SUSTAINABLE DESIGN STANDARD (DS-05)

MX-FAE-STD-A105

Facilities, Architecture & Engineering
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METROLINX

Metrolinx Design Standards
Metrolinx Sustainable Design Standard

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Amendment Record

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1.0	February 2021	Initial version
2.0	October 2025	Editorial updates to clarify requirements Removal of Stormwater Management Requirements to Civil Stormwater Standard Addition of LEED requirements for GO and Subway stations

PREFACE

This is the second edition of the Sustainable Design Standard (MX-FAE-STD-A105). The purpose of this standard is to provide project delivery teams and designers consistent requirements and design best practices to apply to the delivery of capital and operationally cost-efficient buildings, facilities and sites with high life-cycle sustainability performance.

The technical content within the Sustainable Design Standard MX-FAE-STD-A105) was developed by the Metrolinx Facilities Architecture & Engineering office within the Asset Management & Maintenance Division, which includes specialized subject matter experts.

This Standard is available for external users to download via the Metrolinx public download site at:
https://www.metrolinx.com/en/metrolinx-technical-standards

Suggestions for revision or improvements can be sent to Metrolinx Facilities Architecture & Engineering, Attention: Senior Manager, Architectural Standards, who will introduce the proposed changes to Metrolinx Facilities Architecture & Engineering. The Senior Manager, Architectural Standards, ultimately authorizes the changes. A description of the proposed change shall be included along with information on the background on the background of the application and any other useful rationale or justification. Proposals for revisions or improvements shall include your name, company affiliation (if applicable), email address, and phone number.

This standard is applicable to all Metrolinx projects and provides architectural and urban design requirements for stations, facilities, stops, and associated customer-facing infrastructure.

For additional information, contact the owner of this Standard.

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1 INTRODUCTION

1.1. PURPOSE

The purpose of the Sustainable Design Standard is to provide project delivery teams and designers consistent requirements and design best practices to apply to the delivery of capital and operationally cost-efficient buildings, facilities and sites with high life-cycle sustainability performance. The standard emphasizes performance criteria and provides a range of recommendations and options for designers to apply to meet the performance criteria. While emphasizing design requirements and best practices, the standard also covers reporting and technical aspects of sustainability.

Refer to Metrolinx I&IT Standards for all technology system requirements.

For project applicability, refer to Appendix A of this Standard.

1.2. SCOPE

The Sustainable Design Standard identifies key sustainable design requirements, recommendations, and options to be applied by consultants, designers, contractors, and shall be:

- Mandatory for the design of all new, expanded and reconstructed Metrolinx buildings and facilities;
- Mandatory for State-of-Good-Repair (**SOGR**) capital infrastructure programs for Metrolinx sites and facilities; and
- Not applicable to On Corridor (**OnCorr**) rail and civil infrastructure outside station sites. At stations, the standard does not apply to rail and civil infrastructure within the active rail corridor.

This standard shall apply to all delivery methodologies, including third-party deliveries, market-driven strategy deliveries, joint developments, Alternate Finance and Procurement (**AFP**), Construction Management (**CM**), Design Build (**DB**), Design Bid Build (**DBB**), and any other procurement types that involve design and/or construction of buildings and sites. The applicability matrix (Table 10 in Section 11) provides a detailed breakdown of applicability of each standard section to the main project elements based on capital cost, Gross Floor Area (**GFA**), and site area. This standard applies to all Metrolinx-delivered new buildings, sites, building expansions, building reconstructions, and State-of-Good-Repair (**SOGR**) projects, subject to size and cost thresholds and project elements. Per Table 10, the following sub-sections do not apply to projects operated under GO Transit: 3.3.3 Mechanical Systems, 3.3.4 Electrical Systems, 4.1 Water Modelling, Metering and Monitoring, and 6.3 Light Pollution Reduction.

For the purpose of this standard, the term building refers to a fully enclosed structure that supports human occupation, including pedestrian bridges, tunnels, parking garages, fully enclosed shelters, and vertical pedestrian access. Buildings include any attached enclosed structures containing mechanical, electrical or other ancillary uses. Buildings include new stations, maintenance facilities and storage facilities. Buildings include above-grade, at-grade, and

below-grade. Applicability of the standard to temporary buildings shall be addressed on a case-by-case basis.

1.3. HOW TO USE THIS STANDARD

The approach for sustainable design needs to be an integral part of the design process, from concept to completion, with consideration to ongoing O&M of all Metrolinx facilities and infrastructure projects, apart from On Corridor rail and civil-related works.

The standard is broken down into topic sections and sub-sections. Topics may have requirements, guidance and options. Guidance and options represent acceptable design approaches, subject to alignment with other Metrolinx standards; however, other design solutions may be acceptable, subject to alignment with other requirements of this standard, and other project requirements. MAPPs and PAs shall reference this standard as a requirement and do not need to repeat requirements outlined within this standard. However, project delivery teams may elect to use MAPP or PA requirements to refine the applicability of standard sections/ sub-sections to reflect project opportunities and constraints. In particular, this standard covers many of the requirements of the CaGBC's Zero Carbon Building standard.

The design stages noted within this standard for various submissions are based on design submission schedules of typical projects; it is recognized that some projects will need to adapt the submission timing as appropriate to the project's submission schedule. For stations integrated into other buildings, this standard only applies to the portion of the building and site for which Metrolinx has obtained or intends to obtain full property rights.

1.4. LEGISLATIVE AND POLICY FRAMEWORK

The Sustainable Design Standard supports Metrolinx policies and strategies, in particular the 2041 Regional Transportation Plan, the Sustainability Strategy, and Climate Resiliency Strategy. The vision of the Metrolinx 2041 Regional Transportation Plan is that "The GTHA will have a sustainable transportation system that is aligned with land use, and supports healthy and complete communities. The system will provide safe, convenient and reliable connections, and support a high quality of life, a prosperous and competitive economy, and a protected environment."

It is required that each project be designed in accordance with the current version of all applicable standards, regulations, and codes to the approval of all authorities having jurisdiction. Where sustainability requirements vary between documents, the most stringent requirements shall apply. Furthermore, the Guidelines and Options available to a project in this standard may be constrained by applicable standards, regulations and codes. Applicable legislation includes, but is not limited to, the latest versions of:

- Ontario Building Code
- National Energy Code for Buildings
- National Building Code of Canada

- Applicable standards, regulations, and codes to the approval of all authorities having jurisdiction in effect at the time of a project agreement.

1.5. KEY CONCEPTSASSOCIATED FRAMEWORKS

1.5.1. LEED

LEED is a third-party sustainability framework that provides certification based on building performance over a selection of credits. For more information on Metrolinx's LEED requirements, refer to Section 7 of this Standard.

1.5.2. MUNICIPAL GREEN DEVELOPMENT STANDARDS

Green Development Standards are frameworks municipalities are developing that introduce requirements related to the Site Plan Approval process, such as the Toronto Green Standard.

1.5.3. FEDERAL CLIMATE LENS ASSESSMENT

A Climate Lens Assessment is applicable to projects applying for federal funding under the Investing in Canada Infrastructure Guidance. There are two main components: a climate risk and vulnerability assessment and a greenhouse gas mitigation assessment.

1.6. ADMINISTERING STANDARDS

1.6.1. OVERVIEW

The Sustainable Design Standard provides guidance and requirements for sustainability at stations and facilities. This standard shall be applied together with the project contract documents.

1.6.2. RELATIONSHIP BETWEEN METROLINX STANDARDS

Refer to Front End Design Standard (DS-00).

1.6.3. LEGISLATIVE CODES AND STANDARDS

Refer to Front End Design Standard (DS-00).

1.6.4. DESIGN REVIEW AND SUBMITTAL PROCESS AND REQUIREMENTS

Refer to Front End Design Standard (DS-00).

1.6.5. ACRONYMS AND TERMINOLOGY

Refer to Front End Design Standard (DS-00).

2 PRE-PROJECT LIFE CYCLE ANALYSIS

2.1. LIFE CYCLE ASSESSMENT (EMBODIED CARBON)

2.1.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits;

b) Municipal Green Development standards; and

c) Federal Climate Lens Assessment.

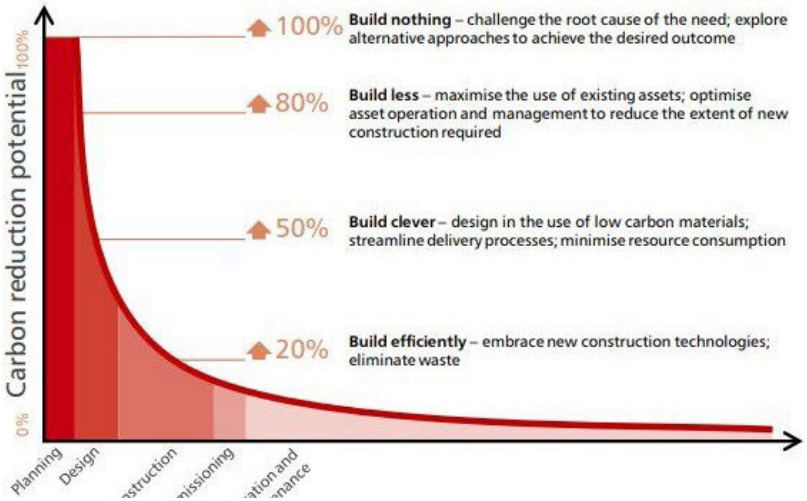

Figure 1: Carbon Reduction Curve. While reducing carbon emissions is possible at all stages of project delivery, opportunities are greater and most cost-efficient in earlier stages.

2.1.2. REQUIREMENTS

All new building projects shall:

a) Develop a life cycle assessment (or LCA) for embodied carbon that:

   i. For buildings, bridge structures, underpasses and platforms, use the Athena Impact Estimator for Buildings Software, One-Click LCA, Tally or equivalent with prior approval from Metrolinx. Any software used shall use analysis specific to the GTHA; and

   ii. For roadways and parking lots, use the Athena Pavement LCA software or equivalent with prior approval from Metrolinx.

b) Provide CO_2e emissions by project life-cycle stages (product, construction, operations, and end-of-life), with summary and detailed breakdown by components and materials;

c) Provide Metrolinx the input or Bill of Materials used for the LCA;

d) Include the social cost of carbon used by Environment and Climate Change Canada as part of the analysis; and

e) Provide Metrolinx the summary output generated by the LCA software;

f) Provide a report on the embodied carbon analysis, including:

   i. Boundary of Assessment: this section will describe required scope and limits of the assessment. In the

context of LCA, specific elements could include the timescale of the assessment, what particular construction materials and the types of activities are considered, etc.;

ii. Greenhouse Gases Considered: this section describes the types of GHGs considered in the assessment. Minimally, carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF_6); and nitrogen trifluoride (NF_3) shall be considered in the assessment and converted to tonnes CO_2 equivalent for the purpose of the calculations;

iii. Emissions Scope: this section describes the required scope of emissions considered in the analysis of the Project (Scope 1 covers direct emissions from owned or controlled sources, including construction and operation of infrastructure. Scope 2 covers indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed by the infrastructure owner. Scope 3 includes all other indirect emissions that occur in the project's value chain, including production and transportation of materials used in construction and operations);

iv. Data Collection and Calculation Method: this section provides information regarding the formulae and data used in the analysis, including a clear list of assumptions and inputs into the LCA calculation

v. Exclusions: this section describes the information that was intentionally omitted from the assessment, rationale or justification for exclusions to be provided.

2.1.3. OPTIONS

All building projects (new, reconstruction and expansion) and roadway and pavement construction may:

a) Calculate the CO2e LCA for additional project components not covered by the above software (such as landscaping). Calculations should use techniques defined in PAS 2080 or equivalent; and

b) Compare the CO2e LCA of different design options during the design development phase of a project. The same methodology should be used for each option (i.e. a comparison cannot be made between options analyzed using different software). Note that at a minimum, the following metrics should be the same in order to conduct a comparison of design options for a building:

- Location;
- Building Type (type of occupancy);
- Building Life Expectancy (Years);
- Building Height (m); and
- Gross floor area (m^2).

2.1.4. REPORTING DIRECTIONS

Table 1 defines a list of materials with Global Warming Potential equivalencies to be calculated as part of the LCA to be provided to Metrolinx if a non-software approach is approved.

Table 1: Life Cycle Assumptions Included in the LCA Analysis

ACTIVITY	MATERIAL	GLOBAL WARMING POTENTIAL
Construction Materials	Concrete	CO2e per kg or per tonne (Kg CO2e)
	Concrete w/ reinforcement	CO2e per kg
	Steel	CO2e per kg
	Wood	CO2e per kg
	Aggregate/fill	CO2e per kg
	Glass	CO2e per kg
	Aluminum	CO2e per kg
	Asphalt	CO2e per kg
Transport	Input and export from site of materials	CO2e per tonne transported per km driven
	Construction equipment	CO2e per L of diesel or gasoline.
Energy	Natural Gas	CO2e per kWh
	Hydroelectric	CO2e per kWh
	Propane	CO2e per kWh
	Fuel/Oil	CO2e per kWh
	Renewables Generation on Site	CO2e per kWh
Water	Potable Water (site operations only)	CO2e per L
Other activities as defined by Metrolinx		

2.2. MATERIAL LIFE CYCLE IMPACTS

2.2.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits; and

b) Municipal Green Development standards.

2.2.2. REQUIREMENTS

All projects shall:

a) Achieve a minimum 75% Construction Waste Diversion by volume, excluding aggregate, fill and hazardous materials;

b) Use optimal and compact building form to reduce overall building materials used; and

c) Use low-carbon cement or Portland-limestone Cement for concrete or mortar, which has a higher proportion of Supplementary Cementitious Materials (SCM) (e.g. slag, fly ash, etc.) as a partial substitute for Portland cement.

2.2.3. GUIDANCE

All projects should:

a) Use products, where available, from manufacturers who have validated triple bottom line (environmental, economic, and social) life-cycle information relevant to the product through independent, consensus-based, third-party certifications. The products must have earned and still maintain certification under the scheme.

2.2.4. OPTIONS

Projects may consider:

a) Decreasing the volume and/or weight of the structure, which has considerable potential for reducing embodied carbon. Replacing solid concrete with cellular concrete and hollow core concrete can significantly reduce structure's weight and embodied emissions;

b) Replacing concrete with a wood structure reduces the building weight, and therefore the quantity of foundation materials needed, resulting in fewer carbon emissions. Wood also has a lower embodied carbon and sequesters carbon, as compared to concrete and metal materials;

c) Using reusable material as raw material where feasible. Hazardous materials shall not be reused. For example, crushed concrete can be used as aggregates in new concrete, and Green Label Plus or recycled material can be used in carpet;

d) Where feasible, use prefabricated elements or modular volumetric construction, such as façade panels and glazing systems, to reduce construction time and waste and enhance reuse;

e) Incorporating high-quality upcycled materials from waste can reduce emissions, if the upcycling facility has low impacts.

3 HIGH PERFORMANCE BUILDINGS

3.1. BUILDING ENERGY AND CARBON PERFORMANCE TARGETS

3.1.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits; and

b) Municipal Green Development standards.

3.1.2. REQUIREMENTS

All new buildings with a GFA of actively heated and cooled spaces greater than 100 m^2 shall:

a) Meet NECB 2015 Climate Zone 7's prescriptive path requirements for the building envelope;

b) Achieve a Thermal Energy Demand Intensity (TEDI) of ≤ 32 kWh/m^2/year;

c) Achieve a minimum 25% Energy Improvement over a reference building per the corresponding version of ASHRAE 90.1 or NECB, where the building is pursuing LEED;

d) Achieve a minimum 25% Energy Improvement over a reference building per ASHRAE 90.1 2013 or NECB 2015 for other buildings; and

e) Projects are to exclude snowmelt systems from energy performance targets.

All other buildings shall:

f) The energy performance shall meet ASHRAE 90.1 2013 or NECB 2015, where the building is pursuing a Building Permit only; and

g) Where the building is to meet OBC SB-10, the energy performance of the design shall meet the requirements of ASHRAE 90.1 2013 or NECB 2015, and additional requirements introduced through OBC SB-10 2017 Division 3 Chapter 2.

3.1.3. OPTIONS

New building projects with a GFA of actively heated and cooled spaces greater than 100 m^2 may:

a) Use Energy Star Portfolio Manager Site Canadian National Median Site Energy Use Intensity (EUI) in (GJ/m^2) as a benchmark for the new building design, and the site EUI from the energy model should be less than the National Median Site EUI. Refine design options to achieve EUI benchmark/target; and

b) Achieve LEED certification with a focus on energy efficiency-related credits.

3.2. ENERGY SIMULATIONS AND MODELLING

3.2.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits;

b) Municipal Green Development standards; and

c) Federal Climate Lens Assessment.

3.2.2. REQUIREMENTS

All new buildings with a GFA of actively heated and cooled spaces greater than 100 m^2 shall:

a) Produce a preliminary energy model (a simplified box type is acceptable) at no later than 30% Design (development design to schematic design stage) that:

   i. Helps the design team and Metrolinx explore the energy consequences of design options;

   ii. Provides an early estimate of energy performance to inform the design process;

   iii. Follows the standardized methodology provided in ASHRAE Standard 209-2018, "Energy Simulation Aided Design for Buildings except Low Rise Residential Buildings;" and

   iv. Is updated to reflect design details as the design is being refined further throughout design; and

   v. Is summarized in a report submitted at no later than 30% Design.

b) Produce a full-building simulation model that:

   i. Reports the end-use breakdown to inform the design team of major energy-related matters;

   ii. Reports the building's Energy Use Intensity (EUI) in kWh/m^2/year, Thermal Energy Demand Intensity (TEDI) in kWh/m^2/year, and Greenhouse Gas Intensity (GHGI) in kgCO_2/m^2/year, Peak Electricity Demand (kW), and the generated renewable energy (kWh/year) along with Solar Photo-Voltaic and/or Solar Thermal design analysis when it is applicable;

   iii. Is made available to Metrolinx upon the substantial completion of the project; and

   iv. Is summarized in a report submitted to Metrolinx upon completion of the project.

c) Produce a preliminary Energy model and full-building simulation model that:

   i. Uses energy model calculations performed using climate data (CWEC file is preferred), including temperature, humidity, and insolation, that are representative of a 10-year average. For urban regions where the weather data are not available, the energy modelling shall be performed using available weather data that best represents the climate at the building site;

   ii. Incorporates operation schedules relating to the presence of occupants, where relevant (with occupant counts provided by Metrolinx) and of loads due to the operation of the building. The

predefined schedules from ASHRAE 90.1 and NECB can be selected. Occupant counts are not relevant to stations;

iii. Where snow melt systems are proposed, compare metrics with and without a snow melt system;

iv. Is the basis of design option life-cycle cost. The utility rates, carbon tax, and GHG emission factors to be used in the calculation are to be provided by Metrolinx; and

v. Uses an hour-by-hour energy simulation software. See Section 3.2.3(b) for a list of recommended software.

d) Produce an As-Constructed Stage Energy Report that:

i. Reflects the building's final design, including any changes made during the construction phase that are submitted after occupancy begins and all necessary shop drawings and as-built drawings are issued; and

ii. Produces anticipated load demands to be validated through sub-metering at time of commissioning.

All other new buildings to meet OBC SB-10 shall:

e) Produce an energy model and summary report proving the energy performance of the design meets the requirements of ASHRAE 90.1 2013 or NECB 2015, and additional requirements introduced through OBC SB-10.

3.2.3. GUIDANCE

All new building projects should:

a) Use the ASHRAE 90.1 and NECB pre-defined operation schedules, Lighting Power Density (LPD) and plug loads, and occupant densities in the preliminary energy model;

b) Use the following preferred energy simulation software: IESVE, DOE-2, EnergyPlus™, Hourly Analysis Program (HAP), or equivalent that conforms to ASHRAE 140 "Evaluation of Building Energy Analysis Computer Programs";

c) Perform energy modelling for any passive design strategies to estimate and verify the impacts from the passive design strategies. Note that the calculated annual GHG emission, peak electric demand might still need to be reported as per OBC SB-10;

d) Follow CaGBC's supplemental document, Guidance for Energy Modelling Compliance Documentation in LEED Canada; and

e) Follow Energy Efficiency Report Submission & Modelling Guidelines for TGS Version 3.

3.2.4. OPTIONS

Post-construction energy modelling may:

a) Evaluate design options that facilitate a future transition away from natural gas systems to electric, including solar PV, with minimal impact to the building's energy systems. The evaluations should be supported with a

GHG emissions comparison between an NG-fired heating system option and a fully electrified heating system option;

b) Update energy models to reflect any changes and modifications that are made to the facility, calibrated with the measured energy data on an annual basis for the duration of the Contract Operate and Maintain period; and

c) Run the energy model with RETScreen® Clean Energy Project Analysis Software, by Natural Resources Canada, to allow for performance analysis with sub-meter energy data after site is commissioned (and GHG analysis).

3.3. ENERGY EFFICIENT DESIGNS

3.3.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits; and

b) Municipal Green Development standards.

3.3.2. BUILDING ENVELOPE

3.3.2.1. REQUIREMENTS

All new buildings with a GFA of actively heated and cooled spaces greater than 100m^2 shall:

a) Minimize thermal bridges by maintaining a continuous thermal barrier throughout the building envelope. Where interruptions are necessary, use solutions such as thermal break connectors at slab edges or thermally broken cladding clips to reduce heat transfer;

b) Perform a whole-building air leakage test of the actively heated and cooled space after construction completion per the requirements of ASHRAE 90.1–2016 Section 5.4.3.1.3(a). The building shall achieve a normalized maximum air leakage rate of 2.0 L/s-m^2 at 75 Pa, in accordance with ASTM E779 or ASTM E1827 by an independent third party. The airtight line shall be continuous even when formed of different materials, and it shall be joined up, even where there are penetrations. A summary report shall be submitted to Metrolinx, summarizing the method undertaken, test results, and corrective actions undertaken or planned. Summary report shall clearly state confirmation that the performance criteria have been met;

Subject to alignment with other applicable Design Standards, all new buildings with a GFA of actively heated and cooled spaces less than 100 m^2 shall:

c) Optimize glazing placement, ratios and building orientation to increase solar gains in the winter months while mitigating solar gain in the summer months; in particular, shading devices or other design strategies shall be provided over south facing glazing to lessen incoming solar gains in the summer months while still allowing solar gains in the winter months; and

d) Specify exterior glazing to be insulating and Low-E glass.

3.3.2.2. GUIDANCE

Subject to alignment with other applicable Design Standards, all building projects (new, reconstruction and expansion) should:

a) Optimize building orientation and site placement in the preliminary design stage to reduce the TEDI. Provide a study of winter solar radiation gain, minimum energy loss, etc. Building orientations and characteristics of the site have a huge influence to building over time. It is recognized that site constraints and orientation to fixed assets, such as rail corridors, may limit options;

b) Design a compact building form that minimizes complicated junctions and variations in the façade. This will provide a more efficient area-to-volume ratio and will minimize thermal bridging through the building envelope;

c) Optimize glazing placement during the building orientation design. Optimal design should increase solar gains in the winter months while mitigating solar gain in the summer months; in particular, shading devices or other design strategies should be provided over south-facing glazing to lessen incoming solar gains in the summer months while still allowing solar gains in the winter months;

d) Provide passive ventilation through the appropriate placement of windows and operable windows to use incoming fresh air to move warm and stale air out of a building;

e) Optimize natural light from the sun (daylighting) to reduce the need for artificial, electric lighting within buildings. Natural light can dramatically reduce a building's EUI; and

f) Optimize the quantity of glazing seams and arrangement to achieve a low TEDI**.** This can significantly influence the impact of thermal bridging to the wall interface.

3.3.2.3. OPTIONS

a) Use Light Shelves to help to gather and reflect incoming solar radiation and help to light deep interior spaces without overheating. A light shelf is a horizontal surface that reflects daylight into a building space. The design of light shelves shall facilitate window maintenance.

a) Use electrochromic glass to improve indoor comfort and lower energy consumption. It also eliminates the need for traditional blinds and shading, saving material and maintenance cost;

b) Use Intermediate Building Elements. Understanding that the appropriate building orientation may not always be in line with the site, specifically tracks, the design should introduce building elements such as canopies, etc., to tie in the two together, these elements shall allow for the building to maintain its required orientation while architecturally connecting it to the tracks or other binding site features; and

c) Use solar tube lighting, also known as a sun tube, sun tunnel, light tube, or tubular skylight.

3.3.3. MECHANICAL SYSTEMS

Mechanical systems shall be designed to achieve efficiency targets per the requirements of Section 3.1. For GO-branded buildings, mechanical requirements are specified in other standards.

3.3.3.1. GUIDANCE

To improve energy efficiency, particularly the EUI, it is recommended that all new buildings that will not be operated under GO Transit should specify:

a) High efficiency rooftop units with economizers;

b) Motors for mechanical equipment such as pumps and fans be 'Premium Efficiency Motors';

c) Variable frequency drive for all motors above 3 HP (2.2 kW) be complete;

d) Part-load performance of equipment be considered during selection of mechanical equipment, as it is a critical consideration for HVAC sizing. Most HVAC equipment only operates at its rated, peak efficiency for 1% to 2.5% of the time. Select equipment that can operate efficiently at part-load;

e) Energy recovery units with a minimum effectiveness of 60% for mechanical ventilation of spaces;

f) Ductwork connected to mechanical equipment be designed to reduce the static pressure of the system. Follow SMACNA standards for best practices for ductwork construction;

g) VAV units for air terminals, wherever possible, to reduce the energy consumption; and

h) Air curtains for overhead doors in the maintenance facilities and for the high-traffic doors in the station buildings. Air curtains should be considered for doors separating the conditioned spaces with outdoors.

3.3.3.2. OPTIONS

All new buildings that will not be operated under GO Transit targeting a higher level of performance (EUI and GHGI) may specify:

a) Where, air source heat pumps are proposed, it is recommended that:

   i. Air source heat pumps are variable refrigerant flow type heat pumps; and

   ii. A supplementary heating source be included to supplement the air source heat pump when the outdoor temperature is below the frost temp of the unit. For a lower GHGI, the supplementary heating source should use an electrical system.

b) Ground source heat pumps. Where ground source heat pumps are proposed, it is recommended that:

   i. A feasibility study be conducted prior to proposing geothermal energy for space heating and for domestic hot water heating;

   ii. The system provides heating and chilled water in various mechanical equipment such as hydronic air handling units, rooftop units and fan coil units, etc.;

iii. Charging of geothermal bore may be required to maintain energy levels in the bore and to avoid freezing of the bore. If feasible, charging of the bore should be done through a renewable source of energy such as solar PV to achieve a lower GHGI. Additional solar panels would be required to charge the bore; and

iv. During winter, when the bore temperature drops below freezing, the heat pump will be ineffective and will not be operational. At that time, a supplementary boiler will be required to provide heating water for space heating.

c) Air-to-water heat pumps. Where air-to-water heat pumps are proposed, it is recommended that:

i. The system provides heating and chilled water in hydronic air handling units, rooftop units and fan coil units.

ii. Additional source of heating, such as a boiler, be included when the outdoor air temperature drops below frost temperature of the heat pump.

d) Solar Walls to pre-heat ventilation, subject to applicable Design Standards. Solar wall can be used to preheat the outside ventilation air. The perforated solar panels installed on south wall will allow fresh air to enter a wall cavity behind the metal collector, where the HVAC system is connected to preheat large volumes of ventilation air to the building. Related alternative technologies include Trombe walls or air shafts. However, for south exterior facades where there is no need for glazing, using solar thermal walls is suggested;

e) Double-skin façades (DSF), subject to applicable Design Standards. The double-skin façade, or DSF, is an envelope construction composed of two transparent ''skins'' that are separated by an air corridor. It integrates passive design strategies, such as natural ventilation, daylighting, and solar energy. The DSF is a hybrid which uses some mechanical energy in addition to the natural and renewable energy resources. A DSF system can be created over an entire façade or just a portion of it, and it is applicable to all kinds of buildings; and

f) Earth tubes for pre-conditioning of make-up air.

3.3.4. ELECTRICAL SYSTEMS

3.3.4.1. REQUIREMENTS – ENERGY AUTOMATIC SYSTEMS

All new buildings or extensions that will not be operated under GO Transit with a GFA of actively heated and cooled greater than 100 m^2 shall:

a) Specify time scheduling for control of electrical and mechanical systems (heating, cooling, lighting, etc.) to automatically control systems to conserve energy. Time scheduling strategies include time-of-day and time-of-year controls;

b) Specify occupancy-based controls for electrical systems such as lighting and specially designated receptacles to conserve energy in unoccupied spaces;

c) Specify occupancy-based controls for ventilation to adjust the amount of fresh air based on the occupancy to conserve energy;

d) Implement electrical and mechanical systems time scheduling functions to allow for automatic switch off at appropriate times to conserve energy; and

e) Specify temperature sensors in all regularly occupied enclosed spaces and connect these sensors to building management systems, where applicable and where heating or cooling is provided.

3.3.4.2. REQUIREMENTS – ENERGY METERING AND MONITORING

The objectives of this section are to allow for accurate energy monitoring and management for new buildings that will not be operated under GO Transit, through continuous energy metering, and to accurately meter all large energy uses.

All new buildings or extensions that will not be operated under GO Transit with a GFA of actively heated and cooled spaces greater than 100 m^2 shall specify:

a) Energy metering for all whole-building energy sources (electricity, natural gas, chilled water, steam, fuel oil, propane, biomass, etc.) used by the asset;

b) Energy metering to independently meter energy loads for individual end uses which are anticipated to exceed 100kW or 10% (per LEED BD+C Advanced Energy Metering Credit.) of total annual consumption of the building;

c) A monitoring system that uses digital metering technology for monitoring of electricity usage. This system shall have the ability to distinguish and monitor electrical information divided into different categories (lighting, mechanical, receptacle loads), different geographic locations (floors, wings, area types), and different times of day;

d) A graphic interface for monitoring electricity usage and for providing an easy-to-understand way of visualizing information. Ability to distinguish and visualize information divided into different categories (lighting, mechanical, receptacle loads), different geographic locations (floors, wings, area types), and different temporal situations (times of day, time periods);

e) A monitoring system interface accessible from Metrolinx office PC workstations;

f) A monitoring system that can monitor building zones independently and be able to distinguish metering data by zone; and

g) Meters that conform either to the Canadian Standards Association (CSA) Standard C900 Heat Meter Standard or to the European Committee for Standardization (CEN) Standard EN 1434.

3.3.4.3. REQUIREMENTS – LIGHTING

All buildings that will not be operated under GO Transit shall:

a) Use only LED integrated light fixtures and avoid usage of LED retrofit light bulbs, which are generally less energy efficient;

b) Install automatic lighting control systems for exterior spaces;

For interior spaces:

c) Utilize time-of-day and time-of-year lighting controls in non-24-hour occupied locations to reduce energy usage as appropriate for the intended occupancy, which are customizable by the facility operator;

d) Utilize vacancy or occupancy sensing solutions in all regularly occupied spaces to reduce unnecessary energy usage; Design lighting zones with a high degree of granularity to minimize wasted light; and

e) Utilize natural daylighting as much as possible with consideration of energy consumption requirements and the impact on the natural environment. Minimize use of artificial light when natural daylight is present through the use of photocells and sensors.

3.3.4.4. REQUIREMENTS – GENERAL

Electrical designs for buildings (new, extensions and reconstructions) that will not be operated under GO Transit shall:

a) Avoid oversizing power transformers to control transformers unwanted heat emission; transformers must be sized adequately, meeting the asset's electrical load requirements plus 50% allowance for potential future growth as required by industry standards;

b) Dry type power transformers shall meet the 2019 NRCan Energy Efficiency Regulations, requiring an energy efficiency percentage which is third-party certified, calculated for the 1.2 KV class at 0.35 of the nominal power rating and for the BIL 20-199 kV class at0.50 of the nominal power. Compliant product models as listed on NRCan's database (https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/dry-type-transformers);

c) Ensure all electric motors meet Canada's Energy Efficiency Regulations published by NRCan, which set a performance standard for their energy consumption; and

d) Utilize Variable Speed Drive (**VSD**) to control motors where required by process.

3.4. SOLAR PV RENEWABLE ENERGY

3.4.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits.

3.4.2. REQUIREMENTS - GENERAL

a) All new Metrolinx buildings shall not consider the installation of Solar PV renewable energy systems where:

   i. System is unable to supply a minimum of 5% of the building's total energy load;

   ii. Metrolinx is not responsible for utility costs post-construction and commissioning;

   iii. Clear roof area is designed for less than 100 m^2 and/or designed for overbuild, and/or a shadow study indicates sufficient insolation;

iv. Electrical and mechanical rooms provide inadequate space to support metering and electrical panel equipment related to the solar PV system;

v. Otherwise, implementing a green roof; and

vi. Otherwise, implementing an alternative on-site renewable energy production method.

All Solar PV installations shall:

b) Where the panels will be placed on the roof, design roofs for solar PV installations, including load checks, roof shape, size and orientation; design drawings shall identify area for solar PV installations.

c) Orient sloped roofs, if applicable, to face south to ensure sunlight will strike the solar collector at an optimal angle;

d) Locate roof accessories and structures to minimize shading on solar PV panels and any areas designated for future solar PV panels. Where shading onto the building is anticipated, hourly analysis software, such as PV Watts or IESVE, shall be used. Where shading onto the building is not anticipated, software using average daily statistics is acceptable, such as RETScreen®.

e) Allocate space for renewable energy equipment as follows:

i. Space on roofs and electrical rooms, including space for conduits and cable trays;

ii. Space in electrical rooms for solar PV is in addition to spare wall space requirements per other Metrolinx standards; and

iii. Space in the main electrical service for the interconnection of solar AC disconnection box.

f) Avoid running mechanical piping such as plumbing, HVAC and water above the areas preserved for solar PV equipment in electrical rooms to eliminate damage from potential leaks or condensation;

g) Provide two spare conduits from the roof to main electrical room, in addition to spare conduit requirements from other Metrolinx Standards, sized based upon potential capacity of future solar PV;

h) Avoid running mechanical services above solar PV equipment in electrical rooms unless these mechanical services are required to support the PV equipment (e.g., fire protection services, cooling, etc.);

i) Use energy modelling per Section 3.1 to estimate the design building electric power demand profile;

j) Solar PV installation shall incorporate an advanced energy metering system with data logging and monitoring capability of string-level data or individual PV modules' data in the case of micro-inverters; and

k) Comply with the following requirements. Recognizing that the PV technology is an evolving and rapidly improving industry, the listed must be considered as minimum requirements, and all references must be updated to the latest current at the time of a given project:

i. Lightning Protection: PV installation must be bonded to ground according to manufacturer instructions and CEC;

ii. Access, pathways, and smoke ventilation must be as per the Ontario Building Code (OBC) and the Ontario Fire Code. Access and spacing requirements must be observed in order to: ensure access to the roof, provide pathways to specific areas of the roof, provide for smoke ventilation opportunities in the area, and, where applicable, provide emergency access egress from the roof; and

iii. The electrical systems analysis and studies must account for and incorporate the solar PV system and components in the various analyses performed. This includes, but not limited to, short-circuit study, power flow study, protection coordination study, arc flash analysis, power quality and harmonics assessment.

3.4.3. REQUIREMENTS – SOLAR PV MODULE

All solar PV modules shall meet the following requirements:

a) PV modules and panels must be of minimum performance in accordance with International Building Code, International Residential Code, CSA C22.1, Safety Standard for Electrical Installations, Canadian Electrical Code, Part 1 and the National Building Code of Canada, ULC/ORD-C1703 Flat-Plate Photovoltaic Modules and panels;

b) Be one of the following panel types:

i. Monocrystalline: Listed to ULC/ORD-C1703 Flat-Plate Photovoltaic Modules and Panels; and

ii. Polycrystalline: Listed to ULC/ORD-C1703 Flat-Plate Photovoltaic Modules and Panels.

c) Bypass diodes shall be built into each PV module either between each cell or each string of cells;

d) Hail Protection: PV modules must be in compliance with testing procedure per ASTM E-1038, Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls;

e) Be coordinated with Utility for local utility-specific requirements; and

f) Be designed to withstand wind gusts of up to 120 km/hr.

3.4.4. REQUIREMENTS – SOLAR PV INVERTER

All solar PV inverters shall:

a) Be designed and installed in compliance with the latest versions of:

i. The Canadian Electrical Code;

ii. CAN/CSA-C22.2 No. 257 Interconnecting Inverter-Based Micro-Distributed Resources to Distribution Systems;

iii. UL 1741-10 Standard for Inverters, Converters, Controllers and Interconnection System. Equipment for Use with Distributed Energy Resources; and

iv. IEEE 1547- Standard for Interconnection and Interoperability of Distributed Energy Resources

with Associated Electric Power Systems Interfaces and its amendments.

b) Solar PV inverters must be installed in accordance with CAN/CSA-C22.2 NO. 62109-2:16 Safety of power converters for use in photovoltaic power systems – Part 2: Requirements for Inverters;

c) Solar PV inverters must be complete with rated integrated AC and DC disconnect as required by the Canadian Electrical Code;

d) Solar PV inverters and modules must be installed in a location restricted to public interference;

e) Solar PV design Intent must be to operate the inverters at 0.95 leading, with option to adjust as required by Utility or to optimize Utility demand charges; and

f) Inverters shall be pure sine wave and not simulated sine wave.

3.4.5. REQUIREMENTS – WARRANTIES

The solar PV electrical system shall have warranties meeting the following requirements:

a) Minimum 10-year manufacturer's warranty against deficiencies in materials and workmanship for modules and inverters; and

b) Minimum 25-year manufacturer's warranty on power output as follows:

   i. Minimum 90% rated power output for the entire first 10 years; and

   ii. Not less than 80% rated power output for the balance of the 25 years.

3.4.6. GUIDANCE

It is recommended that all projects:

a) Assess strategies to meet the requirements of Section 3.5.2, including non-roof Solar PV installations on buildings, where the roof area is less than 100 m^2; and

b) Consider building an integrated photovoltaic (BIPV) system for glazed fenestration or glazed curtain walls. For such buildings, the feasibility of integrating BIPV with existing framing must be carried out. The energy production of BIPV is generally small compared to conventional PV systems; as such, a business case may be necessary to justify such installation.

3.4.7. OPTIONS

Projects may consider as applicable and feasible:

a) Installing bi-facial solar panels above high albedo roofs;

b) Installing battery storage where renewable solar system size is larger than the asset's power demand at any point of the day to avoid the need for any solar system curtailment. Battery storage design decisions should be coordinated with the recommendations of the energy modelling efforts based on specific electrical utility exporting restrictions, electrical power cost benefit analysis, and GHG emission reduction objectives;

c) Feeding excess energy back to the grid to offset a project's energy consumption and to provide an income stream during operations;

d) Providing shading structures such as canopies in parking lots with solar PV;

e) Installing pole-mounted solar panels;

f) Supporting future non-roof renewable energy power installations, such as platforms and parking lots, through additional spare conduit installation and larger spare space allocation in the electrical room:

   i. Allocate space for renewable energy equipment in electrical rooms for solar PV, in addition to spare wall space requirements per other Metrolinx standards;

   ii. Allocate space in the main electrical service for the interconnection of solar AC disconnection box;

Figure 2: Clarkson GO Station

   iii. Avoid running mechanical piping such as plumbing, HVAC and water above the areas preserved for future solar PV equipment in electrical rooms to eliminate damage from potential leaks or condensation; and

   iv. Provide two spare conduits from the renewable energy equipment location to main electrical room.

g) External lighting be solar-powered; and

h) Lighting, heating, ventilation, and/or other electrical loads at stand-alone shelters, Station Access Modules, and other buildings be solar-powered, with battery or grid power backup.

Figure 3: Erindale GO Station, 250kW, Installed 2013

3.5. HEAT ISLAND MITIGATION

3.5.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits; and

b) Municipal Green Development standards.

3.5.2. REQUIREMENTS

All landscape projects with new or reconstructed hardscapes not being delivered through State of Good Repair (SOGR) shall:

a) Provide a plan and calculations showing at least 50% of the site hardscape, using any combination of the following strategies:

   i. Provide shade from the existing tree canopy or within

   ii. 10 years of landscape installation. Landscaping (trees) must be in place at the time of operations;

   iii. Provide shade with solar canopies; please refer to examples included in Section 3.5.3;

   iv. Use hardscape materials with an SRI of at least 29; and

   v. Permeable paving (see Section 5.2.6).

All building projects (new, reconstruction and expansion) shall:

b) Use a combination of green, cool roof or solar PV for at least 75% of available new or reconstructed roof space.

3.5.3. OPTIONS

Projects that will not be operated under GO Transit may consider the following strategies for the remaining hard scape to mitigate the heat island effect (parking, bus loops, PUDO, and surface road):

a) Permeable paving (see Section 5.2.6);

b) Pavement with an SRI of at least 29; and

c) Shade from the existing tree canopy or new canopy within 10 years of landscape installation.

4 BUILDING WATER MANAGEMENT

4.1. WATER MODELLING, METERING AND MONITORING

4.1.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits.

4.1.2. REQUIREMENTS

All buildings (new, expansion and reconstruction) with indoor water consumption and that will not be operated under GO Transit shall:

a) Conduct a water audit during the commissioning process to correct issues such as: accuracy of the interface between water meters and the BAS or asset management software, and conducting leak detection;

b) Specify a monitoring system that uses digital metering technology for monitoring usage of potable water sources and non-potable (greywater) sources. This system shall have the ability to distinguish and monitor water consumption information divided into different categories, different locations (floors, wings, functional areas), and different times of day. The monitoring

c) Specify a graphical interface for monitoring portable water usage and for providing an intuitive visualization of information. Ability to distinguish and visualize information divided into different categories, different locations (floors, wings, functional areas), and different temporal situations (times of day, time periods);

d) Specify a monitoring system with a remotely accessible interface via web platform or approved equivalent, and shall meet Metrolinx data security requirements. The data should be exportable to Microsoft Excel for use, storage and analysis by Metrolinx;

e) Specify permanent water meters that measure the total potable water and non-potable water use for assets and connect the meters to a monitoring system;

f) Specify water meters for cooling tower make-up water connection and blowdown. Connect the meters to the monitoring system;

g) Specify metering and monitoring of facilities that utilize reclaimed water systems, so that the true reclaimed water component can be determined; and

h) Specify metering and monitoring of alternate water sources such as rainwater harvesting systems and well water systems.

4.1.3. OPTIONS

All buildings (new, expansion and reconstruction) that will not be operated under GO Transit with indoor water consumption may consider the provision of additional water meters for domestic hot water heaters, boiler with annual water use of >100,000 gallons (378 500 liters), potable and non-potable water source for irrigation and indoor plumbing, and connect all meters to the monitoring system.

4.2. WATER EFFICIENT DESIGN

4.2.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

i) Select LEED credits.

4.2.2. REQUIREMENTS – WATER EFFICIENCY

All buildings (new, expansion and reconstruction) with indoor water consumption shall:

j) Select low-flow plumbing fixtures to reduce overall water consumption by minimum 30% for MSF buildings and 35% for station buildings.

4.2.3. CALCULATIONS

All buildings (new, expansion and reconstruction) with indoor water consumption shall:

a) Create a table or plumbing fixture schedule that indicates the flush or flow rate information for each fixture;

b) Gather information such as fixture model, flush or flow rates, percentage of occupants with access to the fixture, etc.;

c) Determine project occupancy based on the architectural inputs. Clearly distinguish between the full-time employees and visitors. Report visitors as daily average total;

d) Create a separate table for each subset if the project has different sets of fixtures for different parts of the building. If the fixtures are uniform across the project and restroom access is unrestricted, multiple calculations are not necessary; one calculation can cover all building fixtures and occupants; and

e) Estimate the number of days of operations per year.

4.2.4. REQUIREMENTS – COOLING TOWER

All buildings (new, expansion and reconstruction) proposing a cooling tower shall:

a) Specify high-efficiency cooling towers with minimum drift and evaporative loss;

b) Specify high-efficiency cooling towers with minimum drift and evaporative loss;

c) Target maximum number of cycles of concentration to minimize make-up water quantity. Achieving a minimum of 5 cycles of concentration for make-up water having less than or equal to 200 ppm (200 mg/L) total hardness as calcium carbonate or 3.5 cycles for make-up water with more than 200 ppm (200 mg/L) total hardness as calcium carbonate;

d) Have drift losses not exceeding 0.002% of recirculated water volume for counter-flow towers and 0.005% for crossflow towers; and

e) Provide a water meter in the makeup to cooling tower to verify water efficiency of the cooling tower.

4.2.5. REQUIREMENTS – RECLAIMED WATER

All buildings (new, expansion and reconstruction) and sites proposing alternative, non-potable water sources shall:

a) Design and install the water reclamation system per CSA standard B.128.1-06/B128.2-06. The water reclamation system shall be complete with filtration units to separate both dissolved and undissolved contaminants such as sediment particles, oil, grease, VOC, metals, etc., from the reclaimed water;

b) Conduct a water quality test after installation of the water reclamation system. Water quality shall meet or exceed Health Canada's "Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing;"

c) Calculate the total annual projected water savings using the following calculation; and

$$\text{Total \% Improvement from Baseline} = \left\{ \frac{\text{Annual baseline water consumption} - \left(\text{Annual design case water consumption} - \text{Annual non-potable water supply} \right)}{\text{Annual Baseline water consumption}} \right\} \times 100$$

d) Address any changes to the calculated usage demand of seasonal availability or storage capacity. If the non-potable water is used for multiple applications, for example, flush fixtures and landscape irrigation, a sufficient quantity must be available to meet the demands for all uses. The amount of non-potable water meant for indoor and outdoor uses cannot exceed the total annual non-potable water supply.

4.2.6. GUIDANCE

All buildings (new, expansion and reconstruction) and sites should:

a) Use the following equation for basic indoor water use reduction calculations;

$$\text{Daily water use of each fixture unit} = \left(\text{Fixture flush or flow rate} \right) \times \left(\text{Duration of use} \right) \times \left(\text{Number of users} \right) \times \left(\text{Number of uses per person per day} \right)$$

b) The duration of use, number of users, and uses per person per day must be the same in both the baseline and the design case;

c) Dual flush toilet flush rates shall be calculated as the average using a 1:2 (high flush: low flush) ratio; and

d) Refer to LEED V4 Reference guide for more details; LEED V4 Indoor water calculator: https://www.usgbc.org/resources/indoor-water-use-calculator.

4.2.7. OPTIONS

All buildings (new, expansion and reconstruction) and sites should:

a) Consider alternatives to potable water sources wherever feasible. Alternate water sources include municipally supplied reclaimed water, rainwater, stormwater, and foundation dewatering water;

b) Consider reclaimed water as a potential alternate source of water for facilities that have a high demand for water for vehicle wash bays (Figure 4). Wastewater from the vehicle wash could be reclaimed, filtered, and stored

to reuse for future vehicle washes. The vehicle wash system shall be designed in a way to utilize reclaimed water. Wastewater through trench drain is collected in a sediment settling tank. The sediment settling tank will separate the bigger sediment particles. Submersible sump pumps in the sediment settling tank will pump the water through multiple-level filtration units, where the remaining smaller particulate will be filtered. The water will be stored in the tank to be reused for next wash. Below is a sample diagram for reclaimed water. The filtration units for the reclaimed water system should be adequately designed to separate both soluble and insoluble contaminants, such as solid particulates, dissolved metals, VOCs, etc., to ensure water quality meets acceptable standards. The vehicle wash detergent should be a biodegradable type detergent and should be suitable for a reclaimed water system; and

c) Consider roof rainwater harvesting. Rainwater collected from a roof can be used for providing an alternative source of water for toilets and irrigation. Rainwater collected off a roof is filtered to an acceptable level before being stored in a collection tank. From the collection tank, the water shall be distributed in washrooms for toilet and urinal flushes and/or irrigation. A separate non-potable water distribution system shall be designed to supply water for toilets and irrigation. Based on the type of facility, roof catchment area, and

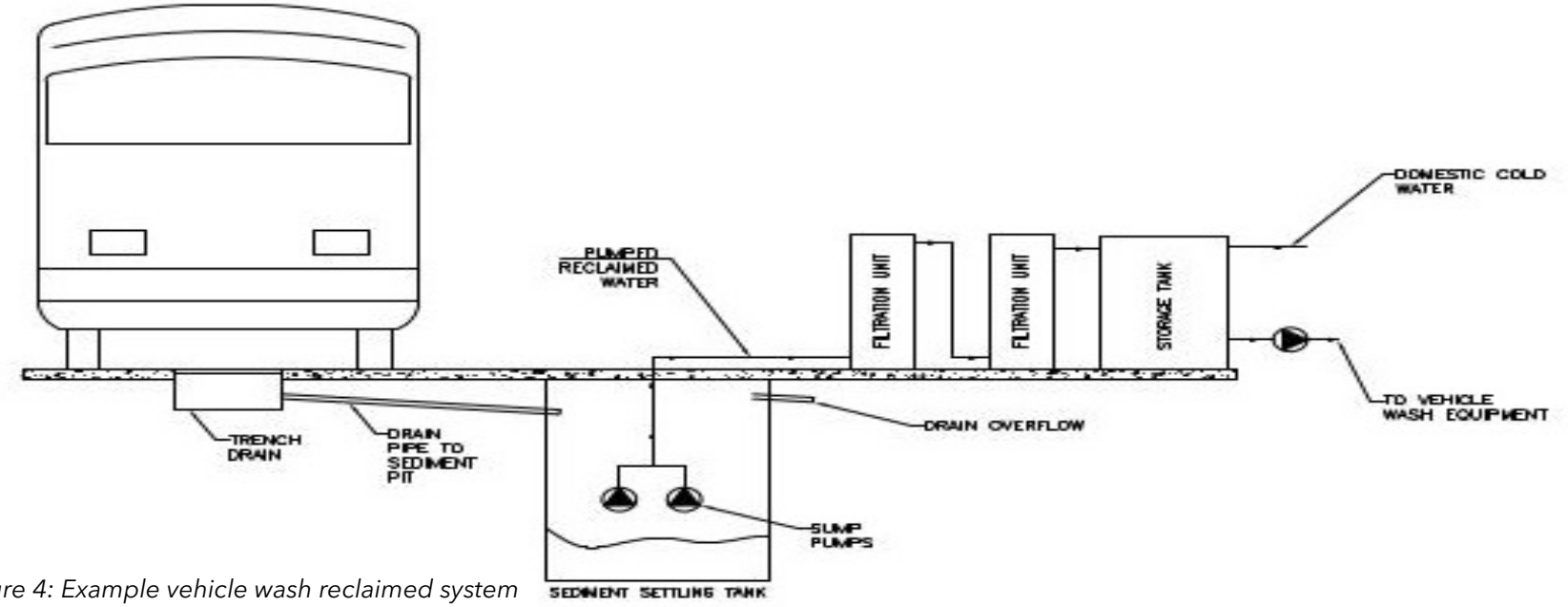

Figure 4: Example vehicle wash reclaimed system

grey water demand for the facility, designer to perform a life-cycle cost analysis and feasibility study to assess the cost-effectiveness of rainwater harvesting system over a 20-year time frame.

Rainwater that will be used as grey water shall be collected only from impervious roofing surfaces constructed from approved materials. Rainwater harvesting off the green roof is only permitted if the greywater is used only for irrigation.

The flush valves for the water closets and urinals should be a geared type or a diaphragm type to ensure better screening of solid particles.

The overflow drains from the sediment settling tank should be passed through an oil separator before connecting to building sanitary drain.

5 STORMWATER MANAGEMENT

5.1. STORMWATER PERFORMANCE CRITERIA

5.1.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits; and

b) Municipal Green Development standards.

5.1.2. REQUIREMENTS – GENERAL

All projects otherwise preparing a stormwater management report, shall:

a) Review current climate change projections before incorporating climate change into any design, as the science behind projections of future extreme precipitation are rapidly evolving, and better estimates for a specific location may be available;

b) Incorporate science-based, documented, repeatable processes to climate change considerations into stormwater management planning;

c) Develop all hydrological and hydraulic modelling in collaboration with the local regulatory agencies to ensure proper development of the updated computer models;

d) Design stormwater management controls to safely convey stormwater discharge, while minimizing

flooding and erosion impacts on adjacent properties; and

e) Refer to FCE-S-03 Stormwater Systems Standard for further requirements.

5.2. LOW IMPACT DEVELOPMENT PRACTICES

5.2.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits; and

b) Municipal Green Development standards.

This section provides a list of potential LID practices on Metrolinx sites, but is not an exhaustive list.

5.2.2. REQUIREMENTS – GENERAL

All projects proposing LIDs shall:

a) Provide at project handover a maintenance and inspection manual for each LID practice covering the asset life-cycle;

b) Plant selection criteria shall be:

   i. Drought-tolerant plants;

   ii. Salt tolerant at locations likely to receive higher salt loads, including spray and direct run-off;

   iii. Native species to the ecoregion.

   iv. Non-invasive species;

   v. Appropriate to local climate conditions;

   vi. Resilient and low maintenance;

   vii. A selection of diverse plantings that avoid monocultures; and

   viii. Where conditions or restrictions occur within the site limiting availability to conform with requirements above, alternative species may be requested for review and approval by the owner of this standard.

5.2.3. GUIDANCE – GENERAL

All projects proposing LID practices should:

a) Incorporate vegetation;

b) Incorporate stormwater infiltration where supported by the soil characteristics and groundwater; and

c) Design per recommendations in the *Low Impact Development Stormwater Management Wiki* co-developed by the Credit Valley Conservation authority, the Toronto and Region Conservation Authority, and the Lake Simcoe Region Conservation Authority (wiki.sustainabletechnologies.ca/).

d) Refer to the TRCA Low Impact Development Treatment Train Tool for preliminary water budget analysis and pollutant load removal estimates for pre- and post-development scenarios.

5.2.4. OPTIONS – GENERAL

Compare the life-cycle cost of low-impact development practices against traditional, end-of-pipe stormwater management practices (see also Section 2.1).

5.2.5. GREEN ROOF

5.2.5.1. REQUIREMENTS

All buildings (new, expansions and reconstructions) proposing a green roof shall:

a) Green roofs proposed on buildings and facilities (excluding platforms) that will be operated under GO Transit, shall be designed to reduce operational energy costs;

b) Provide a green roof implementation feasibility study;

c) Adhere to the following plant selection criteria:

   i. Meet the requirements of Section 5.2.2;

   ii. Consider building exposure;

   iii. Exclude species that present potential fire risk;

   iv. Use a minimum of five plant species; and

   v. Select native species that provide pollinator habitat to the extent feasible while prioritizing plants that are adaptable, drought-tolerant and low-maintenance.

d) Consider the impact to operation and maintenance in the design. This includes, but is not limited to, access requirements and associated track protection requirements;

e) Utilize pre-vegetated modules or plugs; seeding applications shall not be accepted

f) Design an extensive green roof, tolerant for extreme climate conditions such as heat, drought, cold stress, freeze and wind;

g) Utilize a modular system. Implementation of a non-modular system is more suitable for the project, subject to Metrolinx approval, based on the alternative being more suitable for the site;

h) Provide fire resistance and wind uplift study reports for the selected green roof system;

i) Design the green roof to not be accessible to the public;

j) Use growing media depth that ranges from a minimum of 60 mm (2-1/2") to a maximum of 150 mm (6"). Note that generally a depth up to 100 mm (4-1/4") will be sufficient and appropriate;

k) Undertake the design in consultation with a professional horticulturist or green roof consultant and other professionals (architects, structural, civil, mechanical and other engineers); and

l) If Metrolinx is to perform ongoing maintenance of the green roof after the warranty period, an Operation and Maintenance Manual specific for the project green roof system shall be provided. It shall address the following operations:

   i. Irrigation – amount, time and control;

ii. Weeding – frequency and type of weeds to be removed;

iii. Plant replacement (if required);

iv. Fertilization (where required) – amount, frequency and type;

v. Herbicides, insecticides, and fungicides should be avoided or used sparingly;

vi. Inspection of drains, edging, roof penetrations, flashing and non-planted areas; and

vii. Assignment of responsibility for removal of, care for, and re-installation of growing medium and vegetation in the event of a leak.

5.2.5.2. GUIDANCE

All buildings (new, expansions and reconstructions) implementing a green roof should:

a) Design the green roof to cover a minimum 50% of available roof space; and

b) Design a cool roof on areas of available roof space not covered by the Green Roof

5.2.5.3. DESIGN REQUIREMENTS

a) Green Roof Assembly shall, as a minimum, consist of a root repellent system, a drainage system, a filtering layer, a growing medium and plants. It shall be installed on waterproof membrane of an applicable roof;

b) Green Roof shall accommodate:

i. Perimeter safety gap for the operations and maintenance;

ii. Minimum 600 mm wide vegetation-free zone shall be installed at the perimeter of the roof; and

iii. Minimum 300 mm wide vegetation-free zone shall be installed around all roof penetrations to act as a fire break and prevent root intrusion.

c) Roof drains shall:

i. Be protected from vegetation coverage or loose soil or gravel, which can obstruct the drain; and

ii. Be designed to allow regular inspection and maintenance.

d) Irrigation shall:

i. Be customized for the project green roof system based on the intended use of the roof, choice of plant material, media depth, environmental conditions and budget; and

ii. Be water efficient.

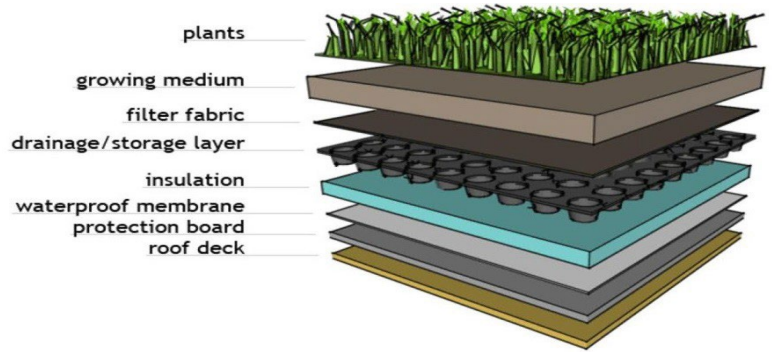

Figure 5: Basic Green Roof Assembly. Diagram is for information purposes only.

5.2.6. PERMEABLE PAVING

Permeable paving is a permeable hardscape that allows stormwater infiltration through the surface into a stone reservoir. Permeable paving includes:

- permeable interlocking concrete pavers (PICP) - impermeable concrete units with inter-block voids filled with open-graded aggregate;
- plastic or concrete grid systems – a grid system with large pore spaces that can be planted or filled with aggregate;
- pervious concrete – concrete with a high porosity; and
- pervious asphalt – asphalt with a high porosity.

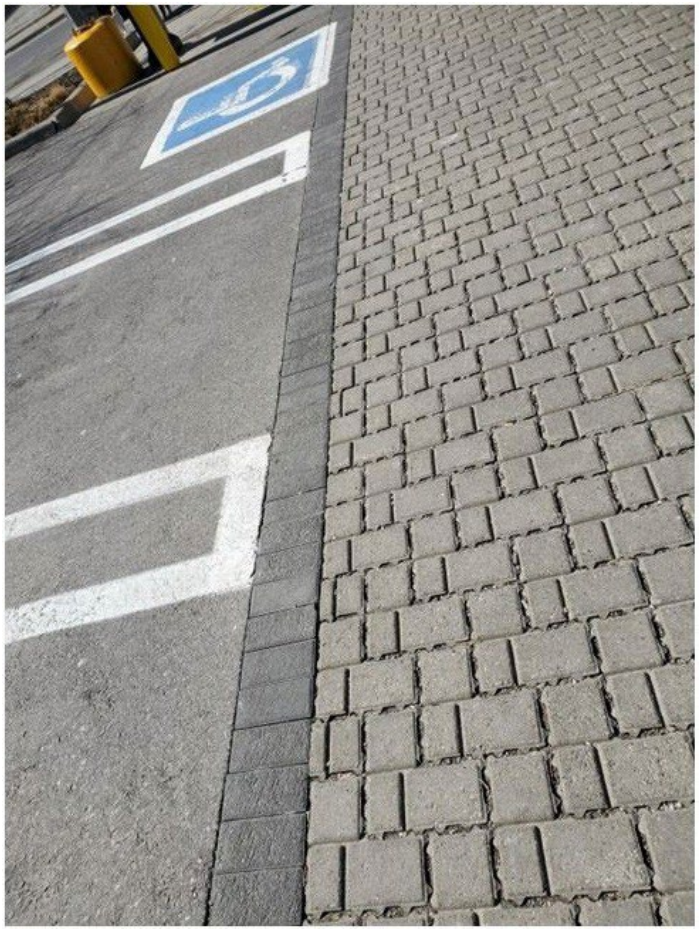

Figure 6: PICP at Green P lot, North of Dundas Street West at Manning Avenue

Figure 7: Concrete Open Grid

Figure 8: Permeable Concrete Paving at Lakeside Park, Mississauga

5.2.6.1. REQUIREMENTS – GENERAL

a) Pervious asphalt, pervious concrete and pervious pavers shall be restricted to areas of low vehicular and pedestrian traffic volumes with lower frequency of winter maintenance, such as maintenance access roads/paths. They shall not be considered where heavy vehicle loads, including emergency and maintenance vehicles, are to be expected;

b) inter-blockFor locations to be operated under GO Transit, permeable paving shall not be permitted in areas of public vehicular parking and movement;

c) Pavers shall be locally available to facilitate future maintenance.

All permeable paving designs shall:

a) Not be in areas that are subject to contamination, or downstream of potential contamination, including areas for fuel storage and refuelling;

b) Be designed in accordance with applicable Source Water Protection requirements:

c) Not receive runoff from landscape areas. Adjacent landscape areas shall be graded to drain away from the permeable paving to prevent sediments from running into the permeable surface and clogging the pore spaces;

d) Be designed such that the impervious area draining to the pervious area does not exceed 1.2 times the receiving area;

e) Be located downslope of building foundations;

f) Be located at least 4 m away from building foundations if they receive runoff from other surfaces;

g) Be designed to accommodate underground utilities where applicable;

h) Meet the run-off storage, infiltration and structural design criteria for the application;

i) Allow for overflow or stormwater conveyance when the surface is overloaded or clogged;

j) Be designed to allow for annual inspections and maintenance with monitoring wells, and inspection and cleanout ports connected to the sub-drain system at recommended intervals;

k) Be designed and installed to minimize uneven settlement and trip hazards;

l) Be designed and installed with the sub-base recommended by the manufacturer for the proposed use to eliminate any differential settlement or unevenness in surface;

m) Underlay PICP and open-grid pavers in areas of vehicular traffic with a geogrid;

n) Adjacent surfaces and materials to be flush and level with pavers, unless otherwise indicated in the design. Adequate edging shall be used to ensure no lateral or vertical movement of pavers;

o) Meet AODA requirements by providing a firm, stable, slip-resistant surface that canes, crutches, or the wheels of mobility devices will not sink into;

p) Be heel-proof with openings less than 13 mm wide;

q) Have a surface slope of between 1% and 5%;

r) Be accompanied by a construction plan to provide requirements for protection during construction;

s) Be accompanied upon handover to Metrolinx by a maintenance schedule for the permeable paving;

t) Be designed to minimize life-cycle operations and maintenance costs; and

u) Be designed to withstand vehicle loads, including maintenance vehicles, where vehicular use is anticipated.

5.2.6.2. REQUIREMENTS – PERMABLE INTERLOCKING CONCRETE PAVERS

The design of PICP shall tightly abut the edge restraints to prevent spreading of joints. Concrete edge restraints shall be used over plastic or metal.

5.2.6.3. REQUIREMENTS – STONE RESERVOIR

The design of the stone reservoir shall:

a) Be such that the base of the stone reservoir is at least one meter above the seasonally high-water table;

b) Incorporate a non-woven needle-punched or woven monofilament geotextile fabric to separate the stone reservoir and native soils;

c) Consists of clean, washed stone. The cross-section shall be as per recommendations of the geotechnical and stormwater management report; and

d) Be a flat bottom when designed for complete infiltration, and may be sloped at 1% to 5% when designed for partial infiltration.

5.2.6.4. OPTIONS

Projects may provide passive irrigation for new plant material on site through designing adjacent soil cells for tree pits to receive a portion of the stormwater infiltrated through the cross-section

Figure 9: Bioretention Cell Capturing and Treating runoff from Adjacent Parking Lot

5.2.7. BIORETENTION CELLS

Bioretention cells, also known as Rain Gardens, are non-linear systems without underdrains. Bioretention cells are ideal for receiving roof runoff and as source control in smaller drainage areas, ranging from 100 m² to 0.5 hectares.

5.2.7.1. REQUIREMENTS

All Bioretention cells shall:

a) Meet the requirements of Section 5.2.2;

b) Include an overflow capture device to handle flows from larger storm events; the overflow inlet shall be at a minimum 150 mm above the filter bed;

c) Not be used as an end-of-pipe control;

d) Have a ratio of impervious drainage to bioretention cell area from 5:1 to 15:1;

e) Have side slopes of no steeper than 2:1;

f) Provide access, visibility and maintenance laydown areas for any utility holes, handwells, manifold chambers, and catch basins located within the Bioretention cell; and

g) Where the bioretention is not receiving clean stormwater, install OGS unit(s) as pre-treatment devices to prevent sediment and debris from entering infiltration facilities to avoid clogging and system failure. Where site constraints prevent the use of OGS units as pre-treatment, acceptable alternative pre-treatment devices may include Leaf Screens, in-ground filters, or vegetated filter strips or grass swales.

5.2.8. INFILTRATION TRENCH – REQUIREMENTS

An infiltration trench is a level, linear trench system which distributes concentrated stormwater runoff flow and promotes infiltration into native soils. It is often a channel of decorative stone, with a geotextile separating the stone from the native soils. Infiltration trenches are ideal for receiving stormwater runoff sheet flow from parking lots and pathways.

5.2.8.1. REQUIREMENTS

All infiltration trenches shall:

a) Install a perforated pipe, unless otherwise recommended by studies of the soil characteristics. The perforated pipe shall have a minimum diameter of 150 mm, but recommended diameter of 200 mm. Where soil infiltration is not recommended (such as high groundwater), the perforated pipe shall be placed at the base of the reservoir aggregate; otherwise, the perforated pipe shall be placed at an appropriate depth above the base of the reservoir aggregate to support infiltration;

b) Protect adjacent subsurface infrastructure by maintaining an appropriate minimum clearance or by constructing a deep curb to separate the roadbed subgrade or parallel utility line from the facility;

c) Be filled with 50 mm crushed angular clear stone with a 40% void ratio; and

d) Provide access, visibility, and maintenance laydown areas for any manholes, handwells, manifold chambers, and catch basins located within the infiltration trench.

5.2.9. BIOSWALE

Bioswales (vegetated swales) are linear bioretention systems conveying stormwater flows. Bioswale filters are effective at filtering pollutants from stormwater runoff to improve water quality prior to discharge to receiving natural systems, and can be designed to control velocities.

5.2.9.1. REQUIREMENTS

All bioswales shall:

a) Meet the requirements of Section 5.2.2;

b) Contain engineered soil mixture with a maximum clay content of 5%;

c) Have a bottom (base) width of 0.75 m to 3 m;

d) Have a side (longitudinal) slope a minimum of 3:1 to allow sediments and pollutants to settle; a side (longitudinal) slope of 4:1 is recommended;

e) Provide an overflow capture device to handle flows from larger storm events; the overflow inlet shall be a minimum 150 mm above filter bed;

f) Install OGS unit(s) as pre-treatment devices to prevent sediment and debris from entering infiltration facilities, to avoid clogging and system failure. Where there are site constraints preventing the use of OGS units as pre-treatment, acceptable alternative pre-treatment devices may include Leaf Screens, in-ground filters, or vegetated filter strips or grass swales;

g) Install a perforated pipe, unless otherwise recommended by studies of the soil characteristics. The perforated pipe shall have a minimum diameter of 150 mm, but recommended diameter of 200 mm. Where soil infiltration is not recommended (such as high groundwater), the perforated pipe shall be placed at the

Figure 10: Bioswale along Country Code Court Boulevard in Brampton

base of the reservoir aggregate; otherwise, the perforated pipe shall be placed at an appropriate depth above the base of the reservoir aggregate to support infiltration;

h) Be designed to enhance evapotranspiration, such as with smaller cells to slow down water, where infiltration is not feasible;

i) Incorporate vegetation to enhance water quality treatment; and

j) Provide access, visibility and maintenance laydown areas for any manholes, handwells, manifold chambers, and catch basins located within the bioswale.

5.2.9.2. OPTIONS

All bioswales may:

a) Implement a cascade-pool design to allow for water detention/variance/dissipation of energy during high-flow events; and

b) Incorporation of compost filter socks to enhance pollutant removal and vegetative growth.

5.2.10. STORMWATER DETENTION ROOFS

Stormwater detention roofs are also known as blue roofs and are designed to retain stormwater.

5.2.10.1. REQUIREMENTS

a) All stormwater detention roofs shall:

b) Provide maintenance walkways to enable access while roof is holding water as required

c) Provide waterproofing 150 mm above the peak ponding elevation;

d) Be a maximum 2% slope;

e) Achieved water retention using flow control devices such as drain covers, small check dams, weirs, and modular tray systems; and

f) Have a fully separated controlled layout from any solar PV or solar thermal systems.

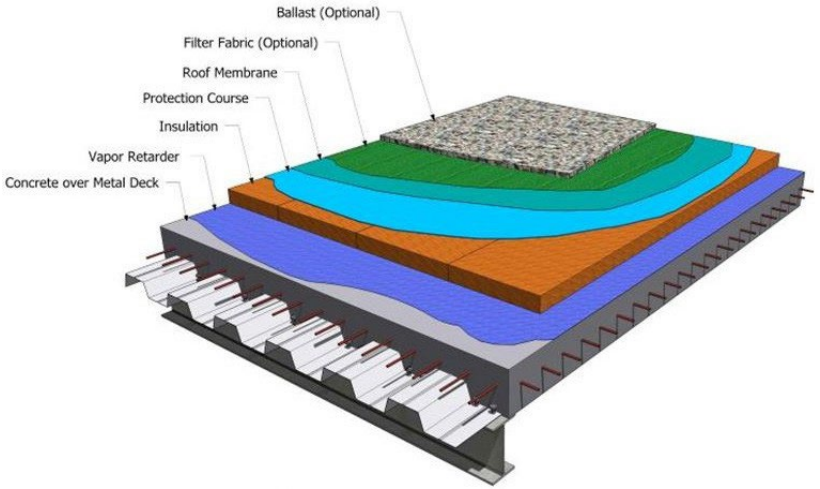

Figure 11: Conventional Blue Roof Assembly - Illustration for information purposes only

5.2.11. CISTERNS AND RAIN BARRELS - REQUIREMENTS

Cisterns shall be sized based on supplying a minimum percentage of demand (i.e. **greywater** system shall provide 100% of irrigation demand).

5.2.12. MANUFACTURED, STRUCTURAL LIDS – REQUIREMENTS

Manufactured, structural LID practices include soakaway pits, infiltration chambers, and perforated stormwater pipes.

a) Soakaway pits and infiltration chambers shall have level bed bottoms; and

b) Infiltration chambers shall have manholes and inspection ports to provide access for monitoring and maintenance activities.

All manufactured, structured LID practices shall:

c) Install OGS unit(s) as pre-treatment devices to prevent sediment and debris from entering infiltration facilities, to avoid clogging and system failure. Where there are site constraints preventing the use of OGS units as pre-treatment, acceptable alternative pre-treatment devices may include Leaf Screens, in-ground filters, or vegetated filter strips or grass swales;

d) Install inlet and overflow outlets to facilities below the maximum frost penetration depth to prevent freezing; and

e) Design outlet pipes with a capacity equal to or greater than the inlet pipes.

6 ECOLOGY

6.1. SOIL AND VEGETATION MANAGEMENT

6.1.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits; and

b) Municipal Green Development standards.

6.1.2. REQUIREMENTS

a) All designs and specifications for tree planting shall provide a minimum volume of 30 m^3 of high-quality soil per tree, with a minimum soil depth of 0.8 m and a maximum of 1.2 m of high-quality soil above a well-drained sub-soil or drainage layer. The minimum soil volume can be 20 m^3, where the soil volume is shared

b) Plant selection criteria shall be:

i. Drought-tolerant plants;

ii. Salt tolerant at locations likely to receive higher salt loads, including spray and direct run-off;

iii. Native species to the ecoregion.

iv. Non-invasive species;

v. Appropriate to local climate conditions;

vi. Resilient and low maintenance;

vii. A selection of diverse plantings that avoid monocultures; and

viii. Where conditions or restrictions occur within the site limiting availability to conform with requirements above, alternative species may be requested for review and approval by the owner of this standard.

All projects proposing LID practices for stormwater infiltration into native soils or that are disturbing a minimum 100 m^3 of native soil to receive seeding and/or planting, shall:

c) Prepare and submit at no later than 90% Design a soil management plan. The plan shall:

i. Minimize impacts to soil health during construction, including soil compaction;

ii. Provide requirements for soil stockpile management to preserve the integrity of excavated soils;

iii. Restores the health of soils degraded during construction or previously degraded;

iv. Be developed in conjunction with landscaping construction plans to ensure the project life-cycle of soil management is achieved through construction, post-construction restoration and future management and maintenance;

v. Ensure that soils are fit for purpose (including the needs of the vegetation it is supporting, the activity of people using the site, and the current and future climate conditions);

vi. Ensure soil infiltration rates and pollution adsorption capacity of soils are protect and restored;

vii. Incorporate recommendations from testing of the existing soil to determine the agricultural properties; all areas to receive seeding or planting shall complete soil sampling and agricultural testing of existing on-site soils (or clean fill materials) for to provide specific pH and nutrient control recommendations necessary to amend site soils prior to seeding or planting operations; and

viii. Immediately upon completion of LID construction, stabilize with native terraseeding.

6.1.3. GUIDANCE

All designs and specifications for tree planting should:

a) Avoid impermeable surface treatments within a minimum of 1.8 m from tree trunks up to dripline, whichever is larger; and

b) Propose that surface treatments within a minimum of 1.8m from tree trunks up to dripline, whichever is larger, be installed once the surrounding area has had the opportunity to establish itself to allow for subsidence effects and to provide direct access for irrigation during establishment. Installation of the final surface two years post-planting is recommended.

c) Refer to the Metrolinx Vegetation Guideline for best management practices for tree end-use, vegetation removals, restoration, and maintenance.

Soil management plans should:

d) Increase the organic matter content of the soil through the addition of compost or other organic soil amendments to improve the water-retention capacity of soils supporting vegetation;

e) Protect soil along the edge of the site not essential to construction from compaction and relocation through construction and post-construction; and

f) Support root growth for areas under footpaths, verges and garden beds via quality fit-for-purpose soil preparation, including structural soils;

g) Construction and disturbance to soil, as well as soil importation, may introduce invasive species due to open areas. Refer to the Metrolinx Vegetation Guideline for details on invasive species management and suggested applications.

6.2. BIRD FRIENDLY DESIGN

6.2.1. OBJECTIVES

The requirements of this section are aligned with:

a) LEED credit requirements; and

b) Municipal Green Development Standards.

6.2.2. REQUIREMENTS

All projects proposing glazing shall:

c) Treat at least 95% of surface #1 of exterior glazing within the first 16 m above ground level.

Exterior glazing treatment includes at least one of the following:

i. Low reflectance, opaque materials, including solid back-painted frit or silicone backing opaque coatings, and should have an outside reflectance of 15% or less;

d) Visual markers applied to the glass with a maximum spacing of 50 mm x 50 mm, and markers must be at least 5 mm in size; and

e) Ceramic frit patterns shall have a high contrast

f) Secure enclosed spaces such as ground-level ventilation,

g) Avoid interior vegetation in buildings near windows that are visible from outside; and

h) Minimize the use of clear and fritted glazing while meeting other Metrolinx standards and requirements, including for daylighting, CPTED, and architectural expression.

6.2.3. GUIDANCE

To reduce the risk of nighttime collisions, all buildings should minimize unnecessary lighting visible from exterior windows at nighttime using the following techniques:

a) Avoid placing emergency lighting/night lighting near windows of buildings taller than 3 stories;

b) Utilize occupancy and time-based lighting controls techniques to ensure that any unnecessary lights are turned off; and

c) Increase granularity of dimming zones to allow only necessary lights to remain on in areas that are occupied, without affecting nearby areas that are unoccupied.

6.3. LIGHT POLLUTION REDUCTION

6.3.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits; and

b) Municipal Green Development standards.

6.3.2. REQUIREMENTS

All projects for buildings and sites that will not be operated under GO Transit proposing exterior lighting shall:

a) Implement a cohesive and adaptable hierarchy of lighting that achieves other lighting objectives with the minimum light necessary;

b) Restrict light spillage to sensitive areas (i.e. residential or natural habitats) such as through directional lighting or light shields;

c) Meet the IES TM-15-11 BUG (Backlight, Uplight and Glare) classification of outdoor fixtures;

d) Provide a map and worksheet demonstrating BUG ratings meeting lighting zone requirements; and

e) Use exterior light fixtures that meet the IESNA Full Cut-off Classification or an Uplight rating (as a part of the BUG rating system) of zero.

6.3.3. OPTIONS

All projects for buildings and sites that will not be operated under GO Transit proposing exterior lighting may:

a) Use an appropriate colour temperature to the context of its application (i.e. maximum 3000K in residential areas, including mixed-use areas with residences, maximum 4000K along high traffic arterial roads); and

b) Use fixtures with a Dark Sky Fixture Seal of Approval where a maximum CCT of 3000K is appropriate.

All projects for buildings (new, expansion and reconstruction) that will not be operated under GO Transit may:

c) Install an automatic device that reduces the outward spillage of internal light; and

d) Ensure any rooftop architectural illumination is directed downward

7 LEED

7.1. GENERAL REQUIREMENTS

All Projects required to pursue LEED certification shall:

a) Target and achieve all Prerequisite credits in order to achieve certification;

b) Refer to Table 3 for mandatory credits and credits that are not to be pursued, subject to building type;

c) Refer to Table 3 for overall certification level subject to building type;

d) Refer to Section 9 for the submission of checklists for Metrolinx Review. Checklists shall indicate Prerequisite and Mandatory credits which must be targeted and achieved. There shall also be additional columns indicating optional points for consideration from which the shortfall can be made and credits that are not to be pursued;

e) Where conditions or restrictions occur within the site limiting availability to conform with Mandatory credits, alternative credits may be requested for review and approval by the owner of this standard.

7.2. LEED AT GO STATIONS AND MSFS

All GO Stations, Terminals, and Maintenance Storage Facilities (MSFs) are to achieve LEED certification, where station meets LEED minimum program requirements.

Silver certification is the minimum requirement and shall follow Table 2.

7.3. LEED AT SUBWAY STATIONS AND MSFS

Suitability of LEED certification at each Station shall be evaluated on a case-by-case basis. Where LEED certification is not pursued, select credit requirements may be included in the project agreement in lieu of the requirement of LEED certification.

In general, the pursuit of LEED certification is encouraged to be pursued:

a) the Station meets LEED Minimum Program Requirements;

b) the Station has enclosed and actively heated and cooled public spaces that will be regularly occupied by people;

c) achievement of all prerequisite credits is possible; and

d) the implementation of enough credits is possible such that LEED certification can be achievable.

Refer to Table 2 for credit applicability when LEED certification is pursued. If select credit requirements are to be included in project agreement, selection is to be from those designated as mandatory.

A minimum of LEED Gold certification is required at the MSF, unless stated otherwise in the Project Agreement.

Refer to Table 2 for MSF requirements.

Table 2: LEED Requirements Table

	GO STATIONS	GO MSFS	SUBWAY STATIONS	SUBWAY MSFS
LEED Certification Requirement	Silver	Silver	N/A	Gold
INTEGRATIVE PROCESS (IP)				
Integrative Process	Optional: 1	Optional: 1	Optional: 1	Optional: 1
LOCATION AND TRANSPORTATION (LT)				
Sensitive Land Protection	Optional: 1	Optional: 1	Optional: 1	Optional: 1
High Priority Site	Optional: 2	Optional: 2	Optional: 2	Optional: 2
Surrounding Density and Diverse Uses	Optional: 5	Optional: 5	Optional: 5	Optional: 5
Access to Quality Transit	Optional: 5	Optional: 5	Optional: 5	Optional: 5
Bicycle Facilities	Not to be Pursued: 1	Optional: 1	Not to be Pursued: 1	Optional: 1
Reduced Parking Footprint	Not to be Pursued: 1	Optional: 1	Not to be Pursued: 1	Not to be Pursued: 1
Green Vehicles	Optional: 1	Mandatory: 1	Optional:1	Mandatory: 1

	GO STATIONS	GO MSFS	SUBWAY STATIONS	SUBWAY MSFS
SUSTAINABLE SITES (SS)				
PREREQUISITE Construction Activity Pollution Prevention	Prerequisite	Prerequisite	Prerequisite	Prerequisite
Site Assessment	Optional:1	Optional:1	Optional:1	Optional:1
Site Development – Protect or Restore Habitat	Optional:2	Optional:2	Optional:2	Optional:2
Open Space	Optional:1	Mandatory: 1	Optional:1	Optional:1
Rainwater Management	Optional:3	Optional:3	Optional:3	Optional:3
Heat Island Reduction	Optional:2	Optional:2	Mandatory: 2	Mandatory: 2
Light Pollution Reduction	Mandatory: 1*	Mandatory: 1	Mandatory: 1	Mandatory: 1
* Recognition that in some situations, this is not applicable. If credit not targeted, consultant to demonstrate why it cannot be achieved.				

	GO STATIONS	GO MSFS	SUBWAY STATIONS	SUBWAY MSFS
WATER EFFICIENCY (WE)				
PREREQUISITE Outdoor Water Use Reduction	Prerequisite	Prerequisite	Prerequisite	Prerequisite
PREREQUISITE Indoor Water Use Reduction	Prerequisite	Prerequisite	Prerequisite	Prerequisite
PREREQUISITE Building-Level Metering	Prerequisite	Prerequisite	Prerequisite	Prerequisite
Outdoor Water Use Reduction	Mandatory: 2	Mandatory: 2	Mandatory: 1 Optional: 1	Mandatory: 1 Optional: 1
Indoor Water Use Reduction	Mandatory: 3 Optional: 3	Mandatory: 2 Optional: 4	Mandatory: 3 Optional: 3	Mandatory: 6
Cooling Tower Water Use	Not to be Pursued: 2	Optional: 2	Optional: 2	Optional: 2
Water Metering	Mandatory: 1	Mandatory: 1	Mandatory: 1	Mandatory: 1

	GO STATIONS	GO MSFS	SUBWAY STATIONS	SUBWAY MSFS
Energy & atmosphere				
PREREQUISITE Fundamental Commissioning and Verification	Prerequisite	Prerequisite	Prerequisite	Prerequisite
PREREQUISITE Minimum Energy Performance	Prerequisite	Prerequisite	Prerequisite	Prerequisite
PREREQUISITE Building Level Metering	Prerequisite	Prerequisite	Prerequisite	Prerequisite
PREREQUISITE Fundamental Refrigerant Management	Prerequisite	Prerequisite	Prerequisite	Prerequisite
Enhanced Commissioning	Mandatory: 6	Mandatory: 6	Mandatory: 6	Mandatory: 6
Optimize Energy Performance	Mandatory: 7 Optional: 3 Not to be pursued: 8	Mandatory: 7 Optional: 8 Not to be pursued: 3	Optional: 18	Mandatory: 7 Optional: 11
Advanced Energy Metering	Mandatory: 1	Mandatory: 1	Mandatory: 1	Mandatory: 1

	GO STATIONS	GO MSFS	SUBWAY STATIONS	SUBWAY MSFS
Demand Response	Not to be Pursued: 2	Optional: 2	Not to be Pursued: 2	Optional: 2
Renewable Energy Production	Optional: 3	Optional: 3	Optional: 3	Optional: 3
Enhanced Refrigerant Management	Mandatory: 1	Mandatory: 1	Mandatory: 1	Mandatory: 1
Green Power and Carbon Offsets	Optional: 2	Optional: 2	Not to be Pursued: 2	Not to be Pursued: 2
MATERIALS & RESOURCES (MR)				
PREREQUISITE Storage & Collection of Recyclables	Prerequisite	Prerequisite	Prerequisite	Prerequisite
PREREQUISITE Construction and Demolition Waste Management Planning	Prerequisite	Prerequisite	Prerequisite	Prerequisite
Building Life-Cycle Impact Reduction	Optional: 3 Not to be pursued: 2	Optional: 3 Not to be pursued: 2	Optional: 3 Not to be pursued: 2	Optional: 3 Not to be pursued: 2
Building Product Disclosures and Optimization – Environmental Product Declarations	Mandatory: 1 Not to be pursued: 1	Mandatory: 1 Not to be Pursued: 1	Mandatory: 1 Optional: 1	Mandatory: 1 Optional:1

	GO STATIONS	GO MSFS	SUBWAY STATIONS	SUBWAY MSFS
Building Product Disclosures and Optimization – Sourcing of Raw Materials	Mandatory: 1 Not to be Pursued: 1	Mandatory: 1 Not to be Pursued: 1	Mandatory: 1 Optional: 1	Mandatory: 1 Optional: 1
Building Product Disclosures and Optimization – Material Ingredients	Mandatory: 1 Not to be Pursued: 1	Mandatory: 1 Not to be Pursued: 1	Mandatory: 1 Optional:1	Mandatory: 1 Optional: 1
Construction and Demolition Waste Management	Mandatory: 2	Mandatory: 2	Mandatory: 2	Mandatory: 2
INDOOR ENVIRONMENTAL QUALITY (EQ)				
PREREQUISITE Minimum Indoor Air Quality Performance	Prerequisite	Prerequisite	Prerequisite	Prerequisite
PREREQUISITE Environmental Tobacco Smoke (ETS) Control	Prerequisite	Prerequisite	Prerequisite	Prerequisite
Enhanced Indoor Air Quality Strategies	Optional: 2	Optional: 2	Optional: 2	Optional: 2
Low-Emitting Materials	Mandatory: 2 Optional: 1	Mandatory: 2 Optional: 1	Mandatory: 3	Mandatory: 3

	GO STATIONS	GO MSFS	SUBWAY STATIONS	SUBWAY MSFS
Construction IAQ Management Plan	Mandatory: 1	Mandatory: 1	Mandatory: 1	Mandatory: 1
Indoor Air Quality Assessment	Optional: 2	Optional: 2	Mandatory: 2	Mandatory: 2
Thermal Comfort	Mandatory: 1	Mandatory: 1	Optional:1	Mandatory: 1
Interior Lighting	Mandatory: 2	Mandatory: 1 Optional:1	Mandatory: 2	Mandatory: 1 Optional: 1
Daylight	Optional: 2 Not to be Pursued: 1	Mandatory: 1 Not to be Pursued: 2	Optional:3	Optional: 3
Quality Views	Optional:1	Not to be Pursued: 1	Optional:1	Optional:1
Acoustic Performance	Optional:1	Optional:1	Optional:1	Optional:1
INNOVATION (IN)				
Innovation	Mandatory: 3 Optional:2	Mandatory: 3 Optional:2	Optional:5	Optional:5
LEED Accredited Professional	Mandatory: 1	Mandatory: 1	Mandatory: 1	Mandatory: 1
REGIONAL PRIORITY (RP)				
Regional Priority Credit	Optional:4	Optional:4	Optional:4	Optional:4

8 RESILIENCE

8.1. CLIMATE VULNERABILITY AND RISK ASSESSMENTS

8.1.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credits; and

b) Federal Climate Lens Assessment.

8.1.2. REQUIREMENTS

All project locations shall:

a) Undertake a preliminary Climate Risk and Vulnerability assessment at no later than 30% Design that identifies opportunities early in design to improve climate resiliency. The preliminary climate risk and vulnerability analysis shall address how risks will be identified and quantified. The preliminary climate risk and vulnerability analysis can be a review and update to the TPAP analysis undertaken in line with the MECP Guideline Considering Climate Change in the Environmental Assessment Process;

b) Perform a Climate Risk and Vulnerability assessment using the PIEVC method established by Engineers Canada and conduct their assessment using the PIEVC Vulnerability Assessment templates and instructions found in Section 7.1.5 (https://pievc.ca/), or ISO 14091, or equivalent, with prior approval by Metrolinx. The PIEVC summary report shall be submitted no later than 60% Design;

c) Address through the risk assessment, at a minimum, four critical changing climate parameters:

   i. Increase in extreme temperature

   ii. Increase in the occurrence of extreme rainfall events

   iii. Increase in the occurrence of freezing rain events

   iv. Increase in the frequency of extreme wind events

d) Assess the impacts of climate change on both assets and operations;

e) Demonstrate how the project will adapt to high risks to an acceptable level. Acceptable level is to be defined as medium risk or lower in alignment with the PIEVC Scoring Matrix in Table 6;

f) Provide options for adapting to medium risks in alignment with the PIEVC Scoring Matrix in Table 6;

g) Consider, through the vulnerability assessment, the anticipated lifespan of the project, and of its individual elements, calculated per Section 7: Predicted Service Life of Components and Assemblies of CSA 478: Guideline on Durability in Buildings;

h) Include in the development of the vulnerability assessment, participation and review from key internal and external stakeholders, including Metrolinx Operations and Maintenance, Engineering and Asset Management, and Transportation Policy and other departments, as follows:

i. Hold at least one workshop with key stakeholders to collect information on the severity of impacts. The workshop can be scoped based upon analysis from previous PIEVC reports deemed to be sufficient and applicable based on professional judgement; and

ii. Prepare a report with a risk analysis of medium and high-risk items, along with high-level cost estimation of each adaptation option.

i) Climate projections shall represent a conservative, high-emission scenario as recognized by the international community.

8.1.3. OPTIONS

All project locations may implement mitigation measures for medium risks.

8.1.4. REPORTING DIRECTION

The standard approach to risk assessment to climate impacts is a quantitative risk evaluation process that consists of:

a) A scale to describe the likelihood/probability of the risk arising (Table 4);

b) A scale to describe the level of consequence/severity of that risk, should it happen (Table 5);

c) A scale to assign a priority rating to each risk, given these two variables (Table 6); and

d) A risk table representing all interactions with associated likelihood/probability and severity scores. See Table 12 for an acceptable example. Note risk scores have been omitted from the table. Infrastructure components in Table 12 shall be updated as appropriate for the project.

Table 3: PIEVC Probability Score

PIEVC Score	Probability of Occurrence	
0	< 0.1%	<1 in 1,000
1	1%	1 in 100
2	5%	1 in 20
3	10%	1 in 10
4	20%	1 in 5
5	40%	1 in 2.5
6	70%	1 in 1.4
7	> 99%	>1 in 1.01

Table 4: PIEVC Severity Score Factor

PIEVC Score	Severity characteristics
0	Negligible or Not Applicable
1	Very Low/Unlikely/Rare/Measurable Change
2	Low/Seldom/Marginal/Change in Serviceability
3	Occasional Loss of Some Capacity
4	Moderate Loss of Some Capacity
5	Likely Regular/Loss of Capacity and Loss of Some Function
6	Major/Likely/Critical Loss of Function
7	Extreme/Frequent/Continuous/Loss of Asset

Table 5: PIEVC Scoring Matrix

Severity	Probability 0	1	2	3	4	5	6	7
7	0	7	14	21	28	35	42	49
6	0	6	12	18	24	30	36	42
5	0	5	10	15	20	25	30	35
4	0	4	8	12	16	20	24	28
3	0	3	6	9	12	15	18	21
2	0	2	4	6	8	10	12	14
1	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0

Special Case
Low Risk
Medium Risk
High Risk

8.2. DESIGN FOR FUTURE CLIMATE

8.2.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credit requirements; and

b) Federal Climate Lens Assessment.

8.2.2. REQUIREMENTS

All projects shall:

a) Provide designs that account for future climatic conditions over the anticipated lifespan of the project and its individual elements (i.e. account for at a minimum potential increase in rainfall intensity, temperature, windspeed, among others); and

b) Incorporate the following adaptation measures, where applicable:

   i. The size of A/C units accounts for higher average heat tolerances;

   ii. Future-proof roofs of conditioned spaces to accommodate larger A/C units;

   iii. All assets, especially glass doors, windows, waiting shelter, signage, and solar PV panels, shall ensure design is able to withstand higher extreme wind gusts (typically ≥ 120 km/hr);

   iv. All assets are designed to be resilient to freeze-thaw cycles;

   v. Design communication systems to withstand higher wind gusts (typically ≥ 120 km/hr);

   vi. Installation of backflow preventers at connections to the municipal services network;

   vii. Installation of back-up (redundant or spare) sump pumps;

   viii. Installation of back-up power;

   ix. Installation of an early warning alarm system which notifies operation and maintenance staff when a cooling system is overloaded;

   x. Other measures as appropriate to the climate vulnerabilities identified in 7.1; and

   xi. Durability per CSA S478.

8.3. SNOW AND ICE MANAGEMENT

8.3.1. OBJECTIVES

The requirements of this section are aligned with the intent of:

a) Select LEED credit requirements; and

b) Federal Climate Lens Assessment.

8.3.2. REQUIREMENTS

All projects shall:

a) Design assets to minimize the likelihood of hazardous conditions arising from snow and ice accumulation, including;

   i. Slips, trips and falls; and

   ii. Falling snow and ice that has accumulated on structures.

All site projects proposing a minimum 0.5 ha of new or reconstructed hardscape shall:

b) Develop a snow and ice management plan during design, and submit at no later than 60% Design, that:

   i. Identifies snow storage areas to be used during the operations phases, while supporting clear, barrier-free access;

   ii. Indicates the expected volume of snow to be cleared on an annual and daily basis;

   iii. Considers the access of snow ploughs and the impact snow storage and removal will have on the hardscape and landscape. For example, keep signage supports adjacent to, rather than in the path of travel, to minimize conflicts with snow removal equipment; and

   iv. Considers access to all areas which require regular clearing during winter months, including sidewalks, entrances, staircases, parking spaces, ramps and roofs.

c) Prevent water from pooling or flowing through vehicular and pedestrian travel routes to the greatest extent possible, with a strategy for cold weather months included. Roof drains shall be directed away from vehicular or pedestrian travel routes; and

d) Minimize through design strategies the need for snow and ice management during operations. Recommended strategies include:

   i. proper location of snow storage;

   ii. use of deciduous plants to reduce winter shading;

   iii. snowmelt systems;

   iv. permeable paving (note that permeable hardscapes are less prone to ice accretion);

   v. minimal road grades at intersections; and

   vi. rougher pavement.

8.3.3. GUIDANCE

Snow and ice management plans should identify snow storage areas during construction.

8.3.4. REPORTING DIRECTION

A template table of contents has been provided for informational purposes only and is intended to provide guidance. It is recommended that the Snow and Ice Management Plan follow a standardized format with the following sections:

   i. Executive Summary;

   ii. Section 1: Climatic Information, including the expected volume of snow expected on site;

iii. Section 2: Snow clearing strategy for site, indicating areas that will be cleared and where snow will be stored;

iv. Section 3: Melt strategy for site indicating how snow and ice melt, including rain on snow and ice, will be managed to ensure the impact on operations will be minimized; and

v. Section 4: Snow and ice safety strategy for site, indicating how the design prevents snow and ice build-up and falling in high traffic areas.

9 SUSTAINABILITY PLAN & REPORTING

9.1. SUSTAINABILITY PLAN

9.1.1. OBJECTIVES

The requirements of this section are to ensure compliance (but not limited) to:

a) Required LEED credits;

b) Municipal Green Developments standards; and

c) Federal Climate Lens Assessment.

9.1.2. REQUIREMENTS - PRELIMINARY SUSTAINABILITY POTENTIAL ANALYSIS

All project locations shall submit a Preliminary Sustainability Potential Analysis at no later than 30% Design, which shall:

a) Outline the sustainable design concept, including the functional and technical requirements;

b) Provide a checklist and strategy to meet each section of this standard, as appropriate to a 30% Design;

c) Provide a checklist and strategy (including Municipal frameworks) for any sustainability certifications being pursued;

d) Provide a preliminary energy analysis per Section 3.2.2(a);

e) Provide a preliminary climate vulnerability and risk assessment per Section 8.1; and

f) All checklists to provide references to all associated reports and drawings.

9.1.3. REQUIREMENTS – DRAFT SUSTAINABILITY PLAN

All project locations shall submit a draft Sustainability Plan at no later than 60% Design, which shall:

a) Provide an updated checklist and strategy for any sustainability certifications being pursued;

b) Provide an updated checklist to meet all applicable requirements of this standard;

c) Include LCA of embodied carbon per Section 2.1;

d) Include the submission of all design phase reports and analysis that have not yet been submitted;

e) Provide sustainability goals, targets and metrics for construction (for projects with a capital cost of more than $50 Million); sustainability goals, targets, and metrics shall be proposed to align with the Project Agreement or MAPP and Metrolinx Sustainability Plan;

f) Provide the template for the construction sustainability report (for projects with a capital cost of more than $50 Million); and

g) All checklists to provide references to all associated reports and drawings.

9.1.4. REQUIREMENTS – FINAL SUSTAINABILITY PLAN

All projects shall submit a final Sustainability Plan at 90% or 100% Design, which shall update the draft Sustainability Plan.

9.2. CONSTRUCTION SUSTAINABILITY REPORTING

9.2.1. OBJECTIVES

The requirements of this section are to ensure compliance (but not limited) to:

a) Required LEED credits;

b) Municipal Green Developments standards; and

c) Federal Climate Lens Assessment.

9.2.2. REQUIREMENTS

All project locations shall:

a) Produce a Construction Sustainability Report that:

   i. Tracks and monitors sustainable practices during project delivery, reported at six-month intervals using at a minimum the metrics outlined in Table 7;

   ii. Identifies any targets not met, with a rationale as well as a recovery plan for the next year to get the project back on track to meet the target;

   iii. Provides any updates as required to the Sustainability Plan; and

   iv. Updated targets and metrics, if required.

b) Produce a Sustainability Substantial Completion Report that:

   i. Summarizes the sustainability reporting results during construction using at a minimum the metrics outlined in Table 7; and

   ii. Provide copies of any available Environmental Product Declarations for project materials.

c) Establish targets for each metric in Table 7 that, at a minimum, support the achievement of the project sustainability goals and align with design standards. Targets shall include the following:

   i. Description of the utilization and application of measurement parameters and monitoring methods; and

   ii. Metrics for evaluating the achievement of sustainable design targets throughout the project term.

   iii. Be prepared to provide Metrolinx with the supporting information (including data) behind each metric, upon request.

9.2.3. REPORTING DIRECTION

Construction sustainability reports shall be provided to Metrolinx on a biannual basis and include reports on the metrics outlined in Table 7.

Table 6: Construction Sustainability Reporting Metrics

ACTIVITY	REPORTING CATEGORY	UNIT OF MEASURE	BIANNUAL REPORT	SUBSTANTIAL COMPLETION REPORT
Construction Materials Imported to Site	Concrete	Tonnes		X
	Steel	Tonnes		X
	Soil/Aggregate/fill imported	Tonnes	X	X
	Aluminum	Tonnes		X
	Asphalt	Tonnes		X
	Wood	Tonnes & Percentage FSC Certified or equivalent		X
	Glass	Tonnes		X
	Other materials per Section 2.2	Tonnes		X
	Soil/ Aggregate/fill exported	Tonnes	X	X
Transport & Fuels	Diesel consumed on-site by construction activities	L	X	X
	Gasoline consumed on-site by construction activities	L	X	X
	Trucking of soils/aggregate/fill (Import and Export)	km	X	X
Energy	Natural Gas	m^3	X	X
	Grid power	kWh	X	X

ACTIVITY	REPORTING CATEGORY	UNIT OF MEASURE	BIANNUAL REPORT	SUBSTANTIAL COMPLETION REPORT
	Non-Grid Renewable Energy	kWh	X	X
Waste (excluding aggregate, fill and hazardous materials)	Recycled and composted	Tonnes	X	X
	Diversion Rate: [(Units of Recycling + Composting + Reused)/(Units of Recycling + Composting + Reused + Landfilled)] x100	%	X	X
	Reused Materials (on site)	Tonnes	X	X
	Landfilled	Tonnes	X	X
Landscape	Native plantings (separate by trees, shrubs, and plants)	Percentage native plants		X
	Disturbed Soils	Volume or % of area of native soils protected from compaction during construction or restored		X
	Proportion of site & roof vegetated	%		X
Water	Water consumption during construction	L	X	X
	Percentage of landscaping planted with drought-tolerant species	%		X

10 LIST OF FIGURES AND TABLES

10.1. FIGURES

Figure 1 – Carbon reduction curve. While reducing carbon emissions is possible at all stages of project delivery, opportunities are greater and most cost-efficient in earlier stages

Figure 2 - Clarkson GO Station. On top of the 1,500 space, five-storey parking structure, the roof is entirely covered with solar panels

Figure 3 - Erindale GO Station, 250 kW, Installed 2013

Figure 4 - Example vehicle wash reclaimed system

Figure 5 - Basic green roof assembly. Diagram is for information purposes only | Roofgenious

Figure 6 - PICP at Green P lot, North of Dundas Street West at Manning Avenue

Figure 7 – Concrete open grid | alamy.com

Figure 8 - Permeable concrete paving at Lakeside Park, Mississauga | https://wiki.sustainabletechnologies.ca/

Figure 9- Bioretention cell capturing and treating runoff from adjacent parking lot
| https://wiki.sustainabletechnologies.ca/

Figure 10 - Bioswale along Country Code Court Boulevard in Brampton | https://wiki.sustainabletechnologies.ca/

Figure 11 - Conventional blue roof assembly for illustration purposes only

10.2. TABLES

Table 1 – Life-cycle assumptions included in the LCA analysis

Table 2 – LEED Requirements Table

Table 3 – PIEVC Probability Score

Table 4 - PIEVC Severity Score Factor

Table 5 – PIEVC Scoring Matrix

Table 6 – Construction scoring reporting metrics

11 DEFINITIONS

TERM	DEFINITION
BUG Rating	The Backlight, Uplight, and Glare rating is used to evaluate the luminaire's optical performance in relation to light trespass, sky glow, and high-angle brightness control.
Climate change	Refers to any change in climate over time, whether due to natural variability or as a result of human activity.
Cool Roof	Roofing designed with high solar reflectivity to minimize heat absorption and reduce cooling loads. Shall have a three-year aged SRI of at least 64 for roofs with a slope less than 1:6, and a three-year aged SRI of at least 29 for roofs with a slope greater than 1:6.
Correlated Colour Temperature (CCT)	A specification of the colour appearance of the light emitted by a lamp, relating its colour to the colour of light from a reference source when heated to a particular temperature, measured in degrees Kelvin (K).
Criteria Air Contaminants	Criteria Air Contaminants are emissions of seven air pollutants tracked by Environment Canada that affect our health and contribute to air pollution problems such as ground-level ozone, haze, and acid rain. Not to be Pursued: • Total Particulate Matter (TPM) • Particulate Matter with a diameter less than or equal to 10 microns (PM_{10}) • Particulate Matter with a diameter less than or equal to 2.5 microns ($PM_{2.5}$) • Sulphur Oxides (SO_x) • Nitrogen Oxides (NO_x) • Volatile Organic Compounds (VOC) • Carbon Monoxide (CO) Source: Environment Canada. National Pollutant Release Inventory.

TERM	DEFINITION
Energy Use Intensity (EUI)	The total amount of energy consumed in a building per floor area net of on-site renewable energy generated (expressed as kWh/m^2/year). Also known at Total Energy Use Intensity (TEUI) in TGS.
Environmental Footprint	The effect that a person, company, activity, etc. has on the environment; for example, the quantity of natural resources that they use and the amount of harmful gases that they produce.
Greenhouse gas (GHG)	Gases that trap the sun's warmth within the atmosphere, causing a greenhouse effect, such as water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3).
Greenhouse Gas Intensity (GHGI)	The total amount of GHGs from a building's energy use (expressed as kg/m^2/year)
Greywater	Untreated building wastewater which has not come into contact without fecal contamination.
Heat island	An urban area characterized by ambient temperatures higher than those of the surrounding non-urban area. The cause is a higher absorption of solar energy by materials of the urban fabric, such as asphalt.
Intensity-Duration-Frequency curve (IDF Curve)	A graphical representation of the probability that a given average rainfall intensity and duration will occur.
Leadership in Energy and Environmental Design (LEED®)	An internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance.
Life-cycle Assessment (LCA)	A technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling.
Life-Cycle Cost Analysis	A method for assessing the total cost of facility ownership. It is a tool that can be used to determine the most cost-effective option among different competing alternatives to purchase, own, operate, maintain, and finally dispose of an object or process.

TERM	DEFINITION
Low Impact Development (LID)	Is applied to minimize runoff at source and mimic the natural water balance by focusing on practices that promote increased evapotranspiration, infiltration and groundwater recharge, and lower surface runoff volumes and flow rates.
Major Storm	That storm drainage system which carries the total runoff of the drainage system, less the runoff carried by the minor system. The major system will function whether or not it has been planned and designed, and whether or not developments are situated wisely with respect to it. The Major Drainage System usually includes many features such as streets, gullies, and major drainage channels.
Minor Storm	That storm drainage system which is frequently used for collecting, transporting, and disposing of snowmelt, miscellaneous minor flows, and storm runoff up to the capacity of the system. The minor system may include many features, ranging from curbs and gutters to storm sewer pipes and open drainage ways. The capacity should be equal to the maximum rate of runoff to be expected from the minor design storm, which may have a frequency of occurrence of one in 10 years for industrial Sites.
Net present value (NPV)	The difference between the present value of cash inflows and the present value of cash outflows over a period of time.
On Corridor / Off Corridor	On corridor or "Oncorr" refers to the Metrolinx main rail network and associated infrastructure, such as rail bridges, signalling systems, culverts, among other infrastructure. Off corridor or "Offcorr" refers to the Metrolinx infrastructure that supports the rail network, such as stations, bus terminals, other bus infrastructure, maintenance facilities, and pedestrian bridges, among other infrastructure.
Permeable Paving	A permeable hardscape that allows stormwater infiltration through the surface into a stone reservoir. Permeable paving includes: • permeable interlocking concrete pavers • plastic or concrete grid systems • pervious concrete • pervious asphalt

TERM	DEFINITION
Resilience	The ability of Metrolinx, its infrastructure assets, and the component parts of its regional transit system to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.
Solar Reflectance Index (SRI)	Measures of the constructed surface's ability to stay cool in the sun by reflecting solar radiation and emitting thermal radiation.
Supplementary Cementitious Materials (SCMs)	Contribute to the properties of hardened concrete through hydraulic or pozzolanic activity. Typical examples are fly ashes, slag cement (ground, granulated blast-furnace slag), and silica fume. These can be used individually with Portland or blended cement, or in different combinations. Supplementary cementitious materials are often added to concrete to make concrete mixtures more economical, reduce permeability, increase strength, or influence other concrete properties.
Thermal Energy Demand Intensity (TEDI)	The annual heat loss from building's envelope, net of passive heat gains and losses (expressed as kWh/m^2/ year).
Thermal Bridge	A thermal bridge, also called a cold bridge, heat bridge, or thermal bypass, is an area or component of an object which has higher thermal conductivity than the surrounding materials, creating a path of least resistance for heat transfer.
Total Suspended Solids (TSS)	The dry-weight of suspended particles that are not dissolved, in a sample of water that can be trapped by a filter that is analyzed using a filtration apparatus.
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability to climate change is the degree to which Metrolinx infrastructure assets, our passengers, employees and contractors, and the region within which we provide transit services, are susceptible to, and unable to cope with, the adverse impacts of climate change.

APPENDIX A: APPLICABILITY MATRIX

	PROJECT CATEGORIZATION					
Section	**New & Reconstructed Buildings with GFA >100 m² Actively Heated & Cooled**	**Expansion to Existing Buildings**	**New & Reconstructed Buildings with GFA <100 m² Actively Heated & Cooled**	**Site (Non-Building)**	**SOGR**	**Other**
Life Cycle Assessment (Embodied Carbon)	Requirements Guidance	Requirements Guidance	Requirements Guidance	Requirements Guidance	Requirements Guidance	
Material Life Cycle Impacts	Requirements Guidelines	Requirements Guidelines	Requirements Guidelines	Requirements Guidelines	Requirements Guidelines	Min. GFA for heated/ cooled spaces. Partly excludes GO Transit projects
Building Energy and Carbon Performance	Requirements Options	No	No	No	No	Min. GFA for heated/ cooled spaces
Energy Simulations and Modelling	Requirements Guidance Options	No	Requirements Guidance Options	No	No	
Energy Efficient Design – Building Envelope	Requirements	Guidance	Guidance	No	No	
Energy Efficient Design –Mechanical System	Guidance Options	No	Guidance Options	No	No	Excludes GO Transit projects
Energy Efficient Design – Electrical Systems – Energy Automation and Control	Requirements	No	No	No	No	Excludes GO Transit projects

	PROJECT CATEGORIZATION					
Section	**New & Reconstructed Buildings with GFA >100 m² Actively Heated & Cooled**	**Expansion to Existing Buildings**	**New & Reconstructed Buildings with GFA <100 m² Actively Heated & Cooled**	**Site (Non-Building)**	**SOGR**	**Other**
Energy Efficient Design – Electrical Systems – Energy Metering and Monitoring	Requirements	No	No	No	No	Excludes GO Transit projects
Energy Efficient Design – Electrical Systems – Lighting	Requirements	Requirements	Requirements	Requirements	Requirements	Excludes GO Transit projects
Energy Efficient Design – Electrical Systems – General	Requirements	Requirements	Requirements	No	No	Excludes GO Transit projects
Solar PV Renewable Energy	Requirements	Requirements	Requirements	No	No	See s.3.4.2(a)
Heat Island Mitigation	Requirements	Requirements	Requirements	Requirements Options	No	If non-road plus roof area >0.25ha
Water Modelling, Metering and Monitoring	Requirements Options	Requirements Options	Requirements Options	No	No	Non-GO Transit assets with operational water consumption
Water Efficient Design	Requirements Guidance	Requirements Guidance	Requirements Guidance	Scope Dependent	No	Operational water consumption
Stormwater Performance Criteria	Requirements Guidance	Requirements Guidance	Requirements Guidance	Requirements Guidance	No	SWM report
Low Impact Development Strategies	Requirements Guidance Options	Requirements Guidance Options	Requirements Guidance Options	Requirements Guidance Options	Requirements Guidance Options	LID practices are proposed

	PROJECT CATEGORIZATION					
Section	**New & Reconstructed Buildings with GFA >100 m^2 Actively Heated & Cooled**	**Expansion to Existing Buildings**	**New & Reconstructed Buildings with GFA <100 m^2 Actively Heated & Cooled**	**Site (Non-Building)**	**SOGR**	**Other**
Soil Management	No	No	No	Requirements Guidance	Requirements Guidance	Vegetated ground LIDs or > 100 m^3 of disturbed native soil for planting
Bird-Friendly Design	Requirements Guidance	Requirements Guidance	Requirements Guidance	No	Requirements Guidance	Glazing within 12 m of the ground or ground-level ventilation
Light Pollution Reduction	Requirements Guidance	Requirements Guidance	Requirements Guidance	Requirements Guidance	Requirements Guidance	Non-GO Transit assets only proposing exterior lights
Climate Vulnerability and Risk Assessment	Requirements Guidance	Requirements Guidance	Requirements Guidance	Requirements Guidance	Requirements Guidance	
Design for Future Climate	Requirements Guidance	Requirements Guidance	Requirements Guidance	Requirements Guidance	Requirements Guidance	
Snow and Ice Management	Requirements Guidance	Requirements Guidance	Requirements Guidance	Requirements Guidance	Requirements Guidance	Minimum 0.5 ha of new or reconstructed hardscape
Sustainability Plan	Requirements Guidance	Requirements Guidance	Requirements	Requirements	Requirements	
Construction Sustainability Reporting	Requirements	Requirements	Requirements	Requirements	Requirements	

APPENDIX B: CLIMATE RISK ASSESSMENT TEMPLATE

Infrastructure Components		Infrastructure Response Considerations											High Temperature								High Wind								Heavy Rain				Freezing Rain			
		Structural Design	*Functionality*	*Serviceability*	*Operations, Maintenance*	*Emergency Response*	*Liability Considerations*	*Policy Considerations*	*Socio-economic Effects*	*Public relations*	*Watershed, Surface Water & Groundwater*	*Other Environmental Effects*	Daily Temp ≥ 40 °C				Daily Temp ≥ 32 °C				Gusts ≥ 90 km/h				Gusts ≥ 120 km/h				2-hour Rainfall ≥ 60 mm				Ice Accretion ≥ 25 mm			
		Mark Relevant Responses with ✓											Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R
	Roofs																																			
1	Main Building																																			
2	Roof Canopies																																			
	Walls																																			
3	Solid																																			
4	Glass																																			
	Interior Components																																			
5	Electrical (power, lighting)																																			
6	Mechanical (elevator, sprinkler systems)																																			
7	Communications																																			
	Site																																			
8	Parking Lots																																			
9	Sidewalks																																			
XX	Additional component to be added as required																																			