# Draft Drainage and Stormwater Management Report–Gerrard-Carlaw South TOC

Dickens block, Thackeray block, Carlaw block, Badgerow block

Issued for Rezoning

Contract RFS-2019-NAFC-110

PO 214244

HDR Project 10206938

Ontario Line Technical Advisor

TORONTO, ONTARIO

February 2023

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# Abbreviations

| | |
|---|---|
| BMP | Best Management Practice |
| 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 |
| 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 |
| WWFMG | Wet Weather Flow Management Guidelines |

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# 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 Ontario Line Technical Advisory Services team have been organized into the following segments, as shown in **Figure 1-1**:

- Maintenance Storage Facility (MSF), and
- Four linear geographical segments:
  - Segment 1: Lakeshore (containing both Lakeshore West and Lakeshore East)
  - Segment 2: Downtown
  - Segment 3: Pape
  - Segment 4: Thorncliffe

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 Gerrard-Carlaw South TOC located north of Dickens Street between Logan Avenue and Carlaw Avenue in the City of Toronto with respect to drainage conveyance, stormwater quantity control, stormwater quality treatment, and water balance.

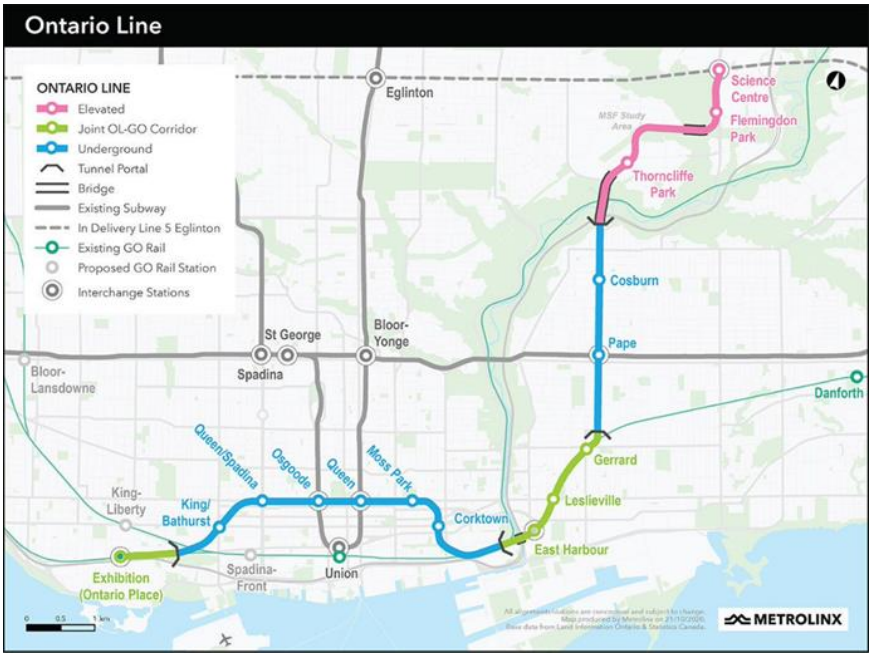



**Figure 1-1. Ontario Line Segments**

## 1.2 Gerrard-Carlaw South TOC

Gerrard-Carlaw South TOC is located north of Dickens Street between Logan Avenue and Carlaw Avenue. A development building is proposed at the northwest intersection of Dickens Street and Thackeray Street (Dickens block). Additionally, two other buildings are proposed at the northeast corner of Dickens Street and Thackeray Street (Thackeray block and Carlaw block). Thackeray street is extended north of the northeast sites to meet Carlaw Street aligned with Badgerow Street. Another building is proposed north of the extended street which is the Badgerow block.

## 1.3 Background Review

In preparation of the Gerrard-Carlaw South TOC Drainage and Stormwater Management Report, the following essential documents were obtained and reviewed:

- Drawing 10206938-UT0000-03-BP999, Composite Utility Plan
- Drawing 10206938-TD0000-03-RF320, Architectural Roof Plan
- Drawing 10206938-TD0000-03-RF330, Architectural Roof Plan
- Drawing 10206938-LA0000-03-DS350, Landscape Plan

# 2 Existing Conditions

There are two site developments proposed on the northwest and northeast sides of the intersection of Dickens Street and Thackeray Street. There is a parking lot on the west side of Thackeray Street and two to three-story interconnected commercial buildings on the east side. The Gerrard-Carlaw South TOC is not within a TRCA riverine watershed but are part of the Lake Ontario Waterfront area and is within the Basement Flooding Study Area 3. **Figure 2-1** shows an aerial image of the subject sites' location.


**Figure 2-1. Area Plan**

## 2.1 Minor and Major Flows

The existing parking lot component at 10 Dickens Street is graded to convey runoff from the site to the catch basins located on Dickens Street. It is also assumed that the downspout drainage discharge from the building roofs at 388 Carlaw Avenue to the storm sewer systems on Carlaw Avenue. Based on the existing grading surfaces, there are offsite flows from the GO Lines in the Joint Rail Corridor that are currently incoming to the proposed TOC site locations. There is a retaining wall at the northwest corner of the site, adjacent to the joint corridor that directs the runoff from the rail to Logan Avenue. There are gabion baskets between the rail and the northeast corner of the building at 388 Carlaw where water infiltrates in the vegetated area and there is no off-site drainage. The parking lot at the northeast corner of the building at 388 Carlaw drains towards Carlaw Avenue. Please refer to the attached existing drainage plan in **Appendix A**.

Existing storm drainage adjacent to the 10 Dickens site include a 450 mm Combined sewer and a 675 mm storm sewer on Logan Avenue. There is a 375 mm combined sewer that runs from west to east on Dickens Street and increases in size to a 525 mm combined sewer. Furthermore, there is also a 1050 mm x 1475 mm storm sewer, 600 mm x 900 mm combined sewer, and a 300 mm combined sewer flowing southward on Carlaw Avenue.

Major flows on Thackeray Street flow from north to south into Dickens Street. Major flows on Dickens Street travel from west to east. Major flows on Carlaw Avenue from north of Badgerow Avenue flow north towards Gerrard Street East. Major flows on Carlaw Avenue starting from south of Badgerow Avenue flow from north to south towards Dickens Street.

With the limited information that is currently available, it is not possible to further comment on the existing drainage.

# 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, 2021)
- 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)

- Light Rail Transit Design Criteria Manual (Metrolinx, 2016)

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.

## 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 Version 4 - Tier 1).
- 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 residential infill development (between 0.1 ha and 5 ha) where storm/combined sewer infrastructure exists, erosion control is not required unless the site is located in close proximity to natural watercourse (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

There are two site developments proposed at the intersection of Dickens Street and Thackeray Street. The proposed catchment area for the existing 10 Dickens at the northwest corner of the intersection contains the proposed Dickens block and the Thackeray Street. The new Thackeray Street ROW extension through to Carlaw Avenue effectively divides the 388 Carlaw Block into separate future properties. The existing 388-A Carlaw at the northeast corner of the ROW extension includes the proposed Badgerow block, whereas the existing 388-B Carlaw at the southeast corner of the ROW extension includes the Carlaw and Thackeray blocks. Refer to the attached proposed drainage plan in **Appendix A**.

The courtyard between the Carlaw block buildings is to drain to the proposed catch basin on Thackeray Street as shown in the proposed courtyard drainage sketch in **Appendix A**. The courtyard area has a proposed pervious pavement underlain with Granular O, and sloped insulation, and subdrain to convey the stormwater. The proposed walkway tunnel from the courtyard to Carlaw Avenue is considered impervious pavement. A portion of the surface runoff from the tunnel can be conveyed through the subdrains and the rest is conveyed to Carlaw Avenue

The proposed Gerrard Station is located North of the proposed TOC sites along the rail path and will have a separate roof to the proposed TOC development. It is assumed that the portion of the GO track currently draining into the proposed TOC site locations will be contained on the rail path by a retaining wall which will be constructed by others, prior to the development of the TOC sites. The construction of the retaining wall will need to be confirmed during detail design.

Ontario Line Gerrard-Carlaw South TOC site development is as follows:

- One proposed building at the northwest intersection of Dickens Street and Thackeray Street with a total catchment area of 0.73 ha.
- Three proposed buildings at the northeast corner of Dickens Street and Thackeray Street with a total catchment area of 1.35 ha. Site divides by Thackeray Street ROW extension to Carlaw Avenue.
- A portion of Thackeray Street has a catchment area of 0.26 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 Gerrard-Carlaw South TOC site. 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**. Pervious paver and subdrains are also proposed for the Carlaw block courtyard drainage shown 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 234 $m^3$, 110 $m^3$, and 254 $m^3$ for Dickens, Badgerow, and Carlaw blocks respectively, as shown in **Table 5-1**. Detailed calculations are included in **Appendix B**. In concept, storage tanks with orifice controls can be installed in the first underground level to provide the required storage volume for the proposed blocks. Storage for Thackery St can be provided in combination of bioswale and superpipe. Controlled runoff from the Dickens block building and Thackeray Street can discharge to the existing 375 mm combined sewer along Dickens Street. Controlled runoff from Carlaw block buildings can discharge to the existing culvert storm sewer on Carlaw Avenue. Sewers will be confirmed during the detailed design.

**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. | | |
| Dickens block | 1.44 | 1.09 | 0.79 | 0.5 | 0.69 | 176 | 234 |
| Badgerow block | 0.37 | 0.46 | 0.83 | 0.5 | 0.66 | 45 | 110 |
| Carlaw blocks | 0.92 | 0.93 | 0.90 | 0.5 | 0.77 | 113 | 254 |

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

The water balance criterion of TGS Version 4 Tier 1 requires the retention of 5 mm of runoff over the proposed areas, which are equivalent to the retention of 55 $m^3$/event, 23 $m^3$/event, and 47 $m^3$/event for Dickens, Badgerow, and Carlaw blocks respectively. Total proposed green roof for the Dickens, Badgerow, and Carlaw blocks are 0.14 ha, 0.04 ha, and 0.22

ha respectively. In concept, the proposed green roof, the landscaping, and the impervious surface will achieve a certain retention by initial abstraction. To meet the TGS Version 4 Tier 1 criterion, the remaining required water balance will be stored in underground storage tanks for reuse. In concept, the required tank storage is 28 $m^3$, 11 $m^3$, and 55 $m^3$ to for Dickens, Badgerow, and Carlaw blocks respectively to meet the water balance criterion. 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 | | Reuse | | | Total[1] ($m^3$) |
|---|---|---|---|---|---|---|---|---|
| | | | Depth (mm) | Volume ($m^3$) | Depth (mm) | Required Volume ($m^3$) | Proposed Volume ($m^3$) | |
| Dickens block | Impervious Area | 0.70 | 1 | 7 | 4 | 28 | 28 | 60 |
| | Landscape | 0.25 | 7 | 18 | 0 | 0 | | |
| | Green Roof | 0.14 | 5 | 7 | 0 | 0 | | |
| Badgerow block | Impervious Area | 0.28 | 1 | 3 | 4 | 11 | 11 | 26 |
| | Landscape | 0.14 | 7 | 10 | 0 | 0 | | |
| | Green Roof | 0.04 | 5 | 2 | 0 | 0 | | |
| Carlaw blocks | Impervious Area | 0.69 | 1 | 7 | 4 | 28 | 55 | 74 |
| | Landscape | 0.02 | 7 | 1 | 0 | 0 | | |
| | Green Roof | 0.22 | 5 | 11 | 0 | 0 | | |

Notes:

[1] The sum of initial abstraction and proposed reuse volume

## 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 a green roof, landscaping, water reuse, inline treatment, and an OGS units 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 | Land Use | Area (ha) | TSS Produced[1] (g) | Source TSS Removed (g) | Inline TSS Removed (g) | Reqd. Reuse Storage in Tank ($m^3$) | Water Reuse TSS Removed (g) | OGS TSS Removed (g) | TSS Removal |
|---|---|---|---|---|---|---|---|---|---|
| Dickens block | Imperv. Roadway | 0.13 | 733] | 0 | 366 | 28 | 55 | 2 | 80% |
| | At-Grade Imperv. | 0.36 | 5400 | 0 | 2700 | | 404 | 1148 | |
| | Imperv. Roof | 0.21 | 1365 | 0 | 0 | | 204 | 580 | |
| | Green Roof | 0.14 | 917 | 734 | 0 | | 27 | 78 | |
| | Landscape | 0.25 | 1625 | 1300 | 260 | | 10 | 28 | |
| Badgerow block | Imperv. Roadway | 0 | 0 | 0 | 0 | 11 | 0 | 2 | 81% |
| | At-Grade Imperv. | 0.22 | 3300 | 0 | 1650 | | 240 | 705 | |
| | Imperv. Roof | 0.06 | 390 | 0 | 0 | | 57 | 167 | |
| | Green Roof | 0.04 | 260 | 208 | 0 | | 8 | 22 | |
| | Landscape | 0.14 | 910 | 728 | 146 | | 5 | 16 | |
| Carlaw blocks | Imperv. Roadway | 0.07 | 0 | 0 | 0 | 55 | 0 | 2 | 80% |
| | At-Grade Imperv. | 0.26 | 3900 | 0 | 1950 | | 601 | 675 | |
| | Imperv. Roof | 0.36 | 2340 | 0 | 0 | | 721 | 809 | |
| | Green Roof | 0.22 | 1430 | 1144 | 0 | | 88 | 99 | |
| | Landscape | 0.02 | 130 | 104 | 21 | | 2 | 2 | |

Notes:
[1] Assumed 0.65g/$m^2$ TSS produced for High-Density Residential land use, and 2.82kg/curb-km per 5-day build-up (EPA Reference Manual III – Water Quality)

## 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 Gerrard-Carlaw South TOC Development Sites. The RCD satisfies SWM and drainage requirements for the Proposed Gerrard Sites as follows:

- **Quantity Control:**

  Storage tank units with orifice controls are proposed in the first underground level to provide quantity control. The required storage volumes are 234 $m^3$, 110 $m^3$, and 254 $m^3$ for Dickens, Badgerow, and Carlaw blocks respectively, released over 24 hours.

- **Quality Control:**

  Quality control for each site will be provided via the proposed green roof along with inline treatments, the water retained in the storage tanks for reuse, and Oil Grit Separator units. The required storage volumes are 28 $m^3$, 11 $m^3$, and 55 $m^3$ for Dickens, Badgerow, and Carlaw blocks respectively to meet quality requirements.

- **Water Balance:**

  Green roof and water reuse are proposed to satisfy the 5 mm retention requirement. Reuse volume for quality control will satisfy the water balance requirements.

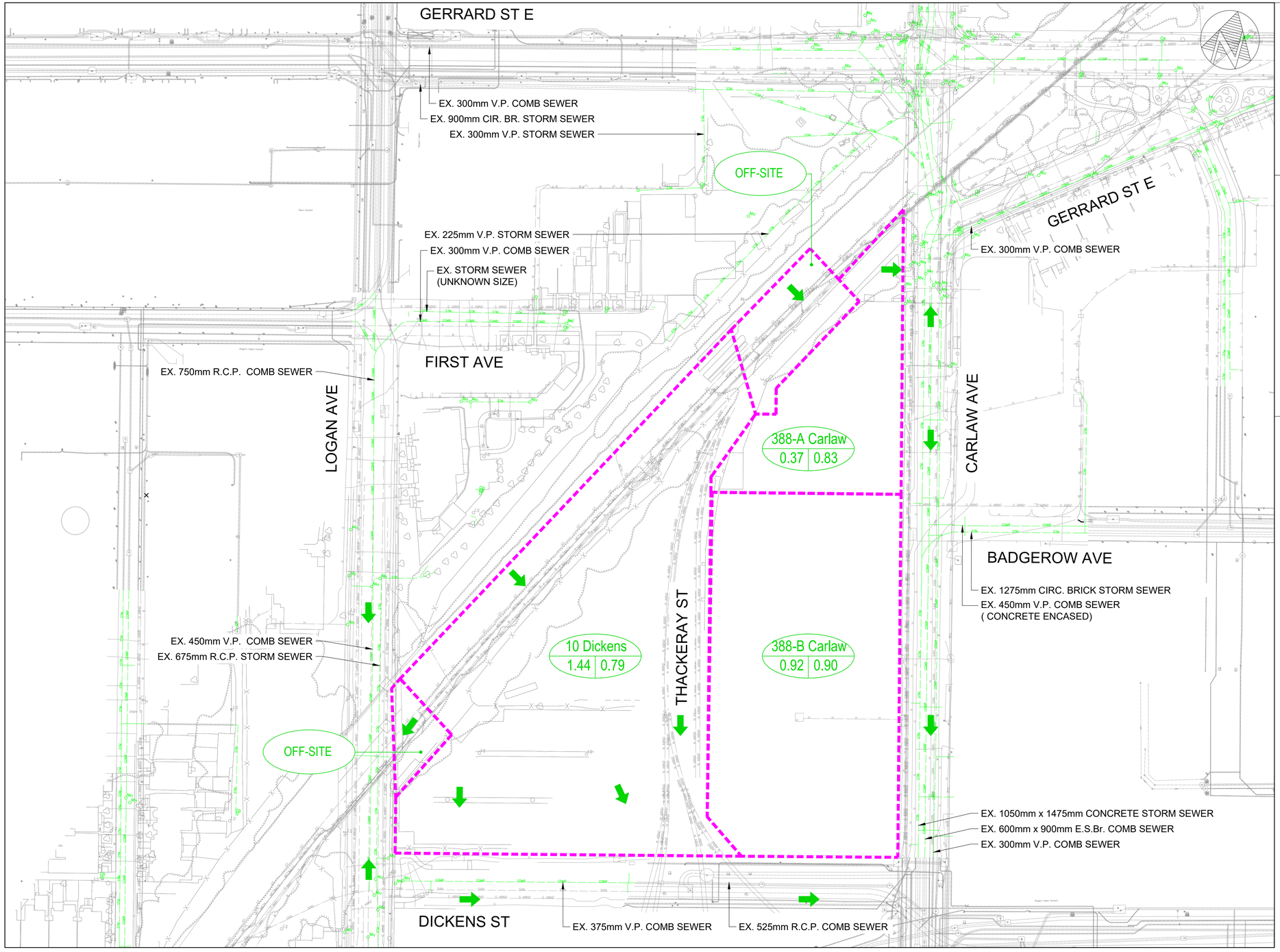
- **Minor Drainage System:**

  Water captured from the roofs of the building will be discharged into the existing storm/ combined 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.

## LEGEND

- EXISTING STORM CATCHMENT
- 101 / 0.98 | 0.9 — DRAINAGE AREA ID; RUNOFF COEFFICIENT; DRAINAGE AREA (ha)
- OVERLAND FLOW DIRECTION
- STM STM — EXISTING STORM SEWER
- COMB COMB — EXISTING COMBINED SEWER

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STATUS

HDR

ONE TEAM
ONTARIO LINE TECHNICAL ADVISOR

DESIGNED D. NUTTALL
DRAWN M. KHODADADI
CHECKED XXX
APPROVED XXX

ONTARIO LINE SUBWAY

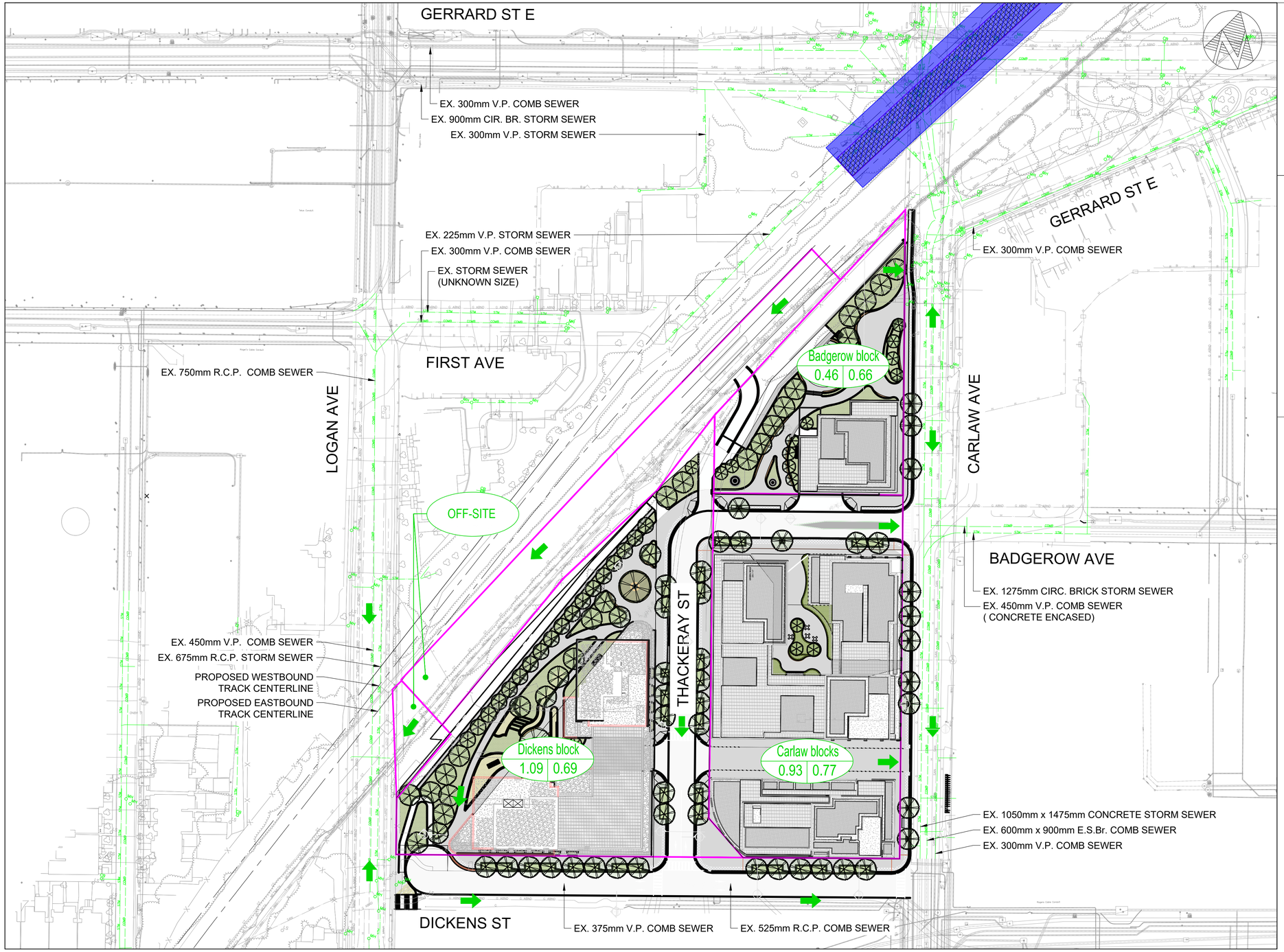
TITLE
GERRARD TOC
EXISTING DRAINAGE PLAN

Plot Date: 11 November 2022

METROLINX
Infrastructure Ontario

Dwg. No.

Sheet No.

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3. NOT ALL AERIAL UTILITIES HAVE BEEN IDENTIFIED OR SHOWN ON THIS PLAN.
4. EXHIBIT TO BE UPDATED AS NEW INFORMATION IS MADE AVAILABLE.
5. REFER TO THE SERVICING PLAN FOR THE PROPOSED STORM SEWERS AND SERVICING CONNECTIONS.

## LEGEND

- PROPOSED STORM CATCHMENT
- 101 / 0.98 | 0.9 — DRAINAGE AREA ID; RUNOFF COEFFICIENT; DRAINAGE AREA (ha)
- OVERLAND FLOW DIRECTION
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RCD
NOT FOR CONSTRUCTION
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STATUS

HDR

ONE TEAM
ONTARIO LINE TECHNICAL ADVISOR

DESIGNED D. NUTTALL
DRAWN M. KHODADADI
CHECKED XXX
APPROVED XXX

ONTARIO LINE SUBWAY

TITLE
GERRARD TOC
PROPOSED DRAINAGE PLAN

Plot Date: 9 February 2023

METROLINX
Infrastructure Ontario

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Sheet No.

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PLOTTED BY: KHODADADI, MAHSA

# Appendix B. Stormwater Management Calculations

ONE TEAM
ONTARIO LINE TECHNICAL ADVISOR

| | | | | |
|---|---|---|---|---|
| | Project | OLTA | No.10206938 | |
| | By | M. Khodadadi | Date | 09-Feb-2023 |
| | Checked | D. Nuttall | Checked | 09-Feb-2023 |

**Stormwater Management Calculations**

## Pre-Development Runoff Coefficients & Uncontrolled Peak Flows - 10 Dickens

| 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) | | | | | | | | | | | |
| Impervious | 1.19 | 0.90 | 1.07 | 1.10 | 0.95 | 1.13 | 1.20 | 0.95 | 1.13 | 1.25 | 0.95 | 1.13 |
| Landscape | 0.25 | 0.25 | 0.06 | 1.10 | 0.28 | 0.07 | 1.20 | 0.30 | 0.08 | 1.25 | 0.31 | 0.08 |
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| | | | | | | | | | | | | |
| | **1.44** | | **1.13** | | | **1.20** | | | **1.21** | | | **1.21** |

| | | | |
|---|---|---|---|
| Total Drainage Area | | 1.44 | ha |
| Weighted C | 2-10-yr | 0.79 | ***Note 3** |
| | 25-yr | 0.83 | |
| | 50-yr | 0.84 | |
| | 100-yr | 0.84 | |

**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 | 0.176 | 176 |
| 5 | 131.792 | 0.415 | 415 |
| 10 | 162.268 | 0.511 | 511 |
| 25 | 189.522 | 0.631 | 631 |
| 50 | 224.324 | 0.751 | 751 |
| 100 | 250.320 | 0.840 | 840 |

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| | | | | |
|---|---|---|---|---|
| | Project | OLTA | No.10206938 | |
| | By | M. Khodadadi | Date | 09-Feb-2023 |
| | Checked | D. Nuttall | Checked | 09-Feb-2023 |

**Stormwater Management Calculations**

## Post-Development Runoff Coefficients - Dickens block

| 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 |
| Impervious | 0.70 | 0.90 | 0.63 | 1.10 | 0.95 | 0.67 | 1.20 | 0.95 | 0.67 | 1.25 | 0.95 | 0.67 |
| Landscape | 0.25 | 0.25 | 0.06 | 1.10 | 0.28 | 0.07 | 1.20 | 0.30 | 0.08 | 1.25 | 0.31 | 0.08 |
| Green Roof | 0.14 | 0.40 | 0.06 | 1.10 | 0.44 | 0.06 | 1.20 | 0.48 | 0.07 | 1.25 | 0.50 | 0.07 |
| Permeable Roof | 0.00 | 0.80 | 0.00 | 1.10 | 0.88 | 0.00 | 1.20 | 0.96 | 0.00 | 1.25 | 1.00 | 0.00 |
| | | | | | | | | | | | | |
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| | | | | | | | | | | | | |
| | **1.09** | | **0.75** | | | **0.80** | | | **0.81** | | | **0.81** |

| | | | |
|---|---|---|---|
| Total Drainage Area | | 1.09 | ha |
| Weighted C | 2-10-yr | 0.69 | |
| | 25-yr | 0.73 | |
| | 50-yr | 0.74 | |
| | 100-yr | 0.75 | |

**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/l [City of Toronto IDF Curve]

A = Watershed Area (ha)

IDF Eqn : $i = A * T \wedge B$

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 | 0.183 | 183 |
| 5 | 131.792 | 0.274 | 274 |
| 10 | 162.268 | 0.338 | 338 |
| 25 | 189.522 | 0.419 | 419 |
| 50 | 224.324 | 0.503 | 503 |
| 100 | 250.320 | 0.566 | 566 |

| | | | | |
|---|---|---|---|---|
| | Project | OLTA | | No.10206938 |
| | By | M. Khodadadi | Date | 09-Feb-2023 |
| | Checked | D. Nuttall | Checked | 09-Feb-2023 |
| **Stormwater Management Calculations** | | | | |

## REQUIRED STORAGE (POST - PRE) 100 yr

### Dickens block

| | | |
|---|---|---|
| Watershed Area, A | 1.09 | ha |
| Weighted Post Development Runoff Coefficient, C | 0.75 | |

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] | | 0.176 | $m^3/s$ |

| 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 | 0.566 | 339.47 | 105.83 | **233.64** | 250.320 |
| 20 | 0.325 | 389.94 | 211.65 | 178.29 | 143.771 |
| 30 | 0.235 | 422.88 | 317.48 | 105.40 | 103.944 |
| 40 | 0.187 | 447.93 | 423.31 | 24.62 | 82.575 |
| 50 | 0.156 | 468.37 | 468.37 | 0.00 | 69.075 |
| 60 | 0.135 | 485.76 | 485.76 | 0.00 | 59.700 |
| 70 | 0.119 | 500.97 | 500.97 | 0.00 | 52.774 |
| 80 | 0.107 | 514.53 | 514.53 | 0.00 | 47.427 |
| 90 | 0.098 | 526.80 | 526.80 | 0.00 | 43.162 |
| | | | | | |
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| | | |
|---|---|---|
| Maximum Storage (Post - Pre) | 234 | $m^3$ |

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|---|---|---|---|---|
| | Project | OLTA | No.10206938 | |
| | By | M. Khodadadi | Date | 09-Feb-2023 |
| | Checked | D. Nuttall | Date | 9-Feb-2023 |

**Stormwater Management Calculations**

## Water Balance Calculations - Dickens block

| **Site Chracteristics** | | |
|---|---|---|
| Site Area | 1.09 | ha |

| **Retention Requirements** | | |
|---|---|---|
| Per Event Retain depth of | 5 | mm |
| Site requirement | 55 | $m^3$/event |

| **Catchment Area characteristics** | | **Capture Event Characteristics** | | | **Water Infiltration/ Reuse Characteristics** | | **Total Volume Retained ($m^3$)** | **% of Target** |
|---|---|---|---|---|---|---|---|---|
| **Runoff Source** | **Area (ha)** | **Capture Event (mm)** | **Initial Abstraction** | **Initial Abstraction Volume ($m^3$)** | **Run off Depth (mm)** | **Infiltration/ Reuse Volume ($m^3$)** | | |
| Impervious | 0.70 | 5 | 1 | 7 | 4 | 28 | 35 | 64% |
| Landscape | 0.25 | | 7 | 18 | 0 | 0 | 18 | 32% |
| Green Roof | 0.14 | | 5 | 7 | 0 | 0 | 7 | 13% |
| Permeable Roof | 0.00 | | 5 | 0 | 0 | 0 | 0 | 0% |
| | | | | | **Totals** | **28** | **60** | **109%** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Project | OLTA | No.10206938 | | | |
| | By | M. Khodadadi | Date | 09-Feb-2023 | | |
| | Checked | D.Nuttall | Checked | 09-Feb-2023 | | |

**Stormwater Management Calculations**

**Water Quality Treatment Train Calculations - Dickens bloc**

| | | | | | Step 1 - Source | | | | | | Step 2 - Inline Treatment | | | | Step 3 - Water Reuse | | | | Step 4 - OGS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area (ha) | Curb Length (km) | Land Use | Runoff Coefficient | Quality Event (mm) | Relative Sediment Loading[1] ($g/m^2$) | Roadway Sediment Loading[2] (g/curb-km) | Relative TSS Produced (g) | Source Removal Efficiency | Source TSS Removal (g) | Step 1 Remaining TSS (g) | Inline Treatment | Expected Performance | Inline TSS Removal (g) | Step 2 Remaining TSS (g) | Runoff to Storage Tank ($m^3$) | Fraction of Runoff Intercepted by Water Re-Use | Reuse TSS Removal (g) | Step 3 - Remaining TSS (g) | OGS Removal Efficiency | OGS TSS Removal (g) | Step 4 - Remaining TSS (g) |
| 0.13 | 0.26 | Impervious Roadway | 0.9 | 25 | N/A | 2819 | 733 | 0% | 0 | 733 | CB Shield | 0.5 | 366 | 366 | 29 | | 55 | 312 | | 2 | 310 |
| 0.36 | N/A | At Grade Impervious | 0.9 | 25 | 1.50 | N/A | 5400 | 0% | 0 | 5400 | CB Shield | 0.5 | 2700 | 2700 | 81 | | 404 | 2296 | | 1148 | 1148 |
| 0.21 | N/A | Impermeable Roo | 0.9 | 25 | 0.65 | N/A | 1365 | 0% | 0 | 1365 | | | 0 | 1365 | 47 | 0.15 | 204 | 1161 | 50% | 580 | 580 |
| 0.00 | N/A | Permeable Roo | 0.8 | 25 | 0.65 | N/A | 0 | 0% | 0 | 0 | | | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 |
| 0.14 | N/A | Green Roo | 0.4 | 25 | 0.65 | N/A | 917 | 80% | 734 | 183 | | | 0 | 183 | 14 | | 27 | 156 | | 78 | 78 |
| 0.25 | N/A | Landscape | 0.25 | 25 | 0.65 | N/A | 1625 | 80% | 1300 | 325 | Grass Swale | 0.8 | 260 | 65 | 16 | | 10 | 55 | | 28 | 28 |
| **TOTALS** | | | | | | | **9307** | | | **7273** | | | | **4313** | | | | **3668** | | | **1834** |

| | |
|---|---|
| **Required Reuse Storage Volume in Tank ($m^3$)** | **28** |
| **TOTAL TSS Produced (g)** | **9307.15** |
| **TOTAL TSS Remaining (g)** | **1834** |
| **TSS Removal Efficiency (%)** | **80%** |

Notes

[1] Sediment loading for high density residential land use (EPA Reference Manual III - Water Quality)

[2] Sediment loading for roadway with winter mainenance (EPA Reference Manual III - Water Quality)

| | | | | |
|---|---|---|---|---|
| | Project | OLTA | No.10206938 | |
| | By | M. Khodadadi | Date | 09-Feb-2023 |
| | Checked | D. Nuttall | Checked | 09-Feb-2023 |

**Stormwater Management Calculations**

## Pre-Development Runoff Coefficients & Uncontrolled Peak Flows - 388-A Carlaw

| 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) | | | | | | | | | | | |
| Impervious | 0.33 | 0.90 | 0.30 | 1.10 | 0.95 | 0.31 | 1.20 | 0.95 | 0.31 | 1.25 | 0.95 | 0.31 |
| Landscape | 0.04 | 0.25 | 0.01 | 1.10 | 0.28 | 0.01 | 1.20 | 0.30 | 0.01 | 1.25 | 0.31 | 0.01 |
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| | **0.37** | | **0.31** | | | **0.32** | | | **0.33** | | | **0.33** |

| | | | |
|---|---|---|---|
| Total Drainage Area | | 0.37 | ha |
| Weighted C | 2-10-yr | 0.83 | ***Note 3** |
| | 25-yr | 0.88 | |
| | 50-yr | 0.88 | |
| | 100-yr | 0.88 | |

**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 : $i = A * T \wedge B$

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 | 0.045 | 45 |
| 5 | 131.792 | 0.112 | 112 |
| 10 | 162.268 | 0.138 | 138 |
| 25 | 189.522 | 0.171 | 171 |
| 50 | 224.324 | 0.203 | 203 |
| 100 | 250.320 | 0.227 | 227 |

| | | | | |
|---|---|---|---|---|
| | Project | OLTA | No.10206938 | |
| | By | M. Khodadadi | Date | 09-Feb-2023 |
| | Checked | D. Nuttall | Checked | 09-Feb-2023 |

**Stormwater Management Calculations**

## Post-Development Runoff Coefficients - Badgerow block

| 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 |
| Impervious | 0.28 | 0.90 | 0.25 | 1.10 | 0.95 | 0.27 | 1.20 | 0.95 | 0.27 | 1.25 | 0.95 | 0.27 |
| Landscape | 0.14 | 0.25 | 0.04 | 1.10 | 0.28 | 0.04 | 1.20 | 0.30 | 0.04 | 1.25 | 0.31 | 0.04 |
| Green Roof | 0.04 | 0.40 | 0.02 | 1.10 | 0.44 | 0.02 | 1.20 | 0.48 | 0.02 | 1.25 | 0.50 | 0.02 |
| Permeable Roof | 0.00 | 0.80 | 0.00 | 1.10 | 0.88 | 0.00 | 1.20 | 0.96 | 0.00 | 1.25 | 1.00 | 0.00 |
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| | | | | | | | | | | | | |
| | **0.46** | | **0.30** | | | **0.32** | | | **0.33** | | | **0.33** |

| | | | |
|---|---|---|---|
| Total Drainage Area | | 0.46 | ha |
| Weighted C | 2-10-yr | 0.66 | |
| | 25-yr | 0.70 | |
| | 50-yr | 0.71 | |
| | 100-yr | 0.72 | |

**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/l [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 | 0.074 | 74 |
| 5 | 131.792 | 0.111 | 111 |
| 10 | 162.268 | 0.137 | 137 |
| 25 | 189.522 | 0.170 | 170 |
| 50 | 224.324 | 0.204 | 204 |
| 100 | 250.320 | 0.229 | 229 |

| | | | | |
|---|---|---|---|---|
| | Project | OLTA | | No.10206938 |
| | By | M. Khodadadi | Date | 09-Feb-2023 |
| | Checked | D. Nuttall | Checked | 09-Feb-2023 |
| **Stormwater Management Calculations** | | | | |

## REQUIRED STORAGE (POST - PRE) — 100 yr

### Badgerow block

| | | |
|---|---|---|
| Watershed Area, A | 0.46 | ha |
| Weighted Post Development Runoff Coefficient, C | 0.72 | |

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] | | 0.045 | $m^3/s$ |

| 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 | 0.229 | 137.57 | 27.19 | **110.38** | 250.320 |
| 20 | 0.132 | 158.03 | 54.38 | 103.65 | 143.771 |
| 30 | 0.095 | 171.38 | 81.57 | 89.80 | 103.944 |
| 40 | 0.076 | 181.53 | 108.77 | 72.76 | 82.575 |
| 50 | 0.063 | 189.81 | 135.96 | 53.85 | 69.075 |
| 60 | 0.055 | 196.86 | 163.15 | 33.71 | 59.700 |
| 70 | 0.048 | 203.02 | 190.34 | 12.68 | 52.774 |
| 80 | 0.043 | 208.52 | 208.52 | 0.00 | 47.427 |
| 90 | 0.040 | 213.49 | 213.49 | 0.00 | 43.162 |
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|---|---|---|
| Maximum Storage (Post - Pre) | 110 | $m^3$ |

| | | | | |
|---|---|---|---|---|
| | Project | OLTA | No.10206938 | |
| | By | M. Khodadadi | Date | 09-Feb-2023 |
| | Checked | D. Nuttall | Date | 9-Feb-2023 |

**Stormwater Management Calculations**

## Water Balance Calculations - Badgerow block

| **Site Chracteristics** | | |
|---|---|---|
| Site Area | 0.46 | ha |

| **Retention Requirements** | | |
|---|---|---|
| Per Event Retain depth of | 5 | mm |
| Site requirement | 23 | $m^3$/event |

| **Catchment Area characteristics** | | **Capture Event Characteristics** | | | **Water Infiltration/ Reuse Characteristics** | | **Total Volume Retained ($m^3$)** | **% of Target** |
|---|---|---|---|---|---|---|---|---|
| **Runoff Source** | **Area (ha)** | **Capture Event (mm)** | **Initial Abstraction** | **Initial Abstraction Volume ($m^3$)** | **Run off Depth (mm)** | **Infiltration/ Reuse Volume ($m^3$)** | | |
| Impervious | 0.28 | 5 | 1 | 3 | 4 | 11 | 14 | 61% |
| Landscape | 0.14 | | 7 | 10 | 0 | 0 | 10 | 43% |
| Green Roof | 0.04 | | 5 | 2 | 0 | 0 | 2 | 9% |
| Permeable Roof | 0.00 | | 5 | 0 | 0 | 0 | 0 | 0% |
| | | | | | **Totals** | **11** | **26** | **112%** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Project | OLTA | No.10206938 | | | |
| | By | M. Khodadadi | Date | 09-Feb-2023 | | |
| | Checked | D.Nuttall | Checked | 09-Feb-2023 | | |

**Stormwater Management Calculations**

**Water Quality Treatment Train Calculations - Badgerow bloc**

| | | | | | Step 1 - Source | | | | | | Step 2 - Inline Treatment | | | | Step 3 - Water Reuse | | | | Step 4 - OGS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area (ha) | Curb Length (km) | Land Use | Runoff Coefficient | Quality Event (mm) | Relative Sediment Loading[1] ($g/m^2$) | Roadway Sediment Loading[2] (g/curb-km) | Relative TSS Produced (g) | Source Removal Efficiency | Source TSS Removal (g) | Step 1 Remaining TSS (g) | Inline Treatment | Expected Performance | Inline TSS Removal (g) | Step 2 Remaining TSS (g) | Runoff to Storage Tank ($m^3$) | Fraction of Runoff Intercepted by Water Re-Use | Reuse TSS Removal (g) | Step 3 - Remaining TSS (g) | OGS Removal Efficiency | OGS TSS Removal (g) | Step 4 - Remaining TSS (g) |
| 0 | 0 | Impervious Roadway | 0.9 | 25 | N/A | 2819 | 0 | 0% | 0 | 0 | CB Shield | 0.5 | 0 | 0 | 0 | | 0 | 0 | | 2 | -2 |
| 0.22 | N/A | At Grade Impervious | 0.9 | 25 | 1.50 | N/A | 3300 | 0% | 0 | 3300 | CB Shield | 0.5 | 1650 | 1650 | 50 | | 240 | 1410 | | 705 | 705 |
| 0.06 | N/A | Impermeable Roo | 0.9 | 25 | 0.65 | N/A | 390 | 0% | 0 | 390 | | | 0 | 390 | 14 | 0.15 | 57 | 333 | 50% | 167 | 167 |
| 0.00 | N/A | Permeable Roo | 0.8 | 25 | 0.65 | N/A | 0 | 0% | 0 | 0 | | | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 |
| 0.04 | N/A | Green Roof | 0.4 | 25 | 0.65 | N/A | 260 | 80% | 208 | 52 | | | 0 | 52 | 4 | | 8 | 44 | | 22 | 22 |
| 0.14 | N/A | Landscape | 0.25 | 25 | 0.65 | N/A | 910 | 80% | 728 | 182 | Grass Swale | 0.8 | 146 | 36 | 9 | | 5 | 31 | | 16 | 16 |
| **TOTALS** | | | | | | | **4860** | | | **3924** | | | | **2128** | | | | **1819** | | | **910** |

| | |
|---|---|
| **Required Reuse Storage Volume in Tank ($m^3$)** | **11** |
| **TOTAL TSS Produced (g)** | **4860.00** |
| **TOTAL TSS Remaining (g)** | **910** |
| **TSS Removal Efficiency (%)** | **81%** |

Notes

[1] Sediment loading for high density residential land use (EPA Reference Manual III - Water Quality)

[2] Sediment loading for roadway with winter mainenance (EPA Reference Manual III - Water Quality)

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| | By | M. Khodadadi | Date | 09-Feb-2023 |
| | Checked | D. Nuttall | Checked | 09-Feb-2023 |

**Stormwater Management Calculations**

## Pre-Development Runoff Coefficients & Uncontrolled Peak Flows - 388-B Carlaw

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Impervious | 0.92 | 0.90 | 0.83 | 1.10 | 0.95 | 0.87 | 1.20 | 0.95 | 0.87 | 1.25 | 0.95 | 0.87 |
| Landscape | 0.00 | 0.25 | 0.00 | 1.10 | 0.28 | 0.00 | 1.20 | 0.30 | 0.00 | 1.25 | 0.31 | 0.00 |
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| | | | | | | | | | | | | |
| | **0.92** | | **0.83** | | | **0.87** | | | **0.87** | | | **0.87** |

| | | | |
|---|---|---|---|
| Total Drainage Area | | 0.92 | ha |
| Weighted C | 2-10-yr | 0.90 | ***Note 3** |
| | 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 : $i = A * T \wedge B$

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 | 0.113 | 113 |
| 5 | 131.792 | 0.303 | 303 |
| 10 | 162.268 | 0.373 | 373 |
| 25 | 189.522 | 0.460 | 460 |
| 50 | 224.324 | 0.545 | 545 |
| 100 | 250.320 | 0.608 | 608 |

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**Stormwater Management Calculations**

## Post-Development Runoff Coefficients - Carlaw blocks

| 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 |
| Impervious | 0.69 | 0.90 | 0.62 | 1.10 | 0.95 | 0.66 | 1.20 | 0.95 | 0.66 | 1.25 | 0.95 | 0.66 |
| Landscape | 0.02 | 0.25 | 0.01 | 1.10 | 0.28 | 0.01 | 1.20 | 0.30 | 0.01 | 1.25 | 0.31 | 0.01 |
| Green Roof | 0.22 | 0.40 | 0.09 | 1.10 | 0.44 | 0.10 | 1.20 | 0.48 | 0.11 | 1.25 | 0.50 | 0.11 |
| Permeable Roof | 0.00 | 0.80 | 0.00 | 1.10 | 0.88 | 0.00 | 1.20 | 0.96 | 0.00 | 1.25 | 1.00 | 0.00 |
| | | | | | | | | | | | | |
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| | | | | | | | | | | | | |
| | **0.93** | | **0.71** | | | **0.76** | | | **0.77** | | | **0.77** |

| | | | |
|---|---|---|---|
| Total Drainage Area | | 0.93 | ha |
| Weighted C | 2-10-yr | 0.77 | |
| | 25-yr | 0.81 | |
| | 50-yr | 0.82 | |
| | 100-yr | 0.83 | |

**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/l [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 | 0.175 | 175 |
| 5 | 131.792 | 0.261 | 261 |
| 10 | 162.268 | 0.322 | 322 |
| 25 | 189.522 | 0.399 | 399 |
| 50 | 224.324 | 0.478 | 478 |
| 100 | 250.320 | 0.537 | 537 |

| | | | | |
|---|---|---|---|---|
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| **Stormwater Management Calculations** | | | | |

## REQUIRED STORAGE (POST - PRE) — 100 yr

### Carlaw blocks

| | | |
|---|---|---|
| Watershed Area, A | 0.93 | ha |
| Weighted Post Development Runoff Coefficient, C | 0.83 | |

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] | | 0.113 | $m^3/s$ |

| 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 | 0.537 | 321.97 | 67.61 | **254.36** | 250.320 |
| 20 | 0.308 | 369.85 | 135.22 | 234.63 | 143.771 |
| 30 | 0.223 | 401.09 | 202.83 | 198.26 | 103.944 |
| 40 | 0.177 | 424.85 | 270.45 | 154.40 | 82.575 |
| 50 | 0.148 | 444.24 | 338.06 | 106.18 | 69.075 |
| 60 | 0.128 | 460.73 | 405.67 | 55.07 | 59.700 |
| 70 | 0.113 | 475.16 | 473.28 | 1.88 | 52.774 |
| 80 | 0.102 | 488.02 | 488.02 | 0.00 | 47.427 |
| 90 | 0.093 | 499.65 | 499.65 | 0.00 | 43.162 |
| | | | | | |
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| | | |
|---|---|---|
| Maximum Storage (Post - Pre) | 254 | $m^3$ |

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**Stormwater Management Calculations**

## Water Balance Calculations - Carlaw blocks

| **Site Chracteristics** | | |
|---|---|---|
| Site Area | 0.93 | ha |

| **Retention Requirements** | | |
|---|---|---|
| Per Event Retain depth of | 5 | mm |
| Site requirement | 47 | $m^3$/event |

| **Catchment Area characteristics** | | **Capture Event Characteristics** | | | **Water Infiltration/ Reuse Characteristics** | | **Total Volume Retained ($m^3$)** | **% of Target** |
|---|---|---|---|---|---|---|---|---|
| **Runoff Source** | **Area (ha)** | **Capture Event (mm)** | **Initial Abstraction** | **Initial Abstraction Volume ($m^3$)** | **Run off Depth (mm)** | **Infiltration/ Reuse Volume ($m^3$)** | | |
| Impervious | 0.69 | 5 | 1 | 7 | 4 | 28 | 35 | 74% |
| Landscape | 0.02 | | 7 | 1 | 0 | 0 | 1 | 3% |
| Green Roof | 0.22 | | 5 | 11 | 0 | 0 | 11 | 24% |
| Permeable Roof | 0.00 | | 5 | 0 | 0 | 0 | 0 | 0% |
| | | | | | **Totals** | **28** | **47** | **101%** |

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| | Checked | D.Nuttall | Checked | 09-Feb-2023 | | |

**Stormwater Management Calculations**

**Water Quality Treatment Train Calculations - Carlaw blocks**

| | | | | | Step 1 - Source | | | | | | Step 2 - Inline Treatment | | | | Step 3 - Water Reuse | | | | Step 4 - OGS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area (ha) | Curb Length (km) | Land Use | Runoff Coefficient | Quality Event (mm) | Relative Sediment Loading[1] ($g/m^2$) | Roadway Sediment Loading[2] (g/curb-km) | Relative TSS Produced (g) | Source Removal Efficiency | Source TSS Removal (g) | Step 1 Remaining TSS (g) | Inline Treatment | Expected Performance | Inline TSS Removal (g) | Step 2 Remaining TSS (g) | Runoff to Storage Tank ($m^3$) | Fraction of Runoff Intercepted by Water Re-Use | Reuse TSS Removal (g) | Step 3 - Remaining TSS (g) | OGS Removal Efficiency | OGS TSS Removal (g) | Step 4 - Remaining TSS (g) |
| 0.07 | 0 | Impervious Roadway | 0.9 | 25 | N/A | 2819 | 0 | 0% | 0 | 0 | CB Shield | 0.5 | 0 | 0 | 16 | | 0 | 0 | | 2 | -2 |
| 0.26 | N/A | At Grade Impervious | 0.9 | 25 | 1.50 | N/A | 3900 | 0% | 0 | 3900 | CB Shield | 0.5 | 1950 | 1950 | 59 | | 601 | 1349 | | 675 | 675 |
| 0.36 | N/A | Impermeable Roof | 0.9 | 25 | 0.65 | N/A | 2340 | 0% | 0 | 2340 | | | 0 | 2340 | 81 | 0.31 | 721 | 1619 | 50% | 809 | 809 |
| 0.00 | N/A | Permeable Roof | 0.8 | 25 | 0.65 | N/A | 0 | 0% | 0 | 0 | | | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 |
| 0.22 | N/A | Green Roof | 0.4 | 25 | 0.65 | N/A | 1430 | 80% | 1144 | 286 | | | 0 | 286 | 22 | | 88 | 198 | | 99 | 99 |
| 0.02 | N/A | Landscape | 0.25 | 25 | 0.65 | N/A | 130 | 80% | 104 | 26 | Grass Swale | 0.8 | 21 | 5 | 1 | | 2 | 4 | | 2 | 2 |
| **TOTALS** | | | | | | | **7800** | | | **6552** | | | | **4581** | | | | **3170** | | | **1585** |

| | |
|---|---|
| **Required Reuse Storage Volume in Tank ($m^3$)** | **55** |
| **TOTAL TSS Produced (g)** | **7800.00** |
| **TOTAL TSS Remaining (g)** | **1585** |
| **TSS Removal Efficiency (%)** | **80%** |

Notes

[1] Sediment loading for high density residential land use (EPA Reference Manual III - Water Quality)
[2] Sediment loading for roadway with winter mainenance (EPA Reference Manual III - Water Quality)