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36 Years

# PROJECT PYTHON
# 222 CITIGATE DRIVE

## Servicing and Stormwater Management Report

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## 222 CITIGATE DRIVE
### OTTAWA, ONTARIO

## SERVICING AND STORMWATER MANAGEMENT REPORT


Prepared By:

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Issued: April 9, 2020

Revised: June 1, 2020

Novatech File: 120025
Report Ref: R-2020-044

June 1, 2020

City of Ottawa
Planning Infrastructure and Economic Development Department
110 Laurier Avenue West, 4th Floor
Ottawa, ON
K1P 1J1

**Attention:** **Jeffrey Shillington**

**Reference:** **222 CitiGate Drive, Ottawa**
**Servicing and Stormwater Management Report**
**Novatech File No.: 120025**

---

Please find enclosed the 'Servicing and Stormwater Management Report' for the above noted project. This report has been revised per City comments in support of the Site Plan Application and is hereby resubmitted for review and approval.

Should you have any questions or comments, please do not hesitate to contact us.

Sincerely,

**NOVATECH**

Lee Sheets, C.E.T.
Director | Land Development & Public Sector Engineering

cc:



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# TABLE OF CONTENTS

## LIST OF TABLES



## LIST OF FIGURES



## LIST OF APPENDICIES



## LIST OF DRAWINGS (enclosed)



## LIST OF DRAWINGS (separate)



## ENCLOSED CD

- Report (pdf)
- Drawings (pdf)
- PCSWMM Packaged Model Files
    - 100-year 3-hour Chicago Storm

# 1.0 INTRODUCTION

Novatech has been retained to prepare a Servicing and Stormwater Management Report for the proposed development located at 222 CitiGate Drive within Ottawa, Ontario. This report will support a Site Plan Application for the proposed development. **Figure 1** is a Key Plan showing the site location.

This report outlines the site sanitary and water servicing, along with the proposed storm drainage and stormwater management strategy for the proposed development.

## 1.1 Existing Conditions

The total site area is approximately 26.0 hectares in size and is located within the CitiGate Development southeast of the Highway 416 and Fallowfield Road interchange. The site is registered as Block 13 on the registered Plan 4M-1538 of the CitiGate Development and has a municipal address of 222 CitiGate Drive. The site is bounded by Fallowfield Drive to the north, the O'Keefe Municipal Drain and the future CitiGate Drive extension to the East, vacant land to the South, and Highway 416 to the west. The topography of the site slopes easterly towards the O'Keefe Municipal Drain and the future CitiGate Drive extension. **Figure 2** shows the existing site conditions and **Figure** 3 shows the subject site with respect to the surrounding areas.

It should be noted that the CitiGate Drive extension has received City of Ottawa approval and the works will be constructed prior to the occupancy of this proposed development. The scope of work is for the construction of Systemhouse Street and CitiGate Drive extensions including the underground watermain and storm sewer infrastructure. For the purposes of this report the watermain and storm sewer extensions in CiteGate Drive and Systemhouse Street will be considered as existing.

## 1.2 Proposed Development

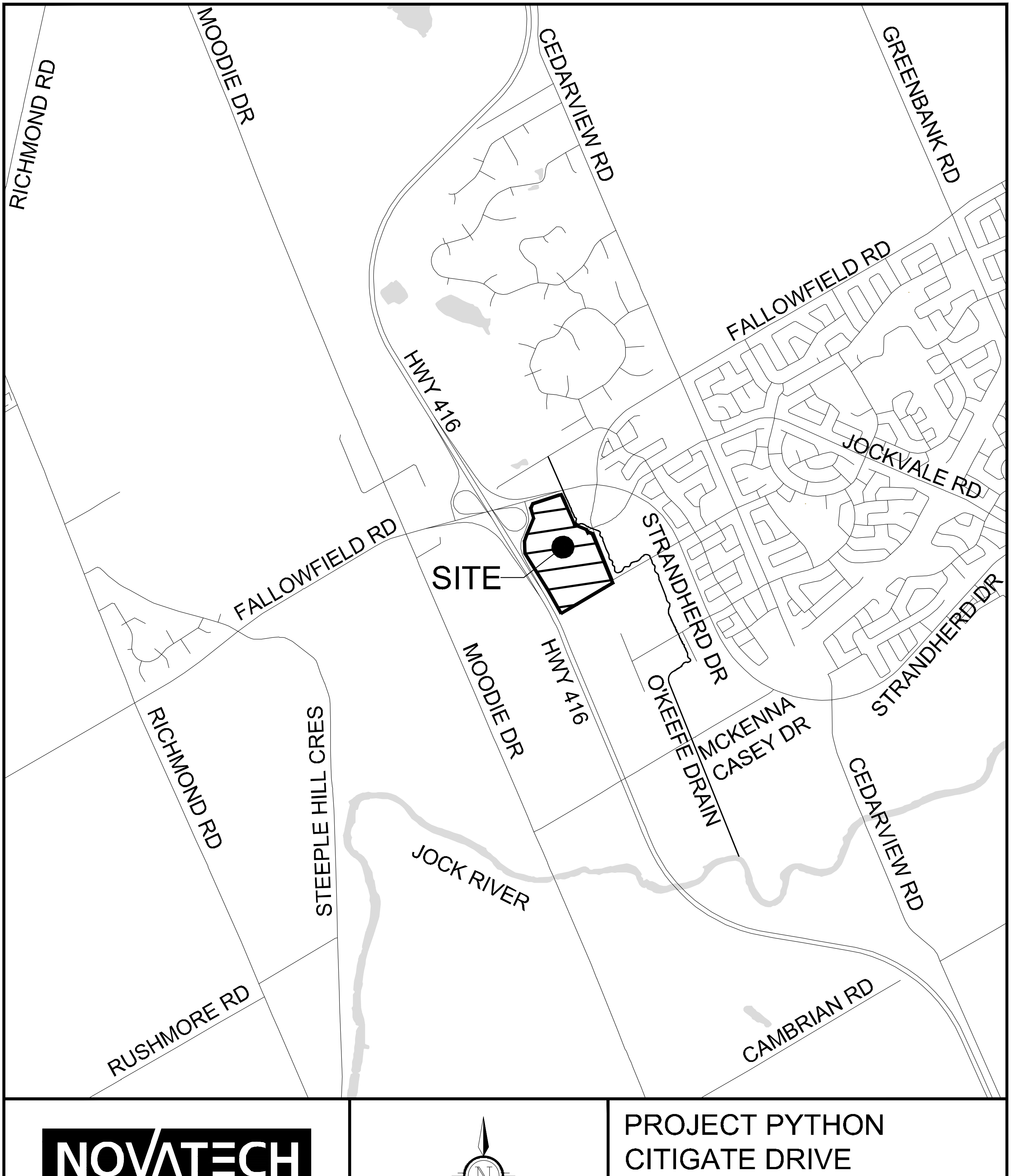
The proposed development consists of a single prestige office/light industrial building, truck and trailer parking and staff parking lots which will cover approximately 23.5 hectares of the 26.0 hectare site. The remaining 2.5 hectares will remain vacant for the time being with the potential of a future development. Access to the site would be provided by 4 separate entrances, two from CitiGate Drive and two from the proposed private roadway extension. **Figure 4** shows the proposed development.

It should be noted that this report should be read in conjunction with the engineering drawing set:

| | |
|---|---|
| 120025-ND | Notes and Details |
| 120025-GP | General Plan of Services |
| 120025-GR | Grading Plan |
| 120025-ESC | Erosion Sediment Control Plan |

## 1.3 Site Design and Constraints

As indicated previously the subject site is part of the CitiGate Development. Design criteria and information for the CitiGate Development is provided in a report entitled '*CitiGate 416 Corporate Campus, Detailed Servicing and Stormwater Management Report (Phase 1)*' prepared by Novatech, dated October 1, 2014 (CitiGate Phase 1 Report). The CitiGate Phase 1 Report provides design criteria for the interior sites and designed the overall servicing systems including sanitary sewers, watermain and stormwater management systems. Each system is discussed in more detail in the appropriate sections of this report.



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N

PROJECT PYTHON
CITIGATE DRIVE

KEYPLAN

| SCALE | | |
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| N.T.S | | |
| DATE JUNE 2020 | JOB 120025 | FIGURE FIG-1 |

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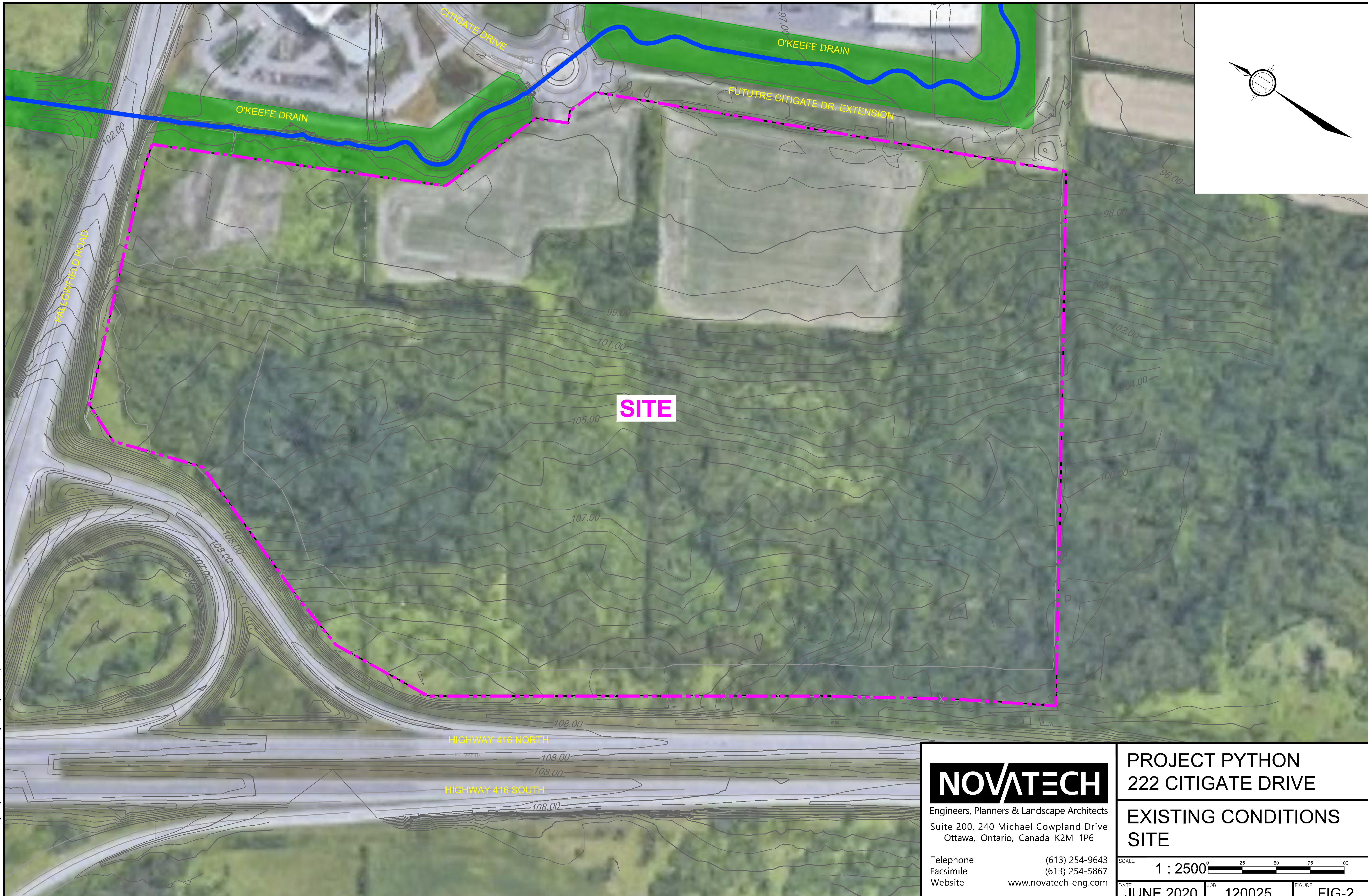


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PROJECT PYTHON
222 CITIGATE DRIVE

EXISTING CONDITIONS SITE

SCALE 1 : 2500

| DATE | JOB | FIGURE |
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| JUNE 2020 | 120025 | FIG-2 |

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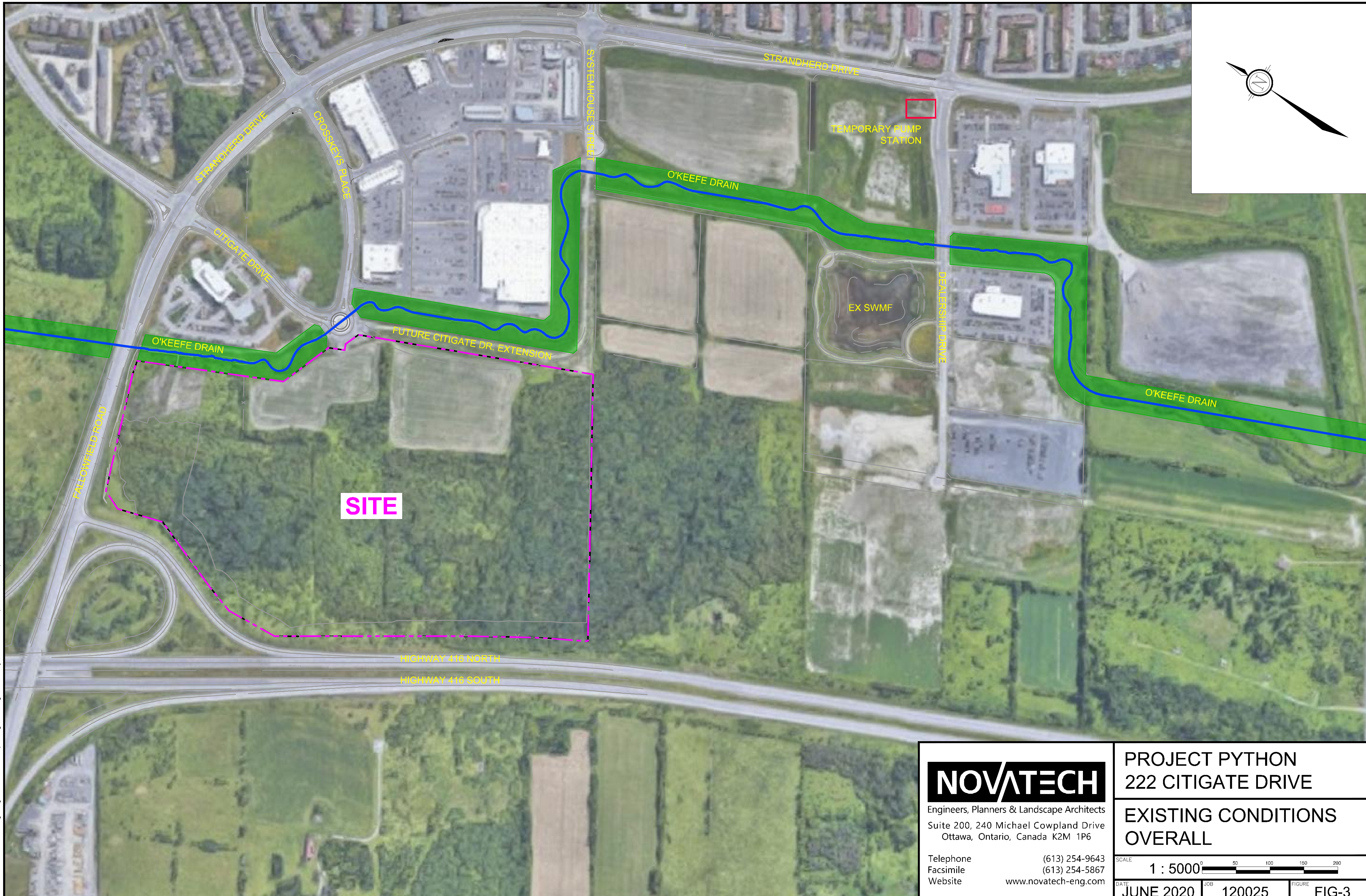


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PROJECT PYTHON
222 CITIGATE DRIVE

EXISTING CONDITIONS
OVERALL

| SCALE | | |
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| 1 : 5000 (0, 50, 100, 150, 200) | | |
| DATE JUNE 2020 | JOB 120025 | FIGURE FIG-3 |

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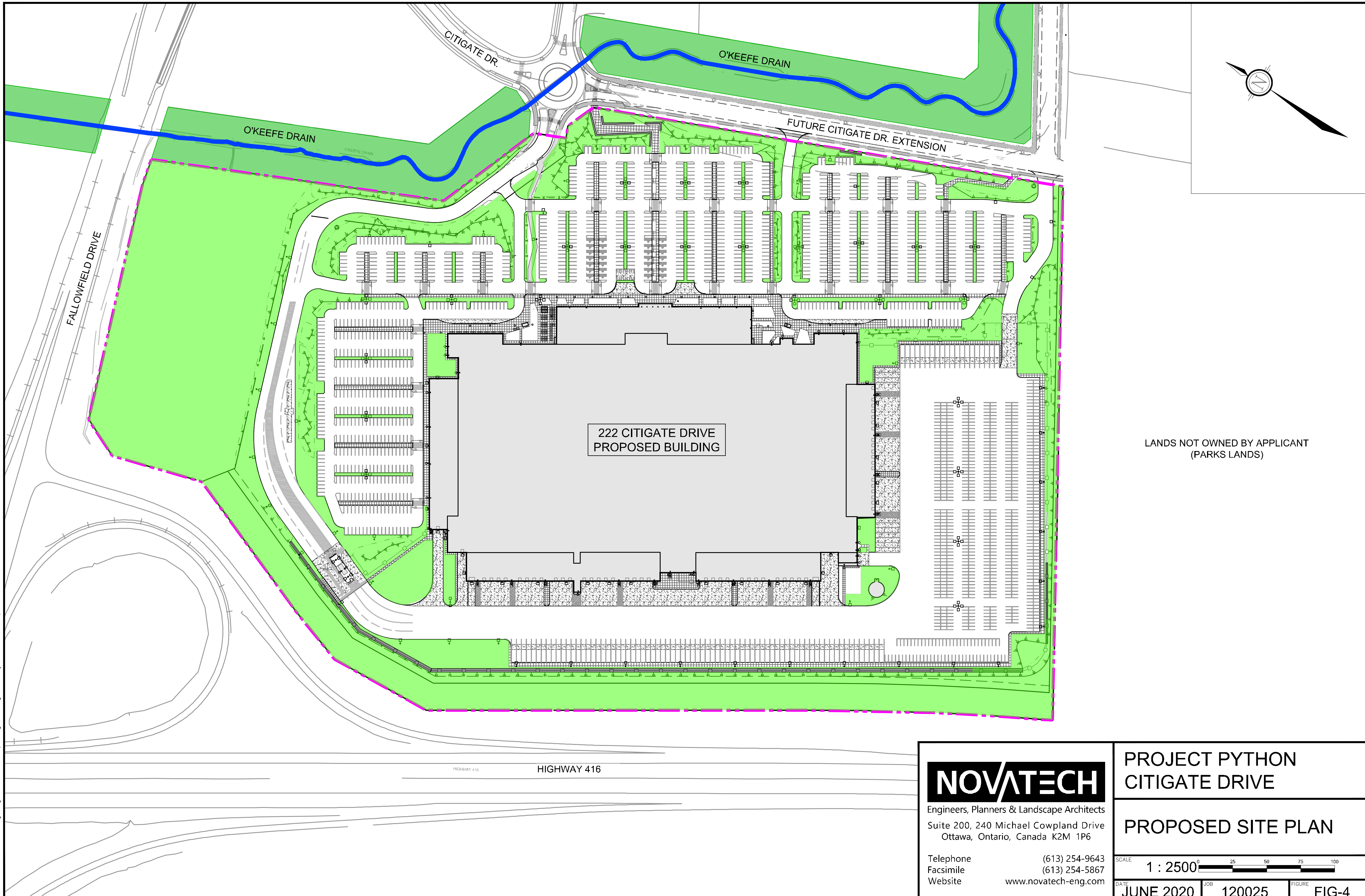


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A geotechnical investigation was completed for the subject development and a report provided entitled '*Geotechnical Investigation, Proposed Python Building Complex, CitiGate Drive,* Ottawa, Ontario' prepared by Paterson Group dated March 30, 2020. The following criteria is to be included in the servicing and grading design:

- Groundwater level is estimated to be between 3 to 4 meters below existing grade.
- Bedrock elevation fluctuates over the site and is estimated between 0 to 15 meters below existing grade.
- The report also provides detailed asphalt and concrete compositions along with pipe bedding and foundation cover requirements for the site.
- There is a recommended permissible grade raise restriction for this site of 2 to 3 meters for the access roadways and parking areas on the east side of the proposed building.
- A preloading program for 8 to 12 months should be implemented to eliminate all post construction settlement.
- It should also be noted that an MECP permit to take water category 3 may be required if more than 400,000 L/day of ground and/or surface water is to be pumped during construction.

### 1.4 Background Reports

This report provides information on the considerations and approach by which Novatech has designed and evaluated the proposed servicing and stormwater management strategies. This report should be read in conjunction with the following:

- *CitiGate 416 Corporate Campus Detailed Servicing and Stormwater Management Report (Phase1), prepared by Novatech revised dated October 1, 2014.*
- *Geotechnical Investigation, Proposed Python Building Complex, CitiGate Drive, Ottawa, ON, prepared by Paterson Group dated March 30,2020.*

## 2.0 WATER SERVICING

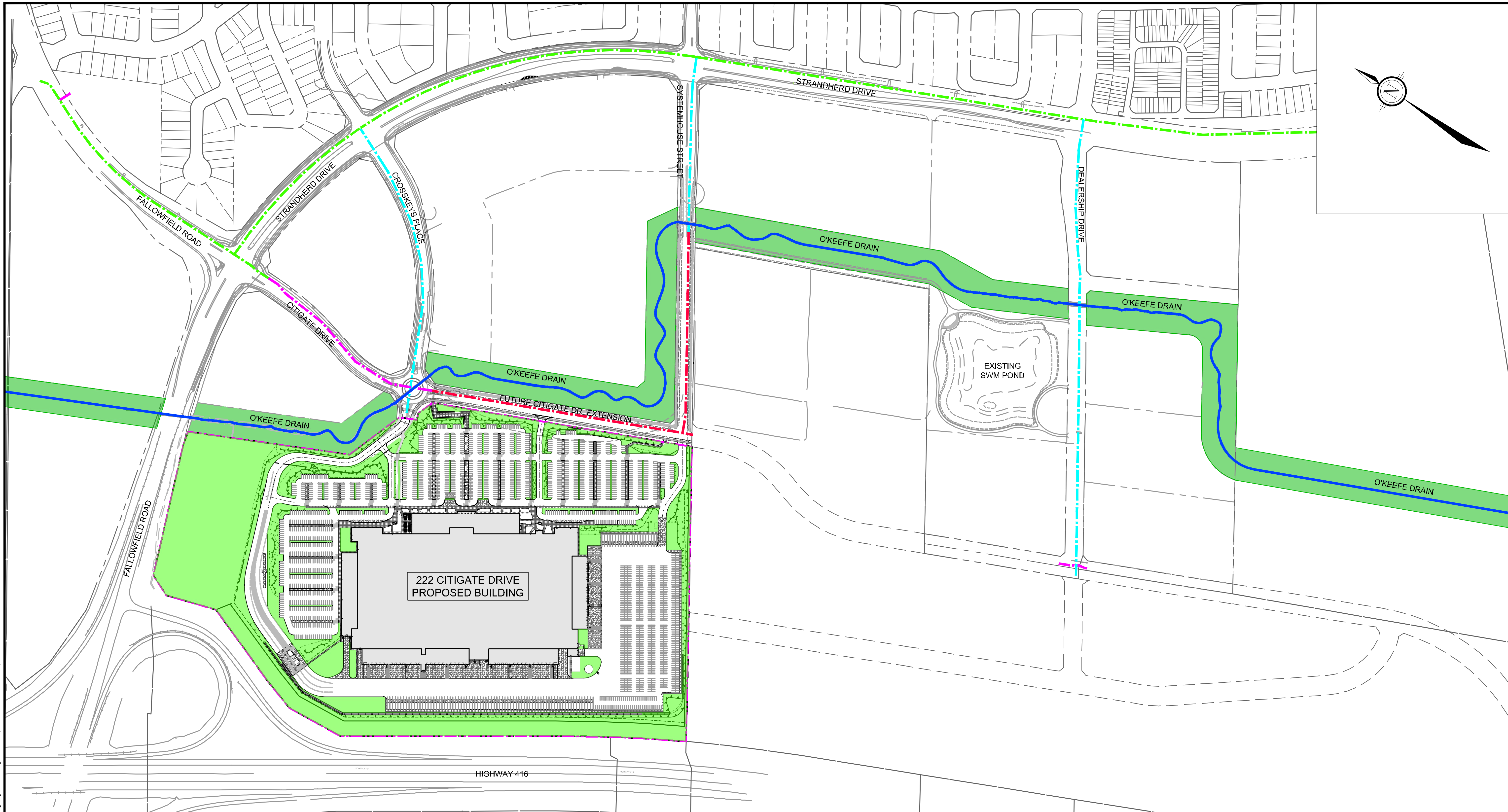
### 2.1 Existing Water Services

There is an existing 200mm diameter watermain in CitiGate Drive and a 250mm diameter watermain in Crosskey Place that were constructed as part of the Phase 1 CitiGate development. This watermain infrastructure currently terminates at the extents of the CitiGate Drive and Crosskey Place round-a-bout right-of-way limits. There is also an existing 250mm diameter watermain in Systemhouse Street which is capped on the west side of the realigned O'Keefe drain. Each watermain described is connected to the existing 400mm diameter watermain in Strandherd Drive.

As previously mentioned, the existing 250mm diameter watermain in CitiGate Drive is to extend from its termination point at the round-a-bout to the capped 250mm watermain in Systemhouse Street. For the purposes of this report the 250mm diameter watermain extension in CitiGate Drive will be referred to as existing. Refer to **Figure 5** Existing Water Servicing for more details.

### 2.2 Proposed Water Servicing

It is proposed to service the development by constructing approximately 320 meters of 250mm diameter private watermain on site. The private watermain on site will provide service to both the




LEGEND

- PROPOSED 250mmØ WATERMAIN (CITIGATE DRIVE EXTENSION)
- EXISTING 200mmØ WATERMAIN
- EXISTING 250mmØ WATERMAIN
- EXISTING 400mmØ WATERMAIN

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PROJECT PYTHON
222 CITIGATE DRIVE

EXISTING WATERMAIN SERVICING

| SCALE | | | |
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100mm diameter domestic building service connection and the fire suppression system water storage tank. The proposed 250mm diameter watermain on site will connect to the existing 250mm watermain in CitiGate Drive near the south east corner of the site. As per the City of Ottawa Technical Bulletin ISDTB-2014-02, the proposed development will require two service connections as the average day demand is greater than 50 cubic meters of water. The two services will be separated by an isolation valve on the existing watermain system in the event maintenance on the system is required. A water meter chamber will be required on the private watermain near the property line due to the large quantity of pipe and the potential for leakage. Refer to the General Plan of Services (120025-GP) for water servicing details.

### *2.2.1 Proposed Development Domestic Water Demands*

Design Criteria from the City of Ottawa Water Distribution Guidelines and Section 8 of the Ontario Building Code were used to calculate the theoretical water demands for proposed development. The demand calculations are based on flow requirements for the proposed different uses on site.

The water demand calculations for the proposed development are calculated based on the following criteria:

- Industrial Water Demand
  - per each water closet = 950L/day
  - per each loading bay = 150L/day (each)
- Commercial Office Water Demand
  - per each 9.3m² floor space = 75L/day
- Peaking Factor
  - Max Day = 1.5
  - Peak Hour = 1.8

The domestic water demands for the proposed development are summarized in **Table 2.1** below.

**Table 2.1: Domestic Water Demand Summary**

| Use | Ave. Daily Demand (L/s) | Max. Daily Demand (L/s) | Peak Hour Demand (L/s) |
|---|---|---|---|
| Industrial Flows | 1.197 | 1.795 | 3.231 |
| Commercial Flows | 0.146 | 0.218 | 0.393 |
| **Total Domestic Demands** | **1.34** | **2.01** | **3.62** |

### *2.2.2 Proposed Development Fire Protection System*

The fire flow calculations and fire protection system for this type of development are complex so Civelec Consulting Inc. a specialized fire consulting engineer was retained. They have calculated the required fire flow for the development to be 1750 USGPM. Civelec has also designed the fire protection infrastructure on site which includes the following:

- The proposed 250mm diameter watermain on site provides water to drive fire pump and provides water as required to fill the 950,000-liter fire suppression water storage tank which provides water to the standby fire pump.

- Two internal fire pump rooms in the southwest corner of the building contains 2 pumps which draw water from the city watermain and from fire suppression storage tank to pressurize the system and to control the fire as required.
- There are approximately 1140 meters of 250mm diameter high pressure fire protection watermain that loops around the building.
- There are eight proposed fire hydrants evenly spaced around the proposed building that are directly connected to the high pressure watermain loop.
- There are multiple connections to the building from the fire loop which supply the internal sprinkler system.
- There are 2 fire hydrants located next to the pump rooms and are connected to the city incoming feed main to allow the firefighter to properly use the siamese connections.

### 2.3 Boundary Conditions and Hydraulic Analysis

The latest boundary conditions are specific to the block 13 connection points on the 250mm diameter watermain in CitiGate Drive. These boundary conditions were based on the updated total domestic demands for the northern portion of the Citi Gate development (including block 13) and fire flows for block 13. The boundary condition domestic demands are calculated from more conservative general land use demands and fire underwriter survey. The boundary condition water demands were calculated using the following criteria provided in Section 4 of City of Ottawa Design Guidelines – Water Distribution:

- Light Industrial Water Demand = 35,000L/ha/day
- Peaking Factor
    - Max Day = 1.5 ; Peak Hour = 1.8
- Fire Flows = Fire Underwriters Survey

The boundary condition water demands for the Citi Gate development are summarized below in **Table 2.3.** The demand from node 36 is the total allotment for block 13.

**Table 2.2: Boundary Condition Water Demand Summary**

| Model Node ID | Block No. | Fire Flow (L/s) | Avg Day (L/s) | Max Day (L/s) | Peak Hour (L/s) |
|---|---|---|---|---|---|
| 14 | 16 | N/A | 1.01 | 1.52 | 2.73 |
| 15 | 1 | N/A | 1.42 | 2.13 | 3.83 |
| 16 | 2 | N/A | 4.86 | 7.29 | 13.13 |
| 17 | 3 | N/A | 2.15 | 3.22 | 5.80 |
| 36 | 13 | 267 | 10.17 | 15.25 | 27.45 |
| | | | 19.61 | 29.41 | 52.94 |

The latest boundary conditions provide system pressures and head based on the ground elevation at the site connection locations for three theoretical conditions:

1. High Pressure check under Average Day conditions
2. Peak Hour demand
3. Maximum Day + Fire Flow demand.

A summary of the boundary condition results are provided below in **Table 2.3**.

**Table 2.3: Boundary Condition Summary**

| Condition | Service Connection Location | Min/Max Allowable Operating Pressures (psi) | Operating Pressures (psi) | |
|---|---|---|---|---|
| | | | Connection 1 | Connection 2 |
| High Pressure | CitiGate Dr | 80psi (Max) | 77.1 | 78.1 |
| Max Day + Fire Flow | CitiGate Dr | 20psi (Min) | 59.3 | 52.7 |
| Peak Hour | CitiGate Dr | 40psi (Min) | 71.1 | 72.0 |

The theoretical domestic water demand and fire flows calculated based on the specific building use are much lower than the flows accounted for in the latest boundary conditions and the Citi Gate watermain design. The flows accounted for in CitiGate design are conservative and would allow for future development on site. Based on the latest boundary conditions the watermain infrastructure in CitiGate Drive can provide adequate pressures for domestic use and flows for fire protection. Refer to **Appendix A** for water demand, fire flow calculations, watermain schematics, boundary conditions and the fire protection study information.

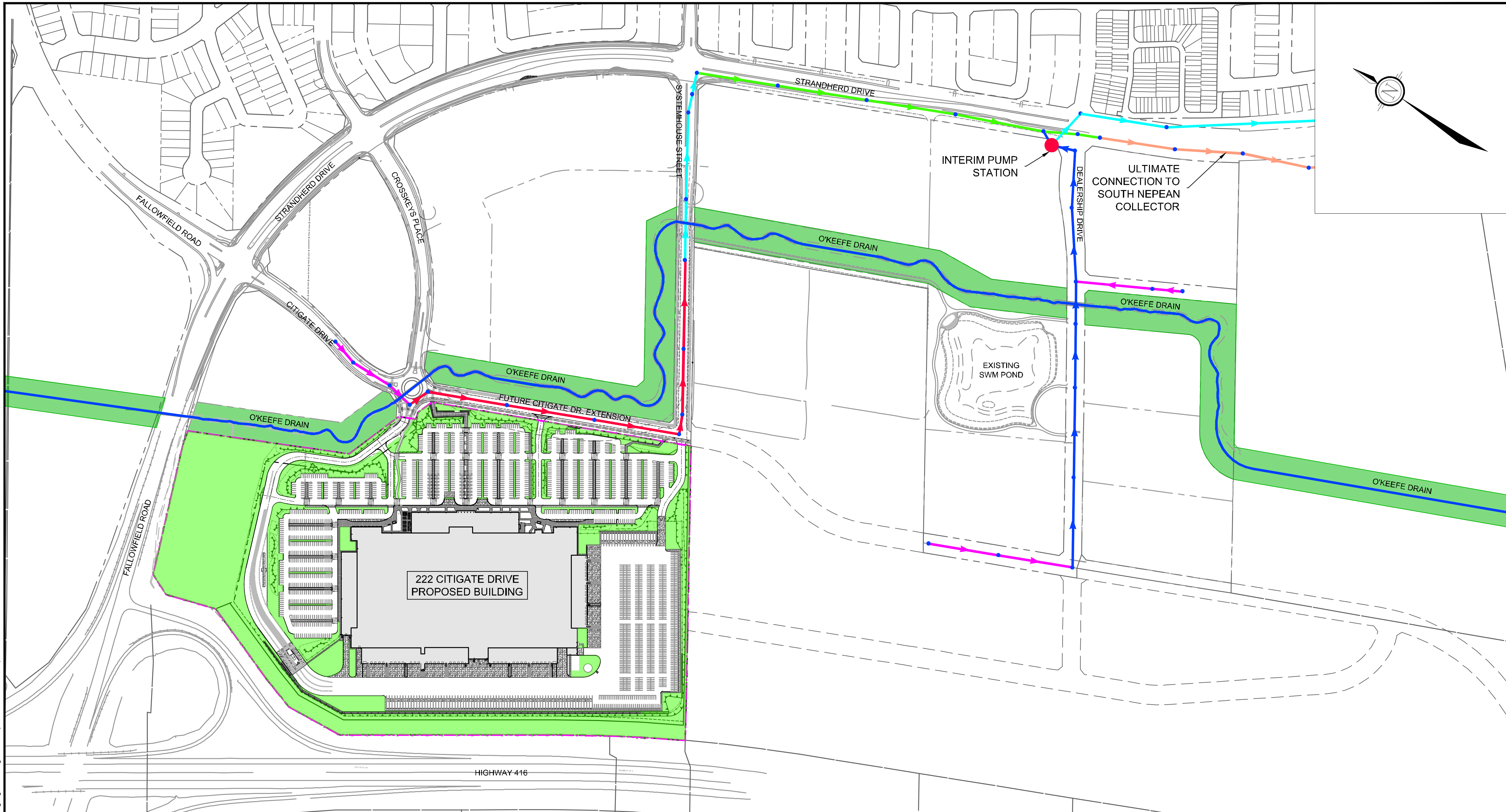
## 3.0 SANITARY SERVICING

### 3.1 Existing Sanitary Services

There is an existing 300mm diameter sanitary sewer fronting the site in CitiGate Drive that was constructed as part of the Phase 1 CitiGate development. The conveyance of the existing sanitary sewer is as follows:

- Sanitary flows for this portion of the CitiGate development are conveyed south on CitiGate Drive and east on Systemhouse Street via a 300mm diameter sewer.
- The 300mm diameter sewer then connects to a 525mm diameter sewer in Strandherd Drive where flows are conveyed south to an interim pump station at the corner of Strandherd Drive and Dealership Drive.
- The pump station conveys flows in the interim condition to a gravity sewer which outlets to the Tartan Pump Station.
- In the ultimate condition sanitary flows from the development will be conveyed by the 300mm sewer in CitiGate Drive and Systemhouse Street to the South Nepean Collector Trunk sewer in Strandherd Drive.

Refer to **Figure 6** Existing Sanitary Servicing for more details.




## LEGEND

- EXISTING 250mmØ SANITARY SEWER
- EXISTING 300mmØ SANITARY SEWER
- EXISTING 375mmØ SANITARY SEWER
- EXISTING 450mmØ SANITARY SEWER
- EXISTING 525mmØ SANITARY SEWER
- FUTURE 525mmØ TRUNK SANITARY SEWER
- SANITARY MANHOLE

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# PROJECT PYTHON
# 222 CITIGATE DRIVE

## EXISTING SANITARY SERVICING

| SCALE | DATE | JOB | FIGURE |
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| 1 : 5000 | JUNE 2020 | 120025 | 6 |

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## 3.2 Proposed Sanitary Services

It is proposed to service the development by constructing approximately 775m of 250mm diameter private sanitary sewer on site. The proposed 250mm diameter sewer will outlet to the existing 300mm diameter sanitary sewer in CitiGate Drive at the far south east corner of the site as recommended in the CitiGate Phase 1 Report. Refer to the General Plan of Services (120025-GP) for details.

### *3.2.1 Proposed Peak Sanitary Flows*

The total theoretical peak sanitary flow for the proposed development was calculated based on the following criteria from Section 4 of the City of Ottawa Sewer Design Guidelines and Section 8 of the Ontario Building Code:

- Site Area Block 13 = 25.9ha
- Industrial Sanitary Flow
    - per each water closet = 950L/day
    - per each loading bay = 150L/day (each)
- Commercia Office Sanitary Flow
    - per each 9.3m² floor space = 75L/day
- Commercial Peaking Factor = 1.5
- Light Industrial Peaking Factor = 3.5 (Appendix 4-B)
- Infiltration Rate = 0.33L/s/ha

The proposed sanitary flows are summarized below in **Table 3.1**.

**Table 3.1: Peak Sanitary Flow Summary**

| Proposed Use | Peak Flow (L/s) |
|---|---|
| Industrial Flows | 4.19 |
| Commercial Flows | 0.29 |
| Sewer Infiltration Flow | 7.56 |
| **Total Peak Flows** | **12.04** |
| Future Commercial Development Flows | 1.47 |
| Sewer Infiltration Flows | 1.00 |
| **Total Additional Future Peak Flows** | **2.47** |
| **Total Development Peak Flows** | **14.51** |

## 3.3 CitiGate Sanitary Flow Allotment

The proposed development block 13 was originally designed as block 14 and 15 in the original CitiGate Phase 1 report. The sanitary flow allotment for each block was calculated in CitiGate Phase 1 report using the following criteria provided in Section 4 of City of Ottawa Sewer Design Guidelines:

- Site Area Block 14 = 18.03ha
- Site Area Block 15 = 7.98ha

- Design Sanitary Flow = 50,000L/ha/d (Commercial/Institutional Flow Rate)
- Commercial Peaking Factor =1.5
- Infiltration Rate = 0.28L/s/ha

The sanitary flow allotments are summarized below in **Table 3.2**.

**Table 3.2: Sanitary Flow Allotment Summary**

| Block No. | Peak Flow (L/s) | Infiltration Flow (L/s) | Total Peak Design Flow (L/s) |
|---|---|---|---|
| Block 14 | 15.65 | 5.05 | 20.70 |
| Block 15 | 6.93 | 2.23 | 9.16 |
| **Total Allocation for Block 13** | **22.58** | **7.28** | **29.86** |

The Sanitary Sewer Design Sheet provided in the CitiGate Phase 1 Report shows the total sanitary flow allotment for the Block 13 development area to be 29.86 L/s. A copy of the sanitary drainage area plans and sanitary sewer design sheet from the CitiGate Phase 1 Report are included in **Appendix B** for reference.

The proposed 250mm diameter sanitary sewer on site has a theoretical capacity of 34.1 L/s at the proposed slope of 0.3%. Therefore, there is adequate capacity in the proposed infrastructure to convey the required peak flow of 14.51 L/s from the site. Also, based on the total flow allotment of 29.86L/s from CitiGate Phase 1 Report there is capacity in the existing infrastructure for the proposed development. Refer to **Appendix B**, for the proposed detailed sanitary flow calculations, sanitary drainage area pans and sanitary sewer design sheets.

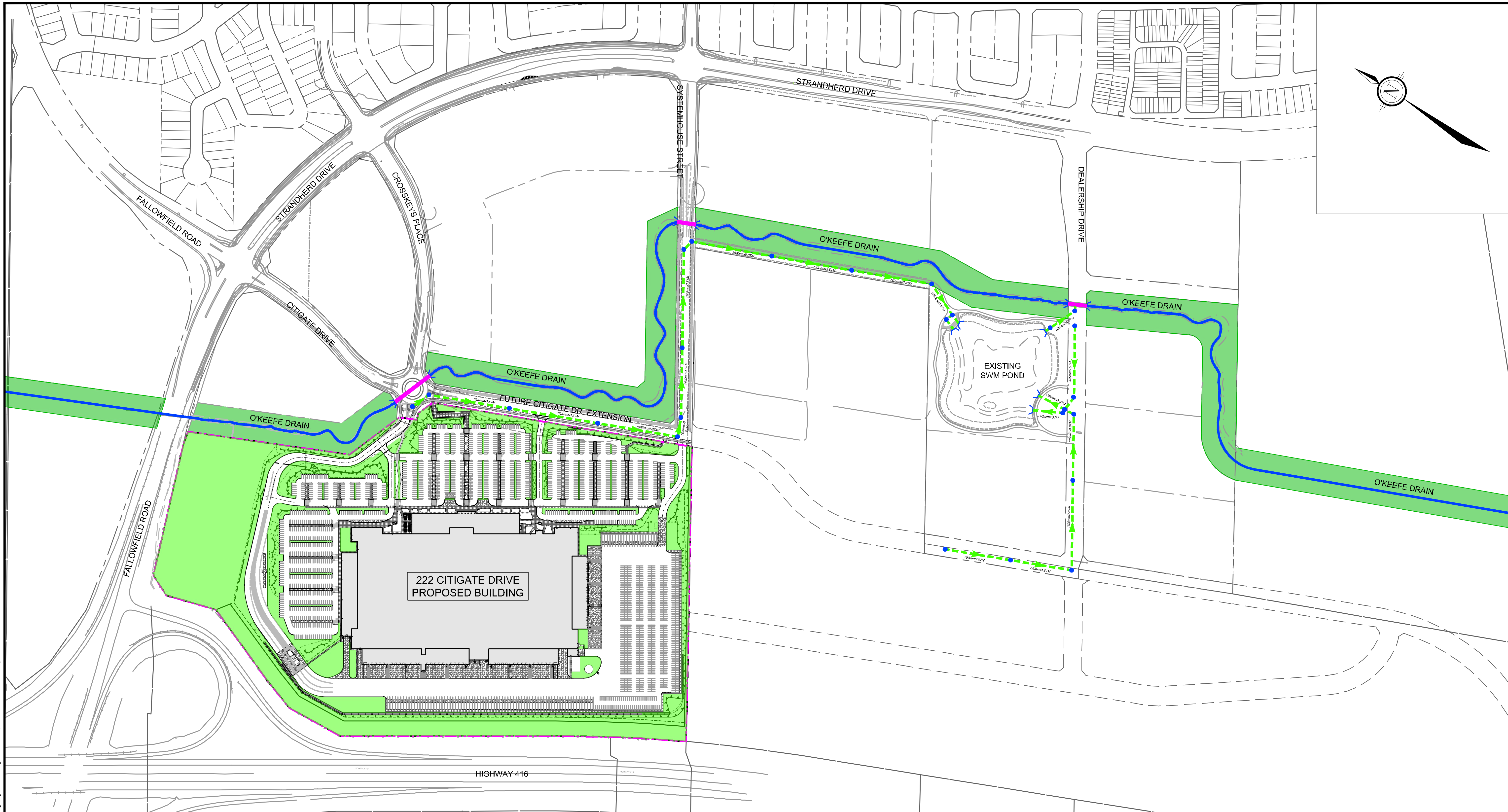
## 4.0 STORM SERVICING AND STORMWATER MANAGEMENT

The storm servicing and stormwater management strategy for the site is based on the established criteria in the 2014 CitiGate SWM Report.

### 4.1 Existing Off-Site Storm Infrastructure – CitiGate (Phase 1)

The storm infrastructure servicing the CitiGate (Phase 1) lands includes a stormwater management facility (SWM Facility ‘A’) and storm sewers with sizes ranging from 1800mm to 1950mm in diameter. The storm sewer system extends from the north outlet to the SWM facility, to the roundabout, along an extension of CitiGate Drive. Currently only the storm infrastructure at the north outlet to the SWM Facility is constructed. The storm sewer will be extended to the roundabout in advance of the development of the site. Refer to **Figure 7 –** Existing Storm Servicing.

The CitiGate Drive storm sewer receives drainage from the proposed development, CitiGate Drive storm infrastructure, and existing flows from the Parks lands. The Parks lands are located between the proposed development and the SWM Facility. Flows are currently collected via a ditch-inlet catchbasin (DICB). The future development of the Parks lands will also outlet to the SWM Facility.




## LEGEND

- EXISTING STORM SEWER
- EXISTING CULVERT
- STORM MANHOLE
- HEADWALL

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# PROJECT PYTHON
# 222 CITIGATE DRIVE

## EXISTING STORM SERVICING

SCALE 1 : 5000 (0, 50, 100, 150, 200)

DATE JUNE 2020 | JOB 120025 | FIGURE 7

The SWM Facility was designed to provide stormwater quality and quantity control before outlettting to the O'Keefe Drain. The facility was sized to accommodate all future development within the tributary drainage area, including Phases 1 & 2, and adjacent lands.

## 4.2 Stormwater Management Criteria

### *4.2.1 Stormwater Quality Control*

The existing SWM Facility was sized to provide an Enhanced level of stormwater quality control. The permanent pool and extended detention have been sized to provide 80% long-term removal of total suspended solids (TSS).

The future development blocks identified in the 2014 CitiGate SWM Report were estimated to be 85% impervious. The proposed development, including the future development lands to the north, has a total imperviousness of 79%. The overall drainage area to the pond will remain unchanged due to the proposed development.

### *4.2.2 Stormwater Quantity Control – Allowable Release Rate*

The 2014 CitiGate SWM Report included the following stormwater management criteria for the future development blocks that drain to SWM Facility 'A' (lands west of the O'Keefe Drain):

- Allowable release rates and storage requirements for individual sites are to be calculated as follows, based on a runoff coefficient of C=0.80:
    - The 5-year peak flow can be released uncontrolled.
- The maximum release rate is not to exceed 120% of the 5-year peak flow for all storms up to and including the 100-year event.
- Ensure no overland flow for all storms up-to and including the 100-year event.

Based on these release rates, it was anticipated that 100 $m^3$/ha of on-site storage would be enough to prevent major system (overland) flows during the 100-year event.

The proposed development will alter the storm servicing layout that was previously approved as part of the CitiGate (Phase 1). For example, the previous storm servicing layout included a storm sewer for a 'ring-road' that encompassed the entire CitiGate lands. The proposed development includes both the future development blocks and future ring-road; therefore, the allowable release rate specified above would not apply in this case.

The allowable release rate for the proposed development was established using the results from the approved Autodesk Storm and Sanitary Analysis (SSA) SWMM model that was built for the CitiGate Phase 1 lands. Report excerpts (model results) are provided in **Appendix C**.

The proposed development will outlet to storm maintenance holes 208 & 214. The 100-year allowable release rate to these nodes is based on the following model results for a 100-year, 3-hour Chicago Storm (critical design storm):

| Structure | 100-year Allowable Release Rate |
|---|---|
| Storm MH208 | 3,413 L/s |
| Storm MH214 | 4,586 L/s |

Note that the off-site storm sewer was designed to convey the 5-year peak flow and surcharge during larger storm events. The storm sewer can surcharge as there are no basement connections.

## 4.3 Proposed On-Site Storm Infrastructure

The on-site storm sewer and stormwater management system will include storm sewers ranging in size from 450mm to 1350mm in diameter. On-site storage will be provided underground using Stormtech MC-3500 & MC-4500 arch-type storage chambers covered in 50mm ($D_{50}$) clearstone (**Appendix C**). Peak flows will be attenuated to the allowable release rates specified using orifices and flow control structures. The inlet controls at each flow control structures are as follows:

MH01: 600mm (x3) openings within a 2.40m wide weir (top of weir elev. = 97.55m)
MH11: 600mm (x3) openings within a 2.40m wide weir (top of weir elev. = 98.45m)
MH103: 340mm orifice
MH108: 300mm orifice
MH118: 108mm orifice

The south storm sewer will include two (2) flow control structures connected in series. This is to utilize all of the pipe storage at the higher elevation; instead of providing all of the storage within the chambers at the lower elevation, near the outlet.

No above ground (i.e. surface storage) is accounted for in the storm servicing design. The 100-year peak flow will be attenuated to the allowable release rate via underground storage (at the request of the client). Check valves will be installed within the pipe downstream the flow controls.

Refer to the General Plan of Services (Drawing 120025-GP).

### *4.3.1 Storm Sewer Sizing Criteria*

The storm drainage design is based on the principals of dual drainage (i.e. minor and major system). The on-site storm sewers (i.e. minor system) have been designed based on the criteria outlined in the City of Ottawa Sewer Design Guidelines (October 2012) and associated technical bulletins. The design criteria used in sizing the storm sewers are summarized in **Table 4.1**.

**Table 4.1: Storm Sewer Design Parameters**

| Parameter | Design Criteria |
|---|---|
| Private Roads | 5 Year Return Period |
| Storm Sewer Design | Rational Method |
| IDF Rainfall Data | Ottawa Sewer Design Guidelines |
| Initial Time of Concentration (Tc) | 10 min |
| Minimum Velocity | 0.8 m/s |
| Maximum Velocity | 3.0 m/s |
| Minimum Diameter | 250 mm |

Refer to the storm sewer design sheets provided in **Appendix C** and Storm Drainage Area Plan (Drawing 120025-STM).

### *4.3.2 Overland Flow Sizing Criteria*

As previously indicated all flows will be contained underground for all storm events up-to and including the 100-year storm event. Storm events that exceed the 100-year storm will pond on the surface and be conveyed through major system flow pathways. The grading design includes maximum 0.35m of surface ponding before ‘spilling’ over a high-point. This would happen only in very rare events that exceed the 100-year storm.

Refer to the Grading Plan (Drawing 120025-GR).

### *4.3.3 Temperature Mitigation*

The O'Keefe Drain is considered a cool-cold watercourse, as such on-site lot level thermal mitigation best management practices have been provided for temperature mitigation. The proposed storm drainage and stormwater management design incorporates the use of underground storage. As such there will be no surface ponding. In addition, the use of permeable storage chambers for the stormwater management system provides direct contact between the stormwater and the surrounding soil. This increases the amount of heat transfer to the surrounding soil. This approach is consistent with the recommendations in the 2014 CitiGate SWM Report.

## 4.4 Stormwater Management Modeling

The *City of Ottawa Sewer Design Guidelines* (October 2012) requires hydrologic / hydraulic modeling for all dual drainage systems. The performance of the proposed storm drainage system for the site was evaluated using the PCSWMM hydrologic / hydraulic model.

The PCSWMM model schematics and 100-year model output data are provided in **Appendix D**. Digital copies of the modeling files and model output for all storm events are provided on the enclosed CD.

### *4.4.1 Design Storms*

The hydrologic analysis was completed using the following synthetic design storms that are consistent with the 2014 CitiGate SWM analysis:

- 3-hour Chicago storm distribution
- 12-hour SCS Type II storm distribution

The return periods analyzed include the 5-year & 100-year storm events. The IDF parameters used to generate the design storms were taken from the *City of Ottawa Sewer Design Guidelines* (October 2012).

The 3-hour Chicago distribution generated the highest peak flows for both the minor and major systems and was determined to be the critical storm distribution for the design of the storm drainage system.

The proposed drainage system was also ‘stress tested’ using a 100-year (+20%) 3-hour Chicago design storm. This design storm has a 20% higher intensity and total volume compared to the 100-year event.

### *4.4.2 Model Development*

The PCSWMM model includes the subcatchment areas to the trunk storm sewer system, the future development area to the north, and the future CitiGate Drive Extension. Individual drainage areas to each inlet have been lumped together to determine the total area to each pipe run. The purpose of the model is to ensure that the proposed storm drainage and stormwater management system adheres to the allowable release rates specified and that there is no surface ponding during the 100-year storm event.

*Infiltration*

Infiltration losses for all catchment areas were modeled using Horton's infiltration equation, which defines the infiltration capacity of soil over the duration of a precipitation event using a decay function that ranges from an initial maximum infiltration rate to a minimum rate as the storm progresses. The default values as specified in the City of Ottawa Sewer Design Guidelines were used for all catchments.

| | | |
|---|---|---|
| Horton's Equation: | Initial infiltration rate: | $f_o = 76.2$ mm/hr |
| $f(t) = f_c + (f_o - f_c)e^{-k(t)}$ | Final infiltration rate: | $f_c = 13.2$ mm/hr |
| | Decay Coefficient: | $k = 4.14$/hr |

*Depression Storage*

The default values for depression storage in the City of Ottawa were used for all subcatchments.

- Depression Storage (pervious areas): 4.67 mm
- Depression Storage (impervious areas): 1.57 mm

The rooftops assumed to provide no depression storage (zero-impervious parameter).

*Equivalent Width*

'Equivalent Width' refers to the width of the sub-catchment flow path. This parameter (Table 5.1) is calculated as described in Section 5.4.5.6 of the City of Ottawa Sewer Design Guidelines. The flow path lengths are shown on the PCSWMM model schematics provided in **Appendix D**.

*Impervious Values*

Runoff coefficients for each subcatchment area were determined based on the proposed site plan. Refer to the Storm Drainage Area Plan (120025-SWM) for details. Percent impervious values were calculated using:

$$\%imp = (C - 0.20) / 0.70$$

*Storm Drainage Areas*

For modeling purposes, the site has been divided into subcatchments based on the drainage areas tributary to each inlet of the proposed storm sewer system. The subcatchment areas are shown on the Storm Drainage Area Plan (120025-SWM).

The hydrologic modeling parameters for each subcatchment were developed based on the Site Plan (**Figure 3**) and Storm Drainage Area Plan specified above. Subcatchment parameters are provided in **Table 4.2**.

**Table 4.2: Subcatchment Parameters**

| Area ID | Catchment Area (ha) | Runoff Coefficient (C) | Percent Impervious (%) | Zero-Imperv. (%) | Equiv. Width (Flow Length) (m) | Average Slope (%) |
|---|---|---|---|---|---|---|
| ***Controlled Areas*** | | | | | | |
| A-01 | 0.25 | 0.65 | 64.3 | 0 | 83 (30) | 1.5 |
| A-04 | 0.10 | 0.66 | 65.7 | 0 | 100 (10) | 1.5 |
| A-06 | 0.66 | 0.73 | 75.7 | 0 | 264 (25) | 1.5 |
| A-07 | 1.04 | 0.81 | 87.1 | 0 | 173 (60) | 1.5 |
| A-08 | 1.05 | 0.84 | 91.4 | 0 | 162 (65) | 1.5 |
| A-09 | 0.64 | 0.79 | 84.3 | 0 | 128 (50) | 1.5 |
| A-10 | 0.88 | 0.86 | 94.3 | 0 | 220 (40) | 1.5 |
| A-11 | 0.04 | 0.83 | 90.0 | 0 | 40 (10) | 1.5 |
| A-12 | 0.45 | 0.47 | 38.6 | 0 | 180 (25) | 1.5 |
| A-13 | 0.30 | 0.63 | 61.4 | 0 | 120 (25) | 1.5 |
| A-14a | 0.35 | 0.73 | 75.7 | 0 | 140 (25) | 1.5 |
| A-14b | 0.07 | 0.90 | 100.0 | 100 | 35 (20) | 1.5 |
| A-15a | 0.25 | 0.87 | 95.7 | 0 | 125 (20) | 1.5 |
| A-15b | 0.36 | 0.90 | 100.0 | 100 | 72 (50) | 1.5 |
| A-16a | 0.82 | 0.90 | 100.0 | 100 | 103 (80) | 1.5 |
| A-16b | 0.67 | 0.90 | 100.0 | 100 | 112 (60) | 1.5 |
| A-17a | 0.17 | 0.89 | 98.6 | 0 | 68 (25) | 1.5 |
| A-17b | 0.25 | 0.90 | 100.0 | 100 | 63 (40) | 1.5 |
| A-18 | 0.23 | 0.89 | 98.6 | 0 | 115 (20) | 1.5 |
| A-19 | 0.47 | 0.67 | 67.1 | 0 | 188 (25) | 1.5 |
| A-20 | 0.23 | 0.50 | 42.9 | 0 | 77 (30) | 1.5 |
| A-21a | 0.25 | 0.66 | 65.7 | 0 | 125 (20) | 1.5 |
| A-21b | 0.05 | 0.90 | 100.0 | 100 | 33 (15) | 1.5 |
| A-22a | 1.16 | 0.79 | 84.3 | 0 | 193 (60) | 1.5 |
| A-22b | 0.76 | 0.90 | 100.0 | 100 | 117 (65) | 1.5 |
| A-23a | 2.08 | 0.53 | 47.1 | 0 | 297 (70) | 1.5 |
| A-23b | 0.65 | 0.90 | 100.0 | 100 | 81 (80) | 1.5 |
| A-24a | 1.16 | 0.69 | 70.0 | 0 | 211 (55) | 1.5 |
| A-24b | 1.06 | 0.90 | 100.0 | 100 | 133 (80) | 1.5 |
| A-25a | 1.11 | 0.66 | 65.7 | 0 | 222 (50) | 1.5 |
| A-25b | 0.48 | 0.90 | 100.0 | 100 | 80 (60) | 1.5 |
| A-26a | 1.27 | 0.86 | 94.3 | 0 | 212 (60) | 1.5 |
| A-26b | 0.66 | 0.90 | 100.0 | 100 | 94 (70) | 1.5 |
| A-27a | 1.84 | 0.67 | 67.1 | 0 | 307 (60) | 1.5 |
| A-27b | 0.08 | 0.90 | 100.0 | 100 | 40 (20) | 1.5 |
| A-28 | 0.11 | 0.63 | 61.4 | 0 | 55 (20) | 1.5 |
| **TOTAL (Controlled)** | **22.00** | **0.76** | **80.7** | **-** | **-** | **-** |

| Area ID | Catchment Area (ha) | Runoff Coefficient (C) | Percent Impervious (%) | Zero-Imperv. (%) | Equiv. Width (Flow Length) (m) | Average Slope (%) |
|---|---|---|---|---|---|---|
| ***Uncontrolled / Direct Runoff Areas*** | | | | | | |
| A-02 | 0.25 | 0.60 | 57.1 | 0 | 125 (20) | 1.5 |
| A-03 | 0.10 | 0.55 | 50.0 | 0 | 50 (20) | 1.5 |
| A-05 | 0.18 | 0.59 | 55.7 | 0 | 90 (20) | 1.5 |
| D-01 | 0.25 | 0.22 | 2.9 | 0 | 250 (10) | 1.5 |
| D-02 | 0.53 | 0.39 | 27.1 | 0 | 353 (15) | 1.5 |
| D-03 | 0.04 | 0.20 | 0.0 | 0 | 80 (5) | 1.5 |
| **TOTAL (Uncontrolled)** | **1.35** | **0.43** | **32.9** | **-** | **-** | **-** |
| ***External Drainage Areas*** | | | | | | |
| FUT | 2.66 | 0.80 | 85.0 | 50 | 231 (115) | 1.5 |
| CG-DR-EXT | 0.52 | 0.80 | 85.0 | 0 | 14 (375) | 1.5 |
| **OVERALL** | **26.53** | **0.75** | **78.8** | **-** | **-** | **-** |

### *4.4.3 Model Results*

The on-site storage and conveyance system requirements were refined using the PCSWMM model. The model was used to ensure that peak flows are controlled to the allowable release rates and ensure that the 100-year hydraulic grade line is contained on-site within the storm sewer system.

*Storage Requirements*

The 2014 CitiGate SWM analysis estimated that 100 $m^3$/ha of storage would be sufficient to control the 100-year storm event. The 100-year storm event was to be controlled to a 5-year peak flow that is increased by 20%. Storage was assumed to be provided on the surface.

Per the client request, the 100-year storm is to be confined underground in the proposed storm sewer and stormwater management system. Due to the site configurations / building area the PCSWMM model indicates that the storage required is more than the previously estimated 100 $m^3$/ha. The storage required and storage provided in the storm sewers and stormwater management system is shown in **Table 4.3** below.

**Table 4.3: Required (100-year) and Provided Storage Volumes**

| Storage Node (MH) ID | Drainage Area (ha) | Inlet Control Device | Required 100-yr Storage Volume* ($m^3$) | Provided Storage Volume ($m^3$) | | |
|---|---|---|---|---|---|---|
| | | | | Storm Sewers | SWM System | TOTAL |
| ***South Outlet*** | | | | | | |
| Storage-S01 (MH11) | 10.81 | 600mm (x3) 2.40m Weir | 1,298 | 605 | 822 | 1,427 |
| Storage-S02 (MH01) | +4.22 | 600mm (x3) 2.40m Weir | 1,614 | 342 | 1,298 | 1,640 |
| **TOTAL (South Outlet)** | **15.03** | **-** | **2,912** | **947** | **2,120** | **3,067** |
| ***North Outlet*** | | | | | | |
| Storage-N01 (MH118) | 0.72 | 108mm Orifice | 236 | 17 | 218 | 235 |
| Storage-N02 (MH108) | 3.76 | 300mm Orifice | 1,120 | 144 | 1,054 | 1,198 |
| Storage-N03 (MH103) | 2.30 | 340mm Orifice | 431 | 84 | 348 | 432 |
| Storage-NFUT | 2.66 | 450mm Pipe** | 306 | - | 306** | 306** |
| **TOTAL (North Outlet)** | **9.44** | **-** | **2,093** | **245** | **1,926** | **2,171** |
| **OVERALL** | **24.47** | **-** | **5,005** | **1,192** | **4,046** | **5,238** |

**Based on PCSWMM Model Results for a 100-year, 3-hour Chicago Storm.*
***Theoretical outlet control pipe and provided storage for the future development area (Storage-NFUT).*

*Peak Flows*

As shown in **Table 4.4**, the overall release rates from the site (both uncontrolled / controlled) will adhere to the allowable release rates specified in **Section 4.2.2**. Peak flows are controlled at storm MH's 208 & 214. The uncontrolled drainage, including the future CitiGate Drive extension, is accounted for in the overall release rates.

**Table 4.4: Summary of Peak Flows**

| Outfall | Allowable Release Rate (L/s) | Peak Flow (L/s) | | | |
|---|---|---|---|---|---|
| | | External Areas | Uncontrolled Areas | Controlled Areas | Overall (Outfall) |
| ***5-year*** | | | | | |
| Storm MH208 | - | 654 | 124 | 539 | **1,289** |
| Storm MH214 (overall) | - | +101 (755) | +73 (197) | +1,742 (2,281) | **+1,874 (3,163)** |
| ***100-year*** | | | | | |
| Storm MH208 | 3,413 | 842 | 309 | 705 | **1,775** |
| Storm MH214 (overall) | 4,586 | +198 (1,040) | +209 (518) | +2,674 (3,379) | **+2,801 (4,576)** |

**Based on PCSWMM Model Results for a 3-hour Chicago Storm; outfall results account for hydrograph timing.*

*Hydraulic Grade Line (HGL)*

The PCSWMM model was used to estimate the hydraulic grade line (HGL) elevation of the of the storm sewer system during the 100-year storm event. **Table 4.5** provides a summary of the 100-year HGL elevation at each storm manhole within the proposed development. The model results indicate that the 100-year HGL elevations will be confined within the storm sewer system.

**Table 4.5: Estimated Hydraulic Grade Line (HGL) Elevations**

| MH ID | Obvert Elevation (m) | T/G Elevation (m) | 100-yr HGL Elevation (m) | Surcharge (m) | Clearance from T/G (m) | HGL in Stress Test (m) |
|---|---|---|---|---|---|---|
| CBMH109 | 98.42 | 102.00 | 100.60 | 2.18 | 1.40 | 101.28 |
| CBMH201 | 98.87 | 100.55 | 99.53 | 0.66 | 1.02 | 100.55 |
| CBMH211 | 98.25 | 100.81 | 99.04 | 0.80 | 1.77 | 100.67 |
| MH01 | 95.92 | 99.07 | 97.53 | 1.61 | 1.54 | 97.90 |
| MH02 | 96.04 | 98.37 | 97.63 | 1.59 | 0.74 | 98.07 |
| MH04 | 97.93 | 100.90 | 98.72 | 0.79 | 2.18 | 99.75 |
| MH05 | 98.57 | 101.42 | 98.96 | 0.00 | 2.46 | 100.10 |
| MH06 | 96.62 | 100.60 | 97.99 | 1.37 | 2.61 | 98.58 |
| MH07 | 97.70 | 102.11 | 98.77 | 1.07 | 3.34 | 99.47 |
| MH08 | 98.80 | 102.70 | 100.30 | 1.50 | 2.40 | 101.12 |
| MH09 | 99.06 | 102.38 | 100.74 | 1.68 | 1.64 | 101.55 |
| MH10A | 99.82 | 102.63 | 101.61 | 1.79 | 1.02 | 102.45 |
| MH10B | 100.55 | 102.51 | 101.80 | 1.25 | 0.71 | 102.51 |
| MH101 | 96.81 | 98.62 | 96.52 | 0.00 | 2.10 | 96.86 |
| MH102 | 97.06 | 99.85 | 96.77 | 0.00 | 3.08 | 97.12 |
| MH103 | 97.27 | 100.69 | 99.04 | 1.77 | 1.65 | 100.65 |
| MH104 | 98.18 | 101.88 | 99.41 | 1.23 | 2.47 | 100.74 |
| MH105 | 98.65 | 100.60 | 99.54 | 0.89 | 1.06 | 100.60 |
| MH106 | 97.22 | 100.69 | 96.89 | 0.00 | 3.80 | 97.25 |
| MH107 | 97.32 | 100.84 | 97.00 | 0.00 | 3.84 | 97.34 |
| MH108 | 97.98 | 100.94 | 100.29 | 2.32 | 0.65 | 100.90 |
| MH11 | 98.29 | 101.25 | 99.33 | 1.04 | 1.92 | 100.08 |
| MH110 | 98.52 | 102.29 | 100.66 | 2.15 | 1.63 | 101.36 |
| MH111 | 100.33 | 102.73 | 101.01 | 0.68 | 1.72 | 101.96 |
| MH113 | 98.78 | 102.29 | 100.83 | 2.05 | 1.46 | 101.55 |
| MH114 | 100.00 | 102.58 | 101.43 | 1.44 | 1.15 | 102.29 |
| MH115 | 100.32 | 102.24 | 101.49 | 1.17 | 0.75 | 102.24 |
| MH116 | 101.68 | 103.55 | 101.81 | 0.13 | 1.74 | 102.88 |
| MH117 | 97.60 | 99.87 | 97.40 | 0.00 | 2.47 | 97.80 |
| MH118 | 97.93 | 100.03 | 99.53 | 1.60 | 0.50 | 100.03 |
| MH119 | 99.30 | 101.65 | 99.54 | 0.24 | 2.11 | 100.24 |
| MH12 | 98.62 | 101.54 | 99.97 | 1.35 | 1.57 | 100.62 |
| MH120 | 102.08 | 104.32 | 102.85 | 0.77 | 1.47 | 104.32 |
| MH13 | 98.87 | 101.56 | 100.35 | 1.48 | 1.21 | 100.97 |
| MH14 | 99.29 | 101.58 | 100.96 | 1.67 | 0.62 | 101.50 |
| MH15 | 99.66 | 101.57 | 101.17 | 1.51 | 0.40 | 101.57 |
| MH16 | 99.98 | 102.03 | 101.20 | 1.22 | 0.83 | 101.74 |

**Based on PCSWMM Model Results for a 3-hour Chicago Storm.*

*Stress Test*

**Table 4.5** also provides the estimated HGL elevations for the 'stress test' event. The stress test event represents a 20% increase (rainfall intensity and total precipitation) in the 100-year design event. The 'stress test' event will not be confined within the storm sewer system. Ponding will occur within the parking lot sags and may cascade off-site. The major system overland flow will be diverted through overland pathways and spill off-site to the future CitiGate Drive; ultimately discharging to the O'Keefe Drain.

*Foundation Drains*

The proposed building will be slab-on-grade, consistent with the 2014 CitiGate Report. As such, there are no concerns with the surcharged HGL elevations. The general grade of the site will allow water to pond in the parking lot and overflow downstream before impacting the building, which is at a higher grade. Refer to the Grading Plan (drawing 120025-GR).

### *4.4.4 Future Development Area*

The PCSWMM model includes the 2.66 ha future development area to the north (adjacent Fallowfield Road). This area is represented in the model based on the following:

| | |
|---|---|
| Drainage Area: | 2.66 ha |
| Imperviousness: | 85% (C=0.80) |
| 100-year Allowable Release Rate: | 842 L/s (approx. 20% increase of 5-year – 654 L/s) |
| *Est. On-Site Storage Requirements:* | *306 $m^3$ (115 $m^3$/ha)* |

The future development of these lands is to adhere to the above release rates. The storage requirements have been estimated as above-ground surface storage in the PCSWMM model.

The 2014 CitiGate SWM Report originally estimated the impervious percentage (85%). This value was used for the future development blocks for the design of the stormwater management facility.

## 5.0 EROSION AND SEDIMENT CONTROL

Temporary erosion and sediment control measures will be implemented on-site during construction in accordance with the Best Management Practices for Erosion and Sediment Control. This includes the following temporary measures:

- Filter socks (catchbasin inserts) will be placed in existing and proposed catchbasins and catchbasin manholes, and will remain in place until vegetation has been established and construction is completed;
- Silt fencing will be placed along the surrounding construction limits;
- Mud mats will be installed at the site entrances;
- Strawbale or rock check dams will be installed in swales and ditches;
- The contractor will be required to perform regular street sweeping and cleaning as required, to suppress dust and to provide safe and clean roadways adjacent to the construction site;

Erosion and sediment control measures should be inspected daily and after every rain event to determine maintenance, repair or replacement requirements. Sediments or granulars that enter site sewers shall be removed immediately by the contractor. These measures will be implemented prior to the commencement of construction and maintained in good order until vegetation has been established. Refer to the Erosion and Sediment Control Plan (120025-ESC) for additional information.

## 6.0 CONCLUSIONS AND RECOMMENDATIONS

*Watermain*

The analysis of the proposed watermain network confirms the following:

- The proposed 250mm diameter watermain that connects to the existing watermain along CitiGate Drive can service the proposed development.
- It is anticipated that there are adequate pressures in the existing watermain infrastructure to meet the required domestic demands for the development.
- It is anticipated that there is adequate flow to service the proposed fire protections system.
- Flows and pressures will be confirmed with an updated hydraulic analysis once the City provides new boundary conditions.

*Sanitary Servicing*

The analysis of the proposed sanitary servicing confirms the following:

- There is adequate capacity within the existing sanitary infrastructure to service the proposed development.
- The existing sanitary allotment would allow for future expansion or development on site.

*Stormwater Management*

The following provides a summary of the storm sewer and stormwater management system:

- Proposed storm sewer system is to connect with the existing storm sewer system on the extension of CitiGate Drive.
    - Storm sewers (minor system) have been designed to convey the uncontrolled 5-year peak flow using the Rational Method.
    - Underground storage is be provided within the storm sewers and stormwater management systems, which are to consist of Stormtech MC-3500 / MC-4500 Arch-type Chambers (or approved equivalent).
    - There will be no surface ponding during the 100-year storm event as the 100-year hydraulic grade line (HGL) is contained within the storm sewer system.
- Parking lot graded to ensure that static ponding depths do not exceed 0.35m.
    - Surface ponding would only office for storm events greater than the 100-year event.
    - A major overland flow route is provided to the CitiGate Drive extension and ultimately the O'Keefe Drain.

*Erosion and Sediment control*

- Erosion and sediment control measures (i.e. filter fabric, catchbasin inserts, silt fences, etc.) will be implemented prior to construction and are to remain in place until vegetation is established.

## 7.0 CLOSURE

The preceding report is respectfully submitted for review and approval. Please contact the undersigned should you have questions or require additional information.

**NOVATECH**

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# Appendix A

Water Servicing Information

## Detailed Building Use Domestic Water Demands

### Daily Demands from OBC Table 8.2.1.3

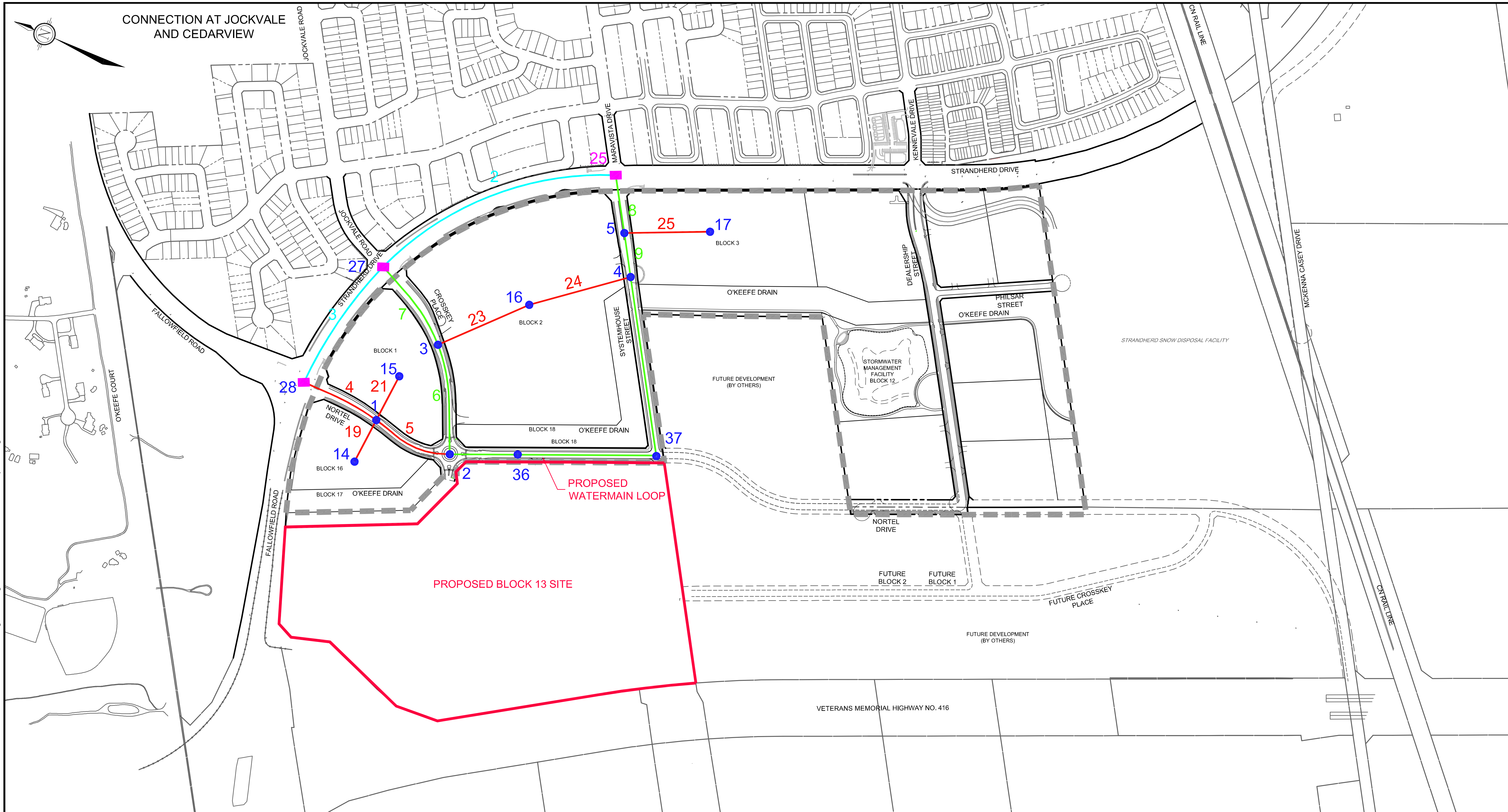
| Establishment | Daily Demand Volume | |
|---|---|---|
| Industrial Building: | 150 | L/day/loading bay |
| | 950 | L/day/bathroom |
| Commercial Office: | 75 | L/day/9.3m² Floor area |

### Commercial / Industrial Peaking Factors City of Ottawa Water Distrubution Guidelines

| Conditions | Peaking Factor | |
|---|---|---|
| Maximum Day | 1.5 | x avg day |
| Peak Hour | 1.8 | x max day |

### Proposed Development Conditions

| | Commercial Office | Industrial Building | Totals |
|---|---|---|---|
| Floor Area | 1559 | N/A | |
| No. Bathrooms | N/A | 100 | |
| No. Loading Bays | N/A | 56 | |
| Total Daily Volume (Liters) | 12572.6 | 103400.0 | 115972.6 |
| Avg Day Demand (L/s) | 0.146 | 1.197 | 1.34 |
| Max Day Demand (L/s) | 0.218 | 1.795 | 2.01 |
| Peak Hour Demand (L/s) | 0.393 | 3.231 | 3.62 |




## LEGEND

9 — FEEDERMAIN (250mm dia) AND PIPE NUMBER

6 — DISTRIBUTION WATERMAIN (200mm dia) AND PIPE NUMBER

5 — EXISTING BACKBONE WATERMAIN (400mm dia) BY OTHERS AND PIPE NUMBER

6 — WATERMAIN NODE AND NUMBER

2 — RESERVOIR AND NUMBER (BOUNDARY CONDITION LOCATION)

3 — EXISTING DISTRIBUTION / FEEDERMAIN (300mm dia) AND PIPE NUMBER

PHASE LINE (PHASE 1)

NOTE: WATERMAIN NODE AND PIPE NUMBERS ARE AS PER APPROVED PHASE 1 REPORT, R-2014-115, DATED JAN. 9, 2015

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CITI GATE
416 CORPORATE CAMPUS

WATER MODEL SCHEMATIC

| SCALE | | | |
|---|---|---|---|
| N.T.S | | | |
| DATE | JOB | FIGURE | |
| APR 2020 | 120025 | FIG A1 | |

SHT11X17.DWG - 279mmX432mm

M:\2020\120025\DATA\Calculations\Sewer Calcs\Water\20200318 - Land Use Citi Gate Calcs\109203-Figure-D.dwg, FIGURE-D, Mar 18, 2020 - 3:55pm, szorgel

# Table B1
# Block 13
# Water Demand

| Node | Block # | Area (ha) | Demand (L/s) | | |
|---|---|---|---|---|---|
| | | | High Pressure (Average Day) | Max. Daily | Peak Hour |
| 14 | 16 | 2.5 | 1.01 | 1.52 | 2.73 |
| 15 | 1 | 3.5 | 1.42 | 2.13 | 3.83 |
| 16 | 2 | 12.0 | 4.86 | 7.29 | 13.13 |
| 17 | 3 | 5.3 | 2.15 | 3.22 | 5.80 |
| 36 | 13 | 25.1 | 10.17 | 15.25 | 27.45 |
| | | | **19.61** | **29.41** | **52.94** |

**Notes:**
1. All water demand calculations based on the City of Ottawa Design Guidelines for Water Distribution Table 4.2.
2. Water Demand is based assuming all lands to be Industrial - Light with a demand of 35,000L/gross ha/d.
3. Peaking Factors: Maximum Daily Demand = 1.5 Average Daily Demand (High Pressure); Peak Hour = 1.8 Max Daily Demand.

**Fireflows**

| | | |
|---|---|---|
| Industrial Light Fireflow - Block 13 | 267 | L/s |
| Industrial Light Fireflow (as per Approved Phase 1 Design Brief dated Sept. 5, 2014) | 165 | L/s |

Prepared By:
NOVATECH
Date: March 18, 2020

# FUS - Fire Flow Calculations

As per 1999 Fire Underwriter's Survey Guidelines

Engineers, Planners & Landscape Architects

| | |
|---|---|
| **Novatech Project #:** | 120025 |
| **Project Name:** | Citigate Block 13 |
| **Date:** | 3/18/2020 |
| **Input By:** | Steve Zorgel |
| **Reviewed By:** | MSP |

Legend: Input by User; No Information or Input Required

**Building Description:** Building to have 5 floors, sprinklered, exposure is >45m all sides.

**Fire Resistive Construction**

| Step | | | Choose | | Value Used | Total Fire Flow (L/min) |
|---|---|---|---|---|---|---|
| **Base Fire Flow** | | | | | | |
| 1 | **Construction Material** | | | **Multiplier** | | |
| | **Coefficient related to type of construction C** | Wood frame | | 1.5 | 0.6 | |
| | | Ordinary construction | | 1 | | |
| | | Non-combustible construction | | 0.8 | | |
| | | Modified Fire resistive construction (2 hrs) | Yes | 0.6 | | |
| | | Fire resistive construction (> 3 hrs) | | 0.6 | | |
| 2 | **Floor Area** | | | | | |
| | A | Building Footprint ($m^2$) | 37200 | | | |
| | | Number of Floors/Storeys | 5 | | | |
| | | Protected Openings (1 hr) | Yes | | | |
| | | Area of structure considered ($m^2$) | | | **55,800** | |
| | F | **Base fire flow without reductions** $F = 220\, C\, (A)^{0.5}$ | | | | **31,000** |
| **Reductions or Surcharges** | | | | | | |
| 3 | **Occupancy hazard reduction or surcharge** | | | **Reduction/Surcharge** | | |
| | (1) | Non-combustible | | -25% | 0% | **31,000** |
| | | Limited combustible | | -15% | | |
| | | Combustible | Yes | 0% | | |
| | | Free burning | | 15% | | |
| | | Rapid burning | | 25% | | |
| 4 | **Sprinkler Reduction** | | | **Reduction** | | |
| | (2) | Adequately Designed System (NFPA 13) | Yes | -30% | -30% | **-15,500** |
| | | Standard Water Supply | Yes | -10% | -10% | |
| | | Fully Supervised System | Yes | -10% | -10% | |
| | | | | **Cumulative Total** | **-50%** | |
| 5 | **Exposure Surcharge (cumulative %)** | | | | **Surcharge** | |
| | (3) | North Side | > 45.1m | | 0% | **0** |
| | | East Side | > 45.1m | | 0% | |
| | | South Side | > 45.1m | | 0% | |
| | | West Side | > 45.1m | | 0% | |
| | | | | **Cumulative Total** | **0%** | |
| **Results** | | | | | | |
| 6 | (1) + (2) + (3) | **Total Required Fire Flow, rounded to nearest 1000L/min** | | | **L/min** | **16,000** |
| | | (2,000 L/min < Fire Flow < 45,000 L/min) | | or | L/s | **267** |
| | | | | or | USGPM | 4,227 |
| 7 | **Storage Volume** | Required Duration of Fire Flow (hours) | | | Hours | 3.5 |
| | | Required Volume of Fire Flow ($m^3$) | | | $m^3$ | 3360 |

# Boundary Conditions
## 416 Citigate Dr.

### Provided Information

| Scenario | Demand | |
|---|---|---|
| | L/min | L/s |
| Average Daily Demand | 1,177 | 19.61 |
| Maximum Daily Demand | 1,765 | 29.41 |
| Peak Hour | 3,176 | 52.94 |
| Fire Flow Demand #1 | 16,020 | 267.00 |

### Location


### Results

**Connection 1 – Citigate Dr.**

| Demand Scenario | Head (m) | Pressure[1] (psi) |
|---|---|---|
| Maximum HGL | 151.5 | 77.1 |
| Peak Hour | 147.3 | 71.1 |
| Max Day plus Fire 1 | 139.0 | 59.3 |

[1] Ground Elevation = 97.3 m

**Connection 2 – Citigate Dr.**

| Demand Scenario | Head (m) | Pressure[1] (psi) |
|---|---|---|
| Maximum HGL | 151.5 | 78.1 |
| Peak Hour | 147.3 | 72.0 |
| Max Day plus Fire 1 | 133.6 | 52.7 |

[1] Ground Elevation = 96.6 m

**Disclaimer**

*The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation. Fire Flow analysis is a reflection of available flow in the watermain; there may be additional restrictions that occur between the watermain and the hydrant that the model cannot take into account.*

FIRE PROTECTION STUDY FOR

**PROJECT PYTHON**

OTTAWA, ONTARIO

ALTERNATIVE SOLUTION
FOR EXITING

CIVELEC
CONSULTANTS INC.

FIRE PROTECTION STUDY FOR

# PROJEC PYTHON

OTTAWA, ONTARIO

ALTERNATIVE SOLUTION
FOR EXITING

Prepared by


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May 15 2020

CIVELEC
CONSULTANTS

## 1. Executive Summary

1.1 The developer is planning to build a semi-automated light industrial sort center. The building will be approximately 58,222 m2 on the ground floor including 3280 m2 of offices. The ground floor will have approximately 25,427 m2 of mezzanines. The building will also have additional 4 levels of robotic sorting platforms each having an area of 45,075 m2. The building is considered 6 storeys high (5 stories and mezzanine that is calculated as a floor in building height). The ground floor will be approximately 8.53 m (28 ft) high with mezzanine levels located at approximately 4.27 m (14 ft) height. The robotic platforms will be 4.27 m (14 ft) high and the top platform roof will be 4.57 m (15 ft) above the platform.

1.2 The ground floor and mezzanines will be used for packaging shipping and receiving. This area will have numerous conveyers and automated handling systems. 2nd, 3rd 4th and 5th floors (robotic platforms) will be used for a sorting area and manual picking sector on the perimeter of the building. The merchandise is placed in special pods that are 2.616 m (8 ft 7 in) high. The individual items are located in the pods. The pods are delivered to the picking stations by robots. The individual items are loaded into the pods or removed from the pods. The items are transported to the ground floor by conveyer systems typically in open plastic totes. The pods stationary and delivery area has restricted access and is not occupied during normal operation.

1.3 Due to the configuration of the automated system and the equipment, the travel distance to reach an exit exceeds the requirements of the Ontario Building Code article 3.4.2.5 (1).

1.4 As the main aisles cannot lead directly to an exit the use of exception (3.4.2.5 (2)) by providing exits at the perimeter of the building cannot be used.

1.5 Our alternative solution is to meet the Objectives and Functional Statements that are: to facilitate the timely movement of persons to a safe place in an emergency. An objective is to limit the probability that as a result of design and construction of the building, the person in the building will be exposed to an unacceptable risk of injury due to hazards caused persons being delayed in or impeded from moving to a safe place during an emergency.

1.6 We have calculated the time to exit as well as the time it will take for smoke descend to a level of 3m for ground floor, 2$^{nd}$ , 3$^{rd}$ , 4$^{th}$ and 5$^{th}$ floor as well as from the platform located on the ground floor. The worst case scenario is exiting from the platform.

| | |
|---|---|
| Fire starts | time = 0 sec. |
| Sprinkler system is activated | time = 237 sec (approximately 4 min) |
| Alarm system is activated | time = 267 sec (4 min and 30 sec) |
| Evacuation starts | time = 567 sec (9 min and 30 sec) |

| | |
|---|---|
| Person reaches exit (221 sec) | time = 788 sec (13 min and 08 sec) |
| Smoke reaches 3 m level above platform | time = 8,760 sec (2 hr and 26 min) |

1.7 From the above mentioned calculations we can see that the occupant can exit the building from the platform before the smoke reaches 3 m above the floor level of the platform. Based on travel speed given on Ontario Building Code the time for a person time to exit was calculated at 3 minutes and 25 seconds. The time for the smoke level to descend to 3 m from the floor of the platform was calculated to be 2 hours 12 minutes after the evacuation.

1.8 Based on the time travel exit study evacuation, the exiting is considered safe.

1.9 For detailed code study see Appendix A.

1.10 See detailed calculation sheets – Appendix B

**2. Building Description**

2.1 The building will be approximately 58,222 $m^2$ on the ground floor including 3280 $m^2$ of offices. The ground floor will have approximately 25,427 $m^2$ of mezzanines. The building will also have additional 4 levels of robotic sorting platforms each having an area of 45,075 $m^2$. The building is considered 6 storeys high. The ground floor will be approximately 8.53 m (28 ft) high with mezzanine levels located at approximately 4.27 m (14 ft) height. The robotic platforms will be 4.27 m (14 ft) high and the top platform roof will be 4.57 m (15 ft) above the platform.

2.2 The ground floor will be used for packaging shipping and receiving. This area will have numerous conveyers and automated handling systems. 2$^{nd}$, 3$^{rd}$, 4$^{th}$ and 5$^{th}$ floors will be used for a sorting area and manual picking sector on the perimeter of the building. The merchandize is placed in special pods that are 2.616 m (8 ft 7 in) high. The individual items are stored in the pods. The pods are delivered to the picking stations by robots. The individual items are loaded into the pods or removed from the pods. The items are transported to the ground floor by conveyer systems typically in open plastic totes. The pods sorting and delivery area has restricted access and is not occupied during normal operation.

2.3 Typical merchandize consist of combination of class 2, 3, 4 and class A non-expanded cartooned plastics as defined by NFPA 13. Due to the plastic totes and pods, the commodity is classified as exposed non-expanded class A plastics.

2.5 The building will be approximately 28.65 m (94 ft) high.

2.6 The semi-automated conveyer system will be used for transport of goods. As the actual sorting and conveyer plans are not yet available, we have used plans for a similar use building that are provided in appendix D

2.7 See appendix C for plans.

2.5 The building will be approximately 28.65 m (94 ft) high.

2.6 The semi-automated conveyer system will be used for transport of goods. As the actual layout and conveyer plans are not yet available, we have used two conveyer crossings ant two conveyer gates in the calculations.

2.5 See appendix C for plans.

**3. Proposed description for Exit Location for typical floors**

3.1 Exits will be provided so that a travel to an exit will not exceed 45 m from: office area and mechanical rooms.

3.2 In the typical floor areas (2, 3, 4 and 5$^{th}$ levels) the exact equipment and conveyer layout is not completed, we have used maximum travel distance and 2 stair crossing of the conveyers and 2 gate in the conveyer system. The distance to an exit used is 140 m. When the travel distance is converted travel time to an exit, the maximum exit time is calculated to be 207 seconds (3 min and 27 seconds).

3.3 As the alarm system is normally activated by the sprinkler system with a typical delay of 30 sec. and the sprinkler system is calculated to activate 3 minutes after the start of the fire.

**4. Code Requirements**

4.1 The OBC 3.4.2.5. states: *Location of Exits*

*(1) Except as permitted by Sentences (2), 3.2.8.4.(4) and 3.3.2.4.(13) to (16), if more than one exit is required from a floor area, the exits shall be located so that the travel distance to at least one exit shall be not more than,*

*(a) 25 m in a high hazard industrial occupancy,*

*(b) 40 m in a business and personal services occupancy,*

*(c) 45 m in a floor area that contains an occupancy other than a high hazard industrial occupancy, provided it is sprinklered,*

*(d) 105 m in any floor area, served by a public corridor, in which rooms and suites are not separated from the remainder of the floor area by a fire separation, provided,*

*(i) the public corridor is not less than 9 m wide,*

*(ii) the ceiling height in the public corridor is not less than 4 m above all floor surfaces,*

*(iii) the building is sprinklered, and*

*(iv) not more than one-half of the required egress doorways from a room or suite open into the public corridor if the room or suite is required to have more than one egress doorway,*

*(e) 60 m in any storage garage that conforms to the*

*(f) 30 m in any floor area other than those referred to in requirements of Article 3.2.2.83., and Clauses (a) to (e).*

*(2) Except for a high hazard industrial occupancy, Sentence (1) need not apply if exits are placed along the perimeter of the floor area and are not more than 60 m apart, measured along the perimeter, provided each main aisle in the floor area leads directly to an exit.*

*(3) Exits shall be located and arranged so that they are clearly visible or their locations are clearly indicated and they are accessible at all times.*

4.2 Ontario Building Code has a special section that deals with “Shelf and Rack Storage Systems”. Even though we do not consider the automated sorting system configuration to be a “Shelf and Rack Storage” the exiting and use is similar.

4.3 Ontario Building Code article 3.16.1.7 provides requirements and calculation methods for exiting times from Shelf and Rack Storage System. The article states:

3.16.1.7. Exits and Means of Egress

*(1) Except as permitted in Sentences (2) and (3), every walkway or platform level shall be provided with no fewer than two exits conforming to Section 3.4.*

*(2) An access to exit from an elevated platform level may be provided by means of open unenclosed stairs serving,*

*(a) not more than four platform levels, the highest of which shall be not more than 12 m above the main floor, where the shelf and rack storage system is intended for the storage of Class I, II, III and IV commodities, as defined in NFPA 13, “Installation of Sprinkler Systems”, and*

*(b) not more than two platform levels, where the shelf and rack storage system is intended for the storage of Group A, B and C plastics and rubber tires, as defined in NFPA 13, "Installation of Sprinkler Systems".*

*(3) Any single platform or walkway in a shelf and rack storage system may be served by a single unenclosed stair leading to the platform or walkway level immediately below provided,*

*(a) the platform or walkway does not exceed 200 m2 in area,*

*(b) the travel distance on the platform or walkway to the level below, including the travel distance along the single unenclosed egress stair, does not exceed 25 m, and*

*(c) the platform or walkway below is provided with two separate egress stairs or exits.*

*(4) The maximum travel distance on an elevated platform to the ground floor level, including the travel distance along unenclosed stairs, shall not exceed 45 m.*

*(5) The maximum travel distance on an elevated platform to an exit serving that platform shall not exceed 45 m.*

*(6) Except as permitted in Sentence (7), the maximum travel distance from the bottom of an unenclosed stair to an exit along a main aisle on the ground floor level shall not exceed 45 m.*

*(7) Where the travel distance in Sentence (6) exceeds 45 m,*

*(a) an egress system serving the shelf and rack storage system shall be designed on the basis of a time-based egress analysis using the following criteria:*

*(i) occupant egress speed of 1 m/sec shall be used for horizontal egress routes within the shelf and rack storage system,*

*(ii) occupant egress speed of 0.6 m/sec shall be used for vertical egress routes within the shelf and rack storage system, measured on the diagonal along the nosing of the stairs,*

*(iii) occupant egress speed of 1.3 m/sec shall be used for horizontal egress routes along a main aisle on the ground floor level,*

*(iv) each lift-gate shall be accorded an egress time of 10 seconds,*

*(v) each at-level conveyor cross-over shall be accorded a time of 5 seconds,*

*(vi) a safety factor of 1.5 shall be used in calculating the total egress time,*

*(b) the total egress time shall be calculated using the following formula:*

***Total Egress Time = (Hp + Vp/0.6 + Hm/1.3 + 10Nlg + 5Nlc ) 1.5 (in seconds)***

where:
Hp = horizontal travel distance on the shelf and rack storage system, in metres,
Vp = vertical travel distance on the shelf and rack storage system, in metres,
Hm = horizontal travel distance on the main floor, in metres,
Nlg = number of lift gates in the means of egress,
Nlc = number of at-level cross overs in the means of egress,

*(c) the total egress time from any point in the shelf and rack storage system shall be a maximum of 4 minutes,*

*(d) a fire alarm and detection system conforming to Subsection 3.2.4. shall be installed in the building,*

*(e) smoke detectors shall be provided under all solid decking and walkways,*

## 5 Code Compliance

5.1 The OBC provides two alternatives to comply to the code.

5.2 One option is to use the descriptive design of Part B of the OBC and if this part B is used for the design it is assumed that the objectives of Part A of OBC are met.

5.3 The second option is to use the objectives and functional statements of the code. The design requires to present an alternative solution with a proof of meeting the objectives of Part A of OBC.

## 6. Requirements for Alternative Solution

6.1 The OBC article 1.2.1.1 states: Complience with Division B

*(1) Complience with Division B shall be achieved,*

*(a) by complying with the applicable acceptance solution in Division B, or*

*(b) by using alternative solutions that will achieve the level of performance required by the applicable acceptable solutions in respect of objectives and functional statements attributed to the acceptable solutions in Supplementary Standard SA-1.*

*(2) For the purposes of Clause (1)(b), the level of performance in respect of functional statement refers to the performance of the functional statements as it relates to the objective with which it is associated in Supplementary Standard SA-1.*

*Clause A-1.2.1.1.(1)(b) states: "Where a design differs from the acceptable solutions in Division B, then it should be treated as an "alternative solution." A proponent of an alternative solution must demonstrate that the alternative solution addresses the same issues as the applicable acceptable solutions in Division B and their attributed objectives and functional statements. However, because the objectives and functional statements are entirely qualitative, demonstrating compliance with them in isolation is not possible. Therefore,* Clause 1.2.1.1.(1)(b) *identifies the principle that Division B establishes the quantitative performance targets that alternative solutions must meet. In many cases, these targets are not defined very precisely by the acceptable solutions — certainly far less precisely than would be the case with a true performance code, which would have quantitative performance targets and prescribed methods of performance measurement for all aspects of building performance. Nevertheless,* Clause 1.2.1.1.(1)(b) *makes it clear that an effort must be made to demonstrate that an alternative solution will perform as well as a design that would satisfy the applicable acceptable solutions in Division B – not "well enough" but "as well as." . . .*

*Applicable Acceptable Solutions*

*In demonstrating that an alternative solution will perform as well as a design that would satisfy the applicable acceptable solutions in Division B, its evaluation should not be limited to comparison with the acceptable solutions to which an alternative is proposed. It is possible that acceptable solutions elsewhere in the Code also apply. The proposed alternative solution may be shown to perform as well as the most apparent acceptable solution which it is replacing but may not perform as well as other relevant acceptable solutions. For example, an innovative sheathing material may perform adequately as sheathing in a wall system that is braced by other means but may not perform adequately as sheathing in a wall system where the sheathing must provide the structural bracing. All applicable acceptable solutions should be taken into consideration in demonstrating the compliance of an alternative solution."*

## 7. Travel Distance to Exits

### 7.1 Code requirements and objectives

7.1.1 This alternative solution is to comply with the objectives of Travel Distance – Location of Exits 3.4.2.5 of OBC.

7.1.2 3.4.2.5. Location of Exits

1) *Except as permitted by Sentences (2) and 3.3.2.5.(6), if more than one exit is required from a floor area, the exits shall be located so that the travel distance to at least one exit shall be not more than*

   a) *25 m in a high-hazard industrial occupancy,*

b) *40 m in a business and personal services occupancy,*

c) *45 m in a floor area that contains an occupancy other than a high hazard industrial occupancy, provided it is sprinklered,*

2) *Except for a high-hazard industrial occupancy, Sentence (1) need not apply if exits are placed along the perimeter of the floor area and are not more than 60 m apart, measured along the perimeter, provided each main aisle in the floor area leads directly to an exit.*

7.1.3 The applicable objectives and functional statements as summarized by the OBC SA-1 table 3 are the following:

| 3.4.2.5. Location of Exits | | |
|---|---|---|
| (1) | | [F10–OS3.7] |

7.1.4 The objectives of the Code are achieved by measures, such as those described in the acceptable solutions in Division B, that are intended to allow the *building* or its elements to perform the following functions:

F10 – To facilitate the timely movement of persons to a safe place in an emergency

7.1.5 [OS3]

An objective of this Code is to limit the probability that, as a result of the design or construction of the building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to hazards. The risks of injury due to hazards addressed in this Code are those caused by persons being delayed in or impeded from moving to a safe place during an emergency

7.1.6 To summarize the code objectives, the code takes into consideration that a typical fire spread and generated smoke will not adversely affect occupants if they can reach an exit within 45 m for a fire condition when the fire is controlled by sprinklers.

7.1.7 As the prescriptive part of the code must cover most of the buildings, and individual evaluation of fire spread and smoke spread is not easily done, the prescriptive code (part B) determines the safe travel distance (this can be converted to a travel time as demonstrated in article 3.16.1.1 of OBC).

7.1.8 To meet the objectives and functional statements associated with article 3.4.2.5 we plan to demonstrate by using fire modeling that the occupants have ample time to exit the building using the proposed exits and not be affected by the smoke or the fire.

## 7.2 Exiting proposal

7.2.1 The sprinkler systems in the automated sorting areas are designed using K 25.2 EC sprinklers rated at 165 deg F. This sprinkler system is designed not only to control the fire but to extinguish the fire.

7.2.2 To assure minimal fire spread as well as an audibility of the fire alarm system, upon activation of any fire alarm, the automated sorting system, conveyer system and the ventilation fans will shut down.

7.2.3 To assure proper operation of the sprinkler system smoke extraction is not recommended.

## 7.3 Fire modeling and test results

7.3.1 We have used a fire that follows exponential growth for a fast fire following $\alpha t^2$. The maximum temperature and velocity was calculated using Alpert's Correlations for celling jets. The activation of sprinklers was simulated by convective heating and using the sprinkler RTI. We have used buoyant plume model for calculation of total upward mass flow.

7.3.2 In our calculations we have calculated total upward mass (smoke) generated by the fire with the fire growing exponentially until the opening of the sprinkler heads. Once the sprinkler heads open we have assumed that fire will no longer grow but remain constant and generate upward mass flow at a constant rate.

7.3.3 These assumptions are very conservative as the sprinkler system is expected to extinguish the fire rather than to only control the fire. In addition we have not accounted for heating of air with flames prior to the heat generated with adequate energy to activate the sprinklers. This provides additional safety margins.

7.3.4 For the toxicity of the smoke level we have used polyurethane as the fuel. This calculation is very conservative as most of the combustibles will generate smaller percentages of by products (soot, CO2, CO and HCl.) Therefore the calculated toxicity values are considered conservative.

7.3.5 Our model is based on equations from graduate courses of Fire Dynamic at Carleton University for fire that is not oxygen controlled.

7.3.6 Civelec Consultants and Harrington Group (fire protection consultants) have made a full scale test using the K25 EC QR pendent sprinkler and the proposed structural assembly at

UL test center in Chicago. In the tests using a full-scale test with the same structural configurations and elevations two (2) K25.2 EC QR sprinklers opened and extinguished the fire and the maximum air temperature and sprinkler activation times were very similar to our calculated results. During the test, we were located approximately 3 m from the fire and remained at this distance until the sprinklers operated. At that point we have slowly exited the test center building without being affected by the smoke.

## 7.4 Exiting study

7.4.1 Based on travel time determined by National Research Council and used in Ontario Building Code, the exit time can be estimated by using the following equation:

Total Egress Time = $(H_p + V_p/0.6 + H_m/1.3 + 10N_{lg} + 5N_{lc}) \times 1.5$ (in seconds)

where

| | | |
|---|---|---|
| $H_p$ | = | horizontal travel distance on the platform |
| $V_p$ | = | vertical travel distance |
| $H_m$ | = | horizontal travel distance on a main floor |
| $N_{lg}$ | = | number of gates to open |
| $N_{lc}$ | = | number of stairs crossings |

7.4.2 We have calculated time to exit and obtained the following results: (for calculation details see appendix B, and for visual egress route see plans in appendix C).

7.4.3 In our fire and smoke model we have used $\alpha t^2$ growth of fire. We have calculated the accumulation of smoke as the fire increases until the activation of sprinklers. Once the sprinklers are activated we have assumed that the generation of smoke will remain constant. This assumption is very conservative as the sprinklers used in our design are designed to extinguish the fire rather than to only control the fire.

7.4.4 The worst case scenario is on the mezzanine floor due to the relatively low ceiling. If the fire starts at the ground level below the high section of the ceiling.

| Item | Event Time | Running Time |
|---|---|---|
| Fire starts | | 0 |
| Sprinkler system is activated | 3 min 57 sec | 3 min 57 sec |
| Alarm system is activated | 30 sec | 4 min 27 sec |
| Evacuation starts | 0 | 9 min 27 sec |
| Person reaches ground level | 3 min 8 sec | 12 min 35 sec |
| Person reaches exit | 33 sec | 13 min 08 sec |
| Smoke reaches 3 m above platform | | 146 min |
| Smoke reaches 3 m above ground | | 631 min |

The calculations demonstrate that it will take 3 minutes 41 seconds to move from the most remote area to the exit and 2 conveyer crossings and 2 conveyer gate crossing. Considering that the evacuation starts 9 minutes and 27 seconds after the fire starts (this includes 5 minutes to take the decision to evacuate). Based on the above, 13 minutes and 8 seconds after the start of fire the person reaches an exit. The calculations also show that the smoke will descend to 3 m above the ground floor will take over 10 hours (631 minutes) after the start of the fire. The safety margin to escape from the smoke is calculated to be the time between the evacuation and the time that the smoke will reach 3 m above the platform. This is calculated at 2 hours and 12 minutes.

7.4.5 We have also calculated time that it would take if the occupant will decide to reach an exit in the opposite direction, longer route to an exit. In this case the exiting time is calculated to 6 minutes and 4 seconds (364 seconds). Even if the occupant will take the long way out it is demonstrated that the person has adequate time to safely exit the building.

7.4.6 The following table provides times for exiting from typical floors (2$^{nd}$, 3$^{rd}$ and 4$^{th}$):

| Item | Event Time | Running Time |
|---|---|---|
| Fire starts | | 0 |
| Sprinkler system is activated | 2 min 58 sec | 2 min 58 sec |
| Alarm system is activated | 30 sec | 3 min 28 sec |
| Evacuation starts | 0 | 8 min 28 sec |
| Person reaches exit | 3 min 27 sec | 11 min 55 sec |
| Smoke reaches 3 m above floor | 417 min | 6 hours 57 min |

7.4.7 The typical scenario is on the $2^{nd}$, $3^{rd}$ or $4^{th}$ floor due to the relatively low ceiling. If the fire starts at the ground level below the high section of the roof. The calculations demonstrate that it will take 3 minutes 27 seconds to move from the most remote area to the exit and 2 conveyer crossings and 2 conveyer gate crossing. Considering that the evacuation starts 8 minutes and 28 seconds after the fire starts (this includes 5 minutes to take the decision to evacuate), 11 minutes and 55 seconds after the start of fire the person reaches an exit. The calculations also show that the smoke will descend to 3 m above the slab 6 hrs and 57 minutes after the start of the fire. The safety margin to escape from the smoke is calculated at approximately 6 hrs 45 minutes.

7.4.8 The following table provides times for exiting from ground floor:

| **Item** | **Event Time** | **Running Time** |
|---|---|---|
| Fire starts | | 0 |
| Sprinkler system is activated | 3 min 57 sec | 3 min 57 sec |
| Alarm system is activated | 30 sec | 4 min 27 sec |
| Evacuation starts | 0 | 9 min 27 sec |
| Person reaches exit | 3 min 27 sec | 12 min 54 sec |
| Smoke reaches 3 m above floor | 631 min | 10 hours 31 min |

7.4.9 In this scenario there is a very large volume available to collect the smoke. The calculations demonstrate that it will take 3 minutes 27 seconds to move from the most remote area to the exit including 2 conveyer crossings and 2 conveyer gate crossing. Considering that the evacuation starts 9 minutes and 27 seconds after the fire starts (this includes 5 minutes to take the decision to evacuate), 12 minutes and 54 seconds after the start of fire the person reaches an exit. The calculations also show that the smoke will descend to 3 m above the ground level 10 hrs and 31 minutes after the start of the fire.

7.4.10 As the estimated time to exit from the most remote area is less than 4 minutes, the occupants will have an adequate time to exit the building.

7.4.11 We have used time based egress analyses using the same equations as Ontario Building Code. The design objective for the travel routes was to attain 4 min egress time. We have calculated the time that the smoke will descend to 3 m above the travel pass and verified that adequate time is available to safely exit before being affected by the smoke layer.

7.4.12 The Ontario Building Code allows travel distance to exceed 45 m from “shelf and Rack Storage System,” subject to time based egress analyses and the time for egress should not exceed 4 minutes. The time based egress analyses does not take into consideration fire modeling and in a relatively small buildings where the occupants could be affected by the smoke. In our case we have met the 4 minute exit time and calculated the time for the smoke to reach 3 m above the slab without affecting the exiting.

## 8. Smoke layer analyses

8.1 We have used polyurethane (expected to provide to worst case scenario) as the burning material to determine the toxicity levels expected in the smoke layer.

8.2 The worst case scenario results of our calculations are as follows:

| Item | amounts generated (g/g) | amounts | survibility |
|---|---|---|---|
| Soot | 0.133 | | |
| CO2 | 1.55 | 0.9 % | critical 2% |
| CO | 0.01 | 92 ppm | 382 minutes |
| HCl | 0.0015 | 10.68 ppm | critical = 100 ppm |
| HCN | 0.0006 | 5.70 ppm | critical = 180 ppm |

Visibility of reflective signs was calculated at 0.36 m.

Due to the large area, the fire is not expected to be oxygen controlled that explains low toxicity of the smoke layer.

8.3 We understand that after the smoke layer cools down, the smoke will slowly mix with the cool air and affect all sections of the building. The time for this smoke despersement is not expected to affect the exiting. The sprinkler operation time required by NFPA is 60 minutes. Therefore the smoke generation is expected to stop before 60 minutes. Due to the size of the building, the smoke concentration after the cooling would be greatly reduced and is not expected to cause major problem for safety of trained firefighters.

## 9. Design and Construction Requirements

9.1 The design of the sprinkler system must meet the conditions of this report.

9.2 The system must be designed by a professional engineer licensed in Ontario.

9.3 The system must be inspected and certified by a P. Eng. representing our office.

## 10. Conclusion

10.1 This code equivalency report is based on OBC, NRC tests FM Global data sheets, NFPA. The analyses are based on graduate courses – fire dynamics at Carleton University in fire protection. The calculations demonstrate that adequate time is available to exit the building before the occupants are affected by the smoke layer.

## 11. Copyright

# APPENDIX A

# CODE STUDY

# 1. General

## 1.1 Building description

1.1.1 The building will be approximately 58,222 $m^2$ on the ground floor including 3280 $m^2$ of offices. The ground floor will have approximately 25,427 $m^2$ of mezzanines. The building will also have additional 4 levels of robotic sorting platforms each having an area of 45,075 $m^2$. The building is considered 6 storeys high. The ground floor will be approximately 8.53 m (28 ft) high with mezzanine levels located at approximately 4.27 m (14 ft) height. The robotic platforms will be 4.27 m (14 ft) high and the top platform roof will be 4.57 m (15 ft) above the platform. The top floor is located approximately 21.34 m above the ground floor.

1.1.2 The ground floor and mezzanines will be used for packaging shipping and receiving. This area will have numerous conveyers and automated handling systems. 2$^{nd}$, 3$^{rd}$ 4$^{th}$ and 5$^{th}$ floors (robotic platforms) will be used for a sorting area and manual picking sector on the perimeter of the building. The articles are placed in special pods that are 2.616 m (8 ft 7 in) high. The individual items are loaded in the pods. The pods are delivered to the picking stations by robots. The individual items are loaded into the pods or removed from the pods. The items are transported to the ground floor by conveyer systems typically in open plastic totes. The pods stationary and delivery area has restricted access and is not occupied during normal operation.

1.1.3 The mezzanines located above the ground level are considered as a floor in calculating the building height. We may consider this area as shelf and racking system (to be decided) and in this case, these mezzanines will not form an interconnected floor space and will not be calculated as a floor in building height. This will not change any code requirements but will be part of the alternative solution.

1.1.4 The floors fire resistance will be provided using sprinkler system with increased reliability. See alternative solution.

1.1.6 Due to the ASRS, the maximum travel distance of 45 m cannot be respected and a time travel study will be used to assure safe exiting. See alternative solution.

1.1.7 The mechanical equipment:

- Fire pumps room will be located within the building. Each pump room will be separated by 2 hr separation. The building will have two diesel driven fire pumps (one in each section.)
- Some of the ventilation equipment will be located on the roof.
- Battery charging will be in an open areas in the in the robotic sections of the building.

1.1.8 The building will be approximately 28.65 m (94 ft) high.

### 1.2 Used codes

1.2.1 The building is designed to the Ontario Building Code 2012 Division B with the O. Reg. 88/19 amendments, and to Division A for exiting from the warehouse areas, fire resistance of the floors.

1.2.2 A separate alternative solution reports will be prepared for compliance with Division A of OBC.

1.2.2 The building size requires to use Part 3 of the OBC.

### 1.3 Occupant load

1.3.1 The occupant load is to be based on the OBC table 3.1.17.1. See table 1.2.6 of this report.

1.3.2 Where the occupant load based on OBC is not realistic, a real occupant load can be used but a sign indicating the maximum number of occupants must be provided.

1.3.3 The real occupant load is used for the following areas:

| | |
|---|---|
| Ground level | 550 occupants |
| Mezzanine level | 50 occupants |
| Level 2 | 176 occupants |
| Level 3 | 176 occupants |
| Level 4 | 176 occupants |
| Level 5 | 176 occupants |
| Total | 1304 occupants |

The maximum foreseen occupant load for the building due to washroom limitations is 2810 occupants.

## 2. Building Fire Safety

### 2.1 Major occupancies

2.1.1 The building is classified as medium hazard industrial occupancy F2. The office area is classified as Business and Personal services – D. This occupancy is not classified as a major occupancy as the use is subsidiary and normal for F2 operations.

## 2.2 Building area

2.2.1 For determining the building construction requirements the building area is approximately 60,000 $m^2$ (640,000 $ft^2$).

## 2.3 Number of storeys

2.3.1 The building is considered as 5 storeys high. The platforms on the ground floor are not calculated as a storey in building height as this will be considered under "shelf and rack storage system" section of the OBC. The remaining mezzanines aggregate area is expected to be less than 10 % of the floor area and will be used only to service equipment. (Ref OBC 3.2.1.1 (4))

## 2.4 Number of streets

2.4.1 See definition of street in OBC section 1.

2.4.2 The fire fighting equipment will have access from all sides of the building. The access is over 75 % of the perimeter. The building is considered to be accessed from 3 streets. (Reference OBC 3.2.2.10).

## 2.5 Building construction requirements

2.5.1 The building is to be constructed in compliance with article 3.2.2.67 Group F, Division 2, Any Height, Any Area, Sprinklered
Except for the use of heavy timber construction as permitted by Article 3.2.2.16., the *building* shall be of *noncombustible construction*, and

a) the *building* shall be *sprinklered* throughout,
b) floor assemblies shall be *fire separations* with a *fire-resistance rating* not less than 2 h,
c) *mezzanines* shall have a *fire-resistance rating* not less than 1 h, and
d) *loadbearing* walls, columns and arches shall have a *fire-resistance rating* not less than that required for the supported assembly.

## 2.6 Spatial separation and exposure protection

2.6.1 The building has the following limiting distances:

| Wall | Limiting distance | Permitted unprotected opening | Wall construction |
|---|---|---|---|
| North | Over 15m | 100% | No restrictions |
| East | Over 15 m | 100% | No restrictions |
| South | Over 15 m | 100% | No restrictions |
| West | Over 15 m | 100% | No restrictions |

2.6.2 Based on Table 3.2.3.2.1 E if the limiting distance is 15 m or more the exposing wall is permitted to have 100% unprotected openings.

**2.7 Fire alarm system**

2.7.1 The building is required to have a fire alarm system. (Reference OBC 3.2.4.1)

2.7.2 The Fire alarm system is permitted to be single or two stage system. (Reference OBC 3.2.4.3)

2.7.3 A fire alarm annunciator is to be installed near the main entrance. (Reference OBC 3.2.4.9)

2.7.4 Audible signal devices forming part of a fire alarm system shall be installed in a *building* so that *alert signals* and *alarm signals* are clearly audible throughout the *floor area* in which they are installed.

The sound pattern of an *alarm signal* shall conform to the temporal pattern defined in Clause 4.2 of International Standard ISO 8201, “Acoustics – Audible emergency evacuation signal.”

The sound patterns of *alert signals* shall be significantly different from the temporal patterns of *alarm signals*.

The fire *alarm signal* sound pressure level shall be not more than 100 dBA in the office areas.

The sound pressure level from a fire alarm system's audible signal device within a *floor area* shall be not less than 10 dBA above the ambient noise level without being less than 65 dBA.

Fire alarm audible signal devices shall be supplemented by visual signal devices in any *floor area* in which

a) the ambient noise level is more than 87 dBA, or
b) the occupants of the *floor area*
   i) use ear protective devices,
   ii) are located within an audiometric booth, or

iii) are located within sound insulating enclosures.

Audible signal devices shall be installed in a *service space* and shall be connected to the fire alarm system. (OBC 3.2.4.20)

2.7.5 The fire alarm system is to be connected to a Central station Supervision for each of the following (OBC 3.2.4.8 and10):

- Any fire detection
- Any sprinkler water flow
- Any Fire Alarm system trouble
- Any Sprinkler system trouble
- Any closed sprinkler valves
- Any fire pump off / trouble
- Any fire pump running

2.7.6 The voice communication system is not required for this building.

2.7.7 The fire alarm system is to shut down the following upon any fire detection:

All robots
All conveyers and VRCs
All “Big Ass Fans” or similar fans
Any HVAC system that provides supply to more than one fire rated area.
Close fire shutters
Open all maglocks for doors

## 2.8 Fire fighter access routes

2.8.1 Access route for fire trucks is required only for the building face that has the principal entrance. (OBC 3.2.5.4)

2.8.2 The fire route is to be 3 to 15 m from the main entrance (OBC 3.2.5.6). The acceptance of the layout will have to be discussed with the chief building official.

2.8.3 The route is to be located so that a fire truck can be connected to the hydrant and reach the Siamese connection within 45 m. (OBC 3.2.5.16)

2.8.4 The access route is to have:

- Width at least 6 m.
- Turning radius centerline not less than 12 m.
- Overhead clearance not less than 5 m.
- Change in elevation less than 1 in 12.5 over 15 m.
- If longer dead end than 90 m, requires turnaround facility.
- Connection to public thoroughfare.

## 2.9 Water supplies

2.9.1 Adequate water supplies will be provided from municipal water distribution system. An additional water supply will be provided by a water tank. The municipal water supply and tank (each) is to be adequate for sprinkler flow and reserve for hydrants based on NFPA 13 and FM Global standards and an alternative solution for fire resistance rating of the floors.

## 2.10 Standpipe system and hose system (OBC 3.2.9)

2.10.1 The standpipe and hose system (as per NFPA 14) is required by OBC for building over 14 m high. Building height is measured from the lowest average ground level taken from each side of the building. It is expected that standpipe system will be required. An alternative solution may be proposed to eliminate the need for hoses and hose connections within certain sections of the floor area or be modified depending on fire department firefighting procedures.

2.10.2 65 mm hose connections are required.

2.10.3 Hose stations with 30 m of 38 mm diameter hose are required.

2.10.4 Hose stations in the office areas will be in hose cabinets with an extinguisher and a hose.

2.10.5 Depending on the meeting with the city and fire department, an alternative solution may be required. This would modify the standpipe requirements mentioned above.

## 2.11 Sprinkler system (OBC 3.2.5.13)

2.11.1 The building will be fully sprinklered as per FM Global standards and NFPA 13 2013.

2.11.2 Use of combustible sprinkler piping is not permitted for areas that are not considered light hazard. (OBC 3.2.5.14)

## 2.12 Fire department connection (OBC 3.2.5.16)

2.12.1 The fire department connection is to be located within 45 m from the fire hydrant. The connection is to be 300 to 900 mm from ground.

## 2.13 Fire pumps (OBC 3.2.5.19)

2.13.1 The additional pressure for water supplies will be provided by two fire pumps, one taking suction from the municipal water supplies and one taking suction from the tank. The fire pumps will be diesel driven. The fire pumps installation will follow requirements of NFPA 20.

**2.14 Protection from freezing. (OBC 3.2.5.18)**

2.14.1 Any equipment susceptible to must be adequately protected.

**2.15 Lighting (OBC 3.2.7.1)**

2.15.1 Exits and access to exits for public, electrical room and transformer vault shall have average light level at floor of 50 lx.

2.15.2 Elevator machine room shall have average light level at floor of 100 lx.

**2.16 Emergency lighting (OBC 3.2.7.3)**

2.16.1 Exits and access to exits for public, service rooms, main corridors in open area shall have average light level at floor of 10 lx and minimum level of 1 lx.

2.16.2 The power supply for emergency lights is 30 minutes. (OBC 3.2.7.4)

2.16.3 Illuminated signs for direction of exit are also required in mechanical rooms. (OBC 3.3.1.23)

## 3. High buildings

**3.1 Classification of high building (OBC 3.2.6)**

3.1.1 This building is not classified as high building and the OBC requirement for high building do not apply as long as the following condition are met (the floor of the top storey is 21.34 m above ground floor):

Total number of occupants above ground floor = TO
The cumulative width of exit stairs measured in meters = EW

TO / (EW x 1.8) must be less than 300

## 4. Fire separations

**4.1 Interconnected floors and mezzanines**

4.1.1 The building will have an interconnected floor space between 1st and mezzanine (platforms) floor. The interconnected floors space will be sprinklered, and will contain only group D or F2 occupancy. The interconnected floor space does not need any additional protection. (Reference OBC 3.2.8.2 (6)).

## 4.2 Fire resistance

4.2.1 The following is a summary of required fire resistance.

| Location | Required rating | Reference |
|---|---|---|
| | | |
| Floors and supporting columns** | 2 hr** | 3.2.2.67 |
| Mezzanine floors and supporting columns | 1 hr * | 3.2.2.67 |
| Roof and supporting columns | None | |
| Walls mechanical rooms | None | |
| Robotic area office mezz/electrical | See 4.2.2 | |
| Fire Pump room (separation inside the building | 2 hr | NFPA 20 |
| Open robotic area to offices | Not required | |
| Exits (staircase) | 2 hr | 3.4.4.1 |
| Elevators shaft | 1.5 hr | 3.5.3.1 |
| Elevator machine room | 1.5 hr | 3.5.3.3 |
| Between Elevator shaft and elevator mechanical room *** | Not required | 3.5.3.3 |
| Janitor rooms | None required | 3.3.1.20 (3) |
| Room with liquids having flash point less than 93.3 F | 1 hr | 3.6.2.1 |
| Electrical room | 1 hr | 3.6.2.1 |
| Electrical vault | 3 hr<br>2 hrs if sprinklered | 3.6.2.7 |
| Garbage room | 1 hr | 3.6.2.5 |
| Generator room | 1 hr | 3.6.2.8 |
| Vertical service space | 1 hr | 3.6.3.1 |
| Duct shafts | 1 hr | 3.6.3.1 |

* if the mezzanine supporting column supports also other mezzanine or floor that requires higher rating, than this column shall have the higher rating. An alternative solution will be provided for the mezzanines in the process area.

** An alternative solution will be provided for 2 hr fire resistance rating.

*** Fire resistance is required only if the electrical room contains electrical equipment that is required to be in an electrical room by the electrical code.

4.2.2 The MHE Shafts will be treated as openings in the floors as permitted in section 3.6 of OBC for conveyer systems or similar. The shafts will have 2hr fire resistance rating.

4.2.3 As the robotic area and all associated area are under the same management, the building does not have any suites.

4.2.4 As per the tenant specification, any fire shutter will be provided with a fusible link and an electric release activated by the fire alarm panel. The shutter will close if the fusible link is melted or by electric release activated by the fire alarm panel upon any alarm signal.

## 5. Exiting

### 5.1 Access to exits

5.1.1 Roof exit is permitted to be stairway or a fixed ladder. (If a stairway or a ladder is connected to a roof hatch and the roof hatch must be open to provide access to the mechanical equipment the roof, this seems to meet the intent of OBC.) (OBC 3.3.1.3)

5.1.2 If the mechanical rooms (service rooms) are larger than 200 $m^2$ least 2 means of egress is to be provided. (OBC 3.3.1.3)

5.1.3 Maximum travel distance to a door for a mechanical room with only one means of egress is 25 m (inside the mechanical room). (OBC 3.3.1.3)

5.1.4 The headroom clearance for access to exit is 2,100 mm with doors 2,030 mm stairwell landings 2,050 mm and door closures can not reduce height to less than 1,980 mm.

5.1.5 The minimum corridor width for access to exit is 1,100 mm.

5.1.6 Dead end corridor should be avoided. Maximum length is 9 m if serving lees than 30 people, doors to the corridor are self closing and other means of egress is provided for the rooms leading into the corridor.

5.1.7 Egress doors shall swing in the direction of an egress if the door is to serve more than 60 people. (OBC 3.3.1.10)

5.1.8 The width of access to exits (corridor) shall be wider of 1.100 mm or 6.1 mm/person. (OBC 3.3.1.16)

5.1.9 From any area a means of egress (passage) can not be reduced to less than 750 mm.

### 5.2 Exits

5.2.1 To avoid requirements for high buildings the cumulative width of exit stairs must meet the requirements of section 3.1.1 of this report. Upon review and using the actual occupancy load, this condition is met.

5.2.1 At least two exits are required from each storey.

5.2.2 Mezzanines require at least two exits with the exceptions of the following articles.

5.2.3 Mezzanine does not require exits (but requires means of egress) if:

- A mezzanine does not require to terminate at a vertical fire separation and does not have to have special protection required by articles 3.2.8.3 to 3.2.8.11 and is less than 500 m$^2$. (OBC 3.4.2.2(2))
- Occupant load is less than 60, the area of the mezzanine is 300 m$^2$ for offices and 200 m$^2$ for industrial occupancy or less and the travel distance to a stair does not exceed 25 m. (OBC 3.4.2.2(4))

5.2.4 Maximum travel distance to exit is 45. (OBC 3.4.2.5(1)(c)). A perimeter exiting is permitted for a building having exits located at 60 m at the perimeter. (OBC 3.4.2.5 (2)) Aisles must lead directly to an exit. See alternative solution for exiting.

5.2.5 Maximum travel distance from a mechanical room is 50 m. (OBC 3.4.2.4 (3)).

5.2.6 The headroom clearance for access to exit is 2,100 mm with doors 2,030 mm stairwell landings 2,050 mm and door closures can not reduce height to less than 1,980 mm. (OBC 3.3.1.8 → 3.4.3.5)

### 5.3 Guards

5.3.1 Normally the guards are required to limit openings to 200 mm diameter. In our case the building will have limited access only to maintenance staff or escorted visitors. As such, the larger opening do not represent hazard.

## 6. Accessibility

### 6.1 Elevators

6.1.1 Elevator serving the office areas is to have electrical supply protected by 1 hr. fire rating (OBC 3.3.1.7 → 3.2.6.5 (6)) is waived by OBC 3.3.1.7 (3)). Therefore fire resistance for elevators electrical supply is not required.

6.1.2 Elevator shall conform to Appendix E of CSA B44 Safety code for Elevators. (OBC 3.5.2.2)

### 6.2 Handicapped

6.2.1 The elevator must have a vestibule with 45 minute fire rating or lead into a corridor with no occupancy that has a fire separation of 1 hr from other areas is waived as the building is sprinklered. (OBC 3.3.1.7 (3))

### 6.3 Entrance

6.3.1 The number of barrier free entrances from outdoor side walk depends on total number of these entrances as follows (OBC 3.8.1.2):

- 1 to 3 requires 1 barrier free
- 4 to 5 requires 2 barrier free
- More than 5 requires not less than 50%

### 6.4 Accessibility

6.4.1 Any floors accessible by elevators will have barrier free path of travel. (OBC 3.8.2.1)

6.4.2 Illumination in the barrier free path of travel will be at least an average of 50 lx at the floor level. (OBC 3.8.1.6)

6.4.3 Barrier free access is not required for mechanical rooms, janitor rooms, service rooms etc.

### 6.5 Barrier free washrooms

6.5.1 The robotic operation requires mobility and the barrier free access will be provided only for the main office area.

6.5.2 Washrooms will be barrier free unless another barrier free washroom is provided within 45 m. (OBC 3.8.2.3)

## 7. Sanitary – Health requirements

### 7.1 Washrooms

7.1.1 The number of male vs female washrooms is to be equal unless a ratio can be as per the real ratio if the ratio can be determined with reasonable accuracy. (OBC 3.7.4.2)

7.1.2 2/3 of the male WC can be urinals. (OBC 3.7.4.2)

7.1.3 At least 1 lavatory is to be provided for 2 WC (or urinals). (OBC 3.7.4.2)

7.1.4 If wash fountains are provided, 500 mm / WC.

7.1.5 The following table should be used to determine the number of washrooms for F2 or D occupancy.

| Number of persons of each sex | Minimum number of WC and Lavatories for each sex |
|---|---|
| Up to 9 | 1 |
| 10 to 24 | 2 |
| 25 to 49 | 3 |
| 50 to 74 | 4 |
| 75 to 100 | 5 |
| Over 100 | 6 plus 1 / each additional 30 over 100 |

7.1.6 In our case the total occupant load is 1304. If equally divided we have 652 of each sex. Therefore we need 5 for first 100 and 19 additional for total of 24 WC for each sex.

7.1.7 We have 97 WC and this is adequate for an occupancy of 2810 and the actual estimated occupancy is 1304.

### 7.2 Potable water

7.2.1 Potable water is to be provided within 100 m of any working area.

## 8. Safety during Construction

### 8.1 OBC and OFC requirements

8.1.1 OBC and OFC do not include conditions for construction of a new building. The following sections are requirements of the NBC and NFC that we consider should be applied to the construction site as a good construction practice.

### 8.2 Fire Safety Plan

8.2.1 Prior to the commencement of construction, a fire safety plan shall be prepared for the site and shall include

a) the designation and organization of site personnel to carry out fire safety duties, including a fire watch service if applicable,
b) the emergency procedures to be followed in the event of a fire, including
   i) initiating a fire warning,
   ii) notifying the fire department,
   iii) instructing site personnel on the procedures to be followed once the warning has been initiated, and

iv) confining, controlling and extinguishing the fire,

c) measures for controlling fire hazards in and around the building

d) a maintenance procedure for firefighting measures required in Section 5.6.

## 8.3 Access for Firefighting

8.3.1 Unobstructed access to fire hydrants, portable extinguishers and to fire department connections for standpipe and sprinkler systems shall be maintained.

8.3.2 A means shall be provided to allow firefighters to perform their duties on all levels of the building.

8.3.3 Provision shall be made for the use of existing elevators, hoists or lifts to assist firefighting personnel in reaching all levels of the building.

8.3.4 Access routes for fire department vehicles shall be provided and maintained to construction and be made for access by fire department equipment and personnel.

## 8.4 Portable Extinguishers

8.4.1 In addition to the other requirements of the Code, portable extinguishers shall be provided in unobstructed and easily accessible locations in any areas

a) where hot work operations are carried out,
b) where combustibles are stored,
c) near or on any internal combustion engines,
d) where flammable liquids and combustible liquids or gases are stored or handled,
e) where temporary fuel-fired equipment is used, or
f) that are designated for smoking.

8.4.2 The extinguishers shall have a minimum rating of 3-A:20-B:C on moveable equipment and 4-A:40-B:C in all other locations.

## 8.5 Standpipe Systems

8.5.1 The standpipe system is to be installed progressively as the construction is advancing and a permanent or temporary standpipe system shall be provided with conspicuously marked and readily accessible fire department connections on the outside of the building at street level and shall have at least one hose outlet at each floor.

8.5.2 The standpipe system shall, as a minimum, be securely supported and restrained on alternate floors, at least one hose valve for attaching fire department hose shall be provided at each intermediate landing or floor level in the exit stairway.

8.5.3 Valves shall be kept closed at all times and guarded against mechanical damage, the standpipe shall be not more than one floor below the highest forms, staging, and similar combustible elements at all times.

8.5.4 If the standpipe system is temporary, it shall remain in service until the permanent standpipe installation is complete.

**8.6 Hot Surface Applications**

8.6.1 Roofing operations and other surface applications that involve heat sources and hot processes shall be considered hot works and shall conform to the requirements of the OBC.

8.6.2 Bitumen kettles shall not be located on roofs, be provided with adequate metal covers that are close-fitting and constructed of steel having a thickness of not less than No. 14 sheet metal gauge thickness, be under constant supervision when in operation, and be maintained free of excessive residue.

8.6.3 Mops that have been used for spreading bitumen shall be kept outside the building in a safe location when not in use.

**8.7 Ignition Sources**

8.7.1 Devices capable of producing ignition, internal combustion engines, temporary heating equipment and associated devices shall be kept at a safe distance from combustible material so as not to cause ignition.

8.7.2 The clearance between combustible materials and temporary heating equipment, including flues, shall be in conformance with the minimum clearances shown on certified heating equipment.

**8.8 Provision for Egress**

8.8.1 In areas of a building where construction are taking place, at least one exit shall be accessible and usable at all times.

**8.9 Fire Warning**

8.9.1 A means shall be provided to alert site personnel of a fire and such means shall be capable of being heard throughout the building or facility.

# APPENDIX B

# CALCULATION

## EXITING CALCULATIONS | Platform | SMOKE LEVEL 3 m

Exiting normal way

**BUILDING**

| | | | |
|---|---|---|---|
| **Building height** | **Bh** | **8.53** | **m** |
| **Building length** | **Bl** | **284** | **m** |
| **Building width** | **Bw** | **150** | **m** |
| **Height of the base of fire** | **Zo** | **0.5** | **m** |

**HEAT RELEASE CALCULATIONS**

Fire groth $Q = \alpha t^2$

Slow fire a = 0.0066
Medium fire a = 0.02675
Fast fire a = 0.0469
Ultra fast fire a = 0.1876

**Time calculations to reach tempearture to activate sprinklers**

| | | | |
|---|---|---|---|
| **Time 1 (s)** | **210** | | |
| a | 0.02675 | | |
| Q (kW) = | 1179.68 | AS activation | 237 |
| Heat release rate | 30 kw/m2 | Heat release verification for smoke to reach ceiling | |

$$z_{max} = \left[Q_C^{2/3}\left(\frac{14.1}{\Delta T_{min}} - 0.0026\right)\right]^{3/5}$$

**Smoke height calculations**

| | | | |
|---|---|---|---|
| Time | Ts | | |
| Smoke height | Sh | dTmin (deg C)= | 2 |
| | | Qc (kW) = | 1179.68 |
| | | **Zmax (m) =** | **55.14 au dessus du niveau du sol** |

**Ceiling jet temperature calculations**

| | | | |
|---|---|---|---|
| Temperature ambient | T (deg C) | **20** | |
| **Ceiling (sprinkler) height from floor** | **Hr** | **8.2** | Sprinkler height |
| **Ceiling height from base of fire** | **H** | **7.7** | |
| **Horizontal distance from center of fire** | **r** | **1.5** | |

For r < 0.18 H $T_{max} = 16.9\frac{Q^{2/3}}{H^{5/3}} + T_\infty$

For r > 0.18 H $T_{max} = 5.38\frac{Q^{2/3}/H^{5/3}}{(r/H)^{2/3}} + T_\infty$

**Maximum Temperature (deg C)** **79.53** at ceiling (sprinkler) height

**Ceiling jet velocity calcualtions**

for r<0.15 H $u_{max} = 0.96\left(\frac{Q}{H}\right)^{1/3}$

for r > 0.15 H $u_{max} = 0.195\frac{(Q/H)^{1/3}}{(r/H)^{5/6}}$

Maximum jet velocity Umax = 4.08 at celing (sprinkler ) height

**Sprinkler activation calculations**

$$t_r = \frac{RTI}{u^{1/2}} ln\left(\frac{T_g - T_a}{T_g - T_r}\right)$$

| | | | | | |
|---|---|---|---|---|---|
| | | STANDARD | 80 | TO | 100 |
| Sprinkler response factor RTI (98) | 25 | QR STANDARD | 40 | TO | 50 |
| Sprinkler activation temperature (deg C) | 73 | ESFR | 25 | TO | 30 |

| | | |
|---|---|---|
| **Time for sprinklers to open T 2 (s)** | **27** | **time calculated from time 1** |
| **Time for sprinklers to open from start of fire (s)** | **237** | **time calculated T1 +T2** |

**Mass flows calculations**

$$\dot{m} = 0.071Q_c^{1/3}(z - z_0)^{5/3}\left[1 + 0.026Q_c^{2/3}(z - z_0)^{-5/3}\right]$$

| | |
|---|---|
| Qc (kW) = 0.7Q = | 825.77 |
| calculation of effective fire height z = | 3.73 |
| Base of the fire height Zo | 0.50 |
| **Mass flow m (kg/s) =** | **6.24** |

**Volumetric flows calculations**

Volume of smke at sprinkler activation T1+T2 437.4715

Volumetric flows - steady state

$$\dot{V} = \frac{\dot{m}}{\rho_p}$$

$$\rho_p = \rho \frac{T_\infty}{T_p}$$

| | |
|---|---|
| T (deg K) | 293 |
| Tp (deg K) | 353 |
| ρ (gas) (kg/m3) = | 1.203 |
| V (m3/s) | 6.24 |

***Smoke level calculations***

**Elapse time from sprinkler activation (s)**
**Tas (s)** ***8550*** **Time from start of fire (s)** **8760**

$$H_s = H_b - (V_s T_s + V_{totalAS})/(B_L B_W)$$

**Bottom elevation of smoke layer Hs (m) =** **7.27** smoke height 4.27 m + 3 m = 7.27 m

**Smoke layer contents calculations**

| USED POLYURETHANE AS DATA | | weight | moles | survibility | ppm | | |
|---|---|---|---|---|---|---|---|
| Soot concentration (g/g) | 0.133 | | | | | | |
| CO2 concentration (g/g) | 1.55 | 889868.18 | 20224.28 | | 9029.59 | 0.90 | % crtical at 2% |
| CO concentration (g/g) | 0.01 | 5741.09 | 205.04 | | 91.54 | 382.33 | time(min) |
| HCl concentration (g/g) | 0.0015 | 861.16 | 23.92 | | 10.68 | critical = 100 | |
| HCN concentration (g/g) | 0.0006 | 344.47 | 12.76 | | 5.70 | critical = 180 | |

| | | |
|---|---|---|
| Heat release Hch (kj/g) | 18 | |
| Volume (m3) | 53777 | |
| Moles of air | 2239777 | |
| Mass consumption (g/s) | 66 | |
| Total mass | 574109 | |
| soot concentration g/m3 Cs | 1.397 | is mass consumed / volume |
| Visibility | | |
| Km | 6.0 | |
| K=Km soot | 8.383 | |
| **Visibility of reflective signs** | **0.36** | 3 / (Km x Cs) |

**PLATEFORM**
**EXITING**

**Exiting times based on Ontario Building Code**

$$T_{egress} = \left(H_p + {}^{V_p}/_{0.6} + {}^{H_m}/_{1.3} + 10N_{lg} + 5N_k\right)1.5$$

| | |
|---|---|
| Horizontal Travel Distance Rack Hp (m) | 75 |
| vertical travel distance rack Vp (m) | 12 |
| Horizontal Travel Distance floor Hm (m) | 29.0 |
| Number of gates - Rack Nig | 2 |
| number of crossing - stairs rack Nk | 2 |

| | unit | total |
|---|---|---|
| **time to get to the stairs (s)** | **113** | **113** |
| **time to cross obstuctions** | **45** | **158** |
| **time to get to ground level (s)** | **30** | **188** |
| **time to exit ground level (s)** | **33** | **221** |

| EXITING CALCULATIONS | Platform | SMOKE LEVEL 3 m | |
|---|---|---|---|
| | Exiting long way | | |
| **BUILDING** | | | |
| **Building height** | **Bh** | **8.53** | **m** |
| **Building length** | **Bl** | **284** | **m** |
| **Building width** | **Bw** | **150** | **m** |
| **Height of the base of fire** | **Zo** | **0.5** | **m** |

**HEAT RELEASE CALCULATIONS**

Fire groth $Q = \alpha t^2$

Slow fire a = 0.0066
Medium fire a = 0.02675
Fast fire a = 0.0469
Ultra fast fire a = 0.1876

**Time calculations to reach tempearture to activate sprinklers**

| | | | |
|---|---|---|---|
| **Time 1 (s)** | **210** | | |
| a | 0.02675 | | |
| Q (kW) = | 1179.68 | AS activation | 237 |
| Heat release rate | 30 kw/m2 | Heat release verification for smoke to reach ceiling | |

$$z_{max} = \left[Q_C^{2/3}\left(\frac{14.1}{\Delta T_{min}} - 0.0026\right)\right]^{3/5}$$

**Smoke height calculations**

| | | |
|---|---|---|
| Time | Ts | |
| Smoke height | Sh | |

| | | |
|---|---|---|
| dTmin (deg C)= | 2 | |
| Qc (kW) = | 1179.68 | |
| **Zmax (m) =** | **55.14** | **au dessus du niveau du sol** |

**Ceiling jet temperature calculations**

| | | | |
|---|---|---|---|
| Temperature ambient | T (deg C) | **20** | |
| **Ceiling (sprinkler) height from floor** | **Hr** | **8.2** | Sprinkler height |
| **Ceiling height from base of fire** | **H** | **7.7** | |
| **Horizontal distance from center of fire** | **r** | **1.5** | |

For r < 0.18 H $T_{max} = 16.9\frac{Q^{2/3}}{H^{5/3}} + T_\infty$

For r > 0.18 H $T_{max} = 5.38\frac{Q^{2/3}/H^{5/3}}{(r/H)^{2/3}} + T_\infty$

**Maximum Temperature (deg C)** **79.53** at ceiling (sprinkler) height

**Ceiling jet velocity calcualtions**

for r<0.15 H $u_{max} = 0.96\left(\frac{Q}{H}\right)^{1/3}$

for r > 0.15 H $u_{max} = 0.195\frac{(Q/H)^{1/3}}{(r/H)^{5/6}}$

Maximum jet velocity Umax = 4.08 at celing (sprinkler ) height

**Sprinkler activation calculations**

$$t_r = \frac{RTI}{u^{1/2}} ln\left(\frac{T_g - T_a}{T_g - T_r}\right)$$

| | | | | | |
|---|---|---|---|---|---|
| | | STANDARD | 80 | TO | 100 |
| Sprinkler response factor RTI (98) | 25 | QR STANDARD | 40 | TO | 50 |
| Sprinkler activation temperature (deg C) | 73 | ESFR | 25 | TO | 30 |

| | | |
|---|---|---|
| **Time for sprinklers to open T 2 (s)** | **27** | **time calculated from time 1** |
| **Time for sprinklers to open from start of fire (s)** | **237** | **time calculated T1 +T2** |

**Mass flows calculations**

$$\dot{m} = 0.071 Q_c^{1/3}(z - z_0)^{5/3}\left[1 + 0.026 Q_c^{2/3}(z - z_0)^{-5/3}\right]$$

| | |
|---|---|
| Qc (kW) = 0.7Q = | 825.77 |
| calculation of effective fire height z = | 3.73 |
| Base of the fire height Zo | 0.50 |
| **Mass flow m (kg/s) =** | **6.24** |

**Volumetric flows calculations**

Volume of smke at sprinkler activation T1+T2 437.4715

Volumetric flows - steady state

$$\dot{V} = \frac{\dot{m}}{\rho_p}$$

$$\rho_p = \rho \frac{T_\infty}{T_p}$$

| | |
|---|---|
| T (deg K) | 293 |
| Tp (deg K) | 353 |
| ρ (gas) (kg/m3) = | 1.203 |
| V (m3/s) | 6.24 |

***Smoke level calculations***

**Elapse time from sprinkler activation (s)**
**Tas (s)** ***8550*** **Time from start of fire (s)** **8760**

$$H_s = H_b - (V_sT_s + V_{totalAS})/(B_LB_W)$$

**Bottom elevation of smoke layer Hs (m) =** **7.27** smoke height 4.27 m + 3 m = 7.27 m

**Smoke layer contents calculations**

| USED POLYURETHANE AS DATA | | weight | moles | survibility | ppm | | |
|---|---|---|---|---|---|---|---|
| Soot concentration (g/g) | 0.133 | | | | | | |
| CO2 concentration (g/g) | 1.55 | 889868.18 | 20224.28 | | 9029.59 | 0.90 | % crtical at 2% |
| CO concentration (g/g) | 0.01 | 5741.09 | 205.04 | | 91.54 | 382.33 | time(min) |
| HCl concentration (g/g) | 0.0015 | 861.16 | 23.92 | | 10.68 | critical = 100 | |
| HCN concentration (g/g) | 0.0006 | 344.47 | 12.76 | | 5.70 | critical = 180 | |

| | | |
|---|---|---|
| Heat release Hch (kj/g) | 18 | |
| Volume (m3) | 53777 | |
| Moles of air | 2239777 | |
| Mass consumption (g/s) | 66 | |
| Total mass | 574109 | |
| soot concentration g/m3 Cs | 1.397 | is mass consumed / volume |
| Visibility | | |
| Km | 6.0 | |
| K=Km soot | 8.383 | |
| **Visibility of reflective signs** | **0.36** | 3 / (Km x Cs) |

**PLATEFORM**
**EXITING**

**Exiting times based on Ontario Building Code**

$$T_{egress} = \left(H_p + {}^{V_p}/_{0.6} + {}^{H_m}/_{1.3} + 10N_{lg} + 5N_k\right)1.5$$

| | |
|---|---|
| Horizontal Travel Distance Rack Hp (m) | 66 |
| vertical travel distance rack Vp (m) | 12 |
| Horizontal Travel Distance floor Hm (m) | 165.0 |
| Number of gates - Rack Nig | 2 |
| number of crossing - stairs rack Nk | 2 |

| | unit | total |
|---|---|---|
| **time to get to the stairs (s)** | **99** | **99** |
| **time to cross obstuctions** | **45** | **144** |
| **time to get to ground level (s)** | **30** | **174** |
| **time to exit ground level (s)** | **190** | **364** |

## EXITING CALCULATIONS MAIN FLOOR SMOKE LEVEL 3 m

**BUILDING**

| | | | |
|---|---|---|---|
| **Building height** | **Bh** | **8.53** | **m** |
| **Building length** | **Bl** | **284** | **m** |
| **Building width** | **Bw** | **150** | **m** |
| **Height of the base of fire** | **Zo** | **0.5** | **m** |

**HEAT RELEASE CALCULATIONS**

Fire groth $Q = \alpha t^2$

Slow fire a = 0.0066
Medium fire a = 0.02675
Fast fire a = 0.0469
Ultra fast fire a = 0.1876

**Time calculations to reach tempearture to activate sprinklers**

| | | | |
|---|---|---|---|
| **Time 1 (s)** | **210** | | |
| a | 0.02675 | | |
| Q (kW) = | 1179.68 | AS activation | 237 |
| Heat release rate | 30 kw/m2 | Heat release verification for smoke to reach ceiling | |

$$z_{max} = \left[Q_C^{2/3}\left(\frac{14.1}{\Delta T_{min}} - 0.0026\right)\right]^{3/5}$$

**Smoke height calculations**

| | | | |
|---|---|---|---|
| Time | Ts | dTmin (deg C)= | 2 |
| Smoke height | Sh | Qc (kW) = | 1179.68 |

**Zmax (m) = 55.14 au dessus du niveau du sol**

**Ceiling jet temperature calculations**

| | | | |
|---|---|---|---|
| Temperature ambient | T (deg C) | 20 | |
| **Ceiling (sprinkler) height from floor** | **Hr** | **8.2** | Sprinkler height |
| **Ceiling height from base of fire** | **H** | **7.7** | |
| **Horizontal distance from center of fire** | **r** | **1.5** | |

For r < 0.18 H $$T_{max} = 16.9\frac{Q^{2/3}}{H^{5/3}} + T_\infty$$

For r > 0.18 H $$T_{max} = 5.38\frac{Q^{2/3}/H^{5/3}}{\left(r/H\right)^{2/3}} + T_\infty$$

**Maximum Temperature (deg C)** **79.53** at ceiling (sprinkler) height

**Ceiling jet velocity calcualtions**

for r<0.15 H $$u_{max} = 0.96\left(\frac{Q}{H}\right)^{1/3}$$

for r > 0.15 H $$u_{max} = 0.195\frac{\left(Q/H\right)^{1/3}}{\left(r/H\right)^{5/6}}$$

Maximum jet velocity Umax = 4.08 at celing (sprinkler ) height

**Sprinkler activation calculations**

$$t_r = \frac{RTI}{u^{1/2}} ln\left(\frac{T_g - T_a}{T_g - T_r}\right)$$

| | | | | | |
|---|---|---|---|---|---|
| | | STANDARD | 80 | TO | 100 |
| Sprinkler response factor RTI (98) | 25 | QR STANDARD | 40 | TO | 50 |
| Sprinkler activation temperature (deg C) | 73 | ESFR | 25 | TO | 30 |

| | | |
|---|---|---|
| **Time for sprinklers to open T 2 (s)** | **27** | **time calculated from time 1** |
| **Time for sprinklers to open from start of fire (s)** | **237** | **time calculated T1 +T2** |

**Mass flows calculations**

$$\dot{m} = 0.071 Q_c^{1/3}(z - z_0)^{5/3}\left[1 + 0.026 Q_c^{2/3}(z - z_0)^{-5/3}\right]$$

| | |
|---|---|
| Qc (kW) = 0.7Q = | 825.77 |
| calculation of effective fire height z = | 3.73 |
| Base of the fire height Zo | 0.50 |
| **Mass flow m (kg/s) =** | **6.24** |

**Volumetric flows calculations**

Volume of smke at sprinkler activation T1+T2 437.4715

Volumetric flows - steady state

$$\dot{V} = \frac{\dot{m}}{\rho_p}$$

$$\rho_p = \rho \frac{T_\infty}{T_p}$$

| | |
|---|---|
| T (deg K) | 293 |
| Tp (deg K) | 353 |
| ρ (gas) (kg/m3) = | 1.203 |
| V (m3/s) | 6.24 |

***Smoke level calculations***

**Elapse time from sprinkler activation (s)**
**Tas (s)** ***37700*** **Time from start of fire (s)** **37910**

$$H_s = H_b - (V_s T_s + V_{totalAS})/(B_L B_W)$$

**Bottom elevation of smoke layer Hs (m) = 3.00** smoke height 0 m + 3 m = 3 m

**Smoke layer contents calculations**

| USED POLYURETHANE AS DATA | | weight | moles | survibility | ppm | | |
|---|---|---|---|---|---|---|---|
| Soot concentration (g/g) | 0.133 | | | | | | |
| CO2 concentration (g/g) | 1.55 | 3851016.27 | 87523.10 | | 8918.32 | 0.89 | % crtical at 2% |
| CO concentration (g/g) | 0.01 | 24845.27 | 887.33 | | 90.42 | 387.10 | time(min) |
| HCl concentration (g/g) | 0.0015 | 3726.79 | 103.52 | | 10.55 | critical = 100 | |
| HCN concentration (g/g) | 0.0006 | 1490.72 | 55.21 | | 5.63 | critical = 180 | |

| | | |
|---|---|---|
| Heat release Hch (kj/g) | 18 | |
| Volume (m3) | 235632 | |
| Moles of air | 9813857 | |
| Mass consumption (g/s) | 66 | |
| Total mass | 2484527 | |
| soot concentration g/m3 Cs | 1.397 | is mass consumed / volume |
| Visibility | | |
| Km | 6.0 | |
| K=Km soot | 8.383 | |
| **Visibility of reflective signs** | **0.36** | 3 / (Km x Cs) |

**PLATEFORM**
**EXITING**

**Exiting times based on Ontario Building Code**

$$T_{egress} = \left(H_p + {}^{V_p}/_{0.6} + {}^{H_m}/_{1.3} + 10N_{lg} + 5N_k\right)1.5$$

| | |
|---|---|
| Horizontal Travel Distance Rack Hp (m) | 0 |
| vertical travel distance rack Vp (m) | 0 |
| Horizontal Travel Distance floor Hm (m) | 140.0 |
| Number of gates - Rack Nig | 2 |
| number of crossing - stairs rack Nk | 2 |

| | unit | total |
|---|---|---|
| **time to get to the stairs (s)** | **0** | **0** |
| **time to cross obstuctions** | **45** | **45** |
| **time to get to ground level (s)** | **0** | **45** |
| **time to exit ground level (s)** | **162** | **207** |

## EXITING CALCULATIONS — 4th LEVEL — SMOKE LEVEL 3 m

**BUILDING**

| | | | |
|---|---|---|---|
| **Building height** | **Bh** | **4.27** | **m** |
| **Building length** | **Bl** | **284** | **m** |
| **Building width** | **Bw** | **150** | **m** |
| **Height of the base of fire** | **Zo** | **0.5** | **m** |

**HEAT RELEASE CALCULATIONS**

Fire groth $Q = \alpha t^2$

Slow fire a = 0.0066
Medium fire a = 0.02675
Fast fire a = 0.0469
Ultra fast fire a = 0.1876

**Time calculations to reach tempearture to activate sprinklers**

| | | | |
|---|---|---|---|
| **Time 1 (s)** | **120** | | |
| a | 0.02675 | | |
| Q (kW) = | 385.20 | AS activation | 155 |
| Heat release rate | 30 kw/m2 | Heat release verification for smoke to reach ceiling | |

$$z_{max} = \left[Q_C^{2/3}\left(\frac{14.1}{\Delta T_{min}} - 0.0026\right)\right]^{3/5}$$

**Smoke height calculations**

Time Ts
Smoke height Sh

dTmin (deg C)= 2
Qc (kW) = 385.20

**Zmax (m) = 35.42 au dessus du niveau du sol**

**Ceiling jet temperature calculations**

| | | | |
|---|---|---|---|
| Temperature ambient | T (deg C) | **20** | |
| **Ceiling (sprinkler) height from floor** | **Hr** | **4** | Sprinkler height |
| **Ceiling height from base of fire** | **H** | **3.5** | |
| **Horizontal distance from center of fire** | **r** | **1.5** | |

For r < 0.18 H $$T_{max} = 16.9\frac{Q^{2/3}}{H^{5/3}} + T_\infty$$

For r > 0.18 H $$T_{max} = 5.38\frac{Q^{2/3}/H^{5/3}}{(r/H)^{2/3}} + T_\infty$$

**Maximum Temperature (deg C) 82.10** at ceiling (sprinkler) height

**Ceiling jet velocity calcualtions**

for r<0.15 H $$u_{max} = 0.96\left(\frac{Q}{H}\right)^{1/3}$$

for r > 0.15 H $$u_{max} = 0.195\frac{(Q/H)^{1/3}}{(r/H)^{5/6}}$$

Maximum jet velocity Umax = 1.89 at celing (sprinkler ) height

**Sprinkler activation calculations**

$$t_r = \frac{RTI}{u^{1/2}} ln\left(\frac{T_g - T_a}{T_g - T_r}\right)$$

| | | | | |
|---|---|---|---|---|
| | | STANDARD | 80 TO | 100 |
| Sprinkler response factor RTI (98) | 25 | QR STANDARD | 40 TO | 50 |
| Sprinkler activation temperature (deg C) | 73 | ESFR | 25 TO | 30 |

| | | |
|---|---|---|
| **Time for sprinklers to open T 2 (s)** | **35** | **time calculated from time 1** |
| **Time for sprinklers to open from start of fire (s)** | **155** | **time calculated T1 +T2** |

**Mass flows calculations**

$$\dot{m} = 0.071 Q_c^{1/3}(z - z_0)^{5/3}\left[1 + 0.026 Q_c^{2/3}(z - z_0)^{-5/3}\right]$$

| | |
|---|---|
| Qc (kW) = 0.7Q = | 269.64 |
| calculation of effective fire height z = | 2.65 |
| Base of the fire height Zo | 0.50 |
| **Mass flow m (kg/s) =** | **2.15** |

**Volumetric flows calculations**

Volume of smke at sprinkler activation T1+T2 110.1716

Volumetric flows - steady state

$$\dot{V} = \frac{\dot{m}}{\rho_p}$$

$$\rho_p = \rho \frac{T_\infty}{T_p}$$

| | |
|---|---|
| T (deg K) | 293 |
| Tp (deg K) | 355 |
| ρ (gas) (kg/m3) = | 1.203 |
| V (m3/s) | 2.16 |

***Smoke level calculations***

**Elapse time from sprinkler activation (s)**
**Tas (s)** ***24900*** **Time from start of fire (s)** **25020**

$$H_s = H_b - (V_s T_s + V_{totalAS})/(B_L B_W)$$

**Bottom elevation of smoke layer Hs (m) =** **3.00** smoke height 0 m + 3 m = 3 m

**Smoke layer contents calculations**

| USED POLYURETHANE AS DATA | | weight | moles | survibility | ppm | | |
|---|---|---|---|---|---|---|---|
| Soot concentration (g/g) | 0.133 | | | | | | |
| CO2 concentration (g/g) | 1.55 | 829913.40 | 18861.67 | | 8394.44 | 0.84 | % crtical at 2% |
| CO concentration (g/g) | 0.01 | 5354.28 | 191.22 | | 85.10 | 411.26 | time(min) |
| HCl concentration (g/g) | 0.0015 | 803.14 | 22.31 | | 9.93 | critical = 100 | |
| HCN concentration (g/g) | 0.0006 | 321.26 | 11.90 | | 5.30 | critical = 180 | |

| | | |
|---|---|---|
| Heat release Hch (kj/g) | 18 | |
| Volume (m3) | 53949 | |
| Moles of air | 2246923 | |
| Mass consumption (g/s) | 21 | |
| Total mass | 535428 | |
| soot concentration g/m3 Cs | 1.316 | is mass consumed / volume |

Visibility

| | |
|---|---|
| Km | 6.0 |
| K=Km soot | 7.898 |

**Visibility of reflective signs** **0.38** 3 / (Km x Cs)

**PLATEFORM**
**EXITING**

**Exiting times based on Ontario Building Code**

$$T_{egress} = \left(H_p + {}^{V_p}/_{0.6} + {}^{H_m}/_{1.3} + 10N_{lg} + 5N_k\right)1.5$$

| | |
|---|---|
| Horizontal Travel Distance Rack Hp (m) | 0 |
| vertical travel distance rack Vp (m) | 0 |
| Horizontal Travel Distance floor Hm (m) | 140.0 |
| Number of gates - Rack Nig | 2 |
| number of crossing - stairs rack Nk | 2 |

| | unit | total |
|---|---|---|
| **time to get to the stairs (s)** | **0** | **0** |
| **time to cross obstuctions** | **45** | **45** |
| **time to get to ground level (s)** | **0** | **45** |
| **time to exit ground level (s)** | **162** | **207** |

# APPENDIX C

# PLANS

HYDROSTATIC TESTING:

1) ALL PIPING SHALL BE HYDROSTATICALLY TESTED AT 225 PSI FOR 2 HOURS.

2) THE PERMITTED AMOUNT OF UNDERGROUND PIPING LEAKAGE SHALL BE AS FOLLOWS:

   a. THE AMOUNT OF LEAKAGE AT THE JOINTS SHALL NOT EXCEED 2 QT/HR PER 100 GASKETS OR JOINTS, IRRESPECTIVE OF PIPE DIAMETER.
   b. THE AMOUNT OF LEAKAGE IN BURIED PIPING SHALL BE MEASURED AT THE SPECIFIED TEST PRESSURE BY PUMPING FROM A CALIBRATED CONTAINER.

3) THE HYDROSTATIC TESTING SHALL BE CARRIED OUT PROGRESSIVELY **BEFORE THE JOINTS ARE BURIED**. BACKFILLING SHALL BE DONE SO AS TO LEAVE THE JOINTS FOR THE PORTION OF PIPING BEING TESTED, EXPOSED.

FLUSHING:

THE ENTIRE PIPING NETWORK INCLUDING ISOLATED SEGMENTS AND PORTIONS FEEDING HYDRANTS MUST BE TEST FLUSHED AT THE SPECIFIED RATE AS REQUIRED BY NFPA 24 AND NFPA 20 CHAPTER 14.
( SEE DETAIL #X ON FPU2 )

NOTES:

1) COORDINATE THE EXACT LOCATION OF THE UNDERGROUND PIPING ON SITE.

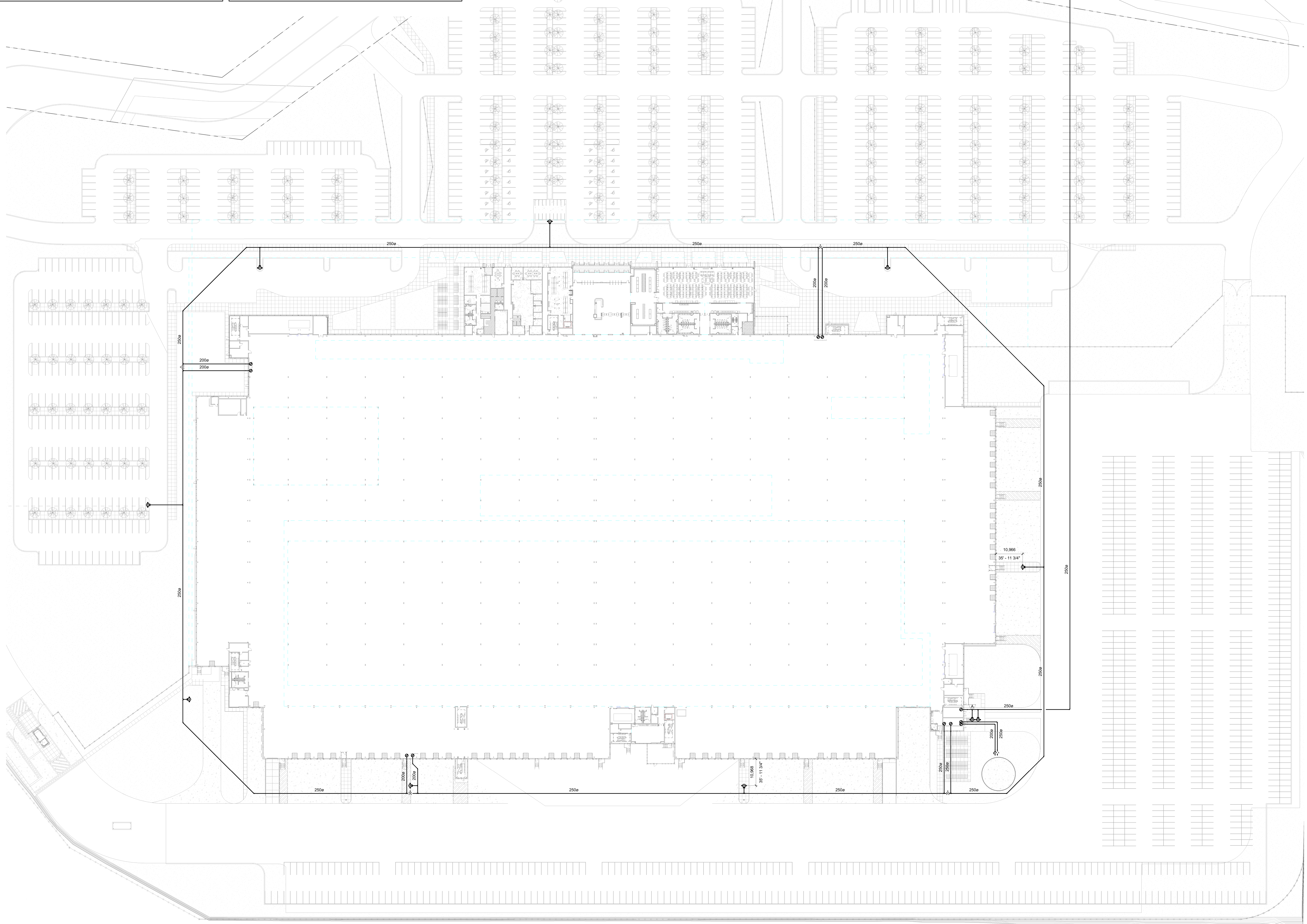
2) UNLESS NOTED OTHERWISE, ALL FITTINGS ARE TO BE DUCTILE IRON WITH MECHANICAL JOINTS.

3) CORROSION RESISTANCE: AFTER INSTALLATION, RODS, NUTS, BOLTS, WASHERS, CLAMPS, AND OTHER RESTRAINING DEVICES SHALL BE CLEANED AND THOROUGHLY COATED WITH A BITUMINOUS OR OTHER ACCEPTABLE CORROSION-RETARDING MATERIAL.

4) THE CONTRACTOR SHALL INSTALL RIGID PVC PIPING WITH CSA UL APPROVED PVC FITTINGS FOR UNDERGROUND CONDUIT FOR THE P.I.V.'S WIRING. ALL THE ELBOWS ARE TO BE LONG RADIUS. THE CONTRACTOR SHALL INSTALL EXPANSION JOINTS AS REQUESTED BY MANUFACTURER. CONTRACTOR IS TO INSTALL PULL CORD IN EACH CONDUIT AND CONNECT THE P.I.V.'S TO THE BUILDING. THE CONDUIT SHALL RAISE A MINIMUM OF 3 FT ABOVE THE GROUND OR THE FINISHED FLOOR. INSTALL CAPS AT THE END OF PIPES TO PREVENT FOR ANY FRAGMENT TO ENTER. PROVIDE PULL BOX AS REQUIRED BY CODE AND STANDARDS.

5) ADJUST DEPTH OF MAINS TO ACCOMMODATE CHANGES OF GRADE LEVELS TO PROVIDE ADEQUATE COVER TO PREVENT FREEZING. SEE CIVIL ENGINEER DRAWINGS FOR DETAILS, TRENCHING, COMPACTION AND FILL.

6) FIRE HYDRANTS ARE TO BE INSTALLED A MINIMUM OF 5 FT FROM ANY SIDEWALKS.




1 UNDERGROUND OVERALL
1 : 500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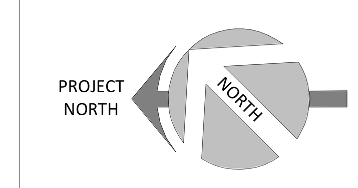
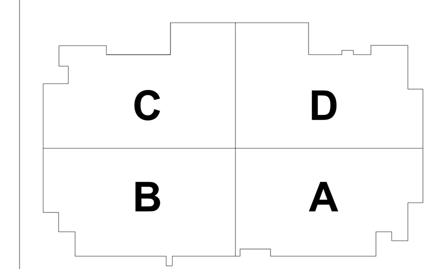
Suite 200 - St-Laurent
(Québec) H4R 1V4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| 1 | 2020-03-18 | ISSUED FOR OVERALL 33% REVIEW | MAL |

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PYTHON



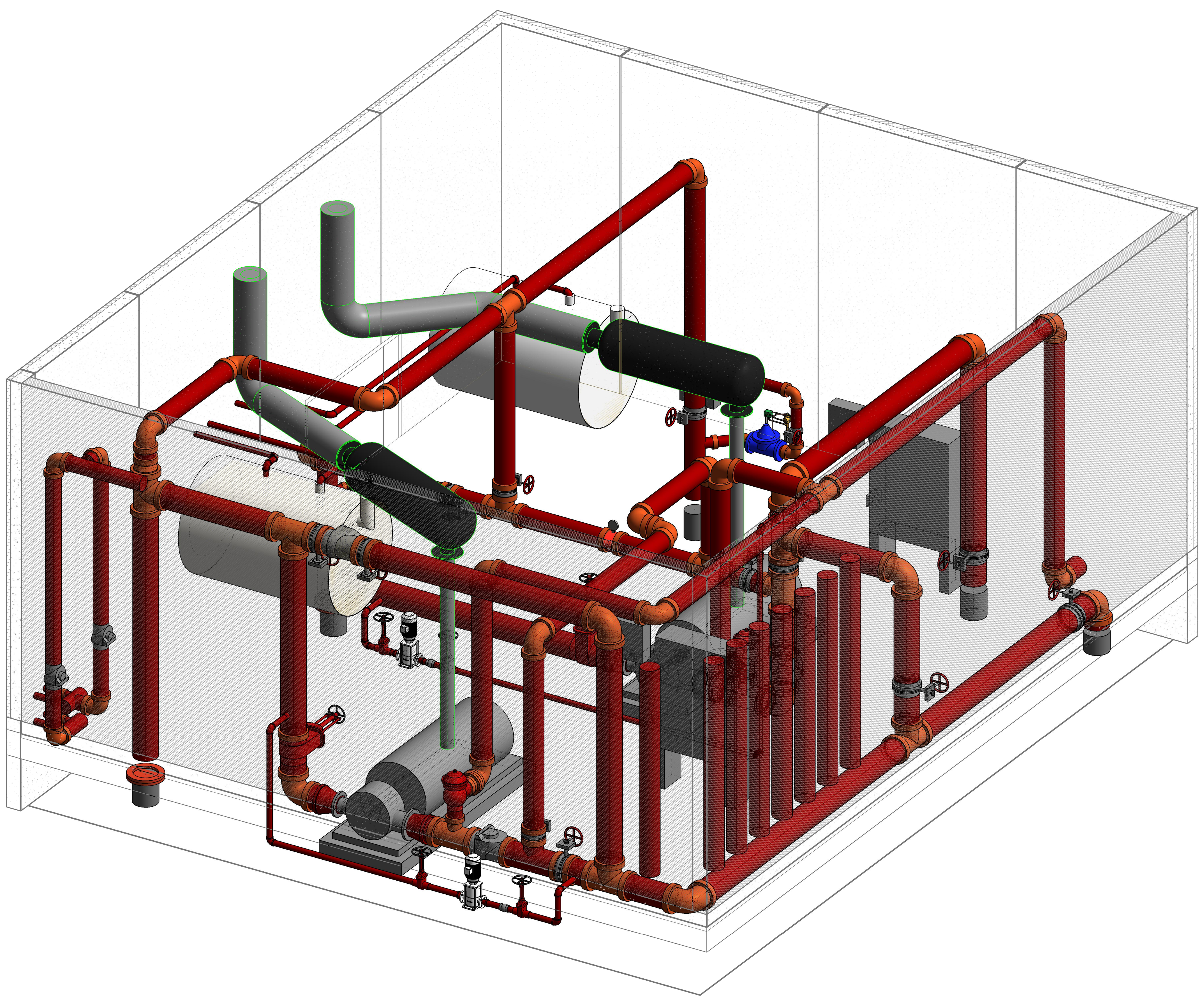
FIRE PROTECTION

UNDERGROUND - OVERALL

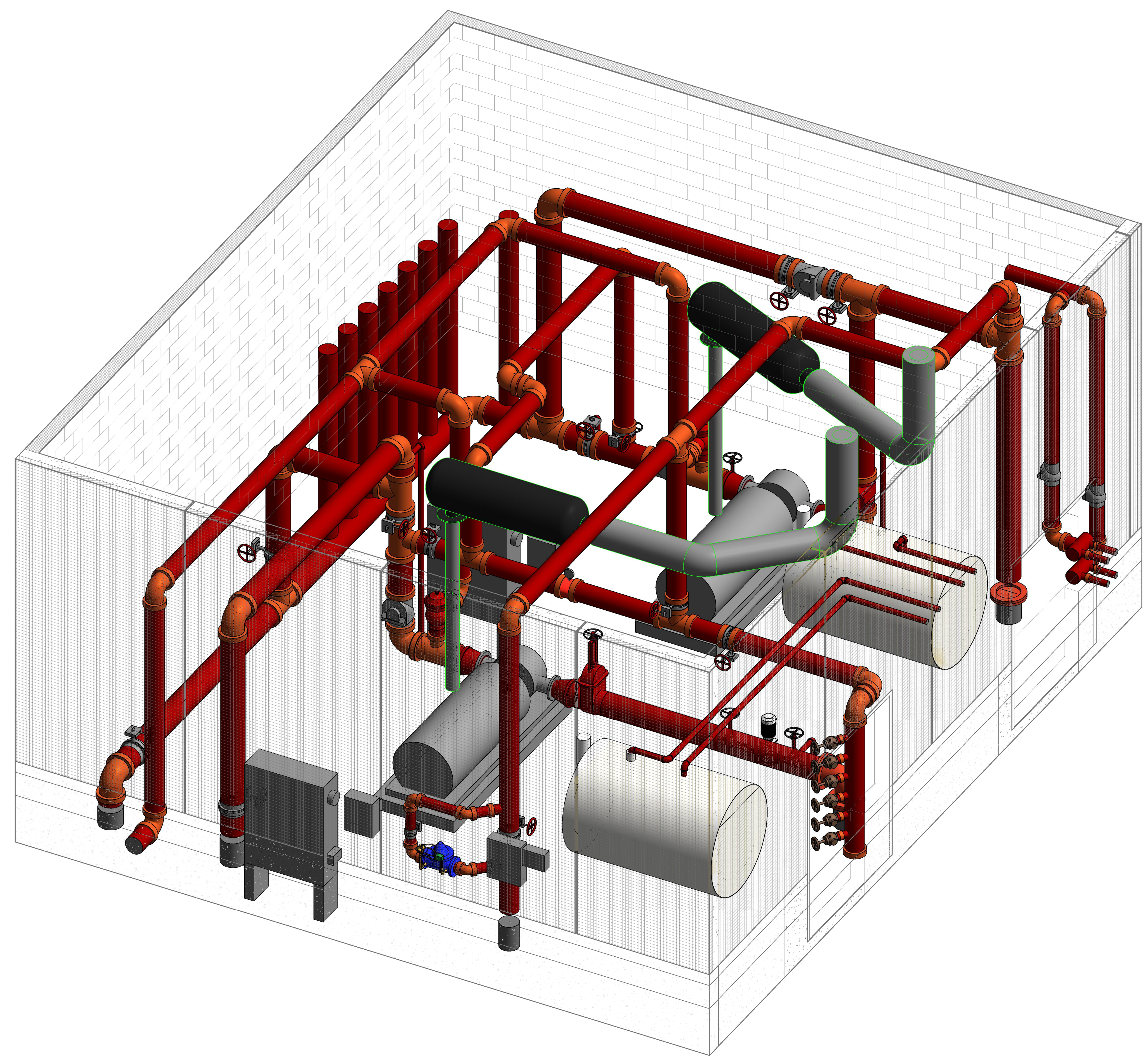
DRAWN BY: M.A.L. CHECKED BY: P.L.

SCALE: As indicated

FOLIO: 2002-04A **FPU1** R1



2 PUMP ROOMS 3D (2)



1 PUMP ROOMS 3D


GKC ARCHITECTS
100 - 7275 ST-URBAIN MONTRÉAL QC H2R 2Y5 **T:**514.737.6255 WWW.GKC.CA

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| C | D |
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PYTHON



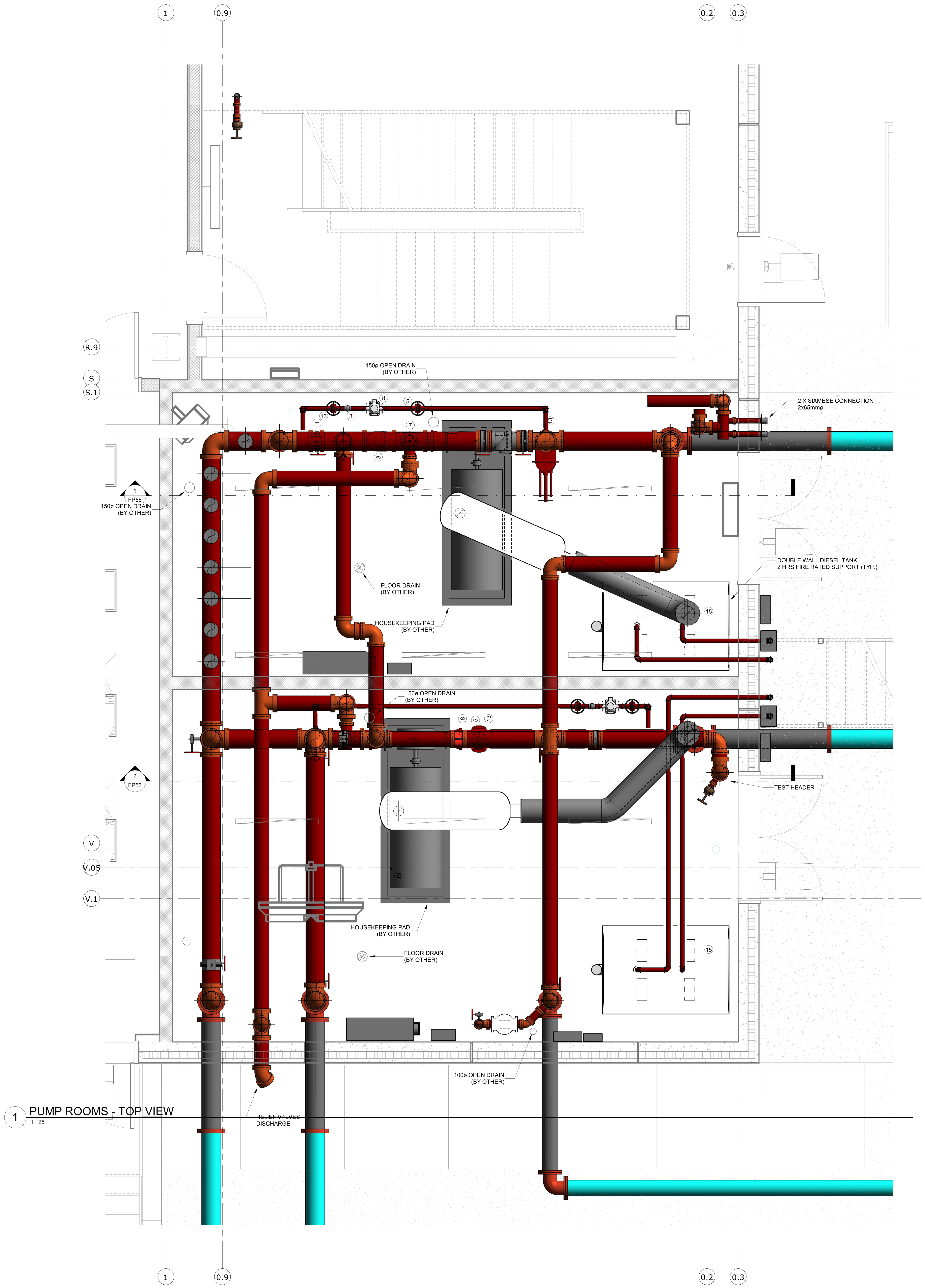
FIRE PROTECTION

PUMP ROOMS - 3D

DRAWN BY: M.A.L. CHECKED BY: P.L.

SCALE:

FOLIO: 2002-04A **FP54**

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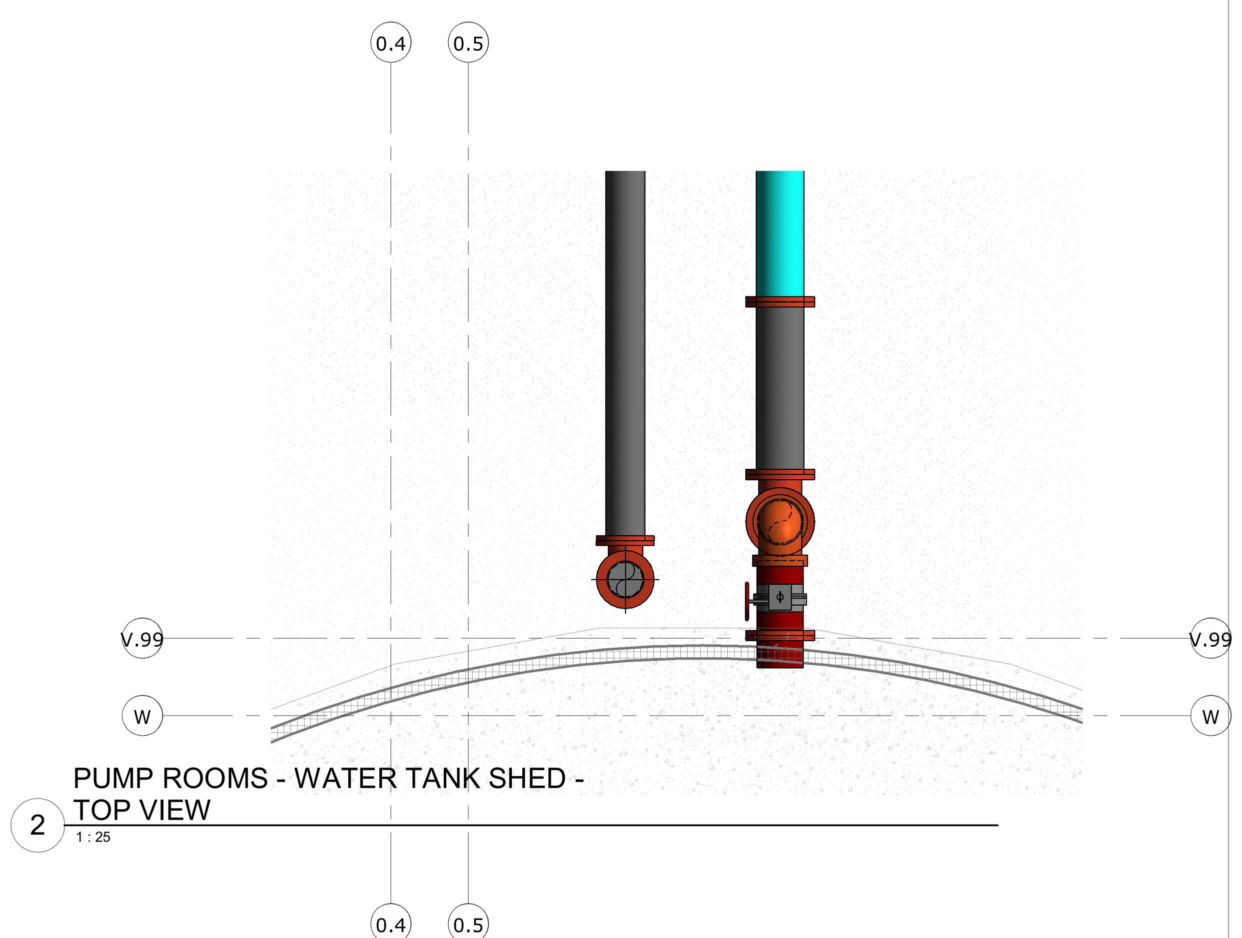
1 : 25



2 PUMP ROOMS - WATER TANK SHED - TOP VIEW
1 : 25

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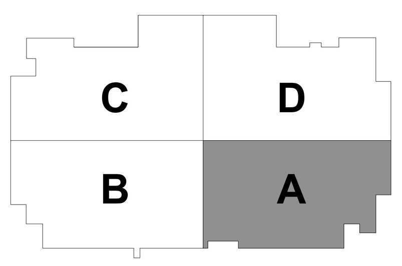


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| 1 | 2020-03-18 | ISSUED FOR OVERALL 33% REVIEW | MAL |

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PYTHON



FIRE PROTECTION

PUMP ROOMS - TOP VIEW

DRAWN BY: M.A.L.  CHECKED BY: P.L.

SCALE: 1 : 25

FOLIO: 2002-04A  **FP55** R1

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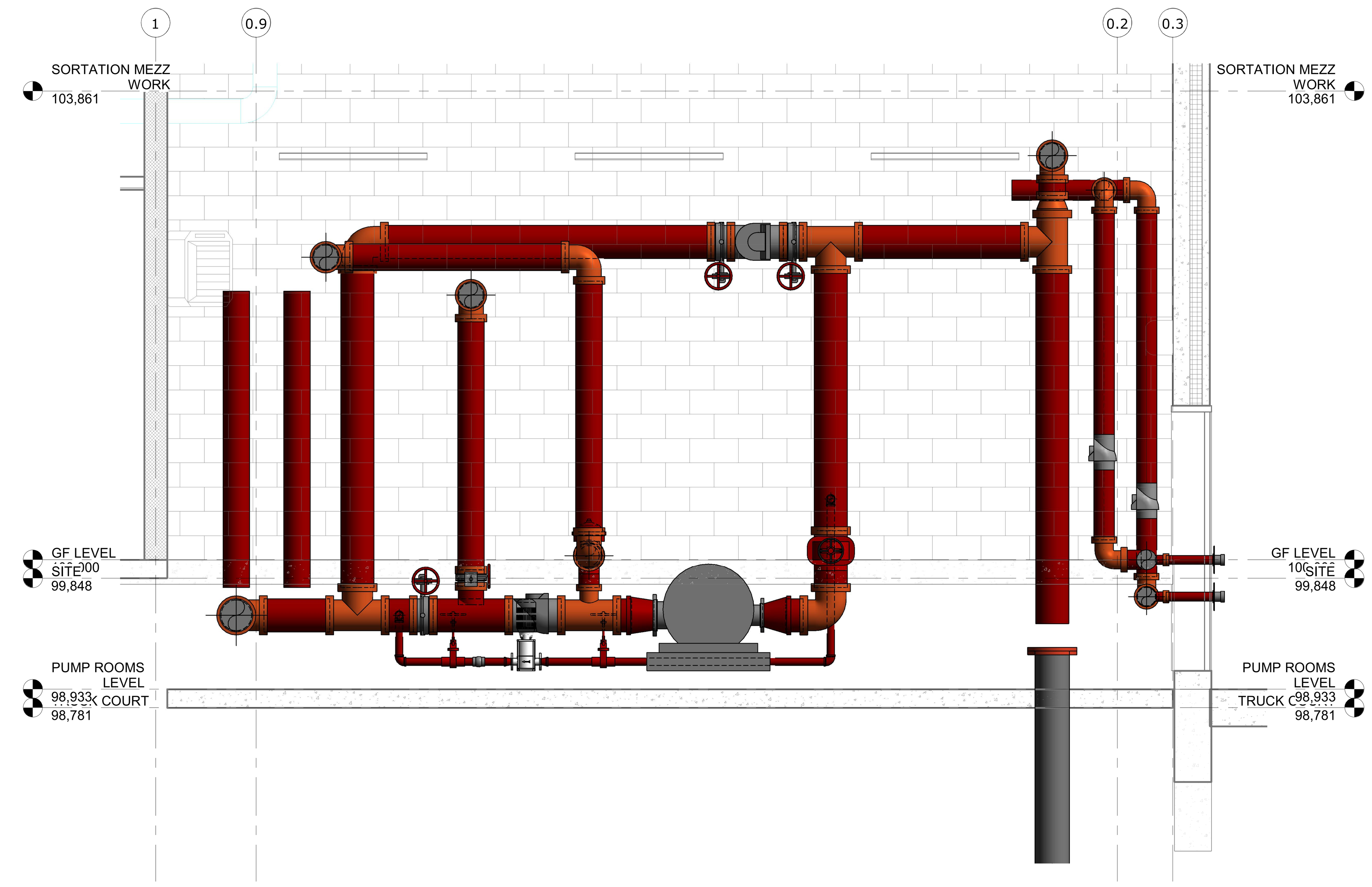


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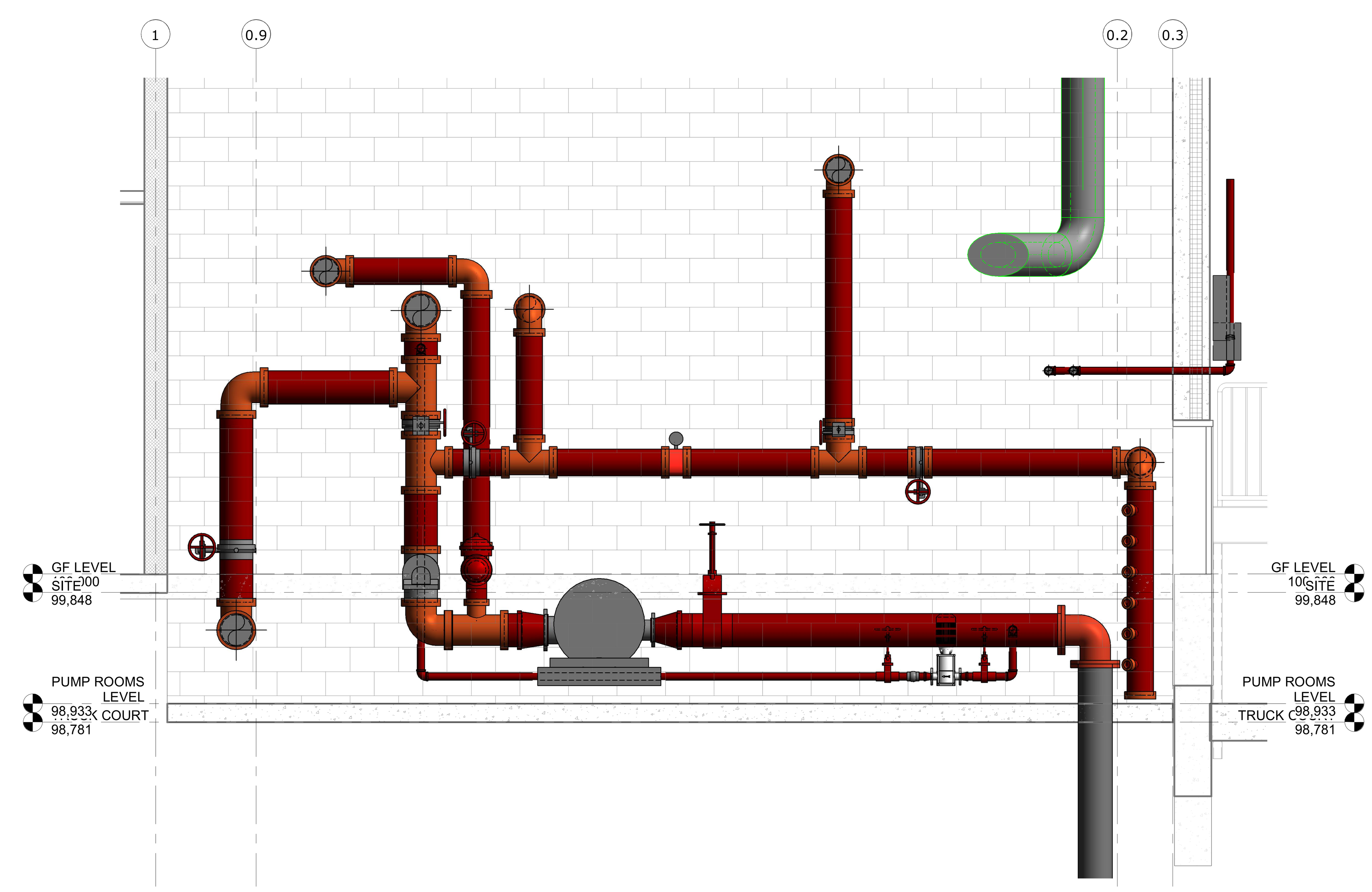


2 Section 30
1 : 25


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PROJECT NORTH

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| B | A |

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PYTHON



# FIRE PROTECTION

## PUMP ROOMS - CROSS SECTIONS

DRAWN BY: M.A.L.
CHECKED BY: P.L.
SCALE: 1 : 25
FOLIO: 2002-04A
**FP56**

2020-04-01 5:40:23 PM

FIRE PROTECTION STUDY FOR

**PROJECT PYTHON**

OTTAWA, ONTARIO

ALTERNATIVE SOLUTION
FOR FIRE RATING

CIVELEC
CONSULTANTS INC.

FIRE PROTECTION STUDY FOR

# PROJEC PYTHON

OTTAWA, ONTARIO

ALTERNATIVE SOLUTION
FOR FIRE RATING

Prepared by

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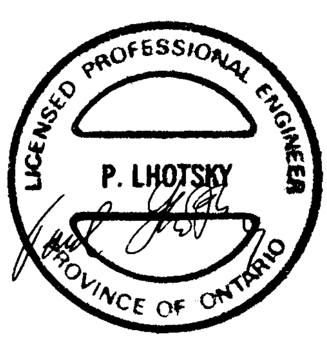
Paul Lhotsky, PhD, P. Eng.




May 15 2020

CIVELEC
CONSULTANTS

## 1. Executive Summary

1.1 The developer is planning to build a semi-automated light industrial sort center. The building will be approximately 58,222 $m^2$ on the ground floor including 3280 m2 of offices. The ground floor will have approximately 25,427 m2 of mezzanines. The building will also have additional 4 levels of robotic sorting platforms each having an area of 45,075 m2. The building is considered 6 storeys high (5 stories and mezzanine that is calculated as a floor in building height). The ground floor will be approximately 8.53 m (28 ft) high with mezzanine levels located at approximately 4.27 m (14 ft) height. The robotic platforms will be 4.27 m (14 ft) high and the top platform roof will be 4.57 m (15 ft) above the platform.

1.2 The ground floor and mezzanines will be used for packaging shipping and receiving. This area will have numerous conveyers and automated handling systems. 2$^{nd}$, 3$^{rd}$ 4$^{th}$ and 5$^{th}$ floors (robotic platforms) will be used for a sorting area and manual picking sector on the perimeter of the building. The merchandise is placed in special pods that are 2.616 m (8 ft 7 in) high. The individual items are located in the pods. The pods are delivered to the picking stations by robots. The individual items are loaded into the pods or removed from the pods. The items are transported to the ground floor by conveyer systems typically in open plastic totes. The pods stationary and delivery area has restricted access and is not occupied during normal operation.

1.3 Due to the building and floor construction and use, the building structure will have an equivalent fire resistance rating of 2 hours. And the fire resistance shall be determined on the basis of the results of tests conducted in conformance with *CAN/ULC-S101, "Fire Endurance Tests of Building Construction and Materials"*. This alternative solution is for the Ontario Building Code article 3.2.2.67 and 3.1.7.1

1.4 Our alternative solution is to meet the Objectives and Functional Statements that are: An objective is to retard the effects of fire on areas beyond its point of origin and to retard failure or collapse due to the effects of fire.

1.5 Part B of OBC requires sprinkler protection and physical fire resistance rating that have the same objectives. In summary OBC requires a redundant system to control fire spread and collapse of the building.

1.6 The alternative solution is to use a special sprinkler head and high sprinkler density to extinguish the fire rather than to only control the fire.

1.7 The reliability of the sprinkler system will be increased by providing two independent water supplies, two fire pumps and water supply loops so that any one impairment in the water supplies can be isolated and provide adequate water supply to the sprinkler system.

1.8 For detailed code study see Appendix A.

## 2. Building Description

2.1 The building will be approximately 58,222 $m^2$ on the ground floor including 3280 m2 of offices. The ground floor will have approximately 25,427 m2 of mezzanines. The building will also have additional 4 levels of robotic sorting platforms each having an area of 45,075 m2. The building is considered 6 storeys high. The ground floor will be approximately 8.53 m (28 ft) high with mezzanine levels located at approximately 4.27 m (14 ft) height. The robotic platforms will be 4.27 m (14 ft) high and the top platform roof will be 4.57 m (15 ft) above the platform.

2.2 The ground floor will be used for packaging shipping and receiving. This area will have numerous conveyers and automated handling systems. 2nd, 3rd, 4th and 5th floors will be used for a sorting area and manual picking sector on the perimeter of the building. The merchandize is placed in special pods that are 2.616 m (8 ft 7 in) high. The individual items are stored in the pods. The pods are delivered to the picking stations by robots. The individual items are loaded into the pods or removed from the pods. The items are transported to the ground floor by conveyer systems typically in open plastic totes. The pods sorting and delivery area has restricted access and is not occupied during normal operation.

2.3 Typical merchandize consist of combination of class 2, 3, 4 and class A non-expanded cartooned plastics as defined by NFPA 13. Due to the plastic totes and pods, the commodity is classified as exposed non-expanded class A plastics.

2.5 The building will be approximately 28.65 m (94 ft) high.

2.6 The semi-automated conveyer system will be used for transport of goods. As the actual sorting and conveyer plans are not yet available, we have used plans for a similar use building that are provided in appendix D

2.7 See appendix C for plans.

## 3. Description for floor structure

3.1 The floors for 2nd, 3rd, 4th and 5th level are to have a 7 in concrete slab on a beam and joist supporting structure.

3.2 The concrete slab will have approximately 2 to 2.5 hr. of fire resistance as per OBC.

3.3 The alternative solution is for the beams, joists as well as for the columns. The beams, joists and columns are to be steel.

## 4. Code Requirements

4.1 The OBC 3.2.2.67. states: *Group F, Division 2, Any Height, Any Area, Sprinklered*

*(1) Except as permitted by Articles 3.2.2.68. to 3.2.2.72., a building classified as Group F, Division 2 shall conform to Sentence (2).*

*(2) Except as permitted by Article 3.2.2.16., the building referred to in Sentence (1) shall be of noncombustible construction, and,*

*(a) except as permitted by Sentence 3.2.2.7.(1), the building shall be sprinklered,*

*(b) floor assemblies shall be fire separations with a fire resistance rating not less than 2 h,*

*(c) mezzanines shall have a fire-resistance rating not less 1 h, and*

*(d) loadbearing walls, columns and arches shall have a fire-resistance rating not less than that required for the supported assembly.*

4.2 The OBC defines fire resistance as: *Fire-resistance rating means the time in minutes or hours that a material or assembly of materials will withstand the passage of flame and the transmission of heat when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived from that test and performance as prescribed in this Code.*

*4.3* The OBC article 3.1.7.1. Determination of Ratings states:

*(1) Except as permitted by Sentence (2) and Article 3.1.7.2., the rating of a material, assembly of materials or a structural member that is required to have a fire-resistance rating, shall be determined on the basis of the results of tests conducted in conformance with CAN/ULC-S101, "Fire Endurance Tests of Building Construction and Materials".*

4.2 Ontario Building Code has a special section that deals with "Shelf and Rack Storage Systems". Even though we do not consider the automated sorting system configuration to be a "Shelf and Rack Storage" the use is similar.

4.3 Ontario Building Code does not require fire resistance rating for a "Shelf and Rack Storage System."

4.4 OBC article 3.2.8.2 (3) states:
"*If a* closure *in an opening in a* fire separation *would disrupt the nature of a manufacturing process, such as a continuous flow of material from* storey *to* storey, *the*

closure *for the opening is permitted to be omitted provided precautions are taken to offset the resulting hazard.*"

4.5 Typical protection of openings between floors as described above is provided by installing "a water curtain" – sprinklers located at the perimeter of the opening at every 6 ft. where the opening can create a chimney effect.

**5 Code Compliance**

5.1 The OBC provides two alternatives to comply to the code.

5.2 One option is to use the descriptive design of Part B of the OBC and if this part B is used for the design it is assumed that the objectives of Part A of OBC are met.

5.3 The second option is to use the objectives and functional statements of the code. The design requires to present an alternative solution with a proof of meeting the objectives of Part A of OBC.

**6. Requirements for Alternative Solution**

6.1 The OBC article 1.2.1.1 states: Complience with Division B

*(1) Complience with Division B shall be achieved,*

*(a) by complying with the applicable acceptance solution in Division B, or*

*(b) by using alternative solutions that will achieve the level of performance required by the applicable acceptable solutions in respect of objectives and functional statements attributed to the acceptable solutions in Supplementary Standard SA-1.*

*(2) For the purposes of Clause (1)(b), the level of performance in respect of functional statement refers to the performance of the functional statements as it relates to the objective with which it is associated in Supplementary Standard SA-1.*

*Clause A-1.2.1.1.(1)(b) states: "Where a design differs from the acceptable solutions in Division B, then it should be treated as an "alternative solution." A proponent of an alternative solution must demonstrate that the alternative solution addresses the same issues as the applicable acceptable solutions in Division B and their attributed objectives and functional statements. However, because the objectives and functional statements are entirely qualitative, demonstrating compliance with them in isolation is not possible. Therefore,* Clause 1.2.1.1.(1)(b) *identifies the principle that Division B establishes the quantitative performance targets that alternative solutions must meet. In many cases, these targets are not defined very precisely by the acceptable solutions — certainly far less precisely than would be the case with a true performance code, which would have quantitative performance targets and prescribed methods of performance measurement* *for all aspects of building performance. Nevertheless,* Clause 1.2.1.1.(1)(b) *makes it clear that an effort must be made to demonstrate that an alternative solution will perform as well as a design that would satisfy the applicable acceptable solutions in Division B – not "well enough" but "as well as." . . .*

*Applicable Acceptable Solutions*

*In demonstrating that an alternative solution will perform as well as a design that would satisfy the applicable acceptable solutions in Division B, its evaluation should not be limited to comparison with the acceptable solutions to which an alternative is proposed. It is possible that acceptable solutions elsewhere in the Code also apply. The proposed alternative solution may be shown to perform as well as the most apparent acceptable solution which it is replacing but may not perform as well as other relevant acceptable solutions. For example, an innovative sheathing material may perform adequately as sheathing in a wall system that is braced by other means but may not perform adequately as sheathing in a wall system where the sheathing must provide the structural bracing. All applicable acceptable solutions should be taken into consideration in demonstrating the compliance of an alternative solution."*

# 7. Fire resistance

## 7.1 Code requirements and objectives

7.1.1 The applicable objectives and functional statements as summarized by the OBC SA-1 table 3 are the following:

| 3.2.2.67. *Group F, Division 2, Any Height, Any Area, Sprinklered* | | |
|---|---|---|
| (2) d | | [F3, F4–OP1.2] [F04-OP1.3] |
| (2)d | | [F3, F4–OS1.2] [F04-OS1.3] |

and

| 3.1.7.1. Determination of Ratings | | |
|---|---|---|
| (1) | | [F3–OP1.2] [F04-OP1.3] |
| (1) | | [F3–OS1.2] [F04-OS1.3] |

7.1.2 The objectives of the Code are achieved by measures, such as those described in the acceptable solutions in Division B, that are intended to allow the *building* or its elements to perform the following functions:

7.1.3 The functional statements are:

F03 To retard the effects of fire on areas beyond its point of origin.

F04 To retard failure or collapse due to the effects of fire.

7.1.4 The objectives are:

OP1 An *objective* of this Code is to limit the probability that, as a result of its damage due to fire.

OP1.2 An *objective* of this Code is to limit the probability that, as a result of its design or *construction*, a *building* will be exposed to an unacceptable risk of damage due to fire caused by fire or explosion impacting areas beyond its point of origin.

OP1.3 An *objective* of this Code is to limit the probability that, as a result of its design or *construction*, a *building* will be exposed to an unacceptable risk of damage due to fire caused by collapse of physical elements due to a fire or explosion.

OS 1 An *objective* of this Code is to limit the probability that, as a result of the design or *construction* of a *building*, a person in or adjacent to the *building* will be exposed to an unacceptable risk of injury due to fire.

OS1.2 An *objective* of this Code is to limit the probability that, as a result of the will be exposed to an unacceptable risk of injury due to fire caused by fire or explosion impacting areas beyond its point of origin.

OS1.3 An *objective* of this Code is to limit the probability that, as a result of the design or *construction* of a *building*, a person in or adjacent to the *building* will be exposed to an unacceptable risk of injury due to fire caused by the collapse of physical elements due to a fire or explosion

7.1.6 To summarize the code objectives, the fire resistance required by OBC is there to limit the fire spread and to provide protection from heat in case of fire to minimize the possibility of a structural failure that could eventually cause a collapse.

7.1.7 The OBC requires a redundancy in the control of the fire spread and structural failure.

7.1.8 The OBC part B uses passive protection is provided by using insulation to limit the temperature from affecting the structural strength of steel members and by limiting temperature on the non-fire-exposed side from igniting combustibles. This fire resistance requirement will not limit the fire spread horizontally and if the floors have openings as permitted by article 3.2.8.2 (3), the fire resistance rating will not limit the fire spread to adjacent floor.

7.1.9 The OBC part B uses sprinklers as active protection to limit the extend of the fire spread. OBC part B does not require to use sprinklers that will extinguish the fire but requires the sprinkler design to at least control the fire within the sprinkler operation design area.

7.1.10 To summarize, OBC uses sprinkler system to limit the fire spread and uses the passive fire resistance to prevent structural collapse and ignition of combustibles on non-fire-exposed surface of the fire rated division.

## 7.2 Fire resistance proposal

7.2.1 We propose to install a sprinkler system that is designed to extinguish that fire rather than to only control the fire. This alternative solution is to meet two objectives, one is to limit the spread of fire and the second one is to prevent a collapse.

7.2.2 Providing a fire resistance on beams, joists and columns does not prevent the fire spread on the same floor level or from spreading to another floor if there are openings as permitted by article 3.2.8.2(3). Providing a sprinkler system that will extinguish the fire, the fire spread is eliminated and the objectives to limit the fire spread are achieved and exceed the performance to the minimal design based on OBC part B.

7.2.3 We propose to provide two (2) independent water supplies, two (2) fire pumps, each able to provide adequate flow and pressure, totally redundant water supply piping that can provide adequate water supply with any one piping impairment. This system redundancy will provide structural collapse protection comparable to the physical protection provided by fire resistance coating when installed as per part B of OBC.

7.2.4 The combustible load on 2$^{nd}$ and 3$^{rd}$ floor is classified as class 4 commodity and cartooned type A plastics. The worst case scenario is to classify the storage as uncartoned class A plastics.

7.2.5 NFPA 13 2013 figure 15.2.2 provides guidance as to the application of table 15.2.6 (a) to determine the sprinkler density. The worst case classification is solid piled non-expanded, non-cartooned class A plastics that are not stable as the contents of pods would fall out as the pods would burn. The required sprinkler density as per column A of figure 15.2.2 of NFPA 13 is 0.20 gpm/ft$^2$.

7.2.5 In order to provide better protection for the beams, joists and columns we have decided to use an extended coverage K25.2 sprinkler head that will provide larger percentage of water that will flow onto the structural elements – beams, joists and columns.

7.2.6 NFPA 13 does not have specific design criteria for K25.2 extended coverage sprinkler. FM Global requirements for the design using pendent K 25.2 extended coverage fast response sprinklers are as follows:

To protect class 4 and cartooned plastics up to 12 ft with a 15 ft high ceiling, flow 6 sprinklers at 30 psi – In our case this translates to a minimum density of 1.19 gpm/ft$^2$ and flowing 828 gpm.

To protect un-cartooned plastics up to 12 ft with a 15 ft high ceiling,
flow 12 sprinklers at 7 psi – In our case this translates to a minimum density of 0.57 gpm/ft$^2$ and flowing 800 gpm.

To protect un-cartooned plastics up to 17 ft with a 20 ft high ceiling,
flow 8 sprinklers at 20 psi – In our case this translates to a minimum density of 0.97 gpm/ft$^2$ and flowing 902 gpm.

7.2.2 We propose to use K 25.2 EC QR sprinklers rated at 155 deg F. (see sprinkler data sheet Appendix “B”). The design should be flowing 8 sprinklers at 40 psi. This design will provide a minimum density of 1.12 gpm/ft$^2$.

7.2.3 NFPA 13 article 17.1.4.1 states that the steel protection (fire rating) can be provided with sprinklers having a density of 0.68 gpm/ft$^2$ or by using CMSA or ESFR sprinklers. The K 25.2 EC QR is considered as ESFR and CMSA sprinkler.

**7.3 Fire modeling**

7.3.1 OBC requires that the fire resistance rating is based on CAN/ULC S101 test. The test consists of exposing the tested assembly to temperature that increases as per the standard time temperature curve. The temperature of the standard time temperature curve at 2 hr is 1750 deg F.

7.3.2 The heat transfer to the water flow protecting the structural elements can be calculated as:

Q = K(Ta-Ts)A

Where:
K heat transfer coefficient approximately 50 w/m$^2$K
Ta air temperature (K)
Ts water temperature (K)
A surface m$^2$

Q = 50 (1227-293)1 = 46,700 W/m$^2$

Specific heat of water is 4.186 j/g

Therefore 1 L of water heated from 20 deg to 80 deg C will absorb 4.186 KJ x 60 = 251.15 KJ

If we want to limit the water temperature to maximum increase from 20 deg to 80 deg C we need to absorb 46,700 W / 60 = 778.4 W.

Therefore we need 778.4 / 4.186 = 185.9 g/s of water per $m^2$.

0.1859 L = 0.0491 gal.

1 $m^2$ = 10.76 $ft^2$.

Therefore required density = 60 x 0.0491 / 10.76 = 0.2737 gpm/$ft^2$

As the proposed sprinkler density is 1.12 gpm/$ft^2$ we need that 25% of the water be projected onto the surface. For this reason we have selected the extended coverage sprinklers.

7.3.3 The similar water cooling is also part of the OBC that has an option to provide 2 hr fire resistance using window sprinkler.

7.3.4 We have calculated the maximum air temperature at the ceiling level at the time of sprinkler activation. As per our calculations the maximum air temperature at the ceiling of the ground floor is 91 deg C and at the 2nd, 3rd , or 4th floor ceiling the maximum temperature is 86 deg C. See appendix E for calculations.

7.3.5 Our model is based on equations from graduate courses of Fire Dynamic at Carleton University for fire that is not oxygen controlled.

7.3.6 UL, Civelec Consultants and Harrington Group (fire protection consultants) have made a full scale test using the K25 EC QR pendent sprinkler and the proposed structural assembly at UL test center in Chicago. In the experiment using a full-scale test with the same structural configurations and elevations two (2) K25.2 EC QR sprinklers opened and extinguished the fire and the maximum air temperature and sprinkler activation times were very similar to our calculated results. During one series of tests, we have used 20 psi end head pressure and in another series of tests we have used 30 psi end head pressure. Similar results were obtained and in both series the fire was extinguished. (We propose to use 40 psi end head pressure).

**7.3.7 Test Procedure**

7.3.1 ULC, UL and NFPA provide standard procedures for evaluating performance of materials, assemblies under fire conditions, for example CAN/ULC S101 test will evaluate the fire resistance of an assembly. ULC, UL, NFPA and FM also developed standards for testing heat release, smoke release and fire propagations. These test standards are used to provide information if the use of these materials is acceptable with respect to the building codes.

7.3.2 The actual fire protection codes are developed based on fire modeling, small scale fire tests and large scale fire tests. There are no specific procedures developed for these tests as the objectives and configurations vary for majority of tests.

7.3.3 The full scale tests are usually performed in specially designed facilities that are equipped with sophisticated monitoring and measuring systems. In most of the cases, the tests are financed by insurance companies, by private organizations and by Governments. Some of the test results are not disclosed and some are published and used to developed fire protection standards.

7.3.4 In Canada the building codes use NFPA as a reference code for the design of fire protection systems. Most of the design criteria in NFPA is based on full scale fire tests that were conducted by different organizations, for example FM Global research (FMRC), Spacesaver Corporation, Southwest Research institute etc.

7.3.5 As we needed to determine the maximum temperatures at the ceiling level and also to determine the fire protection design criteria that would reduce the fire spread (based on NFPA 13 the standard sprinkler system will limit the fire spread to 2,500 ft2. In our case we have limited the fire spread to 260 ft2 (2 sprinklers operating) during the tests and are designing the sprinkler system up 1,150 ft2 (8 sprinklers operating).

7.3.6 Most of the test facilities use the same ignition procedure and calibration of monitoring systems. This was also the case for the UL test. The ignition was achieved with two standard half igniters, which are 76 mm x 76 mm (3 in. x 3 in.) cylinders of rolled cellu-cotton. Each igniter is soaked in 118 ml (4 oz.) of gasoline and sealed in a plastic bag, The igniters were placed in an offset ignition orientation, in the center transverse flue, between the pods. The igniters were lit with a flaming propane torch at the start of each test and the fires were allowed to develop naturally.

Documentation for each test included video, still photography, and pertinent measurements necessary to evaluate sprinkler performance. All instrumentation was calibrated in accordance with ISO 17025

7.3.7 We have also tested the sprinkler effectiveness with obstruction to the water distribution having 3 in sprinkler piping spaced at 6 in center to center obstructing water distribution from 3 sprinkler heads. The fire was extinguished with 3 sprinklers operating. We expect to use ESFR sprinkler obstruction rules, but the results demonstrate that if these rules cannot be adhered to 100% we still expect the system to extinguish the fire.

7.3.8 The sprinkler protection for structure is based on a fire that is controlled by the sprinkler system. The OBC requires the sprinkler protection as well as the passive protection by providing an insulation that will protect the structure to reach temperatures close to 500 deg C - temperature when the structural elements strength is reduced.

7.3.9 The OBC passive protection of the structure will work relatively well if the fire is below the protected structure. The OBC does not require fire resistance protection for the roof and the structural elements supporting the roof. The OBC permits that possible collapse protection for the roof is solely provided by the sprinkler system. If the roof of the building collapses due to the fire, typically the floors below will also collapse as the structure is not normally designed to withstand the impact and forces caused by the collapsing roof structure. We can conclude that sprinkler system can provide an adequate protection against a collapse in case of a fire.

## 8. Reliability analyses

8.1 The OBC requires an additional structural fire protection using a passive protection and to provide sprinklers that will control the fire. To have an acceptable alternative solution, the probability of a structural collapse due to the fire should be comparable to the reliability when the design is based on the part B of OBC.

8.2 In case of a sprinkler system failure the structural protection from collapse is provided by the passive fire resistance of the structure. As mentioned before this passive protection is only applicable if the fire occurs below the protected structure.

8.3 The majority of sprinkler system failure is due to problems with the water supplies. In our case we will provide two independent water supplies, each adequate for the required sprinkler flows. The water supply mains will be arranged that any impairment can be isolated and the sprinkler system will be fully functional with the impairment. The water pressure will be increased using two diesel drivel fire pumps, each designed to provide adequate water pressure for the operation of the sprinkler system. The fire pumps will be in separate fire compartments 2 hr fire rated, in a pump house that is located outside of the building.

8.4 All sprinkler control valves, fire pump operation etc. will be monitored by the local fire alarm panel that will signal the trouble signal to the maintenance. In addition these trouble signals will be transmitted to the central station as per the OBC.

8.5 With the water supply redundancy, the risk of collapse of the structure is comparable or lower than the risk when the building fire resistance is designed to part B of OBC.

## 9. Design and Construction Requirements

9.1 The design of the sprinkler system must meet the conditions of this report.

9.2 The system must be designed by a professional engineer licensed in Ontario.

9.3 The system must be inspected and certified by a P. Eng. representing our office.

**10. Conclusion**

10.1 This code equivalency report is based on OBC, NRC, UL full scale test using actual fire loads and configuration, FM Global data sheets and NFPA. The analyses are based on graduate courses – fire dynamics at Carleton University in fire protection. The calculations demonstrate that adequate collapse protection and fire spread protection will be provided if the sprinkler system and water supplies will be designed and installed as per this report.

**11. Copyright**

# APPENDIX A

# PLANS

HYDROSTATIC TESTING:

1) ALL PIPING SHALL BE HYDROSTATICALLY TESTED AT 225 PSI FOR 2 HOURS.

2) THE PERMITTED AMOUNT OF UNDERGROUND PIPING LEAKAGE SHALL BE AS FOLLOWS:

   a. THE AMOUNT OF LEAKAGE AT THE JOINTS SHALL NOT EXCEED 2 QT/HR PER 100 GASKETS OR JOINTS, IRRESPECTIVE OF PIPE DIAMETER.
   b. THE AMOUNT OF LEAKAGE IN BURIED PIPING SHALL BE MEASURED AT THE SPECIFIED TEST PRESSURE BY PUMPING FROM A CALIBRATED CONTAINER.

3) THE HYDROSTATIC TESTING SHALL BE CARRIED OUT PROGRESSIVELY **BEFORE THE JOINTS ARE BURIED**. BACKFILLING SHALL BE DONE SO AS TO LEAVE THE JOINTS FOR THE PORTION OF PIPING BEING TESTED, EXPOSED.

FLUSHING:

THE ENTIRE PIPING NETWORK INCLUDING ISOLATED SEGMENTS AND PORTIONS FEEDING HYDRANTS MUST BE TEST FLUSHED AT THE SPECIFIED RATE AS REQUIRED BY NFPA 24 AND NFPA 20 CHAPTER 14.
( SEE DETAIL #X ON FPU2 )

NOTES:

1) COORDINATE THE EXACT LOCATION OF THE UNDERGROUND PIPING ON SITE.

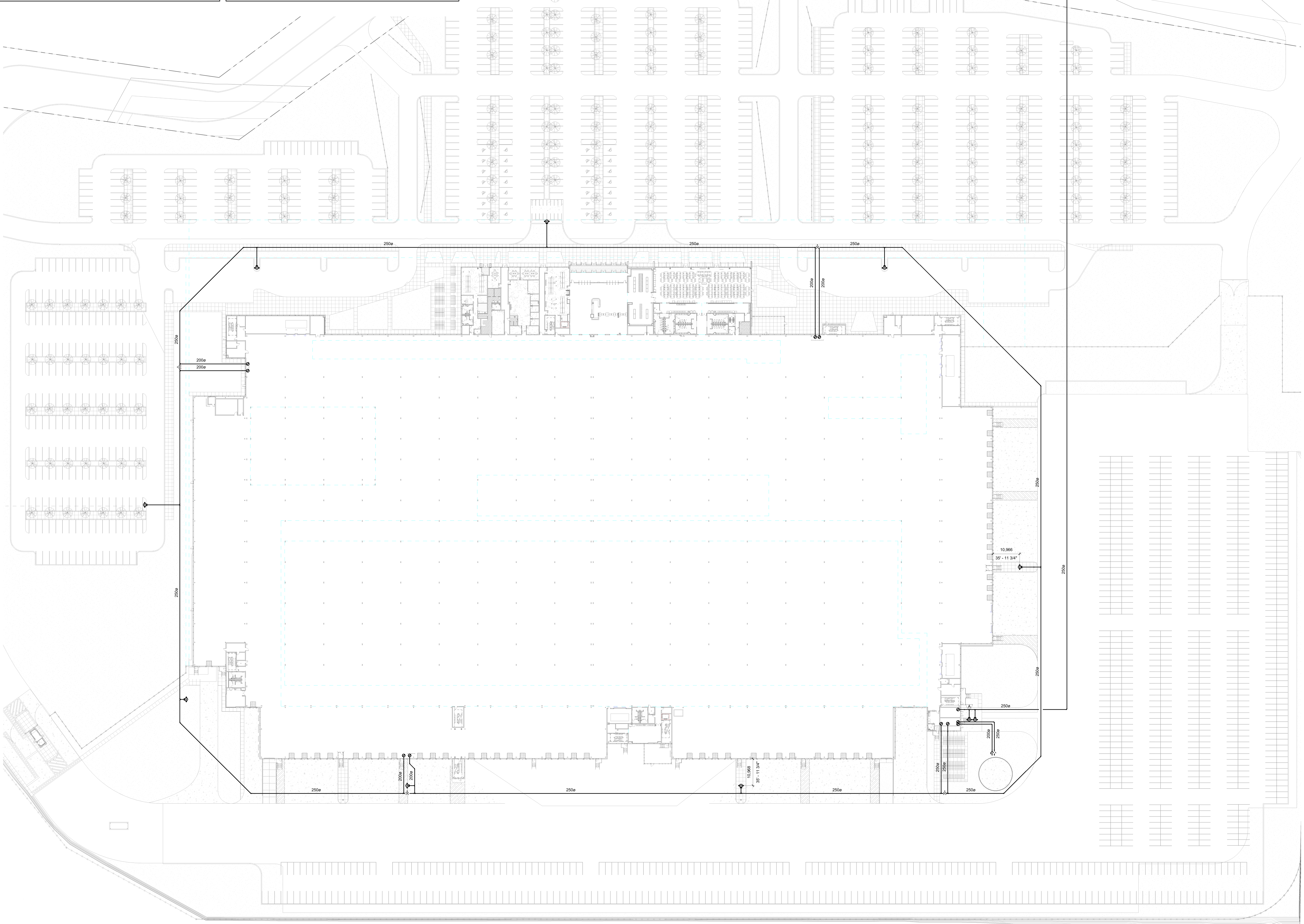
2) UNLESS NOTED OTHERWISE, ALL FITTINGS ARE TO BE DUCTILE IRON WITH MECHANICAL JOINTS.

3) CORROSION RESISTANCE: AFTER INSTALLATION, RODS, NUTS, BOLTS, WASHERS, CLAMPS, AND OTHER RESTRAINING DEVICES SHALL BE CLEANED AND THOROUGHLY COATED WITH A BITUMINOUS OR OTHER ACCEPTABLE CORROSION-RETARDING MATERIAL.

4) THE CONTRACTOR SHALL INSTALL RIGID PVC PIPING WITH CSA UL APPROVED PVC FITTINGS FOR UNDERGROUND CONDUIT FOR THE P.I.V.'S WIRING. ALL THE ELBOWS ARE TO BE LONG RADIUS. THE CONTRACTOR SHALL INSTALL EXPANSION JOINTS AS REQUESTED BY MANUFACTURER. CONTRACTOR IS TO INSTALL PULL CORD IN EACH CONDUIT AND CONNECT THE P.I.V.'S TO THE BUILDING. THE CONDUIT SHALL RAISE A MINIMUM OF 3 FT ABOVE THE GROUND OR THE FINISHED FLOOR. INSTALL CAPS AT THE END OF PIPES TO PREVENT FOR ANY FRAGMENT TO ENTER. PROVIDE PULL BOX AS REQUIRED BY CODE AND STANDARDS.

5) ADJUST DEPTH OF MAINS TO ACCOMMODATE CHANGES OF GRADE LEVELS TO PROVIDE ADEQUATE COVER TO PREVENT FREEZING. SEE CIVIL ENGINEER DRAWINGS FOR DETAILS, TRENCHING, COMPACTION AND FILL.

6) FIRE HYDRANTS ARE TO BE INSTALLED A MINIMUM OF 5 FT FROM ANY SIDEWALKS.




1 UNDERGROUND OVERALL
1 : 500


GKC ARCHITECTS
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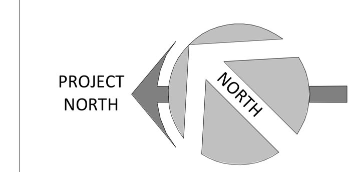
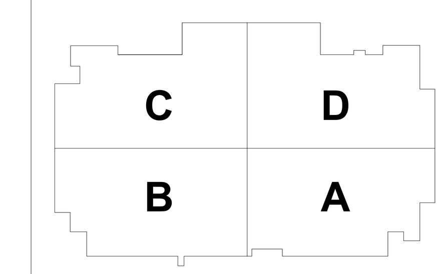
cci@civelec.com
3900, Côte-Vertu
Suite 200 - St-Laurent
(Québec) H4R 1V4


**PRELIMINARY**
NOT TO BE USED
FOR CONSTRUCTION

| No. | Date | Revision | By |
|---|---|---|---|
| 1 | 2020-03-18 | ISSUED FOR OVERALL 33% REVIEW | MAL |

2020-05-21 4:18:57 PM

PYTHON



FIRE PROTECTION

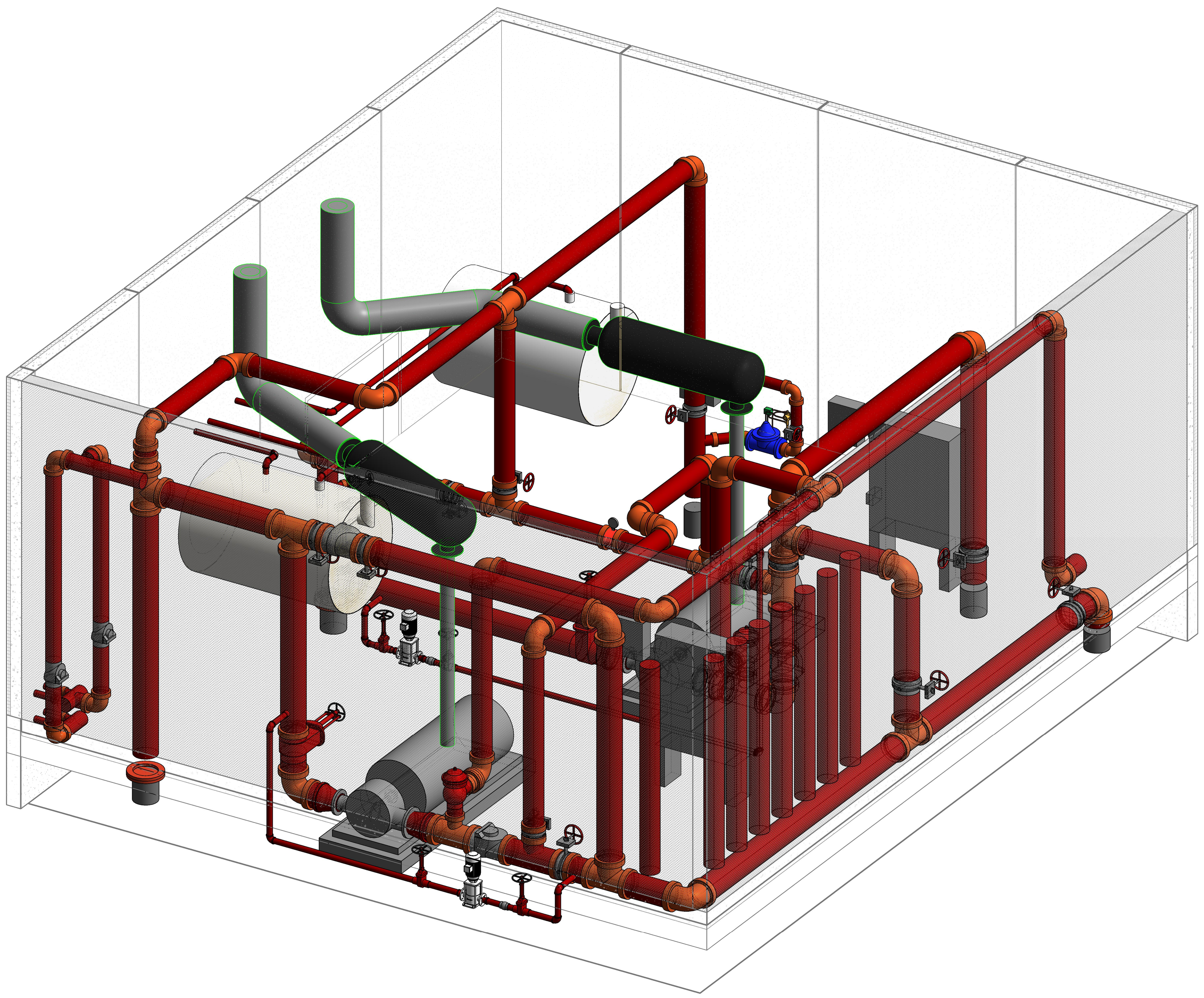
UNDERGROUND - OVERALL

DRAWN BY: M.A.L. CHECKED BY: P.L.

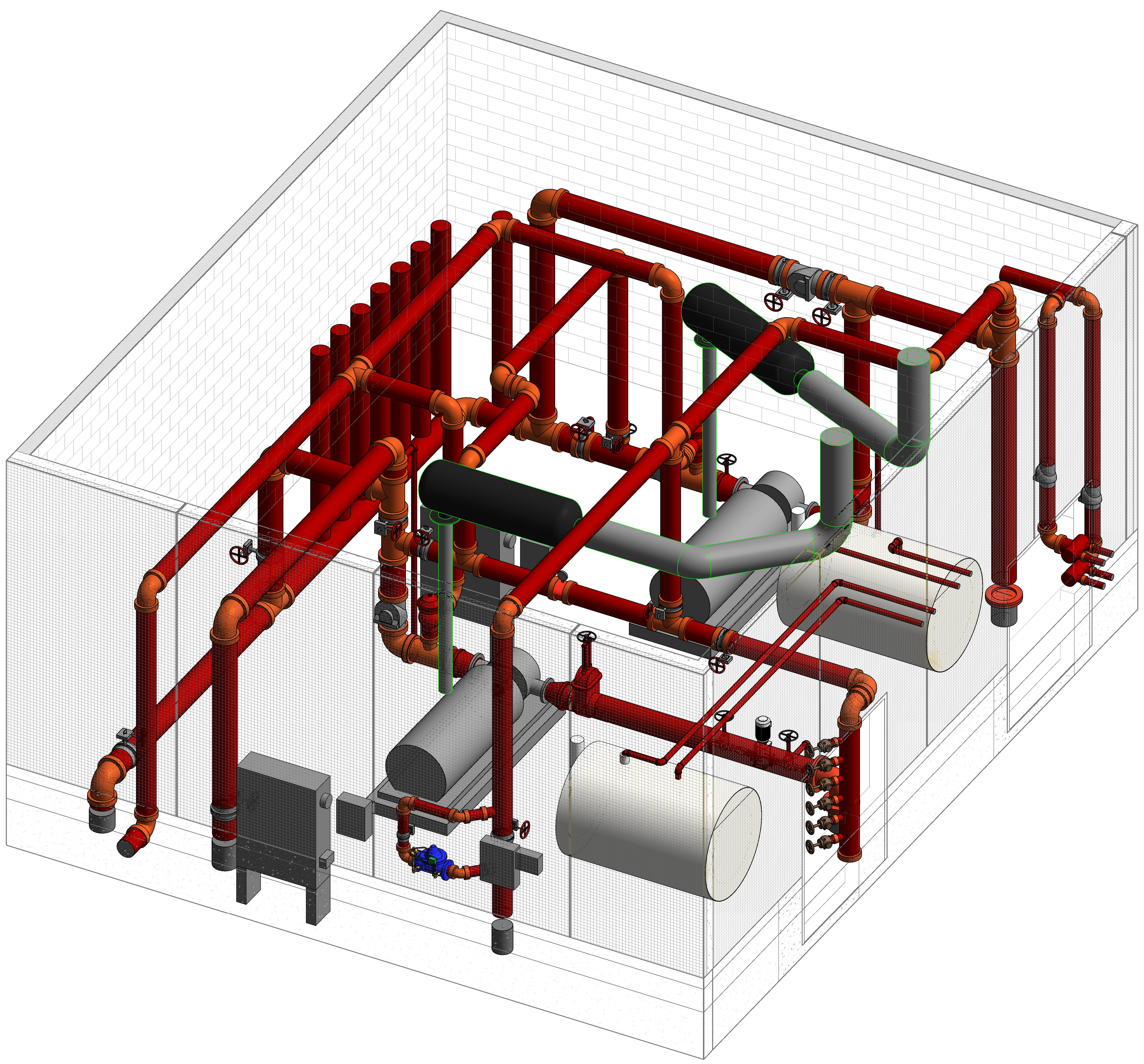
SCALE: As indicated

FOLIO: 2002-04A **FPU1** R1

2020-05-21 4:18:57 PM



2 PUMP ROOMS 3D (2)



1 PUMP ROOMS 3D

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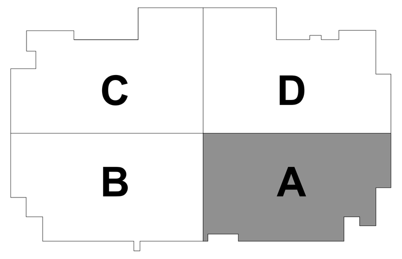



**PRELIMINARY**
NOT TO BE USED
FOR CONSTRUCTION

| No. | Date | Revision | By |
|---|---|---|---|

2020-04-01 5:40:03 PM

PYTHON



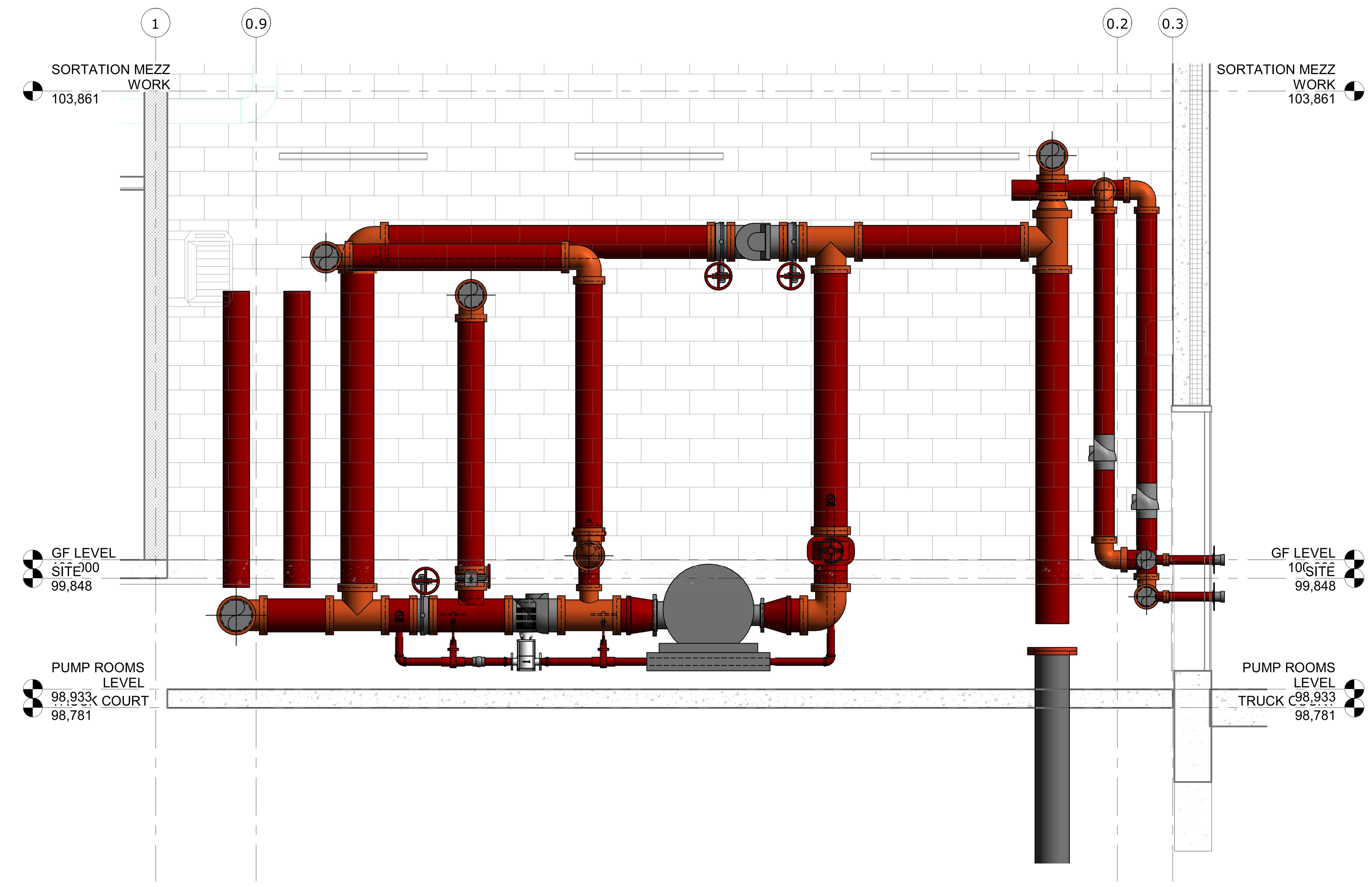
FIRE PROTECTION

PUMP ROOMS - 3D

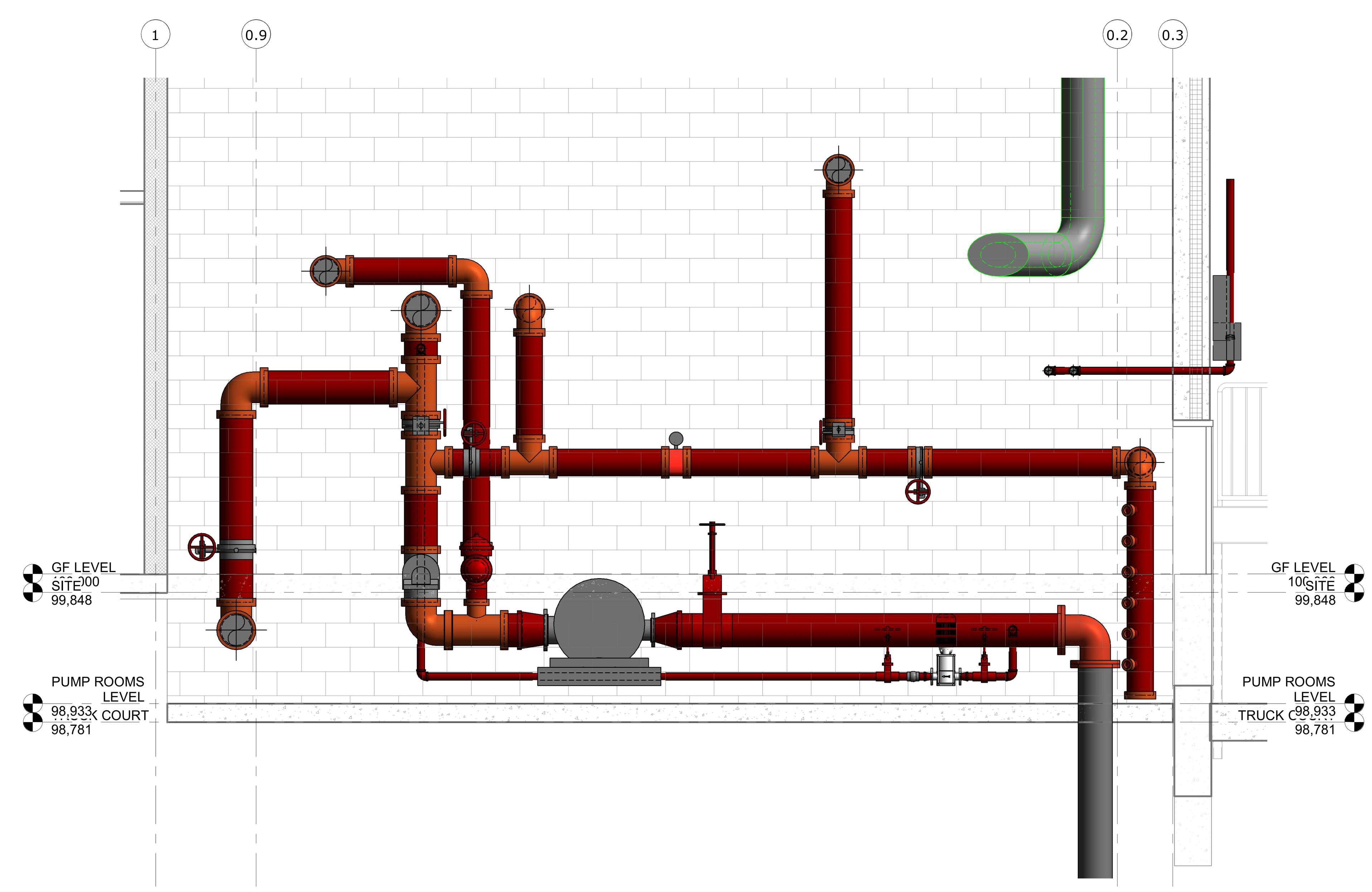
DRAWN BY: M.A.L. CHECKED BY: P.L.

SCALE:

FOLIO: 2002-04A **FP54**




1 Section 9
1 : 25

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1 : 25

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PROJECT NORTH

NORTH

| C | D |
|---|---|
| B | A |

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| No. | Date | Revision | By |
|---|---|---|---|

2020-04-01 5:40:23 PM

PYTHON



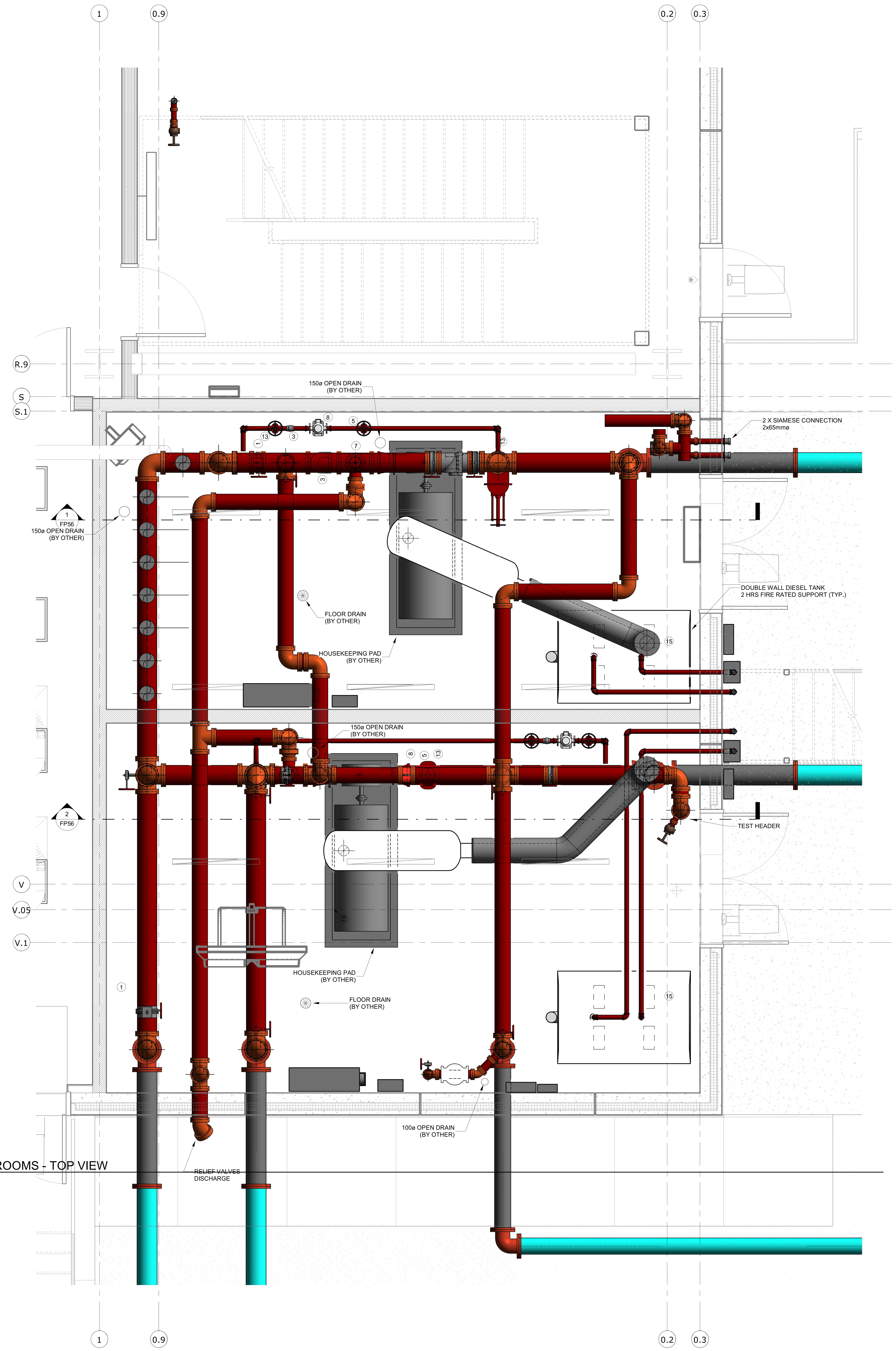
FIRE PROTECTION

PUMP ROOMS - CROSS SECTIONS

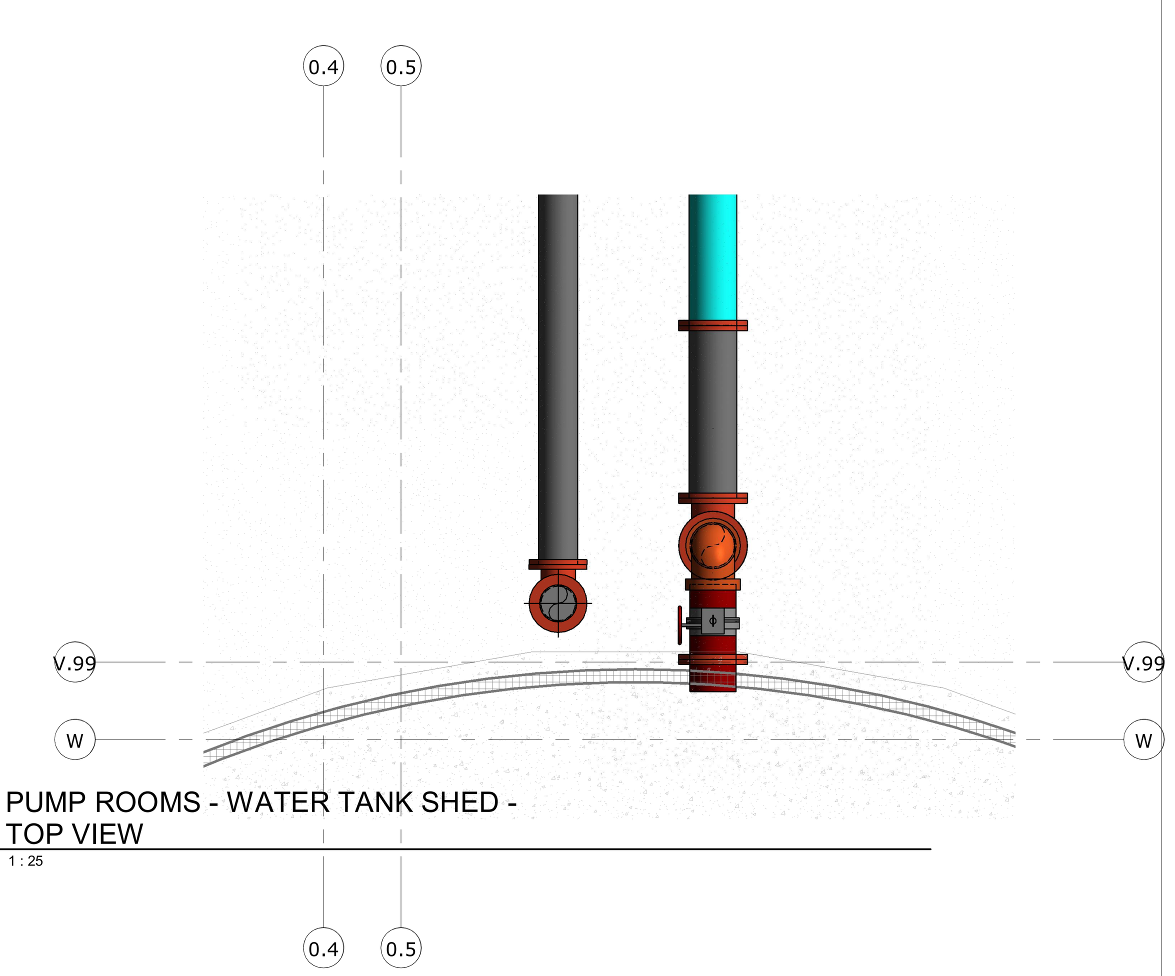
DRAWN BY: M.A.L. CHECKED BY: P.L.

SCALE: 1 : 25

FOLIO: 2002-04A **FP56**




1 PUMP ROOMS - TOP VIEW
1 : 25




2 PUMP ROOMS - WATER TANK SHED - TOP VIEW
1 : 25

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| C | D |
|---|---|
| B | A |

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| 1 | 2020-03-18 | ISSUED FOR OVERALL 33% REVIEW | MAL |

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PYTHON



FIRE PROTECTION

PUMP ROOMS - TOP VIEW

DRAWN BY: M.A.L. CHECKED BY: P.L.

SCALE: 1 : 25

FOLIO: 2002-04A **FP55** R1

2020-04-01 5:40:15 PM

# <u>Appendix B</u>

Sanitary Servicing Information

## Detailed Building Use Sanitary Flows

### Daily Demands from OBC Table 8.2.1.3

| Establishment | Daily Demand Volume | |
|---|---|---|
| Industrial Building: | 150 | L/day/loading bay |
| | 950 | L/day/bathroom |
| Commercial Office: | 75 | L/day/9.3m² Floor area |

### Daily Demands from City of Ottawa Sewer Design Guidelines

| Establishment | Daily Demand Volume | |
|---|---|---|
| Avg Commercial Flow | 28000 | L/ha/day |

### Commercial / Industrial Peaking Factors City of Ottawa Sewer Design Guidelines

| Building Use | Peaking Factor | |
|---|---|---|
| Commercial | 1.5 | Sewer Design Guidelines Appendix 4A |
| Industrial | 3.5 | Sewer Design Guidelines Appendix 4B |

### Proposed Building Sanitary Flows

| | Commercial Office | Industrial Building | Guard House | Future Guard House | Totals |
|---|---|---|---|---|---|
| Floor Area | 1559 | N/A | 26.3 | 26.3 | |
| No. Bathrooms | N/A | 100 | N/A | N/A | |
| No. Loading Bays | N/A | 56 | N/A | N/A | |
| Total Daily Volume (Liters) | 12572.6 | 103400.0 | 1972.5 | 1972.5 | 119917.6 |
| Peak Building Sanitary Flow (L/s) | 0.218 | 4.189 | 0.034 | 0.034 | **4.48** |

### Future Development Area

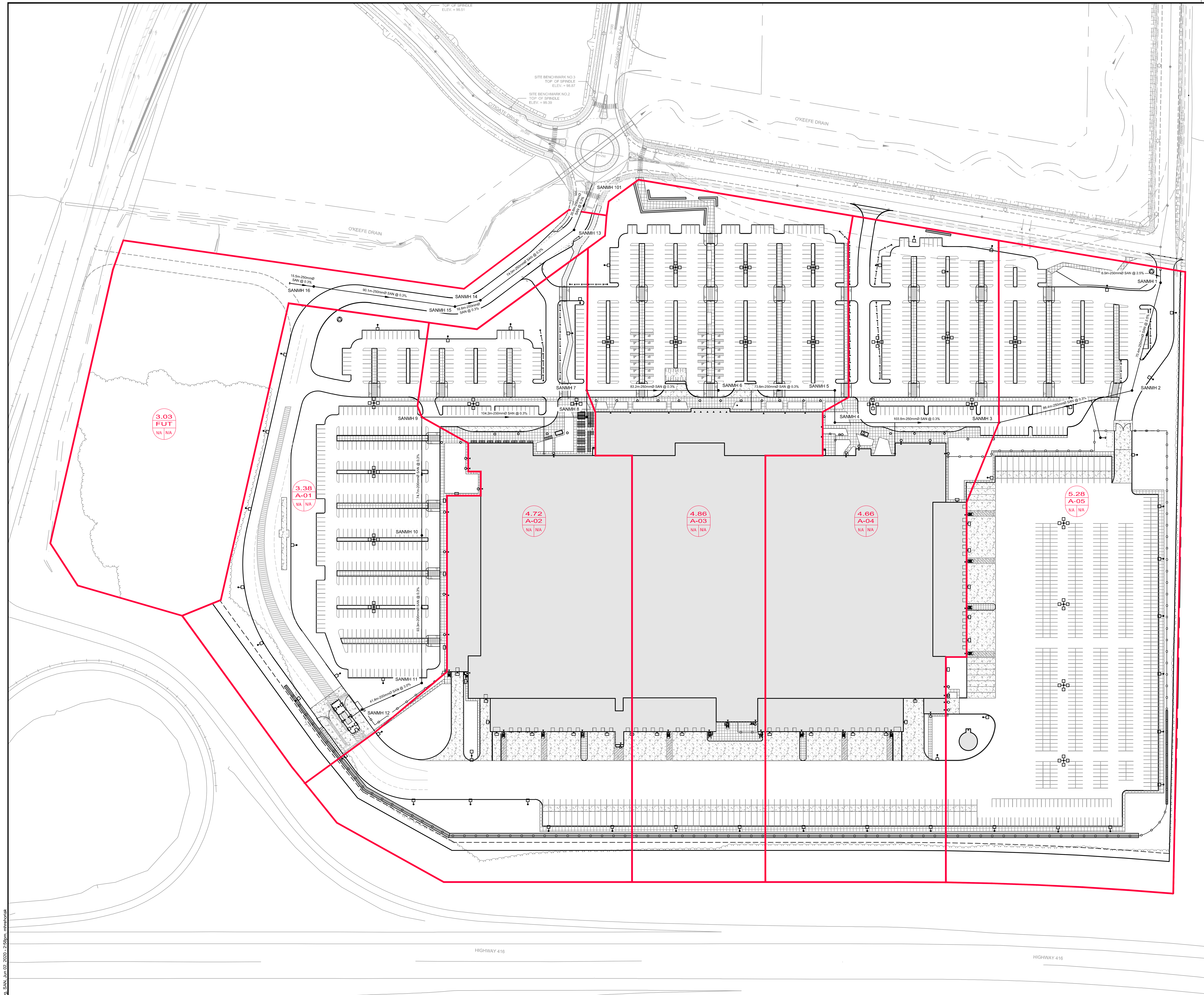
| | |
|---|---|
| Area (ha) | 3.0 |
| Total Daily Volume (Liters) | 84840.0 |
| Peak Building Sanitary Flow (L/s) | 1.47 |

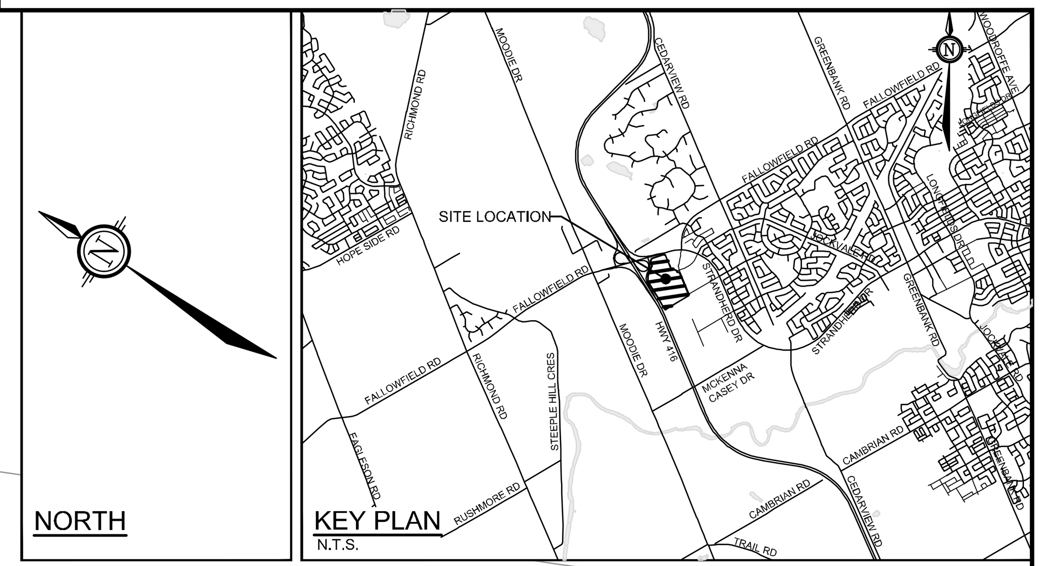
### Extraneous Flows

| Total Site Area (ha) | Extraneous Flow Alottment (L/s/ha) | Total Extraneous Flows (L/s) |
|---|---|---|
| 25.94 | 0.33 | **8.56** |

### Total Site Peak Sanitary Flows

| Total Peak Building Sanitary Flows (L/s) | Future Development Area Sanitary Flows (L/s) | Total Extraneous Flows (L/s) | Total Site Peak Flows (L/s) |
|---|---|---|---|
| 4.48 | 1.47 | 8.56 | **14.51** |




## LEGEND

- PROPERTY LINE
- PROPOSED SANITARY SEWER AND MANHOLE
- DIRECTION OF FLOW
- SAN MH — EXISTING SANITARY MANHOLE & SEWER
- SANITARY SEWER DRAINAGE AREA BOUNDARY
- 6.388 / A-01 / N/A N/A — DRAINAGE AREA (ha) / SAN SEWER PIPE RUN / POPULATION / NO. UNITS

REFER TO 120025-ND FOR ADDITIONAL NOTES

NOTE:
THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

NOT FOR CONSTRUCTION

| No. | REVISION | DATE | BY |
|---|---|---|---|
| 5 | REVISED PER CITY COMMENTS | JUNE 1/2020 | MJH |
| 4 | ISSUED FOR INTERNAL REVIEW | MAY 19/2020 | MJH |
| 3 | ISSUED FOR FOUNDATION PERMIT | MAY 5/2020 | MJH |
| 2 | ISSUED FOR DESIGN REVIEW | APR 20/2020 | MJH |
| 1 | APPLICATION FOR SITE PLAN APPROVAL | APR 6/2020 | MJH |

SCALE 1:1000

| | |
|---|---|
| DESIGN | MJH/ARM |
| CHECKED | JLS |
| DRAWN | MJH/ARM |
| CHECKED | JLS |
| APPROVED | JLS |

FOR REVIEW ONLY

LICENSED PROFESSIONAL ENGINEER A.R. MESTWARP 100201604 June 1, 2020 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER M.J. HREHORIAK 100211256 JUNE 1/20 PROVINCE OF ONTARIO

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Telephone (613) 254-9643
Facsimile (613) 254-5867
Website www.novatech-eng.com

LOCATION
PROJECT PYTHON
222 CITIGATE DRIVE, CITY OF OTTAWA

DRAWING NAME
SANITARY DRAINAGE PLAN

PROJECT No. 120025
REV #5
DRAWING No. 120025 - SAN

D07-12-20-0038

PLAN # 18129

Project No. 120025
Project Name: Project Python
Project Location: 222 Citigate Drive, Ottawa

NOVATECH
Engineers, Planners & Landscape Architects

Date: May 2020

## Sanitary Sewer Design Sheet

| LOCATION | | | COMMERCIAL / INDUTRIAL FLOW | | | | | | | PIPE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AREA ID | FROM | TO | AREA (ha) | ACCUM AREA (ha) | PEAK FACTOR | PEAK FLOW (l/s) | ACCUM PEAK FLOW (l/s) | INFIL. FLOW (l/s) | TOTAL PEAK FLOW (l/s) | PIPE SIZE (mm) | PIPE SLOPE (%) | LENGTH (m) | CAPACITY (l/s) | VELOCITY (m/s) | Q/Qfull |
| **A-01** | MH 12 | MH 11 | 3.38 | 3.38 | 1.5 | 0.034 | 0.03 | 1.12 | 1.15 | 200 | 3.00 | 41.4 | 56.8 | 1.8 | 2.0% |
| | MH 11 | MH 10 | 0.00 | 3.38 | 0.0 | 0.000 | 0.03 | 1.12 | 1.15 | 200 | 0.30 | 93.3 | 17.9 | 0.6 | 6.4% |
| | MH 10 | MH 9 | 0.00 | 3.38 | 0.0 | 0.000 | 0.03 | 1.12 | 1.15 | 200 | 0.30 | 74.7 | 17.9 | 0.6 | 6.4% |
| **A-02**** | MH 9 | MH 8 | 4.72 | 8.10 | 3.5 | 1.396 | 1.43 | 2.67 | 4.10 | 250 | 0.30 | 104.2 | 32.5 | 0.7 | 12.6% |
| | MH 8 | MH 7 | 0.00 | 8.10 | 0.0 | 0.000 | 1.43 | 2.67 | 4.10 | 250 | 0.30 | 16.9 | 32.5 | 0.7 | 12.6% |
| | MH 7 | MH 6 | 0.00 | 8.10 | 0.0 | 0.000 | 1.43 | 2.67 | 4.10 | 250 | 0.30 | 83.2 | 32.5 | 0.7 | 12.6% |
| **A-03**** | MH 6 | MH 5 | 4.86 | 12.96 | Varies* | 1.615 | 3.05 | 4.28 | 7.32 | 250 | 0.30 | 73.6 | 32.5 | 0.7 | 22.5% |
| | MH 5 | MH 4 | 0.00 | 12.96 | 0.0 | 0.000 | 3.05 | 4.28 | 7.32 | 250 | 0.30 | 20.3 | 32.5 | 0.7 | 22.5% |
| **A-04**** | MH 4 | MH 3 | 4.66 | 17.62 | 3.5 | 1.396 | 4.44 | 5.81 | 10.26 | 250 | 0.30 | 103.8 | 32.5 | 0.7 | 31.5% |
| | MH 3 | MH 2 | 0.00 | 17.62 | 0.0 | 0.000 | 4.44 | 5.81 | 10.26 | 250 | 0.30 | 86.4 | 32.5 | 0.7 | 31.5% |
| **A-05** | MH 2 | MH 1 | 5.28 | 22.90 | 1.5 | 0.034 | 4.48 | 7.56 | 12.04 | 250 | 2.50 | 70.4 | 93.9 | 1.9 | 12.8% |
| | MH 1 | EX STUB | 0.00 | 22.90 | 0.0 | 0.000 | 4.48 | 7.56 | 12.04 | 250 | 2.50 | 8.0 | 93.9 | 1.9 | 12.8% |
| | | | | | | | | | | | | | | | |
| **Future** | STUB | MH 16 | 3.03 | 3.03 | 1.5 | 1.500 | 1.47 | 1.00 | 2.47 | 250 | 0.30 | 15.5 | 32.5 | 0.7 | 7.6% |
| | MH 16 | MH 15 | 0.00 | 3.03 | 0.0 | 0.000 | 1.47 | 1.00 | 2.47 | 250 | 0.30 | 90.1 | 32.5 | 0.7 | 7.6% |
| | MH 15 | MH 14 | 0.00 | 3.03 | 0.0 | 0.000 | 1.47 | 1.00 | 2.47 | 250 | 0.30 | 16.6 | 32.5 | 0.7 | 7.6% |
| | MH 14 | MH 13 | 0.00 | 3.03 | 0.0 | 0.000 | 1.47 | 1.00 | 2.47 | 250 | 0.30 | 74.0 | 32.5 | 0.7 | 7.6% |
| | MH 13 | EXMH 101 | 0.00 | 3.03 | 0.0 | 0.000 | 1.47 | 1.00 | 2.47 | 250 | 0.30 | 30.8 | 32.5 | 0.7 | 7.6% |
| | | | | | | | **5.95** | **8.56** | **14.51** | | | | | | |

* Area A-03 contains commercial and industrial land uses with peaking factors of 1.5 and 3.5 respectively. Refer to the detailed building use sanitary flows for a comprehensive breakdown.

** The Industrial portion of the building was divided evenly between the 3 proposed building services (areas A-02, A-03, and A-04).

**Design Parameters:**

City of Ottawa Sewer Design Guidelines (Appendix 4-A)

| | | |
|---|---|---|
| - Extraneous Flows | 0.33 | l/s/ha |
| - Commercial Peaking Factor | 1.5 | |

City of Ottawa Sewer Design Guidelines (Appendix 4-B)

| | |
|---|---|
| Industrial Peaking factor | 3.5 |


NOTE:
THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

CITI GATE 416 CORPORATE CAMPUS

REGIONAL THE REGIONAL GROUP

| No. | REVISION | DATE | BY |
|---|---|---|---|
| 4. | ISSUED FOR SWM APPROVAL | AUG 10/14 | MER |
| 3. | ISSUED FOR APPROVAL | JUL 23/14 | MER |
| 2. | REV. PER CITY COMMENTS / ISS. FOR MOE APPROVAL | JUNE 27/14 | MER |
| 1. | ISSUED FOR CITY REVIEW | MAR 31/14 | MER |

SCALE 1:1000

DESIGN LAB
CHECKED MER
DRAWN MTM/BET
CHECKED MER
APPROVED JGR

LICENSED PROFESSIONAL ENGINEER M.E. RIDDELL 100040125 PROVINCE OF ONTARIO Aug 10/14

REGISTERED PROFESSIONAL ENGINEER J.G. RIDDELL PROVINCE OF ONTARIO

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Ottawa, Ontario, Canada K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Website www.novatech-eng.com

LOCATION
CITY OF OTTAWA
CITI GATE 416 CORPORATE CAMPUS

DRAWING NAME
SANITARY DRAINAGE AREA PLAN (OUTLET A)

PROJECT No. 109203-00
REV # 4
DRAWING No. 109203-CG-SAN1

PLANB1.DWG - 1000mmx707mm

M:\2009\109203\Citi Gate\CAD\Design\109203-CG-SAN.dwg, SAN1, Aug 11, 2014 - 2:52pm, bthurber

CITI GATE
416 CORPORATE CAMPUS

NOVATECH
Engineers, Planners & Landscape Architects

# SANITARY SEWER DESIGN SHEET
Citi Gate 416 Corporate Campus
Phase 1 - As-Built

NOVATECH FILE NO.: 109203-0
CITY FILE NO.: D07-16-12-0023
DESIGNED BY: LAB
CHECKED BY: MER/MSP
PREPARED March 31, 2014
REVISED: August 10, 2014
REVISED: September 25, 2015 **AS-BUILT**

| Location | | | | | | Wastewater Flow Q(w) | | Extraneous Flow Q(i) | | Design Flow Q(d) | Proposed Sanitary Sewer | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Area I.D.** | **Street** | **Block Number** | **From MH** | **To MH** | **Area (ha)** | **Individual Peak Flow Rate 50,000 L/ha/d (L/s)** | **Cumulative Peak Flow Rate (L/s)** | **Individual Infiltration Rate 0.28 L/s/ha (L/s)** | **Cumulative Infiltration Rate (L/s)** | **Peak Design Flow (L/s)** | **Length (m)** | **Pipe Size (mm)** | **Type of Pipe** | **Grade %** | **Capacity (L/s)** | **Full Flow Velocity (m/s)** | **Percentage of Capacity** |
| **Sanitary Outlet A to Strandherd Drive at Maravista Drive<br>Plan Reference: Sanitary Drainage Area Plan (109203-CG-SAN1)** | | | | | | | | | | | | | | | | | |
| A-1 | Nortel Drive | | 201 | 203 | 0.40 | 0.35 | 0.35 | 0.11 | 0.11 | 0.46 | | | | | | | |
| A-2 | Nortel Drive | Block 1 | 201 | 203 | 3.49 | 3.03 | 3.38 | 0.98 | 1.09 | 4.47 | | | | | | | |
| A-3 | Nortel Drive | Block 16 | 201 | 203 | 2.50 | 2.17 | 5.55 | 0.70 | 1.79 | 7.34 | | | | | | | |
| A-4 | Nortel Drive | | 201 | 203 | 0.09 | 0.08 | 5.63 | 0.03 | 1.81 | 7.44 | ***36.0*** | 250 | PVC | ***0.53*** | 45.16 | 0.89 | 16% |
| | | BLOCK 13 ALLOTMENT | | | | | | | | | | | | | | | |
| A-5 | Nortel Drive | | 203 | 205 | 0.13 | 0.11 | 5.74 | 0.04 | 1.85 | 7.59 | ***57.5*** | 250 | PVC | ***0.28*** | 32.83 | 0.65 | 23% |
| A-6 | Nortel Drive | Block 17 | 205 | 101 | 1.17 | 1.02 | 6.75 | 0.33 | 2.18 | 8.93 | | | | | | | |
| A-7 | Nortel Drive | | 205 | 101 | 0.20 | 0.17 | 6.93 | 0.06 | 2.23 | 9.16 | ***37.3*** | 250 | PVC | ***0.21*** | 28.43 | 0.56 | 32% |
| ~~A-9~~ | ~~Crosskey Place~~ | | ~~101~~ | ~~207~~ | ~~0.92~~ | ~~0.80~~ | ~~7.73~~ | ~~0.26~~ | 7.54 | 15.27 | | | | | | | |
| A-8 | Crosskey Place | Block 14 | 101 | 207 | 18.03 | 15.65 | 23.38 | 5.05 | 5.05 | 28.43 | ***29.0*** | 300 | PVC | ***0.17*** | 41.59 | 0.57 | 68% |
| A-10 | Nortel Drive | Block 15 | 207 | 209 | 7.98 | 6.93 | 30.30 | 2.23 | 9.77 | 40.08 | | | | | | | |
| ~~A-11~~ | ~~Nortel Drive~~ | | ~~207~~ | ~~209~~ | ~~0.30~~ | ~~0.26~~ | ~~30.56~~ | ~~0.08~~ | 9.86 | 40.42 | ***106.5*** | 300 | PVC | ***0.27*** | 52.42 | 0.72 | 77% |
| A-12 | Nortel Drive | | 209 | 211 | 0.31 | 0.27 | 30.83 | 0.09 | 9.95 | 40.78 | ***118.8*** | 300 | PVC | ***0.29*** | 54.33 | 0.74 | 75% |
| A-13 | Nortel Drive | | 211 | 213 | 0.31 | 0.27 | 31.10 | 0.09 | 10.03 | 41.13 | ***114.6*** | 300 | PVC | ***0.22*** | 47.32 | 0.65 | 87% |
| A-14 | Systemhouse Street | | 213 | 401 | 0.07 | 0.06 | 31.16 | 0.02 | 10.05 | 41.22 | ***26.4*** | 300 | PVC | ***0.23*** | 48.38 | 0.66 | 85% |
| A-15 | Systemhouse Street | | 401 | 403 | 0.21 | 0.18 | 31.35 | 0.06 | 10.11 | 41.46 | ***86.8*** | 300 | PVC | ***0.28*** | 53.38 | 0.73 | 78% |
| A-16 | Systemhouse Street | | 403 | 405 | 0.29 | 0.25 | 31.60 | 0.08 | 10.19 | 41.79 | ***118.8*** | 300 | PVC | ***0.32*** | 57.07 | 0.78 | 73% |
| A-17 | Systemhouse Street | Block 18 | 405 | 407 | 2.29 | 1.99 | 33.59 | 0.64 | 10.83 | 44.42 | | | | | | | |
| A-18 | Systemhouse Street | | 405 | 407 | 0.20 | 0.17 | 33.76 | 0.06 | 10.89 | 44.65 | ***80.4*** | 375 | PVC | ***0.14*** | 68.44 | 0.60 | 65% |
| A-19 | Systemhouse Street | Block 2 | 407 | 409 | 11.95 | 10.37 | 44.13 | 3.35 | 14.24 | 58.37 | | | | | | | |
| A-20 | Systemhouse Street | Block 3 | 407 | 409 | 5.28 | 4.58 | 48.72 | 1.48 | 15.71 | 64.43 | | | | | | | |
| A-21 | Systemhouse Street | | 407 | 409 | 0.30 | 0.26 | 48.98 | 0.08 | 15.80 | 64.77 | ***117.2*** | 375 | PVC | ***0.25*** | 91.46 | 0.80 | 71% |
| A-22 | Systemhouse Street | | 409 | 101 | 0.16 | 0.14 | 49.11 | 0.04 | 15.84 | 64.96 | ***54.8*** | 375 | PVC | ***0.24*** | 89.61 | 0.79 | 72% |
| | | | | | | | | | | **64.96** | | | | | | | |
| | | | | | 56.58 | | | | | | | | | | | | |

Notes:
1. Q(d) = Q(w) + Q(i) , where
2. Q(i) = 0.28 L/s/ha
3. Peaking Factor = 1.5

Q(d) = Design Flow (L/s)
Q(w) = Peak Wastewater Flow (L/s)
Q(i) = Extraneous Flow (L/s)

Legend
***0.20*** As-built pipe grade (%) or length (m)

REGISTERED PROFESSIONAL ENGINEER
J.G. RIDDELL
25/9/15
PROVINCE OF ONTARIO

Prepared by Novatech Engineering Consultants Ltd.
M:\2009\109203\Citi Gate\DATA\Calculations\SAN\20150925-SAN-ASBUILT-PH1.xlsxSan Design Sheet - Outlet A

NOVATECH FILE NO.: 109203-0
CITY FILE NO.: D07-16-12-0023
DESIGNED BY: LAB
CHECKED BY: MER/MSP
DATE (Issued with report): March 31, 2014
REVISED : August 10, 2014
REVISED : September 25, 2015 **AS-BUILT**

# SANITARY SEWER DESIGN SHEET
## Citi Gate 416 Corporate Campus
## Phase 1 - As-Built

CITI GATE 416 CORPORATE CAMPUS — NOVATECH Engineers, Planners & Landscape Architects

| Location | | | | | | Wastewater Flow Q(w) | | Extraneous Flow Q(i) | | Design Flow Q(d) | Proposed Sanitary Sewer | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Area I.D.** | **Street** | **Block Number** | **From MH** | **To MH** | **Area (ha)** | **Individual Peak Flow Rate 50,000 L/ha/d (L/s)** | **Cumulative Peak Flow Rate (L/s)** | **Individual Infiltration Rate 0.28 L/s/ha (L/s)** | **Cumulative Infiltration Rate (L/s)** | **Peak Design Flow (L/s)** | **Length (m)** | **Pipe Size (mm)** | **Type of Pipe** | **Grade %** | **Capacity (L/s)** | **Full Flow Velocity (m/s)** | **Percentage of Capacity** |
| **Sanitary Outlet B to Strandherd Drive at Kennevale Drive Plan**<br>**Reference: Sanitary Drainage Area Plan (109203-CG-SAN2)** | | | | | | | | | | | | | | | | | |
| C-1 | Nortel Drive | Lands Owned by Others | Fut | 501 | 22.68 | 19.69 | 19.69 | 6.35 | 6.35 | 26.04 | ***4.0*** | 300 | PVC | ***0.20*** | 45.12 | 0.62 | 58% |
| B-1 | Dealership Street | Lands Owned by Others | Fut | 501 | 27.06 | 23.49 | 23.49 | 7.58 | 7.58 | 31.07 | ***12.5*** | 300 | PVC | ***0.20*** | 45.12 | 0.62 | 69% |
| B-2 | Dealership Street | Block 11 | 501 | 503 | 2.72 | 2.36 | 45.54 | 0.76 | 14.69 | 60.23 | | | | | | | |
| B-3 | Dealership Street | Block 10 | 501 | 503 | 2.14 | 1.86 | 47.40 | 0.60 | 15.29 | 62.68 | | | | | | | |
| B-4 | Dealership Street | | 501 | 503 | 0.28 | 0.24 | 47.64 | 0.08 | 15.37 | 63.01 | ***119.5*** | 450 | PVC | ***0.14*** | 111.29 | 0.68 | 57% |
| B-5 | Dealership Street | Block 9 | 503 | 505 | 1.84 | 1.60 | 49.24 | 0.52 | 15.88 | 65.12 | | | | | | | |
| B-6 | Dealership Street | | 503 | 505 | 0.29 | 0.25 | 49.49 | 0.08 | 15.96 | 65.45 | ***119.2*** | 450 | PVC | ***0.16*** | 118.97 | 0.72 | 55% |
| B-7 | Dealership Street | Block 12 (SWM) | 505 | 507 | 3.20 | 2.78 | 52.27 | 0.90 | 16.86 | 69.12 | | | | | | | |
| B-8 | Dealership Street | Block 8 | 505 | 507 | 1.64 | 1.42 | 53.69 | 0.46 | 17.32 | 71.01 | | | | | | | |
| B-9 | Dealership Street | | 505 | 507 | 0.20 | 0.17 | 53.86 | 0.06 | 17.37 | 71.24 | ***85.7*** | 450 | PVC | ***0.12*** | 103.03 | 0.63 | 69% |
| B-10 | Dealership Street | Block 19 | 507 | 509 | 2.51 | 2.18 | 56.04 | 0.70 | 18.08 | 74.12 | | | | | | | |
| B-11 | Dealership Street | | 507 | 509 | 0.13 | 0.11 | 56.15 | 0.04 | 18.11 | 74.27 | ***55.9*** | 450 | PVC | ***0.16*** | 118.97 | 0.72 | 62% |
| B-12 | Philsar Street | Block 6 | 603 | 601 | 1.62 | 1.41 | 1.41 | 0.45 | 0.45 | 1.86 | | | | | | | |
| B-13 | Philsar Street | | 603 | 601 | 0.23 | 0.20 | 1.61 | 0.06 | 0.52 | 2.12 | ***41.2*** | 250 | PVC | ***0.19*** | 27.04 | 0.53 | 8% |
| B-15 | Philsar Street | | 601 | 509 | 0.19 | 0.16 | 1.77 | 0.05 | 0.57 | 2.34 | ***101.2*** | 250 | PVC | ***0.25*** | 31.02 | 0.61 | 8% |
| B-16 | Dealership Street | Block 4 | 509 | 511 | 3.39 | 2.94 | 60.87 | 0.95 | 19.63 | 80.50 | | | | | | | |
| B-17 | Dealership Street | | 509 | 511 | 0.24 | 0.21 | 61.08 | 0.07 | 19.70 | 80.78 | ***99.5*** | 450 | PVC | ***0.17*** | 122.63 | 0.75 | 66% |
| B-14 | Dealership Street | Block 5 | 511 | 513 | 2.14 | 1.86 | 62.93 | 0.60 | 20.30 | 83.23 | | | | | | | |
| B-18 | Dealership Street | | 511 | 513 | 0.20 | 0.17 | 63.11 | 0.06 | 20.36 | 83.46 | ***75.9*** | 450 | PVC | ***0.20*** | 133.02 | 0.81 | 63% |
| B-19 | Outlet to Lift Station | | 513 | 515 | 0.04 | 0.03 | 63.14 | 0.01 | 20.37 | **83.51** | ***35.5*** | 450 | PVC | ***0.42*** | 192.76 | 1.17 | 43% |
| | | | | | 72.74 | | | | | | | | | | | | |

Notes:
1. $Q(d) = Q(w) + Q(i)$, where
2. $Q(i) = 0.28$ L/s/ha
3. Peaking Factor = 1.5

Q(d) = Design Flow (L/s)
Q(w) = Peak Wastewater Flow (L/s)
Q(i) = Extraneous Flow (L/s)

Legend:
***0.20*** As-built pipe grade (%) or length (m)

# **Appendix C**

Storm Servicing Information


## LEGEND

PROPERTY LINE
PROPOSED STORM SEWER AND MANHOLE
DIRECTION OF FLOW
PROPOSED CATCHBASIN MANHOLE
PROPOSED CATCHBASIN
STM MH — EXISTING STORM MANHOLE & SEWER
CB 1 — EXISTING CATCHBASIN
STORM SEWER DRAINAGE AREA BOUNDARY
0.085 / A-16 / 0.78 — DRAINAGE AREA (ha) / DRAINAGE AREA ID / RUNOFF COEFFICIENT

REFER TO 120025-ND FOR ADDITIONAL NOTES

NOTE:
THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

NOT FOR CONSTRUCTION

| No. | REVISION | DATE | BY |
|---|---|---|---|
| 5 | REVISED PER CITY COMMENTS | JUNE 1/2020 | MJH |
| 4 | ISSUED FOR INTERNAL REVIEW | MAY 19/2020 | MJH |
| 3 | ISSUED FOR FOUNDATION PERMIT | MAY 5/2020 | MJH |
| 2 | ISSUED FOR DESIGN REVIEW | APR 20/2020 | MJH |
| 1 | APPLICATION FOR SITE PLAN APPROVAL | APR 6/2020 | MJH |

SCALE
1:1000
1:1000
0 10 20 30 40

DESIGN MJH/ARM
CHECKED JLS
DRAWN MJH/ARM
CHECKED JLS
APPROVED JLS

FOR REVIEW ONLY

LICENSED PROFESSIONAL ENGINEER A. R. MESTWARP 100201604 PROVINCE OF ONTARIO June 1, 2020
LICENSED PROFESSIONAL ENGINEER M. J. HREHORIAK 100211256 PROVINCE OF ONTARIO June 1/20

NOVATECH
Engineers, Planners & Landscape Architects
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Ottawa, Ontario, Canada K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Website www.novatech-eng.com

LOCATION
PROJECT PYTHON
222 CITIGATE DRIVE, CITY OF OTTAWA

DRAWING NAME
STORM DRAINAGE AREA PLAN

PROJECT No. 120025
REV REV #5
DRAWING No. 120025 - STM

D07-12-20-0038

PLAN # 18129

**Project Python**
**222 CitiGate Drive**
**Project No.: 120025**

# STORM SEWER DESIGN SHEET
## (222 CITIGATE DR)
### FLOW RATES BASED ON RATIONAL METHOD

NOVATECH
Engineers, Planners & Landscape Architects

| LOCATION | | | AREA (ha) | | | | | FLOW | | | | | | | TOTAL FLOW | SEWER DATA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AREA ID | From Manhole | To Manhole | Total Area (ha) | C = 0.20 | C = 0.90 | C | AC (ha) | Indiv 2.78 AC | Accum 2.78 AC | Time of Concentration | Rainfall Intensity 2 Year (mm/hr) | Rainfall Intensity 5 Year (mm/hr) | Rainfall Intensity 10 Year (mm/hr) | Peak Flow (L/s) | Total Peak Flow, Q (L/s) | Dia. (m) Actual | Dia. (mm) | Type | Slope (%) | Length (m) | Capacity (L/s) | Velocity (m/s) | Flow Time (min) | Ratio Q/Q full |
| **NORTH PARKING SYSTEM (1:5 YEAR STORM EVENT)** | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| **A-19** | STMMH 120 | STMMH 119 | 0.470 | 0.155 | 0.315 | 0.67 | 0.31 | 0.874 | 0.874 | 10.00 | | 104.19 | | 91.1 | 91.1 | 0.305 | 300 | PVC | 2.60 | 97.3 | 162.5 | 2.23 | 0.73 | 56% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.73 | | | | | | | | | | | | | | |
| **A-01** | STMMH 119 | STMMH 118 | 0.250 | 0.089 | 0.161 | 0.65 | 0.16 | 0.452 | 1.327 | 10.73 | | 100.50 | | 133.3 | 133.3 | 0.457 | 450 | Conc | 2.00 | 59.1 | 420.3 | 2.56 | 0.38 | 32% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.73 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.11 | | | | | | | | | | | | | | |
| | STMMH 118 | STMMH 117 | | | | | 0.00 | 0.000 | 1.327 | 11.11 | | 98.66 | | 130.9 | 130.9 | 0.457 | 450 | Conc | 2.00 | 21.8 | 420.3 | 2.56 | 0.14 | 31% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.11 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| **FUT** | STUB | STMMH 117 | 2.660 | 0.399 | 2.261 | 0.80 | 2.11 | 5.879 | 5.879 | 10.00 | | 104.19 | | 612.5 | 612.5 | 0.914 | 900 | Conc | 0.30 | 12.5 | 1,033.9 | 1.57 | 0.13 | 59% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.25 | | | | | | | | | | | | | | |
| **A-02** | STMMH 117 | STMMH 107 | 0.250 | 0.107 | 0.143 | 0.60 | 0.15 | 0.417 | 7.623 | 11.25 | | 98.00 | | 747.0 | 747.0 | 0.914 | 900 | Conc | 0.30 | 93.7 | 1,033.9 | 1.57 | 0.99 | 72% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.25 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| **A-20** | STMMH 116 | STMMH 115 | 0.230 | 0.131 | 0.099 | 0.50 | 0.12 | 0.321 | 0.321 | 10.00 | | 104.19 | | 33.4 | 33.4 | 0.305 | 300 | PVC | 2.80 | 48.9 | 168.7 | 2.31 | 0.35 | 20% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.35 | | | | | | | | | | | | | | |
| **A-21** | STMMH 115 | STMMH 114 | 0.300 | 0.086 | 0.214 | 0.70 | 0.21 | 0.583 | 0.904 | 10.35 | | 102.37 | | 92.5 | 92.5 | 0.533 | 525 | Conc | 1.00 | 31.0 | 448.4 | 2.01 | 0.26 | 21% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.35 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.61 | | | | | | | | | | | | | | |
| **A-22** | STMMH 114 | STMMH 113 | 1.920 | 0.182 | 1.738 | 0.83 | 1.60 | 4.450 | 5.353 | 10.61 | | 101.08 | | 541.1 | 541.1 | 0.838 | 825 | Conc | 1.00 | 118.7 | 1,496.7 | 2.71 | 0.73 | 36% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.61 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.34 | | | | | | | | | | | | | | |
| | STMMH 113 | STMMH 110 | 0.000 | 0.000 | 0.000 | | 0.00 | 0.000 | 5.353 | 11.34 | | 97.61 | | 522.6 | 522.6 | 0.838 | 825 | Conc | 1.00 | 22.8 | 1,496.7 | 2.71 | 0.14 | 35% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.34 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| **A-17** | STMMH 111 | STMMH 110 | 0.420 | 0.000 | 0.420 | 0.90 | 0.38 | 1.051 | 1.051 | 10.00 | | 104.19 | | 109.5 | 109.5 | 0.457 | 450 | Conc | 1.40 | 76.8 | 351.7 | 2.14 | 0.60 | 31% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.48 | | | | | | | | | | | | | | |
| | STMMH 110 | CBMH 109 | 0.000 | 0.000 | 0.000 | | 0.00 | 0.000 | 6.404 | 11.48 | | 96.98 | | 621.1 | 621.1 | 0.838 | 825 | Conc | 1.00 | 8.8 | 1,496.7 | 2.71 | 0.05 | 41% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.48 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.53 | | | | | | | | | | | | | | |
| **A-18** | CBMH 109 | STMMH 108 | 0.230 | 0.003 | 0.227 | 0.89 | 0.20 | 0.570 | 6.974 | 11.53 | | 96.73 | | 674.6 | 674.6 | 0.838 | 825 | Conc | 1.00 | 42.6 | 1,496.7 | 2.71 | 0.26 | 45% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.53 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.80 | | | | | | | | | | | | | | |
| **A-06** | STMMH 108 | STMMH 107 | 0.660 | 0.160 | 0.500 | 0.73 | 0.48 | 1.340 | 8.314 | 11.80 | | 95.58 | | 794.6 | 794.6 | 0.838 | 825 | Conc | 1.00 | 17.9 | 1,496.7 | 2.71 | 0.11 | 53% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.80 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 12.25 | | | | | | | | | | | | | | |
| | STMMH 107 | STMMH 106 | 0.000 | 0.000 | 0.000 | | 0.00 | 0.000 | 15.937 | 12.25 | | 93.66 | | 1,492.6 | 1,492.6 | 1.067 | 1050 | Conc | 0.40 | 17.8 | 1,800.9 | 2.01 | 0.15 | 83% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 12.25 | | | | | | | | | | | | | | |

**Project Python**
**222 CitiGate Drive**
**Project No.: 120025**

# STORM SEWER DESIGN SHEET
## (222 CITIGATE DR)
### FLOW RATES BASED ON RATIONAL METHOD

NOVATECH
Engineers, Planners & Landscape Architects

| LOCATION | | | AREA (ha) | | | | | FLOW | | | | | | | TOTAL FLOW | SEWER DATA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AREA ID | From Manhole | To Manhole | Total Area (ha) | C = 0.20 | C = 0.90 | C | AC (ha) | Indiv 2.78 AC | Accum 2.78 AC | Time of Concentration | Rainfall Intensity 2 Year (mm/hr) | Rainfall Intensity 5 Year (mm/hr) | Rainfall Intensity 10 Year (mm/hr) | Peak Flow (L/s) | Total Peak Flow, Q (L/s) | Dia. (m) Actual | Dia. (mm) | Type | Slope (%) | Length (m) | Capacity (L/s) | Velocity (m/s) | Flow Time (min) | Ratio Q/Q full |
| | | | | | | | 0.00 | 0.000 | 0.000 | 12.39 | | | | | | | | | | | | | | |
| **A-03** | STMMH 106 | STMMH 102 | 0.100 | 0.050 | 0.050 | 0.55 | 0.06 | 0.153 | 16.090 | 12.39 | | 93.05 | | 1,497.1 | 1,497.1 | 1.067 | 1050 | Conc | 0.40 | 38.2 | 1,800.9 | 2.01 | 0.32 | 83% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 12.39 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| **A-08** | STMMH 105 | STMMH 104 | 1.050 | 0.090 | 0.960 | 0.84 | 0.88 | 2.452 | 2.452 | 10.00 | | 104.19 | | 255.5 | 255.5 | 0.762 | 750 | Conc | 0.50 | 92.3 | 820.8 | 1.80 | 0.85 | 31% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.85 | | | | | | | | | | | | | | |
| **A-07** | STMMH 104 | STMMH 103 | 1.040 | 0.134 | 0.906 | 0.81 | 0.84 | 2.341 | 4.793 | 10.85 | | 99.89 | | 478.8 | 478.8 | 0.762 | 750 | Conc | 1.00 | 87.8 | 1,160.8 | 2.55 | 0.57 | 41% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.85 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.43 | | | | | | | | | | | | | | |
| **A-04, A-28** | STMMH 103 | STMMH 102 | 0.210 | 0.077 | 0.133 | 0.64 | 0.14 | 0.376 | 5.169 | 11.43 | | 97.20 | | 502.4 | 502.4 | 0.762 | 750 | Conc | 1.00 | 19.9 | 1,160.8 | 2.55 | 0.13 | 43% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.43 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 12.71 | | | | | | | | | | | | | | |
| | STMMH 102 | STMMH 101 | 0.000 | 0.000 | 0.000 | | 0.00 | 0.000 | 21.258 | 12.71 | | 91.77 | | 1,950.9 | 1,950.9 | 1.067 | 1050 | Conc | 0.60 | 37.2 | 2,205.7 | 2.47 | 0.25 | 88% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 12.71 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 12.96 | | | | | | | | | | | | | | |
| **A-05** | STMMH 101 | EX STMMH | 0.180 | 0.080 | 0.100 | 0.59 | 0.11 | 0.295 | 21.553 | 12.96 | | 90.78 | | 1,956.6 | 1,956.6 | 1.067 | 1050 | Conc | 0.60 | 31.1 | 2,205.7 | 2.47 | 0.21 | 89% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 12.96 | | | | | | | | | | | | | | |
| **SOUTH PARKING SYSTEM (1:5 YEAR STORM EVENT)** | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| **A-23** | STMMH 16 | STMMH 15 | 2.730 | 1.100 | 1.630 | 0.62 | 1.69 | 4.690 | 4.690 | 10.00 | | 104.19 | | 488.7 | 488.7 | 0.914 | 900 | Conc | 0.30 | 102.5 | 1,033.9 | 1.57 | 1.09 | 47% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.09 | | | | | | | | | | | | | | |
| **A-24** | STMMH 15 | STMMH 14 | 2.220 | 0.348 | 1.872 | 0.79 | 1.75 | 4.877 | 9.567 | 11.09 | | 98.79 | | 945.1 | 945.1 | 1.219 | 1200 | Conc | 0.30 | 120.0 | 2,226.9 | 1.91 | 1.05 | 42% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.09 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 12.13 | | | | | | | | | | | | | | |
| **A-25** | STMMH 14 | STMMH 13 | 1.590 | 0.381 | 1.209 | 0.73 | 1.16 | 3.237 | 12.804 | 12.13 | | 94.13 | | 1,205.2 | 1,205.2 | 1.219 | 1200 | Conc | 0.30 | 120.0 | 2,226.9 | 1.91 | 1.05 | 54% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 12.13 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 13.18 | | | | | | | | | | | | | | |
| **A-27** | STMMH 13 | STMMH 12 | 1.930 | 0.576 | 1.325 | 0.68 | 1.31 | 3.635 | 16.439 | 13.18 | | 89.93 | | 1,478.4 | 1,478.4 | 1.219 | 1200 | Conc | 0.30 | 80.4 | 2,226.9 | 1.91 | 0.70 | 66% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 13.18 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 13.88 | | | | | | | | | | | | | | |
| **A-26** | STMMH 12 | STMMH 11 | 1.930 | 0.072 | 1.858 | 0.87 | 1.69 | 4.689 | 21.128 | 13.88 | | 87.34 | | 1,845.4 | 1,845.4 | 1.219 | 1200 | Conc | 0.30 | 88.6 | 2,226.9 | 1.91 | 0.77 | 83% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 13.88 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 14.66 | | | | | | | | | | | | | | |
| **A-14** | STMMH 11 | STMMH 06 | 0.420 | 0.085 | 0.335 | 0.76 | 0.32 | 0.885 | 22.013 | 14.66 | | 84.68 | | 1,864.0 | 1,864.0 | 1.219 | 1200 | Conc | 0.30 | 44.5 | 2,226.9 | 1.91 | 0.39 | 84% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 14.66 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| **A-16A** | STMMH 10B | STMMH 10A | 0.820 | 0.000 | 0.820 | 0.90 | 0.74 | 2.052 | 2.052 | 10.00 | | 104.19 | | 213.8 | 213.8 | 0.610 | 600 | Conc | 1.00 | 72.4 | 640.2 | 2.19 | 0.55 | 33% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.55 | | | | | | | | | | | | | | |
| **A-16B** | STMMH 10A | STMMH 07 | 0.670 | 0.000 | 0.670 | 0.90 | 0.60 | 1.676 | 3.728 | 10.55 | | 101.37 | | 377.9 | 377.9 | 0.610 | 599 | Conc | 1.00 | 70.0 | 640.2 | 2.19 | 0.53 | 59% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.55 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.08 | | | | | | | | | | | | | | |
| | STMMH 09 | STMMH 07 | 0.000 | 0.000 | 0.000 | | 0.00 | 0.000 | 3.728 | 11.08 | | 98.80 | | 368.3 | 368.3 | 0.610 | 600 | Conc | 1.00 | 20.3 | 640.2 | 2.19 | 0.15 | 58% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.08 | | | | | | | | | | | | | | |

**Project Python**
**222 CitiGate Drive**
**Project No.: 120025**

# STORM SEWER DESIGN SHEET
## (222 CITIGATE DR)
### FLOW RATES BASED ON RATIONAL METHOD

NOVATECH
Engineers, Planners & Landscape Architects

| LOCATION | | | AREA (ha) | | | | | FLOW | | | | | | | TOTAL FLOW | SEWER DATA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AREA ID | From Manhole | To Manhole | Total Area (ha) | C = 0.20 | C = 0.90 | C | AC (ha) | Indiv 2.78 AC | Accum 2.78 AC | Time of Concentration | Rainfall Intensity 2 Year (mm/hr) | Rainfall Intensity 5 Year (mm/hr) | Rainfall Intensity 10 Year (mm/hr) | Peak Flow (L/s) | Total Peak Flow, Q (L/s) | Dia. (m) Actual | Dia. (mm) | Type | Slope (%) | Length (m) | Capacity (L/s) | Velocity (m/s) | Flow Time (min) | Ratio Q/Q full |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.24 | | | | | | | | | | | | | | |
| **A-15** | STMMH 07 | STMMH 06 | 0.610 | 0.011 | 0.599 | 0.89 | 0.54 | 1.505 | 5.233 | 11.24 | | 98.09 | | 513.3 | 513.3 | 0.610 | 600 | Conc | 1.00 | 106.6 | 640.2 | 2.19 | 0.81 | 80% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 11.24 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 15.05 | | | | | | | | | | | | | | |
| **A-13** | STMMH 06 | STMMH 05 | 0.300 | 0.116 | 0.184 | 0.63 | 0.19 | 0.525 | 27.771 | 15.05 | | 83.40 | | 2,316.2 | 2,316.2 | 1.219 | 1200 | Conc | 0.70 | 81.9 | 3,401.6 | 2.91 | 0.47 | 68% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 15.05 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 15.52 | | | | | | | | | | | | | | |
| **A-12** | STMMH 05 | STMMH 02 | 0.450 | 0.276 | 0.174 | 0.47 | 0.21 | 0.589 | 28.360 | 15.52 | | 81.93 | | 2,323.4 | 2,323.4 | 1.219 | 1200 | Conc | 0.70 | 66.9 | 3,401.6 | 2.91 | 0.38 | 68% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 15.52 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| **A-09** | STMMH 04 | STMMH 03 | 0.640 | 0.100 | 0.540 | 0.79 | 0.51 | 1.407 | 1.407 | 10.00 | | 104.19 | | 146.6 | 146.6 | 0.533 | 525 | Conc | 1.00 | 63.2 | 448.4 | 2.01 | 0.52 | 33% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.00 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.52 | | | | | | | | | | | | | | |
| **A-10** | STMMH 03 | STMMH 02 | 0.880 | 0.050 | 0.830 | 0.86 | 0.76 | 2.104 | 3.511 | 10.52 | | 101.50 | | 356.4 | 356.4 | 0.610 | 600 | Conc | 1.50 | 116.0 | 784.0 | 2.69 | 0.72 | 45% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 10.52 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 15.90 | | | | | | | | | | | | | | |
| **A-11** | STMMH 02 | STMMH 01 | 0.040 | 0.004 | 0.036 | 0.83 | 0.03 | 0.092 | 31.963 | 15.90 | | 80.76 | | 2,581.4 | 2,581.4 | 1.219 | 1200 | Conc | 0.60 | 15.0 | 3,149.3 | 2.70 | 0.09 | 82% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 15.90 | | | | | | | | | | | | | | |
| | | | | | | | 0.00 | 0.000 | 0.000 | 15.99 | | | | | | | | | | | | | | |
| | STMMH 01 | EX STMMH | 0.000 | 0.000 | 0.000 | | 0.00 | 0.000 | 31.963 | 15.99 | | 80.49 | | 2,572.6 | 2,572.6 | 1.219 | 1200 | Conc | 0.60 | 12.2 | 3,149.3 | 2.70 | 0.08 | 82% |
| | | | | | | | 0.00 | 0.000 | 0.000 | 15.99 | | | | | | | | | | | | | | |

Q = 2.78 AIC, where
Q = Peak Flow in Litres per Second (L/s)
A = Area in hectares (ha)
I = Rainfall Intensity (mm/hr), 5 year storm
C = Runoff Coefficient

| | | |
|---|---|---|
| **Consultant:** | Novatech | |
| **Date:** | May 25, 2020 | |
| **Design By:** | Matthew Hrehoriak | |
| **Client:** | **Dwg. Reference:** | **Checked By:** |
| | 120025-STM | LS |

| PROJECT INFORMATION | |
|---|---|
| ENGINEERED PRODUCT MANAGER: | HAIDER NASRULLAH<br>647-850-9417<br>HAIDER.NASRULLAH@ADS-PIPE.COM |
| ADS SALES REP: | MICHAEL REID<br>613-882-4186<br>MICHAEL.REID@ADS-PIPE.COM |
| PROJECT NO: | S181876 |
| ADS SITE COORDINATOR: | MATTHEW BEGHIN<br>519-710-3687<br>MATTHEW.BEGHIN@ADS-PIPE.COM |

ADVANCED DRAINAGE SYSTEMS, INC.

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# PROJECT PYTHON

## OTTAWA,ON.

## MC-3500 STORMTECH CHAMBER SPECIFICATIONS

1. CHAMBERS SHALL BE STORMTECH MC-3500.
2. CHAMBERS SHALL BE ARCH-SHAPED AND SHALL BE MANUFACTURED FROM VIRGIN, IMPACT-MODIFIED POLYPROPYLENE COPOLYMERS.
3. CHAMBERS SHALL BE CERTIFIED TO CSA B184, "POLYMERIC SUB-SURFACE STORMWATER MANAGEMENT STRUCTURES", AND MEET THE REQUIREMENTS OF ASTM F2418-16a, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 45x76 DESIGNATION SS.
4. CHAMBER ROWS SHALL PROVIDE CONTINUOUS, UNOBSTRUCTED INTERNAL SPACE WITH NO INTERNAL SUPPORTS THAT WOULD IMPEDE FLOW OR LIMIT ACCESS FOR INSPECTION.
5. THE STRUCTURAL DESIGN OF THE CHAMBERS, THE STRUCTURAL BACKFILL, AND THE INSTALLATION REQUIREMENTS SHALL ENSURE THAT THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12.12, ARE MET FOR: 1) LONG-DURATION DEAD LOADS AND 2) SHORT-DURATION LIVE LOADS, BASED ON THE CSA S6 CL-625 TRUCK AND THE AASHTO DESIGN TRUCK WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.
6. CHAMBERS SHALL BE DESIGNED, TESTED AND ALLOWABLE LOAD CONFIGURATIONS DETERMINED IN ACCORDANCE WITH ASTM F2787, "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS". LOAD CONFIGURATIONS SHALL INCLUDE: 1) INSTANTANEOUS (<1 MIN) AASHTO DESIGN TRUCK LIVE LOAD ON MINIMUM COVER 2) MAXIMUM PERMANENT (75-YR) COVER LOAD AND 3) ALLOWABLE COVER WITH PARKED (1-WEEK) AASHTO DESIGN TRUCK.
7. REQUIREMENTS FOR HANDLING AND INSTALLATION:
   - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
   - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 75 mm (3").
   - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2418 SHALL BE GREATER THAN OR EQUAL TO 500 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 23° C / 73° F), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.
8. ONLY CHAMBERS THAT ARE APPROVED BY THE SITE DESIGN ENGINEER WILL BE ALLOWED. UPON REQUEST BY THE SITE DESIGN ENGINEER OR OWNER, THE CHAMBER MANUFACTURER SHALL SUBMIT A STRUCTURAL EVALUATION FOR APPROVAL BEFORE DELIVERING CHAMBERS TO THE PROJECT SITE AS FOLLOWS:
   - THE STRUCTURAL EVALUATION SHALL BE SEALED BY A REGISTERED PROFESSIONAL ENGINEER.
   - THE STRUCTURAL EVALUATION SHALL DEMONSTRATE THAT THE SAFETY FACTORS ARE GREATER THAN OR EQUAL TO 1.95 FOR DEAD LOAD AND 1.75 FOR LIVE LOAD, THE MINIMUM REQUIRED BY ASTM F2787 AND BY SECTIONS 3 AND 12.12 OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS FOR THERMOPLASTIC PIPE.
   - THE TEST DERIVED CREEP MODULUS AS SPECIFIED IN ASTM F2418 SHALL BE USED FOR PERMANENT DEAD LOAD DESIGN EXCEPT THAT IT SHALL BE THE 75-YEAR MODULUS USED FOR DESIGN.
9. CHAMBERS AND END CAPS SHALL BE PRODUCED AT AN ISO 9001 CERTIFIED MANUFACTURING FACILITY.

IMPORTANT - THIS PROJECT REQUIRES COMPACTION OF EMBEDMENT STONE AND REQUIREMENTS FOR STONE HARDNESS AND SHAPE WHICH ARE NOT SPECIFIED IN OTHER STORMTECH DOCUMENTS. CONTRACTORS MUST FOLLOW THE SPECIAL PROVISIONS IN THIS PLAN SET.

## IMPORTANT - NOTES FOR THE BIDDING AND INSTALLATION OF MC-3500 CHAMBER SYSTEM

1. STORMTECH MC-3500 CHAMBERS SHALL NOT BE INSTALLED UNTIL THE MANUFACTURER'S REPRESENTATIVE HAS COMPLETED A PRE-CONSTRUCTION MEETING WITH THE INSTALLERS.
2. STORMTECH MC-3500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. CHAMBERS ARE NOT TO BE BACKFILLED WITH A DOZER OR AN EXCAVATOR SITUATED OVER THE CHAMBERS. STORMTECH RECOMMENDS 3 BACKFILL METHODS:
   - STONESHOOTER LOCATED OFF THE CHAMBER BED.
   - BACKFILL AS ROWS ARE BUILT USING AN EXCAVATOR ON THE FOUNDATION STONE OR SUBGRADE.
   - BACKFILL FROM OUTSIDE THE EXCAVATION USING A LONG BOOM HOE OR EXCAVATOR.
4. THE FOUNDATION STONE SHALL BE LEVELED AND COMPACTED PRIOR TO PLACING CHAMBERS.
5. JOINTS BETWEEN CHAMBERS SHALL BE PROPERLY SEATED PRIOR TO PLACING STONE.
6. MAINTAIN MINIMUM - 230 mm (9") SPACING BETWEEN THE CHAMBER ROWS.
7. INLET AND OUTLET MANIFOLDS MUST BE INSERTED A MINIMUM OF 300 mm (12") INTO CHAMBER END CAPS.
8. EMBEDMENT STONE SURROUNDING CHAMBERS MUST BE A CLEAN, CRUSHED, ANGULAR STONE WELL GRADED BETWEEN ¾" AND 2" (20-50 mm)..
9. STONE MUST BE PLACED ON THE TOP CENTER OF THE CHAMBER TO ANCHOR THE CHAMBERS IN PLACE AND PRESERVE ROW SPACING.
10. THE CONTRACTOR MUST REPORT ANY DISCREPANCIES WITH CHAMBER FOUNDATION MATERIALS BEARING CAPACITIES TO THE SITE DESIGN ENGINEER.
11. ADS RECOMMENDS THE USE OF "FLEXSTORM CATCH IT" INSERTS DURING CONSTRUCTION FOR ALL INLETS TO PROTECT THE SUBSURFACE STORMWATER MANAGEMENT SYSTEM FROM CONSTRUCTION SITE RUNOFF.

## NOTES FOR CONSTRUCTION EQUIPMENT

1. STORMTECH MC-3500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
2. THE USE OF EQUIPMENT OVER MC-3500 CHAMBERS IS LIMITED:
   - NO EQUIPMENT IS ALLOWED ON BARE CHAMBERS.
   - NO RUBBER TIRED LOADER, DUMP TRUCK, OR EXCAVATORS ARE ALLOWED UNTIL PROPER FILL DEPTHS ARE REACHED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
   - WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT CAN BE FOUND IN THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. FULL 900 mm (36") OF STABILIZED COVER MATERIALS OVER THE CHAMBERS IS REQUIRED FOR DUMP TRUCK TRAVEL OR DUMPING.

**USE OF A DOZER TO PUSH EMBEDMENT STONE BETWEEN THE ROWS OF CHAMBERS MAY CAUSE DAMAGE TO CHAMBERS AND IS NOT AN ACCEPTABLE BACKFILL METHOD. ANY CHAMBERS DAMAGED BY USING THE "DUMP AND PUSH" METHOD ARE NOT COVERED UNDER THE STORMTECH STANDARD WARRANTY.**

CONTACT STORMTECH AT 1-888-892-2694 WITH ANY QUESTIONS ON INSTALLATION REQUIREMENTS OR WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT.

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## MC-4500 STORMTECH CHAMBER SPECIFICATIONS

1. CHAMBERS SHALL BE STORMTECH MC-4500.
2. CHAMBERS SHALL BE ARCH-SHAPED AND SHALL BE MANUFACTURED FROM VIRGIN, IMPACT-MODIFIED POLYPROPYLENE COPOLYMERS.
3. CHAMBERS SHALL BE CERTIFIED TO CSA B184, "POLYMERIC SUB-SURFACE STORMWATER MANAGEMENT STRUCTURES", AND MEET THE REQUIREMENTS OF ASTM F2418-16a, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 60x101.
4. CHAMBER ROWS SHALL PROVIDE CONTINUOUS, UNOBSTRUCTED INTERNAL SPACE WITH NO INTERNAL SUPPORTS THAT WOULD IMPEDE FLOW OR LIMIT ACCESS FOR INSPECTION.
5. THE STRUCTURAL DESIGN OF THE CHAMBERS, THE STRUCTURAL BACKFILL, AND THE INSTALLATION REQUIREMENTS SHALL ENSURE THAT THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12.12, ARE MET FOR: 1) LONG-DURATION DEAD LOADS AND 2) SHORT-DURATION LIVE LOADS, BASED ON THE CSA S6 CL-625 TRUCK AND THE AASHTO DESIGN TRUCK WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.
6. CHAMBERS SHALL BE DESIGNED, TESTED AND ALLOWABLE LOAD CONFIGURATIONS DETERMINED IN ACCORDANCE WITH ASTM F2787, "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS". LOAD CONFIGURATIONS SHALL INCLUDE: 1) INSTANTANEOUS (<1 MIN) AASHTO DESIGN TRUCK LIVE LOAD ON MINIMUM COVER 2) MAXIMUM PERMANENT (75-YR) COVER LOAD AND 3) ALLOWABLE COVER WITH PARKED (1-WEEK) AASHTO DESIGN TRUCK.
7. REQUIREMENTS FOR HANDLING AND INSTALLATION:
   - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
   - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 75 mm (3").
   - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2418 SHALL BE GREATER THAN OR EQUAL TO 500 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 23° C / 73° F), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.
8. ONLY CHAMBERS THAT ARE APPROVED BY THE SITE DESIGN ENGINEER WILL BE ALLOWED. UPON REQUEST BY THE SITE DESIGN ENGINEER OR OWNER, THE CHAMBER MANUFACTURER SHALL SUBMIT A STRUCTURAL EVALUATION FOR APPROVAL BEFORE DELIVERING CHAMBERS TO THE PROJECT SITE AS FOLLOWS:
   - THE STRUCTURAL EVALUATION SHALL BE SEALED BY A REGISTERED PROFESSIONAL ENGINEER.
   - THE STRUCTURAL EVALUATION SHALL DEMONSTRATE THAT THE SAFETY FACTORS ARE GREATER THAN OR EQUAL TO 1.95 FOR DEAD LOAD AND 1.75 FOR LIVE LOAD, THE MINIMUM REQUIRED BY ASTM F2787 AND BY SECTIONS 3 AND 12.12 OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS FOR THERMOPLASTIC PIPE.
   - THE TEST DERIVED CREEP MODULUS AS SPECIFIED IN ASTM F2418 SHALL BE USED FOR PERMANENT DEAD LOAD DESIGN EXCEPT THAT IT SHALL BE THE 75-YEAR MODULUS USED FOR DESIGN.
9. CHAMBERS AND END CAPS SHALL BE PRODUCED AT AN ISO 9001 CERTIFIED MANUFACTURING FACILITY.

IMPORTANT - THIS PROJECT REQUIRES COMPACTION OF EMBEDMENT STONE AND REQUIREMENTS FOR STONE HARDNESS AND SHAPE WHICH ARE NOT SPECIFIED IN OTHER STORMTECH DOCUMENTS. CONTRACTORS MUST FOLLOW THE SPECIAL PROVISIONS IN THIS PLAN SET.

## IMPORTANT - NOTES FOR THE BIDDING AND INSTALLATION OF MC-4500 CHAMBER SYSTEM

1. STORMTECH MC-4500 CHAMBERS SHALL NOT BE INSTALLED UNTIL THE MANUFACTURER'S REPRESENTATIVE HAS COMPLETED A PRE-CONSTRUCTION MEETING WITH THE INSTALLERS.
2. STORMTECH MC-4500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. CHAMBERS ARE NOT TO BE BACKFILLED WITH A DOZER OR EXCAVATOR SITUATED OVER THE CHAMBERS. STORMTECH RECOMMENDS 3 BACKFILL METHODS:
   - STONESHOOTER LOCATED OFF THE CHAMBER BED.
   - BACKFILL AS ROWS ARE BUILT USING AN EXCAVATOR ON THE FOUNDATION STONE OR SUBGRADE.
   - BACKFILL FROM OUTSIDE THE EXCAVATION USING A LONG BOOM HOE OR EXCAVATOR.
4. THE FOUNDATION STONE SHALL BE LEVELED AND COMPACTED PRIOR TO PLACING CHAMBERS.
5. JOINTS BETWEEN CHAMBERS SHALL BE PROPERLY SEATED PRIOR TO PLACING STONE.
6. MAINTAIN MINIMUM - 230 mm (9") SPACING BETWEEN THE CHAMBER ROWS.
7. INLET AND OUTLET MANIFOLDS MUST BE INSERTED A MINIMUM OF 300 mm (12") INTO CHAMBER END CAPS.
8. EMBEDMENT STONE SURROUNDING CHAMBERS MUST BE A CLEAN, CRUSHED, ANGULAR STONE WELL GRADED BETWEEN ¾" AND 2" (20-50 mm).
9. STONE SHALL BE BROUGHT UP EVENLY AROUND CHAMBERS SO AS NOT TO DISTORT THE CHAMBER SHAPE. STONE DEPTHS SHOULD NEVER DIFFER BY MORE THAN 300 mm (12") BETWEEN ADJACENT CHAMBER ROWS.
10. STONE MUST BE PLACED ON THE TOP CENTER OF THE CHAMBER TO ANCHOR THE CHAMBERS IN PLACE AND PRESERVE ROW SPACING.
11. THE CONTRACTOR MUST REPORT ANY DISCREPANCIES WITH CHAMBER FOUNDATION MATERIAL BEARING CAPACITIES TO THE SITE DESIGN ENGINEER.
12. ADS RECOMMENDS THE USE OF "FLEXSTORM CATCH IT" INSERTS DURING CONSTRUCTION FOR ALL INLETS TO PROTECT THE SUBSURFACE STORMWATER MANAGEMENT SYSTEM FROM CONSTRUCTION SITE RUNOFF.

## NOTES FOR CONSTRUCTION EQUIPMENT

1. STORMTECH MC-4500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
2. THE USE OF EQUIPMENT OVER MC-4500 CHAMBERS IS LIMITED:
   - NO EQUIPMENT IS ALLOWED ON BARE CHAMBERS.
   - NO RUBBER TIRED LOADER, DUMP TRUCK, OR EXCAVATORS ARE ALLOWED UNTIL PROPER FILL DEPTHS ARE REACHED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
   - WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT CAN BE FOUND IN THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. FULL 900 mm (36") OF STABILIZED COVER MATERIALS OVER THE CHAMBERS IS REQUIRED FOR DUMP TRUCK TRAVEL OR DUMPING.

**USE OF A DOZER TO PUSH EMBEDMENT STONE BETWEEN THE ROWS OF CHAMBERS MAY CAUSE DAMAGE TO CHAMBERS AND IS NOT AN ACCEPTABLE BACKFILL METHOD. ANY CHAMBERS DAMAGED BY USING THE "DUMP AND PUSH" METHOD ARE NOT COVERED UNDER THE STORMTECH STANDARD WARRANTY.**

CONTACT STORMTECH AT 1-888-892-2694 WITH ANY QUESTIONS ON INSTALLATION REQUIREMENTS OR WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT.

## PROPOSED LAYOUT - SYSTEM 1

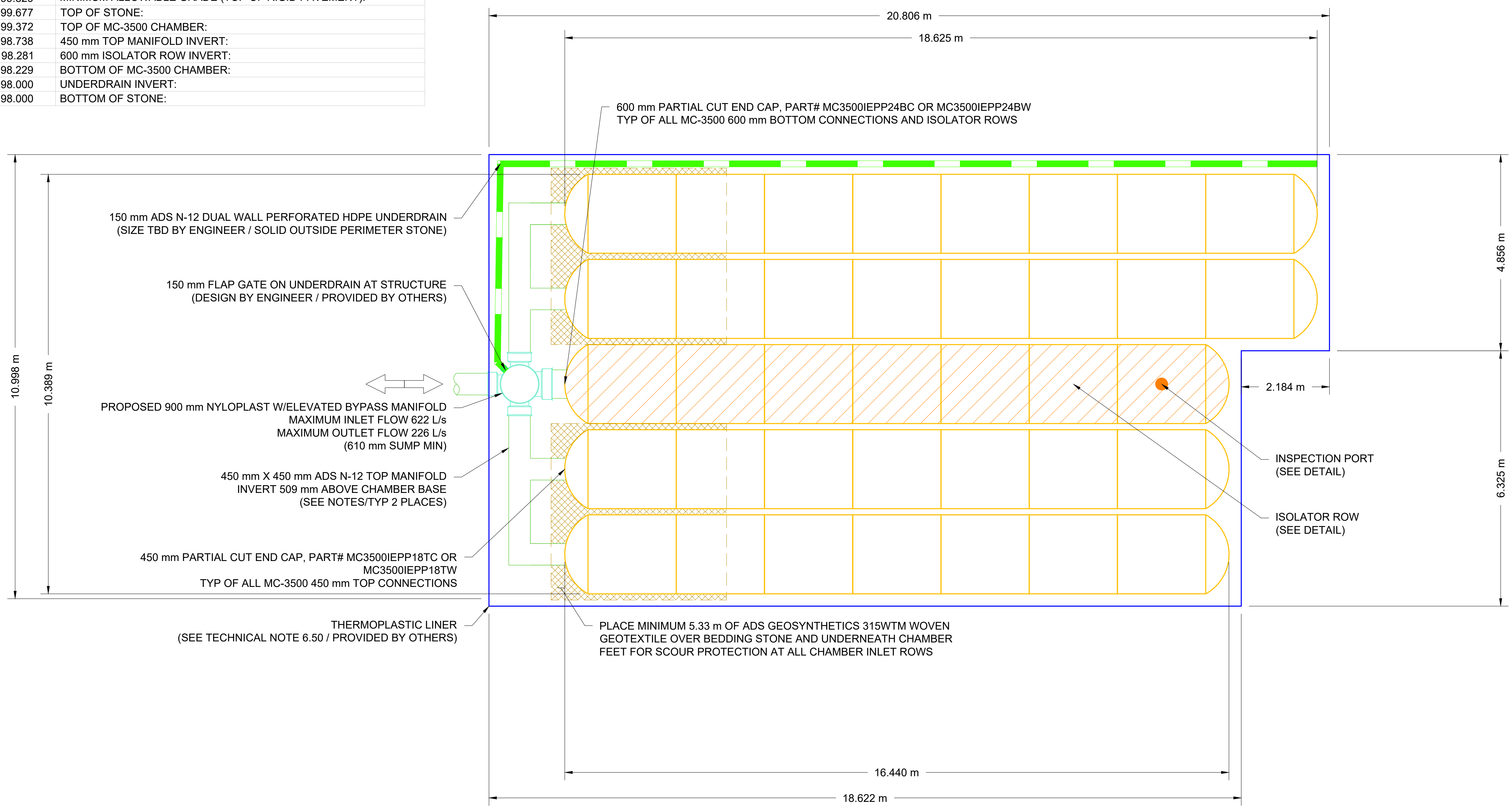
| | |
|---|---|
| 37 | STORMTECH MC-3500 CHAMBERS |
| 10 | STORMTECH MC-3500 END CAPS |
| 305 | STONE ABOVE (mm) |
| 229 | STONE BELOW (mm) |
| 40 | % STONE VOID |
| **218.3** | **INSTALLED SYSTEM VOLUME (m³) (PERIMETER STONE INCLUDED)** |
| 218.8 | SYSTEM AREA (m²) |
| 63.9 | SYSTEM PERIMETER (m) |

## PROPOSED ELEVATIONS - SYSTEM 1

| | |
|---|---|
| 101.810 | MAXIMUM ALLOWABLE GRADE (TOP OF PAVEMENT/UNPAVED): |
| 99.982 | MINIMUM ALLOWABLE GRADE (UNPAVED WITH TRAFFIC): |
| 99.829 | MINIMUM ALLOWABLE GRADE (UNPAVED NO TRAFFIC): |
| 99.829 | MINIMUM ALLOWABLE GRADE (BASE OF FLEXIBLE PAVEMENT): |
| 99.829 | MINIMUM ALLOWABLE GRADE (TOP OF RIGID PAVEMENT): |
| 99.677 | TOP OF STONE: |
| 99.372 | TOP OF MC-3500 CHAMBER: |
| 98.738 | 450 mm TOP MANIFOLD INVERT: |
| 98.281 | 600 mm ISOLATOR ROW INVERT: |
| 98.229 | BOTTOM OF MC-3500 CHAMBER: |
| 98.000 | UNDERDRAIN INVERT: |
| 98.000 | BOTTOM OF STONE: |

## NOTES

- MANIFOLD SIZE TO BE DETERMINED BY SITE DESIGN ENGINEER. SEE TECHNICAL NOTE 6.32 FOR MANIFOLD SIZING GUIDANCE.
- DUE TO THE ADAPTATION OF THIS CHAMBER SYSTEM TO SPECIFIC SITE AND DESIGN CONSTRAINTS, IT MAY BE NECESSARY TO CUT AND COUPLE ADDITIONAL PIPE TO STANDARD MANIFOLD COMPONENTS IN THE FIELD.
- THE SITE DESIGN ENGINEER MUST REVIEW ELEVATIONS AND IF NECESSARY ADJUST GRADING TO ENSURE THE CHAMBER COVER REQUIREMENTS ARE MET.
- THIS CHAMBER SYSTEM WAS DESIGNED WITHOUT SITE-SPECIFIC INFORMATION ON SOIL CONDITIONS OR BEARING CAPACITY. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR DETERMINING THE SUITABILITY OF THE SOIL AND PROVIDING THE BEARING CAPACITY OF THE INSITU SOILS. THE BASE STONE DEPTH MAY BE INCREASED OR DECREASED ONCE THIS INFORMATION IS PROVIDED.
- ADS DOES NOT DESIGN OR PROVIDE MEMBRANE LINER SYSTEMS. TO MINIMIZE THE LEAKAGE POTENTIAL OF LINER SYSTEMS, THE MEMBRANE LINER SYSTEM SHOULD BE DESIGNED BY A KNOWLEDGEABLE GEOTEXTILE PROFESSIONAL AND INSTALLED BY A QUALIFIED CONTRACTOR.




PROJECT PYTHON
OTTAWA,ON.

DATE: 05/05/20 | DRAWN: RCT
PROJECT #: S181876 | CHECKED: JMQ

| DATE | DRWN | CHKD | DESCRIPTION |
|---|---|---|---|
| 06/01/20 | RCT | JMQ | REVISED SYSTEM 1&4 |
| 05/28/20 | RCT | JMQ | NEW SITE PLAN/MARKUPS |

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4640 TRUEMAN BLVD
HILLIARD, OH 43026

SCALE = 1 : 100

## PROPOSED LAYOUT - SYSTEM 2

| | |
|---|---|
| 195 | STORMTECH MC-3500 CHAMBERS |
| 26 | STORMTECH MC-3500 END CAPS |
| 305 | STONE ABOVE (mm) |
| 229 | STONE BELOW (mm) |
| 40 | % STONE VOID |
| **1,054.7** | **INSTALLED SYSTEM VOLUME (m³) (PERIMETER STONE INCLUDED)** |
| 1,020.1 | SYSTEM AREA (m²) |
| 128.7 | SYSTEM PERIMETER (m) |

## PROPOSED ELEVATIONS - SYSTEM 2

| | |
|---|---|
| 102.010 | MAXIMUM ALLOWABLE GRADE (TOP OF PAVEMENT/UNPAVED): |
| 100.182 | MINIMUM ALLOWABLE GRADE (UNPAVED WITH TRAFFIC): |
| 100.029 | MINIMUM ALLOWABLE GRADE (UNPAVED NO TRAFFIC): |
| 100.029 | MINIMUM ALLOWABLE GRADE (BASE OF FLEXIBLE PAVEMENT): |
| 100.029 | MINIMUM ALLOWABLE GRADE (TOP OF RIGID PAVEMENT): |
| 99.877 | TOP OF STONE: |
| 99.572 | TOP OF MC-3500 CHAMBER: |
| 98.938 | 450 mm TOP MANIFOLD INVERT: |
| 98.481 | 600 mm ISOLATOR ROW INVERT: |
| 98.429 | BOTTOM OF MC-3500 CHAMBER: |
| 98.200 | UNDERDRAIN INVERT: |
| 98.200 | BOTTOM OF STONE: |

## NOTES

- MANIFOLD SIZE TO BE DETERMINED BY SITE DESIGN ENGINEER. SEE TECHNICAL NOTE 6.32 FOR MANIFOLD SIZING GUIDANCE.
- DUE TO THE ADAPTATION OF THIS CHAMBER SYSTEM TO SPECIFIC SITE AND DESIGN CONSTRAINTS, IT MAY BE NECESSARY TO CUT AND COUPLE ADDITIONAL PIPE TO STANDARD MANIFOLD COMPONENTS IN THE FIELD.
- THE SITE DESIGN ENGINEER MUST REVIEW ELEVATIONS AND IF NECESSARY ADJUST GRADING TO ENSURE THE CHAMBER COVER REQUIREMENTS ARE MET.
- THIS CHAMBER SYSTEM WAS DESIGNED WITHOUT SITE-SPECIFIC INFORMATION ON SOIL CONDITIONS OR BEARING CAPACITY. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR DETERMINING THE SUITABILITY OF THE SOIL AND PROVIDING THE BEARING CAPACITY OF THE INSITU SOILS. THE BASE STONE DEPTH MAY BE INCREASED OR DECREASED ONCE THIS INFORMATION IS PROVIDED.
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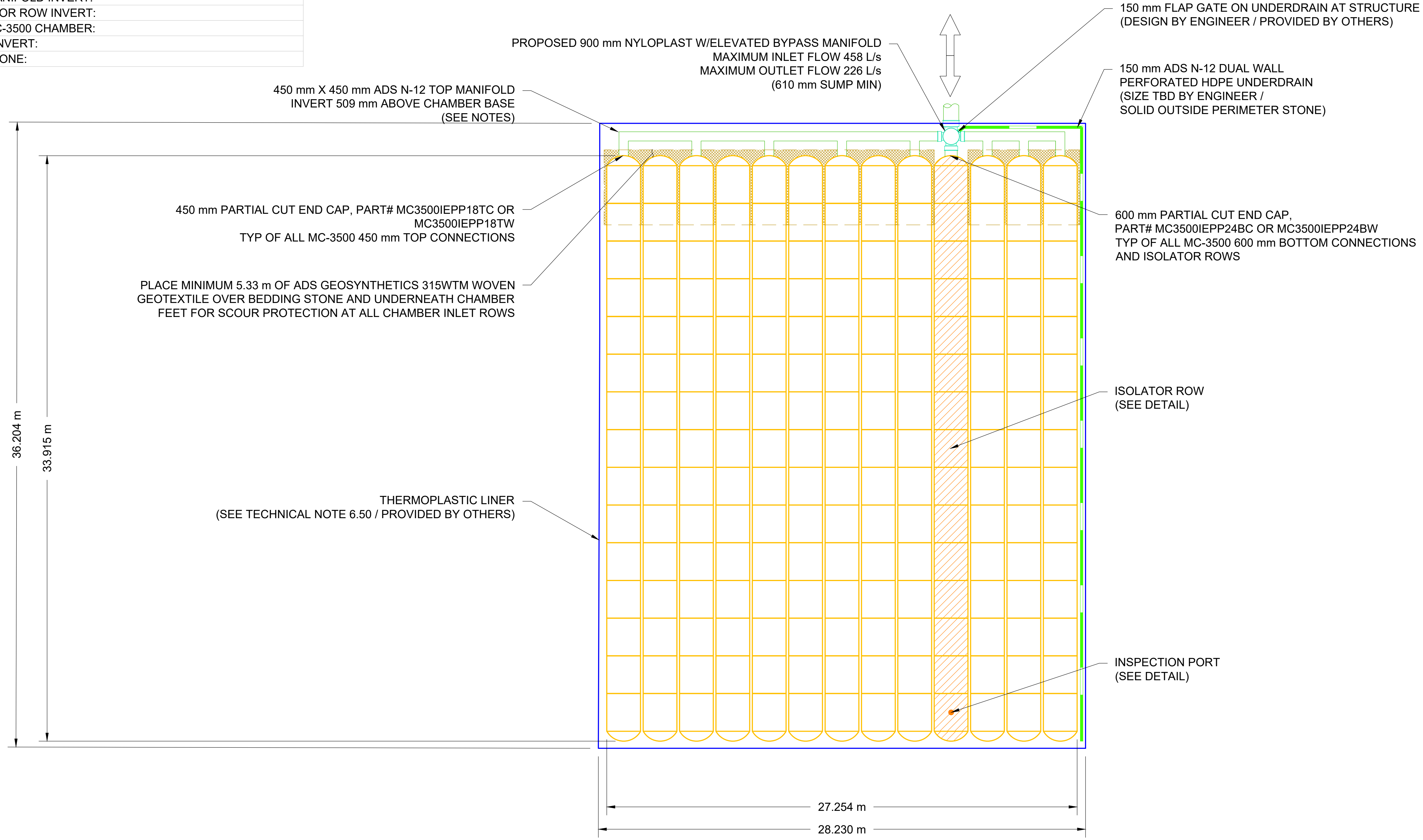


PROJECT PYTHON
OTTAWA,ON.

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SCALE = 1 : 250

## PROPOSED LAYOUT - SYSTEM 3

| | |
|---|---|
| 72 | STORMTECH MC-3500 CHAMBERS |
| 8 | STORMTECH MC-3500 END CAPS |
| 305 | STONE ABOVE (mm) |
| 600 | STONE BELOW (mm) |
| 40 | % STONE VOID |
| **455.7** | **INSTALLED SYSTEM VOLUME (m³) (PERIMETER STONE INCLUDED)** |
| **348.7** | **INSTALLED SYSTEM VOLUME (m³) ABOVE ELEVATION 97.652 (PERIMETER STONE INCLUDED)** |
| 388.1 | SYSTEM AREA (m²) |
| 103.8 | SYSTEM PERIMETER (m) |

## PROPOSED ELEVATIONS - SYSTEM 3

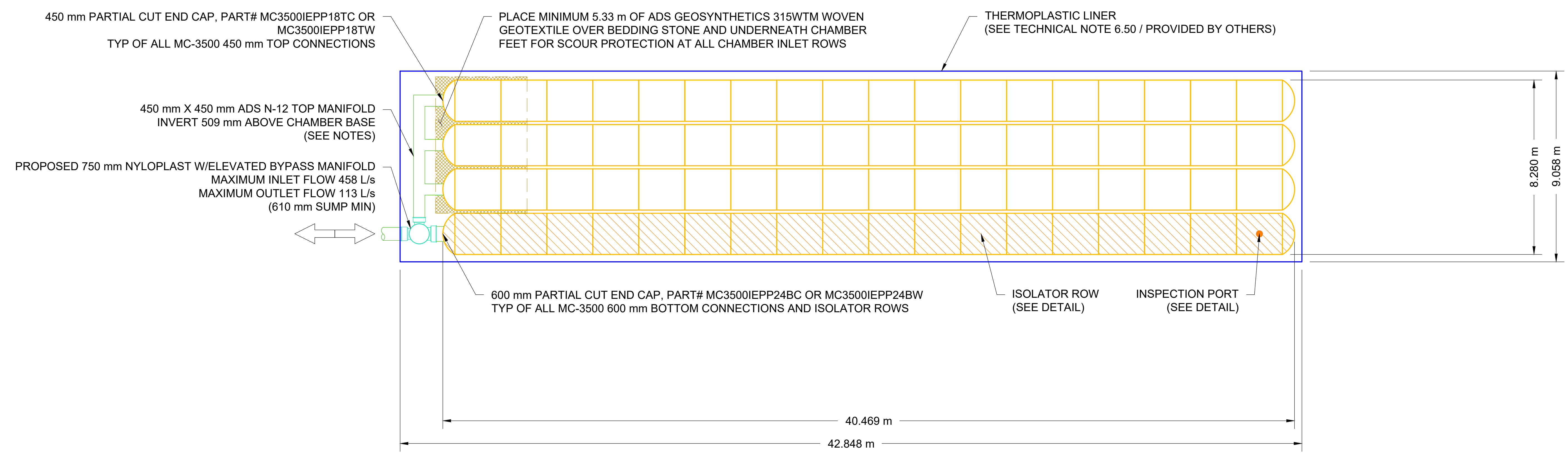
| | |
|---|---|
| 102.000 | MAXIMUM ALLOWABLE GRADE (TOP OF PAVEMENT/UNPAVED): |
| 99.353 | MINIMUM ALLOWABLE GRADE (UNPAVED WITH TRAFFIC): |
| 99.200 | MINIMUM ALLOWABLE GRADE (UNPAVED NO TRAFFIC): |
| 99.200 | MINIMUM ALLOWABLE GRADE (BASE OF FLEXIBLE PAVEMENT): |
| 99.200 | MINIMUM ALLOWABLE GRADE (TOP OF RIGID PAVEMENT): |
| 99.048 | TOP OF STONE: |
| 98.743 | TOP OF MC-3500 CHAMBER: |
| 98.109 | 450 mm TOP MANIFOLD INVERT: |
| 97.652 | 600 mm ISOLATOR ROW INVERT: |
| 97.600 | BOTTOM OF MC-3500 CHAMBER: |
| 97.000 | BOTTOM OF STONE: |

## NOTES

- MANIFOLD SIZE TO BE DETERMINED BY SITE DESIGN ENGINEER. SEE TECHNICAL NOTE 6.32 FOR MANIFOLD SIZING GUIDANCE.
- DUE TO THE ADAPTATION OF THIS CHAMBER SYSTEM TO SPECIFIC SITE AND DESIGN CONSTRAINTS, IT MAY BE NECESSARY TO CUT AND COUPLE ADDITIONAL PIPE TO STANDARD MANIFOLD COMPONENTS IN THE FIELD.
- THE SITE DESIGN ENGINEER MUST REVIEW ELEVATIONS AND IF NECESSARY ADJUST GRADING TO ENSURE THE CHAMBER COVER REQUIREMENTS ARE MET.
- THIS CHAMBER SYSTEM WAS DESIGNED WITHOUT SITE-SPECIFIC INFORMATION ON SOIL CONDITIONS OR BEARING CAPACITY. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR DETERMINING THE SUITABILITY OF THE SOIL AND PROVIDING THE BEARING CAPACITY OF THE INSITU SOILS. THE BASE STONE DEPTH MAY BE INCREASED OR DECREASED ONCE THIS INFORMATION IS PROVIDED.
- ADS DOES NOT DESIGN OR PROVIDE MEMBRANE LINER SYSTEMS. TO MINIMIZE THE LEAKAGE POTENTIAL OF LINER SYSTEMS, THE MEMBRANE LINER SYSTEM SHOULD BE DESIGNED BY A KNOWLEDGEABLE GEOTEXTILE PROFESSIONAL AND INSTALLED BY A QUALIFIED CONTRACTOR.
- **NOT FOR CONSTRUCTION**: THIS LAYOUT IS FOR DIMENSIONAL PURPOSES ONLY TO PROVE CONCEPT & THE REQUIRED STORAGE VOLUME CAN BE ACHIEVED ON SITE.

## TIER 1 DEEP COVER SPECIAL PROVISIONS

1. INSTALLATION REQUIREMENTS SHALL BE AS SPECIFIED IN THE STORMTECH DESIGN MANUALS AND CONSTRUCTION GUIDES EXCEPT AS MODIFIED IN THESE SPECIAL PROVISIONS.
2. ATTENTION IS CALLED TO "TABLE 1 - ACCEPTABLE FILL MATERIALS" IN THE STORMTECH CONSTRUCTION GUIDE AND ALL OTHER APPEARANCES OF THE "ACCEPTABLE FILL MATERIALS TABLE. FOR AREAS OF THE SYSTEM WITH COVER ABOVE 7 FEET (2.1 m) FOR THE MC-4500 AND ABOVE 8 FEET (2.4 m) FOR THE MC-3500, EMBEDMENT STONE SHALL BE COMPACTED WITH 3 PASSES OF A WALK BEHIND VIBRATORY PLATE COMPACTOR OR JUMPING JACK IN 12" (300 mm) LIFTS.
3. STONE SHALL HAVE RELATIVELY FLAT SIDES AND SHARP EDGES (ANGULAR) OR RELATIVELY FLAT SIDES AND ROUNDED EDGES AND SHALL CONTAIN LESS THAN 20% FLAT OR ELONGATED PARTICLES. FLAT OR ELONGATED STONE IS UNACCEPTABLE. FOR DESCRIPTIONS OF ANGULARITY SEE ASTM D2488 "STANDARD PRACTICE FOR DESCRIPTION AND IDENTIFICATION OF SOILS (VISUAL-MANUAL PROCEDURE)".
4. STONE SHALL BE HARD AND DURABLE. IT IS THE ENGINEER'S OR CONTRACTOR'S RESPONSIBILITY TO SELECT HARD AND DURABLE STONE. STORMTECH CONSIDERS AN LA ABRASION VALUE OF LESS THAN OR EQUAL TO 30 TO BE HARD STONE.
5. FOUNDATION STONE SHALL BE MECHANICALLY COMPACTED WITH A VIBRATORY ROLLER OR VIBRATORY PLATE IN 6" (152 mm) LIFTS.
6. EMBEDMENT STONE MUST BE DUMPED IN PLACE BY A STONE SHOOTER OR CONVEYOR OR EXCAVATOR.
7. INSPECTION DURING THE INSTALLATION BY THE ENGINEER, OWNER OR OTHER REPRESENTATIVE IS RECOMMENDED. THE INSPECTION SHALL INCLUDE OBSERVATIONS OF THE CHAMBER SYMMETRY DURING BACKFILLING TO ENSURE THE CONTRACTOR'S METHODS ARE NOT CAUSING UNACCEPTABLE DISTORTION OF THE CHAMBERS.
8. AN ADS FIELD TECHNICIAN WILL CONDUCT A PRE-CONSTRUCTION MEETING TO TRAIN REPRESENTATIVES OF THOSE RESPONSIBLE FOR CONSTRUCTING THE SYSTEM AND THOSE CONDUCTING THE MANDATORY INSPECTIONS OF THE INSTALLATION.




PROJECT PYTHON
OTTAWA,ON.

DATE: 05/05/20 DRAWN: RCT
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SCALE = 1 : 200

## PROPOSED LAYOUT - SYSTEM 4

| | |
|---|---|
| 261 | STORMTECH MC-4500 CHAMBERS |
| 12 | STORMTECH MC-4500 END CAPS |
| 305 | STONE ABOVE (mm) |
| 229 | STONE BELOW (mm) STANDARD PARAMETERS |
| 750 | STONE BELOW (mm) TIER 1 PARAMETERS |
| 40 | % STONE VOID |
| **1,503.7** | **INSTALLED SYSTEM VOLUME (m³) (PERIMETER STONE INCLUDED)** |
| **1,298.1** | **INSTALLED SYSTEM VOLUME (m³) ABOVE ELEVATION 95.75 (PERIMETER STONE INCLUDED)** |
| 988.0 | SYSTEM AREA (m²) |
| 166.6 | SYSTEM PERIMETER (m) |

## PROPOSED ELEVATIONS - SYSTEM 4

| | |
|---|---|
| 100.400 | MAXIMUM GRADE PER ENGINEERS PLANS (TIER 1 PARAMETERS): |
| 99.603 | MAXIMUM GRADE PER ENGINEERS PLANS (STANDARD PARAMETERS): |
| 98.265 | MINIMUM ALLOWABLE GRADE (UNPAVED WITH TRAFFIC): |
| 98.113 | MINIMUM ALLOWABLE GRADE (UNPAVED NO TRAFFIC): |
| 98.113 | MINIMUM ALLOWABLE GRADE (BASE OF FLEXIBLE PAVEMENT): |
| 98.113 | MINIMUM ALLOWABLE GRADE (TOP OF RIGID PAVEMENT): |
| 97.808 | TOP OF STONE: |
| 97.503 | TOP OF MC-4500 CHAMBER: |
| 96.564 | 600 mm TOP MANIFOLD INVERT: |
| 96.036 | 600 mm ISOLATOR ROW INVERT: |
| 95.979 | BOTTOM OF MC-4500 CHAMBER: |
| 95.750 | UNDERDRAIN INVERT: |
| 95.750 | BOTTOM OF STONE: (STANDARD PARAMETERS) |
| 95.229 | BOTTOM OF STONE: (TIER 1 PARAMETERS) |

## NOTES

- MANIFOLD SIZE TO BE DETERMINED BY SITE DESIGN ENGINEER. SEE TECHNICAL NOTE 6.32 FOR MANIFOLD SIZING GUIDANCE.
- DUE TO THE ADAPTATION OF THIS CHAMBER SYSTEM TO SPECIFIC SITE AND DESIGN CONSTRAINTS, IT MAY BE NECESSARY TO CUT AND COUPLE ADDITIONAL PIPE TO STANDARD MANIFOLD COMPONENTS IN THE FIELD.
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## TIER 1 DEEP COVER SPECIAL PROVISIONS

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3. STONE SHALL HAVE RELATIVELY FLAT SIDES AND SHARP EDGES (ANGULAR) OR RELATIVELY FLAT SIDES AND ROUNDED EDGES AND SHALL CONTAIN LESS THAN 20% FLAT OR ELONGATED PARTICLES. FLAT OR ELONGATED STONE IS UNACCEPTABLE. FOR DESCRIPTIONS OF ANGULARITY SEE ASTM D2488 "STANDARD PRACTICE FOR DESCRIPTION AND IDENTIFICATION OF SOILS (VISUAL-MANUAL PROCEDURE)".
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5. FOUNDATION STONE SHALL BE MECHANICALLY COMPACTED WITH A VIBRATORY ROLLER OR VIBRATORY PLATE IN 6" (152 mm) LIFTS.
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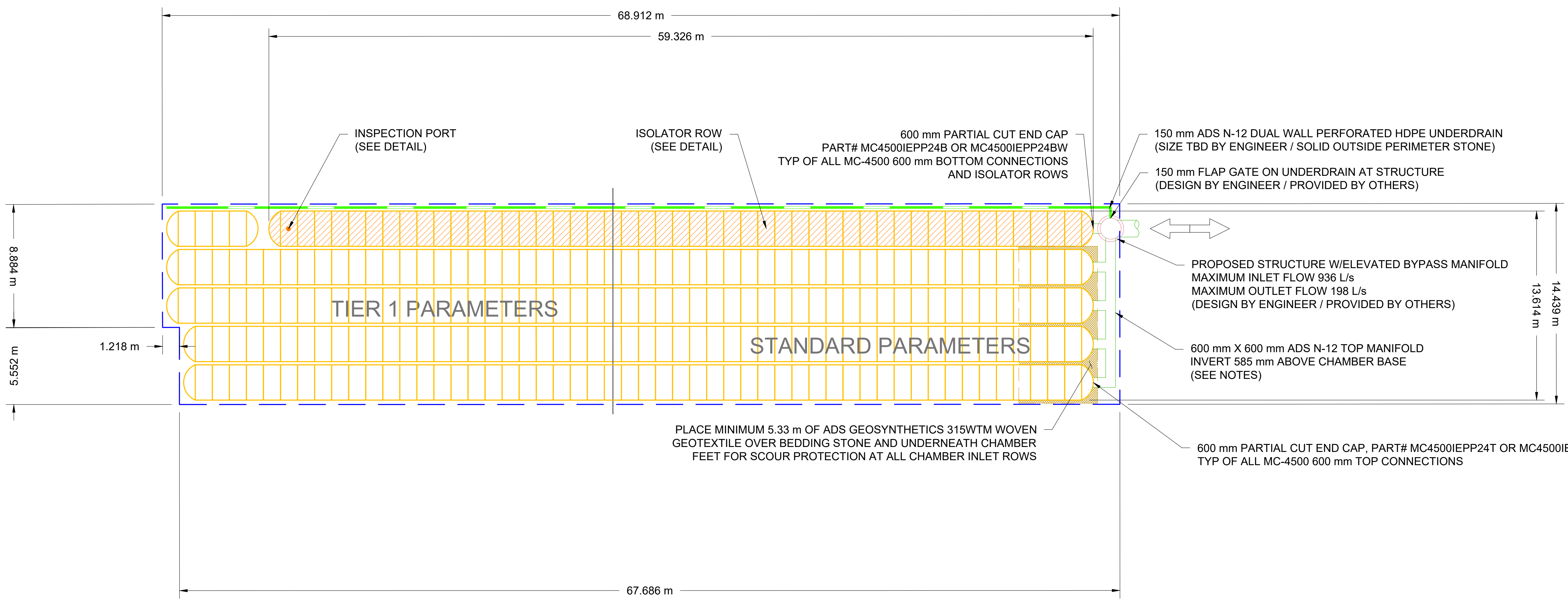


PROJECT PYTHON
OTTAWA,ON.

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SCALE = 1 : 300

## PROPOSED LAYOUT - SYSTEM 5

| | |
|---|---|
| 164 | STORMTECH MC-4500 CHAMBERS |
| 8 | STORMTECH MC-4500 END CAPS |
| 305 | STONE ABOVE (mm) |
| 229 | STONE BELOW (mm) |
| 40 | % STONE VOID |
| **822.4** | **INSTALLED SYSTEM VOLUME ($m^3$) (PERIMETER STONE INCLUDED)** |
| 632.6 | SYSTEM AREA ($m^2$) |
| 131.9 | SYSTEM PERIMETER (m) |

## PROPOSED ELEVATIONS - SYSTEM 5

| | |
|---|---|
| 101.900 | MAXIMUM ALLOWABLE GRADE (TOP OF PAVEMENT/UNPAVED): |
| 100.315 | MINIMUM ALLOWABLE GRADE (UNPAVED WITH TRAFFIC): |
| 100.163 | MINIMUM ALLOWABLE GRADE (UNPAVED NO TRAFFIC): |
| 100.163 | MINIMUM ALLOWABLE GRADE (BASE OF FLEXIBLE PAVEMENT): |
| 100.163 | MINIMUM ALLOWABLE GRADE (TOP OF RIGID PAVEMENT): |
| 99.858 | TOP OF STONE: |
| 99.553 | TOP OF MC-4500 CHAMBER: |
| 98.614 | 600 mm TOP MANIFOLD INVERT: |
| 98.086 | 600 mm ISOLATOR ROW INVERT: |
| 98.029 | BOTTOM OF MC-4500 CHAMBER: |
| 97.800 | UNDERDRAIN INVERT: |
| 97.800 | BOTTOM OF STONE: |

## NOTES

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4. STONE SHALL BE HARD AND DURABLE. IT IS THE ENGINEER'S OR CONTRACTOR'S RESPONSIBILITY TO SELECT HARD AND DURABLE STONE. STORMTECH CONSIDERS AN LA ABRASION VALUE OF LESS THAN OR EQUAL TO 30 TO BE HARD STONE.
5. FOUNDATION STONE SHALL BE MECHANICALLY COMPACTED WITH A VIBRATORY ROLLER OR VIBRATORY PLATE IN 6" (152 mm) LIFTS.
6. EMBEDMENT STONE MUST BE DUMPED IN PLACE BY A STONE SHOOTER OR CONVEYOR OR EXCAVATOR.
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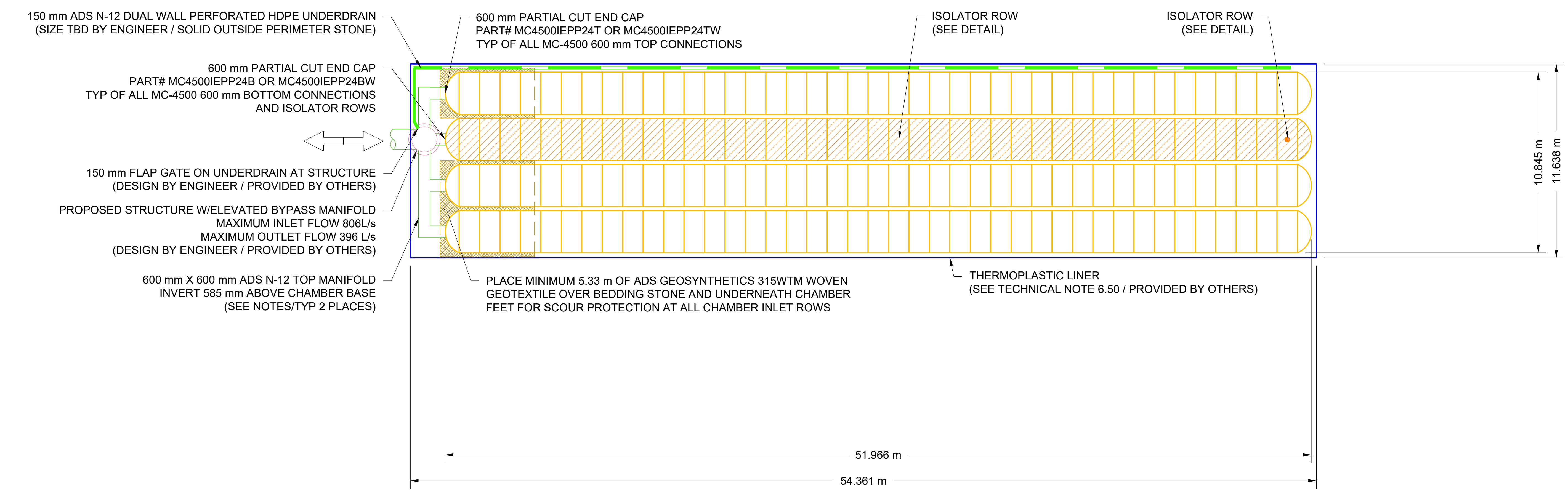


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OTTAWA,ON.

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HILLIARD, OH 43026

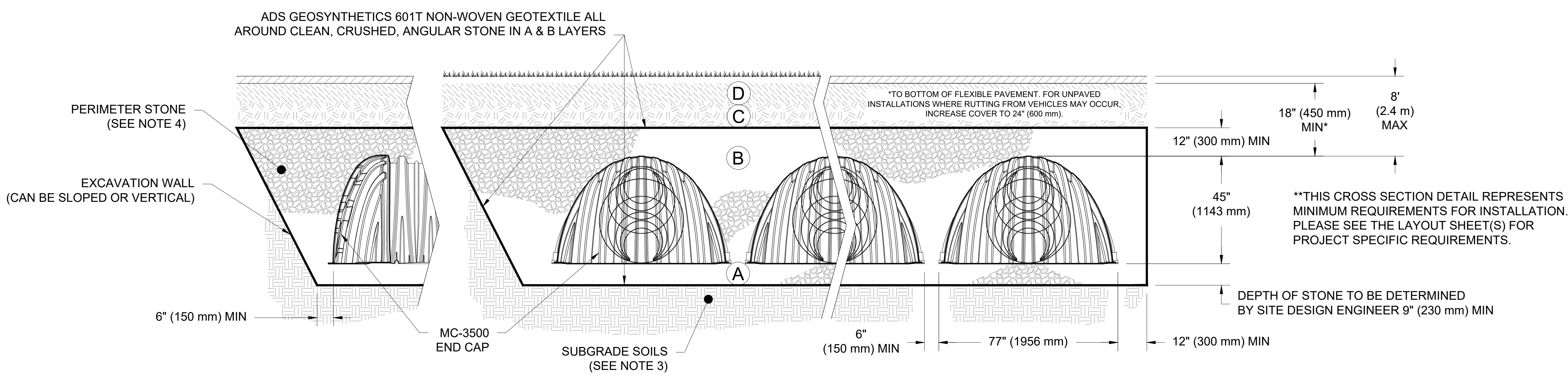

SCALE = 1 : 250

# ACCEPTABLE FILL MATERIALS: STORMTECH MC-3500 CHAMBER SYSTEMS

| MATERIAL LOCATION | | DESCRIPTION | AASHTO MATERIAL CLASSIFICATIONS | COMPACTION / DENSITY REQUIREMENT |
|---|---|---|---|---|
| D | **FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER | ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS. | N/A | PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS. |
| C | **INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER. | GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE.<br><br>MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER. | AASHTO M145[1]<br>A-1, A-2-4, A-3<br><br>OR<br><br>AASHTO M43[1]<br>3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10 | BEGIN COMPACTIONS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS. |
| B | **EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE. | CLEAN, CRUSHED, ANGULAR STONE | AASHTO M43[1]<br>3, 4 | NO COMPACTION REQUIRED. |
| A | **FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER. | CLEAN, CRUSHED, ANGULAR STONE | AASHTO M43[1]<br>3, 4 | PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE.[2,3] |

PLEASE NOTE:

1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.
4. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.




## NOTES:

1. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418-16a, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 45x76 DESIGNATION SS.
2. MC-3500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
4. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
5. REQUIREMENTS FOR HANDLING AND INSTALLATION:
   - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
   - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 3".
   - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2418 SHALL BE GREATER THAN OR EQUAL TO 500 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 73° F / 23° C), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.

PROJECT PYTHON
OTTAWA,ON.

DATE: 05/05/20 DRAWN: RCT
PROJECT #: S181876 CHECKED: JMQ

| DATE | DRWN | CHKD | DESCRIPTION |
|---|---|---|---|
| 06/01/20 | RCT | JMQ | REVISED SYSTEM 1&4 |
| 05/28/20 | RCT | JMQ | NEW SITE PLAN/MARKUPS |

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4640 TRUEMAN BLVD
HILLIARD, OH 43026

# ACCEPTABLE FILL MATERIALS: STORMTECH MC-3500 CHAMBER SYSTEMS

| MATERIAL LOCATION | | DESCRIPTION | AASHTO MATERIAL CLASSIFICATIONS | COMPACTION / DENSITY REQUIREMENT |
|---|---|---|---|---|
| D | **FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER | ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS. | N/A | PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS. |
| C | **INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER. | GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE.<br><br>MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER. | AASHTO M145[1]<br>A-1, A-2-4, A-3<br><br>OR<br><br>AASHTO M43[1]<br>3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10 | BEGIN COMPACTIONS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS. |
| B | **EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE. | CLEAN, CRUSHED, ANGULAR STONE | AASHTO M43[1]<br>3, 4 | NO COMPACTION REQUIRED. |
| A | **FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER. | CLEAN, CRUSHED, ANGULAR STONE | AASHTO M43[1]<br>3, 4 | PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE.[2,3] |

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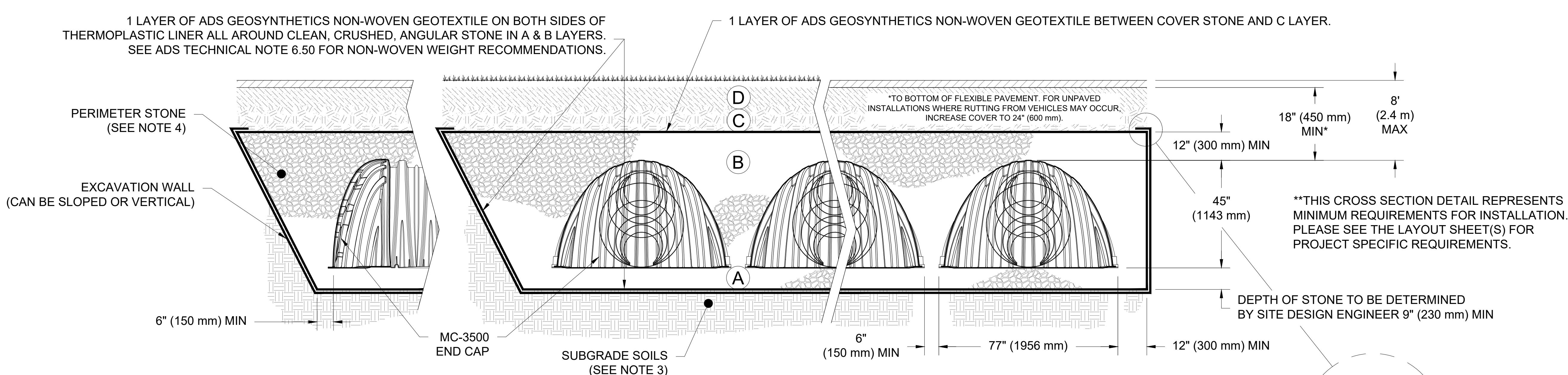
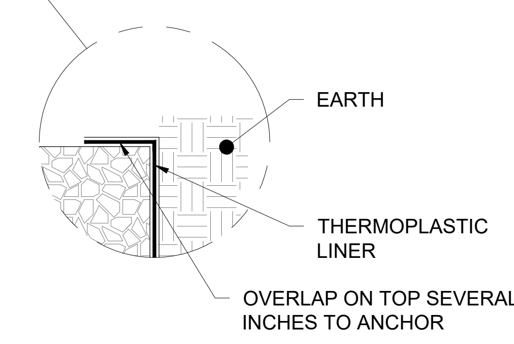
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.
4. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.




THERMOPLASTIC LINER DETAIL

## NOTES:

1. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418-16a, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 45x76 DESIGNATION SS.
2. MC-3500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
4. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
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   - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2418 SHALL BE GREATER THAN OR EQUAL TO 500 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 73° F / 23° C), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.

PROJECT PYTHON
OTTAWA,ON.

DATE: 05/05/20 | DRAWN: RCT
PROJECT #: S181876 | CHECKED: JMQ

| DATE | DRWN | CHKD | DESCRIPTION |
|---|---|---|---|
| 06/01/20 | RCT | JMQ | REVISED SYSTEM 1&4 |
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# ACCEPTABLE FILL MATERIALS: STORMTECH MC-3500 CHAMBER SYSTEMS

| MATERIAL LOCATION | | DESCRIPTION | AASHTO MATERIAL CLASSIFICATIONS | COMPACTION / DENSITY REQUIREMENT |
|---|---|---|---|---|
| D | **FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER | ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS. | N/A | PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS. |
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| B | **EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE. | CLEAN, CRUSHED, ANGULAR STONE | AASHTO M43[1]<br>3, 4 | COMPACTION REQUIRED. SEE SPECIAL REQUIREMENTS ON LAYOUT PAGE. |
| A | **FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER. | CLEAN, CRUSHED, ANGULAR STONE | AASHTO M43[1]<br>3, 4 | PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE.[2,3] |

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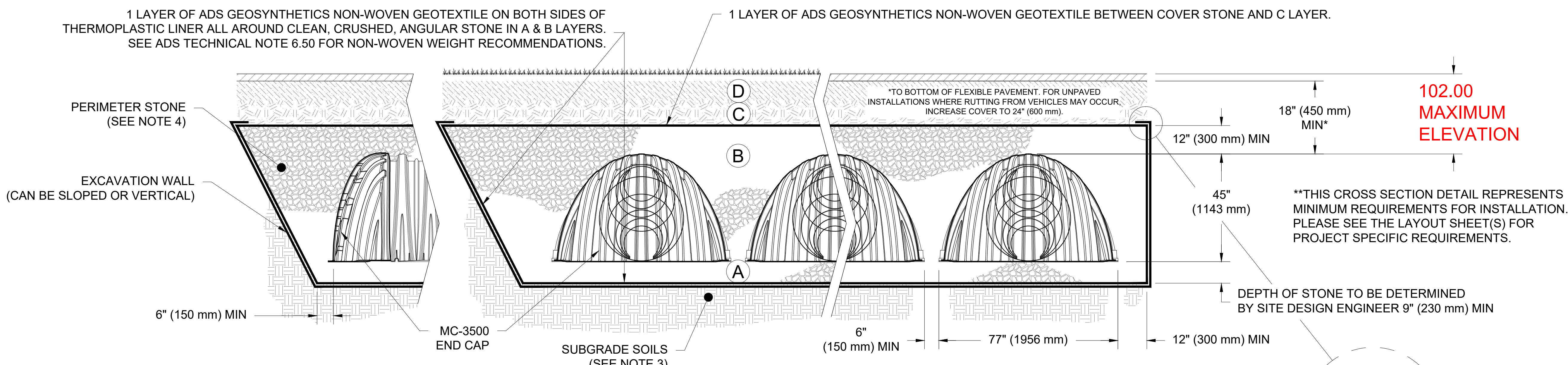


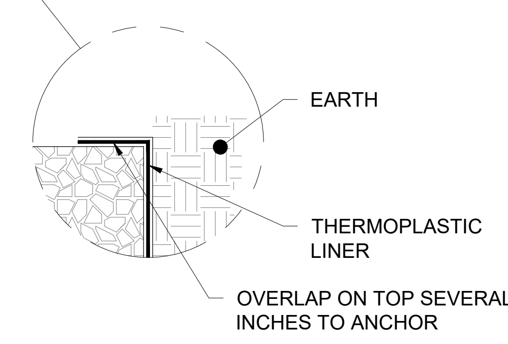


THERMOPLASTIC LINER DETAIL

## PROJECT PYTHON SYSTEM 3 CROSS SECTION

## NOTES:

1. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418-16a, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 45x76 DESIGNATION SS.
2. MC-3500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
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PROJECT PYTHON
OTTAWA,ON.
DATE: 05/05/20
DRAWN: RCT
PROJECT #: S181876
CHECKED: JMQ

| DATE | DRWN | CHKD | DESCRIPTION |
|---|---|---|---|
| 06/01/20 | RCT | JMQ | REVISED SYSTEM 1&4 |
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# ACCEPTABLE FILL MATERIALS: STORMTECH MC-4500 CHAMBER SYSTEMS

| MATERIAL LOCATION | | DESCRIPTION | AASHTO MATERIAL CLASSIFICATIONS | COMPACTION / DENSITY REQUIREMENT |
|---|---|---|---|---|
| D | **FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER | ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS. | N/A | PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS. |
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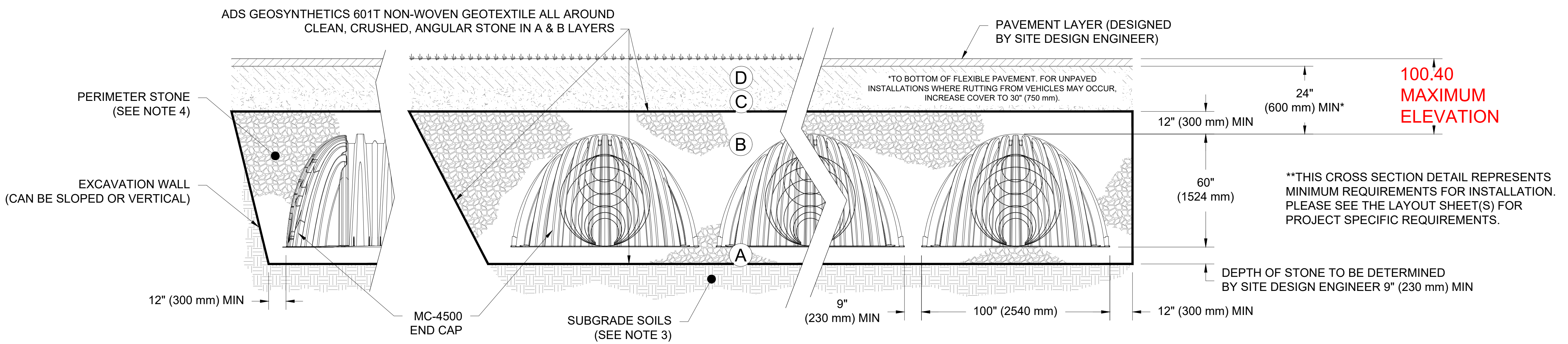


## PROJECT PYTHON SYSTEM 4 CROSS SECTION

## NOTES:

1. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418-16a, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 60x101
2. MC-4500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
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PROJECT PYTHON
OTTAWA,ON.

DATE: 05/05/20 DRAWN: RCT
PROJECT #: S181876 CHECKED: JMQ

| DATE | DRWN | CHKD | DESCRIPTION |
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| 06/01/20 | RCT | JMQ | REVISED SYSTEM 1&4 |
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4640 TRUEMAN BLVD
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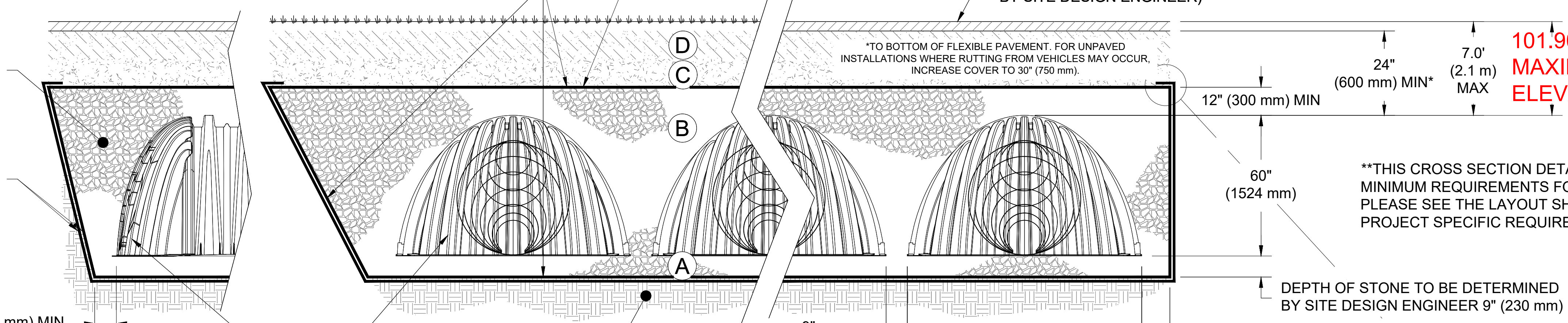
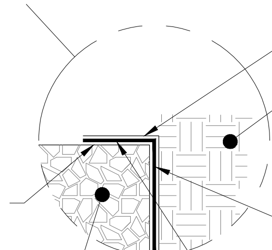
# ACCEPTABLE FILL MATERIALS: STORMTECH MC-4500 CHAMBER SYSTEMS

| MATERIAL LOCATION | | DESCRIPTION | AASHTO MATERIAL CLASSIFICATIONS | COMPACTION / DENSITY REQUIREMENT |
|---|---|---|---|---|
| D | **FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER | ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS. | N/A | PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS. |
| C | **INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER. | GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE.<br><br>MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER. | AASHTO M145[1]<br>A-1, A-2-4, A-3<br><br>OR<br><br>AASHTO M43[1]<br>3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10 | BEGIN COMPACTIONS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS. |
| B | **EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE. | CLEAN, CRUSHED, ANGULAR STONE | AASHTO M43[1]<br>3, 4 | COMPACTION REQUIRED. SEE SPECIAL REQUIREMENTS ON LAYOUT PAGE. |
| A | **FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER. | CLEAN, CRUSHED, ANGULAR STONE | AASHTO M43[1]<br>3, 4 | PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE.[2,3] |

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.
4. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.




## PROJECT PYTHON SYSTEM 5 CROSS SECTION




THERMOPLASTIC LINER DETAIL

## NOTES:

1. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418-16a, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 60x101
2. MC-4500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
4. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
5. REQUIREMENTS FOR HANDLING AND INSTALLATION:
   - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
   - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 3".
   - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2418 SHALL BE GREATER THAN OR EQUAL TO 500 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 73° F / 23° C), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.

PROJECT PYTHON
OTTAWA,ON.

DATE: 05/05/20 DRAWN: RCT
PROJECT #: S181876 CHECKED: JMQ

| DATE | DRWN | CHKD | DESCRIPTION |
|---|---|---|---|
| 06/01/20 | RCT | JMQ | REVISED SYSTEM 1&4 |
| 05/28/20 | RCT | JMQ | NEW SITE PLAN/MARKUPS |

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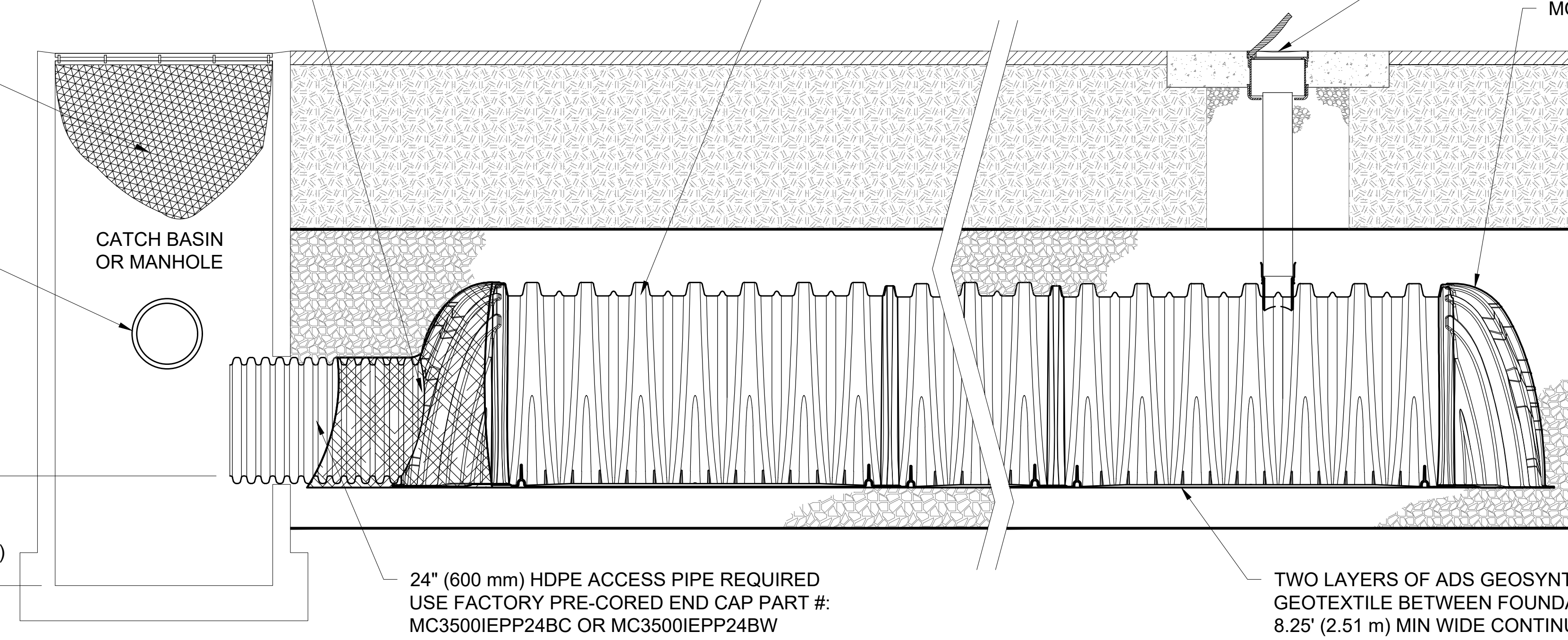



## MC-3500 ISOLATOR ROW DETAIL

NTS

## INSPECTION & MAINTENANCE

STEP 1) INSPECT ISOLATOR ROW FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
  - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
  - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
  - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
  - A.4. LOWER A CAMERA INTO ISOLATOR ROW FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
  - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- B. ALL ISOLATOR ROWS
  - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW
  - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW THROUGH OUTLET PIPE
    - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
    - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
  - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.

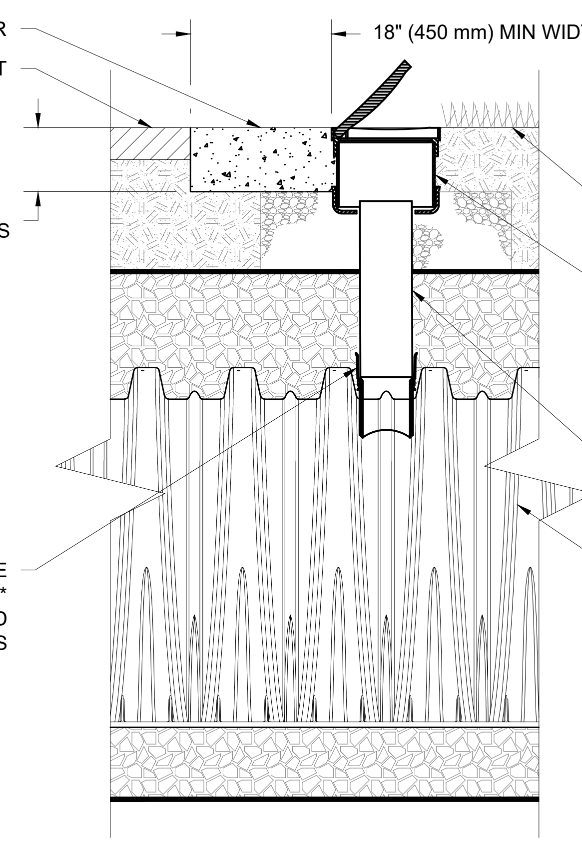
STEP 2) CLEAN OUT ISOLATOR ROW USING THE JETVAC PROCESS
- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45" (1.1 m) OR MORE IS PREFERRED
- B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
- C. VACUUM STRUCTURE SUMP AS REQUIRED

STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.

STEP 4) INSPECT AND CLEAN BASINS AND MANHOLES UPSTREAM OF THE STORMTECH SYSTEM.

## NOTES

1. INSPECT EVERY 6 MONTHS DURING THE FIRST YEAR OF OPERATION. ADJUST THE INSPECTION INTERVAL BASED ON PREVIOUS OBSERVATIONS OF SEDIMENT ACCUMULATION AND HIGH WATER ELEVATIONS.
2. CONDUCT JETTING AND VACTORING ANNUALLY OR WHEN INSPECTION SHOWS THAT MAINTENANCE IS NECESSARY.




* THE PART# **2712AG6IPKIT** CAN BE USED TO ORDER ALL NECESSARY COMPONENTS FOR A SOLID LID INSPECTION PORT INSTALLATION

## MC-3500 6" (150 mm) INSPECTION PORT DETAIL

NTS

PROJECT PYTHON
OTTAWA,ON.

DATE: 05/05/20 DRAWN: RCT
PROJECT #: S181876 CHECKED: JMQ

| DATE | DRWN | CHKD | DESCRIPTION |
|---|---|---|---|
| 06/01/20 | RCT | JMQ | REVISED SYSTEM 1&4 |
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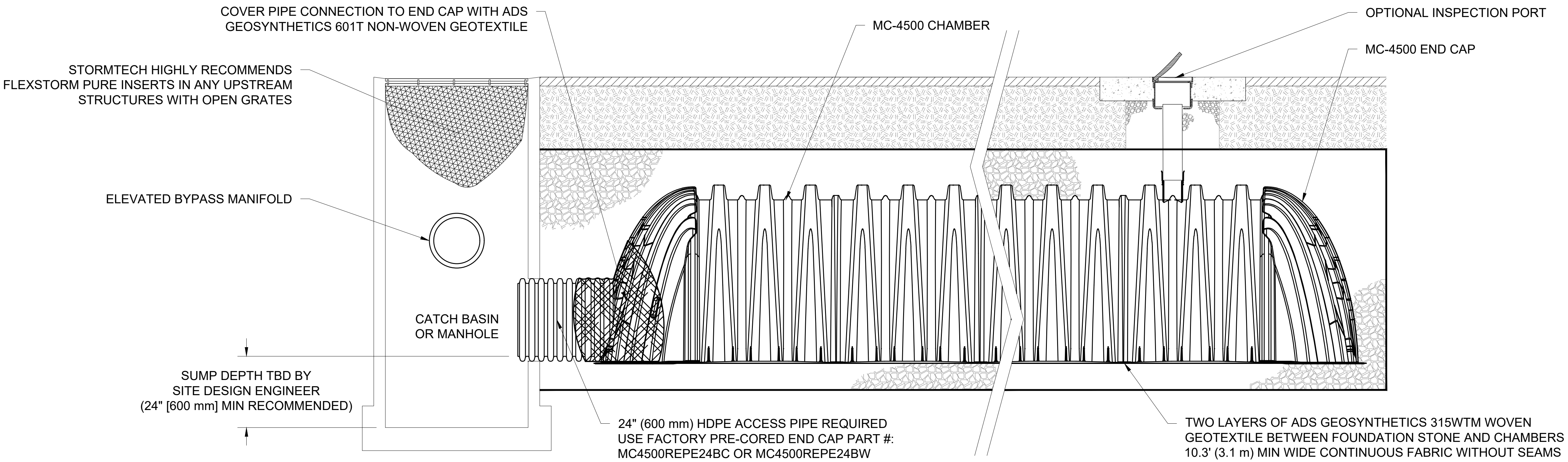


## MC-4500 ISOLATOR ROW DETAIL

NTS

## INSPECTION & MAINTENANCE

STEP 1) INSPECT ISOLATOR ROW FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
  - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
  - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
  - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
  - A.4. LOWER A CAMERA INTO ISOLATOR ROW FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
  - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- B. ALL ISOLATOR ROWS
  - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW
  - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW THROUGH OUTLET PIPE
    - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
    - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
  - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.

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- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45" (1.1 m) OR MORE IS PREFERRED
- B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
- C. VACUUM STRUCTURE SUMP AS REQUIRED

STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.

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## NOTES

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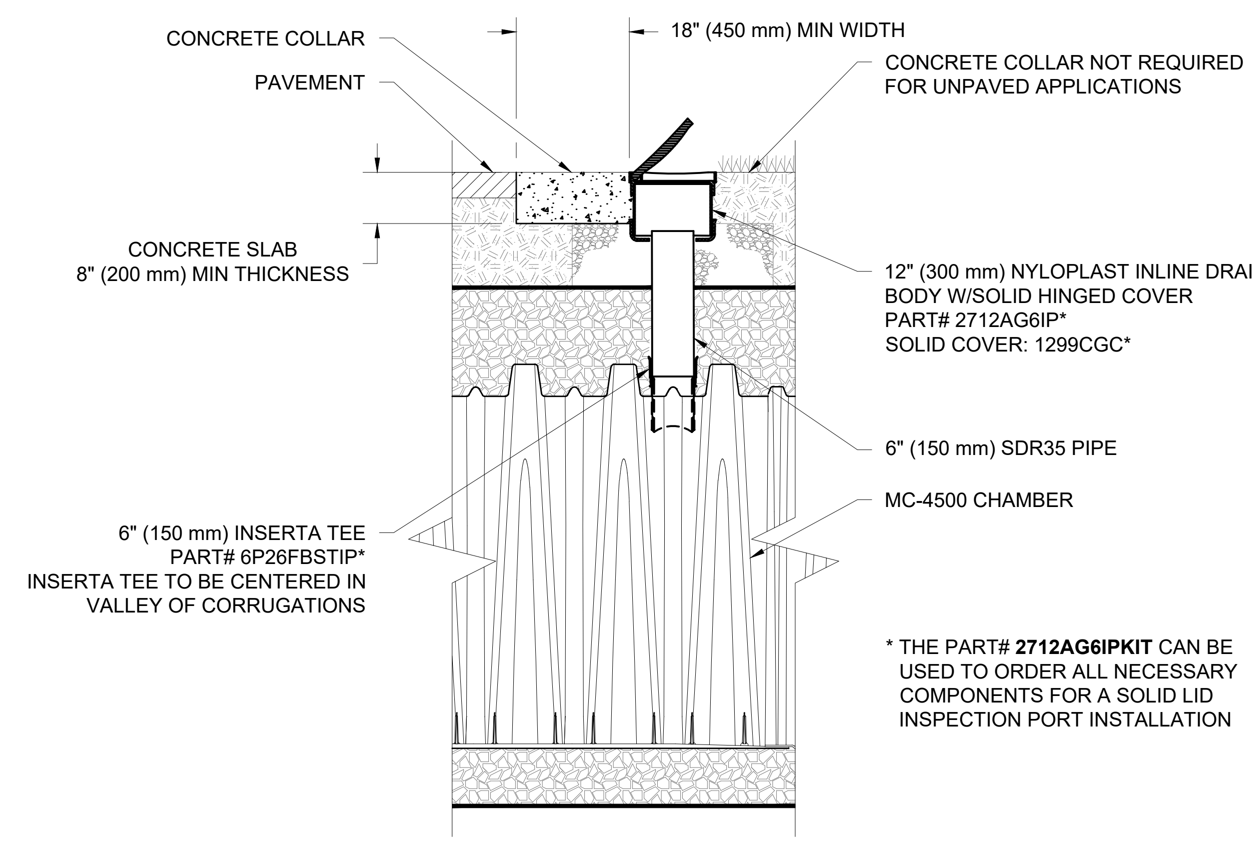


* THE PART# **2712AG6IPKIT** CAN BE USED TO ORDER ALL NECESSARY COMPONENTS FOR A SOLID LID INSPECTION PORT INSTALLATION

## MC-4500 6" (150 mm) INSPECTION PORT DETAIL

NTS

PROJECT PYTHON
OTTAWA,ON.

| DATE: 05/05/20 | DRAWN: RCT |
|---|---|
| PROJECT #: S181876 | CHECKED: JMQ |

| DATE | DRWN | CHKD | DESCRIPTION |
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| 06/01/20 | RCT | JMQ | REVISED SYSTEM 1&4 |
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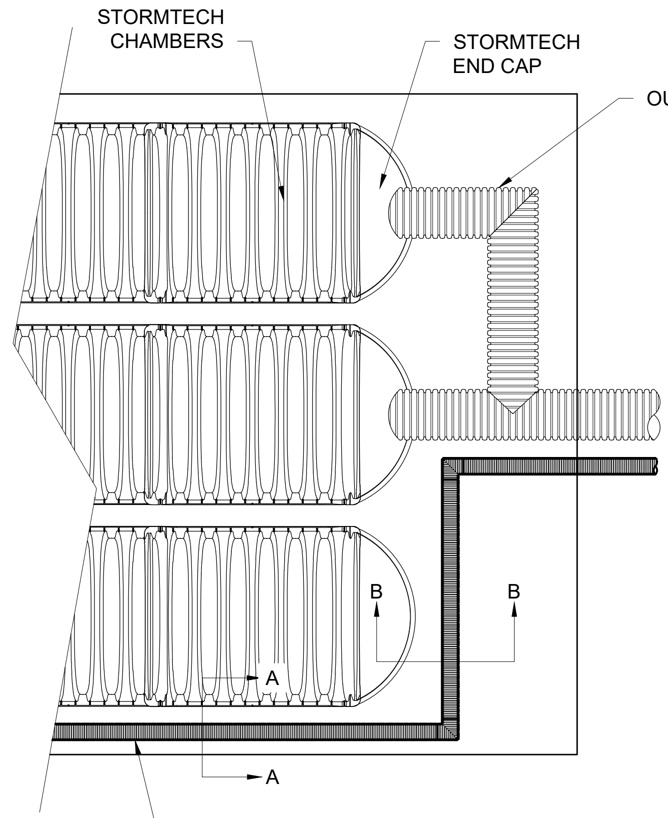
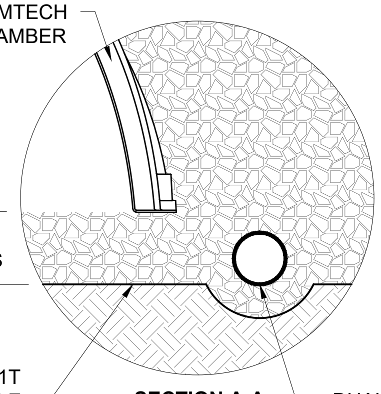
THIS DRAWING HAS BEEN PREPARED BASED ON INFORMATION PROVIDED TO ADS UNDER THE DIRECTION OF THE SITE DESIGN ENGINEER OR OTHER PROJECT REPRESENTATIVE. THE SITE DESIGN ENGINEER SHALL REVIEW THIS DRAWING PRIOR TO CONSTRUCTION. IT IS THE ULTIMATE RESPONSIBILITY OF THE SITE DESIGN ENGINEER TO ENSURE THAT THE PRODUCT(S) DEPICTED AND ALL ASSOCIATED DETAILS MEET ALL APPLICABLE LAWS, REGULATIONS, AND PROJECT REQUIREMENTS.

SHEET 14 OF 16

## UNDERDRAIN DETAIL

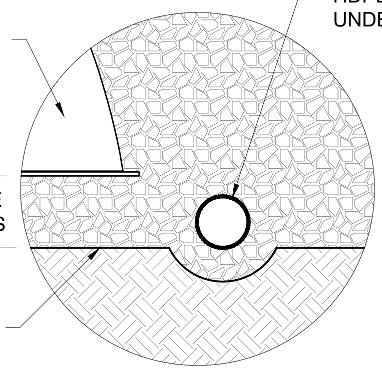
NTS




**SECTION A-A**

DUAL WALL PERFORATED HDPE UNDERDRAIN

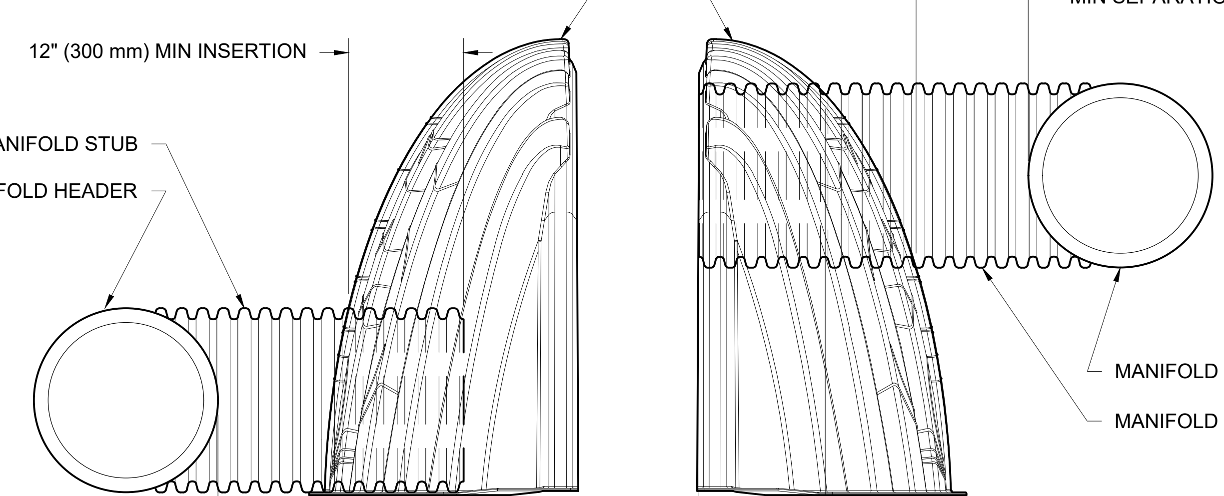



**SECTION B-B**

NUMBER AND SIZE OF UNDERDRAINS PER SITE DESIGN ENGINEER
4" (100 mm) TYP FOR SC-310 & SC-160LP SYSTEMS
6" (150 mm) TYP FOR SC-740, DC-780, MC-3500 & MC-4500 SYSTEMS

## MC-SERIES END CAP INSERTION DETAIL

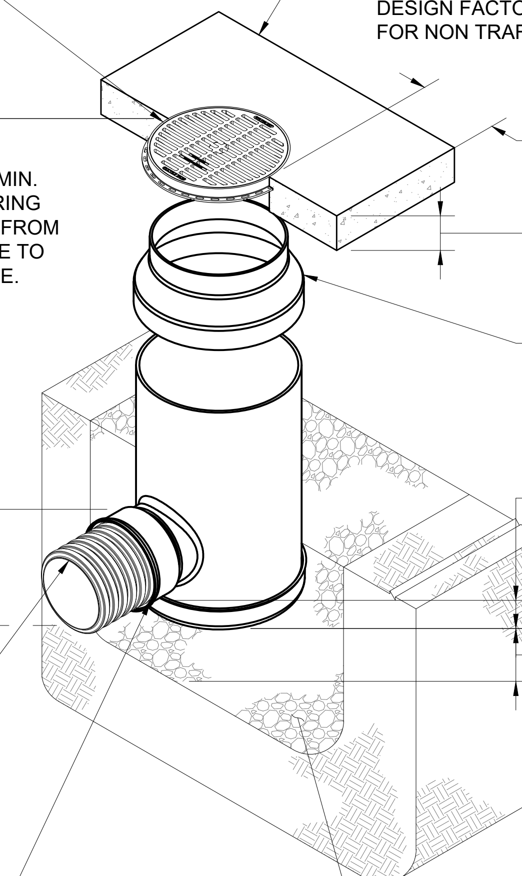
NTS



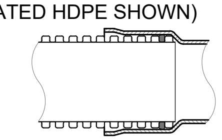

NOTE: MANIFOLD STUB MUST BE LAID HORIZONTAL FOR A PROPER FIT IN END CAP OPENING.

## 36" (900 mm) NYLOPLAST DRAIN BASIN

NTS




WATERTIGHT JOINT (CORRUGATED HDPE SHOWN)



## NOTES

1. GRATES/SOLID COVER SHALL BE DUCTILE IRON PER ASTM A536 GRADE 70-50-05.
2. FRAMES SHALL BE DUCTILE IRON PER ASTM A536 GRADE 70-50-05.
3. DRAIN BASIN TO BE CUSTOM MANUFACTURED ACCORDING TO PLAN DETAILS. RISERS ARE NEEDED FOR BASINS OVER 84" (2.13 m) DUE TO SHIPPING RESTRICTIONS. SEE DRAWING NO. 7001-110-065.
4. DRAINAGE CONNECTION STUB JOINT TIGHTNESS SHALL CONFORM TO ASTM D3212 FOR CORRUGATED HDPE (ADS N-12/HANCOR DUAL WALL), N-12 HP, & PVC SEWER.
5. ADAPTERS CAN BE MOUNTED ON ANY ANGLE 0° TO 360°. TO DETERMINE MINIMUM ANGLE BETWEEN ADAPTERS SEE DRAWING NO. 7001-110-012.

| GRATE OPTION | LOAD RATING | PART # | DWG # |
|---|---|---|---|
| PEDESTRIAN | MEETS H-20 | 3099CGP | 7001-110-220 |
| STANDARD | MEETS H-20 | 3099CGS | 7001-110-221 |
| SOLID COVER | MEETS H-20 | 3099CGC | 7001-110-222 |
| DOME | N/A | 3099CGD | 7001-110-223 |

PROJECT PYTHON
OTTAWA,ON.

DATE: 05/05/20 DRAWN: RCT
PROJECT #: S181876 CHECKED: JMQ

| DATE | DRWN | CHKD | DESCRIPTION |
|---|---|---|---|
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| 05/28/20 | RCT | JMQ | NEW SITE PLAN/MARKUPS |


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## MC-3500 TECHNICAL SPECIFICATION

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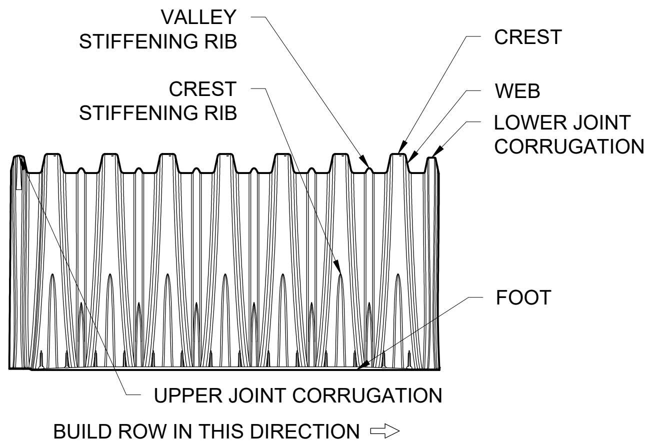
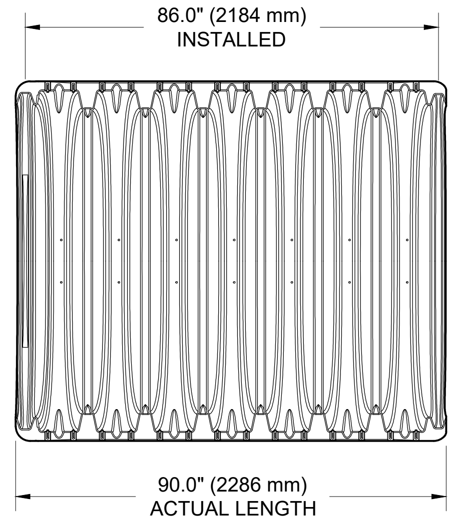
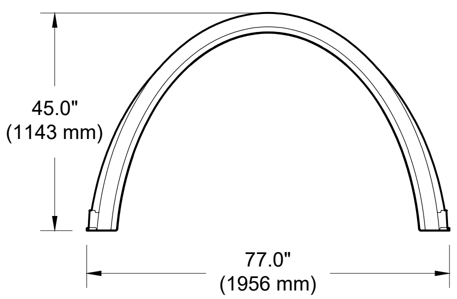
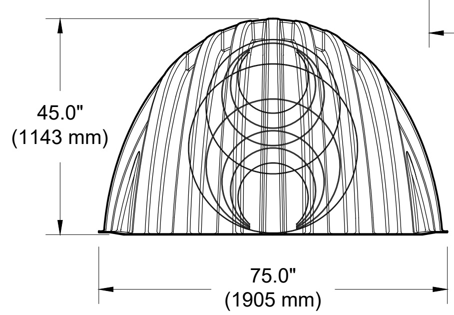
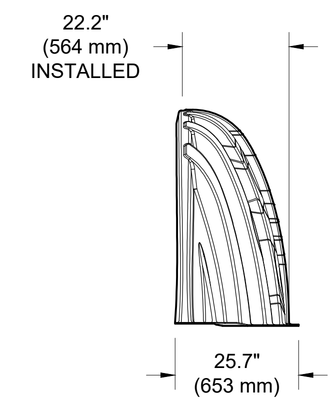



**NOMINAL CHAMBER SPECIFICATIONS**

| | | |
|---|---|---|
| SIZE (W X H X INSTALLED LENGTH) | 77.0" X 45.0" X 86.0" | (1956 mm X 1143 mm X 2184 mm) |
| CHAMBER STORAGE | 109.9 CUBIC FEET | (3.11 m³) |
| MINIMUM INSTALLED STORAGE* | 175.0 CUBIC FEET | (4.96 m³) |
| WEIGHT | 134 lbs. | (60.8 kg) |

**NOMINAL END CAP SPECIFICATIONS**

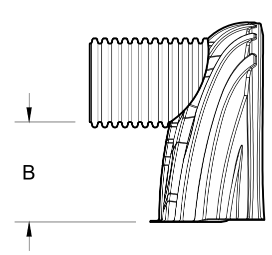
| | | |
|---|---|---|
| SIZE (W X H X INSTALLED LENGTH) | 75.0" X 45.0" X 22.2" | (1905 mm X 1143 mm X 564 mm) |
| END CAP STORAGE | 14.9 CUBIC FEET | (0.42 m³) |
| MINIMUM INSTALLED STORAGE* | 45.1 CUBIC FEET | (1.28 m³) |
| WEIGHT | 49 lbs. | (22.2 kg) |

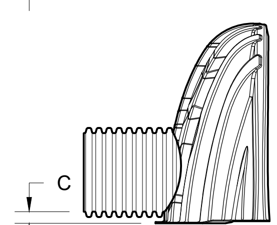
*ASSUMES 12" (305 mm) STONE ABOVE, 9" (229 mm) STONE FOUNDATION, 6" (152 mm) STONE BETWEEN CHAMBERS, 6" (152 mm) STONE PERIMETER IN FRONT OF END CAPS AND 40% STONE POROSITY.

PARTIAL CUT HOLES AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
PARTIAL CUT HOLES AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"
END CAPS WITH A PREFABRICATED WELDED STUB END WITH "W"
END CAPS WITH A WELDED CROWN PLATE END WITH "C"

| PART # | STUB | B | C |
|---|---|---|---|
| MC3500IEPP06T | 6" (150 mm) | 33.21" (844 mm) | --- |
| MC3500IEPP06B | | --- | 0.66" (17 mm) |
| MC3500IEPP08T | 8" (200 mm) | 31.16" (791 mm) | --- |
| MC3500IEPP08B | | --- | 0.81" (21 mm) |
| MC3500IEPP10T | 10" (250 mm) | 29.04" (738 mm) | --- |
| MC3500IEPP10B | | --- | 0.93" (24 mm) |
| MC3500IEPP12T | 12" (300 mm) | 26.36" (670 mm) | --- |
| MC3500IEPP12B | | --- | 1.35" (34 mm) |
| MC3500IEPP15T | 15" (375 mm) | 23.39" (594 mm) | --- |
| MC3500IEPP15B | | --- | 1.50" (38 mm) |
| MC3500IEPP18TC | 18" (450 mm) | 20.03" (509 mm) | --- |
| MC3500IEPP18TW | | | |
| MC3500IEPP18BC | | --- | 1.77" (45 mm) |
| MC3500IEPP18BW | | | |
| MC3500IEPP24TC | 24" (600 mm) | 14.48" (368 mm) | --- |
| MC3500IEPP24TW | | | |
| MC3500IEPP24BC | | --- | 2.06" (52 mm) |
| MC3500IEPP24BW | | | |
| MC3500IEPP30BC | 30" (750 mm) | --- | 2.75" (70 mm) |

NOTE: ALL DIMENSIONS ARE NOMINAL

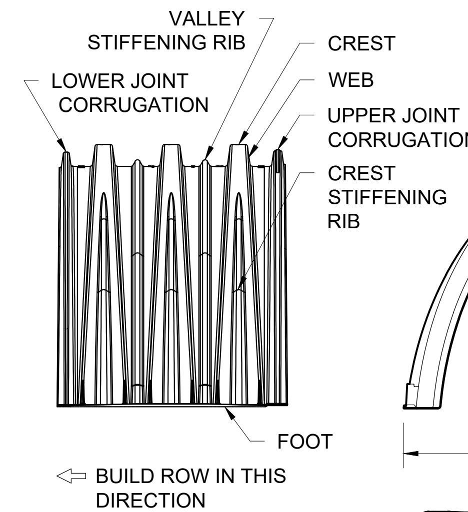


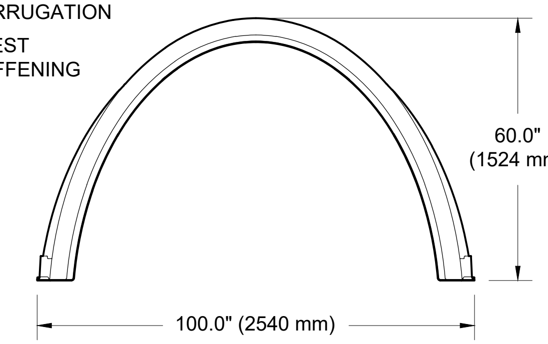



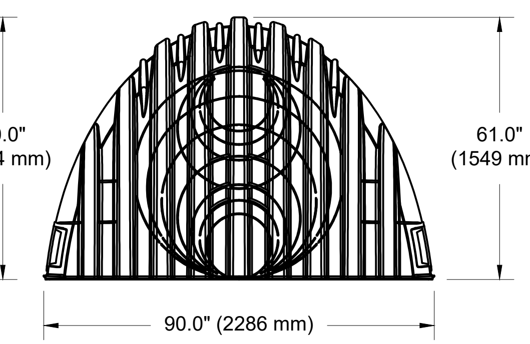

CUSTOM PARTIAL CUT INVERTS ARE AVAILABLE UPON REQUEST. INVENTORIED MANIFOLDS INCLUDE 12-24" (300-600 mm) SIZE ON SIZE AND 15-48" (375-1200 mm) ECCENTRIC MANIFOLDS. CUSTOM INVERT LOCATIONS ON THE MC-3500 END CAP CUT IN THE FIELD ARE NOT RECOMMENDED FOR PIPE SIZES GREATER THAN 10" (250 mm). THE INVERT LOCATION IN COLUMN 'B' ARE THE HIGHEST POSSIBLE FOR THE PIPE SIZE.

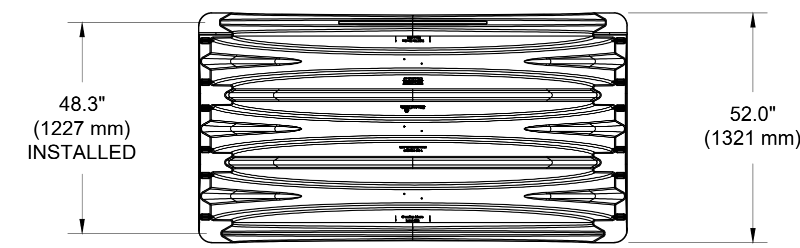
## MC-4500 TECHNICAL SPECIFICATION

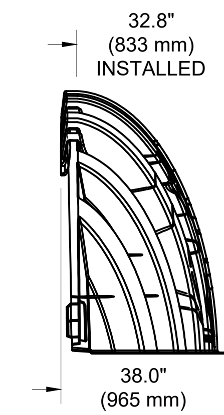
NTS




**NOMINAL CHAMBER SPECIFICATIONS**

| | | |
|---|---|---|
| SIZE (W X H X INSTALLED LENGTH) | 100.0" X 60.0" X 48.3" | (2540 mm X 1524 mm X 1227 mm) |
| CHAMBER STORAGE | 106.5 CUBIC FEET | (3.01 m³) |
| MINIMUM INSTALLED STORAGE* | 162.6 CUBIC FEET | (4.60 m³) |
| WEIGHT (NOMINAL) | 125.0 lbs. | (56.7 kg) |

**NOMINAL END CAP SPECIFICATIONS**

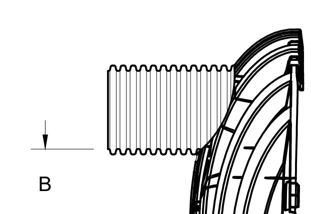
| | | |
|---|---|---|
| SIZE (W X H X INSTALLED LENGTH) | 90.0" X 61.0" X 32.8" | (2286 mm X 1549 mm X 833 mm) |
| END CAP STORAGE | 39.5 CUBIC FEET | (1.12 m³) |
| MINIMUM INSTALLED STORAGE* | 115.3 CUBIC FEET | (3.26 m³) |
| WEIGHT (NOMINAL) | 90 lbs. | (40.8 kg) |

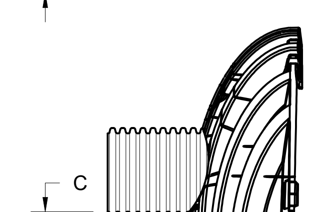
*ASSUMES 12" (305 mm) STONE ABOVE, 9" (229 mm) STONE FOUNDATION AND BETWEEN CHAMBERS, 12" (305 mm) STONE PERIMETER IN FRONT OF END CAPS AND 40% STONE POROSITY.

PARTIAL CUT HOLES AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
PARTIAL CUT HOLES AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"
END CAPS WITH A PREFABRICATED WELDED STUB END WITH "W"

| PART # | STUB | B | C |
|---|---|---|---|
| MC4500IEPP06T | 6" (150 mm) | 42.54" (1081 mm) | --- |
| MC4500IEPP06B | | --- | 0.86" (22 mm) |
| MC4500IEPP08T | 8" (200 mm) | 40.50" (1029 mm) | --- |
| MC4500IEPP08B | | --- | 1.01" (26 mm) |
| MC4500IEPP10T | 10" (250 mm) | 38.37" (975 mm) | --- |
| MC4500IEPP10B | | --- | 1.33" (34 mm) |
| MC4500IEPP12T | 12" (300 mm) | 35.69" (907 mm) | --- |
| MC4500IEPP12B | | --- | 1.55" (39 mm) |
| MC4500IEPP15T | 15" (375 mm) | 32.72" (831 mm) | --- |
| MC4500IEPP15B | | --- | 1.70" (43 mm) |
| MC4500IEPP18T | 18" (450 mm) | 29.36" (746 mm) | --- |
| MC4500IEPP18TW | | | |
| MC4500IEPP18B | | --- | 1.97" (50 mm) |
| MC4500IEPP18BW | | | |
| MC4500IEPP24T | 24" (600 mm) | 23.05" (585 mm) | --- |
| MC4500IEPP24TW | | | |
| MC4500IEPP24B | | --- | 2.26" (57 mm) |
| MC4500IEPP24BW | | | |
| MC4500IEPP30BW | 30" (750 mm) | --- | 2.95" (75 mm) |
| MC4500IEPP36BW | 36" (900 mm) | --- | 3.25" (83 mm) |
| MC4500IEPP42BW | 42" (1050 mm) | --- | 3.55" (90 mm) |

NOTE: ALL DIMENSIONS ARE NOMINAL




CUSTOM PREFABRICATED INVERTS ARE AVAILABLE UPON REQUEST. INVENTORIED MANIFOLDS INCLUDE 12-24" (300-600 mm) SIZE ON SIZE AND 15-48" (375-1200 mm) ECCENTRIC MANIFOLDS. CUSTOM INVERT LOCATIONS ON THE MC-4500 END CAP CUT IN THE FIELD ARE NOT RECOMMENDED FOR PIPE SIZES GREATER THAN 10" (250 mm). THE INVERT LOCATION IN COLUMN 'B' ARE THE HIGHEST POSSIBLE FOR THE PIPE SIZE.

PROJECT PYTHON
OTTAWA,ON.

DATE: 05/05/20 DRAWN: RCT
PROJECT #: S181876 CHECKED: JMQ

| DATE | DRWN | CHKD | DESCRIPTION |
|---|---|---|---|
| 06/01/20 | RCT | JMQ | REVISED SYSTEM 1&4 |
| 05/28/20 | RCT | JMQ | NEW SITE PLAN/MARKUPS |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860-529-8188 | 888-892-2694 | WWW.STORMTECH.COM

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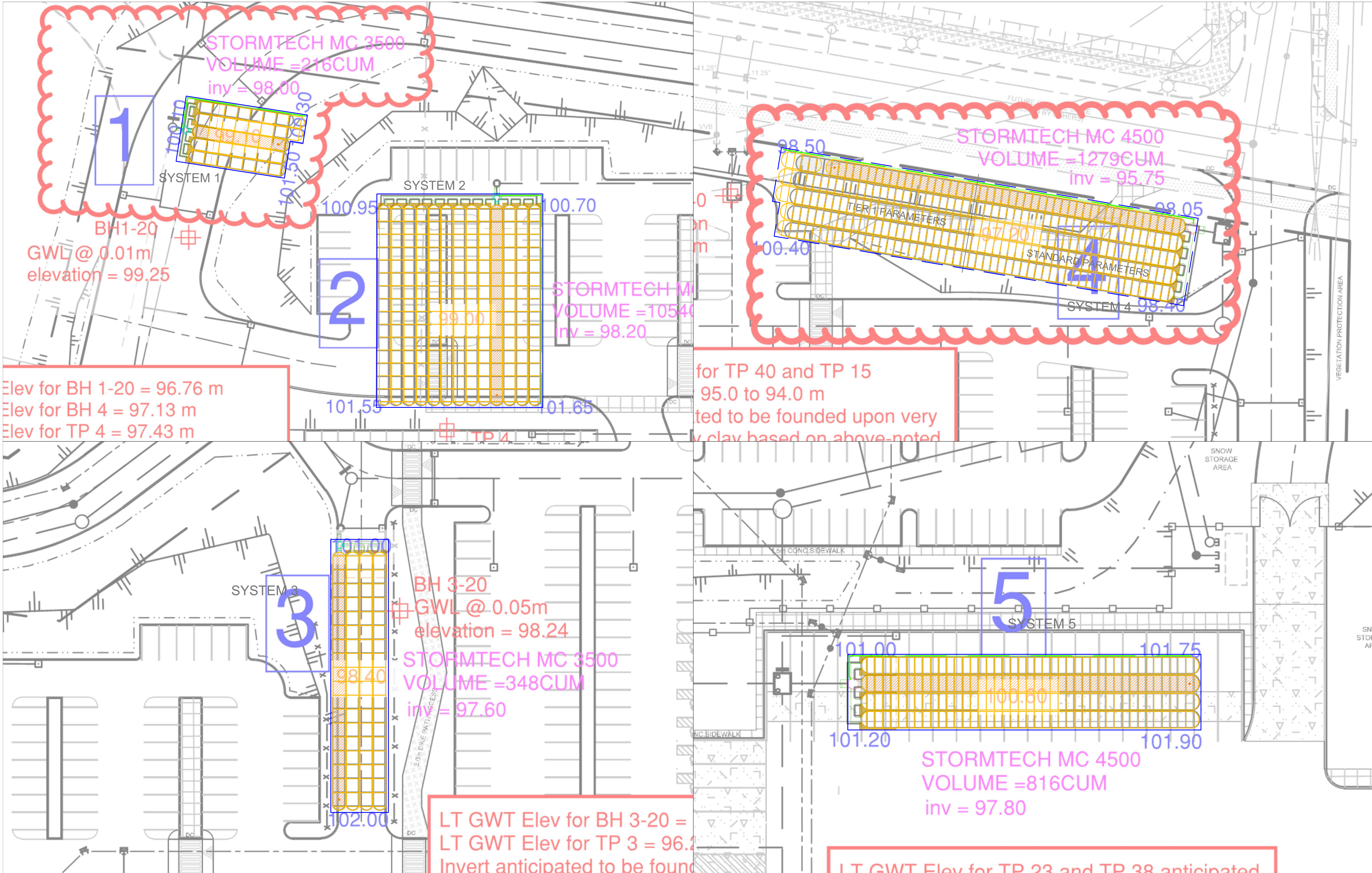
ADVANCED DRAINAGE SYSTEMS, INC.
4640 TRUEMAN BLVD
HILLIARD, OH 43026


STORMTECH MC 3500
VOLUME =216CUM
inv = 98.00
1
SYSTEM 1
BH1-20
GWL @ 0.01m
elevation = 99.25
Elev for BH 1-20 = 96.76 m
Elev for BH 4 = 97.13 m
Elev for TP 4 = 97.43 m
SYSTEM 2
2
100.95
100.70
99.00
101.55
101.65
STORMTECH M
VOLUME =1054
inv = 98.20
TP 4
STORMTECH MC 4500
VOLUME =1279CUM
inv = 95.75
98.50
98.05
100.40
97.20
TIER 1 PARAMETERS
STANDARD PARAMETERS
4
SYSTEM 4
98.40
for TP 40 and TP 15
95.0 to 94.0 m
ted to be founded upon very
VEGETATION PROTECTION AREA
SYSTEM 3
3
101.00
BH 3-20
GWL @ 0.05m
elevation = 98.24
STORMTECH MC 3500
VOLUME =348CUM
inv = 97.60
98.40
102.00
LT GWT Elev for BH 3-20 =
LT GWT Elev for TP 3 = 96.
Invert anticipated to be foun
SNOW STORAGE AREA
CONC SIDEWALK
5
SYSTEM 5
101.00
101.75
100.60
101.20
101.90
STORMTECH MC 4500
VOLUME =816CUM
inv = 97.80
LT GWT Elev for TP 23 and TP 38 anticipated

**Project:** **Project Python Rev2 System 1**

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| | | | | | |
|---|---|---|---|---|---|
| Chamber Model - | MC-3500 | | | | |
| Units - | **Metric** | Click Here for Imperial | | | |
| Number of Chambers - | 37 | | | | |
| Number of End Caps - | 10 | | | | |
| Voids in the stone (porosity) - | 40 | % | | | |
| Base of Stone Elevation - | 98.00 | m | ☑ Include Perimeter Stone in Calculations | | |
| Amount of Stone Above Chambers - | 305 | mm | | | |
| Amount of Stone Below Chambers - | 229 | mm | | | |
| Amount of Stone Between Chambers - | 152 | mm | | | |
| | 218.8 | sq.meters | Min. Area - | 185.437 | sq.meters |

| Height of System *(mm)* | Incremental Single Chamber *(cubic meters)* | Incremental Single End Cap *(cubic meters)* | Incremental Chambers *(cubic meters)* | Incremental End Cap *(cubic meters)* | Incremental Stone *(cubic meters)* | Incremental Chamber, End *(cubic meters)* | Cumulative System *(cubic meters)* | Elevation *(meters)* |
|---|---|---|---|---|---|---|---|---|
| 1676 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 218.30 | 99.68 |
| 1651 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 216.08 | 99.65 |
| 1626 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 213.86 | 99.63 |
| 1600 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 211.64 | 99.60 |
| 1575 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 209.42 | 99.57 |
| 1549 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 207.19 | 99.55 |
| 1524 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 204.97 | 99.52 |
| 1499 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 202.75 | 99.50 |
| 1473 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 200.53 | 99.47 |
| 1448 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 198.31 | 99.45 |
| 1422 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 196.08 | 99.42 |
| 1397 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 193.86 | 99.40 |
| 1372 | 0.00 | 0.00 | 0.06 | 0.00 | 2.198 | 2.26 | 191.64 | 99.37 |
| 1346 | 0.01 | 0.00 | 0.20 | 0.01 | 2.138 | 2.35 | 189.38 | 99.35 |
| 1321 | 0.01 | 0.00 | 0.31 | 0.01 | 2.094 | 2.41 | 187.03 | 99.32 |
| 1295 | 0.01 | 0.00 | 0.42 | 0.01 | 2.047 | 2.48 | 184.62 | 99.30 |
| 1270 | 0.02 | 0.00 | 0.72 | 0.02 | 1.926 | 2.67 | 182.14 | 99.27 |
| 1245 | 0.03 | 0.00 | 1.08 | 0.02 | 1.781 | 2.88 | 179.47 | 99.24 |
| 1219 | 0.04 | 0.00 | 1.31 | 0.03 | 1.686 | 3.03 | 176.59 | 99.22 |
| 1194 | 0.04 | 0.00 | 1.49 | 0.04 | 1.612 | 3.14 | 173.56 | 99.19 |
| 1168 | 0.04 | 0.00 | 1.65 | 0.04 | 1.546 | 3.24 | 170.42 | 99.17 |
| 1143 | 0.05 | 0.00 | 1.79 | 0.05 | 1.488 | 3.32 | 167.19 | 99.14 |
| 1118 | 0.05 | 0.01 | 1.92 | 0.05 | 1.435 | 3.40 | 163.87 | 99.12 |
| 1092 | 0.05 | 0.01 | 2.03 | 0.06 | 1.387 | 3.47 | 160.46 | 99.09 |
| 1067 | 0.06 | 0.01 | 2.14 | 0.06 | 1.342 | 3.54 | 156.99 | 99.07 |
| 1041 | 0.06 | 0.01 | 2.24 | 0.07 | 1.301 | 3.60 | 153.45 | 99.04 |
| 1016 | 0.06 | 0.01 | 2.33 | 0.07 | 1.261 | 3.66 | 149.84 | 99.02 |
| 991 | 0.07 | 0.01 | 2.42 | 0.08 | 1.225 | 3.72 | 146.18 | 98.99 |
| 965 | 0.07 | 0.01 | 2.50 | 0.08 | 1.191 | 3.77 | 142.46 | 98.97 |
| 940 | 0.07 | 0.01 | 2.58 | 0.08 | 1.158 | 3.82 | 138.70 | 98.94 |
| 914 | 0.07 | 0.01 | 2.65 | 0.09 | 1.127 | 3.86 | 134.88 | 98.91 |
| 889 | 0.07 | 0.01 | 2.72 | 0.09 | 1.098 | 3.91 | 131.01 | 98.89 |
| 864 | 0.08 | 0.01 | 2.78 | 0.09 | 1.071 | 3.95 | 127.11 | 98.86 |
| 838 | 0.08 | 0.01 | 2.84 | 0.10 | 1.045 | 3.99 | 123.16 | 98.84 |
| 813 | 0.08 | 0.01 | 2.90 | 0.10 | 1.020 | 4.03 | 119.17 | 98.81 |
| 787 | 0.08 | 0.01 | 2.96 | 0.11 | 0.996 | 4.06 | 115.15 | 98.79 |
| 762 | 0.08 | 0.01 | 3.01 | 0.11 | 0.973 | 4.09 | 111.09 | 98.76 |
| 737 | 0.08 | 0.01 | 3.06 | 0.11 | 0.952 | 4.13 | 106.99 | 98.74 |
| 711 | 0.08 | 0.01 | 3.11 | 0.12 | 0.931 | 4.16 | 102.86 | 98.71 |
| 686 | 0.09 | 0.01 | 3.16 | 0.12 | 0.912 | 4.19 | 98.71 | 98.69 |
| 660 | 0.09 | 0.01 | 3.20 | 0.12 | 0.894 | 4.21 | 94.52 | 98.66 |
| 635 | 0.09 | 0.01 | 3.24 | 0.12 | 0.875 | 4.24 | 90.30 | 98.64 |
| 610 | 0.09 | 0.01 | 3.28 | 0.13 | 0.859 | 4.27 | 86.06 | 98.61 |
| 584 | 0.09 | 0.01 | 3.32 | 0.13 | 0.843 | 4.29 | 81.80 | 98.58 |
| 559 | 0.09 | 0.01 | 3.35 | 0.13 | 0.828 | 4.31 | 77.51 | 98.56 |
| 533 | 0.09 | 0.01 | 3.39 | 0.14 | 0.813 | 4.33 | 73.19 | 98.53 |
| 508 | 0.09 | 0.01 | 3.42 | 0.14 | 0.800 | 4.36 | 68.86 | 98.51 |
| 483 | 0.09 | 0.01 | 3.45 | 0.14 | 0.787 | 4.37 | 64.50 | 98.48 |
| 457 | 0.09 | 0.01 | 3.48 | 0.14 | 0.774 | 4.39 | 60.13 | 98.46 |
| 432 | 0.09 | 0.01 | 3.50 | 0.15 | 0.762 | 4.41 | 55.73 | 98.43 |
| 406 | 0.10 | 0.01 | 3.53 | 0.15 | 0.751 | 4.43 | 51.32 | 98.41 |
| 381 | 0.10 | 0.01 | 3.55 | 0.15 | 0.740 | 4.44 | 46.89 | 98.38 |
| 356 | 0.10 | 0.02 | 3.58 | 0.15 | 0.730 | 4.46 | 42.45 | 98.36 |
| 330 | 0.10 | 0.02 | 3.60 | 0.15 | 0.720 | 4.47 | 37.99 | 98.33 |
| 305 | 0.10 | 0.02 | 3.62 | 0.16 | 0.711 | 4.49 | 33.52 | 98.30 |
| 279 | 0.10 | 0.02 | 3.64 | 0.16 | 0.701 | 4.50 | 29.03 | 98.28 |
| 254 | 0.10 | 0.02 | 3.67 | 0.17 | 0.686 | 4.53 | 24.52 | 98.25 |
| 229 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 20.00 | 98.23 |
| 203 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 17.78 | 98.20 |
| 178 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 15.55 | 98.18 |
| 152 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 13.33 | 98.15 |
| 127 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 11.11 | 98.13 |
| 102 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 8.89 | 98.10 |
| 76 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 6.67 | 98.08 |
| 51 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 4.44 | 98.05 |
| 25 | 0.00 | 0.00 | 0.00 | 0.00 | 2.222 | 2.22 | 2.22 | 98.03 |

**Project:** **Project Python Rev 1 Bed 2**

| | | |
|---|---|---|
| Chamber Model - | MC-3500 | |
| Units - | **Metric** | Click Here for Imperial |
| Number of Chambers - | 195 | |
| Number of End Caps - | 26 | |
| Voids in the stone (porosity) - | 40 | % |
| Base of Stone Elevation - | 98.20 | m |
| Amount of Stone Above Chambers - | 305 | mm |
| Amount of Stone Below Chambers - | 229 | mm |
| Amount of Stone Between Chambers - | 152 | mm |
| | 1020.1 | sq.meters |

☑ Include Perimeter Stone in Calculations

Min. Area - 936.998 sq.meters

| Height of System *(mm)* | Incremental Single Chamber *(cubic meters)* | Incremental Single End Cap *(cubic meters)* | Incremental Chambers *(cubic meters)* | Incremental End Cap *(cubic meters)* | Incremental Stone *(cubic meters)* | Incremental Chamber, End *(cubic meters)* | Cumulative System *(cubic meters)* | Elevation *(meters)* |
|---|---|---|---|---|---|---|---|---|
| 1676 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 1054.57 | 99.88 |
| 1651 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 1044.21 | 99.85 |
| 1626 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 1033.85 | 99.83 |
| 1600 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 1023.49 | 99.80 |
| 1575 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 1013.13 | 99.77 |
| 1549 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 1002.77 | 99.75 |
| 1524 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 992.41 | 99.72 |
| 1499 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 982.05 | 99.70 |
| 1473 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 971.70 | 99.67 |
| 1448 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 961.34 | 99.65 |
| 1422 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 950.98 | 99.62 |
| 1397 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 940.62 | 99.60 |
| 1372 | 0.00 | 0.00 | 0.32 | 0.00 | 10.231 | 10.55 | 930.26 | 99.57 |
| 1346 | 0.01 | 0.00 | 1.07 | 0.02 | 9.923 | 11.01 | 919.71 | 99.55 |
| 1321 | 0.01 | 0.00 | 1.62 | 0.03 | 9.699 | 11.35 | 908.70 | 99.52 |
| 1295 | 0.01 | 0.00 | 2.23 | 0.04 | 9.452 | 11.72 | 897.35 | 99.50 |
| 1270 | 0.02 | 0.00 | 3.79 | 0.05 | 8.821 | 12.67 | 885.63 | 99.47 |
| 1245 | 0.03 | 0.00 | 5.68 | 0.06 | 8.062 | 13.80 | 872.96 | 99.44 |
| 1219 | 0.04 | 0.00 | 6.90 | 0.08 | 7.568 | 14.55 | 859.16 | 99.42 |
| 1194 | 0.04 | 0.00 | 7.85 | 0.09 | 7.180 | 15.13 | 844.61 | 99.39 |
| 1168 | 0.04 | 0.00 | 8.69 | 0.11 | 6.842 | 15.63 | 829.48 | 99.37 |
| 1143 | 0.05 | 0.00 | 9.43 | 0.12 | 6.540 | 16.09 | 813.85 | 99.34 |
| 1118 | 0.05 | 0.01 | 10.10 | 0.13 | 6.267 | 16.50 | 797.76 | 99.32 |
| 1092 | 0.05 | 0.01 | 10.70 | 0.15 | 6.020 | 16.87 | 781.26 | 99.29 |
| 1067 | 0.06 | 0.01 | 11.27 | 0.16 | 5.787 | 17.22 | 764.40 | 99.27 |
| 1041 | 0.06 | 0.01 | 11.79 | 0.17 | 5.575 | 17.54 | 747.18 | 99.24 |
| 1016 | 0.06 | 0.01 | 12.28 | 0.18 | 5.373 | 17.84 | 729.64 | 99.22 |
| 991 | 0.07 | 0.01 | 12.74 | 0.20 | 5.186 | 18.12 | 711.81 | 99.19 |
| 965 | 0.07 | 0.01 | 13.17 | 0.21 | 5.009 | 18.38 | 693.69 | 99.17 |
| 940 | 0.07 | 0.01 | 13.58 | 0.22 | 4.841 | 18.64 | 675.30 | 99.14 |
| 914 | 0.07 | 0.01 | 13.96 | 0.23 | 4.684 | 18.87 | 656.67 | 99.11 |
| 889 | 0.07 | 0.01 | 14.32 | 0.24 | 4.536 | 19.09 | 637.80 | 99.09 |
| 864 | 0.08 | 0.01 | 14.67 | 0.25 | 4.394 | 19.31 | 618.70 | 99.06 |
| 838 | 0.08 | 0.01 | 14.99 | 0.26 | 4.260 | 19.51 | 599.40 | 99.04 |
| 813 | 0.08 | 0.01 | 15.30 | 0.27 | 4.132 | 19.70 | 579.89 | 99.01 |
| 787 | 0.08 | 0.01 | 15.60 | 0.27 | 4.010 | 19.88 | 560.19 | 98.99 |
| 762 | 0.08 | 0.01 | 15.88 | 0.28 | 3.895 | 20.06 | 540.31 | 98.96 |
| 737 | 0.08 | 0.01 | 16.15 | 0.29 | 3.784 | 20.22 | 520.25 | 98.94 |
| 711 | 0.08 | 0.01 | 16.40 | 0.30 | 3.679 | 20.38 | 500.03 | 98.91 |
| 686 | 0.09 | 0.01 | 16.63 | 0.31 | 3.582 | 20.52 | 479.65 | 98.89 |
| 660 | 0.09 | 0.01 | 16.86 | 0.32 | 3.489 | 20.66 | 459.13 | 98.86 |
| 635 | 0.09 | 0.01 | 17.09 | 0.32 | 3.395 | 20.81 | 438.46 | 98.84 |
| 610 | 0.09 | 0.01 | 17.29 | 0.33 | 3.312 | 20.93 | 417.66 | 98.81 |
| 584 | 0.09 | 0.01 | 17.48 | 0.34 | 3.231 | 21.05 | 396.73 | 98.78 |
| 559 | 0.09 | 0.01 | 17.67 | 0.35 | 3.154 | 21.17 | 375.68 | 98.76 |
| 533 | 0.09 | 0.01 | 17.84 | 0.35 | 3.081 | 21.28 | 354.51 | 98.73 |
| 508 | 0.09 | 0.01 | 18.01 | 0.36 | 3.011 | 21.38 | 333.23 | 98.71 |
| 483 | 0.09 | 0.01 | 18.17 | 0.37 | 2.945 | 21.48 | 311.85 | 98.68 |
| 457 | 0.09 | 0.01 | 18.32 | 0.37 | 2.881 | 21.58 | 290.37 | 98.66 |
| 432 | 0.09 | 0.01 | 18.47 | 0.38 | 2.821 | 21.67 | 268.80 | 98.63 |
| 406 | 0.10 | 0.01 | 18.60 | 0.38 | 2.765 | 21.75 | 247.13 | 98.61 |
| 381 | 0.10 | 0.01 | 18.73 | 0.39 | 2.710 | 21.83 | 225.38 | 98.58 |
| 356 | 0.10 | 0.02 | 18.85 | 0.40 | 2.659 | 21.91 | 203.55 | 98.56 |
| 330 | 0.10 | 0.02 | 18.98 | 0.40 | 2.608 | 21.99 | 181.64 | 98.53 |
| 305 | 0.10 | 0.02 | 19.09 | 0.40 | 2.560 | 22.06 | 159.65 | 98.50 |
| 279 | 0.10 | 0.02 | 19.21 | 0.41 | 2.512 | 22.13 | 137.60 | 98.48 |
| 254 | 0.10 | 0.02 | 19.35 | 0.44 | 2.442 | 22.23 | 115.47 | 98.45 |
| 229 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 93.23 | 98.43 |
| 203 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 82.87 | 98.40 |
| 178 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 72.51 | 98.38 |
| 152 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 62.15 | 98.35 |
| 127 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 51.80 | 98.33 |
| 102 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 41.44 | 98.30 |
| 76 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 31.08 | 98.28 |
| 51 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 20.72 | 98.25 |
| 25 | 0.00 | 0.00 | 0.00 | 0.00 | 10.359 | 10.36 | 10.36 | 98.23 |

**Project:** **Project Python Rev 1 Bed 3**

| | | | |
|---|---|---|---|
| Chamber Model - | MC-3500 | | |
| Units - | **Metric** | Click Here for Imperial | |
| Number of Chambers - | 72 | | |
| Number of End Caps - | 8 | | |
| Voids in the stone (porosity) - | 40 | % | |
| Base of Stone Elevation - | 97.00 | m | ☑ Include Perimeter Stone in Calculations |
| Amount of Stone Above Chambers - | 305 | mm | |
| Amount of Stone Below Chambers - | 600 | mm | |
| Amount of Stone Between Chambers - | 152 | mm | |
| | 388.1 | sq.meters | Min. Area - 343.553 sq.meters |

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| Height of System *(mm)* | Incremental Single Chamber *(cubic meters)* | Incremental Single End Cap *(cubic meters)* | Incremental Chambers *(cubic meters)* | Incremental End Cap *(cubic meters)* | Incremental Stone *(cubic meters)* | Incremental Chamber, End | Cumulative System *(cubic meters)* | Elevation *(meters)* |
|---|---|---|---|---|---|---|---|---|
| 2057 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 455.76 | 99.06 |
| 2032 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 451.82 | 99.03 |
| 2007 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 447.88 | 99.01 |
| 1981 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 443.94 | 98.98 |
| 1956 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 440.00 | 98.96 |
| 1930 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 436.06 | 98.93 |
| 1905 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 432.11 | 98.91 |
| 1880 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 428.17 | 98.88 |
| 1854 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 424.23 | 98.85 |
| 1829 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 420.29 | 98.83 |
| 1803 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 416.35 | 98.80 |
| 1778 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 412.41 | 98.78 |
| 1753 | 0.00 | 0.00 | 0.12 | 0.00 | 3.894 | 4.01 | 408.47 | 98.75 |
| 1727 | 0.01 | 0.00 | 0.40 | 0.01 | 3.781 | 4.18 | 404.46 | 98.73 |
| 1702 | 0.01 | 0.00 | 0.60 | 0.01 | 3.698 | 4.31 | 400.27 | 98.70 |
| 1676 | 0.01 | 0.00 | 0.82 | 0.01 | 3.607 | 4.44 | 395.97 | 98.68 |
| 1651 | 0.02 | 0.00 | 1.40 | 0.02 | 3.375 | 4.79 | 391.53 | 98.65 |
| 1626 | 0.03 | 0.00 | 2.10 | 0.02 | 3.095 | 5.21 | 386.74 | 98.63 |
| 1600 | 0.04 | 0.00 | 2.55 | 0.02 | 2.912 | 5.48 | 381.52 | 98.60 |
| 1575 | 0.04 | 0.00 | 2.90 | 0.03 | 2.770 | 5.70 | 376.04 | 98.57 |
| 1549 | 0.04 | 0.00 | 3.21 | 0.03 | 2.645 | 5.89 | 370.34 | 98.55 |
| 1524 | 0.05 | 0.00 | 3.48 | 0.04 | 2.534 | 6.05 | 364.46 | 98.52 |
| 1499 | 0.05 | 0.01 | 3.73 | 0.04 | 2.433 | 6.20 | 358.41 | 98.50 |
| 1473 | 0.05 | 0.01 | 3.95 | 0.05 | 2.343 | 6.34 | 352.20 | 98.47 |
| 1448 | 0.06 | 0.01 | 4.16 | 0.05 | 2.257 | 6.47 | 345.86 | 98.45 |
| 1422 | 0.06 | 0.01 | 4.35 | 0.05 | 2.179 | 6.58 | 339.40 | 98.42 |
| 1397 | 0.06 | 0.01 | 4.53 | 0.06 | 2.104 | 6.70 | 332.81 | 98.40 |
| 1372 | 0.07 | 0.01 | 4.70 | 0.06 | 2.036 | 6.80 | 326.12 | 98.37 |
| 1346 | 0.07 | 0.01 | 4.86 | 0.06 | 1.971 | 6.90 | 319.32 | 98.35 |
| 1321 | 0.07 | 0.01 | 5.01 | 0.07 | 1.909 | 6.99 | 312.42 | 98.32 |
| 1295 | 0.07 | 0.01 | 5.15 | 0.07 | 1.851 | 7.08 | 305.43 | 98.30 |
| 1270 | 0.07 | 0.01 | 5.29 | 0.07 | 1.797 | 7.16 | 298.36 | 98.27 |
| 1245 | 0.08 | 0.01 | 5.42 | 0.08 | 1.745 | 7.24 | 291.20 | 98.24 |
| 1219 | 0.08 | 0.01 | 5.54 | 0.08 | 1.695 | 7.31 | 283.96 | 98.22 |
| 1194 | 0.08 | 0.01 | 5.65 | 0.08 | 1.648 | 7.38 | 276.65 | 98.19 |
| 1168 | 0.08 | 0.01 | 5.76 | 0.08 | 1.604 | 7.45 | 269.27 | 98.17 |
| 1143 | 0.08 | 0.01 | 5.86 | 0.09 | 1.561 | 7.51 | 261.83 | 98.14 |
| 1118 | 0.08 | 0.01 | 5.96 | 0.09 | 1.520 | 7.57 | 254.31 | 98.12 |
| 1092 | 0.08 | 0.01 | 6.06 | 0.09 | 1.482 | 7.63 | 246.74 | 98.09 |
| 1067 | 0.09 | 0.01 | 6.14 | 0.09 | 1.446 | 7.68 | 239.11 | 98.07 |
| 1041 | 0.09 | 0.01 | 6.23 | 0.10 | 1.412 | 7.73 | 231.43 | 98.04 |
| 1016 | 0.09 | 0.01 | 6.31 | 0.10 | 1.378 | 7.79 | 223.69 | 98.02 |
| 991 | 0.09 | 0.01 | 6.38 | 0.10 | 1.347 | 7.83 | 215.91 | 97.99 |
| 965 | 0.09 | 0.01 | 6.45 | 0.10 | 1.318 | 7.88 | 208.08 | 97.97 |
| 940 | 0.09 | 0.01 | 6.52 | 0.11 | 1.289 | 7.92 | 200.20 | 97.94 |
| 914 | 0.09 | 0.01 | 6.59 | 0.11 | 1.263 | 7.96 | 192.28 | 97.91 |
| 889 | 0.09 | 0.01 | 6.65 | 0.11 | 1.237 | 8.00 | 184.32 | 97.89 |
| 864 | 0.09 | 0.01 | 6.71 | 0.11 | 1.213 | 8.03 | 176.33 | 97.86 |
| 838 | 0.09 | 0.01 | 6.76 | 0.11 | 1.189 | 8.07 | 168.29 | 97.84 |
| 813 | 0.09 | 0.01 | 6.82 | 0.12 | 1.167 | 8.10 | 160.22 | 97.81 |
| 787 | 0.10 | 0.01 | 6.87 | 0.12 | 1.147 | 8.13 | 152.12 | 97.79 |
| 762 | 0.10 | 0.01 | 6.92 | 0.12 | 1.126 | 8.16 | 143.99 | 97.76 |
| 737 | 0.10 | 0.02 | 6.96 | 0.12 | 1.108 | 8.19 | 135.82 | 97.74 |
| 711 | 0.10 | 0.02 | 7.01 | 0.12 | 1.089 | 8.22 | 127.63 | 97.71 |
| 686 | 0.10 | 0.02 | 7.05 | 0.12 | 1.071 | 8.25 | 119.41 | 97.69 |
| 660 | 0.10 | 0.02 | 7.09 | 0.13 | 1.054 | 8.27 | 111.17 | 97.66 |
| 635 | 0.10 | 0.02 | 7.15 | 0.13 | 1.029 | 8.31 | 102.90 | 97.64 |
| 610 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 94.59 | 97.61 |
| 584 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 90.65 | 97.58 |
| 559 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 86.70 | 97.56 |
| 533 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 82.76 | 97.53 |
| 508 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 78.82 | 97.51 |
| 483 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 74.88 | 97.48 |
| 457 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 70.94 | 97.46 |
| 432 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 67.00 | 97.43 |
| 406 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 63.06 | 97.41 |
| 381 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 59.12 | 97.38 |
| 356 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 55.18 | 97.36 |
| 330 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 51.23 | 97.33 |
| 305 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 47.29 | 97.30 |
| 279 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 43.35 | 97.28 |
| 254 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 39.41 | 97.25 |
| 229 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 35.47 | 97.23 |
| 203 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 31.53 | 97.20 |
| 178 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 27.59 | 97.18 |
| 152 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 23.65 | 97.15 |
| 127 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 19.71 | 97.13 |
| 102 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 15.76 | 97.10 |
| 76 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 11.82 | 97.08 |
| 51 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 7.88 | 97.05 |
| 25 | 0.00 | 0.00 | 0.00 | 0.00 | 3.941 | 3.94 | 3.94 | 97.03 |

**Project:** **Project Python Rev2 System 4**

| | | |
|---|---|---|
| Chamber Model - | MC-4500 | |
| Units - | **Metric** | Click Here for Imperial |
| Number of Chambers - | 261 | |
| Number of End Caps - | 12 | |
| Voids in the stone (porosity) - | 40 | % |
| Base of Stone Elevation - | 95.23 | m |
| Amount of Stone Above Chambers - | 305 | mm |
| Amount of Stone Below Chambers - | 750 | mm |

☑ Include Perimeter Stone in Calculations

988 sq.meters Min. Area - 924.577 sq.meters

| Height of System *(mm)* | Incremental Single Chamber *(cubic meters)* | Incremental Single End Cap *(cubic meters)* | Incremental Chambers *(cubic meters)* | Incremental End Cap *(cubic meters)* | Incremental Stone *(cubic meters)* | Incremental Chamber, End *(cubic meters)* | Cumulative System *(cubic meters)* | Elevation *(meters)* |
|---|---|---|---|---|---|---|---|---|
| 2591 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1503.73 | 97.82 |
| 2565 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1493.70 | 97.79 |
| 2540 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1483.66 | 97.77 |
| 2515 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1473.63 | 97.74 |
| 2489 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1463.60 | 97.72 |
| 2464 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1453.57 | 97.69 |
| 2438 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1443.53 | 97.67 |
| 2413 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1433.50 | 97.64 |
| 2388 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1423.47 | 97.62 |
| 2362 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1413.43 | 97.59 |
| 2337 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1403.40 | 97.57 |
| 2311 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 1393.37 | 97.54 |
| 2286 | 0.00 | 0.00 | 0.30 | 0.00 | 9.910 | 10.22 | 1383.33 | 97.52 |
| 2261 | 0.00 | 0.00 | 0.86 | 0.01 | 9.685 | 10.55 | 1373.12 | 97.49 |
| 2235 | 0.00 | 0.00 | 1.22 | 0.02 | 9.539 | 10.77 | 1362.56 | 97.46 |
| 2210 | 0.01 | 0.00 | 1.54 | 0.02 | 9.407 | 10.97 | 1351.79 | 97.44 |
| 2184 | 0.01 | 0.00 | 1.98 | 0.03 | 9.228 | 11.24 | 1340.82 | 97.41 |
| 2159 | 0.01 | 0.00 | 3.35 | 0.04 | 8.680 | 12.06 | 1329.58 | 97.39 |
| 2134 | 0.02 | 0.00 | 4.92 | 0.04 | 8.048 | 13.01 | 1317.51 | 97.36 |
| 2108 | 0.02 | 0.00 | 5.91 | 0.05 | 7.649 | 13.61 | 1304.50 | 97.34 |
| 2083 | 0.03 | 0.01 | 6.71 | 0.06 | 7.323 | 14.10 | 1290.89 | 97.31 |
| 2057 | 0.03 | 0.01 | 7.41 | 0.07 | 7.038 | 14.52 | 1276.80 | 97.29 |
| 2032 | 0.03 | 0.01 | 8.04 | 0.08 | 6.785 | 14.91 | 1262.27 | 97.26 |
| 2007 | 0.03 | 0.01 | 8.60 | 0.09 | 6.556 | 15.25 | 1247.37 | 97.24 |
| 1981 | 0.03 | 0.01 | 9.12 | 0.10 | 6.344 | 15.57 | 1232.12 | 97.21 |
| 1956 | 0.04 | 0.01 | 9.61 | 0.11 | 6.146 | 15.86 | 1216.55 | 97.18 |
| 1930 | 0.04 | 0.01 | 10.06 | 0.12 | 5.961 | 16.14 | 1200.69 | 97.16 |
| 1905 | 0.04 | 0.01 | 10.49 | 0.13 | 5.787 | 16.40 | 1184.55 | 97.13 |
| 1880 | 0.04 | 0.01 | 10.89 | 0.14 | 5.622 | 16.65 | 1168.14 | 97.11 |
| 1854 | 0.04 | 0.01 | 11.27 | 0.15 | 5.464 | 16.89 | 1151.49 | 97.08 |
| 1829 | 0.04 | 0.01 | 11.64 | 0.16 | 5.315 | 17.11 | 1134.61 | 97.06 |
| 1803 | 0.05 | 0.01 | 11.98 | 0.17 | 5.172 | 17.32 | 1117.50 | 97.03 |
| 1778 | 0.05 | 0.01 | 12.31 | 0.18 | 5.036 | 17.53 | 1100.17 | 97.01 |
| 1753 | 0.05 | 0.02 | 12.63 | 0.19 | 4.906 | 17.72 | 1082.65 | 96.98 |
| 1727 | 0.05 | 0.02 | 12.93 | 0.19 | 4.782 | 17.91 | 1064.92 | 96.96 |
| 1702 | 0.05 | 0.02 | 13.22 | 0.20 | 4.663 | 18.09 | 1047.01 | 96.93 |
| 1676 | 0.05 | 0.02 | 13.50 | 0.21 | 4.548 | 18.26 | 1028.93 | 96.91 |
| 1651 | 0.05 | 0.02 | 13.77 | 0.21 | 4.438 | 18.43 | 1010.67 | 96.88 |
| 1626 | 0.05 | 0.02 | 14.03 | 0.22 | 4.334 | 18.58 | 992.24 | 96.85 |
| 1600 | 0.05 | 0.02 | 14.28 | 0.23 | 4.230 | 18.74 | 973.66 | 96.83 |
| 1575 | 0.06 | 0.02 | 14.52 | 0.24 | 4.131 | 18.89 | 954.92 | 96.80 |
| 1549 | 0.06 | 0.02 | 14.75 | 0.25 | 4.037 | 19.03 | 936.04 | 96.78 |
| 1524 | 0.06 | 0.02 | 14.97 | 0.25 | 3.945 | 19.16 | 917.01 | 96.75 |
| 1499 | 0.06 | 0.02 | 15.18 | 0.26 | 3.858 | 19.30 | 897.84 | 96.73 |
| 1473 | 0.06 | 0.02 | 15.38 | 0.27 | 3.773 | 19.42 | 878.55 | 96.70 |
| 1448 | 0.06 | 0.02 | 15.58 | 0.27 | 3.692 | 19.54 | 859.12 | 96.68 |
| 1422 | 0.06 | 0.02 | 15.77 | 0.28 | 3.613 | 19.66 | 839.58 | 96.65 |
| 1397 | 0.06 | 0.02 | 15.95 | 0.28 | 3.537 | 19.78 | 819.92 | 96.63 |
| 1372 | 0.06 | 0.02 | 16.13 | 0.29 | 3.465 | 19.88 | 800.14 | 96.60 |
| 1346 | 0.06 | 0.02 | 16.30 | 0.29 | 3.396 | 19.99 | 780.25 | 96.58 |
| 1321 | 0.06 | 0.03 | 16.46 | 0.30 | 3.327 | 20.09 | 760.27 | 96.55 |
| 1295 | 0.06 | 0.03 | 16.62 | 0.31 | 3.262 | 20.19 | 740.17 | 96.52 |
| 1270 | 0.06 | 0.03 | 16.77 | 0.31 | 3.199 | 20.28 | 719.98 | 96.50 |
| 1245 | 0.06 | 0.03 | 16.92 | 0.31 | 3.141 | 20.37 | 699.70 | 96.47 |
| 1219 | 0.07 | 0.03 | 17.06 | 0.32 | 3.082 | 20.46 | 679.33 | 96.45 |
| 1194 | 0.07 | 0.03 | 17.19 | 0.32 | 3.027 | 20.54 | 658.87 | 96.42 |
| 1168 | 0.07 | 0.03 | 17.32 | 0.33 | 2.974 | 20.62 | 638.33 | 96.40 |
| 1143 | 0.07 | 0.03 | 17.44 | 0.33 | 2.923 | 20.70 | 617.71 | 96.37 |
| 1118 | 0.07 | 0.03 | 17.56 | 0.33 | 2.877 | 20.77 | 597.01 | 96.35 |
| 1092 | 0.07 | 0.03 | 17.67 | 0.34 | 2.828 | 20.84 | 576.24 | 96.32 |
| 1067 | 0.07 | 0.03 | 17.78 | 0.34 | 2.784 | 20.91 | 555.40 | 96.30 |
| 1041 | 0.07 | 0.03 | 17.88 | 0.35 | 2.742 | 20.97 | 534.49 | 96.27 |
| 1016 | 0.07 | 0.03 | 17.98 | 0.35 | 2.702 | 21.03 | 513.53 | 96.25 |
| 991 | 0.07 | 0.03 | 18.07 | 0.35 | 2.664 | 21.09 | 492.50 | 96.22 |
| 965 | 0.07 | 0.03 | 18.16 | 0.36 | 2.628 | 21.14 | 471.41 | 96.19 |
| 940 | 0.07 | 0.03 | 18.24 | 0.36 | 2.594 | 21.19 | 450.27 | 96.17 |
| 914 | 0.07 | 0.03 | 18.32 | 0.36 | 2.564 | 21.24 | 429.08 | 96.14 |
| 889 | 0.07 | 0.03 | 18.39 | 0.36 | 2.533 | 21.28 | 407.84 | 96.12 |
| 864 | 0.07 | 0.03 | 18.46 | 0.37 | 2.503 | 21.33 | 386.56 | 96.09 |
| 838 | 0.07 | 0.03 | 18.53 | 0.37 | 2.476 | 21.37 | 365.23 | 96.07 |
| 813 | 0.07 | 0.03 | 18.59 | 0.37 | 2.451 | 21.41 | 343.86 | 96.04 |
| 787 | 0.07 | 0.03 | 18.68 | 0.38 | 2.412 | 21.46 | 322.46 | 96.02 |
| 762 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 300.99 | 95.99 |
| 737 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 290.96 | 95.97 |
| 711 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 280.92 | 95.94 |
| 686 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 270.89 | 95.91 |
| 660 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 260.86 | 95.89 |
| 635 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 250.83 | 95.86 |
| 610 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 240.79 | 95.84 |
| 584 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 230.76 | 95.81 |
| 559 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 220.73 | 95.79 |
| 533 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 210.69 | 95.76 |
| 508 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 200.66 | 95.74 |
| 483 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 190.63 | 95.71 |
| 457 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 180.59 | 95.69 |
| 432 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 170.56 | 95.66 |
| 406 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 160.53 | 95.64 |
| 381 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 150.50 | 95.61 |
| 356 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 140.46 | 95.58 |
| 330 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 130.43 | 95.56 |
| 305 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 120.40 | 95.53 |
| 279 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 110.36 | 95.51 |
| 254 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 100.33 | 95.48 |
| 229 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 90.30 | 95.46 |
| 203 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 80.26 | 95.43 |
| 178 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 70.23 | 95.41 |
| 152 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 60.20 | 95.38 |
| 127 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 50.17 | 95.36 |
| 102 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 40.13 | 95.33 |
| 76 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 30.10 | 95.31 |
| 51 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 20.07 | 95.28 |
| 25 | 0.00 | 0.00 | 0.00 | 0.00 | 10.033 | 10.03 | 10.03 | 95.25 |

205.6m3@96.75

**Project:** **Project Python Rev 1 Bed 5**

StormTech
Detention • Retention • Water Quality
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| | | |
|---|---|---|
| Chamber Model - | MC-4500 | |
| Units - | **Metric** | Click Here for Imperial |
| Number of Chambers - | 164 | |
| Number of End Caps - | 8 | |
| Voids in the stone (porosity) - | 40 | % |
| Base of Stone Elevation - | 97.80 | m |
| Amount of Stone Above Chambers - | 305 | mm |
| Amount of Stone Below Chambers - | 229 | mm |

☑ Include Perimeter Stone in Calculations

632.6 sq.meters Min. Area - 582.409 sq.meters

| Height of System *(mm)* | Incremental Single Chamber *(cubic meters)* | Incremental Single End Cap *(cubic meters)* | Incremental Chambers *(cubic meters)* | Incremental End Cap *(cubic meters)* | Incremental Stone *(cubic meters)* | Incremental Chamber, End *(cubic meters)* | Cumulative System *(cubic meters)* | Elevation *(meters)* |
|---|---|---|---|---|---|---|---|---|
| 2057 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 822.49 | 99.86 |
| 2032 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 816.06 | 99.83 |
| 2007 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 809.64 | 99.81 |
| 1981 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 803.22 | 99.78 |
| 1956 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 796.79 | 99.76 |
| 1930 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 790.37 | 99.73 |
| 1905 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 783.94 | 99.71 |
| 1880 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 777.52 | 99.68 |
| 1854 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 771.10 | 99.65 |
| 1829 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 764.67 | 99.63 |
| 1803 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 758.25 | 99.60 |
| 1778 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 751.82 | 99.58 |
| 1753 | 0.00 | 0.00 | 0.19 | 0.00 | 6.347 | 6.54 | 745.40 | 99.55 |
| 1727 | 0.00 | 0.00 | 0.54 | 0.01 | 6.205 | 6.75 | 738.86 | 99.53 |
| 1702 | 0.00 | 0.00 | 0.77 | 0.01 | 6.113 | 6.89 | 732.11 | 99.50 |
| 1676 | 0.01 | 0.00 | 0.97 | 0.01 | 6.030 | 7.01 | 725.22 | 99.48 |
| 1651 | 0.01 | 0.00 | 1.25 | 0.02 | 5.918 | 7.18 | 718.20 | 99.45 |
| 1626 | 0.01 | 0.00 | 2.10 | 0.02 | 5.573 | 7.70 | 711.02 | 99.43 |
| 1600 | 0.02 | 0.00 | 3.09 | 0.03 | 5.176 | 8.30 | 703.32 | 99.40 |
| 1575 | 0.02 | 0.00 | 3.71 | 0.04 | 4.925 | 8.67 | 695.02 | 99.37 |
| 1549 | 0.03 | 0.01 | 4.22 | 0.04 | 4.720 | 8.98 | 686.35 | 99.35 |
| 1524 | 0.03 | 0.01 | 4.66 | 0.05 | 4.541 | 9.25 | 677.37 | 99.32 |
| 1499 | 0.03 | 0.01 | 5.05 | 0.06 | 4.382 | 9.49 | 668.12 | 99.30 |
| 1473 | 0.03 | 0.01 | 5.40 | 0.06 | 4.238 | 9.70 | 658.64 | 99.27 |
| 1448 | 0.03 | 0.01 | 5.73 | 0.07 | 4.104 | 9.90 | 648.93 | 99.25 |
| 1422 | 0.04 | 0.01 | 6.04 | 0.07 | 3.980 | 10.09 | 639.03 | 99.22 |
| 1397 | 0.04 | 0.01 | 6.32 | 0.08 | 3.864 | 10.26 | 628.94 | 99.20 |
| 1372 | 0.04 | 0.01 | 6.59 | 0.09 | 3.754 | 10.43 | 618.68 | 99.17 |
| 1346 | 0.04 | 0.01 | 6.84 | 0.09 | 3.650 | 10.58 | 608.25 | 99.15 |
| 1321 | 0.04 | 0.01 | 7.08 | 0.10 | 3.551 | 10.73 | 597.66 | 99.12 |
| 1295 | 0.04 | 0.01 | 7.31 | 0.11 | 3.457 | 10.87 | 586.93 | 99.10 |
| 1270 | 0.05 | 0.01 | 7.53 | 0.11 | 3.367 | 11.01 | 576.05 | 99.07 |
| 1245 | 0.05 | 0.01 | 7.74 | 0.12 | 3.282 | 11.14 | 565.04 | 99.04 |
| 1219 | 0.05 | 0.02 | 7.94 | 0.12 | 3.200 | 11.26 | 553.91 | 99.02 |
| 1194 | 0.05 | 0.02 | 8.13 | 0.13 | 3.122 | 11.38 | 542.65 | 98.99 |
| 1168 | 0.05 | 0.02 | 8.31 | 0.13 | 3.047 | 11.49 | 531.27 | 98.97 |
| 1143 | 0.05 | 0.02 | 8.49 | 0.14 | 2.975 | 11.60 | 519.78 | 98.94 |
| 1118 | 0.05 | 0.02 | 8.65 | 0.14 | 2.905 | 11.70 | 508.18 | 98.92 |
| 1092 | 0.05 | 0.02 | 8.82 | 0.15 | 2.839 | 11.80 | 496.48 | 98.89 |
| 1067 | 0.05 | 0.02 | 8.97 | 0.15 | 2.774 | 11.90 | 484.68 | 98.87 |
| 1041 | 0.06 | 0.02 | 9.12 | 0.16 | 2.712 | 11.99 | 472.78 | 98.84 |
| 1016 | 0.06 | 0.02 | 9.27 | 0.16 | 2.652 | 12.08 | 460.79 | 98.82 |
| 991 | 0.06 | 0.02 | 9.40 | 0.17 | 2.595 | 12.17 | 448.71 | 98.79 |
| 965 | 0.06 | 0.02 | 9.54 | 0.17 | 2.540 | 12.25 | 436.54 | 98.77 |
| 940 | 0.06 | 0.02 | 9.67 | 0.18 | 2.486 | 12.33 | 424.29 | 98.74 |
| 914 | 0.06 | 0.02 | 9.79 | 0.18 | 2.435 | 12.41 | 411.96 | 98.71 |
| 889 | 0.06 | 0.02 | 9.91 | 0.19 | 2.386 | 12.48 | 399.55 | 98.69 |
| 864 | 0.06 | 0.02 | 10.02 | 0.19 | 2.338 | 12.55 | 387.07 | 98.66 |
| 838 | 0.06 | 0.02 | 10.14 | 0.19 | 2.293 | 12.62 | 374.52 | 98.64 |
| 813 | 0.06 | 0.02 | 10.24 | 0.19 | 2.249 | 12.69 | 361.89 | 98.61 |
| 787 | 0.06 | 0.03 | 10.35 | 0.20 | 2.205 | 12.75 | 349.21 | 98.59 |
| 762 | 0.06 | 0.03 | 10.44 | 0.20 | 2.165 | 12.81 | 336.46 | 98.56 |
| 737 | 0.06 | 0.03 | 10.54 | 0.21 | 2.125 | 12.87 | 323.64 | 98.54 |
| 711 | 0.06 | 0.03 | 10.63 | 0.21 | 2.089 | 12.93 | 310.77 | 98.51 |
| 686 | 0.07 | 0.03 | 10.72 | 0.21 | 2.051 | 12.98 | 297.84 | 98.49 |
| 660 | 0.07 | 0.03 | 10.80 | 0.22 | 2.017 | 13.03 | 284.86 | 98.46 |
| 635 | 0.07 | 0.03 | 10.88 | 0.22 | 1.983 | 13.09 | 271.83 | 98.44 |
| 610 | 0.07 | 0.03 | 10.96 | 0.22 | 1.951 | 13.13 | 258.74 | 98.41 |
| 584 | 0.07 | 0.03 | 11.03 | 0.22 | 1.923 | 13.18 | 245.61 | 98.38 |
| 559 | 0.07 | 0.03 | 11.10 | 0.23 | 1.892 | 13.22 | 232.43 | 98.36 |
| 533 | 0.07 | 0.03 | 11.17 | 0.23 | 1.864 | 13.26 | 219.21 | 98.33 |
| 508 | 0.07 | 0.03 | 11.24 | 0.23 | 1.838 | 13.30 | 205.95 | 98.31 |
| 483 | 0.07 | 0.03 | 11.30 | 0.23 | 1.812 | 13.34 | 192.64 | 98.28 |
| 457 | 0.07 | 0.03 | 11.35 | 0.24 | 1.788 | 13.38 | 179.30 | 98.26 |
| 432 | 0.07 | 0.03 | 11.41 | 0.24 | 1.766 | 13.41 | 165.92 | 98.23 |
| 406 | 0.07 | 0.03 | 11.46 | 0.24 | 1.744 | 13.44 | 152.51 | 98.21 |
| 381 | 0.07 | 0.03 | 11.51 | 0.24 | 1.725 | 13.47 | 139.07 | 98.18 |
| 356 | 0.07 | 0.03 | 11.56 | 0.24 | 1.706 | 13.50 | 125.60 | 98.16 |
| 330 | 0.07 | 0.03 | 11.60 | 0.24 | 1.687 | 13.53 | 112.10 | 98.13 |
| 305 | 0.07 | 0.03 | 11.64 | 0.25 | 1.670 | 13.56 | 98.57 | 98.10 |
| 279 | 0.07 | 0.03 | 11.68 | 0.25 | 1.654 | 13.58 | 85.01 | 98.08 |
| 254 | 0.07 | 0.03 | 11.74 | 0.25 | 1.630 | 13.62 | 71.43 | 98.05 |
| 229 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 57.82 | 98.03 |
| 203 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 51.39 | 98.00 |
| 178 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 44.97 | 97.98 |
| 152 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 38.54 | 97.95 |
| 127 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 32.12 | 97.93 |
| 102 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 25.70 | 97.90 |
| 76 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 19.27 | 97.88 |
| 51 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 12.85 | 97.85 |
| 25 | 0.00 | 0.00 | 0.00 | 0.00 | 6.424 | 6.42 | 6.42 | 97.83 |

# Citi Gate: 416 Corporate Campus - Phase 1
# Junctions

## AutoDesk Storm and Sanitary Analysis
## Chicago 100-year 3-hour Storm Model Output Results

MH208
Q100yr (3-hour Chic.)
= 3,412.51 L/s

NOVATECH
Engineers, Planners & Landscape Architects

| SN | Element ID | Description | Invert Elevation (m) | Ground/Rim (Max) Elevation (m) | Ground/Rim (Max) Offset (m) | Initial Water Elevation (m) | Initial Water Depth (m) | Surcharge Elevation (m) | Surcharge Depth (m) | Ponded Area (m²) | Minimum Pipe Cover (mm) | Peak Inflow (lps) | Peak Lateral Inflow (lps) | Maximum HGL Elevation Attained (m) | Maximum HGL Depth Attained (m) | Maximum Surcharge Depth Attained (m) | Minimum Freeboard Attained (m) | Average HGL Elevation Attained (m) | Average HGL Depth Attained (m) | Time of Maximum HGL Occurrence (days hh:mm) | Time of Peak Flooding Occurrence (days hh:mm) | Total Flooded Volume (ha-mm) | Total Time Flooded (minutes) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 100 | Mcon MH - Concentric | 96.08 | 101.08 | 5.00 | 96.08 | 0.00 | 101.08 | 0.00 | 0.00 | 3672.00 | 71.74 | 0.00 | 96.61 | 0.53 | 0.00 | 4.48 | 96.37 | 0.29 | 0 01:30 | 0 00:00 | 0.00 | 0.00 |
| 2 | 100a | | 96.33 | 100.80 | 4.47 | 96.33 | 0.00 | 100.80 | 0.00 | 0.00 | 0.00 | 173.88 | 0.00 | 96.59 | 0.26 | 0.00 | 4.28 | 96.35 | 0.02 | 0 01:30 | 0 00:00 | 0.00 | 0.00 |
| 3 | 100b | | 96.27 | 100.60 | 4.33 | 96.27 | 0.00 | 100.60 | 0.00 | 0.00 | 870.00 | 182.79 | 0.00 | 96.55 | 0.28 | 0.00 | 4.05 | 96.29 | 0.02 | 0 01:26 | 0 00:00 | 0.00 | 0.00 |
| 4 | 102 | Mcon MH - Concentric | 97.94 | 100.70 | 2.76 | 97.94 | 0.00 | 100.70 | 0.00 | 0.00 | 1732.00 | 20.82 | 0.00 | 98.33 | 0.39 | 0.00 | 2.38 | 98.23 | 0.29 | 0 01:20 | 0 00:00 | 0.00 | 0.00 |
| 5 | 102a | | 97.83 | 100.40 | 2.57 | 97.83 | 0.00 | 100.40 | 0.00 | 0.00 | 1060.00 | 53.88 | 0.00 | 98.00 | 0.17 | 0.00 | 2.40 | 97.84 | 0.01 | 0 01:20 | 0 00:00 | 0.00 | 0.00 |
| 6 | 104 | Mcon MH - Concentric | 97.35 | 100.35 | 3.00 | 97.35 | 0.00 | 100.35 | 0.00 | 0.00 | 839.00 | 65.02 | 0.00 | 97.81 | 0.46 | 0.00 | 2.54 | 97.65 | 0.30 | 0 01:20 | 0 00:00 | 0.00 | 0.00 |
| 7 | 104a | | 97.41 | 100.20 | 2.79 | 97.41 | 0.00 | 100.20 | 0.00 | 0.00 | 910.00 | 116.82 | 0.00 | 97.61 | 0.20 | 0.00 | 2.59 | 97.42 | 0.01 | 0 01:20 | 0 00:00 | 0.00 | 0.00 |
| 8 | 104b | | 97.16 | 100.00 | 2.84 | 97.16 | 0.00 | 100.00 | 0.00 | 0.00 | 2388.00 | 175.84 | 0.00 | 97.45 | 0.29 | 0.00 | 2.55 | 97.18 | 0.02 | 0 01:20 | 0 00:00 | 0.00 | 0.00 |
| 9 | 106 | Mcon MH - Concentric | 95.82 | 99.93 | 4.11 | 95.82 | 0.00 | 99.93 | 0.00 | 0.00 | 2559.00 | 312.52 | 0.00 | 96.46 | 0.64 | 0.00 | 3.47 | 96.14 | 0.32 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 10 | 106a | | 95.91 | 99.72 | 3.81 | 95.91 | 0.00 | 99.72 | 0.00 | 0.00 | 1060.00 | 349.10 | 0.00 | 96.29 | 0.38 | 0.00 | 3.43 | 95.94 | 0.03 | 0 01:25 | 0 00:00 | 0.00 | 0.00 |
| 11 | 106b | | 95.63 | 99.45 | 3.82 | 95.63 | 0.00 | 99.45 | 0.00 | 0.00 | 1070.00 | 407.37 | 0.00 | 96.31 | 0.68 | 0.00 | 3.14 | 95.66 | 0.03 | 0 01:25 | 0 00:00 | 0.00 | 0.00 |
| 12 | 108 | Mcon MH - Concentric | 94.90 | 99.11 | 4.21 | 94.90 | 0.00 | 99.11 | 0.00 | 0.00 | 900.00 | 457.53 | 0.00 | 96.25 | 1.35 | 0.00 | 2.86 | 95.23 | 0.33 | 0 01:25 | 0 00:00 | 0.00 | 0.00 |
| 13 | 108a | | 94.92 | 98.86 | 3.95 | 94.92 | 0.00 | 98.86 | 0.00 | 0.00 | 860.00 | 491.55 | 0.00 | 96.18 | 1.26 | 0.00 | 2.68 | 94.96 | 0.04 | 0 01:25 | 0 00:00 | 0.00 | 0.00 |
| 14 | 108b | | 94.63 | 98.59 | 3.96 | 94.63 | 0.00 | 98.59 | 0.00 | 0.00 | 790.00 | 547.60 | 0.00 | 96.12 | 1.49 | 0.00 | 2.47 | 94.68 | 0.05 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 15 | 110 | Mcon MH - Concentric | 93.86 | 98.42 | 4.56 | 93.86 | 0.00 | 98.42 | 0.00 | 0.00 | 3218.00 | 487.31 | 0.00 | 96.06 | 2.20 | 0.00 | 2.36 | 94.24 | 0.38 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 16 | 110a | | 94.10 | 98.34 | 4.24 | 94.10 | 0.00 | 98.34 | 0.00 | 0.00 | 800.00 | 548.83 | 0.00 | 96.03 | 1.93 | 0.00 | 2.31 | 94.24 | 0.14 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 17 | 110b | | 94.06 | 98.26 | 4.20 | 94.06 | 0.00 | 98.26 | 0.00 | 0.00 | 2510.00 | 599.41 | 0.00 | 96.03 | 1.97 | 0.00 | 2.23 | 94.23 | 0.17 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 18 | 110c | | 93.98 | 98.12 | 4.14 | 93.98 | 0.00 | 98.12 | 0.00 | 0.00 | 2440.00 | 630.57 | 0.00 | 96.01 | 2.03 | 0.00 | 2.11 | 94.21 | 0.23 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 19 | 110d | | 93.94 | 98.06 | 4.12 | 93.94 | 0.00 | 98.06 | 0.00 | 0.00 | 1019.00 | 652.32 | 0.00 | 95.99 | 2.05 | 0.00 | 2.07 | 94.19 | 0.25 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 20 | 110e | | 93.87 | 97.93 | 4.06 | 93.87 | 0.00 | 97.93 | 0.00 | 0.00 | 1434.00 | 680.89 | 0.00 | 95.96 | 2.09 | 0.00 | 1.97 | 94.19 | 0.32 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 21 | 112 | Mcon MH - Concentric | 93.43 | 97.81 | 4.38 | 93.43 | 0.00 | 97.81 | 0.00 | 0.00 | 990.00 | 712.57 | 0.00 | 95.91 | 2.48 | 0.00 | 1.90 | 94.16 | 0.73 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 22 | 112a | | 93.62 | 97.60 | 3.99 | 93.62 | 0.00 | 97.60 | 0.00 | 0.00 | 1037.00 | 743.80 | 0.00 | 95.85 | 2.24 | 0.00 | 1.75 | 94.16 | 0.55 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 23 | 112b | | 93.50 | 97.39 | 3.90 | 93.50 | 0.00 | 97.39 | 0.00 | 0.00 | 1024.00 | 777.43 | 0.00 | 95.80 | 2.30 | 0.00 | 1.59 | 94.16 | 0.66 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 24 | 114 | Mcon MH - Concentric | 93.13 | 97.27 | 4.14 | 93.13 | 0.00 | 97.27 | 0.00 | 0.00 | 1018.00 | 795.27 | 0.00 | 95.75 | 2.62 | 0.00 | 1.52 | 94.14 | 1.01 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 25 | 114a | | 93.35 | 97.14 | 3.79 | 93.35 | 0.00 | 97.14 | 0.00 | 0.00 | 983.00 | 822.49 | 0.00 | 95.69 | 2.34 | 0.00 | 1.45 | 94.14 | 0.79 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 26 | 114b | | 93.26 | 96.99 | 3.73 | 93.30 | 0.04 | 96.99 | 0.00 | 0.00 | 819.00 | 859.83 | 0.00 | 95.65 | 2.39 | 0.00 | 1.34 | 94.14 | 0.88 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 27 | 114c | | 93.21 | 96.90 | 3.69 | 93.30 | 0.09 | 96.90 | 0.00 | 0.00 | 763.00 | 867.87 | 0.00 | 95.62 | 2.41 | 0.00 | 1.28 | 94.14 | 0.93 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 28 | 115 | | 96.06 | 96.36 | 0.30 | 96.06 | 0.00 | 96.36 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 96.06 | 0.00 | 0.00 | 0.35 | 96.06 | 0.00 | 0 00:00 | 0 00:00 | 0.00 | 0.00 |
| 29 | 116 | Mcon MH - Concentric | 92.83 | 96.76 | 3.93 | 93.30 | 0.47 | 96.76 | 0.00 | 0.00 | 830.00 | 912.72 | 0.00 | 95.55 | 2.72 | 0.00 | 1.21 | 94.13 | 1.30 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 30 | 116a | | 92.98 | 96.47 | 3.49 | 93.30 | 0.32 | 96.47 | 0.00 | 0.00 | 739.00 | 934.91 | 0.00 | 95.43 | 2.45 | 0.00 | 1.04 | 94.13 | 1.15 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 31 | 116b | | 92.89 | 96.30 | 3.41 | 93.30 | 0.41 | 96.30 | 0.00 | 0.00 | 1630.00 | 951.86 | 0.00 | 95.39 | 2.50 | 0.00 | 0.91 | 94.13 | 1.24 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 32 | 118 | Mcon MH - Concentric | 92.46 | 96.26 | 3.80 | 93.30 | 0.84 | 96.26 | 0.00 | 0.00 | 700.00 | 966.25 | 0.00 | 95.31 | 2.85 | 0.00 | 0.95 | 94.13 | 1.67 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 33 | 118a | | 92.71 | 96.17 | 3.46 | 93.30 | 0.59 | 96.17 | 0.00 | 0.00 | 777.00 | 1000.57 | 0.00 | 95.25 | 2.54 | 0.00 | 0.92 | 94.12 | 1.41 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 34 | 118b | | 92.63 | 96.03 | 3.40 | 93.30 | 0.67 | 96.03 | 0.00 | 0.00 | 809.00 | 1064.86 | 0.00 | 95.21 | 2.58 | 0.00 | 0.82 | 94.12 | 1.49 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 35 | 118c | | 92.59 | 95.96 | 3.37 | 93.30 | 0.71 | 95.96 | 0.00 | 0.00 | 980.00 | 1204.47 | 0.00 | 95.18 | 2.59 | 0.00 | 0.78 | 94.12 | 1.53 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 36 | 120 | Mcon MH - Concentric | 92.21 | 95.84 | 3.63 | 93.30 | 1.09 | 95.84 | 0.00 | 0.00 | 1009.00 | 1271.39 | 0.00 | 95.08 | 2.87 | 0.00 | 0.76 | 94.12 | 1.91 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 37 | 120a | | 92.47 | 95.80 | 3.33 | 93.30 | 0.83 | 95.80 | 0.00 | 0.00 | 1200.00 | 1302.93 | 0.00 | 95.00 | 2.53 | 0.00 | 0.80 | 94.12 | 1.65 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 38 | 122 | Mcon MH - Concentric | 91.96 | 95.57 | 3.61 | 93.30 | 1.34 | 95.57 | 0.00 | 0.00 | 2256.00 | 1300.77 | 0.00 | 94.78 | 2.82 | 0.00 | 0.79 | 94.11 | 2.15 | 0 01:29 | 0 00:00 | 0.00 | 0.00 |
| 39 | 122a | | 92.19 | 95.62 | 3.43 | 93.30 | 1.11 | 95.62 | 0.00 | 0.00 | 2384.00 | 1300.83 | 0.00 | 94.68 | 2.49 | 0.00 | 0.94 | 94.11 | 1.92 | 0 01:29 | 0 00:00 | 0.00 | 0.00 |
| 40 | 124 | Mcon MH - Concentric | 91.66 | 95.78 | 4.12 | 93.30 | 1.64 | 95.78 | 0.00 | 0.00 | 2772.00 | 1298.40 | 0.00 | 94.53 | 2.87 | 0.00 | 1.26 | 94.10 | 2.44 | 0 01:42 | 0 00:00 | 0.00 | 0.00 |
| 41 | 126 | Mcon MH - Concentric | 91.44 | 95.75 | 4.31 | 93.30 | 1.86 | 95.75 | 0.00 | 0.00 | 2958.00 | 1298.37 | 0.00 | 94.45 | 3.01 | 0.00 | 1.29 | 94.09 | 2.65 | 0 01:55 | 0 00:00 | 0.00 | 0.00 |
| 42 | 1308 (STM MH3) | Strandherd ID: RELOCATED EX. STM MH3Citi Gate ID: 1308 | 95.05 | 97.99 | 2.94 | 95.05 | 0.00 | 98.29 | 0.30 | 0.00 | 970.00 | 2370.63 | 0.00 | 96.66 | 1.61 | 0.00 | 1.33 | 96.49 | 1.44 | 0 01:20 | 0 00:00 | 0.00 | 0.00 |
| 43 | 200 | | 96.76 | 98.53 | 1.77 | 96.76 | 0.00 | 98.83 | 0.30 | 0.00 | 0.00 | 106.81 | 0.00 | 97.85 | 1.09 | 0.00 | 0.68 | 97.54 | 0.78 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 44 | 202 | | 96.59 | 98.65 | 2.06 | 96.59 | 0.00 | 98.95 | 0.30 | 0.00 | 1235.00 | 106.74 | 0.00 | 97.79 | 1.20 | 0.00 | 0.86 | 97.54 | 0.95 | 0 00:26 | 0 00:00 | 0.00 | 0.00 |
| 45 | 204 | | 96.28 | 98.29 | 2.01 | 96.28 | 0.00 | 98.59 | 0.30 | 0.00 | 0.00 | 146.72 | 0.00 | 97.68 | 1.40 | 0.00 | 0.61 | 97.53 | 1.25 | 0 01:22 | 0 00:00 | 0.00 | 0.00 |
| 46 | 206 | | 95.62 | 98.34 | 2.72 | 95.62 | 0.00 | 98.64 | 0.30 | 0.00 | 1255.00 | 147.36 | 0.00 | 97.65 | 2.03 | 0.00 | 0.69 | 97.53 | 1.91 | 0 01:33 | 0 00:00 | 0.00 | 0.00 |
| 47 | 206A | | 96.05 | 98.39 | 2.34 | 96.05 | 0.00 | 98.69 | 0.30 | 0.00 | 1050.00 | 281.24 | 0.00 | 97.57 | 1.52 | 0.00 | 0.82 | 97.53 | 1.48 | 0 01:38 | 0 00:00 | 0.00 | 0.00 |
| 48 | 208 | | 94.46 | 98.17 | 3.71 | 94.76 | 0.30 | 98.47 | 0.30 | 0.00 | 1280.00 | 3412.51 | 0.00 | 98.13 | 3.67 | 0.00 | 0.04 | 94.96 | 0.50 | 0 01:43 | 0 00:00 | 0.00 | 0.00 |
| 49 | 2-1/2-2 | | 97.05 | 98.25 | 1.20 | 97.05 | 0.00 | 98.55 | 0.30 | 0.00 | 0.00 | 227.88 | 77.83 | 98.46 | 1.41 | 0.00 | 0.14 | 97.56 | 0.51 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 50 | 210 | | 94.30 | 97.93 | 3.63 | 94.30 | 0.00 | 98.23 | 0.30 | 0.00 | 0.00 | 3441.94 | 0.00 | 97.96 | 3.66 | 0.00 | 0.16 | 94.78 | 0.48 | 0 01:42 | 0 00:00 | 0.00 | 0.00 |
| 51 | 2-11/2-12 | | 94.88 | 96.49 | 1.61 | 94.88 | 0.00 | 96.79 | 0.30 | 0.00 | 0.00 | 145.12 | 55.48 | 96.57 | 1.69 | 0.00 | 0.22 | 94.90 | 0.02 | 0 01:25 | 0 00:00 | 0.00 | 0.00 |
| 52 | 212 | | 94.03 | 97.82 | 3.79 | 94.03 | 0.00 | 98.12 | 0.30 | 0.00 | 0.00 | 4959.05 | 0.00 | 97.79 | 3.76 | 0.00 | 0.33 | 94.53 | 0.50 | 0 01:41 | 0 00:00 | 0.00 | 0.00 |
| 53 | 2-13/2-14 | | 94.61 | 96.11 | 1.50 | 94.91 | 0.30 | 96.41 | 0.30 | 0.00 | 0.00 | 167.36 | 99.29 | 96.23 | 1.62 | 0.00 | 0.18 | 94.66 | 0.05 | 0 01:27 | 0 00:00 | 0.00 | 0.00 |

## AutoDesk Storm and Sanitary Analysis
## Chicago 100-year 3-hour Storm Model Output Results

MH214
Q100yr (3-hour Chic.)
= 4,586.32 L/s

NOVATECH
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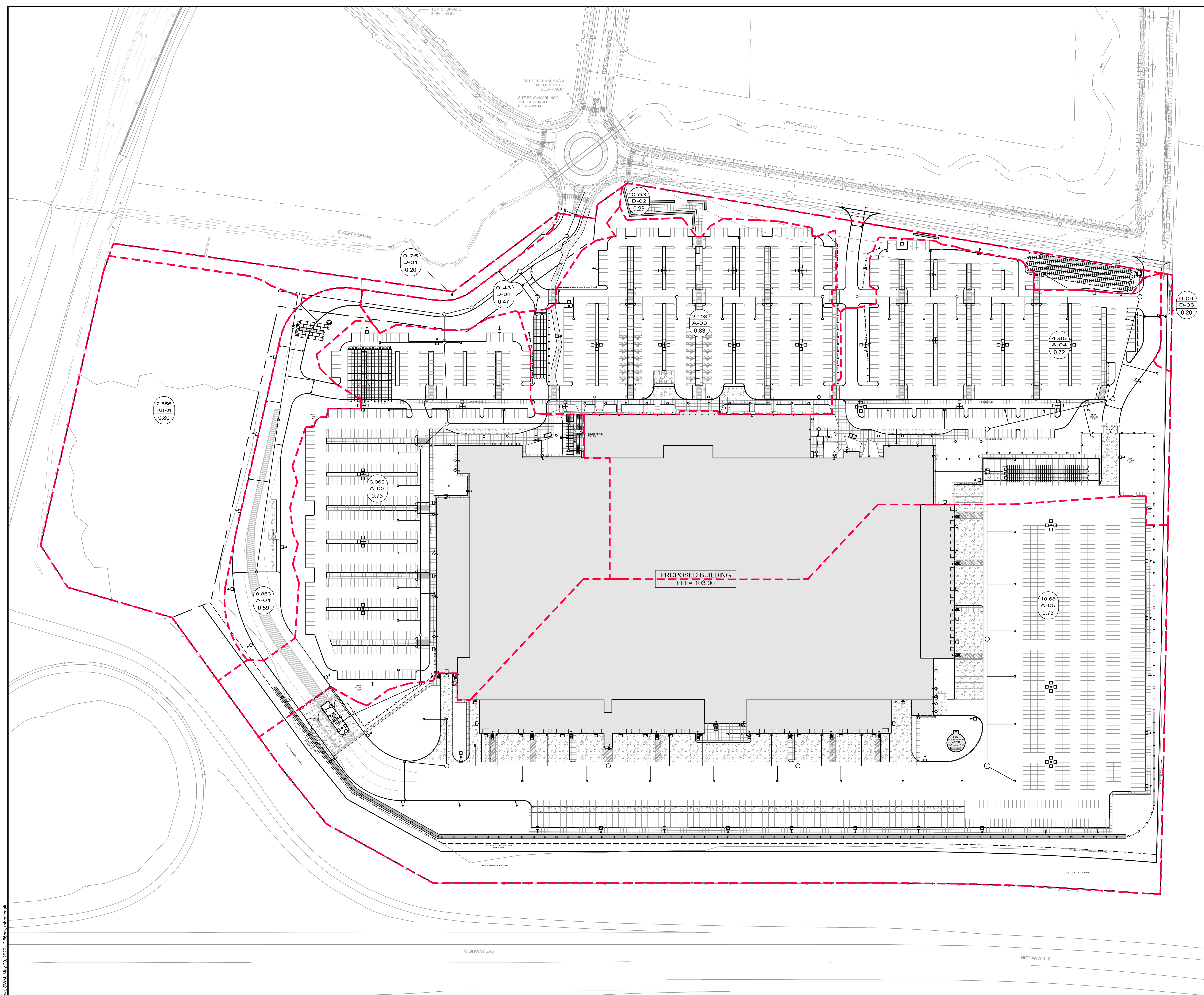
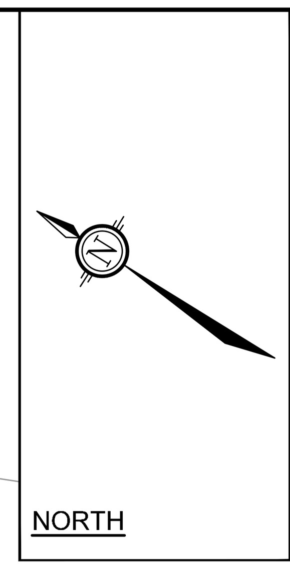
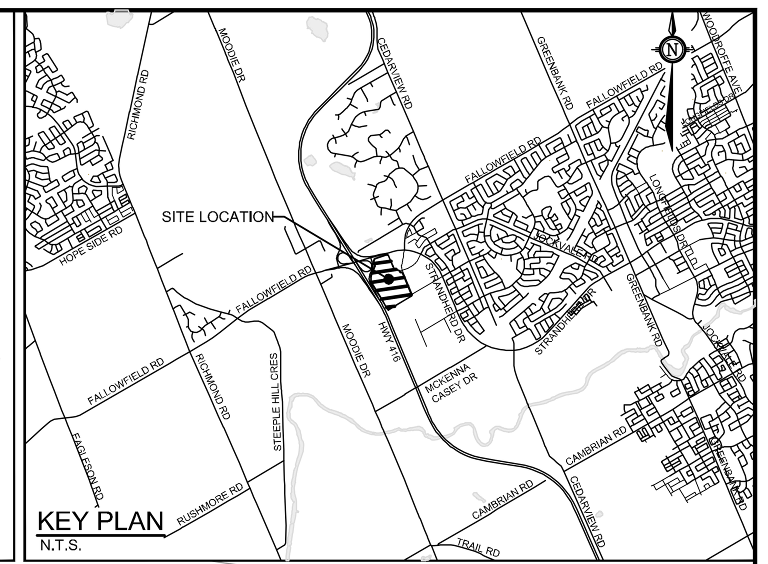
| SN | Element ID | Description | Invert Elevation (m) | Ground/Rim (Max) Elevation (m) | Ground/Rim (Max) Offset (m) | Initial Water Elevation (m) | Initial Water Depth (m) | Surcharge Elevation (m) | Surcharge Depth (m) | Ponded Area (m²) | Minimum Pipe Cover (mm) | Peak Inflow (lps) | Peak Lateral Inflow (lps) | Maximum HGL Elevation Attained (m) | Maximum HGL Depth Attained (m) | Maximum Surcharge Depth Attained (m) | Minimum Freeboard Attained (m) | Average HGL Elevation Attained (m) | Average HGL Depth Attained (m) | Time of Maximum HGL Occurrence (days hh:mm) | Time of Peak Flooding Occurrence (days hh:mm) | Total Flooded Volume (ha-mm) | Total Time Flooded (minutes) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 54 | 214 | | 94.05 | 97.78 | 3.73 | 94.05 | 0.00 | 98.08 | 0.30 | 0.00 | 1870.00 | 4586.32 | 0.00 | 97.43 | 3.38 | 0.00 | 0.35 | 94.26 | 0.21 | 0 01:41 | 0 00:00 | 0.00 | 0.00 |
| 55 | 2-3/2-4 | | 96.98 | 98.18 | 1.20 | 96.98 | 0.00 | 98.48 | 0.30 | 0.00 | 0.00 | 84.51 | 84.51 | 98.30 | 1.32 | 0.00 | 0.18 | 97.57 | 0.59 | 0 01:27 | 0 00:00 | 0.00 | 0.00 |
| 56 | 230 | | 94.17 | 97.09 | 2.92 | 95.47 | 1.30 | 97.39 | 0.30 | 0.00 | 2120.00 | 122.67 | 0.00 | 96.66 | 2.49 | 0.00 | 0.43 | 94.50 | 0.33 | 0 01:17 | 0 00:00 | 0.00 | 0.00 |
| 57 | 232 | | 93.40 | 96.71 | 3.31 | 93.70 | 0.30 | 97.01 | 0.30 | 0.00 | 0.00 | 772.97 | 0.00 | 97.01 | 3.61 | 0.30 | 0.00 | 93.89 | 0.49 | 0 01:15 | 0 01:15 | 0.02 | 0.00 |
| 58 | 2-5/2-6 | | 96.80 | 98.00 | 1.20 | 96.80 | 0.00 | 98.30 | 0.30 | 0.00 | 0.00 | 293.51 | 96.38 | 98.23 | 1.43 | 0.00 | 0.07 | 96.85 | 0.05 | 0 01:43 | 0 00:00 | 0.00 | 0.00 |
| 59 | 2-7/2-8 | | 96.63 | 97.83 | 1.20 | 96.63 | 0.00 | 98.13 | 0.30 | 0.00 | 0.00 | 67.15 | 67.15 | 97.96 | 1.33 | 0.00 | 0.16 | 96.67 | 0.04 | 0 01:45 | 0 00:00 | 0.00 | 0.00 |
| 60 | 2-9/2-10 | | 96.50 | 97.70 | 1.20 | 96.50 | 0.00 | 98.00 | 0.30 | 0.00 | 0.00 | 89.34 | 89.34 | 97.80 | 1.30 | 0.00 | 0.20 | 96.55 | 0.05 | 0 01:44 | 0 00:00 | 0.00 | 0.00 |
| 61 | 300 | | 95.12 | 98.06 | 2.94 | 95.12 | 0.00 | 98.36 | 0.30 | 0.00 | 2160.00 | 120.95 | 0.00 | 96.17 | 1.05 | 0.00 | 1.89 | 96.08 | 0.96 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 62 | 302 | | 95.32 | 98.26 | 2.94 | 95.32 | 0.00 | 98.56 | 0.30 | 0.00 | 0.00 | 120.97 | 0.00 | 96.37 | 1.05 | 0.00 | 1.89 | 96.09 | 0.77 | 0 01:16 | 0 00:00 | 0.00 | 0.00 |
| 63 | 304 | | 95.54 | 98.08 | 2.54 | 95.54 | 0.00 | 98.38 | 0.30 | 0.00 | 0.00 | 71.28 | 0.00 | 96.49 | 0.95 | 0.00 | 1.59 | 96.09 | 0.55 | 0 01:16 | 0 00:00 | 0.00 | 0.00 |
| 64 | 306 | | 95.72 | 98.31 | 2.59 | 95.72 | 0.00 | 98.61 | 0.30 | 0.00 | 1915.00 | 33.33 | 0.00 | 96.51 | 0.79 | 0.00 | 1.80 | 96.09 | 0.37 | 0 01:16 | 0 00:00 | 0.00 | 0.00 |
| 65 | 308 | | 95.99 | 97.81 | 1.82 | 95.99 | 0.00 | 98.11 | 0.30 | 0.00 | 0.00 | 15.93 | 0.00 | 96.49 | 0.50 | 0.00 | 1.32 | 96.29 | 0.30 | 0 01:25 | 0 00:00 | 0.00 | 0.00 |
| 66 | 3-3/3-4 | | 96.71 | 97.91 | 1.20 | 96.85 | 0.14 | 98.21 | 0.30 | 0.00 | 0.00 | 88.58 | 88.58 | 98.00 | 1.29 | 0.00 | 0.21 | 96.75 | 0.04 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 67 | 3-5/3-6 | | 96.45 | 97.65 | 1.20 | 96.45 | 0.00 | 97.95 | 0.30 | 0.00 | 0.00 | 22.93 | 22.93 | 97.66 | 1.21 | 0.00 | 0.34 | 96.48 | 0.03 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 68 | 400 | | 93.97 | 97.27 | 3.30 | 93.97 | 0.00 | 97.57 | 0.30 | 0.00 | 1410.00 | 4602.19 | 0.00 | 97.23 | 3.26 | 0.00 | 0.04 | 94.18 | 0.21 | 0 01:33 | 0 00:00 | 0.00 | 0.00 |
| 69 | 402 | | 93.75 | 97.10 | 3.35 | 93.75 | 0.00 | 97.40 | 0.30 | 0.00 | 1370.00 | 4629.29 | 0.00 | 96.94 | 3.19 | 0.00 | 0.16 | 94.01 | 0.26 | 0 01:34 | 0 00:00 | 0.00 | 0.00 |
| 70 | 404 | | 93.46 | 96.93 | 3.47 | 93.46 | 0.00 | 97.23 | 0.30 | 0.00 | 1640.00 | 4629.51 | 0.00 | 96.61 | 3.15 | 0.00 | 0.32 | 93.93 | 0.47 | 0 01:32 | 0 00:00 | 0.00 | 0.00 |
| 71 | 406 | | 93.81 | 97.05 | 3.24 | 93.81 | 0.00 | 97.35 | 0.30 | 0.00 | 2366.00 | 422.80 | 0.00 | 94.69 | 0.88 | 0.00 | 2.36 | 94.18 | 0.37 | 0 02:00 | 0 00:00 | 0.00 | 0.00 |
| 72 | 408 | | 93.41 | 96.99 | 3.58 | 93.41 | 0.00 | 97.29 | 0.30 | 0.00 | 0.00 | 65.54 | 0.00 | 94.69 | 1.28 | 0.00 | 2.30 | 94.36 | 0.95 | 0 02:00 | 0 00:00 | 0.00 | 0.00 |
| 73 | 4-1/4-2 | | 95.77 | 96.97 | 1.20 | 95.77 | 0.00 | 97.27 | 0.30 | 0.00 | 0.00 | 71.34 | 71.34 | 97.16 | 1.39 | 0.00 | 0.11 | 95.84 | 0.07 | 0 01:51 | 0 00:00 | 0.00 | 0.00 |
| 74 | 410 | | 94.35 | 96.09 | 1.74 | 94.35 | 0.00 | 96.39 | 0.30 | 0.00 | 0.00 | 11.15 | 0.00 | 94.72 | 0.37 | 0.00 | 1.37 | 94.64 | 0.29 | 0 01:21 | 0 00:00 | 0.00 | 0.00 |
| 75 | 412 | | 93.82 | 97.22 | 3.40 | 93.82 | 0.00 | 97.52 | 0.30 | 0.00 | 2536.00 | 408.71 | 0.00 | 94.69 | 0.87 | 0.00 | 2.53 | 94.18 | 0.36 | 0 02:07 | 0 00:00 | 0.00 | 0.00 |
| 76 | 4-3/4-4 | | 95.64 | 96.84 | 1.20 | 95.64 | 0.00 | 97.14 | 0.30 | 0.00 | 0.00 | 66.88 | 66.88 | 96.95 | 1.31 | 0.00 | 0.19 | 95.69 | 0.05 | 0 01:42 | 0 00:00 | 0.00 | 0.00 |
| 77 | 4-5/4-6 | | 95.59 | 96.79 | 1.20 | 95.59 | 0.00 | 97.09 | 0.30 | 0.00 | 0.00 | 14.25 | 0.00 | 96.41 | 0.82 | 0.00 | 0.71 | 95.61 | 0.02 | 0 01:32 | 0 00:00 | 0.00 | 0.00 |
| 78 | 4-7/4-8 | | 95.48 | 96.74 | 1.26 | 95.48 | 0.00 | 97.04 | 0.30 | 0.00 | 0.00 | 95.63 | 95.63 | 96.86 | 1.38 | 0.00 | 0.18 | 95.53 | 0.05 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 79 | 498 | | 93.13 | 97.53 | 4.40 | 93.13 | 0.00 | 97.83 | 0.30 | 0.00 | 0.00 | 1376.67 | 0.00 | 95.73 | 2.60 | 0.00 | 1.80 | 93.84 | 0.71 | 0 01:16 | 0 00:00 | 0.00 | 0.00 |
| 80 | 500 | | 93.08 | 96.42 | 3.34 | 93.08 | 0.00 | 96.72 | 0.30 | 0.00 | 1720.00 | 2226.63 | 0.00 | 95.55 | 2.47 | 0.00 | 0.87 | 93.83 | 0.75 | 0 01:16 | 0 00:00 | 0.00 | 0.00 |
| 81 | 502 | | 92.81 | 95.67 | 2.86 | 92.81 | 0.00 | 95.97 | 0.30 | 0.00 | 115.00 | 3025.00 | 0.00 | 94.90 | 2.09 | 0.00 | 0.77 | 93.81 | 1.00 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 82 | 504 | | 92.60 | 95.72 | 3.12 | 92.60 | 0.00 | 96.02 | 0.30 | 0.00 | 1740.00 | 3025.50 | 0.00 | 94.37 | 1.77 | 0.00 | 1.35 | 93.78 | 1.18 | 0 01:23 | 0 00:00 | 0.00 | 0.00 |
| 83 | 506 | | 92.61 | 95.61 | 3.00 | 92.61 | 0.00 | 95.91 | 0.30 | 0.00 | 1210.00 | 1490.22 | 0.00 | 94.31 | 1.70 | 0.00 | 1.30 | 93.77 | 1.16 | 0 02:34 | 0 00:00 | 0.00 | 0.00 |
| 84 | 508 | | 93.04 | 95.70 | 2.66 | 93.04 | 0.00 | 96.00 | 0.30 | 0.00 | 1270.00 | 70.47 | 0.00 | 94.30 | 1.26 | 0.00 | 1.40 | 93.81 | 0.77 | 0 02:39 | 0 00:00 | 0.00 | 0.00 |
| 85 | 510 | | 92.60 | 95.92 | 3.32 | 92.60 | 0.00 | 96.22 | 0.30 | 0.00 | 2565.00 | 76.40 | 0.00 | 93.69 | 1.09 | 0.00 | 2.23 | 93.09 | 0.49 | 0 02:00 | 0 00:00 | 0.00 | 0.00 |
| 86 | 5-11/5-12 | | 93.76 | 94.95 | 1.19 | 93.76 | 0.00 | 95.25 | 0.30 | 0.00 | 0.00 | 40.15 | 40.15 | 95.05 | 1.29 | 0.00 | 0.20 | 93.80 | 0.04 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 87 | 512 | | 92.95 | 96.17 | 3.22 | 92.95 | 0.00 | 96.47 | 0.30 | 0.00 | 0.00 | 74.35 | 0.00 | 93.73 | 0.78 | 0.00 | 2.44 | 93.31 | 0.36 | 0 02:01 | 0 00:00 | 0.00 | 0.00 |
| 88 | 514 | | 93.21 | 95.19 | 1.98 | 93.21 | 0.00 | 95.49 | 0.30 | 0.00 | 0.00 | 24.79 | 0.00 | 93.68 | 0.47 | 0.00 | 1.51 | 93.52 | 0.31 | 0 02:01 | 0 00:00 | 0.00 | 0.00 |
| 89 | 520 | | 92.73 | 95.71 | 2.98 | 92.73 | 0.00 | 96.01 | 0.30 | 0.00 | 2110.00 | 1399.94 | 0.00 | 94.32 | 1.59 | 0.00 | 1.39 | 93.78 | 1.05 | 0 02:37 | 0 00:00 | 0.00 | 0.00 |
| 90 | 5-3/5-4 | | 94.30 | 95.50 | 1.20 | 94.30 | 0.00 | 95.80 | 0.30 | 0.00 | 0.00 | 2099.63 | 97.37 | 95.73 | 1.43 | 0.00 | 0.57 | 94.52 | 0.22 | 0 01:33 | 0 00:00 | 0.00 | 0.00 |
| 91 | 5-5/5-6 | | 94.31 | 95.51 | 1.20 | 94.31 | 0.00 | 95.81 | 0.30 | 0.00 | 0.00 | 53.35 | 53.35 | 94.82 | 0.51 | 0.00 | 1.49 | 94.32 | 0.01 | 0 01:20 | 0 00:00 | 0.00 | 0.00 |
| 92 | 5-7/5-8 | | 94.34 | 95.54 | 1.20 | 94.34 | 0.00 | 95.84 | 0.30 | 0.00 | 0.00 | 64.78 | 64.78 | 95.08 | 0.74 | 0.00 | 0.76 | 94.36 | 0.02 | 0 01:20 | 0 00:00 | 0.00 | 0.00 |
| 93 | 5-9/5-10 | | 94.41 | 95.61 | 1.20 | 94.41 | 0.00 | 95.91 | 0.30 | 0.00 | 0.00 | 84.51 | 84.51 | 95.71 | 1.30 | 0.00 | 0.20 | 94.46 | 0.05 | 0 01:24 | 0 00:00 | 0.00 | 0.00 |
| 94 | 600 | | 92.31 | 95.02 | 2.71 | 92.31 | 0.00 | 95.32 | 0.30 | 0.00 | 0.00 | 86.02 | 0.00 | 93.66 | 1.35 | 0.00 | 1.36 | 92.96 | 0.65 | 0 02:01 | 0 00:00 | 0.00 | 0.00 |
| 95 | 602 | | 92.15 | 94.36 | 2.21 | 92.15 | 0.00 | 94.66 | 0.30 | 0.00 | 0.00 | 147.71 | 0.00 | 93.64 | 1.49 | 0.00 | 0.72 | 92.93 | 0.78 | 0 02:01 | 0 00:00 | 0.00 | 0.00 |
| 96 | 6-3/6-4 | | 93.15 | 94.35 | 1.20 | 93.15 | 0.00 | 94.65 | 0.30 | 0.00 | 0.00 | 103.06 | 62.87 | 94.40 | 1.25 | 0.00 | 0.25 | 93.26 | 0.11 | 0 01:20 | 0 00:00 | 0.00 | 0.00 |
| 97 | 700 | | 93.41 | 97.00 | 3.59 | 93.41 | 0.00 | 97.30 | 0.30 | 0.00 | 1320.00 | 4642.22 | 56.29 | 96.42 | 3.01 | 0.00 | 0.58 | 93.92 | 0.51 | 0 01:32 | 0 00:00 | 0.00 | 0.00 |
| 98 | 702 | | 92.89 | 97.00 | 4.11 | 92.89 | 0.00 | 97.30 | 0.30 | 0.00 | 0.00 | 5423.20 | 0.00 | 96.11 | 3.22 | 0.00 | 0.89 | 93.89 | 1.00 | 0 01:32 | 0 00:00 | 0.00 | 0.00 |
| 99 | 702 MAJ | | 95.80 | 96.05 | 0.25 | 95.80 | 0.00 | 96.05 | 0.00 | 0.00 | 0.00 | 617.05 | 0.00 | 96.09 | 0.29 | 0.00 | 2.92 | 95.81 | 0.01 | 0 01:33 | 0 00:00 | 0.00 | 0.00 |
| 100 | 704 | | 92.67 | 96.80 | 4.13 | 92.67 | 0.00 | 97.10 | 0.30 | 0.00 | 0.00 | 6074.32 | 0.00 | 95.74 | 3.07 | 0.00 | 1.06 | 93.86 | 1.19 | 0 01:33 | 0 00:00 | 0.00 | 0.00 |
| 101 | 704 MAJ | | 95.53 | 95.83 | 0.30 | 95.53 | 0.00 | 95.83 | 0.00 | 0.00 | 0.00 | 565.39 | 0.00 | 95.75 | 0.22 | 0.00 | 2.94 | 95.53 | 0.00 | 0 01:33 | 0 00:00 | 0.00 | 0.00 |
| 102 | 706 | | 92.60 | 95.37 | 2.77 | 92.60 | 0.00 | 95.67 | 0.30 | 0.00 | 0.00 | 7067.79 | 0.00 | 95.12 | 2.52 | 0.00 | 0.63 | 93.82 | 1.22 | 0 01:32 | 0 00:00 | 0.00 | 0.00 |
| 103 | 706 MAJ | | 95.25 | 95.50 | 0.25 | 95.25 | 0.00 | 95.50 | 0.00 | 0.00 | 0.00 | 257.62 | 0.00 | 95.41 | 0.16 | 0.00 | 2.99 | 95.26 | 0.01 | 0 01:40 | 0 00:00 | 0.00 | 0.00 |
| 104 | 708 | | 92.27 | 95.55 | 3.28 | 92.27 | 0.00 | 95.85 | 0.30 | 0.00 | 0.00 | 7067.74 | 0.00 | 94.63 | 2.36 | 0.00 | 0.92 | 93.79 | 1.52 | 0 01:32 | 0 00:00 | 0.00 | 0.00 |
| 105 | 710 | | 92.18 | 95.25 | 3.07 | 92.18 | 0.00 | 95.55 | 0.30 | 0.00 | 1150.00 | 4341.19 | 0.00 | 94.30 | 2.12 | 0.00 | 0.95 | 93.77 | 1.59 | 0 02:34 | 0 00:00 | 0.00 | 0.00 |
| 106 | 800 | | 92.27 | 95.38 | 3.11 | 92.27 | 0.00 | 95.68 | 0.30 | 0.00 | 0.00 | 4507.35 | 0.00 | 94.31 | 2.04 | 0.00 | 1.07 | 93.77 | 1.50 | 0 02:45 | 0 00:00 | 0.00 | 0.00 |
| 107 | 802 | | 92.21 | 96.28 | 4.07 | 92.21 | 0.00 | 96.58 | 0.30 | 0.00 | 2670.00 | 2533.48 | 0.00 | 94.30 | 2.09 | 0.00 | 1.98 | 93.76 | 1.55 | 0 02:32 | 0 00:00 | 0.00 | 0.00 |

# Appendix D
Stormwater Management Modeling





NORTH



KEY PLAN
N.T.S.

## LEGEND

- PROPERTY LINE
- PROPOSED STORM SEWER AND MANHOLE
- DIRECTION OF FLOW
- PROPOSED CATCHBASIN MANHOLE
- PROPOSED CATCHBASIN
- STM MH — EXISTING STORM MANHOLE & SEWER
- CB 1 — EXISTING CATCHBASIN
- STORM SEWER DRAINAGE AREA BOUNDARY
- 0.085 / A-16 / 0.78 — DRAINAGE AREA (ha) / DRAINAGE AREA ID / RUNOFF COEFFICIENT

REFER TO 120025-ND FOR ADDITIONAL NOTES

NOTE:
THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

NOT FOR CONSTRUCTION

| No. | REVISION | DATE | BY |
|---|---|---|---|
| 5 | REVISED PER CITY COMMENTS | JUNE 1/2020 | MJH |
| 4 | ISSUED FOR INTERNAL REVIEW | MAY 19/2020 | MJH |
| 3 | ISSUED FOR FOUNDATION PERMIT | MAY 5/2020 | MJH |
| 2 | ISSUED FOR DESIGN REVIEW | APR 20/2020 | MJH |
| 1 | APPLICATION FOR SITE PLAN APPROVAL | APR 6/2020 | MJH |

SCALE 1:1000

DESIGN MJH/ARM
CHECKED JLS
DRAWN MJH/ARM
CHECKED JLS
APPROVED JLS

FOR REVIEW ONLY

LICENSED PROFESSIONAL ENGINEER A. R. MESTWARP 100201604 June 1, 2020 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER M. J. HREHORIAK 100211256 JUNE 1/20 PROVINCE OF ONTARIO

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Ottawa, Ontario, Canada K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Website www.novatech-eng.com

LOCATION
PROJECT PYTHON
222 CITIGATE DRIVE, CITY OF OTTAWA

DRAWING NAME
STORMWATER MANAGEMENT PLAN

PROJECT No. 120025
REV REV #5
DRAWING No. 120025 - SWM

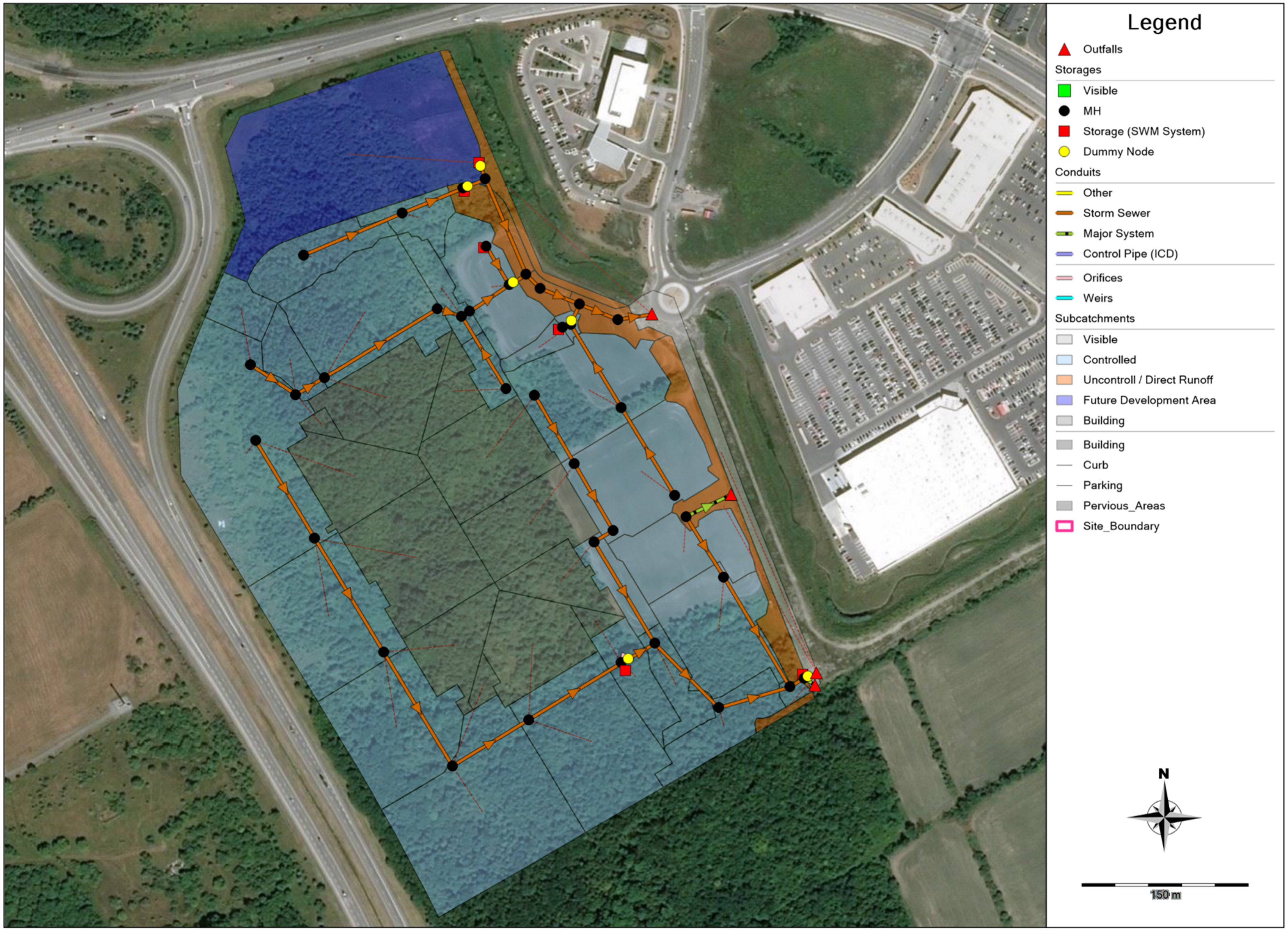
D07-12-20-0038

PLAN # 18129

**222 CitiGate Drive – Project Python (120025)**
**PCSWMM Model Schematics**

NOVATECH
Engineers, Planners & Landscape Architects

## Overall Model Schematic

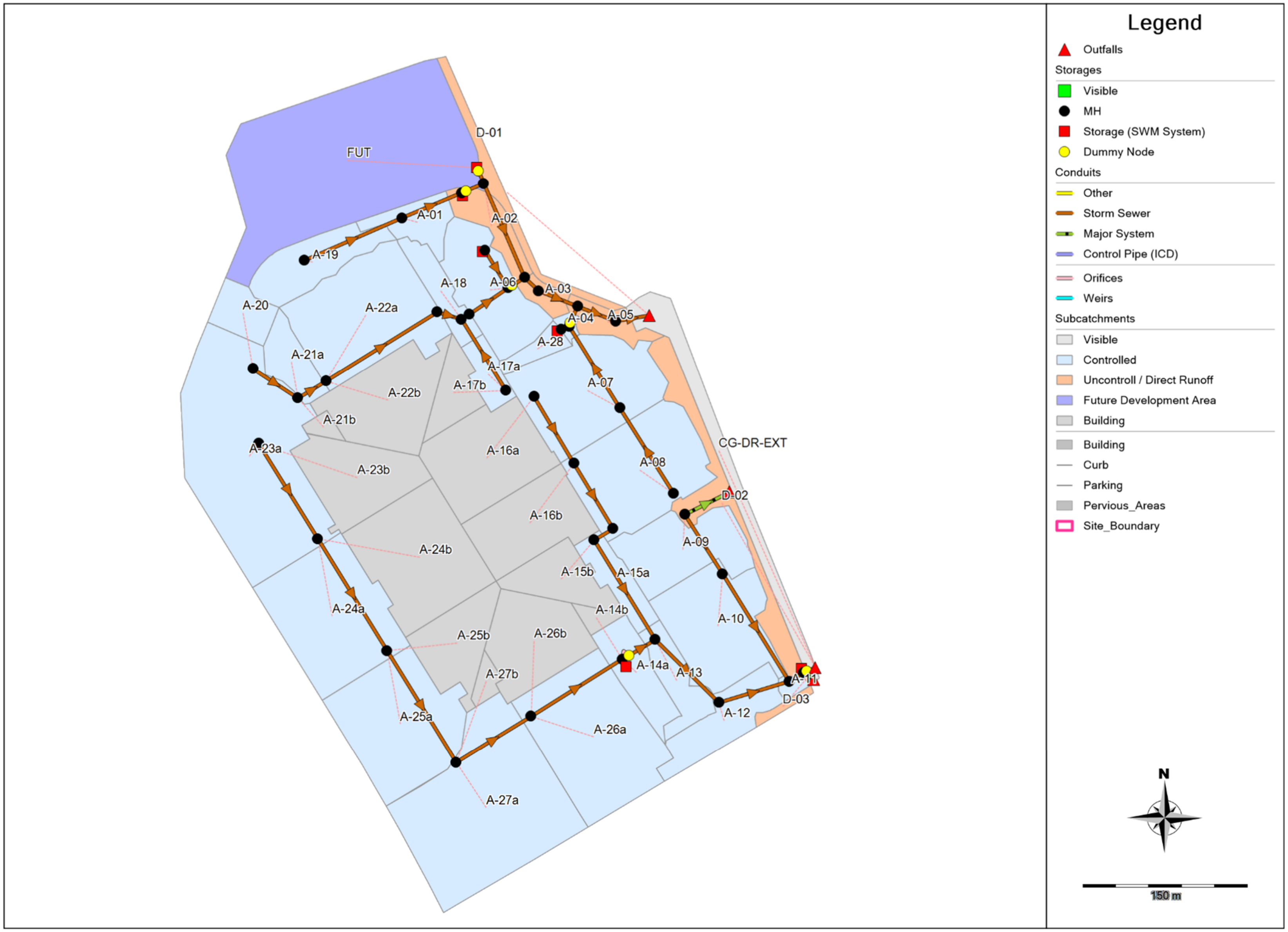



Date: 2020-06-01

222 CitiGate Drive – Project Python (120025)
PCSWMM Model Schematics

NOVATECH
Engineers, Planners & Landscape Architects

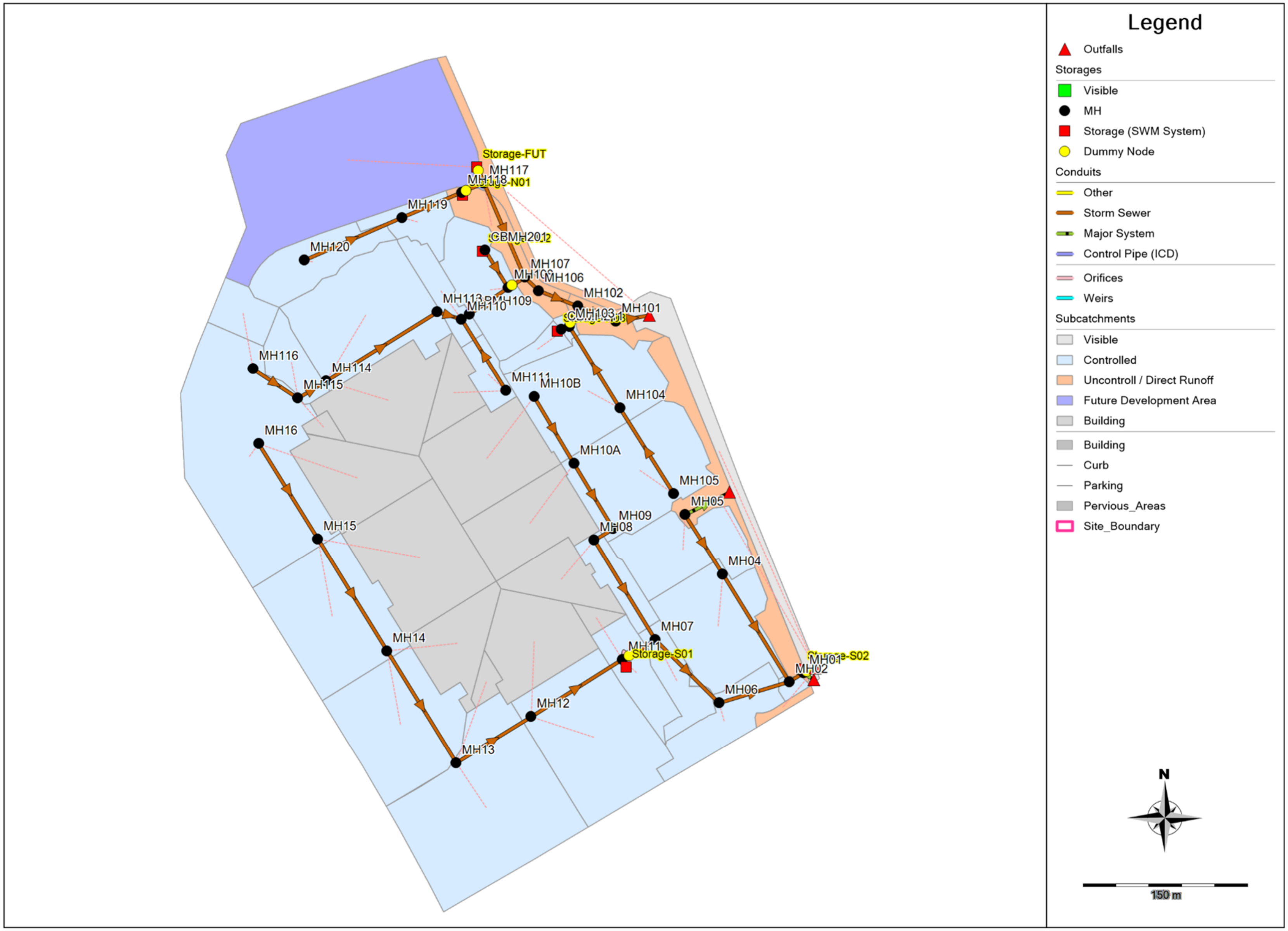
## Subcatchments




Date: 2020-06-01

**222 CitiGate Drive – Project Python (120025)**
**PCSWMM Model Schematics**

## Maintenance Holes (Storage Nodes)




Date: 2020-06-01

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

*************
Element Count
*************

Number of rain gages ...... 1
Number of subcatchments ... 44
Number of nodes ........... 53
Number of links ........... 57
Number of pollutants ...... 0
Number of land uses ....... 0

****************
Raingage Summary
****************

| Name | Data Source | Data Type | Recording Interval |
|---|---|---|---|
| Raingage1 | C3hr-100yr | INTENSITY | 10 min. |

********************
Subcatchment Summary
********************

| Name | Area | Width | %Imperv | %Slope | Rain Gage | Outlet |
|---|---|---|---|---|---|---|
| A-01 | 0.25 | 83.33 | 64.30 | 1.5000 | Raingage1 | MH119 |
| A-02 | 0.25 | 125.00 | 57.10 | 1.5000 | Raingage1 | MH117 |
| A-03 | 0.10 | 50.00 | 50.00 | 1.5000 | Raingage1 | MH106 |
| A-04 | 0.10 | 100.00 | 65.70 | 1.5000 | Raingage1 | MH103 |
| A-05 | 0.18 | 90.00 | 55.70 | 1.5000 | Raingage1 | MH101 |
| A-06 | 0.66 | 264.00 | 75.70 | 1.5000 | Raingage1 | MH108 |
| A-07 | 1.04 | 173.33 | 87.10 | 1.5000 | Raingage1 | MH104 |
| A-08 | 1.05 | 161.54 | 91.40 | 1.5000 | Raingage1 | MH105 |
| A-09 | 0.64 | 128.00 | 84.30 | 1.5000 | Raingage1 | MH05 |
| A-10 | 0.88 | 220.00 | 94.30 | 1.5000 | Raingage1 | MH04 |
| A-11 | 0.04 | 40.00 | 90.00 | 1.5000 | Raingage1 | MH02 |
| A-12 | 0.45 | 180.00 | 38.60 | 1.5000 | Raingage1 | MH06 |
| A-13 | 0.30 | 120.00 | 61.40 | 1.5000 | Raingage1 | MH07 |
| A-14a | 0.35 | 140.00 | 75.70 | 1.5000 | Raingage1 | MH11 |
| A-14b | 0.07 | 35.00 | 100.00 | 1.5000 | Raingage1 | MH11 |
| A-15a | 0.25 | 125.00 | 95.70 | 1.5000 | Raingage1 | MH08 |
| A-15b | 0.36 | 72.00 | 100.00 | 1.5000 | Raingage1 | MH08 |
| A-16a | 0.82 | 102.50 | 100.00 | 1.5000 | Raingage1 | MH10B |
| A-16b | 0.67 | 111.67 | 100.00 | 1.5000 | Raingage1 | MH10A |
| A-17a | 0.17 | 68.00 | 98.60 | 1.5000 | Raingage1 | MH111 |
| A-17b | 0.25 | 62.50 | 100.00 | 1.5000 | Raingage1 | MH111 |
| A-18 | 0.23 | 115.00 | 98.60 | 1.5000 | Raingage1 | MH110 |
| A-19 | 0.47 | 188.00 | 67.10 | 1.5000 | Raingage1 | MH120 |
| A-20 | 0.23 | 76.67 | 42.90 | 1.5000 | Raingage1 | MH116 |
| A-21a | 0.25 | 125.00 | 65.70 | 1.5000 | Raingage1 | MH115 |
| A-21b | 0.05 | 33.33 | 100.00 | 1.5000 | Raingage1 | MH115 |
| A-22a | 1.16 | 193.33 | 84.30 | 1.5000 | Raingage1 | MH114 |
| A-22b | 0.76 | 116.92 | 100.00 | 1.5000 | Raingage1 | MH114 |
| A-23a | 2.08 | 297.14 | 47.10 | 1.5000 | Raingage1 | MH16 |
| A-23b | 0.65 | 81.25 | 100.00 | 1.5000 | Raingage1 | MH16 |
| A-24a | 1.16 | 210.91 | 70.00 | 1.5000 | Raingage1 | MH15 |
| A-24b | 1.06 | 132.50 | 100.00 | 1.5000 | Raingage1 | MH15 |
| A-25a | 1.11 | 222.00 | 65.70 | 1.5000 | Raingage1 | MH14 |
| A-25b | 0.48 | 80.00 | 100.00 | 1.5000 | Raingage1 | MH14 |
| A-26a | 1.27 | 211.67 | 94.30 | 1.5000 | Raingage1 | MH12 |
| A-26b | 0.66 | 94.29 | 100.00 | 1.5000 | Raingage1 | MH12 |
| A-27a | 1.84 | 306.67 | 67.10 | 1.5000 | Raingage1 | MH13 |
| A-27b | 0.08 | 40.00 | 100.00 | 1.5000 | Raingage1 | MH13 |
| A-28 | 0.11 | 55.00 | 61.40 | 1.5000 | Raingage1 | MH103 |
| CG-DR-EXT | 0.52 | 13.87 | 85.00 | 1.5000 | Raingage1 | EX-MH214 |
| D-01 | 0.25 | 250.00 | 2.90 | 1.5000 | Raingage1 | EX-MH208 |
| D-02 | 0.53 | 353.33 | 27.10 | 1.5000 | Raingage1 | EX-MH214 |
| D-03 | 0.04 | 80.00 | 0.00 | 1.5000 | Raingage1 | EX-MH214 |
| FUT | 2.66 | 231.30 | 85.00 | 1.5000 | Raingage1 | Storage-FUT |

************
Node Summary
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| Name | Type | Invert Elev. | Max. Depth | Ponded Area | External Inflow |
|---|---|---|---|---|---|
| EX-MH208 | OUTFALL | 95.57 | 1.05 | 0.0 | |
| EX-MH214 | OUTFALL | 94.65 | 1.20 | 0.0 | |
| HP-MH01 | OUTFALL | 98.00 | 1.00 | 0.0 | |
| HP-MH05 | OUTFALL | 100.00 | 1.00 | 0.0 | |
| CBMH109 | STORAGE | 97.59 | 4.41 | 0.0 | |
| CBMH201 | STORAGE | 98.12 | 2.43 | 0.0 | |
| CBMH211 | STORAGE | 97.57 | 3.24 | 0.0 | |
| FUT-Dummy | STORAGE | 96.75 | 4.25 | 0.0 | |
| MH01 | STORAGE | 94.72 | 4.35 | 0.0 | |
| MH01-Dummy | STORAGE | 94.72 | 3.35 | 0.0 | |

| | | | | |
|---|---|---|---|---|
| MH02 | STORAGE | 94.84 | 3.53 | 0.0 |
| MH04 | STORAGE | 97.33 | 3.57 | 0.0 |
| MH05 | STORAGE | 98.04 | 3.38 | 0.0 |
| MH06 | STORAGE | 95.42 | 5.18 | 0.0 |
| MH07 | STORAGE | 96.50 | 5.61 | 0.0 |
| MH08 | STORAGE | 98.20 | 4.50 | 0.0 |
| MH09 | STORAGE | 98.46 | 3.92 | 0.0 |
| MH101 | STORAGE | 95.76 | 2.86 | 0.0 |
| MH102 | STORAGE | 96.01 | 3.84 | 0.0 |
| MH103 | STORAGE | 96.52 | 4.17 | 0.0 |
| MH103-Dummy | STORAGE | 96.52 | 4.17 | 0.0 |
| MH104 | STORAGE | 97.43 | 4.45 | 0.0 |
| MH105 | STORAGE | 97.90 | 2.70 | 0.0 |
| MH106 | STORAGE | 96.17 | 4.52 | 0.0 |
| MH107 | STORAGE | 96.27 | 4.57 | 0.0 |
| MH108 | STORAGE | 97.15 | 3.79 | 0.0 |
| MH108-Dummy | STORAGE | 97.15 | 3.79 | 0.0 |
| MH10A | STORAGE | 99.22 | 3.41 | 0.0 |
| MH10B | STORAGE | 99.95 | 2.56 | 0.0 |
| MH11 | STORAGE | 97.09 | 4.16 | 0.0 |
| MH110 | STORAGE | 97.69 | 4.60 | 0.0 |
| MH111 | STORAGE | 99.88 | 2.85 | 0.0 |
| MH113 | STORAGE | 97.95 | 4.34 | 0.0 |
| MH114 | STORAGE | 99.17 | 3.41 | 0.0 |
| MH115 | STORAGE | 99.79 | 2.45 | 0.0 |
| MH116 | STORAGE | 101.38 | 2.17 | 0.0 |
| MH117 | STORAGE | 96.70 | 3.17 | 0.0 |
| MH118 | STORAGE | 97.59 | 2.44 | 0.0 |
| MH118-Dummy | STORAGE | 97.59 | 2.44 | 0.0 |
| MH119 | STORAGE | 98.85 | 2.80 | 0.0 |
| MH11-Dummy | STORAGE | 97.09 | 4.16 | 0.0 |
| MH12 | STORAGE | 97.42 | 4.12 | 0.0 |
| MH120 | STORAGE | 101.78 | 2.54 | 0.0 |
| MH13 | STORAGE | 97.67 | 3.89 | 0.0 |
| MH14 | STORAGE | 98.09 | 3.49 | 0.0 |
| MH15 | STORAGE | 98.46 | 3.11 | 0.0 |
| MH16 | STORAGE | 98.78 | 3.25 | 0.0 |
| Storage-FUT | STORAGE | 99.00 | 2.30 | 0.0 |
| Storage-N01 | STORAGE | 98.00 | 2.03 | 0.0 |
| Storage-N02 | STORAGE | 98.20 | 2.35 | 0.0 |
| Storage-N03 | STORAGE | 97.60 | 3.21 | 0.0 |
| Storage-S01 | STORAGE | 97.80 | 3.80 | 0.0 |
| Storage-S02 | STORAGE | 95.75 | 2.32 | 0.0 |

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Link Summary
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| Name | From Node | To Node | Type | Length | %Slope | Roughness |
|---|---|---|---|---|---|---|
| CBMH109-MH108 | CBMH109 | MH108 | CONDUIT | 42.5 | 1.0116 | 0.0130 |
| CBMH201-MH108 | CBMH201 | MH108 | CONDUIT | 40.8 | 1.0054 | 0.0130 |
| CBMH211-MH103 | CBMH211 | MH103 | CONDUIT | 8.0 | 1.9929 | 0.0130 |
| FUT-Dummy | Storage-FUT | FUT-Dummy | CONDUIT | 10.0 | 0.3000 | 0.0130 |
| FUT-MH117 | FUT-Dummy | MH117 | CONDUIT | 12.5 | 0.3205 | 0.0130 |
| MH-01 | MH01 | HP-MH01 | CONDUIT | 3.0 | 2.3340 | 0.0150 |
| MH01-EX-MH214 | MH01-Dummy | EX-MH214 | CONDUIT | 12.2 | 0.5714 | 0.0130 |
| MH02-MH01 | MH02 | MH01 | CONDUIT | 15.0 | 0.6000 | 0.0130 |
| MH04-MH02 | MH04 | MH02 | CONDUIT | 116.0 | 1.4914 | 0.0130 |
| MH05 | MH05 | HP-MH05 | CONDUIT | 3.0 | 14.1393 | 0.0150 |
| MH05-MH04 | MH05 | MH04 | CONDUIT | 63.2 | 0.9966 | 0.0130 |
| Mh06-MH02 | MH06 | MH02 | CONDUIT | 66.9 | 0.6730 | 0.0130 |
| MH07-MH06 | MH07 | MH06 | CONDUIT | 81.9 | 0.7079 | 0.0130 |
| MH08-MH07 | MH08 | MH07 | CONDUIT | 106.6 | 1.0319 | 0.0130 |
| MH09-MH08 | MH09 | MH08 | CONDUIT | 20.3 | 0.9833 | 0.0130 |
| MH101-MH100 | MH101 | EX-MH208 | CONDUIT | 31.1 | 0.6107 | 0.0130 |
| MH102-MH101 | MH102 | MH101 | CONDUIT | 37.2 | 0.5908 | 0.0130 |
| MH103-MH102 | MH103-Dummy | MH102 | CONDUIT | 19.9 | 1.0031 | 0.0130 |
| MH104-MH103 | MH104 | MH103 | CONDUIT | 87.8 | 1.0028 | 0.0130 |
| MH105-MH104 | MH105 | MH104 | CONDUIT | 92.3 | 0.4982 | 0.0130 |
| MH106-MH102 | MH106 | MH102 | CONDUIT | 38.2 | 0.3926 | 0.0130 |
| MH107-MH106 | MH107 | MH106 | CONDUIT | 17.8 | 0.3937 | 0.0130 |
| MH108-MH107 | MH108-Dummy | MH107 | CONDUIT | 17.9 | 1.0040 | 0.0130 |
| MH10A-MH09 | MH10A | MH09 | CONDUIT | 70.0 | 1.0001 | 0.0130 |
| MH10B-MH10A | MH10B | MH10A | CONDUIT | 72.5 | 0.9938 | 0.0130 |
| MH110-CBMH109 | MH110 | CBMH109 | CONDUIT | 8.8 | 1.0205 | 0.0130 |
| MH111-MH110 | MH111 | MH110 | CONDUIT | 76.8 | 1.4060 | 0.0130 |
| MH113-MH110 | MH113 | MH110 | CONDUIT | 22.8 | 1.0075 | 0.0130 |
| MH114-MH113 | MH114 | MH113 | CONDUIT | 118.7 | 1.0028 | 0.0130 |
| MH115-MH114 | MH115 | MH114 | CONDUIT | 31.0 | 0.9994 | 0.0130 |
| MH116-MH115 | MH116 | MH115 | CONDUIT | 48.9 | 2.8016 | 0.0130 |
| MH117-MH107 | MH117 | MH107 | CONDUIT | 93.7 | 0.2988 | 0.0130 |
| MH118-MH117 | MH118-Dummy | MH117 | CONDUIT | 21.8 | 2.0178 | 0.0130 |
| MH119-MH118 | MH119 | MH118 | CONDUIT | 59.1 | 1.9967 | 0.0130 |
| MH11-MH07 | MH11-Dummy | MH07 | CONDUIT | 26.8 | 0.4853 | 0.0130 |
| MH120-MH119 | MH120 | MH119 | CONDUIT | 97.4 | 2.5478 | 0.0130 |
| MH12-MH11 | MH12 | MH11 | CONDUIT | 106.3 | 0.3010 | 0.0130 |
| MH13-MH12 | MH13 | MH12 | CONDUIT | 80.4 | 0.2986 | 0.0130 |
| MH14-MH13 | MH14 | MH13 | CONDUIT | 120.0 | 0.3000 | 0.0130 |
| MH15-MH14 | MH15 | MH14 | CONDUIT | 120.0 | 0.3000 | 0.0130 |
| MH16-MH15 | MH16 | MH15 | CONDUIT | 102.5 | 0.3025 | 0.0130 |
| Storage-N01-MH118 | Storage-N01 | MH118 | CONDUIT | 2.0 | 1.0001 | 0.0130 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Storage-N02-CBMH201 | Storage-N02 | CBMH201 | CONDUIT | 2.0 | 0.9804 | 0.0130 |
| Storage-N03-CBMH211 | Storage-N03 | CBMH211 | CONDUIT | 4.0 | 0.5000 | 0.0130 |
| Storage-S01-MH11 | Storage-S01 | MH11 | CONDUIT | 7.5 | 1.0667 | 0.0130 |
| Storage-S02-MH01 | Storage-S02 | MH01 | CONDUIT | 4.0 | 1.0102 | 0.0130 |
| MH01-Orifice1 | MH01 | MH01-Dummy | ORIFICE | | | |
| MH01-Orifice2 | MH01 | MH01-Dummy | ORIFICE | | | |
| MH01-Orifice3 | MH01 | MH01-Dummy | ORIFICE | | | |
| MH103-Orifice | MH103 | MH103-Dummy | ORIFICE | | | |
| MH108-Orifice | MH108 | MH108-Dummy | ORIFICE | | | |
| MH118-ICD | MH118 | MH118-Dummy | ORIFICE | | | |
| MH11-Orifice1 | MH11 | MH11-Dummy | ORIFICE | | | |
| MH11-Orifice2 | MH11 | MH11-Dummy | ORIFICE | | | |
| MH11-Orifice3 | MH11 | MH11-Dummy | ORIFICE | | | |
| MH01-Weir | MH01 | MH01-Dummy | WEIR | | | |
| MH11-Weir | MH11 | MH11-Dummy | WEIR | | | |

*********************
Cross Section Summary
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| Conduit | Shape | Full Depth | Full Area | Hyd. Rad. | Max. Width | No. of Barrels | Full Flow |
|---|---|---|---|---|---|---|---|
| CBMH109-MH108 | CIRCULAR | 0.82 | 0.53 | 0.21 | 0.82 | 1 | 1443.81 |
| CBMH201-MH108 | CIRCULAR | 0.75 | 0.44 | 0.19 | 0.75 | 1 | 1116.37 |
| CBMH211-MH103 | CIRCULAR | 0.68 | 0.36 | 0.17 | 0.68 | 1 | 1186.74 |
| FUT-Dummy | CIRCULAR | 0.45 | 0.16 | 0.11 | 0.45 | 1 | 156.17 |
| FUT-MH117 | CIRCULAR | 0.90 | 0.64 | 0.23 | 0.90 | 1 | 1024.95 |
| MH-01 | RECT_OPEN | 1.00 | 3.00 | 0.75 | 3.00 | 1 | 25223.84 |
| MH01-EX-MH214 | CIRCULAR | 1.20 | 1.13 | 0.30 | 1.20 | 1 | 2947.36 |
| MH02-MH01 | CIRCULAR | 1.20 | 1.13 | 0.30 | 1.20 | 1 | 3020.15 |
| MH04-MH02 | CIRCULAR | 0.60 | 0.28 | 0.15 | 0.60 | 1 | 749.90 |
| MH05 | RECT_OPEN | 1.00 | 3.00 | 0.75 | 3.00 | 1 | 62083.59 |
| MH05-MH04 | CIRCULAR | 0.53 | 0.22 | 0.13 | 0.53 | 1 | 429.35 |
| Mh06-MH02 | CIRCULAR | 1.20 | 1.13 | 0.30 | 1.20 | 1 | 3198.49 |
| MH07-MH06 | CIRCULAR | 1.20 | 1.13 | 0.30 | 1.20 | 1 | 3280.35 |
| MH08-MH07 | CIRCULAR | 0.60 | 0.28 | 0.15 | 0.60 | 1 | 623.78 |
| MH09-MH08 | CIRCULAR | 0.60 | 0.28 | 0.15 | 0.60 | 1 | 608.91 |
| MH101-MH100 | CIRCULAR | 1.05 | 0.87 | 0.26 | 1.05 | 1 | 2134.20 |
| MH102-MH101 | CIRCULAR | 1.05 | 0.87 | 0.26 | 1.05 | 1 | 2099.01 |
| MH103-MH102 | CIRCULAR | 0.75 | 0.44 | 0.19 | 0.75 | 1 | 1115.05 |
| MH104-MH103 | CIRCULAR | 0.75 | 0.44 | 0.19 | 0.75 | 1 | 1114.89 |
| MH105-MH104 | CIRCULAR | 0.75 | 0.44 | 0.19 | 0.75 | 1 | 785.85 |
| MH106-MH102 | CIRCULAR | 1.05 | 0.87 | 0.26 | 1.05 | 1 | 1711.05 |
| MH107-MH106 | CIRCULAR | 1.05 | 0.87 | 0.26 | 1.05 | 1 | 1713.52 |
| MH108-MH107 | CIRCULAR | 0.82 | 0.53 | 0.21 | 0.82 | 1 | 1438.36 |
| MH10A-MH09 | CIRCULAR | 0.60 | 0.28 | 0.15 | 0.60 | 1 | 614.06 |
| MH10B-MH10A | CIRCULAR | 0.60 | 0.28 | 0.15 | 0.60 | 1 | 612.15 |
| MH110-CBMH109 | CIRCULAR | 0.82 | 0.53 | 0.21 | 0.82 | 1 | 1450.13 |
| MH111-MH110 | CIRCULAR | 0.45 | 0.16 | 0.11 | 0.45 | 1 | 338.09 |
| MH113-MH110 | CIRCULAR | 0.82 | 0.53 | 0.21 | 0.82 | 1 | 1440.89 |
| MH114-MH113 | CIRCULAR | 0.82 | 0.53 | 0.21 | 0.82 | 1 | 1437.55 |
| MH115-MH114 | CIRCULAR | 0.53 | 0.22 | 0.13 | 0.53 | 1 | 429.96 |
| MH116-MH115 | CIRCULAR | 0.30 | 0.07 | 0.07 | 0.30 | 1 | 161.87 |
| MH117-MH107 | CIRCULAR | 0.90 | 0.64 | 0.23 | 0.90 | 1 | 989.67 |
| MH118-MH117 | CIRCULAR | 0.45 | 0.16 | 0.11 | 0.45 | 1 | 405.02 |
| MH119-MH118 | CIRCULAR | 0.45 | 0.16 | 0.11 | 0.45 | 1 | 402.89 |
| MH11-MH07 | CIRCULAR | 1.20 | 1.13 | 0.30 | 1.20 | 1 | 2716.05 |
| MH120-MH119 | CIRCULAR | 0.30 | 0.07 | 0.07 | 0.30 | 1 | 154.36 |
| MH12-MH11 | CIRCULAR | 1.20 | 1.13 | 0.30 | 1.20 | 1 | 2139.03 |
| MH13-MH12 | CIRCULAR | 1.20 | 1.13 | 0.30 | 1.20 | 1 | 2130.63 |
| MH14-MH13 | CIRCULAR | 1.20 | 1.13 | 0.30 | 1.20 | 1 | 2135.56 |
| MH15-MH14 | CIRCULAR | 1.20 | 1.13 | 0.30 | 1.20 | 1 | 2135.56 |
| MH16-MH15 | CIRCULAR | 1.20 | 1.13 | 0.30 | 1.20 | 1 | 2144.43 |
| Storage-N01-MH118 | CIRCULAR | 0.45 | 0.16 | 0.11 | 0.45 | 1 | 285.13 |
| Storage-N02-CBMH201 | CIRCULAR | 0.75 | 0.44 | 0.19 | 0.75 | 1 | 1102.40 |
| Storage-N03-CBMH211 | CIRCULAR | 0.68 | 0.36 | 0.17 | 0.68 | 1 | 594.43 |
| Storage-S01-MH11 | CIRCULAR | 1.05 | 0.87 | 0.26 | 1.05 | 1 | 2820.53 |
| Storage-S02-MH01 | CIRCULAR | 1.05 | 0.87 | 0.26 | 1.05 | 1 | 2744.72 |

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************

```
Flow Units ............... LPS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
```

```
Surcharge Method ......... EXTRAN
Starting Date ............ 03/18/2020 00:00:00
Ending Date .............. 03/19/2020 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 2.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 4
Head Tolerance ........... 0.001500 m


*********************
Control Actions Taken
*********************


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         1.901        71.667
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.257         9.699
Surface Runoff ...........         1.639        61.778
Final Storage ............         0.022         0.821
Continuity Error (%) .....        -0.879


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         1.639        16.395
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         1.641        16.413
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.001         0.006
Continuity Error (%) .....        -0.150
```

```
*************************
Highest Continuity Errors
*************************
Node MH08 (1.34%)


***************************
Time-Step Critical Elements
***************************
Link Storage-N02-CBMH201 (22.88%)
Link Storage-N01-MH118 (9.93%)
Link Storage-S02-MH01 (4.57%)
Link MH01-EX-MH214 (1.89%)


********************************
Highest Flow Instability Indexes
********************************
Link MH11-Orifice1 (62)
Link MH11-Orifice2 (62)
Link MH11-Orifice3 (62)
Link MH01-Orifice1 (58)
Link MH01-Orifice2 (58)


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.10 sec
Average Time Step           :     1.60 sec
Maximum Time Step           :     2.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.03
Percent Not Converging      :     0.01


***************************
Subcatchment Runoff Summary
***************************
```

| Subcatchment | Total Precip mm | Total Runon mm | Total Evap mm | Total Infil mm | Imperv Runoff mm | Perv Runoff mm | Total Runoff mm | Total Runoff 10^6 ltr | Peak Runoff LPS | Runoff Coeff |
|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| A-01 | 71.67 | 0.00 | 0.00 | 16.03 | 45.23 | 10.03 | 55.26 | 0.14 | 108.07 | 0.771 |
| A-02 | 71.67 | 0.00 | 0.00 | 19.17 | 40.10 | 12.25 | 52.35 | 0.13 | 107.69 | 0.731 |
| A-03 | 71.67 | 0.00 | 0.00 | 22.42 | 35.11 | 14.12 | 49.23 | 0.05 | 41.10 | 0.687 |
| A-04 | 71.67 | 0.00 | 0.00 | 15.13 | 46.11 | 10.43 | 56.53 | 0.06 | 46.64 | 0.789 |
| A-05 | 71.67 | 0.00 | 0.00 | 19.81 | 39.12 | 12.62 | 51.74 | 0.09 | 76.86 | 0.722 |
| A-06 | 71.67 | 0.00 | 0.00 | 10.79 | 53.24 | 7.11 | 60.35 | 0.40 | 308.33 | 0.842 |
| A-07 | 71.67 | 0.00 | 0.00 | 5.75 | 61.53 | 3.71 | 65.24 | 0.68 | 496.29 | 0.910 |
| A-08 | 71.67 | 0.00 | 0.00 | 3.81 | 64.59 | 2.53 | 67.12 | 0.70 | 509.57 | 0.937 |
| A-09 | 71.67 | 0.00 | 0.00 | 7.00 | 59.50 | 4.51 | 64.01 | 0.41 | 302.98 | 0.893 |
| A-10 | 71.67 | 0.00 | 0.00 | 2.51 | 66.52 | 1.78 | 68.30 | 0.60 | 432.48 | 0.953 |
| A-11 | 71.67 | 0.00 | 0.00 | 4.38 | 63.18 | 3.24 | 66.42 | 0.03 | 19.55 | 0.927 |
| A-12 | 71.67 | 0.00 | 0.00 | 27.87 | 27.10 | 16.76 | 43.86 | 0.20 | 160.59 | 0.612 |
| A-13 | 71.67 | 0.00 | 0.00 | 17.29 | 43.15 | 10.93 | 54.08 | 0.16 | 129.62 | 0.755 |
| A-14a | 71.67 | 0.00 | 0.00 | 10.79 | 53.24 | 7.11 | 60.35 | 0.21 | 163.51 | 0.842 |
| A-14b | 71.67 | 0.00 | 0.00 | 0.00 | 71.91 | 0.00 | 71.91 | 0.05 | 34.72 | 1.003 |
| A-15a | 71.67 | 0.00 | 0.00 | 1.88 | 67.31 | 1.40 | 68.71 | 0.17 | 123.21 | 0.959 |
| A-15b | 71.67 | 0.00 | 0.00 | 0.00 | 72.19 | 0.00 | 72.19 | 0.26 | 178.35 | 1.007 |
| A-16a | 71.67 | 0.00 | 0.00 | 0.00 | 72.28 | 0.00 | 72.28 | 0.59 | 404.07 | 1.009 |
| A-16b | 71.67 | 0.00 | 0.00 | 0.00 | 72.23 | 0.00 | 72.23 | 0.48 | 331.52 | 1.008 |
| A-17a | 71.67 | 0.00 | 0.00 | 0.61 | 69.42 | 0.46 | 69.88 | 0.12 | 84.14 | 0.975 |
| A-17b | 71.67 | 0.00 | 0.00 | 0.00 | 72.12 | 0.00 | 72.12 | 0.18 | 123.95 | 1.006 |
| A-18 | 71.67 | 0.00 | 0.00 | 0.61 | 69.36 | 0.46 | 69.82 | 0.16 | 113.84 | 0.974 |
| A-19 | 71.67 | 0.00 | 0.00 | 14.69 | 47.17 | 9.42 | 56.60 | 0.27 | 210.32 | 0.790 |
| A-20 | 71.67 | 0.00 | 0.00 | 26.02 | 30.14 | 15.44 | 45.58 | 0.10 | 82.32 | 0.636 |
| A-21a | 71.67 | 0.00 | 0.00 | 15.26 | 46.15 | 9.95 | 56.11 | 0.14 | 112.92 | 0.783 |
| A-21b | 71.67 | 0.00 | 0.00 | 0.00 | 71.84 | 0.00 | 71.84 | 0.04 | 24.80 | 1.002 |
| A-22a | 71.67 | 0.00 | 0.00 | 7.03 | 59.54 | 4.45 | 64.00 | 0.74 | 545.12 | 0.893 |
| A-22b | 71.67 | 0.00 | 0.00 | 0.00 | 72.25 | 0.00 | 72.25 | 0.55 | 375.75 | 1.008 |
| A-23a | 71.67 | 0.00 | 0.00 | 25.06 | 33.21 | 13.12 | 46.32 | 0.96 | 654.46 | 0.646 |
| A-23b | 71.67 | 0.00 | 0.00 | 0.00 | 72.28 | 0.00 | 72.28 | 0.47 | 320.30 | 1.009 |
| A-24a | 71.67 | 0.00 | 0.00 | 13.65 | 49.39 | 8.14 | 57.53 | 0.67 | 492.87 | 0.803 |
| A-24b | 71.67 | 0.00 | 0.00 | 0.00 | 72.28 | 0.00 | 72.28 | 0.77 | 522.34 | 1.009 |
| A-25a | 71.67 | 0.00 | 0.00 | 15.63 | 46.32 | 9.27 | 55.59 | 0.62 | 458.35 | 0.776 |
| A-25b | 71.67 | 0.00 | 0.00 | 0.00 | 72.23 | 0.00 | 72.23 | 0.35 | 237.51 | 1.008 |
| A-26a | 71.67 | 0.00 | 0.00 | 2.51 | 66.63 | 1.73 | 68.36 | 0.87 | 622.55 | 0.954 |
| A-26b | 71.67 | 0.00 | 0.00 | 0.00 | 72.26 | 0.00 | 72.26 | 0.48 | 325.99 | 1.008 |
| A-27a | 71.67 | 0.00 | 0.00 | 15.08 | 47.35 | 8.78 | 56.13 | 1.03 | 753.99 | 0.783 |
| A-27b | 71.67 | 0.00 | 0.00 | 0.00 | 71.91 | 0.00 | 71.91 | 0.06 | 39.68 | 1.003 |
| A-28 | 71.67 | 0.00 | 0.00 | 17.21 | 43.13 | 11.11 | 54.23 | 0.06 | 48.58 | 0.757 |
| CG-DR-EXT | 71.67 | 0.00 | 0.00 | 7.32 | 60.00 | 3.48 | 63.48 | 0.33 | 197.58 | 0.886 |
| D-01 | 71.67 | 0.00 | 0.00 | 43.50 | 2.05 | 27.49 | 29.53 | 0.07 | 83.60 | 0.412 |
| D-02 | 71.67 | 0.00 | 0.00 | 32.75 | 19.02 | 20.45 | 39.47 | 0.21 | 192.90 | 0.551 |
| D-03 | 71.67 | 0.00 | 0.00 | 44.28 | 0.00 | 29.64 | 29.64 | 0.01 | 15.66 | 0.414 |
| FUT | 71.67 | 0.00 | 0.00 | 6.84 | 60.78 | 4.05 | 64.84 | 1.72 | 1209.08 | 0.905 |

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Node Depth Summary
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| Node | Type | Average Depth Meters | Maximum Depth Meters | Maximum HGL Meters | Time of Max Occurrence days | Time of Max Occurrence hr:min | Reported Max Depth Meters |
|---|---|---|---|---|---|---|---|
| EX-MH208 | OUTFALL | 0.10 | 0.71 | 96.28 | 0 | 01:11 | 0.71 |
| EX-MH214 | OUTFALL | 0.10 | 0.90 | 95.55 | 0 | 01:24 | 0.90 |
| HP-MH01 | OUTFALL | 0.00 | 0.00 | 98.00 | 0 | 00:00 | 0.00 |
| HP-MH05 | OUTFALL | 0.00 | 0.00 | 100.00 | 0 | 00:00 | 0.00 |
| CBMH109 | STORAGE | 0.29 | 3.01 | 100.60 | 0 | 01:11 | 3.00 |
| CBMH201 | STORAGE | 0.17 | 1.41 | 99.53 | 0 | 01:31 | 1.41 |
| CBMH211 | STORAGE | 0.06 | 1.47 | 99.04 | 0 | 01:19 | 1.47 |
| FUT-Dummy | STORAGE | 0.06 | 0.68 | 97.43 | 0 | 01:10 | 0.68 |
| MH01 | STORAGE | 0.21 | 2.81 | 97.53 | 0 | 01:24 | 2.81 |
| MH01-Dummy | STORAGE | 0.15 | 1.45 | 96.17 | 0 | 01:24 | 1.45 |
| MH02 | STORAGE | 0.19 | 2.79 | 97.63 | 0 | 01:23 | 2.79 |
| MH04 | STORAGE | 0.05 | 1.39 | 98.72 | 0 | 01:11 | 1.39 |
| MH05 | STORAGE | 0.03 | 0.92 | 98.96 | 0 | 01:10 | 0.92 |
| MH06 | STORAGE | 0.15 | 2.57 | 97.99 | 0 | 01:19 | 2.57 |
| MH07 | STORAGE | 0.12 | 2.27 | 98.77 | 0 | 01:15 | 2.27 |
| MH08 | STORAGE | 0.07 | 2.10 | 100.30 | 0 | 01:12 | 2.09 |
| MH09 | STORAGE | 0.07 | 2.28 | 100.74 | 0 | 01:12 | 2.27 |
| MH101 | STORAGE | 0.10 | 0.76 | 96.52 | 0 | 01:11 | 0.76 |
| MH102 | STORAGE | 0.10 | 0.76 | 96.77 | 0 | 01:11 | 0.76 |
| MH103 | STORAGE | 0.18 | 2.52 | 99.04 | 0 | 01:19 | 2.52 |
| MH103-Dummy | STORAGE | 0.05 | 0.41 | 96.93 | 0 | 01:16 | 0.41 |
| MH104 | STORAGE | 0.10 | 1.98 | 99.41 | 0 | 01:11 | 1.97 |
| MH105 | STORAGE | 0.07 | 1.64 | 99.54 | 0 | 01:10 | 1.64 |
| MH106 | STORAGE | 0.10 | 0.72 | 96.89 | 0 | 01:11 | 0.72 |
| MH107 | STORAGE | 0.10 | 0.73 | 97.00 | 0 | 01:11 | 0.73 |
| MH108 | STORAGE | 0.41 | 3.14 | 100.29 | 0 | 01:11 | 3.14 |
| MH108-Dummy | STORAGE | 0.08 | 0.36 | 97.51 | 0 | 01:11 | 0.36 |
| MH10A | STORAGE | 0.07 | 2.39 | 101.61 | 0 | 01:11 | 2.38 |
| MH10B | STORAGE | 0.05 | 1.85 | 101.80 | 0 | 01:11 | 1.83 |
| MH11 | STORAGE | 0.14 | 2.24 | 99.33 | 0 | 01:15 | 2.24 |
| MH110 | STORAGE | 0.27 | 2.97 | 100.66 | 0 | 01:11 | 2.96 |
| MH111 | STORAGE | 0.03 | 1.13 | 101.01 | 0 | 01:11 | 1.13 |
| MH113 | STORAGE | 0.22 | 2.88 | 100.83 | 0 | 01:11 | 2.87 |
| MH114 | STORAGE | 0.07 | 2.26 | 101.43 | 0 | 01:10 | 2.26 |
| MH115 | STORAGE | 0.04 | 1.70 | 101.49 | 0 | 01:11 | 1.70 |
| MH116 | STORAGE | 0.01 | 0.43 | 101.81 | 0 | 01:11 | 0.42 |
| MH117 | STORAGE | 0.07 | 0.70 | 97.40 | 0 | 01:10 | 0.70 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| MH118 | STORAGE | 0.40 | 1.94 | 99.53 | 0 | 01:35 | 1.94 |
| MH118-Dummy | STORAGE | 0.03 | 0.10 | 97.69 | 0 | 01:35 | 0.10 |
| MH119 | STORAGE | 0.06 | 0.69 | 99.54 | 0 | 01:34 | 0.69 |
| MH11-Dummy | STORAGE | 0.12 | 2.14 | 99.23 | 0 | 01:15 | 2.14 |
| MH12 | STORAGE | 0.13 | 2.55 | 99.97 | 0 | 01:12 | 2.54 |
| MH120 | STORAGE | 0.03 | 1.07 | 102.85 | 0 | 01:11 | 1.06 |
| MH13 | STORAGE | 0.12 | 2.68 | 100.35 | 0 | 01:12 | 2.68 |
| MH14 | STORAGE | 0.11 | 2.87 | 100.96 | 0 | 01:11 | 2.87 |
| MH15 | STORAGE | 0.09 | 2.71 | 101.17 | 0 | 01:11 | 2.67 |
| MH16 | STORAGE | 0.07 | 2.42 | 101.20 | 0 | 01:11 | 2.42 |
| Storage-FUT | STORAGE | 0.08 | 1.29 | 100.29 | 0 | 01:12 | 1.29 |
| Storage-N01 | STORAGE | 0.25 | 1.53 | 99.53 | 0 | 01:35 | 1.53 |
| Storage-N02 | STORAGE | 0.15 | 1.33 | 99.53 | 0 | 01:31 | 1.33 |
| Storage-N03 | STORAGE | 0.06 | 1.44 | 99.04 | 0 | 01:19 | 1.44 |
| Storage-S01 | STORAGE | 0.05 | 1.53 | 99.33 | 0 | 01:15 | 1.53 |
| Storage-S02 | STORAGE | 0.08 | 1.78 | 97.53 | 0 | 01:24 | 1.78 |

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Node Inflow Summary
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| Node | Type | Maximum Lateral Inflow LPS | Maximum Total Inflow LPS | Time of Max Occurrence days | hr:min | Lateral Inflow Volume 10^6 ltr | Total Inflow Volume 10^6 ltr | Flow Balance Error Percent |
|---|---|---|---|---|---|---|---|---|
| EX-MH208 | OUTFALL | 83.60 | 1775.26 | 0 | 01:11 | 0.0739 | 6.41 | 0.000 |
| EX-MH214 | OUTFALL | 406.15 | 2801.06 | 0 | 01:22 | 0.551 | 10 | 0.000 |
| HP-MH01 | OUTFALL | 0.00 | 0.00 | 0 | 00:00 | 0 | 0 | 0.000 ltr |
| HP-MH05 | OUTFALL | 0.00 | 0.00 | 0 | 00:00 | 0 | 0 | 0.000 ltr |
| CBMH109 | STORAGE | 0.00 | 1227.93 | 0 | 01:11 | 0 | 2.04 | -0.028 |
| CBMH201 | STORAGE | 0.00 | 1151.61 | 0 | 01:11 | 0 | 1.97 | -0.015 |
| CBMH211 | STORAGE | 0.00 | 644.47 | 0 | 01:07 | 0 | 0.702 | 0.013 |
| FUT-Dummy | STORAGE | 0.00 | 842.03 | 0 | 01:12 | 0 | 1.72 | 0.012 |
| MH01 | STORAGE | 0.00 | 3932.90 | 0 | 01:12 | 0 | 10.7 | 0.031 |
| MH01-Dummy | STORAGE | 0.00 | 2674.32 | 0 | 01:24 | 0 | 9.45 | -0.031 |
| MH02 | STORAGE | 19.55 | 3974.54 | 0 | 01:12 | 0.0266 | 9.43 | -0.202 |
| MH04 | STORAGE | 432.48 | 711.44 | 0 | 01:09 | 0.601 | 1.01 | 0.061 |
| MH05 | STORAGE | 302.98 | 302.98 | 0 | 01:10 | 0.41 | 0.41 | 0.214 |
| MH06 | STORAGE | 160.59 | 3414.60 | 0 | 01:12 | 0.197 | 8.38 | -0.228 |
| MH07 | STORAGE | 129.62 | 3355.13 | 0 | 01:12 | 0.162 | 8.18 | 0.027 |
| MH08 | STORAGE | 301.57 | 857.42 | 0 | 01:07 | 0.432 | 1.51 | 1.356 |
| MH09 | STORAGE | 0.00 | 601.55 | 0 | 01:08 | 0 | 1.08 | -0.223 |
| MH101 | STORAGE | 76.86 | 1706.60 | 0 | 01:11 | 0.0932 | 6.34 | 0.013 |
| MH102 | STORAGE | 0.00 | 1647.41 | 0 | 01:11 | 0 | 6.25 | 0.011 |
| MH103 | STORAGE | 95.22 | 983.11 | 0 | 01:10 | 0.116 | 1.85 | -0.050 |
| MH103-Dummy | STORAGE | 0.00 | 354.41 | 0 | 01:19 | 0 | 1.5 | -0.042 |
| MH104 | STORAGE | 496.29 | 964.03 | 0 | 01:10 | 0.679 | 1.38 | -0.025 |
| MH105 | STORAGE | 509.57 | 509.57 | 0 | 01:10 | 0.705 | 0.705 | -0.018 |
| MH106 | STORAGE | 41.10 | 1307.77 | 0 | 01:11 | 0.0492 | 4.74 | -0.041 |
| MH107 | STORAGE | 0.00 | 1274.41 | 0 | 01:11 | 0 | 4.69 | -0.031 |
| MH108 | STORAGE | 308.33 | 1485.43 | 0 | 01:10 | 0.398 | 3.43 | 0.053 |
| MH108-Dummy | STORAGE | 0.00 | 316.82 | 0 | 01:11 | 0 | 2.43 | -0.001 |
| MH10A | STORAGE | 331.52 | 688.18 | 0 | 01:10 | 0.484 | 1.08 | 0.091 |
| MH10B | STORAGE | 404.07 | 404.07 | 0 | 01:10 | 0.593 | 0.593 | 0.023 |
| MH11 | STORAGE | 198.23 | 3682.10 | 0 | 01:10 | 0.262 | 7.23 | -0.021 |
| MH110 | STORAGE | 113.84 | 1248.33 | 0 | 01:10 | 0.161 | 2.04 | -0.226 |
| MH111 | STORAGE | 208.09 | 208.09 | 0 | 01:10 | 0.299 | 0.299 | 0.776 |
| MH113 | STORAGE | 0.00 | 1019.91 | 0 | 01:10 | 0 | 1.57 | -0.622 |
| MH114 | STORAGE | 920.87 | 1099.19 | 0 | 01:10 | 1.29 | 1.57 | 0.280 |
| MH115 | STORAGE | 137.72 | 207.76 | 0 | 01:09 | 0.176 | 0.281 | 0.120 |
| MH116 | STORAGE | 82.32 | 82.32 | 0 | 01:10 | 0.105 | 0.105 | 0.278 |
| MH117 | STORAGE | 107.69 | 959.43 | 0 | 01:10 | 0.131 | 2.26 | 0.105 |
| MH118 | STORAGE | 0.00 | 265.11 | 0 | 01:10 | 0 | 0.623 | -0.365 |
| MH118-Dummy | STORAGE | 0.00 | 33.46 | 0 | 01:35 | 0 | 0.406 | -0.013 |
| MH119 | STORAGE | 108.07 | 280.48 | 0 | 01:10 | 0.138 | 0.403 | -0.243 |
| MH11-Dummy | STORAGE | 0.00 | 2561.26 | 0 | 01:15 | 0 | 6.53 | 0.040 |
| MH12 | STORAGE | 948.54 | 3614.17 | 0 | 01:10 | 1.35 | 6.27 | 0.019 |
| MH120 | STORAGE | 210.32 | 210.32 | 0 | 01:10 | 0.266 | 0.266 | 0.389 |
| MH13 | STORAGE | 793.67 | 2846.10 | 0 | 01:10 | 1.09 | 4.92 | -0.022 |
| MH14 | STORAGE | 695.86 | 2352.77 | 0 | 01:08 | 0.964 | 3.83 | -0.024 |
| MH15 | STORAGE | 1015.20 | 2126.19 | 0 | 01:07 | 1.43 | 2.87 | 0.068 |
| MH16 | STORAGE | 974.76 | 974.76 | 0 | 01:10 | 1.43 | 1.43 | -0.066 |
| Storage-FUT | STORAGE | 1209.08 | 1209.08 | 0 | 01:10 | 1.73 | 1.73 | 0.033 |
| Storage-N01 | STORAGE | 0.00 | 227.16 | 0 | 01:10 | 0 | 0.219 | -0.006 |
| Storage-N02 | STORAGE | 0.00 | 1144.52 | 0 | 01:11 | 0 | 0.977 | -0.017 |
| Storage-N03 | STORAGE | 0.00 | 638.51 | 0 | 01:07 | 0 | 0.349 | -0.037 |
| Storage-S01 | STORAGE | 0.00 | 1301.81 | 0 | 01:06 | 0 | 0.697 | -0.055 |
| Storage-S02 | STORAGE | 0.00 | 1669.70 | 0 | 01:11 | 0 | 1.27 | -0.067 |

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Node Surcharge Summary
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No nodes were surcharged.

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Node Flooding Summary

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No nodes were flooded.

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Storage Volume Summary
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| Storage Unit | Average Volume 1000 m3 | Avg Pcnt Full | Evap Pcnt Loss | Exfil Pcnt Loss | Maximum Volume 1000 m3 | Max Pcnt Full | Time of Max Occurrence days hr:min | Maximum Outflow LPS |
|---|---|---|---|---|---|---|---|---|
| CBMH109 | 0.000 | 7 | 0 | 0 | 0.003 | 68 | 0 01:11 | 1222.89 |
| CBMH201 | 0.000 | 7 | 0 | 0 | 0.002 | 58 | 0 01:31 | 1144.52 |
| CBMH211 | 0.000 | 2 | 0 | 0 | 0.002 | 45 | 0 01:19 | 638.51 |
| FUT-Dummy | 0.000 | 1 | 0 | 0 | 0.001 | 16 | 0 01:10 | 842.62 |
| MH01 | 0.000 | 5 | 0 | 0 | 0.003 | 65 | 0 01:24 | 3926.12 |
| MH01-Dummy | 0.000 | 4 | 0 | 0 | 0.002 | 43 | 0 01:24 | 2674.33 |
| MH02 | 0.000 | 5 | 0 | 0 | 0.003 | 79 | 0 01:23 | 3932.90 |
| MH04 | 0.000 | 1 | 0 | 0 | 0.002 | 39 | 0 01:11 | 647.62 |
| MH05 | 0.000 | 1 | 0 | 0 | 0.001 | 27 | 0 01:10 | 282.08 |
| MH06 | 0.000 | 3 | 0 | 0 | 0.003 | 50 | 0 01:19 | 3369.57 |
| MH07 | 0.000 | 2 | 0 | 0 | 0.003 | 40 | 0 01:15 | 3307.31 |
| MH08 | 0.000 | 1 | 0 | 0 | 0.002 | 47 | 0 01:12 | 797.44 |
| MH09 | 0.000 | 2 | 0 | 0 | 0.003 | 58 | 0 01:12 | 563.16 |
| MH101 | 0.000 | 4 | 0 | 0 | 0.001 | 27 | 0 01:11 | 1706.89 |
| MH102 | 0.000 | 3 | 0 | 0 | 0.001 | 20 | 0 01:11 | 1649.41 |
| MH103 | 0.000 | 4 | 0 | 0 | 0.003 | 60 | 0 01:19 | 946.39 |
| MH103-Dummy | 0.000 | 1 | 0 | 0 | 0.000 | 10 | 0 01:16 | 358.61 |
| MH104 | 0.000 | 2 | 0 | 0 | 0.002 | 44 | 0 01:11 | 889.66 |
| MH105 | 0.000 | 3 | 0 | 0 | 0.002 | 61 | 0 01:10 | 468.47 |
| MH106 | 0.000 | 2 | 0 | 0 | 0.001 | 16 | 0 01:11 | 1307.05 |
| MH107 | 0.000 | 2 | 0 | 0 | 0.001 | 16 | 0 01:11 | 1274.19 |
| MH108 | 0.000 | 11 | 0 | 0 | 0.004 | 83 | 0 01:11 | 1467.82 |
| MH108-Dummy | 0.000 | 2 | 0 | 0 | 0.000 | 9 | 0 01:11 | 316.82 |
| MH10A | 0.000 | 2 | 0 | 0 | 0.003 | 70 | 0 01:11 | 601.55 |
| MH10B | 0.000 | 2 | 0 | 0 | 0.002 | 72 | 0 01:11 | 359.58 |
| MH11 | 0.000 | 3 | 0 | 0 | 0.003 | 54 | 0 01:15 | 3617.60 |
| MH110 | 0.000 | 6 | 0 | 0 | 0.003 | 65 | 0 01:11 | 1227.93 |
| MH111 | 0.000 | 1 | 0 | 0 | 0.001 | 40 | 0 01:11 | 194.90 |
| MH113 | 0.000 | 5 | 0 | 0 | 0.003 | 66 | 0 01:11 | 968.10 |
| MH114 | 0.000 | 2 | 0 | 0 | 0.003 | 66 | 0 01:10 | 1019.91 |
| MH115 | 0.000 | 1 | 0 | 0 | 0.002 | 69 | 0 01:11 | 193.09 |
| MH116 | 0.000 | 1 | 0 | 0 | 0.000 | 20 | 0 01:11 | 76.06 |
| MH117 | 0.000 | 2 | 0 | 0 | 0.001 | 22 | 0 01:10 | 958.93 |
| MH118 | 0.000 | 16 | 0 | 0 | 0.002 | 80 | 0 01:35 | 255.24 |
| MH118-Dummy | 0.000 | 1 | 0 | 0 | 0.000 | 4 | 0 01:35 | 33.45 |
| MH119 | 0.000 | 2 | 0 | 0 | 0.001 | 25 | 0 01:34 | 265.11 |
| MH11-Dummy | 0.000 | 3 | 0 | 0 | 0.002 | 51 | 0 01:15 | 2560.66 |
| MH12 | 0.000 | 3 | 0 | 0 | 0.003 | 62 | 0 01:12 | 3501.83 |
| MH120 | 0.000 | 1 | 0 | 0 | 0.001 | 42 | 0 01:11 | 175.77 |
| MH13 | 0.000 | 3 | 0 | 0 | 0.003 | 69 | 0 01:12 | 2767.80 |
| MH14 | 0.000 | 3 | 0 | 0 | 0.003 | 82 | 0 01:11 | 2148.07 |
| MH15 | 0.000 | 3 | 0 | 0 | 0.003 | 87 | 0 01:11 | 1690.14 |
| MH16 | 0.000 | 2 | 0 | 0 | 0.003 | 74 | 0 01:11 | 1167.30 |
| Storage-FUT | 0.002 | 1 | 0 | 0 | 0.145 | 92 | 0 01:12 | 842.03 |
| Storage-N01 | 0.038 | 18 | 0 | 0 | 0.219 | 100 | 0 01:30 | 23.16 |
| Storage-N02 | 0.110 | 10 | 0 | 0 | 0.976 | 92 | 0 01:31 | 151.23 |
| Storage-N03 | 0.015 | 4 | 0 | 0 | 0.347 | 99 | 0 01:19 | 160.19 |
| Storage-S01 | 0.021 | 3 | 0 | 0 | 0.693 | 84 | 0 01:15 | 486.30 |
| Storage-S02 | 0.054 | 4 | 0 | 0 | 1.272 | 98 | 0 01:24 | 802.92 |

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Outfall Loading Summary
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| Outfall Node | Flow Freq Pcnt | Avg Flow LPS | Max Flow LPS | Total Volume 10^6 ltr |
|---|---|---|---|---|
| EX-MH208 | 99.04 | 138.08 | 1775.26 | 6.414 |
| EX-MH214 | 99.13 | 200.97 | 2801.06 | 10.000 |
| HP-MH01 | 0.00 | 0.00 | 0.00 | 0.000 |
| HP-MH05 | 0.00 | 0.00 | 0.00 | 0.000 |
| System | 49.54 | 339.05 | 0.00 | 16.413 |

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Link Flow Summary
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| Link | Type | Maximum \|Flow\| LPS | Time of Max Occurrence days hr:min | Maximum \|Veloc\| m/sec | Max/ Full Flow | Max/ Full Depth |
|---|---|---|---|---|---|---|
| CBMH109-MH108 | CONDUIT | 1222.89 | 0 01:11 | 2.29 | 0.85 | 1.00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CBMH201-MH108 | CONDUIT | 1151.61 | 0 | 01:11 | 2.61 | 1.03 | 1.00 |
| CBMH211-MH103 | CONDUIT | 644.47 | 0 | 01:07 | 1.93 | 0.54 | 1.00 |
| FUT-Dummy | CONDUIT | 842.03 | 0 | 01:12 | 5.29 | 5.39 | 1.00 |
| FUT-MH117 | CONDUIT | 842.62 | 0 | 01:12 | 1.69 | 0.82 | 0.76 |
| MH-01 | CONDUIT | 0.00 | 0 | 00:00 | 0.00 | 0.00 | 0.00 |
| MH01-EX-MH214 | CONDUIT | 2674.33 | 0 | 01:24 | 2.55 | 0.91 | 0.87 |
| MH02-MH01 | CONDUIT | 3932.90 | 0 | 01:12 | 3.48 | 1.30 | 1.00 |
| MH04-MH02 | CONDUIT | 647.62 | 0 | 01:10 | 2.29 | 0.86 | 1.00 |
| MH05 | CONDUIT | 0.00 | 0 | 00:00 | 0.00 | 0.00 | 0.00 |
| MH05-MH04 | CONDUIT | 282.08 | 0 | 01:06 | 1.79 | 0.66 | 1.00 |
| Mh06-MH02 | CONDUIT | 3369.57 | 0 | 01:12 | 2.98 | 1.05 | 1.00 |
| MH07-MH06 | CONDUIT | 3307.31 | 0 | 01:13 | 2.92 | 1.01 | 1.00 |
| MH08-MH07 | CONDUIT | 797.44 | 0 | 01:08 | 2.83 | 1.28 | 1.00 |
| MH09-MH08 | CONDUIT | 563.16 | 0 | 01:11 | 1.99 | 0.92 | 1.00 |
| MH101-MH100 | CONDUIT | 1706.89 | 0 | 01:11 | 2.64 | 0.80 | 0.70 |
| MH102-MH101 | CONDUIT | 1649.41 | 0 | 01:12 | 2.53 | 0.79 | 0.71 |
| MH103-MH102 | CONDUIT | 358.61 | 0 | 01:22 | 1.79 | 0.32 | 0.57 |
| MH104-MH103 | CONDUIT | 889.66 | 0 | 01:10 | 2.01 | 0.80 | 1.00 |
| MH105-MH104 | CONDUIT | 468.47 | 0 | 01:10 | 1.36 | 0.60 | 1.00 |
| MH106-MH102 | CONDUIT | 1307.05 | 0 | 01:11 | 2.02 | 0.76 | 0.70 |
| MH107-MH106 | CONDUIT | 1274.19 | 0 | 01:11 | 2.05 | 0.74 | 0.68 |
| MH108-MH107 | CONDUIT | 316.82 | 0 | 01:11 | 1.72 | 0.22 | 0.38 |
| MH10A-MH09 | CONDUIT | 601.55 | 0 | 01:08 | 2.13 | 0.98 | 1.00 |
| MH10B-MH10A | CONDUIT | 359.58 | 0 | 01:05 | 1.53 | 0.59 | 1.00 |
| MH110-CBMH109 | CONDUIT | 1227.93 | 0 | 01:11 | 2.30 | 0.85 | 1.00 |
| MH111-MH110 | CONDUIT | 194.90 | 0 | 01:05 | 1.83 | 0.58 | 1.00 |
| MH113-MH110 | CONDUIT | 968.10 | 0 | 01:11 | 1.81 | 0.67 | 1.00 |
| MH114-MH113 | CONDUIT | 1019.91 | 0 | 01:10 | 1.91 | 0.71 | 1.00 |
| MH115-MH114 | CONDUIT | 193.09 | 0 | 01:13 | 1.78 | 0.45 | 1.00 |
| MH116-MH115 | CONDUIT | 76.06 | 0 | 01:12 | 2.04 | 0.47 | 1.00 |
| MH117-MH107 | CONDUIT | 958.93 | 0 | 01:11 | 1.97 | 0.97 | 0.72 |
| MH118-MH117 | CONDUIT | 33.45 | 0 | 01:35 | 1.43 | 0.08 | 0.37 |
| MH119-MH118 | CONDUIT | 265.11 | 0 | 01:10 | 1.82 | 0.66 | 1.00 |
| MH11-MH07 | CONDUIT | 2560.66 | 0 | 01:15 | 2.26 | 0.94 | 1.00 |
| MH120-MH119 | CONDUIT | 175.77 | 0 | 01:11 | 2.59 | 1.14 | 1.00 |
| MH12-MH11 | CONDUIT | 3501.83 | 0 | 01:10 | 3.10 | 1.64 | 1.00 |
| MH13-MH12 | CONDUIT | 2767.80 | 0 | 01:11 | 2.45 | 1.30 | 1.00 |
| MH14-MH13 | CONDUIT | 2148.07 | 0 | 01:11 | 1.90 | 1.01 | 1.00 |
| MH15-MH14 | CONDUIT | 1690.14 | 0 | 01:08 | 1.57 | 0.79 | 1.00 |
| MH16-MH15 | CONDUIT | 1167.30 | 0 | 01:07 | 1.23 | 0.54 | 1.00 |
| Storage-N01-MH118 | CONDUIT | 227.16 | 0 | 01:10 | 1.46 | 0.80 | 1.00 |
| Storage-N02-CBMH201 | CONDUIT | 1144.52 | 0 | 01:11 | 3.30 | 1.04 | 1.00 |
| Storage-N03-CBMH211 | CONDUIT | 638.51 | 0 | 01:07 | 3.76 | 1.07 | 1.00 |
| Storage-S01-MH11 | CONDUIT | 1301.81 | 0 | 01:06 | 2.89 | 0.46 | 1.00 |
| Storage-S02-MH01 | CONDUIT | 1669.70 | 0 | 01:11 | 3.45 | 0.61 | 1.00 |
| MH01-Orifice1 | ORIFICE | 891.44 | 0 | 01:24 | | | 1.00 |
| MH01-Orifice2 | ORIFICE | 891.44 | 0 | 01:24 | | | 1.00 |
| MH01-Orifice3 | ORIFICE | 891.44 | 0 | 01:24 | | | 1.00 |
| MH103-Orifice | ORIFICE | 354.41 | 0 | 01:19 | | | 1.00 |
| MH108-Orifice | ORIFICE | 316.82 | 0 | 01:11 | | | 1.00 |
| MH118-ICD | ORIFICE | 33.46 | 0 | 01:35 | | | 1.00 |
| MH11-Orifice1 | ORIFICE | 521.05 | 0 | 01:06 | | | 1.00 |
| MH11-Orifice2 | ORIFICE | 521.05 | 0 | 01:06 | | | 1.00 |
| MH11-Orifice3 | ORIFICE | 521.05 | 0 | 01:06 | | | 1.00 |
| MH01-Weir | WEIR | 0.00 | 0 | 00:00 | | | 0.00 |
| MH11-Weir | WEIR | 1832.17 | 0 | 01:15 | | | 0.31 |

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Flow Classification Summary
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| Conduit | Adjusted /Actual Length | Dry | Up Dry | Down Dry | Sub Crit | Sup Crit | Up Crit | Down Crit | Norm Ltd | Inlet Ctrl |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ---------- Fraction of Time in Flow Class ---------- | | | | | | | | |
| CBMH109-MH108 | 1.00 | 0.01 | 0.00 | 0.00 | 0.58 | 0.00 | 0.00 | 0.41 | 0.36 | 0.00 |
| CBMH201-MH108 | 1.00 | 0.03 | 0.01 | 0.00 | 0.20 | 0.00 | 0.00 | 0.76 | 0.01 | 0.00 |
| CBMH211-MH103 | 1.00 | 0.04 | 0.00 | 0.00 | 0.07 | 0.00 | 0.00 | 0.88 | 0.00 | 0.00 |
| FUT-Dummy | 1.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 | 0.00 |
| FUT-MH117 | 1.00 | 0.01 | 0.00 | 0.00 | 0.49 | 0.00 | 0.00 | 0.50 | 0.06 | 0.00 |
| MH-01 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MH01-EX-MH214 | 1.00 | 0.01 | 0.00 | 0.00 | 0.99 | 0.00 | 0.00 | 0.00 | 0.67 | 0.00 |
| MH02-MH01 | 1.00 | 0.01 | 0.00 | 0.00 | 0.21 | 0.02 | 0.00 | 0.76 | 0.00 | 0.00 |
| MH04-MH02 | 1.00 | 0.01 | 0.00 | 0.00 | 0.06 | 0.01 | 0.00 | 0.92 | 0.02 | 0.00 |
| MH05 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MH05-MH04 | 1.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.01 | 0.00 | 0.95 | 0.01 | 0.00 |
| Mh06-MH02 | 1.00 | 0.01 | 0.00 | 0.00 | 0.08 | 0.01 | 0.00 | 0.90 | 0.00 | 0.00 |
| MH07-MH06 | 1.00 | 0.01 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.94 | 0.00 | 0.00 |
| MH08-MH07 | 1.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.96 | 0.01 | 0.00 |
| MH09-MH08 | 1.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.96 | 0.00 | 0.00 |
| MH101-MH100 | 1.00 | 0.01 | 0.00 | 0.00 | 0.61 | 0.38 | 0.00 | 0.00 | 0.68 | 0.00 |
| MH102-MH101 | 1.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.02 | 0.00 | 0.96 | 0.00 | 0.00 |
| MH103-MH102 | 1.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.96 | 0.00 | 0.00 |
| MH104-MH103 | 1.00 | 0.01 | 0.00 | 0.00 | 0.22 | 0.01 | 0.00 | 0.76 | 0.08 | 0.00 |
| MH105-MH104 | 1.00 | 0.01 | 0.00 | 0.00 | 0.22 | 0.08 | 0.00 | 0.70 | 0.07 | 0.00 |
| MH106-MH102 | 1.00 | 0.01 | 0.00 | 0.00 | 0.10 | 0.16 | 0.00 | 0.73 | 0.00 | 0.00 |
| MH107-MH106 | 1.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.96 | 0.00 | 0.00 |
| MH108-MH107 | 1.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.99 | 0.00 | 0.00 |
| MH10A-MH09 | 1.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.96 | 0.00 | 0.00 |
| MH10B-MH10A | 1.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.20 | 0.00 | 0.76 | 0.12 | 0.00 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MH110-CBMH109 | 1.00 | 0.01 | 0.00 | 0.00 | 0.21 | 0.00 | 0.00 | 0.78 | 0.00 | 0.00 |
| MH111-MH110 | 1.00 | 0.01 | 0.00 | 0.00 | 0.10 | 0.01 | 0.00 | 0.89 | 0.06 | 0.00 |
| MH113-MH110 | 1.00 | 0.01 | 0.00 | 0.00 | 0.21 | 0.00 | 0.00 | 0.78 | 0.00 | 0.00 |
| MH114-MH113 | 1.00 | 0.01 | 0.00 | 0.00 | 0.20 | 0.00 | 0.00 | 0.79 | 0.06 | 0.00 |
| MH115-MH114 | 1.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.97 | 0.00 | 0.00 |
| MH116-MH115 | 1.00 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.97 | 0.00 | 0.00 |
| MH117-MH107 | 1.00 | 0.01 | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.89 | 0.00 | 0.00 |
| MH118-MH117 | 1.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.96 | 0.01 | 0.00 |
| MH119-MH118 | 1.00 | 0.01 | 0.00 | 0.00 | 0.35 | 0.00 | 0.00 | 0.64 | 0.11 | 0.00 |
| MH11-MH07 | 1.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.97 | 0.00 | 0.00 |
| MH120-MH119 | 1.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.02 | 0.00 | 0.95 | 0.03 | 0.00 |
| MH12-MH11 | 1.00 | 0.01 | 0.00 | 0.00 | 0.48 | 0.00 | 0.00 | 0.52 | 0.08 | 0.00 |
| MH13-MH12 | 1.00 | 0.01 | 0.00 | 0.00 | 0.44 | 0.00 | 0.00 | 0.55 | 0.09 | 0.00 |
| MH14-MH13 | 1.00 | 0.01 | 0.00 | 0.00 | 0.06 | 0.00 | 0.00 | 0.93 | 0.00 | 0.00 |
| MH15-MH14 | 1.00 | 0.01 | 0.00 | 0.00 | 0.41 | 0.00 | 0.00 | 0.58 | 0.12 | 0.00 |
| MH16-MH15 | 1.00 | 0.01 | 0.00 | 0.00 | 0.37 | 0.00 | 0.00 | 0.62 | 0.14 | 0.00 |
| Storage-N01-MH118 | 1.00 | 0.03 | 0.00 | 0.00 | 0.30 | 0.02 | 0.00 | 0.65 | 0.00 | 0.00 |
| Storage-N02-CBMH201 | 1.00 | 0.03 | 0.00 | 0.00 | 0.16 | 0.03 | 0.00 | 0.78 | 0.00 | 0.00 |
| Storage-N03-CBMH211 | 1.00 | 0.04 | 0.00 | 0.00 | 0.06 | 0.01 | 0.00 | 0.89 | 0.00 | 0.00 |
| Storage-S01-MH11 | 1.00 | 0.04 | 0.00 | 0.00 | 0.04 | 0.01 | 0.00 | 0.91 | 0.00 | 0.00 |
| Storage-S02-MH01 | 1.00 | 0.04 | 0.00 | 0.00 | 0.05 | 0.02 | 0.00 | 0.90 | 0.00 | 0.00 |

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Conduit Surcharge Summary
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| Conduit | Hours Full Both Ends | Hours Full Upstream | Hours Full Dnstream | Hours Above Full Normal Flow | Hours Capacity Limited |
|---|---|---|---|---|---|
| CBMH109-MH108 | 2.19 | 2.19 | 2.50 | 0.01 | 0.01 |
| CBMH201-MH108 | 1.51 | 1.51 | 2.12 | 0.05 | 0.01 |
| CBMH211-MH103 | 0.62 | 0.62 | 0.75 | 0.01 | 0.01 |
| FUT-Dummy | 0.33 | 0.40 | 0.33 | 0.70 | 0.33 |
| MH01-EX-MH214 | 0.01 | 0.55 | 0.01 | 0.01 | 0.01 |
| MH02-MH01 | 0.78 | 0.78 | 0.81 | 0.25 | 0.34 |
| MH04-MH02 | 0.15 | 0.15 | 0.74 | 0.01 | 0.01 |
| MH05-MH04 | 0.08 | 0.08 | 0.15 | 0.01 | 0.01 |
| Mh06-MH02 | 0.66 | 0.66 | 0.75 | 0.11 | 0.15 |
| MH07-MH06 | 0.41 | 0.41 | 0.50 | 0.04 | 0.23 |
| MH08-MH07 | 0.25 | 0.31 | 0.41 | 0.20 | 0.13 |
| MH09-MH08 | 0.29 | 0.31 | 0.30 | 0.01 | 0.23 |
| MH104-MH103 | 0.72 | 0.72 | 1.09 | 0.01 | 0.01 |
| MH105-MH104 | 0.49 | 0.49 | 0.72 | 0.01 | 0.01 |
| MH10A-MH09 | 0.25 | 0.25 | 0.30 | 0.01 | 0.15 |
| MH10B-MH10A | 0.16 | 0.16 | 0.25 | 0.01 | 0.01 |
| MH110-CBMH109 | 2.05 | 2.05 | 2.18 | 0.01 | 0.01 |
| MH111-MH110 | 0.12 | 0.12 | 0.99 | 0.01 | 0.01 |
| MH113-MH110 | 1.67 | 1.67 | 2.01 | 0.01 | 0.01 |
| MH114-MH113 | 0.19 | 0.19 | 1.63 | 0.01 | 0.01 |
| MH115-MH114 | 0.16 | 0.16 | 0.19 | 0.01 | 0.01 |
| MH116-MH115 | 0.04 | 0.04 | 0.16 | 0.01 | 0.01 |
| MH119-MH118 | 1.02 | 1.02 | 3.83 | 0.01 | 0.01 |
| MH11-MH07 | 0.29 | 0.33 | 0.29 | 0.01 | 0.29 |
| MH120-MH119 | 0.08 | 0.15 | 0.08 | 0.17 | 0.08 |
| MH12-MH11 | 0.44 | 0.44 | 0.51 | 0.21 | 0.20 |
| MH13-MH12 | 0.38 | 0.38 | 0.44 | 0.13 | 0.14 |
| MH14-MH13 | 0.31 | 0.31 | 0.37 | 0.02 | 0.13 |
| MH15-MH14 | 0.24 | 0.24 | 0.31 | 0.01 | 0.01 |
| MH16-MH15 | 0.17 | 0.17 | 0.24 | 0.01 | 0.01 |
| Storage-N01-MH118 | 2.88 | 2.88 | 2.96 | 0.01 | 0.01 |
| Storage-N02-CBMH201 | 1.30 | 1.30 | 1.41 | 0.05 | 0.01 |
| Storage-N03-CBMH211 | 0.60 | 0.60 | 0.61 | 0.08 | 0.01 |
| Storage-S01-MH11 | 0.25 | 0.25 | 0.29 | 0.01 | 0.01 |
| Storage-S02-MH01 | 0.48 | 0.49 | 0.53 | 0.01 | 0.07 |

Analysis begun on: Tue Jun 2 12:36:59 2020
Analysis ended on: Tue Jun 2 12:37:04 2020
Total elapsed time: 00:00:05

# Appendix E

Development Servicing Checklist

# 4. Development Servicing Study Checklist

The following section describes the checklist of the required content of servicing studies. It is expected that the proponent will address each one of the following items for the study to be deemed complete and ready for review by City of Ottawa Infrastructure Approvals staff.

The level of required detail in the Servicing Study will increase depending on the type of application. For example, for Official Plan amendments and re-zoning applications, the main issues will be to determine the capacity requirements for the proposed change in land use and confirm this against the existing capacity constraint, and to define the solutions, phasing of works and the financing of works to address the capacity constraint. For subdivisions and site plans, the above will be required with additional detailed information supporting the servicing within the development boundary.

## 4.1 General Content

N/A ☐ Executive Summary (for larger reports only).

☒ Date and revision number of the report.

☒ Location map and plan showing municipal address, boundary, and layout of proposed development.

☒ Plan showing the site and location of all existing services.

☒ Development statistics, land use, density, adherence to zoning and official plan, and reference to applicable subwatershed and watershed plans that provide context to which individual developments must adhere.

☐ Summary of Pre-consultation Meetings with City and other approval agencies.

☒ Reference and confirm conformance to higher level studies and reports (Master Servicing Studies, Environmental Assessments, Community Design Plans), or in the case where it is not in conformance, the proponent must provide justification and develop a defendable design criteria.

☒ Statement of objectives and servicing criteria.

☒ Identification of existing and proposed infrastructure available in the immediate area.

☒ Identification of Environmentally Significant Areas, watercourses and Municipal Drains potentially impacted by the proposed development (Reference can be made to the Natural Heritage Studies, if available).

☒ Concept level master grading plan to confirm existing and proposed grades in the development. This is required to confirm the feasibility of proposed stormwater management and drainage, soil removal and fill constraints, and potential impacts to neighbouring properties. This is also required to confirm that the proposed grading will not impede existing major system flow paths.

N/A ☐ Identification of potential impacts of proposed piped services on private services (such as wells and septic fields on adjacent lands) and mitigation required to address potential impacts.

N/A ☐ Proposed phasing of the development, if applicable.

☒ Reference to geotechnical studies and recommendations concerning servicing.

☒ All preliminary and formal site plan submissions should have the following information:

- Metric scale
- North arrow (including construction North)
- Key plan
- Name and contact information of applicant and property owner
- Property limits including bearings and dimensions
- Existing and proposed structures and parking areas
- Easements, road widening and rights-of-way
- Adjacent street names

## 4.2 Development Servicing Report: Water

☒ Confirm consistency with Master Servicing Study, if available

☒ Availability of public infrastructure to service proposed development

N/A ☐ Identification of system constraints

☒ Identify boundary conditions

☒ Confirmation of adequate domestic supply and pressure

☒ Confirmation of adequate fire flow protection and confirmation that fire flow is calculated as per the Fire Underwriter's Survey. Output should show available fire flow at locations throughout the development.

☒ Provide a check of high pressures. If pressure is found to be high, an assessment is required to confirm the application of pressure reducing valves.

N/A ☐ Definition of phasing constraints. Hydraulic modeling is required to confirm servicing for all defined phases of the project including the ultimate design

☒ Address reliability requirements such as appropriate location of shut-off valves

N/A ☐ Check on the necessity of a pressure zone boundary modification.

☒ Reference to water supply analysis to show that major infrastructure is capable of delivering sufficient water for the proposed land use. This includes data that shows that the expected demands under average day, peak hour and fire flow conditions provide water within the required pressure range

☒ Description of the proposed water distribution network, including locations of proposed connections to the existing system, provisions for necessary looping, and appurtenances (valves, pressure reducing valves, valve chambers, and fire hydrants) including special metering provisions.

N/A ☐ Description of off-site required feedermains, booster pumping stations, and other water infrastructure that will be ultimately required to service proposed development, including financing, interim facilities, and timing of implementation.

☒ Confirmation that water demands are calculated based on the City of Ottawa Design Guidelines.

☒ Provision of a model schematic showing the boundary conditions locations, streets, parcels, and building locations for reference.

## 4.3 Development Servicing Report: Wastewater

☒ Summary of proposed design criteria (Note: Wet-weather flow criteria should not deviate from the City of Ottawa Sewer Design Guidelines. Monitored flow data from relatively new infrastructure cannot be used to justify capacity requirements for proposed infrastructure).

☒ Confirm consistency with Master Servicing Study and/or justifications for deviations.

N/A ☐ Consideration of local conditions that may contribute to extraneous flows that are higher than the recommended flows in the guidelines. This includes groundwater and soil conditions, and age and condition of sewers.

☒ Description of existing sanitary sewer available for discharge of wastewater from proposed development.

☒ Verify available capacity in downstream sanitary sewer and/or identification of upgrades necessary to service the proposed development. (Reference can be made to previously completed Master Servicing Study if applicable)

☒ Calculations related to dry-weather and wet-weather flow rates from the development in standard MOE sanitary sewer design table (Appendix ‘C’) format.

☒ Description of proposed sewer network including sewers, pumping stations, and forcemains.

N/A ☐ Discussion of previously identified environmental constraints and impact on servicing (environmental constraints are related to limitations imposed on the development in order to preserve the physical condition of watercourses, vegetation, soil cover, as well as protecting against water quantity and quality).

N/A ☐ Pumping stations: impacts of proposed development on existing pumping stations or requirements for new pumping station to service development.

N/A ☐ Forcemain capacity in terms of operational redundancy, surge pressure and maximum flow velocity.

N/A ☐ Identification and implementation of the emergency overflow from sanitary pumping stations in relation to the hydraulic grade line to protect against basement flooding.

☐ Special considerations such as contamination, corrosive environment etc.

## 4.4 Development Servicing Report: Stormwater Checklist

☒ Description of drainage outlets and downstream constraints including legality of outlets (i.e. municipal drain, right-of-way, watercourse, or private property)

N/A ☐ Analysis of available capacity in existing public infrastructure.

☒ A drawing showing the subject lands, its surroundings, the receiving watercourse, existing drainage patterns, and proposed drainage pattern.

☒ Water quantity control objective (e.g. controlling post-development peak flows to pre-development level for storm events ranging from the 2 or 5 year event (dependent on the receiving sewer design) to 100 year return period); if other objectives are being applied, a rationale must be included with reference to hydrologic analyses of the potentially affected subwatersheds, taking into account long-term cumulative effects.

☒ Water Quality control objective (basic, normal or enhanced level of protection based on the sensitivities of the receiving watercourse) and storage requirements.

☒ Description of the stormwater management concept with facility locations and descriptions with references and supporting information.

N/A ☐ Set-back from private sewage disposal systems.

☒ Watercourse and hazard lands setbacks.

N/A ☐ Record of pre-consultation with the Ontario Ministry of Environment and the Conservation Authority that has jurisdiction on the affected watershed.

☒ Confirm consistency with sub-watershed and Master Servicing Study, if applicable study exists.

- [X] Storage requirements (complete with calculations) and conveyance capacity for minor events (1:5 year return period) and major events (1:100 year return period).
- [X] Identification of watercourses within the proposed development and how watercourses will be protected, or, if necessary, altered by the proposed development with applicable approvals.
- [X] Calculate pre and post development peak flow rates including a description of existing site conditions and proposed impervious areas and drainage catchments in comparison to existing conditions.
- N/A [ ] Any proposed diversion of drainage catchment areas from one outlet to another.
- [X] Proposed minor and major systems including locations and sizes of stormwater trunk sewers, and stormwater management facilities.
- N/A [ ] If quantity control is not proposed, demonstration that downstream system has adequate capacity for the post-development flows up to and including the 100-year return period storm event.
- [ ] Identification of potential impacts to receiving watercourses
- [ ] Identification of municipal drains and related approval requirements.
- [X] Descriptions of how the conveyance and storage capacity will be achieved for the development.
- [ ] 100 year flood levels and major flow routing to protect proposed development from flooding for establishing minimum building elevations (MBE) and overall grading.
- N/A [ ] Inclusion of hydraulic analysis including hydraulic grade line elevations.
- [X] Description of approach to erosion and sediment control during construction for the protection of receiving watercourse or drainage corridors.
- N/A [ ] Identification of floodplains – proponent to obtain relevant floodplain information from the appropriate Conservation Authority. The proponent may be required to delineate floodplain elevations to the satisfaction of the Conservation Authority if such information is not available or if information does not match current conditions.
- N/A [ ] Identification of fill constraints related to floodplain and geotechnical investigation.

## 4.5 Approval and Permit Requirements: Checklist

The Servicing Study shall provide a list of applicable permits and regulatory approvals necessary for the proposed development as well as the relevant issues affecting each approval. The approval and permitting shall include but not be limited to the following:

☒ Conservation Authority as the designated approval agency for modification of floodplain, potential impact on fish habitat, proposed works in or adjacent to a watercourse, cut/fill permits and Approval under Lakes and Rivers Improvement Act. The Conservation Authority is not the approval authority for the Lakes and Rivers Improvement Act. Where there are Conservation Authority regulations in place, approval under the Lakes and Rivers Improvement Act is not required, except in cases of dams as defined in the Act.

☐ Application for Certificate of Approval (CofA) under the Ontario Water Resources Act.

N/A ☐ Changes to Municipal Drains.

N/A ☐ Other permits (National Capital Commission, Parks Canada, Public Works and Government Services Canada, Ministry of Transportation etc.)

## 4.6 Conclusion Checklist

☒ Clearly stated conclusions and recommendations

N/A ☐ Comments received from review agencies including the City of Ottawa and information on how the comments were addressed. Final sign-off from the responsible reviewing agency.

☒ All draft and final reports shall be signed and stamped by a professional Engineer registered in Ontario

# Appendix F

Drawings