DILLON CONSULTING

MUNICIPALITY OF WEST ELGIN

Water Distribution System Analysis

January 2025 – 24-7728

Table of Contents

Tables

Appendices

1.0 Introduction

Dillon Consulting Limited (Dillon) was retained by the Municipality of West Elgin (Municipality) to develop a hydraulic model of the Municipality's water distribution network. The model provides a computer numeric simulation of the distribution network hydraulic performance using WaterCAD CONNECT Edition software. The model is based on geographic information system (GIS) data, historic water consumption data, agreements for water supply, as well as operational data provided by the Municipality.

This report documents the model set-up, the parameters used for validation of the model performance, a summary of the observed operating conditions of the existing West Elgin water system, and a projection of the model results under future demand scenarios. This report concludes with hydraulic deficiencies within the system based on model review of existing and proposed future conditions, and recommendations for upgrades as appropriate.

1.1 Background

The Municipality of West Elgin water distribution system services approximately 1,700 customers (approximate population of 5,000 people) in both rural areas and the settlement areas of Rodney, West Lorne, Clachan, Eagle, New Glasgow and Port Glasgow. The distribution system watermains range in size from 100 mm to 350 mm diameter, with a total length of approximately 160 km.

1.2 Objectives

The objectives of the hydraulic analysis are to:

- Develop a validated hydraulic model of the Municipality's water distribution system;
- Identify areas within the network that do not meet minimum performance requirements in accordance with provincial guidelines; and
- Develop recommendations for future capital projects to improve the operation of the distribution system and service future growth.

The hydraulic model developed for this project can be used by the Municipality in the future as a long-range planning tool to review and evaluate various operational alternatives. Future revisions to the model will be required to accurately represent the water system as the network is expanded and development in the Municipality proceeds.

2.0 Existing Water Distribution System

West Elgin is a member of the Tri-County Water Board, whose other members include the Municipality of Southwest Middlesex, the Village of Newbury, the Municipality of Chatham/Kent, and the Municipality of Dutton/Dunwich. The Tri-County water distribution system is operated in accordance with the terms of the Tri-County Water Board servicing agreement.

West Elgin is located at the upstream end of the water supply network. Water from the water treatment plant (WTP) located on the Lake Erie shoreline near Eagle is conveyed through West Elgin to the other member municipalities by approximately 12 km of trunk watermain owned by the Tri-County System. Meter chambers are located at the connections to the other member municipalities, as shown on the system schematic presented in **Appendix A**.

Brief descriptions of the significant components of the water distribution network are provided below.

2.1 Water Treatment Plant

The Tri-county WTP is a Class 2 water treatment facility with a design capacity of 12,160 m^3/day. It operates both a High Lift Pumping Station (HLPS) and a Low Lift Pumping Station (LLPS). Drinking water is supplied to the Tri-County municipalities via two 350 mm watermains leaving the plant that are fed by the HLPS.

The HLPS operates based on flow and pressure setpoint requirements and can supply drinking water to member Tri-County municipalities under combined or split mode settings. In combined mode, either of the 350 mm watermains leaving the WTP can be selected to feed the entire Tri-County distribution system. In Split Mode, the west watermain supplies West Lorne, Rodney and Southwest Middlesex while the east watermain supplies Dutton-Dunwich. Based on information provided by the Ontario Clean Water Agency (OCWA) which is the system operator, the default setting is Split Mode.

2.2 Distribution Pipe Network

The distribution network consists of watermains (excluding services) ranging in diameter from 100 mm to 350 mm diameter. All physical data for the pipe network is based on GIS information provided by the Municipality. Pipe age and material were not identified in the available GIS information for most of the network.

2.3 West Lorne Standpipe

Based on GIS information of the West Lorne standpipe provided by the Municipality, the ground elevation at the base of the standpipe is approximately 214.08 m. The total storage is approximately 3,000 m^3, based on a diameter of 9.75 m. The information presented in the **Table 1** summarizes the setpoints of the West Lorne standpipe.

Table 1: West Lorne Standpipe Operating Setpoints

Setpoint	Elevation (m)	Level (m)
Maximum Fill	254.38	40.0
High Water Level	250.88	36.5
Low Water Level	247.38	33.0

2.4 Rodney Elevated Storage Tank

Based on GIS information provided by the Municipality, the ground elevation at the base of the Rodney elevated storage tank is approximately 209.38 m. The calculated total storage of the tank is approximately 226 m^3, based on a diameter of 12 m measured from recent aerial photography. The information presented in **Table 2** summarizes the operating setpoints of the elevated storage tank provided by OCWA.

Table 2: Rodney Elevated Storage Tank Operating Setpoints

Setpoint	Elevation (m)	Level (m)
Assumed Overflow	249.38	10.0
High Water Level	248.88	9.5
Low Water Level	247.38	8.0

2.5 Connections to Tri-County Member Municipalities

A summary of the Tri-County system service connections to other municipalities is presented in the **Table 3**.

Table 3: Municipal Connections

Municipality	Connection ID	Description
Dutton-Dunwich	FIT302 & two meters without IDs	Meters located on Talbot Line, Marsh Line, and Pioneer Line, all east of Graham Road
Southwest Middlesex, Newbury, and Chatham-Kent	FIT310	Meter located on Finney Street

2.6 Pumps

Four high lift pumps at the WTP supply water to the West Elgin water distribution system. Three are constant speed pumps and one operates on a Variable Frequency Drive (VFD). The pumps have a design capacity of 200 L/s and 1000 kPa. Drinking water discharged from the WTP is controlled by a PRV to maintain the system flow setpoint requirement of 70 L/s.

There are no known booster pumps located within the West Elgin water distribution network.

2.7 Control Valves

Except for the PRVs located at the WTP, there are no known pressure or flow control valves located within the West Elgin water distribution network. According to Municipal staff, there are four isolation valves in the system at the supply points to Rodney. These isolation valves are normally open under typical operating conditions.

3.0 Hydraulic Model Development

Brief descriptions of the data and assumptions used to build the hydraulic model are provided below.

3.1 Water Supply

The West Elgin water distribution network was modelled under steady state conditions. Water is supplied in the model from both the West Lorne standpipe and the Rodney water tower. The hydraulic grade line (HGL) for both standpipe and tower were set to 247.38 m, which is the operating low water level for both tanks.

3.2 Pipe Network

The locations, sizes, and alignment of the West Elgin watermains were taken from available GIS information. Junctions were assigned to the ends of each pipe and the ground elevation at each junction was interpolated from available topographic mapping.

Pipe friction losses are calculated in the WaterCAD model using the Hazen-Williams equation, which uses an empirical roughness coefficient (C-factor) that is selected based on the pipe material, diameter, and condition. C-factors were assigned to the modelled pipes based on provincial guidance, as summarized in **Table 4**.

Table 4: Watermain C-Factors

Pipe Diameter (mm)	C-Factor
<= 150	100
200 - 250	110
> 250	120

3.3 Water Demands

The Municipality provided water billing records for 2021, 2022, and 2023. This data was used to estimate the locations and magnitudes of demands within the West Elgin water distribution network.

3.3.1 Average Daily Demand and Per-Capita Consumption

Average daily demand (ADD) in the West Elgin water distribution network was estimated using the 2023 water billing data. The total annual billed volumes were reviewed and locations with either low or high values were identified.

At locations with billed annual volumes less than 100 m^3/year, the values were compared with the reported volumes for 2021 and 2022. Where the billing data showed similar annual volumes for each year, the 2023 data were used. At locations where the billed volumes were greater for 2021 and 2022 than 2023, the average of the 2021/2022 data were used.

At locations with billed annual volumes greater than 1000 m^3/year, aerial photography was used to verify that the observed water consumption was consistent with the existing land use.

3.3.2 Demand Allocation

Accurately assigning the locations of demands within the network is an important step in setting up the water distribution system analysis. GIS was used to georeference each water billing record based on the corresponding address. The associated demands were then allocated to the model by assigning each billing meter location to the nearest modelled junction.

3.3.3 Peaking Factors

Peaking factors for the West Elgin water distribution system were calculated based on the existing West Elgin population using the guidance presented in Design Guidelines for Drinking Water Systems (MOE, 2008). The resulting peaking factors are 2.0 for maximum day demand (MMD) conditions and 3.0 for peak hour demand (PHD) conditions.

These peaking factors were applied to all the demands in the West Elgin portion of the network for each of the evaluated scenarios. However, the peaking factors at the locations that represent the Tri-County Member Municipality connections were limited to 2.0 under PHD conditions, under the assumption that downstream storage provides the necessary additional capacity to meet peak demands.

4.0 Model Validation

A model validation was performed to verify that the hydraulic model produces results that are consistent with observed system behavior. The hydraulic model was validated using the hydrant test data summarized in **Appendix B**.

4.1 Static Pressure Comparison

The static pressures at all the West Elgin fire hydrants were calculated using the hydraulic model under existing ADD conditions and compared with the static pressure measured at each hydrant for the flow tests. The detailed comparison calculations are presented in **Appendix B** and a summary of the comparison results is presented in **Table 5**.

Table 5: Model Validation Static Pressure Summary

Parameter	Value
No. of Evaluated Hydrants	191
No. of Hydrants with Calculated Absolute Difference >10 psi	4
Maximum Calculated Difference (psi)	9.8
Minimum Calculated Difference (psi)	-22.7
Median Calculated Difference (psi)	0.3

The calculation results show that the calculated difference in static pressures was greater than 10 psi at four locations. The hydrants where these differences occurred are all located near the WTP, and in all cases the measured static pressure was greater than the value calculated using the hydraulic model. The differences in the static pressures at these locations could be caused by the HLPs running at the time of the hydrant flow tests.

4.2 Fire Flow Comparison

Fire flow calculations were completed for all the fire hydrants represented in the hydraulic model to estimate the available fire flow at a minimum service pressure of 20 psi. The fire flow calculations were calculated under existing ADD conditions and the results were compared with the corresponding hydrant test data. The detailed comparison calculations are presented in **Appendix B** and a summary of the comparison results is presented in **Table 6**.

Table 6: Model Validation Fire Flow Summary

Parameter	Value
No. of Evaluated Hydrants	191
No. of Hydrants with Calculated Absolute Difference >50 L/s	44
Maximum Calculated Difference (L/s)	183
Minimum Calculated Difference (L/s)	-661
Median Calculated Difference (L/s)	-11

The calculation results show that the calculated absolute difference in fire flow was greater than 50 L/s at 44 locations. There are several reasons why this may occur. Most significantly, specific system conditions were assumed for the fire flows calculated using the hydraulic model. For these calculations, the water levels in the standpipe and water tower were assumed to be at their low operating limit and the HLPS was assumed to be turned off. In contrast, the actual system conditions were likely different at the time of the field tests, which likely accounts for much of the difference between the two data sets. Other reasons for the differences may include errors in the hydrant test measurements and inaccurate representations of the hydrant leads at some locations.

4.3 Validation Conclusion

The model validation was completed using measured flow data at 191 fire hydrants. This is an excellent sample size, covering nearly the entire network.

The median calculated pressure difference is 0.3 psi, which suggests that the hydraulic model provides an accurate representation of the static pressures in the overall existing system. The median calculated difference in fire flows is reasonably small, and the negative value indicates that the fire flows calculated using the model are on average lower than the results from the hydrant flow tests. Based on this, the hydraulic model provides reasonable, slightly conservative predictions of the anticipated fire flows in the West Elgin water distribution network.

Overall, the hydraulic model provides an accurate representation of the existing hydraulic conditions in the West Elgin network. The model can be used with confidence to evaluate the hydraulic performance of the system. However, field testing should always be completed to confirm the model results prior to completing system changes.

5.0 Existing System Performance

The hydraulic model was used to evaluate the West Elgin water distribution network performance under existing water demands. Steady state calculations were performed for ADD, MDD, and PHD scenarios, in addition to fire flow conditions.

5.1 Normal Operating Conditions

Existing conditions hydraulic calculations were performed to identify locations within the Municipality of West Elgin system with low service pressures, and to establish a baseline to evaluate the effects of future development. The following system conditions were assumed to yield conservative estimates of the minimum system pressures:

- The HLPS at the WTP is turned off;
- The water surface elevation in the Rodney standpipe is 247.38 m, which is the lower limit of its operating range; and
- The water surface elevation in West Lorne elevated water tank is 247.38 m, which is the lower limit of its operating range.

The existing conditions hydraulic calculation results are summarized in **Table 7**.

Table 7: Existing Conditions Results Summary

Demand	Minimum Calculated Pressure (psi)	Maximum Calculated Pressure (psi)	Number of Junctions with Pressure <40 psi	Number of Junctions with Pressure >100 psi
ADD	43.4	102.3	0	1
MDD	43.0	101.9	0	1
PHD	42.3	101.6	0	1

Based on the guidance presented in Design Guidelines for Drinking Water Systems (MOE, 2008), the minimum allowable service pressure in a water distribution network is 40 psi, and the maximum recommended pressure is 100 psi.

The calculation results presented in **Table 7** show that the minimum pressures for all the existing condition evaluated scenarios are greater than 40 psi. The lowest pressures occur at the eastern limits of the Queens Line and Silver Clay Line watermains and are due to the locally high ground elevations at these locations.

The calculated maximum pressures are greater than 100 psi at one location in Port Glasgow. The highest pressures occur at southern limit of the 100 mm diameter watermain located on Havens Lake

Road, near the Port Glasgow Marina and Yacht Club. The high pressures at this location are due to the low ground elevations at this location, which is on the Lake Erie shoreline.

5.2 Fire Flow Conditions

Steady state hydraulic calculations were performed using the hydraulic model to estimate the available fire flows at all the fire hydrants included in the West Elgin hydraulic model. The fire flow calculations were performed using the following system conditions:

- Minimum allowable residual pressure of 20 psi;
- Maximum day demand (MDD) conditions;
- The WTP pump is turned off;
- The water surface elevation in the Rodney standpipe is 247.38 m, which is the lower limit of its operating range; and
- The water surface elevation in West Lorne elevated water tank is 247.38 m, which is the lower limit of its operating range.

The minimum fire flow design threshold is dependant on the type of buildings serviced by the hydrant, their construction, setbacks from other structures, and the presence or absence of fire suppression systems. The minimum fire flow identified in the National Fire Protection Association (NFPA) standards is 31.5 L/s, for one and two-family dwellings. A summary of the NFPA hydrant colour coding is presented in **Table 8**.

Table 8: NFPA Hydrant Colour Codes

Colour	Available Fire Flow (gpm)	Available Fire Flow (L/s)
Blue	>1,500	>94.6
Green	1,000 to 1,499	63.1 to 94.6
Orange	500 to 999	31.5 to 63.0
Red	<500	<31.5

Based on the hydraulic model results, the calculated available fire flows are lower than 31.5 L/s at 34 locations, as documented in **Appendix C**. As shown in **Table 8**, the corresponding colour code for these hydrants is red. These results were compared with the colour coding assigned based on the hydrant field test data. In all but one case, the corresponding NFPA colour coding based on the hydrant test data was either orange or red, which shows that the hydraulic model accurately predicts the locations with the lowest fire flows.

The pipe network was reviewed to identify potential causes of the low available fire flows at these locations. The following conditions contribute to low calculated fire flows in the West Elgin system:

- **Hydrants located on long, small diameter watermains** – Most of the hydrants with low predicted fire flows are located on watermains of 150 mm diameter or less;
- **Lack of watermain looping** – The closest lateral to most of the hydrants with low predicted fire flows is more than 1 km away; and
- **Ground Elevation** – Hydrants located at higher elevations tend to have lower predicted fire flows.

6.0 Future Conditions

The following two development scenarios were used to evaluate the ability of the water distribution system to accommodate future development:

1. Full buildout of the West Elgin settlement areas based on future land use information from the Official Plan; and
2. Full buildout of the West Elgin settlement areas and supplying the Area Water Board member municipalities at their maximum allocations.

Hydraulic calculations were performed for both the future scenarios based on the following system conditions:

- The WTP pump is turned off;
- The water surface elevation in the Rodney standpipe is 247.38 m, which is the lower limit of its operating range; and
- The water surface elevation in West Lorne elevated water tank is 247.38 m, which is the lower limit of its operating range.

These conditions were selected to yield conservative estimates of the minimum system pressures.

6.1 Future Condition Demands

The future condition demands in West Elgin were estimated based on the future land uses identified in the Official Plan. The total future growth population identified in the Official Plan was allocated to each settlement area based on its area of undeveloped land designated for residential use. A per capita demand of 350 L/capita/day based on the guidance presented in Design Guidelines for Drinking Water Systems (MOE, 2008) was used to calculate the future residential demand for each settlement area. Future demands for undeveloped employment lands were calculated based on a unit demand of 28 m^3/ha/day. This value was taken from the guidance presented in Design Guidelines for Drinking Water Systems (MOE, 2008).

A summary of the West Elgin future conditions demands is presented in **Table 9**.

Table 9: West Elgin Future Demands

Parameter	Settlement Area	
	Rodney	West Lorne
Future Residential Area (ha)	95	85
No. Future Residential Units	406	364
Future Residential Population	894	800
Future Residential ADD (m^3/day)	313	280
Future Employment Lands Area (ha)	20	20
Future Employment Lands ADD (m^3/day)	560	560
Total Future ADD (m^3/day)	873	840

Future condition demands for the Area Water Board member municipalities are based on the maximum allowable supply rates identified in the Tri-County Water Board servicing agreement, as summarized in **Table 10**.

Table 10: Tri-County Water Board Member Future Demands

Municipality	Demand (m^3/year)	Average Day Demand (L/s)
West Elgin	1,714,857	54.4
Dutton-Dunwich	759,074	24.1
Southwest Middlesex/Newbury/ Chatham-Kent	1,491,973	47.3

6.2 Future Scenario 1 Results

Future conditions hydraulic calculations were performed to evaluate the impacts of future growth on the water distribution system performance. In this scenario, the water demands at Rodney and West Lorne were increased to represent the growth conditions presented in **Table 9** and the water demands for the other Area Water Board member municipalities remained at existing condition rates. The future conditions hydraulic calculation results under normal operating conditions are summarized in **Table 11**.

Table 11: Future Conditions Scenario 1 Results Summary

Demand	Minimum Calculated Pressure (psi)	Maximum Calculated Pressure (psi)	Number of Junctions with Pressure <40 psi	Number of Junctions with Pressure >100 psi
ADD	43.3	102.2	0	1
MDD	42.2	101.6	0	1
PHD	41.9	101.6	0	1

The analysis results presented in **Table 11** show that the lowest calculated pressures meet the minimum provincial requirements for the evaluated future development condition. Similar to existing conditions, the highest calculated pressures occur near the Port Glasgow Marina and Yacht Club.

Hydraulic calculations were performed using the hydraulic model to estimate the available fire flows under future demand conditions at all the fire hydrants included in the West Elgin hydraulic model. The hydraulic model results show that 35 of the evaluated hydrants have calculated fire flow less that 31.5 L/s at a minimum pressure of 20 psi, compared with 34 hydrants under existing conditions.

Based on the hydraulic analysis results, the existing West Elgin water distribution system has sufficient capacity to accommodate the anticipated growth identified in the Official Plan.

6.3 Future Scenario 2 Results

In this scenario, the water demands at Rodney and West Lorne were increased to represent the growth conditions presented in **Table 9** and the water demands for the other Area Water Board member municipalities were increased to the maximum demand allocations presented in the Water Board Agreement, as summarized in **Table 10**. The future conditions hydraulic calculation results under normal operating conditions are summarized in **Table 12**.

Table 12: Future Conditions Scenario 2 Results Summary

Demand	Minimum Calculated Pressure (psi)	Maximum Calculated Pressure psi)	Number of Junctions with Pressure <40 psi	Number of Junctions with Pressure >100 psi
ADD	42.3	102.2	0	1
MDD	38.2	101.5	12	1
PHD	37.7	101.6	25	1

Similar to the Scenario 1 results, the minimum calculated pressures are greater than 40 psi under ADD conditions. However, under MDD and PHD conditions, the minimum calculated pressures are less than 40 psi. The locations with the lowest calculated pressures are generally located on Queens Line north of West Lorne and on Dunborough Road from Downie Line to Stalker Line, as documented in **Appendix C**.

Hydraulic calculations were performed using the hydraulic model to estimate the available fire flows under future demand conditions at all the fire hydrants included in the West Elgin hydraulic model. The hydraulic model results show that 35 of the evaluated hydrants have calculated fire flow less that 31.5 L/s at a minimum pressure of 20 psi, compared with 34 hydrants under existing conditions. Thus, while the future development demands reduce the fire flow performance of the existing system, the anticipated change is not drastic.

Based on the hydraulic analysis results, the existing West Elgin water distribution system does not have sufficient capacity to meet the minimum service pressure requirements under the Future Scenario 2 demand conditions. Future system improvements will be required to mitigate the impacts of the anticipated maximum day future demands in the Tri-County Member Municipalities.

6.4 Future System Improvements

The calculation results for the Future Scenario 2 MDD and PHD conditions show that the minimum calculated pressures in West Elgin are less than 40 psi. The lowest calculated pressures are all located north of West Lorne, downstream of the connection to the Glencoe Reservoir, which services Southwest Middlesex, Newbury, and Chatham-Kent.

Future improvements to the West Elgin water distribution system network will likely be required if the municipalities of Southwest Middlesex, Newbury, and Chatham-Kent are supplied at the maximum allocation identified in the Tri-County Water Board Agreement. **Table 13** shows the impact of the future demands on the local calculated HGL elevations at the connection to the Glencoe Reservoir and on Graham Road near the locations of the upstream-most low pressures.

Table 13: Calculated HGL Comparison – PHD Condition

Development Condition	Calculated Hydraulic Gradeline Elevation (m)	
	Connection to Glencoe Reservoir	Graham Road at Queens Line
Existing	246.97	246.97
Future Scenario 1	246.37	246.02
Future Scenario 2	243.43	243.08

The calculation results summarized in **Table 13**, show that the future Tri-County Member demands evaluated in Future Scenario 2 significantly reduce the HGL elevation in the northern portion of the West Elgin water distribution network, resulting in low calculated service pressures north of West Lorne. However, the following considerations should be kept in mind when evaluating these results:

- A MDD peaking factor of 2.0 was applied to the supply to the Glencoe Reservoir. This assumption may overestimate the actual future peak flow supplied at this connection; and
- The calculations are performed based on the maximum allowable demand allocations to Southwest Middlesex, Newbury, and Chatham-Kent. The timing of the future development that would require this future demand is uncertain but is likely to increase gradually. Thus, there is no current urgency to implement mitigation measures.

Two potential system improvements should be considered to mitigate the anticipated future low pressures north of West Lorne:

1. Provide a flow control valve to limit the peak flows supplied to the Glencoe Reservoir; or
2. Provide a booster pumping station downstream of the Glencoe Reservoir connection to increase service pressures north of West Lorne.

The proposed flow control valve would limit the peak flow supplied to the Glencoe Reservoir to the maximum supply rate presented in the Tri-County Board Agreement. This would reduce the headloss from the West Lorne Standpipe to the Glencoe Reservoir connection, resulting in a higher local HGL elevation. This strategy should be discussed with the Tri-County Board and the Municipality of Southwest Middlesex system operator to confirm the anticipated future supply requirements and obligations.

A booster pumping station located north of West Lorne would increase local service pressures and could also be designed to improve local fire flows. Since it would provide direct benefit to only the West Elgin system, the Municipality of West Elgin would likely be solely responsible for its design, construction, and operation.

7.0 Conclusions and Recommendations

Dillon developed a hydraulic model of the Municipality of West Elgin's water distribution system that can be used as a long-range planning tool to review and evaluate various operational alternatives. The model was used to evaluate both existing condition and future development condition scenarios to evaluate the system performance. The hydraulic analysis results suggest:

- Under existing conditions, the minimum pressures in the existing West Elgin water distribution system are greater than the minimum provincial requirement of 40 psi;
- Under existing conditions, the calculated available fire flows at 34 hydrants are less than 31.5 L/s;
- The existing West Elgin water distribution network provides sufficient capacity to accommodate the proposed growth identified in the Official Plan, while maintaining minimum service pressures of 40 psi; and
- Supplying the Tri-County Board Member Municipalities at the maximum rates allocated in the Tri-County Board Agreement causes the minimum calculated service pressures in the West Elgin system to fall lower than 40 psi.

The following recommendations were developed based on the results of the hydraulic analysis:

- The fire flow results should be reviewed with the Municipality's fire protection services to evaluate whether hydrants with low available fire flows present a significant risk and whether a mitigation strategy should be developed;
- The water distribution system should be periodically monitored near the Port Glasgow Marina and Yacht Club since the local high pressures can increase the risk of watermain breaks, though based on information provided by Municipal operations staff the risk may be relatively low, as this portion of the system is comprised of DR26 PVC pressure pipe;
- A strategy should be developed to mitigate low pressures north of West Lorne when supply to the Glencoe Reservoir is increased; and
- The hydraulic model should be periodically updated to accurately represent the water distribution system as the network is expanded and development in the Municipality proceeds.

The hydraulic analysis presented in this report was limited to evaluating the performance of the existing water distribution network. As future development proceeds, the Municipality should consider:

- Evaluating the existing system storage to confirm that there is adequate capacity to accommodate fire flows and emergency storage requirements;
- Completing a risk assessment to evaluate the impacts of various watermain break scenarios and developing corresponding mitigation strategies;
- Completing extended period simulation hydraulic calculations if the Municipality has any concerns about water quality, residual chlorine, or water quality within the distribution network; and
- Confirming the capacity of the existing WTP pumps to meet future demands.

Appendix A

System Schematic

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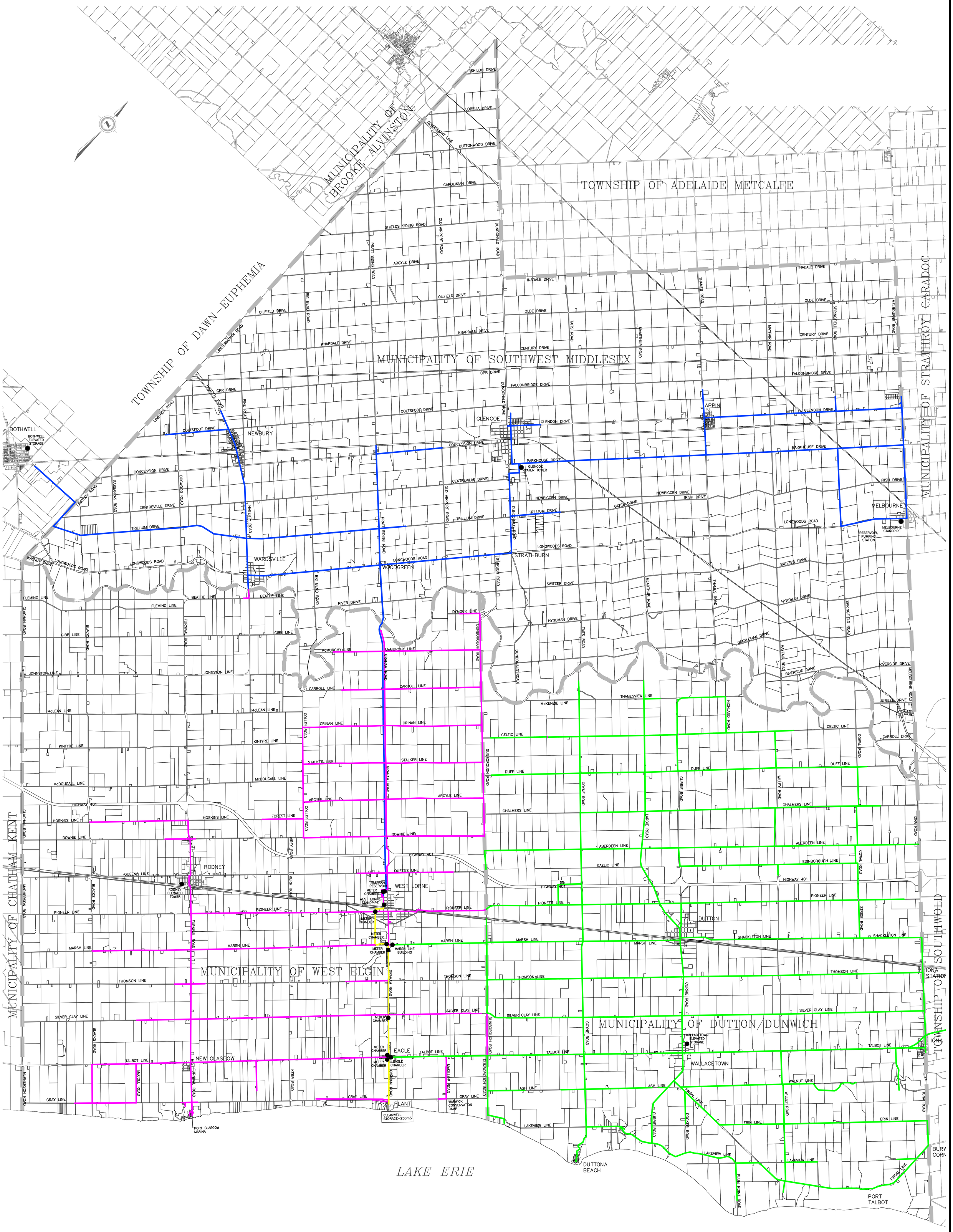
TRI-COUNTY TRUNK WATER LINES



LEGEND

- TRI-COUNTY
- DUTTON/DUNWICH
- SOUTHWEST MIDDLESEX
- WEST ELGIN

0 2000m

SPRIET ASSOCIATES LONDON LIMITED

DATE: FEBRUARY 24, 2021

PROJECT NO. 220296

Appendix B

Model Validation

Hydraulic Model Validation Summary

West Elgin Fire Flow Date	Time	Test Hydrant Information HY_ID Number	Pressure Static (PSI)	Fire Flow Rating @ 20 psi gpm	@ 20 psi (L/s)	Color Code	Model Results HY_ID Number	Pressure Static (PSI)	Pressure % of actual (PSI)	Static Pressure Difference (PSI)	Fire Flow @ 20 psi (L/s)	Color Code	Fire Flow Difference @ 20 psi (L/s)	Fire Flow % of actual %
3-Apr-2023	7:58:00	1	63.26	1892.08	119.37	BLUE	1	62.6	99%	-0.66	143.38	BLUE	24	120%
3-Apr-2023	8:29:00	2	61.12	1804.13	113.82	BLUE	2	63.5	104%	2.38	143.94	BLUE	30	126%
3-Apr-2023	8:43:00	3	64.25	1502.29	94.78	BLUE	3	65.9	103%	1.65	145.52	BLUE	51	154%
3-Apr-2023	9:23:00	4	83.81	1425.08	89.91	GREEN	4	65.6	78%	-18.21	65.75	GREEN	-24	73%
3-Apr-2023	9:42:00	5	90.81	1325.98	83.66	GREEN	5	68.1	75%	-22.71	53.08	ORANGE	-31	63%
3-Apr-2023	9:54:00	6	89.40	1060.11	66.88	GREEN	6	71.7	80%	-17.70	44.64	ORANGE	-22	67%
3-Apr-2023	9:07:00	7	64.15	1655.64	104.45	BLUE	7	74	115%	9.85	56.15	ORANGE	-48	54%
3-Apr-2023	10:22:00	8	61.86	1753.34	110.62	BLUE	8	61.3	99%	-0.56	147.59	BLUE	37	133%
3-Apr-2023	10:38:00	9	69.18	1325.8	83.64	GREEN	9	59.6	86%	-9.58	215.50	BLUE	132	258%
3-Apr-2023	10:59:00	10	67.46	1149.65	72.53	GREEN	10	58.9	87%	-8.56	60.07	ORANGE	-12	83%
3-Apr-2023	11:12:00	11	65.98	1168.52	73.72	GREEN	11	58.4	89%	-7.58	83.35	GREEN	10	113%
4-Apr-2023	9:32:00	12	80.97	12461.9	786.22	BLUE	12	60.4	75%	-20.57	125.42	BLUE	-661	16%
4-Apr-2023	10:00:00	13	58.46	2098.63	132.40	BLUE	13	60.3	103%	1.84	166.12	BLUE	34	125%
4-Apr-2023	9:50:00	14	56.67	2111.84	133.24	BLUE	14	58.1	103%	1.43	165.73	BLUE	32	124%
4-Apr-2023	8:36:00	15	56.88	1500.31	94.65	BLUE	15	55.5	98%	-1.38	138.07	BLUE	43	146%
4-Apr-2023	8:46:00	16	55.91	983.65	62.06	ORANGE	16	55.4	99%	-0.51	44.98	ORANGE	-17	72%
4-Apr-2023	11:52:00	17	62.50	2415.71	152.41	BLUE	17	54.1	87%	-8.40	84.78	GREEN	-68	56%
4-Apr-2023	12:26:00	18	61.07	2912.23	183.73	BLUE	18	54.6	89%	-6.47	212.50	BLUE	29	116%
4-Apr-2023	14:05:00	19	50.12	1806.63	113.98	BLUE	19	55.4	111%	5.28	125.75	BLUE	12	110%
3-Apr-2023	17:41:00	20	57.49	1986.12	125.30	BLUE	20	57.6	100%	0.11	152.52	BLUE	27	122%
4-Apr-2023	14:26:00	21	56.22	567.65	35.81	ORANGE	21	57.5	102%	1.28	24.07	RED	-12	67%
5-Apr-2023	8:41:00	22	55.27	380.17	23.98	RED	22	57.5	104%	2.23	18.49	RED	-5	77%
5-Apr-2023	8:27:00	23	56.81	353.54	22.30	RED	23	57.5	101%	0.69	13.82	RED	-8	62%
3-Apr-2023	17:10:00	24	58.12	1741.69	109.88	BLUE	24	59.1	102%	0.98	97.12	BLUE	-13	88%
3-Apr-2023	16:54:00	25	62.16	1562.39	98.57	BLUE	25	63.8	103%	1.64	83.17	GREEN	-15	84%
4-Apr-2023	10:51:00	26	62.67	1426.65	90.01	GREEN	26	62.1	99%	-0.57	31.59	ORANGE	-58	35%
4-Apr-2023	10:27:00	27	56.58	832.55	52.53	ORANGE	27	57.9	102%	1.32	26.68	RED	-26	51%
3-Apr-2023	16:42:00	28	68.57	1473.64	92.97	GREEN	28	69.9	102%	1.33	70.67	GREEN	-22	76%
3-Apr-2023	12:45:00	29	69.16	658.86	41.57	ORANGE	29	69.4	100%	0.24	30.28	RED	-11	73%
3-Apr-2023	12:29:00	30	66.19	626.74	39.54	ORANGE	30	64.9	98%	-1.29	27.58	RED	-12	70%
3-Apr-2023	12:18:00	31	63.83	691.83	43.65	ORANGE	31	63.4	99%	-0.43	28.82	RED	-15	66%
3-Apr-2023	11:58:00	32	62.50	905.59	57.13	ORANGE	32	62.3	100%	-0.20	43.86	ORANGE	-13	77%
3-Apr-2023	11:43:00	33	62.42	917.86	57.91	ORANGE	33	61.2	98%	-1.22	58.64	ORANGE	1	101%
3-Apr-2023	16:10:00	34	69.67	1253.04	79.05	GREEN	34	69.7	100%	0.03	68.08	GREEN	-11	86%
3-Apr-2023	16:24:00	35	69.94	1213.29	76.55	GREEN	35	70.9	101%	0.96	63.93	GREEN	-13	84%
3-Apr-2023	15:54:00	36	72.26	1321.79	83.39	GREEN	36	72.6	100%	0.34	57.33	ORANGE	-26	69%
3-Apr-2023	15:42:00	37	73.23	1144.39	72.20	GREEN	37	74	101%	0.77	43.99	ORANGE	-28	61%
3-Apr-2023	15:28:00	38	74.75	761.07	48.02	ORANGE	38	74.4	100%	-0.35	38.62	ORANGE	-9	80%
3-Apr-2023	15:08:00	39	75.22	826.39	52.14	ORANGE	39	79.3	105%	4.08	36.98	ORANGE	-15	71%
3-Apr-2023	13:11:00	40	67.46	562.52	35.49	ORANGE	40	70.5	105%	3.04	21.63	RED	-14	61%
3-Apr-2023	13:25:00	41	72.40	348.22	21.97	RED	41	72.6	100%	0.20	17.34	RED	-5	79%
3-Apr-2023	13:58:00	42	72.45	274.52	17.32	RED	42	73.8	102%	1.35	17.59	RED	0	102%
3-Apr-2023	14:30:00	43	76.59	548.53	34.61	ORANGE	43	77.6	101%	1.01	17.75	RED	-17	51%
3-Apr-2023	14:20:00	44	76.26	274.22	17.30	RED	44	76.8	101%	0.54	15.85	RED	-1	92%
3-Apr-2023	17:30:00	45	57.25	1934.43	122.04	BLUE	45	60.4	106%	3.15	151.96	BLUE	30	125%
5-Apr-2023	9:19:00	46	56.65	1919.69	121.11	BLUE	46	57.2	101%	0.55	191.31	BLUE	70	158%
5-Apr-2023	9:35:00	47	54.18	1718.61	108.43	BLUE	47	55.7	103%	1.52	135.39	BLUE	27	125%
5-Apr-2023	10:20:00	49	56.14	1400.65	88.37	GREEN	49	57.6	103%	1.46	92.19	GREEN	4	104%
5-Apr-2023	10:33:00	50	53.37	1205.93	76.08	GREEN	50	54.9	103%	1.53	71.81	GREEN	-4	94%
5-Apr-2023	10:52:00	51	53.02	1296.09	81.77	GREEN	51	53.9	102%	0.88	66.10	GREEN	-16	81%
6-Apr-2023	7:15:00	52	51.60	1193.01	75.27	GREEN	52	52.6	102%	1.00	58.60	ORANGE	-17	78%
6-Apr-2023	7:30:00	53	48.99	946.87	59.74	ORANGE	53	48.9	100%	-0.09	43.25	ORANGE	-16	72%
6-Apr-2023	7:48:00	54	47.09	876.47	55.30	ORANGE	54	48	102%	0.91	30.08	RED	-25	54%
6-Apr-2023	8:03:00	55	46.18	866.38	54.66	ORANGE	55	47.6	103%	1.42	26.61	RED	-28	49%
6-Apr-2023	8:30:00	56	45.37	878.51	55.43	ORANGE	56	47.3	104%	1.93	24.94	RED	-30	45%
6-Apr-2023	9:01:00	57	48.76	708.33	44.69	ORANGE	57	47.5	97%	-1.26	22.53	RED	-22	50%
6-Apr-2023	8:47:00	58	48.82	837.57	52.84	ORANGE	58	48.3	99%	-0.52	21.31	RED	-32	40%
11-Apr-2023	12:30:00	59	48.17	883.11	55.72	ORANGE	59	49.4	103%	1.23	23.68	RED	-32	43%
4-Apr-2023	13:20:00	60	52.59	1382.98	87.25	GREEN	60	50.7	96%	-1.89	74.01	GREEN	-13	85%
4-Apr-2023	13:32:00	61	52.10	1398.71	88.24	GREEN	61	51.2	98%	-0.90	93.83	GREEN	6	106%
11-Apr-2023	15:00:00	62	50.01	1547.07	97.60	BLUE	62	50.2	100%	0.19	156.44	BLUE	59	160%
11-Apr-2023	15:44:00	63	49.46	1594.87	100.62	BLUE	63	50.2	101%	0.74	98.63	BLUE	-2	98%
11-Apr-2023	15:30:00	64	50.27	1697.58	107.10	BLUE	64	50.2	100%	-0.07	113.30	BLUE	6	106%
11-Apr-2023	10:52:00	65	52.29	2533.71	159.85	BLUE	65	50	96%	-2.29	134.49	BLUE	-25	84%
11-Apr-2023	11:04:00	66	55.17	2137.54	134.86	BLUE	66	50.6	92%	-4.57	141.30	BLUE	6	105%
11-Apr-2023	10:40:00	67	50.62	2340.14	147.64	BLUE	67	48.7	96%	-1.92	70.70	GREEN	-77	48%
11-Apr-2023	10:22:00	68	55.48	2590.97	163.46	BLUE	68	50	90%	-5.48	125.69	BLUE	-38	77%
6-Apr-2023	11:35:00	69	55.91	1786.58	112.72	BLUE	69	49	88%	-6.91	64.46	GREEN	-48	57%
6-Apr-2023	11:22:00	70	55.77	2627.24	165.75	BLUE	70	49	88%	-6.77	134.34	BLUE	-31	81%

Hydraulic Model Validation Summary

West Elgin Fire Flow Date		Test Hydrant Information					Model Results							
		HY_ID	Pressure Static	Fire Flow Rating			HY_ID	Pressure Static	Pressure % of actual	Static Pressure Difference	Fire Flow		Fire Flow Difference	Fire Flow % of actual
	Time	Number	(PSI)	@ 20 psi gpm	@ 20 psi (L/s)	Color Code	Number	(PSI)	(PSI)	(PSI)	@ 20 psi (L/s)	Color Code	@ 20 psi (L/s)	%
6-Apr-2023	11:04:00	71	55.03	2465.01	155.52	BLUE	71	49.1	89%	-5.93	125.83	BLUE	-30	81%
6-Apr-2023	10:33:00	72	48.33	2190.39	138.19	BLUE	72	49.6	103%	1.27	141.93	BLUE	4	103%
6-Apr-2023	10:00:00	73	50.05	2617.05	165.11	BLUE	73	51.3	102%	1.25	219.78	BLUE	55	133%
11-Apr-2023	16:05:00	74	49.36	360.46	22.74	RED	74	49.7	101%	0.34	32.62	ORANGE	10	143%
11-Apr-2023	16:19:00	75	49.21	1549.73	97.77	BLUE	75	48.8	99%	-0.41	59.21	ORANGE	-39	61%
11-Apr-2023	16:42:00	76	58.38	2081.15	131.30	BLUE	76	48.9	84%	-9.48	115.02	BLUE	-16	88%
11-Apr-2023	11:15:00	77	50.79	2309.86	145.73	BLUE	77	49.5	97%	-1.29	129.12	BLUE	-17	89%
11-Apr-2023	11:34:00	78	49.36	1859.81	117.34	BLUE	78	48.7	99%	-0.66	100.44	BLUE	-17	86%
12-Apr-2023	11:20:00	80	48.12	1432.69	90.39	GREEN	80	48	100%	-0.12	48.56	ORANGE	-42	54%
12-Apr-2023	11:02:00	81	50.62	1424.02	89.84	GREEN	81	49.5	98%	-1.12	54.12	ORANGE	-36	60%
12-Apr-2023	10:29:00	82	50.56	1491.4	94.09	GREEN	82	47.8	95%	-2.76	51.09	ORANGE	-43	54%
12-Apr-2023	8:44:00	83	48.47	1211.55	76.44	GREEN	83	47.8	99%	-0.67	42.76	ORANGE	-34	56%
11-Apr-2023	12:40:00	84	49.38	2762.86	174.31	BLUE	84	50.2	102%	0.82	186.71	BLUE	12	107%
11-Apr-2023	12:51:00	85	54.32	2784.01	175.64	BLUE	85	50	92%	-4.32	112.95	BLUE	-63	64%
11-Apr-2023	13:05:00	86	55.30	2483.34	156.67	BLUE	86	49.9	90%	-5.40	151.94	BLUE	-5	97%
11-Apr-2023	13:35:00	87	55.06	3199.19	201.84	BLUE	87	49.9	91%	-5.16	149.60	BLUE	-52	74%
11-Apr-2023	13:20:00	88	55.13	2538.27	160.14	BLUE	88	49.8	90%	-5.33	117.62	BLUE	-43	73%
11-Apr-2023	13:49:00	89	52.10	2700.27	170.36	BLUE	89	49.7	95%	-2.40	90.14	GREEN	-80	53%
12-Apr-2023	7:57:00	90	55.98	1708.85	107.81	BLUE	90	49.5	88%	-6.48	72.94	GREEN	-35	68%
12-Apr-2023	8:24:00	91	50.37	1231.94	77.72	GREEN	91	49.1	97%	-1.27	61.37	ORANGE	-16	79%
12-Apr-2023	8:14:00	92	50.37	1261.89	79.61	GREEN	92	48.7	97%	-1.67	55.67	ORANGE	-24	70%
12-Apr-2023	12:26:00	93	53.89	492.01	31.04	RED	93	46.2	86%	-7.69	23.81	RED	-7	77%
12-Apr-2023	13:42:00	94	52.85	2730.7	172.28	BLUE	94	49.7	94%	-3.15	161.59	BLUE	-11	94%
12-Apr-2023	13:14:00	95	55.79	2082.6	131.39	BLUE	95	49.7	89%	-6.09	63.04	ORANGE	-68	48%
12-Apr-2023	13:32:00	96	55.20	2517.99	158.86	BLUE	96	48.7	88%	-6.50	186.29	BLUE	27	117%
12-Apr-2023	14:15:00	97	50.76	2550.71	160.92	BLUE	97	49.3	97%	-1.46	171.90	BLUE	11	107%
11-Apr-2023	14:33:00	98	49.03	1586.16	100.07	BLUE	98	49.3	101%	0.27	90.09	GREEN	-10	90%
12-Apr-2023	15:13:00	99	48.37	4260.9	268.82	BLUE	99	49	101%	0.63	250.00	BLUE	-19	93%
12-Apr-2023	14:58:00	100	49.05	3744.29	236.23	BLUE	100	48.9	100%	-0.15	100.71	BLUE	-136	43%
12-Apr-2023	14:44:00	101	49.60	4166.12	262.84	BLUE	101	49.1	99%	-0.50	250.00	BLUE	-13	95%
13-Apr-2023	10:34:00	102	48.85	3634.21	229.28	BLUE	102	49.6	102%	0.75	412.00	BLUE	183	180%
13-Apr-2023	10:52:00	103	50.19	5916.99	373.30	BLUE	103	49.5	99%	-0.69	69.21	GREEN	-304	19%
13-Apr-2023	11:04:00	104	55.69	3047.95	192.30	BLUE	104	48.9	88%	-6.79	236.13	BLUE	44	123%
12-Apr-2023	14:27:00	105	49.78	4105.46	259.01	BLUE	105	48.9	98%	-0.88	152.01	BLUE	-107	59%
12-Apr-2023	15:39:00	106	55.37	2202.44	138.95	BLUE	106	49.1	89%	-6.27	144.56	BLUE	6	104%
13-Apr-2023	7:46:00	107	54.56	2784.3	175.66	BLUE	107	49.1	90%	-5.46	142.00	BLUE	-34	81%
13-Apr-2023	8:04:00	108	54.18	2022.33	127.59	BLUE	108	48.6	90%	-5.58	92.82	GREEN	-35	73%
12-Apr-2023	15:25:00	109	48.72	2302.4	145.26	BLUE	109	49.4	101%	0.68	61.83	ORANGE	-83	43%
12-Apr-2023	15:54:00	110	55.62	1958.73	123.58	BLUE	110	48.8	88%	-6.82	69.91	GREEN	-54	57%
12-Apr-2023	16:25:00	111	49.88	2637.09	166.37	BLUE	111	47.9	96%	-1.98	135.19	BLUE	-31	81%
12-Apr-2023	16:49:00	112	50.62	2273.15	143.41	BLUE	112	49.3	97%	-1.32	71.63	GREEN	-72	50%
12-Apr-2023	16:13:00	113	55.65	2438.82	153.87	BLUE	113	48.6	87%	-7.05	126.73	BLUE	-27	82%
13-Apr-2023	8:17:00	114	49.82	1912.03	120.63	BLUE	114	47.9	96%	-1.92	87.64	GREEN	-33	73%
13-Apr-2023	12:09:00	115	49.18	1083.68	68.37	GREEN	115	48.5	99%	-0.68	149.42	BLUE	81	219%
13-Apr-2023	12:22:00	116	48.92	456.97	28.83	RED	116	47.4	97%	-1.52	20.74	RED	-8	72%
13-Apr-2023	12:39:00	117	46.89	352.92	22.27	RED	117	46.4	99%	-0.49	15.05	RED	-7	68%
13-Apr-2023	12:55:00	118	48.78	351.43	22.17	RED	118	45.8	94%	-2.98	12.95	RED	-9	58%
13-Apr-2023	11:41:00	119	48.79	1006.81	63.52	GREEN	119	48.8	100%	0.01	36.68	ORANGE	-27	58%
13-Apr-2023	13:20:00	120	47.38	1053.33	66.45	GREEN	120	48.9	103%	1.52	92.59	GREEN	26	139%
17-Apr-2023	10:44:00	121	50.72	1175.53	74.16	GREEN	121	49.6	98%	-1.12	84.66	GREEN	10	114%
17-Apr-2023	11:38:00	122	47.90	1014.92	64.03	GREEN	122	52.6	110%	4.70	70.60	GREEN	7	110%
17-Apr-2023	12:40:00	123	50.12	1160.42	73.21	GREEN	123	57.8	115%	7.68	76.11	GREEN	3	104%
17-Apr-2023	14:52:00	124	48.16	892.27	56.29	ORANGE	124	55.8	116%	7.64	48.85	ORANGE	-7	87%
17-Apr-2023	15:45:00	125	52.37	789.11	49.79	ORANGE	125	55.8	107%	3.43	36.85	ORANGE	-13	74%
17-Apr-2023	16:39:00	126	58.64	563.95	35.58	ORANGE	126	62.4	106%	3.76	35.35	ORANGE	0	99%
17-Apr-2023	10:27:00	127	41.92	1102.4	69.55	GREEN	127	50.1	120%	8.18	55.65	ORANGE	-14	80%
17-Apr-2023	11:21:00	128	46.30	907.46	57.25	ORANGE	128	47.9	103%	1.60	42.24	ORANGE	-15	74%
17-Apr-2023	11:56:00	129	48.92	882.26	55.66	ORANGE	129	48.9	100%	-0.02	45.55	ORANGE	-10	82%
17-Apr-2023	12:53:00	130	52.88	930.45	58.70	ORANGE	130	49.7	94%	-3.18	43.49	ORANGE	-15	74%
17-Apr-2023	15:15:00	131	52.04	757.68	47.80	ORANGE	131	52.4	101%	0.36	32.68	ORANGE	-15	68%
17-Apr-2023	16:19:00	132	52.14	765.52	48.30	ORANGE	132	53.8	103%	1.66	24.98	RED	-23	52%
17-Apr-2023	17:23:00	133	56.14	357.23	22.54	RED	133	63.4	113%	7.26	18.85	RED	-4	84%
17-Apr-2023	17:03:00	134	53.04	417.48	26.34	RED	134	61.7	116%	8.66	15.58	RED	-11	59%
17-Apr-2023	10:06:00	135	49.75	1125.94	71.04	GREEN	135	49.3	99%	-0.45	61.61	ORANGE	-9	87%
19-Apr-2023	8:00:00	136	54.61	269.89	17.03	RED	136	50.4	92%	-4.21	17.42	RED	0	102%
17-Apr-2023	11:00:00	137	48.40	1009.6	63.70	GREEN	137	47.5	98%	-0.90	43.85	ORANGE	-20	69%
17-Apr-2023	12:20:00	138	46.30	802.54	50.63	ORANGE	138	49.5	107%	3.20	53.48	ORANGE	3	106%
17-Apr-2023	13:19:00	139	57.25	1157.02	73.00	GREEN	139	52.3	91%	-4.95	50.72	ORANGE	-22	69%
12-Apr-2023	11:32:00	140	47.48	1397.37	88.16	GREEN	140	48	101%	0.52	55.68	ORANGE	-32	63%

Hydraulic Model Validation Summary

West Elgin Fire Flow Date	Time	Test Hydrant Information HY_ID Number	Pressure Static (PSI)	Fire Flow Rating @ 20 psi gpm	@ 20 psi (L/s)	Color Code	Model Results HY_ID Number	Pressure Static (PSI)	Pressure % of actual (PSI)	Static Pressure Difference (PSI)	Fire Flow @ 20 psi (L/s)	Color Code	Fire Flow Difference @ 20 psi (L/s)	Fire Flow % of actual %
18-Apr-2023	11:21:00	142	54.68	1835.47	115.80	BLUE	142	56	102%	1.32	214.85	BLUE	99	186%
18-Apr-2023	11:39:00	143	55.77	1412.97	89.14	GREEN	144	59.1	106%	3.33	199.04	BLUE	110	223%
18-Apr-2023	12:03:00	143	54.91	2741.5	172.96	BLUE	143	56.3	103%	1.39	211.06	BLUE	38	122%
18-Apr-2023	11:51:00	144	58.04	2742.43	173.02	BLUE	145	54.8	94%	-3.24	233.62	BLUE	61	135%
18-Apr-2023	12:25:00	145	53.85	2406.23	151.81	BLUE	146	55.1	102%	1.25	120.77	BLUE	-31	80%
18-Apr-2023	12:16:00	146	54.84	2377.48	150.00	BLUE	147	54.9	100%	0.06	246.51	BLUE	97	164%
18-Apr-2023	12:36:00	147	54.84	2267.89	143.08	BLUE	148	55	100%	0.16	241.40	BLUE	98	169%
18-Apr-2023	12:49:00	148	55.42	2185.42	137.88	BLUE	149	54.7	99%	-0.72	250.00	BLUE	112	181%
18-Apr-2023	13:00:00	149	54.42	2067.98	130.47	BLUE	150	55.5	102%	1.08	250.00	BLUE	120	192%
18-Apr-2023	14:01:00	150	53.75	2011.82	126.93	BLUE	151	57.1	106%	3.35	250.00	BLUE	123	197%
18-Apr-2023	13:52:00	151	55.27	2137.38	134.85	BLUE	152	56.8	103%	1.53	250.00	BLUE	115	185%
18-Apr-2023	14:14:00	153	52.52	1996.4	125.95	BLUE	153	54	103%	1.48	149.00	BLUE	23	118%
18-Apr-2023	14:35:00	154	52.44	2297.12	144.93	BLUE	154	54.2	103%	1.76	62.17	ORANGE	-83	43%
18-Apr-2023	14:46:00	155	53.85	1125.66	71.02	GREEN	155	54.8	102%	0.95	49.43	ORANGE	-22	70%
18-Apr-2023	15:02:00	156	55.65	2411.27	152.13	BLUE	156	56.5	102%	0.85	184.92	BLUE	33	122%
18-Apr-2023	15:25:00	157	53.26	1727.99	109.02	BLUE	157	54.6	103%	1.34	113.79	BLUE	5	104%
18-Apr-2023	15:15:00	158	53.68	1757.72	110.89	BLUE	158	54.4	101%	0.72	54.17	ORANGE	-57	49%
19-Apr-2023	9:13:00	159	53.92	2068.31	130.49	BLUE	159	55.1	102%	1.18	205.30	BLUE	75	157%
19-Apr-2023	9:34:00	160	53.01	2139.8	135.00	BLUE	160	54.2	102%	1.19	124.86	BLUE	-10	92%
19-Apr-2023	9:50:00	161	53.52	1936.59	122.18	BLUE	161	55.1	103%	1.58	163.58	BLUE	41	134%
19-Apr-2023	10:02:00	162	53.45	2064.86	130.27	BLUE	162	54.4	102%	0.95	176.44	BLUE	46	135%
19-Apr-2023	10:12:00	163	53.62	2020.61	127.48	BLUE	163	55	103%	1.38	184.51	BLUE	57	145%
19-Apr-2023	12:00:00	164	51.53	2109.8	133.11	BLUE	164	54.1	105%	2.57	162.97	BLUE	30	122%
19-Apr-2023	11:51:00	165	54.49	1811.19	114.27	BLUE	165	55.8	102%	1.31	120.70	BLUE	6	106%
19-Apr-2023	11:37:00	166	53.68	1543.49	97.38	BLUE	166	56.7	106%	3.02	58.51	ORANGE	-39	60%
19-Apr-2023	11:27:00	167	51.85	1591.61	100.41	BLUE	167	54.2	105%	2.35	108.79	BLUE	8	108%
19-Apr-2023	10:24:00	168	53.18	1821.54	114.92	BLUE	168	55.1	104%	1.92	136.80	BLUE	22	119%
19-Apr-2023	10:56:00	169	55.35	1693.96	106.87	BLUE	169	57	103%	1.65	92.94	GREEN	-14	87%
19-Apr-2023	11:16:00	170	51.53	1560.51	98.45	BLUE	170	54.1	105%	2.57	37.13	ORANGE	-61	38%
18-Apr-2023	15:39:00	171	53.85	2500.65	157.77	BLUE	171	55.4	103%	1.55	250.00	BLUE	92	158%
18-Apr-2023	16:09:00	172	52.39	1831.63	115.56	BLUE	172	53.9	103%	1.51	209.96	BLUE	94	182%
18-Apr-2023	15:59:00	173	53.01	1970.85	124.34	BLUE	173	54.1	102%	1.09	154.35	BLUE	30	124%
18-Apr-2023	16:42:00	174	52.69	1800.29	113.58	BLUE	174	54.8	104%	2.11	118.21	BLUE	5	104%
18-Apr-2023	16:53:00	175	52.88	1851.69	116.82	BLUE	175	55.2	104%	2.32	197.04	BLUE	80	169%
18-Apr-2023	16:20:00	176	51.88	1826.04	115.21	BLUE	176	54.7	105%	2.82	56.39	ORANGE	-59	49%
18-Apr-2023	17:05:00	178	53.01	1729.86	109.14	BLUE	178	54.9	104%	1.89	187.06	BLUE	78	171%
18-Apr-2023	17:34:00	179	51.79	1561.22	98.50	BLUE	179	52.7	102%	0.91	134.41	BLUE	36	136%
18-Apr-2023	17:23:00	180	49.75	1560.43	98.45	BLUE	180	51.9	104%	2.15	104.28	BLUE	6	106%
19-Apr-2023	12:32:00	181	46.67	1165.97	73.56	GREEN	181	51.3	110%	4.63	74.92	GREEN	1	102%
19-Apr-2023	12:45:00	182	50.56	1276.47	80.53	GREEN	182	51.1	101%	0.54	69.95	GREEN	-11	87%
19-Apr-2023	12:59:00	183	48.47	889.52	56.12	ORANGE	183	51.7	107%	3.23	55.99	ORANGE	0	100%
19-Apr-2023	13:09:00	184	52.66	857.02	54.07	ORANGE	184	51.9	99%	-0.76	52.05	ORANGE	-2	96%
6-Apr-2023	10:45:00	189	54.11	2340.96	147.69	BLUE	189	49.2	91%	-4.91	129.63	BLUE	-18	88%
11-Apr-2023	16:32:00	190	58.68	2075.58	130.95	BLUE	190	50	85%	-8.68	152.30	BLUE	21	116%
17-Apr-2023	16:07:00	192	58.62	699.19	44.11	ORANGE	192	67.3	115%	8.68	19.97	RED	-24	45%
19-Apr-2023	10:37:00	168C	54.27	1774.28	111.94	BLUE	168C	56.1	103%	1.83	120.37	BLUE	8	108%
12-Apr-2023	10:49:00	79A	48.05	1490.19	94.02	GREEN	79A	47.5	99%	-0.55	44.62	ORANGE	-49	47%
11-Apr-2023	14:21:00	98A	50.20	1964.4	123.93	BLUE	98A	49.3	98%	-0.90	132.84	BLUE	9	107%
11-Apr-2023	14:08:00	98B	49.88	2129.68	134.36	BLUE	98B	49.6	99%	-0.28	59.70	ORANGE	-75	44%
17-Apr-2023	15:29:00	124-B	54.11	773.35	48.79	ORANGE	124-B	52.6	97%	-1.51	17.26	RED	-32	35%
4-Apr-2023	8:12:00	16-B	54.04	846.96	53.43	ORANGE	16-B	54.4	101%	0.36	17.54	RED	-36	33%
4-Apr-2023	11:30:00	17-B	57.45	1297.99	81.89	GREEN	17-B	56	97%	-1.45	19.21	RED	-63	23%
6-Apr-2023	10:15:00	72-B	48.89	2391.11	150.86	BLUE	72-B	50.2	103%	1.31	159.72	BLUE	9	106%
									Min	-22.7		Min	-661	
									Max	9.8		Max	183	
									Median	0.3		Median	-11	
									Mean	-0.6		Mean	-7	

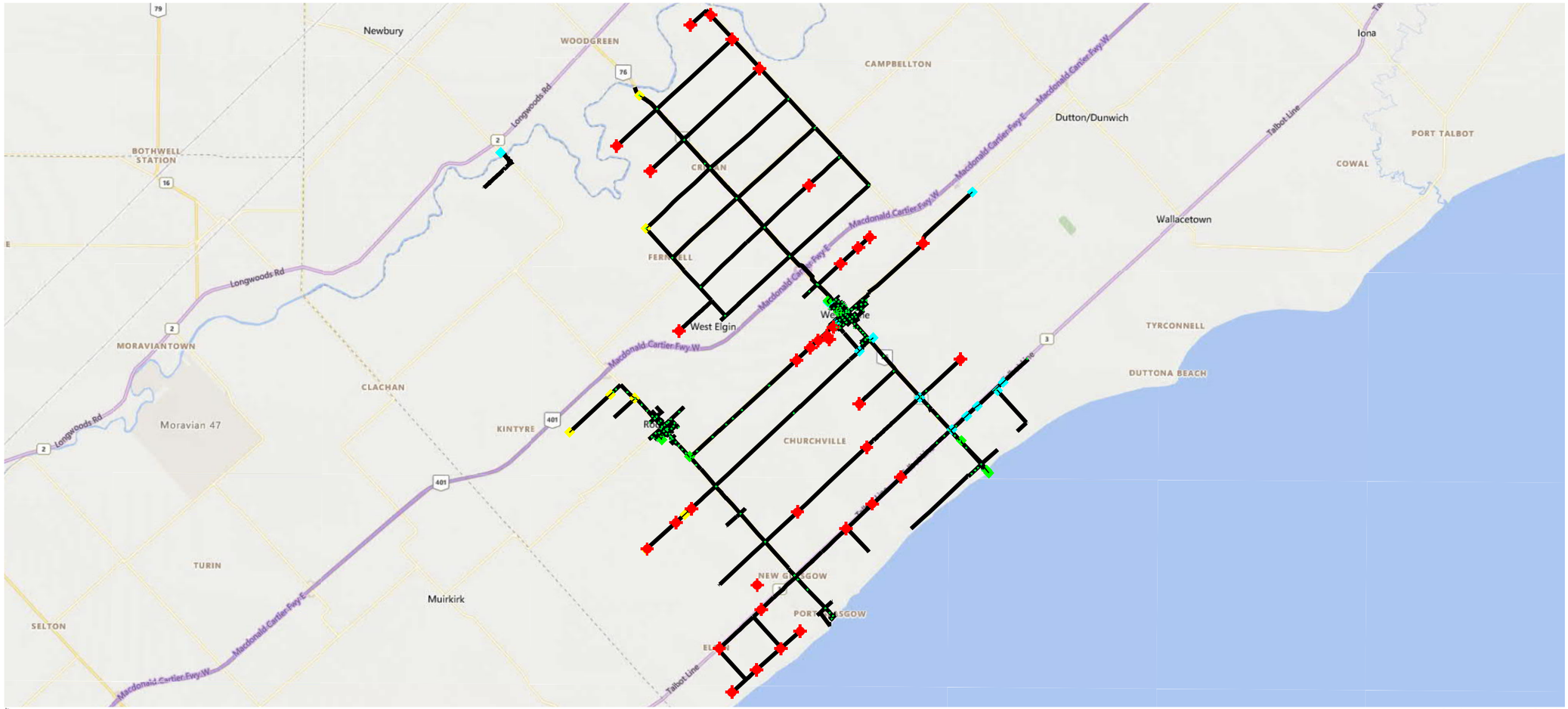
Appendix C

Model Results

DILLON CONSULTING

Existing Conditions
Hydrants with Low Fire Flows

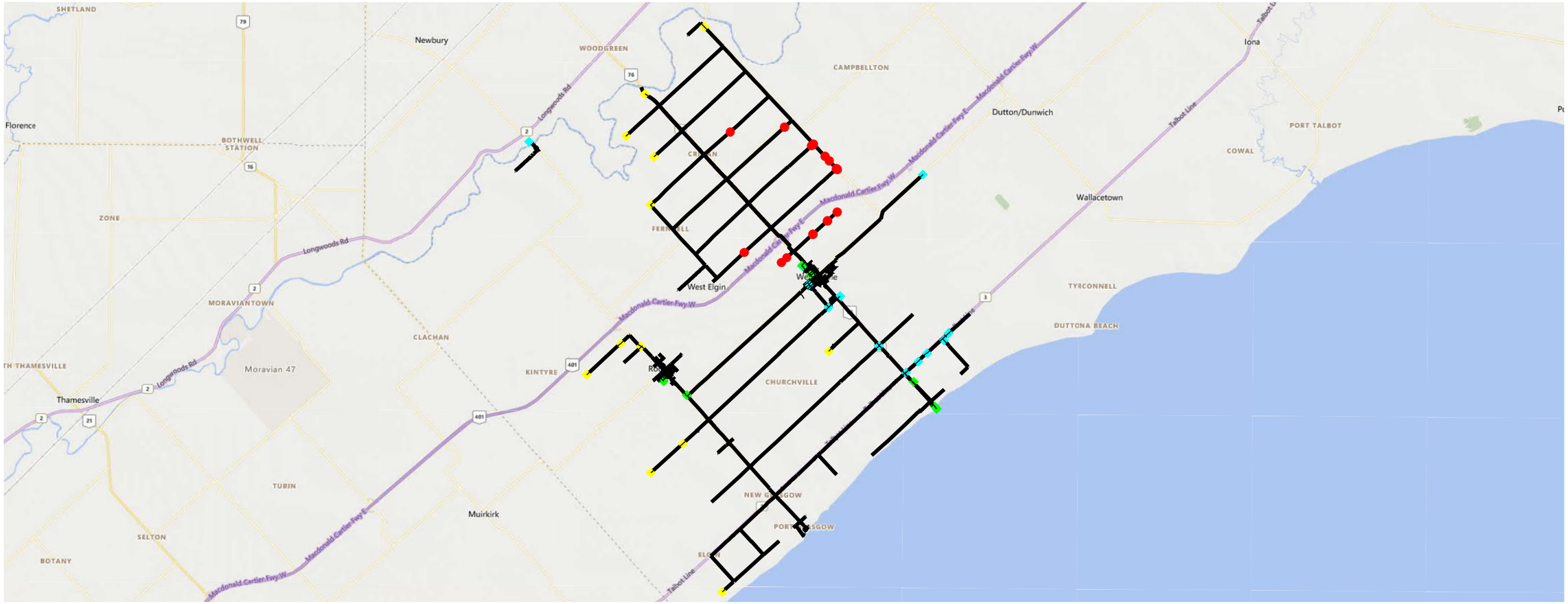
Active Scenario: Max Day + Fire



Hydrants with Calculated Available Fire Flow <31.5 L/s

Future Scenario 2
Low Pressure Junctions

Active Scenario: PHD



Bing

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● Junctions with Minimum Calculated Pressure < 40 psi