Draft Drainage and Stormwater Management Report–Corktown

Integrated Transit Oriented Communities

383 King Street East, 39 Berkeley Street, 250-260 Front Street East
68-70 Parliament Street
265-271 Front Street East & 3-25 Berkeley Street
Toronto Ontario M5A 2W3

Preliminary Rezoning Civil Draft Report

Contract RFS-2019-NAFC-110

PO 214244

HDR Project 10206938

Ontario Line Technical Advisor

TORONTO, ONTARIO

February 16, 2021

Doug Jackson, PE: Project Manager
Matt DeMarco, PMP: Deputy Project Manager
Tyrone Gan, P.Eng Principal-In-Charge

Disclaimer

The material in this report reflects HDR's professional judgment considering the scope, schedule and other limitations stated in the document and in the contract between HDR and the client. The opinions in the document are based on conditions and information existing at the time the document was published and do not consider any subsequent changes. In preparing the document, HDR did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that HDR shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party resulting from decisions made or actions taken based on this document.

In preparing this report, HDR relied, in whole or in part, on data and information provided by the Client and third parties that was current at the time of such usage, which information has not been independently verified by HDR and which HDR has assumed to be accurate, complete, reliable, and current. Therefore, while HDR has utilized its best efforts in preparing this report, HDR does not warrant or guarantee the conclusions set forth in this report which are dependent or based upon data, information or statements supplied by third parties or the client, or that the data and information have not changed since being provided in the report. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that HDR shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party resulting from decisions made or actions taken based on this document.

Contents

Figures

Tables

Appendices

Abbreviations

BMP	Best Management Practice
DMOG	Digital Map Owners Group Database
DRM	Design Requirements Manual
HGL	Hydraulic Grade Line
HGRA	High Volume Groundwater Recharge Areas
IBC	Initial Business Case
IDF	Intensity-Duration-Frequency
IO	Infrastructure Ontario
mbgs	m below ground surface
MECP	Ministry of the Environment, Conservation and Parks
OL	Ontario Line
OGS	Oil and Grit Separator
RCD	Reference Concept Design
SPA	Site Plan Application
SWM	Stormwater Management
TGS	Toronto Green Standard
TMC681	Toronto Municipal Code Chapter 681
TOC	Transit Oriented Communities
TSS	Total Suspended Solids
TRCA	Toronto and Region Conservation Authority
WWFMG	Wet Weather Flow Management Guidelines

This page is intentionally left blank.

1 Introduction

1.1 Project Description

The Province of Ontario is planning to build a new 15.5 km rapid transit line serving the City of Toronto. The development of this line is being managed jointly by Metrolinx, the Provincial Transit Agency responsible for the Greater Toronto and Hamilton Area, and Infrastructure Ontario (IO). The work is based on an Initial Business Case (IBC) published in July 2019, including a representative alignment for the Ontario Line. The Proposed Ontario Line (OL) is running between the Ontario Science Centre and Exhibition GO Station. The Ontario Line Technical Advisory Services team have been organized into the following segments, as shown in **Figure 1-1**.

- Operation Maintenance and Storage Facility (OMSF), and
- Four linear geographical segments:
  - Lakeshore (containing both Lakeshore West and Lakeshore East)
  - Downtown
  - Pape
  - Thorncliffe

The Downtown Segment is predominantly underground and begins at the tunnel portal near Strachan Avenue in the west and ends at the tunnel portal within Don Yard in the east. The segment consists of six stations:

- King/Bathurst Station
- Queen/Spadina Station
- Osgoode Station
- Queen Station
- Moss Park Station
- Corktown Station

Transit Oriented Communities (TOC) are proposed at the Ontario Line Stations to integrate high density, mixed-used developments with the transit infrastructure. This Drainage and Stormwater Management report summarizes the drainage and stormwater management (SWM) requirements for the proposed Ontario Line TOC at the intersection of Berkeley Street and Front Street East in the City of Toronto with respect to drainage conveyance, stormwater quantity control, stormwater quality treatment, and water balance.

Figure 1-1. Ontario Line Segments

1.2 Corktown Station

Corktown station is located at the intersection of Berkeley Street and Front Street East. Two development buildings are proposed at the northeast (King Site) and southeast (Front Site) corners of the intersection. The proposed Corktown Station will be housed within a larger structure and will include two components on the ground level.

Background Review

In preparation of the Corktown TOC Drainage and Stormwater Management Report, the following essential documents were obtained and reviewed:

- Digital Map Owners Group Database (DMOG), City of Toronto;
- Drawing PND-03-0810-09 Corktown TOC Site B1+B2-201120, Architectural plan;
- Drawing PND-03-0810-09 Corktown TOC Site F-201120, Architectural plan; and
- Ontario Line Downtown Segment Stormwater Management Report, Metrolinx, November 23, 2020.

2 Existing Conditions

The existing site are of relatively flat terrain with a single- and two-storey commercial buildings and associated parking lots at the southeast and northeast corners of the intersection. Corktown Station is located in the Don River Watershed. Corktown Station is within Basement Flooding Study Area 62, the study of which was started in 2019 according to the City of Toronto.

2.1 Minor and Major Flows

The existing parking lot component of both sites are graded to contain runoff on site and direct it to catch basins located at low points and at a loading bay. It is assumed that roof drains discharge to the on-site storm sewer system as downspouts discharging to grade are evident. The presence of on-site controls could not be established based on the information received at the time of the preparation of this report. Runoff in excess of the capacity of the on-site storm sewer system ponds in the parking lots and then spills to the adjacent municipal roadways.

Existing storm sewers adjacent to the sites include a 600 mm x 900 mm combined sewer flowing from north to south along Berkeley Street, and a 900 mm storm sewer along Berkeley Street adjacent to King Site which is connected to a 1200 mm storm sewer adjacent to the Front Site. There are also a 600 mm x 900 mm combined sewer along King Street East, 250 mm x 450 mm combined sewer along Front Street East, and 950 mm x 1500 mm combined sewer along Parliament Street adjacent to King Site which is connected to a 1050 mm x 1500 mm combined sewer along Parliament Street adjacent to Front Site. Please refer to the attached existing conditions drainage plan in **Appendix A**.

Major flows on Berkeley Street flow travel from north to south. Major flows on King Street East travel from west to east. Front Street East is relatively flat adjacent to both sites, however, runoff in excess of the minor system capacity on Front Street in this area spills south along Berkeley Street or Parliament Ave.

The City is working on the InfoWorks model for this area, and will not be available before the year 2021. With limited information that is currently available, its not possible to further comment on where the existing buildings are draining.

3 Stormwater Management Criteria

Stormwater management requirements are specified by the authorities having jurisdiction over the Project. These requirements are applicable to all locations where the proposed design will influence or be influenced by surface water runoff. The stormwater management design criteria are described below and supplemented by the Project Specific Output Specifications (PSOS). Stormwater management criteria for this Project are set by the following documents:

- Stormwater Management Planning and Design Manual (MECP, 2003)
- Drainage Management Manual (MTO, 1997)
- Municipal Code Chapter 681, Sewers 681-1 (City of Toronto, 2019)

- Design Criteria for Sewers and Watermains (City of Toronto, 2019)
- Wet Weather Flow Management Guidelines (City of Toronto, 2006)
- Stormwater Management Criteria (TRCA, 2012)
- Living City Policies (TRCA, 2014)
- Toronto Green Standard (City of Toronto, 2018)
- Low Impact Development Stormwater Management Planning and Design Guide (Credit Valley Conservation and TRCA, 2010)
- Erosion & Sediment Control Guidelines for Urban Construction (TRCA, 2019)
- GO Design Requirements Manual (Metrolinx, 2019)
- Design Standard, 'DS-05, Sustainable Design Standard, Version 1.0 (Metrolinx, May 2020)

The Wet Weather Flow Management Guidelines (WWFMG) provide requirements and guidance on stormwater management for developments within the City of Toronto. Table 7 in the WWFMG provides a summary of applicable design criteria based on the type and size of proposed development. Storm sewer and inlet design requirements for the City of Toronto are provided in the Design Criteria for Sewers and Watermains. The Toronto Green Standard (TGS) provides additional stormwater standards specifically related to sustainable development. The TRCA Stormwater Management Criteria provides design requirements related to stormwater management for developments within the jurisdiction of the Toronto and Region Conservation Authority (TRCA). Requirements vary depending on the watershed in which a proposed development is located. The GO Design Requirements Manual (DRM) supplements the local guidelines and provides guidance to be adhered to in all Metrolinx developments. The Metrolinx Design Standard, 'DS-05, Sustainable Design Standard, Version 1.0, May 2020' provides SWM requirements for Metrolinx sites that are greater than 0.5 ha.

3.1 SWM Criteria Summary

The key criteria applicable to this Project are summarized in the following sections. Additional criteria and general guidance can be found in the PSOS and the guideline documents listed at the beginning of **Section 3**.

3.1.1 Quality Control

- Provide a long-term average removal of 80% of total suspended solids (TSS) from the storm runoff of additional impervious areas (TRCA Guidelines).
- Provide a long-term average removal of 80% of total suspended solids (TSS) on an annual loading basis from all the storm runoff leaving the site (WWFMG, TGS).
    - OGS devices are credited with a maximum of 50% TSS removal (WWFMG, TRCA).

3.1.2 Quantity/Flood Control

- Provide protection against surface flooding from ponding on streets during the 100-year event. Consult *Toronto Water – Sewer Asset Planning Section* for developments within the City's chronic basement flooding areas (WWFMG).

- Drainage discharged to the municipal storm sewer must be controlled to the peak release rate from the lower of:
  - The existing conditions peak flow from design event with a 2-year return period assuming a runoff coefficient of 0.5, if the existing imperviousness is greater than 50%; and,
  - The existing capacity of the storm sewer (WWFMG).
- In absence of an approved or adequate overland flow route, all flows from the 2-year up to the 100-year return storm events shall be stored on site and released at the allowable release rate as defined above (WWFMG).
- Peak flows should be calculated using the intensity-duration-frequency (IDF) information in the WWFMG.

3.1.3 Water Balance

- Retain all runoff from the 5 mm rainfall event on site through infiltration, evaporation, and/or rainwater reuse (WWFMG, TGS - Tier 1).
- Retain all runoff from the 10 mm rainfall event on site through infiltration, evaporation, and/or rainwater reuse (TGS - Tier 2).
- For sites located in high volume groundwater recharge areas (HGRA), pre-development groundwater recharge rates should be maintained (TRCA).

3.1.4 Erosion Control

- For infill/redevelopment sites (<2 ha), where the site does not drain to a sensitive watercourse, erosion control should be provided through the retention of a small design rainfall event (typically 5 mm). This is often achieved by satisfying the water balance retention requirement (WWFMG, TRCA).
- For new large development sites (> 5 ha) discharge directly and/or in proximity (within 100 m) of natural watercourses, it is required to complete an Erosion Analysis Report to determine the erosion control criteria for the sites (WWFMG).
- For sites where it is not feasible (this condition must be reviewed and agreed by City staff) to complete an erosion analysis study report, it is typically required that runoff from a 25 mm design storm shall be detained on-site and released over a minimum of 24 hours (WWFMG).

3.1.5 Private Water Discharge

Within the City of Toronto, the discharge of water from a private site (Private Water) to a municipal sewer system is regulated under Toronto Municipal Code Chapter 681 (TMC681). TMC681 defines Private Water to include both surface and groundwater. In the case of surface water, compliance with these requirements is generally demonstrated by satisfying the quality and quantity control requirements of the City of Toronto Wet Weather Flow Management Guidelines (WWFMG).

In the case of groundwater or a mixture of surface water and groundwater, if temporary or permanent discharging is permitted, a “Private Water Discharge Approval Application” must be approved by the City of Toronto (Toronto Water, Environmental Monitoring and Protection Unit). A Private Water Discharge Approval Application is required for all

structures that are not waterproofed where the foundation is ≤ 1 m above the seasonally high groundwater elevation.

The following outlines the general requirements that must be satisfied in order to be granted a permit for long-term or short-term discharge of groundwater to a municipal storm, sanitary, or combined sewer.

Storm Sewer

Quality Requirements

- Water quality tests must demonstrate that the water to be discharged meets the quality requirements specified in TMC681, Table 2.
    - If water quality does not meet TMC681, Table 2 requirements, on-site treatment system may be designed to raise the quality enough to allow the water to be discharged to the storm sewer.
- Design must include provision for water quality testing for the duration of the discharge period through grab sampling.
- Design must include backup plan in case water quality changes and no longer meets TMC681, Table 2.

Quantity Requirements

- Design of discharge system must meet quantity control requirements of the WWFMG. As such, the proposed groundwater discharge rate should be removed from the overall allowable site release rate for the site's stormwater management system.
- Design must include provision for water quantity testing for the duration of the discharge period including continuous monitoring of flows.

Sanitary or Combined Sewer

Quality Requirements

- Water quality tests must demonstrate that the water to be discharged meets the quality requirements specified in TMC681, Table 1.
    - If water quality does not meet TMC681, Table 1 requirements, on-site treatment system may be designed to raise the quality enough to allow the water to be discharged to the sanitary or combined sewer.
- Design must include provision for water quality testing for the duration of the discharge period through grab sampling.
- Design must include backup plan in case water quality changes and no longer meets TMC681, Table 1.

Quantity Requirements

- Hydraulic analysis of the downstream system up to a trunk sewer must be conducted. The model must be calibrated based on monitoring data and needs to consider:

- Average wastewater flow with peaking factor
- Inflow and Infiltration (based on monitoring done by the applicant)
- Both wet weather and dry weather flows*

- Assessment must compare the downstream Hydraulic Grade Line (HGL) vs the City's basement flooding freeboard requirement which is HGL ≤ 1.8 m below ground surface (mbgs), not a comparison of proposed HGL vs existing HGL (where the 1.8 mbgs criterion is already violated).

  *In some cases, if the HGL criteria are not met during wet weather, it may be possible to provide on-site storage and automated flow monitoring/control to store the Private Water during the wet weather and release it at a controlled rate during dry weather (referred to as a Discharge Management Plan). These plans are evaluated on a case-by-case basis and approved based on an analysis of the modelling sensitivity, risk, and adequacy of contingencies presented.

If the requirements noted above cannot be met, the Private Water must be hauled off site and treated/disposed elsewhere. It should be noted that the process for obtaining approval to discharge Private Water to a municipal sewer is often lengthy as it involves field investigations, coordination between multiple design disciplines, and review by multiple City departments.

3.2 Erosion & Sediment Control Guidelines during Construction

On-site temporary erosion and sediment control should be provided during construction as per the Erosion & Sediment Control Guidelines for Urban Construction (TRCA, 2019).

4 Proposed Conditions

Four multi-story development buildings are proposed at the northeast (King Site) and southeast (Front Site) corners of the intersection as shown on Proposed Drainage Area Plan **(Appendix A)**. The proposed station will run across the King Site and the proposed buildings will be integrated into the station building. As such, the station building will not have a separate roof and will not receive direct precipitation.

Ontario Line Corktown TOC site developments are as follows:

- Two proposed building at the northeast intersection of Berkeley Street and Front Street East (Site B1 and B2) with a total area of 0.86 ha; and
- A proposed building at the southwest intersection of Berkeley Street and Front Street East (Front Site) with a total area of 1.25 ha.

5 Stormwater Management Plan

As per the applicable SWM criteria summarized in **Section 3.1**, it is required to provide water balance, as well as quantity, quality and erosion control for the proposed Corktown sites. The stormwater best management practices (BMP) considered for the site include

a green roof, underground detention/retention tanks, and oil/grit separator (OGS) units. The Proposed Conditions Drainage Plan is presented in **Appendix A**.

All building openings should be protected from flooding. During detail design, depth of overland flow at these locations should be calculated using dual drainage models to confirm that all openings to the buildings will have sufficient freeboard above the maximum water elevation during the 100-year storm event.

5.1 Quantity Control

Drainage discharged to a municipal storm sewer must be controlled to the allowable peak release rate as stated in **Section 3.1.2** of this report. In absence of an adequate overland flow route, all site runoff from the 2-year up to the 100-year return storm events will be stored on site and released at the allowable release rate (2-yr pre-development rate). The capacity of the receiving sewer systems will need to be calculated during detail design to confirm the allowable release rate. The quantity control storage volumes were calculated as 279 m^3,and 403 m^3 for King Site and Front Site, respectively, as shown in **Table 5-1**. Detailed calculations are included in **Appendix B**. In concept, a storage tank with orifice control can be installed in the first underground level to provide the required storage volume. Controlled runoff from the northeast building can discharge to the existing 900 mmx1500 mm combined sewer along Parliament Street and to 600mmx900mm combined sewer along Berkeley Street. Controlled runoff from the southeast building can discharge to the existing 1200 mm storm sewer running along Berkeley Street and to the 1500 mm combined sewer running along Parliament Street.

Table 5-1. Quantity Control Storage

ID	Area (ha)		Runoff Coefficient			Allowable Release Rate[2] (L/s)	Required Storage Volume (m^3)
	Exist.	Prop.	Exist.	Exist.[1] (City Criteria)	Prop.		
King Site	0.86	0.86	0.9	0.5	0.9	106	279
Front Site	1.25	1.25	0.9	0.5	0.9	153	403

Note:

[1] Assuming a runoff coefficient of 0.5, if the existing imperviousness is greater than 50%.

[2] Based on the 2-yr pre-development flow rate

5.2 Water Balance and Erosion Control

The water balance criterion of TGS Tier 2 requires the retention of 10 mm of runoff over the proposed area, which is equivalent to the retention of 4002.7 m^3/year for King Site and 5776 m^3/year for Front Site. Total proposed green roof for King Site is 3114 m^2 and for Front Site is 5039 m^2. In concept, the proposed green roof will achieve retention of 1154 m^3/year and 1867 m^3/year for King Site and Front Site, respectively, equivalent to 29% and 32% of the annual target. To meet the TGS Tier 2 criterion, the remaining runoff to meet the water balance target up to 100% retention for each site will be stored in the storage tank for reuse. The required tank storage is 74.7 m^3 for King Site and

107.2 m^3 for Front site. By satisfying the water balance retention criterion, the erosion control criterion will be achieved for the sites, since they have a drainage area less than 2 ha. Refer to **Table 5-2** for water balance storage summary and **Appendix B** for detailed calculations.

Table 5-2. Water Balance Storage

ID	Land-Cover Type	Area (ha)	Initial Abstraction (mm)	% of Annual Rain	Total Annual Volume (m^3)	% of Target	Required Storage Tank Volume (m^3)
King Site	Impervious Area	0.5529	1	14	512	13	74.7
King Site	Green Roof -Intensive	0.3114	7	56	1154	29	
Front Site	Impervious Area	0.7433	1	14	688	12	107.2
Front Site	Green Roof -Intensive	0.5039	7	56	1867	32	

5.3 Quality Control

Quality control will be required to provide long-term average removal of 80% of total suspended solids (TSS) from all runoff leaving the site as per WWFMG. In concept, combination of OGS units and green roof will provide the required quality control to the runoff leaving the site as shown in **Table 5-3**. Detailed calculations are provided in **Appendix B**.

Table 5-3. Quality Control Storage

ID	Area (ha)	Paved Area (ha)	% Impervious[1]	Req. Volume[2] (m^3)	Mitigation Measures	Prop. Green Roof Area (m^2)	Prop. Green roof Storage Volume (m^3)
King Site	0.86	0.86	0.9	32.02	Green Roof (Infiltration)	3114	187
Front Site	1.25	1.25	0.9	46.21	Green Roof (Infiltration)	5039	302

Notes:
[1] Based on RC value
[2] From Table 3.2 of MOE SWM Planning and Design Manual (2003)

5.4 Dewatering

There will be a need for dewatering during construction. Watertight structures should be specified as much as possible to minimize long-term dewatering requirements. The

anticipated quantity and quality of the water will need to be specified at each site to support potential discharge management plan. Water quality will determine if dewatering effluent will require treatment and be directed toward the municipal storm sewer or sanitary sewer (likely sanitary). Please refer to **Subsection 3.1.5** for further details

6 Conclusions and Recommendations

This Stormwater Management Report is prepared in support of the Site Plan Application (SPA) and Reference Concept Design (RCD) for the proposed Corktown TOC Development Sites. The Reference Concept Design (RCD) satisfies SWM and drainage requirements for the Proposed Corktown Sites as follows:

- **Quantity Control:**

  Storage tank units with orifice control are proposed in the first underground level to provide quantity control.

- **Quality Control:**

  Quality control for each site will be provided via the proposed green roof and an Oil Grit Separator unit.

- **Water Balance:**

  Green roof and water reuse are proposed to satisfy the 10 mm retention requirement.

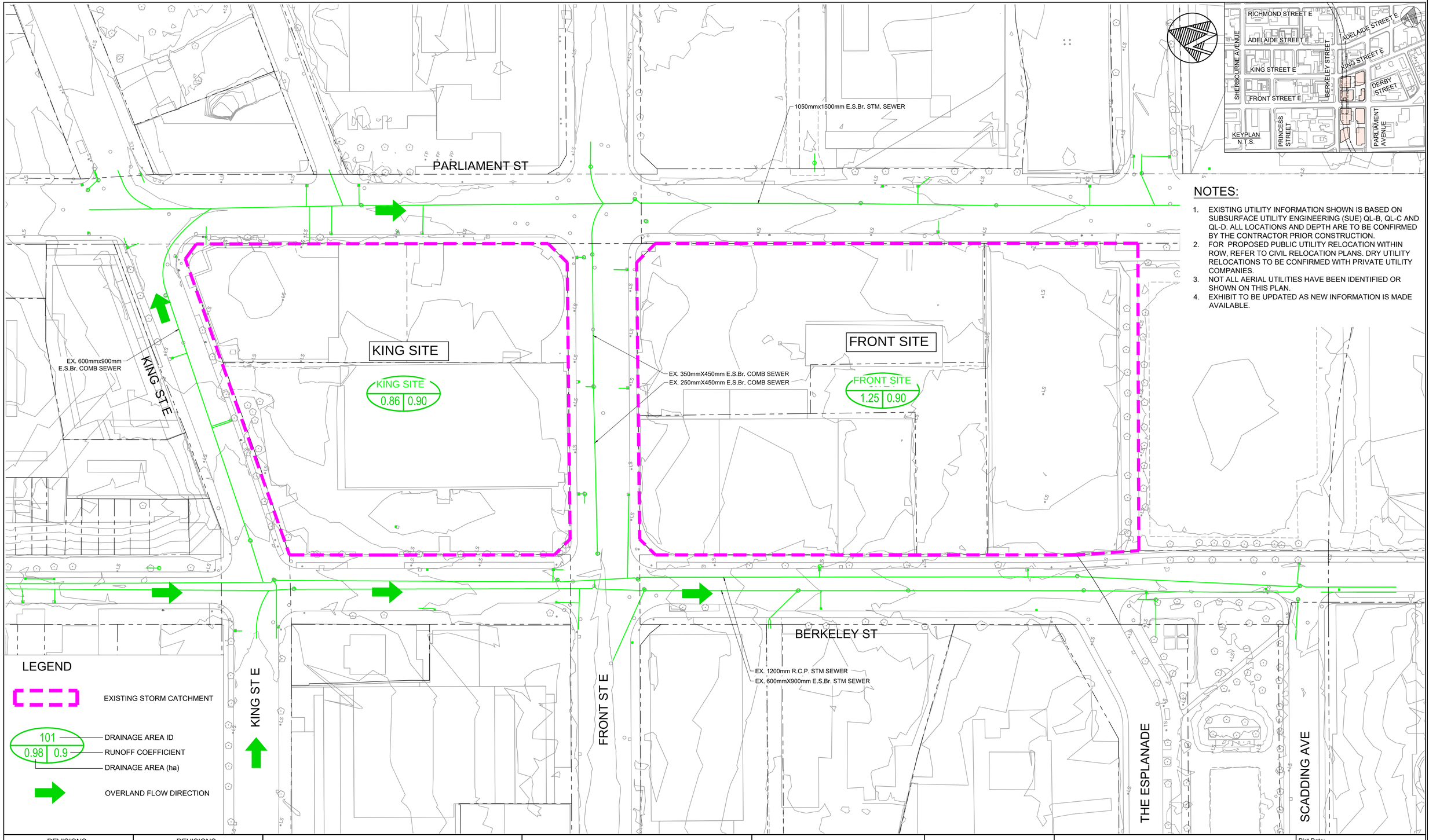
- **Minor Drainage System:**

  Water captured from the roofs of the building will be discharged into the existing storm sewer systems after receiving quality and quantity treatment.

- **Major Drainage System:**

  Major system drainage patterns will be generally maintained under proposed conditions. For the proposed aboveground structures, major system flows will be captured and controlled using underground storage.

Appendix A. Drainage Area Plans



NOTES:

1. EXISTING UTILITY INFORMATION SHOWN IS BASED ON SUBSURFACE UTILITY ENGINEERING (SUE) QL-B, QL-C AND QL-D. ALL LOCATIONS AND DEPTH ARE TO BE CONFIRMED BY THE CONTRACTOR PRIOR CONSTRUCTION.
2. FOR PROPOSED PUBLIC UTILITY RELOCATION WITHIN ROW, REFER TO CIVIL RELOCATION PLANS. DRY UTILITY RELOCATIONS TO BE CONFIRMED WITH PRIVATE UTILITY COMPANIES.
3. NOT ALL AERIAL UTILITIES HAVE BEEN IDENTIFIED OR SHOWN ON THIS PLAN.
4. EXHIBIT TO BE UPDATED AS NEW INFORMATION IS MADE AVAILABLE.

REVISIONS		REVISIONS	
1		4	
2		5	
3		6	

RCD
NOT FOR CONSTRUCTION

SCALE(S) 1:300 (0 3 6 9 12m)

STATUS

ONE TEAM
ONTARIO LINE TECHNICAL ADVISOR

DESIGNED	S. KHORSHID	2020/12/08
DRAWN	H. WANG	2020/09/09
CHECKED	M. LI	2020/12/08
APPROVED	APPROVED	2020/12/08

ONTARIO LINE SUBWAY

TITLE
TOC
CORKTOWN STATION
EXISTING DRAINAGE PLAN

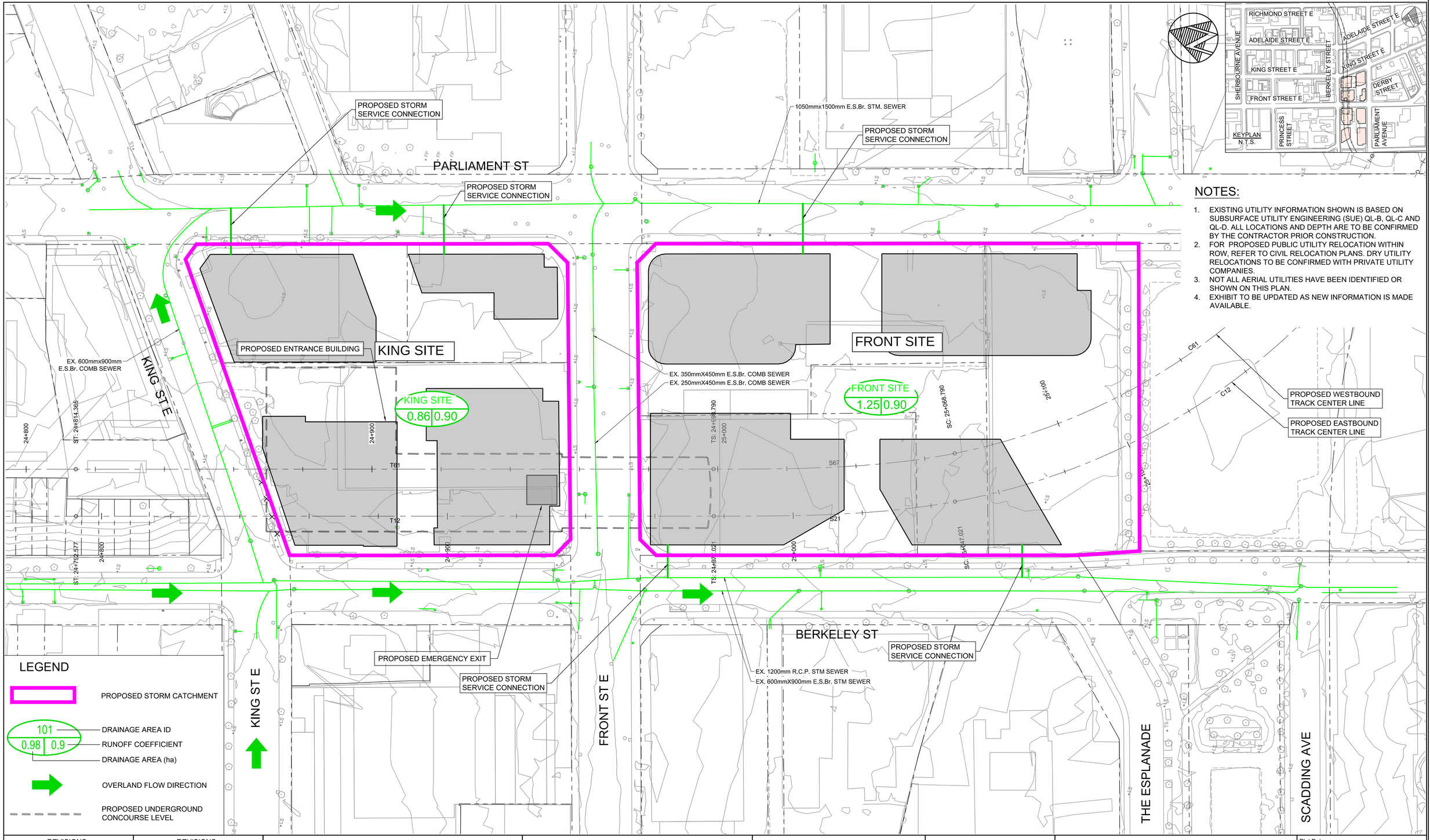
Plot Date:

METROLINX
Infrastructure Ontario

Dwg. No. DR0500-02-SF180

Sheet No.

FILE: 10206938-dr0500-02-sf180.dwg
PLOTTED BY: USER



NOTES:

1. EXISTING UTILITY INFORMATION SHOWN IS BASED ON SUBSURFACE UTILITY ENGINEERING (SUE) QL-B, QL-C AND QL-D. ALL LOCATIONS AND DEPTH ARE TO BE CONFIRMED BY THE CONTRACTOR PRIOR CONSTRUCTION.
2. FOR PROPOSED PUBLIC UTILITY RELOCATION WITHIN ROW, REFER TO CIVIL RELOCATION PLANS. DRY UTILITY RELOCATIONS TO BE CONFIRMED WITH PRIVATE UTILITY COMPANIES.
3. NOT ALL AERIAL UTILITIES HAVE BEEN IDENTIFIED OR SHOWN ON THIS PLAN.
4. EXHIBIT TO BE UPDATED AS NEW INFORMATION IS MADE AVAILABLE.

LEGEND

- PROPOSED STORM CATCHMENT
- 101 — DRAINAGE AREA ID
- 0.98 | 0.9 — RUNOFF COEFFICIENT / DRAINAGE AREA (ha)
- OVERLAND FLOW DIRECTION
- PROPOSED UNDERGROUND CONCOURSE LEVEL

REVISIONS		REVISIONS	
1		4	
2		5	
3		6	

RCD
NOT FOR CONSTRUCTION

SCALE(S) 1:300 (0 3 6 9 12m)

STATUS

DESIGNED S. KHORSHID 2020/12/08
DRAWN H. WANG 2020/09/09
CHECKED M. LI 2020/12/08
APPROVED APPROVED 2020/12/08

ONTARIO LINE SUBWAY

TITLE
TOC
CORKTOWN STATION
PROPOSED DRAINAGE PLAN

Plot Date:

METROLINX
Infrastructure Ontario

Dwg. No. DR0500-02-SF181

Sheet No.

FILE: 10206938-dr0500-02-sf180.dwg
PLOTTED BY: USER

Appendix B. Stormwater Management Calculations

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	08-Dec-2020
	Checked	S. Sadek	Checked	09-Dec-2020

Stormwater Management Calculations

Pre-Development Runoff Coefficients & Uncontrolled Peak Flows - King Site

Catchment	Area, A	2-10-yr		25-yr			50-yr			100-yr		
ID	(ha)	C	A x C	C_f	C	A x C	C_f	C	A x C	C_f	C	A x C
King Site -Corktown (Paved)	0.8643	0.9	0.7779	1.1	0.95	0.8211	1.2	0.95	0.8211	1.3	0.95	0.8211
King Site -Corktown (Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.3	0.25	0.0000
	0.8643		**0.7779**			**0.8211**			**0.8211**			**0.8211**

Total Drainage Area		0.8643	ha
Weighted C	2-yr	0.50	
	5-10-yr	0.90	
	25-yr	0.95	
	50-yr	0.95	
	100-yr	0.95	

NOTE:

1. C_f = Runoff Coefficient Factor
2. Reference of C_f : MTO
3. Use 'C' value as 0.5 if the existing weighted 'C ' value is greater than 0.5 for 2-yr return period

Run off Calculation (using Rational Method):

Q = C * i * A / 360 cms

C = Runoff Coefficient

i = Rainfall Intensity (mm/ [City of Toronto IDF Curve]

A = Watershed Area (ha)

IDF Eqn : i = A * T ^ B

A & B parameter for IDF Curve

Year	A =	B =
2	21.800	-0.780
5	32.000	-0.790
10	38.700	-0.800
25	45.200	-0.800
50	53.500	-0.800
100	59.700	-0.800

T_c (min)	10

Peak Flows

	Rainfall	Peak Flow	
Year	mm/hr	m^3/s	(L/s)
2	88.189	0.106	106
5	131.792	0.285	285
10	162.268	0.351	351
25	189.522	0.432	432
50	224.324	0.512	512
100	250.320	0.571	571

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	08-Dec-2020
	Checked	S. Sadek	Checked	09-Dec-2020

Stormwater Management Calculations

Post-Development Runoff Coefficients & Uncontrolled Peak Flows King Site

Catchment	Area, A	2-10-yr		25-yr			50-yr			100-yr		
ID	(ha)	C	A x C	C_f	C	A x C	C_f	C	A x C	C_f	C	A x C
King Site -Corktown (Paved)	0.8643	0.9	0.7779	1.1	0.95	0.8211	1.2	0.95	0.8211	1.3	0.95	0.8211
King Site -Corktown (Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.3	0.25	0.0000
	0.8643		**0.7779**			**0.8211**			**0.8211**			**0.8211**

Total Drainage Area		0.8643	ha
Weighted C	2-10-yr	0.90	
	25-yr	0.95	
	50-yr	0.95	
	100-yr	0.95	

NOTE:

1. C_f = Runoff Coefficient Factor
2. Reference of C_f: MTO

Run off Calculation (using Rational Method):

Q = C * i * A / 360 cms

C = Runoff Coefficient

i = Rainfall Intensity (mm/ [City of Toronto IDF Curve]

A = Watershed Area (ha)

IDF Eqn : i = A * T ^ B

A & B parameter for IDF Curve

Year	A =	B =
2	21.800	-0.780
5	32.000	-0.790
10	38.700	-0.800
25	45.200	-0.800
50	53.500	-0.800
100	59.700	-0.800

T_c (min)	10

Peak Flows

Year	Rainfall	Peak Flow	
	mm/hr	m^3/s	(L/s)
2	88.189	0.191	191
5	131.792	0.285	285
10	162.268	0.351	351
25	189.522	0.432	432
50	224.324	0.512	512
100	250.320	0.571	571

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	08-Dec-2020
	Checked	S. Sadek	Checked	09-Dec-2020

Stormwater Management Calculations

REQUIRED STORAGE (POST - PRE) 2 yr

King Site

Watershed Area, A	0.8643	ha
Weighted Post Development Runoff Coefficient, C	0.900	

Using Modified Rational Method

Q = C * i * A / 360 cms

C = Runoff Coefficient

i = Rainfall intensity (mm/hr) [From IDF Curve]

A = Watershed Area (ha)

Allowable Release rate [2 yr Pre-development Flow]	0.106	m^3/s

Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m^3)	Release Flow Volume (m^3)	Required Storage Volume (m^3)	Rainfall 2 Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.191	114.33	63.52	50.81	88.189
20	0.111	133.17	127.04	6.13	51.358
30	0.081	145.59	145.59	0.00	37.433
60	0.047	169.58	169.58	0.00	21.800
120	0.027	197.51	197.51	0.00	12.696
360	0.012	251.51	251.51	0.00	5.389
720	0.007	292.94	292.94	0.00	3.138
1440	0.004	341.20	341.20	0.00	1.828

Maximum Storage (Post - Pre)	51	m^3

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	08-Dec-2020
	Checked	S. Sadek	Checked	09-Dec-2020

Stormwater Management Calculations

REQUIRED STORAGE (POST - PRE) 100 yr

King Site

Watershed Area, A	0.8643	ha
Weighted Post Development Runoff Coefficient, C	0.950	

Using Modified Rational Method

Q = C * i * A / 360 cms

C = Runoff Coefficient

i = Rainfall intensity (mm/hr) [From IDF Curve]

A = Watershed Area (ha)

Allowable Release rate [2 yr Pre-development Flow]	0.106	m^3/s

Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m^3)	Release Flow Volume (m^3)	Required Storage Volume (m^3)	Rainfall 100 Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.571	342.56	63.52	279.04	250.320
20	0.328	393.49	127.04	266.46	143.771
30	0.237	426.73	190.55	236.18	103.944
60	0.136	490.19	381.11	109.08	59.700
120	0.078	563.08	563.08	0.00	34.289
360	0.032	701.44	701.44	0.00	14.238
720	0.019	805.75	805.75	0.00	8.178
1440	0.011	925.56	925.56	0.00	4.697

Maximum Storage (Post - Pre)	279	m^3

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	08-Dec-2020
	Checked	S. Sadek	Checked	09-Dec-2020

Stormwater Management Calculations

Pre-Development Runoff Coefficients & Uncontrolled Peak Flows - Front Site

Catchment ID	Area, A (ha)	2-10-yr C	2-10-yr A x C	25-yr C_f	25-yr C	25-yr A x C	50-yr C_f	50-yr C	50-yr A x C	100-yr C_f	100-yr C	100-yr A x C
Front Site -Corktown (Paved)	1.2472	0.9	1.1225	1.1	0.95	1.1848	1.2	0.95	1.1848	1.25	0.95	1.1848
Front Site -Corktown(Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.25	0.25	0.0000
	1.2472		**1.1225**			**1.1848**			**1.1848**			**1.1848**

Total Drainage Area		1.2472	ha
Weighted C	2-yr	0.50	
	5-10-yr	0.90	
	25-yr	0.95	
	50-yr	0.95	
	100-yr	0.95	

NOTE:

1. C_f = Runoff Coefficient Factor
2. Reference of C_f: MTO
3. Use 'C' value as 0.5 if the existing weighted 'C ' value is greater than 0.5 for 2-yr return period

Run off Calculation (using Rational Method):

Q = C * i * A / 360 cms

C = Runoff Coefficient

i = Rainfall Intensity (r [City of Toronto IDF Curve]

A = Watershed Area (ha)

IDF Eqn i = A * T ^ B

A & B parameter for IDF Curve

Year	A =	B =
2	21.800	-0.780
5	32.000	-0.790
10	38.700	-0.800
25	45.200	-0.800
50	53.500	-0.800
100	59.700	-0.800

T_c (min)	10

Peak Flows

Year	Rainfall mm/hr	Peak Flow m^3/s	Peak Flow (L/s)
2	88.189	0.153	153
5	131.792	0.411	411
10	162.268	0.506	506
25	189.522	0.624	624
50	224.324	0.738	738
100	250.320	0.824	824

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	08-Dec-2020
	Checked	S. Sadek	Checked	09-Dec-2020

Stormwater Management Calculations

Post-development Runoff Coefficients & Uncontrolled Peak Flows - **Front Site**

Catchment	Area, A	2-10-yr		25-yr			50-yr			100-yr		
		C	A x C	C_f	C	A x C	C_f	C	A x C	C_f	C	A x C
ID	(ha)											
Front Site -Corktown (Paved)	1.2472	0.9	1.1225	1.1	0.95	1.1848	1.2	0.95	1.1848	1.25	0.95	1.1848
Front Site -Corktown(Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.25	0.25	0.0000
	1.2472		**1.1225**			**1.1848**			**1.1848**			**1.1848**

Total Drainage Area		1.2472	ha
Weighted C	2-10-yr	0.90	
	25-yr	0.95	
	50-yr	0.95	
	100-yr	0.95	

NOTE:

1. C_f = Runoff Coefficient Factor
2. Reference of C_f: MTO

Run off Calculation (using Rational Method):

Q = C * i * A / 360 cms

C = Runoff Coefficient

i = Rainfall Intensity (mm/ [City of Toronto IDF Curve]

A = Watershed Area (ha)

IDF Eqn : i = A * T ^ B

A & B parameter for IDF Curve

Year	A =	B =
2	21.800	-0.780
5	32.000	-0.790
10	38.700	-0.800
25	45.200	-0.800
50	53.500	-0.800
100	59.700	-0.800

T_c (min)	10

Peak Flows

Year	Rainfall	Peak Flow	
	mm/hr	m^3/s	(L/s)
2	88.189	0.275	275
5	131.792	0.411	411
10	162.268	0.506	506
25	189.522	0.624	624
50	224.324	0.738	738
100	250.320	0.824	824

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	08-Dec-2020
	Checked	S. Sadek	Checked	09-Dec-2020

Stormwater Management Calculations

REQUIRED STORAGE (POST - PRE)	2	yr
Front Site		
Watershed Area, A	1.2472	ha
Weighted Post Development Runoff Coefficient, C	0.900	

Using Modified Rational Method

Q = C * i * A / 360 cms

C = Runoff Coefficient

i = Rainfall intensity (mm/hr) [From IDF Curve]

A = Watershed Area (ha)

Allowable Release rate [2 yr Pre-development Flow]	0.153	m^3/s

Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m^3)	Release Flow Volume (m^3)	Required Storage Volume (m^3)	Rainfall 2 Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.275	164.98	91.66	73.33	88.189
20	0.160	192.16	183.32	8.85	51.358
30	0.117	210.09	210.09	0.00	37.433
60	0.068	244.70	244.70	0.00	21.800
120	0.040	285.01	285.01	0.00	12.696
360	0.017	362.93	362.93	0.00	5.389
720	0.010	422.72	422.72	0.00	3.138
1440	0.006	492.36	492.36	0.00	1.828

Maximum Storage (Post - Pre)	73	m^3

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	08-Dec-2020
	Checked	S. Sadek	Checked	09-Dec-2020

Stormwater Management Calculations

REQUIRED STORAGE (POST - PRE) 100 yr

Front Site

Watershed Area, A	1.2472	ha
Weighted Post Development Runoff Coefficient, C	0.950	

Using Modified Rational Method

Q = C * i * A / 360 cms

C = Runoff Coefficient

i = Rainfall intensity (mm/hr) [From IDF Curve]

A = Watershed Area (ha)

Allowable Release rate [2yr Pre-development Flow]	0.153	m^3/s

Storm Duration (min)	Storm Runoff Rate (cms)	Storm Runoff Volume (m^3)	Release Flow Volume (m^3)	Required Storage Volume (m^3)	Rainfall Yr mm/hr
0	0.000	0.00	0.00	0.00	0.00
10	0.824	494.31	91.66	402.66	250.320
20	0.473	567.82	183.32	384.50	143.771
30	0.342	615.78	274.97	340.81	103.944
60	0.196	707.35	549.95	157.40	59.700
120	0.113	812.53	812.53	0.00	34.289
360	0.047	1012.20	1012.20	0.00	14.238
720	0.027	1162.71	1162.71	0.00	8.178
1440	0.015	1335.60	1335.60	0.00	4.697

Maximum Storage (Post - Pre)	403	m^3

	Project	OLTA	No.10206938		
	By	S. Khorshid	Date	08-Dec-2020	
	Checked	S. Sadek	Checked	09-Dec-2020	

Stormwater Management Calculations

WATER BALANCE CALCULATIONS - King Site

Site Characteristics		
Site Area	0.8643	ha

Retention Requirements		
rainfall/year (source: Canadian Climate Normals 1971-2000 Lester B. Pearson	661.6	mm/yr
Retain depth of	10	mm/yr
% annual rain	70%	
Site requirement	4002.7	m^3/yr

Tabular Format of WWFMG - Figure 1A

% of Total Average Annual Rainfall Depth

Rainfall (mm)	% Annual
0	0
2.5	30
5	47
10	70
15	82
20	90
25	94
30	97
35	99
40	100

Catchment Area characteristics		Capture Event Characteristics			Source Characteristics					Tank Characteristics for water reuse						Totals	
Area (ha)		Capture Event (mm)	% of Annual Rain	Total Annual Volume (m^3)	Initial Abstraction (mm)	% of Annual Rain	Source Volume (m^3)	Source Annual Volume (m^3)	% of Target	Overflow to Tank	Overflow Depth to Tank (mm)	% of Annual Rain	Tank Volume (m^3)	Tank Annual Volume (m^3)	% of Target	Total Annual Volume (m^3)	% of Target
0.5529	Impervious Roof	10	70%	2561	1	14%	5.53	512	13%	Yes	9	56%	49.76	2048	51%	2561	64%
0.3114	Proposed Green Roof	15	82%	1689	7	56%	21.80	1154	29%	Yes	8	26%	24.91	536	13%	1689	42%
															Total	4250	106%

	Project	OLTA	No.10206938		
	By	S. Khorshid	Date	08-Dec-2020	
	Checked	S. Sadek	Checked	09-Dec-2020	

Stormwater Management Calculations

WATER BALANCE CALCULATIONS - Front Site

Site Characteristics		
Site Area	1.2472	ha

Retention Requirements		
rainfall/year (source: Canadian Climate Normals 1971-2000 Lester B. Pearson	661.6	mm/yr
Retain depth of	10	mm/yr
% annual rain	70%	
Site requirement	5776.0	m^3/yr

Tabular Format of WWFMG - Figure 1A

% of Total Average Annual Rainfall Depth

Rainfall (mm)	% Annual
0	0
2.5	30
5	47
10	70
15	82
20	90
25	94
30	97
35	99
40	100

Catchment Area characteristics		Capture Event Characteristics			Source Characteristics					Tank Characteristics for water reuse						Totals	
Area (ha)		Capture Event (mm)	% of Annual Rain	Total Annual Volume (m^3)	Initial Abstraction (mm)	% of Annual Rain	Source Volume (m^3)	Source Annual Volume (m^3)	% of Target	Overflow to Tank	Overflow Depth to Tank (mm)	% of Annual Rain	Tank Volume (m^3)	Tank Annual Volume (m^3)	% of Target	Total Annual Volume (m^3)	% of Target
0.7433	Impervious Roof	10	70%	3442	1	14%	7.43	688	12%	Yes	9	56%	66.90	2754	48%	3442	60%
0.5039	Proposed Green Roof	15	82%	2734	7	56%	35.27	1867	32%	Yes	8	26%	40.31	867	15%	2734	47%
															Total	6176	107%

	Project	OLTA	No.10206938		
	By	S. Khorshid	Date	08-Dec-2020	
	Checked	S. Sadek	Checked	09-Dec-2020	
Stormwater Management Calculations					

QUALITY CONTROL CALCULATIONS

Drainage Area ID [1]	Proposed			Req. Volume for Quality Control[1] (m^3) [5]	Mitigation Measures [6]	Proposed Water Quality/ Balance Storage Volume (m^3) [7]
	Drainage Area (ha) [2]	Paved Area (ha) [3]	% Impervious[2] [4]			
King Site	0.86	0.86	90.0%	32.02	Infiltration (Green roof)	187
Front Site	1.25	1.25	90.0%	46.21	Infiltration (Green roof)	302

[1] From Table 3.2 of MOE SWM Planning and Design Manual (2003)

[2] Based on RC value

MOE Table 3.2

Impervious Level (%)	W.Q. Storage Volume* (m^3/ha)
35%	25
55%	30
70%	35
85%	40

Green Roof (infiltration)			
	Area (ha)	**Depth (m)**	Void Space, n
Site B1	0.3114	0.15	0.4
Site F	0.5039	0.15	0.4