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Cc: Date: **August 31, 2022**
Subject: **499 Mohawk Road East Water Servicing Feasibility Study**

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499 Mohawk Road East

Watermain Hydraulic Assessment

C3 WATER INC.

August 31, 2022



Table of Contents

1.0	Introduction	1
1.1	Limitations	1
2.0	Criteria	2
2.1	Domestic Demands	2
2.2	Pressure Requirements	2
2.3	Fire Flow Requirements	2
3.0	Boundary Conditions	2
3.1	Pressure District 5	2
3.2	Pressure District 6	3
4.0	Model Verification	4
5.0	Model Analysis.....	7
5.1	Pressures	8
5.2	Fire Flows	9
5.3	System Flushing	10
6.0	Conclusion and Recommendations	14



Table of Tables

Table 2-1: Proposed Development Demands.....	2
Table 2-2: Pressure Requirements.....	2
Table 3-1: PD5 Boundary Conditions	3
Table 3-2: PD6 Boundary Conditions	4
Table 4-1: Hydrant Field Test Data.....	4
Table 5-1: Pressure Results (psi)	9
Table 5-2: Available Fire Flows (L/s) (MDD) – PD5 & PD6 Connection – Tanks at 50%.....	9
Table 5-3: Available Fire Flows (L/s) (MDD) – Existing Hydrants – Pre- and Post-Development	10
Table 5-4: Flushing Results	13

Table of Figures

Figure 4-1: Hydrant Testing Locations.....	5
Figure 4-2: Model Verification – Hydrant HC31H002 Mohawk Road.....	6
Figure 4-3: Model Verification – Hydrant HC10H005 Upper Sherman Avenue	6
Figure 4-4: Surrounding Watermains with Adjusted C-Factors.....	7
Figure 5-1: Model Layout.....	8
Figure 5-2: Flushing Configuration 1	11
Figure 5-3: Flushing Configuration 2	11
Figure 5-4: Flushing Configuration 3	12
Figure 5-5: Flushing Configuration 4	12
Figure 5-6: Flushing Configuration 5	13

APPENDIX A: Domestic Demand Calculations

APPENDIX B: Detailed Pressure Results

APPENDIX C: Detailed Fire Flow Results

APPENDIX D: Flushing Reports



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1	August 17, 2022	Draft 1	Brad Sun	Sam Ziemann
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SIGN OFF

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DATE: August 31, 2022

Prepared by: **Sam Ziemann, P.Eng., President**
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1.0 Introduction

The proposed 499 Mohawk Drive East development site is located on the border of Pressure District 5 (PD5) and Pressure District 6 (PD6) in the City of Hamilton. Figure 1 illustrates the proposed development area. C3 Water Inc. (C3W) has been retained by the New Horizon Development Group Inc. (NHDGI) to complete a watermain hydraulic assessment for the proposed development.

Four potential water service connection locations were considered, including three on the existing 300mm watermain on Mohawk Road East within PD6, and one on the existing 300mm watermain on Upper Sherman Avenue in PD5. The existing ground elevation of the development area is approximately 208m.



Figure 1: Proposed Development Area

1.1 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 Domestic Demands

Demands for the development were calculated by Lanhack Consultants Inc. (Lanhack). Demands were determined based on a service population of 5,196 and determined using the City of Hamilton Water and Wastewater Masterplan, Class Environmental Assessment Report (Nov. 2006). The residential demands for the development are presented in Table 2-1. For a breakdown of the calculations, refer to Appendix A.

Table 2-1: Proposed Development Demands

ADD (L/s)	MDD (L/s)	PHD (L/s)
21.65	41.14	64.95

2.2 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 2-2 provides the pressure criteria that were utilized.

Table 2-2: 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)		

2.3 Fire Flow Requirements

The fire flow requirements for the proposed development were determined by Lanhack using both the Ontario Building Code (OBC) method and the City’s Watermain Fire Flow Requirement Design Guidelines. Both methods yielded a fire flow requirement of 150 L/s. Fire Flow calculations can be found in Appendix A.

3.0 Boundary Conditions

3.1 Pressure District 5



PD5 is supplied by pump stations HD005 and HD05A and has a floating storage reservoir HDR05 with a top water level of 236m. At a development elevation of 208 m, the development would have a pressure of 24.2 m – 30 m (34.4 – 42.7 psi) at a PD5 HGL range of 232.3 m – 236 m (Tank HDR05 50% -100% full). The development area does not experience a significant change in elevation across the property. The PD5 boundary conditions used in the model were based on direction from the City and are summarized in Table 3-1 below. The PD5 boundaries specified by the City are as follows:

- 2021 and 2031 planning horizons.
- Reservoir HDR05 level at 50% and 70%.
- HD05A PMP-4 on in all scenarios.
- If PMP-4 is insufficient to meet pressures or flows, set HD05A PMP-1 on and PMP-4 off.
- If the above is insufficient to meet pressures or flows, set both PMP-1 and PMP-4 to on.

Table 3-1: PD5 Boundary Conditions

Element	Initial Status – HGL	
	232.32 m (50%)	233.88 m (70%)
HD005-HLP01	Off	Off
HD005-HLP02	Off	Off
HD005-HLP03	Off	Off
HD005-HLP04	Off	Off
HD05A-PMP-1	On/Off	On/Off
HD05A-PMP-2	Off	Off
HD05A-PMP-4	On/Off	On/Off

3.2 Pressure District 6

PD6 is a closed zone with no floating storage, supplied by pump stations HD06A and HD06B which draw water from PD5 (reservoir HDR05). PD6 has a maximum hydraulic grade line of 274m. At a development elevation of 208 m, the development would have a pressure of 66 m (93.9 psi) at the maximum PD6 HGL of 274m. Boundary conditions for PD6 were applied based on input from the City and are summarized in Table 3-2 below. The City has specified that HD06A and HD06B pump stations should be modelled each with one of the largest pumps turned off at each station to represent firm capacity. If pressure results are above the preferred operating conditions, additional pumps may be turned off. Each station also has a recirculation valve to relieve pressures into HDR05 during periods of low demand. The City specified pressure setpoints for the recirculation lines of 430 kPa (271m HGL) and 675 kPa (277m HGL) for HD06A and HD06B, respectively.

Table 3-2: PD6 Boundary Conditions

Element	Initial Status – HGL	
Tank HDR05 level	232.32 m (50%)	233.88 m (70%)
HD06A-PMP-1	On	On
HD06A-PMP-3	On	On
HD06A-PMP-4	Off	Off
HD06A-PMP-5	On	On
HD06B-PMP-1	On	On
HD06B-PMP-2	On	On
HD06B-PMP-4	Off	Off

4.0 Model Verification

Field test results were used to verify the model accuracy in the development area. Field testing was conducted by L&D Waterworks Inc. on May 13, 2022. The results of this testing are provided in Table 4-1 below. Figure 4-1 shows the hydrant testing locations in relation to the proposed development. Based on the hydrant field tests, the available fire flow in the area is expected to range from 147 – 381 L/s. The field-testing data showed the static pressure at the hydrant in PD6 at 84 psi, and the static pressure at the PD5 hydrant was 32 psi. The field testing also showed significantly higher available flow in PD6 on Mohawk Road compared to PD5 on Upper Sherman Avenue.

Table 4-1: Hydrant Field Test Data

Pressure District	Road	Hydrant	Testing Date	Predicted Flow (L/s) at 20 psi	Static Pressure (psi)
PD6	Mohawk Rd. E	HC31H002	May 13, 2022	381	84
PD5	Upper Sherman Ave.	HD10H005		147	32

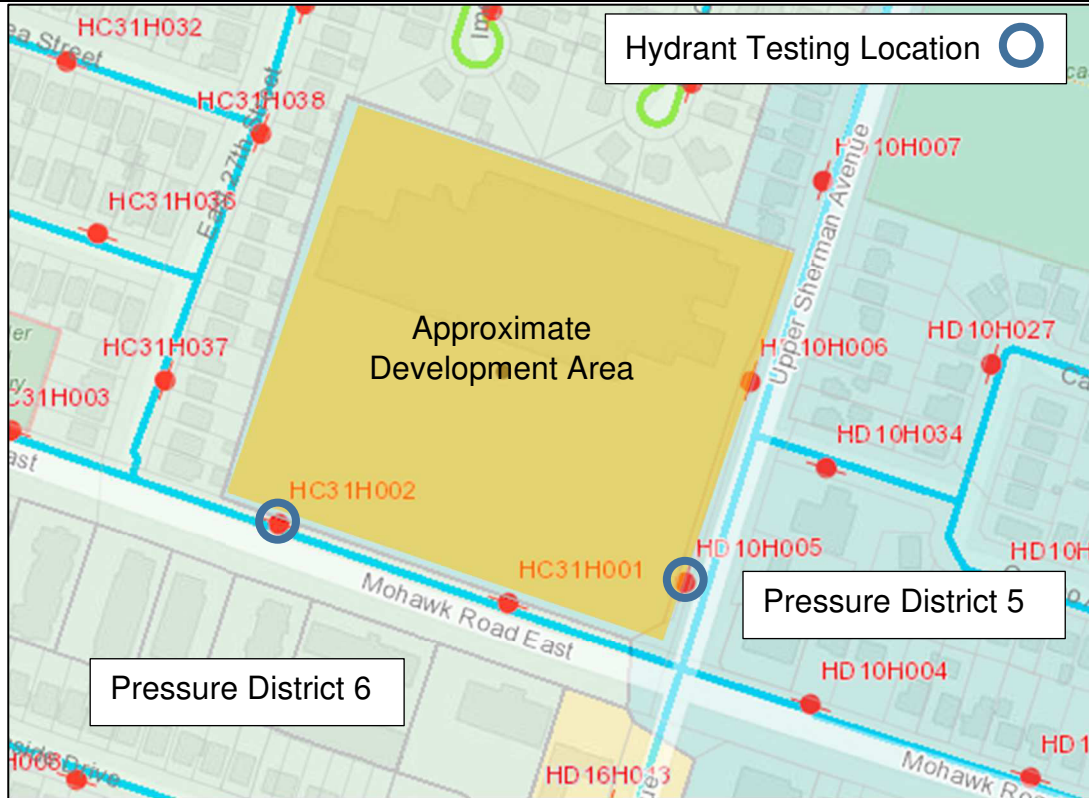


Figure 4-1: Hydrant Testing Locations

SCADA data from the time of testing was requested from the City to match the system boundary conditions in the model. The results for hydrant HC31H002 on Mohawk Road East in PD6 are presented in Figure 4-2. The static pressure in the model was found to be higher than what was recorded in the field tests. This may be a result of differences in elevation between the model and the field at either the hydrant or the station PRVs. The focus of the model verification was on the drop in pressure caused by the hydrant flow test.

The watermain along Mohawk Road is reported in the City’s GIS as being 300mm PVC, and modelled with a C-factor of 130, with the exception of one block between Bishopsgate Avenue and E 27th Street which had a C-factor of 80 in the model. The dashed orange line shows the model results with no changes to the model C-factors. Because the model was significantly more conservative than the field tests at higher flows, the C-factors along Mohawk Road were raised to 140, as well as a section of Upper Wentworth Street. The watermain that were changed are illustrated in Figure 4-4.

With the adjusted C-factors, the model was still found to be conservative compared to the field test results at the theoretical available fire flow of 381 L/s.

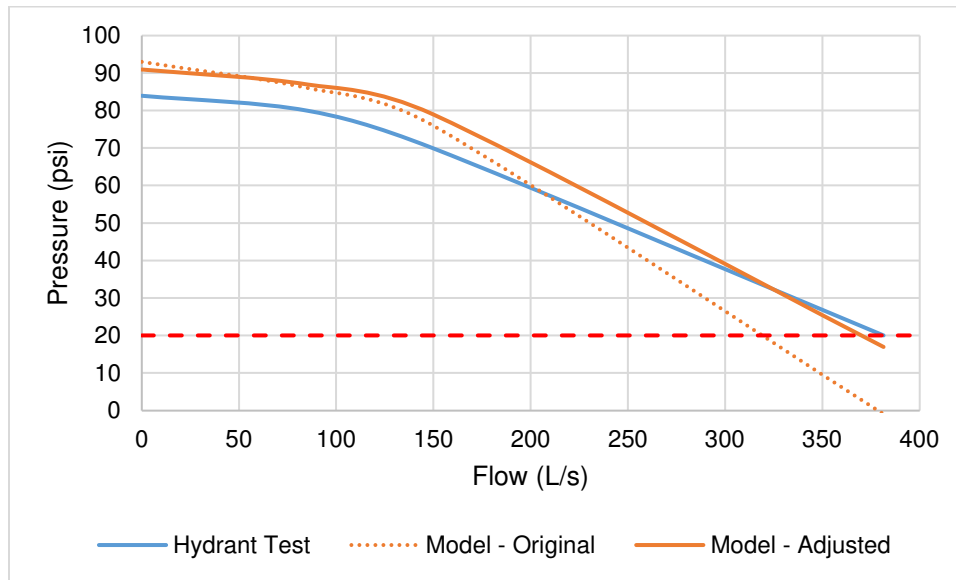


Figure 4-2: Model Verification – Hydrant HC31H002 Mohawk Road

The field test results for hydrant HD10H005 on Upper Sherman Avenue are presented in Figure 4-3.

Initial model results were less conservative than the field tests. As such, the C-factor for surrounding pipes were changed to match the results more closely. The pipes with adjusted C-factors are presented in Figure 4-4. The selected watermains consisted of 150, 200, and 300mm diameters with existing C-factors ranging from 80 to 130. The cast iron watermains selected have all been changed to a C-factor of 50.

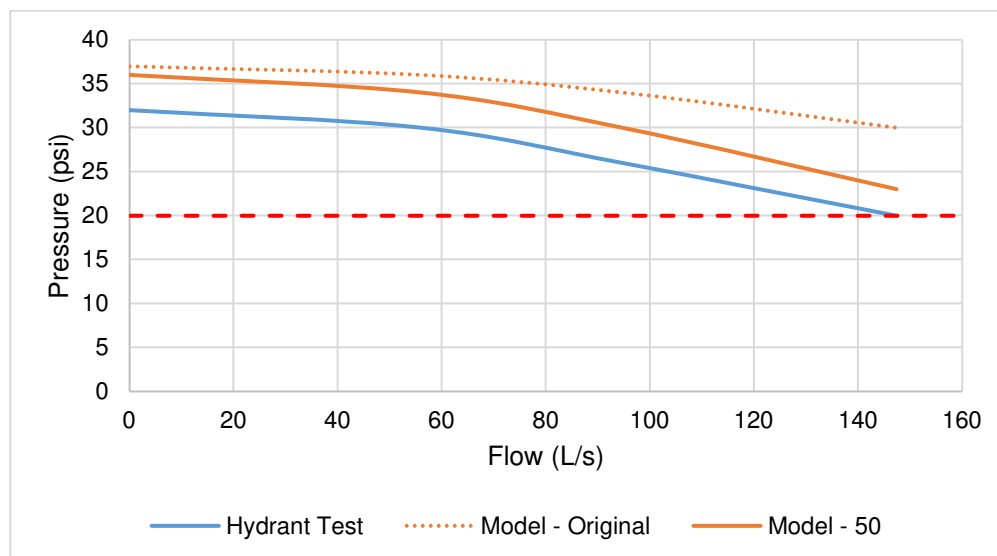


Figure 4-3: Model Verification – Hydrant HC10H005 Upper Sherman Avenue

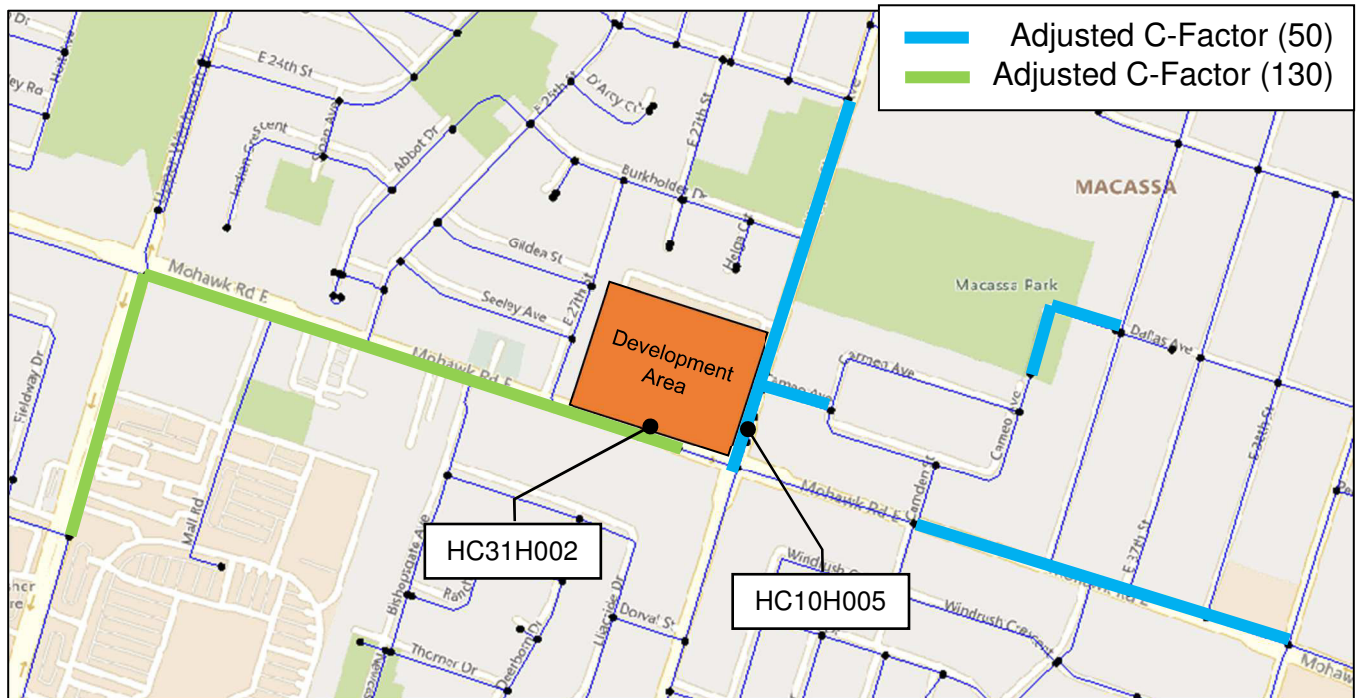


Figure 4-4: Surrounding Watermains with Adjusted C-Factors

5.0 Model Analysis

The proposed development was modelled under ADD, MDD, and PHD existing (2021) and future (2031) conditions with the HDR05 tank set to both 50% and 70% full. The layout of the development setup and fire hydrants (H1 to H4) in the model are shown in Figure 5-1 below. Hydrant locations and development grading were provided by Graziani and Corazza Architects. The development was modelled as a 200mm loop with three connections to Mohawk Road (PD6) and one connection to Upper Sherman Avenue (PD5). Check valves were modelled at all connections to the distribution system. Domestic servicing to each building has not yet been established.

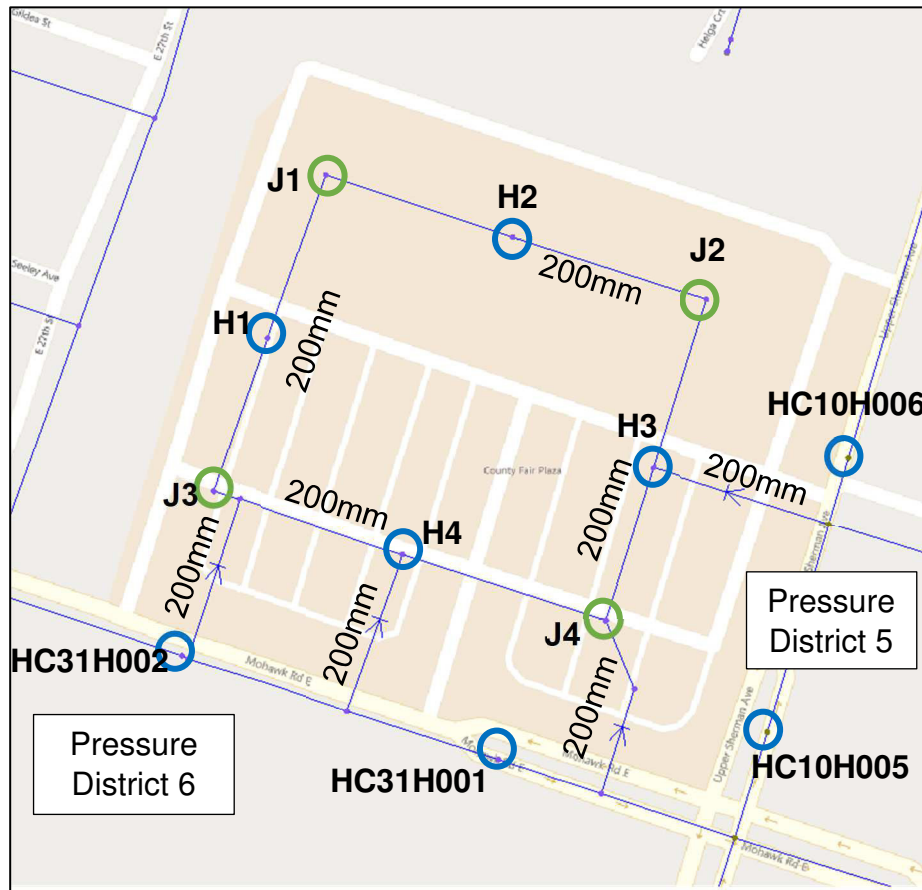


Figure 5-1: Model Layout

5.1 Pressures

Although the proposed development was modelled with connections to both Mohawk Road and Upper Sherman Avenue, as PD6 operates at a higher HGL than PD5, under typical operating conditions, water would be expected to flow into the development through the Mohawk Road connection only. Domestic servicing to each building has not yet been established but based on the elevation of the development and the operating grade lines of PD5 and PD6, it is recommended that each building be primarily serviced by PD6 (Mohawk Road) with the PD5 connection available as a back-up supply if needed.

With the PD6 recirculation valves at HD06A and HD06B Pumping Stations set to maintain a pressure of 430 kPa (271m HGL) and 675 kPa (277m HGL), respectively, the pressure at the development was found to range from 58 – 92 psi. Under these typical operating conditions, all supply to the development was through the PD6 (Mohawk Road) connections. This is above the City’s preferred operating range of 40-80 psi but below maximum allowable operating pressure of 100 psi. Table 5-1 summarizes the pressure results in the development area. The model results presented are based on the ground elevations within the development area. Pressure

may need to be boosted within the buildings to adequately supply the maximum unit heights. Detailed pressure results can be found in Appendix B.

The field test results for static pressure at PD6 hydrant HC31H002 on Mohawk Road, as shown in Table 4-1 above, was within the range pressures seen in the model at the development when connected to PD6.

Table 5-1: Pressure Results (psi)

Scenario	2021						2031					
	Tank at 50%			Tank at 70%			Tank at 50%			Tank at 70%		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
ADD	88	90	89	88	91	89	90	92	91	90	92	91
MDD	80	82	81	80	82	81	84	86	85	85	87	85
PHD	58	60	59	59	61	60	75	77	76	75	77	76

5.2 Fire Flows

A fire flow analysis was completed under MDD conditions with connections to both Upper Sherman Ave and Mohawk Road, with all connections equipped with a check valve to prevent flow between zones. Fire flows within the development were supplied by both PD6 and PD5. The proposed watermains within the development area were modelled as 200mm. The fire flow results predicted by the model are representative of the amount of water available in a watermain and not the extent of flows available from a hydrant. Several hydrants may need to be operated to provide desired fire flows but may not be equivalent to model results.

All hydrants within the development area were able to achieve an available fire flow of 150 L/s. The results of this analysis are presented in Table 5-2. The existing hydrants on Mohawk Road in the development area were able to meet the fire flow requirements. The existing hydrants on Upper Sherman Avenue in the development area were not able to meet the fire flow requirements under 2031 conditions. Detailed fire flow results can be found in Appendix C.

Table 5-2: Available Fire Flows (L/s) (MDD) – PD5 & PD6 Connection – Tanks at 50%

Hydrant	Location	2021	2031
H1	Within Development (PD6)	261	207
H2	Within Development (PD6)	246	204
H3	Within Development (PD6)	361	281
H4	Within Development (PD6)	365	322
HC31H001	Mohawk Rd (PD6)	327	346
HC31H002	Mohawk Rd (PD6)	353	374
HD10H005	Upper Sherman Ave (PD5)	150	101
HD10H006	Upper Sherman Ave (PD5)	161	112



Table 5-3 compares the available fire flow at the existing hydrants with and without the development. The model results demonstrate that the development demands did not significantly impact the available fire flow at the existing hydrants.

Table 5-3: Available Fire Flows (L/s) (MDD) – Existing Hydrants – Pre- and Post-Development

Hydrant	Location	Pre-development		Post-development	
		2021	2031	2021	2031
HC31H001	Mohawk Rd (PD6)	327	346	327	346
HC31H002	Mohawk Rd (PD6)	353	374	353	374
HD10H005	Upper Sherman Ave (PD5)	150	101	150	101
HD10H006	Upper Sherman Ave (PD5)	161	112	161	112

5.3 System Flushing

The hydraulic model was used to evaluate the flushing capacity of the proposed watermains within the development. The ADD 2021 scenario was used. 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. Various nodes were modelled as hydrant nodes, each 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.

The flushing configurations are illustrated in figures below. Configurations 1 to 4 flush the development watermains and the connection to PD6. Configuration 5 flushes the connection to PD5.

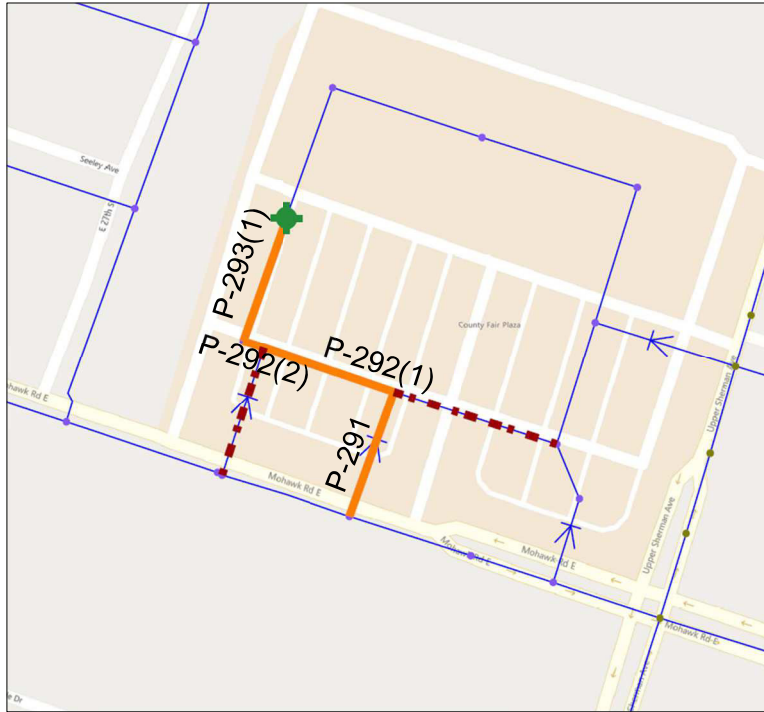


Figure 5-4: Flushing Configuration 3

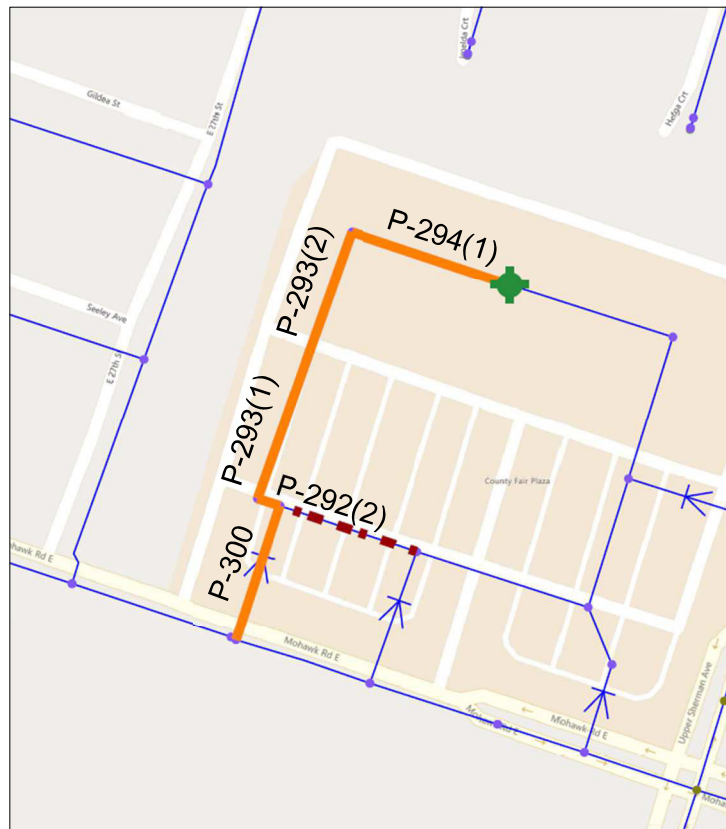


Figure 5-5: Flushing Configuration 4



Figure 5-6: Flushing Configuration 5

The flushing analysis indicates that the required target velocity of 0.8 m/s can be achieved in all development watermains. The results of the analysis are summarized below in Table 5-4. Flushing reports can be found in Appendix D.

Table 5-4: Flushing Results

Pressure District	Configuration	Pipe	Dia. (mm)	Velocity (m/s)	Meets Criteria?
PD6	1	P-295(1)	200	1.39	TRUE
		P-295(2)	200	1.39	TRUE
		P-294(2)	200	1.22	TRUE
		P-298	200	1.57	TRUE
		P-299	200	1.57	TRUE
	2	P-296	200	2.76	TRUE
		P-298	200	2.94	TRUE
		P-299	200	2.94	TRUE
	3	P-296	200	1.87	TRUE
		P-298	200	1.7	TRUE
		P-299	200	1.87	TRUE
		P-292(2)	200	1.87	TRUE
	4	P-293(1)	200	1.44	TRUE
		P-293(2)	200	1.44	TRUE
		P-294(1)	200	1.26	TRUE
P-292(2)		200	1.61	TRUE	
P-300		200	1.61	TRUE	
PD5	5	P-297	200	1.66	TRUE

6.0 Conclusion and Recommendations

1. The proposed development was modelled as a 200mm loop with three servicing connections to Mohawk Road (PD6) and one connection to Upper Sherman Avenue (PD5). Check valves were modelled on all connections.
2. The pressures within the development area ranged from 58 to 92 psi with connections to both PD5 and PD6. This is above the City's preferred operating range of 40-80 psi but below the maximum allowable operating pressure of 100 psi.
3. All proposed hydrants within the development area achieved the target fire flow of 150 L/s when 200mm pipes were installed within the development area.
4. Existing hydrants HD10H006 & HD10H005 on Upper Sherman Road were unable to achieve the required fire flow under the 2031 scenario. It was found that 150 L/s was not achieved at these hydrants under 2031 conditions with or without the development active and was therefore not a result of the development demands.
5. Existing hydrants HC31H001 & HC31H002 on Mohawk Road were able to meet the required fire flow.
6. A flushing target velocity of 0.8 m/s was met in all development watermains under the proposed flushing configurations.



APPENDIX A

Domestic Demand Calculations

Table 2.1: Sanitary Discharge Flow Rate

Type of Unit	Number of Bedrooms per Unit ⁽¹⁾	Average Daily Flow per Capita (L/d) ⁽²⁾	Total Number of Units ⁽³⁾	Design Population ⁽⁴⁾	Total Peak Flow ⁽⁵⁾⁽⁶⁾ (L/s)	Including Infiltration Allowance ⁽⁷⁾ (L/s)
1-Bedroom Unit	1.0	360	1,442	2,884	77.94	80.32
2-Bedroom Unit	2.0	360	503	2,012		
3-Bedroom Unit	3.0	360	50	300		
<i>(1) Number of bedrooms based on site plan and floor plans prepared by Graziani and Corazza Architects Inc.</i>						
<i>(2) Average Domestic Sewage Flow Rate from City of Hamilton Development Guideline Chapter E.1.4 Daily Flow = 360 L/day/capita</i>						
<i>(3) Refer to site plan prepared by Graziani and Corazza Architects Inc. – Appendix B</i>						
<i>(4) Design population based on two (2) persons per sleeping room within a dwelling unit or suite. Refer to OBC Section 3.1.17.1.(1).(b)</i>						
<i>(5) Total Avg. Flow = [(Avg. Daily Flow per Capita) x (Total Design Population)] = [360 L/d/person x (2,884 persons + 2,012 persons + 300 persons)] / 24 / 60 / 60 = 21.65 L/s</i>						
<i>(6) Total peak flow determined from City of Hamilton Development Guideline Chapter E.1.5 (Babbitt Formula) $M = 5 / P^{0.2} = 5 / (5,196/1,000)^{0.2} = 3.60$</i>						
<i>(7) Infiltration Allowance determined from the City of Hamilton development Guideline Chapter E.1.6. Infiltration Allowance of 0.6 L/s/ha was used for the site = 0.6 L/s x 3.96 ha = 2.38 L/s</i>						

Total Sanitary Discharge Peak Flow Rate = 80.32 L/s

Table 3.1: Estimated Domestic Water Supply Demands

Expected ⁽¹⁾ Population	Average Day ⁽²⁾ Demand (L/s)	Maximum Day ⁽³⁾ Demand (L/s)	Peak Hour ⁽⁴⁾ Demand (L/s)	Fire Flow ⁽⁵⁾ (L/s)	Max. Day + Fire Flow (L/s)
5,196	21.65	41.14	64.95	150.00	191.14
<i>(1) Design population based on two (2) persons per sleeping room within a dwelling unit or suite. Refer to OBC Section 3.1.17.1.(1).(b)</i>					
<i>(2) Average Consumption Rate for Residential Area = 360 L/cap/day = (360 L/d x 5,196 persons) / 24 / 60 / 60 = 21.65 L/s</i>					
<i>(3) *Maximum Day Factor of 1.9 x Average Day Demand</i>					
<i>(4) *Peak Hour Factor of 3.0 x Average Day Demand</i>					
<i>(5) Fire Flow of (150.00 L/s) calculation based on greater of OBC and the City of Hamilton Watermain Fire Flow Requirement Design Guidelines - Appendix A</i>					

**Demand Factors from: City of Hamilton Water and Wastewater Masterplan, Class Environmental Assessment Report (November 2006)*



APPENDIX B

Detailed Pressure Results

ADD - PD5 & 6

50% - 2021

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	5.413		270.52	89	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	5.413		270.52	89	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	5.413		270.55	88	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	5.413		270.54	90	(N/A)

70% - 2021

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	5.413		270.64	89	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	5.413		270.64	89	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	5.413		270.67	88	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	5.413		270.67	91	(N/A)

50% - 2031

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	5.413		271.82	90	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	5.413		271.82	91	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	5.413		271.85	90	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	5.413		271.85	92	(N/A)

70% - 2031

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	5.413		272.02	91	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	5.413		272.02	91	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	5.413		272.05	90	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	5.413		272.05	92	(N/A)

MDD - PD5 & 6

50% - 2021

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	10.285		264.67	80	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	10.285		264.67	81	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	10.285		264.76	80	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	10.285		264.75	82	(N/A)

70% - 2021

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	10.285		264.67	80	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	10.285		264.67	81	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	10.285		264.76	80	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	10.285		264.75	82	(N/A)

50% - 2031

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	10.285		267.57	84	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	10.285		267.57	85	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	10.285		267.66	84	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	10.285		267.67	86	(N/A)

70% - 2031

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	10.285		267.79	85	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	10.285		267.79	85	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	10.285		267.88	84	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	10.285		267.89	87	(N/A)

PHD - PD5 & 6

50% - 2021

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	16.238		249.29	58	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	16.238		249.29	59	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	16.238		249.48	58	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	16.238		249.47	60	(N/A)

70% - 2021

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	16.238		249.53	59	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	16.238		249.53	59	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	16.238		249.72	59	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	16.238		249.71	61	(N/A)

50% - 2031

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	16.238		260.91	75	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	16.238		260.91	76	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	16.238		261.1	75	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	16.238		261.13	77	(N/A)

70% - 2031

ID	Label	Elevation (m)	Zone	Demand Collection	Demand (L/s)	Notes	Hydraulic Grade (m)	Pressure (psi)	Fire Flow (Available) (L/s)
33485	J1	208.15	6	<Collection: 1 item>	16.238		261.17	75	(N/A)
33487	J2	207.7	6	<Collection: 1 item>	16.238		261.17	76	(N/A)
33483	J3	208.46	6	<Collection: 1 item>	16.238		261.36	75	(N/A)
33489	J4	206.89	6	<Collection: 1 item>	16.238		261.39	77	(N/A)



APPENDIX C

Detailed Fire Flow Results

Post-dev.

2021

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) (psi)	Pressure (Calculated Residual) (psi)
H1	6	6	TRUE	150	261	150	261	20	20
H2	6	6	TRUE	150	246	150	246	20	20
H3	6	6	TRUE	150	361	150	361	20	20
H4	6	6	TRUE	150	365	150	365	20	20
HC31H001	6	14	TRUE	150	327	150	327	20	20
HC31H002	6	7	TRUE	150	353	150	353	20	20
HD10H005	5	2	TRUE	150	150	150	150	20	20
HD10H006	5	3	TRUE	150	161	150	161	20	20

2031

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) (psi)	Pressure (Calculated Residual) (psi)
H1	6	13	TRUE	150	207	150	207	20	20
H2	6	6	TRUE	150	204	150	204	20	20
H3	6	6	TRUE	150	281	150	281	20	20
H4	6	6	TRUE	150	322	150	322	20	20
HC31H001	6	7	TRUE	150	346	150	346	20	20
HC31H002	6	6	TRUE	150	374	150	374	20	20
HD10H005	5	11	FALSE	150	101	150	101	20	20
HD10H006	5	4	FALSE	150	112	150	112	20	20

Pre-dev.

2021

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) (psi)	Pressure (Calculated Residual) (psi)
H1	6	12	TRUE	150	284	150	284	20	20
H2	6	5	TRUE	150	266	150	266	20	20
H3	6	6	TRUE	150	396	150	396	20	20
H4	6	7	TRUE	150	396	150	396	20	20
HC31H001	6	5	TRUE	150	327	150	327	20	20
HC31H002	6	5	TRUE	150	353	150	353	20	20
HD10H005	5	2	TRUE	150	150	150	150	20	20
HD10H006	5	3	TRUE	150	161	150	161	20	20

2031

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) (psi)	Pressure (Calculated Residual) (psi)
H1	6	4	TRUE	150	238	150	238	20	20
H2	6	6	TRUE	150	229	150	229	20	20
H3	6	6	TRUE	150	316	150	316	20	20
H4	6	6	TRUE	150	360	150	360	20	20
HC31H001	6	4	TRUE	150	346	150	346	20	20
HC31H002	6	5	TRUE	150	374	150	374	20	20
HD10H005	5	11	FALSE	150	101	150	101	20	20
HD10H006	5	4	FALSE	150	112	150	112	20	20



APPENDIX D

Flushing Reports

Configuration 1

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?
33493	P-295(1)	60	200	Event - 1	1.39	TRUE	0.5	TRUE	TRUE
33494	P-295(2)	54	200	Event - 1	1.39	TRUE	0.5	TRUE	TRUE
33513	P-294(2)	69	200	Event - 1	1.22	TRUE	0.39	TRUE	TRUE
33521	P-298	25	200	Event - 1	1.57	TRUE	0.62	TRUE	TRUE
33525	P-299	37	200	Event - 1	1.57	TRUE	0.62	TRUE	TRUE

Configuration 2

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?
33491	P-296	72	200	Event - 2	2.76	TRUE	0	TRUE	TRUE
33521	P-298	25	200	Event - 2	2.94	TRUE	0	TRUE	TRUE
33525	P-299	37	200	Event - 2	2.94	TRUE	0	TRUE	TRUE

Configuration 3

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?
33482	P-296	56	200	Event - 3	1.87	TRUE	0.87	TRUE	TRUE
33509	P-298	55	200	Event - 3	1.7	TRUE	0.72	TRUE	TRUE
33530	P-299	58	200	Event - 3	1.87	TRUE	0.87	TRUE	TRUE
33531	P-292(2)	9	200	Event - 3	1.87	TRUE	0.87	TRUE	TRUE

Configuration 4






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?
33509	P-293(1)	55	200	Event - 4	1.44	TRUE	0.53	TRUE	TRUE
33510	P-293(2)	59	200	Event - 4	1.44	TRUE	0.53	TRUE	TRUE
33512	P-294(1)	66	200	Event - 4	1.26	TRUE	0.42	TRUE	TRUE
33531	P-292(2)	9	200	Event - 4	1.61	TRUE	0.65	TRUE	TRUE
33535	P-300	57	200	Event - 4	1.61	TRUE	0.65	TRUE	TRUE

Configuration 5

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?
33495	P-297	62	200	Event - 5	1.66	TRUE	0.69	TRUE	TRUE

Flushing Field Report

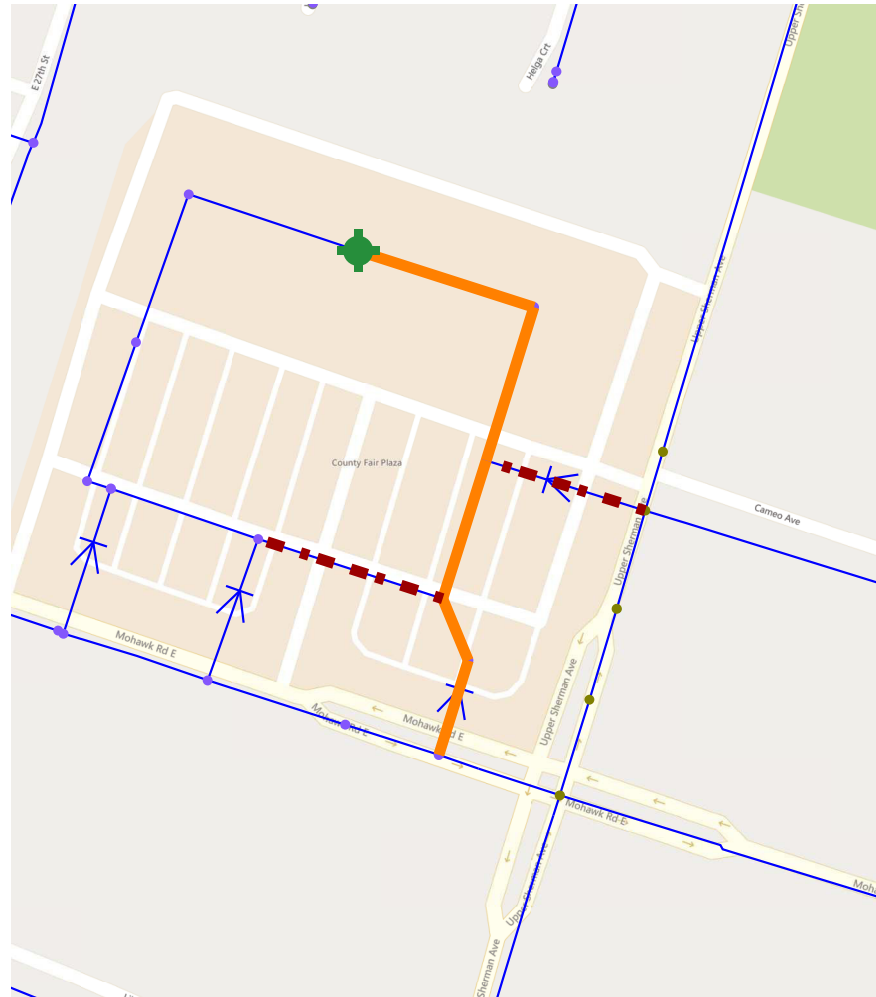
Study: Flushing Study

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

Flushing Field Report

Study: Flushing Study; Area: 499 Mohawk; Event: Event - 1

Primary View



Flushing Field Report

Study: Flushing Study; Area: 499 Mohawk; Event: Event - 1

Fire Hydrant	Notes	Pressure (psi) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (psi)	Predicted Flow (L/s)
H2				78	83.5932

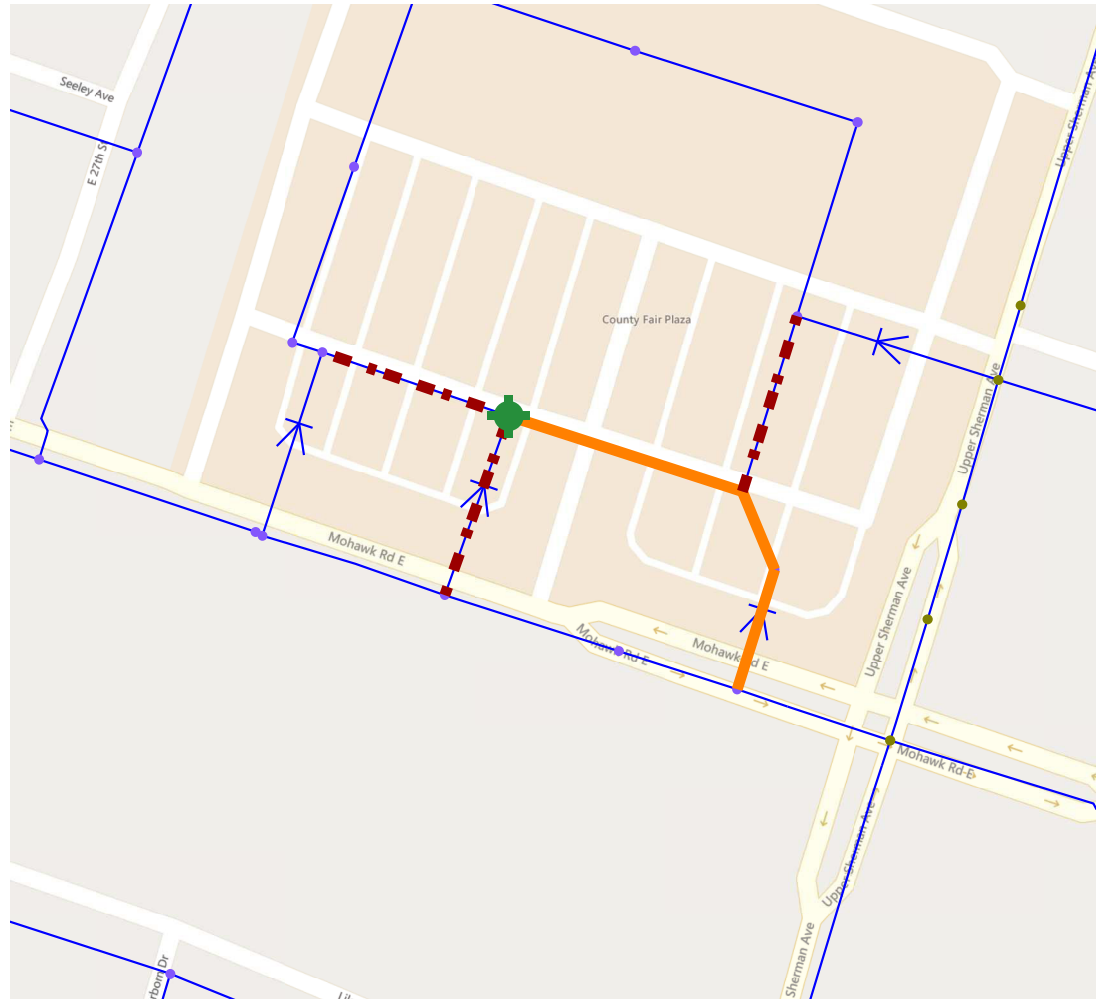
Valve	Operation	Notes	Flushing	Minimum	Recommended
P-296	Close <input type="checkbox"/>		Time (min)	3.0	3.0
P-297	Close <input type="checkbox"/>		Volume (ML)	0.0	0.0
	<input type="checkbox"/>		Start Time _____		
	<input type="checkbox"/>		End Time _____		
	<input type="checkbox"/>		Operator _____		
	<input type="checkbox"/>		Date _____		
	<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			Water Quality		
P-299, P-298, P-295(2), P-295(1), P-294(2)			Clear	<input type="checkbox"/>	<input type="checkbox"/>
			Colored	<input type="checkbox"/>	<input type="checkbox"/>
			Chlorine Residual		
			Turbidity		

Notes _____

Flushing Field Report

Study: Flushing Study; Area: 499 Mohawk; Event: Event - 2

Primary View



Flushing Field Report

Study: Flushing Study; Area: 499 Mohawk; Event: Event - 2

Fire Hydrant	Notes	Pressure (psi) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (psi)	Predicted Flow (L/s)
H4				(N/A)	(N/A)

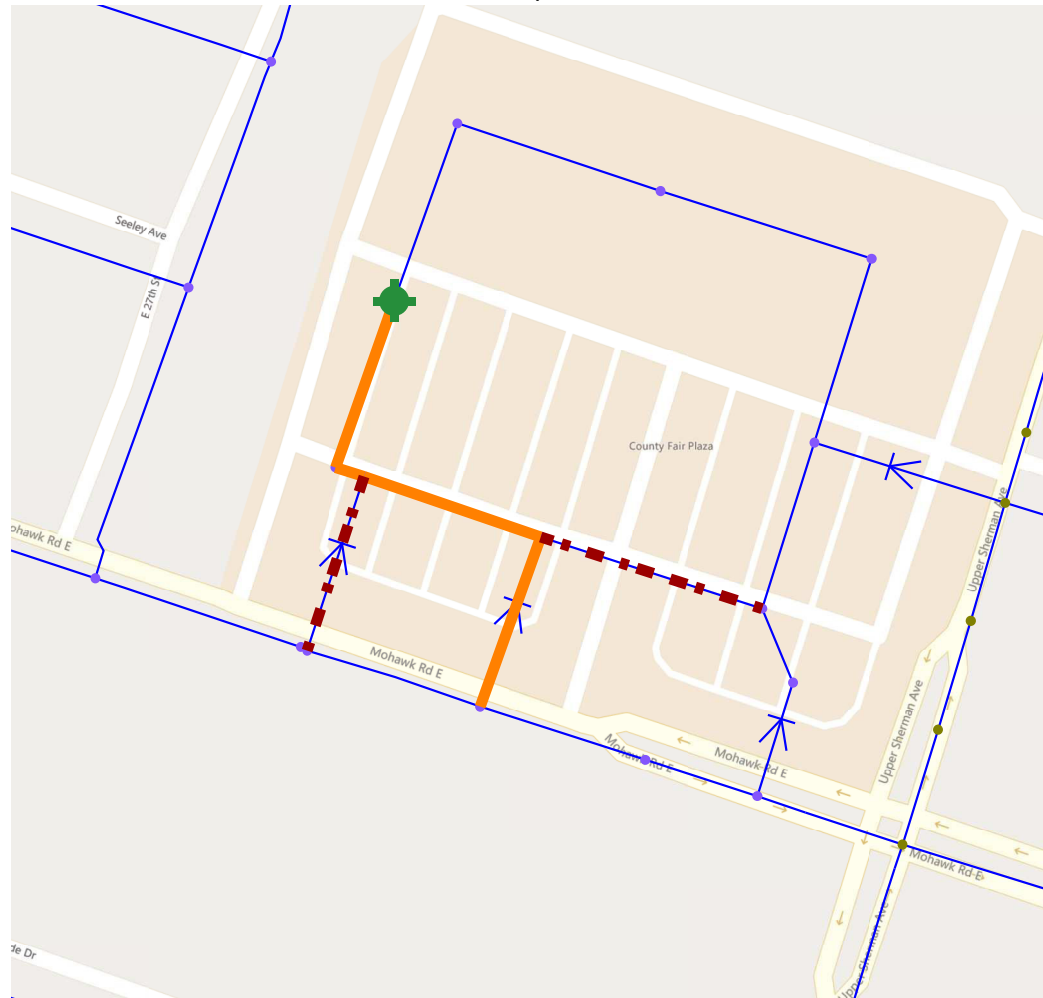
Valve	Operation	Notes	Flushing	Minimum	Recommended
P-296	Reopen <input type="checkbox"/>		Time (min)	(N/A)	(N/A)
P-297	Reopen <input type="checkbox"/>		Volume (ML)	(N/A)	(N/A)
P-292(1)	Close <input type="checkbox"/>		Start Time _____		
P-291	Close <input type="checkbox"/>		End Time _____		
P-295(2)	Close <input type="checkbox"/>		Operator _____		
	<input type="checkbox"/>		Date _____		
	<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"/>				
Pipe Run to be Cleaned			Water Quality		
P-299, P-298, P-296			Clear	<input type="checkbox"/>	<input type="checkbox"/>
			Colored	<input type="checkbox"/>	<input type="checkbox"/>
			Chlorine Residual		
			Turbidity		

Notes _____

Flushing Field Report

Study: Flushing Study; Area: 499 Mohawk; Event: Event - 3

Primary View



Flushing Field Report

Study: Flushing Study; Area: 499 Mohawk; Event: Event - 3

Fire Hydrant	Notes	Pressure (psi) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (psi)	Predicted Flow (L/s)
H1				(N/A)	(N/A)

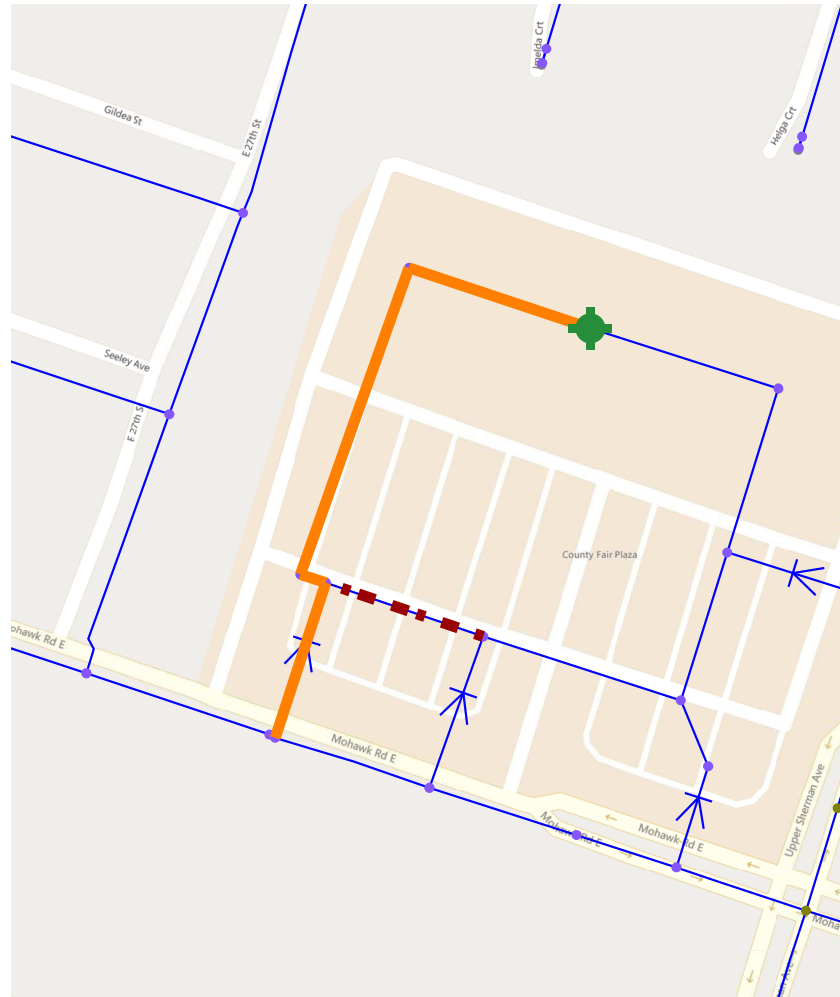
Valve	Operation	Notes	Flushing	Minimum	Recommended																											
P-297	Reopen <input type="checkbox"/>		Time (min)	(N/A)	(N/A)																											
P-296	Closed (prior) <input type="checkbox"/>		Volume (ML)	(N/A)	(N/A)																											
P-300	Close <input type="checkbox"/>		<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> <th style="text-align: left;">Water Quality</th> <th style="text-align: center;">Initial</th> <th style="text-align: center;">Final</th> </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	Initial	Final	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	Initial	Final																														
Clear	<input type="checkbox"/>	<input type="checkbox"/>																														
Colored	<input type="checkbox"/>	<input type="checkbox"/>																														
Chlorine Residual																																
Turbidity																																
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	<input type="checkbox"/>																															
	<input type="checkbox"/>																															
	<input type="checkbox"/>																															
Pipe Run to be Cleaned																																
P-291, P-292(1), P-292(2), P-293(1)																																

Notes _____

Flushing Field Report

Study: Flushing Study; Area: 499 Mohawk; Event: Event - 4

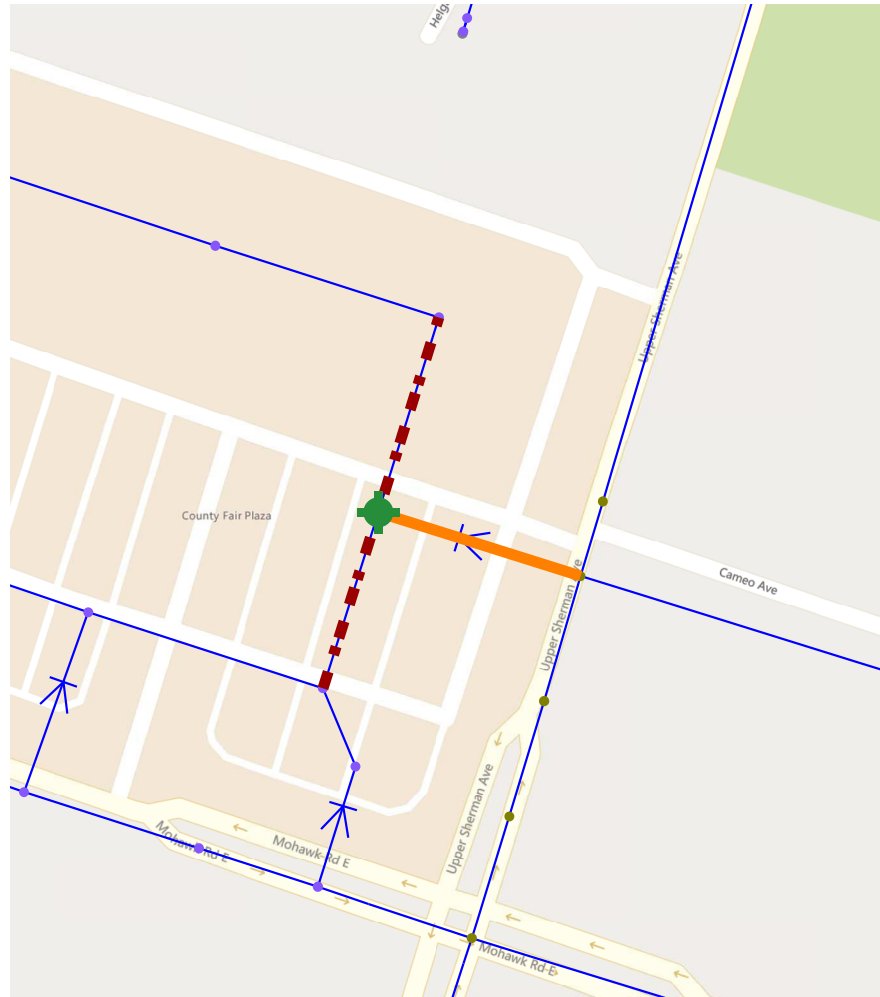
Primary View



Flushing Field Report

Study: Flushing Study; Area: 499 Mohawk; Event: Event - 5

Primary View



Flushing Field Report

Study: Flushing Study; Area: 499 Mohawk; Event: Event - 5

Fire Hydrant	Notes	Pressure (psi) Static, Dynamic	Measured Flow (L/s)	Predicted Pressure (psi)	Predicted Flow (L/s)
H3				(N/A)	(N/A)

Valve	Operation	Notes	Flushing	Minimum	Recommended
P-292(1)	Reopen <input type="checkbox"/>		Time (min)	(N/A)	(N/A)
P-295(1)	Close <input type="checkbox"/>		Volume (ML)	(N/A)	(N/A)
P-295(2)	Close <input type="checkbox"/>		Start Time _____		
	<input type="checkbox"/>		End Time _____		
	<input type="checkbox"/>		Operator _____		
	<input type="checkbox"/>		Date _____		
	<input type="checkbox"/>		Water Quality		
	<input type="checkbox"/>			Initial	Final
	<input type="checkbox"/>		Clear	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>		Colored	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>		Chlorine Residual		
	<input type="checkbox"/>		Turbidity		
Pipe Run to be Cleaned					
P-297					

Notes _____

