

Scott Beedie BURPI

117 Forest Avenue & 175 Catherine Street South Watermain Hydraulic Analysis

Friday, November 17, 2023

Urban Solutions | C3W-221655

CIMA+

900–101 Frederick Street
Kitchener, ON N2H 6R2
cima.ca

Contact

Sam Ziemann
sam.ziemann@cima.ca
T 519-404-4529



Engineering for **people**

Urban Solutions

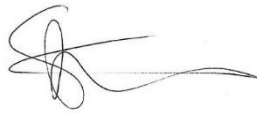
Water Hydraulic Analysis

117 Forest Avenue &
175 Catherine Street South
Watermain Hydraulic Assessment

Project no C3W-221655

Prepared by: Alec Orr, B.A.Sc., E.I.T. Water Specialist

Ryan Bolger, Student



Verified by: Sam Ziemann, P.Eng., President



Table of Contents

1	Introduction.....	1
1.1	Background.....	1
1.2	Limitations.....	3
2	Criteria.....	4
2.1	Pressure Requirements	4
2.2	Domestic Demand.....	4
2.3	Fire Flow Demand.....	5
3	Hydraulic Water Model	6
3.1	Boundary Conditions.....	6
3.2	Model Verification.....	6
3.2.1	Dual Hydrant Test Results	11
3.3	Development.....	12
4	Analysis.....	14
4.1	Available Fire Flow.....	14
4.2	System Pressures	14
4.3	Flushing	15
5	Conclusions.....	17

List of Tables

Table 2-1.	Pressure Requirements.....	4
Table 2-2.	Estimated Domestic Demands for the Proposed Development (SLA)	4
Table 2-3.	Hamilton Residential Fire Flow Requirements	5
Table 3-1.	Model Boundary Conditions – Base Configuration.....	6
Table 3-2.	Hydrant Field Testing Results – HA15H025 – July 21, 2022	7
Table 3-3.	Hydrant Field Testing Results – HA15H027 – July 21, 2023	7
Table 3-4.	Summary of Boundary Conditions at Time of Hydrant Testing.....	9
Table 3-5.	Theoretical Fire Flows at Hydrants HA15025 and HA15H027 at 20 PSI.....	11

Table 3-6. Summary of Hydrant and Model Data for Dual Hydrant Tests	12
Table 4-1. Available Fire Flow Results (L/s) for the Proposed Development	14
Table 4-2. Pressure Results (kPa) with Tanks Set at 50%.....	15
Table 4-3. Pressure Results (kPa) with Tanks Set at 75%.....	15
Table 4-4. Flushing Results with Tanks Set to 50% (ADD 2021)	16

List of Figures

Figure 1-1. Proposed Development Area (Approximate).....	2
Figure 3-1. Field Testing Hydrant Used for Model Verification	8
Figure 3-2. Verification Results – Hydrant HA15H025 on Forest Avenue	10
Figure 3-3. Verification Results – Hydrant HA15H027 on Young Street.....	11
Figure 3-4. Model Layout for the Proposed Development Area	13

List of Appendices

Appendix A: Site Plan

Appendix B: Field Testing Report

Appendix C: Model Verification – C-factor Change Log

Appendix D: Fire Flow Results

Appendix E: System Pressures

Appendix F: Flushing Results

1 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 24-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 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. Peaking factors of 2.75 and 4.13 were used for max day demand (MDD) and peak hour demand (PHD), respectively. 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 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	6.6	18.2	23.7

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 2-3.

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 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 Level	144.33 m (50%)	146.08 m (75%)
WTP Pumps	Off	Off
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, 2023

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

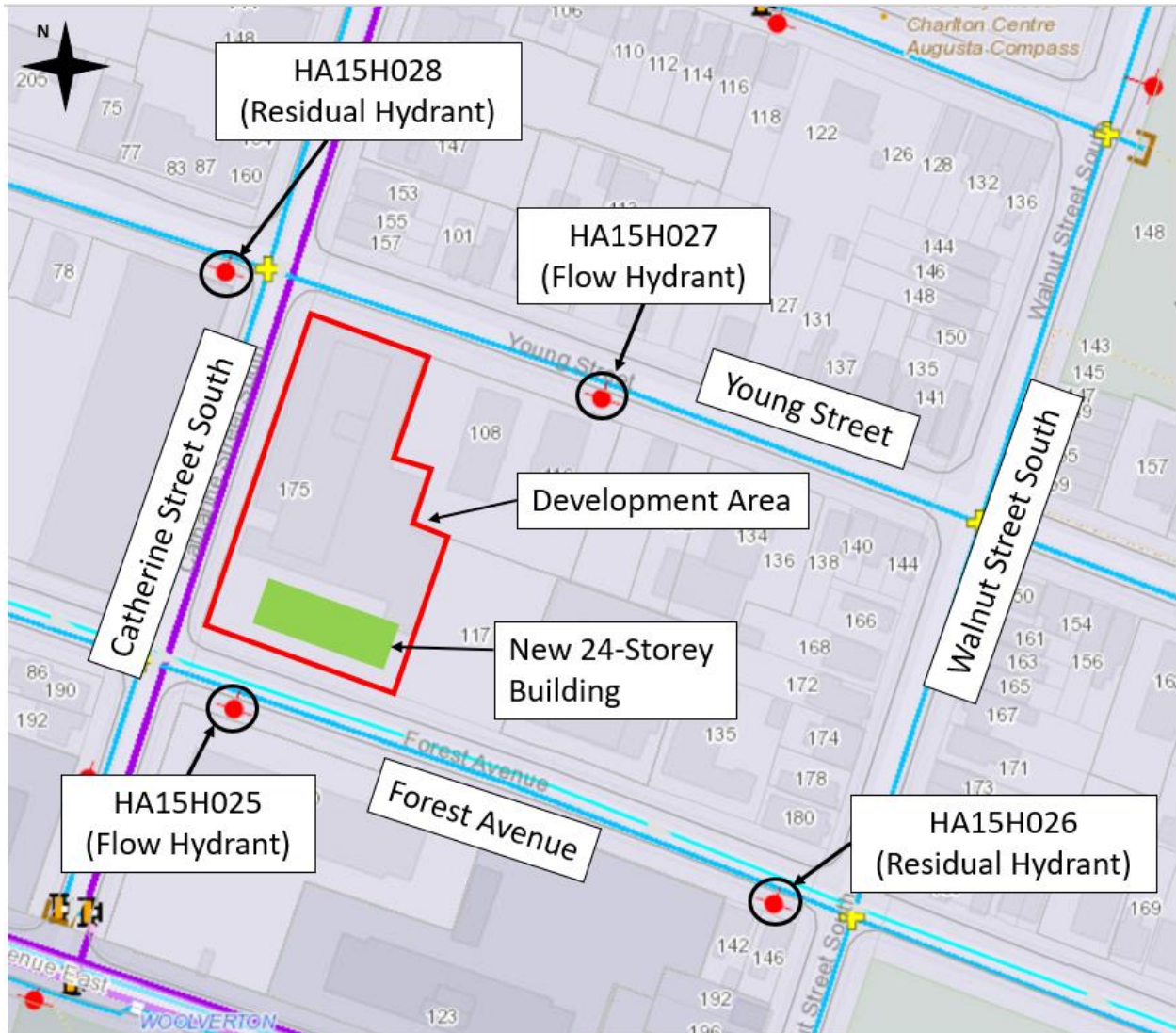


Figure 3-1. Field Testing Hydrant Used for Model Verification

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 HA15H025	Flow Hydrant 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%)
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.

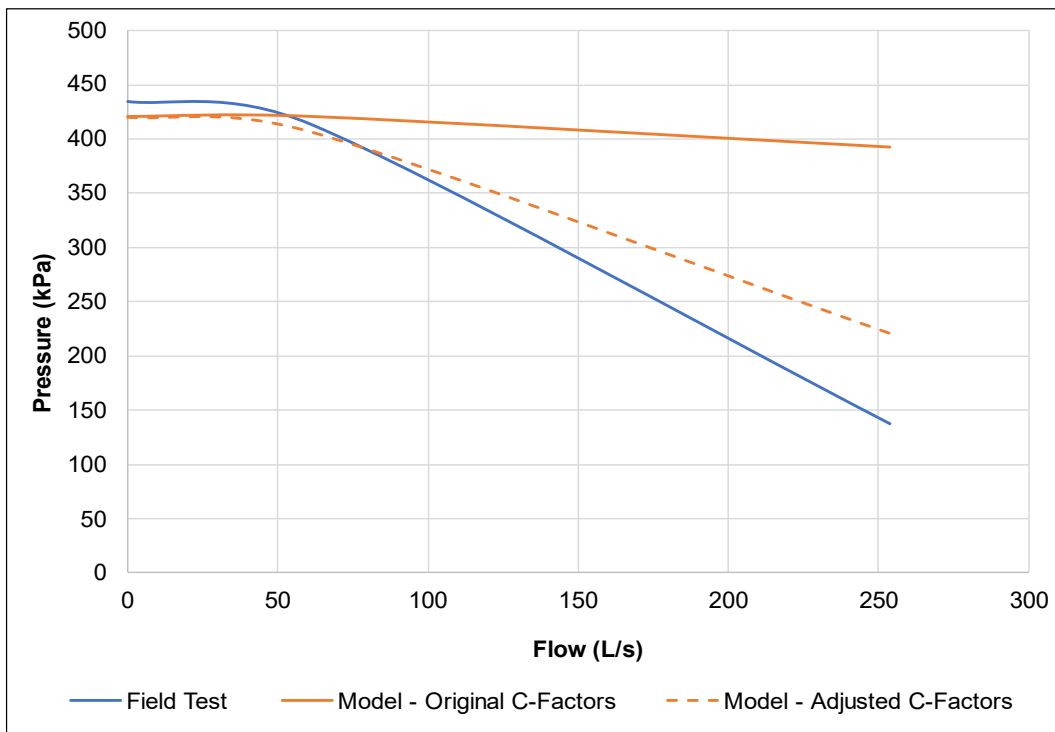


Figure 3-2. Verification Results – Hydrant HA15H025 on Forest Avenue

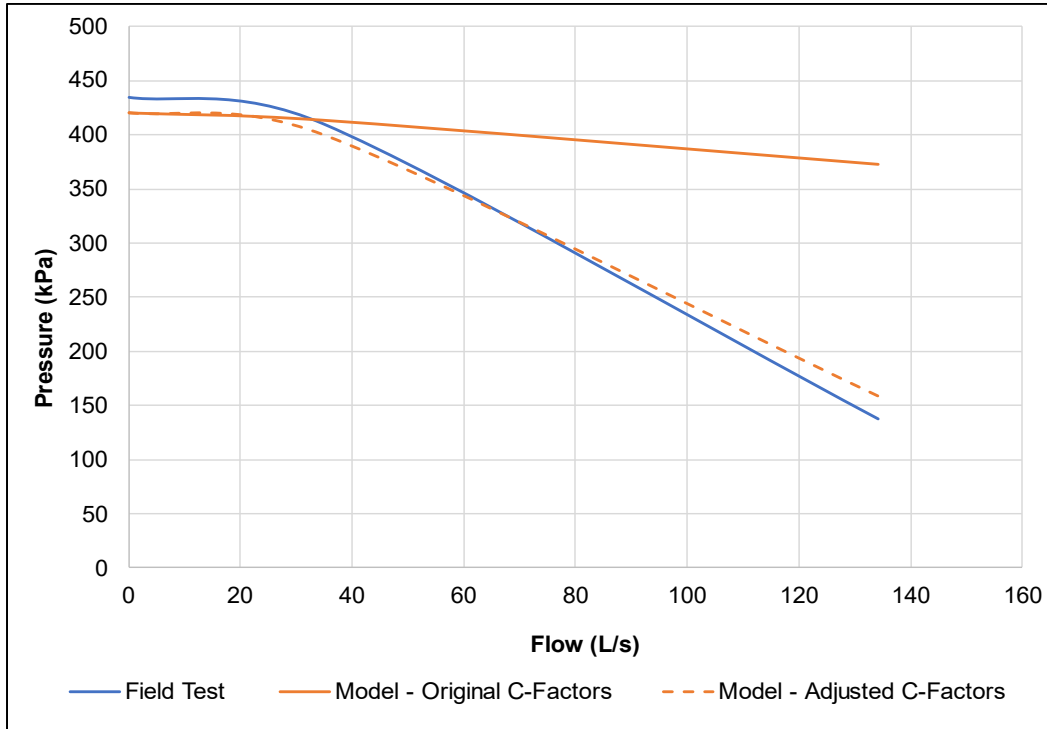


Figure 3-3. Verification Results – Hydrant HA15H027 on Young Street

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 HA15025 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. **Error! Reference source not found.** 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 **Error! Reference source not found.** and **Error! Reference source not found.**

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.

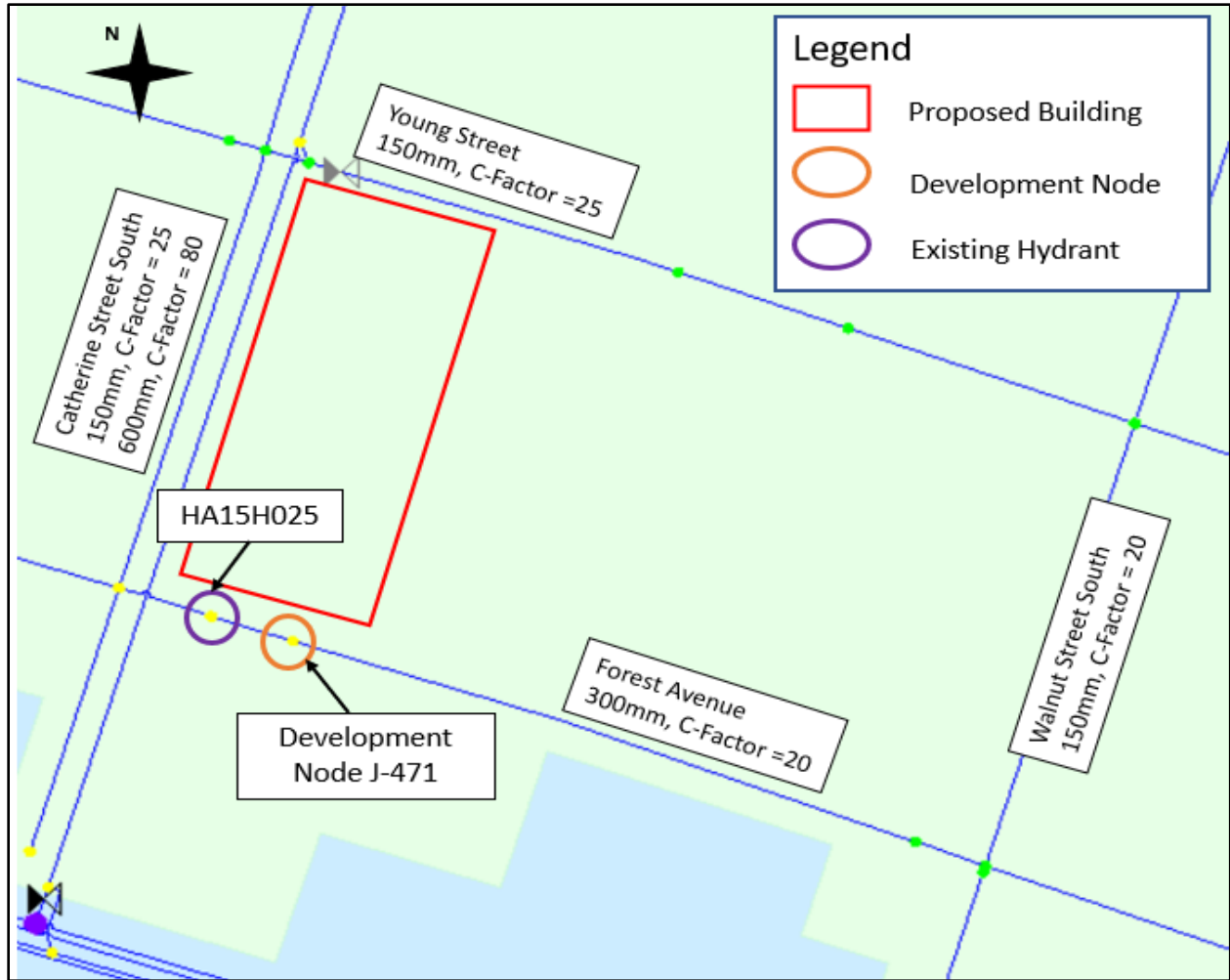


Figure 3-4. Model Layout for the Proposed Development Area

4 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	166	173	156	162	TRUE
J-471	158	164	150	157	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 370 kPa – 423 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	403	392	389	377	370
J-471	406	405	394	390	379	371

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

Node	ADD		MDD		PHD	
	2021	2031	2021	2031	2021	2031
HA15H025	421	420	410	406	395	387
J-471	423	421	412	408	396	389

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 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 370 kPa – 423 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

A

Appendix A: Site Plan

YOUNG STREET

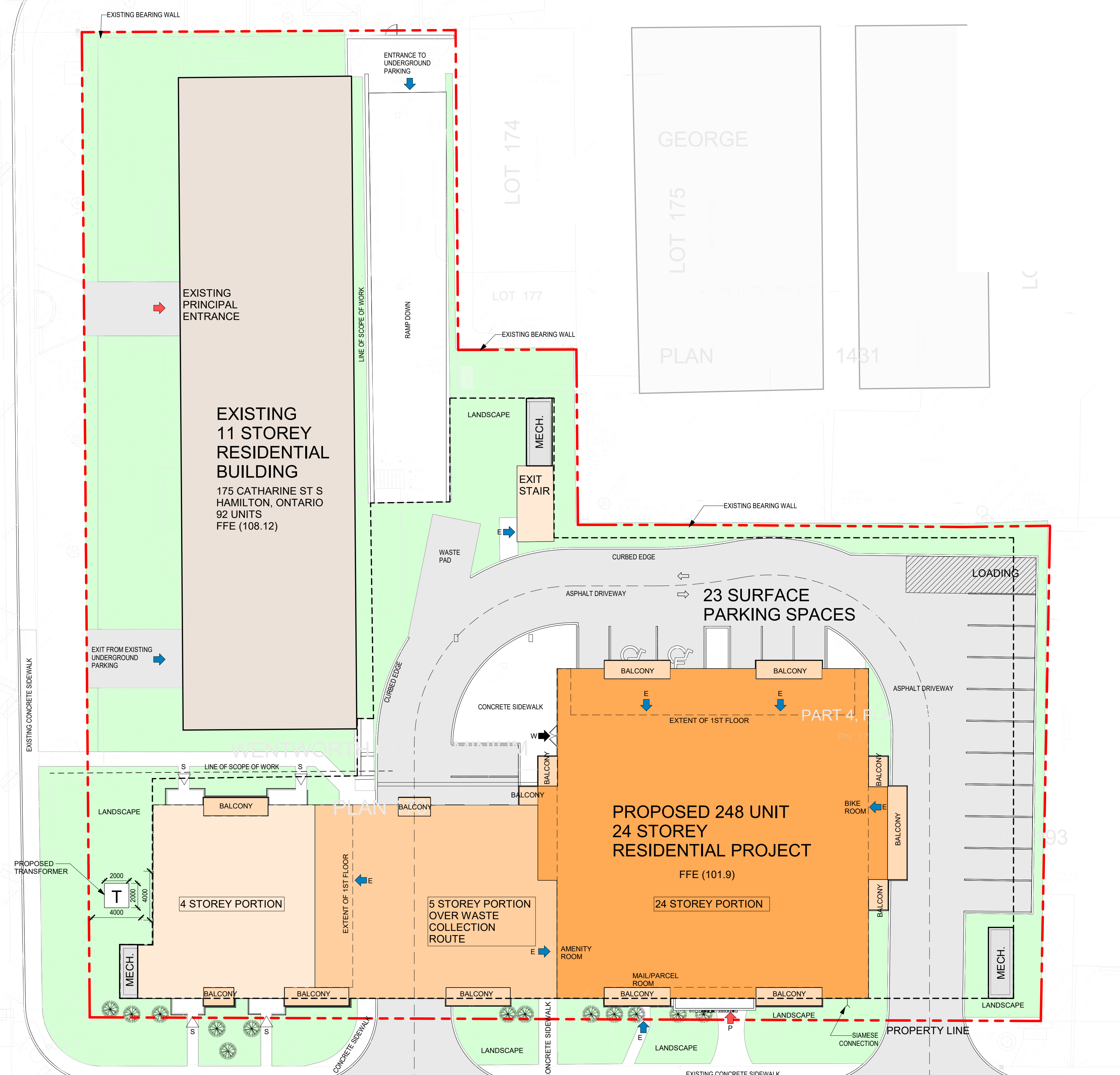
SURVEY INFORMATION
TAKEN FROM DRAWINGS
PREPARED BY A.T.
MCLAREN LIMITED ON
AUGUST 10TH, 2021

KEY PLAN

175 CATHARINE ST S
HAMILTON, ONTARIO



CATHARINE STREET SOUTH



LEGEND

- PROPERTY LINE
- P **PRINCIPAL ENTRANCE** AS PER ONTARIO BUILDING CODE AND FIRE ACCESS/FIRE CODE
- E ENTRY/ EXITS DOOR
- W WASTE SERVICE DOOR
- S ENTRY TO SINGLE SUITE FROM GROUND LEVEL
- EXTENT OF UNDERGROUND
- FIRE ROUTE
- WASTE COLLECTION ROUTE

SITE STATISTICS

GENERAL INFORMATION	
BUILDING AREA	1,192sqm
BUILDING HEIGHT	68.4m
# OF STOREYS	22
# OF RESIDENTIAL STOREYS	22
# OF UNDERGROUND LEVELS	2
SITE AREA	4,530.5sqm (shared/combined)

PARKING PER LEVEL

Level	Parking Space Type	Count
UNDERGROUND LEVEL 3	Barrier-Free	1
	Small	45
		46
UNDERGROUND LEVEL 2	Barrier-Free	3
	Small	61
		64
UNDERGROUND LEVEL 1	Barrier-Free	3
	Small	55
		58
1st FLOOR	Barrier-Free	2
1st FLOOR	Small	21
		23
Grand total		191

GROSS SELLABLE AREA

Floor	# of Units	Areas
1st FLOOR	4	228.6 m ²
2nd FLOOR	0	205.1 m ²
2nd FLOOR	9	521.7 m ²
3rd FLOOR	17	1010.5 m ²
4th FLOOR	17	1010.5 m ²
5th FLOOR	13	767.2 m ²
6th FLOOR	13	767.2 m ²
7th FLOOR	10	590.1 m ²
8th FLOOR	10	590.1 m ²
9th FLOOR	10	590.1 m ²
10th FLOOR	10	590.1 m ²
11th FLOOR	10	590.1 m ²
12th FLOOR	10	590.1 m ²
13th FLOOR	10	590.1 m ²
14th FLOOR	10	590.1 m ²
15th FLOOR	10	590.1 m ²
16th FLOOR	10	590.1 m ²
17th FLOOR	10	590.1 m ²
18th FLOOR	10	590.1 m ²
19th FLOOR	10	590.1 m ²
20th FLOOR	10	590.1 m ²
21st FLOOR	10	590.1 m ²
22nd FLOOR	10	590.1 m ²
23rd FLOOR	10	590.1 m ²
24th FLOOR	5	590.1 m ²
Total of GSA	248	15133.3 m ²

Unit Breakdown Per Floor

Level	1 BED UNITS	2 BED UNITS	3 BED UNITS	TOTAL UNITS
1st FLOOR	0	3	1	4
2nd FLOOR	4	5	0	9
3rd FLOOR	10	7	0	17
4th FLOOR	10	7	0	17
5th FLOOR	8	5	0	13
6th FLOOR	8	5	0	13
7th FLOOR	6	4	0	10
8th FLOOR	6	4	0	10
9th FLOOR	6	4	0	10
10th FLOOR	6	4	0	10
11th FLOOR	6	4	0	10
12th FLOOR	6	4	0	10
13th FLOOR	6	4	0	10
14th FLOOR	6	4	0	10
15th FLOOR	6	4	0	10
16th FLOOR	6	4	0	10
17th FLOOR	6	4	0	10
18th FLOOR	6	4	0	10
19th FLOOR	6	4	0	10
20th FLOOR	6	4	0	10
21st FLOOR	6	4	0	10
22nd FLOOR	6	4	0	10
23rd FLOOR	6	4	0	10
24th FLOOR	0	0	5	5
TOTAL UNITS	142	100	6	248

Type of Unit	Total	Percentage
1 BED	142	57.26%
2 BED	100	40.32%
3 BED	6	2.42%
TOTAL	248	100.00%

CONTRACTOR MUST CHECK AND VERIFY ALL DIMENSIONS AND JOB CONDITIONS BEFORE PROCEEDING WITH WORK.
ALL DRAWINGS MAY BE SUBJECT TO CHANGE DUE TO COMMENTS FROM MUNICIPAL DEPARTMENTS AND OTHER AGENCIES WITH AUTHORITY.
ALL DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF THE ARCHITECTS AND MUST BE RETURNED AT THE COMPLETION OF THE WORK.
THE CONTRACTOR WORKING FROM DRAWINGS NOT SPECIFICALLY MARKED FOR CONSTRUCTION MUST ASSUME FULL RESPONSIBILITY AND BEAR COSTS FOR ANY CORRECTIONS OR DAMAGES RESULTING FROM HIS OR HER WORK.

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 THIS DRAWING 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

THIS DOCUMENT IS INCOMPLETE AND MAY NOT BE USED FOR REGULATORY APPROVAL, PERMIT OR CONSTRUCTION AND ARE FOR USE BY CONSULTANTS, SUBCONSULTANTS, OWNER AND CONTRACTORS TO PROVIDE THEIR INPUT TO THE COORDINATION OF THIS DOCUMENT.

BROCKTON APARTMENTS
175 Catharine St S
Hamilton, Ontario

DRAWING SHEET TITLE:
SITE PLAN

DRAWING SCALE:
As indicated

PROJECT NUMBER:
21039

DRAWN BY: CHECKED BY:
DRAWING SHEET NUMBER:
A0.01

PLOT DATE:
2021-08-05

2 SITE PLAN
A0.01 1:200

PROJECT NAME: 2022-08-22-26-54-PM FILE PATH: C:\Real\Loco\21039 - Brockton Apartments - immo\csm\A0.01.dwg

B

Appendix B: Field Testing Report



FLOWMETRIX
INDU-TECH
PROCESS

Fire Flow Testing Report

Residual Hydrant #
N.F.P.A. Colour Code

HA15H026
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.

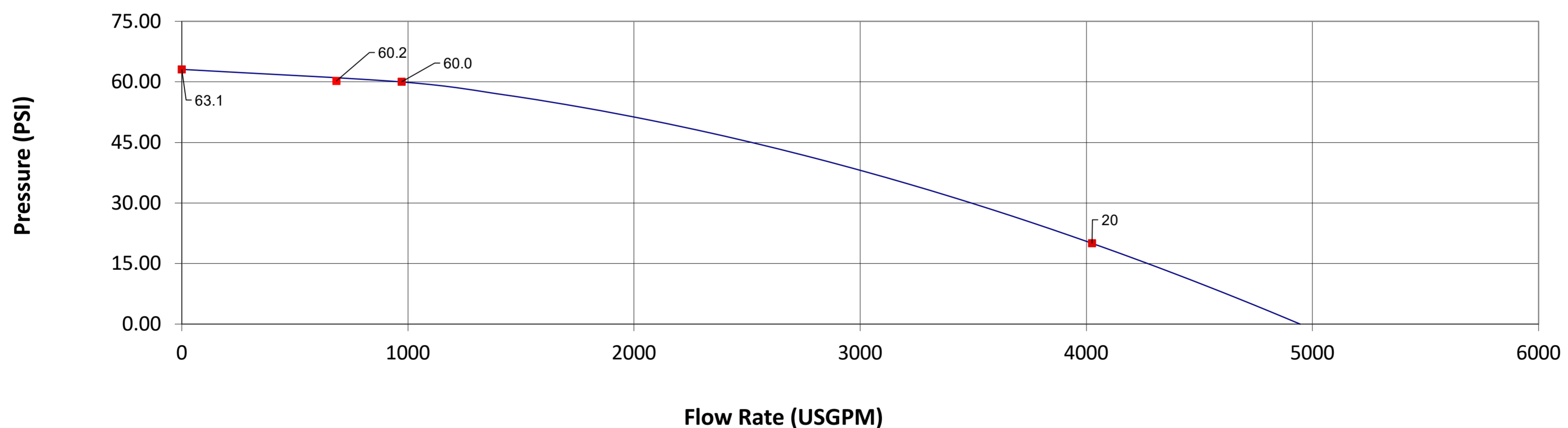
HYDRANT #	HA15H026
N.F.P.A. COLOUR CODE	BLUE
STATIC PRESSURE	63.1 psi
RESIDUAL PRESSURE - ONE PORT OPEN	60.2 psi
RESIDUAL PRESSURE - TWO PORTS OPEN	60.0 psi
PRESSURE DROP	3.1 psi
% PRESSURE DROP	4.9 % psi
Flow at Test Hydrant @ 20 psi	4025 USGPM

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



FLOWMETRIX
INDU-TECH
PROCESS

Fire Flow Testing Report

Residual Hydrant #
NFWPA Colour Code

HA15H028
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.

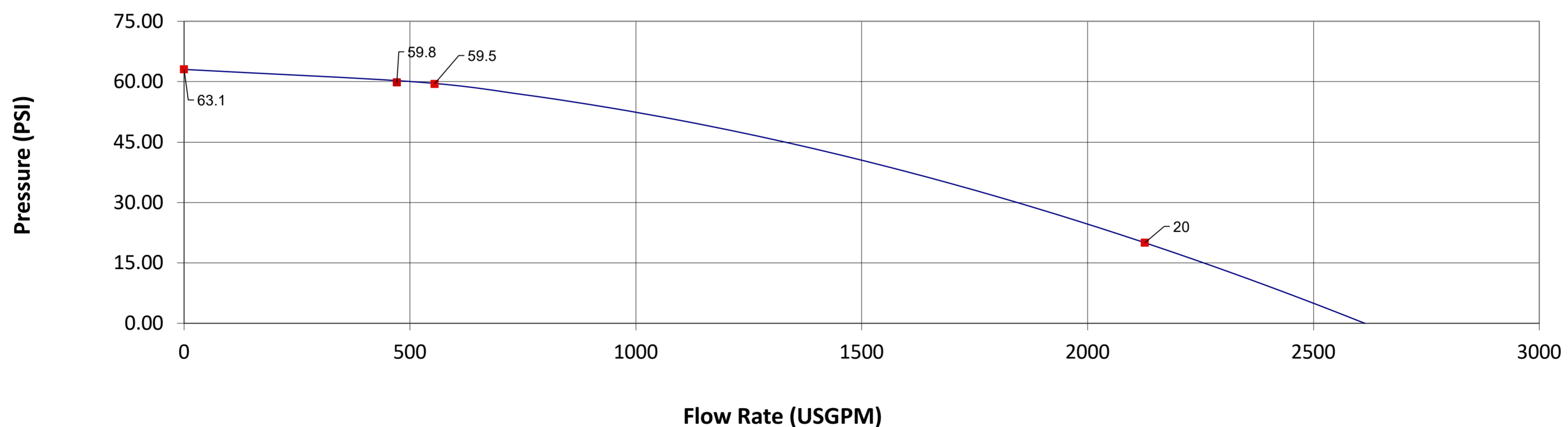
HYDRANT #	HA15H028
N.F.P.A. COLOUR CODE	BLUE
STATIC PRESSURE	63.1 psi
RESIDUAL PRESSURE - ONE PORT OPEN	59.8 psi
RESIDUAL PRESSURE - TWO PORTS OPEN	59.5 psi
PRESSURE DROP	3.6 psi
% PRESSURE DROP	5.7 % psi
Flow at Test Hydrant @ 20 psi	2127 USGPM

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
		2.5	Round	LPD250	0.90	3.4		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
OPERATOR: Jordan Whitlock
OPERATOR: Brendan Howatt
City of Hamilton



**FLOWMETRIX
INDU-TECH
PROCESS**

Fire Flow Testing Report

Residual Hydrant #
NFWA Colour Code

HA15H026
BLUE



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

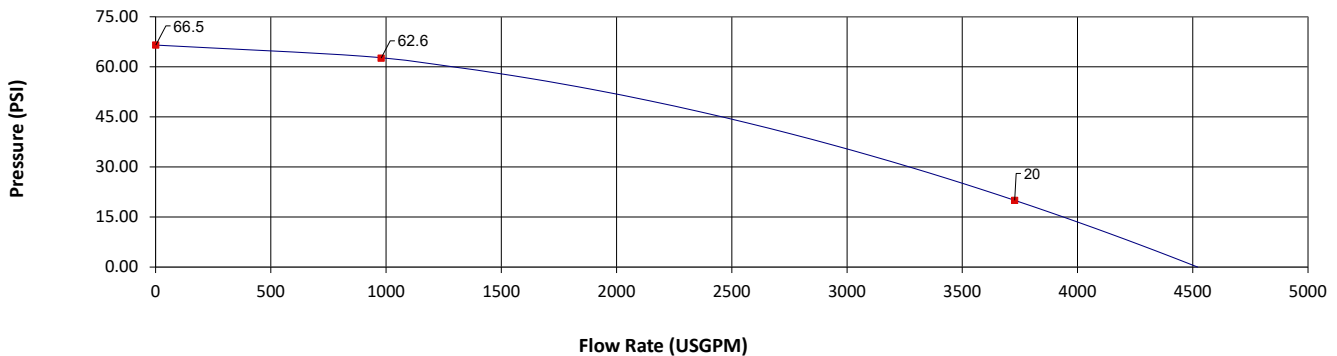
DATE	September 13, 2022
TIME	12:00 PM
ADDRESS	146 Forest Avenue Hamilton, ON L8N 1X5
SIZE-inches/mm	8 300
MATERIAL	DI
CONTACT INFO	Scott Beedie Urban Solutions (905) 546-1087 sbeedie@urbansolutions.info

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

Pressure - Flow Graph
at Test Hydrant



COMMENTS

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



FLOWMETRIX
INDU-TECH
PROCESS
WESTCAN

Fire Flow Testing Report

Residual Hydrant #
NFWA Colour Code

HA15H028
BLUE



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

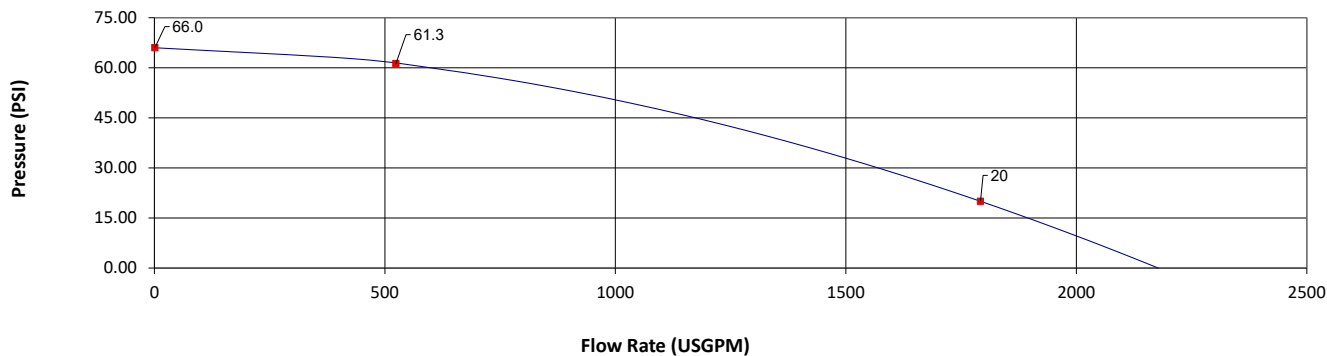
DATE	September 13, 2022
TIME	12:30 PM
ADDRESS	50 Young Street Hamilton, ON L8N 1V2
SIZE-inches/mm	6 150
MATERIAL	DI
CONTACT INFO	Scott Beedie Urban Solutions (905) 546-1087 sbeedie@urbansolutions.info

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

Pressure - Flow Graph
at Test Hydrant



COMMENTS

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

C

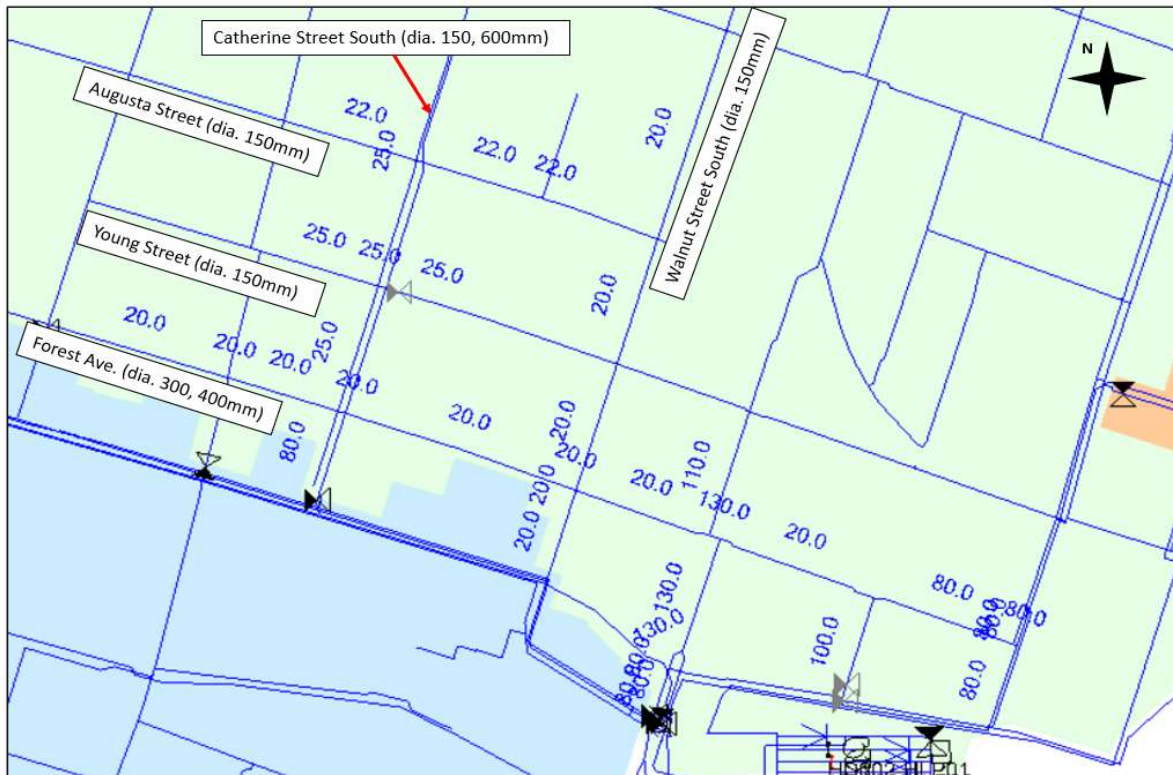
Appendix C: Model Verification – C-factor Change Log



Engineering
for **people**

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



D

Appendix D: Fire Flow Results



Engineering
for **people**

MDD - 2021 Tanks 50%

Label	Zone	Satisfies Fire Flow Constraints?	Fire Flow Status	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)	Pressure (Zone Lower Limit) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Pressure (System Lower Limit) (kPa)	Pressure (Calculated System Lower Limit) (kPa)	Junction w/ Minimum Pressure (System)	Is Fire Flow Run Balanced?
HA15H025	2	TRUE	Passed	150	166.16	150	166.16	138	138	138	152	J-471	(N/A)	-18,164	DL06T014	TRUE
J-471	2	TRUE	Passed	150	157.68	168.18	175.86	138	138	138	155	HA28L002	(N/A)	-18,164	DL06T014	TRUE

MDD - 2021 Tanks 75%

Label	Zone	Satisfies Fire Flow Constraints?	Fire Flow Status	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)	Pressure (Zone Lower Limit) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Pressure (System Lower Limit) (kPa)	Pressure (Calculated System Lower Limit) (kPa)	Junction w/ Minimum Pressure (System)	Is Fire Flow Run Balanced?
HA15H025	2	TRUE	Passed	150	172.82	150	172.82	138	138	138	153	J-471	(N/A)	-18,164	DL06T014	TRUE
J-471	2	TRUE	Passed	150	164.01	168.18	182.19	138	138	138	172	HA28L002	(N/A)	-18,164	DL06T014	TRUE

MDD - 2021 Tanks 50%

Label	Zone	Satisfies Fire Flow Constraints?	Fire Flow Status	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)	Pressure (Zone Lower Limit) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Pressure (System Lower Limit) (kPa)	Pressure (Calculated System Lower Limit) (kPa)	Junction w/ Minimum Pressure (System)	Is Fire Flow Run Balanced?
HA15H025	2	TRUE	Passed	150	156.04	150	156.04	138	138	138	149	HA155004	(N/A)	-34	HD03A-J22	TRUE
J-471	2	TRUE	Passed	150	150.49	168.18	168.67	138	138	138	155	HA28L002	(N/A)	-34	HD03A-J22	TRUE

MDD - 2021 Tanks 75%

Label	Zone	Satisfies Fire Flow Constraints?	Fire Flow Status	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)	Pressure (Zone Lower Limit) (kPa)	Pressure (Calculated Zone Lower Limit) (kPa)	Junction w/ Minimum Pressure (Zone)	Pressure (System Lower Limit) (kPa)	Pressure (Calculated System Lower Limit) (kPa)	Junction w/ Minimum Pressure (System)	Is Fire Flow Run Balanced?
HA15H025	2	TRUE	Passed	150	162.45	150	162.45	138	138	138	151	J-471	(N/A)	-34	HD03A-J22	TRUE
J-471	2	TRUE	Passed	150	156.67	168.18	174.85	138	138	138	171	HA15H025	(N/A)	-34	HD03A-J22	TRUE

E

Appendix E: System Pressures



Engineering
for **people**

ADD -2021 Tank -75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 1 item>	0	145.59	421
33553	J-471	102.34	2	<Collection: 1 item>	6.61	145.59	423

ADD - 2021 tank 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 1 item>	0	143.84	404
33553	J-471	102.34	2	<Collection: 1 item>	6.61	143.84	406

ADD - 2031 tanks 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 0 items>	0	143.74	403
33553	J-471	102.34	2	<Collection: 1 item>	6.61	143.74	405

ADD - 2031 tanks 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 0 items>	0	145.51	420
33553	J-471	102.34	2	<Collection: 1 item>	6.61	145.51	422

MDD - 2021 tanks 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 0 items>	0	142.68	393
33553	J-471	102.34	2	<Collection: 1 item>	18.18	142.64	394

MDD - 2021 tanks 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 0 items>	0	144.43	410
33553	J-471	102.34	2	<Collection: 1 item>	18.18	144.39	412

MDD - 2031 tanks 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 0 items>	0	142.28	389

33553	J-471	102.34	2	<Collection: 1 item>	18.18	142.26	391
-------	-------	--------	---	----------------------	-------	--------	-----

MDD - 2031 tanks 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 0 items>	0	144.03	406
33553	J-471	102.34	2	<Collection: 1 item>	18.18	144.01	408

PHD - 2021 Tanks 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 0 items>	0	141.14	378
33553	J-471	102.34	2	<Collection: 1 item>	23.7	141.09	379

PHD - 2021 Tanks 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 0 items>	0	142.89	395
33553	J-471	102.34	2	<Collection: 1 item>	23.7	142.84	396

PHD - 2031 Tanks 50%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 0 items>	0	140.34	370
33553	J-471	102.34	2	<Collection: 1 item>	23.7	140.3	371

PHD - 2031 Tanks 75%

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Hydraulic Grade (m)	Pressure (kPa)
33471	HA15H025	102.56	2	<Collection: 0 items>	0	142.09	387
33553	J-471	102.34	2	<Collection: 1 item>	23.7	142.05	389

F

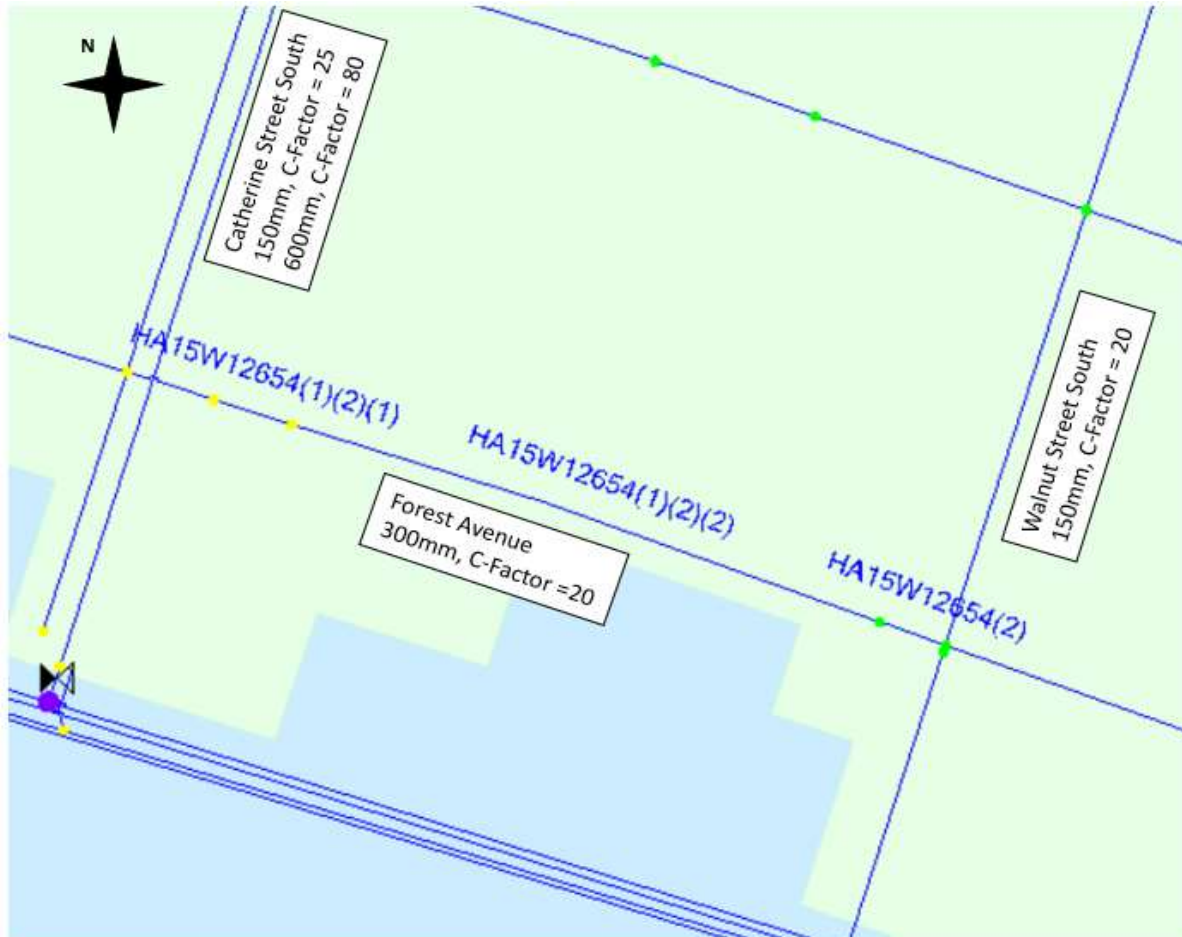
Appendix F: Flushing Results



Engineering
for **people**






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/m ²)	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

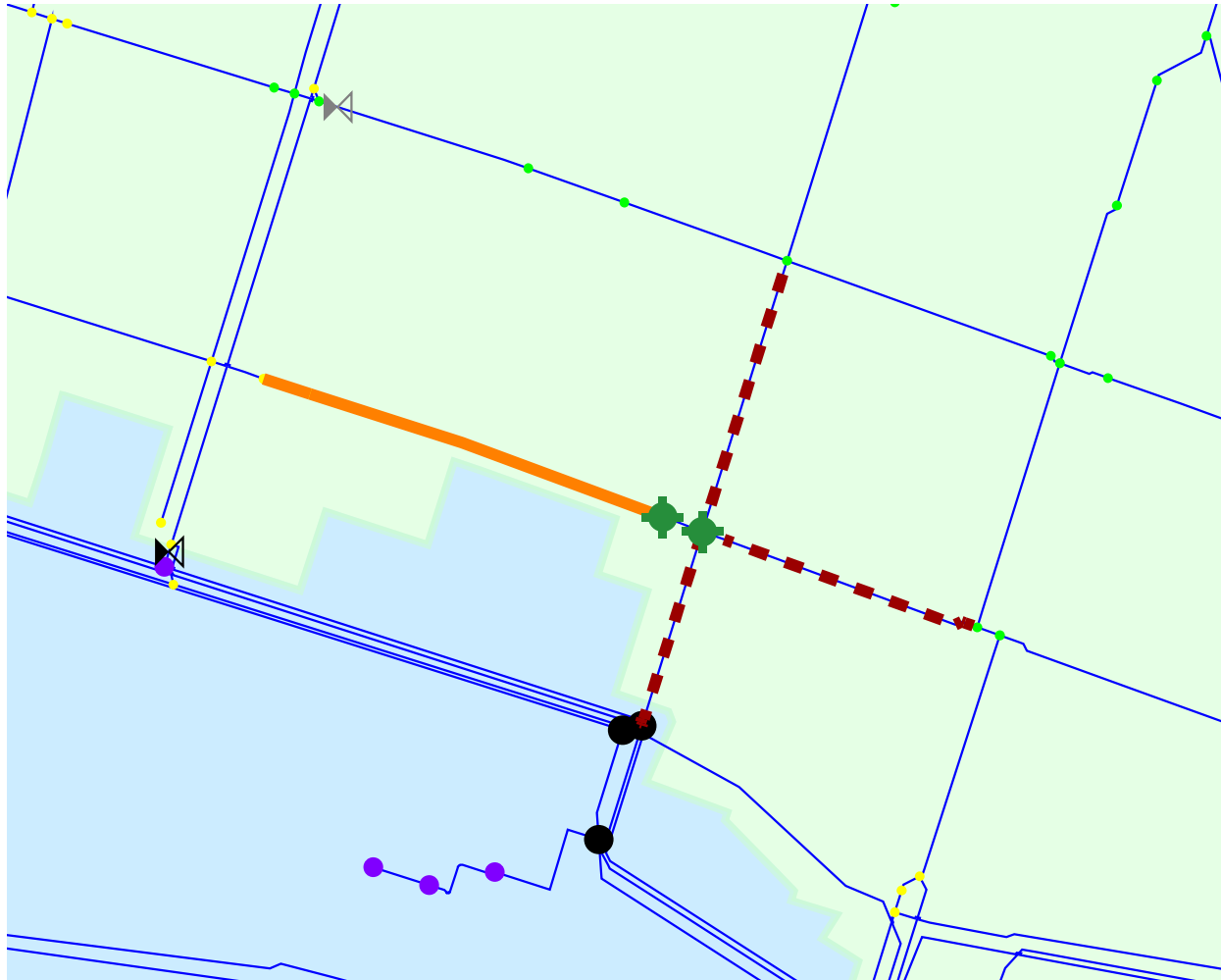
Study: Flushing Study

Legend	
	Valves to Open
	Valves to Close
	Flushing Hydrants
	Pipe Run
	Closed Pipes

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	Flushing	Minimum	Recommended																											
HA14W13290	Close <input type="checkbox"/>		Time (min)	2.2	2.2																											
HA14W23899	Close <input type="checkbox"/>		Volume (ML)	0.0	0.0																											
HA14W13250	Close <input type="checkbox"/>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>Start Time</td><td colspan="2">_____</td></tr> <tr><td>End Time</td><td colspan="2">_____</td></tr> <tr><td>Operator</td><td colspan="2">_____</td></tr> <tr><td>Date</td><td colspan="2">_____</td></tr> <tr><td colspan="3">Water Quality</td></tr> <tr><td>Clear</td><td style="text-align: center;"><input type="checkbox"/></td><td style="text-align: center;"><input type="checkbox"/></td></tr> <tr><td>Colored</td><td style="text-align: center;"><input type="checkbox"/></td><td style="text-align: center;"><input type="checkbox"/></td></tr> <tr><td>Chlorine Residual</td><td></td><td></td></tr> <tr><td>Turbidity</td><td></td><td></td></tr> </table>			Start Time	_____		End Time	_____		Operator	_____		Date	_____		Water Quality			Clear	<input type="checkbox"/>	<input type="checkbox"/>	Colored	<input type="checkbox"/>	<input type="checkbox"/>	Chlorine Residual			Turbidity		
Start Time	_____																															
End Time	_____																															
Operator	_____																															
Date	_____																															
Water Quality																																
Clear	<input type="checkbox"/>	<input type="checkbox"/>																														
Colored	<input type="checkbox"/>	<input type="checkbox"/>																														
Chlorine Residual																																
Turbidity																																
	<input type="checkbox"/>																															
	<input type="checkbox"/>																															
	<input type="checkbox"/>																															
	<input type="checkbox"/>																															
	<input type="checkbox"/>																															
	<input type="checkbox"/>																															
	<input type="checkbox"/>																															
	<input type="checkbox"/>																															
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 <input type="checkbox"/>	
HA14W23899	Reopen <input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	
	<input type="checkbox"/>	