

Table of Contents

SCHEDULE 15-2 DESIGN AND CONSTRUCTION 1

PART 5 DESIGN AND CONSTRUCTION REQUIREMENTS – STATIONS 1

ARTICLE 1 INTRODUCTION 1

1.1 Introduction 1

1.2 Overview 1

1.3 Tunney’s Pasture Station 5

1.4 Bayview Station 5

1.5 Lebreton Station 6

1.6 Downtown West Station 6

1.7 Downtown East Station 8

1.8 Rideau Station 8

1.9 Campus Station 10

1.10 Lees Station 12

1.11 Hurdman Station 13

1.12 Train Station 14

1.13 St. Laurent Station 14

1.14 Cyrville Station 15

1.15 Blair Station 15

1.16 Design Principles and Guidelines 16

ARTICLE 2 ARCHITECTURAL DESIGN CRITERIA 17

2.1 Introduction 17

2.2 Elements of Continuity and Variability: 18

2.3 Station Sizing and Capacity 21

2.4 Circulation and Egress 25

2.5 Functional Requirements 34

2.6 Project Elements 44

2.7 Material Requirements 55

ARTICLE 3 STRUCTURAL DESIGN CRITERIA 92

3.1 Introduction 92

3.2 Reference Documents 92

3.3 Federally Mandated Station Requirements 93

3.4 Durability 93

3.5 Station Structural Loads 93

3.6 Load Combinations 96

3.7 Design Considerations for Retaining Walls 96

3.8 General Design Considerations 97

3.9 Existing Structure Considerations 99

3.10 Reinforced Concrete 100

3.11 Structural Steel 101

3.12 Masonry 103

3.13 Concrete Slabs on Grade 103

ARTICLE 4 MECHANICAL DESIGN CRITERIA 105

4.1	Reference Documents	105
4.2	General Requirements.....	107
4.3	Design Requirements	108
4.4	System Requirements.....	111
4.5	HVAC Equipment.....	112
4.6	Heating Equipment	115
4.7	Ductwork.....	118
4.8	Supply Air Diffusers	119
4.9	Exhaust / Return Registers and Grilles	119
4.10	Supply Registers and Grilles.....	119
4.11	Intake and Exhaust Wall Louvers	120
4.12	Volume Dampers in Branch Ducts	120
4.13	Fire / Smoke Dampers	120
4.14	Air Filtration	120
4.15	HVAC Piping.....	121
4.16	Thermal Insulation	121
4.17	Acoustic Lining.....	122
4.18	Building Automatic System.....	122
4.19	Emergency Ventilation Systems	124
4.20	Plumbing.....	124
4.21	Fire Protection.....	135
ARTICLE 5 ELECTRICAL DESIGN CRITERIA.....		142
5.1	Introduction.....	142
5.2	Reference Documents	142
5.3	Basis for Design	143
5.4	Functional Requirements	145
ARTICLE 6 WAYFINDING AND SIGNAGE.....		155
6.1	Introduction.....	155
6.2	Goals & Objectives	155
6.3	Scope.....	155
6.4	General Responsibilities	156
6.5	General Requirements.....	157
6.6	Conditions	173

**SCHEDULE 15-2
DESIGN AND CONSTRUCTION**

**PART 5
DESIGN AND CONSTRUCTION REQUIREMENTS – STATIONS**

ARTICLE 1 INTRODUCTION

1.1 Introduction

- (a) The OLRT Stations shall be efficient, universally accessible, sustainable facilities that provide Passengers with an enjoyable, comfortable and safe transit experience.
- (b) Stations shall act as a catalyst for transit oriented Design and shall enhance connectivity to surrounding neighbourhoods while not precluding integration opportunities with future planned developments.
- (c) Project Co shall provide LRT Stations, complete, to fully support the operational requirements of the OLRT while minimizing crowding, travel impedances and physical barriers.
- (d) Stations shall be planned and designed to satisfy the requirements in Schedule 15-2, Part 1, Article 2, Operational Performance Requirements.

1.2 Overview

- (a) Thirteen (13) Stations shall be constructed for the OLRT Project.
- (b) Types of Stations constructed for the OLRT Project shall include the following:
 - (i) New Underground Stations Downtown West, Downtown East and Rideau;
 - (ii) At Grade Stations include all Stations constructed with the platform level at grade, above grade, within the existing BRT trench, or within an existing building as follows:
 - A. Terminal/Transfer Stations Tunney's Pasture, Bayview, Hurdman and Blair;
 - B. BRT to LRT Station conversions including Campus, Lees, St. Laurent and Cyrville; and
 - C. New At Grade Stations Lebreton and Train.
- (c) Project Co shall Design and construct the Stations, and shall obtain necessary Permits, Licences and Approvals for the same. Station Structures and systems shall be designed and constructed to satisfy the life expectancy requirements of this Schedule 15 - Output Specifications.

- (d) Emergency Planning:
- (i) Project Co shall be responsible for the preparation, submission and maintenance (including revisions as necessary) of fire safety plan(s), for approval by the authority having jurisdiction, pursuant to Ontario Fire Code, Section 2.8 Emergency Planning, where applicable.
- (e) Stations Design shall consider pedestrian circulation as a critical element. Station Designs shall facilitate the transfer of Passengers from one mode of transportation to another by minimizing transfer effort and providing generous capacity under normal operations and to ensure safe and speedy exiting under emergency conditions. Station capacity shall be planned and designed to serve the projected operations contained in this Article. Project Co shall provide calculations and Passenger modeling to demonstrate that generous public spaces have been achieved in Station Design and that a high level of service has been provided for Passenger circulation including calculations for entry and exit volumes. Stations Design shall consider intuitive Passenger flow, minimizing obstacles and pinch-points. Calculations and Passenger modeling shall be submitted according to Schedule 10 – Review Procedure.
- (f) Stations Platforms shall be constructed to satisfy the requirements of the Operational Performance Requirements defined in Schedule 15-2 Part 1 Article 2 as follows:
- (i) All At Grade Stations shall be constructed to satisfy the requirements of Operating Scenario 2 except Tunney’s Pasture Station which will be designed to satisfy the greater of the requirements of Operating Scenario 1 or Operating Scenario 2.
 - (ii) All Underground Stations shall initially be sized accordingly to accommodate the Passenger carrying capacities of 24,000 pphpd as outlined in Schedule 15-2 Part 1 Clause 2.5 (c).
- (g) Stations shall be planned, designed and constructed with provisions for installation of a fare control system including but not limited to fare control turnstile gates and fare vending equipment to be installed by the City.
- (h) All Stations shall provide a roof Structure overtop the Platform. Stations are not required to be climate controlled, however provisions shall be made for radiant on-demand heating, wind screens and other Structures to provide comfort for waiting Passengers.
- (i) Downtown Underground Stations shall have entrances both on public right-of-way as well as entrances integrated within Third Party Facilities at properties such as Place de Ville and the Rideau Centre.
- (i) All utilities and services required for construction and operation of the Station and Station entrance within third party facilities shall be separate and independent of the building(s) services, with the exception of any code related interconnections.

- (ii) Project Co shall provide the City with definition of all permanent and temporary property easement requirements necessary to construct all Underground Station entrances where integrated in to Third Party Facilities.
- (j) St. Laurent Station shall be converted from a BRT Station to an LRT Station.
- (k) The Platform width of the three (3) downtown Stations shall be such as to protect for future installation of Platform edge doors.
- (l) Artwork shall be integrated into the Station Designs. Stations shall have adequate and easily understood signage, graphics and markings. Project Co shall work with the City to develop and implement a Wayfinding Signage program.
- (m) Five (5) LRT Stations (Tunney's Pasture, Bayview, Lebreton, Hurdman and Train) are located on Federal Government lands and are considered Federally Mandated Stations and therefore are subject to FLUA, and Design approval by the NCC under Section 12 of the National Capital Act. Project Co shall be responsible for advancing the designs of Federally Mandated Stations in accordance with the following:
 - (i) Background
 - A. Coordination is needed to plan, preserve and develop an exceptional capital for the Canadians. The National Capital Act makes the National Capital Commission (NCC) responsible for coordinating and approving projects related to federally-owned lands and buildings in Canada's National Capital Region. The NCC is a Crown Corporation and therefore functions at a distance from the federal government, reporting to Parliament through the Minister of Foreign Affairs.
 - B. All individuals and federal organizations need NCC approval before undertaking projects on federal lands and buildings in Canada's National Capital Region.
 - C. The NCC's mandate to approve federal land uses, transactions and designs is set out in sections 12 and 12.1 of the National Capital Act.
 - (ii) City undertaking of Stations requiring NCC Design Approval
 - A. For complex projects with high symbolic value for the Capital such as the OLRT, the federal land use approval process can be lengthy. To mitigate risk to the project schedule and to provide certainty to Project Co, the City has developed designs for the five (5) Federally Mandated Stations and Campus Station to a conceptual level of design through the Preliminary Engineering phase of the Project.
 - B. The Federally Mandated Station Designs have received a limited endorsement by the NCC, which is outlined along with conditions, in a letter from the NCC to the City dated February 6, 2012.

- (iii) Project Co's approach to the Federally Mandated Stations will be assessed in terms of general compliance with the Federally Mandated Station Drawings and the spirit of the NCC requirements and conditions as outlined in Appendices 1 and 2 of the February 6th NCC Limited Endorsement Letter. Specifically, compliance will be measured on the following criteria:
 - A. The extent to which connectivity aspects of the Federally Mandated Stations are respected recognizing that the pedestrian connectivity of the Federally Mandated Stations as reflected in the current designs are of particular importance to the NCC; and
 - B. The extent to which the Project Co's design drawings are consistent with the appearance, quality and overall architectural concept for the Station recognizing that these aspects of the design are of particular importance to the NCC.
- (iv) The Sponsors will provide compliance feedback on specific design components of the Federally Mandated Stations as outlined in the RFP.
- (v) The functional layout, Platform configuration, and interior layout of the Federally Mandated Stations may be optimized in the design, provided the designs meet all the terms of the Project Agreement.
- (vi) Alternative design details that enhance constructability shall be permitted provided the submitted designs satisfy all the terms of the Project Agreement.
- (vii) Project Co shall address, incorporate and, or resolve all comments and conditions contained in the NCC OLRT Negotiation Mandate document dated October 25, 2012.
- (n) All Stations shall be designed and constructed to permit Emergency Vehicle access. If any new Works are required to ensure Emergency Vehicle access, then these Works shall be the responsibility of Project Co.
 - (i) At the following stations, Emergency vehicle access can be via the bus transfer area (Tunney's Pasture, Hurdman, Blair, St. Laurent);
 - (ii) At the following stations, Emergency vehicle access can be via the nearest City street (Bayview, Lebreton, Lees, Train, Cyrville);
 - (iii) At the following stations, Emergency vehicle access can be via the municipal road ROW adjacent to station entrances (DTW, DTE, Rideau); and
 - (iv) At Campus Station, Emergency vehicle access can be via the University of Ottawa plaza area on the east side of Campus Station.

- (o) All Stations, facilities supporting the OLRT and where applicable, associated Bus facilities, shall be designed and constructed in accordance with Transport Canada rules and regulations.

1.3 Tunney's Pasture Station

- (a) Tunney's Pasture is an existing bus transit Station along the BRT that shall be converted to serve as the west terminus of the OLRT and Operating Scenario 1. The existing bus service shall be relocated from its current lower level to a new bus loop at grade to be constructed as part of the OLRT Project.
- (b) Tunney's Pasture Station is a Federally Mandated Station. Existing Bridges across the Station shall be refurbished and converted into two new entrances at the upper level, which shall be connected to the Platform level with stairs, elevators and escalators. The western entrance shall provide a direct connection to the reconfigured bus loop. This entrance shall be designed to allow for a non-fare paid connection from Scott Street to Tunney's Pasture Campus when the OLRT is extended and the Station becomes a line Station.
- (c) The new Station Design shall facilitate the fast and convenient movement of Passengers between buses and the LRT.
- (d) The new Station shall be located within the existing BRT utilizing elements of the existing Station. The western end of the Platform shall be located to allow for the extension of Goldenrod Driveway and provide bus circulation out of the BRT with access to the new Station and access from the new Station to Scott Street. The eastern end of the Platform shall not extend past the eastern side of Holland Ave.
- (e) The Station shall be designed as to permit Passengers to transfer between the BRT and LRT without passing through fare control barriers and/ or revalidating fare payment.

1.4 Bayview Station

- (a) Bayview Station is an existing Station along the BRT that provides a connection to the existing O-Train. Construction and configuration of the new Bayview Station shall be coordinated with the replacement of the West Transitway CPR Overpass O-Train Bridge. The new Station shall be directly above the relocated O-Train Platform and provide an efficient vertical connection to the OLRT. The O-Train track shall be extended north and a new O-Train Platform shall be provided and shall properly integrate with the LRT Station above as well as protect for a possible future extension of the O-Train corridor north across the Prince of Wales Bridge to Gatineau. Sufficient space and clearance to structural elements at the lower level of the Station shall be provided to allow for a future double-tracked electrified light rail line to replace the O-Train corridor and extend north to Gatineau.
- (b) Bayview Station shall be designed such that Alignments for a future extension of the OLRT to the west and a future extension running north-south are protected.

- (c) Bayview Station is a Federally Mandated Station.
- (d) Enhancing pedestrian connections to this Station shall be incorporated into the Station Design. Several pathways from surrounding communities shall be constructed as part of the Project.
- (e) The Station Platform shall be located to provide a direct connection to the O-Train and to provide an at grade entrance from Albert Street at the east side of the existing overpass on Albert Street.
- (f) The western entrance shall be located at the lower level of the Station serving as a direct connection to the O-Train. The eastern entrance shall be located at Platform level no more than 20m east of the existing overpass.
- (g) The Station shall be designed as to permit Passengers to transfer between the LRT and O-Train without passing thru fare control barriers and/or revalidating fare payment.

1.5 Lebreton Station

- (a) Lebreton Station is an existing Station along the BRT. The OLRT Alignment shall be located a short distance south of the existing bus Transitway.
- (b) Lebreton Station is a Federally Mandated Station.
- (c) The new Station shall be integrated with a new Booth Street Bridge. The Bridge shall be provided to elevate Booth Street through the Lebreton Flats Development project to the east and west of Booth Street. The Station Platform shall be located below the Bridge, along the edge of the existing aqueduct. The Station Platforms shall extend east and west of Booth Street and the Bridge shall provide protection over the Platforms. Pedestrian access shall be provided on both the east and west sides of Booth Street with the ability to descend to the Platforms below. An additional entrance shall be provided at platform level directly under Booth Street Bridge.
- (d) Passengers shall have direct visual and physical access to the existing cycling and pedestrian pathways along the aqueduct.
- (e) The Station Design shall respect the heritage Designation of both the adjacent Bridge and aqueduct as well as incorporate an Algonquin cultural theme.

1.6 Downtown West Station

- (a) Downtown West shall be a new Underground Station that will replace a number of street level bus stations along the BRT. This Station shall provide a principal connection to downtown Ottawa along Queen Street near Lyon Street.
- (b) The Station Structure shall be constructed entirely within the City's Queen Street and Lyon Street right of ways with the exception of entrances and entrance connections.

- (i) The eastern limits of the Station shall accommodate an entrance located within Place de Ville.
 - (ii) The western limits of the Station shall accommodate the below grade passageway to the western entrance.
 - (iii) The Station shall be located to maintain a minimum distance of 300m from leading Platform edge of the Station to the trailing Platform edge of an adjacent Station in both east bound and west bound directions
- (c) The Station shall be provided with two (2) entrances.

[REDACTED]

- (ii) The western entrance shall be located at the Southeast corner of Queen Street and Lyon Street within the City right of way in front of the Delta Hotel. An elevator entrance, housing two (2) elevators, shall be provided within the City right of way on the south side of Queen Street and configured in such a manner as not to compromise the pedestrian flow on the City right of way.

- A. A total of four knock out panels for future below grade Station connectors shall be protected, final location of these features shall be coordinated with the City and private property Owner's during final Design.

- (iii) Private property required for entries will be After Acquired Lands.

1.7 Downtown East Station

- (a) Downtown East is a new Underground Station; that will replace a number of street level bus stations. This Station shall provide a principal connection to downtown Ottawa along Queen Street. The Platform can be located anywhere between sixty-five (65) metres east of the east limits of Bank Street and thirty (30) meters east of the east limits of Metcalfe Street.
- (b) The Station Structure shall be constructed entirely within the City's Queen Street right of way.
 - (i) The Station shall be located to maintain a minimum distance of 300m from leading Platform edge of the Station to the trailing Platform edge of an adjacent Station in both east bound and west bound directions.
- (c) The Station shall be served with a minimum of two (2) Station entrances on Queen Street.
 - (i) The eastern entrance shall be located within the City right of way near the southwest corner of Queen Street and O'Connor Street in front of the World Exchange Plaza Building.
 - (ii) Any new structures shall not compromise the view-shed to the Parliamentary Precinct.
 - (iii) Elevators may be integrated within the western and eastern entrance locations or may be located on City right of way provided pedestrian flow on the City right of way is not compromised.
 - (iv) [REDACTED]
 - (v) A total of three knock out panels for future below grade Station connectors shall be provided. Final location of these features shall be coordinated with the City and private property Owner's during final Design.

1.8 Rideau Station

- (a) Rideau Station is a new Underground Station; This Station shall provide a principal connection to the Rideau Centre and the Byward Market area along Rideau Street, between Colonel By and Nicholas Street. The Station will remain a significant transfer point from the bus stop on Rideau Street.
- (b) The Station Structure shall be constructed entirely within the Alignment Envelope.

- (i) The western limit of the Station structure shall not extend past the eastern sideline of the Colonel By/ Rideau Street intersection.
 - (ii) The Station shall be located to maintain a minimum distance of 300m from leading Platform edge of the Station to the trailing Platform edge of an adjacent Station in the east and west bound direction.
 - (iii) Private property required for the entries will be After Acquired Lands.
- (c) The Station shall be served with a total of two (2) Station entrances.
- (i) The eastern Station entrance shall be located within the existing Scotiabank property adjacent to William Street north of Rideau Street, as After Acquired Lands.
 - (ii) [REDACTED]
 - (iii) The Station concourse design shall include a non paid fare zone to allow for a connection that transverses Rideau Street. Hence, a knockout panel at concourse level shall be provided on the south the of the Rideau Station eastern concourse.
 - A. Non fare paid zone shall allow the free unimpeded passage of pedestrians and shall be a minimum of 6m wide; and
 - B. The fare barriers shall be located as to provide sufficient queuing space for Passengers entering and leaving the station.
 - i. Fare barrier queuing space shall be in addition to the minimum width of the non fare paid zone.
 - (iv) [REDACTED]
- (v) Project Co shall be responsible for the Design and Construction aspects of the Station entries as follows:
- A. Project Co shall be responsible for all aspects of the construction relating to the eastern entrance including the demolition of existing Scotiabank building and foundations.
 - B. [REDACTED]

C. [REDACTED]

D. Project Co is advised that the NCC possesses covenants on the exterior building façade of the Rideau Centre.

(vi) Existing pedestrian Bridges:

A. Bridges connecting buildings on the north and south side of Rideau Street shall remain through the duration of the Project;

B. Temporary closures of the Bridges during the construction of the Project shall be permitted in accordance with the following:

i. One Bridge shall remain open to the public at all times throughout the duration of the Project;

ii. Temporary closure of a single pedestrian Bridge shall be limited to a single duration of no more than 45 consecutive calendar days. Multiple closures of a single Bridge shall not be permitted;

iii. No closure of any pedestrian Bridge shall occur at any time during the months of September, November and/or December.

iv. The closure of the pedestrian Bridge located above the Friedman Mall entrance shall not be permitted to occur at any time during the period of June 30 to July 2 inclusive, of any calendar year.

v. Pedestrian Bridges are required to be re-opened after the closure period and shall remain open to the public for use in perpetuity.

vi. At least 30 calendar days prior to the commencement of the planned closure, Project Co shall provide the City and the property owners with an advance written notice of request for temporary closure;

- vii. Project Co shall be responsible to provide a pedestrian detour and detour signage within the existing buildings to direct pedestrians to alternative routes during the temporary closure period;
 - 1 Project Co's proposed detour plan shall be submitted with the advance temporary closure notice to the City and property owners and shall be approved in writing by the property owners prior to the closure of a bridge;
 - The property owners have agreed not to unreasonably withhold or unduly delay the approval of the detour plan and signage specifications.
 - 2 All signage type, graphics, colours, materials shall be pre-approved by the owners. Project Co is encouraged to obtain the property owners' approval of the signage specifications prior to requesting the closure; and
 - 3 All signage shall be installed no later than 72 hours prior to the commencement of the pedestrian Bridge closure.
- viii. Project Co. shall be responsible for the removal of all temporary signage and shall repair and/or replace in kind any damaged surfaces to pre-closure condition;
 - 1 All signage shall be removed and all necessary repairs of any surfaces damaged by the installation or removal of the detour signage shall be made no later than 24 hours following the end of the pedestrian Bridge closure period.

1.9 Campus Station

- (a) Campus Station is an existing bus transit station along the BRT, which shall be converted to serve as a station along the OLRT. The existing four lanes of Nicholas Street shall remain in their current condition.
- (b) Campus Station is located immediately adjacent to the Rideau Canal (a UNESCO World Heritage Site) and an integral component of the University of Ottawa, and final Design of this Station shall be coordinated with the University of Ottawa.
- (c) The new Station shall be integrated with the existing underground pedestrian tunnel that connects the University of Ottawa to Colonel By Drive and the Rideau Canal, the Sandy Hill neighbourhood, and the Golden Triangle neighbourhood via the Corktown Footbridge. The existing ramp, stairs and plaza adjacent to the existing station shall be demolished and replaced as part of Project. Project Co's east plaza design shall include safe and efficient cycling and pedestrian connections to the Station from the existing

- pedestrian tunnel. A large multi-media display (funded by the City artwork program) shall overlook the east plaza and shall be included in this Project.
- (d) The Station Structure shall be constructed entirely within the right of way identified in other parts of this agreement.
- (i) The northwestern limits of the Station Platform shall be located no closer than 12.5m from the southwest corner of Vanier Hall when measured along the Alignment.
- (ii) The southeastern limit of the Platform shall be located so that the future Platform extension does not reduce the available pedestrian sidewalk between Marion Hall and components of the LRT and LRT Station to less than 6m.
- (iii) The Station shall be served by two entrances:
- A. One entrance location shall be located in the pedestrian plaza formed by Vanier Hall and Careg Hall at Platform level
- B. One entrance shall be located below grade accessed from the existing pedestrian connector level.
- (e) Project Co shall be required to make modifications to the entrance stairs and railings of Vanier Hall and Marion Hall to ensure sufficient public circulation capacity between the new Station, LRT Alignment right of way and the afore mentioned buildings as follows:
- (i) Clear dimension required between the LRT barrier and Vanier Hall shall be no less than 4.0 m clear as indicated on the Reference Drawings; and
- (ii) Clear dimension required between the LRT barrier and Marion Hall shall be no less than 4.0 m clear as indicated on the Reference Drawings.
- (f) Project Co shall be responsible for all internal or external modifications of the existing buildings necessary to maintain the required egress requirements of the existing buildings and new Station.
- (i) The architectural design solution of the entrance modifications shall not diminish the importance of the entrances functioning as main building entries.
- (ii) The reconfiguration and reconstruction of the entries shall be respective and complimentary to the existing building architecture.

1.10 Lees Station

- (a) Lees Station is situated along the BRT between Highway 417 and the Lees Avenue overpasses and is to be converted to an LRT Station.

- (b) Land in the vicinity of Lees Station is contaminated with Coal Tar and there exists a ground water treatment plant on site to treat the contaminated leachate. Any new civil or other works that would involve disturbing the surrounding soil shall be minimized.
- (c) The Station Structure shall be constructed entirely within the Lands identified in other parts of this agreement.
 - (i) The eastern and western limits of the Platform shall accommodate the reuse of existing Infrastructure for the new Station and to protect for future Platform expansion to the northwest along the LRT Alignment.
- (d) The Station shall be served by one entrance located on the south side of the existing BRT.

1.11 Hurdman Station

- (a) Hurdman is an existing bus transit station along the BRT. A new elevated LRT Station shall be constructed to the north of the existing Station to allow BRT operation to continue throughout the duration of the Construction Activities.
- (b) The BRT Transfer Station shall be re-designed to ensure it supports the City operational and lay-by requirements. Hurdman Station shall serve as a major transit transfer point with the new Train Station along the OLRT while continuing to serve as a bus station for the South-East BRT.
- (c) Hurdman Station is a Federally Mandated Station.
- (d) Hurdman Station shall facilitate pedestrian connections between the termination of the BRT and local buses and the LRT Station. The BRT and local buses shall have a combined Platform on the south side of the LRT Station. Sufficient space shall be allocated at Hurdman Station for circulation, bus drop-off and lay-by areas.
- (e) The Station will connect to existing pathways adjacent to the Rideau River and Riverside Drive
 - (i) The Station, Station structure, bus transfer area, and Guideway structure shall be located to provide for access to the properties north of the Station as required in Schedule 15-2 Part 1.
- (f) The Station shall have two entrance locations at the bus platform level.
- (g) The Station shall be designed as to permit Passengers to transfer between the BRT and LRT without passing through fare control barriers and revalidating fare payment.
- (h) An unpaid pedestrian connection shall be provided from the south side of the Station to the north side of the Station through the Station concourse

1.12 Train Station

- (a) Train is an existing bus transit station along the BRT and a new Station shall be built to the west of the current Station; outside of the traffic 'D'.
- (b) Train Station is a Federally Mandated Station.
- (c) The Design of Train Station shall be coordinated with VIA to ensure connections to the existing VIA station are as efficient as possible and do not preclude future expansion to the VIA station or lands surrounding the VIA station.
 - (i) Project Co shall provide a knockout panel at Platform level to accommodate a future underground connection to the VIA rail station and future development. Final location of the knockout panel shall be coordinated with the City and VIA during final Design.
- (d) The Project includes a pedestrian Bridge spanning the 417 to provide enhanced access to the Station. Refer to Schedule 40 – Highway Work for requirements of this Bridge.

1.13 St. Laurent Station

- (a) St. Laurent station is an existing bus transit station along the BRT that is currently located within the existing St. Laurent Shopping Centre. The Station shall be converted to serve as an OLRT Station while maintaining its use as a bus station at the upper level. The lowest level of the existing station shall be converted from a BRT corridor and Station to serve as an LRT Station and Platform.
- (b) Project Co shall be responsible for any work that the LRT conversion requires to meet all applicable codes.
- (c) The Station shall facilitate the movement of Passengers between local buses, LRT, and adjacent commercial development. Passengers arrive from the local buses or commercial development and descend to the Platform level for the OLRT.
- (d) The existing pathway connection from the southwest under Highway 417 shall be maintained, providing access to the Platform. Barriers shall be provided along this connection to prevent pedestrians from accessing track level.
- (e) Station systems shall be integrated where necessary to the existing facility.
- (f) A private owner is currently planning a grade separated pedestrian connection overtop Highway 417. Project Co shall co-ordinate with the City to ensure access to the site and an efficient pedestrian connection to the upper floor of the Station.
- (g) The Station shall be served by existing entrance locations on the mezzanine level and bus transfer levels.

- (i) Station Platform shall be located in the east west direction to utilize existing vertical circulation elements and satisfy the trackwork requirements of this Schedule 15 - Output Specifications.

1.14 Cyrville Station

- (a) Cyrville Station is an existing bus transit station along the BRT at Cyrville Road, directly northeast of Highway 417, and shall be converted to an OLRT Station.
- (b) Protection for future pedestrian connections to and from the “Place des Gouverneurs” located northeast, and Queensway Corporate Complex located northwest of the Station shall be protected.
- (c) One entrance from Cyrville Road shall be provided, however, the Station design shall protect for a future additional entrance such that entrances can be located on both sides of Cyrville Road in the future.
- (d) The Station Platform shall be located in the east-west direction to allow for future entrance locations on both sides of Cyrville Road while maintaining trackway Design criteria and minimizing the impact of future construction on the operation of the Station.

1.15 Blair Station

- (a) Blair Station is an existing bus transit station along the BRT that will be converted to serve as the new eastern terminus of the LRT and hence requires the Construction of an extensive BRT Transfer area to the north of the LRT Station.
- (b) Project Co shall work with the City to ensure the new BRT transfer area layout and Design supports the City’s bus operations and provides sufficient lay-up area.
- (c) The new Station Design shall not prohibit the current pedestrian connections between the LRT, the BRT, the commercial lands to the north and the Ottawa Road 174 pedestrian overpass. The new Platform shall be accessible from both the bus level below and from the existing pedestrian walkway above.
- (d) The new station design must maintain a non-fare paid connection at the existing upper level to maintain public access between the commercial lands to the north and the development parcels to the south of Ottawa Road 417 via the existing pedestrian overpass.
- (e) The Station shall be designed as to permit Passengers to transfer between the BRT and LRT without passing through fare control barriers and/ or revalidating fare payment. The eastern most edge of the Platform shall be located to provide the following:
 - (i) Access to the existing vertical circulation cores;
 - (ii) Protection for the Platform extension to the east;

- (iii) Allow for Construction of a TPSS between the rails east of the Platform extension; and
- (f) The Station shall be served by two entrance locations at the bus platform level and one vertical connection direct to the Platform from the existing overhead pedestrian connector.
- (g) The bus transfer platform and Structures shall be located within the Lands.

1.16 Design Principles and Guidelines

- (a) Accessibility
 - (i) Project Co shall ensure all Stations and all public spaces are designed to be universally accessible including satisfying the requirements of Transport Canada, Canadian Transportation Agency Code of Practice - Terminal Accessibility, AODA and applicable City Guidelines and CSA Standards, including but not limited to CAN/CSA B651. The application of Design guidelines and criteria, standards and practices shall accommodate the needs of persons with physical, sensory, and mental disabilities.
 - (ii) Accessible interior routes need to be connected to accessible entrances and accessible exterior routes.
- (b) Crime Prevention Through Environment Design (CPTED)
 - (i) Project Co shall Design all Station-related public accessible areas (Platforms, entrances and passageways, sidewalks, parking areas, bus Platforms) using CPTED principles. An independently contracted CPTED review and report of the Project design shall be provided to the City by Project Co as part of each design submittal.

ARTICLE 2 ARCHITECTURAL DESIGN CRITERIA

2.1 Introduction

- (a) This Article presents the specific criteria that are necessary for Project Co to carry out the final Design and Construction of the components and elements of LRT Stations and other building-type Structures on the OLRT.
- (b) Project Co. shall design and construct buildings in accordance with the all applicable codes and standards.
- (c) Code Analysis
 - (i) Project Co shall perform a code analysis with respect to the OBC and NFPA 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems*. The code analysis for each Station shall address the following minimum requirements:
 - A. Building Size, Use and Occupancy;
 - i. Building area and number of storeys;
 - ii. Mezzanines; and
 - iii. Description of Stations as either open or enclosed;
 - B. Structural Design:
 - i. Including where the existing BRT retaining walls that form part of a Station;
 - C. Occupant load;
 - D. Construction requirements;
 - E. Interconnected floor spaces;
 - F. Spatial separation;
 - G. Fire department access;
 - H. Fire separations and compartmentalization;
 - I. Egress and exiting;
 - J. Fire protection systems, Emergency power and communication systems;
 - K. Emergency Ventilation;
 - L. Washrooms;

- M. Barrier Free Design; and
- N. Alternative Solutions:
 - i. Description of performance; and
 - ii. Proposed method of compliance.

2.2 Elements of Continuity and Variability:

- (a) The design of each Station shall be unique while utilizing a common vocabulary of elements and features that unifies and identifies the systems as a whole maintaining an equal quality of design.
- (b) Station Design elements are divided into two classifications: Elements of Continuity and Elements of Variability. Elements of Continuity are standard Designs established for the purpose of System-wide Station identity, functional consistency, and a reduction in capital, operations, and maintenance costs. They shall include System-wide components such as signage, elevators, and escalators; systems Equipment; ancillary facilities. Elements of Variability are not required to be consistent between stations. Where required in this Schedule 15 - Output Specifications, Project Co shall provide Station elements as listed in the following table.

Table 5-2.1

Station Elements of Continuity (C)/Variability (V)	
Element	C or V
Information devices, all signs/graphics, including accessibility signs/graphics	C
• Station markers	C
• System and Station vicinity/maps	C
• Bus information	C
• Directional signage and graphics	C
• Identification	C
• Regulatory	C
• Variable message signs	C
Vertical circulation	
• Stairs	C
• Escalators	C
• Escalator cladding, lighting, and detailing	C

• Elevators	C
• Elevator enclosure Design and detailing	C
• Elevator cab Design and detailing	C
Communications	
• Public address speakers	C
• Public address systems for hearing impaired	C
• Emergency telephones	C
• Patron assistance telephones	C
• Patron assistance for hearing impaired	C
• Maintenance telephones	C
Station control and security	
• Intrusion alarms	C
• CCTV Equipment	C
Fare collection Equipment (Provide infrastructure and coordination only)	
• Ticket vending machines	C
• Fare Barriers	C
• Fare collection machines	C
• Emergency exit gates	C
• Accessible gates (for the disabled)	C
Site development plazas	
• Paving	V
• Streets, curbs, and gutters	C
• Walkways	V
• Retaining walls	V
• Bollards, bumpers	V
• Handrails/railings	V
• Landscaping	V
• Fences	C
• Benches	C
• Bus stop shelters	V

• Trash receptacles	C
• Planters	V
• Lighting (lamp)	C
• Lighting (fixture)	V
• Bicycle racks	C
• Bus bays	V
Station Elements	
• Roof form (Design)	V
• Platform seating	C
• Trash receptacles	C
• Public address speaker housing	V
• Doors, gates, and hardware	C
• Floor material	V
• Wall and ceiling finishes public areas	V
• Hose bibs	C
• Lighting (lamp)	C
• Lighting (fixture)	V
• Security gates at Station entrances	V
• Acoustical materials and details	V
• Concourse configuration	V
• Smoke and exhaust enclosure	V
• Handrails—public areas	C
• Guardrails—public areas	C
• Railings/handrails—emergency exits	C
• Linear Platform edge detail and material	C
• Stairway details and materials	V
• Electrical outlets	C
• Platform service gates	C
• Fire hose cabinet	C
• Emergency telephone	C

Ancillary rooms	
• Incoming power room	V
• Train control/communication room	V
• Substations	V
• Auxiliary electrical rooms	V
• Miscellaneous auxiliary rooms	V
• Toilet room—fixtures, accessories materials	V
• Custodial rooms	V
• Staff room	C
• Fan rooms	V
• Storage rooms	V
• Utility boxes	V
• Doors and hardware	V
• Elevator Machine Room	C
• Mechanical grates, louvers, and grilles	V
Artwork	V
<i>C = Elements of continuity</i>	
<i>V = Elements of variability</i>	

2.3 Station Sizing and Capacity

(a) General:

- (i) Project Co shall provide Station Designs sized to accommodate the anticipated Passenger volumes as outlined in Part 1 Article 2 – Operational Performance Requirements of this Schedule 15 - Output Specifications for Operating Scenario 2 with the exception of Tunney’s Pasture which shall be designed for Operating Scenario 1 with the Station functioning as a terminal Station and the Underground Stations which shall be designed to accommodate the Passenger carrying capacities of 24,000 pphpd as outlined in Schedule 15-2 Part 1 Clause 2.5 (c).
- (ii) Project Co shall provide bus transfer stations and platforms satisfying the bus transfer operations.
- (iii) Stations, Platforms and circulation elements both horizontal and vertical shall be sized to meet the following minimum requirements:

- A. Minimum emergency egress requirements shall satisfy the requirements of both the OBC and NFPA 130.
 - i. Where requirements conflict, the most restrictive requirement shall apply.
- B. A Platform clearance time of no more than 0.8 times the shortest Headway anticipated under normal operations for the ultimate Design capacity.
 - i. For centre Platform Stations, two Trains arriving at the same time shall be considered as the base case for modeling purposes.
 - ii. For side Platform Stations with a shared mezzanine level, two Trains arriving at the same time shall be considered as the base case for modeling purposes.

(b) Level of service:

- (i) The following levels of service indicated below shall be provided in the Design of public spaces as referenced in other parts of this article:

Location	Level of Service (LOS)	Measure
Platforms (Normal)*	C	0.8m ² per person
Platforms (Emergency)*	D	0.4m ² per person
Waiting Areas	C	0.8m ² per person
Passageways – 1 way	D	50 ppm per metre
Passageways – 2 way	C	40 ppm per metre
Stairways – 1 way	E	55 ppm per metre
Stairways – 2 way	D	35 ppm per metre

**Note: Normal Platform refers to the level of service during the daily peak 15 minutes. Emergency Platform refers to the level of service provided during an Emergency in which an incoming fully loaded Train must evacuate onto a Platform with waiting Passengers at the daily peak 15 minutes.*

- (c) As an integral part of the Design, Project Co shall utilize Passenger modeling software to develop and verify the Design of all aspects of the Station circulation including but not limited to the interior circulation, vertical circulation, site circulation and bus platform operations based upon the Operating Scenarios identified in this Article.
 - (i) The software utilized by Project Co shall be a proven and widely used product in the Design and analysis of rapid transit and intermodal transit facilities.
 - (ii) Project Co shall provide modeling simulations for each Underground Station utilizing interpolated Passenger data reflecting the Passenger carrying capacities of 24,000 phpd as outlined in Schedule 15-2 Part 1 Clause 2.5 (c).

- (iii) The Design of the Station facilities shall be adjusted based upon the results of the simulation.
- (iv) The Passenger simulation analysis shall be submitted in accordance with Schedule 10 – Review Procedure.
- (d) Surge spaces, queuing and runoff
 - (i) Project Co shall be responsible for determining the amount of queuing space required at each element within the Design to meet the level of service required in each area. The calculated requirements shall be equal to or greater than the requirements below for the following items;
 - A. Runoff provided at the top and bottom of escalators shall be a minimum of 5000mm.
 - B. Surge space provided at the top and bottom of public stairs shall be a minimum of 5000mm
 - C. Runoff provided space in front of an elevator shall be a minimum of 3000mm
 - D. Queuing distance provided at fare barriers, entry and exit sides shall be a minimum of 5000mm.
 - E. Queuing space provided at a ticket vending machine or automatic teller shall be a minimum 3000mm when facing a wall or obstruction.
 - F. Queuing space provided at a ticket vending machine of automatic teller shall be a minimum 2000mm when adjoining another queue space.
 - G. Where two or more elements listed above converge, the surge or runoff spaces shall be cumulative.
- (e) Platform Sizing:
 - (i) Length
 - A. The minimum finished Platform length shall be as indicated in this article
All At Grade Stations are to be implemented to allow an eventual full build out to accommodate the Passenger carrying capacities of 24,000 pphpd as outlined in Schedule 15-2 Part 1 Clause 2.5 (c).
 - i. During the initial build, Project Co shall construct and finish all Underground Station Platforms to a usable length of not less than 120m.
 - (ii) Width

- A. Platform width shall be calculated in accordance with the requirements of the OBC, NFPA, Passenger data and the Level of Service for the Platform space as required in this article.
- B. The final width of the Platform shall be the greater of the following: the minimum required by OBC; the minimum required by NFPA 130; or the minimum width to satisfy the LOS requirements
- i. Calculation of Platform width shall be based upon this Part and Part 1 Article 2 – Operational Performance Requirements and operational Headways as determined by Project Co.
 - ii. Platform width minimums for Stations shall be as follows:
 - 1 Width of Station Platforms shall be sufficient to satisfy the greater of the following:
 - The calculated width for Operational Scenario 1;
 - The calculated width for Operational Scenario 2; and
 - The calculated width for Passenger carrying capacities of 24,000 pphpd. Project Co shall extrapolate the provided Passenger forecast data by 1% per year at each Station until the Passenger carrying capacities of 24,000 pphpd, as outlined in Schedule 15-2 Part 1 Clause 2.5 (c), are satisfied.
 - 2 Both platforms in a side Platform configuration shall be equal in size based upon the greater of the calculated required width per direction.
 - iii. For centre loading configuration, shelters, equipment and amenities are to be placed in the centre portion of the Platform to maximize the clear Platform area for circulation.
 - iv. For side loading Platform configurations, shelters, Equipment and amenities are to be placed adjacent to the side walls to maximize the clear Platform area for circulation.
 - v. Where fixed objects, excluding vertical circulation elements and Passenger convenience items, restrict the Platform width below the calculated minimum, the following shall apply:
 - 1 The total length of the reduced Platform shall not exceed 20% of the total length of the Platform; and

- 2 The length of any one contiguous Platform reduction shall not exceed 10m in length.

2.4 Circulation and Egress

(a) Vertical Circulation

(i) Elevators:

- A. Except where noted in this section, each Station Platform, concourse, and entrance shall be serviced by redundant elevators.
 - i. To satisfy the redundancy requirements, elevators shall be located no more than 50m apart.
 - ii. An alternative accessible means of vertical transportation, such as a ramp, shall be permitted, provided the alternative means is within 50m.
- B. A minimum of one elevator serving each Platform, and all levels of the Station, shall be sized to allow for an ambulance stretcher and patrons with bicycles. The other elevator shall provide redundancy for accessibility purposes.
- C. The following Station specific requirements shall apply:
 - i. Train Station shall, at a minimum, have one elevator per Platform to grade with protection for an additional future elevator to grade serving each Platform. Project Co shall comply with the following to provide protection for the future installation of elevators:
 1. Planning and design of station shall indicate the location of the future elevator;
 2. Relocation of building systems or LRT systems for future installation elevator shall not be required;
 3. Design and construction of electrical and mechanical services shall protect for future loads in the initial design; and
 4. Design and construction of structural systems shall protect for future loads in the initial Design;
 - ii. Downtown East shall have elevators serving each Platform to the concourse level within the fare paid zone; and elevators serving concourse level to each at grade Station entrance location.

1. Elevators serving concourse level to an at grade Station entrance at a centralized location in conjunction with two at grade Station entrances served only by stairs and escalators, may be substituted for the above concourse to grade requirements; and
 - iii. Blair Station shall have elevators serving each level of the Station within the fare paid zone, and elevators serving the pedestrian over pass to grade level outside of the fare paid zone on the northern side of the bus transfer area.
- D. All elevators shall meet the following general requirements:
- i. Conform to all applicable Acts and codes, including the CAN/CSA B44 Safety Code for Elevators and Escalators (latest edition including Appendix E), OBC, NFPA, NBC, AODA, CSA Accessible Design for the Built Environment CAN/CSA B651-04, and City of Ottawa Accessibility Standards;
 - ii. Be of heavy duty components and construction designed specifically for transportation system usage;
 - iii. Traction elevators shall be provided where they serve more than 14m of travel; and
 - iv. No running time, cycle counters or trip counters that would cause the elevators to shut down or alter its operation in any way shall be provided.
- E. In addition all new elevators shall have the following:
- i. The elevator car walls and hoistway walls shall be constructed utilizing glass. Both elevator cab and hoist way enclosure shall be constructed of glass to the maximum extent possible in all Stations.
 1. At a minimum, 50% of the total elevator cab and hoist way's vertical enclosure surface area shall be constructed of glass;
 2. Glass surfaces of the elevator and elevator hoist way shall be aligned.
 - ii. CCTV camera coverage shall be provided within the cab and at each landing;
 - iii. Access locations to elevators shall be weather protected so as to minimize the infiltration of precipitation into the elevator shafts and or cabs;

- iv. Elevator cab flooring shall be aluminum, rubber, or other durable, non-absorbent material with a non-slip surface with coefficient of friction of not less than 0.60;
- v. Elevators shall accommodate a minimum capacity of 1180kg, or the heaviest piece of Equipment to be transported between levels for maintenance, whichever is greater;
- vi. The minimum inside cab dimensions shall be 1370mm wide x 2032mm deep with 915mm wide x 2135mm high doors or to accommodate the largest unit of maintenance Equipment that must be transported between the levels served, whichever is greater;
- vii. Minimum car operating speeds shall be 0.5m per second for elevators with a travel distance of less than 20m and 1.0m per second for elevators with a travel distance of more than 20m;
- viii. Elevator machine rooms shall be located as near as possible to hoist ways, but clear of public walking and landing areas, and shall be acoustically treated to minimize noise levels;
- ix. Oil heaters shall be installed in the hydraulic elevator storage tank if the elevator is not in a heated area;
- x. Elevators shall be equipped with a self-recharging battery pack which will maintain lighting, return the elevator to level of fire department access, open the doors, and render the elevator inoperative in the event of a power failure;
- xi. All elevator keying shall match the keying of the existing elevators within the OLRT System;
- xii. Shall be equipped with a hands-free telephone connected with TSCC;
- xiii. Graffiti-resistant finish material in the cab interior shall be provided;
- xiv. Lighting in elevator cabs shall be designed using fluorescent or LED fixtures. Lighting shall be covered with a protective transparent shield to prevent vandalism;
- xv. The operating status of the elevator shall be monitored by the BMS system and the TSCC;
- xvi. Elevators shall be able to be controlled at the Station only;

- xvii. Elevators intended for use in moving Equipment to and from locations within the facility shall be sized to accommodate the intended Equipment
- xviii. Elevator pit walls shall be lined with a non-porous material and shall be drained; and
- xix. Existing elevators shall be reused and refurbished to meet at a minimum the following:
 - 1. Existing cab doors shall be replaced with full glass doors;
 - 2. Existing control Equipment shall be upgraded if required to be compatible with the BMS and TSCC monitoring requirements;
 - 3. Project Co shall be responsible to make all upgrades to existing elevators in order to obtain certification of the Equipment.

(ii) Escalators

- A. Escalators shall meet the following requirements:
 - i. Conform to all applicable codes and acts including the CAN/CSA B44 Safety Code for Elevators and Escalators (latest edition), OBC, NFPA, NBC, AODA, CSA Accessible Design for the Built Environment CAN/CSA B651-04, and City of Ottawa Accessibility Standards;
 - ii. Shall be of heavy duty components and construction and shall meet or exceed the requirements for the “Heavy Duty Transportation System Escalator Design Guidelines,” published by the APTA; and
 - iii. No running time, cycle counters or trip counters that would cause the escalators to shut down or alter its operation in any way shall be provided.
- B. Where protection for future escalators are indicated, Project Co shall comply with the following:
 - i. Planning and design of station shall indicate the location of the future escalator;
 - ii. Relocation of building systems or LRT systems for future installation elevator shall not be required;

- iii. Design and construction of electrical and mechanical services shall make protection for future loads in the initial design; and
 - iv. Design and construction of structural systems shall make protection for future loads in the initial design;
- C. In addition, the escalators shall meet the following requirements:
- i. Shall have a minimum step width of 1000mm;
 - ii. The running headroom shall not be less than 2200mm;
 - iii. All escalators shall have reversing capabilities. A keying device shall be required to change direction;
 - iv. Shall be capable of operating with a full load at a speed of 0.5m per second in both directions;
 - v. Shall be designed for continuous operation, 24 hours a day, 365 days a year;
 - vi. Provide escalators capable of operating with full specified performance capability while exposed to the following climatic and environmental conditions:
 - 1. Exposed exterior installations: Design escalators to operate while exposed to natural elements of weather, including sunlight, rain, slush, snow and ice, all conditions of relative humidity while exposed to road salt, airborne dust and debris; and in dry bulb temperature -40°C to 40°C;
 - vii. Step chain rollers shall be mounted outside the chain link;
 - viii. Escalator shall have 3 flat steps at the top and bottom landings;
 - ix. Escalators shall have brushes along the skirt panels;
 - x. The sides and bottom of the escalators shall be clad in stainless steel where exposed;
 - xi. Escalators forming part of the required egress route shall be capable of being interlocked with the fire alarm system and shut down in the event of an alarm;
 - xii. Escalators shall have a high deck with angled stainless steel balustrades;

- xiii. Escalator status to be monitored by the BAS in the Station and at the TSCC;
 - xiv. Escalators shall be able to be controlled only at the escalator in the Station; and
 - xv. Escalators shall have provisions for being operated from the TSCC.
- D. Project Co shall determine the final quantity of escalators as determined by the outcome of the Passenger modeling results. At a minimum, Project Co shall provide escalators in the following quantities:
- i. Tunney's Pasture –one (1) escalator serving each Platform;
 - ii. Bayview Station –one (1) escalator serving each Platform;
 - iii. Lebreton Station –two (2) escalators serving each Platform, with provisions for the installation of two (2) additional escalators per Platform;
 - iv. Downtown West Station – two (2) escalators serving each Platform and one (1) escalator serving each entrance location;
 - v. Downtown East –two (2) escalators serving each Platform and one (1) escalator serving each entrance location;
 - vi. Rideau Station – two (2) escalators serving each entry, two (2) escalators serving each level of the Station, two (2) escalators serving each Platform;
 - 1 Project Co shall determine the number of escalators required based upon the proposed design. Escalator quantities shall be based upon Station configuration, Level of Service requirements and in conformance with this and other parts.
 - vii. Campus Station – None required;
 - viii. Lees Station – None required;
 - ix. Hurdman Station – Two (2) escalators serving the Platform level;
 - x. Train Station – None required, protection for one (1) future escalator at each platform;
 - xi. St. Laurent Station – Existing escalators shall remain and be refurbished or replaced with new;

- xii. Cyrville Station – None required; and
- xiii. Blair Station – One (1) escalator serving the Platform level.

(b) Stairs and ramps

(i) Stairs

- A. New stairs shall be constructed of precast or cast in place concrete with precast concrete treads with cast in nosings. Tactile warning strips shall be provided at landing areas.
- B. Sizing shall be per code minimum requirements and per level of service requirements as noted in other parts of this article.
- C. In addition to ensuring that the applicable code requirements are met, the following criteria shall be incorporated into the interior and exterior stairway Design.
 - i. Open risers shall not be permitted;
 - ii. Continuous railings shall be provided on both sides of the stairs;
 - iii. Stairs adjacent to an escalator shall be parallel to the angle of inclination of the escalator and sized to have landings at a common level; and
 - iv. The Design of exterior stairway landing levels shall include a grated drainable catchment basin to trap grit, water and snow.
 - v. All public stairs, interior and exterior, shall include a bicycle wheel trough on one side of each flight of stairs.
 - 1 For new construction, the bicycle trough shall be integral with the stair construction.
 - 2 For existing stair construction, the trough is permitted to be surface applied, provided the trough, fasteners and accessories to do not reduce the required egress width.
 - 3 All bicycle wheel troughs shall include textured, non-slip surfaces to provide traction for bicycle wheels.

(ii) Railings

- A. Guardrails where required by code shall be provided as follows:

- i. The Design and Construction of guardrails for all Stations shall be consistent;
- ii. The design of all guardrails shall meet the intent of the details provided in the Federally Mandated Station drawings. The use of other frameless and partially framed glass railing systems shall be acceptable;
- iii. All handrails associated with public stairs shall be stainless steel pipe sections which are supported by cast aluminum or stainless steel bracket supported from wall or guard rail system;
- iv. Railings and Platform gates shall be provided at the Platform ends, if otherwise unprotected, and shall be set back a minimum of 300mm from the edge of the Platform; and
- v. Vertical railing supports are to be welded flush to preinstalled embedded anchor plates.

(iii) Ramps:

- A. All interior and exterior ramps shall be designed and constructed to be universally accessible, including satisfying the requirements of OBC, AODA and applicable City Guidelines and CSA Standards, including but not limited to CAN/CSA B651.

(c) Corridors and Passageways:

(i) Public

- A. The width of public passageways shall:
 - i. Meet or exceed exiting requirements set forth in the OBC and NFPA;
 - ii. Shall be a minimum of 4000mm; and
 - iii. Shall be sized in order to satisfy the level of service indicated in other parts of this article.
- B. Corridors and passageways shall have a minimum clear height of 3500mm, excluding space required for mechanical and electric services. Soffits, not exceeding 2000mm in width when measured perpendicular to the passageway, shall be permitted provided a minimum clear height of 2800mm is provided at the soffit location and soffits are separated by a distance no less than 10000mm.
- C. All public corridors and passageways shall have full CCTV coverage.

- (ii) Non Public
 - A. The minimal acceptable width of passageways for non-public use shall be the greater of the following: code calculated minimum, 1200mm, or sized as required to move Equipment for maintenance.
- (iii) Public- Use Pedways (Overpass / Underpass)
 - A. The absolute minimum width shall be 5000mm, unless existing to remain.
 - B. The minimum clear height shall not be less than 3000mm, unless existing to remain.
- (d) All escalators, stairs and escalator/stair groups shall have CCTV coverage from escalator/stair landing to escalator/stair landing.
- (e) Emergency Egress:
 - (i) Egress to Track level from the Platform along the length of the Platform for purposes of satisfying code exiting requirements is prohibited.
 - (ii) Where required, exit off of the end of the Platform into the Guideway area is acceptable for At Grade Stations in accordance with the following:
 - A. Doors/ gates protecting the end of the Platform shall be sized appropriately to satisfy code requirements.
 - B. Doors/ gates at Platform ends shall be equipped with panic device hardware.
 - C. The position of doors/ gates shall be monitored at the TSCC. Unauthorized opening of the gate shall sound an audible signal in the Station and notify the TSCC.
 - D. Beyond the Platform end, the egress path shall be segregated from Track level with a fence or railing system to prevent public access to the tracks and or crossing the tracks.
 - i. Railing system shall be designed to meet the OBC requirements for a guardrail including but not limited to structural capacity and balustrade spacing.
 - E. The path of travel shall lead to a public way.
 - F. Crossing of the Tracks to access the public way is strictly prohibited
- (f) Station entrances:

- (i) Entrances to Stations for use by the public shall be equipped with doors, rolling grilles or ornamental gates or other means to secure the Stations buildings during hours of non-operation.
- (g) Wayfinding
 - (i) Provide tactile floor wayfinding throughout all Stations to OBC and CAN/CSA B651-04: Accessible Design for the Built Environment.

2.5 Functional Requirements

- (a) Stations shall meet the functional requirements as indicated in the following table:

Ottawa Light Rail Transit Project

Table 5-2.2 – Functional Requirements

Functional Requirement	Station Name												
	Tunney's Pasture	Bayview	Le Breton	Downtown West	Downtown East	Rideau	Campus	Lees	Hurdman	Train	St. Laurent	Cyrville	Blair
Platform Length (m) (*11)													
Finished Platform Length (m) (*11)													
Platform Roof Coverage (m) (*11)				n/a	n/a	n/a					n/a		
Number of Entrances	2	2	3	2	2	3	2	1	2	1	7	2	4
# of Accessible Entrances (*1)	2	2	3	2	2	3	2	1	2	1	2	2	1
Building Connections To (*4):	0	0	0	1		3	0	0	0	0	1	0	1
Bus Operator Building	-	-	-	-	-	-	-	-	1	-	-	-	1+E
Pedestrian Connection To (*4):	4	2	3	2	3	5	3	1	2		6	3	4
Number of PPUDO Spaces (*5)		E	0	0	0	0	0	E	4	0	0,(*7)	E	0,(*7)
Number of Bicycle Racks	Refer to Part 1 Landscaping Article												
Number of Bus Bays (*5)	18	-	-	-	-	-	-	-	11	-	E	-	15
Number of Bus Layby Bays (*5)	-	-	-	-	-	-	-	-	18	-	E	-	20
Bus Supervisor Office	1	-	-	-	-	-	-	-	1	-	-	-	1
Platform Shelter Count (Total) (*3)	2	2	2	0	0	0	2	2	2	2	2	2	1
Platform Shelter Count (Heated)	2	2	2	0	0	0	2	2	2	2	2	1	1
Public Washroom Facilities (*2)	1	-	-	-	-	-	-	-	-	-	-	-	1
Staff Washrooms (Male/ Female) (*9)	1/1	-	-	1/1	1/1	1/1	-	-	1/1	-	E	-	1/1
Notes:													
(*1)	Accessible entries include only those entries which include appropriate door openers and means of accessible station access (elevators, etc.) beyond. For this escalators are not considered accessible. Future connections are not included.												
(*2)	Provide Public Washrooms in accordance with OBC												
(*3)	Platform shelter counts are only inclusive of small, freestanding shelter structures.												
(*4)	See connections listing below.												
(*5)	E indicates existing												
(*6)	There is an indicated "possible location for entry to retail concourse level" at this point. It has been included in this count as a building entry.												
(*7)	Passenger pick up and drop off will occur at the adjacent mall parking lot as it currently functions												
(*8)	Not Used												
(*9)	Separate segregated single occupancy washroom facilities for male and female shall be provided.												
(*10)	Not Used												
(*11)	To be determined by Project Co.												

(b) As indicated in the table above, the Design and Construction of the Stations shall provide sidewalks, pathways, plazas and MUP's in accordance with the design criteria set forth in Schedule 15-2 Part 1 for the following connections:

- (i) Tunney's Pasture Station:
 - A. Provide new MUP north of Scott Street, south of the Station. The new MUP shall connect to the existing MUPs east and west of the Station. New MUP shall terminate at existing MUP both east and west of the Station within the Lands;
 - B. Provide new sidewalks, pathways, bus platform area, PPUDO and entry plaza adjacent to the west bound lane of Scott Street, as required. Width of the sidewalk shall be sufficient to accommodate the waiting, loading and unloading of Passengers. New sidewalk and pathway shall extend from Tunney's Pasture Driveway on the east to the extension of Goldenrod Driveway at the west;
 - C. Provide new sidewalks, pathways and plaza adjacent to the south bound lane of Tunney's Pasture Driveway connecting to the Station entrance. The sidewalk along Tunney's Pasture Driveway shall be continuous from Scott Street to Yarrow Driveway;
 - D. Provide new crosswalks and sidewalks within the limits of the Lands at the intersections of Tunney's Pasture Driveway and Yarrow Driveway; Goldenrod Driveway and Yarrow Driveway; Goldenrod Driveway and the Transitway (west side only); Goldenrod Driveway and Scott Street; and Scott Street and Tunney's Pasture Driveway;
 - E. Provide new sidewalk, bus platforms and PPUDO adjacent to the eastbound lane of Yarrow Driveway. Width of the sidewalk shall be sufficient to accommodate the waiting, loading and unloading of Passengers. Sidewalk shall be continuous from Tunney's Pasture Driveway to the extension of Goldenrod Driveway;
 - F. Provide a new sidewalk adjacent to the south bound lane of Goldenrod Driveway. Sidewalk shall extend from the existing pathway adjacent to Scott Street to the existing sidewalk at the intersection of Yarrow Driveway. Sidewalk shall adjoin the existing pathway and sidewalk within the limits of the Lands;
 - G. Provide sidewalk bounding the bus platform within the fare paid zone north of the Station. Width of the sidewalk within the bus platform area shall be sufficient to accommodate the loading and unloading Passengers as well as circulation and appurtenances; and
 - H. Provide pedestrian pathway, for exit purposes only, from the fare paid zone to Yarrow Driveway at the western end of the Bus platform area.
- (ii) Bayview Station:

- A. Provide sidewalk adjacent to Albert Street serving the PPUDO east of the Station entrance. The sidewalk limits shall extend from the eastern side of the existing bridge on Albert Street for a distance of approximately 150 m to the east. Provide a curb ramp and an access aisle adjacent and parallel to the vehicle pull-up space at the PPUDO;
 - B. Provide a new 4m wide MUP connection from the Station entry at the O-Train platform level to the existing sidewalk on Bayview Road, south of the Tom Brown Arena parking area. Pathway shall adjoin existing sidewalk within the limits of the Lands. Provide a pedestrian pathway connection between Tom Brown Arena and the MUP to provide direct, convenient and barrier-free access between the arena and Bayview Station;
 - C. Provide pathways and plaza north of the Station at the O-Train platform level, designed and constructed to provide connection from the Station to future MUP works to the north (Champagne/O-Train Corridor Pathway), west (Scott Street to Ottawa River Connection) and east (future potential MUP). Required pathways shall extend to the limit as defined by the Lands. Termination of the pathways shall be coordinated with the identified City projects;
 - D. Provide a new 4m wide MUP from south of the Station and east of the O-Train platform level leading to the Station entry at the O-Train level. The new MUP shall extend south of the Station for a distance of approximately 30m beyond Albert Street. The southern termination shall be coordinated with the Champagne/O-Train Corridor Pathway Project and the temporary O-Train station access pathway to the BRT; and
 - E. Provide a transfer connection from the Platform to the O-Train at O-Train platform level within the fare paid zone.
- (iii) Lebreton Station:
- A. Provide pedestrian connections comprising of bus platform area and Station entrance plazas integrated with the Booth Street Bridge sidewalks one to either side of Booth Street. Sidewalk and plaza area shall be sized to allow for the loading and unloading of Passengers as well as circulation;
 - B. Provide a pedestrian pathway connection to and across the Heritage Bridge north the Station from the Station Entry at Platform Level;
 - C. Provide a new 4m wide MUP along the south side of the aqueduct. The new MUP shall be constructed from the Heritage Bridge extending westerly to adjoin the existing pavement at the Broad Street Bridge, and extending easterly approximately 160m to cross the covered portion of the aqueduct and connect to the existing MUP located on the north side of the aqueduct adjacent to Lett Street, within the limits of the Lands;

- D. Provide a new 5m wide MUP at the north side of the aqueduct. The MUP shall be constructed from the Heritage Bridge extending west-northwest to adjoin the existing MUP, new MUP shall extend to the limit of the Lands. Project Co's design and construction shall not preclude for the future extension of the new MUP to the east from the Heritage Bridge; and
 - E. Project Co's design and construction shall include provisions for a future pedestrian pathway and connection from the Station adjacent to the southern edge of the Guideway extending to the east at Platform level to the limits of the Lands.
 - F. Project Co shall allow sufficient space to protect for a future 4 m MUP to be constructed south of the alignment, in the vicinity of the Station including but not limited to providing sufficient buffer space between the OLRT right of way fencing and the Structure supporting the Booth Street Bridge.
- (iv) Downtown West Station:
- A. Provide sidewalks and plaza area to accommodate pedestrian access from street level Station entry within the Place De Ville Podium Building to the public sidewalk on the north side of Queen Street; and
 - B. Provide sidewalks and plaza area to accommodate pedestrian access from street level western Station entry to the public sidewalks on the south side of Albert Street and the west side of Lyon Street.
- (v) Downtown East:
- A. All street level Station entrances shall provide pedestrian access to the public sidewalks on the south side of Queen Street.
- (vi) Rideau Station:
- A. Pedestrian connections to the north and south side of Rideau Street;
 - B. Pedestrian connections to William Street;
 - C. Building connection to the future Rideau Centre development; and
 - D. Future building connections at a location to be determined during final Design.
- (vii) Campus Station:
- A. Provide pedestrian and cycling connections from the Station entry at the below grade passage to the existing pathway to the west at the limit of the Lands;

- B. Provide pathways, stairs, and ramps as required to connect the existing pedestrian underpass to the plaza and Station entry at Platform level;
- C. Provide paving from the Station entry to all adjoining surfaces within the lands in the area bordered by Vanier, Careg and Marion Hall;
- D. Provide pathways and plazas extending from the new pedestrian plaza adjacent to the Station extending to the sidewalk adjacent to the eastbound lane of Laurier Avenue within the Lands; and
- E. Provide a new continuous MUP from the east side of the below grade passage through the new pedestrian plaza to the eastern Station limits, and continuing from the eastern Station limits to Lees Station adjacent to the west bound track of the Guideway.
- F. Provide a four (4) metre wide pedestrian pathway from Campus Station to Laurier Avenue and provide a plaza on the south side of Laurier Avenue in accordance with the requirements of Schedule 15-2 Part 1 .

(viii) Lees Station:

- A. Provide a new continuous 4m wide MUP located at Platform level outside of the fare paid zone adjacent to the west bound track of the Guideway. The MUP width may be reduced in certain locations outside the Station area in accordance with Schedule 15-2 Part 1. The new MUP shall extend from the below grade passage at Campus Station to the west to Hurdman Station to the east across the Rideau River Bridge adjacent to the west bound Track of the Guideway. Southeast of the Station and north of the Rideau River Bridge where the Guideway rises out of the trench, a pathway with a minimum width of 3.0m, shall be provided from the new MUP adjacent to the west bound track of the Guideway to the University of Ottawa Lees Campus parking lot to the north;
 - i. Width of the MUP on the Rideau River Bridge Structure shall be, at a minimum, not less than the existing MUP width of 2.4m and shall be maximized where possible; and
 - ii. MUP on the existing Rideau River Bridge Structure is not required to carry vehicle loads.
- B. Southeast of the Station and north of the Rideau River Bridge, where the Guideway rises out of the trench, a new MUP shall be provided adjacent to the eastbound Track of the Guideway connecting from the Rideau River Bridge to the existing paths adjacent to the west side of the trench and along the north side of the Rideau River. The new MUP shall extend across the Rideau River Bridge to Hurdman Station adjacent to the eastbound Track of the Guideway;

- i. Width of the MUP on the Rideau River Bridge Structure shall be, at a minimum, not less than the existing MUP width of 2.4m and shall be maximized where possible; and
 - ii. MUP on the existing Rideau River Bridge Structure is not required to carry vehicle loads.
 - C. Existing pathway and crossover connections at the north end of the Rideau River Bridge, under the Guideway shall be maintained; and
 - D. Provide new sidewalks and plaza areas as required to access the Station and associated features at the Station entrance level.
- (ix) Hurdman Station:
 - A. Provide two new MUPs as a continuation of the MUPs on the Rideau River Bridge, one from each side of the Rideau River Bridge at grade. Maintain the existing MUP crossover under the Rideau River Bridge adjacent to the bridge abutment and connect the new MUPs to the crossover;
 - B. Provide a new MUP crossover at grade under the OLRT Guideway east of the existing crossover at the Rideau River Bridge;
 - C. Provide new MUP from the new crossover under the OLRT Guideway to the Station entrance on the north side of the OLRT Guideway;
 - D. Provide a new MUP extending from the Station entrance on the north side of the Station to the existing MUP to the east on the north side of the Guideway. The new MUP shall extend to adjoin the existing MUP within the limits of the Lands to the east;
 - E. Provide a new MUP from the Station to the existing MUP to the north. New MUP shall adjoin the existing within the limits of the Lands;
 - F. Provide a new MUP at the new east underpass Structure, connecting the existing MUP south of the Station access road to the MUP adjacent to the west bound Track of the Guideway;
 - G. Provide plaza, pathways and sidewalks connecting the Station entry to the bus Transfer area and PPUDO to the south of the Station;
 - H. Provide a new pedestrian connection linking the areas north and south of the Station outside of the fare paid zone;
 - I. Provide new sidewalks, bus platform areas and all required appurtenances in the fare paid zone adequately sized to support the loading and unloading of Passengers, circulation to and from the Station; and

- J. Provide a new pedestrian pathway connection to the south, east of the Transitway, adjoining the existing pathways extending to the limits of the Lands.

- (x) Train Station:
 - A. Provide MUPs connecting the existing MUP south of Tremblay Road and west of the “D”-shaped driveway to the Coventry Multi-Use Bridge and to the southwest corner of the Tremblay Road/VIA Rail Station driveway intersection, limit of work shall be within the Lands. Coordinate the design and layout of MUP with Work contained in Schedule 40, Highway Work;
 - B. Provide sidewalks and plaza connecting to existing adjoining sidewalks as required to connect the Station entry to the existing pathway network; and
 - C. Provide covered pedestrian pathway connecting the Station to the VIA Rail Station, weather protection does not need to be continuous at the crossing of the driveway leading to the parking lot between VIA Rail and the Station. Limit of pathway shall extend to the limits as described in the Lands.

- (xi) St. Laurent Station:
 - A. Existing building connection to the St. Laurent Station at the intermediate level shall be maintained;
 - B. Five existing pedestrian entries to the Station from the bus platform shall be maintained; and
 - C. Existing pedestrian connection through the tunnel to the south west of the Station shall be maintained and modified to satisfy requirements of the OBC and NFPA 130.

- (xii) Cyrville Station:
 - A. Provide sidewalks and an entry plaza off of Cyrville Road. Sidewalk construction shall extend east and west to adjoin existing construction within the limits of the Lands;
 - B. Project Co’s Design and Construction shall include provisions for future 3m wide MUP connections from the development to the northeast and northwest to provide a continuous pathway connection under the Bridge;
 - C. Project Co’s design and construction shall include provisions for a future continuous MUP to be located adjacent to the Guideway on the west side of the Guideway at Platform level, within the limits of the Lands; and

- D. Project Co's design and construction shall include provisions for a future continuous MUP to be located adjacent to the westbound Track of the Guideway under the Aviation Parkway Bridges.

- (xiii) Blair Station:
 - A. Existing building connection to the covered walkway over the Queensway to the south of the Station shall be maintained;
 - B. Provide a 6m wide pedestrian pathway from the north tower leading to the Gloucester Centre crosswalk within the limits of the Lands;
 - C. Existing pedestrian entry from the north tower to the bus loop shall be maintained;
 - D. Existing main pedestrian entry from the centre tower to the bus loop shall be maintained;
 - E. New pedestrian entry at west of Platform to the bus loop shall be provided;
 - F. Provide a sidewalk bounding the bus platform area adjacent to the Station. Sidewalk shall be continuous from the eastern limits of the bus platform extending to the mall access road to the northwest. Width of the sidewalk within the bus platform area shall be sufficient to accommodate the loading and unloading of Passengers as well as circulation and appurtenances. Sidewalk shall terminate at the existing sidewalk within the limits of the Lands at the west bus access point;
 - G. Provide a sidewalk bounding the bus platform area north of the Station. Sidewalk shall be continuous from the northern bus access point at the mall access road to the east extending to the western bus access point. Width of the sidewalk within the bus platform area shall be sufficient to accommodate the loading and unloading of Passengers as well as circulation and appurtenances. Sidewalk shall terminate at the existing sidewalk within the limits of the Lands at both northern and western bus access points; and
 - H. Provide a pedestrian pathway, including crosswalks, adjacent to the north side of the existing BRT from the eastern limit of the Blair Road Bridge to the sidewalk of the north bus platform area and extend to adjoin the existing to the east within the Lands.

- (c) As indicated in Table 5-2.2, the Design and Construction of the Stations shall provide the following minimum bus bay requirements:
 - (i) Tunney's Pasture Station:
 - A. Eleven (11) bus bays shall be provided within the fare paid zone;

- B. Two (2) bus bays shall be provided on Scott Street; and
- C. Five (5) bus bays shall be provided on Yarrow Street.
- (ii) Hurdman Station:
 - A. Eleven (11) bus bays shall be provided within the fare paid zone.
- (iii) Blair Station:
 - A. Ten (10) bus bays shall be provided within the fare paid zone.
- (iv) All bus bays shall accommodate articulated vehicles.
- (d) Project Co shall provide bus operator buildings as indicated in the above table.
 - (i) New facilities shall be constructed to meet the requirements of the City's standard bus operator building.
 - (ii) Program elements within the facility shall include the following:
 - A. Multiple occupancy male washroom;
 - B. Multiple occupancy female washroom;
 - C. Breakroom with kitchenette and casework;
 - D. Staff work area;
 - E. Maintenance room with slop sink, accessed from the exterior;
 - i. Room shall be 60m², with no side less than 6m
 - ii. Shall be equipped with a personnel door and a 4m wide overhead door
 - F. Building entry and maintenance room shall have electronic access control;
 - G. Mechanical and electrical support rooms;
 - H. New building shall be designed and constructed with materials compatible with the adjacent Station;
 - I. Buildings shall be provided with natural light and windows conforming to City's standard bus operator building requirements; and
 - J. Building shall be equipped with telephone and data services.

- (e) Project Co shall provide public washrooms at terminus Stations, within the Fare Paid area, in accordance with the OBC.
- (f) Refer to the Functional Program included in Appendix A of this Schedule 15 – Output Specifications for a listing of programmatic spaces.
 - (i) The Functional Program represents the anticipated programmatic elements required for each typical Station type based upon the Reference Concept. Mandatory program requirements are contained within the main body of this Schedule 15-2. It is the responsibility of Project Co to determine the minimum Station program requirements to provide a fully functioning system
- (g) Refer to the Room Data Sheets included in Appendix B of this Schedule 15 - Output Specifications for finish materials, environmental requirements, data outlets, etc.

2.6 Project Elements

- (a) Platforms:
 - (i) Platform Height
 - A. The finished level of the Platform at Platform edge shall be level with finished floor height of the vehicle.
 - (ii) Platform Drainage
 - A. The cross slopes of the Platforms shall not exceed 2% with a minimum of 1% toward the Track.
 - B. The longitudinal cross slope of the Platform surface shall not exceed 1.5%.
 - C. The path of travel lanes on the Platform shall comply with all accessibility requirements.
 - (iii) Platform floor finish
 - A. The finished floor material shall have a non-slip surface with a coefficient of friction of at least 0.60.
 - B. A detectable tactile warning strip, comprised of a non-slip, colour contrasting surface shall be placed along the trackside edge of the Platform
 - C. Floor colour and texture shall be different from the flooring in the areas approaching the Platform.
 - D. Lighting fixtures shall be installed at the ceiling, signage band or underside of the roof Structure to provide continuous light on the Platform edge warning strip.

- (iv) Clearances from Platform
 - A. Vertical Clearances above Platform Surface
 - i. Any Station element that could be targeted for theft or vandalism (e.g. light fixtures, speakers, CCTV cameras, etc.) shall be located a minimum of 3050mm above the finished Platform surface. The possible use of benches, waste receptacles etc. by vandals to stand on to reach these elements shall be considered by Project Co in the final Design placement of all items.
- (v) Service Outlets
 - A. Service outlets required for power and water shall be as follows:
 - i. Electrical – provide 15 A/120 V split receptacles at 20m intervals along the Platform area.
 - ii. Water Hose Bibs – at a minimum provide one (1) tamper proof hose bib on each Platform.
- (vi) Service/Maintenance Personnel Access Requirements
 - A. Project Co shall provide access from the Platform to Track level at each end of each of the Station. Access off of the end of the Platform shall be restricted by gate with latch and fencing. Provide access as appropriate to the Guideway.
- (vii) Platform barriers:
 - A. All side Platform configured Stations shall be provided with a continuous barrier fence between Tracks.
 - i. Barrier type shall be as indicated by fence type FE-2 as shown on the Federally Mandated Station Drawings.
 - ii. The barrier shall extend a minimum of 15m beyond the end of the Station Platform at each end of the Station or shall extend to a fixed divider wall in the case of the Underground Stations.
- (viii) The O-Train platform at Bayview Station shall be designed and constructed to satisfy the following minimum requirements:
 - A. Platform length shall be a minimum of 40m;
 - B. Platform width shall be a minimum of 5.0m.
 - C. Platform height shall be 0.5525m (21 ¾”) above top of rail;

- D. Distance of the platform edge to the centreline of the track shall be 1.384 m (54 ½”) and shall be constructed in such a manner to maintain a 12.7 mm (½”) gap. Final distance of Platform edge to centreline of the Track shall be verified with OC Transpo during the final design; and
 - E. Project Co shall confirm final dimensions with the City prior to the commencement of construction.
- (b) Fare collection and control:
- (i) Project Co shall coordinate the future installation of fare collection Equipment with the City.
 - A. Dimensions, locations and coordination of all fare control Equipment shall be developed and coordinated with the City during the detailed Design and shall be included in the Passenger model simulations.
 - (ii) Project Co shall be responsible for the coordination of the installation of fare collection Equipment.
 - (iii) Project Co shall ensure that all building services and feeds are sized appropriately to accommodate the fare collection Equipment.
 - (iv) Project Co’s final Design shall have sufficient space to accommodate fare barriers, including queuing space on the entry and exit side of the barriers for all Stations.
 - A. Project Co shall plan and design the location of equipment as to ensure the year round operation of the fare Equipment.
 - B. All fare collection, vending, and control Equipment shall be located within the station structure.
 - i. If it is not feasible to locate all fare Equipment within in the Station structure, the Equipment shall be fully protected from the elements to ensure year round operation.
 - C. The fare control line shall have full CCTV coverage for inbound and out bound direction.
 - (v) Fare Paid Zone:
 - A. Project Co shall plan, design and construct all Station with segregated fare paid and non-fare paid zones.
 - i. The fare paid zone of the Station and all fare paid transfer areas shall be segregated from non-fare paid zones by continuous 1.8m fencing or barrier.

- ii. Fare paid zones at Tunney’s Pasture, Bayview, Hurdman, and Blair Stations shall be planned and designed to allow bus or train Passengers to transfer to the LRT within the fare paid zone of the station.
- iii. The following additional requirements shall apply for bus Transfer Stations:
 - 1. Fare paid transfer area of Stations shall be designed to prohibit transferring Passengers from crossing bus traffic; and
 - 2. All islands provided within a bus transfer area shall contain a combination of barriers not limited to fencing, landscaping, other physical elements to prevent Passengers from traversing bus traffic to access the LRT Station and bus platforms.
- B. Fare control line for Underground Stations shall be located below grade.
- C. Fare control measures at St. Laurent Station are only required where the existing pathway connection from the southwest under Highway 417 enters the Station Platform area.
- (vi) All fare vending and fare control Equipment located in public spaces shall be recessed within niches where feasible;
 - A. Free standing Equipment shall be permitted provided Project Co provides sufficient queuing and circulation space as well as space required for maintenance and re-stocking activities, without compromising Passenger movement through the Station.
- (vii) Project Co shall provide all conduits, cable ducts and accessories required for the installation of the fare control Equipment.
- (viii) Exposed conduit and cable duct shall be avoided within public spaces to the greatest extent possible.
 - A. If the use of exposed conduit is required in public spaces Project Co shall paint or otherwise treat the conduit to blend in with the surface to which the conduit is attached.
- (c) Weather protection:
 - (i) Project Co shall provide a study of the building envelope with respect to the micro-climatic and geographical location of each Station to determine the extent of the weather protection required.

- (ii) Roof Design features shall include, but are not limited to the following:
 - A. Skylights to allow natural daylight to reach the Platform surface.
 - B. Roof accessibility systems such as hatches and retractable ladders, for cleaning and maintenance if required.
 - C. Fall protection measures that form a permanent part of the roof Structure.
 - D. Heat traced gutters and downspouts for roof drainage tied directly into a Stormwater Management system.
 - E. Snow guards shall be provided on all roofs.
 - i. Project Co shall be responsible for the design of snow guard systems.
 - ii. Particular attention shall be paid to the design and placement of snow guards on areas of roof above Station entrances and areas of roof adjacent to spaces of public circulation or gathering such as sidewalks and bus platforms to ensure the protection of the public from falling snow and ice.

- (iii) Roof requirements:
 - A. Roof structures shall cover all vertical circulation elements (stairs, escalators and elevators) and Fare Control equipment.
 - B. Project Co shall provide roof structures covering the Platform area at all Stations with the exception of the Underground Stations and St. Laurent Station:
 - i. Project Co shall determine the extent of roof coverage required utilizing the Passenger forecast data and the results of the micro climate study for each Station identified in c) i) above;
 - ii. Roof structures shall cover the entire width of the Platform;
 - iii. Project Co shall be responsible to determine the applicability of extending the roof coverage beyond the edge of the Platform based upon the results of the micro-climate study for each Station identified in c)i) above; and
 - iv. Project Co shall determine the appropriate height of the roof structure above the Platform surface based upon the results of the micro-climate study for each Station identified in c)i) above.

- C. Project Co shall be responsible for all interfaces and implications of the Platform roof structure, including but not limited to the following:
 - i. Interface of roof structure with LRT vehicle;
 - ii. Protection of OCS from falling ice and debris;
 - iii. Protection/isolation of any roof structure from stray current;
 - iv. Support of OCS;
 - v. Integration of lighting and signage requirements; and
 - vi. Integration of any other station or systems element.

- (d) Windscreens:
 - (i) Project Co shall provide wind screens to provide Passengers protection from the elements. Windscreens shall be predominately constructed of structurally supported glass walls. The Design of all windscreens shall meet the spirit and intent of the details provided in the Federally Mandated Station drawings. The use of other frameless and partially framed systems shall be acceptable.
 - (ii) At a minimum, windscreens shall be provided at the perimeter edge of the Platform (side Platform) or outside edge of the Guideway (centre Platform).
 - (iii) Project Co shall provide a study of the building envelope with respect to the micro climatic and geographical location of each Station to determine the extent of the windscreen, including: where windscreens are required, extent of windscreen required, and required height of windscreen.

- (e) Taxi Service points:
 - (i) Project Co shall provide signage with local taxi service phone numbers at all taxi service points.
 - (ii) Project Co shall provide pathways to support communication infrastructure to allow for multiple direct phone lines to taxi services, wi-fi and cellular technology, in coordination with the City.

- (f) Designated Waiting Areas:
 - (i) Project Co shall provide one (1) DWA at all individual Station Platforms, including connecting bus platforms.
 - (ii) On LRT Platforms, the DWA shall be located near the centre of the Platform length.

- (iii) DWAs shall be provided with the following features:
 - A. Signage indicating location of DWAs and indicating the amenities available in the DWA, which shall be consistent at all Stations;
 - B. Each DWA shall have fixed CCTV security coverage, PTZ cameras shall not be used for DWA;
 - C. Enhanced lighting level of 220 lux;
 - D. Transit information panels that show scheduled times, maps, and other relevant information shall be included;
 - E. A clock integrated with the Passenger Information Display shall be viewable from the DWA;
 - F. Companion seating;
 - G. Emergency phones at accessible height with handles, braille, and user-friendly directions;
 - H. Emergency cabinet with fire extinguisher;
 - I. Infrastructure to support a pay phone;
 - J. Accessible seating for four including seating with handles and backs;
 - K. Tinted glass or anything that compromises Safety or sightlines shall be prohibited from use in the DWAs;
 - L. Garbage and recycling receptacles shall be provided adjacent to the DWA;
 - M. All DWAs located on Platforms, with the exception of Underground Stations, shall be equipped with timed, Passenger activated heating.
 - N. DWAs on bus platform shelters shall be provided with timed, Passenger activated heating on bus platforms at intermodal bus transfer Stations; and
 - O. Location of DWA shall be indicated on the platform floor surface, Platform markings for all DWAs shall extend to the platform edge.

- (g) Advertising:
 - (i) Provide pathways for all Infrastructure to support advertising in the Stations, including conduits, lighting etc.
 - (ii) Location and type of advertising shall be coordinated with the City.

- (h) Public washroom features shall be provided as follows:

- (i) CCTV coverage of the exterior of the washroom entrance doorway of each washroom shall be provided.
 - (ii) Each public washroom shall provide infant changing facilities.
 - (iii) Toilet partitioning shall be ceiling hung stainless steel panels.
 - (iv) Toilet stall latch shall be surface mounted dead bolt type.
 - (v) Coat hooks shall be installed on the stall door above head level.
 - (vi) Graffiti resistant mirrors shall be provided at each wash basin.
 - (vii) Soap dispensers, toilet tissue dispensers, towel dispensers and disposal units shall be provided.
 - (viii) Wash basins shall be built into a counter or vanity.
 - (ix) Shall be heated and ventilated.
 - (x) All fixtures shall be vandal-proof and be equipped with automatic water controls.
 - (xi) Toilet compartments and cubicles door and partition thickness shall be 25mm; pilaster thickness to be 32mm.
 - A. No system shall contain material capable of supporting growth of bacteria, fungi, mould, etc. or encourage the harbourage of insects or mites. No system shall, to any appreciable degree, develop or shed electrostatic charges.
 - B. All fasteners shall be concealed or tamper proof.
- (i) Staff washrooms shall be provided at Stations as indicated in the functional requirement table above:
- (i) Staff washrooms shall be provided with the following:
 - A. A mirror shall be provided at the wash basin; and
 - B. Soap dispenser, toilet tissue dispensers, towel dispensers and disposal unit shall be provided.
 - (ii) Staff washrooms shall be conditioned and ventilated.
 - (iii) All existing washroom facilities at St. Laurent Station shall remain.
- (j) Project Co shall provide a multipurpose room at Downtown East Station for use by transit security and other staff for Emergency response and operational purposes as follows:

- (i) Shall have a usable floor area of no less than 12m²;
 - (ii) Shall be rectangular with a minimum dimension of 3m;
 - (iii) Shall be provided with a CCTV feed and space for monitoring Equipment for at least one emergency responder to monitor; and
 - (iv) Entrance door to room shall have electronic access control.
- (k) Automatic teller machines:
- (i) Project Co shall provide all required infrastructure to support the installation of automatic teller machines and coordinate their location with the City.
- (l) Emergency phones shall be provided
- (i) Project Co shall provide emergency phones providing direct audio connection to the TSCC as follows.
 - A. Provide one emergency phone at each entrance;
 - B. Provide two (2) emergency phones on each LRT Platform;
 - C. In addition to the emergency phones required on Platforms each DWA shall have an emergency phone;
 - D. Provide a minimum of one emergency phone at each bus platform in addition to the emergency phone at the DWA; and
 - E. Provide emergency phones at new PPUDO;
 - (ii) Provide additional emergency phones as required where identified in the threat and vulnerability study. Emergency phones at outdoor locations shall be identified with a blue marker light.
- (m) Payphones:
- (i) Project Co shall provide provisions for public pay phones in accordance with the following:
 - A. Provide conduit and space for one (1) pay phone at every Platform, and located at every DWA;
 - B. Provide conduit and space for pay phones at new PPDUO's;
 - C. The City will arrange with a Third Party Contractor for payphone installation and maintenance of public payphones; and

- D. All public phones shall meet the requirements of the Ontario Barrier-Free Design and the Accessibility for Ontarians with Disabilities Act.
- (n) Transit information panels:
 - (i) Project Co shall provide at least two transit information panels at every bus and LRT Platform, and one (1) at each DWA per Platform.
- (o) Project Co shall provide clocks displaying time of day, with a minimum of one (1) clock per Platform, including bus platforms at Terminal/Transfer Stations.
- (p) Trash and recycling receptacles:
 - (i) Project Co shall provide trash and recycling receptacles in the following locations and minimum quantities:
 - A. Three (3) on each Platform including one (1) located at the DWA;
 - B. One (1) located on each mezzanine or concourse level of the Station;
 - C. All receptacles provided in public spaces shall be transparent to allow visual identification of their contents; and
 - D. Where provided, all receptacle groups shall be five stream receptacles to separate at source; organics, paper, glass, metal and other refuse.
- (q) Platform seating:
 - (i) Project Co shall provide seating for four (4) on each Platform for each vehicle of the 2031 consist length.
 - (ii) Project Co shall provide seating for four (4) on each Platform for every two bus bays at Terminal/Transfer Stations.
 - (iii) Armrests shall be provided on all benches.
 - (iv) Seating shall be cantilevered from walls to facilitate floor maintenance, where located adjacent to a wall.
 - (v) The location of Platform seating shall not interfere with access to overhead lighting and Equipment.
- (r) Outdoor shelters:
 - (i) Provide one 4m (nominal) bus shelter for each bus bay at Terminal/Transfer, applicable at Tunney's Pasture, and Blair Stations.

- A. Shelters shall be the City standard modular shelter or equivalent as approved by the City.
 - B. Heating shall be required only in shelters utilized as DWAs.
- (s) Bus supervisor's office
- (i) Bus supervisor's office shall be provided at the Transfer Stations as indicated in the functional requirement table. The bus supervisor's office shall have the following requirements:
 - A. Shall be located at bus platform level, within the Station;
 - B. Shall be located adjacent to the bus transfer platform and contain a line of site to monitor bus operations.
 - C. Shall be have a minimum area of 12m² with no side less than 3m;
 - D. Shall be conditioned;
 - E. Shall be accessed from the bus platform area; and
 - F. Shall be equipped with a minimum of two (2) data and two (2) telephone connections.
- (t) Retail spaces
- (i) Shell space or provisions protecting for future retail use shall be provided in the following Stations:
 - A. Tunney's Pasture Station, Rideau Station, Hurdman Station and Blair Station
 - (ii) Protect retail shell spaces or provisions for future retail spaces at Federally Mandated Stations as generally shown in the Federally Mandated Station Design drawings.
 - (iii) Provide a 15m² shell space at Blair Station accessible from inside of the station at the lowest level.
 - (iv) Provide a 15m² shell space at Rideau Station located within the non-fare paid zone.
 - (v) All retail shell spaces shall have electrical and communications services roughed in for the protection of future development.
 - (vi) All retail spaces shall have water and sanitary services roughed in for the protection of future development.

- (vii) At Hurdman Station, where provisions for future retail space have been protected, all utilities referenced in this section shall be accessible from within the identified protected area.
- (viii) Once developed and occupied by a tenant, control of retail spaces and revenue generated from the retail space shall belong to the City.
- (u) Art display cases:
 - (i) Rideau Station:
 - A. Project Co shall provide, at a minimum, 25 lineal metres of fully recessed public art display cases within the non fare paid connector of the Station:
 - i. Cases shall be provided with full view, vandal resistant, transparent glass panels;
 - ii. Cases shall be lockable, tamperproof and fully accessible to authorized staff;
 - iii. Cases shall be located in a continuous and uninterrupted arrangement;
 - iv. Cases shall be lined in drywall mounted to 13 mm plywood;
 - v. Lower limit of the display cases shall be located no more than 0.8 m above the finish floor level;
 - vi. Display cases shall be a minimum of 0.5 m deep;
 - vii. Height of display case shall be a minimum of 2.0 m high;
 - viii. Each display case shall be provided with individual lighting system with dimmable lighting controls located in the electrical room;
 - ix. Lighting system shall support multiple types of luminaries; and
 - x. Each case shall be provided with one dedicated 120V/ 20A electrical outlet.

2.7 Material Requirements

- (a) Architectural cast in place concrete, (ARCH CIP CONC)
 - (i) Design and performance requirements
 - A. Provide architectural cast in place concrete in accordance with CSA-A23.1/A23.2.

- B. Architectural Cast in Place Concrete Finishes:
 - i. Staining or discolouration from release agents not permitted.
 - ii. Maximum of 15 air voids or bug holes for 1m² of surface area; 5mm maximum size of visible holes; honeycombing not permitted.
 - iii. Surface sacking or abrasive blasting to conceal surface imperfections not permitted. Patching only permitted upon prior approval of the City.
 - iv. Form finish is final appearance. Provide smooth forms which do not telegraph plywood grain or other surface imperfections unless otherwise specified.
 - v. Colour: Light grey.
 - C. Limit of Concrete Surface Irregularities:
 - i. Offsets and Fins: 3mm.
 - ii. Variations in Plane: 3mm in 1.5m.
 - D. Tie Holes: Uniform profile and diameter, of pattern approved by the City, in symmetrical layout, filled with plugs matching appearance of adjacent concrete.
 - E. Control Joints: Tapered, 20 x 20mm.
 - F. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
 - i. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces.
 - ii. Corners: Square.
- (ii) Materials – general
- A. Sustainable Design:
 - i. Design of Mixtures: Provide concrete mixture containing fly ash and other acceptable replacements as needed, to reduce the total amount of portland cement, by not less than 40 percent.
 - ii. Minimum Recycled Content: Provide steel materials with postconsumer recycled content of not less than 60%.

- B. Source Limitations for Concrete: Each colour, size, type, and variety of concrete material and concrete mixture obtained from a single manufacturer with resources to provide consistent quality in appearance and physical properties, for each station.
- (iii) Form-facing materials
- A. Form-Facing Panels for Smooth-Formed, As-Cast Finishes: Non-Absorptive; as appropriate, and that will provide continuous, true, and smooth concrete surfaces; 1200 x 2400mm size to greatest extent possible. Use one of the following:
 - i. Exterior-Grade Plywood Panels: Medium-density overlay, Class 1, or better, mill-applied release agent and edge sealed.
 - ii. Steel.
 - iii. Glass-fibre-reinforced plastic.
 - B. Forms for Cylindrical Columns: Metal, glass-fibre-reinforced plastic, paper, or fibre tubes that will provide surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation. Spiral effect created by Sonatube or similar forms not permitted.
 - C. Form Ties: Factory-fabricated, leak-proof, internally disconnecting ties.
 - i. Furnish ties with tapered tie cone spreaders that, when removed, will leave holes 25mm in diameter on concrete surface.
 - ii. Furnish internally disconnecting ties that will leave no metal closer than 38mm, after exposing aggregate, from the architectural concrete surface.
 - D. Form Release Agents: Commercially formulated, colourless form-release agents that will not bond with, stain, discolour or adversely affect concrete surfaces.
 - i. Formulate form-release agent with rust inhibitor for steel form-facing materials.
 - E. Form Sealers: Types that that will not stain, discolour or adversely affect concrete surfaces.
 - F. Fasteners for Form Reglets: Galvanized or approved non-corrosion-resistant steel.

- (iv) Accessories
 - A. Repair Materials:
 - i. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
 - ii. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.
- (b) Precast concrete stair units, (PC), Prefabricated stair nosings, (STAIR NSG), Prefabricated tactile warning strips (TWS).
 - (i) Design and performance requirements
 - A. Calculate erection forces and structural properties of precast items in accordance with requirements of CSA-A23.3 and CSA-A23.4.
 - B. Precast Concrete Unit:
 - i. General: Resistant to water, freeze-thaw cycling, de-icing salts / chemicals, staining, wear and degradation from cleaning substances.
 - ii. Surfaces Exposed to View: As-cast-finish, non-slip, appearance and finish to match PCC PAVER 1 precast concrete pavers specified for this Project, and as follows:
 - 1. Uniform colour and texture.
 - 2. Free of staining, discoloration, honeycombing, air holes, fins, and protrusions, surface cracking and minor chips or spalling at edges or ends.
 - iii. Semi-Exposed Surfaces (surfaces not visible to the public): As specified for surfaces exposed to view except as follows:
 - 1. Surfaces may contain small holes caused by air bubbles.
 - 2. Removal of minor protrusions and repairing of honeycombing and air holes is permitted.
 - iv. Edges and ends ground smooth; chamfers not permitted.
 - C. Casting Tolerances:

- i. Variation in Overall Unit Height and Width: Plus or minus 3mm for units 3m or under; plus zero, minus 3mm for units exceeding 3m.
 - ii. Variation in Unit Thickness: Plus or minus 3mm.
 - iii. Local Smoothness: 3mm per 3m.
 - (ii) Materials - general
 - A. Sustainable Design:
 - i. Design of Mixtures: Provide concrete mixture containing fly ash and other acceptable replacements as needed, to reduce the total amount of portland cement, by not less than 40%.
 - ii. Minimum Recycled Content: Provide steel materials with postconsumer recycled content of not less than 60%.
 - B. Materials and Construction: Shop produced to CSA-A23.4 and CPCI Precast / Prestressed Concrete Manual.
 - (iii) Concrete materials
 - A. Concrete: High density, non-porous, produced from proprietary premixed material requiring the addition of water and admixtures, in proportions recommended by concrete producer to achieve specified performance and appearance requirements, in accordance with CSA-A 23.1, and to the following material standards:
 - i. Portland Cement: CSA-A5.
 - ii. Aggregates: CSA-A23.1, Fine and Course gradations.
 - iii. Water: CSA-A23.1.
 - iv. Admixtures: ASTM C494; air-entraining agents to ASTM C260, type not detrimental to the concrete.
 - v. Supplementary Cementing Materials: CSA-A23.5.
 - (iv) Reinforcement
 - A. Reinforcing Steel Bars: CSA-G30.18, deformed steel, unfinished, Grade 400R, deformed steel billet bars, unfinished, size commensurate with precast unit design.
 - (v) Accessories

- A. Connection Materials: Conform to requirements of CSA-A23.1/A23.2, and as follows:
 - i. Stainless-Steel Plate: ASTM A666, Type 316, of grade suitable for application.
- B. Stainless-Steel Bolts and Studs: ASTM F593, Type 316, high strength steel type for structural joints; hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel anti-vibration washers or lock washers.
- C. Concrete Anchors: ASTM A193, Grade B7, high strength stainless steel, Type 316.
- D. Setting Materials
 - i. Mortar and Grout: CSA A179M, Type M.
 - ii. Grout, premixed, non-shrink, non-metallic.
 - iii. Setting Shims: Plastic.
- E. Concrete Surface Repair Filler: Type as recommended by fabricator, and to conform to design and performance requirements.
- F. Prime Paint for Steel Items: CAN/CGSB-1.181, zinc rich.
- G. Stair Nosing (STAIR NSG):
 - i. 76.2 x 6.4mm high, length equal to full width of stair, extruded aluminum, with black aluminum oxide grit in epoxy base abrasive inserts.
 - ii. Product: Model CT-20/3A manufactured by KN Crowder, or approved equivalent.
 - iii. Include manufacturer recommended epoxy setting adhesive.
- H. Tactile Warning Strips (TWS):
 - i. 76.2 x 6.4mm high, extruded aluminum, with black aluminum oxide grit in epoxy base abrasive inserts.
 - ii. Product: Model CT-22/3A manufactured by KN Crowder, or approved equivalent.
- I. Include manufacturer recommended epoxy setting adhesive, and permanent seal between adjacent elements.

- (c) Stone cladding, (Smooth Finish STN 1) (Rough Finish STN 2)
- (i) Design and performance requirements
- A. Structural Performance: Dimension stone cladding assembly shall withstand the effects of gravity loads, seismic loads, and loads and stresses within limits and under conditions indicated, including wind loads, loads due to maintenance, in accordance with applicable codes.
- i. Equipment Loads: Allow for loads of window cleaning and maintenance equipment.
- ii. Stone Anchors: Capable of withstanding not less than two times the weight of the stone cladding in both compression and tension.
- B. Quality Standards: Perform work in accordance with CSA-A371 and recommendations of Indiana Limestone Handbook published by Indiana Limestone Institute of America, Inc (ILI).
- C. General: Design stone anchors and anchoring systems according to ASTM C1242.
- D. Form external corners to square joint profile.
- E. Stone Coursing: Running, stack or ashlar bond, with a uniform consistent joint width of 10mm.
- F. Mortar Joints: Raked and recessed.
- G. Tolerances of Installed Work:
- i. Maximum Variation from Plane of Wall: 6mm in 6m, 12mm in 12m or more.
- ii. Maximum Variation between Face Plane of Adjacent Panels: 1.6mm.
- iii. Maximum Variation from Plumb: 6mm in 3m, 10mm in 6m or 12mm in 12m or more.
- iv. Maximum Variation from Level Coursing: 3mm in 3m, 6mm in 6m, or 10mm maximum.
- v. Maximum Variation of Joint Thickness: 3mm/m.
- (ii) Material – general
- A. Sustainable Design:

- i. Regional Materials: Limestone shall be fabricated within 800 km of Project site from stone that has been extracted within 800 km of Project site.

B. STONE SUPPLIERS

- i. Acceptable Stone Suppliers:
 - 1. RGT Cloutier Construction, Pembroke, Ontario, or approved equivalent supplier.

(iii) Limestone

- A. Material Standard: Comply with ASTM C568.
- B. Provide units having minimal variation in colour with adjacent units and over the full area of the installation; resistant to freeze-thaw cycling; and within colour range indicated on Sample Boards, or as approved by the City.
- C. Smooth Finish Stone (STN 1): As Manufactured by RGT Cloutier Construction or approved equivalent.
 - i. Grade: Select
 - ii. Colour: Buff
 - iii. Surface Texture: Smooth matt finish.
 - iv. Face Size: 200 x 600mm nominal, cut square with square corners.
 - v. Thickness: 200mm nominal.
- D. Rough Finish Stone (STN 2): As Manufactured by RGT Cloutier Construction or approved equivalent.
 - i. Grade: Select.
 - ii. Colour: Buff.
 - iii. Surface Texture: Medium rough matt finish.
 - iv. Face Size: 200 x 600mm nominal, cut square with square corners.
 - v. Thickness: 200mm nominal.

(iv) Mortar materials

- A. Setting and Pointing Mortar: CSA-A179, non staining, types applicable to specific locations of walls, and to suit bearing capacity and lateral strength of masonry; tested for compliance with performance requirements.
 - i. Colour: Within colour range of stone indicated on Sample Board, or as approved by the City.
 - B. Water: Clean and potable.
 - C. Admixtures: Not permitted, unless otherwise authorized by the City.
- (v) Accessories
- A. Anchors, Dowels, and Ties: Stainless steel to ASTM A167, Type 304.
 - B. Sealant: Non staining, type suitable for use where subject to contact with pavement de-icing substances and frequent use of maintenance cleaners.
 - i. Colour: Within colour range of stone indicated on Sample Board, as selected by the City.
 - C. Associated Materials: Non staining, including setting buttons, spacers, weeps, cavity vents, joint fillers, back coating for stone, and cleaning solutions.
 - i. Flashing Colour: Within colour range of stone indicated on Sample Board, or as approved by the City.
- (d) Architecturally exposed structural steel, (AESS)
- (i) Quality Assurance
 - A. Requirements specified in the referenced Quality Standard, supplemented as follows:
 - i. Category 2 AESS: AESS that is within 6m vertically or horizontally of a walking surface and is visible to a person standing on that walking surface.
 - ii. Category 3 AESS: AESS that is not defined as Category 2 or that can be viewed at a distance greater than that specified in Category 2.
 - (ii) Design and performance requirements
 - A. Standard: Perform Work to AISC publication Code of Standard Practice for Steel Buildings and Bridges, Section 10 as supplemented by AISC

publication “AESS Supplement” to “Modern Steel Construction”, May 2003.

- B. Fabrication - General:
- i. Assemble and erect AESS to provide structurally sound, non-corroding assemblies
 - ii. Fabricate and assemble AESS in the shop to greatest extent possible.
 - iii. Weld connections.
 - iv. Detail AESS assemblies to minimize field handling and expedite erection.
 - v. Design location of field joints in AESS assemblies to occur at concealed locations to the fullest extent possible.
 - vi. Seal weld open ends of round and rectangular hollow structural section with 9mm closure plates. Provide continuous, sealed welds at angle to gusset plate connections and similar locations where AESS is exposed to weather.
- C. Welding: Comply with the requirements of AWS D1.1, and as supplemented by the following requirements:
- i. Welds Ground Smooth: Grind welds smooth. For groove welds, make weld flush to surface each side and within plus 1mm and minus 0mm of plate thickness.
 - ii. Contouring and Blending of Welds: Fillet welds to be ground-contoured or blended, oversize welds as required and grind to provide smooth transition.
 - iii. Minimize Weld Show Through: At locations where welding on the far side of an exposed connection occurs, grind distortion and marking of the steel to a smooth profile with adjacent material.
- D. Piece Marks Hidden: Fabricate AESS such that piece marks are either fully hidden when erected or made with such media to permit full removal after erection; grind off labels and manufacturer markings.
- E. Minimized Distortion of Rolled Members:
- i. Fully shape items to be rolled to a final curved shape and tie during shipping to prevent stress relieving.

- ii. Distortion of the web or stem, and of outstanding flanges or legs of angles shall be visibly acceptable to the City from a distance of 6m under any lighting condition determined by the City.
- F. Shop Connections:
 - i. Bolted Connections: Align bolt heads to greatest extent possible.
 - ii. Curved Members: Fabricate members to curved shape by rolling to final shape in fabrication shop.
- G. Fabrication Tolerances:
 - i. Distortion of webs, stems, outstanding flanges, and legs of angles to curved surfaces shall not be visible from a distance of 6m, under any lighting conditions.
- H. Treatment of Dissimilar Metals:
 - i. Where applicable, coat surfaces of dissimilar metals in contact with each other with acceptable isolating materials to prevent galvanic corrosion.
- (iii) Materials – General
 - A. Sustainable Design:
 - i. Minimum recycled content: Provide steel materials with postconsumer recycled content of not less than 25%.
- (iv) Materials and assembled units
 - A. Galvanizing:
 - i. Structural Steel Components: ASTM A123/A123M, 600 g/sq m coating.
 - ii. Non-Structural Items: ASTM A123/A123M, 380 g/sq m coating.
 - iii. Anchor Bolts and Fasteners: ASTM A153/A153M.
 - B. Finishes:
 - i. Prepare surfaces and apply shop primer to ungalvanized AESS ready to receive field-applied finish paint specified in PAINTING.
 - ii. Prepare galvanize AESS ready to receive field-applied finish paint specified in PAINTING.

- C. Use special care in handling and shipping of AESS both before and after finishing.
- (e) Painted metal fabrications, (MISC MTL PTD)
 - (i) Quality assurance
 - A. Welded Steel Construction: CSA-W59.
 - (ii) Materials - general
 - A. Sustainable Design:
 - i. Minimum Recycled Content: Provide steel materials with postconsumer recycled content of not less than 25%.
 - (iii) Materials
 - A. Steel Sections and Plates: CAN/CSA-G40.20/G40.21, Grade 300W.
 - B. Exposed Mechanical Fastenings: Flush countersunk stainless steel screws or bolts; consistent with design of fabricated item, strength and size to suit application.
 - C. Bolts, Nuts, and Washers
 - i. For Interior Items: Steel, ASTM A307.
 - ii. For Exterior Items: Stainless steel, ASTM F738M and ASTM F836M.
 - D. Welding Materials: Type required for materials being welded.
 - E. Touch-Up Primer for Galvanized Surfaces: SPCC-Paint 20, Type II Organic zinc rich.
 - F. Galvanizing:
 - i. Structural Steel Components: ASTM A123/A123M, 600 g/sq m coating.
 - ii. Non-Structural Items: ASTM A123/A123M, 380 g/sq m coating.
 - iii. Anchor Bolts and Fasteners: ASTM A153/A153M.
 - G. Finishes:
 - i. Shop prime ungalvanized metal fabrications ready to receive field-applied finish paint specified in Painting.

- ii. Prepare galvanize metal fabrications ready to receive field-applied finish paint specified in Painting.
- H. Treatment of Dissimilar Metals:
 - i. Where applicable, coat surfaces of dissimilar metals in contact with each other with acceptable isolating materials to prevent galvanic corrosion.
- (f) Stainless steel fabrications
 - (i) Quality assurance
 - A. Welded Steel Construction: CSA-W59.
 - (ii) Materials - general
 - A. Sustainable Design:
 - i. Minimum Recycled Content: Provide stainless steel materials with postconsumer recycled content of not less than 60%.
 - 1 Where finish quality may be compromised by the percentage of postconsumer recycled content, provide materials with the maximum postconsumer recycled content acceptable to the selected manufacturer.
 - (iii) Materials
 - A. Stainless Steel Sheet: ASTM A240M or ASTM A666, Type 316, stretcher-levelled standard of flatness.
 - B. Stainless Steel Bars and Shapes: ASTM A276, Type 316L.
 - C. Exposed Mechanical Fastenings: Flush countersunk stainless steel screws or bolts; consistent with design of fabricated item, of type compatible with material being fastened, strength and size to suit application.
 - D. Stainless-Steel Bolts and Nuts: ASTM F738M and ASTM F836M.
 - E. Welding Materials: Type required for materials being welded.
 - F. Treatment of Dissimilar Metals:
 - i. Where applicable, coat surfaces of dissimilar metals in contact with each other with acceptable isolating materials to prevent galvanic corrosion.

- (iv) Structural glass fittings
 - A. Fittings for Connecting Glass to Structure: Stainless steel, ASTM A 666, Type 316, cast or machined as specified, point glazing system of brackets and spider design compression fittings, for four point, two point or single point attachment. Provide with bolts, nuts and gaskets as recommended by fitting manufacturer.
 - i. Product: Series S15 manufactured by Stella Custom Glass Hardware or approved equivalent.
- (g) Wood items, (Benches: WD FIN 1) (Exposed Wood Ceilings: WD FIN 2) (Exposed Structural Wood: STRUC WD)
 - (i) Design and performance requirements
 - A. STRUC WD: Prefabricate wood items to greatest extent possible.
 - (ii) Materials
 - A. STRUC WD: Ash species sourced from trees infected by emerald ash borer, grade to suit application, cut and appearance to match sample on Sample Board, or as approved by the City.
 - B. WD FIN 1: Ash species sourced from trees infected by emerald ash borer, clear, knot-free, minimal colour variation, grade to suit application, cut and appearance to match sample on Sample Board, or as approved by the City.
 - C. WD FIN 2: Ash species sourced from trees infected by emerald ash borer, fire-retardant treated, knot-free, minimal colour variation, grade to suit application, cut and appearance to match sample on Sample Board, or as approved by The City.
 - i. Fire-Retardant-Treatment: By pressure process, capable of providing a maximum flame spread/smoke development rating required by applicable code when tested to ASTM E84, and using materials acceptable to the authorities having jurisdiction.
 - (iii) City supplied material:
 - A. The City is currently removing ash trees within the City of Ottawa affected by the Emerald Ash Borer. In-line with the City's sustainability goals, a portion of this wood material will be processed and made available for use in construction of the Stations and MSF.
 - B. The City, at no cost to Project Co, will provide up to 300,000 board feet of emerald ash wood for use as secondary members within the soffit of the

timber diamonds or other components of the interior surface as designed by Project Co.

i. Project Co shall use a minimum of 200,000 board feet of the emerald ash bore wood that is visible to the public as part of the station roofs, ceilings or walls or any other manner.

1 Material shall be permitted for use in the ceiling and walls of all Stations outside of the touch zone of the public when measured from adjacent walking surfaces and surfaces that could be utilized to access the material, including but not limited to benches, trash receptacles, etc.

2 The City supports and encourages the use of this material in all Stations and the Maintenance and Storage Facility.

ii. Material description:

1 Species: Ash, (White, Red, Green, European).

2 Visual grade (appearance only): Ash No.2AC as categorized by the National Hardwood Lumber association (NHLA).

3 Total quantity available: 750,000 board feet, (2x4) (38mm x 89mm nominal).

4 Length of Material: 610-1830 mm. Random lengths of which 75% shall be >900 mm.

C. Project Co shall be responsible for ordering, pick-up (within a 50 km radius of the site) and all shipping costs of the material.

D. Project Co shall coordinate the Station construction schedule with the City to identify a production schedule and pick-up schedule. The City will have processed ash wood ready for pick-up by Project Co according to the following schedule which can be amended if both parties are agreeable:

i. Hurdman Station July 2015

ii. Train, Cyrville & Blair Stations March 2016

iii. St.Laurent & Underground Stations June 2016

iv. Lebreton Station October 2016

v. Tunney's Pasture, Bayview, Campus and Lees December 2016

- E. For design purposes, as secondary members within the soffit of the timber diamonds, the material provided by the City shall have the following minimum properties:
 - i. Modulus of Rupture: 86 MPa minimum.
 - ii. Compression parallel to grain: 41 MPa, minimum.
 - iii. Compression perpendicular to grain: 5.2 MPa, minimum.
 - iv. Shear parallel to grain: 10.8 MPa, minimum.
 - v. Modulus of Elasticity: 11000 MPa, minimum.
 - vi. Properties are test values, not allowable stresses, and represent lumber with 12% moisture content. The values are typical for black ash which is typically the weakest species of ash. It is anticipated the bulk of the lumber available will be the white, green or European ash, which should meet or exceed the values listed above.

- (h) Prefinished aluminum shingles, (ALUM SHINGLES PREFIN)
 - (i) Design and performance requirements
 - A. General:
 - i. Perform Work in accordance with standard details and requirements of CRCA Roofing Specifications Manual, supplemented by requirements of NRCA Steep Roofing Manual and SMACNA Architectural Sheet Metal Manual.
 - ii. Fire Hazard and Windstorm Requirements:
 - 1. Provide roofing, flashings, and component materials equivalent to requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system and with Fire Hazard Classification Class A, CAN/ULC-S107.
 - iii. Roof Assembly Windstorm Classification, Class 1 Construction, wind uplift requirement of I90, in accordance with FM 1 28 - Design Wind Loads.
 - iv. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer, based on testing and field experience.

- B. Aluminum Shingle Roofing:
 - i. Engineer and specially configure roof panels and drainage channels to comply with performance requirements and achieve uniformity in appearance and layout.
 - ii. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes at the location of the place of the work, to prevent buckling, opening of joints, overstressing of assembly and other components, failure of joint sealants, failure of connections, and other detrimental effects.
 - iii. Aluminum Sheets:
 - 1. Accurate to profile, free from distortion or defects detrimental to appearance or performance.
 - 2. Appearance of Finished Work: Variations in appearance of adjacent panels are not acceptable. Noticeable variations in the same panel not permitted. Maintain orientation and location of panel finish and appearance variations during production and installation.
 - iv. Attachment Requirements: Shingles attached by concealed fastener and clip system; fasteners and other penetrations to be sealed with a layer of roof membrane or waterproofing mastic; achieve water tight seal.
 - v. Installed Shingle Roofing Performance: Weathertight; folded seams shall not trap or retain moisture.

(ii) Materials - general

A. Sustainable Design:

- i. Minimum recycled content for Aluminum: 50%.

(iii) Aluminum shingle roofing materials

- A. General: Custom fabricate aluminum sheet shingle roofing to comply referenced quality standards that apply to design, panel width dimensions, geometry, metal thickness, and other characteristics of installation. Fabricate roofing panels and accessories in shop to greatest extent possible.
- B. Aluminum Sheet: ASTM B209M, alloy and temper to suit application and performance requirements; smooth, flat, 1.29mm minimum thickness; Shop pre-coated with high performance coating.

- C. Shingle Shape and Dimensions: With hemmed edges designed to securely mechanically engage sheet with cleat.
 - D. Finish:
 - i. Exposed Finish: Three-coat fluoropolymer, AAMA 620; fluoropolymer finish containing not less than 70% PVDF resin by weight in both colour coat and clear topcoat; preparation, pretreatment and finish coat application to coating and resin manufacturers' written instructions.
 - 1. Colour: Custom colour; to match Alucobond Series C, Titanium C3010-DXLE or as approved by the City.
 - ii. Concealed Finish: Pretreat with manufacturer's standard white or light-coloured acrylic or polyester-backer finish system.
 - E. Drainage Mat:
 - i. Provide continuous Enkamat 7010 three dimensional multi-use drainage mat, 11.43mm thickness, made of continuous nylon filaments fused at their intersections, manufactured by Colbond, or approved equivalent.
 - F. Cleats: Intermittent attachment devices for mechanically securing shingle hems; aluminum of thickness and shape to comply with performance requirements.
 - G. Cleat Fasteners: Stainless steel, of type recommended by referenced quality standards and to comply with performance requirements.
- (iv) Flashing materials
- A. Sheet Flashings for Shingle Roofing: Prefinished aluminum sheet, same specification as aluminum sheet for shingles except 3mm thickness.
- (i) Snow guards, (SNOW GUARDS)
- (i) Design and performance requirements
 - A. Provide snow guards in accordance with manufacturer's requirements.
 - (ii) Manufacturers
 - A. Original Metal Snow Guard manufactured by Sno-Gem or approved equivalent.
 - (iii) Snow guards

- A. Prefinished aluminum, 63.5mm high, 89mm wide, 89mm deep.
 - B. Attachment Method: Directly to shingles using permanent adhesive supplemented by rivet fasteners without penetrating roofing membrane.
 - C. Finish: Coating and colour as specified for prefinished aluminum shingles.
- (j) Overhead coiling grilles, (OCDR)
- (i) Manufacturers
 - A. Overhead coiling grille model 671 series manufactured by Overhead Door Corporation or approved equivalent.
 - (ii) Materials
 - A. Sustainable Design:
 - i. Minimum Recycled Content:
 - 1. Provide steel materials with postconsumer recycled content of not less than 60%.
 - 2. Provide aluminum materials with postconsumer recycled content of not less than 25%.
 - B. Grille: Conforming to the following:
 - i. Curtain Material: Stainless steel, ASTM A666, Type 316.
 - ii. Curtain consisting of a network of minimum, 8mm diameter horizontal rods, or rods covered with tube spacers.
 - iii. Interconnect rods by vertical links approximately 16mm wide and rotating on rods.
 - iv. Space rods at approximately 38mm o.c.
 - v. Space links approximately 150mm apart in a straight in-line.
 - C. Endlocks: Continuous end links; locking and retaining grille curtain in guides against excessive pressures, maintaining grille alignment, and prevent lateral movement.
 - D. Bottom Bar: Stainless Steel tube, finished to match grille.
 - i. Astragal: Equip each grille bottom bar with a combination astragal of replaceable, adjustable, continuous, compressible gasket of

flexible vinyl, rubber, or neoprene as a cushion bumper and safety edge.

- E. Grille Curtain Jamb Guides: Stainless steel angles, of profile to retain grille in place, fitted with integral wear stripping to prevent metal-to-metal contact and to minimize operational noise; include with removable stops on guides to prevent overtravel of curtain.
 - i. Mounting Brackets: Stainless steel.
 - F. Roller Shaft Counterbalance: Aluminum pipe and helical steel spring system, capable of producing torque sufficient to assure smooth operation of grille from any position; with adjustable spring tension.
 - G. Hood Enclosure: Stainless steel, Type 316, minimum 0.65mm thick, internally reinforced to maintain rigidity and shape, closed ends, removable soffit.
- (iii) Electric Operator:
- A. General: Provide electric operator assembly of size and capacity recommended and provided by grille manufacturer for grille and operation-cycle requirements specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control Stations, control devices, integral gearing for locking grille, and accessories required for proper operation.
 - B. Electrical Components, Devices, and Accessories: Listed and labelled as defined in NFPA 70, Article 100, by CSA or ULC as applicable.
 - i. Motor Mounting: Side-mounted.
 - ii. Speed: Minimum 0.2 m/s, maximum 0.3 m/s.
- (iv) Control Station: Standard three button (OPEN STOP CLOSE) control for each operator; 24 volt circuit; surface mounted, weatherproof type. Provide two keys per station.
- i. Provide connection for off-site remote control by Operations and Maintenance Centre.
- (v) Safety Edge: Located at grille bottom bar, full width, electro mechanical pneumatic sensitized type, wired to immediately stop grille upon striking object, and reverse downward grille travel; hollow covered seal.
- (k) Glazed aluminum curtain walls, (CTW)
- (i) Design and performance requirements – UNINSULATED WALLS

- A. Quality Standard: Perform Work in accordance with AAMA Aluminum Curtain Wall Design Guide Manual.
- B. Design and size components to withstand dead and live loads caused by pressure and suction of wind, acting normal to plane of system as calculated in accordance with applicable code, as measured in accordance with ASTM E330.
- C. Design and size components to withstand seismic loads and sway displacement as calculated in accordance with applicable codes, and with deflections not less than.
 - i. Deflection Normal to Wall Plane: Limit mullion deflection to $L/175$, with full recovery of glazing materials.
 - ii. Deflection Parallel to Glazing Plane: $L/360$ of clear span or 3mm, whichever is smaller.
 - iii. Reduce deflection values when performance of structural glazing or water tightness will be compromised, or when detrimental effect to system components will occur.
- D. Size glass units and glass dimensions to limits established in CAN/CGSB-12.20.
- E. Assembly to accommodate without damage to components or deterioration of seals, movement between components and between perimeter framing and adjacent structures, dynamic loading and release of loads, deflection of structural support framing, and movements of adjacent structure.
- F. Surface Temperature: System to be capable of withstanding metal surface temperature range of 110°C over a 12 hour period, without buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance.
- G. Design glass attachments and joints to achieve weathertight seals.
- H. Not Permitted: Vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, vibrations caused by train movements, loosening, weakening, or fracturing of attachments or components of system.
- I. Water Leakage at Sealed Joints: None, when measured in accordance with ASTM E331, at pressure differential of 720 Pa.
- J. Joints: Accurately fitted and secure joints and corners; joints flush, hairline, and weatherproof.

- K. Fasteners and Attachments: Concealed from view.
- (ii) Design and performance requirements – INSULATED WALLS
 - A. In addition to the requirements specified for uninsulated curtain wall assemblies include the following requirements.
 - B. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 1.64 W/sq. m x K (0.29 Btu/sq. ft. x h x °F) as determined according to NFRC 100.
 - C. Sound Transmission of Wall System (Exterior to Interior): Value as required by applicable code, when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.
 - D. Air Infiltration: Limit air infiltration through assembly to 0.0003 cu m/sq m of wall area, measured at a reference differential pressure across assembly of 720 Pa as measured in accordance with ASTM E283.
 - E. Water Leakage: None, when measured in accordance with ASTM E331, at pressure differential of 720 Pa.
 - F. Condensation Resistance: Prevent condensation and frost on inside surfaces of system when subject to outside temperature of minus 25°C and 24 kph wind speed and inside temperature of 21°C when interior relative humidity is 50%.
 - G. System Internal Drainage: Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to the exterior by a weep drainage network.
 - H. Air and Vapour Seal: Maintain continuous air barrier and vapour retarder throughout assembly, primarily in line with inside pane of glass and heel bead of glazing compound. Locate air seals to prevent contact between interior humid air and exterior cold air and structure components, and to prevent moisture accumulation on these surfaces during cold weather.
- (iii) Materials - general
 - A. Sustainable Design:
 - i. Minimum Recycled Content: Provide aluminum materials with postconsumer recycled content of not less than 50%.
 - 1 Where finish quality may be compromised by the percentage of postconsumer recycled content, provide materials with the maximum postconsumer recycled content acceptable to the selected manufacturer.

- (iv) Curtain wall glazing system
 - A. Subject to conformance with requirements, design curtain wall assemblies based on:
 - i. Model 1600 Wall System 2 Structural Silicone Glazed SSG Curtainwall manufactured by Kawneer for uninsulated curtain walls.
 - ii. Model 1600 Wall System1 manufactured by Kawneer for insulated curtain walls.
- (v) Materials
 - A. Extruded Aluminum: ASTM B221/B221M.
 - B. Sheet Aluminum: ASTM B209/B209M. Facings AA 5005-T6, minimum 3mm thick; flashings AA 5005-H14, minimum 2mm thick.
 - C. Fasteners: Compatible with aluminum as per manufacture's recommendation.
- (vi) Components
 - A. Uninsulated Mullion Profile: Glazing stops sufficient size to provide bite on glass; drainage holes, deflector plates and internal flashings to accommodate internal weep drainage system; internal mullion baffles to eliminate "stack effect" air movement within internal spaces.
 - i. Mullion Caps: Aluminum, finish to match curtain wall mullion sections, secured with concealed tamperproof fastening method.
 - B. Insulated Mullion Profile: Thermally broken with interior tubular section insulated from exterior pressure plate matching stops and glass fibre pressure plate of sufficient size and strength to provide bite on glass; drainage holes, deflector plates and internal flashings to accommodate internal weep drainage system, internal mullion baffles to eliminate "stack effect" air movement within internal spaces.
 - i. Mullion Caps: Aluminum, finish to match curtain wall mullion sections, secured with concealed tamperproof fastening method.
 - C. Flashings: 3mm thick aluminum, finish to match mullion sections where exposed, secured with concealed fastening method.
- (vii) Glass and glazing materials
 - A. Glass and Glazing Materials:

- i. Glazing Materials: Type to suit application to achieve weather, and moisture infiltration performance requirements.
 - (viii) Sealant materials
 - A. General: Sealants to be compatible with other materials and products in curtain wall assembly and adjacent construction.
 - B. Structural Silicone Sealant for Glass-to-Glass Joints
 - C. Exposed and Concealed Sealants (Not Used for Glazing): Type as recommended by curtain wall manufacturer, and reviewed by manufacturer to suit Project requirements.
 - D. Colours of Exposed Sealants: As selected by the City.
 - (ix) Finishes
 - A. Exposed Aluminum Surfaces:
 - i. Finish Coatings: Conform to AAMA 611.
 - ii. Clear Anodic Coating, Type CI: Class I, AA A41 anodized to 0.018mm thickness, prepared with a mechanical M12, chemical C22 pre-treatment.
 - B. Concealed Aluminum Surfaces: Mill finish.
- (l) Skylight glazing system, (SKLT) (SKLT NO CAPS)
 - (i) Summary
 - A. Section Includes:
 - i. Site-assembled, sloped, self-supporting, factory prefinished, glazed aluminum tube framing system with captured mullions (SKLT).
 - ii. Site-assembled, sloped, self-supporting, factory prefinished, glazed aluminum tube framing system with butt-glazed lites and structural silicone sealant-filled joints on four sides, on exterior side; capless mullions. (SKLT NO CAPS).
 - iii. Associated flashings and sealants.
 - (ii) Design and performance requirements
 - A. Quality Standard: Perform Work in accordance with AAMA Aluminum Curtain Wall Design Guide Manual.

- B. Design and size components to withstand dead and live loads caused by pressure and suction of wind, acting normal to plane of system as calculated in accordance with applicable code, as measured in accordance with ASTM E330.
 - C. Design and size components to withstand seismic loads and sway displacement as calculated in accordance with applicable codes, and with deflections not less than.
 - i. Limit framing deflection to $L/200$ or 12mm.
 - ii. Limit flexure of glass to $L/120$ or 6mm.
 - D. Size glass units and glass dimensions to limits established in CAN/CGSB-12.20.
 - E. Assembly to accommodate without damage to components or deterioration of seals, movement between components and between perimeter framing and adjacent structures, dynamic loading and release of loads, deflection of structural support framing, and movements of adjacent structure.
 - F. Design glass attachments and joints to achieve weathertight seals.
 - G. Ensure no vibration harmonics or wind whistles.
 - H. Water Leakage at Sealed Joints: None, when measured in accordance with ASTM E331, at pressure differential of 720 Pa.
 - I. Design sloped glazing to freely drain and prevent accumulation of water at lower extremities of glazing at mullion.
 - J. Fasteners and Attachments: Concealed from view.
- (iii) Materials - general
- A. Sustainable Design:
 - i. Minimum Recycled Content: Provide aluminum materials with postconsumer recycled content of not less than 50%.
 - 1. Where finish quality may be compromised by the percentage of postconsumer recycled content, provide materials with the maximum postconsumer recycled content acceptable to the selected manufacturer.
 - ii. Provide glass products with postconsumer recycled content of not less than 25%.

- (iv) Sloped glazing system
 - A. Subject to conformance with requirements, design sloped glazed assemblies based on model 1600 SG manufactured by Kawneer.

- (v) Materials
 - A. Extruded Aluminum: ASTM B221/B221M.
 - B. Sheet Aluminum: ASTM B209/B209M. Facings AA 5005-T6, minimum 3mm thick; flashings AA 5005-H14, minimum 2mm thick.
 - C. Fasteners: Stainless steel.

- (vi) Components
 - A. Mullion Profile with Caps: Matching stops and pressure plate of sufficient size and strength to provide bite on glass; drainage holes, deflector plates and internal flashings to accommodate internal weep drainage system.
 - B. Capless Mullion Profile: Glazing stops of sufficient size and strength to provide bite on glass; drainage holes, deflector plates and internal flashings to accommodate internal weep drainage system.
 - C. Glazing Panel Configuration: Triangular, or diamond shaped.
 - D. Flashings: 3mm thick aluminum, finish to match mullion sections where exposed, secured with concealed fastening method.

- (vii) Glass and glazing materials
 - A. Glass and Glazing Materials:
 - i. Glazing Materials: Type to suit application to achieve weather, and moisture infiltration performance requirements.

- (viii) Sealant materials
 - A. General: Sealants to be compatible with other materials and products in sloped glazing assembly and adjacent construction.
 - B. Structural Silicone Sealant for Glass-to-Glass Joints
 - C. Exposed and Concealed Sealants (Not Used for Glazing): Type as recommended by sloped glazing assembly manufacturer, and reviewed by manufacturer to suit to suit Project requirements.
 - D. Colours of Exposed Sealants: As selected by the City.

- (ix) Finishes
 - A. Exposed Aluminum Surfaces:
 - i. Finish Coatings: Conform to AAMA 611.
 - ii. Clear Anodic Coating, Type CI: Class I, AA A41 anodized to 0.018mm thickness, prepared with a mechanical M12, chemical C22 pre-treatment.
 - B. Concealed Aluminum Surfaces: Mill finish.
- (m) Glass and glazing, (GL)
 - (i) Design and performance requirements
 - A. Quality Standards: Comply with applicable requirements of GANA (Glass Association of North America) Glazing Manual, and GANA Laminated Glazing Reference Manual, for design and fabrication of glazing and installation methods.
 - B. Glass Deflection: Unless otherwise specified, limit glass deflection to 1/200 or flexure limit of glass with full recovery of glazing materials, whichever is less.
 - C. Glass Panels: Sizes required to fit openings with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, and to comply with system performance requirements.
 - D. Heat-Treated Glass: Fabricated by horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed.
 - E. Butt-Glazed Lites: Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with minimal chamfers at junctions of edges and faces.
 - F. Exposed Edges and Corners:
 - i. Grind smooth and polish exposed glass edges.
 - ii. Radius 90-degree corners 12mm; 19mm at all other angles.
 - G. Holes and Cutouts: Sized to receive hardware fittings and accessories before tempering glass. Provide minimal chamfers to exposed glass edges.
 - (ii) Glass products – general

- A. Sustainable Design:
 - i. Minimum Recycled Content: Provide glass products with postconsumer recycled content of not less than 25%.
 - ii. VOC Content: For sealants used inside of the weatherproofing system protecting interior spaces, not more than 100 g/L.
- (iii) Flat glass materials
 - A. Float Glass: CAN/CGSB-12.3 or ASTM C1036.
 - B. Safety Glass: CAN/CGSB-12.1 or ASTM C1172, and ANSI Z97.1, laminated, tempered, laminated and tempered.
 - i. Laminated Float Glass: Two sheets of clear float glass, as specified, with a fully-bonded, high-impact, UV-resistant, clear polyvinyl butyl interlayer 1.52mm (0.060 in) minimum thickness.
 - ii. Tempered Laminated Float Glass: Two sheets of fully tempered clear float glass fully-bonded, high-impact, UV-resistant, clear polyvinyl butyral interlayer 1.52mm (0.060 in) minimum thickness.
 - C. Ceramic-Coated (Back-Painted or Fritted) Glass: Ceramic bake solid coating to prevent adhesive or substrate being visible through glass. Colours, textures and patterns as selected by the City.
- (iv) Sealed insulating glass
 - A. General: CAN/CGSB-12.8, double pane; total unit thickness of 25mm minimum. Inner and outer pane types subject to requirements and as scheduled.
 - i. Interpane Space: Dry hermetic air, kept dry with a dehydrating agent.
 - ii. Edge Seal Construction: Dual seal, silicone foam warm-edge spacer system with high-performance acrylic adhesive structural seal, backed with moisture vapor seal. Edge seal colour to be selected by the City.
 - iii. Super Spacer by Edgetech IG.
 - B. Vision Glass Units Performance: Subject to conformance to requirements, provide sealed insulating glass units with minimum performance values based on units comprising an outer lite of 6mm clear float glass, 13mm air

space and, inner lite of 6mm clear float glass with Low E coating on third surface.

- i. Visible Light Transmittance: 69%.
- ii. Winter Nighttime U-Factor: 0.29.
- iii. Shading Coefficient: 0.44.

C. Low Emissivity (Low E) Glass Coating: Soft, sputtered applied to third surface; hard, pyrolitic coating on second surface for over-size glass units.

- i. Product: Solarban 70 XL manufactured by PPG.

(v) Glazing sealants

A. General:

- i. Provide glazing sealants that are compatible with one another and with other materials they will contact, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
- ii. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for conditions existing at time of installation.

B. Structural Silicone Sealant for Glass Joints: Structural silicone sealant, ASTM C1184, Grade NS, Class; non-sagging, non-staining, fungus-resistant, non-bleeding; 138 kPa minimum tensile strength.

C. Colours of Exposed Sealants: As selected by the City.

(vi) Glazing accessories

A. Lock Strip Gaskets: ASTM C542, ozone-resistant precision extruded neoprene or EPDM compound. Use gaskets with separate locking strips that are 10-points higher Shore A durometer hardness value than gasket body. Fabricate gaskets in accordance with recommendations of ASTM C716.

B. Setting Blocks: Neoprene, EPDM or silicone, 80 to 90 Shore A durometer hardness tested to ASTM D2240. Maximum compression set to ASTM D395 and ASTM C864

C. Spacers: Neoprene EPDM or silicone, 40 to 60 Shore A durometer hardness tested to ASTM D2240; quantity and location in accordance with

IGMAC standards and as recommended by the frame and glass manufacturer.

- D. Glazing Tape: Preformed butyl compound, UV resistant, self-adhering, coiled on release paper, service temperature range of minus 40°C to plus 50°C, colour as selected by the City.
- E. Pre-Shimmed Glazing Tape: Pre-formed butyl tape, UV resistant, self-adhering, integral continuous serrated synthetic rubber shim and release paper, 10 to 15 Shore A durometer hardness, service temperature range of minus 54 to plus 104°C, designed for 25 to 50% compression, colour as selected by the City.
- F. Glazing Wedges and Splines: Precision extruded neoprene or EPDM compound, UV resistant, 55 to 65 Shore A durometer hardness.
- G. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

(vii) Glazing schedule

- A. GL 1- Windscreens and Guardrails: Clear, single tempered, glass.
- B. GL 2 - Curtain Walls, Uninsulated: Clear, single float glass; tempered or laminated where required by code.
- C. GL 2A – Curtain Walls, Insulated: Clear, sealed insulating glass, tempered or laminated where required by code.
- D. GL 3 - Not used.
- E. GL 4 – Skylights with Mullion Caps: Clear, single tempered laminated.
- F. GL 5 – Skylights with Capless Mullions: Clear, single tempered laminated glass.

(n) Lime-based plastering

(i) Plastering system

- A. Subject to conformance with requirements, provide lime plastering system based on Lime Plaster manufactured by Eco Stucco, a division Mediterranean Colors, LLC, www.ecostucco.com, or approved equal.
- B. Provide manufacturer's trowel-applied scratch and brown coats, and smooth finish coat similar to manufacturer's Fossil finish, thicknesses to be not less than manufacturer's recommended value.

- iii. Compression Strength: 980 kg/m², ASTM D695.
- iv. Flexural Strength: 993 kg/m², ASTM D790.
- v. Flame Spread Index for 6mm Thickness: Less than 25, ASTM E84.
- vi. Freeze-Thaw Durability: No Disintegration ASTM C 1026.
- vii. Colour: Federal Yellow #33538 lusterless.

(iv) Accessories

- A. Tile Anchors and Fasteners: Manufacturer's standard rust resistant cast in place type, with stainless steel countersunk screws.
- B. Platform Edge Angle and Anchors: Continuous steel angle, slotted holes for anchors; steel M20 bolts, nuts, and plate washers; galvanised steel for interior applications; stainless steel for exterior locations.
- C. Floor Finish Termination Angle: 75 (varies dependent on depth of mortar bed) x 50 x 3 x 2480 continuous galvanized angle as protection for anti-fracture membrane under edge tile adjustable set screw.
- D. Sealants: Compatible with substrates; salt and freeze-thaw-resistant. Include closed cell foam backer rod.
 - i. Between Platform Edge Tiles: Polyurethane elastomeric sealant.
 - ii. Between Platform Edge Tile and Platform Edge Angle: Hybrid epoxy/urethane type.

(p) Painting, (PTD)

(i) Materials

- A. Paint for architecturally exposed structural steel and painted metal fabrications on galvanized and shop-primed surfaces, exterior and interior application, and where compliance with flame spread fire performance is required. Paint system dry film thickness of 11 mils minimum.
 - i. Primer coat - Epoxy Zinc Primer:
 - 1. Meet requirements of SSPC Paint 20 Type II.
 - 2. Minimum Dry Film Thickness: 3 mils.
 - 3. Products:

- International Paint; Interzinc 52
 - ICI High Performance Coatings; Catha-Cote, 313 Organic Zinc, or approved equivalent.
- ii. Intermediate Coat - High Build Epoxy Coat:
1. Minimum Dry Film Thickness: 6 mils.
 2. Products:
 - International Paint; Intergard 475HS
 - ICI High Performance Coatings; Bar Rust 236 New Technology Epoxy or approved equivalent.
- iii. Polyurethane Finish Coat - Polyurethane, Two-Component, Pigmented, Gloss:
1. Minimum Dry Film Thickness: 2 mils.
 2. Gloss level: Satin.
 3. Products:
 - International Paint; Interthane 990.
 - ICI High Performance Coatings; Devthane, 379 (H) UVA. Acrylic Urethane or approved equivalent.
- iv. Adjust coating formula where flame spread fire performance is required; provide minimum Class A surface burning characteristic. Increase number of coatings as recommended by paint manufacturer for non galvanized surfaces.
- (ii) Colours
- A. PTD 1: To match paint colour of prefinished aluminum shingles.
 - B. PTD 2: Base white.
 - C. PTD 3: 'Overcoat' CC-544 by Benjamin Moore.
 - D. PTD 4: 'Citrus Blast' 2018-30 by Benjamin Moore.
 - E. Final Colours to be reviewed by the City to ensure colour scheme is integrated with the revitalized City Brand.

(q) Graffiti-resistant coatings, (GRAF)

(i) Materials

- A. Graffiti-Resistant Coating to be applied to all porous opaque surfaces including but not limited to concrete and stone that are reachable to tag:
 - i. Polymer, siloxane, silane blend; colourless; containing 10 % minimum solids by volume weight, airless spray type.
 - ii. Water Transmission Reduction after Application: 5% maximum.
 - iii. Acceptable Product: Fabrishield Paint Repellent PR 60 for limestone; 61 for other surfaces, by Fabrikem Manufacturing Ltd.

(r) Bird protection devices, (BPW)

(i) Design and performance requirements

- A. Design system of bird control using specified devices to prevent pest birds from landing, roosting, nesting or climbing on horizontal surfaces at Stations, except for the roof exterior, tops of windscreens, security fences, handrails, guardrails, stone, and architectural concrete.
- B. Attaching Hardware:
 - i. To allow for removal and reinstallation without causing damage to the installation surface, the bird barrier or mounting system.
 - ii. Design clips and brackets for maximum concealment from view.
- C. Installed Devices: Aligned, accurately and tightly fitted and fastened, free of defects to surfaces.

(ii) Manufacturers

- A. Subject to conformance to requirements provide FliteLine Post and Wire Deterrent manufactured by Nixalite of America, www.nixalite.com or approved equivalent product; bird spikes are not permitted.

(iii) Wire bird barrier

- A. Wire: UV coated stainless steel aircraft cable, 0.8mm diameter; 50 kg breaking strength.
- B. Posts: Manufacturer's standard posts with two line capacity of type to suit substrate application.

- C. Mounting Hardware:
 - i. Stainless steel, designed to suit installation substrate.
 - ii. Provide custom fabricated devices for attaching barrier to substrates where standard means of attachment is not possible.
- (iv) Finishes
 - A. Factory finish components of bird control devices including accessories, with manufacturer's standard paint system.
 - B. Colour: Colour as selected by City's Representative.
- (s) Floor grilles, (FLR GR)
 - (i) Design and performance requirements
 - A. Design floor grilles to withstand the minimum following loads without deformation:
 - i. Uniform Floor Load: 14.36 kN/sq. m.
 - ii. Wheel Load: Minimum 160 kg, 1000 passes without damage, solid 50mm wide polyurethane wheel.
 - B. Maximum Deflection: 1/180th of span.
 - C. Grille Direction: Bars perpendicular to direction of user travel, to greatest extent possible.
 - D. Installed Grille: Grille wearing surface flush with adjacent floor finish; bars and frames square, rigid with tight joints at corners; assembly free of deformities and rattle.
 - i. Maximum Gap Formed at Recessed Frame from Grille Size: 6mm.
 - (ii) Manufacturers
 - A. Entrance floor grille model BSA-1-3 HL, modified as specified, manufactured by Bolar, www.bolar.com, or approved equivalent.
 - (iii) Materials - general
 - A. Sustainable Design:
 - i. Provide stainless steel materials with postconsumer recycled content of not less than 60%.

- B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 316.
- (iv) Entrance floor grilles
 - A. General: Provide manufacturer's stainless steel floor-grille assemblies modified to comply with Heavy Load product line, consisting of treads joined together by cross members, and with support legs and other components needed to produce a complete installation. Include locking device for each panel and lifting hooks.
 - B. Floor Grille:
 - i. Tread Rails: 4.7mm wide x 50mm deep 'T' profile, 3mm thickness.
 - ii. Maximum Span: 610mm, or as recommended by the manufacturer.
 - iii. Maximum Individual Panel Size: 1200 x 1200mm.
 - iv. Finish: No. 4 finish.
 - v. Frames: Manufacturer's standard frames, including perimeter frames, of size and style for grille type, for permanent recessed installation in floor, complete with installation anchorages and accessories; same material and finish as grilles. Provide concealed frameless supports except at perimeter frame.
 - C. Support System: Manufacturer's special deep-pit stainless steel frame and support system with intermediate support beams, sized and spaced as recommended by manufacturer and equipped with vinyl support cushions.
 - D. Drain Pan: Stainless steel sheet, 1.5mm minimum thickness, welded construction, bottom surface with positive slope to drain; holes cut for drain and equipped with adaptors for connection to drain lines; bottom of pan with protective coating as recommended by manufacturer; provision for heat-traced drainage.
- (v) Design and performance requirements
 - A. Pavers: High density, resistant to freeze thaw, salt and moisture, durable and capable of withstanding loads of heavy snow removal equipment, and high volume pedestrian and vehicular traffic.
- (vi) Materials – General
 - A. Sustainable Design:

- i. Regional Materials: Provide concrete pavers that have been manufactured within 800 km of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 800 km of Project site.
- (vii) Materials
- A. Pavers: Solid interlocking paving units complying with ASTM C936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.
 - B. PCC PAVER 1:
 - i. Face Size: 300 x 600mm.
 - ii. Colour: To match Cambrian Black Buffed by Transpavé, Saint-Eustache QC.
 - iii. Edge: Square, chamfered edges are not permitted.
 - C. PCC PAVER 2:
 - i. Face Size: 300 x 600mm
 - ii. Colour: To match Beige Grey by Transpavé, Saint-Eustache QC.
 - iii. Edge: Square, chamfered edges are not permitted.
 - D. Setting Materials: Sand layer of suitable physical properties, moisture content and density to allow setting and compacting of pavers. Geotextile membrane as recommended by manufacturer.

ARTICLE 3 STRUCTURAL DESIGN CRITERIA

3.1 Introduction

- (a) This Article presents the structural Design criteria and performance requirements for Station Structures including: foundations and superstructures for above grade Stations; retaining walls appurtenant to above grade Stations; interior structural elements contained within the exterior Shell of underground cut-and-cover Station box Structures; interior structural elements contained within the Permanent Lining of mined Tunnel Stations; and renovation of existing buildings impacted by the Station Construction.

3.2 Reference Documents

- (a) The structural Design shall comply with the criteria contained in this Article, and all standards, regulations, policies, Applicable Law, guidelines or practices applicable to the Project, including but not limited to each of the following Reference Documents. In the event of a conflict between criteria, commitments or requirements contained within one document when compared with another, the more stringent shall apply:
 - (i) OBC;
 - (ii) NBC;
 - (iii) User’s Guide – NBC: Structural Commentaries (Part 4);
 - (iv) CAN/CSA S6 - CHBDC*;
 - (v) CAN/CSA A23.1/A23.2 - Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete;
 - (vi) CAN/CSA A23.3 - Design of Concrete Structures;
 - (vii) CAN/CSA O86 - Engineering Design in Wood;
 - (viii) CAN/CSA S16 - Design of Steel Structures;
 - (ix) CAN/CSA S304.1 - Design of Masonry Structures;
 - (x) CAN/CSA S413 - Parking Structures;
 - (xi) CAN/CSA S136 – North American Specification for the Design of Cold-Formed Steel Structural Members;

**Note: Portions of the Station that support Vehicle loads shall be considered Train Structures. Train Structures shall be designed to satisfy the requirements of this Article and Schedule 15-2, Part 1, Article 21 and shall meet or exceed the applicable building code(s) and the CHBDC.*

- (xii) Canadian Foundation Engineering Manual;
- (xiii) CAN/CSA S478 – *Guideline on Durability in Buildings*;
- (xiv) ACI 201.2R – *Guide to Durable Concrete*;
- (xv) AREMA Manual for Railway Engineering hereinafter referred to as the AREMA Manual
- (xvi) ACI 360R – *Design of Slabs on Grade*;
- (xvii) CSA S448.1 – *Repair of Reinforced Concrete in Buildings and Parking Structures*; and
- (xviii) AISC/CISC Steel Design Guide Series 11 – *Floor Vibrations Due to Human Activity*.

3.3 Federally Mandated Station Requirements

- (a) Stations located on Federal Government lands subject to the regulations of the NCC shall meet the requirements of both the OBC and the NBC. Stations outside of Federal Government lands need only meet the requirements of the OBC.

3.4 Durability

- (a) Develop and submit results from a durability model of the concrete Structure using a widely accepted software package such as Life365 or Stadium. The model shall be used to demonstrate expected life cycle performance consistent with the Project requirements. Refer to ACI 201.2R. Results shall be submitted according to Schedule 10 – Review Procedure.
- (b) Time-dependent Design calculations, including corrosion, fatigue and creep shall be based on the required Design Life.

3.5 Station Structural Loads

- (a) Dead Loads
 - (i) Dead loads or permanent loads shall be as specified in OBC, NBC and CAN/CSA S6, as applicable.
 - (ii) Mass densities for materials shall be standard unless analysis or testing indicates that other criteria shall be used. Perform a sensitivity analysis for the actual weight where a variation might affect the adequacy of the Design or in cases where the Construction may vary from normal practice.
- (b) Live Loads

- (i) Live loads include the LRT Vehicle Design loads and highway vehicular loads specified in Part 1 Article 21 – Civil Structural Design Criteria as well as all floor and roof live loads as described in the Design codes and standards specified earlier in this Article.
 - (ii) Design electrical Equipment rooms, pump rooms, machinery rooms, storage rooms, service rooms, battery rooms and fan Equipment rooms containing fire ventilation Equipment for a specified live load of 12 kPa, or the actual Equipment load where greater than 12 kPa, applied uniformly over the entire area, or on any portion of the area, whichever produces the most critical effects in each member.
- (c) Environmental Loads
- (i) Snow, rain, ice, ice accretion, wind and earthquake loads shall be as described in the Design codes laid out earlier in the article using the Importance Category of “Normal” with the building code and “Emergency Route” within CHBDC.
 - (ii) Include allowance for the build-up of ice on Track slabs and the build-up of compacted snow on vertical faces of barrier walls and Platform support walls adjacent to Track slabs at exposed parts of above grade Stations where the potential for such build-up exists. The magnitude of these loads shall suit the planned snow removal system.
 - (iii) Station Structures, partitions and affected non-structural elements shall be designed to resist the piston effect wind pressures from transit Vehicles. The minimum uniform Design pressure for these elements shall be 2.0 kPa in either the positive or negative direction.
- (d) Fatigue Loading
- (i) Ridership criteria shall be assessed to determine the expected number of Trains the Structure will support during its Design Life. A service load analysis for fatigue shall be applied to affected structural elements and is generally based on the number of full loading cycles that are applied to the Structure. The loading cycles applied to each member and connection shall include the number of Vehicles, trucks or wheel load passes, whichever produces the most critical effect.
- (e) Earth Loading
- (i) Vertical and horizontal earth pressures acting on retaining walls and Underground Station Structures: refer to Part 1 Article 12 – Geotechnical/Foundation Design Criteria, Part 1 Article 21 – Structural Design Criteria and Requirements and Part 3 Article 2 – General Structural Design Criteria.
 - (ii) Structures which retain earth shall be designed for horizontal earth pressure due to earth against the Structure and load surcharges resting on the soil above or beside the Structure.

- (f) Water/Buoyancy/Flood Loading
 - (i) The effects of water pressure and buoyancy shall be considered whenever groundwater is present. Establish high and low water tables for the life of the Structure with due consideration given to the possibility of future changes in groundwater elevation.
 - (ii) The Design shall take into account the effect of water pressures during the Construction sequence.
 - (iii) During Construction and backfill operations, the elevation of the groundwater shall be observed and controlled so that the calculated total mass of Structure and backfill shall always exceed the calculated uplift due to buoyancy by a safe margin. The backfill shall be considered as the volume contained within vertical planes defined by the outside limits of the Structure.
 - (iv) Local flooding may also add load to underground Structures. Design of the Structure shall make allowance for flood elevations based on 100 year flood data.
- (g) Adjacent Structure/Additional Surcharge Loading
 - (i) Horizontal and vertical distribution of loads from foundations of existing buildings shall be determined by Project Co.
 - (ii) Determine the minimum and maximum loads which can be transferred to the underground Structure. Where possible, these loads shall be based on the actual Design loads for the Adjacent Structure. In the absence of this information, use a rational approach to evaluate probable loading of the existing Structure.
 - (iii) When performing the above analyses, determine the need for all permanent underpinning of buildings or Structures.
- (h) Thermal, Shrinkage, and Creep Loading
 - (i) The secondary effects due to the stresses and movements resulting from temperature changes, thermal gradients, creep and shrinkage shall be considered in the Design. Determine these loads and the appropriate Design solution in accordance with the requirements of OBC, NBC, CAN/CSA S6 and AREMA, as applicable.
- (i) Other Loads and Effects:
 - (i) as applicable to the use and occupancy for the Structure or element under consideration;
 - (ii) as required by the Design codes, standards and references listed in this Article;

- (iii) refer to Part 1 Article 21 – Structural Design Criteria and Requirements for loads pact; horizontal impact (hunting or nosing force); centrifugal force; rolling (rocking) force; longitudinal force; rail direct fixation temperature forces; OCS thermal forces; derailment load; Vehicle collision, emergency braking, broken rail forces, ice accretion on the roof of LRT Vehicles and any other load or load combination required by the LRT Vehicle manufacturer;
- (iv) Construction loads, Construction staging loads and maintenance loads;
- (v) loads due to fan induced airflows during operation of fire ventilation fans;
- (vi) loads induced on the Structures by tolerable differential settlement;
- (vii) loads to protect for future expansion where applicable; and
- (viii) other loads and effects specified in Part 1 Article 21 – Protection of Existing Adjacent Structures and Part 3 Article 2 – General Structural Design Criteria where applicable.

3.6 Load Combinations

- (a) Load factors, resistance factors and load combinations shall be in accordance with the applicable building and Bridge codes for the particular Station and structural element under consideration.
- (b) Refer to Part 1 Article 21 – Structural Design Criteria and Requirements for load factors, resistance factors and load combinations for Station Structures supporting LRT Vehicles.
- (c) For Structures carrying more than one Track, determine the combination of LRT Vehicle axle loads on one or more Tracks which produces the most critical effect.

3.7 Design Considerations for Retaining Walls

- (a) Design considerations and factors influencing the behaviour of retaining walls are provided in CAN/CSA S6. The Design of any retaining wall is site specific, necessitating the need for specific geotechnical input and an understanding of wall construction methods. Provide architectural enhancement of walls where specified in the architectural Design.
- (b) Retaining walls shall be designed to resist the following loads:
 - (i) Superimposed surface and subsurface loads (Adjacent vehicles and Structures);
 - (ii) System imposed forces (trackway vicinity);
 - (iii) Earth or rock pressures and hydrostatic pressures;
 - (iv) Earthquake lateral pressures;

- (v) Wind Loads, where required;
 - (vi) Self-weight;
 - (vii) Loads during Construction;
 - (viii) Thermal, shrinkage, and creep loads; and
 - (ix) Other retaining wall loads. specified in Part 1 Article 12 – Geotechnical/Foundation Design Criteria and Part 1 Article 21 – Structural Design Criteria and Requirements.
- (c) Retaining Walls shall be analyzed for:
- (i) Stability against sliding;
 - (ii) Stability against bearing failure and overturning;
 - (iii) Settlement;
 - (iv) Overall stability;
 - (v) Structural strength;
 - (vi) Protect for future wall repair when locating retaining walls;
 - (vii) Provide Compensating Construction where existing retaining walls are impacted by the Station renovations as required by OBC and NBC, as applicable; and
 - (viii) Other requirements specified in Part 1 Article 12 – Geotechnical/Foundation Design Criteria and Part 1 Article 21 – Structural Design Criteria and Requirements.

3.8 General Design Considerations

- (a) Design the structural foundations, superstructures, systems, elements and connections to meet all of the requirements stipulated in the codes, standards and references listed in this Article.
- (b) Slope structural members to provide drainage where required.
- (c) Deflection and Vibration Control
 - (i) All structural members shall have adequate stiffness to limit deflections which may adversely affect the strength and serviceability of the Station Structure.
 - (ii) In members supporting Train loads, deflections due to live load, including dynamic factors, shall not exceed 1/1000 of the span for interior spans and 1/300 for cantilever arm length.

- (iii) The maximum total (dead and live load) long term total deflection considering creep and cracking for members supporting Train loads shall be limited to 1/500 of the interior spans and 1/180 of cantilever arm length.
 - (iv) Members not supporting rail loads, such as roofs, concourse and Platform slabs, shall be designed to standard acceptable engineering practices for serviceability taking into consideration the flexibility, or lack of flexibility, of the materials supported by the Structure.
 - (v) Members and systems supporting the light rail System shall be proportioned so that the natural frequency of the first mode of vertical vibration is greater than 2.5 Hz.
 - (vi) Design floor systems susceptible to vibration in accordance with AISC/CISC Steel Design Guide Series 11 – *Floor Vibrations Due to Human Activity*, to meet the acceptance criteria for indoor footbridges.
- (d) Settlements
- (i) Foundations shall be designed so that total and differential settlements do not adversely affect the strength or serviceability of the Station Structures.
 - (ii) Structural members and systems supporting LRT Vehicles shall be designed so that total and differential settlements do not adversely affect the operation and serviceability of the LRT Vehicles.
- (e) Seismic Design for Elements of Structures, Non-Structural Components and Equipment
- (i) Design elements and components of buildings, non-structural components and Equipment for earthquake loads and effects as required by OBC and NBC.
- (f) Waterproofing
- (i) Underground pits, shafts and rooms shall be sealed to prevent water ingress. The Design measures shall provide zero leakage for the Design Life of the Structure.
- (g) Fire Protection
- (i) Structural elements and load bearing assemblies shall be of the required type of construction and shall have fire resistance ratings as required by the code analysis and the architectural Design.
 - (ii) Provide concrete cover to reinforcing steel in reinforced concrete elements as required to provide the required fire resistance rating for the element or assembly.
 - (iii) Provide intumescent paint where the architectural Design utilizes exposed structural steel assemblies that require a fire resistance rating.

- (iv) Adhesive anchors shall not be used for connections for structural assemblies required to have a fire resistance rating.
- (h) Protect for the future replacement or addition of elevators, escalators, transformers, ventilation fans and other large/heavy Equipment without strengthening and/or temporary removal and replacement of structural members.

3.9 Existing Structure Considerations

- (a) Renovation of Existing Buildings:
 - (i) Comply with OBC and NBC as applicable.
 - (ii) Comply with the Heritage Act as applicable.
 - (iii) Obtain reference drawings, specifications and Construction records for the affected Structures.
 - (iv) Perform as built surveys to verify the accuracy of the reference drawings.
 - (v) Excavate test pits to verify the size and depth of existing foundations.
 - (vi) Conduct destructive investigations to verify existing conditions.
 - (vii) Conduct materials testing to determine and verify existing material properties.
 - (viii) Comply with the requirements for Basic Renovation or Extensive Renovation as determined by the Code Analysis at each location.
 - (ix) Provide Compensating Construction as required by OBC and NBC, as applicable.
 - (x) Perform selective demolition in accordance with OBC and NBC as applicable,
 - (xi) Repair any damage caused by the Work to the satisfaction of the property owner.
- (b) Interface Between Existing and New Deck Structures Supporting Pedestrian and Vehicular Traffic
 - (i) At locations where new framed floors are built adjacent to existing floor/Bridge Structures, the new Structure shall be designed and constructed in a manner that minimizes the vertical differential movement at the interface between Structures so that normal serviceability of the Station is maintained under permanent and transient loads. Joints between new and existing slabs shall be flush with no vertical offsets that could create pedestrian tripping hazards or bumps under wheel loading. The Design shall address: long term deflection (creep) of concrete; differential live loading; total and differential footing settlement; beam and slab camber; expansion joint cover Design; and other effects where applicable.

- (c) Where existing Structures are incorporated into or form part of the Station Structures, rehabilitate the existing Structures as required to meet the required Design Life.

3.10 Reinforced Concrete

- (a) This Subsection applies to reinforced, prestressed, and precast concrete Structures.
- (b) Design concrete Structures in accordance with CAN/CSA A23.3 and CAN/CSA S6, where they are applicable.
- (c) Concrete materials, testing methods, and Construction practices for plain and reinforced concrete shall conform to the following standards:
 - (i) CSA
 - A. CAN/CSA A23.1/A23.2
 - B. CAN/CSA-S6 where applicable
 - C. CAN/CSA S413 -- for structural elements that will be exposed to deicing salts
 - D. CAN/CSA A3000 - (Consists of A3001, A3002, A3003, A3004, A3005)
 - E. ASTM International Standards referenced in the CSA Standards.
- (d) Provide materials, details and protection systems to meet or exceed the specified requirements for durability: refer to Subsection 3.4 in this Article.
- (e) All concrete exposed to freezing and thawing cycles shall be air entrained.
- (f) All non-prestressed reinforcement and testing methods shall conform to the following standards:
 - (i) CSA
 - A. G30.18-M92-Billet-Steel Bars for Concrete Reinforcement
 - B. W186-M1990-Welding of Reinforcing Bars in Reinforced Concrete Construction
 - (ii) ASTM International Standards referenced in the CSA Standards.
- (g) All bent reinforcing bars shall meet the bend test requirements of CAN/CSA G30.18.
- (h) The finish of exposed concrete Structures shall comply with the architectural specifications.

- (i) Provide a nonslip surface finish in accordance with CAN/CSA A23.1 at exterior slabs subject to pedestrian traffic and at other locations required by the architectural articles.
- (j) Provide hardener at exposed concrete floors.
- (k) Fatigue
 - (i) Train Structures, including ground-supported slabs, shall meet CHBDC standards for fatigue.
- (l) Joints in Structures
 - (i) Provide expansion joints, contraction joints and construction joints: in accordance with the all applicable codes and standards and in accordance with good industry practice; to control shrinkage stresses and minimize shrinkage cracking; and to meet or exceed the requirements for durability specified in Subsection 3.4 of this Article.
 - (ii) Provide waterstops in all joints below grade.
 - (iii) Construction joints locations shall be planned in advance in order to minimize the number of joints while still keeping the length of individual concrete pours within standard acceptable maximum lengths. The shape of the pour as well as the amount of reinforcement in the section shall be taken into consideration when determining joint location and spacing.
 - (iv) Co-ordinate the location of joints and joint details with the architectural Design.

3.11 Structural Steel

- (a) The Code of Standard Practice for Structural Steel published by the CISC shall be referenced with respect to the furnishing of structural steel.
- (b) Design of structural steel Structures shall be in accordance with CAN/CSA S16 Design of Steel Structures and CAN/CSA S6 Canadian Highway Bridge Design Code, where they are applicable.
- (c) Design of cold formed steel Structures shall be in accordance with CAN/CSA-S136 North American Specification for the Design of Cold-Formed Steel Structural Members.
- (d) Provide materials, details and protection systems to meet or exceed the requirements for durability.
- (e) Steel materials, testing and Construction requirements shall conform to the following standards:
 - (i) CAN/CSA S16

- (ii) CAN/CSA G40.20/G40.21
 - (iii) CAN/CSA-S6, where applicable
 - (iv) CAN/CSA S413 -- for structural elements that will be exposed to deicing salts.
 - (v) ASTM International Standards referenced in the CSA Standards.
- (f) Provide concealed connections where required by the architectural Design.
- (g) Protection of Steelwork
- (i) Project Co shall endeavour to make all parts of a Structure accessible for inspection, cleaning and maintenance. Where this is not possible, consideration shall be given to concrete encasement of steelwork, use of special protective coatings or the use of atmospheric corrosion resistant steel.
- (h) Protective Coatings
- (i) Structural steel members and connections exposed to weather, high humidity or water spray shall be protected against corrosion. Localized corrosion likely to occur from entrapped water, excessive condensation, or from other factors shall be minimized by suitable Design and detail. Provide positive means of drainage to prevent standing water on steel surfaces.
 - (ii) Co-ordinate the protective coating systems with the architectural Design.
 - (iii) The minimum protection system shall be painting with a high performance coating system.
 - (iv) Where hot dip galvanized protection system is utilized, the following shall apply:
 - A. Bolts, nuts and washers used with galvanized Structures shall also be galvanized in accordance with CAN/CSA G164
 - B. Protection must be restored when damage to the galvanized coating has occurred during welding or as a result of rough handling or abrasion.
 - C. Where exposed to public view, all galvanized surfaces shall be finish painted.
- (i) Steel deck shall not be used for Structures exposed to the exterior or to deicing salts.
- (j) Fatigue
- (i) Structural members and components shall be sized for the effects of fatigue due to repeated applications of load. Guideways which are subjected to frequent Vehicle passes and certain types of Equipment support shall be evaluated for the effects of

fatigue. Evaluation for the effects of fatigue shall include consideration of out-of-plane stresses and secondary effects.

3.12 Masonry

- (a) Design of masonry Structures shall be in accordance with CAN/CSA S304.1
- (b) The Design and Construction of reinforced and unreinforced masonry shall comply with the criteria contained in this Article, and all standards, regulations, policies, Applicable Law, guidelines or practices applicable to the Project, including but not limited to each of the following Reference Documents. In the event of a conflict between criteria, commitments or requirements contained within one document when compared with another, the more stringent shall apply:
 - (i) CSA
 - A. CAN/CSA A23.1/A23.2
 - B. CAN/CSA A165
 - C. CAN/CSA A179
 - D. CAN/CSA A370
 - E. CAN/CSA A371
 - F. CAN/CSA G164
 - G. CSA G30.18
- (c) Horizontal joint reinforcing shall be galvanized.
- (d) Masonry Structures shall be designed to resist all applied vertical and lateral loads as required by the OBC (and the NBC where applicable). This requirement applies to load-bearing and non load-bearing masonry.

3.13 Concrete Slabs on Grade

- (a) Design Track slabs in accordance with AREMA, CAN/CSA S6 and ACI 201.2R.
- (b) Design Platform and other slabs on grade in accordance with CAN/CSA A23.3 and ACI 201.2R.
- (c) Remove existing fill material below slabs on grade and replace with engineered fill to a depth and extent as required to meet the limitations for settlement specified in Subsection 3.8 (d) of this Article. Reuse of existing excavated fill material is subject to the same limitations.

- (d) Design and construct the interface between Track slabs and Platform slabs to maintain the vertical distance between top of rail elevation and finished Platform elevation as required by the LRT Vehicle with short and long term differential settlements not to exceed the tolerance specified by the LRT Vehicle manufacturer for vertical offset between the Track and finished Platform elevations.
- (e) Provide control joints or other measures to prevent uncontrolled shrinkage cracking.
- (f) Where the location and spacing of transverse joints in Track slabs does not match the location and spacing of joints in the adjacent Platform slabs, provide connection Design and detailing at the interface between slabs to address differential concrete shrinkage.
- (g) Provide measures to prevent frost heave.
- (h) Design joints to prevent vertical differential movement between slab panels.
- (i) Provide slopes to drain slabs and prevent ponding.
- (j) Provide subdrainage systems below slabs at locations where the potential exists for the groundwater elevation to reach the underside of the slab subbase.

ARTICLE 4 MECHANICAL DESIGN CRITERIA

- (a) This Article contains mechanical requirements developed for the OLRT. These requirements govern the functional requirements, operation and control of the heating systems, ventilation systems, air conditioning systems, water and sewage systems, drainage systems, fire protection systems, emergency fire/smoke ventilation, and building temperature control / automation systems.
- (b) These requirements are intended to promote uniformity of Design and standardization of Equipment, and its location throughout the OLRT System. The information contained in these sections is not intended to conflict with the minimum requirements of the current codes and standards adopted by the OBC. If a conflict is found, the most stringent shall apply.

4.1 Reference Documents

- (a) The Design and Construction of mechanical components shall comply with the criteria contained in this Article, and all standards, regulations, policies, Applicable Law, guidelines or practices applicable to the Project, including but not limited to each of the following Reference Documents. In the event of a conflict between criteria, commitments or requirements contained within one document when compared with another, the more stringent shall apply:
 - (i) OBC*;
 - (ii) NBC*;
 - (iii) OFC;
 - (iv) OESC;
 - (v) CSA;
 - (vi) CEC;
 - (vii) CAN/CSA B139;
 - (viii) OHSA;
 - (ix) ARI;
 - (x) AMCA Standard 210 ;
 - (xi) AMCA Standard 300 ;
 - (xii) AMCA Standard 301;
 - (xiii) ANSI;

- (xiv) ASHRAE Handbooks;
 - (xv) ASHRAE Standard 90.1;
 - (xvi) ASHRAE Standard 62.1;
 - (xvii) MNECB;
 - (xviii) Green Energy Act;
 - (xix) ASPE;
 - (xx) ASME;
 - (xxi) ASTM;
 - (xxii) APTA, Rail Transit Committee, "Guidelines for Design of Rapid Transit Facilities";
 - (xxiii) DOT "Recommended Emergency Preparedness Guidelines for Rail Transit Systems";
 - (xxiv) NEMA;
 - (xxv) SMACNA;
 - (xxvi) TIAC;
 - (xxvii) PDI;
 - (xxviii) UL;
 - (xxix) ULC; and
 - (xxx) Underwriter's Laboratories, Inc. – UUKL-864.
- (b) Particular references shall be made to the following sections of NFPA:
- (i) NFPA Standard 10, "Portable Fire Extinguishers";
 - (ii) NFPA Standard 13, "Installation of Sprinkler Systems";
 - (iii) NFPA Standard 14, "Standpipe, Private Hydrant, and Hose Systems";
 - (iv) NFPA Standard 20, "Installation of Stationary Pumps for Fire Protection";
 - (v) NFPA Standard 70, "National Electrical Code";
 - (vi) NFPA Standard 90A, "Installation of Air-conditioning and Ventilating Systems";

- (vii) NFPA Standard 101, "Life Safety Code";
- (viii) NFPA Standard 130, "Fixed Guideway Transit and Passenger Rail Systems";
- (ix) NFPA Standard 204, "Smoke and Heat Venting";
- (x) NFPA Standard 502, "Standard for Road Tunnels, Bridges and Other Limited Access Highways";
- (xi) NFPA Standard 1963, "Fire Hose Connections"; and
- (xii) NFPA Standard 2001, "Clean Agent Fire Extinguishing Systems".

**Note: Federally Mandated Stations are subject to the regulations of the NCC and shall meet or exceed the requirements of both the OBC and the NBC.*

4.2 General Requirements

- (a) All engineering and Design of mechanical systems shall be provided by Professional Engineers educated in mechanical engineering having the prerequisite experience in the building systems contained within this Article.
- (b) Mechanical Design, Equipment, and installation shall comply with local Authorities Having Jurisdiction.
- (c) Provide temperature, pressure, and velocity control to provide an acceptable level of comfort for both Passengers and operating and maintenance personnel. Provide the necessary environmental controls required for the optimum performance of the transit System.
- (d) Place floor-mounted Equipment on heavy-weight reinforced concrete housekeeping pads with chamfered edges.
- (e) Provide a BAS for each Station to control the systems and Equipment in this Article. Provide one OWS for each Station, complete with GUI, all computer hardware and software. Each workstation shall be connected to the TSCC, and communicate with other control systems. System shall be expandable to protect for future system expansion. Mechanical Equipment shall have standalone control, and shall be controlled and monitored by the BAS.
- (f) The analytical Design of the ventilation systems serving the Tunnel and the public areas of the Stations shall be carried out by the use of a certified applicable computer modeling program.
- (g) All Equipment, ductwork, pipes, supports, accessories, and their connections to the Structure, shall be designed to resist seismic force and to accommodate building seismic deflection in accordance with OBC 4.1.8.17. Additionally, where mechanical infrastructure crosses expansion joints, or other places where differential lateral

displacement may occur, the piping, ducts etc shall be attached in a manner that accommodates the differential movement.

- (h) Project Co shall coordinate all locations of louvers, HVAC Equipment and ductwork visible in public areas with the architect and may be subject to NCC approval.

4.3 Design Requirements

- (a) Scope

- (i) The following shall be provided with heating and cooling systems based on criteria set forth in this Article. All spaces listed here may not be included in each Station:

- A. Staff Washrooms;
 - B. Public Washrooms;
 - C. Communications/Telephone Rooms;
 - D. Elevator Machine Rooms;
 - E. Escalator Machine Rooms;
 - F. Emergency Power Rooms (UPS);
 - G. Fare Equipment Rooms;
 - H. Lunchroom;
 - I. Multi-purpose rooms;
 - J. Bus supervisor's office;
 - K. All spaces within bus operators buildings;
 - L. Passenger Station Electrical Rooms (if not feasible to heat and ventilate to maintain space conditions); and
 - M. Traction Power Substations when constructed within the limits of a station; underground; combined with an entrance facility or within an existing building.

- (ii) The following areas require heating and ventilation based on criteria set forth in this article:

- A. Emergency Generator Rooms;
 - B. Fire Pump Rooms;

Ottawa Light Rail Transit Project

- C. Janitor Closets / Rooms;
- D. Passenger Station Electrical Rooms (if feasible to heat and ventilate to maintain space conditions);
- E. DWAs;
- F. Sewage Ejector Rooms;
- G. Storage and maintenance Rooms;
- H. Sump Pump Rooms;
- I. Ventilation Rooms; and
- J. Valve Rooms.

(b) Design Conditions

(i) Indoor Design Conditions:

- A. Air conditioning Design parameters for Station spaces shall be as detailed in Table 5-4.1.

Table 5-4.1: Indoor Design Conditions

Space/Room (See Note 1)	Minimum Temperature (°C)	Maximum Temperature (°C)	Outside Air per Occupant(l/s)	Air Filtration (MERV)	Humidity Summer / Winter (%RH)
Fare Equipment Room	18	26	12	12	50/30
Lunch Room	22	24	17	8	50/10
Bus supervisor's	18	24	17	8	50/10

office					
Multi-purpose Room	18	24	17	8	50/10
Public Washrooms	22	5.5 (See Note 2)	(See Note 3)	8	-

Notes for Table 5-4.1:

- i. *For spaces not listed, Project Co shall be responsible to determine the indoor environmental requirements in compliance with all codes standards and equipment requirements Ventilation Design shall maintain space temperature Design for 5.5°above outside ambient summer Design temperature.*
- ii. *Ventilation Design shall maintain space temperature Design for 5.5°above outside ambient summer Design temperature. Space may be included in central air handling system that provides heating and cooling if justified by first cost as add-on to space(s) that require mechanical cooling.*
- iii. *Provide mechanical exhaust system at exhaust rate as required by the OBC. Provide outside air for exhaust air make-up. Recirculation of supply air to this space is not permitted.*

(ii) Air Distribution System Design Velocities

A. Design velocities shall be selected to suit system performance requirements and to minimize noise, drafts, and intake of dust particles. The maximum recommended velocities in air distribution systems are:

B. Sheet Metal Ducts

- i. Branch supply duct: 6m/s (1,200ft/min)
- ii. Fresh-air intake duct: 6m/s (1,200ft/min)
- iii. Main exhaust and return ducts: 6m/s (1,200ft/min)
- iv. Branch exhaust and return ducts: 2.5m/s (500ft/min)

- v. Transfer duct: 1.25m/s (250ft/min)
- C. Air Outlets and Intakes
 - i. Supply registers and diffusers: 3.56m/s (700ft/min) neck velocity
 - ii. Exhaust and return grilles: 2.5m/s (500ft/min) through the net core area
 - iii. Transfer grilles: 1.25m/s (250ft/min) through the net core area
 - iv. Transfer louvers: 1.25m/s (250ft/min) through the net core area
 - v. Intake and discharge louvers: 2.5m/s (500ft/min) through the net core area

4.4 System Requirements

- (a) System concepts shall be based on the energy conservation guideline of the MNECB, OBC – Supplementary Standard SB-10 (including all revisions) and ASHRAE 90.1 (current OBC adopted version).
- (b) Economizer cycles shall be included for individual systems requiring mechanical cooling greater than 16 kW, except for spaces requiring critical indoor environmental control, such as, communication/telephone Equipment rooms. Economizer cycles shall be designed to vary the outside air from minimum air requirement based on ASHRAE Standard 62.1 (OBC currently adopted version) to 100% air requirement to meet space cooling needs when exterior conditions are acceptable.
- (c) Spaces requiring heating only shall have ventilation systems (as a separate system or a combined heating and ventilating system if deemed size appropriate) that provides cooling by introducing ambient (outside) air at a rate to limit the maximum space temperature to 5.5°C above ambient (outside) temperature.
- (d) Mechanical cooling shall be considered for heating and ventilation applications where the air flow rates become impractical to utilize ventilation to maintain the room temperature (such as Passenger Station Electric Rooms).
- (e) Outside air intakes shall be located to avoid the introduction of dirt, debris, fumes, odours, noise, irritants and biological agents from traffic and other external sources into the station rooms, and to avoid short circuiting of Station exhaust air. The height to the bottom of the intake shall be a minimum 3 meters above pedestrian accessible walking surface or Station site grade level.
- (f) The air conditioned rooms which service Equipment that requires reliability, such as, communication/telephone rooms, signal rooms, elevator machine rooms, shall also be positively pressurized to mitigate infiltration of contaminants such as brake dust from adjacent spaces.

- (g) The air filters shall be standardized in type and sizes to the extent possible.
- (h) Natural gas-fired Equipment shall not be permitted inside underground facilities.

4.5 HVAC Equipment

(a) General

- (i) To the extent practical, heat from condensing units shall be rejected to atmosphere at grade level. At a minimum, heat shall be rejected to outdoor areas remote from the public.
- (ii) Condensing units shall not be located in Tunnels, shafts, or any other areas subject to brake dust and debris.
- (iii) To the extent possible, condensing units serving the underground Stations shall be located at grade level.
- (iv) Air for ducted condensing units shall be taken from a location free from brake dust and debris.
- (v) Heat recovery systems as well as free cooling shall be utilized where practical for energy conservation.
- (vi) The level of fresh air supplied to occupied spaces shall be automatically controlled for energy conservation.
- (vii) All Equipment, ductwork, pipes, supports, accessories, and their connections to the Structure, must be designed to resist seismic force and to accommodate building seismic deflection in accordance with OBC 4.1.8.17. Additionally, where mechanical Infrastructure crosses expansion joints, or other places where differential lateral displacement may occur, the piping, ducts etc shall be attached in a manner that accommodates the differential movement.
- (viii) HVAC Equipment and piping shall not be located directly above any electrical device or Equipment.

(b) Air Handling Units

- (i) AHUs shall be provided for the following typical spaces:
 - A. Staff Washrooms**;
 - B. Communications/Telephone Rooms;
 - C. Elevator Machine Rooms**;
 - D. Escalator Machine Rooms**;

- E. Emergency Generator Rooms*;
- F. Emergency Power Rooms (UPS);
- G. Fare Equipment Rooms**;
- H. Fire Pump Room*;
- I. Janitor Closets / Rooms*;
- J. Lunchroom**;
- K. Multipurpose room**;
- L. Staff Washroom **;
- M. Public Washrooms*;
- N. Passenger Station Electrical Rooms;
- O. Sewage Ejector Rooms*;
- P. Storage and maintenance Rooms**;
- Q. Sump Pump Rooms*;
- R. Traction Power Substation;
- S. Ventilation Rooms*; and
- T. Valve Rooms*.

** Provide heating and ventilation for this space as the minimum requirement. This space may be heated and cooled by a central air handling system if justified by first cost when combined with a space (or spaces) requiring both heating and cooling versus an independent heating and ventilating only system. Local space temperature control shall be provided.*

*** This space may be heated and cooled by a central air handling system if justified by first cost when combined with a space (or spaces) requiring both heating and cooling versus an independent heating and cooling system. Local space temperature control shall be provided.*

(ii) AHUs shall be provided with the following:

- A. Mixing plenum.
- B. Opposed-blade motor-operated dampers or parallel low-leakage blade dampers with high-quality neoprene blade seals.

- C. Replaceable filter section, with differential pressure gauge across each filter bank.
 - D. Direct-expansion cooling coil and electric or gas heating coil section. Provide with stainless steel, double sloped, IAQ drain pan in cooling coil section.
 - E. Fan section: fans shall be non-overloading air foil type or backward inclined blades. Each fan shall be complete with adjustable pitch V-belt drive, electric motor, vibration isolators for mounting of fan and motor base, belt guard, magnetic starter, local hand-off-auto fan switch, space thermostat. The fan power requirement at any point of the fan power-capacity curve of the selected electric motors shall not exceed the maximum KW rating of the motors without using the motor safety factor. Fan outlet velocity shall not exceed 11.0 m/s.
 - F. Controls to include SCR controller for the electric heating coil and VFD control. AHUs to be controlled and monitored by the BAS system.
 - G. The unit casing shall be double-walled, G-90 galvanized steel, walls shall be a minimum of R-15 insulation, with hinged insulated access doors, interior lighting and water proof electric outlets, drain trap, stainless and steel condensate drain pan.
 - H. Single zone AHUs shall be controlled by a room thermostat activating either heating or DX cooling coil based on the temperature setting.
 - I. Where multiple zones are served from a single AHU, single temperature control shall be provided in the most critical rooms.
 - J. Where multiple critical zones are served from a single AHU, provide each zone with thermostats and VAV boxes.
- (c) Ductless Split Air Conditioning Units
- (i) Split Ductless Air Conditioning Units shall be provided (when not part of a central air handling system as described above) for the following spaces:
 - A. Staff Washrooms;
 - B. Elevator Machine Rooms;
 - C. Escalator Equipment Rooms; and
 - D. Lunchrooms.
 - (ii) Split Ductless Air Conditioning Units shall include the following components:

- A. Indoor, wall mounted or ceiling mounted, direct expansion fan coil unit consisting of a cooling coil, supply fan, fan motor, integral temperature sensing, all mounted in a unit cabinet, wired remote wall-mounted controller.
 - B. Air cooled outdoor unit with a propeller fan, high efficiency rotary or scroll type compressor, outdoor coil, refrigeration components, controls and safeties, all installed in a unit cabinet. Head pressure control for low outdoor ambient of -18°C operation. System shall be fully charged with refrigerant R-410a.
 - C. Field installed accessories, such as, low ambient temperature kit and winter start control.
- (d) Heat Rejection
- (i) Air-Cooled Condensing Units
 - A. Outdoor, air-cooled condensing units consisting of rotary scroll compressors, condenser coils, condenser fans (minimum one per compressor), refrigeration specialties, (sight glass, isolation valves, head pressure controls, charging valves, etc), operating controls, painted steel frame, electrical components (overloads, safeties, starters, etc).
 - B. Units shall utilize R-410a refrigerant.
 - C. Powder coated steel housing and structural frame.
 - D. Compressors and condenser fans shall be provided with vibration isolation.
 - E. Accessories shall include, low ambient control (where required for proper operation), hot-gas bypass (to evaporator coil) for capacity control, phase-loss protection, brown-out protection, condenser coil hail guards and condenser fan guards.

4.6 Heating Equipment

- (a) These criteria cover the heating systems and Equipment for the following typical areas:
 - (i) Staff Washrooms;
 - (ii) Communications/Telephone Rooms;
 - (iii) Elevator Machine Rooms;
 - (iv) Escalator Machine Rooms;
 - (v) Emergency Generator Rooms;

- (vi) Emergency Power Rooms (UPS);
 - (vii) Fare Equipment Rooms;
 - (viii) Fire Pump Room;
 - (ix) Janitor Closets / Rooms;
 - (x) Lunchroom;
 - (xi) DWAs;
 - (xii) Public Washrooms;
 - (xiii) Passenger Station Electrical Rooms;
 - (xiv) Sewage Ejector Rooms;
 - (xv) Storage and maintenance Rooms;
 - (xvi) Sump Pump Rooms;
 - (xvii) Traction Power Substation;
 - (xviii) Ventilation Rooms; and
 - (xix) Valve Rooms.
- (b) System Concepts
- (i) Heating systems shall be integral with cooling systems where space cooling system are provided. Electric resistance heating coils shall be provided as an integral part of the air handling Equipment or zoned duct mounted electric resistance heating coils may be used if the cooling ductwork system is serving multiple spaces.
 - (ii) Heated and ventilated spaces shall be heated with electric resistance unit heaters (cabinet type for finished spaces or ceiling suspended projection type for unfinished spaces), where heating and cooling air handling units are not provided for the space. The electric heating coil shall be an integral part of the air handling unit or supply air duct mounted downstream of the air handling unit, where heating and cooling air handling systems are provided.
 - (iii) Indirect gas-fired unit heaters may be provided in lieu of electric unit heaters if natural gas is readily available and combustion venting is easily achieved with the Design of the Station.

- (iv) Warming shelters for Passengers shall be heated with electric infrared heaters suspended from the ceiling or Structure. The units shall be thermostatically controlled.
- (c) Heating Equipment
 - (i) Electric Duct Heaters
 - A. Duct heater coils shall be of the slip-in type with open-type nickel chromium wire elements and designed to slide into ducts.
 - B. Duct heaters shall be interlocked with supply fans so they do not operate when the fan is off, and equipped with pressure airflow switches wired into the control circuit.
 - C. Duct heaters shall be sized so that the minimum air velocity through the coil complies with the heater manufacturer's requirements based on the kilowatts per unit area requirements and the coil enter air temperature.
 - (ii) Electric Unit Heaters
 - A. Shall be ceiling or Structure suspended type.
 - B. Electric Unit heaters shall have integral fan coils.
 - C. Electric heating element shall be open-type nickel chromium wire type.
 - D. Unit casing shall be factory painted steel with integral inlet and outlet louvers.
 - E. Units shall be provided with high temperature safety switches.
 - (iii) Electric Heating Coils for Air Handling Units
 - A. Factory installed by the air handling unit manufacturer.
 - B. Open-coil configuration with elements constructed of nickel-chromium wire.
 - C. Safeties included shall be:
 - i. Three-pole disconnect contactor;
 - ii. Airflow switches;
 - iii. Automatic reset high-temperature limit; and
 - iv. Step controller to control the stages of heat.

- (iv) Electric Radiant Heater
 - A. Heaters shall be UL/ULC listed for horizontal outdoor surface and suspended mounting.
 - B. Enclosures shall be a minimum 20 gauge cold rolled steel finished with powered coated paint.
 - C. Reflectors shall be one-piece construction and a minimum 0.030 gold anodized aluminum with the proper angle to reflect infrared heat.
 - D. Elements shall be infrared quartz tube with high thermal shock characteristics.
 - E. Heaters required on platforms and shelters:
 - i. Each individual unit shall be rated at 6,000W minimum; and
 - ii. Each individual unit shall be independently controlled by a patron activated switch, controlling a rated contactor with a maximum run time of 15 minutes. Contactor shall have a hand-off-auto selector switch with pilot light.

- (v) Gas Fire Unit Heater
 - A. Heaters shall be ETL listed for horizontal suspended mounting.
 - B. Heaters shall be 90% or greater combustion efficiency.
 - C. Heaters shall have indirect gas-fired separate combustion / intake section with power venting fan.
 - D. Burner shall be stainless-steel, one piece construction.
 - E. Enclosures shall be galvanized steel finished with powered coated paint.
 - F. Provide with all controls, gas-valves, direct spark ignition and safety limits switches.

4.7 Ductwork

- (a) Ductwork materials, construction, joints, fittings and accessories shall be in accordance with the latest SMACNA standards and the OBC.
- (b) Ducts shall be sized by the static regain method, or for an equal pressure drop of 0.85 Pa per meter of duct, as appropriate. Maximum velocities shall not exceed those specified.

- (c) Sheet metal ducts shall be constructed of galvanized steel unless otherwise specified, designed for medium or high air pressure operation with airtight joints to suit the application, and sufficiently stiffened and supported to avoid sagging and vibration.
- (d) Flexible ductwork shall not be used in Stations.
- (e) All Equipment, ductwork, pipes, supports, accessories, and their connections to the Structure, shall be designed to resist seismic force and to accommodate building seismic deflection in accordance with OBC 4.1.8.17.
- (f) Ductwork shall be concealed from public view.

4.8 Supply Air Diffusers

- (a) Supply air diffusers shall be selected to provide the required throw and spread with the least amount of draft and noise.
- (b) Supply air diffusers shall be provided with opposed blade damper, adjustable from the face of the diffuser.

4.9 Exhaust / Return Registers and Grilles

- (a) Exhaust and return air registers shall be sized for the velocities indicated in this Article. They shall be equipped with fixed, non-see-through blades or louvers, or the duct behind them shall be painted black.
- (b) Registers shall be equipped with opposed-blade, adjustable-volume dampers, key-operated through the face.
- (c) Registers and grilles shall be constructed of aluminum with factory applied finish.
- (d) Registers and Grilles shall be located out of the reach of Passengers.
- (e) Registers and Grilles shall be provided with removable, cleanable insect screens.

4.10 Supply Registers and Grilles

- (a) Supply air registers shall be sized for the velocities indicated in this Article. They shall be equipped with fixed, non-see-through blades or louvers, or the duct behind them shall be painted black.
- (b) Registers shall be equipped with opposed-blade, adjustable-volume dampers, key-operated through the face.
- (c) Registers and grilles shall be constructed of aluminum with factory applied finish.
- (d) Supply registers and grilles shall be located out of the reach of Passengers.

4.11 Intake and Exhaust Wall Louvers

- (a) Wall louvers shall be weather resistant extruded aluminum construction.
- (b) Wall louvers shall be tested and certified in accordance with AMCA Standard 500-L for certified air and water penetration performance ratings. The certified ratings to indicate the following:
 - (i) Water penetration of 0.003 kg /m² or less at a free area velocity of 305 meters per minute; and
 - (ii) The maximum air pressure drop shall be 0.381mm hg at 305 meters per minute for intake mode.
- (c) All louvers shall have baked enamel finish.
- (d) Louvers shall have bird screens.
- (e) Louvers shall have insect and bird screens when used for intake out without downstream air filters.

4.12 Volume Dampers in Branch Ducts

- (a) Adjustable volume dampers shall be provided for all branch ducts serving more than one outlet.
- (b) The dampers shall be equipped with locking quadrants, and blades sufficiently stiffened at the edges to effectively close off the duct with no vibration under any condition of operation.

4.13 Fire / Smoke Dampers

- (a) Fire dampers and/or smoke dampers or combined fire/smoke dampers shall be provided in ducts where required by NFPA, OBC and local codes, whichever is more stringent. Fire dampers shall be Type B or C and UL/ULC approved.

4.14 Air Filtration

- (a) Replaceable media filter sections shall be arranged in banks.
- (b) Filter media shall have a MERV rating as indicated in Table 4-1, when evaluated under the guidelines of ASHRAE Standard 52.2.
- (c) Initial resistance to airflow shall not exceed 62 Pa at a velocity of 2.5m/s.
- (d) The air filter material shall be classified by Underwriters' Laboratories as UL Class 2.
- (e) Differential pressure gauges shall be provided cross each filter bank.

4.15 HVAC Piping

- (a) Refrigerant piping
 - (i) Piping sizes greater than 5/8" O.D. shall be hard copper complying with ASTM B280, type ACR.
 - (ii) Piping sizes 5/8" O.D. or smaller may be either hard copper complying with ASTM B280, Type ACR or annealed copper complying with ASTM B280, with minimum wall thickness as per CAN/CSA B52 and ASME B31.5.
 - (iii) All piping fittings shall meet ASTM B16.22 shall be brazed with silver solder. All joints shall be brazed with silver solder. Valves and refrigerant specialties shall be flared, flanged or brazed connections.
- (b) Condenser Water (Glycol) Piping
 - (i) Piping shall be ASTM A53 Grade B.
 - (ii) Piping joints NPS2 and smaller shall be screw joints and fitting.
 - (iii) Piping joints NPS2-1/2 and larger shall be welded joint and fittings.
 - (iv) Screwed fittings shall meet ASME B16.3 Class 150.
 - (v) Piping flanges shall meet ASME B16.5.

4.16 Thermal Insulation

- (a) Externally applied thermal insulation shall be provided for the following ductwork:
 - (i) All outside air ductwork and outside air louver plenums to air handling Equipment (air handling units, make-up air units and supply air fan inlets);
 - (ii) All supply and return air ductwork transporting supply or return air that is above or below the conditioned space Design or in an unconditioned space;
 - (iii) Exhaust ductwork from a shower area where ductwork is in an unheated space;
 - (iv) Exhaust ductwork 3m from the exhaust air louver where ductwork is in an unheated space; and
 - (v) All supply, return, exhaust and relief air plenums.
- (b) Thermal insulation shall be provided for the following piping systems:
 - (i) Refrigerant – Suction and hot-gas piping;
 - (ii) Condenser water; and

- (iii) Piping exposed in public spaces or to public view shall have a rigid aluminum jacket.
- (c) Ductwork and plenum insulation shall be the following:
 - (i) Concealed and Round Duct: Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Complying with ASTM C553, Type III with factory-applied FSK jacket;
 - (ii) Exposed Ductwork: Mineral-Fiber Rigid Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket; and
 - (iii) Insulation thickness and R-value shall be per the requirements of ASHRAE 90.1.
- (d) Piping insulation shall be the following:
 - (i) Flexible Elastomeric Insulation: Closed-cell, sponge or expanded rubber materials. Comply with ASTM C534, Type I for tubular materials;
 - (ii) Mineral-Fiber, Preformed Pipe Insulation: Type I, 454°C Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ; and
 - (iii) Insulation thickness and R-value shall be per the requirements of ASHRAE 90.1.

4.17 Acoustic Lining

- (a) Interconnecting ductwork between men's and women's washrooms shall be acoustically lined to prevent cross-talk.

4.18 Building Automatic System

- (a) Temperature Control Systems
 - (i) Provide an open-protocol industrial control system for each Station. The system shall connect to the CTS via a station gateway and be controlled from the BAS server location at the TSCC. Dual redundant links to the station gateway shall be provided. The BAS shall provide additions interfaces to support the controlled and monitored equipment. In the event of loss of CTS the BAS shall maintain local control and monitoring functionality until the CTA is reconnected..
 - (ii) When controlling smoke management (emergency ventilation) fans through the BAS, all control devices and the control network shall be UUKL-864 listed for smoke control systems.

- (iii) All systems shall utilize electronic/electric actuators. Pneumatic systems and/or actuators shall not be permitted.
- (iv) All sensors shall be electronic. All sensors, in public spaces, shall have vandal/tamper resistant housing and mounting.
- (b) Single Zone Heating and Cooling Systems
 - (i) Single Zone Heating and Cooling Air Handling Systems
 - A. Utilize room thermostat to control the heating coil(s), cooling coils and condensing units in order to maintain the maximum air temperature setting in the room.
 - B. Utilize direct digital controls to determine use of 100% outside air economizer cooling versus mechanical cooling.
- (c) Heating and Ventilation Systems
 - (i) Single Zone Heating and Ventilation Air Handling Systems
 - A. Utilize room thermostat to control the heating coil(s) and outside air dampers for economizer cooling.
 - B. The supply air temperature required shall be based on room temperature and outside air temperature.
 - (ii) Separate Heating Units and Ventilation Systems
 - A. Utilize room / space thermostats to control heating units and ventilation system.
 - B. Simultaneous heating and ventilation shall not be permitted beyond minimum outside air requirements for the space.
- (d) Variable Air Volume Heating and Cooling Systems
 - (i) Utilize duct temperature sensors to control the pre-heating coil(s), cooling coils and condensing units in order to maintain the maximum air temperature setting for the supply duct.
 - (ii) Utilize room / space temperature to modulate the variable volume supply terminal boxes and heating coil to maintain the room / space temperature set point.
 - (iii) Utilize direct digital controls to determine use of 100 % outside air economizers versus mechanical cooling.

- (iv) Provide verification that the outside air flow minimum requirements are being met at all times.
- (e) Emergency Ventilation Systems
 - (i) Provide controls to automatically operate the emergency ventilation system based on smoke detection and/or fire sprinkler system activation.
 - (ii) Emergency Ventilation Systems shall be controlled by UUKL listed control system.
 - (iii) Provide fire fighters control panel for manual control of the system.

4.19 Emergency Ventilation Systems

- (a) Design Criteria
 - (i) Provide emergency ventilation systems for the following Stations and associated Tunnels:
 - A. Downtown East;
 - B. Downtown West;
 - C. Rideau;
 - D. St. Laurent; and
 - E. Any Station (in addition to the above listed) or Tunnel requiring emergency ventilation per the OBC and / or NFPA-130.

4.20 Plumbing

- (a) General Design Requirements
 - (i) Each Station shall be serviced by one municipal water connection split at the property line for two building connections. One connection shall be metered for potable water and one metered to serve the fire protection system.
 - (ii) All valves and accessories shall be arranged in places accessible for operation without the use of chain wheel valve operation or additional access platforms.
 - (iii) To the extent possible, piping shall not be embedded in concrete Structure.
 - (iv) Sleeves shall be provided wherever pipes penetrate Structures.
 - (v) Piping shall not be routed through areas containing electrical, communication, signaling Equipment, or any other Equipment essential for the safe operation of

the transit System, with the exception of water supply to the emergency eye/face wash stations servicing the room.

- (vi) Equipment requiring drainage shall not be located directly over critical Equipment rooms such as communication rooms, signal rooms, and electrical rooms.
 - (vii) Rooms with lavatories, sinks, mop sinks and eyewash stations shall be provided with cold and hot water services. These rooms shall include but not limited to:
 - A. Washrooms;
 - B. Lunchrooms;
 - C. Janitor's Rooms;
 - D. Battery Rooms;
 - E. HVAC Rooms; and
 - F. Sump Pump and Sewage Ejector Rooms
 - (viii) Isolation valves shall be provided at, but not limited to, the following locations:
 - A. On each pressure main at building entrances, at a location approved by the Relevant Authority;
 - B. On the inlet and outlet side of each water heater;
 - C. On each branch of distribution mains;
 - D. At each Station floor level or area requiring isolation;
 - E. At each plumbing fixture or a group of fixtures; and
 - F. On both sides of in-line accessories and Equipment that requires removal or isolation from the piping system for maintenance purpose.
- (b) Piping Systems
- (i) Pipes and Fittings
 - A. Water distribution piping embedded in Structures shall be soft annealed copper tubing Type K with no buried joints. Embedded Type K copper piping shall be protected from direct contact with the concrete by use of a piping jacketing material (such as rubber). However, embedded piping shall be avoided where possible. Water piping within Structures shall be hard drawn-copper tubing Type L with wrought brass or copper fittings.

- B. Water service entrances shall be ductile iron grooved joint for 75mm diameter and larger.
- C. Water service entrances shall be Type K soft copper for 50mm diameter and less.
- D. Drainage pipes 50mm and smaller within Structure shall be copper tube Type DWV or hard Type M copper. Drainage pipes 75mm and larger within Structure shall be heavy weight cast iron pipe with one layer of protective coating, bell and spigot fittings, below ground; and service-weight, no-hub, above ground. Plastic pipe is only permitted for below ground. All piping material listed herein shall meet the OBC. All piping slopes as required by the OBC.
- E. Vent pipes 50mm and smaller within Structures shall be copper tube Type DWV or hard Type M copper. Vent pipes 75mm and larger shall be galvanized steel threaded pipe or no-hub service-weight cast iron pipe and fittings.
- F. Forced mains shall be ductile iron pipe with grooved joints or standard-weight galvanized steel pipe with joints of a size and type and as approved by the local Authorities Having Jurisdiction.
- G. Main pumped discharge pipes to the City sewer and main vent pipes to grade level or roof shall be one size larger than required by the OBC.
- H. Domestic cold water incoming service lines shall be one size oversized and shall not be less than 50mm in diameter or as indicated in the City of Ottawa Design Guidelines.
- I. The minimum size of fixture drainage piping installed beneath floor slabs shall be 50mm; the maximum size of waste pipe installed in structural slabs shall be 50mm.
- J. Above-ground natural gas piping system less than 6.9 kPA shall be ASTM A53 Grade B Schedule 40 with threaded fittings (ASTM A197) for piping sizes 51mm and less. Pipe sizes 64mm or larger shall be ASTM A53 Grade B seamless piping with welded fittings (ASTM A234) and welded joints.
- K. Above-ground natural gas piping system over 6.9 kPA shall be ASTM A106 Grade B Schedule 40 with socket weld fittings (ASTM A105) for piping sizes 51mm and less. Pipe sizes 64mm or larger shall be ASTM A53 Grade B Schedule 40 seamless piping with welded fittings (ASTM A234) and welded joints.

- L. Fuel-oil piping systems shall comply with CAN/CSA B139 and shall be black steel ASTM A53 with welded joints and fitting for above ground piping. Buried piping shall be double wall (complying with UL971) PVDF complying with ASTM D3222 for carrier pipe with mechanical couplings to seal carrier, and PE pipe complying with ASTM D4976 for containment piping. Provide transition sump Structures between buried and above ground piping.
 - M. Dielectric couplings shall be provided for the connection of pipes of dissimilar metals, and in all metallic piping entering a facility.
 - N. Corrosion control measures shall be provided for buried pipes and pipes contained in the Tunnel subject to DC stray currents.
 - O. Above ground combustible pipe materials such as ABS, PVC, CPVC, polyethylene, and polypropylene shall not be permitted.
 - P. Piping exposed to freezing temperatures shall be insulated and provided with electric heat tracing cable system as per this Article.
- (ii) Cold Water Service
- A. The domestic cold water shall be metered per the City of Ottawa requirements.
 - B. Fire water service connections shall be metered per the City of Ottawa requirements.
 - C. Each service shall have a main shut-off valve immediately inside the Structure wall.
 - D. Cold water for retail areas shall be separately metered.
 - E. Backflow preventers shall be provided to conform to local code requirements.
 - F. Where service water pressure is above 550 kPa at the water service room, pressure reducing valve assemblies shall be provided which include a pressure reducing valve, three-valve bypass and strainer.
 - G. Minimum fixture service requirements shall be calculated from the following water supply fixture unit values:
 - i. Flush valve water closet: 10;
 - ii. Flush valve urinal: 5;
 - iii. Lavatory: 2;

- iv. Service (mop) sink: 3; and
 - v. Kitchen Sink: 2.
- (iii) Hot Water Service
- A. Potable water heater shall be commercial grade electric or natural gas-fired meeting the requirements of ASHRAE 90.1 / OBC SB-10 or MNECB (the most stringent). Water heater shall be sized based on 38.9° C temperature rise and in accordance with ASPE or ASHRAE, and sized to meet the demands of the fixtures that are served by the heater.
 - B. Combination pressure-temperature relief valves shall be provided in accordance with code requirements with the discharge piped indirectly to 152mm above a nearby floor drain or a mop sink.
 - C. Thermal expansion of the water shall be accommodated by providing a bladder type expansion tank designed for use with potable water.
 - D. Hot water circulation pump shall be provided where the supply piping exceeds 15m in length. Provide time-clock function to control operating period of each circulation pump.
 - E. When water heaters are located above the floor or if not located on the lowest floor in the facility, set the water heater in a secondary drain pan with an indirect drain connection to the nearest floor drain.
 - F. Provide a thermostatic mixing valve to deliver a maximum of 43.3°C (110°F) hot water to any hand-washing lavatory or sink.
- (c) Insulation and Freeze Protection
- (i) Piping insulation shall be the following:
 - A. Flexible Elastomeric Insulation: Closed-cell, sponge or expanded rubber materials. Comply with ASTM C534, Type I for tubular materials.
 - B. Mineral-Fiber, Preformed Pipe Insulation: Type I, 454 deg C Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ.
 - C. Insulation thickness and R-value shall be per the requirements of ASHRAE 90.1.
 - (ii) The following piping shall be insulated:
 - A. Cold water piping;

- B. Hot water piping and hot water circulation piping;
 - C. Portions of drainage piping subject to freezing;
 - D. Portions of drainage piping subject to sweating; and
 - E. Electric heat traced piping.
- (iii) Electric Heat Tracing Cable
- A. Piping exposed to ambient temperatures at or below freezing shall be provided with electric heating tracing cable system as indicated herein in addition to thermal piping insulation:
 - B. Provide a complete ULC Listed system of heating cable and components approved specifically for pipe heat tracing. The heat tracing system shall conform to ANSI/IEEE Standard 515.1.
 - C. The self-regulating heat cable shall consist of two nickel-plated copper bus wires embedded in a radiation cross-linked semi-conductive polymer core.
 - D. The heat cable shall be capable of varying its heat output along its entire length, allowing the heat cable to cross over itself without overheating.
 - E. The heat cable shall be covered by a polyolefin dielectric jacket rated 300 VAC at 105°C and a tinned copper braid (12 AWG equivalent wire size).
 - F. In addition to a tinned copper braid, the heating cable shall be covered by a polyolefin outer jacket for protection from aqueous inorganic chemicals.
 - G. The heat cable shall operate on a line voltage of (110-120 or 208-277) VAC without the use of transformers.
 - H. The heat cable shall be suitable for use on metallic and non-metallic piping.
- (d) Plumbing Fixtures and Specialties
- (i) Fixtures shall be water conserving type and shall meet the consumption outlined in the OBC, ASHRAE 90.1 or the requirements herein or the requirements of Relevant Authority. The most stringent of these shall apply.
 - A. Water closets shall be wall-hung, of the siphon-jet, elongated-bowl type, and shall have a flush valve. Water closets shall be constructed of vitreous china complying with ASME A112.19.2. / CAN/CSA B45.1. Water closets shall be designed for 4.8 Lpf. Provide with concealed floor mounted fixture carrier. Provide with heavy-duty open-front seat with self-sustaining check hinges.

- B. Urinals shall be wall-hung, of the washout type, and shall have a flush valve. Urinals shall be constructed of vitreous china complying with ASME A112.19.2. / CAN/CSA B45.1. Urinals shall be designed for 1.9 Lpf. Provide with concealed floor supported fixture carrier. Waterless urinals shall not be provided for any OLRT Station.
 - C. Flush valves shall be diaphragm oscillating type, manually operated Design for low consumption in staff areas, hard wired electronic infrared in public washrooms.
 - D. Lavatories shall be wall-hung or counter top; hard wired electronic infrared “No Touch” faucets for public areas.
 - E. Water supplies to fixtures shall have loose key-operated service valves.
 - F. The pipe connection shall be designed for the pressure recommended by the fixture manufacturer; the pressure, however, shall not be less than 207 kPa for flush valves, and not less than 138 kPa for other fixtures.
 - G. The water supply to lavatories and flush-valve fixtures shall be provided with water hammer shock-absorbing devices.
 - H. Shock-absorbing devices shall also be provided at each pipe riser and in accordance with standard PDI-WH201.
 - I. Vacuum breakers shall be installed on all outlets with hose bib and wall hydrant connections and submerged inlets.
 - J. Mop sinks complete with both hot and cold water service shall be provided in janitor’s rooms.
 - K. Lunchrooms shall be provided with stainless steel sink units, mounted in counter-top assemblies.
- (ii) Emergency Eye / Face Wash Stations
- A. Emergency eye wash station shall be provided in the following spaces:
 - i. Electrical Battery Rooms or any other room containing acid batteries;
 - ii. Janitorial Rooms or any other rooms containing chemicals; and
 - iii. HVAC Equipment Rooms.
 - B. Emergency eyewash / face wash stations shall meet ANSI Standard Z358.1
 - C. Eyewash stations shall be wall or pedestal mounted.

- D. Eyewash stations may be combined with emergency showers where both are required in the same space.
 - E. Emergency eye / face wash shall be provided with tempered water through a thermostatic mixing valve.
- (iii) Emergency Shower Stations
- A. Emergency showers shall be provided for the following spaces:
 - i. Battery Rooms or other rooms containing acid batteries or chemicals; and
 - ii. Where required by local Authorities Having Jurisdiction.
 - B. Emergency shower stations shall meet ANSI Standard Z358.1.
 - C. Emergency showers may be combined with emergency eye / face wash where both are required in the same space.
 - D. Emergency showers shall be provided with tempered water through a thermostatic mixing valve.
- (iv) Hose Bibs and Wall Hydrants
- A. Provide hose bibs for the following spaces:
 - i. Washrooms;
 - ii. HVAC Rooms;
 - iii. Janitor's Rooms;
 - iv. HVAC Rooms;
 - v. Fire Pump Rooms;
 - vi. Refuse Rooms; and
 - vii. Sump Pump and Sewage Ejector Rooms.
 - B. Provide non-freeze wall hydrants for the following areas:
 - i. Concourse Level;
 - ii. Platform Level; and
 - iii. Public Areas.

- iv. Bus transfer platforms
- C. Hose bibs shall be as follows:
 - i. Brass construction, DN 20 size, Brass wheel handle;
 - ii. Teflon impregnated packing;
 - iii. DN 20 hose connection;
 - iv. Integral backflow preventer meeting ASSE-1052 requirements; and
 - v. Soldered inlet (exposed supply).
- D. Wall hydrants shall be as follows:
 - i. Freeze-proof faucet, bronze casing;
 - ii. Recessed hinged, locking polished bronze (nickel) box and cover;
 - iii. Self draining;
 - iv. Integral backflow preventer meeting ASSE-1052 requirements;
 - v. DN 20 size; and
 - vi. Length as required.
- (v) Drinking Fountains
 - A. Provide frost resistant drinking fountains in public spaces.
 - B. Drinking fountains shall be as follows:
 - i. Standard: Comply with NSF 61;
 - ii. Unit designed for mounting on exterior of building with valve and waste located in adjacent heated space;
 - iii. Designed to operate without draining into ground;
 - iv. Wall mounted rectangular, stainless steel;
 - v. Receptor: Rectangular, stainless steel with bubbler. Barrier-Free units where required;
 - vi. Push-button control;

- vii. Supply Fittings: Remote air operated shutoff and flow-control valve assembly; and
 - viii. Drain: Grid type NPS DN 32 with remote P-trap for frost-resistance.
- (vi) Trap Primers
- A. Per the OBC, all floor drains, without a permanent source of water, shall have an automatic trap sealing device to maintain the water seal.
 - B. Project Co shall provide one of the following methods of maintaining trap seal prime. The methods below are in order of acceptability:
 - i. Indirect draining of drinking fountains to floor drain (when available and practical).
 - ii. Using waste water from sinks or lavatory drains by providing specially designed tail-piece or P-Trap with trap primer connection and extending to floor drain P-trap primer connection. Use this when lavatories or sinks are available to prime the nearby floor drain traps.
 - iii. Using vacuum breaker type trap primer connection from specially designed flush valve riser tubing. Extend to floor drain traps.
 - iv. When a, b or c above is not available, use automatic trap primer valves designed to meet maintain the trap water seal by allowing water flow when the pressure drops in the cold water supply line at a water closet or urinal. Connections to the automatic trap primer valve must be made at a flush valve, mop sink or sink faucet.
- (vii) Floor Drains
- A. The following areas (but not limited to) shall be provided with floor drains:
 - i. HVAC rooms at air handling Equipment (for condensate disposal);
 - ii. Elevator machine rooms (for condensate disposal);
 - iii. Escalator machine rooms(for condensate disposal);
 - iv. Emergency generator rooms;
 - v. Emergency power rooms (UPS) (for condensate disposal);
 - vi. Fare Equipment rooms (for condensate disposal);

- vii. Fire pump room;
- viii. Janitor closets / rooms;
- ix. Lunchroom (for condensate disposal);
- x. Staff washroom;
- xi. Public washrooms;
- xii. Sewage ejector rooms;
- xiii. Sump pump rooms;
- xiv. Ventilation rooms;
- xv. Valve Rooms;
- xvi. Top and bottom of stairs of Station entrances (trench drains);
- xvii. Bottom of stairs (trench drains);
- xviii. Escalator lower pits;
- xix. Platform areas, where drainage to track level is not achievable;
- xx. Track level within the stations;
- xxi. Concourse levels, along the edge of the perimeter wall;; and
- xxii. Connecting passageways, along the edge of the perimeter wall;

(viii) Sewage Ejector

- A. Where the waste discharge from plumbing fixtures is located below the invert level of the City's gravity sanitary piping system, provide a package sewage ejector to lift with discharge of these fixtures that are below the City's sanitary main to the sanitary sewer main.
- B. Sewage ejectors shall be packaged units with duplex electric motor-driven centrifugal pump units completely assembled and tested at the factory as described below:
 - i. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump, cast iron housing;
 - ii. Impeller: Statically and dynamically balanced, ASTM B584, stainless steel, non-clog, open, or semi-open Design for solids handling;

- iii. Pump and Motor Shaft: Stainless steel. Mechanical seal; and
 - iv. Motor: Hermetically sealed, capacitor-start type with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
- (ix) Sump Pump
- A. Where the storm water discharge from below grade inlets (such as area drains, trench drains and structural foundation drainage is located below the invert elevation of the City's gravity storm sewer piping system, provide a package sump pump to lift the subsurface water to the City's storm sewer main.
 - B. Sump pumps shall be packaged units with duplex electric motor-driven centrifugal pump units completely assembled and tested at the factory as described below:
 - i. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump, cast iron housing;
 - ii. Impeller: Statically and dynamically balanced, ASTM B584, stainless steel, non-clog;
 - iii. Pump and Motor Shaft: Stainless steel. Mechanical seal; and
 - iv. Motor: Hermetically sealed, capacitor-start type with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

4.21 Fire Protection

- (a) General Design Requirements
- (i) Project Co shall provide complete automatic dry standpipe system for all Stations and portions of Tunnels within 20m of the Platform. The automatic dry standpipe system shall meet the requirements of, but not limited to, the OBC, NFPA-130 and NFPA-14.
 - (ii) Project Co shall provide complete automatic sprinkler system for areas of each Station required by the OBC. These areas shall include but are not limited to the following:
 - A. Booths and kiosks that are non-mercantile occupancy with floor area greater than 20m²;

- B. Public area if leased space exceeds 15% of public area;
 - C. Service rooms;
 - D. Escalator enclosure; and
 - E. Roofing if required fire resistance rating per OBC.
- (iii) Sprinkler systems shall be wet type if not subject to freezing weather conditions; otherwise dry-pipe systems shall be required.
 - (iv) Project Co shall evaluate cost and performance impact between providing automatic dry-pipe sprinkler system in Platform level of enclosed Stations to control the fire / smoke development and the reduction in the emergency ventilation system required airflow and Equipment versus not providing sprinklers in the Platform level and the required emergency ventilation system without sprinklers.
 - (v) The exception to item 4.21(a) (iii) above is St. Laurent Station. St Laurent Station has an existing dry-pipe sprinkler system on the Platform level. This system shall be revised by Project Co as required to meet the requirements of NFPA-13.
 - (vi) Project Co shall perform/obtain water flow / pressure test for each Station for use in Designing fire sprinkler and standpipe systems.
 - (vii) Provide clean agent fire suppression system for all communications Equipment rooms. Comply with NFPA-2001.
 - (viii) Project Co shall provide electric or diesel engine driven fire pumps, as required, to maintain standpipe system flow and pressure required by the OBC and the Relevant Authority Fire pumps shall be installed in accordance with NFPA-20.
 - (ix) All sprinkler system shall be designed and installed per the requirements of NFPA-13.
 - (x) All standpipe system shall be designed and installed per the requirements of NFPA-14.
 - (xi) Project Co shall provide a fire department connection for each Station at the location determined by the Relevant Authority.
 - (xii) Project Co shall provide portable fire extinguishers as required by the OBC and the Relevant Authority throughout each Station.
- (b) Sprinkler Systems
 - (i) Automatic wet piping system

- A. All systems shall be hydraulically evaluated for the most cost and performance effective Design.
 - B. All sprinkler zones shall be with NFPA-13 and ULC alarm valve assembly.
 - C. Systems shall be designed for the water density required by NFPA-13 for the area hazard group classification.
 - D. Provide sprinkler head guards for upright sprinklers in service spaces and where sprinkler heads are susceptible to damage.
 - E. Piping shall be black steel meeting the requirements of NFPA-13. Plastic (non-metal) and copper piping shall not be utilized for OLRT Structures.
 - F. Joints shall be either screwed, welded or roll-groove joints with ULC approved rigid-coupling system.
 - G. All piping fittings shall be ULC approved use in wet sprinkler systems.
 - H. Valves shall be ULC listed for fire sprinkler service.
 - I. Piping hangers shall be ULC listed for fire sprinkler piping systems.
 - J. All fire sprinkler systems shall be designed and installed with seismic anchoring, support and bracing based on the seismic criteria for Ottawa, Ontario, Canada.
 - K. Provide a double-detector check valve for incoming fire water service.
 - L. Buried water piping shall be outside coated, cement-mortar lined, ductile – iron piping and fittings per the requirements of NFPA-24. Provide required restraints or thrust blocks.
 - M. Provide wall or post-indicating valve on incoming fire water service main. The location of this valve shall be per the requirements of the Relevant Authority. Valves shall be ULC listed.
 - N. Provide alarm check valve for each system. Alarm check valve shall be ULC listed for fire service.
- (ii) Automatic dry piping system
- A. All systems shall be hydraulically evaluated for the most cost and performance effective Design.
 - B. All sprinkler zones shall be with NFPA-13 and ULC dry-pipe alarm valve assembly.

- C. Provide with an air-compressor assembly
- D. Systems shall be designed for the water density required by NFPA-13 for the area hazard group classification.
- E. Provide sprinkler head guards for upright sprinklers in service spaces and were sprinkler heads are susceptible to damage.
- F. Piping shall be galvanized steel meeting the requirements of NFPA-13. Plastic (non-metal) and copper piping is prohibited for OLRT Structures.
- G. Joints shall be either screwed, welded or roll-groove joints with ULC approved rigid-coupling system.
- H. All piping fittings shall be ULC approved use in dry sprinkler systems.
- I. Valves shall be ULC listed for fire sprinkler service.
- J. Piping hangers shall be galvanized steel and ULC listed for fire sprinkler piping systems.
- K. All fire sprinkler systems shall be designed and installed with seismic anchoring, support and bracing based on the seismic criteria for Ottawa Ontario, Canada.
- L. Provide a double-detector check valve for incoming fire water service.
- M. Buried water piping shall be outside coated, cement-mortar lined, ductile – iron piping and fittings per the requirements of NFPA-24. Provide required restraints or thrust blocks.
- N. Provide wall or post-indicating valve on incoming fire water service main. The location of this valve shall be per the requirements of the Relevant Authority. Valves shall be ULC listed.

(c) Standpipe Systems

- (i) Standpipe systems shall be automatic dry-type, Class III with both 38mm and 65mm hose connections.
- (ii) Standpipe systems shall be provided with two (2) hose connections (38mm and 65mm) at each location. Locations shall be based upon maximum spacing allowed by the OBC with hose stream length allow by the Relevant Authority.
- (iii) Standpipe systems shall be hydraulically calculated to provide the flow and pressure required by the OBC at the most hydraulically remote hose valve connection. The minimum piping diameter shall be 100mm.

- (iv) Automatic dry standpipes shall be constructed of hot-dipped galvanized steel ASTM A53 piping meeting the requirements of NFPA 14.
- (d) Clean Agent Fire Suppression Systems
 - (i) Provide clean agent fire suppression system for all Station communications rooms.
 - (ii) The suppression agent shall be HFC-227ea.
 - (iii) Project Co shall provide complete Design and installation of each clean agent system in accordance with NFPA-2001.
 - (iv) Provide each system with electric push button override.
 - (v) Piping shall be hot dipped galvanized (inside and outside) steel in accordance with NFPA-2001.
 - (vi) Pipe joints for 50mm and small diameter shall be screwed. Piping joints larger than 50mm diameter shall be welded. Piping threads shall meet ANSI B1.20.1.
- (e) Fire Pumps
 - (i) Provide a packaged ULC CSA listed / labeled fire pump where required to meet the flow and pressure requirements of the OBC for Rapid Transit Station standpipes. Project Co shall confirm all flow and pressure requirements of the standpipe systems with the Relevant Authority.
 - (ii) Packaged fire pumps may be diesel engine driven or electric motor driven as deemed cost efficient for actual Station application and installation.
 - (iii) Provide a ULC CSA listed electrically driven jockey pump for pressure maintenance.
 - (iv) Provide pump controller for fire pump and jockey pump.
 - (v) Provide all accessories to meet the requirements of NFPA-20.
 - (vi) Provide above ground, indoor, double wall fuel storage tank for diesel engine driven fire pumps. Provide fuel storage tanks that shall following minimum requirements:
 - A. Meeting the requirements of CAN/CSA B139-000;
 - B. Tank capacity shall meet the required run time of the fire pump during a fire. Project Co shall determine the fire pump run time with the Relevant Authority. Provide reserve tank volume for weekly testing of the fire pump;

- C. Constructed of steel;
 - D. Double wall construction for secondary containment. The secondary containment volume shall be a minimum of 110% of the total primary volume capacity;
 - E. Remote fill connection with automatic shut-off and over-fill containment;
 - F. Level monitor by mechanical visual meters and electronic measuring means;
 - G. Provide with fuel level alarms and tank interstitial containment space monitoring and alarm; and
 - H. Venting of both the primary and secondary containment volumes to the outdoors.
- (vii) Provide ULC listed fire pump controller.
- (viii) Provide ULC listed fire pump test header.
- (f) Portable Fire Extinguishers
- (i) Portable fire extinguishers shall be provided in accordance with NFPA 130, NFPA 10, OBC, OFC, and as modified by these Design criteria.
 - (ii) Station rooms containing a significant amount of electrical, electronic, and signal Equipment shall be provided with CO2 fire extinguishers, in addition to dry chemical fire extinguishers.
 - (iii) An additional Class A fire rated water pump tank extinguisher shall be provided within the refuse storage rooms.
 - (iv) Extinguishers in public area shall be enclosed in recessed stainless steel cabinets with solid covers.
- (g) Fire Department Connections
- (i) Free standing or wall mounted siamese connections constructed of polished bronze or chrome plated bronze. Verify the type required with the Relevant Authority.
 - (ii) Shall meet the requirements of NFPA 13 and ULC listed.
 - (iii) Free standing type shall be freeze resistant with drain down pit / tank.
 - (iv) Provide thread type required by the local fire department. Project Co shall verify the required thread pattern with the Relevant Authority.

- (v) All fire department connections shall be properly label with a permanent size stating the system(s) being served by the connection.

ARTICLE 5 ELECTRICAL DESIGN CRITERIA

5.1 Introduction

- (a) This Article presents the basic electrical Design guidelines, codes, and standard references that Project Co shall follow throughout the electrical Design process of LRT Stations.
- (b) Electrical spaces shall be properly located and sized to facilitate the installation and maintenance of Equipment.
- (c) The Design of the Station electrical systems shall provide for safe, reliable, and continuous operation.
- (d) Accessibility shall be provided to permit removal and replacement of major Equipment. These requirements are intended to promote uniformity in the Design approach and to standardize the type of Equipment and its location throughout the system.
- (e) Electrical power distribution Equipment shall be heavy duty construction and selected to provide Equipment longevity in condition of frequent electrical switching, shall be designed to provide lower Arc Flash potential during maintenance and shall be designed to provide high arc flash energy dispersion.
- (f) For the Design of all electrical systems, sustainable Design elements shall be utilized where applicable and practical.
- (g) The electrical distribution system shall distribute power for Passenger Station lighting, heating, ventilation and other Equipment and systems. Power and circuit requirements for signal and communication systems are subject to other Articles.
- (h) All electrical Equipment shall be individually identified by unique number matching Equipment schedule designation. The label shape, letter size, color coding and background color shall be standardized for the Project. Project identifying labels shall be designated for: cable trays, conduits, junction boxes, cables/wires and all electrical and electronic Equipment. In addition to the identification labels approval labels shall be provided as required per CSA, ULC, or Hydro Ottawa.

5.2 Reference Documents

- (a) The electrical Design and Construction shall comply with the criteria contained in this Article, and all standards, regulations, policies, Applicable Law, guidelines or practices applicable to the Project, including but not limited to each of the following Reference Documents. In the event of a conflict between criteria, commitments or requirements contained within one document when compared with another, the more stringent shall apply:
 - (i) OBC*;

- (ii) NBC*;
- (iii) Ontario Electrical Safety Code, 24th Edition;
- (iv) Canadian Electrical Code, Part I, 21st Ed: Safety Standard for Electrical Installations;
- (v) ANSI;
- (vi) ULC;
- (vii) NEMA;
- (viii) CSA;
- (ix) IESNA Lighting Handbook;
- (x) ASHRAE 90.1;
- (xi) City of Ottawa Standards;
- (xii) NFPA 130: Standard for Fixed Guideway Transit and Passenger Rail Systems;
- (xiii) NFPA 110: Standard for Emergency and Standby Power Systems;
- (xiv) ASME A17.1: Safety Code for Elevators and Escalators;
- (xv) IEEE;
- (xvi) IEC; and
- (xvii) Hydro Ottawa Specifications.

**Note: Federally Mandated Stations shall meet the requirements of both the OBC and the NBC.*

5.3 Basis for Design

- (a) Electrical Load Classification
 - (i) Normal systems include loads which, if de-energized, would have no effect on Passenger Safety or adverse effect to facility systems. This load classification includes all non-essential Station loads and the majority of Station lighting. These loads can tolerate occasional prolonged power outages and do not require a backup power source.
 - (ii) Emergency systems classed per NFPA 130 and NFPA 110

- A. Level 1 systems include loads such as emergency egress lighting, communication systems (if used in Emergency response procedures) and fire alarm systems that cannot tolerate normal electrical supply outages and require an Emergency power supply.
- B. Level 2 systems include loads such as fire pumps, emergency ventilation and smoke removal systems, sewage pumps, and elevators that require a reliable power source, feeders from two separate and distinct utility substations or combination of sources as approved by the AHJ.

**Note: Project Co shall perform FMEA and vulnerability/system assurance/reliability analysis in order to determine any other Safety Critical loads that require emergency power.*

(b) Calculations

- (i) Project Co shall perform short-circuit calculations to determine the AIC rating of the electrical distribution system based upon the actual available short-circuit value or per-unit impedance values obtained from the Hydro Ottawa at the electric service entrance or point of connection.
- (ii) System device coordination and selectivity shall be based on calculated short-circuit values and used for selection of ratings and settings of protection devices.
- (iii) Voltage drop calculations shall be completed for maximum loads, long run circuits and feeders, and under motor starting conditions. Motor circuit calculations shall be based on an 85% lagging power factor. Branch circuit voltage drop from service entrance distribution Equipment to point of utilization shall not exceed 5%.
- (iv) Lighting-level calculations shall be completed for all interior and exterior spaces in conjunction with architectural and/or landscaping Design. The point-by-point method utilizing computer generated calculations shall be used to validate adequate illumination levels and boundaries. The software used shall be industry recognized and the calculations shall follow IESNA procedures. Calculation results shall include maximum, minimum, and average illumination levels along with the appropriate uniformity ratios and lighting power densities per ASHRAE 90.1. Calculations shall also include luminaire locations, mounting heights, manufacture catalog data sheet with product selections and options indicated, lamp data sheet, wattage, lumens, color rendering index, color temperature, room surface reflectance values, light loss factors, and photometric file used. Lighting fixture color rendering temperature shall be consistent for the Station and shall be “warm white” coordinated with the architectural/landscaping Design.
- (v) Arc flash hazard calculations shall be completed for Equipment that is required to be field marked for arc flash warning per CAN/CSA Z462. Hire a licensed professional engineering firm to perform calculations based on actual distribution

system installed, actual minimum and maximum available utility short circuit current and according to IEEE 1584 and CAN/CSA Z462. Values to be calculated shall include, but not be limited to: (a) flash protection boundary in units of centimeter from Equipment; (b) incident energy at 45.72cm working distance from Equipment in units of calories per square centimeter (cal/cm²). The calculated values shall be permanently displayed on Equipment arc flash hazard warning labels.

- (vi) Computations for service, feeder and branch circuit loads shall be based on the nominal system voltage used and applicable demand factors in accordance with the Canadian Electrical Code.
 - (vii) Protection for future growth for all major electrical Equipment and Hydro Ottawa service feeders is required. Before determining the size of service an economic analysis shall be made to determine the most feasible way of protecting for the future growth. Special consideration must be given to requirements for load growth, for anticipated usage and life expectancy with particular attention to the possibility of adding heavy loads such as elevators and escalators, electric heating etc.
- (c) Electrical Safety Provisions
- (i) EGFP shall be provided as required by the latest applicable codes. Ground fault “annunciation only” shall be provided where EGFP is required by code for Equipment or feeders serving Level 2 Emergency Systems.
 - (ii) PGFP shall be provided on branch circuits that have Equipment or outlets for which personnel protection is required by either the latest applicable codes or Good Industry Practice.
 - (iii) Arc flash hazard warning labels shall be provided on the Equipment as per required code. Flash boundary and incident energy values shall be displayed.

5.4 Functional Requirements

- (a) Electrical Service
 - (i) The secondary voltages described herein are the basis of the Reference Concept electrical distribution design. Project Co may select alternative voltages for secondary distribution system.
 - (ii) At Underground Stations, where pad-mounted primary equipment cannot be installed at grade, a Primary switching room shall be provided for incoming service and shall be:
 - A. designed in partnership with HOL and in accordance to HOL Specification GCS0002: Primary Voltage Service Specification;

- B. at grade or within five (5) meters below grade with two walls on the outside to allow ease of access for HOL incoming feeders and designed for a three (3) hour fire envelope;
 - C. dimensions as outlined in the “Hydro Ottawa Information to Support the City of Ottawa’s Proposed light Rail System – Phase 1” report, provided in the Data Room; and
 - D. coordinated with HOL in terms of switchgear location and placement within the rooms.
- (iii) At-Grade Stations shall be provided with a single underground service feeder from Hydro Ottawa at 600VAC, 3phase, 60Hz. Design shall be a transformer installed on an exterior pad or installed within a vault. The demarcation point between Hydro Ottawa and Project Co responsibility shall be the secondary terminals of the on-site 13.2/.6kV transformer. Project Co shall coordinate with Hydro Ottawa, as referenced in the Hydro Ottawa Planning Reports, all requirements related to the installation of the on-site transformer and underground duct-banks.
- A. At-Grade Passenger Stations shall be provided with 600VAC main switchboard, revenue class metering, associated downstream power distribution panels, feeders to 600VAC and 208/120VAC Equipment and (if applicable) transfer switch for the emergency power distribution. Main electrical room will contain, in addition LV transformers, UPS (if applicable), LV lighting control cabinet, heating controls, etc.
 - B. In the event of power outage emergency lighting, fire alarm and other emergency Equipment loads shall be connected to UPS or batteries as required by OESC.
 - C. Connection for a mobile generator shall be provided in all At-Grade Stations. The portable generator system shall be used only for stand-by operation during prolonged Utility outages and is independent of the required emergency (UPS or battery) power supply systems.
- (iv) At Underground Stations where on-site power generation is not feasible, provide feeders from two separate and distinct Utility substations or combination of sources as approved by the AHJ to serve Emergency systems classified as “Level 2” and used for emergency ventilation or fire suppression Equipment. Provide two incoming service feeders at a supply voltage no less than 13.2kV, 3-Phase, 60 Hz from the Utility. Circuit each incoming service feeder from a separate and independent Utility source or TPSS that is electrically and physically isolated from each other. All power sources shall be as approved by the AHJ and in conformance with the applicable code.

- A. For Underground Stations, provide two service feeders from Hydro Ottawa at 13.2kVAC. The service feeders shall be electrically and physically separated and approved by the AHJ for use as an emergency power source. The demarcation point between Hydro Ottawa and Project Co responsibility shall be the cable terminations of the service feeders at Hydro Ottawa owned disconnection equipment.
 - B. One of the service feeders shall be located at Downtown West Station and connected to double ended SWGR with main/tie/tie/main breakers and revenue class metering located in the medium voltage electrical room, adjacent to the Downtown West hydro power room at grade level. The second service feeder shall be located at Rideau Station and connected to the double ended switchgear with main/tie/tie/main breakers and revenue class metering located in the medium voltage electrical room, adjacent to the Rideau hydro power room at grade level. Downtown East Station shall be provided with similar double ended medium voltage Switchgear. All three switchgears shall be interconnected with tie cables running from Downtown West to Downtown East and to Rideau feeding power bus “A” in each Station, similar tie cables shall connect Rideau to Downtown East and Downtown West feeding power bus “B” at each Station.
 - C. Automatic Transfer Switch consisting of two circuit breakers connected to bus “A” and bus “B” shall provide power to the Station downstream distribution system.
 - D. Downstream distribution for each Station shall also include two (2) 13.2kV/600VAC redundant dry type transformers feeding double ended 600VAC switchgear located in 600VAC electrical room and additional two (2) 600/208/120VAC dry type transformers feeding double ended 208VAC switchboard located in the 208VAC Room. Redundant circuit feeders shall be in physically separated raceways.
 - (v) Electrical protection devices shall be automatically coordinated with upstream/downstream LRT distribution system in order to minimize disruption to the LRT operations.
 - (vi) Provide electric heat tracing where required by the mechanical and architectural Design.
 - (vii) All emergency service raceways/feeders shall be fire rated in accordance with applicable codes requirements. Main feeder raceways shall be embedded in concrete slabs/walls and shall be rated for at least two hours.
 - (viii) The superstructure and substructure shall accommodate all required embedded ducts for interior and exterior electrical services as applicable.
- (b) Metering and Monitoring

- (i) Utility revenue metering shall be provided as required by Hydro Ottawa.
- (ii) Remote monitoring system shall be provided for:
 - A. Station main switchboard breakers position;
 - B. Voltage availability at the main buses; and
 - C. Customer energy metering at main service and for services as listed and described in Schedule 8 – Energy Matters.
- (c) Duct banks, Manholes and Handholes
 - (i) Duct banks and manholes shall be designed in accordance with the seismic criteria defined for the Project. Duct banks shall be designed to include at least 25% spare capacity to protect for future growth and expansion. Refer to Paragraph 5.3 (b) (vii) above for direction. In addition, space is to be provisioned for a 24 way fibre to be installed for a separate highways IT network in coordination with the City Highway Operations Department. All ducts to be roped.
 - (ii) Underground ducts shall be sloped to manholes to provide adequate drainage. Provide concrete encasement where required by applicable code.
 - (iii) Manholes and/or handholes shall be designed as per City Standards, sufficiently sized and provide access to cable where necessary.
- (d) Electrical Rooms
 - (i) Main electrical room shall be located as close as practicable to the point of connection of Hydro Ottawa’s electrical service Equipment.
 - (ii) Electrical rooms shall have sufficient space to house all required Equipment. Adequate space shall consider minimum working clearances, conduit entry points and routing, Equipment removal / replacement, building repair and ventilation requirements.
- (e) Grounding and Bonding
 - (i) The Station electrical distribution system shall be solidly grounded, designed to meet OESC.
 - (ii) The grounding electrode system shall be supplemented and bonded together with an embedded ground grid on each side of the Tracks for side Platform Stations. The Passenger Station grounding grid shall not be interconnected with any Traction Power (DC) grounding system. Project Co shall coordinate interconnection grounding points with signal and communication systems to avoid noise propagation.

- (iii) All non-current-carrying metal enclosures and all alternating current Equipment shall be securely connected/bonded to the Station grounding system.
 - (iv) Each metallic equipment housing shall provide a welded boss for attaching a protective ground connection and shall be sized for expected trip currents
 - (v) Grounding of the Platform edge doors for Underground Stations and other metal surfaces within 2 meters of the Vehicle stopped at the Platform shall be coordinated with Traction Power Design in order to prevent or limit possible excessive touch potential in tolerable values as specified in OESC.
 - (vi) Avoid natural gas piping and pipe connected to an active cathodic protection system with the exception where required by the corrosion protection
- (f) Emergency and Standby Power Sources
- (i) Power sources shall be selected based on efficiency, reliability and most economic life cycle cost.
 - (ii) Emergency and standby power sources are identified as follows:
 - A. Standby on-site internal combustion engine generator;
 - B. *Mobile generator;
 - C. UPS system;
 - D. Central battery system or battery packs for unit Equipment; and
 - E. **Second utility power source – Dual/redundant utility power source for loads classified emergency Level 2.

**Note: Provisions for quick connection for a mobile generator shall be provided in At-Grade Stations and where practical for underground Stations. The mobile generator system will be used only for stand-by operation during prolonged utility outages and is independent of the required emergency power supply systems.*

***Note: Authorities having Jurisdiction shall review the Design and approve the dual redundant utility service feeders as emergency power supply source.*
 - (iii) When standby fixed mounted engine generators are to be installed outdoors, a completely enclosed weatherproof/sound attenuated housing to protect the generator from adverse weather conditions and reduce sound levels for surrounding residential neighbourhoods shall be provided. Enclosure shall have critical grade silencing suitable for residential installation. Project Co Design shall follow NEMA/IEC enclosure/environmental protection standards.

- (iv) When second Utility power source is selected, emergency lighting, fire alarm and other emergency Equipment loads shall be connected to a UPS or battery system as required for loads classified as “emergency level 1”.
- (g) General Purpose Receptacles
 - (i) In public areas, general purpose receptacles shall be GFI and provided at 30m distance, and shall have lockable covers. No more than six outlets shall be connected to a branch circuit.
 - (ii) GFI receptacles shall be provided also for Station sign boxes and art elements where required.
 - (iii) In non-public areas general purpose receptacles shall be provided at 7m apart and shall be supplemented where needed for fixed Equipment. No more than five outlets shall be connected to a branch circuit.
 - (iv) A flush-mounted duplex ground fault type receptacle with weatherproof lockable cover shall be provided close to hose bibs.
- (h) Lighting
 - (i) The lighting systems for Stations, park and ride areas, pedestrian walkways, trackway, Tunnels and portals shall be coordinated with architectural/landscaping and signage/wayfinding Design objectives. Lighting Design shall be consistent across all Stations. Standardization of lighting system components is required for perceptual unity and to simplify maintenance.
 - (ii) Lighting levels shall define and differentiate between task areas, decision and transition points, Platform edges and areas of potential hazard. In addition to quantity of light, it is essential that lighting be designed to minimize glare and provide uniform distribution. Luminaires shall be selected, located, and/or aimed to accomplish their primary purpose while producing a minimum of objectionable glare and/or interference with task accuracy, vehicular traffic, and neighbouring areas.
 - (iii) Luminaires that emit light above the horizontal plane shall be avoided. Light spill-over onto adjacent properties shall be minimized. Fixture types that minimize light trespass onto adjacent properties shall be used. Refer to IESNA TM-11-2000, Light Trespass.
 - (iv) The lighting system shall be energy-efficient using high-efficiency light sources and auxiliary Equipment. Luminaires shall have integral ballasts and fuses unless special considerations dictate otherwise. Lighting Equipment shall be vandal-resistant where within reach of the general public.
 - (v) Lighting shall be designed to consider security, AODA, CPTED, CCTV and CAN/CSA B651 requirements.

(vi) Minimum illumination levels shall meet the criteria listed below:

Table 5-5.1: Station Interior

Location	Average Minimum (Lux)	Uniformity (Ave./Min.)	Emergency (Lux)
Station Rail Platform	200	3 : 1	10
Station Building (Public Areas)	200	3 : 1	10
Ticket/Information Kiosk	300	2.5 : 1	10
Stairs, Ramps, Escalators	200	2 : 1	10
Pedestrian Tunnels and Concourse	100	2.5 : 1	10
Service Rooms	500	3 : 1	10
Designated Waiting Areas	220	3 : 1	10
Washrooms	300	3 : 1	10

**Note: Emergency lighting illumination levels shall be designed to meet security, AODA, CPTEd, CCTV and CAN/CSA B651 requirements.*

- (vii) Provision of emergency lighting systems is required by code. Emergency power shall be available at stable system voltage within 10 seconds or less. All batteries shall be sized to continuously carry the rated illumination for a minimum time required for evacuation and as required by applicable code.
- (viii) Emergency lighting fixtures shall be the same model and type as the rest of the lighting fixtures with the addition of emergency battery pack.
- (ix) Lighting system shall be designed so that the failure of any single luminaire or lighting circuit in areas accessible to the public does not leave an area in total darkness.
- (x) Lighting layout shall be coordinated with other building elements so as not to affect the illumination.
- (xi) BAS system shall monitor and control Station lighting system. Where Facility remote control system is not provided, the following controls shall be provided:
 - A. Station central key / timer control system including override switches for service areas;
 - B. Exterior luminaries, including luminaries in signage, shall be group controlled by photo-cell and/or the facility BAS system. Exterior light control shall include a maintenance bypass switch (Hand-Off Auto) located on external wall of the facility for night services such as snow plow and cleaning;

- C. Exterior Lighting areas as required for Safety and comfort shall meet requirement of City Standards and ANSI/ASHRAE/IESNA Standards 90.1 Exterior Lighting Section;
- D. Adopt site lighting criteria to maintain safe light levels while avoiding off-site lighting and night sky pollution. Use computer software to model the site lighting. Technologies to reduce light pollution include full cutoff luminaires, low-reflectance surfaces and low-angle spotlights; and
- E. Exterior lighting shall be designed to consider security, CPTED, AODA and CCTV requirements.

(xii) Minimum illumination levels shall meet the criteria listed below:

Table 5-5.2: Exterior Areas

Location	Average Minimum (Lux) See *Note below.	Uniformity (Ave./Min.)	Emergency (Lux) See *Note below.
At-grade Pedestrian Crossings	100	3 : 1	N/A
Station Bus Platform & Bicycle Parking Area	100	3 : 1	N/A
Shelter and Ticket/Information Area	100	2.5 : 1	N/A
Exterior Station Building (Public Areas)	150 or 200 where operating devices or reading is required	2.5 : 1	N/A
Stairwell	150	2 : 1	N/A
Pedestrian Underpasses and Overpasses	100	2.5 : 1	N/A
Pathways in the Vicinity of Busways	20	3 : 1	N/A

**Note: Average minimum and emergency lighting illumination levels shall be designed to meet security, AODA, CPTED, CCTV and CAN/CSA B651 requirements.*

- (i) Fire Detection and Alarm System
 - (i) All Stations shall be provided with a fire detection and alarm system in accordance with the applicable codes.
 - (ii) The fire detection and alarm system shall be a zoned, non-coded, addressable, microprocessor-based system with automatic alarm initiation, addressable smoke detectors, and automatic multi-detector algorithm for alarms initiated by smoke detectors.

- (iii) Fire panels shall include the ability to verify alarms (2 stages) prior to evacuation. The fire alarm wiring system shall be electrically supervised. The system shall be designed such that the TSCC is notified to validate the event and determine if the fire department is to be dispatched when an alarm signal takes place.
- (iv) The fire detection and alarm system shall be provided with an emergency power supply, consisting of either a generator and/or battery source. The emergency power supply shall power the supervisory function of the fire alarm system for no less than 24 hours and full function for no less than 30 minutes. Upon failure of the normal power source, immediate transfer to the emergency power supply shall take place with no loss of information in the process.
- (v) The fire detection and alarm system shall be connected to and monitored by the TSCC at.
- (vi) A fire alarm annunciator panel with a flush mounted vandal resistant polycarbonate shield shall be provided at every LRT Station in a readily accessible location to fire fighters upon entering the Station. A second annunciator shall be located where required by the City. The annunciator panels shall be monitored simultaneously at the TSCC.
- (vii) Manual pull stations need not be installed in areas accessible to the public.
- (viii) Visual signal devices shall be installed such that the signal from one device is visible throughout the floor area in which they are installed.
- (j) Power for systems and communication Equipment
 - (i) Provide power or conduit complete with pull wire as required.
- (k) Conduits and Raceway
 - (i) Conduits installed in finished areas of new Construction shall be concealed in walls, below or in slabs, or above suspended ceilings. Exposed conduits shall not be run on the exterior surface of buildings. Conduits shall not be run through structural members across pipe shafts or ventilation duct openings.
 - (ii) Conduits in concrete slabs shall be placed between the bottom and top reinforcing steel. Separate conduits to ensure proper concrete bond.
 - (iii) Conduits shall not be embedded in waterproofed or waterbearing walls.
 - (iv) Conduits penetrating exterior walls of any Structure (other than handholes, manholes, or pullboxes) below grade, at grade floors, or below grade floors shall be sealed to prevent moisture migration.

- (v) Grounding-type expansion fittings shall be installed in raceways every 60m or less of linear run or wherever structural joints are crossed to allow for expansion and contraction.
- (vi) Project Co shall provide the raceway system and cable pulling for Equipment described and identified by facility/systems and the City. Raceways shall be designed to include at least 25% spare capacity to protect for future growth and expansion. Refer to Paragraph 5.3 (b) (vii) above for direction.

ARTICLE 6 WAYFINDING AND SIGNAGE

6.1 Introduction

- (a) This article describes wayfinding and signage performance requirements for all OLRT Stations including performance criteria for wayfinding and signage Design.
- (b) The performance specifications will provide brand neutral examples for the application and integration of a comprehensive wayfinding and signage system with the specific architectural and art finishes and features of the OLRT Stations.

6.2 Goals & Objectives

- (a) The overall goal of this Article is to provide a standard signage and wayfinding system that makes transit facilities easy to identify and navigate system wide, that utilize language and visual techniques that people understand, comply with accessibility guidelines, integrate with the Design approach of other Design disciplines and assist in delivering a successful journey for Passengers.
- (b) The objectives for the wayfinding and signage program are as follows:
 - (i) To improve the overall function and aesthetics of the LRT by providing accessible, attractive, identifiable and understandable signage;
 - (ii) To improve wayfinding for Passengers by providing map, text and or pictograph signage for important Station destinations and features;
 - (iii) To provide plain language signage and not ‘over sign’ Stations;
 - (iv) To develop project outcomes that inform and meet the timing of the Design requirements for Station pre-engineering and final Designs; and
 - (v) To achieve the above goals sustainably.

6.3 Scope

- (a) This Article includes requirements for the design, manufacture, supply, delivery, storage, assembly, installation, protection, inspection and testing of all components as described herein, necessary to achieve and deliver a successful, comprehensive and integrated wayfinding and signage system for the OLRT.
- (b) The wayfinding and signage system shall be consistent with other City transit settings (i.e. Transitway stations, O-Train Platforms, etc.) where new wayfinding and sign systems will be implemented by the City.
- (c) The wayfinding and signage system includes but is not limited to providing signage that addresses the following areas and uses:

- (i) Station identification signage - Signage that identifies a Station and is visible whether approaching a Station by foot, bicycle, transit vehicle, taxi or private vehicle;
- (ii) Community orientated wayfinding signage - Signage that identifies and provides a link to other modes of transport, public services, landmarks, pedestrian and bicycle routes or significant destinations in the general vicinity of each Station;
- (iii) Station located wayfinding signage - Signage that assists the movement of Passengers through a Station or to facilities located within the Station. This includes signage that identifies and or directs users to and from Platforms, exits, ticketing and fare payment facilities, information services, elevators, escalators, accessible pathways, bicycle routes through each Station, taxi and connecting bus services;
- (iv) Navigation signage - Signage that works in conjunction with (iii) and provides wayfinding through the available multi modal forms of transportation by identifying directions, major destinations, adjacent Stations and confirms the appropriate transport service. At least two transit information panels similar in size and function with map cases currently used in existing Stations shall be provided at all bus and Train Platforms. Transit information panels shall also be placed at the DWA and at locations prior to payment. Signage indicating the locations of transit information panels shall be provided;
- (v) Schedule and service status signage - Signage that displays real time information on the status of transport services communicated through the use of static visual displays, panels, electronic updates and audio announcements when a service is operating, due to arrive, delayed or cancelled and provide information and notices for hours of operation, trip schedules and timetables; and
- (vi) Regulatory and utility signs - Signage used within a Station that provides users and staff with regulatory notifications such as no smoking, hazards, no littering, emergency exit, emergency phones, fire alarms, elevator buttons, rules of use, disclaimers, etc. Standard traffic signage is also required for private vehicles and for buses circulating through or around a Station.

6.4 General Responsibilities

- (a) Project Co shall Design, fabricate, install, and maintain all wayfinding Equipment.
- (b) The City will determine content, format, and location of all wayfinding Equipment, including but not limited to signage (directional, orientation, information, regulatory, commemorative), electronic displays, transit information panels, and maps, and will provide such specifications to Project Co at the appropriate stage of Design.

Ottawa Light Rail Transit Project

- (c) Any proposed wayfinding Equipment shall be coordinated and compatible with existing wayfinding Equipment, and shall be restrictive in terms of future wayfinding decisions and requirements.
- (d) Any proposed wayfinding Equipment shall support and contribute to the transit customer experience on the OLRT and overall transit network.

6.5 General Requirements

(a) Reference Documents

- (i) The Design and Construction of wayfinding and signage shall comply with the criteria contained in this Article, and all standards, regulations, policies, Applicable Law, guidelines or practices applicable to the Project, including but not limited to each of the following Reference Documents. In the event of a conflict between criteria, commitments or requirements contained within one document when compared with another, the more stringent shall apply:
 - A. City of Ottawa – Official Plan;
 - B. City of Ottawa – Transportation Master Plan;
 - C. Ottawa Urban Design, A Reference Guide to Creating Great Places and Great Spaces, Publication #2103;
 - D. Downtown Ottawa Urban Design Strategy;
 - E. City of Ottawa – TOD Guidelines;
 - F. City of Ottawa – Green Space Master Plan;
 - G. City of Ottawa Cycling Plan;
 - H. City of Ottawa – Pedestrian Plan;
 - I. City of Ottawa – Integrated Street Furniture Program;
 - J. OBC;
 - K. AODA;
 - L. Canadian Transportation Agency, Code of Practice, Passenger Terminal Accessibility
 - M. Canadian Transportation Agency, Code of Practice, Removing Communication Barriers for Travelers with Disabilities
 - N. City of Ottawa Construction Specifications and Details; and

- O. Ontario Traffic Manual.
- (b) Signage System Design
 - (i) Design for the wayfinding and signage system for the OLRT is comprised of identification, directional, information, operational, regulatory, and temporary signage.
 - (ii) The City shall determine Station names for all LRT Stations.
 - (iii) The City shall determine all specifications regarding the branding and service identity of the LRT.
 - (iv) Identification Signage
 - A. The key functions of the identification signage are to identify:
 - i. Stations within the built environment;
 - ii. Station entries;
 - iii. Station facilities;
 - iv. Passenger services;
 - v. Elevator access; and
 - vi. Accessible entries.
 - (v) Directional Signage
 - A. The key functions of the directional signage are to direct:
 - i. Passengers from the Station entries to ticketing facilities and on to the Platform and to the exits;
 - ii. Passengers to connecting transport services and Infrastructure;
 - iii. Passengers to facilities within the Station; and
 - iv. Disabled Passengers to accessible access points.
 - (vi) Information Signage
 - A. The key functions of the information signage are:
 - i. Provide transport network information;
 - ii. Notify Passengers of available services; and

iii. Notify Passengers of delays or changes to scheduled services.

(vii) Operational Signage

A. The main purposes of the operational signage are:

- i. Identify doors, areas and access points for staff and facilities management; and
- ii. Identify ancillary room functions.

(viii) Regulatory Signage

A. The key functions of the regulatory signage are:

- i. Identify potential hazards to Passengers and the public; and
- ii. Identify potential hazards to OLRT staff and Third Party Contractors.

(ix) Temporary Signage

A. The key function of temporary signage is to:

- i. Temporarily identify changes to services, Station facilities, Station closures or hours of operations;
- ii. Temporarily identify hazards to Passengers and the public; and
- iii. Temporarily identify hazards to OLRT staff and Third Party Contractors.

(x) Sign Types

A. The following list of sign types has been developed specifically for the OLRT Project and represents the sign types required to effectively deliver a signage and wayfinding system that meets the stated goals.

- i. The list includes, but is not necessarily limited to, sign types that Project Co. shall Design and supply:

- DR01 Pylon – large;
- DR02.1 Pylon – Medium (exterior with map);
- DR02.2 Pylon – Medium (interior without map);
- DR03 Pylon – Small;
- DR05 Overhead Beams;
- DR05.1 Station ID & Directional Content;
- DR05.2 Direction of Train Travel;

DR05.3	LED sign (time to Train);
DR06	Overhead Beams – Freestanding;
DR07	Illuminated – To area of refuge;
DR08	Directional Info;
ID01	Station Name – Megagraphic;
ID02	Station Name – Large;
ID03	Station Name – Small;
ID04	Station Name – Small;
ID05	Station Name – Small;
ID06.1	Room ID – Front of House (Large with Pictogram);
ID06.2	Room ID – Back of House (Large with Pictogram);
ID06.3	Clip on Regulatory;
ID07.1	Room ID – Front of House Medium;
ID07.2	Room ID – Back of House Medium;
ID08.1	Room ID – Front of House Small;
ID08.2	Room ID – Back of House Small;
ID09	Safe Waiting Area;
ID10	Elevator Jamb;
ID12	Interpretive – Small Art Plaque;
ID13	Honorific – Interpretive;
ID14	Illuminated – Area of Refuge High Level;
ID15	Illuminated – Area of Refuge Low Level;
ID16	Attendant Kiosk;
IN01.1	Fare Threshold – Integrated Floor, Wall & Ceiling;
IN01.2	Fare Threshold – Integrated Floor, Wall;
IN01.3	Fare Threshold – Integrated Floor;
IN02.1	Orientation Point (3 Panels);
IN02.2	Orientation Point (1 Panel);
IN02.3	Orientation Point (4 Panels);
IN06	Temporary Notice – Paper Insert;
IN07	Digital Temporary Notice of Accessible Service Disruption;
IN08	Temporary Signage for Elevator;
IN09	Regulatory – No Smoking/Eating/etc; and
IN10	Regulatory – No Smoking at Entry.

(xi) Sign Dimensions

A. Project Co shall provide signage in accordance to the requirements for the OLRT Sign Family in Appendix C of this Schedule 15 Output Specifications.

(xii) Project Co shall use the exemplar sign family in Appendix D of this Schedule 15 to measure the general Design expectations for sign dimensions, sign and information hierarchy, sign types, sign content, visibility, contrast, layout, sign mass and sophistication against those of Project Co Designs for the wayfinding and signage system.

(xiii) Sign Quantities

- A. Project Co shall be responsible for Designing the wayfinding program including providing sufficient quantities of signs as deemed necessary to design and supply a clear, concise and consistent wayfinding sign system in order to meet the Project requirements.

(xiv) Sign Information

- A. Project Co shall be responsible for updating and maintaining sign information content and messages to ensure that all signage is relevant and reflects relevant changes to the City transit System.

(xv) For Stations subject to FLUA, the following requirements apply:

- A. Signage design shall comply with the NCC commercial signage guidelines.
- B. All text shall to appear in both official languages.
- C. Exterior signage shall not be permitted above the ground floor level.
- D. Backlit signage, billboard signage and digital signage are not permitted outside of the station.

(c) Design Elements and Considerations

- (i) The Design and implementation of the OLRT wayfinding and signage system requires the Project Co to incorporate the following key considerations and elements into the Designs.

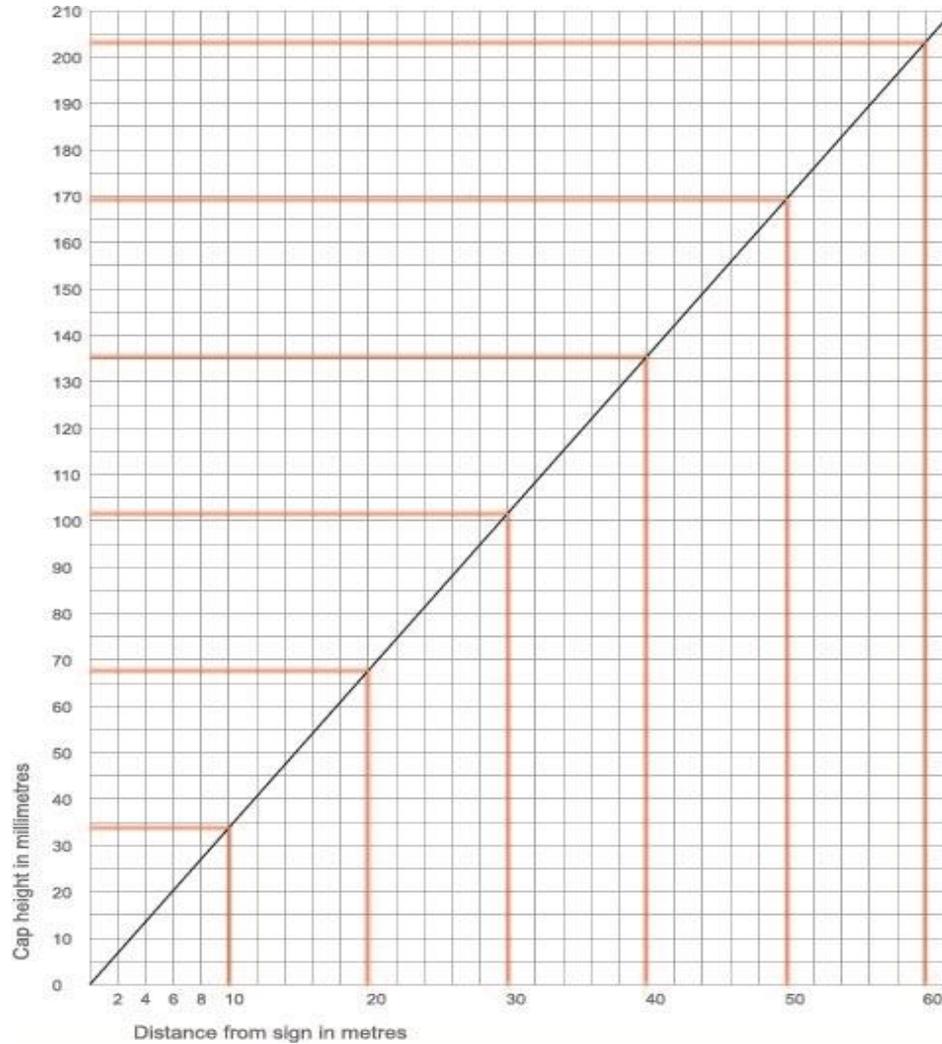
(ii) Line & Letter Spacing

- A. Line spacing where a set of messages is displayed shall be at least 75% of the Cap height so messages can be quickly scanned and destinations identified.

(iii) Language

- A. All signage for the OLRT Project shall feature messages in both English and French.
- B. Where both languages appear on a single sign, Project Co shall follow one of the following two options:
 - i. English text on the left side and French text on the right; or
 - ii. English text on the upper portion of the sign with French text below.

- C. Where pairs of signs are used the sign displaying English text shall be placed at the beginning of the viewing sequence with the second sign in French located beyond it.
 - D. Where the two signs are required they shall be far enough apart to ensure the messages are differentiated and not read as a single message and close enough to one another allowing users to recognize that they represent the same message displayed in the two languages. A minimum gap of four character strokes shall be maintained between English and French messages. A minimum of two character strokes shall be permitted where a graphic device such as a vertical line or hyphen is used to visually separate the two messages.
 - E. Bilingual or unilingual paired signs shall employ the same size, fonts, letter heights, colours and general Design principles for each language.
- (iv) Pictograms
- A. Pictograms shall be used to reinforce sign messages, aid quick recognition and clearly communicate information to all languages and cultures.
 - B. Pictograms shall be based on accepted international standards. Any additional pictograms proposed by Project Co that are not based on international standards shall be presented to the City for acceptance.
- (v) Legibility & Viewing Distance
- A. All signage shall be legible and feature letters and graphic elements of the appropriate size for the identified viewing distances. The chart below provides the viewing distances for text of a particular height. These values are based on the viewer having good vision and reading the signs in daylight whilst stationary.



B. It shall be noted that many factors negatively impact the legibility of sign text. These include angular distortion, speed of travel and low light levels. Factors such as these shall be considered when determining the height of text appearing on signs. Project Co shall increase text heights from those described in the chart as required to maintain sign legibility based on the impact of the above conditions.

(vi) Mock ups of all sign types shall be provided by Project Co to assess the legibility of the proposed Design and text heights. Mock ups shall be reviewed by user groups comprised of a cross section of the community and representing people with diverse abilities.

(vii) Sign Placement

A. Signage shall be placed in visible locations, free from obstructions. Special care shall be taken to ensure that signs are not obstructed by other signs, Design elements or items such as security cameras.

- B. Project Co shall place signs within the accepted standard for a viewers' cone of vision, being 15° above and below the viewers' horizontal line of sight. Signs viewed outside a viewers' cone of vision are read peripherally and with much less detail. The Project Co shall consider the viewers' cone of vision when selecting the height of the sign from floor level and the height of the typeface.
- C. The average persons' eye level when standing is 1500mm from floor level. When seated it is approximately 1000mm from floor level and when driving eye level is approximately 1200mm from floor level. Signage shall be placed depending on how it shall be viewed and taking into account differences in eye level and a sign's audience.
- D. Placement of signage shall be coordinated with the landscaping, architecture, interior Design lighting and other Equipment in order to standardize locations within a Station and across the OLRT System. Signage shall be applied consistently, assist users to know where to expect sign information and aid navigation.

(viii) Contrast and Colour

- A. Project Co shall ensure contrast between sign backgrounds and messages are at a level considered acceptable to maintain sign legibility and deliver a successful signage system.
- B. For environments with light levels between 10-70 foot candles Project Co shall provide signs with a contrast of 75% or higher between the background and message.
- C. For environments with higher light levels (70 foot candles and above) Project Co shall provide signs with a lower contrast level of 65-75%. A dark background shall be used to absorb light and prevent glare.

(ix) Halation

- A. When signs are backlit care must be taken to reduce flare or halation. Halation makes backlit or reversed lettering difficult to read especially when travelling at speed or at night. Project Co shall ensure that signs are designed to minimize the effects of halation. Directional signage shall not feature Designs which purposely use the effect of halation as a feature. This includes signage with halo lighting effects.
- B. Internally illuminated signage shall have reversed opaque or translucent backgrounds to reduce halation and increase legibility.
- C. Internally illuminated signs shall not feature light coloured illuminated backgrounds.

- (x) Lighting
 - A. Design and implementation of internal or external signage illumination shall be coordinated by Project Co with the City to ensure compatibility with the Design intent for the overall lighting scheme.

- (xi) Universal Design
 - A. The principles of universal Design shall be applied to Designs for the wayfinding and signage system by Project Co. The signage system shall whenever possible seek to integrate accessible Design features with the Design as a whole. The goal is to deliver a wayfinding signage system that assists in providing an environment accessible to people with all levels of abilities. As a minimum, signage for the OLRT Stations shall be designed in accordance with the relevant accessibility codes referenced in this document. All directional signage shall be located in compliance with the stated codes.
 - B. The application of tactile indicators shall be coordinated with key sign locations to assist with the recognition of tactile signage locations and aid navigation by the visually impaired.

- (xii) CPTED
 - A. The principles of CPTED shall be applied in order to ensure the Design and placement of the wayfinding and signage system does not compromise the Safety of Passengers or the general public. In general, signage must enhance public Safety by providing uninterrupted site lines in critical areas, reduce areas where people or devices may be concealed and provide sufficient information to users to instil confidence and minimize confusion. All Station, security facilities and supporting transport services shall be easily differentiated and identified whilst being recognisable as part of an organised system.

- (xiii) Vandalism
 - A. All signage elements shall be designed and fabricated to dissuade and provide protection against vandalism and graffiti.
 - B. Tough, scratch and impact resistant materials shall to be utilized to resist damage, maintain appearance, increase product life spans and reduce operational costs. Sacrificial and non-sacrificial anti-graffiti coatings are to be applied to signs where the risk of graffiti is deemed to be high.
 - C. All accessible mechanical fixings shall be 'security fixings' with nonstandard drives. All accessible fixings shall be tamper proof.

- D. Damaged signs shall be repaired or replaced by Project Co. in a timely manner and without negatively impacting Passengers, staff or the general public.
- (xiv) The City Branding Integration
 - A. Project Co shall be responsible for the integration of the City branding with their Design solutions for the wayfinding and signage system for the OLRT project.
- (xv) Local Conditions
 - A. All signage components designed and supplied by Project Co shall be fit for purpose, able to perform in the local climatic conditions presently experienced in Ottawa.
 - B. The effects of snow, ice and the effects of methods of snow dispersal on signage shall be addressed in the Design.
- (d) Fabrication Materials & Finishes
 - (i) Sign material selections and colours are subject to final brand review by the City.
 - (ii) Metalwork
 - A. All work shall be accurately and neatly constructed and securely fitted and fixed.
 - B. Project Co shall use types and grades of metals suited to their required function, finish and method of fabrication, in sections of adequate strength and stiffness for their purpose.
 - C. Where appropriate, prefabricate and preassemble items in the workshop before delivering items to site.
 - D. Care shall be taken to ensure all visible metal surfaces are free from damage, scratching or other surface degradation.
 - E. Fabrication techniques, surface detailing and application of finishes shall be closely controlled to ensure continuity of appearance between individual items.
 - F. All visible metal edges shall be cut with machine tools. No visible edges of metal shall be cut with a guillotine or break press. No radius to edges unless specified.
 - (iii) Stainless Steel

- A. All stainless steel used externally; in basement levels and non air conditioned areas shall be marine alloy, AISI grade 316. In internal areas all stainless steel shall be grade AISI grade 304 unless otherwise specified.
 - B. All stainless steel surface finishes shall be factory or machine finishes. Stainless steel products with a standard mill or 2B finish shall not be hand lished or polished, by the contractor to match factory finishes.
 - C. All brushed or lished stainless steel shall be No.4 linish unless otherwise specified. Grain of finish is to run with long dimension of each sign unless otherwise specified.
 - D. All polished or mirror stainless steel shall be No.8 mirror finish, unless otherwise specified.
 - E. All surfaces shall be ground and polished to produce uniform, directionally textured, polished finishes free of cross scratches.
 - F. All corners shall be 90° and mitred, with a hairline joint and with surface finishes meeting at mitre. No visible welds.
- (iv) Aluminium
- A. All aluminium shall be of an alloy suitable for purpose. For signage applications where sheet and plate is required alloy 5005 shall be used.
 - B. All welding shall be carried out in accordance with international standards, using techniques to avoid buckling and discolouration.
 - C. All exposed welds shall be ground smooth and where aluminium is to be painted all surfaces shall be suitably sanded, primed, filled and smoothed prior to final paint treatment.
- (v) Mild Steel
- A. Steel components shall be of quality mild steel of a gauge and alloy appropriate for location and use.
 - B. Method of welding used shall provide the maximum strength along joints, fill all gaps and run to a clean and regular finish. All welds shall be continuous along joints with no raw or exposed edges.
 - C. Irregular welds shall be ground smooth with particular attention to visible areas.
 - D. After fabrication and prior to pre-treatment and finishing processes, all rust, scale, burrs, weld slag and splatter shall be removed from the weld and surrounding areas.

- E. Steel work shall be free of grind and machine marks by way of finishing or sandblasting without causing damage to the designed form or creating surface irregularities.
 - F. All mild steel framing and signage support Structure, located in external areas shall be hot dipped galvanised regardless of the application of paint finishes unless otherwise specified.
- (vi) Glass
- A. All glass used in the fabrication of signage shall be toughened safety glass.
 - B. Where glass is used in conjunction with applied graphics for the purposes of visual display, all glass shall be low iron toughened safety glass.
 - C. All edges are to be ground and polished smooth. All edges shall be square without chamfered or sharp edges.
 - D. All glass installations located in direct contact with Passengers and staff shall be certified by a Professional Engineer.
- (vii) Acrylic & Polycarbonate
- A. All acrylic used shall contain 90% or more Polymethyl methacrylate.
 - B. Where possible cast acrylic shall be used instead of extruded acrylic or polycarbonate products.
 - C. Cut edges shall be finished smooth and polished. No flame polished edges shall be provided.
- (viii) Fastenings
- A. Fastenings, including anchors, lugs, screws, rivets, and the like shall be fit for purpose and capable of transmitting the loads and stresses imposed. All fastenings shall be sufficient to ensure the assembly is secure and rigid.
 - B. All fastenings and associated components such as sleeves shall be finished to match the sign body treatment and colour, unless otherwise approved.
 - C. All exposed screw heads shall be countersunk. All screw heads shall finish flush with the adjacent exposed surface.
 - D. Project Co shall ensure that all fixings are protected against corrosion and will not mark or stain existing finishes.
 - E. Fixings shall be compatible with the types of metal they are used to secure.

- (ix) Welding
 - A. Welded, brazed or soldered joints on exposed surfaces shall be ground, buffed or polished as applicable to the material and specified finishes. There shall be no buckling or visible surface colour variations in exposed metal finishes.
 - B. Welds and brazes on finished surfaces shall be indistinguishable from the parent metal.
- (x) Precision Cutting
 - A. All cut edges shall be smooth, ground and polished. No visible cut marks, burn marks, splatter or discolouration shall be accepted.
 - B. All start and end cuts for laser and waterjet cutting and shall be located outside the form to be cut. All cut edges shall be de-burred. All edges shall be square. No sharp edges.
- (xi) Metal Separation
 - A. Incompatible metals shall be separated to prevent galvanic reactions. Separation materials shall not be visible on exposed surfaces or cause discolouration to the surrounding finishes over time.
- (xii) Graphic Films
 - A. All corners and edges of finished letterforms, numerals, arrows, pictograms, logotypes and other graphic elements shall be sharp and true to the selected typeface or artwork, with accurate even curves and serifs where applicable.
- (xiii) Screen Printing
 - A. All screen printed graphics shall be applied according using a screen of 120 threads per inch. Registration shall be accurate.
 - B. Screen printing ink shall be Sericol Polyscreen 2 pac system or similar.
- (xiv) Anti-Graffiti Coatings
 - A. All applied coatings shall be compliant with the sustainability goals for the Project and be applied to the manufacturers' instructions by qualified personnel trained in the correct use and application and/or removal of these types of products.
- (e) Electrical

- (i) Internal Lighting
 - A. Project Co shall ensure that all illumination is fit for purpose and provides even illumination. No shadows, visible wiring or hotspots shall be permitted.
 - B. Project Co shall fabricate all signs with internal lighting in such a way as to prevent all light leaks
 - C. All control gear shall be compatible with the lamps used and shall be located within the sign or concealed in a remote location. In all cases Project Co shall ensure that all control gear including transformers, drivers and ballasts are installed in an accessible and safe location which does not interfere with the functioning of the lighting or the sign itself.
 - D. All wiring shall be encased in non-conductive, insulated, electrical conduit, fit for purpose.
 - E. All ballasts and control gear shall be electronic. No solid core transformers or ballasts shall be used.
 - F. All interior lighting fixtures located underneath skylights shall be full cutoff.
- (ii) External Lighting
 - A. Where additional illumination is required for the purposes signage illumination, light fixtures shall match in colour temperature, lumen output and intent.
 - B. All exterior lighting fixtures shall be full cutoff.
- (iii) Activation of Signage Illumination
 - A. Timers for activating signage related lighting shall be integrated with the lighting for the OLRT Stations.
 - B. Activation for sign illumination shall be photo sensitive and linked to the level of ambient daylight. Deactivation will also be automatic and photo sensitive but with the option of a timed deactivation and manual override to reduce power consumption if required.
- (iv) LED Displays
 - A. Project Co shall be responsible for the Design and placement for all LED displays. Project Co shall be responsible for the Design and supply of all shrouds and fixing systems required to maintain a consistent Design language and integrate the displays with the Designs for the wayfinding

and signage system. Design of the shrouds and or fixing systems shall not negatively impact the performance of the base LED displays in any way.

- B. Placement of LED displays as part of the Passenger information systems shall be the responsibility of Project Co. Placement of Passenger information displays shall not obscure or interfere with the operational performance of the wayfinding and signage system.
- C. All LED displays shall be networked and compatible with the OLRT operating system for information displays.
- D. LED displays used for information signage shall comply or exceed the following performance requirements:
 - i. AC Power supply: 120V;
 - ii. Line frequency: 50Hz;
 - iii. Size of characters: 100mm, 16 pixels;
 - iv. View angle of 60° in all direction;
 - v. High visibility during the periods of strong environmental luminosity;
 - vi. LED luminance from 300 up to 700 Cd/m²;
 - vii. Interfaced network card (TFT and character);
 - viii. Ethernet RJ 45 data connection;
 - ix. Wireless remote control function for power on/off and remote access for maintenance;
 - x. Exterior power and network availability indicator light;
 - xi. Remote brightness control;
 - xii. Minimum contrast level of 450:1;
 - xiii. Response time: less than 25ms;
 - xiv. Automatic temperature compensation for display operation;
 - xv. Minimum 3 colour display (red, green, amber);
 - xvi. Compatible with French and English language characters;
 - xvii. Safety anti-glare screen; and

xviii. HD displays shall be in a format ratio of 16:9 and a minimum resolution of 1280 x 768 pixels and shall support HDMI connectors.

(v) LCD Displays

- A. Project Co shall be responsible for the Design and placement for all LCD displays. Project Co shall be responsible for the Design and supply and of all shrouds and fixing systems required to maintain a consistent Design language and integrate the displays with the Designs for the wayfinding and signage system. Design of the shrouds and or fixing systems must not negatively impact the performance of the base LCD displays in any way.
- B. Placement of LCD displays as part of the Passenger information systems shall be the responsibility of Project Co. Placement of Passenger information displays shall not obscure or interfere with the operational performance of the wayfinding and signage system.
- C. All LCD displays shall be networked and compatible with the OLRT operating system for information displays.
- D. LCD displays used for information signage shall comply or exceed the following performance requirements:
 - i. AC Power supply: 120V;
 - ii. Line frequency: 50Hz;
 - iii. Flat and slim Design, low depth (<150mm) and weight (< 50 kg);
 - iv. Robust metal housing with exterior grade finishes;
 - v. Safety Anti-glare and anti-reflective screen;
 - vi. Ratio: 16:9 format;
 - vii. Resolution: 1280 x 768 or more;
 - viii. Luminance: more than 450 Cd/m² ;
 - ix. Contrast: more than 450:1;
 - x. Automatic control of the environment light;
 - xi. Response time: less than 25ms;
 - xii. Inputs: HDMI;

- xiii. Integrated Ethernet network cards with two RJ 45 socket;
- xiv. Wireless remote control function for power on/off, visual settings and remote access for maintenance;
- xv. Exterior power and network availability indicator light;
- xvi. Angle wide viewing: more than 160° in all directions;
- xvii. Shall include integrated (built in) controller, and provision for wireless keyboard & keyboards; and
- xviii. Screen shall be easily removed from site without heavy lifting Equipment and disruption to users.

6.6 Conditions

(a) Site

(i) Site Conditions

- A. No signage is to be fabricated or finished onsite.