3718 Greenbank Road: Servicing and Stormwater Management Report

Stantec Project No. 160401657

March 24, 2023

Prepared for:

Mattamy Homes Ltd.

Prepared by:

Stantec Consulting Ltd.
400-1331 Clyde Avenue
Ottawa ON K2C 3G4

Revision	Description	Author		Quality Check		Independent Review	
1	Issued for Approval	NN	2022-01-13	NC	2021-01-14	DT	2021-01-18
2	Revised per City Comments	DT	2023-03-20	DT	2023-03-24	SG	2023-03-24

This document entitled 3718 Greenbank Road: Servicing and Stormwater Management Report was prepared by Stantec Consulting Ltd. ("Stantec") for the account of Mattamy Homes Ltd. (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ______________________

Davide Milos, EIT

Reviewed by ______________________

Neal Cody, P.Eng.

Approved by ______________________

Dustin Thiffault, P.Eng.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

Mattamy Homes Ltd. has retained Stantec Consulting Ltd. to prepare this Stormwater and Servicing Report in support of a site plan control application for 3718 Greenbank Road (Half Moon Bay South Phase 8 - Residential). The subject site is located within the Brazeau Lands development area otherwise known as The Ridge, located at 3809 Borrisokane Road within the Barrhaven South Urban Expansion Area (BSUEA) in the City of Ottawa. It is bound by Dundonald Drive to the north, Obsidian Street to the west and Future Greenbank Road to the east as illustrated in **Figure 1** below.

Figure 1: Key Plan of 3718 Greenbank Road Development Area

The development land is approximately 3.09ha in area and comprising 19 blocks of townhouses with a total of 228 units. This servicing and stormwater management report will demonstrate that the subject site can be freely serviced by the existing municipal water, sanitary, and storm services while complying with established design criteria recommended in background studies and City of Ottawa guidelines. The proposed site plan is included in **Appendix B** for reference.

This parcel is currently zoned R4Z. The bulk of the current phase of the proposed development has been recently cleared of topsoil which has been stockpiled in several piles across the site. Generally, the ground surface across the subject site is relatively flat within the central portion of the development and sloping sharply towards the north and east property lines. It should be noted that parts of the subject site had undergone excavation and in-filling activities as part of a previous sand extraction operation. The property is within the Jock River watershed and is under the jurisdiction of the Rideau Valley Conservation Authority (RVCA).

1.1 OBJECTIVE

This Site Servicing and Stormwater Management Brief has been prepared to present a servicing scheme that is free of conflicts and presents the most suitable servicing approach that complies with the relevant City design guidelines. The use of the existing infrastructure as obtained from available as-built drawings has been determined in consultation with David Schaeffer Engineering Ltd. (DSEL), J. F. Sabourin and Associates Inc. (JFSA), City of Ottawa staff, and the adjoining property owners. Infrastructure requirements for water supply, sanitary sewer, and storm sewer services are presented in this report.

Criteria and constraints provided by Brazeau Lands (The Ridge) Design brief and the City of Ottawa with further iterations through the 3718 Greenbank Road Functional Servicing Report have been used as a basis for the servicing design of the proposed development. Specific elements and potential development constraints to be addressed are as follows:

- Potable Water Servicing
  - Estimate water demands to characterize the feed for the proposed development which will be serviced by an existing 300mm diameter PVC watermain fronting the site along Obsidian Street.
  - Watermain servicing for the development is to be able to provide average day and maximum day and peak hour demands (i.e., non-emergency conditions) at pressures within the allowable range of 40 to 80 psi (276 to 552 kPa).
  - Under fire flow (emergency) conditions with maximum day demands, the water distribution system is to maintain a minimum pressure greater than 20 psi (140 kPa).
- Prepare a grading plan in accordance with the proposed site plan and existing grades.
- Stormwater Management and Servicing
  - Define major and minor conveyance systems inline with guidelines used for the stormwater management of the Brazeau lands subdivision, as well as those provided in the October 2012

City of Ottawa Sewer Design Guidelines and subsequent technical memorandums, and generally accepted stormwater management design guidelines.

  - As documented in the Barrhaven South Urban Expansion Area Master Servicing Study, by J. L Richards 2018 and Stantec's 2022 Functional Servicing Report for the area, the development will also have Etobicoke Exfiltration Systems (EES) implemented within this subdivision. These EES will be installed within local roadways of the subdivision, to exfiltrate runoff from the development for the more frequent events.
  - Connect to the existing storm maintenance hole structure at the intersection of Haiku and Obsidian Street.

- Wastewater Servicing
  - Estimate wastewater flows generated by the development and size sanitary sewers which will outlet to the existing sanitary sewer stub fronting the site, located off the Haiku and Obsidian Street intersection. The existing maintenance hole (SAN MH3A) will be relocated and cored into for the proposed connection.

The accompanying **Drawing SSP-1** illustrates the proposed internal servicing scheme for the site.

2.0 REFERENCES

The following documents were referenced in the preparation of this stormwater management and servicing report:

- *City of Ottawa Sewer Design Guidelines*, 2nd Edition, City of Ottawa, October 2012.
- *City of Ottawa Design Guidelines – Water Distribution*, First Edition, Infrastructure Services Department, City of Ottawa, July 2010.
- *Design Brief for Cavian Greenbank Development Corporation,* The Ridge (Brazeau Lands), David Schaeffer Engineering Ltd., July 2020.
- *Geotechnical Investigation,* Proposed Mixed Use Development Half Moon Bay South – Phase 8 3718 Greenbank Road - Ottawa, PG5690-1, Paterson Group, March, 2022.
- *Hydraulic Capacity and Modeling Analysis Brazeau Lands*, Final Report, GeoAdvice Engineering Inc., July 2020.
- *Master Servicing Study – Barrhaven South Urban Expansion Area,* J.L. Richards & Associates Limited, Revision 2, May 2018.
- *Pond Design Brief for Brazeau Subdivision,* by J.F. Sabourin and Associates, July 2020.
- *Stormwater Management Report for Brazeau Subdivision,* by J.F. Sabourin and Associates (July 2020).
- *Stormwater Planning and Design Manual,* Ministry of the Environment, March 2003.
- *Technical Bulletin ISTB-2014-02 Revision to Ottawa Design Guidelines – Water*, City of Ottawa, May 2014.
- *Technical Bulletin PIEDTB-2016-01 Revisions to Ottawa Design Guidelines – Sewer,* City of Ottawa, September 2016.
- *3718 Greenbank Road – Functional Servicing Report*, Stantec Consulting Ltd., September 14, 2022.

3.0 POTABLE WATER SERVICING

3.1 BACKGROUND

The subject site is located within Zone 3SW of the City of Ottawa water distribution system. The proposed residential development will include 19 blocks with 228 townhome units. The subject site is within The Ridge (Brazeau lands) subdivision for which David Schaeffer Engineering Ltd. (DSEL) conducted a servicing and stormwater management study in July 2020.

The development will be serviced via two existing 200mm diameter private watermain services located within Obsidian street and fed from the existing 300mm diameter watermain terminating at Dundonald Drive and the future New Greenbank Road alignment and a 400mm diameter watermain from the existing Cambrian Road forming part of the Tamarack Meadows, as shown in the design brief by DSEL in **Appendix E.1**.

In July 2020, GeoAdvice carried out a watermain analysis to determine the hydraulic capacity of the watermain network within Brazeau Lands which includes the residential portion of 3718 Greenbank Road. The analysis was based on boundary conditions obtained from the City of Ottawa. Refer to GeoAdvice water analysis in enclosed in **Appendix A.3.**

3.2 PROPOSED WATERMAIN SIZING AND LAYOUT

The proposed watermain alignment and sizing for the development is demonstrated on **Drawing SSP-1**. A 200mm diameter watermain is proposed to loop around the street fronting Block 1, and a second 200mm diameter watermain is proposed to loop around the street fronting Block 18. The connection points are as follows:

- A 200mm diameter watermain will loop and connect to the existing 200mm stub at Haiku Street via 45^{o} horizontal bend.
- A 200mm diameter watermain will loop and connect to the existing 300mm watermain along Obsidian Street via existing 200mm stub connection at the southwest boundary of the site.

3.2.1 Ground Elevations

The proposed ground elevations within the development range from approximately 103.1 m to 106.5 m, with the ground elevations highest in the southeast corner of the site. This significant variation in ground elevations was largely dictated by the original topography of the site, and to suit tie-in elevations at Obsidian Street.

3.2.2 Domestic Water Demands

The 3718 Greenbank Road development will contain a total of 19 blocks with 228 townhome units and outdoor amenity areas having a total estimated population of 616 persons. Refer to **Appendix A.1** for detailed domestic water demand calculations.

Water demands for the development were calculated using the City of Ottawa's Water Distribution Design Guidelines. For residential developments, the average day (AVDY) per capita water demand is 280L/cap/d. For maximum day (MXDY) demand, AVDY was multiplied by a factor of 2.5 and for peak hour (PKHR) demand, MXDY was multiplied by a factor of 2.2. For maximum day (MXDY) demand of amenity areas, AVDY was multiplied by a factor of 1.5 and for peak hour (PKHR) demand, MXDY was multiplied by a factor of 1.8. The calculated residential water consumption is represented in Table 3-1 below:

Table 3–1: Residential Water Demands

Unit Type	Units/ Amenity areas (m^2)	Persons/Unit	Population	AVDY (L/s)	MXDY (L/s)	PKHR (L/s)
Townhome	228 units	2.7	616	1.99	4.99	10.97
		Total	**616**	**1.99**	**4.99**	**10.97**

3.3 LEVEL OF SERVICE

3.3.1 Allowable Pressures

The City of Ottawa Water Distribution Design Guidelines state that the desired range of system pressures under normal demand conditions (i.e. basic day, maximum day, and peak hour) should be in the range of 350 to 552 kPa (50 to 80 psi) and no less than 275 kPa (40 psi) at the ground elevation in the streets (i.e. at hydrant level). The maximum pressure at any point in the distribution system is to be no higher than 552 kPa (80 psi). As per the Ontario Building Code & Guide for Plumbing, if pressures greater than 552 kPa (80 psi) are anticipated, pressure relief measures (such as pressure reducing valves) are required. Under emergency fire flow conditions, the minimum pressure in the distribution system is allowed to drop to 138 kPa (20 psi).

3.3.2 Fire Flow

The FUS fire flow calculation spreadsheets for the governing fire flow demand scenarios (see **Appendix A.2**) were generated to calculate the expected fire flow demands from the proposed site.

The ground floor area of a single storey of each block was estimated to be 470m^2 based on the average lot sizes shown on the site plan. For assessment of the worst case fire flow requirement, building exposures were reviewed on a block by block basis. Blocks 8 and 11 were determined to be the critical units for assessment given exposures from adjacent units on all sides. The remaining blocks maintain exposures on at most three sides. Blocks 8 and 1 were selected for assessment as they are generally representative of these two site conditions. Fire flow calculations were performed with consideration of a firewall separating the governing block at either midblock (Block 1 and similar areas), or at the ¼ and ¾ mark of the overall building width (Blocks 8 and 11). For the specified configurations, the maximum required fire flow was estimated to be 167 L/s (see **Appendix A.2**).

Fire separation via firewalls will keep the maximum ground floor area of residential blocks below 600m^2 as per building code requirements, and location of firewalls within these blocks has been indicated on the grading plan (**Drawing GP-1**).

3.4 HYDRAULIC MODEL

3.4.1 Boundary Conditions

Boundary conditions for the connections servicing the proposed development were based on the GeoAdvice hydraulic model for the overarching subdivision. Connection points for the model mere determined to be located at approximately nodes J-41 (north connection) and J-78 (south connection). GeoAdvice Model outputs for the varying boundary condition scenarios are noted in the table below:

Table 3–2: Boundary Conditions

Demand Scenario	J-41 Head (m)	J-78 Head (m)
AVDY	156.10	156.10
PKHR	139.22	137.82
MXDY + FF	135.70	135.70

The GeoAdvice report notes that the boundary conditions supplied are for consideration prior to completion of the SUC Zone Reconfiguration. As noted in the report, post-reconfiguration pressure values are only expected to increase during the critical PKHR and MXDY+FF demand scenarios. As such, the model presented can be considered as conservative with respect to available fire flows.

3.4.2 Model Development

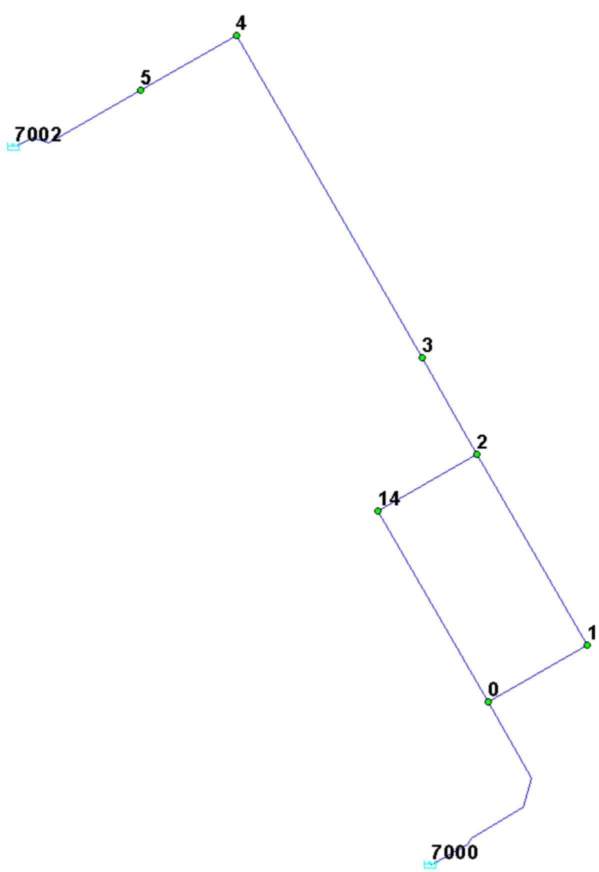
New watermains were added to the hydraulic model to simulate the proposed distribution system. A 200 mm dia. watermain network is used throughout the site following locations of proposed hydrants. Hazen-Williams coefficients (C-factors) were applied to the proposed watermain in accordance with the City of Ottawa's Water Distribution Design Guidelines. The C-factors used are given in **Table 3-3** below.

Table 3–3: C-Factors Used in Watermain Hydraulic Model

Pipe Diameter (mm)	C-Factor
150	100
200 to 250	110
300 to 600	120
Over 600	130

The labelling of the watermain junctions and reservoirs (representing boundary conditions at connections to the existing watermain network) is shown in **Figure 2**.

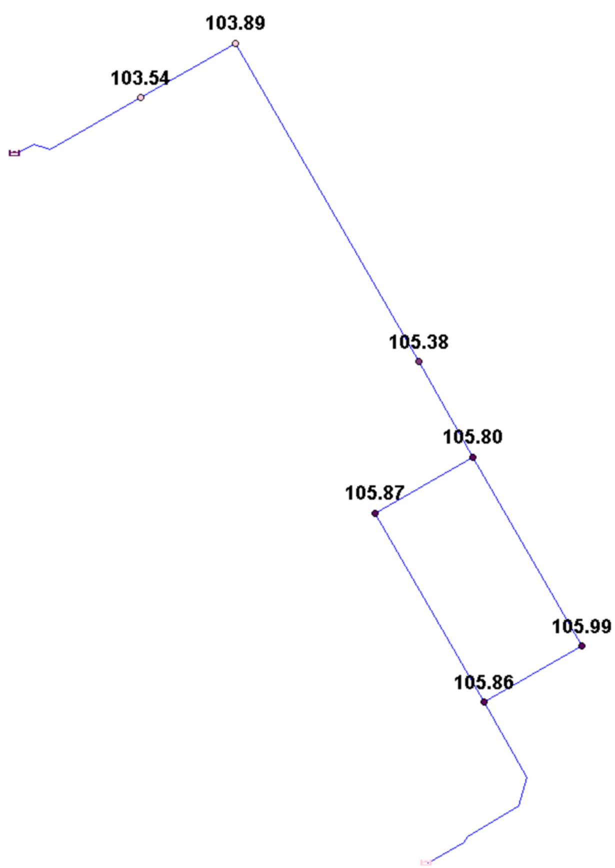
Figure 2: Watermain Model Nodes



3.4.3 Ground Elevations

The ground elevations used at each node along the watermain model network are shown in **Figure 3** below. These elevations were interpolated from the detailed grading plan for the site (**Drawing GP-1**, included in **Appendix E**).

Figure 3: Ground Elevations (m) in Hydraulic Model

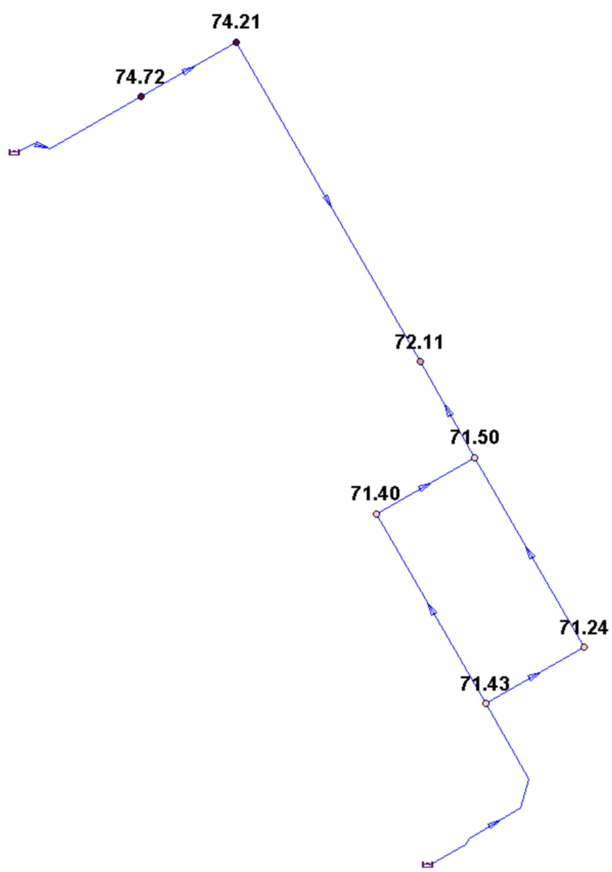


3.5 HYDRAULIC MODELING RESULTS

3.5.1 Average Day (AVDY)

The hydraulic modeling results show that under basic day demands the pressure in the distribution network falls between 491 kPa (71.2 psi) and 515 kPa (74.7 psi). Hydraulic modeling results are given in **Figure 4**.

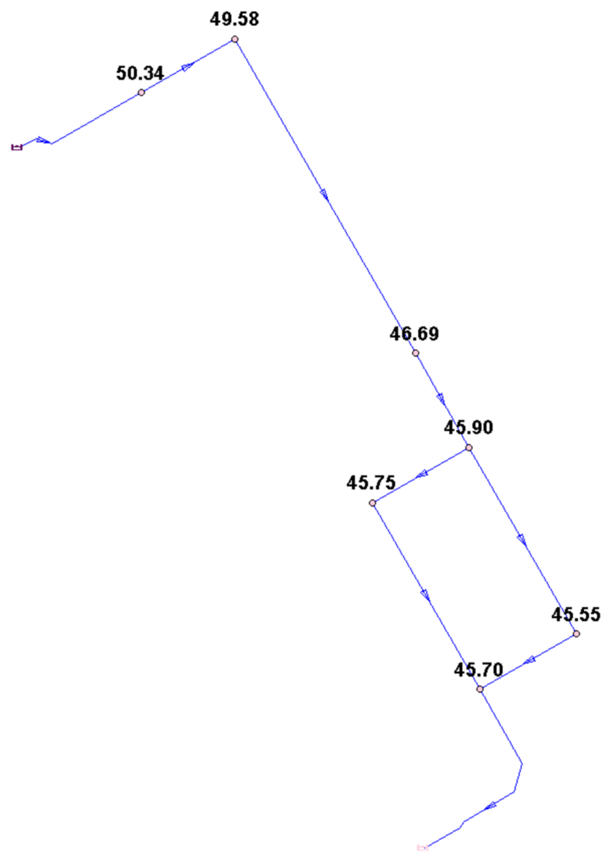
Figure 4: Pressures (psi) Under AVDY Demand Scenario



3.5.2 Peak Hour (PKHR)

The hydraulic modeling results show that under peak hour demands the pressure in the distribution network ranges between 314 kPa (45.6 psi) and 347 kPa (50.3 psi). Hydraulic modeling results are given in **Figure 5.**

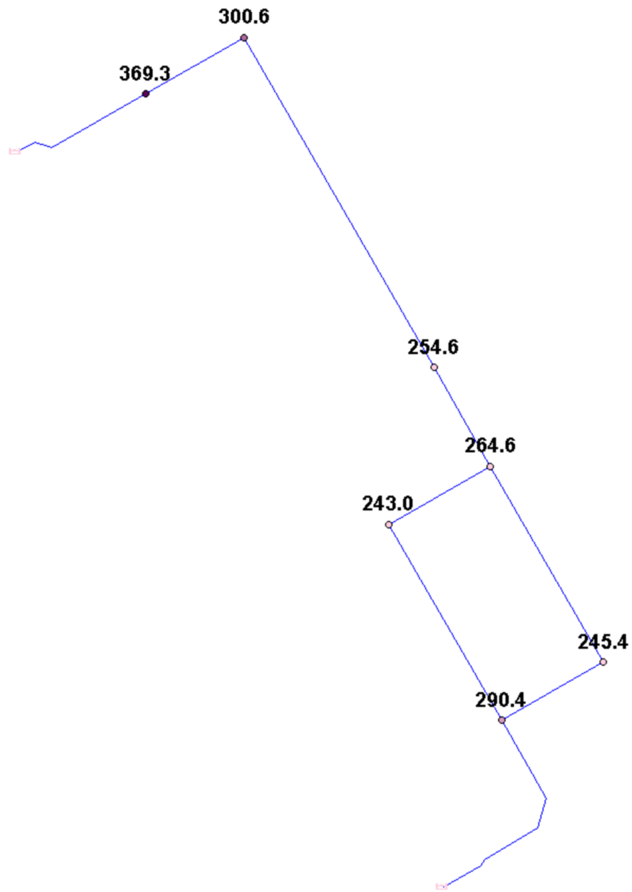
Figure 5: Pressures (psi) Under PKHR Demand Scenario



3.5.3 Maximum Day Plus Fire Flow (MXDY+FF)

A hydraulic analysis using the H_2OMap Water model was conducted to determine if the proposed water distribution network can achieve the required FUS fire flow while maintaining a residual pressure of at least 138 kPa (20 psi), per City Water Distribution Design Guidelines. This was accomplished using a steady-state maximum day demand scenario along with the automated fire flow simulation feature of the software. Hydraulic modeling results are shown on **Figure 6**.

Figure 6: Available Fire Flows (L/s) for MXDY+FF Demand Scenario



A fire flow of 10,000 L/min was achieved at all serviced nodes (see **Appendix A** for details). Sufficient fire flows for each type of unit are provided at every point within the distribution network for the proposed development.

3.6 POTABLE WATER SUMMARY

The proposed watermain alignment and sizing is capable of achieving the required level of service throughout the development. Based on the hydraulic analysis conducted using H_2OMap Water, the following conclusions were made:

- The proposed water distribution system consists entirely of 200mm diameter mains.
- During peak hour conditions, the proposed system is capable of operating above the minimum pressure objective of 276 kPa (40 psi).
- During fire conditions, the proposed system is capable of providing 10,000 L/min fire flows at all modeled nodes, which are sufficient based on FUS calculations for the units within the proposed site.

4.0 WASTEWATER SERVICING

4.1 BACKGROUND

The subject site is located within the study of the Barrhaven South Urban Expansion Area (BSUEA) for which JLR associates prepared a Master Servicing Study in 2018. The study at conceptual level, provided design data for wastewater servicing and estimated residual capacities for sanitary trunk sewer in the area, as shown in the MSS extract in **Appendix E.1.** The subject site is referred to as Mattamy West (Residential) in this study. DSEL relied on this study to prepare a design brief for adjacent The Ridge subdivision (Brazeau Lands).

There is an existing 375mm diameter sanitary sewer collecting wastewater from the Ridge (Brazeau lands), which includes 3718 Greenbank Road, and flows into the sanitary sewer on Greenbank Road. Refer to **Appendix E.1** for The Ridge site servicing study by DSEL (2020). The estimated peak sanitary flows for the subject site were originally determined as 4.45L/s (for a residential area of 1.90ha and a commercial area of 2.99ha) using City of Ottawa design criteria. DSEL estimated the subject site (referred to as Mattamy West (residential) area) to be 1.90ha with a projected population of 162 persons, peak factor of 3.54 and total flow of 2.49L/s which is 13% of the sanitary sewer full capacity. The residential area has subsequently been expanded to 3.09 ha for this site plan application with a corresponding reduction in the future commercial lands.

The proposed development will be serviced by the existing sanitary sewer stub fronting the site, located off the Haiku and Obsidian Street intersection. The existing maintenance hole (SAN MH3A) will be relocated and cored into for the future connection. The wastewater contributions from the site will tie-in to this structure via a 200mm diameter PVC pipe.

4.2 DESIGN CRITERIA

As outlined in the City's Sewer Design Guidelines, the following design parameters were used to calculate estimated wastewater flow rates and to preliminarily size on-site sanitary sewers for the subject site:

- Minimum Full Flow Velocity – 0.6 m/s
- Maximum Full Flow Velocity – 3.0 m/s
- Manning's roughness coefficient for all smooth-walled pipes – 0.013
- Townhouse persons per unit – 2.7
- Extraneous Flow Allowance – 0.33 L/s/ha
- Residential Average Flows – 280 L/cap/day
- Maintenance Hole Spacing – 120 m
- Minimum Cover – 2.5m
- Harmon Correction Factor – 0.8

In addition, a residential peak factor based on Harmon's Equation was used to determine the peak design flows per Ottawa's Sewer Design Guidelines.

Refer to **Appendix C.1** for the sanitary sewer design sheet for 3718 Greenbank Road

4.3 SANITARY SERVICING DESIGN

200 mm diameter sanitary sewers are proposed along the private roadways of the subject site. All sanitary sewers within the site ultimately outlet to existing SAN MH 3A located off Haiku/Obsidian Street at the intersection fronting Block 1. Existing MH SAN 3A is proposed to be relocated slightly closer to the site and cored to allow for connection to the property.

The proposed layout of the sanitary infrastructure is shown on **Drawing SA-1.** Sanitary peak flows will be directed to the 200mm diameter sanitary sewer on Obsidian Street which discharges to a 375mm diameter PVC sanitary sewer at Dundonald Drive which is ultimately directed to the sanitary sewer on Future Greenbank road. The connections to the existing sanitary sewer network and the associated peak flows are summarized in **Table 4–1** below.

Table 4–1 Summary of Proposed Sanitary Peak Flows

Area ID Number	Total area (ha)	No. Units	Population	Total Peak Flow (L/s)
Total Site	3.09	228	616	7.8

A population density of 2.7ppu was applied to the residential townhouse units on site. A residential peak factor based on Harmon Equation was used to determine the peak design flows. An allowance of 0.33 L/s/effective gross ha (for all areas) was used to generate peak extraneous flows.

The total design peak flow for the subject site to be conveyed to the connections at the Obsidian street sewer is 7.8L/s. This value is slightly higher than the previous estimate of 2.49L/s by DSEL based on a service area of 1.9 ha and population of 162 people. The difference (4.68L/s) can be accommodated by the 200mm receiving sewer in Obsidian Street. Estimated peak flows roughly coincide with that previously identified under the approved 3718 Greenbank Road Functional Servicing Report.

JLR Associates identified in its MSS for the BSUEA that there is residual capacity within the sanitary sewers draining Mattamy lands west to new Greenbank road based on a Stantec (2015) hydrodynamic model of trunk sanitary sewers (450 mm in diameter and greater), which in turn demonstrated that the existing downstream trunk system could accommodate the flows generated with no risk of surcharging or basement flooding. Consequently, Stantec concluded that system upgrades were not required. The residual capacity in the sanitary sewer downstream of Greenbank road was estimated as 74.0L/s (Refer to **Appendix E.1** for details).

5.0 STORMWATER MANAGEMENT AND SERVICING

The following sections describe the stormwater management (SWM) design for 3718 Greenbank Road in accordance with the background documents and governing criteria.

5.1 PROPOSED CONDITIONS

The proposed residential development encompasses approximately 3.09 ha of land and consists of 228 back-to-back townhomes and outdoor amenity areas. J.F. Sabourin and Associates Inc. (JFSA) were retained by David Schaeffer Engineering Ltd. (DSEL) to prepare a Stormwater Management (SWM) Plan for the adjacent Ridge (Brazeau) Subdivision.

The storm sewer collection system for the proposed site will discharge to an existing manhole (existing MH 109 within Obsidian Street) located near the northwest corner of the site, at the intersection of Obsidian Street and Haiku Street. This manhole is part of The Ridge's stormwater collections system which eventually discharges to a dry pond (referred to as the Drummond Pond) located in the northwest corner of the subdivision. This pond provides stormwater quantity control for the subdivision. OGS units upstream of the pond provide stormwater quality control for the subdivision.

Detailed grading of the site has been designed to direct emergency overland flows above the 100-year event to Obsidian Street, which runs along the west side of the subject site.

Minor grassed and roof areas at the boundary of the subject site cannot be graded to drain internally and as such will sheet drain uncontrolled offsite. The uncontrolled areas on the west side of the site will drain to the existing Obsidian Street ROW and those on the east side of the site will drain to the Future Greenbank Road ROW.

5.2 DESIGN CRITERIA AND CONSTRAINTS

The design criteria and guidelines used for the stormwater management of the subject subdivision are those that were developed in the background documents by JFSA, DSEL and JLR in the BSUEA MSS with iterations as noted in the 3718 Greenbank Road Functional Servicing Report, as well as those provided in the October 2012 *City of Ottawa Sewer Design Guidelines* and subsequent technical memorandums and generally accepted stormwater management design guidelines.

The SWM design will ensure that the majority of storm runoff within the site be controlled, and site release restricted to the peak flow rate of 402 L/s for the 2-Year storm event and peak flow rate of 437 L/s for the 100-Year storm as calculated using a proportional method for the site. Details can be found in Section 5.3.1. No improvements to downstream infrastructure will be required to service the site, however, a revision in catch basin configuration and inlet control device (ICD) sizing is required for catch basins along the east side of Obsidian Street to account for uncontrolled roof drainage from within the development, and to ensure a 2-year level of service is provided with respect to elimination of surface ponding within downstream roadways.

Storm runoff within the site will be controlled and directed to an existing storm control point identified as MH 3 in the JFSA SWM model. MH 3 has a maximum upstream Hydraulic Grade Line of 99.716m based on JFSA's simulation under the 100-year 3-hour Chicago storm, 100-year 24-hour SCS Type II storm, and the three historical events.

As identified by the approved FSR and the City of Ottawa's Sewer Design Guidelines, the minor and major system stormwater management design criteria and constraints will consist of:

5.2.1 Minor System

a) Storm sewers are to be designed to provide a minimum 2-year level of service.

b) The 100-year hydraulic grade line (HGL) within the development minor systems must be maintained at least 0.3 m below the underside of footing elevation where gravity house connections are installed.

c) For less frequent storms (i.e. larger than 1:2 year), the minor system shall, if required, be limited with the use of inlet control devices to prevent excessive hydraulic surcharges and to maximize the use of surface storage on the road where desired.

d) Catchbasins on the road are to be equipped with City standard type S19 (fish) grates or City standard type S22 side inlets, and grates for catchbasins in rear yards, park and open spaces with pedestrian traffic are to be City standard type S19, S30 and S31.

e) Single catchbasins are to be equipped with 200 mm minimum lead pipes, and double catchbasins are to be equipped with 250 mm minimum lead pipes.

f) Rear yard catchbasins are to be equipped with 250 mm minimum lead pipes. Catchbasins installed on the street, where rear yard catchbasins connect to the main storm sewer through the catchbasin, are to be equipped with 250 mm minimum lead pipes for both single and double catchbasins.

g) Under full flow conditions, the allowable velocity in storm sewers is to be no less than 0.80 m/s and no greater than 3.0 m/s. Where velocities over 3.0 m/s are proposed, provisions shall be made to protect against displacement of sewers by sudden jarring or movement. Velocities greater than 6 m/s are not permitted.

h) City of Ottawa staff have indicated a requirement to ensure no storage is considered within the EES system for modeling of peak runoff.

5.2.2 Major System

a) The major system shall be designed with enough road surface storage to allow the excess runoff of a 100-year storm to be retained within road ponding areas where desired.

b) Inlet control devices would be sized such that they do not create surface ponding on the road during the 2-year design storm on local roads (5-year design storm on collector and 10-year design storm on arterial roads); it should be noted that surface ponding over grates is present during rainfall under any design, as an appropriate depth of water is required for runoff to enter the grate.

c) Roof leaders shall be installed to direct the runoff to splash pads and on to grassed areas.

d) For the 100-year storm, the maximum total depth of water (static + dynamic) on all roads shall not exceed 35 cm at the gutter.

e) During the 100-year + 20% stress test, the maximum extent of surface water on streets, rear yards, public space and parking areas shall not touch the building envelope.

f) When catchbasins are installed in rear yards, safe overland flow routes are to be provided to allow the release of excess flows from such areas.

g) The product of the maximum flow depths on streets and maximum flow velocity must be less than 0.60 m^2/s on all roads.

h) The excess major system flows up to the 100-year return period are to be retained on-site in development blocks such as the proposed development.

i) There must be at least 15 cm of vertical clearance between the spill elevation on the street and the ground elevation at the nearest building envelope that is in the proximity of the flow route or ponding area.

j) There must be at least 30 cm of vertical clearance between the rear yard spill elevation and the ground elevation at the adjacent building envelope.

k) Provide adequate emergency overflow conveyance off-site to ensure water will spill to downstream rights-of-way in the event of a blockage.

5.2.3 Allowable Release Rate

Based on JFSA's Stormwater Management Plan for the Ridge (Brazeau) subdivision and iterated within the 3718 Greenbank Road Functional Servicing Study, the subject site is to control the 100-year flow on site and the minor system for the total site will be restricted to the 100 year storm event release rate of 437 L/s. The 2-year minor system outflow is to be controlled to 402 L/s. The noted flow rates are exclusively for the 3.09ha residential component of the development. The previously identified target release rates for the future 1.22ha commercial development parcel remain unchanged as per the FSR.

Table 5–1 Target Release Rate

Study	Storm Event	Subcatchment A109RES	Subcatchment A2260COM	Total
3718 Greenbank FSR (Residential)	2-Year Flow Rate (L/s)	201	201	**402**
	100-Year Flow Rate (L/s)	230	207	**437**

5.3 MODELING METHODOLOGY

5.3.1 Modeling Rationale

A hydrologic/hydraulic model was completed with PCSWMM for the sewers and roadways/parking areas within the proposed development, accounting for the estimated major and minor systems to evaluate the storm sewer infrastructure and ensure release rates meet the previously defined target criteria. The use of PCSWMM for modeling of the site hydrology and hydraulics allowed for an analysis of the system response during various storm events. The following assumptions were applied to the model:

- Hydrologic parameters as per Ottawa Sewer Design Guidelines, including Horton infiltration, Manning's 'n', and depression storage values.
- 3-hour Chicago distributions and 12-hour SCS Type II distributions for 2-year and 100-year storm events were used to evaluate the urban component of the dual drainage (i.e. minor system capture rates, total overland flow depth, hydraulic grade line (HGL), etc.).
- A 22 mm, 4-hour Chicago storm was used to evaluate the performance of the proposed Etobicoke exfiltration system.
- The 'climate change' scenarios created by adding 20% of the individual intensity values of the 100-year 3-hour Chicago storm and the 100-year 12-hour SCS Type II storm at their specified time step were used as an analytical tool to establish the function of the system under extreme events.
- Minor system capture rates within the proposed development were restricted to the 2-year peak runoff rate.

5.3.2 SWMM Dual Drainage Methodology

The proposed development is modeled in one PCSWMM model as a dual conduit system, where:

1) The minor system consists of storm sewers, represented by circular conduits, and manholes, represented by storage nodes;
2) The major system consists of overland spills, represented by weirs and irregular conduits using street-shaped cross-sections to represent the assumed overland road network with streets at varying slopes, and catch basins with surface ponding areas, represented by storage nodes.

The two systems are connected by outlet/orifice link objects, which represent inlet control devices (ICDs), that connect storage nodes representing catch basins to storage nodes representing manholes. Subcatchments are linked to the nodes representing catch basins and ponding areas so that generated hydrographs are directed there firstly.

5.3.3 Modified Dual Drainage Methodology to Support EES

To account for the presence of the proposed Etobicoke exfiltration system, the PCSWMM model was modified to include additional rectangular conduits in parallel to the conventional sewer lines. Rectangular conduits have been used to simulate drainage properties and dimensions of the clear stone media and perforated pipe but use a width equal to 40% of the actual trench width to simulate the porosity of the trench media. Inverts and obverts of the conduit can therefore still be consistent with design drawings, yet allow hydraulic modeling performed by PCSWMM to simulate hydraulic grade lines within the trench as it slopes upwards to follow traditional sewer grades. In such a manner, unused portions of the EES can be identified and minimized to ensure that an appropriate level of volume control is still provided for the site overall. Additional "dummy" manholes with zero storage were added to the upstream ends of EES conduits in the model to create dead ends. This was done to represent the fact that EES pipes will be capped at their upstream ends and will not convey stormwater through the minor system.

The simulation described above was repeated with varying EES trench depths, lengths, and widths to ensure complete capture of the 22 mm event as described in **Section 5.6** below.

5.3.4 Model Input Parameters

Drawing SD-1 summarizes the discretized subcatchments used in the analysis of the proposed development. All parameters were assigned as per applicable Ottawa Sewer Design Guidelines (OSDG); Ontario Ministry of the Environment, Conservation, and Parks (MECP); and background report requirements.

5.3.4.1 Hydrologic Parameters

Key parameters for the proposed development areas are summarized below, while example input files are provided for the 100-year, 3-hour Chicago storm in Appendix D which indicate all other parameters. For all other input files and results of storm scenarios, please examine the electronic model files located on the digital media provided with this report. This analysis was performed using PCSWMM, which is a front-end GUI to the EPA-SWMM engine. Model files can be examined in any program which can read EPA-SWMM files version 5.1.014.

Table 5–2: presents the general subcatchment parameters used for the proposed development.

Table 5–2: General Subcatchment Parameters

Parameter	Value
Infiltration Method	Horton
Max. Infil. Rate (mm/hr)	76.2

Min. Infil. Rate (mm/hr)	13.2
Decay Constant (1/hr)	4.14
N Imperv	0.013
N Perv	0.25
Dstore Imperv (mm)	1.57
Dstore Perv (mm)	4.67
Zero Imperv (%)	0

Table 5–3 presents the individual parameters that vary for each of the proposed subcatchments in the model. Subcatchment width parameters were determined by multiplying each subcatchment's area in hectares by 225. Subcatchment imperviousness was measured directly from the site plan within AutoCAD considering all paved access, sidewalks, and roof areas as entirely impervious areas, and remaining grassed areas as entirely pervious. Weighted runoff 'C' coefficients were determined for each subcatchment considering impervious areas as C=0.90, and pervious as C=0.20.

Table 5–3: Individual Subcatchment Parameters

Subcatchment ID	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	% Impervious
COM	1.220	274.5	44.4	0.5	90.00
L100D	0.095	21.4	44.4	3.0	72.86
L101A	0.021	4.7	44.4	3.0	60.00
L102A	0.437	98.3	44.4	3.0	84.29
L103A	0.132	29.8	44.4	3.0	80.00
L104A	0.524	117.9	44.4	3.0	82.86
L105A	0.134	30.1	44.4	3.0	61.43
L105B	0.198	44.5	44.4	3.0	54.29
L105C	0.105	23.7	44.4	3.0	25.71
L108A	0.339	76.3	44.4	3.0	85.71
L110A	0.153	34.5	44.4	3.0	70.00
L110B	0.053	11.8	44.4	3.0	71.43
L110C	0.316	71.0	44.4	3.0	88.57
UNC-1	0.155	34.9	44.4	3.0	81.43
UNC-2	0.159	35.9	44.4	3.0	81.43
UNC-3	0.135	30.4	44.4	3.0	75.71
UNC-4	0.132	29.7	44.4	3.0	78.57

5.3.4.2 Surface and Subsurface Storage Parameters

Table 5-4 summarizes the storage node parameters used in the model. Storage nodes represent the depth of the proposed catch basin barrel plus an additional depth to represent the maximum allowable surface water ponding depth. Surface storage was estimated based on surface models created in AutoCAD for the proposed grading plan. See **Drawing SD-1** for surface storage depths, areas, and volumes.

Table 5–4: Surface Storage Parameters

Subcatchment ID	Structure	Invert Elevation (m)	Rim Elevation (m)	CB Barrel Depth (m)	Ponding Depth at Spill (m)	Ponding Area (m2)	Ponding Volume (m3)
L101A	CB 101A	101.89	103.30	1.41	0.05	10.9	0.2
L102A	CB 102A	101.99	103.37	1.38	0.35	552.6	64.5
L103A	CB 103A	102.23	103.60	1.37	0.25	328.9	27.4
L104A	CB 104A	102.66	104.00	1.34	0.35	773.2	90.2
L105A	CB 105A	**103.52**	104.90	1.38	0.17	136.8	7.8
L105B	STM111	102.35	105.33	2.98	-	-	-
L105C	CB 105C	103.82	105.15	1.33	0.05	19.0	0.3
L108A	CB 108A	103.97	105.35	1.38	0.35	898.2	104.8
L110A	CB 110A	104.27	105.65	1.38	0.35	595.4	69.5
L110B	CB 110B	104.05	105.43	1.38	0.25	98.4	8.2
L110C	CB 110C	103.97	105.35	1.38	0.35	863.6	100.8
L110D	CB 110D	104.34	105.72	1.38	0.22	256.9	18.8

At several locations, underground storage was required to ensure there was no surface ponding during 2-year storm events. Big O or "umbilical" storage pipes were added to catch basin barrels to provide this storage. These were modeled using conduits to provide the required storage. Note that the EES system was not included in the 2-year, 100-year, or 100-year + 20% models. This was done at the request of the City of Ottawa which did not want the storage volume provided by the EES to be considered in these events.

Underground storage volumes are summarized in the table below:

Table 5–5: Surface Storage Parameters

Subcatchment ID	Structure	Storage Pipe Diameter (mm)	Storage Pipe Length (m)	Available Storage Volume (m3)
L102A	CB 102A	900	100	63.6

L104A	CB 104A	900	80	50.9
L105B	CB 105D	900	57.5	36.6
L108A	CB 108A	900	70	44.5
L110C	CB 110C	900	48	30.5

5.3.4.3 Hydraulic Parameters

As per the October 2012 City of Ottawa Sewer Design Guidelines, Manning's roughness values of 0.013 were used for sewer modeling and overland flow corridors representing roadways. Flow over grassed areas were modeled using a Manning's roughness value of 0.25. The storm sewers within the proposed development were modeled to estimate flow capacities and hydraulic grade lines (HGLs) in the proposed condition. The proposed storm sewer design sheet is included in **Appendix D**.

Exit losses at manholes were set for all pipe segments based on the flow angle through the structure. Exit losses were assigned as per City guidelines (Appendix 6b of the guidelines), see **Table 5-6** below.

Table 5–6: Exit Loss Coefficients for Bends at Manholes

Degrees	Coefficient
11	0.060
22	0.140
30	0.210
45	0.390
60	0.640
90	1.320
180	0.020

The proposed development's storm sewers were sized to convey runoff from a 2-Year storm using rational method calculations. The rational method design sheet can be found in **Appendix D**.

5.4 MODEL RESULTS AND DISCUSSION

The following section summarizes the key hydrologic and hydraulic model results. For detailed model results or inputs please refer to the example input files in **Appendix D** and the PCSWMM model on the enclosed digital files.

5.4.1 Hydrology

Table 5–7 summarizes the orifice link maximum flow rates and heads across the proposed development under the 2-year and 100-year storm scenarios. Discharge curves are as provided by the manufacturer for the selected IPEX Tempest ICDs.

Table 5–7 : Proposed ICD Schedule

Structure	Invert	ICD Type	100yr Head (m)	100yr Flow (L/s)	Storm Dist.	2yr Head (m)	2yr Flow (L/s)	Storm Dist.
CB 101A	101.89	IPEX TEMPEST LMF 90	0.99	7.2	Chicago	0.15	2.7	Chicago
CB 102A	101.99	IPEX TEMPEST HF 127mm	1.65	40.5	Chicago	0.70	25.6	SCS
CB 103A	102.23	IPEX TEMPEST HF 102mm	1.54	25.2	Chicago	1.21	22.3	Chicago
CB 104A	102.66	IPEX TEMPEST HF 127mm	1.66	40.6	Chicago	0.94	30.0	SCS
CB 105A	103.52	IPEX TEMPEST HF 127mm	1.77	42.0	Chicago	0.27	17.6	Chicago
STM 111	102.35	IPEX TEMPEST HF 108mm	1.24	25.3	SCS	0.34	12.4	Chicago
CB 105C	103.82	IPEX TEMPEST LMF 105	1.46	11.8	SCS	0.35	5.8	Chicago
CB 108A	103.97	IPEX TEMPEST HF 108mm	1.58	28.7	Chicago	0.88	21.2	Chicago
CB 110A	104.27	IPEX TEMPEST HF 127mm	1.50	38.4	Chicago	0.57	22.9	Chicago
CB 110B	104.05	IPEX TEMPEST LMF 90	1.56	9.0	Chicago	1.01	7.2	Chicago
CB 110C	103.97	IPEX TEMPEST HF 108mm	1.60	28.9	Chicago	0.90	21.4	SCS
CB 110D	104.34	IPEX TEMPEST HF 102mm	1.49	24.8	Chicago	0.56	14.8	Chicago

5.4.1.1 Uncontrolled Area

Due to grading restrictions, four subcatchments has been designed without a storage component. The catchment areas discharge off-site uncontrolled to the adjacent streets surrounding the proposed site. Peak discharges from uncontrolled areas UNC-1 and UNC-2 are directed to the future Greenbank Roda ROW, whereas areas UNC-3 and UNC-4 are directed to the Obsidian Street ROW. As noted in the SWM Reports for The Ridge and Drummond Subdivisions (JFSA 2020 and 2022), drainage to Greenbank Road is tributary the Clarke wet pond SWMF, whereas drainage to Obsidian (as well as the site minor system outlet) discharges to a downstream dry pond SWMF and oil/grit separator at Borrisokane Road. Both facilities ultimately outlet to the Jock River. As identified in the JFSA report for the Drummond Subdivision, a substantial flow reduction is proposed for peak flows to the Clarke Pond via the Half Moon Bay Trunk Sewer (approximately 2610L/s during the 100-Year 3hr Chicago event, and 1380L/s during the 100yr 24hr SCS event). Per report excerpts within **Appendix E**, it can be seen that the Clarke Pond can receive peak flows and volumes from the minor uncontrolled areas along the future realigned Greenbank

Road (estimated as 149L/s and 196m3 during the 100-Year 3hr Chicago event and 108.4L/s and 260m3 during the 100-Year 24hr SCS event) without further need for flow control.

It was originally noted within the Functional Servicing Report for 3718 Greenbank Road that catch basin ICDs within the existing Obsidian Street would be reassessed based on peak discharge from uncontrolled areas adjacent to Obsidian. On further review, it was noted that the PCSWMM model for The Ridge Subdivision containing Obsidian Street considered all catch basins along Obsidian to be along a continuous grade, and controlled by catch basin grate openings rather than installed ICDs. The PCSWMM model for The Ridge had also assumed that catch basin CB72 (located at the eastern side of Obsidian at the intersection with Haiku Street to the west) would also be located at a segment of continuous road grade to Dundonald Drive north of the proposed site. The current design for the Drummond Subdivision now considers a sag at Haiku/Obsidian, although the supplied PCSWMM model for The Ridge was not adjusted to correct this change.

As such, contributing road major system segments as noted in the drainage area plan for the Drummond Subdivision as well as all upstream contributions to minor and major systems along Obsidian Street from The Ridge Subdivision have been included in the PCSWMM model for the proposed 3718 Greenbank Road development both to ensure road ponding depths and flow spread do not exceed City of Ottawa criteria during design storm events, but also to consider the effect of peak discharge from uncontrolled areas along Obsidian on downstream infrastructure as reported in JFSA's Stormwater Management Report for The Ridge (Brazeau) Subdivision. Modeled minor system segments include all contributing flows to existing MH109, and major system segments include all contributing flows to the approach to existing CB109, located west of the intersection of Obsidian and Haiku Street.

Report excerpts from SWM report noted above (see **Appendix E**) identify the following peak outflow rates:

Table 5–8: Previously Approved Model Outflow – The Ridge Subdivision

Location	Design Storm	Discharge (L/s)
Minor System – MH109	100-Year 3hr Chicago	790
	100-Year 24hr SCS	770
	100-Year 3hr Chicago + 20%	900
Major System – CB109	100-Year 3hr Chicago	152

Table 5–9: Previously Approved Model HGL – The Ridge Subdivision

Location	Design Storm	HGL (m)
MH109	100-Year 3hr Chicago	99.961
	100-Year 24hr SCS	99.681
	100-Year 3hr Chicago + 20%	100.231

5.4.2 Hydraulic Grade Line

A design sheet has been prepared for the proposed storm sewer in **Appendix D.1** demonstrating all on-site sewers remain free-flowing (HGLs within the sewer) using an uncontrolled 2-year rate.

Table 5–10 below summarizes the hydraulic grade line (HGL) results for the subject site's proposed minor system using the worst case storm event distribution. Per the City of Ottawa Sewer Design Guidelines (2012), a building's underside of footing (USF) must be a minimum 300 mm above the 100-year HGL in the nearest upstream storm manhole. In addition, the buildings USF must also be above the HGL resulting from the 100-year + 20% stress test event.

Table 5–10: Hydraulic Grade Line Results

Block #	USF (m)	Adjacent Upstream MH ID	Adjacent 100-Year HGL (m)	Freeboard (m)	Adjacent 100-Year +20% HGL (m)	Freeboard (m)
1	101.58	101	99.75	1.83	99.77	1.81
2	101.71	101	99.75	1.96	99.77	1.94
3	101.99	103	100.13	1.86	100.14	1.85
4	102.59	104	100.93	1.66	100.95	1.64
5	102.89	104	100.93	1.96	100.95	1.94
6	102.08	102	100.80	1.28	100.80	1.28
7	102.46	102	100.80	1.66	100.80	1.66
8	102.80	106	101.50	1.30	101.50	1.30
9	103.04	106	101.50	1.54	101.50	1.54
10	103.14	105	101.41	1.73	101.43	1.71
11	103.75	106	101.50	2.25	101.50	2.25
12	103.75	106	101.50	2.25	101.50	2.25
13	103.77	107	101.82	1.95	101.82	1.95
14	103.77	109	102.11	1.66	102.11	1.66
15	103.93	109	102.11	1.82	102.11	1.82
16	104.09	109	102.11	1.98	102.11	1.98
17	103.92	110	102.44	1.48	102.44	1.48
18	103.72	110	102.44	1.28	102.44	1.28
19	103.72	110	102.44	1.28	102.44	1.28
		EXMH109	99.68		99.70	

Model results indicate that there is sufficient clearance between the 100-year and 100-year +20% stress test HGLs and the proposed USFs. Additionally, HGL at the downstream existing MH109 does not exceed the previously assumed values per approved background reports (99.69 and 100.23 in the 100-year and 100-year +20% events respectively).

5.4.3 Overland Flow

Table 5-11 below presents the total surface water depths (static ponding depth + dynamic flow) on the proposed roads/parking areas for the worst case 2-year and 100-year design storm distribution and the 100-year +20% climate change storm. In no case do surface water depths on roadways exceed 0.35m during the design storm events. Table rows for CB66, CB68, CB70 and CB72 refer to existing catch basins within Obsidian Street. The noted 2-year water depths for these rows refer to anticipated flow spread at each catch basin along a continuous grade to ensure that modeled flow spreads do not exceed ½ of the associated travel lane per the OSDG (approximate depth of 0.06m). 2-year storm runoff is entirely captured at sag CB72 without presence of surface ponding. The existing CB72 is proposed to be replaced with a double catch basin inlet complete with a 250mm CB lead to convey the required level of surface runoff.

Table 5–11: Maximum Static and Dynamic Water Depths

Storage Node ID	Top of Grate Elevation (m)	Lowest Adjacent Building Opening (m)	2-Year		100-Year		100-Year + 20%	
			Max Surface HGL (m)	Total Surface Ponding Depth (m)	Max Surface HGL (m)	Total Surface Ponding Depth (m)	Max Surface HGL (m)	Total Surface Ponding Depth (m)
101A	103.30	103.55	102.04	0.00	102.88	0.00	103.37	0.07
102A	103.37	103.85	102.69	0.00	103.64	0.27	103.74	0.37
103A	103.60	104.05	103.44	0.00	103.77	0.17	103.80	0.20
104A	104.00	104.64	103.60	0.00	104.32	0.32	104.38	0.38
105A	104.90	105.46	103.88	0.00	105.29	0.39*	105.33	0.43
105B	104.66	104.87	102.69	0.00	103.59	0.00	104.60	0.00
105C	105.15	105.42	104.17	0.00	105.28	0.13	105.28	0.13
108A	105.35	105.95	104.85	0.00	105.55	0.20	105.61	0.26
110A	105.65	106.24	104.84	0.00	105.77	0.12	105.81	0.16
110B	105.43	105.92	105.06	0.00	105.61	0.18	105.66	0.23
110C	105.35	105.95	104.87	0.00	105.57	0.22	105.61	0.26
110D	105.72	106.25	104.90	0.00	105.83	0.11	105.87	0.15
CB72	102.85	102.97	101.82	0.00	103.01	0.16	103.03	0.18
CB70	104.21	104.38	104.25	0.04	104.28	0.07	104.29	0.08
CB68	104.59	104.89	104.64	0.05	104.68	0.09	104.69	0.10
CB66	105.77	106.00	105.80	0.03	105.82	0.05	105.84	0.07

*Occurs within a managed landscaped area - not subject to road surface ponding.

Proposed site grading is such that should catch basin discharge orifices become blocked, flows will spill from catch basin grates overland to the site accesses in the northwest and southwest corners of the property, and out to Obsidian Street. Overland flows progress from Obsidian westward along existing Haiku Street.

5.4.4 Peak System Outflows

As identified in section 5.4.1.1 above, peak runoff from areas tributary to the realigned Greenbank Road proceed to a separate outfall designed with available capacity to receive such flows, and as such do not contribute directly to the allowable release rate to Obsidian Street. Remaining peak discharge from the development is summarized in the table below:

Table 5–12: Peak Site Outflows

Area/ Location	2-Year		100-Year		100-Year + 20%	
	SCS	Chicago	SCS	Chicago	SCS	Chicago
Minor System	180.6	195.0	319.2	317.6	343.1	334.7
Major System	0	0	0	0	0	5.9
UNC-3	17.6	21.9	46.1	62.4	55.7	76.6
UNC-4	17.8	22.2	45.3	61.9	54.6	75.6
Total	**216.0**	**239.1**	**410.6**	**441.9**	**453.4**	**492.8**
Allowable	**402**		**437**		**-**	

Peak discharge from the development slightly exceeds the allowable rate for the 100-year storm event. As additional storage and adjusted ICDs within Obsidian Street have been considered beyond that originally included in the PCSWMM model for the approved The Ridge Subdivision, downstream flow conditions within the receiving minor and major system along Haiku were assessed based on previously approved reported HGLs and flow rates. Comparison of the current modeled rates to that originally assumed is detailed in the tables below, and underscores that no negative impacts to downstream infrastructure are anticipated based on the proposed development:

Table 5–13: Proposed Downstream Flow Conditions

Location	Design Storm	Previously Approved Discharge (L/s)	Revised Model Discharge (L/s)
Minor System – MH109	100-Year 3hr Chicago	790	780.5
	100-Year 24hr SCS	770	765.0
	100-Year 3hr Chicago + 20%	900	812.1
Major System – CB109	100-Year 3hr Chicago	152	138.5

Table 5–14: Proposed Downstream HGL

Location	Design Storm	Previously Approved HGL (m)	Revised Model HGL (m)
MH109	100-Year 3hr Chicago	99.961	99.68
	100-Year 24hr SCS	99.681	99.67
	100-Year 3hr Chicago + 20%	100.231	99.70

5.5 QUALITY CONTROL

Quality treatment of runoff will be partially provided through installation of an Etobicoke Exfiltration System (EES) as highlighted in **Section 5.6** below. This system has been sized to collect and infiltrate runoff from first flush rainfall events up to and including the 22mm rainfall event to meet water balance requirements noted below. In addition, further quality control for the overall development will be provided by the existing downstream oil-grit separator (OGS) for The Ridge subdivision located downstream of the proposed development and discharging to the Jock River via an existing ditch on the west side of Borrisokane Road. The oil-and-grit separator has previously been sized to ensure 80% Total Suspended Solids (TSS) removal for the development inclusive of the proposed site. For more details regarding the OGS units within the downstream development, please refer to JFSA's July 2020, Pond Design Brief for the Ridge (Brazeau) Subdivision.

Based on assumptions made during design of the downstream phases, Phase 8 lands were assumed to contribute at an overall average imperviousness of 68%, and the OGS was sufficiently sized to provide the appropriate level of control at this value. The Phase 8 residential development lands encompass 3.09ha. At the previously assumed imperviousness of 68%, this equates to an impervious area of 2.10ha. Based on subcatchment parameters listed above, and excluding uncontrolled runoff to the realigned Greenbank Road discharging to Clarke Pond, the proposed development overall imperviousness is 76.7%, with a treatable impervious area of 2.13ha.

According to Table 3.2 of the MOE Stormwater Management Planning and Design Manual, the storage volume required to achieve 80% long-term S.S. removal in an infiltration type system such as the proposed EES is about 38 m3/impervious ha. The proposed development would then require approximately 81m3 of storage to provide quality control for the region. Per **Table 5-15** below, the proposed development provides approximately 442m3 of storage.

It is anticipated that the high level of treatment provided by implementation of the proposed on-site EES system (22mm of the required 25mm first flush storm event) in conjunction with the existing OGS via treatment train will provide more than adequate quality control to meet design criteria for the development despite the marginal increase in impervious area to the downstream OGS.

5.6 WATER BALANCE – ETOBICOKE EXFILTRATION SYSTEM

As a Best Management Practices (BMP) approach the Barrhaven South Urban Expansion Area (J.L. Richards & Associates, 2018) MSS requires the capture and infiltration of stormwater via exfiltration system installed on local roads, such as the private roads within the subject site, where the surface runoff is not impacted by the City's winter road salting program to meet pre-development water balance criteria. To avoid groundwater contamination, only salt-free agents may be used on site for winter maintenance of snow and ice. This includes, but is not limited to, all drive aisles, parking areas, sidewalks, and pathways..

The City and RVCA determined that predevelopment infiltration levels should be maintained under post development conditions and that the infiltration should be provided across the development and not simply concentrated to one or two locations. JFSA determined the infiltration target for the site to be of the average simulated annual rainfall volume (552.0 mm), which is calculated to be 220.8mm annually as reported by JFSA in **Appendix E.2.** Similar to the BSUEA MSS, a 22mm storm event was selected for application within the current site plan to conservatively address post-development infiltration targets and water balance concerns.

An Etobicoke Exfiltration System (EES) has been proposed to be located below the storm sewer of the subject site (on sewer sections not identified as catch basin leads), the proposed locations of which are highlighted on **Drawing SD-1**.

For this exercise, the EES has been conservatively sized assuming no infiltration during rain events (seepage = 0 mm/hr). The EES units will be installed underneath storm sewers in specific areas and will consist of a 300 mm diameter perforated pipe surrounded by a clear stone trench with varying dimensions as identified on **Drawing SSP-1**. Minimum 600mm deep sumps (as per City of Ottawa standards) will be installed in upstream catchbasins in order to prevent/mitigate debris and potential oils from entering the perforated pipe system. ICDs within proposed catch basins are proposed as Ipex Tempest models equipped with floatable controls to mitigate oil/debris incursion to the EES.

Table 5–15: 22mm Event Simulated EES Volumes

Pipe ID	Length (m)	Trench Height (m)	Trench Width (m)	Available Volume (m^3)	Used Volume (m^3)[3]
101-100-E	36.2	1.7	1.575	38.8	28.6
102-101-E	62.9	1.6	1.20	48.3	35.5
103-101-E	32.0	1.6	1.425	29.2	27.3
104-103-E	70.3	1.6	1.425	64.1	51.5
105-104-E	44.7	1.7	1.35	41.0	37.2
107-105-E	45.4	1.7	1.35	41.6	36.7
108-107-E	36.1	1.7	1.425	35.0	30.7
109-107-E	70.5	1.7	1.20	57.5	45.3
110-108-E	79.9	2.0	1.35	86.3	80.4

Pipe ID	Length (m)	Trench Height (m)	Trench Width (m)	Available Volume (m^3)	Used Volume (m^3)[3]
Total	**477.9**			**441.9**	**373.2**

1. Trench widths in the PCSWMM model are set at 40% of the values provided in this table to account for 40% clear stone porosity.
2. The available volume for each trench section was calculated based on the above dimensions and assuming 40% clear stone porosity.
3. Volumes used incorporate storage volume provided via 300mm perforated pipe within the EES.

As can be seen in the above table, approximately 84.5% of the available volume in the overall EES system will be used in the 22mm event. In sections where the used volume is greater than the available volume, water spills into the next downstream segment, however there is no outflow from controlled areas of the site during the 22mm event.

5.6.1 Etobicoke Exfiltration System Monitoring

Due to the unique nature of the proposed site stormwater management plan, monitoring requirements have been included for construction stages in addition to the post-construction criteria. In order to ensure the stormwater infrastructure is functioning as designed, the following maintenance and monitoring is recommended for the site. Monitoring described below is in addition to groundwater quality monitoring requirements described further within the BSUEA Environmental Management Plan.

5.6.2 Monitoring During Construction

The following practices are recommended during construction:

- Surface flows to be directed away from EES clear stone bedding as it is being installed prior to backfill;
- Fueling of machinery to be done at designated locations away from proposed EES locations;
- Storage of machinery and material, fill, etc. to be done in designated areas away proposed EES locations;
- Equipment movement through proposed EES locations to be controlled;
- Regular inspection and maintenance of erosion control features corresponding to catch basins, catch basin manholes, and perforated subdrains.
- The EES system is to be jet flushed and inspected via CCTV upon construction completion prior to activation.

5.6.3 Monitoring Post Construction

The post-construction monitoring program is recommended to be phased into two periods as follows:

Stage 1 – years 1 to 2: frequent monitoring and inspection following significant rainfall events >22mm or at least twice per year from May to October (inclusive)

Stage 2 – after year 2: annual monitoring and inspection in the spring to identify any maintenance needed as a result of winter weather/operations.

Monitoring during stage 1 will be required to provide sufficient evidence of compliant performance of the LID features as required by the City of Ottawa for LID projects. Monitoring during stage 2 will be required to ensure the system continues to operate properly and is in compliance with assumed criteria outlined in the MECP ECA to be established for the development.

Monitoring locations are to be within manholes located immediately upstream of City rights-of-way to limit requirements for access easements/agreements, as well as to minimize requirements for additional infrastructure and related costs. The proposed monitoring location for the development is manhole STM 100.

Monitoring wells are to be installed at the base of these manholes for groundwater monitoring, and pressure transducers for continuous water level monitoring are to be installed within the adjacent clear stone media of the EES at the upstream perforated pipe connection to monitor water levels within the EES system. Flow monitoring is to be completed for the outgoing traditional storm sewer to identify EES overflows. Grab samples for quality (TSS% sampling) can be attempted within the same manhole locations and are to occur once per year following significant rainfall events (>22mm) during potential EES overflow events, or as determined through continuous water level monitoring. The monitoring program is expected to continue for the entirety of Stage 1.

Monitoring data is to confirm that the facility is able to drawdown to below the invert level of the perforated pipe connection within 48 hours after a significant rainfall event. Significant increase in drawdown time identifies the need for maintenance flushing of the EES system.

During stage 2, annual inspections of the system at the manholes is to visually confirm that drawdown is occurring within the manhole sump to the invert level of the upstream perforated pipe of the EES within 48 hours of a rainfall event.

5.6.4 Annual Maintenance

Annual maintenance of the EES is to occur during both Stages 1 and 2, and is to include:

- Removal of accumulated trash and debris from sumps and grates
- Removal of accumulated sediment depth in manholes / catch basins

Preventative maintenance via jet pressure washing of the conventional and EES system perforated pipes is to occur every 20 years, or as identified through annual drawdown inspections

6.0 GEOTECHNICAL CONSIDERATIONS AND GRADING

6.1 GEOTECHNICAL INVESTIGATION

A geotechnical investigation report for the development was completed by Paterson Group on March 30, 2021. The geotechnical investigation report is included in **Appendix E.3**.

The objective of the investigation was to determine the subsoil and groundwater conditions at this site by means of a borehole program and to provide geotechnical recommendations for the design of the proposed development based on the results on the results of the boreholes and other soil information available.

Based on the Paterson's report, the subject site is a former agricultural land. The bulk of the current phase of the proposed development has been recently cleared of topsoil which has been stockpiled in several piles across the site. Generally, the ground surface across the subject site is relatively flat within the central portion and slopes up towards the edges. It should be noted that parts of the subject site had undergone excavation and in-filling activities as part of a previous sand extraction operation.

Generally, the subsurface profile across the subject site consists of varying amounts of fill consisting of silty sand mixed with occasional silty clay, gravel and cobbles. Practical refusal to augering was encountered at a range between 4.6 m and 8.3 m below existing ground surface.

6.1.1 Groundwater Control

It is anticipated that groundwater infiltration into the excavations should be low to moderate and controllable using open sumps. The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum of 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes being pumped during the construction phase, between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. Requirements for a PTTW or EASR registration are to be identified by the geotechnical consultant.

6.2 GRADING PLAN

The proposed development site measures 3.09ha in area. The topography across the site includes a moderate grade change with site grades on the east side of the property measuring approximately three

(3) metres higher than the western property line. A detailed Grading Plan (**Drawing GP-1)** has been provided to satisfy the stormwater management requirements, adhere to permissible grade raise restrictions, and provide for minimum cover requirements for the storm and sanitary sewers where possible. Site grading has been established to provide emergency overland flow routes required for stormwater management in accordance with City of Ottawa requirements.

The site maintains emergency overland flow routes for flows in excess of major system storm events to Obsidian Street in accordance with the subdivision design report. A primary grading consideration for this development is the interface between the subject lands and the future Greenbank Road ROW. The proposed elevations along the property line shared with the future Greenbank Road ROW have been coordinated with the design team for Greenbank Road for this submission. As the design for Greenbank Road is currently ongoing, further communication with the City of Ottawa and the design team for Greenbank Road will be required throughout the design stage to ensure the proposed site development utilizes the latest Greenbank Road profiles and resulting property line elevations.

7.0 APPROVALS

An Environmental Compliance Approval (ECA) may be required from the Ontario Ministry of the Environment, Conservation and Parks (MECP) for the proposed works. If the site remains under single ownership, it will comply with the exemptions from O.Reg. 525/98 and an ECA for traditional storm and sanitary sewers as well as the EES system would not be required. These exemptions require that the site is not on industrial land or for industrial use, would drain to an approved outlet and would be under single ownership. If, however, the land will be divided into separate legal properties either through severance or through the condominium process an ECA would then be required for traditional storm and sanitary sewers in addition to the EES. The Rideau Valley Conservation Authority will need to be consulted in order to obtain municipal approval for site development.

An MECP Permit to Take Water (PTTW) or registration on the Environmental Activity and Sector Registry may be required as noted in **Section 6.0** above.

No other approval requirements from other regulatory agencies have been identified at the time of this report.

8.0 EROSION CONTROL

In order to protect downstream water quality and prevent sediment build up in catch basins and storm sewers, erosion and sediment control measures must be implemented during construction. The following recommendations will be included in the contract documents and communicated to the Contractor.

1. Implement best management practices to provide appropriate protection of the existing and proposed drainage system and the receiving water course(s).
2. Limit the extent of the exposed soils at any given time.
3. Re-vegetate exposed areas as soon as possible.
4. Minimize the area to be cleared and grubbed.
5. Protect exposed slopes with geotextiles, geogrid, or synthetic mulches.
6. Provide sediment traps and basins during dewatering works.
7. Install sediment traps (such as SiltSack® by Terrafix) between catch basins and frames.
8. Schedule the construction works at times which avoid flooding due to seasonal rains.

The Contractor will also be required to complete inspections and guarantee the proper performance of their erosion and sediment control measures at least after every rainfall. The inspections are to include:

- Verification that water is not flowing under silt barriers.
- Cleaning and changing the sediment traps placed on catch basins.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 POTABLE WATER SERVICING

The model by GeoAdvice provided by DSEL demonstrates that the pressures in the proposed development's watermain stubs fall within the range of target system pressures with a maximum basic day pressure of 76 psi and 72 psi at J-41 (connection point 1) and J-86 (connection point 2) respectively.

The subject lands can be adequately serviced by the 300mm watermain along Haiku Street and 300mm diameter watermain on Obsidian Street. Private watermains will provide sufficient fire flow to meet FUS requirements. System pressures will fall within the City of Ottawa Water Distribution Guidelines.

9.2 WASTEWATER SERVICING

The total design peak flow for the subject site to be conveyed to the connections at the Obsidian Street. Design flows are slightly higher than the previous estimate of 2.49L/s by DSEL based on a service area of 1.9 ha and population of 162 people. The difference (4.68L/s) can be accommodated by the 200mm receiving sewer in Obsidian Street.

JLR Associates identified in its MSS for BSUEA stated that there is residual capacity within the sanitary sewers draining Mattamy lands west to new Greenbank Road based on a Stantec (2015) hydrodynamic model of trunk sanitary sewers (450 mm in diameter and greater), which in turn demonstrated that the existing downstream trunk system could accommodate the flows generated with no risk of surcharging or basement flooding.

9.3 STORMWATER MANAGEMENT AND SERVICING

The following summarizes the stormwater management conclusions for the proposed development:

- All storm runoff within the site will be controlled and directed to an existing storm control point identified as MH 109 in JFSA SWM model.
- The proposed stormwater management plan is in compliance with the objectives specified in the City of Ottawa Sewer Design Guidelines and in the background reports for the site.
- The minor system (storm sewers) is sized to convey the 2-year storm event under free-flow conditions using City of Ottawa I-D-F parameters.
- ICDs installed on the proposed catch basins force flows in excess of the 2-year event to be conveyed by overland paved areas and stored within proposed parking and access regions.
- Quality control for the development has been provided by an existing downstream oil-grit separator in conjunction with installation of an on-site Etobicoke Exfiltration System.

An Etobicoke Exfiltration System has been proposed to be located below the storm sewer on private roads of the subject site to meet water balance requirements of the BSUEA. The stormwater drainage plan has been designed to achieve stormwater servicing that is free of conflict with other services, respects the stormwater management requirement listed in background studies and in conformity with the City of Ottawa guidelines.

9.4 GRADING

The topography across the site includes a moderate grade change with site grades on the east side of the property measuring three (3) metres higher than the western property line. A detailed Grading Plan has been provided to satisfy the stormwater management requirements, adhere to permissible grade raise restrictions, and provide for minimum cover requirements for the storm and sanitary sewers where possible. A primary grading consideration for this development is the interface between the subject lands and the future Greenbank Road ROW.

9.5 APPROVALS/PERMITS

An Environmental Compliance Approval (ECA) will be required from the Ontario Ministry of the Environment, Conservation and Parks (MECP) for the proposed works. An MECP Permit to Take Water (PTTW) or registration on the Environmental Activity and Sector Registry may be required as noted in Section 6.0 above. No other approval requirements from other regulatory agencies were identified at the time of this report. The Rideau Valley Conservation Authority will need to be consulted in order to obtain municipal approval for site development.

APPENDICES

Appendix A POTABLE WATER SERVICING

A.1 WATER DEMAND CALCULATIONS

Half Moon Bay South Phase 8 - Domestic Water Demand Estimates

Project No. 160401657

Based on Site plan provided by Mattamy Homes

Densities as per City Guidelines:		
Townhomes	2.7	ppu

Building ID	Amenity Area (m^2)	No. of Units	Population	Daily Rate of Demand (L/cap/d or L/ha/d)	Avg Day Demand		Max Day Demand [1]		Peak Hour Demand [2]	
					(L/min)	(L/s)	(L/min)	(L/s)	(L/min)	(L/s)
Back-to-Back Townhomes										
All Blocks	-	228	615.6	280	119.7	2.00	299.3	4.99	658.4	10.97
Total Site :		**228.0**	**616**		**119.7**	**2.00**	**299.3**	**4.99**	**658.4**	**10.97**

Average day water demand for residential areas: 280 L/cap/d , 28000/L/ha/d for commercial/amenity areas

The City of Ottawa water demand criteria used to estimate peak demand rates for residential areas are as follows:

1 maximum day demand rate = 2.5 x average day demand rate for residential

2 peak hour demand rate = 2.2 x maximum day demand rate for residential

3 Water demand criteria used to estimate peak demand rates for amenity/common areas are as follows:

maximum daily demand rate = 1.5 x average day demand rate

peak hour demand rate = 1.8 x maximum day demand rate

A.2 FIRE FLOW REQUIREMENTS PER FUS GUIDELINES

FUS Fire Flow Calculation Sheet (2020)

Stantec Project #: 160401657
Project Name: 3718 Greenbank Road
Date: 11/8/2022
Fire Flow Calculation #: 1
Description: Back-to-Back Townhomes (Block 8 / Block 11)

Notes: 3-storey residential block with 2hr Firewall at mid-block

<table>
<tr><th>Step</th><th>Task</th><th colspan="8">Notes</th><th>Value Used</th><th>Req'd Fire Flow (L/min)</th></tr>
<tr><td>1</td><td>Determine Type of Construction</td><td colspan="8">Type V - Wood Frame / Type IV-D - Mass Timber Construction</td><td>1.5</td><td>-</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Determine Effective Floor Area</td><td colspan="5">Sum of All Floor Areas</td><td colspan="3"></td><td>-</td><td>-</td></tr>
<tr><td>238</td><td>288</td><td>288</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>814</td><td>-</td></tr>
<tr><td>3</td><td>Determine Required Fire Flow</td><td colspan="8">(F = 220 x C x A$^{1/2}$). Round to nearest 1000 L/min</td><td>-</td><td>9000</td></tr>
<tr><td>4</td><td>Determine Occupancy Charge</td><td colspan="8">Limited Combustible</td><td>-15%</td><td>7650</td></tr>
<tr><td rowspan="4">5</td><td rowspan="4">Determine Sprinkler Reduction</td><td colspan="8">None</td><td>0%</td><td rowspan="4">0</td></tr>
<tr><td colspan="8">Non-Standard Water Supply or N/A</td><td>0%</td></tr>
<tr><td colspan="8">Not Fully Supervised or N/A</td><td>0%</td></tr>
<tr><td colspan="8">% Coverage of Sprinkler System</td><td>0%</td></tr>
<tr><td rowspan="5">6</td><td rowspan="5">Determine Increase for Exposures (Max. 75%)</td><td>Direction</td><td>Exposure Distance (m)</td><td>Exposed Length (m)</td><td>Exposed Height (Stories)</td><td>Length-Height Factor (m x stories)</td><td colspan="2">Construction of Adjacent Wall</td><td>Firewall / Sprinklered ?</td><td>-</td><td>-</td></tr>
<tr><td>North</td><td>10.1 to 20</td><td>13.5</td><td>3</td><td>41-60</td><td colspan="2">Type V</td><td>NO</td><td>12%</td><td rowspan="4">2601</td></tr>
<tr><td>East</td><td>3.1 to 10</td><td>20.8</td><td>3</td><td>61-80</td><td colspan="2">Type V</td><td>NO</td><td>18%</td></tr>
<tr><td>South</td><td>20.1 to 30</td><td>13.5</td><td>3</td><td>41-60</td><td colspan="2">Type V</td><td>NO</td><td>4%</td></tr>
<tr><td>West</td><td>0 to 3</td><td>20.8</td><td>3</td><td>61-80</td><td colspan="2">Type V</td><td>YES</td><td>0%</td></tr>
<tr><td rowspan="4">7</td><td rowspan="4">Determine Final Required Fire Flow</td><td colspan="9">Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min</td><td>10000</td></tr>
<tr><td colspan="9">Total Required Fire Flow in L/s</td><td>166.7</td></tr>
<tr><td colspan="9">Required Duration of Fire Flow (hrs)</td><td>2.00</td></tr>
<tr><td colspan="9">Required Volume of Fire Flow (m^3)</td><td>1200</td></tr>
</table>

A.3 HYDRAULIC CAPACITY AND MODELLING

Hydraulic Model Results - Average Day (AVDY)

Junction Results

ID	Demand	Elevation	Head	Pressure	
	(L/s)	(m)	(m)	(psi)	(Kpa)
0	0.11	105.86	156.10	71.43	492.50
1	0.21	105.99	156.10	71.24	491.19
14	0.21	105.87	156.10	71.40	492.29
2	0.21	105.80	156.10	71.50	492.98
3	0.53	105.38	156.10	72.11	497.18
4	0.21	103.89	156.10	74.21	511.66
5	0.42	103.54	156.10	74.72	515.18

Pipe Results

ID	From Node	To Node	Length	Diameter	Roughness	Flow	Velocity
			(m)	(mm)		(L/s)	(m/s)
1000	1	0	36.17	200	110	-0.43	0.01
1001	2	1	69.94	200	110	-0.22	0.01
1002	3	2	35.12	200	110	-0.17	0.01
1003	4	3	117.50	200	110	0.36	0.01
1004	5	4	35.03	200	110	0.57	0.02
1005	5	7002	45.09	200	110	-0.99	0.03
1008	7000	0	72.04	200	110	0.91	0.03
1013	14	0	69.94	200	110	-0.37	0.01
1014	2	14	36.24	200	110	-0.16	0.00

Hydraulic Model Results - Peak Hour (PKHR)

Junction Results

ID	Demand	Elevation	Head	Pressure	
	(L/s)	(m)	(m)	(psi)	(Kpa)
0	0.58	105.86	138.00	45.70	315.09
1	1.16	105.99	138.03	45.55	314.06
14	1.16	105.87	138.06	45.75	315.44
2	1.16	105.80	138.09	45.90	316.47
3	2.89	105.38	138.22	46.69	321.92
4	1.16	103.89	138.77	49.58	341.84
5	2.31	103.54	138.95	50.34	347.08

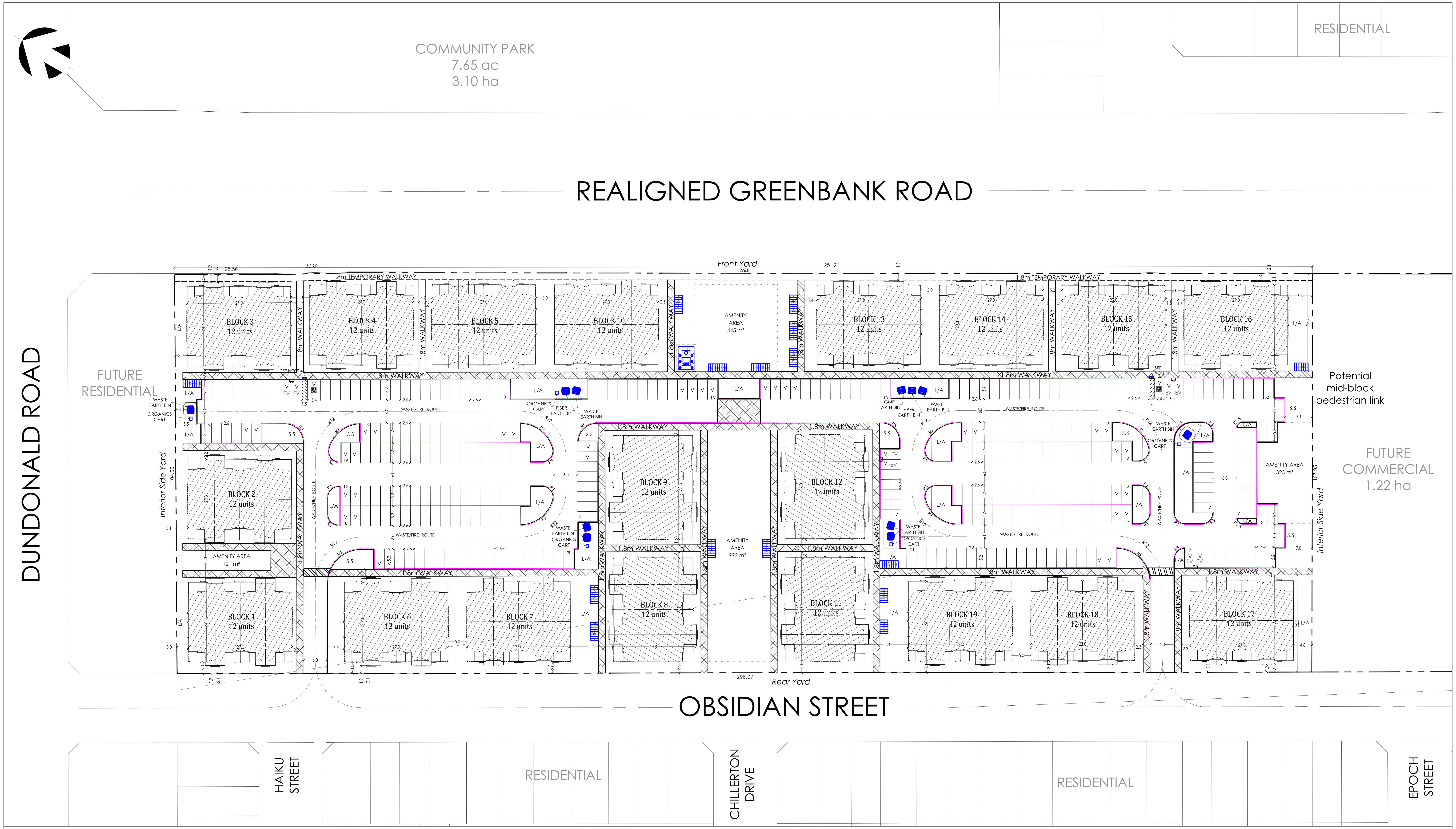
Pipe Results

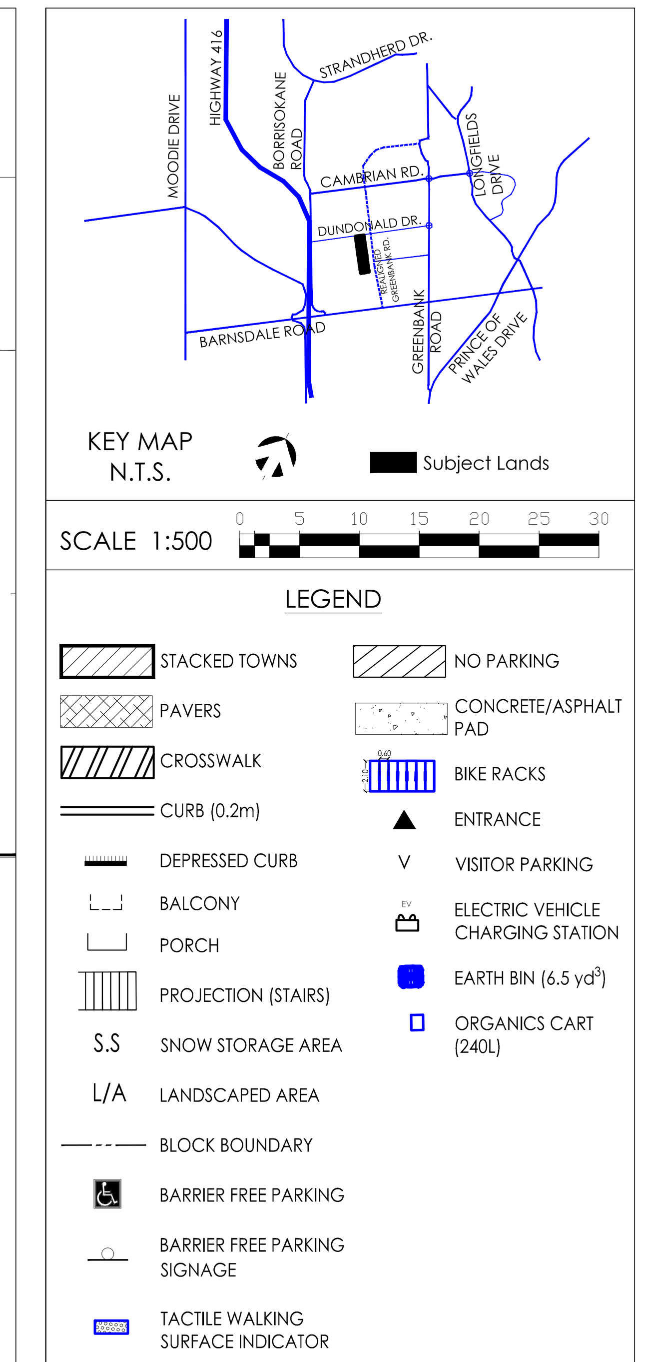
ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)
1000	1	0	36.17	200	110	8.91	0.28
1001	2	1	69.94	200	110	10.07	0.32
1002	3	2	35.12	200	110	21.66	0.69
1003	4	3	117.50	200	110	24.55	0.78
1004	5	4	35.03	200	110	25.71	0.82
1005	5	7002	45.09	200	110	-28.02	0.89
1008	7000	0	72.04	200	110	-17.60	0.56
1013	14	0	69.94	200	110	9.27	0.30
1014	2	14	36.24	200	110	10.43	0.33

Hydraulic Model Results - MXDY+FF (167 L/s)

ID	Static Demand	Static Pressure		Static Head	Fire-Flow Demand	Residual Pressure		Available Flow at Hydrant	Available Flow Pressure	
	(L/s)	(psi)	(Kpa)	(m)	(L/s)	(psi)	(Kpa)	(L/s)	(psi)	(Kpa)
0	0.26	42.42	292.48	135.70	167	34.25	236.15	290.43	20.00	137.90
1	0.53	42.23	291.17	135.70	167	31.19	215.05	245.38	20.00	137.90
14	0.53	42.40	292.34	135.70	167	31.07	214.22	242.99	20.00	137.90
2	0.53	42.49	292.96	135.70	167	32.75	225.80	264.55	20.00	137.90
3	1.32	43.10	297.17	135.69	167	32.30	222.70	254.58	20.00	137.90
4	0.53	45.21	311.71	135.70	167	36.59	252.28	300.58	20.00	137.90
5	1.05	45.71	315.16	135.70	167	39.67	273.52	369.35	20.00	137.90

Appendix B DRAFT SITE PLAN





SITE STATISTICS AND DEVELOPMENT DATA

SITE AREA	30,880m² (3.09 ha)
PAVED AREA	9,508.17m² (31%)
LANDSCAPED AREA	10,600.92m² (34%)
TOTAL BUILDING COVERAGE	10,770.91m² (35%)
TOTAL GROSS FLOOR AREA	24,662.76 m²
DENSITY (UPH)	74 UPH
ZONE CATEGORY	R4(Z)[2798]

DWELLING BLOCK	DWELLING TYPE	GROSS FLOOR AREA (m2)	UNITS
BLOCK 1-19	12 UNIT BACK-TO-BACK STACKED DWELLING	1,298.04 (per Block)	228
	TOTAL	24,662.76	228

SECTION	ZONE PROVISION - PLANNED UNIT DEVELOPMENT	REQUIRED	PROPOSED
162A(Table)(Z)	MIN. LOT AREA (m²)	1,400m2	30,880m²
162A(Table)(Z)	MIN. LOT WIDTH (m)	18m	296.8m
162A(Table)(Z)	MIN. FRONT YARD SETBACK (m)	3.0m	3.0m
2798 (By-law 2022-235)	MIN. INTERIOR SIDE YARD SETBACK:		
	FOR THE NORTHERN LOT LINE	3.0m	3.0m
	FOR THE SOUTHERN LOT LINE	4.75m	4.8m
2798 (By-law 2022-235)	MIN. REAR YARD SETBACK (m)	3.0m	3.0m
162A(Table)(Z)	MAX. BUILDING HEIGHT (m)	14.5m	12.0m (3 storeys)
101(Table)	RESIDENT PARKING - 1.2 spaces/unit	273.6	274
102(Table)	VISITOR PARKING - 0.2 spaces/unit	45.6	46
111A(Table)	MIN. BICYCLE PARKING - 0.5 spaces/unit	114	114
131(Table)(1)	MIN. WIDTH OF PRIVATE WAY/ PARKING AISLE (m)	6.0m	6.0m
131(Table)(2)	MIN. SETBACK FOR ANY WALL OF A RESIDENTIAL USE BUILDING TO A PRIVATE WAY (m)	1.8m	2.9m
131(Table)(4)	MIN. SEPARATION DISTANCE BETWEEN BUILDINGS WITHIN A PLANNED UNIT DEVELOPMENT (m)	1.2m	4.7m
137(Table)	AMENITY AREA:		
	TOTAL MIN. AMENITY AREA (6m² per unit)	1,368m²	1,938m²*
	MIN. COMMUNAL AMENITY AREA (min. 50% area)	684m²	1,881m²

*Individual amenity areas are provided on the balconies

SECTION	ADDITIONAL PROVISIONS	REQUIRED	PROPOSED
65(Table)	PERMITTED PROJECTIONS INTO REQUIRED YARDS:		
65(Table)(5)	FIRE ESCAPES, OPEN STAIRWAYS, STOOP (m)	>0.6m to lot line	1.9m
65(Table)(6)	COVERED OR UNCOVERED BALCONY, PORCH, DECK	>1m to lot line	2.1m
106(1)(a)	MIN. PERPENDICULAR PARKING SPACE SIZE (m)	2.6m x 5.2m	2.6m x 5.2m
106(2)	MIN. BARRIER FREE PARKING**		
	TYPE A PARKING SPACE SIZE (m)	3.4m wide	3.4m wide
	TYPE B PARKING SPACE SIZE (m)	2.4m wide	2.4m wide
	ACCESS AISLE (m)	1.5m	1.5m
111B(Table)	MIN. BICYCLE PARKING SPACE DIMENSION, HORIZONTAL (m)	Width: 0.6m Length: 1.8m	Width: 0.6m Length: 1.8m
111(9)	MIN. BICYCLE PARKING SPACE ACCESS AISLE WIDTH (m)	1.5m	1.8m
109(3)(b)	MAX. WALKWAY WIDTH PERMITTED IN YARD (m)	1.8m	1.8m
110(1)	MIN. % OF PARKING LOT LANDSCAPED	15%	17%
110(Table)(IV)	LANDSCAPED AREA SURROUNDING PARKING LOT		
	ABUTTING A STREET (m)	3.0m	N/A
	NOT ABUTTING A STREET (m)	3.0m	5.5m
110(3)	REFUSE COLLECTION AREAS:		
110(3)(b)	MIN. WASTE COLLECTION SETBACK TO LOT LINE (m)	3.0m	3.0m
110(3)(c)	OPAQUE SCREEN MIN. HEIGHT (m)	2.0m***	2.0m***

**Per the 2014 Guide to the Integrated Accessibility Standards Regulation - Design of Public Spaces Standard, 4% of parking spaces provided for public use must be accessible. 2 of the provided 46 visitor spaces have been designed to be barrier-free, one each of Type A and Type B sizes.
***Section 110(3)(d) where an in-ground refuse container is provide, the screening requirement of Section (3)(c) above may be achieved with soft landscaping (Bylaw 2020-299)

DATE [M.D.Y]	REVISION	BY
12/06/22	Resubmission	CR
01/21/22	General revision	SP
12/02/21	Draft for review	SP

GENERAL NOTES

1. DO NOT SCALE DRAWINGS FOR PRINT.
2. THIS DRAWING IS THE EXCLUSIVE PROPERTY OF KORSIAK URBAN PLANNING AND MATTAMY HOMES. COPYRIGHT RESERVED.
3. WALKWAYS AND CURBS TO BE TIED INTO PUBLIC ROW WHERE APPLICABLE.
4. REFERENCE CITY OF OTTAWA T.W.S.I. DETAIL SC7.3
5. SURVEY BOUNDARY BY J.D BARNES LIMITED.
62 STEACIE DRIVE, SUITE 103, KANATA, ON K2K 2A9

PROJECT TEAM

SITE PLAN DESIGN:
LANDSCAPE ARCHITECTURE:
PLANNING:
TRANSPORTATION:
ARCHITECTURE:
MECHANICAL/ ELECTRICAL:
CIVIL ENGINEER:

50 Hines Road, Suite 100, Ottawa, ON Canada K2K 2M5

Half Moon Bay South
Condo Block

PART OF LOT 8
CONCESSION 3 (RIDEAU FRONT)
GEOGRAPHIC TOWNSHIP OF NEPEAN
CITY OF OTTAWA

TITLE: SITE PLAN

DATE: February 21, 2023 | DRAWN BY: CR | CHECKED BY: KC | DRAWING NO. B

FILE NO.: D07-12-22-0042

JOB NO.: Mattamy - Half Moon Bay

D07-12-22-0042

Appendix C SANITARY SERVICING

C.1 SANITARY SEWER DESIGN SHEET

Stantec

SUBDIVISION:
Half Moon Bay South Phase 8 - Residential

DATE: 3/29/2023
REVISION: 2
DESIGNED BY: AJ
CHECKED BY: DT

SANITARY SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160401657

DESIGN PARAMETERS

MAX PEAK FACTOR (RES.)=	4.0	AVG. DAILY FLOW / PERSON	280 l/p/day	MINIMUM VELOCITY	0.60 m/s
MIN PEAK FACTOR (RES.)=	2.0	COMMERCIAL	28,000 l/ha/day	MAXIMUM VELOCITY	3.00 m/s
PEAKING FACTOR (INDUSTRIAL):	2.4	INDUSTRIAL (HEAVY)	55,000 l/ha/day	MANNINGS n	0.013
PEAKING FACTOR (ICI >20%):	1.5	INDUSTRIAL (LIGHT)	35,000 l/ha/day	BEDDING CLASS	B
PERSONS / SINGLE	3.4	INSTITUTIONAL	28,000 l/ha/day	MINIMUM COVER	2.50 m
PERSONS / TOWNHOME	2.7	INFILTRATION	0.33 l/s/Ha	HARMON CORRECTION FACTOR	0.8
PERSONS / APARTMENT	1.8				

LOCATION			RESIDENTIAL AREA AND POPULATION									COMMERCIAL		INDUSTRIAL (L)		INDUSTRIAL (H)		INSTITUTIONAL		GREEN / UNUSED		C+I+I	INFILTRATION			TOTAL	PIPE								
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (ha)	UNITS SINGLE	UNITS TOWN	UNITS APT	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	FLOW (l/s)	LENGTH (m)	DIA (mm)	MATERIAL	CLASS	SLOPE (%)	CAP. (FULL) (l/s)	CAP. V PEAK FLOW (%)	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
R7A	7	6	0.15	0	12	0	32	0.15	32	3.68	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.15	0.15	0.1	0.4	27.7	200	PVC	SDR 35	1.00	33.4	**1.31%**	1.05	0.30
R10A	10	9	0.57	0	39	0	105	0.57	105	3.59	1.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.57	0.57	0.2	1.4	95.1	200	PVC	SDR 35	0.40	21.1	**6.68%**	0.67	0.31
R12A	12	11	0.53	0	36	0	97	0.53	97	3.60	1.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.53	0.53	0.2	1.3	93.5	200	PVC	SDR 35	0.40	21.1	**6.19%**	0.67	0.30
	11	9	0.00	0	0	0	0	0.53	97	3.60	1.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.53	0.2	1.3	36.1	200	PVC	SDR 35	0.40	21.1	**6.19%**	0.67	0.30
R109A	9	8	0.13	0	9	0	24	1.23	227	3.50	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.13	1.23	0.4	3.0	41.1	200	PVC	SDR 35	0.40	21.1	**14.08%**	0.67	0.39
R13A	13	8	0.58	0	48	0	130	0.58	130	3.57	1.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.58	0.58	0.2	1.7	64.5	200	PVC	SDR 35	0.40	21.1	**7.99%**	0.67	0.33
R108A	8	6	0.57	0	36	0	97	2.38	454	3.40	5.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.57	2.38	0.8	5.8	117.5	200	PVC	SDR 35	0.40	21.1	**27.32%**	0.67	0.47
G6A	6	4	0.04	0	0	0	0	2.57	486	3.38	5.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.0	0.08	2.61	0.9	6.2	35.4	200	PVC	SDR 35	0.40	21.1	**29.28%**	0.67	0.49
R4A	5	4	0.30	0	24	0	65	0.30	65	3.63	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.30	0.30	0.1	0.9	68.9	200	HDPE	SDR 35	0.40	21.1	**4.08%**	0.67	0.27
G6A	4	2	0.00	0	0	0	0	2.87	551	3.36	6.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.0	0.00	2.91	1.0	7.0	3.7	200	PVC	SDR 35	0.40	21.1	**32.91%**	0.67	0.50
R3A	3	2	0.17	0	24	0	65	0.17	65	3.63	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.17	0.17	0.1	0.8	30.3	200	PVC	SDR 35	0.50	23.6	**3.47%**	0.74	0.29
G2A	2	1	0.04	0	0	0	0	3.08	616	3.34	6.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.08	0.0	0.08	3.16	1.0	7.7	29.4	200	PVC	SDR 35	0.40	21.1	**36.45%**	0.67	0.52
	1	EX MH 3A	0.00	0	0	0	0	3.08	616	3.34	6.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.0	0.00	3.16	1.0	7.7	3.8	200	PVC	SDR 35	0.40	21.1	**36.45%**	0.67	0.52
																												200							

Appendix D STORMWATER MANAGEMENT

D.1 STORM SEWER DESIGN SHEET

Stantec	Half Moon Bay South Phase 8 - Residential	STORM SEWER DESIGN SHEET (City of Ottawa)	DESIGN PARAMETERS
	DATE: 2023-03-29		$I = a / (t+b)^c$ (As per City of Ottawa Guidelines, 2012)
	REVISION: 2		
	DESIGNED BY: AJ	FILE NUMBER: 160401657	
	CHECKED BY: DT		

	1:2 yr	1:5 yr	1:10 yr	1:100 yr			
a =	732.951	998.071	1174.184	1735.688	MANNING'S n =	0.013	BEDDING CLASS = B
b =	6.199	6.053	6.014	6.014	MINIMUM COVER:	2.00 m	
c =	0.810	0.814	0.816	0.820	TIME OF ENTRY	10 min	

LOCATION / DRAINAGE AREA

AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (2-YEAR) (ha)	AREA (5-YEAR) (ha)	AREA (10-YEAR) (ha)	AREA (100-YEAR) (ha)	AREA (ROOF) (ha)	C (2-YEAR) (-)	C (5-YEAR) (-)	C (10-YEAR) (-)	C (100-YEAR) (-)
	109	107	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L1110A, L110B, L110C, L110D	110D	108	0.62	0.00	0.00	0.00	0.00	0.76	0.00	0.00	0.00
L108A	108	107	0.34	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00
	107	105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	106	105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L105B, L105A, L105C	105	104	0.44	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00
L104A	104	103	0.52	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00
L103A	103	101	0.13	0.00	0.00	0.00	0.00	0.76	0.00	0.00	0.00
L102A	102	101	0.44	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00
L101A	101	100	0.02	0.00	0.00	0.00	0.00	0.62	0.00	0.00	0.00
	100	EX MH 109	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

AREA ID NUMBER	FROM M.H.	TO M.H.	A x C (2-YEAR) (ha)	ACCUM AxC (2YR) (ha)	A x C (5-YEAR) (ha)	ACCUM. AxC (5YR) (ha)	A x C (10-YEAR) (ha)	ACCUM. AxC (10YR) (ha)	A x C (100-YEAR) (ha)	ACCUM. AxC (100YR) (ha)	T of C (min)
	109	107	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00
											10.00
L1110A, L110B, L110C, L110D	110D	108	0.472	0.472	0.000	0.000	0.000	0.000	0.000	0.000	10.00
L108A	108	107	0.272	0.744	0.000	0.000	0.000	0.000	0.000	0.000	11.23
											11.73
	107	105	0.000	0.744	0.000	0.000	0.000	0.000	0.000	0.000	11.73
											12.23
	106	105	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00
											10.00
L105B, L105A, L105C	105	104	0.247	0.991	0.000	0.000	0.000	0.000	0.000	0.000	12.23
L104A	104	103	0.406	1.397	0.000	0.000	0.000	0.000	0.000	0.000	12.67
											13.31
L103A	103	101	0.099	1.496	0.000	0.000	0.000	0.000	0.000	0.000	13.31
											13.61
L102A	102	101	0.348	0.348	0.000	0.000	0.000	0.000	0.000	0.000	10.00
											10.68
L101A	101	100	0.012	1.856	0.000	0.000	0.000	0.000	0.000	0.000	13.61
	100	EX MH 109	0.000	1.856	0.000	0.000	0.000	0.000	0.000	0.000	14.02
											14.15

AREA ID NUMBER	FROM M.H.	TO M.H.	I_{2-YEAR} (mm/h)	I_{5-YEAR} (mm/h)	$I_{10-YEAR}$ (mm/h)	$I_{100-YEAR}$ (mm/h)	$Q_{CONTROL}$ (L/s)	ACCUM. $Q_{CONTROL}$ (L/s)	Q_{ACT} (CIA/360) (L/s)
	109	107	76.81	104.19	122.14	178.56	0.0	0.0	0.0
L1110A, L110B, L110C, L110D	110D	108	76.81	104.19	122.14	178.56	0.0	0.0	100.7
L108A	108	107	72.39	98.13	115.00	168.07	0.0	0.0	149.6
	107	105	70.74	95.85	112.32	164.13	0.0	0.0	146.2
	106	105	76.81	104.19	122.14	178.56	0.0	0.0	0.0
L105B, L105A, L105C	105	104	69.20	93.75	109.84	160.49	0.0	0.0	190.6
L104A	104	103	67.87	91.93	107.70	157.35	0.0	0.0	263.4
L103A	103	101	66.06	89.43	104.76	153.04	0.0	0.0	274.4
L102A	102	101	76.81	104.19	122.14	178.56	0.0	0.0	74.2
L101A	101	100	65.26	88.35	103.49	151.16	0.0	0.0	336.4
	100	EX MH 109	64.19	86.88	101.76	148.62	0.0	0.0	330.9

PIPE SELECTION

AREA ID NUMBER	FROM M.H.	TO M.H.	LENGTH (m)	PIPE WIDTH OR DIAMETEI (mm)	PIPE HEIGHT (mm)	PIPE SHAPE (-)	MATERIAL (-)	CLASS (-)	SLOPE %	Q_{CAP} (FULL) (L/s)	% FULL (-)	VEL. (FULL) (m/s)	VEL. (ACT) (m/s)	TIME OF FLOW (min)
	109	107	70.5	300	300	CIRCULAR	PVC	-	0.50	68.0	**0.00%**	0.97	0.00	0.00
L1110A, L110B, L110C, L110D	110D	108	79.9	450	450	CIRCULAR	CONCRETE	-	0.50	210.3	**47.87%**	1.28	1.08	1.23
L108A	108	107	36.1	525	525	CIRCULAR	CONCRETE	-	0.50	317.2	**47.15%**	1.42	1.19	0.51
	107	105	45.4	450	450	CIRCULAR	CONCRETE	-	1.00	297.4	**49.14%**	1.81	1.53	0.49
	106	105	43.7	300	300	CIRCULAR	PVC	-	0.50	68.0	**0.00%**	0.97	0.00	0.00
L105B, L105A, L105C	105	104	44.7	450	450	CIRCULAR	CONCRETE	-	1.00	297.4	**64.07%**	1.81	1.67	0.45
L104A	104	103	70.3	525	525	CIRCULAR	CONCRETE	-	1.03	455.3	**57.84%**	2.04	1.82	0.64
L103A	103	101	32.0	525	525	CIRCULAR	CONCRETE	-	1.00	448.7	**61.17%**	2.01	1.82	0.29
L102A	102	101	62.9	300	300	CIRCULAR	PVC	-	1.50	117.8	**62.97%**	1.67	1.53	0.68
L101A	101	100	36.2	675	675	CIRCULAR	CONCRETE	-	0.50	620.1	**54.25%**	1.68	1.48	0.41
	100	EX MH 109	11.3	675	675	CIRCULAR	CONCRETE	-	0.46	594.8	**55.63%**	1.61	1.43	0.13
				675	675									

D.2 SAMPLE PCSWMM INPUT (100YR CHICAGO)

```
[TITLE]
;;Project Title/Notes

[OPTIONS]
;;Option             Value
FLOW_UNITS           LPS
INFILTRATION         HORTON
FLOW_ROUTING         DYNWAVE
LINK_OFFSETS         ELEVATION
MIN_SLOPE            0
ALLOW_PONDING        YES
SKIP_STEADY_STATE    NO

START_DATE           07/23/2009
START_TIME           00:00:00
REPORT_START_DATE    07/23/2009
REPORT_START_TIME    00:00:00
END_DATE             07/23/2009
END_TIME             12:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:01:00
WET_STEP             00:01:00
DRY_STEP             00:01:00
ROUTING_STEP         1
RULE_STEP            00:00:00

INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  H-W
SURCHARGE_METHOD     Slot
VARIABLE_STEP        0
LENGTHENING_STEP     0
MIN_SURFAREA         0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
```



```
LAT_FLOW_TOL         5
MINIMUM_STEP         0.05
THREADS              6

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
CONSTANT         0.0
DRY_ONLY         NO

[RAINGAGES]
;;Name           Format    Interval SCF      Source
;;-------------- --------- -------- -------- ----------
RG1              INTENSITY 0:10     1.0      TIMESERIES 100C

[SUBCATCHMENTS]
;;Name           Rain Gage        Outlet           Area     %Imperv  Width    %Slope   CurbLen  SnowPack

;;-------------- ---------------- ---------------- -------- -------- -------- -------- --------
----------------
;CB_066
A225NE           RG1              CB66             0.0682   49       75.997   0.5      0

;CB_067
A225NW           RG1              CB67             0.1231   71       76.002   0.5      0

;CB_065
A225SE           RG1              CB65             0.0748   49       83       0.5      0

;CB_068
A226NE           RG1              CB68             0.068    50       76.003   0.5      0

;CB_069
A226NW           RG1              CB69             0.1354   73       75.001   0.5      0

;CB_072
A227NE           RG1              CB72             0.0287   50       31.999   0.5      0
```

```
;CB_072
A227NW         RG1            CB72           0.0646   50       72.002   0.5      0

;CB_070
A227SE         RG1            CB70           0.0679   50       76.002   0.5      0

;CB_071
A227SW         RG1            CB71           0.0984   72       63       0.5      0

;CB_039
A229N2         RG1            CHILLERTON2    0.0307   78       25       0.5      0

;5-Year
A561N1         RG1            CB108          0.114    72       59       3        0

A562NE         RG1            CB9            0.021    59       33       1        0

A562R1         RG1            CB-9           0.038    50       62       1.5      0

A562R2         RG1            CB-9           0.029    59       42       1.5      0

A562R3         RG1            CB-9           0.06     61       82       1.5      0

A562R4         RG1            CB-9           0.016    52       22       1.5      0

A562SE         RG1            CB10           0.021    57       33       1        0

;5-Year
A563NE         RG1            CB25           0.112    75       53       0.5      0

COM            RG1            COMM           1.22     90       274.5    0.5      0

;0.71
L100D          RG1            110D           0.095191 72.86    21.418   3        0

;0.62
L101A          RG1            101A           0.020848 60       4.691    3        0
```



```
;0.79
L102A          RG1            102A           0.436689 84.29    98.255   3        0

;0.76
L103A          RG1            103A           0.132319 80       29.772   3        0

;0.78
L104A          RG1            104A           0.523869 82.86    117.871  3        0

;0.63
L105A          RG1            105A           0.133875 61.43    30.122   3        0

;0.58
L105B          RG1            105B           0.197805 54.29    44.506   3        0

;0.38
L105C          RG1            105C           0.105471 25.71    23.731   3        0

;0.80
L108A          RG1            108A           0.338942 85.71    76.262   3        0

;0.69
L110A          RG1            110A           0.153186 70       34.467   3        0

;0.70
L110B          RG1            110B           0.052597 71.43    11.834   3        0

;0.82
L110C          RG1            110C           0.315695 88.57    71.031   3        0

;0.77
UNC-1          RG1            Greenbank_Rd   0.15517  81.43    34.913   3        0

;0.77
UNC-2          RG1            Greenbank_Rd   0.159427 81.43    35.871   3        0

;0.73
UNC-3          RG1            CB68           0.134979 75.71    30.37    3        0
```

```
;0.75
UNC-4            RG1              CB72             0.131927 78.57    29.684   3        0


[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
A225NE           0.013      0.25       1.57       4.67       0          OUTLET
A225NW           0.013      0.25       1.57       4.67       0          OUTLET
A225SE           0.013      0.25       1.57       4.67       0          OUTLET
A226NE           0.013      0.25       1.57       4.67       0          OUTLET
A226NW           0.013      0.25       1.57       4.67       0          OUTLET
A227NE           0.013      0.25       1.57       4.67       0          OUTLET
A227NW           0.013      0.25       1.57       4.67       0          OUTLET
A227SE           0.013      0.25       1.57       4.67       0          OUTLET
A227SW           0.013      0.25       1.57       4.67       0          OUTLET
A229N2           0.013      0.25       1.57       4.67       0          OUTLET
A561N1           0.013      0.25       1.57       4.67       0          OUTLET
A562NE           0.013      0.25       1.57       4.67       0          OUTLET
A562R1           0.013      0.25       1.57       4.67       0          PERVIOUS   100
A562R2           0.013      0.25       1.57       4.67       0          PERVIOUS   100
A562R3           0.013      0.25       1.57       4.67       0          PERVIOUS   100
A562R4           0.013      0.25       1.57       4.67       0          PERVIOUS   100
A562SE           0.013      0.25       1.57       4.67       0          OUTLET
A563NE           0.013      0.25       1.57       4.67       0          OUTLET
COM              0.013      0.25       1.57       4.67       0          OUTLET
L100D            0.013      0.25       1.57       4.67       0          OUTLET
L101A            0.013      0.25       1.57       4.67       0          OUTLET
L102A            0.013      0.25       1.57       4.67       0          OUTLET
L103A            0.013      0.25       1.57       4.67       0          OUTLET
L104A            0.013      0.25       1.57       4.67       0          OUTLET
L105A            0.013      0.25       1.57       4.67       0          OUTLET
L105B            0.013      0.25       1.57       4.67       0          OUTLET
L105C            0.013      0.25       1.57       4.67       0          OUTLET
L108A            0.013      0.25       1.57       4.67       0          OUTLET
L110A            0.013      0.25       1.57       4.67       0          OUTLET
L110B            0.013      0.25       1.57       4.67       0          OUTLET
```



```
L110C            0.013      0.25       1.57       4.67       0          OUTLET
UNC-1            0.013      0.25       1.57       4.67       0          OUTLET
UNC-2            0.013      0.25       1.57       4.67       0          OUTLET
UNC-3            0.013      0.25       1.57       4.67       0          OUTLET
UNC-4            0.013      0.25       1.57       4.67       0          OUTLET

[INFILTRATION]
;;Subcatchment   Param1     Param2     Param3     Param4     Param5
;;-------------- ---------- ---------- ---------- ---------- ----------
A225NE           76.2       13.2       4.14       7          0
A225NW           76.2       13.2       4.14       7          0
A225SE           76.2       13.2       4.14       7          0
A226NE           76.2       13.2       4.14       7          0
A226NW           76.2       13.2       4.14       7          0
A227NE           76.2       13.2       4.14       7          0
A227NW           76.2       13.2       4.14       7          0
A227SE           76.2       13.2       4.14       7          0
A227SW           76.2       13.2       4.14       7          0
A229N2           76.2       13.2       4.14       7          0
A561N1           76.2       13.2       4.14       7          0
A562NE           76.2       13.2       4.14       7          0
A562R1           76.2       13.2       4.14       7          0
A562R2           76.2       13.2       4.14       7          0
A562R3           76.2       13.2       4.14       7          0
A562R4           76.2       13.2       4.14       7          0
A562SE           76.2       13.2       4.14       7          0
A563NE           76.2       13.2       4.14       7          0
COM              76.2       13.2       4.14       7          0
L100D            76.2       13.2       4.14       7          0
L101A            76.2       13.2       4.14       7          0
L102A            76.2       13.2       4.14       7          0
L103A            76.2       13.2       4.14       7          0
L104A            76.2       13.2       4.14       7          0
L105A            76.2       13.2       4.14       7          0
L105B            76.2       13.2       4.14       7          0
L105C            76.2       13.2       4.14       7          0
L108A            76.2       13.2       4.14       7          0
L110A            76.2       13.2       4.14       7          0
```

```
L110B           76.2       13.2       4.14       7          0
L110C           76.2       13.2       4.14       7          0
UNC-1           76.2       13.2       4.14       7          0
UNC-2           76.2       13.2       4.14       7          0
UNC-3           76.2       13.2       4.14       7          0
UNC-4           76.2       13.2       4.14       7          0

[JUNCTIONS]
;;Name          Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
;SLOPE
CB10            103.03     0.4        0          0          0
CB108           104.5      0.4        0          0          0
CB25            104.32     0.4        0          0          0
CB65            106.22     0.4        0          0          0
CB66            105.77     0.4        0          0          0
CB67            105.6      0.4        0          0          0
CB68            104.59     0.4        0          0          0
CB69            104.56     0.4        0          0          0
CB70            104.21     0.4        0          0          0
CB71            103.94     0.4        0          0          0
CB72            101.47     1.78       0          0          0
CB9             103.02     0.4        0          0          0
CB-9            101.64     1.98       0          0          0
CHILLERTON1     104.433    0.4        0          0          0
CHILLERTON2     104.433    0.4        0          0          0
EPOCH           106.038    0.4        0          0          0
HAIKU           102.85     0.4        0          0          0
;HP
Maj_006         104.508    0.4        0          0          0
MH_109          99.072     3.578      0          0          0
MH_225          103.04     3.35       0          0          0
MH_2250A        100.968    4.322      0          0          0
MH_225A         102.224    3.496      0          0          0
MH_226A         100.56     3.67       0          0          0
MH-562          101.178    2.027      0          0          0
MH-563          100.82     3.485      0          0          0
```



```
[OUTFALLS]
;;Name          Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
CB108-109       102.17     FREE                        NO
CHILLERTON      103.141    FREE                        NO
Greenbank_Rd    0          FREE                        NO
MH_110          98.346     FREE                        NO
MH-564          100.643    FREE                        NO

[STORAGE]
;;Name          Elev.    MaxDepth   InitDepth  Shape      Curve Name/Params            N/A      Fevap
Psi      Ksat     IMD
;;-------------- -------- ---------- ---------- ---------- ---------------------------- -------- --------
       -------- --------
;1500mm
100             97.19    6.04       0          FUNCTIONAL 0         0         1.13      0        0
;1500mm
101             97.41    6.3        0          FUNCTIONAL 0         0         1.13      0        0
;CB
101A            101.89   1.76       0          TABULAR    101A                          0        0
;1200mm
102             98.72    5.47       0          FUNCTIONAL 0         0         1.13      0        0
;CB
102A            101.99   1.78       0          TABULAR    102A                          0        0
102A-Dummy      102.191  5          0          FUNCTIONAL 0         0         0.36      0        0
;1500mm
103             97.88    6.09       0          FUNCTIONAL 0         0         1.13      0        0
;CB
103A            102.23   1.72       0          TABULAR    103A                          0        0
;1500mm
104             98.66    6.24       0          FUNCTIONAL 0         0         1.13      0        0
;CB
104A            102.66   1.74       0          TABULAR    104A                          0        0
104A-Dummy      102.861  5          0          FUNCTIONAL 0         0         0.36      0        0
;1200mm
105             99.18    6.18       0          FUNCTIONAL 0         0         1.13      0        0
;1200mm
105A            103.52   1.83       0          TABULAR    105A                          0        0
```

```
105B             102.53   2.07       0          FUNCTIONAL 0         0         1.13     0        0
;CB
105C             103.82   1.73       0          TABULAR    105C                         0        0
;1200mm
106              101.5    3.76       0          FUNCTIONAL 0         0         1.13     0        0
;1200mm
107              99.66    6.22       0          FUNCTIONAL 0         0         1.13     0        0
;1200mm
108              99.77    5.9        0          FUNCTIONAL 0         0         1.13     0        0
;CB
108A             103.97   1.73       0          TABULAR    108A                         0        0
108A-Dummy       104.351  5          0          FUNCTIONAL 0         0         0.36     0        0
;1200mm
109              102.11   3.89       0          FUNCTIONAL 0         0         1.13     0        0
;1200mm
110              100.24   5.52       0          FUNCTIONAL 0         0         1.13     0        0
;CB
110A             104.27   1.73       0          TABULAR    110A                         0        0
;CB
110B             104.05   1.73       0          TABULAR    110B                         0        0
;CB
110C             103.97   1.73       0          TABULAR    110C                         0        0
110C-Dummy       104.171  5          0          FUNCTIONAL 0         0         0.36     0        0
;CB
110D             104.34   1.73       0          TABULAR    110D                         0        0
111              102.35   2.74       0          FUNCTIONAL 0         0         1.13     0        0
COMM             105.22   1.78       0          TABULAR    COMM-V                       0        0

[CONDUITS]
;;Name           From Node        To Node          Length     Roughness  InOffset   OutOffset  InitFlow
MaxFlow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ----------
----------
;600mm
101-100          101              100              36.236     0.013      99.36      99.17      0          0

101A-Obsidian_Street-3 101A       CB72             16.5       0.013      103.35     102.85     0          0
```



```
;750mm
101-EX_109       100              MH_109           11.288     0.013      99.14      99.09      0          0

;300mm
102-101          102              101              62.924     0.013      100.67     99.73      0          0

102A-101A        102A             101A             9.25       0.013      103.72     103.35     0          0

102A-Umb         102A-Dummy       102A             100        0.013      102.191    102.19     0          0

;525mm
103-101          103              101              32.026     0.013      99.83      99.51      0          0

103A-101A        103A             102A             26         0.013      103.85     103.72     0          0

;525mm
104-103          104              103              70.269     0.013      100.61     99.89      0          0

104A-104B        104A             102A             12.61      0.013      104.35     103.72     0          0

104A-Umb         104A-Dummy       104A             80         0.013      102.861    102.86     0          0

;525mm
105-104          105              104              44.683     0.013      101.13     100.68     0          0

105A-104A        105A             104A             80         0.013      105.31     104.35     0          0

105B-111         105B             111              57.5       0.013      102.53     102.35     0          0

105C-104A        105C             104A             64.3       0.013      105.25     104.35     0          0

;300mm
106-105          106              105              43.7       0.013      101.5      101.28     0          0

;525mm
107-105          107              105              45.352     0.013      101.61     101.16     0          0

;450mm
```

108-107	108	107	36.1	0.013	101.72	101.54	0	0
;300mm								
109-107	109	107	70.451	0.013	102.11	101.76	0	0
;300mm								
110-108	110	108	79.888	0.013	102.19	101.79	0	0
110B-S	110B	CB68	18	0.013	105.68	105.59	0	0
110C-110B	110C	110B	5	0.013	105.7	105.68	0	0
110C-Umb	110C-Dummy	110C	48	0.013	104.171	104.17	0	0
110D-110B	110D	110B	9.63	0.013	105.94	105.68	0	0
C10	CB65	CB66	75.651	0.013	106.22	105.77	0	0
C11	CB66	CB68	88.352	0.013	105.77	104.59	0	0
C12	EPOCH	CB67	74.924	0.013	106.038	105.6	0	0
C13	CB67	CB69	74.585	0.013	105.6	104.56	0	0
C14	CB69	CHILLERTON2	26.282	0.013	104.56	104.433	0	0
C15	CHILLERTON2	CB71	61.414	0.013	104.433	103.94	0	0
C16	CB71	HAIKU	57.185	0.013	103.94	102.85	0	0
C17	HAIKU	CB108-109	40	0.013	102.85	102.17	0	0
C18	CHILLERTON2	CHILLERTON	59.854	0.013	104.433	103.141	0	0
C19	CB68	CHILLERTON1	32.699	0.013	104.59	104.433	0	0
C2	108A-Dummy	108A	70	0.013	104.351	104.35	0	0

C20	CHILLERTON1	CB70	42.952	0.013	104.433	104.21	0	0
C21	CB70	CB72	77.691	0.013	104.21	102.85	0	0
C22	CB9	CB72	29.25	0.013	103.02	102.85	0	0
C23	CB108	CB10	48.81	0.013	104.5	103.03	0	0
C25	CB10	HAIKU	30.857	0.013	103.03	102.85	0	0
C26	Maj_006	CB25	38.078	0.013	104.508	104.32	0	0
C27	CB25	CB9	48.542	0.013	104.32	103.02	0	0
C6	MH-563	MH-564	73.5	0.013	100.82	100.673	0	0
STM-109-110	MH_109	MH_110	60	0.013	99.151	98.731	0	0
STM-2250A-226A	MH_2250A	MH_226A	25	0.013	100.968	100.58	0	0
STM-225-225A	MH_225	MH_225A	88	0.013	103.04	102.424	0	0
STM-225A-2250A	MH_225A	MH_2250A	88.5	0.013	102.224	101.118	0	0
STM-226A-109	MH_226A	MH_109	93	0.013	100.56	99.072	0	0
STM-562-563	MH-562	MH-563	29.5	0.013	101.178	101.045	0	0

[ORIFICES]

;;Name	From Node	To Node	Type	Offset	Qcoeff	Gated	CloseTime
;;--------------	----------------	----------------	------------	----------	----------	--------	----------
;200mm							
102A-O1	102A	102	SIDE	101.99	0.572	NO	0
;200mm							
103A-O1	103A	103	SIDE	102.23	0.572	NO	0
;200mm							
104A-O1	104A	104	SIDE	102.66	0.572	NO	0

```
;200mm
105A-O1          105A             105              SIDE         103.52     0.572      NO       0
105B-O1          111              105              SIDE         102.35     0.572      NO       0
;200mm
108A-O1          108A             108              SIDE         103.97     0.572      NO       0
110A-O1          110A             110              SIDE         104.27     0.572      NO       0
110C-O1          110C             110              SIDE         103.97     0.572      NO       0
110D-O1          110D             110              SIDE         104.34     0.572      NO       0
CB108-O          CB108            MH-563           BOTTOM       104.5      0.62       NO       0
CB10-O           CB10             MH-562           BOTTOM       103.03     0.62       NO       0
CB25-O           CB25             MH-563           BOTTOM       104.32     0.62       NO       0
CB72-O           CB72             MH_109           SIDE         101.47     0.61       NO       0
CB9-O            CB-9             MH-562           SIDE         101.64     0.62       NO       0
CB9-O1           CB9              CB-9             BOTTOM       103.02     0.62       NO       0

[WEIRS]
;;Name           From Node        To Node          Type         CrestHt    Qcoeff     Gated    EndCon
EndCoeff   Surcharge  RoadWidth  RoadSurf   Coeff. Curve
;;-------------- ---------------- ---------------- ------------ ---------- ---------- -------- --------
---------- ---------- ---------- ---------- ----------------
108A-110C        108A             110C             TRAPEZOIDAL  105.57     1.68       NO       0        0
       YES
110A-110D        110A             110D             TRANSVERSE   106        1.38       NO       0        0
       YES
COMM-W           COMM             CB65             TRANSVERSE   106.95     1.67       NO       0        0
       YES
W2               CHILLERTON1      CHILLERTON2      TRANSVERSE   104.56     1.67       NO       0        0
       YES
W3               CB72             HAIKU            TRANSVERSE   102.98     1.67       NO       0        0
       YES
W4               105B             CB70             TRANSVERSE   104.55     1.67       NO       0        0
       YES

[OUTLETS]
;;Name           From Node        To Node          Offset     Type             QTable/Qcoeff    Qexpon
Gated
;;-------------- ---------------- ---------------- ---------- ---------------- ---------------- ----------
--------
```



```
;200mm
101A-O1          101A             101              101.89     TABULAR/HEAD     IPEX-90
NO
;200mm
105C-O1          105C             105              103.82     TABULAR/HEAD     IPEX-105
NO
;200mm
110B-O1          110B             110              104.05     TABULAR/HEAD     IPEX-90
NO
CB65-O           CB65             MH_225           106.22     TABULAR/HEAD     16ROW_1CB_So0.03
NO
CB66-O           CB66             MH_225           105.77     TABULAR/HEAD     16ROW_1CB_So0.005
NO
CB67-O           CB67             MH_225           105.6      TABULAR/HEAD     16ROW_1CB_So0.005
NO
CB68-O           CB68             MH_225A          104.59     TABULAR/HEAD     16ROW_1CB_So0.005
NO
CB69-O           CB69             MH_225A          104.56     TABULAR/HEAD     16ROW_1CB_So0.005
NO
CB70-O           CB70             MH_226A          104.21     TABULAR/HEAD     16ROW_1CB_So0.02
NO
CB71-O           CB71             MH_226A          103.94     TABULAR/HEAD     16ROW_1CB_So0.02
NO
COMM-O           COMM             MH_225           105.22     TABULAR/HEAD     COMM-O
NO

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels    Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
101-100          CIRCULAR     0.675            0          0          0          1
101A-Obsidian_Street-3 IRREGULAR 6.40_ROW_1.4_X-Fall 0    0          0          1
101-EX_109       CIRCULAR     0.675            0          0          0          1
102-101          CIRCULAR     0.3              0          0          0          1
102A-101A        IRREGULAR    7.9_ROW_1.4_X-Fall 0        0          0          1
102A-Umb         CIRCULAR     0.9              0          0          0          1
103-101          CIRCULAR     0.525            0          0          0          1
103A-101A        IRREGULAR    6.40_ROW_2.0_X-Fall 0       0          0          1
104-103          CIRCULAR     0.525            0          0          0          1
```

104A-104B	IRREGULAR	6.40_ROW_1.6_X-Fall	0	0	0	1
104A-Umb	CIRCULAR	0.9	0	0	0	1
105-104	CIRCULAR	0.45	0	0	0	1
105A-104A	IRREGULAR	11.6_ROW_1.3_X-Fall	0	0	0	1
105B-111	CIRCULAR	0.9	0	0	0	1
105C-104A	IRREGULAR	11.6_ROW_1.3_X-Fall	0	0	0	1
106-105	CIRCULAR	0.3	0	0	0	1
107-105	CIRCULAR	0.45	0	0	0	1
108-107	CIRCULAR	0.525	0	0	0	1
109-107	CIRCULAR	0.3	0	0	0	1
110-108	CIRCULAR	0.45	0	0	0	1
110B-S	IRREGULAR	6.40_ROW_2.3_X-Fall	0	0	0	1
110C-110B	IRREGULAR	6.40_ROW_0.6_X-Fall	0	0	0	1
110C-Umb	CIRCULAR	0.9	0	0	0	1
110D-110B	IRREGULAR	6.40_ROW_0.6_X-Fall	0	0	0	1
C10	IRREGULAR	18.00_ROW_LS	0	0	0	1
C11	IRREGULAR	18.00_ROW_LS	0	0	0	1
C12	IRREGULAR	18.00_ROW_LS	0	0	0	1
C13	IRREGULAR	18.00_ROW_LS	0	0	0	1
C14	IRREGULAR	18.00_ROW_LS	0	0	0	1
C15	IRREGULAR	18.00_ROW_LS	0	0	0	1
C16	IRREGULAR	18.00_ROW_LS	0	0	0	1
C17	IRREGULAR	18.00_ROW	0	0	0	1
C18	IRREGULAR	18.00_ROW	0	0	0	1
C19	IRREGULAR	18.00_ROW_LS	0	0	0	1
C2	CIRCULAR	0.9	0	0	0	1
C20	IRREGULAR	18.00_ROW_LS	0	0	0	1
C21	IRREGULAR	18.00_ROW_LS	0	0	0	1
C22	IRREGULAR	18.00_ROW_LS	0	0	0	1
C23	IRREGULAR	18.00_ROW_LS	0	0	0	1
C25	IRREGULAR	18.00_ROW_LS	0	0	0	1
C26	IRREGULAR	18.00_ROW_LS	0	0	0	1
C27	IRREGULAR	18.00_ROW_LS	0	0	0	1
C6	CIRCULAR	0.525	0	0	0	1
STM-109-110	CIRCULAR	0.75	0	0	0	1
STM-2250A-226A	CIRCULAR	0.675	0	0	0	1
STM-225-225A	CIRCULAR	0.525	0	0	0	1
STM-225A-2250A	CIRCULAR	0.525	0	0	0	1

STM-226A-109	CIRCULAR	0.675	0	0	0	1
STM-562-563	CIRCULAR	0.3	0	0	0	1
102A-O1	CIRCULAR	0.127	0	0	0	
103A-O1	CIRCULAR	0.102	0	0	0	
104A-O1	CIRCULAR	0.127	0	0	0	
105A-O1	CIRCULAR	0.127	0	0	0	
105B-O1	CIRCULAR	0.108	0	0	0	
108A-O1	CIRCULAR	0.108	0	0	0	
110A-O1	CIRCULAR	0.127	0	0	0	
110C-O1	CIRCULAR	0.108	0	0	0	
110D-O1	CIRCULAR	0.102	0	0	0	
CB108-O	RECT_CLOSED	0.35	0.35	0	0	
CB10-O	RECT_CLOSED	0.35	0.35	0	0	
CB25-O	RECT_CLOSED	0.35	0.35	0	0	
CB72-O	CIRCULAR	0.25	0	0	0	
CB9-O	CIRCULAR	0.108	0	0	0	
CB9-O1	RECT_CLOSED	0.35	0.35	0	0	
108A-110C	TRAPEZOIDAL	0.1	6.4	0	0	
110A-110D	RECT_OPEN	0.1	6.4	0	0	
COMM-W	RECT_OPEN	0.05	8.5	0	0	
W2	RECT_OPEN	0.25	10	0	0	
W3	RECT_OPEN	0.4	10	0	0	
W4	RECT_OPEN	0.05	3	0	0	

```
[TRANSECTS]
;;Transect Data in HEC-2 format
;
NC 0.025    0.025    0.013
X1 11.6_ROW_1.3_X-Fall  7        -5.8     5.8      0.0      0.0      0.0      0.0      0.0
GR 0.198    -7.4     0.15     -5.8     0        -5.8     0.075    0        0.15     5.8
GR 0.3      5.8      0.349    7.4
;
NC 0.025    0.025    0.013
X1 14.75_ROW         7        1.5      10       0.0      0.0      0.0      0.0      0.0
GR 0.2      0        0.15     1.5      0        1.5      0.13     5.75     0        10
GR 0.15     10       0.35     14.75
;
NC 0.025    0.025    0.013
```

```
X1 18.00_ROW        7        4.75     13.25    0.0      0.0      0.0      0.0      0.0
GR 0.35     0        0.15     4.75     0        4.75     0.13     9        0        13.25
GR 0.15     13.25    0.35     18
;
NC 0.025    0.025    0.013
X1 18.00_ROW_LS     4        4.75     9        0.0      0.0      0.0      0.0      0.0
GR 0.35     0        0.15     4.75     0        4.75     0.13     9
;
NC 0.025    0.025    0.013
X1 6.40_ROW_0.6_X-Fall  5       -3.2     3.2      0.0      0.0      0.0      0.0      0.0
GR 0.15     -3.2     0        -3.2     0.02     0        0.04     3.2      0.19     3.2
;
NC 0.025    0.025    0.013
X1 6.40_ROW_1.2_X-Fall  5       -3.2     3.2      0.0      0.0      0.0      0.0      0.0
GR 0.15     -3.2     0        -3.2     0.04     0        0.08     3.2      0.23     3.2
;
NC 0.025    0.025    0.013
X1 6.40_ROW_1.4_X-Fall  7       -3.2     3.2      0.0      0.0      0.0      0.0      0.0
GR 0.213    -5.3     0.15     -3.2     0        -3.2     0.045    0        0.09     3.2
GR 0.24     3.2      0.288    4.8
;
NC 0.025    0.025    0.013
X1 6.40_ROW_1.6_X-Fall  5       -3.2     3.2      0.0      0.0      0.0      0.0      0.0
GR 0.15     -3.2     0        -3.2     0.05     0        0.1      3.2      0.25     3.2
;
NC 0.025    0.025    0.013
X1 6.40_ROW_2.0_X-Fall  7       -3.2     3.2      0.0      0.0      0.0      0.0      0.0
GR 0.216    -5.4     0.15     -3.2     0        -3.2     0.065    0        0.13     3.2
GR 0.28     3.2      0.328    4.8
;
NC 0.025    0.025    0.013
X1 6.40_ROW_2.3_X-Fall  7       -3.2     3.2      0.0      0.0      0.0      0.0      0.0
GR 0.267    -7.1     0.15     -3.2     0        -3.2     0.075    0        0.15     3.2
GR 0.3      3.2      0.417    7.1
;
NC 0.025    0.025    0.013
X1 7.9_ROW_1.4_X-Fall  5       -3.95    3.95     0.0      0.0      0.0      0.0      0.0
GR 0.15     -3.95    0        -3.95    0.055    0        0.11     3.95     0.26     3.95
```



```
[LOSSES]
;;Link           Kentry     Kexit      Kavg       Flap Gate  Seepage
;;-------------- ---------- ---------- ---------- ---------- ----------
101-100          0          0.157      0          NO         0
101-EX_109       0          0.168      0          NO         0
102-101          0          1.344      0          NO         0
103-101          0          0.021      0          NO         0
104-103          0          1.344      0          NO         0
105-104          0          0.021      0          NO         0
106-105          0          1.344      0          NO         0
107-105          0          0.021      0          NO         0
108-107          0          1.344      0          NO         0
109-107          0          0.021      0          NO         0
110-108          0          1.344      0          NO         0
C6               0          0.055      0          NO         0
STM-109-110      0          0.02       0          NO         0
STM-2250A-226A   0          0.02       0          NO         0
STM-225-225A     0          0.02       0          NO         0
STM-225A-2250A   0          0.02       0          NO         0
STM-226A-109     0          1.33       0          NO         0
STM-562-563      0          1.19       0          NO         0

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
P1-Q             Pump1      0          2
P1-Q                        1000       2

16ROW_1CB_So0.005 Rating     0          0
16ROW_1CB_So0.005            0.01       0.3
16ROW_1CB_So0.005            0.02       1.1
16ROW_1CB_So0.005            0.03       3.7
16ROW_1CB_So0.005            0.04       7.2
16ROW_1CB_So0.005            0.05       13.2
16ROW_1CB_So0.005            0.06       16.8
16ROW_1CB_So0.005            0.07       21.4
16ROW_1CB_So0.005            0.08       25.3
```

16ROW_1CB_So0.005	0.09	28.6
16ROW_1CB_So0.005	0.1	33.1
16ROW_1CB_So0.005	0.11	36.7
16ROW_1CB_So0.005	0.12	40.9
16ROW_1CB_So0.005	0.13	44.6
16ROW_1CB_So0.005	0.14	48
16ROW_1CB_So0.005	0.15	49
16ROW_1CB_So0.005	0.16	49
16ROW_1CB_So0.005	0.17	49
16ROW_1CB_So0.005	0.18	49
16ROW_1CB_So0.005	0.19	49
16ROW_1CB_So0.005	0.2	49
16ROW_1CB_So0.005	0.21	49
16ROW_1CB_So0.005	0.22	49
16ROW_1CB_So0.005	0.23	49
16ROW_1CB_So0.005	0.24	49
16ROW_1CB_So0.005	0.25	49
16ROW_1CB_So0.005	0.26	49
16ROW_1CB_So0.005	0.27	49
16ROW_1CB_So0.005	0.28	49
16ROW_1CB_So0.005	0.29	49
16ROW_1CB_So0.005	0.3	49
16ROW_1CB_So0.005	0.31	49
16ROW_1CB_So0.005	0.32	49
16ROW_1CB_So0.005	0.33	49
16ROW_1CB_So0.005	0.34	49
16ROW_1CB_So0.005	0.35	49
16ROW_1CB_So0.005	0.36	49
16ROW_1CB_So0.005	0.37	49
16ROW_1CB_So0.005	0.38	49
16ROW_1CB_So0.005	0.39	49
16ROW_1CB_So0.005	0.4	49
16ROW_1CB_So0.02 Rating	0	0
16ROW_1CB_So0.02	0.01	0.6
16ROW_1CB_So0.02	0.02	1.9
16ROW_1CB_So0.02	0.03	6.2
16ROW_1CB_So0.02	0.04	12

16ROW_1CB_So0.02	0.05	15.4
16ROW_1CB_So0.02	0.06	19.2
16ROW_1CB_So0.02	0.07	23.6
16ROW_1CB_So0.02	0.08	27.5
16ROW_1CB_So0.02	0.09	31.6
16ROW_1CB_So0.02	0.1	36.3
16ROW_1CB_So0.02	0.11	41
16ROW_1CB_So0.02	0.12	45
16ROW_1CB_So0.02	0.13	45
16ROW_1CB_So0.02	0.14	45
16ROW_1CB_So0.02	0.15	45
16ROW_1CB_So0.02	0.16	45
16ROW_1CB_So0.02	0.17	45
16ROW_1CB_So0.02	0.18	45
16ROW_1CB_So0.02	0.19	45
16ROW_1CB_So0.02	0.2	45
16ROW_1CB_So0.02	0.21	45
16ROW_1CB_So0.02	0.22	45
16ROW_1CB_So0.02	0.23	45
16ROW_1CB_So0.02	0.24	45
16ROW_1CB_So0.02	0.25	45
16ROW_1CB_So0.02	0.26	45
16ROW_1CB_So0.02	0.27	45
16ROW_1CB_So0.02	0.28	45
16ROW_1CB_So0.02	0.29	45
16ROW_1CB_So0.02	0.3	45
16ROW_1CB_So0.02	0.31	45
16ROW_1CB_So0.02	0.32	45
16ROW_1CB_So0.03 Rating	0	0
16ROW_1CB_So0.03	0.01	0.5
16ROW_1CB_So0.03	0.02	1.7
16ROW_1CB_So0.03	0.03	5.7
16ROW_1CB_So0.03	0.04	11
16ROW_1CB_So0.03	0.05	14.6
16ROW_1CB_So0.03	0.06	17.9
16ROW_1CB_So0.03	0.07	21.6
16ROW_1CB_So0.03	0.08	25.6

16ROW_1CB_So0.03		0.09	29.8
16ROW_1CB_So0.03		0.1	33.5
16ROW_1CB_So0.03		0.11	38
16ROW_1CB_So0.03		0.12	39
16ROW_1CB_So0.03		0.13	39
16ROW_1CB_So0.03		0.14	39
16ROW_1CB_So0.03		0.15	39
16ROW_1CB_So0.03		0.16	39
16ROW_1CB_So0.03		0.17	39
16ROW_1CB_So0.03		0.18	39
16ROW_1CB_So0.03		0.19	39
16ROW_1CB_So0.03		0.2	39
16ROW_1CB_So0.03		0.21	39
16ROW_1CB_So0.03		0.22	39
16ROW_1CB_So0.03		0.23	39
16ROW_1CB_So0.03		0.24	39
16ROW_1CB_So0.03		0.25	39
16ROW_1CB_So0.03		0.26	39
16ROW_1CB_So0.03		0.27	39
16ROW_1CB_So0.03		0.28	39
16ROW_1CB_So0.03		0.29	39
16ROW_1CB_So0.03		0.3	39
COMM-O	Rating	0	0
COMM-O		1.38	170
COMM-O		1.73	175
COMM-O		1.78	175
IPEX-105	Rating	0	0
IPEX-105		0.1	3.11
IPEX-105		0.2	4.39
IPEX-105		0.3	5.37
IPEX-105		0.4	6.19
IPEX-105		0.5	6.92
IPEX-105		0.6	7.58
IPEX-105		0.7	8.19
IPEX-105		0.8	8.76
IPEX-105		0.9	9.29

IPEX-105		1	9.79
IPEX-105		1.1	10.27
IPEX-105		1.2	10.73
IPEX-105		1.3	11.16
IPEX-105		1.4	11.58
IPEX-105		1.5	11.99
IPEX-105		1.6	12.39
IPEX-105		1.7	12.77
IPEX-105		1.8	13.14
IPEX-105		1.9	13.5
IPEX-105		2	13.85
IPEX-105		2.1	14.19
IPEX-105		2.2	14.52
IPEX-105		2.3	14.85
IPEX-105		2.4	15.17
IPEX-105		2.5	15.48
IPEX-105		2.6	15.79
IPEX-105		2.7	16.09
IPEX-105		2.8	16.39
IPEX-105		2.9	16.68
IPEX-105		3	16.96
IPEX-105		3.1	17.24
IPEX-105		3.2	17.52
IPEX-105		3.3	17.79
IPEX-105		3.4	18.06
IPEX-105		3.5	18.32
IPEX-105		3.6	18.58
IPEX-105		3.7	18.84
IPEX-105		3.8	19.09
IPEX-105		3.9	19.34
IPEX-105		4	19.59
IPEX-105		4.1	19.83
IPEX-105		4.2	20.07
IPEX-105		4.3	20.31
IPEX-105		4.4	20.55
IPEX-105		4.5	20.78
IPEX-105		4.6	21.01
IPEX-105		4.7	21.24

IPEX-105		4.8	21.46
IPEX-105		4.9	21.68
IPEX-105		5	21.9
IPEX-40	Rating	0	0
IPEX-40		0.1	0.42
IPEX-40		0.2	0.59
IPEX-40		0.3	0.73
IPEX-40		0.4	0.85
IPEX-40		0.5	0.95
IPEX-40		0.6	1.04
IPEX-40		0.7	1.13
IPEX-40		0.8	1.21
IPEX-40		0.9	1.28
IPEX-40		1	1.35
IPEX-40		1.1	1.42
IPEX-40		1.2	1.48
IPEX-40		1.3	1.55
IPEX-40		1.4	1.61
IPEX-40		1.5	1.66
IPEX-40		1.6	1.72
IPEX-40		1.7	1.77
IPEX-40		1.8	1.82
IPEX-40		1.9	1.88
IPEX-40		2	1.93
IPEX-40		2.1	1.97
IPEX-40		2.2	2.02
IPEX-40		2.3	2.07
IPEX-40		2.4	2.11
IPEX-40		2.5	2.16
IPEX-40		2.6	2.2
IPEX-40		2.7	2.24
IPEX-40		2.8	2.28
IPEX-40		2.9	2.32
IPEX-40		3	2.37
IPEX-40		3.1	2.4
IPEX-40		3.2	2.44
IPEX-40		3.3	2.48

IPEX-40		3.4	2.52
IPEX-40		3.5	2.56
IPEX-40		3.6	2.59
IPEX-40		3.7	2.63
IPEX-40		3.8	2.67
IPEX-40		3.9	2.7
IPEX-40		4	2.74
IPEX-40		4.1	2.77
IPEX-40		4.2	2.8
IPEX-40		4.3	2.84
IPEX-40		4.4	2.87
IPEX-40		4.5	2.9
IPEX-40		4.6	2.94
IPEX-40		4.7	2.97
IPEX-40		4.8	3
IPEX-40		4.9	3.03
IPEX-40		5	3.06
IPEX-50	Rating	0	0
IPEX-50		0.1	0.73
IPEX-50		0.2	1.02
IPEX-50		0.3	1.24
IPEX-50		0.4	1.43
IPEX-50		0.5	1.59
IPEX-50		0.6	1.75
IPEX-50		0.7	1.88
IPEX-50		0.8	2.02
IPEX-50		0.9	2.14
IPEX-50		1	2.25
IPEX-50		1.1	2.36
IPEX-50		1.2	2.47
IPEX-50		1.3	2.57
IPEX-50		1.4	2.67
IPEX-50		1.5	2.76
IPEX-50		1.6	2.85
IPEX-50		1.7	2.94
IPEX-50		1.8	3.03
IPEX-50		1.9	3.11

IPEX-50		2	3.19
IPEX-50		2.1	3.27
IPEX-50		2.2	3.35
IPEX-50		2.3	3.42
IPEX-50		2.4	3.5
IPEX-50		2.5	3.57
IPEX-50		2.6	3.64
IPEX-50		2.7	3.71
IPEX-50		2.8	3.78
IPEX-50		2.9	3.85
IPEX-50		3	3.91
IPEX-50		3.1	3.98
IPEX-50		3.2	4.04
IPEX-50		3.3	4.11
IPEX-50		3.4	4.17
IPEX-50		3.5	4.23
IPEX-50		3.6	4.29
IPEX-50		3.7	4.35
IPEX-50		3.8	4.41
IPEX-50		3.9	4.46
IPEX-50		4	4.52
IPEX-50		4.1	4.58
IPEX-50		4.2	4.63
IPEX-50		4.3	4.69
IPEX-50		4.4	4.74
IPEX-50		4.5	4.8
IPEX-50		4.6	4.85
IPEX-50		4.7	4.9
IPEX-50		4.8	4.96
IPEX-50		4.9	5.01
IPEX-50		5	5.06
IPEX-55	Rating	0	0
IPEX-55		0.1	0.9
IPEX-55		0.2	1.23
IPEX-55		0.3	1.49
IPEX-55		0.4	1.72
IPEX-55		0.5	1.91

POST-DEVELOPMENT MODEL - 100Y 24H SCS

IPEX-55		0.6	2.09
IPEX-55		0.7	2.26
IPEX-55		0.8	2.42
IPEX-55		0.9	2.56
IPEX-55		1	2.7
IPEX-55		1.1	2.83
IPEX-55		1.2	2.96
IPEX-55		1.3	3.08
IPEX-55		1.4	3.2
IPEX-55		1.5	3.31
IPEX-55		1.6	3.42
IPEX-55		1.7	3.53
IPEX-55		1.8	3.63
IPEX-55		1.9	3.73
IPEX-55		2	3.83
IPEX-55		2.1	3.92
IPEX-55		2.2	4.01
IPEX-55		2.3	4.11
IPEX-55		2.4	4.19
IPEX-55		2.5	4.28
IPEX-55		2.6	4.37
IPEX-55		2.7	4.45
IPEX-55		2.8	4.53
IPEX-55		2.9	4.61
IPEX-55		3	4.69
IPEX-55		3.1	4.77
IPEX-55		3.2	4.85
IPEX-55		3.3	4.92
IPEX-55		3.4	5
IPEX-55		3.5	5.07
IPEX-55		3.6	5.14
IPEX-55		3.7	5.21
IPEX-55		3.8	5.29
IPEX-55		3.9	5.35
IPEX-55		4	5.42
IPEX-55		4.1	5.49
IPEX-55		4.2	5.56
IPEX-55		4.3	5.62

IPEX-55		4.4	5.69
IPEX-55		4.5	5.75
IPEX-55		4.6	5.82
IPEX-55		4.7	5.88
IPEX-55		4.8	5.94
IPEX-55		4.9	6.01
IPEX-55		5	6.07

IPEX-80	Rating	0	0
IPEX-80		0.1	1.81
IPEX-80		0.2	2.56
IPEX-80		0.3	3.13
IPEX-80		0.4	3.61
IPEX-80		0.5	4.04
IPEX-80		0.6	4.43
IPEX-80		0.7	4.78
IPEX-80		0.8	5.11
IPEX-80		0.9	5.42
IPEX-80		1	5.71
IPEX-80		1.1	5.99
IPEX-80		1.2	6.26
IPEX-80		1.3	6.52
IPEX-80		1.4	6.76
IPEX-80		1.5	7
IPEX-80		1.6	7.23
IPEX-80		1.7	7.45
IPEX-80		1.8	7.67
IPEX-80		1.9	7.88
IPEX-80		2	8.08
IPEX-80		2.1	8.28
IPEX-80		2.2	8.48
IPEX-80		2.3	8.67
IPEX-80		2.4	8.85
IPEX-80		2.5	9.04
IPEX-80		2.6	9.21
IPEX-80		2.7	9.39
IPEX-80		2.8	9.56
IPEX-80		2.9	9.73

IPEX-80		3	9.9
IPEX-80		3.1	10.06
IPEX-80		3.2	10.22
IPEX-80		3.3	10.38
IPEX-80		3.4	10.54
IPEX-80		3.5	10.69
IPEX-80		3.6	10.84
IPEX-80		3.7	10.99
IPEX-80		3.8	11.14
IPEX-80		3.9	11.29
IPEX-80		4	11.43
IPEX-80		4.1	11.57
IPEX-80		4.2	11.71
IPEX-80		4.3	11.85
IPEX-80		4.4	11.99
IPEX-80		4.5	12.12
IPEX-80		4.6	12.26
IPEX-80		4.7	12.39
IPEX-80		4.8	12.52
IPEX-80		4.9	12.65
IPEX-80		5	12.78

IPEX-90	Rating	0	0
IPEX-90		0.1	2.21
IPEX-90		0.2	3.17
IPEX-90		0.3	3.9
IPEX-90		0.4	4.51
IPEX-90		0.5	5.05
IPEX-90		0.6	5.54
IPEX-90		0.7	5.99
IPEX-90		0.8	6.41
IPEX-90		0.9	6.8
IPEX-90		1	7.17
IPEX-90		1.1	7.52
IPEX-90		1.2	7.86
IPEX-90		1.3	8.19
IPEX-90		1.4	8.5
IPEX-90		1.5	8.8

IPEX-90		1.6	9.09
IPEX-90		1.7	9.37
IPEX-90		1.8	9.64
IPEX-90		1.9	9.91
IPEX-90		2	10.17
IPEX-90		2.1	10.42
IPEX-90		2.2	10.66
IPEX-90		2.3	10.9
IPEX-90		2.4	11.14
IPEX-90		2.5	11.37
IPEX-90		2.6	11.6
IPEX-90		2.7	11.82
IPEX-90		2.8	12.04
IPEX-90		2.9	12.25
IPEX-90		3	12.46
IPEX-90		3.1	12.67
IPEX-90		3.2	12.87
IPEX-90		3.3	13.07
IPEX-90		3.4	13.27
IPEX-90		3.5	13.46
IPEX-90		3.6	13.65
IPEX-90		3.7	13.84
IPEX-90		3.8	14.03
IPEX-90		3.9	14.21
IPEX-90		4	14.4
IPEX-90		4.1	14.58
IPEX-90		4.2	14.75
IPEX-90		4.3	14.93
IPEX-90		4.4	15.1
IPEX-90		4.5	15.27
IPEX-90		4.6	15.44
IPEX-90		4.7	15.61
IPEX-90		4.8	15.77
IPEX-90		4.9	15.94
IPEX-90		5	16.1
101A	Storage	0	0.36
101A		1.41	0.36

101A		1.46	10.9
101A		1.76	10.91
102A	Storage	0	0.36
102A		1.38	0.36
102A		1.73	552.6
102B	Storage	0	0.36
102B		1.38	0.36
102B		1.63	113.2
102B		1.73	113.21
103A	Storage	0	0.36
103A		1.37	0.36
103A		1.62	328.9
103A		1.72	328.91
104A	Storage	0	0.36
104A		1.34	0.36
104A		1.69	773.2
104B	Storage	0	0.36
104B		1.38	0.36
104B		1.63	140.5
104B		1.73	140.51
105A	Storage	0	0.36
105A		1.68	0.36
105A		1.85	136.8
105A		2.03	136.81
105C	Storage	0	0.36
105C		1.38	0.36
105C		1.43	19
105C		1.73	19.01
108A	Storage	0	0.36
108A		1.38	0.36

```
108A                         1.73       898.2

110A            Storage      0          0.36
110A                         1.38       0.36
110A                         1.73       595.4

110B            Storage      0          0.36
110B                         1.38       0.36
110B                         1.63       98.4
110B                         1.73       98.41

110C            Storage      0          0.36
110C                         1.38       0.36
110C                         1.73       863.6

110D            Storage      0          0.36
110D                         1.38       0.36
110D                         1.6        256.9
110D                         1.73       256.91

C655B-V         Storage      0          0
C655B-V                      1          0
C655B-V                      1.001      0
C655B-V                      3          0

C664B-V         Storage      0          38.5
C664B-V                      1          38.5
C664B-V                      1.001      0
C664B-V                      3          0

C666B-V         Storage      0          49.9
C666B-V                      1          49.9
C666B-V                      1.001      0
C666B-V                      3          0

C668A-V         Storage      0          11.6
C668A-V                      1          11.6
C668A-V                      1.001      0
```



```
C668A-V                      3.17       0

C719A-V         Storage      0          7.2
C719A-V                      1          7.2
C719A-V                      1.001      0
C719A-V                      3          0

C724B-V         Storage      0          25.2
C724B-V                      1          25.2
C724B-V                      1.001      0
C724B-V                      3          0

C726B-V         Storage      0          12.3
C726B-V                      1          12.3
C726B-V                      1.001      0
C726B-V                      3          0

C731C-V         Storage      0          26.12
C731C-V                      1          26.12
C731C-V                      1.001      0
C731C-V                      3          0

COMM-V          Storage      0          0
COMM-V                       1.38       0
COMM-V                       1.78       1530

[TIMESERIES]
;;Name          Date         Time       Value
;;-------------- ---------- ---------- ----------
002C                         0:00       0
002C                         0:10       2.81
002C                         0:20       3.5
002C                         0:30       4.69
002C                         0:40       7.3
002C                         0:50       18.21
002C                         1:00       76.81
002C                         1:10       24.08
002C                         1:20       12.36
```

002C	1:30	8.32
002C	1:40	6.3
002C	1:50	5.09
002C	2:00	4.29
002C	2:10	3.72
002C	2:20	3.29
002C	2:30	2.95
002C	2:40	2.68
002C	2:50	2.46
002C	3:00	2.28

002S	07/23/2009 00:00:00	1.08
002S	07/23/2009 00:15:00	1.08
002S	07/23/2009 00:30:00	1.08
002S	07/23/2009 00:45:00	1.08
002S	07/23/2009 01:00:00	1.08
002S	07/23/2009 01:15:00	1.08
002S	07/23/2009 01:30:00	1.08
002S	07/23/2009 01:45:00	1.08
002S	07/23/2009 02:00:00	1.296
002S	07/23/2009 02:15:00	1.296
002S	07/23/2009 02:30:00	1.296
002S	07/23/2009 02:45:00	1.296
002S	07/23/2009 03:00:00	1.728
002S	07/23/2009 03:15:00	1.728
002S	07/23/2009 03:30:00	1.728
002S	07/23/2009 03:45:00	1.728
002S	07/23/2009 04:00:00	2.592
002S	07/23/2009 04:15:00	2.592
002S	07/23/2009 04:30:00	3.456
002S	07/23/2009 04:45:00	3.456
002S	07/23/2009 05:00:00	5.184
002S	07/23/2009 05:15:00	5.184
002S	07/23/2009 05:30:00	20.736
002S	07/23/2009 05:45:00	57.024
002S	07/23/2009 06:00:00	7.776
002S	07/23/2009 06:15:00	7.776
002S	07/23/2009 06:30:00	3.456

002S	07/23/2009 06:45:00	3.456
002S	07/23/2009 07:00:00	2.592
002S	07/23/2009 07:15:00	2.592
002S	07/23/2009 07:30:00	2.592
002S	07/23/2009 07:45:00	2.592
002S	07/23/2009 08:00:00	1.512
002S	07/23/2009 08:15:00	1.512
002S	07/23/2009 08:30:00	1.512
002S	07/23/2009 08:45:00	1.512
002S	07/23/2009 09:00:00	1.512
002S	07/23/2009 09:15:00	1.512
002S	07/23/2009 09:30:00	1.512
002S	07/23/2009 09:45:00	1.512
002S	07/23/2009 10:00:00	0.864
002S	07/23/2009 10:15:00	0.864
002S	07/23/2009 10:30:00	0.864
002S	07/23/2009 10:45:00	0.864
002S	07/23/2009 11:00:00	0.864
002S	07/23/2009 11:15:00	0.864
002S	07/23/2009 11:30:00	0.864
002S	07/23/2009 12:00:00	0

005C	0:00	0
005C	0:10	3.68
005C	0:20	4.58
005C	0:30	6.15
005C	0:40	9.61
005C	0:50	24.17
005C	1:00	104.19
005C	1:10	32.04
005C	1:20	16.34
005C	1:30	10.96
005C	1:40	8.29
005C	1:50	6.69
005C	2:00	5.63
005C	2:10	4.87
005C	2:20	4.3
005C	2:30	3.86

005C	2:40	3.51
005C	2:50	3.22
005C	3:00	2.98

005S	07/23/2009 00:00:00	1.44
005S	07/23/2009 00:15:00	1.44
005S	07/23/2009 00:30:00	1.44
005S	07/23/2009 00:45:00	1.44
005S	07/23/2009 01:00:00	1.44
005S	07/23/2009 01:15:00	1.44
005S	07/23/2009 01:30:00	1.44
005S	07/23/2009 01:45:00	1.44
005S	07/23/2009 02:00:00	1.728
005S	07/23/2009 02:15:00	1.728
005S	07/23/2009 02:30:00	1.728
005S	07/23/2009 02:45:00	1.728
005S	07/23/2009 03:00:00	2.304
005S	07/23/2009 03:15:00	2.304
005S	07/23/2009 03:30:00	2.304
005S	07/23/2009 03:45:00	2.304
005S	07/23/2009 04:00:00	3.456
005S	07/23/2009 04:15:00	3.456
005S	07/23/2009 04:30:00	4.608
005S	07/23/2009 04:45:00	4.608
005S	07/23/2009 05:00:00	6.912
005S	07/23/2009 05:15:00	6.912
005S	07/23/2009 05:30:00	27.648
005S	07/23/2009 05:45:00	76.032
005S	07/23/2009 06:00:00	10.368
005S	07/23/2009 06:15:00	10.368
005S	07/23/2009 06:30:00	4.608
005S	07/23/2009 06:45:00	4.608
005S	07/23/2009 07:00:00	3.456
005S	07/23/2009 07:15:00	3.456
005S	07/23/2009 07:30:00	3.456
005S	07/23/2009 07:45:00	3.456
005S	07/23/2009 08:00:00	2.016
005S	07/23/2009 08:15:00	2.016

005S	07/23/2009 08:30:00	2.016
005S	07/23/2009 08:45:00	2.016
005S	07/23/2009 09:00:00	2.016
005S	07/23/2009 09:15:00	2.016
005S	07/23/2009 09:30:00	2.016
005S	07/23/2009 09:45:00	2.016
005S	07/23/2009 10:00:00	1.152
005S	07/23/2009 10:15:00	1.152
005S	07/23/2009 10:30:00	1.152
005S	07/23/2009 10:45:00	1.152
005S	07/23/2009 11:00:00	1.152
005S	07/23/2009 11:15:00	1.152
005S	07/23/2009 11:30:00	1.152
005S	07/23/2009 11:45:00	1.152
005S	07/23/2009 12:00:00	0

010S	07/23/2009 00:00:00	1.68
010S	07/23/2009 00:15:00	1.68
010S	07/23/2009 00:30:00	1.68
010S	07/23/2009 00:45:00	1.68
010S	07/23/2009 01:00:00	1.68
010S	07/23/2009 01:15:00	1.68
010S	07/23/2009 01:30:00	1.68
010S	07/23/2009 01:45:00	1.68
010S	07/23/2009 02:00:00	2.02
010S	07/23/2009 02:15:00	2.02
010S	07/23/2009 02:30:00	2.02
010S	07/23/2009 02:45:00	2.02
010S	07/23/2009 03:00:00	2.69
010S	07/23/2009 03:15:00	2.69
010S	07/23/2009 03:30:00	2.69
010S	07/23/2009 03:45:00	2.69
010S	07/23/2009 04:00:00	4.03
010S	07/23/2009 04:15:00	4.03
010S	07/23/2009 04:30:00	5.38
010S	07/23/2009 04:45:00	5.38
010S	07/23/2009 05:00:00	8.06
010S	07/23/2009 05:15:00	8.06

010S	07/23/2009 05:30:00	32.26
010S	07/23/2009 05:45:00	88.70
010S	07/23/2009 06:00:00	12.10
010S	07/23/2009 06:15:00	12.10
010S	07/23/2009 06:30:00	5.38
010S	07/23/2009 06:45:00	5.38
010S	07/23/2009 07:00:00	4.03
010S	07/23/2009 07:15:00	4.03
010S	07/23/2009 07:30:00	4.03
010S	07/23/2009 07:45:00	4.03
010S	07/23/2009 08:00:00	2.35
010S	07/23/2009 08:15:00	2.35
010S	07/23/2009 08:30:00	2.35
010S	07/23/2009 08:45:00	2.35
010S	07/23/2009 09:00:00	2.35
010S	07/23/2009 09:15:00	2.35
010S	07/23/2009 09:30:00	2.35
010S	07/23/2009 09:45:00	2.35
010S	07/23/2009 10:00:00	1.34
010S	07/23/2009 10:15:00	1.34
010S	07/23/2009 10:30:00	1.34
010S	07/23/2009 10:45:00	1.34
010S	07/23/2009 11:00:00	1.34
010S	07/23/2009 11:15:00	1.34
010S	07/23/2009 11:30:00	1.34
010S	07/23/2009 11:45:00	1.34
010S	07/23/2009 12:00:00	0.00

022M	0:10	1.334157488
022M	0:20	1.539221509
022M	0:30	1.829269592
022M	0:40	2.273590134
022M	0:50	3.046310774
022M	1:00	4.747597332
022M	1:10	11.83434263
022M	1:20	49.91741282
022M	1:30	15.64955899
022M	1:40	8.035504354

022M	1:50	5.409986874
022M	2:00	4.096737441
022M	2:10	3.311349782
022M	2:20	2.789038359
022M	2:30	2.416326443
022M	2:40	2.136703141
022M	2:50	1.918926607
022M	3:00	1.744318025
022M	3:10	1.601074776
022M	3:20	1.48131328
022M	3:30	1.379613173
022M	3:40	1.292113904
022M	3:50	1.215981807
022M	4:00	1.149098129

022-tess	0:00	0
022-tess	0:01	0
022-tess	0:02	0
022-tess	0:03	0
022-tess	0:04	0
022-tess	0:05	0
022-tess	0:06	0
022-tess	0:07	0
022-tess	0:08	0
022-tess	0:09	0
022-tess	0:10	0.133415749
022-tess	0:11	0.266831498
022-tess	0:12	0.400247246
022-tess	0:13	0.533662995
022-tess	0:14	0.667078744
022-tess	0:15	0.800494493
022-tess	0:16	0.933910242
022-tess	0:17	1.06732599
022-tess	0:18	1.200741739
022-tess	0:19	1.334157488
022-tess	0:20	1.35466389
022-tess	0:21	1.375170292
022-tess	0:22	1.395676694

POST-DEVELOPMENT MODEL - 100Y 24H SCS

022-tess	0:23	1.416183096
022-tess	0:24	1.436689499
022-tess	0:25	1.457195901
022-tess	0:26	1.477702303
022-tess	0:27	1.498208705
022-tess	0:28	1.518715107
022-tess	0:29	1.539221509
022-tess	0:30	1.568226317
022-tess	0:31	1.597231126
022-tess	0:32	1.626235934
022-tess	0:33	1.655240742
022-tess	0:34	1.684245551
022-tess	0:35	1.713250359
022-tess	0:36	1.742255167
022-tess	0:37	1.771259975
022-tess	0:38	1.800264784
022-tess	0:39	1.829269592
022-tess	0:40	1.873701646
022-tess	0:41	1.9181337
022-tess	0:42	1.962565755
022-tess	0:43	2.006997809
022-tess	0:44	2.051429863
022-tess	0:45	2.095861917
022-tess	0:46	2.140293971
022-tess	0:47	2.184726026
022-tess	0:48	2.22915808
022-tess	0:49	2.273590134
022-tess	0:50	2.350862198
022-tess	0:51	2.428134262
022-tess	0:52	2.505406326
022-tess	0:53	2.58267839
022-tess	0:54	2.659950454
022-tess	0:55	2.737222518
022-tess	0:56	2.814494582
022-tess	0:57	2.891766646
022-tess	0:58	2.96903871
022-tess	0:59	3.046310774
022-tess	1:00	3.21643943

POST-DEVELOPMENT MODEL - 100Y 24H SCS

022-tess	1:01	3.386568086
022-tess	1:02	3.556696741
022-tess	1:03	3.726825397
022-tess	1:04	3.896954053
022-tess	1:05	4.067082709
022-tess	1:06	4.237211365
022-tess	1:07	4.40734002
022-tess	1:08	4.577468676
022-tess	1:09	4.747597332
022-tess	1:10	5.456271862
022-tess	1:11	6.164946392
022-tess	1:12	6.873620921
022-tess	1:13	7.582295451
022-tess	1:14	8.290969981
022-tess	1:15	8.999644511
022-tess	1:16	9.708319041
022-tess	1:17	10.41699357
022-tess	1:18	11.1256681
022-tess	1:19	11.83434263
022-tess	1:20	15.64264965
022-tess	1:21	19.45095667
022-tess	1:22	23.25926369
022-tess	1:23	27.06757071
022-tess	1:24	30.87587773
022-tess	1:25	34.68418474
022-tess	1:26	38.49249176
022-tess	1:27	42.30079878
022-tess	1:28	46.1091058
022-tess	1:29	49.91741282
022-tess	1:30	46.49062744
022-tess	1:31	43.06384205
022-tess	1:32	39.63705667
022-tess	1:33	36.21027129
022-tess	1:34	32.78348591
022-tess	1:35	29.35670052
022-tess	1:36	25.92991514
022-tess	1:37	22.50312976
022-tess	1:38	19.07634437

POST-DEVELOPMENT MODEL - 100Y 24H SCS

022-tess	1:39	15.64955899
022-tess	1:40	14.88815353
022-tess	1:41	14.12674806
022-tess	1:42	13.3653426
022-tess	1:43	12.60393714
022-tess	1:44	11.84253167
022-tess	1:45	11.08112621
022-tess	1:46	10.31972074
022-tess	1:47	9.558315281
022-tess	1:48	8.796909818
022-tess	1:49	8.035504354
022-tess	1:50	7.772952606
022-tess	1:51	7.510400858
022-tess	1:52	7.24784911
022-tess	1:53	6.985297362
022-tess	1:54	6.722745614
022-tess	1:55	6.460193866
022-tess	1:56	6.197642118
022-tess	1:57	5.93509037
022-tess	1:58	5.672538622
022-tess	1:59	5.409986874
022-tess	2:00	5.278661931
022-tess	2:01	5.147336987
022-tess	2:02	5.016012044
022-tess	2:03	4.884687101
022-tess	2:04	4.753362157
022-tess	2:05	4.622037214
022-tess	2:06	4.490712271
022-tess	2:07	4.359387328
022-tess	2:08	4.228062384
022-tess	2:09	4.096737441
022-tess	2:10	4.018198675
022-tess	2:11	3.939659909
022-tess	2:12	3.861121143
022-tess	2:13	3.782582377
022-tess	2:14	3.704043611
022-tess	2:15	3.625504846
022-tess	2:16	3.54696608

POST-DEVELOPMENT MODEL - 100Y 24H SCS

022-tess	2:17	3.468427314
022-tess	2:18	3.389888548
022-tess	2:19	3.311349782
022-tess	2:20	3.25911864
022-tess	2:21	3.206887497
022-tess	2:22	3.154656355
022-tess	2:23	3.102425213
022-tess	2:24	3.05019407
022-tess	2:25	2.997962928
022-tess	2:26	2.945731786
022-tess	2:27	2.893500644
022-tess	2:28	2.841269501
022-tess	2:29	2.789038359
022-tess	2:30	2.751767167
022-tess	2:31	2.714495976
022-tess	2:32	2.677224784
022-tess	2:33	2.639953593
022-tess	2:34	2.602682401
022-tess	2:35	2.565411209
022-tess	2:36	2.528140018
022-tess	2:37	2.490868826
022-tess	2:38	2.453597635
022-tess	2:39	2.416326443
022-tess	2:40	2.388364113
022-tess	2:41	2.360401783
022-tess	2:42	2.332439452
022-tess	2:43	2.304477122
022-tess	2:44	2.276514792
022-tess	2:45	2.248552462
022-tess	2:46	2.220590132
022-tess	2:47	2.192627801
022-tess	2:48	2.164665471
022-tess	2:49	2.136703141
022-tess	2:50	2.114925488
022-tess	2:51	2.093147834
022-tess	2:52	2.071370181
022-tess	2:53	2.049592527
022-tess	2:54	2.027814874

022-tess	2:55	2.006037221
022-tess	2:56	1.984259567
022-tess	2:57	1.962481914
022-tess	2:58	1.94070426
022-tess	2:59	1.918926607
022-tess	3:00	1.901465749
022-tess	3:01	1.884004891
022-tess	3:02	1.866544032
022-tess	3:03	1.849083174
022-tess	3:04	1.831622316
022-tess	3:05	1.814161458
022-tess	3:06	1.7967006
022-tess	3:07	1.779239741
022-tess	3:08	1.761778883
022-tess	3:09	1.744318025
022-tess	3:10	1.7299937
022-tess	3:11	1.715669375
022-tess	3:12	1.70134505
022-tess	3:13	1.687020725
022-tess	3:14	1.6726964
022-tess	3:15	1.658372076
022-tess	3:16	1.644047751
022-tess	3:17	1.629723426
022-tess	3:18	1.615399101
022-tess	3:19	1.601074776
022-tess	3:20	1.589098626
022-tess	3:21	1.577122477
022-tess	3:22	1.565146327
022-tess	3:23	1.553170178
022-tess	3:24	1.541194028
022-tess	3:25	1.529217878
022-tess	3:26	1.517241729
022-tess	3:27	1.505265579
022-tess	3:28	1.49328943
022-tess	3:29	1.48131328
022-tess	3:30	1.471143269
022-tess	3:31	1.460973259
022-tess	3:32	1.450803248

022-tess	3:33	1.440633237
022-tess	3:34	1.430463226
022-tess	3:35	1.420293216
022-tess	3:36	1.410123205
022-tess	3:37	1.399953194
022-tess	3:38	1.389783184
022-tess	3:39	1.379613173
022-tess	3:40	1.370863246
022-tess	3:41	1.362113319
022-tess	3:42	1.353363392
022-tess	3:43	1.344613465
022-tess	3:44	1.335863538
022-tess	3:45	1.327113612
022-tess	3:46	1.318363685
022-tess	3:47	1.309613758
022-tess	3:48	1.300863831
022-tess	3:49	1.292113904
022-tess	3:50	1.284500694
022-tess	3:51	1.276887485
022-tess	3:52	1.269274275
022-tess	3:53	1.261661065
022-tess	3:54	1.254047855
022-tess	3:55	1.246434646
022-tess	3:56	1.238821436
022-tess	3:57	1.231208226
022-tess	3:58	1.223595017
022-tess	3:59	1.215981807
022-tess	4:00	1.209293439
022-tess	4:01	1.202605071
022-tess	4:02	1.195916704
022-tess	4:03	1.189228336
022-tess	4:04	1.182539968
022-tess	4:05	1.1758516
022-tess	4:06	1.169163232
022-tess	4:07	1.162474865
022-tess	4:08	1.155786497
022-tess	4:09	1.149098129
022-tess	4:10	1.034188316

022-tess	4:11	0.919278503
022-tess	4:12	0.80436869
022-tess	4:13	0.689458877
022-tess	4:14	0.574549064
022-tess	4:15	0.459639252
022-tess	4:16	0.344729439
022-tess	4:17	0.229819626
022-tess	4:18	0.114909813
022-tess	4:19	-1.51268E-14
022-tess	4:20	0
025M	0:10	1.516088055
025M	0:20	1.749115351
025M	0:30	2.078715445
025M	0:40	2.583625152
025M	0:50	3.461716789
025M	1:00	5.394996968
025M	1:10	13.44811663
025M	1:20	56.72433275
025M	1:30	17.78358976
025M	1:40	9.131254948
025M	1:50	6.147712357
025M	2:00	4.655383456
025M	2:10	3.762897479
025M	2:20	3.169361772
025M	2:30	2.745825503
025M	2:40	2.428071751
025M	2:50	2.180598417
025M	3:00	1.982179574
025M	3:10	1.819403154
025M	3:20	1.683310546
025M	3:30	1.567742242
025M	3:40	1.468311255
025M	3:50	1.381797508
025M	4:00	1.305793328
025S	07/23/2009 0:00:00	1.98
025S	07/23/2009 0:15:00	1.98

025S	07/23/2009 0:30:00	1.98
025S	07/23/2009 0:45:00	1.98
025S	07/23/2009 1:00:00	1.98
025S	07/23/2009 1:15:00	1.98
025S	07/23/2009 1:30:00	1.98
025S	07/23/2009 1:45:00	1.98
025S	07/23/2009 2:00:00	2.376
025S	07/23/2009 2:15:00	2.376
025S	07/23/2009 2:30:00	2.376
025S	07/23/2009 2:45:00	2.376
025S	07/23/2009 3:00:00	3.168
025S	07/23/2009 3:15:00	3.168
025S	07/23/2009 3:30:00	3.168
025S	07/23/2009 3:45:00	3.168
025S	07/23/2009 4:00:00	4.752
025S	07/23/2009 4:15:00	4.752
025S	07/23/2009 4:30:00	6.336
025S	07/23/2009 4:45:00	6.336
025S	07/23/2009 5:00:00	9.504
025S	07/23/2009 5:15:00	9.504
025S	07/23/2009 5:30:00	38.016
025S	07/23/2009 5:45:00	104.544
025S	07/23/2009 6:00:00	14.256
025S	07/23/2009 6:15:00	14.256
025S	07/23/2009 6:30:00	6.336
025S	07/23/2009 6:45:00	6.336
025S	07/23/2009 7:00:00	4.752
025S	07/23/2009 7:15:00	4.752
025S	07/23/2009 7:30:00	4.752
025S	07/23/2009 7:45:00	4.752
025S	07/23/2009 8:00:00	2.772
025S	07/23/2009 8:15:00	2.772
025S	07/23/2009 8:30:00	2.772
025S	07/23/2009 8:45:00	2.772
025S	07/23/2009 9:00:00	2.772
025S	07/23/2009 9:15:00	2.772
025S	07/23/2009 9:30:00	2.772
025S	07/23/2009 9:45:00	2.772

025S	07/23/2009 10:00:00	1.584
025S	07/23/2009 10:15:00	1.584
025S	07/23/2009 10:30:00	1.584
025S	07/23/2009 10:45:00	1.584
025S	07/23/2009 11:00:00	1.584
025S	07/23/2009 11:15:00	1.584
025S	07/23/2009 11:30:00	1.584
025S	07/23/2009 11:45:00	1.584
025S	07/23/2009 12:00:00	0

100C	0:00	0
100C	0:10	6.05
100C	0:20	7.54
100C	0:30	10.16
100C	0:40	15.97
100C	0:50	40.65
100C	1:00	178.56
100C	1:10	54.05
100C	1:20	27.32
100C	1:30	18.24
100C	1:40	13.74
100C	1:50	11.06
100C	2:00	9.29
100C	2:10	8.02
100C	2:20	7.08
100C	2:30	6.35
100C	2:40	5.76
100C	2:50	5.28
100C	3:00	4.88

100S	07/23/2009 00:00:00	2.4
100S	07/23/2009 00:15:00	2.4
100S	07/23/2009 00:30:00	2.4
100S	07/23/2009 00:45:00	2.4
100S	07/23/2009 01:00:00	2.4
100S	07/23/2009 01:15:00	2.4
100S	07/23/2009 01:30:00	2.4
100S	07/23/2009 01:45:00	2.4

100S	07/23/2009 02:00:00	2.88
100S	07/23/2009 02:15:00	2.88
100S	07/23/2009 02:30:00	2.88
100S	07/23/2009 02:45:00	2.88
100S	07/23/2009 03:00:00	3.84
100S	07/23/2009 03:15:00	3.84
100S	07/23/2009 03:30:00	3.84
100S	07/23/2009 03:45:00	3.84
100S	07/23/2009 04:00:00	5.76
100S	07/23/2009 04:15:00	5.76
100S	07/23/2009 04:30:00	7.68
100S	07/23/2009 04:45:00	7.68
100S	07/23/2009 05:00:00	11.52
100S	07/23/2009 05:15:00	11.52
100S	07/23/2009 05:30:00	46.08
100S	07/23/2009 05:45:00	126.72
100S	07/23/2009 06:00:00	17.28
100S	07/23/2009 06:15:00	17.28
100S	07/23/2009 06:30:00	7.68
100S	07/23/2009 06:45:00	7.68
100S	07/23/2009 07:00:00	5.76
100S	07/23/2009 07:15:00	5.76
100S	07/23/2009 07:30:00	5.76
100S	07/23/2009 07:45:00	5.76
100S	07/23/2009 08:00:00	3.36
100S	07/23/2009 08:15:00	3.36
100S	07/23/2009 08:30:00	3.36
100S	07/23/2009 08:45:00	3.36
100S	07/23/2009 09:00:00	3.36
100S	07/23/2009 09:15:00	3.36
100S	07/23/2009 09:30:00	3.36
100S	07/23/2009 09:45:00	3.36
100S	07/23/2009 10:00:00	1.92
100S	07/23/2009 10:15:00	1.92
100S	07/23/2009 10:30:00	1.92
100S	07/23/2009 10:45:00	1.92
100S	07/23/2009 11:00:00	1.92
100S	07/23/2009 11:15:00	1.92

```
100S            07/23/2009 11:30:00   1.92
100S            07/23/2009 11:45:00   1.92
100S            07/23/2009 12:00:00   0

120C                       0:00       0
120C                       0:10       7.26
120C                       0:20       9.048
120C                       0:30       12.192
120C                       0:40       19.164
120C                       0:50       48.78
120C                       1:00       214.272
120C                       1:10       64.86
120C                       1:20       32.784
120C                       1:30       21.888
120C                       1:40       16.488
120C                       1:50       13.272
120C                       2:00       11.148
120C                       2:10       9.624
120C                       2:20       8.496
120C                       2:30       7.62
120C                       2:40       6.912
120C                       2:50       6.336
120C                       3:00       5.856

120S            07/23/2009 0:00:00    2.88
120S            07/23/2009 0:15:00    2.88
120S            07/23/2009 0:30:00    2.88
120S            07/23/2009 0:45:00    2.88
120S            07/23/2009 1:00:00    2.88
120S            07/23/2009 1:15:00    2.88
120S            07/23/2009 1:30:00    2.88
120S            07/23/2009 1:45:00    2.88
120S            07/23/2009 2:00:00    3.46
120S            07/23/2009 2:15:00    3.46
120S            07/23/2009 2:30:00    3.46
120S            07/23/2009 2:45:00    3.46
120S            07/23/2009 3:00:00    4.61
120S            07/23/2009 3:15:00    4.61
```



```
120S            07/23/2009 3:30:00    4.61
120S            07/23/2009 3:45:00    4.61
120S            07/23/2009 4:00:00    6.91
120S            07/23/2009 4:15:00    6.91
120S            07/23/2009 4:30:00    9.22
120S            07/23/2009 4:45:00    9.22
120S            07/23/2009 5:00:00    13.82
120S            07/23/2009 5:15:00    13.82
120S            07/23/2009 5:30:00    55.30
120S            07/23/2009 5:45:00    152.06
120S            07/23/2009 6:00:00    20.74
120S            07/23/2009 6:15:00    20.74
120S            07/23/2009 6:30:00    9.22
120S            07/23/2009 6:45:00    9.22
120S            07/23/2009 7:00:00    6.91
120S            07/23/2009 7:15:00    6.91
120S            07/23/2009 7:30:00    6.91
120S            07/23/2009 7:45:00    6.91
120S            07/23/2009 8:00:00    4.03
120S            07/23/2009 8:15:00    4.03
120S            07/23/2009 8:30:00    4.03
120S            07/23/2009 8:45:00    4.03
120S            07/23/2009 9:00:00    4.03
120S            07/23/2009 9:15:00    4.03
120S            07/23/2009 9:30:00    4.03
120S            07/23/2009 9:45:00    4.03
120S            07/23/2009 10:00:00   2.30
120S            07/23/2009 10:15:00   2.30
120S            07/23/2009 10:30:00   2.30
120S            07/23/2009 10:45:00   2.30
120S            07/23/2009 11:00:00   2.30
120S            07/23/2009 11:15:00   2.30
120S            07/23/2009 11:30:00   2.30
120S            07/23/2009 11:45:00   2.30
120S            07/23/2009 12:00:00   0.00

[REPORT]
;;Reporting Options
```

```
INPUT      YES
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]
Subcatch   A561N1           Drummond
Subcatch   A562NE           Drummond
Subcatch   A562R1           Drummond
Subcatch   A562R2           Drummond
Subcatch   A562R3           Drummond
Subcatch   A562R4           Drummond
Subcatch   A562SE           Drummond
Subcatch   A563NE           Drummond
Node       CB10             Major-System
Node       CB108            Major-System
Node       CB25             Major-System
Node       CB65             Major-System
Node       CB66             Major-System
Node       CB67             Major-System
Node       CB69             External_Inflow
Node       CB70             Major-System
Node       CB71             Major-System
Node       CHILLERTON1      Major-System
Node       CHILLERTON2      Major-System
Node       EPOCH            Major-System
Node       HAIKU            External_Inflow
Node       Maj_006          Major-System
Node       MH_109           MH
Node       MH_225           MH
Node       MH_2250A         MH
Node       MH_225A          MH
Node       MH_226A          MH
Node       MH-562           MH
Node       MH-563           MH
Node       CB108-109        Major-System
Node       MH_110           MH
```



```
Node       MH-564           MH
Node       100              MN
Node       101              MN
Node       101A             RD
Node       102              MN
Node       102A             RD
Node       103              MN
Node       103A             RD
Node       104              MN
Node       104A             RD
Node       105              MN
Node       105A             RD
Node       105B             RD
Node       105C             RD
Node       106              MN
Node       107              MN
Node       108              MN
Node       108A             RD
Node       109              MN
Node       110              MN
Node       110A             RD
Node       110B             RD
Node       110C             RD
Node       110D             RD
Node       111              MN
Link       101-100          HMBS_8
Link       101A-Obsidian_Street-3 MJ
Link       101-EX_109       HMBS_8
Link       102-101          HMBS_8
Link       102A-101A        MJ
Link       102A-Umb         Umbilical
Link       103-101          HMBS_8
Link       103A-101A        MJ
Link       104-103          HMBS_8
Link       104A-104B        MJ
Link       104A-Umb         Umbilical
Link       105-104          HMBS_8
Link       105A-104A        MJ
```

```
Link       105C-104A        MJ
Link       106-105          HMBS_8
Link       107-105          HMBS_8
Link       108-107          HMBS_8
Link       109-107          HMBS_8
Link       110-108          HMBS_8
Link       110B-S           MJ
Link       110C-110B        MJ
Link       110C-Umb         Umbilical
Link       110D-110B        MJ
Link       C10              MJ
Link       C11              MJ
Link       C12              MJ
Link       C13              MJ
Link       C14              MJ
Link       C15              MJ
Link       C16              MJ
Link       C17              MJ
Link       C18              MJ
Link       C19              MJ
Link       C2               Umbilical
Link       C20              MJ
Link       C21              MJ
Link       C22              MJ
Link       C23              MJ
Link       C25              MJ
Link       C26              MJ
Link       C27              MJ
Link       102A-O1          C-DRAN
Link       103A-O1          HMBS_8
Link       104A-O1          C-DRAN
Link       105A-O1          C-DRAN
Link       108A-O1          C-DRAN
Link       101A-O1          C-DRAN
Link       105C-O1          C-DRAN
Link       110B-O1          C-DRAN

[MAP]
```



```
DIMENSIONS       364064.09105     5011150.94315    364473.13595     5011628.09785
UNITS            Meters

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
CB10             364150.231         5011530.975
CB108            364120.216         5011552.186
CB25             364146.453         5011567.975
CB65             364318.21          5011246.534
CB66             364287.8           5011299.668
CB67             364276.48          5011311.395
CB68             364245.616         5011373.43
CB69             364241.961         5011371.436
CB70             364200.468         5011451.61
CB71             364197             5011449.635
CB72             364168.302         5011507.254
CB9              364153.92          5011532.864
CB-9             364151.23          5011534.393
CHILLERTON1      364227.486         5011404.707
CHILLERTON2      364224.086         5011402.526
EPOCH            364311.697         5011250.142
HAIKU            364164.971         5011505.348
Maj_006          364177.065         5011590.615
MH_109           364165.865         5011507.924
MH_225           364318.318         5011242.671
MH_2250A         364225.153         5011404.625
MH_225A          364268.824         5011328.785
MH_226A          364212.269         5011427.185
MH-562           364148.456         5011538.146
MH-563           364133.661         5011563.861
CB108-109        364119.697         5011479.649
CHILLERTON       364207.946         5011392.735
Greenbank_Rd     364332.558         5011462.453
MH_110           364113.972         5011478.105
MH-564           364193.769         5011606.409
100              364177.152         5011507.353
101              364208.592         5011525.29
```

```
101A             364188.35         5011516.875
102              364238.888        5011472.164
102A             364222.639        5011510.51
102A-Dummy       364236.601        5011518.813
103              364236.444        5011541.23
103A             364227.405        5011556.639
104              364271.443        5011480.22
104A             364243.789        5011490.104
104A-Dummy       364236.224        5011503.65
105              364293.705        5011441.477
105A             364285.319        5011440.533
105B             364232.8          5011413.384
105C             364296.99         5011457.909
106              364255.778        5011419.684
107              364316.3          5011402.155
108              364285.001        5011384.165
108A             364306.495        5011381.006
108A-Dummy       364314.386        5011385.793
109              364351.282        5011340.343
110              364324.819        5011314.908
110A             364339.775        5011323.503
110B             364300.626        5011324.07
110C             364321.81         5011355.162
110C-Dummy       364330.924        5011359.457
110D             364325.098        5011310.985
111              364283.828        5011442.579
COMM             364328.942        5011248.381

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
101A-Obsidian_Street-3 364175.952         5011509.736
102A-101A        364203.956         5011515.104
103A-101A        364228.889         5011543.528
103A-101A        364229.121         5011538.658
103A-101A        364221.632         5011533.888
105A-104A        364286.064         5011443.856
105A-104A        364268.7           5011474.098
```

POST-DEVELOPMENT MODEL - 100Y 24H SCS

```
110B-S           364284.382         5011317.357
110C-110B        364315.228         5011337.25
110C-110B        364306.07          5011327.405
110D-110B        364317.878         5011323.622
C23              364133.76          5011559.865
C27              364137.461         5011561.905
W4               364218.001         5011427.616

[POLYGONS]
;;Subcatchment   X-Coord            Y-Coord
;;-------------- ------------------ ------------------

[SYMBOLS]
;;Gage           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
```

D.3 SAMPLE PCSWMM OUTPUT (100YR CHICAGO)

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

WARNING 02: maximum depth increased for Node CB68
WARNING 02: maximum depth increased for Node CB72

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 35
Number of nodes 59
Number of links 81
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
RG1	100C	INTENSITY	10 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
A225NE	0.07	76.00	49.00	0.5000	RG1	CB66
A225NW	0.12	76.00	71.00	0.5000	RG1	CB67
A225SE	0.07	83.00	49.00	0.5000	RG1	CB65
A226NE	0.07	76.00	50.00	0.5000	RG1	CB68
A226NW	0.14	75.00	73.00	0.5000	RG1	CB69

A227NE	0.03	32.00	50.00	0.5000	RG1	CB72
A227NW	0.06	72.00	50.00	0.5000	RG1	CB72
A227SE	0.07	76.00	50.00	0.5000	RG1	CB70
A227SW	0.10	63.00	72.00	0.5000	RG1	CB71
A229N2	0.03	25.00	78.00	0.5000	RG1	CHILLERTON2
A561N1	0.11	59.00	72.00	3.0000	RG1	CB108
A562NE	0.02	33.00	59.00	1.0000	RG1	CB9
A562R1	0.04	62.00	50.00	1.5000	RG1	CB-9
A562R2	0.03	42.00	59.00	1.5000	RG1	CB-9
A562R3	0.06	82.00	61.00	1.5000	RG1	CB-9
A562R4	0.02	22.00	52.00	1.5000	RG1	CB-9
A562SE	0.02	33.00	57.00	1.0000	RG1	CB10
A563NE	0.11	53.00	75.00	0.5000	RG1	CB25
COM	1.22	274.50	90.00	0.5000	RG1	COMM
L100D	0.10	21.42	72.86	3.0000	RG1	110D
L101A	0.02	4.69	60.00	3.0000	RG1	101A
L102A	0.44	98.25	84.29	3.0000	RG1	102A
L103A	0.13	29.77	80.00	3.0000	RG1	103A
L104A	0.52	117.87	82.86	3.0000	RG1	104A
L105A	0.13	30.12	61.43	3.0000	RG1	105A
L105B	0.20	44.51	54.29	3.0000	RG1	105B
L105C	0.11	23.73	25.71	3.0000	RG1	105C
L108A	0.34	76.26	85.71	3.0000	RG1	108A
L110A	0.15	34.47	70.00	3.0000	RG1	110A
L110B	0.05	11.83	71.43	3.0000	RG1	110B
L110C	0.32	71.03	88.57	3.0000	RG1	110C
UNC-1	0.16	34.91	81.43	3.0000	RG1	Greenbank_Rd
UNC-2	0.16	35.87	81.43	3.0000	RG1	Greenbank_Rd
UNC-3	0.13	30.37	75.71	3.0000	RG1	CB68
UNC-4	0.13	29.68	78.57	3.0000	RG1	CB72

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow

CB10	JUNCTION	103.03	0.40	0.0
CB108	JUNCTION	104.50	0.40	0.0
CB25	JUNCTION	104.32	0.40	0.0
CB65	JUNCTION	106.22	0.40	0.0
CB66	JUNCTION	105.77	0.40	0.0
CB67	JUNCTION	105.60	0.40	0.0
CB68	JUNCTION	104.59	1.42	0.0
CB69	JUNCTION	104.56	0.40	0.0
CB70	JUNCTION	104.21	0.40	0.0
CB71	JUNCTION	103.94	0.40	0.0
CB72	JUNCTION	101.47	1.91	0.0
CB9	JUNCTION	103.02	0.40	0.0
CB-9	JUNCTION	101.64	1.98	0.0
CHILLERTON1	JUNCTION	104.43	0.40	0.0
CHILLERTON2	JUNCTION	104.43	0.40	0.0
EPOCH	JUNCTION	106.04	0.40	0.0
HAIKU	JUNCTION	102.85	0.40	0.0
Maj_006	JUNCTION	104.51	0.40	0.0
MH_109	JUNCTION	99.07	3.58	0.0
MH_225	JUNCTION	103.04	3.35	0.0
MH_2250A	JUNCTION	100.97	4.32	0.0
MH_225A	JUNCTION	102.22	3.50	0.0
MH_226A	JUNCTION	100.56	3.67	0.0
MH-562	JUNCTION	101.18	2.03	0.0
MH-563	JUNCTION	100.82	3.48	0.0
CB108-109	OUTFALL	102.17	0.35	0.0
CHILLERTON	OUTFALL	103.14	0.35	0.0
Greenbank_Rd	OUTFALL	0.00	0.00	0.0
MH_110	OUTFALL	98.35	1.13	0.0
MH-564	OUTFALL	100.64	0.55	0.0
100	STORAGE	97.19	6.04	0.0
101	STORAGE	97.41	6.30	0.0
101A	STORAGE	101.89	1.76	0.0
102	STORAGE	98.72	5.47	0.0
102A	STORAGE	101.99	1.78	0.0
102A-Dummy	STORAGE	102.19	5.00	0.0
103	STORAGE	97.88	6.09	0.0
103A	STORAGE	102.23	1.72	0.0

104	STORAGE	98.66	6.24	0.0
104A	STORAGE	102.66	1.74	0.0
104A-Dummy	STORAGE	102.86	5.00	0.0
105	STORAGE	99.18	6.18	0.0
105A	STORAGE	103.52	1.83	0.0
105B	STORAGE	102.53	2.07	0.0
105C	STORAGE	103.82	1.73	0.0
106	STORAGE	101.50	3.76	0.0
107	STORAGE	99.66	6.22	0.0
108	STORAGE	99.77	5.90	0.0
108A	STORAGE	103.97	1.73	0.0
108A-Dummy	STORAGE	104.35	5.00	0.0
109	STORAGE	102.11	3.89	0.0
110	STORAGE	100.24	5.52	0.0
110A	STORAGE	104.27	1.73	0.0
110B	STORAGE	104.05	1.73	0.0
110C	STORAGE	103.97	1.73	0.0
110C-Dummy	STORAGE	104.17	5.00	0.0
110D	STORAGE	104.34	1.73	0.0
111	STORAGE	102.35	2.74	0.0
COMM	STORAGE	105.22	1.78	0.0

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
101-100	101	100	CONDUIT	36.2	0.5243	0.0130
101A-Obsidian_Street-3	101A	CB72	CONDUIT	16.5	3.0317	0.0130
101-EX_109	100	MH_109	CONDUIT	11.3	0.4430	0.0130
102-101	102	101	CONDUIT	62.9	1.4940	0.0130
102A-101A	102A	101A	CONDUIT	9.3	4.0032	0.0130
102A-Umb	102A-Dummy	102A	CONDUIT	100.0	0.0010	0.0130
103-101	103	101	CONDUIT	32.0	0.9992	0.0130
103A-101A	103A	102A	CONDUIT	26.0	0.5000	0.0130
104-103	104	103	CONDUIT	70.3	1.0247	0.0130
104A-104B	104A	102A	CONDUIT	12.6	5.0023	0.0130

104A-Umb	104A-Dummy	104A	CONDUIT	80.0	0.0013	0.0130
105-104	105	104	CONDUIT	44.7	1.0071	0.0130
105A-104A	105A	104A	CONDUIT	80.0	1.2001	0.0130
105B-111	105B	111	CONDUIT	57.5	0.3130	0.0130
105C-104A	105C	104A	CONDUIT	64.3	1.3998	0.0130
106-105	106	105	CONDUIT	43.7	0.5034	0.0130
107-105	107	105	CONDUIT	45.4	0.9923	0.0130
108-107	108	107	CONDUIT	36.1	0.4986	0.0130
109-107	109	107	CONDUIT	70.5	0.4968	0.0130
110-108	110	108	CONDUIT	79.9	0.5007	0.0130
110B-S	110B	CB68	CONDUIT	18.0	0.5000	0.0130
110C-110B	110C	110B	CONDUIT	5.0	0.4000	0.0130
110C-Umb	110C-Dummy	110C	CONDUIT	48.0	0.0021	0.0130
110D-110B	110D	110B	CONDUIT	9.6	2.7009	0.0130
C10	CB65	CB66	CONDUIT	75.7	0.5948	0.0130
C11	CB66	CB68	CONDUIT	88.4	1.3357	0.0130
C12	EPOCH	CB67	CONDUIT	74.9	0.5846	0.0130
C13	CB67	CB69	CONDUIT	74.6	1.3945	0.0130
C14	CB69	CHILLERTON2	CONDUIT	26.3	0.4832	0.0130
C15	CHILLERTON2	CB71	CONDUIT	61.4	0.8028	0.0130
C16	CB71	HAIKU	CONDUIT	57.2	1.9064	0.0130
C17	HAIKU	CB108-109	CONDUIT	40.0	1.7002	0.0130
C18	CHILLERTON2	CHILLERTON	CONDUIT	59.9	2.1591	0.0130
C19	CB68	CHILLERTON1	CONDUIT	32.7	0.4801	0.0130
C2	108A-Dummy	108A	CONDUIT	70.0	0.0014	0.0130
C20	CHILLERTON1	CB70	CONDUIT	43.0	0.5192	0.0130
C21	CB70	CB72	CONDUIT	77.7	1.7508	0.0130
C22	CB9	CB72	CONDUIT	29.3	0.5812	0.0130
C23	CB108	CB10	CONDUIT	48.8	3.0130	0.0130
C25	CB10	HAIKU	CONDUIT	30.9	0.5833	0.0130
C26	Maj_006	CB25	CONDUIT	38.1	0.4937	0.0130
C27	CB25	CB9	CONDUIT	48.5	2.6791	0.0130
C6	MH-563	MH-564	CONDUIT	73.5	0.2000	0.0130
STM-109-110	MH_109	MH_110	CONDUIT	60.0	0.7000	0.0130
STM-2250A-226A	MH_2250A	MH_226A	CONDUIT	25.0	1.5522	0.0130
STM-225-225A	MH_225	MH_225A	CONDUIT	88.0	0.7000	0.0130
STM-225A-2250A	MH_225A	MH_2250A	CONDUIT	88.5	1.2498	0.0130
STM-226A-109	MH_226A	MH_109	CONDUIT	93.0	1.6002	0.0130

STM-562-563	MH-562	MH-563	CONDUIT	29.5	0.4509	0.0130
102A-O1	102A	102	ORIFICE			
103A-O1	103A	103	ORIFICE			
104A-O1	104A	104	ORIFICE			
105A-O1	105A	105	ORIFICE			
105B-O1	111	105	ORIFICE			
108A-O1	108A	108	ORIFICE			
110A-O1	110A	110	ORIFICE			
110C-O1	110C	110	ORIFICE			
110D-O1	110D	110	ORIFICE			
CB108-O	CB108	MH-563	ORIFICE			
CB10-O	CB10	MH-562	ORIFICE			
CB25-O	CB25	MH-563	ORIFICE			
CB72-O	CB72	MH_109	ORIFICE			
CB9-O	CB-9	MH-562	ORIFICE			
CB9-O1	CB9	CB-9	ORIFICE			
108A-110C	108A	110C	WEIR			
110A-110D	110A	110D	WEIR			
COMM-W	COMM	CB65	WEIR			
W2	CHILLERTON1	CHILLERTON2	WEIR			
W3	CB72	HAIKU	WEIR			
W4	105B	CB70	WEIR			
101A-O1	101A	101	OUTLET			
105C-O1	105C	105	OUTLET			
110B-O1	110B	110	OUTLET			
CB65-O	CB65	MH_225	OUTLET			
CB66-O	CB66	MH_225	OUTLET			
CB67-O	CB67	MH_225	OUTLET			
CB68-O	CB68	MH_225A	OUTLET			
CB69-O	CB69	MH_225A	OUTLET			
CB70-O	CB70	MH_226A	OUTLET			
CB71-O	CB71	MH_226A	OUTLET			
COMM-O	COMM	MH_225	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
101-100	CIRCULAR	0.68	0.36	0.17	0.68	1	608.72
101A-Obsidian_Street-3	6.40_ROW_1.4_X-Fall	0.29	1.82	0.20	10.10	1	8209.25
101-EX_109	CIRCULAR	0.68	0.36	0.17	0.68	1	559.48
102-101	CIRCULAR	0.30	0.07	0.07	0.30	1	118.21
102A-101A	7.9_ROW_1.4_X-Fall	0.26	1.62	0.19	7.90	1	8355.90
102A-Umb	CIRCULAR	0.90	0.64	0.23	0.90	1	57.25
103-101	CIRCULAR	0.53	0.22	0.13	0.53	1	429.92
103A-101A	6.40_ROW_2.0_X-Fall	0.33	2.04	0.21	10.20	1	3884.38
104-103	CIRCULAR	0.53	0.22	0.13	0.53	1	435.36
104A-104B	6.40_ROW_1.6_X-Fall	0.25	1.28	0.19	6.40	1	7213.46
104A-Umb	CIRCULAR	0.90	0.64	0.23	0.90	1	64.01
105-104	CIRCULAR	0.45	0.16	0.11	0.45	1	286.14
105A-104A	11.6_ROW_1.3_X-Fall	0.35	3.50	0.24	14.80	1	11453.37
105B-111	CIRCULAR	0.90	0.64	0.23	0.90	1	1012.94
105C-104A	11.6_ROW_1.3_X-Fall	0.35	3.50	0.24	14.80	1	12369.84
106-105	CIRCULAR	0.30	0.07	0.07	0.30	1	68.62
107-105	CIRCULAR	0.45	0.16	0.11	0.45	1	284.02
108-107	CIRCULAR	0.53	0.22	0.13	0.53	1	303.70
109-107	CIRCULAR	0.30	0.07	0.07	0.30	1	68.16
110-108	CIRCULAR	0.45	0.16	0.11	0.45	1	201.76
110B-S	6.40_ROW_2.3_X-Fall	0.42	3.23	0.23	14.20	1	6514.73
110C-110B	6.40_ROW_0.6_X-Fall	0.19	1.09	0.16	6.40	1	1565.13
110C-Umb	CIRCULAR	0.90	0.64	0.23	0.90	1	82.63
110D-110B	6.40_ROW_0.6_X-Fall	0.19	1.09	0.16	6.40	1	4066.97
C10	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	3346.78
C11	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	5015.07
C12	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	3317.84
C13	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	5124.33
C14	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	3016.48
C15	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	3887.96
C16	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	5991.52
C17	18.00_ROW	0.35	3.37	0.19	18.00	1	11316.47
C18	18.00_ROW	0.35	3.37	0.19	18.00	1	12752.35
C19	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	3006.84
C2	CIRCULAR	0.90	0.64	0.23	0.90	1	68.43

C20	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	3126.72
C21	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	5741.73
C22	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	3308.19
C23	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	7532.30
C25	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	3314.27
C26	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	3049.09
C27	18.00_ROW_LS	0.35	1.69	0.19	9.00	1	7102.57
C6	CIRCULAR	0.53	0.22	0.13	0.53	1	192.34
STM-109-110	CIRCULAR	0.75	0.44	0.19	0.75	1	931.50
STM-2250A-226A	CIRCULAR	0.68	0.36	0.17	0.68	1	1047.32
STM-225-225A	CIRCULAR	0.53	0.22	0.13	0.53	1	359.84
STM-225A-2250A	CIRCULAR	0.53	0.22	0.13	0.53	1	480.82
STM-226A-109	CIRCULAR	0.68	0.36	0.17	0.68	1	1063.40
STM-562-563	CIRCULAR	0.30	0.07	0.07	0.30	1	64.93

****
Transect Summary
****

Transect 11.6_ROW_1.3_X-Fall

Area:

0.0005	0.0022	0.0048	0.0086	0.0135
0.0194	0.0264	0.0345	0.0436	0.0539
0.0652	0.0776	0.0910	0.1056	0.1212
0.1379	0.1557	0.1745	0.1944	0.2154
0.2375	0.2606	0.2842	0.3083	0.3329
0.3579	0.3833	0.4093	0.4356	0.4619
0.4883	0.5146	0.5410	0.5673	0.5937
0.6200	0.6463	0.6727	0.6990	0.7254
0.7517	0.7781	0.8044	0.8310	0.8580
0.8855	0.9134	0.9418	0.9707	1.0000

Hrad:

0.0142	0.0283	0.0425	0.0567	0.0708
0.0850	0.0992	0.1133	0.1275	0.1417
0.1558	0.1700	0.1842	0.1983	0.2125
0.2267	0.2408	0.2550	0.2692	0.2833

	0.2975	0.3187	0.3460	0.3726	0.3985
	0.4238	0.4485	0.4725	0.4964	0.5205
	0.5448	0.5692	0.5936	0.6181	0.6427
	0.6672	0.6918	0.7164	0.7410	0.7657
	0.7903	0.8149	0.8395	0.8642	0.8883
	0.9117	0.9346	0.9569	0.9787	1.0000
Width:					
	0.0365	0.0729	0.1094	0.1459	0.1824
	0.2188	0.2553	0.2918	0.3282	0.3647
	0.4012	0.4377	0.4741	0.5106	0.5471
	0.5836	0.6200	0.6565	0.6930	0.7294
	0.7659	0.7918	0.8075	0.8232	0.8390
	0.8547	0.8704	0.8861	0.8919	0.8919
	0.8919	0.8919	0.8919	0.8919	0.8919
	0.8919	0.8919	0.8919	0.8919	0.8919
	0.8919	0.8919	0.8922	0.9076	0.9230
	0.9384	0.9538	0.9692	0.9846	1.0000

Transect 14.75_ROW

Area:					
	0.0005	0.0020	0.0046	0.0081	0.0127
	0.0182	0.0248	0.0324	0.0411	0.0507
	0.0613	0.0730	0.0857	0.0994	0.1141
	0.1298	0.1465	0.1642	0.1829	0.2017
	0.2206	0.2395	0.2593	0.2798	0.3012
	0.3234	0.3465	0.3704	0.3950	0.4202
	0.4457	0.4715	0.4978	0.5244	0.5513
	0.5787	0.6064	0.6344	0.6629	0.6917
	0.7208	0.7504	0.7803	0.8106	0.8412
	0.8722	0.9036	0.9354	0.9675	1.0000
Hrad:					
	0.0161	0.0323	0.0484	0.0645	0.0806
	0.0968	0.1129	0.1290	0.1452	0.1613
	0.1774	0.1935	0.2097	0.2258	0.2419
	0.2581	0.2742	0.2903	0.3131	0.3448
	0.3764	0.4079	0.4380	0.4663	0.4930
	0.5182	0.5421	0.5648	0.5867	0.6085
	0.6302	0.6517	0.6730	0.6941	0.7149

	0.7356	0.7560	0.7761	0.7960	0.8157
	0.8351	0.8544	0.8733	0.8921	0.9106
	0.9289	0.9470	0.9649	0.9825	1.0000
Width:					
	0.0310	0.0621	0.0931	0.1241	0.1551
	0.1862	0.2172	0.2482	0.2793	0.3103
	0.3413	0.3724	0.4034	0.4344	0.4654
	0.4965	0.5275	0.5585	0.5763	0.5763
	0.5763	0.5908	0.6164	0.6419	0.6674
	0.6929	0.7184	0.7439	0.7633	0.7746
	0.7858	0.7971	0.8084	0.8197	0.8309
	0.8422	0.8535	0.8647	0.8760	0.8873
	0.8986	0.9098	0.9211	0.9324	0.9436
	0.9549	0.9662	0.9775	0.9887	1.0000

Transect 18.00_ROW

Area:					
	0.0005	0.0019	0.0043	0.0076	0.0119
	0.0171	0.0233	0.0304	0.0385	0.0475
	0.0575	0.0684	0.0803	0.0931	0.1069
	0.1216	0.1373	0.1539	0.1714	0.1890
	0.2067	0.2244	0.2428	0.2619	0.2816
	0.3021	0.3232	0.3451	0.3676	0.3908
	0.4147	0.4393	0.4646	0.4906	0.5172
	0.5446	0.5726	0.6014	0.6308	0.6609
	0.6917	0.7232	0.7554	0.7883	0.8218
	0.8561	0.8910	0.9267	0.9630	1.0000
Hrad:					
	0.0175	0.0349	0.0524	0.0699	0.0874
	0.1048	0.1223	0.1398	0.1573	0.1747
	0.1922	0.2097	0.2272	0.2446	0.2621
	0.2796	0.2971	0.3145	0.3393	0.3736
	0.4078	0.4420	0.4748	0.5059	0.5355
	0.5637	0.5906	0.6163	0.6408	0.6643
	0.6869	0.7086	0.7295	0.7496	0.7689
	0.7877	0.8058	0.8233	0.8403	0.8568
	0.8728	0.8884	0.9035	0.9183	0.9327
	0.9468	0.9605	0.9740	0.9871	1.0000

Width:

0.0254	0.0509	0.0763	0.1017	0.1271
0.1526	0.1780	0.2034	0.2288	0.2543
0.2797	0.3051	0.3306	0.3560	0.3814
0.4068	0.4323	0.4577	0.4722	0.4722
0.4722	0.4828	0.5013	0.5197	0.5382
0.5567	0.5751	0.5936	0.6121	0.6306
0.6490	0.6675	0.6860	0.7044	0.7229
0.7414	0.7599	0.7783	0.7968	0.8153
0.8337	0.8522	0.8707	0.8892	0.9076
0.9261	0.9446	0.9631	0.9815	1.0000

Transect 18.00_ROW_LS

Area:

0.0005	0.0019	0.0043	0.0076	0.0119
0.0171	0.0233	0.0304	0.0385	0.0475
0.0575	0.0684	0.0803	0.0931	0.1069
0.1216	0.1373	0.1539	0.1714	0.1890
0.2067	0.2244	0.2428	0.2619	0.2816
0.3021	0.3232	0.3451	0.3676	0.3908
0.4147	0.4393	0.4646	0.4906	0.5172
0.5446	0.5726	0.6014	0.6308	0.6609
0.6917	0.7232	0.7554	0.7883	0.8218
0.8561	0.8910	0.9267	0.9630	1.0000

Hrad:

0.0175	0.0349	0.0524	0.0699	0.0874
0.1048	0.1223	0.1398	0.1573	0.1747
0.1922	0.2097	0.2272	0.2446	0.2621
0.2796	0.2971	0.3145	0.3393	0.3736
0.4078	0.4420	0.4748	0.5059	0.5355
0.5637	0.5906	0.6163	0.6408	0.6643
0.6869	0.7086	0.7295	0.7496	0.7689
0.7877	0.8058	0.8233	0.8403	0.8568
0.8728	0.8884	0.9035	0.9183	0.9327
0.9468	0.9605	0.9740	0.9871	1.0000

Width:

0.0254	0.0509	0.0763	0.1017	0.1271
0.1526	0.1780	0.2034	0.2288	0.2543

0.2797	0.3051	0.3306	0.3560	0.3814
0.4068	0.4323	0.4577	0.4722	0.4722
0.4722	0.4828	0.5012	0.5197	0.5382
0.5567	0.5751	0.5936	0.6121	0.6306
0.6490	0.6675	0.6860	0.7044	0.7229
0.7414	0.7599	0.7783	0.7968	0.8153
0.8337	0.8522	0.8707	0.8892	0.9076
0.9261	0.9446	0.9631	0.9815	1.0000

Transect 6.40_ROW_0.6_X-Fall

Area:

0.0011	0.0042	0.0096	0.0170	0.0265
0.0382	0.0520	0.0680	0.0860	0.1062
0.1282	0.1506	0.1729	0.1953	0.2176
0.2400	0.2624	0.2847	0.3071	0.3294
0.3518	0.3741	0.3965	0.4188	0.4412
0.4635	0.4859	0.5082	0.5306	0.5529
0.5753	0.5976	0.6200	0.6424	0.6647
0.6871	0.7094	0.7318	0.7541	0.7765
0.7988	0.8212	0.8435	0.8659	0.8882
0.9106	0.9329	0.9553	0.9776	1.0000

Hrad:

0.0117	0.0234	0.0351	0.0468	0.0585
0.0702	0.0819	0.0936	0.1053	0.1170
0.1341	0.1573	0.1805	0.2036	0.2266
0.2496	0.2725	0.2954	0.3182	0.3409
0.3637	0.3863	0.4089	0.4315	0.4540
0.4764	0.4988	0.5212	0.5435	0.5657
0.5879	0.6100	0.6321	0.6542	0.6761
0.6981	0.7200	0.7418	0.7636	0.7853
0.8070	0.8287	0.8502	0.8718	0.8933
0.9147	0.9361	0.9575	0.9788	1.0000

Width:

0.0950	0.1900	0.2850	0.3800	0.4750
0.5700	0.6650	0.7600	0.8550	0.9500
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000

1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000

Transect 6.40_ROW_1.2_X-Fall

Area:

0.0007	0.0028	0.0063	0.0111	0.0174
0.0251	0.0341	0.0445	0.0564	0.0696
0.0842	0.1002	0.1176	0.1364	0.1566
0.1782	0.2012	0.2253	0.2495	0.2737
0.2979	0.3221	0.3463	0.3705	0.3947
0.4189	0.4432	0.4674	0.4916	0.5158
0.5400	0.5642	0.5884	0.6126	0.6368
0.6611	0.6853	0.7095	0.7337	0.7579
0.7821	0.8063	0.8305	0.8547	0.8789
0.9032	0.9274	0.9516	0.9758	1.0000

Hrad:

0.0127	0.0253	0.0380	0.0507	0.0633
0.0760	0.0887	0.1013	0.1140	0.1267
0.1393	0.1520	0.1647	0.1773	0.1900
0.2027	0.2153	0.2355	0.2604	0.2853
0.3101	0.3348	0.3595	0.3841	0.4086
0.4330	0.4574	0.4817	0.5060	0.5302
0.5543	0.5783	0.6023	0.6262	0.6501
0.6739	0.6976	0.7212	0.7448	0.7683
0.7918	0.8152	0.8385	0.8618	0.8850
0.9081	0.9312	0.9542	0.9771	1.0000

Width:

0.0575	0.1150	0.1725	0.2300	0.2875
0.3450	0.4025	0.4600	0.5175	0.5750
0.6325	0.6900	0.7475	0.8050	0.8625
0.9200	0.9775	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000

1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000

Transect 6.40_ROW_1.4_X-Fall

Area:

0.0006	0.0026	0.0058	0.0104	0.0162
0.0234	0.0318	0.0415	0.0526	0.0649
0.0785	0.0935	0.1097	0.1272	0.1461
0.1661	0.1864	0.2067	0.2269	0.2472
0.2675	0.2878	0.3081	0.3284	0.3487
0.3689	0.3895	0.4107	0.4325	0.4549
0.4779	0.5015	0.5257	0.5505	0.5759
0.6020	0.6286	0.6556	0.6825	0.7095
0.7364	0.7634	0.7908	0.8189	0.8475
0.8768	0.9067	0.9372	0.9683	1.0000

Hrad:

0.0144	0.0289	0.0433	0.0578	0.0722
0.0866	0.1011	0.1155	0.1300	0.1444
0.1588	0.1733	0.1877	0.2022	0.2166
0.2363	0.2647	0.2930	0.3212	0.3493
0.3773	0.4052	0.4330	0.4607	0.4883
0.5158	0.5431	0.5692	0.5942	0.6182
0.6412	0.6633	0.6845	0.7049	0.7245
0.7434	0.7616	0.7804	0.7996	0.8190
0.8386	0.8586	0.8785	0.8977	0.9163
0.9342	0.9514	0.9682	0.9843	1.0000

Width:

0.0406	0.0811	0.1217	0.1622	0.2028
0.2433	0.2839	0.3244	0.3650	0.4055
0.4461	0.4867	0.5272	0.5678	0.6083
0.6337	0.6337	0.6337	0.6337	0.6337
0.6337	0.6337	0.6337	0.6337	0.6337
0.6337	0.6519	0.6709	0.6899	0.7089
0.7279	0.7469	0.7659	0.7850	0.8040
0.8230	0.8416	0.8416	0.8416	0.8416
0.8416	0.8479	0.8669	0.8859	0.9050
0.9240	0.9430	0.9620	0.9810	1.0000

Transect 6.40_ROW_1.6_X-Fall

Area:

0.0006	0.0025	0.0056	0.0100	0.0156
0.0225	0.0306	0.0400	0.0506	0.0625
0.0756	0.0900	0.1056	0.1225	0.1406
0.1600	0.1806	0.2025	0.2256	0.2500
0.2750	0.3000	0.3250	0.3500	0.3750
0.4000	0.4250	0.4500	0.4750	0.5000
0.5250	0.5500	0.5750	0.6000	0.6250
0.6500	0.6750	0.7000	0.7250	0.7500
0.7750	0.8000	0.8250	0.8500	0.8750
0.9000	0.9250	0.9500	0.9750	1.0000

Hrad:

0.0131	0.0262	0.0392	0.0523	0.0654
0.0785	0.0915	0.1046	0.1177	0.1308
0.1438	0.1569	0.1700	0.1831	0.1962
0.2092	0.2223	0.2354	0.2485	0.2615
0.2872	0.3129	0.3384	0.3639	0.3893
0.4146	0.4399	0.4650	0.4901	0.5151
0.5401	0.5650	0.5897	0.6145	0.6391
0.6637	0.6882	0.7126	0.7369	0.7612
0.7854	0.8095	0.8336	0.8576	0.8815
0.9053	0.9291	0.9528	0.9764	1.0000

Width:

0.0500	0.1000	0.1500	0.2000	0.2500
0.3000	0.3500	0.4000	0.4500	0.5000
0.5500	0.6000	0.6500	0.7000	0.7500
0.8000	0.8500	0.9000	0.9500	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000

Transect 6.40_ROW_2.0_X-Fall

Area:

0.0005	0.0021	0.0047	0.0083	0.0130

0.0187	0.0254	0.0332	0.0420	0.0519
0.0628	0.0748	0.0877	0.1017	0.1168
0.1329	0.1500	0.1682	0.1874	0.2076
0.2282	0.2488	0.2694	0.2904	0.3121
0.3345	0.3577	0.3815	0.4060	0.4313
0.4572	0.4838	0.5112	0.5388	0.5665
0.5941	0.6218	0.6494	0.6771	0.7047
0.7324	0.7600	0.7877	0.8159	0.8448
0.8745	0.9048	0.9358	0.9676	1.0000

Hrad:

0.0155	0.0309	0.0464	0.0619	0.0773
0.0928	0.1082	0.1237	0.1392	0.1546
0.1701	0.1856	0.2010	0.2165	0.2320
0.2474	0.2629	0.2783	0.2938	0.3120
0.3422	0.3723	0.4024	0.4317	0.4597
0.4863	0.5118	0.5361	0.5594	0.5818
0.6032	0.6238	0.6436	0.6642	0.6852
0.7066	0.7281	0.7499	0.7719	0.7940
0.8162	0.8385	0.8610	0.8834	0.9048
0.9254	0.9452	0.9641	0.9824	1.0000

Width:

0.0317	0.0633	0.0950	0.1266	0.1583
0.1900	0.2216	0.2533	0.2850	0.3166
0.3483	0.3799	0.4116	0.4433	0.4749
0.5066	0.5383	0.5699	0.6016	0.6275
0.6275	0.6275	0.6303	0.6518	0.6732
0.6946	0.7161	0.7375	0.7590	0.7804
0.8018	0.8233	0.8431	0.8431	0.8431
0.8431	0.8431	0.8431	0.8431	0.8431
0.8431	0.8431	0.8499	0.8714	0.8928
0.9142	0.9357	0.9571	0.9786	1.0000

Transect 6.40_ROW_2.3_X-Fall

Area:

0.0005	0.0018	0.0041	0.0074	0.0115
0.0165	0.0225	0.0294	0.0372	0.0459
0.0556	0.0662	0.0776	0.0900	0.1034
0.1176	0.1328	0.1488	0.1657	0.1833

0.2017	0.2207	0.2405	0.2610	0.2822
0.3041	0.3267	0.3501	0.3741	0.3989
0.4244	0.4507	0.4773	0.5039	0.5305
0.5570	0.5840	0.6117	0.6401	0.6693
0.6991	0.7297	0.7609	0.7929	0.8257
0.8591	0.8932	0.9281	0.9637	1.0000

Hrad:

0.0180	0.0359	0.0539	0.0719	0.0898
0.1078	0.1258	0.1438	0.1617	0.1797
0.1977	0.2156	0.2336	0.2516	0.2695
0.2875	0.3055	0.3237	0.3581	0.3904
0.4209	0.4497	0.4770	0.5029	0.5276
0.5510	0.5735	0.5949	0.6154	0.6351
0.6541	0.6723	0.6924	0.7131	0.7344
0.7560	0.7781	0.7992	0.8194	0.8388
0.8575	0.8756	0.8929	0.9097	0.9260
0.9417	0.9569	0.9717	0.9860	1.0000

Width:

0.0251	0.0501	0.0752	0.1002	0.1253
0.1504	0.1754	0.2005	0.2255	0.2506
0.2757	0.3007	0.3258	0.3508	0.3759
0.4009	0.4260	0.4510	0.4706	0.4901
0.5097	0.5293	0.5489	0.5685	0.5880
0.6076	0.6272	0.6468	0.6663	0.6859
0.7055	0.7251	0.7254	0.7254	0.7254
0.7259	0.7455	0.7651	0.7846	0.8042
0.8238	0.8434	0.8630	0.8825	0.9021
0.9217	0.9413	0.9608	0.9804	1.0000

Transect 7.9_ROW_1.4_X-Fall
Area:

0.0006	0.0024	0.0054	0.0096	0.0150
0.0216	0.0294	0.0384	0.0486	0.0600
0.0725	0.0863	0.1013	0.1175	0.1349
0.1535	0.1733	0.1943	0.2164	0.2398
0.2644	0.2898	0.3151	0.3405	0.3659
0.3912	0.4166	0.4420	0.4673	0.4927
0.5180	0.5434	0.5688	0.5941	0.6195

0.6449	0.6702	0.6956	0.7210	0.7463
0.7717	0.7971	0.8224	0.8478	0.8732
0.8985	0.9239	0.9493	0.9746	1.0000

Hrad:

0.0132	0.0263	0.0395	0.0526	0.0658
0.0789	0.0921	0.1053	0.1184	0.1316
0.1447	0.1579	0.1711	0.1842	0.1974
0.2105	0.2237	0.2368	0.2500	0.2632
0.2763	0.3003	0.3261	0.3519	0.3777
0.4033	0.4289	0.4545	0.4799	0.5053
0.5307	0.5559	0.5811	0.6063	0.6314
0.6564	0.6813	0.7062	0.7310	0.7558
0.7805	0.8051	0.8297	0.8542	0.8787
0.9031	0.9274	0.9517	0.9759	1.0000

Width:

0.0473	0.0945	0.1418	0.1891	0.2364
0.2836	0.3309	0.3782	0.4255	0.4727
0.5200	0.5673	0.6145	0.6618	0.7091
0.7564	0.8036	0.8509	0.8982	0.9455
0.9927	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000

****
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 ........ YES
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... SLOT
Starting Date ............ 07/23/2009 00:00:00
Ending Date .............. 07/23/2009 12:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:01:00
Dry Time Step ............ 00:01:00
Routing Time Step ........ 1.00 sec
Variable Time Step ....... NO
Maximum Trials ........... 8
Number of Threads ........ 6
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.393        71.667
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.057        10.374
Surface Runoff ...........         0.330        60.156
Final Storage ............         0.007         1.211
Continuity Error (%) .....        -0.104


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
```



```
Wet Weather Inflow .......         0.330         3.296
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.327         3.269
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 ......         0.002         0.021
Continuity Error (%) .....         0.178


*************************
Highest Continuity Errors
*************************
Node CB9 (1.49%)


********************************
Highest Flow Instability Indexes
********************************
Link 110C-Umb (2)
Link 104A-Umb (1)


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     1.00 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.01
Percent Not Converging      :     0.02


***************************
```

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
A225NE	71.67	0.00	0.00	22.74	34.41	13.84	48.24	0.03	28.89	0.673
A225NW	71.67	0.00	0.00	12.94	49.83	7.86	57.69	0.07	55.89	0.805
A225SE	71.67	0.00	0.00	22.74	34.41	13.84	48.24	0.04	31.66	0.673
A226NE	71.67	0.00	0.00	22.28	35.11	13.58	48.69	0.03	28.98	0.679
A226NW	71.67	0.00	0.00	12.05	51.23	7.31	58.54	0.08	61.71	0.817
A227NE	71.67	0.00	0.00	22.28	35.11	13.58	48.68	0.01	12.23	0.679
A227NW	71.67	0.00	0.00	22.28	35.11	13.58	48.68	0.03	27.52	0.679
A227SE	71.67	0.00	0.00	22.28	35.11	13.58	48.69	0.03	28.94	0.679
A227SW	71.67	0.00	0.00	12.47	50.54	7.61	58.14	0.06	45.02	0.811
A229N2	71.67	0.00	0.00	9.73	54.75	6.05	60.81	0.02	14.56	0.848
A561N1	71.67	0.00	0.00	12.36	50.55	7.74	58.29	0.07	53.73	0.813
A562NE	71.67	0.00	0.00	18.06	41.43	11.36	52.79	0.01	9.71	0.737
A562R1	71.67	0.00	0.00	26.25	35.10	44.76	44.76	0.02	17.73	0.625
A562R2	71.67	0.00	0.00	22.27	41.42	48.61	48.61	0.01	13.74	0.678
A562R3	71.67	0.00	0.00	21.31	42.83	49.54	49.54	0.03	28.52	0.691
A562R4	71.67	0.00	0.00	25.42	36.51	45.56	45.56	0.01	7.49	0.636
A562SE	71.67	0.00	0.00	18.95	40.02	11.91	51.93	0.01	9.66	0.725
A563NE	71.67	0.00	0.00	11.18	52.63	6.75	59.38	0.07	51.12	0.829
COM	71.67	0.00	0.00	4.46	63.13	2.72	65.84	0.80	585.97	0.919
L100D	71.67	0.00	0.00	12.12	51.13	7.35	58.48	0.06	43.34	0.816
L101A	71.67	0.00	0.00	18.03	42.11	10.65	52.76	0.01	8.69	0.736
L102A	71.67	0.00	0.00	6.95	59.15	4.32	63.47	0.28	209.61	0.886
L103A	71.67	0.00	0.00	8.88	56.14	5.47	61.61	0.08	62.46	0.860
L104A	71.67	0.00	0.00	7.59	58.15	4.70	62.85	0.33	250.16	0.877
L105A	71.67	0.00	0.00	17.37	43.12	10.29	53.40	0.07	56.42	0.745
L105B	71.67	0.00	0.00	20.69	38.11	12.08	50.19	0.10	78.54	0.700
L105C	71.67	0.00	0.00	34.29	18.05	18.97	37.02	0.04	30.06	0.517
L108A	71.67	0.00	0.00	6.32	60.15	3.94	64.08	0.22	163.45	0.894
L110A	71.67	0.00	0.00	13.43	49.13	8.09	57.22	0.09	68.55	0.798
L110B	71.67	0.00	0.00	12.77	50.13	7.72	57.85	0.03	23.75	0.807
L110C	71.67	0.00	0.00	5.04	62.15	3.16	65.31			

POST-DEVELOPMENT MODEL - 100Y 24H SCS

								0.21	153.49	0.911
UNC-1	71.67	0.00	0.00	8.24	57.15	5.08	62.23	0.10	73.69	0.868
UNC-2	71.67	0.00	0.00	8.24	57.15	5.08	62.23	0.10	75.71	0.868
UNC-3	71.67	0.00	0.00	10.82	53.13	6.60	59.73	0.08	62.42	0.833
UNC-4	71.67	0.00	0.00	9.53	55.14	5.84	60.98	0.08	61.87	0.851

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
CB10	JUNCTION	0.00	0.05	103.08	0 01:10	0.05
CB108	JUNCTION	0.00	0.04	104.54	0 01:10	0.04
CB25	JUNCTION	0.00	0.04	104.36	0 01:10	0.04
CB65	JUNCTION	0.00	0.05	106.27	0 01:10	0.05
CB66	JUNCTION	0.00	0.05	105.82	0 01:10	0.05
CB67	JUNCTION	0.00	0.05	105.65	0 01:10	0.05
CB68	JUNCTION	0.01	0.09	104.68	0 01:10	0.09
CB69	JUNCTION	0.01	0.09	104.65	0 01:10	0.09
CB70	JUNCTION	0.01	0.07	104.28	0 01:10	0.07
CB71	JUNCTION	0.00	0.06	104.00	0 01:08	0.06
CB72	JUNCTION	0.05	1.54	103.01	0 01:10	1.54
CB9	JUNCTION	0.00	0.08	103.10	0 01:10	0.08
CB-9	JUNCTION	0.06	1.53	103.17	0 01:10	1.53
CHILLERTON1	JUNCTION	0.01	0.09	104.52	0 01:10	0.09
CHILLERTON2	JUNCTION	0.00	0.05	104.48	0 01:10	0.05
EPOCH	JUNCTION	0.00	0.00	106.04	0 00:00	0.00
HAIKU	JUNCTION	0.00	0.07	102.92	0 01:10	0.06
Maj_006	JUNCTION	0.00	0.00	104.51	0 00:00	0.00

MH_109	JUNCTION	0.14	0.61	99.68	0 01:11	0.61
MH_225	JUNCTION	0.04	0.29	103.33	0 01:10	0.29
MH_2250A	JUNCTION	0.03	0.24	101.20	0 01:10	0.24
MH_225A	JUNCTION	0.04	0.28	102.51	0 01:10	0.28
MH_226A	JUNCTION	0.03	0.25	100.81	0 01:10	0.25
MH-562	JUNCTION	0.02	0.25	101.43	0 01:10	0.25
MH-563	JUNCTION	0.02	0.27	101.09	0 01:10	0.27
CB108-109	OUTFALL	0.00	0.07	102.24	0 01:10	0.06
CHILLERTON	OUTFALL	0.00	0.05	103.19	0 01:10	0.05
Greenbank_Rd	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
MH_110	OUTFALL	0.00	0.00	98.35	0 00:00	0.00
MH-564	OUTFALL	0.00	0.00	100.64	0 00:00	0.00
100	STORAGE	1.93	2.51	99.70	0 01:11	2.51
101	STORAGE	1.91	2.34	99.75	0 01:12	2.34
101A	STORAGE	0.02	0.99	102.88	0 01:10	0.97
102	STORAGE	1.89	2.08	100.80	0 01:22	2.08
102A	STORAGE	0.21	1.65	103.64	0 01:22	1.65
102A-Dummy	STORAGE	0.17	1.59	103.78	0 01:11	1.56
103	STORAGE	1.90	2.25	100.13	0 01:14	2.25
103A	STORAGE	0.09	1.54	103.77	0 01:12	1.54
104	STORAGE	1.91	2.27	100.93	0 01:14	2.27
104A	STORAGE	0.28	1.66	104.32	0 01:24	1.66
104A-Dummy	STORAGE	0.23	1.56	104.42	0 01:20	1.55
105	STORAGE	1.90	2.23	101.41	0 01:14	2.23
105A	STORAGE	0.05	1.77	105.29	0 01:10	1.77
105B	STORAGE	0.05	0.89	103.42	0 01:20	0.86
105C	STORAGE	0.07	1.46	105.28	0 01:10	1.46
106	STORAGE	0.00	0.00	101.50	0 00:00	0.00
107	STORAGE	1.88	2.16	101.82	0 01:14	2.16
108	STORAGE	1.90	2.23	102.00	0 01:14	2.23
108A	STORAGE	0.24	1.58	105.55	0 01:23	1.58
108A-Dummy	STORAGE	0.16	1.30	105.65	0 01:20	1.29
109	STORAGE	0.00	0.00	102.11	0 00:00	0.00
110	STORAGE	1.90	2.20	102.44	0 01:13	2.20
110A	STORAGE	0.06	1.50	105.77	0 01:11	1.50
110B	STORAGE	0.09	1.56	105.61	0 01:13	1.56
110C	STORAGE	0.23	1.60	105.57	0 01:22	1.60
110C-Dummy	STORAGE	0.18	1.45	105.62	0 01:20	1.45

110D	STORAGE	0.06	1.49	105.83	0	01:11	1.49
111	STORAGE	0.08	1.07	103.42	0	01:21	1.07
COMM	STORAGE	0.17	1.73	106.95	0	01:20	1.73

****
Node Inflow Summary
****

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
CB10	JUNCTION	9.66	40.36	0 01:10	0.0109	0.0364	-0.111
CB108	JUNCTION	53.73	53.73	0 01:10	0.0664	0.0664	-0.070
CB25	JUNCTION	51.12	51.12	0 01:10	0.0665	0.0665	-0.153
CB65	JUNCTION	31.66	31.66	0 01:10	0.0361	0.0361	-0.136
CB66	JUNCTION	28.89	46.18	0 01:10	0.0329	0.0501	0.232
CB67	JUNCTION	55.89	55.89	0 01:10	0.071	0.071	-0.045
CB68	JUNCTION	91.40	122.00	0 01:10	0.114	0.147	-0.102
CB69	JUNCTION	61.71	101.59	0 01:10	0.0793	0.128	0.007
CB70	JUNCTION	28.94	115.80	0 01:10	0.0331	0.128	0.144
CB71	JUNCTION	45.02	64.94	0 01:10	0.0572	0.0796	-0.190
CB72	JUNCTION	101.62	263.57	0 01:10	0.126	0.252	-0.479
CB9	JUNCTION	9.71	74.81	0 01:10	0.0111	0.054	1.518
CB-9	JUNCTION	67.48	67.48	0 01:10	0.0681	0.0815	-0.000
CHILLERTON1	JUNCTION	0.00	89.87	0 01:10	0	0.095	0.048
CHILLERTON2	JUNCTION	14.56	86.52	0 01:10	0.0187	0.0956	0.083
EPOCH	JUNCTION	0.00	0.00	0 00:00	0	0	0.000 ltr
HAIKU	JUNCTION	0.00	144.40	0 01:10	0	0.0744	0.291
Maj_006	JUNCTION	0.00	0.00	0 00:00	0	0	0.000 ltr
MH_109	JUNCTION	0.00	781.02	0 01:11	0	2.76	0.052
MH_225	JUNCTION	0.00	216.16	0 01:10	0	0.86	-0.004
MH_2250A	JUNCTION	0.00	271.98	0 01:10	0	0.964	-0.001
MH_225A	JUNCTION	0.00	272.31	0 01:10	0	0.964	-0.002
MH_226A	JUNCTION	0.00	312.72	0 01:10	0	1.04	-0.024

MH-562	JUNCTION	0.00	55.25	0 01:10	0	0.09	-0.000
MH-563	JUNCTION	0.00	100.67	0 01:10	0	0.173	-0.010
CB108-109	OUTFALL	0.00	138.48	0 01:10	0	0.0741	0.000
CHILLERTON	OUTFALL	0.00	65.50	0 01:10	0	0.0731	0.000
Greenbank_Rd	OUTFALL	149.39	149.39	0 01:10	0.196	0.196	0.000
MH_110	OUTFALL	0.00	780.46	0 01:11	0	2.75	0.000
MH-564	OUTFALL	0.00	100.06	0 01:10	0	0.173	0.000
100	STORAGE	0.00	315.52	0 01:14	0	1.48	0.047
101	STORAGE	0.00	314.85	0 01:14	0	1.48	-0.011
101A	STORAGE	8.69	8.69	0 01:10	0.011	0.011	-0.001
102	STORAGE	0.00	40.49	0 01:22	0	0.275	0.025
102A	STORAGE	209.61	273.47	0 01:08	0.277	0.348	0.727
102A-Dummy	STORAGE	0.00	114.50	0 01:06	0	0.0704	-0.672
103	STORAGE	0.00	269.33	0 01:14	0	1.2	0.005
103A	STORAGE	62.46	62.46	0 01:10	0.0815	0.0815	0.020
104	STORAGE	0.00	244.19	0 01:14	0	1.12	0.005
104A	STORAGE	250.16	315.19	0 01:05	0.329	0.405	0.628
104A-Dummy	STORAGE	0.00	121.94	0 01:03	0	0.0688	-0.801
105	STORAGE	0.00	204.27	0 01:13	0	0.793	0.003
105A	STORAGE	56.42	56.42	0 01:10	0.0715	0.0715	0.001
105B	STORAGE	78.54	78.54	0 01:10	0.0993	0.0994	-0.169
105C	STORAGE	30.06	30.06	0 01:10	0.039	0.039	-0.022
106	STORAGE	0.00	0.00	0 00:00	0	0	0.000 ltr
107	STORAGE	0.00	129.40	0 01:14	0	0.591	-0.038
108	STORAGE	0.00	129.41	0 01:14	0	0.593	0.074
108A	STORAGE	163.45	218.76	0 01:09	0.217	0.288	0.416
108A-Dummy	STORAGE	0.00	93.73	0 01:05	0	0.0707	-0.295
109	STORAGE	0.00	0.00	0 00:00	0	0	0.000 ltr
110	STORAGE	0.00	100.91	0 01:12	0	0.379	0.015
110A	STORAGE	68.55	68.55	0 01:10	0.0876	0.0876	0.010
110B	STORAGE	23.75	23.75	0 01:10	0.0304	0.0304	0.010
110C	STORAGE	153.49	183.07	0 01:07	0.206	0.241	0.250
110C-Dummy	STORAGE	0.00	76.15	0 01:04	0	0.0351	-0.494
110D	STORAGE	43.34	43.34	0 01:10	0.0557	0.0557	0.016
111	STORAGE	0.00	73.07	0 01:09	0	0.0996	0.167
COMM	STORAGE	585.97	585.97	0 01:10	0.803	0.803	0.020

Node Surcharge Summary

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
CB-9	JUNCTION	0.42	1.179	0.451

Node Flooding Summary

No nodes were flooded.

Storage Volume Summary

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
100	0.002	32	0	0	0.003	42	0 01:11	317.58
101	0.002	30	0	0	0.003	37	0 01:12	315.52
101A	0.000	0	0	0	0.000	9	0 01:10	7.15
102	0.002	35	0	0	0.002	38	0 01:22	40.48
102A	0.003	3	0	0	0.060	47	0 01:22	149.05
102A-Dummy	0.000	3	0	0	0.001	32	0 01:11	67.37
103	0.002	31	0	0	0.003	37	0 01:14	269.34
103A	0.001	1	0	0	0.019	25	0 01:12	25.23
104	0.002	31	0	0	0.003	36	0 01:14	244.12
104A	0.010	5	0	0	0.113	64	0 01:24	152.22
104A-Dummy	0.000	5	0	0	0.001	31	0 01:20	85.23
105	0.002	31	0	0	0.003	36	0 01:14	203.99
105A	0.000	0	0	0	0.004	41	0 01:10	41.96
105B	0.000	3	0	0	0.001	43	0 01:20	73.07
105C	0.000	1	0	0	0.001	22	0 01:10	24.65
106	0.000	0	0	0	0.000	0	0 00:00	0.00
107	0.002	30	0	0	0.002	35	0 01:14	129.40
108	0.002	32	0	0	0.003	38	0 01:14	129.40
108A	0.003	2	0	0	0.053	34	0 01:23	118.03
108A-Dummy	0.000	3	0	0	0.000	26	0 01:20	56.59
109	0.000	0	0	0	0.000	0	0 00:00	0.00
110	0.002	34	0	0	0.002	40	0 01:13	100.88
110A	0.000	0	0	0	0.012	12	0 01:11	38.44
110B	0.000	1	0	0	0.007	30	0 01:13	8.97
110C	0.004	3	0	0	0.061	40	0 01:22	100.80
110C-Dummy	0.000	4	0	0	0.001	29	0 01:20	32.38
110D	0.000	0	0	0	0.008	12	0 01:11	24.84
111	0.000	3	0	0	0.001	39	0 01:21	26.52
COMM	0.011	4	0	0	0.234	76	0 01:20	174.99

Outfall Loading Summary

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
CB108-109	25.09	6.84	138.48	0.074
CHILLERTON	26.62	6.35	65.50	0.073
Greenbank_Rd	31.23	14.50	149.39	0.196
MH_110	68.04	93.63	780.46	2.752
MH-564	32.37	12.38	100.06	0.173
System	36.67	133.70	1205.57	3.269

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
101-100	CONDUIT	315.52	0	01:14	1.37	0.52	0.68
101A-Obsidian_Street-3	CHANNEL	0.00	0	00:00	0.00	0.00	0.28
101-EX_109	CONDUIT	317.58	0	01:13	1.10	0.57	0.85
102-101	CONDUIT	40.48	0	01:23	1.46	0.34	0.41
102A-101A	CHANNEL	0.00	0	00:00	0.00	0.00	0.00
102A-Umb	CONDUIT	114.50	0	01:06	0.39	2.00	1.00
103-101	CONDUIT	269.34	0	01:15	2.09	0.63	0.58
103A-101A	CHANNEL	0.00	0	00:00	0.00	0.00	0.00
104-103	CONDUIT	244.12	0	01:14	1.90	0.56	0.57
104A-104B	CHANNEL	0.00	0	00:00	0.00	0.00	0.00
104A-Umb	CONDUIT	121.94	0	01:03	0.31	1.91	1.00
105-104	CONDUIT	203.99	0	01:14	1.95	0.71	0.63
105A-104A	CHANNEL	0.00	0	00:00	0.00	0.00	0.00
105B-111	CONDUIT	73.07	0	01:09	0.38	0.07	1.00
105C-104A	CHANNEL	12.84	0	01:10	0.49	0.00	0.07
106-105	CONDUIT	0.00	0	00:00	0.00	0.00	0.22
107-105	CONDUIT	129.40	0	01:15	1.67	0.46	0.52
108-107	CONDUIT	129.40	0	01:14	1.08	0.43	0.54
109-107	CONDUIT	0.00	0	00:00	0.00	0.00	0.11
110-108	CONDUIT	100.88	0	01:13	1.21	0.50	0.52
110B-S	CHANNEL	0.00	0	00:00	0.00	0.00	0.00
110C-110B	CHANNEL	0.00	0	00:00	0.00	0.00	0.00
110C-Umb	CONDUIT	76.15	0	01:04	0.21	0.92	1.00
110D-110B	CHANNEL	0.00	0	00:00	0.00	0.00	0.00
C10	CHANNEL	17.33	0	01:10	0.45	0.01	0.14
C11	CHANNEL	30.75	0	01:10	0.38	0.01	0.20
C12	CHANNEL	0.00	0	00:00	0.00	0.00	0.08

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C13	CHANNEL	39.90	0	01:10	0.48	0.01	0.20
C14	CHANNEL	72.13	0	01:10	0.97	0.02	0.19
C15	CHANNEL	19.98	0	01:10	0.48	0.01	0.15
C16	CHANNEL	47.51	0	01:09	1.03	0.01	0.17
C17	CHANNEL	138.48	0	01:10	1.00	0.01	0.19
C18	CHANNEL	65.50	0	01:10	0.91	0.01	0.13
C19	CHANNEL	89.87	0	01:10	0.66	0.03	0.26
C2	CONDUIT	93.73	0	01:05	0.34	1.37	1.00
C20	CHANNEL	88.26	0	01:10	0.82	0.03	0.23
C21	CHANNEL	88.68	0	01:10	0.88	0.02	0.33
C22	CHANNEL	74.17	0	01:10	0.64	0.02	0.34
C23	CHANNEL	30.70	0	01:10	1.02	0.00	0.13
C25	CHANNEL	15.43	0	01:10	0.43	0.00	0.16
C26	CHANNEL	0.00	0	00:00	0.00	0.00	0.06
C27	CHANNEL	28.20	0	01:10	0.93	0.00	0.18
C6	CONDUIT	100.06	0	01:10	1.04	0.52	0.46
STM-109-110	CONDUIT	780.46	0	01:11	2.36	0.84	0.70
STM-2250A-226A	CONDUIT	272.04	0	01:10	2.45	0.26	0.35
STM-225-225A	CONDUIT	215.79	0	01:10	1.74	0.60	0.56
STM-225A-2250A	CONDUIT	271.98	0	01:10	2.29	0.57	0.54
STM-226A-109	CONDUIT	312.58	0	01:10	1.36	0.29	0.63
STM-562-563	CONDUIT	55.15	0	01:10	1.00	0.85	0.73
102A-O1	ORIFICE	40.49	0	01:22			1.00
103A-O1	ORIFICE	25.23	0	01:12			1.00
104A-O1	ORIFICE	40.55	0	01:24			1.00
105A-O1	ORIFICE	41.96	0	01:10			1.00
105B-O1	ORIFICE	23.44	0	01:21			1.00
108A-O1	ORIFICE	28.71	0	01:23			1.00
110A-O1	ORIFICE	38.44	0	01:11			1.00
110C-O1	ORIFICE	28.88	0	01:22			1.00
110D-O1	ORIFICE	24.84	0	01:11			1.00
CB108-O	ORIFICE	22.94	0	01:10			
CB10-O	ORIFICE	24.68	0	01:10			
CB25-O	ORIFICE	22.62	0	01:10			
CB72-O	ORIFICE	157.77	0	01:10			1.00
CB9-O	ORIFICE	30.56	0	01:10			1.00
CB9-O1	ORIFICE	36.91	0	01:10			
108A-110C	WEIR	0.73	0	01:22			0.02

110A-110D	WEIR	0.00	0	00:00	0.00
COMM-W	WEIR	0.00	0	00:00	0.00
W2	WEIR	0.00	0	00:00	0.00
W3	WEIR	83.80	0	01:10	0.07
W4	WEIR	0.00	0	00:00	0.00
101A-O1	DUMMY	7.15	0	01:10	
105C-O1	DUMMY	11.81	0	01:10	
110B-O1	DUMMY	8.97	0	01:13	
CB65-O	DUMMY	13.55	0	01:10	
CB66-O	DUMMY	13.27	0	01:10	
CB67-O	DUMMY	14.97	0	01:10	
CB68-O	DUMMY	29.07	0	01:10	
CB69-O	DUMMY	27.84	0	01:10	
CB70-O	DUMMY	24.00	0	01:10	
CB71-O	DUMMY	17.46	0	01:08	
COMM-O	DUMMY	174.99	0	01:20	

****
Flow Classification Summary
****

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 ----------								
101-100	1.00	0.05	0.00	0.00	0.12	0.09	0.00	0.73	0.00	0.00
101A-Obsidian_Street-3	1.00	0.98	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
101-EX_109	1.00	0.04	0.01	0.00	0.95	0.00	0.01	0.00	0.00	0.00
102-101	1.00	0.05	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
102A-101A	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
102A-Umb	1.00	0.06	0.00	0.00	0.21	0.00	0.00	0.73	0.00	0.00
103-101	1.00	0.05	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
103A-101A	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104-103	1.00	0.05	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
104A-104B	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104A-Umb	1.00	0.06	0.00	0.00	0.23	0.00	0.00	0.71	0.00	0.00

105-104	1.00	0.05	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
105A-104A	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
105B-111	1.00	0.03	0.00	0.00	0.97	0.00	0.00	0.00	0.54	0.00
105C-104A	1.00	0.97	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
106-105	1.00	0.88	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
107-105	1.00	0.05	0.00	0.00	0.00	0.06	0.00	0.89	0.04	0.00
108-107	1.00	0.05	0.00	0.00	0.95	0.00	0.00	0.00	0.80	0.00
109-107	1.00	0.94	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
110-108	1.00	0.05	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
110B-S	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
110C-110B	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
110C-Umb	1.00	0.06	0.00	0.00	0.20	0.00	0.00	0.74	0.00	0.00
110D-110B	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C10	1.00	0.56	0.07	0.00	0.36	0.00	0.00	0.00	0.95	0.00
C11	1.00	0.32	0.28	0.00	0.40	0.00	0.00	0.00	0.96	0.00
C12	1.00	0.39	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13	1.00	0.28	0.11	0.00	0.58	0.03	0.00	0.00	0.96	0.00
C14	1.00	0.03	0.33	0.00	0.40	0.24	0.00	0.00	0.70	0.00
C15	1.00	0.03	0.00	0.00	0.88	0.09	0.00	0.00	0.23	0.00
C16	1.00	0.03	0.47	0.00	0.26	0.24	0.00	0.00	0.73	0.00
C17	1.00	0.04	0.00	0.00	0.41	0.55	0.00	0.00	0.16	0.00
C18	1.00	0.03	0.00	0.00	0.32	0.64	0.00	0.00	0.26	0.00
C19	1.00	0.03	0.29	0.00	0.66	0.01	0.00	0.00	0.92	0.00
C2	1.00	0.07	0.00	0.00	0.19	0.00	0.00	0.74	0.00	0.00
C20	1.00	0.03	0.00	0.00	0.53	0.43	0.00	0.00	0.00	0.00
C21	1.00	0.56	0.00	0.00	0.01	0.00	0.00	0.43	0.02	0.00
C22	1.00	0.65	0.00	0.00	0.02	0.00	0.00	0.33	0.02	0.00
C23	1.00	0.42	0.01	0.00	0.34	0.24	0.00	0.00	0.01	0.00
C25	1.00	0.03	0.63	0.00	0.33	0.01	0.00	0.00	0.95	0.00
C26	1.00	0.22	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C27	1.00	0.21	0.00	0.00	0.55	0.24	0.00	0.00	0.02	0.00
C6	1.00	0.03	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00
STM-109-110	1.00	0.04	0.00	0.00	0.00	0.00	0.00	0.96	0.00	0.00
STM-2250A-226A	1.00	0.04	0.00	0.00	0.00	0.00	0.00	0.96	0.00	0.00
STM-225-225A	1.00	0.03	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00
STM-225A-2250A	1.00	0.03	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00
STM-226A-109	1.00	0.03	0.00	0.00	0.97	0.00	0.00	0.00	0.97	0.00
STM-562-563	1.00	0.03	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full Both Ends	Hours Full Upstream	Hours Full Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
102A-Umb	1.09	1.09	1.09	0.09	0.52
104A-Umb	1.69	1.69	1.69	0.07	0.81
105B-111	0.01	0.01	0.26	0.01	0.01
110C-Umb	1.36	1.36	1.36	0.01	0.66
C2	1.26	1.26	1.27	0.03	0.61

Analysis begun on: Wed Mar 29 15:54:10 2023
Analysis ended on: Wed Mar 29 15:54:12 2023
Total elapsed time: 00:00:02

Appendix E EXTERNAL REPORTS

E.1 DESIGN BRIEF (SITE SERVICING STUDY) FOR THE RIDGE (BRAZEAU LANDS) BY DSEL (JULY 2020)

david schaeffer engineering ltd

120 Iber Road, Suite 103
Ottawa, Ontario K2S 1E9
Tel. (613)836-0856
Fax (613) 836-7183
www.DSEL.ca

DESIGN BRIEF

FOR

CAIVAN GREENBANK DEVELOPMENT CORPORATION

THE RIDGE (BRAZEAU LANDS)

3809 BORRISOKANE ROAD

CITY OF OTTAWA

PROJECT NO.: 18-1030
JULY 27TH , 2020
4TH SUBMISSION

DESIGN BRIEF
FOR
CAIVAN GREENBANK DEVELOPMENT CORPORATION

THE RIDGE (BRAZEAU LANDS)

PROJECT NO: 18-1030

TABLE OF CONTENTS

TABLES

APPENDICES

DESIGN BRIEF
FOR
CAIVAN GREENBANK DEVELOPMENT CORPORATION

THE RIDGE (BRAZEAU LANDS)

CITY OF OTTAWA
PROJECT NO: 18-1030

1.0 INTRODUCTION

David Schaeffer Engineering Limited (DSEL) has been retained to prepare the detailed design of the Brazeau Lands development area located at 3809 Borrisokane Road within the Barrhaven South Urban Expansion Area (***BSUEA***) on behalf of Caivan Greenbank Development Corporation (CGDC). This design brief is submitted in support of that development. The development is now being referred to as “The Ridge” Subdivision for marketing purposes.

The proposed development area is illustrated in ***Figure 1*** (see ***Appendix A***) and is located north of Barnsdale Road, east of Highway 416 (and Borrisokane Road), south of Cambrian Road and west of the future New Greenbank Road alignment. The current zoning is Mineral Extraction (ME) and is amended to permit low-rise residential uses. The western portion of the property is outside of the urban boundary and will remain at the current zoning while the eastern side (approximately 24.7 ha) is within the urban boundary and is to be rezoned as noted above. The development will also include a 0.91 ha block for a road connection to Borrisokane Road, a future 0.89 ha right-of-way (ROW) area within the Drummond Lands (also owned by CGDC) for servicing outlets, and a 3.94 ha pond block within the Drummond Lands that will service both properties. The lands are planned to be developed with a mix of detached single homes, townhomes, park blocks, SWM blocks, open space and a road network (see ***Figure 2*** for the lotted legal plan in ***Appendix A***).

This design brief is prepared to demonstrate conformance with the design criteria of the City of Ottawa, background studies, including the Master Servicing Study, and general industry practice.

1.1 Existing Conditions

The Ridge subdivision was previously an aggregate extraction pit operated in accordance with the Ontario Aggregate Resources Act and Regulations. Processes have been undertaken to remove this designation.

The property ground surface is significantly disturbed as a result of the mineral extraction activities that have occurred over the years with stockpiles of materials at various locations and elevations. The eastern portion of the site adjacent to the New Greenbank Road future alignment range in elevations from approximately 108.0m to 104.5m. On-site elevations vary due to the various stockpiles of materials but are general averaging about 99.0m. Drainage is generally conveyed westward towards Borrisokane Road which is owned by, and under the jurisdiction of, the Ministry of Transportation.

The property is within the Jock River watershed and is under the jurisdiction of the Rideau Valley Conservation Authority (RVCA).

2.0 GUIDELINES, PREVIOUS STUDIES, AND REPORTS

2.1 Existing Studies, Guidelines, and Reports

The following studies were utilized in the preparation of this report.

- Ottawa Sewer Design Guidelines,
  City of Ottawa, *SDG002,* October 2012
  *(**Sewer Design Guidelines**)*
  - Technical Bulletin ISDTB-2014-01
    City of Ottawa, February 5, 2014
    (ITSB-2014-01)
  - Technical Bulletin PIEDTB-2016-01
    City of Ottawa, September 6, 2016
    (PIEDTB-2016-01)
  - Technical Bulletin ISTB-2018-01
    City of Ottawa, March 21, 2018
    (ISTB-2018-01)
  - Technical Bulletin ISTB-2018-04
    City of Ottawa, June 27, 2018
    (ISTB-2018-04)
- Ottawa Design Guidelines – Water Distribution
  City of Ottawa, July 2010.
  *(**Water Supply Guidelines**)*
  - Technical Bulletin ISD-2010-2
    City of Ottawa, December 15, 2010.
    (ISD-2010-2)
  - Technical Bulletin ISDTB-2014-2
    City of Ottawa, May 27, 2014.
    (ISDTB-2014-2)

- Technical Bulletin ISTB-2018-02
  City of Ottawa, March 21, 2018
  (ISTB-2018-02)

- Design Guidelines for Sewage Works,
  Ministry of the Environment, Conservation and Parks, 2008. (formerly MOECC)
  *(**MECP Design Guidelines**)*

- Highway Drainage Design Standards (MTO 2008)

- Drainage Management Manual (MTO 1997),
  Ministry of Transportation.
  *(**MTO Manuals**)*

- Stormwater Planning and Design Manual,
  Ministry of the Environment, March 2003.
  *(**SWMP Design Manual**)*

- City of Ottawa Official Plan,
  adopted by Council 2003.
  *(**Official Plan**)*

- South Nepean Collector: Phase 2 Hydraulics Review / Assessment Technical Memorandum
  Novatech, August 2015
  *(**Novatech SNC Memo**)*

- Master Servicing Study – Barrhaven South Urban Expansion Area, J.L. Richards & Associates Limited, Revision 2, May 2018
  *(**BSUEA MSS**)*

- Servicing Brief – Quinn's Pointe Residential Stages 2, 3 & 4, J.L. Richards & Associates Limited, Revision 1, October 2018 (File No. 26610-001.1)
  *(**Quinn's Pointe Brief**)*

- Stormwater Management Report for Brazeau Subdivision, by J.F. Sabourin and Associates (July 2020)
  *(**JFSA SWM Report**)*

- Pond Design Brief for Brazeau Subdivision, by J.F. Sabourin and Associates (July 2020)
  *(**JFSA Pond Report**)*

- Caivan Brazeau/Drummond Development – LID Design Update, by J.F. Sabourin and Associates (July 2020)
  *(**JFSA LID Analysis**)*

- Geotechnical Investigation, Proposed Residential Development, Brazeau Lands – Borrisokane Road, Paterson Group (January 2019)
  (***Geotechnical Report***)

- Groundwater Infiltration Review, Proposed Residential Development, Brazeau Pit and Drummonds Pit – Borrisokane Road, Paterson Group (August 2019)
  (***Infiltration Review***)

- Supplemental Hydrogeological Review, Proposed Residential Development, The Ridge – Borrisokane Road, Paterson Group (March 4, 2020)
  (***Hydrogeological Review***)

- Borrisokane Ditch Erosion Assessment: The Ridge (Brazeau) Subdivision, J.F. Sabourin and Associates Inc. (June 2020)
  (***JFSA Erosion Assessment***)

3.0 WATER SUPPLY SERVICING

3.1 Existing Water Supply Services

The ***BSUEA MSS*** provided an overview of the existing watermain infrastructure associated with the BSUEA. The ***BSUEA MSS*** completed an overall assessment of the water supply for the area in order to examine the feasibility of the extension of existing infrastructure that would meet the required City and MECP criteria for the whole of the development area.

The 'Master Watermain" plan (Drawing MWM) from the ***BSUEA MSS*** is provided in ***Appendix B*** and illustrates the existing watermains in proximity to The Ridge development area. In addition, a conceptual watermain plan (Drawing CWM) from the preliminary Servicing Brief for Minto's Quinn's Pointe (Stages 2, 3 & 4) residential area is provided for reference. The proposed watermain servicing connections points for The Ridge development area are as follows:

- Existing 300mm diameter watermain terminating at Dundonald Drive and the future New Greenbank Road alignment;
- Proposed 300mm diameter watermain from the existing Cambrian Road 400mm diameter watermain forming part of the Tamarack Meadows development network located north of The Ridge and Drummond lands.

As adjacent developments to the east are advanced there will be a future required connection to the development from the existing 300mm diameter watermain on Kilbirnie Drive at Alex Polowin Avenue (or future extension location that is dependent upon the advancement of the Quinn's Pointe development).

3.2 Water Supply Servicing Design

The ***BSUEA MSS*** presents overall watermain infrastructure details for the BSUEA. The subject property was deemed serviceable and the ***MSS*** reviewed a number of servicing scenarios (i.e. existing and built-out conditions) that confirmed that the area could be adequately serviced conforming to relevant City and MECP Guidelines and Policies.

The water analysis contained in the ***BSUEA MSS*** utilized system level water demands as developed by the City due to the fact that the number of units and densities resulted in an overall population that would exceed 3,000. The excerpt of the system level demands listed in Table 7-1 of the ***MSS*** can be found in ***Appendix B*** and are summarized as follows:

Table 1A: Water Supply Design Criteria (System Level Demands)

Land Use Type	Consumption Rate
JLR BSUEA MSS, May 2018 for Population Exceeding 3000 Persons	
Single Family Residential	180 L/cap/day
Multi-unit Residential (Townhouse / Back to Back)	198 L/cap/day
Apartment Residential	219 L/cap/day
Commercial	50,000 L/ha/day
Institutional	50,000 L/ha/day
Outdoor Water Demand	1049 L/unit/day (single detached)

The estimated water demands within the ***BSUEA MSS*** were summarized in Table 7-2 (excerpt found in ***Appendix B***). The table summarized a total population of 1,194 for the Brazeau Lands development area along with some commercial and institutional components. Based on the current development concept the water demand table is refined to reflect a revised residential unit count and the removal of the commercial, institutional and high density components. Based on the development layout illustrated in ***Figure 2*** the development area will have 347 single family homes and 279 towns with associated populations of 1,180 and 754 respectively. The adjusted water demands for comparison purposes are summarized in the following table:

Table 1B: Estimated Water Demands - Brazeau Land Updates

Design Parameter	Area (ha)	Units	Pop.	ADD SFH [1]	ADD MLT [2]	ADD APT [3]	ADD COM [4]	ADD INS [5]	Total BSDY	OWD[6]	Total MXDY
From Table 7-2 of MSS	12.72	398	1194	1.56	0.87	0.17	0.39	0.85	3.84	2.67	6.51
Revised per Updated Development Plan (Residential Area)	23.83	626[7]	1934	2.45	1.73	0	0	0	4.18	4.21	8.39
		+228	+740						**+0.34**	+1.54	**+1.88**

1 Daily Demand, Single Family Homes, L/s (see Table 1A for Consumption Rate)
2 Average Daily Demand, Multi-Units (Townhouses and Back to Back Unit) L/s
3 Average Daily Demand, Apartment Units, L/s
4 Average Daily Demand, Commercial, L/s
5 Average Daily Demand, Institutional, L/s
6 Outdoor Water Demand, L/s, calculated as 1,049 L per SFH unit per day per MSS
7 Comprised of 347 Singles Family Homes and 279 Townhouses

With reference to Table 7-2, the overall Total BSDY increased by 0.34 L/s (to 19.00 L/s) which is a 1.8% increase over the previous 18.66 L/s. The total MXDY increases by 1.88 L/s which is a 5.9% increase over the previous 31.48 L/s.

The typical Water Supply Design Criteria used are as summarized in the following table:

Table 1C: Water Supply Design Criteria

Design Parameter	Value
Residential – Single Family	3.4 p/unit
Residential – Semi-Detached	2.7 p/unit
Residential – Townhome	2.7 p/unit
Residential – Average Daily Demand	350 L/p/day
Residential – Maximum Daily Demand	2.5 x Average Daily Demand
Residential – Maximum Hourly Demand	2.2 x Maximum Daily Demand
Residential – Minimum Hourly Demand	0.5 x Average Daily Demand
Commercial / Institutional Average Daily Demand	50,000 L/ha/day
Park Average Daily Demand	28,000 L/ha/day
Commercial / Institutional / Park Maximum Daily Demand	1.5 x Average Daily Demand
Commercial / Institutional / Park Maximum Hour Demand	1.8 x Maximum Daily Demand
Commercial / Institutional / Park Minimum Hourly Demand	0.5 x Average Daily Demand
Fire Flow	Calculated as per the Fire Underwriter's Survey 1999.
Minimum Watermain Size	150 mm diameter
Service Lateral Size	19 mm dia. Copper or equivalent
Minimum Depth of Cover	2.4 m from top of watermain to finished grade
Peak hourly demand operating pressure	275 kPa and 690 kPa
Fire flow operating pressure minimum	140 kPa
Extracted from Section 4: Ottawa Design Guidelines, Water Distribution (July 2010), ISDTB-2010-2	

A boundary condition request was submitted (provided in ***Appendix B*** for reference) in order to obtain water supply parameters for use in the hydraulic modelling assessment of the network. A hydraulic analysis was prepared for the water distribution network to confirm that water supply is available within the required pressure range, under the anticipated demand during average day, peak hour and fire flow conditions and was based on boundary conditions requested from the City of Ottawa. Refer to the *Hydraulic Capacity and Modeling Analysis, Brazeau Lands* prepared by *GeoAdvice Engineering Inc. dated June 10, 2020* ***(GeoAdvice Water Analysis)***, enclosed in ***Appendix B.***

The proposed water layout is shown in the general plan of services overview presented in ***Figures 3, 3A, 3B*** at the back of this report as well as in the GeoAdvice report figures. The Ridge development will initially require a minimum of two watermain feeds to the service the property. Based on the nearby existing infrastructure, and surrounding development plans, it is proposed that an extension of the existing Dundonald Drive 300mm watermain will provide service to the northeast portion of the property. In addition, the second proposed feed to service The Ridge will be through the Drummond Lands from the proposed 300mm watermain that is being advanced for the Tamarack Meadows development north of the property. Ultimately there will be future connections to Greenbank Road and Kilbirnie Drive (to the south) when those development areas are advanced.

3.3 Summary of Hydraulic Modeling Analysis

A complete watermain analysis has been prepared to confirm that the network is sized adequately, which is the greater of maximum day plus fire and maximum hour for both the Phase 1 and Phase 1&2 scenario. Refer to the ***GeoAdvice Report,*** enclosed in ***Appendix B.***

System Pressures

The modeling indicates that the development can be adequately serviced by the proposed watermain network. Modeled service pressures for the development are summarized in the following table. The detailed pipe and junction tables are contained in the ***GeoAdvice Report***, enclosed in ***Appendix B.***

Table 1D: Summary of Available System Pressures

	Minimum Hour Demand Maximum Pressure		Peak Hour Demand Minimum Pressure	
	kPA	psi	kPA	psi
Phase 1	538	78	290	42
Phases 1&2	538	78	262	38

The generally accepted best practice is to design new water distribution systems to operate between 350 kPa (50 psi) and 480 kPa (70 psi) as outlined in the City of Ottawa Design Guidelines. Low pressures (slightly below 40 psi) are predicted in the south and southeast area of the site due to higher ground elevations. However, this is without considering provision of the future watermain connection from the Quinn's Pointe development area. Per Section 4.1 of the ***GeoAdvice Report***, this future additional connection (as required by the ***BSUEA MSS***) will provide an additional head of up to seven meters and resolve this low pressure condition. Should the availability of the additional watermain feed not be in place during the advancement of Phase 2 of The Ridge, it would be recommended that oversized service laterals be provided in order to compensate. For now, the current design drawings have demonstrated the requirement of a 25mm water service lateral in the areas that are slightly below the 40psi threshold.

3.4 Fire Flows – Fire Underwriters Survey

Fire Flow requirements are established in the boundary condition request found in ***Appendix B*** as prepared by GeoAdvice. Calculations for the single detached dwellings and traditional townhomes reached the City of Ottawa's cap of 10,000 L/min (167 L/s) as outlined in *ISDTB-2014-02*. At this time, there is not enough information available to calculate the required fire flows of the park so a required fire flow of 250 L/s was assumed, which is a typical requirement for similar land uses. The fire flows are calculated in accordance with the Fire Underwriters Survey's Water Supply for Public

Fire Protection Guideline (1999). Detailed FUS calculations can be found in the GeoAdvice reporting.

Available Fire Flows

The minimum allowable pressure under fire flow conditions is 140 kPa (20 psi) at the location of the fire. A summary of the available fire flows is presented in the following table. The detailed fire flow reports are found in the ***GeoAdvice Report*** enclosed in ***Appendix B***.

1E: Summary of Available Fire Flows

	Required Fire Flow (L/s)	Minimum Available Flow (L/s)	Junction ID
Phase 1	167	177	J-45
	250	249	J-47
Phase 1 & 2	167	194	J-66
	250	269	J-47

As shown in the above table the model predicts the network will be able to provide all required fire flows within the development limits. Detailed results are included in the ***GeoAdvice Report***, enclosed in ***Appendix B***.

3.5 Water Supply Conclusion

The subject lands have been previously reviewed within the ***BSUEA MSS*** for the BSUEA development areas. The interim condition of The Ridge subdivision can be serviced by City of Ottawa infrastructure through the extension of the existing 300mm watermain from Dundonald Road from the east side of the property and a proposed connection north of the property, through the Drummond Lands, to a new 300mm watermain extension from Cambrian Road. In the interim condition for Phase 2 areas (i.e. only two feeds into the development area) there are pockets of low pressure (slightly below 40psi) areas along the southern boundary that are proposed to have 25mm water service laterals to compensate. Ultimately there will be additional connections to future watermains along Greenbank Road and Kilbirnie Drive (from the south as the Minto Quinn's Pointe development advances) that will alleviate the low pressure condition. See ***Figure WAT-1*** in ***Appendix B*** for the watermain network overview. These extensions are in accordance with the ***MSS*** projected infrastructure. The proposed water supply design conforms to all relevant City and MECP Guidelines and Policies.

4.0 WASTEWATER SERVICING

4.1 Existing Wastewater Services

Sanitary flows from the ***BSUEA*** were proposed to outlet to the existing 900mm diameter Greenbank Road sanitary trunk sewer. The existing South Nepean Collector (SNC) will provide the sanitary outlet for the entire Barrhaven South Community, which includes the BSUEA development area.

Trunk sanitary sewers exist north of the Brazeau Lands area and are located along Cambrian Road (see JLR's *Master Sanitary Drainage Area* plan 'MSAN' in ***Appendix C***). The outlet connection point to existing for the Brazeau Lands is as follows:

- Existing 500 mm / 600 mm / 750 mm diameter sanitary trunk running east on Cambrian Road then extending north along existing Greenbank Road and east to the South Nepean Collector (SNC). The current sewer termination is at the New Greenbank Road alignment.

As per the ***BSUEA MSS*** the subject property is tributary to the existing sanitary trunk sewer along Cambrian Road.

4.2 Wastewater Design

The subject property will be serviced by an internal gravity sanitary sewer system that will generally follow the local road network with select servicing easements and land crossing permissions as required to achieve efficiencies in servicing and grading designs. The wastewater layout can be found in the general plan of services overview presented in ***Figures 3, 3A and 3B*** at the back of this report. The sanitary drainage area plans and design sheets, along with background ***BSUEA MSS*** information, can all be found in ***Appendix C*** for reference.

The ***BSUEA MSS*** proposed that the wastewater outlet from the Brazeau Lands would tie into the off-site Cambrian Road trunk sewer at existing sanitary 'EX MH57A' via the Future Greenbank Road alignment and that is now the intent of The Ridge (Brazeau) design. The *Master Sanitary Drainage Area* plan 'MSAN' from the ***BSUEA MSS*** is provided in ***Appendix C*** for reference. Sanitary flows from the adjacent Drummond Lands were originally proposed to be conveyed to Cambrian Road (MA11 to MA10) through Tamarack's "The Meadows Phase 7 & 8" (***Meadows***) development area at 3640 Greenbank Road (D07-16-18-0011) in the ***BSUEA MSS***. Although there were prior concepts of bringing The Ridge sanitary flows through the Drummond/Tamarack properties, the current sanitary sewer alignments, that are in line with the ***BSUEA MSS,*** are proposed in order to minimize overall sewer depths and alleviate City concerns with alternate routing.

4.2.1 Brazeau (The Ridge) Lands

In the ***BSUEA MSS***, Table 6-3 (provided in ***Appendix C***) summarized the anticipated flows from the "Brazeau Aggregate Extraction Area" lands (i.e. The Ridge development). With the more detailed development concept, the site statistics are refined and the sanitary design sheet found in ***Appendix C*** more accurately reflects the anticipated sanitary flows. As per Section 3.2 of this report, the anticipated unit count for The Ridge is 347 single family homes and 279 townhouse units.
When applying the City of Ottawa wastewater design criteria the estimated peak sanitary flows from The Ridge and other areas tributary to the sewer network results in the following:

i) The Ridge residential area + 4.3 ha of Drummond lands (~31.06 L/s);
ii) Drummond Lands (direct to Greenbank Road (~20.29 L/s);
iii) Mattamy lands adjacent to Future Greenbank Road (residential area of 1.90 ha and commercial area of 2.99 ha) (~4.45 L/s);
iv) Future Brazeau commercial area (13.83 ha) west of the subdivision (~9.05 L/s)
v) Commercial area (ABIC) (~4.84 L/s)

For comparison to the ***MSS*** Table 6-3 values, criteria the estimated peak sanitary flows from The Ridge and Mattamy areas is approximately 49.38 L/s. This would be in comparison to the ***MSS*** sum of the 21.50 L/s (Brazeau Lands flow), 1.8 L/s Mattamy Commercial, and approximately 1.9 L/s Mattamy Residential. For comparison this would be 69.69 L/s versus the 25.2 L/s (i.e. +44.49 L/s) previously summarized in the JLR's Table 6-3.

Table 6-4 in the ***BSUEA MSS*** identified critical residual capacities in existing trunk sanitary sewers associated with the BSUEA area. Specifically, the Cambrian Road sewer is the outlet for the Brazeau Lands property and has a limiting pipe reach from existing MH13A to MH15A with a residual capacity of approximately 52.9 L/s. The additional 44.49 L/s of anticipated sanitary flows uses approximately ~84% of the residual capacity leaving 8.41 L/s. Review of the ***BSUEA MSS*** sanitary design sheet indicates that there are no other sanitary sewer constraints up to the SNC.

4.2.2 Greenbank Road Sewer Alignment

As noted, the sanitary outlet for The Ridge will be along the Future Greenbank Road EA alignment as per the ***BSUEA MSS***. As per JLR's *Master Sanitary Drainage Area* plan 'MSAN' in ***Appendix C*** this alignment is represented by the sewer run from MH900 to EXMH57A on Cambrian Road ranging in size from 250mm to 375mm. The proposed design has a 375mm sanitary (capacities of the design can be seen in the sewer design sheet). MH900 would equate to the MH402A proposed within The Ridge design. Per Section 6.3.1.2 the depth of the sewer at this location was estimated to have a cover depth of approximately 7.43m. Based on The Ridge detailed design, which has taken into consideration all of the site grading and sewer crossing constraints that result from detailed design, the proposed cover is 8.5m at MH402A per the profile drawing for this trunk sewer (See Drawing 61 in ***Appendix C***). The elevated EA road profile results in the greater depth of the sewer at this location. As the sewer progresses northward towards Cambrian Road the depth of cover is gradually reduced as the road profile drops down in elevation. The proposed sanitary sewer is set at either minimum slopes, to mitigate depth of cover, or at slopes to establish flow capacities that are approximately 75%-78% of the proposed sewer's capacity. See markups of the profile drawings in ***Appendix C*** for reference.

4.2.3 Wastewater Design Criteria

The following table summarizes the City design guidelines and criteria applied in the preliminary sanitary design information above and detailed in ***Appendix C***.

Table 2: Wastewater Design Criteria

Design Parameter	Value
Current Design Guidelines	
Residential - Single Family / Townhome	3.4 p/unit & 2.7 p/unit respectively
Residential – Apartment	1.8 p/unit
Average Daily Demand	280 L/d/person
Peaking Factor	Harmon's Peaking Factor. Max 4.0, Min 2.0
Commercial / Institutional Flows	28,000 L/ha/day
Commercial / Institutional Peak Factor	1.5
Infiltration and Inflow Allowance	0.33 L/s/ha
Park Flows	28,000 L/ha/d
Park Peaking Factor	1.0
Sanitary sewers are to be sized employing the Manning's Equation	$Q = \frac{1}{n} A R^{2/3} S^{1/2}$
Minimum Sewer Size	200mm diameter
Minimum Manning's 'n'	0.013
Minimum Depth of Cover	2.5m from crown of sewer to grade
Minimum Full Flowing Velocity	0.6m/s
Maximum Full Flowing Velocity	3.0m/s
Extracted from Sections 4 and 6 of the City of Ottawa Sewer Design Guidelines, October 2012, and recent residential subdivisions in City of Ottawa.	

4.3 Wastewater Servicing Conclusion

The subject property will be serviced by local sanitary sewers which will outlet to the Future Greenbank Road ROW alignment via new sanitary sewers. The sewer will connect to existing sewers along Cambrian Road as demonstrated in the ***BSUEA MSS*** at 'EX MH57A' per JLR's *Drawing **MSAN***. There is residual capacity in the downstream sewers providing sufficient capacity for the peak sanitary flows for the subject property.

5.0 STORMWATER CONVEYANCE

5.1 Existing Stormwater Drainage

The ***BSUEA*** is tributary to three sub-watersheds as depicted in the 'Figure 3-1' excerpt from the ***BSUEA MSS*** provided in ***Appendix D***. The Brazeau Lands are within the Jock River Subwatershed.

Due to the recent land use for mineral extraction the majority of the land area is lower than the surrounding topography. As identified in the ***BSUEA MSS***, the BSUEA *Existing Condition Report* identified that the original drainage pattern for the development area was northwards via overland flow paths with no defined channels. Per the existing topography characterized within available City of Ottawa base mapping, flows from the subject property will now be ultimately conveyed to the Jock River by storm systems (pipes and ditches as required) along Borrisokane Road.

5.2 Proposed Stormwater Management Strategy

The future flows from the land area are planned to meet the following criteria per the ***BSUEA MSS***:

- Meet the existing flow in the downstream system;
- Meet the quality control target of 80% TSS removal as per the Jock River Reach One Subwatershed Study (Stantec, 2007); and,
- Preserve pre-infiltration condition levels (Section 5.3.4 of ***BSUEA MSS***)

In order to provide drainage conveyance to a Borrisokane Road storm outlet, the site grading will be adjusted to convey flows westward. As noted in the ***BSUEA MSS***, the *Existing Conditions Report* for the BSUEA identified that the culvert downstream of the aggregate properties receives a pre-development flow of 1,300 L/s during the 1:100 year event (see Figure 3-1, and Tables 5-2 and 5-5 in ***Appendix D*** from the ECR noting the constrained culvert CVR-C1). Servicing of both The Ridge and Drummond properties have been developed such that the downstream pre-development flow is not exceeded. Any downstream systems should have sufficient capacity for the pre-development flow.

The ***BSUEA MSS*** conceptualized the following requirements for the development areas:

- The design of the storm drainage system has been undertaken using the dual-drainage approach. The ***BSUEA MSS*** sets out the design criteria for future draft plan and site plan applications for the BSUEA.

- Two (2) separate storm servicing solutions were developed; one conventional servicing strategy and one that incorporates the Etobicoke Exfiltration System (EES) or alternative, which was recommended (see ***BSUEA MSS*** Drawing MST-2 for details and Section 5.2.1 of this report for discussion).
- The downstream boundary conditions or flow criteria to achieve are developed in the ***BSUEA MSS*** and are used in the design constraints.
- Allowable minor system release rates were set at the required storm event and future design should maintain the same release rate criteria.
- Stormwater management facilities have been identified in the stormwater management solution for the aggregate extraction areas.

The stormwater management designs will consist of:

- A storm sewer system designed to capture at least the minimum design capture events required under PIETB-2016-01;
- One dry Stormwater Management (SWM) Pond designed to provide required quantity controls along with oil-grit separator (OGS) units that will provide an Enhanced Level of Protection [80% total suspended solids (TSS) removal] per MECP guidelines. The SWM pond will provide controls to levels which respect any downstream pre-development flows;
- An on-site road network designed to maximize the available storage in the on-site road network for the 100-year design event, where possible, with controlled release of stormwater to the minor storm system; and
- An overland flow route designed to safely convey stormwater runoff flows in excess of the on-site road storage.

5.2.1 Infiltration – Etobicoke Exfiltration System (EES)

Within the ***BSUEA MSS***, Section 5.4.4 discussed the recommendation of distributed infiltration for development areas. An analysis was carried out and summarized in the *Existing Conditions Report* which determined the various contributions of the water budget based on long-term simulation.

The section also notes that the overall pre-development infiltration from the ***BSUEA MSS*** area was determined but that the aggregate extraction areas were excluded in that determination. Ongoing investigations for both the Brazeau and Drummond properties have been completed and are summarized in the attached "*Groundwater Infiltration Review*" memorandum completed by Paterson Group (see ***Appendix D*** for reference). The memorandum summarizes the estimate infiltration rates that could be anticipated throughout the sites for various soil type conditions that were found during their investigations. These values were used during the detailed design determinations.

Section 5.5 of the ***BSUEA MSS*** discusses the various storm servicing strategies for the development areas. The section went through the various options to achieve the required infiltration targets with the preferred arrangement being the Etobicoke Exfiltration System (EES) Infiltration Strategy. Other alternatives were reviewed, however the EES system is the most suitable for the site and is proposed to be implemented in accordance with the City's preference.

A key point of note, as required by the ***MSS***, is that capture of stormwater by the exfiltration system has strategically located insofar as the system is to be installed on local roads (where required to achieve the required infiltration levels) where the surface runoff is less impacted by the City's winter road salting program. Therefore collector and arterial roads will have conventional storm sewer installations that will convey flows to a proposed downstream oil-grit-separator (OGS) units and end-of-line dry pond facility. JFSA has prepared their ***JFSA LID Analysis*** design memo to assess the infiltration volumes anticipated for the EES system proposed. See ***Appendix D*** for the analysis. A visual representation of the EES system and drainage capture areas can be seen in the *Figure 2* of the JFSA technical memorandum and can also be seen in the Storm Drainage Area plans.

As summarized in the JFSA analysis, there will be a total of 24 EES systems implemented within the development area in order to meet the infiltration requirements. The EES units will be installed underneath storm sewers within the ROW in specific areas determined as being suitable based on site constraints. Each system will consist of one or two 250 mm diameter perforated pipes surrounded by a 0.85 m deep by 1.20 m wide clear stone trench. Goss traps will be installed in upstream catchbasins in order to prevent/mitigate debris and potential oils from entering the perforated pipe system. Detail drawings of the proposed EES units provided in Figure 1 of the ***JFSA LID Analysis***. See ***Appendix D*** for the full summary of the design parameters for each EES in Tables A1 and A2 (pipe diameter, system lengths and volumes, inverts etc).

For protection measures of the EES system during construction see Section 7.1.

5.2.2 EES Temporary Monitoring

As per Section 5.5.1.8 of the ***BSUEA MSS*** there are requirements for temporary monitoring of the proposed infiltration system in order to assess and confirm that the EES operates as intended. The objectives of the monitoring will be to estimate the drawdown time of the EES (i.e. time for water levels to drop) to see if the infiltration values projected are in line with the results, and to determine the average rate of capture before runoff is conveyed by the traditional storm sewer system. The final locations and configuration will be coordinated with City staff through this detailed design process as it has been indicated that the City has vetted a "Smart Cover" arrangement through the advancement of the adjacent Minto development area.

Proposed monitoring locations have been circulated to the City and are identified in a markup of the *Figure 2* from the ***JFSA LID Analysis*** provided in ***Appendix D***. The City has concurred with the preliminary locations pending full acceptance of the EES design.

5.3 Post-Development Stormwater Management Targets

Stormwater management requirements for the proposed alternative Stormwater management scheme have been adopted from the ***Jock River SWS***, ***City Standards***, and the ***MECP SWMP Manual***.

Given the general criteria mentioned above, the following specific standards are expected to be required for stormwater management within the subject property:

- Enhanced quality treatment will be provided for stormwater runoff from the subject property, corresponding to a long-term average TSS removal efficiency of 80%, as defined by the MECP prescribed treatment levels;
- Downstream receiving drainage features, culverts, and sewers will be assessed for responses to planned stormwater management outflows, and infrastructure rehabilitation or capacity improvement measures will be planned, as required;
- Storm sewers on local roads are to be designed to provide at least a 2-year level of service without any ponding per the City's latest Technical Bulletin PIEDTB-2016-01;
- Storm sewers on collector roads are to be designed to provide at least a 5-year level of service without any ponding per the City's latest Technical Bulletin PIEDTB-2016-01;
- For less frequent storms (i.e. larger than 2-year or 5-year), the minor system sewer capture will be restricted with the use of inlet control devices to prevent excessive hydraulic surcharges;
- Under full flow conditions, the allowable velocity in storm sewers is to be no less than 0.80 m/s and no greater than 6.0 m/s;
- For the 100-year storm and for all roads, the maximum depth of water (static and/or dynamic) on streets, rear yards, public space and parking areas shall not exceed 0.35 m at the gutter;
- The major system shall be designed with sufficient capacity to allow the excess runoff of a 100-year storm to be conveyed within the public right-of-way ROW, or adjacent to the ROW, provided the water level does not touch any part of the building envelope; must remain below all building openings during the stress test event (100-year + 20%); and must maintain 15 cm vertical clearance between spill elevation on the street and the ground elevation at the nearest building envelope;

- Flow across road intersections shall not be permitted for minor storms (generally 5-year or less);
- When catchbasins are installed in rear yards, safe overland flow routes are to be provided to allow the release of excess flows from such areas. A minimum of 30 cm of vertical clearance is required between the rear yard spill elevation and the ground elevation at the adjacent building envelope; and
- The product of the maximum flow depths on streets and maximum flow velocity must be less than 0.60 m^2/s on all roads.

5.3.1 Quality Control

As per the ***Jock River SWS,*** Enhanced quality treatment will be provided for stormwater runoff from the subject property, corresponding to a long-term average Total Suspended Solid removal efficiency of 80%, as described by the MECP prescribed treatment levels. This will be achieved via the proposed EES system installations (where possible) and OGS unit(s) for all other areas. The location/details of the OGS units near the SWM pond inlet can be seen in '*Storm Drainage Plan'* Drawing No. 88 and SWM Pond Drawings No. 77/79 found in ***Appendix D***.

The ***BSUEA MSS*** reviewed the quality control aspects of the proposed EES installations. Section 5.5.1.3 of the ***MSS*** concludes that based on the EES sizing for the 22mm rainfall (i.e. 95^{th} percentile rainfall event) the storage requirements satisfies the requirements for water quality control per the MECP land uses and further downstream control measures would not be required.

5.3.1.1 EES Infiltration Targets

As a part of the ***BSUEA MSS*** it was determined that pre-development infiltration within the study area accounted for 40% of the overall site's water budget. The City and RVCA determined that pre-development infiltration levels should be maintained under post-development conditions and that the infiltration should be provided across the development and not simply concentrated to one or two locations.

The EES is intended to capture frequent storm events and the initial "first flush" of large storm events by trapping flow in the perforated pipe sub drain and surrounding media. It is also intended to infiltrate runoff from frequent events into the surrounding soils, while runoff from larger events will overtop the capacity of the EES system and would then overflow to the conventional storm sewer system above

As specified by the Master Servicing Study, the proposed development should infiltrate 40% of the annual runoff. As the hourly rainfall data used in this simulation does not extend the full year, the infiltration target for this analysis has been assumed to be 40% of the average simulated rainfall volume (552.0 mm), which is calculated to be 220.8mm or 59,744 m^3 based on the study area. See the ***JFSA LID Analysis*** for full details.

5.3.2 Quantity Control – Dry Pond

The ***BSUEA MSS*** currently shows a stormwater pond servicing scenario on each of The Ridge and Brazeau Lands outside of the urban development area (refer to attached '*Barrhaven South Urban Expansion Area – Master Storm Drainage Plan EES'*) drawing from the ***BSUEA MSS*** for illustration). However, this two pond concept was proposed in the ***BSUEA MSS*** due to the desire at that time in order to not have the two properties 'linked' and therefore they would not be dependent upon one another in order to advance development.

As noted in prior sections of this report, the two properties have now coordinated servicing strategies to the benefit of both properties, as well as the City, as follows (refer to the Storm Drainage Area Plan and Pond Plan in ***Appendix D***):

- The single pond option will be a dry facility with OGS units to treat stormwater requiring treatment. This is in line with the ***MSS***;
- If a pond was proposed within the Brazeau Lands location shown in the ***MSS***, it would have required a large box culvert outlet in order to convey emergency flow out to Borrisokane Road due to topography constraints. Based on an increase in elevation downstream of that outlet, the emergency flows could not be conveyed overland. With the single pond concept on the Drummond Lands, a box culvert would no longer be required due to the more suitable topography at the Drummond outlet and the associated availability of emergency relief;
- A single pond option keeps more infrastructure within the new development areas and minimizes infrastructure proposed within the Borrisokane Road right-of-way (ROW);
- In accordance with the City's typical preference, there will be a reduction in maintenance costs with one less facility to manage.

Similar to the changes associated with the sanitary outlet revision, the only impacted properties are those proponents that are directly benefitting from the changes and would be considered a Minor Change per Section 11.1.1 of the ***BSUEA MSS***.

As noted in the ***Jock River SWS***, quantity control is not required for the Jock River; however, based on past reports (***BSUEA MSS*** and Existing Condition Report), the limited capacity of the ditch infrastructure along Borrisokane Road will require that the stormwater management facility provide a storage volume for quantity control. Any infrastructure upgrades or adjustments relating to the Borrisokane Road ROW will require appropriate permits and approvals from the Ministry of Transportation until such time as the ongoing process for the transfer of the roadway to be under the jurisdiction of the City of Ottawa is completed.

5.3.2.1 Erosion Targets – Borrisokane Road ROW

As requested by City staff an erosion assessment has been completed for the Borrisokane Road ditch outlet. JFSA has prepared a technical memorandum under separate cover entitled "*Borrisokane Ditch Erosion Assessment: The Ridge (Brazeau) Subdivision*" (June 2020) which reviewed the pond outlet for the site (the west ditch of Borrisokane Road north of Cambrian Road). The study concluded that the critical erosion velocity of the receiver is approximately 1.2 m/s which was then converted to a critical discharge threshold using a 1D HEC-RAS model of the ditch which determined that the threshold ranges from 4.20 m^3/s to 7.9 m^3/s for the middle and lower reaches of the ditch. From JFSA's hydrologic modelling of the ditch, under proposed conditions, the peak flow is assessed at 3.82 m^3/s for the 100-year 24-hour SCS event which is lower than the existing threshold range determined.

5.4 Stormwater Management Design

As shown in the *Storm Drainage Area Plan*, the proposed stormwater management design consists of OGS units for quality control and an end-of-line dry SWM pond for quantity control prior to discharge along Borrisokane Road. The pond will be located within the portion of the Drummond quarry land that is between the future Drummond residential area to be developed (within the urban boundary) and Borrisokane Road. The facility will be sized to meet the required level of quantity control based on a restricted outflow of 1,300 L/s as noted in Section 5.2. See the ***JFSA Pond Report*** under separate cover for full details of the SWM pond design.

In accordance with the Paterson ***Hydrogeological Review*** (under separate cover) for the area of the pond, the bottom elevation has been set at an elevation of 96.00m and will be lined as required to mitigate the inflow of perched groundwater in the area due to seasonal conditions.

The SWM pond will outlet to the Borrisokane Road roadside ditch. It is proposed that there will be a new 900mm/1200mm storm sewer installation along Borrisokane Road which extends northward to the vicinity of Cambrian Road where it discharges to the western roadside ditch. The proposed alignment was submitted via the City's Municipal Consent process at the City's request. No significant concerns were raised with the proposal.

5.4.1 Borrisokane Road – Ministry of Transportation Requirements

Borrisokane Road, along the frontage of The Ridge development area and northwards to Cambrian Road, is currently owned by, and under the jurisdiction of, the Ministry of Transportation. As such, any proposed underground stormwater infrastructure or grading/landscaping will require permits to facilitate the design and implementation of those works until such time that the process underway to transfer jurisdiction to the City of Ottawa is complete. We are working directly with MTO for the required permitting.

Culverts:
For any stormwater flows outletting to any existing, or new, Borrisokane Road ROW culverts the stormwater management reporting will evaluate peak flow rates, velocities and headwater levels at pre- and post-development conditions for design and regulatory storms.

Ditches:
For any stormwater flows outletting to existing Borrisokane Road ROW ditches, the stormwater management reporting will evaluate peak flow rates, velocities and depth of flow at pre- and post-development conditions for design and regulatory storms.

Inlet Control Devices:
Insofar as the Ministry has indicated that they do not recognize any benefit from the attenuation of storm water runoff from inlet control devices. In the circumstance where on-site SWM measures do not operate as intended water from the pond will spill to the Borrisokane roadside ditch via a reinforced grassed emergency spillway as shown in the '*SWM Pond'* Drawing No. 76.

5.5 Proposed Minor System

The subject property will be serviced by an internal gravity storm sewer system that follows the local road network and servicing easements as required. The drainage is conveyed within the underground piped sewer system to the proposed SWM pond with select areas of local streets that will have the EES installed to achieve infiltration targets.

Street catchbasins will collect drainage from the streets and front yards, while rear yard catchbasins will capture drainage from backyards. Perforated catch basin leads will be provided in rear yards, to add to the infiltration network, except the last segment where it connects to the right-of-way which will be solid pipe, per City standards.

The preliminary rational method design of the minor system captures drainage for storm events up to and including the 2-year (local) and 5-year (collector) event assuming the use of inlet control devices (ICD) for all catchbasins within the subject property. The peak design flows are calculated based on an average predicted runoff coefficient (C-value) ranging from 0.71 to 0.54 for most of the development area (see storm design sheet in ***Appendix D*** for details. The storm system has also been sized to consider the potential for future commercial lands to the west where required.

The following table summarizes the standards that will be employed in the detailed design of the storm sewer network. The drainage area information can be found in the *Storm Drainage Plans* and rational method design sheets provided in ***Appendix D***.

Table 3: Storm Sewer Design Criteria

Design Parameter	Value
Minor System Design Return Period	1:2 yr (PIEDTB-2016-01) for local roads, without ponding 1:5 yr for collector roads, without ponding
Major System Design Return Period	1:100 year
Intensity Duration Frequency Curve (IDF) 2-year storm event: A=732.951 | B=6.199 | C=0.810 5-year storm event: A = 998.071 | B = 6.053 | C = 0.814	$i = \frac{A}{(t_c + B)^C}$
Minimum Time of Concentration	10 minutes
Rational Method	$Q = CiA$
Storm sewers are to be sized employing the Manning's Equation	$Q = \frac{1}{n} A R^{2/3} S^{1/2}$
Runoff coefficient for paved and roof areas	0.9
Runoff coefficient for landscaped areas	0.2
Minimum Sewer Size	250 mm diameter
Minimum Manning's 'n' for pipe flow	0.013
Minimum Depth of Cover	1.5 m from crown of sewer to grade
Minimum Full Flowing Velocity	0.8 m/s
Maximum Full Flowing Velocity	6.0 m/s
Clearance from 100-Year Hydraulic Grade Line to Building Opening	0.30 m
Max. Allowable Flow Depth on Municipal Roads	35 cm above gutter (PIEDTB-2016-01)
Extent of Major System	Contained within the ROW, or adjacent to the ROW, provided that the water level not touch any part of the building envelope and remains below the lowest building opening during the stress test event (100-year + 20%) and 15cm vertical clearance is maintained between spill elevation on the street and the ground elevation at the building envelope (PIEDTB-2016-01)
Stormwater Management Model	DDSWMM (release 2.1), SWMHYMO (v. 5.02)
Model Parameters	Fo = 76.2 mm/hr, Fc = 13.2 mm/hr, DCAY = 4.14/hr, D.Stor.Imp. = 1.57 mm, D.Stor.Per. = 4.67 mm
Imperviousness	Based on runoff coefficient (C) where Percent Imperviousness = (C - 0.2) / 0.7 x 100%.
Design Storms	Chicago 3-hour Design Storms and 24-hour SCS Type II Design Storms. Max. Intensity averaged over 10 minutes.
Historical Events	July 1st, 1979, August 4th, 1988 and August 8th, 1996
Climate Change Street Test	20% increase in the 100-year, 3-hour Chicago storm
Design Parameter	**Value**
Extracted from City of Ottawa Sewer Design Guidelines, October 2012, and ISSU,	

5.6 Quality Control (OGS Units)

Enhanced quality treatment for the development, corresponding to a long-term average Total Suspended Solid removal efficiency of 80%, will be achieved via the proposed EES system installations and two OGS unit(s). The location/details of the OGS units near the SWM pond inlet can be seen in '*Storm Drainage Plan'* Drawing No. 88 and SWM Pond Drawings No. 77/79 found in ***Appendix D*** along with the details of the OGS unit sizing provided by Contech. The units have been configured as off-line units to allow for the bypass of larger flows.

5.7 Hydraulic Grade Line Analysis

A detailed hydraulic grade line (HGL) modelling analysis has been completed for the proposed system based on the 100-year 3-hour Chicago, 12-hour SCS, and 24-hour SCS design storms, including historical design storms and climate change stress test as required. The HGL is provided in the plan and profile drawings for the subdivision and details of the modelling can be found in the ***JFSA SWM Report***.

5.8 Proposed Major System

Major system conveyance, or overland flow (OLF), is provided to accommodate flows in excess of the minor system capacity. OLF is accommodated by generally storing stormwater up to the 100-year design event in road sags then routing additional surface flow along the road network and service easements towards the proposed drainage features to the Jock River, as shown in the *Storm Drainage Plans*. Stormwater ultimately discharges to the Borrisokane Road ROW which will require appropriate permits and approvals from the Ministry of Transportation if the process to change the jurisdiction to the City of Ottawa does not occur.

5.9 Stormwater Servicing Conclusions

The stormwater runoff is designed to be captured by an internal gravity sewer system that is to convey flows to an end-of-line dry SWM pond facility and OGS units for the quality control treatment of stormwater flows that originate from collector and arterial roadways due to City salting procedures. An Enhanced Level of protection will be provided for stormwater runoff from the subject property before ultimately being discharged to the Jock River. Quantity control is not required for the Jock River, notwithstanding, some quantity control by on-site and SWM pond storage will be provided due to downstream infrastructure constraints.

Infiltration targets noted in the MSS will be achieved via the installation of the EES system within local ROWs which will also provide Enhanced Level quality control as detailed in the ***MSS***.

6.0 PROPOSED GRADING

The grading design includes a saw-toothed road design with varying road grades in order to maximize available surface storage for management of flows up to the 100-year design event where possible. The proposed site grading has also been developed to optimize earthworks and provide major system conveyance to the end-of-line facility which eventually outlets to the Borrisokane Road ROW and then to the Jock River. Roadway connections to the future New Greenbank Road will be coordinated with that future design based on the Environmental Assessment Study profile for that roadway. Reduced size grading plans are found in ***Appendix E*** in order to provide an overview context for the proposed grading.

The geotechnical review of the site makes note of the significant grade raises that will be found within the development area. No grade raise restrictions are indicated for the site. However, an extensive earthworks program is being undertaken which will be continuously monitored by the geotechnical consultant in order to ensure that appropriate fill material, placement, and compaction are provided throughout the property. The monitoring program is based on the detailed grading proposed and will ultimately be reviewed and signed off by a licensed Geotechnical Engineer. Any grading onto adjacent properties has been coordinated with adjacent landowners for permissions and retaining walls will be implemented where required.

7.0 EROSION AND SEDIMENT CONTROL

Soil erosion occurs naturally and is a function of soil type, climate and topography. The extent of erosions losses is exaggerated during construction where the vegetation has been removed and the top layer of soil is disturbed.

- Erosion and sediment controls must be in place during construction. The following recommendations to the contractor will be included in contract documents.
- Limit extent of exposed soils at any given time.
- Re-vegetate exposed areas as soon as possible.
- Minimize the area to be cleared and grubbed.
- Protect exposed slopes with plastic or synthetic mulches.
- Install silt fence to prevent sediment from entering existing ditches.
- No refueling or cleaning of equipment near existing watercourses.
- Provide sediment traps and basins during dewatering.
- Install filter cloth between catch basins and frames.
- Installation of mud mats at construction accesses.

7.1 EES Protection During Construction

From the *Low Impact Development Stormwater Management Planning and Design Guide* prepared by CVC and TRCA (ver 1.0, 2010):

- Prior to site works, the location of LIDs should be marked and vehicles are to avoid the area other than during the installation of the LID. Drainage not to be directed to the LID;
- To minimize siltation in the newly installed EES system, both the upstream and downstream ends of the EES system should be plugged immediately during the construction phase. The upstream plug is to be removed at approximately an occupancy of 80% similar to the Quinn's Pointe development;
- Upland drainage areas need to be properly stabilized with vegetation as soon as possible in order to reduce sediment loads;
- The facility should be excavated to design dimensions from the side using a backhoe or excavator. The base of the facility should be level or match the slope of the above storm sewer;
- The bottom of the facility should be scarified to improve infiltration; and
- Geotextile fabric should be correctly installed to optimize system function. When laying the geotextile, the width should include sufficient material to compensate for perimeter irregularities in the facility and a 150mm minimum top overlap.

8.0 CONCLUSION AND RECOMMENDATIONS

This report provides details on the planned on-site municipal services for the subject property and demonstrates that adequate municipal infrastructure capacity for the planned development of the subject property:

- The subject lands have been reviewed by the ***BSUEA MSS*** and has shown that water supply to the property can be provided. An analysis completed by GeoAdvice also documents the water supply network and results. The network will be expanded through neighboring properties to enhance/meet the water demands of the proposed development as adjacent properties are also developed.

- Sanitary service is to be provided to the subject property via connection to the sanitary sewer located along Cambrian Road through the Future Greenbank Road ROW as per the ***MSS***. With the inclusion of the subject property, the existing downstream sewers have sufficient capacity to accommodate the subject property's proposed sanitary flows.

- Stormwater service is to be provided by capturing stormwater runoff via an internal gravity sewer system that will convey flows to a proposed end-of-line dry SWM pond facility for quantity control. Quality control will be provided for arterial and collector roadway (and select local roadway) drainage via the use of OGS units to an Enhanced Level of protection (80% TSS removal) prior to discharge to the SWM Pond. Quality control for local streets will be provided via the proposed Etobicoke Exfiltration System as documented in the ***MSS***, as well as within the OGS units downstream. Quantity control is not required for the Jock River, however, some quantity control by on-site and SWM pond storage will be provided due to downstream infrastructure constraints. An erosion threshold assessment has been completed by JFSA for the Borrisokane Road west side ditch north of Cambrian Road (pond outlet) and has confirmed that the projected flows are lower than the threshold determined.

- As suggested in the ***BSUEA MSS*** the infiltration will be achieved via use of the preferred EES system. The JFSA reporting demonstrates that the required infiltration targets are met.

- Erosion and sediment control measures will be implemented and maintained throughout construction.

- The design of The Ridge has been completed in general conformance with the City of Ottawa Design Guidelines and criteria presented in other background study documents.

Prepared by,
David Schaeffer Engineering Ltd.

LICENSED PROFESSIONAL ENGINEER
K.L. MURPHY
90475369
July 28/20
PROVINCE OF ONTARIO

Per: Kevin L. Murphy, P.Eng.

2020-07-27_Brazeau_Servicing_Subm4.doc

Hydraulic Capacity and Modeling Analysis Brazeau Lands

Final Report

Prepared for:
David Schaeffer Engineering Ltd.
120 Iber Road, Unit 103
Stittsville, ON K2S 1E9

Prepared by:
GeoAdvice Engineering Inc.
Unit 203, 2502 St. John's Street
Port Moody, BC V3H 2B4

Submission Date: July 28, 2020

Contact: Mr. Werner de Schaetzen, Ph.D., P.Eng.
Project: 2019-091-DSE

Document History and Version Control

Revision No.	Date	Document Description	Revised By	Reviewed By
R0	November 7, 2019	Draft	Ben Loewen	Werner de Schaetzen
R1	December 20, 2019	Final	Ben Loewen	Werner de Schaetzen
R2	June 10, 2020	Updated Draft	Ferdinand de Schoutheete	Werner de Schaetzen
R3	July 28, 2020	Final	Ferdinand de Schoutheete	Werner de Schaetzen

Statement of Qualifications and Limitations

This document represents GeoAdvice Engineering Inc. best professional judgment based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, express or implied is made.

Contents

1 Introduction

GeoAdvice Engineering Inc. ("GeoAdvice") was retained by David Schaeffer Engineering Ltd. ("DSEL") to size the proposed water main network for the Brazeau Lands development ("Development") in the City of Ottawa, ON ("City").

Under existing conditions, the development will be serviced by the Barrhaven pressure zone; however, in the future, it will be serviced by pressure zone 3C.

There are 347 single detached dwellings, 279 traditional townhomes and 1 park serviced as part of the development.

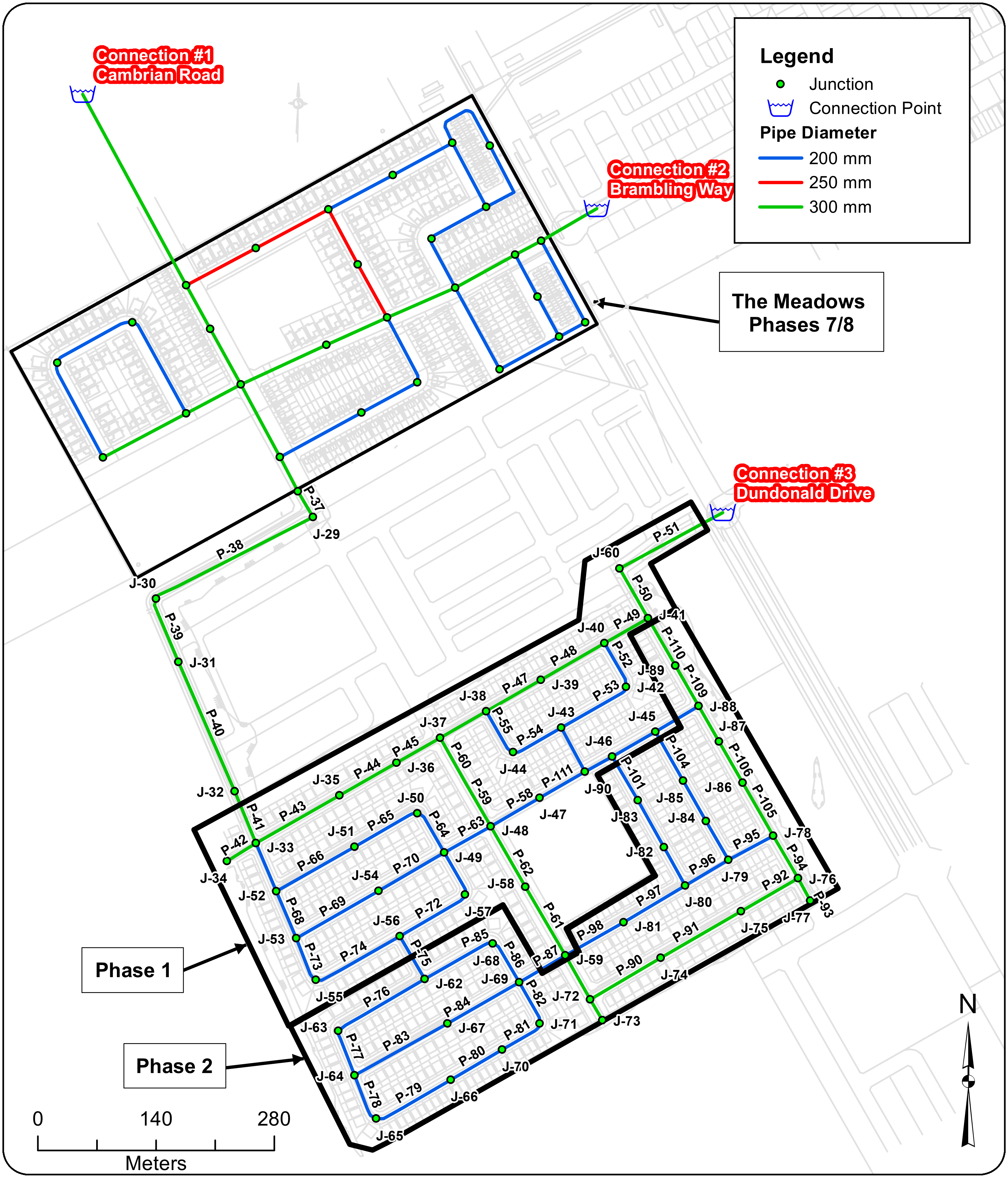
The Brazeau Lands development will have three (3) connections to the City water distribution system:

- Connection 1: Apolune Street and Cambrian Road;
- Connection 2: Jackdaw Avenue and Future Greenbank Road; and
- Connection 3: Dundonald Drive and Future Greenbank Road.

The development site is shown in **Figure 1.1** on the following page, with the final recommended pipe diameters.

This report describes the assumptions and results of the hydraulic modeling and capacity analysis using InfoWater (Innovyze), a GIS water distribution system modeling and management software application.

The results presented in this memo are based on the analysis of steady state simulations. The predicted available fire flows, as calculated by the hydraulic model, represent the flow available in the water main while maintaining a residual pressure of 20 psi. No extended period simulations were completed in this analysis to assess the water quality or to assess the hydraulic impact on storage and pumping.



GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis of the Brazeau Lands**
Client: **David Schaeffer Engineering Ltd.**
Date: **June 2020**
Created by: **BL**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

Brazeau Lands Site Layout and Connection Points

Figure 1.1

2 Modeling Considerations

2.1 Water Main Configuration

The water main network was modeled based on the drawing prepared by DSEL (1030_Gen_Rev4.dwg) and provided to GeoAdvice on June 2nd, 2020.

2.2 Elevations

Elevations of the modeled junctions were assigned according to a site grading plan prepared by DSEL (1030_Grad_Rev4.dwg) and provided to GeoAdvice on June 2nd, 2020.

2.3 Consumer Demands

Demand factors used for this analysis were taken according to the City of Ottawa 2010 Design Guidelines *Table 4.2 Consumption Rate for Subdivisions of 501 to 3,000 Persons*. Population densities were assigned according to *Table 4.1 Per Unit Populations* from the City of Ottawa Design Guidelines. A summary of these tables highlighting relevant data for this development is shown in **Table 2.1** below.

Table 2.1: City of Ottawa Demand Factors

Demand Type	Amount	Units
Average Day Demand		
Residential	350	L/c/d
Park	28,000	L/ha/d
Maximum Daily Demand		
Residential	2.5 x avg. day	L/c/d
Park	1.5 x avg. day	L/ha/d
Peak Hour Demand		
Residential	2.2 x max. day	L/c/d
Park	1.8 x max. day	L/ha/d
Minimum Hour Demand		
Residential	0.5 x avg. day	L/c/d
Park	0.5 x avg. day	L/ha/d

Table 2.2 and **Table 2.4** summarize the residential water demand calculations for the Brazeau Lands development.

Table 2.2: Development Population and Demand Calculations – Phase 1

Dwelling Type	Number of Units	Persons Per Unit*	Population	Average Day Demand (L/s)	Maximum Day Demand (L/s)	Peak Hour Demand (L/s)	Minimum Hour Demand (L/s)
Single Detached	172	3.4	585	2.37	5.92	13.03	1.18
Traditional Townhome	133	2.7	360	1.46	3.65	8.02	0.73

***City of Ottawa Design Guidelines**

Table 2.3: Development Population and Demand Calculations – Phases 1&2

Dwelling Type	Number of Units	Persons Per Unit*	Population	Average Day Demand (L/s)	Maximum Day Demand (L/s)	Peak Hour Demand (L/s)	Minimum Hour Demand (L/s)
Single Detached	347	3.4	1,180	4.78	11.95	26.29	2.39
Traditional Townhome	279	2.7	754	3.05	7.64	16.80	1.53

***City of Ottawa Design Guidelines**

Table 2.6 summarizes the non-residential water demand calculations for the Brazeau Lands development (included in both Phase 1 and Phases 1&2).

Table 2.4: Non-Residential Demand Calculations

Land Use Type	Area (ha)	Average Day Demand (L/s)	Maximum Day Demand (L/s)	Peak Hour Demand (L/s)	Minimum Hour Demand (L/s)
Park	1.72	0.56	0.84	1.51	0.28

Table 2.5 summarizes the demands for the Meadows Phases 7/8 subdivision development located north of the Brazeau Lands and downstream of Connections 1 and 2 (accounted for in the HGLs provided by the City in the boundary conditions request).

Table 2.5: The Meadows Phases 7/8

Average Day Demand (L/s)	Maximum Day Demand (L/s)	Peak Hour Demand (L/s)	Minimum Hour Demand (L/s)
6.20	13.50	28.50	3.10

Demands were grouped into demand polygons then uniformly distributed to the model nodes located within each polygon. Detailed calculations of demands as well as the illustrated allocation areas are shown in **Appendix A**.

2.4 Fire Flow Demand

Fire flow calculations were completed for all dwelling types in accordance with the Fire Underwriters Survey's (FUS) Water Supply for Public Fire Protection Guideline (1999) and City of Ottawa Technical Bulletin ISTB-2018-02 as summarized in **Appendix B**.

All the single detached dwellings have a minimum separation of 10 m between the backs of adjacent units and are, therefore, subject to the 10,000 L/min (167 L/s) cap outlined in City of Ottawa Technical Bulletin ISDTB-2014-02.

Most of the traditional townhouse dwellings comply with the City of Ottawa Technical Bulletin ISDTB-2014-02 and are, therefore, subject to the 10,000 L/min (167 L/s) cap.

The traditional townhouse dwellings located on Blocks 168 and 384 do not have a minimum separation of 10 m between the backs of adjacent units and therefore do not comply with the provisions under the City of Ottawa Technical Bulletin ISDTB-2014-02. The required fire flow for those blocks were calculated to be 167 L/s based on the Fire Underwriters Survey's (FUS) Water Supply for Public Fire Protection Guideline (1999). The agreement of this calculation with the City of Ottawa cap of 167 L/s is purely coincidental.

At this time, there is not enough information available to calculate the required fire flow of the park. As such, a required fire flow of 250 L/s was assumed for the park. This is a typical, conservative value for similar land use.

Fire flow simulations were completed at each model node in the Brazeau development. The locations of nodes do not necessarily represent hydrant locations.

Detailed FUS fire flow calculations as well as the illustrated spatial allocation of the required fire flows are shown in **Appendix B**.

2.5 Boundary Conditions

The boundary conditions were provided by the City of Ottawa in the form of Hydraulic Grade Line (HGL) at the following locations:

- Connection 1: Apolune Street and Cambrian Road;
- Connection 2: Jackdaw Avenue and Future Greenbank Road; and
- Connection 3: Dundonald Drive and Future Greenbank Road.

The above connection points are illustrated in **Figure 1.1**.

Boundary conditions were provided for Peak Hour, Maximum Day plus Fire and Minimum Hour (high pressure check) conditions.

Under existing conditions, the Brazeau Lands development will be serviced by the Barrhaven pressure zone; however, in the future, it will be serviced by pressure zone 3C. As such, boundary conditions were provided under the existing and future pressure zone configurations.

In total, two (2) sets of boundary conditions were provided by the City and can be found in **Appendix C**.

The boundary conditions for the existing pressure zone configuration are more conservative. As such, the results presented in this report are based on the boundary conditions for the existing pressure zone configuration.

Table 2.6 summarizes the boundary conditions used to size the Brazeau Lands water network.

Table 2.6: Existing Boundary Conditions

Condition	Connection 1 HGL (m)	Connection 2 HGL (m)	Connection 3 HGL (m)
Min Hour (max. pressure)	156.4	156.4	156.4
Peak Hour (min. pressure)	135.7	135.6	135.7
Max Day + Fire Flow (167 L/s)	144.0	141.2	142.0
Max Day + Fire Flow (250 L/s)	135.4	129.9	131.5

3 Hydraulic Capacity Design Criteria

3.1 Pipe Characteristics

Pipe characteristics of internal diameter (ID) and Hazen-Williams C factors were assigned in the model according to the City of Ottawa Design Guidelines for PVC water main material. Pipe characteristics used for the development are outlined in **Table 3.1** below.

Table 3.1: Model Pipe Characteristics

Nominal Diameter (mm)	ID PVC (mm)	Hazen Williams C-Factor (/)
200	204	110
250	250	110
300	297	120

3.2 Pressure Requirements

As outlined in the City of Ottawa Design Guidelines, the generally accepted best practice is to design new water distribution systems to operate between 350 kPa (50 psi) and 480 kPa (70 psi). The maximum pressure at any point in the distribution system in occupied areas outside of the public right-of-way shall not exceed 552 kPa (80 psi). Pressure requirements are outlined in **Table 3.2.**

Table 3.2: Pressure Requirements

Demand Condition	Minimum Pressure		Maximum Pressure	
	(kPa)	(psi)	(kPa)	(psi)
Normal Operating Pressure (maximum daily flow)	350	50	480	70
Peak Hour Demand (minimum allowable pressure)	276	40	-	-
Maximum Fixture Pressure (Ontario Building Code)	-	-	552	80
Maximum Distribution Pressure (minimum hour check)	-	-	552	80
Maximum Day Plus Fire	140	20	-	-

4 Hydraulic Capacity Analysis

The proposed water mains within the development were sized to the minimum diameter which would satisfy the greater of maximum day plus fire and peak hour demand. Modeling was carried out for minimum hour, peak hour and maximum day plus fire flow using InfoWater. Only the existing pressure zone configuration was analyzed, since the boundary conditions are more conservative.

Detailed pipe and junction model input data can be found in **Appendix D**.

4.1 Development Pressure Analysis

Modeled service pressures for the development are summarized in **Table 4.1** below.

Table 4.1: Summary of the Brazeau Lands Available Service Pressures

Phase	Minimum Hour Demand Maximum Pressure	Peak Hour Demand Minimum Pressure
Phase 1	538 kPa (78 psi)	290 kPa (42 psi)
Phases 1&2	538 kPa (78 psi)	**262 kPa (38 psi)**

As outlined in the City of Ottawa Design Guidelines, the generally accepted best practice is to design new water distribution systems to operate between 350 kPa (50 psi) and 480 kPa (70 psi). The maximum pressure at any point in the distribution system in occupied areas outside of the public right-of-way shall not exceed 552 kPa (80 psi).

Low pressures are predicted at junctions J-66, J-70, J-71, J-72, J-73, J-74, J-75, J-76 and J-77 under peak hour demand. Those low pressures are due to high elevations in the southern part of the Brazeau Lands development and are within 5% of the minimum allowable pressure of 276 kPa (40 psi). The future Zone 3C boundary conditions will provide an additional head of about seven (7) meters at each connection point, and will thus resolve the low PHD pressures at the southern part of the Brazeau Lands development.

Detailed pipe and junction result tables and maps can be found in **Appendix E**.

4.2 Development Fire Flow Analysis

A summary of the minimum available fire flows in the Brazeau Lands development is shown below in **Table 4.2**.

Table 4.2: Summary of the Brazeau Lands Minimum Available Fire Flows

Phase	Required Fire Flow	Minimum Available Flow	Junction ID
Phase 1	167 L/s	177 L/s	J-45
	250 L/s	249 L/s	J-47
Phases 1&2	167 L/s	194 L/s	J-66
	250 L/s	269 L/s	J-47

As shown in the table above, the available fire flow is greater than the required fire flow under both Phase 1 and Phases 1&2 conditions.

A summary of the residual pressures in the Brazeau Lands is shown below in **Table 4.3**. The minimum allowable pressure under fire flow conditions is 140 kPa (20 psi) at the location of the fire.

Table 4.3: Summary of the Brazeau Lands Residual Pressures (MDD + FF)

Phase	Maximum Residual Pressure	Average Residual Pressure	Minimum Residual Pressure
Phase 1	365 kPa (53 psi)	296 kPa (43 psi)	140 kPa (20 psi)
Phases 1&2	365 kPa (53 psi)	296 kPa (43 psi)	159 kPa (23 psi)

There is sufficient residual pressure at all the junctions within the Brazeau Lands development.

Detailed fire flow results and figures illustrating the fire flow results can be found in **Appendix F**.

5 Other Servicing Considerations

5.1 Water Supply Security

The City of Ottawa Design Guidelines allow single feed systems for developments up to a total average day demand of 50 m^3/day and require two (2) feeds if the development exceeds 50 m^3/day for supply security, according to Technical Bulletin ISDTB-2014-02.

The Brazeau Lands services a total average day demand of 725 m^3/day; as such, two (2) feeds are required.

5.2 Valves

No comment has been made in this technical memorandum with respect to exact placement of isolation valves within the distribution network for the Brazeau Lands other than to summarize the City of Ottawa Design Guidelines for number, location, and spacing of isolation valves:

- Tee intersection – two (2) valves
- Cross intersection – three (3) valves
- Valves shall be located 2 m away from the intersection
- 300 m spacing for 150 mm to 400 mm diameter valves
- Gate valves for 100 mm to 300 mm diameter mains
- Butterfly valves for 400 mm and larger diameter mains

Drain valves are not strictly required under the City of Ottawa Design Guidelines for water mains under 600 mm in diameter. The Guidelines indicate that "small diameter water mains shall be drained through hydrant via pumping if needed."

Air valves are not strictly required under the City of Ottawa Design Guidelines for water mains up to and including 400 mm in diameter. The Guidelines indicate that air removal "can be accomplished by the strategic positioning of hydrant at the high points to remove the air or by installing or utilizing available 50 mm chlorination nozzles in 300 mm and 400 mm chambers."

The detailed engineering drawings for the Brazeau Lands are expected to identify valves in accordance with the requirements noted above.

5.3 Hydrants

No comment has been made in this technical memorandum with respect to exact placement of hydrants within the distribution network for the Brazeau Lands other than to summarize the City of Ottawa Design Guidelines for maximum hydrant spacing:

- 125 m for single family unit residential areas on lots where frontage at the street line is 15 m or longer
- 110 m for single family unit residential areas on lots where frontage at the street line is less than 15 m and for residential areas zoned for row housing, doubles or duplexes
- 90 m for institutional, commercial, industrial, apartments and high-density areas

The detailed engineering drawings for the Brazeau Lands development are expected to identify hydrants in accordance with the requirements noted above.

6 Conclusions

The hydraulic capacity and modeling analysis of Phase 1 of the Brazeau Lands development yielded the following conclusions:

- The proposed water main network can deliver all domestic flows, with service pressures expected to range between 290 kPa (42 psi) and 538 kPa (78 psi).
- The proposed water main network is able to deliver fire flows to all junctions.
- Hydraulic modeling was only completed for the existing pressure zone configuration since the boundary conditions are more conservative.

The hydraulic capacity and modeling analysis of Phases 1&2 of the Brazeau Lands development yielded the following conclusions:

- The proposed water main network can deliver all domestic flows except for junctions J-66, J-70, J-71, J-72, J-73, J-74, J-75, J-76 and J-77, with service pressures expected to range between 262 kPa (38 psi) and 538 kPa (78 psi).
- The junctions with low pressures are due to high elevations in the southern part of the Brazeau Lands development and are within 5% of the minimum allowable pressure of 276 kPa (40 psi).
- The future Zone 3C boundary conditions will provide an additional head of about seven (7) meters at each connection point, and will thus resolve the low PHD pressures at the southern part of the Brazeau Lands development.
- The proposed water main network is able to deliver fire flows to all junctions.
- Hydraulic modeling was only completed for the existing pressure zone configuration since the boundary conditions are more conservative.

Submission

Prepared by:

Ferdinand de Schoutheete
Hydraulic Modeler / Project Engineer

Approved by:

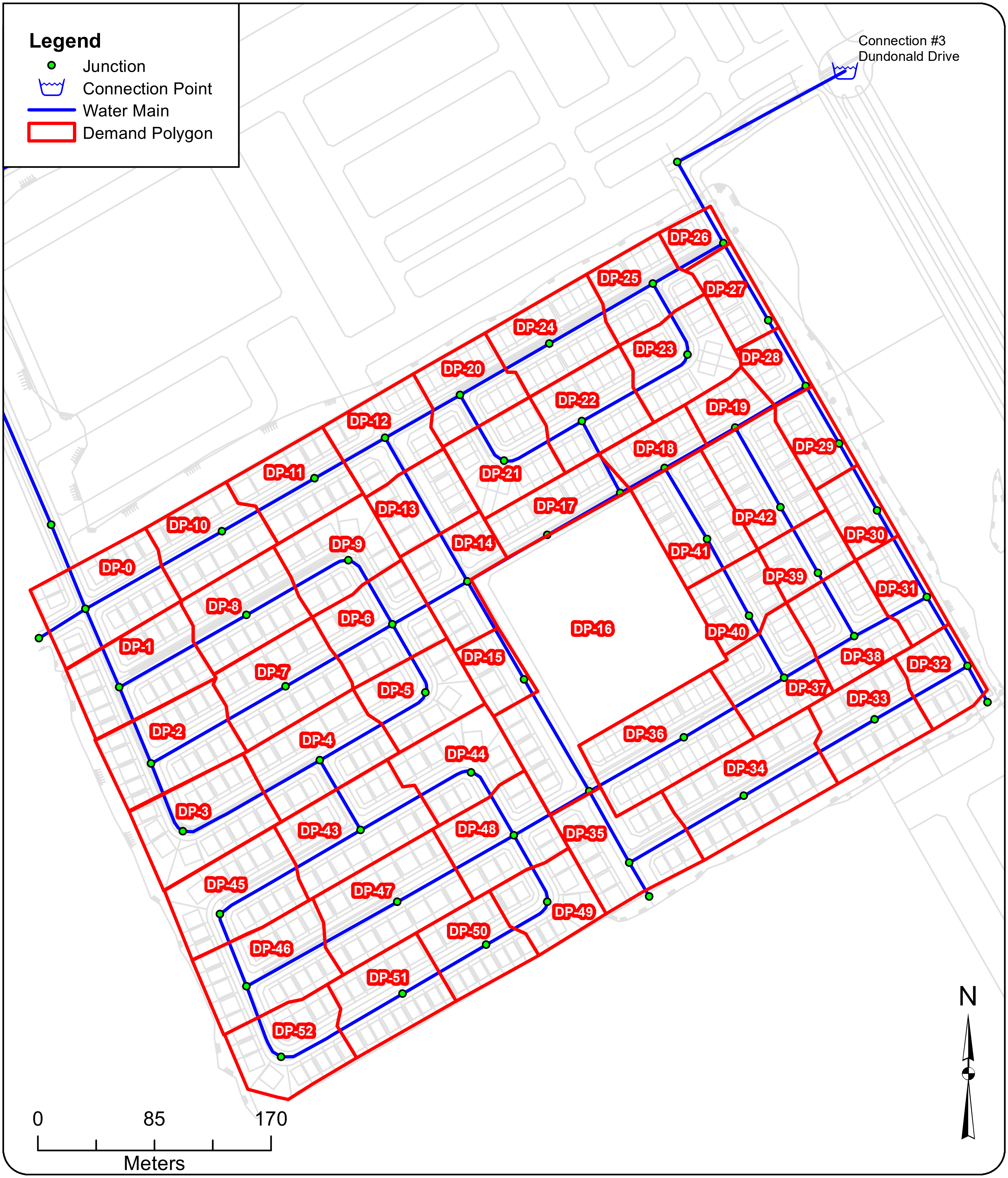
LICENSED PROFESSIONAL ENGINEER
W. B. F. de Schaetzen
100116349
PROVINCE OF ONTARIO

July 28, 2020

Werner de Schaetzen, Ph.D., P.Eng.
Senior Modeling Review / Project Manager

Appendix A Domestic Water Demand Calculations and Allocation

Appendix A Domestic Water Demand Calculations and Allocation



GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis of the Brazeau Lands**
Client: **David Schaeffer Engineering Ltd.**
Date: **June 2020**
Created by: **BL**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

Demand Allocation Phases 1&2

Figure A.1

Consumer Water Demands

Phase 1 Residential Demands

Dwelling Type	Number of Units	Population **		Average Day Demand			Max Day 2.5 x Avg. Day (L/s)	Fire Flow (L/s)	Peak Hour 2.2 x Max Day (L/s)	Min Hour 0.5 x Avg. Day (L/s)
		Persons per Unit	Population Per Dwelling Type	(L/c/d)	(L/d)	(L/s)				
Single Detached	172	3.4	585	350	204,750	2.37	5.92	167*	13.03	1.18
Traditional Townhome	133	2.7	360		126,000	1.46	3.65	167*	8.02	0.73
Subtotal	**305**		**945**		**330,750**	**3.83**	**9.57**		**21.05**	**1.91**

Phases 1&2 Residential Demands

Dwelling Type	Number of Units	Population **		Average Day Demand			Max Day 2.5 x Avg. Day (L/s)	Fire Flow (L/s)	Peak Hour 2.2 x Max Day (L/s)	Min Hour 0.5 x Avg. Day (L/s)
		Persons per Unit	Population Per Dwelling Type	(L/c/d)	(L/d)	(L/s)				
Single Detached	347	3.4	1,180	350	413,000	4.78	11.95	167*	26.29	2.39
Traditional Townhome	279	2.7	754		263,900	3.05	7.64	167*	16.80	1.53
Subtotal	**626**		**1,934**		**676,900**	**7.83**	**19.59**		**43.09**	**3.92**

Non Residential Demands

Property Type	Area (ha)		Average Day Demand			Max Day 1.5 x Avg. Day (L/s)	Fire Flow (L/s)	Peak Hour 1.8 x Max Day (L/s)	Min Hour 0.5 x Avg. Day (L/s)
			** (L/ha/d)	(L/d)	(L/s)				
Park w/ Splash Pad	1.72		28,000	48,160	0.56	0.84	250**	1.51	0.28
Subtotal	**1.72**			**48,160**	**0.56**	**0.84**		**1.51**	**0.28**

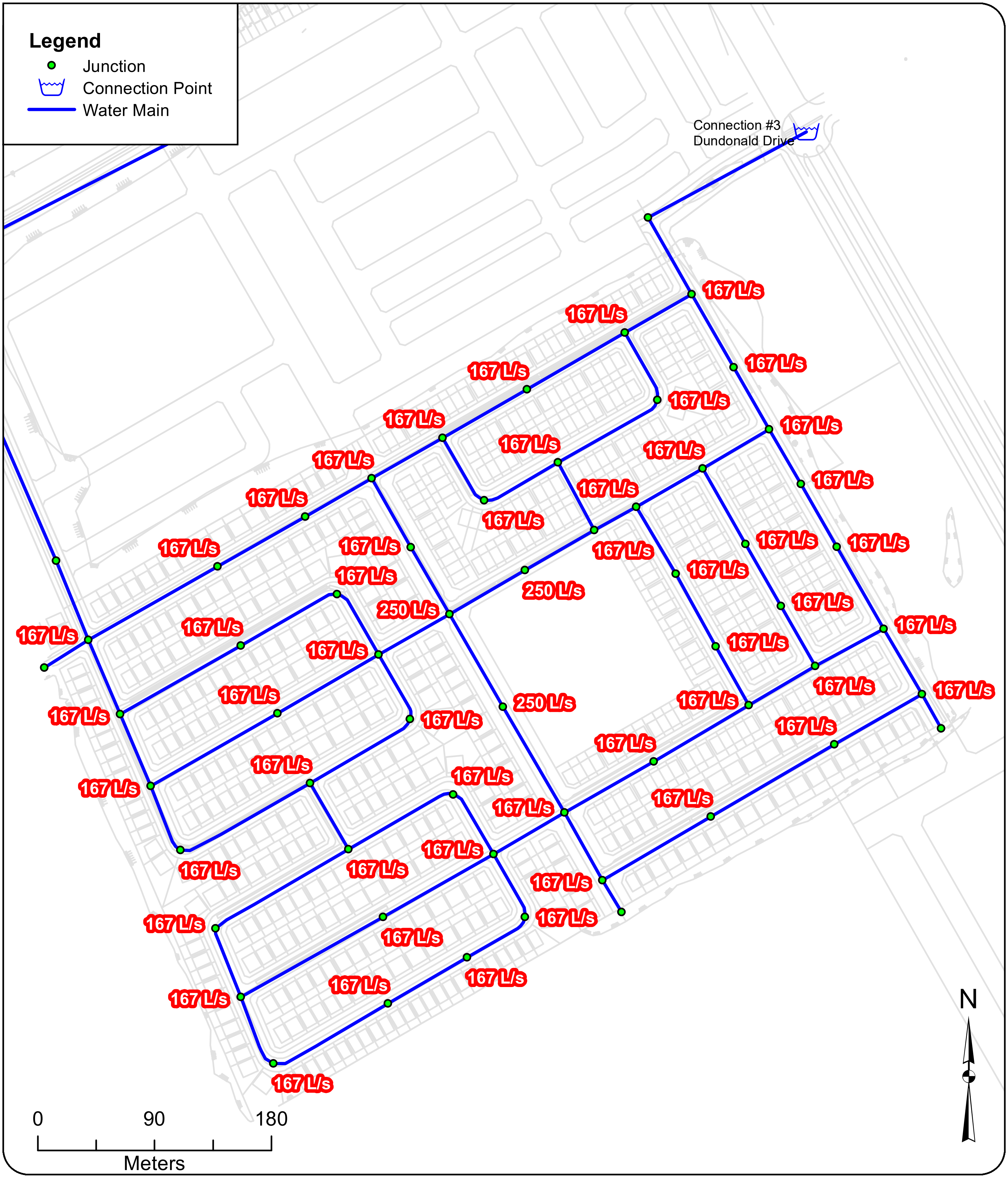
The Meadows Phases 7/8		**ADD (L/s)**	**MDD (L/s)**	**PHD (L/s)**	**MHD (L/s)**
Total Demand:		**6.20**	**13.50**	**28.50**	**3.10**

		ADD (L/s)	**MDD (L/s)**	**PHD (L/s)**	**MHD (L/s)**
Without the Meadows Phases 7/8 Demands	Phase 1	**4.39**	**10.41**	**22.56**	**2.19**
	Phases 1&2	**8.39**	**20.42**	**44.59**	**4.20**
With the Meadows Phases 7/8 Demands	Phase 1	**10.59**	**23.91**	**51.06**	**5.29**
	Phases 1&2	**14.59**	**33.92**	**73.09**	**7.30**

*Based on FUS fire flow calculation

**Assumed based on similar information from previously completed projects, as agreed upon with DSEL

Appendix B FUS Fire Flow Calculations and Allocation



GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis of the Brazeau Lands**
Client: **David Schaeffer Engineering Ltd.**
Date: **June 2020**
Created by: **BL**
Reviewed by: **WdS**

Required Fire Flow Phases 1&2

Figure B.1

FUS Required Fire Flow Calculation

Client: David Schaeffer Engineering Ltd.
Project: 2019-091-DSE
Development: Brazeau Lands — Blocks 300-313, Single Detached
Zoning: Multi Family Residential
Date: November 6, 2019

Calculations Based on "Water Supply for Public Fire Protection", Fire Underwriters Survey, 1999.

A. Type of Construction: Wood Frame Construction

B. Ground Floor Area: 1927 m^2

Note: ground floor area based on drawing provided to GeoAdvice on September 12, 2019.

C. Number of Storeys: 2

Note: all buildings, including adjacent buildings, assumed to be 2 storeys.

Note: The single detached dwellings are separated by less than 3 m; therefore, they must be considered as one fire area. The combined area of 14 units is considered in this calculation.

D. Required Fire Flow*: $F = 220C\sqrt{A}$

C: Coefficient related to the type of construction — **C =** 1.5

A: Effective area — **A =** 3854 m^2 (Combined area of 14 units)

The total floor area in m^2 in the building being considered

F = 20,486 L/min **D = 20,000 L/min***

E. Occupancy

Occupancy content hazard — Limited Combustible — -15 % of **D** — **-3,000 L/min** — **E = 17,000 L/min**

F. Sprinkler Protection

Automatic sprinkler protection — None — 0 % of **E** — **0 L/min** — **F = 17,000 L/min**

G. Exposures

Side	Separation Distance	Length-Height Factor - Adjacent Structure	Construction Type - Adjacent Structure	Exposure
West	20.1 to 30 m	0-30 m-storeys	Wood Frame or Non-Combustible	8%
East	20.1 to 30 m	0-30 m-storeys	Wood Frame or Non-Combustible	8%
North	10.1 to 20 m	Over 120 m-storeys	Wood Frame or Non-Combustible	15%
South	20.1 to 30 m	Over 120 m-storeys	Wood Frame or Non-Combustible	10%
			Total	**41%**

% of **E** — **+ 6,970 L/min** — **G = 23,970 L/min**

H. Wood Shake Charge — No — **0 L/min** — **H = 23,970 L/min**

For wood shingle or shake roofs

The required fire flow exceeds the cap in the City of Ottawa Technical Bulletin ISDTB-2014-02 4.2. The single detached dwellings comply with the provisions of the Bulletin; therefore, the required fire flow is:

Total Fire Flow Required	**10,000**	**L/min***
	167	**L/s**
Required Duration of Fire Flow	**2**	**Hrs**
Required Volume of Fire Flow	**1,200**	**m^3**

*Rounded to the nearest 1,000 L/min

The Total Required Fire Flow for the Brazeau Lands development should be reviewed when drawings and site plans have been finalized. The Total Required Fire Flow may be reduced or increased depending on area, construction, occupancy, exposures, and level of sprinkler protection. If any of these items change the Total Required Fire Flow should be reviewed to determine the impact.

Consideration should be given for fire prevention during construction phases as the required fire flows during construction of buildings is substantially higher than after the buildings are occupied. This is due to exposed framing and inactive sprinkler systems. Fires starting in unprotected portion of buildings quickly become too strong for sprinkler systems in protected portion of buildings. As such, special precautions should be taken any time construction is occurring.

* The amount and rate of water application required in firefighting to confine and control the fires possible in a building or group of buildings which comprise essentially the same fire area by virtue of immediate exposure.

** Rounded to the nearest 1,000 L/min

Notes to calculations

Type of Construction	Coefficient	Unit
Wood Frame Construction	1.5	-
Ordinary Construction	1	-
Non-Combustible Construction	0.8	-
Fire Resistive Construction (< 2 hrs)	0.7	-
Fire Resistive Construction (> 2 hrs)	0.6	-

Occupancy Fire Hazard	Factor	Unit
Non-Combustible	-25	%
Limited Combustible	-15	%
Combustible	0	%
Free Burning	15	%
Rapid Burning	25	%

Sprinkler Protection	Factor	Unit
None	0	%
Automatic	-30	%
Automatic + Standard Supply	-40	%
Fully Supervised	-50	%
Fully Supervised + Fire Resistive	-70	%

Zoning
Single Family Residential
Multi Family Residential
Commercial
Institutional
Industrial

Wood Shake Charge	Factor	Unit
Yes	4000	L/min
No	0	L/min

Required Duration of Fire Flow	
Fire Flow Required (L/min)	Duration (hours)
2,000 or less	1.00
3000	1.25
4000	1.50
5000	1.75
6000	2.00
7000	2.00
8000	2.00
9000	2.00
10000	2.00
11000	2.25
12000	2.50
13000	2.75
14000	3.00
15000	3.25
16000	3.50
17000	3.75
18000	4.00
19000	4.25
20000	4.50
21000	4.75
22000	5.00
23000	5.25
24000	5.50
25000	5.75
26000	6.00
27000	6.25
28000	6.50
29000	6.75
30000	7.00
31000	7.25
32000	7.50
33000	7.75
34000	8.00
35000	8.25
36000	8.50
37000	8.75
38000	9.00
39000	9.25
40000 and over	9.50

Notes to calculations

Separation Distance	Length-Height Factor of Exposed Wall of Adjacent Structure	Construction of Exposed Wall of Adjacent Structure			
		Wood Frame or Non-Combustible	Ordinary or Fire-Resistive with Unprotected Openings	Ordinary or Fire-Resistive with Semi-Protected Openings	Ordinary or Fire-Resistive with Blank Wall
0.0 to 3 m	0-30 m-storeys	22%	21%	16%	0%
	31-60 m-storeys	23%	22%	17%	0%
	61-90 m-storeys	24%	23%	18%	0%
	91-120 m-storeys	25%	24%	19%	0%
	Over 120 m-storeys	25%	25%	20%	0%
3.1 to 10 m	0-30 m-storeys	17%	15%	11%	0%
	31-60 m-storeys	18%	16%	12%	0%
	61-90 m-storeys	19%	18%	14%	0%
	91-120 m-storeys	20%	19%	15%	0%
	Over 120 m-storeys	20%	19%	15%	0%
10.1 to 20 m	0-30 m-storeys	12%	10%	7%	0%
	31-60 m-storeys	13%	11%	8%	0%
	61-90 m-storeys	14%	13%	10%	0%
	91-120 m-storeys	15%	14%	11%	0%
	Over 120 m-storeys	15%	15%	12%	0%
20.1 to 30 m	0-30 m-storeys	8%	6%	4%	0%
	31-60 m-storeys	8%	7%	5%	0%
	61-90 m-storeys	9%	8%	6%	0%
	91-120 m-storeys	10%	9%	7%	0%
	Over 120 m-storeys	10%	10%	8%	0%
30.1 to 45 m	0-30 m-storeys	5%	5%	5%	0%
	31-60 m-storeys	5%	5%	5%	0%
	61-90 m-storeys	5%	5%	5%	0%
	91-120 m-storeys	5%	5%	5%	0%
	Over 120 m-storeys	5%	5%	5%	0%
Beyond 45 m	0-30 m-storeys	0%	0%	0%	0%
	31-60 m-storeys	0%	0%	0%	0%
	61-90 m-storeys	0%	0%	0%	0%
	91-120 m-storeys	0%	0%	0%	0%
	Over 120 m-storeys	0%	0%	0%	0%
Fire Wall	0-30 m-storeys	10%	10%	10%	10%
	31-60 m-storeys	10%	10%	10%	10%
	61-90 m-storeys	10%	10%	10%	10%
	91-120 m-storeys	10%	10%	10%	10%
	Over 120 m-storeys	10%	10%	10%	10%

Brazeau Lands - FUS Required Fire Flow Summary

Brazeau Lands	
Type of Construction	Wood Frame Construction
Construction Coefficient	1.5
Effective Total Area (m^2)	3,854
Required Fire Flow (L/min)	20,000
Occupancy Charge	-15
Sprinkler Protection Reduction	0
Exposure (%)	
North (%)	8%
East (%)	8%
South (%)	15%
West (%)	10%
Total Exposure (%)	41%
Wood Shake Charge (L/min)	0
Total Required Fire Flow (L/min)	10,000
Total Required Fire Flow (L/s)	167

FUS Required Fire Flow Calculation

Calculations Based on "Water Supply for Public Fire Protection", Fire Underwriters Survey, 1999.

Client: David Schaeffer Engineering Ltd.
Project: 2019-091-DSE
Development: Brazeau Lands — Blocks 173, Traditional Townhouse
Zoning: Multi Family Residential
Date: November 6, 2019

A. Type of Construction: Wood Frame Construction

B. Ground Floor Area: 474 **m^2**

Note: ground floor area based on drawing provided to GeoAdvice on September 12, 2019.

C. Number of Storeys: 2

Note: all buildings, including adjacent buildings, assumed to be 2 storeys.

Note: The townhouse dwellings are separated by less than 3 m; therefore, they must be considered as one fire area. The combined area of 5 units is considered in this calculation.

D. Required Fire Flow*: $F = 220C\sqrt{A}$

C: Coefficient related to the type of construction — **C =** 1.5

A: Effective area — **A =** 947 **m^2** (Combined area of 5 units)

The total floor area in m^2 in the building being considered

F = 10,156 L/min — **D = 10,000 L/min***

E. Occupancy

Occupancy content hazard — Limited Combustible — -15 % of **D** — **-1,500 L/min** — **E = 8,500 L/min**

F. Sprinkler Protection

Automatic sprinkler protection — None — 0 **% of E** — **0 L/min** — **F = 8,500 L/min**

G. Exposures

Side	Separation Distance	Length-Height Factor - Adjacent Structure	Construction Type - Adjacent Structure	Exposure
West	3.1 to 10 m	0-30 m-storeys	Wood Frame or Non-Combustible	17%
East	3.1 to 10 m	0-30 m-storeys	Wood Frame or Non-Combustible	17%
North	10.1 to 20 m	61-90 m-storeys	Wood Frame or Non-Combustible	14%
South	20.1 to 30 m	31-60 m-storeys	Wood Frame or Non-Combustible	8%
			Total	**56%**

% of E — **+ 4,760 L/min** — **G = 13,260 L/min**

H. Wood Shake Charge — No — **0 L/min** — **H = 13,260 L/min**

For wood shingle or shake roofs

The required fire flow exceeds the cap in the City of Ottawa Technical Bulletin ISDTB-2014-02 4.2. The townhouse dwellings comply with the provisions of the Bulletin; therefore, the required fire flow is:

Total Fire Flow Required	**10,000**	**L/min***
	167	**L/s**
Required Duration of Fire Flow	**2**	**Hrs**
Required Volume of Fire Flow	**1,200**	**m^3**

*Rounded to the nearest 1,000 L/min

The Total Required Fire Flow for the Brazeau Lands development should be reviewed when drawings and site plans have been finalized. The Total Required Fire Flow may be reduced or increased depending on area, construction, occupancy, exposures, and level of sprinkler protection. If any of these items change the Total Required Fire Flow should be reviewed to determine the impact.

Consideration should be given for fire prevention during construction phases as the required fire flows during construction of buildings is substantially higher than after the buildings are occupied. This is due to exposed framing and inactive sprinkler systems. Fires starting in unprotected portion of buildings quickly become too strong for sprinkler systems in protected portion of buildings. As such, special precautions should be taken any time construction is occurring.

* The amount and rate of water application required in firefighting to confine and control the fires possible in a building or group of buildings which comprise essentially the same fire area by virtue of immediate exposure.

** Rounded to the nearest 1,000 L/min

Notes to calculations

Type of Construction	Coefficient	Unit
Wood Frame Construction	1.5	-
Ordinary Construction	1	-
Non-Combustible Construction	0.8	-
Fire Resistive Construction (< 2 hrs)	0.7	-
Fire Resistive Construction (> 2 hrs)	0.6	-

Occupancy Fire Hazard	Factor	Unit
Non-Combustible	-25	%
Limited Combustible	-15	%
Combustible	0	%
Free Burning	15	%
Rapid Burning	25	%

Sprinkler Protection	Factor	Unit
None	0	%
Automatic	-30	%
Automatic + Standard Supply	-40	%
Fully Supervised	-50	%
Fully Supervised + Fire Resistive	-70	%

Zoning
Single Family Residential
Multi Family Residential
Commercial
Institutional
Industrial

Wood Shake Charge	Factor	Unit
Yes	4000	L/min
No	0	L/min

Required Duration of Fire Flow	
Fire Flow Required (L/min)	Duration (hours)
2,000 or less	1.00
3000	1.25
4000	1.50
5000	1.75
6000	2.00
7000	2.00
8000	2.00
9000	2.00
10000	2.00
11000	2.25
12000	2.50
13000	2.75
14000	3.00
15000	3.25
16000	3.50
17000	3.75
18000	4.00
19000	4.25
20000	4.50
21000	4.75
22000	5.00
23000	5.25
24000	5.50
25000	5.75
26000	6.00
27000	6.25
28000	6.50
29000	6.75
30000	7.00
31000	7.25
32000	7.50
33000	7.75
34000	8.00
35000	8.25
36000	8.50
37000	8.75
38000	9.00
39000	9.25
40000 and over	9.50

Notes to calculations

Separation Distance	Length-Height Factor of Exposed Wall of Adjacent Structure	Construction of Exposed Wall of Adjacent Structure			
		Wood Frame or Non-Combustible	Ordinary or Fire-Resistive with Unprotected Openings	Ordinary or Fire-Resistive with Semi-Protected Openings	Ordinary or Fire-Resistive with Blank Wall
0.0 to 3 m	0-30 m-storeys	22%	21%	16%	0%
	31-60 m-storeys	23%	22%	17%	0%
	61-90 m-storeys	24%	23%	18%	0%
	91-120 m-storeys	25%	24%	19%	0%
	Over 120 m-storeys	25%	25%	20%	0%
3.1 to 10 m	0-30 m-storeys	17%	15%	11%	0%
	31-60 m-storeys	18%	16%	12%	0%
	61-90 m-storeys	19%	18%	14%	0%
	91-120 m-storeys	20%	19%	15%	0%
	Over 120 m-storeys	20%	19%	15%	0%
10.1 to 20 m	0-30 m-storeys	12%	10%	7%	0%
	31-60 m-storeys	13%	11%	8%	0%
	61-90 m-storeys	14%	13%	10%	0%
	91-120 m-storeys	15%	14%	11%	0%
	Over 120 m-storeys	15%	15%	12%	0%
20.1 to 30 m	0-30 m-storeys	8%	6%	4%	0%
	31-60 m-storeys	8%	7%	5%	0%
	61-90 m-storeys	9%	8%	6%	0%
	91-120 m-storeys	10%	9%	7%	0%
	Over 120 m-storeys	10%	10%	8%	0%
30.1 to 45 m	0-30 m-storeys	5%	5%	5%	0%
	31-60 m-storeys	5%	5%	5%	0%
	61-90 m-storeys	5%	5%	5%	0%
	91-120 m-storeys	5%	5%	5%	0%
	Over 120 m-storeys	5%	5%	5%	0%
Beyond 45 m	0-30 m-storeys	0%	0%	0%	0%
	31-60 m-storeys	0%	0%	0%	0%
	61-90 m-storeys	0%	0%	0%	0%
	91-120 m-storeys	0%	0%	0%	0%
	Over 120 m-storeys	0%	0%	0%	0%
Fire Wall	0-30 m-storeys	10%	10%	10%	10%
	31-60 m-storeys	10%	10%	10%	10%
	61-90 m-storeys	10%	10%	10%	10%
	91-120 m-storeys	10%	10%	10%	10%
	Over 120 m-storeys	10%	10%	10%	10%

Brazeau Lands - FUS Required Fire Flow Summary

Brazeau Lands	
Type of Construction	Wood Frame Construction
Construction Coefficient	1.5
Effective Total Area (m^2)	947
Required Fire Flow (L/min)	10,000
Occupancy Charge	-15
Sprinkler Protection Reduction	0
Exposure (%)	
North (%)	17%
East (%)	17%
South (%)	14%
West (%)	8%
Total Exposure (%)	56%
Wood Shake Charge (L/min)	0
Total Required Fire Flow (L/min)	10,000
Total Required Fire Flow (L/s)	167

FUS Required Fire Flow Calculation

Calculations Based on "Water Supply for Public Fire Protection", Fire Underwriters Survey, 1999.

Client: David Schaeffer Engineering Ltd.
Project: 2019-091-DSE
Development: Brazeau Lands
Zoning: Multi Family Residential — Blocks 384, Traditional Townhouse
Date: November 6, 2019

A. Type of Construction: Wood Frame Construction

B. Ground Floor Area: 380 m^2

Note: ground floor area based on drawing provided to GeoAdvice on September 12, 2019.

C. Number of Storeys: 2

Note: all buildings, including adjacent buildings, assumed to be 2 storeys.

Note: The townhouse dwellings are separated by less than 3 m; therefore, they must be considered as one fire area. The combined area of 4 units is considered in this calculation.

D. Required Fire Flow*: $F = 220C\sqrt{A}$

C: Coefficient related to the type of construction — **C =** 1.5

A: Effective area — **A =** 760 m^2 (Combined area of 4 units)

The total floor area in m^2 in the building being considered

F = 9,095 L/min — **D = 9,000 L/min***

E. Occupancy

Occupancy content hazard: Limited Combustible — -15 % of **D** — **-1,350 L/min** — **E = 7,650 L/min**

F. Sprinkler Protection

Automatic sprinkler protection: None — 0 % of **E** — **0 L/min** — **F = 7,650 L/min**

G. Exposures

Side	Separation Distance	Length-Height Factor - Adjacent Structure	Construction Type - Adjacent Structure	Exposure
West	10.1 to 20 m	0-30 m-storeys	Wood Frame or Non-Combustible	12%
East	Beyond 45 m	0-30 m-storeys	Wood Frame or Non-Combustible	0%
North	3.1 to 10 m	0-30 m-storeys	Wood Frame or Non-Combustible	17%
South	20.1 to 30 m	0-30 m-storeys	Wood Frame or Non-Combustible	8%
			Total	**37%**

% of **E** — **+ 2,831 L/min** — **G = 10,481 L/min**

H. Wood Shake Charge — No — **0 L/min** — **H = 10,481 L/min**

For wood shingle or shake roofs

The required fire flow exceeds the cap in the City of Ottawa Technical Bulletin ISDTB-2014-02 4.2. The townhouse dwellings **do not** comply with the provisions of the Bulletin; therefore, the required fire flow is:

Total Fire Flow Required	**10,000**	**L/min***
	167	**L/s**
Required Duration of Fire Flow	**2**	**Hrs**
Required Volume of Fire Flow	**1,200**	**m^3**

*Rounded to the nearest 1,000 L/min

The Total Required Fire Flow for the Brazeau Lands development should be reviewed when drawings and site plans have been finalized. The Total Required Fire Flow may be reduced or increased depending on area, construction, occupancy, exposures, and level of sprinkler protection. If any of these items change the Total Required Fire Flow should be reviewed to determine the impact.

Consideration should be given for fire prevention during construction phases as the required fire flows during construction of buildings is substantially higher than after the buildings are occupied. This is due to exposed framing and inactive sprinkler systems. Fires starting in unprotected portion of buildings quickly become too strong for sprinkler systems in protected portion of buildings. As such, special precautions should be taken any time construction is occurring.

* The amount and rate of water application required in firefighting to confine and control the fires possible in a building or group of buildings which comprise essentially the same fire area by virtue of immediate exposure.

** Rounded to the nearest 1,000 L/min

Notes to calculations

Type of Construction	Coefficient	Unit
Wood Frame Construction	1.5	-
Ordinary Construction	1	-
Non-Combustible Construction	0.8	-
Fire Resistive Construction (< 2 hrs)	0.7	-
Fire Resistive Construction (> 2 hrs)	0.6	-

Occupancy Fire Hazard	Factor	Unit
Non-Combustible	-25	%
Limited Combustible	-15	%
Combustible	0	%
Free Burning	15	%
Rapid Burning	25	%

Sprinkler Protection	Factor	Unit
None	0	%
Automatic	-30	%
Automatic + Standard Supply	-40	%
Fully Supervised	-50	%
Fully Supervised + Fire Resistive	-70	%

Zoning
Single Family Residential
Multi Family Residential
Commercial
Institutional
Industrial

Wood Shake Charge	Factor	Unit
Yes	4000	L/min
No	0	L/min

Required Duration of Fire Flow	
Fire Flow Required (L/min)	Duration (hours)
2,000 or less	1.00
3000	1.25
4000	1.50
5000	1.75
6000	2.00
7000	2.00
8000	2.00
9000	2.00
10000	2.00
11000	2.25
12000	2.50
13000	2.75
14000	3.00
15000	3.25
16000	3.50
17000	3.75
18000	4.00
19000	4.25
20000	4.50
21000	4.75
22000	5.00
23000	5.25
24000	5.50
25000	5.75
26000	6.00
27000	6.25
28000	6.50
29000	6.75
30000	7.00
31000	7.25
32000	7.50
33000	7.75
34000	8.00
35000	8.25
36000	8.50
37000	8.75
38000	9.00
39000	9.25
40000 and over	9.50

Notes to calculations

Separation Distance	Length-Height Factor of Exposed Wall of Adjacent Structure	Construction of Exposed Wall of Adjacent Structure			
		Wood Frame or Non-Combustible	Ordinary or Fire-Resistive with Unprotected Openings	Ordinary or Fire-Resistive with Semi-Protected Openings	Ordinary or Fire-Resistive with Blank Wall
0.0 to 3 m	0-30 m-storeys	22%	21%	16%	0%
	31-60 m-storeys	23%	22%	17%	0%
	61-90 m-storeys	24%	23%	18%	0%
	91-120 m-storeys	25%	24%	19%	0%
	Over 120 m-storeys	25%	25%	20%	0%
3.1 to 10 m	0-30 m-storeys	17%	15%	11%	0%
	31-60 m-storeys	18%	16%	12%	0%
	61-90 m-storeys	19%	18%	14%	0%
	91-120 m-storeys	20%	19%	15%	0%
	Over 120 m-storeys	20%	19%	15%	0%
10.1 to 20 m	0-30 m-storeys	12%	10%	7%	0%
	31-60 m-storeys	13%	11%	8%	0%
	61-90 m-storeys	14%	13%	10%	0%
	91-120 m-storeys	15%	14%	11%	0%
	Over 120 m-storeys	15%	15%	12%	0%
20.1 to 30 m	0-30 m-storeys	8%	6%	4%	0%
	31-60 m-storeys	8%	7%	5%	0%
	61-90 m-storeys	9%	8%	6%	0%
	91-120 m-storeys	10%	9%	7%	0%
	Over 120 m-storeys	10%	10%	8%	0%
30.1 to 45 m	0-30 m-storeys	5%	5%	5%	0%
	31-60 m-storeys	5%	5%	5%	0%
	61-90 m-storeys	5%	5%	5%	0%
	91-120 m-storeys	5%	5%	5%	0%
	Over 120 m-storeys	5%	5%	5%	0%
Beyond 45 m	0-30 m-storeys	0%	0%	0%	0%
	31-60 m-storeys	0%	0%	0%	0%
	61-90 m-storeys	0%	0%	0%	0%
	91-120 m-storeys	0%	0%	0%	0%
	Over 120 m-storeys	0%	0%	0%	0%
Fire Wall	0-30 m-storeys	10%	10%	10%	10%
	31-60 m-storeys	10%	10%	10%	10%
	61-90 m-storeys	10%	10%	10%	10%
	91-120 m-storeys	10%	10%	10%	10%
	Over 120 m-storeys	10%	10%	10%	10%

Brazeau Lands - FUS Required Fire Flow Summary

Brazeau Lands	
Type of Construction	Wood Frame Construction
Construction Coefficient	1.5
Effective Total Area (m^2)	760
Required Fire Flow (L/min)	9,000
Occupancy Charge	-15
Sprinkler Protection Reduction	0
Exposure (%)	
North (%)	12%
East (%)	0%
South (%)	17%
West (%)	8%
Total Exposure (%)	37%
Wood Shake Charge (L/min)	0
Total Required Fire Flow (L/min)	10,000
Total Required Fire Flow (L/s)	167

FUS Required Fire Flow Calculation

Client: David Schaeffer Engineering Ltd.
Project: 2019-091-DSE
Development: Brazeau Lands
Zoning: Multi Family Residential   Blocks 168, Traditional Townhouse
Date: November 6, 2019

Calculations Based on "Water Supply for Public Fire Protection", Fire Underwriters Survey, 1999.

A. Type of Construction: Wood Frame Construction

B. Ground Floor Area: 380 **m^2**

Note: ground floor area based on drawing provided to GeoAdvice on September 12, 2019.

C. Number of Storeys: 2

Note: all buildings, including adjacent buildings, assumed to be 2 storeys.

Note: The townhouse dwellings are separated by less than 3 m; therefore, they must be considered as one fire area. The combined area of 4 units is considered in this calculation.

D. Required Fire Flow*: $F = 220C\sqrt{A}$

C: Coefficient related to the type of construction — **C =** 1.5

A: Effective area — **A =** 760 **m^2** (Combined area of 4 units)

The total floor area in m^2 in the building being considered

F = 9,095 L/min **D = 9,000 L/min***

E. Occupancy

Occupancy content hazard — Limited Combustible — -15 % of **D** — **-1,350 L/min** — **E = 7,650 L/min**

F. Sprinkler Protection

Automatic sprinkler protection — None — 0 % of **E** — **0 L/min** — **F = 7,650 L/min**

G. Exposures

Side	Separation Distance	Length-Height Factor - Adjacent Structure	Construction Type - Adjacent Structure	Exposure
West	30.1 to 45 m	0-30 m-storeys	Wood Frame or Non-Combustible	5%
East	10.1 to 20 m	0-30 m-storeys	Wood Frame or Non-Combustible	12%
North	3.1 to 10 m	0-30 m-storeys	Wood Frame or Non-Combustible	17%
South	Beyond 45 m	31-60 m-storeys	Wood Frame or Non-Combustible	0%
			Total	**34%**

% of **E** — **+ 2,601 L/min** — **G = 10,251 L/min**

H. Wood Shake Charge — No — **0 L/min** — **H = 10,251 L/min**

For wood shingle or shake roofs

The required fire flow exceeds the cap in the City of Ottawa Technical Bulletin ISDTB-2014-02 4.2. The townhouse dwellings **do not** comply with the provisions of the Bulletin; therefore, the required fire flow is:

Total Fire Flow Required	**10,000**	**L/min***
	167	**L/s**
Required Duration of Fire Flow	**2**	**Hrs**
Required Volume of Fire Flow	**1,200**	**m^3**

*Rounded to the nearest 1,000 L/min

The Total Required Fire Flow for the Brazeau Lands development should be reviewed when drawings and site plans have been finalized. The Total Required Fire Flow may be reduced or increased depending on area, construction, occupancy, exposures, and level of sprinkler protection. If any of these items change the Total Required Fire Flow should be reviewed to determine the impact.

Consideration should be given for fire prevention during construction phases as the required fire flows during construction of buildings is substantially higher than after the buildings are occupied. This is due to exposed framing and inactive sprinkler systems. Fires starting in unprotected portion of buildings quickly become too strong for sprinkler systems in protected portion of buildings. As such, special precautions should be taken any time construction is occurring.

* The amount and rate of water application required in firefighting to confine and control the fires possible in a building or group of buildings which comprise essentially the same fire area by virtue of immediate exposure.

** Rounded to the nearest 1,000 L/min

Notes to calculations

Type of Construction	Coefficient	Unit
Wood Frame Construction	1.5	-
Ordinary Construction	1	-
Non-Combustible Construction	0.8	-
Fire Resistive Construction (< 2 hrs)	0.7	-
Fire Resistive Construction (> 2 hrs)	0.6	-

Occupancy Fire Hazard	Factor	Unit
Non-Combustible	-25	%
Limited Combustible	-15	%
Combustible	0	%
Free Burning	15	%
Rapid Burning	25	%

Sprinkler Protection	Factor	Unit
None	0	%
Automatic	-30	%
Automatic + Standard Supply	-40	%
Fully Supervised	-50	%
Fully Supervised + Fire Resistive	-70	%

Zoning
Single Family Residential
Multi Family Residential
Commercial
Institutional
Industrial

Wood Shake Charge	Factor	Unit
Yes	4000	L/min
No	0	L/min

Required Duration of Fire Flow	
Fire Flow Required (L/min)	**Duration (hours)**
2,000 or less	1.00
3000	1.25
4000	1.50
5000	1.75
6000	2.00
7000	2.00
8000	2.00
9000	2.00
10000	2.00
11000	2.25
12000	2.50
13000	2.75
14000	3.00
15000	3.25
16000	3.50
17000	3.75
18000	4.00
19000	4.25
20000	4.50
21000	4.75
22000	5.00
23000	5.25
24000	5.50
25000	5.75
26000	6.00
27000	6.25
28000	6.50
29000	6.75
30000	7.00
31000	7.25
32000	7.50
33000	7.75
34000	8.00
35000	8.25
36000	8.50
37000	8.75
38000	9.00
39000	9.25
40000 and over	9.50

Notes to calculations

Separation Distance	Length-Height Factor of Exposed Wall of Adjacent Structure	Construction of Exposed Wall of Adjacent Structure			
		Wood Frame or Non-Combustible	Ordinary or Fire-Resistive with Unprotected Openings	Ordinary or Fire-Resistive with Semi-Protected Openings	Ordinary or Fire-Resistive with Blank Wall
0.0 to 3 m	0-30 m-storeys	22%	21%	16%	0%
	31-60 m-storeys	23%	22%	17%	0%
	61-90 m-storeys	24%	23%	18%	0%
	91-120 m-storeys	25%	24%	19%	0%
	Over 120 m-storeys	25%	25%	20%	0%
3.1 to 10 m	0-30 m-storeys	17%	15%	11%	0%
	31-60 m-storeys	18%	16%	12%	0%
	61-90 m-storeys	19%	18%	14%	0%
	91-120 m-storeys	20%	19%	15%	0%
	Over 120 m-storeys	20%	19%	15%	0%
10.1 to 20 m	0-30 m-storeys	12%	10%	7%	0%
	31-60 m-storeys	13%	11%	8%	0%
	61-90 m-storeys	14%	13%	10%	0%
	91-120 m-storeys	15%	14%	11%	0%
	Over 120 m-storeys	15%	15%	12%	0%
20.1 to 30 m	0-30 m-storeys	8%	6%	4%	0%
	31-60 m-storeys	8%	7%	5%	0%
	61-90 m-storeys	9%	8%	6%	0%
	91-120 m-storeys	10%	9%	7%	0%
	Over 120 m-storeys	10%	10%	8%	0%
30.1 to 45 m	0-30 m-storeys	5%	5%	5%	0%
	31-60 m-storeys	5%	5%	5%	0%
	61-90 m-storeys	5%	5%	5%	0%
	91-120 m-storeys	5%	5%	5%	0%
	Over 120 m-storeys	5%	5%	5%	0%
Beyond 45 m	0-30 m-storeys	0%	0%	0%	0%
	31-60 m-storeys	0%	0%	0%	0%
	61-90 m-storeys	0%	0%	0%	0%
	91-120 m-storeys	0%	0%	0%	0%
	Over 120 m-storeys	0%	0%	0%	0%
Fire Wall	0-30 m-storeys	10%	10%	10%	10%
	31-60 m-storeys	10%	10%	10%	10%
	61-90 m-storeys	10%	10%	10%	10%
	91-120 m-storeys	10%	10%	10%	10%
	Over 120 m-storeys	10%	10%	10%	10%

Brazeau Lands - FUS Required Fire Flow Summary

Brazeau Lands	
Type of Construction	Wood Frame Construction
Construction Coefficient	1.5
Effective Total Area (m^2)	760
Required Fire Flow (L/min)	9,000
Occupancy Charge	-15
Sprinkler Protection Reduction	0
Exposure (%)	
North (%)	5%
East (%)	12%
South (%)	17%
West (%)	0%
Total Exposure (%)	34%
Wood Shake Charge (L/min)	0
Total Required Fire Flow (L/min)	10,000
Total Required Fire Flow (L/s)	167

Appendix C Boundary Conditions

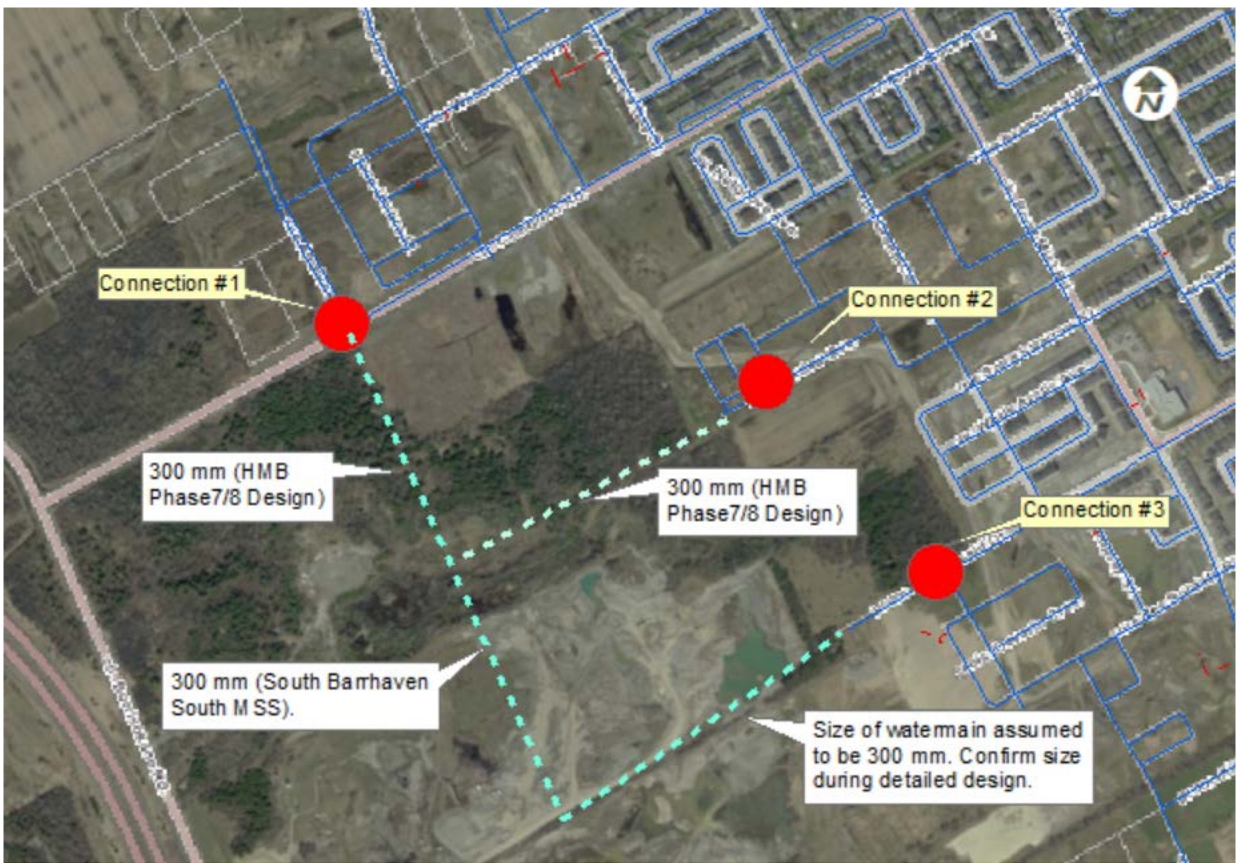
Boundary Conditions for HMB Phases 7 and 8 and Brazeau Lands

Information Provided:

Date provided: September 2019

Scenario	Demand	
	L/min	L/s
Average Daily Demand	846	14.10
Maximum Daily Demand	1961	32.69
Peak Hour	4224	70.40
Fire Flow Demand #1	10000	166.67
Fire Flow Demand #2	15000	250.00
Fire Flow Demand #3	17000	283.33

Location:



Results

Connection 1 - Cambrian Road

Demand Scenario	Existing Barrhaven PZ		Future Zone 3C	
	Head (m)	Pressure[1] (psi)	Head (m)	Pressure[1] (psi)
Maximum HGL	156.4	102.9	147.7	77.3
Peak Hour	135.7	60.4	142.8	70.4
Max Day plus Fire (#1)	144.0	72.2	140.0	66.4
Max Day plus Fire (#2)	135.4	59.9	134.9	59.2
Max Day plus Fire (#3)	133.7	57.4	132.5	55.7

[1] Ground Elevation = 93.3 m

Connection 2 - Brambling Way

Demand Scenario	Existing Barrhaven PZ		Future Zone 3C	
	Head (m)	Pressure[1] (psi)	Head (m)	Pressure[1] (psi)
Maximum HGL	156.4	100.1	147.7	74.6
Peak Hour	135.6	57.4	142.7	67.5
Max Day plus Fire (#1)	141.2	65.4	139.9	63.5
Max Day plus Fire (#2)	129.9	49.4	134.6	56.0
Max Day plus Fire (#3)	126.6	44.7	132.1	52.4

[1] Ground Elevation = 95.2 m

Connection 3 - Dundonald Drive

Demand Scenario	Existing Barrhaven PZ		Future Zone 3C	
	Head (m)	Pressure[1] (psi)	Head (m)	Pressure[1] (psi)
Maximum HGL	156.4	86.5	147.7	61.0
Peak Hour	135.7	43.9	142.6	53.7
Max Day plus Fire (#1)	142.0	52.9	138.6	48.1
Max Day plus Fire (#2)	131.5	38.0	132.2	38.9
Max Day plus Fire (#3)	128.7	34.0	128.9	34.3

[1] Ground Elevation = 104.8 m

Notes:

1) As per the Ontario Building Code in areas that may be occupied, the static pressure at any fixture shall not exceed 552 kPa (80 psi.) Pressure control measures to be considered are as follows, in order of preference:
   a) If possible, systems to be designed to residual pressures of 345 to 552 kPa (50 to 80 psi) in all occupied areas outside of the public right-of-way without special pressure control equipment.

b) Pressure reducing valves to be installed immediately downstream of the isolation valve in the home/ building, located downstream of the meter so it is owner maintained.

2) A third pump was turned on during all fire simulations under Existing Barrhaven Pressure.
3) Future pipes were added to the water model as shown in the figure above.

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.

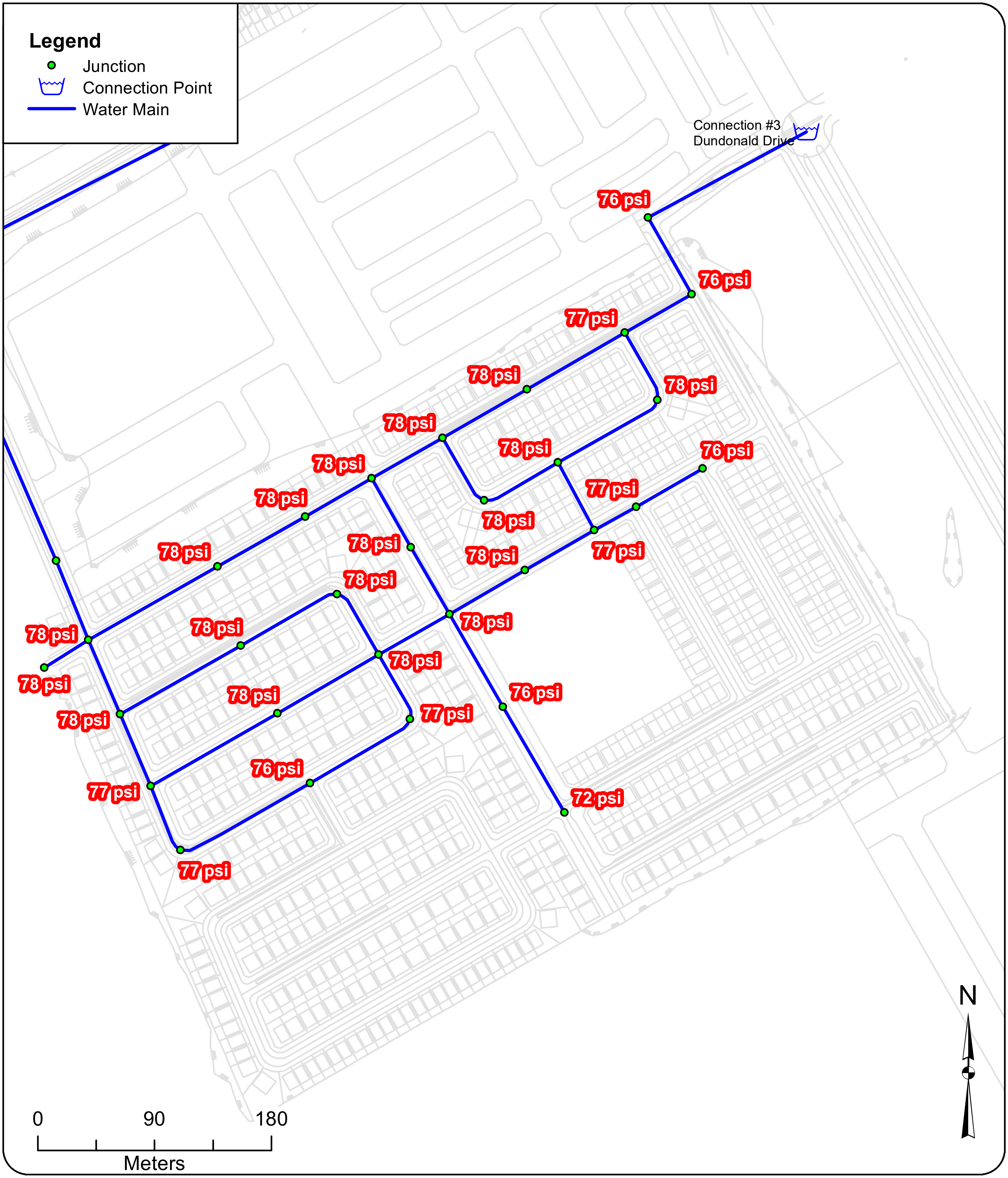
Appendix D Pipe and Junction Model Inputs

Model Inputs - Phases 1 and 2

ID	From	To	Length (m)	Diameter (mm)	Roughness ()
P-100	J-82	J-83	63.79	204	110
P-101	J-83	J-46	60.03	204	110
P-102	J-79	J-84	53.32	204	110
P-103	J-84	J-85	55.04	204	110
P-104	J-85	J-45	66.63	204	110
P-105	J-78	J-86	72.81	297	120
P-106	J-86	J-87	55.90	297	120
P-107	J-87	J-88	48.49	297	120
P-108	J-45	J-88	59.54	204	110
P-109	J-88	J-89	55.04	297	120
P-110	J-89	J-41	65.11	297	120
P-111	J-90	J-47	61.51	204	110
P-112	J-43	J-90	59.19	204	110
P-42	J-33	J-34	40.11	297	120
P-43	J-33	J-35	114.35	297	120
P-44	J-35	J-36	77.83	297	120
P-45	J-36	J-37	59.20	297	120
P-46	J-37	J-38	62.88	297	120
P-47	J-38	J-39	74.92	297	120
P-48	J-39	J-40	87.18	297	120
P-49	J-40	J-41	59.39	297	120
P-50	J-41	J-60	67.93	297	120
P-51	J-60	CONNECTION_3	138.92	297	120
P-52	J-40	J-42	58.39	204	110
P-53	J-42	J-43	83.72	204	110
P-54	J-43	J-44	72.67	204	110
P-55	J-44	J-38	58.67	204	110
P-56	J-45	J-46	59.20	204	110
P-57	J-46	J-90	81.24	204	110
P-58	J-47	J-48	84.62	204	110
P-59	J-48	J-61	59.65	297	120
P-60	J-61	J-37	60.99	297	120
P-61	J-59	J-58	94.07	297	120
P-62	J-58	J-48	82.47	297	120
P-63	J-48	J-49	63.07	204	110
P-64	J-49	J-50	57.71	204	110
P-65	J-50	J-51	84.62	204	110
P-66	J-51	J-52	106.76	204	110
P-67	J-33	J-52	62.05	204	110
P-68	J-52	J-53	60.2	204	110
P-69	J-53	J-54	112.78	204	110
P-70	J-54	J-49	90	204	110
P-71	J-49	J-57	56.32	204	110
P-72	J-57	J-56	92.28	204	110
P-73	J-53	J-55	55.27	204	110
P-74	J-55	J-56	113.38	204	110
P-75	J-56	J-62	58.69	204	110
P-76	J-62	J-63	119.4	204	110
P-77	J-63	J-64	56.35	204	110
P-78	J-64	J-65	58.6	204	110
P-79	J-65	J-66	100.76	204	110
P-80	J-66	J-70	70.42	204	110
P-81	J-70	J-71	55.7	204	110
P-82	J-71	J-69	54.8	204	110
P-83	J-64	J-67	125.85	204	110
P-84	J-67	J-69	97.99	204	110
P-85	J-62	J-68	92.12	204	110
P-86	J-68	J-69	56.42	204	110
P-87	J-69	J-59	63.46	204	110
P-88	J-59	J-72	59.77	297	120
P-89	J-72	J-73	28.67	297	120
P-90	J-72	J-74	96.85	297	120
P-91	J-74	J-75	110.13	297	120
P-92	J-75	J-76	78.16	297	120
P-93	J-77	J-76	30.34	297	120
P-94	J-76	J-78	58.2	297	120
P-95	J-78	J-79	59.97	204	110
P-96	J-79	J-80	59.39	204	110
P-97	J-80	J-81	85.15	204	110
P-98	J-81	J-59	79.25	204	110
P-99	J-80	J-82	51.74	204	110

ID	Elevation (m)	ADD (L/s)
J-33	101.29	0.18
J-34	101.41	0.00
J-35	101.33	0.16
J-36	101.25	0.16
J-37	101.64	0.06
J-38	101.46	0.14
J-39	101.83	0.20
J-40	101.96	0.14
J-41	102.65	0.04
J-42	101.87	0.16
J-43	101.72	0.18
J-44	101.59	0.16
J-45	103.27	0.06
J-46	102.38	0.08
J-47	101.77	0.12
J-48	101.83	0.06
J-49	101.74	0.14
J-50	101.40	0.12
J-51	101.41	0.18
J-52	101.35	0.20
J-53	102.22	0.20
J-54	101.87	0.20
J-55	102.52	0.20
J-56	103.00	0.20
J-57	102.46	0.12
J-58	102.95	0.06
J-59	105.68	0.64
J-60	102.80	0.00
J-61	101.51	0.06
J-62	104.21	0.00
J-63	106.39	0.20
J-64	106.74	0.20
J-65	107.17	0.20
J-66	107.78	0.18
J-67	106.62	0.20
J-68	106.00	0.22
J-69	107.07	0.14
J-70	108.43	0.14
J-71	108.62	0.16
J-72	107.85	0.12
J-73	108.47	0.16
J-74	107.68	0.00
J-75	108.00	0.24
J-76	108.27	0.16
J-77	108.93	0.08
J-78	106.17	0.00
J-79	105.57	0.06
J-80	105.54	0.18
J-81	105.54	0.18
J-82	104.30	0.28
J-83	103.10	0.12
J-84	104.73	0.20
J-85	103.68	0.12
J-86	105.81	0.20
J-87	105.51	0.08
J-88	104.78	0.08
J-89	103.69	0.04
J-90	102.07	0.08

Appendix E MHD and PHD Model Results



GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis of the Brazeau lands**
Client: **David Schaeffer Engineering Ltd.**
Date: **June 2020**
Created by: **BL**
Reviewed by: **WdS**

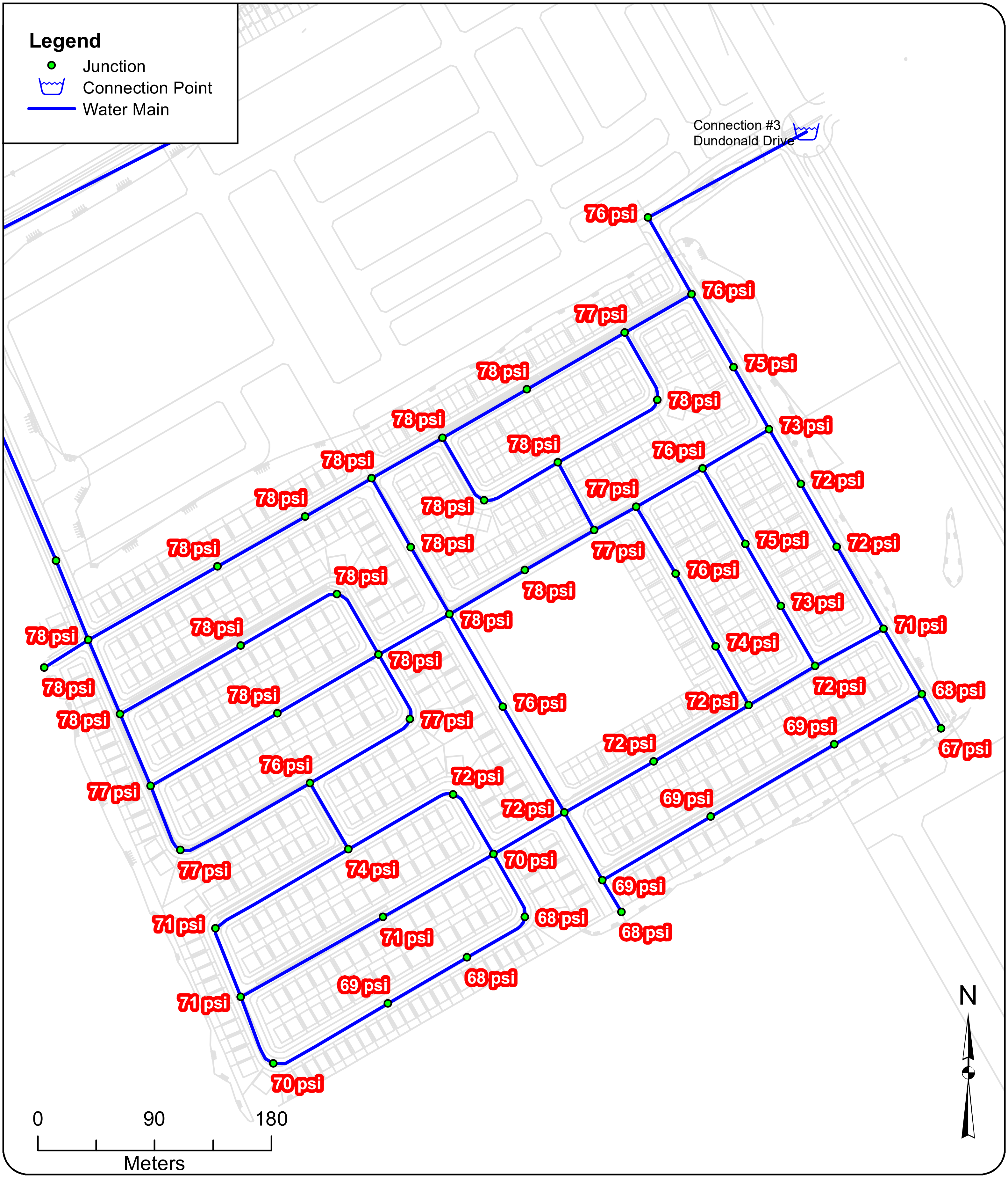
MHD Pressure Results - Phase 1

Figure E.1

Minimum Hour Demand Modeling Results - Phase 1

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/km)
P-42	J-33	J-34	40.11	297	120	0.00	0.00	0.00	0.00
P-43	J-33	J-35	114.35	297	120	-0.09	0.00	0.00	0.00
P-44	J-35	J-36	77.83	297	120	-0.16	0.00	0.00	0.00
P-45	J-36	J-37	59.20	297	120	-0.25	0.00	0.00	0.00
P-46	J-37	J-38	62.88	297	120	-0.88	0.01	0.00	0.00
P-47	J-38	J-39	74.92	297	120	-1.05	0.02	0.00	0.00
P-48	J-39	J-40	87.18	297	120	-1.15	0.02	0.00	0.00
P-49	J-40	J-41	59.39	297	120	-1.68	0.02	0.00	0.00
P-50	J-41	J-60	67.93	297	120	-1.69	0.02	0.00	0.00
P-51	J-60	CONNECTION_3	138.92	297	120	-1.69	0.02	0.00	0.00
P-52	J-40	J-42	58.39	204	110	0.45	0.01	0.00	0.00
P-53	J-42	J-43	91.90	204	110	0.37	0.01	0.00	0.00
P-54	J-43	J-44	64.49	204	110	-0.02	0.00	0.00	0.00
P-55	J-44	J-38	58.67	204	110	-0.10	0.00	0.00	0.00
P-56	J-45	J-46	59.20	204	110	-0.03	0.00	0.00	0.00
P-57	J-46	J-90	37.06	204	110	-0.08	0.00	0.00	0.00
P-58	J-47	J-48	67.31	204	110	0.16	0.00	0.00	0.00
P-59	J-48	J-61	59.65	297	120	-0.58	0.01	0.00	0.00
P-60	J-61	J-37	60.99	297	120	-0.61	0.01	0.00	0.00
P-61	J-59	J-58	94.07	297	120	-0.32	0.00	0.00	0.00
P-62	J-58	J-48	82.47	297	120	-0.35	0.01	0.00	0.00
P-63	J-48	J-49	63.07	204	110	0.36	0.01	0.00	0.00
P-64	J-49	J-50	57.71	204	110	0.04	0.00	0.00	0.00
P-65	J-50	J-51	84.62	204	110	-0.02	0.00	0.00	0.00
P-66	J-51	J-52	106.76	204	110	-0.11	0.00	0.00	0.00
P-67	J-33	J-52	62.05	204	110	0.42	0.01	0.00	0.00
P-68	J-52	J-53	60.20	204	110	0.21	0.01	0.00	0.00
P-69	J-53	J-54	112.78	204	110	-0.01	0.00	0.00	0.00
P-70	J-54	J-49	90.00	204	110	-0.10	0.00	0.00	0.00
P-71	J-49	J-57	56.32	204	110	0.14	0.00	0.00	0.00
P-72	J-57	J-56	92.28	204	110	0.08	0.00	0.00	0.00
P-73	J-53	J-55	55.27	204	110	0.12	0.00	0.00	0.00
P-74	J-55	J-56	113.38	204	110	0.02	0.00	0.00	0.00
P-111	J-90	J-47	61.51	204	110	0.22	0.01	0.00	0.00
P-112	J-43	J-90	59.19	204	110	0.30	0.01	0.00	0.00

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (psi)
J-33	0.09	101.29	156	78
J-34	0.00	101.41	156	78
J-35	0.08	101.33	156	78
J-36	0.08	101.25	156	78
J-37	0.03	101.64	156	78
J-38	0.07	101.46	156	78
J-39	0.10	101.83	156	78
J-40	0.07	101.96	156	77
J-41	0.02	102.65	156	76
J-42	0.08	101.87	156	78
J-43	0.09	101.72	156	78
J-44	0.08	101.59	156	78
J-45	0.03	103.27	156	76
J-46	0.04	102.38	156	77
J-47	0.06	101.77	156	78
J-48	0.03	101.83	156	78
J-49	0.07	101.74	156	78
J-50	0.06	101.40	156	78
J-51	0.09	101.41	156	78
J-52	0.10	101.35	156	78
J-53	0.10	102.22	156	77
J-54	0.10	101.87	156	78
J-55	0.10	102.52	156	77
J-56	0.10	103.00	156	76
J-57	0.06	102.46	156	77
J-58	0.03	102.95	156	76
J-59	0.32	105.68	156	72
J-60	0.00	102.80	156	76
J-61	0.03	101.51	156	78
J-90	0.00	102.07	156	77



GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis of the Brazeau Lands**
Client: **David Schaeffer Engineering Ltd.**
Date: **June 2020**
Created by: **BL**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

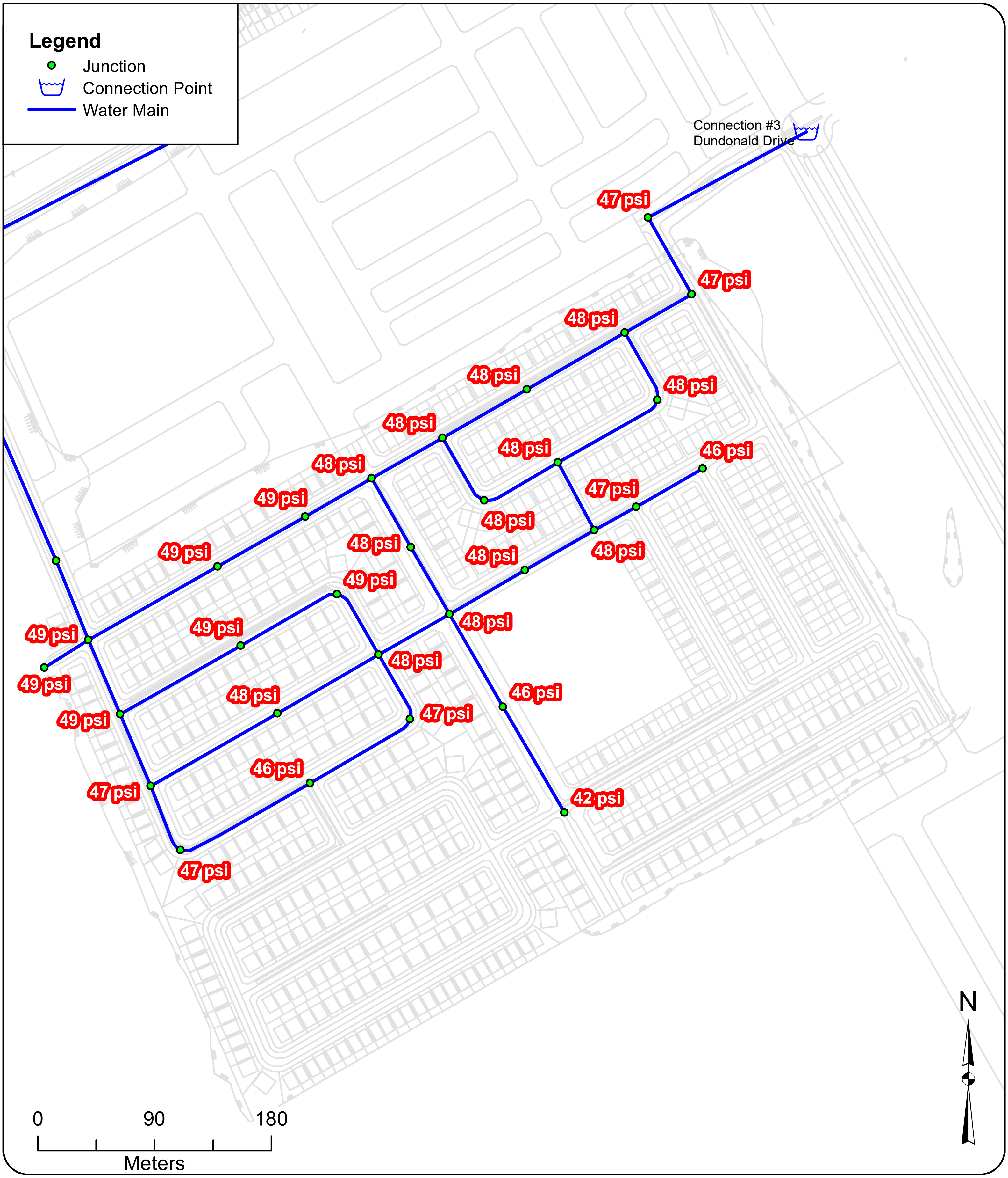
MHD Pressure Results - Phases 1&2

Figure E.2

Minimum Hour Demand Modeling Results - Phases 1 and 2

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/km)
P-42	J-33	J-34	40.11	297	120	0.00	0.00	0.00	0.00
P-43	J-33	J-35	114.35	297	120	0.35	0.01	0.00	0.00
P-44	J-35	J-36	77.83	297	120	0.28	0.00	0.00	0.00
P-45	J-36	J-37	59.20	297	120	0.20	0.00	0.00	0.00
P-46	J-37	J-38	62.88	297	120	-0.73	0.01	0.00	0.00
P-47	J-38	J-39	74.92	297	120	-0.95	0.01	0.00	0.00
P-48	J-39	J-40	87.18	297	120	-1.05	0.02	0.00	0.00
P-49	J-40	J-41	59.39	297	120	-1.56	0.02	0.00	0.00
P-50	J-41	J-60	67.93	297	120	-3.05	0.04	0.00	0.01
P-51	J-60	CONNECTION_3	138.92	297	120	-3.05	0.04	0.00	0.01
P-52	J-40	J-42	58.39	204	110	0.44	0.01	0.00	0.00
P-53	J-42	J-43	83.72	204	110	0.35	0.01	0.00	0.00
P-54	J-43	J-44	72.67	204	110	-0.07	0.00	0.00	0.00
P-55	J-44	J-38	58.67	204	110	-0.15	0.00	0.00	0.00
P-56	J-45	J-46	59.20	204	110	0.21	0.01	0.00	0.00
P-57	J-46	J-90	81.24	204	110	-0.10	0.00	0.00	0.00
P-58	J-47	J-48	84.62	204	110	0.18	0.01	0.00	0.00
P-59	J-48	J-61	59.65	297	120	-0.87	0.01	0.00	0.00
P-60	J-61	J-37	60.99	297	120	-0.90	0.01	0.00	0.00
P-61	J-59	J-58	94.07	297	120	-0.53	0.01	0.00	0.00
P-62	J-58	J-48	82.47	297	120	-0.56	0.01	0.00	0.00
P-63	J-48	J-49	63.07	204	110	0.45	0.01	0.00	0.00
P-64	J-49	J-50	57.71	204	110	-0.03	0.00	0.00	0.00
P-65	J-50	J-51	84.62	204	110	-0.09	0.00	0.00	0.00
P-66	J-51	J-52	106.76	204	110	-0.18	0.01	0.00	0.00
P-67	J-33	J-52	62.05	204	110	0.62	0.02	0.00	0.00
P-68	J-52	J-53	60.20	204	110	0.33	0.01	0.00	0.00
P-69	J-53	J-54	112.78	204	110	-0.03	0.00	0.00	0.00
P-70	J-54	J-49	90.00	204	110	-0.13	0.00	0.00	0.00
P-71	J-49	J-57	56.32	204	110	0.28	0.01	0.00	0.00
P-72	J-57	J-56	92.28	204	110	0.22	0.01	0.00	0.00
P-73	J-53	J-55	55.27	204	110	0.26	0.01	0.00	0.00
P-74	J-55	J-56	113.38	204	110	0.17	0.01	0.00	0.00
P-111	J-90	J-47	61.51	204	110	0.24	0.01	0.00	0.00
P-112	J-43	J-90	59.19	204	110	0.33	0.01	0.00	0.00
P-75	J-56	J-62	58.69	204	110	0.29	0.01	0.00	0.00
P-76	J-62	J-63	119.4	204	110	0.19	0.01	0.00	0.00
P-77	J-63	J-64	56.35	204	110	0.10	0.00	0.00	0.00
P-78	J-64	J-65	58.6	204	110	0.09	0.00	0.00	0.00
P-79	J-65	J-66	100.76	204	110	0.00	0.00	0.00	0.00
P-80	J-66	J-70	70.42	204	110	-0.10	0.00	0.00	0.00
P-81	J-70	J-71	55.7	204	110	-0.18	0.01	0.00	0.00
P-82	J-71	J-69	54.8	204	110	-0.24	0.01	0.00	0.00
P-83	J-64	J-67	125.85	204	110	-0.09	0.00	0.00	0.00
P-84	J-67	J-69	97.99	204	110	-0.20	0.01	0.00	0.00
P-85	J-62	J-68	92.12	204	110	0.00	0.00	0.00	0.00
P-86	J-68	J-69	56.42	204	110	-0.07	0.00	0.00	0.00
P-87	J-69	J-59	63.46	204	110	-0.59	0.02	0.00	0.00
P-88	J-59	J-72	59.77	297	120	-0.29	0.00	0.00	0.00
P-89	J-72	J-73	28.67	297	120	0.00	0.00	0.00	0.00
P-90	J-72	J-74	96.85	297	120	-0.37	0.01	0.00	0.00
P-91	J-74	J-75	110.13	297	120	-0.49	0.01	0.00	0.00
P-92	J-75	J-76	78.16	297	120	-0.57	0.01	0.00	0.00
P-93	J-77	J-76	30.34	297	120	0.00	0.00	0.00	0.00
P-94	J-76	J-78	58.2	297	120	-0.61	0.01	0.00	0.00
P-95	J-78	J-79	59.97	204	110	0.21	0.01	0.00	0.00
P-96	J-79	J-80	59.39	204	110	0.22	0.01	0.00	0.00
P-97	J-80	J-81	85.15	204	110	0.23	0.01	0.00	0.00
P-98	J-81	J-59	79.25	204	110	0.09	0.00	0.00	0.00
P-99	J-80	J-82	51.74	204	110	-0.10	0.00	0.00	0.00
P-100	J-82	J-83	63.79	204	110	-0.16	0.00	0.00	0.00
P-101	J-83	J-46	60.03	204	110	-0.26	0.01	0.00	0.00
P-102	J-79	J-84	53.32	204	110	-0.09	0.00	0.00	0.00
P-103	J-84	J-85	55.04	204	110	-0.15	0.00	0.00	0.00
P-104	J-85	J-45	66.63	204	110	-0.25	0.01	0.00	0.00
P-105	J-78	J-86	72.81	297	120	-0.86	0.01	0.00	0.00
P-106	J-86	J-87	55.9	297	120	-0.89	0.01	0.00	0.00
P-107	J-87	J-88	48.49	297	120	-0.93	0.01	0.00	0.00
P-108	J-45	J-88	59.54	204	110	-0.49	0.01	0.00	0.00
P-109	J-88	J-89	55.04	297	120	-1.44	0.02	0.00	0.00
P-110	J-89	J-41	65.11	297	120	-1.48	0.02	0.00	0.00

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (psi)
J-33	0.09	101.29	156	78
J-34	0.00	101.41	156	78
J-35	0.08	101.33	156	78
J-36	0.08	101.25	156	78
J-37	0.03	101.64	156	78
J-38	0.07	101.46	156	78
J-39	0.10	101.83	156	78
J-40	0.07	101.96	156	77
J-41	0.02	102.65	156	76
J-42	0.08	101.87	156	78
J-43	0.09	101.72	156	78
J-44	0.08	101.59	156	78
J-45	0.03	103.27	156	76
J-46	0.04	102.38	156	77
J-47	0.06	101.77	156	78
J-48	0.03	101.83	156	78
J-49	0.07	101.74	156	78
J-50	0.06	101.40	156	78
J-51	0.09	101.41	156	78
J-52	0.10	101.35	156	78
J-53	0.10	102.22	156	77
J-54	0.10	101.87	156	78
J-55	0.10	102.52	156	77
J-56	0.10	103.00	156	76
J-57	0.06	102.46	156	77
J-58	0.03	102.95	156	76
J-59	0.32	105.68	156	72
J-60	0.00	102.80	156	76
J-61	0.03	101.51	156	78
J-90	0.00	102.07	156	77
J-62	0.10	104.21	156	74
J-63	0.10	106.39	156	71
J-64	0.10	106.74	156	71
J-65	0.09	107.17	156	70
J-66	0.10	107.78	156	69
J-67	0.11	106.62	156	71
J-68	0.07	106.00	156	72
J-69	0.07	107.07	156	70
J-70	0.08	108.43	156	68
J-71	0.06	108.62	156	68
J-72	0.08	107.85	156	69
J-73	0.00	108.47	156	68
J-74	0.12	107.68	156	69
J-75	0.08	108.00	156	69
J-76	0.04	108.27	156	68
J-77	0.00	108.93	156	67
J-78	0.03	106.17	156	71
J-79	0.09	105.57	156	72
J-80	0.09	105.54	156	72
J-81	0.14	105.54	156	72
J-82	0.06	104.30	156	74
J-83	0.10	103.10	156	76
J-84	0.06	104.73	156	73
J-85	0.10	103.68	156	75
J-86	0.04	105.81	156	72
J-87	0.04	105.51	156	72
J-88	0.02	104.78	156	73
J-89	0.04	103.69	156	75



Project: **Hydraulic Capacity and Modeling Analysis of the Brazeau Lands**
Client: **David Schaeffer Engineering Ltd.**
Date: **June 2020**
Created by: **BL**
Reviewed by: **WdS**

GeoAdvice Engineering Inc.

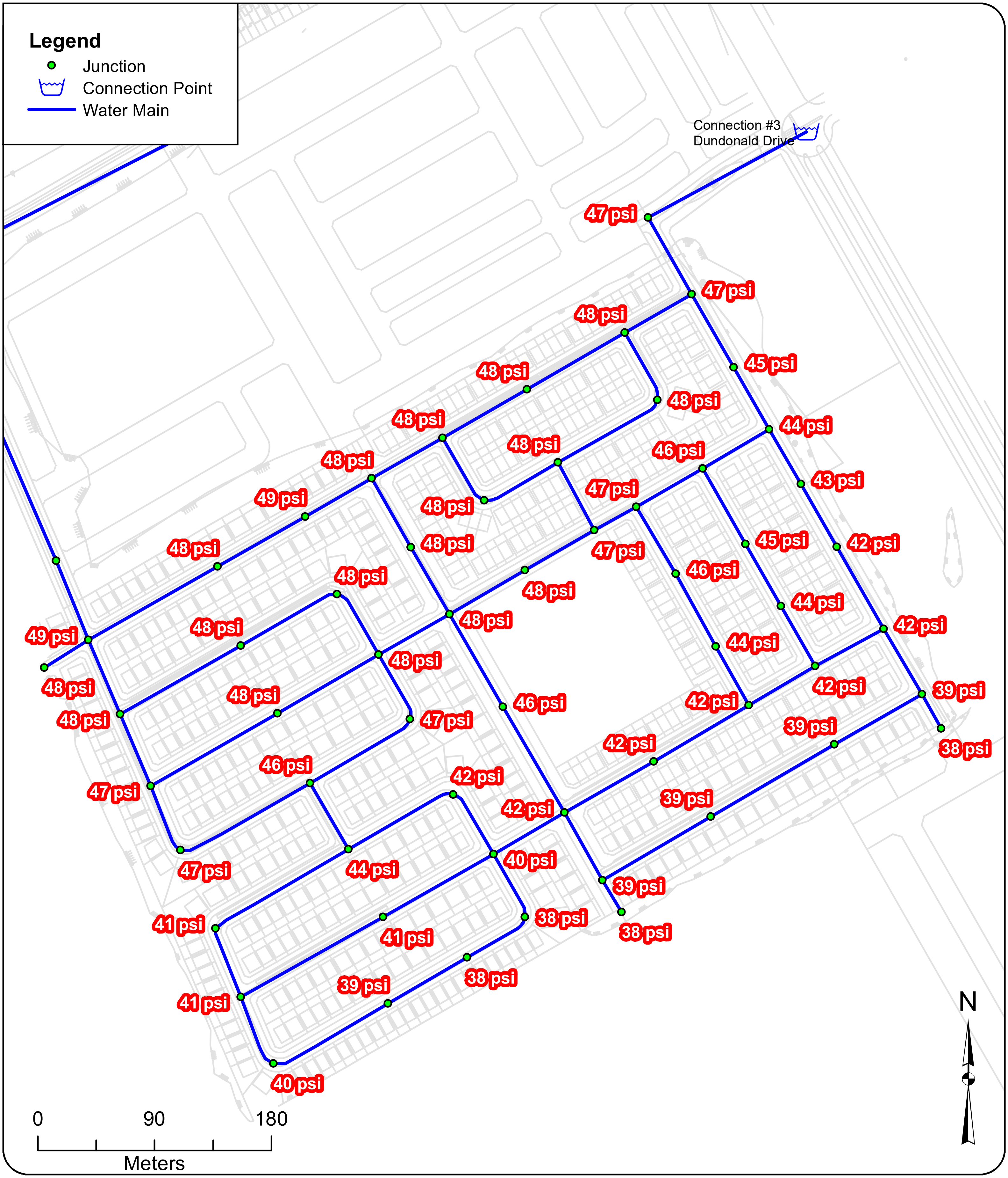
PHD Pressure Results - Phase 1

Figure E.3

Peak Hour Demand Modeling Results - Phase 1

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/km)
P-42	J-33	J-34	40.11	297	120	0.00	0.00	0.00	0.00
P-43	J-33	J-35	114.35	297	120	-2.53	0.04	0.00	0.01
P-44	J-35	J-36	77.83	297	120	-3.36	0.05	0.00	0.01
P-45	J-36	J-37	59.20	297	120	-4.27	0.06	0.00	0.02
P-46	J-37	J-38	62.88	297	120	-10.16	0.15	0.01	0.11
P-47	J-38	J-39	74.92	297	120	-11.85	0.17	0.01	0.15
P-48	J-39	J-40	87.18	297	120	-13.00	0.19	0.02	0.18
P-49	J-40	J-41	59.39	297	120	-18.81	0.27	0.02	0.35
P-50	J-41	J-60	67.93	297	120	-18.99	0.27	0.02	0.36
P-51	J-60	CONNECTION_3	138.92	297	120	-18.99	0.27	0.05	0.36
P-52	J-40	J-42	58.39	204	110	5.02	0.15	0.01	0.23
P-53	J-42	J-43	91.90	204	110	4.12	0.13	0.01	0.16
P-54	J-43	J-44	64.49	204	110	-0.06	0.00	0.00	0.00
P-55	J-44	J-38	58.67	204	110	-0.91	0.03	0.00	0.01
P-56	J-45	J-46	59.20	204	110	-0.36	0.01	0.00	0.00
P-57	J-46	J-90	37.06	204	110	-0.84	0.03	0.00	0.01
P-58	J-47	J-48	67.31	204	110	1.65	0.05	0.00	0.03
P-59	J-48	J-61	59.65	297	120	-5.28	0.08	0.00	0.03
P-60	J-61	J-37	60.99	297	120	-5.59	0.08	0.00	0.04
P-61	J-59	J-58	94.07	297	120	-1.96	0.03	0.00	0.01
P-62	J-58	J-48	82.47	297	120	-2.26	0.03	0.00	0.01
P-63	J-48	J-49	63.07	204	110	4.29	0.13	0.01	0.17
P-64	J-49	J-50	57.71	204	110	0.63	0.02	0.00	0.00
P-65	J-50	J-51	84.62	204	110	-0.06	0.00	0.00	0.00
P-66	J-51	J-52	106.76	204	110	-1.04	0.03	0.00	0.01
P-67	J-33	J-52	62.05	204	110	4.28	0.13	0.01	0.17
P-68	J-52	J-53	60.20	204	110	2.10	0.06	0.00	0.04
P-69	J-53	J-54	112.78	204	110	-0.21	0.01	0.00	0.00
P-70	J-54	J-49	90.00	204	110	-1.27	0.04	0.00	0.02
P-71	J-49	J-57	56.32	204	110	1.63	0.05	0.00	0.03
P-72	J-57	J-56	92.28	204	110	0.95	0.03	0.00	0.01
P-73	J-53	J-55	55.27	204	110	1.17	0.04	0.00	0.02
P-74	J-55	J-56	113.38	204	110	0.11	0.00	0.00	0.00
P-111	J-90	J-47	61.51	204	110	2.31	0.07	0.00	0.05
P-112	J-43	J-90	59.19	204	110	3.16	0.10	0.01	0.10

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (psi)
J-33	0.99	101.29	136	49
J-34	0.00	101.41	136	49
J-35	0.83	101.33	136	49
J-36	0.91	101.25	136	49
J-37	0.30	101.64	136	48
J-38	0.78	101.46	136	49
J-39	1.15	101.83	136	48
J-40	0.78	101.96	136	48
J-41	0.18	102.65	136	47
J-42	0.90	101.87	136	48
J-43	1.02	101.72	136	48
J-44	0.84	101.59	136	48
J-45	0.36	103.27	136	46
J-46	0.48	102.38	136	47
J-47	0.66	101.77	136	48
J-48	0.38	101.83	136	48
J-49	0.76	101.74	136	48
J-50	0.68	101.40	136	49
J-51	0.99	101.41	136	49
J-52	1.14	101.35	136	49
J-53	1.14	102.22	136	47
J-54	1.06	101.87	136	48
J-55	1.06	102.52	136	47
J-56	1.06	103.00	136	46
J-57	0.68	102.46	136	47
J-58	0.30	102.95	136	46
J-59	1.96	105.68	136	42
J-60	0.00	102.80	136	47
J-61	0.30	101.51	136	48
J-90	0.00	102.07	136	48



GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis of the Brazeau Lands**
Client: **David Schaeffer Engineering Ltd.**
Date: **June 2020**
Created by: **BL**
Reviewed by: **WdS**

PHD Pressure Results - Phases 1&2

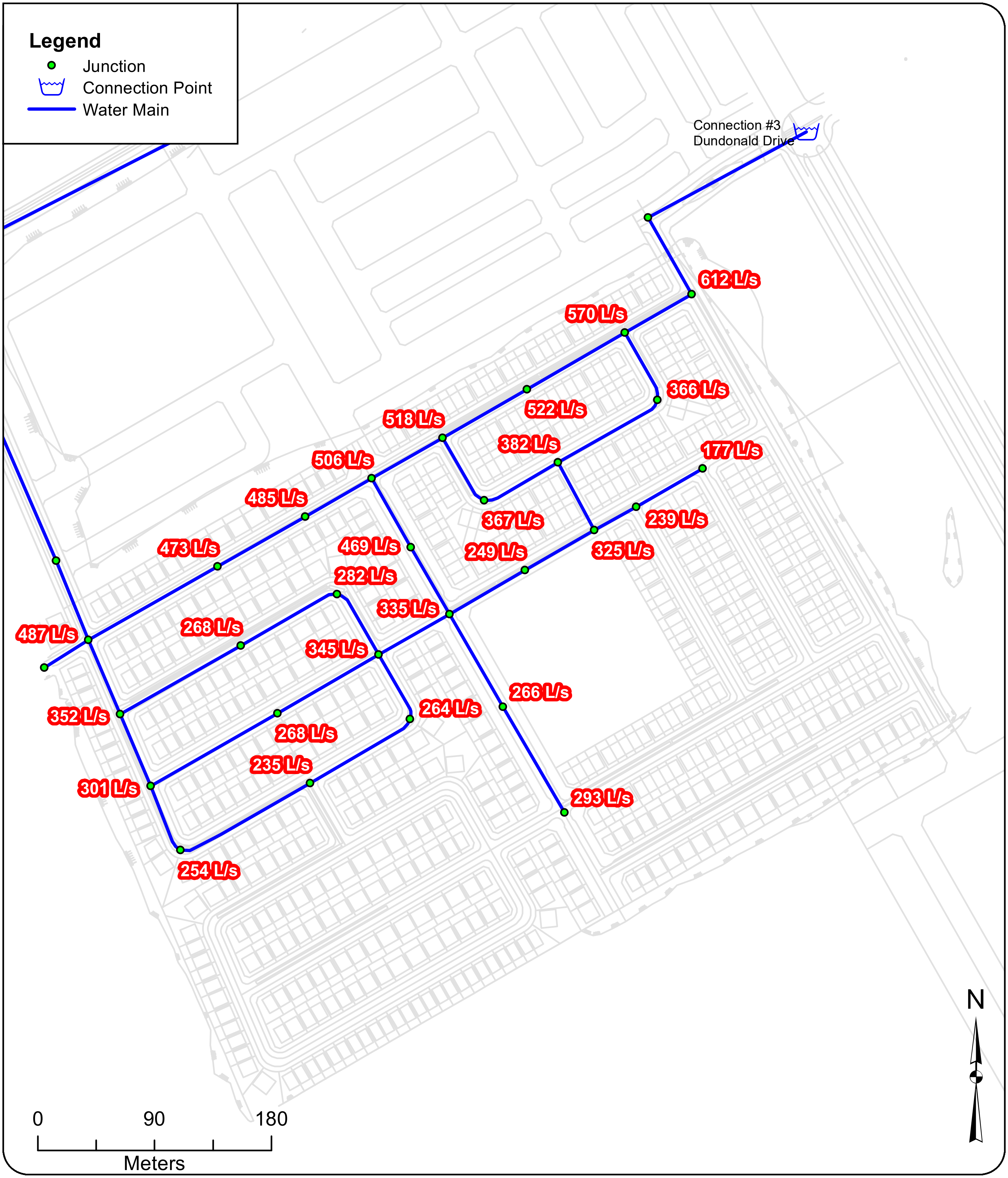
Figure E.4

Peak Hour Demand Modeling Results -Phases 1 and 2

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/km)
P-42	J-33	J-34	40.11	297	120	0.00	0.00	0.00	0.00
P-43	J-33	J-35	114.35	297	120	3.16	0.05	0.00	0.01
P-44	J-35	J-36	77.83	297	120	2.33	0.03	0.00	0.01
P-45	J-36	J-37	59.20	297	120	1.42	0.02	0.00	0.00
P-46	J-37	J-38	62.88	297	120	-8.04	0.12	0.00	0.07
P-47	J-38	J-39	74.92	297	120	-10.35	0.15	0.01	0.12
P-48	J-39	J-40	87.18	297	120	-11.49	0.17	0.01	0.14
P-49	J-40	J-41	59.39	297	120	-17.00	0.25	0.02	0.29
P-50	J-41	J-60	67.93	297	120	-33.05	0.48	0.07	1.01
P-51	J-60	CONNECTION_3	138.92	297	120	-33.05	0.48	0.14	1.01
P-52	J-40	J-42	58.39	204	110	4.72	0.14	0.01	0.20
P-53	J-42	J-43	83.72	204	110	3.82	0.12	0.01	0.14
P-54	J-43	J-44	72.67	204	110	-0.68	0.02	0.00	0.01
P-55	J-44	J-38	58.67	204	110	-1.52	0.05	0.00	0.02
P-56	J-45	J-46	59.20	204	110	2.27	0.07	0.00	0.05
P-57	J-46	J-90	81.24	204	110	-0.92	0.03	0.00	0.01
P-58	J-47	J-48	84.62	204	110	1.88	0.06	0.00	0.04
P-59	J-48	J-61	59.65	297	120	-8.86	0.13	0.01	0.09
P-60	J-61	J-37	60.99	297	120	-9.16	0.13	0.01	0.09
P-61	J-59	J-58	94.07	297	120	-4.98	0.07	0.00	0.03
P-62	J-58	J-48	82.47	297	120	-5.28	0.08	0.00	0.03
P-63	J-48	J-49	63.07	204	110	5.08	0.16	0.01	0.23
P-64	J-49	J-50	57.71	204	110	-0.22	0.01	0.00	0.00
P-65	J-50	J-51	84.62	204	110	-0.90	0.03	0.00	0.01
P-66	J-51	J-52	106.76	204	110	-1.89	0.06	0.00	0.04
P-67	J-33	J-52	62.05	204	110	6.57	0.20	0.02	0.37
P-68	J-52	J-53	60.20	204	110	3.54	0.11	0.01	0.12
P-69	J-53	J-54	112.78	204	110	-0.41	0.01	0.00	0.00
P-70	J-54	J-49	90.00	204	110	-1.48	0.05	0.00	0.02
P-71	J-49	J-57	56.32	204	110	3.06	0.09	0.01	0.09
P-72	J-57	J-56	92.28	204	110	2.38	0.07	0.01	0.06
P-73	J-53	J-55	55.27	204	110	2.82	0.09	0.00	0.08
P-74	J-55	J-56	113.38	204	110	1.76	0.05	0.00	0.03
P-111	J-90	J-47	61.51	204	110	2.55	0.08	0.00	0.06
P-112	J-43	J-90	59.19	204	110	3.47	0.11	0.01	0.11
P-75	J-56	J-62	58.69	204	110	3.08	0.09	0.01	0.09
P-76	J-62	J-63	119.4	204	110	2.11	0.06	0.01	0.05
P-77	J-63	J-64	56.35	204	110	1.05	0.03	0.00	0.01
P-78	J-64	J-65	58.6	204	110	0.97	0.03	0.00	0.01
P-79	J-65	J-66	100.76	204	110	-0.01	0.00	0.00	0.00
P-80	J-66	J-70	70.42	204	110	-1.15	0.04	0.00	0.01
P-81	J-70	J-71	55.7	204	110	-2.06	0.06	0.00	0.04
P-82	J-71	J-69	54.8	204	110	-2.67	0.08	0.00	0.07
P-83	J-64	J-67	125.85	204	110	-1.06	0.03	0.00	0.01
P-84	J-67	J-69	97.99	204	110	-2.27	0.07	0.01	0.05
P-85	J-62	J-68	92.12	204	110	-0.17	0.01	0.00	0.00
P-86	J-68	J-69	56.42	204	110	-0.93	0.03	0.00	0.01
P-87	J-69	J-59	63.46	204	110	-6.63	0.20	0.02	0.38
P-88	J-59	J-72	59.77	297	120	-2.83	0.04	0.00	0.01
P-89	J-72	J-73	28.67	297	120	0.00	0.00	0.00	0.00
P-90	J-72	J-74	96.85	297	120	-3.74	0.05	0.00	0.02
P-91	J-74	J-75	110.13	297	120	-5.03	0.07	0.00	0.03
P-92	J-75	J-76	78.16	297	120	-5.93	0.09	0.00	0.04
P-93	J-77	J-76	30.34	297	120	0.00	0.00	0.00	0.00
P-94	J-76	J-78	58.2	297	120	-6.39	0.09	0.00	0.05
P-95	J-78	J-79	59.97	204	110	2.36	0.07	0.00	0.06
P-96	J-79	J-80	59.39	204	110	2.34	0.07	0.00	0.05
P-97	J-80	J-81	85.15	204	110	2.34	0.07	0.00	0.05
P-98	J-81	J-59	79.25	204	110	0.78	0.02	0.00	0.01
P-99	J-80	J-82	51.74	204	110	-0.96	0.03	0.00	0.01
P-100	J-82	J-83	63.79	204	110	-1.63	0.05	0.00	0.03
P-101	J-83	J-46	60.03	204	110	-2.71	0.08	0.00	0.07
P-102	J-79	J-84	53.32	204	110	-0.94	0.03	0.00	0.01
P-103	J-84	J-85	55.04	204	110	-1.54	0.05	0.00	0.03
P-104	J-85	J-45	66.63	204	110	-2.62	0.08	0.00	0.07
P-105	J-78	J-86	72.81	297	120	-9.11	0.13	0.01	0.09
P-106	J-86	J-87	55.9	297	120	-9.53	0.14	0.01	0.10
P-107	J-87	J-88	48.49	297	120	-9.95	0.14	0.01	0.11
P-108	J-45	J-88	59.54	204	110	-5.25	0.16	0.01	0.24
P-109	J-88	J-89	55.04	297	120	-15.45	0.22	0.01	0.25
P-110	J-89	J-41	65.11	297	120	-15.87	0.23	0.02	0.26

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (psi)
J-33	0.99	101.29	135	49
J-34	0.00	101.41	135	48
J-35	0.83	101.33	135	49
J-36	0.91	101.25	135	49
J-37	0.30	101.64	135	48
J-38	0.78	101.46	135	48
J-39	1.15	101.83	135	48
J-40	0.78	101.96	135	48
J-41	0.18	102.65	135	47
J-42	0.90	101.87	135	48
J-43	1.02	101.72	135	48
J-44	0.84	101.59	135	48
J-45	0.36	103.27	135	46
J-46	0.48	102.38	135	47
J-47	0.66	101.77	135	48
J-48	0.38	101.83	135	48
J-49	0.76	101.74	135	48
J-50	0.68	101.40	135	48
J-51	0.99	101.41	135	48
J-52	1.14	101.35	135	48
J-53	1.14	102.22	135	47
J-54	1.06	101.87	135	48
J-55	1.06	102.52	135	47
J-56	1.06	103.00	135	46
J-57	0.68	102.46	135	47
J-58	0.30	102.95	135	46
J-59	1.96	105.68	135	42
J-60	0.00	102.80	136	47
J-61	0.30	101.51	135	48
J-90	0.00	102.07	135	47
J-62	1.14	104.21	135	44
J-63	1.06	106.39	135	41
J-64	1.14	106.74	135	41
J-65	0.98	107.17	135	40
J-66	1.14	107.78	135	39
J-67	1.21	106.62	135	41
J-68	0.76	106.00	135	42
J-69	0.76	107.07	135	40
J-70	0.91	108.43	135	38
J-71	0.61	108.62	135	38
J-72	0.91	107.85	135	39
J-73	0.00	108.47	135	38
J-74	1.29	107.68	135	39
J-75	0.91	108.00	135	39
J-76	0.45	108.27	135	39
J-77	0.00	108.93	135	38
J-78	0.36	106.17	135	42
J-79	0.96	105.57	135	42
J-80	0.96	105.54	135	43
J-81	1.56	105.54	135	42
J-82	0.66	104.30	135	44
J-83	1.08	103.10	135	46
J-84	0.60	104.73	135	44
J-85	1.08	103.68	135	45
J-86	0.42	105.81	135	42
J-87	0.42	105.51	135	43
J-88	0.24	104.78	135	44
J-89	0.42	103.69	135	45

Appendix F MDD+FF Model Results

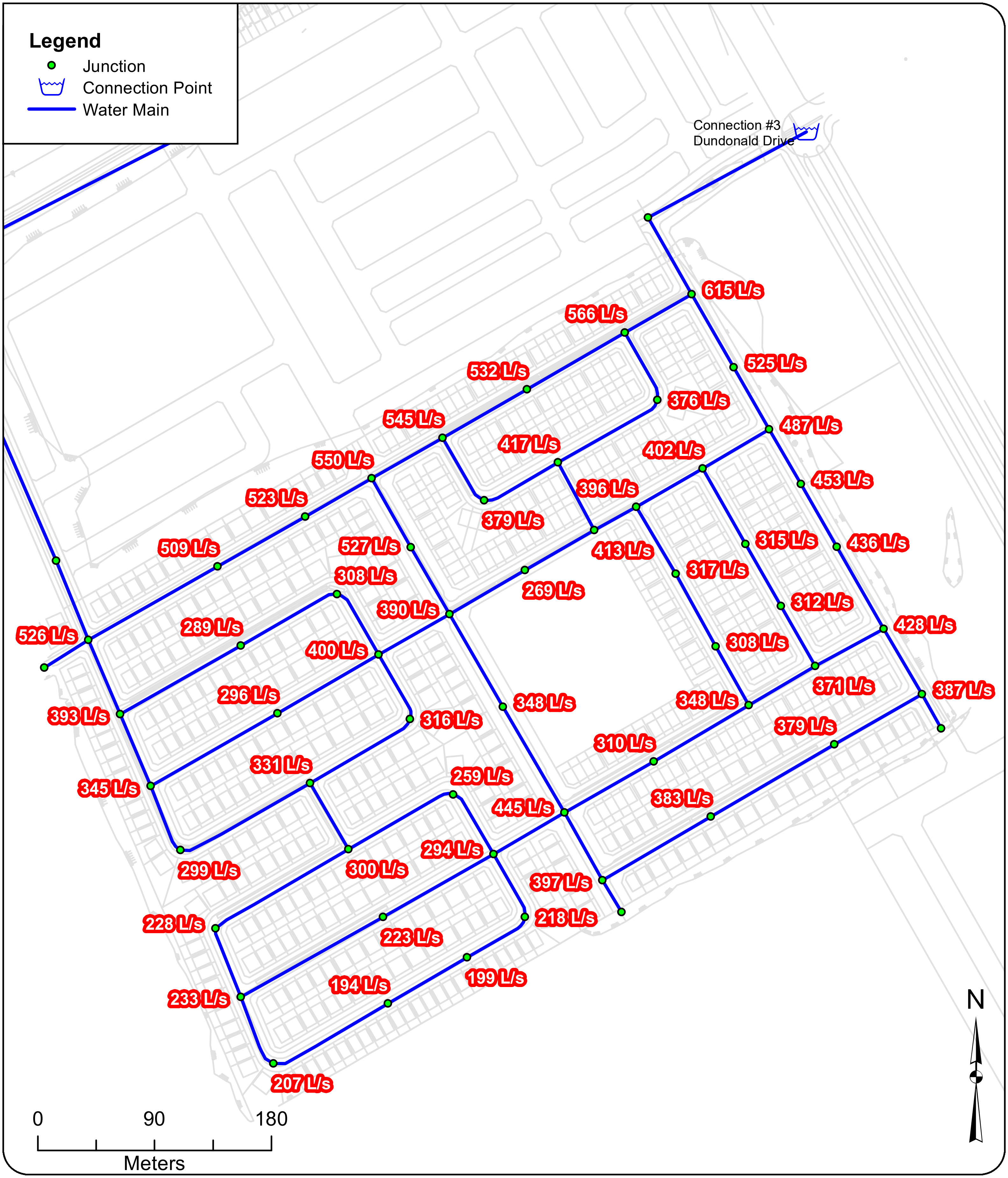


GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis of the Brazeau Lands**
Client: **David Schaeffer Engineering Ltd.**
Date: **June 2020**
Created by: **BL**
Reviewed by: **WdS**

Available Fire Flow @ 20 psi - Phase 1

Figure F.1



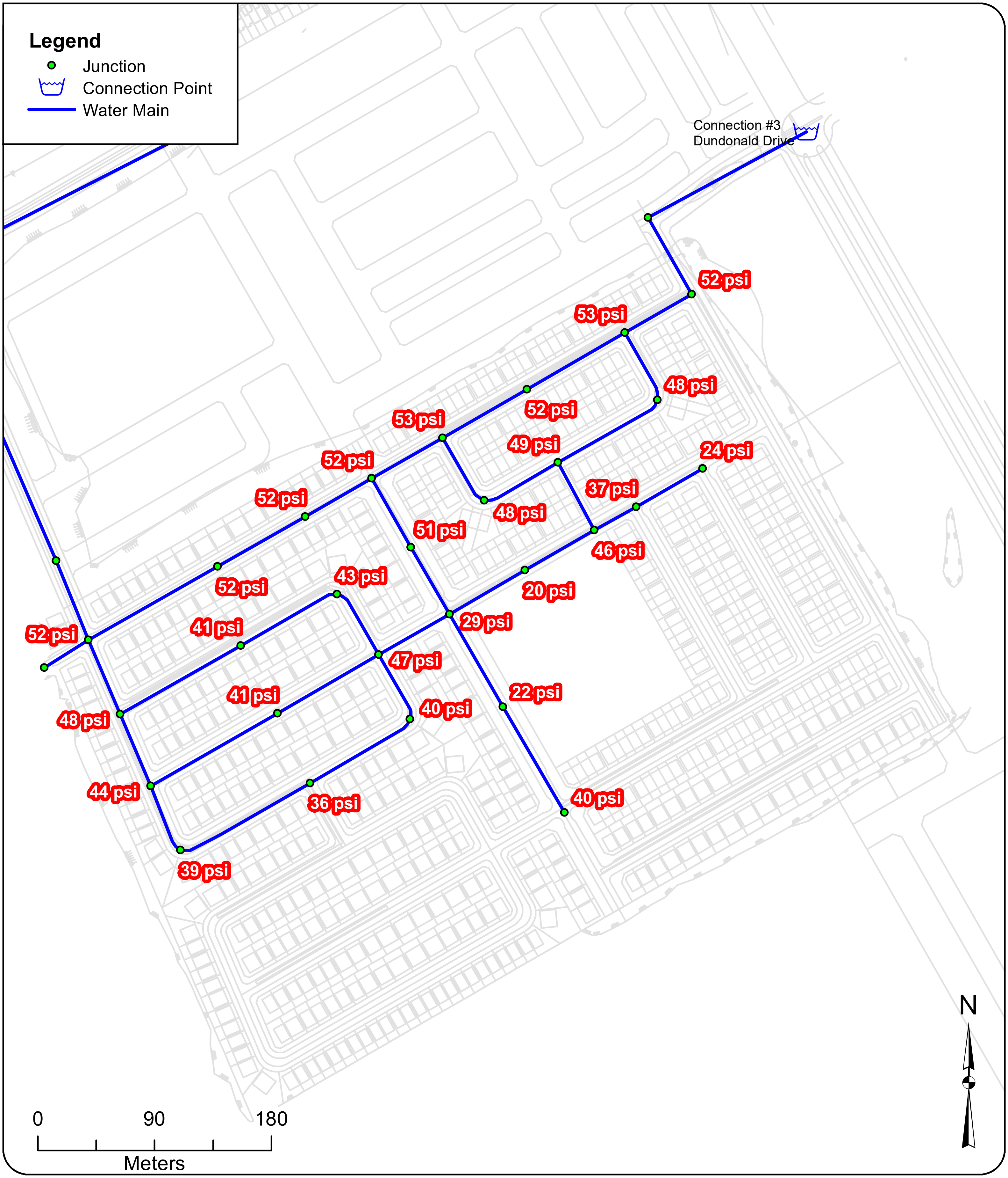
GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis of the Brazeau Lands**
Client: **David Schaeffer Engineering Ltd.**
Date: **June 2020**
Created by: **BL**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

Available Fire Flow @ 20 psi - Phases 1&2

Figure F.2



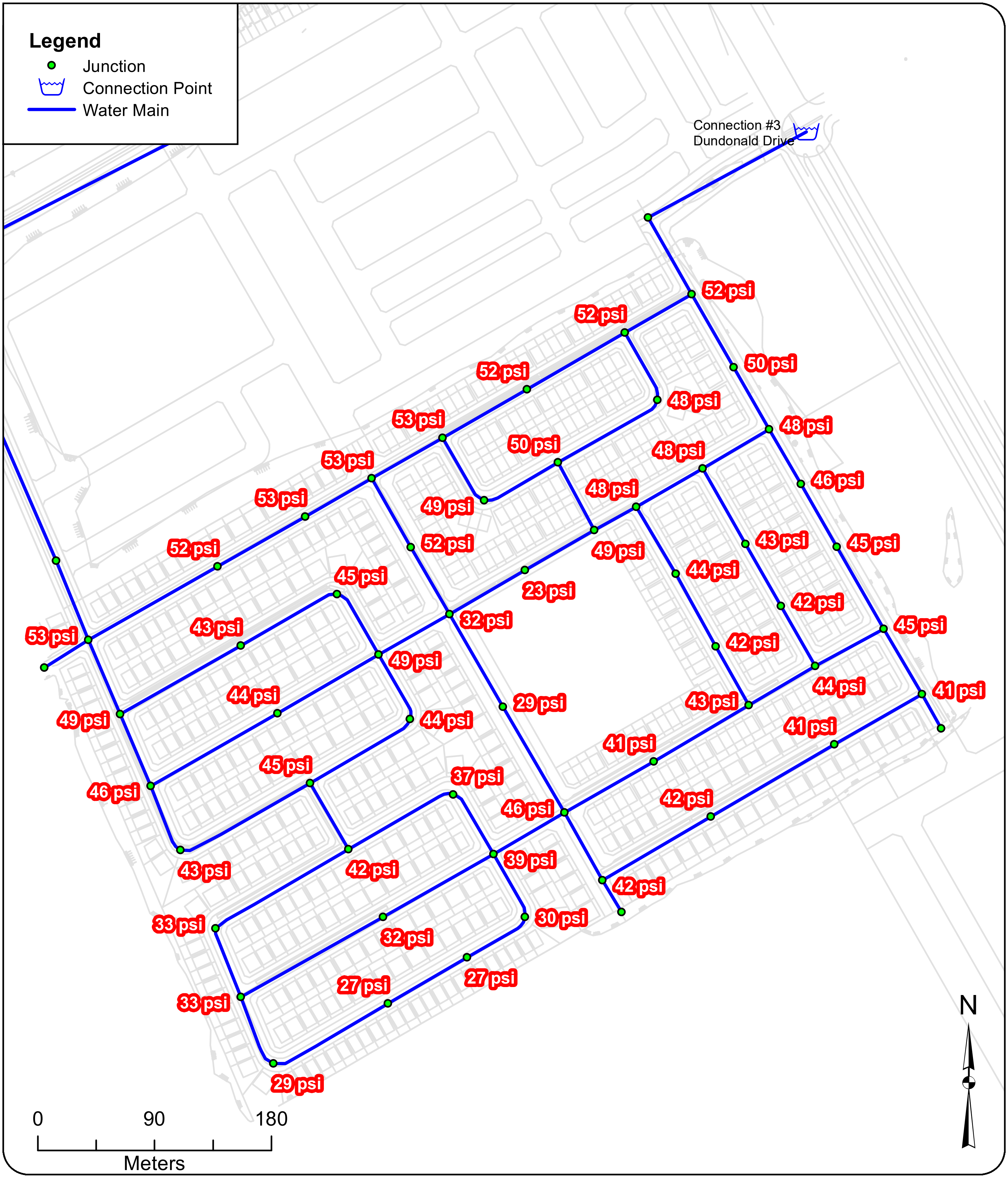
GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis of the Brazeau Lands**
Client: **David Schaeffer Engineering Ltd.**
Date: **June 2020**
Created by: **BL**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

Residual Pressure @ Required Fire Flow - Phase 1

Figure F.3



GeoAdvice Engineering Inc.

Project: **Hydraulic Capacity and Modeling Analysis of the Brazeau Lands**
Client: **David Schaeffer Engineering Ltd.**
Date: **June 2020**
Created by: **BL**
Reviewed by: **WdS**

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

Residual Pressure @ Required Fire Flow - Phases 1&2

Figure F.4

Fire Flow Modeling Results - Phase 1

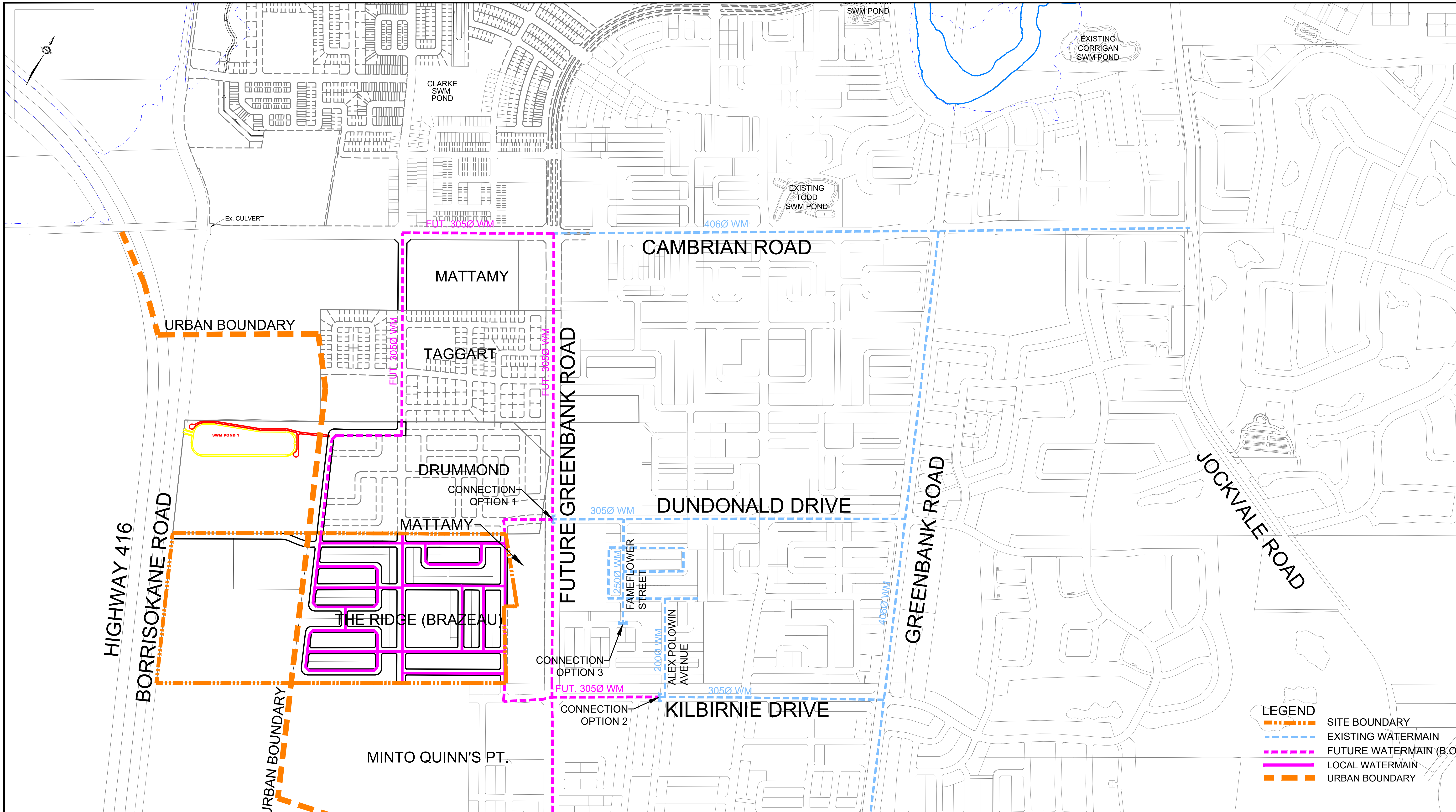
ID	Static Demand (L/s)	Fire-Flow Demand (L/s)	Residual Pressure (psi)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
J-33	0.45	167	52	487	20
J-35	0.38	167	52	473	20
J-36	0.41	167	52	485	20
J-37	0.14	167	52	506	20
J-38	0.36	167	53	518	20
J-39	0.52	167	52	522	20
J-40	0.36	167	53	570	20
J-41	0.08	167	52	612	20
J-42	0.41	167	48	366	20
J-43	0.47	167	49	382	20
J-44	0.38	167	48	367	20
J-45	0.16	167	24	177	20
J-46	0.22	167	37	239	20
J-49	0.34	167	47	345	20
J-50	0.31	167	43	282	20
J-51	0.45	167	41	268	20
J-52	0.52	167	48	352	20
J-53	0.52	167	44	301	20
J-54	0.48	167	41	268	20
J-55	0.48	167	39	254	20
J-56	0.48	167	36	235	20
J-57	0.31	167	40	264	20
J-59	1.04	167	40	293	20
J-61	0.14	167	51	469	20
J-90	0.00	167	46	325	20
J-47	0.30	250	20	249	20
J-48	0.17	250	29	335	20
J-58	0.14	250	22	266	20

Fire Flow Modeling Results - Phases 1 and 2

ID	Static Demand (L/s)	Fire-Flow Demand (L/s)	Residual Pressure (psi)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
J-33	0.45	167	53	526	20
J-35	0.38	167	52	509	20
J-36	0.41	167	53	523	20
J-37	0.14	167	53	550	20
J-38	0.36	167	53	545	20
J-39	0.52	167	52	532	20
J-40	0.36	167	52	566	20
J-41	0.08	167	52	615	20
J-42	0.41	167	48	376	20
J-43	0.47	167	50	417	20
J-44	0.38	167	49	379	20
J-45	0.16	167	48	402	20
J-46	0.22	167	48	396	20
J-49	0.34	167	49	400	20
J-50	0.31	167	45	308	20
J-51	0.45	167	43	289	20
J-52	0.52	167	49	393	20
J-53	0.52	167	46	345	20
J-54	0.48	167	44	296	20
J-55	0.48	167	43	299	20
J-56	0.48	167	45	331	20
J-57	0.31	167	44	316	20
J-59	1.04	167	46	445	20
J-61	0.14	167	52	527	20
J-62	0.52	167	42	300	20
J-63	0.48	167	33	228	20
J-64	0.52	167	33	233	20
J-65	0.45	167	29	207	20
J-66	0.52	167	27	194	20
J-67	0.55	167	32	223	20
J-68	0.34	167	37	259	20
J-69	0.34	167	39	294	20
J-70	0.41	167	27	199	20
J-71	0.28	167	30	218	20
J-72	0.41	167	42	397	20
J-74	0.58	167	42	383	20
J-75	0.41	167	41	379	20
J-76	0.21	167	41	387	20
J-78	0.16	167	45	428	20
J-79	0.44	167	44	371	20
J-80	0.44	167	43	349	20
J-81	0.71	167	41	310	20
J-82	0.30	167	42	308	20
J-83	0.49	167	44	317	20
J-84	0.27	167	42	312	20
J-85	0.49	167	43	315	20
J-86	0.19	167	45	436	20
J-87	0.19	167	46	453	20
J-88	0.11	167	48	487	20
J-89	0.19	167	50	525	20
J-90	0.00	167	49	413	20
J-47	0.30	250	23	269	20
J-48	0.17	250	32	390	20
J-58	0.14	250	29	348	20

Connection point 1: Existing watermain node off Haiku/ Obsidian street intersection fronting Block 1. (J-41)

Connection point 2: Existing watermain node on Obsidian street (J-86)



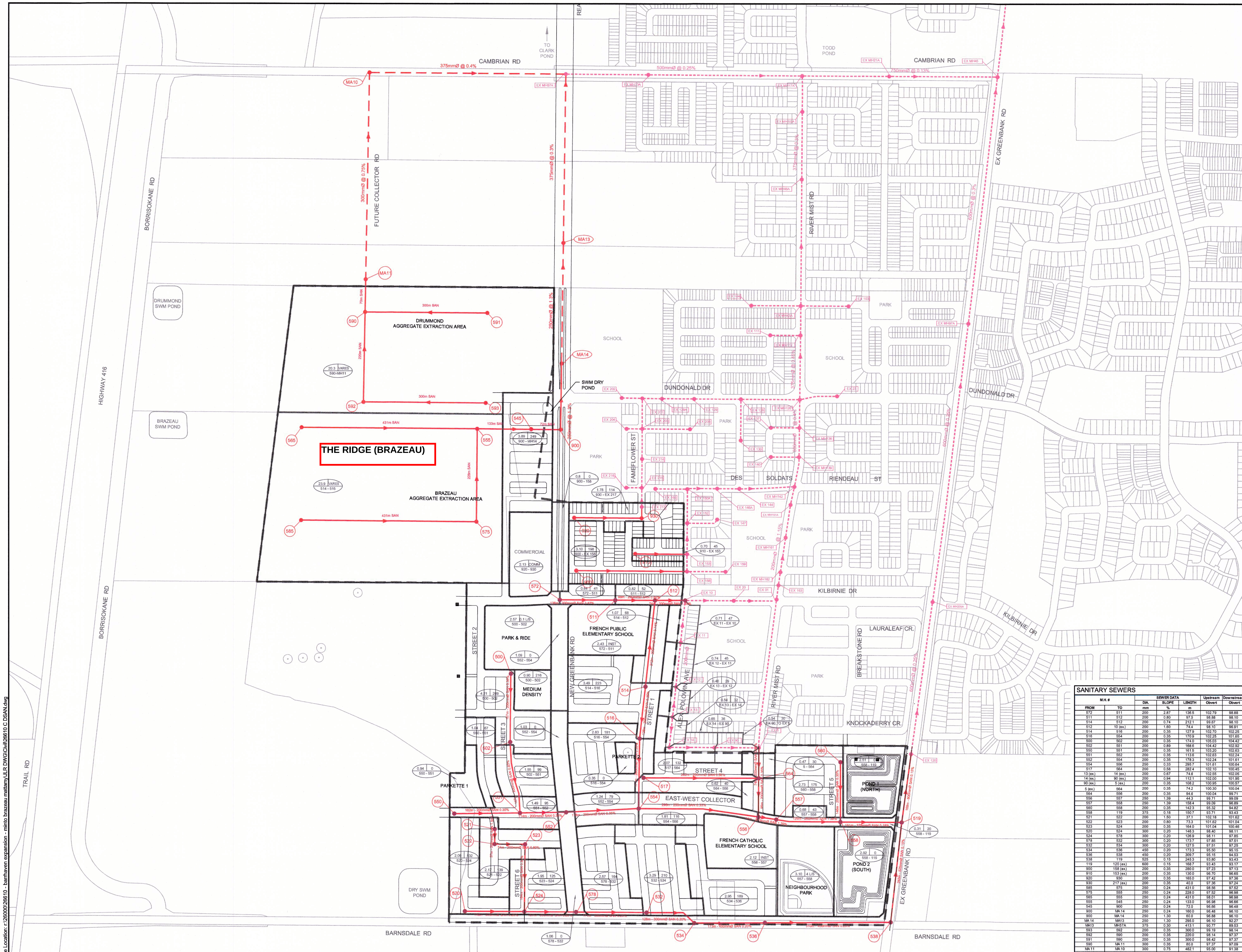
DSEL
david schaeffer engineering ltd

120 Iber Road, Unit 103
Stittsville, ON K2S 1E9
TEL: (613) 836-0856
FAX: (613) 836-7183
www.DSEL.ca

CAIVAN - BRAZEAU
WATERMAIN SERVICING PLAN
CITY OF OTTAWA

PROJECT No.:	18-1030
SCALE:	1:10,000
DATE:	APRIL 2020
FIGURE:	WAT-1

APPENDIX C



SANITARY SEWERS

M.H. #		SEWER DATA			Upstream	Downstream
		DIA.	SLOPE	LENGTH	Obvert	Obvert
FROM	TO	mm	%	m		
572	511	200	2.87	136.5	102.79	98.88
511	512	200	0.80	97.5	98.88	98.10
514	512	200	0.74	212.1	99.67	98.10
512	10 (ex.)	200	1.60	74.4	98.10	96.91
514	516	200	0.35	127.9	102.70	102.25
516	554	200	0.35	170.9	102.25	101.65
500	502	200	0.35	174.0	105.03	104.42
502	551	200	0.89	168.6	104.42	102.92
550	551	200	0.35	161.5	103.20	102.63
551	552	200	0.35	113.6	102.63	102.24
552	554	200	0.35	178.3	102.24	101.61
554	556	250	0.33	295.7	101.61	100.64
517	564	200	0.58	282.4	102.10	100.45
13 (ex.)	14 (ex.)	200	0.67	74.6	102.55	102.05
14 (ex.)	90 (ex.)	200	0.94	112.1	102.00	101.95
90 (ex.)	5 (ex.)	200	0.35	108.2	100.95	100.57
5 (ex.)	564	200	0.35	74.2	100.30	100.04
564	556	200	0.35	94.6	100.04	99.71
556	557	250	1.39	44.3	99.71	99.09
557	558	250	1.39	158.4	99.09	96.89
560	558	200	0.35	142.3	95.32	94.82
558	119	375	0.18	150.7	93.71	93.43
521	522	200	1.50	37.1	102.18	101.62
522	523	200	0.80	73.3	101.62	101.04
523	524	200	0.35	164.0	101.04	100.46
520	524	300	0.20	146.3	98.40	98.11
524	578	300	0.20	126.9	98.11	97.85
578	532	300	0.20	173.7	97.85	97.51
532	534	300	0.20	127.5	97.51	97.25
534	536	450	0.20	173.3	95.50	95.15
536	538	450	0.20	309.7	95.15	94.53
538	119	525	0.15	245.3	93.80	93.43
119	120 (ex.)	600	0.15	168.7	93.43	93.17
900	158 (ex.)	200	0.35	280.0	97.23	97.13
910	153 (ex.)	200	0.35	130.0	96.70	96.65
920	930	200	0.35	165.0	97.42	97.36
930	217 (ex.)	200	0.35	40.0	97.36	97.24
585	575	250	0.24	431.0	98.56	97.52
575	555	250	0.24	228.0	97.52	96.98
565	555	250	0.24	431.0	98.01	96.98
555	545	250	0.24	133.0	96.98	96.66
545	900	250	0.24	72.0	96.66	96.48
900	MA 14	250	0.24	160.0	96.48	96.10
900	MA 14	250	1.30	60.0	96.88	96.10
MA 14	MA13	250	1.30	295.0	96.10	92.27
MA13	MH57A	375	0.30	413.1	90.77	89.53
593	592	200	0.35	300.0	99.19	98.14
592	590	200	0.35	220.0	98.14	97.37
591	590	200	0.35	300.0	98.42	97.37
590	MA 11	300	0.35	80.0	97.37	97.09
MA 11	MA 10	300	0.75	482.1	95.00	91.38
MA 10	MH57A	375	0.41	449.7	91.38	89.53

LEGEND

PROPOSED SANITARY, PER 2018 BSUEA MSS
FUTURE SANITARY, PER 2014 BS MSS
EXISTING SANITARY
DRAINAGE BOUNDARY
LIMIT OF STUDY AREA FOR BSUEA
AREA IN HECTARES
POPULATION
PIPE REACH UPSTREAM MAINTENANCE HOLE TO DOWNSTREAM MAINTENANCE HOLE
0.23 | 5
41-32

COMM	COMMERCIAL
INST	INSTITUTIONAL
VARIES	SEE DESIGN SHEET FOR CONTRIBUTING FLOWS

No.	ISSUE / REVISION	DD/MM/YY
4	ISSUED FOR PLANNING COMMITTEE APPROVAL	04/05/18
3	ADDRESS COMMENTS, RE-ISSUE BSUEA MSS 2ND SUBMISSION	26/02/18
2	ISSUED AS PART OF DRAFT MSS	20/09/17
1	ISSUED FOR PRE-TAC WORKING MEETING	31/08/17

VERIFY SHEET SIZE AND SCALES. BAR TO THE RIGHT IS 25mm IF THIS IS A FULL SIZE DRAWING. 0 25mm

SCALE: 1:4000

CLIENT:

CONSULTANT: www.jlrichards.ca

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

CONSULTANT:

PROFESSIONAL STAMP: LICENSED PROFESSIONAL ENGINEER — M. N. L. DALRYMPLE — May 4/18 — PROVINCE OF ONTARIO

PROJECT NORTH

PROJECT:

BARRHAVEN SOUTH URBAN EXPANSION AREA (BSUEA)

DRAWING:

MASTER SANITARY DRAINAGE AREA

DESIGN: JW
DRAWN: CJM
CHECKED: LD
JLR #: 26610
DRAWING #: MSAN

File Location: r:\26000\26610 - barrhaven expansion - minto brazeau mattamy\JLR DWG\Civil\26610 C DSAN.dwg

PLOT DATE: May 3, 2018 4:34:47 PM

was assumed to have 4 washbasins that deliver 375 L/d and four (4) water closets that generate 150 L/hr for 10 hr/day resulting in a total flow of 7500 L/day.

Table 6-3: Land Use and Theoretical Wastewater Flows

Land Use	Flow Rate	Area (ha)	Units	Pop.	Average Flow (L/S)	Peak Factor	Infiltration	Total Flows (L/s)
Minto and Mattamy Lands								
Schools	28,000 L/ha/d	4.55			1.50	1.5	1.50	3.8
Park Block	4 L/s	4.39			4.0	1	1.45	5.5
Commercial	28,000 L/ha/d	2.13			0.70	1.5	0.70	1.8
Low-Medium density Residential	280 l/c/d	35.26	1080	3378	11.0	2.92	11.64	43.6
High Density Residential	280 l/c/d	0.90	120	216	0.7	3.51	0.30	2.8
Roads	-	27.00				1	8.91	8.9
Park and Ride		2.57			0.1	1	0.85	1.0
Total		**76.8**	**1200**	**3594**	**17.95**		**25.35**	**67.4**
Brazeau Aggregate Extraction Area								
Schools	28,000 L/ha/d	1.47			0.48	1.5	0.49	1.2
Commercial	28,000 L/ha/d	0.67			0.22	1.5	0.22	0.6
Low-Medium Density Residential	280 l/c/d	10.27	360	1126	3.65	3.21	3.39	15.1
High Density Residential	280 l/c/d	0.28	38	68	0.22	3.63	0.09	0.9
Roads	-	7.95				1	2.62	2.6
Park Block	-	1.48				1	0.49	0.5
Pond Blocks	-	1.78				1	0.59	0.6
Total		**23.9**		**1194**	**4.57**		**7.89**	**21.5**
Drummond Aggregate Extraction Area								
Schools	28,000 L/ha/d	1.25			0.41	1.5	0.41	1.0
Commercial	28,000 L/ha/d	0.57			0.18	1.5	0.19	0.5
Low-Medium Density Residential	280 l/c/d	8.72	288	900	2.92	3.26	2.88	12.4
High Density Residential	280 l/c/d	0.24	32	58	0.19	3.64	0.08	0.8
Roads	-	6.75				1	2.23	2.2

Land Use	**Flow Rate**	**Area (ha)**	**Units**	**Pop.**	**Average Flow (L/S)**	**Peak Factor**	**Infiltration**	**Total Flows (L/s)**
Park Blocks	-	1.26				1	0.42	0.4
Pond Blocks	-	1.51				1	0.50	0.5
Total		**20.3**		**958**	**3.70**		**6.71**	**17.8**
Barrhaven South Urban Expansion Area Totals								
Total		**121.0**		**5746**	**26.22**		**40.0**	**106.7**

Based on the land uses presented on the Demonstration Plan (Figure 4-2), the BSUEA would generate a peak wastewater flow of approximately 106.7 L/s.

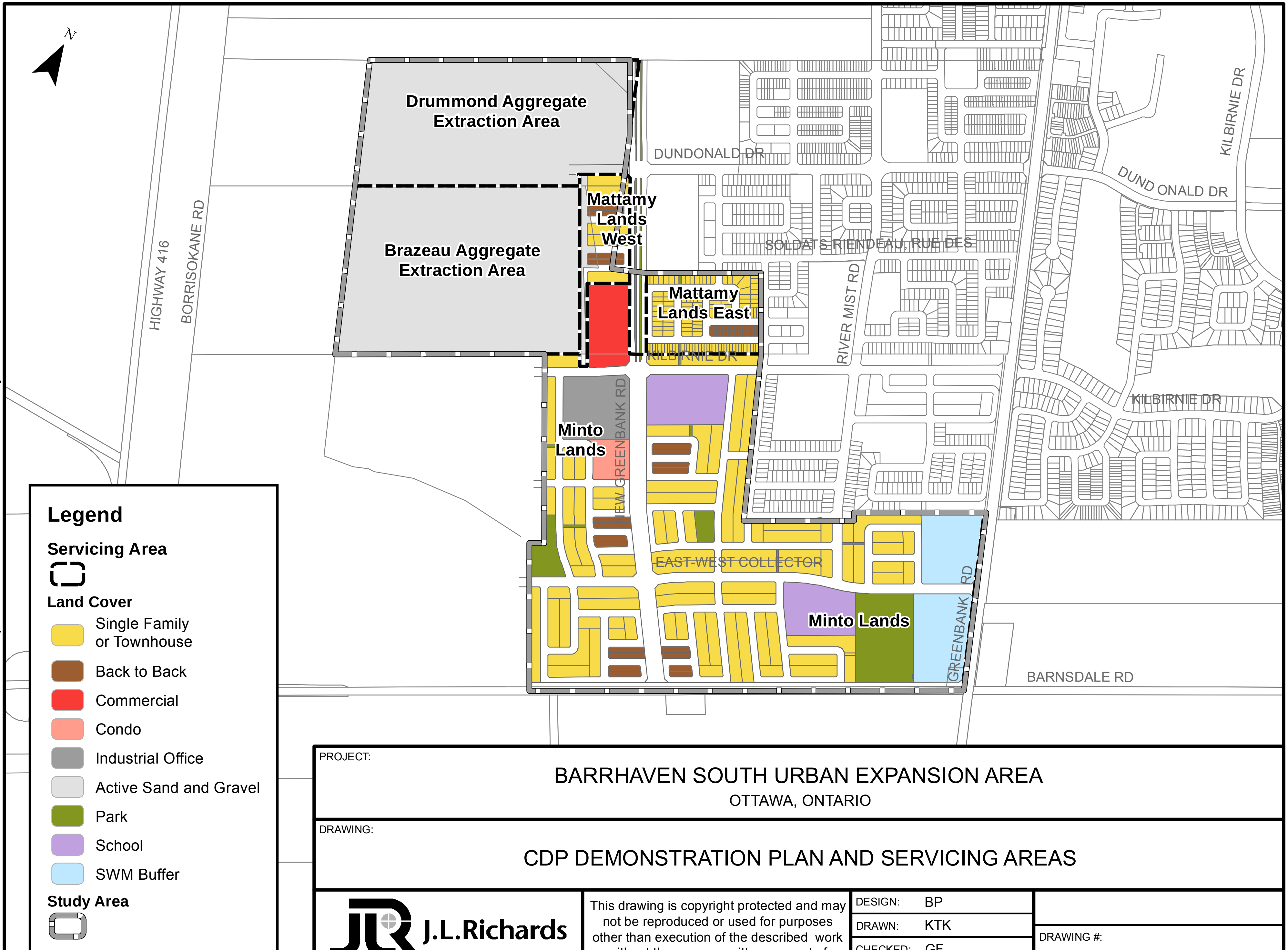
6.3 Wastewater Collection System Strategy

6.3.1 Proposed Sewer System Layout and Sizing

A trunk sanitary sewer system layout was developed based on the ROW corridors identified on the BSUEA Demonstration Plan for the purposes of demonstrating the feasibility of providing wastewater servicing for the BSUEA lands, refer to the Key Servicing Plans. Proposed trunk sanitary sewers were sized based on the aforementioned design criteria and the drainage areas depicted on the Master Sanitary Drainage Area Drawing MSAN, refer to the BSUEA Sanitary Sewer Design Sheet (Appendix J) for detailed calculations. Final configuration and sizing of the wastewater collection system will be confirmed at detailed design of each subdivision stage. At such time, refinements may be implemented.

The proposed BSUEA trunk sanitary sewers will discharge to existing/planned sanitary sewers at the following six (6) locations, as shown on Figure 6-2:

1. The Future Collector Road
2. New Greenbank Road
3. Flameflower Street
4. Alex Polowin Avenue
5. Kilbirnie Drive
6. Greenbank Road



PROJECT:

BARRHAVEN SOUTH URBAN EXPANSION AREA

OTTAWA, ONTARIO

DRAWING:

CDP DEMONSTRATION PLAN AND SERVICING AREAS

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS
www.jlrichards.ca

DESIGN:	BP
DRAWN:	KTK
CHECKED:	GF
JLR #:	26610

DRAWING #:

FIGURE 4-2

File Location: R:\26000\26610 - Barrhaven Expansion - Minto Brazeau Mattamy\JLR DWG\GIS\26610 C CDP.mxd

Plot Date: April 30, 2018 3:27:45 PM

It is noted that the residual capacity in the River Mist Road trunk sanitary sewer has in fact increased with the addition of the BSUEA peak flows. This is the result of adding a relatively small tributary area while reducing the average daily residential flow from 350 L/cap to 280 L/cap combined with diverting some existing drainage areas, located in Quinn's Pointe, away from the outlet.

Table 6-4: Residual Capacity Comparison in the BSC Trunk Sanitary Sewers

Existing Trunk Sanitary Sewer	Limiting Pipe reach	Current Minimum Residual Capacity	Proposed BSUEA Tributary Lands	Proposed BSUEA Tributary Area	Revised Minimum Residual Capacity with inclusion of BSUEA Peak Flow
Cambrian Road	MH 13A to MH15A	51.4 L/s	Drummond, Brazeau, Mattamy West (Residential only)	48 ha	52.9 L/s
River Mist Road	MH 102A to MH 17A	14.4 L/s	Mattamy East, Mattamy West (Commercial only), Northwest corner of Minto	12 ha	30.5 L/s
River Mist Road	MH 1 to MH 163	5.58 L/s	Minto	5 ha	4.63 L/s
Greenbank Road	MH 45 to MH 435A	295.4 L/s	Minto	60 ha	283.2 L/s

With the addition of the BSUEA lands, a total theoretical peak wastewater flow of 403.7 L/s was calculated at the most downstream maintenance hole in the BSC (MH 501A on Greenbank Road), as indicated in the Sanitary Sewer Design Sheet in Appendix J. This calculated theoretical peak flow is less than the 590 L/s allocated for all of the BSC in Stantec's City-wide 2013 Wastewater Collection System Assessment. In this assessment, Stantec created a hydrodynamic model of trunk sanitary sewers (450 mm in diameter and greater) which demonstrated that the existing downstream trunk system could accommodate the theoretical flow of 590 L/s generated by the BSC with no risk of surcharging or basement flooding. Consequently, Stantec concluded that system upgrades were not required to accommodate the anticipated growth in the BSC. Since the Stantec assessment considered a peak flow that was 186 L/s greater than that calculated for the BSC and the BSUEA combined, it is understood that the existing trunk sanitary sewers located downstream of the BSC can accommodate the additional flows generated by the BSUEA.

BARRHAVEN SOUTH URBAN EXPANSION (BSUEA)

BSUEA SANITARY SEWER DESIGN SHEET

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS

CITY OF OTTAWA
MINTO COMMUNITIES INC.
JLR NO. 26610

Designed by: A.T
Checked by: H.M
Date : February 2018

DESIGN PARAMETERS

Single Family	3.4	pers/unit	q =	280	L/cap/day
Semi-Detached/Townhouse (row)	2.7	pers/unit	I =	0.330	L/s/ha
Apt Units	1.8	pers/unit	Inst. =	28000	L/ha/day
Manning's Coeff. N =	0.013		ICI Peaking Factor* =	1.0/1.5	

*ICI Peaking Factor = 1.5 if ICI in contributing area is >20%, 1.0 if ICI in contributing area is <20%

STREET	M.H. # FROM	M.H. # TO	RESIDENTIAL: NUMBER OF UNITS SING.	MULT.	APT.	AREA ha	POPUL. peop.	CUMULATIVE POPUL. peop.	CUMULATIVE AREA ha	PEAKING FACTOR	POPUL. FLOW l/s	COMMERCIAL AREA ha	CUMM. AREA ha	INST. FLOW l/s	INSTITUTIONAL AREA ha	CUMM. AREA ha	INST. FLOW l/s	(Infiltration) PEAK EXTR. FLOW l/s	PLUG FLOW l/s	PEAK DES. FLOW l/s	SEWER DATA DIA. mm	SLOPE %	CAPAC. l/s	VEL. m/s	LENGTH m	RESIDUAL CAP. l/s	UPSTREAM Center Line	Obvert	Invert	Cover	DOWNSTREAM Center Line	Obvert	Invert	Cover	ICI Peaking Factor ICI/ TOTAL	P.F
MINTO LANDS WITHIN BSUEA (OUTLETS TO RIVER MIST.)																																				
Kilbirnie Dr.	572	511		10		0.64	27	27	0.64	3.69	0.32		0.00	0.00	2.43	2.43	1.18	1.01		2.52	200	2.87	57.9	1.79	136.50	55.40	107.40	102.79	102.59	4.61	103.50	98.88	98.68	4.62	0.79	1.50
Kilbirnie Dr.	511	512		27		0.82	73	100	1.46	3.59	1.16	0.00	0.00	0.00	0.00	2.43	0.79	1.28		3.24	200	0.80	30.6	0.94	97.52	27.37	103.50	98.88	98.68	4.62	103.40	98.10	97.90	5.30	0.00	1.00
Street 1	514	512	21			1.07	71	71	1.07	3.62	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.35		1.19	200	0.74	29.4	0.91	212.06	28.24	105.60	99.67	99.47	5.93	103.40	98.10	97.90	5.30	0.00	1.00
Kilbirnie Dr.	512	10 (ex.)					0	171	2.53	3.54	1.96	0.00	0.00	0.00	0.00	2.43	0.79	1.64		4.39	200	1.60	43.3	1.33	74.41	38.89	103.40	98.10	97.90	5.30	101.18	96.91	96.71	4.27	0.00	1.00
MINTO LANDS WITHIN BSUEA (OUTLETS TO EXISTING GREENBANK)																																				
Street 1	514	516	14	104		3.49	328	328	3.49	3.45	3.67		0.00	0.00		0.00	0.00	1.15		4.82	200	0.35	20.2	0.62	127.86	15.42	105.60	102.70	102.50	2.90	105.40	102.25	102.05	3.15	0.00	1.00
Street 1	516	554	20	54		3.18	214	542	6.67	3.36	5.91		0.00	0.00		0.00	0.00	2.20		8.11	200	0.35	20.2	0.62	170.90	12.13	105.40	102.25	102.05	3.15	105.20	101.65	101.45	3.55	0.00	1.00
Street 3	500	502	25	70	115	7.16	481	481	7.16	3.39	5.28		0.00	0.00		0.00	0.00	2.36	0.10	7.74	200	0.35	20.2	0.62	174.02	12.50	108.10	105.03	104.827	3.07	107.90	104.42	104.218	3.48	0.00	1.00
Street 3	502	551	8	44		1.55	146	627	8.71	3.34	6.78		0.00	0.00		0.00	0.00	2.87		9.76	200	0.89	32.3	1.00	168.60	22.52	107.90	104.42	104.218	3.48	105.90	102.92	102.717	2.98	0.00	1.00
East-West Collector	550	551	20			1.98	68	68	1.98	3.63	0.80		0.00	0.00		0.00	0.00	0.65		1.45	200	0.35	20.2	0.62	161.54	18.79	105.50	103.20	103.00	2.30	105.90	102.63	102.43	3.27	0.00	1.00
East-West Collector	551	552	22			1.49	75	770	12.18	3.30	8.23		0.00	0.00		0.00	0.00	4.02		12.34	200	0.35	20.2	0.62	113.56	7.90	105.90	102.63	102.43	3.27	106.15	102.24	102.03	3.91	0.00	1.00
East-West Collector	552	554	12	20		3.36	95	865	15.54	3.27	9.17		0.00	0.00		0.00	0.00	5.13		14.40	200	0.35	20.2	0.62	178.26	5.84	106.15	102.24	102.03	3.91	105.20	101.61	101.41	3.59	0.00	1.00
East-West Collector	554	556	11	34		1.81	129	1536	24.02	3.14	15.62		0.00	0.00		0.00	0.00	7.93		23.65	250	0.33	35.6	0.70	295.67	11.99	105.20	101.61	101.36	3.59	103.55	100.64	100.38	2.91	0.00	1.00
Street 4	517	564	20	35		2.07	163	163	2.07	3.54	1.87		0.00	0.00		0.00	0.00	0.68		2.55	200	0.58	26.2	0.81	282.43	23.60	105.30	102.10	101.90	3.20	103.65	100.45	100.25	3.20	0.00	1.00
Alex Polowin Ave.	13 (ex.)	14 (ex.)	12			0.54	41	41	0.54	3.67	0.49		0.00	0.00		0.00	0.00	0.18		0.67	200	0.67	28.0	0.86	74.56	27.34	105.00	102.55	102.35	2.45	105.52	102.05	101.85	3.47	0.00	1.00
Alex Polowin Ave.	14 (ex.)	90 (ex.)	13			0.65	44	85	1.19	3.61	0.99		0.00	0.00		0.00	0.00	0.39		1.39	200	0.94	33.2	1.02	112.06	31.79	105.00	102.00	101.80	3.00	103.96	101.95	101.75	2.01	0.00	1.00
Russet Terrace	90 (ex.)	5 (ex.)	6			0.54	20	105	1.73	3.59	1.22		0.00	0.00		0.00	0.00	0.57		1.79	200	0.35	20.2	0.62	108.16	18.45	103.93	100.95	100.75	2.98	103.80	100.57	100.37	3.23	0.00	1.00
River Mist Rd.	5 (ex.)	564	8			0.47	27	132	2.20	3.57	1.53		0.00	0.00		0.00	0.00	0.73		2.25	200	0.35	20.2	0.62	74.22	17.99	103.90	100.30	100.10	3.60	103.80	100.04	99.84	3.76	0.00	1.00
River Mist Rd.	564	556	7	9		0.64	48	343	4.91	3.44	3.83		0.00	0.00		0.00	0.00	1.62		5.55	200	0.35	20.2	0.62	94.59	14.70	103.65	100.04	99.84	3.61	103.55	99.71	99.51	3.84	0.00	1.00
East-West Collector	556	557					0	1879	28.93	3.09	18.79		0.00	0.00	2.20	2.20	0.71	10.27		29.87	250	1.39	73.1	1.44	44.25	43.27	103.55	99.71	99.46	3.84	102.78	99.09	98.84	3.69	0.07	1.00
East-West Collector	557	558	6			1.12	20	1899	30.05	3.08	18.97		0.00	0.00	2.86	5.06	1.64	11.59	4.00	36.30	250	1.39	73.1	1.44	158.35	36.85	102.78	99.09	98.84	3.69	99.90	96.89	96.64	3.01	0.09	1.00
Street 5	560	558	50			3.09	170	170	3.09	3.54	1.95		0.00	0.00		0.00	0.00	1.02		2.97	200	0.35	20.2	0.62	142.27	17.27	98.80	95.32	95.12	3.48	99.90	94.82	94.62	5.08	0.00	1.00
East-West Collector	558	119				5.74	0	2069	38.88	3.06	20.51		0.00	0.00		5.06	1.64	14.50		40.75	375	0.18	77.6	0.68	150.71	36.85	99.90	93.71	93.32	6.20	99.55	93.43	93.05	6.12	0.00	1.00
Street 6	521	522	24	33		2.17	171	171	2.17	3.54	1.96		0.00	0.00		0.00	0.00	0.72		2.68	200	1.50	41.9	1.29	37.09	39.23	105.18	102.18	101.98	3.00	104.50	101.62	101.42	2.88	0.00	1.00
	522	523					0	171	2.17	3.54	1.96		0.00	0.00		0.00	0.00	0.72		2.68	200	0.80	30.6	0.94	73.27	27.93	104.50	101.62	101.42	2.88	105.11	101.04	100.83	4.07	0.00	1.00
	523	524		71		1.95	192	363	4.12	3.43	4.04		0.00	0.00		0.00	0.00	1.36		5.40	200	0.35	20.2	0.62	164.00	14.84	105.11	101.04	100.83	4.07	103.50	100.46	100.26	3.04	0.00	1.00
Adjacent to Barnsdale Rd	520	524	41			2.06	139	139	2.06	3.56	1.60		0.00	0.00		0.00	0.00	0.68		2.28	300	0.20	45.1	0.62	146.25	42.83	102.80	98.40	98.10	4.40	103.50	98.11	97.80	5.39	0.00	1.00
Adjacent to Barnsdale Rd	524	578					0	502	6.18	3.38	5.50		0.00	0.00		0.00	0.00	2.04		7.54	300	0.20	45.1	0.62	126.92	37.58	103.50	98.11	97.80	5.39	104.92	97.85	97.55	7.07	0.00	1.00
Adjacent to Barnsdale Rd	578	532		87		3.63	235	737	9.81	3.31	7.89		0.00	0.00		0.00	0.00	3.24		11.13	300	0.20	45.1	0.62	173.72	33.98	104.92	97.85	97.55	7.07	103.80	97.51	97.20	6.29	0.00	1.00
Adjacent to Barnsdale Rd	532	534	50	26		3.29	240	977	13.10	3.25	10.27		0.00	0.00		0.00	0.00	4.32		14.60	300	0.20	45.1	0.62	127.45	30.52	103.80	97.51	97.20	6.29	103.00	97.25	96.95	5.75	0.00	1.00
Adjacent to Barnsdale Rd	534	536	55			2.96	187	1164	16.06	3.21	12.09		0.00	0.00		0.00	0.00	5.30		17.39	450	0.20	133.0	0.81	173.27	115.63	103.00	95.50	95.04	7.50	101.56	95.15	94.70	6.41	0.00	1.00
Easement (Barnsdale to E-W Collector)	536	538					0	1164	16.06	3.21	12.09		0.00	0.00		0.00	0.00	5.30		17.39	450	0.20	133.0	0.81	309.73	115.63	101.56	95.15	94.70	6.41	99.75	94.53	94.08	5.22	0.00	1.00
	538	119					0	1164	16.06	3.21	12.09		0.00	0.00		0.00	0.00	5.30		17.39	525	0.15	173.8	0.78	245.34	156.37	99.75	93.80	93.26	5.95	99.55	93.43	92.89	6.12	0.00	1.00
Ex. Greenbank Rd.	119	120 (ex.)					0	3233	54.94	2.93	30.72		0.00	0.00		5.06	1.64	19.80		56.26	600	0.15	248.1	0.85	168.66	191.83	99.55	93.43	92.82	6.12		93.17	92.57		0.00	1.00
																					600	0.25														
MATTAMY LANDS EAST OUTLETS TO DUNDONALD DR. & DES SOLDATS																																				
	900	158 (ex.)	31	51		3.10	243	243	3.10	3.49	2.75	0.00	0.00	0.00		0.00	0.00	1.02		3.77	200	0.35	20.2	0.62	280.00	16.47	106.62	97.23	97.02	9.39	101.03	97.13	97.13	3.90	0.00	1.00
	910	153 (ex.)		28		0.71	76	76	0.71	3.62	0.89	0.00	0.00	0.00		0.00	0.00	0.23		1.12	200	0.35	20.2	0.62	130.00	19.12	104.00	96.70	96.49	7.30	100.35	96.65	96.65	3.70	0.00	1.00
	920	930	36			1.81	122	122	1.81	3.57	1.42	2.13	2.13	1.04		0.00	0.00	1.30		3.75	200	0.35	20.2	0.62	165.00	16.49	106.07	97.42	97.21	8.65	101.70	97.36	97.16	4.34	0.54	1.50
	930	217 (ex.)						122	1.81	3.57	1.42	0.00	2.13	1.04		0.00	0.00	1.30		3.75	200	0.35	20.2	0.62	40.00	16.49	101.70	97.36	97.16	4.34	101.70	97.24	97.04	4.46	0.54	1.50
BRAZEAU AGGREGATE EXTRACTION AREA OUTLETS TO NEW GREENBANK ROAD*																																				
	585	575	178	236	37	21.77	1309	1309	21.77	3.18	13.48	0.68	0.68	0.22	1.45	1.45	0.47	7.89		22.06	250	0.24	30.4	0.60	431.00	8.34		98.56	98.30			97.52	97.27		0.09	1.00
	575	555					0	1309	21.77		0.00		0.68	0.22		1.45	0.47	7.89		8.58	250	0.24	30.4	0.60	228.00	21.82		97.52	97.27			96.98	96.72		0.03	1.00
	565	555					0	0	0.00		0.00		0.00	0.00		0.00	0.00	0.00		0.00	250	0.24	30.4	0.60	431.00	30.39		98.01	97.76			96.98	96.72		0.00	1.00
	555	545					0	1309	21.77		0.00		0.68	0.22		1.45	0.47	7.89		8.58	250	0.24	30.4	0.60	133.00	21.82		96.98	96.72			96.66	96.40		0.03	1.00
	545	900					0	1309	21.77		0.00		0.68	0.22		1.45	0.47	7.89		8.58	250	0.24	30.4	0.60	72.00	21.82	104.31	96.66	96.40	7.65	103.00	96.48	96.23	6.52	0.03	1.00
	900	MA 14																			250	0.24	30.4	0.60	160.00	30.39		96.48	96.23			96.10	95.85			
MATTAMY LANDS WEST OUTLETS TO NEW GREENBANK RD																																				
Realigned Greenbank Rd.	900	MA 14	8	102		3.89	303	1612	25.66	3.13	16.32	0.00	0.68	0.22	0.00	1.45	0.47	9.17		26.18	250	1.30	70.7	1.40	60.00	44.55	104.31	96.88	96.63	7.43	103.00	96.10	95.85	6.90	0.03	1.00
	MA 14	MA13				0.00	0	1612	25.66	3.13	16.32	0.00	0.68	0.22	0.00	1.45	0.47	9.17		26.18	250	1.30	70.7	1.40	295.00	44.50	103.00	96.10	95.85	6.90	95.20	92.27	92.02	2.93	0.03	1.00
	MA13	MH57A						1612	25.66	3.13	16.32		0.68	0.22		1.45	0.47	9.17		26.18	375	0.30	100.2	0.88	413.10	74.00	92.27	90.77	90.39	1.50	93.60	89.53	89.15	4.07	0.03	1.00
DRUMMOND AGGREGATE EXTRACTION AREA OUTLETS TO PROPOSED COLLECTOR RD.*												1																								
	593	592																			200	0.35	20.2	0.62	300.00	20.24		99.19	98.99			98.14	97.94			1.00
	592	590																			200	0.35	20.2	0.62	220.00	20.24		98.14	97.94			97.37	97.17			1.00
	591	590																			200	0.35	20.2	0.62	300.00	20.24		98.42	98.22			97.37	97.17			1.00
	590	MA 11	151	226	31	18.48	1179	1179	18.48	3.20	12.24	0.58	0.58	0.19	0.40	0.40	0.13	6.42		18.98	300	0.35	59.7	0.82	80.00	40.70		97.37	97.07		100.00	97.09	96.79	2.91	0.05	1.00
	MA 11	MA 10					0	1179	18.48	3.20	12.24		0.58	0.19		0.40		6.42		18.85	300	0.75	87.4	1.20	482.10	68.52	100.00	95.00	94.69	5.00	93.50	91.38	91.08	2.12	0.03	1.00
	MA 10	MH57A					0	1179	18.48	3.20	12.24		0.58	0.19		0.40		6.42		18.85	375	0.41	117.3	1.03	449.70	98.47	93.50	91.38	91.00	2.12	93.60	89.53	89.15	4.07		1.00
							0																													

*ONLY FLOW CONTRIBUTIONS FROM BSUEA ARE SHOWN, FOR SANITARY FLOWS FROM OTHER CONTRIBUTING AREAS TRIBUTARY TO CAMBRIAN ROAD, SEE OVERALL SANITARY SPREADSHEET

BARRHAVEN SOUTH URBAN EXPANSION AREA (BSUEA)

CITY OF OTTAWA
MINTO COMMUNITIES INC.

JLR NO. 26610

BARRHAVEN SOUTH SANITARY SEWER DESIGN SHEET

Designed by: AT
Checked by:HM

			PROPOSED AND BSUEA DESIGN PARAMETERS		
Single Family	3.4	pers/unit	q =	280	L/cap/day
Semi-Detached/Townhouse (row)	2.7	pers/unit	I =	0.330	L/s/ha
Apt Units	1.8	pers/unit	Inst./Comm. =	28000	L/ha/day
Manning's Coeff. N =	0.013		Commerial PF*=	1.0/1.5	

*1.5 if ICI in contributing area is >20%, 1.0 if ICI in contributing area is <20%

Sources:	
	Half Moon Bay South Subdivision - Phase 4 - Excluding Arterials- Sanitary sewer design sheet prepared by Stantec (2015)
	Quinn's Pointe - Excluding Arterials-Sanitary sewer design sheet prepared by J.L Richards (2015)
	Barrhaven South Master Servicing Study Addendum - Sanitary sewer design sheet prepared Stantec (2014)

Legend

	Proposed
	Proposed by Others
	Existing

TOTAL PEAK FLOW TO MH57A = 112.80 L/s
(USING CUMULATIVE AREAS,
POPULATIONS AND PEAK FACTORS)

Date: February 2018

				RESIDENTIAL									COMMERCIAL			INSTITUTIONAL			GREEN/UNUSED												
STREET	SOURCE	M.H. #		NUMBER OF UNITS			AREA	POPULATION	CUMULATIVE		PEAKING FACTOR	POPUL.		CUMM.	INST.		CUMM.	INST.		CUMM.	PEAK EXTR.	PLUG	PEAK DES.	SEWER DATA					RESIDUAL		ICI*
		FROM	TO	SING.	MULT.	APT.	TOTAL ha	TOTAL peop.	POPUL. peop.	AREA ha		FLOW l/s	AREA ha	AREA ha	FLOW l/s	AREA ha	AREA ha	FLOW l/s	AREA ha	AREA ha	FLOW l/s	FLOW l/s	FLOW l/s	DIA. mm	SLOPE %	CAPAC. l/s	VEL. m/s	LENGTH m	CAP. l/s	ICI/ TOTAL	Peaking Factor
CAMBRIAN ROAD OUTLET VIA FUTURE REALIGNED GREENBANK AND FUTURE COLLECTOR																															
Drummond Aggregate Extraction Area		545	MA11	151	226	31.00	18.48	1179	1179	18.48	3.20	12.24	0.58	0.58	0.19	1.23	1.23	0.40		0.00	6.70		19.5	300	0.75	87.4	1.20	300.00	67.85	0.09	1.00
Future Collector Road	Stantec (2014)	MA11	MA10				14.23	1523	2702	32.71	2.98	26.13		0.58	0.19	2.80	4.03	1.31	2.50	2.50	13.14		40.77	300	0.75	87.4	1.20	482.10	46.60	0.12	1.00
Cambrian Rd.	Stantec (2014)	MA10	MH57A				12.81	1371	4073	45.52	2.86	37.76		0.58	0.19	7.22	11.25	3.65	14.49	16.99	24.53		66.13	375	0.40	115.7	1.01	449.70	49.55	0.16	1.00
Brazeau Aggregate Extraction Area + Mattamy Lands		900	MA14	186	368	37.00	25.66	1693	1693	25.66	3.11	17.08	0.68	0.68	0.22	1.45	1.45	0.47		0.00	9.17		26.9	250	1.30	70.7	1.40	350.00	43.80	0.08	1.00
New Greenbank Road	Stantec (2014)	MA14	MA13				4.79	513	2206	30.45	3.04	21.75		0.68	0.33	7.45	8.90	4.33		0.00	13.21		39.61	250	1.30	70.7	1.40	295.00	31.12	0.24	1.50
New Greenbank Road	Stantec (2014)	MA13	MH57A				10.99	1176	3382	41.44	2.92	31.98		0.68	0.22		8.90	2.88	0.53	0.53	17.01		52.10	375	0.30	100.2	0.88	413.10	48.09	0.19	1.00
Cambrian Road	Stantec	MH57A	MH13A				4.29	458	7913	91.25	2.64	67.80	3.44	4.70	1.52	0.00	20.15	6.53		17.52	44.09		119.95	500	0.25	197.0	0.97	216.50	77.01	0.19	1.00
Cambrian Road	Stantec	MH13A	MH15A				6.21	634	8547	97.46	2.62	72.51		4.70	1.52	0.00	20.15	6.53		17.52	46.14		126.70	500	0.20	176.2	0.87	165.20	49.46	0.18	1.00
Cambrian Road	Stantec	MH15A	MH17A				5.61	870	9417	103.07	2.58	78.87		4.70	1.52	0.00	20.15	6.53		17.52	48.00		134.92	600	0.13	231.0	0.79	202.00	96.04	0.17	1.00
QUINN'S POINTE OUTLET TO MH163 RIVER MIST RD.							103.07	9417																							
Kilbirnie Drive		572	511		10		0.64	27	27	0.64	3.69	0.32		0.00	0.00	2.43	2.43	1.18		0.00	1.01		2.52	200	2.87	57.9	1.79	136.50	55.38	0.79	1.50
Kilbirnie Drive		511	512		27		0.82	73	100	1.46	3.59	1.17		0.00	0.00		2.43	1.18		0.00	1.28		3.63	200	0.80	30.6	0.94	97.50	26.97	0.62	1.50
Future Collector Road		514	512	21			1.07	71	71	1.07	3.63	0.83		0.00	0.00		0.00	0.00		0.00	0.35		1.19	200	0.74	29.4	0.91	212.10	28.25	0.00	1.00
Kilbirnie Drive		512	EX10				0.00	0	171	2.53	3.54	1.96		0.00	0.00		2.43	1.18		0.00	1.64		4.78	200	1.60	43.3	1.33	74.00	38.50	0.49	1.50
River Mist Road		EX5	EX4	12			0.55	41	41	0.55	3.67	0.49		0.00	0.00		0.00	0.00		0.00	0.18		0.67	200	0.33	19.8	0.61	74.90	19.10	0.00	1.00
Boddington Street		EX101	EX100	14			0.72	48	48	0.72	3.65	0.57		0.00	0.00		0.00	0.00		0.00	0.24		0.81	200	0.98	33.8	1.04	90.13	33.00	0.00	1.00
Boddington Street		EX100	EX4	8			0.44	27	75	1.16	3.62	0.88		0.00	0.00		0.00	0.00		0.00	0.38		1.26	200	0.91	32.6	1.01	91.40	31.34	0.00	1.00
River Mist Road		EX4	EX3	12			0.53	41	157	2.24	3.55	1.81		0.00	0.00		0.00	0.00		0.00	0.74		2.54	200	0.32	19.4	0.60	74.95	16.82	0.00	1.00
Clonfadda Terrace		EX111	EX110	13			0.62	44	44	0.62	3.66	0.52		0.00	0.00		0.00	0.00		0.00	0.20		0.73	200	1.04	34.8	1.07	76.25	34.10	0.00	1.00
Clonfadda Terrace		EX110	EX3	15			0.64	51	95	1.26	3.60	1.11		0.00	0.00		0.00	0.00		0.00	0.42		1.52	200	0.83	31.2	0.96	108.32	29.67	0.00	1.00
River Mist Road		EX3	EX2	3			0.32	10	262	3.82	3.48	2.96		0.00	0.00		0.00	0.00		0.00	1.26		4.22	200	0.35	20.2	0.62	100.22	16.00	0.00	1.00
River Mist Road		EX2	EX1		14		0.55	38	300	4.37	3.46	3.37		0.00	0.00		0.00	0.00		0.00	1.44		4.81	200	1.77	45.5	1.40	112.11	40.65	0.00	1.00
Alex Polowin Avenue		EX13	EX12	11			0.46	37	37	0.46	3.67	0.44		0.00	0.00		0.00	0.00		0.00	0.15		0.59	200	1.01	34.4	1.06	74.36	33.77	0.00	1.00
Alex Polowin Avenue		EX12	EX11	24			0.74	82	119	1.20	3.58	1.38		0.00	0.00		0.00	0.00		0.00	0.40		1.78	200	2.14	50.1	1.54	107.77	48.32	0.00	1.00
Alex Polowin Avenue		EX11	EX10	17			0.71	58	177	1.91	3.53	2.03		0.00	0.00		0.00	0.00		0.00	0.63		2.66	200	1.65	44.0	1.36	103.97	41.35	0.00	1.00
Kilbirnie Drive		EX10	EX20		14		0.57	38	386	5.01	3.42	4.28		0.00	0.00		2.43	1.18		0.00	2.46		7.92	200	0.32	19.3	0.60	118.98	11.42	0.33	1.50
Block 251 (School)		Stub	EX20				0.00	0	0	0.00	3.80	0.00		0.00	0.00	2.83	2.83	1.38		0.00	0.93		2.31	200	0.32	19.3	0.60	11.00	16.99	1.00	1.50
Kilbirnie Drive		EX20	EX1		15		0.54	41	427	5.55	3.41	4.71		0.00	0.00		5.26	2.56		0.00	3.57		10.84	200	0.32	19.4	0.60	106.01	8.52	0.49	1.50
River Mist Road		EX1	MH163				0.08	0	727	10.00	3.31	7.79		0.00	0.00		5.26	2.56		0.00	5.04		15.39	200	0.32	19.3	0.60	39.41	3.96	0.34	1.50
MH163 TO MH17A RIVERMIST ROAD OUTLETS VIA CAMBRIAN ROAD							10.00	727																							
River Mist Road	Stantec (2015)	MH163	EX162				0.08	0	727	10.08	3.31	7.79		0.00	0.00		5.26	2.56		0.00	5.06		15.41	250	0.85	57.2	1.13	36.30	41.78	0.34	1.50
River Mist Road		EX162	EX161				0.20	0	727	10.28	3.31	7.79		0.00	0.00		5.26	2.56		0.00	5.13		15.48	250	1.15	66.5	1.31	44.40	51.05	0.34	1.50
River Mist Road		EX161A	EX161				0.00	0	0	0.00	3.80	0.00		0.00	0.00		0.00	0.00	0.91	0.91	0.30		0.30	150	1.00	15.9	0.87	14.00	15.59	0.00	1.00
River Mist Road		EX161	151				0.19	0	727	10.47	3.31	7.79		0.00	0.00		5.26	2.56		0.91	5.49		15.84	250	1.15	66.5	1.31	57.70	50.69	0.32	1.50
River Mist Road		EX151A	151				0.00	0	0	0.00	3.80	0.00		0.00	0.00	2.77	2.77	1.35		0.00	0.91		2.26	150	1.00	15.9	0.87	12.70	13.63	1.00	1.50
River Mist Road		151	EX151				0.09	0	727	10.56	3.31	7.79		0.00	0.00		8.03	3.90		0.91	6.44		18.13	300	1.40	119.4	1.64	17.90	101.23	0.41	1.50
River Mist Road		EX151	MH142				0.00	0	727	10.56	3.31	7.79		0.00	0.00		8.03	3.90		0.91	6.44		18.13	300	1.40	119.4	1.64	44.40	101.23	0.41	1.50
Buffalograss Cres.	Stantec (2015)	EX159	EX158		24		0.56	65	65	0.56	3.63	0.77		0.00	0.00		0.00	0.00		0.00	0.18		0.95	200	0.40	21.6	0.67	95.50	20.69	0.00	1.00
Mattamy Lands East		900	EX158	31	51		3.10	243	243	3.10	3.49	2.75		0.00	0.00		0.00	0.00		0.00	1.02		3.77	200	0.35	20.2	0.62	280.00	16.46	0.00	1.00
Alex Polowin ave.		EX158	EX153	0	0		0.13	0	308	3.79	3.46	3.45		0.00	0.00		0.00	0.00		0.00	1.25		4.70	200	0.40	21.6	0.67	45.00	16.94	0.00	1.00
Mattamy Lands East		910	EX153		28		0.71	76	76	0.71	3.62	0.89		0.00	0.00		0.00	0.00		0.00	0.23		1.13	200	0.35	20.2	0.62	130.00	19.12	0.00	1.00
Alex Polowin ave.		EX153	EX152				0.12	0	384	4.62	3.42	4.26		0.00	0.00		0.00	0.00		0.00	1.52		5.79	200	0.80	30.6	0.94	70.00	24.82	0.00	1.00
Alex Polowin ave.		EX152	EX150				0.00	0	384	4.62	3.42	4.26		0.00	0.00		0.00	0.00		0.00	1.52		5.79	200	0.80	30.6	0.94	85.70	24.82	0.00	1.00
Rue Des Soldats Riendeau St.		EX165	EX150	17			0.67	58	58	0.67	3.64	0.68		0.00	0.00		0.00	0.00		0.00	0.22		0.91	200	1.50	41.9	1.29	101.20	41.00	0.00	1.00
Rue Des Soldats Riendeau St.	Stantec (2015)	EX150	EX146	6			0.30	20	462	5.59	3.39	5.08		0.00	0.00		0.00	0.00		0.00	1.84		6.93	200	0.80	30.6	0.94	72.00	23.68	0.00	1.00

BARRHAVEN SOUTH URBAN EXPANSION AREA (BSUEA)

CITY OF OTTAWA
MINTO COMMUNITIES INC.
JLR NO. 26610

BARRHAVEN SOUTH SANITARY SEWER DESIGN SHEET

Designed by: AT
Checked by:HM

PROPOSED AND BSUEA DESIGN PARAMETERS

Single Family	3.4	pers/unit	q =	280	L/cap/day
Semi-Detached/Townhouse (row)	2.7	pers/unit	I =	0.330	L/s/ha
Apt Units	1.8	pers/unit	Inst./Comm. =	28000	L/ha/day
Manning's Coeff. N =	0.013		Commerial PF*=	1.0/1.5	

*1.5 if ICI in contributing area is >20%, 1.0 if ICI in contributing area is <20%

Sources:
- Half Moon Bay South Subdivision - Phase 4 - Excluding Arterials- Sanitary sewer design sheet prepared by Stantec (2015)
- Quinn's Pointe - Excluding Arterials-Sanitary sewer design sheet prepared by J.L Richards (2015)
- Barrhaven South Master Servicing Study Addendum - Sanitary sewer design sheet prepared Stantec (2014)

Legend
- Proposed
- Proposed by Others
- Existing

Date: February 2018

STREET	SOURCE	M.H. # FROM	M.H. # TO	RESIDENTIAL: NUMBER OF UNITS SING.	MULT.	APT.	AREA TOTAL ha	POPULATION TOTAL peop.	CUMULATIVE POPUL. peop.	CUMULATIVE AREA ha	PEAKING FACTOR	POPUL. FLOW l/s	COMMERCIAL: AREA ha	CUMM. AREA ha	INST. FLOW l/s	INSTITUTIONAL: AREA ha	CUMM. AREA ha	INST. FLOW l/s	GREEN/UNUSED: AREA ha	CUMM. AREA ha	PEAK EXTR. FLOW l/s	PLUG FLOW l/s	PEAK DES. FLOW l/s	SEWER DATA: DIA. mm	SLOPE %	CAPAC. l/s	VEL. m/s	LENGTH m	RESIDUAL CAP. l/s	ICI/ TOTAL	ICI* Peaking Factor
Remora Way		EX147	EX146	20			0.94	68	68	0.94	3.63	0.80		0.00	0.00		0.00	0.00		0.00	0.31		1.11	200	1.00	34.2	1.06	78.20	33.11	0.00	1.00
Rue Des Soldats Riendeau St.		EX146	EX145	2			0.08	7	537	6.61	3.37	5.86		0.00	0.00		0.00	0.00		0.00	2.18		8.04	200	0.50	24.2	0.75	19.30	16.15	0.00	1.00
Rue Des Soldats Riendeau St.		EX145	EX144				0.07	0	537	6.68	3.37	5.86		0.00	0.00		0.00	0.00		0.00	2.20		8.06	200	0.50	24.2	0.75	35.90	16.13	0.00	1.00
Rue Des Soldats Riendeau St.		EX144	EX143	9			0.54	31	568	7.22	3.36	6.18		0.00	0.00		0.00	0.00		0.00	2.38		8.56	200	0.50	24.2	0.75	114.90	15.63	0.00	1.00
Rue Des Soldats Riendeau St.		EX143	MH142				0.00	0	568	7.22	3.36	6.18		0.00	0.00		0.00	0.00		0.00	2.38		8.56	200	0.40	21.6	0.67	21.50	13.08	0.00	1.00
River Mist Road		MH142	EX139	3			0.26	10	1305	18.04	3.18	13.44		0.00	0.00		8.03	3.90		0.91	8.90		26.25	300	0.40	63.8	0.87	74.80	37.56	0.30	1.50
		EX140	EX139	7			0.40	24	24	0.40	3.70	0.29		0.00	0.00		0.00	0.00		0.00	0.13		0.42	200	0.65	27.6	0.85	67.70	27.17	0.00	1.00
River Mist Road		EX139	EX136	10			0.47	34	1363	18.91	3.17	13.99		0.00	0.00		8.03	3.90		0.91	9.19		27.08	300	0.41	64.6	0.89	64.70	37.51	0.29	1.50
		EX137	EX136	15			0.84	51	51	0.84	3.65	0.60		0.00	0.00		0.00	0.00		0.00	0.28		0.88	200	0.65	27.6	0.85	67.80	26.71	0.00	1.00
River Mist Road		EX136	MH126	4			0.29	14	1428	20.04	3.16	14.60		0.00	0.00		8.03	3.90		0.91	9.56		28.07	300	0.41	64.6	0.89	78.90	36.52	0.28	1.50
Mattamy Lands East		920	930	36			1.83	122	122	1.83	3.58	1.41	2.13	2.13	1.04		0.00	0.00		0.00	1.31		3.76	200	0.35	20.2	0.62	165.00	15.50	0.54	1.50
Mattamy Lands East		930	EX217					0	122	1.83	3.58	1.41		2.13	1.04		0.00	0.00		0.00	1.31		3.76	200	0.36	20.5	0.63	40.00	15.50	0.54	1.50
Flameflower St.		EX217	EX215				0.05	0	122	1.88	3.58	1.41		2.13	1.04		0.00	0.00		0.00	1.32		3.77	200	2.00	48.4	1.49	34.50	44.62	0.53	1.50
Flameflower St.	Stantec (2015)	EX216	EX215		5		0.19	14	14	0.19	3.72	0.17		0.00	0.00		0.00	0.00		0.00	0.06		0.23	200	0.65	27.6	0.85	45.20	27.35	0.00	1.00
Flameflower St.		EX215	EX214		15		0.34	41	177	2.41	3.53	2.03		2.13	1.04		0.00	0.00		0.00	1.50		4.56	200	2.00	48.4	1.49	72.00	43.83	0.47	1.50
Flameflower St.		EX214	EX203		15		0.35	41	218	2.76	3.51	2.48		2.13	1.04		0.00	0.00		0.00	1.61		5.13	200	2.00	48.4	1.49	73.50	43.26	0.44	1.50
Devario Cres.		EX204	EX203				0.54	62	62	0.54	3.64	0.73		0.00	0.00		0.00	0.00	3.10	3.10	1.20		1.93	200	1.50	41.9	1.29	36.50	39.97	0.00	1.00
Devario Cres.		EX208	EX203				2.50	187	187	2.50	3.53	2.14		0.00	0.00		0.00	0.00		0.00	0.83		2.96	200	0.40	21.6	0.67	120.00	18.68	0.00	1.00
Flameflower St.		EX203	EX201				0.12	0	467	5.92	3.39	5.13		2.13	0.69		0.00	0.00		3.10	3.68		9.50	200	0.40	21.6	0.67	73.70	12.14	0.19	1.00
Dundonald Dr.		EX202	EX201	4			0.53	14	14	0.53	3.72	0.17		0.00	0.00		0.00	0.00		0.00	0.17		0.34	200	3.25	61.7	1.90	50.00	61.34	0.00	1.00
Dundonald Dr.		EX201	EX129A	3			0.21	10	491	6.66	3.38	5.38		2.13	0.69		0.00	0.00		3.10	3.92		10.00	200	0.40	21.6	0.67	47.80	11.64	0.18	1.00
Dundonald Dr.		EX129A	EX129	18			0.75	61	552	7.41	3.36	6.01		2.13	0.69		0.00	0.00		3.10	4.17		10.87	200	0.40	21.6	0.67	100.90	10.77	0.17	1.00
Dundonald Dr.		EX129	EX128	11			0.58	37	589	7.99	3.35	6.39		2.13	0.69		0.00	0.00		3.10	4.36		11.45	200	0.40	21.6	0.67	91.70	10.19	0.16	1.00
Lamprey St.		EX130	EX128				1.16	85	85	1.16	3.61	0.99		0.00	0.00		0.00	0.00	0.40	0.40	0.51		1.51	200	0.50	24.2	0.75	96.50	22.69	0.00	1.00
Dundonald Dr.		EX128	EX127	9			0.37	31	705	9.52	3.31	7.57		2.13	0.69		0.00	0.00		3.50	5.00		13.26	200	0.50	24.2	0.75	49.80	10.93	0.14	1.00
Dundonald Dr.		EX127	MH126	13			0.66	44	749	10.18	3.30	8.01		2.13	0.69		0.00	0.00		3.50	5.22		13.92	200	0.32	19.4	0.60	97.80	5.43	0.13	1.00
Dundonald Dr.		EX23	MH126				1.06	71	71	1.06	3.63	0.83		0.00	0.00		0.00	0.00		0.00	0.35		1.18	200	1.47	41.5	1.28	89.30	40.30	0.00	1.00
School		EX123A	EX123				0.00	0	0	0.00	3.80	0.00		0.00	0.00	2.06	2.06	1.00		0.00	0.68		1.68	250	0.89	58.5	1.16	15.80	56.85	1.00	1.50
River Mist. Dr.		MH126	EX123		5		0.29	14	2262	31.57	3.03	22.25		2.13	1.04		8.03	3.90		4.41	15.23		42.41	375	0.45	122.7	1.08	122.00	80.29	0.22	1.50
River Mist. Rd.		EX123	MH112		7		0.34	19	2281	31.91	3.03	22.42		2.13	1.04		10.09	4.90		4.41	16.02		44.38	375	0.42	118.5	1.04	90.30	74.16	0.25	1.50
White Arctic Ave.		EX111	MH112				3.39	378	378	3.39	3.43	4.20		0.00	0.00		0.00	0.00		0.00	1.12		5.32	200	0.32	19.4	0.60	74.80	14.04	0.00	1.00

BARRHAVEN SOUTH URBAN EXPANSION AREA (BSUEA)

CITY OF OTTAWA
MINTO COMMUNITIES INC.
JLR NO. 26610

BARRHAVEN SOUTH SANITARY SEWER DESIGN SHEET

Designed by: AT
Checked by:HM

			PROPOSED AND BSUEA DESIGN PARAMETERS		
Single Family	3.4	pers/unit	q =	280	L/cap/day
Semi-Detached/Townhouse (row)	2.7	pers/unit	I =	0.330	L/s/ha
Apt Units	1.8	pers/unit	Inst./Comm. =	28000	L/ha/day
Manning's Coeff. N =	0.013		Commerial PF*=	1.0/1.5	

*1.5 if ICI in contributing area is >20%, 1.0 if ICI in contributing area is <20%

Sources:	Half Moon Bay South Subdivision - Phase 4 - Excluding Arterials- Sanitary sewer design sheet prepared by Stantec (2015)
	Quinn's Pointe - Excluding Arterials-Sanitary sewer design sheet prepared by J.L Richards (2015)
	Barrhaven South Master Servicing Study Addendum - Sanitary sewer design sheet prepared Stantec (2014)

Legend	
	Proposed
	Proposed by Others
	Existing

Date: February 2018

STREET	SOURCE	M.H. # FROM	M.H. # TO	RESIDENTIAL NUMBER OF UNITS SING.	MULT.	APT.	AREA TOTAL ha	POPULATION TOTAL peop.	CUMULATIVE POPUL. peop.	CUMULATIVE AREA ha	PEAKING FACTOR	POPUL. FLOW l/s	COMMERCIAL AREA ha	CUMM. AREA ha	INST. FLOW l/s	INSTITUTIONAL AREA ha	CUMM. AREA ha	INST. FLOW l/s	GREEN/UNUSED AREA ha	CUMM. AREA ha	PEAK EXTR. FLOW l/s	PLUG FLOW l/s	PEAK DES. FLOW l/s	SEWER DATA DIA. mm	SLOPE %	CAPAC. l/s	VEL. m/s	LENGTH m	RESIDUAL CAP. l/s	ICI/ TOTAL	ICI* Peaking Factor
River Mist. Rd.		MH112	EX102				0.14	0	2659	35.44	2.99	25.76		2.13	1.04		10.09	4.90		4.41	17.18		48.88	375	0.31	101.8	0.89	68.00	52.96	0.23	1.50
Dutchmans Way		EX103	EX102	18			0.80	61	61	0.80	3.64	0.72		0.00	0.00		0.00	0.00		0.00	0.26		0.98	200	2.02	48.6	1.50	120.00	47.65	0.00	1.00
Song Sparrow St.		EX104	EX102				3.83	386	386	3.83	3.42	4.28		0.00	0.00		0.00	0.00		0.00	1.26		5.55	200	0.44	22.7	0.70	114.60	17.15	0.00	1.00
River Mist Road	Stantec (2015)	EX102	EX101				0.07	0	3106	40.14	2.94	29.63		2.13	1.04		10.09	4.90		4.41	18.73		54.30	375	0.29	98.5	0.86	34.00	44.20	0.22	1.50
	Stantec (2014)	EX101	MH43A				0.00	0	3106	40.14	2.94	29.63		2.13	1.04		10.09	4.90		4.41	18.73		54.30	375	0.30	100.2	0.88	38.00	45.88	0.22	1.50
		MH43A	MH44A				6.56	352	3458	46.70	2.91	32.63		2.13	0.69		10.09	3.27		4.41	20.90		57.49	375	0.30	100.2	0.88	81.00	42.70	0.19	1.00
		MH44A	MH45A				0.00	0	3458	46.70	2.91	32.63		2.13	0.69		10.09	3.27		4.41	20.90		57.49	375	0.30	100.2	0.88	64.00	42.70	0.19	1.00
		MH45A	MH46A				0.00	0	3458	46.70	2.91	32.63		2.13	0.69		10.09	3.27		4.41	20.90		57.49	375	0.30	100.2	0.88	85.00	42.70	0.19	1.00
		MH46A	MH47A				8.40	562	4020	55.10	2.87	37.33		2.13	0.69		10.09	3.27	1.60	6.01	24.20		65.49	375	0.30	100.2	0.88	41.00	34.70	0.17	1.00
		MH47A	MH101A				0.00	0	4020	55.10	2.87	37.33		2.13	0.69		10.09	3.27		6.01	24.20		65.49	375	0.30	100.2	0.88	64.00	34.70	0.17	1.00
		MH101A	MH102A				0.00	0	4020	55.10	2.87	37.33		2.13	0.69		10.09	3.27		6.01	24.20		65.49	375	0.30	100.2	0.88	64.00	34.70	0.17	1.00
River Mist Road	Stantec (2014)	MH102A	MH17A				5.24	420	4440	60.34	2.83	40.78		2.13	0.69		10.09	3.27		6.01	25.93		70.67	375	0.30	100.2	0.88	81.00	29.52	0.16	1.00
CAMBRIAN RD. FROM MH17A TO MH45A							60.34	4440																							
Cambrian Rd.	Stantec (2014)	MH17A	MH21A				26.01	1956	15813	189.42	2.76	141.19		6.83	2.21	2.96	33.20	10.76	5.10	28.63	75.72		229.88	750	0.13	419.5	0.92	204.30	189.62	0.16	1.00
Cambrian Rd.	Stantec (2014)	MH21A	MH45				7.04	408	16221	196.46	2.74	144.25		6.83	2.21		33.20	10.76	0.00	28.63	78.04		235.26	750	0.13	419.5	0.92	277.80	184.24	0.15	1.00
MINTO LANDS WITHIN BSUEA OUTLETS TO 120 (QUINN'S POINTE) EXISTING GREENBANK RD.							196.46																								
Future Collector		514	516	16	104		3.49	335	335	3.49	3.45	3.74		0.00	0.00	0.00	0.00	0.00		0.00	1.15		4.89	200	0.35	20.2	0.62	127.90	15.35	0.00	1.00
Future Collector		516	554	20	54		3.18	214	549	6.67	3.36	5.98		0.00	0.00	0.00	0.00	0.00		0.00	2.20		8.18	200	0.35	20.2	0.62	170.90	12.06	0.00	1.00
Future Collector																0.00															
Future Collector		500	502	25	70	115	7.16	481	481	7.16	3.39	5.28		0.00	0.00	0.00	0.00	0.00		0.00	2.36	0.10	7.74	200	0.35	20.2	0.62	174.00	11.41	0.00	1.00
Future Collector		502	551	8	44		1.55	146	627	8.71	3.34	6.78		0.00	0.00	0.00	0.00	0.00		0.00	2.87		9.76	200	0.88	32.1	0.99	171.30	20.22	0.00	1.00
East-West Collector		550	551	20			1.98	68	68	1.98	3.63	0.80		0.00	0.00	0.00	0.00	0.00		0.00	0.65		1.45	200	0.35	20.2	0.62	99.90	18.73	0.00	1.00
East-West Collector		551	552	22	0		1.49	75	770	12.18	3.30	8.23		0.00	0.00	0.00	0.00	0.00		0.00	4.02		12.34	200	0.35	20.2	0.62	175.00	7.90	0.00	1.00
East-West Collector		552	554	12	20		3.36	95	865	15.54	3.27	9.17		0.00	0.00	0.00	0.00	0.00		0.00	5.13		14.40	200	0.35	20.2	0.62	178.30	3.37	0.00	1.00
East-West Collector		554	556	11	34		1.81	129	1543	24.02	3.14	15.68		0.00	0.00	0.00	0.00	0.00		0.00	7.93		23.71	250	0.33	35.6	0.70	295.60	9.15	0.00	1.00
Future Collector		517	564	20	35		2.07	163	163	2.07	3.54	1.87		0.00	0.00	0.00	0.00	0.00		0.00	0.68		2.55	200	0.59	26.3	0.81	280.00	23.71	0.00	1.00
Alex Polowin Ave.		13	14	12	0		0.54	41	41	0.54	3.67	0.49		0.00	0.00	0.00	0.00	0.00		0.00	0.00		0.49	200	0.67	28.0	0.86	74.56	27.53	0.00	1.00
Alex Polowin Ave.		14	90	13	0		0.65	44	85	1.19	3.61	0.99		0.00	0.00	0.00	0.00	0.00		0.00	0.00		0.99	200	0.94	33.1	1.02	112.06	32.13	0.00	1.00
Alex Polowin Ave.		90	5	11	0		0.54	37	122	1.73	3.58	1.41		0.00	0.00	0.00	0.00	0.00		0.00	0.00		1.41	200	0.35	20.3	0.63	108.16	18.87	0.00	1.00
River Mist Road		5	563	0			0.00	0	122	1.73	3.58	1.41		0.00	0.00	0.00	0.00	0.00		0.00	0.00		1.41	200	0.42	22.2	0.68	80.00	20.76	0.00	1.00
River Mist Road		563	564	8			0.47	27	149	2.20	3.55	1.72		0.00	0.00	0.00	0.00	0.00		0.00	0.73		2.44	200	0.42	22.2	0.68	50.00	19.73	0.00	1.00
River Mist Road		564	556	7	9		0.64	48	360	4.91	3.43	4.01		0.00	0.00		0.00	0.00		0.00	1.62		5.63	200	0.35	20.2	0.62	95.00	14.62	0.00	1.00
East-West Collector		556	557						1903	28.93	3.08	19.01		0.00	0.00	2.20	2.20	0.71		0.00	10.27		30.09	300	1.39	118.9	1.63	44.30	84.53	0.07	1.00
East-West Collector		557	558	6			1.12	20	1923	30.05	3.08	19.19		0.00	0.00	2.86	5.06	1.64		0.00	11.59	4.00	36.42	300	1.39	118.9	1.63	158.40	80.38	0.14	1.00
Future Collector		560	558	50	0		3.09	170	170	3.09	3.54	1.95		0.00	0.00		0.00	0.00		0.00	1.02		2.97	200	0.35	20.2	0.62	150.00	17.27	0.00	1.00
East-West Collector		558	119				5.74	0	2093	38.88	3.06	20.73		0.00	0.00		5.06	1.64		0.00	14.50		40.97	450	0.13	107.2	0.65	150.00	63.75	0.12	1.00
Future Collector		521	522	24	33		2.17	171	171	2.17	3.54	1.96		0.00	0.00		0.00	0.00		0.00	0.72		2.68	200	1.26	38.4	1.18	230.00	35.74	0.00	1.00
		522	523						171	2.17				0.00	0.00		0.00	0.00		0.00											
		523	524		71		1.95	192	363	4.12				0.00	0.00		0.00	0.00		0.00										0.00	1.00
Future Collector		520	524	41			2.06	139	139	2.06	3.56	1.60		0.00	0.00		0.00	0.00		0.00	0.68		2.28	200	0.26	17.4	0.54	72.20	15.16	0.00	1.00
Future Collector		524	578		0		0.00	0	502	6.18	3.38	5.50		0.00	0.00		0.00	0.00		0.00	2.04		7.54	300	0.20	45.1	0.62	200.90	37.58	0.00	1.00
Future Collector		578	532		87		3.63	235	737	9.81	3.31	7.89		0.00	0.00		0.00	0.00		0.00	3.24		11.13	300	0.20	45.1	0.62	173.70	33.98	0.00	1.00
Future Collector		532	534	50	26		3.29	240	977	13.10	3.25	10.27		0.00	0.00		0.00	0.00		0.00	4.32		14.60	300	0.20	45.1	0.62	127.45	30.52	0.00	1.00
Future Collector		534	536	55			2.96	187	1164	16.06	3.21	12.09		0.00	0.00		0.00	0.00		0.00	5.30		17.39	450	0.20	133.0	0.81	173.27	115.63	0.00	1.00
Future Collector		536	538				0.00	0	1164	16.06	3.21	12.09		0.00	0.00	0.00	0.00	0.00		0.00	5.30		17.39	450	0.20	133.0	0.81	309.73	115.63	0.00	1.00
		538	119	0			0.00	0	1164	16.06	3.21	12.09		0.00	0.00		0.00	0.00		0.00	5.30		17.39	525	0.15	173.8	0.78	245.34	156.37	0.00	1.00
Greenbank Rd.		119	EX120					0	3257	54.94	2.93	30.92		0.00	0.00		5.06	1.64		0.00	19.80		56.46	600	0.15	248.1	0.85	168.66	187.53	0.08	1.00
QUINN'S POINTE OUTLETS TO MH205A EXISTING GREENBANK RD.							54.94	3257																							
Greenbank Road		EX120	EX121				0.22	0	3257	55.16	2.93	30.92		0.00	0.00	0.00	5.06	1.64		0.00	19.87		56.53	600	0.16	259.0	0.89	58.09	202.51	0.08	1.00
Greenbank Road		EX121	EX122				0.28	0	3640	61.99	2.90	34.16		0.00	0.00	0.00	6.63	2.15		0.00	22.64		63.05	600	0.33	369.2	1.27	75.27	306.17	0.10	1.00

BARRHAVEN SOUTH URBAN EXPANSION AREA (BSUEA)

CITY OF OTTAWA
MINTO COMMUNITIES INC.
JLR NO. 26610

BARRHAVEN SOUTH SANITARY SEWER DESIGN SHEET

Designed by: AT
Checked by:HM

			PROPOSED AND BSUEA DESIGN PARAMETERS		
Single Family	3.4	pers/unit	q =	280	L/cap/day
Semi-Detached/Townhouse (row)	2.7	pers/unit	I =	0.330	L/s/ha
Apt Units	1.8	pers/unit	Inst./Comm. =	28000	L/ha/day
Manning's Coeff. N =	0.013		Commerial PF*=	1.0/1.5	

*1.5 if ICI in contributing area is >20%, 1.0 if ICI in contributing area is <20%

Sources:	
	Half Moon Bay South Subdivision - Phase 4 - Excluding Arterials- Sanitary sewer design sheet prepared by Stantec (2015)
	Quinn's Pointe - Excluding Arterials-Sanitary sewer design sheet prepared by J.L Richards (2015)
	Barrhaven South Master Servicing Study Addendum - Sanitary sewer design sheet prepared Stantec (2014)

Legend	
	Proposed
	Proposed by Others
	Existing

Date: February 2018

STREET	SOURCE	M.H. #		RESIDENTIAL									COMMERCIAL			INSTITUTIONAL			GREEN/UNUSED					SEWER DATA					RESIDUAL		ICI*
				NUMBER OF UNITS			AREA	POPULATION	CUMULATIVE		PEAKING	POPUL.		CUMM.	INST.		CUMM.	INST.		CUMM.	PEAK EXTR.	PLUG	PEAK DES.								
		FROM	TO	SING.	MULT.	APT.	TOTAL ha	TOTAL peop.	POPUL. peop.	AREA ha	FACTOR	FLOW l/s	AREA ha	AREA ha	FLOW l/s	AREA ha	AREA ha	FLOW l/s	AREA ha	AREA ha	FLOW l/s	FLOW l/s	FLOW l/s	DIA. mm	SLOPE %	CAPAC. l/s	VEL. m/s	LENGTH m	CAP. l/s	ICI/ TOTAL	Peaking Factor
Greenbank Road		EX122	EX123R				0.45	0	3640	62.44	2.90	34.16		0.00	0.00	0.00	6.63	2.15		0.00	22.79		63.20	600	0.21	291.1	1.00	121.02	227.90	0.10	1.00
Easement		EX44	EX123R				0.00	0	259	2.62	3.48	2.93		0.00	0.00	0.00	0.00	0.00		0.00	0.86		3.79	300	0.35	59.9	0.82	19.00	56.12	0.00	1.00
Greenbank Road		EX123R	MH205A				0.43	0	3899	65.49	2.87	36.32		0.00	0.00	0.00	6.63	2.15		0.00	23.80		66.37	600	0.25	319.2	1.09	120.80	252.85	0.09	1.00
Kilbirnie Drive	JLR (2016)	EX24	MH205A		3		0.11	8	224	2.15	3.50	2.54		0.00	0.00	0.00	0.00	0.00		0.00	0.71		3.25	200	0.71	28.8	0.89	28.70	25.59	0.00	1.00
Existing Greenbank Road		MH205A	EX98A					0	4123	67.64	2.86	38.18		0.00	0.00	0.00	6.63	2.15		0.00	24.51		73.94	600	0.25	320.3	1.10	126.00	246.34	0.09	1.00
EXISTING GREENBANK RD. FROM MH 98A TO MH45A							6.15	484																							
Existing Greenbank Road	IBI	EX98A	MH99A				0.00	0	4123	67.64	2.86	38.18		0.00	0.00		6.63	2.15		0.00	24.51		73.94	600	0.25	320.3		125.00	246.34	0.09	1.00
Existing Greenbank Road	IBI	MH99A	MH100A				0.00	0	4123	67.64	2.86	38.18		0.00	0.00		6.63	2.15		0.00	24.51		73.94	600	0.25	320.3		108.00	246.34	0.09	1.00
Existing Greenbank Road	IBI	MH100A	MH204A				0.00	0	4123	67.64	2.86	38.18		0.00	0.00		6.63	2.15		0.00	24.51		73.94	600	0.25	320.3		105.00	246.34	0.09	1.00
Existing Greenbank Road	IBI	MH204A	MH206A				0.00	0	4123	67.64	2.86	38.18		0.00	0.00		6.63	2.15		0.00	24.51		73.94	600	0.25	320.3		103.00	246.34	0.09	1.00
Existing Greenbank Road	IBI	MH206A	MH97A				0.00	0	4123	67.64	2.86	38.18		0.00	0.00		6.63	2.15		0.00	24.51		73.94	600	0.25	320.3		125.00	246.34	0.09	1.00
Existing Greenbank Road	IBI	MH97A	MH96A				19.95	1631	5754	87.59	2.75	51.29		0.00	0.00		6.63	2.15	0.81	0.81	31.36		93.90	600	0.30	350.8		98.00	256.95	0.07	1.00
Existing Greenbank Road	IBI	MH96A	MH95A				0.00	0	5754	87.59	2.75	51.29		0.00	0.00		6.63	2.15		0.81	31.36		93.90	600	0.30	350.8		129.00	256.95	0.07	1.00
Existing Greenbank Road	IBI	MH95A	MH201A				0.00	0	5754	87.59	2.75	51.29		0.00	0.00		6.63	2.15		0.81	31.36		93.90	600	0.30	350.8		123.00	256.95	0.07	1.00
Existing Greenbank Road	IBI	MH201A	MH201B				12.13	787	6541	99.72	2.71	57.40		0.00	0.00		6.63	2.15		0.81	35.36		104.01	600	0.30	350.8		124.00	246.83	0.06	1.00
Existing Greenbank Road	IBI	MH201B	MH200A				0.00	0	6541	99.72	2.71	57.40		0.00	0.00		6.63	2.15		0.81	35.36		104.01	600	0.30	350.8		68.00	246.83	0.06	1.00
Existing Greenbank Road	IBI	MH200A	MH200C				0.00	0	6541	99.72	2.71	57.40		0.00	0.00		6.63	2.15		0.81	35.36		104.01	600	0.50	452.9		48.00	348.93	0.06	1.00
Existing Greenbank Road	IBI	MH200C	MH45				0.00	0	6541	99.72	2.71	57.40		0.00	0.00		6.63	2.15		0.81	35.36		104.01	600	0.12	221.9		26.00	117.88	0.06	1.00
Existing Greenbank Road North	Stantec (2014)	MH45	MH435A				5.12	548	23310	301.30	2.27	171.38		6.83	2.21		39.83	12.91	0.00	29.44	124.54		320.14	900	0.10	597.2		296.00	277.08	0.12	1.00
	↓	MA9	MA8				22.23	2378	2378	22.23	3.02	23.28	0.00	0.00	0.00	2.45	2.45	0.79	9.54	9.54	11.29		35.37	450	0.11	98.4		507.50	63.03	0.07	1.00
		MA8	MA7				2.88	308	2686	25.11	2.99	25.99	0.00	0.00	0.00	0.00	2.45	0.79	0.78	10.32	12.50		39.29	450	0.11	98.4		317.10	59.11	0.06	1.00
		MA7	MA6				18.50	1979	4665	43.61	2.82	42.61	0.00	0.00	0.00	0.00	2.45	0.79	0.00	10.32	18.61		62.01	450	0.11	98.4		573.10	36.39	0.04	1.00
Realigned Greenbank Road		MA6	MA5				21.68	2320	6985	65.29	2.69	60.80	0.00	0.00	0.00	0.00	2.45	0.79	0.00	10.32	25.76		87.36	525	0.10	140.5		473.90	53.14	0.03	1.00
Realigned Greenbank Road		MA5	MA4				9.53	1020	8005	74.82	2.64	68.49	0.00	0.00	0.00	0.00	2.45	0.79	0.00	10.32	28.90		98.19	525	0.10	140.5		439.40	42.31	0.03	1.00
Realigned Greenbank Road		MA4	MH521A				8.07	863	8868	82.89	2.61	74.87	0.00	0.00	0.00	0.00	2.45	0.79	2.42	12.74	32.37		108.03	525	0.10	140.5		530.70	32.47	0.02	1.00
		MH521A	MH522A				3.80	231	9099	86.69	2.60	76.56	0.00	0.00	0.00	0.00	2.45	0.79	0.02	12.76	33.63		110.98	600	0.10	201.5		49.90	90.52	0.02	1.00
		MH522A	MH435A				0.00	0	9099	86.69	2.60	76.56	0.00	0.00	0.00	0.00	2.45	0.79	0.00	12.76	33.63		110.98	600	0.10	201.5		11.10	90.52	0.02	1.00
		MH435A	MH501A				0.00	0	32409	387.99	2.16	226.39	0.00	6.83	2.21	0.00	42.28	13.70	0.00	42.20	158.17		409.57	900	0.10	597.0		13.30	187.43	0.10	1.00

Sanitary design calculation for the proposed HMB phase 8 site by DSEL (2020)

SANITARY SEWER CALCULATION SHEET

Ottawa

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION									COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	UNITS Singles	UNITS Townhouse	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
Drummond Future Road																													
	Plug	305A	0.89				67	0.89	67	3.63	0.79		0.00		0.00		0.00	0.00	0.89	0.89	0.29	1.08	8.0	200	0.35	19.40	0.06	0.62	0.33
To Expansion Road, Pipe 305A - 306A								0.89	67				0.00		0.00		0.00			0.89									
Future Residential																													
	Ctrl 3A	109A	1.90				162	1.90	162	3.54	1.86		0.00		0.00		0.00	0.00	1.90	1.90	0.63	2.49	11.0	200	0.35	19.40	0.13	0.62	0.42
To Obsidian Street, Pipe 109A - 400A								1.90	162				0.00		0.00		0.00			1.90									
Focality Crescent																													
	107A	108A	0.14	3		3	9	0.14	9	3.74	0.11		0.00		0.00		0.00	0.00	0.14	0.14	0.05	0.16	12.5	200	2.45	51.34	0.00	1.63	0.36
	108A	110A	0.17	5		5	14	0.31	23	3.70	0.28		0.00		0.00		0.00	0.00	0.17	0.31	0.10	0.38	50.5	200	0.35	19.40	0.02	0.62	0.24
To Haiku Street, Pipe 110A - 1100A								0.31	23				0.00		0.00		0.00			0.31									
	107A	112A	0.45	18		18	49	0.45	49	3.65	0.58		0.00		0.00		0.00	0.00	0.45	0.45	0.15	0.73	73.5	200	0.70	27.44	0.03	0.87	0.37
	112A	113A	0.43	16		16	44	0.88	93	3.60	1.09		0.00		0.00		0.00	0.00	0.43	0.88	0.29	1.38	70.5	200	0.35	19.40	0.07	0.62	0.36
	113A	114A	0.12	3		3	9	1.00	102	3.59	1.19		0.00		0.00		0.00	0.00	0.12	1.00	0.33	1.52	12.5	200	0.35	19.40	0.08	0.62	0.36
	114A	115A	0.18	5		5	14	1.18	116	3.58	1.35		0.00		0.00		0.00	0.00	0.18	1.18	0.39	1.74	50.5	200	0.40	20.74	0.08	0.66	0.40
To Haiku Street, Pipe 115A - 111A								1.18	116				0.00		0.00		0.00			1.18									
Sturnidae Street																													
	124A	125A	0.60	18	18		62	0.60	62	3.64	0.73		0.00		0.00		0.00	0.00	0.60	0.60	0.20	0.93	101.0	200	0.65	26.44	0.04	0.84	0.39
	125A	126A	0.50	12	12		41	1.10	103	3.59	1.20		0.00		0.00		0.00	0.00	0.50	1.10	0.36	1.56	91.0	200	0.35	19.40	0.08	0.62	0.37
Contribution From Montology Way, Pipe 123A - 126A								0.81	63				0.00		0.00		0.00		0.81	1.91									
	126A	106A						1.91	166	3.54	1.91		0.00		0.00		0.00	0.00	0.00	1.91	0.63	2.54	63.0	200	0.35	19.40	0.13	0.62	0.42
To Elevation Road, Pipe 106A - 116A								1.91	166				0.00		0.00		0.00			1.91									
Park																													
	Ctrl 4A	104A						0.00					0.00		0.00	1.72	1.72	0.19	1.72	1.72	0.57	0.75	10.5	200	0.35	19.40	0.04	0.62	0.29
To Chillerton Drive, Pipe 104A - 106A								0.00	0				0.00		0.00		1.72			1.72									
Canadensis Lane																													
	229A	230A	0.42	15		15	41	0.42	41	3.67	0.49		0.00		0.00		0.00	0.00	0.42	0.42	0.14	0.63	73.5	200	2.00	46.38	0.01	1.48	0.51
	230A	103A	0.48	18		18	49	0.90	90	3.60	1.05		0.00		0.00		0.00	0.00	0.48	0.90	0.30	1.35	90.0	200	3.00	56.81	0.02	1.81	0.75
To Chillerton Drive, Pipe 103A - 104A								0.90	90				0.00		0.00		0.00			0.90									
Surface Lane																													
	227A	228A	0.47	18		18	49	0.47	49	3.65	0.58		0.00		0.00		0.00	0.00	0.47	0.47	0.16	0.74	72.5	200	2.00	46.38	0.02	1.48	0.53
	228A	102A	0.48	18		18	49	0.95	98	3.60	1.14		0.00		0.00		0.00	0.00	0.48	0.95	0.31	1.46	90.0	200	0.85	30.24	0.05	0.96	0.49
To Chillerton Drive, Pipe 102A - 103A								0.95	98				0.00		0.00		0.00			0.95									
Chillerton Drive																													
	101A	102A	0.14	3		3	9	0.14	9	3.74	0.11		0.00		0.00		0.00	0.00	0.14	0.14	0.05	0.16	25.5	200	2.60	52.89	0.00	1.68	0.34
Contribution From Surface Lane, Pipe 228A - 102A								0.95	98				0.00		0.00		0.00		0.95	1.09									
	102A	103A	0.22	7		7	19	1.31	126	3.57	1.46		0.00		0.00		0.00	0.00	0.22	1.31	0.43	1.89	59.0	200	1.70	42.76	0.04	1.36	0.67
Contribution From Canadensis Lane, Pipe 230A - 103A								0.90	90				0.00		0.00		0.00		0.90	2.21									
	103A	104A	0.46	14		14	38	2.67	254	3.49	2.87		0.00		0.00		0.00	0.00	0.46	2.67	0.88	3.75	120.0	200	0.50	23.19	0.16	0.74	0.54
Contribution From Park, Pipe 4A - 104A								0.00	0				0.00		0.00		1.72		1.72	4.39									
	104A	106A	0.08	1		1	3	2.75	257	3.49	2.90		0.00		0.00		1.72	0.19	0.08	4.47	1.48	4.56	45.5	200	0.35	19.40	0.24	0.62	0.50
To Elevation Road, Pipe 106A - 116A								2.75	257				0.00		0.00		1.72			4.47									

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha
Average Daily Flow =	280	l/p/day		
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha
Max Res. Peak Factor =	3.80			
Commercial/Inst./Park Peak Factor =	1.00			
Institutional =	0.32	l/s/Ha		

Industrial Peak Factor = as per MOE Graph
Extraneous Flow = 0.330 L/s/ha
Minimum Velocity = 0.600 m/s
Manning's n = (Conc) 0.013 (Pvc) 0.013
Townhouse coeff= 2.7
Single house coeff= 3.4

Designed: SLM	PROJECT: Ciavan Communities - Brazeau Phase 1
Checked: ADF	LOCATION: City of Ottawa
Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. 80-83	File Ref: 18-1030	Date: 27 Jul 2020	Sheet No. 1 of 6

1030_SAN_slm.xlsx

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION									COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	UNITS Singles	UNITS Townhouse	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
Epoch Street																													
	220A	221A	0.42	10		10	27	0.42	27	3.69	0.32		0.00		0.00		0.00	0.00	0.42	0.42	0.14	0.46	77.5	200	0.95	31.97	0.01	1.02	0.35
	221A	222A	0.49	18		18	49	0.91	76	3.62	0.89		0.00		0.00		0.00	0.00	0.49	0.91	0.30	1.19	93.0	200	0.35	19.40	0.06	0.62	0.34
	222A	223A	0.52	20		20	54	1.43	130	3.57	1.50		0.00		0.00		0.00	0.00	0.52	1.43	0.47	1.98	100.5	200	0.35	19.40	0.10	0.62	0.40
To Elevation Road, Pipe 223A - 105A								1.43	130				0.00		0.00		0.00			1.43									
Eminence Street																													
	215A	216A	0.49	12	12		41	0.49	41	3.67	0.49		0.00		0.00		0.00	0.00	0.49	0.49	0.16	0.65	75.5	200	0.85	30.24	0.02	0.96	0.39
	216A	217A	0.72	17	17		58	1.21	99	3.60	1.15		0.00		0.00		0.00	0.00	0.72	1.21	0.40	1.55	113.5	200	0.35	19.40	0.08	0.62	0.37
	217A	219A	0.45	12	12		41	1.66	140	3.56	1.62		0.00		0.00		0.00	0.00	0.45	1.66	0.55	2.16	83.5	200	0.35	19.40	0.11	0.62	0.41
To Elevation Road, Pipe 219A - 223A								1.66	140				0.00		0.00		0.00			1.66									
Elevation Road																													
	218A	219A	0.13	2	2		7	0.13	7	3.74	0.08		0.00		0.00		0.00	0.00	0.13	0.13	0.04	0.13	24.0	200	2.65	53.39	0.00	1.70	0.35
Contribution From Eminence Street, Pipe 217A - 219A								1.66	140				0.00		0.00		0.00		1.66	1.79									
	219A	223A	0.23	4	4		14	2.02	161	3.54	1.85		0.00		0.00		0.00	0.00	0.23	2.02	0.67	2.52	59.0	200	0.85	30.24	0.08	0.96	0.58
Contribution From Epoch Street, Pipe 222A - 223A								1.43	130				0.00		0.00		0.00		1.43	3.45									
	223A	105A	0.42	6	6		21	3.87	312	3.46	3.50		0.00		0.00		0.00	0.00	0.42	3.87	1.28	4.77	82.5	200	0.70	27.44	0.17	0.87	0.65
	105A	106A	0.42	7	7		24	4.29	336	3.45	3.75		0.00		0.00		0.00	0.00	0.42	4.29	1.42	5.17	94.0	200	1.30	37.40	0.14	1.19	0.83
Contribution From Chillerton Drive, Pipe 104A - 106A								2.75	257				0.00		0.00		1.72		4.47	8.76									
Contribution From Sturnidae Street, Pipe 126A - 106A								1.91	166				0.00		0.00		0.00		1.91	10.67									
			0.35	11		11	30	9.30	789				0.00		0.00		1.72		0.35	11.02									
	106A	116A	0.35	8	8		28	9.65	817	3.28	8.69		0.00		0.00		1.72	0.19	0.35	11.37	3.75	12.63	118.0	200	0.35	19.40	0.65	0.62	0.66
To Haiku Street, Pipe 116A - 1160A								9.65	817				0.00		0.00		1.72			11.37									
			1.57				118	1.57	118				0.00		0.00		0.00		1.57	1.57									
	309A	310A	5.67				595	7.24	713	3.31	7.65		0.00		0.00		0.00	0.00	5.67	7.24	2.39	10.04	15.0	250	0.25	29.73	0.34	0.61	0.55
To Expansion Road, Pipe 310A - 1311A								7.24	713				0.00		0.00		0.00			7.24									
Drummond Future Road																													
	301A	302A	1.27				95	1.27	95	3.60	1.11		0.00		0.00		0.00	0.00	1.27	1.27	0.42	1.53	94.5	200	0.35	19.40	0.08	0.62	0.36
To Expansion Road, Pipe 302A - 1180A								1.27	95				0.00		0.00		0.00			1.27									
Drummond Future Road																													
			0.22				23	0.22	23				0.00		0.00	1.45	1.45		1.67	1.67									
	1303A	3031A	0.61				46	0.83	69	3.63	0.81		0.00		0.00		1.45	0.16	0.61	2.28	0.75	1.72	108.0	200	0.35	19.40	0.09	0.62	0.38
To Expansion Road, Pipe 3031A - 302A								0.83	69				0.00		0.00		1.45			2.28									
Expansion Road																													
			0.16				17	0.16	17				0.00		0.00		0.00		0.16	0.16									
	303A	3031A	0.19				14	0.35	31	3.68	0.37		0.00		0.00		0.00	0.00	0.19	0.35	0.12	0.49	65.0	200	0.65	26.44	0.02	0.84	0.32
Contribution From Drummond Future Road, Pipe 1303A - 3031A								0.83	69				0.00		0.00		1.45		2.28	2.63									
	3031A	302A	0.22				17	1.40	117	3.58	1.36		0.00		0.00		1.45	0.16	0.22	2.85	0.94	2.45	59.0	200	0.35	19.40	0.13	0.62	0.42
Contribution From Expansion Road, Pipe 301A - 302A								1.27	95				0.00		0.00		0.00		1.27	4.12									
	302A	1180A	0.20				15	2.87	227	3.50	2.58		0.00		0.00		1.45	0.16	0.20	4.32	1.43	4.16	49.5	200	0.35	19.40	0.21	0.62	0.49
	1180A	118A						2.87	227	3.50	2.58		0.00		0.00		1.45	0.16	0.00	4.32	1.43	4.16	11.0	200	0.35	19.40	0.21	0.62	0.49
To Haiku Street, Pipe 118A - 117A								2.87	227				0.00		0.00		1.45			4.32									

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha
Average Daily Flow =	280	l/p/day		
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha
Max Res. Peak Factor =	3.80			
Commercial/Inst./Park Peak Factor =	1.00			
Institutional =	0.32	l/s/Ha		

Industrial Peak Factor = as per MOE Graph

Extraneous Flow =		0.330	L/s/ha	
Minimum Velocity =		0.600	m/s	
Manning's n =	(Conc)	0.013	(Pvc)	0.013
Townhouse coeff=		2.7		
Single house coeff=		3.4		

Designed: SLM

Checked: ADF

Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. 80-83

PROJECT: **Ciavan Communities - Brazeau Phase 1**

LOCATION: **City of Ottawa**

File Ref: 18-1030

Date: **27 Jul 2020**

Sheet No. 2 of 6

SANITARY SEWER CALCULATION SHEET

Ottawa

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION									COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	UNITS Singles	UNITS Townhouse	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
			0.19				20	0.19	20				0.00		0.00		0.00		0.19	0.19									
	303A	305A	0.21				16	0.40	36	3.67	0.43		0.00		0.00		0.00	0.00	0.21	0.40	0.13	0.56	69.5	200	2.45	51.34	0.01	1.63	0.52
Contribution From Drummond Future Road, Pipe 1305A - 305A								0.89	67				0.00		0.00		0.00		0.89	1.29									
			0.13				14	1.42	117				0.00		0.00		0.00		0.13	1.42									
	305A	306A	0.16				12	1.58	129	3.57	1.49		0.00		0.00		0.00	0.00	0.16	1.58	0.52	2.01	53.5	200	0.35	19.40	0.10	0.62	0.40
	306A	307A	0.13				10	1.71	139	3.56	1.60		0.00		0.00		0.00	0.00	0.13	1.71	0.56	2.17	10.5	200	0.35	19.40	0.11	0.62	0.41
	307A	308A	0.41				31	2.12	170	3.54	1.95		0.00		0.00		0.00	0.00	0.41	2.12	0.70	2.65	78.0	200	0.35	19.40	0.14	0.62	0.43
	308A	3033A	0.39				29	2.51	199	3.52	2.27		0.00		0.00		0.00	0.00	0.39	2.51	0.83	3.10	67.0	200	0.35	19.40	0.16	0.62	0.45
	3033A	310A	0.31				23	2.82	222	3.50	2.52		0.00		0.00		0.00	0.00	0.31	2.82	0.93	3.45	62.0	200	0.40	20.74	0.17	0.66	0.49
Contribution From Drummond Future Road, Pipe 309A - 310A								7.24	713.00				0.00		0.00		0.00		0.00	7.24									
			0.07				5	10.13	940				0.00		0.00		0.00		0.07	10.13									
	310A	1311A	1.22				128	11.35	1068	3.23	11.16		0.00		0.00		0.00	0.00	1.22	11.35	3.75	14.91	111.5	250	0.25	29.73	0.50	0.61	0.61
	1311A	1312A						11.35	1068	3.23	11.16		0.00		0.00		0.00	0.00	0.00	11.35	3.75	14.91	111.0	250	0.25	29.73	0.50	0.61	0.61
	1312A	1313A	4.04				424	15.39	1492	3.14	15.21		0.00		0.00		0.00	0.00	4.04	15.39	5.08	20.29	108.5	250	0.25	29.73	0.68	0.61	0.65
	1313A	405A						15.39	1492	3.14	15.21		0.00		0.00		0.00	0.00	0.00	15.39	5.08	20.29	89.0	250	0.25	29.73	0.68	0.61	0.65
To Future Greenbank Road, Pipe 405A - 406A								15.39	1492				0.00		0.00		0.00			15.39									
Drummond Commercial																													
	1321A	3211A						0.00				7.40	7.40		0.00		0.00	2.40	7.40	7.40	2.44	4.84	11.0	200	0.50	23.19	0.21	0.74	0.58
To Haiku Street, Pipe 3211A - 133A								0.00	0				7.40		0.00		0.00			7.40									
Brazeau Commercial																													
	Ctrl 1A	132A						0.00				13.83	13.83		0.00		0.00	4.48	13.83	13.83	4.56	9.05	15.5	200	0.35	19.40	0.47	0.62	0.60
To Haiku Street, Pipe 132A - 3211A								0.00	0				13.83		0.00		0.00			13.83									
Haiku Street																													
Contribution From Brazeau Commercial, Pipe 1A - 132A								0.00	0				13.83		0.00		0.00		13.83	13.83									
	132A	3211A	0.69				0	0.69	0				13.83		0.00		0.00	4.48	0.69	14.52	4.79	9.27	63.5	200	0.35	19.40	0.48	0.62	0.61
Contribution From Drummond Commercial, Pipe 1321A - 3211A								0.00	0				7.40		0.00		0.00		7.40	21.92									
	3211A	133A						0.69	0				21.23		0.00		0.00	6.88	0.00	21.92	7.23	14.11	9.5	200	0.35	19.40	0.73	0.62	0.67
	133A	134A	0.16				0	0.85	0				21.23		0.00		0.00	6.88	0.16	22.08	7.29	14.17	61.5	200	0.35	19.40	0.73	0.62	0.67
	134A	135A	0.06				0	0.91	0				21.23		0.00		0.00	6.88	0.06	22.14	7.31	14.19	39.5	200	0.35	19.40	0.73	0.62	0.67
To Haiku Street, Pipe 135A - 118A								0.91	0				21.23		0.00		0.00			22.14									
Montology Way																													
	1260A	127A	0.24	3	3		11	0.24	11	3.73	0.13		0.00		0.00		0.00	0.00	0.24	0.24	0.08	0.21	37.5	200	0.65	26.44	0.01	0.84	0.24
	127A	128A	0.13	2	2		7	0.37	18	3.71	0.22		0.00		0.00		0.00	0.00	0.13	0.37	0.12	0.34	12.5	200	0.35	19.40	0.02	0.62	0.23
	128A	129A	0.48	12	12		41	0.85	59	3.64	0.70		0.00		0.00		0.00	0.00	0.48	0.85	0.28	0.98	76.5	200	0.35	19.40	0.05	0.62	0.32
	129A	130A	0.60	17	17		58	1.45	117	3.58	1.36		0.00		0.00		0.00	0.00	0.60	1.45	0.48	1.84	102.0	200	0.35	19.40	0.09	0.62	0.39
	130A	131A						1.45	117	3.58	1.36		0.00		0.00		0.00	0.00	0.00	1.45	0.48	1.84	7.5	200	0.35	19.40	0.09	0.62	0.39
To Montology Way, Pipe 131A - 135A								1.45	117				0.00		0.00		0.00			1.45									
Rugosa Street																													
	211A	204A	0.49	12	12		41	0.49	41	3.67	0.49		0.00		0.00		0.00	0.00	0.49	0.49	0.16	0.65	89.0	200	0.80	29.34	0.02	0.93	0.37
	204A	205A	0.74	19	19		65	1.23	106	3.59	1.23		0.00		0.00		0.00	0.00	0.74	1.23	0.41	1.64	120.0	200	0.35	19.40	0.08	0.62	0.37
	205A	206A						1.23	106	3.59	1.23		0.00		0.00		0.00	0.00	0.00	1.23	0.41	1.64	13.5	200	0.35	19.40	0.08	0.62	0.37
To Appalachian Circle, Pipe 206A - 207A								1.23	106				0.00		0.00		0.00			1.23									

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha					
Average Daily Flow =	280	l/p/day			Industrial Peak Factor = as per MOE Graph				
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha	Extraneous Flow =		0.330	L/s/ha	
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha	Minimum Velocity =		0.600	m/s	
Max Res. Peak Factor =	3.80				Manning's n =	(Conc)	0.013	(Pvc)	0.013
Commercial/Inst./Park Peak Factor =	1.00				Townhouse coeff=		2.7		
Institutional =	0.32	l/s/Ha			Single house coeff=		3.4		

Designed: SLM

Checked: ADF

Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. 80-83

PROJECT: **Ciavan Communities - Brazeau Phase 1**

LOCATION: **City of Ottawa**

File Ref: 18-1030

Date: **27 Jul 2020**

Sheet No. 3 of 6

1030_SAN_slm.xlsx

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION									COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	UNITS Singles	UNITS Townhouse	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
Appalachian Circle																													
	209A	210A	0.08	1	1		4	0.08	4	3.76	0.05		0.00		0.00		0.00	0.00	0.08	0.08	0.03	0.08	12.5	200	2.95	56.33	0.00	1.79	0.29
	210A	211A	0.20	4	4		14	0.28	18	3.71	0.22		0.00		0.00		0.00	0.00	0.20	0.28	0.09	0.31	50.5	200	3.80	63.94	0.00	2.04	0.52
	211A	212A	0.19	4	4		14	0.47	32	3.68	0.38		0.00		0.00		0.00	0.00	0.19	0.47	0.16	0.54	50.0	200	0.45	22.00	0.02	0.70	0.29
	212A	213A	0.09	1	1		4	0.56	36	3.67	0.43		0.00		0.00		0.00	0.00	0.09	0.56	0.18	0.61	12.5	200	1.55	40.83	0.02	1.30	0.47
	213A	214A	0.53	14	14		48	1.09	84	3.61	0.98		0.00		0.00		0.00	0.00	0.53	1.09	0.36	1.34	86.5	200	2.35	50.28	0.03	1.60	0.68
To Foundation Lane, Pipe 214A - 119A								1.09	84				0.00		0.00		0.00			1.09									
	209A	201A	0.58	18	18		62	0.58	62	3.64	0.73		0.00		0.00		0.00	0.00	0.58	0.58	0.19	0.92	93.5	200	0.65	26.44	0.03	0.84	0.39
	201A	202A	0.69	22	22		75	1.27	137	3.56	1.58		0.00		0.00		0.00	0.00	0.69	1.27	0.42	2.00	116.5	200	0.95	31.97	0.06	1.02	0.56
	202A	203A	0.18	3	3		11	1.45	148	3.55	1.70		0.00		0.00		0.00	0.00	0.18	1.45	0.48	2.18	13.5	200	0.80	29.34	0.07	0.93	0.54
	203A	206A	0.17	4	4		14	1.62	162	3.54	1.86		0.00		0.00		0.00	0.00	0.17	1.62	0.53	2.40	50.5	200	1.10	34.40	0.07	1.09	0.62
Contribution From Rugosa Street, Pipe 205A - 206A								1.23	106				0.00		0.00		0.00		1.23	2.85									
	206A	207A	0.20	5	5		17	3.05	285	3.47	3.21		0.00		0.00		0.00	0.00	0.20	3.05	1.01	4.21	50.5	200	0.35	19.40	0.22	0.62	0.49
	207A	208A	0.12	2	2		7	3.17	292	3.47	3.28		0.00		0.00		0.00	0.00	0.12	3.17	1.05	4.33	12.0	200	0.35	19.40	0.22	0.62	0.50
	208A	214A	0.65	18	18		62	3.82	354	3.44	3.94		0.00		0.00		0.00	0.00	0.65	3.82	1.26	5.20	112.5	200	1.90	45.21	0.12	1.44	0.95
To Unknown Road1 - 07, Pipe 214A - 119A								3.82	354				0.00		0.00		0.00			3.82									
Foundation Lane																													
Contribution From Appalachian Circle, Pipe 208A - 214A								3.82	354				0.00		0.00		0.00		3.82	3.82									
Contribution From Appalachian Circle, Pipe 213A - 214A								1.09	84				0.00		0.00		0.00		1.09	4.91									
	214A	119A	0.08				0	4.99	438	3.40	4.83		0.00		0.00		0.00	0.00	0.08	4.99	1.65	6.48	59.0	200	0.35	19.40	0.33	0.62	0.55
To Montology Way, Pipe 119A - 120A								4.99	438				0.00		0.00		0.00			4.99									
Travertine Way																													
	119A	122A	0.52	13	13		45	0.52	45	3.66	0.53		0.00		0.00		0.00	0.00	0.52	0.52	0.17	0.71	86.5	200	0.65	26.44	0.03	0.84	0.36
	122A	123A	0.09	1	1		4	0.61	49	3.65	0.58		0.00		0.00		0.00	0.00	0.09	0.61	0.20	0.78	12.5	200	1.50	40.17	0.02	1.28	0.50
	123A	126A	0.20	4	4		14	0.81	63	3.63	0.74		0.00		0.00		0.00	0.00	0.20	0.81	0.27	1.01	50.0	200	3.20	58.67	0.02	1.87	0.70
To Sturnidae Street, Pipe 126A - 106A								0.81	63				0.00		0.00		0.00			0.81									
Contribution From Foundation Lane, Pipe 214A - 119A								4.99	438				0.00		0.00		0.00		4.99	4.99									
	119A	120A	0.60	17	17		58	5.59	496	3.38	5.43		0.00		0.00		0.00	0.00	0.60	5.59	1.84	7.28	103.5	200	0.35	19.40	0.38	0.62	0.57
	120A	121A	0.14	2	2		7	5.73	503	3.38	5.51		0.00		0.00		0.00	0.00	0.14	5.73	1.89	7.40	13.5	200	0.35	19.40	0.38	0.62	0.57
	121A	131A	0.43	10	10		34	6.16	537	3.37	5.86		0.00		0.00		0.00	0.00	0.43	6.16	2.03	7.89	110.0	200	0.90	31.12	0.25	0.99	0.82
Contribution From Montology Way, Pipe 130A - 131A								1.45	117				0.00		0.00		0.00		1.45	7.61									
	131A	135A	0.19	4	4		14	7.80	668	3.32	7.20		0.00		0.00		0.00	0.00	0.19	7.80	2.57	9.77	58.5	200	0.35	19.40	0.50	0.62	0.62
To Haiku Street, Pipe 135A - 118A								7.80	668				0.00		0.00		0.00			7.80									
Haiku Street																													
Contribution From Montology Way, Pipe 131A - 135A								7.80	668				0.00		0.00		0.00		7.80	7.80									
Contribution From Haiku Street, Pipe 134A - 135A								0.91	0				21.23		0.00		0.00		22.14	29.94									
	135A	118A						8.71	668	3.32	7.20		21.23		0.00		0.00	6.88	0.00	29.94	9.88	23.96	6.5	250	0.25	29.73	0.81	0.61	0.67
Contribution From Expansion Road, Pipe 1180A - 118A								2.87	227				0.00		0.00		1.45		4.32	34.26									
	118A	117A						11.58	895	3.26	9.47		21.23		0.00		1.45	7.04	0.00	29.94	9.88	26.38	119.0	300	0.20	43.25	0.61	0.61	0.64
Contribution From Haiku Street - Local Sewer, Pipe 118A - 117A								0.70	65				0.00		0.00		0.00			0.70									
	117A	116A						12.28	960	3.25	10.11		21.23		0.00		1.45	7.04	0.00	30.64	10.11	27.26	125.5	375	0.15	67.91	0.40	0.61	0.58
Contribution From Elevation Road, Pipe 106A - 116A								9.65	817				0.00		0.00		1.72		11.37	42.01									
	116A	1160A						21.93	1777	3.10	17.85		21.23		0.00		3.17	7.22	0.00	42.01	13.86	38.94	17.0	375	0.15	67.91	0.57	0.61	0.63
To Haiku Street, Pipe 1160A - 1150A								21.93	1777				21.23		0.00		3.17			42.01									

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha					
Average Daily Flow =	280	l/p/day			Industrial Peak Factor = as per MOE Graph				
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha	Extraneous Flow =		0.330	L/s/ha	
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha	Minimum Velocity =		0.600	m/s	
Max Res. Peak Factor =	3.80				Manning's n =	(Conc)	0.013	(Pvc)	0.013
Commercial/Inst./Park Peak Factor =	1.00				Townhouse coeff=		2.7		
Institutional =	0.32	l/s/Ha			Single house coeff=		3.4		

Designed: SLM	PROJECT: Ciavan Communities - Brazeau Phase 1		
Checked: ADF	LOCATION: City of Ottawa		
Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. 80-83	File Ref: 18-1030	Date: 27 Jul 2020	Sheet No. 4 of 6

1030_SAN_slm.xlsx

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION									COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	UNITS Singles	UNITS Townhouse	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
Haiku Street - Local Sewer																													
	109A	1100A	0.20	6		6	17	0.20	17	3.71	0.20		0.00		0.00		0.00	0.00	0.20	0.20	0.07	0.27	55.5	200	1.00	32.80	0.01	1.04	0.30
To Haiku Street, Pipe 1100A - 109A								0.20	17				0.00		0.00		0.00			0.20									
	1150A	1160A	0.24	6		6	17	0.24	17	3.71	0.20		0.00		0.00		0.00	0.00	0.24	0.24	0.08	0.28	41.5	200	0.65	26.44	0.01	0.84	0.27
To Haiku Street, Pipe 1160A - 115A								0.24	17				0.00		0.00		0.00			0.24									
	110A	111A	0.41	16		16	44	0.41	44	3.66	0.52		0.00		0.00		0.00	0.00	0.41	0.41	0.14	0.66	74.5	200	0.65	26.44	0.02	0.84	0.35
To Haiku Street, Pipe 111A - 110A								0.41	44				0.00		0.00		0.00			0.41									
	111A	115A	0.49	19		19	52	0.49	52	3.65	0.61		0.00		0.00		0.00	0.00	0.49	0.49	0.16	0.78	87.5	200	0.65	26.44	0.03	0.84	0.37
To Haiku Street, Pipe 115A - 111A								0.49	52				0.00		0.00		0.00			0.49									
	118A	117A	0.70	19	19		65	0.70	65	3.63	0.77		0.00		0.00		0.00	0.00	0.70	0.70	0.23	1.00	119.0	200	0.65	26.44	0.04	0.84	0.40
To Haiku Street, Pipe 117A - 116A								0.70	65				0.00		0.00		0.00			0.70									
	117A	116A	0.67	15	15		51	0.67	51	3.65	0.60		0.00		0.00		0.00	0.00	0.67	0.67	0.22	0.82	125.5	200	0.65	26.44	0.03	0.84	0.38
To Haiku Street, Pipe 116A - 1160A								0.67	51				0.00		0.00		0.00			0.67									
Haiku Street																													
Contribution From Haiku Street, Pipe 116A - 1160A								22.60	1828				21.23		0.00		3.17		42.68	42.68									
Contribution From Haiku Street - Local Sewer, Pipe 1150A - 1160A								0.24	17.00				0.00		0.00		0.00		0.00	0.24									
	1160A	1150A						22.84	1845	3.09	18.48		21.23		0.00		3.17	7.22	0.00	42.92	14.16	39.86	41.5	375	0.15	67.91	0.59	0.61	0.64
	1150A	115A						22.84	1845	3.09	18.48		21.23		0.00		3.17	7.22	0.00	42.92	14.16	39.86	4.5	375	0.15	67.91	0.59	0.61	0.64
Contribution From Focality Crescent, Pipe 114A - 115A								1.18	116				0.00		0.00		0.00		1.18	44.10									
Contribution From Haiku Street - Local Sewer, Pipe 111A - 115A								0.67	51.00				0.00		0.00		0.00		0.00	0.67									
	115A	111A						24.69	2012	3.07	20.00		21.23		0.00		3.17	7.22	0.00	44.77	14.77	41.99	87.5	375	0.15	67.91	0.62	0.61	0.65
Contribution From Haiku Street - Local Sewer, Pipe 110A - 111A								0.70	65.00				0.00		0.00		0.00		0.00	0.70									
	111A	110A						25.39	2077	3.06	20.59		21.23		0.00		3.17	7.22	0.00	45.47	15.01	42.81	74.5	375	0.15	67.91	0.63	0.61	0.65
Contribution From Focality Crescent, Pipe 108A - 110A								0.31	23				0.00		0.00		0.00		0.31	45.78									
	110A	1100A						25.70	2100	3.06	20.79		21.23		0.00		3.17	7.22	0.00	45.78	15.11	43.12	4.0	375	0.15	67.91	0.64	0.61	0.65
Contribution From Haiku Street - Local Sewer, Pipe 109A - 1100A								0.20	17.00				0.00		0.00		0.00		0.00	0.20									
	1100A	109A						25.90	2117	3.05	20.95		21.23		0.00		3.17	7.22	0.00	45.98	15.17	43.34	55.5	375	0.15	67.91	0.64	0.61	0.65
To Obsidian Street, Pipe 109A - 400A								25.90	2117				21.23		0.00		3.17			45.98									
Future Commercial																													
	2A	2250A						0.00				2.99	2.99		0.00		0.00	0.97	2.99	2.99	0.99	1.96	11.0	200	0.35	19.40	0.10	0.62	0.39
To Obsidian Street, Pipe 2250A - 226A								0.00	0				2.99		0.00		0.00			2.99									
Obsidian Street																													
	224A	225A	0.33	9		9	25	0.33	25	3.69	0.30		0.00		0.00		0.00	0.00	0.33	0.33	0.11	0.41	75.0	200	0.65	26.44	0.02	0.84	0.30
	225A	2250A	0.27	8		8	22	0.60	47	3.66	0.56		0.00		0.00		0.00	0.00	0.27	0.60	0.20	0.75	67.5	200	0.90	31.12	0.02	0.99	0.41
Contribution From Future Commercial, Pipe 2A - 2250A								0.00	0				2.99		0.00		0.00		2.99	3.59									
	2250A	226A	0.15	3		3	9	0.75	56	3.64	0.66		2.99		0.00		0.00	0.97	0.15	3.74	1.23	2.86	46.0	200	1.40	38.81	0.07	1.24	0.71
	226A	109A	0.34	9		9	25	1.09	81	3.61	0.95		2.99		0.00		0.00	0.97	0.34	4.08	1.35	3.26	92.0	200	1.60	41.49	0.08	1.32	0.78
Contribution From Haiku Street, Pipe 1100A - 109A								25.90	2117				21.23		0.00		3.17		45.98	50.06									
Contribution From Future Residential, Pipe 3A - 109A								1.90	162				0.00		0.00		0.00		1.90	51.96									
	109A	400A	0.09				0	28.98	2360	3.02	23.12		24.22		0.00		3.17	8.19	0.09	52.05	17.18	48.49	63.0	375	0.15	67.91	0.71	0.61	0.67
To Drummond Future Road , Pipe 400A - 401A								28.98	2360				24.22		0.00		3.17			52.05									

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha
Average Daily Flow =	280	l/p/day		
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha
Max Res. Peak Factor =	3.80			
Commercial/Inst./Park Peak Factor =	1.00			
Institutional =	0.32	l/s/Ha		

Industrial Peak Factor = as per MOE Graph
Extraneous Flow = 0.330 L/s/ha
Minimum Velocity = 0.600 m/s
Manning's n = (Conc) 0.013 (Pvc) 0.013
Townhouse coeff= 2.7
Single house coeff= 3.4

Designed: SLM
Checked: ADF
Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. 80-83

PROJECT: **Ciavan Communities - Brazeau Phase 1**
LOCATION: **City of Ottawa**
File Ref: 18-1030
Date: **27 Jul 2020**
Sheet No. 5 of 6

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION									COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	UNITS Singles	UNITS Townhouse	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
Drummond Future Road																													
Contribution From Obsidian Street, Pipe 109A - 400A								28.98	2360				24.22		0.00		3.17		52.05	52.05									
	400A	401A	0.24				25	29.22	2385	3.02	23.34		24.22		0.00		3.17	8.19	0.24	52.29	17.26	48.79	72.5	375	0.15	67.91	0.72	0.61	0.67
	401A	402A	0.14				15	29.36	2400	3.02	23.48		24.22		0.00		3.17	8.19	0.14	52.43	17.30	48.97	62.0	375	0.15	67.91	0.72	0.61	0.67
To future Greenbank Road, Pipe 402A - 403A								29.36	2400				24.22		0.00		3.17			52.43									
Future Greenbank Road																													
Contribution From Drummond Future Road, Pipe 401A - 402A								29.36	2400				24.22		0.00		3.17		52.43	52.43									
	402A	403A	0.38				0	29.74	2400	3.02	23.48		24.22		0.00		3.17	8.19	0.38	52.81	17.43	49.09	80.0	375	0.15	67.91	0.72	0.61	0.67
	403A	404A	0.33				0	30.07	2400	3.02	23.48		24.22		0.00		3.17	8.19	0.33	53.14	17.54	49.20	80.0	375	0.15	67.91	0.72	0.61	0.67
	404A	405A	0.33				0	30.40	2400	3.02	23.48		24.22		0.00		3.17	8.19	0.33	53.47	17.65	49.31	81.0	375	0.15	67.91	0.73	0.61	0.67
Contribution From Expansion Road, Pipe 1313A - 405A							0	15.39	1492				0.00		0.00		0.00		0.00	15.39									
	405A	406A	0.25				0	46.04	3892	2.88	36.26		24.22		0.00		3.17	8.19	0.25	69.11	22.81	67.26	59.5	375	0.25	87.67	0.77	0.79	0.87
	406A	407A	0.35				0	46.39	3892	2.88	36.26		24.22	6.06	6.06		3.17	10.15	6.41	75.52	24.92	71.34	83.5	375	0.30	96.03	0.74	0.87	0.95
	407A	408A	0.46				0	46.85	3892	2.88	36.26		24.22		6.06		3.17	10.15	0.46	75.98	25.07	71.49	110.0	375	0.30	96.03	0.74	0.87	0.95
	408A	409A	0.40				0	47.25	3892	2.88	36.26		24.22		6.06		3.17	10.15	0.40	76.38	25.21	71.62	96.5	375	0.30	96.03	0.75	0.87	0.95
	409A	410A	0.51				0	47.76	3892	2.88	36.26		24.22		6.06		3.17	10.15	0.51	76.89	25.37	71.79	120.0	375	0.30	96.03	0.75	0.87	0.95
	410A	570A	0.30				0	48.06	3892	2.88	36.26		24.22		6.06		3.17	10.15	0.30	77.19	25.47	71.89	63.0	375	0.30	96.03	0.75	0.87	0.95
	570A	57A						48.06	3892	2.88	36.26		24.22		6.06		3.17	10.15	0.00	77.19	25.47	71.89	15.0	375	0.50	123.98	0.58	1.12	1.16

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha
Average Daily Flow =	280	l/p/day		
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha
Max Res. Peak Factor =	3.80			
Commercial/Inst./Park Peak Factor =	1.00			
Institutional =	0.32	l/s/Ha		

Industrial Peak Factor = as per MOE Graph
Extraneous Flow = 0.330 L/s/ha
Minimum Velocity = 0.600 m/s
Manning's n = (Conc) 0.013 (Pvc) 0.013
Townhouse coeff= 2.7
Single house coeff= 3.4

Designed: SLM
Checked: ADF
Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. 80-83

PROJECT: **Ciavan Communities - Brazeau Phase 1**
LOCATION: **City of Ottawa**
File Ref: 18-1030
Date: **27 Jul 2020**
Sheet No. 6 of 6

1030_SAN_slm.xlsx

E.2 STORMWATER MANAGEMENT REPORT FOR THE RIDGE (BRAZEAU LANDS) BY JFSA (JULY 2020)

Stormwater Management Report for The Ridge (Brazeau) Subdivision

City of Ottawa
July 2020

Prepared for: David Schaeffer Engineering Ltd.

JFSA Ref. No.: 1800-19

Prepared by:

JFSA Water Resources and Environmental Consultants

J.F. Sabourin and Associates Inc.
www.jfsa.com

JFSA Water Resources and Environmental Consultants

J.F. Sabourin and Associates Inc.
52 Springbrook Drive, Ottawa, ON K2S 1B9
tel.: 613.836.3884, fax: 613.836.0332, www.jfsa.com

Stormwater Management Report for The Ridge (Brazeau) Subdivision

in the City of Ottawa

July 2020

Prepared for :

David Schaeffer Engineering Ltd.

LICENSED PROFESSIONAL ENGINEER
J. J. BURNETT
100227734
PROVINCE OF ONTARIO

Prepared by :

Jonathon Burnett, B.Eng., P.Eng.

JFSA Ref. No.: 1800-19

Stormwater Management Report for The Ridge (Brazeau) Subdivision
in the City of Ottawa

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

Stormwater Management Report for The Ridge (Brazeau) Subdivision
in the City of Ottawa
July 2020

1 INTRODUCTION AND OBJECTIVES

J.F. Sabourin and Associates Inc. (JFSA) were retained by David Schaeffer Engineering Ltd. (DSEL) to prepare a Stormwater Management (SWM) Plan for the Ridge (Brazeau) Subdivision, located within the City of Ottawa. As shown by the image provided on the cover page, the future development is located east of Borrisokane and Highway 416, and south of Cambrian Road. The proposed development will be serviced by a dry SWM pond that will be implemented in the northwest corner of the development and will discharge to the Jock River via an existing ditch on the west side of Borrisokane Road. The proposed development will also be serviced by two oil-and-grit separators that discharge to the SWM pond, that have been sized to ensure 80% Total Suspended Solids (TSS) removal, for more details regarding the OGS units with the development please refer to JFSA's July 2020, Pond Design Brief for the Ridge (Brazeau) Subdivision. As documented in the Barrhaven South Urban Expansion Area Master Servicing Study, by J. L Richards 2018, the development will also have Etobicoke Exfiltration Systems (EES) implemented within this subdivision. These EES will be installed within local roadways of the subdivision, to exfiltrate runoff from the development for the more frequent events. To ensure that the SWM analysis is conservative, these EES's have not been included in this detailed analysis. Please refer to JFSA's "The Ridge (Brazeau) LID Design Report" July 2020 for full details regarding the operations and benefits of the proposed Etobicoke Exfiltration Systems within the site.

The Ridge (Brazeau) development has a total drainage area of 37.03 ha, including a 3.94 ha pond block, a 1.72 ha park block, 2.68 ha of commercial blocks and 28.69 ha of residential development. The proposed development will be treated by the dry pond, along with 21.21 ha of external future commercial development and 13.5 ha of external residential development, for a total drainage area of 71.75 ha. Figure 1 provides an overview of the location of these respective blocks within the subdivision.

The purpose of this report is to evaluate the major and minor system flows of the proposed development with respect to new proposed stormwater management guidelines and to check the adequacy of the proposed pipe sizes to convey the 2-year (5-year on collector and 10-year on arterial roads) and the 100-year storm flows from within the development and from external areas. Background documents that were reviewed in preparing this report include the following:

- *Stormwater Management Planning and Design Manual,* Ministry of the Environment, March 2003.

- *Jock River Flood Risk Mapping (within the City of Ottawa) Hydraulics Report*, PSR Group Ltd. and J.F. Sabourin and Associates Inc., November 2004.
- *Erosion and Sediment Control Guidelines for Urban Construction,* Conservation Halton et al., December 2006.
- *Draft City of Ottawa Stormwater Management Facility Design Guidelines*, IBI Group, April 2012.
- *City of Ottawa Sewer Design Guidelines*, City of Ottawa, October 2012.
- *Technical Bulletin ISDTB-2014-01, Revisions to Ottawa Design Guidelines – Sewer,* City of Ottawa, February 2014.
- *City of Ottawa Technical Bulletin PIEDTB-2016-01*, City of Ottawa, September 2016.
- *City of Ottawa Technical Bulletin ISTB-2018-04*, City of Ottawa, June 2018.
- *Functional Servicing Report for Caivan Communities, Brazeau Lands, 3809 Borrisokane Road*, David Schaeffer Engineering Limited, September 2019.
- *Design Brief for the Stormwater Management Pond for the Ridge (Brazeau) Subdivision,* David Schaeffer Engineering Limited and J.F. Sabourin and Associates Inc., April 2020.

As per the new approach formalized in the September 2016 *City of Ottawa Technical Bulletin PIEDTB-2016-01*, the proposed subdivision has been designed with a 2-year minor system level of service on local roads and 5-year level of service on collector roads (Elevation Road). Where possible with grading and minor system capture limitations, road ponding areas up to 35 cm deep were used to contain the 100-year major system flows.

The SWMHYMO and PCSWMM computer programs were used to model the major and minor systems, to ensure that all the new stormwater management requirements are satisfied. The general SWM design criteria and guidelines that are to be met are described in Section 2.

Figure 1: General Site Location

2 DESIGN CRITERIA AND GUIDELINES

The design criteria and guidelines used for the stormwater management of the subject subdivision are those that were developed in the background documents, as well as those provided in the October 2012 *City of Ottawa Sewer Design Guidelines* and subsequent technical memorandums, and generally accepted stormwater management design guidelines.

The detailed design of the proposed development determined that the 37.03 ha subdivision has an average imperviousness of 54%. The total 71.75 ha drainage area to the dry pond has an average imperviousness of 64%.

A detailed analysis of the proposed dual drainage system was required to confirm that the following general design criteria and guidelines for the minor and major systems would be met.

2.1 Minor System

a) Storm sewers are to be designed to provide a minimum 2-year level of service, plus 5-year inflows on collector roads (Elevation Road) and 10-year inflows on arterial roads.

b) The 100-year hydraulic grade line (HGL) within the development minor systems must be maintained at least 0.3 m below the underside of footing elevation where gravity house connections are installed.

c) For less frequent storms (i.e. larger than 1:2 year or 1:5 year on collector / 1:10 year on arterial roads), the minor system shall, if required, will be limited with the use of inlet control devices to prevent excessive hydraulic surcharges and to maximize the use of surface storage on the road where desired.

d) Catchbasins on the road are to be equipped with City standard type S19 (fish) grates or City standard type S22 side inlets, and grates for catchbasins in rear yards, park and open spaces with pedestrian traffic are to be City standard type S19, S30 and S31.

e) Single catchbasins are to be equipped with 200 mm minimum lead pipes, and double catchbasins are to be equipped with 250 mm minimum lead pipes.

f) Rearyard catchbasins are to be equipped with 250 mm minimum lead pipes. Catchbasins installed on the street, where rearyard catchbasins connect to the main storm sewer through the catchbasin, are to be equipped with 250 mm minimum lead pipes for both single and double catchbasins.

g) Under full flow conditions, the allowable velocity in storm sewers is to be no less than 0.80 m/s and no greater than 3.0 m/s. Where velocities over 3.0 m/s are proposed, provisions shall be made to protect against displacement of sewers by sudden jarring or movement. Velocities greater than 6 m/s are not permitted.

2.2 Major System

a) The major system shall be designed with enough road surface storage to allow the excess runoff of a 100-year storm to be retained within road ponding areas where desired.

b) Inlet control devices should be sized such that they do not create surface ponding on the road during the 2-year design storm on local roads (5-year design storm on collector and 10-year design storm on arterial roads); it should be noted that surface ponding over grates is present during rainfall under any design, as an appropriate depth of water is required for runoff to enter the grate (refer to Tables D-6 of Appendix D).

c) Roof leaders shall be installed to direct the runoff to splash pads and on to grassed areas.

d) For the 100-year storm, the maximum total depth of water (static + dynamic) on all roads shall not exceed 35 cm at the gutter.

e) During the 100-year + 20% stress test, the maximum extent of surface water on streets, rearyards, public space and parking areas shall not touch the building envelope.

f) When catchbasins are installed in rear yards, safe overland flow routes are to be provided to allow the release of excess flows from such areas.

g) The product of the maximum flow depths on streets and maximum flow velocity must be less than 0.60 m^2/s on all roads.

h) The excess major system flows up to the 100-year return period are to be retained on-site in development blocks such as parks, schools, commercial, etc.

i) There must be at least 15 cm of vertical clearance between the spill elevation on the street and the ground elevation at the nearest building envelope that is in the proximity of the flow route or ponding area.

j) There must be at least 30 cm of vertical clearance between the rearyard spill elevation and the ground elevation at the adjacent building envelope.

3 ASSUMPTIONS AND SOURCE OF DATA USED IN THIS STUDY

Sources of information and assumptions made in this study are listed below:

- Stormwater management model: *SWMHYMO (version 5.50), and PCSWMM (version 7.2)*
- Minor system design: *1:2 year, plus 1:5-year inflows on collector roads and 1:10 year on arterial roads. See the Rational Method Calculations in Appendix A.*
- Major system design: *1:100 year*
- Max. 100-yr water depth on roads: *35 cm above the gutter*
- Extent of the major system: *Shall not touch the building envelope during the 100-year + 20% stress test*
- PCSWMM model parameters: *Fo = 76.2 mm/hr, Fc = 13.2 mm/hr, DCAY = 4.14/hr, D.Stor.Imp. = 1.57 mm, D.Stor.Per. = 4.67 mm (as per 2012 City of Ottawa Sewer Design Guidelines)* *Detailed Area Imperviousness: based on development layout. Lumped Area Imperviousness: based on runoff coefficient (C) where C = 0.7 x imperviousness ratio+ 0.2.*
- Design storms: *2-, 5-, 10- and 100-year 3-hour Chicago and 100-year 24-hour SCS Type II storms as per 2012 City of Ottawa Sewer Design Guidelines; peak averaged over 10 minutes.*
- Historical Events: *July 1st, 1979; August 4th, 1988; and August 8th, 1996 events as per 2012 City of Ottawa Sewer Design Guidelines.*
- Stress Test: *20% increase in the 100-year 3-hour Chicago storm.*
- Street catchbasin covers: *City Standard Type S19 (fish) or City Standard Type S22 (side inlet). Type S19 approach flow-capture curves as per MTO design charts (equivalent to OPSD 400.010). Type S22 approach flow-capture curves as per the 2004 City of Ottawa Guidelines.*
- Rearyard catchbasin covers: *City Standard Type S19, S30 and S31*
- Curb and gutter: *City Standard SC1.3 (mountable) and SC1.1 (barrier). In the absence of flow capture curves for these curbs and gutters, OPSD 600.010 curb and gutters are assumed.*
- Manning's' roughness coeff.: *0.013 for concrete and PVC pipes (free flow).*
- Minor system losses: *Refer to Appendix C for maintenance hole loss coefficients.*
- Underside of footing elevations: *As provided by DSEL.*
- Freeboard in HGL analysis: *0.3 m between the underside of footing elevation and 100-year hydraulic gradeline.*
- Inlet Control Devices: *Refer to Appendix B for Plas-Tech ICD details.*
- Depth of backyard swales: *As per DSEL's Grading Plan*
- Street and pipe dimensions: *As per DSEL's Plan and Profiles*
- Right-of-way characteristics: *As per DSEL's Details of Roads*
- Downstream HGL: *92.5 m based on the top of bank elevation of the ditch that the SWM pond will outlet to.*

4 PROPOSED MINOR AND MAJOR SYSTEM DRAINAGE

The proposed minor and major system drainage routes are shown in plan view in Figures 2 and 3. The residential areas where enough detail was available were modelled in PCSWMM. External or large undetailed future development areas within the subdivision were modelled in SWMHYMO based on the preliminary design information available. The hydrographs generated by SWMHYMO were then read into the PCSWMM model as external hydrographs.

Per the new proposed standards, the minor system has been designed to accommodate a minimum of the 2-year post-development flows from within the site and from external areas, plus 5-year inflows on collector roads (Elevation Road) and 10-year inflows on arterial roads. A Rational Method design was conducted by DSEL (refer to Appendix A) to estimate minor system flows based on the City of Ottawa IDF relationship and selected runoff coefficients.

The minor system release rates from the parklands were set to the 5-year flow based on the rational method, with onsite storage provided up to the 100-year event. The east most commercial lands were limited to the 2-year rational method, with onsite storage provided up to the 100-year event. The ABIC commercial lands were limited to the 2-year pre-development flow per the rational method, and the Brazeau Commercial site limited to maximum flow 1.8m³/s (as per the most recent analysis for the Commercial Brazeau lands), with both sites assumed to have onsite storage provided to the 100-year event. Refer to DSEL's June 2020 Site Plan Report for more details regarding the ABIC site. The collector roads (Elevation Road) were limited to the 5-year rational method as per the City guidelines. The residential lands were limited to 2-year Chicago 3-hour flow + 14% (as calculated by SWMHYMO) to account for additional capture during the 100-year storm as a result of increased head over the catchbasins and lead pipes or inlet control devices, with onsite storage provided to the 100-year event.

For these residential lands under the stress test scenario (100-year Chicago 3-hour +20%) it was assumed that the minor system was set at 107% of 100-year capture, and 100-year + 20% stress test storage set to 145% of 100-year storage. This approach for the residential lands is based on the Abbottsville Crossing was a pilot project. Which looked at the 2-year capture on local road and containment of excess 100-year flows in road ponding areas. Minor system capture during the 100-year + 20% stress test at the detailed design stage for a subdivision or site plan can be evaluated based on the actual design information, e.g. catch basin grate and ICD head-capture relationships, surface storage volumes, simulated water depth, etc. However, there is no set standard or easy rule of thumb for excess capture through catch basin grates, lead pipes and Inlet Control Devices (ICDs) during the 100-year + 20% stress test for undetailed future development areas, where these details don't exist yet. As such, the detailed modelling for the Abbottsville Crossing pilot project has been used as a reference to create a rule of thumb for undetailed areas. As shown in Table D-8 of Appendix D of the September 2018 SWM Report for the Abbottsville Crossing subdivision, minor system capture in the detailed subdivision modelling during the 100-year + 20% storm was 107% greater than the 100-year capture. Similarly, 100-year + 20% surface storage volumes used were 155% greater than those used during the 100-year storm. This was reduced to 145% to be conservative for preliminary modelling of undetailed areas. Refer to Table D-3C in Appendix D for the simulated release rates for the various undetailed lands for the full suite of return periods based on the SWMHYMO modelling.

As noted earlier in this report, where possible with grading limitations, road ponding areas up to 35 cm deep were used to contain the 100-year major system flows in the development. Note that rearyard catchbasins were connected to catchbasins on the road where possible, to allow rearyard runoff access to the storage in road ponding areas at regular intervals. In a design of this type where lots are serviced by gravity house connections, inlet control devices (ICDs) can be used to limit minor system capture at each catchbasin to the appropriate level of service.

Within the development, circular orifice plate type Inlet Control Devices (ICDs) of City standard diameters 83 mm, 94 mm, 102 mm, 108 mm, 127 mm, 152 mm and 178 mm will be used to limit minor system capture to a minimum of the 2-year flow (refer to Appendix B for Plas-Tech ICD details), allowing for sub-surface storage of 0.5 m^3 in single catchbasins, 1.0 m^3 in double catch basins, and 1.9 m^3 in catchbasin manholes. Note that this subsurface catchbasin storage has not been included in the modelling to be conservative.

The street segments within the proposed development have been designed using a 'saw tooth' or 'sagged' road profile. The runoff from within these segments will be conveyed to catchbasins located at the lowest point within the street segment. Flows more than the catchbasin capture rate will be temporarily stored within the 'sagged' street segments and released slowly to the storm sewers, up to the 100-year design storm. When the storage on a specific street segment is surpassed due to blockage or an event greater than the 100-year storm, the excess water will flow towards the next downstream street sag, and eventually to the pond. It should be noted that the major system would outlet during the 100-year + 20% stress test without flooding any of the properties within the subdivision.

If the drainage system’s capacity to capture surface flows is exceeded, Figure 4 presents the maximum extent of static surface ponding and volume on the streets based on grading. Additionally, surface storage volumes that may exist in the rear yards have not been considered in this model, and runoff from these areas have been directed straight to the catchbasin that the rear yard swale will discharge to. This has been completed to ensure that the peak flows and ponding volumes calculated in the model are conservative.

The SWMHYMO and PCSWMM analyses, discussed in Sections 4.1 and 4.2, have demonstrated that the proposed drainage system for the subdivision will have sufficient capacity to control the excess flow during a 100-year storm and safely capture and convey the 2-year (plus 5-year on collector roads and 10-year on arterial roads) flow to the pond.

4.1 Major System and SWM Analysis

The PCSWMM and SWMHYMO computer programs were used to model the major and minor system flows within the proposed development and from external areas. As noted above, as the PCSWMM program is most appropriate for use in modelling small urban drainage areas, most undetailed future development areas were instead modelled using SWMHYMO.

The PCSWMM and SWMHYMO models were developed based on the information provided in Figures 2 and 3. Nine (9) simulations were conducted, one for each of the following rainfall events:

i) The 25 mm, 3-hour Chicago storm;
ii) the 2-year, 3-hour Chicago storm;
iii) the 5-year, 3-hour Chicago storm;
iv) the 100-year, 3-hour Chicago storm;
v) the 100-year, 24-hour SCS Type II storm
vi) the July 1st, 1979 historical event;
vii) the August 4th, 1988 historical event;
viii) the August 8th, 1996 historical event; and
ix) the 100-year, 3-hour Chicago storm + 20%.

Note that the purpose of simulating the 100-year, 3-hour Chicago storm with a 20% increase is to stress test the drainage system for potential flooding, as per the October 2012 *City of Ottawa Sewer Design Guidelines*.

The depression storage and infiltration parameters in both the PCSWMM and SWMHYMO models are as per the October 2012 *City of Ottawa Sewer Design Guidelines*. The percent imperviousness of the detailed drainage areas was measured based on the proposed development layout. The proposed development layouts have been established based on zoning requirements and represent the largest allowable footprint on each lot. DSEL have measured the impervious area in each catchment discreetly, and as such, the percent impervious values can be considered to be based on zoning. The percent imperviousness of undetailed (lumped/external) drainage areas were calculated based on the runoff coefficient (C), where C = 0.7 x imperviousness ratio + 0.2. Figure 1 provides an overview of the subcatchments, and Table D-3A and D-3B provide a full summary of all subcatchment parameters modelled in PCSWMM and SWMHYMO respectively.

The approach flow/capture curves applied in the PCSWMM model were based on the values outlined in the City of Ottawa Sewer Design Guidelines (Appendix 7-A.13). These approach flow/capture curves were converted to a depth/capture curve using PCSWMM's diversion node and kinematic wave equations. A depth/capture curve was derived for each of the cross-section profiles and the various slopes. Where required inflows are limited by circular orifice plate type Inlet Control Devices (ICDs) of City standard diameters 83 mm, 94 mm, 102 mm, 108 mm, 127 mm, 152 mm and 178 mm. Note that 200 mm diameter lead pipes were assumed and are required between single catchbasins and the storm sewers, and 250 mm diameter lead pipes were assumed and are required between rearyard catchbasins or single catchbasin manholes and the storm sewers. Double catchbasins and double catchbasin maintenance holes are to be equipped with 250 mm diameter lead pipes. No temporary CBs are required within the development. Refer to Table D-4A in Appendix D for the depth/capture curves applied in the model for catch basins on a constant slope, and Table D-4B for catchbasins at localized depressions with ICD's.

Within the proposed subdivision, the dynamic flow depth on the road (at the gutter) will be minimal during the 100-year Chicago storm, as the 100-year flows are mostly retained within the road ponding areas and do not accumulate as in a typical subdivision design. Furthermore, it was determined that for the 100-year storm at all major system segments, the product of the depth of water (m) at the gutter multiplied by the velocity of flow (m/s) will not exceed the maximum allowable 0.6 m^2/s (refer to Table D-8 of Appendix D, where the calculated maximum was determined to be 0.56 m^2/s). Table D-9 of Appendix D presents the stress test results for dynamic flow depth on the road based on a 20% increase in the 100-year storm, as per the October 2012 *City of Ottawa Sewer Design Guidelines*. As shown in Table D-9, the maximum dynamic flow depth under these conditions is calculated as 0.48 cm, and the product of the depth of water at the gutter multiplied by the velocity of flow is 0.59 m^2/s. Refer below for an assessment of the ponding depth on the road.

Details of the 100-year street maximum water depth and surf elevations are provided in Table D-7 of Appendix D. Based on DSEL's grading the major system has approximately 896 m^3 of storage at these localized low points throughout the development. Depths calculated by the PCSWMM model demonstrates that a total 100-year depth of water (static and dynamic) on the street at these ponding areas will not exceed the maximum depth of 35 cm.

Table D-7 of Appendix D also presents the street storage stress test results based on a 20% increase in the 100-year storm, as per the October 2012 *City of Ottawa Sewer Design Guidelines*. As shown in Table D-7, the maximum depth of water (static + dynamic overflow) at any ponding area under these conditions is calculated as 48 cm. The maximum extent of surface water during the 100-year + 20% stress test will not touch the building envelopes, refer to DSEL drawings number 95-97 for the flood extent of these ponding depths.

An overland flow route is to be provided on Expansion Road in the subdivision to safely convey flows to the pond (Junction C144). This overflow has been set that the crest of the spill elevation and has been represented in the model as a 5m wide open rectangular cross-section. The curb cut and overland flow route are to be constructed as required to convey the 100-year major system flow without exceeding 35 cm during the 100-year storm, and without touching the building envelopes during the 100-year + 20% stress test. Based on the PCSWMM model the overland flow route will have a maximum normal flow depth of 5 cm during the 100-year 3-hour Chicago storm and 6 cm during the 100-year + 20% stress test. Table 1 presents a summary of the major system results simulated in PCSWMM during the 100-year Chicago storm.

Table 1: Summary of Major System Results for the 100-Yea

Catch Basin ID	Flow Depth (cm)	Approach Flow (m^3/s)	Captured Flow (m^3/s)
CB_001	20	0.032	0.021
CB_002	20	0.032	0.019
CB_003	28	0.222	0.099
CB_004	28	0.222	0.045
CB_005	21	0.132	0.044
CB_006	21	0.132	0.071
CB_007	10	0.180	0.038
CB_008	9	0.133	0.034
CB_009	9	0.133	0.034
CB_010	7	0.070	0.020
CB_011	7	0.070	0.020
CB_012	15	0.043	0.031
CB_013	15	0.043	0.018
CB_014	5	0.048	0.014
CB_015	5	0.048	0.014
CB_016	5	0.064	0.016
CB_017	9	0.747	0.195
CB_018	10	0.414	0.036
CB_019	10	0.453	0.034
CB_020	9	0.406	0.033
CB_021	27	0.120	0.033
CB_022	27	0.120	0.033
CB_023	13	0.085	0.021
CB_024	29	0.177	0.073
CB_025	29	0.177	0.046
CB_026	23	0.077	0.019
CB_027	23	0.077	0.024
CB_028	23	0.076	0.032
CB_029	23	0.076	0.019
CB_030	28	0.204	0.051
CB_031	28	0.204	0.073
CB_032	20	0.101	0.070
CB_033	20	0.101	0.019
CB_034	5	0.054	0.011
CB_035	4	0.056	0.012
CB_036	8	0.113	0.026
CB_037	8	0.113	0.026
CB_038	9	0.249	0.035
CB_039	25	0.190	0.098
CB_040	25	0.190	0.064
CB_041	7	0.112	0.023
CB_042	7	0.112	0.023
CB_043	9	0.192	0.030
CB_044	9	0.192	0.030
CB_045	27	0.197	0.089
CB_046	27	0.197	0.065
CB_047	29	0.307	0.090
CB_048	29	0.307	0.090
CB_049	27	0.168	0.045
CB_050	27	0.168	0.072
CB_051	29	0.192	0.073
CB_052	29	0.192	0.046
CB_053	10	0.496	0.033
CB_054	9	0.412	0.029
CB_055	12	0.428	0.042

Table 1: Summary of Major System Results for the 100-Yea

Catch Basin ID	Flow Depth (cm)	Approach Flow (m^3/s)	Captured Flow (m^3/s)
CB_056	9	0.130	0.030
CB_057	9	0.130	0.030
CB_058	10	0.273	0.039
CB_059	8	0.210	0.029
CB_060	8	0.210	0.029
CB_061	6	0.112	0.022
CB_062	6	0.112	0.022
CB_065	3	0.032	0.006
CB_066	6	0.047	0.016
CB_067	6	0.047	0.016
CB_068	6	0.074	0.017
CB_069	6	0.074	0.017
CB_070	6	0.067	0.018
CB_071	6	0.067	0.018
CB_072	6	0.133	0.020
CB_073	35	0.278	0.074
CB_074	35	0.278	0.067
CB_075	13	0.273	0.043
CB_076	13	0.273	0.043
CB_077	8	0.300	0.029
CB_078	28	0.204	0.036
CB_079	28	0.204	0.029
CB_080	35	0.225	0.101
CB_081	35	0.225	0.091
CB_082	29	0.165	0.066
CB_083	29	0.165	0.100
CB_084	34	0.172	0.034
CB_085	34	0.172	0.046
CB_086	21	0.141	0.071
CB_087	21	0.141	0.044
CB_088	31	0.109	0.020
CB_089	31	0.109	0.046
CB_090	4	0.058	0.011
CB_091	6	0.101	0.018
CB_092	6	0.101	0.018
CB_093	8	0.234	0.025
CB_095	9	0.135	0.036
CB_096	9	0.135	0.036
CB_097	6	0.059	0.018
CB_098	6	0.059	0.018
CB_099	27	0.146	0.045
CB_100	27	0.146	0.050
CB_101	3	0.016	0.004
CB_102	31	0.178	0.073
CB_103	31	0.178	0.020
CB_104	9	0.060	0.029
CB_105	9	0.060	0.029
CB_106	30	0.199	0.066
CB_107	30	0.199	0.100
CB_108	8	0.164	0.028
CB_109	6	0.152	0.023
CB_111	29	0.182	0.046
CB_112	9	0.062	0.028
CB_113	9	0.062	0.028
CB_114	26	0.181	0.072

Table 1: Summary of Major System Results for the 100-Yea

Catch Basin ID	Flow Depth (cm)	Approach Flow (m^3/s)	Captured Flow (m^3/s)
CB_115	26	0.181	0.072
CB_116	12	0.071	0.043
CB_118	19	0.059	0.027
CB_119	19	0.059	0.024
CB_120	19	0.112	0.070
CB_121	19	0.112	0.044
CB_123	12	0.071	0.048
CB_124	16	0.050	0.035
CB_125	16	0.050	0.018
CB_126	19	0.069	0.021
CB_127	19	0.069	0.032
CB_128	10	0.180	0.038
CB_129	6	0.045	0.015
CB_130	6	0.045	0.015
CB_131	11	0.402	0.037
CB_201	0	0.012	0.012
CB_203	11	0.103	0.020
CB_204	0	0.014	0.014
CB_205	14	0.146	0.048
CB_206	16	0.090	0.021
CB_207	16	0.086	0.021
CB_208	0	0.018	0.018
DCB_063	28	0.170	0.033
DCB_064	28	0.170	0.051
DCB_110	29	0.182	0.073
DCB_117	5	0.160	0.082
DCB_122	5	0.160	0.042
DICB_1	22	0.052	0.019
DICB_2	22	0.052	0.019
DICB_3	25	0.097	0.025
DICB_4	25	0.097	0.025

4.2 Minor System and Hydraulic Grade line Analysis

The minor system analysis was completed using the PCSWMM program based on the peak flows captured during the rainfall events. Note that the storm sewer design is as provided by DSEL, and a Manning's roughness coefficient of 0.013 was used for concrete and PVC storm sewer pipes. Refer to Appendix C for maintenance hole loss coefficients used in the PCSWMM model.

The minor system performance was analyzed under restrictive downstream conditions. Restrictive downstream conditions for the pond are based on the approximate top of bank elevation of 92.5 m at the existing Borrisokane Road ditch that the storm sewer will outlet too. Table 2 presents the peak minor system outflows obtained with the above-mentioned simulations.

Table 2: Comparison of Minor System Flows to the Pond

Location	DSEL Rational Method Flow (m^3/s)	2-Year PCSWMM/ SWMHYMO Flow (m^3/s)	5-Year PCSWMM/ SWMHYMO Flow (m^3/s)	100-Year PCSWMM/ SWMHYMO Flow (m^3/s)
MH 501 to Pond	1.028	2.924	3.966	5.175
MH 401 to Pond	4.787	2.836	4.252	5.737
Total (1)	5.815	5.76	8.218	10.912

(1)The total flow is taken as the direct summation of peak inflows and does not consider the difference in the timing of peaks

Table 2 shows that the total 2-year flows simulated by the PCSWMM/SWMHYMO models are similar to the values calculated by DSEL's Rational Method calculations. Although there is a difference in the individual flows calculated at MH 401 and MH 501 between the Rational method and PCSWMM results. This can be explained by the fact that these two branches will be connected upstream at MH 313 and MH 307 to make full use of the OGS units and minor system infrastructure; this connection has been represented in the PCSWMM modelling but not in the Rational Method calculations.

The PCSWMM/SWMHYMO simulations have determined that for the selected 2-, 5- and 100-year storms, the total minor system flows would be 5.76 m^3/s, 8.218 m^3/s and 10.912 m^3/s, respectively. Note that the values above are simply a summation of peak flows from MH 501 and MH 401 and do not consider the timing of peaks. Although the 100-year flow will surcharge most parts of the minor system, a freeboard of 0.3 m between the 100-year hydraulic grade line and the underside of footings has been provided throughout the proposed development.

The proposed development will provide 80% TSS removal through the use of 2 OGS units, that will treat runoff from high pollutant areas. The total area directed to the OGS units is equal to 60.42 ha, note this does not include the Pond Block or ABIC lands which would not contribute to the OGS. The two OGS units (manufacturer: CDS model: PMSU5668_10) will be implemented within this development downstream of MH 313 and MH 307. Each unit will have a total holding capacity of 25,960 L, a sump capacity of 8,896 L and an oil capacity of 4,435 L. Note that the two units are identical as the flow to each unit will be close to equal for a given event due to the upstream flow connection, and have been sized based on this consideration. Full details of the OGS unit sizing and specifications can be found in JFSA's July 2020 Pond Design Brief for the Ridge (Brazeau) subdivision. Refer to DSEL drawing sheet number 79 for detailed drawings of the proposed OGS units.

A portion of the Ridge development will also be treated for water quality via EES units that will capture and infiltrate runoff from local street roads. For full details regarding the EES units within the development refer to JFSA July 2020 LID Memo for the Ridge (Brazeau) Development. Catchbasins that capture runoff to these EES units will be fitted with Goss traps. It has been assumed that the surrounding future lands will have independent water quality measures on-site, whether that be by way of OGS or EES units or SWM ponds.

Tables C-1A and C-1E of Appendix C summarizes the pipe data and hydraulic simulation results for the 100-year 3-hour Chicago storm, 100-year 24-hour SCS Type II storm and the three historical events. Note that a minimum freeboard of 0.3 m between the hydraulic grade line and the underside of footings has been provided throughout the proposed developments for the 100-year storms, and a minimum freeboard of 0 m has been provided throughout the proposed development for the historical events. Additionally, note that the majority of the flowing full pipe velocities are no less than 0.80 m/s and no greater than 3.0 m/s for all proposed pipes with the exception of 4 locations. Where velocities over 3.0 m/s are proposed, provisions shall be made to protect against displacement of sewers by sudden jarring or movement. Velocities greater than 6 m/s are not permitted.

Table C-1F of Appendix C presents the climate change stress test results for the hydraulic grade line analysis based on a 20% increase in the 100-year storm, as per the October 2012 *City of Ottawa Sewer Design Guidelines*. Under these conditions, no locations within the proposed developments have a USF freeboard less than 0 m.

Table 3 presents the composite hydraulic grade line results for the 100-year 3-hour Chicago and 100-year 24-hour SCS Type II design storms. Note to simplify this analysis, the highest HGL and the lowest USF on a single pipe length are compared, if it is found that the freeboard between these two locations is either less than 0.3m or less than 0.0m this location is flagged yellow or red respectively. This flag then initiates a detailed analysis for this segment, where the HGL is interpolated along the full length of the pipe and then compared with the individual USF along with the distance, to confirm whether there is an HGL issue along that segment.

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	Lot Number	USF (m)	Freeboard [(2)] (m)	Interpolated HGL Length HGL (m)	Interpolated HGL Dist. From D/S MH (m)	Interpolated HGL HGL (m)
MH_401	POND	96.930	96.730	#N/A	#N/A	#N/A			
MH_501	POND	96.920	96.730	#N/A	#N/A	#N/A			
MH_1002	MH_1003	95.200	94.592	#N/A	#N/A	#N/A			
MH_1003	MH_1004	94.592	93.316	#N/A	#N/A	#N/A			
MH_1004	MH_1005	93.316	92.923	#N/A	#N/A	#N/A			
MH_1005	MH_1006	92.923	92.831	#N/A	#N/A	#N/A			
MH_1006	MH_1007	92.831	92.740	#N/A	#N/A	#N/A			
MH_1007	MH_1008	92.740	92.580	#N/A	#N/A	#N/A			
MH_1008	MH_1009	92.580	92.500	#N/A	#N/A	#N/A			
MH_101	MH_102	100.935	100.197	174-2	101.41	0.475			
MH_102	MH_103	100.197	99.575	172-5	100.47	0.273			
				172-5	100.47	0.822	59.0	6.9	99.648
				173-1	100.78	1.014	59.0	18.1	99.766
				173-2	100.78	0.930	59.0	26.1	99.850
				173-3	101.1	1.174	59.0	33.3	99.926
				173-4	101.1	1.090	59.0	41.3	100.010
				173-5	101.1	1.009	59.0	48.9	100.091
				174-1	101.41	1.241	59.0	56.3	100.169
MH_103	MH_104	99.575	99.245	169-2	99.81	0.235			
				169-2	99.81	0.558	120.0	2.7	99.252
				169-3	99.81	0.538	120.0	10	99.273
				169-4	99.81	0.516	120.0	18	99.295
				170-1	99.93	0.606	120.0	28.6	99.324
				170-2	99.93	0.584	120.0	36.6	99.346
				170-3	99.93	0.563	120.0	44.2	99.367
				171-1	99.99	0.594	120.0	54.9	99.396
				171-2	99.99	0.572	120.0	62.9	99.418
				171-3	99.99	0.552	120.0	70.1	99.438
				171-4	99.99	0.530	120.0	78.1	99.460
				172-1	100.47	0.961	120.0	96.1	99.509
				172-2	100.47	0.939	120.0	104.1	99.531
				172-3	100.47	0.919	120.0	111.3	99.551
				172-4	100.47	0.903	120.0	117	99.567
MH_104	MH_106	99.245	99.115	169-1	99.81	0.565			
MH_105	MH_106	100.002	99.115	148	100.03	0.028			
				148	100.03	0.792	91.0	12.6	99.238
				147	100.16	0.803	91.0	24.8	99.357
				146	100.3	0.844	91.0	35	99.456
				145	100.42	0.855	91.0	46.2	99.565
				144	100.56	0.856	91.0	60.4	99.704
				143	100.93	1.092	91.0	74.2	99.838
				142	101.5	1.518	91.0	88.9	99.982
MH_106	MH_116	99.115	98.880	166-1	99.53	0.415			
MH_107	MH_108	99.460	99.478	176-1	100.1	0.640			
MH_107	MH_112	99.460	99.411	185-1	99.89	0.430			
MH_108	MH_110	99.478	99.456	175-1	100.15	0.672			
MH_109	MH_110	99.691	99.456	164-2	100.01	0.319			
				164-2	100.01	0.549	60.0	1.2	99.461
				164-3	100.25	0.768	60.0	6.7	99.482
				164-4	100.25	0.736	60.0	14.7	99.514
				165-1	100.42	0.865	60.0	25.3	99.555
				165-2	100.93	1.345	60.0	32.9	99.585
				165-3	100.93	1.314	60.0	40.9	99.616
MH_110	MH_111	99.456	99.235	162-1	99.69	0.234			
				188-4	99.86	0.619	75.0	2	99.241
				162-1	99.69	0.436	75.0	6.3	99.254

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	Lot Number	USF (m)	Freeboard (2) (m)	Interpolated HGL Length HGL (m)	Interpolated HGL Dist. From D/S MH (m)	Interpolated HGL HGL (m)
				188-3	99.86	0.598	75.0	9.2	99.262
				162-2	99.69	0.413	75.0	14.3	99.277
				188-2	99.86	0.574	75.0	17.2	99.286
				162-3	99.69	0.391	75.0	21.6	99.299
				188-1	99.86	0.552	75.0	24.8	99.308
				162-4	99.69	0.362	75.0	31.6	99.328
				187-4	99.86	0.520	75.0	35.5	99.340
				163-1	99.77	0.417	75.0	40.2	99.353
				187-3	99.86	0.497	75.0	43.5	99.363
				163-2	99.77	0.394	75.0	47.8	99.376
				187-2	99.86	0.476	75.0	50.7	99.384
				163-3	99.77	0.371	75.0	55.8	99.399
				187-1	99.86	0.452	75.0	58.7	99.408
				164-1	100.01	0.579	75.0	66.5	99.431
MH_111	MH_115	99.235	99.046	159-1	99.58	0.345			
MH_112	MH_113	99.411	99.214	183-1	99.74	0.329			
MH_113	MH_114	99.214	99.146	181-1	99.85	0.636			
MH_1	MH_133	98.777	98.629	Est. Fut	99.86	1.083			
MH_114	MH_115	99.146	99.046	182-1	99.58	0.434			
MH_115	MH_116	99.046	98.880	157-1	99.46	0.414			
MH_116	MH_117	98.880	98.727	30	99.32	0.440			
MH_117	MH_118	98.727	98.545	20	99.11	0.383			
				18	99.18	0.628	121.0	4.4	98.552
				2	99.16	0.603	121.0	7.7	98.557
				406	99.18	0.611	121.0	16.1	98.569
				404	99.18	0.604	121.0	20.3	98.576
				407	99.16	0.576	121.0	25.7	98.584
				405	99.18	0.589	121.0	30.5	98.591
				19	99.16	0.558	121.0	37.9	98.602
				3	99.14	0.534	121.0	40.7	98.606
				20	99.11	0.493	121.0	48.1	98.617
				4	99.14	0.518	121.0	51.2	98.622
				21	99.12	0.486	121.0	59.3	98.634
				5	99.22	0.582	121.0	62.1	98.638
				22	99.21	0.557	121.0	71.5	98.653
				6	99.23	0.575	121.0	73.3	98.655
				23	99.22	0.550	121.0	82.9	98.670
				7	99.24	0.563	121.0	87.8	98.677
				24	99.28	0.589	121.0	97.3	98.691
				8	99.31	0.610	121.0	102.8	98.700
				25	99.36	0.645	121.0	113.1	98.715
				9	99.4	0.677	121.0	118.2	98.723
MH_118	MH_136	98.545	98.434	#N/A	#N/A	#N/A			
MH_119	MH_120	100.114	99.688	101	100.65	0.536			
MH_119	MH_122	100.114	99.693	#N/A	#N/A	#N/A			
MH_120	MH_121	99.688	99.310	116	101.03	1.342			
MH_121	MH_132	99.310	98.588	106	99.54	0.230			
				106	99.54	0.906	114.0	7.2	98.634
				107	99.71	0.999	114.0	19.4	98.711
				108	99.88	1.098	114.0	30.6	98.782
				109	100.05	1.204	114.0	40.8	98.846
				110	100.15	1.224	114.0	53.4	98.926
				111	100.32	1.322	114.0	64.8	98.998
				112	100.48	1.404	114.0	77	99.076
				113	100.57	1.423	114.0	88.2	99.147
				114	100.57	1.359	114.0	98.4	99.211

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	Lot Number	USF (m)	Freeboard [2] (m)	Interpolated HGL Length HGL (m)	Dist. From D/S MH (m)	HGL (m)
				115	100.65	1.373	114.0	108.8	99.277
MH_122	MH_123	99.663	99.517	131	100.61	0.947			
MH_123	MH_127	99.517	99.112	135	99.89	0.373			
MH_124	MH_125	99.469	99.331	72	99.77	0.301			
				82	99.89	0.552	101.0	5.4	99.338
				69	99.84	0.498	101.0	8.4	99.342
				70	99.78	0.424	101.0	18.6	99.356
				81	99.89	0.532	101.0	19.6	99.358
				71	99.78	0.408	101.0	29.7	99.372
				80	99.92	0.547	101.0	31	99.373
				72	99.77	0.384	101.0	39.9	99.386
				79	100.04	0.645	101.0	46.9	99.395
				73	99.82	0.419	101.0	51.1	99.401
				78	100.04	0.635	101.0	54.4	99.405
				74	99.88	0.465	101.0	61.3	99.415
				77	100	0.581	101.0	64.6	99.419
				413	99.93	0.499	101.0	73.4	99.431
				415	100.08	0.646	101.0	75.2	99.434
				412	99.98	0.537	101.0	82.3	99.443
				414	100.1	0.651	101.0	86.4	99.449
				75	99.98	0.521	101.0	94	99.459
				76	100.16	0.695	101.0	98.1	99.465
MH_125	MH_127	99.331	99.112	65	99.58	0.249			
				88	99.82	0.670	91.5	16	99.150
				63	99.59	0.438	91.5	16.6	99.152
				87	99.82	0.637	91.5	29.7	99.183
				64	99.59	0.405	91.5	30.3	99.185
				86	99.65	0.440	91.5	41.1	99.210
				65	99.58	0.363	91.5	43.9	99.217
				85	99.74	0.495	91.5	55.5	99.245
				66	99.69	0.438	91.5	58.6	99.252
				84	99.76	0.477	91.5	71.3	99.283
				67	99.78	0.490	91.5	74.4	99.290
				83	99.89	0.573	91.5	85.7	99.317
				68	99.84	0.515	91.5	88.8	99.325
MH_126	MH_127	100.307	99.112	#N/A	#N/A	#N/A			
MH_127	MH_128	99.112	99.004	47	99.56	0.448			
MH_128	MH_129	99.004	98.958	45	99.49	0.486			
MH_129	MH_130	98.958	98.842	43	99.41	0.452			
MH_130	MH_131	98.842	98.616	33	99.18	0.338			
MH_1302	MH_302	98.440	98.370	Est. Fut	99.36	0.920			
MH_1303	MH_303	98.435	98.291	Est. Fut	99.29	0.855			
MH_1304	MH_304	98.185	98.086	Est. Fut	98.86	0.675			
MH_131	MH_132	98.616	98.588	#N/A	#N/A	#N/A			
MH_1312	MH_310	97.937	97.853	Est. Fut	99.14	1.203			
MH_132	MH_136	98.588	98.434	103	99.33	0.742			
MH_133	MH_134	98.629	98.573	#N/A	#N/A	#N/A			
MH_134	MH_135	98.573	98.511	#N/A	#N/A	#N/A			
MH_135	MH_136	98.511	98.434	#N/A	#N/A	#N/A			
MH_136	MH_302	98.434	98.370	1	99.38	0.946			
MH_201	MH_202	105.434	104.453	321	105.28	-0.154			
				321	105.28	0.757	119.5	8.5	104.523
				430	107.31	2.770	119.5	10.6	104.540
				431	107.37	2.783	119.5	16.3	104.587
				428	105.36	0.725	119.5	22.2	104.635
				233	107.4	2.705	119.5	29.5	104.695

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	Lot Number	USF (m)	Freeboard [2] (m)	Interpolated HGL Length HGL (m)	Dist. From D/S MH (m)	HGL (m)
				429	105.37	0.658	119.5	31.5	104.712
				234	107.46	2.718	119.5	35.2	104.742
				320	105.45	0.638	119.5	43.7	104.812
				235	107.5	2.655	119.5	47.7	104.845
				319	105.56	0.657	119.5	54.8	104.903
				236	107.62	2.716	119.5	54.9	104.904
				318	105.66	0.673	119.5	65	104.987
				237	107.69	2.685	119.5	67.3	105.005
				238	107.8	2.748	119.5	73	105.052
				317	105.77	0.691	119.5	76.2	105.079
				239	107.87	2.709	119.5	86.2	105.161
				316	105.9	0.721	119.5	88.4	105.179
				240	107.99	2.783	119.5	91.9	105.207
				315	106.02	0.748	119.5	99.8	105.272
				241	108.06	2.744	119.5	105.1	105.316
				242	108.16	2.797	119.5	110.8	105.363
				314	106.13	0.741	119.5	114	105.389
MH_202	MH_203	104.453	104.385	230	105.39	0.937			
MH_203	MH_206	104.385	103.787	225	104.9	0.515			
MH_204	MH_205	103.979	103.873	285	104.64	0.661			
MH_205	MH_206	103.873	103.787	#N/A	#N/A	#N/A			
MH_206	MH_207	103.787	103.339	221	104.52	0.733			
MH_207	MH_208	103.339	103.021	219	104.39	1.051			
MH_208	MH_215	103.021	101.393	212	102.46	-0.561			
				271	102.46	0.938	112.0	8.9	101.522
				212	102.46	0.882	112.0	12.7	101.578
				270	102.67	0.941	112.0	23.1	101.729
				213	102.68	0.927	112.0	24.8	101.753
				214	102.89	0.988	112.0	35	101.902
				269	102.93	1.015	112.0	35.9	101.915
				215	103.1	1.035	112.0	46.2	102.065
				268	103.18	1.099	112.0	47.3	102.081
				216	103.36	1.118	112.0	58.4	102.242
				267	103.42	1.162	112.0	59.5	102.258
				217	103.62	1.212	112.0	69.8	102.408
				266	103.68	1.259	112.0	70.7	102.421
				423	103.94	1.371	112.0	80.9	102.569
				421	103.83	1.245	112.0	82	102.585
				422	104.04	1.310	112.0	92	102.730
				420	104.04	1.294	112.0	93.1	102.746
				265	104.35	1.450	112.0	103.7	102.900
				218	104.3	1.372	112.0	105.6	102.928
MH_209	MH_201	105.833	105.434	313	106.24	0.407			
MH_209	MH_210	105.833	105.596	254	108.31	2.477			
MH_210	MH_212	105.596	103.579	258	105.12	-0.476			
				258	105.12	0.955	54.0	15.7	104.165
				257	105.54	0.938	54.0	27.4	104.602
				256	106.05	1.025	54.0	38.7	105.025
				255	106.58	1.178	54.0	48.8	105.402
MH_211	MH_212	104.040	103.579	#N/A	#N/A	#N/A			
MH_212	MH_204	103.579	103.979	284	104.71	1.131			
MH_212	MH_213	103.579	103.233	203	104.1	0.521			
MH_213	MH_214	103.233	103.053	204	104.02	0.787			
MH_214	MH_215	103.053	101.393	272	102.37	-0.683			
				272	102.37	0.841	90.0	7.4	101.529
				211	102.46	0.776	90.0	15.8	101.684

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	Lot Number	USF (m)	Freeboard [2] (m)	Interpolated HGL		
							Length HGL (m)	Dist. From D/S MH (m)	HGL (m)
				273	102.59	0.799	90.0	21.6	101.791
				210	102.68	0.771	90.0	28	101.909
				274	102.86	0.788	90.0	36.8	102.072
				209	102.89	0.792	90.0	38.2	102.098
				275	103.11	0.828	90.0	48.2	102.282
				208	103.15	0.846	90.0	49.4	102.304
				276	103.37	0.863	90.0	60.4	102.507
				207	103.4	0.834	90.0	63.6	102.566
				277	103.55	0.905	90.0	67.9	102.645
				206	103.66	0.884	90.0	75	102.776
				278	103.55	0.613	90.0	83.7	102.937
				205	103.83	0.860	90.0	85.5	102.970
MH_215	MH_119	101.393	100.114	#N/A	#N/A	#N/A			
MH_216	MH_217	105.511	105.093	346	105.85	0.339			
MH_217	MH_218	105.093	104.927	356	105.71	0.617			
MH_218	MH_220	104.927	104.166	357	105.75	0.823			
MH_219	MH_220	105.649	104.166	#N/A	#N/A	#N/A			
MH_220	MH_224	103.894	102.523	259	104.74	0.846			
MH_221	MH_222	103.088	102.811	396-1	103.56	0.472			
MH_222	MH_223	102.811	102.698	366-1	103.37	0.559			
MH_2	MH_2260	102.506	102.126	Est. Fut	103.49	0.984			
MH_223	MH_224	102.698	102.523	365-1	103.42	0.722			
MH_224	MH_105	102.025	100.067	141	101.9	-0.125			
				141	101.9	1.561	82.0	11.4	100.339
				140	102.18	1.502	82.0	25.6	100.678
				139	102.55	1.602	82.0	36.9	100.948
				138	102.92	1.728	82.0	47.1	101.192
				137	103.3	1.843	82.0	58.2	101.457
				136	103.81	2.029	82.0	71.8	101.781
MH_225	MH_226	103.572	103.053	388-3	103.75	0.178			
				389-2	103.75	0.667	99.5	5.8	103.083
				389-1	103.75	0.610	82.0	13.8	103.140
				388-3	103.75	0.543	82.0	24.4	103.207
				388-2	103.88	0.624	82.0	32.1	103.256
				388-1	103.88	0.573	82.0	40.1	103.307
				387-4	104.02	0.646	82.0	50.7	103.374
				387-3	104.02	0.595	82.0	58.7	103.425
				387-2	104.02	0.550	82.0	65.9	103.470
				387-1	104.02	0.499	82.0	73.9	103.521
MH_2260	MH_227	102.126	101.119	392-1	102.46	0.334			
MH_226	MH_2260	103.053	102.126	391-3	103.08	0.027			
				391-3	103.08	0.921	64.0	2.3	102.159
				391-2	103.45	1.185	64.0	9.6	102.265
				391-1	103.45	1.069	64.0	17.6	102.381
				390-3	103.58	1.046	64.0	28.2	102.534
				390-2	103.58	0.930	64.0	36.2	102.650
				390-1	103.58	0.820	64.0	43.8	102.760
				389-4	103.75	0.835	64.0	54.5	102.915
				389-3	103.75	0.719	64.0	62.5	103.031
MH_227	MH_109	101.119	99.691	394-3	100.86	-0.259			
				394-4	100.86	0.874	93.0	19.2	99.986
				394-3	100.86	0.751	93.0	27.2	100.109
				394-2	101.26	1.039	93.0	34.5	100.221
				394-1	101.26	0.916	93.0	42.5	100.344
				393-3	101.49	0.968	93.0	54.1	100.522
				393-2	101.81	1.172	93.0	61.7	100.638

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	Lot Number	USF (m)	Freeboard [(2)] (m)	Interpolated HGL Length HGL (m)	Dist. From D/S MH (m)	HGL (m)
				393-1	101.81	1.049	93.0	69.7	100.761
				392-4	102.21	1.269	93.0	81.4	100.941
				392-3	102.21	1.146	93.0	89.4	101.064
MH_228	MH_229	102.612	101.073	384-3	102.12	-0.492			
				384-3	102.12	0.997	74.5	2.4	101.123
				379-2	102.14	0.997	74.5	3.4	101.143
				384-4	102.12	0.832	74.5	10.4	101.288
				379-1	102.14	0.832	74.5	11.4	101.308
				385-1	102.35	0.843	74.5	21	101.507
				378-3	102.57	1.043	74.5	22	101.527
				385-2	102.65	0.986	74.5	28.6	101.664
				378-2	102.67	0.983	74.5	29.7	101.687
				385-3	102.65	0.821	74.5	36.6	101.829
				378-1	102.67	0.818	74.5	37.7	101.852
				386-1	102.73	0.680	74.5	47.3	102.050
				377-4	103.02	0.949	74.5	48.3	102.071
				386-2	103.08	0.865	74.5	55.3	102.215
				377-3	103.28	1.044	74.5	56.3	102.236
				377-2	103.34	0.955	74.5	63.5	102.385
				377-1	103.34	0.790	74.5	71.5	102.550
MH_229	MH_102	101.073	100.197	381-1	101.35	0.277			
				382-1	101.52	1.184	86.5	13.7	100.336
				381-4	101.35	1.004	86.5	14.7	100.346
				382-2	101.52	1.103	86.5	21.7	100.417
				381-3	101.35	0.923	86.5	22.7	100.427
				382-3	101.52	1.030	86.5	28.9	100.490
				381-2	101.35	0.849	86.5	30	100.501
				382-4	101.52	0.949	86.5	36.9	100.571
				381-1	101.35	0.768	86.5	38	100.582
				383-1	101.62	0.941	86.5	47.6	100.679
				380-3	101.59	0.901	86.5	48.6	100.689
				383-2	101.62	0.860	86.5	55.6	100.760
				380-2	101.59	0.820	86.5	56.6	100.770
				383-3	101.62	0.783	86.5	63.2	100.837
				380-1	101.59	0.743	86.5	64.2	100.847
				384-1	101.95	1.006	86.5	73.8	100.944
				379-4	101.96	1.004	86.5	74.9	100.956
				384-2	101.95	0.925	86.5	81.8	101.025
				379-3	101.96	0.923	86.5	82.9	101.037
MH_230	MH_231	102.557	100.982	374-3	102.03	-0.527			
				374-3	102.03	0.994	73.5	2.5	101.036
				368-3	102.24	1.151	73.5	5	101.089
				374-4	102.03	0.823	73.5	10.5	101.207
				368-2	102.24	0.979	73.5	13	101.261
				368-1	102.24	0.817	73.5	20.6	101.423
				375-1	102.4	0.964	73.5	21.2	101.436
				375-2	102.57	0.971	73.5	28.8	101.599
				367-3	102.71	1.057	73.5	31.3	101.653
				375-3	102.57	0.799	73.5	36.8	101.771
				367-2	102.71	0.886	73.5	39.3	101.824
				367-1	102.71	0.723	73.5	46.9	101.987
				376-1	103	1.002	73.5	47.4	101.998
				376-2	103	0.831	73.5	55.4	102.169
				376-3	103.37	1.044	73.5	62.7	102.326
				376-4	103.37	0.873	73.5	70.7	102.497
MH_231	MH_103	100.982	99.575	371-1	100.56	-0.422			

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	Lot Number	USF (m)	Freeboard [2] (m)	Interpolated HGL Length HGL (m)	Interpolated HGL Dist. From D/S MH (m)	Interpolated HGL HGL (m)
				371-3	100.56	0.775	87.0	13	99.785
				372-1	100.95	1.150	87.0	13.9	99.800
				371-2	100.56	0.645	87.0	21	99.915
				372-2	100.95	1.021	87.0	21.9	99.929
				371-1	100.56	0.522	87.0	28.6	100.038
				372-3	100.95	0.903	87.0	29.2	100.047
				372-4	100.95	0.773	87.0	37.2	100.177
				370-3	101.09	0.879	87.0	39.3	100.211
				370-2	101.09	0.750	87.0	47.3	100.340
				373-1	100.97	0.622	87.0	47.8	100.348
				370-1	101.09	0.627	87.0	54.9	100.463
				373-2	101.32	0.843	87.0	55.8	100.477
				373-3	101.32	0.720	87.0	63.4	100.600
				369-3	101.61	0.976	87.0	65.5	100.634
				369-2	101.61	0.846	87.0	73.5	100.764
				374-1	101.56	0.787	87.0	74.1	100.773
				369-1	101.61	0.722	87.0	81.2	100.888
				374-2	101.56	0.657	87.0	82.1	100.903
MH_302	MH_303	98.370	98.291	#N/A	#N/A	#N/A			
MH_303	MH_304	98.291	98.086	#N/A	#N/A	#N/A			
MH_304	MH_306TEE	98.086	97.813	#N/A	#N/A	#N/A			
MH_306TEE	MH_307	97.813	97.550	#N/A	#N/A	#N/A			
MH_313	MH_307	97.449	97.550	#N/A	#N/A	#N/A			
MH_307	MH_400	97.550	97.537	#N/A	#N/A	#N/A			
MH_309	MH_310	97.979	97.853	#N/A	#N/A	#N/A			
MH_310	MH_311	97.853	97.779	#N/A	#N/A	#N/A			
MH_3	MH_109	99.716	99.691	#N/A	#N/A	#N/A			
MH_3111TEE	MH_312	97.671	97.526	#N/A	#N/A	#N/A			
MH_311	MH_3111TEE	97.779	97.671	#N/A	#N/A	#N/A			
MH_312	MH_313	97.526	97.449	#N/A	#N/A	#N/A			
MH_313	MH_500	97.449	97.416	#N/A	#N/A	#N/A			
MH_400	OGS_1	97.537	97.517	#N/A	#N/A	#N/A			
OGS_1	OGS_1-Out	97.517	97.265	#N/A	#N/A	#N/A			
OGS_1-Out	MH_401	97.265	96.930	#N/A	#N/A	#N/A			
MH_4	MH_104	99.324	99.245	#N/A	#N/A	#N/A			
MH_500	OGS_2	97.416	97.406	#N/A	#N/A	#N/A			
OGS_2	OGS_2-Out	97.406	97.174	#N/A	#N/A	#N/A			
OGS_2-Out	MH_501	97.174	96.920	#N/A	#N/A	#N/A			

[2] Conservative estimate of freeboard based on U/S HGL and lowest USF connected to pipe. Actual HGL / freeboard at all connecting lots interpolated where conservative estimate does not meet freeboard requirements.

[3] Future USF elevations estimated as 1.8 m below the upstream top of manhole elevations.

Colour	Meaning
Green	Interpolated HGL elevation
Yellow	Freebaord Less than 0.3m
Red	Freebaord Less than 0.0m

5 EROSION AND SEDIMENT CONTROL DURING AND AFTER CONSTRUCTION

Silt and erosion control strategies shall be implemented during construction activities to minimize the transfer of silt off-site. The following measures should be implemented:

i) Silt control fences shall be installed as required to prevent the movement of silt off-site during rainfall events.

ii) Construction of a mud mat shall be installed at the site entrance to promote self-cleaning of truck tires when leaving the site.

iii) All catch basins shall be equipped with a crushed stone filter to prevent the capture of silt in the storm sewer system.

iv) Regular cleaning of the adjacent roads shall be undertaken during the construction activities.

v) Regular inspection and maintenance of the silt control measures shall be undertaken until the site has been stabilized.

vi) The erosion and sediment control devices shall be removed after the site has been stabilized.

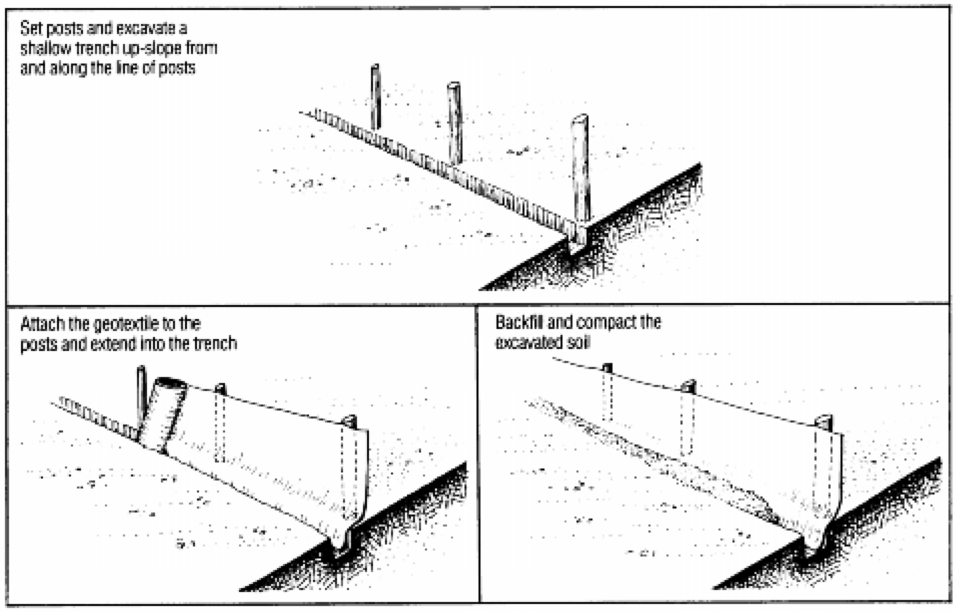


Figure 5: Typical installation of silt fences

Figure 6: Catchbasin with geotextile to protect storm sewer pipes from sediment contamination

6 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The Ridge (Brazeau) development is in the City of Ottawa, east of Borrisokane and Highway 416, and south of Cambrian Road. The development has a total drainage area of 37.03 ha, which will be treated by two oil-and-grit separators for quality control, which then discharges to a dry SWM pond. The dry SWM pond discharges to the Jock River through an existing ditch running north, parallel to Borrisokane Road. The development will also have Etobicoke Exfiltration Systems (EES) implemented within this subdivision. These EES will be installed within local roadways of the subdivision, to exfiltrate runoff from the development for the more frequent events.

Per the City of Ottawa design guidelines, the minor system has been designed to accommodate a minimum of the 2-year post-development flows from within the site and from external areas (plus 5-year flows on collector and 10-year flows on arterial roads). The combined SWMHYMO / PCSWMM model analyses have determined that the minor system will surcharge in most parts of the system. However, with the use of Inlet Control Devices, a minimum freeboard of 0.3 m is provided between the 100-year hydraulic grade line and the underside of footings throughout the subdivision.

The PCSWMM/SWMHYMO simulations have determined that for the selected 2-, 5- and 100-year storms, the total minor system flows would be 5.76 m^3/s, 8.218 m^3/s and 10.912 m^3/s, respectively.

Within the subdivision, the peak water depths do not exceed the maximum allowable 35 cm depth at the gutter for the simulated 100-year storm (Table D-7 of Appendix D). Furthermore, it was determined that for the 100-year event, the product of the velocity and depth of flow does not exceed the maximum allowable 0.60 m^2/s. Also as required, the maximum extent of surface water during the 100-year + 20% stress test will not touch the building envelopes.

Table C-1A- C1F of Appendix C summarizes the hydraulic grade line analysis for the various storm. Note that the full pipe velocities are generally no less than 0.80 m/s and no greater than 3.0 m/s for the proposed pipes. Where velocities over 3.0 m/s are proposed, provisions shall be made to protect against displacement of sewers by sudden jarring or movement.

Stress test results for the major and minor drainage systems based on a 20% increase in the 100-year storm, as per the October 2012 *City of Ottawa Sewer Design Guidelines*, are summarized in Section 4.

Recommendations for silt and erosion control strategies to be implemented during construction are presented in Section 6.

In conclusion, the proposed design satisfies all selected design guidelines and requirements.

Legend

ICD Type

- 83mm Circular Orifice Plate
- 94mm Circular Orifice Plate
- 102mm Circular Orifice Plate
- 108mm Circular Orifice Plate
- 127mm Circular Orifice Plate
- 152mm Circular Orifice Plate
- 178mm Circular Orifice Plate
- No ICD

Conduits

- Minor System

Junctions

- Maintenance Hole
- Site Plan

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
52 Springbrook Drive (613) 836-3884
Ottawa, ON, K2S 1B9 www.jfsa.com

DSEL
david schaeffer engineering ltd

SCALE : 1:3500

0 50 100 150 200 m

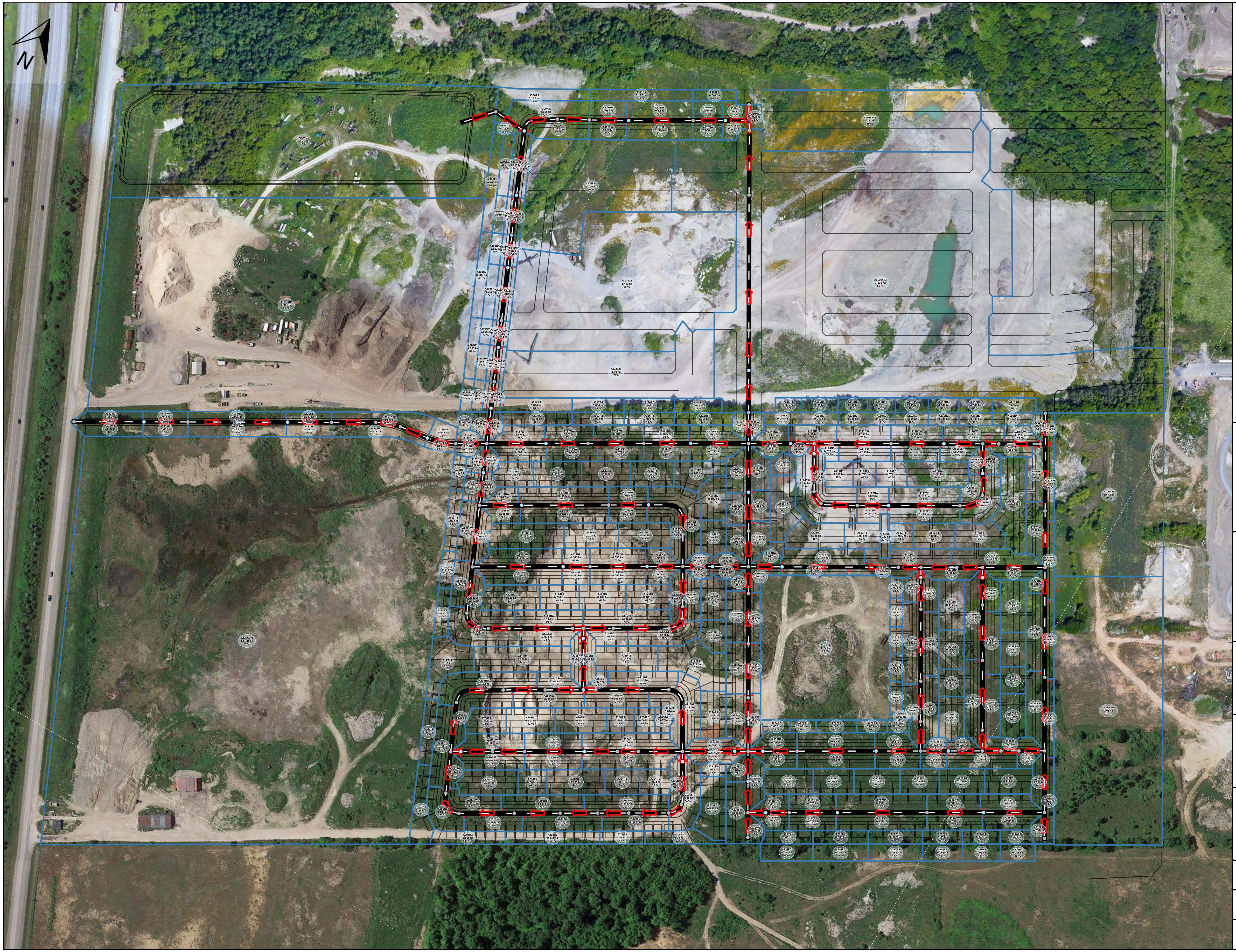
PROJECT :

The Ridge Phase 1

TITLE :

Figure 2: Minor System Overview

PROJECT	1800-19
DRAWN:	JB
DATE:	JUNE 2020



Legend

- Subcatchments
- Junctions
  - Major System
  - Low Point
- Major System
- Catch Basins
- Site Plan

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
52 Springbrook Drive
Ottawa, ON, K2S 1B9
(613) 836-3884
www.jfsa.com

DSEL
david schaeffer engineering ltd

SCALE : 1:3,500

0 50 100 150 200 m

PROJECT :

Brazeau Phase 1

TITLE :

Figure 3: Major System Overview

PROJECT	1800-19
DRAWN:	JB
DATE:	APRIL 2020

Legend

Maximum Available Storage
- Volume at Low Points (m^3)
- Max Depth at Low Points(m)

— Site Plan

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
52 Springbrook Drive
Ottawa, ON, K2S 1B9
(613) 836-3884
www.jfsa.com

DSEL
david schaeffer engineering ltd

SCALE : 1:3500

0 50 100 150 200 m

PROJECT :

Brazeau Phase 1

TITLE :

Figure 4: Major System Storage

PROJECT	1800-19
DRAWN:	JB
DATE:	APRIL 2020

APPENDIX

A

Rational Method Design Sheets
(as per DSEL)

JFSA Water Resources and Environmental Consultants

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 — Arterial Roads Return Frequency = 10 years

LOCATION			AREA (Ha) 2 YEAR				5 YEAR				10 YEAR				100 YEAR				FLOW						SEWER DATA								
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min)	RATIO Q/Q full
FUTURE ROAD (DRUMMOND LAND)																																	
	Plug	304	1.20	0.65	2.17	2.17			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	167	600	600	CONC	0.20	10.0	274.6	0.97	0.17	0.61
To Expansion Road, Pipe 304 - 306TEE						2.17				0.00				0.00				0.00	10.17														
			1.00	0.65	1.81	1.81			0.00	0.00			0.00	0.00			0.00	0.00	15.00														
					0.00	1.81	1.45	0.40	1.61	1.61			0.00	0.00			0.00	0.00	15.00														
	Plug	303			0.00	1.81			0.00	1.61			0.00	0.00			0.00	0.00	15.11	61.51	83.20	97.44	142.28	245	750	750	CONC	0.15	10.5	431.2	0.98	0.18	0.57
To Expansion Road, Pipe 303 - 304						1.81				1.61				0.00				0.00	15.29														
			0.99	0.65	1.79	1.79																											
	Plug	302			0.00	1.79			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	137	525	525	CONC	0.20	10.5	192.3	0.89	0.20	0.71
To Expansion Road, Pipe 302 - 303						1.79				0.00				0.00				0.00	10.20														
COMMERCIAL BLOCK - SOUTH																																	
			13.83	0.75	28.84	28.84			0.00	0.00			0.00	0.00			0.00	0.00	13.00														
	CTRL MH 1	133			0.00	28.84			0.00	0.00			0.00	0.00			0.00	0.00	13.00	66.93	90.63	106.17	155.11	1930	1500	1500	CONC	0.20	19.0	3161.3	1.79	0.18	0.61
To Haiku Street, Pipe 133 - 134						28.84				0.00				0.00				0.00	13.18														
Haiku Street																																	
COMMERCIAL BLOCK - SOUTH, Pipe CTRL MH 1 - 133						28.84				0.00				0.00				0.00	13.18														
From ABIC Property			7.39	0.30																				210.40									
	133	134	0.58	0.90	1.45	30.29			0.00	0.00			0.00	0.00			0.00	0.00	13.18	66.43	89.95	105.37	153.93	2222	1500	1500	CONC	0.15	77.0	2737.8	1.55	0.83	0.81
	134	135	0.31	0.90	0.78	31.06			0.00	0.00			0.00	0.00			0.00	0.00	14.01	64.22	86.91	101.80	148.69	2205	1500	1500	CONC	0.15	61.0	2737.8	1.55	0.66	0.81
			0.05	0.54	0.08	31.14			0.00	0.00			0.00	0.00			0.00	0.00	14.01														
	135	136	0.18	0.71	0.36	31.49			0.00	0.00			0.00	0.00			0.00	0.00	14.01	64.22	86.91	101.80	148.69	2233	1650	1650	CONC	0.10	37.0	2882.2	1.35	0.46	0.77
To Expansion Road, Pipe 136 - 302						31.49				0.00				0.00				0.00	14.46														
Sturnidae Street																																	
					0.00	0.00	0.03	0.71	0.06	0.06			0.00	0.00			0.00	0.00															
			0.10	0.54	0.15	0.15			0.00	0.06			0.00	0.00			0.00	0.00															
	126	127	0.19	0.71	0.38	0.53			0.00	0.06			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	47	300	300	PVC	0.40	28.5	61.2	0.87	0.55	0.76
To Montology Way, Pipe 127 - 128						0.53				0.06				0.00				0.00	10.55														
			0.23	0.54	0.35	0.35			0.00	0.00			0.00	0.00			0.00	0.00															
	124	125	0.36	0.71	0.71	1.06			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	81	375	375	PVC	0.35	101.0	103.7	0.94	1.79	0.78
			0.21	0.54	0.32	1.37			0.00	0.00			0.00	0.00			0.00	0.00															
	125	127	0.34	0.71	0.67	2.04			0.00	0.00			0.00	0.00			0.00	0.00	11.79	70.55	95.59	112.01	163.68	144	600	600	CONC	0.25	91.5	307.0	1.09	1.40	0.47
To Montology Way, Pipe 127 - 128						2.04				0.00				0.00				0.00	13.20														
Montology Way																																	
Contribution From Travertine Way, Pipe 123 - 127						1.33				0.00				0.00				0.00	12.08														
Contribution From Sturnidae Street, Pipe 125 - 127						2.04				0.00				0.00				0.00	13.20														
Contribution From Sturnidae Street, Pipe 126 - 127						0.53				0.06				0.00				0.00	10.55														
	127	128			0.00	3.90			0.00	0.06			0.00	0.00			0.00	0.00	13.20	66.38	89.87	105.28	153.80	264	675	675	CONC	0.20	54.0	375.9	1.05	0.86	0.70
	128	129			0.00	3.90			0.00	0.06			0.00	0.00			0.00	0.00	14.05	64.10	86.74	101.60	148.40	255	675	675	CONC	0.30	13.5	460.4	1.29	0.17	0.55
			0.25	0.54	0.38	4.27			0.00	0.06			0.00	0.00			0.00	0.00															
	129	130	0.40	0.71	0.79	5.06			0.00	0.06			0.00	0.00			0.00	0.00	14.23	63.65	86.14	100.88	147.35	327	750	750	CONC	0.15	77.0	431.2	0.98	1.31	0.76
			0.18	0.54	0.27	5.33			0.00	0.06			0.00	0.00			0.00	0.00															
	130	131	0.40	0.71	0.79	6.12			0.00	0.06			0.00	0.00			0.00	0.00	15.54	60.51	81.84	95.83	139.93	375	750	750	CONC	0.15	100.5	431.2	0.98	1.72	0.87
	131	132			0.00	6.12			0.00	0.06			0.00	0.00			0.00	0.00	17.26	56.90	76.90	90.03	131.41	353	1200	1200	CONC	0.15	12.0	1510.0	1.34	0.15	0.23
To Travertine Way, Pipe 132 - 136						6.12				0.06				0.00				0.00	17.41														
Rugosa Street																																	
	211	212	0.26	0.54	0.39	0.39			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	30	300	300	PVC	0.35	26.5	57.2	0.81	0.55	0.52
To Appalachian Circle, Pipe 212 - 213						0.39				0.00				0.00				0.00	10.55														
	212	204			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	300	300	PVC	0.50	92.5	68.4	0.97	1.59	0.00
			0.49	0.54	0.74	0.74			0.00	0.00			0.00	0.00			0.00	0.00															
	204	205	0.50	0.71	0.99	1.72			0.00	0.00			0.00	0.00			0.00	0.00	11.59	71.18	96.47	113.04	165.19	123	525	525	CONC	0.20	118.0	192.3	0.89	2.21	0.64

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: SLM
Checked: ADF
Dwg. Reference: Storm Drainage Plan 84-87

PROJECT: Ciavan Communities - Brazeau Phase 1
LOCATION: City of Ottawa
File Ref: 18-1030 | Date: 15-Jun-20 | Sheet No. 1 OF 6

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

Ottawa

LOCATION			AREA (Ha)																FLOW						SEWER DATA									
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
	205	206	0.25	0.71	0.49	2.22			0.00	0.00			0.00	0.00			0.00	0.00	13.81	64.73	87.62	102.63	149.91	143	525	525	CONC	0.20	16.0	192.3	0.89	0.30	0.75
To Appalachian Circle, Pipe 206 - 207						2.22				0.00				0.00				0.00	14.11														
Appalachian Circle																																	
	209	210			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	300	300	PVC	2.40	13.0	149.8	2.12	0.10	0.00
	210	212	0.20	0.71	0.39	0.39			0.00	0.00			0.00	0.00			0.00	0.00	10.10	76.41	103.66	121.51	177.63	30	300	300	PVC	3.80	54.0	188.5	2.67	0.34	0.16
Contribution From Rugosa Street, Pipe 211 - 212						0.39				0.00				0.00				0.00	10.55														
	212	213			0.00	0.79			0.00	0.00			0.00	0.00			0.00	0.00	10.55	74.77	101.40	118.85	173.72	59	375	375	PVC	0.45	49.5	117.6	1.06	0.77	0.50
	213	214	0.12	0.71	0.24	1.02			0.00	0.00			0.00	0.00			0.00	0.00	11.32	72.08	97.70	114.49	167.33	74	375	375	PVC	1.00	13.5	175.3	1.59	0.14	0.42
			0.36	0.54	0.54	1.56			0.00	0.00			0.00	0.00			0.00	0.00															
	214	215	0.44	0.71	0.87	2.43			0.00	0.00			0.00	0.00			0.00	0.00	11.46	71.61	97.06	113.74	166.21	174	375	375	PVC	2.35	90.0	268.8	2.43	0.62	0.65
To Foundation Lane, Pipe 215 - 119						2.43				0.00				0.00				0.00	12.08														
			0.07	0.54	0.11	0.11			0.00	0.00			0.00	0.00			0.00	0.00															
	209	201	0.25	0.71	0.49	0.60			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	46	300	300	PVC	0.55	94.0	71.7	1.01	1.54	0.64
			0.10	0.54	0.15	0.75			0.00	0.00			0.00	0.00			0.00	0.00															
	201	202	0.37	0.71	0.73	1.48			0.00	0.00			0.00	0.00			0.00	0.00	11.54	71.34	96.69	113.30	165.58	106	375	375	PVC	0.90	119.5	166.3	1.51	1.32	0.63
	202	203			0.00	1.48			0.00	0.00			0.00	0.00			0.00	0.00	12.87	67.31	91.15	106.78	156.00	100	450	450	CONC	0.20	14.0	127.5	0.80	0.29	0.78
			0.20	0.54	0.30	1.78			0.00	0.00			0.00	0.00			0.00	0.00															
	203	206	0.20	0.71	0.39	2.17			0.00	0.00			0.00	0.00			0.00	0.00	13.16	66.49	90.02	105.46	154.06	145	450	450	CONC	0.45	54.5	191.3	1.20	0.76	0.76
Contribution From Rugosa Street, Pipe 205 - 206						2.22				0.00				0.00				0.00	14.11														
			0.08	0.54	0.12	4.51			0.00	0.00			0.00	0.00			0.00	0.00															
	206	207	0.14	0.71	0.28	4.79			0.00	0.00			0.00	0.00			0.00	0.00	14.11	63.96	86.56	101.38	148.07	306	600	600	CONC	0.40	49.5	388.3	1.37	0.60	0.79
	207	208			0.00	4.79			0.00	0.00			0.00	0.00			0.00	0.00	14.71	62.47	84.51	98.98	144.54	299	600	600	CONC	1.90	12.5	846.4	2.99	0.07	0.35
			0.12	0.54	0.18	4.97			0.00	0.00			0.00	0.00			0.00	0.00															
	208	215	0.32	0.71	0.63	5.60			0.00	0.00			0.00	0.00			0.00	0.00	14.78	62.30	84.28	98.70	144.15	349	600	600	CONC	1.90	112.0	846.4	2.99	0.62	0.41
To Foundation Lane, Pipe 215 - 119						5.60				0.00				0.00				0.00	15.40														
Foundation Lane																																	
Contribution From Appalachian Circle, Pipe 208 - 215						5.60				0.00				0.00				0.00	15.40														
Contribution From Appalachian Circle, Pipe 214 - 215						2.43				0.00				0.00				0.00	12.08														
	215	119	0.20	0.71	0.39	8.42			0.00	0.00			0.00	0.00			0.00	0.00	15.40	60.84	82.28	96.35	140.69	512	675	675	CONC	1.60	55.0	1063.3	2.97	0.31	0.48
To Travertine Way, Pipe 119 - 120						8.42				0.00				0.00				0.00	15.71														
Travertine Way																																	
			0.15	0.54	0.23	0.23			0.00	0.00			0.00	0.00			0.00	0.00															
	119	122	0.21	0.71	0.41	0.64			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	49	300	300	PVC	0.55	90.0	71.7	1.01	1.48	0.69
			0.13	0.71	0.26	0.90			0.00	0.00			0.00	0.00			0.00	0.00															
	122	123	0.29	0.54	0.44	1.33			0.00	0.00			0.00	0.00			0.00	0.00	11.48	71.56	96.98	113.65	166.09	95	300	300	PVC	1.55	13.0	120.4	1.70	0.13	0.79
	123	127			0.00	1.33			0.00	0.00			0.00	0.00			0.00	0.00	11.61	71.14	96.41	112.98	165.10	95	300	300	PVC	1.60	49.5	122.3	1.73	0.48	0.77
To Montology Way, Pipe 127 - 128						1.33				0.00				0.00				0.00	12.08														
Contribution From Foundation Lane, Pipe 215 - 119						8.42				0.00				0.00				0.00	15.71														
			0.21	0.71	0.41	8.84			0.00	0.00			0.00	0.00			0.00	0.00															
	119	120	0.39	0.54	0.59	9.42			0.00	0.00			0.00	0.00			0.00	0.00	15.71	60.14	81.33	95.23	139.05	567	900	900	CONC	0.20	103.0	809.6	1.27	1.35	0.70
	120	121			0.00	9.42			0.00	0.00			0.00	0.00			0.00	0.00	17.06	57.30	77.45	90.67	132.35	540	900	900	CONC	0.20	14.0	809.6	1.27	0.18	0.67
			0.21	0.54	0.32	9.74			0.00	0.00			0.00	0.00			0.00	0.00															
	121	132	0.52	0.71	1.03	10.77			0.00	0.00			0.00	0.00			0.00	0.00	17.24	56.94	76.95	90.08	131.50	613	900	900	CONC	1.10	114.0	1898.7	2.98	0.64	0.32
Contribution From Montology Way, Pipe 131 - 132						6.12				0.06				0.00				0.00	17.41														
			0.17	0.71	0.34	17.22			0.00	0.06			0.00	0.00			0.00	0.00															
	132	136	0.42	0.54	0.63	17.85			0.00	0.06			0.00	0.00			0.00	0.00	17.88	55.71	75.28	88.12	128.62	999	1200	1200	CONC	0.20	59.5	1743.6	1.54	0.64	0.57
To Expansion Road, Pipe 136 - 302						17.85				0.06				0.00				0.00	18.52														
Focality Crescent																																	
	107	108			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	300	300	PVC	0.65	13.0	78.0	1.10	0.20	0.00
			0.28	0.72	0.56	0.56			0.00	0.00			0.00	0.00			0.00	0.00															
	108	110	0.34	0.58	0.55	1.11			0.00	0.00			0.00	0.00			0.00	0.00	10.20	76.06	103.17	120.93	176.78	84	450	450	CONC	0.20	54.0	127.5	0.80	1.12	0.66
To Haiku Street, Pipe 110 - 111						1.11				0.00				0.00				0.00	11.32														

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: SLM	PROJECT: Ciavan Communities - Brazeau Phase 1		
Checked: ADF	LOCATION: City of Ottawa		
Dwg. Reference: Storm Drainage Plan 83-86	File Ref: 18-1030	Date: 15-Jun-20	Sheet No. 2 OF 6

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Ottawa

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Arterial Roads Return Frequency = 10 years

Manning 0.013

Design Data for HMB ph 8 storm outlet point (MH 3)

Location	LOCATION From Node	LOCATION To Node	2 YEAR AREA (Ha)	2 YEAR R	2 YEAR Indiv. 2.78 AC	2 YEAR Accum. 2.78 AC	5 YEAR AREA (Ha)	5 YEAR R	5 YEAR Indiv. 2.78 AC	5 YEAR Accum. 2.78 AC	10 YEAR AREA (Ha)	10 YEAR R	10 YEAR Indiv. 2.78 AC	10 YEAR Accum. 2.78 AC	100 YEAR AREA (Ha)	100 YEAR R	100 YEAR Indiv. 2.78 AC	100 YEAR Accum. 2.78 AC	FLOW Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	SEWER DATA DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min)	RATIO Q/Q full
	107	112			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	300	300	PVC	0.35	74.0	57.2	0.81	1.52	0.00
			0.04	0.72	0.08	0.08			0.00	0.00			0.00	0.00			0.00	0.00															
			0.15	0.58	0.24	0.32			0.00	0.00			0.00	0.00			0.00	0.00															
			0.22	0.58	0.35	0.68			0.00	0.00			0.00	0.00			0.00	0.00															
	112	113	0.33	0.72	0.66	1.34			0.00	0.00			0.00	0.00			0.00	0.00	11.52	71.41	96.78	113.41	165.73	95	450	450	CONC	0.20	73.5	127.5	0.80	1.53	0.75
	113	114			0.00	1.34			0.00	0.00			0.00	0.00			0.00	0.00	13.05	66.78	90.43	105.94	154.76	89	450	450	CONC	0.20	13.0	127.5	0.80	0.27	0.70
			0.32	0.72	0.64	1.98			0.00	0.00			0.00	0.00			0.00	0.00															
	114	115	0.34	0.58	0.55	2.53			0.00	0.00			0.00	0.00			0.00	0.00	13.32	66.03	89.40	104.73	152.98	167	675	675	CONC	0.40	54.0	531.6	1.49	0.61	0.31
To Haiku Street, Pipe 115 - 116						2.53				0.00				0.00				0.00	13.93														
COMMERCIAL BLOCK - EAST																																	
			2.68	0.75	5.59	5.59			0.00	0.00			0.00	0.00			0.00	0.00	12.50														
	CTRL MH 2	2260			0.00	5.59			0.00	0.00			0.00	0.00			0.00	0.00	12.50	68.38	92.61	108.51	158.53	382	675	675	CONC	0.40	10.0	531.6	1.49	0.11	0.72
To Obsidian Street, Pipe 2260 - 227						5.59				0.00				0.00				0.00	12.61														
Obsidian Street																																	
	225	226	0.27	0.72	0.54	0.54			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	42	300	300	PVC	0.50	99.5	68.4	0.97	1.71	0.61
	226	2260	0.20	0.72	0.40	0.94			0.00	0.00			0.00	0.00			0.00	0.00	11.71	70.79	95.93	112.41	164.27	67	300	300	PVC	1.05	64.0	99.1	1.40	0.76	0.67
From COMMERCIAL BLOCK - EAST- 122, Pipe CTRL MH 2 - 2260						5.59				0.00				0.00				0.00	12.61														
	2260	227			0.00	6.53			0.00	0.00			0.00	0.00			0.00	0.00	12.61	68.05	92.16	107.97	157.75	444	675	675	CONC	1.55	49.5	1046.5	2.92	0.28	0.42
	227	109	0.26	0.72	0.52	7.05			0.00	0.00			0.00	0.00			0.00	0.00	12.89	67.23	91.04	106.66	155.82	474	675	675	CONC	1.60	93.0	1063.3	2.97	0.52	0.45
To Haiku Street, Pipe 109 - 110						7.05				0.00				0.00				0.00	13.42														
Haiku Street																																	
			1.93	0.68	3.65	3.65			0.00	0.00			0.00	0.00			0.00	0.00	11.50														
	CTRL MH 3	109			0.00	3.65			0.00	0.00			0.00	0.00			0.00	0.00	11.50	71.49	96.89	113.54	165.92	261	600	600	CONC	0.40	10.0	388.3	1.37	0.12	0.67
Contribution From Obsidian Street, Pipe 227 - 109						7.05				0.00				0.00				0.00	13.42														
	109	110	0.18	0.72	0.36	11.06			0.00	0.00			0.00	0.00			0.00	0.00	13.42	65.78	89.05	104.31	152.38	727	750	750	CONC	0.70	60.0	931.4	2.11	0.47	0.78
Contribution From Focality Crescent, Pipe 108 - 110						1.11				0.00				0.00				0.00	11.32														
			0.16	0.58	0.26	12.42			0.00	0.00			0.00	0.00			0.00	0.00															
			0.19	0.58	0.31	12.73			0.00	0.00			0.00	0.00			0.00	0.00															
	110	111	0.33	0.72	0.66	13.39			0.00	0.00			0.00	0.00			0.00	0.00	13.89	64.52	87.32	102.28	149.40	864	900	900	CONC	0.40	75.0	1144.9	1.80	0.69	0.75
	111	115	0.18	0.72	0.36	13.75			0.00	0.00			0.00	0.00			0.00	0.00	14.58	62.77	84.92	99.46	145.25	863	975	975	CONC	0.20	91.0	1002.2	1.34	1.13	0.86
Contribution From Focality Crescent, Pipe 114 - 115						2.53				0.00				0.00				0.00	13.93														
					0.00	16.28	0.04	0.72	0.08	0.08			0.00	0.00			0.00	0.00															
			0.15	0.58	0.24	16.52			0.00	0.08			0.00	0.00			0.00	0.00															
			0.16	0.58	0.26	16.78			0.00	0.08			0.00	0.00			0.00	0.00															
	115	116	0.19	0.72	0.38	17.16			0.00	0.08			0.00	0.00			0.00	0.00	15.71	60.13	81.32	95.22	139.03	1038	1050	1050	CONC	0.50	59.0	1930.9	2.23	0.44	0.54
To Inselberg Street, Pipe 116 - 117						17.16				0.08				0.00				0.00	16.16														
PARK BLOCK																																	
	CTRL MH 4	104			0.00	0.00	1.72	0.40	1.91	1.91			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	199	525	525	CONC	0.40	9.5	272.0	1.26	0.13	0.73
To Chillerton Drive, Pipe 104 - 106						0.00				1.91				0.00				0.00	10.13														
Canadensis Lane																																	
			0.01	0.72	0.02	0.02			0.00	0.00			0.00	0.00			0.00	0.00															
			0.03	0.58	0.05	0.07			0.00	0.00			0.00	0.00			0.00	0.00															
			0.04	0.58	0.06	0.13			0.00	0.00			0.00	0.00			0.00	0.00															
			0.16	0.58	0.26	0.39			0.00	0.00			0.00	0.00			0.00	0.00															
	230	231	0.19	0.72	0.38	0.77			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	59	300	300	PVC	2.00	73.5	136.8	1.93	0.63	0.43
			0.12	0.58	0.19	0.96			0.00	0.00			0.00	0.00			0.00	0.00															
			0.21	0.58	0.34	1.30			0.00	0.00			0.00	0.00			0.00	0.00															
	231	103	0.41	0.72	0.82	2.12			0.00	0.00			0.00	0.00			0.00	0.00	10.63	74.46	100.96	118.34	172.97	158	525	525	CONC	2.00	87.0	608.2	2.81	0.52	0.26
To Chillerton Drive, Pipe 103 - 104						2.12				0.00				0.00				0.00	11.15														

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: SLM
Checked: ADF
Dwg. Reference: Storm Drainage Plan 83-86

PROJECT: **Ciavan Communities - Brazeau Phase 1**
LOCATION: **City of Ottawa**
File Ref: 18-1030
Date: 15-Jun-20
Sheet No. 3 OF 6

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Arterial Roads Return Frequency = 10 years

Manning 0.013

Ottawa

Location	LOCATION From Node	To Node	AREA (Ha) 2 YEAR AREA (Ha)	2 YEAR R	2 YEAR Indiv. 2.78 AC	2 YEAR Accum. 2.78 AC	5 YEAR AREA (Ha)	5 YEAR R	5 YEAR Indiv. 2.78 AC	5 YEAR Accum. 2.78 AC	10 YEAR AREA (Ha)	10 YEAR R	10 YEAR Indiv. 2.78 AC	10 YEAR Accum. 2.78 AC	100 YEAR AREA (Ha)	100 YEAR R	100 YEAR Indiv. 2.78 AC	100 YEAR Accum. 2.78 AC	FLOW Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	SEWER DATA DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min)	RATIO Q/Q full
Surface Lane																																	
			0.17	0.58	0.27	0.27			0.00	0.00			0.00	0.00			0.00	0.00															
	228	229	0.31	0.72	0.62	0.89			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	69	300	300	PVC	2.00	74.5	136.8	1.93	0.64	0.50
			0.20	0.58	0.32	1.22			0.00	0.00			0.00	0.00			0.00	0.00															
	229	102	0.39	0.72	0.78	2.00			0.00	0.00			0.00	0.00			0.00	0.00	10.64	74.43	100.92	118.29	172.90	149	525	525	CONC	0.85	86.5	396.5	1.83	0.79	0.37
To Chillerton Drive, Pipe 102 - 103						2.00				0.00				0.00				0.00	11.43														
Chillerton Drive																																	
	101	102			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	300	300	PVC	2.60	30.5	155.9	2.21	0.23	0.00
Contribution From Surface Lane, Pipe 229 - 102						2.00				0.00				0.00				0.00	11.43														
	102	103	0.13	0.72	0.26	2.26			0.00	0.00			0.00	0.00			0.00	0.00	11.43	71.72	97.21	113.91	166.47	162	525	525	CONC	1.55	59.0	535.4	2.47	0.40	0.30
Contribution From Canadensis Lane, Pipe 231 - 103						2.12				0.00				0.00				0.00	11.15														
	103	104	0.19	0.72	0.38	4.76			0.00	0.00			0.00	0.00			0.00	0.00	11.83	70.44	95.44	111.84	163.43	335	750	750	CONC	0.40	120.0	704.1	1.59	1.25	0.48
From PARK BLOCK - 123, Pipe CTRL MH 4 - 104						0.00				1.91				0.00				0.00	10.13														
	104	106	0.26	0.72	0.52	5.28			0.00	1.91			0.00	0.00			0.00	0.00	13.08	66.70	90.32	105.80	154.56	525	1050	1050	CONC	0.15	41.5	1057.6	1.22	0.57	0.50
To Elevation Road, Pipe 106 - 116						5.28				1.91				0.00				0.00	13.65														
Epoch Street																																	
	221	222	0.09	0.72	0.18	0.18			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	14	300	300	PVC	0.50	77.5	68.4	0.97	1.34	0.20
			0.11	0.58	0.18	0.36			0.00	0.00			0.00	0.00			0.00	0.00															
			0.22	0.72	0.44	0.80			0.00	0.00			0.00	0.00			0.00	0.00															
			0.31	0.54	0.47	1.26			0.00	0.00			0.00	0.00			0.00	0.00															
			0.31	0.58	0.50	1.76			0.00	0.00			0.00	0.00			0.00	0.00															
	222	223	0.40	0.72	0.80	2.56			0.00	0.00			0.00	0.00			0.00	0.00	11.34	72.03	97.63	114.41	167.21	185	600	600	CONC	0.15	95.5	237.8	0.84	1.89	0.78
					0.00	2.56	0.07	0.71	0.14	0.14			0.00	0.00			0.00	0.00															
	223	224	0.13	0.72	0.26	2.82			0.00	0.14			0.00	0.00			0.00	0.00	13.23	66.29	89.76	105.15	153.60	200	600	600	CONC	0.20	97.0	274.6	0.97	1.66	0.73
To Elevation Road, Pipe 224 - 105						2.82				0.14				0.00				0.00	14.89														
Eminence Street																																	
			0.09	0.54	0.14	0.14			0.00	0.00			0.00	0.00			0.00	0.00															
			0.11	0.54	0.17	0.30			0.00	0.00			0.00	0.00			0.00	0.00															
	216	217	0.39	0.71	0.77	1.07			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	82	375	375	PVC	0.60	75.5	135.8	1.23	1.02	0.61
			0.25	0.54	0.38	1.45			0.00	0.00			0.00	0.00			0.00	0.00															
			0.32	0.54	0.48	1.93			0.00	0.00			0.00	0.00			0.00	0.00															
	217	218	0.46	0.71	0.91	2.83			0.00	0.00			0.00	0.00			0.00	0.00	11.02	73.09	99.08	116.12	169.72	207	600	600	CONC	0.20	113.0	274.6	0.97	1.94	0.75
					0.00	2.83	0.04	0.71	0.08	0.08			0.00	0.00			0.00	0.00															
	218	220	0.10	0.71	0.20	3.03			0.00	0.08			0.00	0.00			0.00	0.00	12.96	67.04	90.78	106.34	155.36	210	600	600	CONC	0.20	80.5	274.6	0.97	1.38	0.77
To Elevation Road, Pipe 220 - 224						3.03				0.08				0.00				0.00	14.34														
Elevation Road																																	
					0.00	0.00																											
	Plug East	310	1.22	0.65	2.20	2.20			0.00	0.00			0.00	0.00			0.00	0.00	14.71	62.46	84.51	98.97	144.53	138	750	750	CONC	0.20	9.5	497.9	1.13	0.14	0.28
To Elevation Road, Pipe 310 - 311						2.20				0.00				0.00				0.00	14.85														
					0.00	0.00	2.56	0.65	0.00	0.00			0.00	0.00			0.00	0.00	16.00														
			5.09	0.65	0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	16.00														
	Plug South	310			9.20	9.20			4.63	4.63			0.00	0.00			0.00	0.00	16.00	59.50	80.46	94.21	137.55	919	1050	1050	CONC	0.15	17.5	1057.6	1.22	0.24	0.87
To Elevation Road, Pipe 310 - 311						9.20				4.63				0.00				0.00	16.24														
	219	220			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	300	300	PVC	2.65	25.0	157.4	2.23	0.19	0.00
Contribution From Eminence Street, Pipe 218 - 220						3.03				0.08				0.00				0.00	14.34														
					0.00	3.03	0.05	0.71	0.10	0.18			0.00	0.00			0.00	0.00															
			0.06	0.71	0.12	3.15			0.00	0.18			0.00	0.00			0.00	0.00															
	220	224			0.00	3.15	0.12	0.71	0.24	0.41			0.00	0.00			0.00	0.00	14.34	63.36	85.74	100.42	146.66	235	600	600	CONC	1.90	59.0	846.4	2.99	0.33	0.28

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: SLM	PROJECT: Ciavan Communities - Brazeau Phase 1	
Checked: ADF	LOCATION: City of Ottawa	
Dwg. Reference: Storm Drainage Plan 83-86	File Ref: 18-1030	Date: 15-Jun-20 / Sheet No. 4 OF 6

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

Ottawa

Location	From Node	To Node	2 YEAR AREA (Ha)	2 YEAR R	2 YEAR Indiv. 2.78 AC	2 YEAR Accum. 2.78 AC	5 YEAR AREA (Ha)	5 YEAR R	5 YEAR Indiv. 2.78 AC	5 YEAR Accum. 2.78 AC	10 YEAR AREA (Ha)	10 YEAR R	10 YEAR Indiv. 2.78 AC	10 YEAR Accum. 2.78 AC	100 YEAR AREA (Ha)	100 YEAR R	100 YEAR Indiv. 2.78 AC	100 YEAR Accum. 2.78 AC	Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min)	RATIO Q/Q full
Contribution From Epoch Street, Pipe 223 - 224						2.82				0.14				0.00				0.00	14.89														
					0.00	5.97	0.03	0.58	0.05	0.60			0.00	0.00			0.00	0.00															
			0.06	0.71	0.12	6.09			0.00	0.60			0.00	0.00			0.00	0.00															
			0.11	0.54	0.17	6.26			0.00	0.60			0.00	0.00			0.00	0.00															
	224	105			0.00	6.26	0.16	0.71	0.32	0.92			0.00	0.00			0.00	0.00	14.89	62.02	83.91	98.26	143.50	465	600	600	CONC	1.90	82.0	846.4	2.99	0.46	0.55
	105	106			0.00	6.26	0.35	0.71	0.69	1.61			0.00	0.00			0.00	0.00	15.35	60.96	82.45	96.55	140.98	514	675	675	CONC	1.40	91.0	994.6	2.78	0.55	0.52
Contribution From Chillerton Drive, Pipe 104 - 106						5.28				1.91				0.00				0.00	13.65														
			0.20	0.58	0.32	11.86			0.00	3.52			0.00	0.00			0.00	0.00															
					0.00	11.86	0.21	0.72	0.42	3.94			0.00	0.00			0.00	0.00															
	106	116			0.00	11.86	0.22	0.71	0.43	4.37			0.00	0.00			0.00	0.00	15.89	59.73	80.77	94.58	138.09	1062	1350	1350	CONC	0.20	122.5	2387.0	1.67	1.22	0.44
To Haiku Street, Pipe 116 - 117						11.86				4.37				0.00				0.00	17.12														
Haiku Street																																	
Contribution From Elevation Road, Pipe 106 - 116						11.86				4.37				0.00				0.00	17.12														
Contribution From Haiku Street, Pipe 115 - 116						17.16				0.08				0.00				0.00	16.16														
					0.00	29.02	0.04	0.71	0.08	4.53			0.00	0.00			0.00	0.00															
			0.13	0.54	0.20	29.21			0.00	4.53			0.00	0.00			0.00	0.00															
			0.13	0.54	0.20	29.41			0.00	4.53			0.00	0.00			0.00	0.00															
			0.29	0.54	0.44	29.85			0.00	4.53			0.00	0.00			0.00	0.00															
	116	117	0.31	0.71	0.61	30.46			0.00	4.53			0.00	0.00			0.00	0.00	17.12	57.18	77.28	90.47	132.07	2092	1650	1650	CONC	0.10	122.5	2882.2	1.35	1.51	0.73
			0.15	0.54	0.23	30.68			0.00	4.53			0.00	0.00			0.00	0.00															
			0.16	0.54	0.24	30.92			0.00	4.53			0.00	0.00			0.00	0.00															
	117	118	0.49	0.71	0.97	31.89			0.00	4.53			0.00	0.00			0.00	0.00	18.63	54.34	73.40	85.91	125.38	2066	1650	1650	CONC	0.10	121.0	2882.2	1.35	1.50	0.72
	118	136			0.00	31.89			0.00	4.53			0.00	0.00			0.00	0.00	20.13	51.82	69.97	81.88	119.46	1970	1950	1950	CONC	0.10	11.0	4499.9	1.51	0.12	0.44
To Expansion Road, Pipe 136 - 302						31.89				4.53				0.00				0.00	20.25														
Expansion Road																																	
Contribution From Elevation Road, Plug East - 310						2.20				0.00				0.00				0.00	14.85														
Contribution From Elevation Road, Plug South - 310						9.20				4.63				0.00				0.00	16.24														
					0.00	11.40	0.06	0.54	0.09	4.72			0.00	0.00			0.00	0.00															
			0.09	0.54	0.14	11.54			0.00	4.72			0.00	0.00			0.00	0.00															
			0.16	0.71	0.32	11.85			0.00	4.72			0.00	0.00			0.00	0.00															
	310	311	0.16	0.71	0.32	12.17			0.00	4.72			0.00	0.00			0.00	0.00	16.24	58.99	79.76	93.38	136.34	1094	1200	1200	CONC	0.15	62.5	1510.0	1.34	0.78	0.72
			0.21	0.54	0.32	12.48			0.00	4.72			0.00	0.00			0.00	0.00															
	311	3111TEE	0.25	0.71	0.49	12.98			0.00	4.72			0.00	0.00			0.00	0.00	17.02	57.38	77.56	90.79	132.54	1110	1200	1200	CONC	0.15	72.0	1510.0	1.34	0.90	0.74
	3111TEE	312			0.00	12.98			0.00	4.72			0.00	0.00			0.00	0.00	17.92	55.64	75.18	88.00	128.44	1077	1200	1200	CONC	0.15	76.5	1510.0	1.34	0.95	0.71
	312	313	0.06	0.54	0.09	13.07			0.00	4.72			0.00	0.00			0.00	0.00	18.87	53.92	72.83	85.24	124.39	1048	1200	1200	CONC	0.15	21.5	1510.0	1.34	0.27	0.69
To POND INLET - 120, Pipe 313 - 500						13.07				4.72				0.00				0.00	19.14														
Contribution From Haiku Street, Pipe 118 - 136						31.89				4.53				0.00				0.00	20.25														
Contribution From Travertine Way, Pipe 132 - 136						17.85				0.06				0.00				0.00	18.52														
Contribution From Haiku Street, Pipe 135 - 136						31.49				0.00				0.00				0.00	14.46														
	136	302	0.03	0.54	0.05	81.28			0.00	4.59			0.00	0.00			0.00	0.00	20.25	51.63	69.70	81.57	119.01	4727	2250	2250	CONC	0.10	54.0	6590.6	1.66	0.54	0.72
From FUTURE ROAD (DRUMMOND LAND) - Plug - 302						1.79				0.00				0.00				0.00	10.20														
			0.06	0.54	0.09	83.16			0.00	4.59			0.00	0.00			0.00	0.00															
	302	303	0.16	0.71	0.32	83.48			0.00	4.59			0.00	0.00			0.00	0.00	20.79	50.79	68.55	80.22	117.03	4765	2250	2250	CONC	0.10	59.0	6590.6	1.66	0.59	0.72
From FUTURE ROAD (DRUMMOND LAND) - Plug - 303						1.81				1.61				0.00				0.00	15.29														
			0.09	0.54	0.14	85.42			0.00	6.21			0.00	0.00			0.00	0.00															
	303	304	0.22	0.71	0.43	85.85			0.00	6.21			0.00	0.00			0.00	0.00	21.39	49.90	67.35	78.80	114.95	4912	2250	2250	CONC	0.10	134.5	6590.6	1.66	1.35	0.75
From FUTURE ROAD (DRUMMOND LAND) - Plug - 304						2.17				0.00				0.00				0.00	10.17														
			0.10	0.54	0.15	88.17			0.00	6.21			0.00	0.00			0.00	0.00															
	304	306TEE	0.28	0.71	0.55	88.72			0.00	6.21			0.00	0.00			0.00	0.00	22.74	48.00	64.76	75.76	110.49	4871	2250	2250	CONC	0.10	42.5	6590.6	1.66	0.43	0.74
POND INLET - 120, Pipe 306TEE - 307TEE						88.72				6.21				0.00				0.00	23.17														
POND INLET																																	
Contribution From Expansion Road, Pipe 312 - 313						13.07				4.72				0.00				0.00	19.14														
	313	500			0.00	13.07			0.00	4.72			0.00	0.00			0.00	0.00	19.14	53.46	72.19	84.49	123.30	1039	2250	2250	CONC	0.10	33.5	6590.6	1.66	0.34	0.16
	500	HW501			0.00	13.07			0.00	4.72			0.00	0.00			0.00	0.00	19.48	52.89	71.42	83.58	121.96	1028	2250	2250	CONC	0.10	5.0	6590.6	1.66	0.05	0.16

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: SLM	PROJECT: Ciavan Communities - Brazeau Phase 1	
Checked: ADF	LOCATION: City of Ottawa	
Dwg. Reference: Storm Drainage Plan 83-86	File Ref: 18-1030	Date: 15-Jun-20
		Sheet No. 5 OF 6

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

Ottawa

LOCATION			AREA (Ha) 2 YEAR				5 YEAR				10 YEAR				100 YEAR				FLOW						SEWER DATA								
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min)	RATIO Q/Q full
Contribution From Expansion Road, Pipe 305TEE - 306TEE						88.72				6.21				0.00				0.00	23.17														
	306TEE	307	0.18	0.71	0.36	89.08			0.00	6.21			0.00	0.00			0.00	0.00	23.17	47.44	63.99	74.85	109.17	4833	2250	2250	CONC	0.10	13.0	6590.6	1.66	0.13	0.73
	307	400			0.00	89.08			0.00	6.21			0.00	0.00			0.00	0.00	23.30	47.27	63.76	74.58	108.77	4817	2250	2250	CONC	0.10	23.5	6590.6	1.66	0.24	0.73
	400	HW401			0.00	89.08			0.00	6.21			0.00	0.00			0.00	0.00	23.53	46.96	63.34	74.09	108.05	4787	2250	2250	CONC	0.10	15.5	6590.6	1.66	0.16	0.73
POND OUTLET - CONSTANT FLOW RATE 1300 L/S																																	
			0.00	0.00	0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00						1300									
	HW OUT	1002			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	1300	900	900	CONC	0.60	7.5	1402.3	2.20	0.06	0.93
	1002	1003			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.06	76.59	103.89	121.79	178.04	1300	900	900	CONC	0.60	28.0	1402.3	2.20	0.21	0.93
To BORRISOKANE - 190, Pipe 1003 - 1004						0.00				0.00				0.00				0.00	10.27					1300									
BORRISOKANE ROAD - CONSTANT FLOW RATE 1300 L/S																																	
Contribution From POND OUTLET - 192, Pipe 1002 - 1003						0.00				0.00				0.00				0.00	10.27					1300									
	1003	1004			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.27	75.79	102.80	120.50	176.14	1300	900	900	CONC	0.60	108.5	1402.3	2.20	0.82	0.93
	1004	1005			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	11.09	72.86	98.77	115.76	169.18	1300	975	975	CONC	0.40	106.0	1417.4	1.90	0.93	0.92
	1005	1006			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	12.02	69.83	94.61	110.86	161.99	1300	1200	1200	CONC	0.20	106.0	1743.6	1.54	1.15	0.75
	1006	1007			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	13.17	66.47	89.99	105.42	154.01	1300	1200	1200	CONC	0.20	106.0	1743.6	1.54	1.15	0.75
	1007	1008			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	14.31	63.44	85.85	100.55	146.85	1300	1200	1200	CONC	0.20	88.0	1743.6	1.54	0.95	0.75
	1008	HW1009			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	15.26	61.15	82.72	96.86	141.45	1300	1200	1200	CONC	0.20	14.5	1743.6	1.54	0.16	0.75

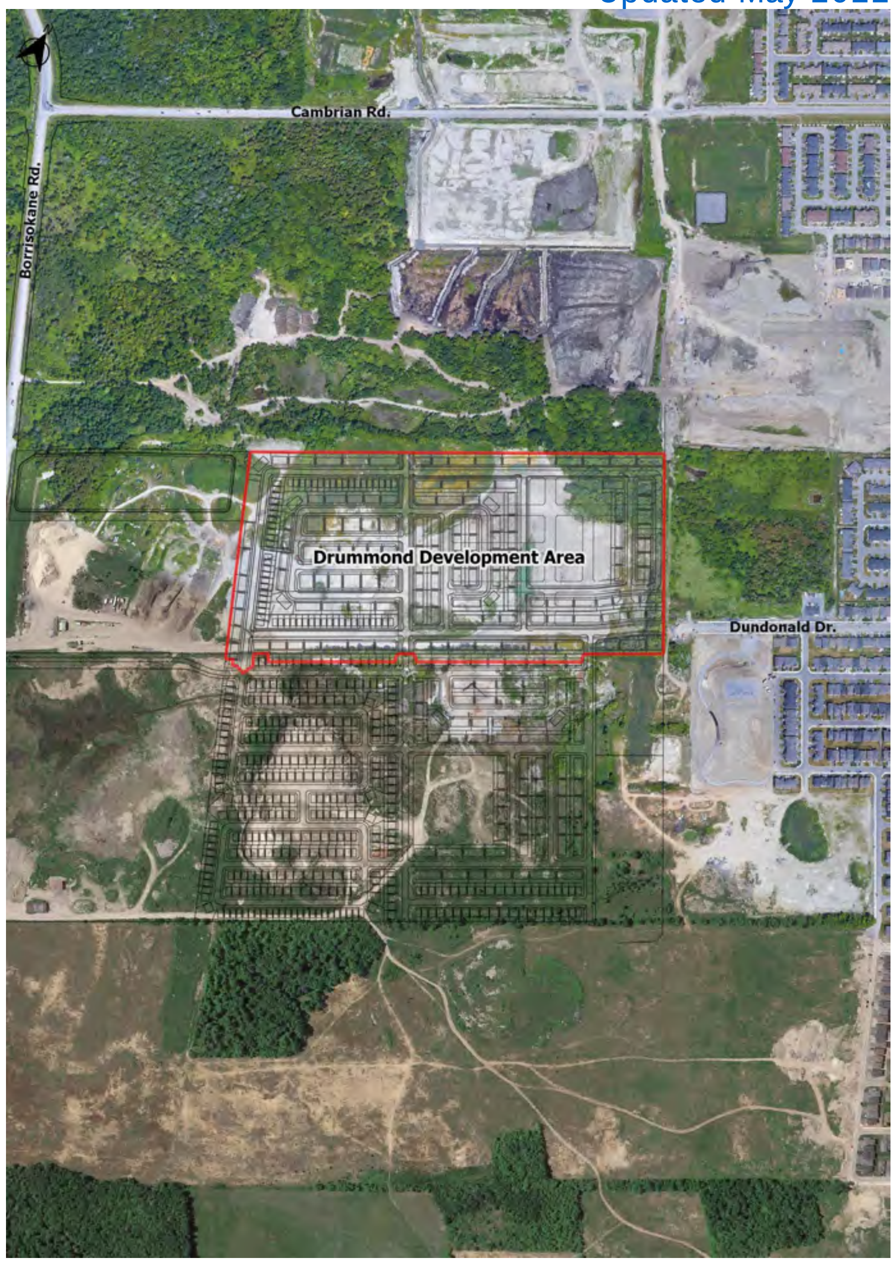
Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: SLM	PROJECT: **Ciavan Communities - Brazeau Phase 1**		
Checked: ADF	LOCATION: **City of Ottawa**		
Dwg. Reference: Storm Drainage Plan 83-86	File Ref: 18-1030	Date: 15-Jun-20	Sheet No. 6 OF 6

Stormwater Management Report for The Drummond Subdivision

City of Ottawa
October 2021
Updated May 2022



Prepared for: David Schaeffer Engineering Ltd.

Prepared by:

JFSA Water Resources and Environmental Consultants

JFSA Ref. No.: 2226-21

J.F. Sabourin and Associates Inc.
www.jfsa.com

JFSA Water Resources and Environmental Consultants

J.F. Sabourin and Associates Inc.
52 Springbrook Drive, Ottawa, ON K2S 1B9
tel.: 613.836.3884, fax: 613.836.0332, www.jfsa.com

Stormwater Management Report for The Drummond Subdivision

in the City of Ottawa

May 2022

Prepared for :

David Schaeffer Engineering Ltd.

LICENSED PROFESSIONAL ENGINEER
J. J. BURNETT
100227734
PROVINCE OF ONTARIO

Prepared by :

Jonathon Burnett, B.Eng., P.Eng.

JFSA Ref. No.: 2226-21

Stormwater Management Report for The Drummond Subdivision
in the City of Ottawa

TABLE OF CONTENTS

APPENDICES

LIST OF TABLE2

LIST OF FIGURES

Background: Rational for Report Update

This report is an update of the February 2022 "Stormwater Management Report for The Drummond Subdivision". The previous version of the report has been updated to address several City comments. These updates include the addition of a column to Table D6 showing the theoretical minimum ICD size based on the rational method, to compare to the ICD size provided. Additional tables/figures have been provided in Attachment B showing how the theoretical orifice representation in the model for CBs on slopes compares to the empirical approach flow capture curves outlined in the City guidelines. The report text has also been revised to address comments about DCB lead pipe sizes, and clarify that all values provided in the report are based on the maximum report timestep (1 minute) and not the maximum simulated timestep (1 second), and an additional explanation as to why the 100-year minor system flows are almost twice that of the 2-year flows.

Stormwater Management Report for The Drummond Subdivision

in the City of Ottawa
October 2021
Updated May 2022

1 INTRODUCTION AND OBJECTIVES

J.F. Sabourin and Associates Inc. (JFSA) was retained by David Schaeffer Engineering Ltd. (DSEL) to prepare a Stormwater Management (SWM) Plan for the Drummond Subdivision, located in Barrhaven within the City of Ottawa. As shown by the image provided on the cover page, the future development is located east of Borrisokane and Highway 416, south of Cambrian Road and north of the Ridge Development. The site has a total drainage area of approximately 19.16 ha, with 13.28 ha of the proposed development being serviced by a dry SWM pond that is implemented in the northwest corner of the development which services both the Ridge and Drummond sites and will discharge to the Jock River via an existing ditch on the west side of Borrisokane Road. This portion of the proposed development will meet water quality requirements via two oil-and-grit separators that discharge to the SWM pond, which have been sized to ensure 80% Total Suspended Solids (TSS) removal, for more details regarding the OGS units within the development please refer to JFSA's July 2020, Pond Design Brief for the Ridge (Brazeau) Subdivision. The remaining 5.88 ha of the Drummond site will discharge to the east to the Halfmoon Bay SWM facility, refer to JFSA August 2021 *"Stormwater Management Report for Phase 3 of the Half Moon Bay West Subdivision"* for full details on this SWM facility.

As documented in the Barrhaven South Urban Expansion Area Master Servicing Study, by J. L Richards 2018, the development will also have Etobicoke Exfiltration Systems (EES) implemented within this subdivision. These EES will be installed within local roadways of the subdivision, to exfiltrate runoff from the development for the more frequent events. To ensure some conservatism within the SWM design, the benefits of these EES have not been included in this detailed SWM analysis. Full details of these EES units and the respective post-development water budget have been documented in JFSA May 2022 memo titled "*The Drummond (The Ridge Phase 3/4): Low Impact Development (LID) Design*"

The Drummond development has a total drainage area of approximately 19.16 ha, and consists primarily of single and townhomes, making up 16.97 ha, with the remaining 2.19 ha consisting of park blocks. Figure 1 provides an overview of the location of these respective blocks within the subdivision.

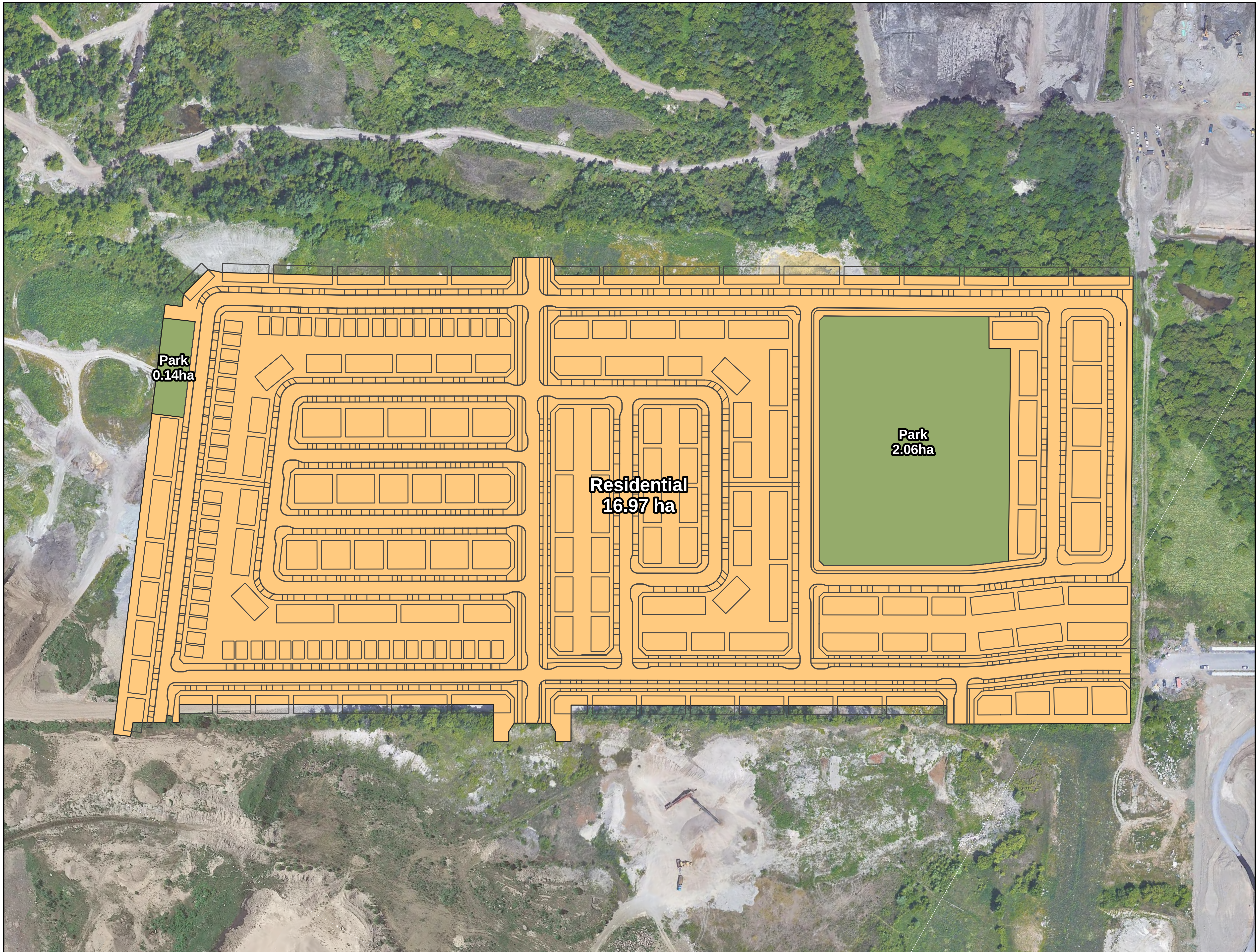
The purpose of this report is to evaluate the major and minor system flows of the proposed development with respect to the City of Ottawa stormwater management guidelines and to check the adequacy of the proposed pipe sizes to convey the 2-year (5-year on collector and 10-year on arterial roads) and the 100-year storm flows from within the development and from external areas. As well as assess the site's quality control targets, SWM pond operations and flow contributions to Greenbank Road.

The following background documents were reviewed in preparing this report:

- *Stormwater Management Planning and Design Manual,* Ministry of the Environment, March 2003.
- *Jock River Flood Risk Mapping (within the City of Ottawa) Hydraulics Report*, PSR Group Ltd. and J.F. Sabourin and Associates Inc., November 2004.
- *Erosion and Sediment Control Guidelines for Urban Construction,* Conservation Halton et al., December 2006.
- *Draft City of Ottawa Stormwater Management Facility Design Guidelines,* IBI Group, April 2012.
- *City of Ottawa Sewer Design Guidelines,* City of Ottawa, October 2012.
- *Technical Bulletin ISDTB-2014-01, Revisions to Ottawa Design Guidelines – Sewer,* City of Ottawa, February 2014.
- *City of Ottawa Technical Bulletin PIEDTB-2016-01*, City of Ottawa, September 2016.
- *City of Ottawa Technical Bulletin ISTB-2018-04,* City of Ottawa, June 2018.
- *Functional Servicing Report for Caivan Communities, Brazeau Lands, 3809 Borrisokane Road,* David Schaeffer Engineering Limited, September 2019.
- *Design Brief for the Stormwater Management Pond for the Ridge (Brazeau) Subdivision,* David Schaeffer Engineering Limited and J.F. Sabourin and Associates Inc., July 2020.
- *Stormwater Management Report Pond for the Ridge (Brazeau) Subdivision,* David Schaeffer Engineering Limited and J.F. Sabourin and Associates Inc., July 2020.
- *The Ridge (Brazeau): Low Impact Development (LID) Design,* J.F. Sabourin and Associates Inc., July 2020.
- *Brazeau / Drummond Oil-Grit Separator Design Details,* David Schaeffer Engineering Limited, July 2020.
- *Stormwater Management Report for Phase 3 of the Half Moon Bay West Subdivision for full details on this SWM facility, JFSA August 2021*

As per the September 2016 *City of Ottawa Technical Bulletin PIEDTB-2016-01*, the proposed subdivision has been designed with a 2-year minor system level of service on local roads and a 5-year level of service on collector roads (Dundonald Drive & Elevation Road). Where possible with grading and minor system capture limitations, road ponding areas up to 35 cm deep were used to contain the 100-year major system flows.

PCSWMM was used to model the major and minor systems, to ensure that all stormwater management requirements are satisfied. The general SWM design criteria and guidelines that are to be met are described in Section 2. The existing Ridge detailed PCSWMM model (developed by JFSA in 2020) has been updated to include the detailed design of the Drummond site, which was previously represented in the Ridge model as lumped subcatchments. Small refinements have also been made to the drainage areas within the Ridge development which have also been incorporated in this updated analysis, refer to JFSAs February 2022 memo titled: "*The Ridge – Updated HGL Analysis*" for full details regarding changes to the Ridge development.



Legend

- Park
- Residential
- Development Plan

SCALE: 1:2500

0 50 100 m

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
52 Springbrook Drive
Ottawa, ON, K2S 1B9
(613) 836-3884
www.jfsa.com

DSEL
david schaeffer engineering ltd

Drummond SWM Report

Figure 1: Site Overview

PROJECT	2226-21
DRAWN	MP
DATE	FEB 2022

2 DESIGN CRITERIA AND GUIDELINES

The design criteria and guidelines used for the stormwater management of the subject subdivision are those that were developed in the background documents, as well as those provided in the October 2012 *City of Ottawa Sewer Design Guidelines* and subsequent technical memorandums, and generally accepted stormwater management design guidelines.

The detailed design of the proposed development determined that the 19.16 ha subdivision has an average imperviousness of 62%. The total 71 ha drainage area to the dry pond has an average imperviousness of 64%. A detailed analysis of the proposed dual drainage system was required to confirm that the following general design criteria and guidelines for the minor and major systems would be met.

2.1 Minor System

a) Storm sewers are to be designed to provide a minimum 2-year level of service, plus 5-year inflows on collector roads (Dundonald Drive & Elevation Road) and 10-year inflows on arterial roads.

b) The 100-year hydraulic grade line (HGL) within the development minor systems must be maintained at least 0.3 m below the underside of footing elevation where gravity house connections are installed.

c) For less frequent storms (i.e. larger than 1:2 year or 1:5 year on collector / 1:10 year on arterial roads), the minor system shall, if required, will be limited with the use of inlet control devices to prevent excessive hydraulic surcharges and to maximize the use of surface storage on the road where desired.

d) Catchbasins on the road are to be equipped with City standard type S19 (fish) grates or City standard type S22 side inlets, and grates for catchbasins in rear yards, park and open spaces with pedestrian traffic are to be City standard type S19, S30 and S31.

e) Both Single and double catchbasins are to be equipped with 200 mm minimum lead pipes.

f) Rearyard catchbasins are to be equipped with 250 mm minimum lead pipes. Catchbasins installed on the street, where rearyard catchbasins connect to the main storm sewer through the catchbasin, are to be equipped with 250 mm minimum lead pipes for both single and double catchbasins.

g) Under full flow conditions, the allowable velocity in storm sewers is to be no less than 0.80 m/s and no greater than 3.0 m/s. Where velocities over 3.0 m/s are proposed, provisions shall be made to protect against displacement of sewers by sudden jarring or movement. Velocities greater than 6 m/s are not permitted.

2.2 Major System

a) The major system shall be designed with enough road surface storage to allow the excess runoff of a 100-year storm to be retained within road ponding areas where desired.

b) Inlet control devices should be sized such that they do not create surface ponding on the road during the 2-year design storm on local roads (5-year design storm on collector and 10-year design storm on arterial roads); it should be noted that surface ponding over grates is present during rainfall under any design, as an appropriate depth of water is required for runoff to enter the grate (refer to Tables D-6 of Appendix D).

c) Roof leaders shall be installed to direct the runoff to splash pads and onto grassed areas.

d) For the 100-year storm, the maximum total depth of water (static + dynamic) on all roads shall not exceed 35 cm at the gutter.

e) During the 100-year + 20% stress test, the maximum extent of surface water on streets, rearyards, public space and parking areas shall not touch the building envelope.

f) When catchbasins are installed in rear yards, safe overland flow routes are to be provided to allow the release of excess flows from such areas.

g) The product of the maximum flow depths on streets and maximum flow velocity must be less than 0.60 m^2/s on all roads.

h) The excess major system flows up to the 100-year return period are to be retained on-site in development blocks such as parks, schools, commercial, etc.

i) There must be at least 15 cm of vertical clearance between the spill elevation on the street and the ground elevation at the nearest building envelope that is in the proximity of the flow route or ponding area.

j) There must be at least 30 cm of vertical clearance between the rearyard spill elevation and the ground elevation at the adjacent building envelope.

3 ASSUMPTIONS AND SOURCE OF DATA USED IN THIS STUDY

Sources of information and assumptions made in this study are listed below:

- Stormwater management model: *PCSWMM (version 7.4)*
- Minor system design: *1:2 year, plus 1:5-year inflows on collector roads and 1:10 year on arterial roads. See the Rational Method Calculations in Appendix A.*
- Major system design: *1:100 year*
- Max. 100-yr water depth on roads: *35 cm above the gutter*
- Extent of the major system: *Shall not touch the building envelope during the 100-year + 20% stress test*
- PCSWMM model parameters: *Fo = 76.2 mm/hr, Fc = 13.2 mm/hr, DCAY = 4.14/hr, D.Stor.Imp. = 1.57 mm, D.Stor.Per. = 4.67 mm (as per 2012 City of Ottawa Sewer Design Guidelines)* *Detailed Area Imperviousness: based on development layout. Lumped Area Imperviousness: based on runoff coefficient (C) where C = 0.7 x imperviousness ratio+ 0.2.*
- Design storms: *2-, 5-, 10- and 100-year 3-hour Chicago and 100-year 24-hour SCS Type II storms as per 2012 City of Ottawa Sewer Design Guidelines; peak averaged over 10 minutes.*
- Historical Events: *July 1st, 1979; August 4th, 1988; and August 8th, 1996 events as per 2012 City of Ottawa Sewer Design Guidelines.*
- Stress Test: *20% increase in the 100-year 3-hour Chicago storm.*
- Street catchbasin covers: *City Standard Type S19 (fish) or City Standard Type S22 (side inlet). Type S19 approach flow-capture curves as per MTO design charts (equivalent to OPSD 400.010). Type S22 approach flow-capture curves as per the 2004 City of Ottawa Guidelines.*
- Rearyard catchbasin covers: *City Standard Type S19, S30 and S31*
- Curb and gutter: *City Standard SC1.3 (mountable) and SC1.1 (barrier). In the absence of flow capture curves for these curbs and gutters, OPSD 600.010 curb and gutters are assumed.*
- Manning's' roughness coeff.: *0.013 for concrete and PVC pipes (free flow).*
- Minor system losses: *Refer to Appendix C for maintenance hole loss coefficients.*
- Underside of footing elevations: *As provided by DSEL.*
- Freeboard in HGL analysis: *0.3 m between the underside of footing elevation and 100-year hydraulic gradeline.*
- Inlet Control Devices: *Refer to Appendix B for Plas-Tech ICD details.*
- Depth of backyard swales: *As per DSEL's Grading Plan*
- Street and pipe dimensions: *As per DSEL's Plan and Profiles*
- Right-of-way characteristics: *As per DSEL's Details of Roads*
- Downstream HGL: *92.5 m based on the top of bank elevation of the ditch that the SWM pond will outlet to.*

4 PROPOSED MINOR AND MAJOR SYSTEM DRAINAGE

As mentioned above, the Drummond development shares a dry SWM pond with the Ridge Development; a detailed PCSWMM model of the Ridge site was developed by JFSA in July 2020, which included the Drummond lands, but as lumped subcatchments. As additional detail is now available for the Drummond lands the Ridge PCSWMM model has been updated to include all the modelling details (major & minor system) of the Drummond Site. There have also been a few refinements to the total drainage area within the Ridge development, which have been included in this updated analysis, in addition to a few minor stormwater pipe invert updates to reflect the as-built survey. The HGL within the Ridge development has been assessed based on these latest model updates with full details and USF analysis/results provided in JFSA's February 2022 memo titled "*The Ridge – Updated HGL Analysis*".

Within the Drummond development, the minor system within the site has been designed to accommodate a minimum of the 2-year post-development flows from within the site and from external areas and 5-year inflows on collector roads (Dundonald Drive & Elevation Road). A Rational Method design was conducted by DSEL (refer to Appendix A) to estimate minor system flows based on the City of Ottawa IDF relationship and selected runoff coefficients. The minor system release rates from the parklands were set to the 5-year flow based on the rational method, with no onsite storage assumed.

As noted earlier in this report, where possible with grading limitations, road ponding areas up to 35 cm deep were used to contain the 100-year major system flows in the development. Note that rearyard catchbasins were connected to catchbasins on the road where possible, to allow rearyard runoff access to the storage in road ponding areas at regular intervals. In a design of this type where lots are serviced by gravity house connections, inlet control devices (ICDs) can be used to limit minor system capture at each catchbasin to the appropriate level of service.

Within the development, circular orifice plate type Inlet Control Devices (ICDs) of City standard diameters of 83 mm, 94 mm, 102 mm, 108 mm, 127 mm, 152 mm and 178 mm will be used to limit minor system capture to a minimum of the 2-year flow (refer to Appendix B for Plas-Tech ICD details), allowing for sub-surface storage of 0.5 m^3 in single catchbasins, 1.0 m^3 in double catch basins, and 1.9 m^3 in catchbasin manholes. Note that this subsurface catchbasin storage has not been included in the modelling to be conservative.

The street segments within the proposed development have been designed using a 'saw tooth' or 'sagged' road profile. The runoff from within these segments will be conveyed to catchbasins located at the lowest point within the street segment. Flows more than the catchbasin capture rate will be temporarily stored within the 'sagged' street segments and released slowly to the storm sewers, up to the 100-year design storm. When the storage on a specific street segment is surpassed due to blockage or an event greater than the 100-year storm, the excess water will flow towards the next downstream street sag, and eventually to the pond. It should be noted that the major system would outlet during the 100-year + 20% stress test without flooding any of the properties within the subdivision.

If the drainage system's capacity to capture surface flows is exceeded, Figure 5 presents the maximum extent of static surface ponding and volume on the streets based on grading. Additionally, surface storage volumes that may exist in the rear yards have not been considered in this model, and runoff from these areas has been directed straight to the catchbasin on the road that each rear yard swale will discharge to. This has been completed to ensure that the peak flows and ponding volumes calculated in the model are conservative.

The PCSWMM analysis, discussed in Sections 4.1 and 4.2, demonstrates that the proposed drainage system for the subdivision will have sufficient capacity to control the excess flow during a 100-year storm and safely capture and convey the 2-year (plus 5-year on collector roads) flow to the pond.

It is important to note that all values presented in this report are based on the maximum reported value (at 1-minute intervals), instead of the maximum simulated values (at 1-second intervals) as this avoids the model reporting any small blips/instabilities that may occur during any model simulation as real values, the justification for this being that there may be simply short-term model convergence issues reflected in the maximum simulated values that are not reflective of the real result. Taking the results reported by the model every minute, instead of every second ensures that these minor model convergence issues are not reported as real results.

4.1 Major System and SWM Analysis

The PCSWMM model was developed based on the information provided in Figures 2 and 3. Nine (9) simulations were conducted, one for each of the following rainfall events:

i) the 2-year, 3-hour Chicago storm;
ii) the 5-year, 3-hour Chicago storm;
iii) the 100-year, 3-hour Chicago storm;
iv) the 100-year, 24-hour SCS Type II storm
v) the July 1st, 1979 historical event;
vi) the August 4th, 1988 historical event;
vii) the August 8th, 1996 historical event; and
viii) the 100-year, 3-hour Chicago storm + 20%.

Note that the purpose of simulating the 100-year, 3-hour Chicago storm with a 20% increase is to stress test the drainage system for potential flooding, as per the October 2012 *City of Ottawa Sewer Design Guidelines*. The depression storage and infiltration parameters in both the PCSWMM and SWMHYMO models are as per the October 2012 *City of Ottawa Sewer Design Guidelines*. The percent imperviousness of the detailed drainage areas has been established based on zoning requirements and represents the largest allowable footprint on each lot. Figure 3 provides an overview of the subcatchments along with pervious area calculations (note that this analysis considers that all residential lots will also have a 3x3 patio at the rear of each unit), Table D-3 provides a full summary of all Drummond subcatchment parameters modelled in PCSWMM.

Where required inflows are limited by circular orifice plate type Inlet Control Devices (ICDs) of City standard diameters 83 mm, 94 mm, 102 mm, 108 mm, 127 mm, 152 mm and 178 mm. In locations where these CBs only capture flow from the road (no rear yard contribution), these ICDs have simply been represented as depth/flow curves based on the ponding at the CB grate, that reflect the function of the respective ICDs under a full head (ICD invert to road ponding elevation). Refer to Table D-4A in Appendix D for inflow curves for catchbasins at localized depressions with ICDs.

For CBs on a slope, the capture has been represented as a bottom orifice with a grate opening area equal to the opening area of the grate. When these CB also have inflow from rear yard CBs, the full CB has been represented with the grate allowing flow into the CB from the road and the orifice at the bottom of the CB representing the ICD. Note that for this development 200 mm diameter lead pipes were assumed and are required between single catchbasins and the storm sewers, and 250 mm diameter lead pipes were assumed and are required between rearyard catchbasins or single catchbasin maintenance holes and the storm sewers (note that this detail has not been included in the modelling). No temporary CBs are required within the development.

As requested by the City, rational method calculations have been completed to determine the peak flows to each of the CBs within the development based on the required level of service (2/5Year), see table D2 in Appendix D for full details. Table D6 outlines these rational method calculations against the 2-year simulated flows in the PCSWMM model, as we as the capture and ponding depths at each CB. It is important to note that the rational method calculations assume 100 % capture at each CB, which is true for CBs at low points but not always the case for CBs on a slope, also the rational method calculation tables assumed a 2 year level of service for the 2-year event and a 5-year level of service for the collector roads throughout the development, but the PCSWMM simulated results are for the 2-year event throughout the side. Even in light of the expected differences due to assumptions and approach, from this analysis, it was found that the average difference between the rational method and simulated flows was only 2 L/s.

Within the proposed subdivision, the dynamic flow depth on the road (at the gutter) will be minimal during the 100-year Chicago storm, as the 100-year flows are mostly retained within the road ponding areas and do not accumulate as in a typical subdivision design. Furthermore, it was determined that for the 100-year storm at all major system segments, the product of the depth of water (m) at the gutter multiplied by the velocity of flow (m/s) will not exceed the maximum allowable 0.6 m^2/s (refer to Table D-8 of Appendix D, where the calculated maximum was determined to be 0.34 m^2/s). Table D-9 of Appendix D presents the stress test results for dynamic flow depth on the road based on a 20% increase in the 100-year storm, as per the October 2012 *City of Ottawa Sewer Design Guidelines*. As shown in Table D-9, the maximum dynamic flow depth under these conditions is calculated as 0.38 cm, and the product of the depth of water at the gutter multiplied by the velocity of flow is 0.41 m^2/s.

Details of the 100-year street maximum water depth and surf elevations are provided in Table D-7 of Appendix D. Based on DSEL's grading the major system has approximately 264 m^3 of storage at these localized low points throughout the development. Depths calculated by the PCSWMM model demonstrate that a total 100-year depth of water (static and dynamic) on the street at these ponding areas will not exceed the maximum depth of 35 cm.

Table D-7 of Appendix D also presents the street storage stress test results based on a 20% increase in the 100-year storm, as per the October 2012 *City of Ottawa Sewer Design Guidelines*. As shown in Table D-7, the maximum depth of water (static + dynamic overflow) at any ponding area under these conditions is calculated as 44 cm. The maximum extent of surface water during the 100-year + 20% stress test will not touch the building envelopes, refer to stress test ponding extent figures provided by DSEL.

An overland flow route is to be provided on Expansion Road in the subdivision to safely convey flows to the pond (Junction C144). This overflow has been set that the crest of the spill elevation and has been represented in the model as a 5m wide open rectangular cross-section. The maximum 100-year major system flow to the pond was found to be 0.565 m^3/s. as required to convey the 100-year major system flow without exceeding 35 cm during the 100-year storm, and without touching the building envelopes during the 100-year + 20% stress test. Based on the PCSWMM model the overland flow route will have a maximum flow depth of 10 cm during the 100-year 3-hour Chicago storm and 18 cm during the 100-year + 20% stress test. Table 1 presents a summary of the major system results simulated in PCSWMM during the 100-year Chicago storm.

For the lands that drain to the Halfmoon Bay SWM facility, 100-Year capture has been provided within the Drummond site and as such, there is no major system flow from the Drummond site to future Greenbank Road.

Table 1: Approach Flows and Captured Flows for the 100-Year Chicago Storm

Catch Basin ID	Total Approach Flow (m³/s)	Total Capture (m³/s)	Max Ponding Depth (cm)
CB-1	0.097	0.035	6
CB-10	0.042	0.033	6
CB-100	0.014	0.012	3
CB-101	0.108	0.047	7
CB-102	0.105	0.040	6
CB-103	0.215	0.067	9
CB-104	0.021	0.017	4
CB-105	0.173	0.022	8
CB-11	0.082	0.082	20
CB-12	0.113	0.044	21
CB_123	0.030	0.021	14
CB_124	0.184	0.029	26
CB_125	0.184	0.033	26
CB_129	0.132	0.030	9
CB-13	0.113	0.024	21
CB_130	0.132	0.030	9
CB-14	0.098	0.024	15
CB-15	0.098	0.062	15
CB-16	0.135	0.063	19
CB-17	0.135	0.063	19
CB-18	0.139	0.065	26
CB-19	0.139	0.025	26
CB-2	0.097	0.035	6
CB-20	0.198	0.057	7
CB-21	0.051	0.025	5
CB-22	0.027	0.025	5
CB-23	0.063	0.063	9
CB-24	0.019	0.017	4
CB-25	0.026	0.024	4
CB-26	0.066	0.066	0
CB-27	0.066	0.066	0
CB-28	0.050	0.019	21
CB-29	0.050	0.019	21
CB-3	0.118	0.041	7
CB-30	0.083	0.036	6
CB-31	0.229	0.060	6
CB-32	0.077	0.034	6
CB-33	0.153	0.027	7
CB-34	0.092	0.043	7
CB-35	0.087	0.044	7
CB-36	0.081	0.037	6
CB-37	0.101	0.047	7
CB-38	0.352	0.091	34
CB-39	0.352	0.091	34
CB-4	0.258	0.061	10
CB-40	0.071	0.025	26
CB-41	0.071	0.019	26
CB-42	0.077	0.023	4
CB-43	0.061	0.042	6
CB-44	0.120	0.030	6
CB-45	0.116	0.029	26
CB-46	0.116	0.029	26
CB-47	0.037	0.029	5
CB-48	0.063	0.030	5
CB-49	0.138	0.045	26
CB-5	0.234	0.032	19

Table 1: Approach Flows and Captured Flows for the 100-Year Chicago Storm

Catch Basin ID	Total Approach Flow (m^3/s)	Total Capture (m^3/s)	Max Ponding Depth (cm)
CB-50	0.138	0.065	26
CB-51	0.113	0.045	24
CB-52	0.113	0.045	24
CB-53	0.079	0.030	5
CB-54	0.079	0.030	5
CB-55	0.009	0.009	3
CB-56	0.039	0.031	5
CB-57	0.031	0.027	5
CB-58	0.029	0.024	4
CB-59	0.050	0.036	6
CB-6	0.234	0.032	19
CB-60	0.065	0.029	5
CB-61	0.198	0.046	29
CB-62	0.198	0.065	29
CB-63	0.065	0.035	6
CB-64	0.229	0.060	6
CB-65	0.107	0.035	6
CB-66	0.088	0.035	6
CB-67	0.244	0.040	8
CB-68	0.154	0.019	28
CB-7	0.015	0.010	2
CB-70	0.081	0.030	5
CB-71	0.081	0.030	5
CB-72	0.151	0.065	27
CB-73	0.151	0.045	27
CB-74	0.161	0.019	28
CB-75	0.161	0.025	28
CB-76	0.094	0.037	6
CB-77	0.105	0.023	5
CB-78	0.043	0.027	5
CB-79	0.043	0.027	5
CB-8	0.015	0.010	2
CB-80	0.046	0.028	5
CB-81	0.046	0.028	5
CB-82	0.037	0.019	17
CB-83	0.037	0.019	17
CB-84	0.099	0.049	7
CB-85	0.123	0.027	7
CB-87	0.110	0.048	7
CB-88	0.180	0.027	8
CB-9	0.109	0.030	6
CB-91	0.323	0.090	31
CB-92	0.323	0.046	31
CB-93	0.462	0.020	31
CB-94	0.462	0.020	31
CB-95	0.217	0.025	31
CB-96	0.217	0.046	31
CB-97	0.207	0.069	9
CB-98	0.330	0.061	9
CB-99	0.142	0.053	8
		Max	**34**

4.2 Minor System and Hydraulic Grade line Analysis

The minor system analysis was completed using the PCSWMM program based on the peak flows captured during the rainfall events. Note that the storm sewer design is as provided by DSEL, and a Manning's roughness coefficient of 0.013 was used for concrete and PVC storm sewer pipes. Refer to Appendix C for maintenance hole loss coefficients used in the PCSWMM model.

The minor system performance was analyzed under restrictive downstream conditions. Restrictive downstream conditions for the pond are based on the approximate top of bank elevation of 92.5 m at the existing Borrisokane Road ditch that the storm sewer will outlet to. Table 2 presents the peak minor system outflows from both the Drummond & Ridge Sites to the SWM pond (MH-500 & MH-400) based on DSEL rational method calculation tables as well as detailed PCSWMM modelling.

Table 2 – Rational Method & Detailed Modelling Peak Flows

Location	DSEL Rational Method Flow (m^3/s)	2-Year PCSWMM Flow (m^3/s)	5-Year PCSWMM Flow (m^3/s)	100-Year PCSWMM Flow (m^3/s)
MH-500	0.888	2.398	3.287	4.125
MH-400	4.833	3.210	4.660	6.009
Total	5.721	5.608	7.947	10.134

Table 2 shows that the total 2-year flows simulated by the PCSWMM model are slightly smaller but overall similar to the values calculated by DSEL's Rational Method calculations, which is as expected as the rational method is a combination of both the 2 and 5 year flows from the various subcatchments. It is also important to note that the rational method calculations do not consider the Maintenance Hole junction between MH 307 and MH 313, which allows flows from the south (larger of the two) to assess the northern storm sewer inlet to the Pond (MH 500), therefore the individual peak flows to MH 400 and 500 per the rational method do not match the detailed PCSMWM modelling that considers this flow split.

The PCSWMM simulations have determined that for the selected 2-, 5- and 100-year storms, the total minor system flows would be 5.608 m^3/s, 7.947 m^3/s and 10.134 m^3/s, respectively. It should be noted that the total 100-Year minor system flows within the development are almost twice that of the 2-Year event, the reason for this is because several ICDs within the development had to be upsized to ensure major system ponding levels did not exceed 0.35cm for the 100-year events. Table D6 provides a full comparison of the applied and theoretical minimum ICD sizes (based on the rational method), which shows that there are several locations where the ICDs had to be upsized from the theoretical minimum to mitigate ponding issues within the development during the 100-year events. The reason that ICDs had to be upsized is due to the cascading design of the major system; best efforts have been made to maximize the major system storage during larger events, but when the runoff from the site exceeds this capacity the major system cascades to the next downstream street segment, which then results in a snowball effect of a major system cascading to the next downstream segment. At some points, this cascading major system flow needs to be captured into the minor system to ensure that ponding elevations and depth x velocity values are not exceeded, as such ICDs have been upsized at various locations throughout the development. And although the 100-year flow will surcharge most parts of the minor system, a freeboard of 0.3 m between the 100-year hydraulic grade line and the underside of footings has been provided throughout the proposed development.

Tables C-1A to C-6B of Appendix C summarize the pipe data and hydraulic simulation results for the 100-year 3-hour Chicago storm, 100-year 24-hour SCS Type II storm and the three historical events. Note that a minimum freeboard of 0.3 m between the hydraulic grade line and the underside of footings has been provided throughout the proposed developments for the 100-year storms, and a minimum freeboard of 0 m has been provided throughout the proposed development for the historical events. Note that at all locations the flowing full pipe velocities are no less than 0.80 m/s and no greater than 3.0 m/s for all proposed pipes with the development

Table C-6B of Appendix C presents the climate change stress test results for the hydraulic grade line analysis based on a 20% increase in the 100-year storm, as per the October 2012 *City of Ottawa Sewer Design Guidelines*. Under these conditions, no locations within the proposed developments have a USF freeboard less than 0 m.

Table 3 presents the composite hydraulic grade line results for the 100-year 3-hour Chicago and 100-year 24-hour SCS Type II design storms. The HGL is interpolated along the full length of the pipe and then compared with each individual USF, to confirm whether there is an HGL issue along that segment. Based on the results below it is seen that there are no HGL issues within the development with an average freeboard of 1.28m throughout the development and a minimum freeboard of 0.30 m at Lot 89-1.

Table 3: USF Freeboard Results - Composite 100-Year Events

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-531	MH-313	76-2	98.43	4.8	21.5	97.74	97.60	97.63	0.80
MH-531	MH-313	76-1	98.43	9.6	21.5	97.74	97.60	97.66	0.77
MH-500	MH-502	146-6	102.89	14.2	92.0	102.97	101.25	101.52	1.37
MH-500	MH-502	146-5	102.89	22.2	92.0	102.97	101.25	101.67	1.22
MH-500	MH-502	146-4	102.89	28.8	92.0	102.97	101.25	101.79	1.10
MH-500	MH-502	146-3	102.89	36.8	92.0	102.97	101.25	101.94	0.95
MH-500	MH-502	146-2	102.89	43.4	92.0	102.97	101.25	102.06	0.83
MH-500	MH-502	146-1	102.89	51.4	92.0	102.97	101.25	102.21	0.68
MH-500	MH-502	145-5	103.05	61.4	92.0	102.97	101.25	102.40	0.65
MH-500	MH-502	145-4	103.05	69.9	92.0	102.97	101.25	102.56	0.49
MH-500	MH-502	145-3	103.55	76.0	92.0	102.97	101.25	102.67	0.88
MH-500	MH-502	145-2	103.55	84.0	92.0	102.97	101.25	102.82	0.73
MH-500	MH-502	145-1	103.55	88.9	92.0	102.97	101.25	102.91	0.64
MH-502	MH-503	148-5	101.09	38.5	119.0	101.25	99.64	100.16	0.93
MH-502	MH-503	148-4	101.09	46.5	119.0	101.25	99.64	100.27	0.82
MH-502	MH-503	148-3	101.09	53.1	119.0	101.25	99.64	100.36	0.73
MH-502	MH-503	148-2	101.09	61.1	119.0	101.25	99.64	100.47	0.62
MH-502	MH-503	148-1	101.44	68.4	119.0	101.25	99.64	100.57	0.87
MH-502	MH-503	147-6	101.65	78.4	119.0	101.25	99.64	100.70	0.95
MH-502	MH-503	147-5	101.65	86.4	119.0	101.25	99.64	100.81	0.84
MH-502	MH-503	147-4	102.03	94.4	119.0	101.25	99.64	100.92	1.11
MH-502	MH-503	147-3	102.03	101.0	119.0	101.25	99.64	101.01	1.02
MH-502	MH-503	147-2	102.66	107.6	119.0	101.25	99.64	101.10	1.56
MH-502	MH-503	147-1	102.66	115.6	119.0	101.25	99.64	101.20	1.46
MH-503	MH-504	150-3	100.3	1.3	73.0	99.64	99.14	99.15	1.15
MH-503	MH-504	156-4	100.04	2.7	73.0	99.64	99.14	99.16	0.88
MH-503	MH-504	150-2	100.3	6.3	73.0	99.64	99.14	99.19	1.11
MH-503	MH-504	156-5	100.04	10.0	73.0	99.64	99.14	99.21	0.83
MH-503	MH-504	150-1	100.3	14.3	73.0	99.64	99.14	99.24	1.06
MH-503	MH-504	157-1	100.3	20.0	73.0	99.64	99.14	99.28	1.02
MH-503	MH-504	149-5	100.7	24.3	73.0	99.64	99.14	99.31	1.39
MH-503	MH-504	157-2	100.3	28.0	73.0	99.64	99.14	99.33	0.97
MH-503	MH-504	149-4	100.7	32.3	73.0	99.64	99.14	99.36	1.34
MH-503	MH-504	157-3	100.3	34.6	73.0	99.64	99.14	99.38	0.92
MH-503	MH-504	149-3	100.7	38.9	73.0	99.64	99.14	99.41	1.29
MH-503	MH-504	157-4	100.3	42.6	73.0	99.64	99.14	99.43	0.87
MH-503	MH-504	149-2	100.7	46.9	73.0	99.64	99.14	99.46	1.24
MH-503	MH-504	157-5	100.3	49.9	73.0	99.64	99.14	99.48	0.82
MH-503	MH-504	149-1	100.7	54.3	73.0	99.64	99.14	99.51	1.19
MH-503	MH-504	158-1	100.48	59.8	73.0	99.64	99.14	99.55	0.93
MH-503	MH-504	158-2	100.48	67.8	73.0	99.64	99.14	99.61	0.87
MH-503	MH-504	158-3	100.48	71.4	73.0	99.64	99.14	99.63	0.85
MH-504	MH-528	154-1	99.24	15.6	108.0	99.14	98.37	98.48	0.76
MH-504	MH-528	153-3	99.92	16.5	108.0	99.14	98.37	98.48	1.44
MH-504	MH-528	154-2	99.24	23.6	108.0	99.14	98.37	98.54	0.70
MH-504	MH-528	153-2	99.92	24.5	108.0	99.14	98.37	98.54	1.38
MH-504	MH-528	154-3	99.24	30.2	108.0	99.14	98.37	98.58	0.66
MH-504	MH-528	153-1	99.92	31.8	108.0	99.14	98.37	98.59	1.33
MH-504	MH-528	154-4	99.24	38.2	108.0	99.14	98.37	98.64	0.60
MH-504	MH-528	152-3	99.92	41.8	108.0	99.14	98.37	98.67	1.25
MH-504	MH-528	155-1	99.28	48.2	108.0	99.14	98.37	98.71	0.57
MH-504	MH-528	152-2	99.92	49.8	108.0	99.14	98.37	98.72	1.20
MH-504	MH-528	155-2	99.28	56.2	108.0	99.14	98.37	98.77	0.51
MH-504	MH-528	152-1	99.92	57.1	108.0	99.14	98.37	98.78	1.14
MH-504	MH-528	155-3	99.59	62.8	108.0	99.14	98.37	98.82	0.77
MH-504	MH-528	151-4	99.96	67.1	108.0	99.14	98.37	98.85	1.11
MH-504	MH-528	155-4	99.59	70.8	108.0	99.14	98.37	98.88	0.71
MH-504	MH-528	151-3	99.96	75.1	108.0	99.14	98.37	98.91	1.05
MH-504	MH-528	155-5	99.59	78.1	108.0	99.14	98.37	98.93	0.66
MH-504	MH-528	151-2	99.96	81.7	108.0	99.14	98.37	98.95	1.01
MH-504	MH-528	156-1	99.73	88.1	108.0	99.14	98.37	99.00	0.73
MH-504	MH-528	151-1	100.04	89.7	108.0	99.14	98.37	99.01	1.03
MH-504	MH-528	156-2	99.73	96.1	108.0	99.14	98.37	99.06	0.67
MH-504	MH-528	150-4	100.3	99.7	108.0	99.14	98.37	99.08	1.22
MH-504	MH-528	156-3	100.04	102.7	108.0	99.14	98.37	99.10	0.94
MH-505	MH-506	92-3	104.3	2.5	13.0	103.56	103.67	103.65	0.65
MH-505	MH-506	92-2	104.3	6.8	13.0	103.56	103.67	103.61	0.69
MH-505	MH-506	92-1	104.3	11.3	13.0	103.56	103.67	103.57	0.73
MH-505	MH-534	99-7	104.61	3.7	94.5	103.56	103.22	103.24	1.37
MH-505	MH-534	95-5	103.94	6.8	94.5	103.56	103.22	103.25	0.69
MH-505	MH-534	99-6	104.67	11.7	94.5	103.56	103.22	103.26	1.41
MH-505	MH-534	94-1	104.13	17.4	94.5	103.56	103.22	103.28	0.85
MH-505	MH-534	99-5	104.86	17.9	94.5	103.56	103.22	103.29	1.57
MH-505	MH-534	94-2	104.13	25.4	94.5	103.56	103.22	103.31	0.82
MH-505	MH-534	100-6	104.86	25.7	94.5	103.56	103.22	103.31	1.55
MH-505	MH-534	94-3	104.13	32.7	94.5	103.56	103.22	103.34	0.79
MH-505	MH-534	100-5	104.78	33.7	94.5	103.56	103.22	103.34	1.44
MH-505	MH-534	100-4	104.97	38.3	94.5	103.56	103.22	103.36	1.61
MH-505	MH-534	94-4	104.13	40.7	94.5	103.56	103.22	103.37	0.76

Table 3: USF Freeboard Results - Composite 100-Year Events

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-505	MH-534	101-6	104.97	47.7	94.5	103.56	103.22	103.39	1.58
MH-505	MH-534	94-5	104.13	48.3	94.5	103.56	103.22	103.39	0.74
MH-505	MH-534	101-5	104.86	53.9	94.5	103.56	103.22	103.41	1.45
MH-505	MH-534	93-1	104.3	58.9	94.5	103.56	103.22	103.43	0.87
MH-505	MH-534	101-4	105.08	61.9	94.5	103.56	103.22	103.44	1.64
MH-505	MH-534	93-2	104.3	66.9	94.5	103.56	103.22	103.46	0.84
MH-505	MH-534	102-6	105.11	71.3	94.5	103.56	103.22	103.48	1.63
MH-505	MH-534	93-3	104.3	74.2	94.5	103.56	103.22	103.49	0.81
MH-505	MH-534	102-5	105.11	75.9	94.5	103.56	103.22	103.49	1.62
MH-505	MH-534	93-4	104.3	82.2	94.5	103.56	103.22	103.51	0.79
MH-505	MH-534	102-4	105.11	83.9	94.5	103.56	103.22	103.52	1.59
MH-505	MH-534	93-5	104.3	89.8	94.5	103.56	103.22	103.54	0.76
MH-506	MH-508	89-1	103.74	7.2	79.0	103.67	103.41	103.44	0.30
MH-506	MH-508	90-3	104.04	27.0	79.0	103.67	103.41	103.50	0.54
MH-506	MH-508	90-2	104.04	34.6	79.0	103.67	103.41	103.53	0.51
MH-506	MH-508	90-1	104.04	42.6	79.0	103.67	103.41	103.55	0.49
MH-506	MH-508	91-4	104.23	53.2	79.0	103.67	103.41	103.59	0.64
MH-506	MH-508	91-3	104.23	61.2	79.0	103.67	103.41	103.61	0.62
MH-506	MH-508	91-2	104.23	68.5	79.0	103.67	103.41	103.64	0.59
MH-506	MH-508	91-1	104.23	76.5	79.0	103.67	103.41	103.66	0.57
MH-5070	MH-513	99-2	104.61	0.1	82.0	103.66	103.42	103.42	1.19
MH-5070	MH-513	105-6	104.46	8.2	82.0	103.66	103.42	103.45	1.01
MH-5070	MH-513	99-3	104.67	8.4	82.0	103.66	103.42	103.45	1.22
MH-5070	MH-513	105-5	104.46	12.8	82.0	103.66	103.42	103.46	1.00
MH-5070	MH-513	99-4	104.86	14.3	82.0	103.66	103.42	103.47	1.39
MH-5070	MH-513	105-4	104.46	20.8	82.0	103.66	103.42	103.48	0.98
MH-5070	MH-513	100-1	104.86	22.1	82.0	103.66	103.42	103.49	1.37
MH-5070	MH-513	100-2	104.78	30.1	82.0	103.66	103.42	103.51	1.27
MH-5070	MH-513	104-8	104.6	30.2	82.0	103.66	103.42	103.51	1.09
MH-5070	MH-513	100-3	104.97	34.7	82.0	103.66	103.42	103.52	1.45
MH-5070	MH-513	104-7	104.6	34.8	82.0	103.66	103.42	103.52	1.08
MH-5070	MH-513	104-6	104.6	42.8	82.0	103.66	103.42	103.55	1.05
MH-5070	MH-513	101-1	104.97	44.1	82.0	103.66	103.42	103.55	1.42
MH-5070	MH-513	104-5	104.6	49.0	82.0	103.66	103.42	103.57	1.03
MH-5070	MH-513	101-2	104.86	50.3	82.0	103.66	103.42	103.57	1.29
MH-5070	MH-513	101-3	105.08	58.3	82.0	103.66	103.42	103.59	1.49
MH-5070	MH-513	103-8	104.79	58.4	82.0	103.66	103.42	103.59	1.20
MH-5070	MH-513	103-7	104.79	63.0	82.0	103.66	103.42	103.61	1.18
MH-5070	MH-513	102-1	105.11	67.7	82.0	103.66	103.42	103.62	1.49
MH-5070	MH-513	103-6	104.79	71.0	82.0	103.66	103.42	103.63	1.16
MH-5070	MH-513	102-2	105.11	72.3	82.0	103.66	103.42	103.63	1.48
MH-5070	MH-513	103-5	104.79	77.2	82.0	103.66	103.42	103.65	1.14
MH-5070	MH-513	102-3	105.11	80.3	82.0	103.66	103.42	103.66	1.45
MH-508	MH-509	88-3	103.73	6.6	41.5	103.41	103.14	103.18	0.55
MH-508	MH-509	88-2	103.73	14.2	41.5	103.41	103.14	103.23	0.50
MH-508	MH-509	88-1	103.73	22.2	41.5	103.41	103.14	103.29	0.44
MH-508	MH-509	89-3	103.74	32.8	41.5	103.41	103.14	103.36	0.38
MH-508	MH-509	89-2	103.74	40.4	41.5	103.41	103.14	103.41	0.33
MH-5080	MH-517	105-1	104.46	6.2	76.5	103.19	103.02	103.04	1.42
MH-5080	MH-517	111-6	104.04	7.8	76.5	103.19	103.02	103.04	1.00
MH-5080	MH-517	105-2	104.46	10.7	76.5	103.19	103.02	103.05	1.41
MH-5080	MH-517	111-5	104.35	14.0	76.5	103.19	103.02	103.05	1.30
MH-5080	MH-517	105-3	104.46	18.7	76.5	103.19	103.02	103.06	1.40
MH-5080	MH-517	112-8	104.49	23.4	76.5	103.19	103.02	103.07	1.42
MH-5080	MH-517	112-7	104.49	28.0	76.5	103.19	103.02	103.08	1.41
MH-5080	MH-517	104-1	104.6	28.1	76.5	103.19	103.02	103.08	1.52
MH-5080	MH-517	104-2	104.6	32.7	76.5	103.19	103.02	103.09	1.51
MH-5080	MH-517	112-6	104.49	36.0	76.5	103.19	103.02	103.10	1.39
MH-5080	MH-517	104-3	104.6	40.7	76.5	103.19	103.02	103.11	1.49
MH-5080	MH-517	112-5	104.49	42.2	76.5	103.19	103.02	103.11	1.38
MH-5080	MH-517	104-4	104.6	46.9	76.5	103.19	103.02	103.12	1.48
MH-5080	MH-517	113-8	104.59	51.6	76.5	103.19	103.02	103.13	1.46
MH-5080	MH-517	113-7	104.59	56.2	76.5	103.19	103.02	103.14	1.45
MH-5080	MH-517	103-1	104.79	56.3	76.5	103.19	103.02	103.14	1.65
MH-5080	MH-517	103-2	104.79	60.9	76.5	103.19	103.02	103.15	1.64
MH-5080	MH-517	113-6	104.59	64.2	76.5	103.19	103.02	103.16	1.43
MH-5080	MH-517	103-3	104.79	68.9	76.5	103.19	103.02	103.17	1.62
MH-5080	MH-517	113-5	104.59	70.4	76.5	103.19	103.02	103.17	1.42
MH-5080	MH-517	103-4	104.79	75.1	76.5	103.19	103.02	103.18	1.61
MH-509	MH-510	87-3	103.63	2.0	10.5	103.14	102.93	102.97	0.66
MH-509	MH-510	87-2	103.63	5.6	10.5	103.14	102.93	103.04	0.59
MH-509	MH-510	87-1	103.63	9.4	10.5	103.14	102.93	103.12	0.51
MH-510	MH-511	85-4	103.36	4.3	64.0	102.93	102.31	102.35	1.01
MH-510	MH-511	112-1	104.49	9.4	64.0	102.93	102.31	102.40	2.09
MH-510	MH-511	85-3	103.36	12.3	64.0	102.93	102.31	102.43	0.93
MH-510	MH-511	112-2	104.49	14.0	64.0	102.93	102.31	102.44	2.05
MH-510	MH-511	85-2	103.36	19.5	64.0	102.93	102.31	102.50	0.86
MH-510	MH-511	112-3	104.49	22.0	64.0	102.93	102.31	102.52	1.97
MH-510	MH-511	85-1	103.36	27.5	64.0	102.93	102.31	102.57	0.79

Table 3: USF Freeboard Results - Composite 100-Year Events

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-510	MH-511	112-4	104.49	28.2	64.0	102.93	102.31	102.58	1.91
MH-510	MH-511	113-1	104.59	37.6	64.0	102.93	102.31	102.67	1.92
MH-510	MH-511	86-3	103.5	38.1	64.0	102.93	102.31	102.68	0.82
MH-510	MH-511	113-2	104.59	42.2	64.0	102.93	102.31	102.72	1.87
MH-510	MH-511	86-2	103.5	45.8	64.0	102.93	102.31	102.75	0.75
MH-510	MH-511	113-3	104.59	50.2	64.0	102.93	102.31	102.79	1.80
MH-510	MH-511	86-1	103.5	53.8	64.0	102.93	102.31	102.83	0.67
MH-510	MH-511	113-4	104.59	56.4	64.0	102.93	102.31	102.85	1.74
MH-511	MH-526	82-3	101.52	20.9	95.5	102.31	100.33	100.76	0.76
MH-511	MH-526	109-2	102.17	26.4	95.5	102.31	100.33	100.88	1.29
MH-511	MH-526	82-2	101.52	28.9	95.5	102.31	100.33	100.93	0.59
MH-511	MH-526	109-3	102.32	30.8	95.5	102.31	100.33	100.97	1.35
MH-511	MH-526	82-1	101.52	36.5	95.5	102.31	100.33	101.09	0.43
MH-511	MH-526	109-4	102.78	38.8	95.5	102.31	100.33	101.13	1.65
MH-511	MH-526	83-3	101.63	47.1	95.5	102.31	100.33	101.31	0.32
MH-511	MH-526	110-1	102.91	48.2	95.5	102.31	100.33	101.33	1.58
MH-511	MH-526	110-2	103.09	52.8	95.5	102.31	100.33	101.42	1.67
MH-511	MH-526	83-2	102.27	54.7	95.5	102.31	100.33	101.46	0.81
MH-511	MH-526	110-3	103.34	60.8	95.5	102.31	100.33	101.59	1.75
MH-511	MH-526	83-1	102.27	62.7	95.5	102.31	100.33	101.63	0.64
MH-511	MH-526	110-4	103.77	67.0	95.5	102.31	100.33	101.72	2.05
MH-511	MH-526	84-3	102.46	73.4	95.5	102.31	100.33	101.85	0.61
MH-511	MH-526	111-1	103.89	76.4	95.5	102.31	100.33	101.91	1.98
MH-511	MH-526	111-2	103.98	81.0	95.5	102.31	100.33	102.01	1.97
MH-511	MH-526	84-2	103.15	81.0	95.5	102.31	100.33	102.01	1.14
MH-511	MH-526	84-1	103.15	88.9	95.5	102.31	100.33	102.17	0.98
MH-511	MH-526	111-3	104.04	89.1	95.5	102.31	100.33	102.17	1.87
MH-511	MH-526	111-4	104.35	95.3	95.5	102.31	100.33	102.30	2.05
MH-513	MH-515	108-6	102.64	21.6	81.0	103.42	100.72	101.44	1.20
MH-513	MH-515	97-2	102.99	26.5	81.0	103.42	100.72	101.61	1.38
MH-513	MH-515	108-5	102.57	29.6	81.0	103.42	100.72	101.71	0.86
MH-513	MH-515	97-3	103.15	30.9	81.0	103.42	100.72	101.75	1.40
MH-513	MH-515	108-4	102.98	35.8	81.0	103.42	100.72	101.92	1.06
MH-513	MH-515	97-4	103.6	38.9	81.0	103.42	100.72	102.02	1.58
MH-513	MH-515	107-6	103.11	45.2	81.0	103.42	100.72	102.23	0.88
MH-513	MH-515	98-1	103.73	48.3	81.0	103.42	100.72	102.33	1.40
MH-513	MH-515	107-5	103.33	49.8	81.0	103.42	100.72	102.38	0.95
MH-513	MH-515	98-2	103.92	52.9	81.0	103.42	100.72	102.49	1.43
MH-513	MH-515	107-4	103.75	56.2	81.0	103.42	100.72	102.60	1.15
MH-513	MH-515	98-3	104.16	60.9	81.0	103.42	100.72	102.75	1.41
MH-513	MH-515	106-6	103.85	65.6	81.0	103.42	100.72	102.91	0.94
MH-513	MH-515	98-4	104.59	67.1	81.0	103.42	100.72	102.96	1.63
MH-513	MH-515	106-5	104.08	73.6	81.0	103.42	100.72	103.18	0.90
MH-513	MH-515	99-1	104.61	76.5	81.0	103.42	100.72	103.27	1.34
MH-513	MH-515	106-4	104.34	79.8	81.0	103.42	100.72	103.38	0.96
MH-515	MH-518	114-5	101.66	3.6	44.0	100.72	100.51	100.53	1.13
MH-515	MH-518	115-1	101.78	14.3	44.0	100.72	100.51	100.58	1.20
MH-515	MH-518	115-2	102.22	21.9	44.0	100.72	100.51	100.62	1.60
MH-515	MH-518	115-3	102.22	29.9	44.0	100.72	100.51	100.65	1.57
MH-515	MH-518	115-4	102.22	37.1	44.0	100.72	100.51	100.69	1.53
MH-517	MH-518	109-8	102.23	19.4	82.0	103.02	100.51	101.11	1.12
MH-517	MH-518	108-1	102.64	20.7	82.0	103.02	100.51	101.15	1.49
MH-517	MH-518	109-7	102.17	27.4	82.0	103.02	100.51	101.35	0.82
MH-517	MH-518	108-2	102.57	28.7	82.0	103.02	100.51	101.39	1.18
MH-517	MH-518	109-6	102.32	31.8	82.0	103.02	100.51	101.49	0.83
MH-517	MH-518	108-3	102.98	34.9	82.0	103.02	100.51	101.58	1.40
MH-517	MH-518	109-5	102.78	39.8	82.0	103.02	100.51	101.73	1.05
MH-517	MH-518	107-1	103.11	44.3	82.0	103.02	100.51	101.87	1.24
MH-517	MH-518	107-2	103.33	48.9	82.0	103.02	100.51	102.01	1.32
MH-517	MH-518	110-8	102.91	49.2	82.0	103.02	100.51	102.02	0.89
MH-517	MH-518	110-7	103.09	53.8	82.0	103.02	100.51	102.16	0.93
MH-517	MH-518	107-3	103.75	55.3	82.0	103.02	100.51	102.21	1.54
MH-517	MH-518	110-6	103.34	61.8	82.0	103.02	100.51	102.41	0.93
MH-517	MH-518	106-1	103.85	64.7	82.0	103.02	100.51	102.49	1.36
MH-517	MH-518	110-5	103.77	68.0	82.0	103.02	100.51	102.60	1.17
MH-517	MH-518	106-2	104.08	72.7	82.0	103.02	100.51	102.74	1.34
MH-517	MH-518	111-8	103.89	77.4	82.0	103.02	100.51	102.88	1.01
MH-517	MH-518	106-3	104.34	78.9	82.0	103.02	100.51	102.93	1.41
MH-517	MH-518	111-7	103.98	82.0	82.0	103.02	100.51	103.02	0.96
MH-518	MH-526	114-1	101.36	19.7	47.0	100.51	100.33	100.41	0.95
MH-518	MH-526	114-2	101.66	27.3	47.0	100.51	100.33	100.44	1.22
MH-518	MH-526	114-3	101.66	35.3	47.0	100.51	100.33	100.47	1.19
MH-518	MH-526	114-4	101.66	42.5	47.0	100.51	100.33	100.50	1.16
MH-519	MH-520	129-3	104.07	4.0	54.5	103.48	103.41	103.41	0.66
MH-519	MH-520	138-1	104.08	5.4	54.5	103.48	103.41	103.41	0.67
MH-519	MH-520	129-2	104.07	12.0	54.5	103.48	103.41	103.42	0.65
MH-519	MH-520	138-2	104.08	13.0	54.5	103.48	103.41	103.42	0.66
MH-519	MH-520	129-1	104.07	19.6	54.5	103.48	103.41	103.43	0.64
MH-519	MH-520	138-3	104.08	21.0	54.5	103.48	103.41	103.43	0.65

Table 3: USF Freeboard Results - Composite 100-Year Events

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-519	MH-520	128-3	104.09	30.2	54.5	103.48	103.41	103.45	0.64
MH-519	MH-520	139-1	104.23	31.6	54.5	103.48	103.41	103.45	0.78
MH-519	MH-520	128-2	104.09	38.2	54.5	103.48	103.41	103.46	0.63
MH-519	MH-520	139-2	104.23	39.2	54.5	103.48	103.41	103.46	0.77
MH-519	MH-520	128-1	104.09	45.8	54.5	103.48	103.41	103.46	0.63
MH-519	MH-520	139-3	104.23	47.2	54.5	103.48	103.41	103.47	0.76
MH-519	MH-523	140-3	104.25	2.3	11.5	103.48	103.32	103.35	0.90
MH-519	MH-523	140-2	104.25	7.0	11.5	103.48	103.32	103.42	0.83
MH-519	MH-523	140-1	104.25	10.5	11.5	103.48	103.32	103.46	0.79
MH-520	MH-521	136-1	103.94	3.7	57.5	103.41	103.12	103.14	0.80
MH-520	MH-521	131-3	103.81	8.8	57.5	103.41	103.12	103.16	0.65
MH-520	MH-521	136-2	103.94	11.4	57.5	103.41	103.12	103.18	0.76
MH-520	MH-521	131-2	103.81	16.8	57.5	103.41	103.12	103.20	0.61
MH-520	MH-521	136-3	103.94	19.4	57.5	103.41	103.12	103.22	0.72
MH-520	MH-521	131-1	103.81	24.5	57.5	103.41	103.12	103.24	0.57
MH-520	MH-521	137-1	103.94	30.0	57.5	103.41	103.12	103.27	0.67
MH-520	MH-521	130-3	103.94	35.1	57.5	103.41	103.12	103.29	0.65
MH-520	MH-521	137-2	103.94	37.6	57.5	103.41	103.12	103.31	0.63
MH-520	MH-521	130-2	103.94	43.1	57.5	103.41	103.12	103.33	0.61
MH-520	MH-521	137-3	103.94	45.6	57.5	103.41	103.12	103.35	0.59
MH-520	MH-521	130-1	103.94	50.7	57.5	103.41	103.12	103.37	0.57
MH-521	MH-522	135-1	103.67	1.0	11.5	103.12	102.94	102.95	0.72
MH-521	MH-522	135-2	103.67	5.3	11.5	103.12	102.94	103.02	0.65
MH-521	MH-522	135-3	103.67	9.5	11.5	103.12	102.94	103.09	0.58
MH-522	MH-525	133-3	102.71	7.1	55.0	102.94	101.07	101.31	1.40
MH-522	MH-525	133-4	103.1	14.4	55.0	102.94	101.07	101.56	1.54
MH-522	MH-525	133-5	103.1	22.4	55.0	102.94	101.07	101.83	1.27
MH-522	MH-525	134-1	103.55	32.9	55.0	102.94	101.07	102.19	1.36
MH-522	MH-525	134-2	103.55	40.6	55.0	102.94	101.07	102.45	1.10
MH-522	MH-525	134-3	103.55	48.6	55.0	102.94	101.07	102.72	0.83
MH-523	MH-524	141-5	103.68	20.5	55.0	103.32	102.49	102.80	0.88
MH-523	MH-524	141-4	103.68	28.5	55.0	103.32	102.49	102.92	0.76
MH-523	MH-524	141-3	104.25	35.7	55.0	103.32	102.49	103.03	1.22
MH-523	MH-524	141-2	104.25	43.7	55.0	103.32	102.49	103.15	1.10
MH-523	MH-524	141-1	104.25	51.3	55.0	103.32	102.49	103.27	0.98
MH-524	MH-5240	126-1	103.57	5.3	65.0	102.49	102.20	102.22	1.35
MH-524	MH-5240	122-4	103.32	5.6	65.0	102.49	102.20	102.22	1.10
MH-524	MH-5240	126-2	103.57	13.3	65.0	102.49	102.20	102.26	1.31
MH-524	MH-5240	122-3	103.32	13.6	65.0	102.49	102.20	102.26	1.06
MH-524	MH-5240	122-2	103.32	20.9	65.0	102.49	102.20	102.29	1.03
MH-524	MH-5240	126-3	103.57	20.9	65.0	102.49	102.20	102.29	1.28
MH-524	MH-5240	122-1	103.32	28.9	65.0	102.49	102.20	102.33	0.99
MH-524	MH-5240	127-1	103.57	31.6	65.0	102.49	102.20	102.34	1.23
MH-524	MH-5240	121-3	103.45	39.5	65.0	102.49	102.20	102.37	1.08
MH-524	MH-5240	127-2	103.57	39.6	65.0	102.49	102.20	102.37	1.20
MH-524	MH-5240	121-2	103.45	47.1	65.0	102.49	102.20	102.41	1.04
MH-524	MH-5240	127-3	103.57	47.2	65.0	102.49	102.20	102.41	1.16
MH-524	MH-5240	121-1	103.45	55.1	65.0	102.49	102.20	102.44	1.01
MH-5240	MH-525	124-1	102.67	16.1	63.5	102.20	101.07	101.36	1.31
MH-5240	MH-525	123-5	102.2	19.8	63.5	102.20	101.07	101.42	0.78
MH-5240	MH-525	124-2	102.67	24.1	63.5	102.20	101.07	101.50	1.17
MH-5240	MH-525	123-4	102.74	27.4	63.5	102.20	101.07	101.56	1.18
MH-5240	MH-525	124-3	102.67	31.7	63.5	102.20	101.07	101.63	1.04
MH-5240	MH-525	123-3	102.74	35.4	63.5	102.20	101.07	101.70	1.04
MH-5240	MH-525	125-1	103.28	42.3	63.5	102.20	101.07	101.82	1.46
MH-5240	MH-525	123-2	103.08	42.6	63.5	102.20	101.07	101.83	1.25
MH-5240	MH-525	125-2	103.28	50.3	63.5	102.20	101.07	101.96	1.32
MH-5240	MH-525	123-1	103.08	50.6	63.5	102.20	101.07	101.97	1.11
MH-5240	MH-525	125-3	103.28	58.0	63.5	102.20	101.07	102.10	1.18
MH-5240	MH-525	122-5	103.32	61.3	63.5	102.20	101.07	102.16	1.16
MH-52400	MH-538	119-1	102.26	15.8	58.0	102.25	101.17	101.47	0.79
MH-52400	MH-538	119-2	102.26	23.8	58.0	102.25	101.17	101.61	0.65
MH-52400	MH-538	119-3	102.65	31.4	58.0	102.25	101.17	101.75	0.90
MH-52400	MH-538	120-1	103.45	42.1	58.0	102.25	101.17	101.95	1.50
MH-52400	MH-538	120-2	103.45	50.1	58.0	102.25	101.17	102.10	1.35
MH-52400	MH-538	120-3	103.45	57.4	58.0	102.25	101.17	102.23	1.22
MH-525	MH-526	132-1	101.26	15.8	58.5	101.07	100.33	100.53	0.73
MH-525	MH-526	132-2	101.26	23.8	58.5	101.07	100.33	100.63	0.63
MH-525	MH-526	132-3	101.65	31.0	58.5	101.07	100.33	100.72	0.93
MH-525	MH-526	132-4	101.65	39.0	58.5	101.07	100.33	100.82	0.83
MH-525	MH-526	133-1	101.85	49.7	58.5	101.07	100.33	100.96	0.89
MH-525	MH-526	133-2	102.71	57.3	58.5	101.07	100.33	101.05	1.66
MH-528	MH-529	5	101.37	6.6	62.5	98.37	98.10	98.13	3.24
MH-528	MH-529	81-1	98.72	9.8	62.5	98.37	98.10	98.14	0.58
MH-528	MH-529	4	101.37	12.7	62.5	98.37	98.10	98.15	3.22
MH-528	MH-529	81-2	98.72	17.8	62.5	98.37	98.10	98.17	0.55
MH-528	MH-529	81-3	98.72	25.0	62.5	98.37	98.10	98.21	0.51
MH-528	MH-529	3	101.37	25.5	62.5	98.37	98.10	98.21	3.16
MH-528	MH-529	2	101.42	31.6	62.5	98.37	98.10	98.23	3.19

Table 3: USF Freeboard Results - Composite 100-Year Events

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-528	MH-529	81-4	98.72	33.0	62.5	98.37	98.10	98.24	0.48
MH-528	MH-529	81-5	99.3	40.6	62.5	98.37	98.10	98.27	1.03
MH-528	MH-529	1	101.42	41.7	62.5	98.37	98.10	98.28	3.14
MH-529	MH-530	13	101.13	3.2	72.0	98.10	97.96	97.97	3.16
MH-529	MH-530	79-1	98.62	6.4	72.0	98.10	97.96	97.97	0.65
MH-529	MH-530	12	101.13	9.2	72.0	98.10	97.96	97.98	3.15
MH-529	MH-530	79-2	98.62	14.4	72.0	98.10	97.96	97.99	0.63
MH-529	MH-530	79-3	98.62	21.7	72.0	98.10	97.96	98.00	0.62
MH-529	MH-530	11	101.13	22.0	72.0	98.10	97.96	98.00	3.13
MH-529	MH-530	10	101.13	28.1	72.0	98.10	97.96	98.01	3.12
MH-529	MH-530	79-4	98.62	29.7	72.0	98.10	97.96	98.02	0.60
MH-529	MH-530	80-1	98.72	40.3	72.0	98.10	97.96	98.04	0.68
MH-529	MH-530	9	101.22	40.9	72.0	98.10	97.96	98.04	3.18
MH-529	MH-530	8	101.32	47.0	72.0	98.10	97.96	98.05	3.27
MH-529	MH-530	80-2	98.72	48.3	72.0	98.10	97.96	98.05	0.67
MH-529	MH-530	80-3	98.72	55.6	72.0	98.10	97.96	98.07	0.65
MH-529	MH-530	7	101.37	59.8	72.0	98.10	97.96	98.08	3.29
MH-529	MH-530	80-4	98.72	63.6	72.0	98.10	97.96	98.08	0.64
MH-529	MH-530	6	101.37	65.9	72.0	98.10	97.96	98.09	3.28
MH-529	MH-530	80-5	98.72	70.1	72.0	98.10	97.96	98.10	0.62
MH-530	MH-531	76-3	98.43	3.0	76.5	97.96	97.74	97.74	0.69
MH-530	MH-531	77-1	98.55	5.8	76.5	97.96	97.74	97.75	0.80
MH-530	MH-531	77-2	98.55	13.8	76.5	97.96	97.74	97.78	0.77
MH-530	MH-531	77-3	98.55	21.0	76.5	97.96	97.74	97.80	0.75
MH-530	MH-531	77-4	98.55	29.0	76.5	97.96	97.74	97.82	0.73
MH-530	MH-531	18	101.07	29.6	76.5	97.96	97.74	97.82	3.25
MH-530	MH-531	78-1	98.58	39.6	76.5	97.96	97.74	97.85	0.73
MH-530	MH-531	17	101.11	42.4	76.5	97.96	97.74	97.86	3.25
MH-530	MH-531	78-2	98.58	47.6	76.5	97.96	97.74	97.88	0.70
MH-530	MH-531	16	101.13	48.5	76.5	97.96	97.74	97.88	3.25
MH-530	MH-531	78-3	98.58	54.9	76.5	97.96	97.74	97.90	0.68
MH-530	MH-531	15	101.13	61.3	76.5	97.96	97.74	97.92	3.21
MH-530	MH-531	78-4	98.58	62.9	76.5	97.96	97.74	97.92	0.66
MH-530	MH-531	14	101.13	67.4	76.5	97.96	97.74	97.93	3.20
MH-530	MH-531	78-5	98.58	70.5	76.5	97.96	97.74	97.94	0.64
MH-534	MH-535	97-8	102.99	19.4	78.5	103.22	100.98	101.54	1.45
MH-534	MH-535	96-1	103.02	20.3	78.5	103.22	100.98	101.56	1.46
MH-534	MH-535	97-7	102.99	27.4	78.5	103.22	100.98	101.76	1.23
MH-534	MH-535	96-2	103.02	28.3	78.5	103.22	100.98	101.79	1.23
MH-534	MH-535	97-6	103.15	31.8	78.5	103.22	100.98	101.89	1.26
MH-534	MH-535	96-3	103.42	35.5	78.5	103.22	100.98	102.00	1.42
MH-534	MH-535	97-5	103.6	39.8	78.5	103.22	100.98	102.12	1.48
MH-534	MH-535	96-4	103.42	43.5	78.5	103.22	100.98	102.22	1.20
MH-534	MH-535	98-8	103.73	49.2	78.5	103.22	100.98	102.39	1.34
MH-534	MH-535	98-7	103.92	53.8	78.5	103.22	100.98	102.52	1.40
MH-534	MH-535	95-1	103.47	54.2	78.5	103.22	100.98	102.53	0.94
MH-534	MH-535	98-6	104.16	61.8	78.5	103.22	100.98	102.75	1.41
MH-534	MH-535	95-2	103.47	62.2	78.5	103.22	100.98	102.76	0.71
MH-534	MH-535	98-5	104.59	68.0	78.5	103.22	100.98	102.92	1.67
MH-534	MH-535	95-3	103.94	69.4	78.5	103.22	100.98	102.96	0.98
MH-534	MH-535	95-4	103.94	77.4	78.5	103.22	100.98	103.19	0.75
MH-534	MH-535	99-8	104.61	77.4	78.5	103.22	100.98	103.19	1.42
MH-535	MH-515	115-5	102.22	1.2	44.0	100.98	100.72	100.73	1.49
MH-535	MH-515	116-1	102.3	11.9	44.0	100.98	100.72	100.79	1.51
MH-535	MH-515	116-2	102.3	19.5	44.0	100.98	100.72	100.84	1.46
MH-535	MH-515	116-3	102.3	27.5	44.0	100.98	100.72	100.88	1.42
MH-535	MH-515	117-1	102.4	38.1	44.0	100.98	100.72	100.95	1.45
MH-5350	MH-539	118-3	102.4	16.8	52.5	101.68	100.15	100.64	1.76
MH-5350	MH-539	118-2	102.4	24.8	52.5	101.68	100.15	100.87	1.53
MH-5350	MH-539	118-1	102.4	32.4	52.5	101.68	100.15	101.09	1.31
MH-5350	MH-539	117-3	102.4	43.1	52.5	101.68	100.15	101.40	1.00
MH-5350	MH-539	117-2	102.4	51.1	52.5	101.68	100.15	101.64	0.76
MH-536	MH-538	196-1	102.56	6.1	59.0	102.69	101.17	101.33	1.23
MH-536	MH-538	142-1	103.33	15.7	59.0	102.69	101.17	101.58	1.75
MH-536	MH-538	195-4	103.31	16.1	59.0	102.69	101.17	101.59	1.72
MH-536	MH-538	142-2	103.33	23.7	59.0	102.69	101.17	101.78	1.55
MH-536	MH-538	195-3	103.31	24.1	59.0	102.69	101.17	101.79	1.52
MH-536	MH-538	142-3	103.72	30.3	59.0	102.69	101.17	101.95	1.77
MH-536	MH-538	195-2	103.7	30.7	59.0	102.69	101.17	101.96	1.74
MH-536	MH-538	142-4	103.72	38.3	59.0	102.69	101.17	102.15	1.57
MH-536	MH-538	195-1	103.7	38.7	59.0	102.69	101.17	102.16	1.54
MH-536	MH-538	143-1	103.96	48.3	59.0	102.69	101.17	102.41	1.55
MH-536	MH-538	194-4	103.92	48.7	59.0	102.69	101.17	102.42	1.50
MH-536	MH-538	143-2	103.96	56.3	59.0	102.69	101.17	102.62	1.34
MH-536	MH-538	194-3	103.92	56.7	59.0	102.69	101.17	102.63	1.29
MH-537	MH-536	194-2	103.92	4.4	64.5	103.01	102.69	102.71	1.21
MH-537	MH-536	143-3	103.96	4.7	64.5	103.01	102.69	102.71	1.25
MH-537	MH-536	194-1	103.92	12.4	64.5	103.01	102.69	102.75	1.17
MH-537	MH-536	144-1	103.96	14.7	64.5	103.01	102.69	102.76	1.20

Table 3: USF Freeboard Results - Composite 100-Year Events

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-537	MH-536	193-4	103.88	22.4	64.5	103.01	102.69	102.80	1.08
MH-537	MH-536	144-2	103.96	22.7	64.5	103.01	102.69	102.80	1.16
MH-537	MH-536	144-3	103.96	29.3	64.5	103.01	102.69	102.83	1.13
MH-537	MH-536	193-3	103.88	30.4	64.5	103.01	102.69	102.84	1.04
MH-537	MH-536	193-2	103.88	37.0	64.5	103.01	102.69	102.87	1.01
MH-537	MH-536	144-4	103.96	37.3	64.5	103.01	102.69	102.87	1.09
MH-537	MH-536	144-5	103.96	44.6	64.5	103.01	102.69	102.91	1.05
MH-537	MH-536	193-1	103.88	45.0	64.5	103.01	102.69	102.91	0.97
MH-537	MH-536	192-4	103.75	55.0	64.5	103.01	102.69	102.96	0.79
MH-538	MH-539	197-3	101.08	16.5	58.5	101.17	100.15	100.44	0.64
MH-538	MH-539	197-2	101.08	24.5	58.5	101.17	100.15	100.58	0.50
MH-538	MH-539	197-1	101.42	31.8	58.5	101.17	100.15	100.71	0.71
MH-538	MH-539	196-4	102.16	41.8	58.5	101.17	100.15	100.88	1.28
MH-538	MH-539	196-3	102.16	49.8	58.5	101.17	100.15	101.02	1.14
MH-538	MH-539	196-2	102.56	56.4	58.5	101.17	100.15	101.14	1.42
MH-542	MH-543	58	103.46	5.4	53.0	100.01	99.86	99.88	3.58
MH-542	MH-543	62-5	100.72	8.9	53.0	100.01	99.86	99.89	0.83
MH-542	MH-543	62-4	100.72	16.2	53.0	100.01	99.86	99.91	0.81
MH-542	MH-543	59	103.46	18.2	53.0	100.01	99.86	99.91	3.55
MH-542	MH-543	62-3	100.72	24.2	53.0	100.01	99.86	99.93	0.79
MH-542	MH-543	60	103.42	24.3	53.0	100.01	99.86	99.93	3.49
MH-542	MH-543	62-2	100.72	30.8	53.0	100.01	99.86	99.95	0.77
MH-542	MH-543	61	103.33	37.1	53.0	100.01	99.86	99.97	3.36
MH-542	MH-543	62-1	100.72	38.8	53.0	100.01	99.86	99.97	0.75
MH-543	MH-544	66-2	100.62	3.8	118.0	99.86	98.52	98.57	2.05
MH-543	MH-544	45	103.16	4.0	118.0	99.86	98.52	98.57	4.59
MH-543	MH-544	46	103.46	10.1	118.0	99.86	98.52	98.64	4.82
MH-543	MH-544	66-1	100.62	11.8	118.0	99.86	98.52	98.66	1.96
MH-543	MH-544	65-4	100.72	21.8	118.0	99.86	98.52	98.77	1.95
MH-543	MH-544	47	103.51	22.9	118.0	99.86	98.52	98.78	4.73
MH-543	MH-544	48	103.51	29.0	118.0	99.86	98.52	98.85	4.66
MH-543	MH-544	65-3	100.72	29.8	118.0	99.86	98.52	98.86	1.86
MH-543	MH-544	65-2	100.72	36.4	118.0	99.86	98.52	98.94	1.78
MH-543	MH-544	49	103.51	41.8	118.0	99.86	98.52	99.00	4.51
MH-543	MH-544	65-1	100.72	44.4	118.0	99.86	98.52	99.03	1.69
MH-543	MH-544	50	103.51	47.9	118.0	99.86	98.52	99.07	4.44
MH-543	MH-544	64-4	100.86	54.4	118.0	99.86	98.52	99.14	1.72
MH-543	MH-544	51	103.51	60.8	118.0	99.86	98.52	99.21	4.30
MH-543	MH-544	64-3	100.86	62.4	118.0	99.86	98.52	99.23	1.63
MH-543	MH-544	52	103.51	66.9	118.0	99.86	98.52	99.28	4.23
MH-543	MH-544	64-2	100.86	69.0	118.0	99.86	98.52	99.31	1.55
MH-543	MH-544	64-1	100.86	77.0	118.0	99.86	98.52	99.40	1.46
MH-543	MH-544	53	103.57	79.7	118.0	99.86	98.52	99.43	4.14
MH-543	MH-544	54	103.61	85.8	118.0	99.86	98.52	99.50	4.11
MH-543	MH-544	63-5	100.86	87.0	118.0	99.86	98.52	99.51	1.35
MH-543	MH-544	63-4	100.86	94.3	118.0	99.86	98.52	99.59	1.27
MH-543	MH-544	55	103.59	98.6	118.0	99.86	98.52	99.64	3.95
MH-543	MH-544	63-3	100.86	102.3	118.0	99.86	98.52	99.69	1.17
MH-543	MH-544	56	103.49	104.7	118.0	99.86	98.52	99.71	3.78
MH-543	MH-544	63-2	100.86	108.9	118.0	99.86	98.52	99.76	1.10
MH-543	MH-544	63-1	100.86	116.9	118.0	99.86	98.52	99.85	1.01
MH-543	MH-544	57	103.46	117.5	118.0	99.86	98.52	99.86	3.60
MH-544	MH-5440	68-3	99.4	3.4	57.5	98.52	98.46	98.47	0.93
MH-544	MH-5440	68-2	99.4	10.7	57.5	98.52	98.46	98.47	0.93
MH-544	MH-5440	68-1	99.4	18.7	57.5	98.52	98.46	98.48	0.92
MH-544	MH-5440	67-3	99.49	28.7	57.5	98.52	98.46	98.49	1.00
MH-544	MH-5440	42	102.27	30.0	57.5	98.52	98.46	98.49	3.78
MH-544	MH-5440	67-2	100.2	36.0	57.5	98.52	98.46	98.50	1.70
MH-544	MH-5440	43	102.6	42.8	57.5	98.52	98.46	98.51	4.09
MH-544	MH-5440	67-1	100.2	44.0	57.5	98.52	98.46	98.51	1.69
MH-544	MH-5440	44	102.93	48.9	57.5	98.52	98.46	98.51	4.42
MH-544	MH-5440	66-3	100.62	54.0	57.5	98.52	98.46	98.52	2.10
MH-546	MH-547	177-1	102.31	8.8	99.5	102.14	101.43	101.50	0.81
MH-546	MH-547	177-2	102.61	16.1	99.5	102.14	101.43	101.55	1.06
MH-546	MH-547	177-3	102.61	24.1	99.5	102.14	101.43	101.60	1.01
MH-546	MH-547	178-1	102.71	34.1	99.5	102.14	101.43	101.67	1.04
MH-546	MH-547	178-2	102.71	42.1	99.5	102.14	101.43	101.73	0.98
MH-546	MH-547	178-3	103.04	48.7	99.5	102.14	101.43	101.78	1.26
MH-546	MH-547	178-4	103.04	56.7	99.5	102.14	101.43	101.84	1.20
MH-546	MH-547	179-1	103.04	66.7	99.5	102.14	101.43	101.91	1.13
MH-546	MH-547	179-2	103.4	74.0	99.5	102.14	101.43	101.96	1.44
MH-546	MH-547	179-3	103.4	82.0	99.5	102.14	101.43	102.01	1.39
MH-546	MH-547	179-4	103.4	88.6	99.5	102.14	101.43	102.06	1.34
MH-546	MH-547	179-5	103.4	96.6	99.5	102.14	101.43	102.12	1.28
MH-547	MH-548	175-1	101.33	5.2	60.0	101.43	100.74	100.80	0.53
MH-547	MH-548	175-2	101.33	13.6	60.0	101.43	100.74	100.90	0.43
MH-547	MH-548	175-3	101.64	20.2	60.0	101.43	100.74	100.98	0.66
MH-547	MH-548	175-4	101.64	28.2	60.0	101.43	100.74	101.07	0.57
MH-547	MH-548	176-1	101.82	38.2	60.0	101.43	100.74	101.18	0.64

Table 3: USF Freeboard Results - Composite 100-Year Events

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-547	MH-548	176-2	102.27	45.8	60.0	101.43	100.74	101.27	1.00
MH-547	MH-548	176-3	102.27	53.9	60.0	101.43	100.74	101.36	0.91
MH-548	MH-549	174-2	100.89	0.3	29.5	100.74	100.32	100.32	0.57
MH-548	MH-549	174-3	100.89	8.2	29.5	100.74	100.32	100.44	0.45
MH-548	MH-549	174-4	101.21	14.8	29.5	100.74	100.32	100.53	0.68
MH-548	MH-549	174-5	101.21	22.8	29.5	100.74	100.32	100.65	0.56
MH-549	MH-550	174-1	100.89	2.7	12.5	100.32	99.94	100.02	0.87
MH-550	MH-551	170-6	100.02	1.6	112.0	99.94	98.85	98.87	1.15
MH-550	MH-551	170-5	100.3	6.9	112.0	99.94	98.85	98.92	1.38
MH-550	MH-551	171-8	100.3	16.4	112.0	99.94	98.85	99.01	1.29
MH-550	MH-551	171-7	100.33	21.0	112.0	99.94	98.85	99.06	1.27
MH-550	MH-551	171-6	100.46	29.0	112.0	99.94	98.85	99.13	1.33
MH-550	MH-551	171-5	100.73	35.2	112.0	99.94	98.85	99.19	1.54
MH-550	MH-551	172-10	100.73	44.6	112.0	99.94	98.85	99.28	1.45
MH-550	MH-551	172-9	100.77	49.2	112.0	99.94	98.85	99.33	1.44
MH-550	MH-551	172-8	100.9	57.2	112.0	99.94	98.85	99.41	1.49
MH-550	MH-551	172-7	100.96	61.6	112.0	99.94	98.85	99.45	1.51
MH-550	MH-551	172-6	101.27	69.6	112.0	99.94	98.85	99.53	1.74
MH-550	MH-551	173-10	101.27	77.4	112.0	99.94	98.85	99.60	1.67
MH-550	MH-551	173-9	101.33	85.4	112.0	99.94	98.85	99.68	1.65
MH-550	MH-551	173-8	101.43	91.6	112.0	99.94	98.85	99.74	1.69
MH-550	MH-551	173-7	101.5	96.0	112.0	99.94	98.85	99.78	1.72
MH-550	MH-551	173-6	101.91	104.0	112.0	99.94	98.85	99.86	2.05
MH-551	MH-559	169-8	99.46	10.7	52.5	98.85	96.32	96.84	2.62
MH-551	MH-559	169-7	99.43	18.7	52.5	98.85	96.32	97.22	2.21
MH-551	MH-559	169-6	99.53	23.1	52.5	98.85	96.32	97.43	2.10
MH-551	MH-559	169-5	99.86	31.1	52.5	98.85	96.32	97.82	2.04
MH-551	MH-559	170-8	99.86	40.5	52.5	98.85	96.32	98.27	1.59
MH-551	MH-559	170-7	99.9	45.1	52.5	98.85	96.32	98.49	1.41
MH-552	MH-553	172-1	100.73	1.3	64.5	100.31	99.30	99.32	1.41
MH-552	MH-553	172-2	100.77	4.9	64.5	100.31	99.30	99.38	1.39
MH-552	MH-553	167-4	100.44	7.6	64.5	100.31	99.30	99.42	1.02
MH-552	MH-553	172-3	100.9	13.0	64.5	100.31	99.30	99.51	1.39
MH-552	MH-553	167-3	100.44	15.6	64.5	100.31	99.30	99.55	0.89
MH-552	MH-553	172-4	100.96	17.2	64.5	100.31	99.30	99.57	1.39
MH-552	MH-553	167-2	100.44	22.2	64.5	100.31	99.30	99.65	0.79
MH-552	MH-553	172-5	101.27	25.2	64.5	100.31	99.30	99.70	1.57
MH-552	MH-553	167-1	100.44	30.2	64.5	100.31	99.30	99.77	0.67
MH-552	MH-553	173-1	101.27	33.1	64.5	100.31	99.30	99.82	1.45
MH-552	MH-553	168-4	100.69	40.2	64.5	100.31	99.30	99.93	0.76
MH-552	MH-553	173-2	101.33	41.1	64.5	100.31	99.30	99.94	1.39
MH-552	MH-553	173-3	101.43	47.2	64.5	100.31	99.30	100.04	1.39
MH-552	MH-553	168-3	100.69	48.2	64.5	100.31	99.30	100.06	0.63
MH-552	MH-553	173-4	101.5	51.6	64.5	100.31	99.30	100.11	1.39
MH-552	MH-553	168-2	101.48	54.8	64.5	100.31	99.30	100.16	1.32
MH-552	MH-553	173-5	101.91	59.6	64.5	100.31	99.30	100.23	1.68
MH-552	MH-553	168-1	101.48	62.8	64.5	100.31	99.30	100.28	1.20
MH-553	MH-557	169-1	99.46	16.0	103.5	99.30	98.02	98.21	1.25
MH-553	MH-557	169-2	99.43	25.6	103.5	99.30	98.02	98.33	1.10
MH-553	MH-557	169-3	99.53	30.0	103.5	99.30	98.02	98.39	1.14
MH-553	MH-557	169-4	99.86	38.0	103.5	99.30	98.02	98.49	1.37
MH-553	MH-557	165-4	99.5	38.5	103.5	99.30	98.02	98.49	1.01
MH-553	MH-557	165-3	99.5	46.5	103.5	99.30	98.02	98.59	0.91
MH-553	MH-557	170-1	99.86	47.4	103.5	99.30	98.02	98.61	1.25
MH-553	MH-557	170-2	99.9	52.0	103.5	99.30	98.02	98.66	1.24
MH-553	MH-557	165-2	99.5	53.1	103.5	99.30	98.02	98.68	0.82
MH-553	MH-557	170-3	100.02	59.9	103.5	99.30	98.02	98.76	1.26
MH-553	MH-557	165-1	99.5	61.2	103.5	99.30	98.02	98.78	0.72
MH-553	MH-557	170-4	100.3	66.1	103.5	99.30	98.02	98.84	1.46
MH-553	MH-557	166-5	99.7	71.2	103.5	99.30	98.02	98.90	0.80
MH-553	MH-557	171-1	100.3	75.5	103.5	99.30	98.02	98.96	1.34
MH-553	MH-557	166-4	99.7	79.2	103.5	99.30	98.02	99.00	0.70
MH-553	MH-557	171-2	100.33	80.2	103.5	99.30	98.02	99.01	1.32
MH-553	MH-557	166-3	100.04	85.8	103.5	99.30	98.02	99.08	0.96
MH-553	MH-557	171-3	100.46	88.2	103.5	99.30	98.02	99.11	1.35
MH-553	MH-557	166-2	100.04	93.8	103.5	99.30	98.02	99.18	0.86
MH-553	MH-557	171-4	100.73	94.4	103.5	99.30	98.02	99.19	1.54
MH-553	MH-557	166-1	100.04	101.1	103.5	99.30	98.02	99.27	0.77
MH-554	MH-556	160-4	100.02	2.6	81.5	99.74	98.99	99.01	1.01
MH-554	MH-556	160-3	100.02	10.6	81.5	99.74	98.99	99.09	0.93
MH-554	MH-556	160-2	100.02	17.2	81.5	99.74	98.99	99.15	0.87
MH-554	MH-556	160-1	100.02	25.2	81.5	99.74	98.99	99.22	0.80
MH-554	MH-556	159-5	100.12	35.2	81.5	99.74	98.99	99.31	0.81
MH-554	MH-556	159-4	100.48	42.5	81.5	99.74	98.99	99.38	1.10
MH-554	MH-556	159-3	100.48	50.5	81.5	99.74	98.99	99.45	1.03
MH-554	MH-556	159-2	100.48	57.1	81.5	99.74	98.99	99.51	0.97
MH-554	MH-556	159-1	100.48	65.1	81.5	99.74	98.99	99.59	0.89
MH-554	MH-556	158-5	100.48	75.1	81.5	99.74	98.99	99.68	0.80
MH-554	MH-556	158-4	100.48	78.8	81.5	99.74	98.99	99.71	0.77

Table 3: USF Freeboard Results - Composite 100-Year Events

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-556	MH-557	162-3	99.15	7.8	70.0	98.99	98.02	98.12	1.03
MH-556	MH-557	164-1	99.39	11.9	70.0	98.99	98.02	98.18	1.21
MH-556	MH-557	162-2	99.15	14.4	70.0	98.99	98.02	98.22	0.93
MH-556	MH-557	164-2	99.39	19.9	70.0	98.99	98.02	98.29	1.10
MH-556	MH-557	162-1	99.15	22.4	70.0	98.99	98.02	98.33	0.82
MH-556	MH-557	164-3	99.39	26.5	70.0	98.99	98.02	98.38	1.01
MH-556	MH-557	161-4	99.55	32.5	70.0	98.99	98.02	98.47	1.08
MH-556	MH-557	164-4	99.39	34.5	70.0	98.99	98.02	98.50	0.89
MH-556	MH-557	161-3	99.55	40.5	70.0	98.99	98.02	98.58	0.97
MH-556	MH-557	161-2	99.55	47.1	70.0	98.99	98.02	98.67	0.88
MH-556	MH-557	161-1	99.55	55.1	70.0	98.99	98.02	98.78	0.77
MH-556	MH-557	160-5	99.64	65.1	70.0	98.99	98.02	98.92	0.72
MH-557	MH-558	163-3	98.67	4.5	36.5	98.02	97.74	97.77	0.90
MH-557	MH-558	163-2	98.67	11.1	36.5	98.02	97.74	97.82	0.85
MH-557	MH-558	163-1	98.67	19.1	36.5	98.02	97.74	97.88	0.79
MH-557	MH-558	162-5	98.77	29.1	36.5	98.02	97.74	97.96	0.81
MH-557	MH-558	162-4	99.15	35.1	36.5	98.02	97.74	98.00	1.15
MH-558	MH-559	163-5	98.32	8.9	14.5	97.74	96.32	97.19	1.13
MH-558	MH-559	163-4	98.67	10.4	14.5	97.74	96.32	97.34	1.33
MH-561	MH-537	192-3	103.75	3.1	42.5	103.09	103.01	103.02	0.73
MH-561	MH-537	192-2	103.75	5.2	42.5	103.09	103.01	103.02	0.73
MH-561	MH-537	180-1	103.86	12.6	42.5	103.09	103.01	103.04	0.82
MH-561	MH-537	192-1	103.75	13.2	42.5	103.09	103.01	103.04	0.71
MH-561	MH-537	180-2	103.86	19.9	42.5	103.09	103.01	103.05	0.81
MH-561	MH-537	191-4	103.8	23.2	42.5	103.09	103.01	103.06	0.74
MH-561	MH-537	180-3	103.86	27.9	42.5	103.09	103.01	103.07	0.79
MH-561	MH-537	191-3	103.8	31.2	42.5	103.09	103.01	103.07	0.73
MH-561	MH-537	180-4	103.86	34.5	42.5	103.09	103.01	103.08	0.78
MH-561	MH-537	191-2	103.8	37.7	42.5	103.09	103.01	103.08	0.72
MH-561	MH-563	182-3	102.47	2.6	61.0	103.09	101.29	101.37	1.10
MH-561	MH-563	182-2	102.47	10.6	61.0	103.09	101.29	101.60	0.87
MH-561	MH-563	190-1	103.21	17.4	61.0	103.09	101.29	101.80	1.41
MH-561	MH-563	182-1	102.81	17.9	61.0	103.09	101.29	101.82	0.99
MH-561	MH-563	190-2	103.21	25.4	61.0	103.09	101.29	102.04	1.17
MH-561	MH-563	181-4	103.55	27.9	61.0	103.09	101.29	102.11	1.44
MH-561	MH-563	190-3	103.8	32.0	61.0	103.09	101.29	102.24	1.56
MH-561	MH-563	181-3	103.55	35.9	61.0	103.09	101.29	102.35	1.20
MH-561	MH-563	190-4	103.8	40.0	61.0	103.09	101.29	102.47	1.33
MH-561	MH-563	181-2	103.86	42.5	61.0	103.09	101.29	102.55	1.31
MH-561	MH-563	190-5	103.8	47.3	61.0	103.09	101.29	102.69	1.11
MH-561	MH-563	181-1	103.86	50.5	61.0	103.09	101.29	102.78	1.08
MH-561	MH-563	191-1	103.8	55.7	61.0	103.09	101.29	102.94	0.86
MH-561	MH-563	180-5	103.86	59.1	61.0	103.09	101.29	103.04	0.82
MH-563	MH-564	187-2	102.43	3.4	73.5	101.29	101.00	101.02	1.41
MH-563	MH-564	185-1	102.24	4.5	73.5	101.29	101.00	101.02	1.22
MH-563	MH-564	184-4	102.57	10.2	73.5	101.29	101.00	101.04	1.53
MH-563	MH-564	187-3	102.75	10.9	73.5	101.29	101.00	101.05	1.70
MH-563	MH-564	184-3	102.57	18.2	73.5	101.29	101.00	101.07	1.50
MH-563	MH-564	188-1	102.75	20.8	73.5	101.29	101.00	101.08	1.67
MH-563	MH-564	184-2	102.57	24.8	73.5	101.29	101.00	101.10	1.47
MH-563	MH-564	188-2	102.75	28.8	73.5	101.29	101.00	101.12	1.63
MH-563	MH-564	184-1	102.57	32.8	73.5	101.29	101.00	101.13	1.44
MH-563	MH-564	188-3	102.75	36.2	73.5	101.29	101.00	101.14	1.61
MH-563	MH-564	183-3	102.57	42.8	73.5	101.29	101.00	101.17	1.40
MH-563	MH-564	189-1	102.64	46.2	73.5	101.29	101.00	101.18	1.46
MH-563	MH-564	183-2	102.57	50.8	73.5	101.29	101.00	101.20	1.37
MH-563	MH-564	189-2	102.64	54.4	73.5	101.29	101.00	101.22	1.42
MH-563	MH-564	183-1	102.57	58.6	73.5	101.29	101.00	101.23	1.34
MH-563	MH-564	189-3	102.64	61.6	73.5	101.29	101.00	101.24	1.40
MH-564	MH-8500	186-1	102.24	17.1	48.5	101.00	99.70	100.16	2.08
MH-564	MH-8500	185-5	101.61	19.9	48.5	101.00	99.70	100.23	1.38
MH-564	MH-8500	186-2	102.24	25.1	48.5	101.00	99.70	100.37	1.87
MH-564	MH-8500	185-4	101.61	27.9	48.5	101.00	99.70	100.45	1.16
MH-564	MH-8500	186-3	102.24	32.4	48.5	101.00	99.70	100.57	1.67
MH-564	MH-8500	185-3	101.93	34.5	48.5	101.00	99.70	100.63	1.30
MH-564	MH-8500	187-1	102.43	42.4	48.5	101.00	99.70	100.84	1.59
MH-564	MH-8500	185-2	101.93	42.5	48.5	101.00	99.70	100.84	1.09
								Min	0.30
								Max	4.82
								Average	1.28

4.3 Half Moon Bay West SWM Facility

As mentioned above approximately 5.88 ha of the proposed Drummond development will discharge to the Half Moon Bay Phase 3 SWM pond. In the analysis completed by JFSA in August 2021 of the Half moon bay SWM facility, it was assumed that 9.61 ha of these lands would drain to the Halfmoon Bay SWM Pond with an average imperviousness of 29% (A x C = 27.19). Based on the latest development plan the 5.88 ha at 54% impervious (A x C = 26.32) from the Drummond lands will drain to the Halfmoon Bay Facility. As such it is seen that although the impervious area has increased the total drainage area to the Greenbank storm sewer is reduced. It is important to also note that in the JFSA August 2021 report, to ensure a conservative design no onsite controls or storage were assumed for any of these lands. Figure E1 in Attachment E outlines the changes in drainage areas per the August 2021 analysis (red) and the latest May 2022 design (green). Also included in this attachment are hydrographs comparing the peak flows on the proposed Greenbank trunk sewer that will service these lands at the intersection of Cambrian Road MH905-TEE. Table 4 below outlines the peak flows and total runoff volumes from both analyses. From these tables, it is seen that the onsite storage provided within the Drummond subdivision, greatly reduces the maximum peak flows within this storm sewer system, due to the total reduction in drainage area the total runoff volume is also decreased. As such the previous analysis completed by JFSA in August 2021 for the Half Moon Bay SWM facility, is conservative, and the fundamental conclusions drawn in this analysis remain valid.

Table 4: Peak Flows to Half Moon Bay Trunk Sewer (MH905-Tee)

Event	Parameter	Halfmoon Bay Phase 3 - SWM Report (JFSA Aug 2021)	Drummond SWM Report (JFSA May 2022)	Difference Drummond - HMB
100YrCHI3Hr	Max Flow (m^3/s)	7.40	4.79	-2.61
	Volume (m^3)	12,759	10,704	-2,055
100YrSCS24Hr	Max Flow (m^3/s)	5.89	4.51	-1.38
	Volume (m^3)	16,392	13,300	-3,091

4.4 The Ridge Development

To ensure that the proposed Drummond development does not negatively impact the existing Ridge site, a detailed HGL/USF analysis of the Ridge site has been completed based on the latest modelling. From this analysis, it was found that sufficient freeboard is provided to all units within the development for both 100-Year events. Full details of this analysis and the minor refinements to the Ridge drainage areas have been outlined in JFSA's February 2022 memo titled "*The Ridge – Updated HGL Analysis*".

4.5 The Ridge/Drummond SWM Pond / OGS

Based on this latest analysis the 100-Year peak flows out of the SWM pond that services both the Drummond and Ridge lands are 1.268 m^3/s and 1.254m^3/s for the 3 Hr Chicago and 24 Hr SCS storm, respectively. With both of these values being less than the allowable 1.3 m^3/s specified by the Barrhaven South Master Servicing Study.

Peak flow from the updated modelling (which considered the proposed EES units) were provided to Echelon Environmental to re-assess the OGS sizing for this facility. The following tables outline the peak flows to each of the OGS units for the 2,5,10,15,22 & 50mm events, with table 5A outlining the latest peak flows and Table 5B outlining the previous OGS sizing completed as a part of the Ridge Development. It is important to note that the previous analysis for the Ridge has the Drummond lands as simple lumped catchments. Based on the updated modelling the peak flows to the OGS units have slightly increased for the 2-10mm event, but the larger events 15mm-50mm see a reduction in the previously assumed peak flows. Given that the larger return periods (15-22mm event) primarily drive the OGS sizing, and the fact that the peak flows for these events are lower than previously assumed, it can be concluded that the previous OGS sizing completed for the Ridge is sufficient. Please refer to the addendum provided by Echelon Environmental in Appendix D of DSEL's report confirming that the OGS units will function as previously intended.

Table 5A - Peak Flows to OGS Units -May 2022 (Detailed Design of Ridge & Drummond)

Unit	2mmCHI4Hr	5mmCHI4Hr	10mmCHI4Hr	15mmCHI4Hr	22mmCHI4Hr	50mmCHI4Hr
OGS 1	0.004	0.065	0.247	0.454	0.786	3.745
OGS 2	0.004	0.058	0.232	0.435	0.759	2.652

Table 5B - Peak Flows to OGS Units -Jan 2021 (Detailed Design of Ridge Only)

Unit	2mmCHI4Hr	5mmCHI4Hr	10mmCHI4Hr	15mmCHI4Hr	22mmCHI4Hr	50mmCHI4Hr
OGS 1	0.004	0.049	0.194	0.494	1.032	3.792
OGS 2	0.003	0.043	0.193	0.497	0.984	3.218

4.6 Rear Yard Spills /Easement Assessment

The City expressed concerns regarding the capture rates of the rear yard CBs during large events and the need for easements between lots in locations where the rear yards will spill to the road between residential units. A detailed analysis of each of the rear yard locations where an easement may be required has been completed and documented in JFSA February 2022 memo titled *"Drummond – Rear Yard Catchbasin Capacity Analysis"*. From this analysis, it was determined that for all locations assessed, the total allowable capture is greater than the total peak flow for the 100-year event. Therefore, it can be concluded that there will be no major system spill from the rear yards between units for events up to and including the 100-year event, as such no easements will be required within this subdivision.

5 EROSION AND SEDIMENT CONTROL DURING AND AFTER CONSTRUCTION

Silt and erosion control strategies shall be implemented during construction activities to minimize the transfer of silt off-site. The following measures should be implemented:

i) Silt control fences shall be installed as required to prevent the movement of silt off-site during rainfall events.

ii) Construction of a mud mat shall be installed at the site entrance to promote self-cleaning of truck tires when leaving the site.

iii) All catch basins shall be equipped with a crushed stone filter to prevent the capture of silt in the storm sewer system.

iv) Regular cleaning of the adjacent roads shall be undertaken during the construction activities.

v) Regular inspection and maintenance of the silt control measures shall be undertaken until the site has been stabilized.

vi) The erosion and sediment control devices shall be removed after the site has been stabilized.

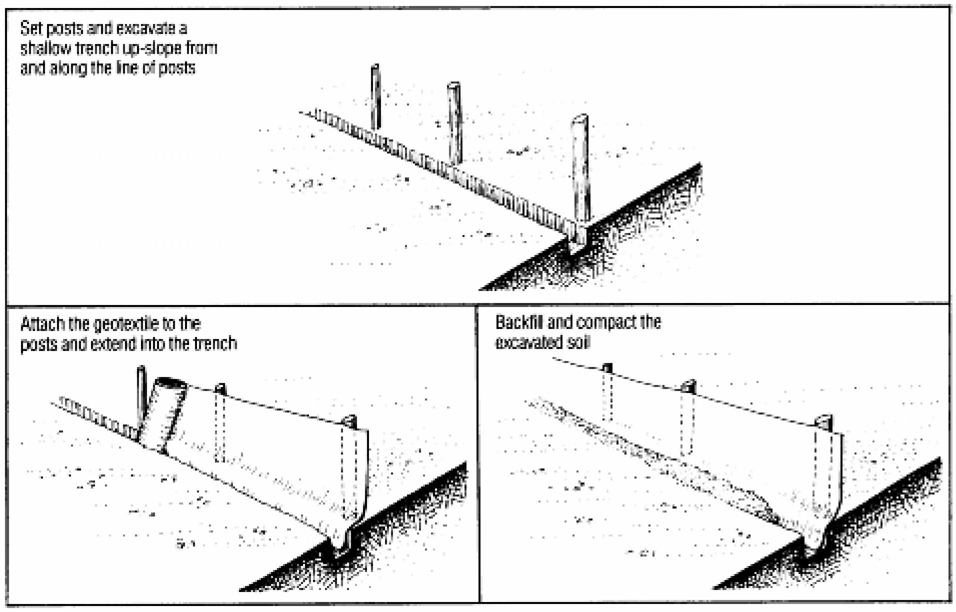


Figure 5: Typical installation of silt fences

Figure 6: Catchbasin with geotextile to protect storm sewer pipes from sediment contamination

6 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

J.F. Sabourin and Associates Inc. (JFSA) were retained by David Schaeffer Engineering Ltd. (DSEL) to prepare a Stormwater Management (SWM) Plan for the Drummond Subdivision, located in Barrhaven within the City of Ottawa. The development is located east of Borrisokane Road and Highway 416, south of Cambrian Road and north of the Ridge Development. Approximately 13.27 ha of the proposed development will be serviced by a dry SWM pond that is implemented in the northwest corner of the development which services both the Ridge and Drummond. The remaining 5.88 ha of the Drummond site will discharge to the east to the Halfmoon Bay SWM facility.

Per the City of Ottawa design guidelines, the minor system has been designed to accommodate a minimum of the 2-year post-development flows from within the site and from external areas (plus 5-year flows on collector roads). The PCSWMM model analysis has determined that the minor system will surcharge in most parts of the system. However, with the use of Inlet Control Devices, a minimum freeboard of 0.3 m is provided between the 100-year hydraulic grade line and the underside of footings throughout the subdivision.

The model simulations have determined that for the selected 2-, 5- and 100-year storms, the total minor system flows would be 5.608 m^3/s, 7.947 m^3/s and 10.134 m^3/s, respectively. Within the subdivision, the peak water depths do not exceed the maximum allowable 35 cm depth at the gutter for the simulated 100-year storm (Table D-7 of Appendix D). Furthermore, it was determined that for the 100-year event, the product of the velocity and depth of flow does not exceed the maximum allowable 0.60 m^2/s. Also as required, the maximum extent of surface water during the 100-year + 20% stress test will not touch the building envelopes. Table C-1A-C6A of Appendix C summarizes the hydraulic grade line analysis for the various storm. Note that the full pipe velocities are generally no less than 0.80 m/s and no greater than 3.0 m/s for the proposed pipes.

Stress test results for the major and minor drainage systems based on a 20% increase in the 100-year storm, as per the October 2012 *City of Ottawa Sewer Design Guidelines*, are summarized in Section 4. The peak flows out of the proposed SWM pond for both 100-year events is less than the allowable 1.3 m^3/s specified by the Barrhaven South Master Servicing Study.

Recommendations for silt and erosion control strategies to be implemented during construction are presented in Section 5.

In conclusion, the proposed design satisfies all selected design guidelines and requirements.

Legend

Conduits - Minor

MinorSystem

Junctions

MH

Site_Map

ICD

83mm-ICD

94mm-ICD

102mm-ICD

108mm-ICD

127mm-ICD

152mm-ICD

178mm-ICD

No ICD

SCALE: 1:2500

0 50 100 m

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
52 Springbrook Drive
Ottawa, ON, K2S 1B9
(613) 836-3884
www.jfsa.com

DSEL
david schaeffer engineering ltd

Drummond SWM Report

Figure 2: Minor System

PROJECT	2226-21
DRAWN	MP
DATE	FEB 2022

C:\OneDrive\J.F. Sabourin and Associates Inc\JFSA-OTTAWA-SERVER - Documents\PROJ\2226-21\202201-Submission 2\Design\GIS\20220217-Report Figures

Legend

- Major System
- Major System Junction
- Site Map

SCALE: 1:2500

0 50 100 m

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
52 Springbrook Drive
Ottawa, ON, K2S 1B9
(613) 836-3884
www.jfsa.com

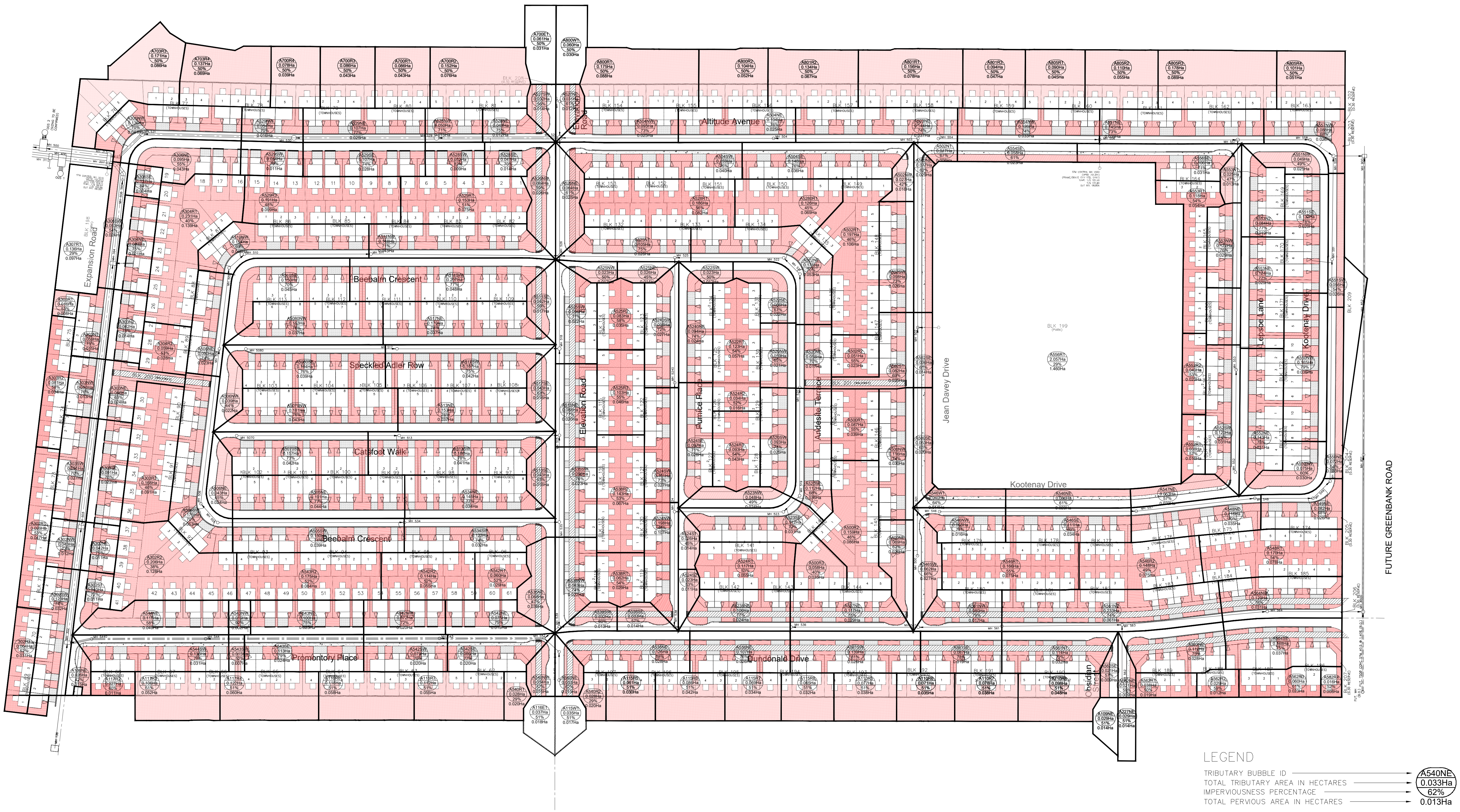
DSEL
david schaeffer engineering ltd

Drummond SWM Report

Figure 3: Major System

PROJECT	2226-21
DRAWN	MP
DATE	FEB 2022

C:\OneDrive\J.F. Sabourin and Associates Inc\JFSA-OTTAWA-SERVER - Documents\PROJ\2226-21\202201-Submission 2\Design\GIS\20220217-Report Figures



david schaeffer engineering ltd

120 Iber Road, Unit 103
Stittsville, Ontario, K2S 1E9
Tel. (613) 836-0856
Fax. (613) 836-7183
www.DSEL.ca

CAIVAN COMMUNITIES - THE RIDGE PHASE 3&4

CITY OF OTTAWA

FIGURE 4: SUBCATCHMENTS & IMPERVIOUSNESS HATCH FIGURE

SCALE:	1:2000	PROJECT No.:	19-1123
DATE:	FEBRUARY 2022	FIGURE:	1 of 1

Legend

- Major System
- Surface Storage Volume
- Site Map

SCALE: 1:2500

0 50 100 m

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
52 Springbrook Drive
Ottawa, ON, K2S 1B9
(613) 836-3884
www.jfsa.com

DSEL
david schaeffer engineering ltd

Drummond SWM Report

Figure 5: Extent of Surface Storage

PROJECT	2226-21
DRAWN	MP
DATE	FEB 2022

C:\OneDrive\J.F. Sabourin and Associates Inc\JFSA-OTTAWA-SERVER - Documents\PROJ\2226-21\202201-Submission 2\Design\GIS\20220217-Report Figures

APPENDIX

A

Rational Method Design Sheets
(as per DSEL)

JFSA Water Resources and Environmental Consultants

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

Ottawa

LOCATION			AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
Promontory																																	
Contribution From Dundonald Drive, Pipe 539 - 542						0.87				1.93				0.00				0.00	12.73														
Contribution From Elevation Road, Pipe 541 - 542						0.00				0.11				0.00				0.00	10.49														
			0.17	0.56	0.27	1.14			0.00	2.05			0.00	0.00			0.00	0.00															
	542	543	0.31	0.73	0.63	1.78			0.00	2.05			0.00	0.00			0.00	0.00	12.73	67.69	91.68	107.41	156.92	308	750	750	CONC	0.15	53.0	431.1703	0.9760	0.9051	0.714
			0.18	0.57	0.28	2.05			0.00	2.05			0.00	0.00			0.00	0.00															
	543	544	0.25	0.75	0.51	2.57			0.00	2.05			0.00	0.00			0.00	0.00	13.64	65.18	88.23	103.35	150.97	348	825	825	CONC	0.15	118.0	555.9418	1.0400	1.8910	0.626
	544	5440	0.25	0.69	0.47	3.04			0.00	2.05			0.00	0.00			0.00	0.00	15.53	60.55	81.89	95.89	140.01	352	825	825	CONC	1.20	57.5	1572.4410	2.9416	0.3258	0.224
	5440	302			0.00	3.04			0.00	2.05			0.00	0.00			0.00	0.00	15.85	59.82	80.89	94.72	138.30	348	825	825	CONC	1.20	12.5	1572.4410	2.9416	0.0708	0.221
To Expansion Road, Pipe 302 - 303						3.04				2.05				0.00				0.00	15.93														
Jean Davey																																	
			0.24	0.67	0.45	0.45			0.00	0.00			0.00	0.00			0.00	0.00															
	500	502	0.30	0.53	0.45	0.89			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	86	300	300	PVC	1.25	92.0	108.1147	1.5295	1.0025	0.792
			0.12	0.66	0.22	1.12			0.00	0.00			0.00	0.00			0.00	0.00															
			0.22	0.65	0.40	1.51			0.00	0.00			0.00	0.00			0.00	0.00															
	502	503	0.25	0.54	0.38	1.89			0.00	0.00			0.00	0.00			0.00	0.00	11.00	73.16	99.18	116.24	169.89	138	450	450	PVC	1.60	119.0	360.6339	2.2675	0.8747	0.383
To Altitude, Pipe 503 - 504						1.89				0.00				0.00				0.00	11.88														
Pumice																																	
					0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00															
			0.12	0.57	0.19	0.19			0.00	0.00			0.00	0.00			0.00	0.00															
	524	538	0.25	0.52	0.36	0.55			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	42	300	300	PVC	2.10	58.0	140.1327	1.9825	0.4876	0.300
To Dundonald Drive, Pipe 538 - 539						0.55				0.00				0.00				0.00	10.49														
Contribution From Andesite, Pipe 523 - 524						0.29				0.00				0.00				0.00	10.74														
			0.13	0.57	0.21	0.50			0.00	0.00			0.00	0.00			0.00	0.00															
	524	5240	0.20	0.71	0.39	0.89			0.00	0.00			0.00	0.00			0.00	0.00	10.74	74.09	100.46	117.74	172.10	66	375	375	PVC	0.30	65.0	96.0323	0.8695	1.2459	0.690
	5240	525	0.19	0.71	0.38	1.27			0.00	0.00			0.00	0.00			0.00	0.00	11.98	69.95	94.77	111.05	162.26	89	375	375	PVC	1.55	63.5	218.2843	1.9764	0.5355	0.407
To Andesite, Pipe 525 - 526						1.27				0.00				0.00				0.00	12.52														
Andesite																																	
	519	523			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	300	300	PVC	0.35	11.5	57.2089	0.8093	0.2368	0.000
	523	524	0.16	0.66	0.29	0.29			0.00	0.00			0.00	0.00			0.00	0.00	10.24	75.91	102.96	120.69	176.42	22	300	300	PVC	1.80	55.0	129.7377	1.8354	0.4994	0.172
To Pumice, Pipe 524 - 525						0.29				0.00				0.00				0.00	10.74														
	519	520	0.21	0.69	0.39	0.39			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	30	300	300	PVC	0.50	54.5	68.3778	0.9673	0.9390	0.442
	520	521	0.11	0.67	0.20	0.60			0.00	0.00			0.00	0.00			0.00	0.00	10.94	73.38	99.48	116.59	170.41	44	375	375	PVC	0.50	57.5	123.9771	1.1225	0.8537	0.354
	521	522			0.00	0.60			0.00	0.00			0.00	0.00			0.00	0.00	11.79	70.54	95.59	112.01	163.68	42	375	375	PVC	0.35	11.5	103.7267	0.9392	0.2041	0.407
					0.00	0.60			0.00	0.00			0.00	0.00			0.00	0.00															
			0.27	0.67	0.50	1.10			0.00	0.00			0.00	0.00			0.00	0.00															
	522	525	0.12	0.58	0.19	1.29			0.00	0.00			0.00	0.00			0.00	0.00	12.00	69.90	94.71	110.97	162.16	90	375	375	PVC	2.55	55.0	279.9798	2.5350	0.3616	0.323
Contribution From Pumice, Pipe 524 - 525						1.27				0.00				0.00				0.00	12.52														
					0.00	2.56			0.00	0.00			0.00	0.00			0.00	0.00															
			0.15	0.67	0.28	2.84			0.00	0.00			0.00	0.00			0.00	0.00															
					0.00	2.84	0.10	0.74	0.20	0.20			0.00	0.00			0.00	0.00															
	525	526	0.08	0.61	0.14	2.98			0.00	0.20			0.00	0.00			0.00	0.00	12.52	68.32	92.54	108.42	158.41	222	525	525	CONC	1.80	58.5	576.9891	2.6654	0.3658	0.384
To Elevation Road, Pipe 526 - 528						2.98				0.20				0.00				0.00	12.88														
Speckled Adler																																	
	5080	517	0.32	0.73	0.65	0.65			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	50	300	300	PVC	0.55	72.5	71.7152	1.0146	1.1910	0.695
					0.00	0.65	0.04	0.64	0.08	0.08			0.00	0.00			0.00	0.00															
	517	518	0.34	0.74	0.70	1.35			0.00	0.08			0.00	0.00			0.00	0.00	11.19	72.52	98.30	115.20	168.36	105	300	300	PVC	2.30	86.0	146.6540	2.0747	0.6909	0.718
To Elevation Road, Pipe 518 - 526						1.35				0.08				0.00				0.00	11.88														
Catsfoot																																	
	5070	513	0.34	0.72	0.68	0.68			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	52	300	300	PVC	0.50	82.0	68.3778	0.9673	1.4128	0.764
					0.00	0.68	0.04	0.64	0.08	0.08			0.00	0.00			0.00	0.00															
	513	515	0.34	0.74	0.70	1.38			0.00	0.08			0.00	0.00			0.00	0.00	11.41	71.78	97.28	114.00	166.60	106	300	300	PVC	2.30	81.0	146.6540	2.0747	0.6507	0.726
To Elevation Road, Pipe 515 - 518						1.38				0.08				0.00				0.00	12.06														

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
22-05-05
PROVINCE OF ONTARIO

Designed:	PROJECT:		
R.A.	Ridge Phases 3 and 4		
Checked:	LOCATION:		
W.L.	City of Ottawa		
Dwg. Reference:	File Ref:	Date:	Sheet No.
Storm Drainage Plan, Dwgs No. 54-55	19-1123	May 2022	SHEET 1 OF 4

1123_Stm4.xlsx

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

Ottawa

LOCATION			AREA (Ha) 2 YEAR				5 YEAR				10 YEAR				100 YEAR				FLOW						SEWER DATA								
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min)	RATIO Q/Q full
Beebalm																																	
	505	534	0.34	0.73	0.69	0.69			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	53	375	375	PVC	0.45	94.5	117.6150	1.0649	1.4790	0.452
	534	535	0.27	0.73	0.55	1.24			0.00	0.00			0.00	0.00			0.00	0.00	11.48	71.56	96.98	113.65	166.08	89	375	375	PVC	3.00	78.5	303.6807	2.7496	0.4758	0.292
To Elevation Road, Pipe 535 - 515						1.24				0.00				0.00				0.00	11.95														
	505	506			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	300	300	PVC	0.60	13.0	74.9041	1.0597	0.2045	0.000
	506	508	0.26	0.63	0.46	0.46			0.00	0.00			0.00	0.00			0.00	0.00	10.20	76.03	103.13	120.88	176.71	35	300	300	PVC	0.35	79.0	57.2089	0.8093	1.6268	0.605
	508	509	0.09	0.72	0.18	0.64			0.00	0.00			0.00	0.00			0.00	0.00	11.83	70.42	95.42	111.81	163.39	45	300	300	PVC	0.45	41.5	64.8688	0.9177	0.7537	0.690
	509	510			0.00	0.64			0.00	0.00			0.00	0.00			0.00	0.00	12.58	68.13	92.27	108.10	157.94	43	300	300	PVC	0.40	10.5	61.1589	0.8652	0.2023	0.708
	510	511	0.30	0.68	0.57	1.20			0.00	0.00			0.00	0.00			0.00	0.00	12.79	67.54	91.46	107.15	156.54	81	375	375	PVC	0.55	64.0	130.0283	1.1773	0.9060	0.625
					0.00	1.20	0.04	0.61	0.07	0.07			0.00	0.00			0.00	0.00															
	511	526	0.36	0.73	0.73	1.93			0.00	0.07			0.00	0.00			0.00	0.00	13.69	65.03	88.03	103.11	150.62	132	450	450	CONC	2.80	95.5	477.0738	2.9997	0.5306	0.277
To Elevation Road, Pipe 526 - 528						1.93				0.07				0.00				0.00	14.22														
Elevation Road																																	
	527	528			0.00	0.00	0.06	0.61	0.11	0.11			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	11	300	300	PVC	0.35	18.5	57.2089	0.8093	0.3810	0.195
To Expansion Road, Pipe 528 - 529						0.00				0.11				0.00				0.00	10.38														
	535	539			0.00	0.00	0.07	0.53	0.10	0.10			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	10	300	300	PVC	2.40	52.5	149.8082	2.1194	0.4129	0.070
To Dundonald Drive, Pipe 539 - 542						0.00				0.10				0.00				0.00	10.41														
	540	541			0.00	0.00	0.07	0.61	0.11	0.11			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	12	300	300	PVC	0.35	11.5	57.2089	0.8093	0.2368	0.207
	541	542			0.00	0.00			0.00	0.11			0.00	0.00			0.00	0.00	10.24	75.91	102.96	120.69	176.42	12	300	300	PVC	0.35	12.5	57.2089	0.8093	0.2574	0.204
To Promontory, Pipe 542 - 543						0.00				0.11				0.00				0.00	10.49														
Contribution From Beebalm, Pipe 534 - 535						1.24				0.00				0.00				0.00	11.95														
	535	515			0.00	1.24	0.10	0.73	0.20	0.20			0.00	0.00			0.00	0.00	11.95	70.03	94.89	111.19	162.47	106	450	450	CONC	0.20	44.0	127.5033	0.8017	0.9147	0.831
Contribution From Catsfoot, Pipe 513 - 515						1.38				0.08				0.00				0.00	12.06														
			0.10	0.59	0.17	2.79			0.00	0.28			0.00	0.00			0.00	0.00															
	515	518			0.00	2.79	0.09	0.74	0.19	0.46			0.00	0.00			0.00	0.00	12.87	67.30	91.14	106.77	155.98	230	600	600	CONC	0.30	44.0	336.3080	1.1894	0.6165	0.684
Contribution From Speckled Adler, Pipe 517 - 518						1.35				0.08				0.00				0.00	11.88														
	518	526			0.00	4.14			0.00	0.54			0.00	0.00			0.00	0.00	13.49	65.59	88.79	104.01	151.93	319	675	675	CONC	0.30	47.0	460.4091	1.2866	0.6088	0.694
Contribution From Beebalm, Pipe 511 - 526						1.93				0.07				0.00				0.00	14.22														
Contribution From Andesite, Pipe 525 - 526						2.98				0.20				0.00				0.00	12.88														
	526	528			0.00	9.05	0.13	0.63	0.22	1.03			0.00	0.00			0.00	0.00	14.22	63.66	86.15	100.90	147.37	665	675	675	CONC	1.60	59.5	1063.2692	2.9713	0.3337	0.626
To Expansion Road, Pipe 528 - 529						9.05				1.03				0.00				0.00	14.56														
Expansion Road																																	
Contribution From Altitude, Pipe 504 - 528						3.67				0.00				0.00				0.00	14.00														
Contribution From Elevation Road, Pipe 526 - 528						9.05				1.03				0.00				0.00	14.56														
Contribution From Elevation Road, Pipe 527 - 528						0.00				0.11				0.00				0.00	10.38														
					0.00	12.72			0.00	1.14			0.00	0.00			0.00	0.00															
	528	529	0.20	0.73	0.40	13.12			0.00	1.14			0.00	0.00			0.00	0.00	14.56	62.83	85.01	99.57	145.41	921	1050	1050	CONC	0.25	62.5	1365.3626	1.5768	0.6606	0.675
			0.34	0.55	0.52	13.64			0.00	1.14			0.00	0.00			0.00	0.00															
	529	530	0.32	0.73	0.65	14.29			0.00	1.14			0.00	0.00			0.00	0.00	15.22	61.26	82.86	97.03	141.69	970	1200	1200	CONC	0.15	72.0	1509.9717	1.3351	0.8988	0.642
	530	531			0.00	14.29			0.00	1.14			0.00	0.00			0.00	0.00	16.12	59.25	80.11	93.80	136.95	938	1200	1200	CONC	0.15	76.5	1509.9717	1.3351	0.9550	0.621
	531	313			0.00	14.29			0.00	1.14			0.00	0.00			0.00	0.00	17.07	57.27	77.41	90.62	132.29	907	1200	1200	CONC	0.15	21.5	1509.9717	1.3351	0.2684	0.600
To POND INLET, Pipe 313 - 500						14.29				1.14				0.00				0.00	17.34														
Contribution From Haiku Street, Pipe 134 - 135						31.06				0.00				0.00				0.00	14.01														
			0.05	0.54	0.08	31.14			0.00	0.00			0.00	0.00			0.00	0.00															
	135	136	0.18	0.71	0.36	31.49			0.00	0.00			0.00	0.00			0.00	0.00	14.01	64.22	86.91	101.80	148.69	2022	1650	1650	CONC	0.10	37.0	2882.2416	1.3479	0.4575	0.702
	136	302			0.00	31.49			0.00	0.00			0.00	0.00			0.00	0.00	14.46	63.06	85.33	99.94	145.96	1986	2250	2250	CONC	0.10	54.0	6590.6247	1.6576	0.5430	0.301
To Expansion Road, Pipe 136 - 302						31.49				0.00				0.00				0.00	15.01														
Contribution From Haiku Street, Pipe 118 - 136						32.93				4.53				0.00				0.00	20.48														
Contribution From Travertine Way, Pipe 132 - 136						17.85				0.06				0.00				0.00	18.50														
Contribution From Promontory, Pipe 544 - 302						3.04				2.05				0.00				0.00	15.93														

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
22-05-05
PROVINCE OF ONTARIO

Designed:	PROJECT:		
R.A.	Ridge Phases 3 and 4		
Checked:	LOCATION:		
W.L.	City of Ottawa		
Dwg. Reference:	File Ref:	Date:	Sheet No.
Storm Drainage Plan, Dwgs No. 54-55	19-1123	May 2022	SHEET 2 OF 4

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

Ottawa

LOCATION			AREA (Ha) 2 YEAR				5 YEAR				10 YEAR				100 YEAR				FLOW Time of Conc.	Intensity 2 Year	Intensity 5 Year	Intensity 10 Year	Intensity 100 Year	Peak Flow	SEWER DATA DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF FLOW	RATIO
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	(min)	Q/Q full
			0.16	0.54	0.24	85.56			0.00	6.64			0.00	0.00			0.00	0.00															
			0.21	0.47	0.27	85.83			0.00	6.64			0.00	0.00			0.00	0.00															
	302	303	0.18	0.71	0.36	86.19			0.00	6.64			0.00	0.00			0.00	0.00	20.48	51.28	69.22	81.00	118.18	4879	2250	2250	CONC	0.10	59.0	6590.6247	1.6576	0.5932	0.740
			0.09	0.54	0.14	86.32			0.00	6.64			0.00	0.00			0.00	0.00															
			0.17	0.52	0.25	86.57			0.00	6.64			0.00	0.00			0.00	0.00															
	303	304	0.30	0.71	0.59	87.16			0.00	6.64			0.00	0.00			0.00	0.00	21.07	50.37	67.99	79.55	116.05	4842	2250	2250	CONC	0.10	134.5	6590.6247	1.6576	1.3524	0.735
			0.29	0.50	0.40	87.56			0.00	6.64			0.00	0.00			0.00	0.00															
	304	306TEE	0.30	0.71	0.59	88.16			0.00	6.64			0.00	0.00			0.00	0.00	22.42	48.43	65.35	76.45	111.51	4704	2250	2250	CONC	0.10	42.5	6590.6247	1.6576	0.4273	0.714
To POND INLET, Pipe 306TEE - 307						88.16				6.64				0.00				0.00	22.85														
BLK 198 (PARK)																																	
	3070	307			0.00	0.00	0.14	0.40	0.16	0.16			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	16	300	300	PVC	0.50	5.5	68.3778	0.9673	0.0948	0.237
To POND INLET, Pipe 307 - 400						0.00				0.16				0.00				0.00	10.09														
POND INLET																																	
Contribution From Expansion Road, Pipe 531 - 313						14.29				1.14				0.00				0.00	17.34														
	313	500			0.00	14.29			0.00	1.14			0.00	0.00			0.00	0.00	17.34	56.74	76.69	89.77	131.04	898	2250	2250	CONC	0.10	33.5	6590.6247	1.6576	0.3368	0.136
	500	HW			0.00	14.29			0.00	1.14			0.00	0.00			0.00	0.00	17.68	56.09	75.80	88.73	129.51	888	2250	2250	CONC	0.10	5.0	6590.6247	1.6576	0.0503	0.135
Contribution From Expansion Road, Pipe 304 - 306TEE						88.16				6.64				0.00				0.00	22.85														
	306TEE	307	0.23	0.65	0.42	88.57			0.00	6.64			0.00	0.00			0.00	0.00	22.85	47.86	64.56	75.52	110.15	4667	2250	2250	CONC	0.10	13.0	6590.6247	1.6576	0.1307	0.708
Contribution From BLK 199 (PARK), Pipe 302 - 303						0.00				0.16				0.00				0.00	10.09														
	307	400			0.00	88.57			0.00	6.80			0.00	0.00			0.00	0.00	22.98	47.68	64.32	75.25	109.74	4660	2250	2250	CONC	0.10	23.5	6590.6247	1.6576	0.2363	0.707
	400	3112			0.00	88.57			0.00	6.80			0.00	0.00			0.00	0.00	23.22	47.37	63.90	74.75	109.01	4630	2250	2250	CONC	0.10	6.0	6590.6247	1.6576	0.0603	0.703
ABIC PROPERTY																								210.40									
	3112	HW			0.00	88.57			0.00	6.80			0.00	0.00			0.00	0.00	23.28	47.29	63.79	74.62	108.83	4833	2250	2250	CONC	0.10	9.5	6590.6247	1.6576	0.0955	0.733
To POND HW						102.86				7.94				0.00				0.00	23.37														
Kootenay																																	
			0.31	0.57	0.50	0.50			0.00	0.00			0.00	0.00			0.00	0.00															
	546	547	0.34	0.66	0.62	1.12			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	86	375	375	PVC	0.80	99.5	156.8200	1.4199	1.1679	0.549
	547	548	0.05	0.60	0.09	1.21			0.00	0.00			0.00	0.00			0.00	0.00	11.17	72.59	98.40	115.32	168.54	88	375	375	PVC	1.55	60.0	218.2843	1.9764	0.5060	0.401
			0.12	0.69	0.24	1.44			0.00	0.00			0.00	0.00			0.00	0.00															
	548	549	0.17	0.58	0.27	1.72			0.00	0.00			0.00	0.00			0.00	0.00	11.67	70.92	96.11	112.62	164.58	122	375	375	PVC	1.00	29.5	175.3301	1.5875	0.3097	0.694
	549	550	0.08	0.68	0.15	1.87			0.00	0.00			0.00	0.00			0.00	0.00	11.98	69.94	94.77	111.04	162.25	131	375	375	PVC	1.00	12.5	175.3301	1.5875	0.1312	0.745
	550	551	0.31	0.68	0.59	2.45			0.00	0.00			0.00	0.00			0.00	0.00	12.11	69.54	94.21	110.38	161.29	171	525	525	CONC	1.55	112.0	535.4232	2.4734	0.7547	0.319
	551	559	0.24	0.67	0.45	2.90			0.00	0.00			0.00	0.00			0.00	0.00	12.87	67.30	91.14	106.77	155.98	195	525	525	CONC	1.40	52.5	508.8565	2.3506	0.3722	0.384
To Kootenay, Pipe 559 - 900						2.90				0.00				0.00				0.00	13.24														
Contribution From Altitude, Pipe 558 - 559						2.61				2.29				0.00				0.00	12.09														
	559	900			0.00	5.51			0.00	2.29			0.00	0.00			0.00	0.00	13.24	66.25	89.70	105.08	153.51	570	675	675	CONC	0.80	15.5	751.8449	2.1010	0.1230	0.758
To GREENBANK ROAD, Pipe 900 - 901						5.51				2.29				0.00				0.00	13.36														
Lepsoe																																	
					0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00															
			0.09	0.58	0.15	0.15			0.00	0.00			0.00	0.00			0.00	0.00															
	552	553	0.26	0.74	0.53	0.68			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	52	300	300	PVC	1.55	64.0	120.3915	1.7032	0.6263	0.434
			0.12	0.58	0.19	0.87			0.00	0.00			0.00	0.00			0.00	0.00															
	553	557	0.36	0.72	0.72	1.59			0.00	0.00			0.00	0.00			0.00	0.00	10.63	74.48	101.00	118.38	173.03	119	375	375	PVC	1.40	103.5	207.4534	1.8783	0.9184	0.572
To Altitude, Pipe 557 - 558						1.59				0.00				0.00				0.00	11.54														
BLK 200 (PARK)																																	
	Ctrl MH 5560	556			0.00	0.00	2.06	0.40	2.29	2.29			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	238	525	525	CONC	0.55	14.5	318.9427	1.4733	0.1640	0.747
To Altitude, Pipe 556 - 557						0.00				2.29				0.00				0.00	10.16														

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: R.A.	PROJECT: Ridge Phases 3 and 4		
Checked: W.L.	LOCATION: City of Ottawa		
Dwg. Reference: Storm Drainage Plan, Dwgs No. 54-55	File Ref: 19-1123	Date: May 2022	Sheet No. SHEET 3 OF 4

1123_Stm4.xlsx

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Arterial Roads Return Frequency = 10 years

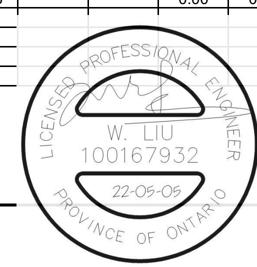
Manning 0.013

Ottawa

LOCATION			AREA (Ha) 2 YEAR				5 YEAR				10 YEAR				100 YEAR				FLOW						SEWER DATA								
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min)	RATIO Q/Q full
Altitude																																	
	554	556	0.18	0.69	0.35	0.35			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	27	300	300	PVC	0.95	81.5	94.2522	1.3334	1.0187	0.288
Contribution From BLK 200 (PARK), Pipe Ctrl MH 5560 - 556						0.00				2.29				0.00				0.00	10.16														
	556	557	0.11	0.70	0.21	0.57			0.00	2.29			0.00	0.00			0.00	0.00	11.02	73.10	99.10	116.15	169.75	268	525	525	CONC	1.20	70.0	471.1096	2.1763	0.5361	0.569
Contribution From Lepsoe, Pipe 553 - 557						1.59				0.00				0.00				0.00	11.54														
	557	558	0.23	0.70	0.45	2.61			0.00	2.29			0.00	0.00			0.00	0.00	11.55	71.31	96.64	113.25	165.49	407	675	675	CONC	0.45	36.5	563.8837	1.5758	0.3861	0.722
	558	559			0.00	2.61			0.00	2.29			0.00	0.00			0.00	0.00	11.94	70.08	94.95	111.26	162.57	400	675	675	CONC	0.45	14.5	563.8837	1.5758	0.1534	0.709
To Kootenay, Pipe 559 - 900						2.61				2.29				0.00				0.00	12.09														
Contribution From Jean Davey, Pipe 502 - 503						1.89				0.00				0.00				0.00	11.88														
	503	504	0.14	0.72	0.28	2.17			0.00	0.00			0.00	0.00			0.00	0.00	11.88	70.28	95.22	111.58	163.05	152	525	525	CONC	0.25	73.0	215.0311	0.9933	1.2248	0.709
			0.31	0.56	0.49	2.65			0.00	0.00			0.00	0.00			0.00	0.00															
	504	528	0.50	0.73	1.02	3.67			0.00	0.00			0.00	0.00			0.00	0.00	13.10	66.64	90.24	105.71	154.43	245	600	600	CONC	0.85	108.0	566.0907	2.0021	0.8990	0.432
To Expansion Road, Pipe 528 - 529						3.67				0.00				0.00				0.00	14.00														
Obsidian Street																																	
			0.04	0.61	0.07	0.07			0.00	0.00			0.00	0.00			0.00	0.00															
	562	563	0.14	0.60	0.24	0.31			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	24	300	300	PVC	0.45	29.5	64.8688	0.9177	0.5358	0.363
To Dundonald Drive, Pipe 563 - 564						0.31				0.00				0.00				0.00	10.54														
Dundonald Drive																																	
	561	563			0.00	0.00	0.35	0.71	0.69	0.69			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	72	300	300	PVC	2.90	61.0	164.6755	2.3297	0.4364	0.437
Contribution From Obsidian Street, Pipe 562 - 563						0.31				0.00				0.00				0.00	10.54														
	563	564			0.00	0.31	0.11	0.73	0.23	0.92			0.00	0.00			0.00	0.00	10.54	74.81	101.45	118.91	173.81	116	525	525	CONC	0.20	73.5	192.3297	0.8885	1.3788	0.603
	564	8500			0.00	0.31	0.28	0.73	0.56	1.48			0.00	0.00			0.00	0.00	11.91	70.16	95.06	111.39	162.77	162	525	525	CONC	2.05	48.5	615.7555	2.8445	0.2842	0.263
To GREENBANK ROAD, Pipe 8500 - 851						0.31				1.48				0.00				0.00	12.20														
	561	537			0.00	0.00	0.31	0.76	0.64	0.64			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	67	375	375	PVC	0.60	42.5	135.8101	1.2296	0.5760	0.494
	537	536			0.00	0.00	0.12	0.73	0.24	0.88			0.00	0.00			0.00	0.00	10.58	74.66	101.25	118.67	173.46	89	450	450	CONC	0.20	64.5	127.5033	0.8017	1.3409	0.702
	536	538			0.00	0.00	0.21	0.73	0.43	1.31			0.00	0.00			0.00	0.00	11.92	70.15	95.05	111.38	162.75	125	450	450	CONC	2.15	59.0	418.0477	2.6285	0.3741	0.298
Contribution From Pumice, Pipe 524 - 538						0.55				0.00				0.00				0.00	10.49														
			0.21	0.57	0.32	0.87			0.00	1.31			0.00	0.00			0.00	0.00															
	538	539			0.00	0.87	0.27	0.71	0.52	1.83			0.00	0.00			0.00	0.00	12.29	69.00	93.47	109.52	160.02	231	525	525	CONC	2.10	58.5	623.2194	2.8789	0.3387	0.371
Contribution From Elevation Road, Pipe 535 - 539						0.00				0.10				0.00				0.00	10.41														
	539	542			0.00	0.87			0.00	1.93			0.00	0.00			0.00	0.00	12.63	67.99	92.09	107.89	157.63	237	525	525	CONC	0.60	9.5	333.1248	1.5389	0.1029	0.712
To Promontory, Pipe 542 - 543						0.87				1.93				0.00				0.00	12.73														
GREENBANK ROAD																																	
					0.00	0.00			0.00	0.00	2.52	0.85	5.95	5.95			0.00	0.00	14.90														
	850	8500			0.00	0.00			0.00	0.00	0.18	0.85	0.43	6.38			0.00	0.00	14.90	62.00	83.88	98.23	143.45	627	750	750	CONC	1.40	40.5	1317.2471	2.9816	0.2264	0.476
Contribution From Dundonald Drive, Pipe 564 - 8500						0.31				1.48				0.00				0.00	12.20														
	8500	851			0.00	0.31			0.00	1.48	0.34	0.85	0.80	7.18			0.00	0.00	15.13	61.47	83.15	97.37	142.19	841	750	750	CONC	1.05	79.5	1140.7695	2.5822	0.5131	0.738
	851	852			0.00	0.31			0.00	1.48	0.34	0.85	0.80	7.99			0.00	0.00	15.64	60.30	81.55	95.49	139.42	902	750	750	CONC	1.40	79.5	1317.2471	2.9816	0.4444	0.685
	852	900			0.00	0.31			0.00	1.48	0.29	0.85	0.69	8.67			0.00	0.00	16.08	59.32	80.21	93.92	137.12	951	750	750	CONC	1.40	71.5	1317.2471	2.9816	0.3997	0.722
Contribution From Kootenay, Pipe 559 - 900						5.51				2.29				0.00				0.00	13.36														
	900	901			0.00	5.82			0.00	3.77	0.29	0.85	0.69	9.36			0.00	0.00	16.48	58.47	79.05	92.55	135.12	1504	1650	1650	CONC	0.25	70.0	4557.2242	2.1313	0.5474	0.330
					0.00	5.82			0.00	3.77	0.58	0.85	1.37	10.73			0.00	0.00															
	901	902			0.00	5.82	6.06	0.65	10.95	14.72			0.00	10.73			0.00	0.00	17.03	57.36	77.52	90.76	132.48	2448	1650	1650	CONC	0.45	150.0	6114.1578	2.8594	0.8743	0.400
					0.00	5.82	0.54	0.40	0.60	15.32			0.00	10.73			0.00	0.00															
					0.00	5.82			0.00	15.32	0.63	0.85	1.49	12.22			0.00	0.00															
	902	903			0.00	5.82	1.63	0.40	1.81	17.13			0.00	12.22			0.00	0.00	17.91	55.66	75.21	88.04	128.50	2688	2250	2250	CONC	0.30	150.0	11415.2969	2.8710	0.8708	0.235
	903	904			0.00	5.82			0.00	17.13	0.63	0.85	1.49	13.71			0.00	0.00	18.78	54.09	73.06	85.51	124.79	2738	2250	2250	CONC	0.15	150.0	8071.8338	2.0301	1.2315	0.339
	904	905TEE			0.00	5.82			0.00	17.13	0.18	0.85	0.43	14.13			0.00	0.00	20.01	52.02	70.23	82.19	119.92	2667	2550	2550	CONC	0.15	20.0	11270.0535	2.2068	0.1511	0.237
	905TEE	506000			0.00	5.82			0.00	17.13			0.00	14.13			0.00	0.00	20.16	51.78	69.90	81.80	119.35	2655	2550	2550	CONC	0.15	31.0	11270.0535	2.2068	0.2341	0.236

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s



Designed: R.A.	PROJECT: Ridge Phases 3 and 4		
Checked: W.L.	LOCATION: City of Ottawa		
Dwg. Reference: Storm Drainage Plan, Dwgs No. 54-55	File Ref: 19-1123	Date: May 2022	Sheet No. SHEET 4 OF 4

1123_Stm4.xlsx

APPENDIX

B

Inlet Control Devices

JFSA Water Resources and Environmental Consultants

Products – StormTech Orifice Plate

Our StormTech Orifice Plate uses a calibrated orifice to control the outflow at a specific rate at a specific head in the catch basin. This is our simplest and most economical Inlet Control Device (ICD), and can be sometimes used by municipalities as a starting point for storm water management until more information is gathered. As with all our products, it can be swapped out with another StormTech ICD once more is known about the system.

Orifice Plate units can have any shape or size of orifice customized to meet your needs. Standard designs include Round, Diamond, Keyhole and Diamond Keyhole shaped orifices. Keyholes help create a torsional flow pattern through the orifice that can help unblock some debris.

Orifice plate ICD's do not form water traps to prevent odours and are also prone to blockage by floatables like leaves, twigs, bottles and cans, especially during higher rainfall periods. Monitoring of these types of installs is recommended and sometimes leads to recommendations to upgrade to water trap devices, such as Odour Traps and Sumps, to prevent blockage and odours. But in locations where they work properly they are an economical alternative solution.

Primary Function(s): Flow Control for Medium to High Flow Rates (15 to 100 l/s | 237 to 1585 GPM).

Other Functions(s): None.

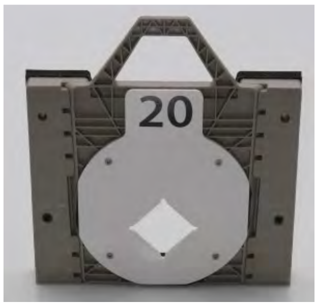
Outflow Pipe Diameter: 150 mm to 300 mm | 6 inch to 12 inch. Special orders can be made for larger sizes.

Catch Basin Types: All – with or without sumps.
Rectangular or Round Catch Basins (Round requires built-in adapter that can be provided).
Standard Round is 600 mm, but larger sizes available (900 mm, 1200 mm, 1600 mm …etc.).
Fits through even small Catch Basin openings (300 mm x 450 mm).

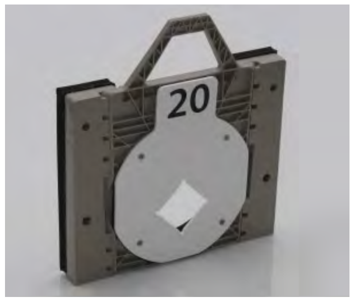
Specifications:
Orifice Plate: HDPE Thermoplastic with UV resistant additives.
Handle Plate (common): HDPE Thermoplastic.
Handle Plate (common): HDPE Thermoplastic.
Mounting Plate (common): HDPE Thermoplastic.
Hardware (common): Stainless Steel Wedge Bolts with Nut and Washer (4).
Welds: None.
Inner Ring Seal: Rubber Bulb Seal EPDM. Held in place and reusable. No need to replace.
Wall Seal: 3/8 or 5/8 inch Neoprene closed cell sponge gasket attached to Mounting Plate.
Identifier: 50 mm high numeric's on top of unit. Peel and stick. Note: Not visible from street surface.
Special Tools: None required.
Weight: Removable Unit: 0.5 kg / 1 lb. Maximum Total Assembly: 2.3 kg / 5 lb.

Products – StormTech Orifice Plate (continued)

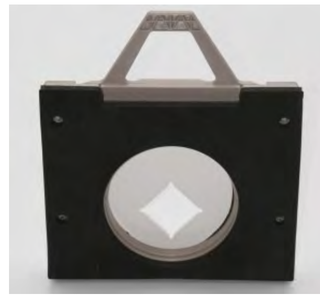
Orifice Plate – Square Adapter (with Diamond Orifice pictured)



Front

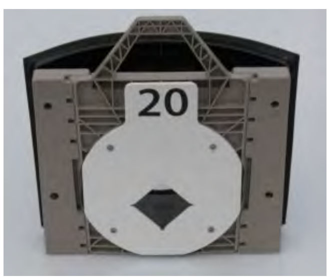


Left Angle

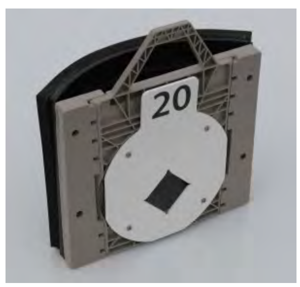


Back – View from Wall

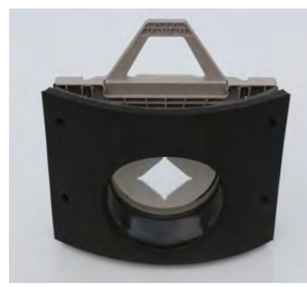
Orifice Plate – Round Adapter



Front



Left Angle



Back – View from Wall

Installation:

1. If necessary, cut protruding out-flowing pipe back flush to Catch Basin wall.
2. Use Mounting Plate as template to mark four hole pattern on Catch Basin wall.
3. Install four Stainless Steel Wedge Bolts (provided) perpendicular to Mounting Plate.
4. Install Mounting Plate and hand secure with four washers and nuts (provided).
5. Torque nuts to 40 N-·m or 30 lbf·ft. Do not over-tighten.
6. Snap unit into place by pushing Handle Plate into dove-tail slot of Mounting Plate.
7. Record Unit Identifier along with Catch Basin Location according to municipal requirements.
8. Note – Unit Identifier with this model is NOT easily seen from street level.

Table B-1: Plas-Tech StormTech Orifice Plate Inlet Control Device (ICD) Capacities [1]

ICD Diameter (mm)	Capture (L/s)							
	CB (1.38 m lead pipe invert depth)				CBMH (1.74 m lead pipe invert depth)			
Water Depth:	*0 cm*	*Average*	*30 cm*	*35 cm*	*0 cm*	*Average*	*30 cm*	*35 cm*
Head:	*1.28 m*	*1.4 m*	*1.58 m*	*1.63 m*	*1.64 m*	*1.76 m*	*1.94 m*	*1.99 m*
83	17.6	18.4	19.6	19.9	19.9	20.7	21.7	22.0
94	22.6	23.6	25.1	25.5	25.6	26.5	27.8	28.2
102	26.6	27.8	29.6	30.0	30.1	31.2	32.8	33.2
108	29.8	31.2	33.2	33.7	33.8	35.0	36.7	37.2
127	41.3	43.2	45.8	46.6	46.7	48.4	50.8	51.5
152	59.1	61.8	65.7	66.7	66.9	69.3	72.8	73.7
178	81.1	84.8	90.1	91.5	91.8	95.0	99.8	101.1

[1] For circular orifices plate type with diameters as specified by City of Ottawa standards.

CB Grate - 0.5% Longitudinal Slope

Approach Flow Capture Per Design Charts/Manual

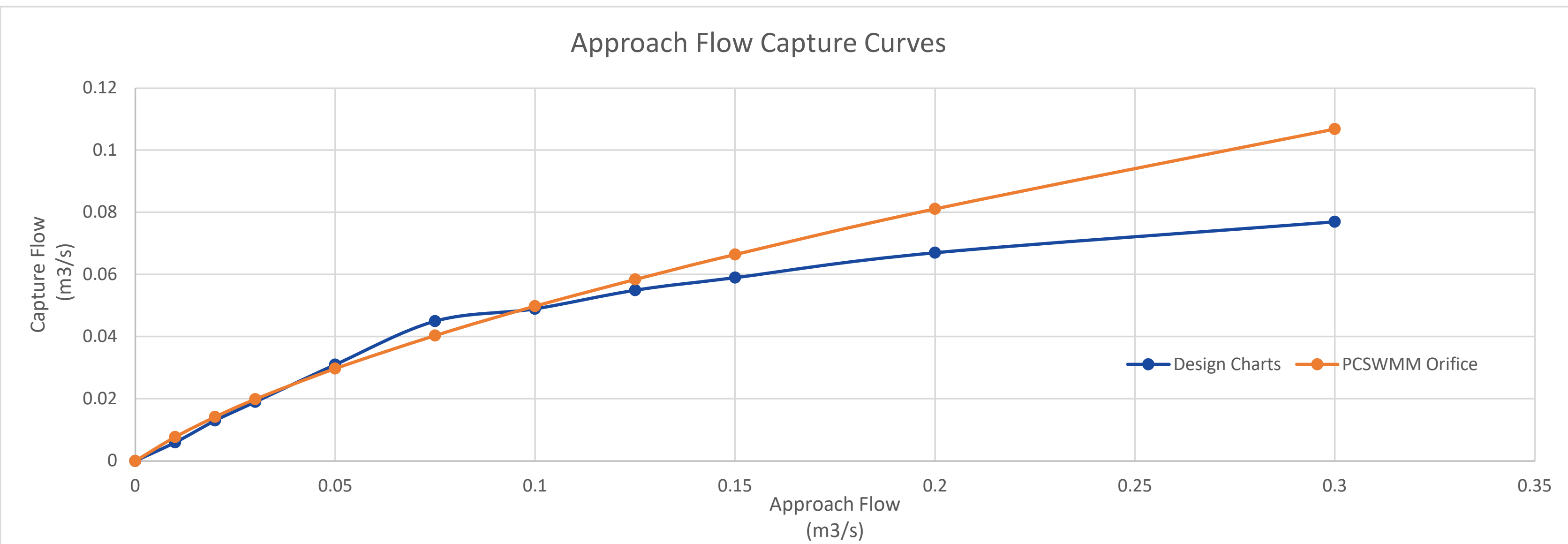
* Curve based on MTO Design Charts,
* derived for 2% cross slope & 0.5% longitudinal slope
* assuming OPSD 400.01 grates and OPSD 600.01 curbs and gutters
* The 250 mm lead pipe does not control the flow.

PCSWMM Model Orifice

2% cross slope & 0.5% longitudinal slope
0.35m x 0.35m
Rectangular Bottom Opening
$C_o = 0.62$

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0
0.010	0.006
0.020	0.013
0.030	0.019
0.050	0.031
0.075	0.045
0.100	0.049
0.125	0.055
0.150	0.059
0.200	0.067
0.300	0.077

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0.000
0.010	0.008
0.020	0.014
0.030	0.020
0.050	0.030
0.075	0.040
0.100	0.050
0.125	0.058
0.150	0.066
0.200	0.081
0.300	0.107



R^2 = **0.953**

CB Grate - 1% Longitudinal Slope

Approach Flow Capture Per Design Charts/Manual

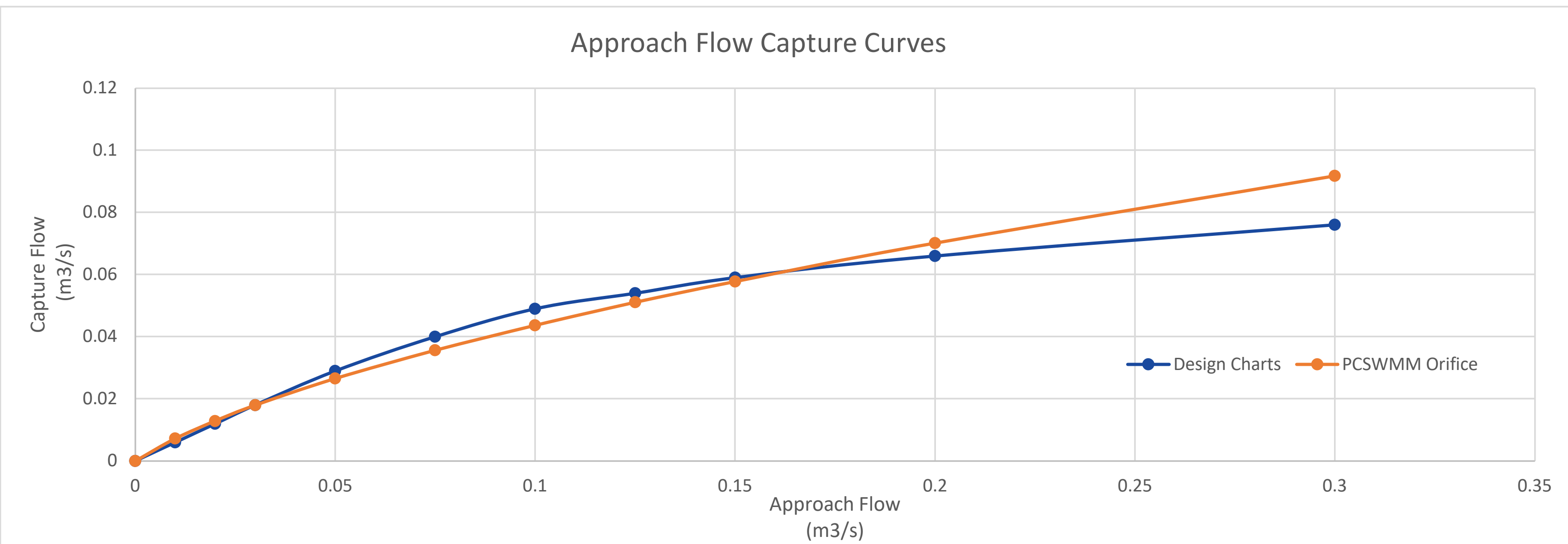
* Curve based on MTO Design Charts,
* derived for 2% cross slope & 1% longitudinal slope
* assuming OPSD 400.01 grates and OPSD 600.01 curbs and gutters
* The 250 mm lead pipe does not control the flow.

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0
0.010	0.006
0.020	0.012
0.030	0.018
0.050	0.029
0.075	0.04
0.100	0.049
0.125	0.054
0.150	0.059
0.200	0.066
0.300	0.076

PCSWMM Model Orifice

2% cross slope & 1% longitudinal slope
0.35m x 0.35m
Rectangular Bottom Opening
C_o = 0.62

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0.000
0.010	0.007
0.020	0.013
0.030	0.018
0.050	0.027
0.075	0.036
0.100	0.044
0.125	0.051
0.150	0.058
0.200	0.070
0.300	0.092



R^2 = 0.965

CB Grate - 2% Longitudinal Slope

Approach Flow Capture Per Design Charts/Manual

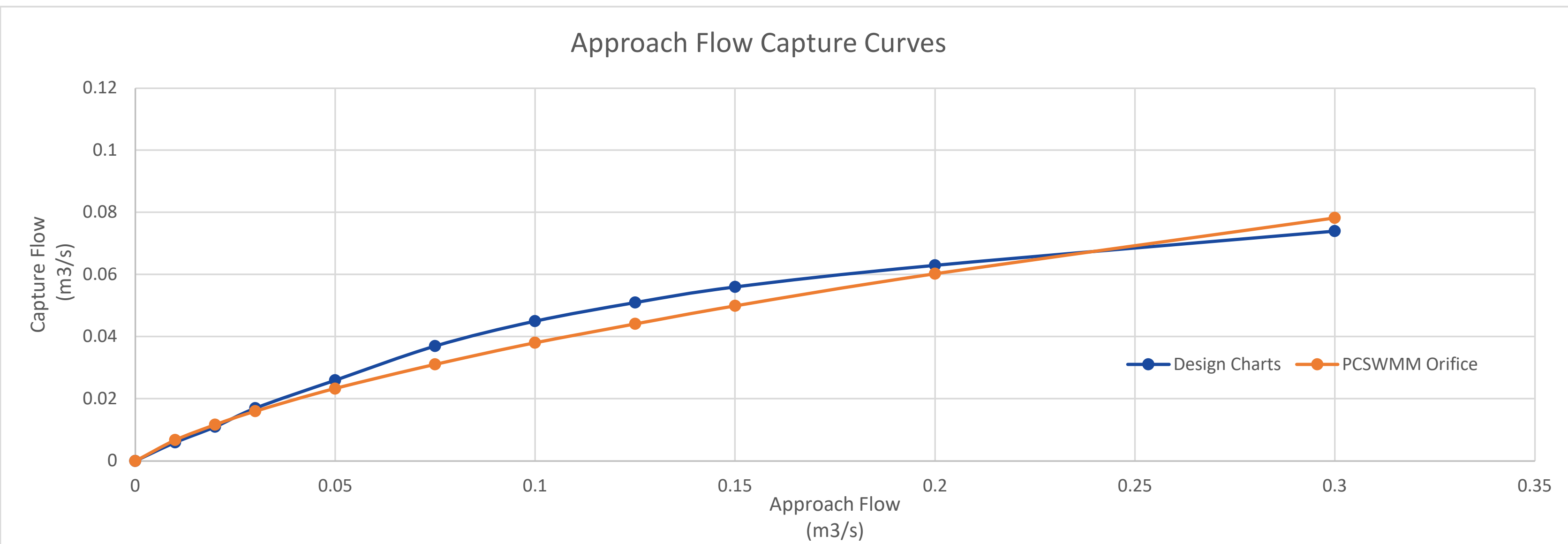
* Curve based on MTO Design Charts,
* derived for 2% cross slope & 2% longitudinal slope
* assuming OPSD 400.01 grates and OPSD 600.01 curbs and gutters
* The 250 mm lead pipe does not control the flow.

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0
0.010	0.006
0.020	0.011
0.030	0.017
0.050	0.026
0.075	0.037
0.100	0.045
0.125	0.051
0.150	0.056
0.200	0.063
0.300	0.074

PCSWMM Model Orifice

2% cross slope & 2% longitudinal slope
0.35m x 0.35m
Rectangular Bottom Opening
$C_o = 0.62$

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0.000
0.010	0.007
0.020	0.012
0.030	0.016
0.050	0.023
0.075	0.031
0.100	0.038
0.125	0.044
0.150	0.050
0.200	0.060
0.300	0.078



R^2 = **0.978**

CB Grate - 3% Longitudinal Slope

Approach Flow Capture Per Design Charts/Manual

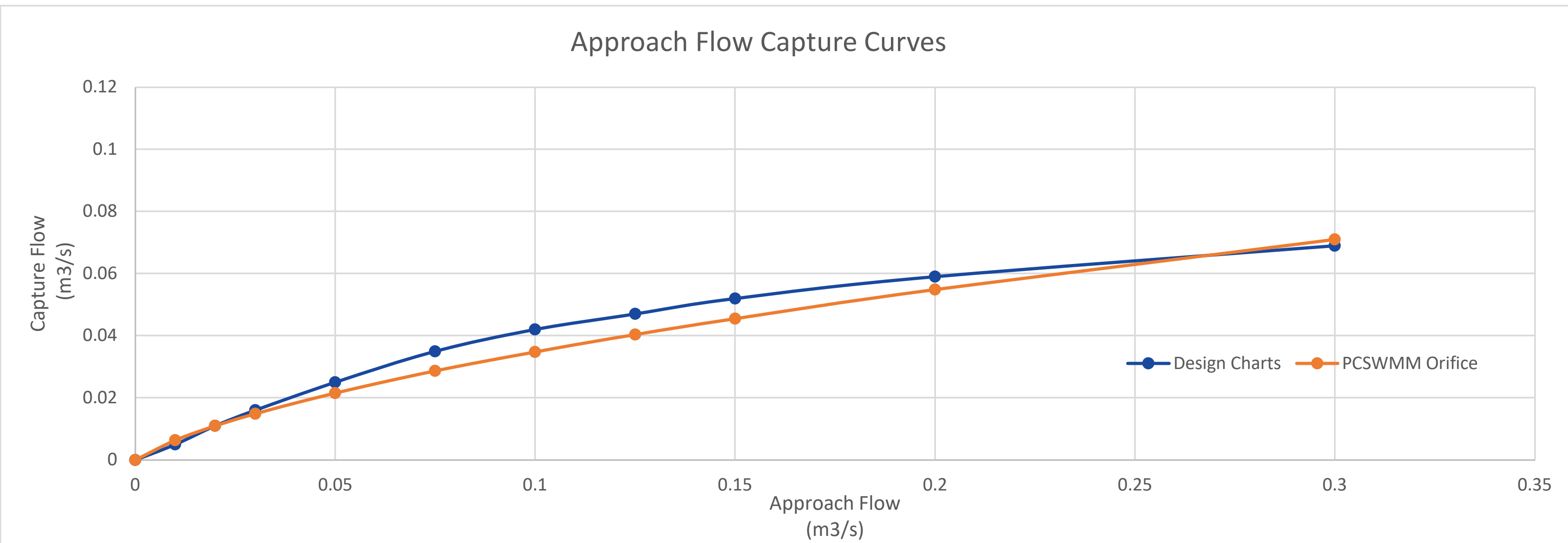
* Curve based on MTO Design Charts,
* derived for 2% cross slope & 3% longitudinal slope
* assuming OPSD 400.01 grates and OPSD 600.01 curbs and gutters
* The 250 mm lead pipe does not control the flow.

PCSWMM Model Orifice

2% cross slope & 3% longitudinal slope
0.35m x 0.35m
Rectangular Bottom Opening
$C_o = 0.62$

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0
0.010	0.005
0.020	0.011
0.030	0.016
0.050	0.025
0.075	0.035
0.100	0.042
0.125	0.047
0.150	0.052
0.200	0.059
0.300	0.069

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0.000
0.010	0.006
0.020	0.011
0.030	0.015
0.050	0.022
0.075	0.029
0.100	0.035
0.125	0.040
0.150	0.046
0.200	0.055
0.300	0.071



R^2 = **0.979**

CICB Grate - 1% Longitudinal Slope

Approach Flow Capture Per Design Charts/Manual

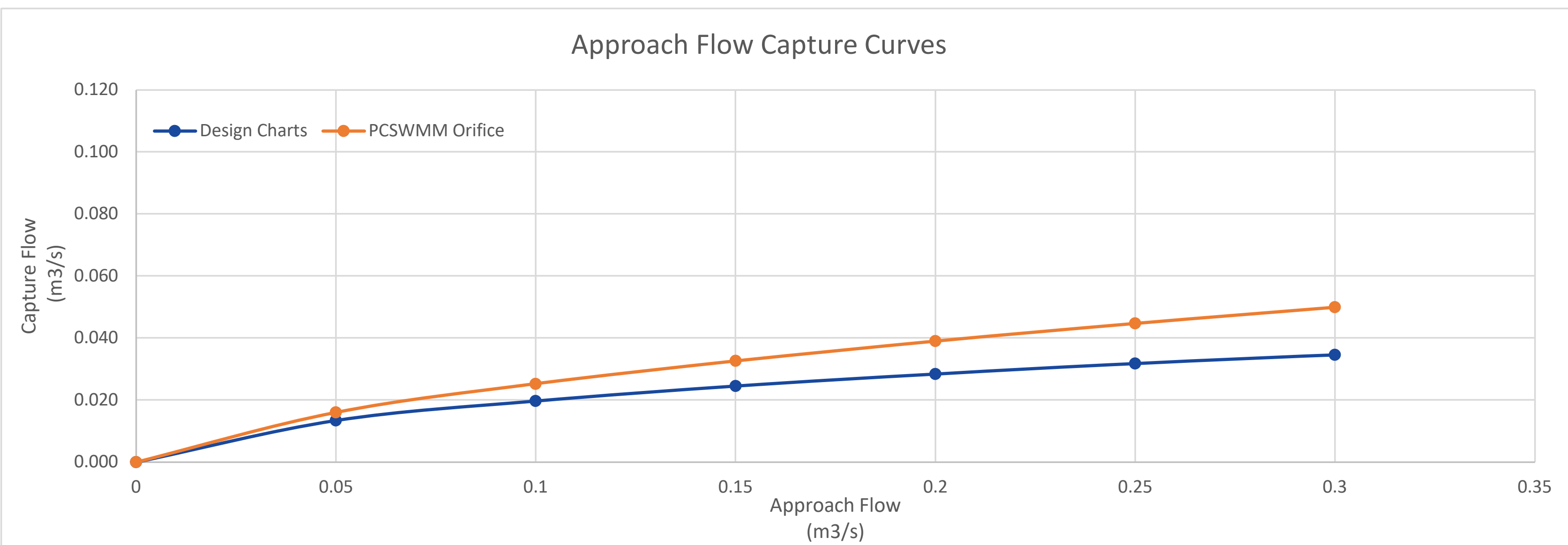
* Curve based on City of Ottawa Sewer Design Guidelines(Appendix 7-A.13),
* derived for 3% cross slope & 1% longitudinal slope
* Assuming Type S22 Curb Inlet and OPSD 600.01 curbs and gutters
* The 250 mm lead pipe does not control the flow.

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0.000
0.050	0.013
0.100	0.020
0.150	0.025
0.200	0.028
0.250	0.032
0.300	0.035

PCSWMM Model Orifice

3% cross slope & 1% longitudinal slope
0.65m x 0.13m
Rectangular Side Opening
C_o = 0.62

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0.000
0.050	0.016
0.100	0.025
0.150	0.033
0.200	0.039
0.250	0.045
0.300	0.050



R^2 = 0.993

CICB Grate - 2% Longitudinal Slope

Approach Flow Capture Per Design Charts/Manual

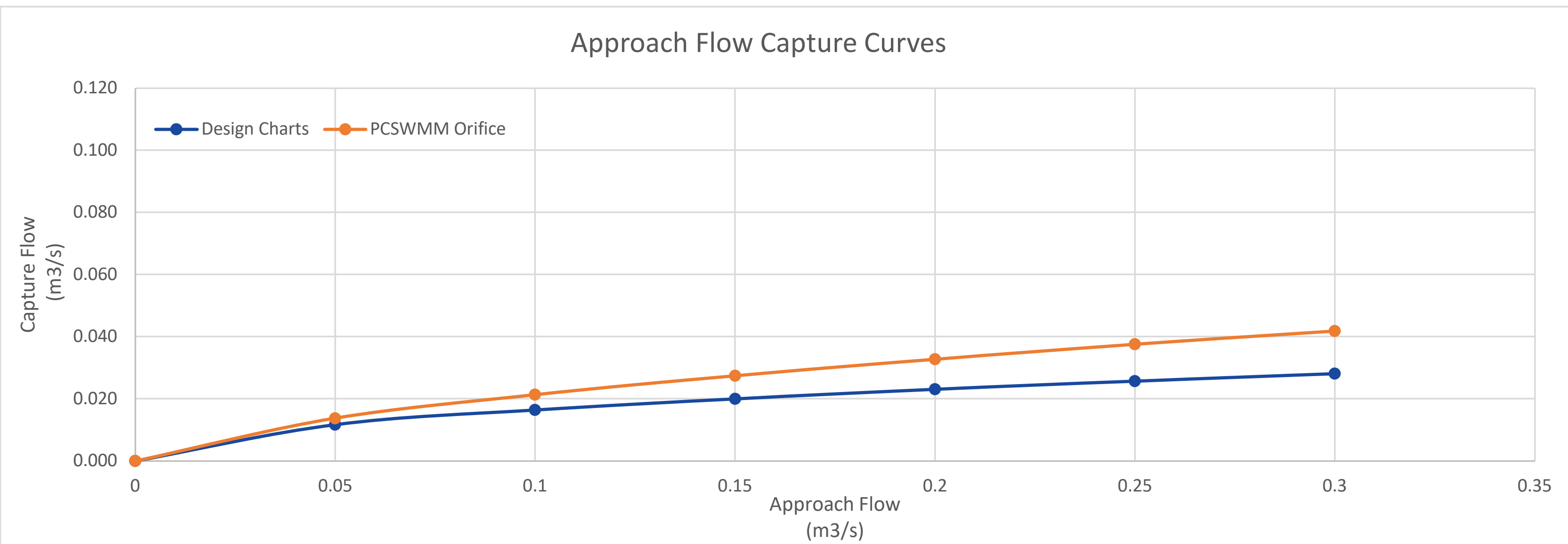
* Curve based on City of Ottawa Sewer Design Guidelines(Appendix 7-A.13),
* derived for 3% cross slope & 2% longitudinal slope
* Assuming Type S22 Curb Inlet and OPSD 600.01 curbs and gutters
* The 250 mm lead pipe does not control the flow.

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0.000
0.050	0.012
0.100	0.016
0.150	0.020
0.200	0.023
0.250	0.026
0.300	0.028

PCSWMM Model Orifice

3% cross slope & 2% longitudinal slope
0.65m x 0.13m
Rectangular Side Opening
C_o = 0.62

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0.000
0.050	0.014
0.100	0.021
0.150	0.027
0.200	0.033
0.250	0.038
0.300	0.042



R^2 = 0.990

CICB Grate - 3% Longitudinal Slope

Approach Flow Capture Per Design Charts/Manual

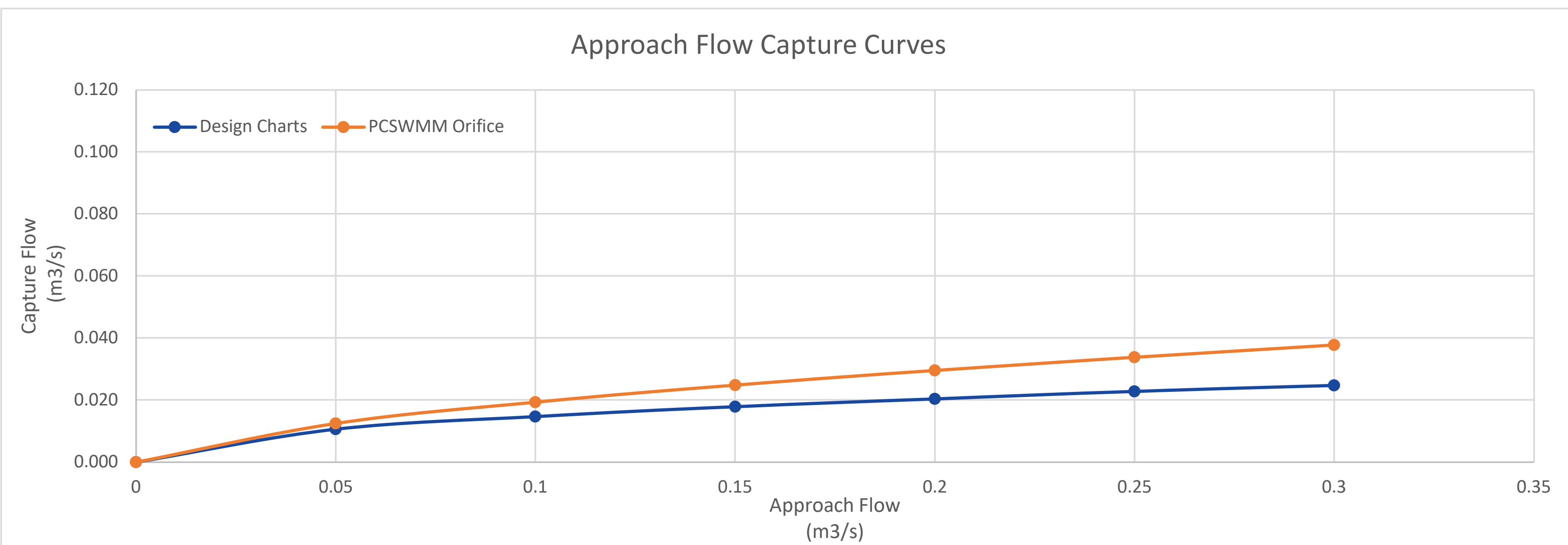
* Curve based on City of Ottawa Sewer Design Guidelines(Appendix 7-A.13),
* derived for 3% cross slope & 3% longitudinal slope
* Assuming Type S22 Curb Inlet and OPSD 600.01 curbs and gutters
* The 250 mm lead pipe does not control the flow.

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0.000
0.050	0.011
0.100	0.015
0.150	0.018
0.200	0.020
0.250	0.023
0.300	0.025

PCSWMM Model Orifice

3% cross slope & 3% longitudinal slope
0.65m x 0.13m
Rectangular Side Opening
C_o = 0.62

Approach Flow (m^3/s)	Capture Flow (m^3/s)
0.000	0.000
0.050	0.012
0.100	0.019
0.150	0.025
0.200	0.030
0.250	0.034
0.300	0.038



R^2 = **0.988**

APPENDIX C

Manhole Loss Coefficient Nomograph and Table

Pipe Data and Hydraulic Simulation Results

JFSA Water Resources and Environmental Consultants

MANHOLE LOSS COEFFICIENT NOMOGRAPH AND TABLE

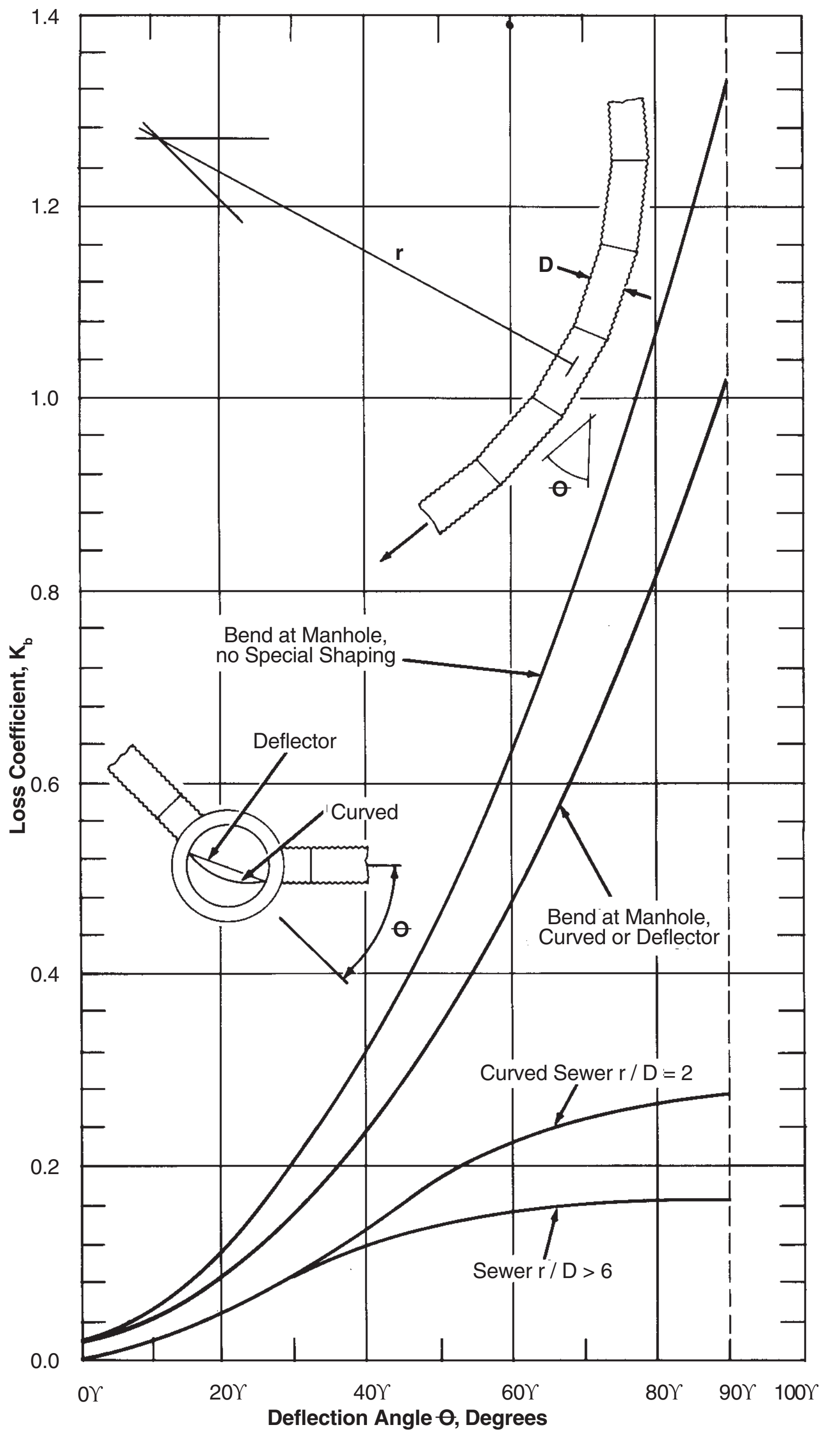


Figure 4.13 Sewer bend loss coefficient[16]

Angle	Exit Loss
0	0.02
5	0.035
10	0.055
15	0.08
20	0.11
25	0.16
30	0.21
35	0.26
40	0.32
45	0.39
50	0.47
55	0.54
60	0.635
65	0.73
70	0.84
75	0.95
80	1.07
85	1.19
90	1.33

Table C1A: Pipe Data and Hydraulic Simulation Results - 100-Year Chicago 3 Hour Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH_136	MH_302	96.484	96.41	101.19	101.14	2250	53.9	0.1	0.013	1.66	6.59	7.37	1.12	-0.23	01:15	98.50	98.44
MH_302	MH_303	96.41	96.331	101.14	101.08	2250	58.9	0.1	0.013	1.66	6.59	8.09	1.23	-0.22	01:14	98.44	98.35
MH_303	MH_304	96.331	96.176	101.08	100.73	2250	134.3	0.1	0.013	1.67	6.62	8.20	1.24	-0.23	01:15	98.35	98.15
MH_304	MH_306TEE	96.176	96.133	100.73	100.27	2250	42.5	0.1	0.013	1.67	6.62	8.26	1.25	-0.28	01:15	98.15	97.87
MH_306TEE	MH_307	96.133	96.1	100.27	100.35	2250	11.2	0.1	0.013	1.79	7.10	8.27	1.16	-0.51	01:15	97.87	97.64
MH_307	MH_400	96.1	96.067	100.35	100.35	2250	22.7	0.1	0.013	1.71	6.79	6.01	0.89	-0.71	01:14	97.64	97.61
MH_400	OGS_1	96.067	96.037	100.35	100.5	750	4.9	0.2	0.013	1.13	0.50	1.01	2.02	0.79	01:01	97.61	97.57
MH_500	OGS_2	96.056	96.026	100.35	100.428	750	5.0	0.2	0.013	1.13	0.50	1.01	2.02	0.55	01:38	97.36	97.32
MH-313	MH_500	96.099	96.056	99.835	100.35	2250	33.0	0.1	0.013	1.68	6.69	4.13	0.62	-0.75	01:14	97.60	97.36
MH-500	MH-502	102.24	100.94	105.21	104.245	300	92.0	1.3	0.013	1.53	0.11	0.13	1.20	0.43	01:10	102.97	101.25
MH-502	MH-503	100.94	98.961	104.245	102.42	450	119.0	1.6	0.013	2.27	0.36	0.28	0.78	-0.14	01:10	101.25	99.64
MH-5020	MH-502	101.143	100.94	104.27	104.245	300	10.5	0.5	0.013	0.97	0.07	0.00	0.03	-0.19	01:02	101.25	101.25
MH-503	MH-504	98.961	98.683	102.42	101.89	525	73.0	0.3	0.013	1.00	0.22	0.34	1.55	0.16	01:10	99.64	99.14
MH-504	MH-528	98.683	97.315	101.89	101.06	600	108.0	0.9	0.013	2.00	0.57	0.53	0.94	-0.14	01:10	99.14	98.37
MH-505	MH-506	103.478	103.351	105.836	106.28	300	13.0	0.6	0.013	1.06	0.07	0.01	0.17	-0.22	01:10	103.56	103.67
MH-505	MH-534	103.478	103.033	105.836	105.406	375	94.5	0.5	0.013	1.06	0.12	0.01	0.10	-0.30	01:10	103.56	103.22
MH-506	MH-508	103.351	103.054	106.28	105.88	300	79.0	0.4	0.013	0.81	0.06	0.06	1.01	0.02	01:06	103.67	103.41
MH-5070	MH-513	103.12	102.394	105.92	105.51	300	82.0	0.5	0.013	0.97	0.07	0.06	0.86	0.24	01:10	103.66	103.42
MH-508	MH-509	103.054	102.837	105.88	105.67	300	41.5	0.5	0.013	0.92	0.06	0.08	1.22	0.06	01:09	103.41	103.14
MH-5080	MH-517	102.898	102.054	105.7	105.28	300	76.5	0.6	0.013	1.01	0.07	0.06	0.85	-0.01	01:10	103.19	103.02
MH-509	MH-510	102.837	102.718	105.67	105.6	300	10.5	0.4	0.013	0.87	0.06	0.08	1.29	0.00	01:10	103.14	102.93
MH-510	MH-511	102.718	102.077	105.6	105.25	375	64.0	0.6	0.013	1.18	0.13	0.08	0.61	-0.17	01:10	102.93	102.31
MH-511	MH-526	102.077	98.642	105.25	103	450	95.5	2.8	0.013	3.00	0.48	0.25	0.53	-0.22	01:10	102.31	100.33
MH-513	MH-515	102.394	100.231	105.51	104	300	81.0	2.3	0.013	2.08	0.15	0.17	1.15	0.73	01:10	103.42	100.72
MH-515	MH-518	100.231	99.793	104	103.59	600	44.0	0.3	0.013	1.19	0.34	0.38	1.14	-0.11	01:11	100.72	100.51
MH-517	MH-518	102.054	99.793	105.28	103.59	300	82.0	2.3	0.013	2.08	0.15	0.16	1.10	0.67	01:10	103.02	100.51
MH-518	MH-526	99.793	98.642	103.59	103	675	47.0	0.3	0.013	1.29	0.46	0.54	1.18	0.05	01:13	100.51	100.33
MH-519	MH-520	103.476	103.127	105.766	106.01	300	54.5	0.5	0.013	0.97	0.07	0.00	0.00	-0.30	00:00	103.48	103.41
MH-519	MH-523	103.476	103.213	105.766	105.726	300	11.5	0.3	0.013	0.81	0.06	0.00	0.00	-0.30	00:00	103.48	103.32
MH-520	MH-521	103.127	102.808	106.01	105.71	375	57.5	0.5	0.013	1.12	0.12	0.11	0.87	-0.09	01:10	103.41	103.12
MH-521	MH-522	102.808	102.725	105.71	105.64	375	11.5	0.3	0.013	0.94	0.10	0.11	1.04	-0.06	01:10	103.12	102.94
MH-522	MH-525	102.725	100.69	105.64	104.2	375	55.0	2.6	0.013	2.54	0.28	0.17	0.60	-0.17	01:10	102.94	101.07
MH-523	MH-524	103.213	102.148	105.726	104.956	300	55.0	1.8	0.013	1.84	0.13	0.04	0.29	-0.19	01:11	103.32	102.49
MH-524	MH-5240	102.148	101.917	104.956	105.23	375	65.0	0.3	0.013	0.87	0.10	0.11	1.12	-0.03	01:10	102.49	102.20
MH-5240	MH-525	101.917	100.69	105.23	104.2	375	63.5	1.6	0.013	1.98	0.22	0.17	0.76	-0.09	01:10	102.20	101.07
MH-52400	MH-538	102.155	100.883	104.956	103.676	300	58.0	1.8	0.013	1.84	0.13	0.02	0.18	-0.21	01:10	102.25	101.17
MH-525	MH-526	100.69	98.642	104.2	103	525	58.5	1.8	0.013	2.67	0.58	0.40	0.69	-0.15	01:09	101.07	100.33
MH-526	MH-528	98.642	97.315	103	101.06	675	59.5	1.6	0.013	2.97	1.06	1.21	1.14	1.02	01:11	100.33	98.37
MH-527	MH-528	99.084	97.315	101.18	101.06	300	18.5	0.4	0.013	0.81	0.06	0.02	0.33	-0.16	01:10	99.22	98.37
MH-528	MH-529	97.315	97.009	101.06	100.82	1050	62.5	0.3	0.013	1.58	1.37	1.78	1.31	0.00	01:11	98.37	98.10
MH-529	MH-530	97.009	96.851	100.82	100.58	1200	72.0	0.2	0.013	1.34	1.51	1.77	1.17	-0.11	01:11	98.10	97.96

Table C1A: Pipe Data and Hydraulic Simulation Results - 100-Year Chicago 3 Hour Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-530	MH-531	96.851	96.656	100.58	100.45	1200	76.5	0.2	0.013	1.34	1.51	1.90	1.26	-0.09	01:11	97.96	97.74
MH-531	MH-313	96.656	96.099	100.45	99.835	1200	21.5	0.1	0.013	1.33	1.50	1.90	1.26	-0.12	01:12	97.74	97.60
MH-534	MH-535	103.033	100.603	105.406	103.886	375	78.5	3.0	0.013	2.75	0.30	0.16	0.52	-0.19	01:10	103.22	100.98
MH-535	MH-515	100.603	100.231	103.886	104	450	44.0	0.2	0.013	0.80	0.13	0.16	1.22	-0.07	01:11	100.98	100.72
MH-5350	MH-539	101.607	99.624	103.886	102.466	300	52.5	2.4	0.013	2.12	0.15	0.02	0.11	-0.23	01:10	101.68	100.15
MH-536	MH-538	102.515	100.883	105.446	103.676	450	59.0	2.2	0.013	2.63	0.42	0.12	0.30	-0.28	01:10	102.69	101.17
MH-537	MH-536	102.673	102.515	105.126	105.446	450	64.5	0.2	0.013	0.80	0.13	0.12	0.97	-0.11	01:10	103.01	102.69
MH-538	MH-539	100.883	99.624	103.676	102.466	525	58.5	2.1	0.013	2.88	0.62	0.36	0.58	-0.23	01:10	101.17	100.15
MH-539	MH-542	99.624	99.339	102.466	102.396	525	9.5	0.6	0.013	1.54	0.33	0.38	1.13	0.00	01:10	100.15	100.01
MH-540	MH-541	100.072	99.961	101.646	102.506	300	14.5	0.4	0.013	0.81	0.06	0.07	1.20	-0.02	01:10	100.35	100.23
MH-541	MH-542	99.961	99.339	102.506	102.396	300	10.0	0.4	0.013	0.81	0.06	0.07	1.21	-0.03	01:10	100.23	100.01
MH-542	MH-543	99.339	99.184	102.396	102.186	750	53.0	0.2	0.013	0.98	0.43	0.57	1.32	-0.08	01:10	100.01	99.86
MH-543	MH-544	99.184	97.993	102.186	102.016	825	118.0	0.2	0.013	1.04	0.56	0.65	1.17	-0.14	01:11	99.86	98.52
MH-544	MH-5440	97.993	97.273	102.016	101	825	57.5	1.2	0.013	2.94	1.57	0.70	0.45	-0.30	01:12	98.52	98.46
MH-5440	MH_302	97.273	96.41	101	101.14	825	12.3	1.2	0.013	2.97	1.59	0.70	0.44	0.36	01:12	98.46	98.44
MH-546	MH-547	102.009	101.183	104.84	104.04	375	99.5	0.8	0.013	1.42	0.16	0.04	0.24	-0.25	01:13	102.14	101.43
MH-547	MH-548	101.183	100.223	104.04	103.13	375	60.0	1.6	0.013	1.98	0.22	0.17	0.77	-0.13	01:10	101.43	100.74
MH-548	MH-549	100.223	99.898	103.13	102.8	375	29.5	1.0	0.013	1.59	0.18	0.19	1.11	0.14	01:10	100.74	100.32
MH-549	MH-550	99.898	99.618	102.8	102.64	375	12.5	1.0	0.013	1.59	0.18	0.19	1.11	0.05	01:10	100.32	99.94
MH-550	MH-551	99.618	97.862	102.64	100.93	525	112.0	1.6	0.013	2.47	0.54	0.36	0.68	-0.21	01:10	99.94	98.85
MH-551	MH-559	97.862	94.699	100.93	100.39	525	52.5	1.4	0.013	2.35	0.51	0.54	1.07	0.46	01:10	98.85	96.32
MH-552	MH-553	100.139	99.064	102.99	101.99	300	64.5	1.6	0.013	1.70	0.12	0.08	0.62	-0.13	01:10	100.31	99.30
MH-553	MH-557	99.064	97.315	101.99	100.86	375	103.5	1.4	0.013	1.88	0.21	0.15	0.73	-0.14	01:10	99.30	98.02
MH-554	MH-556	99.668	98.669	102.47	101.7	300	81.5	1.0	0.013	1.33	0.09	0.01	0.13	-0.23	01:10	99.74	98.99
MH-556	MH-557	98.669	97.315	101.7	100.86	525	70.0	1.2	0.013	2.18	0.47	0.32	0.68	-0.21	01:10	98.99	98.02
MH-5560	MH-556	98.809	98.669	101.67	101.7	525	14.5	0.6	0.013	1.48	0.32	0.26	0.82	-0.01	01:10	99.33	98.99
MH-557	MH-558	97.315	97.121	100.86	100.39	675	36.5	0.4	0.013	1.57	0.56	0.67	1.19	0.03	01:10	98.02	97.74
MH-558	MH-559	97.121	94.699	100.39	100.39	675	14.5	0.4	0.013	1.57	0.56	0.67	1.19	-0.05	01:10	97.74	96.32
MH-559	MH-900	94.699	92.925	100.39	95.41	675	15.5	0.8	0.013	2.10	0.75	1.21	1.61	0.95	01:10	96.32	93.76
MH-561	MH-537	103.003	102.673	105.281	105.126	375	42.5	0.6	0.013	1.23	0.14	0.02	0.13	-0.28	01:10	103.09	103.01
MH-561	MH-563	103.003	100.82	105.281	104.305	300	61.0	2.9	0.013	2.33	0.16	0.00	0.00	-0.21	01:10	103.09	101.29
MH-562	MH-563	101.178	100.82	103.205	104.305	300	29.5	0.5	0.013	0.92	0.06	0.06	0.97	-0.01	01:10	101.47	101.29
MH-563	MH-564	100.82	100.643	104.305	103.985	525	73.5	0.2	0.013	0.89	0.19	0.24	1.24	-0.06	01:10	101.29	101.00
MH-564	MH-8500	100.643	99.407	103.985	102.733	525	48.5	2.1	0.013	2.84	0.62	0.37	0.59	-0.17	01:10	101.00	99.70
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.00	0.00	-0.75	00:00	101.11	99.70
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	0.36	0.32	-0.46	01:10	99.70	97.64
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	0.36	0.28	-0.48	01:10	97.64	95.78
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	0.36	0.29	-0.47	01:11	95.78	93.76
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.45	0.54	-0.82	01:11	93.76	92.48
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	3.89	0.64	-0.69	01:11	92.48	91.02
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	4.29	0.38	-1.26	01:12	91.02	90.69

Table C1A: Pipe Data and Hydraulic Simulation Results - 100-Year Chicago 3 Hour Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	4.68	0.58	-1.11	01:12	90.69	90.33
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	4.75	0.42	-1.39	01:13	90.33	90.30
OGS_1	OGS_1-Out	96.037	96.015	100.5	100.35	750	4.9	0.2	0.013	1.14	0.50	1.01	2.01	0.78	01:01	97.57	97.19
OGS_1-Out	MH_3112	96.015	96.01	100.35	100.35	2250	6.2	0.1	0.013	1.63	6.49	6.01	0.93	-1.08	01:14	97.19	97.17
OGS_2	OGS_2-Out	96.026	96.004	100.428	100.35	750	5.1	0.2	0.013	1.12	0.49	1.01	2.03	0.54	01:38	97.32	96.95
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.45	0.54	-0.82	01:11	93.76	92.48
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	0.36	0.32	-0.46	01:10	99.70	97.64
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.00	0.00	-0.75	00:00	101.11	99.70
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	0.36	0.28	-0.48	01:10	97.64	95.78
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	0.36	0.29	-0.47	01:11	95.78	93.76
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.45	0.54	-0.82	01:11	93.76	92.48
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	3.89	0.64	-0.69	01:11	92.48	91.02
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	4.29	0.38	-1.26	01:12	91.02	90.69
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	4.68	0.58	-1.11	01:12	90.69	90.33
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	4.75	0.42	-1.39	01:13	90.33	90.30

Table C1B: USF Freeboard Results - 100-Year Chicago 3 Hour Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-531	MH-313	76-2	98.43	4.8	21.5	97.74	97.60	97.63	0.80
MH-531	MH-313	76-1	98.43	9.6	21.5	97.74	97.60	97.66	0.77
MH-500	MH-502	146-6	102.89	14.2	92.0	102.97	101.25	101.52	1.37
MH-500	MH-502	146-5	102.89	22.2	92.0	102.97	101.25	101.67	1.22
MH-500	MH-502	146-4	102.89	28.8	92.0	102.97	101.25	101.79	1.10
MH-500	MH-502	146-3	102.89	36.8	92.0	102.97	101.25	101.94	0.95
MH-500	MH-502	146-2	102.89	43.4	92.0	102.97	101.25	102.06	0.83
MH-500	MH-502	146-1	102.89	51.4	92.0	102.97	101.25	102.21	0.68
MH-500	MH-502	145-5	103.05	61.4	92.0	102.97	101.25	102.40	0.65
MH-500	MH-502	145-4	103.05	69.9	92.0	102.97	101.25	102.56	0.49
MH-500	MH-502	145-3	103.55	76.0	92.0	102.97	101.25	102.67	0.88
MH-500	MH-502	145-2	103.55	84.0	92.0	102.97	101.25	102.82	0.73
MH-500	MH-502	145-1	103.55	88.9	92.0	102.97	101.25	102.91	0.64
MH-502	MH-503	148-5	101.09	38.5	119.0	101.25	99.64	100.16	0.93
MH-502	MH-503	148-4	101.09	46.5	119.0	101.25	99.64	100.27	0.82
MH-502	MH-503	148-3	101.09	53.1	119.0	101.25	99.64	100.36	0.73
MH-502	MH-503	148-2	101.09	61.1	119.0	101.25	99.64	100.47	0.62
MH-502	MH-503	148-1	101.44	68.4	119.0	101.25	99.64	100.57	0.87
MH-502	MH-503	147-6	101.65	78.4	119.0	101.25	99.64	100.70	0.95
MH-502	MH-503	147-5	101.65	86.4	119.0	101.25	99.64	100.81	0.84
MH-502	MH-503	147-4	102.03	94.4	119.0	101.25	99.64	100.92	1.11
MH-502	MH-503	147-3	102.03	101.0	119.0	101.25	99.64	101.01	1.02
MH-502	MH-503	147-2	102.66	107.6	119.0	101.25	99.64	101.10	1.56
MH-502	MH-503	147-1	102.66	115.6	119.0	101.25	99.64	101.20	1.46
MH-503	MH-504	150-3	100.3	1.3	73.0	99.64	99.14	99.15	1.15
MH-503	MH-504	156-4	100.04	2.7	73.0	99.64	99.14	99.16	0.88
MH-503	MH-504	150-2	100.3	6.3	73.0	99.64	99.14	99.19	1.11
MH-503	MH-504	156-5	100.04	10.0	73.0	99.64	99.14	99.21	0.83
MH-503	MH-504	150-1	100.3	14.3	73.0	99.64	99.14	99.24	1.06
MH-503	MH-504	157-1	100.3	20.0	73.0	99.64	99.14	99.28	1.02
MH-503	MH-504	149-5	100.7	24.3	73.0	99.64	99.14	99.31	1.39
MH-503	MH-504	157-2	100.3	28.0	73.0	99.64	99.14	99.33	0.97
MH-503	MH-504	149-4	100.7	32.3	73.0	99.64	99.14	99.36	1.34
MH-503	MH-504	157-3	100.3	34.6	73.0	99.64	99.14	99.38	0.92
MH-503	MH-504	149-3	100.7	38.9	73.0	99.64	99.14	99.41	1.29
MH-503	MH-504	157-4	100.3	42.6	73.0	99.64	99.14	99.43	0.87
MH-503	MH-504	149-2	100.7	46.9	73.0	99.64	99.14	99.46	1.24
MH-503	MH-504	157-5	100.3	49.9	73.0	99.64	99.14	99.48	0.82
MH-503	MH-504	149-1	100.7	54.3	73.0	99.64	99.14	99.51	1.19
MH-503	MH-504	158-1	100.48	59.8	73.0	99.64	99.14	99.55	0.93
MH-503	MH-504	158-2	100.48	67.8	73.0	99.64	99.14	99.61	0.87
MH-503	MH-504	158-3	100.48	71.4	73.0	99.64	99.14	99.63	0.85
MH-504	MH-528	154-1	99.24	15.6	108.0	99.14	98.37	98.48	0.76
MH-504	MH-528	153-3	99.92	16.5	108.0	99.14	98.37	98.48	1.44
MH-504	MH-528	154-2	99.24	23.6	108.0	99.14	98.37	98.54	0.70
MH-504	MH-528	153-2	99.92	24.5	108.0	99.14	98.37	98.54	1.38
MH-504	MH-528	154-3	99.24	30.2	108.0	99.14	98.37	98.58	0.66
MH-504	MH-528	153-1	99.92	31.8	108.0	99.14	98.37	98.59	1.33
MH-504	MH-528	154-4	99.24	38.2	108.0	99.14	98.37	98.64	0.60
MH-504	MH-528	152-3	99.92	41.8	108.0	99.14	98.37	98.67	1.25
MH-504	MH-528	155-1	99.28	48.2	108.0	99.14	98.37	98.71	0.57
MH-504	MH-528	152-2	99.92	49.8	108.0	99.14	98.37	98.72	1.20
MH-504	MH-528	155-2	99.28	56.2	108.0	99.14	98.37	98.77	0.51
MH-504	MH-528	152-1	99.92	57.1	108.0	99.14	98.37	98.78	1.14
MH-504	MH-528	155-3	99.59	62.8	108.0	99.14	98.37	98.82	0.77
MH-504	MH-528	151-4	99.96	67.1	108.0	99.14	98.37	98.85	1.11
MH-504	MH-528	155-4	99.59	70.8	108.0	99.14	98.37	98.88	0.71
MH-504	MH-528	151-3	99.96	75.1	108.0	99.14	98.37	98.91	1.05
MH-504	MH-528	155-5	99.59	78.1	108.0	99.14	98.37	98.93	0.66
MH-504	MH-528	151-2	99.96	81.7	108.0	99.14	98.37	98.95	1.01
MH-504	MH-528	156-1	99.73	88.1	108.0	99.14	98.37	99.00	0.73
MH-504	MH-528	151-1	100.04	89.7	108.0	99.14	98.37	99.01	1.03
MH-504	MH-528	156-2	99.73	96.1	108.0	99.14	98.37	99.06	0.67
MH-504	MH-528	150-4	100.3	99.7	108.0	99.14	98.37	99.08	1.22
MH-504	MH-528	156-3	100.04	102.7	108.0	99.14	98.37	99.10	0.94
MH-505	MH-506	92-3	104.3	2.5	13.0	103.56	103.67	103.65	0.65
MH-505	MH-506	92-2	104.3	6.8	13.0	103.56	103.67	103.61	0.69
MH-505	MH-506	92-1	104.3	11.3	13.0	103.56	103.67	103.57	0.73
MH-505	MH-534	99-7	104.61	3.7	94.5	103.56	103.22	103.24	1.37
MH-505	MH-534	95-5	103.94	6.8	94.5	103.56	103.22	103.25	0.69
MH-505	MH-534	99-6	104.67	11.7	94.5	103.56	103.22	103.26	1.41
MH-505	MH-534	94-1	104.13	17.4	94.5	103.56	103.22	103.28	0.85
MH-505	MH-534	99-5	104.86	17.9	94.5	103.56	103.22	103.29	1.57
MH-505	MH-534	94-2	104.13	25.4	94.5	103.56	103.22	103.31	0.82
MH-505	MH-534	100-6	104.86	25.7	94.5	103.56	103.22	103.31	1.55
MH-505	MH-534	94-3	104.13	32.7	94.5	103.56	103.22	103.34	0.79
MH-505	MH-534	100-5	104.78	33.7	94.5	103.56	103.22	103.34	1.44
MH-505	MH-534	100-4	104.97	38.3	94.5	103.56	103.22	103.36	1.61
MH-505	MH-534	94-4	104.13	40.7	94.5	103.56	103.22	103.37	0.76

Table C1B: USF Freeboard Results - 100-Year Chicago 3 Hour Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-505	MH-534	101-6	104.97	47.7	94.5	103.56	103.22	103.39	1.58
MH-505	MH-534	94-5	104.13	48.3	94.5	103.56	103.22	103.39	0.74
MH-505	MH-534	101-5	104.86	53.9	94.5	103.56	103.22	103.41	1.45
MH-505	MH-534	93-1	104.3	58.9	94.5	103.56	103.22	103.43	0.87
MH-505	MH-534	101-4	105.08	61.9	94.5	103.56	103.22	103.44	1.64
MH-505	MH-534	93-2	104.3	66.9	94.5	103.56	103.22	103.46	0.84
MH-505	MH-534	102-6	105.11	71.3	94.5	103.56	103.22	103.48	1.63
MH-505	MH-534	93-3	104.3	74.2	94.5	103.56	103.22	103.49	0.81
MH-505	MH-534	102-5	105.11	75.9	94.5	103.56	103.22	103.49	1.62
MH-505	MH-534	93-4	104.3	82.2	94.5	103.56	103.22	103.51	0.79
MH-505	MH-534	102-4	105.11	83.9	94.5	103.56	103.22	103.52	1.59
MH-505	MH-534	93-5	104.3	89.8	94.5	103.56	103.22	103.54	0.76
MH-506	MH-508	89-1	103.74	7.2	79.0	103.67	103.41	103.44	0.30
MH-506	MH-508	90-3	104.04	27.0	79.0	103.67	103.41	103.50	0.54
MH-506	MH-508	90-2	104.04	34.6	79.0	103.67	103.41	103.53	0.51
MH-506	MH-508	90-1	104.04	42.6	79.0	103.67	103.41	103.55	0.49
MH-506	MH-508	91-4	104.23	53.2	79.0	103.67	103.41	103.59	0.64
MH-506	MH-508	91-3	104.23	61.2	79.0	103.67	103.41	103.61	0.62
MH-506	MH-508	91-2	104.23	68.5	79.0	103.67	103.41	103.64	0.59
MH-506	MH-508	91-1	104.23	76.5	79.0	103.67	103.41	103.66	0.57
MH-5070	MH-513	99-2	104.61	0.1	82.0	103.66	103.42	103.42	1.19
MH-5070	MH-513	105-6	104.46	8.2	82.0	103.66	103.42	103.45	1.01
MH-5070	MH-513	99-3	104.67	8.4	82.0	103.66	103.42	103.45	1.22
MH-5070	MH-513	105-5	104.46	12.8	82.0	103.66	103.42	103.46	1.00
MH-5070	MH-513	99-4	104.86	14.3	82.0	103.66	103.42	103.47	1.39
MH-5070	MH-513	105-4	104.46	20.8	82.0	103.66	103.42	103.48	0.98
MH-5070	MH-513	100-1	104.86	22.1	82.0	103.66	103.42	103.49	1.37
MH-5070	MH-513	100-2	104.78	30.1	82.0	103.66	103.42	103.51	1.27
MH-5070	MH-513	104-8	104.6	30.2	82.0	103.66	103.42	103.51	1.09
MH-5070	MH-513	100-3	104.97	34.7	82.0	103.66	103.42	103.52	1.45
MH-5070	MH-513	104-7	104.6	34.8	82.0	103.66	103.42	103.52	1.08
MH-5070	MH-513	104-6	104.6	42.8	82.0	103.66	103.42	103.55	1.05
MH-5070	MH-513	101-1	104.97	44.1	82.0	103.66	103.42	103.55	1.42
MH-5070	MH-513	104-5	104.6	49.0	82.0	103.66	103.42	103.57	1.03
MH-5070	MH-513	101-2	104.86	50.3	82.0	103.66	103.42	103.57	1.29
MH-5070	MH-513	101-3	105.08	58.3	82.0	103.66	103.42	103.59	1.49
MH-5070	MH-513	103-8	104.79	58.4	82.0	103.66	103.42	103.59	1.20
MH-5070	MH-513	103-7	104.79	63.0	82.0	103.66	103.42	103.61	1.18
MH-5070	MH-513	102-1	105.11	67.7	82.0	103.66	103.42	103.62	1.49
MH-5070	MH-513	103-6	104.79	71.0	82.0	103.66	103.42	103.63	1.16
MH-5070	MH-513	102-2	105.11	72.3	82.0	103.66	103.42	103.63	1.48
MH-5070	MH-513	103-5	104.79	77.2	82.0	103.66	103.42	103.65	1.14
MH-5070	MH-513	102-3	105.11	80.3	82.0	103.66	103.42	103.66	1.45
MH-508	MH-509	88-3	103.73	6.6	41.5	103.41	103.14	103.18	0.55
MH-508	MH-509	88-2	103.73	14.2	41.5	103.41	103.14	103.23	0.50
MH-508	MH-509	88-1	103.73	22.2	41.5	103.41	103.14	103.29	0.44
MH-508	MH-509	89-3	103.74	32.8	41.5	103.41	103.14	103.36	0.38
MH-508	MH-509	89-2	103.74	40.4	41.5	103.41	103.14	103.41	0.33
MH-5080	MH-517	105-1	104.46	6.2	76.5	103.19	103.02	103.04	1.42
MH-5080	MH-517	111-6	104.04	7.8	76.5	103.19	103.02	103.04	1.00
MH-5080	MH-517	105-2	104.46	10.7	76.5	103.19	103.02	103.05	1.41
MH-5080	MH-517	111-5	104.35	14.0	76.5	103.19	103.02	103.05	1.30
MH-5080	MH-517	105-3	104.46	18.7	76.5	103.19	103.02	103.06	1.40
MH-5080	MH-517	112-8	104.49	23.4	76.5	103.19	103.02	103.07	1.42
MH-5080	MH-517	112-7	104.49	28.0	76.5	103.19	103.02	103.08	1.41
MH-5080	MH-517	104-1	104.6	28.1	76.5	103.19	103.02	103.08	1.52
MH-5080	MH-517	104-2	104.6	32.7	76.5	103.19	103.02	103.09	1.51
MH-5080	MH-517	112-6	104.49	36.0	76.5	103.19	103.02	103.10	1.39
MH-5080	MH-517	104-3	104.6	40.7	76.5	103.19	103.02	103.11	1.49
MH-5080	MH-517	112-5	104.49	42.2	76.5	103.19	103.02	103.11	1.38
MH-5080	MH-517	104-4	104.6	46.9	76.5	103.19	103.02	103.12	1.48
MH-5080	MH-517	113-8	104.59	51.6	76.5	103.19	103.02	103.13	1.46
MH-5080	MH-517	113-7	104.59	56.2	76.5	103.19	103.02	103.14	1.45
MH-5080	MH-517	103-1	104.79	56.3	76.5	103.19	103.02	103.14	1.65
MH-5080	MH-517	103-2	104.79	60.9	76.5	103.19	103.02	103.15	1.64
MH-5080	MH-517	113-6	104.59	64.2	76.5	103.19	103.02	103.16	1.43
MH-5080	MH-517	103-3	104.79	68.9	76.5	103.19	103.02	103.17	1.62
MH-5080	MH-517	113-5	104.59	70.4	76.5	103.19	103.02	103.17	1.42
MH-5080	MH-517	103-4	104.79	75.1	76.5	103.19	103.02	103.18	1.61
MH-509	MH-510	87-3	103.63	2.0	10.5	103.14	102.93	102.97	0.66
MH-509	MH-510	87-2	103.63	5.6	10.5	103.14	102.93	103.04	0.59
MH-509	MH-510	87-1	103.63	9.4	10.5	103.14	102.93	103.12	0.51
MH-510	MH-511	85-4	103.36	4.3	64.0	102.93	102.31	102.35	1.01
MH-510	MH-511	112-1	104.49	9.4	64.0	102.93	102.31	102.40	2.09
MH-510	MH-511	85-3	103.36	12.3	64.0	102.93	102.31	102.43	0.93
MH-510	MH-511	112-2	104.49	14.0	64.0	102.93	102.31	102.44	2.05
MH-510	MH-511	85-2	103.36	19.5	64.0	102.93	102.31	102.50	0.86
MH-510	MH-511	112-3	104.49	22.0	64.0	102.93	102.31	102.52	1.97
MH-510	MH-511	85-1	103.36	27.5	64.0	102.93	102.31	102.57	0.79

Table C1B: USF Freeboard Results - 100-Year Chicago 3 Hour Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-510	MH-511	112-4	104.49	28.2	64.0	102.93	102.31	102.58	1.91
MH-510	MH-511	113-1	104.59	37.6	64.0	102.93	102.31	102.67	1.92
MH-510	MH-511	86-3	103.5	38.1	64.0	102.93	102.31	102.68	0.82
MH-510	MH-511	113-2	104.59	42.2	64.0	102.93	102.31	102.72	1.87
MH-510	MH-511	86-2	103.5	45.8	64.0	102.93	102.31	102.75	0.75
MH-510	MH-511	113-3	104.59	50.2	64.0	102.93	102.31	102.79	1.80
MH-510	MH-511	86-1	103.5	53.8	64.0	102.93	102.31	102.83	0.67
MH-510	MH-511	113-4	104.59	56.4	64.0	102.93	102.31	102.85	1.74
MH-511	MH-526	82-3	101.52	20.9	95.5	102.31	100.33	100.76	0.76
MH-511	MH-526	109-2	102.17	26.4	95.5	102.31	100.33	100.88	1.29
MH-511	MH-526	82-2	101.52	28.9	95.5	102.31	100.33	100.93	0.59
MH-511	MH-526	109-3	102.32	30.8	95.5	102.31	100.33	100.97	1.35
MH-511	MH-526	82-1	101.52	36.5	95.5	102.31	100.33	101.09	0.43
MH-511	MH-526	109-4	102.78	38.8	95.5	102.31	100.33	101.13	1.65
MH-511	MH-526	83-3	101.63	47.1	95.5	102.31	100.33	101.31	0.32
MH-511	MH-526	110-1	102.91	48.2	95.5	102.31	100.33	101.33	1.58
MH-511	MH-526	110-2	103.09	52.8	95.5	102.31	100.33	101.42	1.67
MH-511	MH-526	83-2	102.27	54.7	95.5	102.31	100.33	101.46	0.81
MH-511	MH-526	110-3	103.34	60.8	95.5	102.31	100.33	101.59	1.75
MH-511	MH-526	83-1	102.27	62.7	95.5	102.31	100.33	101.63	0.64
MH-511	MH-526	110-4	103.77	67.0	95.5	102.31	100.33	101.72	2.05
MH-511	MH-526	84-3	102.46	73.4	95.5	102.31	100.33	101.85	0.61
MH-511	MH-526	111-1	103.89	76.4	95.5	102.31	100.33	101.91	1.98
MH-511	MH-526	111-2	103.98	81.0	95.5	102.31	100.33	102.01	1.97
MH-511	MH-526	84-2	103.15	81.0	95.5	102.31	100.33	102.01	1.14
MH-511	MH-526	84-1	103.15	88.9	95.5	102.31	100.33	102.17	0.98
MH-511	MH-526	111-3	104.04	89.1	95.5	102.31	100.33	102.17	1.87
MH-511	MH-526	111-4	104.35	95.3	95.5	102.31	100.33	102.30	2.05
MH-513	MH-515	108-6	102.64	21.6	81.0	103.42	100.72	101.44	1.20
MH-513	MH-515	97-2	102.99	26.5	81.0	103.42	100.72	101.61	1.38
MH-513	MH-515	108-5	102.57	29.6	81.0	103.42	100.72	101.71	0.86
MH-513	MH-515	97-3	103.15	30.9	81.0	103.42	100.72	101.75	1.40
MH-513	MH-515	108-4	102.98	35.8	81.0	103.42	100.72	101.92	1.06
MH-513	MH-515	97-4	103.6	38.9	81.0	103.42	100.72	102.02	1.58
MH-513	MH-515	107-6	103.11	45.2	81.0	103.42	100.72	102.23	0.88
MH-513	MH-515	98-1	103.73	48.3	81.0	103.42	100.72	102.33	1.40
MH-513	MH-515	107-5	103.33	49.8	81.0	103.42	100.72	102.38	0.95
MH-513	MH-515	98-2	103.92	52.9	81.0	103.42	100.72	102.49	1.43
MH-513	MH-515	107-4	103.75	56.2	81.0	103.42	100.72	102.60	1.15
MH-513	MH-515	98-3	104.16	60.9	81.0	103.42	100.72	102.75	1.41
MH-513	MH-515	106-6	103.85	65.6	81.0	103.42	100.72	102.91	0.94
MH-513	MH-515	98-4	104.59	67.1	81.0	103.42	100.72	102.96	1.63
MH-513	MH-515	106-5	104.08	73.6	81.0	103.42	100.72	103.18	0.90
MH-513	MH-515	99-1	104.61	76.5	81.0	103.42	100.72	103.27	1.34
MH-513	MH-515	106-4	104.34	79.8	81.0	103.42	100.72	103.38	0.96
MH-515	MH-518	114-5	101.66	3.6	44.0	100.72	100.51	100.53	1.13
MH-515	MH-518	115-1	101.78	14.3	44.0	100.72	100.51	100.58	1.20
MH-515	MH-518	115-2	102.22	21.9	44.0	100.72	100.51	100.62	1.60
MH-515	MH-518	115-3	102.22	29.9	44.0	100.72	100.51	100.65	1.57
MH-515	MH-518	115-4	102.22	37.1	44.0	100.72	100.51	100.69	1.53
MH-517	MH-518	109-8	102.23	19.4	82.0	103.02	100.51	101.11	1.12
MH-517	MH-518	108-1	102.64	20.7	82.0	103.02	100.51	101.15	1.49
MH-517	MH-518	109-7	102.17	27.4	82.0	103.02	100.51	101.35	0.82
MH-517	MH-518	108-2	102.57	28.7	82.0	103.02	100.51	101.39	1.18
MH-517	MH-518	109-6	102.32	31.8	82.0	103.02	100.51	101.49	0.83
MH-517	MH-518	108-3	102.98	34.9	82.0	103.02	100.51	101.58	1.40
MH-517	MH-518	109-5	102.78	39.8	82.0	103.02	100.51	101.73	1.05
MH-517	MH-518	107-1	103.11	44.3	82.0	103.02	100.51	101.87	1.24
MH-517	MH-518	107-2	103.33	48.9	82.0	103.02	100.51	102.01	1.32
MH-517	MH-518	110-8	102.91	49.2	82.0	103.02	100.51	102.02	0.89
MH-517	MH-518	110-7	103.09	53.8	82.0	103.02	100.51	102.16	0.93
MH-517	MH-518	107-3	103.75	55.3	82.0	103.02	100.51	102.21	1.54
MH-517	MH-518	110-6	103.34	61.8	82.0	103.02	100.51	102.41	0.93
MH-517	MH-518	106-1	103.85	64.7	82.0	103.02	100.51	102.49	1.36
MH-517	MH-518	110-5	103.77	68.0	82.0	103.02	100.51	102.60	1.17
MH-517	MH-518	106-2	104.08	72.7	82.0	103.02	100.51	102.74	1.34
MH-517	MH-518	111-8	103.89	77.4	82.0	103.02	100.51	102.88	1.01
MH-517	MH-518	106-3	104.34	78.9	82.0	103.02	100.51	102.93	1.41
MH-517	MH-518	111-7	103.98	82.0	82.0	103.02	100.51	103.02	0.96
MH-518	MH-526	114-1	101.36	19.7	47.0	100.51	100.33	100.41	0.95
MH-518	MH-526	114-2	101.66	27.3	47.0	100.51	100.33	100.44	1.22
MH-518	MH-526	114-3	101.66	35.3	47.0	100.51	100.33	100.47	1.19
MH-518	MH-526	114-4	101.66	42.5	47.0	100.51	100.33	100.50	1.16
MH-519	MH-520	129-3	104.07	4.0	54.5	103.48	103.41	103.41	0.66
MH-519	MH-520	138-1	104.08	5.4	54.5	103.48	103.41	103.41	0.67
MH-519	MH-520	129-2	104.07	12.0	54.5	103.48	103.41	103.42	0.65
MH-519	MH-520	138-2	104.08	13.0	54.5	103.48	103.41	103.42	0.66
MH-519	MH-520	129-1	104.07	19.6	54.5	103.48	103.41	103.43	0.64
MH-519	MH-520	138-3	104.08	21.0	54.5	103.48	103.41	103.43	0.65

Table C1B: USF Freeboard Results - 100-Year Chicago 3 Hour Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-519	MH-520	128-3	104.09	30.2	54.5	103.48	103.41	103.45	0.64
MH-519	MH-520	139-1	104.23	31.6	54.5	103.48	103.41	103.45	0.78
MH-519	MH-520	128-2	104.09	38.2	54.5	103.48	103.41	103.46	0.63
MH-519	MH-520	139-2	104.23	39.2	54.5	103.48	103.41	103.46	0.77
MH-519	MH-520	128-1	104.09	45.8	54.5	103.48	103.41	103.46	0.63
MH-519	MH-520	139-3	104.23	47.2	54.5	103.48	103.41	103.47	0.76
MH-519	MH-523	140-3	104.25	2.3	11.5	103.48	103.32	103.35	0.90
MH-519	MH-523	140-2	104.25	7.0	11.5	103.48	103.32	103.42	0.83
MH-519	MH-523	140-1	104.25	10.5	11.5	103.48	103.32	103.46	0.79
MH-520	MH-521	136-1	103.94	3.7	57.5	103.41	103.12	103.14	0.80
MH-520	MH-521	131-3	103.81	8.8	57.5	103.41	103.12	103.16	0.65
MH-520	MH-521	136-2	103.94	11.4	57.5	103.41	103.12	103.18	0.76
MH-520	MH-521	131-2	103.81	16.8	57.5	103.41	103.12	103.20	0.61
MH-520	MH-521	136-3	103.94	19.4	57.5	103.41	103.12	103.22	0.72
MH-520	MH-521	131-1	103.81	24.5	57.5	103.41	103.12	103.24	0.57
MH-520	MH-521	137-1	103.94	30.0	57.5	103.41	103.12	103.27	0.67
MH-520	MH-521	130-3	103.94	35.1	57.5	103.41	103.12	103.29	0.65
MH-520	MH-521	137-2	103.94	37.6	57.5	103.41	103.12	103.31	0.63
MH-520	MH-521	130-2	103.94	43.1	57.5	103.41	103.12	103.33	0.61
MH-520	MH-521	137-3	103.94	45.6	57.5	103.41	103.12	103.35	0.59
MH-520	MH-521	130-1	103.94	50.7	57.5	103.41	103.12	103.37	0.57
MH-521	MH-522	135-1	103.67	1.0	11.5	103.12	102.94	102.95	0.72
MH-521	MH-522	135-2	103.67	5.3	11.5	103.12	102.94	103.02	0.65
MH-521	MH-522	135-3	103.67	9.5	11.5	103.12	102.94	103.09	0.58
MH-522	MH-525	133-3	102.71	7.1	55.0	102.94	101.07	101.31	1.40
MH-522	MH-525	133-4	103.1	14.4	55.0	102.94	101.07	101.56	1.54
MH-522	MH-525	133-5	103.1	22.4	55.0	102.94	101.07	101.83	1.27
MH-522	MH-525	134-1	103.55	32.9	55.0	102.94	101.07	102.19	1.36
MH-522	MH-525	134-2	103.55	40.6	55.0	102.94	101.07	102.45	1.10
MH-522	MH-525	134-3	103.55	48.6	55.0	102.94	101.07	102.72	0.83
MH-523	MH-524	141-5	103.68	20.5	55.0	103.32	102.49	102.80	0.88
MH-523	MH-524	141-4	103.68	28.5	55.0	103.32	102.49	102.92	0.76
MH-523	MH-524	141-3	104.25	35.7	55.0	103.32	102.49	103.03	1.22
MH-523	MH-524	141-2	104.25	43.7	55.0	103.32	102.49	103.15	1.10
MH-523	MH-524	141-1	104.25	51.3	55.0	103.32	102.49	103.27	0.98
MH-524	MH-5240	126-1	103.57	5.3	65.0	102.49	102.20	102.22	1.35
MH-524	MH-5240	122-4	103.32	5.6	65.0	102.49	102.20	102.22	1.10
MH-524	MH-5240	126-2	103.57	13.3	65.0	102.49	102.20	102.26	1.31
MH-524	MH-5240	122-3	103.32	13.6	65.0	102.49	102.20	102.26	1.06
MH-524	MH-5240	122-2	103.32	20.9	65.0	102.49	102.20	102.29	1.03
MH-524	MH-5240	126-3	103.57	20.9	65.0	102.49	102.20	102.29	1.28
MH-524	MH-5240	122-1	103.32	28.9	65.0	102.49	102.20	102.33	0.99
MH-524	MH-5240	127-1	103.57	31.6	65.0	102.49	102.20	102.34	1.23
MH-524	MH-5240	121-3	103.45	39.5	65.0	102.49	102.20	102.37	1.08
MH-524	MH-5240	127-2	103.57	39.6	65.0	102.49	102.20	102.37	1.20
MH-524	MH-5240	121-2	103.45	47.1	65.0	102.49	102.20	102.41	1.04
MH-524	MH-5240	127-3	103.57	47.2	65.0	102.49	102.20	102.41	1.16
MH-524	MH-5240	121-1	103.45	55.1	65.0	102.49	102.20	102.44	1.01
MH-5240	MH-525	124-1	102.67	16.1	63.5	102.20	101.07	101.36	1.31
MH-5240	MH-525	123-5	102.2	19.8	63.5	102.20	101.07	101.42	0.78
MH-5240	MH-525	124-2	102.67	24.1	63.5	102.20	101.07	101.50	1.17
MH-5240	MH-525	123-4	102.74	27.4	63.5	102.20	101.07	101.56	1.18
MH-5240	MH-525	124-3	102.67	31.7	63.5	102.20	101.07	101.63	1.04
MH-5240	MH-525	123-3	102.74	35.4	63.5	102.20	101.07	101.70	1.04
MH-5240	MH-525	125-1	103.28	42.3	63.5	102.20	101.07	101.82	1.46
MH-5240	MH-525	123-2	103.08	42.6	63.5	102.20	101.07	101.83	1.25
MH-5240	MH-525	125-2	103.28	50.3	63.5	102.20	101.07	101.96	1.32
MH-5240	MH-525	123-1	103.08	50.6	63.5	102.20	101.07	101.97	1.11
MH-5240	MH-525	125-3	103.28	58.0	63.5	102.20	101.07	102.10	1.18
MH-5240	MH-525	122-5	103.32	61.3	63.5	102.20	101.07	102.16	1.16
MH-52400	MH-538	119-1	102.26	15.8	58.0	102.25	101.17	101.47	0.79
MH-52400	MH-538	119-2	102.26	23.8	58.0	102.25	101.17	101.61	0.65
MH-52400	MH-538	119-3	102.65	31.4	58.0	102.25	101.17	101.75	0.90
MH-52400	MH-538	120-1	103.45	42.1	58.0	102.25	101.17	101.95	1.50
MH-52400	MH-538	120-2	103.45	50.1	58.0	102.25	101.17	102.10	1.35
MH-52400	MH-538	120-3	103.45	57.4	58.0	102.25	101.17	102.23	1.22
MH-525	MH-526	132-1	101.26	15.8	58.5	101.07	100.33	100.53	0.73
MH-525	MH-526	132-2	101.26	23.8	58.5	101.07	100.33	100.63	0.63
MH-525	MH-526	132-3	101.65	31.0	58.5	101.07	100.33	100.72	0.93
MH-525	MH-526	132-4	101.65	39.0	58.5	101.07	100.33	100.82	0.83
MH-525	MH-526	133-1	101.85	49.7	58.5	101.07	100.33	100.96	0.89
MH-525	MH-526	133-2	102.71	57.3	58.5	101.07	100.33	101.05	1.66
MH-528	MH-529	5	101.37	6.6	62.5	98.37	98.10	98.13	3.24
MH-528	MH-529	81-1	98.72	9.8	62.5	98.37	98.10	98.14	0.58
MH-528	MH-529	4	101.37	12.7	62.5	98.37	98.10	98.15	3.22
MH-528	MH-529	81-2	98.72	17.8	62.5	98.37	98.10	98.17	0.55
MH-528	MH-529	81-3	98.72	25.0	62.5	98.37	98.10	98.21	0.51
MH-528	MH-529	3	101.37	25.5	62.5	98.37	98.10	98.21	3.16
MH-528	MH-529	2	101.42	31.6	62.5	98.37	98.10	98.23	3.19

Table C1B: USF Freeboard Results - 100-Year Chicago 3 Hour Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-528	MH-529	81-4	98.72	33.0	62.5	98.37	98.10	98.24	0.48
MH-528	MH-529	81-5	99.3	40.6	62.5	98.37	98.10	98.27	1.03
MH-528	MH-529	1	101.42	41.7	62.5	98.37	98.10	98.28	3.14
MH-529	MH-530	13	101.13	3.2	72.0	98.10	97.96	97.97	3.16
MH-529	MH-530	79-1	98.62	6.4	72.0	98.10	97.96	97.97	0.65
MH-529	MH-530	12	101.13	9.2	72.0	98.10	97.96	97.98	3.15
MH-529	MH-530	79-2	98.62	14.4	72.0	98.10	97.96	97.99	0.63
MH-529	MH-530	79-3	98.62	21.7	72.0	98.10	97.96	98.00	0.62
MH-529	MH-530	11	101.13	22.0	72.0	98.10	97.96	98.00	3.13
MH-529	MH-530	10	101.13	28.1	72.0	98.10	97.96	98.01	3.12
MH-529	MH-530	79-4	98.62	29.7	72.0	98.10	97.96	98.02	0.60
MH-529	MH-530	80-1	98.72	40.3	72.0	98.10	97.96	98.04	0.68
MH-529	MH-530	9	101.22	40.9	72.0	98.10	97.96	98.04	3.18
MH-529	MH-530	8	101.32	47.0	72.0	98.10	97.96	98.05	3.27
MH-529	MH-530	80-2	98.72	48.3	72.0	98.10	97.96	98.05	0.67
MH-529	MH-530	80-3	98.72	55.6	72.0	98.10	97.96	98.07	0.65
MH-529	MH-530	7	101.37	59.8	72.0	98.10	97.96	98.08	3.29
MH-529	MH-530	80-4	98.72	63.6	72.0	98.10	97.96	98.08	0.64
MH-529	MH-530	6	101.37	65.9	72.0	98.10	97.96	98.09	3.28
MH-529	MH-530	80-5	98.72	70.1	72.0	98.10	97.96	98.10	0.62
MH-530	MH-531	76-3	98.43	3.0	76.5	97.96	97.74	97.74	0.69
MH-530	MH-531	77-1	98.55	5.8	76.5	97.96	97.74	97.75	0.80
MH-530	MH-531	77-2	98.55	13.8	76.5	97.96	97.74	97.78	0.77
MH-530	MH-531	77-3	98.55	21.0	76.5	97.96	97.74	97.80	0.75
MH-530	MH-531	77-4	98.55	29.0	76.5	97.96	97.74	97.82	0.73
MH-530	MH-531	18	101.07	29.6	76.5	97.96	97.74	97.82	3.25
MH-530	MH-531	78-1	98.58	39.6	76.5	97.96	97.74	97.85	0.73
MH-530	MH-531	17	101.11	42.4	76.5	97.96	97.74	97.86	3.25
MH-530	MH-531	78-2	98.58	47.6	76.5	97.96	97.74	97.88	0.70
MH-530	MH-531	16	101.13	48.5	76.5	97.96	97.74	97.88	3.25
MH-530	MH-531	78-3	98.58	54.9	76.5	97.96	97.74	97.90	0.68
MH-530	MH-531	15	101.13	61.3	76.5	97.96	97.74	97.92	3.21
MH-530	MH-531	78-4	98.58	62.9	76.5	97.96	97.74	97.92	0.66
MH-530	MH-531	14	101.13	67.4	76.5	97.96	97.74	97.93	3.20
MH-530	MH-531	78-5	98.58	70.5	76.5	97.96	97.74	97.94	0.64
MH-534	MH-535	97-8	102.99	19.4	78.5	103.22	100.98	101.54	1.45
MH-534	MH-535	96-1	103.02	20.3	78.5	103.22	100.98	101.56	1.46
MH-534	MH-535	97-7	102.99	27.4	78.5	103.22	100.98	101.76	1.23
MH-534	MH-535	96-2	103.02	28.3	78.5	103.22	100.98	101.79	1.23
MH-534	MH-535	97-6	103.15	31.8	78.5	103.22	100.98	101.89	1.26
MH-534	MH-535	96-3	103.42	35.5	78.5	103.22	100.98	102.00	1.42
MH-534	MH-535	97-5	103.6	39.8	78.5	103.22	100.98	102.12	1.48
MH-534	MH-535	96-4	103.42	43.5	78.5	103.22	100.98	102.22	1.20
MH-534	MH-535	98-8	103.73	49.2	78.5	103.22	100.98	102.39	1.34
MH-534	MH-535	98-7	103.92	53.8	78.5	103.22	100.98	102.52	1.40
MH-534	MH-535	95-1	103.47	54.2	78.5	103.22	100.98	102.53	0.94
MH-534	MH-535	98-6	104.16	61.8	78.5	103.22	100.98	102.75	1.41
MH-534	MH-535	95-2	103.47	62.2	78.5	103.22	100.98	102.76	0.71
MH-534	MH-535	98-5	104.59	68.0	78.5	103.22	100.98	102.92	1.67
MH-534	MH-535	95-3	103.94	69.4	78.5	103.22	100.98	102.96	0.98
MH-534	MH-535	95-4	103.94	77.4	78.5	103.22	100.98	103.19	0.75
MH-534	MH-535	99-8	104.61	77.4	78.5	103.22	100.98	103.19	1.42
MH-535	MH-515	115-5	102.22	1.2	44.0	100.98	100.72	100.73	1.49
MH-535	MH-515	116-1	102.3	11.9	44.0	100.98	100.72	100.79	1.51
MH-535	MH-515	116-2	102.3	19.5	44.0	100.98	100.72	100.84	1.46
MH-535	MH-515	116-3	102.3	27.5	44.0	100.98	100.72	100.88	1.42
MH-535	MH-515	117-1	102.4	38.1	44.0	100.98	100.72	100.95	1.45
MH-5350	MH-539	118-3	102.4	16.8	52.5	101.68	100.15	100.64	1.76
MH-5350	MH-539	118-2	102.4	24.8	52.5	101.68	100.15	100.87	1.53
MH-5350	MH-539	118-1	102.4	32.4	52.5	101.68	100.15	101.09	1.31
MH-5350	MH-539	117-3	102.4	43.1	52.5	101.68	100.15	101.40	1.00
MH-5350	MH-539	117-2	102.4	51.1	52.5	101.68	100.15	101.64	0.76
MH-536	MH-538	196-1	102.56	6.1	59.0	102.69	101.17	101.33	1.23
MH-536	MH-538	142-1	103.33	15.7	59.0	102.69	101.17	101.58	1.75
MH-536	MH-538	195-4	103.31	16.1	59.0	102.69	101.17	101.59	1.72
MH-536	MH-538	142-2	103.33	23.7	59.0	102.69	101.17	101.78	1.55
MH-536	MH-538	195-3	103.31	24.1	59.0	102.69	101.17	101.79	1.52
MH-536	MH-538	142-3	103.72	30.3	59.0	102.69	101.17	101.95	1.77
MH-536	MH-538	195-2	103.7	30.7	59.0	102.69	101.17	101.96	1.74
MH-536	MH-538	142-4	103.72	38.3	59.0	102.69	101.17	102.15	1.57
MH-536	MH-538	195-1	103.7	38.7	59.0	102.69	101.17	102.16	1.54
MH-536	MH-538	143-1	103.96	48.3	59.0	102.69	101.17	102.41	1.55
MH-536	MH-538	194-4	103.92	48.7	59.0	102.69	101.17	102.42	1.50
MH-536	MH-538	143-2	103.96	56.3	59.0	102.69	101.17	102.62	1.34
MH-536	MH-538	194-3	103.92	56.7	59.0	102.69	101.17	102.63	1.29
MH-537	MH-536	194-2	103.92	4.4	64.5	103.01	102.69	102.71	1.21
MH-537	MH-536	143-3	103.96	4.7	64.5	103.01	102.69	102.71	1.25
MH-537	MH-536	194-1	103.92	12.4	64.5	103.01	102.69	102.75	1.17
MH-537	MH-536	144-1	103.96	14.7	64.5	103.01	102.69	102.76	1.20

Table C1B: USF Freeboard Results - 100-Year Chicago 3 Hour Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-537	MH-536	193-4	103.88	22.4	64.5	103.01	102.69	102.80	1.08
MH-537	MH-536	144-2	103.96	22.7	64.5	103.01	102.69	102.80	1.16
MH-537	MH-536	144-3	103.96	29.3	64.5	103.01	102.69	102.83	1.13
MH-537	MH-536	193-3	103.88	30.4	64.5	103.01	102.69	102.84	1.04
MH-537	MH-536	193-2	103.88	37.0	64.5	103.01	102.69	102.87	1.01
MH-537	MH-536	144-4	103.96	37.3	64.5	103.01	102.69	102.87	1.09
MH-537	MH-536	144-5	103.96	44.6	64.5	103.01	102.69	102.91	1.05
MH-537	MH-536	193-1	103.88	45.0	64.5	103.01	102.69	102.91	0.97
MH-537	MH-536	192-4	103.75	55.0	64.5	103.01	102.69	102.96	0.79
MH-538	MH-539	197-3	101.08	16.5	58.5	101.17	100.15	100.44	0.64
MH-538	MH-539	197-2	101.08	24.5	58.5	101.17	100.15	100.58	0.50
MH-538	MH-539	197-1	101.42	31.8	58.5	101.17	100.15	100.71	0.71
MH-538	MH-539	196-4	102.16	41.8	58.5	101.17	100.15	100.88	1.28
MH-538	MH-539	196-3	102.16	49.8	58.5	101.17	100.15	101.02	1.14
MH-538	MH-539	196-2	102.56	56.4	58.5	101.17	100.15	101.14	1.42
MH-542	MH-543	58	103.46	5.4	53.0	100.01	99.86	99.88	3.58
MH-542	MH-543	62-5	100.72	8.9	53.0	100.01	99.86	99.89	0.83
MH-542	MH-543	62-4	100.72	16.2	53.0	100.01	99.86	99.91	0.81
MH-542	MH-543	59	103.46	18.2	53.0	100.01	99.86	99.91	3.55
MH-542	MH-543	62-3	100.72	24.2	53.0	100.01	99.86	99.93	0.79
MH-542	MH-543	60	103.42	24.3	53.0	100.01	99.86	99.93	3.49
MH-542	MH-543	62-2	100.72	30.8	53.0	100.01	99.86	99.95	0.77
MH-542	MH-543	61	103.33	37.1	53.0	100.01	99.86	99.97	3.36
MH-542	MH-543	62-1	100.72	38.8	53.0	100.01	99.86	99.97	0.75
MH-543	MH-544	66-2	100.62	3.8	118.0	99.86	98.52	98.57	2.05
MH-543	MH-544	45	103.16	4.0	118.0	99.86	98.52	98.57	4.59
MH-543	MH-544	46	103.46	10.1	118.0	99.86	98.52	98.64	4.82
MH-543	MH-544	66-1	100.62	11.8	118.0	99.86	98.52	98.66	1.96
MH-543	MH-544	65-4	100.72	21.8	118.0	99.86	98.52	98.77	1.95
MH-543	MH-544	47	103.51	22.9	118.0	99.86	98.52	98.78	4.73
MH-543	MH-544	48	103.51	29.0	118.0	99.86	98.52	98.85	4.66
MH-543	MH-544	65-3	100.72	29.8	118.0	99.86	98.52	98.86	1.86
MH-543	MH-544	65-2	100.72	36.4	118.0	99.86	98.52	98.94	1.78
MH-543	MH-544	49	103.51	41.8	118.0	99.86	98.52	99.00	4.51
MH-543	MH-544	65-1	100.72	44.4	118.0	99.86	98.52	99.03	1.69
MH-543	MH-544	50	103.51	47.9	118.0	99.86	98.52	99.07	4.44
MH-543	MH-544	64-4	100.86	54.4	118.0	99.86	98.52	99.14	1.72
MH-543	MH-544	51	103.51	60.8	118.0	99.86	98.52	99.21	4.30
MH-543	MH-544	64-3	100.86	62.4	118.0	99.86	98.52	99.23	1.63
MH-543	MH-544	52	103.51	66.9	118.0	99.86	98.52	99.28	4.23
MH-543	MH-544	64-2	100.86	69.0	118.0	99.86	98.52	99.31	1.55
MH-543	MH-544	64-1	100.86	77.0	118.0	99.86	98.52	99.40	1.46
MH-543	MH-544	53	103.57	79.7	118.0	99.86	98.52	99.43	4.14
MH-543	MH-544	54	103.61	85.8	118.0	99.86	98.52	99.50	4.11
MH-543	MH-544	63-5	100.86	87.0	118.0	99.86	98.52	99.51	1.35
MH-543	MH-544	63-4	100.86	94.3	118.0	99.86	98.52	99.59	1.27
MH-543	MH-544	55	103.59	98.6	118.0	99.86	98.52	99.64	3.95
MH-543	MH-544	63-3	100.86	102.3	118.0	99.86	98.52	99.69	1.17
MH-543	MH-544	56	103.49	104.7	118.0	99.86	98.52	99.71	3.78
MH-543	MH-544	63-2	100.86	108.9	118.0	99.86	98.52	99.76	1.10
MH-543	MH-544	63-1	100.86	116.9	118.0	99.86	98.52	99.85	1.01
MH-543	MH-544	57	103.46	117.5	118.0	99.86	98.52	99.86	3.60
MH-544	MH-5440	68-3	99.4	3.4	57.5	98.52	98.46	98.47	0.93
MH-544	MH-5440	68-2	99.4	10.7	57.5	98.52	98.46	98.47	0.93
MH-544	MH-5440	68-1	99.4	18.7	57.5	98.52	98.46	98.48	0.92
MH-544	MH-5440	67-3	99.49	28.7	57.5	98.52	98.46	98.49	1.00
MH-544	MH-5440	42	102.27	30.0	57.5	98.52	98.46	98.49	3.78
MH-544	MH-5440	67-2	100.2	36.0	57.5	98.52	98.46	98.50	1.70
MH-544	MH-5440	43	102.6	42.8	57.5	98.52	98.46	98.51	4.09
MH-544	MH-5440	67-1	100.2	44.0	57.5	98.52	98.46	98.51	1.69
MH-544	MH-5440	44	102.93	48.9	57.5	98.52	98.46	98.51	4.42
MH-544	MH-5440	66-3	100.62	54.0	57.5	98.52	98.46	98.52	2.10
MH-546	MH-547	177-1	102.31	8.8	99.5	102.14	101.43	101.50	0.81
MH-546	MH-547	177-2	102.61	16.1	99.5	102.14	101.43	101.55	1.06
MH-546	MH-547	177-3	102.61	24.1	99.5	102.14	101.43	101.60	1.01
MH-546	MH-547	178-1	102.71	34.1	99.5	102.14	101.43	101.67	1.04
MH-546	MH-547	178-2	102.71	42.1	99.5	102.14	101.43	101.73	0.98
MH-546	MH-547	178-3	103.04	48.7	99.5	102.14	101.43	101.78	1.26
MH-546	MH-547	178-4	103.04	56.7	99.5	102.14	101.43	101.84	1.20
MH-546	MH-547	179-1	103.04	66.7	99.5	102.14	101.43	101.91	1.13
MH-546	MH-547	179-2	103.4	74.0	99.5	102.14	101.43	101.96	1.44
MH-546	MH-547	179-3	103.4	82.0	99.5	102.14	101.43	102.01	1.39
MH-546	MH-547	179-4	103.4	88.6	99.5	102.14	101.43	102.06	1.34
MH-546	MH-547	179-5	103.4	96.6	99.5	102.14	101.43	102.12	1.28
MH-547	MH-548	175-1	101.33	5.2	60.0	101.43	100.74	100.80	0.53
MH-547	MH-548	175-2	101.33	13.6	60.0	101.43	100.74	100.90	0.43
MH-547	MH-548	175-3	101.64	20.2	60.0	101.43	100.74	100.98	0.66
MH-547	MH-548	175-4	101.64	28.2	60.0	101.43	100.74	101.07	0.57
MH-547	MH-548	176-1	101.82	38.2	60.0	101.43	100.74	101.18	0.64

Table C1B: USF Freeboard Results - 100-Year Chicago 3 Hour Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-547	MH-548	176-2	102.27	45.8	60.0	101.43	100.74	101.27	1.00
MH-547	MH-548	176-3	102.27	53.9	60.0	101.43	100.74	101.36	0.91
MH-548	MH-549	174-2	100.89	0.3	29.5	100.74	100.32	100.32	0.57
MH-548	MH-549	174-3	100.89	8.2	29.5	100.74	100.32	100.44	0.45
MH-548	MH-549	174-4	101.21	14.8	29.5	100.74	100.32	100.53	0.68
MH-548	MH-549	174-5	101.21	22.8	29.5	100.74	100.32	100.65	0.56
MH-549	MH-550	174-1	100.89	2.7	12.5	100.32	99.94	100.02	0.87
MH-550	MH-551	170-6	100.02	1.6	112.0	99.94	98.85	98.87	1.15
MH-550	MH-551	170-5	100.3	6.9	112.0	99.94	98.85	98.92	1.38
MH-550	MH-551	171-8	100.3	16.4	112.0	99.94	98.85	99.01	1.29
MH-550	MH-551	171-7	100.33	21.0	112.0	99.94	98.85	99.06	1.27
MH-550	MH-551	171-6	100.46	29.0	112.0	99.94	98.85	99.13	1.33
MH-550	MH-551	171-5	100.73	35.2	112.0	99.94	98.85	99.19	1.54
MH-550	MH-551	172-10	100.73	44.6	112.0	99.94	98.85	99.28	1.45
MH-550	MH-551	172-9	100.77	49.2	112.0	99.94	98.85	99.33	1.44
MH-550	MH-551	172-8	100.9	57.2	112.0	99.94	98.85	99.41	1.49
MH-550	MH-551	172-7	100.96	61.6	112.0	99.94	98.85	99.45	1.51
MH-550	MH-551	172-6	101.27	69.6	112.0	99.94	98.85	99.53	1.74
MH-550	MH-551	173-10	101.27	77.4	112.0	99.94	98.85	99.60	1.67
MH-550	MH-551	173-9	101.33	85.4	112.0	99.94	98.85	99.68	1.65
MH-550	MH-551	173-8	101.43	91.6	112.0	99.94	98.85	99.74	1.69
MH-550	MH-551	173-7	101.5	96.0	112.0	99.94	98.85	99.78	1.72
MH-550	MH-551	173-6	101.91	104.0	112.0	99.94	98.85	99.86	2.05
MH-551	MH-559	169-8	99.46	10.7	52.5	98.85	96.32	96.84	2.62
MH-551	MH-559	169-7	99.43	18.7	52.5	98.85	96.32	97.22	2.21
MH-551	MH-559	169-6	99.53	23.1	52.5	98.85	96.32	97.43	2.10
MH-551	MH-559	169-5	99.86	31.1	52.5	98.85	96.32	97.82	2.04
MH-551	MH-559	170-8	99.86	40.5	52.5	98.85	96.32	98.27	1.59
MH-551	MH-559	170-7	99.9	45.1	52.5	98.85	96.32	98.49	1.41
MH-552	MH-553	172-1	100.73	1.3	64.5	100.31	99.30	99.32	1.41
MH-552	MH-553	172-2	100.77	4.9	64.5	100.31	99.30	99.38	1.39
MH-552	MH-553	167-4	100.44	7.6	64.5	100.31	99.30	99.42	1.02
MH-552	MH-553	172-3	100.9	13.0	64.5	100.31	99.30	99.51	1.39
MH-552	MH-553	167-3	100.44	15.6	64.5	100.31	99.30	99.55	0.89
MH-552	MH-553	172-4	100.96	17.2	64.5	100.31	99.30	99.57	1.39
MH-552	MH-553	167-2	100.44	22.2	64.5	100.31	99.30	99.65	0.79
MH-552	MH-553	172-5	101.27	25.2	64.5	100.31	99.30	99.70	1.57
MH-552	MH-553	167-1	100.44	30.2	64.5	100.31	99.30	99.77	0.67
MH-552	MH-553	173-1	101.27	33.1	64.5	100.31	99.30	99.82	1.45
MH-552	MH-553	168-4	100.69	40.2	64.5	100.31	99.30	99.93	0.76
MH-552	MH-553	173-2	101.33	41.1	64.5	100.31	99.30	99.94	1.39
MH-552	MH-553	173-3	101.43	47.2	64.5	100.31	99.30	100.04	1.39
MH-552	MH-553	168-3	100.69	48.2	64.5	100.31	99.30	100.06	0.63
MH-552	MH-553	173-4	101.5	51.6	64.5	100.31	99.30	100.11	1.39
MH-552	MH-553	168-2	101.48	54.8	64.5	100.31	99.30	100.16	1.32
MH-552	MH-553	173-5	101.91	59.6	64.5	100.31	99.30	100.23	1.68
MH-552	MH-553	168-1	101.48	62.8	64.5	100.31	99.30	100.28	1.20
MH-553	MH-557	169-1	99.46	16.0	103.5	99.30	98.02	98.21	1.25
MH-553	MH-557	169-2	99.43	25.6	103.5	99.30	98.02	98.33	1.10
MH-553	MH-557	169-3	99.53	30.0	103.5	99.30	98.02	98.39	1.14
MH-553	MH-557	169-4	99.86	38.0	103.5	99.30	98.02	98.49	1.37
MH-553	MH-557	165-4	99.5	38.5	103.5	99.30	98.02	98.49	1.01
MH-553	MH-557	165-3	99.5	46.5	103.5	99.30	98.02	98.59	0.91
MH-553	MH-557	170-1	99.86	47.4	103.5	99.30	98.02	98.61	1.25
MH-553	MH-557	170-2	99.9	52.0	103.5	99.30	98.02	98.66	1.24
MH-553	MH-557	165-2	99.5	53.1	103.5	99.30	98.02	98.68	0.82
MH-553	MH-557	170-3	100.02	59.9	103.5	99.30	98.02	98.76	1.26
MH-553	MH-557	165-1	99.5	61.2	103.5	99.30	98.02	98.78	0.72
MH-553	MH-557	170-4	100.3	66.1	103.5	99.30	98.02	98.84	1.46
MH-553	MH-557	166-5	99.7	71.2	103.5	99.30	98.02	98.90	0.80
MH-553	MH-557	171-1	100.3	75.5	103.5	99.30	98.02	98.96	1.34
MH-553	MH-557	166-4	99.7	79.2	103.5	99.30	98.02	99.00	0.70
MH-553	MH-557	171-2	100.33	80.2	103.5	99.30	98.02	99.01	1.32
MH-553	MH-557	166-3	100.04	85.8	103.5	99.30	98.02	99.08	0.96
MH-553	MH-557	171-3	100.46	88.2	103.5	99.30	98.02	99.11	1.35
MH-553	MH-557	166-2	100.04	93.8	103.5	99.30	98.02	99.18	0.86
MH-553	MH-557	171-4	100.73	94.4	103.5	99.30	98.02	99.19	1.54
MH-553	MH-557	166-1	100.04	101.1	103.5	99.30	98.02	99.27	0.77
MH-554	MH-556	160-4	100.02	2.6	81.5	99.74	98.99	99.01	1.01
MH-554	MH-556	160-3	100.02	10.6	81.5	99.74	98.99	99.09	0.93
MH-554	MH-556	160-2	100.02	17.2	81.5	99.74	98.99	99.15	0.87
MH-554	MH-556	160-1	100.02	25.2	81.5	99.74	98.99	99.22	0.80
MH-554	MH-556	159-5	100.12	35.2	81.5	99.74	98.99	99.31	0.81
MH-554	MH-556	159-4	100.48	42.5	81.5	99.74	98.99	99.38	1.10
MH-554	MH-556	159-3	100.48	50.5	81.5	99.74	98.99	99.45	1.03
MH-554	MH-556	159-2	100.48	57.1	81.5	99.74	98.99	99.51	0.97
MH-554	MH-556	159-1	100.48	65.1	81.5	99.74	98.99	99.59	0.89
MH-554	MH-556	158-5	100.48	75.1	81.5	99.74	98.99	99.68	0.80
MH-554	MH-556	158-4	100.48	78.8	81.5	99.74	98.99	99.71	0.77

Table C1B: USF Freeboard Results - 100-Year Chicago 3 Hour Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-556	MH-557	162-3	99.15	7.8	70.0	98.99	98.02	98.12	1.03
MH-556	MH-557	164-1	99.39	11.9	70.0	98.99	98.02	98.18	1.21
MH-556	MH-557	162-2	99.15	14.4	70.0	98.99	98.02	98.22	0.93
MH-556	MH-557	164-2	99.39	19.9	70.0	98.99	98.02	98.29	1.10
MH-556	MH-557	162-1	99.15	22.4	70.0	98.99	98.02	98.33	0.82
MH-556	MH-557	164-3	99.39	26.5	70.0	98.99	98.02	98.38	1.01
MH-556	MH-557	161-4	99.55	32.5	70.0	98.99	98.02	98.47	1.08
MH-556	MH-557	164-4	99.39	34.5	70.0	98.99	98.02	98.50	0.89
MH-556	MH-557	161-3	99.55	40.5	70.0	98.99	98.02	98.58	0.97
MH-556	MH-557	161-2	99.55	47.1	70.0	98.99	98.02	98.67	0.88
MH-556	MH-557	161-1	99.55	55.1	70.0	98.99	98.02	98.78	0.77
MH-556	MH-557	160-5	99.64	65.1	70.0	98.99	98.02	98.92	0.72
MH-557	MH-558	163-3	98.67	4.5	36.5	98.02	97.74	97.77	0.90
MH-557	MH-558	163-2	98.67	11.1	36.5	98.02	97.74	97.82	0.85
MH-557	MH-558	163-1	98.67	19.1	36.5	98.02	97.74	97.88	0.79
MH-557	MH-558	162-5	98.77	29.1	36.5	98.02	97.74	97.96	0.81
MH-557	MH-558	162-4	99.15	35.1	36.5	98.02	97.74	98.00	1.15
MH-558	MH-559	163-5	98.32	8.9	14.5	97.74	96.32	97.19	1.13
MH-558	MH-559	163-4	98.67	10.4	14.5	97.74	96.32	97.34	1.33
MH-561	MH-537	192-3	103.75	3.1	42.5	103.09	103.01	103.02	0.73
MH-561	MH-537	192-2	103.75	5.2	42.5	103.09	103.01	103.02	0.73
MH-561	MH-537	180-1	103.86	12.6	42.5	103.09	103.01	103.04	0.82
MH-561	MH-537	192-1	103.75	13.2	42.5	103.09	103.01	103.04	0.71
MH-561	MH-537	180-2	103.86	19.9	42.5	103.09	103.01	103.05	0.81
MH-561	MH-537	191-4	103.8	23.2	42.5	103.09	103.01	103.06	0.74
MH-561	MH-537	180-3	103.86	27.9	42.5	103.09	103.01	103.07	0.79
MH-561	MH-537	191-3	103.8	31.2	42.5	103.09	103.01	103.07	0.73
MH-561	MH-537	180-4	103.86	34.5	42.5	103.09	103.01	103.08	0.78
MH-561	MH-537	191-2	103.8	37.7	42.5	103.09	103.01	103.08	0.72
MH-561	MH-563	182-3	102.47	2.6	61.0	103.09	101.29	101.37	1.10
MH-561	MH-563	182-2	102.47	10.6	61.0	103.09	101.29	101.60	0.87
MH-561	MH-563	190-1	103.21	17.4	61.0	103.09	101.29	101.80	1.41
MH-561	MH-563	182-1	102.81	17.9	61.0	103.09	101.29	101.82	0.99
MH-561	MH-563	190-2	103.21	25.4	61.0	103.09	101.29	102.04	1.17
MH-561	MH-563	181-4	103.55	27.9	61.0	103.09	101.29	102.11	1.44
MH-561	MH-563	190-3	103.8	32.0	61.0	103.09	101.29	102.24	1.56
MH-561	MH-563	181-3	103.55	35.9	61.0	103.09	101.29	102.35	1.20
MH-561	MH-563	190-4	103.8	40.0	61.0	103.09	101.29	102.47	1.33
MH-561	MH-563	181-2	103.86	42.5	61.0	103.09	101.29	102.55	1.31
MH-561	MH-563	190-5	103.8	47.3	61.0	103.09	101.29	102.69	1.11
MH-561	MH-563	181-1	103.86	50.5	61.0	103.09	101.29	102.78	1.08
MH-561	MH-563	191-1	103.8	55.7	61.0	103.09	101.29	102.94	0.86
MH-561	MH-563	180-5	103.86	59.1	61.0	103.09	101.29	103.04	0.82
MH-563	MH-564	187-2	102.43	3.4	73.5	101.29	101.00	101.02	1.41
MH-563	MH-564	185-1	102.24	4.5	73.5	101.29	101.00	101.02	1.22
MH-563	MH-564	184-4	102.57	10.2	73.5	101.29	101.00	101.04	1.53
MH-563	MH-564	187-3	102.75	10.9	73.5	101.29	101.00	101.05	1.70
MH-563	MH-564	184-3	102.57	18.2	73.5	101.29	101.00	101.07	1.50
MH-563	MH-564	188-1	102.75	20.8	73.5	101.29	101.00	101.08	1.67
MH-563	MH-564	184-2	102.57	24.8	73.5	101.29	101.00	101.10	1.47
MH-563	MH-564	188-2	102.75	28.8	73.5	101.29	101.00	101.12	1.63
MH-563	MH-564	184-1	102.57	32.8	73.5	101.29	101.00	101.13	1.44
MH-563	MH-564	188-3	102.75	36.2	73.5	101.29	101.00	101.14	1.61
MH-563	MH-564	183-3	102.57	42.8	73.5	101.29	101.00	101.17	1.40
MH-563	MH-564	189-1	102.64	46.2	73.5	101.29	101.00	101.18	1.46
MH-563	MH-564	183-2	102.57	50.8	73.5	101.29	101.00	101.20	1.37
MH-563	MH-564	189-2	102.64	54.4	73.5	101.29	101.00	101.22	1.42
MH-563	MH-564	183-1	102.57	58.6	73.5	101.29	101.00	101.23	1.34
MH-563	MH-564	189-3	102.64	61.6	73.5	101.29	101.00	101.24	1.40
MH-564	MH-8500	186-1	102.24	17.1	48.5	101.00	99.70	100.16	2.08
MH-564	MH-8500	185-5	101.61	19.9	48.5	101.00	99.70	100.23	1.38
MH-564	MH-8500	186-2	102.24	25.1	48.5	101.00	99.70	100.37	1.87
MH-564	MH-8500	185-4	101.61	27.9	48.5	101.00	99.70	100.45	1.16
MH-564	MH-8500	186-3	102.24	32.4	48.5	101.00	99.70	100.57	1.67
MH-564	MH-8500	185-3	101.93	34.5	48.5	101.00	99.70	100.63	1.30
MH-564	MH-8500	187-1	102.43	42.4	48.5	101.00	99.70	100.84	1.59
MH-564	MH-8500	185-2	101.93	42.5	48.5	101.00	99.70	100.84	1.09

Min	0.30
Max	4.82
Average	1.28

Key:

- Yellow: Freeboard to USF less than 0.30 m
- Red: Freeboard to USF less than 0.00 m

Table C2A: Pipe Data and Hydraulic Simulation Results - 100-Year SCS 24 Hour Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH_136	MH_302	96.484	96.41	101.19	101.14	2250	53.9	0.1	0.013	1.66	6.59	7.30	1.11	-0.25	12:01	98.48	98.42
MH_302	MH_303	96.41	96.331	101.14	101.08	2250	58.9	0.1	0.013	1.66	6.59	8.01	1.22	-0.24	12:02	98.42	98.33
MH_303	MH_304	96.331	96.176	101.08	100.73	2250	134.3	0.1	0.013	1.67	6.62	8.12	1.23	-0.25	12:02	98.33	98.13
MH_304	MH_306TEE	96.176	96.133	100.73	100.27	2250	42.5	0.1	0.013	1.67	6.62	8.17	1.23	-0.30	12:02	98.13	97.86
MH_306TEE	MH_307	96.133	96.1	100.27	100.35	2250	11.2	0.1	0.013	1.79	7.10	8.17	1.15	-0.52	12:03	97.86	97.63
MH_307	MH_400	96.1	96.067	100.35	100.35	2250	22.7	0.1	0.013	1.71	6.79	5.92	0.87	-0.72	12:02	97.63	97.60
MH_400	OGS_1	96.067	96.037	100.35	100.5	750	4.9	0.2	0.013	1.13	0.50	1.01	2.02	0.78	11:46	97.60	97.56
MH_500	OGS_2	96.056	96.026	100.35	100.428	750	5.0	0.2	0.013	1.13	0.50	1.01	2.02	0.55	12:18	97.36	97.32
MH-313	MH_500	96.099	96.056	99.835	100.35	2250	33.0	0.1	0.013	1.68	6.69	4.07	0.61	-0.76	12:02	97.59	97.36
MH-500	MH-502	102.24	100.94	105.21	104.245	300	92.0	1.3	0.013	1.53	0.11	0.11	1.03	-0.05	12:00	102.49	101.21
MH-502	MH-503	100.94	98.961	104.245	102.42	450	119.0	1.6	0.013	2.27	0.36	0.25	0.68	-0.18	12:00	101.21	99.52
MH-5020	MH-502	101.143	100.94	104.27	104.245	300	10.5	0.5	0.013	0.97	0.07	0.00	0.01	-0.23	11:44	101.21	101.21
MH-503	MH-504	98.961	98.683	102.42	101.89	525	73.0	0.3	0.013	1.00	0.22	0.29	1.36	0.03	11:59	99.52	99.10
MH-504	MH-528	98.683	97.315	101.89	101.06	600	108.0	0.9	0.013	2.00	0.57	0.48	0.84	-0.18	12:00	99.10	98.29
MH-505	MH-506	103.478	103.351	105.836	106.28	300	13.0	0.6	0.013	1.06	0.07	0.00	0.03	-0.27	12:00	103.51	103.60
MH-505	MH-534	103.478	103.033	105.836	105.406	375	94.5	0.5	0.013	1.06	0.12	0.00	0.02	-0.34	12:00	103.51	103.21
MH-506	MH-508	103.351	103.054	106.28	105.88	300	79.0	0.4	0.013	0.81	0.06	0.06	0.98	-0.05	12:00	103.60	103.38
MH-5070	MH-513	103.12	102.394	105.92	105.51	300	82.0	0.5	0.013	0.97	0.07	0.05	0.73	-0.10	11:59	103.32	103.15
MH-508	MH-509	103.054	102.837	105.88	105.67	300	41.5	0.5	0.013	0.92	0.06	0.08	1.15	0.03	12:00	103.38	103.12
MH-5080	MH-517	102.898	102.054	105.7	105.28	300	76.5	0.6	0.013	1.01	0.07	0.05	0.71	-0.11	12:00	103.09	102.74
MH-509	MH-510	102.837	102.718	105.67	105.6	300	10.5	0.4	0.013	0.87	0.06	0.08	1.23	-0.02	12:00	103.12	102.93
MH-510	MH-511	102.718	102.077	105.6	105.25	375	64.0	0.6	0.013	1.18	0.13	0.08	0.58	-0.17	12:01	102.93	102.30
MH-511	MH-526	102.077	98.642	105.25	103	450	95.5	2.8	0.013	3.00	0.48	0.24	0.50	-0.23	12:00	102.30	100.09
MH-513	MH-515	102.394	100.231	105.51	104	300	81.0	2.3	0.013	2.08	0.15	0.16	1.06	0.46	12:00	103.15	100.69
MH-515	MH-518	100.231	99.793	104	103.59	600	44.0	0.3	0.013	1.19	0.34	0.35	1.03	-0.14	12:00	100.69	100.32
MH-517	MH-518	102.054	99.793	105.28	103.59	300	82.0	2.3	0.013	2.08	0.15	0.15	1.04	0.39	12:01	102.74	100.32
MH-518	MH-526	99.793	98.642	103.59	103	675	47.0	0.3	0.013	1.29	0.46	0.50	1.09	-0.14	12:01	100.32	100.09
MH-519	MH-520	103.476	103.127	105.766	106.01	300	54.5	0.5	0.013	0.97	0.07	0.00	0.00	-0.30	00:00	103.48	103.37
MH-519	MH-523	103.476	103.213	105.766	105.726	300	11.5	0.3	0.013	0.81	0.06	0.00	0.00	-0.30	00:00	103.48	103.32
MH-520	MH-521	103.127	102.808	106.01	105.71	375	57.5	0.5	0.013	1.12	0.12	0.09	0.72	-0.14	12:00	103.37	103.08
MH-521	MH-522	102.808	102.725	105.71	105.64	375	11.5	0.3	0.013	0.94	0.10	0.09	0.85	-0.11	12:00	103.08	102.92
MH-522	MH-525	102.725	100.69	105.64	104.2	375	55.0	2.6	0.013	2.54	0.28	0.14	0.50	-0.19	12:00	102.92	101.05
MH-523	MH-524	103.213	102.148	105.726	104.956	300	55.0	1.8	0.013	1.84	0.13	0.04	0.29	-0.19	12:00	103.32	102.46
MH-524	MH-5240	102.148	101.917	104.956	105.23	375	65.0	0.3	0.013	0.87	0.10	0.10	1.03	-0.06	12:00	102.46	102.19
MH-5240	MH-525	101.917	100.69	105.23	104.2	375	63.5	1.6	0.013	1.98	0.22	0.16	0.72	-0.11	12:00	102.19	101.05
MH-52400	MH-538	102.155	100.883	104.956	103.676	300	58.0	1.8	0.013	1.84	0.13	0.02	0.18	-0.21	12:00	102.25	101.16
MH-525	MH-526	100.69	98.642	104.2	103	525	58.5	1.8	0.013	2.67	0.58	0.36	0.63	-0.17	12:00	101.05	100.09
MH-526	MH-528	98.642	97.315	103	101.06	675	59.5	1.6	0.013	2.97	1.06	1.14	1.07	0.78	12:01	100.09	98.29
MH-527	MH-528	99.084	97.315	101.18	101.06	300	18.5	0.4	0.013	0.81	0.06	0.02	0.28	-0.18	11:55	99.20	98.29
MH-528	MH-529	97.315	97.009	101.06	100.82	1050	62.5	0.3	0.013	1.58	1.37	1.66	1.21	-0.08	12:01	98.29	98.05
MH-529	MH-530	97.009	96.851	100.82	100.58	1200	72.0	0.2	0.013	1.34	1.51	1.65	1.09	-0.16	12:01	98.05	97.93

Table C2A: Pipe Data and Hydraulic Simulation Results - 100-Year SCS 24 Hour Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-530	MH-531	96.851	96.656	100.58	100.45	1200	76.5	0.2	0.013	1.34	1.51	1.78	1.18	-0.12	12:02	97.93	97.72
MH-531	MH-313	96.656	96.099	100.45	99.835	1200	21.5	0.1	0.013	1.33	1.50	1.78	1.18	-0.14	12:02	97.72	97.59
MH-534	MH-535	103.033	100.603	105.406	103.886	375	78.5	3.0	0.013	2.75	0.30	0.14	0.46	-0.19	12:00	103.21	100.94
MH-535	MH-515	100.603	100.231	103.886	104	450	44.0	0.2	0.013	0.80	0.13	0.14	1.08	-0.11	12:00	100.94	100.69
MH-5350	MH-539	101.607	99.624	103.886	102.466	300	52.5	2.4	0.013	2.12	0.15	0.02	0.11	-0.23	12:00	101.68	100.11
MH-536	MH-538	102.515	100.883	105.446	103.676	450	59.0	2.2	0.013	2.63	0.42	0.12	0.28	-0.29	12:00	102.68	101.16
MH-537	MH-536	102.673	102.515	105.126	105.446	450	64.5	0.2	0.013	0.80	0.13	0.12	0.92	-0.12	12:00	103.00	102.68
MH-538	MH-539	100.883	99.624	103.676	102.466	525	58.5	2.1	0.013	2.88	0.62	0.35	0.56	-0.25	12:00	101.16	100.11
MH-539	MH-542	99.624	99.339	102.466	102.396	525	9.5	0.6	0.013	1.54	0.33	0.37	1.10	-0.04	12:00	100.11	99.98
MH-540	MH-541	100.072	99.961	101.646	102.506	300	14.5	0.4	0.013	0.81	0.06	0.04	0.77	-0.10	12:00	100.27	100.16
MH-541	MH-542	99.961	99.339	102.506	102.396	300	10.0	0.4	0.013	0.81	0.06	0.04	0.77	-0.10	12:01	100.16	99.98
MH-542	MH-543	99.339	99.184	102.396	102.186	750	53.0	0.2	0.013	0.98	0.43	0.53	1.23	-0.11	12:01	99.98	99.83
MH-543	MH-544	99.184	97.993	102.186	102.016	825	118.0	0.2	0.013	1.04	0.56	0.61	1.10	-0.17	12:01	99.83	98.50
MH-544	MH-5440	97.993	97.273	102.016	101	825	57.5	1.2	0.013	2.94	1.57	0.67	0.43	-0.31	12:02	98.50	98.44
MH-5440	MH_302	97.273	96.41	101	101.14	825	12.3	1.2	0.013	2.97	1.59	0.67	0.42	0.34	12:02	98.44	98.42
MH-546	MH-547	102.009	101.183	104.84	104.04	375	99.5	0.8	0.013	1.42	0.16	0.04	0.24	-0.25	12:01	102.13	101.41
MH-547	MH-548	101.183	100.223	104.04	103.13	375	60.0	1.6	0.013	1.98	0.22	0.15	0.69	-0.14	12:00	101.41	100.59
MH-548	MH-549	100.223	99.898	103.13	102.8	375	29.5	1.0	0.013	1.59	0.18	0.18	1.00	0.00	12:00	100.59	100.28
MH-549	MH-550	99.898	99.618	102.8	102.64	375	12.5	1.0	0.013	1.59	0.18	0.18	1.00	0.00	12:00	100.28	99.91
MH-550	MH-551	99.618	97.862	102.64	100.93	525	112.0	1.6	0.013	2.47	0.54	0.31	0.58	-0.23	12:00	99.91	98.65
MH-551	MH-559	97.862	94.699	100.93	100.39	525	52.5	1.4	0.013	2.35	0.51	0.49	0.96	0.27	12:00	98.65	96.13
MH-552	MH-553	100.139	99.064	102.99	101.99	300	64.5	1.6	0.013	1.70	0.12	0.07	0.54	-0.14	12:00	100.30	99.28
MH-553	MH-557	99.064	97.315	101.99	100.86	375	103.5	1.4	0.013	1.88	0.21	0.13	0.63	-0.16	12:00	99.28	97.96
MH-554	MH-556	99.668	98.669	102.47	101.7	300	81.5	1.0	0.013	1.33	0.09	0.01	0.11	-0.24	12:00	99.73	98.98
MH-556	MH-557	98.669	97.315	101.7	100.86	525	70.0	1.2	0.013	2.18	0.47	0.31	0.66	-0.22	12:00	98.98	97.96
MH-5560	MH-556	98.809	98.669	101.67	101.7	525	14.5	0.6	0.013	1.48	0.32	0.26	0.82	-0.01	12:00	99.33	98.98
MH-557	MH-558	97.315	97.121	100.86	100.39	675	36.5	0.4	0.013	1.57	0.56	0.62	1.10	-0.03	12:00	97.96	97.70
MH-558	MH-559	97.121	94.699	100.39	100.39	675	14.5	0.4	0.013	1.57	0.56	0.62	1.10	-0.09	12:00	97.70	96.13
MH-559	MH-900	94.699	92.925	100.39	95.41	675	15.5	0.8	0.013	2.10	0.75	1.10	1.47	0.76	12:00	96.13	93.72
MH-561	MH-537	103.003	102.673	105.281	105.126	375	42.5	0.6	0.013	1.23	0.14	0.01	0.10	-0.30	12:00	103.08	103.00
MH-561	MH-563	103.003	100.82	105.281	104.305	300	61.0	2.9	0.013	2.33	0.16	0.00	0.00	-0.22	12:00	103.08	101.23
MH-562	MH-563	101.178	100.82	103.205	104.305	300	29.5	0.5	0.013	0.92	0.06	0.05	0.83	-0.05	12:00	101.43	101.23
MH-563	MH-564	100.82	100.643	104.305	103.985	525	73.5	0.2	0.013	0.89	0.19	0.20	1.02	-0.12	12:00	101.23	100.94
MH-564	MH-8500	100.643	99.407	103.985	102.733	525	48.5	2.1	0.013	2.84	0.62	0.29	0.48	-0.23	12:00	100.94	99.67
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.00	0.00	-0.75	00:00	101.11	99.67
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	0.29	0.26	-0.49	12:00	99.67	97.61
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	0.29	0.22	-0.51	12:00	97.61	95.75
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	0.29	0.23	-0.50	12:00	95.75	93.72
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.26	0.50	-0.86	12:00	93.72	92.44
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	3.62	0.59	-0.73	12:01	92.44	90.98
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	4.00	0.35	-1.30	12:02	90.98	90.65

Table C2A: Pipe Data and Hydraulic Simulation Results - 100-Year SCS 24 Hour Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	4.40	0.55	-1.15	12:01	90.65	90.29
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	4.48	0.40	-1.43	12:02	90.29	90.26
OGS_1	OGS_1-Out	96.037	96.015	100.5	100.35	750	4.9	0.2	0.013	1.14	0.50	1.01	2.01	0.77	11:46	97.56	97.18
OGS_1-Out	MH_3112	96.015	96.01	100.35	100.35	2250	6.2	0.1	0.013	1.63	6.49	5.92	0.91	-1.09	12:02	97.18	97.16
OGS_2	OGS_2-Out	96.026	96.004	100.428	100.35	750	5.1	0.2	0.013	1.12	0.49	1.01	2.03	0.54	12:18	97.32	96.94
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.26	0.50	-0.86	12:00	93.72	92.44
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	0.29	0.26	-0.49	12:00	99.67	97.61
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.00	0.00	-0.75	00:00	101.11	99.67
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	0.29	0.22	-0.51	12:00	97.61	95.75
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	0.29	0.23	-0.50	12:00	95.75	93.72
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.26	0.50	-0.86	12:00	93.72	92.44
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	3.62	0.59	-0.73	12:01	92.44	90.98
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	4.00	0.35	-1.30	12:02	90.98	90.65
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	4.40	0.55	-1.15	12:01	90.65	90.29
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	4.48	0.40	-1.43	12:02	90.29	90.26

Table C2B: USF Freeboard Results - 100-Year SCS 24Hr Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-531	MH-313	76-2	98.43	4.8	21.5	97.72	97.59	97.62	0.81
MH-531	MH-313	76-1	98.43	9.6	21.5	97.72	97.59	97.65	0.78
MH-500	MH-502	146-6	102.89	14.2	92.0	102.49	101.21	101.41	1.48
MH-500	MH-502	146-5	102.89	22.2	92.0	102.49	101.21	101.52	1.37
MH-500	MH-502	146-4	102.89	28.8	92.0	102.49	101.21	101.61	1.28
MH-500	MH-502	146-3	102.89	36.8	92.0	102.49	101.21	101.72	1.17
MH-500	MH-502	146-2	102.89	43.4	92.0	102.49	101.21	101.81	1.08
MH-500	MH-502	146-1	102.89	51.4	92.0	102.49	101.21	101.93	0.96
MH-500	MH-502	145-5	103.05	61.4	92.0	102.49	101.21	102.06	0.99
MH-500	MH-502	145-4	103.05	69.9	92.0	102.49	101.21	102.18	0.87
MH-500	MH-502	145-3	103.55	76.0	92.0	102.49	101.21	102.27	1.28
MH-500	MH-502	145-2	103.55	84.0	92.0	102.49	101.21	102.38	1.17
MH-500	MH-502	145-1	103.55	88.9	92.0	102.49	101.21	102.45	1.10
MH-502	MH-503	148-5	101.09	38.5	119.0	101.21	99.52	100.07	1.02
MH-502	MH-503	148-4	101.09	46.5	119.0	101.21	99.52	100.18	0.91
MH-502	MH-503	148-3	101.09	53.1	119.0	101.21	99.52	100.27	0.82
MH-502	MH-503	148-2	101.09	61.1	119.0	101.21	99.52	100.39	0.70
MH-502	MH-503	148-1	101.44	68.4	119.0	101.21	99.52	100.49	0.95
MH-502	MH-503	147-6	101.65	78.4	119.0	101.21	99.52	100.63	1.02
MH-502	MH-503	147-5	101.65	86.4	119.0	101.21	99.52	100.75	0.90
MH-502	MH-503	147-4	102.03	94.4	119.0	101.21	99.52	100.86	1.17
MH-502	MH-503	147-3	102.03	101.0	119.0	101.21	99.52	100.95	1.08
MH-502	MH-503	147-2	102.66	107.6	119.0	101.21	99.52	101.05	1.61
MH-502	MH-503	147-1	102.66	115.6	119.0	101.21	99.52	101.16	1.50
MH-503	MH-504	150-3	100.3	1.3	73.0	99.52	99.10	99.11	1.19
MH-503	MH-504	156-4	100.04	2.7	73.0	99.52	99.10	99.12	0.92
MH-503	MH-504	150-2	100.3	6.3	73.0	99.52	99.10	99.14	1.16
MH-503	MH-504	156-5	100.04	10.0	73.0	99.52	99.10	99.16	0.88
MH-503	MH-504	150-1	100.3	14.3	73.0	99.52	99.10	99.18	1.12
MH-503	MH-504	157-1	100.3	20.0	73.0	99.52	99.10	99.22	1.08
MH-503	MH-504	149-5	100.7	24.3	73.0	99.52	99.10	99.24	1.46
MH-503	MH-504	157-2	100.3	28.0	73.0	99.52	99.10	99.26	1.04
MH-503	MH-504	149-4	100.7	32.3	73.0	99.52	99.10	99.29	1.41
MH-503	MH-504	157-3	100.3	34.6	73.0	99.52	99.10	99.30	1.00
MH-503	MH-504	149-3	100.7	38.9	73.0	99.52	99.10	99.33	1.37
MH-503	MH-504	157-4	100.3	42.6	73.0	99.52	99.10	99.35	0.95
MH-503	MH-504	149-2	100.7	46.9	73.0	99.52	99.10	99.37	1.33
MH-503	MH-504	157-5	100.3	49.9	73.0	99.52	99.10	99.39	0.91
MH-503	MH-504	149-1	100.7	54.3	73.0	99.52	99.10	99.41	1.29
MH-503	MH-504	158-1	100.48	59.8	73.0	99.52	99.10	99.45	1.03
MH-503	MH-504	158-2	100.48	67.8	73.0	99.52	99.10	99.49	0.99
MH-503	MH-504	158-3	100.48	71.4	73.0	99.52	99.10	99.51	0.97
MH-504	MH-528	154-1	99.24	15.6	108.0	99.10	98.29	98.40	0.84
MH-504	MH-528	153-3	99.92	16.5	108.0	99.10	98.29	98.41	1.51
MH-504	MH-528	154-2	99.24	23.6	108.0	99.10	98.29	98.46	0.78
MH-504	MH-528	153-2	99.92	24.5	108.0	99.10	98.29	98.47	1.45
MH-504	MH-528	154-3	99.24	30.2	108.0	99.10	98.29	98.51	0.73
MH-504	MH-528	153-1	99.92	31.8	108.0	99.10	98.29	98.53	1.39
MH-504	MH-528	154-4	99.24	38.2	108.0	99.10	98.29	98.57	0.67
MH-504	MH-528	152-3	99.92	41.8	108.0	99.10	98.29	98.60	1.32
MH-504	MH-528	155-1	99.28	48.2	108.0	99.10	98.29	98.65	0.63
MH-504	MH-528	152-2	99.92	49.8	108.0	99.10	98.29	98.66	1.26
MH-504	MH-528	155-2	99.28	56.2	108.0	99.10	98.29	98.71	0.57
MH-504	MH-528	152-1	99.92	57.1	108.0	99.10	98.29	98.72	1.20
MH-504	MH-528	155-3	99.59	62.8	108.0	99.10	98.29	98.76	0.83
MH-504	MH-528	151-4	99.96	67.1	108.0	99.10	98.29	98.79	1.17
MH-504	MH-528	155-4	99.59	70.8	108.0	99.10	98.29	98.82	0.77
MH-504	MH-528	151-3	99.96	75.1	108.0	99.10	98.29	98.85	1.11
MH-504	MH-528	155-5	99.59	78.1	108.0	99.10	98.29	98.88	0.71
MH-504	MH-528	151-2	99.96	81.7	108.0	99.10	98.29	98.90	1.06
MH-504	MH-528	156-1	99.73	88.1	108.0	99.10	98.29	98.95	0.78
MH-504	MH-528	151-1	100.04	89.7	108.0	99.10	98.29	98.96	1.08
MH-504	MH-528	156-2	99.73	96.1	108.0	99.10	98.29	99.01	0.72
MH-504	MH-528	150-4	100.3	99.7	108.0	99.10	98.29	99.04	1.26
MH-504	MH-528	156-3	100.04	102.7	108.0	99.10	98.29	99.06	0.98
MH-505	MH-506	92-3	104.3	2.5	13.0	103.51	103.60	103.58	0.72
MH-505	MH-506	92-2	104.3	6.8	13.0	103.51	103.60	103.55	0.75
MH-505	MH-506	92-1	104.3	11.3	13.0	103.51	103.60	103.52	0.78
MH-505	MH-534	99-7	104.61	3.7	94.5	103.51	103.21	103.22	1.39
MH-505	MH-534	95-5	103.94	6.8	94.5	103.51	103.21	103.23	0.71
MH-505	MH-534	99-6	104.67	11.7	94.5	103.51	103.21	103.25	1.42
MH-505	MH-534	94-1	104.13	17.4	94.5	103.51	103.21	103.27	0.86
MH-505	MH-534	99-5	104.86	17.9	94.5	103.51	103.21	103.27	1.59
MH-505	MH-534	94-2	104.13	25.4	94.5	103.51	103.21	103.29	0.84
MH-505	MH-534	100-6	104.86	25.7	94.5	103.51	103.21	103.29	1.57
MH-505	MH-534	94-3	104.13	32.7	94.5	103.51	103.21	103.32	0.81
MH-505	MH-534	100-5	104.78	33.7	94.5	103.51	103.21	103.32	1.46
MH-505	MH-534	100-4	104.97	38.3	94.5	103.51	103.21	103.33	1.64
MH-505	MH-534	94-4	104.13	40.7	94.5	103.51	103.21	103.34	0.79

Table C2B: USF Freeboard Results - 100-Year SCS 24Hr Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-505	MH-534	101-6	104.97	47.7	94.5	103.51	103.21	103.36	1.61
MH-505	MH-534	94-5	104.13	48.3	94.5	103.51	103.21	103.36	0.77
MH-505	MH-534	101-5	104.86	53.9	94.5	103.51	103.21	103.38	1.48
MH-505	MH-534	93-1	104.3	58.9	94.5	103.51	103.21	103.40	0.90
MH-505	MH-534	101-4	105.08	61.9	94.5	103.51	103.21	103.41	1.67
MH-505	MH-534	93-2	104.3	66.9	94.5	103.51	103.21	103.42	0.88
MH-505	MH-534	102-6	105.11	71.3	94.5	103.51	103.21	103.44	1.67
MH-505	MH-534	93-3	104.3	74.2	94.5	103.51	103.21	103.44	0.86
MH-505	MH-534	102-5	105.11	75.9	94.5	103.51	103.21	103.45	1.66
MH-505	MH-534	93-4	104.3	82.2	94.5	103.51	103.21	103.47	0.83
MH-505	MH-534	102-4	105.11	83.9	94.5	103.51	103.21	103.47	1.64
MH-505	MH-534	93-5	104.3	89.8	94.5	103.51	103.21	103.49	0.81
MH-506	MH-508	89-1	103.74	7.2	79.0	103.60	103.38	103.40	0.34
MH-506	MH-508	90-3	104.04	27.0	79.0	103.60	103.38	103.46	0.58
MH-506	MH-508	90-2	104.04	34.6	79.0	103.60	103.38	103.48	0.56
MH-506	MH-508	90-1	104.04	42.6	79.0	103.60	103.38	103.50	0.54
MH-506	MH-508	91-4	104.23	53.2	79.0	103.60	103.38	103.53	0.70
MH-506	MH-508	91-3	104.23	61.2	79.0	103.60	103.38	103.55	0.68
MH-506	MH-508	91-2	104.23	68.5	79.0	103.60	103.38	103.57	0.66
MH-506	MH-508	91-1	104.23	76.5	79.0	103.60	103.38	103.59	0.64
MH-5070	MH-513	99-2	104.61	0.1	82.0	103.32	103.15	103.15	1.46
MH-5070	MH-513	105-6	104.46	8.2	82.0	103.32	103.15	103.17	1.29
MH-5070	MH-513	99-3	104.67	8.4	82.0	103.32	103.15	103.17	1.50
MH-5070	MH-513	105-5	104.46	12.8	82.0	103.32	103.15	103.18	1.28
MH-5070	MH-513	99-4	104.86	14.3	82.0	103.32	103.15	103.18	1.68
MH-5070	MH-513	105-4	104.46	20.8	82.0	103.32	103.15	103.20	1.26
MH-5070	MH-513	100-1	104.86	22.1	82.0	103.32	103.15	103.20	1.66
MH-5070	MH-513	100-2	104.78	30.1	82.0	103.32	103.15	103.21	1.57
MH-5070	MH-513	104-8	104.6	30.2	82.0	103.32	103.15	103.22	1.38
MH-5070	MH-513	100-3	104.97	34.7	82.0	103.32	103.15	103.22	1.75
MH-5070	MH-513	104-7	104.6	34.8	82.0	103.32	103.15	103.22	1.38
MH-5070	MH-513	104-6	104.6	42.8	82.0	103.32	103.15	103.24	1.36
MH-5070	MH-513	101-1	104.97	44.1	82.0	103.32	103.15	103.24	1.73
MH-5070	MH-513	104-5	104.6	49.0	82.0	103.32	103.15	103.25	1.35
MH-5070	MH-513	101-2	104.86	50.3	82.0	103.32	103.15	103.26	1.60
MH-5070	MH-513	101-3	105.08	58.3	82.0	103.32	103.15	103.27	1.81
MH-5070	MH-513	103-8	104.79	58.4	82.0	103.32	103.15	103.27	1.52
MH-5070	MH-513	103-7	104.79	63.0	82.0	103.32	103.15	103.28	1.51
MH-5070	MH-513	102-1	105.11	67.7	82.0	103.32	103.15	103.29	1.82
MH-5070	MH-513	103-6	104.79	71.0	82.0	103.32	103.15	103.30	1.49
MH-5070	MH-513	102-2	105.11	72.3	82.0	103.32	103.15	103.30	1.81
MH-5070	MH-513	103-5	104.79	77.2	82.0	103.32	103.15	103.31	1.48
MH-5070	MH-513	102-3	105.11	80.3	82.0	103.32	103.15	103.32	1.79
MH-508	MH-509	88-3	103.73	6.6	41.5	103.38	103.12	103.16	0.57
MH-508	MH-509	88-2	103.73	14.2	41.5	103.38	103.12	103.21	0.52
MH-508	MH-509	88-1	103.73	22.2	41.5	103.38	103.12	103.26	0.47
MH-508	MH-509	89-3	103.74	32.8	41.5	103.38	103.12	103.33	0.41
MH-508	MH-509	89-2	103.74	40.4	41.5	103.38	103.12	103.38	0.36
MH-5080	MH-517	105-1	104.46	6.2	76.5	103.09	102.74	102.77	1.69
MH-5080	MH-517	111-6	104.04	7.8	76.5	103.09	102.74	102.78	1.26
MH-5080	MH-517	105-2	104.46	10.7	76.5	103.09	102.74	102.79	1.67
MH-5080	MH-517	111-5	104.35	14.0	76.5	103.09	102.74	102.81	1.54
MH-5080	MH-517	105-3	104.46	18.7	76.5	103.09	102.74	102.83	1.63
MH-5080	MH-517	112-8	104.49	23.4	76.5	103.09	102.74	102.85	1.64
MH-5080	MH-517	112-7	104.49	28.0	76.5	103.09	102.74	102.87	1.62
MH-5080	MH-517	104-1	104.6	28.1	76.5	103.09	102.74	102.87	1.73
MH-5080	MH-517	104-2	104.6	32.7	76.5	103.09	102.74	102.89	1.71
MH-5080	MH-517	112-6	104.49	36.0	76.5	103.09	102.74	102.91	1.58
MH-5080	MH-517	104-3	104.6	40.7	76.5	103.09	102.74	102.93	1.67
MH-5080	MH-517	112-5	104.49	42.2	76.5	103.09	102.74	102.93	1.56
MH-5080	MH-517	104-4	104.6	46.9	76.5	103.09	102.74	102.95	1.65
MH-5080	MH-517	113-8	104.59	51.6	76.5	103.09	102.74	102.98	1.61
MH-5080	MH-517	113-7	104.59	56.2	76.5	103.09	102.74	103.00	1.59
MH-5080	MH-517	103-1	104.79	56.3	76.5	103.09	102.74	103.00	1.79
MH-5080	MH-517	103-2	104.79	60.9	76.5	103.09	102.74	103.02	1.77
MH-5080	MH-517	113-6	104.59	64.2	76.5	103.09	102.74	103.03	1.56
MH-5080	MH-517	103-3	104.79	68.9	76.5	103.09	102.74	103.05	1.74
MH-5080	MH-517	113-5	104.59	70.4	76.5	103.09	102.74	103.06	1.53
MH-5080	MH-517	103-4	104.79	75.1	76.5	103.09	102.74	103.08	1.71
MH-509	MH-510	87-3	103.63	2.0	10.5	103.12	102.93	102.96	0.67
MH-509	MH-510	87-2	103.63	5.6	10.5	103.12	102.93	103.03	0.60
MH-509	MH-510	87-1	103.63	9.4	10.5	103.12	102.93	103.10	0.53
MH-510	MH-511	85-4	103.36	4.3	64.0	102.93	102.30	102.34	1.02
MH-510	MH-511	112-1	104.49	9.4	64.0	102.93	102.30	102.39	2.10
MH-510	MH-511	85-3	103.36	12.3	64.0	102.93	102.30	102.42	0.94
MH-510	MH-511	112-2	104.49	14.0	64.0	102.93	102.30	102.44	2.05
MH-510	MH-511	85-2	103.36	19.5	64.0	102.93	102.30	102.49	0.87
MH-510	MH-511	112-3	104.49	22.0	64.0	102.93	102.30	102.51	1.98
MH-510	MH-511	85-1	103.36	27.5	64.0	102.93	102.30	102.57	0.79

Table C2B: USF Freeboard Results - 100-Year SCS 24Hr Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-510	MH-511	112-4	104.49	28.2	64.0	102.93	102.30	102.58	1.91
MH-510	MH-511	113-1	104.59	37.6	64.0	102.93	102.30	102.67	1.92
MH-510	MH-511	86-3	103.5	38.1	64.0	102.93	102.30	102.67	0.83
MH-510	MH-511	113-2	104.59	42.2	64.0	102.93	102.30	102.71	1.88
MH-510	MH-511	86-2	103.5	45.8	64.0	102.93	102.30	102.75	0.75
MH-510	MH-511	113-3	104.59	50.2	64.0	102.93	102.30	102.79	1.80
MH-510	MH-511	86-1	103.5	53.8	64.0	102.93	102.30	102.83	0.67
MH-510	MH-511	113-4	104.59	56.4	64.0	102.93	102.30	102.85	1.74
MH-511	MH-526	82-3	101.52	20.9	95.5	102.30	100.09	100.57	0.95
MH-511	MH-526	109-2	102.17	26.4	95.5	102.30	100.09	100.70	1.47
MH-511	MH-526	82-2	101.52	28.9	95.5	102.30	100.09	100.76	0.76
MH-511	MH-526	109-3	102.32	30.8	95.5	102.30	100.09	100.80	1.52
MH-511	MH-526	82-1	101.52	36.5	95.5	102.30	100.09	100.93	0.59
MH-511	MH-526	109-4	102.78	38.8	95.5	102.30	100.09	100.99	1.79
MH-511	MH-526	83-3	101.63	47.1	95.5	102.30	100.09	101.18	0.45
MH-511	MH-526	110-1	102.91	48.2	95.5	102.30	100.09	101.20	1.71
MH-511	MH-526	110-2	103.09	52.8	95.5	102.30	100.09	101.31	1.78
MH-511	MH-526	83-2	102.27	54.7	95.5	102.30	100.09	101.35	0.92
MH-511	MH-526	110-3	103.34	60.8	95.5	102.30	100.09	101.50	1.84
MH-511	MH-526	83-1	102.27	62.7	95.5	102.30	100.09	101.54	0.73
MH-511	MH-526	110-4	103.77	67.0	95.5	102.30	100.09	101.64	2.13
MH-511	MH-526	84-3	102.46	73.4	95.5	102.30	100.09	101.79	0.67
MH-511	MH-526	111-1	103.89	76.4	95.5	102.30	100.09	101.86	2.03
MH-511	MH-526	111-2	103.98	81.0	95.5	102.30	100.09	101.96	2.02
MH-511	MH-526	84-2	103.15	81.0	95.5	102.30	100.09	101.96	1.19
MH-511	MH-526	84-1	103.15	88.9	95.5	102.30	100.09	102.14	1.01
MH-511	MH-526	111-3	104.04	89.1	95.5	102.30	100.09	102.15	1.89
MH-511	MH-526	111-4	104.35	95.3	95.5	102.30	100.09	102.29	2.06
MH-513	MH-515	108-6	102.64	21.6	81.0	103.15	100.69	101.35	1.29
MH-513	MH-515	97-2	102.99	26.5	81.0	103.15	100.69	101.50	1.49
MH-513	MH-515	108-5	102.57	29.6	81.0	103.15	100.69	101.59	0.98
MH-513	MH-515	97-3	103.15	30.9	81.0	103.15	100.69	101.63	1.52
MH-513	MH-515	108-4	102.98	35.8	81.0	103.15	100.69	101.78	1.20
MH-513	MH-515	97-4	103.6	38.9	81.0	103.15	100.69	101.87	1.73
MH-513	MH-515	107-6	103.11	45.2	81.0	103.15	100.69	102.07	1.04
MH-513	MH-515	98-1	103.73	48.3	81.0	103.15	100.69	102.16	1.57
MH-513	MH-515	107-5	103.33	49.8	81.0	103.15	100.69	102.21	1.12
MH-513	MH-515	98-2	103.92	52.9	81.0	103.15	100.69	102.30	1.62
MH-513	MH-515	107-4	103.75	56.2	81.0	103.15	100.69	102.40	1.35
MH-513	MH-515	98-3	104.16	60.9	81.0	103.15	100.69	102.54	1.62
MH-513	MH-515	106-6	103.85	65.6	81.0	103.15	100.69	102.69	1.16
MH-513	MH-515	98-4	104.59	67.1	81.0	103.15	100.69	102.73	1.86
MH-513	MH-515	106-5	104.08	73.6	81.0	103.15	100.69	102.93	1.15
MH-513	MH-515	99-1	104.61	76.5	81.0	103.15	100.69	103.02	1.59
MH-513	MH-515	106-4	104.34	79.8	81.0	103.15	100.69	103.12	1.22
MH-515	MH-518	114-5	101.66	3.6	44.0	100.69	100.32	100.35	1.31
MH-515	MH-518	115-1	101.78	14.3	44.0	100.69	100.32	100.44	1.34
MH-515	MH-518	115-2	102.22	21.9	44.0	100.69	100.32	100.51	1.71
MH-515	MH-518	115-3	102.22	29.9	44.0	100.69	100.32	100.57	1.65
MH-515	MH-518	115-4	102.22	37.1	44.0	100.69	100.32	100.63	1.59
MH-517	MH-518	109-8	102.23	19.4	82.0	102.74	100.32	100.90	1.33
MH-517	MH-518	108-1	102.64	20.7	82.0	102.74	100.32	100.93	1.71
MH-517	MH-518	109-7	102.17	27.4	82.0	102.74	100.32	101.13	1.04
MH-517	MH-518	108-2	102.57	28.7	82.0	102.74	100.32	101.17	1.40
MH-517	MH-518	109-6	102.32	31.8	82.0	102.74	100.32	101.26	1.06
MH-517	MH-518	108-3	102.98	34.9	82.0	102.74	100.32	101.35	1.63
MH-517	MH-518	109-5	102.78	39.8	82.0	102.74	100.32	101.50	1.28
MH-517	MH-518	107-1	103.11	44.3	82.0	102.74	100.32	101.63	1.48
MH-517	MH-518	107-2	103.33	48.9	82.0	102.74	100.32	101.77	1.56
MH-517	MH-518	110-8	102.91	49.2	82.0	102.74	100.32	101.78	1.13
MH-517	MH-518	110-7	103.09	53.8	82.0	102.74	100.32	101.91	1.18
MH-517	MH-518	107-3	103.75	55.3	82.0	102.74	100.32	101.96	1.79
MH-517	MH-518	110-6	103.34	61.8	82.0	102.74	100.32	102.15	1.19
MH-517	MH-518	106-1	103.85	64.7	82.0	102.74	100.32	102.23	1.62
MH-517	MH-518	110-5	103.77	68.0	82.0	102.74	100.32	102.33	1.44
MH-517	MH-518	106-2	104.08	72.7	82.0	102.74	100.32	102.47	1.61
MH-517	MH-518	111-8	103.89	77.4	82.0	102.74	100.32	102.61	1.28
MH-517	MH-518	106-3	104.34	78.9	82.0	102.74	100.32	102.65	1.69
MH-517	MH-518	111-7	103.98	82.0	82.0	102.74	100.32	102.74	1.24
MH-518	MH-526	114-1	101.36	19.7	47.0	100.32	100.09	100.19	1.17
MH-518	MH-526	114-2	101.66	27.3	47.0	100.32	100.09	100.23	1.43
MH-518	MH-526	114-3	101.66	35.3	47.0	100.32	100.09	100.27	1.39
MH-518	MH-526	114-4	101.66	42.5	47.0	100.32	100.09	100.30	1.36
MH-519	MH-520	129-3	104.07	4.0	54.5	103.48	103.37	103.38	0.70
MH-519	MH-520	138-1	104.08	5.4	54.5	103.48	103.37	103.38	0.70
MH-519	MH-520	129-2	104.07	12.0	54.5	103.48	103.37	103.39	0.68
MH-519	MH-520	138-2	104.08	13.0	54.5	103.48	103.37	103.39	0.69
MH-519	MH-520	129-1	104.07	19.6	54.5	103.48	103.37	103.41	0.66
MH-519	MH-520	138-3	104.08	21.0	54.5	103.48	103.37	103.41	0.67

Table C2B: USF Freeboard Results - 100-Year SCS 24Hr Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-519	MH-520	128-3	104.09	30.2	54.5	103.48	103.37	103.43	0.66
MH-519	MH-520	139-1	104.23	31.6	54.5	103.48	103.37	103.43	0.80
MH-519	MH-520	128-2	104.09	38.2	54.5	103.48	103.37	103.44	0.65
MH-519	MH-520	139-2	104.23	39.2	54.5	103.48	103.37	103.45	0.78
MH-519	MH-520	128-1	104.09	45.8	54.5	103.48	103.37	103.46	0.63
MH-519	MH-520	139-3	104.23	47.2	54.5	103.48	103.37	103.46	0.77
MH-519	MH-523	140-3	104.25	2.3	11.5	103.48	103.32	103.35	0.90
MH-519	MH-523	140-2	104.25	7.0	11.5	103.48	103.32	103.42	0.83
MH-519	MH-523	140-1	104.25	10.5	11.5	103.48	103.32	103.46	0.79
MH-520	MH-521	136-1	103.94	3.7	57.5	103.37	103.08	103.10	0.84
MH-520	MH-521	131-3	103.81	8.8	57.5	103.37	103.08	103.12	0.69
MH-520	MH-521	136-2	103.94	11.4	57.5	103.37	103.08	103.14	0.80
MH-520	MH-521	131-2	103.81	16.8	57.5	103.37	103.08	103.16	0.65
MH-520	MH-521	136-3	103.94	19.4	57.5	103.37	103.08	103.18	0.76
MH-520	MH-521	131-1	103.81	24.5	57.5	103.37	103.08	103.20	0.61
MH-520	MH-521	137-1	103.94	30.0	57.5	103.37	103.08	103.23	0.71
MH-520	MH-521	130-3	103.94	35.1	57.5	103.37	103.08	103.25	0.69
MH-520	MH-521	137-2	103.94	37.6	57.5	103.37	103.08	103.27	0.67
MH-520	MH-521	130-2	103.94	43.1	57.5	103.37	103.08	103.29	0.65
MH-520	MH-521	137-3	103.94	45.6	57.5	103.37	103.08	103.31	0.63
MH-520	MH-521	130-1	103.94	50.7	57.5	103.37	103.08	103.33	0.61
MH-521	MH-522	135-1	103.67	1.0	11.5	103.08	102.92	102.93	0.74
MH-521	MH-522	135-2	103.67	5.3	11.5	103.08	102.92	102.99	0.68
MH-521	MH-522	135-3	103.67	9.5	11.5	103.08	102.92	103.05	0.62
MH-522	MH-525	133-3	102.71	7.1	55.0	102.92	101.05	101.29	1.42
MH-522	MH-525	133-4	103.1	14.4	55.0	102.92	101.05	101.54	1.56
MH-522	MH-525	133-5	103.1	22.4	55.0	102.92	101.05	101.81	1.29
MH-522	MH-525	134-1	103.55	32.9	55.0	102.92	101.05	102.17	1.38
MH-522	MH-525	134-2	103.55	40.6	55.0	102.92	101.05	102.43	1.12
MH-522	MH-525	134-3	103.55	48.6	55.0	102.92	101.05	102.70	0.85
MH-523	MH-524	141-5	103.68	20.5	55.0	103.32	102.46	102.78	0.90
MH-523	MH-524	141-4	103.68	28.5	55.0	103.32	102.46	102.91	0.77
MH-523	MH-524	141-3	104.25	35.7	55.0	103.32	102.46	103.02	1.23
MH-523	MH-524	141-2	104.25	43.7	55.0	103.32	102.46	103.15	1.10
MH-523	MH-524	141-1	104.25	51.3	55.0	103.32	102.46	103.26	0.99
MH-524	MH-5240	126-1	103.57	5.3	65.0	102.46	102.19	102.21	1.36
MH-524	MH-5240	122-4	103.32	5.6	65.0	102.46	102.19	102.21	1.11
MH-524	MH-5240	126-2	103.57	13.3	65.0	102.46	102.19	102.24	1.33
MH-524	MH-5240	122-3	103.32	13.6	65.0	102.46	102.19	102.24	1.08
MH-524	MH-5240	122-2	103.32	20.9	65.0	102.46	102.19	102.27	1.05
MH-524	MH-5240	126-3	103.57	20.9	65.0	102.46	102.19	102.27	1.30
MH-524	MH-5240	122-1	103.32	28.9	65.0	102.46	102.19	102.31	1.01
MH-524	MH-5240	127-1	103.57	31.6	65.0	102.46	102.19	102.32	1.25
MH-524	MH-5240	121-3	103.45	39.5	65.0	102.46	102.19	102.35	1.10
MH-524	MH-5240	127-2	103.57	39.6	65.0	102.46	102.19	102.35	1.22
MH-524	MH-5240	121-2	103.45	47.1	65.0	102.46	102.19	102.38	1.07
MH-524	MH-5240	127-3	103.57	47.2	65.0	102.46	102.19	102.38	1.19
MH-524	MH-5240	121-1	103.45	55.1	65.0	102.46	102.19	102.42	1.03
MH-5240	MH-525	124-1	102.67	16.1	63.5	102.19	101.05	101.34	1.33
MH-5240	MH-525	123-5	102.2	19.8	63.5	102.19	101.05	101.40	0.80
MH-5240	MH-525	124-2	102.67	24.1	63.5	102.19	101.05	101.48	1.19
MH-5240	MH-525	123-4	102.74	27.4	63.5	102.19	101.05	101.54	1.20
MH-5240	MH-525	124-3	102.67	31.7	63.5	102.19	101.05	101.62	1.05
MH-5240	MH-525	123-3	102.74	35.4	63.5	102.19	101.05	101.68	1.06
MH-5240	MH-525	125-1	103.28	42.3	63.5	102.19	101.05	101.81	1.47
MH-5240	MH-525	123-2	103.08	42.6	63.5	102.19	101.05	101.81	1.27
MH-5240	MH-525	125-2	103.28	50.3	63.5	102.19	101.05	101.95	1.33
MH-5240	MH-525	123-1	103.08	50.6	63.5	102.19	101.05	101.96	1.12
MH-5240	MH-525	125-3	103.28	58.0	63.5	102.19	101.05	102.09	1.19
MH-5240	MH-525	122-5	103.32	61.3	63.5	102.19	101.05	102.15	1.17
MH-52400	MH-538	119-1	102.26	15.8	58.0	102.25	101.16	101.46	0.80
MH-52400	MH-538	119-2	102.26	23.8	58.0	102.25	101.16	101.61	0.65
MH-52400	MH-538	119-3	102.65	31.4	58.0	102.25	101.16	101.75	0.90
MH-52400	MH-538	120-1	103.45	42.1	58.0	102.25	101.16	101.95	1.50
MH-52400	MH-538	120-2	103.45	50.1	58.0	102.25	101.16	102.10	1.35
MH-52400	MH-538	120-3	103.45	57.4	58.0	102.25	101.16	102.23	1.22
MH-525	MH-526	132-1	101.26	15.8	58.5	101.05	100.09	100.35	0.91
MH-525	MH-526	132-2	101.26	23.8	58.5	101.05	100.09	100.48	0.78
MH-525	MH-526	132-3	101.65	31.0	58.5	101.05	100.09	100.60	1.05
MH-525	MH-526	132-4	101.65	39.0	58.5	101.05	100.09	100.73	0.92
MH-525	MH-526	133-1	101.85	49.7	58.5	101.05	100.09	100.91	0.94
MH-525	MH-526	133-2	102.71	57.3	58.5	101.05	100.09	101.03	1.68
MH-528	MH-529	5	101.37	6.6	62.5	98.29	98.05	98.07	3.30
MH-528	MH-529	81-1	98.72	9.8	62.5	98.29	98.05	98.09	0.63
MH-528	MH-529	4	101.37	12.7	62.5	98.29	98.05	98.10	3.27
MH-528	MH-529	81-2	98.72	17.8	62.5	98.29	98.05	98.12	0.60
MH-528	MH-529	81-3	98.72	25.0	62.5	98.29	98.05	98.14	0.58
MH-528	MH-529	3	101.37	25.5	62.5	98.29	98.05	98.15	3.22
MH-528	MH-529	2	101.42	31.6	62.5	98.29	98.05	98.17	3.25

Table C2B: USF Freeboard Results - 100-Year SCS 24Hr Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-528	MH-529	81-4	98.72	33.0	62.5	98.29	98.05	98.17	0.55
MH-528	MH-529	81-5	99.3	40.6	62.5	98.29	98.05	98.20	1.10
MH-528	MH-529	1	101.42	41.7	62.5	98.29	98.05	98.21	3.21
MH-529	MH-530	13	101.13	3.2	72.0	98.05	97.93	97.94	3.19
MH-529	MH-530	79-1	98.62	6.4	72.0	98.05	97.93	97.94	0.68
MH-529	MH-530	12	101.13	9.2	72.0	98.05	97.93	97.95	3.18
MH-529	MH-530	79-2	98.62	14.4	72.0	98.05	97.93	97.95	0.67
MH-529	MH-530	79-3	98.62	21.7	72.0	98.05	97.93	97.97	0.65
MH-529	MH-530	11	101.13	22.0	72.0	98.05	97.93	97.97	3.16
MH-529	MH-530	10	101.13	28.1	72.0	98.05	97.93	97.98	3.15
MH-529	MH-530	79-4	98.62	29.7	72.0	98.05	97.93	97.98	0.64
MH-529	MH-530	80-1	98.72	40.3	72.0	98.05	97.93	98.00	0.72
MH-529	MH-530	9	101.22	40.9	72.0	98.05	97.93	98.00	3.22
MH-529	MH-530	8	101.32	47.0	72.0	98.05	97.93	98.01	3.31
MH-529	MH-530	80-2	98.72	48.3	72.0	98.05	97.93	98.01	0.71
MH-529	MH-530	80-3	98.72	55.6	72.0	98.05	97.93	98.02	0.70
MH-529	MH-530	7	101.37	59.8	72.0	98.05	97.93	98.03	3.34
MH-529	MH-530	80-4	98.72	63.6	72.0	98.05	97.93	98.04	0.68
MH-529	MH-530	6	101.37	65.9	72.0	98.05	97.93	98.04	3.33
MH-529	MH-530	80-5	98.72	70.1	72.0	98.05	97.93	98.05	0.67
MH-530	MH-531	76-3	98.43	3.0	76.5	97.93	97.72	97.72	0.71
MH-530	MH-531	77-1	98.55	5.8	76.5	97.93	97.72	97.73	0.82
MH-530	MH-531	77-2	98.55	13.8	76.5	97.93	97.72	97.75	0.80
MH-530	MH-531	77-3	98.55	21.0	76.5	97.93	97.72	97.78	0.77
MH-530	MH-531	77-4	98.55	29.0	76.5	97.93	97.72	97.80	0.75
MH-530	MH-531	18	101.07	29.6	76.5	97.93	97.72	97.80	3.27
MH-530	MH-531	78-1	98.58	39.6	76.5	97.93	97.72	97.83	0.75
MH-530	MH-531	17	101.11	42.4	76.5	97.93	97.72	97.84	3.27
MH-530	MH-531	78-2	98.58	47.6	76.5	97.93	97.72	97.85	0.73
MH-530	MH-531	16	101.13	48.5	76.5	97.93	97.72	97.85	3.28
MH-530	MH-531	78-3	98.58	54.9	76.5	97.93	97.72	97.87	0.71
MH-530	MH-531	15	101.13	61.3	76.5	97.93	97.72	97.89	3.24
MH-530	MH-531	78-4	98.58	62.9	76.5	97.93	97.72	97.89	0.69
MH-530	MH-531	14	101.13	67.4	76.5	97.93	97.72	97.91	3.22
MH-530	MH-531	78-5	98.58	70.5	76.5	97.93	97.72	97.91	0.67
MH-534	MH-535	97-8	102.99	19.4	78.5	103.21	100.94	101.50	1.49
MH-534	MH-535	96-1	103.02	20.3	78.5	103.21	100.94	101.53	1.49
MH-534	MH-535	97-7	102.99	27.4	78.5	103.21	100.94	101.74	1.25
MH-534	MH-535	96-2	103.02	28.3	78.5	103.21	100.94	101.76	1.26
MH-534	MH-535	97-6	103.15	31.8	78.5	103.21	100.94	101.86	1.29
MH-534	MH-535	96-3	103.42	35.5	78.5	103.21	100.94	101.97	1.45
MH-534	MH-535	97-5	103.6	39.8	78.5	103.21	100.94	102.09	1.51
MH-534	MH-535	96-4	103.42	43.5	78.5	103.21	100.94	102.20	1.22
MH-534	MH-535	98-8	103.73	49.2	78.5	103.21	100.94	102.37	1.36
MH-534	MH-535	98-7	103.92	53.8	78.5	103.21	100.94	102.50	1.42
MH-534	MH-535	95-1	103.47	54.2	78.5	103.21	100.94	102.51	0.96
MH-534	MH-535	98-6	104.16	61.8	78.5	103.21	100.94	102.73	1.43
MH-534	MH-535	95-2	103.47	62.2	78.5	103.21	100.94	102.74	0.73
MH-534	MH-535	98-5	104.59	68.0	78.5	103.21	100.94	102.91	1.68
MH-534	MH-535	95-3	103.94	69.4	78.5	103.21	100.94	102.95	0.99
MH-534	MH-535	95-4	103.94	77.4	78.5	103.21	100.94	103.18	0.76
MH-534	MH-535	99-8	104.61	77.4	78.5	103.21	100.94	103.18	1.43
MH-535	MH-515	115-5	102.22	1.2	44.0	100.94	100.69	100.70	1.52
MH-535	MH-515	116-1	102.3	11.9	44.0	100.94	100.69	100.76	1.54
MH-535	MH-515	116-2	102.3	19.5	44.0	100.94	100.69	100.80	1.50
MH-535	MH-515	116-3	102.3	27.5	44.0	100.94	100.69	100.85	1.45
MH-535	MH-515	117-1	102.4	38.1	44.0	100.94	100.69	100.91	1.49
MH-5350	MH-539	118-3	102.4	16.8	52.5	101.68	100.11	100.61	1.79
MH-5350	MH-539	118-2	102.4	24.8	52.5	101.68	100.11	100.85	1.55
MH-5350	MH-539	118-1	102.4	32.4	52.5	101.68	100.11	101.08	1.32
MH-5350	MH-539	117-3	102.4	43.1	52.5	101.68	100.11	101.40	1.00
MH-5350	MH-539	117-2	102.4	51.1	52.5	101.68	100.11	101.64	0.76
MH-536	MH-538	196-1	102.56	6.1	59.0	102.68	101.16	101.32	1.24
MH-536	MH-538	142-1	103.33	15.7	59.0	102.68	101.16	101.57	1.76
MH-536	MH-538	195-4	103.31	16.1	59.0	102.68	101.16	101.58	1.73
MH-536	MH-538	142-2	103.33	23.7	59.0	102.68	101.16	101.77	1.56
MH-536	MH-538	195-3	103.31	24.1	59.0	102.68	101.16	101.78	1.53
MH-536	MH-538	142-3	103.72	30.3	59.0	102.68	101.16	101.94	1.78
MH-536	MH-538	195-2	103.7	30.7	59.0	102.68	101.16	101.95	1.75
MH-536	MH-538	142-4	103.72	38.3	59.0	102.68	101.16	102.14	1.58
MH-536	MH-538	195-1	103.7	38.7	59.0	102.68	101.16	102.15	1.55
MH-536	MH-538	143-1	103.96	48.3	59.0	102.68	101.16	102.40	1.56
MH-536	MH-538	194-4	103.92	48.7	59.0	102.68	101.16	102.41	1.51
MH-536	MH-538	143-2	103.96	56.3	59.0	102.68	101.16	102.61	1.35
MH-536	MH-538	194-3	103.92	56.7	59.0	102.68	101.16	102.62	1.30
MH-537	MH-536	194-2	103.92	4.4	64.5	103.00	102.68	102.70	1.22
MH-537	MH-536	143-3	103.96	4.7	64.5	103.00	102.68	102.70	1.26
MH-537	MH-536	194-1	103.92	12.4	64.5	103.00	102.68	102.74	1.18
MH-537	MH-536	144-1	103.96	14.7	64.5	103.00	102.68	102.75	1.21

Table C2B: USF Freeboard Results - 100-Year SCS 24Hr Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-537	MH-536	193-4	103.88	22.4	64.5	103.00	102.68	102.79	1.09
MH-537	MH-536	144-2	103.96	22.7	64.5	103.00	102.68	102.79	1.17
MH-537	MH-536	144-3	103.96	29.3	64.5	103.00	102.68	102.82	1.14
MH-537	MH-536	193-3	103.88	30.4	64.5	103.00	102.68	102.83	1.05
MH-537	MH-536	193-2	103.88	37.0	64.5	103.00	102.68	102.86	1.02
MH-537	MH-536	144-4	103.96	37.3	64.5	103.00	102.68	102.86	1.10
MH-537	MH-536	144-5	103.96	44.6	64.5	103.00	102.68	102.90	1.06
MH-537	MH-536	193-1	103.88	45.0	64.5	103.00	102.68	102.90	0.98
MH-537	MH-536	192-4	103.75	55.0	64.5	103.00	102.68	102.95	0.80
MH-538	MH-539	197-3	101.08	16.5	58.5	101.16	100.11	100.41	0.67
MH-538	MH-539	197-2	101.08	24.5	58.5	101.16	100.11	100.55	0.53
MH-538	MH-539	197-1	101.42	31.8	58.5	101.16	100.11	100.68	0.74
MH-538	MH-539	196-4	102.16	41.8	58.5	101.16	100.11	100.86	1.30
MH-538	MH-539	196-3	102.16	49.8	58.5	101.16	100.11	101.01	1.15
MH-538	MH-539	196-2	102.56	56.4	58.5	101.16	100.11	101.13	1.43
MH-542	MH-543	58	103.46	5.4	53.0	99.98	99.83	99.85	3.61
MH-542	MH-543	62-5	100.72	8.9	53.0	99.98	99.83	99.86	0.86
MH-542	MH-543	62-4	100.72	16.2	53.0	99.98	99.83	99.88	0.84
MH-542	MH-543	59	103.46	18.2	53.0	99.98	99.83	99.88	3.58
MH-542	MH-543	62-3	100.72	24.2	53.0	99.98	99.83	99.90	0.82
MH-542	MH-543	60	103.42	24.3	53.0	99.98	99.83	99.90	3.52
MH-542	MH-543	62-2	100.72	30.8	53.0	99.98	99.83	99.92	0.80
MH-542	MH-543	61	103.33	37.1	53.0	99.98	99.83	99.94	3.39
MH-542	MH-543	62-1	100.72	38.8	53.0	99.98	99.83	99.94	0.78
MH-543	MH-544	66-2	100.62	3.8	118.0	99.83	98.50	98.55	2.07
MH-543	MH-544	45	103.16	4.0	118.0	99.83	98.50	98.55	4.61
MH-543	MH-544	46	103.46	10.1	118.0	99.83	98.50	98.62	4.84
MH-543	MH-544	66-1	100.62	11.8	118.0	99.83	98.50	98.64	1.98
MH-543	MH-544	65-4	100.72	21.8	118.0	99.83	98.50	98.75	1.97
MH-543	MH-544	47	103.51	22.9	118.0	99.83	98.50	98.76	4.75
MH-543	MH-544	48	103.51	29.0	118.0	99.83	98.50	98.83	4.68
MH-543	MH-544	65-3	100.72	29.8	118.0	99.83	98.50	98.84	1.88
MH-543	MH-544	65-2	100.72	36.4	118.0	99.83	98.50	98.91	1.81
MH-543	MH-544	49	103.51	41.8	118.0	99.83	98.50	98.97	4.54
MH-543	MH-544	65-1	100.72	44.4	118.0	99.83	98.50	99.00	1.72
MH-543	MH-544	50	103.51	47.9	118.0	99.83	98.50	99.04	4.47
MH-543	MH-544	64-4	100.86	54.4	118.0	99.83	98.50	99.12	1.74
MH-543	MH-544	51	103.51	60.8	118.0	99.83	98.50	99.19	4.32
MH-543	MH-544	64-3	100.86	62.4	118.0	99.83	98.50	99.21	1.65
MH-543	MH-544	52	103.51	66.9	118.0	99.83	98.50	99.26	4.25
MH-543	MH-544	64-2	100.86	69.0	118.0	99.83	98.50	99.28	1.58
MH-543	MH-544	64-1	100.86	77.0	118.0	99.83	98.50	99.37	1.49
MH-543	MH-544	53	103.57	79.7	118.0	99.83	98.50	99.40	4.17
MH-543	MH-544	54	103.61	85.8	118.0	99.83	98.50	99.47	4.14
MH-543	MH-544	63-5	100.86	87.0	118.0	99.83	98.50	99.48	1.38
MH-543	MH-544	63-4	100.86	94.3	118.0	99.83	98.50	99.57	1.29
MH-543	MH-544	55	103.59	98.6	118.0	99.83	98.50	99.62	3.97
MH-543	MH-544	63-3	100.86	102.3	118.0	99.83	98.50	99.66	1.20
MH-543	MH-544	56	103.49	104.7	118.0	99.83	98.50	99.68	3.81
MH-543	MH-544	63-2	100.86	108.9	118.0	99.83	98.50	99.73	1.13
MH-543	MH-544	63-1	100.86	116.9	118.0	99.83	98.50	99.82	1.04
MH-543	MH-544	57	103.46	117.5	118.0	99.83	98.50	99.83	3.63
MH-544	MH-5440	68-3	99.4	3.4	57.5	98.50	98.44	98.45	0.95
MH-544	MH-5440	68-2	99.4	10.7	57.5	98.50	98.44	98.45	0.95
MH-544	MH-5440	68-1	99.4	18.7	57.5	98.50	98.44	98.46	0.94
MH-544	MH-5440	67-3	99.49	28.7	57.5	98.50	98.44	98.47	1.02
MH-544	MH-5440	42	102.27	30.0	57.5	98.50	98.44	98.47	3.80
MH-544	MH-5440	67-2	100.2	36.0	57.5	98.50	98.44	98.48	1.72
MH-544	MH-5440	43	102.6	42.8	57.5	98.50	98.44	98.49	4.11
MH-544	MH-5440	67-1	100.2	44.0	57.5	98.50	98.44	98.49	1.71
MH-544	MH-5440	44	102.93	48.9	57.5	98.50	98.44	98.49	4.44
MH-544	MH-5440	66-3	100.62	54.0	57.5	98.50	98.44	98.50	2.12
MH-546	MH-547	177-1	102.31	8.8	99.5	102.13	101.41	101.48	0.83
MH-546	MH-547	177-2	102.61	16.1	99.5	102.13	101.41	101.53	1.08
MH-546	MH-547	177-3	102.61	24.1	99.5	102.13	101.41	101.59	1.02
MH-546	MH-547	178-1	102.71	34.1	99.5	102.13	101.41	101.66	1.05
MH-546	MH-547	178-2	102.71	42.1	99.5	102.13	101.41	101.72	0.99
MH-546	MH-547	178-3	103.04	48.7	99.5	102.13	101.41	101.76	1.28
MH-546	MH-547	178-4	103.04	56.7	99.5	102.13	101.41	101.82	1.22
MH-546	MH-547	179-1	103.04	66.7	99.5	102.13	101.41	101.89	1.15
MH-546	MH-547	179-2	103.4	74.0	99.5	102.13	101.41	101.95	1.45
MH-546	MH-547	179-3	103.4	82.0	99.5	102.13	101.41	102.00	1.40
MH-546	MH-547	179-4	103.4	88.6	99.5	102.13	101.41	102.05	1.35
MH-546	MH-547	179-5	103.4	96.6	99.5	102.13	101.41	102.11	1.29
MH-547	MH-548	175-1	101.33	5.2	60.0	101.41	100.59	100.66	0.67
MH-547	MH-548	175-2	101.33	13.6	60.0	101.41	100.59	100.78	0.55
MH-547	MH-548	175-3	101.64	20.2	60.0	101.41	100.59	100.87	0.77
MH-547	MH-548	175-4	101.64	28.2	60.0	101.41	100.59	100.98	0.66
MH-547	MH-548	176-1	101.82	38.2	60.0	101.41	100.59	101.12	0.70

Table C2B: USF Freeboard Results - 100-Year SCS 24Hr Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-547	MH-548	176-2	102.27	45.8	60.0	101.41	100.59	101.22	1.05
MH-547	MH-548	176-3	102.27	53.9	60.0	101.41	100.59	101.33	0.94
MH-548	MH-549	174-2	100.89	0.3	29.5	100.59	100.28	100.28	0.61
MH-548	MH-549	174-3	100.89	8.2	29.5	100.59	100.28	100.37	0.52
MH-548	MH-549	174-4	101.21	14.8	29.5	100.59	100.28	100.44	0.77
MH-548	MH-549	174-5	101.21	22.8	29.5	100.59	100.28	100.52	0.69
MH-549	MH-550	174-1	100.89	2.7	12.5	100.28	99.91	99.99	0.90
MH-550	MH-551	170-6	100.02	1.6	112.0	99.91	98.65	98.67	1.35
MH-550	MH-551	170-5	100.3	6.9	112.0	99.91	98.65	98.73	1.57
MH-550	MH-551	171-8	100.3	16.4	112.0	99.91	98.65	98.84	1.46
MH-550	MH-551	171-7	100.33	21.0	112.0	99.91	98.65	98.89	1.44
MH-550	MH-551	171-6	100.46	29.0	112.0	99.91	98.65	98.98	1.48
MH-550	MH-551	171-5	100.73	35.2	112.0	99.91	98.65	99.05	1.68
MH-550	MH-551	172-10	100.73	44.6	112.0	99.91	98.65	99.15	1.58
MH-550	MH-551	172-9	100.77	49.2	112.0	99.91	98.65	99.20	1.57
MH-550	MH-551	172-8	100.9	57.2	112.0	99.91	98.65	99.29	1.61
MH-550	MH-551	172-7	100.96	61.6	112.0	99.91	98.65	99.34	1.62
MH-550	MH-551	172-6	101.27	69.6	112.0	99.91	98.65	99.43	1.84
MH-550	MH-551	173-10	101.27	77.4	112.0	99.91	98.65	99.52	1.75
MH-550	MH-551	173-9	101.33	85.4	112.0	99.91	98.65	99.61	1.72
MH-550	MH-551	173-8	101.43	91.6	112.0	99.91	98.65	99.68	1.75
MH-550	MH-551	173-7	101.5	96.0	112.0	99.91	98.65	99.73	1.77
MH-550	MH-551	173-6	101.91	104.0	112.0	99.91	98.65	99.82	2.09
MH-551	MH-559	169-8	99.46	10.7	52.5	98.65	96.13	96.64	2.82
MH-551	MH-559	169-7	99.43	18.7	52.5	98.65	96.13	97.03	2.40
MH-551	MH-559	169-6	99.53	23.1	52.5	98.65	96.13	97.24	2.29
MH-551	MH-559	169-5	99.86	31.1	52.5	98.65	96.13	97.62	2.24
MH-551	MH-559	170-8	99.86	40.5	52.5	98.65	96.13	98.08	1.78
MH-551	MH-559	170-7	99.9	45.1	52.5	98.65	96.13	98.30	1.60
MH-552	MH-553	172-1	100.73	1.3	64.5	100.30	99.28	99.30	1.43
MH-552	MH-553	172-2	100.77	4.9	64.5	100.30	99.28	99.36	1.41
MH-552	MH-553	167-4	100.44	7.6	64.5	100.30	99.28	99.40	1.04
MH-552	MH-553	172-3	100.9	13.0	64.5	100.30	99.28	99.49	1.41
MH-552	MH-553	167-3	100.44	15.6	64.5	100.30	99.28	99.53	0.91
MH-552	MH-553	172-4	100.96	17.2	64.5	100.30	99.28	99.55	1.41
MH-552	MH-553	167-2	100.44	22.2	64.5	100.30	99.28	99.63	0.81
MH-552	MH-553	172-5	101.27	25.2	64.5	100.30	99.28	99.68	1.59
MH-552	MH-553	167-1	100.44	30.2	64.5	100.30	99.28	99.76	0.68
MH-552	MH-553	173-1	101.27	33.1	64.5	100.30	99.28	99.80	1.47
MH-552	MH-553	168-4	100.69	40.2	64.5	100.30	99.28	99.92	0.77
MH-552	MH-553	173-2	101.33	41.1	64.5	100.30	99.28	99.93	1.40
MH-552	MH-553	173-3	101.43	47.2	64.5	100.30	99.28	100.03	1.40
MH-552	MH-553	168-3	100.69	48.2	64.5	100.30	99.28	100.04	0.65
MH-552	MH-553	173-4	101.5	51.6	64.5	100.30	99.28	100.10	1.40
MH-552	MH-553	168-2	101.48	54.8	64.5	100.30	99.28	100.15	1.33
MH-552	MH-553	173-5	101.91	59.6	64.5	100.30	99.28	100.22	1.69
MH-552	MH-553	168-1	101.48	62.8	64.5	100.30	99.28	100.27	1.21
MH-553	MH-557	169-1	99.46	16.0	103.5	99.28	97.96	98.16	1.30
MH-553	MH-557	169-2	99.43	25.6	103.5	99.28	97.96	98.28	1.15
MH-553	MH-557	169-3	99.53	30.0	103.5	99.28	97.96	98.34	1.19
MH-553	MH-557	169-4	99.86	38.0	103.5	99.28	97.96	98.44	1.42
MH-553	MH-557	165-4	99.5	38.5	103.5	99.28	97.96	98.45	1.05
MH-553	MH-557	165-3	99.5	46.5	103.5	99.28	97.96	98.55	0.95
MH-553	MH-557	170-1	99.86	47.4	103.5	99.28	97.96	98.56	1.30
MH-553	MH-557	170-2	99.9	52.0	103.5	99.28	97.96	98.62	1.28
MH-553	MH-557	165-2	99.5	53.1	103.5	99.28	97.96	98.64	0.86
MH-553	MH-557	170-3	100.02	59.9	103.5	99.28	97.96	98.72	1.30
MH-553	MH-557	165-1	99.5	61.2	103.5	99.28	97.96	98.74	0.76
MH-553	MH-557	170-4	100.3	66.1	103.5	99.28	97.96	98.80	1.50
MH-553	MH-557	166-5	99.7	71.2	103.5	99.28	97.96	98.87	0.83
MH-553	MH-557	171-1	100.3	75.5	103.5	99.28	97.96	98.92	1.38
MH-553	MH-557	166-4	99.7	79.2	103.5	99.28	97.96	98.97	0.73
MH-553	MH-557	171-2	100.33	80.2	103.5	99.28	97.96	98.98	1.35
MH-553	MH-557	166-3	100.04	85.8	103.5	99.28	97.96	99.06	0.98
MH-553	MH-557	171-3	100.46	88.2	103.5	99.28	97.96	99.09	1.37
MH-553	MH-557	166-2	100.04	93.8	103.5	99.28	97.96	99.16	0.88
MH-553	MH-557	171-4	100.73	94.4	103.5	99.28	97.96	99.17	1.56
MH-553	MH-557	166-1	100.04	101.1	103.5	99.28	97.96	99.25	0.79
MH-554	MH-556	160-4	100.02	2.6	81.5	99.73	98.98	99.00	1.02
MH-554	MH-556	160-3	100.02	10.6	81.5	99.73	98.98	99.08	0.94
MH-554	MH-556	160-2	100.02	17.2	81.5	99.73	98.98	99.14	0.88
MH-554	MH-556	160-1	100.02	25.2	81.5	99.73	98.98	99.21	0.81
MH-554	MH-556	159-5	100.12	35.2	81.5	99.73	98.98	99.30	0.82
MH-554	MH-556	159-4	100.48	42.5	81.5	99.73	98.98	99.37	1.11
MH-554	MH-556	159-3	100.48	50.5	81.5	99.73	98.98	99.44	1.04
MH-554	MH-556	159-2	100.48	57.1	81.5	99.73	98.98	99.50	0.98
MH-554	MH-556	159-1	100.48	65.1	81.5	99.73	98.98	99.58	0.90
MH-554	MH-556	158-5	100.48	75.1	81.5	99.73	98.98	99.67	0.81
MH-554	MH-556	158-4	100.48	78.8	81.5	99.73	98.98	99.70	0.78

Table C2B: USF Freeboard Results - 100-Year SCS 24Hr Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-556	MH-557	162-3	99.15	7.8	70.0	98.98	97.96	98.07	1.08
MH-556	MH-557	164-1	99.39	11.9	70.0	98.98	97.96	98.13	1.26
MH-556	MH-557	162-2	99.15	14.4	70.0	98.98	97.96	98.17	0.98
MH-556	MH-557	164-2	99.39	19.9	70.0	98.98	97.96	98.25	1.14
MH-556	MH-557	162-1	99.15	22.4	70.0	98.98	97.96	98.28	0.87
MH-556	MH-557	164-3	99.39	26.5	70.0	98.98	97.96	98.34	1.05
MH-556	MH-557	161-4	99.55	32.5	70.0	98.98	97.96	98.43	1.12
MH-556	MH-557	164-4	99.39	34.5	70.0	98.98	97.96	98.46	0.93
MH-556	MH-557	161-3	99.55	40.5	70.0	98.98	97.96	98.55	1.00
MH-556	MH-557	161-2	99.55	47.1	70.0	98.98	97.96	98.64	0.91
MH-556	MH-557	161-1	99.55	55.1	70.0	98.98	97.96	98.76	0.79
MH-556	MH-557	160-5	99.64	65.1	70.0	98.98	97.96	98.91	0.73
MH-557	MH-558	163-3	98.67	4.5	36.5	97.96	97.70	97.73	0.94
MH-557	MH-558	163-2	98.67	11.1	36.5	97.96	97.70	97.78	0.89
MH-557	MH-558	163-1	98.67	19.1	36.5	97.96	97.70	97.83	0.84
MH-557	MH-558	162-5	98.77	29.1	36.5	97.96	97.70	97.90	0.87
MH-557	MH-558	162-4	99.15	35.1	36.5	97.96	97.70	97.95	1.20
MH-558	MH-559	163-5	98.32	8.9	14.5	97.70	96.13	97.09	1.23
MH-558	MH-559	163-4	98.67	10.4	14.5	97.70	96.13	97.26	1.41
MH-561	MH-537	192-3	103.75	3.1	42.5	103.08	103.00	103.01	0.74
MH-561	MH-537	192-2	103.75	5.2	42.5	103.08	103.00	103.01	0.74
MH-561	MH-537	180-1	103.86	12.6	42.5	103.08	103.00	103.03	0.83
MH-561	MH-537	192-1	103.75	13.2	42.5	103.08	103.00	103.03	0.72
MH-561	MH-537	180-2	103.86	19.9	42.5	103.08	103.00	103.04	0.82
MH-561	MH-537	191-4	103.8	23.2	42.5	103.08	103.00	103.05	0.75
MH-561	MH-537	180-3	103.86	27.9	42.5	103.08	103.00	103.06	0.80
MH-561	MH-537	191-3	103.8	31.2	42.5	103.08	103.00	103.06	0.74
MH-561	MH-537	180-4	103.86	34.5	42.5	103.08	103.00	103.07	0.79
MH-561	MH-537	191-2	103.8	37.7	42.5	103.08	103.00	103.07	0.73
MH-561	MH-563	182-3	102.47	2.6	61.0	103.08	101.23	101.31	1.16
MH-561	MH-563	182-2	102.47	10.6	61.0	103.08	101.23	101.55	0.92
MH-561	MH-563	190-1	103.21	17.4	61.0	103.08	101.23	101.76	1.45
MH-561	MH-563	182-1	102.81	17.9	61.0	103.08	101.23	101.77	1.04
MH-561	MH-563	190-2	103.21	25.4	61.0	103.08	101.23	102.00	1.21
MH-561	MH-563	181-4	103.55	27.9	61.0	103.08	101.23	102.08	1.47
MH-561	MH-563	190-3	103.8	32.0	61.0	103.08	101.23	102.20	1.60
MH-561	MH-563	181-3	103.55	35.9	61.0	103.08	101.23	102.32	1.23
MH-561	MH-563	190-4	103.8	40.0	61.0	103.08	101.23	102.45	1.35
MH-561	MH-563	181-2	103.86	42.5	61.0	103.08	101.23	102.52	1.34
MH-561	MH-563	190-5	103.8	47.3	61.0	103.08	101.23	102.67	1.13
MH-561	MH-563	181-1	103.86	50.5	61.0	103.08	101.23	102.76	1.10
MH-561	MH-563	191-1	103.8	55.7	61.0	103.08	101.23	102.92	0.88
MH-561	MH-563	180-5	103.86	59.1	61.0	103.08	101.23	103.03	0.83
MH-563	MH-564	187-2	102.43	3.4	73.5	101.23	100.94	100.96	1.47
MH-563	MH-564	185-1	102.24	4.5	73.5	101.23	100.94	100.96	1.28
MH-563	MH-564	184-4	102.57	10.2	73.5	101.23	100.94	100.98	1.59
MH-563	MH-564	187-3	102.75	10.9	73.5	101.23	100.94	100.99	1.76
MH-563	MH-564	184-3	102.57	18.2	73.5	101.23	100.94	101.01	1.56
MH-563	MH-564	188-1	102.75	20.8	73.5	101.23	100.94	101.02	1.73
MH-563	MH-564	184-2	102.57	24.8	73.5	101.23	100.94	101.04	1.53
MH-563	MH-564	188-2	102.75	28.8	73.5	101.23	100.94	101.06	1.69
MH-563	MH-564	184-1	102.57	32.8	73.5	101.23	100.94	101.07	1.50
MH-563	MH-564	188-3	102.75	36.2	73.5	101.23	100.94	101.08	1.67
MH-563	MH-564	183-3	102.57	42.8	73.5	101.23	100.94	101.11	1.46
MH-563	MH-564	189-1	102.64	46.2	73.5	101.23	100.94	101.12	1.52
MH-563	MH-564	183-2	102.57	50.8	73.5	101.23	100.94	101.14	1.43
MH-563	MH-564	189-2	102.64	54.4	73.5	101.23	100.94	101.16	1.48
MH-563	MH-564	183-1	102.57	58.6	73.5	101.23	100.94	101.17	1.40
MH-563	MH-564	189-3	102.64	61.6	73.5	101.23	100.94	101.18	1.46
MH-564	MH-8500	186-1	102.24	17.1	48.5	100.94	99.67	100.12	2.12
MH-564	MH-8500	185-5	101.61	19.9	48.5	100.94	99.67	100.19	1.42
MH-564	MH-8500	186-2	102.24	25.1	48.5	100.94	99.67	100.33	1.91
MH-564	MH-8500	185-4	101.61	27.9	48.5	100.94	99.67	100.40	1.21
MH-564	MH-8500	186-3	102.24	32.4	48.5	100.94	99.67	100.52	1.72
MH-564	MH-8500	185-3	101.93	34.5	48.5	100.94	99.67	100.57	1.36
MH-564	MH-8500	187-1	102.43	42.4	48.5	100.94	99.67	100.78	1.65
MH-564	MH-8500	185-2	101.93	42.5	48.5	100.94	99.67	100.79	1.14

Key:

Freeboard to USF less than 0.30 m

Freeboard to USF less than 0.00 m

Min	0.34
Max	4.84
Average	1.35

Table C3A: Pipe Data and Hydraulic Simulation Results - 1979 Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH_136	MH_302	96.484	96.41	101.19	101.14	2250	53.9	0.1	0.013	1.66	6.59	7.09	1.08	-0.30	01:36	98.43	98.37
MH_302	MH_303	96.41	96.331	101.14	101.08	2250	58.9	0.1	0.013	1.66	6.59	7.74	1.17	-0.29	01:35	98.37	98.29
MH_303	MH_304	96.331	96.176	101.08	100.73	2250	134.3	0.1	0.013	1.67	6.62	7.85	1.18	-0.29	01:35	98.29	98.09
MH_304	MH_306TEE	96.176	96.133	100.73	100.27	2250	42.5	0.1	0.013	1.67	6.62	7.91	1.19	-0.34	01:35	98.09	97.83
MH_306TEE	MH_307	96.133	96.1	100.27	100.35	2250	11.2	0.1	0.013	1.79	7.10	7.91	1.11	-0.55	01:35	97.83	97.60
MH_307	MH_400	96.1	96.067	100.35	100.35	2250	22.7	0.1	0.013	1.71	6.79	5.68	0.84	-0.75	01:34	97.60	97.57
MH_400	OGS_1	96.067	96.037	100.35	100.5	750	4.9	0.2	0.013	1.13	0.50	1.01	2.02	0.75	01:10	97.57	97.53
MH_500	OGS_2	96.056	96.026	100.35	100.428	750	5.0	0.2	0.013	1.13	0.50	1.01	2.02	0.53	01:18	97.34	97.30
MH-313	MH_500	96.099	96.056	99.835	100.35	2250	33.0	0.1	0.013	1.68	6.69	3.90	0.58	-0.79	01:34	97.56	97.34
MH-500	MH-502	102.24	100.94	105.21	104.245	300	92.0	1.3	0.013	1.53	0.11	0.10	0.90	-0.08	01:30	102.46	101.19
MH-502	MH-503	100.94	98.961	104.245	102.42	450	119.0	1.6	0.013	2.27	0.36	0.22	0.62	-0.20	01:30	101.19	99.42
MH-5020	MH-502	101.143	100.94	104.27	104.245	300	10.5	0.5	0.013	0.97	0.07	0.00	0.00	-0.25	01:17	101.19	101.19
MH-503	MH-504	98.961	98.683	102.42	101.89	525	73.0	0.3	0.013	1.00	0.22	0.25	1.16	-0.07	01:31	99.42	99.06
MH-504	MH-528	98.683	97.315	101.89	101.06	600	108.0	0.9	0.013	2.00	0.57	0.42	0.74	-0.22	01:31	99.06	98.22
MH-505	MH-506	103.478	103.351	105.836	106.28	300	13.0	0.6	0.013	1.06	0.07	0.00	0.00	-0.30	01:30	103.48	103.57
MH-505	MH-534	103.478	103.033	105.836	105.406	375	94.5	0.5	0.013	1.06	0.12	0.00	0.00	-0.38	01:31	103.48	103.20
MH-506	MH-508	103.351	103.054	106.28	105.88	300	79.0	0.4	0.013	0.81	0.06	0.05	0.87	-0.08	01:30	103.57	103.31
MH-5070	MH-513	103.12	102.394	105.92	105.51	300	82.0	0.5	0.013	0.97	0.07	0.04	0.63	-0.13	01:30	103.29	102.92
MH-508	MH-509	103.054	102.837	105.88	105.67	300	41.5	0.5	0.013	0.92	0.06	0.07	1.02	-0.04	01:30	103.31	103.09
MH-5080	MH-517	102.898	102.054	105.7	105.28	300	76.5	0.6	0.013	1.01	0.07	0.04	0.61	-0.13	01:30	103.07	102.64
MH-509	MH-510	102.837	102.718	105.67	105.6	300	10.5	0.4	0.013	0.87	0.06	0.07	1.08	-0.05	01:30	103.09	102.91
MH-510	MH-511	102.718	102.077	105.6	105.25	375	64.0	0.6	0.013	1.18	0.13	0.07	0.51	-0.19	01:31	102.91	102.29
MH-511	MH-526	102.077	98.642	105.25	103	450	95.5	2.8	0.013	3.00	0.48	0.22	0.45	-0.24	01:30	102.29	99.92
MH-513	MH-515	102.394	100.231	105.51	104	300	81.0	2.3	0.013	2.08	0.15	0.14	0.97	0.23	01:34	102.92	100.66
MH-515	MH-518	100.231	99.793	104	103.59	600	44.0	0.3	0.013	1.19	0.34	0.32	0.96	-0.17	01:30	100.66	100.29
MH-517	MH-518	102.054	99.793	105.28	103.59	300	82.0	2.3	0.013	2.08	0.15	0.14	0.98	0.29	01:33	102.64	100.29
MH-518	MH-526	99.793	98.642	103.59	103	675	47.0	0.3	0.013	1.29	0.46	0.46	1.01	-0.17	01:31	100.29	99.92
MH-519	MH-520	103.476	103.127	105.766	106.01	300	54.5	0.5	0.013	0.97	0.07	0.00	0.00	-0.30	00:00	103.48	103.35
MH-519	MH-523	103.476	103.213	105.766	105.726	300	11.5	0.3	0.013	0.81	0.06	0.00	0.00	-0.30	00:00	103.48	103.32
MH-520	MH-521	103.127	102.808	106.01	105.71	375	57.5	0.5	0.013	1.12	0.12	0.07	0.60	-0.16	01:30	103.35	103.05
MH-521	MH-522	102.808	102.725	105.71	105.64	375	11.5	0.3	0.013	0.94	0.10	0.07	0.72	-0.14	01:30	103.05	102.90
MH-522	MH-525	102.725	100.69	105.64	104.2	375	55.0	2.6	0.013	2.54	0.28	0.12	0.44	-0.20	01:30	102.90	101.03
MH-523	MH-524	103.213	102.148	105.726	104.956	300	55.0	1.8	0.013	1.84	0.13	0.04	0.28	-0.19	01:31	103.32	102.44
MH-524	MH-5240	102.148	101.917	104.956	105.23	375	65.0	0.3	0.013	0.87	0.10	0.09	0.96	-0.08	01:30	102.44	102.18
MH-5240	MH-525	101.917	100.69	105.23	104.2	375	63.5	1.6	0.013	1.98	0.22	0.15	0.68	-0.11	01:30	102.18	101.03
MH-52400	MH-538	102.155	100.883	104.956	103.676	300	58.0	1.8	0.013	1.84	0.13	0.02	0.18	-0.21	01:30	102.25	101.15
MH-525	MH-526	100.69	98.642	104.2	103	525	58.5	1.8	0.013	2.67	0.58	0.34	0.58	-0.19	01:30	101.03	99.92
MH-526	MH-528	98.642	97.315	103	101.06	675	59.5	1.6	0.013	2.97	1.06	1.09	1.02	0.61	01:30	99.92	98.22
MH-527	MH-528	99.084	97.315	101.18	101.06	300	18.5	0.4	0.013	0.81	0.06	0.01	0.23	-0.19	01:28	99.19	98.22
MH-528	MH-529	97.315	97.009	101.06	100.82	1050	62.5	0.3	0.013	1.58	1.37	1.54	1.13	-0.15	01:31	98.22	97.99
MH-529	MH-530	97.009	96.851	100.82	100.58	1200	72.0	0.2	0.013	1.34	1.51	1.54	1.02	-0.22	01:32	97.99	97.87

Table C3A: Pipe Data and Hydraulic Simulation Results - 1979 Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-530	MH-531	96.851	96.656	100.58	100.45	1200	76.5	0.2	0.013	1.34	1.51	1.67	1.10	-0.18	01:32	97.87	97.68
MH-531	MH-313	96.656	96.099	100.45	99.835	1200	21.5	0.1	0.013	1.33	1.50	1.66	1.11	-0.18	01:32	97.68	97.56
MH-534	MH-535	103.033	100.603	105.406	103.886	375	78.5	3.0	0.013	2.75	0.30	0.13	0.42	-0.20	01:30	103.20	100.93
MH-535	MH-515	100.603	100.231	103.886	104	450	44.0	0.2	0.013	0.80	0.13	0.13	1.01	-0.12	01:30	100.93	100.66
MH-5350	MH-539	101.607	99.624	103.886	102.466	300	52.5	2.4	0.013	2.12	0.15	0.02	0.11	-0.23	01:30	101.68	100.10
MH-536	MH-538	102.515	100.883	105.446	103.676	450	59.0	2.2	0.013	2.63	0.42	0.11	0.27	-0.29	01:30	102.68	101.15
MH-537	MH-536	102.673	102.515	105.126	105.446	450	64.5	0.2	0.013	0.80	0.13	0.11	0.87	-0.14	01:30	102.98	102.68
MH-538	MH-539	100.883	99.624	103.676	102.466	525	58.5	2.1	0.013	2.88	0.62	0.33	0.54	-0.26	01:30	101.15	100.10
MH-539	MH-542	99.624	99.339	102.466	102.396	525	9.5	0.6	0.013	1.54	0.33	0.35	1.05	-0.05	01:30	100.10	99.95
MH-540	MH-541	100.072	99.961	101.646	102.506	300	14.5	0.4	0.013	0.81	0.06	0.03	0.51	-0.14	01:24	100.23	100.11
MH-541	MH-542	99.961	99.339	102.506	102.396	300	10.0	0.4	0.013	0.81	0.06	0.03	0.51	-0.15	01:24	100.11	99.95
MH-542	MH-543	99.339	99.184	102.396	102.186	750	53.0	0.2	0.013	0.98	0.43	0.50	1.15	-0.14	01:30	99.95	99.81
MH-543	MH-544	99.184	97.993	102.186	102.016	825	118.0	0.2	0.013	1.04	0.56	0.58	1.05	-0.20	01:31	99.81	98.42
MH-544	MH-5440	97.993	97.273	102.016	101	825	57.5	1.2	0.013	2.94	1.57	0.64	0.41	-0.39	01:28	98.42	98.39
MH-5440	MH_302	97.273	96.41	101	101.14	825	12.3	1.2	0.013	2.97	1.59	0.64	0.40	0.30	01:28	98.39	98.37
MH-546	MH-547	102.009	101.183	104.84	104.04	375	99.5	0.8	0.013	1.42	0.16	0.04	0.23	-0.25	01:32	102.13	101.40
MH-547	MH-548	101.183	100.223	104.04	103.13	375	60.0	1.6	0.013	1.98	0.22	0.14	0.63	-0.16	01:30	101.40	100.54
MH-548	MH-549	100.223	99.898	103.13	102.8	375	29.5	1.0	0.013	1.59	0.18	0.16	0.94	-0.06	01:30	100.54	100.23
MH-549	MH-550	99.898	99.618	102.8	102.64	375	12.5	1.0	0.013	1.59	0.18	0.16	0.94	-0.05	01:30	100.23	99.89
MH-550	MH-551	99.618	97.862	102.64	100.93	525	112.0	1.6	0.013	2.47	0.54	0.27	0.51	-0.26	01:30	99.89	98.51
MH-551	MH-559	97.862	94.699	100.93	100.39	525	52.5	1.4	0.013	2.35	0.51	0.44	0.87	0.13	01:30	98.51	95.97
MH-552	MH-553	100.139	99.064	102.99	101.99	300	64.5	1.6	0.013	1.70	0.12	0.06	0.49	-0.15	01:30	100.29	99.26
MH-553	MH-557	99.064	97.315	101.99	100.86	375	103.5	1.4	0.013	1.88	0.21	0.12	0.56	-0.17	01:30	99.26	97.89
MH-554	MH-556	99.668	98.669	102.47	101.7	300	81.5	1.0	0.013	1.33	0.09	0.01	0.08	-0.24	01:30	99.73	98.97
MH-556	MH-557	98.669	97.315	101.7	100.86	525	70.0	1.2	0.013	2.18	0.47	0.29	0.62	-0.23	01:30	98.97	97.89
MH-5560	MH-556	98.809	98.669	101.67	101.7	525	14.5	0.6	0.013	1.48	0.32	0.25	0.79	-0.02	01:30	99.32	98.97
MH-557	MH-558	97.315	97.121	100.86	100.39	675	36.5	0.4	0.013	1.57	0.56	0.56	0.99	-0.11	01:30	97.89	97.66
MH-558	MH-559	97.121	94.699	100.39	100.39	675	14.5	0.4	0.013	1.57	0.56	0.56	0.99	-0.13	01:31	97.66	95.97
MH-559	MH-900	94.699	92.925	100.39	95.41	675	15.5	0.8	0.013	2.10	0.75	1.00	1.33	0.59	01:30	95.97	93.68
MH-561	MH-537	103.003	102.673	105.281	105.126	375	42.5	0.6	0.013	1.23	0.14	0.01	0.10	-0.30	01:30	103.08	102.98
MH-561	MH-563	103.003	100.82	105.281	104.305	300	61.0	2.9	0.013	2.33	0.16	0.00	0.00	-0.22	01:30	103.08	101.18
MH-562	MH-563	101.178	100.82	103.205	104.305	300	29.5	0.5	0.013	0.92	0.06	0.05	0.74	-0.07	01:30	101.41	101.18
MH-563	MH-564	100.82	100.643	104.305	103.985	525	73.5	0.2	0.013	0.89	0.19	0.16	0.85	-0.17	01:30	101.18	100.91
MH-564	MH-8500	100.643	99.407	103.985	102.733	525	48.5	2.1	0.013	2.84	0.62	0.24	0.39	-0.26	01:30	100.91	99.65
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.00	0.00	-0.75	00:00	101.11	99.65
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	0.24	0.21	-0.51	01:30	99.65	97.59
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	0.24	0.18	-0.53	01:30	97.59	95.72
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	0.24	0.19	-0.53	01:30	95.72	93.68
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.04	0.45	-0.90	01:31	93.68	92.39
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	3.32	0.54	-0.78	01:31	92.39	90.93
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	3.64	0.32	-1.35	01:31	90.93	90.60

Table C3A: Pipe Data and Hydraulic Simulation Results - 1979 Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	4.05	0.50	-1.20	01:32	90.60	90.24
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	4.12	0.37	-1.48	01:32	90.24	90.21
OGS_1	OGS_1-Out	96.037	96.015	100.5	100.35	750	4.9	0.2	0.013	1.14	0.50	1.01	2.01	0.74	01:10	97.53	97.19
OGS_1-Out	MH_3112	96.015	96.01	100.35	100.35	2250	6.2	0.1	0.013	1.63	6.49	5.68	0.87	-1.08	01:34	97.19	97.19
OGS_2	OGS_2-Out	96.026	96.004	100.428	100.35	750	5.1	0.2	0.013	1.12	0.49	1.01	2.03	0.52	01:18	97.30	97.18
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.04	0.45	-0.90	01:31	93.68	92.39
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	0.24	0.21	-0.51	01:30	99.65	97.59
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.00	0.00	-0.75	00:00	101.11	99.65
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	0.24	0.18	-0.53	01:30	97.59	95.72
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	0.24	0.19	-0.53	01:30	95.72	93.68
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.04	0.45	-0.90	01:31	93.68	92.39
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	3.32	0.54	-0.78	01:31	92.39	90.93
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	3.64	0.32	-1.35	01:31	90.93	90.60
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	4.05	0.50	-1.20	01:32	90.60	90.24
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	4.12	0.37	-1.48	01:32	90.24	90.21

Table C3B: USF Freeboard Results - 1979 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-531	MH-313	76-2	98.43	4.8	21.5	97.68	97.56	97.59	0.84
MH-531	MH-313	76-1	98.43	9.6	21.5	97.68	97.56	97.61	0.82
MH-500	MH-502	146-6	102.89	14.2	92.0	102.46	101.19	101.39	1.50
MH-500	MH-502	146-5	102.89	22.2	92.0	102.46	101.19	101.50	1.39
MH-500	MH-502	146-4	102.89	28.8	92.0	102.46	101.19	101.59	1.30
MH-500	MH-502	146-3	102.89	36.8	92.0	102.46	101.19	101.70	1.19
MH-500	MH-502	146-2	102.89	43.4	92.0	102.46	101.19	101.79	1.10
MH-500	MH-502	146-1	102.89	51.4	92.0	102.46	101.19	101.90	0.99
MH-500	MH-502	145-5	103.05	61.4	92.0	102.46	101.19	102.04	1.01
MH-500	MH-502	145-4	103.05	69.9	92.0	102.46	101.19	102.15	0.90
MH-500	MH-502	145-3	103.55	76.0	92.0	102.46	101.19	102.24	1.31
MH-500	MH-502	145-2	103.55	84.0	92.0	102.46	101.19	102.35	1.20
MH-500	MH-502	145-1	103.55	88.9	92.0	102.46	101.19	102.42	1.13
MH-502	MH-503	148-5	101.09	38.5	119.0	101.19	99.42	99.99	1.10
MH-502	MH-503	148-4	101.09	46.5	119.0	101.19	99.42	100.11	0.98
MH-502	MH-503	148-3	101.09	53.1	119.0	101.19	99.42	100.21	0.88
MH-502	MH-503	148-2	101.09	61.1	119.0	101.19	99.42	100.33	0.76
MH-502	MH-503	148-1	101.44	68.4	119.0	101.19	99.42	100.44	1.00
MH-502	MH-503	147-6	101.65	78.4	119.0	101.19	99.42	100.59	1.06
MH-502	MH-503	147-5	101.65	86.4	119.0	101.19	99.42	100.71	0.94
MH-502	MH-503	147-4	102.03	94.4	119.0	101.19	99.42	100.82	1.21
MH-502	MH-503	147-3	102.03	101.0	119.0	101.19	99.42	100.92	1.11
MH-502	MH-503	147-2	102.66	107.6	119.0	101.19	99.42	101.02	1.64
MH-502	MH-503	147-1	102.66	115.6	119.0	101.19	99.42	101.14	1.52
MH-503	MH-504	150-3	100.3	1.3	73.0	99.42	99.06	99.07	1.23
MH-503	MH-504	156-4	100.04	2.7	73.0	99.42	99.06	99.08	0.96
MH-503	MH-504	150-2	100.3	6.3	73.0	99.42	99.06	99.09	1.21
MH-503	MH-504	156-5	100.04	10.0	73.0	99.42	99.06	99.11	0.93
MH-503	MH-504	150-1	100.3	14.3	73.0	99.42	99.06	99.13	1.17
MH-503	MH-504	157-1	100.3	20.0	73.0	99.42	99.06	99.16	1.14
MH-503	MH-504	149-5	100.7	24.3	73.0	99.42	99.06	99.18	1.52
MH-503	MH-504	157-2	100.3	28.0	73.0	99.42	99.06	99.20	1.10
MH-503	MH-504	149-4	100.7	32.3	73.0	99.42	99.06	99.22	1.48
MH-503	MH-504	157-3	100.3	34.6	73.0	99.42	99.06	99.23	1.07
MH-503	MH-504	149-3	100.7	38.9	73.0	99.42	99.06	99.25	1.45
MH-503	MH-504	157-4	100.3	42.6	73.0	99.42	99.06	99.27	1.03
MH-503	MH-504	149-2	100.7	46.9	73.0	99.42	99.06	99.29	1.41
MH-503	MH-504	157-5	100.3	49.9	73.0	99.42	99.06	99.31	0.99
MH-503	MH-504	149-1	100.7	54.3	73.0	99.42	99.06	99.33	1.37
MH-503	MH-504	158-1	100.48	59.8	73.0	99.42	99.06	99.36	1.12
MH-503	MH-504	158-2	100.48	67.8	73.0	99.42	99.06	99.40	1.08
MH-503	MH-504	158-3	100.48	71.4	73.0	99.42	99.06	99.41	1.07
MH-504	MH-528	154-1	99.24	15.6	108.0	99.06	98.22	98.34	0.90
MH-504	MH-528	153-3	99.92	16.5	108.0	99.06	98.22	98.34	1.58
MH-504	MH-528	154-2	99.24	23.6	108.0	99.06	98.22	98.40	0.84
MH-504	MH-528	153-2	99.92	24.5	108.0	99.06	98.22	98.41	1.51
MH-504	MH-528	154-3	99.24	30.2	108.0	99.06	98.22	98.45	0.79
MH-504	MH-528	153-1	99.92	31.8	108.0	99.06	98.22	98.46	1.46
MH-504	MH-528	154-4	99.24	38.2	108.0	99.06	98.22	98.51	0.73
MH-504	MH-528	152-3	99.92	41.8	108.0	99.06	98.22	98.54	1.38
MH-504	MH-528	155-1	99.28	48.2	108.0	99.06	98.22	98.59	0.69
MH-504	MH-528	152-2	99.92	49.8	108.0	99.06	98.22	98.61	1.31
MH-504	MH-528	155-2	99.28	56.2	108.0	99.06	98.22	98.66	0.62
MH-504	MH-528	152-1	99.92	57.1	108.0	99.06	98.22	98.66	1.26
MH-504	MH-528	155-3	99.59	62.8	108.0	99.06	98.22	98.71	0.88
MH-504	MH-528	151-4	99.96	67.1	108.0	99.06	98.22	98.74	1.22
MH-504	MH-528	155-4	99.59	70.8	108.0	99.06	98.22	98.77	0.82
MH-504	MH-528	151-3	99.96	75.1	108.0	99.06	98.22	98.80	1.16
MH-504	MH-528	155-5	99.59	78.1	108.0	99.06	98.22	98.83	0.76
MH-504	MH-528	151-2	99.96	81.7	108.0	99.06	98.22	98.86	1.10
MH-504	MH-528	156-1	99.73	88.1	108.0	99.06	98.22	98.91	0.82
MH-504	MH-528	151-1	100.04	89.7	108.0	99.06	98.22	98.92	1.12
MH-504	MH-528	156-2	99.73	96.1	108.0	99.06	98.22	98.97	0.76
MH-504	MH-528	150-4	100.3	99.7	108.0	99.06	98.22	99.00	1.30
MH-504	MH-528	156-3	100.04	102.7	108.0	99.06	98.22	99.02	1.02
MH-505	MH-506	92-3	104.3	2.5	13.0	103.48	103.57	103.55	0.75
MH-505	MH-506	92-2	104.3	6.8	13.0	103.48	103.57	103.52	0.78
MH-505	MH-506	92-1	104.3	11.3	13.0	103.48	103.57	103.49	0.81
MH-505	MH-534	99-7	104.61	3.7	94.5	103.48	103.20	103.21	1.40
MH-505	MH-534	95-5	103.94	6.8	94.5	103.48	103.20	103.22	0.72
MH-505	MH-534	99-6	104.67	11.7	94.5	103.48	103.20	103.24	1.43
MH-505	MH-534	94-1	104.13	17.4	94.5	103.48	103.20	103.25	0.88
MH-505	MH-534	99-5	104.86	17.9	94.5	103.48	103.20	103.26	1.60
MH-505	MH-534	94-2	104.13	25.4	94.5	103.48	103.20	103.28	0.85
MH-505	MH-534	100-6	104.86	25.7	94.5	103.48	103.20	103.28	1.58
MH-505	MH-534	94-3	104.13	32.7	94.5	103.48	103.20	103.30	0.83
MH-505	MH-534	100-5	104.78	33.7	94.5	103.48	103.20	103.30	1.48
MH-505	MH-534	100-4	104.97	38.3	94.5	103.48	103.20	103.31	1.66
MH-505	MH-534	94-4	104.13	40.7	94.5	103.48	103.20	103.32	0.81

Table C3B: USF Freeboard Results - 1979 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-505	MH-534	101-6	104.97	47.7	94.5	103.48	103.20	103.34	1.63
MH-505	MH-534	94-5	104.13	48.3	94.5	103.48	103.20	103.34	0.79
MH-505	MH-534	101-5	104.86	53.9	94.5	103.48	103.20	103.36	1.50
MH-505	MH-534	93-1	104.3	58.9	94.5	103.48	103.20	103.37	0.93
MH-505	MH-534	101-4	105.08	61.9	94.5	103.48	103.20	103.38	1.70
MH-505	MH-534	93-2	104.3	66.9	94.5	103.48	103.20	103.40	0.90
MH-505	MH-534	102-6	105.11	71.3	94.5	103.48	103.20	103.41	1.70
MH-505	MH-534	93-3	104.3	74.2	94.5	103.48	103.20	103.42	0.88
MH-505	MH-534	102-5	105.11	75.9	94.5	103.48	103.20	103.42	1.69
MH-505	MH-534	93-4	104.3	82.2	94.5	103.48	103.20	103.44	0.86
MH-505	MH-534	102-4	105.11	83.9	94.5	103.48	103.20	103.45	1.66
MH-505	MH-534	93-5	104.3	89.8	94.5	103.48	103.20	103.46	0.84
MH-506	MH-508	89-1	103.74	7.2	79.0	103.57	103.31	103.34	0.40
MH-506	MH-508	90-3	104.04	27.0	79.0	103.57	103.31	103.40	0.64
MH-506	MH-508	90-2	104.04	34.6	79.0	103.57	103.31	103.43	0.61
MH-506	MH-508	90-1	104.04	42.6	79.0	103.57	103.31	103.45	0.59
MH-506	MH-508	91-4	104.23	53.2	79.0	103.57	103.31	103.49	0.74
MH-506	MH-508	91-3	104.23	61.2	79.0	103.57	103.31	103.51	0.72
MH-506	MH-508	91-2	104.23	68.5	79.0	103.57	103.31	103.54	0.69
MH-506	MH-508	91-1	104.23	76.5	79.0	103.57	103.31	103.56	0.67
MH-5070	MH-513	99-2	104.61	0.1	82.0	103.29	102.92	102.92	1.69
MH-5070	MH-513	105-6	104.46	8.2	82.0	103.29	102.92	102.96	1.50
MH-5070	MH-513	99-3	104.67	8.4	82.0	103.29	102.92	102.96	1.71
MH-5070	MH-513	105-5	104.46	12.8	82.0	103.29	102.92	102.98	1.48
MH-5070	MH-513	99-4	104.86	14.3	82.0	103.29	102.92	102.99	1.87
MH-5070	MH-513	105-4	104.46	20.8	82.0	103.29	102.92	103.02	1.44
MH-5070	MH-513	100-1	104.86	22.1	82.0	103.29	102.92	103.02	1.84
MH-5070	MH-513	100-2	104.78	30.1	82.0	103.29	102.92	103.06	1.72
MH-5070	MH-513	104-8	104.6	30.2	82.0	103.29	102.92	103.06	1.54
MH-5070	MH-513	100-3	104.97	34.7	82.0	103.29	102.92	103.08	1.89
MH-5070	MH-513	104-7	104.6	34.8	82.0	103.29	102.92	103.08	1.52
MH-5070	MH-513	104-6	104.6	42.8	82.0	103.29	102.92	103.12	1.48
MH-5070	MH-513	101-1	104.97	44.1	82.0	103.29	102.92	103.12	1.85
MH-5070	MH-513	104-5	104.6	49.0	82.0	103.29	102.92	103.14	1.46
MH-5070	MH-513	101-2	104.86	50.3	82.0	103.29	102.92	103.15	1.71
MH-5070	MH-513	101-3	105.08	58.3	82.0	103.29	102.92	103.18	1.90
MH-5070	MH-513	103-8	104.79	58.4	82.0	103.29	102.92	103.18	1.61
MH-5070	MH-513	103-7	104.79	63.0	82.0	103.29	102.92	103.21	1.58
MH-5070	MH-513	102-1	105.11	67.7	82.0	103.29	102.92	103.23	1.88
MH-5070	MH-513	103-6	104.79	71.0	82.0	103.29	102.92	103.24	1.55
MH-5070	MH-513	102-2	105.11	72.3	82.0	103.29	102.92	103.25	1.86
MH-5070	MH-513	103-5	104.79	77.2	82.0	103.29	102.92	103.27	1.52
MH-5070	MH-513	102-3	105.11	80.3	82.0	103.29	102.92	103.28	1.83
MH-508	MH-509	88-3	103.73	6.6	41.5	103.31	103.09	103.12	0.61
MH-508	MH-509	88-2	103.73	14.2	41.5	103.31	103.09	103.16	0.57
MH-508	MH-509	88-1	103.73	22.2	41.5	103.31	103.09	103.21	0.52
MH-508	MH-509	89-3	103.74	32.8	41.5	103.31	103.09	103.27	0.47
MH-508	MH-509	89-2	103.74	40.4	41.5	103.31	103.09	103.31	0.43
MH-5080	MH-517	105-1	104.46	6.2	76.5	103.07	102.64	102.68	1.78
MH-5080	MH-517	111-6	104.04	7.8	76.5	103.07	102.64	102.69	1.35
MH-5080	MH-517	105-2	104.46	10.7	76.5	103.07	102.64	102.70	1.76
MH-5080	MH-517	111-5	104.35	14.0	76.5	103.07	102.64	102.72	1.63
MH-5080	MH-517	105-3	104.46	18.7	76.5	103.07	102.64	102.75	1.71
MH-5080	MH-517	112-8	104.49	23.4	76.5	103.07	102.64	102.77	1.72
MH-5080	MH-517	112-7	104.49	28.0	76.5	103.07	102.64	102.80	1.69
MH-5080	MH-517	104-1	104.6	28.1	76.5	103.07	102.64	102.80	1.80
MH-5080	MH-517	104-2	104.6	32.7	76.5	103.07	102.64	102.83	1.77
MH-5080	MH-517	112-6	104.49	36.0	76.5	103.07	102.64	102.84	1.65
MH-5080	MH-517	104-3	104.6	40.7	76.5	103.07	102.64	102.87	1.73
MH-5080	MH-517	112-5	104.49	42.2	76.5	103.07	102.64	102.88	1.61
MH-5080	MH-517	104-4	104.6	46.9	76.5	103.07	102.64	102.90	1.70
MH-5080	MH-517	113-8	104.59	51.6	76.5	103.07	102.64	102.93	1.66
MH-5080	MH-517	113-7	104.59	56.2	76.5	103.07	102.64	102.96	1.63
MH-5080	MH-517	103-1	104.79	56.3	76.5	103.07	102.64	102.96	1.83
MH-5080	MH-517	103-2	104.79	60.9	76.5	103.07	102.64	102.98	1.81
MH-5080	MH-517	113-6	104.59	64.2	76.5	103.07	102.64	103.00	1.59
MH-5080	MH-517	103-3	104.79	68.9	76.5	103.07	102.64	103.03	1.76
MH-5080	MH-517	113-5	104.59	70.4	76.5	103.07	102.64	103.03	1.56
MH-5080	MH-517	103-4	104.79	75.1	76.5	103.07	102.64	103.06	1.73
MH-509	MH-510	87-3	103.63	2.0	10.5	103.09	102.91	102.94	0.69
MH-509	MH-510	87-2	103.63	5.6	10.5	103.09	102.91	103.00	0.63
MH-509	MH-510	87-1	103.63	9.4	10.5	103.09	102.91	103.07	0.56
MH-510	MH-511	85-4	103.36	4.3	64.0	102.91	102.29	102.33	1.03
MH-510	MH-511	112-1	104.49	9.4	64.0	102.91	102.29	102.38	2.11
MH-510	MH-511	85-3	103.36	12.3	64.0	102.91	102.29	102.41	0.95
MH-510	MH-511	112-2	104.49	14.0	64.0	102.91	102.29	102.42	2.07
MH-510	MH-511	85-2	103.36	19.5	64.0	102.91	102.29	102.48	0.88
MH-510	MH-511	112-3	104.49	22.0	64.0	102.91	102.29	102.50	1.99
MH-510	MH-511	85-1	103.36	27.5	64.0	102.91	102.29	102.55	0.81

Table C3B: USF Freeboard Results - 1979 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-510	MH-511	112-4	104.49	28.2	64.0	102.91	102.29	102.56	1.93
MH-510	MH-511	113-1	104.59	37.6	64.0	102.91	102.29	102.65	1.94
MH-510	MH-511	86-3	103.5	38.1	64.0	102.91	102.29	102.66	0.84
MH-510	MH-511	113-2	104.59	42.2	64.0	102.91	102.29	102.70	1.89
MH-510	MH-511	86-2	103.5	45.8	64.0	102.91	102.29	102.73	0.77
MH-510	MH-511	113-3	104.59	50.2	64.0	102.91	102.29	102.77	1.82
MH-510	MH-511	86-1	103.5	53.8	64.0	102.91	102.29	102.81	0.69
MH-510	MH-511	113-4	104.59	56.4	64.0	102.91	102.29	102.83	1.76
MH-511	MH-526	82-3	101.52	20.9	95.5	102.29	99.92	100.44	1.08
MH-511	MH-526	109-2	102.17	26.4	95.5	102.29	99.92	100.58	1.59
MH-511	MH-526	82-2	101.52	28.9	95.5	102.29	99.92	100.64	0.88
MH-511	MH-526	109-3	102.32	30.8	95.5	102.29	99.92	100.68	1.64
MH-511	MH-526	82-1	101.52	36.5	95.5	102.29	99.92	100.83	0.69
MH-511	MH-526	109-4	102.78	38.8	95.5	102.29	99.92	100.88	1.90
MH-511	MH-526	83-3	101.63	47.1	95.5	102.29	99.92	101.09	0.54
MH-511	MH-526	110-1	102.91	48.2	95.5	102.29	99.92	101.12	1.79
MH-511	MH-526	110-2	103.09	52.8	95.5	102.29	99.92	101.23	1.86
MH-511	MH-526	83-2	102.27	54.7	95.5	102.29	99.92	101.28	0.99
MH-511	MH-526	110-3	103.34	60.8	95.5	102.29	99.92	101.43	1.91
MH-511	MH-526	83-1	102.27	62.7	95.5	102.29	99.92	101.47	0.80
MH-511	MH-526	110-4	103.77	67.0	95.5	102.29	99.92	101.58	2.19
MH-511	MH-526	84-3	102.46	73.4	95.5	102.29	99.92	101.74	0.72
MH-511	MH-526	111-1	103.89	76.4	95.5	102.29	99.92	101.81	2.08
MH-511	MH-526	111-2	103.98	81.0	95.5	102.29	99.92	101.93	2.05
MH-511	MH-526	84-2	103.15	81.0	95.5	102.29	99.92	101.93	1.22
MH-511	MH-526	84-1	103.15	88.9	95.5	102.29	99.92	102.12	1.03
MH-511	MH-526	111-3	104.04	89.1	95.5	102.29	99.92	102.13	1.91
MH-511	MH-526	111-4	104.35	95.3	95.5	102.29	99.92	102.28	2.07
MH-513	MH-515	108-6	102.64	21.6	81.0	102.92	100.66	101.26	1.38
MH-513	MH-515	97-2	102.99	26.5	81.0	102.92	100.66	101.40	1.59
MH-513	MH-515	108-5	102.57	29.6	81.0	102.92	100.66	101.49	1.08
MH-513	MH-515	97-3	103.15	30.9	81.0	102.92	100.66	101.52	1.63
MH-513	MH-515	108-4	102.98	35.8	81.0	102.92	100.66	101.66	1.32
MH-513	MH-515	97-4	103.6	38.9	81.0	102.92	100.66	101.75	1.85
MH-513	MH-515	107-6	103.11	45.2	81.0	102.92	100.66	101.92	1.19
MH-513	MH-515	98-1	103.73	48.3	81.0	102.92	100.66	102.01	1.72
MH-513	MH-515	107-5	103.33	49.8	81.0	102.92	100.66	102.05	1.28
MH-513	MH-515	98-2	103.92	52.9	81.0	102.92	100.66	102.14	1.78
MH-513	MH-515	107-4	103.75	56.2	81.0	102.92	100.66	102.23	1.52
MH-513	MH-515	98-3	104.16	60.9	81.0	102.92	100.66	102.36	1.80
MH-513	MH-515	106-6	103.85	65.6	81.0	102.92	100.66	102.49	1.36
MH-513	MH-515	98-4	104.59	67.1	81.0	102.92	100.66	102.54	2.05
MH-513	MH-515	106-5	104.08	73.6	81.0	102.92	100.66	102.72	1.36
MH-513	MH-515	99-1	104.61	76.5	81.0	102.92	100.66	102.80	1.81
MH-513	MH-515	106-4	104.34	79.8	81.0	102.92	100.66	102.89	1.45
MH-515	MH-518	114-5	101.66	3.6	44.0	100.66	100.29	100.32	1.34
MH-515	MH-518	115-1	101.78	14.3	44.0	100.66	100.29	100.41	1.37
MH-515	MH-518	115-2	102.22	21.9	44.0	100.66	100.29	100.48	1.74
MH-515	MH-518	115-3	102.22	29.9	44.0	100.66	100.29	100.54	1.68
MH-515	MH-518	115-4	102.22	37.1	44.0	100.66	100.29	100.60	1.62
MH-517	MH-518	109-8	102.23	19.4	82.0	102.64	100.29	100.85	1.38
MH-517	MH-518	108-1	102.64	20.7	82.0	102.64	100.29	100.89	1.75
MH-517	MH-518	109-7	102.17	27.4	82.0	102.64	100.29	101.08	1.09
MH-517	MH-518	108-2	102.57	28.7	82.0	102.64	100.29	101.12	1.45
MH-517	MH-518	109-6	102.32	31.8	82.0	102.64	100.29	101.20	1.12
MH-517	MH-518	108-3	102.98	34.9	82.0	102.64	100.29	101.29	1.69
MH-517	MH-518	109-5	102.78	39.8	82.0	102.64	100.29	101.43	1.35
MH-517	MH-518	107-1	103.11	44.3	82.0	102.64	100.29	101.56	1.55
MH-517	MH-518	107-2	103.33	48.9	82.0	102.64	100.29	101.69	1.64
MH-517	MH-518	110-8	102.91	49.2	82.0	102.64	100.29	101.70	1.21
MH-517	MH-518	110-7	103.09	53.8	82.0	102.64	100.29	101.84	1.25
MH-517	MH-518	107-3	103.75	55.3	82.0	102.64	100.29	101.88	1.87
MH-517	MH-518	110-6	103.34	61.8	82.0	102.64	100.29	102.06	1.28
MH-517	MH-518	106-1	103.85	64.7	82.0	102.64	100.29	102.15	1.70
MH-517	MH-518	110-5	103.77	68.0	82.0	102.64	100.29	102.24	1.53
MH-517	MH-518	106-2	104.08	72.7	82.0	102.64	100.29	102.38	1.70
MH-517	MH-518	111-8	103.89	77.4	82.0	102.64	100.29	102.51	1.38
MH-517	MH-518	106-3	104.34	78.9	82.0	102.64	100.29	102.56	1.78
MH-517	MH-518	111-7	103.98	82.0	82.0	102.64	100.29	102.64	1.34
MH-518	MH-526	114-1	101.36	19.7	47.0	100.29	99.92	100.08	1.28
MH-518	MH-526	114-2	101.66	27.3	47.0	100.29	99.92	100.14	1.52
MH-518	MH-526	114-3	101.66	35.3	47.0	100.29	99.92	100.20	1.46
MH-518	MH-526	114-4	101.66	42.5	47.0	100.29	99.92	100.26	1.40
MH-519	MH-520	129-3	104.07	4.0	54.5	103.48	103.35	103.36	0.71
MH-519	MH-520	138-1	104.08	5.4	54.5	103.48	103.35	103.36	0.72
MH-519	MH-520	129-2	104.07	12.0	54.5	103.48	103.35	103.38	0.69
MH-519	MH-520	138-2	104.08	13.0	54.5	103.48	103.35	103.38	0.70
MH-519	MH-520	129-1	104.07	19.6	54.5	103.48	103.35	103.39	0.68
MH-519	MH-520	138-3	104.08	21.0	54.5	103.48	103.35	103.40	0.68

Table C3B: USF Freeboard Results - 1979 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-519	MH-520	128-3	104.09	30.2	54.5	103.48	103.35	103.42	0.67
MH-519	MH-520	139-1	104.23	31.6	54.5	103.48	103.35	103.42	0.81
MH-519	MH-520	128-2	104.09	38.2	54.5	103.48	103.35	103.44	0.65
MH-519	MH-520	139-2	104.23	39.2	54.5	103.48	103.35	103.44	0.79
MH-519	MH-520	128-1	104.09	45.8	54.5	103.48	103.35	103.46	0.63
MH-519	MH-520	139-3	104.23	47.2	54.5	103.48	103.35	103.46	0.77
MH-519	MH-523	140-3	104.25	2.3	11.5	103.48	103.32	103.35	0.90
MH-519	MH-523	140-2	104.25	7.0	11.5	103.48	103.32	103.42	0.83
MH-519	MH-523	140-1	104.25	10.5	11.5	103.48	103.32	103.46	0.79
MH-520	MH-521	136-1	103.94	3.7	57.5	103.35	103.05	103.07	0.87
MH-520	MH-521	131-3	103.81	8.8	57.5	103.35	103.05	103.09	0.72
MH-520	MH-521	136-2	103.94	11.4	57.5	103.35	103.05	103.11	0.83
MH-520	MH-521	131-2	103.81	16.8	57.5	103.35	103.05	103.14	0.67
MH-520	MH-521	136-3	103.94	19.4	57.5	103.35	103.05	103.15	0.79
MH-520	MH-521	131-1	103.81	24.5	57.5	103.35	103.05	103.18	0.63
MH-520	MH-521	137-1	103.94	30.0	57.5	103.35	103.05	103.20	0.74
MH-520	MH-521	130-3	103.94	35.1	57.5	103.35	103.05	103.23	0.71
MH-520	MH-521	137-2	103.94	37.6	57.5	103.35	103.05	103.24	0.70
MH-520	MH-521	130-2	103.94	43.1	57.5	103.35	103.05	103.27	0.67
MH-520	MH-521	137-3	103.94	45.6	57.5	103.35	103.05	103.29	0.65
MH-520	MH-521	130-1	103.94	50.7	57.5	103.35	103.05	103.31	0.63
MH-521	MH-522	135-1	103.67	1.0	11.5	103.05	102.90	102.91	0.76
MH-521	MH-522	135-2	103.67	5.3	11.5	103.05	102.90	102.97	0.70
MH-521	MH-522	135-3	103.67	9.5	11.5	103.05	102.90	103.02	0.65
MH-522	MH-525	133-3	102.71	7.1	55.0	102.90	101.03	101.27	1.44
MH-522	MH-525	133-4	103.1	14.4	55.0	102.90	101.03	101.52	1.58
MH-522	MH-525	133-5	103.1	22.4	55.0	102.90	101.03	101.79	1.31
MH-522	MH-525	134-1	103.55	32.9	55.0	102.90	101.03	102.15	1.40
MH-522	MH-525	134-2	103.55	40.6	55.0	102.90	101.03	102.41	1.14
MH-522	MH-525	134-3	103.55	48.6	55.0	102.90	101.03	102.68	0.87
MH-523	MH-524	141-5	103.68	20.5	55.0	103.32	102.44	102.77	0.91
MH-523	MH-524	141-4	103.68	28.5	55.0	103.32	102.44	102.90	0.78
MH-523	MH-524	141-3	104.25	35.7	55.0	103.32	102.44	103.01	1.24
MH-523	MH-524	141-2	104.25	43.7	55.0	103.32	102.44	103.14	1.11
MH-523	MH-524	141-1	104.25	51.3	55.0	103.32	102.44	103.26	0.99
MH-524	MH-5240	126-1	103.57	5.3	65.0	102.44	102.18	102.20	1.37
MH-524	MH-5240	122-4	103.32	5.6	65.0	102.44	102.18	102.20	1.12
MH-524	MH-5240	126-2	103.57	13.3	65.0	102.44	102.18	102.23	1.34
MH-524	MH-5240	122-3	103.32	13.6	65.0	102.44	102.18	102.23	1.09
MH-524	MH-5240	122-2	103.32	20.9	65.0	102.44	102.18	102.26	1.06
MH-524	MH-5240	126-3	103.57	20.9	65.0	102.44	102.18	102.26	1.31
MH-524	MH-5240	122-1	103.32	28.9	65.0	102.44	102.18	102.29	1.03
MH-524	MH-5240	127-1	103.57	31.6	65.0	102.44	102.18	102.30	1.27
MH-524	MH-5240	121-3	103.45	39.5	65.0	102.44	102.18	102.34	1.11
MH-524	MH-5240	127-2	103.57	39.6	65.0	102.44	102.18	102.34	1.23
MH-524	MH-5240	121-2	103.45	47.1	65.0	102.44	102.18	102.37	1.08
MH-524	MH-5240	127-3	103.57	47.2	65.0	102.44	102.18	102.37	1.20
MH-524	MH-5240	121-1	103.45	55.1	65.0	102.44	102.18	102.40	1.05
MH-5240	MH-525	124-1	102.67	16.1	63.5	102.18	101.03	101.32	1.35
MH-5240	MH-525	123-5	102.2	19.8	63.5	102.18	101.03	101.39	0.81
MH-5240	MH-525	124-2	102.67	24.1	63.5	102.18	101.03	101.47	1.20
MH-5240	MH-525	123-4	102.74	27.4	63.5	102.18	101.03	101.52	1.22
MH-5240	MH-525	124-3	102.67	31.7	63.5	102.18	101.03	101.60	1.07
MH-5240	MH-525	123-3	102.74	35.4	63.5	102.18	101.03	101.67	1.07
MH-5240	MH-525	125-1	103.28	42.3	63.5	102.18	101.03	101.79	1.49
MH-5240	MH-525	123-2	103.08	42.6	63.5	102.18	101.03	101.80	1.28
MH-5240	MH-525	125-2	103.28	50.3	63.5	102.18	101.03	101.94	1.34
MH-5240	MH-525	123-1	103.08	50.6	63.5	102.18	101.03	101.94	1.14
MH-5240	MH-525	125-3	103.28	58.0	63.5	102.18	101.03	102.08	1.20
MH-5240	MH-525	122-5	103.32	61.3	63.5	102.18	101.03	102.14	1.18
MH-52400	MH-538	119-1	102.26	15.8	58.0	102.25	101.15	101.45	0.81
MH-52400	MH-538	119-2	102.26	23.8	58.0	102.25	101.15	101.60	0.66
MH-52400	MH-538	119-3	102.65	31.4	58.0	102.25	101.15	101.74	0.91
MH-52400	MH-538	120-1	103.45	42.1	58.0	102.25	101.15	101.95	1.50
MH-52400	MH-538	120-2	103.45	50.1	58.0	102.25	101.15	102.10	1.35
MH-52400	MH-538	120-3	103.45	57.4	58.0	102.25	101.15	102.23	1.22
MH-525	MH-526	132-1	101.26	15.8	58.5	101.03	99.92	100.22	1.04
MH-525	MH-526	132-2	101.26	23.8	58.5	101.03	99.92	100.37	0.89
MH-525	MH-526	132-3	101.65	31.0	58.5	101.03	99.92	100.51	1.14
MH-525	MH-526	132-4	101.65	39.0	58.5	101.03	99.92	100.66	0.99
MH-525	MH-526	133-1	101.85	49.7	58.5	101.03	99.92	100.86	0.99
MH-525	MH-526	133-2	102.71	57.3	58.5	101.03	99.92	101.01	1.70
MH-528	MH-529	5	101.37	6.6	62.5	98.22	97.99	98.01	3.36
MH-528	MH-529	81-1	98.72	9.8	62.5	98.22	97.99	98.02	0.70
MH-528	MH-529	4	101.37	12.7	62.5	98.22	97.99	98.03	3.34
MH-528	MH-529	81-2	98.72	17.8	62.5	98.22	97.99	98.05	0.67
MH-528	MH-529	81-3	98.72	25.0	62.5	98.22	97.99	98.08	0.64
MH-528	MH-529	3	101.37	25.5	62.5	98.22	97.99	98.08	3.29
MH-528	MH-529	2	101.42	31.6	62.5	98.22	97.99	98.10	3.32

Table C3B: USF Freeboard Results - 1979 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-528	MH-529	81-4	98.72	33.0	62.5	98.22	97.99	98.11	0.61
MH-528	MH-529	81-5	99.3	40.6	62.5	98.22	97.99	98.14	1.16
MH-528	MH-529	1	101.42	41.7	62.5	98.22	97.99	98.14	3.28
MH-529	MH-530	13	101.13	3.2	72.0	97.99	97.87	97.88	3.25
MH-529	MH-530	79-1	98.62	6.4	72.0	97.99	97.87	97.88	0.74
MH-529	MH-530	12	101.13	9.2	72.0	97.99	97.87	97.89	3.24
MH-529	MH-530	79-2	98.62	14.4	72.0	97.99	97.87	97.89	0.73
MH-529	MH-530	79-3	98.62	21.7	72.0	97.99	97.87	97.91	0.71
MH-529	MH-530	11	101.13	22.0	72.0	97.99	97.87	97.91	3.22
MH-529	MH-530	10	101.13	28.1	72.0	97.99	97.87	97.92	3.21
MH-529	MH-530	79-4	98.62	29.7	72.0	97.99	97.87	97.92	0.70
MH-529	MH-530	80-1	98.72	40.3	72.0	97.99	97.87	97.94	0.78
MH-529	MH-530	9	101.22	40.9	72.0	97.99	97.87	97.94	3.28
MH-529	MH-530	8	101.32	47.0	72.0	97.99	97.87	97.95	3.37
MH-529	MH-530	80-2	98.72	48.3	72.0	97.99	97.87	97.95	0.77
MH-529	MH-530	80-3	98.72	55.6	72.0	97.99	97.87	97.96	0.76
MH-529	MH-530	7	101.37	59.8	72.0	97.99	97.87	97.97	3.40
MH-529	MH-530	80-4	98.72	63.6	72.0	97.99	97.87	97.98	0.74
MH-529	MH-530	6	101.37	65.9	72.0	97.99	97.87	97.98	3.39
MH-529	MH-530	80-5	98.72	70.1	72.0	97.99	97.87	97.99	0.73
MH-530	MH-531	76-3	98.43	3.0	76.5	97.87	97.68	97.68	0.75
MH-530	MH-531	77-1	98.55	5.8	76.5	97.87	97.68	97.69	0.86
MH-530	MH-531	77-2	98.55	13.8	76.5	97.87	97.68	97.71	0.84
MH-530	MH-531	77-3	98.55	21.0	76.5	97.87	97.68	97.73	0.82
MH-530	MH-531	77-4	98.55	29.0	76.5	97.87	97.68	97.75	0.80
MH-530	MH-531	18	101.07	29.6	76.5	97.87	97.68	97.75	3.32
MH-530	MH-531	78-1	98.58	39.6	76.5	97.87	97.68	97.78	0.80
MH-530	MH-531	17	101.11	42.4	76.5	97.87	97.68	97.78	3.33
MH-530	MH-531	78-2	98.58	47.6	76.5	97.87	97.68	97.80	0.78
MH-530	MH-531	16	101.13	48.5	76.5	97.87	97.68	97.80	3.33
MH-530	MH-531	78-3	98.58	54.9	76.5	97.87	97.68	97.82	0.76
MH-530	MH-531	15	101.13	61.3	76.5	97.87	97.68	97.83	3.30
MH-530	MH-531	78-4	98.58	62.9	76.5	97.87	97.68	97.84	0.74
MH-530	MH-531	14	101.13	67.4	76.5	97.87	97.68	97.85	3.28
MH-530	MH-531	78-5	98.58	70.5	76.5	97.87	97.68	97.86	0.72
MH-534	MH-535	97-8	102.99	19.4	78.5	103.20	100.93	101.49	1.50
MH-534	MH-535	96-1	103.02	20.3	78.5	103.20	100.93	101.52	1.50
MH-534	MH-535	97-7	102.99	27.4	78.5	103.20	100.93	101.73	1.26
MH-534	MH-535	96-2	103.02	28.3	78.5	103.20	100.93	101.75	1.27
MH-534	MH-535	97-6	103.15	31.8	78.5	103.20	100.93	101.85	1.30
MH-534	MH-535	96-3	103.42	35.5	78.5	103.20	100.93	101.96	1.46
MH-534	MH-535	97-5	103.6	39.8	78.5	103.20	100.93	102.08	1.52
MH-534	MH-535	96-4	103.42	43.5	78.5	103.20	100.93	102.19	1.23
MH-534	MH-535	98-8	103.73	49.2	78.5	103.20	100.93	102.36	1.37
MH-534	MH-535	98-7	103.92	53.8	78.5	103.20	100.93	102.49	1.43
MH-534	MH-535	95-1	103.47	54.2	78.5	103.20	100.93	102.50	0.97
MH-534	MH-535	98-6	104.16	61.8	78.5	103.20	100.93	102.72	1.44
MH-534	MH-535	95-2	103.47	62.2	78.5	103.20	100.93	102.73	0.74
MH-534	MH-535	98-5	104.59	68.0	78.5	103.20	100.93	102.90	1.69
MH-534	MH-535	95-3	103.94	69.4	78.5	103.20	100.93	102.94	1.00
MH-534	MH-535	95-4	103.94	77.4	78.5	103.20	100.93	103.17	0.77
MH-534	MH-535	99-8	104.61	77.4	78.5	103.20	100.93	103.17	1.44
MH-535	MH-515	115-5	102.22	1.2	44.0	100.93	100.66	100.67	1.55
MH-535	MH-515	116-1	102.3	11.9	44.0	100.93	100.66	100.73	1.57
MH-535	MH-515	116-2	102.3	19.5	44.0	100.93	100.66	100.78	1.52
MH-535	MH-515	116-3	102.3	27.5	44.0	100.93	100.66	100.83	1.47
MH-535	MH-515	117-1	102.4	38.1	44.0	100.93	100.66	100.90	1.50
MH-5350	MH-539	118-3	102.4	16.8	52.5	101.68	100.10	100.61	1.79
MH-5350	MH-539	118-2	102.4	24.8	52.5	101.68	100.10	100.85	1.55
MH-5350	MH-539	118-1	102.4	32.4	52.5	101.68	100.10	101.07	1.33
MH-5350	MH-539	117-3	102.4	43.1	52.5	101.68	100.10	101.40	1.00
MH-5350	MH-539	117-2	102.4	51.1	52.5	101.68	100.10	101.64	0.76
MH-536	MH-538	196-1	102.56	6.1	59.0	102.68	101.15	101.31	1.25
MH-536	MH-538	142-1	103.33	15.7	59.0	102.68	101.15	101.56	1.77
MH-536	MH-538	195-4	103.31	16.1	59.0	102.68	101.15	101.57	1.74
MH-536	MH-538	142-2	103.33	23.7	59.0	102.68	101.15	101.76	1.57
MH-536	MH-538	195-3	103.31	24.1	59.0	102.68	101.15	101.77	1.54
MH-536	MH-538	142-3	103.72	30.3	59.0	102.68	101.15	101.93	1.79
MH-536	MH-538	195-2	103.7	30.7	59.0	102.68	101.15	101.94	1.76
MH-536	MH-538	142-4	103.72	38.3	59.0	102.68	101.15	102.14	1.58
MH-536	MH-538	195-1	103.7	38.7	59.0	102.68	101.15	102.15	1.55
MH-536	MH-538	143-1	103.96	48.3	59.0	102.68	101.15	102.40	1.56
MH-536	MH-538	194-4	103.92	48.7	59.0	102.68	101.15	102.41	1.51
MH-536	MH-538	143-2	103.96	56.3	59.0	102.68	101.15	102.61	1.35
MH-536	MH-538	194-3	103.92	56.7	59.0	102.68	101.15	102.62	1.30
MH-537	MH-536	194-2	103.92	4.4	64.5	102.98	102.68	102.70	1.22
MH-537	MH-536	143-3	103.96	4.7	64.5	102.98	102.68	102.70	1.26
MH-537	MH-536	194-1	103.92	12.4	64.5	102.98	102.68	102.73	1.19
MH-537	MH-536	144-1	103.96	14.7	64.5	102.98	102.68	102.75	1.21

Table C3B: USF Freeboard Results - 1979 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-537	MH-536	193-4	103.88	22.4	64.5	102.98	102.68	102.78	1.10
MH-537	MH-536	144-2	103.96	22.7	64.5	102.98	102.68	102.78	1.18
MH-537	MH-536	144-3	103.96	29.3	64.5	102.98	102.68	102.81	1.15
MH-537	MH-536	193-3	103.88	30.4	64.5	102.98	102.68	102.82	1.06
MH-537	MH-536	193-2	103.88	37.0	64.5	102.98	102.68	102.85	1.03
MH-537	MH-536	144-4	103.96	37.3	64.5	102.98	102.68	102.85	1.11
MH-537	MH-536	144-5	103.96	44.6	64.5	102.98	102.68	102.89	1.07
MH-537	MH-536	193-1	103.88	45.0	64.5	102.98	102.68	102.89	0.99
MH-537	MH-536	192-4	103.75	55.0	64.5	102.98	102.68	102.94	0.81
MH-538	MH-539	197-3	101.08	16.5	58.5	101.15	100.10	100.40	0.68
MH-538	MH-539	197-2	101.08	24.5	58.5	101.15	100.10	100.54	0.54
MH-538	MH-539	197-1	101.42	31.8	58.5	101.15	100.10	100.67	0.75
MH-538	MH-539	196-4	102.16	41.8	58.5	101.15	100.10	100.85	1.31
MH-538	MH-539	196-3	102.16	49.8	58.5	101.15	100.10	101.00	1.16
MH-538	MH-539	196-2	102.56	56.4	58.5	101.15	100.10	101.12	1.44
MH-542	MH-543	58	103.46	5.4	53.0	99.95	99.81	99.83	3.63
MH-542	MH-543	62-5	100.72	8.9	53.0	99.95	99.81	99.84	0.88
MH-542	MH-543	62-4	100.72	16.2	53.0	99.95	99.81	99.86	0.86
MH-542	MH-543	59	103.46	18.2	53.0	99.95	99.81	99.86	3.60
MH-542	MH-543	62-3	100.72	24.2	53.0	99.95	99.81	99.88	0.84
MH-542	MH-543	60	103.42	24.3	53.0	99.95	99.81	99.88	3.54
MH-542	MH-543	62-2	100.72	30.8	53.0	99.95	99.81	99.89	0.83
MH-542	MH-543	61	103.33	37.1	53.0	99.95	99.81	99.91	3.42
MH-542	MH-543	62-1	100.72	38.8	53.0	99.95	99.81	99.91	0.81
MH-543	MH-544	66-2	100.62	3.8	118.0	99.81	98.42	98.47	2.15
MH-543	MH-544	45	103.16	4.0	118.0	99.81	98.42	98.47	4.69
MH-543	MH-544	46	103.46	10.1	118.0	99.81	98.42	98.54	4.92
MH-543	MH-544	66-1	100.62	11.8	118.0	99.81	98.42	98.56	2.06
MH-543	MH-544	65-4	100.72	21.8	118.0	99.81	98.42	98.68	2.04
MH-543	MH-544	47	103.51	22.9	118.0	99.81	98.42	98.69	4.82
MH-543	MH-544	48	103.51	29.0	118.0	99.81	98.42	98.76	4.75
MH-543	MH-544	65-3	100.72	29.8	118.0	99.81	98.42	98.77	1.95
MH-543	MH-544	65-2	100.72	36.4	118.0	99.81	98.42	98.85	1.87
MH-543	MH-544	49	103.51	41.8	118.0	99.81	98.42	98.92	4.59
MH-543	MH-544	65-1	100.72	44.4	118.0	99.81	98.42	98.95	1.77
MH-543	MH-544	50	103.51	47.9	118.0	99.81	98.42	98.99	4.52
MH-543	MH-544	64-4	100.86	54.4	118.0	99.81	98.42	99.06	1.80
MH-543	MH-544	51	103.51	60.8	118.0	99.81	98.42	99.14	4.37
MH-543	MH-544	64-3	100.86	62.4	118.0	99.81	98.42	99.16	1.70
MH-543	MH-544	52	103.51	66.9	118.0	99.81	98.42	99.21	4.30
MH-543	MH-544	64-2	100.86	69.0	118.0	99.81	98.42	99.24	1.62
MH-543	MH-544	64-1	100.86	77.0	118.0	99.81	98.42	99.33	1.53
MH-543	MH-544	53	103.57	79.7	118.0	99.81	98.42	99.36	4.21
MH-543	MH-544	54	103.61	85.8	118.0	99.81	98.42	99.43	4.18
MH-543	MH-544	63-5	100.86	87.0	118.0	99.81	98.42	99.45	1.41
MH-543	MH-544	63-4	100.86	94.3	118.0	99.81	98.42	99.53	1.33
MH-543	MH-544	55	103.59	98.6	118.0	99.81	98.42	99.59	4.00
MH-543	MH-544	63-3	100.86	102.3	118.0	99.81	98.42	99.63	1.23
MH-543	MH-544	56	103.49	104.7	118.0	99.81	98.42	99.66	3.83
MH-543	MH-544	63-2	100.86	108.9	118.0	99.81	98.42	99.71	1.15
MH-543	MH-544	63-1	100.86	116.9	118.0	99.81	98.42	99.80	1.06
MH-543	MH-544	57	103.46	117.5	118.0	99.81	98.42	99.81	3.65
MH-544	MH-5440	68-3	99.4	3.4	57.5	98.42	98.39	98.39	1.01
MH-544	MH-5440	68-2	99.4	10.7	57.5	98.42	98.39	98.40	1.00
MH-544	MH-5440	68-1	99.4	18.7	57.5	98.42	98.39	98.40	1.00
MH-544	MH-5440	67-3	99.49	28.7	57.5	98.42	98.39	98.41	1.08
MH-544	MH-5440	42	102.27	30.0	57.5	98.42	98.39	98.41	3.86
MH-544	MH-5440	67-2	100.2	36.0	57.5	98.42	98.39	98.41	1.79
MH-544	MH-5440	43	102.6	42.8	57.5	98.42	98.39	98.42	4.18
MH-544	MH-5440	67-1	100.2	44.0	57.5	98.42	98.39	98.42	1.78
MH-544	MH-5440	44	102.93	48.9	57.5	98.42	98.39	98.42	4.51
MH-544	MH-5440	66-3	100.62	54.0	57.5	98.42	98.39	98.42	2.20
MH-546	MH-547	177-1	102.31	8.8	99.5	102.13	101.40	101.47	0.84
MH-546	MH-547	177-2	102.61	16.1	99.5	102.13	101.40	101.52	1.09
MH-546	MH-547	177-3	102.61	24.1	99.5	102.13	101.40	101.58	1.03
MH-546	MH-547	178-1	102.71	34.1	99.5	102.13	101.40	101.65	1.06
MH-546	MH-547	178-2	102.71	42.1	99.5	102.13	101.40	101.71	1.00
MH-546	MH-547	178-3	103.04	48.7	99.5	102.13	101.40	101.76	1.28
MH-546	MH-547	178-4	103.04	56.7	99.5	102.13	101.40	101.82	1.22
MH-546	MH-547	179-1	103.04	66.7	99.5	102.13	101.40	101.89	1.15
MH-546	MH-547	179-2	103.4	74.0	99.5	102.13	101.40	101.94	1.46
MH-546	MH-547	179-3	103.4	82.0	99.5	102.13	101.40	102.00	1.40
MH-546	MH-547	179-4	103.4	88.6	99.5	102.13	101.40	102.05	1.35
MH-546	MH-547	179-5	103.4	96.6	99.5	102.13	101.40	102.11	1.29
MH-547	MH-548	175-1	101.33	5.2	60.0	101.40	100.54	100.62	0.71
MH-547	MH-548	175-2	101.33	13.6	60.0	101.40	100.54	100.74	0.59
MH-547	MH-548	175-3	101.64	20.2	60.0	101.40	100.54	100.83	0.81
MH-547	MH-548	175-4	101.64	28.2	60.0	101.40	100.54	100.95	0.69
MH-547	MH-548	176-1	101.82	38.2	60.0	101.40	100.54	101.09	0.73

Table C3B: USF Freeboard Results - 1979 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-547	MH-548	176-2	102.27	45.8	60.0	101.40	100.54	101.20	1.07
MH-547	MH-548	176-3	102.27	53.9	60.0	101.40	100.54	101.32	0.95
MH-548	MH-549	174-2	100.89	0.3	29.5	100.54	100.23	100.23	0.66
MH-548	MH-549	174-3	100.89	8.2	29.5	100.54	100.23	100.32	0.57
MH-548	MH-549	174-4	101.21	14.8	29.5	100.54	100.23	100.39	0.82
MH-548	MH-549	174-5	101.21	22.8	29.5	100.54	100.23	100.47	0.74
MH-549	MH-550	174-1	100.89	2.7	12.5	100.23	99.89	99.96	0.93
MH-550	MH-551	170-6	100.02	1.6	112.0	99.89	98.51	98.53	1.49
MH-550	MH-551	170-5	100.3	6.9	112.0	99.89	98.51	98.60	1.70
MH-550	MH-551	171-8	100.3	16.4	112.0	99.89	98.51	98.71	1.59
MH-550	MH-551	171-7	100.33	21.0	112.0	99.89	98.51	98.77	1.56
MH-550	MH-551	171-6	100.46	29.0	112.0	99.89	98.51	98.87	1.59
MH-550	MH-551	171-5	100.73	35.2	112.0	99.89	98.51	98.94	1.79
MH-550	MH-551	172-10	100.73	44.6	112.0	99.89	98.51	99.06	1.67
MH-550	MH-551	172-9	100.77	49.2	112.0	99.89	98.51	99.12	1.65
MH-550	MH-551	172-8	100.9	57.2	112.0	99.89	98.51	99.21	1.69
MH-550	MH-551	172-7	100.96	61.6	112.0	99.89	98.51	99.27	1.69
MH-550	MH-551	172-6	101.27	69.6	112.0	99.89	98.51	99.37	1.90
MH-550	MH-551	173-10	101.27	77.4	112.0	99.89	98.51	99.46	1.81
MH-550	MH-551	173-9	101.33	85.4	112.0	99.89	98.51	99.56	1.77
MH-550	MH-551	173-8	101.43	91.6	112.0	99.89	98.51	99.64	1.79
MH-550	MH-551	173-7	101.5	96.0	112.0	99.89	98.51	99.69	1.81
MH-550	MH-551	173-6	101.91	104.0	112.0	99.89	98.51	99.79	2.12
MH-551	MH-559	169-8	99.46	10.7	52.5	98.51	95.97	96.49	2.97
MH-551	MH-559	169-7	99.43	18.7	52.5	98.51	95.97	96.87	2.56
MH-551	MH-559	169-6	99.53	23.1	52.5	98.51	95.97	97.09	2.44
MH-551	MH-559	169-5	99.86	31.1	52.5	98.51	95.97	97.48	2.38
MH-551	MH-559	170-8	99.86	40.5	52.5	98.51	95.97	97.93	1.93
MH-551	MH-559	170-7	99.9	45.1	52.5	98.51	95.97	98.15	1.75
MH-552	MH-553	172-1	100.73	1.3	64.5	100.29	99.26	99.28	1.45
MH-552	MH-553	172-2	100.77	4.9	64.5	100.29	99.26	99.34	1.43
MH-552	MH-553	167-4	100.44	7.6	64.5	100.29	99.26	99.38	1.06
MH-552	MH-553	172-3	100.9	13.0	64.5	100.29	99.26	99.47	1.43
MH-552	MH-553	167-3	100.44	15.6	64.5	100.29	99.26	99.51	0.93
MH-552	MH-553	172-4	100.96	17.2	64.5	100.29	99.26	99.54	1.42
MH-552	MH-553	167-2	100.44	22.2	64.5	100.29	99.26	99.62	0.82
MH-552	MH-553	172-5	101.27	25.2	64.5	100.29	99.26	99.66	1.61
MH-552	MH-553	167-1	100.44	30.2	64.5	100.29	99.26	99.74	0.70
MH-552	MH-553	173-1	101.27	33.1	64.5	100.29	99.26	99.79	1.48
MH-552	MH-553	168-4	100.69	40.2	64.5	100.29	99.26	99.90	0.79
MH-552	MH-553	173-2	101.33	41.1	64.5	100.29	99.26	99.92	1.41
MH-552	MH-553	173-3	101.43	47.2	64.5	100.29	99.26	100.01	1.42
MH-552	MH-553	168-3	100.69	48.2	64.5	100.29	99.26	100.03	0.66
MH-552	MH-553	173-4	101.5	51.6	64.5	100.29	99.26	100.08	1.42
MH-552	MH-553	168-2	101.48	54.8	64.5	100.29	99.26	100.13	1.35
MH-552	MH-553	173-5	101.91	59.6	64.5	100.29	99.26	100.21	1.70
MH-552	MH-553	168-1	101.48	62.8	64.5	100.29	99.26	100.26	1.22
MH-553	MH-557	169-1	99.46	16.0	103.5	99.26	97.89	98.10	1.36
MH-553	MH-557	169-2	99.43	25.6	103.5	99.26	97.89	98.23	1.20
MH-553	MH-557	169-3	99.53	30.0	103.5	99.26	97.89	98.28	1.25
MH-553	MH-557	169-4	99.86	38.0	103.5	99.26	97.89	98.39	1.47
MH-553	MH-557	165-4	99.5	38.5	103.5	99.26	97.89	98.40	1.10
MH-553	MH-557	165-3	99.5	46.5	103.5	99.26	97.89	98.50	1.00
MH-553	MH-557	170-1	99.86	47.4	103.5	99.26	97.89	98.52	1.34
MH-553	MH-557	170-2	99.9	52.0	103.5	99.26	97.89	98.58	1.32
MH-553	MH-557	165-2	99.5	53.1	103.5	99.26	97.89	98.59	0.91
MH-553	MH-557	170-3	100.02	59.9	103.5	99.26	97.89	98.68	1.34
MH-553	MH-557	165-1	99.5	61.2	103.5	99.26	97.89	98.70	0.80
MH-553	MH-557	170-4	100.3	66.1	103.5	99.26	97.89	98.77	1.53
MH-553	MH-557	166-5	99.7	71.2	103.5	99.26	97.89	98.83	0.87
MH-553	MH-557	171-1	100.3	75.5	103.5	99.26	97.89	98.89	1.41
MH-553	MH-557	166-4	99.7	79.2	103.5	99.26	97.89	98.94	0.76
MH-553	MH-557	171-2	100.33	80.2	103.5	99.26	97.89	98.95	1.38
MH-553	MH-557	166-3	100.04	85.8	103.5	99.26	97.89	99.03	1.01
MH-553	MH-557	171-3	100.46	88.2	103.5	99.26	97.89	99.06	1.40
MH-553	MH-557	166-2	100.04	93.8	103.5	99.26	97.89	99.13	0.91
MH-553	MH-557	171-4	100.73	94.4	103.5	99.26	97.89	99.14	1.59
MH-553	MH-557	166-1	100.04	101.1	103.5	99.26	97.89	99.23	0.81
MH-554	MH-556	160-4	100.02	2.6	81.5	99.73	98.97	98.99	1.03
MH-554	MH-556	160-3	100.02	10.6	81.5	99.73	98.97	99.07	0.95
MH-554	MH-556	160-2	100.02	17.2	81.5	99.73	98.97	99.13	0.89
MH-554	MH-556	160-1	100.02	25.2	81.5	99.73	98.97	99.20	0.82
MH-554	MH-556	159-5	100.12	35.2	81.5	99.73	98.97	99.30	0.82
MH-554	MH-556	159-4	100.48	42.5	81.5	99.73	98.97	99.36	1.12
MH-554	MH-556	159-3	100.48	50.5	81.5	99.73	98.97	99.44	1.04
MH-554	MH-556	159-2	100.48	57.1	81.5	99.73	98.97	99.50	0.98
MH-554	MH-556	159-1	100.48	65.1	81.5	99.73	98.97	99.58	0.90
MH-554	MH-556	158-5	100.48	75.1	81.5	99.73	98.97	99.67	0.81
MH-554	MH-556	158-4	100.48	78.8	81.5	99.73	98.97	99.70	0.78

Table C3B: USF Freeboard Results - 1979 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-556	MH-557	162-3	99.15	7.8	70.0	98.97	97.89	98.01	1.14
MH-556	MH-557	164-1	99.39	11.9	70.0	98.97	97.89	98.07	1.32
MH-556	MH-557	162-2	99.15	14.4	70.0	98.97	97.89	98.11	1.04
MH-556	MH-557	164-2	99.39	19.9	70.0	98.97	97.89	98.19	1.20
MH-556	MH-557	162-1	99.15	22.4	70.0	98.97	97.89	98.23	0.92
MH-556	MH-557	164-3	99.39	26.5	70.0	98.97	97.89	98.30	1.09
MH-556	MH-557	161-4	99.55	32.5	70.0	98.97	97.89	98.39	1.16
MH-556	MH-557	164-4	99.39	34.5	70.0	98.97	97.89	98.42	0.97
MH-556	MH-557	161-3	99.55	40.5	70.0	98.97	97.89	98.51	1.04
MH-556	MH-557	161-2	99.55	47.1	70.0	98.97	97.89	98.61	0.94
MH-556	MH-557	161-1	99.55	55.1	70.0	98.97	97.89	98.74	0.81
MH-556	MH-557	160-5	99.64	65.1	70.0	98.97	97.89	98.89	0.75
MH-557	MH-558	163-3	98.67	4.5	36.5	97.89	97.66	97.69	0.98
MH-557	MH-558	163-2	98.67	11.1	36.5	97.89	97.66	97.73	0.94
MH-557	MH-558	163-1	98.67	19.1	36.5	97.89	97.66	97.78	0.89
MH-557	MH-558	162-5	98.77	29.1	36.5	97.89	97.66	97.84	0.93
MH-557	MH-558	162-4	99.15	35.1	36.5	97.89	97.66	97.88	1.27
MH-558	MH-559	163-5	98.32	8.9	14.5	97.66	95.97	97.01	1.31
MH-558	MH-559	163-4	98.67	10.4	14.5	97.66	95.97	97.18	1.49
MH-561	MH-537	192-3	103.75	3.1	42.5	103.08	102.98	102.99	0.76
MH-561	MH-537	192-2	103.75	5.2	42.5	103.08	102.98	103.00	0.75
MH-561	MH-537	180-1	103.86	12.6	42.5	103.08	102.98	103.01	0.85
MH-561	MH-537	192-1	103.75	13.2	42.5	103.08	102.98	103.01	0.74
MH-561	MH-537	180-2	103.86	19.9	42.5	103.08	102.98	103.03	0.83
MH-561	MH-537	191-4	103.8	23.2	42.5	103.08	102.98	103.04	0.76
MH-561	MH-537	180-3	103.86	27.9	42.5	103.08	102.98	103.05	0.81
MH-561	MH-537	191-3	103.8	31.2	42.5	103.08	102.98	103.06	0.74
MH-561	MH-537	180-4	103.86	34.5	42.5	103.08	102.98	103.06	0.80
MH-561	MH-537	191-2	103.8	37.7	42.5	103.08	102.98	103.07	0.73
MH-561	MH-563	182-3	102.47	2.6	61.0	103.08	101.18	101.26	1.21
MH-561	MH-563	182-2	102.47	10.6	61.0	103.08	101.18	101.51	0.96
MH-561	MH-563	190-1	103.21	17.4	61.0	103.08	101.18	101.72	1.49
MH-561	MH-563	182-1	102.81	17.9	61.0	103.08	101.18	101.74	1.07
MH-561	MH-563	190-2	103.21	25.4	61.0	103.08	101.18	101.97	1.24
MH-561	MH-563	181-4	103.55	27.9	61.0	103.08	101.18	102.05	1.50
MH-561	MH-563	190-3	103.8	32.0	61.0	103.08	101.18	102.18	1.62
MH-561	MH-563	181-3	103.55	35.9	61.0	103.08	101.18	102.30	1.25
MH-561	MH-563	190-4	103.8	40.0	61.0	103.08	101.18	102.43	1.37
MH-561	MH-563	181-2	103.86	42.5	61.0	103.08	101.18	102.51	1.35
MH-561	MH-563	190-5	103.8	47.3	61.0	103.08	101.18	102.66	1.14
MH-561	MH-563	181-1	103.86	50.5	61.0	103.08	101.18	102.76	1.10
MH-561	MH-563	191-1	103.8	55.7	61.0	103.08	101.18	102.92	0.88
MH-561	MH-563	180-5	103.86	59.1	61.0	103.08	101.18	103.02	0.84
MH-563	MH-564	187-2	102.43	3.4	73.5	101.18	100.91	100.93	1.50
MH-563	MH-564	185-1	102.24	4.5	73.5	101.18	100.91	100.93	1.31
MH-563	MH-564	184-4	102.57	10.2	73.5	101.18	100.91	100.95	1.62
MH-563	MH-564	187-3	102.75	10.9	73.5	101.18	100.91	100.95	1.80
MH-563	MH-564	184-3	102.57	18.2	73.5	101.18	100.91	100.98	1.59
MH-563	MH-564	188-1	102.75	20.8	73.5	101.18	100.91	100.99	1.76
MH-563	MH-564	184-2	102.57	24.8	73.5	101.18	100.91	101.00	1.57
MH-563	MH-564	188-2	102.75	28.8	73.5	101.18	100.91	101.02	1.73
MH-563	MH-564	184-1	102.57	32.8	73.5	101.18	100.91	101.03	1.54
MH-563	MH-564	188-3	102.75	36.2	73.5	101.18	100.91	101.04	1.71
MH-563	MH-564	183-3	102.57	42.8	73.5	101.18	100.91	101.07	1.50
MH-563	MH-564	189-1	102.64	46.2	73.5	101.18	100.91	101.08	1.56
MH-563	MH-564	183-2	102.57	50.8	73.5	101.18	100.91	101.10	1.47
MH-563	MH-564	189-2	102.64	54.4	73.5	101.18	100.91	101.11	1.53
MH-563	MH-564	183-1	102.57	58.6	73.5	101.18	100.91	101.13	1.44
MH-563	MH-564	189-3	102.64	61.6	73.5	101.18	100.91	101.14	1.50
MH-564	MH-8500	186-1	102.24	17.1	48.5	100.91	99.65	100.09	2.15
MH-564	MH-8500	185-5	101.61	19.9	48.5	100.91	99.65	100.17	1.44
MH-564	MH-8500	186-2	102.24	25.1	48.5	100.91	99.65	100.30	1.94
MH-564	MH-8500	185-4	101.61	27.9	48.5	100.91	99.65	100.38	1.23
MH-564	MH-8500	186-3	102.24	32.4	48.5	100.91	99.65	100.49	1.75
MH-564	MH-8500	185-3	101.93	34.5	48.5	100.91	99.65	100.55	1.38
MH-564	MH-8500	187-1	102.43	42.4	48.5	100.91	99.65	100.75	1.68
MH-564	MH-8500	185-2	101.93	42.5	48.5	100.91	99.65	100.76	1.17
								Min	0.40
								Max	4.92
								Average	1.39

Key:

Freeboard to USF less than 0.30 m

Freeboard to USF less than 0.00 m

Table C4A: Pipe Data and Hydraulic Simulation Results - 1988 Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m³/s)	Peak Pipe Flow (m³/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH_136	MH_302	96.484	96.41	101.19	101.14	2250	53.9	0.1	0.013	1.66	6.59	7.02	1.06	-0.31	02:04	98.42	98.36
MH_302	MH_303	96.41	96.331	101.14	101.08	2250	58.9	0.1	0.013	1.66	6.59	7.70	1.17	-0.30	02:03	98.36	98.28
MH_303	MH_304	96.331	96.176	101.08	100.73	2250	134.3	0.1	0.013	1.67	6.62	7.80	1.18	-0.30	02:03	98.28	98.09
MH_304	MH_306TEE	96.176	96.133	100.73	100.27	2250	42.5	0.1	0.013	1.67	6.62	7.86	1.19	-0.34	02:04	98.09	97.83
MH_306TEE	MH_307	96.133	96.1	100.27	100.35	2250	11.2	0.1	0.013	1.79	7.10	7.86	1.11	-0.55	02:04	97.83	97.60
MH_307	MH_400	96.1	96.067	100.35	100.35	2250	22.7	0.1	0.013	1.71	6.79	5.69	0.84	-0.75	02:04	97.60	97.57
MH_400	OGS_1	96.067	96.037	100.35	100.5	750	4.9	0.2	0.013	1.13	0.50	1.01	2.02	0.75	01:30	97.57	97.53
MH_500	OGS_2	96.056	96.026	100.35	100.428	750	5.0	0.2	0.013	1.13	0.50	1.01	2.02	0.53	01:38	97.34	97.30
MH-313	MH_500	96.099	96.056	99.835	100.35	2250	33.0	0.1	0.013	1.68	6.69	3.92	0.59	-0.79	02:03	97.56	97.34
MH-500	MH-502	102.24	100.94	105.21	104.245	300	92.0	1.3	0.013	1.53	0.11	0.12	1.06	-0.03	02:00	102.51	101.22
MH-502	MH-503	100.94	98.961	104.245	102.42	450	119.0	1.6	0.013	2.27	0.36	0.26	0.71	-0.17	02:01	101.22	99.47
MH-5020	MH-502	101.143	100.94	104.27	104.245	300	10.5	0.5	0.013	0.97	0.07	0.00	0.01	-0.22	01:28	101.22	101.22
MH-503	MH-504	98.961	98.683	102.42	101.89	525	73.0	0.3	0.013	1.00	0.22	0.27	1.27	-0.02	02:02	99.47	99.08
MH-504	MH-528	98.683	97.315	101.89	101.06	600	108.0	0.9	0.013	2.00	0.57	0.44	0.78	-0.20	02:01	99.08	98.25
MH-505	MH-506	103.478	103.351	105.836	106.28	300	13.0	0.6	0.013	1.06	0.07	0.01	0.07	-0.26	02:00	103.52	103.62
MH-505	MH-534	103.478	103.033	105.836	105.406	375	94.5	0.5	0.013	1.06	0.12	0.00	0.02	-0.33	02:01	103.52	103.21
MH-506	MH-508	103.351	103.054	106.28	105.88	300	79.0	0.4	0.013	0.81	0.06	0.06	1.01	-0.03	01:59	103.62	103.38
MH-5070	MH-513	103.12	102.394	105.92	105.51	300	82.0	0.5	0.013	0.97	0.07	0.05	0.79	-0.10	02:00	103.32	102.94
MH-508	MH-509	103.054	102.837	105.88	105.67	300	41.5	0.5	0.013	0.92	0.06	0.08	1.19	0.03	02:00	103.38	103.13
MH-5080	MH-517	102.898	102.054	105.7	105.28	300	76.5	0.6	0.013	1.01	0.07	0.05	0.75	-0.11	02:00	103.09	102.66
MH-509	MH-510	102.837	102.718	105.67	105.6	300	10.5	0.4	0.013	0.87	0.06	0.08	1.26	-0.01	02:00	103.13	102.93
MH-510	MH-511	102.718	102.077	105.6	105.25	375	64.0	0.6	0.013	1.18	0.13	0.08	0.58	-0.17	02:01	102.93	102.30
MH-511	MH-526	102.077	98.642	105.25	103	450	95.5	2.8	0.013	3.00	0.48	0.24	0.50	-0.23	02:00	102.30	100.05
MH-513	MH-515	102.394	100.231	105.51	104	300	81.0	2.3	0.013	2.08	0.15	0.14	0.97	0.25	02:02	102.94	100.67
MH-515	MH-518	100.231	99.793	104	103.59	600	44.0	0.3	0.013	1.19	0.34	0.34	1.00	-0.16	02:00	100.67	100.30
MH-517	MH-518	102.054	99.793	105.28	103.59	300	82.0	2.3	0.013	2.08	0.15	0.15	0.99	0.31	02:02	102.66	100.30
MH-518	MH-526	99.793	98.642	103.59	103	675	47.0	0.3	0.013	1.29	0.46	0.48	1.04	-0.16	02:01	100.30	100.05
MH-519	MH-520	103.476	103.127	105.766	106.01	300	54.5	0.5	0.013	0.97	0.07	0.00	0.00	-0.30	00:00	103.48	103.39
MH-519	MH-523	103.476	103.213	105.766	105.726	300	11.5	0.3	0.013	0.81	0.06	0.00	0.00	-0.30	00:00	103.48	103.32
MH-520	MH-521	103.127	102.808	106.01	105.71	375	57.5	0.5	0.013	1.12	0.12	0.10	0.79	-0.11	02:00	103.39	103.10
MH-521	MH-522	102.808	102.725	105.71	105.64	375	11.5	0.3	0.013	0.94	0.10	0.10	0.95	-0.08	02:00	103.10	102.93
MH-522	MH-525	102.725	100.69	105.64	104.2	375	55.0	2.6	0.013	2.54	0.28	0.15	0.55	-0.17	02:00	102.93	101.06
MH-523	MH-524	103.213	102.148	105.726	104.956	300	55.0	1.8	0.013	1.84	0.13	0.04	0.28	-0.19	02:00	103.32	102.47
MH-524	MH-5240	102.148	101.917	104.956	105.23	375	65.0	0.3	0.013	0.87	0.10	0.10	1.05	-0.06	02:00	102.47	102.19
MH-5240	MH-525	101.917	100.69	105.23	104.2	375	63.5	1.6	0.013	1.98	0.22	0.16	0.72	-0.11	02:01	102.19	101.06
MH-52400	MH-538	102.155	100.883	104.956	103.676	300	58.0	1.8	0.013	1.84	0.13	0.02	0.18	-0.21	02:00	102.25	101.16
MH-525	MH-526	100.69	98.642	104.2	103	525	58.5	1.8	0.013	2.67	0.58	0.38	0.66	-0.16	02:00	101.06	100.05
MH-526	MH-528	98.642	97.315	103	101.06	675	59.5	1.6	0.013	2.97	1.06	1.13	1.06	0.73	02:01	100.05	98.25
MH-527	MH-528	99.084	97.315	101.18	101.06	300	18.5	0.4	0.013	0.81	0.06	0.02	0.31	-0.17	01:59	99.21	98.25
MH-528	MH-529	97.315	97.009	101.06	100.82	1050	62.5	0.3	0.013	1.58	1.37	1.60	1.17	-0.12	02:02	98.25	98.02
MH-529	MH-530	97.009	96.851	100.82	100.58	1200	72.0	0.2	0.013	1.34	1.51	1.60	1.06	-0.19	02:02	98.02	97.89

Table C4A: Pipe Data and Hydraulic Simulation Results - 1988 Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-530	MH-531	96.851	96.656	100.58	100.45	1200	76.5	0.2	0.013	1.34	1.51	1.72	1.14	-0.16	02:03	97.89	97.69
MH-531	MH-313	96.656	96.099	100.45	99.835	1200	21.5	0.1	0.013	1.33	1.50	1.72	1.14	-0.17	02:03	97.69	97.56
MH-534	MH-535	103.033	100.603	105.406	103.886	375	78.5	3.0	0.013	2.75	0.30	0.14	0.46	-0.19	02:00	103.21	100.95
MH-535	MH-515	100.603	100.231	103.886	104	450	44.0	0.2	0.013	0.80	0.13	0.14	1.11	-0.10	02:00	100.95	100.67
MH-5350	MH-539	101.607	99.624	103.886	102.466	300	52.5	2.4	0.013	2.12	0.15	0.02	0.11	-0.23	02:00	101.68	100.11
MH-536	MH-538	102.515	100.883	105.446	103.676	450	59.0	2.2	0.013	2.63	0.42	0.12	0.29	-0.28	02:00	102.69	101.16
MH-537	MH-536	102.673	102.515	105.126	105.446	450	64.5	0.2	0.013	0.80	0.13	0.12	0.94	-0.12	02:00	103.00	102.69
MH-538	MH-539	100.883	99.624	103.676	102.466	525	58.5	2.1	0.013	2.88	0.62	0.35	0.56	-0.25	02:00	101.16	100.11
MH-539	MH-542	99.624	99.339	102.466	102.396	525	9.5	0.6	0.013	1.54	0.33	0.37	1.10	-0.04	02:00	100.11	99.97
MH-540	MH-541	100.072	99.961	101.646	102.506	300	14.5	0.4	0.013	0.81	0.06	0.04	0.66	-0.12	02:00	100.25	100.14
MH-541	MH-542	99.961	99.339	102.506	102.396	300	10.0	0.4	0.013	0.81	0.06	0.04	0.66	-0.12	02:00	100.14	99.97
MH-542	MH-543	99.339	99.184	102.396	102.186	750	53.0	0.2	0.013	0.98	0.43	0.52	1.21	-0.12	02:00	99.97	99.82
MH-543	MH-544	99.184	97.993	102.186	102.016	825	118.0	0.2	0.013	1.04	0.56	0.60	1.08	-0.19	02:01	99.82	98.42
MH-544	MH-5440	97.993	97.273	102.016	101	825	57.5	1.2	0.013	2.94	1.57	0.66	0.42	-0.39	02:01	98.42	98.38
MH-5440	MH_302	97.273	96.41	101	101.14	825	12.3	1.2	0.013	2.97	1.59	0.66	0.42	0.28	02:01	98.38	98.36
MH-546	MH-547	102.009	101.183	104.84	104.04	375	99.5	0.8	0.013	1.42	0.16	0.04	0.23	-0.25	02:02	102.13	101.41
MH-547	MH-548	101.183	100.223	104.04	103.13	375	60.0	1.6	0.013	1.98	0.22	0.16	0.71	-0.14	02:00	101.41	100.61
MH-548	MH-549	100.223	99.898	103.13	102.8	375	29.5	1.0	0.013	1.59	0.18	0.18	1.02	0.02	02:00	100.61	100.28
MH-549	MH-550	99.898	99.618	102.8	102.64	375	12.5	1.0	0.013	1.59	0.18	0.18	1.02	0.00	02:01	100.28	99.91
MH-550	MH-551	99.618	97.862	102.64	100.93	525	112.0	1.6	0.013	2.47	0.54	0.32	0.60	-0.23	02:00	99.91	98.65
MH-551	MH-559	97.862	94.699	100.93	100.39	525	52.5	1.4	0.013	2.35	0.51	0.49	0.96	0.27	02:00	98.65	96.18
MH-552	MH-553	100.139	99.064	102.99	101.99	300	64.5	1.6	0.013	1.70	0.12	0.07	0.56	-0.14	02:00	100.30	99.28
MH-553	MH-557	99.064	97.315	101.99	100.86	375	103.5	1.4	0.013	1.88	0.21	0.14	0.66	-0.16	02:00	99.28	97.99
MH-554	MH-556	99.668	98.669	102.47	101.7	300	81.5	1.0	0.013	1.33	0.09	0.01	0.12	-0.23	02:00	99.74	98.99
MH-556	MH-557	98.669	97.315	101.7	100.86	525	70.0	1.2	0.013	2.18	0.47	0.32	0.69	-0.21	02:00	98.99	97.99
MH-5560	MH-556	98.809	98.669	101.67	101.7	525	14.5	0.6	0.013	1.48	0.32	0.26	0.83	0.00	02:00	99.34	98.99
MH-557	MH-558	97.315	97.121	100.86	100.39	675	36.5	0.4	0.013	1.57	0.56	0.64	1.14	0.00	02:00	97.99	97.72
MH-558	MH-559	97.121	94.699	100.39	100.39	675	14.5	0.4	0.013	1.57	0.56	0.64	1.14	-0.08	02:00	97.72	96.18
MH-559	MH-900	94.699	92.925	100.39	95.41	675	15.5	0.8	0.013	2.10	0.75	1.13	1.50	0.81	02:00	96.18	93.73
MH-561	MH-537	103.003	102.673	105.281	105.126	375	42.5	0.6	0.013	1.23	0.14	0.02	0.11	-0.30	02:00	103.08	103.00
MH-561	MH-563	103.003	100.82	105.281	104.305	300	61.0	2.9	0.013	2.33	0.16	0.00	0.00	-0.22	02:00	103.08	101.25
MH-562	MH-563	101.178	100.82	103.205	104.305	300	29.5	0.5	0.013	0.92	0.06	0.06	0.89	-0.03	02:00	101.45	101.25
MH-563	MH-564	100.82	100.643	104.305	103.985	525	73.5	0.2	0.013	0.89	0.19	0.21	1.10	-0.09	02:00	101.25	100.97
MH-564	MH-8500	100.643	99.407	103.985	102.733	525	48.5	2.1	0.013	2.84	0.62	0.32	0.52	-0.20	02:00	100.97	99.68
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.83	0.63	-0.75	02:03	101.11	99.68
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	1.13	0.99	-0.48	02:00	99.68	97.62
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	1.12	0.85	-0.50	02:00	97.62	95.76
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	1.12	0.89	-0.49	02:01	95.76	93.73
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	3.11	0.68	-0.85	02:01	93.73	92.44
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	4.43	0.73	-0.73	02:01	92.44	90.98
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	4.83	0.42	-1.30	02:02	90.98	90.65

Table C4A: Pipe Data and Hydraulic Simulation Results - 1988 Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	5.17	0.64	-1.15	02:02	90.65	90.29
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	5.24	0.46	-1.43	02:03	90.29	90.25
OGS_1	OGS_1-Out	96.037	96.015	100.5	100.35	750	4.9	0.2	0.013	1.14	0.50	1.01	2.01	0.74	01:30	97.53	97.16
OGS_1-Out	MH_3112	96.015	96.01	100.35	100.35	2250	6.2	0.1	0.013	1.63	6.49	5.69	0.88	-1.11	02:04	97.16	97.13
OGS_2	OGS_2-Out	96.026	96.004	100.428	100.35	750	5.1	0.2	0.013	1.12	0.49	1.01	2.03	0.52	01:38	97.30	96.96
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	3.11	0.68	-0.85	02:01	93.73	92.44
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	1.13	0.99	-0.48	02:00	99.68	97.62
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.83	0.63	-0.75	02:03	101.11	99.68
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	1.12	0.85	-0.50	02:00	97.62	95.76
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	1.12	0.89	-0.49	02:01	95.76	93.73
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	3.11	0.68	-0.85	02:01	93.73	92.44
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	4.43	0.73	-0.73	02:01	92.44	90.98
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	4.83	0.42	-1.30	02:02	90.98	90.65
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	5.17	0.64	-1.15	02:02	90.65	90.29
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	5.24	0.46	-1.43	02:03	90.29	90.25

Table C4B: USF Freeboard Results - 1988 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-531	MH-313	76-2	98.43	4.8	21.5	97.69	97.56	97.59	0.84
MH-531	MH-313	76-1	98.43	9.6	21.5	97.69	97.56	97.62	0.81
MH-500	MH-502	146-6	102.89	14.2	92.0	102.51	101.22	101.42	1.47
MH-500	MH-502	146-5	102.89	22.2	92.0	102.51	101.22	101.53	1.36
MH-500	MH-502	146-4	102.89	28.8	92.0	102.51	101.22	101.62	1.27
MH-500	MH-502	146-3	102.89	36.8	92.0	102.51	101.22	101.74	1.15
MH-500	MH-502	146-2	102.89	43.4	92.0	102.51	101.22	101.83	1.06
MH-500	MH-502	146-1	102.89	51.4	92.0	102.51	101.22	101.94	0.95
MH-500	MH-502	145-5	103.05	61.4	92.0	102.51	101.22	102.08	0.97
MH-500	MH-502	145-4	103.05	69.9	92.0	102.51	101.22	102.20	0.85
MH-500	MH-502	145-3	103.55	76.0	92.0	102.51	101.22	102.29	1.26
MH-500	MH-502	145-2	103.55	84.0	92.0	102.51	101.22	102.40	1.15
MH-500	MH-502	145-1	103.55	88.9	92.0	102.51	101.22	102.47	1.08
MH-502	MH-503	148-5	101.09	38.5	119.0	101.22	99.47	100.04	1.05
MH-502	MH-503	148-4	101.09	46.5	119.0	101.22	99.47	100.15	0.94
MH-502	MH-503	148-3	101.09	53.1	119.0	101.22	99.47	100.25	0.84
MH-502	MH-503	148-2	101.09	61.1	119.0	101.22	99.47	100.37	0.72
MH-502	MH-503	148-1	101.44	68.4	119.0	101.22	99.47	100.48	0.96
MH-502	MH-503	147-6	101.65	78.4	119.0	101.22	99.47	100.62	1.03
MH-502	MH-503	147-5	101.65	86.4	119.0	101.22	99.47	100.74	0.91
MH-502	MH-503	147-4	102.03	94.4	119.0	101.22	99.47	100.86	1.17
MH-502	MH-503	147-3	102.03	101.0	119.0	101.22	99.47	100.96	1.07
MH-502	MH-503	147-2	102.66	107.6	119.0	101.22	99.47	101.05	1.61
MH-502	MH-503	147-1	102.66	115.6	119.0	101.22	99.47	101.17	1.49
MH-503	MH-504	150-3	100.3	1.3	73.0	99.47	99.08	99.09	1.21
MH-503	MH-504	156-4	100.04	2.7	73.0	99.47	99.08	99.10	0.94
MH-503	MH-504	150-2	100.3	6.3	73.0	99.47	99.08	99.12	1.18
MH-503	MH-504	156-5	100.04	10.0	73.0	99.47	99.08	99.14	0.90
MH-503	MH-504	150-1	100.3	14.3	73.0	99.47	99.08	99.16	1.14
MH-503	MH-504	157-1	100.3	20.0	73.0	99.47	99.08	99.19	1.11
MH-503	MH-504	149-5	100.7	24.3	73.0	99.47	99.08	99.21	1.49
MH-503	MH-504	157-2	100.3	28.0	73.0	99.47	99.08	99.23	1.07
MH-503	MH-504	149-4	100.7	32.3	73.0	99.47	99.08	99.25	1.45
MH-503	MH-504	157-3	100.3	34.6	73.0	99.47	99.08	99.27	1.03
MH-503	MH-504	149-3	100.7	38.9	73.0	99.47	99.08	99.29	1.41
MH-503	MH-504	157-4	100.3	42.6	73.0	99.47	99.08	99.31	0.99
MH-503	MH-504	149-2	100.7	46.9	73.0	99.47	99.08	99.33	1.37
MH-503	MH-504	157-5	100.3	49.9	73.0	99.47	99.08	99.35	0.95
MH-503	MH-504	149-1	100.7	54.3	73.0	99.47	99.08	99.37	1.33
MH-503	MH-504	158-1	100.48	59.8	73.0	99.47	99.08	99.40	1.08
MH-503	MH-504	158-2	100.48	67.8	73.0	99.47	99.08	99.44	1.04
MH-503	MH-504	158-3	100.48	71.4	73.0	99.47	99.08	99.46	1.02
MH-504	MH-528	154-1	99.24	15.6	108.0	99.08	98.25	98.37	0.87
MH-504	MH-528	153-3	99.92	16.5	108.0	99.08	98.25	98.37	1.55
MH-504	MH-528	154-2	99.24	23.6	108.0	99.08	98.25	98.43	0.81
MH-504	MH-528	153-2	99.92	24.5	108.0	99.08	98.25	98.44	1.48
MH-504	MH-528	154-3	99.24	30.2	108.0	99.08	98.25	98.48	0.76
MH-504	MH-528	153-1	99.92	31.8	108.0	99.08	98.25	98.49	1.43
MH-504	MH-528	154-4	99.24	38.2	108.0	99.08	98.25	98.54	0.70
MH-504	MH-528	152-3	99.92	41.8	108.0	99.08	98.25	98.57	1.35
MH-504	MH-528	155-1	99.28	48.2	108.0	99.08	98.25	98.62	0.66
MH-504	MH-528	152-2	99.92	49.8	108.0	99.08	98.25	98.63	1.29
MH-504	MH-528	155-2	99.28	56.2	108.0	99.08	98.25	98.68	0.60
MH-504	MH-528	152-1	99.92	57.1	108.0	99.08	98.25	98.69	1.23
MH-504	MH-528	155-3	99.59	62.8	108.0	99.08	98.25	98.73	0.86
MH-504	MH-528	151-4	99.96	67.1	108.0	99.08	98.25	98.77	1.19
MH-504	MH-528	155-4	99.59	70.8	108.0	99.08	98.25	98.79	0.80
MH-504	MH-528	151-3	99.96	75.1	108.0	99.08	98.25	98.83	1.13
MH-504	MH-528	155-5	99.59	78.1	108.0	99.08	98.25	98.85	0.74
MH-504	MH-528	151-2	99.96	81.7	108.0	99.08	98.25	98.88	1.08
MH-504	MH-528	156-1	99.73	88.1	108.0	99.08	98.25	98.93	0.80
MH-504	MH-528	151-1	100.04	89.7	108.0	99.08	98.25	98.94	1.10
MH-504	MH-528	156-2	99.73	96.1	108.0	99.08	98.25	98.99	0.74
MH-504	MH-528	150-4	100.3	99.7	108.0	99.08	98.25	99.02	1.28
MH-504	MH-528	156-3	100.04	102.7	108.0	99.08	98.25	99.04	1.00
MH-505	MH-506	92-3	104.3	2.5	13.0	103.52	103.62	103.60	0.70
MH-505	MH-506	92-2	104.3	6.8	13.0	103.52	103.62	103.57	0.73
MH-505	MH-506	92-1	104.3	11.3	13.0	103.52	103.62	103.53	0.77
MH-505	MH-534	99-7	104.61	3.7	94.5	103.52	103.21	103.22	1.39
MH-505	MH-534	95-5	103.94	6.8	94.5	103.52	103.21	103.23	0.71
MH-505	MH-534	99-6	104.67	11.7	94.5	103.52	103.21	103.25	1.42
MH-505	MH-534	94-1	104.13	17.4	94.5	103.52	103.21	103.27	0.86
MH-505	MH-534	99-5	104.86	17.9	94.5	103.52	103.21	103.27	1.59
MH-505	MH-534	94-2	104.13	25.4	94.5	103.52	103.21	103.29	0.84
MH-505	MH-534	100-6	104.86	25.7	94.5	103.52	103.21	103.30	1.56
MH-505	MH-534	94-3	104.13	32.7	94.5	103.52	103.21	103.32	0.81
MH-505	MH-534	100-5	104.78	33.7	94.5	103.52	103.21	103.32	1.46
MH-505	MH-534	100-4	104.97	38.3	94.5	103.52	103.21	103.34	1.63
MH-505	MH-534	94-4	104.13	40.7	94.5	103.52	103.21	103.34	0.79

Table C4B: USF Freeboard Results - 1988 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-505	MH-534	101-6	104.97	47.7	94.5	103.52	103.21	103.37	1.60
MH-505	MH-534	94-5	104.13	48.3	94.5	103.52	103.21	103.37	0.76
MH-505	MH-534	101-5	104.86	53.9	94.5	103.52	103.21	103.39	1.47
MH-505	MH-534	93-1	104.3	58.9	94.5	103.52	103.21	103.40	0.90
MH-505	MH-534	101-4	105.08	61.9	94.5	103.52	103.21	103.41	1.67
MH-505	MH-534	93-2	104.3	66.9	94.5	103.52	103.21	103.43	0.87
MH-505	MH-534	102-6	105.11	71.3	94.5	103.52	103.21	103.44	1.67
MH-505	MH-534	93-3	104.3	74.2	94.5	103.52	103.21	103.45	0.85
MH-505	MH-534	102-5	105.11	75.9	94.5	103.52	103.21	103.46	1.65
MH-505	MH-534	93-4	104.3	82.2	94.5	103.52	103.21	103.48	0.82
MH-505	MH-534	102-4	105.11	83.9	94.5	103.52	103.21	103.48	1.63
MH-505	MH-534	93-5	104.3	89.8	94.5	103.52	103.21	103.50	0.80
MH-506	MH-508	89-1	103.74	7.2	79.0	103.62	103.38	103.41	0.33
MH-506	MH-508	90-3	104.04	27.0	79.0	103.62	103.38	103.47	0.58
MH-506	MH-508	90-2	104.04	34.6	79.0	103.62	103.38	103.49	0.55
MH-506	MH-508	90-1	104.04	42.6	79.0	103.62	103.38	103.51	0.53
MH-506	MH-508	91-4	104.23	53.2	79.0	103.62	103.38	103.54	0.69
MH-506	MH-508	91-3	104.23	61.2	79.0	103.62	103.38	103.57	0.66
MH-506	MH-508	91-2	104.23	68.5	79.0	103.62	103.38	103.59	0.64
MH-506	MH-508	91-1	104.23	76.5	79.0	103.62	103.38	103.61	0.62
MH-5070	MH-513	99-2	104.61	0.1	82.0	103.32	102.94	102.94	1.67
MH-5070	MH-513	105-6	104.46	8.2	82.0	103.32	102.94	102.98	1.48
MH-5070	MH-513	99-3	104.67	8.4	82.0	103.32	102.94	102.98	1.69
MH-5070	MH-513	105-5	104.46	12.8	82.0	103.32	102.94	103.00	1.46
MH-5070	MH-513	99-4	104.86	14.3	82.0	103.32	102.94	103.01	1.85
MH-5070	MH-513	105-4	104.46	20.8	82.0	103.32	102.94	103.04	1.42
MH-5070	MH-513	100-1	104.86	22.1	82.0	103.32	102.94	103.05	1.81
MH-5070	MH-513	100-2	104.78	30.1	82.0	103.32	102.94	103.08	1.70
MH-5070	MH-513	104-8	104.6	30.2	82.0	103.32	102.94	103.08	1.52
MH-5070	MH-513	100-3	104.97	34.7	82.0	103.32	102.94	103.10	1.87
MH-5070	MH-513	104-7	104.6	34.8	82.0	103.32	102.94	103.10	1.50
MH-5070	MH-513	104-6	104.6	42.8	82.0	103.32	102.94	103.14	1.46
MH-5070	MH-513	101-1	104.97	44.1	82.0	103.32	102.94	103.15	1.82
MH-5070	MH-513	104-5	104.6	49.0	82.0	103.32	102.94	103.17	1.43
MH-5070	MH-513	101-2	104.86	50.3	82.0	103.32	102.94	103.17	1.69
MH-5070	MH-513	101-3	105.08	58.3	82.0	103.32	102.94	103.21	1.87
MH-5070	MH-513	103-8	104.79	58.4	82.0	103.32	102.94	103.21	1.58
MH-5070	MH-513	103-7	104.79	63.0	82.0	103.32	102.94	103.23	1.56
MH-5070	MH-513	102-1	105.11	67.7	82.0	103.32	102.94	103.25	1.86
MH-5070	MH-513	103-6	104.79	71.0	82.0	103.32	102.94	103.27	1.52
MH-5070	MH-513	102-2	105.11	72.3	82.0	103.32	102.94	103.28	1.83
MH-5070	MH-513	103-5	104.79	77.2	82.0	103.32	102.94	103.30	1.49
MH-5070	MH-513	102-3	105.11	80.3	82.0	103.32	102.94	103.31	1.80
MH-508	MH-509	88-3	103.73	6.6	41.5	103.38	103.13	103.17	0.56
MH-508	MH-509	88-2	103.73	14.2	41.5	103.38	103.13	103.21	0.52
MH-508	MH-509	88-1	103.73	22.2	41.5	103.38	103.13	103.26	0.47
MH-508	MH-509	89-3	103.74	32.8	41.5	103.38	103.13	103.33	0.41
MH-508	MH-509	89-2	103.74	40.4	41.5	103.38	103.13	103.38	0.36
MH-5080	MH-517	105-1	104.46	6.2	76.5	103.09	102.66	102.70	1.76
MH-5080	MH-517	111-6	104.04	7.8	76.5	103.09	102.66	102.71	1.33
MH-5080	MH-517	105-2	104.46	10.7	76.5	103.09	102.66	102.72	1.74
MH-5080	MH-517	111-5	104.35	14.0	76.5	103.09	102.66	102.74	1.61
MH-5080	MH-517	105-3	104.46	18.7	76.5	103.09	102.66	102.77	1.69
MH-5080	MH-517	112-8	104.49	23.4	76.5	103.09	102.66	102.79	1.70
MH-5080	MH-517	112-7	104.49	28.0	76.5	103.09	102.66	102.82	1.67
MH-5080	MH-517	104-1	104.6	28.1	76.5	103.09	102.66	102.82	1.78
MH-5080	MH-517	104-2	104.6	32.7	76.5	103.09	102.66	102.85	1.75
MH-5080	MH-517	112-6	104.49	36.0	76.5	103.09	102.66	102.86	1.63
MH-5080	MH-517	104-3	104.6	40.7	76.5	103.09	102.66	102.89	1.71
MH-5080	MH-517	112-5	104.49	42.2	76.5	103.09	102.66	102.90	1.59
MH-5080	MH-517	104-4	104.6	46.9	76.5	103.09	102.66	102.92	1.68
MH-5080	MH-517	113-8	104.59	51.6	76.5	103.09	102.66	102.95	1.64
MH-5080	MH-517	113-7	104.59	56.2	76.5	103.09	102.66	102.98	1.61
MH-5080	MH-517	103-1	104.79	56.3	76.5	103.09	102.66	102.98	1.81
MH-5080	MH-517	103-2	104.79	60.9	76.5	103.09	102.66	103.00	1.79
MH-5080	MH-517	113-6	104.59	64.2	76.5	103.09	102.66	103.02	1.57
MH-5080	MH-517	103-3	104.79	68.9	76.5	103.09	102.66	103.05	1.74
MH-5080	MH-517	113-5	104.59	70.4	76.5	103.09	102.66	103.05	1.54
MH-5080	MH-517	103-4	104.79	75.1	76.5	103.09	102.66	103.08	1.71
MH-509	MH-510	87-3	103.63	2.0	10.5	103.13	102.93	102.97	0.66
MH-509	MH-510	87-2	103.63	5.6	10.5	103.13	102.93	103.03	0.60
MH-509	MH-510	87-1	103.63	9.4	10.5	103.13	102.93	103.11	0.52
MH-510	MH-511	85-4	103.36	4.3	64.0	102.93	102.30	102.34	1.02
MH-510	MH-511	112-1	104.49	9.4	64.0	102.93	102.30	102.39	2.10
MH-510	MH-511	85-3	103.36	12.3	64.0	102.93	102.30	102.42	0.94
MH-510	MH-511	112-2	104.49	14.0	64.0	102.93	102.30	102.44	2.05
MH-510	MH-511	85-2	103.36	19.5	64.0	102.93	102.30	102.49	0.87
MH-510	MH-511	112-3	104.49	22.0	64.0	102.93	102.30	102.51	1.98
MH-510	MH-511	85-1	103.36	27.5	64.0	102.93	102.30	102.57	0.79

Table C4B: USF Freeboard Results - 1988 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-510	MH-511	112-4	104.49	28.2	64.0	102.93	102.30	102.58	1.91
MH-510	MH-511	113-1	104.59	37.6	64.0	102.93	102.30	102.67	1.92
MH-510	MH-511	86-3	103.5	38.1	64.0	102.93	102.30	102.67	0.83
MH-510	MH-511	113-2	104.59	42.2	64.0	102.93	102.30	102.71	1.88
MH-510	MH-511	86-2	103.5	45.8	64.0	102.93	102.30	102.75	0.75
MH-510	MH-511	113-3	104.59	50.2	64.0	102.93	102.30	102.79	1.80
MH-510	MH-511	86-1	103.5	53.8	64.0	102.93	102.30	102.83	0.67
MH-510	MH-511	113-4	104.59	56.4	64.0	102.93	102.30	102.85	1.74
MH-511	MH-526	82-3	101.52	20.9	95.5	102.30	100.05	100.54	0.98
MH-511	MH-526	109-2	102.17	26.4	95.5	102.30	100.05	100.67	1.50
MH-511	MH-526	82-2	101.52	28.9	95.5	102.30	100.05	100.73	0.79
MH-511	MH-526	109-3	102.32	30.8	95.5	102.30	100.05	100.78	1.54
MH-511	MH-526	82-1	101.52	36.5	95.5	102.30	100.05	100.91	0.61
MH-511	MH-526	109-4	102.78	38.8	95.5	102.30	100.05	100.96	1.82
MH-511	MH-526	83-3	101.63	47.1	95.5	102.30	100.05	101.16	0.47
MH-511	MH-526	110-1	102.91	48.2	95.5	102.30	100.05	101.19	1.72
MH-511	MH-526	110-2	103.09	52.8	95.5	102.30	100.05	101.29	1.80
MH-511	MH-526	83-2	102.27	54.7	95.5	102.30	100.05	101.34	0.93
MH-511	MH-526	110-3	103.34	60.8	95.5	102.30	100.05	101.48	1.86
MH-511	MH-526	83-1	102.27	62.7	95.5	102.30	100.05	101.53	0.74
MH-511	MH-526	110-4	103.77	67.0	95.5	102.30	100.05	101.63	2.14
MH-511	MH-526	84-3	102.46	73.4	95.5	102.30	100.05	101.78	0.68
MH-511	MH-526	111-1	103.89	76.4	95.5	102.30	100.05	101.85	2.04
MH-511	MH-526	111-2	103.98	81.0	95.5	102.30	100.05	101.96	2.02
MH-511	MH-526	84-2	103.15	81.0	95.5	102.30	100.05	101.96	1.19
MH-511	MH-526	84-1	103.15	88.9	95.5	102.30	100.05	102.14	1.01
MH-511	MH-526	111-3	104.04	89.1	95.5	102.30	100.05	102.15	1.89
MH-511	MH-526	111-4	104.35	95.3	95.5	102.30	100.05	102.29	2.06
MH-513	MH-515	108-6	102.64	21.6	81.0	102.94	100.67	101.28	1.36
MH-513	MH-515	97-2	102.99	26.5	81.0	102.94	100.67	101.41	1.58
MH-513	MH-515	108-5	102.57	29.6	81.0	102.94	100.67	101.50	1.07
MH-513	MH-515	97-3	103.15	30.9	81.0	102.94	100.67	101.54	1.61
MH-513	MH-515	108-4	102.98	35.8	81.0	102.94	100.67	101.68	1.30
MH-513	MH-515	97-4	103.6	38.9	81.0	102.94	100.67	101.76	1.84
MH-513	MH-515	107-6	103.11	45.2	81.0	102.94	100.67	101.94	1.17
MH-513	MH-515	98-1	103.73	48.3	81.0	102.94	100.67	102.03	1.70
MH-513	MH-515	107-5	103.33	49.8	81.0	102.94	100.67	102.07	1.26
MH-513	MH-515	98-2	103.92	52.9	81.0	102.94	100.67	102.16	1.76
MH-513	MH-515	107-4	103.75	56.2	81.0	102.94	100.67	102.25	1.50
MH-513	MH-515	98-3	104.16	60.9	81.0	102.94	100.67	102.38	1.78
MH-513	MH-515	106-6	103.85	65.6	81.0	102.94	100.67	102.51	1.34
MH-513	MH-515	98-4	104.59	67.1	81.0	102.94	100.67	102.55	2.04
MH-513	MH-515	106-5	104.08	73.6	81.0	102.94	100.67	102.74	1.34
MH-513	MH-515	99-1	104.61	76.5	81.0	102.94	100.67	102.82	1.79
MH-513	MH-515	106-4	104.34	79.8	81.0	102.94	100.67	102.91	1.43
MH-515	MH-518	114-5	101.66	3.6	44.0	100.67	100.30	100.33	1.33
MH-515	MH-518	115-1	101.78	14.3	44.0	100.67	100.30	100.42	1.36
MH-515	MH-518	115-2	102.22	21.9	44.0	100.67	100.30	100.49	1.73
MH-515	MH-518	115-3	102.22	29.9	44.0	100.67	100.30	100.55	1.67
MH-515	MH-518	115-4	102.22	37.1	44.0	100.67	100.30	100.61	1.61
MH-517	MH-518	109-8	102.23	19.4	82.0	102.66	100.30	100.86	1.37
MH-517	MH-518	108-1	102.64	20.7	82.0	102.66	100.30	100.90	1.74
MH-517	MH-518	109-7	102.17	27.4	82.0	102.66	100.30	101.09	1.08
MH-517	MH-518	108-2	102.57	28.7	82.0	102.66	100.30	101.13	1.44
MH-517	MH-518	109-6	102.32	31.8	82.0	102.66	100.30	101.22	1.10
MH-517	MH-518	108-3	102.98	34.9	82.0	102.66	100.30	101.31	1.67
MH-517	MH-518	109-5	102.78	39.8	82.0	102.66	100.30	101.45	1.33
MH-517	MH-518	107-1	103.11	44.3	82.0	102.66	100.30	101.58	1.53
MH-517	MH-518	107-2	103.33	48.9	82.0	102.66	100.30	101.71	1.62
MH-517	MH-518	110-8	102.91	49.2	82.0	102.66	100.30	101.72	1.19
MH-517	MH-518	110-7	103.09	53.8	82.0	102.66	100.30	101.85	1.24
MH-517	MH-518	107-3	103.75	55.3	82.0	102.66	100.30	101.90	1.85
MH-517	MH-518	110-6	103.34	61.8	82.0	102.66	100.30	102.08	1.26
MH-517	MH-518	106-1	103.85	64.7	82.0	102.66	100.30	102.17	1.68
MH-517	MH-518	110-5	103.77	68.0	82.0	102.66	100.30	102.26	1.51
MH-517	MH-518	106-2	104.08	72.7	82.0	102.66	100.30	102.40	1.68
MH-517	MH-518	111-8	103.89	77.4	82.0	102.66	100.30	102.53	1.36
MH-517	MH-518	106-3	104.34	78.9	82.0	102.66	100.30	102.57	1.77
MH-517	MH-518	111-7	103.98	82.0	82.0	102.66	100.30	102.66	1.32
MH-518	MH-526	114-1	101.36	19.7	47.0	100.30	100.05	100.16	1.20
MH-518	MH-526	114-2	101.66	27.3	47.0	100.30	100.05	100.20	1.46
MH-518	MH-526	114-3	101.66	35.3	47.0	100.30	100.05	100.24	1.42
MH-518	MH-526	114-4	101.66	42.5	47.0	100.30	100.05	100.28	1.38
MH-519	MH-520	129-3	104.07	4.0	54.5	103.48	103.39	103.39	0.68
MH-519	MH-520	138-1	104.08	5.4	54.5	103.48	103.39	103.40	0.68
MH-519	MH-520	129-2	104.07	12.0	54.5	103.48	103.39	103.41	0.66
MH-519	MH-520	138-2	104.08	13.0	54.5	103.48	103.39	103.41	0.67
MH-519	MH-520	129-1	104.07	19.6	54.5	103.48	103.39	103.42	0.65
MH-519	MH-520	138-3	104.08	21.0	54.5	103.48	103.39	103.42	0.66

Table C4B: USF Freeboard Results - 1988 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-519	MH-520	128-3	104.09	30.2	54.5	103.48	103.39	103.44	0.65
MH-519	MH-520	139-1	104.23	31.6	54.5	103.48	103.39	103.44	0.79
MH-519	MH-520	128-2	104.09	38.2	54.5	103.48	103.39	103.45	0.64
MH-519	MH-520	139-2	104.23	39.2	54.5	103.48	103.39	103.45	0.78
MH-519	MH-520	128-1	104.09	45.8	54.5	103.48	103.39	103.46	0.63
MH-519	MH-520	139-3	104.23	47.2	54.5	103.48	103.39	103.46	0.77
MH-519	MH-523	140-3	104.25	2.3	11.5	103.48	103.32	103.35	0.90
MH-519	MH-523	140-2	104.25	7.0	11.5	103.48	103.32	103.42	0.83
MH-519	MH-523	140-1	104.25	10.5	11.5	103.48	103.32	103.46	0.79
MH-520	MH-521	136-1	103.94	3.7	57.5	103.39	103.10	103.12	0.82
MH-520	MH-521	131-3	103.81	8.8	57.5	103.39	103.10	103.14	0.67
MH-520	MH-521	136-2	103.94	11.4	57.5	103.39	103.10	103.16	0.78
MH-520	MH-521	131-2	103.81	16.8	57.5	103.39	103.10	103.18	0.63
MH-520	MH-521	136-3	103.94	19.4	57.5	103.39	103.10	103.20	0.74
MH-520	MH-521	131-1	103.81	24.5	57.5	103.39	103.10	103.22	0.59
MH-520	MH-521	137-1	103.94	30.0	57.5	103.39	103.10	103.25	0.69
MH-520	MH-521	130-3	103.94	35.1	57.5	103.39	103.10	103.27	0.67
MH-520	MH-521	137-2	103.94	37.6	57.5	103.39	103.10	103.29	0.65
MH-520	MH-521	130-2	103.94	43.1	57.5	103.39	103.10	103.31	0.63
MH-520	MH-521	137-3	103.94	45.6	57.5	103.39	103.10	103.33	0.61
MH-520	MH-521	130-1	103.94	50.7	57.5	103.39	103.10	103.35	0.59
MH-521	MH-522	135-1	103.67	1.0	11.5	103.10	102.93	102.94	0.73
MH-521	MH-522	135-2	103.67	5.3	11.5	103.10	102.93	103.00	0.67
MH-521	MH-522	135-3	103.67	9.5	11.5	103.10	102.93	103.07	0.60
MH-522	MH-525	133-3	102.71	7.1	55.0	102.93	101.06	101.30	1.41
MH-522	MH-525	133-4	103.1	14.4	55.0	102.93	101.06	101.55	1.55
MH-522	MH-525	133-5	103.1	22.4	55.0	102.93	101.06	101.82	1.28
MH-522	MH-525	134-1	103.55	32.9	55.0	102.93	101.06	102.18	1.37
MH-522	MH-525	134-2	103.55	40.6	55.0	102.93	101.06	102.44	1.11
MH-522	MH-525	134-3	103.55	48.6	55.0	102.93	101.06	102.71	0.84
MH-523	MH-524	141-5	103.68	20.5	55.0	103.32	102.47	102.79	0.89
MH-523	MH-524	141-4	103.68	28.5	55.0	103.32	102.47	102.91	0.77
MH-523	MH-524	141-3	104.25	35.7	55.0	103.32	102.47	103.02	1.23
MH-523	MH-524	141-2	104.25	43.7	55.0	103.32	102.47	103.15	1.10
MH-523	MH-524	141-1	104.25	51.3	55.0	103.32	102.47	103.27	0.98
MH-524	MH-5240	126-1	103.57	5.3	65.0	102.47	102.19	102.21	1.36
MH-524	MH-5240	122-4	103.32	5.6	65.0	102.47	102.19	102.21	1.11
MH-524	MH-5240	126-2	103.57	13.3	65.0	102.47	102.19	102.24	1.33
MH-524	MH-5240	122-3	103.32	13.6	65.0	102.47	102.19	102.25	1.07
MH-524	MH-5240	122-2	103.32	20.9	65.0	102.47	102.19	102.28	1.04
MH-524	MH-5240	126-3	103.57	20.9	65.0	102.47	102.19	102.28	1.29
MH-524	MH-5240	122-1	103.32	28.9	65.0	102.47	102.19	102.31	1.01
MH-524	MH-5240	127-1	103.57	31.6	65.0	102.47	102.19	102.32	1.25
MH-524	MH-5240	121-3	103.45	39.5	65.0	102.47	102.19	102.36	1.09
MH-524	MH-5240	127-2	103.57	39.6	65.0	102.47	102.19	102.36	1.21
MH-524	MH-5240	121-2	103.45	47.1	65.0	102.47	102.19	102.39	1.06
MH-524	MH-5240	127-3	103.57	47.2	65.0	102.47	102.19	102.39	1.18
MH-524	MH-5240	121-1	103.45	55.1	65.0	102.47	102.19	102.43	1.02
MH-5240	MH-525	124-1	102.67	16.1	63.5	102.19	101.06	101.35	1.32
MH-5240	MH-525	123-5	102.2	19.8	63.5	102.19	101.06	101.41	0.79
MH-5240	MH-525	124-2	102.67	24.1	63.5	102.19	101.06	101.49	1.18
MH-5240	MH-525	123-4	102.74	27.4	63.5	102.19	101.06	101.55	1.19
MH-5240	MH-525	124-3	102.67	31.7	63.5	102.19	101.06	101.62	1.05
MH-5240	MH-525	123-3	102.74	35.4	63.5	102.19	101.06	101.69	1.05
MH-5240	MH-525	125-1	103.28	42.3	63.5	102.19	101.06	101.81	1.47
MH-5240	MH-525	123-2	103.08	42.6	63.5	102.19	101.06	101.82	1.26
MH-5240	MH-525	125-2	103.28	50.3	63.5	102.19	101.06	101.95	1.33
MH-5240	MH-525	123-1	103.08	50.6	63.5	102.19	101.06	101.96	1.12
MH-5240	MH-525	125-3	103.28	58.0	63.5	102.19	101.06	102.09	1.19
MH-5240	MH-525	122-5	103.32	61.3	63.5	102.19	101.06	102.15	1.17
MH-52400	MH-538	119-1	102.26	15.8	58.0	102.25	101.16	101.46	0.80
MH-52400	MH-538	119-2	102.26	23.8	58.0	102.25	101.16	101.61	0.65
MH-52400	MH-538	119-3	102.65	31.4	58.0	102.25	101.16	101.75	0.90
MH-52400	MH-538	120-1	103.45	42.1	58.0	102.25	101.16	101.95	1.50
MH-52400	MH-538	120-2	103.45	50.1	58.0	102.25	101.16	102.10	1.35
MH-52400	MH-538	120-3	103.45	57.4	58.0	102.25	101.16	102.23	1.22
MH-525	MH-526	132-1	101.26	15.8	58.5	101.06	100.05	100.32	0.94
MH-525	MH-526	132-2	101.26	23.8	58.5	101.06	100.05	100.46	0.80
MH-525	MH-526	132-3	101.65	31.0	58.5	101.06	100.05	100.59	1.06
MH-525	MH-526	132-4	101.65	39.0	58.5	101.06	100.05	100.72	0.93
MH-525	MH-526	133-1	101.85	49.7	58.5	101.06	100.05	100.91	0.94
MH-525	MH-526	133-2	102.71	57.3	58.5	101.06	100.05	101.04	1.67
MH-528	MH-529	5	101.37	6.6	62.5	98.25	98.02	98.04	3.33
MH-528	MH-529	81-1	98.72	9.8	62.5	98.25	98.02	98.05	0.67
MH-528	MH-529	4	101.37	12.7	62.5	98.25	98.02	98.06	3.31
MH-528	MH-529	81-2	98.72	17.8	62.5	98.25	98.02	98.08	0.64
MH-528	MH-529	81-3	98.72	25.0	62.5	98.25	98.02	98.11	0.61
MH-528	MH-529	3	101.37	25.5	62.5	98.25	98.02	98.11	3.26
MH-528	MH-529	2	101.42	31.6	62.5	98.25	98.02	98.13	3.29

Table C4B: USF Freeboard Results - 1988 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-528	MH-529	81-4	98.72	33.0	62.5	98.25	98.02	98.14	0.58
MH-528	MH-529	81-5	99.3	40.6	62.5	98.25	98.02	98.17	1.13
MH-528	MH-529	1	101.42	41.7	62.5	98.25	98.02	98.17	3.25
MH-529	MH-530	13	101.13	3.2	72.0	98.02	97.89	97.90	3.23
MH-529	MH-530	79-1	98.62	6.4	72.0	98.02	97.89	97.90	0.72
MH-529	MH-530	12	101.13	9.2	72.0	98.02	97.89	97.91	3.22
MH-529	MH-530	79-2	98.62	14.4	72.0	98.02	97.89	97.92	0.70
MH-529	MH-530	79-3	98.62	21.7	72.0	98.02	97.89	97.93	0.69
MH-529	MH-530	11	101.13	22.0	72.0	98.02	97.89	97.93	3.20
MH-529	MH-530	10	101.13	28.1	72.0	98.02	97.89	97.94	3.19
MH-529	MH-530	79-4	98.62	29.7	72.0	98.02	97.89	97.94	0.68
MH-529	MH-530	80-1	98.72	40.3	72.0	98.02	97.89	97.96	0.76
MH-529	MH-530	9	101.22	40.9	72.0	98.02	97.89	97.96	3.26
MH-529	MH-530	8	101.32	47.0	72.0	98.02	97.89	97.97	3.35
MH-529	MH-530	80-2	98.72	48.3	72.0	98.02	97.89	97.98	0.74
MH-529	MH-530	80-3	98.72	55.6	72.0	98.02	97.89	97.99	0.73
MH-529	MH-530	7	101.37	59.8	72.0	98.02	97.89	98.00	3.37
MH-529	MH-530	80-4	98.72	63.6	72.0	98.02	97.89	98.00	0.72
MH-529	MH-530	6	101.37	65.9	72.0	98.02	97.89	98.01	3.36
MH-529	MH-530	80-5	98.72	70.1	72.0	98.02	97.89	98.02	0.70
MH-530	MH-531	76-3	98.43	3.0	76.5	97.89	97.69	97.69	0.74
MH-530	MH-531	77-1	98.55	5.8	76.5	97.89	97.69	97.70	0.85
MH-530	MH-531	77-2	98.55	13.8	76.5	97.89	97.69	97.72	0.83
MH-530	MH-531	77-3	98.55	21.0	76.5	97.89	97.69	97.74	0.81
MH-530	MH-531	77-4	98.55	29.0	76.5	97.89	97.69	97.76	0.79
MH-530	MH-531	18	101.07	29.6	76.5	97.89	97.69	97.77	3.30
MH-530	MH-531	78-1	98.58	39.6	76.5	97.89	97.69	97.79	0.79
MH-530	MH-531	17	101.11	42.4	76.5	97.89	97.69	97.80	3.31
MH-530	MH-531	78-2	98.58	47.6	76.5	97.89	97.69	97.81	0.77
MH-530	MH-531	16	101.13	48.5	76.5	97.89	97.69	97.82	3.31
MH-530	MH-531	78-3	98.58	54.9	76.5	97.89	97.69	97.83	0.75
MH-530	MH-531	15	101.13	61.3	76.5	97.89	97.69	97.85	3.28
MH-530	MH-531	78-4	98.58	62.9	76.5	97.89	97.69	97.85	0.73
MH-530	MH-531	14	101.13	67.4	76.5	97.89	97.69	97.87	3.26
MH-530	MH-531	78-5	98.58	70.5	76.5	97.89	97.69	97.87	0.71
MH-534	MH-535	97-8	102.99	19.4	78.5	103.21	100.95	101.51	1.48
MH-534	MH-535	96-1	103.02	20.3	78.5	103.21	100.95	101.54	1.48
MH-534	MH-535	97-7	102.99	27.4	78.5	103.21	100.95	101.74	1.25
MH-534	MH-535	96-2	103.02	28.3	78.5	103.21	100.95	101.77	1.25
MH-534	MH-535	97-6	103.15	31.8	78.5	103.21	100.95	101.87	1.28
MH-534	MH-535	96-3	103.42	35.5	78.5	103.21	100.95	101.98	1.44
MH-534	MH-535	97-5	103.6	39.8	78.5	103.21	100.95	102.10	1.50
MH-534	MH-535	96-4	103.42	43.5	78.5	103.21	100.95	102.21	1.21
MH-534	MH-535	98-8	103.73	49.2	78.5	103.21	100.95	102.37	1.36
MH-534	MH-535	98-7	103.92	53.8	78.5	103.21	100.95	102.50	1.42
MH-534	MH-535	95-1	103.47	54.2	78.5	103.21	100.95	102.51	0.96
MH-534	MH-535	98-6	104.16	61.8	78.5	103.21	100.95	102.73	1.43
MH-534	MH-535	95-2	103.47	62.2	78.5	103.21	100.95	102.74	0.73
MH-534	MH-535	98-5	104.59	68.0	78.5	103.21	100.95	102.91	1.68
MH-534	MH-535	95-3	103.94	69.4	78.5	103.21	100.95	102.95	0.99
MH-534	MH-535	95-4	103.94	77.4	78.5	103.21	100.95	103.18	0.76
MH-534	MH-535	99-8	104.61	77.4	78.5	103.21	100.95	103.18	1.43
MH-535	MH-515	115-5	102.22	1.2	44.0	100.95	100.67	100.68	1.54
MH-535	MH-515	116-1	102.3	11.9	44.0	100.95	100.67	100.75	1.55
MH-535	MH-515	116-2	102.3	19.5	44.0	100.95	100.67	100.80	1.50
MH-535	MH-515	116-3	102.3	27.5	44.0	100.95	100.67	100.85	1.45
MH-535	MH-515	117-1	102.4	38.1	44.0	100.95	100.67	100.92	1.48
MH-5350	MH-539	118-3	102.4	16.8	52.5	101.68	100.11	100.61	1.79
MH-5350	MH-539	118-2	102.4	24.8	52.5	101.68	100.11	100.85	1.55
MH-5350	MH-539	118-1	102.4	32.4	52.5	101.68	100.11	101.08	1.32
MH-5350	MH-539	117-3	102.4	43.1	52.5	101.68	100.11	101.40	1.00
MH-5350	MH-539	117-2	102.4	51.1	52.5	101.68	100.11	101.64	0.76
MH-536	MH-538	196-1	102.56	6.1	59.0	102.69	101.16	101.32	1.24
MH-536	MH-538	142-1	103.33	15.7	59.0	102.69	101.16	101.57	1.76
MH-536	MH-538	195-4	103.31	16.1	59.0	102.69	101.16	101.58	1.73
MH-536	MH-538	142-2	103.33	23.7	59.0	102.69	101.16	101.77	1.56
MH-536	MH-538	195-3	103.31	24.1	59.0	102.69	101.16	101.78	1.53
MH-536	MH-538	142-3	103.72	30.3	59.0	102.69	101.16	101.94	1.78
MH-536	MH-538	195-2	103.7	30.7	59.0	102.69	101.16	101.95	1.75
MH-536	MH-538	142-4	103.72	38.3	59.0	102.69	101.16	102.15	1.57
MH-536	MH-538	195-1	103.7	38.7	59.0	102.69	101.16	102.16	1.54
MH-536	MH-538	143-1	103.96	48.3	59.0	102.69	101.16	102.41	1.55
MH-536	MH-538	194-4	103.92	48.7	59.0	102.69	101.16	102.42	1.50
MH-536	MH-538	143-2	103.96	56.3	59.0	102.69	101.16	102.62	1.34
MH-536	MH-538	194-3	103.92	56.7	59.0	102.69	101.16	102.63	1.29
MH-537	MH-536	194-2	103.92	4.4	64.5	103.00	102.69	102.71	1.21
MH-537	MH-536	143-3	103.96	4.7	64.5	103.00	102.69	102.71	1.25
MH-537	MH-536	194-1	103.92	12.4	64.5	103.00	102.69	102.75	1.17
MH-537	MH-536	144-1	103.96	14.7	64.5	103.00	102.69	102.76	1.20

Table C4B: USF Freeboard Results - 1988 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-537	MH-536	193-4	103.88	22.4	64.5	103.00	102.69	102.80	1.08
MH-537	MH-536	144-2	103.96	22.7	64.5	103.00	102.69	102.80	1.16
MH-537	MH-536	144-3	103.96	29.3	64.5	103.00	102.69	102.83	1.13
MH-537	MH-536	193-3	103.88	30.4	64.5	103.00	102.69	102.83	1.05
MH-537	MH-536	193-2	103.88	37.0	64.5	103.00	102.69	102.87	1.01
MH-537	MH-536	144-4	103.96	37.3	64.5	103.00	102.69	102.87	1.09
MH-537	MH-536	144-5	103.96	44.6	64.5	103.00	102.69	102.90	1.06
MH-537	MH-536	193-1	103.88	45.0	64.5	103.00	102.69	102.91	0.97
MH-537	MH-536	192-4	103.75	55.0	64.5	103.00	102.69	102.96	0.79
MH-538	MH-539	197-3	101.08	16.5	58.5	101.16	100.11	100.41	0.67
MH-538	MH-539	197-2	101.08	24.5	58.5	101.16	100.11	100.55	0.53
MH-538	MH-539	197-1	101.42	31.8	58.5	101.16	100.11	100.68	0.74
MH-538	MH-539	196-4	102.16	41.8	58.5	101.16	100.11	100.86	1.30
MH-538	MH-539	196-3	102.16	49.8	58.5	101.16	100.11	101.01	1.15
MH-538	MH-539	196-2	102.56	56.4	58.5	101.16	100.11	101.13	1.43
MH-542	MH-543	58	103.46	5.4	53.0	99.97	99.82	99.84	3.62
MH-542	MH-543	62-5	100.72	8.9	53.0	99.97	99.82	99.85	0.87
MH-542	MH-543	62-4	100.72	16.2	53.0	99.97	99.82	99.87	0.85
MH-542	MH-543	59	103.46	18.2	53.0	99.97	99.82	99.87	3.59
MH-542	MH-543	62-3	100.72	24.2	53.0	99.97	99.82	99.89	0.83
MH-542	MH-543	60	103.42	24.3	53.0	99.97	99.82	99.89	3.53
MH-542	MH-543	62-2	100.72	30.8	53.0	99.97	99.82	99.91	0.81
MH-542	MH-543	61	103.33	37.1	53.0	99.97	99.82	99.93	3.40
MH-542	MH-543	62-1	100.72	38.8	53.0	99.97	99.82	99.93	0.79
MH-543	MH-544	66-2	100.62	3.8	118.0	99.82	98.42	98.47	2.15
MH-543	MH-544	45	103.16	4.0	118.0	99.82	98.42	98.47	4.69
MH-543	MH-544	46	103.46	10.1	118.0	99.82	98.42	98.54	4.92
MH-543	MH-544	66-1	100.62	11.8	118.0	99.82	98.42	98.56	2.06
MH-543	MH-544	65-4	100.72	21.8	118.0	99.82	98.42	98.68	2.04
MH-543	MH-544	47	103.51	22.9	118.0	99.82	98.42	98.69	4.82
MH-543	MH-544	48	103.51	29.0	118.0	99.82	98.42	98.77	4.74
MH-543	MH-544	65-3	100.72	29.8	118.0	99.82	98.42	98.78	1.94
MH-543	MH-544	65-2	100.72	36.4	118.0	99.82	98.42	98.86	1.86
MH-543	MH-544	49	103.51	41.8	118.0	99.82	98.42	98.92	4.59
MH-543	MH-544	65-1	100.72	44.4	118.0	99.82	98.42	98.95	1.77
MH-543	MH-544	50	103.51	47.9	118.0	99.82	98.42	98.99	4.52
MH-543	MH-544	64-4	100.86	54.4	118.0	99.82	98.42	99.07	1.79
MH-543	MH-544	51	103.51	60.8	118.0	99.82	98.42	99.14	4.37
MH-543	MH-544	64-3	100.86	62.4	118.0	99.82	98.42	99.16	1.70
MH-543	MH-544	52	103.51	66.9	118.0	99.82	98.42	99.22	4.29
MH-543	MH-544	64-2	100.86	69.0	118.0	99.82	98.42	99.24	1.62
MH-543	MH-544	64-1	100.86	77.0	118.0	99.82	98.42	99.34	1.52
MH-543	MH-544	53	103.57	79.7	118.0	99.82	98.42	99.37	4.20
MH-543	MH-544	54	103.61	85.8	118.0	99.82	98.42	99.44	4.17
MH-543	MH-544	63-5	100.86	87.0	118.0	99.82	98.42	99.46	1.40
MH-543	MH-544	63-4	100.86	94.3	118.0	99.82	98.42	99.54	1.32
MH-543	MH-544	55	103.59	98.6	118.0	99.82	98.42	99.59	4.00
MH-543	MH-544	63-3	100.86	102.3	118.0	99.82	98.42	99.64	1.22
MH-543	MH-544	56	103.49	104.7	118.0	99.82	98.42	99.67	3.82
MH-543	MH-544	63-2	100.86	108.9	118.0	99.82	98.42	99.72	1.14
MH-543	MH-544	63-1	100.86	116.9	118.0	99.82	98.42	99.81	1.05
MH-543	MH-544	57	103.46	117.5	118.0	99.82	98.42	99.82	3.64
MH-544	MH-5440	68-3	99.4	3.4	57.5	98.42	98.38	98.39	1.01
MH-544	MH-5440	68-2	99.4	10.7	57.5	98.42	98.38	98.39	1.01
MH-544	MH-5440	68-1	99.4	18.7	57.5	98.42	98.38	98.40	1.00
MH-544	MH-5440	67-3	99.49	28.7	57.5	98.42	98.38	98.40	1.09
MH-544	MH-5440	42	102.27	30.0	57.5	98.42	98.38	98.40	3.87
MH-544	MH-5440	67-2	100.2	36.0	57.5	98.42	98.38	98.41	1.79
MH-544	MH-5440	43	102.6	42.8	57.5	98.42	98.38	98.41	4.19
MH-544	MH-5440	67-1	100.2	44.0	57.5	98.42	98.38	98.41	1.79
MH-544	MH-5440	44	102.93	48.9	57.5	98.42	98.38	98.42	4.51
MH-544	MH-5440	66-3	100.62	54.0	57.5	98.42	98.38	98.42	2.20
MH-546	MH-547	177-1	102.31	8.8	99.5	102.13	101.41	101.48	0.83
MH-546	MH-547	177-2	102.61	16.1	99.5	102.13	101.41	101.53	1.08
MH-546	MH-547	177-3	102.61	24.1	99.5	102.13	101.41	101.59	1.02
MH-546	MH-547	178-1	102.71	34.1	99.5	102.13	101.41	101.66	1.05
MH-546	MH-547	178-2	102.71	42.1	99.5	102.13	101.41	101.72	0.99
MH-546	MH-547	178-3	103.04	48.7	99.5	102.13	101.41	101.76	1.28
MH-546	MH-547	178-4	103.04	56.7	99.5	102.13	101.41	101.82	1.22
MH-546	MH-547	179-1	103.04	66.7	99.5	102.13	101.41	101.89	1.15
MH-546	MH-547	179-2	103.4	74.0	99.5	102.13	101.41	101.95	1.45
MH-546	MH-547	179-3	103.4	82.0	99.5	102.13	101.41	102.00	1.40
MH-546	MH-547	179-4	103.4	88.6	99.5	102.13	101.41	102.05	1.35
MH-546	MH-547	179-5	103.4	96.6	99.5	102.13	101.41	102.11	1.29
MH-547	MH-548	175-1	101.33	5.2	60.0	101.41	100.61	100.68	0.65
MH-547	MH-548	175-2	101.33	13.6	60.0	101.41	100.61	100.79	0.54
MH-547	MH-548	175-3	101.64	20.2	60.0	101.41	100.61	100.88	0.76
MH-547	MH-548	175-4	101.64	28.2	60.0	101.41	100.61	100.99	0.65
MH-547	MH-548	176-1	101.82	38.2	60.0	101.41	100.61	101.12	0.70

Table C4B: USF Freeboard Results - 1988 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-547	MH-548	176-2	102.27	45.8	60.0	101.41	100.61	101.22	1.05
MH-547	MH-548	176-3	102.27	53.9	60.0	101.41	100.61	101.33	0.94
MH-548	MH-549	174-2	100.89	0.3	29.5	100.61	100.28	100.28	0.61
MH-548	MH-549	174-3	100.89	8.2	29.5	100.61	100.28	100.37	0.52
MH-548	MH-549	174-4	101.21	14.8	29.5	100.61	100.28	100.45	0.76
MH-548	MH-549	174-5	101.21	22.8	29.5	100.61	100.28	100.54	0.67
MH-549	MH-550	174-1	100.89	2.7	12.5	100.28	99.91	99.99	0.90
MH-550	MH-551	170-6	100.02	1.6	112.0	99.91	98.65	98.67	1.35
MH-550	MH-551	170-5	100.3	6.9	112.0	99.91	98.65	98.73	1.57
MH-550	MH-551	171-8	100.3	16.4	112.0	99.91	98.65	98.84	1.46
MH-550	MH-551	171-7	100.33	21.0	112.0	99.91	98.65	98.89	1.44
MH-550	MH-551	171-6	100.46	29.0	112.0	99.91	98.65	98.98	1.48
MH-550	MH-551	171-5	100.73	35.2	112.0	99.91	98.65	99.05	1.68
MH-550	MH-551	172-10	100.73	44.6	112.0	99.91	98.65	99.15	1.58
MH-550	MH-551	172-9	100.77	49.2	112.0	99.91	98.65	99.20	1.57
MH-550	MH-551	172-8	100.9	57.2	112.0	99.91	98.65	99.29	1.61
MH-550	MH-551	172-7	100.96	61.6	112.0	99.91	98.65	99.34	1.62
MH-550	MH-551	172-6	101.27	69.6	112.0	99.91	98.65	99.43	1.84
MH-550	MH-551	173-10	101.27	77.4	112.0	99.91	98.65	99.52	1.75
MH-550	MH-551	173-9	101.33	85.4	112.0	99.91	98.65	99.61	1.72
MH-550	MH-551	173-8	101.43	91.6	112.0	99.91	98.65	99.68	1.75
MH-550	MH-551	173-7	101.5	96.0	112.0	99.91	98.65	99.73	1.77
MH-550	MH-551	173-6	101.91	104.0	112.0	99.91	98.65	99.82	2.09
MH-551	MH-559	169-8	99.46	10.7	52.5	98.65	96.18	96.68	2.78
MH-551	MH-559	169-7	99.43	18.7	52.5	98.65	96.18	97.06	2.37
MH-551	MH-559	169-6	99.53	23.1	52.5	98.65	96.18	97.27	2.26
MH-551	MH-559	169-5	99.86	31.1	52.5	98.65	96.18	97.64	2.22
MH-551	MH-559	170-8	99.86	40.5	52.5	98.65	96.18	98.09	1.77
MH-551	MH-559	170-7	99.9	45.1	52.5	98.65	96.18	98.30	1.60
MH-552	MH-553	172-1	100.73	1.3	64.5	100.30	99.28	99.30	1.43
MH-552	MH-553	172-2	100.77	4.9	64.5	100.30	99.28	99.36	1.41
MH-552	MH-553	167-4	100.44	7.6	64.5	100.30	99.28	99.40	1.04
MH-552	MH-553	172-3	100.9	13.0	64.5	100.30	99.28	99.49	1.41
MH-552	MH-553	167-3	100.44	15.6	64.5	100.30	99.28	99.53	0.91
MH-552	MH-553	172-4	100.96	17.2	64.5	100.30	99.28	99.55	1.41
MH-552	MH-553	167-2	100.44	22.2	64.5	100.30	99.28	99.63	0.81
MH-552	MH-553	172-5	101.27	25.2	64.5	100.30	99.28	99.68	1.59
MH-552	MH-553	167-1	100.44	30.2	64.5	100.30	99.28	99.76	0.68
MH-552	MH-553	173-1	101.27	33.1	64.5	100.30	99.28	99.80	1.47
MH-552	MH-553	168-4	100.69	40.2	64.5	100.30	99.28	99.92	0.77
MH-552	MH-553	173-2	101.33	41.1	64.5	100.30	99.28	99.93	1.40
MH-552	MH-553	173-3	101.43	47.2	64.5	100.30	99.28	100.03	1.40
MH-552	MH-553	168-3	100.69	48.2	64.5	100.30	99.28	100.04	0.65
MH-552	MH-553	173-4	101.5	51.6	64.5	100.30	99.28	100.10	1.40
MH-552	MH-553	168-2	101.48	54.8	64.5	100.30	99.28	100.15	1.33
MH-552	MH-553	173-5	101.91	59.6	64.5	100.30	99.28	100.22	1.69
MH-552	MH-553	168-1	101.48	62.8	64.5	100.30	99.28	100.27	1.21
MH-553	MH-557	169-1	99.46	16.0	103.5	99.28	97.99	98.19	1.27
MH-553	MH-557	169-2	99.43	25.6	103.5	99.28	97.99	98.31	1.12
MH-553	MH-557	169-3	99.53	30.0	103.5	99.28	97.99	98.36	1.17
MH-553	MH-557	169-4	99.86	38.0	103.5	99.28	97.99	98.46	1.40
MH-553	MH-557	165-4	99.5	38.5	103.5	99.28	97.99	98.47	1.03
MH-553	MH-557	165-3	99.5	46.5	103.5	99.28	97.99	98.57	0.93
MH-553	MH-557	170-1	99.86	47.4	103.5	99.28	97.99	98.58	1.28
MH-553	MH-557	170-2	99.9	52.0	103.5	99.28	97.99	98.64	1.26
MH-553	MH-557	165-2	99.5	53.1	103.5	99.28	97.99	98.65	0.85
MH-553	MH-557	170-3	100.02	59.9	103.5	99.28	97.99	98.74	1.28
MH-553	MH-557	165-1	99.5	61.2	103.5	99.28	97.99	98.75	0.75
MH-553	MH-557	170-4	100.3	66.1	103.5	99.28	97.99	98.81	1.49
MH-553	MH-557	166-5	99.7	71.2	103.5	99.28	97.99	98.88	0.82
MH-553	MH-557	171-1	100.3	75.5	103.5	99.28	97.99	98.93	1.37
MH-553	MH-557	166-4	99.7	79.2	103.5	99.28	97.99	98.98	0.72
MH-553	MH-557	171-2	100.33	80.2	103.5	99.28	97.99	98.99	1.34
MH-553	MH-557	166-3	100.04	85.8	103.5	99.28	97.99	99.06	0.98
MH-553	MH-557	171-3	100.46	88.2	103.5	99.28	97.99	99.09	1.37
MH-553	MH-557	166-2	100.04	93.8	103.5	99.28	97.99	99.16	0.88
MH-553	MH-557	171-4	100.73	94.4	103.5	99.28	97.99	99.17	1.56
MH-553	MH-557	166-1	100.04	101.1	103.5	99.28	97.99	99.25	0.79
MH-554	MH-556	160-4	100.02	2.6	81.5	99.74	98.99	99.01	1.01
MH-554	MH-556	160-3	100.02	10.6	81.5	99.74	98.99	99.09	0.93
MH-554	MH-556	160-2	100.02	17.2	81.5	99.74	98.99	99.15	0.87
MH-554	MH-556	160-1	100.02	25.2	81.5	99.74	98.99	99.22	0.80
MH-554	MH-556	159-5	100.12	35.2	81.5	99.74	98.99	99.31	0.81
MH-554	MH-556	159-4	100.48	42.5	81.5	99.74	98.99	99.38	1.10
MH-554	MH-556	159-3	100.48	50.5	81.5	99.74	98.99	99.45	1.03
MH-554	MH-556	159-2	100.48	57.1	81.5	99.74	98.99	99.51	0.97
MH-554	MH-556	159-1	100.48	65.1	81.5	99.74	98.99	99.59	0.89
MH-554	MH-556	158-5	100.48	75.1	81.5	99.74	98.99	99.68	0.80
MH-554	MH-556	158-4	100.48	78.8	81.5	99.74	98.99	99.71	0.77

Table C4B: USF Freeboard Results - 1988 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-556	MH-557	162-3	99.15	7.8	70.0	98.99	97.99	98.10	1.05
MH-556	MH-557	164-1	99.39	11.9	70.0	98.99	97.99	98.16	1.23
MH-556	MH-557	162-2	99.15	14.4	70.0	98.99	97.99	98.19	0.96
MH-556	MH-557	164-2	99.39	19.9	70.0	98.99	97.99	98.27	1.12
MH-556	MH-557	162-1	99.15	22.4	70.0	98.99	97.99	98.31	0.84
MH-556	MH-557	164-3	99.39	26.5	70.0	98.99	97.99	98.37	1.02
MH-556	MH-557	161-4	99.55	32.5	70.0	98.99	97.99	98.45	1.10
MH-556	MH-557	164-4	99.39	34.5	70.0	98.99	97.99	98.48	0.91
MH-556	MH-557	161-3	99.55	40.5	70.0	98.99	97.99	98.57	0.98
MH-556	MH-557	161-2	99.55	47.1	70.0	98.99	97.99	98.66	0.89
MH-556	MH-557	161-1	99.55	55.1	70.0	98.99	97.99	98.78	0.77
MH-556	MH-557	160-5	99.64	65.1	70.0	98.99	97.99	98.92	0.72
MH-557	MH-558	163-3	98.67	4.5	36.5	97.99	97.72	97.75	0.92
MH-557	MH-558	163-2	98.67	11.1	36.5	97.99	97.72	97.80	0.87
MH-557	MH-558	163-1	98.67	19.1	36.5	97.99	97.72	97.86	0.81
MH-557	MH-558	162-5	98.77	29.1	36.5	97.99	97.72	97.93	0.84
MH-557	MH-558	162-4	99.15	35.1	36.5	97.99	97.72	97.97	1.18
MH-558	MH-559	163-5	98.32	8.9	14.5	97.72	96.18	97.13	1.19
MH-558	MH-559	163-4	98.67	10.4	14.5	97.72	96.18	97.28	1.39
MH-561	MH-537	192-3	103.75	3.1	42.5	103.08	103.00	103.01	0.74
MH-561	MH-537	192-2	103.75	5.2	42.5	103.08	103.00	103.01	0.74
MH-561	MH-537	180-1	103.86	12.6	42.5	103.08	103.00	103.03	0.83
MH-561	MH-537	192-1	103.75	13.2	42.5	103.08	103.00	103.03	0.72
MH-561	MH-537	180-2	103.86	19.9	42.5	103.08	103.00	103.04	0.82
MH-561	MH-537	191-4	103.8	23.2	42.5	103.08	103.00	103.05	0.75
MH-561	MH-537	180-3	103.86	27.9	42.5	103.08	103.00	103.06	0.80
MH-561	MH-537	191-3	103.8	31.2	42.5	103.08	103.00	103.06	0.74
MH-561	MH-537	180-4	103.86	34.5	42.5	103.08	103.00	103.07	0.79
MH-561	MH-537	191-2	103.8	37.7	42.5	103.08	103.00	103.07	0.73
MH-561	MH-563	182-3	102.47	2.6	61.0	103.08	101.25	101.33	1.14
MH-561	MH-563	182-2	102.47	10.6	61.0	103.08	101.25	101.57	0.90
MH-561	MH-563	190-1	103.21	17.4	61.0	103.08	101.25	101.77	1.44
MH-561	MH-563	182-1	102.81	17.9	61.0	103.08	101.25	101.79	1.02
MH-561	MH-563	190-2	103.21	25.4	61.0	103.08	101.25	102.01	1.20
MH-561	MH-563	181-4	103.55	27.9	61.0	103.08	101.25	102.09	1.46
MH-561	MH-563	190-3	103.8	32.0	61.0	103.08	101.25	102.21	1.59
MH-561	MH-563	181-3	103.55	35.9	61.0	103.08	101.25	102.33	1.22
MH-561	MH-563	190-4	103.8	40.0	61.0	103.08	101.25	102.45	1.35
MH-561	MH-563	181-2	103.86	42.5	61.0	103.08	101.25	102.53	1.33
MH-561	MH-563	190-5	103.8	47.3	61.0	103.08	101.25	102.67	1.13
MH-561	MH-563	181-1	103.86	50.5	61.0	103.08	101.25	102.77	1.09
MH-561	MH-563	191-1	103.8	55.7	61.0	103.08	101.25	102.92	0.88
MH-561	MH-563	180-5	103.86	59.1	61.0	103.08	101.25	103.03	0.83
MH-563	MH-564	187-2	102.43	3.4	73.5	101.25	100.97	100.99	1.44
MH-563	MH-564	185-1	102.24	4.5	73.5	101.25	100.97	100.99	1.25
MH-563	MH-564	184-4	102.57	10.2	73.5	101.25	100.97	101.01	1.56
MH-563	MH-564	187-3	102.75	10.9	73.5	101.25	100.97	101.01	1.74
MH-563	MH-564	184-3	102.57	18.2	73.5	101.25	100.97	101.04	1.53
MH-563	MH-564	188-1	102.75	20.8	73.5	101.25	100.97	101.05	1.70
MH-563	MH-564	184-2	102.57	24.8	73.5	101.25	100.97	101.07	1.50
MH-563	MH-564	188-2	102.75	28.8	73.5	101.25	100.97	101.08	1.67
MH-563	MH-564	184-1	102.57	32.8	73.5	101.25	100.97	101.10	1.47
MH-563	MH-564	188-3	102.75	36.2	73.5	101.25	100.97	101.11	1.64
MH-563	MH-564	183-3	102.57	42.8	73.5	101.25	100.97	101.13	1.44
MH-563	MH-564	189-1	102.64	46.2	73.5	101.25	100.97	101.15	1.49
MH-563	MH-564	183-2	102.57	50.8	73.5	101.25	100.97	101.16	1.41
MH-563	MH-564	189-2	102.64	54.4	73.5	101.25	100.97	101.18	1.46
MH-563	MH-564	183-1	102.57	58.6	73.5	101.25	100.97	101.19	1.38
MH-563	MH-564	189-3	102.64	61.6	73.5	101.25	100.97	101.21	1.43
MH-564	MH-8500	186-1	102.24	17.1	48.5	100.97	99.68	100.13	2.11
MH-564	MH-8500	185-5	101.61	19.9	48.5	100.97	99.68	100.21	1.40
MH-564	MH-8500	186-2	102.24	25.1	48.5	100.97	99.68	100.35	1.89
MH-564	MH-8500	185-4	101.61	27.9	48.5	100.97	99.68	100.42	1.19
MH-564	MH-8500	186-3	102.24	32.4	48.5	100.97	99.68	100.54	1.70
MH-564	MH-8500	185-3	101.93	34.5	48.5	100.97	99.68	100.60	1.33
MH-564	MH-8500	187-1	102.43	42.4	48.5	100.97	99.68	100.81	1.62
MH-564	MH-8500	185-2	101.93	42.5	48.5	100.97	99.68	100.81	1.12

Min	0.33
Max	4.92
Average	1.36

Key:

Freeboard to USF less than 0.30 m (yellow)

Freeboard to USF less than 0.00 m (red)

Table C5A: Pipe Data and Hydraulic Simulation Results - 1996 Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH_136	MH_302	96.484	96.41	101.19	101.14	2250	53.9	0.1	0.013	1.66	6.59	6.50	0.99	-0.44	01:34	98.29	98.23
MH_302	MH_303	96.41	96.331	101.14	101.08	2250	58.9	0.1	0.013	1.66	6.59	6.99	1.06	-0.43	01:32	98.23	98.15
MH_303	MH_304	96.331	96.176	101.08	100.73	2250	134.3	0.1	0.013	1.67	6.62	7.07	1.07	-0.43	01:32	98.15	97.98
MH_304	MH_306TEE	96.176	96.133	100.73	100.27	2250	42.5	0.1	0.013	1.67	6.62	7.13	1.08	-0.45	01:32	97.98	97.74
MH_306TEE	MH_307	96.133	96.1	100.27	100.35	2250	11.2	0.1	0.013	1.79	7.10	7.13	1.00	-0.64	01:33	97.74	97.54
MH_307	MH_400	96.1	96.067	100.35	100.35	2250	22.7	0.1	0.013	1.71	6.79	5.15	0.76	-0.81	01:32	97.54	97.51
MH_400	OGS_1	96.067	96.037	100.35	100.5	750	4.9	0.2	0.013	1.13	0.50	1.02	2.03	0.69	03:27	97.51	97.47
MH_500	OGS_2	96.056	96.026	100.35	100.428	750	5.0	0.2	0.013	1.13	0.50	1.01	2.02	0.49	01:40	97.30	97.26
MH-313	MH_500	96.099	96.056	99.835	100.35	2250	33.0	0.1	0.013	1.68	6.69	3.58	0.54	-0.85	01:32	97.50	97.30
MH-500	MH-502	102.24	100.94	105.21	104.245	300	92.0	1.3	0.013	1.53	0.11	0.10	0.90	-0.08	01:25	102.46	101.19
MH-502	MH-503	100.94	98.961	104.245	102.42	450	119.0	1.6	0.013	2.27	0.36	0.22	0.61	-0.20	01:26	101.19	99.39
MH-5020	MH-502	101.143	100.94	104.27	104.245	300	10.5	0.5	0.013	0.97	0.07	0.00	0.01	-0.25	01:21	101.19	101.19
MH-503	MH-504	98.961	98.683	102.42	101.89	525	73.0	0.3	0.013	1.00	0.22	0.23	1.07	-0.09	01:27	99.39	99.05
MH-504	MH-528	98.683	97.315	101.89	101.06	600	108.0	0.9	0.013	2.00	0.57	0.39	0.69	-0.23	01:27	99.05	98.16
MH-505	MH-506	103.478	103.351	105.836	106.28	300	13.0	0.6	0.013	1.06	0.07	0.00	0.00	-0.30	00:00	103.48	103.55
MH-505	MH-534	103.478	103.033	105.836	105.406	375	94.5	0.5	0.013	1.06	0.12	0.00	0.00	-0.38	00:00	103.48	103.20
MH-506	MH-508	103.351	103.054	106.28	105.88	300	79.0	0.4	0.013	0.81	0.06	0.05	0.79	-0.10	01:25	103.55	103.29
MH-5070	MH-513	103.12	102.394	105.92	105.51	300	82.0	0.5	0.013	0.97	0.07	0.04	0.60	-0.13	01:26	103.29	102.83
MH-508	MH-509	103.054	102.837	105.88	105.67	300	41.5	0.5	0.013	0.92	0.06	0.06	0.91	-0.06	01:26	103.29	103.07
MH-5080	MH-517	102.898	102.054	105.7	105.28	300	76.5	0.6	0.013	1.01	0.07	0.04	0.57	-0.14	01:26	103.06	102.51
MH-509	MH-510	102.837	102.718	105.67	105.6	300	10.5	0.4	0.013	0.87	0.06	0.06	0.96	-0.07	01:26	103.07	102.90
MH-510	MH-511	102.718	102.077	105.6	105.25	375	64.0	0.6	0.013	1.18	0.13	0.06	0.45	-0.19	01:27	102.90	102.29
MH-511	MH-526	102.077	98.642	105.25	103	450	95.5	2.8	0.013	3.00	0.48	0.20	0.43	-0.24	01:24	102.29	99.83
MH-513	MH-515	102.394	100.231	105.51	104	300	81.0	2.3	0.013	2.08	0.15	0.14	0.96	0.14	01:25	102.83	100.66
MH-515	MH-518	100.231	99.793	104	103.59	600	44.0	0.3	0.013	1.19	0.34	0.32	0.95	-0.17	01:26	100.66	100.29
MH-517	MH-518	102.054	99.793	105.28	103.59	300	82.0	2.3	0.013	2.08	0.15	0.14	0.96	0.16	01:25	102.51	100.29
MH-518	MH-526	99.793	98.642	103.59	103	675	47.0	0.3	0.013	1.29	0.46	0.46	1.00	-0.17	01:26	100.29	99.83
MH-519	MH-520	103.476	103.127	105.766	106.01	300	54.5	0.5	0.013	0.97	0.07	0.00	0.00	-0.30	00:00	103.48	103.34
MH-519	MH-523	103.476	103.213	105.766	105.726	300	11.5	0.3	0.013	0.81	0.06	0.00	0.00	-0.30	00:00	103.48	103.32
MH-520	MH-521	103.127	102.808	106.01	105.71	375	57.5	0.5	0.013	1.12	0.12	0.07	0.57	-0.17	01:25	103.34	103.04
MH-521	MH-522	102.808	102.725	105.71	105.64	375	11.5	0.3	0.013	0.94	0.10	0.07	0.68	-0.14	01:26	103.04	102.90
MH-522	MH-525	102.725	100.69	105.64	104.2	375	55.0	2.6	0.013	2.54	0.28	0.12	0.42	-0.20	01:25	102.90	101.02
MH-523	MH-524	103.213	102.148	105.726	104.956	300	55.0	1.8	0.013	1.84	0.13	0.04	0.28	-0.19	01:30	103.32	102.44
MH-524	MH-5240	102.148	101.917	104.956	105.23	375	65.0	0.3	0.013	0.87	0.10	0.09	0.95	-0.08	01:26	102.44	102.17
MH-5240	MH-525	101.917	100.69	105.23	104.2	375	63.5	1.6	0.013	1.98	0.22	0.15	0.67	-0.13	01:26	102.17	101.02
MH-52400	MH-538	102.155	100.883	104.956	103.676	300	58.0	1.8	0.013	1.84	0.13	0.02	0.18	-0.21	01:25	102.25	101.15
MH-525	MH-526	100.69	98.642	104.2	103	525	58.5	1.8	0.013	2.67	0.58	0.33	0.57	-0.20	01:26	101.02	99.83
MH-526	MH-528	98.642	97.315	103	101.06	675	59.5	1.6	0.013	2.97	1.06	1.03	0.97	0.52	01:27	99.83	98.16
MH-527	MH-528	99.084	97.315	101.18	101.06	300	18.5	0.4	0.013	0.81	0.06	0.01	0.23	-0.19	01:25	99.19	98.16
MH-528	MH-529	97.315	97.009	101.06	100.82	1050	62.5	0.3	0.013	1.58	1.37	1.46	1.07	-0.21	01:28	98.16	97.94
MH-529	MH-530	97.009	96.851	100.82	100.58	1200	72.0	0.2	0.013	1.34	1.51	1.45	0.96	-0.27	01:30	97.94	97.82

Table C5A: Pipe Data and Hydraulic Simulation Results - 1996 Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m³/s)	Peak Pipe Flow (m³/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-530	MH-531	96.851	96.656	100.58	100.45	1200	76.5	0.2	0.013	1.34	1.51	1.58	1.05	-0.23	01:30	97.82	97.62
MH-531	MH-313	96.656	96.099	100.45	99.835	1200	21.5	0.1	0.013	1.33	1.50	1.58	1.05	-0.24	01:31	97.62	97.50
MH-534	MH-535	103.033	100.603	105.406	103.886	375	78.5	3.0	0.013	2.75	0.30	0.13	0.42	-0.20	01:25	103.20	100.93
MH-535	MH-515	100.603	100.231	103.886	104	450	44.0	0.2	0.013	0.80	0.13	0.13	1.00	-0.12	01:26	100.93	100.66
MH-5350	MH-539	101.607	99.624	103.886	102.466	300	52.5	2.4	0.013	2.12	0.15	0.02	0.11	-0.23	01:25	101.68	100.09
MH-536	MH-538	102.515	100.883	105.446	103.676	450	59.0	2.2	0.013	2.63	0.42	0.11	0.26	-0.29	01:25	102.68	101.15
MH-537	MH-536	102.673	102.515	105.126	105.446	450	64.5	0.2	0.013	0.80	0.13	0.11	0.85	-0.14	01:25	102.98	102.68
MH-538	MH-539	100.883	99.624	103.676	102.466	525	58.5	2.1	0.013	2.88	0.62	0.33	0.53	-0.26	01:25	101.15	100.09
MH-539	MH-542	99.624	99.339	102.466	102.396	525	9.5	0.6	0.013	1.54	0.33	0.35	1.04	-0.06	01:26	100.09	99.94
MH-540	MH-541	100.072	99.961	101.646	102.506	300	14.5	0.4	0.013	0.81	0.06	0.03	0.49	-0.15	01:25	100.22	100.11
MH-541	MH-542	99.961	99.339	102.506	102.396	300	10.0	0.4	0.013	0.81	0.06	0.03	0.49	-0.15	01:25	100.11	99.94
MH-542	MH-543	99.339	99.184	102.396	102.186	750	53.0	0.2	0.013	0.98	0.43	0.49	1.13	-0.15	01:26	99.94	99.80
MH-543	MH-544	99.184	97.993	102.186	102.016	825	118.0	0.2	0.013	1.04	0.56	0.57	1.02	-0.20	01:27	99.80	98.35
MH-544	MH-5440	97.993	97.273	102.016	101	825	57.5	1.2	0.013	2.94	1.57	0.63	0.40	-0.47	01:28	98.35	98.24
MH-5440	MH_302	97.273	96.41	101	101.14	825	12.3	1.2	0.013	2.97	1.59	0.64	0.40	0.14	01:27	98.24	98.23
MH-546	MH-547	102.009	101.183	104.84	104.04	375	99.5	0.8	0.013	1.42	0.16	0.04	0.23	-0.25	01:30	102.13	101.40
MH-547	MH-548	101.183	100.223	104.04	103.13	375	60.0	1.6	0.013	1.98	0.22	0.14	0.63	-0.16	01:25	101.40	100.54
MH-548	MH-549	100.223	99.898	103.13	102.8	375	29.5	1.0	0.013	1.59	0.18	0.16	0.94	-0.06	01:26	100.54	100.23
MH-549	MH-550	99.898	99.618	102.8	102.64	375	12.5	1.0	0.013	1.59	0.18	0.16	0.94	-0.05	01:26	100.23	99.88
MH-550	MH-551	99.618	97.862	102.64	100.93	525	112.0	1.6	0.013	2.47	0.54	0.27	0.50	-0.27	01:26	99.88	98.35
MH-551	MH-559	97.862	94.699	100.93	100.39	525	52.5	1.4	0.013	2.35	0.51	0.43	0.84	-0.04	01:27	98.35	95.82
MH-552	MH-553	100.139	99.064	102.99	101.99	300	64.5	1.6	0.013	1.70	0.12	0.06	0.48	-0.15	01:25	100.29	99.27
MH-553	MH-557	99.064	97.315	101.99	100.86	375	103.5	1.4	0.013	1.88	0.21	0.11	0.55	-0.17	01:26	99.27	97.83
MH-554	MH-556	99.668	98.669	102.47	101.7	300	81.5	1.0	0.013	1.33	0.09	0.01	0.08	-0.24	01:25	99.73	98.94
MH-556	MH-557	98.669	97.315	101.7	100.86	525	70.0	1.2	0.013	2.18	0.47	0.25	0.52	-0.26	01:25	98.94	97.83
MH-5560	MH-556	98.809	98.669	101.67	101.7	525	14.5	0.6	0.013	1.48	0.32	0.22	0.69	-0.08	01:25	99.26	98.94
MH-557	MH-558	97.315	97.121	100.86	100.39	675	36.5	0.4	0.013	1.57	0.56	0.48	0.86	-0.16	01:26	97.83	97.62
MH-558	MH-559	97.121	94.699	100.39	100.39	675	14.5	0.4	0.013	1.57	0.56	0.48	0.86	-0.17	01:26	97.62	95.82
MH-559	MH-900	94.699	92.925	100.39	95.41	675	15.5	0.8	0.013	2.10	0.75	0.91	1.21	0.45	01:26	95.82	93.62
MH-561	MH-537	103.003	102.673	105.281	105.126	375	42.5	0.6	0.013	1.23	0.14	0.01	0.10	-0.30	01:25	103.08	102.98
MH-561	MH-563	103.003	100.82	105.281	104.305	300	61.0	2.9	0.013	2.33	0.16	0.00	0.00	-0.22	01:25	103.08	101.18
MH-562	MH-563	101.178	100.82	103.205	104.305	300	29.5	0.5	0.013	0.92	0.06	0.05	0.75	-0.07	01:25	101.41	101.18
MH-563	MH-564	100.82	100.643	104.305	103.985	525	73.5	0.2	0.013	0.89	0.19	0.16	0.85	-0.17	01:25	101.18	100.91
MH-564	MH-8500	100.643	99.407	103.985	102.733	525	48.5	2.1	0.013	2.84	0.62	0.24	0.39	-0.26	01:25	100.91	99.64
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.00	0.00	-0.75	00:00	101.11	99.64
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	0.24	0.21	-0.52	01:25	99.64	97.59
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	0.24	0.18	-0.53	01:26	97.59	95.72
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	0.24	0.19	-0.53	01:26	95.72	93.62
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	1.76	0.39	-0.96	01:27	93.62	92.32
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	2.86	0.47	-0.85	01:28	92.32	90.86
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	3.14	0.28	-1.42	01:28	90.86	90.52

Table C5A: Pipe Data and Hydraulic Simulation Results - 1996 Event

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	3.47	0.43	-1.28	01:30	90.52	90.16
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	3.55	0.31	-1.56	01:30	90.16	90.13
OGS_1	OGS_1-Out	96.037	96.015	100.5	100.35	750	4.9	0.2	0.013	1.14	0.50	1.02	2.02	0.68	03:27	97.47	97.10
OGS_1-Out	MH_3112	96.015	96.01	100.35	100.35	2250	6.2	0.1	0.013	1.63	6.49	5.15	0.79	-1.17	01:32	97.10	97.08
OGS_2	OGS_2-Out	96.026	96.004	100.428	100.35	750	5.1	0.2	0.013	1.12	0.49	1.01	2.04	0.48	01:40	97.26	96.88
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	1.76	0.39	-0.96	01:27	93.62	92.32
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	0.24	0.21	-0.52	01:25	99.64	97.59
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.00	0.00	-0.75	00:00	101.11	99.64
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	0.24	0.18	-0.53	01:26	97.59	95.72
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	0.24	0.19	-0.53	01:26	95.72	93.62
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	1.76	0.39	-0.96	01:27	93.62	92.32
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	2.86	0.47	-0.85	01:28	92.32	90.86
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	3.14	0.28	-1.42	01:28	90.86	90.52
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	3.47	0.43	-1.28	01:30	90.52	90.16
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	3.55	0.31	-1.56	01:30	90.16	90.13

Table C5B: USF Freeboard Results - 1996 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-531	MH-313	76-2	98.43	4.8	21.5	97.62	97.50	97.53	0.90
MH-531	MH-313	76-1	98.43	9.6	21.5	97.62	97.50	97.55	0.88
MH-500	MH-502	146-6	102.89	14.2	92.0	102.46	101.19	101.39	1.50
MH-500	MH-502	146-5	102.89	22.2	92.0	102.46	101.19	101.50	1.39
MH-500	MH-502	146-4	102.89	28.8	92.0	102.46	101.19	101.59	1.30
MH-500	MH-502	146-3	102.89	36.8	92.0	102.46	101.19	101.70	1.19
MH-500	MH-502	146-2	102.89	43.4	92.0	102.46	101.19	101.79	1.10
MH-500	MH-502	146-1	102.89	51.4	92.0	102.46	101.19	101.90	0.99
MH-500	MH-502	145-5	103.05	61.4	92.0	102.46	101.19	102.04	1.01
MH-500	MH-502	145-4	103.05	69.9	92.0	102.46	101.19	102.15	0.90
MH-500	MH-502	145-3	103.55	76.0	92.0	102.46	101.19	102.24	1.31
MH-500	MH-502	145-2	103.55	84.0	92.0	102.46	101.19	102.35	1.20
MH-500	MH-502	145-1	103.55	88.9	92.0	102.46	101.19	102.42	1.13
MH-502	MH-503	148-5	101.09	38.5	119.0	101.19	99.39	99.97	1.12
MH-502	MH-503	148-4	101.09	46.5	119.0	101.19	99.39	100.09	1.00
MH-502	MH-503	148-3	101.09	53.1	119.0	101.19	99.39	100.19	0.90
MH-502	MH-503	148-2	101.09	61.1	119.0	101.19	99.39	100.31	0.78
MH-502	MH-503	148-1	101.44	68.4	119.0	101.19	99.39	100.43	1.01
MH-502	MH-503	147-6	101.65	78.4	119.0	101.19	99.39	100.58	1.07
MH-502	MH-503	147-5	101.65	86.4	119.0	101.19	99.39	100.70	0.95
MH-502	MH-503	147-4	102.03	94.4	119.0	101.19	99.39	100.82	1.21
MH-502	MH-503	147-3	102.03	101.0	119.0	101.19	99.39	100.92	1.11
MH-502	MH-503	147-2	102.66	107.6	119.0	101.19	99.39	101.02	1.64
MH-502	MH-503	147-1	102.66	115.6	119.0	101.19	99.39	101.14	1.52
MH-503	MH-504	150-3	100.3	1.3	73.0	99.39	99.05	99.06	1.24
MH-503	MH-504	156-4	100.04	2.7	73.0	99.39	99.05	99.07	0.97
MH-503	MH-504	150-2	100.3	6.3	73.0	99.39	99.05	99.08	1.22
MH-503	MH-504	156-5	100.04	10.0	73.0	99.39	99.05	99.10	0.94
MH-503	MH-504	150-1	100.3	14.3	73.0	99.39	99.05	99.12	1.18
MH-503	MH-504	157-1	100.3	20.0	73.0	99.39	99.05	99.15	1.15
MH-503	MH-504	149-5	100.7	24.3	73.0	99.39	99.05	99.17	1.53
MH-503	MH-504	157-2	100.3	28.0	73.0	99.39	99.05	99.18	1.12
MH-503	MH-504	149-4	100.7	32.3	73.0	99.39	99.05	99.20	1.50
MH-503	MH-504	157-3	100.3	34.6	73.0	99.39	99.05	99.21	1.09
MH-503	MH-504	149-3	100.7	38.9	73.0	99.39	99.05	99.23	1.47
MH-503	MH-504	157-4	100.3	42.6	73.0	99.39	99.05	99.25	1.05
MH-503	MH-504	149-2	100.7	46.9	73.0	99.39	99.05	99.27	1.43
MH-503	MH-504	157-5	100.3	49.9	73.0	99.39	99.05	99.28	1.02
MH-503	MH-504	149-1	100.7	54.3	73.0	99.39	99.05	99.30	1.40
MH-503	MH-504	158-1	100.48	59.8	73.0	99.39	99.05	99.33	1.15
MH-503	MH-504	158-2	100.48	67.8	73.0	99.39	99.05	99.37	1.11
MH-503	MH-504	158-3	100.48	71.4	73.0	99.39	99.05	99.38	1.10
MH-504	MH-528	154-1	99.24	15.6	108.0	99.05	98.16	98.28	0.96
MH-504	MH-528	153-3	99.92	16.5	108.0	99.05	98.16	98.29	1.63
MH-504	MH-528	154-2	99.24	23.6	108.0	99.05	98.16	98.35	0.89
MH-504	MH-528	153-2	99.92	24.5	108.0	99.05	98.16	98.36	1.56
MH-504	MH-528	154-3	99.24	30.2	108.0	99.05	98.16	98.41	0.83
MH-504	MH-528	153-1	99.92	31.8	108.0	99.05	98.16	98.42	1.50
MH-504	MH-528	154-4	99.24	38.2	108.0	99.05	98.16	98.47	0.77
MH-504	MH-528	152-3	99.92	41.8	108.0	99.05	98.16	98.50	1.42
MH-504	MH-528	155-1	99.28	48.2	108.0	99.05	98.16	98.56	0.72
MH-504	MH-528	152-2	99.92	49.8	108.0	99.05	98.16	98.57	1.35
MH-504	MH-528	155-2	99.28	56.2	108.0	99.05	98.16	98.62	0.66
MH-504	MH-528	152-1	99.92	57.1	108.0	99.05	98.16	98.63	1.29
MH-504	MH-528	155-3	99.59	62.8	108.0	99.05	98.16	98.68	0.91
MH-504	MH-528	151-4	99.96	67.1	108.0	99.05	98.16	98.71	1.25
MH-504	MH-528	155-4	99.59	70.8	108.0	99.05	98.16	98.74	0.85
MH-504	MH-528	151-3	99.96	75.1	108.0	99.05	98.16	98.78	1.18
MH-504	MH-528	155-5	99.59	78.1	108.0	99.05	98.16	98.80	0.79
MH-504	MH-528	151-2	99.96	81.7	108.0	99.05	98.16	98.83	1.13
MH-504	MH-528	156-1	99.73	88.1	108.0	99.05	98.16	98.89	0.84
MH-504	MH-528	151-1	100.04	89.7	108.0	99.05	98.16	98.90	1.14
MH-504	MH-528	156-2	99.73	96.1	108.0	99.05	98.16	98.95	0.78
MH-504	MH-528	150-4	100.3	99.7	108.0	99.05	98.16	98.98	1.32
MH-504	MH-528	156-3	100.04	102.7	108.0	99.05	98.16	99.01	1.03
MH-505	MH-506	92-3	104.3	2.5	13.0	103.48	103.55	103.54	0.76
MH-505	MH-506	92-2	104.3	6.8	13.0	103.48	103.55	103.51	0.79
MH-505	MH-506	92-1	104.3	11.3	13.0	103.48	103.55	103.49	0.81
MH-505	MH-534	99-7	104.61	3.7	94.5	103.48	103.20	103.21	1.40
MH-505	MH-534	95-5	103.94	6.8	94.5	103.48	103.20	103.22	0.72
MH-505	MH-534	99-6	104.67	11.7	94.5	103.48	103.20	103.24	1.43
MH-505	MH-534	94-1	104.13	17.4	94.5	103.48	103.20	103.25	0.88
MH-505	MH-534	99-5	104.86	17.9	94.5	103.48	103.20	103.26	1.60
MH-505	MH-534	94-2	104.13	25.4	94.5	103.48	103.20	103.28	0.85
MH-505	MH-534	100-6	104.86	25.7	94.5	103.48	103.20	103.28	1.58
MH-505	MH-534	94-3	104.13	32.7	94.5	103.48	103.20	103.30	0.83
MH-505	MH-534	100-5	104.78	33.7	94.5	103.48	103.20	103.30	1.48
MH-505	MH-534	100-4	104.97	38.3	94.5	103.48	103.20	103.31	1.66
MH-505	MH-534	94-4	104.13	40.7	94.5	103.48	103.20	103.32	0.81

Table C5B: USF Freeboard Results - 1996 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-505	MH-534	101-6	104.97	47.7	94.5	103.48	103.20	103.34	1.63
MH-505	MH-534	94-5	104.13	48.3	94.5	103.48	103.20	103.34	0.79
MH-505	MH-534	101-5	104.86	53.9	94.5	103.48	103.20	103.36	1.50
MH-505	MH-534	93-1	104.3	58.9	94.5	103.48	103.20	103.37	0.93
MH-505	MH-534	101-4	105.08	61.9	94.5	103.48	103.20	103.38	1.70
MH-505	MH-534	93-2	104.3	66.9	94.5	103.48	103.20	103.40	0.90
MH-505	MH-534	102-6	105.11	71.3	94.5	103.48	103.20	103.41	1.70
MH-505	MH-534	93-3	104.3	74.2	94.5	103.48	103.20	103.42	0.88
MH-505	MH-534	102-5	105.11	75.9	94.5	103.48	103.20	103.42	1.69
MH-505	MH-534	93-4	104.3	82.2	94.5	103.48	103.20	103.44	0.86
MH-505	MH-534	102-4	105.11	83.9	94.5	103.48	103.20	103.45	1.66
MH-505	MH-534	93-5	104.3	89.8	94.5	103.48	103.20	103.46	0.84
MH-506	MH-508	89-1	103.74	7.2	79.0	103.55	103.29	103.32	0.42
MH-506	MH-508	90-3	104.04	27.0	79.0	103.55	103.29	103.38	0.66
MH-506	MH-508	90-2	104.04	34.6	79.0	103.55	103.29	103.41	0.63
MH-506	MH-508	90-1	104.04	42.6	79.0	103.55	103.29	103.43	0.61
MH-506	MH-508	91-4	104.23	53.2	79.0	103.55	103.29	103.47	0.76
MH-506	MH-508	91-3	104.23	61.2	79.0	103.55	103.29	103.49	0.74
MH-506	MH-508	91-2	104.23	68.5	79.0	103.67	103.41	103.64	0.59
MH-506	MH-508	91-1	104.23	76.5	79.0	103.67	103.41	103.66	0.57
MH-5070	MH-513	99-2	104.61	0.1	82.0	103.66	103.42	103.42	1.19
MH-5070	MH-513	105-6	104.46	8.2	82.0	103.66	103.42	103.45	1.01
MH-5070	MH-513	99-3	104.67	8.4	82.0	103.66	103.42	103.45	1.22
MH-5070	MH-513	105-5	104.46	12.8	82.0	103.66	103.42	103.46	1.00
MH-5070	MH-513	99-4	104.86	14.3	82.0	103.66	103.42	103.47	1.39
MH-5070	MH-513	105-4	104.46	20.8	82.0	103.66	103.42	103.48	0.98
MH-5070	MH-513	100-1	104.86	22.1	82.0	103.66	103.42	103.49	1.37
MH-5070	MH-513	100-2	104.78	30.1	82.0	103.66	103.42	103.51	1.27
MH-5070	MH-513	104-8	104.6	30.2	82.0	103.66	103.42	103.51	1.09
MH-5070	MH-513	100-3	104.97	34.7	82.0	103.66	103.42	103.52	1.45
MH-5070	MH-513	104-7	104.6	34.8	82.0	103.66	103.42	103.52	1.08
MH-5070	MH-513	104-6	104.6	42.8	82.0	103.66	103.42	103.55	1.05
MH-5070	MH-513	101-1	104.97	44.1	82.0	103.66	103.42	103.55	1.42
MH-5070	MH-513	104-5	104.6	49.0	82.0	103.66	103.42	103.57	1.03
MH-5070	MH-513	101-2	104.86	50.3	82.0	103.66	103.42	103.57	1.29
MH-5070	MH-513	101-3	105.08	58.3	82.0	103.66	103.42	103.59	1.49
MH-5070	MH-513	103-8	104.79	58.4	82.0	103.66	103.42	103.59	1.20
MH-5070	MH-513	103-7	104.79	63.0	82.0	103.66	103.42	103.61	1.18
MH-5070	MH-513	102-1	105.11	67.7	82.0	103.66	103.42	103.62	1.49
MH-5070	MH-513	103-6	104.79	71.0	82.0	103.66	103.42	103.63	1.16
MH-5070	MH-513	102-2	105.11	72.3	82.0	103.66	103.42	103.63	1.48
MH-5070	MH-513	103-5	104.79	77.2	82.0	103.66	103.42	103.65	1.14
MH-5070	MH-513	102-3	105.11	80.3	82.0	103.66	103.42	103.66	1.45
MH-508	MH-509	88-3	103.73	6.6	41.5	103.41	103.14	103.18	0.55
MH-508	MH-509	88-2	103.73	14.2	41.5	103.41	103.14	103.23	0.50
MH-508	MH-509	88-1	103.73	22.2	41.5	103.41	103.14	103.29	0.44
MH-508	MH-509	89-3	103.74	32.8	41.5	103.41	103.14	103.36	0.38
MH-508	MH-509	89-2	103.74	40.4	41.5	103.41	103.14	103.41	0.33
MH-5080	MH-517	105-1	104.46	6.2	76.5	103.19	103.02	103.04	1.42
MH-5080	MH-517	111-6	104.04	7.8	76.5	103.19	103.02	103.04	1.00
MH-5080	MH-517	105-2	104.46	10.7	76.5	103.19	103.02	103.05	1.41
MH-5080	MH-517	111-5	104.35	14.0	76.5	103.19	103.02	103.05	1.30
MH-5080	MH-517	105-3	104.46	18.7	76.5	103.19	103.02	103.06	1.40
MH-5080	MH-517	112-8	104.49	23.4	76.5	103.19	103.02	103.07	1.42
MH-5080	MH-517	112-7	104.49	28.0	76.5	103.19	103.02	103.08	1.41
MH-5080	MH-517	104-1	104.6	28.1	76.5	103.19	103.02	103.08	1.52
MH-5080	MH-517	104-2	104.6	32.7	76.5	103.19	103.02	103.09	1.51
MH-5080	MH-517	112-6	104.49	36.0	76.5	103.19	103.02	103.10	1.39
MH-5080	MH-517	104-3	104.6	40.7	76.5	103.19	103.02	103.11	1.49
MH-5080	MH-517	112-5	104.49	42.2	76.5	103.19	103.02	103.11	1.38
MH-5080	MH-517	104-4	104.6	46.9	76.5	103.19	103.02	103.12	1.48
MH-5080	MH-517	113-8	104.59	51.6	76.5	103.19	103.02	103.13	1.46
MH-5080	MH-517	113-7	104.59	56.2	76.5	103.19	103.02	103.14	1.45
MH-5080	MH-517	103-1	104.79	56.3	76.5	103.19	103.02	103.14	1.65
MH-5080	MH-517	103-2	104.79	60.9	76.5	103.19	103.02	103.15	1.64
MH-5080	MH-517	113-6	104.59	64.2	76.5	103.19	103.02	103.16	1.43
MH-5080	MH-517	103-3	104.79	68.9	76.5	103.19	103.02	103.17	1.62
MH-5080	MH-517	113-5	104.59	70.4	76.5	103.19	103.02	103.17	1.42
MH-5080	MH-517	103-4	104.79	75.1	76.5	103.19	103.02	103.18	1.61
MH-509	MH-510	87-3	103.63	2.0	10.5	103.14	102.93	102.97	0.66
MH-509	MH-510	87-2	103.63	5.6	10.5	103.14	102.93	103.04	0.59
MH-509	MH-510	87-1	103.63	9.4	10.5	103.14	102.93	103.12	0.51
MH-510	MH-511	85-4	103.36	4.3	64.0	102.93	102.31	102.35	1.01
MH-510	MH-511	112-1	104.49	9.4	64.0	102.93	102.31	102.40	2.09
MH-510	MH-511	85-3	103.36	12.3	64.0	102.93	102.31	102.43	0.93
MH-510	MH-511	112-2	104.49	14.0	64.0	102.93	102.31	102.44	2.05
MH-510	MH-511	85-2	103.36	19.5	64.0	102.93	102.31	102.50	0.86
MH-510	MH-511	112-3	104.49	22.0	64.0	102.93	102.31	102.52	1.97
MH-510	MH-511	85-1	103.36	27.5	64.0	102.93	102.31	102.57	0.79

Table C5B: USF Freeboard Results - 1996 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-510	MH-511	112-4	104.49	28.2	64.0	102.93	102.31	102.58	1.91
MH-510	MH-511	113-1	104.59	37.6	64.0	102.93	102.31	102.67	1.92
MH-510	MH-511	86-3	103.5	38.1	64.0	102.93	102.31	102.68	0.82
MH-510	MH-511	113-2	104.59	42.2	64.0	102.93	102.31	102.72	1.87
MH-510	MH-511	86-2	103.5	45.8	64.0	102.93	102.31	102.75	0.75
MH-510	MH-511	113-3	104.59	50.2	64.0	102.93	102.31	102.79	1.80
MH-510	MH-511	86-1	103.5	53.8	64.0	102.93	102.31	102.83	0.67
MH-510	MH-511	113-4	104.59	56.4	64.0	102.93	102.31	102.85	1.74
MH-511	MH-526	82-3	101.52	20.9	95.5	102.31	100.33	100.76	0.76
MH-511	MH-526	109-2	102.17	26.4	95.5	102.31	100.33	100.88	1.29
MH-511	MH-526	82-2	101.52	28.9	95.5	102.31	100.33	100.93	0.59
MH-511	MH-526	109-3	102.32	30.8	95.5	102.31	100.33	100.97	1.35
MH-511	MH-526	82-1	101.52	36.5	95.5	102.31	100.33	101.09	0.43
MH-511	MH-526	109-4	102.78	38.8	95.5	102.31	100.33	101.13	1.65
MH-511	MH-526	83-3	101.63	47.1	95.5	102.31	100.33	101.31	0.32
MH-511	MH-526	110-1	102.91	48.2	95.5	102.31	100.33	101.33	1.58
MH-511	MH-526	110-2	103.09	52.8	95.5	102.31	100.33	101.42	1.67
MH-511	MH-526	83-2	102.27	54.7	95.5	102.31	100.33	101.46	0.81
MH-511	MH-526	110-3	103.34	60.8	95.5	102.31	100.33	101.59	1.75
MH-511	MH-526	83-1	102.27	62.7	95.5	102.31	100.33	101.63	0.64
MH-511	MH-526	110-4	103.77	67.0	95.5	102.31	100.33	101.72	2.05
MH-511	MH-526	84-3	102.46	73.4	95.5	102.31	100.33	101.85	0.61
MH-511	MH-526	111-1	103.89	76.4	95.5	102.31	100.33	101.91	1.98
MH-511	MH-526	111-2	103.98	81.0	95.5	102.31	100.33	102.01	1.97
MH-511	MH-526	84-2	103.15	81.0	95.5	102.31	100.33	102.01	1.14
MH-511	MH-526	84-1	103.15	88.9	95.5	102.31	100.33	102.17	0.98
MH-511	MH-526	111-3	104.04	89.1	95.5	102.31	100.33	102.17	1.87
MH-511	MH-526	111-4	104.35	95.3	95.5	102.31	100.33	102.30	2.05
MH-513	MH-515	108-6	102.64	21.6	81.0	103.42	100.72	101.44	1.20
MH-513	MH-515	97-2	102.99	26.5	81.0	103.42	100.72	101.61	1.38
MH-513	MH-515	108-5	102.57	29.6	81.0	103.42	100.72	101.71	0.86
MH-513	MH-515	97-3	103.15	30.9	81.0	103.42	100.72	101.75	1.40
MH-513	MH-515	108-4	102.98	35.8	81.0	103.42	100.72	101.92	1.06
MH-513	MH-515	97-4	103.6	38.9	81.0	103.42	100.72	102.02	1.58
MH-513	MH-515	107-6	103.11	45.2	81.0	103.42	100.72	102.23	0.88
MH-513	MH-515	98-1	103.73	48.3	81.0	103.42	100.72	102.33	1.40
MH-513	MH-515	107-5	103.33	49.8	81.0	103.42	100.72	102.38	0.95
MH-513	MH-515	98-2	103.92	52.9	81.0	103.42	100.72	102.49	1.43
MH-513	MH-515	107-4	103.75	56.2	81.0	103.42	100.72	102.60	1.15
MH-513	MH-515	98-3	104.16	60.9	81.0	103.42	100.72	102.75	1.41
MH-513	MH-515	106-6	103.85	65.6	81.0	103.42	100.72	102.91	0.94
MH-513	MH-515	98-4	104.59	67.1	81.0	103.42	100.72	102.96	1.63
MH-513	MH-515	106-5	104.08	73.6	81.0	103.42	100.72	103.18	0.90
MH-513	MH-515	99-1	104.61	76.5	81.0	103.42	100.72	103.27	1.34
MH-513	MH-515	106-4	104.34	79.8	81.0	103.42	100.72	103.38	0.96
MH-515	MH-518	114-5	101.66	3.6	44.0	100.72	100.51	100.53	1.13
MH-515	MH-518	115-1	101.78	14.3	44.0	100.72	100.51	100.58	1.20
MH-515	MH-518	115-2	102.22	21.9	44.0	100.72	100.51	100.62	1.60
MH-515	MH-518	115-3	102.22	29.9	44.0	100.72	100.51	100.65	1.57
MH-515	MH-518	115-4	102.22	37.1	44.0	100.72	100.51	100.69	1.53
MH-517	MH-518	109-8	102.23	19.4	82.0	103.02	100.51	101.11	1.12
MH-517	MH-518	108-1	102.64	20.7	82.0	103.02	100.51	101.15	1.49
MH-517	MH-518	109-7	102.17	27.4	82.0	103.02	100.51	101.35	0.82
MH-517	MH-518	108-2	102.57	28.7	82.0	103.02	100.51	101.39	1.18
MH-517	MH-518	109-6	102.32	31.8	82.0	103.02	100.51	101.49	0.83
MH-517	MH-518	108-3	102.98	34.9	82.0	103.02	100.51	101.58	1.40
MH-517	MH-518	109-5	102.78	39.8	82.0	103.02	100.51	101.73	1.05
MH-517	MH-518	107-1	103.11	44.3	82.0	103.02	100.51	101.87	1.24
MH-517	MH-518	107-2	103.33	48.9	82.0	103.02	100.51	102.01	1.32
MH-517	MH-518	110-8	102.91	49.2	82.0	103.02	100.51	102.02	0.89
MH-517	MH-518	110-7	103.09	53.8	82.0	103.02	100.51	102.16	0.93
MH-517	MH-518	107-3	103.75	55.3	82.0	103.02	100.51	102.21	1.54
MH-517	MH-518	110-6	103.34	61.8	82.0	103.02	100.51	102.41	0.93
MH-517	MH-518	106-1	103.85	64.7	82.0	103.02	100.51	102.49	1.36
MH-517	MH-518	110-5	103.77	68.0	82.0	103.02	100.51	102.60	1.17
MH-517	MH-518	106-2	104.08	72.7	82.0	103.02	100.51	102.74	1.34
MH-517	MH-518	111-8	103.89	77.4	82.0	103.02	100.51	102.88	1.01
MH-517	MH-518	106-3	104.34	78.9	82.0	103.02	100.51	102.93	1.41
MH-517	MH-518	111-7	103.98	82.0	82.0	103.02	100.51	103.02	0.96
MH-518	MH-526	114-1	101.36	19.7	47.0	100.51	100.33	100.41	0.95
MH-518	MH-526	114-2	101.66	27.3	47.0	100.51	100.33	100.44	1.22
MH-518	MH-526	114-3	101.66	35.3	47.0	100.51	100.33	100.47	1.19
MH-518	MH-526	114-4	101.66	42.5	47.0	100.51	100.33	100.50	1.16
MH-519	MH-520	129-3	104.07	4.0	54.5	103.48	103.41	103.41	0.66
MH-519	MH-520	138-1	104.08	5.4	54.5	103.48	103.41	103.41	0.67
MH-519	MH-520	129-2	104.07	12.0	54.5	103.48	103.41	103.42	0.65
MH-519	MH-520	138-2	104.08	13.0	54.5	103.48	103.41	103.42	0.66
MH-519	MH-520	129-1	104.07	19.6	54.5	103.48	103.41	103.43	0.64
MH-519	MH-520	138-3	104.08	21.0	54.5	103.48	103.41	103.43	0.65

Table C5B: USF Freeboard Results - 1996 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-519	MH-520	128-3	104.09	30.2	54.5	103.48	103.41	103.45	0.64
MH-519	MH-520	139-1	104.23	31.6	54.5	103.48	103.41	103.45	0.78
MH-519	MH-520	128-2	104.09	38.2	54.5	103.48	103.41	103.46	0.63
MH-519	MH-520	139-2	104.23	39.2	54.5	103.48	103.41	103.46	0.77
MH-519	MH-520	128-1	104.09	45.8	54.5	103.48	103.41	103.46	0.63
MH-519	MH-520	139-3	104.23	47.2	54.5	103.48	103.41	103.47	0.76
MH-519	MH-523	140-3	104.25	2.3	11.5	103.48	103.32	103.35	0.90
MH-519	MH-523	140-2	104.25	7.0	11.5	103.48	103.32	103.42	0.83
MH-519	MH-523	140-1	104.25	10.5	11.5	103.48	103.32	103.46	0.79
MH-520	MH-521	136-1	103.94	3.7	57.5	103.41	103.12	103.14	0.80
MH-520	MH-521	131-3	103.81	8.8	57.5	103.41	103.12	103.16	0.65
MH-520	MH-521	136-2	103.94	11.4	57.5	103.41	103.12	103.18	0.76
MH-520	MH-521	131-2	103.81	16.8	57.5	103.41	103.12	103.20	0.61
MH-520	MH-521	136-3	103.94	19.4	57.5	103.41	103.12	103.22	0.72
MH-520	MH-521	131-1	103.81	24.5	57.5	103.41	103.12	103.24	0.57
MH-520	MH-521	137-1	103.94	30.0	57.5	103.41	103.12	103.27	0.67
MH-520	MH-521	130-3	103.94	35.1	57.5	103.41	103.12	103.29	0.65
MH-520	MH-521	137-2	103.94	37.6	57.5	103.41	103.12	103.31	0.63
MH-520	MH-521	130-2	103.94	43.1	57.5	103.41	103.12	103.33	0.61
MH-520	MH-521	137-3	103.94	45.6	57.5	103.41	103.12	103.35	0.59
MH-520	MH-521	130-1	103.94	50.7	57.5	103.41	103.12	103.37	0.57
MH-521	MH-522	135-1	103.67	1.0	11.5	103.12	102.94	102.95	0.72
MH-521	MH-522	135-2	103.67	5.3	11.5	103.12	102.94	103.02	0.65
MH-521	MH-522	135-3	103.67	9.5	11.5	103.12	102.94	103.09	0.58
MH-522	MH-525	133-3	102.71	7.1	55.0	102.94	101.07	101.31	1.40
MH-522	MH-525	133-4	103.1	14.4	55.0	102.94	101.07	101.56	1.54
MH-522	MH-525	133-5	103.1	22.4	55.0	102.94	101.07	101.83	1.27
MH-522	MH-525	134-1	103.55	32.9	55.0	102.94	101.07	102.19	1.36
MH-522	MH-525	134-2	103.55	40.6	55.0	102.94	101.07	102.45	1.10
MH-522	MH-525	134-3	103.55	48.6	55.0	102.94	101.07	102.72	0.83
MH-523	MH-524	141-5	103.68	20.5	55.0	103.32	102.49	102.80	0.88
MH-523	MH-524	141-4	103.68	28.5	55.0	103.32	102.49	102.92	0.76
MH-523	MH-524	141-3	104.25	35.7	55.0	103.32	102.49	103.03	1.22
MH-523	MH-524	141-2	104.25	43.7	55.0	103.32	102.49	103.15	1.10
MH-523	MH-524	141-1	104.25	51.3	55.0	103.32	102.49	103.27	0.98
MH-524	MH-5240	126-1	103.57	5.3	65.0	102.49	102.20	102.22	1.35
MH-524	MH-5240	122-4	103.32	5.6	65.0	102.49	102.20	102.22	1.10
MH-524	MH-5240	126-2	103.57	13.3	65.0	102.49	102.20	102.26	1.31
MH-524	MH-5240	122-3	103.32	13.6	65.0	102.49	102.20	102.26	1.06
MH-524	MH-5240	122-2	103.32	20.9	65.0	102.49	102.20	102.29	1.03
MH-524	MH-5240	126-3	103.57	20.9	65.0	102.49	102.20	102.29	1.28
MH-524	MH-5240	122-1	103.32	28.9	65.0	102.49	102.20	102.33	0.99
MH-524	MH-5240	127-1	103.57	31.6	65.0	102.49	102.20	102.34	1.23
MH-524	MH-5240	121-3	103.45	39.5	65.0	102.49	102.20	102.37	1.08
MH-524	MH-5240	127-2	103.57	39.6	65.0	102.49	102.20	102.37	1.20
MH-524	MH-5240	121-2	103.45	47.1	65.0	102.49	102.20	102.41	1.04
MH-524	MH-5240	127-3	103.57	47.2	65.0	102.49	102.20	102.41	1.16
MH-524	MH-5240	121-1	103.45	55.1	65.0	102.49	102.20	102.44	1.01
MH-5240	MH-525	124-1	102.67	16.1	63.5	102.20	101.07	101.36	1.31
MH-5240	MH-525	123-5	102.2	19.8	63.5	102.20	101.07	101.42	0.78
MH-5240	MH-525	124-2	102.67	24.1	63.5	102.20	101.07	101.50	1.17
MH-5240	MH-525	123-4	102.74	27.4	63.5	102.20	101.07	101.56	1.18
MH-5240	MH-525	124-3	102.67	31.7	63.5	102.20	101.07	101.63	1.04
MH-5240	MH-525	123-3	102.74	35.4	63.5	102.20	101.07	101.70	1.04
MH-5240	MH-525	125-1	103.28	42.3	63.5	102.20	101.07	101.82	1.46
MH-5240	MH-525	123-2	103.08	42.6	63.5	102.20	101.07	101.83	1.25
MH-5240	MH-525	125-2	103.28	50.3	63.5	102.20	101.07	101.96	1.32
MH-5240	MH-525	123-1	103.08	50.6	63.5	102.20	101.07	101.97	1.11
MH-5240	MH-525	125-3	103.28	58.0	63.5	102.20	101.07	102.10	1.18
MH-5240	MH-525	122-5	103.32	61.3	63.5	102.20	101.07	102.16	1.16
MH-52400	MH-538	119-1	102.26	15.8	58.0	102.25	101.17	101.47	0.79
MH-52400	MH-538	119-2	102.26	23.8	58.0	102.25	101.17	101.61	0.65
MH-52400	MH-538	119-3	102.65	31.4	58.0	102.25	101.17	101.75	0.90
MH-52400	MH-538	120-1	103.45	42.1	58.0	102.25	101.17	101.95	1.50
MH-52400	MH-538	120-2	103.45	50.1	58.0	102.25	101.17	102.10	1.35
MH-52400	MH-538	120-3	103.45	57.4	58.0	102.25	101.17	102.23	1.22
MH-525	MH-526	132-1	101.26	15.8	58.5	101.07	100.33	100.53	0.73
MH-525	MH-526	132-2	101.26	23.8	58.5	101.07	100.33	100.63	0.63
MH-525	MH-526	132-3	101.65	31.0	58.5	101.07	100.33	100.72	0.93
MH-525	MH-526	132-4	101.65	39.0	58.5	101.07	100.33	100.82	0.83
MH-525	MH-526	133-1	101.85	49.7	58.5	101.07	100.33	100.96	0.89
MH-525	MH-526	133-2	102.71	57.3	58.5	101.07	100.33	101.05	1.66
MH-528	MH-529	5	101.37	6.6	62.5	98.37	98.10	98.13	3.24
MH-528	MH-529	81-1	98.72	9.8	62.5	98.37	98.10	98.14	0.58
MH-528	MH-529	4	101.37	12.7	62.5	98.37	98.10	98.15	3.22
MH-528	MH-529	81-2	98.72	17.8	62.5	98.37	98.10	98.17	0.55
MH-528	MH-529	81-3	98.72	25.0	62.5	98.37	98.10	98.21	0.51
MH-528	MH-529	3	101.37	25.5	62.5	98.37	98.10	98.21	3.16
MH-528	MH-529	2	101.42	31.6	62.5	98.37	98.10	98.23	3.19

Table C5B: USF Freeboard Results - 1996 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-528	MH-529	81-4	98.72	33.0	62.5	98.37	98.10	98.24	0.48
MH-528	MH-529	81-5	99.3	40.6	62.5	98.37	98.10	98.27	1.03
MH-528	MH-529	1	101.42	41.7	62.5	98.37	98.10	98.28	3.14
MH-529	MH-530	13	101.13	3.2	72.0	98.10	97.96	97.97	3.16
MH-529	MH-530	79-1	98.62	6.4	72.0	98.10	97.96	97.97	0.65
MH-529	MH-530	12	101.13	9.2	72.0	98.10	97.96	97.98	3.15
MH-529	MH-530	79-2	98.62	14.4	72.0	98.10	97.96	97.99	0.63
MH-529	MH-530	79-3	98.62	21.7	72.0	98.10	97.96	98.00	0.62
MH-529	MH-530	11	101.13	22.0	72.0	98.10	97.96	98.00	3.13
MH-529	MH-530	10	101.13	28.1	72.0	98.10	97.96	98.01	3.12
MH-529	MH-530	79-4	98.62	29.7	72.0	98.10	97.96	98.02	0.60
MH-529	MH-530	80-1	98.72	40.3	72.0	98.10	97.96	98.04	0.68
MH-529	MH-530	9	101.22	40.9	72.0	98.10	97.96	98.04	3.18
MH-529	MH-530	8	101.32	47.0	72.0	98.10	97.96	98.05	3.27
MH-529	MH-530	80-2	98.72	48.3	72.0	98.10	97.96	98.05	0.67
MH-529	MH-530	80-3	98.72	55.6	72.0	98.10	97.96	98.07	0.65
MH-529	MH-530	7	101.37	59.8	72.0	98.10	97.96	98.08	3.29
MH-529	MH-530	80-4	98.72	63.6	72.0	98.10	97.96	98.08	0.64
MH-529	MH-530	6	101.37	65.9	72.0	98.10	97.96	98.09	3.28
MH-529	MH-530	80-5	98.72	70.1	72.0	98.10	97.96	98.10	0.62
MH-530	MH-531	76-3	98.43	3.0	76.5	97.96	97.74	97.74	0.69
MH-530	MH-531	77-1	98.55	5.8	76.5	97.96	97.74	97.75	0.80
MH-530	MH-531	77-2	98.55	13.8	76.5	97.96	97.74	97.78	0.77
MH-530	MH-531	77-3	98.55	21.0	76.5	97.96	97.74	97.80	0.75
MH-530	MH-531	77-4	98.55	29.0	76.5	97.96	97.74	97.82	0.73
MH-530	MH-531	18	101.07	29.6	76.5	97.96	97.74	97.82	3.25
MH-530	MH-531	78-1	98.58	39.6	76.5	97.96	97.74	97.85	0.73
MH-530	MH-531	17	101.11	42.4	76.5	97.96	97.74	97.86	3.25
MH-530	MH-531	78-2	98.58	47.6	76.5	97.96	97.74	97.88	0.70
MH-530	MH-531	16	101.13	48.5	76.5	97.96	97.74	97.88	3.25
MH-530	MH-531	78-3	98.58	54.9	76.5	97.96	97.74	97.90	0.68
MH-530	MH-531	15	101.13	61.3	76.5	97.96	97.74	97.92	3.21
MH-530	MH-531	78-4	98.58	62.9	76.5	97.96	97.74	97.92	0.66
MH-530	MH-531	14	101.13	67.4	76.5	97.96	97.74	97.93	3.20
MH-530	MH-531	78-5	98.58	70.5	76.5	97.96	97.74	97.94	0.64
MH-534	MH-535	97-8	102.99	19.4	78.5	103.22	100.98	101.54	1.45
MH-534	MH-535	96-1	103.02	20.3	78.5	103.22	100.98	101.56	1.46
MH-534	MH-535	97-7	102.99	27.4	78.5	103.22	100.98	101.76	1.23
MH-534	MH-535	96-2	103.02	28.3	78.5	103.22	100.98	101.79	1.23
MH-534	MH-535	97-6	103.15	31.8	78.5	103.22	100.98	101.89	1.26
MH-534	MH-535	96-3	103.42	35.5	78.5	103.22	100.98	102.00	1.42
MH-534	MH-535	97-5	103.6	39.8	78.5	103.22	100.98	102.12	1.48
MH-534	MH-535	96-4	103.42	43.5	78.5	103.22	100.98	102.22	1.20
MH-534	MH-535	98-8	103.73	49.2	78.5	103.22	100.98	102.39	1.34
MH-534	MH-535	98-7	103.92	53.8	78.5	103.22	100.98	102.52	1.40
MH-534	MH-535	95-1	103.47	54.2	78.5	103.22	100.98	102.53	0.94
MH-534	MH-535	98-6	104.16	61.8	78.5	103.22	100.98	102.75	1.41
MH-534	MH-535	95-2	103.47	62.2	78.5	103.22	100.98	102.76	0.71
MH-534	MH-535	98-5	104.59	68.0	78.5	103.22	100.98	102.92	1.67
MH-534	MH-535	95-3	103.94	69.4	78.5	103.22	100.98	102.96	0.98
MH-534	MH-535	95-4	103.94	77.4	78.5	103.22	100.98	103.19	0.75
MH-534	MH-535	99-8	104.61	77.4	78.5	103.22	100.98	103.19	1.42
MH-535	MH-515	115-5	102.22	1.2	44.0	100.98	100.72	100.73	1.49
MH-535	MH-515	116-1	102.3	11.9	44.0	100.98	100.72	100.79	1.51
MH-535	MH-515	116-2	102.3	19.5	44.0	100.98	100.72	100.84	1.46
MH-535	MH-515	116-3	102.3	27.5	44.0	100.98	100.72	100.88	1.42
MH-535	MH-515	117-1	102.4	38.1	44.0	100.98	100.72	100.95	1.45
MH-5350	MH-539	118-3	102.4	16.8	52.5	101.68	100.15	100.64	1.76
MH-5350	MH-539	118-2	102.4	24.8	52.5	101.68	100.15	100.87	1.53
MH-5350	MH-539	118-1	102.4	32.4	52.5	101.68	100.15	101.09	1.31
MH-5350	MH-539	117-3	102.4	43.1	52.5	101.68	100.15	101.40	1.00
MH-5350	MH-539	117-2	102.4	51.1	52.5	101.68	100.15	101.64	0.76
MH-536	MH-538	196-1	102.56	6.1	59.0	102.69	101.17	101.33	1.23
MH-536	MH-538	142-1	103.33	15.7	59.0	102.69	101.17	101.58	1.75
MH-536	MH-538	195-4	103.31	16.1	59.0	102.69	101.17	101.59	1.72
MH-536	MH-538	142-2	103.33	23.7	59.0	102.69	101.17	101.78	1.55
MH-536	MH-538	195-3	103.31	24.1	59.0	102.69	101.17	101.79	1.52
MH-536	MH-538	142-3	103.72	30.3	59.0	102.69	101.17	101.95	1.77
MH-536	MH-538	195-2	103.7	30.7	59.0	102.69	101.17	101.96	1.74
MH-536	MH-538	142-4	103.72	38.3	59.0	102.69	101.17	102.15	1.57
MH-536	MH-538	195-1	103.7	38.7	59.0	102.69	101.17	102.16	1.54
MH-536	MH-538	143-1	103.96	48.3	59.0	102.69	101.17	102.41	1.55
MH-536	MH-538	194-4	103.92	48.7	59.0	102.69	101.17	102.42	1.50
MH-536	MH-538	143-2	103.96	56.3	59.0	102.69	101.17	102.62	1.34
MH-536	MH-538	194-3	103.92	56.7	59.0	102.69	101.17	102.63	1.29
MH-537	MH-536	194-2	103.92	4.4	64.5	103.01	102.69	102.71	1.21
MH-537	MH-536	143-3	103.96	4.7	64.5	103.01	102.69	102.71	1.25
MH-537	MH-536	194-1	103.92	12.4	64.5	103.01	102.69	102.75	1.17
MH-537	MH-536	144-1	103.96	14.7	64.5	103.01	102.69	102.76	1.20

Table C5B: USF Freeboard Results - 1996 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-537	MH-536	193-4	103.88	22.4	64.5	103.01	102.69	102.80	1.08
MH-537	MH-536	144-2	103.96	22.7	64.5	103.01	102.69	102.80	1.16
MH-537	MH-536	144-3	103.96	29.3	64.5	103.01	102.69	102.83	1.13
MH-537	MH-536	193-3	103.88	30.4	64.5	103.01	102.69	102.84	1.04
MH-537	MH-536	193-2	103.88	37.0	64.5	103.01	102.69	102.87	1.01
MH-537	MH-536	144-4	103.96	37.3	64.5	103.01	102.69	102.87	1.09
MH-537	MH-536	144-5	103.96	44.6	64.5	103.01	102.69	102.91	1.05
MH-537	MH-536	193-1	103.88	45.0	64.5	103.01	102.69	102.91	0.97
MH-537	MH-536	192-4	103.75	55.0	64.5	103.01	102.69	102.96	0.79
MH-538	MH-539	197-3	101.08	16.5	58.5	101.17	100.15	100.44	0.64
MH-538	MH-539	197-2	101.08	24.5	58.5	101.17	100.15	100.58	0.50
MH-538	MH-539	197-1	101.42	31.8	58.5	101.17	100.15	100.71	0.71
MH-538	MH-539	196-4	102.16	41.8	58.5	101.17	100.15	100.88	1.28
MH-538	MH-539	196-3	102.16	49.8	58.5	101.17	100.15	101.02	1.14
MH-538	MH-539	196-2	102.56	56.4	58.5	101.17	100.15	101.14	1.42
MH-542	MH-543	58	103.46	5.4	53.0	100.01	99.86	99.88	3.58
MH-542	MH-543	62-5	100.72	8.9	53.0	100.01	99.86	99.89	0.83
MH-542	MH-543	62-4	100.72	16.2	53.0	100.01	99.86	99.91	0.81
MH-542	MH-543	59	103.46	18.2	53.0	100.01	99.86	99.91	3.55
MH-542	MH-543	62-3	100.72	24.2	53.0	100.01	99.86	99.93	0.79
MH-542	MH-543	60	103.42	24.3	53.0	100.01	99.86	99.93	3.49
MH-542	MH-543	62-2	100.72	30.8	53.0	100.01	99.86	99.95	0.77
MH-542	MH-543	61	103.33	37.1	53.0	100.01	99.86	99.97	3.36
MH-542	MH-543	62-1	100.72	38.8	53.0	100.01	99.86	99.97	0.75
MH-543	MH-544	66-2	100.62	3.8	118.0	99.86	98.52	98.57	2.05
MH-543	MH-544	45	103.16	4.0	118.0	99.86	98.52	98.57	4.59
MH-543	MH-544	46	103.46	10.1	118.0	99.86	98.52	98.64	4.82
MH-543	MH-544	66-1	100.62	11.8	118.0	99.86	98.52	98.66	1.96
MH-543	MH-544	65-4	100.72	21.8	118.0	99.86	98.52	98.77	1.95
MH-543	MH-544	47	103.51	22.9	118.0	99.86	98.52	98.78	4.73
MH-543	MH-544	48	103.51	29.0	118.0	99.86	98.52	98.85	4.66
MH-543	MH-544	65-3	100.72	29.8	118.0	99.86	98.52	98.86	1.86
MH-543	MH-544	65-2	100.72	36.4	118.0	99.86	98.52	98.94	1.78
MH-543	MH-544	49	103.51	41.8	118.0	99.86	98.52	99.00	4.51
MH-543	MH-544	65-1	100.72	44.4	118.0	99.86	98.52	99.03	1.69
MH-543	MH-544	50	103.51	47.9	118.0	99.86	98.52	99.07	4.44
MH-543	MH-544	64-4	100.86	54.4	118.0	99.86	98.52	99.14	1.72
MH-543	MH-544	51	103.51	60.8	118.0	99.86	98.52	99.21	4.30
MH-543	MH-544	64-3	100.86	62.4	118.0	99.86	98.52	99.23	1.63
MH-543	MH-544	52	103.51	66.9	118.0	99.86	98.52	99.28	4.23
MH-543	MH-544	64-2	100.86	69.0	118.0	99.86	98.52	99.31	1.55
MH-543	MH-544	64-1	100.86	77.0	118.0	99.86	98.52	99.40	1.46
MH-543	MH-544	53	103.57	79.7	118.0	99.86	98.52	99.43	4.14
MH-543	MH-544	54	103.61	85.8	118.0	99.86	98.52	99.50	4.11
MH-543	MH-544	63-5	100.86	87.0	118.0	99.86	98.52	99.51	1.35
MH-543	MH-544	63-4	100.86	94.3	118.0	99.86	98.52	99.59	1.27
MH-543	MH-544	55	103.59	98.6	118.0	99.86	98.52	99.64	3.95
MH-543	MH-544	63-3	100.86	102.3	118.0	99.86	98.52	99.69	1.17
MH-543	MH-544	56	103.49	104.7	118.0	99.86	98.52	99.71	3.78
MH-543	MH-544	63-2	100.86	108.9	118.0	99.86	98.52	99.76	1.10
MH-543	MH-544	63-1	100.86	116.9	118.0	99.86	98.52	99.85	1.01
MH-543	MH-544	57	103.46	117.5	118.0	99.86	98.52	99.86	3.60
MH-544	MH-5440	68-3	99.4	3.4	57.5	98.52	98.46	98.47	0.93
MH-544	MH-5440	68-2	99.4	10.7	57.5	98.52	98.46	98.47	0.93
MH-544	MH-5440	68-1	99.4	18.7	57.5	98.52	98.46	98.48	0.92
MH-544	MH-5440	67-3	99.49	28.7	57.5	98.52	98.46	98.49	1.00
MH-544	MH-5440	42	102.27	30.0	57.5	98.52	98.46	98.49	3.78
MH-544	MH-5440	67-2	100.2	36.0	57.5	98.52	98.46	98.50	1.70
MH-544	MH-5440	43	102.6	42.8	57.5	98.52	98.46	98.51	4.09
MH-544	MH-5440	67-1	100.2	44.0	57.5	98.52	98.46	98.51	1.69
MH-544	MH-5440	44	102.93	48.9	57.5	98.52	98.46	98.51	4.42
MH-544	MH-5440	66-3	100.62	54.0	57.5	98.52	98.46	98.52	2.10
MH-546	MH-547	177-1	102.31	8.8	99.5	102.14	101.43	101.50	0.81
MH-546	MH-547	177-2	102.61	16.1	99.5	102.14	101.43	101.55	1.06
MH-546	MH-547	177-3	102.61	24.1	99.5	102.14	101.43	101.60	1.01
MH-546	MH-547	178-1	102.71	34.1	99.5	102.14	101.43	101.67	1.04
MH-546	MH-547	178-2	102.71	42.1	99.5	102.14	101.43	101.73	0.98
MH-546	MH-547	178-3	103.04	48.7	99.5	102.14	101.43	101.78	1.26
MH-546	MH-547	178-4	103.04	56.7	99.5	102.14	101.43	101.84	1.20
MH-546	MH-547	179-1	103.04	66.7	99.5	102.14	101.43	101.91	1.13
MH-546	MH-547	179-2	103.4	74.0	99.5	102.14	101.43	101.96	1.44
MH-546	MH-547	179-3	103.4	82.0	99.5	102.14	101.43	102.01	1.39
MH-546	MH-547	179-4	103.4	88.6	99.5	102.14	101.43	102.06	1.34
MH-546	MH-547	179-5	103.4	96.6	99.5	102.14	101.43	102.12	1.28
MH-547	MH-548	175-1	101.33	5.2	60.0	101.43	100.74	100.80	0.53
MH-547	MH-548	175-2	101.33	13.6	60.0	101.43	100.74	100.90	0.43
MH-547	MH-548	175-3	101.64	20.2	60.0	101.43	100.74	100.98	0.66
MH-547	MH-548	175-4	101.64	28.2	60.0	101.43	100.74	101.07	0.57
MH-547	MH-548	176-1	101.82	38.2	60.0	101.43	100.74	101.18	0.64

Table C5B: USF Freeboard Results - 1996 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-547	MH-548	176-2	102.27	45.8	60.0	101.43	100.74	101.27	1.00
MH-547	MH-548	176-3	102.27	53.9	60.0	101.43	100.74	101.36	0.91
MH-548	MH-549	174-2	100.89	0.3	29.5	100.74	100.32	100.32	0.57
MH-548	MH-549	174-3	100.89	8.2	29.5	100.74	100.32	100.44	0.45
MH-548	MH-549	174-4	101.21	14.8	29.5	100.74	100.32	100.53	0.68
MH-548	MH-549	174-5	101.21	22.8	29.5	100.74	100.32	100.65	0.56
MH-549	MH-550	174-1	100.89	2.7	12.5	100.32	99.94	100.02	0.87
MH-550	MH-551	170-6	100.02	1.6	112.0	99.94	98.85	98.87	1.15
MH-550	MH-551	170-5	100.3	6.9	112.0	99.94	98.85	98.92	1.38
MH-550	MH-551	171-8	100.3	16.4	112.0	99.94	98.85	99.01	1.29
MH-550	MH-551	171-7	100.33	21.0	112.0	99.94	98.85	99.06	1.27
MH-550	MH-551	171-6	100.46	29.0	112.0	99.94	98.85	99.13	1.33
MH-550	MH-551	171-5	100.73	35.2	112.0	99.94	98.85	99.19	1.54
MH-550	MH-551	172-10	100.73	44.6	112.0	99.94	98.85	99.28	1.45
MH-550	MH-551	172-9	100.77	49.2	112.0	99.94	98.85	99.33	1.44
MH-550	MH-551	172-8	100.9	57.2	112.0	99.94	98.85	99.41	1.49
MH-550	MH-551	172-7	100.96	61.6	112.0	99.94	98.85	99.45	1.51
MH-550	MH-551	172-6	101.27	69.6	112.0	99.94	98.85	99.53	1.74
MH-550	MH-551	173-10	101.27	77.4	112.0	99.94	98.85	99.60	1.67
MH-550	MH-551	173-9	101.33	85.4	112.0	99.94	98.85	99.68	1.65
MH-550	MH-551	173-8	101.43	91.6	112.0	99.94	98.85	99.74	1.69
MH-550	MH-551	173-7	101.5	96.0	112.0	99.94	98.85	99.78	1.72
MH-550	MH-551	173-6	101.91	104.0	112.0	99.94	98.85	99.86	2.05
MH-551	MH-559	169-8	99.46	10.7	52.5	98.85	96.32	96.84	2.62
MH-551	MH-559	169-7	99.43	18.7	52.5	98.85	96.32	97.22	2.21
MH-551	MH-559	169-6	99.53	23.1	52.5	98.85	96.32	97.43	2.10
MH-551	MH-559	169-5	99.86	31.1	52.5	98.85	96.32	97.82	2.04
MH-551	MH-559	170-8	99.86	40.5	52.5	98.85	96.32	98.27	1.59
MH-551	MH-559	170-7	99.9	45.1	52.5	98.85	96.32	98.49	1.41
MH-552	MH-553	172-1	100.73	1.3	64.5	100.31	99.30	99.32	1.41
MH-552	MH-553	172-2	100.77	4.9	64.5	100.31	99.30	99.38	1.39
MH-552	MH-553	167-4	100.44	7.6	64.5	100.31	99.30	99.42	1.02
MH-552	MH-553	172-3	100.9	13.0	64.5	100.31	99.30	99.51	1.39
MH-552	MH-553	167-3	100.44	15.6	64.5	100.31	99.30	99.55	0.89
MH-552	MH-553	172-4	100.96	17.2	64.5	100.31	99.30	99.57	1.39
MH-552	MH-553	167-2	100.44	22.2	64.5	100.31	99.30	99.65	0.79
MH-552	MH-553	172-5	101.27	25.2	64.5	100.31	99.30	99.70	1.57
MH-552	MH-553	167-1	100.44	30.2	64.5	100.31	99.30	99.77	0.67
MH-552	MH-553	173-1	101.27	33.1	64.5	100.31	99.30	99.82	1.45
MH-552	MH-553	168-4	100.69	40.2	64.5	100.31	99.30	99.93	0.76
MH-552	MH-553	173-2	101.33	41.1	64.5	100.31	99.30	99.94	1.39
MH-552	MH-553	173-3	101.43	47.2	64.5	100.31	99.30	100.04	1.39
MH-552	MH-553	168-3	100.69	48.2	64.5	100.31	99.30	100.06	0.63
MH-552	MH-553	173-4	101.5	51.6	64.5	100.31	99.30	100.11	1.39
MH-552	MH-553	168-2	101.48	54.8	64.5	100.31	99.30	100.16	1.32
MH-552	MH-553	173-5	101.91	59.6	64.5	100.31	99.30	100.23	1.68
MH-552	MH-553	168-1	101.48	62.8	64.5	100.31	99.30	100.28	1.20
MH-553	MH-557	169-1	99.46	16.0	103.5	99.30	98.02	98.21	1.25
MH-553	MH-557	169-2	99.43	25.6	103.5	99.30	98.02	98.33	1.10
MH-553	MH-557	169-3	99.53	30.0	103.5	99.30	98.02	98.39	1.14
MH-553	MH-557	169-4	99.86	38.0	103.5	99.30	98.02	98.49	1.37
MH-553	MH-557	165-4	99.5	38.5	103.5	99.30	98.02	98.49	1.01
MH-553	MH-557	165-3	99.5	46.5	103.5	99.30	98.02	98.59	0.91
MH-553	MH-557	170-1	99.86	47.4	103.5	99.30	98.02	98.61	1.25
MH-553	MH-557	170-2	99.9	52.0	103.5	99.30	98.02	98.66	1.24
MH-553	MH-557	165-2	99.5	53.1	103.5	99.30	98.02	98.68	0.82
MH-553	MH-557	170-3	100.02	59.9	103.5	99.30	98.02	98.76	1.26
MH-553	MH-557	165-1	99.5	61.2	103.5	99.30	98.02	98.78	0.72
MH-553	MH-557	170-4	100.3	66.1	103.5	99.30	98.02	98.84	1.46
MH-553	MH-557	166-5	99.7	71.2	103.5	99.30	98.02	98.90	0.80
MH-553	MH-557	171-1	100.3	75.5	103.5	99.30	98.02	98.96	1.34
MH-553	MH-557	166-4	99.7	79.2	103.5	99.30	98.02	99.00	0.70
MH-553	MH-557	171-2	100.33	80.2	103.5	99.30	98.02	99.01	1.32
MH-553	MH-557	166-3	100.04	85.8	103.5	99.30	98.02	99.08	0.96
MH-553	MH-557	171-3	100.46	88.2	103.5	99.30	98.02	99.11	1.35
MH-553	MH-557	166-2	100.04	93.8	103.5	99.30	98.02	99.18	0.86
MH-553	MH-557	171-4	100.73	94.4	103.5	99.30	98.02	99.19	1.54
MH-553	MH-557	166-1	100.04	101.1	103.5	99.30	98.02	99.27	0.77
MH-554	MH-556	160-4	100.02	2.6	81.5	99.74	98.99	99.01	1.01
MH-554	MH-556	160-3	100.02	10.6	81.5	99.74	98.99	99.09	0.93
MH-554	MH-556	160-2	100.02	17.2	81.5	99.74	98.99	99.15	0.87
MH-554	MH-556	160-1	100.02	25.2	81.5	99.74	98.99	99.22	0.80
MH-554	MH-556	159-5	100.12	35.2	81.5	99.74	98.99	99.31	0.81
MH-554	MH-556	159-4	100.48	42.5	81.5	99.74	98.99	99.38	1.10
MH-554	MH-556	159-3	100.48	50.5	81.5	99.74	98.99	99.45	1.03
MH-554	MH-556	159-2	100.48	57.1	81.5	99.74	98.99	99.51	0.97
MH-554	MH-556	159-1	100.48	65.1	81.5	99.74	98.99	99.59	0.89
MH-554	MH-556	158-5	100.48	75.1	81.5	99.74	98.99	99.68	0.80
MH-554	MH-556	158-4	100.48	78.8	81.5	99.74	98.99	99.71	0.77

Table C5B: USF Freeboard Results - 1996 Event

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-556	MH-557	162-3	99.15	7.8	70.0	98.99	98.02	98.12	1.03
MH-556	MH-557	164-1	99.39	11.9	70.0	98.99	98.02	98.18	1.21
MH-556	MH-557	162-2	99.15	14.4	70.0	98.99	98.02	98.22	0.93
MH-556	MH-557	164-2	99.39	19.9	70.0	98.99	98.02	98.29	1.10
MH-556	MH-557	162-1	99.15	22.4	70.0	98.99	98.02	98.33	0.82
MH-556	MH-557	164-3	99.39	26.5	70.0	98.99	98.02	98.38	1.01
MH-556	MH-557	161-4	99.55	32.5	70.0	98.99	98.02	98.47	1.08
MH-556	MH-557	164-4	99.39	34.5	70.0	98.99	98.02	98.50	0.89
MH-556	MH-557	161-3	99.55	40.5	70.0	98.99	98.02	98.58	0.97
MH-556	MH-557	161-2	99.55	47.1	70.0	98.99	98.02	98.67	0.88
MH-556	MH-557	161-1	99.55	55.1	70.0	98.99	98.02	98.78	0.77
MH-556	MH-557	160-5	99.64	65.1	70.0	98.99	98.02	98.92	0.72
MH-557	MH-558	163-3	98.67	4.5	36.5	98.02	97.74	97.77	0.90
MH-557	MH-558	163-2	98.67	11.1	36.5	98.02	97.74	97.82	0.85
MH-557	MH-558	163-1	98.67	19.1	36.5	98.02	97.74	97.88	0.79
MH-557	MH-558	162-5	98.77	29.1	36.5	98.02	97.74	97.96	0.81
MH-557	MH-558	162-4	99.15	35.1	36.5	98.02	97.74	98.00	1.15
MH-558	MH-559	163-5	98.32	8.9	14.5	97.74	96.32	97.19	1.13
MH-558	MH-559	163-4	98.67	10.4	14.5	97.74	96.32	97.34	1.33
MH-561	MH-537	192-3	103.75	3.1	42.5	103.09	103.01	103.02	0.73
MH-561	MH-537	192-2	103.75	5.2	42.5	103.09	103.01	103.02	0.73
MH-561	MH-537	180-1	103.86	12.6	42.5	103.09	103.01	103.04	0.82
MH-561	MH-537	192-1	103.75	13.2	42.5	103.09	103.01	103.04	0.71
MH-561	MH-537	180-2	103.86	19.9	42.5	103.09	103.01	103.05	0.81
MH-561	MH-537	191-4	103.8	23.2	42.5	103.09	103.01	103.06	0.74
MH-561	MH-537	180-3	103.86	27.9	42.5	103.09	103.01	103.07	0.79
MH-561	MH-537	191-3	103.8	31.2	42.5	103.09	103.01	103.07	0.73
MH-561	MH-537	180-4	103.86	34.5	42.5	103.09	103.01	103.08	0.78
MH-561	MH-537	191-2	103.8	37.7	42.5	103.09	103.01	103.08	0.72
MH-561	MH-563	182-3	102.47	2.6	61.0	103.09	101.29	101.37	1.10
MH-561	MH-563	182-2	102.47	10.6	61.0	103.09	101.29	101.60	0.87
MH-561	MH-563	190-1	103.21	17.4	61.0	103.09	101.29	101.80	1.41
MH-561	MH-563	182-1	102.81	17.9	61.0	103.09	101.29	101.82	0.99
MH-561	MH-563	190-2	103.21	25.4	61.0	103.09	101.29	102.04	1.17
MH-561	MH-563	181-4	103.55	27.9	61.0	103.09	101.29	102.11	1.44
MH-561	MH-563	190-3	103.8	32.0	61.0	103.09	101.29	102.24	1.56
MH-561	MH-563	181-3	103.55	35.9	61.0	103.09	101.29	102.35	1.20
MH-561	MH-563	190-4	103.8	40.0	61.0	103.09	101.29	102.47	1.33
MH-561	MH-563	181-2	103.86	42.5	61.0	103.09	101.29	102.55	1.31
MH-561	MH-563	190-5	103.8	47.3	61.0	103.09	101.29	102.69	1.11
MH-561	MH-563	181-1	103.86	50.5	61.0	103.09	101.29	102.78	1.08
MH-561	MH-563	191-1	103.8	55.7	61.0	103.09	101.29	102.94	0.86
MH-561	MH-563	180-5	103.86	59.1	61.0	103.09	101.29	103.04	0.82
MH-563	MH-564	187-2	102.43	3.4	73.5	101.29	101.00	101.02	1.41
MH-563	MH-564	185-1	102.24	4.5	73.5	101.29	101.00	101.02	1.22
MH-563	MH-564	184-4	102.57	10.2	73.5	101.29	101.00	101.04	1.53
MH-563	MH-564	187-3	102.75	10.9	73.5	101.29	101.00	101.05	1.70
MH-563	MH-564	184-3	102.57	18.2	73.5	101.29	101.00	101.07	1.50
MH-563	MH-564	188-1	102.75	20.8	73.5	101.29	101.00	101.08	1.67
MH-563	MH-564	184-2	102.57	24.8	73.5	101.29	101.00	101.10	1.47
MH-563	MH-564	188-2	102.75	28.8	73.5	101.29	101.00	101.12	1.63
MH-563	MH-564	184-1	102.57	32.8	73.5	101.29	101.00	101.13	1.44
MH-563	MH-564	188-3	102.75	36.2	73.5	101.29	101.00	101.14	1.61
MH-563	MH-564	183-3	102.57	42.8	73.5	101.29	101.00	101.17	1.40
MH-563	MH-564	189-1	102.64	46.2	73.5	101.29	101.00	101.18	1.46
MH-563	MH-564	183-2	102.57	50.8	73.5	101.29	101.00	101.20	1.37
MH-563	MH-564	189-2	102.64	54.4	73.5	101.29	101.00	101.22	1.42
MH-563	MH-564	183-1	102.57	58.6	73.5	101.29	101.00	101.23	1.34
MH-563	MH-564	189-3	102.64	61.6	73.5	101.29	101.00	101.24	1.40
MH-564	MH-8500	186-1	102.24	17.1	48.5	101.00	99.70	100.16	2.08
MH-564	MH-8500	185-5	101.61	19.9	48.5	101.00	99.70	100.23	1.38
MH-564	MH-8500	186-2	102.24	25.1	48.5	101.00	99.70	100.37	1.87
MH-564	MH-8500	185-4	101.61	27.9	48.5	101.00	99.70	100.45	1.16
MH-564	MH-8500	186-3	102.24	32.4	48.5	101.00	99.70	100.57	1.67
MH-564	MH-8500	185-3	101.93	34.5	48.5	101.00	99.70	100.63	1.30
MH-564	MH-8500	187-1	102.43	42.4	48.5	101.00	99.70	100.84	1.59
MH-564	MH-8500	185-2	101.93	42.5	48.5	101.00	99.70	100.84	1.09

Key:

Freeboard to USF less than 0.30 m (yellow)

Freeboard to USF less than 0.00 m (red)

Min	0.32
Max	4.82
Average	1.30

Table C6A: Pipe Data and Hydraulic Simulation Results - 100-Year Chicago 3 Hour Event + 20%

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m³/s)	Peak Pipe Flow (m³/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH_136	MH_302	96.484	96.41	101.19	101.14	2250	53.9	0.1	0.013	1.66	6.59	8.00	1.21	-0.07	01:14	98.66	98.58
MH_302	MH_303	96.41	96.331	101.14	101.08	2250	58.9	0.1	0.013	1.66	6.59	8.78	1.33	-0.08	01:14	98.58	98.48
MH_303	MH_304	96.331	96.176	101.08	100.73	2250	134.3	0.1	0.013	1.67	6.62	8.91	1.35	-0.10	01:14	98.48	98.25
MH_304	MH_306TEE	96.176	96.133	100.73	100.27	2250	42.5	0.1	0.013	1.67	6.62	8.97	1.35	-0.18	01:14	98.25	97.96
MH_306TEE	MH_307	96.133	96.1	100.27	100.35	2250	11.2	0.1	0.013	1.79	7.10	8.97	1.26	-0.42	01:14	97.96	97.70
MH_307	MH_400	96.1	96.067	100.35	100.35	2250	22.7	0.1	0.013	1.71	6.79	6.54	0.96	-0.65	01:14	97.70	97.67
MH_400	OGS_1	96.067	96.037	100.35	100.5	750	4.9	0.2	0.013	1.13	0.50	1.01	2.02	0.85	00:59	97.67	97.63
MH_500	OGS_2	96.056	96.026	100.35	100.428	750	5.0	0.2	0.013	1.13	0.50	1.00	2.02	0.59	01:03	97.40	97.36
MH-313	MH_500	96.099	96.056	99.835	100.35	2250	33.0	0.1	0.013	1.68	6.69	4.45	0.67	-0.69	01:14	97.66	97.40
MH-500	MH-502	102.24	100.94	105.21	104.245	300	92.0	1.3	0.013	1.53	0.11	0.14	1.32	0.76	01:10	103.30	101.32
MH-502	MH-503	100.94	98.961	104.245	102.42	450	119.0	1.6	0.013	2.27	0.36	0.31	0.86	-0.07	01:10	101.32	100.01
MH-5020	MH-502	101.143	100.94	104.27	104.245	300	10.5	0.5	0.013	0.97	0.07	0.00	0.03	-0.13	01:02	101.31	101.32
MH-503	MH-504	98.961	98.683	102.42	101.89	525	73.0	0.3	0.013	1.00	0.22	0.38	1.75	0.52	01:10	100.01	99.47
MH-504	MH-528	98.683	97.315	101.89	101.06	600	108.0	0.9	0.013	2.00	0.57	0.59	1.04	0.19	01:10	99.47	98.50
MH-505	MH-506	103.478	103.351	105.836	106.28	300	13.0	0.6	0.013	1.06	0.07	0.03	0.35	-0.18	01:10	103.60	103.73
MH-505	MH-534	103.478	103.033	105.836	105.406	375	94.5	0.5	0.013	1.06	0.12	0.03	0.22	-0.25	01:10	103.60	103.24
MH-506	MH-508	103.351	103.054	106.28	105.88	300	79.0	0.4	0.013	0.81	0.06	0.06	1.03	0.08	01:03	103.73	103.46
MH-5070	MH-513	103.12	102.394	105.92	105.51	300	82.0	0.5	0.013	0.97	0.07	0.08	1.17	0.78	01:09	104.20	103.79
MH-508	MH-509	103.054	102.837	105.88	105.67	300	41.5	0.5	0.013	0.92	0.06	0.08	1.29	0.11	01:10	103.46	103.16
MH-5080	MH-517	102.898	102.054	105.7	105.28	300	76.5	0.6	0.013	1.01	0.07	0.09	1.21	0.28	01:08	103.48	103.01
MH-509	MH-510	102.837	102.718	105.67	105.6	300	10.5	0.4	0.013	0.87	0.06	0.08	1.37	0.02	01:10	103.16	102.94
MH-510	MH-511	102.718	102.077	105.6	105.25	375	64.0	0.6	0.013	1.18	0.13	0.08	0.65	-0.16	01:10	102.94	102.35
MH-511	MH-526	102.077	98.642	105.25	103	450	95.5	2.8	0.013	3.00	0.48	0.27	0.56	-0.18	01:10	102.35	100.73
MH-513	MH-515	102.394	100.231	105.51	104	300	81.0	2.3	0.013	2.08	0.15	0.17	1.18	1.10	01:08	103.79	101.13
MH-515	MH-518	100.231	99.793	104	103.59	600	44.0	0.3	0.013	1.19	0.34	0.42	1.25	0.30	01:09	101.13	100.93
MH-517	MH-518	102.054	99.793	105.28	103.59	300	82.0	2.3	0.013	2.08	0.15	0.16	1.12	0.66	01:08	103.01	100.93
MH-518	MH-526	99.793	98.642	103.59	103	675	47.0	0.3	0.013	1.29	0.46	0.58	1.25	0.47	01:14	100.93	100.73
MH-519	MH-520	103.476	103.127	105.766	106.01	300	54.5	0.5	0.013	0.97	0.07	0.00	0.00	-0.30	00:00	103.48	103.48
MH-519	MH-523	103.476	103.213	105.766	105.726	300	11.5	0.3	0.013	0.81	0.06	0.00	0.00	-0.30	00:00	103.48	103.32
MH-520	MH-521	103.127	102.808	106.01	105.71	375	57.5	0.5	0.013	1.12	0.12	0.13	1.04	-0.03	01:10	103.48	103.16
MH-521	MH-522	102.808	102.725	105.71	105.64	375	11.5	0.3	0.013	0.94	0.10	0.13	1.24	-0.03	01:10	103.16	102.96
MH-522	MH-525	102.725	100.69	105.64	104.2	375	55.0	2.6	0.013	2.54	0.28	0.19	0.69	-0.14	01:10	102.96	101.53
MH-523	MH-524	103.213	102.148	105.726	104.956	300	55.0	1.8	0.013	1.84	0.13	0.04	0.29	-0.19	01:11	103.32	102.52
MH-524	MH-5240	102.148	101.917	104.956	105.23	375	65.0	0.3	0.013	0.87	0.10	0.12	1.21	0.00	01:10	102.52	102.22
MH-5240	MH-525	101.917	100.69	105.23	104.2	375	63.5	1.6	0.013	1.98	0.22	0.18	0.84	-0.08	01:09	102.22	101.53
MH-52400	MH-538	102.155	100.883	104.956	103.676	300	58.0	1.8	0.013	1.84	0.13	0.02	0.18	-0.21	01:10	102.25	101.17
MH-525	MH-526	100.69	98.642	104.2	103	525	58.5	1.8	0.013	2.67	0.58	0.42	0.73	0.31	01:12	101.53	100.73
MH-526	MH-528	98.642	97.315	103	101.06	675	59.5	1.6	0.013	2.97	1.06	1.29	1.21	1.42	01:10	100.73	98.50
MH-527	MH-528	99.084	97.315	101.18	101.06	300	18.5	0.4	0.013	0.81	0.06	0.02	0.38	-0.15	01:10	99.23	98.50
MH-528	MH-529	97.315	97.009	101.06	100.82	1050	62.5	0.3	0.013	1.58	1.37	1.91	1.40	0.13	01:11	98.50	98.20
MH-529	MH-530	97.009	96.851	100.82	100.58	1200	72.0	0.2	0.013	1.34	1.51	1.90	1.26	-0.01	01:11	98.20	98.04

Table C6A: Pipe Data and Hydraulic Simulation Results - 100-Year Chicago 3 Hour Event + 20%

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-530	MH-531	96.851	96.656	100.58	100.45	1200	76.5	0.2	0.013	1.34	1.51	2.03	1.34	-0.01	01:11	98.04	97.80
MH-531	MH-313	96.656	96.099	100.45	99.835	1200	21.5	0.1	0.013	1.33	1.50	2.03	1.35	-0.06	01:11	97.80	97.66
MH-534	MH-535	103.033	100.603	105.406	103.886	375	78.5	3.0	0.013	2.75	0.30	0.18	0.60	-0.17	01:10	103.24	101.30
MH-535	MH-515	100.603	100.231	103.886	104	450	44.0	0.2	0.013	0.80	0.13	0.18	1.44	0.25	01:10	101.30	101.13
MH-5350	MH-539	101.607	99.624	103.886	102.466	300	52.5	2.4	0.013	2.12	0.15	0.02	0.11	-0.23	01:10	101.68	100.18
MH-536	MH-538	102.515	100.883	105.446	103.676	450	59.0	2.2	0.013	2.63	0.42	0.13	0.32	-0.28	01:10	102.69	101.17
MH-537	MH-536	102.673	102.515	105.126	105.446	450	64.5	0.2	0.013	0.80	0.13	0.13	1.04	-0.10	01:10	103.02	102.69
MH-538	MH-539	100.883	99.624	103.676	102.466	525	58.5	2.1	0.013	2.88	0.62	0.37	0.60	-0.23	01:10	101.17	100.18
MH-539	MH-542	99.624	99.339	102.466	102.396	525	9.5	0.6	0.013	1.54	0.33	0.39	1.17	0.03	01:10	100.18	100.05
MH-540	MH-541	100.072	99.961	101.646	102.506	300	14.5	0.4	0.013	0.81	0.06	0.10	1.66	0.12	01:10	100.49	100.31
MH-541	MH-542	99.961	99.339	102.506	102.396	300	10.0	0.4	0.013	0.81	0.06	0.10	1.66	0.05	01:10	100.31	100.05
MH-542	MH-543	99.339	99.184	102.396	102.186	750	53.0	0.2	0.013	0.98	0.43	0.61	1.41	-0.04	01:10	100.05	99.89
MH-543	MH-544	99.184	97.993	102.186	102.016	825	118.0	0.2	0.013	1.04	0.56	0.69	1.24	-0.12	01:11	99.89	98.73
MH-544	MH-5440	97.993	97.273	102.016	101	825	57.5	1.2	0.013	2.94	1.57	0.74	0.47	-0.09	01:11	98.73	98.61
MH-5440	MH_302	97.273	96.41	101	101.14	825	12.3	1.2	0.013	2.97	1.59	0.74	0.47	0.52	01:11	98.61	98.58
MH-546	MH-547	102.009	101.183	104.84	104.04	375	99.5	0.8	0.013	1.42	0.16	0.04	0.24	-0.25	01:11	102.14	101.46
MH-547	MH-548	101.183	100.223	104.04	103.13	375	60.0	1.6	0.013	1.98	0.22	0.18	0.82	-0.09	01:10	101.46	100.83
MH-548	MH-549	100.223	99.898	103.13	102.8	375	29.5	1.0	0.013	1.59	0.18	0.21	1.17	0.23	01:10	100.83	100.35
MH-549	MH-550	99.898	99.618	102.8	102.64	375	12.5	1.0	0.013	1.59	0.18	0.21	1.17	0.08	01:10	100.35	100.02
MH-550	MH-551	99.618	97.862	102.64	100.93	525	112.0	1.6	0.013	2.47	0.54	0.41	0.76	-0.13	01:10	100.02	99.09
MH-551	MH-559	97.862	94.699	100.93	100.39	525	52.5	1.4	0.013	2.35	0.51	0.59	1.16	0.70	01:10	99.09	96.57
MH-552	MH-553	100.139	99.064	102.99	101.99	300	64.5	1.6	0.013	1.70	0.12	0.08	0.69	-0.12	01:10	100.32	99.32
MH-553	MH-557	99.064	97.315	101.99	100.86	375	103.5	1.4	0.013	1.88	0.21	0.17	0.80	-0.11	01:10	99.32	98.13
MH-554	MH-556	99.668	98.669	102.47	101.7	300	81.5	1.0	0.013	1.33	0.09	0.01	0.14	-0.22	01:10	99.75	99.01
MH-556	MH-557	98.669	97.315	101.7	100.86	525	70.0	1.2	0.013	2.18	0.47	0.35	0.73	-0.19	01:10	99.01	98.13
MH-5560	MH-556	98.809	98.669	101.67	101.7	525	14.5	0.6	0.013	1.48	0.32	0.27	0.84	0.00	01:10	99.34	99.01
MH-557	MH-558	97.315	97.121	100.86	100.39	675	36.5	0.4	0.013	1.57	0.56	0.74	1.32	0.14	01:10	98.13	97.81
MH-558	MH-559	97.121	94.699	100.39	100.39	675	14.5	0.4	0.013	1.57	0.56	0.74	1.32	0.02	01:10	97.81	96.57
MH-559	MH-900	94.699	92.925	100.39	95.41	675	15.5	0.8	0.013	2.10	0.75	1.33	1.77	1.20	01:10	96.57	93.79
MH-561	MH-537	103.003	102.673	105.281	105.126	375	42.5	0.6	0.013	1.23	0.14	0.02	0.15	-0.28	01:10	103.10	103.02
MH-561	MH-563	103.003	100.82	105.281	104.305	300	61.0	2.9	0.013	2.33	0.16	0.00	0.01	-0.20	01:10	103.10	101.38
MH-562	MH-563	101.178	100.82	103.205	104.305	300	29.5	0.5	0.013	0.92	0.06	0.07	1.09	0.12	01:10	101.60	101.38
MH-563	MH-564	100.82	100.643	104.305	103.985	525	73.5	0.2	0.013	0.89	0.19	0.27	1.42	0.03	01:11	101.38	101.05
MH-564	MH-8500	100.643	99.407	103.985	102.733	525	48.5	2.1	0.013	2.84	0.62	0.43	0.70	-0.12	01:10	101.05	99.73
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.00	0.00	-0.75	00:00	101.11	99.73
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	0.43	0.38	-0.43	01:10	99.73	97.66
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	0.43	0.32	-0.46	01:10	97.66	95.80
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	0.43	0.34	-0.45	01:11	95.80	93.79
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.65	0.58	-0.79	01:11	93.79	92.51
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	4.10	0.67	-0.66	01:11	92.51	91.05
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	4.50	0.39	-1.23	01:12	91.05	90.73

Table C6A: Pipe Data and Hydraulic Simulation Results - 100-Year Chicago 3 Hour Event + 20%

U/S MH	D/S MH	U/S Invert (m)	D/S Invert (m)	U/S MH Cover Elevation (m)	D/S MH Cover Elevation (m)	Pipe Dia (mm)	Pipe Length (m)	Pipe Slope (%)	n (-)	Design Velocity (m/s)	Design Flow (m^3/s)	Peak Pipe Flow (m^3/s)	Peak Flow/ Design Flow	Surcharge U/S (m)	Time To peak (hh:mm)	Max U/S HGL (m)	Max D/S HGL (m)
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	4.93	0.61	-1.07	01:13	90.73	90.37
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	5.01	0.44	-1.35	01:13	90.37	90.33
OGS_1	OGS_1-Out	96.037	96.015	100.5	100.35	750	4.9	0.2	0.013	1.14	0.50	1.01	2.01	0.84	00:59	97.63	97.24
OGS_1-Out	MH_3112	96.015	96.01	100.35	100.35	2250	6.2	0.1	0.013	1.63	6.49	6.54	1.01	-1.03	01:14	97.24	97.22
OGS_2	OGS_2-Out	96.026	96.004	100.428	100.35	750	5.1	0.2	0.013	1.12	0.49	1.00	2.03	0.58	01:03	97.36	97.18
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.65	0.58	-0.79	01:11	93.79	92.51
MH-8500	MH-851	99.407	97.366	102.733	101.045	750	79.4	1.1	0.013	2.58	1.14	0.43	0.38	-0.43	01:10	99.73	97.66
MH-850	MH-8500	101.109	99.407	103.845	102.733	750	40.7	1.4	0.013	2.98	1.31	0.00	0.00	-0.75	00:00	101.11	99.73
MH-851	MH-852	97.366	95.501	101.045	98.725	750	79.5	1.4	0.013	2.98	1.32	0.43	0.32	-0.46	01:10	97.66	95.80
MH-852	MH-900	95.501	92.925	98.725	95.41	750	71.5	1.3	0.013	2.87	1.27	0.43	0.34	-0.45	01:11	95.80	93.79
MH-900	MH-901	92.925	91.516	95.41	95.88	1650	69.7	0.3	0.013	2.14	4.57	2.65	0.58	-0.79	01:11	93.79	92.51
MH-901	MH-902	91.516	90.032	95.88	94.29	1650	150.0	0.5	0.013	2.86	6.11	4.10	0.67	-0.66	01:11	92.51	91.05
MH-902	MH-903	90.032	89.546	94.29	93.03	2250	150.0	0.3	0.013	2.87	11.42	4.50	0.39	-1.23	01:12	91.05	90.73
MH-903	MH-904	89.546	89.171	93.03	93.44	2250	150.0	0.2	0.013	2.03	8.07	4.93	0.61	-1.07	01:13	90.73	90.37
MH-904	MH-905TEE	89.171	89.141	93.44	93.54	2550	20.0	0.2	0.013	2.21	11.27	5.01	0.44	-1.35	01:13	90.37	90.33

Table C6B: USF Freeboard Results - 100-Year Chicago 3 Hour Event +20%

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-531	MH-313	76-2	98.43	4.8	21.5	97.80	97.66	97.69	0.74
MH-531	MH-313	76-1	98.43	9.6	21.5	97.80	97.66	97.72	0.71
MH-500	MH-502	146-6	102.89	14.2	92.0	103.30	101.32	101.63	1.26
MH-500	MH-502	146-5	102.89	22.2	92.0	103.30	101.32	101.80	1.09
MH-500	MH-502	146-4	102.89	28.8	92.0	103.30	101.32	101.94	0.95
MH-500	MH-502	146-3	102.89	36.8	92.0	103.30	101.32	102.11	0.78
MH-500	MH-502	146-2	102.89	43.4	92.0	103.30	101.32	102.25	0.64
MH-500	MH-502	146-1	102.89	51.4	92.0	103.30	101.32	102.43	0.46
MH-500	MH-502	145-5	103.05	61.4	92.0	103.30	101.32	102.64	0.41
MH-500	MH-502	145-4	103.05	69.9	92.0	103.30	101.32	102.82	0.23
MH-500	MH-502	145-3	103.55	76.0	92.0	103.30	101.32	102.96	0.59
MH-500	MH-502	145-2	103.55	84.0	92.0	103.30	101.32	103.13	0.42
MH-500	MH-502	145-1	103.55	88.9	92.0	103.30	101.32	103.23	0.32
MH-502	MH-503	148-5	101.09	38.5	119.0	101.32	100.01	100.43	0.66
MH-502	MH-503	148-4	101.09	46.5	119.0	101.32	100.01	100.52	0.57
MH-502	MH-503	148-3	101.09	53.1	119.0	101.32	100.01	100.60	0.49
MH-502	MH-503	148-2	101.09	61.1	119.0	101.32	100.01	100.68	0.41
MH-502	MH-503	148-1	101.44	68.4	119.0	101.32	100.01	100.76	0.68
MH-502	MH-503	147-6	101.65	78.4	119.0	101.32	100.01	100.87	0.78
MH-502	MH-503	147-5	101.65	86.4	119.0	101.32	100.01	100.96	0.69
MH-502	MH-503	147-4	102.03	94.4	119.0	101.32	100.01	101.05	0.98
MH-502	MH-503	147-3	102.03	101.0	119.0	101.32	100.01	101.12	0.91
MH-502	MH-503	147-2	102.66	107.6	119.0	101.32	100.01	101.19	1.47
MH-502	MH-503	147-1	102.66	115.6	119.0	101.32	100.01	101.28	1.38
MH-503	MH-504	150-3	100.3	1.3	73.0	100.01	99.47	99.48	0.82
MH-503	MH-504	156-4	100.04	2.7	73.0	100.01	99.47	99.49	0.55
MH-503	MH-504	150-2	100.3	6.3	73.0	100.01	99.47	99.52	0.78
MH-503	MH-504	156-5	100.04	10.0	73.0	100.01	99.47	99.55	0.49
MH-503	MH-504	150-1	100.3	14.3	73.0	100.01	99.47	99.58	0.72
MH-503	MH-504	157-1	100.3	20.0	73.0	100.01	99.47	99.62	0.68
MH-503	MH-504	149-5	100.7	24.3	73.0	100.01	99.47	99.65	1.05
MH-503	MH-504	157-2	100.3	28.0	73.0	100.01	99.47	99.68	0.62
MH-503	MH-504	149-4	100.7	32.3	73.0	100.01	99.47	99.71	0.99
MH-503	MH-504	157-3	100.3	34.6	73.0	100.01	99.47	99.73	0.57
MH-503	MH-504	149-3	100.7	38.9	73.0	100.01	99.47	99.76	0.94
MH-503	MH-504	157-4	100.3	42.6	73.0	100.01	99.47	99.79	0.51
MH-503	MH-504	149-2	100.7	46.9	73.0	100.01	99.47	99.82	0.88
MH-503	MH-504	157-5	100.3	49.9	73.0	100.01	99.47	99.84	0.46
MH-503	MH-504	149-1	100.7	54.3	73.0	100.01	99.47	99.87	0.83
MH-503	MH-504	158-1	100.48	59.8	73.0	100.01	99.47	99.91	0.57
MH-503	MH-504	158-2	100.48	67.8	73.0	100.01	99.47	99.97	0.51
MH-503	MH-504	158-3	100.48	71.4	73.0	100.01	99.47	100.00	0.48
MH-504	MH-528	154-1	99.24	15.6	108.0	99.47	98.50	98.64	0.60
MH-504	MH-528	153-3	99.92	16.5	108.0	99.47	98.50	98.64	1.28
MH-504	MH-528	154-2	99.24	23.6	108.0	99.47	98.50	98.71	0.53
MH-504	MH-528	153-2	99.92	24.5	108.0	99.47	98.50	98.72	1.20
MH-504	MH-528	154-3	99.24	30.2	108.0	99.47	98.50	98.77	0.47
MH-504	MH-528	153-1	99.92	31.8	108.0	99.47	98.50	98.78	1.14
MH-504	MH-528	154-4	99.24	38.2	108.0	99.47	98.50	98.84	0.40
MH-504	MH-528	152-3	99.92	41.8	108.0	99.47	98.50	98.87	1.05
MH-504	MH-528	155-1	99.28	48.2	108.0	99.47	98.50	98.93	0.35
MH-504	MH-528	152-2	99.92	49.8	108.0	99.47	98.50	98.95	0.97
MH-504	MH-528	155-2	99.28	56.2	108.0	99.47	98.50	99.00	0.28
MH-504	MH-528	152-1	99.92	57.1	108.0	99.47	98.50	99.01	0.91
MH-504	MH-528	155-3	99.59	62.8	108.0	99.47	98.50	99.06	0.53
MH-504	MH-528	151-4	99.96	67.1	108.0	99.47	98.50	99.10	0.86
MH-504	MH-528	155-4	99.59	70.8	108.0	99.47	98.50	99.14	0.45
MH-504	MH-528	151-3	99.96	75.1	108.0	99.47	98.50	99.18	0.78
MH-504	MH-528	155-5	99.59	78.1	108.0	99.47	98.50	99.20	0.39
MH-504	MH-528	151-2	99.96	81.7	108.0	99.47	98.50	99.23	0.73
MH-504	MH-528	156-1	99.73	88.1	108.0	99.47	98.50	99.29	0.44
MH-504	MH-528	151-1	100.04	89.7	108.0	99.47	98.50	99.31	0.73
MH-504	MH-528	156-2	99.73	96.1	108.0	99.47	98.50	99.37	0.36
MH-504	MH-528	150-4	100.3	99.7	108.0	99.47	98.50	99.40	0.90
MH-504	MH-528	156-3	100.04	102.7	108.0	99.47	98.50	99.43	0.61
MH-505	MH-506	92-3	104.3	2.5	13.0	103.60	103.73	103.71	0.59
MH-505	MH-506	92-2	104.3	6.8	13.0	103.60	103.73	103.66	0.64
MH-505	MH-506	92-1	104.3	11.3	13.0	103.60	103.73	103.62	0.68
MH-505	MH-534	99-7	104.61	3.7	94.5	103.60	103.24	103.26	1.35
MH-505	MH-534	95-5	103.94	6.8	94.5	103.60	103.24	103.27	0.67
MH-505	MH-534	99-6	104.67	11.7	94.5	103.60	103.24	103.29	1.38
MH-505	MH-534	94-1	104.13	17.4	94.5	103.60	103.24	103.31	0.82
MH-505	MH-534	99-5	104.86	17.9	94.5	103.60	103.24	103.31	1.55
MH-505	MH-534	94-2	104.13	25.4	94.5	103.60	103.24	103.34	0.79
MH-505	MH-534	100-6	104.86	25.7	94.5	103.60	103.24	103.34	1.52
MH-505	MH-534	94-3	104.13	32.7	94.5	103.60	103.24	103.37	0.76
MH-505	MH-534	100-5	104.78	33.7	94.5	103.60	103.24	103.37	1.41
MH-505	MH-534	100-4	104.97	38.3	94.5	103.60	103.24	103.39	1.58
MH-505	MH-534	94-4	104.13	40.7	94.5	103.60	103.24	103.40	0.73

Table C6B: USF Freeboard Results - 100-Year Chicago 3 Hour Event +20%

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-505	MH-534	101-6	104.97	47.7	94.5	103.60	103.24	103.42	1.55
MH-505	MH-534	94-5	104.13	48.3	94.5	103.60	103.24	103.42	0.71
MH-505	MH-534	101-5	104.86	53.9	94.5	103.60	103.24	103.45	1.41
MH-505	MH-534	93-1	104.3	58.9	94.5	103.60	103.24	103.46	0.84
MH-505	MH-534	101-4	105.08	61.9	94.5	103.60	103.24	103.48	1.60
MH-505	MH-534	93-2	104.3	66.9	94.5	103.60	103.24	103.49	0.81
MH-505	MH-534	102-6	105.11	71.3	94.5	103.60	103.24	103.51	1.60
MH-505	MH-534	93-3	104.3	74.2	94.5	103.60	103.24	103.52	0.78
MH-505	MH-534	102-5	105.11	75.9	94.5	103.60	103.24	103.53	1.58
MH-505	MH-534	93-4	104.3	82.2	94.5	103.60	103.24	103.55	0.75
MH-505	MH-534	102-4	105.11	83.9	94.5	103.60	103.24	103.56	1.55
MH-505	MH-534	93-5	104.3	89.8	94.5	103.60	103.24	103.58	0.72
MH-506	MH-508	89-1	103.74	7.2	79.0	103.73	103.46	103.49	0.25
MH-506	MH-508	90-3	104.04	27.0	79.0	103.73	103.46	103.56	0.48
MH-506	MH-508	90-2	104.04	34.6	79.0	103.73	103.46	103.58	0.46
MH-506	MH-508	90-1	104.04	42.6	79.0	103.73	103.46	103.61	0.43
MH-506	MH-508	91-4	104.23	53.2	79.0	103.73	103.46	103.64	0.59
MH-506	MH-508	91-3	104.23	61.2	79.0	103.73	103.46	103.67	0.56
MH-506	MH-508	91-2	104.23	68.5	79.0	103.73	103.46	103.70	0.53
MH-506	MH-508	91-1	104.23	76.5	79.0	103.73	103.46	103.72	0.51
MH-5070	MH-513	99-2	104.61	0.1	82.0	104.20	103.79	103.79	0.82
MH-5070	MH-513	105-6	104.46	8.2	82.0	104.20	103.79	103.83	0.63
MH-5070	MH-513	99-3	104.67	8.4	82.0	104.20	103.79	103.84	0.83
MH-5070	MH-513	105-5	104.46	12.8	82.0	104.20	103.79	103.86	0.60
MH-5070	MH-513	99-4	104.86	14.3	82.0	104.20	103.79	103.86	1.00
MH-5070	MH-513	105-4	104.46	20.8	82.0	104.20	103.79	103.90	0.56
MH-5070	MH-513	100-1	104.86	22.1	82.0	104.20	103.79	103.90	0.96
MH-5070	MH-513	100-2	104.78	30.1	82.0	104.20	103.79	103.94	0.84
MH-5070	MH-513	104-8	104.6	30.2	82.0	104.20	103.79	103.94	0.66
MH-5070	MH-513	100-3	104.97	34.7	82.0	104.20	103.79	103.97	1.00
MH-5070	MH-513	104-7	104.6	34.8	82.0	104.20	103.79	103.97	0.63
MH-5070	MH-513	104-6	104.6	42.8	82.0	104.20	103.79	104.01	0.59
MH-5070	MH-513	101-1	104.97	44.1	82.0	104.20	103.79	104.01	0.96
MH-5070	MH-513	104-5	104.6	49.0	82.0	104.20	103.79	104.04	0.56
MH-5070	MH-513	101-2	104.86	50.3	82.0	104.20	103.79	104.04	0.82
MH-5070	MH-513	101-3	105.08	58.3	82.0	104.20	103.79	104.08	1.00
MH-5070	MH-513	103-8	104.79	58.4	82.0	104.20	103.79	104.08	0.71
MH-5070	MH-513	103-7	104.79	63.0	82.0	104.20	103.79	104.11	0.68
MH-5070	MH-513	102-1	105.11	67.7	82.0	104.20	103.79	104.13	0.98
MH-5070	MH-513	103-6	104.79	71.0	82.0	104.20	103.79	104.15	0.64
MH-5070	MH-513	102-2	105.11	72.3	82.0	104.20	103.79	104.15	0.96
MH-5070	MH-513	103-5	104.79	77.2	82.0	104.20	103.79	104.18	0.61
MH-5070	MH-513	102-3	105.11	80.3	82.0	104.20	103.79	104.19	0.92
MH-508	MH-509	88-3	103.73	6.6	41.5	103.46	103.16	103.21	0.52
MH-508	MH-509	88-2	103.73	14.2	41.5	103.46	103.16	103.26	0.47
MH-508	MH-509	88-1	103.73	22.2	41.5	103.46	103.16	103.32	0.41
MH-508	MH-509	89-3	103.74	32.8	41.5	103.46	103.16	103.40	0.34
MH-508	MH-509	89-2	103.74	40.4	41.5	103.46	103.16	103.46	0.28
MH-5080	MH-517	105-1	104.46	6.2	76.5	103.48	103.01	103.05	1.41
MH-5080	MH-517	111-6	104.04	7.8	76.5	103.48	103.01	103.06	0.98
MH-5080	MH-517	105-2	104.46	10.7	76.5	103.48	103.01	103.08	1.38
MH-5080	MH-517	111-5	104.35	14.0	76.5	103.48	103.01	103.10	1.25
MH-5080	MH-517	105-3	104.46	18.7	76.5	103.48	103.01	103.13	1.33
MH-5080	MH-517	112-8	104.49	23.4	76.5	103.48	103.01	103.16	1.33
MH-5080	MH-517	112-7	104.49	28.0	76.5	103.48	103.01	103.18	1.31
MH-5080	MH-517	104-1	104.6	28.1	76.5	103.48	103.01	103.18	1.42
MH-5080	MH-517	104-2	104.6	32.7	76.5	103.48	103.01	103.21	1.39
MH-5080	MH-517	112-6	104.49	36.0	76.5	103.48	103.01	103.23	1.26
MH-5080	MH-517	104-3	104.6	40.7	76.5	103.48	103.01	103.26	1.34
MH-5080	MH-517	112-5	104.49	42.2	76.5	103.48	103.01	103.27	1.22
MH-5080	MH-517	104-4	104.6	46.9	76.5	103.48	103.01	103.30	1.30
MH-5080	MH-517	113-8	104.59	51.6	76.5	103.48	103.01	103.33	1.26
MH-5080	MH-517	113-7	104.59	56.2	76.5	103.48	103.01	103.35	1.24
MH-5080	MH-517	103-1	104.79	56.3	76.5	103.48	103.01	103.36	1.43
MH-5080	MH-517	103-2	104.79	60.9	76.5	103.48	103.01	103.38	1.41
MH-5080	MH-517	113-6	104.59	64.2	76.5	103.48	103.01	103.40	1.19
MH-5080	MH-517	103-3	104.79	68.9	76.5	103.48	103.01	103.43	1.36
MH-5080	MH-517	113-5	104.59	70.4	76.5	103.48	103.01	103.44	1.15
MH-5080	MH-517	103-4	104.79	75.1	76.5	103.48	103.01	103.47	1.32
MH-509	MH-510	87-3	103.63	2.0	10.5	103.16	102.94	102.98	0.65
MH-509	MH-510	87-2	103.63	5.6	10.5	103.16	102.94	103.05	0.58
MH-509	MH-510	87-1	103.63	9.4	10.5	103.16	102.94	103.13	0.50
MH-510	MH-511	85-4	103.36	4.3	64.0	102.94	102.35	102.39	0.97
MH-510	MH-511	112-1	104.49	9.4	64.0	102.94	102.35	102.43	2.06
MH-510	MH-511	85-3	103.36	12.3	64.0	102.94	102.35	102.46	0.90
MH-510	MH-511	112-2	104.49	14.0	64.0	102.94	102.35	102.48	2.01
MH-510	MH-511	85-2	103.36	19.5	64.0	102.94	102.35	102.53	0.83
MH-510	MH-511	112-3	104.49	22.0	64.0	102.94	102.35	102.55	1.94
MH-510	MH-511	85-1	103.36	27.5	64.0	102.94	102.35	102.60	0.76

Table C6B: USF Freeboard Results - 100-Year Chicago 3 Hour Event +20%

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-510	MH-511	112-4	104.49	28.2	64.0	102.94	102.35	102.61	1.88
MH-510	MH-511	113-1	104.59	37.6	64.0	102.94	102.35	102.69	1.90
MH-510	MH-511	86-3	103.5	38.1	64.0	102.94	102.35	102.70	0.80
MH-510	MH-511	113-2	104.59	42.2	64.0	102.94	102.35	102.74	1.85
MH-510	MH-511	86-2	103.5	45.8	64.0	102.94	102.35	102.77	0.73
MH-510	MH-511	113-3	104.59	50.2	64.0	102.94	102.35	102.81	1.78
MH-510	MH-511	86-1	103.5	53.8	64.0	102.94	102.35	102.84	0.66
MH-510	MH-511	113-4	104.59	56.4	64.0	102.94	102.35	102.87	1.72
MH-511	MH-526	82-3	101.52	20.9	95.5	102.35	100.73	101.09	0.43
MH-511	MH-526	109-2	102.17	26.4	95.5	102.35	100.73	101.18	0.99
MH-511	MH-526	82-2	101.52	28.9	95.5	102.35	100.73	101.22	0.30
MH-511	MH-526	109-3	102.32	30.8	95.5	102.35	100.73	101.25	1.07
MH-511	MH-526	82-1	101.52	36.5	95.5	102.35	100.73	101.35	0.17
MH-511	MH-526	109-4	102.78	38.8	95.5	102.35	100.73	101.39	1.39
MH-511	MH-526	83-3	101.63	47.1	95.5	102.35	100.73	101.53	0.10
MH-511	MH-526	110-1	102.91	48.2	95.5	102.35	100.73	101.55	1.36
MH-511	MH-526	110-2	103.09	52.8	95.5	102.35	100.73	101.62	1.47
MH-511	MH-526	83-2	102.27	54.7	95.5	102.35	100.73	101.66	0.61
MH-511	MH-526	110-3	103.34	60.8	95.5	102.35	100.73	101.76	1.58
MH-511	MH-526	83-1	102.27	62.7	95.5	102.35	100.73	101.79	0.48
MH-511	MH-526	110-4	103.77	67.0	95.5	102.35	100.73	101.87	1.90
MH-511	MH-526	84-3	102.46	73.4	95.5	102.35	100.73	101.97	0.49
MH-511	MH-526	111-1	103.89	76.4	95.5	102.35	100.73	102.02	1.87
MH-511	MH-526	111-2	103.98	81.0	95.5	102.35	100.73	102.10	1.88
MH-511	MH-526	84-2	103.15	81.0	95.5	102.35	100.73	102.10	1.05
MH-511	MH-526	84-1	103.15	88.9	95.5	102.35	100.73	102.24	0.91
MH-511	MH-526	111-3	104.04	89.1	95.5	102.35	100.73	102.24	1.80
MH-511	MH-526	111-4	104.35	95.3	95.5	102.35	100.73	102.34	2.01
MH-513	MH-515	108-6	102.64	21.6	81.0	103.79	101.13	101.84	0.80
MH-513	MH-515	97-2	102.99	26.5	81.0	103.79	101.13	102.00	0.99
MH-513	MH-515	108-5	102.57	29.6	81.0	103.79	101.13	102.10	0.47
MH-513	MH-515	97-3	103.15	30.9	81.0	103.79	101.13	102.15	1.00
MH-513	MH-515	108-4	102.98	35.8	81.0	103.79	101.13	102.31	0.67
MH-513	MH-515	97-4	103.6	38.9	81.0	103.79	101.13	102.41	1.19
MH-513	MH-515	107-6	103.11	45.2	81.0	103.79	101.13	102.62	0.49
MH-513	MH-515	98-1	103.73	48.3	81.0	103.79	101.13	102.72	1.01
MH-513	MH-515	107-5	103.33	49.8	81.0	103.79	101.13	102.77	0.56
MH-513	MH-515	98-2	103.92	52.9	81.0	103.79	101.13	102.87	1.05
MH-513	MH-515	107-4	103.75	56.2	81.0	103.79	101.13	102.98	0.77
MH-513	MH-515	98-3	104.16	60.9	81.0	103.79	101.13	103.13	1.03
MH-513	MH-515	106-6	103.85	65.6	81.0	103.79	101.13	103.29	0.56
MH-513	MH-515	98-4	104.59	67.1	81.0	103.79	101.13	103.34	1.25
MH-513	MH-515	106-5	104.08	73.6	81.0	103.79	101.13	103.55	0.53
MH-513	MH-515	99-1	104.61	76.5	81.0	103.79	101.13	103.65	0.96
MH-513	MH-515	106-4	104.34	79.8	81.0	103.79	101.13	103.75	0.59
MH-515	MH-518	114-5	101.66	3.6	44.0	101.13	100.93	100.95	0.71
MH-515	MH-518	115-1	101.78	14.3	44.0	101.13	100.93	101.00	0.78
MH-515	MH-518	115-2	102.22	21.9	44.0	101.13	100.93	101.03	1.19
MH-515	MH-518	115-3	102.22	29.9	44.0	101.13	100.93	101.07	1.15
MH-515	MH-518	115-4	102.22	37.1	44.0	101.13	100.93	101.10	1.12
MH-517	MH-518	109-8	102.23	19.4	82.0	103.01	100.93	101.43	0.80
MH-517	MH-518	108-1	102.64	20.7	82.0	103.01	100.93	101.46	1.18
MH-517	MH-518	109-7	102.17	27.4	82.0	103.01	100.93	101.63	0.54
MH-517	MH-518	108-2	102.57	28.7	82.0	103.01	100.93	101.66	0.91
MH-517	MH-518	109-6	102.32	31.8	82.0	103.01	100.93	101.74	0.58
MH-517	MH-518	108-3	102.98	34.9	82.0	103.01	100.93	101.82	1.16
MH-517	MH-518	109-5	102.78	39.8	82.0	103.01	100.93	101.94	0.84
MH-517	MH-518	107-1	103.11	44.3	82.0	103.01	100.93	102.06	1.05
MH-517	MH-518	107-2	103.33	48.9	82.0	103.01	100.93	102.17	1.16
MH-517	MH-518	110-8	102.91	49.2	82.0	103.01	100.93	102.18	0.73
MH-517	MH-518	110-7	103.09	53.8	82.0	103.01	100.93	102.30	0.79
MH-517	MH-518	107-3	103.75	55.3	82.0	103.01	100.93	102.34	1.41
MH-517	MH-518	110-6	103.34	61.8	82.0	103.01	100.93	102.50	0.84
MH-517	MH-518	106-1	103.85	64.7	82.0	103.01	100.93	102.57	1.28
MH-517	MH-518	110-5	103.77	68.0	82.0	103.01	100.93	102.66	1.11
MH-517	MH-518	106-2	104.08	72.7	82.0	103.01	100.93	102.78	1.30
MH-517	MH-518	111-8	103.89	77.4	82.0	103.01	100.93	102.90	0.99
MH-517	MH-518	106-3	104.34	78.9	82.0	103.01	100.93	102.94	1.40
MH-517	MH-518	111-7	103.98	82.0	82.0	103.01	100.93	103.01	0.97
MH-518	MH-526	114-1	101.36	19.7	47.0	100.93	100.73	100.82	0.54
MH-518	MH-526	114-2	101.66	27.3	47.0	100.93	100.73	100.85	0.81
MH-518	MH-526	114-3	101.66	35.3	47.0	100.93	100.73	100.88	0.78
MH-518	MH-526	114-4	101.66	42.5	47.0	100.93	100.73	100.91	0.75
MH-519	MH-520	129-3	104.07	4.0	54.5	103.48	103.48	103.48	0.59
MH-519	MH-520	138-1	104.08	5.4	54.5	103.48	103.48	103.48	0.60
MH-519	MH-520	129-2	104.07	12.0	54.5	103.48	103.48	103.48	0.59
MH-519	MH-520	138-2	104.08	13.0	54.5	103.48	103.48	103.48	0.60
MH-519	MH-520	129-1	104.07	19.6	54.5	103.48	103.48	103.48	0.59
MH-519	MH-520	138-3	104.08	21.0	54.5	103.48	103.48	103.48	0.60

Table C6B: USF Freeboard Results - 100-Year Chicago 3 Hour Event +20%

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-519	MH-520	128-3	104.09	30.2	54.5	103.48	103.48	103.48	0.61
MH-519	MH-520	139-1	104.23	31.6	54.5	103.48	103.48	103.48	0.75
MH-519	MH-520	128-2	104.09	38.2	54.5	103.48	103.48	103.48	0.61
MH-519	MH-520	139-2	104.23	39.2	54.5	103.48	103.48	103.48	0.75
MH-519	MH-520	128-1	104.09	45.8	54.5	103.48	103.48	103.48	0.61
MH-519	MH-520	139-3	104.23	47.2	54.5	103.48	103.48	103.48	0.75
MH-519	MH-523	140-3	104.25	2.3	11.5	103.48	103.32	103.35	0.90
MH-519	MH-523	140-2	104.25	7.0	11.5	103.48	103.32	103.42	0.83
MH-519	MH-523	140-1	104.25	10.5	11.5	103.48	103.32	103.46	0.79
MH-520	MH-521	136-1	103.94	3.7	57.5	103.48	103.16	103.18	0.76
MH-520	MH-521	131-3	103.81	8.8	57.5	103.48	103.16	103.21	0.60
MH-520	MH-521	136-2	103.94	11.4	57.5	103.48	103.16	103.22	0.72
MH-520	MH-521	131-2	103.81	16.8	57.5	103.48	103.16	103.25	0.56
MH-520	MH-521	136-3	103.94	19.4	57.5	103.48	103.16	103.27	0.67
MH-520	MH-521	131-1	103.81	24.5	57.5	103.48	103.16	103.29	0.52
MH-520	MH-521	137-1	103.94	30.0	57.5	103.48	103.16	103.32	0.62
MH-520	MH-521	130-3	103.94	35.1	57.5	103.48	103.16	103.35	0.59
MH-520	MH-521	137-2	103.94	37.6	57.5	103.48	103.16	103.37	0.57
MH-520	MH-521	130-2	103.94	43.1	57.5	103.48	103.16	103.40	0.54
MH-520	MH-521	137-3	103.94	45.6	57.5	103.48	103.16	103.41	0.53
MH-520	MH-521	130-1	103.94	50.7	57.5	103.48	103.16	103.44	0.50
MH-521	MH-522	135-1	103.67	1.0	11.5	103.16	102.96	102.97	0.70
MH-521	MH-522	135-2	103.67	5.3	11.5	103.16	102.96	103.05	0.62
MH-521	MH-522	135-3	103.67	9.5	11.5	103.16	102.96	103.12	0.55
MH-522	MH-525	133-3	102.71	7.1	55.0	102.96	101.53	101.71	1.00
MH-522	MH-525	133-4	103.1	14.4	55.0	102.96	101.53	101.90	1.20
MH-522	MH-525	133-5	103.1	22.4	55.0	102.96	101.53	102.11	0.99
MH-522	MH-525	134-1	103.55	32.9	55.0	102.96	101.53	102.38	1.17
MH-522	MH-525	134-2	103.55	40.6	55.0	102.96	101.53	102.58	0.97
MH-522	MH-525	134-3	103.55	48.6	55.0	102.96	101.53	102.79	0.76
MH-523	MH-524	141-5	103.68	20.5	55.0	103.32	102.52	102.82	0.86
MH-523	MH-524	141-4	103.68	28.5	55.0	103.32	102.52	102.94	0.74
MH-523	MH-524	141-3	104.25	35.7	55.0	103.32	102.52	103.04	1.21
MH-523	MH-524	141-2	104.25	43.7	55.0	103.32	102.52	103.16	1.09
MH-523	MH-524	141-1	104.25	51.3	55.0	103.32	102.52	103.27	0.98
MH-524	MH-5240	126-1	103.57	5.3	65.0	102.52	102.22	102.24	1.33
MH-524	MH-5240	122-4	103.32	5.6	65.0	102.52	102.22	102.24	1.08
MH-524	MH-5240	126-2	103.57	13.3	65.0	102.52	102.22	102.28	1.29
MH-524	MH-5240	122-3	103.32	13.6	65.0	102.52	102.22	102.28	1.04
MH-524	MH-5240	122-2	103.32	20.9	65.0	102.52	102.22	102.31	1.01
MH-524	MH-5240	126-3	103.57	20.9	65.0	102.52	102.22	102.31	1.26
MH-524	MH-5240	122-1	103.32	28.9	65.0	102.52	102.22	102.35	0.97
MH-524	MH-5240	127-1	103.57	31.6	65.0	102.52	102.22	102.36	1.21
MH-524	MH-5240	121-3	103.45	39.5	65.0	102.52	102.22	102.40	1.05
MH-524	MH-5240	127-2	103.57	39.6	65.0	102.52	102.22	102.40	1.17
MH-524	MH-5240	121-2	103.45	47.1	65.0	102.52	102.22	102.44	1.01
MH-524	MH-5240	127-3	103.57	47.2	65.0	102.52	102.22	102.44	1.13
MH-524	MH-5240	121-1	103.45	55.1	65.0	102.52	102.22	102.47	0.98
MH-5240	MH-525	124-1	102.67	16.1	63.5	102.22	101.53	101.70	0.97
MH-5240	MH-525	123-5	102.2	19.8	63.5	102.22	101.53	101.74	0.46
MH-5240	MH-525	124-2	102.67	24.1	63.5	102.22	101.53	101.79	0.88
MH-5240	MH-525	123-4	102.74	27.4	63.5	102.22	101.53	101.83	0.91
MH-5240	MH-525	124-3	102.67	31.7	63.5	102.22	101.53	101.87	0.80
MH-5240	MH-525	123-3	102.74	35.4	63.5	102.22	101.53	101.91	0.83
MH-5240	MH-525	125-1	103.28	42.3	63.5	102.22	101.53	101.99	1.29
MH-5240	MH-525	123-2	103.08	42.6	63.5	102.22	101.53	101.99	1.09
MH-5240	MH-525	125-2	103.28	50.3	63.5	102.22	101.53	102.07	1.21
MH-5240	MH-525	123-1	103.08	50.6	63.5	102.22	101.53	102.08	1.00
MH-5240	MH-525	125-3	103.28	58.0	63.5	102.22	101.53	102.16	1.12
MH-5240	MH-525	122-5	103.32	61.3	63.5	102.22	101.53	102.19	1.13
MH-52400	MH-538	119-1	102.26	15.8	58.0	102.25	101.17	101.47	0.79
MH-52400	MH-538	119-2	102.26	23.8	58.0	102.25	101.17	101.61	0.65
MH-52400	MH-538	119-3	102.65	31.4	58.0	102.25	101.17	101.75	0.90
MH-52400	MH-538	120-1	103.45	42.1	58.0	102.25	101.17	101.95	1.50
MH-52400	MH-538	120-2	103.45	50.1	58.0	102.25	101.17	102.10	1.35
MH-52400	MH-538	120-3	103.45	57.4	58.0	102.25	101.17	102.23	1.22
MH-525	MH-526	132-1	101.26	15.8	58.5	101.53	100.73	100.95	0.31
MH-525	MH-526	132-2	101.26	23.8	58.5	101.53	100.73	101.06	0.20
MH-525	MH-526	132-3	101.65	31.0	58.5	101.53	100.73	101.15	0.50
MH-525	MH-526	132-4	101.65	39.0	58.5	101.53	100.73	101.26	0.39
MH-525	MH-526	133-1	101.85	49.7	58.5	101.53	100.73	101.41	0.44
MH-525	MH-526	133-2	102.71	57.3	58.5	101.53	100.73	101.51	1.20
MH-528	MH-529	5	101.37	6.6	62.5	98.50	98.20	98.23	3.14
MH-528	MH-529	81-1	98.72	9.8	62.5	98.50	98.20	98.25	0.47
MH-528	MH-529	4	101.37	12.7	62.5	98.50	98.20	98.26	3.11
MH-528	MH-529	81-2	98.72	17.8	62.5	98.50	98.20	98.28	0.44
MH-528	MH-529	81-3	98.72	25.0	62.5	98.50	98.20	98.32	0.40
MH-528	MH-529	3	101.37	25.5	62.5	98.50	98.20	98.32	3.05
MH-528	MH-529	2	101.42	31.6	62.5	98.50	98.20	98.35	3.07

Table C6B: USF Freeboard Results - 100-Year Chicago 3 Hour Event +20%

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-528	MH-529	81-4	98.72	33.0	62.5	98.50	98.20	98.36	0.36
MH-528	MH-529	81-5	99.3	40.6	62.5	98.50	98.20	98.39	0.91
MH-528	MH-529	1	101.42	41.7	62.5	98.50	98.20	98.40	3.02
MH-529	MH-530	13	101.13	3.2	72.0	98.20	98.04	98.05	3.08
MH-529	MH-530	79-1	98.62	6.4	72.0	98.20	98.04	98.06	0.56
MH-529	MH-530	12	101.13	9.2	72.0	98.20	98.04	98.06	3.07
MH-529	MH-530	79-2	98.62	14.4	72.0	98.20	98.04	98.07	0.55
MH-529	MH-530	79-3	98.62	21.7	72.0	98.20	98.04	98.09	0.53
MH-529	MH-530	11	101.13	22.0	72.0	98.20	98.04	98.09	3.04
MH-529	MH-530	10	101.13	28.1	72.0	98.20	98.04	98.10	3.03
MH-529	MH-530	79-4	98.62	29.7	72.0	98.20	98.04	98.11	0.51
MH-529	MH-530	80-1	98.72	40.3	72.0	98.20	98.04	98.13	0.59
MH-529	MH-530	9	101.22	40.9	72.0	98.20	98.04	98.13	3.09
MH-529	MH-530	8	101.32	47.0	72.0	98.20	98.04	98.14	3.18
MH-529	MH-530	80-2	98.72	48.3	72.0	98.20	98.04	98.15	0.57
MH-529	MH-530	80-3	98.72	55.6	72.0	98.20	98.04	98.16	0.56
MH-529	MH-530	7	101.37	59.8	72.0	98.20	98.04	98.17	3.20
MH-529	MH-530	80-4	98.72	63.6	72.0	98.20	98.04	98.18	0.54
MH-529	MH-530	6	101.37	65.9	72.0	98.20	98.04	98.19	3.18
MH-529	MH-530	80-5	98.72	70.1	72.0	98.20	98.04	98.19	0.53
MH-530	MH-531	76-3	98.43	3.0	76.5	98.04	97.80	97.81	0.62
MH-530	MH-531	77-1	98.55	5.8	76.5	98.04	97.80	97.81	0.74
MH-530	MH-531	77-2	98.55	13.8	76.5	98.04	97.80	97.84	0.71
MH-530	MH-531	77-3	98.55	21.0	76.5	98.04	97.80	97.86	0.69
MH-530	MH-531	77-4	98.55	29.0	76.5	98.04	97.80	97.89	0.66
MH-530	MH-531	18	101.07	29.6	76.5	98.04	97.80	97.89	3.18
MH-530	MH-531	78-1	98.58	39.6	76.5	98.04	97.80	97.92	0.66
MH-530	MH-531	17	101.11	42.4	76.5	98.04	97.80	97.93	3.18
MH-530	MH-531	78-2	98.58	47.6	76.5	98.04	97.80	97.95	0.63
MH-530	MH-531	16	101.13	48.5	76.5	98.04	97.80	97.95	3.18
MH-530	MH-531	78-3	98.58	54.9	76.5	98.04	97.80	97.97	0.61
MH-530	MH-531	15	101.13	61.3	76.5	98.04	97.80	97.99	3.14
MH-530	MH-531	78-4	98.58	62.9	76.5	98.04	97.80	98.00	0.58
MH-530	MH-531	14	101.13	67.4	76.5	98.04	97.80	98.01	3.12
MH-530	MH-531	78-5	98.58	70.5	76.5	98.04	97.80	98.02	0.56
MH-534	MH-535	97-8	102.99	19.4	78.5	103.24	101.30	101.78	1.21
MH-534	MH-535	96-1	103.02	20.3	78.5	103.24	101.30	101.80	1.22
MH-534	MH-535	97-7	102.99	27.4	78.5	103.24	101.30	101.98	1.01
MH-534	MH-535	96-2	103.02	28.3	78.5	103.24	101.30	102.00	1.02
MH-534	MH-535	97-6	103.15	31.8	78.5	103.24	101.30	102.09	1.06
MH-534	MH-535	96-3	103.42	35.5	78.5	103.24	101.30	102.18	1.24
MH-534	MH-535	97-5	103.6	39.8	78.5	103.24	101.30	102.29	1.31
MH-534	MH-535	96-4	103.42	43.5	78.5	103.24	101.30	102.38	1.04
MH-534	MH-535	98-8	103.73	49.2	78.5	103.24	101.30	102.52	1.21
MH-534	MH-535	98-7	103.92	53.8	78.5	103.24	101.30	102.63	1.29
MH-534	MH-535	95-1	103.47	54.2	78.5	103.24	101.30	102.64	0.83
MH-534	MH-535	98-6	104.16	61.8	78.5	103.24	101.30	102.83	1.33
MH-534	MH-535	95-2	103.47	62.2	78.5	103.24	101.30	102.84	0.63
MH-534	MH-535	98-5	104.59	68.0	78.5	103.24	101.30	102.98	1.61
MH-534	MH-535	95-3	103.94	69.4	78.5	103.24	101.30	103.02	0.92
MH-534	MH-535	95-4	103.94	77.4	78.5	103.24	101.30	103.22	0.72
MH-534	MH-535	99-8	104.61	77.4	78.5	103.24	101.30	103.22	1.39
MH-535	MH-515	115-5	102.22	1.2	44.0	101.30	101.13	101.14	1.08
MH-535	MH-515	116-1	102.3	11.9	44.0	101.30	101.13	101.18	1.12
MH-535	MH-515	116-2	102.3	19.5	44.0	101.30	101.13	101.21	1.09
MH-535	MH-515	116-3	102.3	27.5	44.0	101.30	101.13	101.24	1.06
MH-535	MH-515	117-1	102.4	38.1	44.0	101.30	101.13	101.28	1.12
MH-5350	MH-539	118-3	102.4	16.8	52.5	101.68	100.18	100.66	1.74
MH-5350	MH-539	118-2	102.4	24.8	52.5	101.68	100.18	100.89	1.51
MH-5350	MH-539	118-1	102.4	32.4	52.5	101.68	100.18	101.11	1.29
MH-5350	MH-539	117-3	102.4	43.1	52.5	101.68	100.18	101.41	0.99
MH-5350	MH-539	117-2	102.4	51.1	52.5	101.68	100.18	101.64	0.76
MH-536	MH-538	196-1	102.56	6.1	59.0	102.69	101.17	101.33	1.23
MH-536	MH-538	142-1	103.33	15.7	59.0	102.69	101.17	101.58	1.75
MH-536	MH-538	195-4	103.31	16.1	59.0	102.69	101.17	101.59	1.72
MH-536	MH-538	142-2	103.33	23.7	59.0	102.69	101.17	101.78	1.55
MH-536	MH-538	195-3	103.31	24.1	59.0	102.69	101.17	101.79	1.52
MH-536	MH-538	142-3	103.72	30.3	59.0	102.69	101.17	101.95	1.77
MH-536	MH-538	195-2	103.7	30.7	59.0	102.69	101.17	101.96	1.74
MH-536	MH-538	142-4	103.72	38.3	59.0	102.69	101.17	102.15	1.57
MH-536	MH-538	195-1	103.7	38.7	59.0	102.69	101.17	102.16	1.54
MH-536	MH-538	143-1	103.96	48.3	59.0	102.69	101.17	102.41	1.55
MH-536	MH-538	194-4	103.92	48.7	59.0	102.69	101.17	102.42	1.50
MH-536	MH-538	143-2	103.96	56.3	59.0	102.69	101.17	102.62	1.34
MH-536	MH-538	194-3	103.92	56.7	59.0	102.69	101.17	102.63	1.29
MH-537	MH-536	194-2	103.92	4.4	64.5	103.02	102.69	102.71	1.21
MH-537	MH-536	143-3	103.96	4.7	64.5	103.02	102.69	102.71	1.25
MH-537	MH-536	194-1	103.92	12.4	64.5	103.02	102.69	102.75	1.17
MH-537	MH-536	144-1	103.96	14.7	64.5	103.02	102.69	102.76	1.20

Table C6B: USF Freeboard Results - 100-Year Chicago 3 Hour Event +20%

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-537	MH-536	193-4	103.88	22.4	64.5	103.02	102.69	102.80	1.08
MH-537	MH-536	144-2	103.96	22.7	64.5	103.02	102.69	102.80	1.16
MH-537	MH-536	144-3	103.96	29.3	64.5	103.02	102.69	102.84	1.12
MH-537	MH-536	193-3	103.88	30.4	64.5	103.02	102.69	102.84	1.04
MH-537	MH-536	193-2	103.88	37.0	64.5	103.02	102.69	102.88	1.00
MH-537	MH-536	144-4	103.96	37.3	64.5	103.02	102.69	102.88	1.08
MH-537	MH-536	144-5	103.96	44.6	64.5	103.02	102.69	102.92	1.04
MH-537	MH-536	193-1	103.88	45.0	64.5	103.02	102.69	102.92	0.96
MH-537	MH-536	192-4	103.75	55.0	64.5	103.02	102.69	102.97	0.78
MH-538	MH-539	197-3	101.08	16.5	58.5	101.17	100.18	100.46	0.62
MH-538	MH-539	197-2	101.08	24.5	58.5	101.17	100.18	100.60	0.48
MH-538	MH-539	197-1	101.42	31.8	58.5	101.17	100.18	100.72	0.70
MH-538	MH-539	196-4	102.16	41.8	58.5	101.17	100.18	100.89	1.27
MH-538	MH-539	196-3	102.16	49.8	58.5	101.17	100.18	101.03	1.13
MH-538	MH-539	196-2	102.56	56.4	58.5	101.17	100.18	101.14	1.42
MH-542	MH-543	58	103.46	5.4	53.0	100.05	99.89	99.91	3.55
MH-542	MH-543	62-5	100.72	8.9	53.0	100.05	99.89	99.92	0.80
MH-542	MH-543	62-4	100.72	16.2	53.0	100.05	99.89	99.94	0.78
MH-542	MH-543	59	103.46	18.2	53.0	100.05	99.89	99.95	3.51
MH-542	MH-543	62-3	100.72	24.2	53.0	100.05	99.89	99.96	0.76
MH-542	MH-543	60	103.42	24.3	53.0	100.05	99.89	99.97	3.45
MH-542	MH-543	62-2	100.72	30.8	53.0	100.05	99.89	99.98	0.74
MH-542	MH-543	61	103.33	37.1	53.0	100.05	99.89	100.00	3.33
MH-542	MH-543	62-1	100.72	38.8	53.0	100.05	99.89	100.01	0.71
MH-543	MH-544	66-2	100.62	3.8	118.0	99.89	98.73	98.77	1.85
MH-543	MH-544	45	103.16	4.0	118.0	99.89	98.73	98.77	4.39
MH-543	MH-544	46	103.46	10.1	118.0	99.89	98.73	98.83	4.63
MH-543	MH-544	66-1	100.62	11.8	118.0	99.89	98.73	98.85	1.77
MH-543	MH-544	65-4	100.72	21.8	118.0	99.89	98.73	98.95	1.77
MH-543	MH-544	47	103.51	22.9	118.0	99.89	98.73	98.96	4.55
MH-543	MH-544	48	103.51	29.0	118.0	99.89	98.73	99.02	4.49
MH-543	MH-544	65-3	100.72	29.8	118.0	99.89	98.73	99.03	1.69
MH-543	MH-544	65-2	100.72	36.4	118.0	99.89	98.73	99.09	1.63
MH-543	MH-544	49	103.51	41.8	118.0	99.89	98.73	99.14	4.37
MH-543	MH-544	65-1	100.72	44.4	118.0	99.89	98.73	99.17	1.55
MH-543	MH-544	50	103.51	47.9	118.0	99.89	98.73	99.20	4.31
MH-543	MH-544	64-4	100.86	54.4	118.0	99.89	98.73	99.27	1.59
MH-543	MH-544	51	103.51	60.8	118.0	99.89	98.73	99.33	4.18
MH-543	MH-544	64-3	100.86	62.4	118.0	99.89	98.73	99.35	1.51
MH-543	MH-544	52	103.51	66.9	118.0	99.89	98.73	99.39	4.12
MH-543	MH-544	64-2	100.86	69.0	118.0	99.89	98.73	99.41	1.45
MH-543	MH-544	64-1	100.86	77.0	118.0	99.89	98.73	99.49	1.37
MH-543	MH-544	53	103.57	79.7	118.0	99.89	98.73	99.52	4.05
MH-543	MH-544	54	103.61	85.8	118.0	99.89	98.73	99.58	4.03
MH-543	MH-544	63-5	100.86	87.0	118.0	99.89	98.73	99.59	1.27
MH-543	MH-544	63-4	100.86	94.3	118.0	99.89	98.73	99.66	1.20
MH-543	MH-544	55	103.59	98.6	118.0	99.89	98.73	99.70	3.89
MH-543	MH-544	63-3	100.86	102.3	118.0	99.89	98.73	99.74	1.12
MH-543	MH-544	56	103.49	104.7	118.0	99.89	98.73	99.76	3.73
MH-543	MH-544	63-2	100.86	108.9	118.0	99.89	98.73	99.80	1.06
MH-543	MH-544	63-1	100.86	116.9	118.0	99.89	98.73	99.88	0.98
MH-543	MH-544	57	103.46	117.5	118.0	99.89	98.73	99.89	3.57
MH-544	MH-5440	68-3	99.4	3.4	57.5	98.73	98.61	98.62	0.78
MH-544	MH-5440	68-2	99.4	10.7	57.5	98.73	98.61	98.64	0.76
MH-544	MH-5440	68-1	99.4	18.7	57.5	98.73	98.61	98.65	0.75
MH-544	MH-5440	67-3	99.49	28.7	57.5	98.73	98.61	98.67	0.82
MH-544	MH-5440	42	102.27	30.0	57.5	98.73	98.61	98.68	3.59
MH-544	MH-5440	67-2	100.2	36.0	57.5	98.73	98.61	98.69	1.51
MH-544	MH-5440	43	102.6	42.8	57.5	98.73	98.61	98.70	3.90
MH-544	MH-5440	67-1	100.2	44.0	57.5	98.73	98.61	98.70	1.50
MH-544	MH-5440	44	102.93	48.9	57.5	98.73	98.61	98.72	4.21
MH-544	MH-5440	66-3	100.62	54.0	57.5	98.73	98.61	98.73	1.89
MH-546	MH-547	177-1	102.31	8.8	99.5	102.14	101.46	101.52	0.79
MH-546	MH-547	177-2	102.61	16.1	99.5	102.14	101.46	101.57	1.04
MH-546	MH-547	177-3	102.61	24.1	99.5	102.14	101.46	101.63	0.98
MH-546	MH-547	178-1	102.71	34.1	99.5	102.14	101.46	101.69	1.02
MH-546	MH-547	178-2	102.71	42.1	99.5	102.14	101.46	101.75	0.96
MH-546	MH-547	178-3	103.04	48.7	99.5	102.14	101.46	101.79	1.25
MH-546	MH-547	178-4	103.04	56.7	99.5	102.14	101.46	101.85	1.19
MH-546	MH-547	179-1	103.04	66.7	99.5	102.14	101.46	101.92	1.12
MH-546	MH-547	179-2	103.4	74.0	99.5	102.14	101.46	101.97	1.43
MH-546	MH-547	179-3	103.4	82.0	99.5	102.14	101.46	102.02	1.38
MH-546	MH-547	179-4	103.4	88.6	99.5	102.14	101.46	102.06	1.34
MH-546	MH-547	179-5	103.4	96.6	99.5	102.14	101.46	102.12	1.28
MH-547	MH-548	175-1	101.33	5.2	60.0	101.46	100.83	100.89	0.44
MH-547	MH-548	175-2	101.33	13.6	60.0	101.46	100.83	100.98	0.35
MH-547	MH-548	175-3	101.64	20.2	60.0	101.46	100.83	101.05	0.59
MH-547	MH-548	175-4	101.64	28.2	60.0	101.46	100.83	101.13	0.51
MH-547	MH-548	176-1	101.82	38.2	60.0	101.46	100.83	101.23	0.59

Table C6B: USF Freeboard Results - 100-Year Chicago 3 Hour Event +20%

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-547	MH-548	176-2	102.27	45.8	60.0	101.46	100.83	101.31	0.96
MH-547	MH-548	176-3	102.27	53.9	60.0	101.46	100.83	101.40	0.87
MH-548	MH-549	174-2	100.89	0.3	29.5	100.83	100.35	100.35	0.54
MH-548	MH-549	174-3	100.89	8.2	29.5	100.83	100.35	100.48	0.41
MH-548	MH-549	174-4	101.21	14.8	29.5	100.83	100.35	100.59	0.62
MH-548	MH-549	174-5	101.21	22.8	29.5	100.83	100.35	100.72	0.49
MH-549	MH-550	174-1	100.89	2.7	12.5	100.35	100.02	100.09	0.80
MH-550	MH-551	170-6	100.02	1.6	112.0	100.02	99.09	99.11	0.91
MH-550	MH-551	170-5	100.3	6.9	112.0	100.02	99.09	99.15	1.15
MH-550	MH-551	171-8	100.3	16.4	112.0	100.02	99.09	99.23	1.07
MH-550	MH-551	171-7	100.33	21.0	112.0	100.02	99.09	99.27	1.06
MH-550	MH-551	171-6	100.46	29.0	112.0	100.02	99.09	99.33	1.13
MH-550	MH-551	171-5	100.73	35.2	112.0	100.02	99.09	99.38	1.35
MH-550	MH-551	172-10	100.73	44.6	112.0	100.02	99.09	99.46	1.27
MH-550	MH-551	172-9	100.77	49.2	112.0	100.02	99.09	99.50	1.27
MH-550	MH-551	172-8	100.9	57.2	112.0	100.02	99.09	99.56	1.34
MH-550	MH-551	172-7	100.96	61.6	112.0	100.02	99.09	99.60	1.36
MH-550	MH-551	172-6	101.27	69.6	112.0	100.02	99.09	99.67	1.60
MH-550	MH-551	173-10	101.27	77.4	112.0	100.02	99.09	99.73	1.54
MH-550	MH-551	173-9	101.33	85.4	112.0	100.02	99.09	99.80	1.53
MH-550	MH-551	173-8	101.43	91.6	112.0	100.02	99.09	99.85	1.58
MH-550	MH-551	173-7	101.5	96.0	112.0	100.02	99.09	99.89	1.61
MH-550	MH-551	173-6	101.91	104.0	112.0	100.02	99.09	99.95	1.96
MH-551	MH-559	169-8	99.46	10.7	52.5	99.09	96.57	97.08	2.38
MH-551	MH-559	169-7	99.43	18.7	52.5	99.09	96.57	97.47	1.96
MH-551	MH-559	169-6	99.53	23.1	52.5	99.09	96.57	97.68	1.85
MH-551	MH-559	169-5	99.86	31.1	52.5	99.09	96.57	98.06	1.80
MH-551	MH-559	170-8	99.86	40.5	52.5	99.09	96.57	98.52	1.34
MH-551	MH-559	170-7	99.9	45.1	52.5	99.09	96.57	98.74	1.16
MH-552	MH-553	172-1	100.73	1.3	64.5	100.32	99.32	99.34	1.39
MH-552	MH-553	172-2	100.77	4.9	64.5	100.32	99.32	99.40	1.37
MH-552	MH-553	167-4	100.44	7.6	64.5	100.32	99.32	99.44	1.00
MH-552	MH-553	172-3	100.9	13.0	64.5	100.32	99.32	99.52	1.38
MH-552	MH-553	167-3	100.44	15.6	64.5	100.32	99.32	99.56	0.88
MH-552	MH-553	172-4	100.96	17.2	64.5	100.32	99.32	99.59	1.37
MH-552	MH-553	167-2	100.44	22.2	64.5	100.32	99.32	99.67	0.77
MH-552	MH-553	172-5	101.27	25.2	64.5	100.32	99.32	99.71	1.56
MH-552	MH-553	167-1	100.44	30.2	64.5	100.32	99.32	99.79	0.65
MH-552	MH-553	173-1	101.27	33.1	64.5	100.32	99.32	99.83	1.44
MH-552	MH-553	168-4	100.69	40.2	64.5	100.32	99.32	99.94	0.75
MH-552	MH-553	173-2	101.33	41.1	64.5	100.32	99.32	99.96	1.37
MH-552	MH-553	173-3	101.43	47.2	64.5	100.32	99.32	100.05	1.38
MH-552	MH-553	168-3	100.69	48.2	64.5	100.32	99.32	100.07	0.62
MH-552	MH-553	173-4	101.5	51.6	64.5	100.32	99.32	100.12	1.38
MH-552	MH-553	168-2	101.48	54.8	64.5	100.32	99.32	100.17	1.31
MH-552	MH-553	173-5	101.91	59.6	64.5	100.32	99.32	100.24	1.67
MH-552	MH-553	168-1	101.48	62.8	64.5	100.32	99.32	100.29	1.19
MH-553	MH-557	169-1	99.46	16.0	103.5	99.32	98.13	98.31	1.15
MH-553	MH-557	169-2	99.43	25.6	103.5	99.32	98.13	98.42	1.01
MH-553	MH-557	169-3	99.53	30.0	103.5	99.32	98.13	98.47	1.06
MH-553	MH-557	169-4	99.86	38.0	103.5	99.32	98.13	98.57	1.29
MH-553	MH-557	165-4	99.5	38.5	103.5	99.32	98.13	98.57	0.93
MH-553	MH-557	165-3	99.5	46.5	103.5	99.32	98.13	98.66	0.84
MH-553	MH-557	170-1	99.86	47.4	103.5	99.32	98.13	98.67	1.19
MH-553	MH-557	170-2	99.9	52.0	103.5	99.32	98.13	98.73	1.17
MH-553	MH-557	165-2	99.5	53.1	103.5	99.32	98.13	98.74	0.76
MH-553	MH-557	170-3	100.02	59.9	103.5	99.32	98.13	98.82	1.20
MH-553	MH-557	165-1	99.5	61.2	103.5	99.32	98.13	98.83	0.67
MH-553	MH-557	170-4	100.3	66.1	103.5	99.32	98.13	98.89	1.41
MH-553	MH-557	166-5	99.7	71.2	103.5	99.32	98.13	98.95	0.75
MH-553	MH-557	171-1	100.3	75.5	103.5	99.32	98.13	99.00	1.30
MH-553	MH-557	166-4	99.7	79.2	103.5	99.32	98.13	99.04	0.66
MH-553	MH-557	171-2	100.33	80.2	103.5	99.32	98.13	99.05	1.28
MH-553	MH-557	166-3	100.04	85.8	103.5	99.32	98.13	99.12	0.92
MH-553	MH-557	171-3	100.46	88.2	103.5	99.32	98.13	99.15	1.31
MH-553	MH-557	166-2	100.04	93.8	103.5	99.32	98.13	99.21	0.83
MH-553	MH-557	171-4	100.73	94.4	103.5	99.32	98.13	99.22	1.51
MH-553	MH-557	166-1	100.04	101.1	103.5	99.32	98.13	99.30	0.74
MH-554	MH-556	160-4	100.02	2.6	81.5	99.75	99.01	99.03	0.99
MH-554	MH-556	160-3	100.02	10.6	81.5	99.75	99.01	99.11	0.91
MH-554	MH-556	160-2	100.02	17.2	81.5	99.75	99.01	99.16	0.86
MH-554	MH-556	160-1	100.02	25.2	81.5	99.75	99.01	99.24	0.78
MH-554	MH-556	159-5	100.12	35.2	81.5	99.75	99.01	99.33	0.79
MH-554	MH-556	159-4	100.48	42.5	81.5	99.75	99.01	99.39	1.09
MH-554	MH-556	159-3	100.48	50.5	81.5	99.75	99.01	99.47	1.01
MH-554	MH-556	159-2	100.48	57.1	81.5	99.75	99.01	99.53	0.95
MH-554	MH-556	159-1	100.48	65.1	81.5	99.75	99.01	99.60	0.88
MH-554	MH-556	158-5	100.48	75.1	81.5	99.75	99.01	99.69	0.79
MH-554	MH-556	158-4	100.48	78.8	81.5	99.75	99.01	99.72	0.76

Table C6B: USF Freeboard Results - 100-Year Chicago 3 Hour Event +20%

US MH	DS MH	Lot #	USF (m)	Dist from DS MH (m)	Pipe Length (m)	US MH HGL (m)	DS MH HGL (m)	Interpolated HGL (m)	Freeboard (m)
MH-556	MH-557	162-3	99.15	7.8	70.0	99.01	98.13	98.22	0.93
MH-556	MH-557	164-1	99.39	11.9	70.0	99.01	98.13	98.28	1.11
MH-556	MH-557	162-2	99.15	14.4	70.0	99.01	98.13	98.31	0.84
MH-556	MH-557	164-2	99.39	19.9	70.0	99.01	98.13	98.38	1.01
MH-556	MH-557	162-1	99.15	22.4	70.0	99.01	98.13	98.41	0.74
MH-556	MH-557	164-3	99.39	26.5	70.0	99.01	98.13	98.46	0.93
MH-556	MH-557	161-4	99.55	32.5	70.0	99.01	98.13	98.54	1.01
MH-556	MH-557	164-4	99.39	34.5	70.0	99.01	98.13	98.56	0.83
MH-556	MH-557	161-3	99.55	40.5	70.0	99.01	98.13	98.64	0.91
MH-556	MH-557	161-2	99.55	47.1	70.0	99.01	98.13	98.72	0.83
MH-556	MH-557	161-1	99.55	55.1	70.0	99.01	98.13	98.82	0.73
MH-556	MH-557	160-5	99.64	65.1	70.0	99.01	98.13	98.95	0.69
MH-557	MH-558	163-3	98.67	4.5	36.5	98.13	97.81	97.85	0.82
MH-557	MH-558	163-2	98.67	11.1	36.5	98.13	97.81	97.91	0.76
MH-557	MH-558	163-1	98.67	19.1	36.5	98.13	97.81	97.98	0.69
MH-557	MH-558	162-5	98.77	29.1	36.5	98.13	97.81	98.06	0.71
MH-557	MH-558	162-4	99.15	35.1	36.5	98.13	97.81	98.11	1.04
MH-558	MH-559	163-5	98.32	8.9	14.5	97.81	96.57	97.33	0.99
MH-558	MH-559	163-4	98.67	10.4	14.5	97.81	96.57	97.46	1.21
MH-561	MH-537	192-3	103.75	3.1	42.5	103.10	103.02	103.03	0.72
MH-561	MH-537	192-2	103.75	5.2	42.5	103.10	103.02	103.03	0.72
MH-561	MH-537	180-1	103.86	12.6	42.5	103.10	103.02	103.05	0.81
MH-561	MH-537	192-1	103.75	13.2	42.5	103.10	103.02	103.05	0.70
MH-561	MH-537	180-2	103.86	19.9	42.5	103.10	103.02	103.06	0.80
MH-561	MH-537	191-4	103.8	23.2	42.5	103.10	103.02	103.07	0.73
MH-561	MH-537	180-3	103.86	27.9	42.5	103.10	103.02	103.08	0.78
MH-561	MH-537	191-3	103.8	31.2	42.5	103.10	103.02	103.08	0.72
MH-561	MH-537	180-4	103.86	34.5	42.5	103.10	103.02	103.09	0.77
MH-561	MH-537	191-2	103.8	37.7	42.5	103.10	103.02	103.09	0.71
MH-561	MH-563	182-3	102.47	2.6	61.0	103.10	101.38	101.45	1.02
MH-561	MH-563	182-2	102.47	10.6	61.0	103.10	101.38	101.68	0.79
MH-561	MH-563	190-1	103.21	17.4	61.0	103.10	101.38	101.87	1.34
MH-561	MH-563	182-1	102.81	17.9	61.0	103.10	101.38	101.89	0.92
MH-561	MH-563	190-2	103.21	25.4	61.0	103.10	101.38	102.10	1.11
MH-561	MH-563	181-4	103.55	27.9	61.0	103.10	101.38	102.17	1.38
MH-561	MH-563	190-3	103.8	32.0	61.0	103.10	101.38	102.28	1.52
MH-561	MH-563	181-3	103.55	35.9	61.0	103.10	101.38	102.39	1.16
MH-561	MH-563	190-4	103.8	40.0	61.0	103.10	101.38	102.51	1.29
MH-561	MH-563	181-2	103.86	42.5	61.0	103.10	101.38	102.58	1.28
MH-561	MH-563	190-5	103.8	47.3	61.0	103.10	101.38	102.72	1.08
MH-561	MH-563	181-1	103.86	50.5	61.0	103.10	101.38	102.81	1.05
MH-561	MH-563	191-1	103.8	55.7	61.0	103.10	101.38	102.95	0.85
MH-561	MH-563	180-5	103.86	59.1	61.0	103.10	101.38	103.05	0.81
MH-563	MH-564	187-2	102.43	3.4	73.5	101.38	101.05	101.07	1.36
MH-563	MH-564	185-1	102.24	4.5	73.5	101.38	101.05	101.07	1.17
MH-563	MH-564	184-4	102.57	10.2	73.5	101.38	101.05	101.10	1.47
MH-563	MH-564	187-3	102.75	10.9	73.5	101.38	101.05	101.10	1.65
MH-563	MH-564	184-3	102.57	18.2	73.5	101.38	101.05	101.13	1.44
MH-563	MH-564	188-1	102.75	20.8	73.5	101.38	101.05	101.15	1.60
MH-563	MH-564	184-2	102.57	24.8	73.5	101.38	101.05	101.16	1.41
MH-563	MH-564	188-2	102.75	28.8	73.5	101.38	101.05	101.18	1.57
MH-563	MH-564	184-1	102.57	32.8	73.5	101.38	101.05	101.20	1.37
MH-563	MH-564	188-3	102.75	36.2	73.5	101.38	101.05	101.21	1.54
MH-563	MH-564	183-3	102.57	42.8	73.5	101.38	101.05	101.24	1.33
MH-563	MH-564	189-1	102.64	46.2	73.5	101.38	101.05	101.26	1.38
MH-563	MH-564	183-2	102.57	50.8	73.5	101.38	101.05	101.28	1.29
MH-563	MH-564	189-2	102.64	54.4	73.5	101.38	101.05	101.30	1.34
MH-563	MH-564	183-1	102.57	58.6	73.5	101.38	101.05	101.31	1.26
MH-563	MH-564	189-3	102.64	61.6	73.5	101.38	101.05	101.33	1.31
MH-564	MH-8500	186-1	102.24	17.1	48.5	101.05	99.73	100.19	2.05
MH-564	MH-8500	185-5	101.61	19.9	48.5	101.05	99.73	100.27	1.34
MH-564	MH-8500	186-2	102.24	25.1	48.5	101.05	99.73	100.41	1.83
MH-564	MH-8500	185-4	101.61	27.9	48.5	101.05	99.73	100.49	1.12
MH-564	MH-8500	186-3	102.24	32.4	48.5	101.05	99.73	100.61	1.63
MH-564	MH-8500	185-3	101.93	34.5	48.5	101.05	99.73	100.67	1.26
MH-564	MH-8500	187-1	102.43	42.4	48.5	101.05	99.73	100.89	1.54
MH-564	MH-8500	185-2	101.93	42.5	48.5	101.05	99.73	100.89	1.04

Min	0.10
Max	4.63
Average	1.15

Key:

- (Yellow) Freeboard to USF less than 0.30 m
- (Red) Freeboard to USF less than 0.00 m

APPENDIX

D

Tables and Calculation Sheets

JFSA Water Resources and Environmental Consultants

Table D-1: Approach Flows and Captured Flows for the 100-Year Chicago Storm

Catch Basin ID	Type	Total Approach Flow (m³/s)	Total Capture (m³/s)	Max Ponding Depth (cm)
CB-1	CB Slope	0.097	0.035	6
CB-10	CB Slope	0.042	0.033	6
CB-100	CB Slope	0.014	0.012	3
CB-101	CB Slope	0.108	0.047	7
CB-102	CB Slope	0.105	0.040	6
CB-103	CB Slope	0.215	0.067	9
CB-104	CB Slope	0.021	0.017	4
CB-105	CB Slope + Rear Yard	0.173	0.022	8
CB-11	CB Slope	0.082	0.082	20
CB-12	Low Point	0.113	0.044	21
CB_123	Low Point	0.030	0.021	14
CB_124	Low Point	0.184	0.029	26
CB_125	Low Point	0.184	0.033	26
CB_129	CB Slope	0.132	0.030	9
CB-13	Low Point	0.113	0.024	21
CB_130	CB Slope	0.132	0.030	9
CB-14	Low Point	0.098	0.024	15
CB-15	Low Point	0.098	0.062	15
CB-16	Low Point	0.135	0.063	19
CB-17	Low Point	0.135	0.063	19
CB-18	Low Point	0.139	0.065	26
CB-19	Low Point	0.139	0.025	26
CB-2	CB Slope	0.097	0.035	6
CB-20	CB Slope + Rear Yard	0.198	0.057	7
CB-21	CB Slope	0.051	0.025	5
CB-22	CB Slope	0.027	0.025	5
CB-23	Low Point	0.063	0.063	9
CB-24	CB Slope	0.019	0.017	4
CB-25	CB Slope	0.026	0.024	4
CB-26	Low Point	0.066	0.066	0
CB-27	Low Point	0.066	0.066	0
CB-28	Low Point	0.050	0.019	21
CB-29	Low Point	0.050	0.019	21
CB-3	CB Slope + Rear Yard	0.118	0.041	7
CB-30	CB Slope	0.083	0.036	6
CB-31	CB Slope + Rear Yard	0.229	0.060	6
CB-32	CB Slope	0.077	0.034	6
CB-33	CB Slope + Rear Yard	0.153	0.027	7
CB-34	CB Slope	0.092	0.043	7
CB-35	CB Slope	0.087	0.044	7
CB-36	CB Slope	0.081	0.037	6
CB-37	CB Slope	0.101	0.047	7
CB-38	Low Point	0.352	0.091	34
CB-39	Low Point	0.352	0.091	34
CB-4	CB Slope + Rear Yard	0.258	0.061	10
CB-40	Low Point	0.071	0.025	26
CB-41	Low Point	0.071	0.019	26
CB-42	CB Slope + Rear Yard	0.077	0.023	4
CB-43	CB Slope	0.061	0.042	6
CB-44	CB Slope + Rear Yard	0.120	0.030	6
CB-45	Low Point	0.116	0.029	26
CB-46	Low Point	0.116	0.029	26
CB-47	CB Slope	0.037	0.029	5
CB-48	CB Slope	0.063	0.030	5
CB-49	Low Point	0.138	0.045	26
CB-5	Low Point	0.234	0.032	19
CB-50	Low Point	0.138	0.065	26

Table D-1: Approach Flows and Captured Flows for the 100-Year Chicago Storm

Catch Basin ID	Type	Total Approach Flow (m^3/s)	Total Capture (m^3/s)	Max Ponding Depth (cm)
CB-51	Low Point	0.113	0.045	24
CB-52	Low Point	0.113	0.045	24
CB-53	CB Slope	0.079	0.030	5
CB-54	CB Slope	0.079	0.030	5
CB-55	CB Slope	0.009	0.009	3
CB-56	CB Slope	0.039	0.031	5
CB-57	CB Slope	0.031	0.027	5
CB-58	CB Slope	0.029	0.024	4
CB-59	CB Slope	0.050	0.036	6
CB-6	Low Point	0.234	0.032	19
CB-60	CB Slope	0.065	0.029	5
CB-61	Low Point	0.198	0.046	29
CB-62	Low Point	0.198	0.065	29
CB-63	CB Slope	0.065	0.035	6
CB-64	CB Slope + Rear Yard	0.229	0.060	6
CB-65	CB Slope	0.107	0.035	6
CB-66	CB Slope	0.088	0.035	6
CB-67	CB Slope + Rear Yard	0.244	0.040	8
CB-68	Low Point	0.154	0.019	28
CB-7	CB Slope	0.015	0.010	2
CB-70	CB Slope	0.081	0.030	5
CB-71	CB Slope	0.081	0.030	5
CB-72	Low Point	0.151	0.065	27
CB-73	Low Point	0.151	0.045	27
CB-74	Low Point	0.161	0.019	28
CB-75	Low Point	0.161	0.025	28
CB-76	CB Slope	0.094	0.037	6
CB-77	CB Slope + Rear Yard	0.105	0.023	5
CB-78	CB Slope	0.043	0.027	5
CB-79	CB Slope	0.043	0.027	5
CB-8	CB Slope	0.015	0.010	2
CB-80	CB Slope	0.046	0.028	5
CB-81	CB Slope	0.046	0.028	5
CB-82	Low Point	0.037	0.019	17
CB-83	Low Point	0.037	0.019	17
CB-84	CB Slope	0.099	0.049	7
CB-85	CB Slope + Rear Yard	0.123	0.027	7
CB-87	CB Slope	0.110	0.048	7
CB-88	CB Slope + Rear Yard	0.180	0.027	8
CB-9	CB Slope + Rear Yard	0.109	0.030	6
CB-91	Low Point	0.323	0.090	31
CB-92	Low Point	0.323	0.046	31
CB-93	Low Point	0.462	0.020	31
CB-94	Low Point	0.462	0.020	31
CB-95	Low Point	0.217	0.025	31
CB-96	Low Point	0.217	0.046	31
CB-97	CB Slope	0.207	0.069	9
CB-98	CB Slope + Rear Yard	0.330	0.061	9
CB-99	CB Slope	0.142	0.053	8

Table D-2: Rational Method CB Flow Calculations

CB	AREA (Ha)								FLOW					
	2 YEAR				5 YEAR				Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)
	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC						
1	0.028	0.40	0.03	0.03	0.034	0.60	0.06	0.06						
			0.00	0.03			0.00	0.06	10.00	76.81	104.19	122.14	178.56	8
2	0.028	0.40	0.03	0.03	0.033	0.63	0.06	0.06						
			0.00	0.03			0.00	0.06	10.00	76.81	104.19	122.14	178.56	8
3	0.103	0.59	0.17	0.17	0.088	0.74	0.18	0.18						
			0.00	0.17			0.00	0.18	10.00	76.81	104.19	122.14	178.56	32
4	0.083	0.73	0.17	0.17			0.00	0.00						
	0.231	0.48	0.31	0.48			0.00	0.00						
	0.059	0.57	0.09	0.57			0.00	0.00						
			0.00	0.57			0.00	0.00	10.00	76.81	104.19	122.14	178.56	44
5					0.064	0.61	0.11	0.11	10.00	76.81	104.19	122.14	178.56	11
6					0.064	0.63	0.11	0.11	10.00	76.81	104.19	122.14	178.56	12
7					0.032	0.59	0.05	0.05	10.00	76.81	104.19	122.14	178.56	5
8					0.031	0.63	0.05	0.05	10.00	76.81	104.19	122.14	178.56	6
9	0.021	0.61	0.04	0.04			0.00	0.00						
	0.038	0.55	0.06	0.09			0.00	0.00						
	0.029	0.61	0.05	0.14			0.00	0.00						
	0.060	0.63	0.10	0.25			0.00	0.00						
	0.016	0.56	0.03	0.27			0.00	0.00	10.00	76.81	104.19	122.14	178.56	21
10	0.021	0.60	0.03	0.03			0.00	0.00	10.00	76.81	104.19	122.14	178.56	3
11					0.233	0.72	0.47	0.47	10.00	76.81	104.19	122.14	178.56	48
12	0.117	0.61	0.20	0.20			0.00	0.00	10.00	76.81	104.19	122.14	178.56	15
13	0.136	0.74	0.28	0.28			0.00	0.00	10.00	76.81	104.19	122.14	178.56	21
14	0.113	0.75	0.24	0.24			0.00	0.00						
	0.015	0.56	0.02	0.26			0.00	0.00	10.00	76.81	104.19	122.14	178.56	20
15	0.100	0.73	0.20	0.20			0.00	0.00						
	0.019	0.84	0.04	0.25			0.00	0.00						
	0.175	0.56							10.00	76.81	104.19	122.14	178.56	19
16	0.075	0.73	0.15	0.15			0.00	0.00						
	0.072	0.70	0.14	0.29			0.00	0.00						
	0.060	0.56												
	0.114	0.56							10.00	76.81	104.19	122.14	178.56	22
17	0.086	0.74	0.18	0.18			0.00	0.00						
	0.079	0.73	0.16	0.34			0.00	0.00	10.00	76.81	104.19	122.14	178.56	26
18					0.126	0.75	0.26	0.26	10.00	76.81	104.19	122.14	178.56	27
19					0.083	0.72	0.17	0.17						
					0.032	0.62	0.06	0.22	10.00	76.81	104.19	122.14	178.56	23
20	0.062	0.58	0.10	0.10			0.00	0.00						
	0.143	0.57	0.23	0.33			0.00	0.00						
			0.00	0.33	0.033	0.60	0.05	0.05	10.00	76.81	104.19	122.14	178.56	31
21					0.107	0.73	0.22	0.22	10.00	76.81	104.19	122.14	178.56	23
22					0.117	0.73	0.24	0.24	10.00	76.81	104.19	122.14	178.56	25
23					0.087	0.75	0.18	0.18						
					0.139	0.77	0.30	0.48	10.00	76.81	104.19	122.14	178.56	50
24					0.080	0.75	0.17	0.17	10.00	76.81	104.19	122.14	178.56	17
25					0.112	0.73	0.23	0.23	10.00	76.81	104.19	122.14	178.56	24
26					0.148	0.73	0.30	0.30	10.00	76.81	104.19	122.14	178.56	31
27					0.129	0.73	0.26	0.26	10.00	76.81	104.19	122.14	178.56	27
28	0.068	0.74	0.14	0.14			0.00	0.00						
	0.062	0.59	0.10	0.24			0.00	0.00	10.00	76.81	104.19	122.14	178.56	19
29	0.040	0.65	0.07	0.07			0.00	0.00	10.00	76.81	104.19	122.14	178.56	6
30	0.060	0.63	0.10	0.10			0.00	0.00	10.00	76.81	104.19	122.14	178.56	8
31	0.166	0.59	0.27	0.27			0.00	0.00						
	0.148	0.54	0.22	0.49			0.00	0.00						
	0.111	0.68	0.21	0.70			0.00	0.00	10.00	76.81	104.19	122.14	178.56	54
32	0.053	0.60	0.09	0.09			0.00	0.00	10.00	76.81	104.19	122.14	178.56	7
33	0.116	0.69	0.22	0.22			0.00	0.00						
	0.170	0.58	0.27	0.50			0.00	0.00	10.00	76.81	104.19	122.14	178.56	38
34	0.082	0.68	0.15	0.15			0.00	0.00	10.00	76.81	104.19	122.14	178.56	12
35	0.075	0.62	0.13	0.13			0.00	0.00	10.00	76.81	104.19	122.14	178.56	10
36	0.072	0.58	0.12	0.12			0.00	0.00	10.00	76.81	104.19	122.14	178.56	9
37	0.165	0.75	0.35	0.35			0.00	0.00	10.00	76.81	104.19	122.14	178.56	27
38	0.049	0.54	0.07	0.07			0.00	0.00						
	0.132	0.75	0.27	0.35			0.00	0.00	10.00	76.81	104.19	122.14	178.56	27

Table D-2: Rational Method CB Flow Calculations

CB	AREA (Ha)								FLOW					
	2 YEAR				5 YEAR				Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)
	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC						
39	0.056	0.58	0.09	0.09			0.00	0.00	10.00	76.81	104.19	122.14	178.56	7
40	0.198	0.52	0.29	0.29			0.00	0.00	10.00	76.81	104.19	122.14	178.56	22
41					0.106	0.74	0.22	0.22						
	0.023	0.57	0.04	0.04			0.00	0.22	10.00	76.81	104.19	122.14	178.56	25
42	0.117	0.57	0.19	0.19			0.00	0.00						
	0.026	0.52	0.04	0.22			0.00	0.00	10.00	76.81	104.19	122.14	178.56	17
43	0.101	0.71	0.20	0.20			0.00	0.00	10.00	76.81	104.19	122.14	178.56	15
44	0.034	0.56	0.05	0.05			0.00	0.00						
	0.093	0.58	0.15	0.20			0.00	0.00						
	0.097	0.70	0.19	0.39			0.00	0.00	10.00	76.81	104.19	122.14	178.56	30
45	0.098	0.70	0.19	0.19			0.00	0.00	10.00	76.81	104.19	122.14	178.56	15
46	0.094	0.72	0.19	0.19			0.00	0.00	10.00	76.81	104.19	122.14	178.56	14
47	0.157	0.71	0.31	0.31			0.00	0.00	10.00	76.81	104.19	122.14	178.56	24
48	0.181	0.73	0.37	0.37			0.00	0.00	10.00	76.81	104.19	122.14	178.56	28
49	0.153	0.73	0.31	0.31			0.00	0.00	10.00	76.81	104.19	122.14	178.56	24
50					0.043	0.64	0.08	0.08						
	0.186	0.75	0.39	0.39			0.00	0.08	10.00	76.81	104.19	122.14	178.56	38
51	0.146	0.74	0.30	0.30			0.00	0.00	10.00	76.81	104.19	122.14	178.56	23
52	0.123	0.72	0.25	0.25			0.00	0.00	10.00	76.81	104.19	122.14	178.56	19
53	0.191	0.74	0.39	0.39			0.00	0.00	10.00	76.81	104.19	122.14	178.56	30
54	0.150	0.72	0.30	0.30			0.00	0.00	10.00	76.81	104.19	122.14	178.56	23
55	0.043	0.52	0.06	0.06			0.00	0.00	10.00	76.81	104.19	122.14	178.56	5
56	0.175	0.69	0.34	0.34			0.00	0.00	10.00	76.81	104.19	122.14	178.56	26
57	0.039	0.51	0.06	0.06			0.00	0.00	10.00	76.81	104.19	122.14	178.56	4
58	0.090	0.72	0.18	0.18			0.00	0.00	10.00	76.81	104.19	122.14	178.56	14
59	0.150	0.69	0.29	0.29			0.00	0.00	10.00	76.81	104.19	122.14	178.56	22
60	0.154	0.68	0.29	0.29			0.00	0.00	10.00	76.81	104.19	122.14	178.56	22
61	0.148	0.70	0.29	0.29			0.00	0.00	10.00	76.81	104.19	122.14	178.56	22
62					0.042	0.61	0.07	0.07						
	0.207	0.74	0.43	0.43			0.00	0.07	10.00	76.81	104.19	122.14	178.56	40
63	0.069	0.63	0.12	0.12			0.00	0.00	10.00	76.81	104.19	122.14	178.56	9
64	0.116	0.72	0.23	0.23			0.00	0.00						
	0.087	0.59	0.14	0.37			0.00	0.00						
	0.159	0.52	0.23	0.60			0.00	0.00						
	0.058	0.48	0.08	0.68			0.00	0.00	10.00	76.81	104.19	122.14	178.56	52
65	0.082	0.68	0.16	0.16			0.00	0.00						
	0.098	0.71	0.19	0.35			0.00	0.00	10.00	76.81	104.19	122.14	178.56	27
66	0.053	0.64	0.09	0.09			0.00	0.00	10.00	76.81	104.19	122.14	178.56	7
67	0.027	0.49	0.04	0.04			0.00	0.00						
	0.197	0.52	0.29	0.32			0.00	0.00						
	0.051	0.59	0.08	0.41			0.00	0.00	10.00	76.81	104.19	122.14	178.56	31
68	0.017	0.67	0.03	0.03			0.00	0.00	10.00	76.81	104.19	122.14	178.56	2
70	0.153	0.73	0.31	0.31			0.00	0.00	10.00	76.81	104.19	122.14	178.56	24
71	0.164	0.73	0.33	0.33			0.00	0.00	10.00	76.81	104.19	122.14	178.56	26
72					0.043	0.64	0.08	0.08						
	0.167	0.73	0.34	0.34			0.00	0.08	10.00	76.81	104.19	122.14	178.56	34
73	0.170	0.75	0.35	0.35			0.00	0.00	10.00	76.81	104.19	122.14	178.56	27
74	0.105	0.73	0.21	0.21			0.00	0.00	10.00	76.81	104.19	122.14	178.56	16
75	0.023	0.55	0.04	0.04	0.096	0.74	0.20	0.20	10.00	76.81	104.19	122.14	178.56	23
76	0.176	0.69	0.34	0.34			0.00	0.00	10.00	76.81	104.19	122.14	178.56	26
77	0.123	0.58	0.20	0.20			0.00	0.00						
	0.066	0.67	0.12	0.32			0.00	0.00						
	0.023	0.55	0.04	0.36			0.00	0.00	10.00	76.81	104.19	122.14	178.56	27
78	0.059	0.66	0.11	0.11			0.00	0.00	10.00	76.81	104.19	122.14	178.56	8
79	0.058	0.69	0.11	0.11			0.00	0.00	10.00	76.81	104.19	122.14	178.56	9
80	0.112	0.68	0.21	0.21			0.00	0.00	10.00	76.81	104.19	122.14	178.56	16
81	0.093	0.71	0.18	0.18			0.00	0.00	10.00	76.81	104.19	122.14	178.56	14
82	0.048	0.54	0.07	0.07			0.00	0.00	10.00	76.81	104.19	122.14	178.56	6
83	0.112	0.70	0.22	0.22			0.00	0.00	10.00	76.81	104.19	122.14	178.56	17
84	0.143	0.75	0.30	0.30			0.00	0.00	10.00	76.81	104.19	122.14	178.56	23
85	0.038	0.60	0.06	0.06			0.00	0.00						
	0.049	0.57	0.08	0.14			0.00	0.00						
	0.120	0.72	0.24	0.38			0.00	0.00	10.00	76.81	104.19	122.14	178.56	29

Table D-2: Rational Method CB Flow Calculations

CB	AREA (Ha)								FLOW					
	2 YEAR				5 YEAR				Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)
	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC						
87	0.084	0.74	0.17	0.17			0.00	0.00						
	0.124	0.74	0.25	0.43			0.00	0.00	10.00	76.81	104.19	122.14	178.56	33
88	0.025	0.53	0.04	0.04			0.00	0.00						
	0.122	0.73	0.25	0.29			0.00	0.00						
	0.118	0.58	0.19	0.47			0.00	0.00	10.00	76.81	104.19	122.14	178.56	36
91	0.153	0.56	0.24	0.24			0.00	0.00						
	0.191	0.54	0.28	0.52			0.00	0.00						
	0.107	0.72	0.21	0.74			0.00	0.00						
	0.054	0.75	0.11	0.85			0.00	0.00	10.00	76.81	104.19	122.14	178.56	65
92	0.107	0.74	0.22	0.22			0.00	0.00						
	0.054	0.69	0.10	0.32			0.00	0.00	10.00	76.81	104.19	122.14	178.56	25
93	0.049	0.73	0.10	0.10			0.00	0.00						
	0.050	0.70	0.10	0.20			0.00	0.00	10.00	76.81	104.19	122.14	178.56	15
94	0.047	0.69	0.09	0.09			0.00	0.00						
	0.052	0.77	0.11	0.20			0.00	0.00	10.00	76.81	104.19	122.14	178.56	16
95	0.159	0.73	0.32	0.32			0.00	0.00	10.00	76.81	104.19	122.14	178.56	25
96	0.093	0.71	0.18	0.18			0.00	0.00	10.00	76.81	104.19	122.14	178.56	14
97	0.104	0.73	0.21	0.21			0.00	0.00	10.00	76.81	104.19	122.14	178.56	16
98	0.148	0.73	0.30	0.30			0.00	0.00						
	0.126	0.52	0.18	0.48			0.00	0.00						
	0.186	0.59	0.31	0.79			0.00	0.00	10.00	76.81	104.19	122.14	178.56	60
99	0.144	0.72	0.29	0.29			0.00	0.00	10.00	76.81	104.19	122.14	178.56	22
100	0.058	0.63	0.10	0.10			0.00	0.00	10.00	76.81	104.19	122.14	178.56	8
101	0.126	0.72	0.25	0.25			0.00	0.00	10.00	76.81	104.19	122.14	178.56	19
102	0.106	0.70	0.21	0.21			0.00	0.00	10.00	76.81	104.19	122.14	178.56	16
103	0.145	0.71	0.29	0.29			0.00	0.00						
	0.088	0.68	0.17	0.45			0.00	0.00	10.00	76.81	104.19	122.14	178.56	35
104					0.068	0.53	0.10	0.10	10.00	76.81	104.19	122.14	178.56	10
105	0.026	0.52	0.04	0.04			0.00	0.00						
	0.083	0.61	0.14	0.18			0.00	0.00						
			0.00	0.18			0.00	0.00	10.00	76.81	104.19	122.14	178.56	14
106	0.077	0.63	0.14	0.14			0.00	0.00						
	0.036	0.63	0.06	0.20			0.00	0.00	10.00	76.81	104.19	122.14	178.56	15
107					0.096	0.73	0.20	0.20	10.00	76.81	104.19	122.14	178.56	20
108					0.114	0.70	0.22	0.22	10.00	76.81	104.19	122.14	178.56	23
116	0.066	0.64	0.12	0.12			0.00	0.00						
	0.168	0.52	0.24	0.36			0.00	0.00						
	0.091	0.73	0.19	0.55			0.00	0.00	10.00	76.81	104.19	122.14	178.56	42
117	0.136	0.69	0.26	0.26			0.00	0.00						
	0.053	0.58	0.09	0.35			0.00	0.00	10.00	76.81	104.19	122.14	178.56	27
122	0.027	0.79	0.06	0.06										
	0.095	0.59	0.15	0.21			0.00	0.00	10.00	76.81	104.19	122.14	178.56	16
123	0.053	0.73	0.11	0.11			0.00	0.00						
	0.091	0.69	0.17	0.28			0.00	0.00	10.00	76.81	104.19	122.14	178.56	22
124	0.064	0.56	0.10	0.10			0.00	0.00						
	0.043	0.71	0.08	0.19			0.00	0.00						
	0.099	0.57	0.16	0.34			0.00	0.00						
	0.123	0.72	0.25	0.59			0.00	0.00	10.00	76.81	104.19	122.14	178.56	45
125	0.042	0.73	0.08	0.08			0.00	0.00						
	0.206	0.47	0.27	0.35			0.00	0.00						
	0.040	0.70	0.08	0.43			0.00	0.00	10.00	76.81	104.19	122.14	178.56	33
129	0.062	0.75	0.13	0.13			0.00	0.00	10.00	76.81	104.19	122.14	178.56	10
130	0.059	0.73	0.12	0.12			0.00	0.00						
	0.016	0.57	0.03	0.14			0.00	0.00						
	0.081	0.61	0.14	0.28			0.00	0.00	10.00	76.81	104.19	122.14	178.56	22

Table D-3: PCSWMM Subcatchment Parameters

Name	Area (ha)	Width (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Subarea Routing	Percent Routed (%)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)		Drying Time (days)
A136NE	0.026	30	0.5	42	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A302NE	0.042	24	0.5	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A302NW	0.043	24	0.5	73	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A302R1	0.099	164	1.5	53	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A302R2	0.206	100	1.5	38	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A302R3	0.064	106	1.5	52	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A302S1	0.040	34	0.5	72	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A302SW	0.113	64	0.5	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A303N1	0.059	36	0.5	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A303N2	0.062	36	0.5	78	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A303NE	0.066	30	0.5	63	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A303NW	0.053	30	0.5	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A303R1	0.016	20	1.5	53	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A303R2	0.081	126	1.5	58	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A303R3	0.168	142	1.5	46	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A303SE	0.091	53	0.5	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A303SW	0.091	53	0.5	70	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A304NE	0.083	48	0.5	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A304R1	0.231	188	1.5	40	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A304R2	0.059	48	1.5	53	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A306NE	0.095	64	0.5	55	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A306NW	0.136	21	0.5	70	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A306SE	0.027	16	1.0	84	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A306SW	0.053	64	0.5	54	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A307R1	0.136	128	1.5	29	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A500NE	0.069	56	1.0	62	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A500NW	0.116	67	1.0	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A500R1	0.087	144	1.5	55	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A500R2	0.159	212	1.5	46	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A500R3	0.058	104	1.5	40	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A500SE	0.053	60	1.0	63	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A502N1	0.017	21	0.5	67	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A502NE	0.077	94	2.0	62	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A502NW	0.027	29	1.0	42	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A502R1	0.197	148	1.5	46	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A502R2	0.051	42	1.5	55	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2		4.14
A502S1	0.082	18	2.0	69	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A502SE	0.036	37	2.0	61	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A502SW	0.098	76	2.0	73	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A503NE	0.144	82	0.5	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A504NE	0.104	57	1.0	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A504NW	0.093	64	1.0	73	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A504SE	0.148	87	1.0	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A504SW	0.159	94	1.0	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A505NE	0.191	87	0.5	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A505SW	0.150	87	0.5	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A506NE	0.043	52	0.5	45	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A506NW	0.039	44	0.5	44	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A506SW	0.175	49	0.5	70	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A5070NW	0.181	84	0.5	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A5070SE	0.157	78	0.5	73	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A5080NW	0.153	74	0.5	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A5080SE	0.164	82	0.5	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A508NE	0.090	83	0.5	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A510NW	0.154	72	0.5	69	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14

Table D-3: PCSWMM Subcatchment Parameters

Name	Area (ha)	Width (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Subarea Routing	Percent Routed (%)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)		Drying Time (days)
A510SE	0.150	100	0.5	70	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A511NW	0.148	94	3.0	71	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A511SE	0.042	43	1.0	59	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A511SW	0.207	102	3.0	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A513NE	0.153	89	2.0	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A513SE	0.043	44	1.0	63	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A513SW	0.186	95	2.0	78	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A515NE	0.088	88	1.0	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A517NE	0.170	94	2.0	78	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A517SE	0.043	44	1.0	63	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A517SW	0.167	86	3.0	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A520NE	0.058	32	0.5	70	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A520NW	0.059	33	0.5	65	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A520SE	0.112	55	0.5	68	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A520SW	0.093	55	0.5	73	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A522NE	0.176	79	2.0	70	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A522R1	0.123	106	1.5	54	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	86.8	4.14
A522SE	0.066	57	1.0	67	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A522SW	0.023	27	3.0	50	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A5238NE	0.106	57	3.0	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A523NW	0.048	59	2.0	49	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A523SE	0.112	59	2.0	72	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A5240NE	0.094	61	2.0	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A5240SW	0.098	64	2.0	72	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A524NW	0.198	65	2.0	46	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A524R1	0.117	200	1.5	53	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	86.8	4.14
A524R2	0.034	56	1.5	52	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	86.8	4.14
A524R3	0.093	82	1.5	54	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	86.8	4.14
A524S1	0.026	31	4.0	45	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A524S2	0.023	31	2.0	53	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A524SE	0.097	63	0.5	71	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A524SW	0.101	58	2.0	73	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A525N1	0.105	68	3.0	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A525NE	0.026	31	4.0	45	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A525NW	0.023	31	2.0	50	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A525R2	0.083	72	1.5	58	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	86.8	4.14
A525R3	0.103	86	1.5	55	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	86.8	4.14
A525SW	0.096	53	1.0	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A526NE	0.064	59	3.0	61	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A526NW	0.064	59	3.0	59	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A527NE	0.031	29	2.0	61	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A527SW	0.032	29	2.0	56	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A5280R1	0.126	108	1.5	45	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	86.8	4.14
A528NE	0.049	37	1.0	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A528NW	0.050	29	0.5	71	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A528R1	0.186	158	1.5	56	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	86.8	4.14
A528SE	0.047	33	1.0	70	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A528SW	0.052	33	0.5	82	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A529NE	0.107	93	0.5	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A529NW	0.054	93	0.5	70	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	86.8	4.14
A529R1	0.153	264	1.5	51	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	86.8	4.14
A529R3	0.191	158	1.5	48	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	86.8	4.14
A529SE	0.107	59	0.5	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A529SW	0.054	34	0.5	79	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14
A534NE	0.146	76	3.0	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2		4.14

Table D-3: PCSWMM Subcatchment Parameters

Name	Area (ha)	Width (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Subarea Routing	Percent Routed (%)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
A534SW	0.123	76	3.0	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A535NE	0.068	48	3.0	47	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A535SW	0.096	88	1.0	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A536NE	0.107	55	3.0	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A537NE	0.117	63	0.5	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A538NE	0.126	64	3.0	78	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A538NW	0.083	48	3.0	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A538R1	0.062	56	1.5	54	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A538R2	0.143	120	1.5	53	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A538SE	0.033	31	4.0	57	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A538SW	0.032	31	2.0	60	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A540NE	0.033	32	4.0	62	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A540NW	0.034	32	4.0	57	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A540R1	0.028	28	1.5	29	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A540R2	0.028	28	1.5	29	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A542NE	0.075	55	0.5	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A542NW	0.072	41	0.5	72	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A542R1	0.060	58	1.5	52	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A542R2	0.114	94	1.5	52	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A542SE	0.086	53	0.5	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A542SW	0.079	44	0.5	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A543NE	0.100	57	0.5	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A543NW	0.019	11	0.5	92	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A543R2	0.175	146	1.5	52	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A543SE	0.113	57	0.5	79	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A543SW	0.015	11	0.5	52	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A544NE	0.117	79	0.5	58	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A544SW	0.136	79	0.5	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A546NE	0.060	63	2.0	61	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A546NW	0.068	46	1.0	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A546R1	0.166	138	1.5	55	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A546R2	0.148	160	1.5	49	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A546SE	0.111	66	2.0	69	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A546SW	0.062	63	1.0	56	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A546W1	0.040	46	1.0	64	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A547NE	0.053	55	2.0	57	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A548NE	0.116	69	1.0	70	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A548R1	0.170	108	1.5	54	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A549NE	0.082	30	1.0	68	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A550NE	0.072	87	1.0	54	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A550NW	0.165	61	2.0	79	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A550SW	0.075	95	1.0	60	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A551NW	0.049	41	1.0	49	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A551SE	0.132	43	1.0	78	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A551SW	0.056	68	1.0	54	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A552NE	0.143	58	2.0	78	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A552R1	0.038	70	1.5	57	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A552R2	0.049	108	1.5	53	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A552SW	0.120	63	2.0	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A553N1	0.025	29	1.0	47	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A553N2	0.084	68	2.0	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A553NE	0.124	51	2.0	77	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A553NW	0.122	43	2.0	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A553R1	0.118	52	1.5	54	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A554NW	0.126	72	1.0	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14

Table D-3: PCSWMM Subcatchment Parameters

Name	Area (ha)	Width (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Subarea Routing	Percent Routed (%)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
A554SE	0.058	61	1.0	61	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A556R1	2.057	165	1.5	29	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A556SE	0.106	83	1.0	71	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A557NE	0.145	83	1.0	73	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A557NW	0.088	30	1.0	68	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A561N1	0.114	59	3.0	72	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A561NE	0.233	112	2.0	74	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A561NW	0.080	44	0.5	79	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A561SE	0.087	41	0.5	78	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A561SW	0.139	66	0.5	81	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A562NE	0.021	33	1.0	59	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A562R1	0.038	62	1.5	50	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A562R2	0.029	42	1.5	59	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A562R3	0.060	82	1.5	61	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A562R4	0.016	22	1.5	52	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A562SE	0.021	33	1.0	57	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A563NE	0.112	53	0.5	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A564NW	0.129	60	3.0	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A564SE	0.148	60	3.0	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A561NW	0.080	44	0.5	79	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A561SE	0.087	41	0.5	78	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A561SW	0.139	66	0.5	81	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A562NE	0.021	33	1.0	59	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A562NW	0.114	19	3.0	72	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A562R1	0.038	62	1.5	50	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A562R2	0.029	42	1.5	59	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A562R3	0.060	82	1.5	61	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A562R4	0.016	22	1.5	52	0.013	0.25	1.57	4.67	PERVIOUS	100	HORTON	76.2	13.2	4.14
A562SE	0.021	33	1.0	57	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A563NE	0.112	53	0.5	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A564NW	0.129	60	3.0	76	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
A564SE	0.148	60	3.0	75	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14
APOND2	0.019	21	0.5	56	0.013	0.25	1.57	4.67	OUTLET	100	HORTON	76.2	13.2	4.14

D-4A- ICD Head Flow Rating Curves

Head (m)	Release Rate (L/s) by ICD Diameter (mm)						
	83	94	102	108	127	152	178
0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.050	3.3	4.3	5.0	5.6	7.8	11.1	15.3
0.100	4.7	6.0	7.1	8.0	11.0	15.8	21.6
0.150	5.8	7.4	8.7	9.7	13.5	19.3	26.5
0.200	6.6	8.5	10.0	11.3	15.6	22.3	30.6
0.250	7.4	9.5	11.2	12.6	17.4	24.9	34.2
0.300	8.1	10.4	12.3	13.8	19.1	27.3	37.4
0.350	8.8	11.3	13.3	14.9	20.6	29.5	40.4
0.400	9.4	12.1	14.2	15.9	22.0	31.5	43.2
0.450	10.0	12.8	15.1	16.9	23.3	33.4	45.8
0.500	10.5	13.5	15.9	17.8	24.6	35.2	48.3
0.550	11.0	14.1	16.6	18.7	25.8	37.0	50.7
0.600	11.5	14.8	17.4	19.5	26.9	38.6	52.9
0.650	12.0	15.4	18.1	20.3	28.0	40.2	55.1
0.700	12.4	15.9	18.8	21.0	29.1	41.7	57.2
0.750	12.9	16.5	19.4	21.8	30.1	43.2	59.2
0.800	13.3	17.0	20.1	22.5	31.1	44.6	61.1
0.850	13.7	17.6	20.7	23.2	32.1	45.9	63.0
0.900	14.1	18.1	21.3	23.9	33.0	47.3	64.8
0.950	14.5	18.6	21.9	24.5	33.9	48.6	66.6
1.000	14.9	19.1	22.4	25.2	34.8	49.8	68.3
1.050	15.2	19.5	23.0	25.8	35.6	51.1	70.0
1.100	15.6	20.0	23.5	26.4	36.5	52.3	71.7
1.150	15.9	20.4	24.1	27.0	37.3	53.4	73.3
1.200	16.3	20.9	24.6	27.6	38.1	54.6	74.9
1.250	16.6	21.3	25.1	28.1	38.9	55.7	76.4
1.300	16.9	21.7	25.6	28.7	39.7	56.8	77.9
1.350	17.3	22.1	26.1	29.2	40.4	57.9	79.4
1.400	17.6	22.6	26.6	29.8	41.2	59.0	80.9
1.450	17.9	22.9	27.0	30.3	41.9	60.0	82.3
1.500	18.2	23.3	27.5	30.8	42.6	61.0	83.7
1.550	18.5	23.7	27.9	31.3	43.3	62.0	85.1
1.600	18.8	24.1	28.4	31.8	44.0	63.0	86.4

(1) Head take from the centre of the Orifice

Coefficient of Discharge = 0.62

Table D-5A: Capacity of Grates

Water Depth H (m)	$Q_{captured}$ (L/s) OPSD 400.01	
	SINGLE * (L/s)	TWIN * (L/s)
0.00	0	0
0.01	1	1
0.02	2	3
0.03	4	5
0.04	7	9
0.05	11	16
0.06	16	27
0.07	20	36
0.08	36	54
0.09	48	71
0.10	61	91
0.11	73	109
0.12	86	127
0.13	99	140
0.14	109	155
0.15	120	169
0.16	129	183
0.17	136	196
0.18	145	211
0.19	150	228
0.20	156	243
0.21	161	259
0.22	167	275
0.23	172	291
0.24	176	307
0.25	181	322
0.26	186	337
0.27	189	354
0.28	194	371
0.29	199	387
0.30	202	403

* From MTO Drainage Management Manual (1997), Design Chart 4.19

Table D-5B: Capacity of Side Inlet (1)

Water Depth (m)	SINGLE Capacity (L/s)	TWIN Capacity (L/s)
0.00	0	0
0.01	1	2
0.02	3	6
0.03	6	12
0.04	9	18
0.05	13	26
0.06	17	34
0.07	22	44
0.08	26	52
0.09	32	64
0.10	37	74
0.11	43	86
0.12	49	98
0.13	62	124
0.14	67	134
0.15	71	142
0.16	75	150
0.17	79	158
0.18	83	166
0.19	86	172
0.20	89	178
0.21	93	186
0.22	96	192
0.23	99	198
0.24	102	204
0.25	105	210
0.26	107	214
0.27	110	220
0.28	113	226
0.29	115	230
0.30	118	236

(1) As per $Q_{weir} = CLH^{3/2}$ where C = 1.8, and $Q_{orifice} = CA\times(2gh)^{0.5}$ where C = 0.65 for a 13 cm high x 65 cm wide side inlet.

Table D-5C: Capacity of Lead Pipes

	Release Rate (L/s) by Pipe Diameter (mm)						
Head (m)	100	150	200	250	300	375	450
0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.050	6.4	14.4	25.5	39.9	57.4	89.7	129.2
0.100	9.0	20.3	36.1	56.4	81.2	126.9	182.7
0.150	11.0	24.9	44.2	69.1	99.4	155.4	223.7
0.200	12.8	28.7	51.0	79.7	114.8	179.4	258.3
0.250	14.3	32.1	57.1	89.1	128.4	200.6	288.8
0.300	15.6	35.2	62.5	97.7	140.6	219.7	316.4
0.350	16.9	38.0	67.5	105.5	151.9	237.3	341.8
0.400	18.0	40.6	72.2	112.8	162.4	253.7	365.3
0.450	19.1	43.1	76.5	119.6	172.2	269.1	387.5
0.500	20.2	45.4	80.7	126.1	181.5	283.7	408.5
0.550	21.2	47.6	84.6	132.2	190.4	297.5	428.4
0.600	22.1	49.7	88.4	138.1	198.9	310.7	447.5
0.650	23.0	51.7	92.0	143.7	207.0	323.4	465.7
0.700	23.9	53.7	95.5	149.2	214.8	335.6	483.3
0.750	24.7	55.6	98.8	154.4	222.3	347.4	500.3
0.800	25.5	57.4	102.1	159.5	229.6	358.8	516.7
0.850	26.3	59.2	105.2	164.4	236.7	369.8	532.6
0.900	27.1	60.9	108.3	169.1	243.6	380.6	548.0
0.950	27.8	62.6	111.2	173.8	250.2	391.0	563.0
1.000	28.5	64.2	114.1	178.3	256.7	401.2	577.7
1.050	29.2	65.8	116.9	182.7	263.1	411.1	591.9
1.100	29.9	67.3	119.7	187.0	269.3	420.7	605.9
1.150	30.6	68.8	122.4	191.2	275.3	430.2	619.5
1.200	31.2	70.3	125.0	195.3	281.2	439.4	632.8
1.250	31.9	71.8	127.6	199.3	287.0	448.5	645.9
1.300	32.5	73.2	130.1	203.3	292.7	457.4	658.6
1.350	33.1	74.6	132.6	207.2	298.3	466.1	671.2
1.400	33.8	75.9	135.0	211.0	303.8	474.7	683.5
1.450	34.4	77.3	137.4	214.7	309.2	483.1	695.6
1.500	34.9	78.6	139.8	218.4	314.4	491.3	707.5
1.550	35.5	79.9	142.1	222.0	319.6	499.4	719.2
1.600	36.1	81.2	144.3	225.5	324.8	507.4	730.7

Short tube orifice coefficient = 0.82

Short tube release rate = $C\pi(Dia/1000)^2/4\times(2\times9.81\times H)^{0.5}\times1000$

Table D-6: ICD Type and Inlet Capture Results for the 2-Year Chicago Storm

Catch Basin ID	Type	Applied ICD	Rational (2/5-Yr) Peak Flow (m³/s)	Minimum Theoretical ICD Size (Rational)	Total Simulated Approach Flow (m³/s)	Total Simulated Capture (m³/s)	Max Ponding Depth (cm)	Flow Spread (m)	% of Total Travel Lane [(1)]
CB-1	CB Slope	-	0.008	-	0.012	0.007	2	0.65	8%
CB-10	CB Slope	-	0.003	-	0.006	0.006	2	0.65	8%
CB-100	CB Slope	-	0.008	-	0.004	0.004	2	0.65	8%
CB-101	CB Slope	-	0.019	-	0.012	0.011	3	0.98	12%
CB-102	CB Slope	-	0.016	-	0.014	0.012	3	0.98	12%
CB-103	CB Slope	-	0.035	-	0.017	0.014	3	0.98	12%
CB-104	CB Slope + Rear Yard	83mm-ICD	0.010	83mm-ICD	0.013	0.013	1	0.33	4%
CB-105	CB Slope + Rear Yard	94mm-ICD	0.014	83mm-ICD	0.022	0.021	3	0.98	12%
CB-11	CB Slope	-	0.048	-	0.028	0.028	8	2.62	31%
CB-12	Low Point	127mm-ICD	0.015	83mm-ICD	0.019	0.019	0	0.00	0%
CB_123	Low Point	83mm-ICD	0.019	83mm-ICD	0.004	0.004	0	0.00	0%
CB_124	Low Point	102mm-ICD	0.029	102mm-ICD	0.033	0.027	3	0.98	12%
CB_125	Low Point	108mm-ICD	0.033	108mm-ICD	0.033	0.030	3	0.98	12%
CB_129	CB Slope	-	0.010	-	0.019	0.008	4	1.31	15%
CB-13	Low Point	94mm-ICD	0.021	94mm-ICD	0.019	0.019	0	0.00	0%
CB_130	CB Slope	-	0.022	-	0.019	0.008	4	1.31	15%
CB-14	Low Point	94mm-ICD	0.020	94mm-ICD	0.033	0.033	0	0.00	0%
CB-15	Low Point	152mm-ICD	0.019	83mm-ICD	0.033	0.033	0	0.00	0%
CB-16	Low Point	152mm-ICD	0.022	94mm-ICD	0.035	0.034	0	0.00	0%
CB-17	Low Point	152mm-ICD	0.026	102mm-ICD	0.035	0.034	0	0.00	0%
CB-18	Low Point	152mm-ICD	0.027	102mm-ICD	0.019	0.019	0	0.00	0%
CB-19	Low Point	94mm-ICD	0.023	94mm-ICD	0.019	0.010	0	0.00	0%
CB-2	CB Slope	-	0.008	-	0.012	0.007	2	0.65	8%
CB-20	CB Slope + Rear Yard	152mm-ICD	0.031	108mm-ICD	0.041	0.041	3	0.98	12%
CB-21	CB Slope	-	0.023	-	0.018	0.012	3	0.98	12%
CB-22	CB Slope	-	0.025	-	0.010	0.010	3	0.98	12%
CB-23	Low Point	178mm-ICD	0.050	152mm-ICD	0.023	0.023	0	0.00	0%
CB-24	CB Slope	-	0.017	-	0.007	0.007	2	0.65	8%
CB-25	CB Slope	-	0.024	-	0.009	0.009	3	0.98	12%
CB-26	Low Point	178mm-ICD	0.031	108mm-ICD	0.023	0.023	0	0.00	0%
CB-27	Low Point	178mm-ICD	0.027	102mm-ICD	0.023	0.023	0	0.00	0%
CB-28	Low Point	83mm-ICD	0.019	83mm-ICD	0.011	0.010	0	0.00	0%
CB-29	Low Point	83mm-ICD	0.006	83mm-ICD	0.011	0.010	0	0.00	0%
CB-3	CB Slope + Rear Yard	127mm-ICD	0.032	108mm-ICD	0.030	0.030	3	0.98	12%
CB-30	CB Slope	-	0.008	-	0.013	0.008	2	0.65	8%
CB-31	CB Slope + Rear Yard	152mm-ICD	0.054	152mm-ICD	0.059	0.055	2	0.65	8%
CB-32	CB Slope	-	0.007	-	0.008	0.008	2	0.65	8%
CB-33	CB Slope + Rear Yard	102mm-ICD	0.029	102mm-ICD	0.033	0.026	3	0.98	12%
CB-34	CB Slope	-	0.012	-	0.014	0.012	3	0.98	12%
CB-35	CB Slope	-	0.010	-	0.012	0.011	3	0.98	12%
CB-36	CB Slope	-	0.009	-	0.010	0.009	2	0.65	8%
CB-37	CB Slope	-	0.027	-	0.019	0.019	4	1.31	15%
CB-38	Low Point	178mm-ICD	0.027	102mm-ICD	0.042	0.042	0	0.00	0%
CB-39	Low Point	178mm-ICD	0.007	83mm-ICD	0.042	0.042	0	0.00	0%
CB-4	CB Slope + Rear Yard	152mm-ICD	0.044	127mm-ICD	0.049	0.049	4	1.31	15%
CB-40	Low Point	94mm-ICD	0.022	94mm-ICD	0.014	0.014	0	0.00	0%
CB-41	Low Point	83mm-ICD	0.019	83mm-ICD	0.014	0.012	0	0.00	0%
CB-42	CB Slope + Rear Yard	94mm-ICD	0.017	83mm-ICD	0.022	0.022	1	0.33	4%
CB-43	CB Slope	-	0.015	-	0.016	0.012	3	0.98	12%
CB-44	CB Slope + Rear Yard	108mm-ICD	0.030	108mm-ICD	0.036	0.028	3	0.98	12%
CB-45	Low Point	102mm-ICD	0.015	83mm-ICD	0.025	0.025	0	0.00	0%
CB-46	Low Point	102mm-ICD	0.014	83mm-ICD	0.025	0.025	0	0.00	0%
CB-47	CB Slope	-	0.024	-	0.013	0.013	3	0.98	12%
CB-48	CB Slope	-	0.028	-	0.020	0.018	4	1.31	15%
CB-49	Low Point	127mm-ICD	0.024	94mm-ICD	0.042	0.034	0	0.00	0%
CB-5	Low Point	108mm-ICD	0.011	83mm-ICD	0.018	0.018	0	0.00	0%

Table D-6: ICD Type and Inlet Capture Results for the 2-Year Chicago Storm

Catch Basin ID	Type	Applied ICD	Rational (2/5-Yr) Peak Flow (m³/s)	Minimum Theoretical ICD Size (Rational)	Total Simulated Approach Flow (m³/s)	Total Simulated Capture (m³/s)	Max Ponding Depth (cm)	Flow Spread (m)	% of Total Travel Lane [(1)]
CB-50	Low Point	152mm-ICD	0.038	127mm-ICD	0.042	0.042	0	0.00	0%
CB-51	Low Point	127mm-ICD	0.023	94mm-ICD	0.033	0.032	0	0.00	0%
CB-52	Low Point	127mm-ICD	0.019	83mm-ICD	0.033	0.032	0	0.00	0%
CB-53	CB Slope	-	0.030	-	0.028	0.017	4	1.31	15%
CB-54	CB Slope	-	0.023	-	0.028	0.017	4	1.31	15%
CB-55	CB Slope	-	0.005	-	0.002	0.002	1	0.33	4%
CB-56	CB Slope	-	0.026	-	0.013	0.013	3	0.98	12%
CB-57	CB Slope	-	0.004	-	0.008	0.008	2	0.65	8%
CB-58	CB Slope	-	0.014	-	0.009	0.009	2	0.65	8%
CB-59	CB Slope	-	0.022	-	0.015	0.015	3	0.98	12%
CB-6	Low Point	108mm-ICD	0.012	83mm-ICD	0.018	0.018	0	0.00	0%
CB-60	CB Slope	-	0.022	-	0.019	0.017	3	0.98	12%
CB-61	Low Point	127mm-ICD	0.022	94mm-ICD	0.042	0.034	0	0.00	0%
CB-62	Low Point	152mm-ICD	0.040	127mm-ICD	0.042	0.042	0	0.00	0%
CB-63	CB Slope	-	0.009	-	0.011	0.011	3	0.98	12%
CB-64	CB Slope + Rear Yard	152mm-ICD	0.052	152mm-ICD	0.059	0.053	2	0.65	8%
CB-65	CB Slope	-	0.027	-	0.017	0.010	2	0.65	8%
CB-66	CB Slope	-	0.007	-	0.013	0.008	2	0.65	8%
CB-67	CB Slope + Rear Yard	127mm-ICD	0.031	108mm-ICD	0.045	0.038	3	0.98	12%
CB-68	Low Point	83mm-ICD	0.002	83mm-ICD	0.017	0.014	0	0.00	0%
CB-7	CB Slope	-	0.005	-	0.004	0.003	1	0.33	4%
CB-70	CB Slope	-	0.024	-	0.027	0.017	4	1.31	15%
CB-71	CB Slope	-	0.026	-	0.027	0.017	4	1.31	15%
CB-72	Low Point	152mm-ICD	0.034	127mm-ICD	0.041	0.041	0	0.00	0%
CB-73	Low Point	127mm-ICD	0.027	102mm-ICD	0.041	0.033	0	0.00	0%
CB-74	Low Point	83mm-ICD	0.016	83mm-ICD	0.016	0.014	0	0.00	0%
CB-75	Low Point	94mm-ICD	0.023	94mm-ICD	0.016	0.016	0	0.00	0%
CB-76	CB Slope	-	0.026	-	0.020	0.014	3	0.98	12%
CB-77	CB Slope + Rear Yard	94mm-ICD	0.025	94mm-ICD	0.026	0.022	2	0.65	8%
CB-78	CB Slope	-	0.008	-	0.012	0.010	2	0.65	8%
CB-79	CB Slope	-	0.009	-	0.012	0.010	2	0.65	8%
CB-8	CB Slope	-	0.006	-	0.004	0.003	1	0.33	4%
CB-80	CB Slope	-	0.016	-	0.016	0.012	3	0.98	12%
CB-81	CB Slope	-	0.014	-	0.016	0.012	3	0.98	12%
CB-82	Low Point	83mm-ICD	0.006	83mm-ICD	0.012	0.011	0	0.00	0%
CB-83	Low Point	83mm-ICD	0.017	83mm-ICD	0.012	0.011	0	0.00	0%
CB-84	CB Slope	-	0.023	-	0.024	0.019	4	1.31	15%
CB-85	CB Slope + Rear Yard	102mm-ICD	0.029	102mm-ICD	0.029	0.026	3	0.98	12%
CB-87	CB Slope	-	0.033	-	0.019	0.015	3	0.98	12%
CB-88	CB Slope + Rear Yard	102mm-ICD	0.029	102mm-ICD	0.034	0.026	4	1.31	15%
CB-9	CB Slope + Rear Yard	108mm-ICD	0.021	94mm-ICD	0.031	0.029	2	0.65	8%
CB-91	Low Point	178mm-ICD	0.065	152mm-ICD	0.051	0.051	0	0.00	0%
CB-92	Low Point	127mm-ICD	0.025	94mm-ICD	0.051	0.051	0	0.00	0%
CB-93	Low Point	83mm-ICD	0.015	83mm-ICD	0.016	0.016	0	0.00	0%
CB-94	Low Point	83mm-ICD	0.016	83mm-ICD	0.016	0.016	0	0.00	0%
CB-95	Low Point	94mm-ICD	0.025	94mm-ICD	0.030	0.021	0	0.00	0%
CB-96	Low Point	127mm-ICD	0.014	83mm-ICD	0.030	0.030	0	0.00	0%
CB-97	CB Slope	-	0.016	-	0.020	0.020	4	1.31	15%
CB-98	CB Slope + Rear Yard	152mm-ICD	0.060	152mm-ICD	0.063	0.057	3	0.98	12%
CB-99	CB Slope	-	0.022	-	0.012	0.011	3	0.98	12%

Table D-7: Ponding at Major Low Points for the 100-Year Chicago Storm & 100-Year Chicago Storm +20%

Catch Basin ID	Major Node	Total Depth		Water Surface Elevation	
		100 Year 3 Hr Chi (cm)	100 Year 3 Hr Chi+20% (cm)	100 Year 3 Hr Chi (m)	100 Year 3 Hr Chi+20% (m)
CB-1	Maj_120	6.0	7.0	102.01	102.02
CB-10	Maj_061	6.0	6.0	103.05	103.05
CB-100	Maj_076	3.0	3.0	101.76	101.76
CB-101	Maj_075	7.0	9.0	101.66	101.68
CB-102	Maj_074	6.0	8.0	101.16	101.18
CB-103	Maj_119	9.0	10.0	100.69	100.70
CB-104	Maj_018	4.0	4.0	103.89	103.89
CB-105	Maj_100	8.0	9.0	103.04	103.05
CB-11	Maj_062	20.0	27.0	104.44	104.51
CB-12	Maj_008	21.0	32.0	101.06	101.17
CB-13	Maj_008	21.0	32.0	101.06	101.17
CB-14	Maj_013	15.0	16.0	102.65	102.66
CB-15	Maj_013	15.0	16.0	102.65	102.66
CB-16	Maj_015	19.0	25.0	102.76	102.82
CB-17	Maj_015	19.0	25.0	102.76	102.82
CB-18	Maj_020	26.0	28.0	103.00	103.02
CB-19	Maj_020	26.0	28.0	103.00	103.02
CB-2	Maj_120	6.0	7.0	102.01	102.02
CB-20	Maj_021	7.0	8.0	103.03	103.04
CB-21	Maj_151	5.0	5.0	104.43	104.43
CB-22	Maj_026	5.0	5.0	105.64	105.64
CB-23	Maj_024	9.0	10.0	105.59	105.60
CB-24	Maj_027	4.0	4.0	105.62	105.62
CB-25	Maj_030	4.0	5.0	104.36	104.37
CB-26	Maj_005	0.0	0.0	102.84	102.84
CB-27	Maj_005	0.0	0.0	102.84	102.84
CB-28	Maj_109	20.0	24.0	104.91	104.95
CB-29	Maj_109	20.0	24.0	104.91	104.95
CB-3	Maj_087	7.0	10.0	103.61	103.64
CB-30	Maj_071	6.0	6.0	104.04	104.04
CB-31	Maj_071	6.0	6.0	104.04	104.04
CB-32	Maj_070	6.0	6.0	103.27	103.27
CB-33	Maj_117	7.0	7.0	103.07	103.07
CB-34	Maj_115	7.0	7.0	102.61	102.62
CB-35	Maj_114-2	7.0	7.0	102.31	102.31
CB-36	Maj_113	6.0	7.0	101.29	101.30
CB-37	Maj_112	7.0	8.0	101.15	101.16
CB-38	Maj_111	34.0	44.0	100.51	100.61
CB-39	Maj_111	34.0	44.0	100.51	100.61
CB-4	Maj_130	10.0	12.0	100.45	100.47
CB-40	Maj_031	26.0	27.0	104.20	104.21
CB-41	Maj_031	26.0	27.0	104.20	104.21
CB-42	Maj_032	4.0	4.0	104.43	104.44
CB-43	Maj_037	6.0	7.0	105.10	105.11
CB-44	Maj_037	6.0	7.0	105.10	105.11
CB-45	Maj_035	26.0	28.0	104.26	104.28
CB-46	Maj_035	26.0	28.0	104.26	104.28
CB-47	Maj_108	5.0	6.0	105.51	105.52
CB-48	Maj_107	5.0	6.0	105.44	105.45
CB-49	Maj_106	26.0	30.0	103.91	103.94
CB-5	Maj_121	19.0	24.0	101.14	101.18
CB-50	Maj_106	26.0	30.0	103.91	103.94
CB-51	Maj_077	24.0	27.0	104.30	104.33
CB-52	Maj_077	24.0	27.0	104.30	104.33
CB-53	Maj_080	5.0	6.0	105.86	105.86
CB-54	Maj_080	5.0	6.0	105.86	105.86
CB-55	Maj_097	3.0	3.0	106.07	106.07
CB-56	Maj_096	5.0	6.0	105.88	105.89
CB-57	Maj_094	5.0	5.0	105.87	105.87
CB-58	Maj_092	4.0	5.0	105.62	105.63
CB-59	Maj_090	6.0	6.0	105.27	105.27
CB-6	Maj_121	19.0	24.0	101.14	101.18
CB-60	Maj_089	5.0	6.0	105.20	105.21
CB-61	Maj_083	29.0	31.0	103.02	103.05

Table D-7: Ponding at Major Low Points for the 100-Year Chicago Storm & 100-Year Chicago Storm +20%

Catch Basin ID	Major Node	Total Depth		Water Surface Elevation	
		100 Year 3 Hr Chi (cm)	100 Year 3 Hr Chi+20% (cm)	100 Year 3 Hr Chi (m)	100 Year 3 Hr Chi+20% (m)
CB-62	Maj_083	29.0	31.0	103.02	103.05
CB-63	Maj_058	6.0	7.0	105.01	105.02
CB-64	Maj_055	6.0	7.0	104.43	104.44
CB-65	Maj_054	6.0	7.0	104.04	104.05
CB-66	Maj_053	11.0	12.0	103.85	103.86
CB-67	Maj_051	8.0	9.0	102.44	102.45
CB-68	Maj_049	28.0	30.0	102.38	102.40
CB-69	Maj_049	28.0	30.0	102.38	102.40
CB-7	Maj_124	2.0	3.0	101.18	101.18
CB-70	Maj_105	6.0	7.0	105.34	105.35
CB-71	Maj_104	5.0	6.0	105.29	105.29
CB-72	Maj_103	27.0	31.0	103.51	103.55
CB-73	Maj_103	27.0	31.0	103.51	103.55
CB-74	Maj_099	28.0	32.0	103.03	103.06
CB-75	Maj_099	28.0	32.0	103.03	103.06
CB-76	Maj_040	6.0	7.0	104.48	104.49
CB-77	Maj_041	5.0	6.0	105.20	105.20
CB-78	Maj_045	5.0	5.0	105.77	105.78
CB-79	Maj_045	5.0	5.0	105.77	105.78
CB-8	Maj_124	2.0	3.0	101.18	101.18
CB-80	Maj_046	5.0	5.0	105.93	105.94
CB-81	Maj_046	5.0	5.0	105.93	105.94
CB-82	Maj_101	17.0	21.0	105.35	105.39
CB-83	Maj_101	17.0	21.0	105.35	105.39
CB-84	Maj_067	8.0	8.0	102.20	102.21
CB-85	Maj_067	8.0	8.0	102.20	102.21
CB-86	Maj_066	7.0	8.0	101.47	101.48
CB-87	Maj_066	7.0	8.0	101.47	101.48
CB-88	Maj_064	8.0	9.0	100.84	100.85
CB-89	Maj_063	29.0	31.0	100.81	100.82
CB-9	Maj_061	6.0	6.0	103.05	103.05
CB-90	Maj_063	29.0	31.0	100.81	100.82
CB-91	Maj_135	31.0	38.0	100.73	100.81
CB-92	Maj_135	31.0	38.0	100.73	100.81
CB-93	Maj_138	30.0	38.0	100.89	100.97
CB-94	Maj_138	30.0	38.0	100.89	100.97
CB-95	Maj_140	31.0	35.0	101.11	101.15
CB-96	Maj_140	31.0	35.0	101.11	101.15
CB-97	Maj_142	9.0	10.0	101.34	101.36
CB-98	Maj_143	9.0	10.0	101.70	101.71
CB-99	Maj_144	8.0	9.0	101.99	102.00
MAX		34.00	44.00		

Table D-8: Major System Flow Depths 100-Year Peak Flow

Link Name	Transect	Max Velocity (m/s)	Max Depth (m)	Depth x Velocity (m^2/s)
Maj_005	1	43466.00	0.00	0.00
Maj_006_1	1	43466.00	0.00	0.00
Maj_006_2	1	43466.00	0.00	0.00
Maj_009_1	1	43466.05	0.00	0.00
Maj_009_2	1	43466.05	0.00	0.00
Maj_012_1	1	43466.05	0.00	0.00
Maj_012_3	1	43466.05	0.00	0.00
Maj_012_4	1	43466.05	0.00	0.00
Maj_014_1	1	43466.00	0.00	0.00
Maj_014_2	1	43466.00	0.00	0.00
Maj_016_1	1	43466.05	0.00	0.00
Maj_016_2	1	43466.05	0.00	0.00
Maj_016_3	1	43466.05	0.01	260.80
Maj_017	1	43466.05	0.00	0.00
Maj_018	1	43466.05	0.00	0.00
Maj_019_1	1	43466.00	0.00	0.00
Maj_019_2	1	43466.00	0.00	0.00
Maj_021	1	43466.05	0.00	0.00
Maj_022_1	1	43466.05	0.00	0.00
Maj_022_2	1	43466.05	0.00	0.00
Maj_023_1	1	43466.00	0.00	0.00
Maj_023_3	1	43466.00	0.00	0.00
Maj_023_4	1	43466.05	0.00	0.00
Maj_025_1	1	43466.05	0.00	0.00
Maj_025_2	1	43466.05	0.01	260.80
Maj_026	1	43466.05	0.00	0.00
Maj_027	1	43466.05	0.00	0.00
Maj_028_1	1	43466.00	0.00	0.00
Maj_028_3	1	43466.00	0.00	0.00
Maj_028_4	1	43466.00	0.00	0.00
Maj_030	1	43466.05	0.00	0.00
Maj_032	1	43466.05	0.00	0.00
Maj_033_1	1	43466.00	0.00	0.00
Maj_033_2	1	43466.00	0.00	0.00
Maj_034_1	1	43466.00	0.00	0.00
Maj_034_2	1	43466.00	0.00	0.00
Maj_036	1	43466.05	0.00	0.00
Maj_037	1	43466.05	0.00	0.00
Maj_038	1	43466.05	0.00	0.00
Maj_039_1	1	43466.05	0.00	0.00
Maj_039_2	1	43466.05	0.00	0.00
Maj_040	1	43466.05	0.00	0.00
Maj_041	1	43466.05	0.00	0.00
Maj_042	1	43466.05	0.00	0.00
Maj_043	1	43466.05	0.00	0.00
Maj_044	1	43466.05	0.00	0.00
Maj_045	1	43466.05	0.00	0.00
Maj_046	1	43466.05	0.00	0.00
Maj_047	1	43466.00	0.00	0.00
Maj_048_1	1	43466.00	0.00	0.00
Maj_048_2	1	43466.00	0.00	0.00
Maj_050	1	43466.05	0.01	260.80

Table D-8: Major System Flow Depths 100-Year Peak Flow

Link Name	Transect	Max Velocity (m/s)	Max Depth (m)	Depth x Velocity (m^2/s)
Maj_051	1	43466.05	0.00	0.00
Maj_053	1	43466.05	0.01	260.80
Maj_054	1	43466.05	0.01	260.80
Maj_055	1	43466.05	0.01	260.80
Maj_056	1	43466.05	0.00	0.00
Maj_057_1	1	43466.05	0.00	0.00
Maj_057_2	1	43466.05	0.00	0.00
Maj_058	1	43466.05	0.01	260.80
Maj_059_1	1	43466.05	0.02	782.39
Maj_059_2	1	43466.05	0.01	521.59
Maj_060_1	1	43466.00	0.00	0.00
Maj_060_2	1	43466.00	0.00	0.00
Maj_062	1	43466.05	0.00	0.00
Maj_064	1	43466.05	0.01	260.80
Maj_068	1	43466.05	0.00	0.00
Maj_069_1	1	43466.05	0.00	0.00
Maj_069_2	1	43466.05	0.00	0.00
Maj_070	1	43466.05	0.01	260.80
Maj_071	1	43466.05	0.01	260.80
Maj_072_1	1	43466.00	0.00	0.00
Maj_072_2	1	43466.00	0.00	0.00
Maj_073_1	1	43466.05	0.02	782.39
Maj_073_2	1	43466.05	0.01	260.80
Maj_074	1	43466.05	0.01	260.80
Maj_076	1	43466.05	0.00	0.00
Maj_078_2	1	43466.05	0.00	0.00
Maj_078_3	1	43466.05	0.00	0.00
Maj_078_4	1	43466.05	0.00	0.00
Maj_079	1	43466.05	0.00	0.00
Maj_080	1	43466.05	0.00	0.00
Maj_081	1	43466.00	0.00	0.00
Maj_082_1	1	43466.00	0.00	0.00
Maj_082_2	1	43466.00	0.00	0.00
Maj_084_1	1	43466.05	0.01	260.80
Maj_084_2	1	43466.05	0.00	0.00
Maj_085	1	43466.05	0.00	0.00
Maj_086_1	1	43466.05	0.00	0.00
Maj_086_2	1	43466.05	0.00	0.00
Maj_087	1	43466.05	0.00	0.00
Maj_088_1	1	43466.05	0.00	0.00
Maj_088_2	1	43466.05	0.00	0.00
Maj_089	1	43466.05	0.00	0.00
Maj_090	1	43466.05	0.00	0.00
Maj_092	1	43466.05	0.00	0.00
Maj_093_1	1	43466.05	0.00	0.00
Maj_093_2	1	43466.05	0.00	0.00
Maj_094	1	43466.05	0.00	0.00
Maj_095_1	1	43466.05	0.00	0.00
Maj_095_2	1	43466.05	0.00	0.00
Maj_095_3	1	43466.05	0.00	0.00
Maj_095_4	1	43466.05	0.00	0.00
Maj_097	1	43466.05	0.00	0.00

Table D-8: Major System Flow Depths 100-Year Peak Flow

Link Name	Transect	Max Velocity (m/s)	Max Depth (m)	Depth x Velocity (m^2/s)
Maj_098	1	43466.00	0.00	0.00
Maj_099	1	43466.05	0.01	260.80
Maj_1	1	43466.05	0.00	0.00
Maj_10	1	43466.05	0.01	260.80
Maj_100	1	43466.05	0.01	260.80
Maj_102	1	43466.00	0.00	0.00
Maj_104	1	43466.05	0.00	0.00
Maj_105	1	43466.05	0.00	0.00
Maj_11	1	43466.05	0.00	0.00
Maj_112	1	43466.05	0.00	0.00
Maj_114	1	43466.05	0.00	0.00
Maj_116	1	43466.05	0.00	0.00
Maj_117	1	43466.05	0.01	260.80
Maj_119	1	43466.05	0.02	782.39
Maj_12	1	43466.05	0.00	0.00
Maj_122	1	43466.05	0.01	260.80
Maj_123_2	1	43466.05	0.01	260.80
Maj_123_3	1	43466.05	0.01	521.59
Maj_124	1	43466.05	0.00	0.00
Maj_126_1	1	43466.05	0.01	260.80
Maj_126_2	1	43466.05	0.01	260.80
Maj_128_1	1	43466.05	0.01	260.80
Maj_128_2	1	43466.05	0.01	260.80
Maj_13	1	43466.05	0.00	0.00
Maj_130	1	43466.05	0.01	260.80
Maj_131	1	43466.05	0.01	260.80
Maj_132	1	43466.05	0.01	260.80
Maj_133	1	43466.05	0.01	521.59
Maj_134_1	1	43466.05	0.01	521.59
Maj_134_2	1	43466.05	0.01	521.59
Maj_136	1	43466.05	0.02	782.39
Maj_137_1	1	43466.05	0.02	782.39
Maj_137_2	1	43466.05	0.02	782.39
Maj_139	1	43466.05	0.02	782.39
Maj_141	1	43466.05	0.01	260.80
Maj_143	1	43466.05	0.02	782.39
Maj_144	1	43466.05	0.01	521.59
Maj_145	1	43466.05	0.01	521.59
Maj_2	1	43466.05	0.00	0.00
Maj_3	1	43466.05	0.02	782.39
Maj_4	1	43466.05	0.01	260.80
Maj_5	1	43466.05	0.01	260.80
Maj_6	1	43466.05	0.00	0.00
Maj_7	1	43466.05	0.00	0.00
Maj_8	1	43466.05	0.00	0.00
Maj_9	1	43466.05	0.00	0.00
Max		**43466.05**	**0.02**	**782.39**

Table D-9: Major System Flow Depths 100-Year+20% Peak Flow

Link Name	Transcect	Max Velocity (m/s)	Max Depth (m)	Depth x Velocity (m^2/s)
Maj_005	1	43466.00	0.00	0.00
Maj_006_1	1	43466.00	0.00	0.00
Maj_006_2	1	43466.00	0.00	0.00
Maj_009_1	1	43466.05	0.00	0.00
Maj_009_2	1	43466.06	0.02	782.39
Maj_012_1	1	43466.05	0.01	260.80
Maj_012_3	1	43466.05	0.01	260.80
Maj_012_4	1	43466.05	0.00	0.00
Maj_014_1	1	43466.05	0.01	260.80
Maj_014_2	1	43466.05	0.01	260.80
Maj_016_1	1	43466.05	0.01	260.80
Maj_016_2	1	43466.05	0.00	0.00
Maj_016_3	1	43466.05	0.01	260.80
Maj_017	1	43466.05	0.00	0.00
Maj_018	1	43466.05	0.00	0.00
Maj_019_1	1	43466.05	0.00	0.00
Maj_019_2	1	43466.05	0.00	0.00
Maj_021	1	43466.05	0.00	0.00
Maj_022_1	1	43466.05	0.00	0.00
Maj_022_2	1	43466.05	0.00	0.00
Maj_023_1	1	43466.00	0.00	0.00
Maj_023_3	1	43466.00	0.00	0.00
Maj_023_4	1	43466.05	0.00	0.00
Maj_025_1	1	43466.05	0.00	0.00
Maj_025_2	1	43466.05	0.01	260.80
Maj_026	1	43466.05	0.00	0.00
Maj_027	1	43466.05	0.00	0.00
Maj_028_1	1	43466.00	0.00	0.00
Maj_028_3	1	43466.00	0.00	0.00
Maj_028_4	1	43466.05	0.00	0.00
Maj_030	1	43466.05	0.00	0.00
Maj_032	1	43466.05	0.00	0.00
Maj_033_1	1	43466.05	0.00	0.00
Maj_033_2	1	43466.05	0.00	0.00
Maj_034_1	1	43466.00	0.00	0.00
Maj_034_2	1	43466.00	0.00	0.00
Maj_036	1	43466.05	0.00	0.00
Maj_037	1	43466.05	0.00	0.00
Maj_038	1	43466.05	0.01	260.80
Maj_039_1	1	43466.05	0.00	0.00
Maj_039_2	1	43466.05	0.01	260.80
Maj_040	1	43466.05	0.00	0.00
Maj_041	1	43466.05	0.00	0.00
Maj_042	1	43466.05	0.00	0.00
Maj_043	1	43466.05	0.00	0.00
Maj_044	1	43466.05	0.00	0.00
Maj_045	1	43466.05	0.00	0.00
Maj_046	1	43466.05	0.00	0.00
Maj_047	1	43466.00	0.00	0.00
Maj_048_1	1	43466.00	0.00	0.00
Maj_048_2	1	43466.00	0.00	0.00
Maj_050	1	43466.05	0.01	260.80

Table D-9: Major System Flow Depths 100-Year+20% Peak Flow

Link Name	Transect	Max Velocity (m/s)	Max Depth (m)	Depth x Velocity (m^2/s)
Maj_051	1	43466.05	0.01	260.80
Maj_053	1	43466.05	0.01	260.80
Maj_054	1	43466.05	0.01	260.80
Maj_055	1	43466.05	0.01	260.80
Maj_056	1	43466.05	0.00	0.00
Maj_057_1	1	43466.05	0.01	260.80
Maj_057_2	1	43466.05	0.01	260.80
Maj_058	1	43466.05	0.01	260.80
Maj_059_1	1	43466.05	0.02	1043.19
Maj_059_2	1	43466.05	0.02	782.39
Maj_060_1	1	43466.00	0.00	0.00
Maj_060_2	1	43466.00	0.00	0.00
Maj_062	1	43466.05	0.00	0.00
Maj_064	1	43466.05	0.01	260.80
Maj_068	1	43466.05	0.00	0.00
Maj_069_1	1	43466.05	0.00	0.00
Maj_069_2	1	43466.05	0.00	0.00
Maj_070	1	43466.05	0.01	260.80
Maj_071	1	43466.05	0.01	260.80
Maj_072_1	1	43466.05	0.00	0.00
Maj_072_2	1	43466.05	0.00	0.00
Maj_073_1	1	43466.05	0.02	1043.19
Maj_073_2	1	43466.05	0.01	260.80
Maj_074	1	43466.05	0.01	521.59
Maj_076	1	43466.05	0.00	0.00
Maj_078_2	1	43466.05	0.00	0.00
Maj_078_3	1	43466.05	0.00	0.00
Maj_078_4	1	43466.05	0.00	0.00
Maj_079	1	43466.05	0.00	0.00
Maj_080	1	43466.05	0.00	0.00
Maj_081	1	43466.00	0.00	0.00
Maj_082_1	1	43466.00	0.00	0.00
Maj_082_2	1	43466.00	0.00	0.00
Maj_084_1	1	43466.05	0.01	260.80
Maj_084_2	1	43466.05	0.01	260.80
Maj_085	1	43466.05	0.01	260.80
Maj_086_1	1	43466.05	0.01	260.80
Maj_086_2	1	43466.05	0.00	0.00
Maj_087	1	43466.05	0.01	260.80
Maj_088_1	1	43466.05	0.01	260.80
Maj_088_2	1	43466.05	0.00	0.00
Maj_089	1	43466.05	0.00	0.00
Maj_090	1	43466.05	0.00	0.00
Maj_092	1	43466.05	0.00	0.00
Maj_093_1	1	43466.05	0.00	0.00
Maj_093_2	1	43466.05	0.00	0.00
Maj_094	1	43466.05	0.00	0.00
Maj_095_1	1	43466.05	0.00	0.00
Maj_095_2	1	43466.05	0.00	0.00
Maj_095_3	1	43466.05	0.00	0.00
Maj_095_4	1	43466.05	0.00	0.00
Maj_097	1	43466.05	0.00	0.00

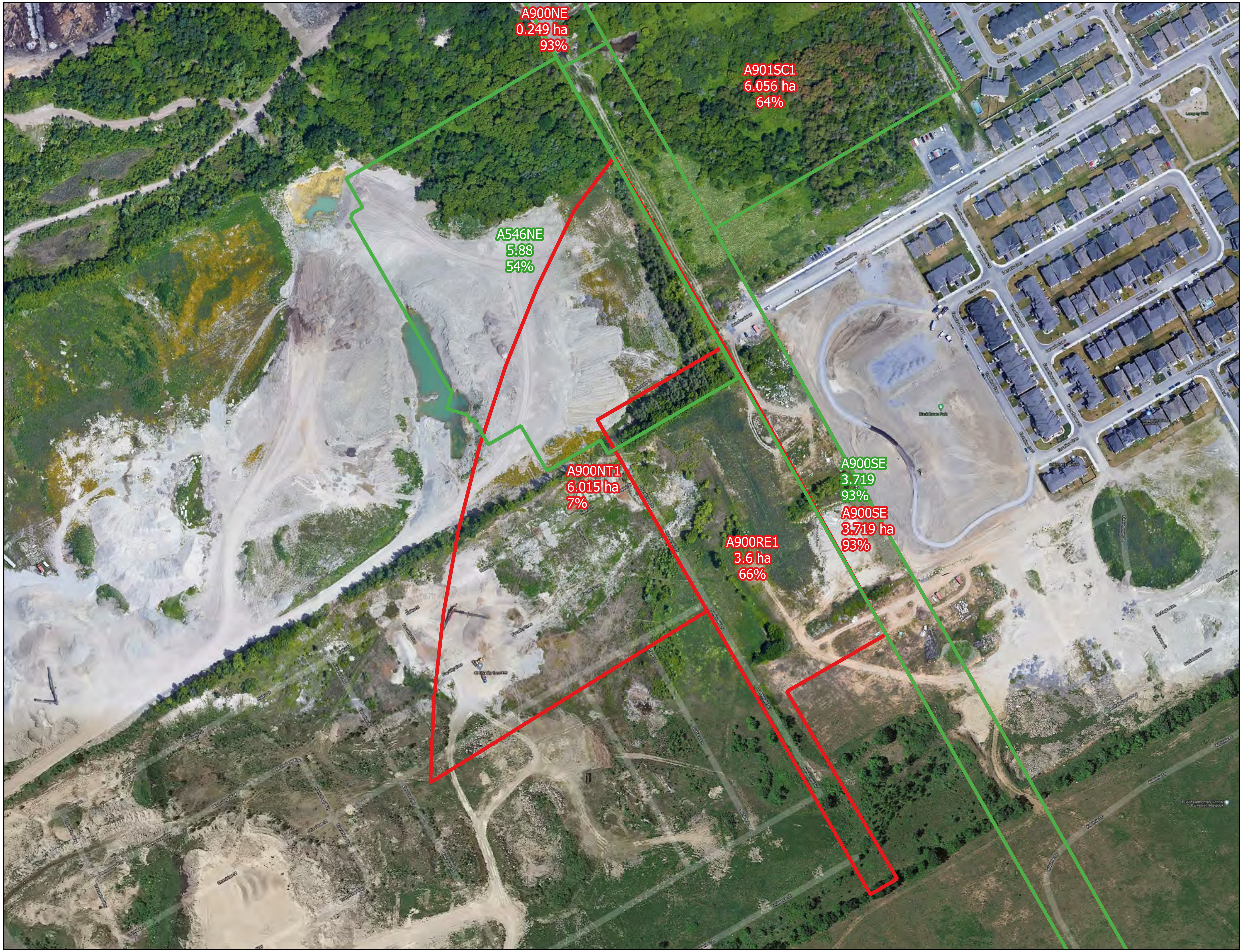
Table D-9: Major System Flow Depths 100-Year+20% Peak Flow

Link Name	Transect	Max Velocity (m/s)	Max Depth (m)	Depth x Velocity (m^2/s)
Maj_098	1	43466.00	0.00	0.00
Maj_099	1	43466.05	0.01	260.80
Maj_1	1	43466.05	0.00	0.00
Maj_10	1	43466.05	0.01	260.80
Maj_100	1	43466.05	0.01	260.80
Maj_102	1	43466.00	0.00	0.00
Maj_104	1	43466.05	0.00	0.00
Maj_105	1	43466.05	0.00	0.00
Maj_11	1	43466.05	0.00	0.00
Maj_112	1	43466.05	0.01	260.80
Maj_114	1	43466.05	0.00	0.00
Maj_116	1	43466.05	0.00	0.00
Maj_117	1	43466.05	0.01	521.59
Maj_119	1	43466.05	0.02	1043.19
Maj_12	1	43466.05	0.01	260.80
Maj_122	1	43466.05	0.01	260.80
Maj_123_2	1	43466.05	0.01	521.59
Maj_123_3	1	43466.05	0.02	1043.19
Maj_124	1	43466.05	0.00	0.00
Maj_126_1	1	43466.06	0.02	782.39
Maj_126_2	1	43466.06	0.02	782.39
Maj_128_1	1	43466.06	0.02	782.39
Maj_128_2	1	43466.06	0.02	782.39
Maj_13	1	43466.05	0.01	260.80
Maj_130	1	43466.05	0.01	521.59
Maj_131	1	43466.06	0.01	521.59
Maj_132	1	43466.06	0.01	521.59
Maj_133	1	43466.05	0.03	1303.98
Maj_134_1	1	43466.05	0.04	1564.78
Maj_134_2	1	43466.05	0.04	1564.78
Maj_136	1	43466.05	0.04	1825.57
Maj_137_1	1	43466.05	0.04	1564.78
Maj_137_2	1	43466.05	0.04	1825.57
Maj_139	1	43466.05	0.04	1564.78
Maj_141	1	43466.05	0.01	260.80
Maj_143	1	43466.05	0.02	1043.19
Maj_144	1	43466.05	0.02	782.39
Maj_145	1	43466.05	0.02	782.39
Maj_2	1	43466.05	0.00	0.00
Maj_3	1	43466.05	0.02	1043.19
Maj_4	1	43466.05	0.01	260.80
Maj_5	1	43466.05	0.01	521.59
Maj_6	1	43466.05	0.00	0.00
Maj_7	1	43466.05	0.00	0.00
Maj_8	1	43466.05	0.01	260.80
Maj_9	1	43466.05	0.01	260.80
Max		**43466.06**	**0.04**	**1825.57**

APPENDIX E

Half Moon Bay SWM Facility Analysis

JFSA Water Resources and Environmental Consultants



N

Legend

- MH
- STM
- Drummond Detailed Design (Feb 2022) -Drainage Area -%imp
- Half Moon Bay SWM Report (Aug 2021) -Drainage Area -%imp

SCALE: 1:3000

0 50 100 150 m

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
52 Springbrook Drive
Ottawa, ON, K2S 1B9
(613) 836-3884
www.jfsa.com

DSEL
david schaeffer engineering ltd

Drummond

Figure E1: Drainage to Halfmoon Bay SWM

PROJECT	2226
DRAWN	JB
DATE	FEB 2022

C:\OneDrive\J.F. Sabourin and Associates Inc\JFSA-OTTAWA-SERVER - Documents\PROJ\2226-21\202201-Submission 2\Design\GIS\20220204-HMB Area Comparsion

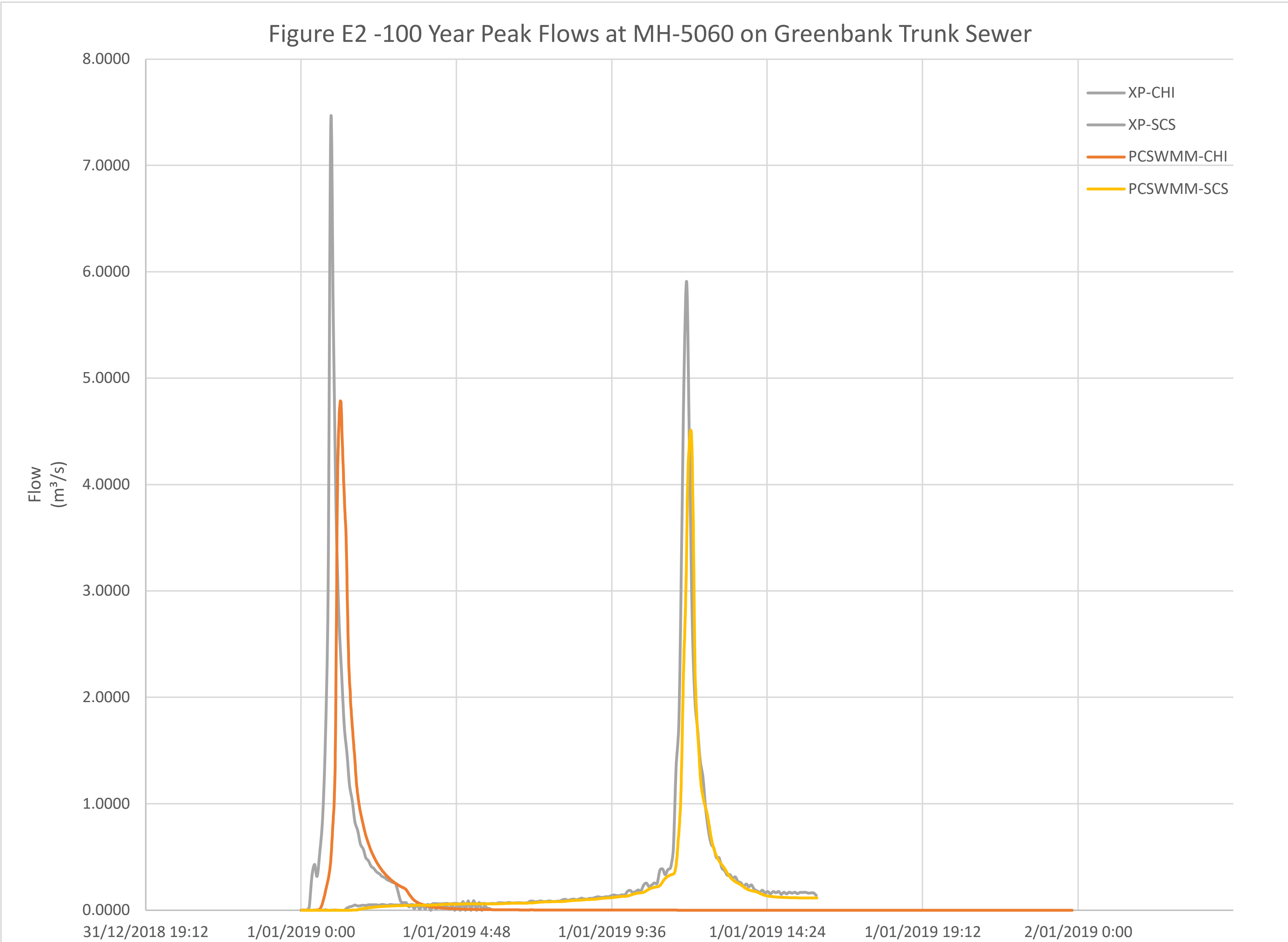


Figure E2 -100 Year Peak Flows at MH-5060 on Greenbank Trunk Sewer
8.0000
7.0000
6.0000
5.0000
4.0000
3.0000
2.0000
1.0000
0.0000
Flow
(m³/s)
31/12/2018 19:12
1/01/2019 0:00
1/01/2019 4:48
1/01/2019 9:36
1/01/2019 14:24
1/01/2019 19:12
2/01/2019 0:00
XP-CHI
XP-SCS
PCSWMM-CHI
PCSWMM-SCS

E.3 GEOTECHNCIAL INVESTIGATION REPORT BY PATERSON INC. (MARCH 2020)

Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Noise and Vibration Studies

patersongroup

Geotechnical Investigation

Proposed Mixed Use Development
Half Moon Bay South - Phase 8
3718 Greenbank Road - Ottawa

Prepared For

Mattamy Homes

March 30, 2021

Report: PG5690-1

Paterson Group Inc.
Consulting Engineers
154 Colonnade Road South
Ottawa (Nepean), Ontario
Canada K2E 7J5

Tel: (613) 226-7381
Fax: (613) 226-6344
www.patersongroup.ca

Table of Contents

Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Mattamy Homes to conduct a geotechnical investigation for Phase 8 of Half Moon Bay South development located at 3718 Greenbank Road, in the City of Ottawa (refer to Figure 1 - Key Plan presented in Appendix 2).

The objective of the investigation was to:

- ❑ determine the subsoil and groundwater conditions at this site by means of a borehole program.
- ❑ provide geotechnical recommendations for the design of the proposed development based on the results of the boreholes and other soil information available.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. The report contains our findings and includes geotechnical recommendations pertaining to the design and construction of the proposed development as understood at the time of this report.

2.0 Proposed Development

It is understood that the current phase of the proposed development will consist of residential condominium blocks with or without basements and commercial areas consisting of slab on grade buildings. Associated driveways, local roadways and landscaping areas are also anticipated as part of the proposed development.

It is further understood that the proposed development will be serviced by future municipal water, sanitary and storm services.

3.0 Method of Investigation

3.1 Field Investigation

The field program for the current geotechnical investigation was carried out between February 17 and 23, 2021 and consisted of advancing a total of 12 boreholes to a maximum depth of 9.8 m below existing grade. Previous investigations were completed within the general area and surroundings of the subject site and consisted of a series of boreholes and test pits advanced to a maximum depth of 9.1 m below ground surface. The borehole locations were distributed in a manner to provide general coverage of the subject site and taking into consideration current site conditions. The test holes locations are shown on Drawing PG5690-1 - Test Hole Location Plan included in Appendix 2.

The test holes were completed using a track mounted drill operated by a two-person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The drilling procedure consisted of drilling to the required depths at the selected locations, and sampling and testing the overburden.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using a 50 mm diameter split-spoon (SS) sampler. All soil samples were visually inspected and initially classified on site. The auger, split-spoon and grab samples were placed in sealed plastic bags and transported to the our laboratory for examination and classification. The depths at which the auger, and split-spoon samples were recovered from the test holes are shown as AU, and SS, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split-spoon samples. The SPT results are recorded as “N” values on the Soil Profile and Test Data sheets. The “N” value is the number of blows required to drive the split-spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

The thickness of the silty sand deposit was evaluated by a dynamic cone penetration testing (DCPT) completed at BH 7-21. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

The subsurface conditions observed at the test hole locations were recorded in detail in the field. Our findings are presented in the Soil Profile and Test Data sheets in Appendix 1.

Groundwater Monitoring

All boreholes were fitted with flexible piezometers to allow groundwater level monitoring. The groundwater observations are discussed in Subsection 4.3 and presented in the Soil Profile and Test Data sheets in Appendix 1.

Sample Storage

All samples from the current investigation will be stored in the laboratory for a period of one month after issuance of this report. They will then be discarded unless we are otherwise directed.

3.2 Field Survey

The test hole locations were determined by Paterson personnel and surveyed in the field by Paterson using a handheld, high precision GPS. The ground surface elevation at each test hole location is referenced to a geodetic datum. The locations of the boreholes are presented on Drawing PG5690-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples were collected from the subject site during the investigation and were visually examined in our laboratory to review the results of the field logging. Three grain size distribution analyses were completed on selected soil samples. The results of our testing are presented in Subsection 4.2 and on Grain Size Distribution Analysis sheets presented in Appendix 1.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was submitted to determine the concentration of sulphate and chloride, the resistivity and the pH of the sample. The results are presented in Appendix 1 and are discussed further in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is a former agricultural land. The bulk of the current phase of the proposed development has been recently cleared of topsoil and peat which has been stockpiled in several piles across the site. Generally, the ground surface across the subject site is relatively flat within the central portion and slopes up towards the edges. It should be noted that parts of the subject site had undergone excavation and in-filling activities as part of a previous sand extraction operation. Historical aerial photographs of the site indicating fill movement activities since 1976 are presented in Appendix 2. The area to the south is significantly elevated. The area to the north and west also present a steep slope where fill was encountered.

The site is bordered to the south by a park and vacant land and to the north and west by future residential developments and the east by the future Greenbank Road.

4.2 Subsurface Profile

Generally, the subsurface profile across the subject site consists of varying amounts of fill consisting of silty sand mixed with occasional silty clay, gravel and cobbles. It should be noted that the fill thickness within BH 9-21, BH 10-21 and BH 11-21 ranged from 4.5 m and up to 8.23 m below ground surface.

A deep deposit of compact to dense brown silty sand to underlain the fill layer. Gravel and cobbles were occasionally encountered within the silty sand layer. The silty sand was observed to be underlain by a glacial till deposit composed of dense brown sandy silt to silty sand with gravel, cobbles and boulders within BH 3-21.

Practical refusal to augering was encountered at a range between 4.6 m and 8.3 m below existing ground surface. Practical refusal to DCPT was encountered at 9.8 m below existing ground surface at BH 7-21.

Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profiles encountered at each test hole location.

Bedrock

Based on available geological mapping, the bedrock in the subject area consists of Paleozoic interbedded Sandstone and Dolomite from the March formation, with an overburden drift thickness of 10 to 15 m depth.

Grain Size Distribution and Hydrometer Testing

Grain size distribution (sieve and hydrometer analysis) testing was completed on three selected soil samples. The results of the grain size analysis are summarized in Table 1 and presented on the Grain-Size Distribution and Hydrometer Testing Results sheets in Appendix 1.

Table 1 - Grain Size Distribution

Borehole	Sample	Gravel (%)	Sand (%)	Silt and Clay (%)
BH2-21	SS3 & SS4	1.8	89.4	8.8
BH4-21	SS4 & SS5	0	88.9	11.1
BH8-21	SS4 & SS5	46.9	43.1	10

4.3 Groundwater

Groundwater levels were measured in the groundwater monitoring wells on March 4, 2021. The piezometers in BH 7-21, BH 11-21 and BH 12-21 were damaged or buried and could not be recorded. The remaining boreholes were dry upon completion.

Long-term groundwater level can also be estimated based on the observed moisture levels, colour and consistency of the recovered soil samples. Based on these observations, the long-term groundwater table can be expected well below 8 m below existing ground surface. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is suitable for the proposed mixed-use development. It is anticipated that the proposed buildings will be founded over conventional footings placed over an undisturbed compact to dense silty sand or dense glacial till bearing surface or an engineered fill pad over an approved fill subgrade bearing medium.

To adequately distribute the foundation loads in areas where the existing fill is encountered below the building footprint, a woven geotextile liner, such as Terratrack 200 or equivalent, should be placed 500 mm below design underside of footing level and extend at least 1 m horizontally beyond the footing face. A biaxial geogrid, such as Terrafix TBX2500 or equivalent, should be placed over the woven geotextile liner. A minimum 500 mm thick pad, consisting of a Granular B Type II, compacted to 98% of its SPMDD should be placed up to design underside of footing level. Prior to placement of the abovenoted engineered fill pad, it is recommended that a proof-rolling program be completed by a vibratory roller making several passes and approved by Paterson personnel over the sub-excavated area below the proposed footings.

For areas where a fill layer is encountered below the granular layer for the floor slab, it is recommended to sub-excavate 500 mm below the underside of floor slab granulars and place a woven geotextile liner, such as Terratrack 200W or equivalent, and a biaxial geogrid, such as Terrafix TBX2500 or equivalent. It is recommended that a proof-rolling program be completed by a vibratory roller making several passes and approved by Paterson personnel prior to placement of the geotextile liner and biaxial geogrid. Any poor performing areas should be removed and reinstated with a select subgrade fill compacted to 98% of its SPMDD under dry and above freezing temperatures.

The proof-rolling program should also be completed across paved areas to ensure that any poor performing soils are removed prior to pavement structure placement.

Due to the absence of a silty clay deposit, the aforementioned site will not be subjected to permissible grade raise restrictions. Also, no tree planting setback restrictions are required for the subject phase of the proposed development due to the absence of a silty clay deposit.

The above and other considerations are further discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing organic materials, should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures.

Fill Placement

Fill used for grading beneath the proposed building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill should be placed in lifts of 300 mm thick or less and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building areas should be compacted to at least 99% of the Standard Proctor Maximum Dry Density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill and beneath parking areas where settlement of the ground surface is of minor concern. In landscaped areas, these materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of the SPMDD.

Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

Proof Rolling

Proof rolling of the subgrade is required in areas where the existing fill, free of significant amounts of organics and deleterious materials, is encountered. It is recommended that the subgrade surface be proof-rolled **under dry conditions and in above freezing temperatures** by an adequately sized roller making several passes to achieve optimum compaction levels. The compaction program should be reviewed and approved by the geotechnical consultant at the time of construction.

5.3 Foundation Design

Conventional Spread Footings

Footings placed directly on an undisturbed, compact silty sand or glacial till bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS.

Footings placed over a minimum 500 mm thick geogrid reinforced engineered pad, consisting of a Granular A or Granular B Type II or approved granular fill alternative placed in maximum 300 mm loose lifts and compacted to 98% of its SPMDD, placed over a subgrade soil approved by the Paterson personnel at the time of construction, can be designed using a bearing resistance value at SLS of **150 kPa** and a factored bearing resistance value at ULS of **250 kPa**.

An undisturbed soil bearing surface consists of a surface from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

Footings placed on a soil bearing surface and designed using the bearing resistance values at SLS given above will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively.

Where the silty sand subgrade is found to be in a loose state, the contractor should compact the subgrade under dry conditions and above freezing temperatures, using suitable compaction equipment, making several passes and approved by Paterson.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to the in-situ bearing medium soils above the groundwater table when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil of the same or higher capacity as the bearing medium soil.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class D**. Based on the current information, including the level of groundwater table and compactness of the underlying sand layer, the soil underlying the subject site is not susceptible to liquefaction. Reference should be made to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Basement Slab / Slab-on-Grade Construction

With the removal of all topsoil and fill, containing significant amounts of deleterious or organic materials, the native soil and/or approved fill pad (placed as per Subsection 5.0) will be considered to be an acceptable subgrade surface on which to commence backfilling for the floor slab. Any poor performing areas should be removed and reinstated with an engineered fill, such as Granular B Type II.

For slab-on-grade areas, it is recommended that the upper 200 mm of sub-slab fill consist OPSS Granular A crushed stone. For basement slabs, it is recommended that the upper 200 mm of sub-floor fill consist of 19 mm clear crushed stone

5.6 Pavement Structure

Driveways, local residential roadways, heavy truck parking/loading areas and roadways with bus traffic are anticipated at this site. The proposed pavement structures are shown in Tables 2, 3 and 4.

Table 2 - Recommended Pavement Structure - Driveways and at-grade car parking areas

Thickness (mm)	Material Description
50	**Wear Course** - HL 3 or Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Table 3 - Recommended Pavement Structure - Local Residential Roadways and Heavy Truck Parking / Loading Areas

Thickness (mm)	Material Description
40	**Wear Course -** Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil	

Table 4 - Recommended Pavement Structure - Roadways with Bus Traffic

Thickness mm	Material Description
40	**Wear Course -** Superpave 12.5 Asphaltic Concrete
50	**Upper Binder Course** - Superpave 19.0 Asphaltic Concrete
50	**Lower Binder Course** - Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
600	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either in situ soil or OPSS Granular B Type II material placed over in situ soil	

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material's SPMDD using suitable vibratory equipment. Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

A perimeter foundation drainage system is recommended for proposed structures. The system should consist of a 100 to 150 mm diameter, geotextile-wrapped, perforated, corrugated, plastic pipe, surrounded on all sides by 150 mm of 10 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

Foundation Backfill

Backfill against the exterior sides of the foundation walls should consist of free-draining, non frost susceptible granular materials. The site materials will be frost susceptible and, as such, are not recommended for re-use as backfill unless a composite drainage system (such as system Delta Drain 6000 or Miradrain G100N) connected to a perimeter drainage system is provided.

6.2 Protection Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effect of frost action. A minimum 1.5 m thick soil cover should be provided for adequate frost protection of heated structured, or an equivalent combination of soil cover and foundation insulation.

Exterior unheated footings, such as those for isolated exterior piers and loading docks, are more prone to deleterious movement associated with frost action than the exterior walls of the heated structure and require additional protection, such as soil cover of 2.1 m or an equivalent combination of soil cover and foundation insulation.

6.3 Excavation Side Slopes

The side slopes of the excavations in the soil and fill overburden materials should either be cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is expected that sufficient room will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e. unsupported excavations).

Unsupported Excavations

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or shallower. The shallower slope is required for excavation below groundwater level. The subsoil at this site is considered to be mainly Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by "cut and cover" methods and excavations will not be left open for extended periods of time.

6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications & Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa.

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe, should consist of OPSS Granular A or Granular B Type II with a maximum size of 25 mm. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to 98% of the material's SPMDD.

It should generally be possible to re-use the site excavated materials above the cover material if the operations are carried out in dry weather conditions.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone, (about 1.5 m below finished grade) and above the cover material should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 225 mm thick lifts and compacted to 95% of the materials SPMDD.

6.5 Groundwater Control

It is anticipated that groundwater infiltration into the excavations should be low to moderate and controllable using open sumps. The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

Permit to Take Water

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum of 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes being pumped during the construction phase, between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project, where excavations are completed in proximity of existing structures which may be adversely affected due to the freezing conditions.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the installation of straw, propane heaters and tarpaulins or other suitable means. The base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

Trench excavations and pavement construction are difficult activities to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Precautions should be considered if such activities are to be completed during freezing conditions. Additional information could be provided, if required.

6.7 Corrosion Potential and Sulphate

The results on analytical testing show that the sulphate content is less than 0.1%. The results are indicative that Type 10 Portland Cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a very low to slightly aggressive corrosive environment.

7.0 Recommendations

It is recommended that the following be completed once the master plan and site development are determined:

❏ Review detailed grading plan(s) from a geotechnical perspective.

❏ Observation of all bearing surfaces prior to the placement of concrete.

❏ Sampling and testing of the concrete and fill materials used.

❏ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.

❏ Observation of all subgrades prior to placing backfilling materials.

❏ Field density tests to determine the level of compaction achieved.

❏ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with Paterson's recommendations could be issued upon request, following the completion of a satisfactory material testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations made in this report are in accordance with Paterson's present understanding of the project. Paterson requests permission to review the grading plan once available. Paterson's recommendations should be reviewed when the drawings and specifications are complete.

The client should be aware that any information pertaining to soils and the test hole log are furnished as a matter of general information only. Test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, Paterson requests to be notified immediately in order to permit reassessment of the recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Mattamy Homes or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
Mar. 30 -2021
F. I. ABOU-SEIDO
100156744
PROVINCE OF ONTARIO

Faisal I. Abou-Seido, P.Eng.

David J. Gilbert, P.Eng.

Report Distribution:

- ❏ Mattamy Homes (1 digital copy)
- ❏ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

GRAIN SIZE DISTRIBUTION ANALYSIS

ANALYTICAL TESTING

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2021 February 17

FILE NO. PG5690

HOLE NO. BH 1-21

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	103.45
Compact to dense, brown **SILTY SAND**	AU	1				
	SS	2	75	17	1	102.45
	SS	3	75	14	2	101.45
	SS	4	83	17		
- Trace gravel by 3.0 m depth	SS	5	83	13	3	100.45
	SS	6	67	25	4	99.45
	SS	7	75	11	5	98.45
	SS	8	75	20		
	SS	9	83	27	6	97.45
	SS	10	92	35	7	96.45
	SS	11	83	24	8	95.45
8.99	SS	12	83	32		
End of Borehole						
(Piezometer dry - March 4, 2021)						

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

FILE NO. PG5690

REMARKS

HOLE NO. BH 2-21

BORINGS BY CME 55 Power Auger

DATE 2021 February 17

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	102.61
Compact to dense, brown **SILTY SAND**	AU	1				
	SS	2	75	25	1	101.61
	SS	3	75	19	2	100.61
	SS	4	75	56		
	SS	5	83	32	3	99.61
	SS	6	67	39	4	98.61
	SS	7	75	28	5	97.61
	SS	8	75	32	6	96.61
	SS	9	75	33		
	SS	10	75	30	7	95.61
- Trace gravel by 7.5 m depth	SS	11	75	37	8	94.61
8.99	SS	12	75	30		

End of Borehole

(Piezometer dry - March 4, 2021)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %
20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

FILE NO. PG5690

REMARKS

HOLE NO. BH 3-21

BORINGS BY CME 55 Power Auger

DATE 2021 February 18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	107.88
FILL: Brown silty sand, some crushed stone and gravel (to 0.61)		AU	1				
Dense brown **SILTY SAND** some gravel (0.61 to 1.07)		SS	2	33	+50	1	106.88
GLACIAL TILL: Dense brown sandy silt to silty sand with gravel, cobbles and boulders (1.07 to 6.86)		SS	3	25	+50	2	105.88
		SS	4	50	+50	3	104.88
		SS	5	50	+50	4	103.88
		SS	6	33	+50	5	102.88
		SS	7	42	+50	6	101.88
		SS	8	33	+50		
		SS	9	42	+50		
End of Borehole (6.86)							

End of Borehole

Practical refusal to augering at 6.86 m depth

(Piezometer dry - March 4, 2021)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2021 February 18

FILE NO. PG5690

HOLE NO. BH 4-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	105.21
FILL: Brown silty sand some clay, gravel, cobbles, trace topsoil		AU	1				
0.76							
Compact to dense, brown **SILTY SAND**		SS	2	50	14	1	104.21
		SS	3	50	27	2	103.21
		SS	4	83	28		
		SS	5	83	25	3	102.21
		SS	6	83	30	4	101.21
		SS	7	83	28	5	100.21
		SS	8	83	34		
		SS	9	83	35	6	99.21
		SS	10	83	29	7	98.21
		SS	11	75	25	8	97.21
		SS	12	58	31		
8.99							
End of Borehole (Piezometer dry - March 4, 2021)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %
20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

FILE NO. PG5690

REMARKS

HOLE NO. BH 5-21

BORINGS BY CME 55 Power Auger

DATE 2021 February 18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	105.57
FILL: Brown silty sand with clay, gravel, trace topsoil		AU	1				
0.81							
Compact to dense, reddish brown **SILTY SAND**		SS	2	58	25	1	104.57
		SS	3	58	7	2	103.57
- Brown by 2.2 m depth		SS	4	83	14		
		SS	5	83	9	3	102.57
		SS	6	58	18	4	101.57
		SS	7	83	32	5	100.57
		SS	8	100	16	6	99.57
		SS	9	83	11		
		SS	10	75	19	7	98.57
		SS	11	75	23	8	97.57
		SS	12	75	24		
8.99							
End of Borehole							
(Piezometer dry - March 4, 2021)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2021 February 19

FILE NO. PG5690

HOLE NO. BH 6-21

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	103.25
FILL: Brown silty sand (to 0.61)	AU	1				
Compact to dense brown **SILTY SAND**	SS	2	75	46	1	102.25
	SS	3	58	22	2	101.25
	SS	4	75	25		
	SS	5	75	23	3	100.25
	SS	6	67	29	4	99.25
	SS	7	67	28	5	98.25
	SS	8	67	26		
	SS	9	75	27	6	97.25
	SS	10	67	22	7	96.25
	SS	11	67	22	8	95.25
(to 8.99)	SS	12	67	20		

End of Borehole

(Piezoemter dry - March 4, 2021)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2021 February 19

FILE NO. PG5690

HOLE NO. BH 7-21

SOIL DESCRIPTION

GROUND SURFACE

FILL: Brown silty sand, some gravel
0.84

Compact to dense, brown **SILTY SAND**

Dynamic Cone Penetration Test commenced at 2.13 m depth.

- Trace gravel by 4.5 m depth

- Some gravel by 6.7 m depth

Practical refusal to augering 8.99 m depth
9.75

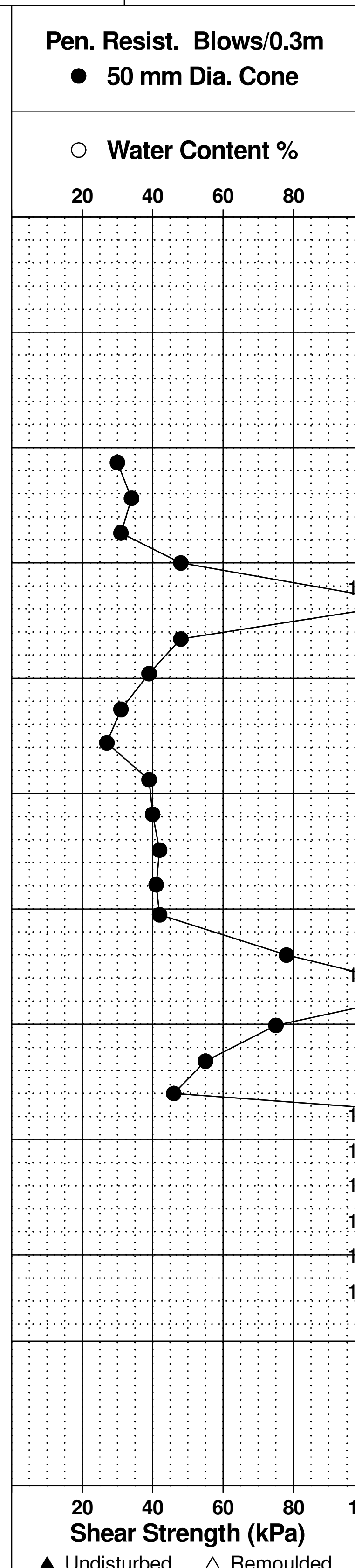
End of Borehole

Practical refusal to DCPT at 9.75 m depth

SAMPLE

TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	50	25
SS	3	75	28
SS	4	75	17
SS	5	75	17
SS	6	67	20
SS	7	67	53
SS	8	67	45
SS	9	67	23
SS	10	75	49
SS	11	67	83
SS	12	75	57

DEPTH (m)	ELEV. (m)
0	103.78
1	102.78
2	101.78
3	100.78
4	99.78
5	98.78
6	97.78
7	96.78
8	95.78
9	94.78



Piezometer Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

FILE NO. PG5690

REMARKS

HOLE NO. BH 8-21

BORINGS BY CME 55 Power Auger

DATE 2021 February 22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	106.13
FILL: Brown silty sand with gravel and crushed stone (0.61)		AU	1				
Compact to dense, brown **SILTY SAND** with gravel and cobbles		SS	2	75	47	1	105.13
		SS	3	75	55	2	104.13
		SS	4	50	45		
		SS	5	50	51	3	103.13
		SS	6	50	56	4	102.13
		SS	7	33	49	5	101.13
		SS	8	50	61		
		SS	9	50	24	6	100.13
		SS	10	33	31	7	99.13
		SS	11	50	51	8	98.13
(8.38) End of Borehole							

Practical refusal to augering at 8.38 m depth

(Piezometer dry - March 4, 2021)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2021 February 22

FILE NO. PG5690

HOLE NO. BH 9-21

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	109.17
ORGANICS (to 0.05)						
FILL: Brown silty sand with gravel (0.05 – 0.69)	AU	1				
FILL: Brown silty clay with sand, gravel, cobbles, trace topsoil (0.69 – 4.57)	SS	2	17	21	1	108.17
	SS	3	25	11	2	107.17
	SS	4	8	4	3	106.17
	SS	5	50	7		
	SS	6	17	26	4	105.17

End of Borehole (4.57)

Practical refusal to augering at 4.57 m depth

(Piezometer dry - March 4, 2021)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

FILE NO. PG5690

REMARKS

HOLE NO. BH10-21

BORINGS BY CME 55 Power Auger **DATE** 2021 February 23

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.05				
FILL: Brown to grey silty clay with sand, gravel, cobbles, trace topsoil	5.49	AU	1		
		SS	2	42	12
		SS	3	42	5
		SS	4	17	3
		SS	5	33	5
		SS	6	25	5
		SS	7	50	10
FILL: Brown silty sand, some gravel	6.02	SS	8	33	7
FILL: Brown to grey silty clay with sand, gravel, trace wood and organics	8.23	SS	9	42	8
		SS	10	33	6
		SS	11	4	9
End of Borehole					
(Piezometer dry - March 4, 2021)					

DEPTH (m)	ELEV. (m)
0	107.98
1	106.98
2	105.98
3	104.98
4	103.98
5	102.98
6	101.98
7	100.98
8	99.98

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

FILE NO. PG5690

REMARKS

HOLE NO. BH11-21

BORINGS BY CME 55 Power Auger **DATE** 2021 February 23

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	105.87		
TOPSOIL 0.05		AU	1						
FILL: Brown silty clay some sand, gravel, trace topsoil - Wood fragments present at 0.9 m depth		SS	2	50	4	1	104.87		
		SS	3	33	5	2	103.87		
		SS	4	50	6				
3.51		SS	5	42	23	3	102.87		
FILL: Brown silty sand with gravel, trace clay		SS	6	8	28	4	101.87		
5.03		SS	7	33	21	5	100.87		
FILL: Brown silty clay with sand, gravel, cobbles, trace organics - Increasing sand with depth		SS	8	25	11	6	99.87		
		SS	9	33	5				
7.54		SS	10	17	+50	7	98.87		
FILL: Brown silty sand with gravel, trace topsoil 8.23		SS	11	42	28	8	97.87		
Compact brown **SILTY SAND** with gravel, trace cobbles 9.14		SS	12	42	67	9	96.87		
End of Borehole (Piezometer destroyed - March 4, 2021)		SS	13	0	+50				

Chart axis: 20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed Use Development
3718 Greenbank Road - Ottawa, Ontraio

DATUM Geodetic

FILE NO. PG5690

REMARKS

HOLE NO. BH12-21

BORINGS BY CME 55 Power Auger **DATE** 2021 February 23

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20, 40, 60, 80)	Piezometer Construction
GROUND SURFACE						0	101.30		
FILL: Brown silty sand with gravel, trace clay		AU	1						
						1	100.30		
		SS	2	50	64				
		SS	3	50	69				
						2	99.30		
		SS	4	42	28				
2.90									
End of Borehole (Piezometer destroyed - March 4, 2021)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Barrhaven South Urban Expansion
Ottawa, Ontario

DATUM Geodetic elevations interpolated from City of Ottawa basemap.

FILE NO. PG3607

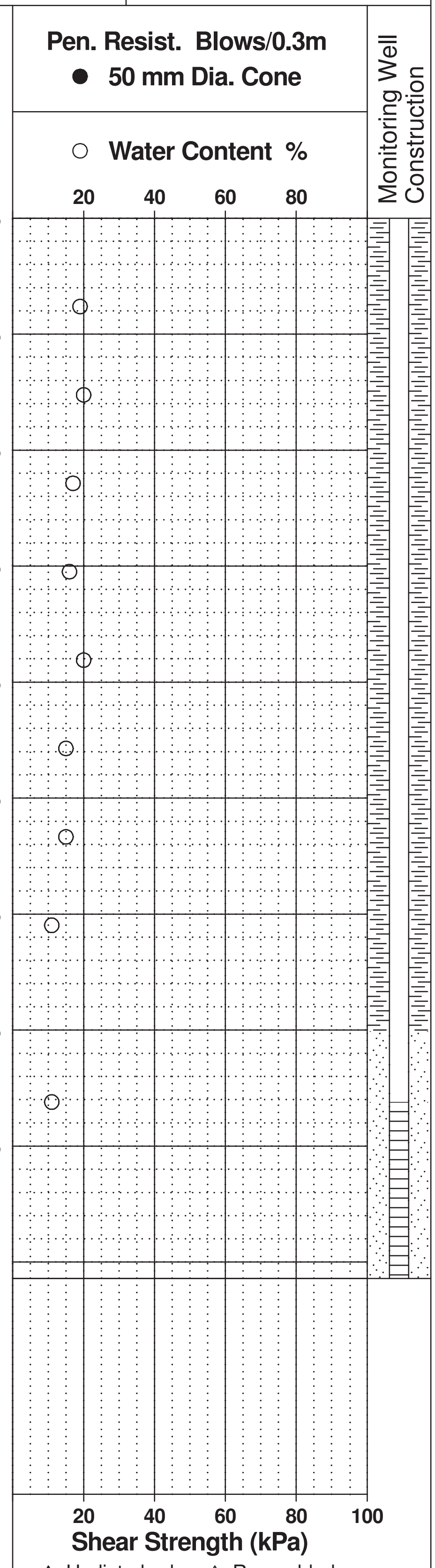
REMARKS

HOLE NO. BH 5-15

BORINGS BY CME 75 Power Auger

DATE December 10, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	108.75
		SS	1	42	13	1	107.75
		SS	2	25	21	2	106.75
		SS	3	33	5	3	105.75
		SS	4	42	4	4	104.75
FILL: Grey silty sand with clay, gravel and wood		SS	5	42	3	5	103.75
		SS	6	42	3	6	102.75
		SS	7	17	5	7	101.75
		SS	8	25	37	8	100.75
		SS	9	0	50+	9	99.75
		SS	10	58	9		
9.14		SS	11	0	1		
End of Borehole (BH dry to 9.14m depth - July 28, 2016)							



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Barrhaven South Urban Expansion
Ottawa, Ontario

DATUM Geodetic elevations interpolated from City of Ottawa basemap.

REMARKS

BORINGS BY Backhoe

DATE December 2, 2015

FILE NO. PG3607

HOLE NO. TP 1-15

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	105.10		
TOPSOIL 0.10		G	1						
Compact, brown **SILTY SAND**, trace boulders and cobbles		G	2			1	104.10		
						2	103.10		
3.00						3	102.10		
End of Test Pit (TP dry upon completion)									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Barrhaven South Urban Expansion
Ottawa, Ontario

DATUM Geodetic elevations interpolated from City of Ottawa basemap.

REMARKS

BORINGS BY Backhoe

DATE December 2, 2015

FILE NO. PG3607

HOLE NO. TP 2-15

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	106.80		
TOPSOIL 0.10									
Compact, brown **SILTY SAND**		G	1			1	105.80		
		G	2			2	104.80		
3.00						3	103.80		
End of Test Pit									
(TP dry upon completion)									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Barrhaven South Urban Expansion
Ottawa, Ontario

DATUM Geodetic elevations interpolated from City of Ottawa basemap.

FILE NO. PG3607

REMARKS

HOLE NO. TP 8-15

BORINGS BY Backhoe **DATE** December 1, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	109.30
Dense, brown **SILTY SAND**		G	1			1	108.30
						2	107.30
3.00		G	2			3	106.30
End of Test Pit							
(TP dry upon completion)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Barrhaven South Urban Expansion
Ottawa, Ontario

DATUM Geodetic elevations interpolated from City of Ottawa basemap.

FILE NO. PG3607

REMARKS

HOLE NO. TP 9-15

BORINGS BY Backhoe **DATE** December 2, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	108.40		
TOPSOIL 0.20									
		G	1			1	107.40		
Brown **SILTY SAND**, trace cobbles						2	106.40		
3.00		G	2			3	105.40		
End of Test Pit									
(TP dry upon completion)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the relative strength of cohesionless soils is the compactness condition, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm. An SPT N value of "P" denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

Consistency	Undrained Shear Strength (kPa)	'N' Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity, S_t, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity:	$S_t < 2$
Medium Sensitivity:	$2 < S_t < 4$
Sensitive:	$4 < S_t < 8$
Extra Sensitive:	$8 < S_t < 16$
Quick Clay:	$S_t > 16$

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube, generally recovered using a piston sampler
G	-	"Grab" sample from test pit or surface materials
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC%	-	Natural water content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic Limit, % (water content above which soil behaves plastically)
PI	-	Plasticity Index, % (difference between LL and PL)
Dxx	-	Grain size at which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2$ / (D10 x D60)
Cu	-	Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: 1 < Cc < 3 and Cu > 4
Well-graded sands have: 1 < Cc < 3 and Cu > 6
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

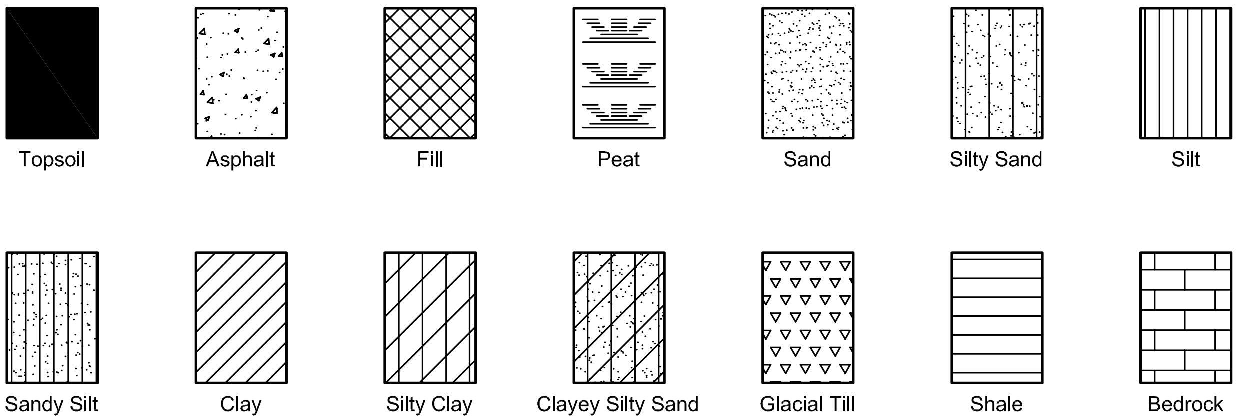
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

k	-	Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

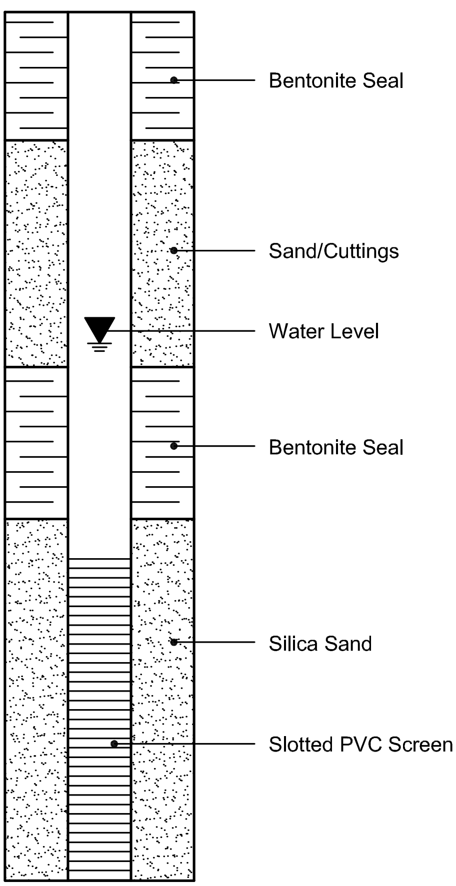
SYMBOLS AND TERMS (continued)

STRATA PLOT

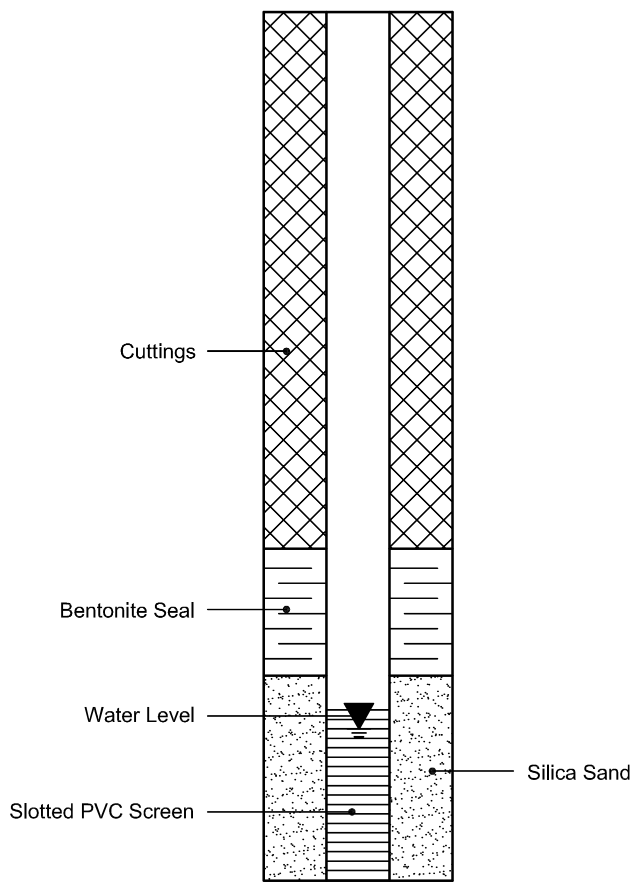


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



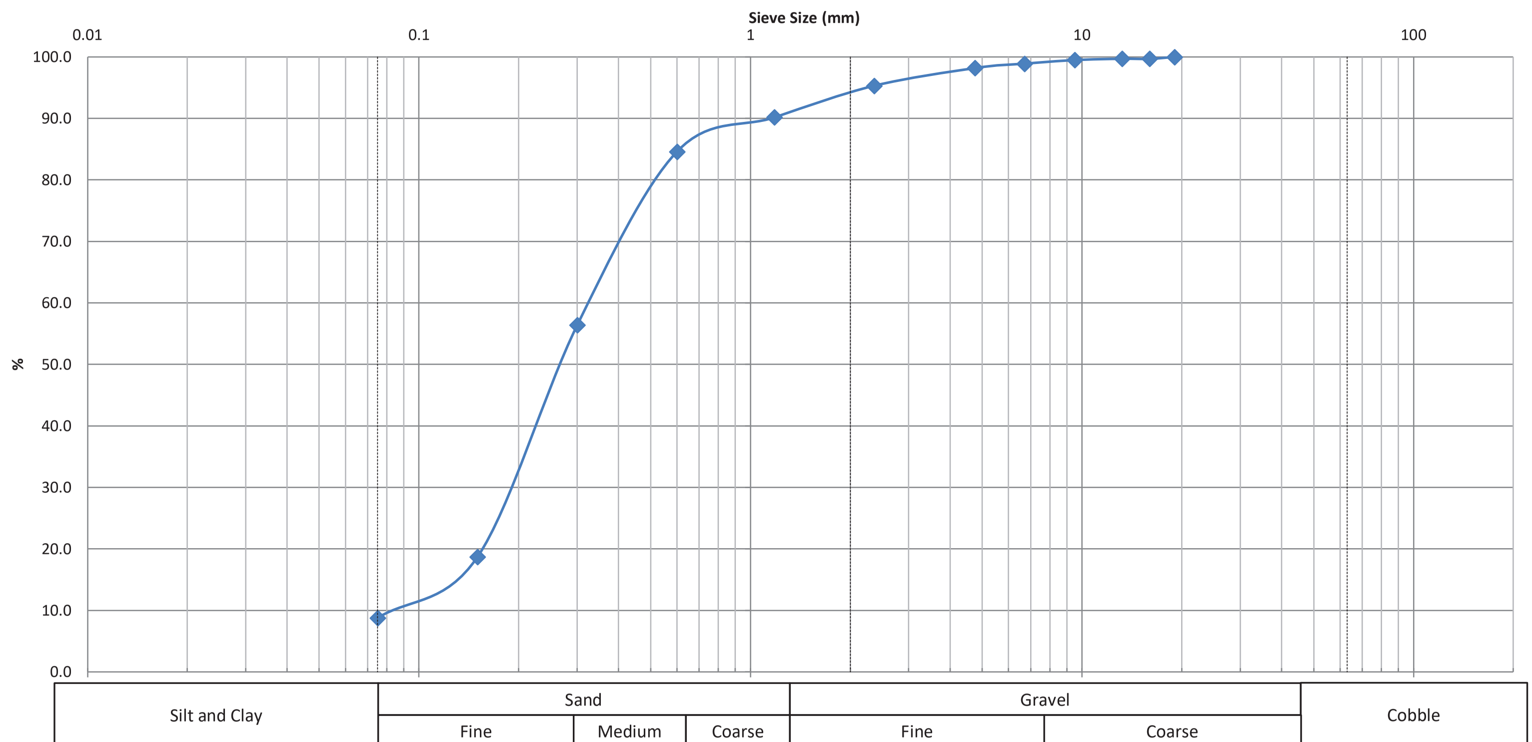
PIEZOMETER CONSTRUCTION



patersongroup
consulting engineers

SIEVE ANALYSIS
ASTM C136

CLIENT:	Mattamy Homes	DESCRIPTION:	Soil	FILE NO:	PG5690
CONTRACT NO.:	-	SPECIFICATION:	**Silty Sand**	LAB NO:	23721
PROJECT:	3718 Greenbank Road	INTENDED USE:	-	DATE RECEIVED:	25-Mar-21
		PIT OR QUARRY:	in-Situ	DATE TESTED:	26-Mar-21
DATE SAMPLED:	17-Feb-21	SOURCE LOCATION:	BH2-21 SS3 & SS4	DATE REPORTED:	29-Mar-21
SAMPLED BY:	G. Paterson	SAMPLE LOCATION:	1.5 - 2.9 m	TESTED BY:	DK



Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
									1.38	3.9
	D100	D60	D30	D10	Gravel (%)	Sand (%)		Silt (%)		Clay (%)
	19.0	0.32	0.19	0.082	1.8	89.4		8.8		

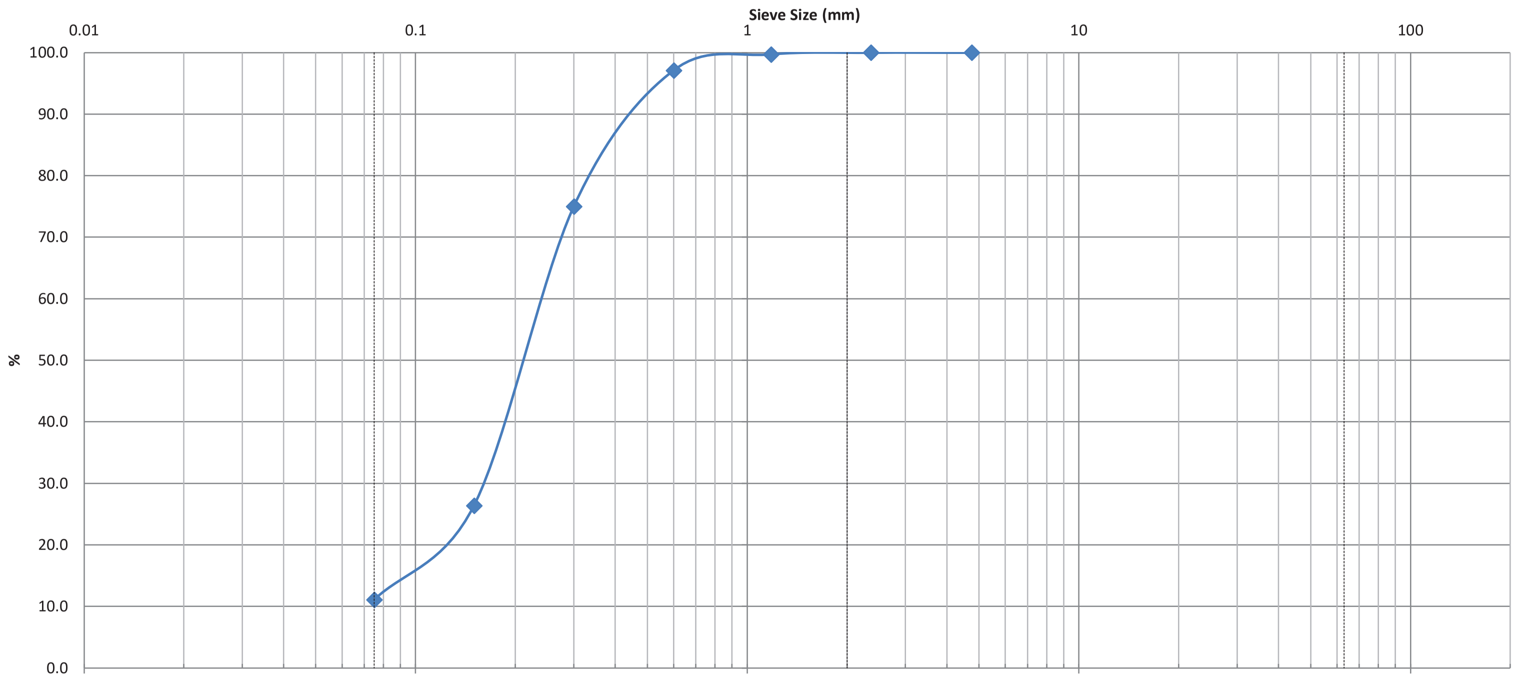
Comments:

REVIEWED BY:	Curtis Beadow	Joe Fosyth, P. Eng.

patersongroup
consulting engineers

SIEVE ANALYSIS
ASTM C136

CLIENT:	Mattamy Homes	DESCRIPTION:	Soil	FILE NO:	PG5690
CONTRACT NO.:	-	SPECIFICATION:	**Silty Sand**	LAB NO:	23722
PROJECT:	3718 Greenbank Road	INTENDED USE:	-	DATE RECEIVED:	25-Mar-21
		PIT OR QUARRY:	in-Situ	DATE TESTED:	26-Mar-21
DATE SAMPLED:	17-Feb-21	SOURCE LOCATION:	BH4-21 SS4 & SS5	DATE REPORTED:	29-Mar-21
SAMPLED BY:	G. Paterson	SAMPLE LOCATION:	2.29 - 3.66 m	TESTED BY:	DK



Silt and Clay	Sand			Gravel		Cobble
	Fine	Medium	Coarse	Fine	Coarse	

Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
									1.80	3.3
	D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)		Clay (%)	
	4.8	0.23	0.17	0.07	0.0	88.9	11.1			

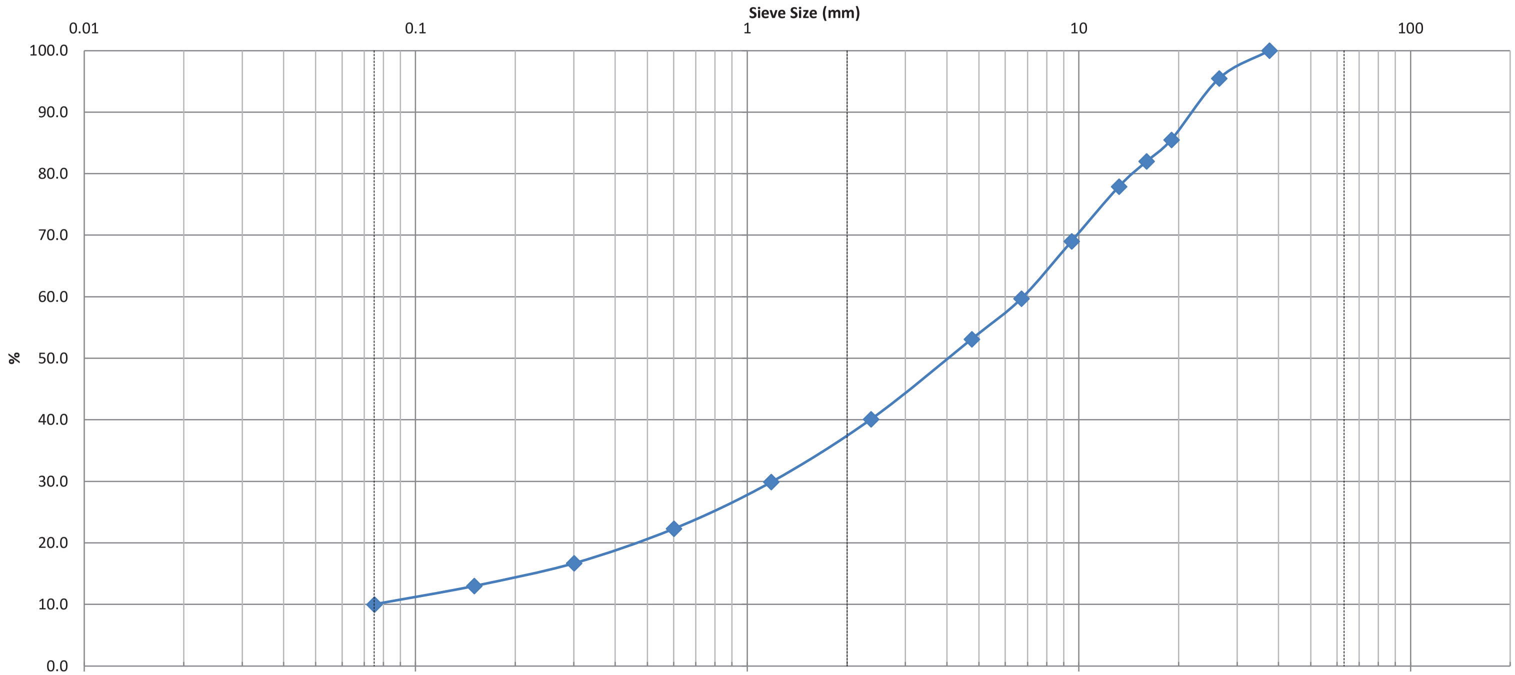
Comments:

REVIEWED BY:	**Curtis Beadow**	**Joe Fosyth, P. Eng.**

patersongroup
consulting engineers

SIEVE ANALYSIS
ASTM C136

CLIENT:	Mattamy Homes	DESCRIPTION:	Soil	FILE NO:	PG5690
CONTRACT NO.:	-	SPECIFICATION:	**Silty Sand**	LAB NO:	23723
PROJECT:	3718 Greenbank Road	INTENDED USE:	-	DATE RECEIVED:	25-Mar-21
		PIT OR QUARRY:	in-Situ	DATE TESTED:	26-Mar-21
DATE SAMPLED:	17-Feb-21	SOURCE LOCATION:	BH8-21 SS4 & SS5	DATE REPORTED:	29-Mar-21
SAMPLED BY:	G. Paterson	SAMPLE LOCATION:	2.29 - 3.66 m	TESTED BY:	DK



Silt and Clay	Sand			Gravel		Cobble
	Fine	Medium	Coarse	Fine	Coarse	

Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
									3.54	104.6
	D100	D60	D30	D10	Gravel (%)	Sand (%)		Silt (%)		Clay (%)
	37.5	6.8	1.25	0.065	46.9	43.1		10.0		

Comments:

REVIEWED BY:	Curtis Beadow	Joe Fosyth, P. Eng.

Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 31927

Report Date: 25-Feb-2021

Order Date: 19-Feb-2021

Project Description: PG5690

	Client ID:	BH7-21-SS5	-	-	-
	Sample Date:	19-Feb-21 09:00	-	-	-
	Sample ID:	2108430-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	95.7	-	-	-
General Inorganics					
pH	0.05 pH Units	7.30	-	-	-
Resistivity	0.10 Ohm.m	143	-	-	-
Anions					
Chloride	5 ug/g dry	7	-	-	-
Sulphate	5 ug/g dry	<5	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURE 2 TO 5 - AERIAL PHOTOGRAPHS

DRAWING PG5690-1 - TEST HOLE LOCATION PLAN

FIGURE 1

KEY PLAN

FIGURE 2

Aerial Photograph - 1976

FIGURE 3

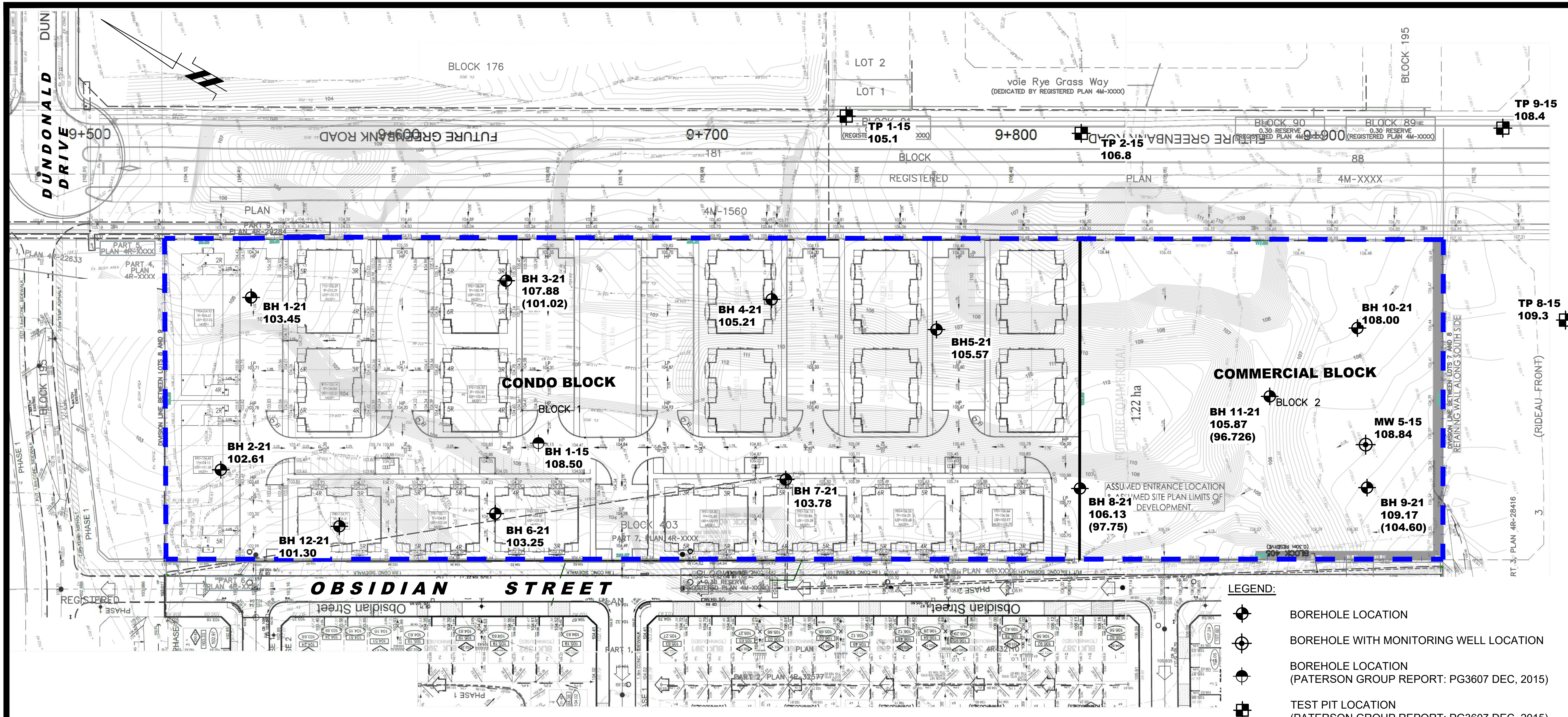
Aerial Photograph - 2002

FIGURE 4

Aerial Photograph - 2008

FIGURE 5

Aerial Photograph - 2019



LEGEND:

⌖	BOREHOLE LOCATION
⌖	BOREHOLE WITH MONITORING WELL LOCATION
⌖	BOREHOLE LOCATION (PATERSON GROUP REPORT: PG3607 DEC, 2015)
▣	TEST PIT LOCATION (PATERSON GROUP REPORT: PG3607 DEC, 2015)
108.87	GROUND SURFACE ELEVATION (m)
(104.63)	PRACTICAL REFUSAL TO AUGERING ELEVATION (m)

GROUND SURFACE ELEVATION AT BOREHOLE LOCATIONS ARE REFERENCED TO A GEODETIC DATUM.

SCALE: 1:1250

0 5 10 15 20 25 50 75m

patersongroup
consulting engineers

154 Colonnade Road South
Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL

MATTAMY HOMES
GEOTECHNICAL INVESTIGATION
PROPOSED BOREHOLES
HALF MOON BAY - SOUTH

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1250	Date: 03/2021
Drawn by: JM	Report No.: PG5690-1
Checked by: OC	Dwg No.: PG5690-1
Approved by: DJG	Revision No.:

p:\autocad drawings\geotechnical\pg56xx\pg5690\pg5690-1-thlp.dwg