To:	**Scott Beedie BURPI**	Company:	**Urban Solutions**
From:	**Sam Ziemann, P.Eng.**	Project Ref. #:	**221655**
	c.519-404-4529		
Copy:		Date:	**October 14, 2022**

Subject: **117 Forest Avenue & 175 Catherine Street South Watermain Hydraulic Analysis**

Urban Solutions

117 Forest Avenue & 175 Catherine Street South Watermain Hydraulic Analysis

C3 WATER INC.

October 14, 2022

VERSION	DATE	DESCRIPTION OF REVISIONS	REVISED BY	REVIEWED BY
1	September 2, 2022	Draft Report	Alec Orr	Sam Ziemann
2	October 14, 2022	Final Report	Alec Orr, Michelle Scott	Sam Ziemann

SIGN OFF

This document, entitled "**117 Forest Avenue & 175 Catherine Street South *Watermain Hydraulic Analysis*"**, was prepared by C3 Water Inc. for **Urban Solutions**

C3W certifies that the information contained in this report is accurate, complete and in accordance with the terms of our engagement. This assessment is based, in part, on information provided by others. Unless specifically noted, C3W has assumed that this information is correct, and has relied on it in the development of conclusions.

The material herein reflects C3 Water's best judgement based upon the information available at the time of preparation. Any use which a third party makes of this report or any reliance on or decisions made based on it, are the responsibilities of such third parties. C3 Water Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based upon this report.

DATE: October 14, 2022

Prepared by: **Alec Orr, B.A.Sc., E.I.T.**
Water Specialist, C. 226-339-6822

Reviewed by: **SAM ZIEMANN, P.Eng.,**
PRESIDENT, C. 519-404-4529

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1.0 INTRODUCTION

1.1 Background

The proposed development at 117 Forest Avenue & 175 Catherine Street South is located in Pressure District 2 (PD2) in the City of Hamilton (City). The development area is located on the northeast corner of the intersection between Forest Avenue and Catherine Street South. Figure 1-1 illustrates the proposed development area and nearby watermains, all of which are cast iron (CI). The development includes a 14-storey multiple dwelling building in addition to the existing 11-storey building located on the subject lands. The development area is currently supplied by a 300 mm watermain on Forest Avenue and a 150 mm watermain on Catherine Street South. A site plan is available in Appendix A.

Figure 1-1. Proposed Development Area (Approximate)

PD2 is supplied by Pressure District 1 through pumping station HD002, which consists of four (4) pumps. PD2 has two (2) storage reservoirs HDR02 and HDR2A that provide storage.

C3 Water Inc (C3W) has been retained by Urban Solutions to complete a watermain hydraulic analysis for the proposed development. This report provides the watermain hydraulic analysis in accordance with the City of Hamilton's Comprehensive Development Guidelines (2018) (Hamilton Guidelines) and the Ministry of Environment, Conservation and Parks (MECP) Design Guidelines for Drinking-Water Systems (2008) (MECP Guidelines). The hydraulic assessment was completed using the City's full pipe model, titled "Hamilton_EPS_200625_include_PD9_10" using Bentley WaterCAD Connect Edition Update 3 10.03.02.75 software.

1.2 Limitations

This TM is intended to provide servicing results for the proposed development based on the City's hydraulic water model. This water model was built and coarsely calibrated by others. As with any modelling assignment, limitations related to the state of the model, the software capabilities, and theoretical data inputs should be considered. The model software also has inherent limitations and assumptions related to the calculation engine and inputs.

2.0 CRITERIA

2.1 Pressure Requirements

The MECP Guidelines outline maximum and minimum system pressures for standard operating conditions as well as fire flow conditions. As outlined in the City of Hamilton's Water and Wastewater Masterplan (KMK, 2006), acceptable hydrant and service connection pressures under normal conditions range from 275 kPa to 690 kPa. Standard operating conditions were assessed for the proposed development to ensure that water services maintained acceptable pressure under various demand and fire flow conditions for existing (2021) and future (2031) scenarios. Table 2-1 provides the pressure criteria that were utilized.

Table 2-1. Pressure Requirements

Pressure Requirement	Minimum	Preferred	Maximum
Standard Operating Conditions	275 kPa (40 psi)	350 to 480 kPa (50 to 70 psi)	690 kPa (100 psi)
Maximum Day Demands + Fire Flows	140 kPa (20 psi)		

2.2 Domestic Demand

The domestic demands for the proposed development were calculated by S. Llewellyn & Associates Limited (SLA) using the Ontario Building Code (OBC) fixture unit method. Demands are only for the new 14-storey multiple dwelling building as it was assumed that the demands for the existing building were already accounted for the in the City's existing water model. The ADD, MDD and PHD for the development are summarized in Table 2-2.

Table 2-2. Estimated Domestic Demands for the Proposed Development (SLA)

Development	Demand (L/s)		
	ADD	MDD	PHD
117 Forest Avenue	1.96	5.39	8.09

2.3 Fire Flow Demand

The fire flow requirements for the proposed development were estimated by the Hamilton Watermain Fire Flow Requirement Design Guidelines Policy (PW19096). The City's residential fire flow requirements are summarized in Table 2-3 below. The development is required to meet a minimum fire flow of 150 L/s at a residual pressure of 140 kPa under MDD conditions, as specified in Table 2-1.

Table 2-3. Hamilton Residential Fire Flow Requirements

Development Type	Target Fire Flow (L/s)
Residential Multi (> 3 Units)	**150**
Residential Medium (≤ 3 Units)	125
Residential Single	75
Residential Single (Dead End)	50

3.0 HYDRAULIC WATER MODEL

3.1 Boundary Conditions

The proposed development was modelled under the following demand scenarios under both existing (2021) and ultimate build-out (currently 2031) conditions:

- Average Day Demand (ADD)
- Maximum Day Demand (MDD)
- MDD plus Fire Flow
- Peak Hour Demand (PHD)

Table 3-1 summarizes the initial boundary conditions set up in the model for PD2. The pumps at the water treatment plant (WTP) were turned off (reservoir only conditions). All pumps at pump station HD002 were turned off. The tank levels for reservoirs HDR02 and HDR2A were set to 50% full (144.33 m) and 75% full (146.08 m), respectively, as specified by the City.

Table 3-1. Model Boundary Conditions – Base Configuration

Element	Initial Status – HGL	
PD2 Tank Levels	144.32 m (50%)	146.08 m (75%)
WTP Pumps	**Off**	**Off**

Element	Initial Status – HGL	
HD002-PMP-1	**Off**	**Off**
HD002-PMP-2	**Off**	**Off**
HD002-PMP-3	**Off**	**Off**
HD002-PMP-4	**Off**	**Off**

3.2 Model Verification

The accuracy of the model in the area of the proposed development was verified using hydrant field test results, completed by SCG Flowmetrix on July 21, 2022. The hydrant field test results for Forest Avenue and Young Street are summarized in Table 3-2 and Table 3-3. Figure 3-1 provides the location of the residual and flow hydrants that were used for verification. Pressures were measured at the residual hydrants. Two hydrant ports were opened at each flow hydrant during the hydrant tests. The hydrant testing reports are available in Appendix B.

Table 3-2. Hydrant Field Testing Results – HA15H025 – July 21, 2022

Forest Avenue	
Flow (L/s) at Hydrant HA15H025	**Pressure (kPa) at Hydrant HA15H026**
0	435
61.33	414
Theoretical Flow at 20 psi	
253.98	140

Table 3-3. Hydrant Field Testing Results – HA15H027 – July 21, 2022

Young Street	
Flow (L/s) at Hydrant HA17H027	**Pressure (kPa) at Hydrant HA017028**
0	435
34.96	410
Theoretical Flow at 20 psi	
134.21	140

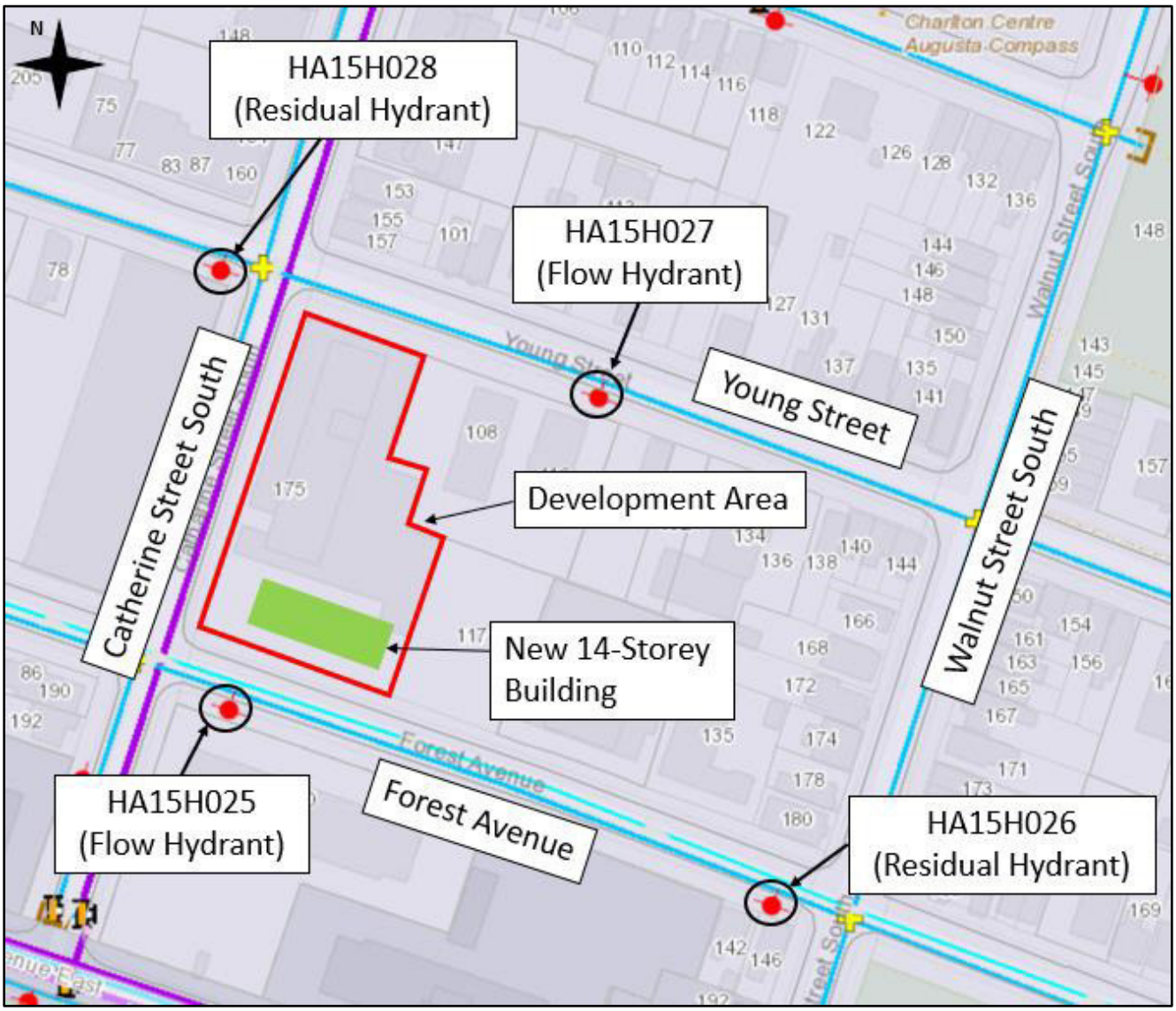


Figure 3-1. Field Testing Hydrant used for Model Verification

PD2 SCADA data was requested from the City to determine the boundary conditions during the field testing. A summary of the boundary conditions used for model verification is provided in Table 3-4. The model was compared to the hydrant test results under 2021 ADD conditions.

Table 3-4. Summary of Boundary Conditions at Time of Hydrant Testing

Element	Flow Hydrant	Flow Hydrant
	HA15H025	HA15H027
Time of Test	12:00 PM	11:30 AM
Average Tank HDR02 Level	143.70 (41%)	143.66 m (41%)
Average Tank HDR2A Level	144.31 (50%)	144.28 m (49%)

Element	Flow Hydrant HA15H025	Flow Hydrant HA15H027
WTP Pump 1	**Off**	**Off**
WTP Pump 2	On	On
WTP Pump 3	On	On
WTP Pump 4	**Off**	**Off**
WTP Pump 5	On	On
WTP Pump 6	**Off**	**Off**
HD002-PMP-1	**Off**	**Off**
HD002-PMP-2	**Off**	**Off**
HD002-PMP-3	**Off**	**Off**
HD002-PMP-4	On	On
PD2 Discharge Flow – Average (L/s)	455	456

Figure 3-2 and Figure 3-3 illustrate the field test and model verification results for the hydrants on Forest Avenue (HA15H025) and Young Street (HA15H027). Field results beyond maximum testing flows are extrapolated. The focus of the model verification was on the drop in pressure caused by the hydrant test.

When using the original C-factors in the City's model, the pressure drop caused by the hydrant flows on Forest Avenue and Young Street were found to be significantly less than what was recorded in the field. C-factors were adjusted in the model such that the model results more closely represented the field test results. In general, the C-factors for the existing 150-300 mm CI watermains between the PD2 pump station (HD002) and the development area were reduced from between 80 and 130 to between 20 and 25. A detailed C-factor change log can be found in Appendix C.

The C-factor changes were made to the model to provide a better fit to the field tests. In C3W's opinion the C-factor adjustments required to match the field testing data are lower than expected as a C-factor of 20 is very conservative for a CI pipe. There may be other factors involved in the limited hydraulic capacity of the system that could be considered such as accuracy of data such as watermain diameters, valve status, system connectivity and other C-factors throughout the PD2 zone.

Additionally, the theoretical fire flows at 140 kPa (20 psi) on Forest Avenue and Young Street were extrapolated based on only a 21 kPa (3.1 psi) and 25 kPa (3.6 psi) difference, respectively, between the field testing static and residual pressures. Typically, it is recommended that a 25% drop in pressure be required to adequately estimate the pressures at 20 psi. Pressure drops of 109 kPa (15.8 psi) would be required at both hydrants to satisfy this recommendation, based on the field testing static pressures.

The model was updated to best match the field results within reasonable accuracy, and the adjusted C-factors were used for the remaining analysis.

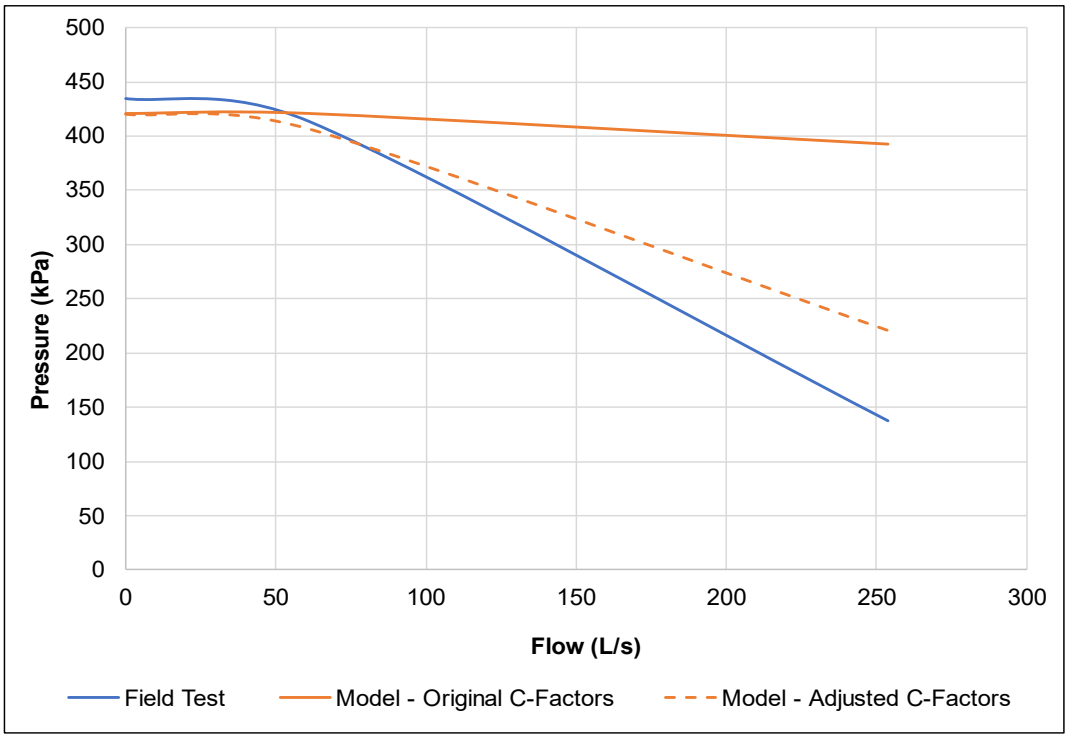


Figure 3-2. Verification Results - Hydrant HA15H025 on Forest Avenue

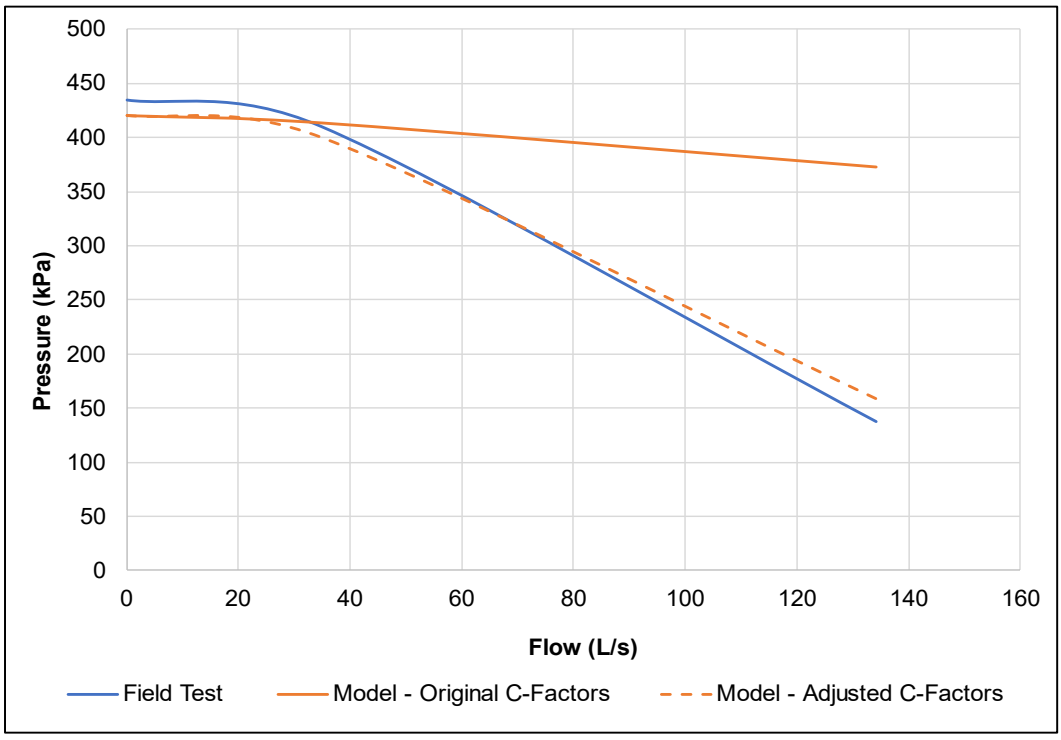


Figure 3-3. Verification Results - Hydrant HA15H027 on Young Street

3.2.1 Dual Hydrant Test Results

Additional hydrant tests were completed by SCG Flowmetrix on September 13, 2022, that involved running hydrants HA15H025 and HA15H027 simultaneously on Forest Avenue and Young Street, respectively. The residual pressures were measured at hydrants HA15H026 and HA15H028 on Forest Avenue and Young Street, respectively, during the tests. The purpose of the tests were to confirm the fire flow near the development when a second nearby hydrant was flowing in the distribution system. The theoretical fire flows at hydrants HA15H025 and HA15H027 at 20 PSI with one (1) and two (2) hydrants running are summarized in Table 3-5. With a second hydrant running, the fire flow near the development drops by approximately 20 L/s. The additional hydrant testing results are included in Appendix B.

Table 3-5 Theoretical Fire Flows at Hydrants HA15H025 and HA15H027 at 20 PSI

Hydrant	Theoretical Flow at 20 PSI (1 hydrant running)	Theoretical Flow at 20 PSI (2 hydrants running)
HA15H025	253.98 L/s	235.14 L/s
HA15H027	134.21 L/s	113.06 L/s

The additional hydrant testing data was also used to confirm the model verification results. Table 3-6 summarizes the residual pressures and flows during both hydrant tests as well as the residual pressures estimated by the model at the field tested flows. The model boundary conditions were updated to reflect system conditions on September 13, 2022. The model results were more conservative than the field test results for the range of flows seen during both tests. This was also shown by the original model verification results in Figure 3-2 and Figure 3-3.

Table 3-6 Summary of Hydrant and Model Data for Dual Hydrant Tests

Hydrant Test	Residual Hydrant	Flow at Hydrant HA15H025 (L/s)	Flow at Hydrant HA15H027 (L/s)	Total Flow (L/s)	Field Test Residual Pressure (PSI)	Model Residual Pressure (PSI)
1	HA15H026	61.7	32.2	93.9	62.6	61.0
2	HA15H028	58.2	33.1	91.3	61.3	57.0

3.3 Development

Figure 3-4 illustrates the location of the proposed development. The development will be serviced by a connection on the existing 300 mm watermain on Forest Avenue.

The elevation of the development node (J-471) was estimated using Hamilton's existing water model and the elevations of the surrounding nodes. The elevation of the demand node is 102.34 m.

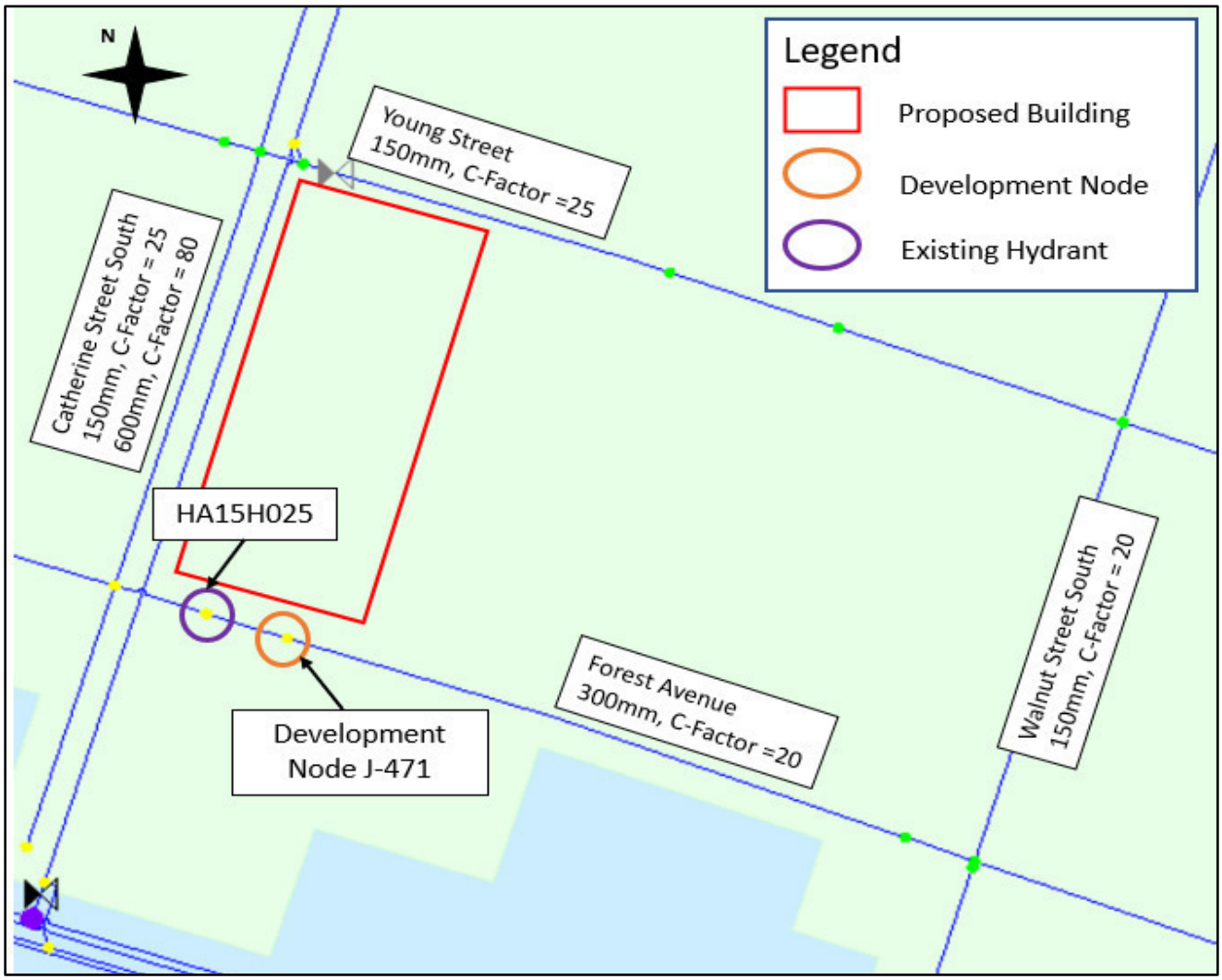


Figure 3-4. Model Layout for the Proposed Development Area

4.0 ANALYSIS

4.1 Available Fire Flow

The model was used to determine the available fire flow at the development node (J-471) and the existing hydrant on Forest Avenue (HA15H025).

Table 4-1 summarizes the available fire flows at the development node (J-471) and the existing hydrant on Forest Avenue (HA15H025) under MDD 2021 and 2031 conditions, at a residual pressure of 140 kPa, and HDR02 and HDR2A tank levels set at 50% and 75%. The minimum available fire flow of 150 L/s can be achieved at the development node and existing hydrant on Forest Avenue (HA15H025) under all scenarios. The complete fire flow results are available in Appendix D.

The fire flow results in the model are lower than the field testing results due to pressure and flow being measured at different hydrants during the field test. The headlosses in the watermain between the two (2) hydrants is not accounted for in the field test since the pressure is not measured at the flow hydrant. In the model analysis, both the flow and pressure are measured at the same hydrant so the headlosses associated with the low C-factor in the existing 300 mm watermain on Forest Avenue are included in the calculation. Due to the low C-factor, there is a high headloss in this section of pipe which results in a lower available fire flow.

Table 4-1. Available Fire Flow Results (L/s) for the Proposed Development

Node	2021		2031		Meets FF Criteria?
	Tank Level				
	50%	75%	50%	75%	
HA15H025	178	185	168	175	TRUE
J-471	170	177	163	169	TRUE

4.2 System Pressures

The pressure results for the development node (J-471) and the existing hydrant on Forest Avenue (HA15H025) are summarized in Table 4-2 and Table 4-3 with PD2 tank levels set to 50% and 75%, respectively, and the PD2 and WTP pumps off. Under each of the scenarios, the pressures ranged between 376 kPa – 424 kPa, which are within the City's allowable operating pressure range of 275 – 690 kPa. The complete system pressure results are included in Appendix E.

Table 4-2. Pressure Results (kPa) with Tanks Set at 50%

Node	ADD		MDD		PHD	
	2021	2031	2021	2031	2021	2031
HA15H025	404	404	396	393	383	376
J-471	407	406	398	395	386	379

Table 4-3. Pressure Results (kPa) with Tanks Set at 75%

Node	ADD		MDD		PHD	
	2021	2031	2021	2031	2021	2031
HA15H025	422	421	413	410	401	394
J-471	424	423	416	412	403	396

4.3 Flushing

The hydraulic model was used to evaluate the flushing capacity in the existing 300 mm watermain on Forest Avenue, with PD2 tank levels set at 50% full and the PD2 and WTP pumps offline. The 2021 ADD scenario was used to represent existing conditions for construction flushing requirements. Flushing demands were modelled to replace domestic demands while the area is under development. Results were based on a minimum velocity of 0.8 m/s as required by the MECP Guidelines. Hydrant nodes were modelled with an emitter coefficient of 11.2 $L/s/m^{0.5}$ (150 gpm/psi). This value is recommended by the American Water Works Association (AWWA) to represent a single 60mm (2.5”) outlet and considers all lateral valve and bends within the hydrant.

Table 4-4 summarizes the flushing results for the existing 300 mm watermain on Forest Avenue. A flushing velocity of 0.8 m/s was achieved in the existing 300 mm watermain when the tank levels are set to 50%. The complete flushing report is available in Appendix F.

Table 4-4. Flushing Results with Tanks set to 50% (ADD 2021)

Pipe	Length (m)	Diameter (mm)	Flushing Velocity (m/s)	Meets Criteria
HA15W12654(1)(2)(1)	20	300	1.12	TRUE
HA15W12654(1)(2)(2)	123	300	1.09	TRUE

5.0 CONCLUSIONS

This analysis was based on the City's existing hydraulic water model. The model was verified using field test results and the City's historical SCADA data. The C-factors of the watermains near the development area were adjusted to provide a closer representation of the hydraulic capacity of the water system based on field testing data provided. Lower than expected C-factors were required on the CI watermains near the development area to better match the model results to the field testing.

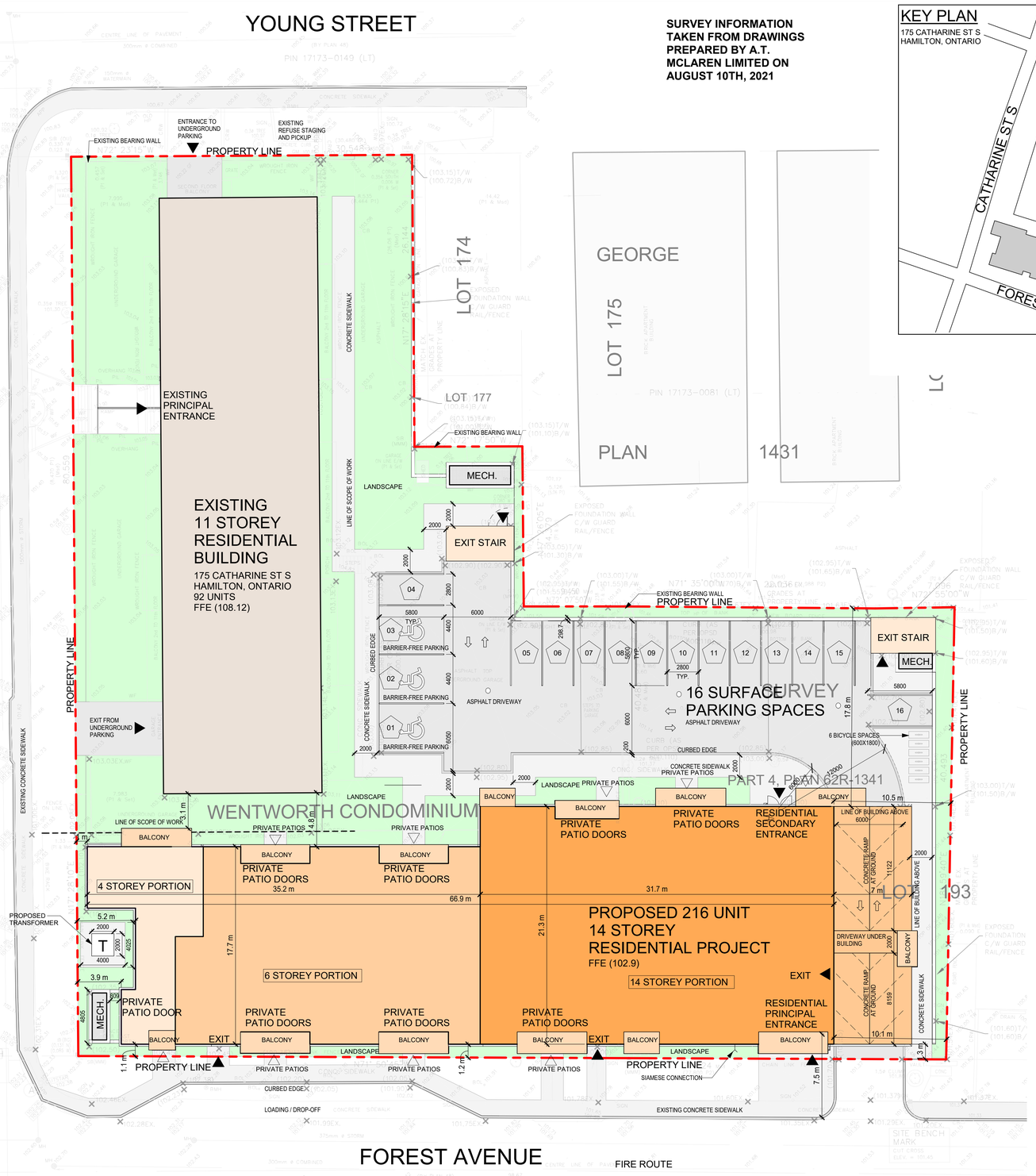
The watermain hydraulic assessment of the proposed 117 Forest Avenue & 175 Catherine Street South development demonstrated that:

1. Under the proposed development conditions, the minimum available fire flow requirement of 150 L/s was achieved at the development node (J-471) and the existing hydrant on Forest Avenue (HA15H025) under MDD 2021 or MDD 2031 conditions.
2. The service pressures under existing conditions, and ultimate build-out (currently 2031*) conditions are within the standards established by the MECP and City of Hamilton Guidelines. Under the proposed development conditions the pressures are expected to range between 376 kPa – 424 kPa.
3. The minimum flushing velocity of 0.8 m/s, as required by the MECP guidelines, can be achieved in the existing 300 mm watermain on Forest Avenue.

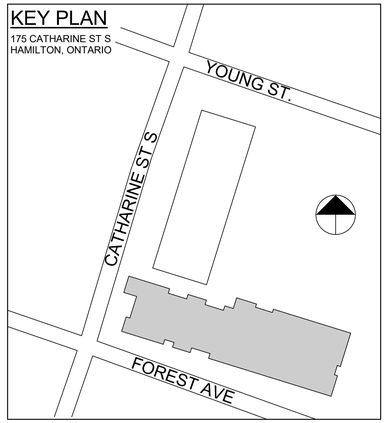
* As amended from time to time as per Official Plan Report Content

APPENDIX A –

Site Plan



2 SP1.01 SITE PLAN 1 : 200



PARKING SUMMARY		
PARKING REQUIRED	RATIO	SPACES
RESIDENTIAL		
NEW BUILDING - 216 UNIT	0.62	130
EXISTING BUILDING - 92 UNIT	0.62	58
BARRIER-FREE		3
VISITOR	INCLUDED	
TOTAL REQUIRED		191
PARKING PROVIDED		
RESIDENTIAL		
NEW BUILDING - 216 UNIT		161
EXISTING BUILDING - 92 UNIT		29
BARRIER-FREE		3
VISITOR	INCLUDED	
TOTAL PROVIDED		193
SMALL PARKING		20
GRAND TOTAL PROVIDED		213

UNDERGROUND GROSS FLOOR AREA	
Floors	**Area**
Not Placed	0.00 m²
UNDERGROUND LEVEL 3	861.66 m²
UNDERGROUND LEVEL 2	2,501.49 m²
UNDERGROUND LEVEL 1	2,892.48 m²
11th FLOOR	625.59 m²
12th FLOOR	625.59 m²
13th FLOOR	625.59 m²
14th FLOOR	625.59 m²
Total	8,758.00 m²

SELLABLE/NON-SELLABLE AREAS	
Floors	**Area**
COMMON AREA	
1st FLOOR	76.12 m²
	76.12 m²
NON-SELLABLE	
1st FLOOR	333.33 m²
2nd FLOOR	157.88 m²
3rd FLOOR	157.88 m²
4th FLOOR	157.88 m²
5th FLOOR	165.84 m²
6th FLOOR	165.84 m²
7th FLOOR	92.05 m²
8th FLOOR	92.05 m²
9th FLOOR	92.05 m²
10th FLOOR	92.05 m²
	1,506.85 m²
SELLABLE	
1st FLOOR	776.40 m²
2nd FLOOR	1,175.06 m²
3rd FLOOR	1,175.06 m²
4th FLOOR	1,175.06 m²
5th FLOOR	1,056.14 m²
6th FLOOR	1,056.14 m²
7th FLOOR	699.59 m²
8th FLOOR	699.59 m²
9th FLOOR	699.59 m²
10th FLOOR	699.59 m²
11th FLOOR	74.00 m²
12th FLOOR	74.00 m²
13th FLOOR	74.00 m²
14th FLOOR	74.00 m²
	9,508.20 m²
UNDERGROUND	
11th FLOOR	625.59 m²
12th FLOOR	625.59 m²
13th FLOOR	625.59 m²
14th FLOOR	625.59 m²
	2,502.38 m²
GROSS FLOOR AREA	13,593.54 m²

TOTAL CONSTRUCTABLE AREA	
Floors	**Area**
UNDERGROUND LEVEL 3	861.66 m²
UNDERGROUND LEVEL 2	2,501.49 m²
UNDERGROUND LEVEL 1	2,892.48 m²
1st FLOOR	1,185.85 m²
2nd FLOOR	1,332.94 m²
3rd FLOOR	1,332.94 m²
4th FLOOR	1,332.94 m²
5th FLOOR	1,221.98 m²
6th FLOOR	1,221.98 m²
7th FLOOR	791.64 m²
8th FLOOR	791.64 m²
9th FLOOR	791.64 m²
10th FLOOR	791.64 m²
11th FLOOR	699.59 m²
12th FLOOR	699.59 m²
13th FLOOR	699.59 m²
14th FLOOR	699.59 m²
Total	19,849.17 m²

UNITS BREAKDOWN			
Level	1 BED UNITS	2 BED UNITS	TOTAL UNITS
1st FLOOR	11	3	14
2nd FLOOR	20	2	22
3rd FLOOR	20	2	22
4th FLOOR	20	2	22
5th FLOOR	19	1	20
6th FLOOR	19	1	20
7th FLOOR	11	1	12
8th FLOOR	11	1	12
9th FLOOR	11	1	12
10th FLOOR	11	1	12
11th FLOOR	0	1	1
12th FLOOR	0	1	1
13th FLOOR	0	1	1
14th FLOOR	0	1	1
TOTAL UNITS	153	19	172

KEY TO DETAIL LOCATION
No. DETAIL NUMBER
No. DRAWING SHEET NUMBER

DRAWING SETS ISSUED	No.	DATE (DD.MM.YY)	BY
ISSUED FOR SPA	1.	23.04.19	KNYMH
ISSUED FOR SPA	2.	10.05.21	KNYMH
SPA COMMENTS	3.	10.08.21	KNYMH
ISSUED FOR BP APPROVAL	4.	29.07.22	KNYMH

ALL PREVIOUS ISSUES OF THIS DRAWING ARE SUPERSEDED.

REVISIONS TO DRAWING	No.	DATE (DD.MM.YY)	BY

NOT FOR CONSTRUCTION

BUILDING PERMIT NUMBER:

KNYMH
ARCHITECTURE • SOLUTIONS
KNYMH INC.
1006 SKYVIEW DRIVE • SUITE 101
BURLINGTON, ONTARIO • L7P 0V1
T 905.639.6595
F 905.639.0394
www.knymh.com info@knymh.com

PROJECT NORTH / TRUE NORTH

BROCKTON APARTMENTS

175 Catharine St S
Hamilton, Ontario

DRAWING SHEET TITLE:

SITE PLAN

DRAWING SCALE:	PROJECT NUMBER:
As indicated	21039

DRAWN BY:	CHECKED BY:	DRAWING SHEET NUMBER:
MN	PM	SP1.01

DRAWING VERSION:

PLOT DATE: 2021-08-05

APPENDIX B –

Field Testing Report

FLOWMETRIX
INDU-TECH
PROCESS

Fire Flow Testing Report

Residual Hydrant # **HA15H026**

NFPA Colour Code **BLUE**

DATE	July 21, 2022
TIME	12:00 PM
ADDRESS	146 Forest Avenue
	Hamilton, ON
	L8N 1X5
SIZE-inches/mm	8 / 300
MATERIAL	DI
CONTACT INFO	Scott Beedie
	Urban Solutions
	(905) 546-1087
	sbeedie@urbansolutions.info

RESIDUAL HYDRANT INFO.

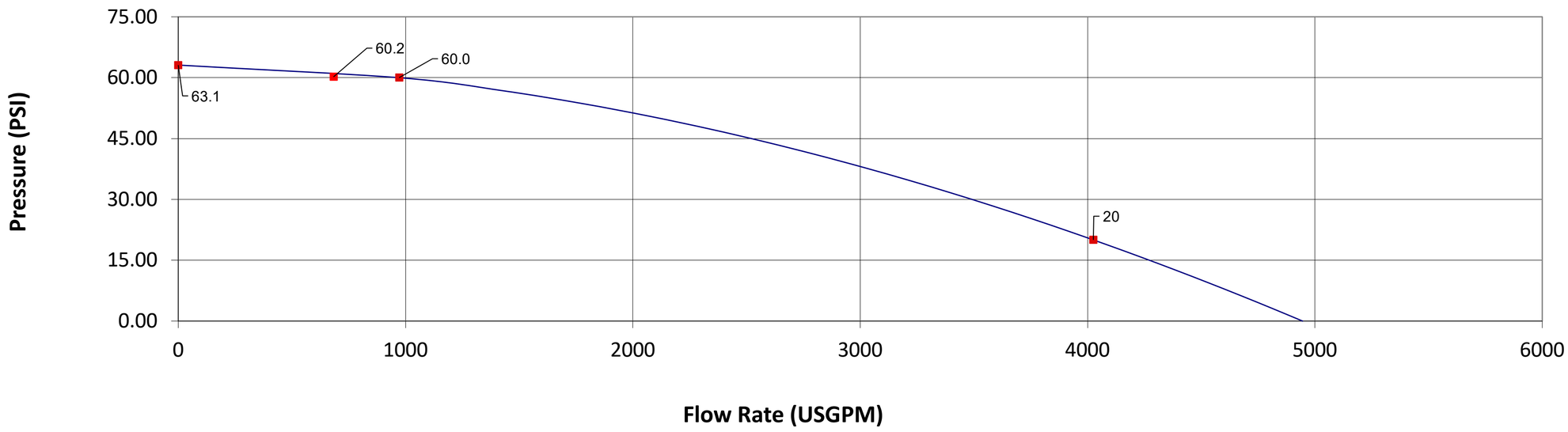
HYDRANT #	HA15H026	
N.F.P.A. COLOUR CODE	BLUE	
STATIC PRESSURE	63.1	psi
RESIDUAL PRESSURE - ONE PORT OPEN	60.2	psi
RESIDUAL PRESSURE - TWO PORTS OPEN	60.0	psi
PRESSURE DROP	3.1	psi
% PRESSURE DROP	4.9	% psi
Flow at Test Hydrant @ 20 psi	4025	USGPM

FLOW HYDRANT(S) INFO.

HYDRANT ASSET ID	HYD. # PORTS	OUTLET DIAMETER (INCHES)	NOZZLE COEFFICIENT	DIFFUSER TYPE	DIFFUSER COEFFICIENT	PITOT READING (psi)	PITOT FLOW (USGPM)	FLOW METER (USGPM)
HA15H025	1	2.5	Round	LPD250	0.90	**20.5**	683	0
								0
HA15H025	2	2.5	Round	LPD250	0.90	**10.4**	972	0
		2.5	Round	LPD250	0.90	**10.4**		0

FIRE FLOW CHART

Pressure - Flow Graph
at Test Hydrant



COMMENTS

OPERATOR	FMX	Jordan Whitlock
OPERATOR		Brendan Howatt
OPERATOR		City of Hamilton

Fire Flow Testing Report

Residual Hydrant #	**HA15H028**
NFPA Colour Code	**BLUE**

DATE	July 21, 2022	
TIME	11:30 AM	
ADDRESS	50 Young Street	
	Hamilton, ON	
	L8N 1V2	
SIZE-inches/mm	6	150
MATERIAL	DI	
CONTACT INFO	Laura Drennan	
	Urban Solutions	
	(905) 546-1087	
	ldrennan@urbansolutions.info	

RESIDUAL HYDRANT INFO.

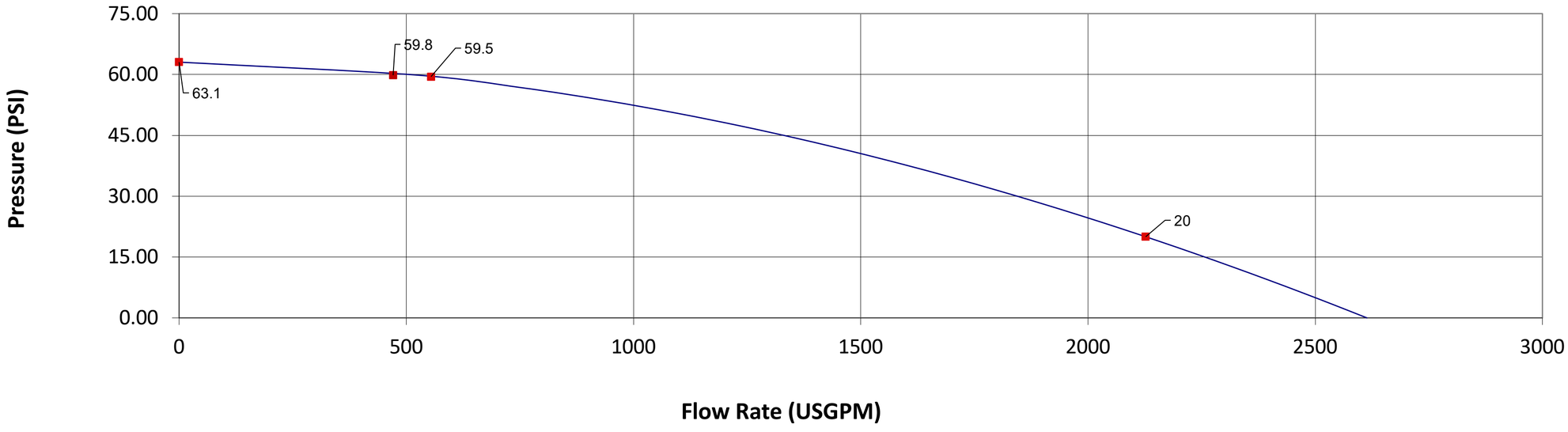
HYDRANT #	HA15H028	
N.F.P.A. COLOUR CODE	BLUE	
STATIC PRESSURE	63.1	psi
RESIDUAL PRESSURE - ONE PORT OPEN	59.8	psi
RESIDUAL PRESSURE - TWO PORTS OPEN	59.5	psi
PRESSURE DROP	3.6	psi
% PRESSURE DROP	5.7	% psi
Flow at Test Hydrant @ 20 psi	2127	USGPM

FLOW HYDRANT(S) INFO.

HYDRANT ASSET ID	HYD. # PORTS	OUTLET DIAMETER (INCHES)	NOZZLE COEFFICIENT	DIFFUSER TYPE	DIFFUSER COEFFICIENT	PITOT READING (psi)	PITOT FLOW (USGPM)	FLOW METER (USGPM)
HA15H027	1	2.5	Round	LPD250	0.90	**9.7**	471	0
								0
HA15H027	2	2.5	Round	LPD250	0.90	**3.4**	554	0
		2.5	Round	LPD250	0.90	**3.4**		0

FIRE FLOW CHART

Pressure - Flow Graph
at Test Hydrant



COMMENTS

OPERATOR	FMX	Jordan Whitlock
OPERATOR		Brendan Howatt
OPERATOR		City of Hamilton

Fire Flow Testing Report

FLOWMETRIX
INDU-TECH
PROCESS

Residual Hydrant # **HA15H026**
NFPA Colour Code **BLUE**

DATE	September 13, 2022
TIME	12:00 PM
ADDRESS	146 Forest Avenue
	Hamilton, ON
	L8N 1X5
SIZE-inches/mm	8 300
MATERIAL	DI
CONTACT INFO	Scott Beedie
	Urban Solutions
	(905) 546-1087
	sbeedie@urbansolutions.info

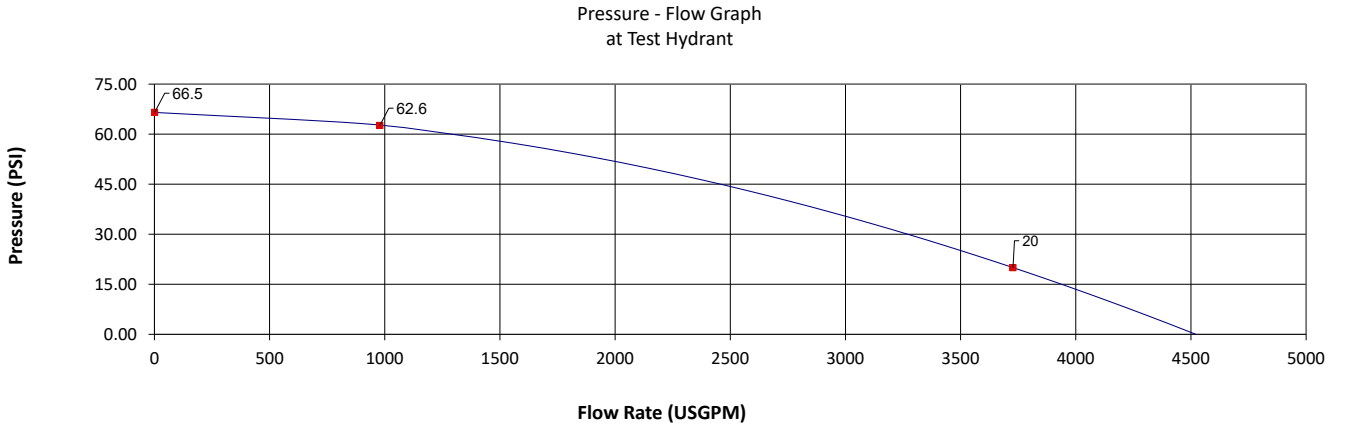
RESIDUAL HYDRANT INFO.

HYDRANT #	HA15H026	
N.F.P.A. COLOUR CODE	BLUE	
STATIC PRESSURE	66.5	psi
RESIDUAL PRESSURE	62.6	psi
PRESSURE DROP	3.9	psi
% PRESSURE DROP	5.9	% psi
Flow on Water Main at Test Hydrant @ 20 psi	3727	USGPM

FLOW HYDRANT(S) INFO.

FLOW HYDRANT ID	HYD. # PORTS	OUTLET DIAMETER (INCHES)	NOZZLE COEFFICIENT	DIFFUSER TYPE	DIFFUSER COEFFICIENT	PITOT READING (psi)	PITOT FLOW (USGPM)	FLOW METER (USGPM)
HA15H025	2	2.5	Round	LPD250	0.90	**10.5**	489	0
		2.5	Round	LPD250	0.90	**10.5**	489	0
HA15H027	2	2.5	Round	LPD250	0.90	**3.1**	266	0
		2.5	Round	Swivel	0.83	**3.1**	245	0
					Total Flow (USGPM)		1490	0
					Total Flow (USGPM)		1490	

FIRE FLOW CHART



COMMENTS

OPERATOR	FMX	Andrew Cheung
OPERATOR	FMX	Noushin Ahanrobay
OPERATOR		City of Hamilton

Fire Flow Testing Report

Residual Hydrant # **HA15H028**

NFPA Colour Code **BLUE**

DATE	September 13, 2022
TIME	12:30 PM
ADDRESS	50 Young Street
	Hamilton, ON
	L8N 1V2
SIZE-inches/mm	6 150
MATERIAL	DI

RESIDUAL HYDRANT INFO.

HYDRANT #	HA15H028	
N.F.P.A. COLOUR CODE	BLUE	
STATIC PRESSURE	66.0	psi
RESIDUAL PRESSURE	61.3	psi
PRESSURE DROP	4.7	psi
% PRESSURE DROP	7.2	% psi
Flow on Water Main At Test Hydrant	20 psi	1792 USGPM

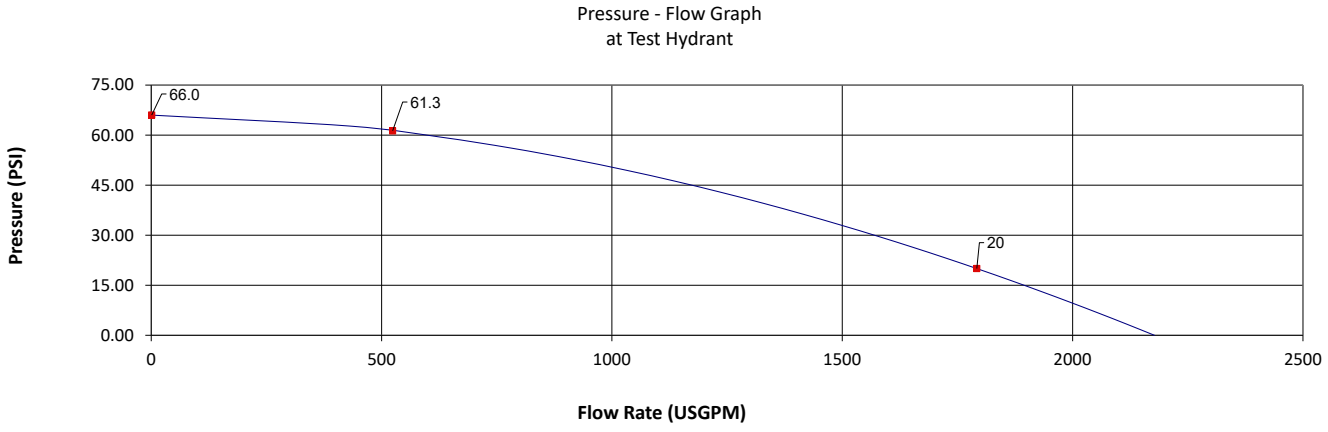
CONTACT INFO

Scott Beedie
Urban Solutions
(905) 546-1087
sbeedie@urbansolutions.info

FLOW HYDRANT(S) INFO.

HYDRANT ASSET ID	HYD. # PORTS	OUTLET DIAMETER (INCHES)	NOZZLE COEFFICIENT	DIFFUSER TYPE	DIFFUSER COEFFICIENT	PITOT READING (psi)	PITOT FLOW (USGPM)	FLOW METER (USGPM)
HA15H025	2	2.5	Round	LPD250	0.90	**9.3**	461	0
		2.5	Round	LPD250	0.90	**9.3**	461	0
HA15H027	2	2.5	Round	LPD250	0.90	**3.0**	262	0
		2.5	Round	LPD250	0.90	**3.0**	262	0
					Total Flow (USGPM)		1445	0
					Total Flow (USGPM)		1445	

FIRE FLOW CHART



COMMENTS

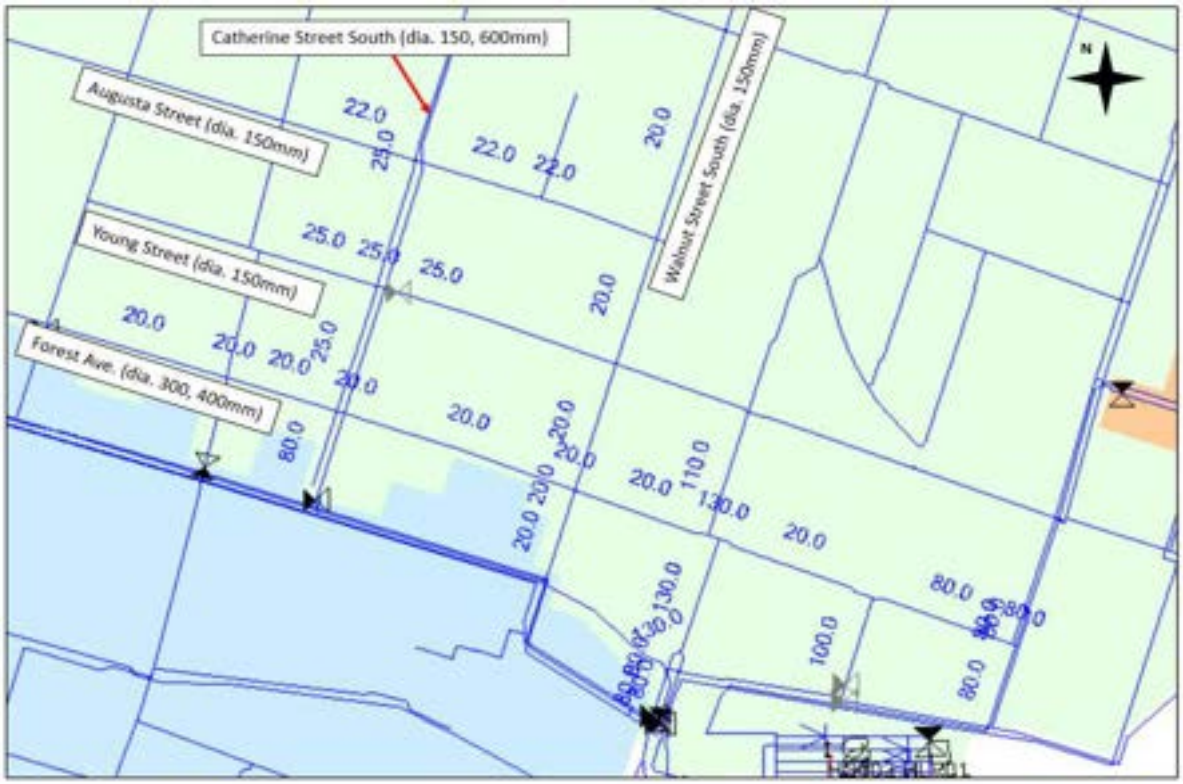
OPERATOR	FMX	Andrew Cheung
OPERATOR	FMX	Noushin Ahanrobay
OPERATOR		City of Hamilton

APPENDIX C –

Model Verification – C-factor Change Log

Model Verification - C-Factor Adjustment Log

ID	Label	Start Node	Stop Node	Street	Diameter (mm)	Material	Hazen-Williams C	Length (m)	Adusted c-factor
33453	HA15W12665(1)	HA15T024	HA15H037	Augusta	150	Cast Iron	80	5	22
33454	HA15W12665(2)	HA15H037	HA14C006	Augusta	150	Cast Iron	80	85	22
33460	HA15W12667(1)	HA15C011	HA15H036	Augusta	150	Cast Iron	80	120	22
33461	HA15W12667(2)	HA15H036	HA15T024	Young Street	150	Cast Iron	80	79	22
23632	HA15W12661	HA15C013	HA15C018	Catherine Street South	150	Cast Iron	80	100	25
33463	HA15W12662(1)	HA14C007	HA15H027	Young Street	150	Cast Iron	80	97	25
33464	HA15W12662(2)	HA15H027	HA15C013	Young Street	150	Cast Iron	80	89	25
33466	HA15W12670(1)	HA15R004	HA15H028	Young Street	150	Cast Iron	80	76	25
33467	HA15W12670(2)	HA15H028	HA15C013	Young Street	150	Cast Iron	80	9	25
23631	HA15W20308	HA15C013	HA15T041	Catherine Street South	150	Cast Iron	80	211	25
23667	HA14W12653	HA14V014	HA14C009	Forest Avenue	150	Cast Iron	80	1	20
23668	HA14W13250	HA14T011	HA14V014	Forest Avenue	150	Cast Iron	80	73	20
23666	HA14W13290	HA14C009	HA14C007	Walnut Street South	150	Cast Iron	80	101	20
23664	HA14W13291	HA14C006	HA14C007	Walnut Street South	150	Cast Iron	80	100	20
23663	HA14W13292	HA14C002	HA14C006	Walnut Street South	150	Cast Iron	80	167	20
28902	HA14W22892	HA14T045	HA14T039	Forest Avenue	300	Cast Iron	130	123	20
23721	HA14W23899	HA14C009	HA14T063	Forest Avenue	300	Cast Iron	130	105	20
33472	HA15W12654(1)(1)	HA15C018	HA15H025	Forest Avenue	300	Cast iron	80	25	20
33473	HA15W12654(1)(2)	HA15H025	HA15H026	Forest Avenue	300	Cast iron	80	143	20
33470	HA15W12654(2)	HA15H026	HA14C009	Forest Avenue	300	Cast iron	80	19	20
23574	HA15W12660	HA15R001(2)	HA15C018	Forest Avenue	300	Cast Iron	80	84	20



APPENDIX D –

Fire Flow Results

Fire Flow Analysis - Proposed Development

MDD 2021 - Tank 50%

Label	Zone	Fire Flow Iterations	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Flow (Total Needed) (L/s)	Flow (Total Available) (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Is Fire Flow Run Balanced?
HA15H025	2	3	TRUE	150	178	150	178.02	138	138	TRUE
J-471	2	3	TRUE	150	170	155.39	175.83	138	138	TRUE

MDD 2021 - Tank 75%

Label	Zone	Fire Flow Iterations	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Flow (Total Needed) (L/s)	Flow (Total Available) (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Is Fire Flow Run Balanced?
HA15H025	2	3	TRUE	150	185	150	184.72	138	138	TRUE
J-471	2	3	TRUE	150	177	155.39	182.19	138	138	TRUE

MDD 2031 - Tank 50%

Label	Zone	Fire Flow Iterations	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Flow (Total Needed) (L/s)	Flow (Total Available) (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Is Fire Flow Run Balanced?
HA15H025	2	3	TRUE	150	168	150	168.06	138	138	TRUE
J-471	2	3	TRUE	150	163	155.39	168.65	138	138	TRUE

MDD 2031 - Tank 75%

Label	Zone	Fire Flow Iterations	Satisfies Fire Flow Constraints?	Fire Flow (Needed) (L/s)	Fire Flow (Available) (L/s)	Flow (Total Needed) (L/s)	Flow (Total Available) (L/s)	Pressure (Residual Lower Limit) (kPa)	Pressure (Calculated Residual) (kPa)	Is Fire Flow Run Balanced?
HA15H025	2	3	TRUE	150	175	150	174.5	138	138	TRUE
J-471	2	3	TRUE	150	169	155.39	174.85	138	138	TRUE

APPENDIX E –

System Pressures

System Pressures - Proposed Development

ADD 2021 - Tank 50%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 1 item>	143.89	404
33553	J-471	TRUE	102.34	2	1.96	<Collection: 1 item>	143.89	407

ADD 2021 - Tank 75%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 1 item>	145.65	422
33553	J-471	TRUE	102.34	2	1.96	<Collection: 1 item>	145.65	424

ADD 2031 - Tank 50%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 0 items>	143.82	404
33553	J-471	TRUE	102.34	2	1.96	<Collection: 1 item>	143.82	406

ADD 2031 - Tank 75%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 0 items>	145.58	421
33553	J-471	TRUE	102.34	2	1.96	<Collection: 1 item>	145.58	423

MDD 2021 - Tank 50%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 0 items>	143.04	396
33553	J-471	TRUE	102.34	2	5.39	<Collection: 1 item>	143.05	398

MDD 2021 - Tank 75%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 0 items>	144.8	413
33553	J-471	TRUE	102.34	2	5.39	<Collection: 1 item>	144.81	416

MDD 2031 - Tank 50%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 0 items>	142.71	393
33553	J-471	TRUE	102.34	2	5.39	<Collection: 1 item>	142.72	395

MDD 2031 - Tank 75%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 0 items>	144.47	410
33553	J-471	TRUE	102.34	2	5.39	<Collection: 1 item>	144.48	412

PHD 2021 - Tank 50%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 0 items>	141.74	383
33553	J-471	TRUE	102.34	2	8.09	<Collection: 1 item>	141.75	386

PHD 2021 - Tank 75%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 0 items>	143.5	401
33553	J-471	TRUE	102.34	2	8.09	<Collection: 1 item>	143.51	403

PHD 2031 - Tank 50%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 0 items>	141.03	376
33553	J-471	TRUE	102.34	2	8.09	<Collection: 1 item>	141.04	379

PHD 2031 - Tank 75%

ID	Label	Is Active?	Elevation (m)	Zone	Demand (L/s)	Demand Collection	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	TRUE	102.56	2	0	<Collection: 0 items>	142.79	394

APPENDIX E –

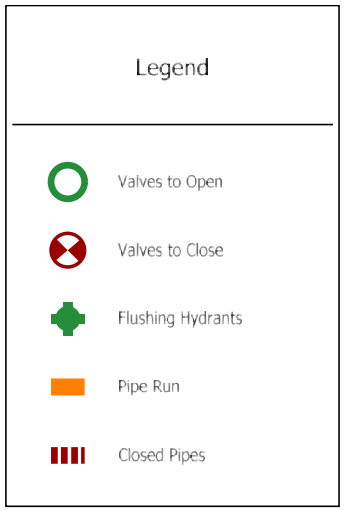
Flushing Results

Flushing Analysis - Proposed Development, ADD 2021, Tanks at 50%

ID	Label	Length (m)	Diameter (mm)	Flushing Event	Velocity (Maximum Flushing) (m/s)	Satisfies Flushing Target Velocity?	Shear Stress (Maximum Flushing) (kg/m²)	Satisfies Flushing Target Shear Stress?	Satisfies Flushing Target?
33554	HA15W12654(1)(2)(1)	20	300	Event - 1	1.12	TRUE	10.19	TRUE	TRUE
33555	HA15W12654(1)(2)(2)	123	300	Event - 1	1.09	TRUE	9.58	TRUE	TRUE

Flushing Field Report

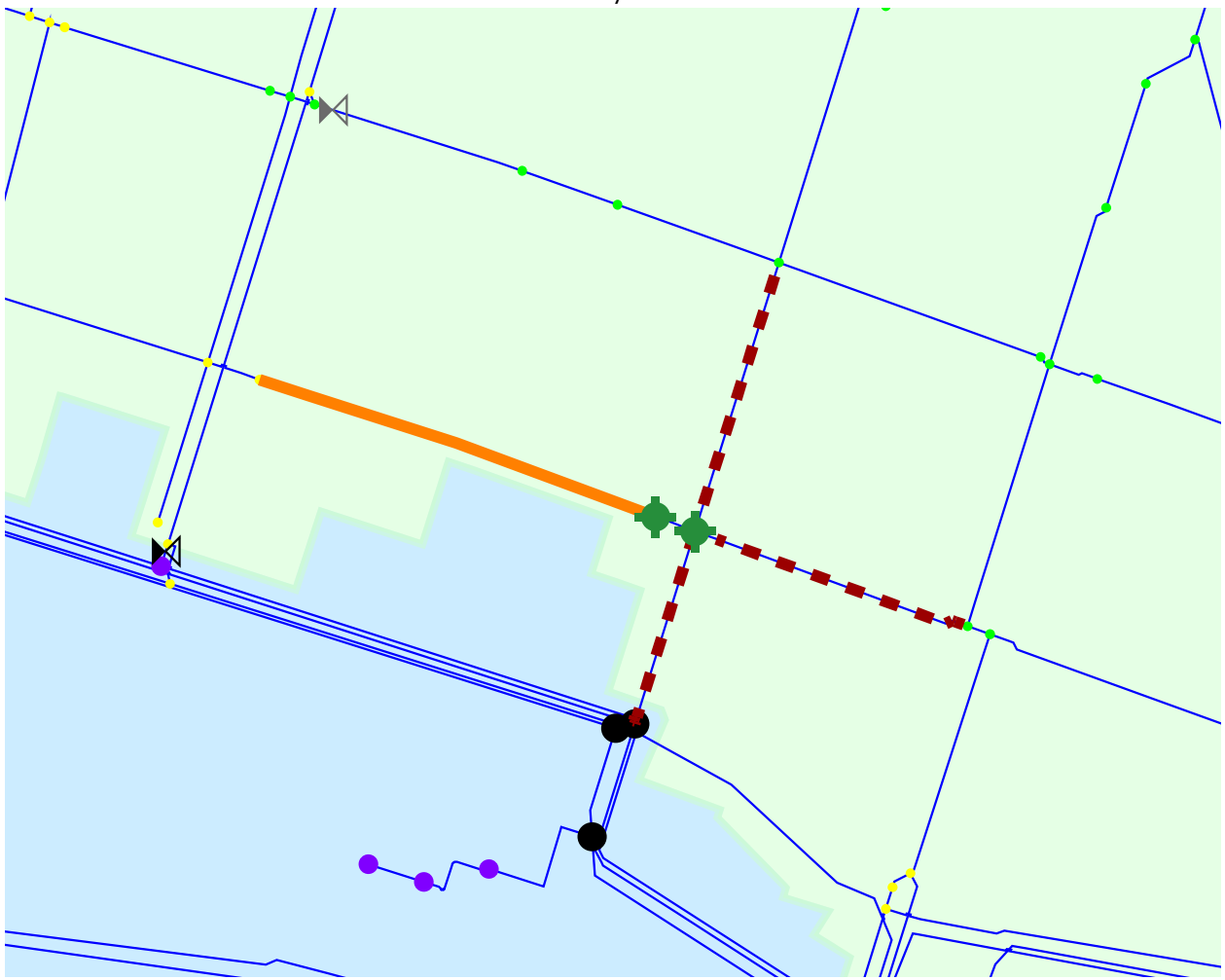
Study: Flushing Study



Flushing Field Report

Study: Flushing Study; Area: Forest; Event: Event - 1

Primary View



Flushing Field Report

Study: Flushing Study; Area: Forest; Event: Event - 1

Fire Hydrant	Notes	Pressure (kPa) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (kPa)	Predicted Flow (L/s)
HA14C009				110	38.72
HA15H026				114	38.53

Valve	Operation	Notes
HA14W13290	Close ☐	
HA14W23899	Close ☐	
HA14W13250	Close ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	

Flushing	Minimum	Recommended
Time (min)	2.2	2.2
Volume (ML)	0.0	0.0

Start Time _____

End Time _____

Operator _____

Date

Water Quality	Initial	Final
Clear	☐	☐
Colored	☐	☐
Chlorine Residual		
Turbidity		

Pipe Run to be Cleaned
HA15W12654(1)(2)(1), HA15W12654(1)(2)(2)

Notes _____

Flushing Field Report

Study: Flushing Study; Area: Forest; Event: Event - 1

Final Actions

Valve	Operation	Notes
HA14W13290	Reopen ☐	
HA14W23899	Reopen ☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	
	☐	