DIALOG®

Canada Centre for Inland Waters Administration and Laboratory Building Laboratory Modernization Plan (LMP)

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Environment Canada

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RS 2.1.2

Design Concept -Appendix B
Sustainability Report

Public Works and Government Services Canada / Travaux publics et Services gouvernementaux Canada

Environment Canada / Environnement Canada

Canada

Introduction

The Canada Centre for Inland Waters (CCIW) is one of the world's leading water research centres and is a home for science and research. The Administration and Laboratory (A&L) building, originally completed in the early 1970's, is in need of modernization to provide lab space meeting the demands of current practice. The modernization of the space must be planned with the next four-plus decades in mind: portioning the environmental impact of construction over a long service life and addressing environmental challenges for generations to come.

This capital project will be aligned with the Federal Sustainable Development Strategy (FSDS) and the federal government's framework for sustainable planning. Goals, targets and priorities are organized under four priority themes: addressing climate change and clean air, maintaining water quality and availability, protecting nature, and shrinking the environmental footprint.

Applying these overarching themes to a laboratory modernization project highlights four key areas of focus:

I. Energy efficiency and greenhouse gas (GHG) reduction

II. Materials impact and lifecycle analysis

III. Enhanced workplace environmental quality

IV. Potable water conservation

Benchmarking sustainability for the modernization means documenting performance and making meaningful contributions in each of these areas; the goal is to create a great place for research, a great place to work and to achieve a quantifiable reduction in the environmental footprint.

The CCIW is home to a successful Federal Buildings Initiative energy efficiency improvement project which is targeting reduction and tracking of the facility's GHG footprint. The lab modernization will aim to contribute to building wide GHG reductions by implementing energy efficiency initiatives and complementing existing projects at the systems and plant levels.

In stakeholder visioning sessions clear themes around sustainability, including: flexibility, efficiency, thermal comfort & control, waste conservation, air quality, lighting control, and carbon footprint. Clearly these topics need to be addressed to create a space that is attractive to occupants now and through decades to come.

Setting benchmarks and targets for success ensures that the finished space reflects these environmental values. The output should be quantifiable reductions in impact (achieved by measures like energy metering and contractor waste tracking) and improvements that can be experienced in the space (like interior glazing providing natural light into office and labs).

Green building certifications like LEED for Commercial Interiors (LEED CI) can be used to communicate success and these will be investigated for cost-benefit analysis.

Sustainable Design Process

Environment Canada has made clear that there is a priority to show leadership in its building projects, achieving a level of sustainability that is consistent with the Federal Sustainable Development Strategy (FSDS) and that goes well above typical standard practice.

Achieving a higher level of performance and integrating new, innovative technologies requires a better design process – one that engages the client, includes all of the stakeholders and harnesses the expertise of the assembled design and construction team. This model, called the Integrated Design Process, is the preferred method of delivery for high performance buildings.

During the development of the LMP Concept Design, DIALOG conducted extensive user group sessions to help determine the needs, values and priorities of the staff groups that will be inhabiting the A&L building in the years to come. A project visioning session was held, allowing the design team members (architects, planners, engineers and sustainability experts) to review trends in lab design and opportunities and challenges presented by the building. Some clear themes emerged:

- Flexibility and adaptability of the laboratory spaces, allowing for future changes to funding and requirements for research
- Energy efficiency: lowering the GHG footprint of the CCIW facility
- Comfortable indoor environment: maintaining thermal conditions for comfort and satisfaction in the lab and office space
- Clean and well-ventilated: appropriately conditioned for science and for scientists
- Appropriate use of durable, consciously selected materials

These themes are embedded in the design of the LMP to ensure that the final product matches the function of the space, needs of occupants and the mission of Environment Canada.

Energy modeling was used to inform the design process, informing the Lifecycle Cost Analysis study (LCCA). The energy model analysis uses a computer simulation of the building to determine the impact of various design options – for building envelope, lighting, HVAC – on the long term performance of the building.

References, Benchmarks and Standards

The following references will be used, either as a minimum standard or as a target for higher levels of performance:

- ANSI/AIHA Z9.5-2012, Laboratory Ventilation
- ASHRAE Guideline 0 – 2013 The Commissioning Process
- ASHRAE Guideline 1.1 – 2007 The HVAC Commissioning Process

- ASHRAE Standard 55-2004, Thermal Comfort Conditions for Human Occupancy
- ASHRAE Standard 62.1 – 2010 Ventilation for Acceptable Indoor Air Quality
- ASHRAE Standard 90.1-2010 Energy Standard for Buildings Except Low-Rise Residential Buildings
- ASHRAE Standard 110-1995 Method of Testing Performance of Laboratory Fume Hoods
- Federal Sustainable Development Strategy for Canada; Environment Canada Sustainable Development Office
- International Institute for Sustainable Laboratories Labs 21 Toolkit
    - o Design Guide for Energy Efficient Research Laboratories
    - o Best Practice Guides: Ventilation, Commissioning, Water Efficiency, HVAC
    - o Environmental Performance Criteria
- International Performance Measurement and Verification Protocol Volume III: Concepts

and Options for Determining Energy Savings in New Construction, April, 2003

- ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework
- LEED Canada for Commercial Interiors, 2007
- LEED Canada for Existing Buildings: Operations and Maintenance, 2009
- NRC National Energy Code for Buildings 2011
- Public Works and Government Services Mechanical Design Guidelines:
    - o MD 15126 Guide for Laboratory Heating, Ventilation and Air Conditioning (HVAC)
    - o MD 15128Minimum Guidelines for Laboratory Fume Hoods
    - o MD 250005 Energy Monitoring and Control Systems Design Guidelines
- Sheet Metal and Air Conditioning Contractors National Association (SMACNA) IAQ Guidelines For Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008

Sustainable Design Strategies

The following strategies, features, and technologies are incorporated in the LMP Concept Design, contributing to a lower environmental footprint and to meeting the goals of the FSDS.

Energy Use and Greenhouse Gas Reduction

Energy use is a primary driver for climate change and reductions in energy use and GHGs are a key measure for any project targeting sustainability. Lab buildings in particular are high users of energy across the sector; achieving a percentage reduction in energy use has proportionately high impact in total GHG emissions.

Heating, Cooling and Ventilation

Exhaust air volumes are a major driver for energy use in labs based on fan energy as well as heating and cooling energy for incoming makeup air. High performance laboratories need to balance safety and adherence with codes and standards with energy conservation to 'right size' exhaust systems to the appropriate number of air changes per hour (ACH).

The ASHRAE lab guide recommends the following:

- Minimum supply air changes
- Minimum exhaust air changes
- Minimum outdoor air changes
- ACH number between 4 and 12

The Health Canada Lab Standards – Space Standards and Design Guidelines recommend air change rates of 10 ACH during occupied periods and 6 ACH during unoccupied periods.

The Labs 21 Best Practice Guide for Ventilation Rates recommends Control banding – classifying and grouping substances used in a process by health risk to determine an appropriate control strategy. It may be possible to classify each laboratory according to toxicity, scale of use and volatility. Under this scheme some zones may be appropriately designed as low as 6 ACH / 4 ACH or even 4 ACH / 2 ACH.

Fume hoods are another major driver of energy use. The quantity and size of fume hoods should be optimized to balance user needs with energy consumption. Lower-energy alternatives such as snorkels, balance hoods and chemical storage cabinets should be considered where appropriate.

Major energy savings will be realized with the conversion of the lab exhaust system to a Variable Air Volume (VAV) fume hood exhaust connected to a manifolded exhaust. Reducing fan power when full airflow is not required will generate large scale electrical savings.

The consolidation to a Central Exhaust System (CES) facilitates the installation of a glycol Heat Recovery (HR) system for all ventilation and exhaust air. The HR system circulates fluid between coils in the exhaust air and outdoor air streams, recovering waste energy from the exhaust that would otherwise be vented to the outdoors. The HR system saves a significant amount of heating energy, particularly in winter months, and is responsible for an estimated energy savings of almost 15% vs. the existing configuration.

Reducing ventilation and exhaust rates to the laboratory spaces is by far the most direct path to saving energy and GHG emissions in the A&L building. We have recommended the use of a Dynamic Air Sampling System (DAS) to monitor air quality in the labs and enable lower exhaust air / ventilation rates. The DAS uses a network of sensors to continuously measure air quality and pollutant levels, and is connected to a control device that will increase ventilation rates significantly when needed. The DAS allows for much lower baseline ventilation rates when air quality is at an acceptable level. The energy modeling study for CCIW demonstrated that the DAS strategy can save up to 36% of energy use and GHG emissions vs. maintaining baseline ventilation rates.

Other energy savings features that are recommended for incorporation:

- Low pressure drop duct design, complete with premium efficiency fan motors, in accordance with ASHRAE 90.1-2010
- Appropriate zoning of lab spaces requiring tight tolerances for temperature and humidity to minimize reheat energy

Power and Lighting

Lighting systems will be designed to appropriately balance environmental quality, safety and energy consumption. Best practices will be followed to optimize systems and minimize lighting energy use. LED lighting fixtures will be investigated as the best balance between up-front costs, maintenance / replacement costs and energy use / GHG footprint.

The ASHRAE 90.1 – 2010 Standard provides maximum allowable Lighting Power Densities (LPDs) for each building space type, taking into account space environment and required lighting levels. Best practice typically allows for a lower connected wattage by focusing on effective placement of light fixtures and efficacy (lumens per watt). The lighting design for the LMP will target on these lighting levels:

Space Type	ASHRAE 90.1 LPD Allowance (W/m²)	Target LPD (W/m²)	% Reduction
Research Laboratory	19.5	13.7	30%
Office - Open Plan	10.5	7.5	28%
Office - Enclosed	11.9	8.5	28%
Meeting/ Multipurpose	13.2	9.5	28%
Storage	6.8	5.8	15%
Restrooms	10.5	8.9	15%

Overhead lighting will be used to reach a basic level of lighting suitable for most tasks, in the range of 300-400 lux. Task lighting will be used to supplement the overhead lighting, providing higher light levels of up to 800 lux on an as-needed basis.

LED lighting is recommended for the lab areas as well as offices and corridors, storage etc. The LED fixtures have higher efficiency, supplying the same output as traditional fluorescent fixtures while using fewer watts and with longer lamp life requiring fewer lamp replacements over the project lifecycle.

Space layouts are designed with daylighting strategy in mind, ensuring that natural light is accessed in areas of the floor plate where it's available. The use of glass partitions allows natural light into the laboratory units, lowering lighting energy while allowing for a greater connection to the exterior. Daylight and occupancy responsive controls will be used to achieve further energy savings.

Operations and Process

A full commissioning process, according to ASHRAE requirements as dictated in Guidelines 0 and 1.1, should be employed to ensure the proper operation of equipment and systems. Operations and maintenance will be considered in the design of all mechanical & electrical systems to provide for ongoing efficiency.

We recommend that energy monitoring be considered for the detailed design, using a network of connected meters to track energy use by system. Benchmarking and metering are a method for laboratory buildings to demonstrate leadership and facilitate ongoing building optimization. Separate metering of energy and water uses (HVAC, lighting, plug loads, equipment) allows potential areas for improvement to be identified and tacked. A 'dashboard' style user interface can be considered to facilitate continuous improvement and benchmarking vs. other lab facilities. Energy use data can be combined with employee engagement – occupant training, user surveys, and communication of energy savings achievements – to achieve deeper energy savings in the operations phase.

Materials and Lifecycle Impact

Construction materials can represent a significant portion of a building's environmental footprint. By adopting a Lifecycle Analysis (LCA) approach we can minimize the impact of construction materials through all phases:

- Extraction
- Manufacturing
- Transportation
- Installation
- Use & Maintenance
- Disposal or reuse

When choosing systems and materials all phases of the materials lifecycle will be considered to ensure that decisions reflect the best possible functionality with lowered lifecycle impacts.

During the demolition and construction phases a Waste Management Plan will be implemented to maximize the diversion of materials from landfill. Wherever possible materials will be identified for reuse on- or off-site through programs like Habitat for Humanity. Recycling facilities will be identified for expected waste materials including wood, metal, gypsum board, cardboard etc. Contractor waste tracking will be required to ensure that a waste diversion rate of over 75% is achieved

The LMP project is designed to maximize flexibility and adaptability in the space, configured with the next 40 years in mind. Material and capital efficiency can be achieved by planning for future expansion and modifications and minimizing the work required to periodically refresh or retrofit the space. As research trends and government requirements change over years to come the space must be ready to accommodate. Durable materials with a long service life are incorporated to minimize maintenance requirements over time and minimize the environmental impact of replacements.

The emergence of Environmental Product Declarations means that new materials can be chosen with the goal of minimizing environmental impact:

- Greenhouse gases
- Ozone depletion
- Acidification of land and water sources
- Eutrophication
- Smog formation

Similarly the emergence of Health Product Declarations (HPDs) and the movement for disclosure and transparency in the construction materials industry is allowing designers and owners to identify and eliminate materials that contain bio-accumulative carcinogens, toxins, mutagens, and endocrine disruptors.

Materials selection will prioritize the use of products with EPDs and HPDs available, minimizing environmental and human impact.

Other materials properties will be evaluated to assist in making sustainable material choices:

- Recycled content
- Regional materials / local manufacture
- FSC certified wood
- Embodied carbon
- Long service life
- Low-emitting materials (VOCs & formaldehyde emissions)

Indoor Environmental Quality

Healthy buildings contribute to occupant wellbeing and satisfaction as well as employee comfort, health and productivity. A premium work environment is one that is well ventilated, comfortable, well lit with access to daylight and natural views, and creates a great environment for research and collaboration. Studies have repeatedly demonstrated that healthy workplaces translate to improved worker satisfaction, less sick days, increased productivity and increased ability to attract and retain talented employees.

Ventilation in laboratory spaces will be designed to provide safety, meet thermal loads, provide adequate outdoor air and balance energy cost. Offices and other spaces will be designed according to the latest version of ASHRAE standard 62.1.

During construction the contractor will be required to create and implement an Indoor Air Quality Management Plan, which will encourage clean air at

occupancy and employ the SMACNA best practices:

- HVAC protection
- Pollutant source control
- Housekeeping
- Pathway interruption
- Scheduling of construction activities

Prior to occupancy it will be required that the contractor administer a building 'flush-out', using increased outdoor air volumes to remove particulates, CO_2 and Volatile Organic Compounds (VOCs) which may be emitted by materials, finishes and furniture. If desired an air quality test can be commissioned to ensure that pollutants are at acceptably low levels prior to occupancy.

In addition to low environmental impact, materials, finishes, and furniture will be selected to best industry standards for low emission of VOCs and other harmful materials:

- South Coast Air Quality Management District Rules # 1113, 1168 (latest versions) for adhesives, sealants and coatings

- Green Seal Standards GS-03, and GS-11, and GS-36 for top coat paints, aerosol adhesives & anti-corrosive coatings

- CRI Green Label program for carpet tile

- FloorScore certification (or equivalent test results per State of California methods) for hard surface flooring including vinyl, linoleum, laminate, rubber flooring, and wall base

- Composite wood materials certified as 'No added urea-formaldehyde' including plywood, MDF, and particle board

- New furniture and seating certified as low-emitting according to GreenGuard, BIFMA Level, or equivalent

Space layout is designed to give occupants access to natural light and views of the exterior. Window shades will be provided to limit excessive glare and preserve light quality. Lighting quality will be maintained throughout the space, balancing safety, function, environmental quality and energy efficiency.

Natural materials, textures, and patterns will be incorporated where possible to enhance the feeling of connection to nature and wellbeing according to the principles of biophilic design.

HVAC controls for space temperature and humidity will be designed to maintain comfort conditions as per the latest version of ASHRAE Standard 55 for Thermal Comfort.

Water Conservation

Water conservation will be a central feature of the LMP, treating water as a valued resource and limiting consumption of potable water.

Plumbing fixtures in washrooms and break rooms will be selected for low flow rates, suggested as follows:

- 4.8L / 3.0L dual flush water closets
- 0.5 LPF urinals
- 1.9 LPM faucets with automatic sensor control
- 5.7 LPM kitchen sink faucets

Based on these fixture selections it can be expected that the building will save over 40% in potable water compared to a baseline building using typical flow rates.

Process water savings can be targeted by considering these laboratory water efficiency measures:

- Elimination of single pass cooling for lab equipment

- Rinsing by counter-current method

- Flow control on/off for intermittent process equipment

Rating Systems and Benchmarks

Green building rating systems are frequently used as a way of communicating sustainable design and construction success to occupants, stakeholders and the public. The LEED certification program (Leadership in Energy and Environmental Design) has gained widespread popularity for its marketing appeal and recognition amongst the general public.

LEED Canada for Commercial Interiors (LEED-CI) is the LEED rating system that is applicable to a modernization project. Based on the sustainable design measures detailed above it is reasonable to expect that LEED Silver or LEED Gold certification could be achieved with the additional investment of LEED consulting services and contractor tracking / documentation. LEED Platinum is possibly achievable however additional measures and/or additional costs may be required.

Registration is open for LEED-CI v1.0 until October 31st 2016, after this date LEED v4 for Interior Design will be the applicable rating system. LEED registration should be conducted before that date if certification under the original LEED CI v1.0 is desired.

The Labs 21 Environmental Performance Criteria (EPC) provide a path for laboratory projects to supplement LEED and achieve measures that are more specific to the complexity, health and safety requirements, flexibility and adaptability needs and energy use of lab facilities. The EPC was designed to be used in conjunction with the LEED rating system. EPC criteria can be used as best practices, or used to contribute to LEED certification by including as 'Innovation in Design' credits.