



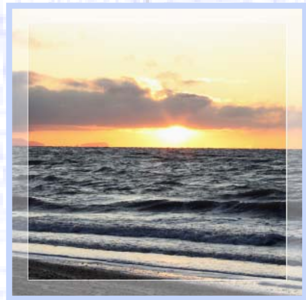


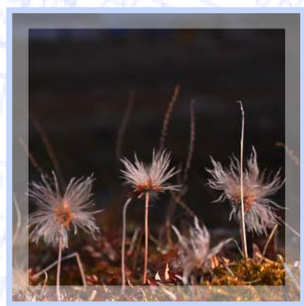


Canadian High Arctic Research Station

Feasibility Study

March 2011

Aboriginal Affairs and Northern Development Canada
Affaires autochtones et Développement du Nord Canada

Canada

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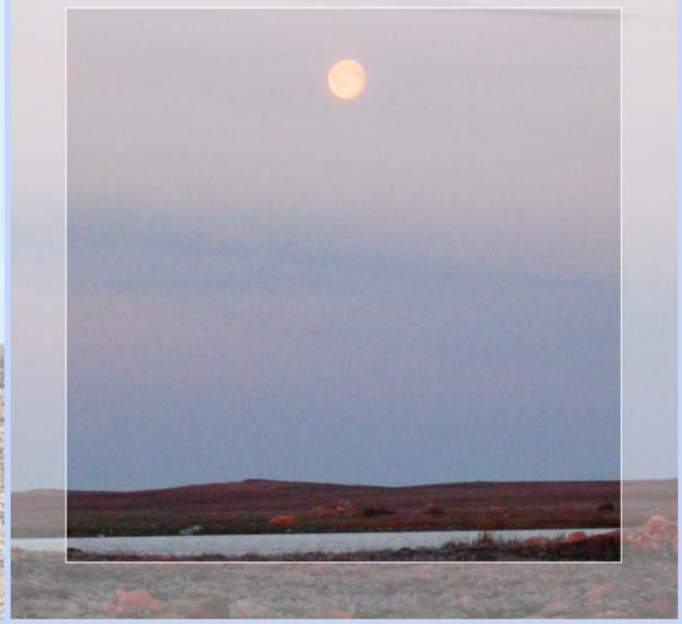
Canada's far North is a fundamental part of Canada – it is part of our heritage, our future and our identity as a country. The North is undergoing rapid changes, from the impacts of climate change to the growth of Northern and Aboriginal governments and institutions. At the same time, domestic and international interest in the Arctic region is rising. This growing interest underscores the importance of Canada to exert effective leadership both at home and abroad in order to promote a prosperous and stable region responsive to Canadian interests and values.

Canada's Northern Strategy

PART I: PROJECT CONTEXT



1. INTRODUCTION

Images of tundra

1.1 Background

1.1.1 Government of Canada Commitments

The project was first announced in 2007 in the Government of Canada's *Speech from the Throne*. Under the rubric of *Strengthening Canada's Sovereignty and Place in the World*, the Government committed to:

> *…build a world-class Arctic research station that will be on the cutting edge of Arctic issues, including environmental science and resource development. This station will be built by Canadians, in Canada's Arctic, and it will be there to serve the world.*

This Station is also a key deliverable under *Canada's Northern Strategy: Our North, Our Heritage, Our Future* and will help to fulfill Canada's vision for the North, in which:

- self-reliant individuals live in healthy, vital communities, manage their own affairs and shape their own destinies;

- the Northern tradition of respect for the land and the environment is paramount and the principles of responsible and sustainable development anchor all decision-making and action;
- strong, responsible, accountable governments work together for a vibrant, prosperous future for all – a place whose people and governments are significant contributing partners to a dynamic, secure Canadian federation; and,
- we patrol and protect our territory through enhanced presence on the land, in the sea and over the skies of the Arctic..

This vision is being achieved by delivering an integrated Northern Strategy based on four equally important and mutually reinforcing priorities:

- Exercising our Arctic Sovereignty;
- Promoting Social and Economic Development;
- Protecting our Environmental Heritage; and,
- Improving and Devolving Northern Governance.

As the lead on the Northern Strategy and the department with the federal mandate for fostering, through scientific investigation and technology, knowledge of the Canadian north and of the means of dealing with conditions related to its further development, Indian and Northern Affairs Canada (INAC) (now known as Aboriginal Affairs and Northern Development Canada (AANDC)) was selected as the head federal department for the Canadian High Arctic Research Station (CHARS) on behalf of the Government.

1.1.2 Needs Assessment for CHARS

The needs assessment was initiated through a Visioning Workshop held May 12-13, 2008, with a wide array of participants from academia, government (federal and territorial), the private sector, and Aboriginal organizations representing a broad range of scientific disciplines, institutional experiences and geographic scope. In preparation for this Workshop, four papers were commissioned to identify Canada's global science advantage in addressing the grand challenges facing the Canadian Arctic. These papers covered several stakeholder perspectives and issues: ArcticNet Network of Centres of Excellence produced a report by a group largely comprised of academics; *Beacons of the North – research Infrastructure in Canada's Arctic and Subarctic* was produced by the Canadian Polar Commission; the Inuit perspective was provided in the paper developed by the Inuit Circumpolar Council of Canada and the Inuit Tapiriit Kanatami; and, a synthesis of the Arctic Science needs scoping papers prepared by federal departments and agencies was undertaken by the University of Alberta.

This Visioning Workshop focused on developing science and technology (S&T) priorities for the Station as well as key approaches and considerations to ensure success in delivering on the priorities. In so doing, they drew from two unique advantages for science in Canada's Arctic: the breadth and diversity of ecosystems that make up

Canada's North; and, Canada's human capital, comprised of the communities and the 110,000 people located in this region.
In their discussions on the potential S&T priorities for CHARS, the participants evaluated the broad spectrum of S&T issues. Additionally, they considered the references in the Speech from the Throne, the Northern Strategy, the priorities for the Government of Canada's program for International Polar Year, the Government of Canada's S&T Strategy and the science plans in the Second International Conference on Arctic Research Planning overview report in order to highlight areas of Canada's strength and opportunities. These issues were distilled into four proposed priorities: sustainable resource development; environmental science and stewardship; climate change; and, healthy and sustainable communities. Technology was identified by participants as having a significant role to play across all four priorities – either in enabling Arctic science in these areas, or in realizing environmental, economic, or social benefit in the North directly through innovation and commercialization. Therefore, technology was considered as a cross-cutting area rather than a priority in itself.

In addition to their convergence on a small number of S&T priorities, the participants voiced strong consensus that the approach to undertaking S&T in Canada's North is inherently as important as the type of science being conducted at the station and integral to the successful delivery of these priorities and the development of the CHARS. Several key themes related to *how* science and technology are done rather than *what* S&T are done emerged from the Workshop:

- Opportunity for integration – the science and technology supported by CHARS should be integrated across disciplines (e.g. natural, physical, health and social sciences); across domains (e.g. marine, space and terrestrial); across modern science, traditional knowledge and local knowledge; across pure and applied science; across data sources; across players (e.g. government, academics, Northerners, international and industry); across scientific process (e.g. modeling, research, dissemination and use, and technology development); across scales.

- The need for coordination – CHARS could serve as an enabler for S&T research activities in the North, generating and sustaining efficiencies and synergies needed for the successful coordination of multidisciplinary science initiatives. Workshop participants acknowledged that, while there may not be sufficient resources to undertake monitoring and science programs in the North analogous to the South, stronger coordination could allow for a development of an integrated Arctic S&T system, making the most effective and efficient use of limited resources by reducing duplication and competition amongst stakeholders.

- Strengthening the use and uptake of science – increased attention to communication and outreach was advocated. It was noted that CHARS could make an important contribution to the successful transfer of Arctic S&T by facilitating communication and outreach by scientists and by directly brokering, translating, and disseminating the S&T conducted at, or with the support of, the Station.

- Leveraging the "people advantage" in the North – throughout the workshop, there was a strong emphasis on the need to leverage the skills and knowledge of Northerners and to engage them in the conduct of Arctic S&T. Through linkages with territorial colleges, communities and local governments, CHARS could provide an important platform of outreach to communities, as well as an opportunity for engagement and the development of a stronger Aboriginal scientific capacity.

Recognizing that science priorities would likely evolve throughout the lifetime of the Station, a number of enabling conditions were highlighted at the workshop that would ensure that the infrastructure, logistics, and location of the station remain responsive to science drivers. It was recommended that these enabling conditions including human resource capacity, funding, governance, and infrastructure should all be addressed to ensure that the vision for CHARS is adequately supported and ultimately achievable. Attention to these would also help foster a dynamic, high-caliber staff and the appropriate facilities and equipment to underpin the roles of the research station and realize the opportunities created.

In particular, human resource capacity would be instrumental in running the station and its associated S&T program. Specialized capacity, needed in many scientific areas, could require specialty training and skills development. Planning to have the contingent of sufficiently trained staff for the launch of CHARS and its successful operations was considered key by participants.

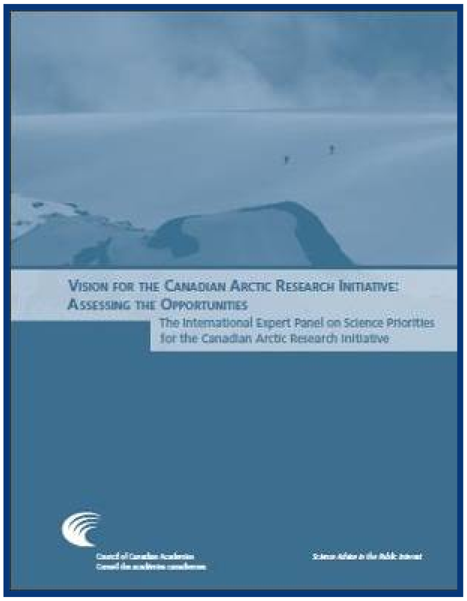
A long-term commitment to sustained funding for science, monitoring and operations was highlighted by participants as a strong signal that Canada aims at achieving world-class status in Arctic science. An inclusive governance structure would also be critical to the success of the Station as the existing, dispersed institutional structures that manage Arctic S&T in Canada was deemed unable to provide the level of integration and coordination needed for this new era of Arctic S&T. The governance structure for CHARS should therefore be able to engage and partner with a multitude of players to ensure the S&T program addresses the challenges faced by the North and Canada.

Following on the Visioning Workshop report on the proposed S&T priorities for the station, AANDC commissioned the Council of Canadian Academies to convene an independent international panel of experts to provide an external perspective on the key findings of the Visioning Workshop report. The panel was tasked with assessing the priorities identified in the Workshop's report and commenting on the extent to which these priorities articulate Canada's global advantages in terms of Arctic science and technology.

In considering the "*what*" of Canada's advantages and potential science priorities, the panel agreed that CHARS must make the most of Canada's two unique advantages with respect to Arctic science: Canada's vast geographical extent – the size and ecological diversity of the Canadian Arctic and Canada's human capital, comprising the knowledge base of its northern inhabitants. Notwithstanding these considerable advantages and potential, the panel drew attention to significant challenges including: the multitude of stakeholders and interests in the North, the high access and maintenance costs faced by Arctic scientists, limited availability of broadband, and the need for the improved access by Northerners to publicly funded research to better inform public policy discussions and to allow constructive collaboration in the setting of community priorities for research. With respect to the four thematic priorities proposed by the Visioning Workshop, the panel suggested expanding the priorities in order to take full advantage of Canada's opportunities, to fully respond to Canada's international obligations with respect to Arctic science and to create a more complete program for CHARS. The panel therefore recommended the addition of "Observation and Monitoring" as an indispensable core activity for building our knowledge base, understanding the environment, exercising stewardship and managing resource development, and of "Technology" as an explicit thematic priority rather than a supporting cross-cutting theme as technologies are crucial components in transforming and monitoring natural landscapes and the built environment.

The panel also considered *how* CHARS could be conceptualized and how the approach taken could capture inherent opportunities for integration, coordination and interdisciplinarity. Building on the Visioning Workshop's report, the panel restated the station's potential to create synergies through integration and coordination of scientific research activities. In addition, the panel emphasized the importance of engaging northern citizens and institutions in a variety of roles, including roles as leaders or co-investigators of their own projects. This type of partnerships would facilitate research directed at improving the lives of northern communities by enabling northerners to participate in assessing research needs and by defining priorities that meet the practical needs of their communities. To maximize CHARS's role as a central hub of Arctic science, it was stated that partnerships should be developed on a national scale, through collaborations among Aboriginal observers, social scientists, natural scientists and engineers, as well as at the international level, in order to build on the results of the International Polar Year and reap the benefits of international scientific collaboration. The panel also considered whether CHARS should have a formal educational role. While the mission of CHARS would likely be focused on scientific research, through engagement and partnerships with Northern communities and stakeholders, CHARS was thought to have an opportunity to support knowledge-sharing mechanisms and to nurture capacity building in Arctic research.

Finally, the panel reflected on the key enabling conditions that are most likely to lead to the long-term success of CHARS. Building on the observations put forward by the Visioning Workshop report, the panel reemphasized that CHARS should maintain sufficient operational and organizational flexibility to respond to shifting priorities, the need for long-term stability and dependability of funding to ensure that long-term research and monitoring can be planned and executed successfully, and the need for easily accessible data-sharing mechanisms. The panel also recommended a governance formula that would ensue that CHARS has the type of leadership that attracts top scientists and under which it would become a “magnet for scientific excellence”.



The panel released their recommendations in their report *Vision for the Canadian Arctic Research Initiative: Assessing the Opportunities.* A copy of this report, which includes the Visioning Workshop report, can be found at the following link: http://www.scienceadvice.ca/documents/(2008-11-05)%20CARI%20Report.pdf

1.1.3 Stakeholder Validation

In summer of 2009, the CHARS Experts and Users Group was struck and formally met 4 times throughout 2009 and 2010. This Group was composed of representatives from the North, Aboriginal organizations, academia, the private sector as well as the federal and territorial governments. Membership can be found in the CHARS Experts and Users Group Terms of reference in Annex A. Members were selected both for their individual expertise and experience and their ability to represent a particular group or sector.

The mandate of this group was to provide guidance and input into a number of the CHARS components including the mandate, activities/services (including the science and technology program) to be offered, infrastructure, governance, and networking. Throughout the feasibility phase, AANDC presented ideas and documentation developed on these topics and solicited feedback from this group. Discussions often affirmed the statements and recommendations received through the activities of the Visioning Workshop and the Council of Canadian Academies, highlighting areas currently lacking and elements that would make CHARS a world-class facility.

While topics were generally discussed in a discrete manner, there was key cross-cutting advice provided, including:

- Strive to make CHARS “the” leading Arctic institute in the world
- Plan for the long-term: 20-30 years
- Complement what exists

- Consider the need for coordination of Canada’s Arctic research that CHARS could fulfill
- Build in flexibility in order to adapt to changing needs
- Facilitate interaction between traditional knowledge and “western science”, and between northerners and researchers
- Provide data management including collection, archiving, data sharing, and knowledge transfer
- Explicit roles for local, regional, national and international levels
- Consider potential for CHARS to be a “one-stop-shop”

1.2 Nunavut Land Claims Agreement

Since CHARS will be located in Nunavut, the Nunavut Land Claims Agreement, also referred to as the Nunavut Final Agreement (or the Agreement) is an additional layer which will need to be considered throughout the planning stages for the Station and once the Station is operational.

In summary, this Agreement:

- was signed on May 25, 1993, in Iqaluit by representatives of the Tungavik Federation of Nunavut (now known as Nunavut Tunngavik Incorporated), the Government of Canada and the Government of the Northwest Territories;
- was ratified by Inuit and the federal government according to the ratification provisions of the Agreement and came into force on July 9, 1993; and,
- involves the largest number of beneficiaries and the largest geographic area of any land claim agreement in Canadian history.

In exchange for the Aboriginal title to their traditional land in the Nunavut Settlement Area (NSA), the Agreement provides Inuit of the NSA with constitutionally protected rights and benefits, including:

- representation with government on joint boards to manage wildlife, conduct environmental assessments and land use planning, and regulate the use of water;
- a share of government royalties from oil, gas and mineral development on Crown lands; and,
- opportunities to participate in economic development in the NSA, including bidding for government contracts, first refusal on sport and commercial development of renewable resources, negotiation of Inuit benefit packages for water development projects in the NSA and territorial parks and conservations areas, as well as on non-renewable resource development wholly or partly on Inuit Owned Lands.

The intent of the Agreement is to encourage self-reliance and to enhance the cultural and social well-being of Inuit while recognizing and respecting traditional values and practices.

The Canadian High Arctic Research Station project will respect the applicable provisions of the Agreement. At the moment, Article 23, Inuit employment with government, Article 24, government contracts, and Article 26, Inuit impact and benefit agreements, have been identified as sections of the Agreement which may impose certain obligations on the building and operation of the Canadian High Arctic Research Station. A summary of these three articles can be found in Annex B.

1.3 Timeline of Activities and Key Engagements

November 2007	Speech from the Throne announces Government of Canada commitment to build a world-class high Arctic research station
May 12-13, 2008	INAC's (now know as AANDC) Visioning Workshop with participation from academia, government (federal and territorial), the private sector, and Aboriginal organizations
November 2008	International Expert Group convened by the Council of Canadian Academies release *Vision for the Canadian Arctic research Initiative: Assessing the Opportunities*
January 27, 2009	Canada's Economic Action Plan commits $2 M for the CHARS feasibility study and $85 M for the Arctic Research Infrastructure Fund (ARIF)
February 13, 2009	Interdepartmental meeting of ADMs to discuss Budget 2009
February 20, 2009	Minister Strahl announces that Cambridge Bay, Resolute Bay and Pond Inlet are the three potential locations for HARS
March 4, 2009	Interdepartmental meeting of ADMs to provide an update on ARIF proposals
March 30-31, 2009	20 ARIF projects announced
May 6, 2009	Interdepartmental meeting of ADMs ▪ Update on ARIF ▪ CHARS feasibility study
May 2009	Experts and Users Group is struck. It's comprised of representatives from the territorial, Aboriginal, academic, private, and federal sectors with a diverse set of expertise and experience, spread over a broad range of research & technical areas.
June 1-5, 2009	The three communities are visited by a joint team from INAC (now know as AANDC) and the Government of Nunavut. In each community there is: ▪ a presentation on CHARS to the mayor and council and follow-up discussion ▪ a tour of the community ▪ a public meeting in the evening to discuss CHARS and the potential emplacement
June 5, 2009	Meeting with Nunavut's Members of the Legislated Assembly on CHARS
June 25, 2009	First meeting of the Experts and Users Group. Discussions focused on: ▪ CHARS objectives ▪ potential mix of functions and programming at CHARS ▪ facilities and infrastructure requirements needed to advance northern-based

	science and technology development ▪ identifying criteria for determining a location for CHARS
September 15-17, 2009	Second visit to Cambridge Bay to update the hamlet officials on the process and to discuss the capacity levels of community infrastructure and services and potential sites for CHARS within the community.
September 21, 2009	Second meeting of the Experts and Users Group. Discussions focused on: ▪ CHARS objectives ▪ Arctic science and technology network(s) ▪ Potential science and technology questions that could focus program funding
October 4-9, 2009	Second visit to Pond Inlet and Resolute Bay to update the hamlet officials on the process and to discuss the capacity levels of community infrastructure and services and potential sites for CHARS within the community.
October 16, 2009	Interdepartmental meeting of ADMs ▪ CHARS update and next steps ▪ Arctic S&T inventory
December 4, 2009	Interdepartmental meeting of ADMs ▪ Update on location ▪ Next steps for CHARS project
February 9-10, 2010	Joint INAC (now know as AANDC) and CPC Network Facility Operators meeting ▪ Best practices and lessons learned ▪ Project updates
February 18-19, 2010	Third meeting of the Experts and Users Group. Discussions focused on: ▪ Location update ▪ Governance for the Station ▪ Monitoring ▪ Education, outreach and training ▪ Infrastructure
March 18, 2010	Interdepartmental meeting of ADMs ▪ Budget 2010 and research Station moving forward ▪ CHARS Feasibility study ▪ ARIF update ▪ ADM Committee mandate ▪ Report on the Antarctic trip
June 16-17, 2010	Fourth meeting of the Experts and Users Group. Discussions focused on: ▪ CHARS Feasibility study ▪ Science and technology program ▪ Infrastructure
August 24, 2010	Prime Minister Harper's announcement of Cambridge Bay as location for CHARS
August 25-27, 2010	Start of consultations and engagement of Cambridge Bay ▪ Overview of CHARS project ▪ Meetings with Hamlet, NIRB, NPC, Health Centre, Arctic College, GN-CGS, Chamber of Commerce, Kitikmeot Housing Corporation, Nunavut Power Corporation, Kitikmeot Heritage Society ▪ Discussion of next steps ▪ Initiated discussions on potential partnership opportunities

September 17, 2010	Interdepartmental meeting of ADMs ▪ CHARS Feasibility study ▪ Next steps
November 25, 2010	Interdepartmental meeting of ADMs ▪ CHARS Feasibility study ▪ Procurement approach
December 3, 2010	Minister Duncan's announcement of mandate for CHARS
December 6, 2010	Fifth meeting of the Experts and Users Group. Discussions focused on: ▪ CHARS Feasibility study
March 21, 2011	Interdepartmental meeting of ADMs ▪ Arctic Science and technology
March 21-24, 2011	Engagement visit of Cambridge Bay ▪ Meetings with Hamlet, NIRB, NPC, Health Centre, Arctic College, GN-CGS, Chamber of Commerce, Kitikmeot Housing Corporation, Nunavut Power Corporation, Kitikmeot Heritage Society, Kitikmeot Economic Development, Royal Bank (Cambridge Bay Branch), GN Housing, Wellness Centre, Community CHARS Steering Committee, Newmont Mining, and Kitikmeot Corporation

2. INSPIRING EXAMPLES

Kamotik on ice

The network of Arctic science and technology facilities across Canada and polar facilities internationally are operated by a variety of owners and many have been in the business for many decades, several for over 50 years. They have survived trend shifts, evolving operating funds and have developed niches that have made them relevant throughout these changing environments. The team developing CHARS has benefitted from visiting many of these facilities and speaking with the staff to better understand the pitfalls and opportunities that CHARS could plan for.

There is a strong recognition that facilities (on land and sea) and networks already exist to support Arctic/Polar research in Canada. The Government of Canada recently strengthened the physical aspect of this network through the Arctic Research Infrastructure Fund ($85 million awarded to 20 different projects at 46 sites). Once CHARS is operational, the intention is for it to serve as an anchor for this network of Arctic research centres in Canada.

Additionally, a wide –range of research facilities operating in other climates have also been visited in order to learn about cross-over issues such as laboratory layouts, general space usage/needs and trends.

Please note that the information in this section was gathered during a fixed period of time and that infrastructure, programs and number of staff at these facilities are constantly evolving to meet changing needs and budget opportunities. Furthermore, many facilities shift and/or increase their programs during their peak periods of research.

2.1 Arctic Research Infrastructure Fund

Canada's Economic Action Plan included the Arctic Research Infrastructure Fund (ARIF). This fund committed up to $85 million from April 2009 to March 2011 to upgrade existing Arctic research facilities. A total of 20 projects at 46 different sites across the North received funding ranging from $500,000 to $11 million. The 46 project sites cover significant geographic area found above the line of discontinuous permafrost.

The projects vary considerably in their scale and complexity. For instance, some projects were limited to upgrading field cabins, others involved completely new research facilities. Access to these sites also varies significantly. Some remote locations are accessible only by chartered aircraft during limited months of the year; others are located within communities with sealift and commercial air service; while a few others are connected by road accessible throughout the year.

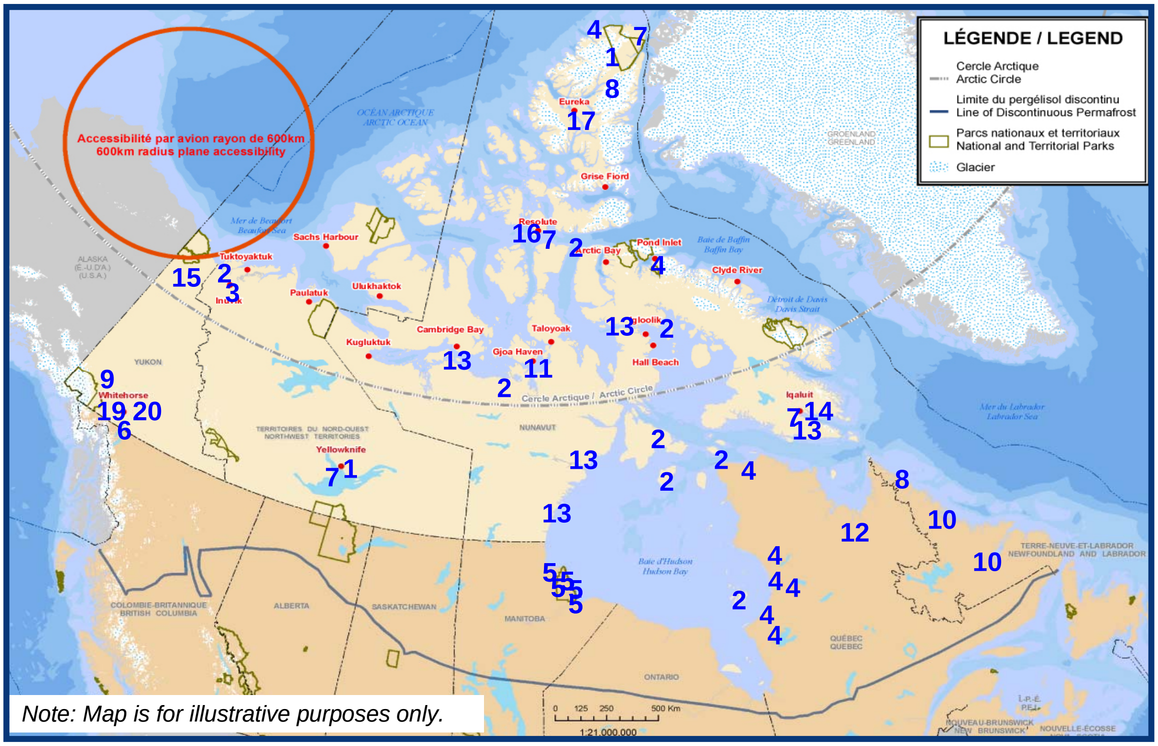

Nunavut Research Vessel


Bird Blind on Coats Island


Nunavik Research Centre


Centre for Northern Studies - Lac à-L'eau Claire

Figure 1: The location of the 46 ARIF project sites.



1. Institute for Circumpolar Heath Research
Project Lead: ICHR, Northwest Territories

2. Arctic Migratory Bird Research Network
Project Lead: Environment Canada

3. Western Arctic Research Centre
Project Lead: Government of Northwest Territories

4. Centre d'études nordiques (CEN) - SAON Network
Project Lead: Université Laval

5. Churchill Northern Studies Centre
Project Lead: Churchill Northern Studies Centre

6. H. S. Bostock Geological Core Library
Project Lead: Yukon Geological Survey

7. Health Canada Radiological Monitoring Network
Project Lead: Health Canada

8. kANGIDLUASUk Base Camp
Project Lead: Nunatsiavut Government

9. Kluane Lake Research Station
Project Lead: Arctic Institute of North America

10. Labrador Institute & Nunatsiavut Research Centre
Project Lead: Government of Newfoundland and Labrador & Nunatsiavut Government

11. M'Clintock Channel Polar Bear Research Cabins
Project Lead: Queen's University

12. Nunavik Research Centre
Project Lead: Makivik Corporation

13. Nunavut Research Institute
Project Lead: Nunavut Arctic College

14. Nunavut Research Vessel
Project Lead: Government of Nunavut

15. Old Crow Research Facility
Project Lead: Vuntut Gwitchin Government

16. Polar Continental Shelf Program
Project Lead: Natural Resources Canada

17. Polar Environment Atmospheric Research Lab
Project Lead: Dalhousie University

18. Quttinirpaaq National Park
Project Lead: Parks Canada

19. Yukon College
Project Lead: Yukon College

20. Yukon Forestry
Project Lead: Government of Yukon

There are a number of noteworthy elements from the ARIF program which will inform the development of CHARS. A summary of these key elements can be found in the following subsections below.

2.1.1 Transportation

From the outset of planning for ARIF, it was acknowledged that one of the largest obstacles for projects was the two-year timeline imposed by the *Canadian Economic Action Plan* funding framework and the related logistics and timing of transportation of materials to project sites. Many of the projects under ARIF were reliant on sealifts with only one or two ships arriving in the site area per year depending on location. Other more remote projects relied in part, or exclusively, on chartered aircraft to get materials to their sites. A few of the projects were able to deliver materials via train or road. In all cases, considerable advanced planning was required to determine how much physical space and weight allocation was required for shipping materials and then to secure that space.

The cost of transporting materials also played a significant role in budget planning. For instance, one project, accessible only by chartered aircraft, estimated the cost of delivering materials to be approximately $10,000 a day for 8-10 day stretches of work on site. Another project had calculated their materials would fit on one barge and the budget was developed accordingly. Final changes to the design, however, required last minute ordering of additional materials which resulted in the need for a second barge, significantly increasing costs. Overall, ARIF projects have reported that significant lead times as well as significant financial contingencies were integral to mitigating problems encountered with transportation.

CHARS considerations

- Locating within the community of Cambridge Bay means regular sealifts could be used. This community is serviced by more than one sealift per year which will further alleviate the management of transportation issues.
- The project will need to be carefully planned in order to account for schedules and availability of shipping and to complete the project by the target year of 2017.
- Budget will need to include significant contingencies for transportation of materials.

2.1.2 Working with Communities

Several ARIF projects reported that the success of their projects was due in part to the support received from the communities that are either hosting their facility or nearby. Project managers consistently highlighted the importance of securing community support and 'buy-in' for infrastructure that will result in research activities in and around communities. Involvement of the community took various forms including: consultations throughout the entire lifespan of the project; partnering directly with communities in order to carry out construction work; and, in some cases, contracting directly to community organizations. Many of these facilities also worked concurrently to strengthen research collaborations with local communities as well as with Aboriginal governments and organizations. To achieve this, one project created a joint-management board for the facility's operations between local First Nations and the territorial government as well as the territorial college.

Local knowledge of communities has meant that projects have benefited from advice on possible alternative plans when problems with delivery, design and construction were encountered. In one such case, a community accepted to take on the construction itself when the project's tender bids far exceeded the budgetary capacity and put the project at risk. More generally, local communities were also an excellent resource in assisting to find appropriate labour, contractors, and assistance in transporting goods from communities to remote field sites.

CHARS considerations:

- A key goal for CHARS is to be able to successfully integrate into Cambridge Bay both through its infrastructure as well as its activities. Consultations from start of design would facilitate successful integration.
- As the project is currently being managed out of the National Capital Area, having a close relationship with the community will bridge some of the issues that may arise throughout the project.
- AANDC will be exploring possibilities to have a community resident foster the integration and ongoing consultations.

2.1.3 Weather Variability

Infrastructure projects undertaken in the North have long had to deal with challenges unique to the often harsh climate, typically shorter building seasons and increased difficulties accessing sites. ARIF projects reported that weather variability (e.g. early or late ice breakup, early or delayed soil thaw) was an additional challenge to those already imposed by a Northern climate. In some cases, the weather variability worked in favour, while in others it worked against ARIF projects. Early ice break-up and ground thaw has meant that work on site was able to begin ahead of schedule. Conversely, late ice break-up in a number of regions posed delays in shipping materials to sites, in some cases by up to a month.

Unpredictable weather activities have been particularly risky in the high Arctic where, for example, one project had booked three days to transport materials to site via helicopter and the slightest variation in weather patterns could have jeopardized the entire project. In general, ARIF projects were able to mitigate the risks posed by negative weather variability through careful planning, being prepared for alternative arrangements, as well as incorporating healthy contingencies into their budgets.

CHARS considerations

- Contingencies in scheduling will need to be integrated into the planning in order to meet the target of completion by 2017
- Contingencies in the budget will need to be incorporated as part of the preparation for possible alternative arrangements.

2.1.4 Contracting

The vast majority of ARIF projects used competitive processes for selecting the design and construction firms. During the tendering process, many projects received bids which greatly exceeded the projections. It is important to recognize that while this issue has been a major lesson learned for ARIF projects, the projects are taking place in an artificially saturated market due to the volume of stimulus-related infrastructure projects in the North, and in Canada in general.

In addition to this operational context, a number of ARIF projects highlighted a variety of challenges with contracting processes including lack of experience and increased risk to project elements. In order to develop a bid, companies generally take into consideration issues such as cost of material, operating environment (e.g. labour and equipment availability at or near site) and degree of risk associated with the project's criteria. Many of these played a role in the contracting issues experiences by ARIF projects and the following reasons summarize common complaints:

- Limited pool of contractors with experience in North and/or remote regions thereby inflating the risk factor and costs/bids.

- The inclusion of new technologies or infrastructure components without previous application in the North inflating the risk factor.
- A few projects reported the challenge of responding to overly complex designs for facilities and/or specs for systems that could be expensive to maintain, repair or replace, ultimately leading to high construction bids.
- The two-year deadline to complete projects has been seen as challenging for contractors inflating the risk factor.

CHARS considerations

- All of these elements are applicable to the CHARS.
- The key mitigation strategy will be to ensure that the project team has the appropriate experience of a project of this scale and complexity as well as knowledge of the community and operating conditions of the North.
- As part of the competition to obtain the design and construction firms for CHARS, experience with northern projects, sustainable methodologies and materials, and experience with projects of this scale and complexity will be part of the evaluation criteria.
- Experience in northern projects shows the optimal number of bids is 4-6. For each fewer bid than this, bids could be expected to be substantially higher.

2.1.5 Project Management

The delivery of ARIF projects has largely rested on having engaged clients. Projects that have been the most successful in delivering on time and within the parameters of their original objectives have been those where the client has been significantly involved with project management and contractors. These projects have reported that this diligence on their part has been successful as contractors have a clear idea as to what the client's specific needs are. In circumstances where, for example, the projects have run into delays, overruns or other unforeseeable obstacles, the engaged client was able to work closely with contractors to find innovative solutions that kept the project on track as planned. Alternatively, where the client tended to leave the project delivery in the hands of contractors, projects needed to compromise the original vision for the project when faced with similar issues.

Beyond overcoming challenges, projects with engaged clients have sometimes been able to achieve greater efficiencies in their overall delivery or have accelerated their project schedule as the client was highly aware of the details of the project planning and delivery.

CHARS considerations

- AANDC, as the project lead, has been actively engaged in the process to date and will need to plan the subsequent project phases with the same level of engagement.
- As CHARS will be used by a number of stakeholders, the engagement of these additional "clients" will need to continue throughout the project so that the facility is designed and constructed to best meet needs.

2.1.6 Sustainable and Green Technologies

A number of ARIF projects are working to incorporate sustainable building approaches, green technologies and alternative energy sources into their project designs. A number of these projects are required by territorial or provincial policies to ensure that their facility meets a LEED® Silver standard or better. Beyond meeting legislative requirements, ARIF projects have expressed a genuine interest in incorporating these sustainable/green technologies into their design for a number of reasons including lowering ongoing operations and maintenance costs, achieving a more positive environmental footprint, and, in a number of cases, to serve as pilot projects to research the applicability and efficacy of these technologies in northern communities. A number of projects found it extremely beneficial to undergo an evaluation of their designs to determine efforts that could be undertaken to 'green' the infrastructure including payback schedules. In many cases, these payback schedules were used by the client to determine which elements would make the most sense to their project – weighing the upfront costs versus the time it would take to realize savings. As with the scale and scope of the projects themselves, the scale and scope of these sustainability initiatives vary significantly. Some of the many examples of initiatives that are being undertaken at various ARIF project sites include but are not limited to the following:

- High efficiency features: furnaces; boilers; stoves; and, water heaters
- Water efficient fixtures: low flow toilets and shower heads; push showers
- Alternative energy sources: photovoltaic systems; wind power generating systems (including portable wind turbines)
- Green products: low volatile organic compound paints and coatings; systems free of HCFC's; waterless urinals; Fibreglass Z-Girts; fibreglass window frames; insulated windows; solar low-e argon windows (including the piloting of the Northern developed quad pane windows at one site as a demonstration project); and, structural insulated panels to reduce on site waste and shipping
- Efficient ventilation: Variable air flow systems; low flow fume hoods
- Recycling: grey water recycling system; recycled material (e.g. metal sidings, carpets)
- Sustainable waste disposal: EcoNomad self-contained potable and wastewater treatment units; high-temperature incinerators at remote sites for waste disposal; composting toilets; on-site waste treatment
- Whole building control systems: Building Automation System

In most cases, the outcome of these technologies is unknown as operations have not yet begun and any efficiencies and lifespan issues will only be known in the years to come.

CHARS considerations

- Revisiting these projects to determine the successes and lessons learned over time will inform options to consider in the design and construction of CHARS.
- Sustainable options for the North are becoming more affordable, available and easy to use.
- Many of the traditional tools used to assess sustainable green building practices such as the Leadership in Energy and Environmental Design (LEED) currently are not geared to reflect the Northern/Arctic realities.
- There is an incredible opportunity to develop, test and incorporate new and emerging technologies. CHARS could incorporate these types of technologies in its building and operations.

2.1.7 Availability of Local Labour

For some ARIF projects, particularly those in more remote locations, the availability of labour was a challenge. The construction season in the North overlaps with periods when many people in northern communities are spending great lengths of time outside of the community for activities such as seasonal work and traditional activities, decreasing the availability of local labour. Of note is the saturation of the construction market during this program mentioned previously. Some ARIF projects noted that given the overall populations in many Northern communities the presence of even one other infrastructure project concurrently taking place depleted available local labour. ARIF recipients reported that advance planning as well as solid working relationships with local communities were key to mitigating challenges associated with the availability of labour. Advanced planning allowed projects to provide early notice to relevant community contacts of forthcoming labour needs.

CHARS considerations

- Labour availability may be an issue for CHARS and the ARIF lesson learned of planning and working closely with the community should be heeded.
- A mitigation option could be to phase the construction of the facility to alleviate the need for external labourers.

2.1.8 Ability to Partner and Network

During the delivery of ARIF, a number of projects were able to partner with other stakeholders (including other projects) in order to achieve efficiencies or to overcome challenges. In most cases, these partnerships were neither anticipated nor planned but became critical to the success of the projects. One such circumstance relates to the sharing of chartered transportation and costs to move materials to multiple sites. Many recipients who opted for this worked with the Polar Continental Shelf Program to coordinate the transportation of people to complete site visits or materials. Similarly, one project was able to work with the Canadian Rangers in order to deliver its materials to a number of extremely remote sites.

As mentioned in the section on *Working with Communities*, partnerships with local communities have also helped several projects to implement a more effective delivery of ARIF projects. Networking between ARIF recipients has also proved highly beneficial. In many cases, these recipients are undertaking infrastructure projects for the first time and the value of discussing issues and sharing project information amongst projects has aided in the successful delivery as well as the quality of the project. Capitalizing on this need, the Canadian Polar Commission and AANDC created the Network of Northern Station Operators. Most of the ARIF station managers are members of this newly formed network and will continue to share information beyond the 2-year ARIF program timeline.

CHARS considerations

- The overall experience that is being gained by the station operators, project managers, design and construction firms through ARIF will provide valuable resources for the CHARS project team to tap into as the project moves forward.
- Participation in the operators network will help to connect CHARS into the existing circle of research facilities in Canada's North and facilitate coordination of activities once it is operational.

2.1.9 Ability to Complete Projects under a Tight Timeline

Overall, ARIF has affirmed that delivering on infrastructure projects in Canada's North has particular challenges not found in southern Canada. Long lead times are required to plan for shipping and delivery of materials and to secure contractors in a competitive and limited pool of experts where construction seasons are short. Compounded with the large number of construction projects happening across Canada, the limited experience of station operators in managing these projects, and the two-year timeline, there were a number of obstacles for ARIF recipients to overcome. Despite all of these challenges, all ARIF recipients finished their projects on time and, with few modifications, as per their original proposal.

AANDC has noted the dedication of the recipients in overcoming these challenges and their drive to be successful. Furthermore, most ARIF recipients belong to new networks and have new or stronger relationships with their hosting communities in addition to the new facilities to operate out of.

CHARS considerations

- With the right planning and dedication of staff, the project can successfully achieve all of its goals within the desired time frame.

2.2 Advice about Polar Facilities

Key advice from visits to polar facilities (both Arctic and Antarctic) covered a number of areas that should be considered throughout the project from design, construction and operations. For instance, the need to be flexible was reiterated repeatedly. In particular, it was advised that flexibility be built into the design as the science and technology would evolve and the facility should be able to evolve alongside. Also, having a flexible governance structure was recommended to maximize partnership opportunities.

The need to develop and maintain an in-house research program was considered critical. This was explained to be the primordial driver for the station's design and governance and essential for achieving the "world-class" status. It was also advised that the program should be multi-disciplinary to optimize the advantages of different research types including terrestrial, marine, air and space sciences. For the design of the program, integration of research outcomes should be considered at the front-end. In relation to the data collection, the importance of continuous and sustained data sets should not be underestimated. Continuous and sustained data delivery through reliable telecommunications that links both national and international researchers is paramount for modern Arctic S&T.

In relation to the program and ongoing operations of the facility, the department was cautioned that successful research facilities have long-term outlooks with budgets that are planned accordingly.

Another key area of advice was connected to leveraging Canada's advantages. For example, most international polar stations operate in isolated environments; Canada's advantage is in the number of populated communities that dot the North. Canada's Arctic also provides significant environmental and ecosystem diversity. Many polar sciences take place in the field and so geographic access is a significant programming component that needs to be considered. One aspect of this will be the connection between CHARS and the other research facilities found across Canada's North.

In defining "world-class", AANDC received consistent advice from international benchmarking, consultations, and site visits; the May 2008 visioning workshop that brought together a broad range of players in Arctic S&T in Canada; bilateral stakeholder engagement; the International Expert Panel chaired by the Council of Canadian Academies; as well as reviews of select research centres and institutes in Canada and abroad. All advised that "world-class" would require cutting-edge infrastructure that:

- anchors a distributed network to harness Canada's unique geographic advantage;
- is designed for modularity;
- minimizes its environmental footprint; and,
- operates year-round.

All advised that "world-class" also requires a cutting-edge science and technology program at the station that:

- defines Canada's niche to address complex, globally significant issues;
- fosters integration across disciplines, sectors, and nations;
- links monitoring, research, modelling, and application;
- builds on Canada's leadership in linking northern residents, traditional knowledge, and world-class scientists to produce both excellent and relevant S&T;
- enables access to, and application of, Arctic data and knowledge for decision making and commercialization; and,
- is funded over long term so the best scientists and engineers commit to polar science and technology in Canada.

In general, the facilities, research, staging and logistics vary greatly across polar research facilities. Stakeholders consulted were clear that there is no one best model to follow and that Canada will need to assess its particular needs and opportunities, and find the balance between these components for CHARS. It was also felt that achieving "world-class" status for Canada would require new infrastructure and a new approach to S&T in Canada's North.

2.3 Polar Research Facilities

The following table provides an overview of key characteristics of polar research facilities. The facilities range in size, program scope and services available. The range of types of staff running each of these facilities points to the business activities that are conducted there. While some are heavily focused on providing logistics to visiting researchers, others run research programs and/or outreach activities and some undertake a mix of all of these activities.

Table 1: Examples of characteristics from polar research facilities

Facility	Total Size/Foot Print	Spaces	Equipment	Organizational Structure
Churchill Northern Studies Centre **Churchill, Manitoba** **Non-profit**	2020 m^2 Expanding to 4607 m^2 through ARIF; new spaces denoted with *	**Labs:** Two dry labs; new wet and dry labs* **Accommodation*:** 84 guests **Meeting Areas*:** lounge classrooms; seminar rooms; fitness centre	**Laboratory:** some laboratory equipment available **Logistics:** snowmobiles; large trucks; buses; transport vans; radio support	Current staff of ~17 in areas including admin, science, logistics, tech support and services
Western Arctic Research Centre **Inuvik, Northwest Territories** **Operated by** Aurora College	~1,200 m^2 Expanding through ARIF to 1323 m^2	**Labs.:** 1 wet lab and 3 dry labs; 3 warehouses; 1 fuel storage building **Accommodation:** four-plex–each unit sleeping up to 6 for a total of 24 **Meeting Areas:** Meeting room; research library	**Laboratory:** microscope; balance; fume hood; drying oven; computers; printers; Horiba field water quality meter **Logistics:** satellite & cell phone; projector; land & marine vehicles; rifles/shotguns; generators	Current staff of ~12 in areas including admin, outreach, science, logistics, tech support and Services
Nunavut Research Institute **Iqaluit, Nunavut** **Owned by** Nunavut Arctic College	260 m^2 Expanding to 928 m^2 under ARIF; new spaces denoted with *	**Laboratory:** 2 dry labs; a water quality lab; four modern laboratories*; chemical storage; cold storage **Accommodation:** Available at College **Meeting Areas:** Meeting room; 15 offices*; classrooms*; conference rooms*; computer rooms*; library	**Laboratory:** basic lab equipment; benches; tables; glassware; balances **Logistics:** land vehicles; tents; sleeping bags; radios; survival suits; recording & AV equipment	Current staff of ~8 in areas including admin, outreach, science and tech support
Polar Continental Shelf Program **Resolute Bay, Nunavut** **Owned by** Natural Resour-ces Canada	5004 m^2 Expanding to 7468 m^2 under ARIF; new spaces denoted with *	**Laboratory:** 6 dry labs; new laboratory facility **Accommodation:** 50 persons - each room has two beds; 35 new beds* **Meeting Areas:** 4 reading rooms; recreation area; library; new lounge/meeting areas*	**Laboratory:** computers; printers; microscope; balance; drying oven; fixed scientific equipment - fume hoods; large cooler; specialized freezer* **Logistics:** land, air, marine vehicles; snow machines; tents & camping equipment; mobile camps*	Current staff of ~15 in areas including admin, logistics, tech support and services

Facility	Total Size/Foot Print	Spaces	Equipment	Organizational Structure
Taiga Environmental Laboratory Facility **Yellowknife, Northwest Territories** **Owned and operated by** Aboriginal Affairs and Northern Development Canada	1,612.7 m²	**Laboratory:** 2 labs; sample reception room; support work and analysis stations; in-lab storage **Accommodation:** Off-site **Meeting Spaces: l**unch and meeting rooms	**Laboratory:** Basic measurement equipment; sample containers; fume hoods; pumps; emergency equipment **Logistics:** Only space and basic equipment provided	Staff of ~14 in areas including admin and science
McMurdo **Hut Point Peninsula, Ross Island, Antarctica** **Run by** the US Antarctic Program; The National Science Foundation (NSF) and Antarctic Support Associates (ASA) also present	1.5 km^2 estimated for total site Over 100 permanent structures	**Laboratory:** Crary Lab – 5 pods to make 4,320 m^2 of working area; biology; earth sciences & atmospheric sciences; aquarium; electronics workshop; darkroom; Radarsat control room; Mount Erebus seismic observatory; cosmic ray monitoring lab arrival heights lab **Accommodation:** multiple dormitories for short-term and long-term residents **Meeting Areas:** meeting rooms; conference area; library; recreational buildings	**Laboratory:** Faraday cage; freezers for processing ice cores and other frozen specimen; penetrations in the roof to accommodate other instruments **Logistical:** land, air and marine vehicles; survival & camping equipment; generator sets; gas-powered ice augers; rock drills; chain saws; portable dive compressors; 12V batteries & battery chargers	Unavailable
Rothera **Adelaide Island, Antarctica** **Primary Funder:** National Environment Research Council (NERC) through British Antarctic Survey (BAS)	7680 m^2 12 main structures (living quarters 2080 m^2; workshops 3740 m^2; science /lab space – 1860 m^2)	**Laboratory:** 3 dry labs; 1 wet lab; storage; dive facility; aquarium and microscope room **Accommodation:** bedrooms for two or four people available with communal bathrooms; Summer – 130; winter - 25 **Meeting Areas:** library; recreational facilities; computer rooms; dining	**Laboratory:** large selection of basic laboratory equipment; medium frequency radar & SKiYMET meteor radar; low power magnetometer **Logistics:** land, air and water transportation; survival gear; camping and climbing equipment	Current staff of ~82 in areas including admin, science, logistics, tech support and services

Facility	Total Size/Foot Print	Spaces	Equipment	Organizational Structure
Abisko Scientific Research Station **Abisko, Sweden** **Owned by** Royal Swedish Academy of Sciences	1000 m^2 37 workrooms & laboratories	**Laboratory:** 3 Labs (two laboratories intended mainly for teaching); microscopy; cold room; growth room; dark room; drawing room; computer room; greenhouse; meteorological observatory **Accommodation:** 28 rooms with 2 beds; 6 rooms with 4 beds; & two family apartments **Meeting Areas:** library; recreation areas; lecture theatres; lounge	**Laboratory:** balances; drying ovens; refrigerator; scales; ventilation hoods; basic chemicals and instruments; specialized equipment for eco-physiological & meteorological research **Logistics:** Various measurement, specimen collection and survival field equipment; land and marine vehicles.	Current staff of ~9 in areas including admin, science and services
Cold Climate Housing Research Centre **Fairbanks, Alaska** **Owned by** Private, non-profit	1394 m^2	**Laboratory**: 2 Research Labs (designed as large test bays) with connecting office and classroom space; cold chambers; mobile research lab **Accommodation: o**ffsite; on campus; or in Fairbanks **Meeting Areas: c**lassroom; library; modular office space; meeting; and demonstration space	**Laboratory:** Basic workshop tools/hardware; strength testing equipment **Logistics:** Projection Equipment	Current staff of ~25 in areas including admin, outreach and science
Ny-Ålesund **Spitsbergen, Svalbard archipelago** **Owned by** Kings Bay (10 Countries have research stations established here)	60 buildings including town, research stations and historical buildings	**Laboratory: e**ach station has labs specific to research – dry; semi-dry; frozen; wet; marine; chemical; exotoxicology; optical calibration labs; radiation observatory; observation and instrument platforms; and a meteorological station **Accommodations:** Max. 200, hotel on site **Meeting Areas:** some stations have small meeting rooms for logistics	**Laboratory:** Basic lab equipment available at most stations; particular stations house - basic equipment for physiology; UV/VIS spectrometers; radiometers; heating equipment **Logistics:** harbour facility and air link to Longyearbyen; telecommunications; boats; snow-scooters; field and security equipment	Current staff of ~24 in areas including admin, science, tech support and services

2.4 Post Occupancy Assessments of Research Facilities

Visiting and researching other facilities allowed AANDC to have a rounded understanding of issues that research facilities deal with, from design to operations, regardless of the location of the facility. By integrating the best practices and mitigating typical issues related to research facilities wherever possible, it is hoped that CHARS will be better placed to meet its challenges as they arise.

In the article *Where Things Went Wrong*, seven main causes of project delivery system problems were identified through retro-commissioning. These causes, which are described below, led the facilities to become underperforming, unable to meet user needs (leading to reduced satisfaction and productivity) and to waste resources.

- Designers and users did not communicate the "why" of the basis of the design – the designers indicated what facility conditions needed to be achieved, but the reasoning involved in reaching those conditions was not documented. During the development of requirements and the design team's basis of design documentation, all parties must be explicit about facility requirements and why those requirements are necessary to avoid misinterpretation, misunderstanding and forgetting as the project advances.
- There was a lack of detail in the design documents - designers knew conceptually how they wanted building systems to operate but did not provide the detailed operational sequences such as what each component should do and when. Detailed sequences need to be developed and provided as part of the construction documents to avoid having the contractor fill in blanks based on their previous experience, lowest cost or personal preference.
- Value engineering decisions were not made by the right people or for the right reasons – decision makers do not adequately understand the consequences of the value engineering decisions. All decision makers need to be fully aware of, and agree to, the impacts (e.g. cost reductions, performance reductions) that these decisions will have on their requirements.
- Systems were never sufficiently tested to ensure proper operation – testing is primarily focused on installation and not on functional performance testing developed for the specific operations of the project.
- Testing, adjusting and balancing (TAB) were neither properly performed nor verified – TAB testing is limited to spot checks and a review of the report instead of actual verification of airflow and hydronic flow quantity needs on all critical systems and components.
- Facility users were not trained on the building systems' operations and limitations – the operations and maintenance staff was not sufficiently trained, did not have hands-on experience operating the systems and/or do not know the "why" of that operation.

Source: Prendergast, P., Whorton, J.A. (2007) *Where Things Went Wrong* (presentation), Labs for the 21st Century, October 4.

3. LOCATION AND SITING

One of the remaining Hudson's Bay trading cabins in Cambridge Bay.

3.1 Context

The determination of the location for the Station was done through a two-step process. The first step consisted of establishing a set of criteria around the conditions that the location should be able to support. These were based on Government of Canada directives through the *Speech From the Throne* as well as lessons learned from other polar research facilities and needs expressed by stakeholders. These included:

- Being in the High Arctic – the 2007 Speech from the Throne
- Being on the Northwest Passage – Government of Canada's interest in a strong presence
- Being located within a community – lessons learned from isolated research facilities
- Transportation access – need identified by stakeholders
- Science and technology potential – need identified by stakeholders

Based on these criteria, a preliminary assessment of communities in the High Arctic was conducted and in February 2009, Minister Strahl announced that the Canadian High Arctic Research Station would be located in Cambridge Bay, Resolute Bay or Pond Inlet, all located within Nunavut.

Following the announcement, AANDC established a process for ensuring that key stakeholders were involved in the project and were kept informed of the progress through existing processes where possible and through new ones when necessary. Work on the location of the Station involved information gathering from, and the principal engagement of: the three candidate communities; a multi-stakeholder Experts and Users Group; Government of Canada departments and agencies; and, bilateral discussions with other interested stakeholders.

Over the course of the summer in 2009, INAC (now know as AANDC) began work with the three communities and undertook two visits to each location. These three communities were found to be able to support and respond to the diverse needs identified for CHARS in different ways. Each exhibited a set of strengths based on user demands (northerners, private sector, government, academic, etc.), available resources (both programming and infrastructure), and research interests (natural, health and social sciences.). An analysis was conducted on each of the communities in order to ascertain and highlight the strengths that could be tapped into as well as the weaknesses that would need to be considered.

In particular, this analysis focused on protected areas, transportation of goods and passengers, demographics, climate, research undertaken around the communities, research potential that the communities could support, community infrastructure and organizations that could be linked into, and, available building sites.

3.2 Overview of Selected Community

On August 24, 2010, Prime Minister Harper announced that Cambridge Bay would be the hosting community for CHARS. (See Annex C for the official News Release.)

Community of Cambridge Bay with Mount Pelly in the background

3.2.1 Geographic Areas of Interest

Figure 2: Satellite image of Cambridge Bay and its location within Canada

Cambridge Bay is located on southeast coast of Victoria Island across from the Canadian mainland. The island is split with the left side belonging to the Northwest Territories and the right side (including Cambridge Bay) belonging to Nunavut.

Approximately 15 kilometres east of the community is Ovayok Territorial Park. The Government of Nunavut states that archaeological sites, trout and char fishing and several species of migratory birds can be found there. On route to the Park from the community, there are additional archaeological sites including sunken ships in the Bay and tent rings, and a picnic area.

Across the Queen Maud Gulf (approximately 60km) is the Queen Maud Gulf Migratory Bird Sanctuary. This is the world’s second largest Ramsar site (i.e. a site of international wetland importance) – designated in 1982 because it contains the largest variety of geese of any nesting area in North America. To the west of this area is significant mineral exploration activity including gold, uranium and diamonds.

Remains of the Baymaud in Cambridge Bay, the vessel used by Amundsen on his second Arctic voyage.

3.2.2 Infrastructure, Services and Potential Partnerships

Community Integration

Locating the Station within a community means that the facility will be able to connect to existing municipal infrastructure. It also provides the additional benefit of being able to integrate within the community by both exploring prospects for partnerships (e.g. programming and/or potentially co-locating some of the Station's components with existing Cambridge Bay facilities) and by planning the overall layout so that researchers, the community's residents and the potential local partners can all take advantage of the new facilities. Throughout the design phase, AANDC will be scoping out possibilities for partnerships and other opportunities for community integration.

General Cambridge Bay Attributes and Organizations

Cambridge Bay is the transportation and administrative centre for the Kitikmeot region of Nunavut. It therefore offers extended benefits such as the multiservice regional health centre. It has jet service and currently has three sea lift services offered yearly.

On the regional economic development side, Cambridge Bay is near significant mining activity. Additionally, it hosts the Kitikmeot Trade Show each year. This is an event where professionals from business, industry, government sectors, regulatory agencies, and Inuit organizations exchange of information to support networking, and to provide opportunities to expand inter-region trade and economic activity.

The Nunavut Arctic College and the Nunavut Research Institute also offer many possibilities for partnerships and sharing of facilities as they have a number of similar programming and infrastructure needs to those of CHARS. The Nunavut Research Institute's role within Nunavut Arctic College is to provide advisory services, act as a development partner in science and technology education and provide scientific licenses according to the Nunavut Scientist Act. The mission of the Institute is to provide leadership in developing, facilitating and promoting traditional knowledge, science, and research as a resource for the well-being of people in Nunavut. In Cambridge Bay, the

College is currently planning to expand its campus with additional accommodation and classrooms. The Nunavut Research Institute has recently installed a laboratory in Cambridge Bay as part of its expansion under the Arctic Research Infrastructure Fund.

There are other key territorial organizations with offices in Cambridge Bay which could offer innovative partnership opportunities and foster synergy of activities. The Nunavut Planning Commission, for instance, has the mandate to prepare and implement land use plans that guide and direct resource use and development under the Nunavut Land Claims Agreement. The Nunavut Tunngavik Incorporated's Land and Resources Department is also located here. It works to promote the development of Nunavut's natural resources, and to promote responsible and sustainable use of the land. The Nunavut Impact Review Board, established through the Nunavut Land Claim Agreement, screens project proposals to determine whether they have significant impact potential on the Nunavut Settlement Area. In doing so, the Board conducts environmental and socio-economic assessments using both Qaujimajatuqangit (Traditional Inuit Knowledge) and scientific methods in order to gauge and monitor the potential impacts of project proposals. The Kitikmeot Inuit Association is also located here. Under the Nunavut Land Claims Agreement, the Kitikmeot Inuit Association works to defend, preserve and promote social, cultural and economic benefits to Inuit of the Kitikmeot Region. In the neighbouring community of Gjoa Haven, the Nunavut Water Board, also established through the Nunavut Land Claims Agreement, has responsibilities and powers over the use, management and regulation of inland water in Nunavut. Its objectives are to provide for the conservation and utilization of waters in Nunavut – except in national parks – in a manner that will provide the optimum benefits for the residents of Nunavut in particular and Canadians in general.

There are a number of businesses in areas such as construction, outfitting, logistics and natural resource harvesting which could be tapped into or partnered with throughout the phases of CHARS. On the construction side, there is a ready labour pool and heavy equipment on site to accomplish most projects. The proximity to Yellowknife offers an additional source of support.

Labs, Research and Technical Spaces

The Kitikmeot Foods Ltd. currently extracts biological samples for the Department of Fisheries and Oceans and packages them on site.

The community has e-health equipment and capacity at the regional health centre. The health centre also has several interview/examination rooms, some portable equipment and a testing lab. Additionally, the centre is capable of proper disposal of chemicals and other toxic materials.

Traditional knowledge spaces can be found at the Kitikmeot Heritage Society, which is co-located with the library and in the same complex as the high school and gym. It collects and archives the oral histories of the Elders, preserves archaeological sites, promotes and preserves Inuktitut and Inuinnaqtun, develops educational and learning materials, and promotes and celebrates cultures and traditions. The Society's staff has previously undertaken licensed research projects and has partnered with other research projects. The facility has many display cases with artefacts and has a humidity controlled space. There are seating areas throughout the display and library areas. The library, main hallway of the complex and the gym could all provide additional seating space depending on the size of group to accommodate.

The Arctic Coast Visitor's Centre has a small exhibit display area with artefacts and historical information.

The community has various machine and workshop spaces that could facilitate technology development. The Kitikmeot Trade Show occurring in February would allow technology to be showcased. This event takes place in the community's gym.

Cambridge Bay currently has high speed internet and cell phone coverage. There are internet stations at the May Hakongak Library available for public use.

Living

Accommodation is available for short and long-term stays with standard hotel rooms, and suites with kitchenettes. A total of 66 rooms for a maximum of 104 guests are currently available. Dining and laundry services are available through the hotels.

The Arctic College also offers accommodation which can be rented when not in use by the students. Typically, the rooms are available during the summer months. They currently have a total of 20 units and plan to add an additional 20 units.

Recreation

The indoor recreation spaces include: a weight room, curling rink and arena currently located in the same complex as the Hamlet offices; and, a bouldering wall. Building of a new arena has recently been approved.

During the summer months the indoor swimming pool is operational. As well, the outdoor basketball court, the baseball diamond and the Many Pebbles Golf Course are accessible.

The picnic area on route to the Ovayok Territorial Park, near Cambridge Bay.

Education and Outreach
Rooms for training, teaching or hosting larger groups are available in several locations. There are various sized meeting rooms at the Arctic Islands Lodge (hotel), the largest able to accommodate up to 100 people. The community centre has a large space with sound system, projection equipment and kitchen area in place. Some of the organizations located here such as the Nunavut Planning Commission have boardrooms that could also be available.

General Offices
The hamlet has recently had the plans for a new building approved. When the current offices are vacated, it may be possible to lease the space. It contains several closed offices, central reception area and boardroom.

Warehouses and Workshops
The community has a docking area (20 x 40 feet) with a barge attached to create an extension. There is a float base area close to the community and a nearby lake that serves as a winter landing location.

Kitchen - Cafeteria
The community has public dining infrastructure through the Quick Stop, a fast food location and the cafeteria dining room at the Arctic Islands Lodge. Currently, the Arctic Island Lodge only offers supper service for hotel guests.

Logistics
Cambridge Bay has a variety of outfitting services available. Outside of the community there is a float plane base.

3.3 Research Potential

Research conducted in the area around Cambridge Bay has generally been related to terrestrial wildlife. The Queen Maud Gulf Migratory Bird Sanctuary, the various caribou herds in the area, and the environmental assessments conducted around the Bathurst Inlet area account for most of this terrestrial wildlife work.

On the marine side, there are many large char areas and some whale habitats slightly east and west of the community. Currently, oceanographic-based research interests lie in the areas to the northeast and to west of Cambridge Bay. While the work itself does not occur around Cambridge Bay, many of the research vessel routes pass by this community and could use CHARS as a transition stop throughout their route to store samples, conduct analysis and change research teams.

A more in-depth analysis of the research potential will be undertaken throughout the design phase as part of the development of options for the science and technology programming that could be offered. The following sub-sections provide a preliminary overview of the diversity of the Cambridge Bay region and the great research potential that CHARS will be able to tap into.

3.3.1 Ecoregions

Figure 3: Terrestrial ecoregions located around Cambridge Bay

Cambridge Bay is in the midst of a variety of ecoregions. Located within the Amundsen Gulf Lowlands ecoregion, there are a total of 8 terrestrial ecoregions within 300km of the community, and an additional 14 terrestrial ecoregions within a 600km radius. (Note that the *Arctic Archipelago Marine* is an ecozone and not an ecoregion.)

3.3.2 State of Knowledge Maps

The following maps were developed by the Nunavut Planning Commission. The data from the maps are derived from:

- Existing Nunavut Planning Commission Land Use Plans
- Nunavut Wildlife Resource and Habitat Values Report, prepared for the Nunavut Planning Commission, October 2008, by Jacques Whitford
- Socio-Demographic and Economic Sector Analysis Report, prepared for the Nunavut Planning Commission, August 2008, by Terriplan Consultants

The maps are presented with the relevant data layers for terrestrial wildlife, marine wildlife and natural resources. They take into consideration what is deemed to be the most important aspects by the Nunavut Planning Commission and the stakeholders they consulted and are not meant to provide a comprehensive overview.

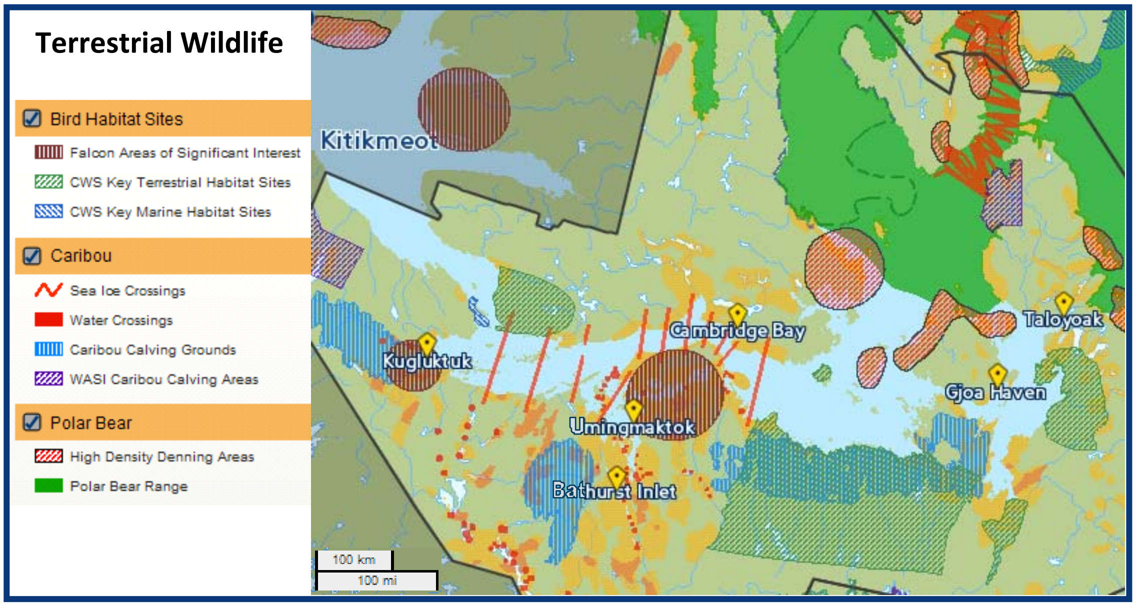


Figure 4: NCP mapping layers related to land use by terrestrial wildlife

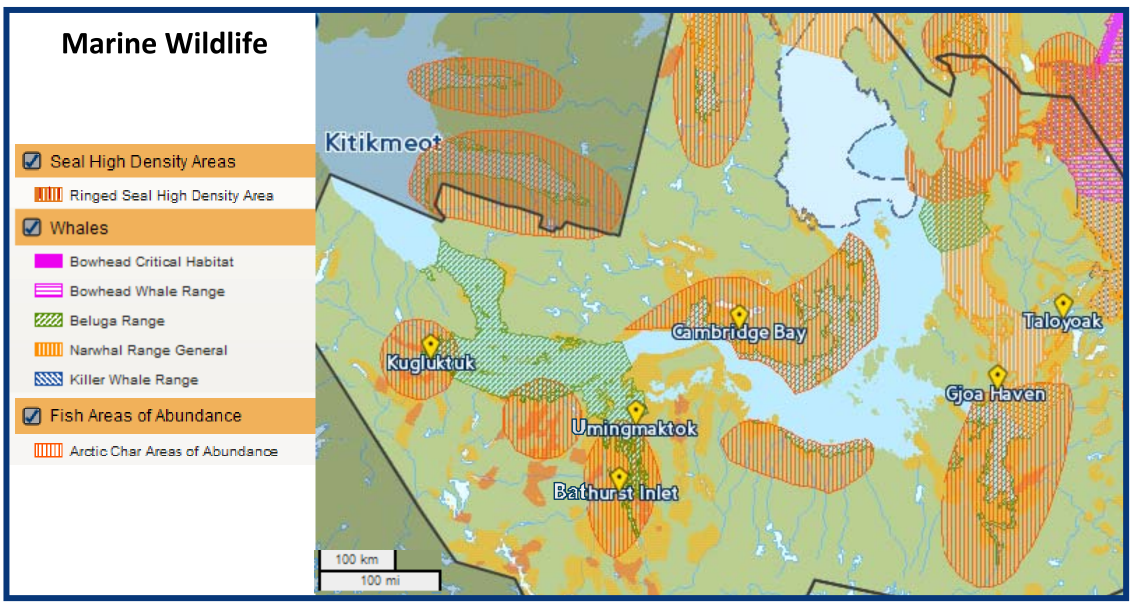


Figure 5: NCP mapping layers related to land use by marine wildlife

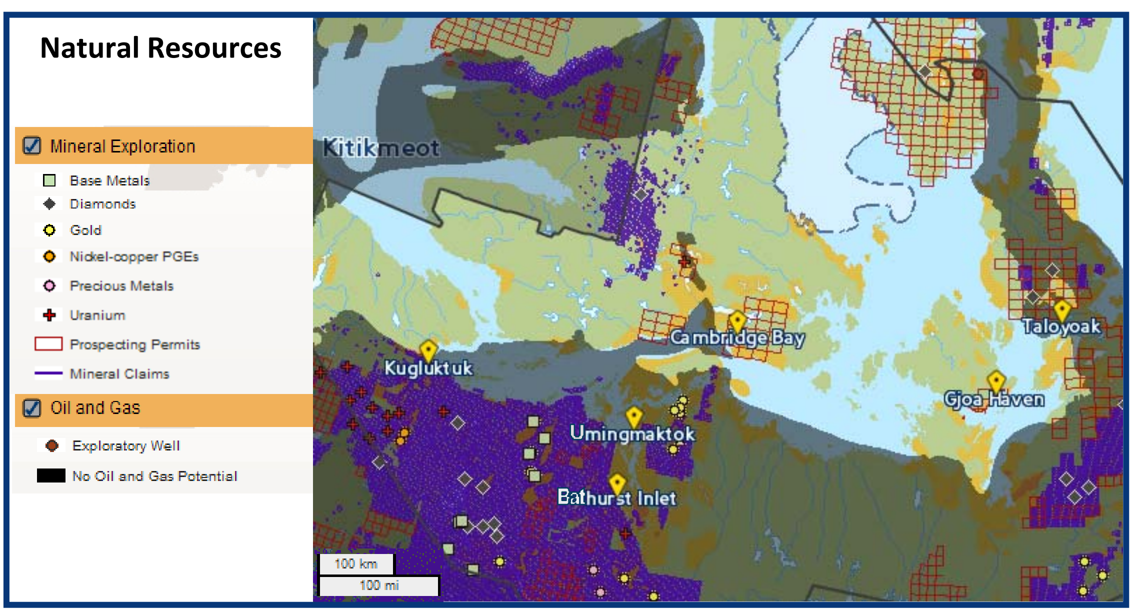
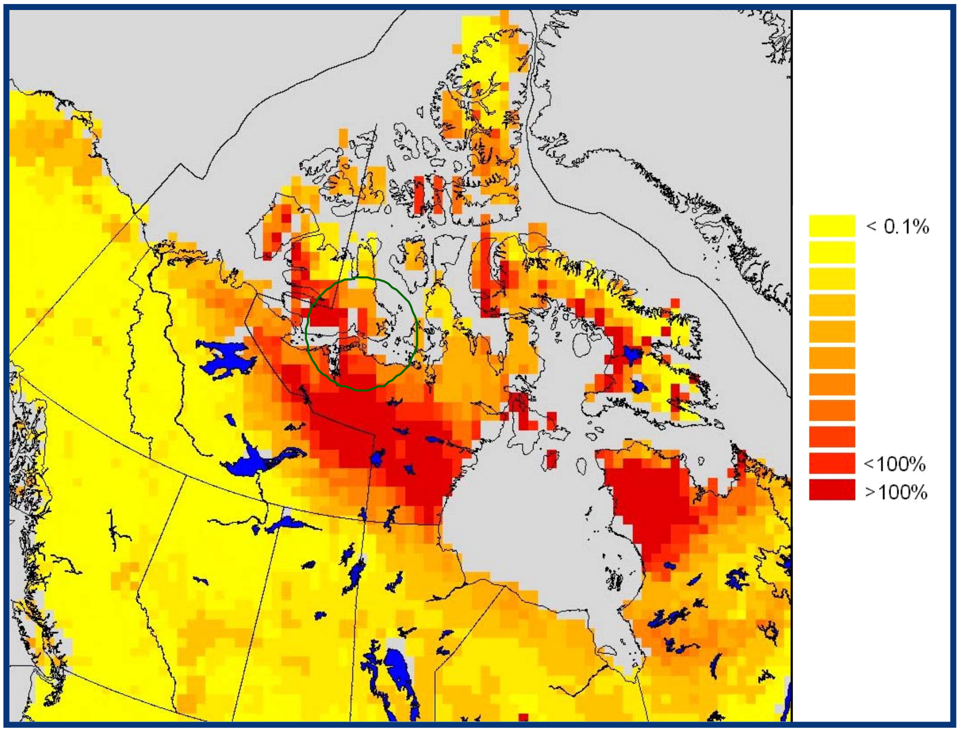


Figure 6: NCP mapping layers related to known natural resource locations

3.3.3 Predicted Climate-Induced Changes

Figure 7: Predicted turnover of mammals and birds by climate-induced changes by 2100



Source: Kathryn Lindsay (Environment Canada) from models and data provided in "Projected climate-induced faunal change in the Western Hemisphere" J.J. Lawler, S. L. Shafer, D. White, P. Kareiva, E. P. Maurer, A. R. Blaustein, and P. J. Bartlein. 2009.

In the map above, the circle represents a 600km diameter (or 300km radius) around Cambridge Bay. The predicted turn over of species by 2100 due to climate-induced changes in the Cambridge Bay area is incredible. In much of this area, it is predicted that species will turn over 100% or more than 100% (turn over completely, then again). This area is part of a "red" band that stretches from the lower Victoria Island down through the Kitikmeot region and across northern Quebec.

Many marine species are either ice-dependent or ice-associated and therefore marine biodiversity around Cambridge Bay is also expected to be affected with predicted changes to sea ice. The area near Cambridge Bay (Dease Strait and Queen Maud Gulf), in general, has a longer open-water season than other areas in the Canadian Arctic.

3.4 Potential Sites within Cambridge Bay

3.4.1 Site Selection Criteria

Discussions have been initiated to determine which lot(s) of land in Cambridge Bay will be used for CHARS.

The attributes of the lots, their size, the needs for CHARS and the availability of sites will determine if the Station will be located in one or several of the potential sites. Additionally, partnership opportunities for the use of existing infrastructure within the community will be undertaken to determine if some spaces could be expanded or leased. All of these factors would increase the options for design, governance, operations and general layout of the facility.

In essence, the criteria for site selection will be made based on the following considerations:

- Location of site
  - Does the site allow the activities of the facility to operate effectively. For example is there marine access to facilitate marine research, launching of vehicles and retrieving of vehicles with minimum displacement necessary
  - Could the site respond to several different CHARS needs
  - Could the site offer the flexibility to respond to changing needs
- Surrounding environment
  - Does the site allow for positive mingling of users and community members
  - Are there past/current issues with the adjacent sites that need to be considered including contamination and heritage, cultural and/or spiritual associations or structures
- Science and technology potential
  - Does the site offer enhanced opportunities for various streams of scientific study and technological activity
- Past/present ownership of site and past/current activities on site
  - Is there contamination or other clean-up required before the site can be used
  - Are there any past/present associations that would reflect negatively on CHARS
  - Are there heritage, spiritual, cultural structures/associations that need to be considered
- Interrelationship of individual sites
  - Do the choice of sites respond/correlate to the identified CHARS needs
  - Is the location of the chosen sites conducive to CHARS productivity (including efficient and effective interaction of users between sites)
  - Do the choice of sites allow for co-location of different facilities and/or offer partnership opportunities
- Topography
  - Does the site have: a slope; an escarpment; concave nature; or, erosion channels/drainage lines

    - Does the site have waterway courses (surface or subsurface), flooding or surface drainage issues
    - Are there soil erosion concerns
    - Does the site have special or unique characteristics and/or microclimates
    - Are there geotechnical issues on the site that will lead to increased costs or time
- Regulations
    - Do the current zoning and permits align with proposed CHARS activities
    - Are there building density, height and size restrictions and required setbacks
    - Are there access/security issues
    - Are there any known easements, covenants, right-of-ways on the property that may affect potential development
- Access to services
    - Is the site already be serviced (water, sewage, waste disposal)
    - Are there roads leading to the site
- Aesthetics
    - Does the site offer nice views/vistas

No detailed discussions about sites have been undertaken during the feasibility phase. Although a range of sites have been considered that offer varying attributes including: access to water and dock, distance and access to main roadway and opportunities for future expansion. Part of the community engagement expected to take place during the design phase will include discussions with the community and with the owners/managers of sites to confirm availability and suitability for CHARS. Broader discussions with the community would also explore opportunities for expanding and/or leasing existing community infrastructure and sharing of new CHARS infrastructure, thereby increasing the options for design, layout and community integration.

Figure 8: Satellite image of the current network of roads and buildings in Cambridge Bay

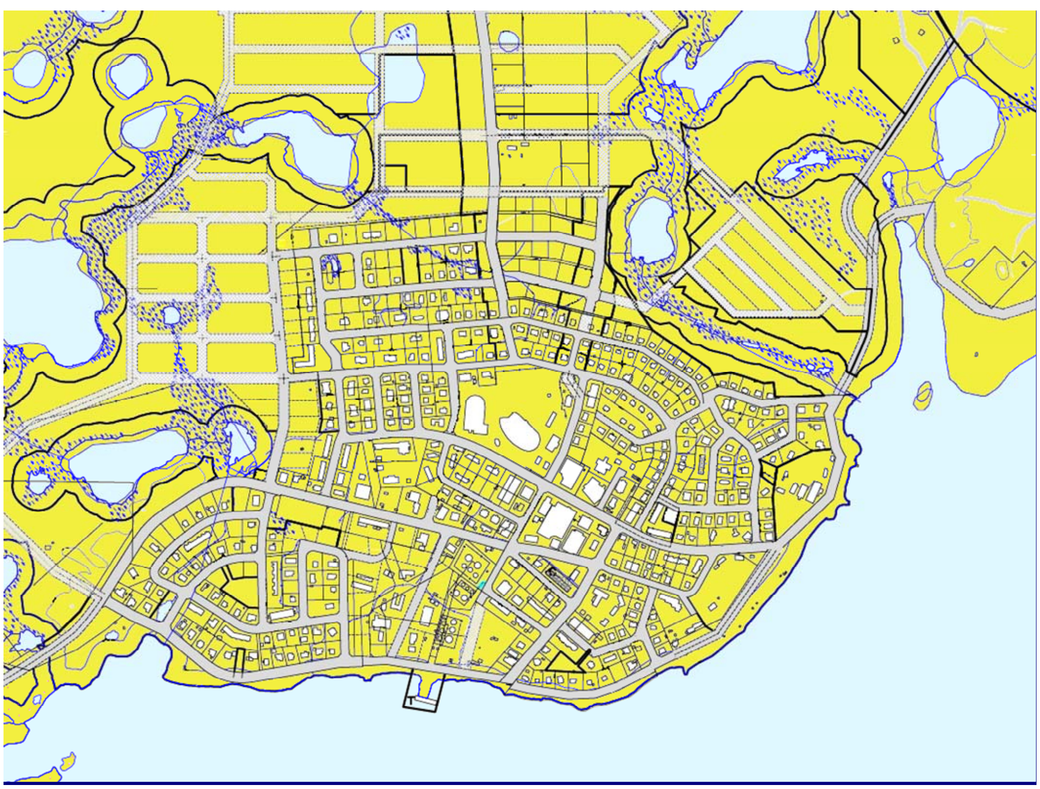
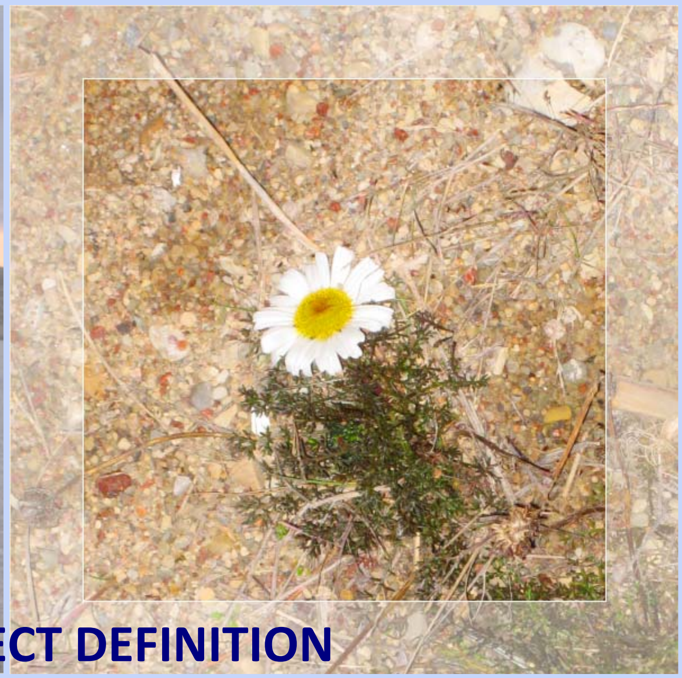


Figure 9: Graphic of the planned network of roads and existing roads/buildings in Cambridge Bay



PART II: PROJECT DEFINITION

4. CHARS MANDATE

Sailboat in Cambridge Bay

The mandate presented below is the result of numerous consultations and discussions with stakeholders. It has been approved by the Government of Canada.

4.1 Mission

To be a world-class research station in Canada's Arctic that is on the cutting edge of Arctic issues. The Station will anchor a strong research presence in Canada's Arctic that serves Canada and the world. It will advance Canada's knowledge of the Arctic in order to improve economic opportunities, environmental stewardship, and the quality of life of Northerners and all Canadians.

4.2 Objectives

Mobilize Arctic science and technology

- To develop and diversify the economy in Canada's Arctic
- To support the effective stewardship of Canada's Arctic lands, waters, and resources
- To create a hub for scientific activity in Canada's vast and diverse Arctic
- To promote self-sufficient, vibrant, and healthy Northern communities
- To inspire and build capacity through training, education, and outreach
- To enhance Canada's visible presence in the Arctic and strengthen Canada's leadership on Arctic issues

4.3 Principles

- Address pressing issues in Canada's Arctic by conducting world-class research and delivering excellent and relevant science and technology
- Complement the network of Arctic expertise and facilities across Canada's Arctic and the whole of the country
- Promote partnerships and collaboration among the private, Aboriginal, academic, and public sectors both domestically and internationally
- Work with Aboriginal peoples of Canada's Arctic and recognize the importance of traditional knowledge in advancing Arctic research
- Integrate across disciplines and across activities – from problem identification, through research and development, to solutions
- Ensure effective use of data, information, and technology through open and timely access and knowledge application
- Be a world leader in green technologies for the Arctic

4.4 Components

1) A world-class facility

The Canadian High Arctic Research Station will provide a year-round facility for world-class science and technology in Canada's Arctic. The Station will include research labs, centres for technology development and traditional knowledge, and facilities for teaching, training, and community engagement. It will provide scientific, technical, and logistical services to strengthen Canada's leadership in Arctic science and technology. It will create a dynamic environment for leading Canadian and international scientists and engineers to come together with Northerners, the private sector, and other stakeholders to address complex challenges facing the Arctic and the globe.

2) Cutting-edge science and technology

CHARS will ensure Canadians lead the way in addressing the challenges facing Canada's Arctic by conducting world-class research and delivering excellent and relevant science and technology. The Station will help to build the next generation of polar scientists, innovators, and managers. The knowledge produced through the Station will be mobilized to support the responsible development of Canada's Arctic and to inform Canadian and global responses to the changes happening in this unique region.

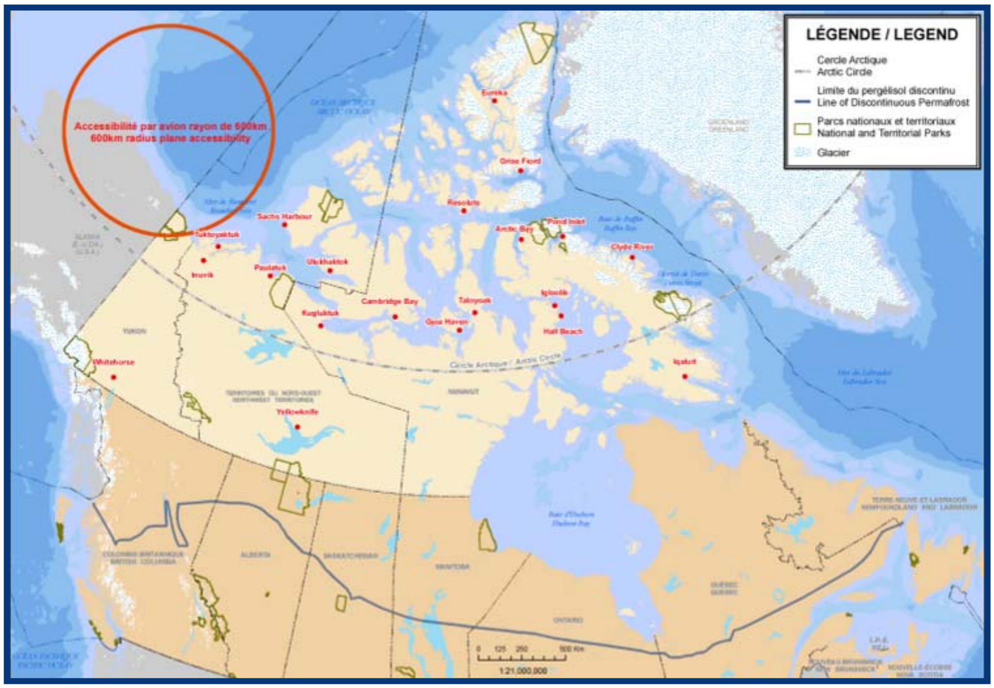
3) A strong research presence across Canada's Arctic

CHARS will be at the centre of a strong Canadian network of Arctic research infrastructure capable of meeting science and technology needs that match the size and diversity of Canada's Arctic. This network will include regional laboratories, field camps, monitoring sites, ships, and satellites. The Station will leverage the efforts of polar researchers, the private sector, and communities throughout Canada while engaging the world to address national priorities.

4.4.1 Geographic Area

For the purpose of CHARS, Canada's Arctic is defined as the lands and waters that lie north of the permafrost line (the area above the grey line in the map below).

Figure 10: Map of Canada with a grey line representing the line of discontinuous permafrost



4.4.2 Scientific Scope

CHARS will take an integrated approach to its science and technology activities. These activities may include: monitoring and surveillance; research, modelling, and prediction; technology development and transfer; knowledge application; and training, education, and outreach as well as the logistics needed to ensure effective delivery. The science and technology undertaken by CHARS will be interdisciplinary and include natural and physical sciences, economic and social sciences, health and life sciences, the humanities, and engineering and technology development.

4.5 Priorities

World-class research excellence is Canada's standard. This will be met by focusing on priorities and targeting basic and applied research in areas of strength and opportunity. Delivering on science and technology priorities will focus funding, build partnerships, and lever Canada's research base to address economic and social challenges and maximize competitive advantage. Although CHARS' priorities may evolve, they will initially be aligned with the following themes.

Table 2: CHARS priorities and outcomes – presented in no particular order

Priority	Outcomes
Resource Development	▪ Resource development that is economically and environmentally sound and promotes social development ▪ Renewable resources and unconventional energy sources that contribute to greater energy security and sustainability
Exercising Sovereignty	▪ Efficient and effective monitoring and surveillance of Canada's vast Arctic ▪ Effective management of Canada's Arctic waters a under changing conditions ▪ Improved response to, and mitigation of, environmental and other disasters
Environmental Stewardship & Climate Change	▪ Effective environmental stewardship through greater knowledge of natural and human systems and their interconnections ▪ Strengthened mitigation efforts through greater understanding of changes in the Arctic climate and the links to global systems, and increased capacity to adapt
Strong & Healthy Communities	▪ Improved infrastructure and diversified economic opportunities ▪ Improved health outcomes and community wellness and resiliency

5. SCIENCE AND TECHNOLOGY PROGRAM

5.1 Overview of the Proposed S&T Program

The science and technology priorities of the CHARS mandate provide the framework that will guide the activities undertaken at CHARS. It is proposed that scientists, engineers, and other Arctic experts at CHARS will conduct research, develop technology, and perform analyses to monitor, understand, and communicate the status and trends of Arctic climate and environmental systems, to support the protection and sound development of the resources in Canada's Arctic, to promote strong and healthy Northern communities, and to strengthen Canada's capacity to exercise sovereignty over its vast Arctic lands and waters.

The science and technology program at CHARS is expected to be the most significant tool in making CHARS a world-class Arctic S&T institution. By combining top talent and secure, long-term funding to undertake cutting-edge S&T with a facility that provides the necessary infrastructure supports, CHARS could become the go-to destination for Arctic science and technology in the world.

World-class for CHARS would mean relevant, solutions-driven S&T: S&T that responds to the most pressing and challenging questions under the CHARS priorities and outcomes. That S&T could be:

- ground-breaking basic research, if a gap in fundamental knowledge is the barrier to moving forward on a pressing issue;
- more effective dissemination of existing knowledge, if mobilization of research findings into management and decision making limits Canada moving forward effectively on a key question;

- community-based monitoring that engages Northerners in improved management of local resources in the context of the cumulative impacts from economic development and climate change; or,
- new technology that allows resource extraction with greater yields and fewer environmental impacts.

Both the quality of the S&T (e.g. reproducibility, contribution to new knowledge, appropriate and ethical methodology) and its applicability to addressing key questions will be hallmarks of the world-class S&T undertaken at CHARS. For CHARS, excellence and relevance are not mutually exclusive measures of world class. Publication in the world's leading scientific journals is but one measure of the quality of S&T that will be carried out at CHARS. The S&T program also will be judged by its impact on policy and management, by its contribution to S&T capacity in Canada and in the North in particular, by the new social and technological innovations it fosters.

The advice received through the Experts and Users discussions and bilateral consultations both domestically and internationally has indicated that the Station should strive for interdisciplinary research in order to best deliver on the CHARS priorities and outcomes. In particular, CHARS would support projects that cannot be undertaken by any one researcher, department, or agency on their own and that therefore require integrated approaches:

- to address interactions between terrestrial, aquatic, and atmospheric processes and systems;
- to predict and identify cumulative effects; and,
- to understand how natural and anthropogenic factors interact to influence environmental systems and society (e.g. global and regional change, environmental stress and resource development).

CHARS would integrate field and laboratory methods with new theory, modeling, data systems, policy analysis, and evaluation to create solutions to the complex challenges facing Canada's Arctic and the globe and to leverage new opportunities for the benefit of Northerners and all Canadians. In order to facilitate this integrated and collaborative approach, CHARS would be designed and built so that both structured and informal interaction are supported through flexible use of spaces and sharing of resources.

A *'Blueprint'* for the CHARS S&T program would be developed to serve as a guiding document for all S&T programming associated with the Station. This document would build on the CHARS priority themes and desired outcomes as outlined in the mandate by detailing targeted S&T questions with an assessment of status, gaps and performance measures for each outcome. The S&T questions are intended to be the mechanism for ensuring relevance of the CHARS S&T program. The *Blueprint* would be a living document and would evolve as S&T questions are answered and new issues, questions, and priorities arise. Within this framework, the government could be able to assign specific questions to CHARS. These questions would be treated as a priority in the development and implementation of the *Blueprint*. The key elements of the *Blueprint,* outlined below, would form the strategic plan for the Station:

> **Priority theme** e.g. Resource Development
> **Desired outcome** e.g. Renewable resources and unconventional energy sources contribute to greater energy security and sustainability
> **Context**: why this issue is important
> **Focal questions**: 1-3 solutions-driven questions that will direct CHARS work
> **Status**: current work being done, key experts, gaps
> **Performance measures**: has progress been made towards outcome; has S&T been relevant?

The *Blueprint* would be developed with broad stakeholder input following the model used by the Northern Contaminants Program to prepare their research agenda. The development of the CHARS *Blueprint* would be guided by an advisory board of senior experts and stakeholders with representation from Northern, Aboriginal, academic, industry and governmental sectors to ensure the relevance and excellence of the CHARS S&T program. Scientific and technical review committees would be engaged in the definition of the context, the focal questions, the status, and performance measures for the *Blueprint*.

Reviews of the *S&T Blueprint* would be undertaken both annually, to adjust the science and technology questions and ensure the appropriate balance between the priorities, and every five years, to ensure a comprehensive assessment of the progress toward the CHARS outcomes and priorities and their continued validity as goals for the Station. The CHARS advisory board would seek regional input into the development and tuning of the science and technology *Blueprint* as well as the overall governance of the S&T program.

The proposed CHARS programming could be supported through an in-house component and through an externally competed fund. CHARS would manage the S&T program as a portfolio – ensuring coherence across the internal and external components, weighing excellence and relevance, balancing risks and opportunity, and ensuring both short-term and long-term benefits to Northerners and all Canadians. CHARS would also promote and facilitate international linkages that contribute to national priorities. Traditional knowledge approaches and their linkages to modern science would be fostered.

In determining the final mix of projects funded, particular attention would be given to promote integration across and within scientific disciplines, between sectors, and across geographic regions. The overall mix of projects would be selected to respond to the objectives and S&T questions in the *Blueprints* and to foster integration between projects and the S&T Program elements:

- Research
- Technology development, testing and application

- Traditional knowledge
- Monitoring
- Reference and experimental site(s)
- Knowledge application
- Education and outreach

5.2 S&T Program Elements

Consultations with the polar research community in Canada and abroad stressed the need for CHARS to develop a clear niche that would set it apart from other polar stations. Potential niche areas are identified under each of the program elements in the sub-sections below. In some cases, these niche areas would require CHARS to coordinate and/or fund work across the network of Arctic research facilities. In other cases, the niche areas would be spearheaded by the staff at CHARS. In all cases, the S&T program elements would respond to the CHARS mandate, priorities, and outcomes.

The Experts and Users Group has highlighted the need and opportunity for CHARS to become a central access point for Arctic S&T. In this sense, CHARS could become a *one-stop-shop* for anyone looking for information about the Arctic, who would want to undertake Arctic research in Canada, or who would want to pursue partnerships or collaborate with Canada with respect to the Arctic. This role would be coordinated with the stakeholders who are responsible for various aspects of Arctic research including: the territorial governments who evaluate, approve and licence research projects; the northern communities, researchers and institutions (both private and public) who have the research information, determine who is given access, the terms of usage, and the method of storing the information; federal departments and agencies which have mandates extending into the Arctic; and, other Arctic research facilities which already facilitate Arctic research in myriad ways.

The following proposed program elements are described in a discreet manner in the following sub-sections. However, the science and technology undertaken at CHARS is expected to cut across disciplines and approaches with a resulting overlap in the spaces and services used. The emphasis and mix of elements will be determined through the *S&T Blueprint* process and, therefore, will change over time as the *Blueprint* evolves.

5.2.1 Research Program

Potential niche for CHARS:

- Northerners engaged and leading research
- Research conducted year-round
- Integration across
  - Traditional Knowledge and western knowledge
  - Disciplines, domains, sectors and activities

    - Scales – local to regional to global

Programming would promote participatory research and would concentrate on solutions-driven approaches to address S&T questions identified in the *Blueprint*.

Potential functions:

- Conducting locally relevant research
- Managing the overall science portfolio
- Managing other research activities including visiting researchers and fee-for-service research

Infrastructure requirements for staff and visitors could include:

- Laboratories – Due to the evolving nature of the work that will be done at CHARS, a modular approach to laboratories would allow researchers to personalize spaces to suit their needs and preferences
    - There are two types of labs that would be required: wet (including marine); and, dry (including computer lab space). The consideration to making all of the lab space "wet lab capable" will be included in planning
    - The types of work within these spaces could include: analytic; geo-science; radio-isotope; molecular; microbiology; cold; GIS; e-health; and social sciences.
- Specialized research spaces – Some research could require spaces designed for special purposes
    - Mobile laboratory units to allow work to take place at experimental sites near CHARS, other field sites or on ships
    - Greenhouse
- Laboratory support spaces – These spaces would support the work done in the laboratories. They would be shared by all users to maximize efficiency of space and equipment
    - Specialized environments – Microscope room; ashing/drying room; balance room; autoclave; and, interview rooms
    - Information management spaces – Telecommunications room; and, data (including archives)
    - Storage spaces – Vehicles; equipment; glassware; samples; and, chemicals
- Research offices – various sizes to accommodate the differing levels of required privacy and length of use (e.g. offices *versus* work stations)
- Meeting rooms including videoconferencing facilities

5.2.2 Traditional Knowledge

Potential niche for CHARS:

- Centre of expertise on integrating traditional knowledge and western science

CHARS would work with Northerners to identify the niche areas, staff, programming functions and governance specifics that would be needed.

Infrastructure requirements for staff and visitors could include:
- Traditional knowledge areas (dedicated space)
- Data archive
- Telecommunications/broadband/GIS
- Broadcast station
- E-learning facility
- Offices and, work stations

5.2.3 Technology Development, Testing and Application

Potential niche for CHARS:
- Incubation for innovative technologies for the North and/or polar environments – developing; testing; applying; and, promoting
- Development of new technologies to support polar S&T (e.g. new monitoring tools)

The approach for this program component could include integrating the technology being tested and developed into demonstration sites. For example, the accommodation units could be part of the testing and development of building materials, finishes and/or systems. Staff and visitors using those areas could be called on to participate in the monitoring and reviewing of products. Science is often advanced by new technological capabilities that permit asking, and answering, new research questions. Having technology development staff and capabilities at the station may spur new research directions or improved approaches to current research priorities.

Potential areas of specialization:
- Sustainable housing and building technology
- Municipal services in northern climates
- Monitoring technologies
- Sustainable resource development

Church in Cambridge Bay built in 1953 using local materials of seal oil, clay and frost shattered rocks.

Infrastructure requirements for staff and visitors could include:

- Laboratories – Technology development and testing spaces
- Workshops – General; and, precision
- Storage spaces – Vehicles; equipment; and, samples
- Research offices; work stations

5.2.4 Monitoring

Potential niche for CHARS:

- Regional observatory
- Reference monitoring sites; experimental environmental site close to Station
    - To facilitate field science and comparative analysis over the long-term and lab-based analysis of samples
    - For testing technology in short and long-term contexts
- Anchor for a Canadian Arctic monitoring network
- Community-based monitoring
- Early alerts through crowd-sourcing, Traditional Knowledge and data mining
- Protocols, sampling strategies for scaling and representation

Potential functions:

- Data collection, integration and analysis
- Federal coordination for territorial/provincial, national, and international monitoring programs
- Developing policy, protocols and standards
- Supporting training and implementation

Infrastructure requirements for staff and visitors could include:

- Monitoring station
- Monitoring reference site(s); experimental ecosystem site(s)
- Data archives
- Telecommunications/broadband/GIS
- Field cabin for shelter and basic preparations and analysis at experimental sites
- Mobile unit(s)
- Storage: vehicles; and, equipment

5.2.5 Knowledge Application

Potential niche for CHARS:

- Be the "go-to" place for Arctic S&T in the world (i.e. a point of entry for all Arctic S&T in Canada)
- Centre of expertise for the CHARS priority areas
- On-site expertise – technical and systems administrative computing services to support researchers and foster integration

Potential functions:

- Brokering between sectors, users and researchers
- Secretariat for the S&T Blueprint (i.e. research agenda)
- Knowledge translation including a *State of the Arctic* report
- Information and data management
- Providing standard baseline data layers
- Leadership on Quality Assurance/Quality Control (standards and protocols)
- Providing data out to a wide range of audiences
- Support for:
    - Computational, statistical and spatial analysis
    - Integration of data from different sources and technologies
    - Community input of data layers

Infrastructure requirements for staff and visitors could include:

- Research offices; and, work stations
- Data archives
- Telecommunications/broadband/GIS
- Broadcasting/media station
- Meeting rooms including video conferencing facilities

5.2.6 Education and Outreach

Potential niche for CHARS:

- Promoting Arctic S&T to northerners, Canadians and the world
- Promoting Canada's excellence in Arctic S&T
- Creating a career path for northerners in Arctic S&T

Activities would be geared both internally and externally. Internal education and outreach activities would focus on attracting groups to CHARS to learn about the Arctic through courses, workshops and conferences. External activities would focus on developing materials and tools for distribution and access outside of CHARS.

Potential functions:

- Training and capacity building
- Promoting a science and technology culture
- Communicating S&T
- Promoting CHARS and the accomplishments of CHARS

Infrastructure requirements for staff and visitors could include:

- Teaching laboratory
- Telecommunications/broadband/GIS

Cambridge Bay library and Kitikmeot Heritage Society

- E-learning facility
- Offices and work stations
- Classrooms/meeting rooms
- Auditorium
- Broadcasting/media station
- Display centre

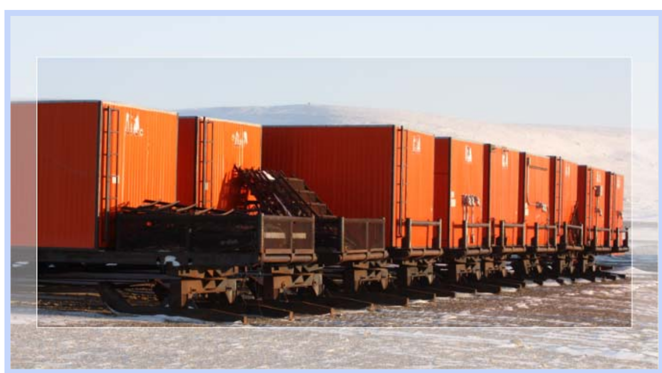
5.2.7 Logistics

Potential niche for CHARS:
- Staging location for visiting researchers
- Providing staff with access to field sites outside of the CHARS area
- Providing logistical services to other users
- Search and rescue centre

Given the high costs and complexity of transporting goods and people in the Arctic, effective and efficient logistics support is critical to northern S&T. Coordination of activities, training and seeking cost efficiencies by CHARS would allow researchers to focus their budgets on achieving results and not on getting to their sites. Such coordination would also improve the safety of conducting northern research in the field.

Potential functions:
- Managing field support needs for research projects (CHARS projects as well as transient and fee-for-service projects) including:
  - Coordinating travel arrangements, equipment, scheduling and fuel caches
  - Safety, including training
  - Storage of research equipment
  - Providing links to guides, translators, research and field assistants, and bear monitors
  - Procurement/contracting for services and equipment rentals
  - Linking to licensing/permitting

Infrastructure requirements for staff and visitors could include:
- Staff offices
- Storage – CHARS storage for vehicles and equipment; storage for equipment and materials brought by researchers
- Mobile laboratory units
- Marine facility – Boat storage; dive site; docking area
- Airport facility – Plane storage; waiting area for researchers
- Telecommunications



Mobile units in Resolute Bay

5.3 Other Program Guidelines

The use of the facilities at CHARS would be provided to the staff, contracted researchers and invited guests on a priority basis. Visiting researchers (both funded and unfunded by CHARS programming) and other guests would have secondary access to spaces and services offered by CHARS but every effort would be made to accommodate preferred timing of visit and needs *vis-à-vis* services and spaces at the facility.

CHARS staff would work year-round at the facility. The majority of visiting researchers are expected to use the facility during the summer months when academic teams are most able to travel. In order to make the best use of the facility throughout the remaining months of the year, opportunities for collaboration and partnerships with other potential users such as the territorial colleges and international community would be explored. Additionally, the program elements themselves could be scheduled at various times of the year to spread out activity. For instance research would be done in the summer, when the demand is greatest, while education and outreach could be concentrated throughout the other seasons.

5.4 S&T Program Drivers for CHARS' Design

As the S&T program will be the heart and soul of the Station and will ensure, ultimately, that the Station is recognized as world-class, it will drive the design of the Station's infrastructure. The challenge in building CHARS is that the S&T program (the social capital) and the infrastructure (the built capital) are being designed and constructed at the same time. This reality will require that the design team and the team designing the S&T program work closely together to ensure that the two components co-evolve. Key goals and characteristics for the S&T program that should influence the design of the Station are:

- ***Integration and interaction:*** The niche for CHARS is integrated and interdisciplinary solutions-driven S&T. The physical layout of the component spaces within the Station and the flow between them should promote interaction within teams working on a particular project and across teams. It should support engagement with visiting researchers, community members, industry representatives, politicians and policy makers, the media, managers, students and tourists. The Station should start conversations and then provide good venues for continuing them over dinner or in a meeting room, as well as expand them, both in person or virtually, through video-conferencing or collaborative computer modeling for example.

- ***Arctic science is field science:*** Much of Arctic S&T is predominantly conducted in the field, not in a laboratory. The Station needs to be connected to the local experimental sites (e.g. network connections to track and adjust monitoring instruments) and support travel and linkages to more distant field sites (e.g. logistics, satellite data downloads back from the field for collaborators to analyze). Data and samples will be brought back to the Station for analysis – with attendant requirements for storage and processing facilities.

- ***Science and technology is increasingly about data and computational analysis:*** Science in general is seeing a greater emphasis on computational analysis, whether that is geo-spatial, modeling and simulation, sophisticated statistics, or data aggregation and query. From the perspective of the Station's infrastructure, this means that laboratories aren't necessarily the sole or even prime location for science and technology. At the same time as science has gotten more computationally intensive, computers have become more powerful and networked. That means computer-based science does not necessarily require the scientists to be locked in some specialized computer lab. Their desktop or laptop computer may have sufficient power to perform the complex calculations needed or it could link them to the dedicated servers at the Station or the cloud of computers out in the global network that do. The need to support integration between field-based, laboratory-based, and computer-based S&T is a core criterion for the success of the CHARS built infrastructure.

- ***The scope for S&T is broad:*** CHARS will support projects not only in the natural and physical sciences, but also in engineering and technology development, social sciences and humanities, and health and life sciences. Again, this means laboratories are not the only venues for S&T: interview rooms may be essential for social sciences; examination rooms would support health research; and, workshops are required to support technology development and engineering studies. The range of possible S&T to support and the evolving nature of the CHARS S&T program pose particular challenges to the design. Flexibility and modularity will be key.

- ***CHARS will be used by a wide array of people.*** The Station will have core in-house staff delivering part of the S&T program as well as short-term and longer-term visiting scientists, experts, and students participating in CHARS-led or funded S&T projects. CHARS will also host users for short and longer-term non-CHARS projects. Transient users on their way to more distant field sites will swell the ranks of people at the Station, particularly in the summer months. The local community may also use the Station, (e.g. the meeting facilities, the traditional knowledge centre, and the outreach and education spaces). All these users will require tailored access to the facility with respect to which rooms, equipment, and services they can avail themselves of, and during what time periods. This range of users creates requirements for security and safety, for supporting positive interaction, and for clear signage on who can go where when. The facility should be inviting to all but protect scientists' projects and non-scientists from those projects.

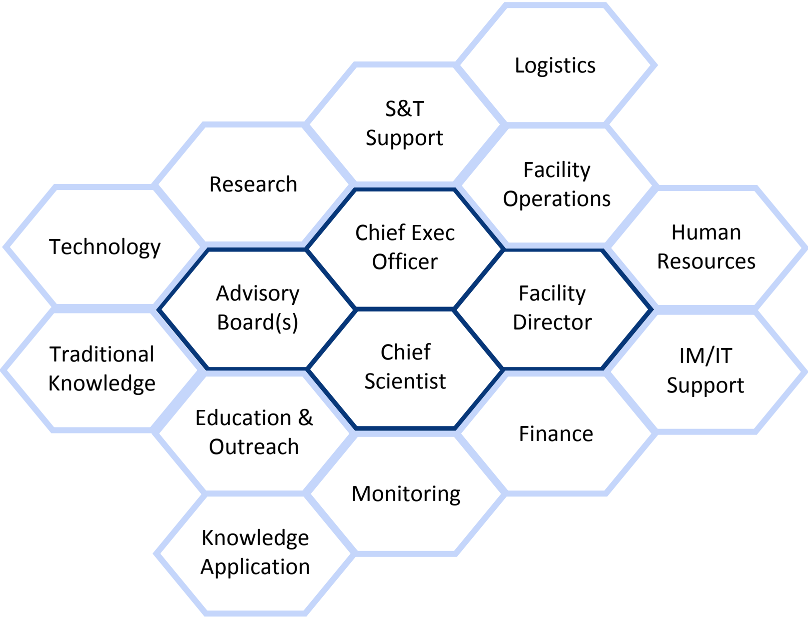
6. ORGANIZATIONAL PLAN

Float base outside the community of Cambridge Bay

6.1 Proposed CHARS Organizational chart

The overall governance and management of the Station remains to be determined. The following chart provides the breakdown of a potential organization which could run the Station and its programs. The number of people in each category and the duration of positions (contracts, seasonal, part-time and full-time) would be tailored to fulfill the needs of the approved program and Station design. Ultimately, the number of staff would be scalable.

Figure 11: Potential CHARS organizational components



6.2 Operational Overview

The Chief Executive Officer would oversee the facility and activities. S/he would also be responsible for ensuring the connection to other federal government departments remains strong and that the work and outcomes recommended by the Advisory Board(s) is relevant to the Government of Canada. Additionally, s/he would represent CHARS at national and international events to promote the accomplishments of CHARS researchers and pursue collaborative opportunities.

It has been strongly recommended by stakeholders to have the CEO and Advisory Board(s) in place during the development of CHARS in order to ensure that the facility, programming, and other operational needs are well informed.

6.2.1 Science and Technology Programming

The Chief Scientist would coordinate the science and technology programming. As part of this, s/he would determine the staffing requirements to work on priority questions identified through the *S&T Blueprint* and ensure that synergies between teams are occurring where needed. S/he would also manage the work/needs of visiting researchers. Moreover, the Chief Scientist would have a large role in developing and maintaining community relations as well as representing CHARS at national and international events.

The staff under the Chief Scientist could be comprised of 35-50 seasonal, part-time and full-time employees undertaking a wide variety of tasks including researching, managing programs, supporting visiting researchers and facilitating the translation of results into reports. It is expected that CHARS will host an additional 75-100 visitors on a regular basis who will undertake research or participate in CHARS programming, use accommodations and logistical support. *Note that these figures represent the best information available at this time and may change as the CHARS S&T programming and operational needs are developed to answer the S&T Blueprint's questions.*

The CHARS staff team under the programming stream could be composed of diverse groups. The Blueprint would guide staffing decisions and funding between program elements and due to this, the numbers could be highly fluid. In order to ensure continuity, a core staff team would be on site. This core team would be composed of individuals who would bring multiple skills and expertise to the Station, further reinforcing the aim of integration and interdisciplinarity of science and technology work.

6.2.2 Administration & Facilities Management

The Director of Facilities would be responsible for the corporate functions and facilities management of CHARS. The work would likely be done through a combination of service contracts and permanent staff. The work of this group would largely support the programming needs and would therefore also be expected to change with the evolving S&T needs. Additionally, the types of services and equipment available at the Station would dictate some of the staffing needs.

7. FUNCTIONAL PROGRAM

Community of Cambridge Bay

The functional program has been prepared to articulate the desired priorities for CHARS and to assist the future architectural design team in their exploration of physical development strategies that will be both cost-effective and functionally viable. As noted in the Science & Technology Program chapter, there will be an ongoing need to ensure that the development of the Station's programming is reflected in the design of the facility. Chapters 7, 8 and 9 provide the planning guidelines and architectural vision that is envisioned for CHARS. They include:

- Project goals and planning considerations
- A functional overview of all components to be accommodated within CHARS
- Functional groupings and relationship diagrams for all components
- Architectural development guidelines
- Detailed space requirements data has also been developed and is available in a separate document

7.1 Overview of the Proposed Functional Program

CHARS is intended to be a sophisticated, technically advanced world-class facility at the leading edge of Arctic science and technology. Buildings and surrounding site development must project a character and image appropriate for the Government of Canada. It would provide an environmentally sustainable research platform which promotes the creativity of the professional, technical and administrative staff and visitors working at the facility, and would support the application of that creativity to solve critical issues facing Canada's Arctic.

The detailed functional program sets out the size requirements for each of the areas related to laboratories, offices, living area, commercial space and supporting spaces. It also proposes the preferred relationships between these spaces and any special considerations (e.g. sound protection or contaminants containment).

No decisions yet have been made on whether to locate all of the building components in one building or to distribute them throughout the community. The groupings and distribution of components throughout the community would be based on the optimal relationship between the site, surroundings, CHARS activities and opportunities for collaboration and efficiencies. Additionally, discussions with Cambridge Bay organizations could lead to some of the CHARS component spaces being integrated into existing or expanded community infrastructure. For instance, health and recreation facilities as well as some accommodation could offer such community integration possibilities.

7.2 Project Goals

The general goals in designing a facility with laboratory, education and outreach components is to provide an inviting and productive research and education atmosphere while planning user spaces that minimize hazard potential and environmental impacts.

Considering that the Station is intended to showcase Canada's leadership on international polar research, the planning should strive for a high standard of design. The Station should acknowledge the importance of an appropriate aesthetic for the Government of Canada in the Arctic. The aesthetic or image should recognize that the building(s) are the 'architectural face' which will fit into the culture of the existing community and all Northerners, and should thus respect the community scale and its values.

Since CHARS is expected to evolve with program changes, the concept and final design should reflect an understanding of the changing nature of the Station and its requirement to adapt to both financial and program adjustments. This plan for this facility will have to appreciate all of the Arctic design and operational constraints associated with current lab planning, as well as those associated with the Cambridge Bay location.

7.2.1 Sustainability

CHARS will strive to implement sustainable measures in all aspects of the Station. This stems primarily from the mandated principle to be a world leader in green technologies for the Arctic but also from the desire to be a demonstration site for new technologies and to render the facility more efficient. It is expected that monitoring the impacts of these new technologies would be part of the Station's education and outreach activities and would inform decisions for their application in other northern facilities.

One of the largest ongoing costs of an Arctic research facility is related to energy; therefore, designing an energy efficient facility would help alleviate future operational budget pressures. When many energy efficient measures are considered from a lifecycle perspective, they may add a cost premium during initial construction but be financially attractive over time.

"Green" technical approaches identify possible avenues for reducing the requirement for outside energy input to the Station. The challenge at CHARS will be the integration of the distinct building operational systems and as such, implies a much broader scope than simply insulation and solar gain. For example, the heat generated from the telecommunications equipment could potentially be leveraged to heat part of the facility.

The LEED approach to evaluating building sustainability recognizes this overall approach by including embedded building energy used in the manufacture and delivery of building components, recycling, heat recovery, operational building energy expended during the delivery of program services and resources which the community provides. Although there are aspects of LEED which are not directly applicable to CHARS due to its Arctic site, certain LEED components can be modified to allow for setting of sustainability targets. Additionally, other programs such as the 2030 Challenge, Labs 21 and current building codes and best practices for the Arctic have been reviewed in order to help set the most likely framework for CHARS sustainability.

Sustainability also includes consideration – on a life-cycle basis – of waste, water, selection of local building materials, transportation costs, environmental impacts of materials and conservation practices. It should be noted that incorporation of sustainability measures will sometimes require a made-for-the-Arctic approach. These approaches could mean that more durable materials are preferable and that choices made to achieve higher operational efficiencies may add an initial cost premium. Considering the remoteness of the Station, some initial costs may be considerably higher than for a southern Canada location. This should be balanced against the commitment to lower the carbon footprint of the Station as well as full life-cycle cost analysis.

Also, decisions on types of systems will need to consider the basic needs for redundancy and simplicity in order to ensure overall reliability. The design for the Station will need to find the appropriate operational balance between the "tried and true" and the new technological applications used as demonstration projects. In the Arctic, system simplicity is paramount, as difficulties in accessing spare parts and specialized technicians; combined with community weather-related access issues, generally make complicated technologies undesirable.

7.2.2 Flexibility

Laboratories

Science has a penchant for unpredictable change. Almost daily, scientific technology is altering methods, which requires, to some degree, facilities to flex with these changes. Flexibility should be considered in both the ability to change over time, and also in terms of being able to provide multiple services to the same space in order to support simultaneous needs.

A key to flexibility in a laboratory building is the manner in which the various services are provided to the laboratory users. The question of vertical or horizontal distribution must be reviewed and made on the basis of life-cycle values.

The rationale of interstitial space is adopted where more sophisticated environments are developed. Interstitial space is the space located between regular-use floors, commonly located in hospitals and laboratory-type buildings to allow space for the mechanical systems of the building. By providing these widely spaced columns and spacious horizontal areas, the laboratory spaces may be easily rearranged throughout their lifecycles and therefore reduce lifecycle cost.

Individual spaces should also be designed with flexibility in mind. Laboratories are not typically as flexible as office spaces where infrastructure remains nearly the same and the insides can easily be changed, regardless of the user. Conversely, scientists may need large data communication capabilities to transmit complex images and specialized Heating, Ventilation, and Air Conditioning (HVAC) systems to maintain re-circulated and filtered air. There is also often a requirement to maintain either positive air pressure to keep dust out of the room or negative pressure to keep fumes away from the occupants. These spaces may need to be reconfigured to accommodate different research needs. For these reasons, laboratories require flexible design schemes with the ability both to ramp up services for one application and to deliver consistently high data transmission speeds for another application.

The design should be able to accommodate varied groups of users and visitors, who require different levels of privacy. It should be able to offer fully serviceable areas with minimum obstructions to obtaining the most advantageous layouts for individual projects. New design methods for conferencing, teaching and laboratories have achieved this by minimizing the number of fixtures in the spaces and opting for dividable spaces with modular pieces instead. As well, spaces should be able to accommodate the growing need for computers, data transmission capabilities and other electronic access throughout facilities. Fundamentally, researchers using the laboratories and other spaces at CHARS must be able to design the space to best suit their work and activities.

Flexibility in the selection of sites, space usage and facility operations should be key factors in the design direction for CHARS. Ever-changing protocols, technologies, and priorities will impose operational as well as architectural and engineering challenges that can only be met by reconfiguration and realignment of existing spaces. No determination on whether the facility should be one- or two-storey in nature has been made. This decision will be based on the evaluation of the cost effectiveness of options, the relative operational efficiency of the choices, the allowable building footprint on the chosen site(s), as well as input received from Cambridge Bay community consultations.

According to the *Whole Building Design Guide*, many private research companies make physical changes to an average of 25% of their labs each year. Most academic institutions annually change the layout of 5 to 10% of their labs.[1] In order for CHARS to accommodate the need for this level of flexibility, create an environment that encourages interaction among researchers from various disciplines, and minimize disruptions to ongoing work, laboratory modules should be used. These modules should initially be designed as wet labs so that in future reconfigurations the complete range of appropriate services can be drawn or excluded as needed. Opting for modularization would also help CHARS to easily adapt to expansions and contractions.

The accommodation of various users can also include "plugging in" moveable lab components. For example, incorporation of specifications for standardized shipping containers or the Canadian Coast Guard specifications for moveable lab components into the planning and design of the Station would allow for the direct interfacing and exchanging of modular container research labs.

Flexibility should also consider the international receptivity of the facility and the various technical needs that visitors and their equipment may need, such as power sources and different voltages.

Accommodations

Given that the number of users, their length of stay and the range of family members accompanying them will change regularly, and that furthermore, the need for accommodations at CHARS will change with the seasonal demand (typically highest in the summer), the accommodations at CHARS should also include the flexibility to reconfigure spaces.

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[1] Tolat, D., Watch, D. *Research Laboratory*, Whole Building Design Guide, National Institute of Building Sciences, http://www.wbdg.org/design/research_lab.php

Although total flexibility is neither practical nor achievable, every effort must be made from the very beginning of the design process to determine the kinds and extent of flexibility that can be practically incorporated.

7.2.3 Community Integration

The need for flexibility at CHARS relates not only to the realignment of operations to meet ongoing program changes but also to the broader community role in CHARS and vice versa. As a small Arctic community, Cambridge Bay has a certain scale and operational capacity. The introduction of major building components requires careful integration within the community so that secondary impacts such as community housing demand, existing utilities (water and electrical), and access to community services (health and recreational activities) are not compromised for the current residents. Planning for the introduction of CHARS into Cambridge Bay will need to include a review of community capacity. This review should also recognize those areas such as storage, recreation, and maintenance services which the community may be capable of providing for CHARS.

Leveraging existing community capacity can benefit both CHARS and Cambridge Bay. Provision of some Station services through existing or upgraded community infrastructure could not only reduce the overall CHARS building footprint, but it could also bring Cambridge Bay closer to the research community. The amalgamation of certain operational aspects of the Station could also promote job creation and the local economy.

Further community consultation with residents and organizations is necessary to identify partnership opportunities.

7.2.4 Quality of the Working Environment

Given the need for the Station to be kept up to stringent user protocols and safety standards, the quality of the work environment could be a design challenge given the difficulties inherent to an Arctic setting. Design considerations have evolved to include components such as maximum use of natural light to complement artificial light, appropriate use of sound insulation and flexible/moveable fixtures so that optimal working environments are supported.

The balance of natural and artificial light will be a critical factor in achieving a favourable working environment at CHARS, due to the 24 hours sun in the summer season and 24 hours of darkness in the winter season. Many structures in the high Arctic are now equipped with full spectrum lighting and blackout shutters to accommodate this range in natural light. While natural light is generally preferred for working areas, some lab work and specialized equipment cannot or should not be exposed to it. Planning of spaces will need to accommodate the requirement for these various working conditions.

The flexible nature of the work spaces, as described above, will also lend itself to promoting a quality work environment where users feel free to adapt the spaces in order to make themselves more comfortable. An important factor to the design should be the promotion of interaction between users, whether they are permanent staff or short-term visitors.

While scientists, engineers and students will form the largest user group for CHARS, other expected visitors to the facility could include school groups, politicians/diplomats, local community members, media and others. Considerations for visitors to the Station to see activities taking place will also need to ensure that researchers can work peacefully without constant interruption. Viewing stations and teaching lab spaces could be considered as some of the options for creating an open facility, while allowing work to proceed.

Acoustics is another factor that will play a vital role in the overall quality of the environment throughout the facility. In some spaces, including the laboratories and study areas, minimizing noise levels will be a significant factor in the success of the space. In other areas such as classrooms and auditoriums, ensuring that speakers can be easily heard will be of primary importance. In cases where viewing or observatory stations are present, the need for soundproofing will be necessary so that the viewers can converse freely while people within the other activity areas can continue to work. Sound insulation, absorption and projection materials/equipment will need to be incorporated throughout the spaces in order to manage the range of acoustical needs.

While these facilities will be non-smoking environments, consideration should be given to the fact that smokers will try and escape harsh Arctic winter conditions by clustering in entry ways and wind sheltered building nooks. This could result in unsightly debris at Station entries. As a solution, the Government of Canada Building in Iqaluit had a wind shelter installed, which took smoking away from the major public entries. It also served to accommodate materials deliveries in the winter.

7.3 Planning Considerations

Modern research facilities create environments that are responsive to present needs and capable of accommodating future demands. Since the specifics of the science and technology program have yet to be finalized, the Station should be designed to accommodate the widest possible range of S&T. All laboratories should be designed to have the capacity to be converted from dry labs into wet labs. This would be accomplished through the use of centralized service corridors which would connect the research areas and contain access to all of the water/plumbing, mechanical, electrical and ventilation needed to convert the labs to meet potential future program requirements.

While research methods, equipment and space layouts continue to evolve and should be taken into consideration, the following represent some of the current priorities and issues of note in modern laboratory planning.

7.3.1 Laboratory Furniture and Fixtures

Laboratory Furniture

- Mobile casework for storage and workstations helps ensure adaptability and flexibility.
- Adjustable shelving allows for maximum usage of the volume of lab space.
- Lab benches can and should be adaptable, interchangeable, and reconfigurable.

Fume Hoods, Biosafety Cabinets, and Local Exhaust Devices

- Low-flow fume hoods minimize make-up air requirements, a critical factor in terms of energy use in laboratories.
- Minimum size and type of cabinets to prevent recirculation of exhaust air in lab space. No chemicals or odorous materials should be used for this type of biosafety cabinet.
- Specialized local exhaust devices capture fumes and exhaust from local equipment, without requiring complete volume air change of a space.

Sharing of Space and Equipment

- The possibility of common or central lab equipment such as fume hoods and biosafety cabinets should be explored to maximize sharing.
- The appropriate balance of open and closed labs and support spaces helps to foster interaction and team based research while creating an open social atmosphere at the lab. This is especially important in an Arctic location where many of the initial CHARS researchers may be from southern Canada and a large portion of the year will be in darkness.
    - Open lab layouts encourage collaborative and team approaches. It allows more flexibility in design and reduces costs over the life of the facility. They have other issues that must be addressed such as housekeeping of the common fume hoods and other chemical and storage areas; greater probability of risks from spills and leaks; and, security and privacy concerns.
    - Closed lab layouts are helpful for ensuring unique environmental controls and processes, greater security and noise reduction when absolutely required. It allows for different types of occupancy and thus greater energy saving; single source of responsibility of the area; more privacy; containment of spills and leaks; and clean room environments. However, it could become space that is

non-productive when unoccupied; take up more floor space; and entail greater construction costs.

7.3.2 Sustainability and Efficiency

Natural Daylight

- Utilizing natural daylight reduces electrical energy use, and has been shown to improve comfort and productivity.
- The amount of glazing should be optimized by energy analysis programs for day lighting requirements for the least amount of energy use and, given local climate conditions.

Environmental Sustainability

- The green initiative and sustainable design of the laboratory should be based on the LABS21 EPC (environmental performance criteria), which is rating system based on the LEED-NC Version Rating System. It outlines ratings for the different initiatives such as sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation and design process. It does not, however, specify the threshold values for the respective silver, gold and platinum levels. The EPC is a comprehensive and powerful design criteria tool that should be used in the design of the laboratory.

Energy Conservation

- High efficiency equipment should be utilized.
- Application of variable-frequency drives on motors helps to vary energy supply to meet system demand. They are very common and should be implemented.
- Air distribution systems and components should experience minimal low pressure drops.
- Energy recovery for exhaust air reduces air heating requirements.
- Application of outdoor air for free cooling reduces or eliminates the need for mechanical cooling.
- Manifolding of fume hood exhaust allows for proper dilution and dispersion, which is especially important in cold climates.
- Right-sizing of prime movers, such as boilers and air handling units, can reduce premature wear and excessive fuel consumption.
- The number of air changes for a given space should correlate with occupancy levels and system demand.
- Locating high heat-generating equipment in a common shared space allows for easier environmental control.
- Consideration should be given to the minimal number and size of fume hoods required to deliver the S&T program activities.

Water Efficiency

- Equipment process water should be in a closed-loop recirculation system, rather than an open-loop system.
- Equipment that uses minimum process water is preferable to equipment with high water demands.
- Grey water and treated black water should be recycled where appropriate. For instance, grey water can be used in flushing toilets while heat recovery from black water can be used to preheat incoming cold water.

Effluent Waste Disposal

- A standard operating procedure should be created to prohibit disposal of chemicals and biological effluents through drainage without proper treatment.
- Options should be investigated to mitigate sewage treatment issues.
- Fail safe systems are essential given the possibility of power failures and limited capacity of local water treatment to handle S&T waste.

7.3.3 Communications

Telecommunications

- The use of and reliance on high speed telecommunications is especially important for research in the Arctic. Communications between labs and buildings within Cambridge Bay and the rest of the world will allow immediate multisite networking, which could reinforce and promote partnerships between Northerners, governments, private sector and academia.
- Depending on the bandwidth strategies, the use of video conferencing technologies may also play a central role in bringing CHARS to an international audience.
- Presently, satellite links are the common method for accessing high speed telecommunications. Installing fibre optic cable through the Northwest Passage has received some attention by the private sector. Consideration should be given in the design of CHARS telecommunication systems to allow easy connection to any possible undersea cabling, as well as other innovative telecommunications options such as satellite advances.

Voice Communications

- A building-wide voice communication system should be provided to facilitate emergency operations procedures. This should be linked to an emergency power source.
- Each lab should be equipped with an intercom to provide emergency voice communications to security staff, who will in turn communicate necessary emergency measures.

7.3.4 Flexibility

- A modular concept for architectural, structural, mechanical and electrical systems will ensure ease of adaptability and modification to meet new program needs.
- Spare capacity should be provided for future loads such as fume hoods and biosafety cabinets.
- Space should allow for installation of new equipment including major future floor load changes.
- Planning should include consideration for future building expansion.
- Workspaces should be flexible, to adapt to changes in research protocols, methods and equipment. The use of 'plug and play' planning for not only lab equipment but entire container labs (such as the Canadian Coast Guard specifications for Modular Payloads) can be used to support research programming across many distinct locations both at CHARS and in other facilities.

7.3.5 Maintainability

Maintenance

- Sufficient spaces should be provided to maintain equipment, to enhance system reliability and operation and maintenance.
- Built-in redundancy should be provided for critical components that are essential for:
  - basic laboratory operations to ensure protection of S&T (e.g. power generators for water circulation in a marine lab or for IT), and,
  - protection of users, including heating and air quality.
- Layouts of mechanical and electrical distribution systems should allow for daily maintenance without interruption and interference of on-going lab activities.
- Systems and automatic building controls should be simple to use and easy to maintain.
- Industrial grade components should be specified to improve system reliability, where appropriate.

Commissioning

- Systems should be properly and thoroughly commissioned prior to take-over of the facility.
- Prospective maintenance staff should involve the commissioning activities as part of training exercises.

7.3.6 Security

Security at the Reception Desk

- The reception area should be located so that all persons entering the building from the public entrance must walk past the desk to gain access to operational areas.

- The desk should hold monitors for the closed circuit television camera system, an access control computer, and a regular Station LAN computer. These should be installed in a lockable cupboard, which can be secured in the absence of a guard on duty.

Entry Points

- Staff and visitor parking should be provided within the main parking area. Visitors will gain access to secure areas through security staff at the reception desk.
- Only designated staff and approved visitors should be granted access to non-public areas outside of working hours. An intercom/CCTV camera connecting the secure areas to the reception desk area is required.
- An entrance adjacent to the loading area could serve as the entrance for all delivery personnel. This entrance should open into a secure vestibule, which will be equipped with a camera/intercom connected to the shipping/receiving room and the main security reception desk.
- Entry points to the building can be located at public entrances, shipping and receiving areas, staff entrances, and emergency exits (as required for code conformance)

Security Devices

- The electronic security system should be comprised of electronic intrusion alarms, electronic door locks, motion detectors, and card readers (swipe and proximity readers).
- All controlled access points should be electronically connected to a central monitoring system, so that access to and from areas can both be programmed and recorded. All closed circuit surveillance should be connected to a central CCTV system and recorded.
- All controllers must be served from the electrical distribution circuits with emergency power backup and all access control systems must be supported with UPS power supply.
- The central security control panel should be located in the (controlled access) electrical room. This panel would be used to control the status of systems including security monitors, alarms, controlled access points, emergency communications systems.
- Security camera monitors should be located at the reception desk. The monitors will enable surveillance of threats and/or incidents and expedite immediate response time.
- All exterior locksets should be equipped with High Security keyways.

Exterior Glazing

- Exterior window glazing in secure areas should be treated to prevent entry.

Fire Protection

- Passive and active fire suppression systems are critical as piped water service is not available everywhere in Cambridge Bay and fire fighting services are limited.
- Passive systems include fire stopping measures, fire dampers, and non-combustible materials and finishes.
- Active measures include hand held fire extinguishers, tank-supplied sprinkler system, and proper ventilation systems.
- The incorporation of a sprinkler system would require construction of a substantial cistern for holding the system water supply. This cistern would require easy exterior filling stations as well as hatches for inspection, cleaning and general maintenance.
- The system would most likely require water pressurization through mechanical pumping, which would have to be on a secure and possibly dedicated emergency power system. Due to the requirements for sprinklers in the building(s), the building code does not allow for construction above two storeys.
- Many non-combustible materials may have been treated with volatile organic chemicals. Therefore the need for fire safety has to be balanced with the requirement for superior indoor air quality.

7.4 Codes, Regulations, Standards & Guidelines

A number of codes, regulations, standards and guidelines will apply to CHARS. A list of these can be found in Annex D.

On route to Ovayok Territorial Park from Cambridge Bay

8. DESCRIPTIONS OF SPACES

Arctic ice and snow formations

8.1 Accommodation Survey

The following accommodation survey provides a list of potential spaces that would make up CHARS. This list of spaces will be further refined and the size of each area will be determined during the design phase, primarily through the development of the S&T program and consultations with stakeholders.

Table 3: Preliminary accommodation survey for CHARS

Program Component	
1 Laboratory Space	
1A Wet Labs – Modular	
	Snow / Ice Cold Lab
	Animal Sample Lab
	Soils & Geology
	Microbiology
	Health Lab
1B Dry Labs – Modular	
	Clean Lab
	Atmospheric
	Analytical
	Environmental Toxicology
	Social science lab
1C Marine Labs – Modular	
	Marine Lab / Aquaria

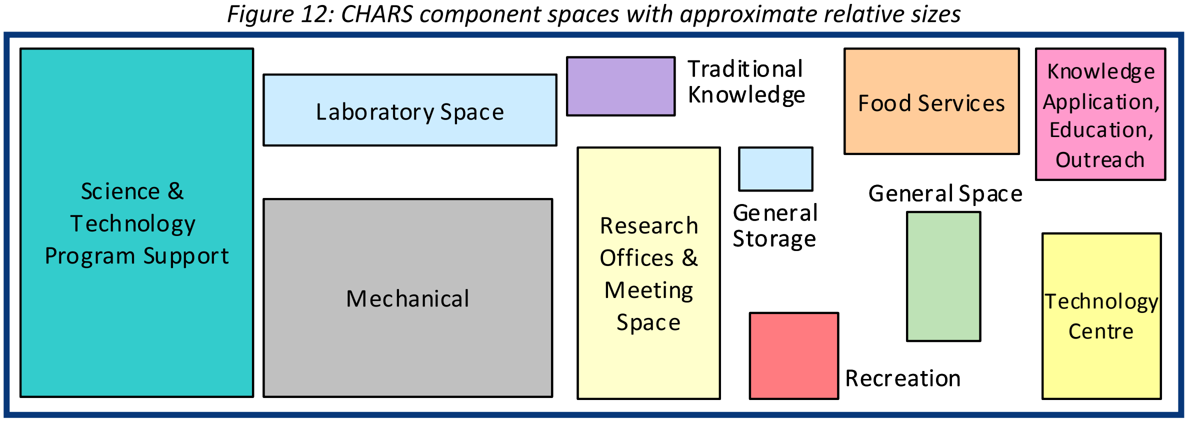
	Rough Lab
1D Computer Labs – Modular	
	Computer lab
	GIS
	Computer Lab Support
	E-Learning
2 Technology Centre	
2A Computer Lab – Modular	
2B Dry Lab – Modular	
2C Workshops	
	Workshop - Dry lab module - electrical
	Workshop -Dry lab module -mechanical
2D Logistics	
	Field Services
	Admin
2E Field Cabins / Monitoring Stations	
	Experimental Sites
3 Knowledge Application, Education & Outreach	
3A Conference and Meetings	
	Multi-purpose auditorium/conference room
	Interview rooms
3B Media	
	Display area
	Media centre/broadcast room
	Library
3C Teaching classroom/lab – wet lab	
4 S&T Program Support	
4A Plant Research	
	Greenhouse
	Growth chamber - controlled environment room
4B Research Support	
	Glass wash, autoclave & storage
	Freezers & Refrigerators
	Chemical Storage
	Gas Storage
4C Preparation	
	Diving facility
	Rock prep room
	Dock
4D Examination Rooms	
4E Dry Lab	
	Balance room
	Digital imaging/ microscope room
4F Storage	

	Equipment storage
	Vessel storage
	Sample Archives
4G Logistics	
	Field Services
	Research Vessel
4H Field Cabins	
	Monitoring Station / Field Cabin
	Plug& Play Lab
5 Research Offices & Meeting Space	
5A Research	
	single offices
	2-person shared offices
	4-person shared offices
5B Meeting Rooms	
	6-person meeting room
	12-person meeting room
	Coffee break rooms (4-person room)
6 Traditional Knowledge Centre	
	single offices
	2-person shared offices
	6-person meeting room
	12-person meeting room
7 Common areas	
	Medical Office
8 General Storage	
	General
	Clerical
	Admin
	Secure
9 General Space	
9A Common Space	
	Entry / Vestibule
	Reception / Atrium
	Commercial space
	Display space
9B Office Space	
	Coats / Boots storage
	Administration Offices
	Photocopy area
10 Recreation	
	Exercise Room
	Entertainment Room
11 Food Services	
11A Kitchen	

11B Food Services Storage	
	Dry kitchen storage
	Cool kitchen storage
	Cold kitchen storage
	Perishable kitchen storage
	Receiving dock
	Pantry
11C Dining Area (multi-purpose)	
12 Mechanical & Maintenance Services	
12A Operations Office	
12B Mechanical & Electrical Equipment	
	Mechanical Room
	Ventilation / HR
	Main electrical
	Local electrical
	Water storage
	Water recycling
	Fire water storage
	Energy Generation
12C Operations & Maintenance Services	
	Composting / incinerator
	Garbage
	Recycling
	Janitorial Storage
	Maintenance Garage
13 Accommodations	

8.2 Component Spaces

Figure 12: CHARS component spaces with approximate relative sizes



The different component spaces related to science, technology and CHARS operations are shown in the figure above with preliminary relative sizes.

The major component areas are visited in turn, in each of the following sections.

8.2.1 Laboratory Components

Core S&T activities will take place in the modular laboratory spaces, traditional knowledge centre, and technology centre and in the field. Technology development at CHARS will occur in the workshops, precision labs and business incubation areas. Technology development is seen as a major link to the private sector, especially in the natural resource sectors, of which there are a number close to Cambridge Bay. Technology development is also seen as a potential link to community resources such as workshops, maintenance areas, storage areas, etc.

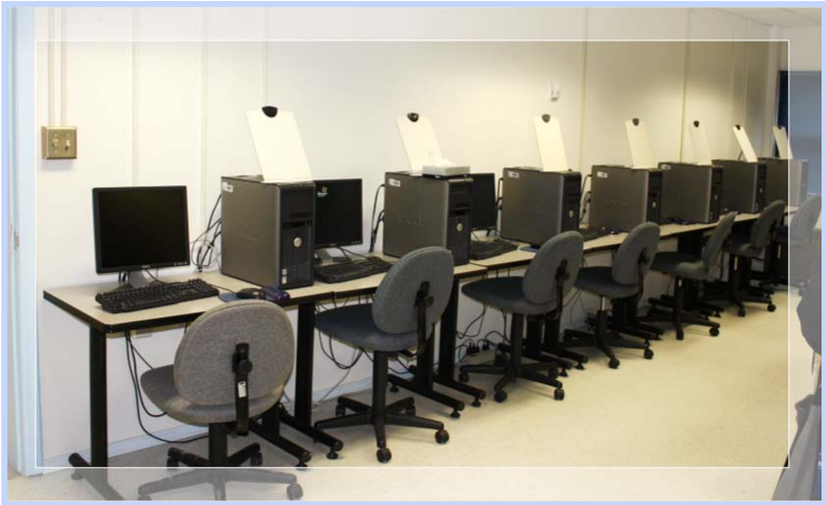
It is expected that these spaces will be used by both CHARS staff and external users from the public, private, academic and international sectors. Security and access issues should be determined through consultation and specific user needs.

Stakeholder consultations, partnership opportunities and a refined S&T program will help inform the general needs for each module. For instance, health related research could be done in partnership with the health centre in Cambridge Bay. Consultations with Aboriginal organizations will also be used to develop the requirements for the traditional knowledge space.

8.2.2 Laboratory Support Components

The laboratory support spaces include equipment rooms with specific environmental needs, data management, telecommunications and storage. Consideration will also be given to the types of vehicles and research vessels that would support the work at CHARS.

In particular, data management and analysis is considered an integral aspect of Arctic research. For many researchers from southern Canada, it is conducted in southern academic locations. With the goal of having visiting researchers conduct the majority of their work at the CHARS facility, the spaces dedicated to computer services and data archives will be considered as priority areas.



Arctic College computer room – plan to make facility wireless in order to save space and provide better access to students

Telehealth room at the Cambridge Bay health centre

This will include the capacity or bandwidth to undertake the storage and processing of data that is required. The proposed data management space may include not only the data generated by CHARS staff and visitors but also access to Arctic information kept at other facilities.

Effective high speed telecommunications are essential to allow researchers to communicate and network with other researchers across Canada and internationally. This will also allow the Station to be accessible by the general Canadian public through any interactive web applications that are implemented.

Storage is another crucial aspect of Arctic research. Travel costs are often the largest component of Arctic research projects and as a cost saving measure, researchers often opt to send equipment ahead of time by sealift and/or leave the equipment at a research facility for the duration of the project (which can sometimes be several years). As with the data management goal of encouraging on-site work, the Station should also have a variety of storage available for equipment as well as researcher needs. Temperature controlled environments such as freezers, cold and heated storage spaces should be available to researchers as well as more specialized storage areas such as biological, chemical and glassware storage.

8.2.3 Education, Training & Outreach Components

Education, Training & Outreach spaces should be designed to create an inviting environment for the general public of all ages be designed to help bridge the division between researchers and non-researchers.

Spaces outfitted with the appropriate equipment for translation services would ensure that Northerners as well as international visitors are able to comfortably and effectively participate in conferences, workshops, joint meetings and traditional knowledge and/or cultural activities. Larger meeting spaces such as an auditorium and classrooms of different sizes could facilitate the ability for CHARS to offer teaching opportunities, workshops, conferences, and support other group gatherings. Teaching/training space would be used for the dual purpose of providing researchers with equipment and safety training and expanding the available meeting space for outreach and engagement activities.

Interview and observation rooms should be available to staff and other researchers conducting social science research.

These spaces could form one of the key links to the broader hosting community and as such, should be both inviting and attuned to traditional and community usage of interior spaces such as this. In particular, the education and outreach spaces should present opportunities for all ages and sectors of the community to participate in Station activities. Some of these spaces could be available for use by the community or other groups when not fully occupied by CHARS activities, further strengthening community involvement.

8.2.4 Office & Office Support Components

Day-to-day operations of the Station, staff work areas and temporary space for researchers should be supported by offices and other business supports such as photocopying, scanning and faxing. These spaces should be used for ongoing operations and maintenance of the CHARS buildings and program activities. Business operations in support of the overall programming should include the management of supplies, records management and telephone services. To accommodate the varying needs of administration, staff researchers and temporary visitors, office space could be available in both open and closed formats with varying access levels. Office supplies and photocopy services would be available to all users.

Formal office space is required not only to support the day-to-day operations of the Station but also to provide space for researchers to consolidate and interpret field and laboratory data, prepare reports and generally organize research materials. These offices should be integrated with the laboratory spaces as they are core to S&T activities.

At times, the offices may not be fully occupied so space demands can easily be met, at other times (notably during the busy summer research season), offices may need to be shared and at the busiest times, researchers may have to make use of their rooms, the lounge, library, study nooks and other open spaces for their work. The challenge in designing the office space will be to view the staff fluctuations and lab flexibility as an ongoing design opportunity.

8.2.5 Living & Recreation Components

A variety of users is expected at the facility, from transients to short-term visitors to resident staff. Projects could be as short as a few days with a single transient user or as long as five years for a research manager with their family. A variety of living spaces should be part of CHARS to accommodate these needs.

Accommodations for permanent staff and short-term and long-term visitors should be available. As part of the strategy to encourage researchers to conduct all aspects of work on site, length of stay will correlate to the type of accommodation available to them (i.e. the longer the stay, the larger and/or more private the accommodation). Laundry facilities will be among the service/spaces in the living components.

Kitchen, dining and food storage areas complement the activities of both the accommodation spaces and the meeting/conferencing spaces. The dining room could be used as swing space for additional meeting, conference, or recreation activities. Dry goods are expected to be ordered and shipped through the sealift and will require a large storage space to house the year's worth of supplies.

Recreation spaces will also be part of CHARS. A fitness area, lounge, entertainment room, quiet room and study nooks can be appropriately integrated into the overall layout so that visitors will be able to meet informally.

In addition to the potential integration of some of the living and recreational spaces into the existing community infrastructure, there is also an opportunity to use a portion of the accommodation requirement as an Arctic housing research platform or demonstration site. The Canadian Mortgage and Housing Company is currently seeking an opportunity to use housing in the Arctic to evaluate building and energy systems. Discussions are underway on a proposal to construct two, four bedroom single family houses as part of the accommodation requirement for CHARS. While these units could help to meet the overall housing needs of the Station, they would also be designed in a way to allow future structural modification. For example, instrumentation and sensors would be used to monitor the performance of various wall systems within such a house. This platform would allow long-term monitoring and testing of a variety of housing components, materials and energy systems as well as act as a demonstration centre for new and emerging technologies.

8.2.6 Community and Commercial Components

A display area, showing Arctic wildlife and traditional Inuit technology

In Cambridge Bay, a study of existing infrastructure such as accommodation, recreation, and catering services will help ascertain what spaces CHARS could complement and/or if there are spaces that could be upgraded. For the recreation spaces in particular, negotiations with the community could be pursued to obtain *quid pro quo* arrangements so that community members can further benefit from CHARS and that Station visitors have greater access to community infrastructure.

Commercial space could also be available within the Station for rental and development by interested parties.

These spaces should be designed in conjunction with the main access points in order to provide maximum visibility and integration into Station operations. Close proximity to display areas and the entry/reception areas could provide additional benefits to businesses locating within CHARS.

An alternative approach to the commercial space may be to include it as a part of an existing commercial enterprise within the community.

8.2.7 Building Support & Mechanical Components

Mechanical/electrical spaces, waste and water services, and energy generation will account for a significant part of the overall Station in terms of infrastructure and operating budget. The design and construction phases should seek out the best from traditional and alternative methods to attain the highest efficiency, have the best environmental footprint possible, and to act as a demonstration centre to inspire changes to building approaches in Arctic communities. The necessity for redundancy of systems also increases the space that will be required for essential building supports and mechanical components.

Research staff and visitors are not expected to have general access to these areas. An exception to this is where the spaces are being used for experimental testing of products or are part of a monitoring program.

Traditionally, having dedicated service corridors has resulted in easy supply of services to the lab areas. These corridors allow for regular maintenance and future reconfiguration of lab services without major construction disturbances to lab operations. Another approach could be to include services in an extra wide and high ceiling, which could also undergo maintenance or alterations without disturbing lab operations.

8.2.8 Logistical Components

A major component in any polar research program is the logistics required to bring research staff and materials to the research sites. The Polar Continental Shelf Project (PCSP) in Resolute Bay devotes a major portion of their operations to the delivery of research teams to their sites through the use of chartered aircraft, vehicles, and boats. PCSP has demonstrated that logistics also requires a huge amount of field equipment storage and maintenance capacity. This capacity has been itemized for CHARS through the storage, workshop, and maintenance areas.

Further to the storage of equipment and delivery of researchers to their sites, logistics also encompasses the monitoring of all researchers in the field. Daily radio contact between PCSP and field personnel is considered an absolute necessity. This contact is used to monitor the well being of the team, verify pick up schedules and provide weather updates. Additionally, as part of the logistics, the pilots, boat personnel and researchers are given daily weather briefings before they leave PCSP for the field.

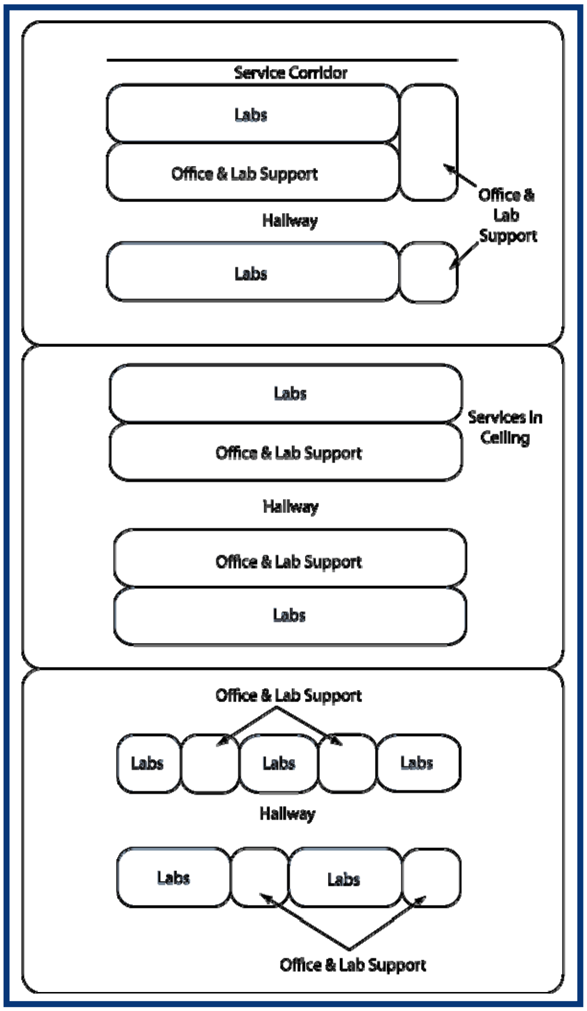
This planning and monitoring function requires spaces that can accommodate telecommunications equipment (such as station-to-field and station-to-aircraft), weather monitoring and forecasting equipment, a briefing room for up to twenty people and space for maps, charts, and other equipment such as satellite phones.

8.3 Adjacency Relationships

8.3.1 Generic Layouts

Lab research operations are generally organized around four components:
- Labs
- Offices and lab support spaces
- Utilities and Other Services
- Staff Access

Figure 13: Adjacency relationships-generic approaches



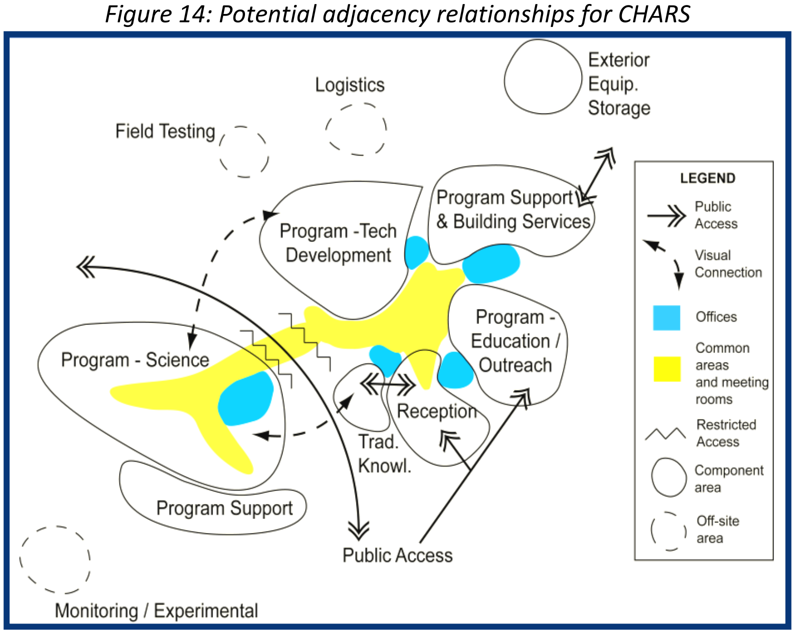
A traditional layout is illustrated in the first diagram, with offices located off a central staff hallway and adjacent to the labs. Support spaces are organized in proximity to the labs with servicing of the labs from a separate service corridor. This layout allows for simple structural configuration of the building but does not promote interdisciplinary discussion.

The second generic layout is similar to the first, with the exception that the services are located at the ceiling level. This requires a higher floor to ceiling height and usually wider staff hallways.

The third layout illustrates a more integrated lab and support space approach. This allows for the offices and support spaces to act as defining partitions for open-plan labs. This layout generally also requires higher ceilings for services, and is more flexible than the first two. It allows for easier adaptation to research program changes and promotes greater interaction amongst research staff from different programs.

8.3.2 Schematic Layouts

Figure 14: Potential adjacency relationships for CHARS

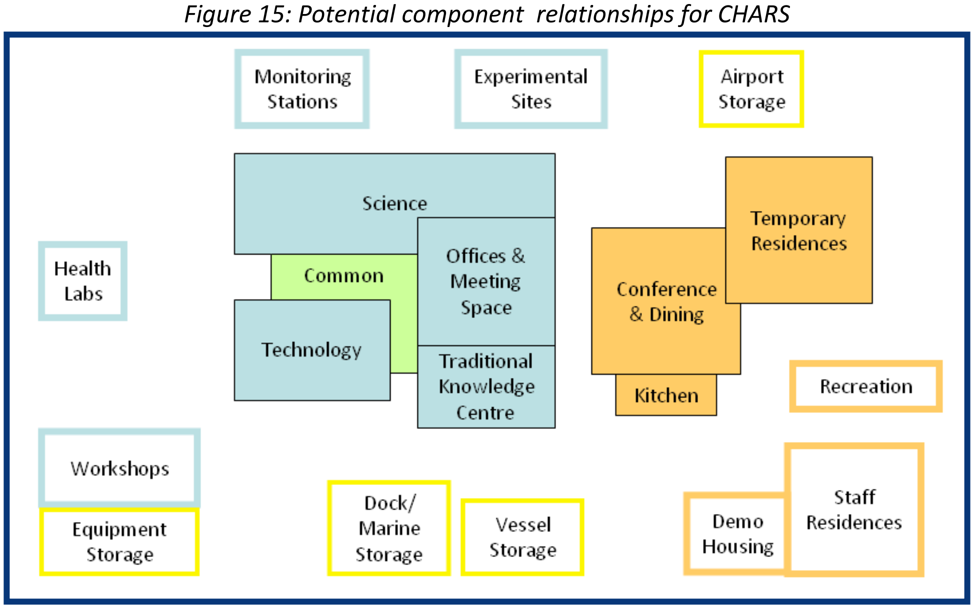


In the schematic on the previous page, a dispersion of offices are adjacent to the research program areas and the common areas flow throughout the program areas. The intent is to encourage interaction amongst both the research staff and operational staff. In this vein, although some elements are illustrated as separate units, all of the areas are expected to have strong interactions. For instance, the traditional knowledge centre and education/outreach spaces are near the reception space, this promotes the idea that the community is expected to access and use these areas.

Additionally, locating the Station 'on a community pathway' encourages the community to be a part of Station activities. Visual links to some select program areas further encourage interaction & participation.

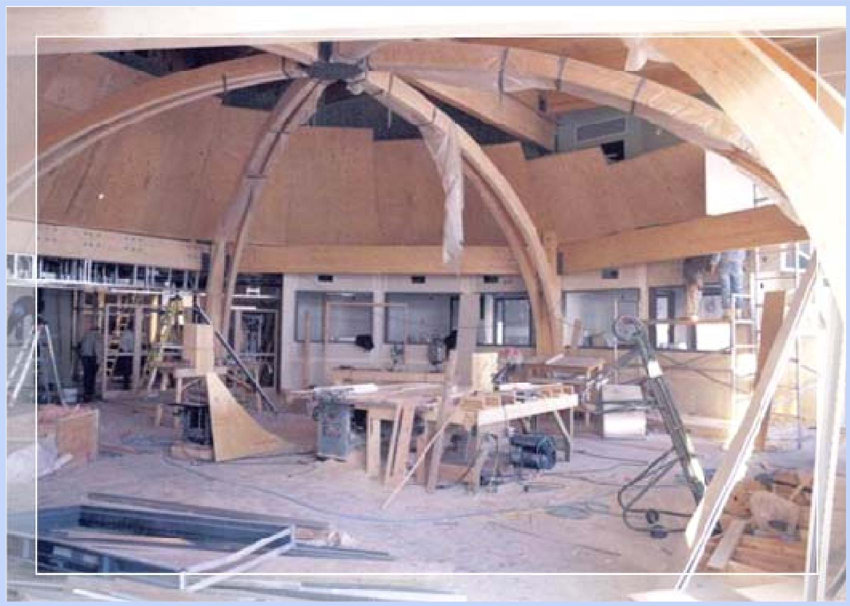
Further refining the relationships between the Station component areas and the community, the areas defined as solid colours below form the core functions for the Station with the outlined areas identifying potential services for delivery by the other organizations.

Figure 15: Potential component relationships for CHARS



The final balance of spaces and services integrated into or delivered by the community versus those to be located at the main Station will be determined through community consultations during the design phase.

9. TECHNICAL REQUIREMENTS



Nunavut Legislature under construction. The structure evokes traditional Inuit building forms.

9.1 Architectural Requirements

The architectural approach to CHARS provides both opportunities and challenges which are not normally part of a design program. As a world class research station, an immediate design response is to raise the Canadian flag by conceiving a facility that frames a building within an Arctic environment. It is important to provide an image of a federal presence that is strong and supportive without being dominating. The challenge is to recognize that the Arctic is rich in culture, resources and history, and thus requires immense respect. As evidenced by early explorers, lack of respect for something as fundamental as the Arctic climate can have severe consequences. This Station represents a new chapter in the exploration of science and technology in the Canadian Arctic by both those native and non-native to the environment.

The Station should provide a showcase for CHARS' cultural, scientific and technological outputs, and foster community interest in the Station's work. The Station should be welcoming in scale so the community is encouraged to visit and use the facility. Station planning should allow youth and students to observe some operations at the Station, in order to help develop their interests in science. The main public entry to the Station should be a bright and open space which welcomes visitors, incorporates displays about research at the Station, and has building materials and decoration that relate to the Arctic environment.

While CHARS will make an international statement on Canadian research in its Arctic, it will also provide an architectural façade relating to the culture of the North. The design of CHARS must therefore reflect an understanding of the scale, resources and other community factors unique to Cambridge Bay.

CHARS should engage and intrigue the research communities both nationally and internationally. As a campus of resources, the Station should present researchers with the opportunity to deliver sound results through the use of quality equipment and communications technologies. The Station should further intrigue the research community as an example of how the resources of Cambridge Bay can reinforce science and technology development. This can include the exploration of building form, energy efficiency, and construction methods for polar environments. As an example, the Canada Mortgage and Housing Corporation has been engaged to help in the design housing that will test structure and building envelopes, while it serves as accommodation for Station staff.

The reality of the Arctic environment consists of long periods of darkness against summers of intense light; therefore the interiors of the Station should celebrate access to natural light and views of the landscape in a way that recognizes both extremes. Since sustainability is a major goal for the Station, the designers will have to carefully and creatively weight the building interior design priorities and the issues relating to the Arctic environment.

Beyond the relationship of the Station to Cambridge Bay, staff and users should feel a sense of community amongst themselves. The interior spaces should promote interaction and cross-disciplinary discussion. As much as possible, common areas such as hallways should be viewed as organic spaces which incorporate areas for reflection, study and discussion. While the lab areas require conformance with a variety of codes, regulations and operational/servicing constraints, the interstitial spaces provide important occasions to explore informal links within the research community. An informal “interior street” could offer glimpses of both the exterior landscape and interior working areas, and keep the Station tuned into the Arctic environment.

In combination with the integration of some Station functions within the community, the organization of common spaces within the research areas will complement an overall view of Cambridge Bay as a research community. A careful consideration of the role of potential off-site components such as storage, maintenance areas, and recreation facilities will have to be completed, to provide both the functional/operational priorities as well as the connection to overall community planning structure. An area such as a coffee shop or restaurant, potentially in conjunction with Arctic College facilities, could act as a catalyst for discussions between residents and researchers. Resource planning and use, as well as human interaction, are important aspects for any conceptual approach and design development in Polar Regions.

The description that best summarizes the approach to research is from the 2007 *Speech from the Throne*: A world class research station in Canada's Arctic that is on the cutting edge of Arctic issues.

9.2 Site Planning and Landscaping

The Station buildings should consider the natural features of the site, including topography, wind patterns and solar access. Landscaping and site development will promote the natural environment through the use of indigenous materials and plantings.

As part of the CHARS building design, future development of the Station should be identified as part of the overall plan. This could include not only immediate site planning options for extensions to the Station, but also the relationship of future extensions/renovations to Cambridge Bay community planning. It is important to establish a formal expansion plan for the Station that outlines the planning opportunities and constraints, as it will set out the capacity of CHARS to effortlessly meet unexpected future S&T programming demands.

9.3 Structural and Building Envelope

Structural design in the Arctic is determined by the topography and site conditions. For example, ad-freeze piles may be more appropriate for uneven terrain while thermosyphon slabs work better for flat well drained sites. Choices of structural systems will also have an effect on interior finishing, as wood post and beam framing lends itself more to exposing the interior structure, while steel framing is generally a better fit for areas that require continuous wall covering (i.e. drywall).

Where applicable, exposing the Station's structure could be used to reinforce the relationship between the buildings and the practical nature of research. Some areas such as main entry lobbies, conference areas, and common hallways, may also benefit from the juxtaposition of wood and concrete structural elements.

Steel frame construction in Cambridge Bay

Due to the variety of terrain and Station functions, the building(s) will probably incorporate a number of foundation systems including pilings for structures elevated above the permafrost and thermo siphons for large concrete slabs at grade.

The level of building rigidity and stiffness is directly related to construction methods and will depend on the functions within the space. For example, most non-research areas do not require a high floor stiffness; conversely, labs that support the operation of optical microscopes to 1000X require intensive vibration control. In order to forecast future research work, one lab module should be designed to even higher vibration resistance levels. This may require independent foundations possibly located on bedrock.

All large, fixed equipment areas should be located so that minimum structural or building alterations are required in order to replace the equipment.

The building envelope should be designed to allow easy reconfiguration of research areas, particularly the labs. The technology development areas should be constructed to allow testing and monitoring of building construction techniques as part of the Station envelope.

9.4 Mechanical Systems

Methods to improve efficiency and comfort are a cost-effective way of increasing productivity and reducing fuel consumption. The HVAC systems of CHARS must not be added as an afterthought[2], these systems are integral to the efficient operation of a building. Failure to properly size and place HVAC equipment could result in excess fuel use, user discomfort, and premature wear.

One common option for HVAC systems is a decoupled air/water system using a discrete heating plant and traditional ventilation. Heat recovery measures such as enthalpy wheels should be employed to reduce heating requirements. Generally, heat is provided through oil-fired burners in the North. Electric heating through resistive heaters is not recommended due to the high cost of electricity. Furthermore, biomass is not yet commercially available in the high Arctic; however, in other Northern facilities such as the North Slave Correctional Facility, wood-pellet boilers for heating have been very successful. The main consideration with this option is supply chain management and logistics.

Free cooling and operable windows are usually sufficient to maintain user comfort during the summer, but needs to be balanced against codes and standards for safe laboratory operation. CHARS will likely contain a high amount of heat-generating process loads, such as computers, other electronic and lab equipment, and freezers.

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[2] Laboratories for the 21st Century: An Introduction to Low-Energy Design", U.S. Department of Energy. Available http: www.labs21century.gov/pdf/lowenergy_508.pdf.

Efforts should be made to cool these loads passively when required, and utilize heat recovery in the colder seasons.

Demand control ventilation is common in the Arctic and could be a good way for CHARS to ensure energy efficiency and user comfort. There will likely be a wide range in occupancy, particularly on an hourly and seasonal basis, and so it is important to adjust ventilation requirements accordingly. CO_2 sensors could be used for this purpose.
A digital control network for building mechanical systems will help ensure high system reliability and energy efficiency. These systems have become quite common, even in the high Arctic, and should be incorporated into CHARS. Real-time monitoring of building and system performance would help optimize the mechanical systems of the facility.

9.5 Plumbing & Water Services

Northern plumbing examples

Cambridge Bay is dependent on trucked freshwater services supplied from a lake just outside the community. Freshwater for the Station will likely come from the same source as the community. Other research water systems, such as saltwater from the sea, will likely be plumbed from the neighbouring inlet. Additionally, there could be a need for de-ionized and distilled water which could either be plumbed into the central service corridor or manufactured within one of the lab support areas. Small water treatment plants are technically, financially and maintenance intensive and may not be feasible, but could serve to help lower the environmental footprint of the Station.

There will be a need for freshwater storage, both to supply the operational needs of the Station as well as for the fire protection system. Typically in an Arctic community, water storage is accomplished through the use of large storage tanks located within a building crawlspace or as an insulated tank sitting on the ground outside of the building. The quantity of water required to meet the Station demands will challenge the designers to incorporate large swimming pool-type cisterns within the building structure.

Every effort should be made to reduce water consumption at the facility, especially in light of potentially limited water infrastructure in Cambridge Bay. Easily implemented measures to reduce water use include low-flow showers and faucets with automatic shut-off, low-flow toilets utilizing grey water re-use, waterless urinals, and composting toilets. Flat plate solar collectors could be used for domestic hot water, to reduce energy demand, however, this technology has not seen much penetration in the Arctic, and contemporary hot water heating is generally provided by winterized diesel oil. On-demand hot water heating, may reduce the overall fuel requirements by removing the need for storage of hot water when not in use. As in the case of the mechanical systems, right-sizing of equipment is integral to proper and efficient functioning of hot water and plumbing systems.

There are limited requirements for storm water systems and roof drainage due to low precipitation levels. Climate change models should be consulted to examine how annual precipitation levels could change over time.

9.6 Sewage Treatment

Sewage treatment is perhaps the greatest environmental challenge faced by all Arctic communities. Most communities dispose of sewage in a lagoon. These lagoons remain on the landscape and with climate change and melting permafrost, may pose future problems if allowed to migrate into adjacent watercourses.

Sewage handling for the Station will be particularly challenging as it may include chemicals and substances which should not be released into a normal Arctic sewage lagoon. Station sewage also provides an opportunity into both disposal and other uses such as waste heat harvesting.

Presently, Cambridge Bay pumps sewage out by truck and hauls it to a lagoon, located on the tundra outside the community. In light of the commitment to sustainable development, measures should be undertaken to, at a minimum, reduce the amount of sewage outputs from the Station. Separation and containment of laboratory chemicals from the main sewage stream is critical at CHARS to avoid environmental damage. Furthermore, sewage costs can be reduced by using double drain systems in laboratories, grey water re-use, and possible on-site sewage treatment solutions.

The treatment of sewage also offers interaction possibilities with the private sectors involved in mining and exploration. Since Cambridge Bay is located adjacent to several Arctic resource exploration and development areas, technology development and testing of small scale waste water treatment systems may benefit CHARS, the private sector, and Arctic communities.

9.7 Electrical Systems

Cambridge Bay, like all Nunavut communities, is not part of a larger electrical grid. Consequently, there are more power supply anomalies such as brown-outs and black-outs than in the South. To meet code requirements, as well as the needs of some precise S&T equipment and experiments for high quality, uninterrupted power, CHARS should be outfitted with proper emergency power supplies and regulators. Uninterruptible power supply (UPS) systems are mandatory for certain research requirements, as well as for emergency lighting and fire fighting equipment such as fire pumps and alarms. Surge suppression is also necessary for sensitive equipment.

Electrical services in Cambridge Bay tend to be supplied by overhead distribution lines from existing utilities. As a research facility with significant power requirements, CHARS will likely require augmentation to the local utilities. This can take the form of either on-site power generation or upgrades to the community infrastructure. The use of alternate energy sources, such as wind or solar may be applicable for supplying additional electrical power to both the Station and the community.

There is a preference in many Nunavut communities for 208V power supply (not 220V), due to the lack of trained electrical workers with experience in higher voltages. This reinforces the need for CHARS to have trained in-house electrical staff to maintain research and industrial equipment that has higher or non-standard power requirements. This may represent a good training opportunity for the local labour pool. It is also important to have the electrical services to research and technology areas organized so that future fit-ups accommodate non-standard equipment electrical needs.

9.8 Security

The location for CHARS, coupled with the interest to promote community participation at the Station makes strict definition of security zones a program-by-program discussion. The traditional knowledge area and even some of the administrative and office areas may have lower security requirements than labs which are handling sensitive substances. For this reason, the discussion of requirements should focus on the potential types of security areas, with the specifics being defined to meet the ongoing development of the S&T program.

Security zones
The following classifications describe different potential levels of security throughout the facility:

- Public zones: The public has unimpeded access and generally surrounds or forms part of a government facility

- Reception zones: The transition from a public zone to a restricted-access area is demarcated and controlled
- Operations zones: Access is limited to accredited staff there and to properly escorted visitors
- Security zones: Access is limited to authorized staff and to authorized and properly escorted visitors
- High security zones: Access is limited to authorized, appropriately screened personnel, and authorized and properly escorted visitors

Preliminary security zones for this project are identified as follows:
- Public zones: Identified community/Station common areas such as the Traditional Knowledge centre
- Reception zones: Main entry lobby and loading dock area
- Operations zones: Balance of the facility except as noted below
- Security zones: Individual lab program suites
- High security zones: None

9.9 Safety

Safety is a very complex matter to be considered in the design of S&T facilities. Particular attention must be paid to the safety of the worker, and the well-being of those people in circumstances that may be hazardous. Emphasis must also be placed on the engineering systems to provide the major components of safety. Several other issues will need to be taken into consideration. Finishes applied to the various surfaces must be considered in the context of safety. For example, whether the surface is durable for continued and heavy use, whether it can be easily cleaned and disinfected, and whether it will become hazardous or slippery if put into contact with various elements.

The potential lack of piped water to the facility will require that systems be operational with little or no water. In the case of sprinkler systems, the feasibility of options such as waterless systems that are eco-friendly or creating and using a cistern should be considered.

In addition to the safety of lab personnel, the safety of the community must also be considered. While CHARS is not designated as a high level containment lab, some chemicals, gases or substances may be dangerous to the general public if not handled properly or if an accident releases them into the broader community. It is important that compliance with Health Canada's Workplace Hazardous Materials Information Systems (WHMIS) regulations during lab operations be considered in the planning of all research areas.

Biosafety - General

- Work will likely involve low risk or inactive agents and as such labs should be designed to, at a maximum, Biosafety Level 2 (BSL) containment, in accordance with Containment Level definitions contained in Health Canada, Laboratory Biosafety Guidelines, 3rd Edition, 2004.
- A BSL lab area will be separated from public areas by a locked door and will be controlled via card access.
- Access to a specific containment lab suite within the lab area will be through lockable doors and controlled via card access.
- Although not required for BSL2 requirements, office areas should be located outside of the containment lab zone.
- Directional inward airflow will be provided such that air will flow towards (not away from) labs
- Primary containment will be achieved through the use of biosafety cabinets and centrifuges.
- Handwash sinks shall be provided in all rooms/labs where there is a possibility of handling an infectious substance.
- Staff will be required to wear appropriate personal protective equipment (gloves, clothing and eyewear)
- Walls separating the lab zones from administrative zones are considered as a containment barrier. As such, these walls shall extend from the floor to the underside of structure and be free of openings.
- Appropriate signage indicating the nature of the hazard being used must be posted outside of each laboratory.
- All labs require observation windows to an adjoining corridor.
- All labs require intercom stations connected to security reception desk.

9.10 Accessibility

With consideration for the Arctic environment, CHARS facilities are meant to be fully accessible. PWGSC, Canadian Standards Association guidelines, and Treasury Board policies will be relied on for achieving an accessible design. Some areas (e.g. mezzanines in the maintenance and workshops) may not be accessible due to structures such as ramp limitations and potential safety concerns for non able-bodied persons.

9.11 Lab Equipment (fixed)

All fixed equipment should be identified on the individual Space Data Sheets and should be considered to be part of the original space planning for the Station.

9.12 Telecommunications and Information Technologies

Telecommunications is critical to CHARS' function as a world-class research facility. In addition to research requirements, it is expected that the facility will operate year-round, and some of the staff will bring their families. Therefore, ensuring adequate professional and personal internet access will be important to attracting and retaining key personnel.

It is important that the telecom requirements are sized properly, as excess capacity could prove extremely expensive. This must be balanced against the need for expansion of capacity if and when the facility grows. A lifecycle approach that recognizes that telecommunication needs – particularly for S&T – have been growing exponentially should be used in comparing capital *versus* maintenance and upgrade costs.

For research purposes, CHARS should consider its participation in Canada's Advanced Research and Innovation Network (CANARIE). CANARIE is an ultra high-speed network, hundreds of times faster than the internet, which facilitates modern research across Canada and the world.

There are currently an estimated 200,000 academic researchers utilizing CANARIE. The need for a high-speed, dedicated research network comes from the high volumes of data transfer involved in modern research. For example, many research applications involve transfer of terabytes of data, which would take days to transfer and quickly consume available bandwidth under regular networks. Furthermore, certain experiments may require specialized networking capability and support that commercial carriers do not provide.

Access to CANARIE would require a custom solution for high bandwidth access to Telesat's AnikF2 Ka-band satellite. This would require at least one 1.2 metre dish; additional dishes may be added depending on power and bandwidth requirements. The advantage of using multiple smaller dishes over one large dish is the mounting infrastructure required. The surface of a large dish acts like a sail when the wind moves over it, putting immense forces on mounting brackets and piles. Given that the dish is attempting to target a satellite in Earth's orbit to within a few millimetres of accuracy, large dishes can become very costly to install.

CANARIE is only to be used for research and education purposes. In order to provide a better level of personal internet than is currently available, a custom commercial solution could be explored. There are two main service providers in Nunavut, SSi Micro (which runs the QINIQ network) and Northwestel (which runs the NetKaster network). QINIQ is the larger network, connecting 56 communities in the North as well as Ottawa.

It is important to establish what constitutes an acceptable capacity for the Station, given budgetary requirements. Videoconferencing, for example, requires 384 kbps for 'talking heads', with 768 kbps if more movement is involved. PCSP recently upgraded their telecommunications package (including access to CANARIE). For their commercial use, there is 512 kbps with burst speeds of up to 1.5 mbps. However, the end users at PCSP are likely quite different from those expected at CHARS, who would be a mix of transient and permanent staff at the facility year-round.

Bandwidth requirements will need to be driven by the research needs. In the interim while the S&T program is developed, PWGSC compiled a preliminary estimate of CHARS bandwidth requirements. General sizing assumptions include:

- 50 to 75 users
- Applications involving video conferencing at 384 kbps/user and internet access at 512 kbps/user
- Concurrent user activity of 20%

Therefore the bandwidth requirement ranges would be:

- Low-end: 50 users x 384 kbps x .20 user activity = 3840 kbps total
- High-end: 75 users x 512 kbps x .20 user activity = 7680 kbps total

It should also be noted once again that there are proposals being developed to run high speed fibre optic cable along the sea bed through the Northwest Passage. There may also be other proposals regarding microwave towers and increased satellite capacity, which should be followed so that once operational, CHARS is positioned to easily align itself with newer technologies.

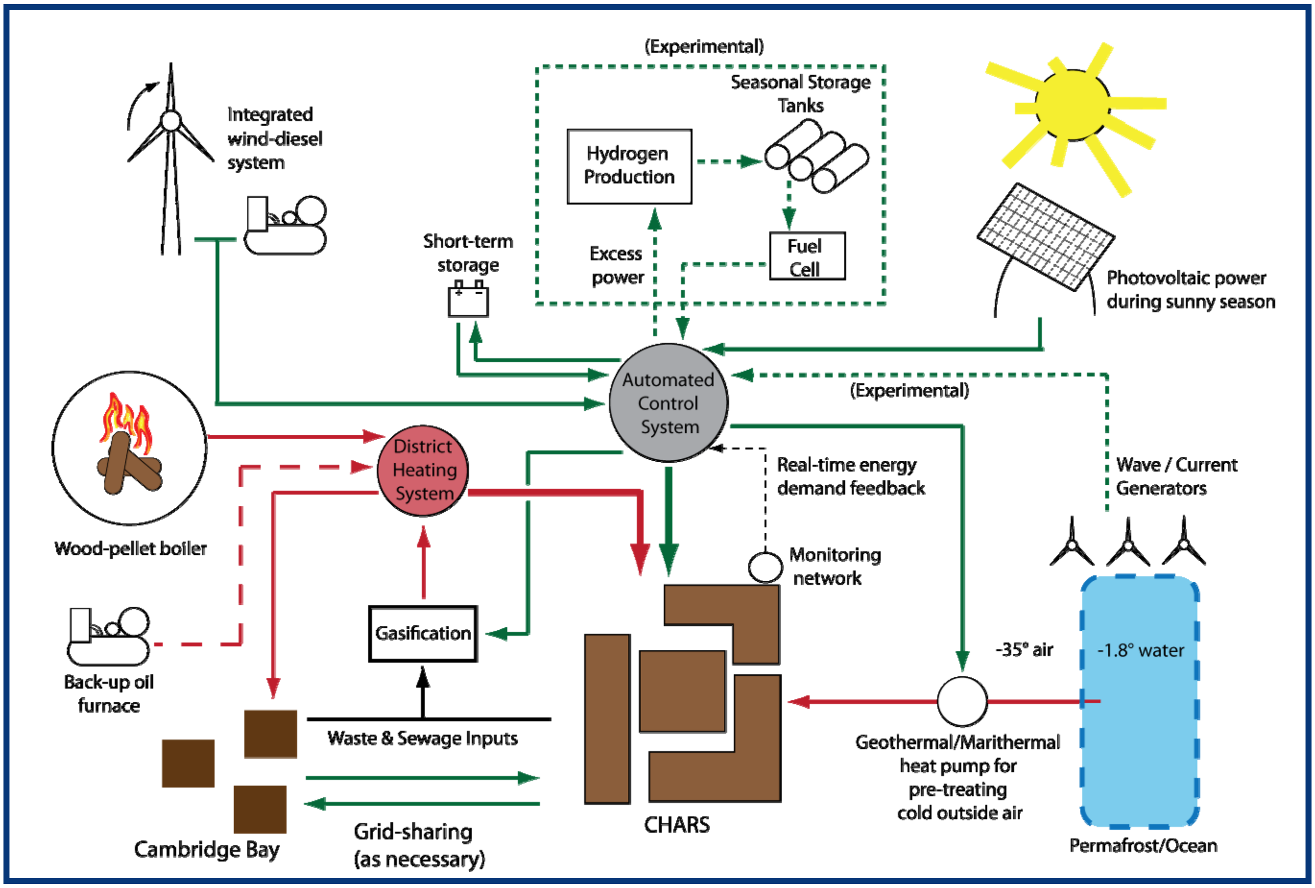
9.13 Energy

Energy costs are exceptionally high in Arctic communities. In terms of infrastructure, laboratories are considered highly energy intensive, often using four to six times more energy per area than a typical office building. While CHARS will need to address this issue for its own operations, there is also a significant potential for developing and/or adapting technologies that would benefit all northern communities. CHARS should therefore address this through the appropriate combination of: 1) employing efficiency improving methods throughout the design, construction and operational phases; and, 2) exploring, testing and integrating alternative energy generating methods. The graphic below illustrates a variety of potential energy planning and approaches for its use.

The laboratories are expected to require the largest proportion of energy. Within these spaces, the fume hoods are the element with the largest consumption. Various industry estimates put the energy consumed by a single fume hood in a year to be 1 to 3.5 times the average residential home. In most cases, the air required for the operation of the fume hood is totally exhausted out of the ventilation system due to what it may contain. This means new air is then introduced which requires a considerable amount of energy to condition. In the Arctic winters, this conditioning would be even more intensive.

A number of strategies and measures have identified areas where efficiencies can be leveraged. The two examples below offer a variety of practical recommendations that can be considered for CHARS. The first focuses on labs while the second addresses broader issues inherent to distributed or campus settings.

Figure 16: Potential green energy options that could be used at CHARS



In 2003, ***Laboratories for the 21st Century*** conducted an analysis to find effective ways to reduce energy use and costs. This analysis evaluated selected energy efficiency measures for a generic laboratory building in the areas of ventilating, cooling, heating, and considered the impacts of humidity controls and plug loads.

The analysis focused on the effects of energy efficiency measures in a simplified laboratory model in four different climactic zones within the United States. The results show that the most efficient measures were the same for all climates but that energy savings differed from climate to climate. Based on the simulation results, the following was concluded:

- Using a variable air volume (VAV) system (e.g. VAV fume hoods) rather than a constant-volume system has the potential to reduce fan energy and energy for space cooling and heating
- Some form of energy recovery should always be considered due to the latent energy recovery achieved with an enthalpy wheel. It is the most efficient of the energy recovery alternatives considered in the analysis.
- The increase in fan energy from energy recovery ventilation systems is not offset by the reduction in space cooling. However, the lower heating energy use more than compensates for the increase in fan energy.
- Energy recovery can potentially reduce the size of the heating and cooling equipment, and a VAV system has the potential to reduce the size of the heating system. The first-cost savings can cover a large portion of the cost of the energy efficiency strategy.
- Because of the high ventilation requirements in laboratory buildings, the air distribution system should be optimized to minimize pressure drop through the system and reduce energy use.
- Humidity control is energy intensive and should be carefully integrated into the control strategies to minimize reheat and subcooling.
- Plug loads and internal gains from plug loads should be accurately assessed in order to design the mechanical system and determine power requirements. Significant increases in first costs and operating costs result from assuming too high a design load.

Source: Enermodal Engineering, Inc., National Renewable Energy Laboratory a DOE national laboratory (2003), Laboratories for the 21st Century: Energy Analysis, a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy – Office of Energy Efficiency and Renewable Energy Federal Energy Management Program.

The ***Climate Neutral Research Campuses*** highlights a number of actions that can be undertaken related to: people and policy; buildings; transportation; energy sources; and, offsets/certificates. Key recommendations that could be relevant to the CHARS context are included below.

While significant energy savings can be supported through the building design and equipment choices, the point is made that the people (users and maintenance staff) and policies need to be incorporated into the overall strategy in order to be successful.

Some estimates suggest energy management and maintenance programs can reduce energy use in individual buildings as much as 40%. The US Department of Energy published a rule of thumb that operations and maintenance (O&M) programs targeting energy efficiency can save 5-20% on energy bills with little capital investment.

Actions such as turning lights off, closing blinds and shutting a fume hood sash are necessary actions for low-energy performance. Additional methods can complement these actions:

- Make energy efficient building management the first step in energy efficiency
- Engage building occupants in the mission of energy conservation
- Educate building occupants about the building systems
- Install energy consumption meters and display the results
- Focus efforts on the big energy users such as laboratories and data centres
- Shut off HVAC service to unused spaces

Installing meters in buildings (and/or individual spaces) will not only allow users to see the energy consumption rates but could also further the CHARS goal of being a testing and demonstration site for new technologies.

The point is made that these types of initiatives can be implemented inexpensively and can show immediate results. For some campus sites, these types of programs have represented the greatest and quickest returns on investment.

Sharing of spaces and organizing usage schedules is one way to make better use of planned space and can often reduce the need for expansions due to organizational growth.

Another energy efficiency act is setting goals for the building(s) which can guide decisions. Whether this is done through benchmark goals, ratings and certificates (e.g. LEED) or standards there are several strategies that can be used to help meet the energy goals that have been set. Amongst these is requiring designers and builders to use energy simulations to substantiate the energy performance goals through the design and construction phases. These simulations can be required as deliverables.

Once the buildings are operational, a policy of continuous maintenance and commissioning can help in several ways to keep the energy efficiency on track. The potential use of diagnostic software in digital building automation systems can help to prompt service and recalibration. While the majority of CHARS will likely consist of new buildings with energy efficient systems, the fact remains that buildings, particularly laboratory buildings, have HVAC and control systems that start to drift from first use toward lower efficiency and higher energy use. After 5 years, a building will benefit from a thorough recalibration of its controls. Planning for this, the maintenance budget can be appropriately applied to areas of greatest need and/or biggest payback.

A consideration for the ongoing optimization of energy use at CHARS is to have an energy savings performance contract. This can be structured so that the savings on energy bills pay for the upgrades. This may be particularly helpful in the cases where existing structures in the community are recommissioned and/or added to and may not meet the CHARS energy efficiency goals.

Source: National Renewable Research Laboratory, Climate Neutral Research Campuses, http://www.nrel.gov/applying_technologies/climate_neutral/

Another area to consider is the *2030 Challenge* which is endorsed by the *Royal Architectural Institute of Canada.* The challenge is to become carbon neutral by 2030.

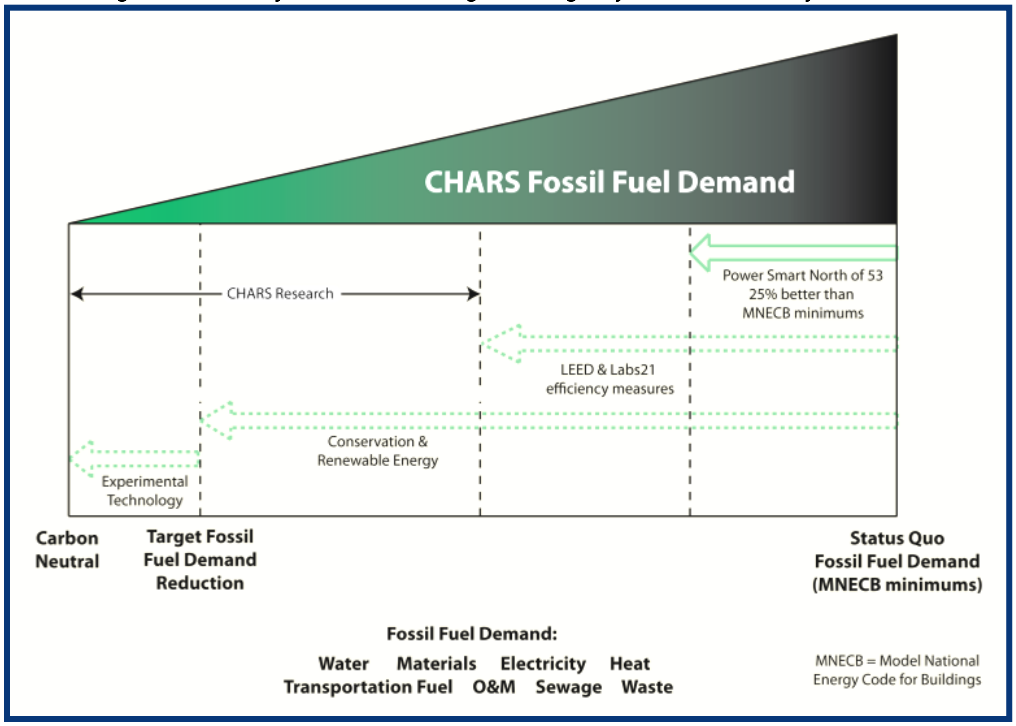
To accomplish this, Architecture 2030 has issued the 2030 Challenge asking the global architecture and building community to adopt the following targets:

- All new buildings, developments and major renovations shall be designed to meet a fossil fuel, Green House Gas (GHG)-emitting, energy consumption performance standard of 50% of the regional (or country) average for that building type.
- At a minimum, an equal amount of existing building area shall be renovated annually to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50% of the regional (or country) average for that building type.
- A fossil fuel reduction standard for all new buildings and major renovations with the following targets:
  - 60% in 2010
  - 70% in 2015
  - 80% in 2020
  - 90% in 2025
  - Carbon-neutral in 2030 (using no fossil fuel GHG emitting energy to operate)

While some of these targets may be accomplished by purchasing (20% maximum) renewable energy and/or certified renewable energy credits, implementing innovative sustainable design strategies and generating on-site renewable power are seen to be the preferred approaches.

While CHARS' mandate includes the principle being a world leader in green technologies for the Arctic, incremental steps may be required to meet various targets. As illustrated by the graphic on the next page, the Model National Energy Code for Buildings (MNECB) should be used to set the basic performance criteria for building construction and operation. The recognition and adoption of LEED and LABS 21 guidelines would further reduce energy consumption and push the usage targets beyond MNECB. The gap that remains between the achieved targets and carbon neutrality should form the basis of the CHARS research in building energy conservation. The Arctic location for this research should naturally focus this gap on buildings within polar regions.

Figure 17: Fossil fuel demand and green targets for consideration for CHARS



9.14 Commissioning

Commissioning expertise should be brought early in the project concept development and should follow the process established under the National Project Management System (NPMS) guidelines. The commissioning documentation should include a description of the following:

- Commissioning objectives
- General description of commissioning by project stage
- Roles and responsibilities
- Occupancy requirements
- Operational criteria
- Life cycle costing criteria
- Cooperation and coordination
- Training
- Correction of deficiencies
- Facility maintenance policy, guidelines and requirements
- Acceptance of the project
- Commissioning documentation
- Commissioning deliverables
- Construction and Commissioning

PART III: PROCESS

10. ENGAGEMENT STRATEGY

Traditional Inuit knives

10.1 Proposed Strategy

Engagement will take place with a number of stakeholders. The level, length and timing will be scaled and scheduled so that the information required throughout the CHARS development process and the opportunities for input are coordinated appropriately. The following provides a preliminary overview of who will be consulted, how they will be consulted, and the outcomes expected. Adjustments will be made throughout the process in order to integrate changes and accommodate project needs.

10.1.1 Federal Government

- CHARS' will aim to have programming that will help fulfill departmental mandates (for the Arctic), makes CHARS world class and undertakes to answer relevant science and technology questions.
- Additionally, the federal government will be contributing in a number of areas including funding, staff and the pursuit and management for internal and external partnerships.

- As such, Federal departments that have mandates in the Arctic will continue to be involved/engaged in the development of the programming and infrastructure requirements.
- This involvement/engagement will be done in a variety of ways:
  - Established Senior Project Advisory Committee of ADMs and interdepartmental committee of Directors will continue to be the information conduit to and from departments. More importantly, they will be used to review materials, ensure their needs are accurately reflected and that timely information and decisions are provided to AANDC.
  - Key departments will be invited to participate in the technical advisory committee. This will ensure that federal needs are provided by those with specialized experience/knowledge and captured in a practical way.
  - Wherever specific issues or questions arise AANDC will contact departments and individuals that are felt could best provide solutions and/or recommendations.
  - Partnerships will be pursued where there are opportunities, interest and/or perceived benefits. Federal departments are expected to be both partners and partnership brokers with external stakeholders.

10.1.2 Hosting Community

- Throughout the analysis work conducted as a prelude to selecting a community, consultations with the hamlet were at the forefront. This approach will be continued through the remainder of the project in order to optimize opportunities for integration within the community through infrastructure development, CHARS programming and partnerships.
- The goal of involving/engaging Cambridge Bay is to ensure that the project builds in all of the possible integration and partnership opportunities and forms a close relationship with the community.
- The community will likely be contributing a local labour force for all phases of the project and will hopefully yield partnerships with individual local organizations.
- The community will also have input into which parcels of land could be available or best suited to CHARS, delivery of municipal services and permitting throughout the project.
- The community members and organizations will be consulted throughout the design phase and subsequently. As a first step, it will be necessary to discuss how the community will want to be consulted. Issues related to expectations, capacity to meet expectations, appropriate timing and methodology will need to be agreed to. Options for engagement include:
  - Consultations to review materials, ensure the local environment/realities and cultural sensitivities are accurately reflected and that timely information and decisions are provided to AANDC.
  - Participation on the technical advisory group will be integral in order to review proposed plans, provide local knowledge/perspective and understand perspectives of other stakeholders with Arctic research interests.

- Partnership opportunities will be discussed largely in the design phase but opportunities for partnering will be considered and pursued throughout all phases as appropriate. Local organizations, the council and the community's private sector are all considered potential partners. Opportunities include sharing of infrastructure (including expansions to existing structures), collaboration on research projects and developing programming for local needs.

10.1.3 Northerners

- CHARS aims to be the hub of Arctic S&T activities and plans to operate year-round. Residents, governments and organizations in the territories are key partners in helping CHARS achieve this aim.
- While the Station will be located in Nunavut, CHARS is meant to be a national institution. In particular, the three territories all extend into the Arctic, the territorial governments provide the licensing and permitting for the researchers, and these governments have regulatory and environmental responsibilities. The territorial governments also have research facilities managed by the territorial colleges and have research programs.
- In particular to the Government of Nunavut, they are also responsible for a number of specific issues including rezoning land (if necessary). Involving them throughout the development of the project will ensure that they are aware of the plans and have the chance to participate in their development.
- Inuit and First Nations participate in all aspects of Arctic research including undertaking research (western and traditional knowledge), operating research stations, and providing outfitting and guiding services to researchers.
- A number of means could be used to consult/engage these groups. It will be necessary to discuss how they will want to be consulted; including which departments/organizations. To date, the northern colleges have been the main contact for the territorial governments and Inuit Tapiriit Kanatami, Nunavut Tunngavik Incorporated, the Council of Yukon First Nations, and Dene Nation have been the main Aboriginal contacts. Contacts for the design phase will need to be determined/confirmed. Issues related to expectations, capacity to meet expectations, appropriate timing and methodology will need to be agreed to. The following are potential options for engagement:
  - Consultations to review materials; ensure the northern environment/realities and cultural sensitivities are accurately reflected; and, that timely information and decisions are provided to AANDC.
  - Participation on the technical advisory group in order to review proposed plans, provide the territorial perspectives and understand perspectives of other stakeholders with Arctic research interests.
  - Partnership opportunities will be discussed largely in the design phase but opportunities for partnering will be considered and pursued throughout all phases as appropriate. Opportunities include sharing of infrastructure (including

expansions to existing structures), collaboration on research projects and developing programming for local needs.

10.1.4 Arctic S&T Network

- The network of research facilities throughout Canada's North includes several other facilities owned and operated by stakeholders including academic, Aboriginal, non-profit and federal sectors.
- These facilities are expected to become part of the hub and spoke network that CHARS would support the coordination of. Coordination amongst the network would strengthen CHARS (as an Arctic S&T hub) and promote better coordination, synergy and sharing of resources.
- A number of means could be used to consult/engage the network. Some options include:
  - Invited participation on advisory committees developed throughout the design phase.
  - Partnerships will be pursued where there are opportunities, interest and/or perceived benefits.

10.1.5 Academics

- The largest contingent of Arctic researchers is from academic institutions. In most cases, teams of researchers conduct their work in the North throughout the summer months and perform the analytical work back in their southern institutions. This contingent includes both national and international components.
- CHARS will be a year-round facility which provides researchers with the support they need to conduct all or the majority of their work on site.
- During the feasibility phase, a number of academic contacts provided input and advice. The number and types of technical contacts from this sector will need to be determined for the design phase. The following means could be used:
  - Representatives from the key academic institutions with Arctic research experience would be invited to participate in advisory committees. This will ensure that that user needs, programming and services are considered for integrated into the design.
  - Wherever necessary, AANDC will contact individuals and organizations that are felt could best provide solutions and/or recommendations to specific questions and/or issues that arise. This will also apply to international organizations.
  - Partnerships will be pursued where there are opportunities, interest and/or perceived benefits. Specific to partnership interests from the international sphere, there will be heavy consideration given to the appropriateness of the proposals and proponents given the Government of Canada's roles, responsibilities and policies.

10.1.6 Private Sector

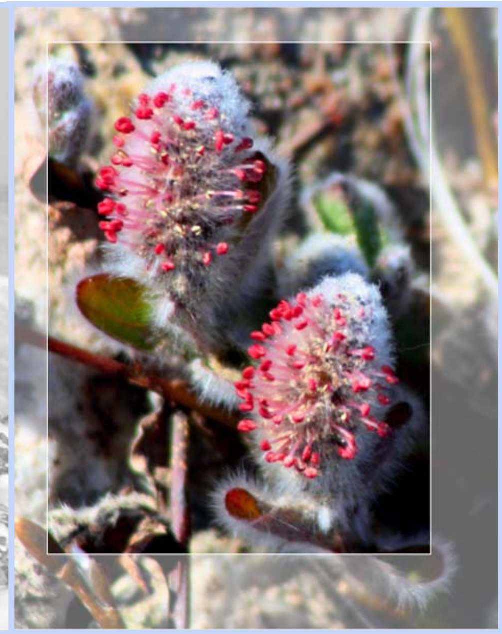
- The private sector includes a variety of business types who have shown interest in working in the North or are currently working there; the largest being natural resource development related. The Government of Canada has a number of regulatory and environmental assessment responsibilities which heavily impact private sector work with regards to timelines, processes and accurate baseline information that is available.
- During the feasibility phase, a number of private sector contacts provided input and advice. The number and types of technical contacts from this sector will need to be determined for the design phase. The following means are proposed:
    - Representatives from the key private sector organizations with Arctic research experience will be invited to participate in the technical advisory committee. This will ensure that that user needs, programming and services are considered for integrated into the design.
    - Wherever necessary, INAC will contact individuals and organizations that are felt could best provide solutions and/or recommendations to specific questions and/or issues that arise.
    - Partnerships will be pursued where there are opportunities, interest and/or perceived benefits. Specific to partnership interests from the private sector, there will be heavy consideration given to the appropriateness of the proposals and proponents given the Government of Canada's roles, responsibilities and policies.

10.1.7 General Public

- AANDC will seek to provide information on the project through different means including the departmental website, posting of contracts on MERX, and public announcements about key project milestones.
- Opportunities will be considered to seek general public input.

11. PROCUREMENT STRATEGY

Ravens



Arctic willow

Both the design and the construction of the Station will be carried out by organizations or firms from outside the federal government. How these firms are chosen and how the work is parcelled or bundled will be determined by the project's procurement strategy. That procurement strategy should be tailored to the specific needs and drivers of the project.

INAC undertook a series of consultations, workshops, and studies to assess the preferred procurement approach for the new Station. INAC, with assistance from PWGSC and PPP Canada, a Crown Corporation established to facilitate the development of the Canadian public-private partnership (P3) market, developed the following initial list of key drivers for the project as the basis for assessing the needs and constraints of the CHARS project vis-à-vis potential procurement methods.

Primary Drivers

- Sovereignty
- Internationally recognized facility delivering relevant results
- Year-round operations
- Green facility and operations
- Flexibility to meet evolving needs
- Close connection to the host community
- Ability to attract and retain top talent

- Canadian hub for Arctic science and technology connected to network
- Environment that promotes collaboration between users and contributes to productivity

Secondary Drivers

- International and/or national partnerships
- Best practice centre for meshing traditional and western research
- Active facility throughout year
- Long-term operations
- 2017 opening date or sooner
- Simplicity in mechanical systems
- Citizen engagement

11.1 Options

A range of procurement options were considered for CHARS. The following table outlines these options with a summary of limitations and benefits associated with each.

Table 4: List of procurement options being considered for CHARS

Procurement Method		Description	Limitations	Benefits
Crown Construction	**Design/Bid/ Build**	This is the traditional method used by PWGSC to obtain design and construction services. A design firm would be initially retained through a competitive proposal process to design CHARS and prepare the design and tender documents. Construction firms would subsequently submit competitive bids based on the scope of work outlined in those tender documents. The successful firm would be awarded the contract to construct CHARS. AANDC would maintain maximum control of the final products throughout design phase.	▪ Little opportunity for accelerating CHARS as construction can start only after design is completed ▪ Each phase distinct with little to no interaction between firms ▪ No opportunity for discussion on optimal and/or innovative approaches ▪ Little incentive for lifecycle outcomes ▪ Delivery delays could lead to extra costs & funding approvals ▪ AANDC and PWGSC retain significant project risks including interface risks between work of design & construction phases	▪ AANDC would have input throughout the design phase ▪ Design-Bid-Build increases potential for partnership negotiations ▪ Design would be able to adapt to science and technology program being developed in parallel ▪ Design and construction firms set up in check and balance for better quality assurance ▪ Costs are known once tenders close

	Procurement Method	Description	Limitations	Benefits
Crown Construction	**Design/Build**	In this method, the contract is with one firm which will provide both the design and the construction services. AANDC (with PWGSC) would develop the design concept to provide an overall view of CHARS' goals. For this, AANDC would consider acquiring an Advocate Architect through a design competition to undertake this initial work and to be AANDC's advisor throughout the design-build process. A Request for Proposals would be called where design-build firms would present their technical proposals and ideas on how to accomplish these goals. The contract would be awarded to the firm with the best combination of technical compliance/innovation, plan for community integration and cost. This proposal is expected to be developed so that construction of CHARS could commence upon award of contract.	▪ The costs for CHARS would not be fully developed when seeking construction funding ▪ Lack of control over the design may compromise programming ▪ Limited incentive for lifecycle outcomes as firm is not responsible for operations ▪ Typically favours larger firms which could limit the participation of northern firms ▪ Lack of defined science and technology program for CHARS could mean design changes leading to extra costs and timeline changes ▪ The integration of the designer and builder eliminates many of the traditional checks and balances	▪ Allows for fast-tracking CHARS as contractor uses their contracting authorities, and design & construction phases overlap ▪ Strong coordination between design and construction thereby minimizing constructability risks
Crown Construction	**Construction Management**	In this method, a Construction Management firm would be hired to provide constructability oversight during the design phase and to act as the general contractor during the construction phase. The Construction Management firm would competitively tender construction trade packages, as portions of the design are complete.	▪ Overall project costs at start only estimates and would not become fixed until the last work package has been let ▪ Construction Management firm not accountable for potential cost overruns ▪ CHARS progress and success would largely be dependent on experience & skill of the Construction Management firm ▪ Limited incentive for lifecycle outcomes as Construction Management firm is not responsible for operations	▪ CHARS project would be fast-tracked ▪ Construction Management firm provides coordination & flexibility in contracting and procurement ▪ Construction Management approach allows for overlap between design and construction ▪ AANDC has maximum design input & control ▪ Process offers opportunity for contractors to provide input into design phase strengthening CHARS goals of having community integration, technology demonstration options and sustainability measures.

Procurement Method		Description	Limitations	Benefits
Non-Crown Construction	**P3 Public-Private Partnership (Design/Build/ Finance/ Operate/ Maintain)**	In this method, the contract is with one firm which would design, construct, finance, operate and maintain CHARS over the course of 20-30 years. AANDC (with PWGSC) would prepare detailed performance specifications for CHARS that would be captured in the Request for Proposals. Firms would provide cost, schedule and approach to develop CHARS and be evaluated on these. The chosen firm would decide the best project delivery strategy in order to remain on scope, schedule and budget. CHARS overall costs would be amortized with P3 Partner over the course of the 20-30 year contracting period.	▪ P3 Partner controls all delivery process with no input from AANDC once the contract is awarded ▪ More complex procurement process (little federal experience) ▪ Level of complexity including Arctic environment, lack of defined science and technology program and desire for demonstration projects (e.g. alternative energy methods) could result in few bids and/or higher bids ▪ Lack of defined science and technology program could lead to design changes & extra costs	▪ P3 contracting authorities and overlap of phases allow for fast tracking of CHARS ▪ Longer term amortization of project costs ▪ Builder is also operator after construction driving the incorporation of lifecycle innovations ▪ Most project risks are transferred to private sector ▪ Long-term warranty; better construction warranty ▪ Schedule and cost certainty through life of contract

11.2 Procurement Analysis

The key drivers the Department had defined were refined into key procurement objectives and qualitative criteria for the CHARS project, as listed below:

Table 5: Analysis of procurement objectives for CHARS to be considered in choosing the preferred procurement method

Procurement Objectives	Qualitative Criteria
Support the Achievement of the Project Objectives:	
▪ To provide a facility that helps advance Canada's knowledge of the North and integrates with the local community	▪ Maximizes Canadian participation ▪ The ability to provide access to areas of the CHARS facilities for the local community e.g. restaurant, library, meeting spaces, accommodation ▪ The ability to access and/or upgrade existing facilities/services within the community to help meet CHARS' needs ▪ The ability to provide long-term employment and/or involvement of the local community
▪ Incorporate lessons from other Polar projects	▪ Allows for significant user input ▪ Captures value engineering ▪ Ensures proper operations going forward
▪ Provide a facility that can be a hub for a science & technology network for Arctic research	▪ Allows for facilities to form a network

Procurement Objectives	Qualitative Criteria
▪ Meet sustainability goals	▪ Minimize environmental footprint ▪ Reduces energy use and costs ▪ Ability to test potential alternative energy sources
▪ Aesthetic quality building	▪ Ensures appropriate building image for the facility
▪ Provision of a safe facility	Ensures: ▪ Safety of the workers ▪ Safe engineering systems ▪ Appropriate types of finishes ▪ Durability of materials
▪ Future flexibility	▪ Ability to accommodate changes in usage/modularization ▪ Allows for flexibility in operations
Provide certainty over cost and schedule	▪ Provides confidence that cost of the Project will not exceed the approved budget during the construction phase and/or during operations especially given the additional contingencies and Arctic cost premiums that are typically seen on such projects ▪ Provides confidence that the facility will be in service by 2017
Achieve Value for Money and sound stewardship over project lifecycle	▪ Provides best value for money and achieves the three elements of economy, efficiency and effectiveness ▪ Value to be achieved through the (1) lifecycle management approach and (2) promotion of innovation and (3) optimal allocation of risk over the life of the Project between the public and private sectors
Maximize Competition (respecting requirements of North America Free Trade Agreement and the Nunavut Land Claims Agreement)	▪ The ability to attract sufficient bidders to ensure a robust procurement competition given: ▪ the remote location; ▪ relatively small project size; ▪ project scope and complexity; ▪ length of time to complete; and ▪ high Canadian and Northern content
Deliver a Fair, Open and Transparent Process	▪ Ability to demonstrate a fair, open and transparent procurement process
Long-term government commitment for funding the research station	▪ Ability of AANDC to commit to a long-term research program that will be funded by the Government of Canada

Given the specific challenges associated with constructing and operating facilities in the North and the still-evolving nature of the S&T program for CHARS, the Station would best be served with the Crown construction option of Construction Management in order to best address the project's objectives. Construction Management would support innovation while ensuring that the development of the S&T program and partnership opportunities could be integrated into the infrastructure plans as they are refined. The delivery model for the CHARS project, therefore, will be Construction Management.

12. BUDGET

Husky

North Warning System

Budget development is a key aspect that will be continually refined with each activity, and at a higher level, with each phase of the project. In order to ensure that the budget is as accurate as possible, the elements of the budget will be clearly defined, captured and developed through each phase. Depending on the procurement option chosen and site(s) selected within the community, costs for the project could include:

- project team (including professional services)
- design (design competition, design development and tendering documentation)
- leasing/purchasing of land and facilities
- permits and construction
- fit up costs including fixtures, furniture and equipment
- operationalizing costs (moving in, telephones, key/locks, etc.)
- ongoing operations, management and programming
- contingencies and northern costs

In conjunction with the development of the budget, the scope and schedule for the project will be refined to achieve and maintain the optimum balance.

12.1 Pre-Construction Design Phase

The pre-construction design phase will be based on the Budget 2010 commitment of $18 million as follows:

Table 6: Budget 2010 allocations for CHARS

2011/12	2012/13	2013/14	2014/15
$3M	$6.2M	$7.3M	$1.5M

12.2 Future Cost Considerations

Future cost considerations to be included in the budget for the Canadian High Arctic Research Station will include allowances and Arctic cost premiums.

12.2.1 Allowances

Allowances are intended to reserve funds for unknowns. Unlike contingencies which are for unforeseeable issues, allowances are for events and project elements that are not yet clearly defined. As this project is still in the early phases of development, the number of these elements and events are more prevalent. As the project progresses, these will become more defined and therefore more predictable.

Community Infrastructure
The aspiration to integrate the facility within the community offers opportunities to partner with existing institutions and organizations and to supplement what is not available or accessible. These opportunities will impact total costs based on the level of work required to convert, add to or upgrade each space.

Conversely there may be land available within the community with existing structures that have either been vacated or abandoned. Costs for decontamination and decommissioning would need to be covered by the project.

12.2.2 Arctic Cost Premiums

Locating the research facility in an Arctic setting will add costs to the project that will need to be accounted for. In particular:

Transportation
The cost of travel to the Arctic will incur higher costs. Similarly, the shipping of goods through sealift or airlift will also have additional cost factors. Additionally, working within the shortened construction and shipping season will mean that more forethought

will be needed for each year to ensure that space on sealifts is booked appropriately and that storage in the community is available.

Temporary Space
Space is at a premium in Cambridge Bay, particularly for housing, but it has been established that sharing of space with organizations such as NPC and Arctic College could potentially allow establishment of a limited CHARS presence in the community before the Station is fully completed in 2017. While the use of existing community capacity, could potentially allow for phasing of CHARS S&T programming and staff, securing interim accommodations may entail renting and possibly some renovations.

Split rock in the tundra

13. SCHEDULE

Barge at the Cambridge Bay dock

Construction equipment

The schedule will also be continually refined as the project advances and decisions on elements are taken and information becomes available. Check points will include, but are not limited to:

- Budget development and cost checks. This will include time to realign the scope and budget
- Approvals (Cabinet , AANDC, the senior project advisory committee, and legal services)
- Negotiations and consultations with stakeholders and partners (community, territorial government, academia, private sector, other federal departments, etc.)

Developing the schedule will require a balance between pushing for time saving measures and building on time to be able to plan around unexpected delays. An aggressive schedule provides the benefit of saving money and obtaining a working facility sooner whereas a more conservative schedule is generally more reliable and allows for better consultation.

The following is the proposed schedule with key milestones for the project. Wherever possible, opportunities will be sought for shortening the process to reduce the overall project schedule, project costs and to begin operations earlier.

Design 2011-2013

- Solicit and hire Design team: 2011
- Design concept and initial design development: 2011 – 2012
- Finalize design development, construction document preparation, and construction tendering process: 2012 – 2013

Construction 2013 – 2017

Operations 2017 – onwards

ANNEX A CHARS Experts & Users Group Terms of Reference

Context

In the 2007 Speech from the Throne, the Government of Canada committed to "build a world-class Arctic research station that will be on the cutting edge of Arctic issues, including environmental science and resource development. This station will be built by Canadians, in Canada's Arctic, and it will be there to serve the world." The new station will support the Canadian Government's Northern Strategy, as science and technology (S&T) underpin all four pillars of that Strategy: sovereignty, economic and social development, environmental protection and governance.

Currently, research infrastructure in Canada's North is a collage of cabins, stations, and ships sparsely spread out over the 3.5 million km^2 of Canada's Arctic. The government's recent investment of $85M will support upgrading at 20 key existing research facilities over two years through the Arctic Research Infrastructure Fund (ARIF). The High Arctic Research station will anchor that strengthened network of research infrastructure and act as a hub for scientific activities in Canada's Arctic.

The new Canadian High Arctic Research Station (CHARS) will establish a world-class platform for Arctic science and technology by ensuring safe and cost-effective access to Canada's North; providing logistical support for research in the field and facilities for analysis in situ; linking to the rest of the world through modern telecommunications infrastructure; and, storing and managing samples, data, and equipment. It will also provide a vehicle for governments, academics, northerners, and industry to undertake, and collaborate in, solutions-driven Arctic science and technology.

The government has allocated $2M over two years to Indian and Northern Affairs Canada (INAC) (now known as Aboriginal Affairs and Northern Development Canada (AANDC)) to develop a feasibility study for HARS. This study will establish preliminary cost estimates for the new Arctic research station. It will define the facilities the station will house and the services it will provide. It will assess the potential for green building options and renewable energies to minimize the environmental footprint of the new station. These aspects will be developed in concert with the S&T program to be carried out at the station. Based on all of these elements, costed options for the design, construction, and operation of the new facility will be developed for fall 2010.

The feasibility study will be led the Arctic Science Policy Directorate (ASP) at AANDC with contracted support from Public Works and Government Services Canada (PWGSC). Recognizing that the long-term success of the new station will depend on meeting users' needs. AANDC will consult widely in the development of the feasibility study. A primary vehicle for seeking input to the design of, and program for, the new station will be the CHARS Experts and Users Group.

Mandate

The CHARS Experts and Users Group is tasked with providing input and advice to AANDC in the development of both the functional program for the new station and the S&T program it will run. The functional program includes what kind of facilities and services the new station should provide and how these should complement and anchor the network of existing research facilities. The S&T program includes the range of activities to be carried out by, or under the management of, the station to address key questions under each of the four priorities: sustainable resource development, environmental science and stewardship, climate change, and healthy and sustainable communities. These activities can be categorized broadly under the headings of research; technology; observation and monitoring; and education, outreach, and knowledge transfer. The S&T program should also consider how the station should interact with different user and stakeholder communities - local, scientific, private sector, and international - relevant to Northern S&T.

The CHARS Experts and Users Group will provide input and advice on the overall development direction of the HARS and perspective on the role the station could play in their particular sector and, equally, how that sector could contribute to the success of the station. The AANDC Arctic Science Policy Directorate will serve as the secretariat to the CHARS Experts and Users Group.

The CHARS Experts and Users Group will build on the considerable input received to date domestically and internationally on the development of the research station. In particular, the advice received at the May 2008 Visioning Workshop in Ottawa and from the International Expert Panel convened in July 2008 by the Canadian Council of Academies provide strong foundations on which the new Group will build. (See http://www.scienceadvice.ca/documents/(2008-11-05)%20CARI%20Report.pdf for the reports from both fora.)

Governance

The CHARS Experts and Users Group will be chaired by Danielle Labonté, Director General of the Northern Strategic Policy Branch, who will report directly to the Patrick Borbey, Assistant Deputy Minister of Northern Affairs, AANDC.

Membership

The CHARS Experts and Users Group will be composed of representatives from the North, academia, and the private sector as well as the federal and territorial governments. The membership of the CHARS Experts and Users Group is listed in Appendix 1. Members were selected both for their individual expertise and experience and their ability to represent a particular group or sector.

Commitment

The CHARS Experts and Users Group will provide advice on the research station over the course of the feasibility study. Approximately 3-4 meetings a year are anticipated for the CHARS Experts and Users Group, with the initial meeting being face-to-face to allow the members to get to know each other. Subsequent meetings will be conducted by teleconference. In addition to the 3-4 meetings each year, members will be called upon to provide advice and input over the phone or by email. The time commitment expected from members is estimated to be 30 hours a year plus travel time to the initial meeting.

HARS Experts and Users Group Membership

Member	Affiliation
Danielle Labonté (Chair)	Aboriginal Affairs and Northern Development Canada
Clint Sawicki	Yukon College
Helmut Epp	Government of NWT, Department of Industry, Tourism and Investment
Mary Ellen Thomas	Nunavut Research Institute
Cindy Dickson	Council of Yukon First Nations
Lee Mandeville	Dene Nation
Scot Nickels	Inuit Tapiriit Kanatami, Senior Science Advisor
Kue Young	University of Toronto
Benoit Beauchamp	University of Calgary, Arctic Institute of North America, Kluane Lake Research Station
Warwick Vincent	Université Laval, Centre d'études nordiques
James Drummond	Dalhousie University, CANDAC, PEARL
Gita Laidler	Carleton University
Chris Hanks	Newmount Mining Corporation
Brian Wright	Chevron
Fred Wrona	Environment Canada, Water and Climate Impacts Research Centre
Martin Bergmann	Natural Resources Canada, Polar Continental Shelf Program
Humfrey Melling	Fisheries and Oceans Canada
Roy Kwiatkowski	Health Canada
Jon Thorliefson	Defence Research and Development Canada
Steven Bigras	Canadian Polar Commission
F. Mary Williams	National Research Council, Institute of Ocean Technology
Natan Obed and other representatives	Nunavut Tunngavik Incorporated
Ray Case	Government of NWT, Department of Environment and Natural Resources
Shelly Watkins	Inuit Tapiriit Kanatami, Youth Project Coordinator

ANNEX B Nunavut Land Claims Agreement

Below are summaries of Articles 23, 24 and 26 of the Nunavut Land Claims Agreement.

Article 23

Article 23 of the Agreement has the objective of increasing Inuit participation in government employment in the NSA to a representative level. To achieve this objective, obligations ranging from Inuit employment plans to pre-employment training plans are required, which are designed to increase and maintain employment of Inuit at a representative level, and provide Inuit with skills to qualify for government employment. Such measures could include but are not limited to:

- measures designed to remove systemic discriminations practices such as artificially inflated education requirements or culturally biased testing procedures;
- intensifying recruitment programs;
- increasing inclusion and placing greater emphasis on Inuit skills, culture and knowledge;
- increasing Inuit involvement in hiring processes;
- measures targeted at improving growth and employment accessibility by the Inuit such as training opportunities, counselling services, promotion of apprenticeships, internships, etc., and,
- training within the NSA.

Article 24

Article 24 of the Agreement aims to provide reasonable support and assistance to Inuit firms to enable them to compete for government contracts in the NSA. This involves the development, implementation or maintenance of procurement policies respecting Inuit firms, as well as bid invitation, bid solicitation and bid criteria requirements.

Of note is the focus on building the capacity of Inuit and Inuit firms, which involves the employment of Inuit labour, engagement of Inuit professional services, and the use of Inuit suppliers and/or firms to carry out contracts. Successful bidders are also required to promote on the-job-training and/or skills development for Inuit.

Article 26

Article 26 of the Nunavut Land Claims Agreement requires that an Inuit impact and benefit agreement (IIBA) be finalized before a Major Development Project may commence, in order to ensure any project that could have a detrimental impact on Inuit or that could reasonably confer a benefit on Inuit, is taken into account. The IIBA must be negotiated and agreed upon between Inuit and the developer, and must be approved by the Minister of Aboriginal Affairs and Northern Development. While the benefits shall be proportional to the nature, scale, impact of the project, they shall contribute to achieving an equal standard of living and working in the NSA to other Inuit and to Canadians in general.

IIBAs promote Inuit training at all levels, Inuit preferential hiring, scholarships, business opportunities and other benefits.

Office of the Prime Minister | Cabinet du Premier ministre

Ottawa, Canada K1A 0A2

Release

Date: August 24, 2010
For immediate release

PRIME MINISTER STEPHEN HARPER ANNOUNCES HIGH ARCTIC RESEARCH STATION COMING TO CAMBRIDGE BAY

CHURCHILL, MANITOBA – Prime Minister Stephen Harper today announced that the new Canadian High Arctic Research Station will be located in Cambridge Bay, Nunavut.

“Through our Northern Strategy our Government is committed to realizing the full potential of Canada’s North” said Prime Minister Harper. “By building this leading-edge research station, we are advancing Canada’s knowledge of the Arctic’s resources and climate while at the same time ensuring that Northern communities are prosperous, vibrant and secure.”

The Canadian High Arctic Research Station will be a world-class, year-round, multidisciplinary facility exploring the cutting-edge of Arctic science and technology issues. It will create jobs, strengthen Canada’s Arctic sovereignty, promote economic and social development and it will help protect and understand the northern environment, contributing to the overall quality of life for Northerners and all Canadians.

The Canadian High Arctic Research Station is an integral part of Canada’s four part Northern Strategy: to assert and defend Canada’s sovereignty, to protect the unique and fragile arctic ecosystem, to develop a strong Northern economy and to encourage good governance and greater local control and opportunity.

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PMO Press Office: 613-957-5555
This document is also available at http://pm.gc.ca

ANNEX D Codes, Regulations, Standards & Guidelines

Codes and Regulations

- National Building Code of Canada 2005
- National Fire Code of Canada, 2005
- National Plumbing Code of Canada 2005
- The Canadian Electrical Code
- The Canada Labour Code
- The Canada Occupational Health and Safety Regulations.
- All other Nunavut Territory and Municipal Acts, Codes, By-laws and regulations appropriate to the area of concern

Standards and Guidelines

- Treasury Board Real Property Accessibility Policy
- Treasury Board Real Accessibility Policy
- CSA B651-04 Accessible Design for the Built Environment
- Treasury Board of Canada Fire Protection Standard for Electronic Data Processing Equipment Design
- Treasury Board of Canada Fire Protection Standard for Design and Construction, Chapter 3-2
- Treasury Board of Canada Standard Fire Alarm Systems – Chapter 3-4
- Telecommunications Infrastructure Standard for Data centers TIA-942
- CAN/CSA-C22.2 No. 214-94 "Communications Cables", Canadian Standards Association
- Commercial Building Standard for Telecommunications Pathways and Spaces, ANSI/TIA/EIA-569-B
- CAN/CSA-T528-93, "Design Guidelines for Administration of Telecommunications Infrastructure in Commercial Buildings", Canadian Standards Association
- J-STD-607A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, ANSI-J-STD-607-A-2002
- Treasury Board Occupational Safety and Personnel Management Manual
- Air Conditioning and Refrigeration Institute (ARI)
- American Conference of Governmental Industrial Hygienists (ACGIH, Industrial Ventilation Handbook)
- Air Diffusion Council (ADC)
- Air Movement and Control Association (AMCA)
- American National Standards Institute (ANSI)
- J-STD-607A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, ANSI-J-STD-607-A-2002
- American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
- ASHRAE Standards, Guidelines and Handbooks

- American Society of Mechanical Engineers (ASME)
- American Society for Testing and Materials (ASTM)
- American Welding Society (AWS)
- Associated Air Balance Council (AABC)
- Canadian Standards Association
- Canadian Electrical Code – CSA Part 1, C22.1-06
- CAN/CSA-C22.2 No. 214-94 "Communications Cables"
- CAN/CSA-T528-93, "Design Guidelines for Administration of Telecommunications Infrastructure in Commercial Buildings"
- Human Resources and Social Development Canada (HRSDC) Standards
- FC 311; Standard for Record Storage – May 1979
- FC 401 : Standard for Fire Extinguishers – Nov 1977
- FC 403; Fire Protection Standard for Sprinkler Systems – Nov 1994
- International Mechanical Code – Latest Version
- Institute of Boiler and Radiation, Hydronic Institute (IBR)
- Laboratory Biosafety Guidelines – 3rd Edition 2004, Health Canada
- Manufacturers Standardization Society of Valve and Fitting Industry (MSS)
- National Fire Protection Association (NFPA)
- NFPA 10; Standard for Portable Fire Extinguishers - 2007
- NFPA 13; Standard for Installation of Sprinkler Systems - 2007
- NFPA 14; Standard for Installation of Standpipe and Hose Systems - 2007
- Public Works and Government Services MD Standards
- MD 15128; Minimum Guidelines for Laboratory Fume Hoods – March 2004
- MD 15129; Perchloric Acid Fume Hoods and Their Exhaust Systems - 2006
- MD 15166; Guidelines for Building Owners, Design Professionals and Maintenance Personnel - 2006
- Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- Telecommunications Industry Association (TIA)
- Commercial Building Telecommunications Cabling Standard Part 1: General Requirements, TIA/EIA-568-B.1
- Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted Pair Cabling Components, TIA/EIA-568-B.2
- Commercial Building Telecommunications Cabling Standard Addendum 1 - Transmission Performance Specification for 4-pair 100 Ohm Category 6 Cabling, TIA/EIA-568-B.2-1
- Optical Fiber Cabling Components Standards, TIA/EIA-568-B.3
- Optical Fiber Cabling Components Standard Addendum 1 - Additional Transmission Performance Specifications for 50/125 µm Optical Fiber Cables, TIA/EIA-568-B.3-1
- Commercial Building Standard for Telecommunications Pathways and Spaces, TIA/EIA-569-B
- Optical Fiber Cabling Components Standards, TIA/EIA-568-B.3

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Top left: seal skin boots	Annie Moulin
Top middle: Arctic cotton	Annie Moulin
Top right: researcher working on ice	Steve Vance - ArcticNet
Middle left: antlers on roof	Annie Moulin
Middle middle: sunset on a beach	Annie Moulin
Middle right: CCGS Amundsen	Marc Tawil - ArcticNet
Bottom left: researcher skiing with gear	Ed Struzik
Bottom middle: mountain dryad	Annie Moulin

Part I

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Page 2: images of tundra	Annie Moulin
Page 11: Kamotik on ice	Annie Moulin
Page 12 top left: Nunavut Research Vessel	GN, Department of Environment
top right: Bird blind on Coats Island	Paul Smith
bottom left: Nunavik Research Centre	Makivik Corporation
bottom right: Lac à L'eau Claire	Centre d'études nordiques
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bottom right: Polar Continental Shelf Program	PWGSC and NRCan
Page 22 top left: Rothera – Antarctica	Danielle Labonté
top right: McMurdo – Antarctica	Patrick Borbey
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Page 27: Hudson's Bay cabin	Annie Moulin
Page 28: Cambridge Bay	Annie Moulin
Page 30: Baymaud in Cambridge Bay	Annie Moulin
Page 32: Picnic area in Cambridge Bay	Annie Moulin

Part II

Page 41: images of Cambridge Bay	Annie Moulin
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