Draft Rezoning Drainage and Stormwater Management Report–Exhibition Integrated Transit Oriented Communities

1-1A Atlantic Avenue,
1 Jefferson Avenue, 2-20 Atlantic Avenue
Toronto Ontario

Contract RFS-2019-NAFC-110

PO 214244

HDR Project 10206938

Ontario Line Technical Advisor

TORONTO, ONTARIO

September 30, 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.

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
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
OGS	Oil and Grit Separator
OL	Ontario Line
RCD	Reference Concept Design
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
TWAG	Toronto Water Asset Geodatabase
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 proposed Lakeshore West Segment includes Exhibition Station and the Liberty Village New Street, between Dufferin Street and Strachan Avenue. 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 **Exhibition Station** with respect to drainage conveyance, stormwater quantity control, stormwater quality treatment, and water balance.

Figure 1-1. Ontario Line Segments

1.2 Exhibition Station

The proposed Lakeshore West Segment is predominantly at grade and extends from the west end of the Ontario Line (OL) to the west end of the downtown tunnel portal located near the end of GO platform. Two development buildings are proposed at the northeast (Site A) and northwest (Site B) corners of Atlantic Avenue and GO corridor intersection.

Background Review

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

- Drawing 10206938-TD001A-LKSRW-EXHIBITION_SITE A, Ontario Line Exhibition Station Site A, Architectural plan;
- Drawing 10206938-TD001B-LKSRW-EXHIBITION_SITE B, Ontario Line Exhibition Station Site B, Architectural plan;
- Liberty New Street, Municipal Class Environmental Assessment, City of Toronto (LEA Consulting Ltd, July 2016);

- Storm Sewer Digital Map Owners Group (DMOG) database and Toronto Water Asset Geodatabase (TWAG), City of Toronto.

2 Existing Conditions

Based on investigation of available information, including site aerial imagery, ccurrently, the Exhibition TOC sites are occupied by developed areas, including commercial buildings, roads and parking lots. The sites are 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

Minor flow within the vicinity of the sites is captured via several catchbasins and conveyed into existing storm sewers adjacent to the sites which includes a 375 mm storm sewer along Atlantic Avenue and a 375 mm storm sewer along Jefferson Avenue. The storm sewers along the local streets discharge north into the Liberty Street storm sewer system. This system discharges west to the existing 1875 mm trunk sewer flowing south along the Dufferin Street. There also exist combined sewers including a 375 mm combined sewer along Atlantic Avenue and a 375 mm combined sewer along Jefferson Avenue. Refer to the Existing Conditions Drainage Plan in **Appendix A**.

Based on the Environmental Assessment report for the Liberty Village New Street (LEA Consulting Ltd, July 2016), stromwater within the industrial and residential developments are controlled on-site and discharged under controlled flow into the existing storm system. Other than that, the major flow from the sites is draining from north to south towards the GO / Metrolinx rail corridor. The GO corridor drains east and west from the existing GO transit stop high point located at the south limit of Atlantic Avenue. Major valley systems are located 4.3 km west at Humber River and 5.8 km east at Don River. The excerpt from the ESR report showing the existing drainage pattern is provided in **Appendix A**. Within the GO / Metrolinx corridor, stormwater is conveyed along the railway via ditches along the right-of-way and drains uncontrolled to the west into an existing culvert located below the Dufferin Street Bridge and to the east to the Bathurst Street grade separation. Based on the ESR report, the culvert connects to the 1875 mm diameter brick sewer draining south along Dufferin Street. The existing drainage pattern is shown in the Existing Drainage Plan in **Appendix A**. The drainage patterns described herein are to be reviewed and confirmed during detailed design for the project.

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 Metrolix 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

Two development buildings are proposed at the northeast (Site A) and northwest (Site B) corners of Atlantic Avenue and GO corridor intersection as shown on Proposed Drainage Area Plans **(Appendix A)**. The proposed buildings at Site B 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 Exhibition TOC site developments are as follows:

- A proposed building at the northeast corner of Atlantic Avenue and GO corridor intersection (Site A) with a total area of 0.48 ha;
- A proposed building at the northwest corner of Atlantic Avenue and GO corridor intersection (Site B) with a total area of 0.48 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 Exhibition TOC 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 154 m^3 and 153 m^3 for site A and B buildings, 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 Site A building can discharge to the existing 375 mm storm sewer running along Atlantic Avenue and controlled runoff from Site B building can discharge to the existing 375 mm storm sewer running along Jefferson Avenue.

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.		
Site A	0.4777	0.4777	0.9	0.5	0.9	59	154
Site B	0.4742	0.4742	0.9	0.5	0.9	58	153

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 2212.3 m^3/year for Site A and 2196.1 m^3/year for Site B. Total proposed green roof for site A is 1838 m^2 and for site B is 1861 m^2. In concept, the proposed green roof will achieve retention of 678 m^3/year for Site A and 689 m^3/year for Site B, equivalent to 31% and 31% of the annual target, respectively. 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 41.2 m^3 for Site A and 40.8 m^3 for Site B. By satisfying the water balance retention criterion, the erosion control criterion will be achieved for site A and B, 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)
Site A	Impervious Area	0.294	1	14%	272	12	41.16
Site A	Green Roof -Intensive	0.183	7	56%	681	31	
Site B	Impervious Area	0.288	1	14%	279	12	40.81
Site B	Green Roof -Intensive	0.186	7	56%	642	31	

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)
Site A	0.48	0.48	90%	17.71	Infiltration (Green roof)	183	110
Site B	0.48	0.48	90%	17.57	Infiltration (Green roof)	186	112

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 Rezoning Application and Reference Concept Design (RCD) for the proposed Exhibition TOC Development Sites. The RCD satisfies SWM and drainage requirements for the Proposed Exhibition 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.

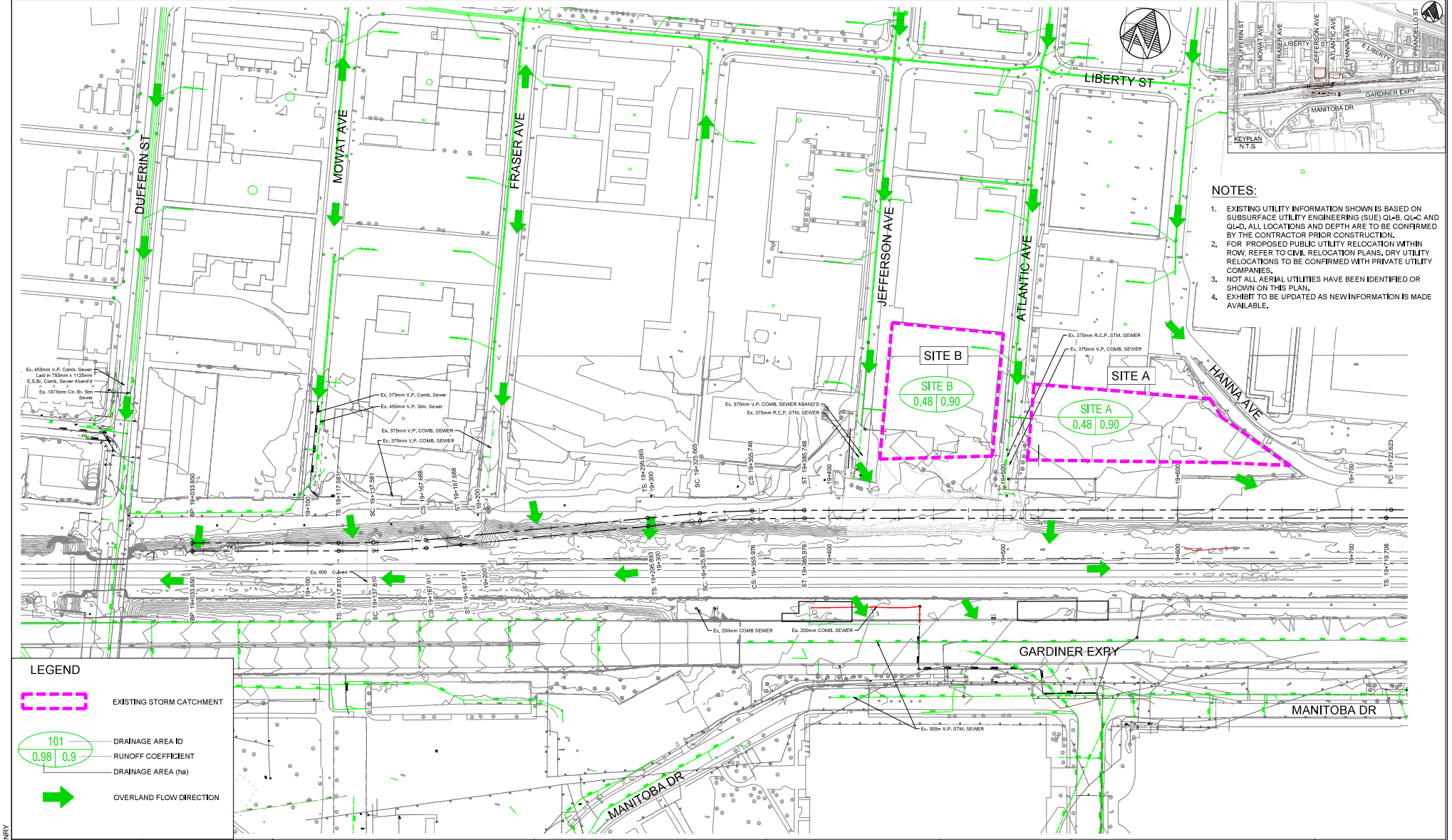
- **Minor Drainage System:**

  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 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	

DRAFT PLAN
NOT FOR CONSTRUCTION
30 SEPTEMBER 2021

SCALE(S) 1:1000 0 15 20 35 40m

STATUS

HDR

ONE TEAM
ONTARIO LINE TECHNICAL ADVISOR

DESIGNED	S.KHORSHID	2020/12/08
DRAWN	H.WANG	2021/09/30
CHECKED	N.ROUSKOV	2021/09/30
APPROVED	APPROVED	2021/09/30

ONTARIO LINE SUBWAY

TITLE
TOC
EXHIBITION STATION
EXISTING DRAINAGE PLAN

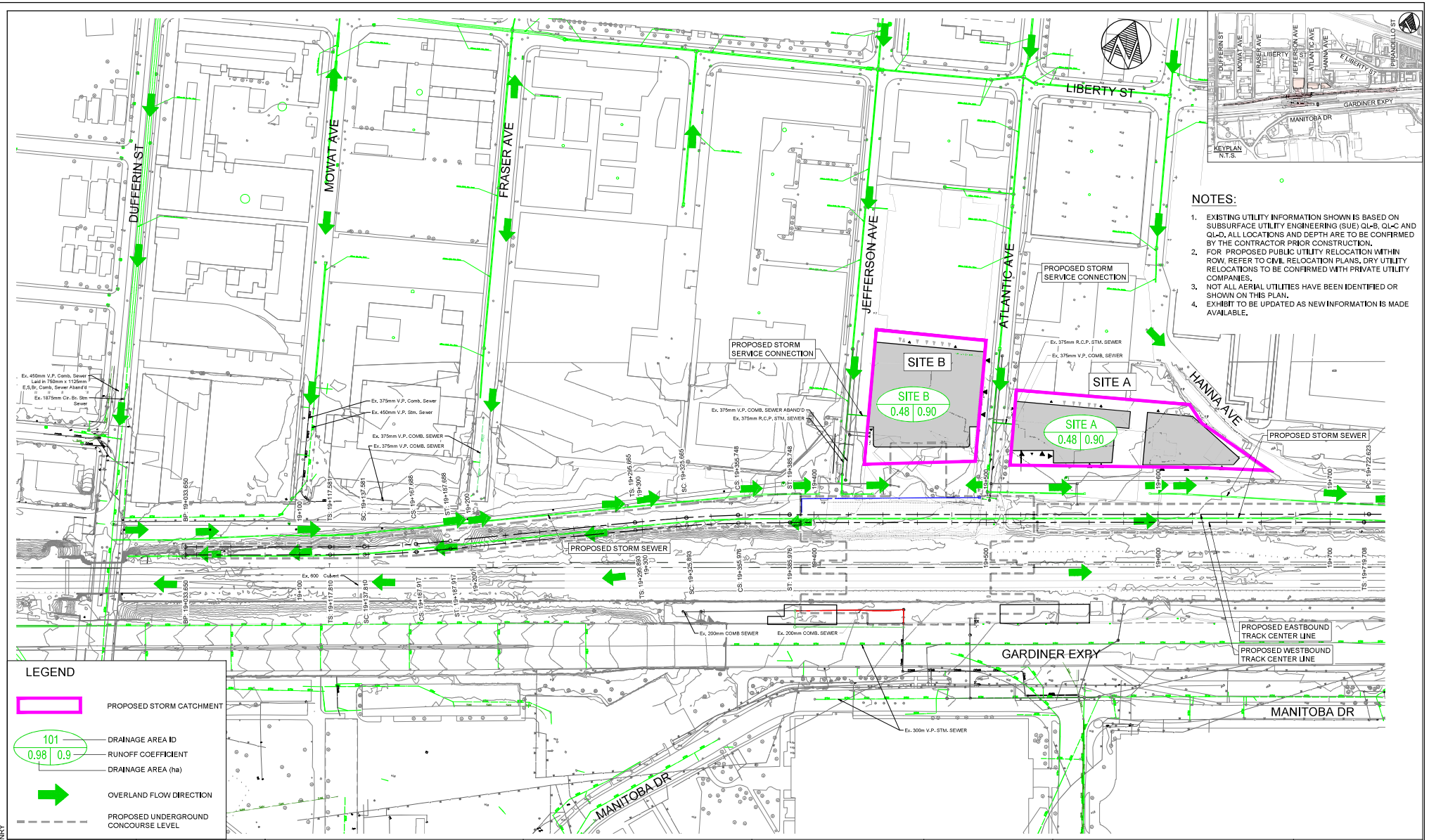
Plot Date:

METROLINX
Infrastructure Ontario

Dwg. No. DR1000-01-SF001

Sheet No.

FILE: 1020693B-dr1000-01-sf001.dwg
PLOTTED BY: WANG, HENRY



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

REVISIONS		REVISIONS	
1		4	
2		5	
3		6	

DRAFT PLAN
NOT FOR CONSTRUCTION
30 SEPTEMBER 2021

SCALE(S) 1:1000 0 15 20 35 40m

STATUS

HDR

ONE TEAM
ONTARIO LINE TECHNICAL ADVISOR

DESIGNED	S.KHORSHID 2021/05/19
DRAWN	H.WANG 2021/09/30
CHECKED	N.ROUSKOV 2021/09/30
APPROVED	APPROVED 2021/09/30

ONTARIO LINE SUBWAY

TITLE
TOC
EXHIBITION STATION
PROPOSED DRAINAGE PLAN

Plot Date:

METROLINX
Infrastructure Ontario

Dwg. No. DR1000-01-SF002

Sheet No.

FILE: 1020693B-dr1000-01-sf001.dwg
PLOTTED BY: WANG, HENRY

Appendix B. Stormwater Management Calculations

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	19-May-2021
	Checked	S. Sadek	Checked	19-May-2021

Stormwater Management Calculations

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

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)											
Site A-Exhibition Station (paved)	0.4777	0.9	0.4299	1.1	0.95	0.4538	1.2	0.95	0.4538	1.3	0.95	0.4538
Site A-Exhibition Station (Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.3	0.25	0.0000
	0.4777		**0.4299**			**0.4538**			**0.4538**			**0.4538**

Total Drainage Area		0.4777	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	0.059	59
5	131.792	0.157	157
10	162.268	0.194	194
25	189.522	0.226	226
50	224.324	0.283	283
100	250.320	0.316	316

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	19-May-2021
	Checked	S. Sadek	Checked	19-May-2021

Stormwater Management Calculations

Post-Development Runoff Coefficients & Uncontrolled Peak Flows -Site A

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
Site A-Exhibition Station (paved)	0.4777	0.9	0.4299	1.1	0.95	0.4538	1.2	0.95	0.4538	1.3	0.95	0.4538
Site A-Exhibition Station (Green)	0	0.2	0.0000	1.1	0.22	0.0000	1.2	0.24	0.0000	1.3	0.25	0.0000
	0.4777		0.4299			0.4538			0.4538			0.4538

Total Drainage Area		0.4777	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

	Rainfall	Peak Flow	
Year	mm/hr	m^3/s	(L/s)
2	88.189	0.105	105
5	131.792	0.157	157
10	162.268	0.194	194
25	189.522	0.239	239
50	224.324	0.283	283
100	250.320	0.316	316

	Project	OLTA	No.10206938	
	By	S. Khorshid	Date	19-May-2021
	Checked	S. Sadek	Checked	19-May-2021
Stormwater Management Calculations				

REQUIRED STORAGE (POST - PRE) 2 yr

Site A

Watershed Area, A	0.4777	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]	0.059	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	0.105	63.19	35.11	28.09	88.189
20	0.061	73.60	70.21	3.39	51.358
30	0.045	80.47	80.47	0.00	37.433
60	0.026	93.72	93.72	0.00	21.800
120	0.015	109.16	109.16	0.00	12.696
360	0.006	139.01	139.01	0.00	5.389
720	0.004	161.91	161.91	0.00	3.138
1440	0.002	188.58	188.58	0.00	1.828

Maximum Storage (Post - Pre)	28	m^3