Lower Mainland Facilities Management
Energy and Environmental Sustainability
Design Guidelines – New Construction and Major Renovations

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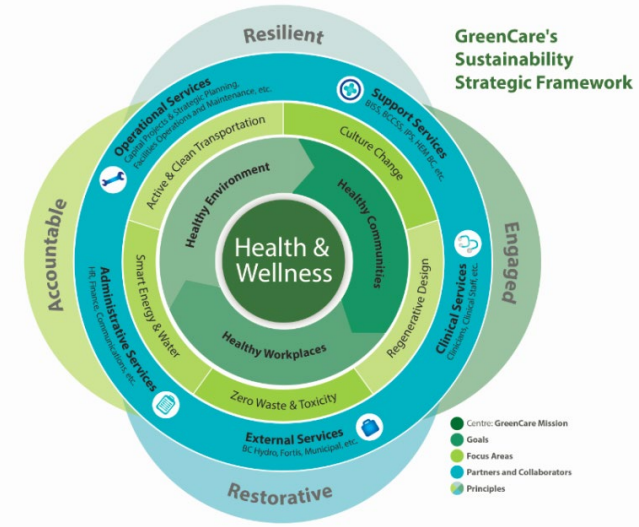
1. INTRODUCTION

1.1 WHO

The Energy and Environmental Sustainability (EES) business unit has taken a leadership role in advancing the environmental sustainability and resilience of assets in the lower mainland; for example, through energy efficiency, water conservation, waste diversion, active and clean transportation, and climate preparedness. For more information on the EES team's scope and mandate, see GreenCare's website and Strategic Framework.



The primary goal of this document is to support implementation of the four health organizations' Sustainability Policy:

> The Lower Mainland Health Organizations will act as leaders with respect to environmental stewardship while engaging the healthcare community in a collaborative approach towards sustainability.
>
> *LMFM CPT2600: Environmental Sustainability Policy*

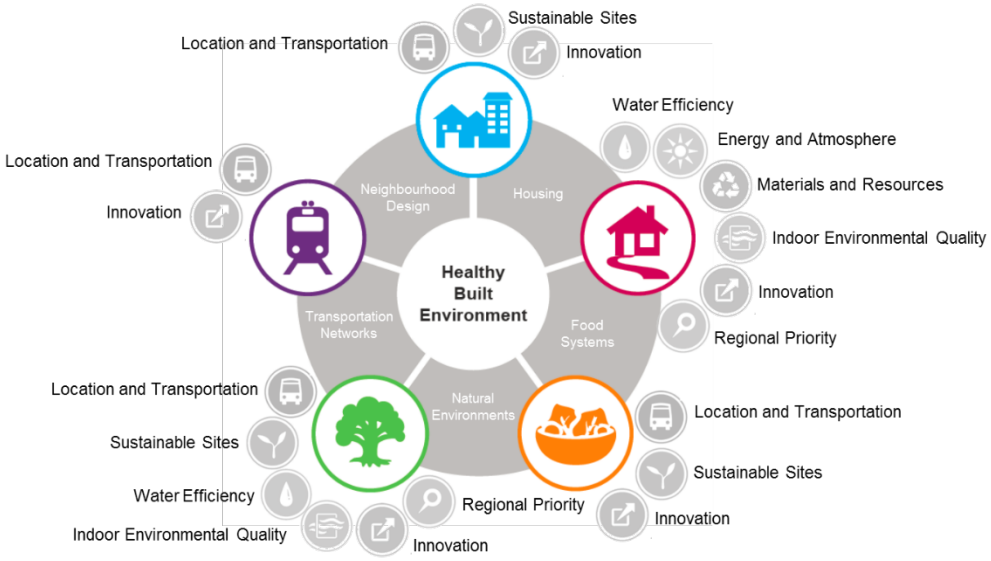
1.2 WHY

EES created the ***EES Design Guidelines for New Construction & Major Renovation projects (EDG)*** with the intent to ensure that new construction and major renovation projects in the lower mainland are built to the highest standard of human and environmental health within the financial constraints of the project. This goal is aligned with the Sustainability Policy noted above, as well as the Climate Change Accountability Act (CCAA), which requires all Public Sector Organizations to be "carbon neutral" as of 2010 and beyond, and sets legislated carbon reduction targets for BC including an 80% reduction by 2050 relative to a 2007 baseline. The legislation will also provide a framework to develop detailed climate-change adaptation reports.

There is a significant and growing body of evidence available that links the impacts of buildings (from the energy they consume to the materials used in their construction) on people (both their occupants as well as local and global populations affected by their impacts). The impacts of buildings span time (short term impacts versus long term impacts) and space (from occupants inside the buildings to the broader global population impacted by climate change).

These connections between health and decisions affecting the planning and design of our built environment are well documented by the PHSA-led Healthy Built Environment (HBE) Linkages initiative and toolkit. The planning principles articulated within the HBE toolkit are also aligned with Leadership and Environmental Design (LEED) rating system.

The figure below illustrates in summary which LEED credit categories were found through an EES review[1] to be supported by each of the five features presented in HBE Linkages Toolkit: Neighbourhood Design, Transportation Networks, Natural Environments, Food Systems, and Housing. This high level review shows that HBE planning principles can potentially contribute to 99 out of 110 LEED points (90% of the total points). More information is available on this subject from EES.



Note: The LEED credit categories that were found to be associated with HBE features are listed around the five icons representing "Neighbourhood Design", "Transportation Networks", "Natural Environments", "Food Systems", and "Housing" in HBE Linkages Toolkit. These credit categories are demonstrated with their indicative icons (in grey color) presented in LEED Reference Guide.

Figure 1: Correlation between HBE Planning Principles and LEED Credit Categories

Several of our sustainability programs are focused on reducing greenhouse gas emissions (climate mitigation) and we are adjusting these to include greater emphasis on adapting to BC's changing climate (climate adaptation). The health organizations are preparing to develop organization-level plans in alignment with the 2016 BC Climate Leadership Plan, and with evolving professional standards and guidance[2] to increase climate-readiness of critical infrastructure[3] servicing health facilities.

[1] A content analysis of the HBE Linkages Toolkit (version 2.0) and the LEED Reference Guide for Building Design and Construction: New Construction (version 4.0) was performed to explore whether there exist any connections between the two. This work was completed by Ghazal Ebrahimi.
[2] E.g. *As government, industry and public awareness of climate change increases, Engineers and Geoscientists BC (EGBC) Registrants will be increasingly expected to assess the potential climate impacts of projects that they are working on, and likely will be expected to offer alternatives that could reduce project greenhouse gas emissions.* https://www.apeg.bc.ca/getmedia/33cce5c7-f7ab-4752-a398-4ca6e2c6dee3/Position-Paper-Final-2016.aspx
[3] http://www2.gov.bc.ca/assets/gov/driving-and-transportation/transportation-infrastructure/engineering-standards-and-guidelines/technical-circulars/2015/t06-15.pdf

1.3 WHAT

The guidelines are not meant to cover every aspect of sustainability in the context of health care; rather, the Minimum Requirements and Best Practices outlined herein focus on infrastructure planning and design decisions that impact health facilities' sustainability and resilience, which by extension impact health service delivery and ultimately human health and wellness. The first section of the design guidelines is generic, while the remaining sections are customized for the specific project or planning process at hand.

1.4 HOW

Our design guidelines are about evolving the state of design and construction practices to achieve the highest standard of human and environmental health within the financial constraints of the project. Simplistically the outcomes of a project are the combination of the people involved and the process they follow. We cannot expect different outcomes if we don't change one or both of these components.

We can enhance the outcomes of our projects by engaging the right people at the right time (for example, engaging climate resilience expertise at the outset to inform performance requirements).

We can also enhance the outcomes by changing our process. We can make slight changes to the business as usual process (for example, setting a well-informed energy target at the outset of the project). We can also make larger changes such as adopting best practice methodologies including Lean principles and tools (see Table 1). It is noted that Lean must be applied holistically and comprehensively in order for the full benefits to be realized; however, elements of this approach can also be utilized as a step towards full adoption.

Table 2 summarizes some examples of the types of involvement (ie; scopes of work) that are currently often missing and need to be embedded into the various phases of a project in order to allow the appropriate decisions to be made by the appropriate people. The example below is focused on energy and carbon management specifically and is not exhaustive.

These design guidelines are part of an ongoing improvement effort and will evolve over time; for now the process outlined below is not customized for a particular project or delivery model.

Table 1: Summary of Key Lean Principles[4]

Principle	Description	Examples of tools and practices
Optimize the Whole	Maximizing value to our customers requires optimizing our value streams; first we need to understand properly identify them.	Value stream mapping WIP limits (work-in-process limits) Last Planner System® Master Schedule Reverse Phase Scheduling Six-Week Look Ahead Weekly Work Plan Pull Planning and Scheduling
Eliminate Waste	Lean thinking looks for ways to eliminate waste of all sorts. Lean thinkers relentlessly seek to eliminate any process, activity, or practice that does not result in value for the customer.	
Build Quality In	Building quality into the process means automating and standardizing tedious, repeatable processes, or any process that is prone to human error.	
Deliver Fast by Managing Flow	The faster we can deliver bits of value to our customers, the sooner we can begin to learn from customer feedback. In order to deliver fast, we have to manage flow and focus on value delivery.	
Create Knowledge	Lean projects have to provide the infrastructure to properly document and retain valuable learning.	
Defer Commitment	Projects should function as just-in-time systems, waiting until the last responsible moment to make decisions. This allows Lean projects to have the agility to make informed decisions, with the most relevant, up-to-date information available.	
Respect People	The success of any Lean initiative hinges upon respect for people.	

[4] Adapted from https://leankit.com/learn/lean/lean-principles/

Table 2: Example Requirements (using Energy & Carbon Management)

Stage of Project	Potentially Missing Scopes of Work	Example Deliverables
Master Planning	Engagement with Population and Public Health (P&PH) to understand drivers and outcomes required to support Public Health (such as reducing emissions from fossil fuels) Clear scope to enable site and community scale considerations such as district energy, and associated stakeholder engagement.	Public Health Needs Assessment Campus Energy Master Plan
Business Case	Quantification of benefits, risks, and life cycle costs of proposed energy and carbon target.	Life cycle cost analysis of energy efficiency options.
Procurement	Include energy & carbon requirements in Bid Documents; Evaluate Proponents	NPV calculation of each proponents energy target
Design	Document energy performance and life cycle costs (per BC Hydro New Construction Program or equivalent)	Energy Modeling Report
Construction	Assess impact of change orders on life cycle cost and risk.	Report summarizing the energy impact of Change Orders
Commissioning	Ensure facility is operating as intended in support of achieving energy and carbon target.	Commissioning report Measurement and Verification Report
Operations	Sufficient documentation and training to enable ongoing operation of the facility as intended Completion of Post Occupancy Evaluation to ensure lessons learned from the build	Training manuals Post Occupancy Evaluation report

2. MINIMUM REQUIREMENTS

Further project-specific customization is required, in collaboration with the project team.

2.1 General Requirements

The Project Manager and indicative design team (if applicable) shall incorporate the requirements outlined herein to the level of detail and accuracy expected as this stage of the planning and design process, and shall take all necessary steps to incorporate the requirements into the documents used to procure the detailed design and construction.

2.2 Climate Resilience & Adaptation Requirements

In collaboration with the Climate Resilience and Adaptation Program Lead, the indicative design team shall develop a plan to assess, reduce and manage relevant climate risks and impacts on health facilities and operational services.

At minimum, the indicative design team shall:

- include relevant expertise on the team;
- utilize relevant future climate projections data, future weather files and intensity-duration-frequency curves – as per the *Moving Toward Climate Resilience Health Facilities* report series and technical briefings for Vancouver Coastal Health (2018), Fraser Health (2019) and Provincial Health Services Authority (2020) – when developing output specifications, designing, and constructing the facility;
- conduct a climate risk assessment during the Business Plan phase using LEED credit IPpc98 *Assessing and Planning for Climate Resilience* as a starting point only;
- integrate climate risk and resilience in the Business Plan; and,
- consult the relevant municipal and community plans for mandates and guidelines related to climate resilience and adaptation, including climate adaptation plans, stormwater management plans, urban forest or shade tree plans, Official Community Plan.

2.3 LEED Gold Requirements

All new construction and major renovation projects greater than 600 m^2 are required to achieve LEED Gold Certification, in accordance with the 2008 BC Climate Action Plan and its policy mandate requiring "all new public buildings to be built to LEED Gold Standards". This requirement is also explicitly stated in the 2008 Throne Speech.

Projects are required to use USGBC's LEED v4 Building Design and Construction: Healthcare (LEED v4 BD+C: HC) for all healthcare related projects[5]. Where LEED v4.1 credits are available and bring value to the owner, their requirements need to be followed instead of comparable credits from LEED v4. Selection between LEED v4.0 and v4.1 credits needs to be discussed with the EES team.

Guidance is provided in Table 2 to ensure design teams pursue credits that reflect the priorities of the Lower Mainland Health Organizations. This table has been developed on a generic basis (taking into account the current understanding of the highest value credits) as a starting point for discussion on each specific project.

[5] See USGBC website for more information: https://www.usgbc.org/credits/healthcare/v4

Any credits that are deemed unachievable or inappropriate for a specific project can be removed from the "Mandatory" list in consultation with EES. Specific credits listed in Table 1 are outlined as "Mandatory" and "Strongly Preferred". The "Mandatory" credits are those that the project is required to achieve (in addition to all prerequisites). The "Strongly Preferred" credits are optional credits, although it is required that 9 of the strongly preferred credits are selected for implementation.

Due to the regional differences, credits marked with an asterisk (*) will be qualified by the regional location and accessibility of resources to achieve the credit; it is thus understood that some regional locations make it impossible to achieve certain credits.

Credit category marked with a double asterisk (**) include pilot credits, which may not be available for formal certification at the time of application; in these instances the intent of the credit shall be pursued and documented.

2.3.1 Table 3: LEED Credit Requirements

Credit Name	Comments
Integrative Process	
Integrative Process	**Mandatory**
Location and Transportation	
Bicycle Facilities	**Mandatory**
Green Vehicles	**Mandatory**
Sustainable Sites	
Site Development- Protect or Restore Habitat	Strongly Preferred
Rainwater Management	Strongly Preferred
Open Space	Strongly Preferred
Places of Respite	**Mandatory**
Direct Exterior Access	**Mandatory**
Water Efficiency	
Outdoor Water Use Reduction	Strongly Preferred
Indoor Water Use Reduction	Strongly Preferred
Cooling Tower Water Use	Strongly Preferred
Water Metering	**Mandatory**
Energy and Atmosphere	
Enhanced Commissioning	**Mandatory**
Optimize Energy Performance	**Mandatory**
Advanced Energy Metering	**Mandatory**
Enhanced Refrigerant Management	**Mandatory**
Materials and Resources	
Building Life-Cycle Impact Reduction	Strongly Preferred
Building Product Disclosure and Optimization – Environmental Product Declarations	Strongly Preferred

Credit Name	Comments
Building Product Disclosure and Optimization – Sourcing of Raw Materials	Strongly Preferred
Building Product Disclosure and Optimization – Material Ingredients	**Mandatory**
PBT Source Reduction—Mercury	**Mandatory**
PBT Source Reduction—Lead, Cadmium, and Copper	**Mandatory**
Design for Flexibility	Strongly Preferred
Construction and Demolition Waste Management	**Mandatory***
Indoor Environmental Quality	
Enhanced Indoor Air Quality Strategies	**Mandatory**
Low-Emitting Materials	**Mandatory**
Construction Indoor Air Quality Management Plan	**Mandatory**
Indoor air quality assessment	Strongly Preferred
Indoor chemical and pollutant source control (eq35)	Strongly Preferred
Thermal Comfort	Strongly Preferred
Interior Lighting	Strongly Preferred
Daylight	Strongly Preferred
Quality Views	Strongly Preferred
Acoustic Performance	Strongly Preferred
Pilot Credits **	
Assessment and Planning for Resilience	**Mandatory**
Designing for Enhanced Resilience	**Mandatory**
Designing with Nature, Biophilic Design for the Interior Environment	**Mandatory**
Performance-Based Indoor Air Quality Design and Assessment	Strongly Preferred
Integrative Process for Health Promotion	Strongly Preferred
Social Equity with the Community	**Mandatory**

2.4 SMART ENERGY & WATER REQUIREMENTS

2.4.1 Energy Consumption and Carbon Emissions Targets

The indicative design team shall develop, in collaboration with the Energy Manager, the following project-specific targets that are aligned with the targets established for the health organization.

1. **Total energy target (in MWh/year)**
    a. To be developed based on a combination of benchmarking, end use breakdown analysis, energy modeling, and Energy Use Intensity (EUI) analysis converted to MWh
2. **Thermal energy demand target (MWh/year)**
    a. This is the annual heating energy demand for space conditioning and conditioning of ventilation air. This is the amount of heating energy that is output from any and all types of heating equipment
    b. To be developed based on understanding of relevant Thermal Energy Demand Intensity (TEDI) targets and converted to MWh
3. **Carbon target (tCO_2e/year)**

a. To be developed based on the targeted total energy target and preferred distribution between fuel source options

Refer to the GreenCare Strategic Framework for more details and use the following Energy Use Intensity (EUI) targets by building space types as guidance:

Primary Use	EUI [kWh/m²/yr]
Support	150
Inpatient	250
Acute Care and Research	375

The above energy performance targets were derived from review of existing lower mainland health facilities, current and future ASHRAE 90.1 building performance benchmarks, and a review of EUI's from high performance hospitals in the US Pacific Northwest and Northern Europe.

2.4.2 Participation in Incentive Programs

The project team must coordinate with the EES Representative to apply to the BC Hydro & FortisBC New Construction (NC) Program(s) and any other relevant incentive programs where applicable and participate in those programs to maximize the benefit to the health organization.

To ensure sufficient time is allowed to analyze energy use performance and life cycle costing as part of the energy modelling and study process, as required by the incentive programs, the EES Representative must be included at the earliest possible phase of the planning and design. Procurement of equipment and plant is prohibited until the Capital Incentive Agreement has been approved.

2.4.3 Low Energy Design

The following draft wording is suggested for inclusion within the output specification documents to complement the energy and carbon targets by specifically requiring a focus on low exergy design as one important means of meeting the targets. These approaches should also be adopted where possible within the indicative design.

"The building mechanical system design and operation must comply with the following energy performance requirements. These requirements are in addition to any other referenced energy performance requirements required by code or outlined in this specification.

a. The first stage of heating shall be provided by building recovered thermal energy.
b. No fossil fuels may be used for space heating loads, ventilation, or domestic hot water pre-heat at the same time heat is being rejected from the facility by either heat rejection equipment or in the form of exhaust / relief air.
c. To maximize total system efficiency:
    a. heating systems are to use the lowest heating fluid temperature to satisfy a load and return the lowest fluid temperature.

b. cooling systems are to utilize the highest fluid temperature to satisfy a load and return the highest fluid temperature.

d. Exhaust/relief air systems over 945 L/s (2,000 cfm) must be equipped with heat recovery capable of reducing the leaving air temperature to no higher than 9°C at all outdoor air conditions.
e. Heat reclaim is to take precedence over air-side and water-side economizing (i.e. "free cooling"). Economizer logic shall be used only when the building cannot benefit from the heat.
f. Heat reclaim must be holistically available for any building load.
g. When possible utilize direct heat transfer of thermal energy from reclaim source to load.
h. Demand based control logic to automatically lower heating temperatures and raise cooling temperatures shall be implemented."

2.4.4 Best Practice Commissioning

The project team shall engage an independent commissioning agent at the earliest feasible point in the project in order that best practice commissioning principles and processes can be embedded into output specifications for design, construction, commissioning, and operations phases.

2.4.5 Water Consumption Target

The indicative design team shall estimate the anticipated indoor and outdoor water use consumption (in m^3/year) to enable ongoing tracking of water use relative to expected.

2.5 Zero Waste & Toxicity Requirements

2.5.1 Construction and Demolition Waste Management

Each project is required to reduce construction and demolition waste sent to landfills and incinerators by recovering, reusing and recycling non-hazardous materials. The LMHOs have a target of 80% waste diversion at all new health care construction projects by 2020 and 90% by 2030. Although we don't currently have an absolute target, each project should aim to keep total material waste under 12.2kgs per square meter.

In order to meet project waste diversion reporting requirements, the contractor is expected to track kgs of construction waste generated and diverted on a quarterly basis (see Construction Specifications – Standard Owner General Requirements – Section 9: Removal of Waste).

For best practice considerations, refer to:

- Demolition, Land Clearing & Construction Waste Management Toolkit
- LEED v4 Construction and Demolition Waste Calculator
- 3Rs Code of Practice for the Building Industry

2.5.2 Waste Collection

Each project is required to include space for recycling (including mixed paper, mixed containers and organics), garbage and biomedical waste collection as per waste collection standards in the LMHOs. Adequate container spaces in the appropriate locations are necessary considerations for reaching waste diversion targets and

efficient waste collection. The LMHOs have a target of 50% waste diversion at all acute and residential care sites by 2020.

The following is a list of waste management elements to consider when planning/designing and operations:

- Waste types generated by facility area
- Container needs and dimensions
- Waste station set-up
- CSA for waste storage and handling

For more detailed information, refer to: ***https://bcgreencare.ca/resource/waste-management-space-design-guidelines***

2.5.3 Waste Reuse and Repurposing

Each project is required to identify opportunities for waste reuse and repurposing before disposing materials in recycling or landfill. For more information on repurposing service providers contact the Zero Waste and Toxicity Leads for the latest information.

2.5.4 Waste Reduction through Procurement Practices

Each project is required to evaluate vendors and their products and services based on how they contribute to waste avoidance, reduction and diversion. This can be accomplished implementing an environmental questionnaire at the following points in time: request for info, request for quotes and request for proposals. The questionnaire includes questions that address quantity of waste generated, type of waste generated, packaging waste, recycled/reclaimed content, and recyclability, as well as, third party environmental certifications and company waste reduction initiatives and strategies. In addition, questions should consider energy and water consumption and GHG emissions.

For sample questions, contact the Zero Waste and Toxicity lead and visit Sharepoint Zero Waste & Toxicity Resources here.

2.5.5 Minimizing Potential Exposure to Toxicity (Chemicals of Concern)

Each project is required to minimize the potential exposure of contractors, staff and patients to toxic chemicals, in particular, those that are known to be hazardous to human and environmental health and present on one or more of the following Chemicals of Concern lists:

- CEPA Toxic Substances List Schedule 1,
- Federal Environmental Quality Guidelines,
- David Suzuki Dirty Dozen,
- The Red List,
- The Proposition 65 List,
- International Chemical Secretariat Sin List and
- RoH – European Commission.

Examples of chemicals that projects should seek to avoid or minimize are:

- Bisphenol A (BPA)
- Legacy chemicals such as mercury, cadmium, lead
- Chlorofluorocarbons (CFCS)
- Formaldehyde
- Halogenated flame retardants (HFRS)
- Polychlorinate Biphenyls (PCBS)
- Perfluorinated Compounds (PFCS, PFOS, PFOA)
- Phthalates (DEHP)
- Polyvinyl Chloride (PVC)
- Volatile Organic Compounds (VOCs)

The LMHOs acknowledge that there may not be proven safe alternatives to these chemicals at this time. Regardless, we want to work with vendors that are taking responsibility by:

- Knowing what goes into their products / willing to find out;
- Are transparent and willing to declare ingredients including chemicals of concern;
- Actively advocating/searching or innovating safer alternatives; and
- Seeking third party certification.

This can be accomplished by implementing an environmental questionnaire at the following points in time: request for info, request for quote, and request for proposals from vendors. The questionnaire includes questions that address quantity and type of chemicals of concern in construction materials, finishings, furnishings, and equipment.

For sample questions and additional information on chemicals of concern for your project, contact the Zero Waste and Toxicity lead and visit Sharepoint Zero Waste and Toxicity Resources here.

2.6 Active & Clean Transportation Requirements

Each new construction or redevelopment project needs to create a Transportation Demand Management (TDM) plan, and engage with the EES team to ensure that the project contributes to the reduction of transportation

needs of staff, patients, and visitors by gas- and diesel-powered single occupancy vehicles, and the increase in transportation via active and clean transportation.
Clean transportation: modes that reduce GHG emissions, and contribute to environmental and human health by providing alternatives to single occupancy vehicles that consume gas and diesel. Includes public transit, electric vehicles, carpooling, electric scooters.

Active transportation: modes that are human-powered and reduce the risk of disease, the effects of psychological stress, and the negative physical impact of a sedentary lifestyle. Includes: walking/rolling, cycling, running, and the use of human-powered or hybrid mobility aids such as wheelchairs, scooters, and e-bikes.

The TDM plan for each new construction, redevelopment or major renovation project will entail two requirements:

- Outline specific actions, goals, monitoring, and proposed reporting schedule that the Lower Mainland Health Care Organization (LMHO) is undertaking concerning TDM. This includes measures to reduce motorized vehicle trips by staff to and from the site.
- A 'TDM: Staff Health and Wellness' letter outlining mechanisms/strategies for reducing vehicular travel to and from the new site, including measures to increase cycling, walking, transit use, carpooling, carsharing and electric vehicle use to date is required. Included in this letter are any other strategies to reduce overall CO^2 pollution from staff vehicles that travel to and from the new site.

2.6.1 Bicycle Facilities

Each project needs to follow the Bicycle Parking Facilities Design Guidelines produced by Lower Mainland Integrated Protection Services, and the minimum requirements by the governing city, municipality, district or township where the facility is located.

Projects need to differentiate between and address both Class A (long term/staff) and Class B (short term/transient) bicycle parking. Class A bicycle storage should include one 110v electrical outlet per five-bicycle capacity.

- Class A: Secured bicycle storage for one of every five employees on a maximum/peak work shift.
- Class B: Six bicycle racks/stalls at every facility entrance.

Showering and changing facilities must be considered in proximity to every bicycle storage room/facility. Showers and changing facilities must be accessible for all and be located at a reasonable time and distance from the secured Class A bicycle storage.

2.6.2 Electric vehicles

Each project needs to demonstrate how they will address current and future demand for electric vehicle charging infrastructure.
Each project must meet the requirements for LEED v4.1 Electric Vehicle credit Option 1 or Option 2 and the minimum required number by the governing city, municipality, district, or township. All EV charging stations must be Level 2 or greater.
Option 1: Install electric vehicle charging stations for 5% of all parking spaces, or minimum two spaces (whichever is greater)
Option 2: Make 10% of all parking spaces or minimum six spaces EV-ready (whichever is greater).
All EV charging installations must follow installation specifications by Lower Mainland Integrated Protection Services contained within *Plan No: ECS Electric Vehicle (EV) Charging Station.* These specifications include standardized equipment type, signage, ground markings, and network host.

3. BEST PRACTICE CONSIDERATIONS

Explore application of the following standards, guidelines, methodologies and resources as applicable:

- A Lean planning, design and construction methodology, and associated principles, tools and approaches
- ASHRAE Standard 209-2018 -- Energy Simulation Aided Design for Buildings
- Healthy Built Environment Linkages Toolkit, v2.0
- Health and Outdoors Opportunities Assessment: *More Access to Green Space, Better Health* (May 2018
- Passive House Standard
- WELL Building Standard
- NYC Climate Resiliency Design Guidelines (April 2018, v2.0)
- Resilience 2.0: Healthcare's Role in Anchoring Community Health and Resilience (January 2017)
- Safe Haven in the Storm: protecting lives and margins with climate-smart health care (January 2018)
- APEG BC Flood Mapping Guidelines