

Appendix B. Technical Memorandums

TM-1: Summary of Project Background

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Region of Waterloo

Wellesley Water and Wastewater Master Plan
July 31, 2025





TM-1: Summary of Project Background

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Client reference: Kaoru Yajima

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Project manager: Tom Mahood

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Jacobs Consultancy Canada Inc.

Kitchener, ON
Canada

T +1.519.579.3500
www.jacobs.com

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Acronyms and abbreviations

ADF	Average Daily Flow
AO	Aesthetic Objective
Ca/Sr	Calcium to Strontium Ratio
DWWP	Drinking Water Works Permit
ECA	Environmental Compliance Approval
GTD	Guideline Technical Document
I&C	Instrumentation and controls
ICI	Industrial, Commercial, and Institutional
LPD	Litres per day
LPM	Litres per minute
MAC	Maximum Acceptable Concentration
MECP	Ministry of the Environment, Conservation, and Parks
MLSS	Mixed Liquor Suspended Solids
NTU	Nephelometric Turbidity Unit
PDF	Peak Daily Flow
PFAS	Per- and polyfluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
PHF	Peak Hourly Flow
PIF	Peak Instantaneous Flow
PTTW	Permit to Take Water
PWQO	Provincial Water Quality Objectives
SCADA	Supervisory Control and Data Acquisition
SWD	Side Wall Depth
TCU	True Colour Units
TDH	Total Dynamic Head
WAS	Waste Activated Sludge

TM-1: Summary of Project Background

WTP Water Treatment Plant

WWTP Wastewater Treatment Plant

1 Introduction

1.1 Background

The Township of Wellesley is one of seven local municipalities in the Region of Waterloo (Region). The Township of Wellesley is a rural community comprised of eleven (11) settlement areas, including the Village of Wellesley, with village being the only settlement area with both municipal wastewater and water servicing. The Region is responsible for maintaining existing levels of service within the water and wastewater systems to provide capacity to the existing population, as well as planning for new growth in the service area and meeting regulatory requirements. To plan and budget for water and wastewater upgrades and new infrastructure to address existing issues and meet future needs to 2051, the Region is undertaking the Wellesley Water and Wastewater Master Plan (WWWMP). The WWWWMP will incorporate recent population forecasts and existing and ongoing condition assessments and review new technologies to reduce flows and treatment while considering climate change impacts (such as extreme weather events). By including the water and wastewater components under a single master plan, it is feasible to develop complementary water management solutions under One Water Framework. One Water is the premise that water is continuously cycling through an integrated system, including groundwater supply, wastewater collection and treatment, and surface water.

The WWWWMP will fulfill the requirements of Phase 1 and Phase 2 of the Municipal Class Environmental Assessment (MCEA) process for Water and Wastewater Projects.

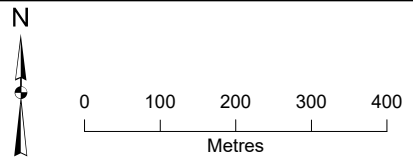
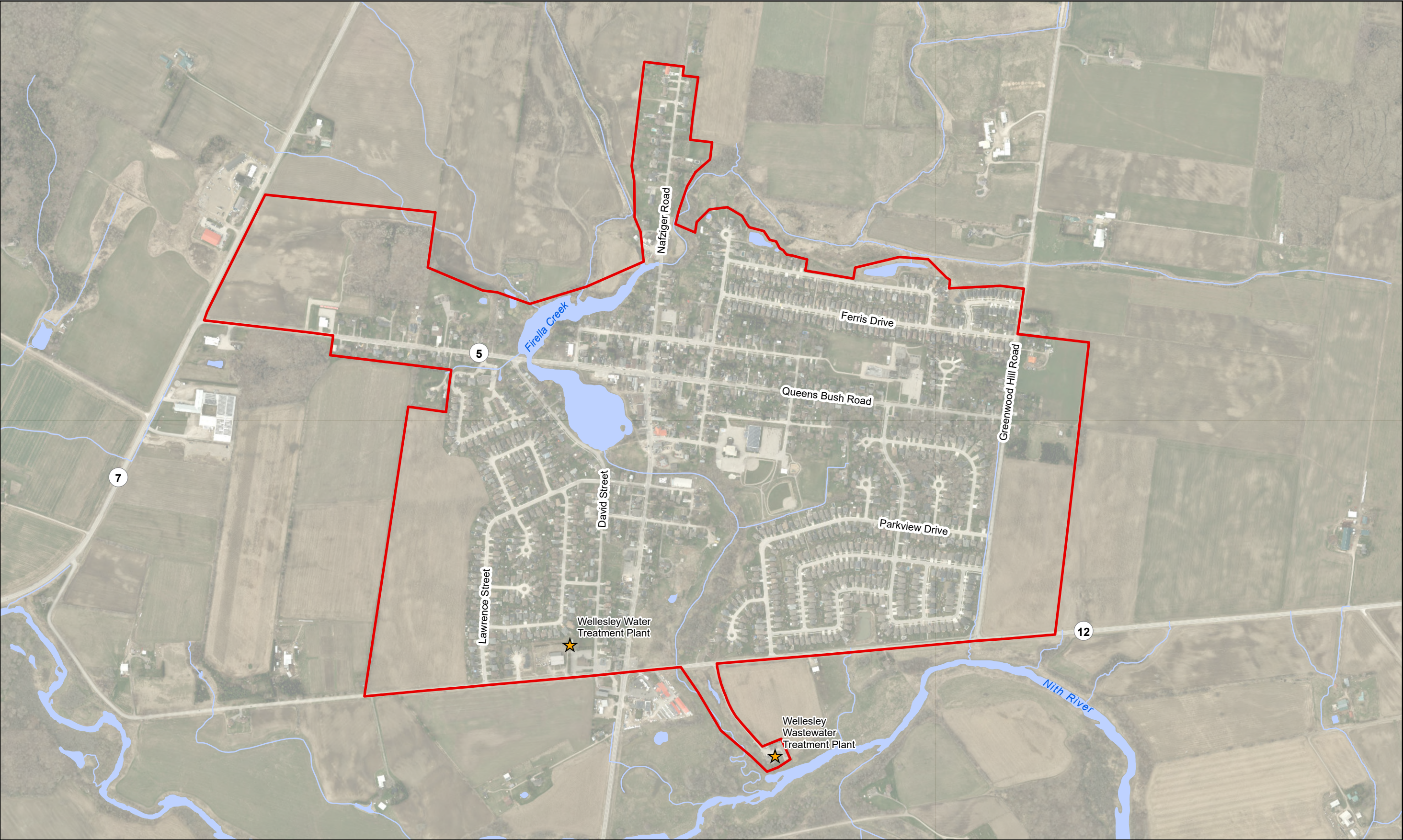
1.2 Purpose

The purpose of the WWWWMP is to address anticipated water and wastewater treatment needs over the next 30 years, and in doing so, to improve the reliability and resiliency of its water and wastewater assets. The goals of the WWWWMP include identifying new required projects, and systematically developing a prioritized implementation plan that is endorsed by the Region and project stakeholders. The proposed solutions will represent the greatest value and least risk to the Region while 1) aligning with the Region's strategic focus, 2) meeting regulatory requirements, and 3) satisfying technical, cost, energy management and resiliency objectives. Technical Memorandum 1 (TM1) summarizes the existing conditions within the study area, including the existing conditions at Wellesley's Water and Wastewater Treatment facilities.

2 Study Area

The study area is shown in Figure 2-1. The study area encompasses the Village of Wellesley as well as additional designated greenfield areas to the east of Greenwood Hill Road and to the west of Lawrence Street. The parcel of land north of Queens Bush Road and east of Hutchinson Road, as well as the Wellesley Wastewater Treatment Plant (WWTP) property and access Road, are also included in the study area.

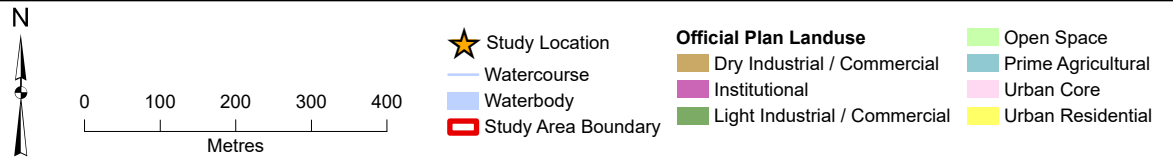
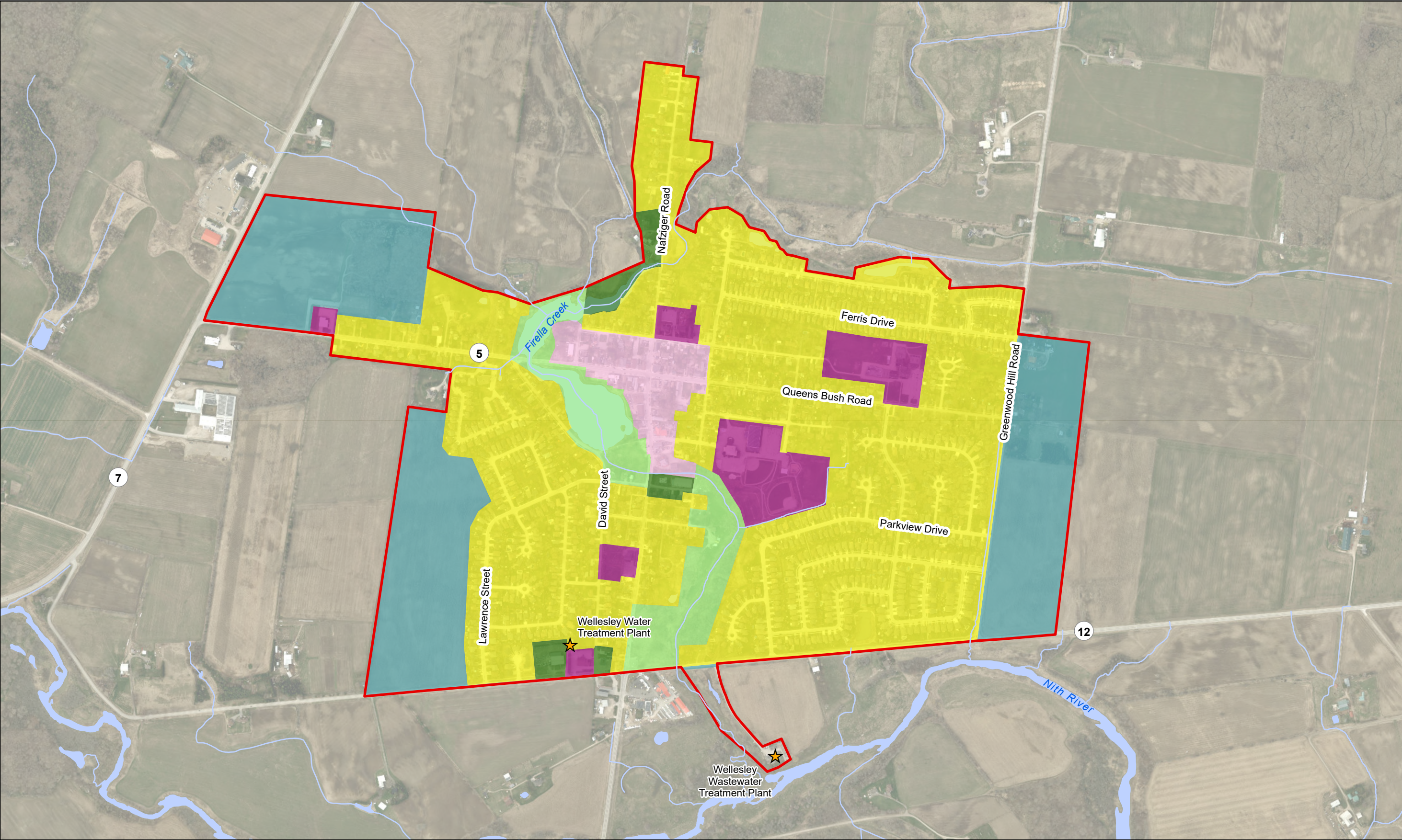
Land use within the study area is primarily classified as urban residential with scattered institutional, industrial, and commercial land use. Areas outlying towards the east and west ends of the study area are classified as prime agricultural land. The land use within the study area is shown in Figure 2-2.



- ★ Study Location
- Watercourse
- Waterbody
- Study Area Boundary

Notes:
1. Aerial Source: Region of Waterloo, 2020.

Figure 2-1
Study Area
Technical Memorandum 1
Region of Waterloo
Wellesley, Ontario



Notes:
1. Aerial Source: Region of Waterloo, 2020.

Figure 2-2
Study Area Land Use
Technical Memorandum 1
Region of Waterloo
Wellesley, Ontario

3 Water System

3.1 Water Treatment Plant Summary

The Wellesley Water Treatment Plant (WTP) is located at 2233 Gerber Road, Wellesley, Ontario. Raw water is supplied to the Wellesley WTP through three groundwater production wells (WY1, WY5, and WY6). The Wellesley WTP is equipped with three (3) dual media pressure filters containing greensand and anthracite for iron and manganese treatment, and a sodium hypochlorite system for pre-oxidation and primary disinfection. Treated water is stored in a 3-celled reservoir with a total usable volume of 902.3 m³ before it is distributed. This is accomplished by a single discharge line without redundancy. The reservoir provides treated water storage and contact time for disinfection.

Backwash water for the filtration system is drawn from the treated water reservoir. Used backwash water is sent to an 86 m³ settling tank equipped with two (2) supernatant pumps. Although the Region has a pilot program for recycling of supernatant, the supernatant recycling system is not actively used. High lift pumping system consists of five (5) high lift pumps which draw water from the reservoir. Two (2) large pumps (rated 60 L/s at 2.5 m) are dedicated fire pumps, and the three (3) small pumps (rated 15.5 L/s at 42.5 m) are used for normal operation. The high lift pumps operate in Pressure Mode to continuously supply water into the distribution system to maintain system pressure. Each pump has a start discharge pressure setpoint. The high lift pump is requested to start once the discharge pressure drops below the setpoint, and requested to stop once pressure is confirmed to be above the setpoint.

The Wellesley WTP was originally constructed in 1993. A condition assessment was completed for the Wellesley WTP in 2018 by C3 Water which identified several short-, medium- and long-term upgrades. Recommendations from the condition assessment were identified to achieve the following key outcomes:

- Confirmation of equipment sizing compared to current demands
- Asset renewals (mechanical, electrical, instrumentation and controls [I&C])
- Opportunities for process improvements (C3 Water, 2018)

The Region is currently undertaking a Wellesley WTP Upgrade project (Contract T2021-183) to implement like-for-like asset renewals (mechanical, electrical, I&C). Control and SCADA upgrades were completed under a separate project in 2021 by Brock Solutions as part of the Water Services Control Upgrades program.

A study of the contactor pipe in 2021 found that dosing chlorine ahead of the contactor pipe did not have a negative impact on treatment performance in terms of meeting turbidity, iron, manganese, dissolved solids, and arsenic treatment objectives (CIMA+, 2021). The contactor pipe was removed in February 2022.

Raw water is drawn from the wells according to Permit to Take Water (PTTW) No. 0345-94UQ6A dated March 6, 2013. The total taking limit is 17.4 L/s or 1,044 Litres per minute (LPM), or 1,503,360 Litres per day (LPD) which also corresponds to the maximum withdrawal rate for any of the three individual wells. The treatment plant is governed by Drinking Water Works Permit (DWWP) No. 012-215, and Municipal Drinking Water License (MDWL) No. 012-115, both dated April 20, 2021. The rated capacity of the Wellesley WTP is 3,006 m³/d. However, the maximum water taking allowed by the PTTW is 1,503 m³/d. Additional information on the three production wells is provided in Table 3-1.

Table 3-1. Groundwater Production Well Dimensions and Pumping Capacity

Well	Diameter, mm	Depth, m	Well Pump Capacity, L/s	Well Pump Total Dynamic Head (TDH), m
WY1	203	48.46	17.4	59.2
WY5	200	52.43	17.4	59.2
WY6	210	52.4	17.4	62.0

3.2 Water Distribution System Summary

3.2.1 Storage

The Wellesley water distribution system does not have floating storage and therefore the volume required for fire storage is provided through a combination of fire flow pumps and reliance on pumper trucks that can utilize water from the Wellesley Pond to help fight fires.

Storage of treated water is provided at the Wellesley WTP by a three-celled reservoir with a total usable volume of 902.3 m³ (Cell A: 188.5 m³; Cell B: 279.8 m³; Cell C: 434.0 m³). The main purpose of this water reservoir is to provide a standby volume of water for firefighting and an additional volume for emergency conditions. In addition, the reservoir will also provide the required volume for primary disinfection.

3.2.2 High Lift Pumps

The high lift pumping system delivers potable water to Wellesley for domestic consumption and firefighting purposes. The water distribution system relies on the pumping system for both water pressure and water supply.

According to the MECP Guidelines for Drinking Water System Design, for a water distribution system without floating storage (or water tower), the firm capacity of a water supply pumping station is the capacity of the pumps with two largest units out of service (including fire pumps). The firm capacity of the Wellesley water supply pumping system is 47 L/s. The emergency or fire flow pumping capacity is 166.5 L/s, calculated as the total capacity of the pumping station. Requirements for fire flows can be supplemented from the fire department's tanker truck. The high lift pumps operate in Pressure Mode to continuously supply water into the distribution system to maintain system pressure. Each pump has a start discharge pressure setpoint. The high lift pump is requested to start once the discharge pressure drops below the setpoint, and requested to stop once pressure is confirmed to be above the setpoint.

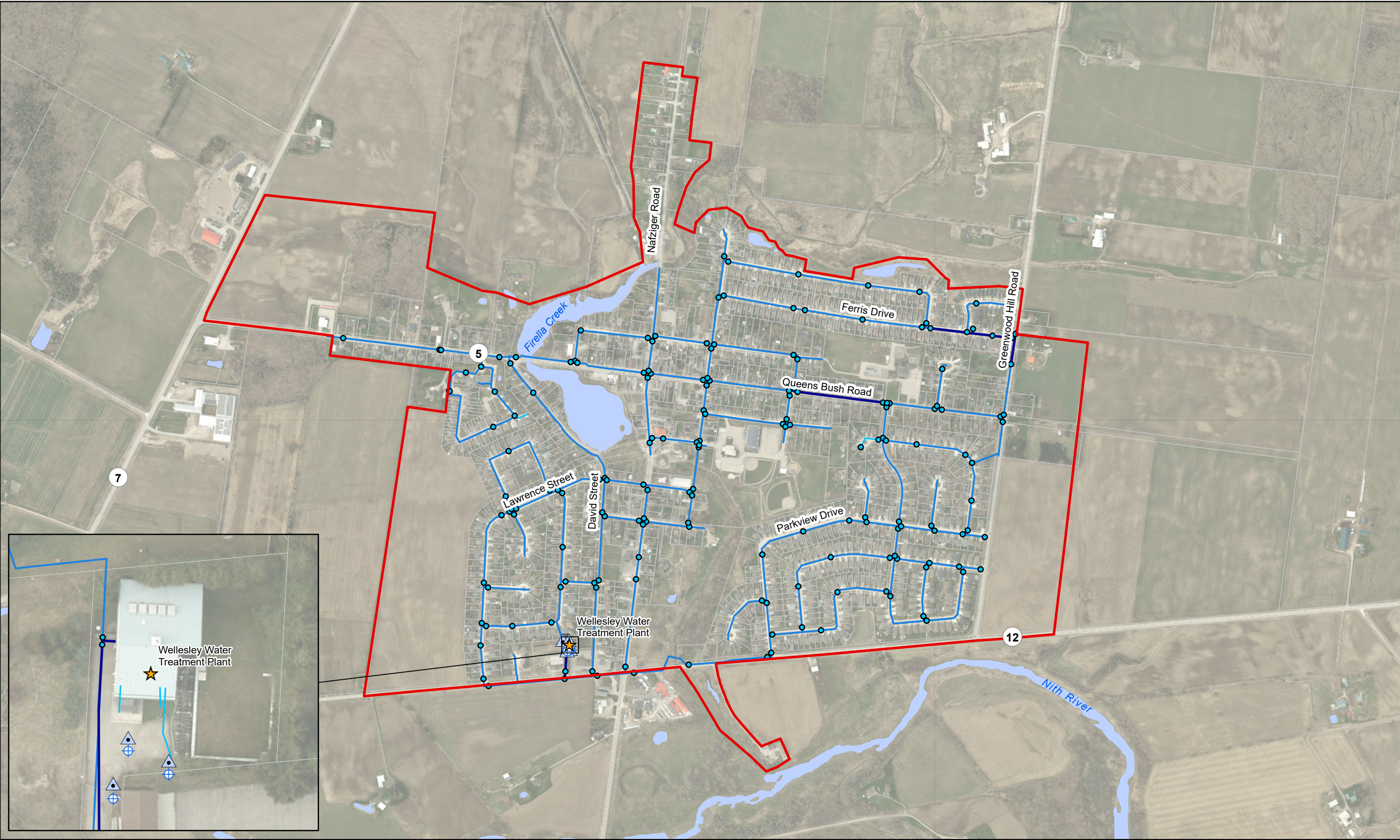
The Wellesley water distribution system has five high lift pumps (vertical turbine type) as listed in Table 3-2.

Table 3-2. High Lift Pumps Characteristics

Pump	Description	Pump Capacity, L/s	Pump Total Dynamic Head (TDH), m	VFD, (Y/N)
WYB5	Duty pump	15.5	42.5	N
WYB6	Duty pump	15.5	42.5	Y
WYB7	Duty pump	15.5	42.5	N
WYB8	Fire pump	60.6	42.5	Y
WYB9	Fire pump	60.6	42.5	Y

3.2.3 Watermains

The Wellesley water distribution system is comprised of approximately 17.3 km of watermains ranging from 150 mm to 300 mm in diameter with 61 percent of pipes of 200 mm in diameter. The majority of the watermains (approximately 98 percent in length) are made of PVC. The drinking water network has been installed relatively recently with 56 percent and 29 percent of the watermains installed in the decade of 1990s and 2000s respectively. Just a small fraction of the watermains were installed prior to 1990 (10 percent) or later than 2010 (5 percent). Figure 3-1 provides an overview of Wellesley's water distribution system.



Notes:
1. Aerial Source: Region of Waterloo, 2020.

Figure 3-1
Water Distribution System Overview
Technical Memorandum 1
Region of Waterloo
Wellesley, Ontario

3.2.4 Operational Controls

The duty pumps (3 in total) generally service the domestic demands (including MDD) and the two larger fire pumps generally are used for firefighting purposes.

The high lift pumps at the WTP operate in the following stages (from lowest to highest water demands):

- Stage 1: WYB5 (Fixed Speed Duty Pump)
- Stage 2: WYB6 (VFD Duty Pump)
- Stage 3: WYB6 (VFD Duty Pump) with WYB5 as required
- Stage 4: WYB6 (VFD Duty Pump) and WYB7 (Fixed Speed Duty Pump)
- Stage 5: WYB8 or WYB9 (Fire Pumps)
- Stage 6: WYB6 (VFD Duty Pump) and WYB8 or WYB9 (Fire Pumps)

The high lift pump system operates between Stages 1 and 2 for average day demand conditions (ADD) and between Stages 2 and 3 for maximum day conditions (MDD).

3.2.5 Level of Service

Table 3-3 specifies the minimum and maximum acceptable pressures according to the Region of Waterloo and Area Municipalities Design Guidelines and Supplemental Specifications for Municipal Services (Region of Waterloo et al., 2022).

Table 3-3. Minimum and Maximum Pressures

Scenario	Pressure (kPa)
Pressure under non-fire flow demand scenario	>275 kPa (40 psi)
Maximum Day plus fire flow	>140 kPa (20 psi)
Maximum static pressure	<700 kPa (100 psi)

The preferred design pressure ranges for average day and maximum day are 350 kPa (50 psi) to 550 kPa (80 psi). The preferred minimum hour and peak hour pressure ranges are 275 kPa and 700 kPa. (Region of Waterloo et al., 2017).

3.3 Water Distribution System Hydraulic Model

3.3.1 Hydraulic Model Summary

The Region provided Jacobs an extended period simulation (EPS) hydraulic model of the Wellesley water distribution system. The hydraulic network model currently runs on the following platform: InfoWater Pro 2.0 with link to ArcGIS Pro.

This water model was updated and calibrated in 2018 to reflect the existing system conditions. In addition, it was validated for operational controls and for accuracy of the model results (headloss). The model validation was completed based on three flow hydrant tests conducted in July 2018.

The hydraulic model represents the following elements:

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- Three wells and associated pumps (no VFDs set in the model)
- Reservoir within the WTP
- Five high lift pumps
 - Pump 5 (WYB5):
 - Pump 6 (WYB6) with VFD
 - Pump 7 (WYB7):
 - Pump 8 (WYB8):
 - Pump 9 (WYB9):

Jacobs updated the pumps in the model to reflect the capacity and TDH listed in Table 3-2.

- Watermain network covering the service area

The model provided includes the working scenarios as listed below:

- Average Day Demand (ADD) 2018
- Maximum Day Demand (MDD) 2018

The water demands are allocated to the model nodes for 2018 ADD and 2018 MDD scenarios and classified as residential and industrial, commercial or institutional (ICI). Table 3-4 shows a summary of the total water demands for both scenarios.

Table 3-4. Water Demands in the Hydraulic Model

Condition	Water Demands, L/s		
	Residential	ICI	Total
ADD	7.3	0.4	7.6
MDD	12.2	0.7	12.9

The diurnal profile assigned to each water consumption type are shown in Figure 3-2.

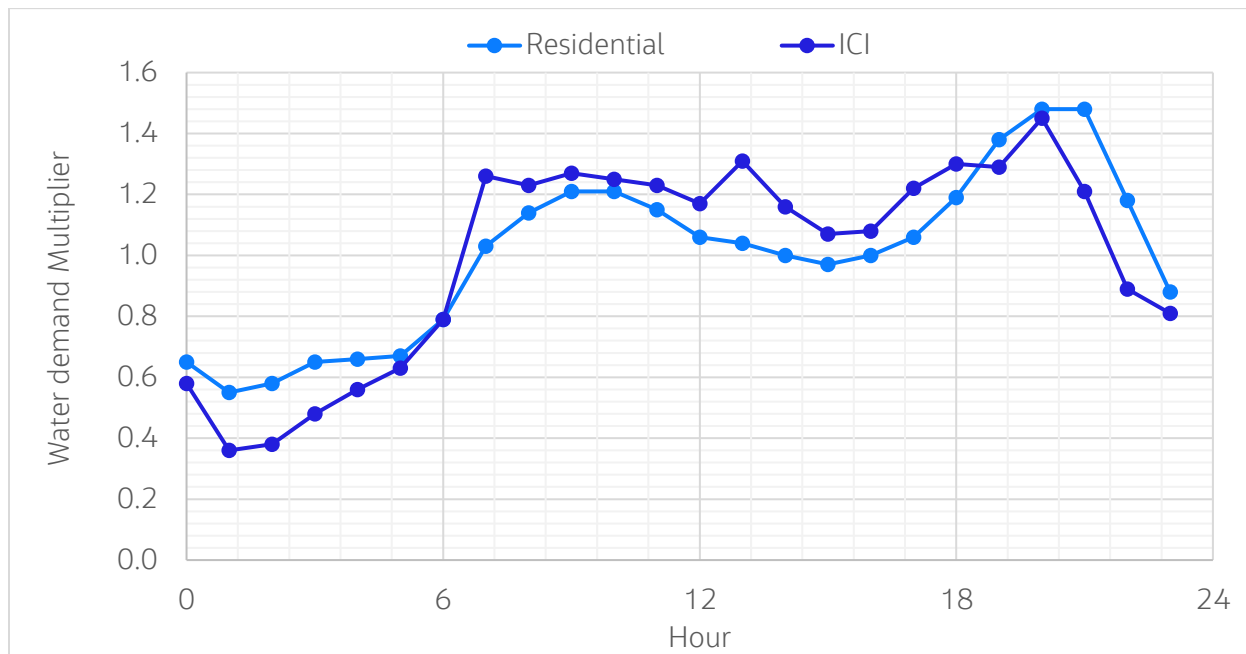


Figure 3-2. Water Diurnal Profile

The high lift pumps are controlled in the model as described below:

- **Pump 5**
 - ON if system demand > 11 L/s
 - OFF if system demand < 9 L/s
 - OFF if system demand > 66 L/s
- **Pump 6**
 - ON if system demand < 18 L/s
 - OFF if system demand > 18 L/s

Pump 6 operates with variable speed to target a discharge pressure of 66 psi (equivalent to HGL of 406 m)

- **Pump 8**
 - ON if system demand > 18 L/s
 - OFF if system demand < 15 L/s

Pumps 7 and 9 are set to inactive in the model.

The model provided by the Region was updated, calibrated and validated in 2018.

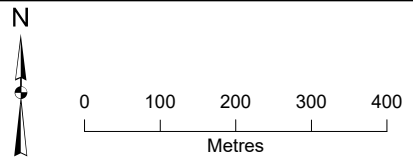
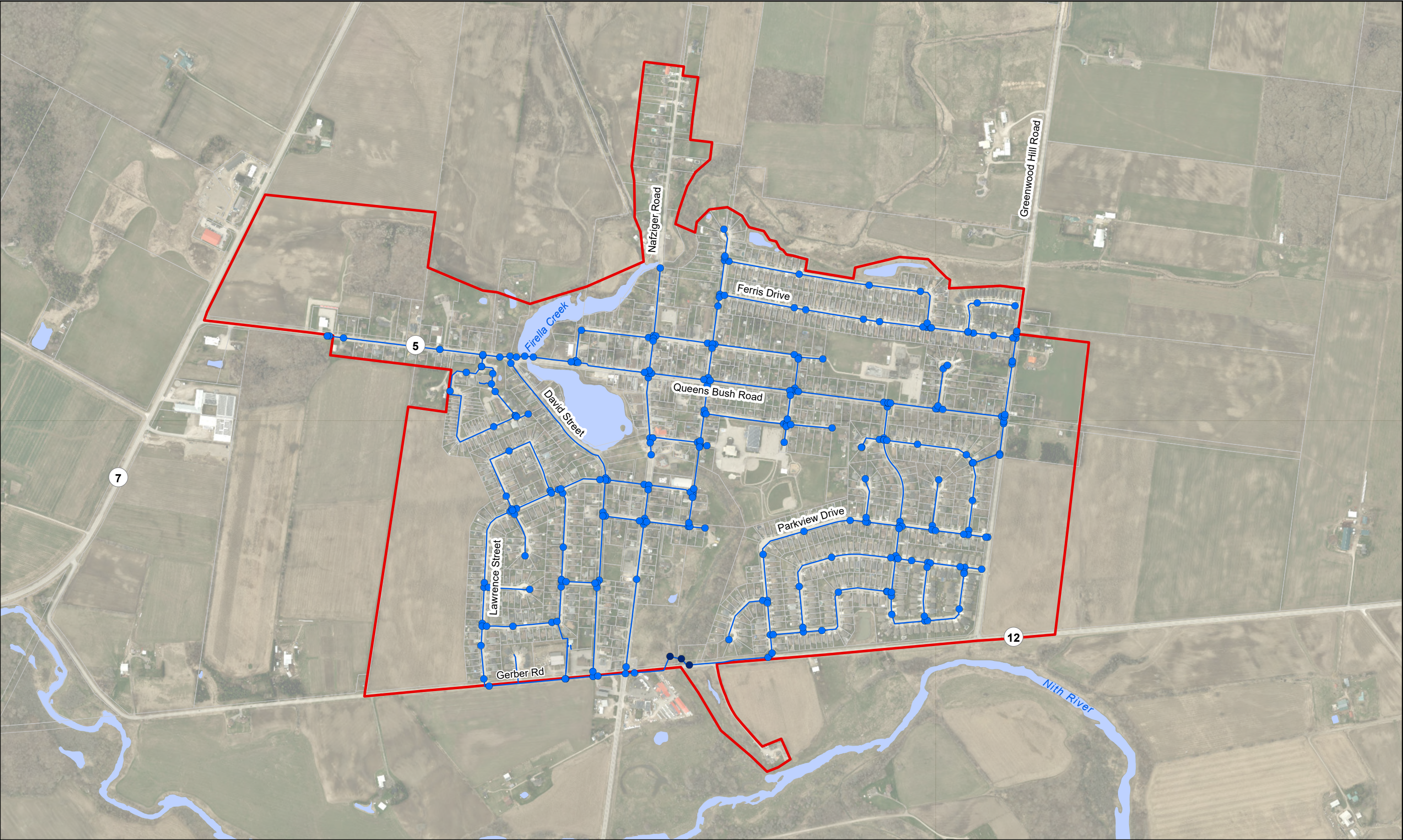
3.3.2 Hydraulic Model Results

The model, as provided by the Region, was run to determine the existing water distribution system pressures as shown in Table 3-5.

Table 3-5. Water Demands in the Hydraulic Model for existing conditions

Condition	System Pressures, kPa (psi)		
	Minimum	Average	Maximum
ADD – Maximum Pressure	381 (55.3)	457 (66.3)	597 (86.6)
MDD – Minimum Pressure	378 (54.8)	454 (65.8)	594 (86.2)

Given that the flow from the high lift pumps is controlled by variable frequency drives (VFD), the pressure at the discharge header was modelled to a fixed value of 66 psi. This causes the pressure to vary very little throughout the day and/or between ADD and MDD for a given node in the system. The pressure ranges approximately between 54 psi and 86 psi with an average value around 66 psi which is within the acceptable values of 40 psi and 90 psi as minimum pressure and maximum pressure respectively.



- | | |
|------------------------------|-----------------------|
| Maximum Water Pressure (psi) | — Watermain |
| ● <40 | ■ Waterbody |
| ● 40-70 | □ Parcel |
| ● 70-100 | ▬ Study Area Boundary |
| ● >100 | |

Notes:
1. Aerial Source: Region of Waterloo, 2020.

Figure 3-2
Water Distribution - Maximum Pressures
Technical Memorandum 1
Region of Waterloo
Wellesley, Ontario

3.4 Water Consumption

3.4.1 Water Treatment Plant

Daily raw and treated water flow data were obtained from the Wellesley WTP Supervisory Control and Data Acquisition (SCADA) system. Raw flow and treated water flow data were available from November 2017 to October 2022.

The total annual volume of raw water drawn from each of the three wells is summarized in Table 3-6. Data is only included for 2018 to 2021 as these are the only years that had a complete set of annual data.

Table 3-6. Total Annual Raw Water Use for each Well at the Wellesley WTP

Year	Well 1 (WY1) Taking (m ³)	Well 5 (WY5) Taking (m ³)	Well 6 (WY6) Taking (m ³)	Total Annual Taking (m ³)
2018	91,843	58,570	66,385	216,798
2019	843	747	184,526	186,116
2020	39,056	31,620	167,236	237,912
2021	104,024	12,552	130,409	246,986

The observations from Table 3-6 are summarized below:

- In 2018, the three wells were drawn fairly evenly, with Well 1 used the most. In 2019 and 2020, Well 6 was drawn from almost exclusively. In 2021, both WY1 and WY6 are main production wells, with only small amount raw water from WY5.
- Under the PTTW, the maximum rate of taking is 1,503 m³/d, or 548,726 m³ per year, assuming 365 days. The current total annual taking is less than half of this amount, approximately 30 to 40 percent of the maximum permitted under the PTTW.
- In 2020, the total annual taking increased by approximately 20 percent and remained at this elevated level for 2021.

The total volume of raw water drawn from the three wells is compared to the treated water discharge flow from the Wellesley WTP in Table 3-7 on a monthly basis for each month where a complete set of treated water data was available (June 2021 to October 2022).

Table 3-7. Wellesley WTP Volumetric Losses

Date	Total Volume of Raw Water Pumped (m ³)	Total Volume of Treated Effluent (m ³)	WTP Volumetric Loss (m ³)	Percent WTP Volumetric Loss (%)
June, 2021	22,758	22,472	285	1.3%
July, 2021	20,549	20,179	370	1.8%
August, 2021	22,239	21,959	280	1.3%
September, 2021	18,395	17,949	446	2.4%
October, 2021	19,962	19,736	226	1.1%

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November, 2021	19,107	18,869	239	1.2%
December, 2021	21,340	21,314	26	0.1%
January, 2022	21,364	21,082	282	1.3%
February, 2022	18,597	18,740	N/A	N/A
March, 2022	20,543	20,737	N/A	N/A
April, 2022	20,816	20,752	63	0.3%
May, 2022	25,216	24,030	1,186	4.7%
June, 2022	29,464	26,983	2,481	8.4%
July, 2022	28,902	28,150	752	2.6%
August, 2022	20,604	20,412	192	0.9%
September, 2022	20,750	20,612	139	0.7%
October, 2022	19,170	19,250	N/A	N/A
Total	369,776	363,228	6,966	1.9%

The observations from Table 3-6 are summarized below:

- In February, March, and October of 2022, the reported total plant effluent slightly exceeded the total raw water pumped. This result is likely due to instrument error as the two volumes were less than one percent different in each case.
- Overall, the plant effluent was approximately 7,000 m³ lower than the total volume drawn from the wells over this 17-month timeline, implying the WTP losses are around 1.9 percent. This water loss is acceptable as typical filter recovery is in the range of 1 to 3 percent.

3.4.2 Water Distribution System

Bi-monthly water billed volumes for the Township from 2017 to 2022 were reviewed. The billing data was organized according to land use in terms of residential, industrial, commercial, and institutional (ICI) properties. Several properties were classified as “other” however these properties appear to be a mix of residential and smaller industrial/commercial properties.

The total billed volumes for each of these land uses by year are summarized in Table 3-8. Data is only included for 2017 to 2021 as these are the only years that had a complete set of annual data. The average annual total water demand by land use is illustrated visually in the pie chart in Figure 3-4.

Table 3-8. Total Billed Volumes by Land Use

Year	Annual Billed Volume (m ³)	Annual Residential Billed Volume (m ³)	Annual Industrial Billed Volume (m ³)	Annual Commercial Billed Volume (m ³)	Annual Institutional Billed Volume (m ³)	Annual Other Billed Volume (m ³)
2017	174,006	164,001	2,718	4,821	1,914	552
2018	180,341	170,636	2,918	3,772	1,680	1,335
2019	177,162	169,817	427	3,819	2,416	683

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Year	Annual Billed Volume (m ³)	Annual Residential Billed Volume (m ³)	Annual Industrial Billed Volume (m ³)	Annual Commercial Billed Volume (m ³)	Annual Institutional Billed Volume (m ³)	Annual Other Billed Volume (m ³)
2020	200,372	187,792	3,563	3,035	4,825	1,157
2021	197,169	186,793	2,176	3,410	3,780	1,010

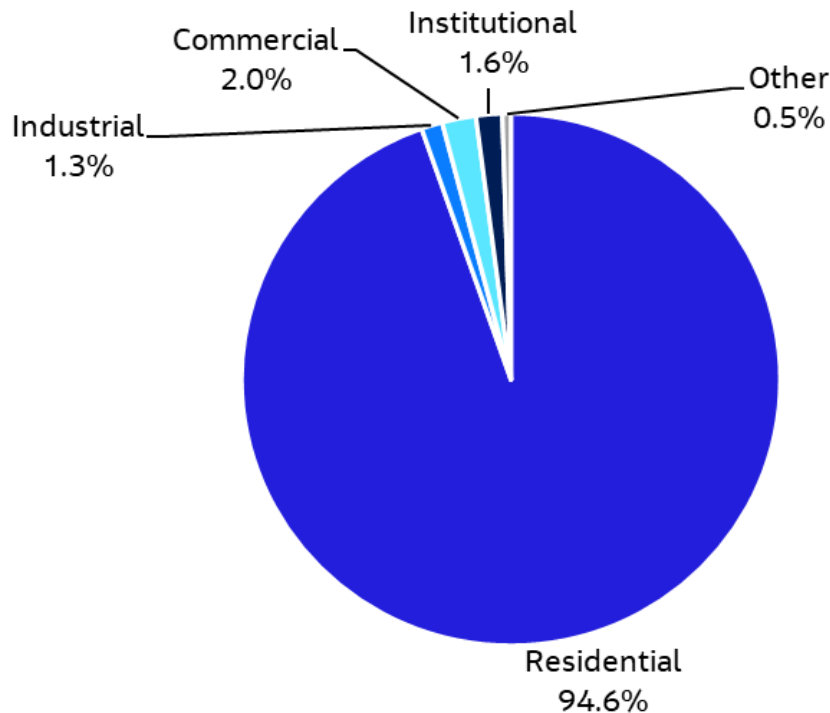


Figure 3-4. Distribution of Annual Average Water Demand by Land Use

The following observations were made from Table 3-8 and Figure 3-4:

- On average, residential properties make up the greatest proportion of water demand with 95 percent of the total average annual billed volume, followed by commercial (2 percent), institutional (1.6 percent), industrial (1.3 percent), and other (0.5 percent).
- Total water demand appears to have increased by approximately 10 percent from 2019 to 2020, with an increase from approximately 177,000 m³ per year to 200,000 m³ per year and remained at this elevated level for 2021.
- The water demand increase was attributable mainly to residential and institutional water use. Whether it was due to a temporary increase of water use during the pandemic or a permanent increase resulting from development or other factors remains to be confirmed.

TM-1: Summary of Project Background

The total number of service connections by land use is presented in Table 3-9. There are significantly more residential service connections than any other land use which explains why this land use makes up the greatest proportion of water demand. In 2020, the number of residential service connections increased by about 5 percent, which may partially contribute to the increased residential water use. A new commercial service connection was added in 2018 and again in 2020. The total number of connections for other land uses has remained relatively unchanged throughout the five-year period.

Table 3-9. Number of Service Connections by Land Use

Year	No. Residential Service Connections	No. Industrial Service Connections	No. Commercial Service Connections	No. Institutional Service Connections	No. Other Service Connections
2017	1079	4	17	10	6
2018	1119	4	18	9	8
2019	1124	5	18	9	5
2020	1178	4	19	10	8
2021	1172	5	19	10	8

To quantify distribution system losses, the water billing volumes were compared to the WTP treated water discharge volumes. These data are compared in Table 3-10 on an annual basis for 2018 to 2021. Data from 2017 and 2022 were excluded as only partial data for the year were available for the raw water volumes.

Table 3-10. Distribution System Volumetric Losses

Year	Total Annual Plant Effluent (m ³)	Total Annual Billed Volume (m ³)	Distribution System Volumetric Loss (m ³)	Percent Distribution System Volumetric Loss (%)
2018	218,300	180,341	37,959	17%
2019	215,019	177,162	37,857	18%
2020	240,424	200,372	40,052	17%
2021	244,505	197,169	47,336	19%

On average, the billed volumes were approximately 40,800 m³ lower than the total WTP discharge volume per year, implying the annual distribution system losses (i.e., unaccounted-for-water) are around 18 percent. Although the unaccounted-for-water seems to fall in a typical range of 10-20%, opportunities may exist for a smaller system like Wellesley to improve the efficiency.

3.4.3 Historical Water Consumption

The average, maximum day, and peak hour flows from the Wellesley WTP between 2018 and 2022 are summarized in Table 3-11. The calculated average per capita flow, maximum day factor, and peak hour factor are also summarized in Table 3-11. Some assumptions were made in the calculations:

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- Populations were estimated using the latest Region planning data which provided population data for 2016, 2021, and 2051 (Region of Waterloo, 2022b). A 1.8 percent annual growth rate was assumed to estimate populations between 2016 and 2021 and for 2022.
- Peak hour flow was calculated by taking hourly averages from the two-minute well flow data provided by the Region and identifying the maximum average hourly flow in a given year. Plant losses were subtracted as 1.9 percent of the total well flow.

Table 3-11. Wellesley WTP Average and Maximum Day Flows

Year	Average Day Flow (m ³ /d)	Population	Average Per Capita Flow (L/cap/d)	Maximum Day Flow (m ³ /d)	Maximum Day Factor	Peak Hour Flow (m ³ /d)	Peak Hour Factor
2018	598	3,501	171	1,134	1.9	1,346	2.3
2019	589	3,563	165	1,008	1.7	1,349	2.3
2020	657	3,626	181	1,079	1.6	1,646	2.5
2021	670	3,680	182	1,012	1.5	1,382	2.1
2022	726	3,745	194	1,221	1.7	N/A	N/A

Note that the per capita flows shown in Table 3-11 only consider the residential population. In reality, the total water demand is shared among residential and ICI properties. The distribution of demand among property types is discussed further in Section 3.4.2. This distribution information can be used to improve the accuracy of the per capita estimate by allocating a percentage of the total flow to each type of use. A per capita estimate for ICI flows can be developed based on the total land area for ICI use or by using an estimate of equivalent population. Additional information on ICI end users is needed to complete this analysis.

Table 3-11 infers the following for the Wellesley Water Supply System:

- Average per capita flow: 179 L/cap/day.
- Average Maximum Day Factor (MDF): 1.69
- Average Peak Hour Factor (PHF): 2.28

Table 3-11 also shows that the average day flow increased from an average of 590 m³/d for 2018 and 2019 to an average of 680 m³/d for 2020 to 2022, while the average Per Capita Flow increased from an average of 168 L/cap/d for 2018 and 2019 to an average of 186 L/cap/d for 2020 to 2022. These increases in demand appears to coincide with the COVID-19 pandemic, and are attributable possibly to:

- The population growth during the pandemic (e.g., migration of residential population from large cities to small communities); and
- The increased water consumption per household during the pandemic.

3.5 Water Treatment Plant Capacity Assessment

3.5.1 Current Capacity

The rated capacity of the Wellesley WTP is 3,006 m³/d as stated in the DWWP and MDWL, however the maximum water taking allowed by the PTTW is 1,503 m³/d. Therefore, the overall WTP capacity is limited by the well taking capacity.

Current plant usage is summarized in Table 3-12. The Wellesley WTP has sufficient capacity in terms of providing ADD and MDD with 44 percent, and 75 percent of the current plant capacity, respectively. The well taking capacity is not sufficient (101 percent) to provide the current PHF.

Table 3-12. Current Flows and WTP Capacity

Parameter	Flow, m ³ /d	Percent of Plant Capacity, %
ADD	668	44
MDD	1,128	75
PHF	1,522	101

3.6 Water Quality Review

Raw and treated water quality data was obtained from the Wellesley WTP between 2002 and 2022. Figure 3-4 to Figure 3-9 present box and whisker plots summarizing the Arsenic, Fluoride, Iron, Manganese and Strontium concentration data. The box represents the first and third quartiles. Inside the box, the marker represents the mean, and the line represents the median. The lines extending outside of the box, or whiskers, represent the maximum and minimum measured concentrations. Points shown outside of these lines are outliers. Regulatory limits from the Ontario Drinking Water Quality Standards (ODWQS, Ontario Regulation 169/03, (Province of Ontario, 2020)) are depicted by the red solid lines and the objectives from the Guideline for Canadian Drinking Water Quality (GCDWQ) are depicted by green dashed lines for aesthetic objectives (AO) and black solid lines for maximum acceptable concentrations (MAC) (Health Canada, 2022). It should be noted that regulation pertinent to treatment standards are laid out by the province and are only published by Health Canada. On average, all parameters were below the regulatory limits at both the wells and treated water sampling locations.

Figure 3-5 shows the raw and treated water arsenic concentration data distribution. The ODWQS arsenic regulatory limit of 0.01 mg/L is consistent with the maximum acceptable concentration (MAC) from the GCDWQ. Raw water concentrations were generally below the limit; however, Well WY6 had a more elevated arsenic level with the maximum concentration and several outliers exceeding the regulatory limit. Well WY6 also had the highest historical water taking. Overall, the treatment is effective in lowering the arsenic level well below the regulatory limit.

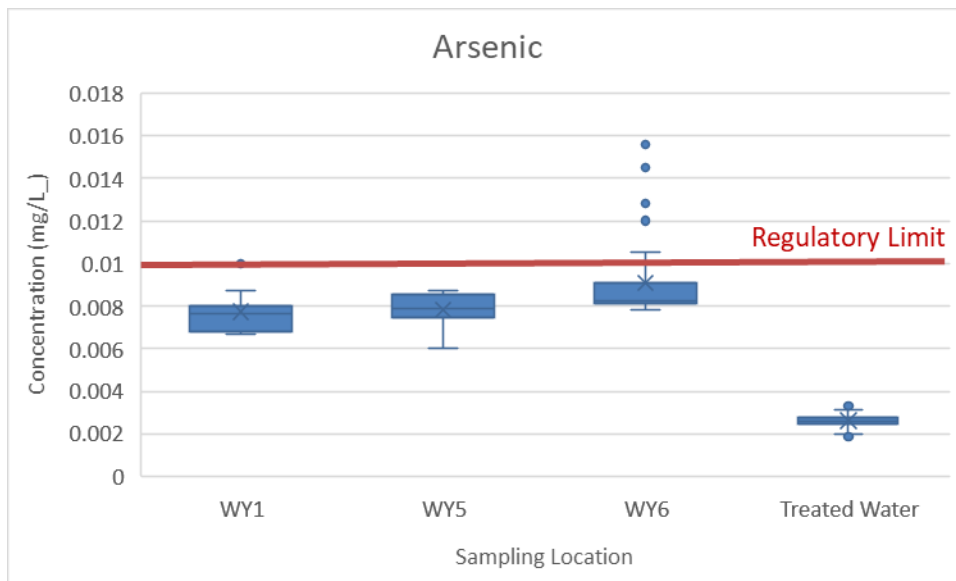


Figure 3-5. Plant Arsenic Concentrations

Figure 3-6 shows the treated water fluoride concentration data distribution. The ODWQS fluoride regulatory limit of 1.5 mg/L is consistent with the MAC from the GCDWQ. The treated water fluoride concentration is below the regulatory limit; however, the maximum measured concentration was within 10 percent of the limit.

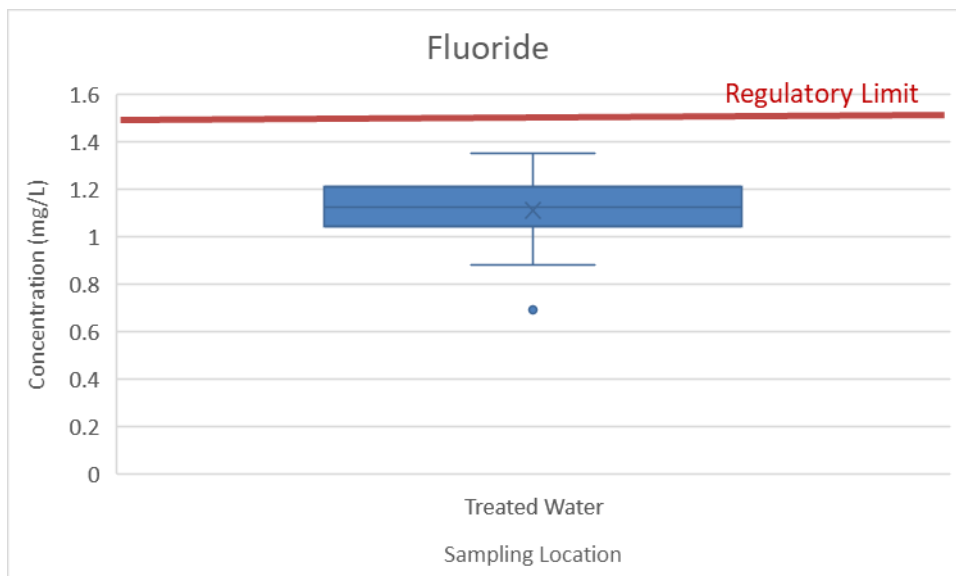


Figure 3-6. Plant Fluoride Concentrations

Figure 3-7 shows the raw and treated water iron concentration data distribution. There is no regulatory limit for iron, however the GCDWQ specifies an aesthetic objective (AO) of 0.3 mg/L. The raw water from all three wells exceed the AO. The iron concentration in the treated water is within acceptable levels which indicates that treatment is effective.

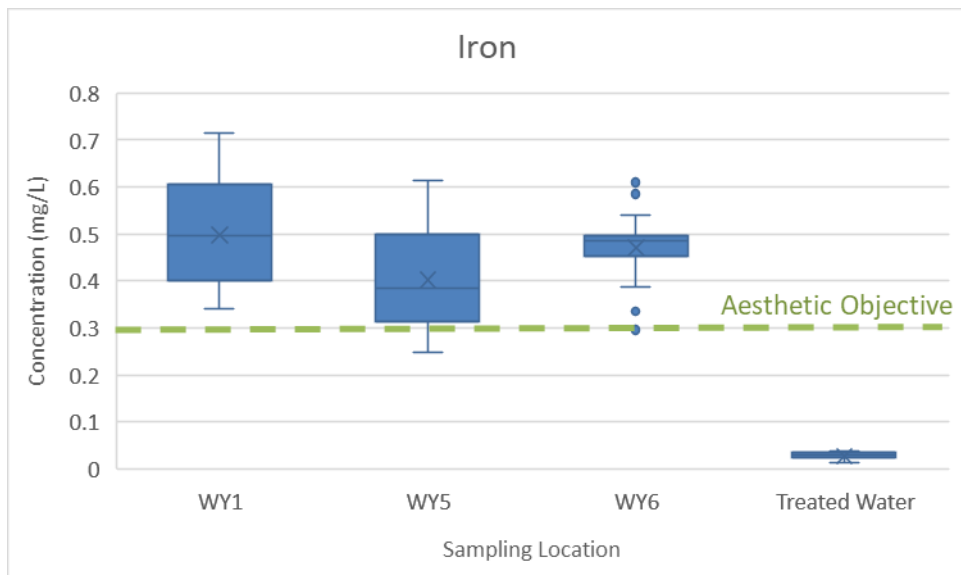


Figure 3-7. Plant Iron Concentrations

Figure 3-8 shows the raw and treated water manganese concentration data distribution. The GCDWQ specifies a MAC of 0.12 mg/L for manganese and an AO of 0.02 mg/L. The current AO for manganese in Ontario is 0.05 mg/L (Government of Ontario, 2006). It is anticipated that the AO for Ontario will be updated in the future to match the Canadian AO. The manganese concentrations in the raw water from all three wells fall far below the MAC and also fall below the Ontario and Canada AOs. This historical data shows the effectiveness of the existing treatment to further reduce manganese levels, therefore treatment for manganese is not a major objective at the Wellesley WTP.

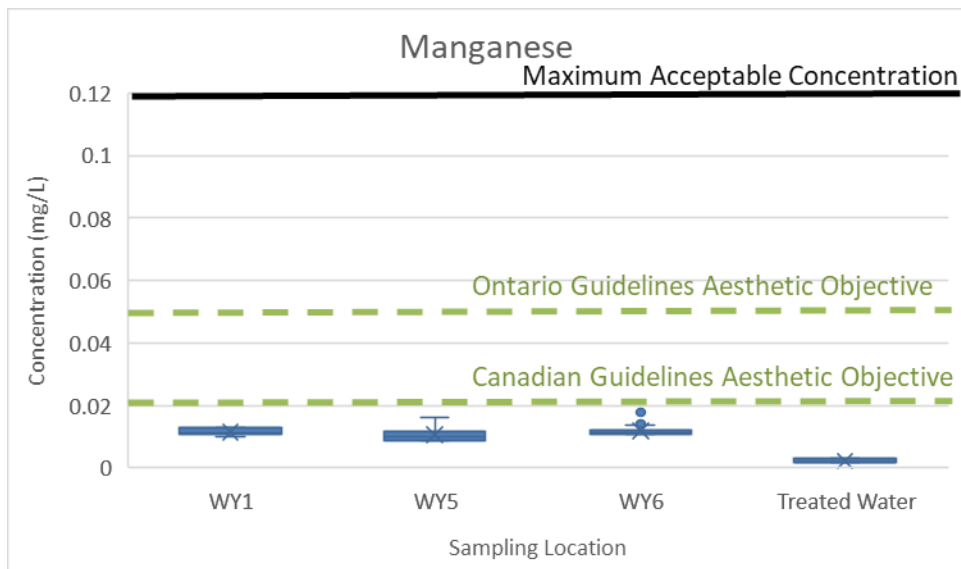


Figure 3-8. Plant Manganese Concentrations

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Figure 3-9 shows the raw water strontium concentration data distribution. Strontium concentrations were not monitored for the treated effluent. There is no regulatory limit for strontium, however the GCDWQ specifies a MAC of 7 mg/L. The strontium concentrations in the raw water from all three wells were above the recommended MAC. Reduction of Strontium is a challenge as the current treatment process is not effective in removing this parameter.

Figure 3-10 shows the ratio between Calcium and Strontium (Ca/Sr) in each of the raw water wells. The research summary in the Health Canada Guideline Technical Document (GTD) for Strontium (Health Canada, 2019) suggests that adsorption of strontium is dependent on whether the amount of calcium in the diet is adequate. However, the research on this aspect is still limited. One study proved that at a calcium to strontium ratio of 3, a negative effect was found. There is no definitive guideline of the minimum calcium to strontium ratio at which the strontium risk could be negligible. Nevertheless, the study as quoted in the Health Canada GTD infers that at or below a ratio of 3:1, strontium can be harmful. As shown in Figure 3-10, the Ca/Sr ratio in the raw water has historically been higher than the minimum of 3:1, ranging from 3.8:1 to 5.4:1. This analysis is based on one annual calcium and strontium sample from 2019 to 2021 for Well WY1 and Well WY5, and from 2018 to 2021 for Well WY6.

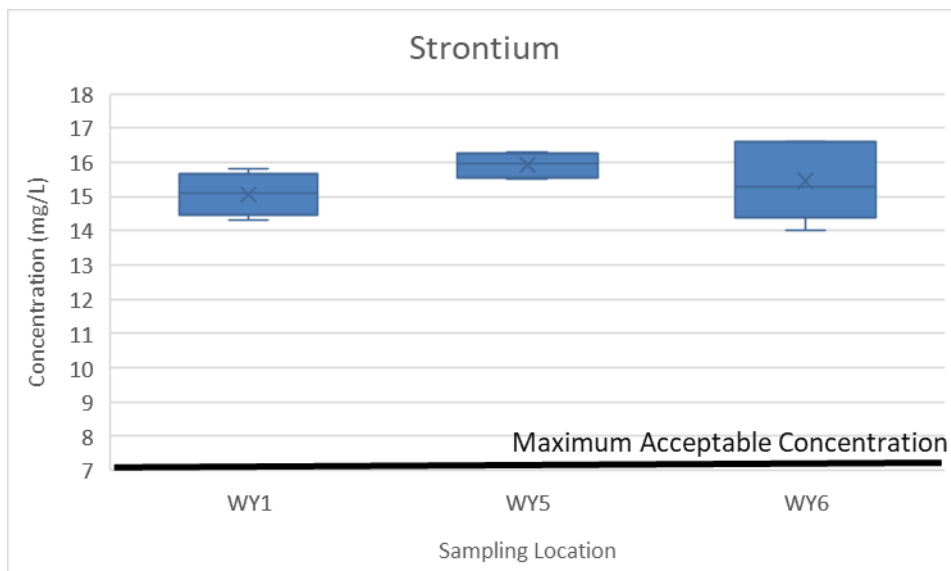


Figure 3-9. Plant Strontium Concentrations

TM-1: Summary of Project Background

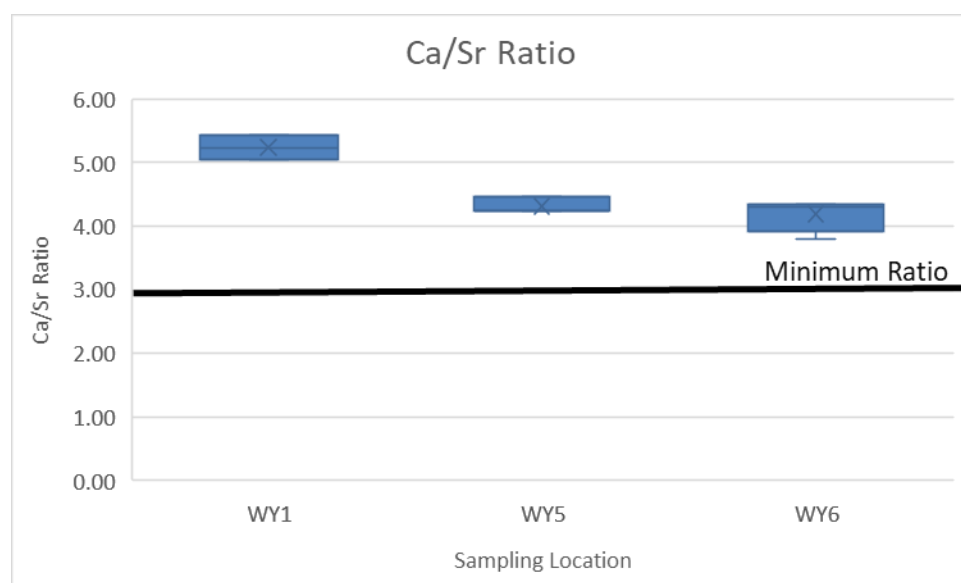


Figure 3-10. Plant Ca/Sr Ratios

The average of the water quality parameters from 2017 to 2022 from the Wellesley WTP are summarized in Table 3-13, in comparison to individual regulatory limits and /or aesthetic objectives (AO) or operational goal (OG). Hardness levels in the treated water are higher than the objective due to the increased hardness of the raw water from the wells. All other properties were below regulatory and objective limits.

Table 3-13. Plant Water Quality Averages

Parameters	Well 1	Well 5	Well 6	Treated Water	Regulatory limit	Objective
Alkalinity (mg/L)	220	217	227	223		<25% decrease ^a 30-500 (as CaCO ₃) ^b
Calcium (mg/L)	74	68	63	67		
Chloride (mg/L)	1.96	1.77	2.05	8.72		<250 ^{b, c}
Chlorine Free (mg/L)	N/A	N/A	N/A	1.12		0.4-2 ^c
Chlorine Total (mg/L)	N/A	N/A	N/A	1.33		>0.02 ^d
Hardness Total (mg/L)	292	274	339	268		80-100 ^{b, c}
Magnesium (mg/L)	25.70	25.13	22.83	24.45		
Nitrogen Nitrate (mg/L)	0.10	0.10	0.10	0.10	<10 ^d	10 ^b
Nitrogen Nitrite (mg/L)	0.01	0.01	0.01	0.01	<1 ^d	1.0 ^b
pH Estimated	8.07	7.99	8.14	8.14		7-10.5 ^c 6.5-8.5 ^{b, e}
Sulphate (mg/L)	145.02	128.50	77.30	112.83		<500 ^{b, c}
Turbidity (Nephelometric Turbidity Unit, NTU)	0.31	0.38	0.32	N/A		5 NTU ^b

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Aluminum (mg/L)	0.01	0.01	0.01	0.01		<0.1 ^b <2.9 ^c <0.075 ^f
Antimony (µg/L)	N/A	N/A	N/A	0.60	<6 ^b	<6 ^b <20 ^d
Barium (mg/L)	N/A	N/A	N/A	0.14	<1 ^d	<1 ^b
Boron (mg/L)	N/A	N/A	N/A	0.06	<5 ^d	<5 ^b <0.2 ^d
Cadmium (µg/L)	N/A	N/A	N/A	0.001	<5 ^d	<0.2 ^d
Dissolved Organic Carbon (mg/L)	1.42	1.42	1.43	N/A		<5 ^b
Total Organic Carbon (mg/L)	N/A	N/A	N/A	1.27		
Chromium (mg/L)	N/A	N/A	N/A	0.0002	<0.05 ^d	<0.05 ^b <0.001 ^d
Colour True (True Colour Units, TCU)	N/A	N/A	N/A	2.1		5 TCU ^b
Conductivity @25 °C (µS/cm ^f)	N/A	N/A	N/A	601		
Mercury (µg/L)	N/A	N/A	N/A	0.1	<1 ^d	<1 ^b <0.2 ^d
Nitrogen						
Ammonia/Ammonium (mg/L)	0.69	0.62	0.48	N/A		
Potassium (mg/L)	1.48	1.43	1.04	N/A		
Selenium (µg/L)					<50 ^d	<10 ^b <100 ^d
	0.2	0.2	0.2	0.2		
Sodium (µg/L)	24.73	23.77	16.45	26.50		<200,000 ^{b,c}
Total Dissolved Solids (mg/L)	N/A	N/A	369.75	386.9		<500 ^{b,c}
Solids Suspended (mg/L)	N/A	N/A	3.06	3.00		
Uranium (µg/L)	N/A	N/A	N/A		<20 ^d	<20 ^b <0.5 ^d
				0.22		

^aAlkalinity should not decrease by more than 25% of the natural concentration (MOE, 1979. Rationale for the Establishment of Ontario's Water Quality Objectives. 236 pp.). OG of 30-500 mg/L as CaCO₃ (Government of Ontario, 2006).

^bOntario Drinking Water Quality Standards, Objectives and Guidelines (Government of Ontario, 2006).

^cGuidelines for Canadian Drinking Water Quality (Health Canada, 2022)

^dWater management: policies, guidelines, provincial water quality objectives (PWQO) (MECP, 1994)

^eOntario Drinking Water Quality Standards (Province of Ontario, 2020)

^fAt pH >6.5 to 9.0, the Interim PWQO is 75 µg/L based on total aluminum measured in clay-free samples. (Province of Ontario, 2020)

^gUnit of measurement of conductivity micro Siemens (µS)

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The average values of the water quality parameters that were measured in the distribution system from 2017 to 2022 at eight locations are summarized in Table 3-14. It can be observed that all water quality parameters measured in the Wellesley Distribution System were within the regulatory and objective limits.

Table 3-14. Distribution System Water Quality Averages

Parameters	WED29	WED43	WED45	WED48	WED50	WED52	WED69	WED78	Regulatory limit	Objective
Alkalinity (mg/L)	N/A	N/A	223	220	N/A	N/A	221	N/A		
Chlorine Free (mg/L)	0.92	0.87	1.02	1.03	0.95	0.97	0.88	0.96		0.4-2 ^a
Chlorine Total (mg/L)	1.09	1.06	1.21	1.23	1.15	1.15	1.03	1.15		>0.02 ^b
pH	N/A	N/A	7.63	7.72	N/A	N/A	7.62	N/A		6.5-8.5 ^b
Manganese Total (µg/L)	0.003	0.003	N/A	0.003	N/A	N/A	0.003	N/A		<20 ^a
Iron Total (µg/L)	0.01	0.01	N/A	0.01	N/A	N/A	0.01	N/A		<300 ^a
Lead (µg/L)	N/A	N/A	0.263	0.301	N/A	N/A	0.200	N/A	<10 ^d	

^aGuidlines for Canadian Drinking Water Quality (Health Canada, 2022)

^bWater management: policies, guidelines, provincial water quality objectives (MECP, 1994)

^cOntario Drinking Water Quality Standards (Province of Ontario, 2020)

^dFor Alkalinity over 80 mg/L (Province of Ontario, 2020)

4 Wellesley Wastewater Treatment Plant

4.1 Facility Overview

The Wellesley Wastewater Treatment Plant (WWTP) is located at 2156 Gerber Road, across the border from Wellesley in the Township of Wilmot, Ontario. The Wellesley WWTP consists of fine screening for preliminary treatment, two extended aeration package plants for secondary treatment (Plant No. 1 and Plant No. 2), cloth media filtration for tertiary treatment, chemical phosphorus precipitation with alum, and ozone disinfection prior to discharge to the Nith River. Waste activated sludge (WAS) is stored in an aerated sludge holding tank prior to haulage to the Waterloo WWTP for further processing. The plant is operated under an Amended Environmental Compliance Approval (ECA) for Sewage Works (No. 6542-AJCJC9), issued by the Ontario Ministry of the Environment, Conservation and Parks (MECP) on June 29, 2017, with a rated average daily flow (ADF) capacity of 1,100 m³/d.

Following fine mechanical screening, wastewater flow is split between the two package plants at an estimated 40/60 percent split between Plant No.1 and No. 2, respectively. During peak flow events above 6,400 m³/d, raw wastewater is mechanically screened and bypassed to tertiary treatment.

Plant No. 1 and No. 2 were constructed in 1973 and 1993, respectively. Each plant consists of a central circular secondary clarifier surrounded by a concentric annular bioreactor. The bioreactors are divided into anoxic and aerobic zones, with nitrified mixed liquor recycle from the last aerobic zone to the anoxic zone. The anoxic zones are approximately 25 percent of the total bioreactor volume. The mixed liquor recycle is pumped in Plant No. 1, while Plant No. 2 achieves recirculation via a pipe alone. This configuration (anoxic zones with mixed liquor recycle) provides denitrification. Alum is added to the bioreactor effluent for phosphorus removal. The tertiary cloth filters were installed in 2019 replacing the previous sand filtration system. A simplified process flow diagram of the Wellesley WWTP is shown in Figure 4-1.

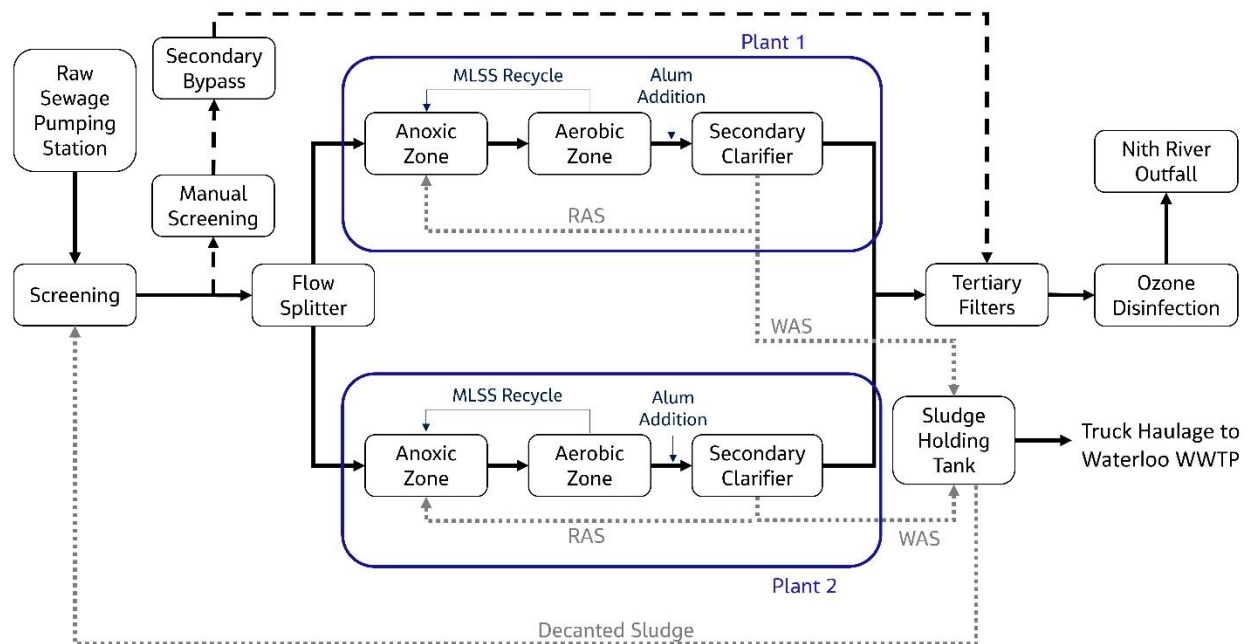


Figure 4-1. Simplified Wellesley WWTP Process Flow Diagram

The Wellesley WWTP has experienced several operational challenges regarding flow splitting and high peak flow events. The influent splitter box is a hydraulic bottleneck and bypasses at the splitter box are a known operational issue at the plant. The flow split between Plant No. 1 and No. 2 was originally designed to be 50/50 for peak flow rates up to 2,200 m³/d; above this flow rate, a split of 40/60 would be targeted for Plant No. 1 and No. 2, respectively to better match the available surface areas of the secondary clarifiers. In 2021, a study was conducted to evaluate the flow splitting between the two plants. Peak flows to Plant No. 2 were limited by the capacity of the underground piping between the splitter box and Plant No. 2. During high flow events, the flow splitting weirs were submerged and flows were distributed according to hydraulic head rather than weir length, which resulted in higher flows at Plant No. 1, approximately 15 to 25 percent higher than flows to Plant No. 2, exceeding the clarifier design surface overflow rate (SOR). The report recommended replacing the 150-mm gravity line between the splitter box and Plant No. 2 with a larger 200-mm diameter line to increase hydraulic capacity. Additionally, new fixed weirs for Plants No. 1 and No. 2 were recommended to achieve a 40/60 flow split (Stantec Consulting Ltd., 2021). The fixed weirs have been installed; however, performance cannot be evaluated until the ongoing clarifier construction is completed (see below for details).

The 2021 report also found that the tertiary filters were backwashed more frequently under high flow events, resulting in higher flow rates through the plant. Frequent filter backwashing also causes bypasses at the influent splitter box. In a subsequent study, Supervisory Control and Data Acquisition (SCADA) controls were recommended to limit the number of backwash pumps operating based on the plant flow rate. The goal of this strategy is to reduce flows to secondary treatment during wet weather events to prevent solids washout (Stantec Consulting Ltd., 2022). The plant is currently trialing filter backwashing based on a timer rather than level indication, with one filter backwashing every hour.

Upgrades are currently ongoing for the Plant No. 1 clarifier and return activated sludge (RAS) and WAS systems for Plant No. 1 and No. 2. The scope of work includes: replacement of the Plant No. 1 clarifier mechanism and mixer; installation of density current baffles; replacement of the effluent weirs, scum baffles, and clarifier drives for both plants; and walkway and grating replacement for Plant No. 1. RAS and WAS system upgrades includes installation of dry well RAS and WAS pumps and provision of above-ground flow meters and piping (CIMA+, January 2020). Plant No. 1 upgrades have been completed and Plant No. 2 is expected to reach substantial completion by 2023.

The Region is planning to replace the ozone disinfection system with a chemical disinfection system in 2024.

4.2 Historical Flows and Loads

4.2.1 Historical Raw Wastewater Flows

4.2.1.1 Summary of 2019 to 2021 Flows

Historical wastewater flow data from 2019 to 2021 were analyzed. Table 4-1 summarizes the historical ADF, peak day flow (PDF), peak hour flow (PHF), and peak 15-minute instantaneous flow (PIF) for each year. The data summary is based on flow data from the final effluent flow meter since plant operations note that this flow monitoring location is more accurate than the raw wastewater flow meter (Ontario Clean Water Agency, 2022). The existing plant design basis is also shown for comparison. On a hydraulic basis, the plant has been operating at approximately 75 to 80 percent of the design ADF capacity of 1,100 m³/d.

Table 4-1. Historical Wastewater Flows (2019 to 2021)

Parameter	2019	2020	2021	Existing Plant Design Basis
ADF, m ³ /d ^a	862	856	903	1,100
Percent of Rated Capacity	78%	78%	82%	N/A
PDF, m ³ /d	3,796	6,016	5,439	3,850
PDF Peak Factor	4.4	7.0	6.0	3.5 ^c
PHF, m ³ /d ^b	N/A	8,475	5,742	4,400
PHF peak factor	N/A	9.9	6.4	4.0 ^c
PIF, m ³ /d ^b	N/A	8,581	8,459	4,400
PIF peak factor	N/A	10.0	9.4	4.0 ^c
Serviced Population ^a	3,604	3,652	3,730	N/A
ADF per capita flow rate, L/cap/d ^a	239	234	242	N/A

^a ADF, population, and per capita data from 2019 to 2021 were obtained from the Region's Water and Wastewater Monitoring Report (Region of Waterloo, 2022)

^b Hourly and 15-minute instantaneous flows were available from December 2019 to September 2022. PHF and PIF are only included for 2020 and 2021 as these are the only full years of data available.

^c Design peaking factors obtained from the Region of Waterloo 2018 Master Plan (CIMA+, 2018).

Notes:

L/cap/d = litres per capita per day

m³/d = cubic meters per day

4.2.1.2 Average Per Capita Flow Rate

Figure 4-2 shows the per capita flow rates from 2016 to 2021. Data for 2016 to 2021 were obtained from the Region's annual water and wastewater monitoring report (Region of Waterloo, 2022). Typical per capita flow rates vary from 225 to 450 L/cap/d (MOE, 2008). Over the last 6 years, the per capita flow rate varied from 227 L/cap/d (2016) to 242 L/cap/d (2021), with an average per capita flow rate of 239 L/cap/d.

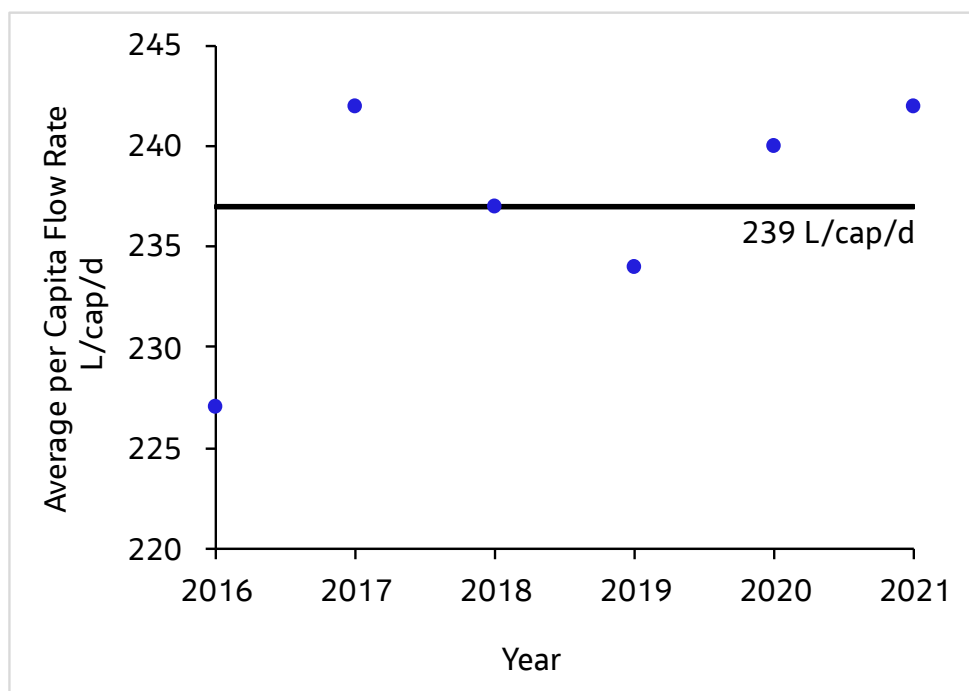


Figure 4-2. Historical Per Capita Wastewater Flow Rates (2016-2021)

4.2.1.3 Peak Flow Analysis and Treatment Bypasses

Historical daily average flow data was provided for 2019 to 2021, and historical hourly, and 15-minute flow data was provided for 2020 and 2021 (recorded by the plant SCADA system). Statistical analyses were completed for the daily flows and 15-minute instantaneous flows. Over this time period, the daily flow was less than the design PDF peak factor of 3.5 approximately 99.7% of the time. Thus, the design PDF peak factor was exceeded for a theoretical total of one day per year. The instantaneous flow was less than the design PIF peak factor of 4.0 approximately 99.6% of the time. Thus, the design PIF peak factor was exceeded for a theoretical total of two days per year.

During high flow events, there are two bypasses that can occur:

1. Splitter Box Bypass – when influent flows exceed the capacity of the flow splitter box of 6,400 m³/d, the flow bypasses secondary treatment, passes through a coarse manual screen, and is sent directly to the tertiary filters.
2. Partial Tertiary Bypass – when flows exceed the peak tertiary filter capacity of 4,400 m³/d, the flow bypasses the tertiary filters and is sent directly to ozone disinfection.

The total bypass volumes from 2019 to 2021 are summarized in Table 4-2 with data obtained from the Wellesley WWTP annual reports. Approximately 3 percent of the total annual plant influent volume was bypassed either at the splitter box or tertiary filters in 2019 to 2020, while only 1 percent was bypassed in 2021.

Table 4-2. Annual Bypass Volumes

Year	Splitter Box Bypass Volume (m ³)	Partial Tertiary Bypass Volume (m ³)	Total Bypass Volume (m ³)	Total Plant Influent Volume (m ³)	Percent Volume Bypassed (%)
2019	5,680	8,096	13,776	405,058	3.4
2020	4,600	7,943	12,543	392,573	3.2
2021	2,119	2,175	4,294	387,744	1.1

4.2.2 Historical Raw Wastewater Characteristics

Historical raw wastewater concentration data from 2019 to 2021 were analyzed to established current plant loadings. Weekly sampling results were available for biochemical oxygen demand (BOD₅), carbonaceous biochemical oxygen demand (cBOD₅), total suspended solids (TSS), total Kjeldahl nitrogen (TKN), total ammonia nitrogen (TAN), and total phosphorus (TP). Table 4-3 summarizes the analysis of raw wastewater characterization from 2019 to 2021 including contaminant concentrations, average and maximum month loads, and per capita load rates. Typical per capita load rates as reported by Metcalf & Eddy are also summarized in Table 4-3.

Table 4-3. Average Historical Wastewater Concentrations and Loads (2019 to 2021)

Parameter	Average Concentration, mg/L ^a	Average Load, kg/d	Maximum Month Load Peak Factor ^b	Per Capita Load, g/cap/d	Typical Per Capita Load, g/cap/d ^c
BOD ₅	171	136	1.5	38	50 – 120
cBOD ₅	158	125	1.5	35	N/A
TSS	248	201	1.5	55	60 – 150
TKN	40	31	1.5	9	9 – 18
TAN	26	20	1.4	5	N/A
TP	5.4	4.3	1.5	1.2	1.5 – 4.5

^a Average of monthly influent concentration data from the Wellesley WWTP operations data

^b Average of Maximum Month peak factors calculated for 2019, 2020, and 2021

^c Adapted from Metcalf & Eddy (2003)

Notes:

g/cap/d = grams per capita per day

kg/d = kilograms per day

mg/L = milligrams per litre

The raw wastewater per capita load rates are lower than typical observed values. Possible explanations include changes in the ratio of residential, commercial, and industrial facilities in the sewershed or the nature of the sampling and analysis program.

Future load projections should account for the possibility of development in the sewershed resulting in per capita loads that are higher than those observed from 2019 to 2021. For planning purposes, higher per capita load rates in line with typical ranges are recommended. As such, conservative per capita loads will be used to forecast future raw wastewater loads to the Wellesley WWTP. This design basis will allow for some

conservatism in site utilization requirements and budgeting. The design per capita values are within typical ranges cited by Metcalf & Eddy. The design per capita values are summarized in Table 4-4.

Table 4-4. Historical Per Capita Loads and Planning Design Basis

Parameter	2019 – 2021 Per Capita Load, g/cap/d	Typical Per Capita Load, g/cap/d ^a	Planning Design Basis, g/cap/d
BOD ₅	38	50 – 120	50
TSS	55	60 – 150	60
TKN	9	9 – 18	15
TP	1.2	1.5 – 4.5	1.5

^a Adapted from Metcalf & Eddy (2003)

4.2.3 Historical Sludge Generation

Historical sludge generation data from 2019 to 2021 were analyzed from plant operations data and are summarized in Table 4-5. WAS generated at the Wellesley WWTP is stored in an aerated holding tank prior to haulage to the Waterloo WWTP for further processing. The sludge holding tank is periodically decanted to headworks.

The typical per capita sludge generation rate for extended aeration plants with chemical phosphorous removal is 50 to 55 g/cap/d per MECP guidelines (MOE, 2008). The sludge generation rate as calculated based on plant data is significantly lower than typical values. As such, a process model was developed to estimate per capita sludge generation rates for use in planning (described in Section 4.2.5).

Table 4-5. Historical Sludge Production (2019 to 2021)

Year	Sludge Generation, m ³ /y	Sludge TS, %	Per Capita Sludge Generation, g/cap/d ^a
2019	5,321	1.04	40
2020	5,593	0.59	24
2021	5,430	0.76	30

^a Population data for 2019 and 2020 were unavailable. Population assumed to increase by 1.8 percent per year based on the recent planning data available from the Region of Waterloo (Region of Waterloo, 2022).

4.2.4 Current Effluent Objectives and Limits

Table 4-6 summarizes the effluent concentration objectives and limits per the current ECA (No. 6542-AJCJC9, issued June 29, 2017). Table 4-7 summarizes the effluent loading limits.

Table 4-6. Wellesley WWTP ECA No. 6542-AJCJC9 Concentration Objectives and Limits

Parameter	Objective	Limit	Averaging Calculator
cBOD ₅ , mg/L	10.0	15.0	Monthly average effluent concentration
TSS, mg/L	10.0	15.0	Monthly average effluent concentration
TP, mg/L	0.3	0.5	Monthly average effluent concentration
TAN, mg/L	0.5	0.75	Monthly average effluent concentration
pH	6.5 to 8.5	6.0 to 9.5	Single sample of final effluent
E. coli, CFU/100 mL	150	200	Monthly Geometric Mean Density

Table 4-7. Wellesley WWTP ECA No. 6542-AJCJC9 Loading Limits

Parameter	Limit, kg/d	Averaging Calculator
cBOD ₅	16.5	Monthly average effluent loading
TSS	16.5	Monthly average effluent loading
TP	0.55	Monthly average effluent loading
TAN	0.82	Monthly average effluent loading

Figure 4-3 to Figure 4-8 present the historical monthly average effluent quality data relative to ECA objectives and limits for cBOD₅, TSS, TP, TAN, pH, and monthly average geomean density for *E. coli*.

Figure 4-9 to Figure 4-12 present the historical monthly effluent loadings relative to ECA limits. Generally, the Wellesley WWTP is compliant with the ECA effluent objectives and limits. In April 2019, several parameters exceeded the effluent limits: TSS, TP, TAN concentrations and loadings, and *E. Coli* geomean density. These exceedances were attributed to multiple bypass events due to wet weather conditions and operation with Plant No. 2 offline for upgrades (Ontario Clean Water Agency, 2020). The effluent limits for *E. Coli* were also exceeded in September 2021 due to several bypass events during wet weather conditions (Ontario Clean Water Agency, 2022).

There appears to be a downward trend in effluent pH (Figure 4-7). This trend could be related to changes in raw wastewater alkalinity, increased alkalinity consumption in the treatment process, decreased alkalinity recovery in the treatment process, or some combination. Increased alkalinity consumption could be caused by an increase in chemicals used for phosphorus removal. Decreased alkalinity recovery could be caused by decreased levels of denitrification occurring in the bioreactors. Determining the root cause of the trend would require further investigation of influent/effluent alkalinity, effluent nitrite/nitrate data, and plant operational data. At this point, the plant is still operating within the effluent pH objective range. However, if effluent pH continues to trend downward, or if the low pH objective is not being achieved, further investigation should be undertaken.

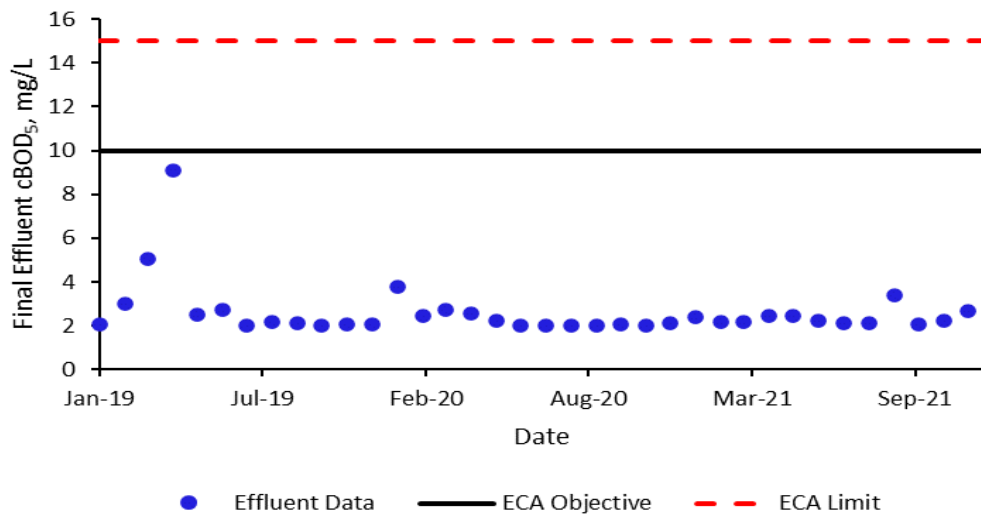


Figure 4-3. Wellesley WWTP Effluent cBOD₅ Concentrations (Monthly Averages) and ECA Limits

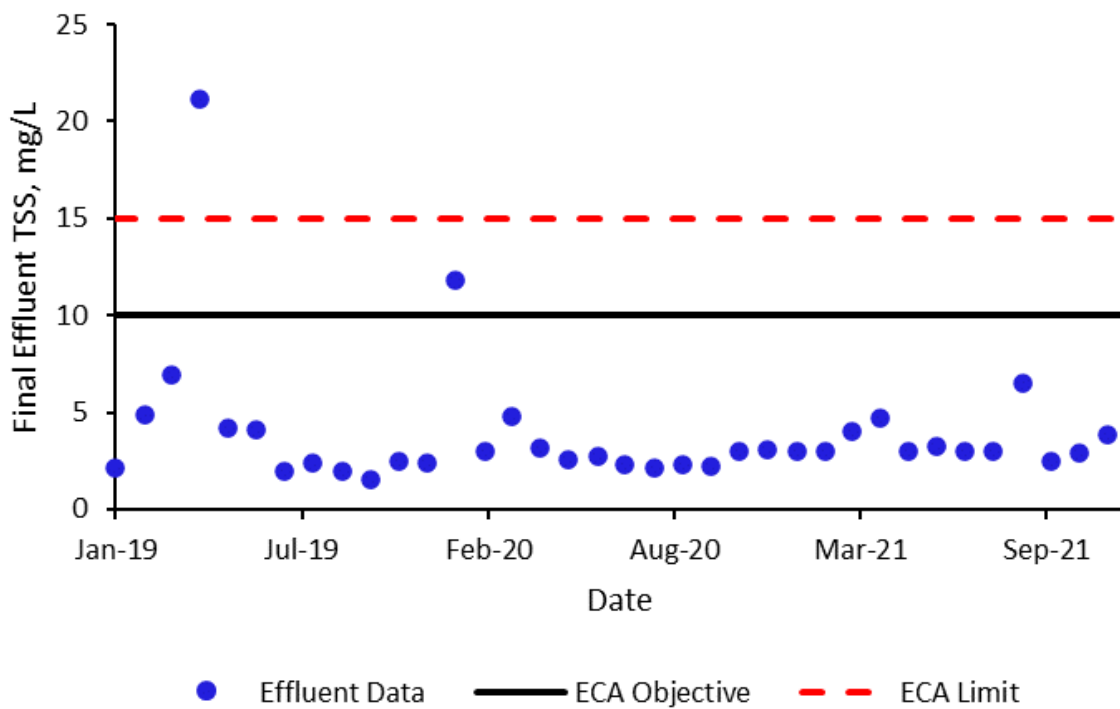


Figure 4-4. Wellesley WWTP Effluent TSS Concentrations (Monthly Averages) and ECA Limits

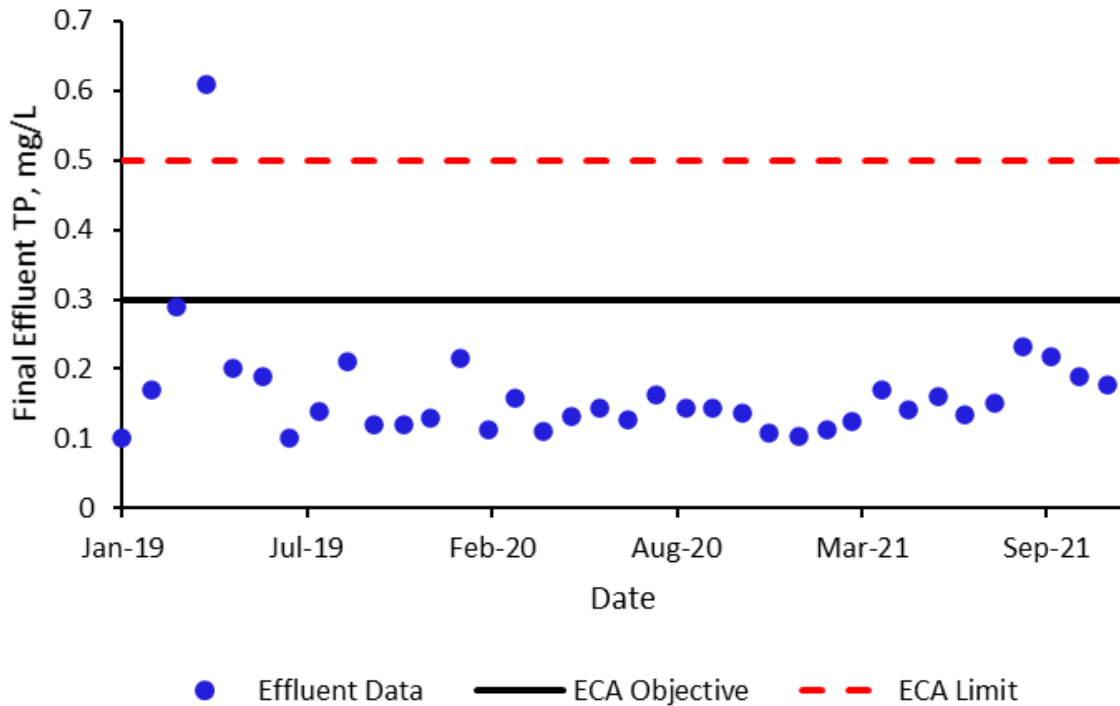


Figure 4-5. Wellesley WWTP Effluent TP Concentrations (Monthly Averages) and ECA Limits

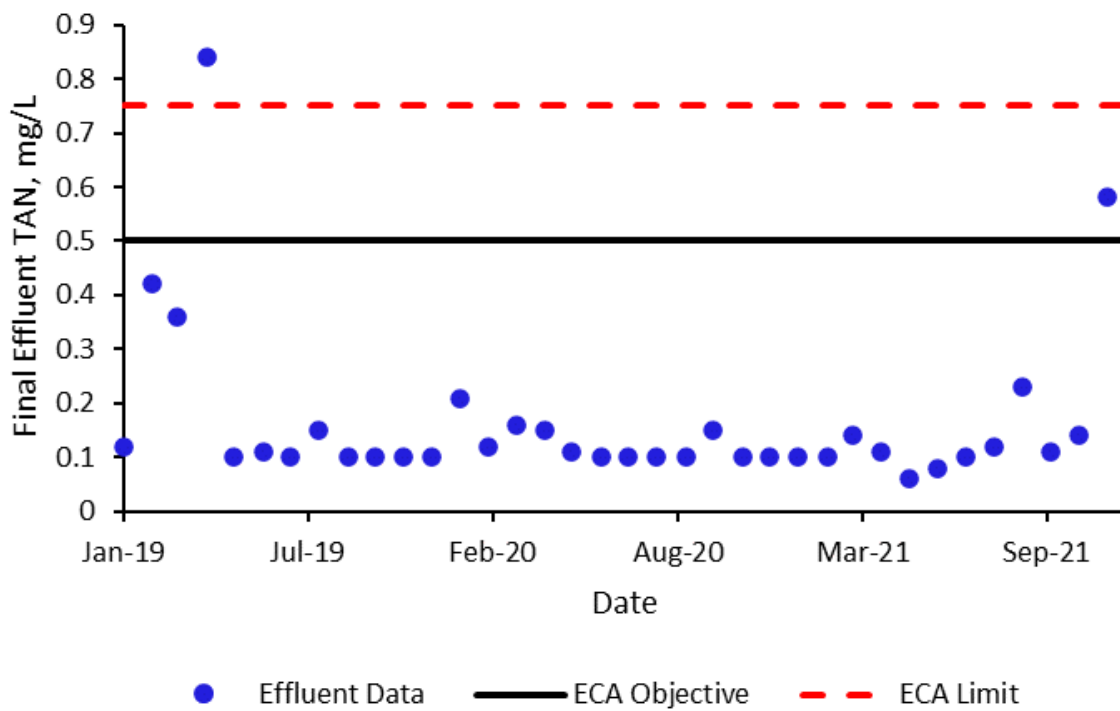


Figure 4-6. Wellesley WWTP Effluent TAN Concentrations (Monthly Averages) and ECA Limits

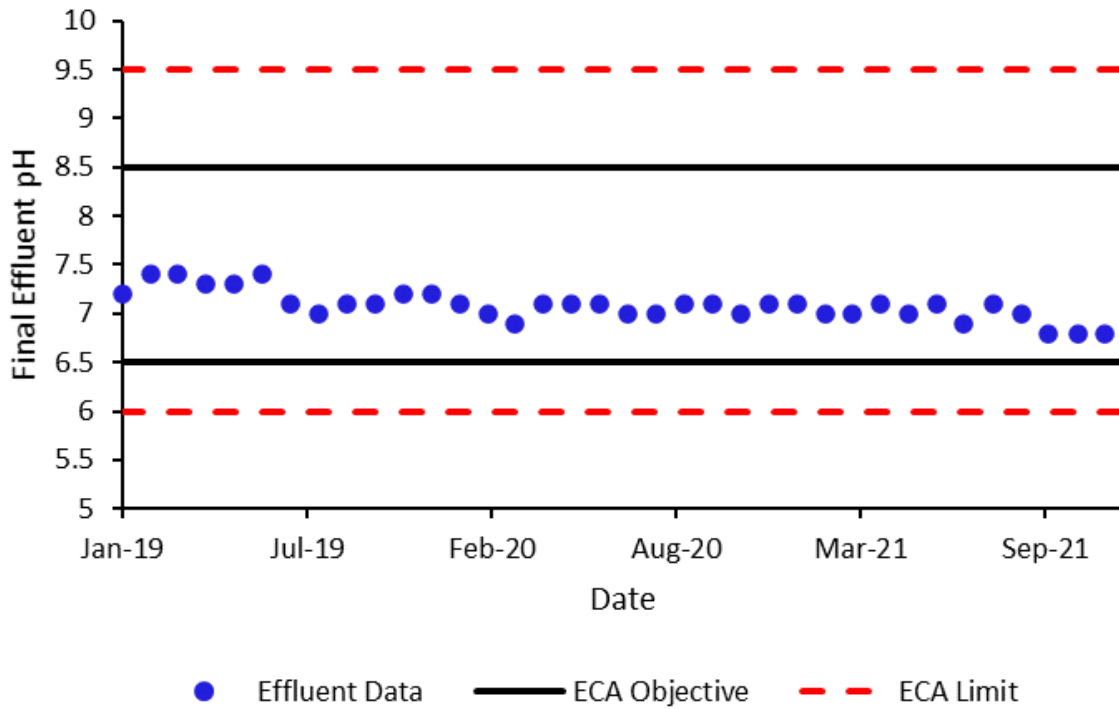


Figure 4-7. Wellesley WWTP Effluent pH (Monthly Averages) and ECA Limits

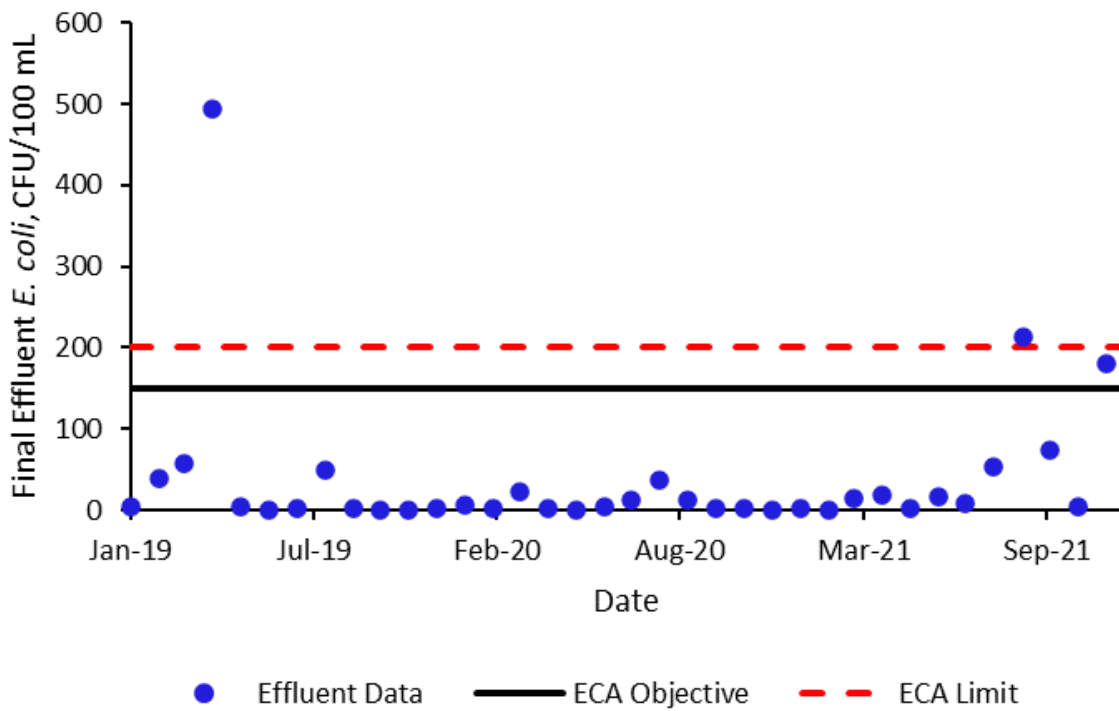


Figure 4-8. Wellesley WWTP Effluent *E. coli* (Monthly Geomean Density) and ECA Limits

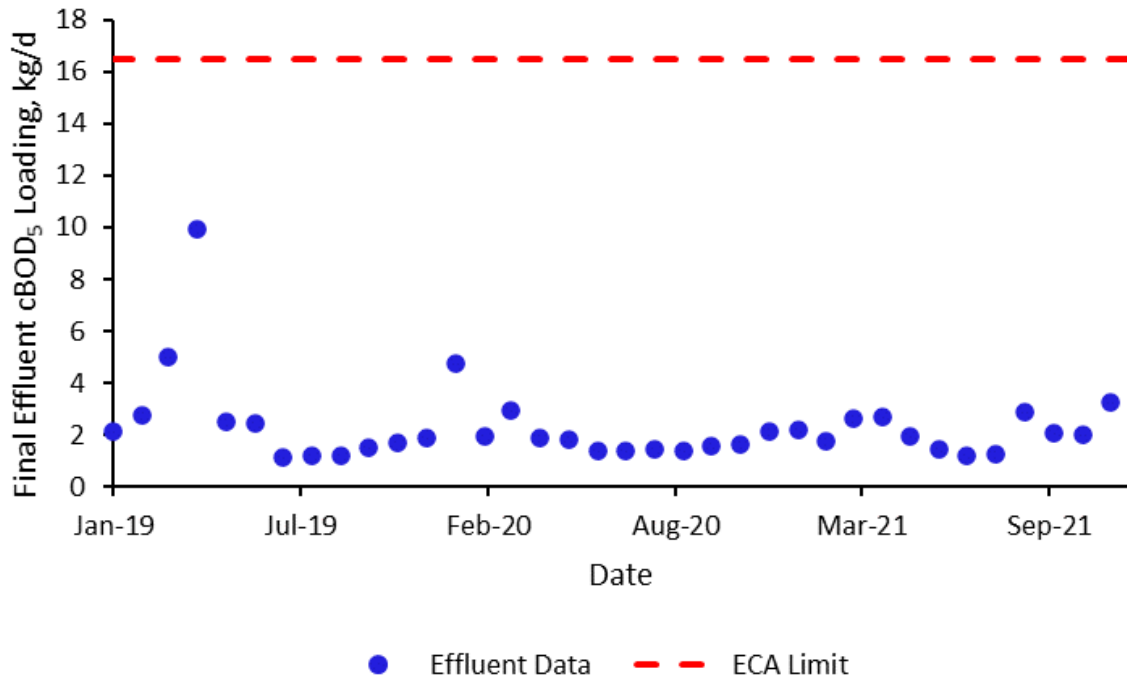


Figure 4-9. Wellesley WWTP Effluent cBOD₅ Loading (Monthly Averages) and ECA Limit

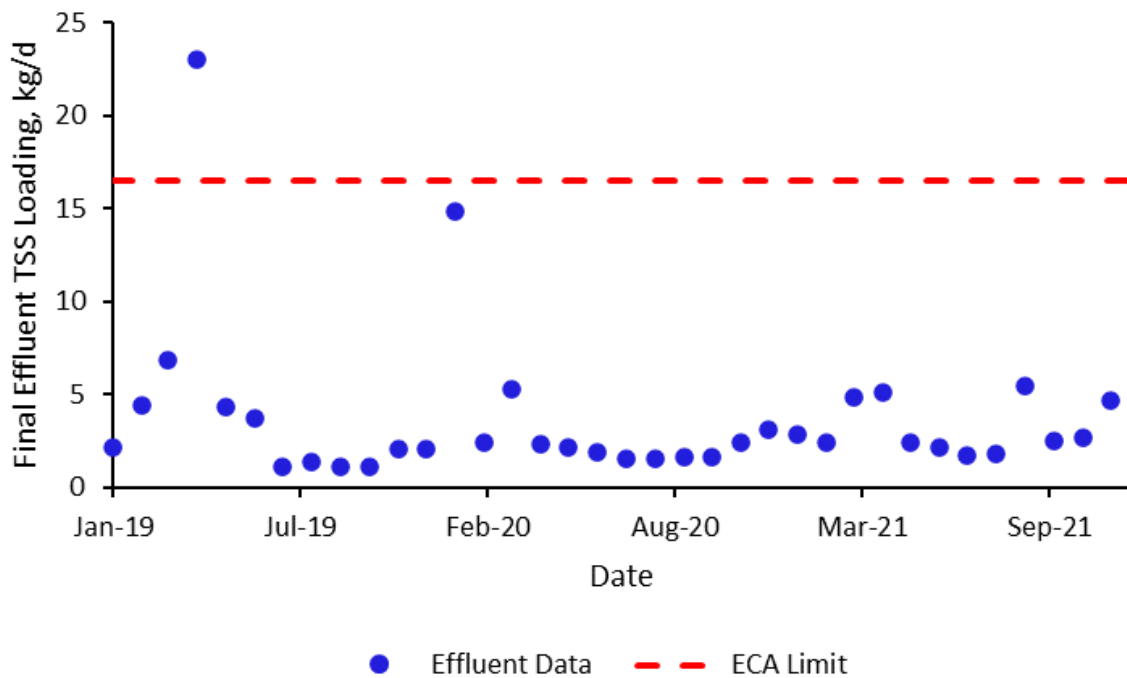


Figure 4-10. Wellesley WWTP Effluent TSS Loading (Monthly Averages) and ECA Limit

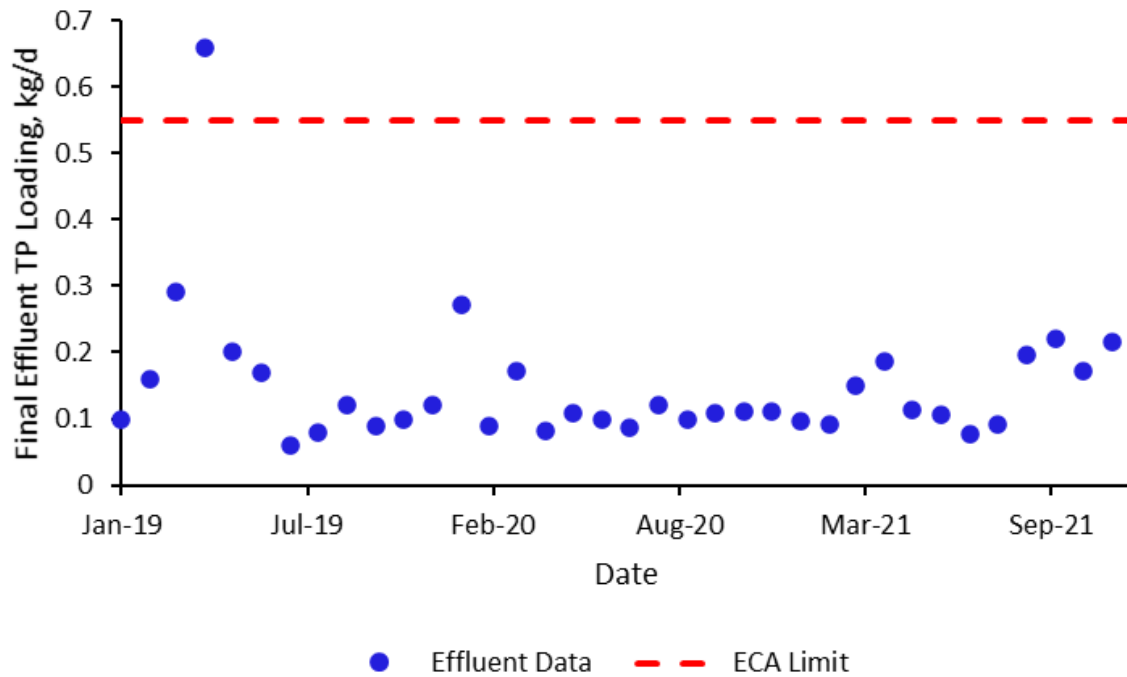


Figure 4-11. Wellesley WWTP Effluent TP Loading (Monthly Averages) and ECA Limit

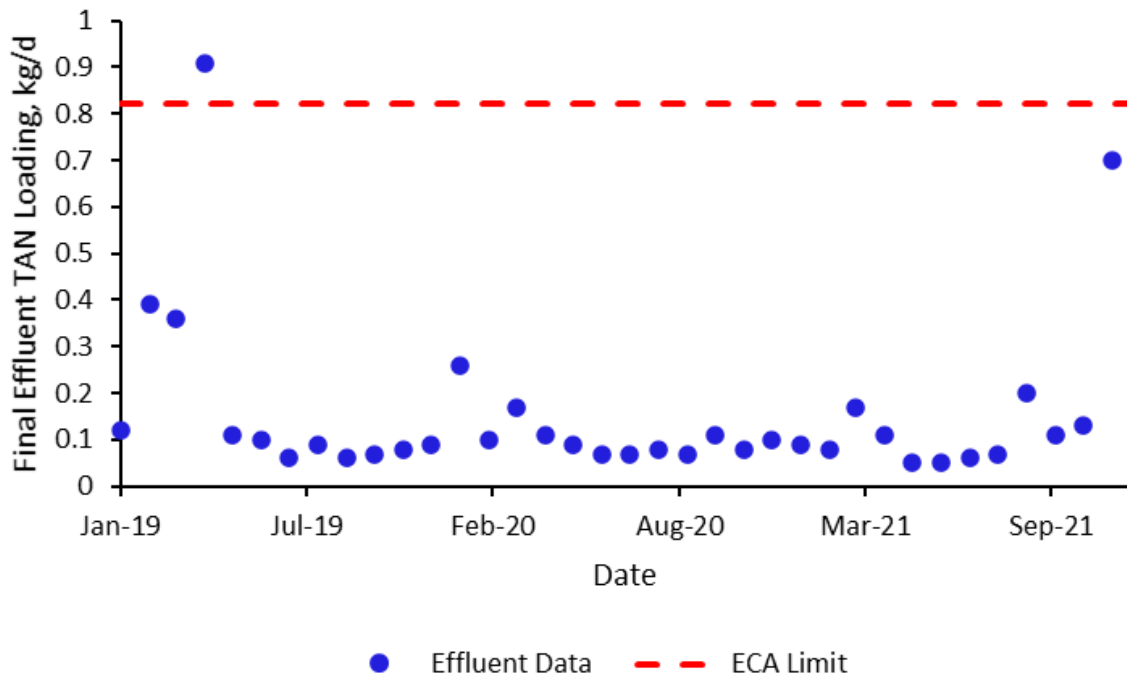


Figure 4-12. Wellesley WWTP Effluent TAN Loading (Monthly Averages) and ECA Limit

4.2.5 Model Development and Calibration

Process modelling and mass balance calculations were carried out using Jacobs' Pro2D simulator. Pro2D (which stands for **Professional Process Design**) is a whole plant simulator that was developed to perform complete wastewater treatment plant simulations and calculate full plant mass balances. Pro2D uses Microsoft Excel as its computational engine. Specific aspects of the model configuration are as follows:

- The model includes all major processes at the Wellesley WWTP, including two package plants for secondary treatment, chemical phosphorus removal, tertiary filtration and backwashing, and sludge storage and decanting.
- The model does not explicitly consider unit processes and systems that have limited impact on the overall mass balance, such as screening and effluent disinfection.
- The unit process design information from the current ECA and historical operational data were entered as model inputs. Historical data from 2019 and 2020 were used for model calibration since both Plants No. 1 and Plant No. 2 were online.

Model calibration is an iterative process. Key operating parameters are adjusted until the model-predicted values for key performance indicators (e.g., bioreactor MLSS, final sludge production) match reasonably well with the plant data and expected sludge generation rates based on the raw wastewater characteristics and sewershed population estimates.

To assess model calibration, the difference between the model and plant-reported data for each parameter was calculated. Acceptable percent differences vary as the measurement method could result in variable or unrepresentative reported plant data. Generally, a percent difference of 10 to 15 percent or less is considered to be well calibrated. Parameters with percent differences greater than 10 to 15 percent were scrutinized to determine possible causes for the calibration discrepancy; however, having some relatively high percent variances do not invalidate the calibration since there is often variability or errors in source data. The model calibration is summarized in Table 4-8.

Table 4-8. Wellesley WWTP Model Calibration Summary

Parameter	2019 to 2020 Plant Data	Model Data	Difference	Notes
Raw Wastewater (Model Inputs)				
Average day flow, m ³ /d	838	838	0%	
TSS, kg/d	208	208	0%	
BOD ₅ , kg/d	136	136	0%	
TKN, kg/d	30	30	0%	
TP, kg/d	4	4.3	0%	
Flow Split to Plant No. 2	N/A	60%	N/A	
Secondary Treatment – Plant No. 1				
Total SRT, d	N/A	19.0	N/A	
MLSS, mg/L	2,700	2,762	2%	

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MLVSS/MLSS, %	82%	76%	-8%	
RAS Rate, %	N/A	95%	N/A	
RAS/WAS TSS, mg/L	5,300	5,468	3%	
Alum addition, kgAlum/d	49	49	0%	
Secondary Treatment – Plant No. 2				
Total SRT, d	N/A	15.0	N/A	
MLSS, mg/L	3,200	3,229	1%	
MLVSS/MLSS, %	80%	76%	-5%	
RAS Rate, %	N/A	65%	N/A	
RAS/WAS TSS, mg/L	7,800	7,850	1%	
Alum addition, kgAlum/d	74	74	0%	
WAS and Hauled Sludge Generation				
Total WAS Mass, kg/d	N/A	173	N/A	
Per Capita WAS Generation, g/cap/d	N/A	48	N/A	Typically ~55 g/cap/d
Hauled Sludge Volume, m ³ /d	15	21	29%	
Hauled Sludge TS, mg/L	8,100	8,100	0%	
Hauled Sludge Mass, kg/d	122	171	29%	
Per Capita Sludge Generation, g/cap/d	34	48	29%	Typically ~50 g/cap/d
Final Effluent				
TSS, mg/L	2.83	2.90	0.07 mg/L	
BOD ₅ , mg/L	2.67	1.04	-1.63 mg/L	
TAN, mg/L	0.19	0.22	0.03 mg/L	
TP, mg/L	0.14	0.09	-0.05 mg/L	

Overall, the model was well-calibrated to the reported operations and performance data, except for the estimated final hauled sludge. As described in section 4.2.3, the plant data suggests that the per capita sludge generation rates are much lower than typical values per MECP guidelines. It is possible that sludge holding tank decant operations impact the final sludge production rates. The model-predicted per capita sludge generation rates and sludge yields that are more in line with typical observed values. As such, the process model will be used to predict plant operations and sludge generation for the planning horizon, rather than plant-reported sludge generation rates. This approach provides some conservatism at the planning level to inform future sludge storage requirements. The plant recently installed WAS flow meters, which will allow sludge production rates to be validated in future design phases.

4.3 Capacity Assessment

A capacity assessment was recently completed as part of the 2018 Region of Waterloo Master Plan (CIMA+, 2018). The purpose of the analysis in this TM is to confirm the unit process capacities as reported in the previous Master Plan, and identify any changes based on recent historical plant data, plant upgrades (e.g., fine screening and cloth media filters), and process modelling. Unit process design information were obtained from the latest ECA No. 6542-AJCJC9, summarized in Table 4-9.

Table 4-9. Unit Process Design Information

Treatment Process	Design Information
Influent Pumping	Two 52 L/s raw sewage pumps (duty/standby) at 12.5 m TDH
Screening	One mechanical fine screen with peak flow capacity of 52 L/s One manual screen for emergency bypass
Extended Aeration Bioreactors	Plant 1: 490 m ³ annular ring, 5.0 m SWD (25 percent anoxic) Plant 2: 509 m ³ annular ring, 4.5 m SWD
Secondary Clarifiers	Plant 1: 38.5 m ² circular tank, 4.5 m SWD Plant 2: 63.6 m ² circular tank, 4.5 m SWD
Aeration System	Two 9.65 m ³ /min blowers (duty/standby)
Tertiary Filtration	Four 5 m ² cloth media filters (one standby), each with a peak hourly flow rate of 61.1 m ³ /h (Alfa Laval, 2015)
Chemical Phosphorus Removal	One 24,000 L alum storage tank Three 17 L/h chemical metering pumps
Ozone Disinfection ¹	One 87 m ³ disinfection contact chamber Two 22.5 kg/d ozone generator systems (duty/standby)
Sludge Storage Tank	One 72 m ³ aerated tank
Outfall	One 400 mm diameter sewer discharging to the Nith River

Notes:

¹ The Region is planning to replace the ozone disinfection system with a chemical disinfection system.

TDH = total dynamic head

SWD = side water depth

The capacity of the existing processes at the Wellesley WWTP were assessed relative to literature guidelines for the design of wastewater treatment processes and the original plant design basis. The plant process model was used for the secondary treatment capacity assessment to predict MLSS concentrations, clarifier SLR, and aeration demand based on a 15-day SRT, RAS rate of 100 percent of the ADF, and dissolved oxygen (DO) concentration of 2.0 mg/L. Table 4-10 summarizes the design guidelines used in the capacity assessment.

Table 4-10. Design Criteria used for Capacity Assessment

Treatment Process	Design Criteria	Reference(s)
Influent Pumping	Firm pumping capacity for design PIF (4.0 peak factor)	MOE Design Guidelines (MOE, 2008)

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Screening	Firm screening capacity for design PIF (4.0 peak factor)	MOE Design Guidelines (MOE, 2008)
Extended Aeration Bioreactors	Minimum SRT 15 days MLSS 3,000 to 5,000 mg/L	MOE Design Guidelines (MOE, 2008)
Secondary Clarifiers	RAS rate at 100% of ADF Maximum surface overflow rate of 37 m ³ /m ² /d at design PHF (4.0 peak factor) Maximum solids loading rate of 170 kg/m ² /d at design PDF (3.5 peak factor)	MOE Design Guidelines (MOE, 2008)
Aeration System	Dissolved oxygen concentration of 2.0 mg/L Blower capacity for maximum month air demand with single largest unit out of service	MOE Design Guidelines (MOE, 2008)
Tertiary Filtration	Design filtration of 203 L/m ² /min at design PDF (3.5 peak factor)	Tertiary filter design specifications (Alfa Laval, 2015)
Chemical Phosphorus Removal	Minimum 10 days of alum storage at ADF Dosing pumps sized to accommodate PIF (4.0 peak factor) Alum dose 116 mgAlum/L (historical average)	MOE Design Guidelines (MOE, 2008) Historical operating data
Disinfection Contact Tank	Ozone system will be replaced with a chemical system in 2024; tank capacity is assessed based on minimum 15-minute contact time at design PHF (4.0 peak factor) considering a baffle factor of 0.6	MOE Design Guidelines (MOE, 2008)
Sludge Storage Tank	Minimum 5 days of storage volume Sludge production rate of 0.2 kgTS per m ³ raw wastewater treated Sludge concentration 8,100 mg/L	MOE Design Guidelines (MOE, 2008) Historical operating data and model calibration results

The capacity assessment results of the Wellesley WWTP are presented in Table 4-11. The plant capacity is limited by the secondary treatment process, which is limited to an AADF capacity of approximately 950 m³/d. This capacity limitation is due to the MECP design guidelines for peak hour surface overflow rate (SOR) of 37 m/d being exceeded at the design peak hour flow rate. At the design peak hour flow rate (4,400 m³/d), the MECP design guideline is exceeded (46 and 42 m/d for Plant 1 and Plant 2, respectively). The solids holding tank also provides less than the recommended 5-day storage volume.

Table 4-11. Capacity Assessment Summary

Unit Process	Equivalent ADF Capacity (m ³ /d)
Influent Pumping	1,100
Screening	1,120
Secondary Treatment (Bioreactors and Clarifiers)	950

Blowers	1,100
Tertiary Filtration	1,260
Alum System	Storage tank: 13,450 Metering Pumps: 1,140
Disinfection Contact Tank	1,250
Sludge Storage Tank	580

4.4 Receiving Water Quality

Table 4-12 presents the seasonal average concentration of the surface water quality parameters upstream (US) and downstream (DS) of Wellesley WWTP located on the Nith River, as depicted in Figure 4-13. The surface water quality data was obtained from the Region of Waterloo's Surface Water Quality Monitoring Program (SWQMP) database (Region of Waterloo, 2022a) initiated in 2007. The seasons indicated in the Table 4-12 are classified as follows:

- Winter – January and February – coldest water temperatures, under ice;
- Spring – March and April – spring melt, rain events;
- Summer – July and August, but can extend to September – low flow; and
- Fall – October and November.

Water Quality Samples were collected from three stations, namely: WELUS (Wellesley Upstream), WELDSN (Wellesley Downstream Near), and WELDSF (Wellesley Downstream Far). The averages reported were compared to PWQOs/CWQG.

It can be interpreted from Table 4-11 that average seasonal downstream concentrations of chloride and unionized ammonia were higher than upstream concentration for the respective season. No significant difference in upstream and downstream concentration of ammonia, total phosphorus, and phosphate was found. Suspended solids concentration at WELDSF (DS far) station was higher than WELDSN (upstream) station in summer and spring. It is anticipated that higher solids concentration at the DS far station could be due to entrainment of solids from non-point sources in summer and spring season.

Although the average TKN concentration in summer and fall at the US and DS near station were similar, the TKN concentration was higher at the DS far station in spring, summer, and fall season, indicating that non-point sources possibly contributing to an increase in average TKN far downstream.

The concentration of chloride, nitrite and unionized ammonia concentration averages, for all the seasons, at the three sampling stations (WELUS, WELDSN, and WELDSF), was below the prescribed PWQO/CWQG guidelines. TP concentration was higher than PWQO for all the seasons. Similarly, nitrate concentration was higher than CWQG, except in summer.

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Table 4-12. Seasonal Averages of Surface Water Quality Parameters- Wellesley WWTP

Parameter/Season	WELUS (2009-2022)				WELDSN (2009-2021)		WELDSF ^a (2007-2022)				PWQO/CWQG
	Winter	Spring	Summer	Fall	Summer	Fall	Winter	Spring	Summer	Fall	
Ammonia-N	0.15	0.16	0.06	0.07	0.07	0.08	0.16	0.18	0.08	0.07	pH and temp dependent ^b
BOD-5	2.13	2.45	2.23	2.19	2.33	2.11	2.18	2.59	2.23	2.13	-
Chloride	34.49	23.92	29.06	35.74	36.76	40.35	37.04	24.87	32.83	36.51	120 ^b
Nitrate-N	6.40	5.88	2.10	4.86	2.24	4.91	6.41	5.52	1.89	4.84	2.93 ^b
Nitrite + Nitrate (as N)	6.43	5.92	2.12	4.89	2.27	4.94	6.41	5.55	1.91	4.87	-
Nitrite-N	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.02	0.03	0.06 ^b
Phosphate (ortho)-P	0.06	0.10	0.02	0.05	0.02	0.05	0.06	0.10	0.01	0.04	-
Solids, Total Suspended	70.26	57.66	13.71	23.80	8.99	16.37	16.61	60.57	16.62	16.00	Background + 5 mg/L
Total Kjeldahl Nitrogen (TKN)	0.95	1.05	0.78	0.85	0.80	0.83	0.82	1.15	0.95	1.05	-
Total Phosphorus (TP)	0.13	0.21	0.06	0.11	0.06	0.10	0.10	0.22	0.06	0.10	0.03 ^c
Unionized Ammonia	1.19	1.72	5.61	1.89	10.31	2.47	1.23	1.81	7.65	3.10	20 ^c

^aWELDSF: BOD-5 seasonal averages based on BOD-5 data reported from 2009-2022. Beginning 2014, WELDSF station only monitored in winter and spring.

^bCanadian Water Quality Guidelines (CWQG) (CCME, 2022)

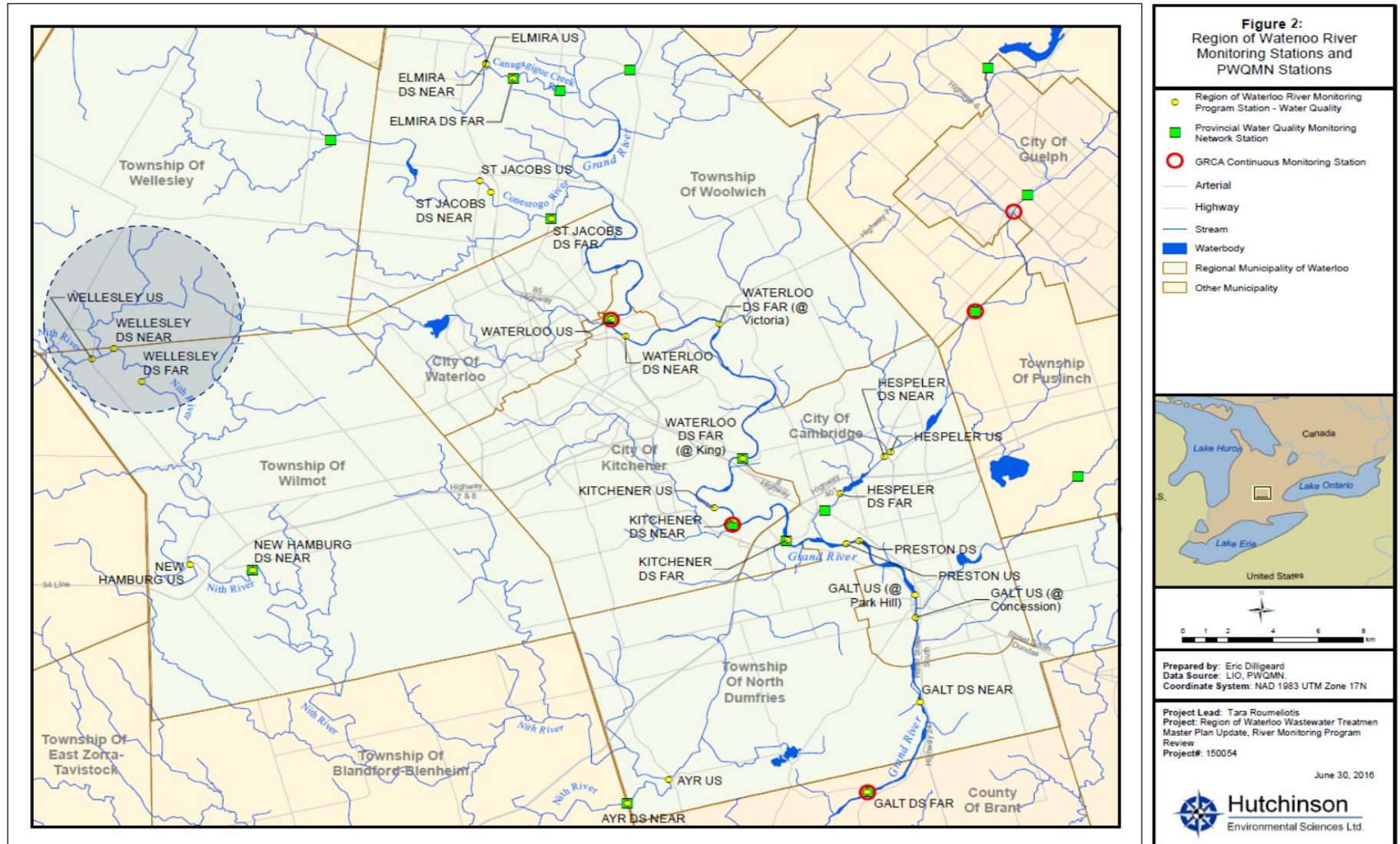
^cProvincial Water Quality Objectives (PWQO) (MECP, 2021)

Note:

All concentrations are in mg/L except unionized ammonia (µg/L)

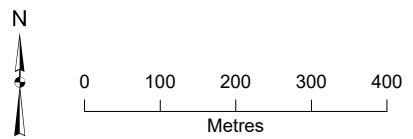
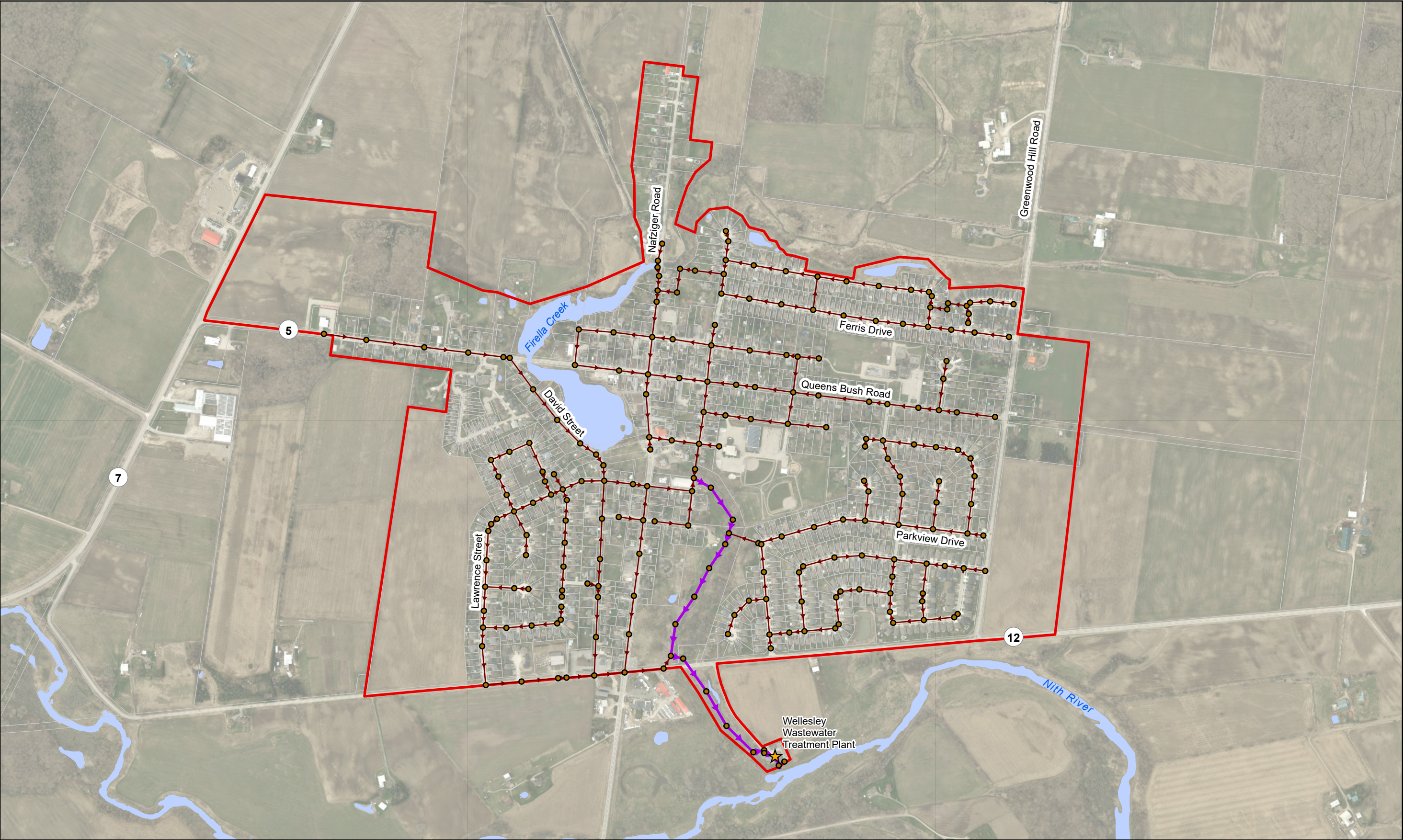
TM-1: Summary of Project Background

Figure 4-13. Region of Waterloo River Monitoring Stations and PWQMN Stations (Source: Region of Waterloo, 2018)



5 Wastewater Collection System

Wellesley's wastewater collection system is comprised of approximately 16 km of sanitary gravity sewers draining to the Wellesley WWTP. The sewers range in size from 200 to 450 mm diameter. There are no sanitary pumping stations within the collection system. The total tributary area to the wastewater collection system is approximately 145 hectares. The wastewater collection system is shown in Figure 5-1.



- ★ Study Location
- Wastewater Manhole
- Wastewater Main (mm)
 - 0 - 250
 - 250 - 400
- Parcels
- Waterbody
- ▭ Study Area Boundary

Notes:
1. Aerial Source: Region of Waterloo, 2020.

DRAFT

Figure 5-1
Wastewater Collection System Overview
Technical Memorandum 1
Region of Waterloo
Wellesley, Ontario

5.1 Inflow and Infiltration Studies

Two recent inflow and infiltration (I/I) studies are summarized in Section 5.1.1 and Section 5.1.2 below.

5.1.1 Development of an Inflow/Infiltration Reduction Program

The purpose of the Region of Waterloo Development of an Inflow/Infiltration Reduction Program (GM BluePlan, 2021) was to identify and assess the I/I within the Wellesley wastewater collection system. The study reviewed previous I/I investigations and provided recommendations for I/I remediation works.

The study indicated that west of Wellesley Pond and the Firella Creek was the area with highest I/I impacts. The sewer installation year of the majority of the pipes in this area is indicative of a high likelihood of foundation drain connections. Previous CCTV investigations also support the possibility of foundation drain connections.

The study also indicated that the area east of the Firella Creek and south of Welwood Avenue was also an area with high I/I. The study reported that previous CCTV investigations revealed flow from private property connections.

Overall, the findings of the study indicated that approximately 20–30% of the flow to the WWTP is I/I. A number of I/I investigations and remediation measures have been implemented within the Village of Wellesley, however, a substantial portion of the remaining I/I may be the result of private property foundation drain connections to the wastewater collection system. The study recommended that the Region develop a plan for investigation and remediation of I/I from private property sources.

5.1.2 Wellesley I/I Assessment and Mitigation Plan

The purpose of the Wellesley I/I Assessment and Mitigation Plan (GM BluePlan, 2017) was to assess I/I based on flow monitoring data collected in 2017. Flow monitoring was collected at 11 different sites throughout the flow monitoring period, however not all 11 sites were collecting data concurrently; no more than eight flow monitors were active at a given time.

A dry weather flow (DWF) analysis and diurnal patterns were produced for weekday and weekends. Seasonal variability was also considered and factored into the diurnal patterns. The DWF and rainfall were used to calculate rainfall derived inflow and infiltration values for each flow monitoring site. It was determined that contributing area to flow monitor WMH 141 had high I/I. Analysis also indicated that flow monitor WMH 112 contributing area also had a relatively high I/I value. Flow Monitor WMH 141 was located along the Firella Creek and west of Parkview Drive, while flow monitor WMH 112 was located along Lawrence Street between Reiner Crescent and David Street.

The RTK method was used to characterize the I/I as either inflow or infiltration based on whether there is a fast, medium, or slow response to rainfall seen in the collection system. This was completed for each monitor for select rainfall events. For flow monitor WMH 141 and WMH 112, the analysis indicated that the main source of I/I appears to be from infiltration. For all flow monitoring sites, the analysis indicated that the base groundwater infiltration was low.

5.2 Sanitary Hydraulic Model

The Region currently has a sanitary hydraulic model for the Village of Wellesley (Wellesley Sanitary Hydraulic Model). In 2017, the Wellesley Sanitary Hydraulic Model was updated and calibrated to dry weather flows. It was calibrated using a total of 11 flow monitors (with a maximum of 8 flow monitors installed at a given time during the flow monitoring period) and applying scaling factors to water billing records such that modelled flows reflected monitored flows.

Currently, the hydraulic model does not contain functionality to model wet weather flow conditions, and to be utilized during this WWWMP it will be necessary to develop a wet weather hydraulic model. To develop a wet weather hydraulic model, Jacobs will build upon the existing Wellesley Sanitary Hydraulic Model and calibrate the model to wet weather flows. The Region will conduct flow monitoring to capture the spring melt and rainfall. The data from the flow monitoring period will be utilized to calibrate the model to wet weather flows.

Once developed, the wet weather hydraulic model will be used to identify existing and future constraints within the wastewater collection system for design rainfall events. Based on the location and nature of these existing and future constraints, the wet weather hydraulic model will be used as a tool to develop and evaluate alternative solutions for the wastewater collection system.

5.3 Level of Service

Based on previous project experience in southern Ontario, typical level of service for sanitary systems includes no surcharging during dry weather periods and wet-weather periods up to 5-year design storms, and hydraulic freeboard greater than 1.8 m during wet weather periods greater than 5-year design storms. Hydraulic freeboard is the difference between the hydraulic grade line within the sanitary pipe and the ground elevation. Typical basement elevations are 1.8 m in depth, and therefore having a freeboard greater than 1.8 m is suggestive of lower risk of basement flooding.

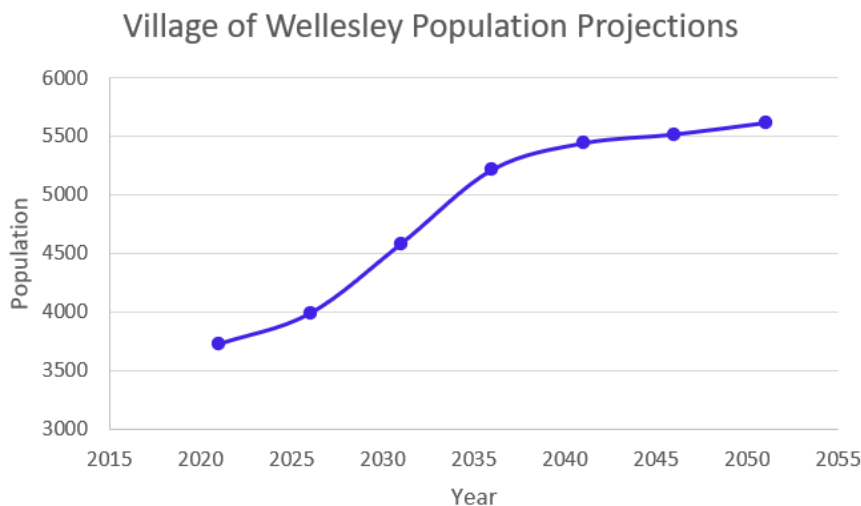
6 Growth Projections

The Region provided existing (2021) and future population values for the Study Area. The total 2021 population within the Study Area is 3,730. The population projections were developed in 5-year increments to the planning horizon of 2051, as shown in Table 6-1 and Figure 6-1. The population within the Study Area is anticipated to increase by 1,887 people, from 3,730 to 5,617.

Table 6-1. Village of Wellesley Growth Projections

Year	Wellesley Village Actual Population
2021	3,730
2026	3,992
2031	4,587
2036	5,218
2041	5,443
2046	5,518
2051	5,617

Figure 6-1. Village of Wellesley Population Projections



ICI growth is anticipated to remain relatively constant throughout the planning horizon of 2051. The anticipated ICI growth includes the Bill Gies Recreation Centre along Queens Bush Road (built in 2024) and a parcel of commercial development on the eastern extent of the Study Area. The future land use at the existing community centre remains uncertain, however it was assumed that some residential growth-related flow increases in addition to the existing ICI flows would occur.

The distribution of flows is based on growth within each Plum Zone (Region of Waterloo, 2024a). Plum Zones within the Study Area include Plum Zone ID 216, 1214, 217, 224, 1018, 219, 220, 1213, and 225. These Plum Zone locations are shown in Figure 6-2. The existing population and the projected 2051

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population for each Plum Zone within the Study Area is summarized in Table 6-2. It was assumed that the growth projected within each Plum Zone would be concentrated within the Study Area.

Figure 6-2. Plum Zones within Study Area

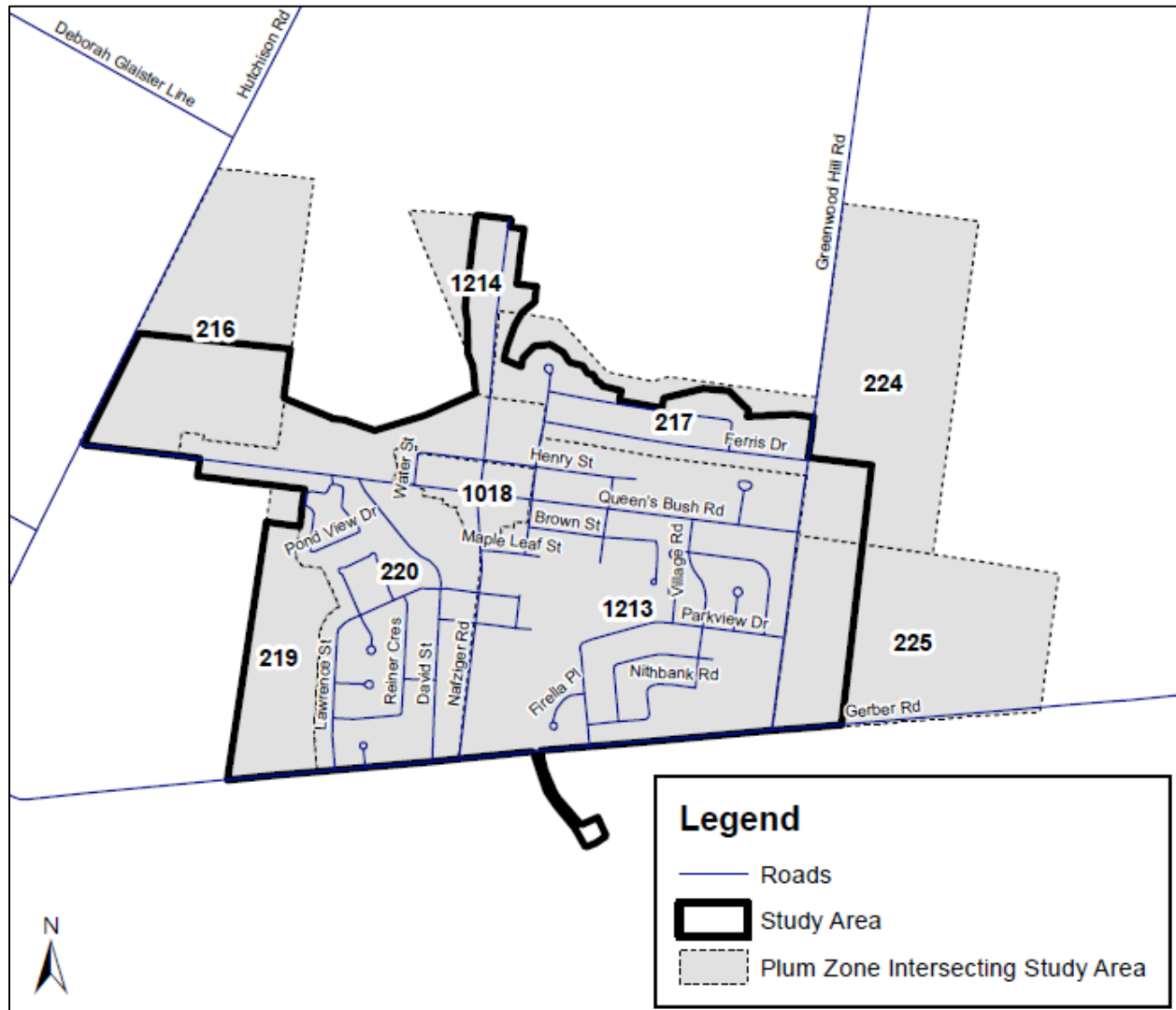


Table 6-2. 2051 Population Distribution by Plum Zone

Plum Zone	Existing Population (2021)	Future Population (2051)
219	3	775
225	11	703
224	19	225
217	676	676
220	1,195	1,264

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1018	173	166
1213	1,598	1,734
1214	53	51
216	2	22
Total	3,730	5,617

Notes:

^[a] Based on (Region of Waterloo, 2024a) and (Region of Waterloo, 2024b)

The residential population projections will be used to estimate future flows and water demand to determine the future needs for Wellesley's water and wastewater infrastructure and to identify when the recommendations should be implemented to service anticipated growth.

7 Natural, Cultural, and Social Inventory Review

In addition to the technical considerations identified in the previous sections, any alternatives introduced in the WWWMP should also consider impacts to the natural, cultural, and social environments as part of the Schedule B Class EA process. This section presents the current inventory of natural, cultural and social environmental features within the study area. Potential impacts to existing features from any proposed alternatives should be considered in the evaluation stage. Further studies and potential mitigation measures should also be identified.

7.1 Environmental Features Review

7.1.1 Natural Environment

A desktop review of the Study Area was completed in 2022. The Study Area occurs within the Township of Wellesley. In a review of imagery, the Study Area is a disturbed feature of mostly residential zones, surrounded by agricultural lands and rural roads (Figure 7-1). However, Firella Creek runs through the Study Area and drains to the Nith River, to the south just outside the Study Area. Nith River valley is designated as a significant valley in the regional official plan. Pockets of wooded areas occur throughout. The Provincially Significant Wetland (PSW) Firella Creek Swamp occurs outside the town boundaries and Study Area to the north, and the Wellesley West Wetland Complex PSW occurs to the west (NHIC, 2022). The Study Area occurs within the Grand River Conservation Authority (GRCA) Regulated Area (GRCA, 2022) (Figure 7-1).



Notes:
1. Aerial Source: Region of Waterloo, 2022.

DRAFT

Figure 7-1
Desktop Natural Environment Background Data

Region of Waterloo
Wellesley, Ontario

7.1.2 Terrestrial Habitat

Based on a desktop review, the Study Area consists primarily of an anthropogenically disturbed residential town. Parkland and cultural meadows occur throughout the Study Area, as well as pockets of wooded areas and agricultural lands. Riparian areas associated with Firella Creek also occur.

7.1.3 Aquatic Habitat and Fisheries

According to Land Information Ontario (LIO) and the Ministry of Natural Resources and Forestry mapping (DMNRF, 2022a), aquatic and fish habitat occurs as part of Firella Creek within the Study Area. Within the 120 meter (m) adjacent lands, the Nith River occurs to the south of the Study Area, just outside the Study Area boundary. The Campbell Agricultural Drain occurs to the north (GRCA, 2022).

7.1.4 Wetlands

According to LIO and the MNRF mapping (MNRF, 2022a), the Study Area does not contain wetland habitat. However, the 120 m adjacent lands contain Firella Creek Swamp PSW to the north, and the Wellesley West Wetland Complex PSW occurs to the west (NHIC, 2022).

7.1.5 Areas of Natural and Scientific Interest (ANSI)

There are no ANSIs located within Study Area or within the 120 m adjacent lands (MNRF, 2022).

7.1.6 Wildlife and Wildlife Habitat

The Study Area is generally comprised of residential and disturbed cultural areas. However, watercourses and wooded areas occur which provide habitat for wildlife, particularly avifauna.

Background data obtained for wildlife included a review of the Ontario Breeding Bird Atlas (OBBA), which provides information on avifauna occurrences based on a 10 km² area. The 2nd Atlas of the OBBA includes data collected from 2001 to 2005 (Bird Studies Canada, 2009). The Study Area and 120 m adjacent lands occur within OBBA Square Summary 17MH39 Region #3: Lambton, and 17MH49 Region #4: London.

LIO and MNRF SAR mapping was also accessed (MNRF, 2022a). A Species at Risk (SAR) screening email has been sent to the Ministry of the Environment, Conservation and Parks (MECP) SAR Branch (SARB) as per the *Endangered Species Act* (ESA) on November 23, 2022. MECP replied on January 27, 2023, and their comments were incorporated into the SAR listed in Section 7.1.7.

7.1.7 Species at Risk

According to the NHIC 1 km² area mapping (MNRF, 2022a), the Department of Fisheries and Oceans Canada (DFO) (Government of Canada, 2022), OBBA and iNaturalist (iNaturalist, 2002), SAR which may occur within the vicinity of the Study Area and/or 120 m adjacent lands is listed in Table 7-1. The presence of SAR or SAR habitat within the Study Area has not been field verified to date.

Table 7-1. Potential SAR within or proximal to the Study Area and 120 m adjacent lands

Common Name	Scientific Name	S Rank	SARO	COSEWIC	SARA
Northern Bobwhite	<i>Colinus virginianus</i>	S1?B	END	END	END

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Least Bittern	<i>Botaurus lentiginosus</i>	S4B	THR	THR	THR
Bald Eagle	<i>Haliaeetus leucocephalus</i>	S4	SC	NAR	THR
Black Tern	<i>Chlidonias niger</i>	S3B, S4M	SC	-	-
Common Nighthawk	<i>Chordeiles minor</i>	S4B	SC	SC	THR
Eastern Whip-poor-will	<i>Antrostomus vociferus</i>	S4B	THR	THR	THR
Chimney Swift	<i>Chaetura pelagica</i>	S3B	THR	THR	THR
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	S3	END	END	END
Eastern Wood-Pewee	<i>Contopus virens</i>	S4B	SC	SC	SC
Acadian Flycatcher	<i>Empidonax virescens</i>	S1B	END	END	END
Bank Swallow	<i>Riparia riparia</i>	S4	THR	THR	THR
Barn Swallow	<i>Hirundo rustica</i>	S4B	SC	SC	THR
Wood Thrush	<i>Hylocichla mustelina</i>	S4B	SC	THR	THR
Golden-winged Warbler	<i>Vermivora chrysoptera</i>	S3B	SC	THR	THR
Cerulean Warbler	<i>Setophaga cerulea</i>	S2B	THR	END	END
Prothonotary Warbler	<i>Protonotaria citrea</i>	S1B	END	END	END
Louisiana Waterthrush	<i>Parkesia motacilla</i>	S2B	THR	THR	THR
Yellow-breasted Chat	<i>Icteria virens</i>	S1B	END	END	-
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	S4B	SC	SC	-
Bobolink	<i>Dolichonyx oryzivorus</i>	S4B	THR	THR	THR
Eastern Meadowlark	<i>Sturnella magna</i>	S4B, S3N	THR	THR	THR
Transverse Lady Beetle	<i>Coccinella transversoguttata</i>	S1	END	SC	-
Yellow-banded Bumble Bee	<i>Bombus terricola</i>	S3S5	SC	SC	SC
Monarch	<i>Danaus plexippus</i>	S2N, S4B	SC	END	SC
Midland Painted Turtle	<i>Chrysemys picta marginata</i>	S4	-	SC	-
Snapping Turtle	<i>Chelydra serpentina</i>	S4	SC	SC	SC
Eastern Milksnake	<i>Lampropeltis triangulum</i>	S4	-	SC	SC
Rainbow Mussel	<i>Villosa iris</i>	S1	SC	SC	SC
Black Ash	<i>Fraxinus nigra</i>	S4	-	THR	-
Butternut	<i>Juglans cinerea</i>	S2?	END	END	END

^a NHIC Subnational Rank

^b Species at Risk Ontario (SARO)

^c Committee on the Status of Endangered Wildlife in Canada (COSEWIC)

^d Species at Risk Act (SARA)

Notes:

? = more data required

S1 = Critically Imperiled (often 5 or fewer occurrences)

S2 = Imperiled (often 20 or fewer occurrences)

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S3 = Vulnerable (restricted range with relatively few populations - often 80 or fewer)
S4 = Uncommon but not rare; some cause for long-term concern due to declines or other factors
S5 = Secure species, common, widespread, and abundant
S#S# = Range given due to uncertainty
B = Status qualifier; breeding
N = Status qualifier; non-breeding
M = Status qualifier; migrant species
H = Status qualifier; possibly extirpated
- = Not at Risk
SC = Special Concern
THR = Threatened
END = Endangered

The following are species of interest from the background search that are not SAR but have an S-rank of 1-3.

- Rough-legged Hawk (*Buteo lagopus*)
- Cup Plant (*Silphium perfoliatum*)

MECP correspondence added the following additional SAR:

- American Badger – Southwestern Ontario population (*Taxidea taxus jacksoni*) - END
- Black Redhorse (*Moxostoma duquesnei*) - THR
- Short-eared Owl (*Asio flammeus*) – THR
- Eastern Small-footed Myotis (*Myotis leibii*) - END
- Little Brown Myotis (*Myotis lucifugus*) - END
- Northern Myotis (*Myotis septentrionalis*) - END
- Tri-coloured Bat (*Perimyotis subflavus*) - END

While some of the species from Table 7-1 have the potential to occur within the Study Area or 120 m adjacent lands, field verification and SAR specific surveys are recommended to confirm presence or absence of SAR and associated habitat.

7.1.8 Fisheries Data

The following fish species are identified according to LIO's Aquatic Resource Area Survey Points: GU-0220-NIT, GU-9999-ZZZ (Figure 7-1), within Nith River, which connects with Firella Creek at the southern boundary and just outside of the Study Area (MNRF, 2022b).

Table 7-2. Fish Species Identified in LIO's Aquatic Resource Area Survey Points Near the Study Area

Common Name	Scientific Name
Blackside Darter	<i>Percina maculata</i>
Common Shiner	<i>Luxilus cornutus</i>
Golden Redhorse	<i>Moxostoma erythrurum</i>
Greenside Darter	<i>Etheostoma blennioides</i>
Hornyhead Chub	<i>Nocomis biguttatus</i>

Johnny Darter	<i>Etheostoma nigrum</i>
Rainbow Darter	<i>Etheostoma caeruleum</i>
Rock Bass	<i>Ambloplites rupestris</i>
Rosyface Shiner	<i>Notropis rubellus</i>
Stonecat	<i>Noturus flavus</i>
Striped Shiner	<i>Luxilus chrysocephalus</i>
White Sucker	<i>Catostomus commersonii</i>

7.1.9 Natural Environment Permitting

Based on the current scope, any future construction plans may require a permit from GRCA under regulation O. Reg 150/06 as the Study Area occurs within the GRCA Regulated Area. Based on the SAR background review and Natural Features such as the woodlands, consideration for SAR and SAR habitat is required for proposed construction within or nearby these areas as per the ESA as administered by the MECP. Further SAR screening is conducted by contacting the MECP's SAR Branch (SARB). DFO review may be required if future work is proposed in-water, or near water for example water crossings. A qualified biologist is required to be retained to review future proposed work.

In order to minimize further biological assessment of identified natural features:

- Landscape Architects should include native tree planting consistent with Wellesley-area woodlands in designs.
- Tree planting areas should be no less than the total area of driplines of identified woodlands and landscape trees to maintain % forest cover within project area. This shall be no less than 3:1 trees by stem count.
- Vegetation clearing should occur outside of April 1st to September 30th to avoid potential migratory birds and roosting bats unless otherwise specified by a qualified biologist. Grasses within work areas shall remain mowed below 20cm during this window to deter ground nesting birds and maximize area visibility.
- Perimeter of work areas should include erosion and sediment control, tree protection, and animex turtle fencing to isolate work areas from identified natural features unless otherwise specified by a qualified biologist.

7.2 Archaeological Inventory

ASI will carry out a desktop Stage 1 Archaeological Inventory to review relevant background information to determine the archaeological potential within the study area. The Stage 1 inventory will determine if a Stage 2 archaeological study is needed, depending on the preferred alternatives. Upon receipt of the Region's comments, the Stage 1 archaeological screening report will be submitted to the Ministry for review and acceptance into the Ontario Public Register of Archaeological Reports. The Stage 1 Archaeological Assessment report will be submitted separately from this TM1.

7.3 Cultural Heritage Inventory

ASI will follow the Ministry's criteria for evaluating the potential for Built Heritage Resources and Cultural Heritage Landscape checklist to identify the presence of protected heritage resources. The Cultural Heritage Inventory will research and identify cultural heritage constraints and determine where subsequent cultural heritage investigations or studies will be required. The Cultural Heritage Inventory report.

8 Regulatory Review

The Region must operate within the administrative, legislative and financial framework established by relevant levels of government. Key provincial, federal and municipal acts and regulations provide directives and guidance for the planning process. Relevant acts and regulations are described in the following sections and will guide the development of the Master Plan.

8.1 Planning

This section outlines relevant planning documents outlining the water and wastewater policies and directives to help guide the development of the Master Plan.

8.1.1 Provincial Policy Statement

The PPS came into effect May 1, 2020 under section 3 of the *Planning Act*. The purpose of the PPS was to provide direction on matters of provincial interest related to land use planning and development and to set the foundation for policy regarding the regulation of development and use of land (Ministry of Municipal Affairs and Housing, 2020). The PPS supports a comprehensive, integrated, and long-term approach to planning, and recognizes linkages among policy areas. Municipal official plans (described in the subsection below) are considered the most important “vehicle” for implementation of the PPS. Policies applicable to the Project are described.

Section 1.1.1: Healthy, liveable, and safe communities are sustained by promoting development and land use patterns that conserve biodiversity and prepare for regional and local impacts of climate change.

Section 1.2.1: A coordinated, integrated, and comprehensive approach should be used when dealing with planning matters within municipalities, including managing natural heritage, water, agricultural, mineral, cultural heritage, and archaeological resources.

Section 1.2.2: Planning authorities shall engage with Indigenous communities and coordinate on land use planning matters.

Section 1.6.6.1: Planning for sewage and water services shall: accommodate forecasted growth in a manner that promotes the efficient use and optimization of existing municipal sewage services; ensure that these systems can be sustained by water resources and prepare for the impacts of climate change; and, promote water conservation and water use efficiency.

Section 1.6.6.2: Municipal sewage services and municipal water services are the preferred form of servicing for settlement areas to support protection of the environment and minimize potential risks to human health and safety. Within settlement areas with existing municipal sewage services and municipal water services, intensification and redevelopment shall be promoted wherever feasible to optimize the use of the services.

Section 1.6.6.7: Planning for stormwater management will:

- be integrated with planning for sewage and water services;
- minimize or prevent increases in contaminant loads;
- minimize erosion or changes in water balance;
- prepare for climate change impacts; and,

- promote stormwater management best practices.

Section 2.2.1: Planning authorities shall protect, improve or restore the quality and quantity of water by planning for efficient and sustainable use of water resources through practices of water conservation and sustaining water quality.

Section 2.1.3: Natural heritage systems shall be identified in Ecoregions 6E.

Section 2.1.5: Development and site alteration shall not be permitted in significant woodlands in Ecoregions 6E, significant wildlife habitat, and significant Areas of Natural and Scientific Interest (ANSIs) unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions.

Section 2.1.7: Development and site alteration shall not be permitted in habitat of endangered species and threatened species, except in accordance with provincial and federal requirements.

Section 2.6.2: Development and site alteration shall not be permitted on lands containing archaeological resources or areas of archaeological potential unless significant archaeological resources have been conserved.

Section 2.6.5: Planning authorities shall engage with Indigenous communities and consider their interests when identifying, protecting and managing cultural heritage and archaeological resources.

Section 3.1.3: Planning authorities shall prepare for the impacts of a changing climate that may increase the risk associated with natural hazards.

In October 2024, the 2024 Provincial Planning Statement came into effect. The 2024 Provincial Planning Statement replaces the 2020 PPS and the Growth Plan for the Greater Golden Horseshoe. The changes and updates in the 2024 Provincial Planning Statement do not directly impact the development and outcomes of the Wellesley WWMP.

8.1.2 Regional Official Plan

The Regional Official Plan, 2015 (amendment 6) (Region of Waterloo, 2015) directs growth and change within the region with the intention of creating a balanced community structure. It is a legal document that contains goals, objectives and policies to manage and direct physical (land use) change and its potential effects on the cultural, social, economic and natural environment within the region (Region of Waterloo, 2015).

In accordance with the Ontario *Planning Act*, the Region is required to prepare and maintain an official plan through regular updates. The ROP is currently undergoing a review, guided by provincial policies such as the Growth Plan for the Greater Golden Horseshoe (Ministry of Municipal Affairs and Housing, 2020) and the Provincial Policy Statement (PPS) (Ministry of Municipal Affairs and Housing, 2020). This plan also serves as a guide for infrastructure planning and strategic investment decisions to support and accommodate forecasted population and economic growth. Objectives and policies applicable to the Project are described below.

Objective 5.2: Plan and manage municipal drinking-water supply systems using a comprehensive, integrated approach that reduces water demand, achieves efficiency of water use and protects, improves or restores the water quality and quantity.

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Objective 5.3: Plan and manage municipal wastewater systems to reduce future treatment capacity requirements, optimize the use of existing wastewater treatment plants and protect, improve or restore water quality and quantity in receiving waters.

Policy 5.B.1: The Region will prepare and update a Regional Wastewater Treatment Master Plan that supports the policies in the ROP, provides direction for planning and staging of investments in the Region's wastewater treatment plants and related facilities, guides the operation of the Region's day-to-day wastewater treatment programs, and protects human health and the natural environment.

Policy 5.B.4: The Region has assumed responsibilities for the wastewater collection systems in Wellesley including monitoring inflow and infiltration associated with wastewater collection.

Policy 5.B.6: Development applications proposing the use of new individual wastewater treatment systems will not be permitted within Wellhead Protection Sensitivity Area 1, High Microbial Risk Management Zones and Surface Water Intake Protection Zone 1, Urban Area designation, and Township Designated Greenfield Areas (notwithstanding Policy 5.B.2).

Policy 5.B.7: Prior to the approval of any development applications proposing the use of individual wastewater treatment systems, studies prepared in accordance with the provisions of the Regional Implementation Guideline for Source Water Protection Studies and approved by the Region, must have demonstrated that such system(s) can operate satisfactorily on the site and will not have a negative impact on groundwater resources.

Policy 5.D.2: The Region, in collaboration with Area Municipalities, will specify procedures for the allocation of drinking-water supply and wastewater capacity for development applications approved under the *Planning Act*.

Objective 7.1: Maintain, enhance or wherever feasible restore environmental features and the ecological and hydrological functions of the Greenlands Network. The study area is not located within a Regionally-defined Environmentally Sensitive Landscape, Regional Recharge Area, Provincial Greenbelt (Region of Waterloo, 2015). The study area includes Regionally-defined Core Environmental Features.

Policy 7.C.3: The Region will collaborate with the Province to ensure that Significant Habitat of Endangered or Threatened Species on lands affected by or contiguous to any proposed development or site alteration is properly identified.

Policy 7.C.4: The Region will collaborate with the Province to ensure that wetlands on lands affected by or contiguous to any proposed development or site alteration are properly evaluated and identified as Provincially Significant Wetlands, where appropriate.

Policy 7.C.10: Development or site alteration will only be permitted on lands contiguous to a Core Environmental Feature where an Environmental Impact Statement, or similar study, submitted in accordance with the policies in Section 7.G has that approval of the proposed development or site alteration would not result in adverse environmental impacts on the features and ecological functions of the Core Environmental Feature. The Region may require conditions of approval to implement such recommendations.

Policy 7.C.12: Where construction of a road on a new right-of-way, widening or upgrading of an existing roadway, construction or upgrading of a trunk sewer, trunk watermain, gas pipeline or electrical transmission line, wastewater treatment facility, waste management facility or groundwater taking project is proposed within or contiguous to a Core Environmental Feature, the submission of an Environmental Impact Statement, or other appropriate study, in accordance with the policies in Section 7.G (Environmental Impact Statements) will be required.

Policy 7.D.1: Development or site alteration will not be permitted within fish habitat, except in accordance with Provincial and Federal requirements to the satisfaction of the Federal Department of Fisheries and Oceans, or its delegate.

Policy 7.H.2: Development or site alteration on hazardous lands and hazardous sites may also be subject to the regulations administered by the Grand River Conservation Authority.

Policy 7.H.7: Development or site alteration will not be permitted within: (a) hazardous lands which are impacted by flooding hazards and/or erosion hazards; (b) erosion access allowances, which will not be less than six metres; and (c) hazardous sites.

Policy 10.A.1: The Region will provide opportunities for public participation in the development, implementation and monitoring of Regional planning policies in accordance with the ROP, the *Planning Act*, the *Environmental Assessment Act* and other relevant legislation and policy.

8.1.3 Township of Wellesley Official Plan

The Township of Wellesley Official Plan (Township of Wellesley, 2013), provides a roadmap to guide future development within the Township of Wellesley until the year 2031. Specifically, the Township's Official Plan presents policies that provide direction for both public and private development. The plan must conform to the policies within the Regional Official Plan, the Provincial Policy Statement, the Growth Plan for the Greater Golden Horseshoe, and the Township's objectives. Objectives and policies applicable to the Project are described below.

Policy 2.7.1.1: Development within the Wellesley Urban Area will provide for a range of residential, commercial, employment, institutional, recreational and open space land uses. Future development within this designation must occur on municipal water and wastewater services in accordance with the policies set out in Section 6.9.

Policy 2.7.2.1: In accordance with the Regional Official Plan, the Township, in collaboration with the Region, will establish a reurbanization target and associated policies in this Plan to ensure that a minimum percentage of new residential development occurring annually within the township will be within the built-up area of the Wellesley Urban Area. Until such time as this target has been established, the Township will endeavour to ensure that by 2015 and each year thereafter, new residential development occurring annually within the township will contribute to the achievement of the 45 percent reurbanization target described in the Regional Official Plan.

Policy 2.7.4.1: Future expansions to the boundaries of the Wellesley Urban Area are only permitted onto lands within the Countryside Line designated on Map 10 of the Township's Official Plan.

Policy 2.7.9.1: Notwithstanding any policies of the Plan to the contrary, the area shown as "Special Policy Area 2.7.9.1" on Map 4 – Wellesley Urban Area, may be developed with individual wastewater treatment systems subject to Policies 6.9.1.2 and 6.9.1.3, and private wells subject to Policies 6.9.2.8 and 6.9.2.9.

Policy 2.7.9.2: Notwithstanding the Urban Residential Designation applicable to the areas shown as "Special Policy 2.7.9.2" on Map 4 Wellesley Urban Area, the development density on these lands shall not exceed the available wastewater treatment plant capacity, taking into account the development potential of any vacant residential lands or reurbanization opportunities within the Wellesley Urban Area.

Policy 3.1.4: Where lands are designated as Prime Agricultural Areas and Rural Areas on Map 10 and Environmental Constraint Areas on Map 3, uses permitted within those designations will be subject to the restrictions as established through the policies contained in Sections 8.1 and 8.2 of this Plan.

Policy 6.9.1: The Township will evaluate wastewater servicing options for development applications. When reviewing development applications in the Wellesley Urban Area, the Township will ensure that no such development is recommended for approval if the Region determines that there is insufficient reserve capacity in the municipal wastewater services

Policy 6.9.2: The Township will evaluate water servicing options for development applications. When reviewing development applications in the Wellesley Urban Area, the Township will ensure that no such development is recommended for approval if the Region determines that there is insufficient reserve capacity in the municipal water services.

Policy 8.1: Maintain, enhance or wherever feasible restore environmental features and the ecological and hydrological functions of the Greenlands Network. The study area is not located within a Regionally-defined Environmentally Sensitive Landscape, Regional Recharge Area, Provincial Greenbelt (Region of Waterloo, 2015). The study area includes Regionally-defined Core Environmental Features.

Policy 8.2: Core Environmental Features may or may not be subject to naturally occurring hazards, but will be protected from development to maintain, protect and enhance their biodiversity and important ecological functions.

Policy 8.6: The Township will maintain and wherever feasible, enhance the quality and quantity of water infiltration and recharge to groundwater aquifers.

Policy 9.5: A Cultural Heritage Impact Assessment will be required by the Township for any proposed development or site alteration that includes or is contiguous to a property designated under the Heritage Act or that includes a non-designated cultural heritage resource that is identified in the Heritage Registry.

Policy 9.6: During the review of development applications and/or site plans, the Township and/or the Region will require the owner/applicant to submit an archaeological assessment conducted by a licensed archaeologist in accordance with the provisions of the Regional Archaeological Implementation Guideline following the Ministry of Tourism, Culture and Sport Standards and Guidelines, to the satisfaction of the Province, where archaeological resources and/or areas of archaeological potential have been identified in the Region's Archaeological Master Plan.

8.2 Grand River Source Protection Plan

The Grand River Source Protection Plan (Grand River Conservation Authority, 2022) provides key objectives and policies to identify risks to municipal drinking water sources to protect the current and future sources of municipal drinking water. The *Ontario Clean Water Act* defines a drinking water threat as *"an activity or condition that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water, and includes an activity or condition that is prescribed by the regulation as a drinking water threat."* The following policies may apply to the Project, specifically within Wellhead Protection Areas.

Policy RW-CW-8: To ensure small onsite sewage systems and holding tanks cease to be or do not become significant drinking water threats, where these activities are or would be significant drinking water threats, the

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Area Municipalities shall implement a septic system maintenance inspection program, as required under the Ontario Building Code for Wellhead Protection Areas A and B where the vulnerability is equal to ten.

Policy RW-MC-9: To ensure new large onsite sewage systems do not become a significant drinking water threat, where this activity would be a significant drinking water threat, MECP shall prohibit, within the Environmental Compliance Approvals process, new large septic systems in Wellhead Protection Areas A and B where the vulnerability is equal to ten.

Policy RW- MC-10: To ensure existing and new large onsite sewage systems cease to be or do not become significant drinking water threats, where this activity is or would be a significant drinking water threat MECP shall ensure that the Environmental Compliance Approval for an existing large onsite sewage system contains terms and conditions as appropriate to ensure that the activity ceases to be a significant drinking water threat in Wellhead Protection Areas A and B where the vulnerability is equal to ten.

Policy RW-MC-11: MECP shall prohibit sewage treatment plant effluent discharge including lagoons and storage of sewage where the tank is completely underground in Wellhead Protection Areas A and B where the vulnerability is equal to ten within the Environmental Compliance Approval process to ensure these activities do not become a significant drinking water threat.

Policy RW-MC-11.1: MECP shall ensure that the Environmental Compliance Approval that governs the storage of sewage (treatment tank or storage tank) and any part of the tank that is at or above grade in all Wellhead Protection Areas A, B and C where the vulnerability is greater than or equal to eight for future activities contain terms and conditions, as appropriate, to ensure that the activity does not become and/or ceases to be a significant drinking water threat to groundwater and drinking water supplies.

RW-MC-12: For sanitary sewers and related pipes including pump stations located within Wellhead Protection Areas A and B where the vulnerability is equal to ten and where this activity is or would be a significant drinking water threat, MECP shall ensure that the Environmental Compliance Approval for existing sanitary sewers and related pipes includes appropriate terms and conditions to ensure that the activity ceases to be a significant drinking water threat within the following areas. MECP shall ensure that the Environmental Compliance Approval for new sanitary sewer and related pipes including pumping stations includes appropriate terms and conditions to ensure that the activity does not become a significant drinking water threat in Wellhead Protection Areas A and B where the vulnerability is equal to ten.

8.3 Water and Wastewater Treatment

Water and wastewater treatment processes must meet the requirements of the following environmental protection legislation and regulations.

- Ontario *Planning Act* is provincial legislation that sets out ground rules for land use planning in Ontario, providing the basis for preparing official plans and associated planning policies that guide future development.
- Ontario *Environmental Protection Act*, is the primary pollution control legislative tool in Ontario and can be used interchangeable with the Ontario *Water Resources Act*, prohibiting the discharge of contaminants to the environment that cause or are likely to cause adverse effects. Amounts of approved contaminants must not exceed prescribed limits.
- Ontario *Water Resources Act*, as amended by the Safeguarding and Sustaining Ontario's Water Act, 2007 is the legal foundation of Ontario's water policy and an important law governing water quality and quantity in Ontario. This Act prohibits the discharge of polluting material in or near water, prohibits or regulates the discharge of sewage, facilitate orders requiring measures to prevent,

reduce or alleviate impairment of water quality, enables the designation and protection of sources of public water supply, and regulates water taking more than 50,000 litres a day.

- Ontario *Safe Drinking Water Act*, S.O. 2002, c. 32: is intended to protect human health through the control and regulation of drinking water systems and drinking water testing. Wastewater systems need to be located, designed, constructed, maintained, and operated in accordance with applicable standards so that drinking water is protected, safe, clean and reliable.
- Ontario *Clean Water Act* requires that communities, through local Source Protection Committees, protect municipal drinking water supplies (and non-municipal supplies if added by the municipality of Minister) from overuse and contamination, now and into the future. This Act aims to prevent contaminants from entering sources of drinking water, including lakes, rivers and aquifers. O.Reg. 435/93: Water Works and Sewage Works applies to wastewater collection and treatment facilities, licensing of facility operators and operating standards.
- Canada *Fisheries Act*: manages and protects Canada's fisheries resources prohibiting the deposit of all deleterious substances that may degrade or alter water quality in a manner that directly or indirectly harms fish, fish habitat or the use of fish by humans. The Wastewater Systems Effluent Regulations (include mandatory minimum effluent quality standards) apply in respect of a wastewater system that deposits effluent as part of a wastewater system. Effluent containing deleterious substances will follow the requirements and standards outlined in this regulation.

8.3.1 Recent Updates in Drinking Water Guidelines

The Guidelines for Canadian Drinking Water Quality (GCDWQ) are established by Health Canada and define water quality goals that treatment plants should strive towards. The guidelines define maximum acceptable concentrations (MAC) and treatment goals based on the health effects of each contaminant. Aesthetic objectives (AOs) are established for contaminants that impact taste and odour. Operational guidance (OG) values are defined for contaminants that can adversely affect treatment processes or drinking water infrastructure. These guidelines represent health advisory levels for contaminants. Although the contaminant guidelines are not specifically regulated, they are used to inform potential future regulations.

The GCDWQ recommend providing a 4-log virus inactivation for primary disinfection of groundwater, compared to the current regulation which requires 2-log inactivation (Health Canada, 2022). The Region has started to implement 4-log virus inactivation at multiple facilities, based on Ministry direction. The timing for Provincial legislation of this recommendation has not been confirmed, however it is anticipated that the regulation will be updated in the near future. The Region is currently studying the potential impact on all its wells under a separate project including the Wellesley wells.

Health Canada has proposed an AO limit of 0.02 mg/L for manganese, with a MAC of 0.12 mg/L (Health Canada, 2022). The AO is not currently regulated but it is anticipated to be adopted in Ontario. As mentioned in under the Water Quality Review Section, the current manganese levels in the wells at the Wellesley WTP are below the AO, and treated water is significantly below the recommended limit. Therefore, this future regulation is not expected to be an issue for the Wellesley WTP.

Health Canada has proposed a MAC of 7.0 mg/L for strontium; however, this limit has not yet been adopted by legislation in Ontario (Health Canada, 2022). As mentioned in Section 3.6, the raw water strontium concentrations exceed the recommended concentration. In the future, upon consideration of background calcium, treatment might be needed to meet the strontium limit, once legislated. During the Master Plan process, we will approach the MECP to understand the timing for the future strontium legislation.

Per- and polyfluoroalkyl substances (PFAS) are an emerging contaminant that are starting to be regulated in Ontario. PFAS are a class of synthetic chemical used in consumer products and fire-fighting foams. Health Canada has established MACs for some PFAS: perfluorooctane sulfonate (PFOS) with MAC of 0.0006 mg/L, and perfluorooctanoic acid (PFOA) with MAC of 0.002 mg/L (Health Canada, 2022). Presently, PFAS monitoring is not required in the Province of Ontario, therefore, the Region currently does not monitor PFAS in drinking water.

Health Canada has identified several contaminants from agricultural leaching or runoff recently (in the past two years) which present a risk to groundwater, including the following:

- Dicamba (MAC of 0.11 mg/L) – readily leaches into groundwater
- 2,4-dichlorophenoxy acetic acid (MAC of 0.1 mg/L) – high potential to leach into groundwater
- 2-methyl-4-chlorophenoxyacetic acid (MAC of 0.35 mg/L) – potential to leach into groundwater
- Metribuzin (MAC of 0.08 mg/L) – potential to leach into groundwater depending on topography, precipitation, and soil characteristics such as pH and organic matter (Health Canada, 2022)

8.3.2 Potential Future Regulations for Effluent Quality

8.3.2.1 Nitrogen Species

Conventional nitrification describes the biological oxidation of ammonia to nitrate carried out by two distinct groups of autotrophic organisms referred to as ammonia oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB). AOB oxidize ammonia to create nitrite (NO_2^-), followed by NOB oxidizing nitrite to nitrate (NO_3^-). Denitrification describes the biological reduction of nitrate and nitrite to nitrogen gas, which is carried out by a broad range of heterotrophic organisms and requires a carbon substrate to provide the electrons needed to reduce nitrate and nitrite to nitrogen gas. Total nitrogen (TN) is a measurement of all nitrogen species including ammonia, organic and reduced nitrogen, nitrite, and nitrate.

Nitrate in water is linked to various health issues in humans, and also has a fertilizing effect in bodies of water wherein too much nitrate could trigger algae blooms in surface waters where nitrate is the limiting nutrient. Nitrate is typically not the limiting nutrient in Ontario surface waters; phosphorus is typically limiting and is therefore subject to regulatory control. In Ontario, there is no specific regulation for nitrate or TN in wastewater treatment plant effluents; however, TN limits have been implemented in treatment plants elsewhere in Canada that discharge to sensitive receiving waters. The Canadian Council of Ministers of the Environment (CCME) published the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME, 2019), which notes a limit of 3 mg/L for nitrate (as nitrogen) for chronic exposure in fresh water lakes, rivers and streams that support aquatic life.

Elsewhere in North America, there is a general trend towards application of TN limits due to anoxia in off-shore waters. For example, Florida has eliminated wastewater effluent discharges to the ocean, and areas that discharge to the Long Island Sound and the Chesapeake Bay need to meet exceedingly strict TN limits (as low as 3 mg/L as nitrogen on an annual basis). In Europe, many plants that discharge to sensitive streams are required to meet a TN limit of 10 mg/L (as nitrogen) on a monthly average basis.

The trend toward the application of TN limits in the remainder of Canada and around the industrialized world may lead to the application of TN limits in plants discharging to Ontario streams and lakes at some point in the future. As a first step in that direction, relatively relaxed limits might be applied (20 to 25 mg/L as nitrogen); however, more stringent TN limits could be expected within the foreseeable future to levels in line

with those currently applied in Europe. Accordingly, it would be prudent to allow for a technology migration path in future plans for the Wellesley WWTP that accommodates the possible imposition of TN limits.

Based on the current regulatory environment, potential future TN limits are somewhat speculative and are therefore not accounted for in the future expansion plans for Wellesley WWTP that will be developed in this Master Plan. It is recommended that in the future, the Region continues to monitor the regulatory environment surrounding TN limits and revisit this parameter when future liquid treatment expansion projects are being planned in greater detail.

Point source phosphorus discharges to the Great Lakes have garnered significant attention because of recent algal blooms across Lake Erie and in localized areas of the Lake Ontario, Lake Huron, and Lake Michigan nearshores. In February 2018, the Ontario MECP and Environment and Climate Change Canada published the Canada-Ontario Lake Erie Action Plan to reduce algal blooms caused by phosphorus discharges to the lake. One of the actions within the plan is to establish, by 2020, a legal effluent total phosphorus (TP) concentration limit of 0.5 mg/L for all wastewater treatment plants in the Lake Erie basin that have an average daily flow capacity above 3.78 ML/d. This TP limit is consistent with the binational recommendation for wastewater treatment plant discharges under the Canada-U.S. Great Lakes Water Quality Agreement (GLWQA). The Lake Erie Action Plan also recognizes soluble reactive phosphorus (SRP) as a parameter of interest for nuisance algal blooms due to SRP being readily bioavailable for algae, however, no recommendations or actions were advanced to make SRP a regulated parameter for wastewater facility effluents.

The Ottawa Nith River ambient conditions and the effluent discharges need to be evaluated relative to the MECP's policies for surface water quality management as outlined in the Provincial Water Quality Objectives (MECP, 1994) and guidelines for Deriving Receiving Water Based Point Source Effluent Requirements for Ontario Waters (MECP, 1994).

8.3.2.2 Emerging Substances of Concern

As analytical technologies advance, a growing list of compounds that can have physiological effects on humans and aquatic organisms are being detected in surface waters and in biosolids. These compounds are referred to as Emerging Substances of Concern (ESOCs) and include endocrine disruptors and hormones, pharmaceuticals, personal care products (soaps, shampoos, perfumes, and antimicrobials), pesticides, herbicides, nanoparticles, and PFAS.

ESOCs enter the wastewater system and the natural environment in various ways. Many ESOCs enter municipal wastewater through bathing, cleaning, laundry, disposal of human waste and unused pharmaceuticals, and agricultural application of pesticides. Removal of some ESOCs in wastewater and drinking water plants does occur, however, removal rates vary with the specific ESOC and type of treatment (EPA, 2010).

While most municipal wastewater treatment plants are not specifically designed to remove ESOCs from wastewater, a number of research projects have reported that removal of some ESOCs occurs in facilities with secondary treatment, as well as those with some form of advanced treatment. In 2010, the MECP conducted a study to determine the world-wide state of research on the removal of ESOCs at municipal wastewater treatment plants (CH2M, 2010). The study indicated that nitrifying wastewater treatment plants appear to eliminate more ESOCs than non-nitrifying plants, and that wastewater treatment plants that nitrify and denitrify further reduce ESOC concentrations. Thus, nitrifying secondary treatment is considered a surrogate for ESOC removal; however, guidelines for the extent to which ESOC removal can be achieved through nitrifying secondary treatment have not been defined.

ESOCs and their fate across wastewater treatment plants is an area of ongoing research. At this level of planning, potential future limits on ESOCs are speculative and are therefore not accounted for in the future expansion plans for Wellesley WWTP that will be developed in this Master Plan. The Region has a Water Research Committee that collaborates with university researchers and various water committees to monitor developments related to ESOCs. It is recommended that in the future, the Region continues to monitor the research developments and regulatory environment surrounding ESOCs and considers the evolving regulatory environment when future liquid treatment expansion projects are being planned in greater detail.

8.3.3 Potential Future Regulations for Biosolids Quality and Disposal

The Wellesley WWTP does not have capacity for solids treatment. WAS is stored in an aerated sludge holding tank prior to haulage to the Waterloo WWTP for further processing. At the Waterloo WWTP, the sludge is anaerobically digested, and dewatered via centrifuges. The biosolids are beneficially used where possible in agriculture or mine tailing pond remediation in northern Ontario, with landfilling used as contingency.

Currently, land application of biosolids requires pathogen reduction, limited metal concentrations, and odour reduction as outlined in O. Reg. 267/03 (Province of Ontario, 2017). Potential future changes in regulations based on increased scrutiny of ESOCs in biosolids could drive biosolids management away from land application. The prevalence and environmental impacts of ESOCs in biosolids is an area of ongoing research in the wastewater industry. It is recommended that in the future, the Region continues to monitor the regulatory environment surrounding ESOCs and biosolids. Potential future ESOC limitations in biosolids would have municipal impacts and should be considered in future biosolids master plans.

8.3.4 Potential Future Regulations for Air, Noise, and Odour

The Ontario Environmental Protection Act Local Air Quality Regulation (O. Reg. 419/05) regulates the maximum allowable concentration of specific air contaminants “at the point of impingement (POI)”, which is typically the property line and other receptors such as building air intakes or windows (Province of Ontario, 2019). Currently, the regulation includes half-hour POI concentration standards and assumes the use of a model that is approved by O. Reg. 346. By February 1, 2020, the MECP will phase in new concentration standards, referred to as Schedule 3 Standards, based on averaging times ranging from ten minutes to 24 hours depending on the contaminant. The new standards also require the use of AERMOD or another approved model, as the existing O. Reg. 346 models do not reflect the latest scientific advancements in air dispersion modelling.

The Schedule 3 Standards have 24-hour and 10-minute odour-based standards for some offensive odorous contaminants, including total reduced sulphur, hydrogen sulphide, and mercaptans; as summarized in Table 8-1. ECA amendment applications after February 1, 2020 must include facility-wide Emission Summary and Dispersion Modelling (ESDM) demonstrating compliance with the new Schedule 3 Standards using an AERMOD model. In ECA applications for wastewater treatment plants, an ESDM report must demonstrate compliance with the 10-minute POI Limit for total reduced sulphur.

Table 8-1. Future Standards for Odorous Compounds (Schedule 3, O. Reg. 419/05)

Contaminant	24 Hour Standard, $\mu\text{g}/\text{m}^3$	10 Minute Standard, $\mu\text{g}/\text{m}^3$
Hydrogen sulphide	7	13
Mercaptans	None	13
Total reduced sulphur	7	13

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Accordingly, the Wellesley WWTP will be required to complete an ESDM for air emissions and odours as part of future expansions or retrofits. These studies will be conducted during project design development. In addition to the specific odorous compounds included in Table 8-1, a commonly accepted method of characterization is the Odour Unit (OU), and a common design limit for odours is a maximum of one OU at the facility's property line. The MECP's design guidelines for wastewater treatment facilities notes that designers and owners should determine appropriate OU limits on a case-by-case basis to mitigate community impacts (Ontario Ministry of the Environment , 2008). It is expected that active odour control will be required for headworks and raw wastewater pumping, solids storage/truck loading, and ancillary processes such as standby power generation. Tank covers for liquid processes may be required depending on the results of modelling. The Master Plan will assume future expansions and upgrades include source control strategies and treatment of captured contaminated/odorous air.

For noise mitigation, the Master Plan will assume future expansions and upgrades allow for compliance with the limits set out in Ministry Publication NPC-300 (Ontario Ministry of the Environment, 2017). Areas subject to elevated noise levels will receive acoustical treatment as required. Noise modelling may also be undertaken during future expansion/retrofit designs to illustrate compliance with provincial guidelines and to identify areas where special noise attenuation might be required and to what level.

9 Problem and Opportunity Statement

The Region of Waterloo is undertaking a water and wastewater master plan for the Village of Wellesley to address anticipated water and wastewater treatment needs, including water distribution and wastewater collection needs, over the next 30 years. Because the population of the Village of Wellesley is expected to increase over the next 30 years it is critical that the water and wastewater infrastructure can meet the anticipated future treatment, distribution and collection system servicing requirements. This water and wastewater master plan represents an opportunity to review the existing service levels and identify projects that are required to be implemented to meet the future needs.

10 Next Steps

This TM1 outlined the existing conditions with respect to Wellesley's water and wastewater systems, including an initial summary of existing constraints, water quality, wastewater characteristics, historical wastewater flow, historical water demand, and natural inventory review. TM1 also highlighted the key regulations, guidelines, and policies relevant to Wellesley's water and wastewater systems, and summarized the anticipated 2051 growth scenario.

Immediately subsequent technical memorandums will be completed as follows:

- TM2: Evaluation Criteria: to describe the evaluation process that will be used to determine the preferred alternative
- TM3: Water Infrastructure Alternatives: to present the water system alternatives
- TM4: Wastewater Infrastructure Alternatives: to present the wastewater system alternatives

In addition to presenting the water and wastewater system alternatives in TM3 and TM4, respectively, these TMs will also detail the 5-year incremental population forecasts, quantify future wastewater flows and water demand, and identify future constraints for the water and wastewater systems.

Concurrent to the above, a wet weather sanitary hydraulic model will be developed and calibrated to support the identification of existing and future wastewater collection system constraints and facilitate the evaluation of alternative solutions for the wastewater collection system.

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Evaluation Framework and Evaluation Criteria

Revision no: R1

Region of Waterloo

Wellesley Water and Wastewater Master Plan
April 12, 2023





Evaluation Framework and Evaluation Criteria

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Jacobs Consultancy Canada Inc.

72 Victoria Street South
Suite 300
Kitchener, ON N2G 4Y9
Canada

T +1.519.579.3500
www.jacobs.com



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1. Introduction

The Region of Waterloo (Region) is undertaking the Wellesley Water and Wastewater Master Plan (WWWMP) in the Village of Wellesley (Wellesley) to plan for water and wastewater upgrades and new infrastructure to address existing issues and meet future needs to 2051. The WWWWMP will incorporate recent population forecasts, identify existing and future constraints, and identify and evaluate alternatives to select a preferred alternative.

The WWWWMP will be carried out as a Master Plan in accordance with Phases 1 and 2 of the Municipal Engineers Association's (MEA's) Municipal Class Environmental Assessment (MCEA) Process (MEA 2000, as amended 2007, 2011, 2015, 2023), which is an approved process under the Ontario Environmental Assessment Act.

Phases 1 and 2 of the MCEA Process will be completed for the Master Plan process, and documented, as follows:

- Phase 1 – Status of existing infrastructure and processes, future needs, inventory of the study area, and identification of the problem and/or opportunity
- Phase 2 – Identification and evaluation of alternative solutions, considering the benefits and impacts to the existing community, natural and economic environments, technical and jurisdictional feasibility, as well as input from project stakeholders, to identify a preferred solution
- Master Plan Report - Preparation of a report to document the MCEA study methodology, stakeholder communications and engagement program, and Phase 1 and 2 findings, which typically recommend a set of works distributed geographically within the Study Area and which are to be implemented over an extended period of time

This TM outlines the screening and evaluation methodology required to complete Phase 2 of the Class EA process for the WWWWMP. A key component of developing a traceable, transparent and defensible evaluation process is the development of evaluation criteria to select the preferred alternative(s).

The methodology for a Master Plan Level EA evaluation process designed to select preferred alternatives is clearly outlined in the MEA Guidelines. Evaluation criteria are selected to address the range of possible impacts based on criteria which evaluate potential impacts to technical, social/cultural, environmental, and financial resources. Each alternative is scored against each criterion and a weighting system is applied to each category of criteria to emphasize criteria that are deemed to have a more substantive impact on the outcome of the evaluation. The alternative scores are then used to determine the recommended preferred alternative. A sensitivity analysis will be performed to examine how changes in criteria category weighting can affect the outcome of the evaluation, which can help refine the scoring and weighting schemes or be used to inform the identification of the preferred alternative.

2. Evaluation Criteria and Evaluation Framework

2.1 Screening of the Long List of Alternatives

A long list of alternatives will be developed for each of the water treatment system, the water distribution system, the wastewater treatment system, and the wastewater collection system. The long list of alternatives will be used to identify the short list of feasible alternative solutions for further evaluation through a pass / fail screening exercise. Alternatives within the long-list of alternatives will pass the screening if they have the potential to provide a viable solution to the constraints identified. The long-list of alternatives will be screened separately for the water treatment system, the water distribution system, the wastewater treatment system, and the wastewater collection system.

2.2 Evaluation Criteria and Evaluation Framework for Short-Listed Alternatives

The short list of alternatives passing the long-list of alternatives screening will be evaluated using a set of evaluation criteria that can be grouped into the following categories:

- Environmental Criteria
- Social Criteria
- Technical Criteria
- Financial Criteria

The purpose of this evaluation is to identify a preferred alternative that best meets the objectives of the Wellesley WWWMP. Draft evaluation criteria are presented in Table 2-1, while Table 2-2 identifies the performance scale used to score each criteria.

Evaluation Framework and Evaluation Criteria

Table 2-1. Evaluation Criteria

Category	Criteria	Description
Environmental	Protects environmental features	Impact of alternative on environmental features including natural areas, designated ANSI, Wetlands, Designated PSWs, and other project specific defined environmental features.
	Protects wildlife and species at risk	Impact of alternative on wildlife and wildlife habitat, including birds, fish, herptiles, mammals, and insects and any other project specific defined wildlife and their project specific habitats.
	Protects groundwater, streams and rivers	Impact of alternative on groundwater quantity and quality, surface water quantity and quality and fluvial geomorphic function of streams and rivers.
	Minimizes climate change impacts	Impact of alternative on climate scale temperature, wind, precipitation and any other project specific climate scale. Measured through qualitative estimates of relative GHG emissions.
Social	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.	Impact of alternative over long term on the levels of noise, odour, traffic, and aesthetics in the study area.
	Minimizes impacts to businesses	Impact of alternative on long term business operations related to closures, access, and any other project specific disturbances.
	Manages and minimizes construction impacts	Impact of alternative on short term business operations during construction related to closures, access, and including noise, traffic, environment and any other project specific disturbances.
	Conserves built heritage and/or cultural heritage landscapes	Impact of alternative to adjacent sites/properties of built or cultural value or interest.
	Conserves archaeological resources	Impact of alternative on heritage resources of value or interest.
	Protects health and safety	Impact of alternative over short term during construction and long term on health and safety of construction and operations personnel and the public.
Technical	Provides reliable service	Resilience of the alternative to impacts from natural and man-made disturbances.
	Meets existing and future needs	Ability of the alternative to meet the existing and future needs as defined by the problem and opportunity statement.

Evaluation Framework and Evaluation Criteria

Category	Criteria	Description
	Aligns with existing and planned infrastructure	Alignment of the alternative with existing infrastructure in terms of integration and operations and ability to accommodate future upgrades to meet projected needs.
	Aligns with existing and future land use	Ability of the impact to accommodate future anticipated land uses.
	Aligns with approval and permitting process	Ability of the alternative to receive permitting and approvals
	Manages and minimizes construction risks	Ability of the alternative to avoid technical risks and adhere to constructability requirements.
	Ability to adapt to climate change	Resilience of the alternative to changes in climate related factors including temperature, wind, precipitation and any other project defined specific climate factors.
Financial	Provides low lifecycle costs	Alternative cost comparison on life cycle costs.

Table 2-2. Performance Scale

Rating	Description	Symbol
5	Very well aligned with criteria	
4	Well aligned with criteria	
3	Somewhat aligned with criteria	
2	Not well aligned with criteria	
1	Low alignment with criteria	

Following the alternative scoring, each criteria category is weighted to assign a level of importance to each category.

A sensitivity analysis is typically performed to evaluate the impact of different weighting factors on the ranking of alternatives. This provides a method to assess the stability of the evaluation exercise. The stability of the evaluation exercise is deemed to be high if different weighting factors used in the sensitivity analysis do not substantially change the outcome of the evaluation. Weighting schemes proposed to assess the stability of the evaluation for the WWWMP are shown in Table 2-3.

Table 2-3. Proposed Evaluation Weighting Schemes

	Even Weighting	Excluding Cost	High Social	High Environmental	High Technical
Technical	25%	33%	20%	20%	40%
Environmental	25%	33%	20%	40%	20%
Social	25%	33%	40%	20%	20%
Financial	25%	0%	20%	20%	20%
Total	100%	100%	100%	100%	100%

3. Next Steps

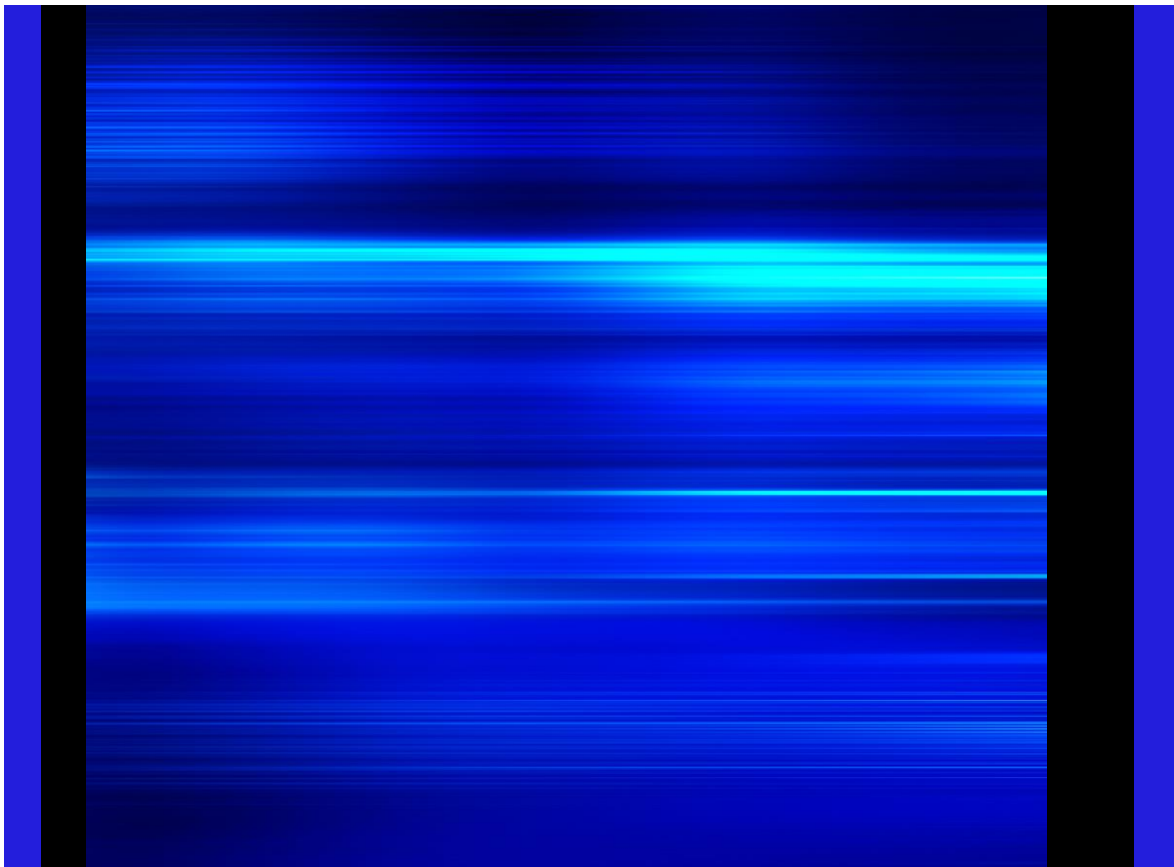
The next steps for the WWWMP are to identify the future constraints and develop alternative solutions for Wellesley's water and wastewater systems in TM3 and TM4, respectively. Following Region acceptance of the evaluation framework described within this TM2, evaluation of the water and wastewater alternatives and selection of the preferred alternative will be completed in TM5.

TM3: Water Infrastructure Alternatives Development

Document no: CE851700-3
Revision no: Final

Region of Waterloo

Wellesley Water and Wastewater Master Plan
July 31, 2025





TM3: Water Infrastructure Alternatives Development

Client name: Region of Waterloo

Project name: Wellesley Water and Wastewater Master Plan

Client reference: Karou Yajima **Project no:** CE851700

Document no: CE851700-3 **Project manager:** Tom Mahood

Revision no: Final **Prepared by:** Melissa Larocque
Mauricio Rojas
Ray Yu

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Jacobs Consultancy Canada Inc.

T +1.519.579.3500
www.jacobs.com

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Acronyms and abbreviations

ADD	Average Day Demand
CT	Contact Time
DWWP	Drinking Water Works Permit
DGSS	Design Guidelines and Supplemental Specifications for Municipal Services
EA	Environmental Assessment
FF	Fire Flow
FFA	Fire Flow Available
FFICI	Fire Flow (Industrial/Commercial/Institutional)
FFR	Fire Flow (Residential)
FUS	Fire Underwriters Survey
GCDWQ	Guideline for Canadian Drinking Water Quality
I/I	Inflow and infiltration
ICI	Industrial/Commercial/Institutional
IUS	Integrated Urban System
L/d	litre per day
L/s	litre per second
m ³ /d	cubic metres per day
MAC	Maximum Acceptable Concentration
MCEA	Municipal Class Environmental Assessment
MDD	Maximum Day Demand
MDWL	Municipal Drinking Water License
MECP	Ministry of the Environment, Conservation and Parks
mg/L	milligrams per litre
N/A	Not Applicable
NFPA	National Fire Protection Association
ODWQS	Ontario Drinking Water Quality Standards
PFAS	Per- and polyfluoroalkyl substances
PFFR	Preferred Fire Flow (Residential)
PFOA	Perfluorooctanoic acid

TM3: Water Infrastructure Alternatives Development

PFOS	Perfluorooctane sulfonate
PHD	Peak Hour Demand
PTTW	Permit to Take Water
Region	Region of Waterloo
TM	Technical Memorandum
Township	Township of Wellesley
VFD	Variable Frequency Drive
WTP	Water Treatment Plant
WWWMP	Wellesley Water and Wastewater Master Plan

1. Introduction

The Township of Wellesley (Township) is one of seven area municipalities in the Region of Waterloo (Region). The Township is a rural community comprised of eleven settlement areas, including the Wellesley Urban Area. The Wellesley Urban Area is currently the only settlement area with both municipal wastewater and water servicing. The Region is responsible for maintaining existing levels of service within the water and wastewater systems to provide capacity to the existing population, as well as planning for new growth in the service area and meeting regulatory requirements. To plan and budget for water and wastewater upgrades and new infrastructure to address existing issues and meet future needs to 2051, the Region is undertaking the Wellesley Water and Wastewater Master Plan (WWWMP).

The purpose of the WWWMP is to address anticipated water and wastewater infrastructure needs over the next 30 years, and in doing so, improve the reliability and resiliency of its water and wastewater assets. The goals of the WWWMP include identifying new projects required to meet the purpose of the WWWMP, and systematically developing a prioritized implementation plan that is endorsed by the Region and project stakeholders. The WWWMP will fulfill the requirements of Phase 1 and Phase 2 of the Municipal Class Environmental Assessment (MCEA) process for Water and Wastewater Projects.

The purpose of this WWWMP Technical Memorandum (TM3) is to establish water supply and demand under existing and future conditions for the Wellesley Urban Area, determine system storage requirements, identify the system constraints, and develop the alternatives to address the identified system constraints in a manner consistent with the MEA Class EA process.

The specific objectives of TM3 are to:

- Establish future water demand projections,
- Confirm fire flow requirements,
- Evaluate system storage requirements,
- Review water distribution sufficiency,
- Identify opportunities and constraints of the water supply and water distribution system,
- Develop and screen alternatives to address issues and accommodate increased future projected demand within the Wellesley Urban Area's water treatment, and supply and water distribution system.

2. Future Needs and Constraints – Water Supply, Treatment, and Distribution

2.1 Water Supply System

2.1.1 Water Treatment Plant and Well Taking Capacity

A summary of various methodologies for calculating future flows is provided in Table 2-1. The Region's 2022 Design Guidelines and Supplemental Specifications for Municipal Services (DGSS) (Region of Waterloo et. al., February 2022) suggest using a per capita demand of 225 L/cap/d. The Ministry of the Environment, Conservation and Parks (MECP)'s 2019 Design Guidelines for Drinking-Water Systems recommends a per capita demand of 270-450 L/cap/d, with a maximum day demand (MDD) factor of 2.0 and a peak hour demand (PHD) factor of 3.0 for a population between 3,000 and 10,000 people.

Historical flow data from 2018 to 2022 were reviewed in TM1 to establish the current demand. The ADF over this time period was calculated to be 668 m³/d, with an average MDD factor of 1.69 and an average PHD factor of 2.28. Per capita demands were estimated for each year. The average per capita demand from 2018 to 2022 was 179 L/cap/day, with a maximum demand of 194 L/cap/day in 2022. These historical records are lower than both the DGSS and the MECP values, however the MECP Design Guidelines recommend using existing records for design purposes when possible. The suggested per capita demands from both the DGSS and MECP will overpredict the future drinking water demand for Wellesley, given that the historical data suggests that actual use is 20 to 30 percent lower.

As shown in Table 2-1, while the calculated per capita water demand is likely the result of the water conservation efforts that the Region has taken in recent years, it is approximately 30 percent lower than the historical per capita wastewater treatment plant flow of 239 L/cap/day (refer to TM4: Wastewater Infrastructure Alternatives Development). This is likely due to inflow and infiltration (I/I), as previous studies described in TM1 indicate that I/I is expected to comprise 20 to 30 percent of the wastewater flows and service area for the water distribution and wastewater collection systems are similar based on the review of the water distribution and sanitary hydraulic models completed in TM1.

The 2015 Integrated Urban System Master Plan was also reviewed, which documents the decreased detached and semi-detached residential water use of 165 L/cap/d (Stantec Consulting Ltd., 2015). This value is slightly lower than the average calculated per capita demand and is also approximately 30 percent lower than the per capita wastewater treatment plant loadings.

The recent historical (2018 to 2022) average per capita demand of 179 L/cap/d were used in the WWWMP. This is a conservative value and considers that this does not include per capita flow contributions from the equivalent employment population.

Table 2-1. Water Treatment and Distribution Future Flows

Parameter	DGSS	MECP	Integrated Urban System MP	Historical Average
Average per Capita Demand (L/c/d)	225	270-450	165	179
MDD Factor	N/A	2.0	N/A	1.69
PHD Factor	N/A	3.0	N/A	2.28

Based on the average historical flow data from 2018 to 2022, the following forms the basis of the future flow projections:

- Average per capita demand: 179 L/cap/day

- Max Day Demand (MDD) Factor: 1.69
- Peak Hour Demand (PHD) Factor: 2.28

These factors were applied to the population projections developed in TM1. The flow projections are shown in Table 2-2 and Figure 2-1.

The rated capacity for the existing Wellesley Water Treatment Plant (WTP) is 3,006 cubic metres per day (m^3/d) as stated in the Drinking Water Works Permit (DWWP) No. 012-215 and Municipal Drinking Water License (MDWL) No. 012-115, both dated April 20, 2021. The total water taking limit is 1,044 litres per minute (L/min), or 1,503 m^3/d , as specified in the Permit To Take Water (PTTW) No. 0345-94UQ6A dated March 6, 2013. The PTTW specifies that one well or multiple wells in any combination at any time may be operated as long as the rate and amount of taking at any time does not exceed 1,044 L/min and 1,503,360 litres per day (L/d).

The current rated WTP capacity is not expected to be exceeded throughout the planning horizon (to 2051); however, the projected MDD will exceed the well taking capacity by 2034. Therefore, well capacity will need to be expanded by 2034 to provide a minimum additional well capacity of 196 m^3/d assuming the current maximum well taking rate is equal to the limit in the PTTW of 1,503 m^3/d . A plan to find additional well supply sources should be initiated 8 to 10 years ahead of that time around 2025. The PHD is also projected to exceed the well taking capacity, however peak flows are accommodated through the storage volume in the reservoir, therefore future well capacity needs were based on the MDD projection.

Table 2-2. Flow Projections

Year	Average Day Demand (ADD), m^3/d	Max Day Demand (MDD), m^3/d	Peak Hour Demand (PHD), m^3/d
2016	605	1,022	1,379
2021	668	1,128	1,522
2026	715	1,208	1,629
2031	821	1,388	1,872
2036	934	1,578	2,130
2041	974	1,647	2,221
2046	988	1,669	2,252
2051	1,005	1,699	2,292

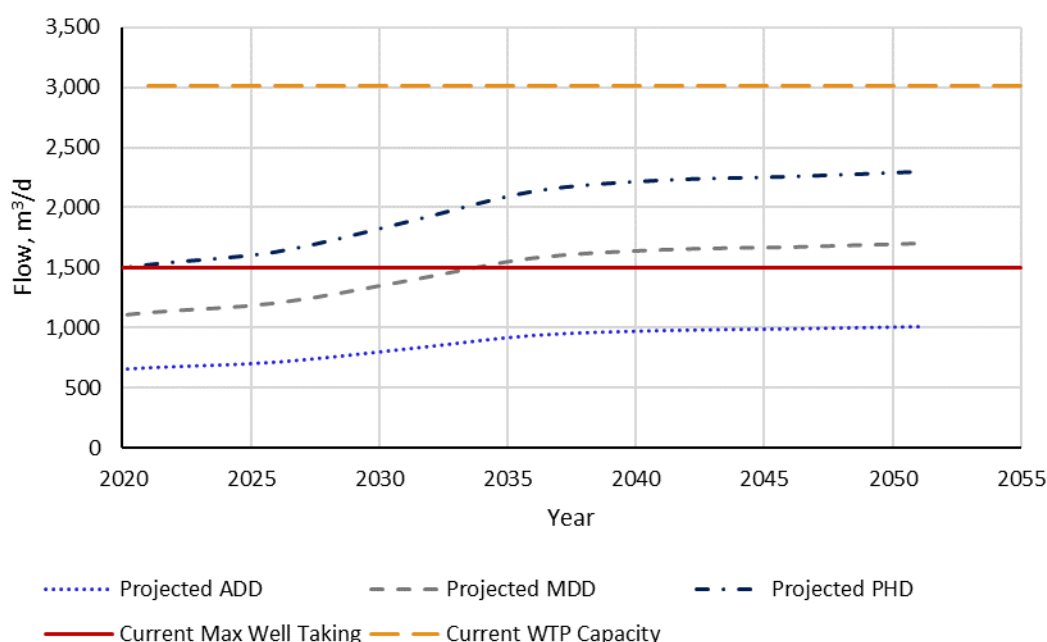


Figure 2-1. Flow Projections for Wellesley WTP

2.1.2 Water Quality

A water quality review was completed in TM1: Summary of Project Background, where most of the treated water parameters were found to comply with the regulatory limits or aesthetic objectives from the Ontario Drinking Water Quality Standards (ODWQS, Ontario Regulation 169/03) or the objectives from the Guideline for Canadian Drinking Water Quality (GCDWQ). Note that, in Ontario, the ODWQS must be adhered to per regulatory requirements. The GCDWQ guidelines were reviewed as supplemental reference information but are not regulatory requirements. There were two main observations:

- Naturally occurring strontium concentrations in the raw water were approximately 220 percent higher than the maximum acceptable concentration (MAC) guideline from the GCDWQ of 7 milligrams per litre (mg/L) (Health Canada, 2023). The current treatment processes at the WTP are not effective in removing strontium; however, no regulatory limit for strontium in Ontario currently exists.
- Naturally occurring fluoride concentrations in the treated water were on average around 75 percent of the ODWQS regulatory limit of 1.5 mg/L (Province of Ontario, 2020). The highest measured fluoride concentration was 90 percent of the regulatory limit. The Region continues to monitor fluoride levels and has developed an action plan in conjunction with Public Health and the MECP.

The Wellesley WTP treated water is currently in compliance with all regulatory limits. However, should strontium become regulated within the planning horizon, alternative approaches for treatment will need to be considered. Preliminary alternatives for strontium treatment have been developed and evaluated in the Region of Waterloo 2020 strontium treatment study (CH2M HILL Canada Limited, 2020).

Per- and polyfluoroalkyl substances (PFAS) are an emerging contaminant of concern due to their widespread use and long residence time in the environment. Health Canada has established Maximum Acceptable Concentrations (MAC) guidelines for some PFAS: perfluorooctane sulfonate (PFOS) with a MAC of 0.0006 mg/L, and perfluorooctanoic acid (PFOA) with a MAC of 0.002 mg/L (Health Canada, 2023). The Region currently does not monitor PFAS in drinking water. No regulatory limit for PFAS currently exists but future regulations are expected within the planning horizon for this Master Plan in Ontario. We recommend, therefore, that the Region develop an action plan for PFAS.

2.1.3 Fire Flow

The required future fire flows were estimated using two methods:

1. MECP Design Guidelines for Drinking-Water Systems (MECP, 2019)
2. Fire Underwriters Survey (FUS) Water Supply for Public Fire Protection (FUS, 2020)

The MECP Design Guideline provides recommended fire flows and durations based on the equivalent population. By 2051, the population in Wellesley is projected to be 5,617. According to the MECP Design Guidelines, a population of this size requires a fire flow of 159 L/s at a 3-hour duration.

Fire flows under the FUS method are calculated for different building types based on details such as square footage, materials of construction, occupancy, sprinkler protection, and exposure. These details are not readily available, therefore estimating fire flows for individual buildings is not practical for the master planning purpose. Fire flows for various property types were developed by the nearby City of Waterloo in its most recent Water Distribution Master Plan (GM BluePlan, 2017). These values were used to estimate the necessary fire flows for residential and commercial properties in the study area. The fire flow requirement for industrial properties from the Water Distribution Master Plan is overly conservative as the industrial properties in the Wellesley study area are relatively small and function more similarly to commercial properties.

The expected future required fire flows and durations by 2051 for both methods and three different property types are summarized in Table 2-3.

Table 2-3. Fire Flows and Durations Required by 2051

Method	Required Fire Flow (L/s)	Duration (h)
MECP	159	3.00
FUS – Residential	75	1.63
FUS – Commercial	175	2.13
FUS - Industrial	233	3.00

The basis for the fire flows for the various building types were reviewed with the local fire department to confirm these estimates are sufficient for their needs as part of the engagement activities for this Master Plan.

The fire flow requirements by building types, can be summarized as follows:

- Fire Flow (Industrial/Commercial/Institutional [FFICI]): 175 L/s – Duration: 2.13 hours
- Residential Fire Flow: minimum 75 L/s (FFR)
- Preferred Residential Fire Flow: minimum preferred 125 L/s (PFFR)

The fire flow for commercial properties from the Water Distribution Master Plan (i.e., 175 L/s) will be used for assessing the storage capacity at the Wellesley WTP because commercial property most accurately reflects the size of existing properties in the Wellesley Urban Area.

Fire flows delivered through the existing water distribution network are subject to the availability of capacity in the network and there are practical limits to the fire flows that can reasonably be supplied. Under the current operating strategy, the fire department supplements fire flows delivered through the water distribution network with their own supply delivered via tanker truck. The fire flows for the various building types calculated above are used as a guideline and it has been assumed that these flows will be delivered through the existing distribution system to its current capacity and supplemented by the fire department via tanker truck which is consistent with current practice. Distribution system capacity is discussed further in Section 2.2.4.

The ICI fire flow requirements were determined based on the Official Plan land use designations and from the billing records for properties classified as industrial users. Fire flow requirements established based on this methodology for the Wellesley Urban Area are illustrated in Figure 2-2.

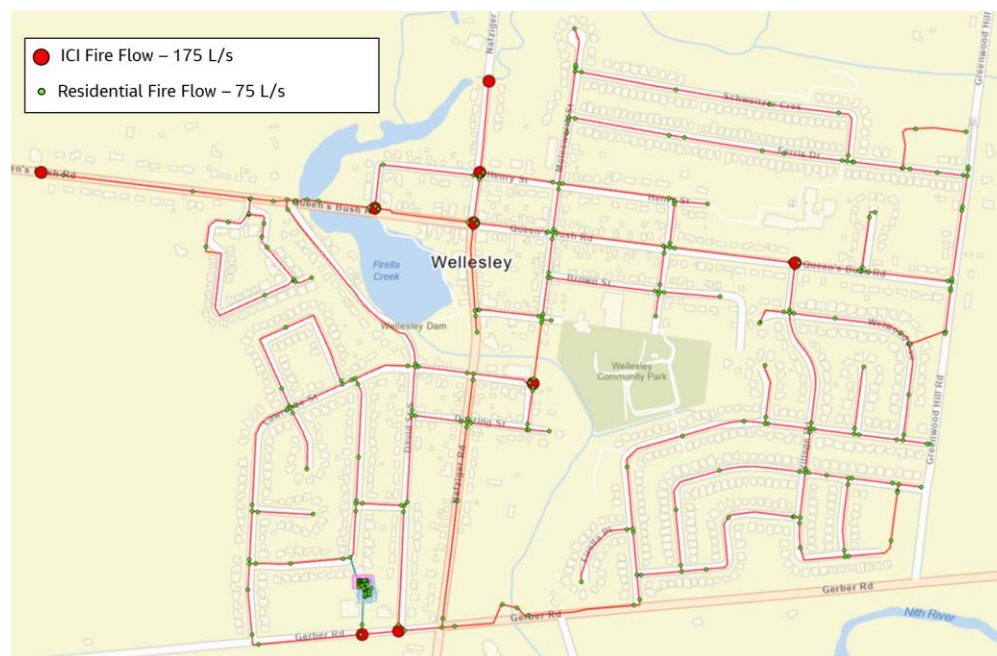


Figure 2-2. ICI and Residential Fire Flow Requirements

2.1.4 Pumping Capacity

The high lift pump station consists of the following pumps:

- Three (3) high lift pumps, each with a capacity of 15.5 L/s at 42.5 m total dynamic head (TDH)
- Two (2) high lift pumps, each with a capacity of 60 L/s at 42.5 m TDH

The total pumping capacity (i.e., with all five pumps operating) is 166.5 L/s. The pump station serves as the sole source of supply for the pressure zone as there is currently no floating storage in the distribution system. In this case, firm pumping capacity for domestic use is calculated as the capacity with the two largest units out of service according to the methodology in the Ministry of the Environment, Conservation and Parks (MECP) Design Guidelines for Drinking-Water Systems (MECP, 2019). The firm capacity of the pump station is 47 L/s. Maximum domestic use is defined by the PHD. As shown in Table 2-4, the pump station has excess total and firm pumping capacity to meet the PHD throughout the planning horizon (to 2051).

Table 2-4. Projected Pumping Recommendations for Domestic Demand

Year	PHD (L/s)	Total Pumping Capacity (L/s)	Firm Pumping Capacity (L/s)
2021	17.6	166.5	47.0
2026	18.9	166.5	47.0
2031	21.7	166.5	47.0
2036	24.6	166.5	47.0
2041	25.7	166.5	47.0
2046	26.1	166.5	47.0
2051	26.5	166.5	47.0

As there is no floating storage in the distribution system, per the MECP Design Guidelines, it is recommended that the high lift pump station provide both the fire flow and MDD in an emergency scenario (MECP, 2019). Firm capacity for emergency use is equal to the total pumping capacity of 166.5 L/s as the National Fire Protection Association (NFPA) 20: Standard for the Installation of Stationary Pumps for Fire Protection does not require a duty/standby configuration for fire emergency demand (NFPA, 2022).

The projected pumping recommendations are presented in Table 2-5, based on the fire flow for ICI properties described in Section 2.1.3. An additional capacity of 28.2 L/s is recommended by 2051 to meet the emergency demand. If the pump station is maintained as the sole source of supply to the distribution system, these additional flows can be provided by upgrading the pump station capacity or by supplementing the existing pump station with the fire department's water supply delivered via tanker truck. For planning purposes, the maximum flows in Table 2-5 are used to analyze the future CT volume needs. The pump station capacity can only be upgraded to match the practical capacity limitations of the existing water distribution system. Any flows needed beyond this capacity should be provided via the fire department's own supply for emergency demand. Distribution system capacity is discussed further in Section 2.2.4.

Table 2-5. Projected Pumping Recommendations for Emergency Demand

Year	Fire Flow (L/s)	MDD (L/s)	Maximum Demand (L/s) – Sum of Fire Flow and MDD	Additional Capacity to Meet Maximum Demand (L/s)
2021	175	13.1	188	21.6
2026	175	14.0	189	22.5
2031	175	16.1	191	24.6
2036	175	18.3	193	26.8
2041	175	19.1	194	27.6
2046	175	19.3	194	27.8
2051	175	19.7	195	28.2

2.1.5 Chlorine Contact Time (CT) Volume

2.1.5.1 Current Conditions

The current CT volume regulatory requirements are summarized in Table 2-6 based on existing regulations. The CT volume was calculated using the methodology from the MECP Procedure for Disinfection of Drinking Water in Ontario (MECP, 2021) with the following assumptions:

- pH range: 6 to 9
- Temperature: 10°C, based on the historical temperature records from 2017 to 2023
- Baffle factor: 0.1 to be consistent with the existing baffle factor. We are aware that curtain baffle walls will be added to Reservoir Cells B and C under the ongoing WTP upgrades by CIMA+ which have the potential to increase the baffle factor in these cells (to 0.3 as suggested by CIMA+ (CIMA+, May 2021)). For planning purposes, 0.1 has been maintained as the baffle factor to provide the most conservative estimate. Following the upgrades, the Region could conduct an assessment (e.g., tracer tests or computational fluid dynamics) to estimate the new baffle factor more accurately.
- Free chlorine residual: 0.66 mg/L, which is the minimum free chlorine residual recorded in the plant discharge from 2017 to 2022.
- Maximum operating high lift pumping flow rate: 130 L/s (based on communications from the Region).
- CT value of 3 min mg/L with free chlorine as oxidant to provide 2-log virus inactivation for primary disinfection. The MDWL for the Wellesley WTP (License 012-115, Issue No. 3, dated April 20th, 2021) specifies a minimum 2-log virus inactivation requirement. This requirement is consistent with MECP guidance for primary disinfection of groundwater (MECP, 2021). The 2-log virus inactivation is the current regulatory requirement.

The existing reservoir consists of three cells with a maximum available volume of 902.3 m³. The maximum available volume represents the storage capacity between the high-water level and floor level in all three reservoir cells. The Wellesley WTP does not have a separate chlorine contact tank to provide CT volume. Therefore, the CT volume must be reserved at all times in the reservoir to meet primary disinfection needs. Any other treated water storage needed would be additive with the CT volume in this case.

As shown in Table 2-6, the existing reservoir currently has sufficient capacity to meet the CT regulatory requirement for 2-log virus inactivation at the maximum operating flow condition (130 L/s). However, it should be noted that the reservoir should be operated with the minimum volume to meet the “2-log virus inactivation requirement” during an emergency event. This will impose an operational restriction on the maximum volume that can be withdrawn during such an event as the reservoir volume cannot drop below 355 m³ in any scenario.

Table 2-6. Current Primary Disinfection Requirements and CT Volumes

Disinfection Level	CT Value (min mg/L) with free chlorine as oxidant, pH of 6 to 9, and temperature of 10°C	CT Volume (m ³)	Remaining Reservoir Volume after meeting CT Volume (m ³)
2-log Virus Inactivation (Required)	3	355	548

2.1.5.2 Future Conditions

The future CT volume was calculated using the methodology from the MECP Procedure for Disinfection of Drinking Water in Ontario (MECP, 2021) with the following assumptions:

- pH range: 6 to 9
- Temperature: 10°C, based on the historical temperature records from 2017 to 2023
- Baffle factor: 0.1
- Free chlorine residual: 0.66 mg/L, which is the minimum free chlorine residual recorded in the plant effluent from 2017 to 2022.
- Projected maximum flow rate: calculated as the sum of the fire flow and MDD to allow for CT recommendations to be met at the maximum discharge rate.
- CT value of 6 min mg/L with free chlorine as oxidant to provide 4-log virus inactivation for primary disinfection. Currently, only 2-log virus inactivation is required by regulation. It is anticipated that the regulatory requirements may be revised to 4-log virus inactivation within the planning horizon. Therefore, 4-log virus inactivation will be used for planning purposes.

The maximum flow through the reservoir is equal to the maximum flow rate from the high lift pumps in a fire emergency event as there is no overflow weir at the reservoir upstream of the high lift pumps. Therefore, primary disinfection should be met at the maximum flow condition (i.e., the sum of fire flow and MDD).

Table 2-7 presents the projected CT volume requirements, for 2-log virus inactivation, and targets for 4-log virus inactivation, throughout the planning horizon.

As shown in Table 2-7, the existing reservoir does not provide sufficient CT volume for 4-log virus inactivation under an emergency event. To meet the CT volume for 4-log virus inactivation at the same flow condition, an additional 160 m³ of reservoir capacity is recommended to be added by 2051 if the pump station is maintained as the sole source of supply.

At any time, the CT volume should be reserved in the reservoir to meet primary disinfection needs as there is no separate chlorine contact tank. The calculated CT volume could be reduced by changing operational strategies, such as increasing the free chlorine residual, re-quantifying the baffle factor, or reducing the projected maximum flow rate by supplementing fire flows from the fire department.

Table 2-7. Projected CT Volumes to Achieve 4-log Virus Inactivation

Year	CT Volume Recommendation for 4-log virus inactivation (m ³)	Remaining Reservoir Volume after Meeting CT Recommendation for 4-log virus inactivation (m ³)
2021	1,026	-124
2026	1,031	-129
2031	1,042	-140
2036	1,054	-152
2041	1,058	-156
2046	1,060	-158
2051	1,062	-160

2.1.6 Storage Capacity

Treated water storage volumes were calculated using the methodology described in the MECP Design Guidelines for Drinking Water Systems. The MECP treated water storage requirement consists of the sum of the following three components:

1. Fire Storage: Calculated based on the fire flow described in Section 2.1.3.
2. Equalization Storage: Calculated as 25 percent of the MDD.
3. Emergency Storage: Calculated as 25 percent of the sum of fire storage and equalization storage.

The projected storage recommendations to 2051 are presented in Table 2-8. The reservoir represents the total storage capacity as there is no floating storage in the distribution system, however, the full reservoir capacity would also be needed to meet the future projected CT volume discussed in Section 2.1.5. As noted in Section 2.1.5, the CT volume must be reserved in the reservoir at all times to meet primary disinfection needs as there is no separate chlorine contact tank. The treated water storage for fire, equalization and emergency demand is therefore added to the CT volume to determine the total reservoir capacity needed. An additional 2,204 m³ of storage is recommended to be added by 2051 for fire, equalization and emergency demand, for a total reservoir capacity of 3,266 m³.

The fire storage is based on the fire flow guidelines for ICI properties discussed in Section 2.1.3. Fire storage is subject to the availability of capacity in the distribution system and there are practical limits to the fire flows that can reasonably be supplied. As discussed in Section 2.1.3, any fire flows needed beyond the practical capacity of the water distribution system would be supplemented through the fire department's own supply delivered via tanker truck as is consistent with current practice. The reservoir therefore may not need to provide the full fire storage as any additional fire storage needs can be met by the fire department's own supply.

Table 2-8. Projected Storage Recommendations

Year	Fire Storage (m ³)	Equalization Storage (m ³)	Emergency Demand (m ³)	Total Treated Water Storage (m ³)
2021	1,339	282	405	2,026
2026	1,339	302	410	2,051
2031	1,339	347	421	2,107
2036	1,339	395	433	2,167
2041	1,339	412	438	2,188
2046	1,339	417	439	2,195
2051	1,339	425	441	2,204

2.1.7 Summary of Constraints

Table 2-9 presents the design basis for the 2051 planning horizon. The key issues identified, in order of priority, include:

- **Chlorine CT Volume:** The existing reservoir at the Wellesley WTP provides a maximum CT volume of 902.3 m³. Based on the current operating strategy with the pump station as the sole source of supply, this volume is sufficient to meet the current CT volume regulatory requirement for 2-log virus inactivation. To achieve the projected future CT volume for 4-log virus inactivation, the addition of 160 m³ of CT volume would be recommended.

- **Treated Water Storage Capacity:** The existing reservoir at the Wellesley WTP represents the total storage capacity as there is no floating storage in the distribution system. This volume is insufficient to meet the projected future CT volume for 4-log virus inactivation as well as fire, equalization and emergency storage recommendations.
- **Firm Pumping Capacity for Emergency Demand:** The pump station serves as the sole source of supply; therefore, the pumps should meet both the fire flow and MDD in an emergency scenario. The emergency use firm pumping capacity of 166.5 L/s with all five pumps in operation cannot meet the fire flow demand of 175 L/s. Upgrading the pump station may not be feasible due to the practical limitations of the existing water distribution system capacity. Requirements for the fire flows can be supplemented from the fire department's tanker truck as being currently practiced. Firm pumping capacity for domestic use, however, is sufficient to meet PHD throughout the planning horizon.
- **Well Capacity:** The current maximum well taking capacity is 1,503 m³/d. The projected MDD is expected to exceed this capacity by 2034, therefore a plan for obtaining a minimum of 196 m³/d additional well capacity should be initiated around 2025. The Wellesley WTP, however, has sufficient capacity (3,006 m³/d) for treatment throughout the planning horizon.
- **Water Quality:** The Wellesley WTP treated water is currently in compliance with all regulatory limits in Ontario. However, should strontium become regulated within the planning horizon, alternative approaches for treatment will need to be considered. The potential impacts to strontium and fluoride concentrations are considered in the evaluation of alternatives through criteria such as public health and safety and meeting existing and future needs.

The issues identified in Table 2-9 are based on the current water system configuration, in which storage is only provided through the reservoir at the Wellesley WTP (i.e., no floating storage), and the pump station serves as the sole source of supply.

Table 2-9. Planning Design Basis for Wellesley WTP

Parameter	2051 Recommended Capacity	Current Capacity	Recommended Additional Capacity
ADD, m ³ /d	1,005	1,503 ^a	Not Applicable (N/A)
MDD, m ³ /d	1,699	1,503 ^a	61
CT Volume, m ³	1,062	902.3	160
Fire, Equalization and Emergency Storage, m ³	2,204	N/A	2,204
Firm Pumping Capacity for Domestic Use (L/s)	26.5	47.0	N/A
Firm Pumping Capacity for Emergency Use (L/s)	195.0	166.5	28.2

a. Overall capacity is limited by the well taking capacity of 1,503 m³/d. The WTP capacity of 3,006 m³/d is sufficient for current and future needs (to 2051).

2.2 Water Distribution System

2.2.1 Water Distribution System Modeling and Results

The updated water distribution model was used to examine issues in the water distribution system. The model was run for ADD and MDD under current conditions and future conditions in 5-years intervals until 2051. Results are presented in Table 2-10.

In addition, the fire flow availability was estimated by performing fire flow runs under MDD conditions for the same years. Results are presented in Table 2-11.

Table 2-10. Water Distribution System Pressures

Year	Scenario	Minimum System Pressure (psi)	Average System Pressure (psi)	Maximum System Pressure (psi)
2021	MDD (minimum pressure in 24 h)	54.6	65.7	86.0
2021	ADD (maximum pressure in 24 h)	55.3	66.3	86.6
2026	MDD (minimum pressure in 24 h)	54.6	65.6	86.0
2026	ADD (maximum pressure in 24 h)	55.3	66.2	86.5
2031	MDD (minimum pressure in 24 h)	54.5	65.5	85.9
2031	ADD (maximum pressure in 24 h)	55.3	66.2	86.5
2036	MDD (minimum pressure in 24 h)	54.3	65.3	85.7
2036	ADD (maximum pressure in 24 h)	55.2	66.2	86.5
2041	MDD (minimum pressure in 24 h)	54.2	65.2	85.6
2041	ADD (maximum pressure in 24 h)	55.2	66.2	86.5
2046	MDD (minimum pressure in 24 h)	54.1	65.2	85.6
2046	ADD (maximum pressure in 24 h)	55.2	66.2	86.5
2051	MDD (minimum pressure in 24 h)	54.1	65.2	85.6
2051	ADD (maximum pressure in 24 h)	55.2	66.2	86.5

Notes:

The minimum pressure under MDD conditions refers to temporal variation during the 24 hours simulation.

The maximum pressure under ADD conditions refers to temporal variation during the 24 hours simulation.

The columns that show minimum, average and maximum pressures refer to geographical variation throughout the system.

Table 2-11. Water Distribution System Fire Flow Available

Year	Scenario	Minimum FF Available (L/s)	Average FF Available (L/s)	Maximum FF Available (L/s)	No. Nodes Failed (out of 265 total) Residential FF (Acceptable, 75 L/s)	No. Nodes Failed (out of 265 total) Residential FF (Preferred, 125 L/s)	No. Nodes Failed (out of 9 total) ICI FF (175 L/s)
2021	MDD + FF	17.7	143.5	199.6	2	34	6
2026	MDD + FF	17.7	143.3	199.3	2	34	6
2031	MDD + FF	17.6	141.6	196.7	2	34	6
2036	MDD + FF	17.6	140.1	194.7	2	48	7
2041	MDD + FF	17.5	139.3	193.8	2	54	7
2046	MDD + FF	17.5	139.1	193.5	2	55	7
2051	MDD + FF	17.5	138.8	193.1	2	58	7

Notes:

FF indicates fire flow

The columns that show minimum, average and maximum FF available refer to geographical variation throughout the system. Results are based on the hydraulic model and do not reflect the current available supply.

2.2.2 Evaluation Criteria

Table 2-12 specifies the minimum and maximum acceptable pressures according to the Region of Waterloo and Area Municipalities Design Guidelines and Supplemental Specifications for Municipal Services (Region of Waterloo et. al., February 2022).

Table 2-12. Minimum and Maximum Pressures

Scenario	Pressure (kPa / psi)
Pressure under non-fire flow demand scenario	>275 kPa (40 psi)
Maximum Day plus fire flow	>140 kPa (20 psi)
Maximum static pressure	<700 kPa (100 psi)

The preferred design pressure ranges for average day and maximum day are 350 kPa (50 psi) to 550 kPa (80 psi). The preferred minimum hour and peak hour pressure ranges are 275 kPa and 700 kPa.

2.2.3 ADD and MDD Analysis

Given that the flow from the high lift pumps is controlled by variable frequency drives (VFD), the pressure at the discharge header was modelled to a fixed value of 66 psi (according to the calibrated water model provided). As a result, the pressure varies very little throughout the day and/or between ADD and MDD for a given node in the system as shown in Table 2-10. Moreover, there is little or no difference between the pressures for 2021 and 2051. The pressure ranges approximately between 54 psi and 86 psi with an average value around 66 psi which is within the acceptable values of 40 psi and 100 psi as minimum pressure and maximum pressure respectively. The same was observed for all the 5-years intervals analyzed between 2021 and 2051. Therefore, no issues were observed in the water system relative to water pressures under ADD and MDD for any of the years considered.

2.2.4 Fire Flow Analysis

The fire flow analysis shows that all the nodes in the system (265 nodes in the model) meet the residential fire flow of 75 L/s except for 2 nodes located at dead-ends both for existing conditions and for future conditions up to 2051 as shown in Figure 2-3 and Figure 2-4.

As for preferred residential fire flow (125 L/s), the number of nodes (out of 265) that have less than 125 L/s of fire flow available ranges from 34 to 58 for 2021 MDD and 2051 MDD conditions respectively (that is 13% to 22% of total number of nodes respectively).

As for ICI fire flow (175 L/s), 6 nodes (out of 9) in the system have less than 175 L/s of fire flow available for all the time periods analyzed from 2021 to 2031. The number of nodes that have less than 175 L/s of fire flow available increases to 7 for all the time periods analyzed from 2031 to 2051.

Table 2-13 show for all 9 ICI nodes in the system, the fire flow available for all the time periods considered and what is the deficit or surplus when compared to 175 L/s. If there is deficit when compared to 175 L/s, this deficit would be supplied by the fire department using tanker trucks as is the current practice. The Region should continue to coordinate with the fire department to achieve these fire flows, and update watermains if there are changes to the existing practice. This is to be further investigated as additional planning information is made available to the Region in regard to the anticipated future development.

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Table 2-13. ICI Fire Flow Available at 9 Locations Considered

Model Node	Location	ICI (Type)	ICI Basis Fire Flow (L/s)	Fire Flow available (L/s); Deficit/Surplus (L/s)													
				2021		2026		2031		2036		2041		2046		2051	
JCT_10005	Queens Bush Rd east of Hutchinson Rd	Recreation Centre	175	105.0	-70.0	105.0	-70.0	104.1	-70.9	103.5	-71.5	103.1	-71.9	103.0	-72.0	102.8	-72.2
JCT_10138	Queens Bush Rd and Nafziger Rd	Livestock Feed	175	158.2	-16.8	158.0	-17.0	156.0	-19.0	154.3	-20.7	153.4	-21.6	153.1	-21.9	152.8	-22.2
JCT_10102	Nafziger Rd 270 m north of Henry St	Food production	175	136.2	-38.8	136.0	-39.0	134.5	-40.5	133.2	-41.8	132.6	-42.4	132.4	-42.6	132.1	-42.9
JCT_10079	Queens Bush and Water St	Computers	175	159.5	-15.5	159.2	-15.8	157.4	-17.6	155.7	-19.3	154.9	-20.1	154.6	-20.4	154.3	-20.7
JCT_10103	Henry St and Nafziger Rd	Library	175	147.4	-27.6	147.1	-27.9	145.3	-29.7	143.6	-31.4	142.8	-32.2	142.5	-32.5	142.2	-32.8
JCT_10028	Nafziger Rd and Gerber Rd	Furniture Store	175	187.6	12.6	187.3	12.3	184.9	9.9	183.0	8.0	182.1	7.1	181.8	6.8	181.4	6.4
JCT_10165	Queens Bush and Village Rd	Public School	175	139.3	-35.7	139.1	-35.9	137.2	-37.8	135.4	-39.6	134.6	-40.4	134.3	-40.7	133.9	-41.1
JCT_10002	Nafziger Rd and Lawrence St	Motorcycle Shop	175	178.1	3.1	177.8	2.8	175.7	0.7	173.9	-1.1	173.1	-1.9	172.8	-2.2	172.4	-2.6
JCT_10029	Gerber Rd 110 m west of David St	Packaging Equipment	175	199.6	24.6	199.3	24.3	196.7	21.7	194.7	19.7	193.8	18.8	193.5	18.5	193.1	18.1

Note: The fire flow available is to be supplied by the water distribution system when it is larger than 175 L/s. If the fire flow available is less than 175 L/s, this amount of flow should be supplied by the water distribution system and the deficit should be supplied by the fire department using tanker trucks as the current practice.

TM3: Water Infrastructure Alternatives Development

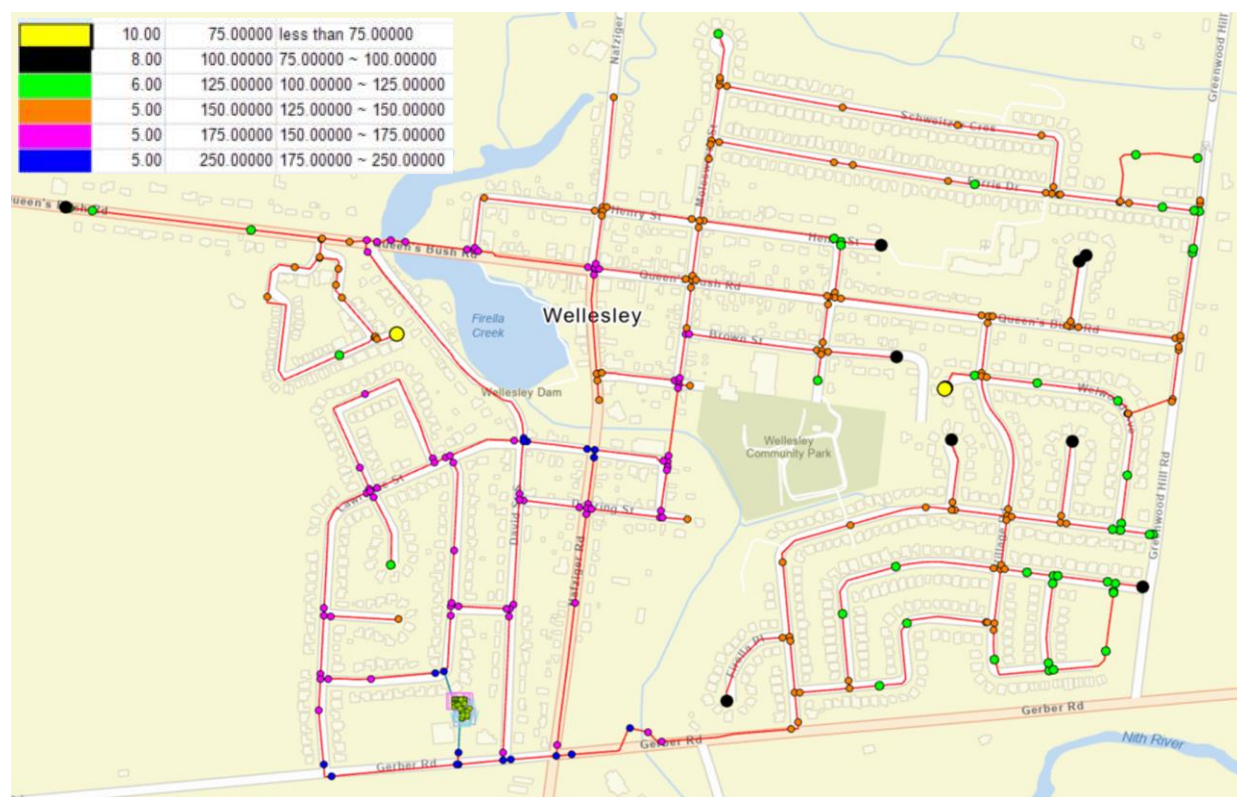


Figure 2-3. 2021 Fire Flow Availability

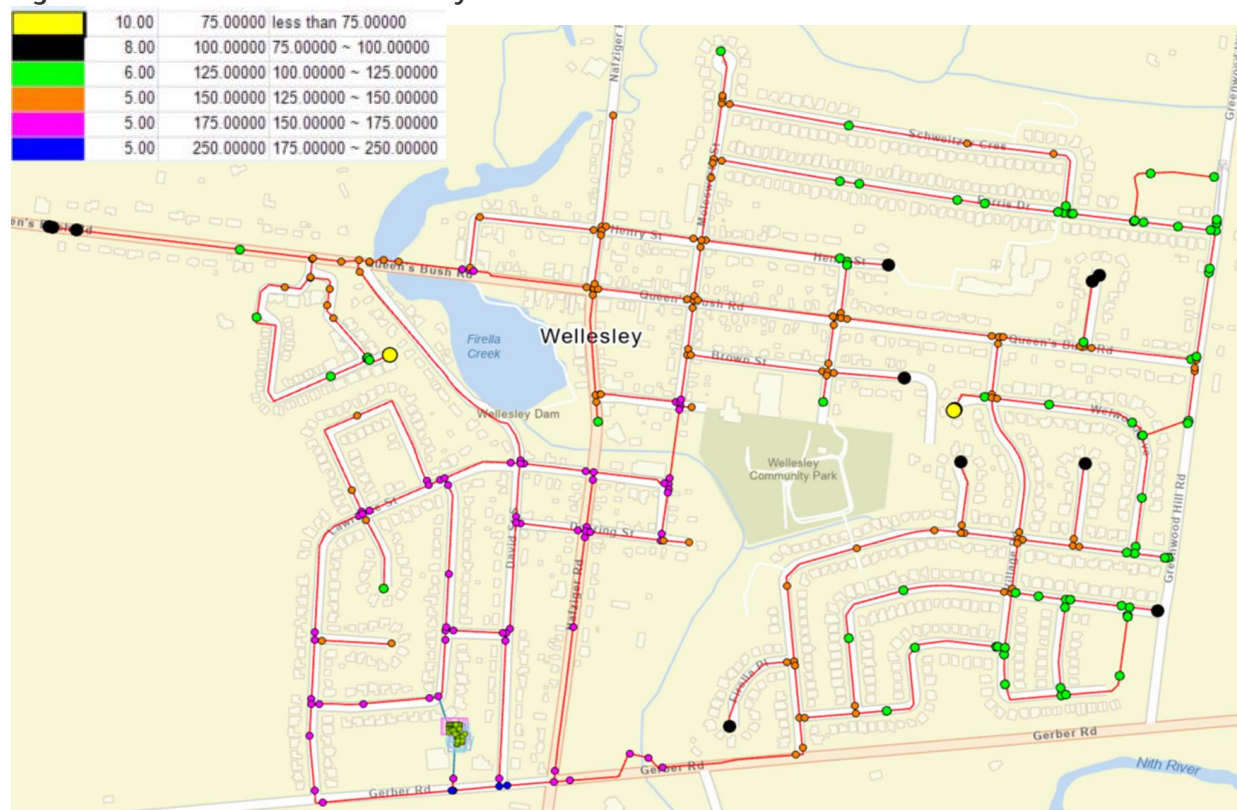


Figure 2-4. 2051 Fire Flow Availability

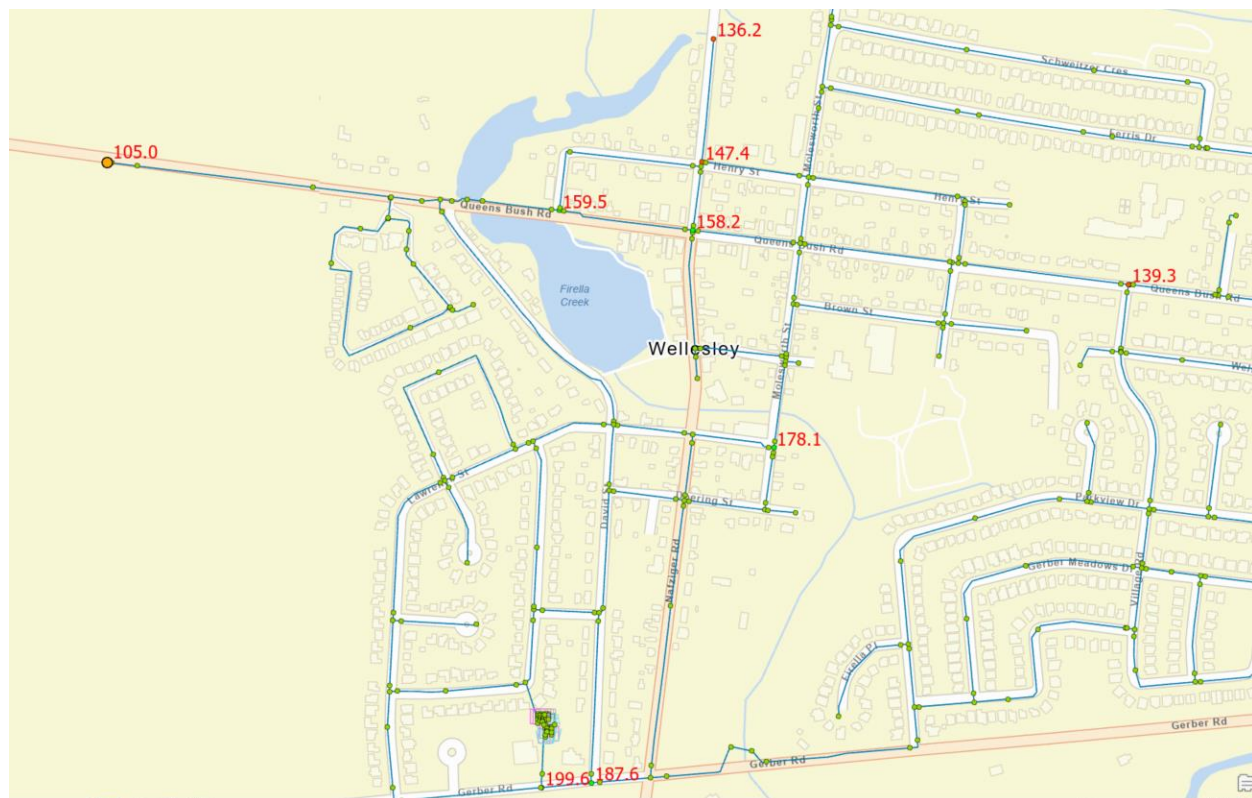


Figure 2-5. 2021 ICI Fire Flow Availability (L/s)

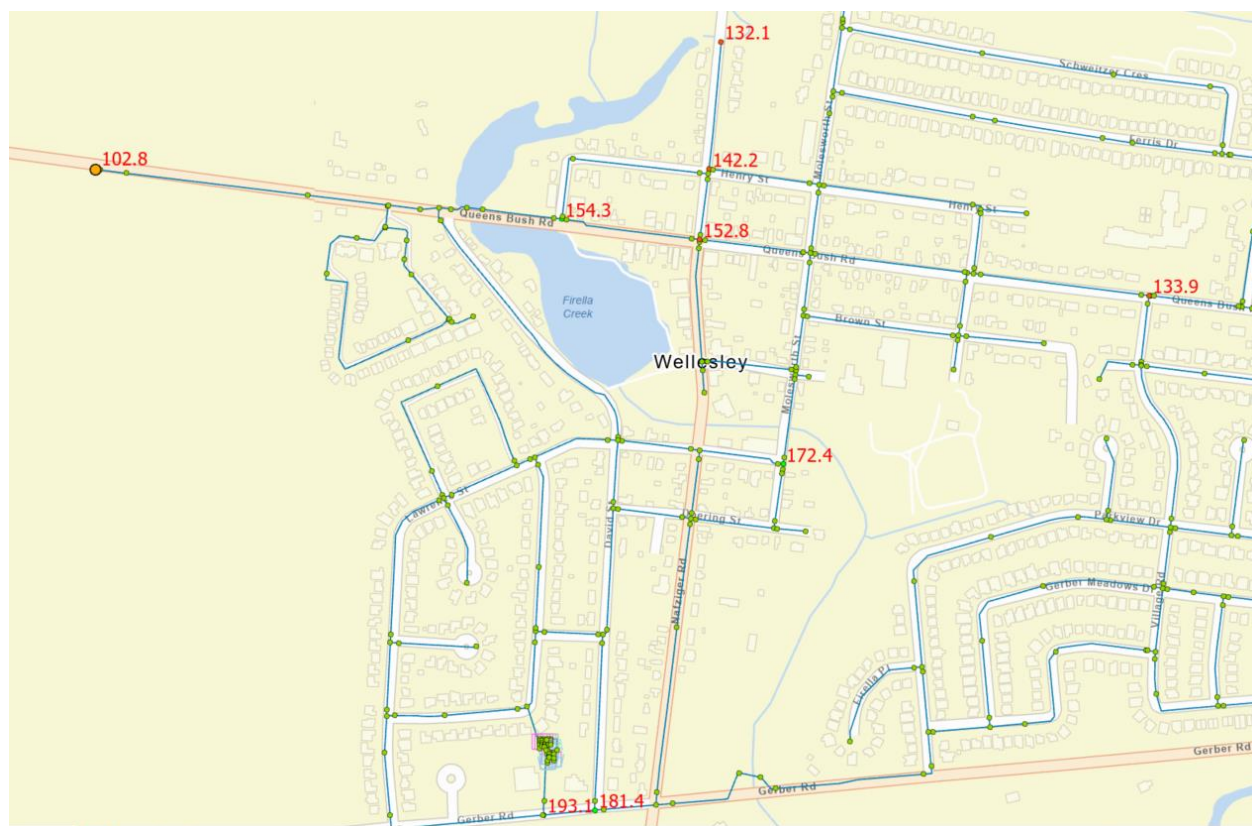


Figure 2-6. 2051 ICI Fire Flow Availability (L/s)

3. Long-List of Alternatives Development

3.1 Water Supply System

Sections 3.1.1 to 3.1.3 present alternatives to address the following constraints:

- **Well Capacity** – The current well taking capacity is expected to be exceeded by the projected MDD by 2034. Additional well supply capacity is recommended within the planning horizon.
- **Future Disinfection and Water Pumping & Storage Needs** – Currently, additional pumping capacity, additional CT volume, and additional treated water storage are identified the planning horizon (to 2051).

In addition, as Value-Added considerations, treated water is currently in compliance with all regulatory limits. However, strontium and fluoride concentrations are elevated compared to Federal Guidelines and may become an issue should the regulatory environment change in Ontario. The capability to address strontium and fluoride concentrations will be considered as a value-added factor in alternatives evaluation. Further, PFAS regulations may be enacted within the planning horizon. We recommend the Region continue to monitor the regulatory landscape in the coming years and take the appropriate measures as recommended by the Province.

3.1.1 Well Capacity

The existing permitted well taking capacity of 1,503 m³/d is expected to be exceeded by 2034. The following alternatives were considered to meet future water supply needs:

1. Do Nothing
 - a. Maintain the existing well supply with 1,503 m³/d capacity.
2. Water Conservation
 - a. Maintain the existing well supply with 1,503 m³/d capacity.
 - b. Implement water conservation efforts to prevent or delay future increases to water demands.
3. Increase Existing Well Supply
 - a. Explore opportunity to increase water taking from the existing wells for a minimum additional capacity of 196 m³/d.
4. Supplement Existing Well Supply
 - a. Maintain the existing well supply with 1,503 m³/d capacity.
 - b. Supplement with a new well with a minimum capacity of 196 m³/d and pump to the WTP (i.e., total combined capacity of at least 1,699 m³/d).
5. Additional External Supply
 - a. Maintain the existing well supply with 1,503 m³/d capacity.
 - b. Provide additional treated water supply at a minimum rate of 196 m³/d from another drinking water system such as the Integrated Urban System (IUS).

3.1.2 Future Disinfection, Water Pumping, and Storage Needs

The future design basis for disinfection and water pumping and storage depends on the operating strategy. Alternatives were developed for two operating strategies: 1) pump station as sole source of supply with no floating storage, and 2) floating storage in distribution system as a supplement to the existing reservoir and pump station. These strategies are discussed further in this section.

First, the pump station can continue to be operated as the sole source of supply with no floating storage in the distribution system. This operating strategy is consistent with the current approach. The design basis for this approach is summarized in Table 2-9. In this case, the pump station is recommended to supply water to meet both the fire flow and MDD which is projected to be 195 L/s by 2051. On-site storage would be sized to meet both the CT volume (1,062 m³) and fire, equalization, and emergency treated water storage (2,204 m³) for a total of 3,266 m³ by 2051.

Second, floating storage, such as an elevated tank, could be constructed to supplement the existing reservoir and pump station. The design basis for this approach is summarized in Table 3-1. In this case, additional storage for fire, emergency and equalization demand can be provided through the floating storage, reserving the reservoir volume for primary disinfection. The maximum flow rate for primary disinfection would be equal to the MDD as fire flow would no longer be provided from the reservoir. To be conservative, the PHD was carried as the maximum flow condition for primary disinfection, resulting in a recommended CT volume of 145 m³. Both the new floating storage and the remaining 758 m³ of useful volume in the reservoir can be used to meet the fire, equalization, and emergency treated water storage needs. In total, 2,349 m³ of storage would be available between the existing reservoir and new floating storage. The pump station would no longer be needed for pumping fire flow. The existing pump station capacity is sufficient to meet the future MDD and PHD, therefore, no upgrade is needed.

Table 3-1. Design Basis if Floating Storage is Provided to Meet Fire Demand and PHD

Parameter	2051 Recommended Capacity	Current Capacity	Additional Capacity to Meet Recommendations
CT Volume Recommendation, m ³	145		
Fire, Equalization and Emergency Storage Recommendation, m ³	2,204	902.3	1,447
Pumping Capacity for Domestic Use (L/s)	26.5	47	N/A

The following alternatives were identified to address future disinfection and water pumping & storage needs:

1. Do Nothing
 - a. Maintain existing on-site storage reservoir with a useful volume of 902.3 m³.
 - b. Maintain the five existing high lift pumps providing a firm pumping capacity of 166.5 L/s for emergency demand and firm pumping capacity of 47 L/s for domestic use. Pump station to remain as the sole source of supply. Any flows beyond the distribution system capacity are to be supplemented by the fire department's own supply and delivered via tanker trunk.
2. New On-site Storage and Additional Pumping Capacity
 - a. Expand on-site storage to provide a total storage of 3,266 m³. A dedicated CT volume of 1,062 m³ would be maintained for primary disinfection needs. An additional 2,204 m³ of treated water storage would be needed for fire, equalization, and emergency demand.

- b. Upgrade high lift pumps to provide firm pumping capacity up to 195 L/s for emergency demand and maintain existing firm pumping capacity of 47 L/s for domestic use. Pump Station to remain as the sole source of supply. Any flows beyond the distribution system capacity are to be supplemented by the fire department's own supply and delivered via tanker truck.
- 3. New Off-site Storage
 - a. Maintain on-site storage reservoir with a useful volume of 902.3 m³. Reservoir to provide a dedicated CT volume of 145 m³ for primary disinfection needs and to offset the treated water storage for fire, equalization, and emergency demand.
 - b. Construct off-site floating storage, such as an elevated tank, to provide the additional storage for fire, equalization, and emergency demand. A total treated water storage of 2,204 m³ will be provided for fire, equalization, and emergency demand, 758 m³ will be provided through the on-site reservoir after meeting primary disinfection needs and 1,447 m³ will be provided through the off-site floating storage.
 - c. Maintain existing high lift pumps to provide firm pumping capacity of 47 L/s for domestic use.

Figure 3-1 and Figure 3-2 illustrate the storage volume and pumping capacity recommendations for the alternatives. The existing reservoir provides a useful volume of 902.3 m³. The existing pump station consists of five high lift pumps, two with 60 L/s capacity and three with 15.5 L/s capacity.

Alternatives 1 and 2 maintain the pump station as the sole source of supply. In this case, the existing reservoir useful volume is insufficient to meet both the future CT volume and fire, equalization, and emergency treated water storage needs as shown in Figure 3-1. The existing pump station capacity is insufficient to meet the fire emergency demand, but excess capacity is available for the domestic demand as shown in Figure 3-2. The domestic demand can be met with the three 15.5 L/s pumps alone (two duty, one standby).

Alternative 3 includes floating storage in the distribution system in addition to the existing reservoir and pump station. In this case, there is excess capacity in the current reservoir for CT volume as shown in Figure 3-1. Additional storage for fire, equalization, and emergency demand would be provided through the floating storage. The pump station also has excess capacity as the pump station would only be needed to meet MDD and PHD rather than fire demand, as shown in Figure 3-2. The demand can be met with the three 15.5 L/s pumps alone (two duty, one standby). The two 60 L/s pumps would no longer be needed and could be re-purposed elsewhere.

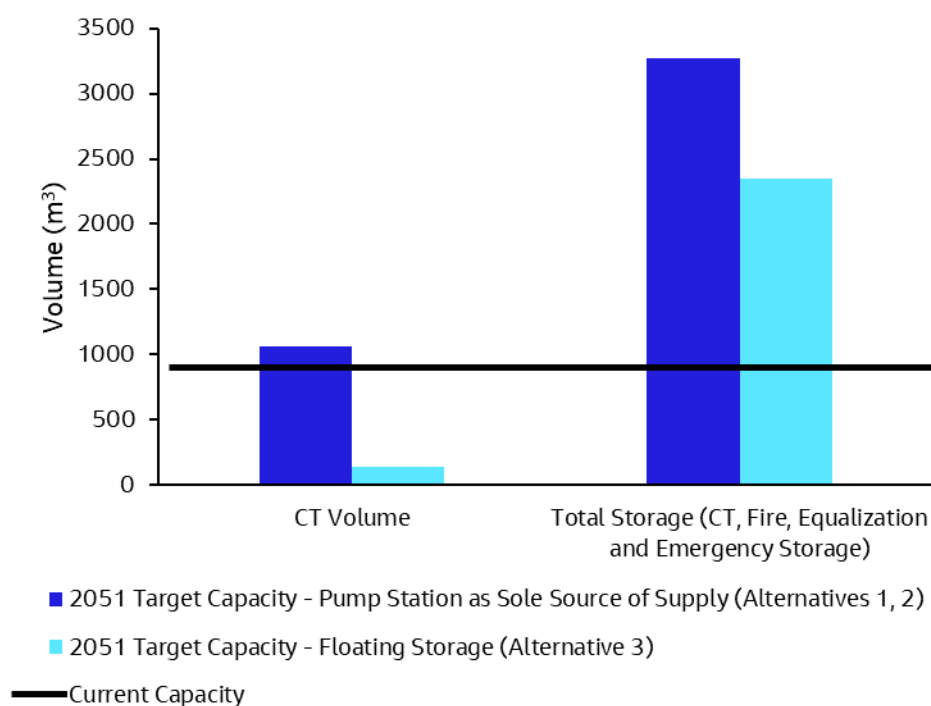


Figure 3-1. 2051 Storage Volume Recommendations

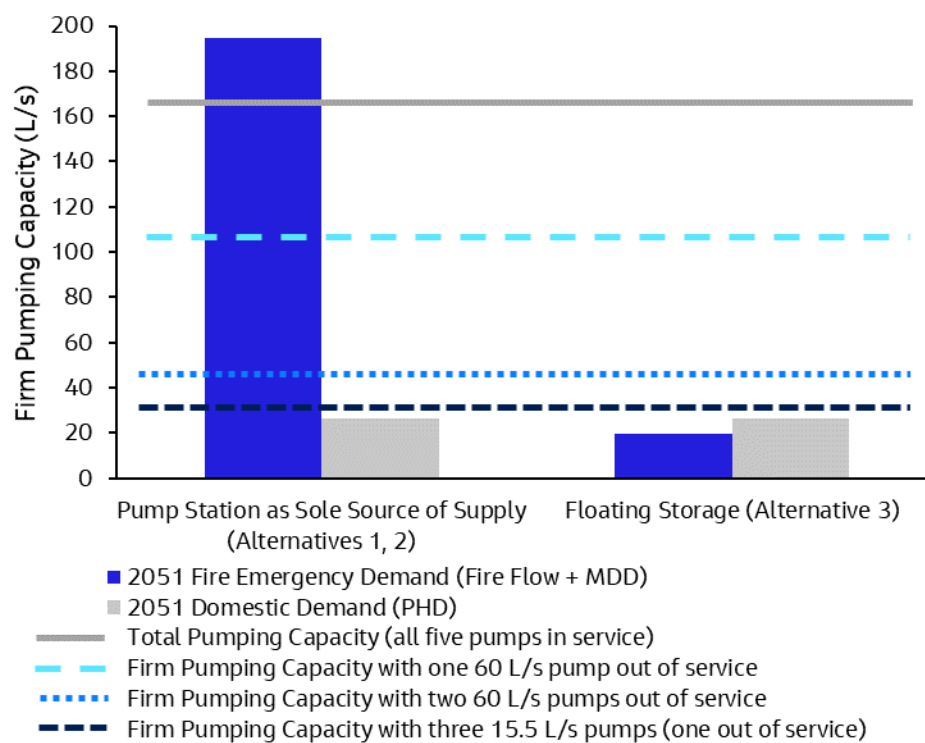


Figure 3-2. 2051 Firm Pumping Capacity Recommendations

3.1.3 Value-Added Considerations for the Wellesley WTP

As the treated water meets the current water quality standards in Ontario, the alternatives in terms of further improving treated water quality for strontium and fluoride at the Wellesley WTP were not considered for evaluation. Nonetheless, two value-added options may be considered:

1. Develop new water sources with lower naturally occurring strontium and fluoride concentrations and pump to the Wellesley WTP
2. Treatment upgrades with a new treatment technology at the Wellesley WTP

Both of these value-added considerations were identified as feasible options for the Wellesley Urban Area Water Supply System in the Region of Waterloo 2020 strontium treatment study (CH2M HILL Canada Limited, 2020).

A new well source could be developed in the vicinity, with a focus on lower concentrations of strontium and fluoride, and with a yield to meet the 2051 water taking recommendations. In the 2020 strontium treatment study, four existing well sites with strontium concentrations below 50 percent of the MAC value were identified through a desktop review of previous groundwater studies (CH2M HILL Canada Limited, 2020). Two of these wells are currently used as monitoring wells. One alternative considered in the 2020 study was to develop production wells in the vicinity of the existing monitoring wells with lower strontium concentrations. An updated hydrogeological study would need to be conducted to confirm the feasibility of developing new production wells.

Alternatively, a new treatment technology could be implemented to treat the naturally occurring strontium and fluoride in the existing raw water sources. Several technologies could address one or both of the contaminants, including lime softening, ion exchange, and nanofiltration, as shown in Table 3-2.

Table 3-2. Potential Treatment Technologies for Strontium and Fluoride

Technology	Ability to Treat Strontium	Ability to Treat Fluoride
Lime Softening	Yes	No
Ion Exchange	Yes	Yes
Nanofiltration	Yes	Yes

This master plan study will not further assess the two abovementioned options. However, potential impacts on strontium and fluoride and their treatment may be considered when the alternatives under Section 3.1.1 and Section 3.1.2 are evaluated.

Additionally, it is noted that the WTP has a single discharge pipe with no redundancy. Therefore, there is no flexibility to allow this line to be taken offline for maintenance. A discharge pipe bypass line could be designed to provide redundancy should the main discharge line need to be taken offline for maintenance. This constraint is a design level issue and is recommended to be addressed in the design phase. Alternatively, implementing floating storage, such as with an elevated tank, will also provide buffer capacity should the discharge pipe need to be taken offline. This will be considered in the evaluation of relevant alternatives.

3.2 Water Distribution System

3.2.1 Pressures

There are no issues identified for the water distribution system in terms of minimum or maximum pressures under ADD and MDD scenarios over the planning horizon.

3.2.2 Fire Flow

The issues for residential fire flow were identified where FFA is less than 75 L/s. These correspond to watermain dead-ends ranging in size from 50 mm to 100 mm in diameter (Pond View Drive dead-end and Village Place). These dead-end watermains should be upgraded to a size of 150 mm in diameter. By doing so, the FFA increases to 110 L/s, according to the modelling results.

The issues for ICI fire flow were identified where FFA is less than 175 L/s. The alternatives for addressing fire flow are consistent with the alternatives for future disinfection and water storage needs presented in Section 3.1.2. The total FFA is limited by the practical capacity of the existing water distribution system. Any additional fire flow needed beyond the distribution system capacity limits can be provided through the fire department's own supply and delivered via tanker trunks as is the current practice. The Region should continue to coordinate with the fire department to achieve these fire flows, and update watermains if there are changes to the existing practice. This is to be further investigated as additional planning information is made available to the Region in regard to the anticipated future development.

Regardless of the alternatives considered, the 200 mm diameter watermain on Queen's Bush Road from David Street (approximately 510 m in length) needs to be upgraded to 250 mm diameter to provide enough FFA to the Bill Gies Recreation Center located at Queen's Bush Road and Hutchison Road.

3.2.3 Floating Storage Location Alternatives

Alternative 3 in Section 3.1.2 includes construction of new floating storage, such as an elevated tank. The alternative locations for the floating storage are presented in Figure 3-3 and include the following general locations:

1. Bill Gies Recreation Centre lands to the west of the Village
2. Undeveloped land to the north of the Village
3. Centrally located near the former arena lands
4. Undeveloped land in the north-east area of the Village
5. Developed land to the south of the Village

None of these alternative locations are expected to impact the distribution system or introduce any technical issues with respect to meeting the minimum water distribution needs. All five locations are therefore feasible alternatives and will be carried forward for detailed evaluation in subsequent TMs. Additional modelling will be completed in TM5 to compare and evaluate the alternative locations against each other to select a preferred alternative. The locations shown in Figure 3-3 represent the general area for the floating storage to be located. A more precise location will be described further in subsequent TMs during the alternatives evaluation process.

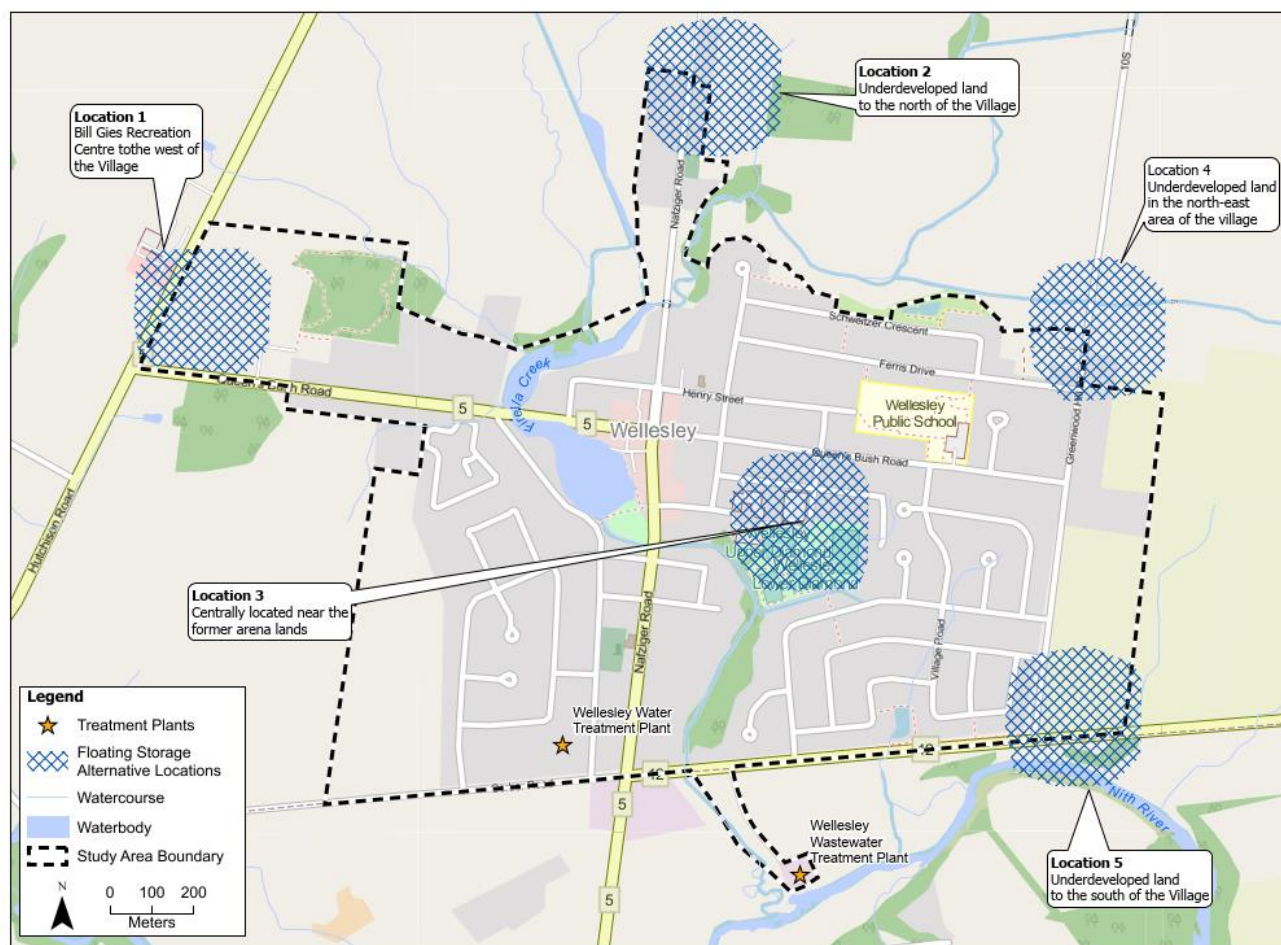


Figure 3-3. Floating Storage Alternative Locations

4. Screening of Long-List

4.1 Screening Criteria

Two major screening criteria were used to identify short-listed alternatives for each of the identified constraints:

1. Ability to resolve identified constraints
2. Constructability

These criteria are discussed further in the following sections.

4.1.1 Ability to Resolve Identified Constraints

For an alternative to be feasible, it must address the constraints identified in Section 2. Two key constraints were identified, and a separate list of alternatives developed for each: 1) well capacity; 2) future disinfection and water pumping and storage needs.

The alternatives developed to address the well capacity constraint must address the following:

- A total well supply capacity of at least 1,699 m³/d is recommended by 2051. The current well supply capacity of 1,503 m³/d is expected to be exceeded by 2034.

The alternatives developed to address future disinfection and water pumping and storage needs must address the following:

- CT Volume: A CT volume of 1,062 m³ is recommended if the pump station is maintained as the sole source of supply. A CT volume of 145 m³ is recommended if floating storage is provided.
- Fire, Emergency, and Equalization Treated Water Storage: A total treated water storage volume of 2,204 m³ is recommended by 2051 for fire, equalization, and emergency storage.
- Firm Pumping Capacity for Emergency Demand: If the pump station is maintained as the sole source of supply, then the pump station should meet both the fire flow and MDD with a firm capacity of 195 L/s or these flows could be supplemented through the fire department's water supply. If floating storage is provided, the pump station would have sufficient capacity to meet MDD and PHD, therefore no upgrade would be required.

4.1.2 Constructability

Constructability was considered at a high level in the long-list screening. Only major concerns such as site constraints if the alternative uses the existing WTP site were considered to determine if an alternative could feasibly be constructed. The existing Wellesley WTP site has limited space for expansion. The WTP site is bordered directly by developed residential, industrial, and institutional properties with no open adjacent space that could be acquired. As shown in Figure 4-1, majority of the existing site has been taken up by the treatment plant, pump station, and underground reservoir.

TM3: Water Infrastructure Alternatives Development

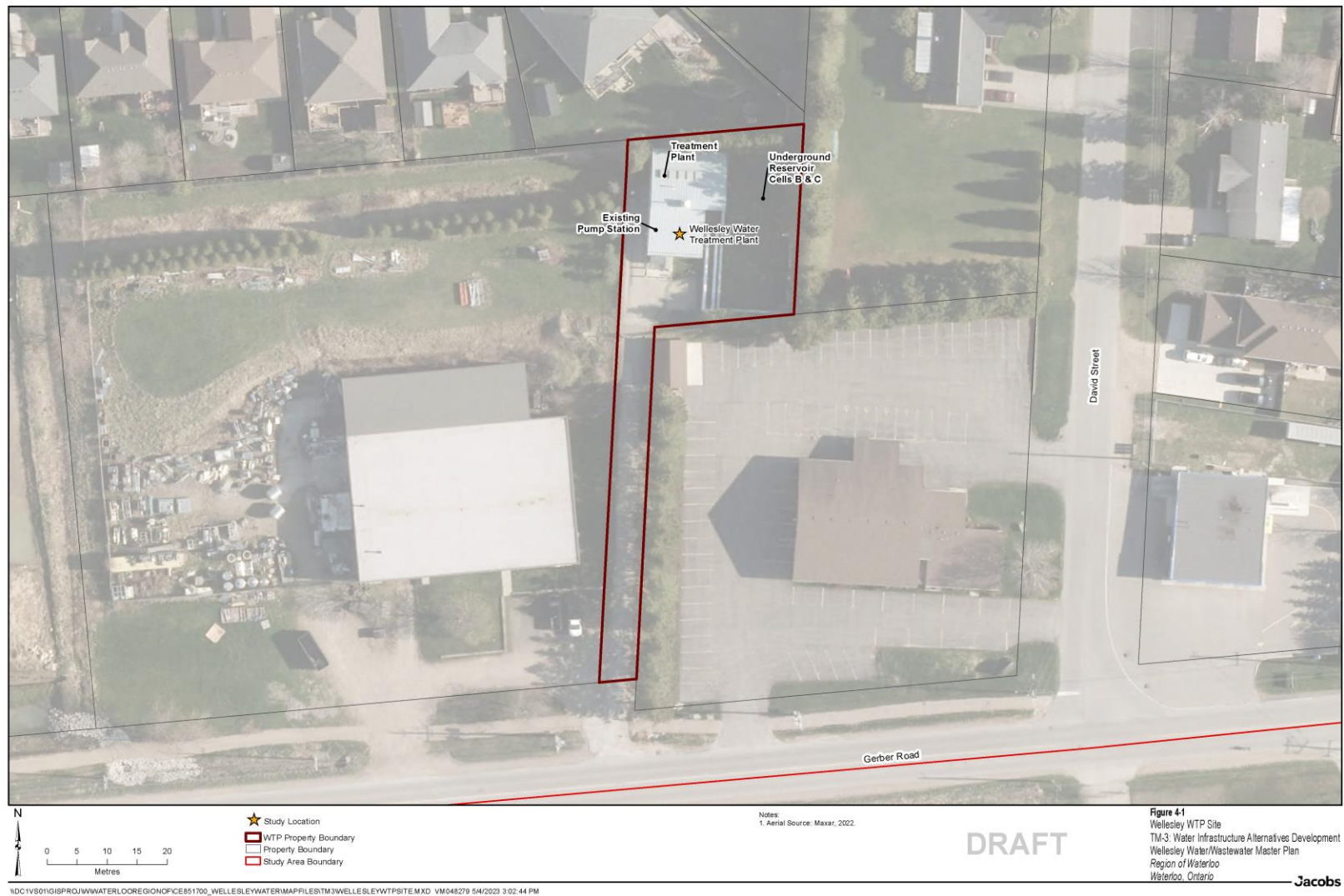


Figure 4-1. Wellesley WTP Site.

4.2 Long-List Screening

Table 4-1 presents the screening results for the well capacity alternatives described in Section 3.1.1. Only the Do Nothing and Water Conservation alternatives do not pass the screening process. Do Nothing will not address the well capacity constraint and results in the supply capacity being exceeded by 2034. Water Conservation has the potential to prevent or delay the well capacity from being exceeded within the planning horizon, however it is uncertain the effectiveness of this approach considering the Region has been implementing water conservation measures through a structured program for over 20 years. All other alternatives were considered viable and short-listed for detailed evaluation.

Table 4-1. Summary and Screening of Well Capacity Alternatives

Alternative	Ability to Resolve All Identified Issues	Constructability	Outcome
1: Do Nothing	Fail Does not address well capacity constraint. Well supply will be exceeded by 2034.	Pass No construction/ expansion on the existing site.	Fail
2: Water Conservation	Fail The Region has already been undertaking water conservation efforts over years. Effectiveness of further water conservation effort is uncertain.	Pass No construction/ expansion on the existing site.	Fail
3: Increase Existing Well Supply	Pass Opportunity to increase well taking may be explored by hydrogeological study. Existing WTP has sufficient capacity to treat additional flows.	Pass Uses existing well supply infrastructure. No construction/ expansion on the existing site.	Pass
4: Supplement Existing with New Well Supply	Pass New well source to address supply issues. To be pumped to existing WTP which has sufficient capacity to treat additional flows.	Pass No expansion on existing WTP site. Land acquisition may be avoided if an existing monitoring well is developed into production well. Raw water main will be needed.	Pass
5: Supplement Existing with External Supply	Pass Additional supply from another drinking water system to avoid new well supply locally from Wellesley.	Pass No construction/ expansion on the existing site. New water main will be needed.	Pass

Table 4-2 presents the screening results for the future disinfection and water storage alternatives described in Section 3.1.2. Do Nothing will not address the identified constraints. Alternative 2 (New Storage On-Site) is screened out as there is insufficient footprint available at the existing WTP site to expand the reservoir. Only the New Storage Off-Site alternative is short-listed for detailed evaluation.

In both cases, the Do Nothing alternative will be carried as a mandatory baseline for detailed evaluation.

Table 4-2. Summary and Screening of Future Disinfection and Water Storage Needs Alternatives

Alternative	Ability to Resolve All Identified Issues	Constructability	Outcome
1: Do Nothing	Fail Does not address future disinfection and water storage constraints.	Pass No construction/ expansion on the existing site.	Fail
2: New Storage On-Site	Pass Expand on-site storage reservoir and pumping capacity to address constraints with the pump station maintained as the sole source of supply.	Fail Insufficient area at the existing site to provide the necessary storage expansion.	Fail
3: New Storage Off-Site	Pass New floating storage to address treated water storage constraint, reduce pumping needs, and reduce the CT volume for disinfection needs.	Pass New construction to occur off-site at a location with sufficient footprint.	Pass

5. Summary of Short-Listed Water Treatment and Water Distribution Alternatives

5.1 Summary

In this TM, constraints were identified for the Wellesley Urban Area water supply and water distribution systems throughout the planning horizon and alternatives were developed to address current and future constraints.

Several constraints regarding well supply capacity, future primary disinfection, and treated water pumping and storage were identified. Alternatives were developed to address these constraints separately.

The short-listed alternatives identified to address well capacity constraints include the following:

1. Do Nothing (kept as a mandatory baseline) – Maintain existing well supply.
2. Increase Existing Well Supply – Explore additional water taking from existing production wells.
3. Supplement Existing Wells with New Well Supply – Maintain existing well supply and supplement with a new well that is pumped to the WTP.
4. Supplement Existing Wellesley Water System with External Supply – Maintain existing well supply and provide additional treated water supply from another drinking water system such as IUS.

The following alternatives were short-listed to address future disinfection, water pumping, and storage constraints:

1. Do Nothing (kept as a mandatory baseline) – Maintain existing reservoir and pump station with the pump station as the sole source of supply for domestic and emergency use.
2. New Storage Off-Site – Maintain existing reservoir for disinfection. Construct floating storage, such as an elevated tank, to provide additional storage for emergency use (i.e., fire demand). Maintain existing pump station for domestic use.

Modelling was completed to identify constraints in the Wellesley Urban Area water distribution system throughout the planning horizon. ICI fire flow constraints were identified but can be mitigated by maintaining the implementation of the current fire-fighting strategy which includes supplying additional fire flows via tanker trucks. The Region should continue to coordinate with the fire department to achieve these fire flows, and update watermains if there are changes to the existing practice.

The short-listed alternative for the future disinfection and water pumping & storage constraints includes construction of floating storage, such as an elevated tank. A list of potential locations for the floating storage was developed, including the following general locations:

1. Bill Gies Recreation Centre lands to the west of the Village
2. Undeveloped land to the north of the Village
3. Centrally located near the former arena lands
4. Undeveloped land in the north-east area of the Village
5. Developed land to the south of the Village

All five locations were considered feasible alternatives and will be carried forward for detailed evaluation in subsequent TMs.

5.2 Next Steps

Following the Region's acceptance of this TM3, the next step will be to evaluate the short-listed alternatives using the evaluation criteria described in TM2. The process and results of the evaluation will be presented in TM5.

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TM4: Wastewater Infrastructure Alternatives Development

Regional Municipality of Waterloo

Wellesley Water and Wastewater Master Plan
July 31, 2025



TM4: Wastewater Infrastructure Alternatives Development

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Project name: Wellesley Water and Wastewater Master Plan

Client reference: Karou Yajima **Project no:** CE851700

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Jacobs Consultancy Canada Inc.

Kitchener, ON
Canada

T +1.519.579.3500
www.jacobs.com



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Acronyms and Abbreviations

ADDF	Annual Average Day Flow
AGS	Aerobic Granular Sludge
CCTV	Closed-Circuit Television
DGSS	Design Guidelines and Supplemental Specifications for Municipal Services
DWF	Dry Weather Flow
I/I	Inflow and Infiltration
ICC	Inventory, Condition and Capital Planning
MABR	Membrane Aerated Biofilm Reactors
MCEA	Municipal Class Environmental Assessment
MECP	Ministry of Environment, Conservation, and Parks
PDF	Peak Day Flow
PHF	Peak Hour Flow
PIF	Peak Instantaneous Flow
RTK	R-Response Ratio, T – Time to Peak, K -Recession Limb Ratio
TM	Technical Memorandum
WTP	Water Treatment Plant
WWF	Wet Weather Flow
WWTP	Wastewater Treatment Plant
WWWMP	Wellesley Water Wastewater Master Plan

1. Introduction

1.1 Background

The Township of Wellesley is one of seven area municipalities in the Regional Municipality of Waterloo (Region). The Township of Wellesley is a rural community comprised of four villages with eleven settlement areas, including the Village of Wellesley (Wellesley), each requiring municipal wastewater and water servicing. The Wellesley Urban Area is currently the only settlement area with both municipal wastewater and water servicing. The Region is responsible for maintaining existing levels of service within the water and wastewater systems to provide capacity for the existing population, as well as planning for new growth in the service area and meeting current and future regulatory requirements. To plan and budget for infrastructure upgrades and expansions to address existing issues and meet future needs to 2051, the Region is undertaking the Wellesley Water and Wastewater Master Plan (WWWMP).

The purpose of the WWWMP is to address anticipated water and wastewater treatment and conveyance needs over the next 30 years (to 2051), and in doing so, improve the reliability and resiliency of its water and wastewater assets. The goals of the WWWMP include identifying new projects required to meet the purpose of the WWWMP, and systematically developing a prioritized implementation plan that is endorsed by the Region and project stakeholders. The WWWMP will fulfill the requirements of Phase 1 and Phase 2 of the Municipal Class Environmental Assessment (MCEA) process for Water and Wastewater Projects.

1.2 Objectives

The purpose of this Technical Memorandum (TM4) is to identify wastewater treatment and conveyance system needs and constraints under existing and future conditions for the Wellesley urban area, and to identify alternative solutions in a manner consistent with the Municipal Engineers Association (MEA) MCEA process.

The specific objectives of TM4 are to:

- Establish future wastewater flow and load projections based on historical data analysis and current population projections,
- Identify opportunities and constraints in the Wellesley wastewater collection system,
- Identify opportunities and constraints for the Wellesley Wastewater Treatment Plant (WWTP), and
- Develop and screen a list of alternatives to address constraints for the Wellesley WWTP and wastewater collection system.

2. Wastewater Flow and Load Projections

2.1 Wastewater Collection System Generation Rate Design Guidelines

The future flow generation rates pertaining to wastewater collection and conveyance based on the Design Guidelines and Supplemental Specifications for Municipal Services (DGSS) (Region of Waterloo et. al, 2022) are summarized in Table 2-1.

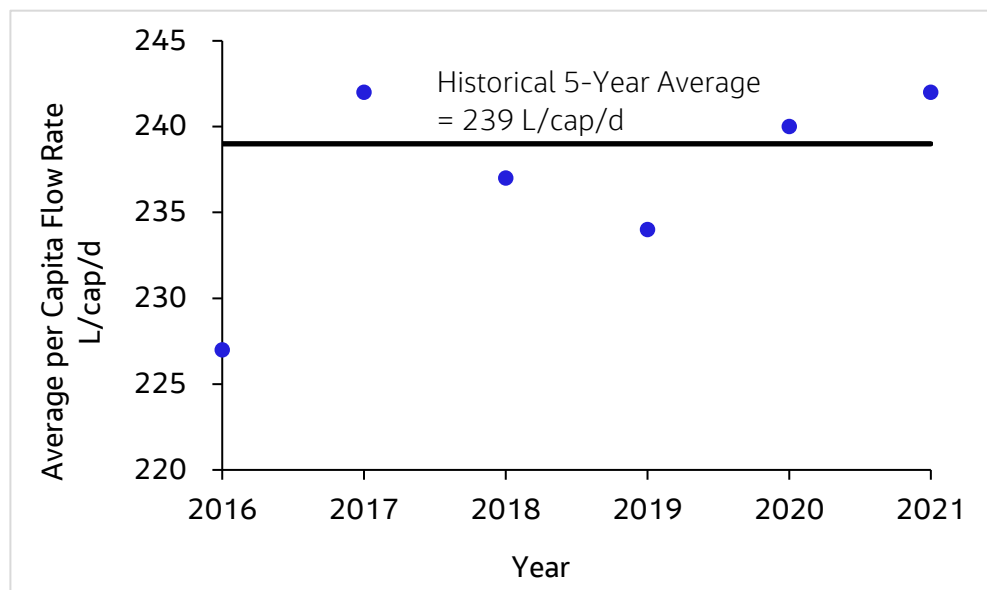
Table 2-1. Wastewater Collection Future Flows

Type	Average	Peaking Factor
Residential	275 L/cap/d	Harmon Peaking Factor Formula
Industrial	0.40 l/s/ha	Known discharges or typical industry sewage flow peaking factor from MECP guidelines
Commercial	Core = 0.95 l/s/ha; Shopping Mall = 0.3 l/s/ha; General = 0.5 l/s/ha.	Known discharges or 2.5
Institutional	0.25 L/s/ha for institutional uses; 0.015 L/s/bed for hospitals	N/A
Inflow and Infiltration (I&I)	Include I&I allowance of 0.25 l/s/ha	

2.2 Historical Wellesley WWTP Wastewater Generation Rates

The historical raw wastewater per capita flow rates for the previous six years are shown in Figure 2-1. The per capita flow rate ranged from 227 L/cap/d (2016) to 242 L/cap/d (2017 and 2021).

Figure 2-1. Historical Per Capita Wastewater Flow Rate



Due to the relatively consistent per capita flow rates, the five-year historical average per capita wastewater flow rate (239 L/cap/d) was used to project future wastewater generation rates at the Wellesley WWTP. As a comparison, the Region's 2018 Master Plan identified an average per capita flow rate of 266 L/cap/d from 2012 to 2014 (Region of Waterloo, 2018). Equivalent employment was not considered in the per capita flow rate calculations; however, reported historical per capita flow rates inherently include both residential and employment populations. As described further in Section 3.2.3, the projected residential growth for the Wellesley WWTP sewershed is 1,887 people between 2021 and 2051, for a total 2051 population of 5,617.

As summarized in TM1, the Wellesley WWTP experiences high peak flows resulting from high I/I in the collection system. While peak flows were up to ten times the annual average flow rate, the design peak day flow (PDF) peaking factor for the Wellesley WWTP is 3.5, and the design peak hour flow (PHF) and peak instantaneous flow (PIF) peaking factor are 4.0 (Region of Waterloo, 2018). Treatment bypasses can occur at three points in the plant, as summarized below. All bypassed flows are directed to the ozone chamber for disinfection prior to discharge to the Nith River.

- Wet well bypass: occurs when the wet well level in the raw wastewater pumping station reaches the bypass level. The raw wastewater is bypassed by gravity to the ozone chamber.
- Splitter box bypass: occurs when the wastewater flow exceeds the hydraulic capacity of the splitter box in the headworks facility (downstream of raw wastewater screen). The screened wastewater is bypassed by gravity to the ozone chamber.
- Tertiary bypass: occurs when the wastewater flow exceeds the hydraulic capacity of the filters. The secondary effluent is bypassed by gravity to the ozone chamber.
- The wastewater treatment design basis established is presented in Table 2-2.

Table 2-2. Wellesley WWTP Planning Design Basis for Influent Flows

Parameter	Value	Basis
Design Year	2051	
Population	5,617	
AADF, m ³ /d	1,345	239 L/cap/d
PDF, m ³ /d	4,700	3.5 peaking factor
PHF/PIF, m ³ /d	5,370	4.0 peaking factor

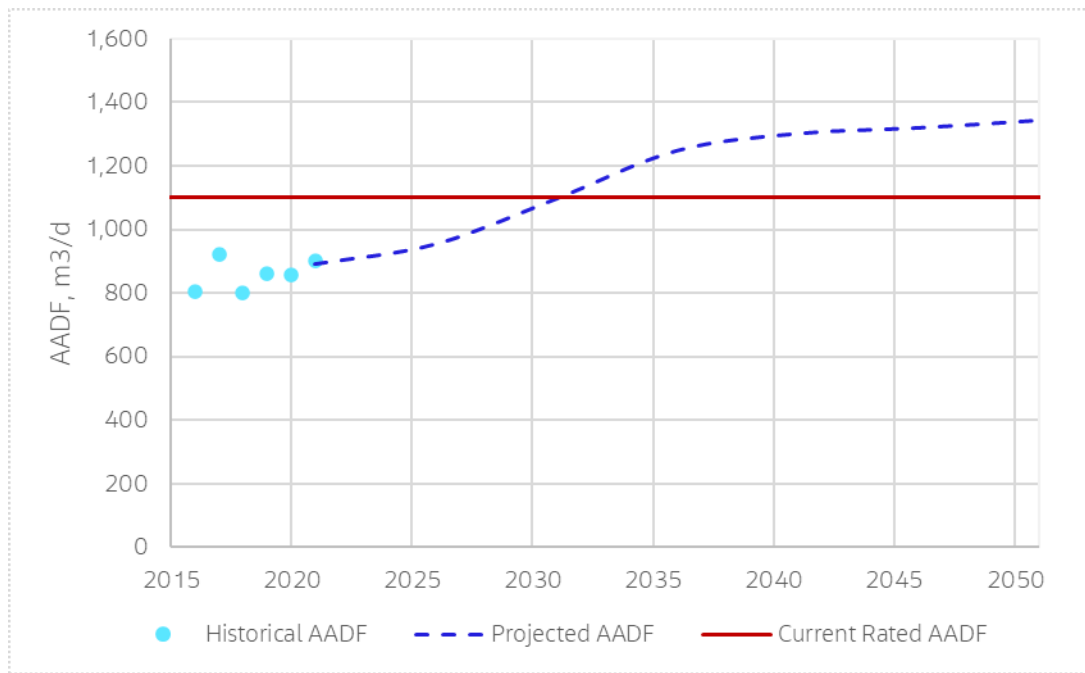
Design per capita load rates were established in TM1. The wastewater per capita load rates from 2019 to 2021 are lower than typical observed values. Possible explanations include changes in the ratio of residential, commercial, and industrial facilities in the sewershed. Future load projections should account for the possibility of development in the sewershed resulting in per capita loads that are higher than those observed from 2019 to 2021. For planning purposes, higher per capita load rates in line with typical ranges are recommended. Conservative per capita loads will be used to forecast future loads to the Wellesley WWTP. This design basis allows for some conservatism in site utilization requirements and budgeting. The design per capita values are within typical ranges cited by Metcalf & Eddy (2014). Table 2-3 presents the projected influent loadings for Year 2051 based on the population projections and loadings generation rates presented in TM1.

Table 2-3. Wellesley WWTP Planning Design Basis for Projected Influent Loadings

Parameter	Value	Basis
Design Year	2051	
Population	5,617	
Average BOD ₅ Load, kg/d	281	50 g/cap/d
Average TSS Load, kg/d	337	60 g/cap/d
Average TKN Load, kg/d	84	15 g/cap/d
Average TP Load, kg/d	78.4	1.5 g/cap/d

Based on the population and flow projections, the Wellesley WWTP annual average day flow (AADF) is expected to reach it's rated capacity (1,100 m³/d) between 2030 and 2035 (refer to Figure 2-2). The forecasted planning period AADF (2051) is 1,345 m³/d. The Region's previous master planning efforts forecast the next plant expansion to take place between 2032 and 2035 (CIMA+, 2018).

Figure 2-2. Historical and Projected Wellesley WWTP AADF



3. Opportunities and Constraints

3.1 Wellesley WWTP

TM1 summarized the treatment capacity of the existing Wellesley WWTP major unit processes based on the previous Regional Master Plan (CIMA+, 2018), recent historical plant data, recent plant upgrades (e.g., fine screening and cloth media filters), and updated process modelling.

Table 3-1 summarizes the capacity assessment in terms of equivalent AADF capacity for each major treatment process at the Wellesley WWTP. Capacity constraints were identified by comparing the firm capacity to the planning period (2051) AADF (1,345 m³/d) and peak hourly flow. All major unit processes are anticipated to require some upgrade or expansion. It should be noted that the influent pumping capacity is based on the duty/standby configuration as specified in ECA No. 6542-AJCJC9. However, recently recorded flows at the WWTP are above the capacity of one pump (4,400 m³/d), indicating that the pumps operate in a lead/lag regime during peak flow conditions. The influent pumping capacity is assumed to be 4,400 m³/d (52 L/s) for wastewater treatment capacity assessment to be consistent with the design of the downstream processes and to allow for redundancy requirements.

Table 3-1. Wellesley WWTP Unit Process Firm Capacity Assessment Summary

Unit Process	Equivalent AADF Capacity (m ³ /d) ¹	Upgrade/Expansion Needed for Planning Period AADF (1,345 m ³ /d)
Influent Pumping	4,400 ¹	Yes
Screening	4,490 ¹	Yes
Secondary Treatment ² (Bioreactors and Clarifiers)	1,100	Yes
Blowers ³	1,100	Yes
Tertiary Filtration	1,260	Yes
Alum System	Storage tank: 13,450 Metering Pumps: 1,140	Yes (Metering pumps only)
Disinfection Contact Tank ⁴	1,250	Yes
Sludge Storage Tank	580	Yes
Outfall ⁵	8,640 ¹	No

Notes:

¹ Influent pumping, screening and outfall capacity is provided based on peak hourly capacity.

² The secondary treatment is limited by the secondary clarifiers' hydraulic loading rate at peak hourly flow according to MECF design guidelines for maximum allowable hourly surface overflow (SOR) rate (37 m³/m²/d). The SOR at PHF (4,400 m³/d) is 43 m³/m²/d. Given that the maximum allowable SOR depends on sludge settleability, which would be site-specific. Historical data analysis for secondary treatment demonstrates good sludge settling characteristics (defined by the measured sludge volume index). The historical maximum sludge volume index (SVI) was estimated to be 90 mL/g, which is significantly lower than typical SVI for conventional activated sludge (120 to 150 mL/g). Using the concept of flux curve analysis, the maximum allowable SOR for Wellesley secondary clarifiers would be 46 m³/m²/d, which is higher than the peak hourly SOR of 43 m³/m²/d. Therefore, considering a peak factor of 4, the clarifier's capacity can handle the rated capacity of 1,100 m³/d AADF.

³ A technology review was completed in January 2024 which recommended blowers that could provide additional capacity up to 1320 m³/d by considering installation an additional blower.

⁴ The capacity of the disinfection contact tank was evaluated in TM1 based on chemical disinfection. The Region has selected UV process in an ongoing project as the preferred strategy for disinfection upgrades. Consideration may be given to an equalization basin to store the peak flows to maintain the disinfection process capacity without exceedance.

⁵ According to the available information, a high-level hydraulic assessment was performed for the outfall. the hydraulic analysis demonstrates that the outfall capacity can handle the projected flows. The peak outfall capacity would be 8,640 m³/d (2,160 m³/d AADF capacity), per the plant's hydraulic profile. It is recommended that a detailed evaluation be undertaken during conceptual design to verify the hydraulic capacity of the outfall, considering recent water elevations in the Nith River.

- The forecasted 2051 AADF is approximately 23 percent greater than the current rated AADF (1,345 m³/d versus 1,100 m³/d). Flow monitoring within the collection system was completed in June 2023. Hydraulic model calibration and future growth scenario simulations revealed existing and future flow constraints within the collection system and at the WWTP Influent PS during the 5-year design storm. Further details on the constraints within the collection system are provided in Section 3.2. The predicted future peak daily and hourly flows are approximately 11,000 m³/d and 29,000 m³/d-32,000 m³/d (after potential conveyance infrastructure upgrades are implemented) during the modelled 5-year design storm, respectively, which are significantly higher than the design basis established in TM1 and presented in Table 2-2.

Given that these peak flows occur during substantial wet weather events (5-year design storm), considering a storage tank in the collection system or an equalization tank at the WWTP would be more feasible compared to upsizing all processes within the WWTP to handle such high peak flows.

In addition, there may be opportunities to implement cost-effective optimization strategies or retrofits to compensate for the capacity deficiency, rather than costly unit process expansions or replacements. Therefore, except for the influent pump station, the downstream processes alternatives will be assessed to provide a capacity to handle a peaking hourly factor of 4 (PHF of 5,370 m³/d). An equalization tank will be required to provide storage for flows above 5,370 m³/d. The pump station alternatives will be assessed to provide a peak hourly flow of 29,000 m³/d -32,000 m³/d.

There is also opportunity to integrate the capacity upgrades with other planned capital works at the plant, including the projects identified in the ongoing Inventory, Condition and Capital Planning (ICC) project, summarized in Table 3-2. Opportunities to tie in required capacity upgrade works with other planned projects will be explored later in the WWWMP when the preferred capacity upgrade alternatives and implementation schedule have been identified.

Table 3-2. Planned Wellesley WWTP Capital Projects (AE, 2023)

Project	Summary of Scope	Completion Year
MCC2 and Plant PLC Replacement	▪ Miscellaneous lighting panel, MCC, power meter upgrades	2024
Disinfection Upgrades	▪ Disinfection study that recommended to replace ozone with chemical disinfection or UV system. The Region has selected UV process in an ongoing project as the preferred strategy for disinfection upgrades.	Study: 2023 Construction: 2024
MCC 1A/B Replacement	▪ MCC replacement	2025
Blower and Aeration Upgrades	▪ Blower study to determine preferred blower technology and upgrade requirements ▪ Replace blowers, ancillary equipment and instrumentation	Study: 2023 Construction: 2027
SCADA Server Upgrades	▪ Expand PLC	2030
Admin Building Roof	▪ Roof replacement	2032

3.2 Wastewater Collection System

3.2.1 Hydraulic Model History

In 2017, the Region completed flow monitoring and the Wellesley Sanitary Hydraulic Model was calibrated to dry weather flows (DWF) using InfoSewer. In February 2023 through June 2023, the Region completed additional flow monitoring with the purpose of capturing rainfall events to calibrate the

hydraulic model to wet weather flow. The model was converted to an InfoWorks ICM version 10.5 model prior to wet weather flow calibration, as described in Section 3.2.2. The results in TM4 are based on this updated hydraulic model that was calibrated in 2023.

3.2.2 Flow Monitoring and Calibration

3.2.2.1 Model Updates

To provide a more robust model for the WWWMP analysis, the Region's existing InfoSewer model was converted to InfoWorks ICM version 10.5. Subcatchments, catchment areas, and populations were delineated and calculated and added into the model. To create subcatchments, parcel data and land use is required. A parcel shapefile and a land use shapefile were provided by the Region (Township of Wellesley, 2015). Land use was assigned to each parcel using a join tool in GIS software. More specific land use for the parcels designated as 'Urban Core' land use was assigned by viewing aerial imagery. The land use within the modelled area is largely residential with scattered institutional parcels along with institutional/commercial/industrial (ICI) land use and medium density residential buildings in the Urban Core in the Queen's Bush Road and Nafziger Road area. Populations were estimated with the assumption of 3 people per parcel or unit for residential buildings. Where medium density residential was determined through aerial imagery, the number of units was estimated from aerial imagery and a population assigned accordingly. ICI parcels were assumed to have an equivalent population density of 62 people per hectare.

To represent downstream boundary conditions, the WWTP influent pump station was also added to the model. An as-built drawing from the Wellesley Wastewater Treatment Plant Expansion Phase No. 1 was used to represent the influent pump station within the hydraulic model (drawing No. 2P1). The pump station was modelled with the following parameters:

- Lead pump on/off level: 340.60 m/340.34 m
- Lag pump on/off level: 341.1 m/340.85 m
- Lead pump capacity: 52 L/s
- Lag pump capacity: 52 L/s with assumed 45 percent headloss; effective modelled capacity 28.5 L/s
- Wet well base area: 2.63 m²

Note that the two pumps at the WWTP influent pump station were modelled in a lead/lag position. As noted in Section 3.1, this is in conflict with the WWTP ECA but is consistent with the observed data recorded at the plant.

The existing hydraulic model was reviewed for connectivity. The invert elevations of several modelled pipes in the vicinity of Village Road and Gerber Meadows Drive were updated using a combination of as-built drawings and inferences. The double-barrel siphon along Nafziger Road was also incorporated into the hydraulic model. The pipe network updates are identified in Table 3-3.

Table 3-3. Pipe Invert Elevation Updates

Pipe ID	Location	Invert Elevation Source
WP232	Campbell Place	Assumed Ministry of Environment, Conservation, and Parks (MECP) minimum pipe slope
WP246	Village Road	As-Built ^a

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Pipe ID	Location	Invert Elevation Source
WP247	Village Road	As-Built ^a
WP214	Village Road	Upstream invert from as-built ^a ; downstream invert inferred
WP215	Village Road	Inferred
WP216	Village Road	Inferred
WP217	Village Road	Downstream invert from as-built ^a ; upstream invert inferred
WP210	Gerber Meadows Drive	Upstream invert inferred
WP209	Gerber Meadows Drive	Upstream invert from as-built ^a ; Downstream invert inferred
Model ID (MH0102.1, DMHS2.1, DMHS1.1, MH0102.2, DMHS4.1, DMHS3.1)	Nafziger Road west of Schweitzer Crescent	Siphon inverts and diameters from Project No. 1-0178-68 as-built drawing set.

^a Drawing C-201 from Village Estates Subdivision Phase VI project

Following the modelled invert updates using the as-built drawing (drawing C-201 from Village Estates Subdivision Phase VI project), downstream pipe invert elevations were inferred as necessary for consistent alignment.

As well, two pipe segments (WP0043 and WP0131), had a negative slope in the model. For this model update the invert elevations at WP0043 and WP0131 were inferred with the assumption that the pipes did not have a negative slope. However, the invert elevations should be confirmed via as-built drawings.

Further details on the model updates are included in Appendix A.

3.2.2.2 Flow Monitoring

The flow monitoring period was from February 15, 2023, through June 16, 2023, and was completed by AMG Environmental (AMG). There were a total of five flow monitors and one rain gauge with two tipping buckets for redundancy. The locations of these flow monitors and rain gauges are shown in Figure 3-1.

Figure 3-1 Monitors were installed in the downstream end of the pipes indicated in Table 3-4. Based on the AMG's data quality report (see Appendix A, Attachment A) all site conditions were determined to be fair, the data quality at WMH17 and WMH28 determined to be fair, and the data quality at the remaining flow monitor locations (WMH78, WMH76, and WMH71) was determined to be good.

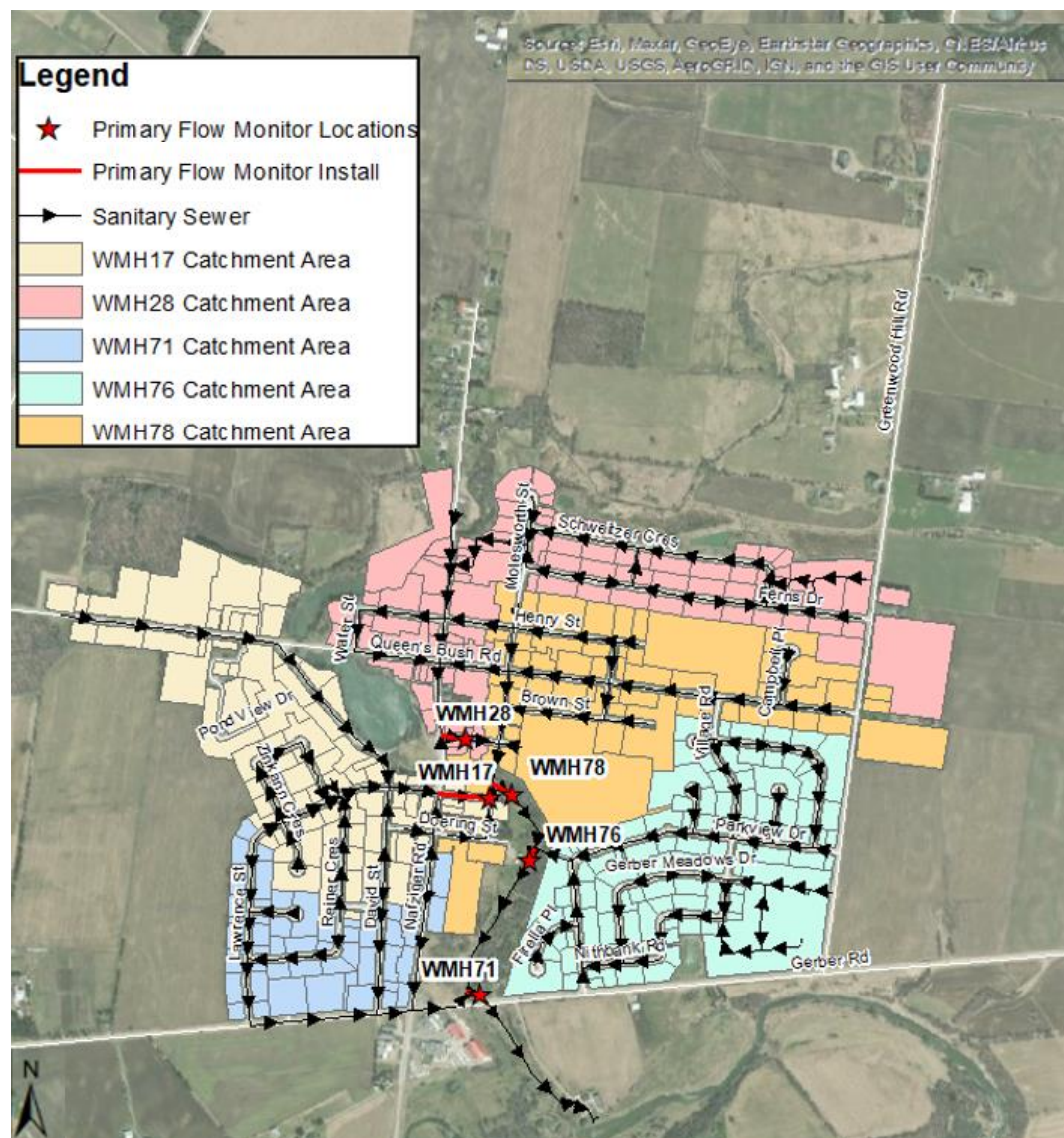
Table 3-4. Flow Monitor Catchment Area Summary

Flow Monitor Node ID	Modelled Pipe ID / Region Pipe ID	Catchment Area (ha) ^a	Upstream Monitor Sites
WMH17	MH0065.1/ WP092	27.0	N/A
WMH28	MH0067 /WP087	29.4	N/A
WMH78	MH0096.1/ WP170	32.2	WMH17, WMH28
WMH76	MH0132.1/ WP173	28.3	WMH17, WMH28, WMH78
WMH71	MH0048.1/ WP047	12.0	WMH17, WMH28, WMH78, WMH76

Notes:

^a Catchment area does not include upstream monitor catchment areas

Figure 3-1. Flow Monitor Locations



3.2.2.3 Dry Weather Flow Calibration

DWF periods were selected by evaluating the longest observed periods without rain based on rain gauge results. For the selected periods, the period start date was selected to ensure that a minimum of three dry weather days were observed previous to the start date to ensure the collection system was operating under dry weather conditions. The DWF period selected was from May 23, 2023, through June 11, 2023, which is a duration of 19 days.

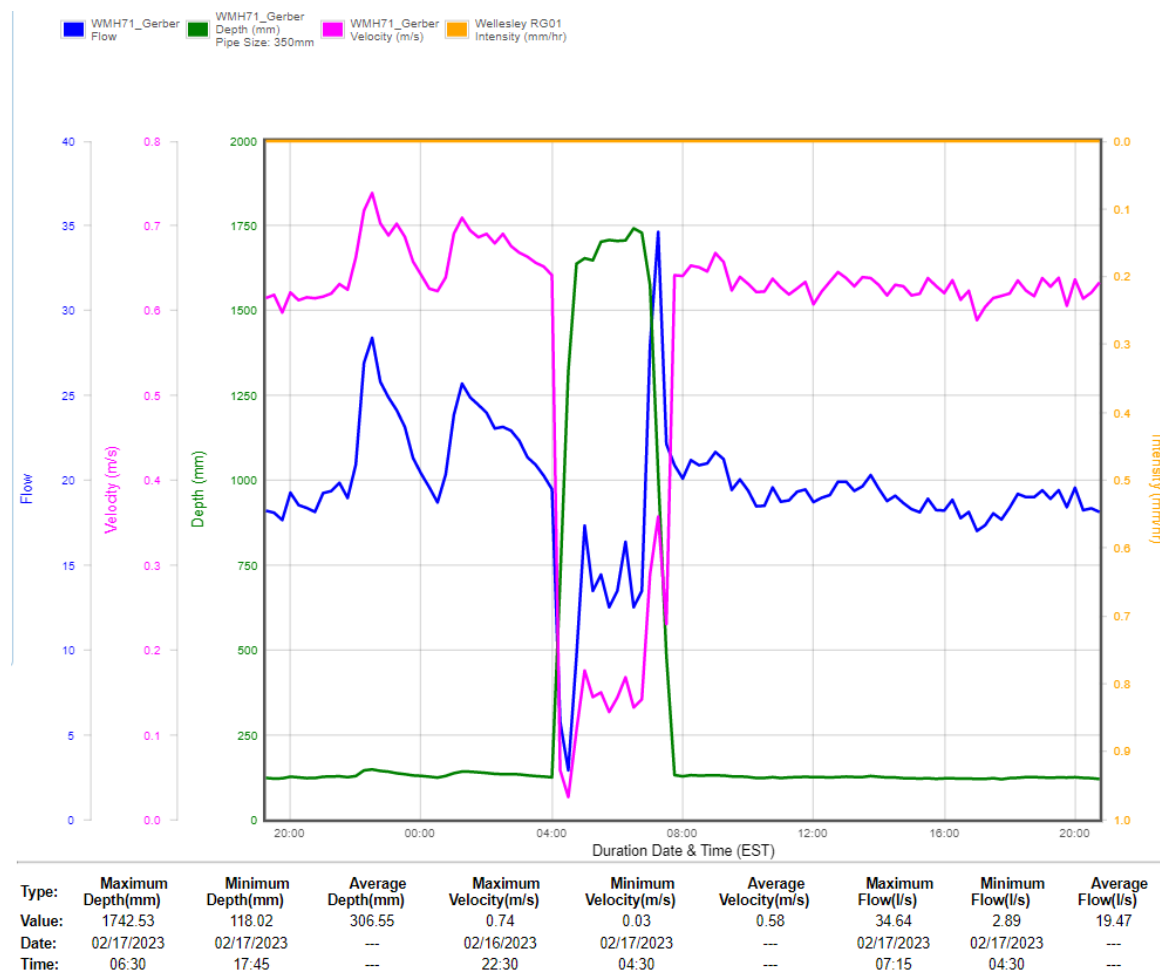
Diurnal patterns were created and checked against the observed data. Groundwater inflow (GWI) was input as baseflow in the model. GWI was estimated for each subcatchment area using the Stevens - Schutzbach Method. Per capita wastewater generation rates were established according to best fit compared to the observed data. Table 3-5 shows the per capita flow rates in litres per capita per day (L/cap/d) used for each catchment area in the model.

Table 3-5. Wastewater Generation Rates

Catchment Area	Wastewater Generation Rate (L/cap/d)
WMH17	160
WMH28	200
WMH78	25
WMH76	125
WMH71	100

The per capita flow rates in Table 3-5 are generally lower than expected. Typical design values are 225-450 LCPD (MECP, 2019). In particular, WMH78 has an exceptionally low per capita flow rate. The reason for the low flow rates remains unknown but the discrepancy was flagged during the model calibration.

Regular spikes of flow consisting of approximately 72 m³ of volume over one hour were observed at WMH71. Following discussions with Region staff, it is possible that these increases can be attributed to the emptying of the backwash holding tank at the Wellesley WWTP into WMH132. However, of note is a surcharge event that occurred on February 17, 2023, as shown in Figure 3-2. During this event, surcharging was observed along Firella Creek Trunk Sewer during DWF. The cause of the February 17, 2023 event is unknown.

Figure 3-2. Flow and Depth Spike at WMH71


Source (AMG, 2023). Note that the units for flow are L/s.

Flow was added to the model to represent the regular DWF flow spikes observed at WMH71.

Criteria used to assess the DWF calibration was referenced from WaPUG (2002), as described in Appendix A. The resulting DWF calibration results and the observed versus predicted figures are shown in Appendix A, Attachment D.

The diurnal patterns of the modelled DWF match well with the observed DWF. The weekday DWF volumes at all flow monitors meet the DWF calibration criteria. The model does not meet the peak flow criteria. However, since the DWF rate is relatively low, many of the peak flow differences can be attributed to local roughness and slope conditions or noise in the observed data.

WMH71 captures flow from all flow monitors and modelled versus observed flows at this location can therefore be representative of overall system calibration. The weekday modelled versus observed DWF volume at WMH71 is within the standard 10 percent threshold that is described in Appendix A. The modelled versus observed DWF peak flows at WMH71 are slightly outside of the 10 percent threshold. The modelled DWF depth is higher than the observed DWF depth at WMH71. This is explained further in the Sanitary Hydraulic Model Documentation Memo in Appendix A.

3.2.2.4 Wet Weather Flow Calibration

Storm events used for wet weather calibration were generally selected by identifying the largest observed events recorded at the rain gauge in terms of both depth and intensity. Each identified event was evaluated using event selection criteria from the WaPUG guidelines (WaPUG, 2002) to determine the suitability of each event for performing calibration, as described in Appendix A.

An analysis of the flow monitoring data suggests a partial blockage immediately downstream of WMH71 that has a substantial impact on the surcharging observed within Wellesley's Wastewater Collection System. An approximately 40 percent blockage equating to a pipe of diameter of 210 mm was represented at the outgoing pipe to WMH71 (Region Pipe ID of WP178; model ID of MH0049.1). As a comparison, the designed pipe diameter was 350mm. The partial blockage was confirmed with a picture obtained from the installation of the flow monitor, as described further in Appendix A.

The RTK (R-Response Ratio, T – Time to Peak, K -Recession Limb Ratio) method was used to calibrate the model to the wet weather events. The RTK method is a method of generating a hydrograph to determine the rainfall derived inflow and infiltration from a modelled subcatchment. Initial RTK parameters were extracted from the previous data analysis performed on the 2017 data (GMBLuePlan, 2017) and were manually adjusted in an iterative process to better fit the 2023 data. As described in Appendix A, Critical Event (CE) 2 and CE3a events were prioritized during the wet weather model calibration due to the GWI variations observed during CE1, CE3b, and CE4 events. Calibrating with a focus on the CE2 and CE3a events resulted in balancing the high response observed during CE1 and CE3b with the low response observed during CE4.

Criteria used to assess the wet weather flow calibration was referenced from WaPUG (2002), as described in Appendix A. The resulting wet weather flow calibration results and the observed versus predicted figures are shown in Appendix A, Attachment E.

The WWF volume criteria is generally met for the CE2 and CE3a storm, with some exceptions including discrepancies in surcharged depths observed at WMH78, WMH76, and WMH71 during CE2. As expected, the observed volume, depth, and peak flows are substantially underestimated in the model for CE1 due to GWI influence and possible saturated soil conditions. During CE4, the observed volume, depth, and peak flows are substantially overestimated at most locations due to low GWI and possible dry soil conditions impacting the observed data. The response pattern is matched fairly well at all monitoring locations. Further flow monitoring is recommended to verify system response to larger rainfall events.

Model limitations are described in Appendix A.

3.2.2.5 Post-Calibration Model Updates

Following the hydraulic model calibration, the Region's wastewater operators removed the observed blockage downstream of WMH71 (Region of Waterloo, pers. comm. 2023) on October 17, 2023. It is suspected that the blockage was a grease deposit. The hydraulic model was then updated to reflect the blockage removal to conduct the Wellesley wastewater collection system analysis for the Wellesley WWWMP.

With the blockage downstream of WMH71 removed, the modelled representation of the WWTP influent PS becomes more influential on upstream water level results. Therefore, refinements to the pump station in the model were completed. Specifically, the Influent PS bypass pipe was added to the model and the head-discharge curve was updated. The bypass pipe is represented as a 375 mm diameter overflow pipe at the Influent PS wet well with an invert elevation of 347.000 m, as per drawing 2P1 in the contract number 92031 as-built drawings. The head-discharge curve was updated to reflect the pump speed before reaching its full 52 L/s speed, as according to drawing 2P1 in the contract number 92031 as-built

drawings. The assumption that the lag pump is effectively 55 percent of the lead pumps' capacity did not change. Drawdown pumping could further verify the capacity of the existing pumping station.

Additionally, as noted in Section 3.2.2.3, the per capita wastewater loading for catchment area WMH78 is exceptionally low. Similarly, the RTK parameters at WMH78 are relatively low compared to the other catchment areas. As described in Appendix A, further investigation outside of the WWWMP is required to determine why the flows from the WMH78 catchment area are low. For the purposes of the WWWMP, the dry weather flow and wet weather flow calibration parameters from a neighbouring catchment area, WMH28, were applied to the WMH78 catchment area.

3.2.3 Future Flow Projections

The future flows within the collection system are based on residential growth projections provided by the Region, as well as anticipated ICI growth based on information provided by the Township of Wellesley staff, as described in TM1. In most cases, the population growth of 1,887 by 2051 was distributed by Plum Zone, the locations of which were provided by the Region. Within Plum Zone 1213, the population was split between two anticipated developments (a development at the existing community centre and a development at Doering Street and Nafziger Road). Additionally, a population of 51 people was added to reflect the un-serviced parcels along Nafziger Road at the north end of the study area in Plum Zone 1214. Table 3-6 summarizes the 2051 future dry weather flows within each plum zone intersecting the Study Area. The population growth within each Plum Zone was assumed to be within the Study Area boundary. Therefore, wet weather flow contribution from areas outside of the study area is not considered during the analysis. The design flows presented in Table 3-6 were determined using the wastewater generation rates described in Table 2-1. Figure 3-3 shows the locations of the Plum Zones with respect to the Study Area.

Table 3-6. 2051 Additional Dry Weather Flows

Location	Plum Zone ID	Land use	Area (ha) ^a	2051 Population ^b	Average Flow (L/s) ^c	Peaking Factor ^c	Peak Wastewater Flow (L/s)	Comments
New Community Centre (Queens Bush Road)	216	Institutional	15.0	0	3.75	1	3.75	
PZ216	216	Residential	2.2	20	0.06	4.4	0.28	
Existing Community Centre (East of Maple Leaf Street)	1213	Residential	6.5	68	0.22	4.3	0.93	
Doering and Nafziger Development	1213	Residential	1.3	68	0.22	4.3	0.93	
Commercial growth east of Greenwood Hill Road	224	Commercial	0.4	0	0.2	2.5	0.50	
Development West of Lawrence Street	219	Residential	18.2	772	2.46	4.0 ^d	9.90 ^e	
Development Northeast of Queens Bush and Greenwood Hill Road	224	Residential	4.0	206	0.66	4.2 ^d	2.78 ^e	No additional wet weather contribution (overlapping parcels with existing buildings).
Future Growth Area [East of Parkview Drive]	225	Residential	9.5	692	2.20	4.2 ^d	9.06 ^e	
Un-serviced Area	1214	Residential	6.5	51	0.16	4.3	0.70	Population growth is -2. Subcatchment is currently unserved. Added 51 people which corresponds to 2051 population for plum zone.
PZ220	220	Residential	59.2	69	0.22	4.4 ^d	0.96 ^e	No additional wet weather contribution (overlapping parcels with existing buildings).
PZ1018	1018	N/A	7.2	0	0	0	0	Not added to model. Population growth is -7, maintained as 0 population growth to be slightly conservative.
PZ217	217	N/A	26.2	0	0	0	0	Not added to model. Population growth is 0.

Notes:

^a Contributing area excludes any area beyond the Study Area boundary.

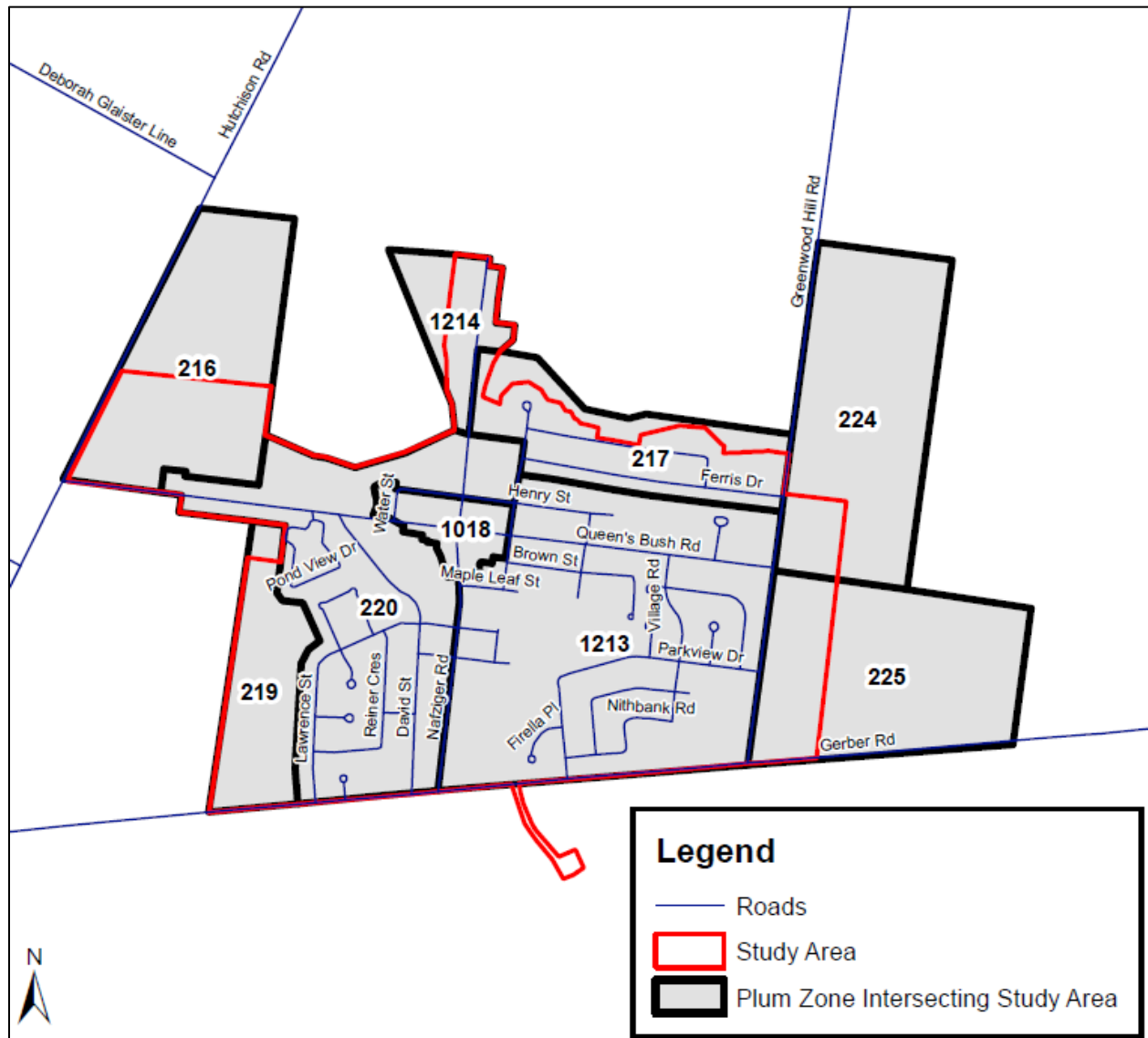
^b Based on Region of Waterloo pers. comm., 2024c and Region of Waterloo pers. comm., 2024d

^c Based on Region of Waterloo et. al, 2022 as described in Table 2-1

^d Plum Zone has been separated into multiple subcatchments in the hydraulic model; value displayed is the average peaking factor for each subcatchment

^e Plum Zone has been separated into multiple subcatchments in the hydraulic model; value displayed is the sum of the peak flow from each subcatchment

Figure 3-3. Plum Zone Location



A future conditions scenario representing the year 2051 as per the population growth described in Table 3-6 was added to the hydraulic model. During DWF simulations, design peak wastewater flow (as identified in Table 3-6) was used for the future subcatchments. The peak DWF rate (peak wastewater flow) at the future subcatchments was represented as a constant flow in the model. No additional GWI was added to the future parcels.

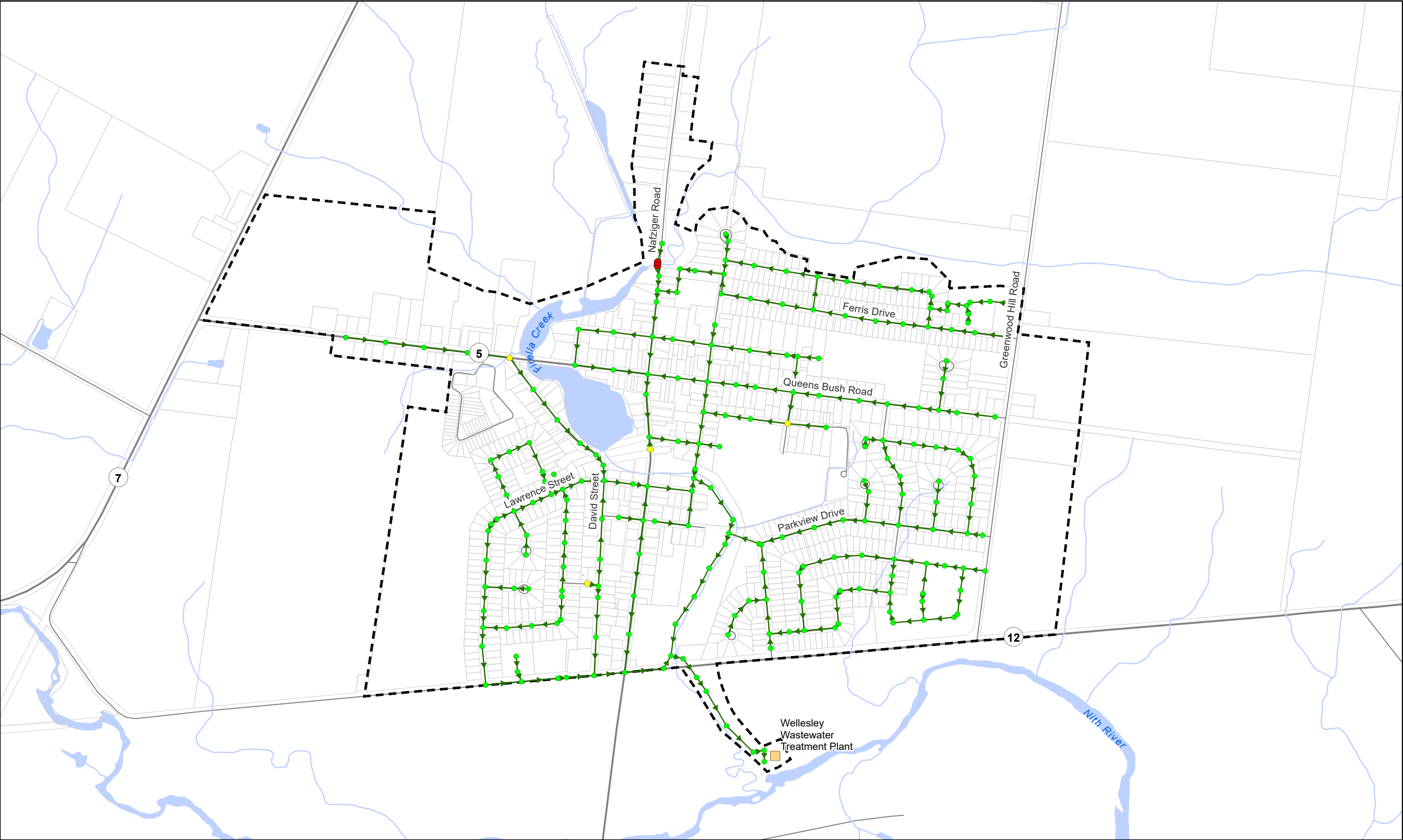
For WWF analysis, two scenarios were considered:

- 1) Average DWF with no peaking factor for existing and future subcatchments, plus assigning RTK parameters from nearby calibrated parcels to future subcatchments.
- 2) Average DWF with no peaking factor for existing and future subcatchments plus assigning the DGSS design I/I rate of 0.25 L/s to the future subcatchments.

For WWF, assigning RTK parameters from nearby calibrated parcels to future parcels (scenario 1) was deemed to be the more realistic option, and was therefore selected as the method to assess the wastewater collection system for the WWWMP.

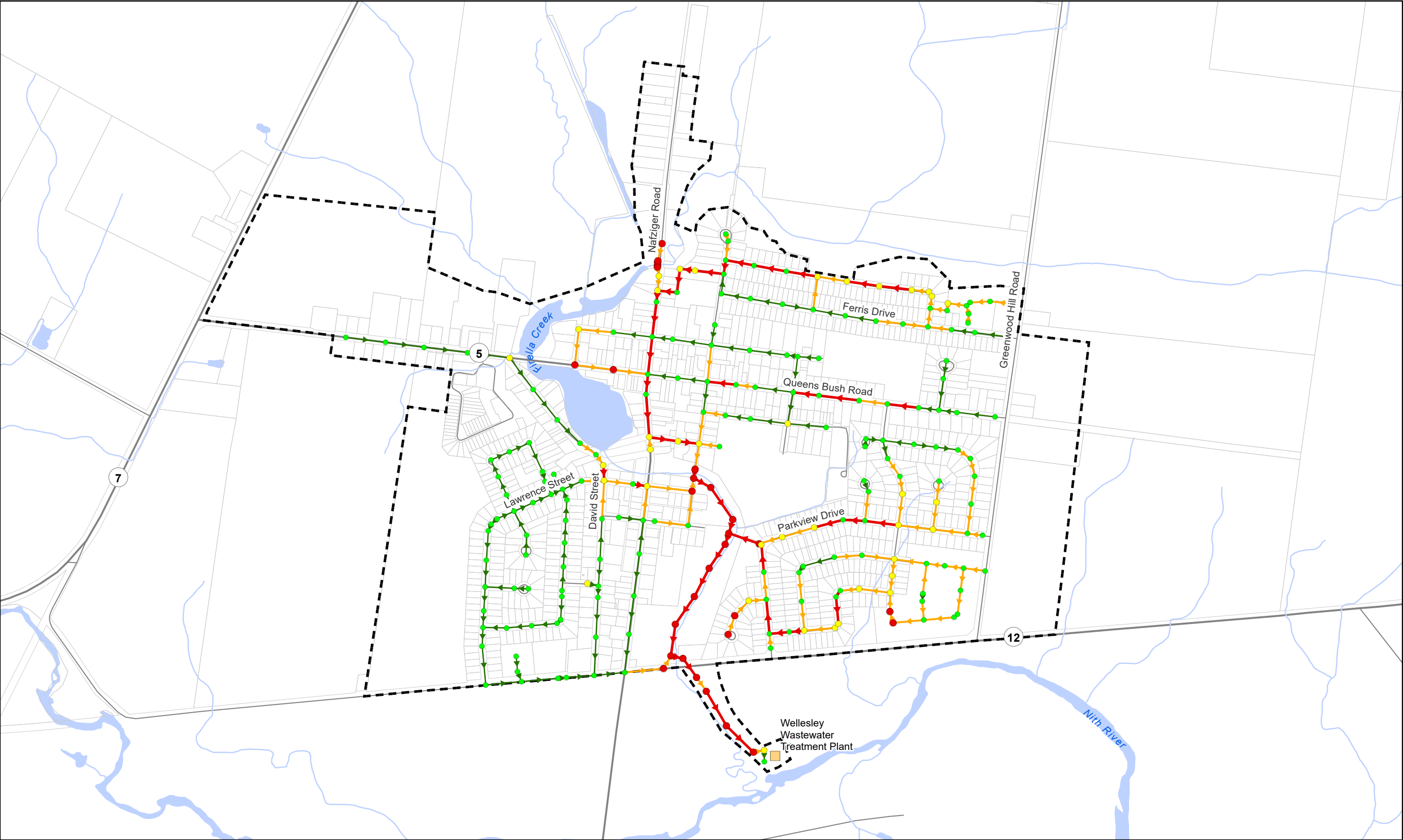
3.2.4 Model Results

Both the existing conditions scenario and the 2051 future conditions scenario were ran under DWF, 5-year design storm, and 25-year design storm rainfall events. The Region did not have design storm events available at the time of this analysis, and therefore the design storm events used for this assessment were from the City of Kitchener. Figures showing the surcharge and freeboard results for the existing conditions scenario and the future conditions scenario under DWF, the 5-year design storm, and the 25-year design storm are shown in Figure 3-4 through Figure 3-9.



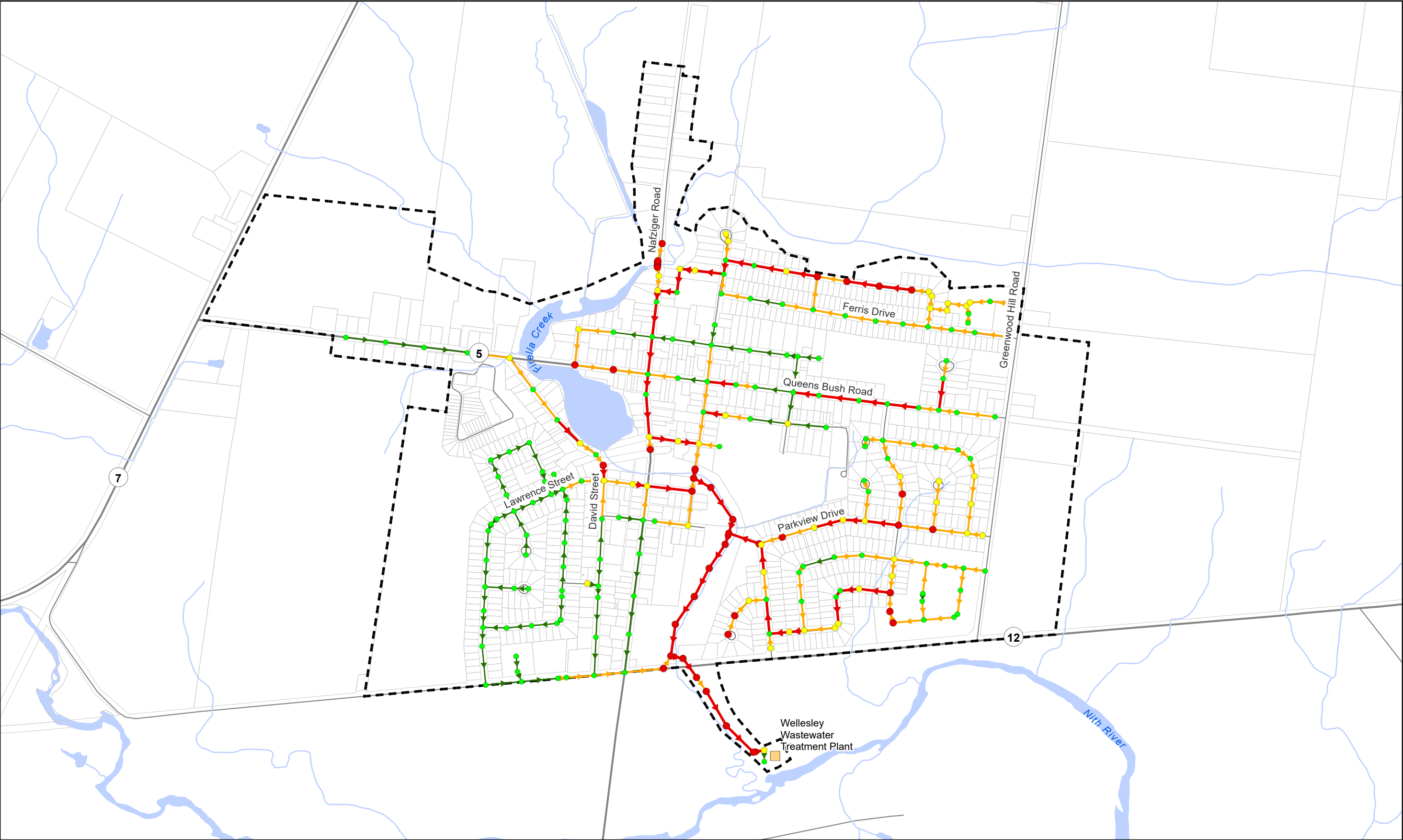
DRAFT

Figure 3-4
Existing Conditions During DWF
TM4 - Wastewater Infrastructure Alternatives Development
ROW Wellesley WWW MP
Region of Waterloo
Waterloo, Ontario



DRAFT

Figure 3-5
Existing Conditions During 5-Year Design Storm
TM4 - Wastewater Infrastructure Alternatives Development
ROW Wellesley WWW MP
Region of Waterloo
Waterloo, Ontario



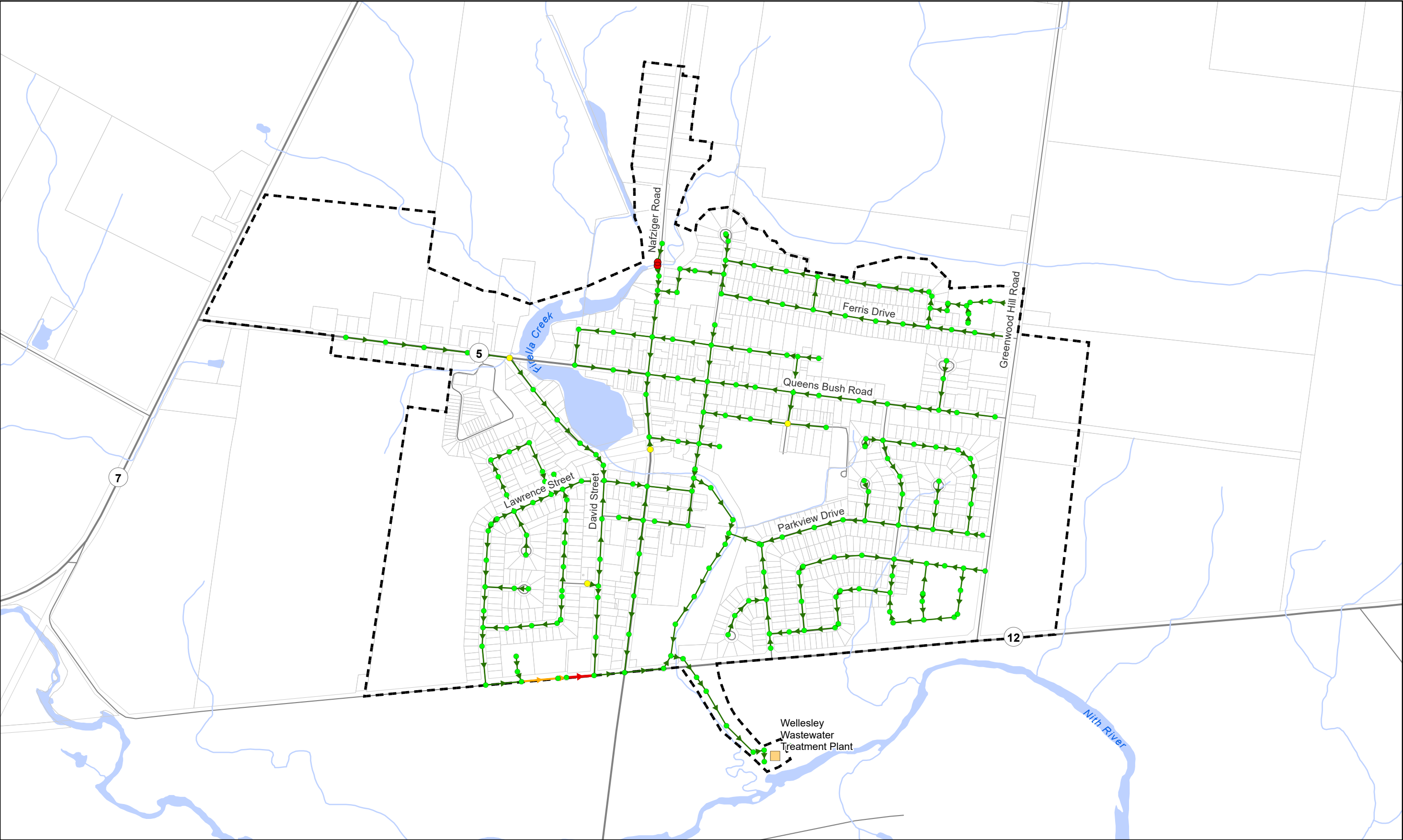
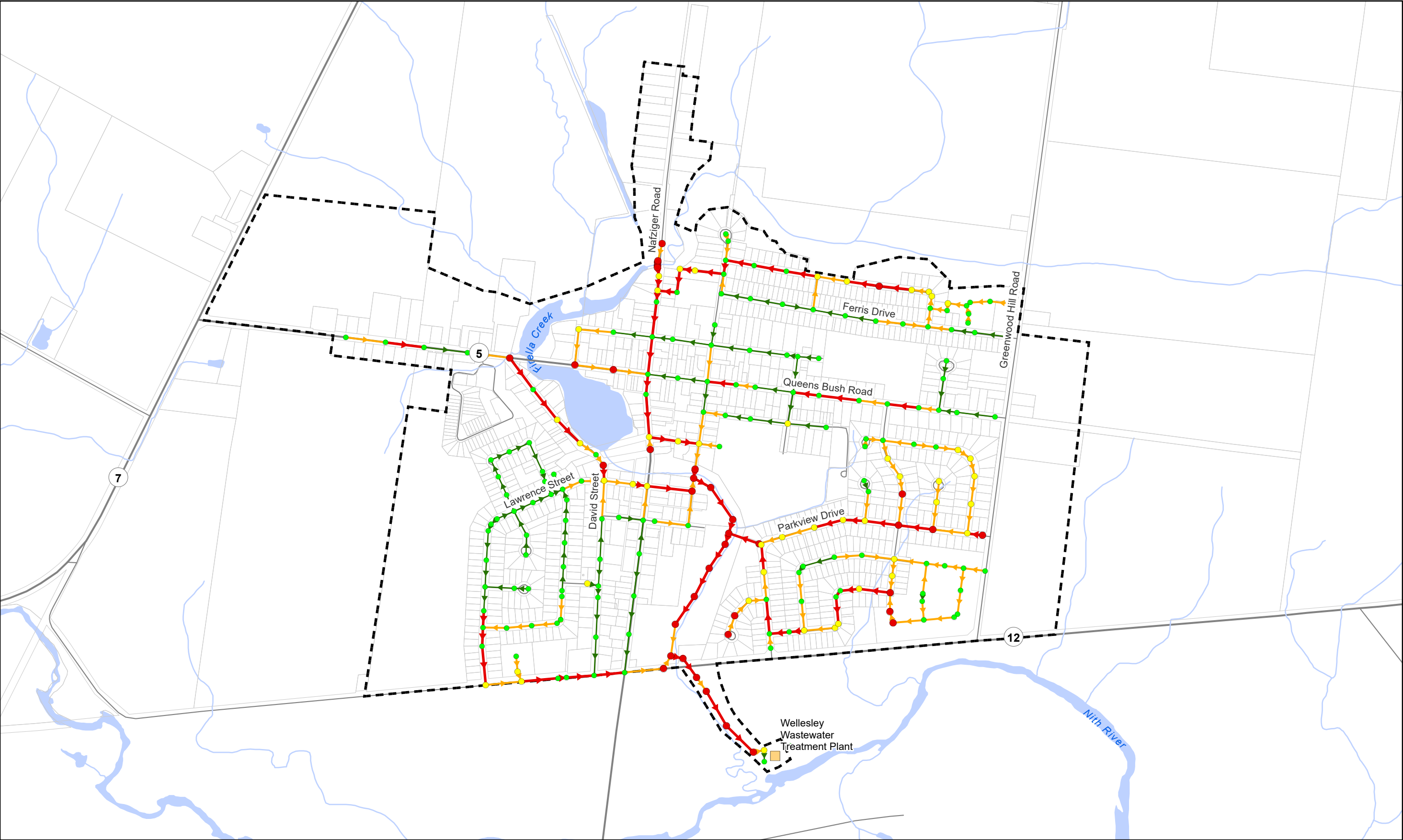
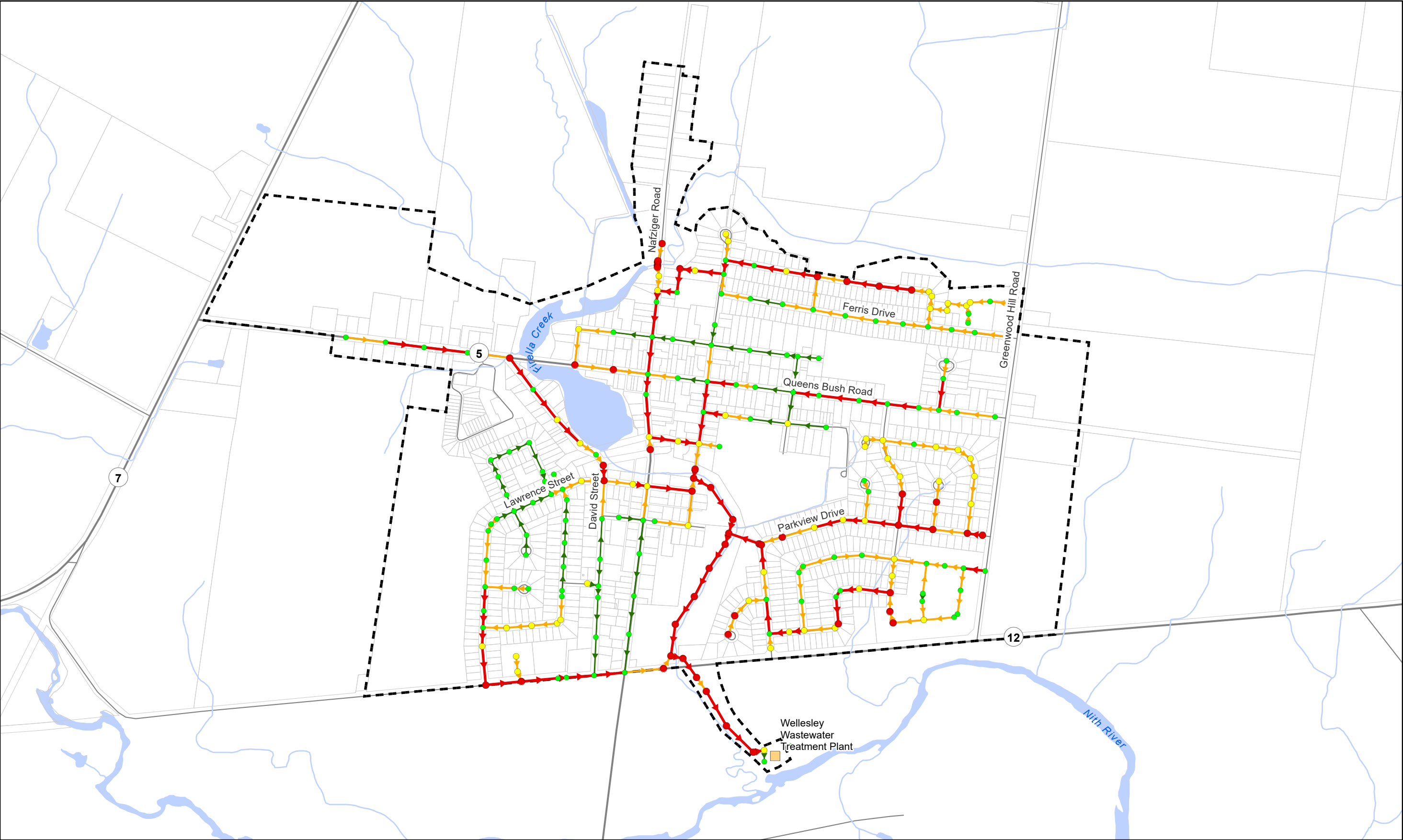


Figure 3-7
Future Conditions During DWF
TM4 - Wastewater Infrastructure Alternatives Development
ROW Wellesley WWW MP
Region of Waterloo
Waterloo, Ontario



DRAFT

Figure 3-8
Future Conditions During 5-Year Design Storm
TM4 - Wastewater Infrastructure Alternatives Development
ROW Wellesley WWW MP
Region of Waterloo
Waterloo, Ontario



A summary of the preliminary results is provided in Table 3-7.

Table 3-7. Summary of Preliminary Modelled Results

Model Scenario	Design Storm/DWF	Results
Existing Conditions	DWF	No surcharging ^a
	5-year	- Pipe capacity constraints along the Firella Creek Trunk Sewer amplified by downstream pump station constraints. Surcharging to surface simulated along the Firella Creek Trunk Sewer. - Pipe capacity constraints along Nafziger Road (north of Maple Leaf Street), Maple Leaf Street, Schweitzer Crescent, Lawrence Street, amplified by surcharging along the Firella Creek Trunk Sewer. - Pipe capacity constraints along Queen's Bush Road (east of Molesworth Street). - Select pipe capacity constraints along Nithbank Road and Parkview Drive. Surcharging is amplified by surcharging along the Firella Creek Trunk Sewer. Surcharging to surface is simulated. - Surcharging due to backflow along various local sewers is simulated. - Approximately 390 m³ of bypass simulated at the influent PS.
	25-year	- Pipe capacity constraints along the Firella Creek Trunk Sewer amplified by downstream pump station constraints. Surcharging to surface simulated along the Firella Creek Trunk Sewer. - Pipe capacity constraints along Nafziger Road (north of Maple Leaf Street), Maple Leaf Street, Schweitzer Crescent, Lawrence Street, amplified by surcharging along the Firella Creek Trunk Sewer. Surcharging to surface is simulated. - Pipe capacity constraints in the vicinity of Nithbank Road and Parkview Drive amplified by surcharging along the Firella Creek Trunk Sewer. Surcharging to surface is simulated. - Pipe capacity constraints along Queen's Bush Road (east of Molesworth Street) with a freeboard greater than 1.8 m. - Select pipe capacity constraints along David Street, amplified by backflow conditions. Surcharging to surface is simulated. - Surcharging due to backflow along various local sewers resulting in freeboard less than 1.8m. - Approximately 1710 m³ of bypass simulated at the influent PS.
Future Conditions (2051)	DWF	Surcharging due to capacity simulated along Gerber Road (pipe ID WP129, pipe immediately west of the intersection of Gerber Road and David Street). The surcharging is the result of intermittent flow spikes modelled from the water treatment plant. The surcharging at WP129 is

TM4: Wastewater Infrastructure Alternatives Development

Model Scenario	Design Storm/DWF	Results
		resulting in surcharging due to backflow for approximately 100 m upstream.
	5-year	▪ Pipe capacity constraints along the Firella Creek Trunk Sewer amplified by downstream pump station constraints. Surcharging to surface is simulated along the Firella Creek Trunk Sewer. ▪ Pipe capacity constraints along Nafziger Road (north of Maple Leaf Street), Maple Leaf Street, Schweitzer Crescent, Lawrence Street, amplified by surcharging along the Firella Creek Trunk Sewer. ▪ Pipe capacity constraints along various portions of Queen's Bush Road ▪ Select pipe capacity constraints along Nithbank Road and Parkview Drive. Surcharging is amplified by surcharging along the Firella Creek Trunk Sewer. Surcharging to surface is simulated. ▪ Pipe capacity constraints along Gerber Road, Lawrence Street, and David Street. ▪ Surcharging due to backflow along various local sewers is simulated. ▪ Approximately 352 m³ of bypass simulated at the influent PS.
	25-year	▪ Pipe capacity constraints along the Firella Creek Trunk Sewer amplified by downstream pump station constraints. Surcharging to surface simulated along the Firella Creek Trunk Sewer. ▪ Pipe capacity constraints along Nafziger Road (north of Maple Leaf Street), Maple Leaf Street, Schweitzer Crescent, Lawrence Street, amplified by surcharging along the Firella Creek Trunk Sewer. Surcharging to surface is simulated. ▪ Pipe capacity constraints in the vicinity of Nithbank Road and Parkview Drive amplified by surcharging along the Firella Creek Trunk Sewer. Surcharging to surface is simulated. ▪ Pipe capacity constraints at various locations along Queen's Bush Road, with a freeboard greater than 1.8 m. ▪ Select pipe capacity constraints along Gerber Road, Lawrence Street, and David Street, amplified by backflow conditions. Surcharging to surface is simulated. ▪ Surcharging due to backflow along various local sewers resulting in freeboard less than 1.8m. ▪ Approximately 2322 m³ of bypass simulated at the influent PS.

^a with the exception of the siphons along Nafziger.

3.2.5 Condition-Based Needs

Previous system-wide CCTV of the Wellesley wastewater collection system was completed in 2017. The results of the inspection indicated grease build-up observed in 61 locations in the sanitary system along with several fractures and cracks throughout the system and sags concentrated in the southwest area of

the collection system (GMBP, 2018). The majority of the significant grease and encrustation was observed along the lower portion of the Firella Creek Trunk Sewer. Sewer flushing, semi-annual inspections, and a customer education program was recommended to address the grease and encrustation defects. The conveyance restrictions were not recommended for repair, while 21 sewer repairs and eight manhole repairs were recommended to address infiltration defects. (GMBP, 2018).

Manhole repairs for several manholes along the Firella Creek Trunk Sewer were completed in 2023, and include raising, grouting, new lid, and/or debris removal. System-wide closed-circuit television (CCTV) inspections are being completed in 2024. (Region of Waterloo pers. comm., 2024b).

4. Development and Screening of Long-List of Alternatives

4.1 Wellesley WWTP

Alternative solutions were developed and screened for each major unit process requiring a capacity upgrade/expansion for the planning horizon (raw wastewater pumping, screening, secondary treatment, sludge storage, and tertiary filtration). The alternatives are generally 1) replace the existing process or equipment with larger capacity units, 2) construct/install additional process tanks or equipment of the same technology to increase capacity, and 3) implement an alternative technology/approach to increase capacity. Table 4-1 summarizes the alternatives for each unit process, the advantages and disadvantages for each, and the results of the screening. The alternatives were developed on the assumption that storage within the collection system would not be implemented, and storage for raw wastewater pumping would be required.

In addition to the main unit processes, the blowers and chemical phosphorus removal metering pumps need to be upgraded/replaced to provide capacity for the planning period. The Region conducted a separate study in 2023 to identify the preferred approach to upgrade the existing blower system (Region of Waterloo, pers. comm. 2024a). As such, alternative solutions for the blower system are not explored in this TM. The existing chemical metering pumps can be replaced with larger capacity units when they reach the end of their useful service life. The timing for these upgrades will be determined based on the ICC report findings and recommendations.

The long list alternatives were screened based on the following criteria:

1. Ability to meet future demand and increase in population (Year 2051)
2. Implementation complexity and how alternative can be implemented at Wellesley WWTP without significant constraints

TM4: Wastewater Infrastructure Alternatives Development

Table 4-1. Summary and Screening of Wastewater Treatment Alternatives

Alternative Description	Advantages	Disadvantages	Screening Evaluation
Raw Wastewater Pumping			
1. Replace existing duty/standby pumps with larger capacity pumps/equalization tank	Opportunity to complete this upgrade when existing pumps reach end-of-life. Construction of equalization tank can eliminate the need for upsizing the downstream processes based on infrequent very high peak flows.	Space in existing wet well is limited. No increase in wet well capacity. Requires large footprint for the equalization basin.	Pass
2. Install a third pump/equalization tank	Opportunity to optimize pumping operations with multiple duty pumps.	Space in existing wet well is limited. No increase in wet well capacity.	Fail Not enough room in existing wet well.
3. Construct a new pump station/equalization tank	Opportunity to construct a new, larger wet well that will provide some flow equalization to help alleviate peak flows through the plant. Opportunity to construct a new combined pump station/headworks facility to address capacity constraints in both systems. Construction of equalization tank can eliminate the need for upsizing the downstream processes based on infrequent very high peak flows	Highest capital cost. Does not make use of existing pump station assets. Requires large footprint for the equalization basin.	Pass
Headworks (Screening)			
1. Replace existing screen and retrofit channel (retrofit or expand existing channel) to increase capacity	Opportunity to complete this upgrade when existing screen reaches end-of-life.	Only one screen (no redundancy). Space in existing screen building is limited. Complex retrofit.	Pass
2. Install a second screen and channel in existing screen building	Improved redundancy with multiple screen channels.	Space in existing screen building is limited. Complex retrofit.	Fail Insufficient space in existing building.
3. Construct a new headworks facility	Opportunity to construct multiple screen channels for redundancy.	Highest capital cost. Does not make use of existing headworks assets.	Pass

TM4: Wastewater Infrastructure Alternatives Development

Alternative Description	Advantages	Disadvantages	Screening Evaluation
	Opportunity to construct a new combined pump station/headworks facility to address capacity constraints in both systems.		
Secondary Treatment ^a			
1. Replace Plants 1 and 2 with a larger capacity plant	Opportunity to eliminate existing operational challenges (flow splitting) in Plants 1 and 2.	Highest capital cost. Does not make use of existing secondary treatment assets.	Fail Does not make use of existing assets
2. Construct new extended aeration Plant No. 3	Secondary treatment capacity expansion would provide capacity beyond the current planning horizon. Consistent O&M requirements with Plants 1&2.	Higher capital cost.	Pass
3. Implement an alternative process intensification technology into Plants 1 and 2 (Densification with AGS or MABR)	Upgrading the current secondary treatment process with new process intensification technology such as Densification with aerobic granular sludge (AGS) or membrane aerated biofilm reactors (MABR) could provide a lower-cost increase in secondary capacity.	Adds O&M complexity to the secondary process operation.	Pass
4. Implement a wet weather management technology (such as cloth media filtration) to handle flows exceeding secondary treatment peak capacity (4,400 m ³ /day)	Wet weather management eliminates the need to oversize the secondary treatment to handle infrequent wet weather flow.	Adds capital cost and O&M complexity due to the intermittent operation	Pass
Sludge Storage			
1. Replace existing storage tank with a new larger storage tank	Increases solids holding capacity volume from 2-days to 5-days of storage.	No redundancy in tank operation.	Pass
2. Construct a second storage tank	Provides redundancy.	More complex O&M requirements with multiple tanks.	Pass
3. Implement an alternative sludge thickening technology	Implementing a sludge thickening process upstream of the storage tank would reduce sludge haulage volume/cost and extend the storage capacity of the existing tank.	Inconsistent with Regional Biosolids Master Plan (Waterloo, 2018), which determined the Region's preference to maintain the current storage strategy at the Wellesley WWTP.	Fail Incompatible with Regional Biosolids Master Plan.

TM4: Wastewater Infrastructure Alternatives Development

Alternative Description		Advantages	Disadvantages	Screening Evaluation
Tertiary Treatment				
Do Nothing	No additional cost. If peak flow exceeds existing peak flow capacity of 4,400 m ³ /d, the redundant unit can be used to treat the additional flows	No redundancy is provided under peak flow events. Lower effluent quality if one filter is under maintenance period		Pass
Expand existing tertiary treatment system	Provides sufficient capacity to handle peak flows with consideration to redundancy	Higher capital cost		Pass

Notes:

^a The Region conducted a separate study in 2023 to identify the preferred approach to upgrade the existing blower system. Additional blower was recommended to increase the firm AADF capacity up to 1,320 m³/d. The bioreactor blower capacity would need to be slightly increased to meet aeration demands associated with the future loadings (AADF of 1,345 m³/d).

4.2 Wastewater Collection

A long list of alternative concepts was developed to mitigate the flow constraints within the Wellesley wastewater collection system, based on the results described in Section 3.2. The long-list of collection system alternative concepts can be grouped into four main categories:

- **Source Controls** -reducing the volume of flow entering the sanitary sewer system by means of water conservation methods, reducing direct stormwater inflows, and reducing infiltration. These controls are often implemented through programs or incentives.
- **Conveyance Controls** -storing or slowing/staggering the flow within the collection system. Methods include inline storage, pipe upsizing, and sewer separation.
- **Flow Diversion** -redirecting the pipes within the collection system to direct flows away from areas of capacity constraints.
- **End-of-Pipe Controls** -includes the reduction of downstream bottlenecks at the end of the conveyance system.

Table 4-2 below lists the advantages and disadvantages of the source controls, conveyance controls, flow diversion, and end-of-pipe controls alternatives as well as the results of the screening. The do-nothing alternative is carried forward as a means of comparison and to comply with EA guidelines for evaluation.

Table 4-2. Summary and Screening of Wastewater Collection System Alternative Concepts

Alternative	Advantages	Disadvantages	Screening Evaluation
Source Controls			
Downspout Disconnection	Educate and provide incentives for residents and private owners to disconnect roof leaders from the sanitary system. This can result in reduced inflow and infiltration in the sanitary system.	Enforcement of downspout disconnection programs can be difficult.	Pass
Rain Barrel Program	Can be a substitute to downspouts connected to the sanitary system.	The Region of Waterloo has a rain barrel program and therefore additional uptake is not expected.	Fail Additional uptake to Region's rain barrel program not expected.
Weeping Tile (Foundation Drain Disconnection)	Has the potential to remove a substantial portion of I/I from the Wellesley collection system.	Enforcement of foundation drain disconnection programs, incentives, and mandates can be difficult.	Pass
Sewer Lining	Can be effective at reducing infiltration into sewer system.	Can reduce sewer capacity.	Pass
Cross-Connection Disconnection	Can be effective at reducing direct inflows.	No evidence of catch-basin connections in Wellesley (GMBP, 2021). Can be difficult to identify.	Pass
WTP Backwash Mitigation	Reduce temporary peak flows observed within the sanitary system.	Mitigation measures may be difficult to implement.	Pass
Conveyance Controls			

TM4: Wastewater Infrastructure Alternatives Development

Alternative	Advantages	Disadvantages	Screening Evaluation
Inline Storage	Provides storage that can reduce peak flows effectively.	Potential to cause odour issues, costs can vary. May result in substantial pipe diameter increases.	Fail The volume of inline storage required would be significant. The diameter and depth of pipe required would not be practical.
Offline Storage	Can have low capital cost. Can be an effective means to store sanitary sewerage.	Potential to cause odour issues. Can result in operational challenges and costs. Requires footprint to implement/construct. Would be required at multiple locations in the Wellesley collection system.	Pass^a
Sewer Separation	Reduces the amount of stormwater entering the sanitary system by separating the storm system from the sanitary system	Wellesley does not have combined sewers.	Fail Not applicable
Pipe Upsizing or Twinning	Can reduce upstream capacity constraints and eliminate bottle necks	Can increase flow to downstream sewers, with the potential to increase the hydraulic gradeline (HGL)	Pass
Flow Redirection			
Weir	Can be effective at changing flow direction at locations with flow bifurcation.	May cause upstream capacity concerns by slowing the downstream flow. Need to be at locations of bifurcation.	Fail No applicable locations
Pipe Realignment	Effective at reducing capacity constraints in areas of concern.	Can increase flow to downstream sewers, with the potential to increase the HGL.	Fail Firella Creek Trunk Sewer capacity is constrained. Firella Creek Trunk sewer conveys flows to the Wellesley WWTP; redirecting flow to enter Firella Creek Trunk sewer at another location will not solve the capacity constraint.

TM4: Wastewater Infrastructure Alternatives Development

Alternative	Advantages	Disadvantages	Screening Evaluation
New Trunk Sewer	Redirects flow away from areas of constraint and conveys flow directly to the Firella Creek Trunk Sewer.	Results in additional assets that require maintenance.	Pass ^b
End-of-Pipe Controls			
Capacity increases at end of the conveyance system (ie. increased Capacity at WWTP Influent PS or Equalization Tanks)	Reduces surcharging due to backwater in the conveyance system. May reduce grease build up and risk of odour by reducing backflow conditions.	Influent PS capacity increases would require integration with WWTP capacity. Equalization tank would require large footprint.	Pass ^c

^a Viable for trunk sewer only. It is not practical to have offline storage for local sewers.

^b Considered to convey flow from future developments at the east and west extents of the Study Area.

^c End-of-Pipe Controls are to be considered and evaluated under wastewater treatment alternatives.

Recent I/I investigations (GMBP, 2021) revealed that the I/I in Wellesley's wastewater collection system is likely largely due to foundation drains on private property. Various programs, mandates, and incentives will be explored further if source control is a recommended preferred alternative. However, it is understood and expected that these implementation measures do take time and may not always be feasible to implement. Therefore, it is likely that this concept will need to be paired with infrastructure upgrades to be viable.

Offline storage is a potential concept to store flows to the Firella Creek Trunk Sewer during wet weather events and is carried forward as a concept to address the trunk sewer constraints. However, offline storage would not be practical to address the local sewer capacity constraints for various reasons, including the risk of generating odours in residential neighbourhoods, the potential need for land acquisition to install an offline storage tank, and the relatively large number of local pipe constraints throughout Wellesley.

Pipe upsizing or twinning is carried forward as a potential concept to address both the local sewer capacity constraints as well as the Firella Creek Trunk Sewer capacity constraint. A new trunk sewer or sub-trunk is also a concept carried forward to convey flow from the future developments on the east and west extents of the Study Area.

End-of-pipe controls, such as capacity increases at the Influent WWTP Influent PS and/or an equalization tank at the wastewater treatment plant will be further considered and evaluated under the wastewater treatment alternatives.

5. Summary of Short-Listed Wastewater Treatment and Wastewater Collection Alternatives

5.1 Wellesley WWTP

The short-listed alternatives for the Wellesley WWTP include the following:

- Raw wastewater pumping:
 - Alternative 1: Replace existing duty/standby pumps with larger capacity pumps and construction of equalization tank.
 - Alternative 2: Construct a new pump station/equalization tank. and construction of equalization tank.
- Headworks:
 - Alternative 1: Replace existing screen and retrofit channel to increase capacity
 - Alternative 2: Construct a new headworks facility
- Secondary treatment:
 - Alternative 1: Construct new extended aeration Plant No. 3
 - Alternative 2: Implement an alternative process intensification technology into Plants 1 and 2 (Densification with AGS or MABR)
 - Alternative 3: Implement a wet weather management technology (such as cloth media filtration) to handle flows exceeding secondary treatment peak capacity
- Sludge storage:
 - Alternative 1: Replace existing storage tank with a new larger storage tank
 - Alternative 2: Construct a second storage tank
- Tertiary filtration:
 - Alternative 1: Do nothing and use the redundant filter to handle flows exceeding 4,400 m³/d
 - Alternative 2: Expand existing tertiary filtration process with additional filter

Note that the above alternatives will be evaluated against the “Do Nothing” alternative (included as a means of comparison).

5.2 Wastewater Collection

The wastewater collection system concepts passing the screening include the following:

- I/I reduction (downspout disconnection, foundation drain disconnection, sewer lining, cross-connection disconnection)
- WTP Backwash Mitigation
- Pipe Upsizing or Twinning

- Offline Storage (concept considered for the Firella Creek Trunk Sewer)
- New Trunk/Sub-Trunk Sewer (concept considered for the local sewers)

As mentioned in Section 4.2, it is expected that source control concepts will need to be paired with infrastructure upgrades to be a viable solution to the constraints. Combinations of concepts have been identified to comprise the short-list of alternatives. Alternatives were grouped into alternatives to address the Firella Creek Trunk Sewer needs (Group A), and alternatives to address the local sewer needs (Group B).

The following short-listed alternatives are alternatives to address the Firella Creek Trunk Sewer needs:

1. **Group A -Alternative 1.** Do nothing and maintain status quo (included as a means of comparison).
2. **Group A -Alternative 2.** Implement I/I reduction measures, WTP backwash mitigation measures, offline storage locations to equalize flows along the Firella Creek Trunk Sewers.
3. **Group A -Alternative 3.** Implement I/I reduction measures, WTP backwash mitigation measures, upsize or twin Firella Creek Trunk Sewer.

The key difference between Alternative 2 and Alternative 3 is that Alternative 2 will store the flows within the collection system to avoid upsizing the Firella Creek Trunk Sewer and avoiding or reducing the need for subsequent upgrades at the WWTP Influent PS (or Equalization Tank), whereas Alternative 3 will involve upsizing the Firella Creek Trunk Sewer and upsizing the WWTP Influent PS (and Equalization Tank). As noted in Section 4.1, raw wastewater pumping and storage considerations at the WWTP will be evaluated under the wastewater treatment alternatives. However, the evaluation of the Firella Creek Trunk Sewer alternatives and wastewater treatment alternatives will need to be collaborated since these alternatives are interconnected.

The following short-listed alternatives are alternatives to address the local needs:

1. **Group B -Alternative 1.** Do nothing and maintain status quo (included as a means of comparison).
2. **Group B -Alternative 2.** Implement I/I reduction measures, pipe capacity increases as necessary for local sewers.
3. **Group B -Alternative 3.** Implement I/I reduction measures, new trunk/sub-trunk sewers to collect flows from future developments on the east and west extents of the study area, pipe capacity increases as necessary for local sewers.

5.3 Next Steps

The next steps of the WWMP are to complete an evaluation of the short-listed alternatives for the Wellesley WWTP and wastewater collections using the evaluation criteria described in TM2. The evaluation process and results will be presented in TM5: Preliminary Preferred Water and Wastewater Alternatives. It is important that the wastewater conveyance system preferred alternative is selected prior to evaluating the treatment alternatives so that appropriate flows to the plant are considered during the evaluation.

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Appendix A. Sanitary Hydraulic Model Documentation Memo

Sanitary Hydraulic Model Documentation Memo

Date: February 27, 2024
Project name: Wellesley Water and Wastewater Master Plan
Project no: CE851700
Attention: Kaoru Yajima
Client: Region of Waterloo
Prepared by: Jacobs
Document no:
Copies to:

Jacobs Consultancy Canada Inc.

Kitchener, ON
Canada
T +1.519.579.3500

www.jacobs.com

Revision	Date	Description	Author	Checked	Reviewed	Approved
0	February 27, 2024	Draft	KM	RS	TWM	TWM
1	February 27, 2024	Final	KM	TWM	TWM	TWM

1. Introduction

Jacobs is currently supporting the Region of Waterloo (Region) to complete the Wellesley Water and Wastewater Master Plan (WWWMP). The analysis of the sanitary collection system in the Village of Wellesley for the WWWMP requires a dry weather and wet weather sanitary hydraulic model to identify current and future infrastructure needs to 2051. Previously, the Region developed an InfoSewer dry weather sanitary hydraulic model for the Village of Wellesley that was calibrated in 2017. In February 2023, the Region initiated a four-month flow monitoring period within the Wellesley wastewater collection system to support the development of a new InfoWorks ICM wet weather hydraulic model calibration.

This technical memorandum documents the process completed to update the Wellesley sanitary hydraulic model, an analysis of the 2023 flow monitoring data, and a summary of the hydraulic model calibration.

2. Hydraulic Model Updates

2.1 Pipe Network

An InfoSewer model was provided to Jacobs by the Region, and was converted to InfoWorks ICM version 10.5 by Jacobs. The existing pipe network within the hydraulic model was reviewed for connectivity. The invert elevations of several modelled pipes in the vicinity of Village Road and Gerber Meadows Drive were updated using a combination of as-built drawings and inference. The double-barrel siphon along Nafziger Road was also incorporated into the hydraulic model. The pipe network updates are identified in Table 2-1.

Table 2-1. Pipe Invert Elevation Updates

Pipe ID	Invert Elevation Source
WP232	Assumed Ministry of Environment, Conservation, and Parks (MECP) minimum pipe slope
WP246	As-Built ^a
WP247	As-Built ^a
WP214	Upstream invert from as-built ^a ; downstream invert inferred
WP215	Inferred
WP216	Inferred
WP217	Downstream invert from as-built ^a ; upstream invert inferred
WP210	Upstream invert inferred
WP209	Upstream invert from as-built ^a ; Downstream invert inferred
Model ID (MH0102.1, DMHS2.1, DMHS1.1, MH0102.2, DMHS4.1, DMHS3.1)	Siphon inverts and diameters from Project No. 1-0178-68 as-built drawing set.
^a As-built from drawing C-201 from Village Estates Subdivision Phase VI project	

Following the modelled invert updates using the C-201 from Village Estates Subdivision Phase VI project drawing, downstream pipe invert elevations were inferred as necessary for consistent alignment, as identified in Table 2-1.

As well, two pipe segments (WP0043 and WP0131), had a negative slope in the model. For this model update the invert elevations at WP0043 and WP0131 were inferred with the assumption that the pipes did not have a negative slope. Additionally, WP226 and WP227 had downstream inverts lower than the outgoing pipe in the model. To correct this, the upstream inverts at WP028 and WP227 were inferred. However, the invert elevations could be confirmed via as-built drawings.

2.2 Subcatchment Delineation and Populations

Delineated subcatchments are required to perform model calibration. Since the existing dry weather flow (DWF) InfoSewer model did not include a file with delineated subcatchments or catchment areas this file had to be created.

To create subcatchments, parcel data and landuse is required. A parcel shapefile and a landuse shapefile was provided by the Region (Township of Wellesley, 2015). Landuse was assigned to each parcel using a join tool in GIS software. More specific landuse for the parcels designated as 'Urban Core' landuse was assigned by viewing aerial imagery. The landuse within the modelled area is largely residential with scattered institutional parcels along with institutional/commercial/industrial (ICI) landuse and medium density residential buildings in the Urban Core in the Queen's Bush Road and Nafziger Road area. Populations were estimated with the assumption of 3 people per parcel or unit for residential buildings. Where medium density residential was determined through aerial imagery, the number of units was estimated from aerial imagery and a population assigned accordingly. ICI parcels were assumed to have an equivalent population density of 62 people per hectare.

Further landuse assumptions were made as follows:

- In the parcel data given, the subcatchment west of Greenwood Hill Road and north of Gerber Road was not delineated into individual residential parcels. The number of units per hectare of nearby residential parcels was used to determine the number of units.
- The retirement home located on Pond View Drive was estimated to have 100 beds.
- The baseball diamonds and soccer fields at the existing community centre east of Maple Leaf Street were not incorporated into the effective area used to estimate ICI equivalent population and wet weather flow runoff.

GIS software was used to determine the closest manhole to each parcel. The closest manhole was assumed to be the manhole flow from the parcel drained to. Adjacent parcels with the same landuse draining to the same manhole were combined to form an individual subcatchment.

Table 2-2 summarizes the landuse and population within the hydraulic model.

Table 2-2. Summary of Landuse and Modelled Populations

Landuse	Total Area (ha)	Equivalent Population
Residential	106.7	3,373
ICI	20.8	1,113
No Building	2.5	0
Total	130.0	4,486

The residential population presented in Table 2-2 (3,373 people) is reasonably comparable to the actual population within the village of Wellesley (the 2021 population is 3,680 (Region of Waterloo, pers. comm. 2022)).

2.3 Boundary Conditions

The flow within Wellesley's collection system drains to the influent pump station at the Wellesley Wastewater Treatment Plant south of Gerber Road. It is understood that this pump station may limit the flow draining from the Firella Creek Trunk Sewer and it is therefore important to represent this boundary condition within the sanitary hydraulic model.

An as-built drawing from the Wellesley Wastewater Treatment Plant Expansion Phase No. 1 was used to represent the influent pump station within the hydraulic model (drawing No. 2P1). The pump station was modelled with the following parameters:

- Lead pump on/off level: 340.60 m/340.34 m
- Lag pump on/off level: 341.1 m/340.85 m
- Lead pump capacity: 52 L/s
- Lag pump capacity: 52 L/s with assumed 45 percent headloss; effective modelled capacity 28.5 L/s
- Wet well base area: 2.63 m²

Although the pumps are variable speed pumps, they are represented as constant speed pumps within the hydraulic model for simplification. According to the as-built drawing (drawing No. 2P1), the lead pump reaches its maximum flow of 52 L/s prior to the water level within the wet well reaching the level of the influent pipe's invert elevation (341.486 m), while the lag pump is reaching its maximum flow within 0.01m of the pipe's invert elevation. Therefore, there is free outfall while the pumps are operating below their maximum capacity and representing the pumps as constant speed pumps is expected to have minimal impacts on the calibration. Additionally, the lag pump was assumed to operate at 55 percent of its capacity to account for headloss.

3. Review of Flow Monitoring Data (2023)

3.1 Overview of 2023 Flow Monitoring Program

The flow monitoring period began in winter 2023 with the intention of capturing a rain on snow event. The flow monitoring period was from February 15, 2023 through June 16, 2023 and was completed by AMG Environmental (AMG). There were a total of five flow monitors (Blue Siren's FlowSIREN with redundant depth and velocity sensors) and one rain gauge with two tipping buckets for redundancy.

The locations of the flow monitors were selected with the following considerations:

- Avoid turbulent flow conditions
- Avoid steep pipes and the potential for supercritical flow
- Capture flows from catchment areas draining into trunk sewer.
- Avoid monitoring locations reported to have poor data quality during the 2017 flow monitoring period

The locations of the flow monitors and rain gauge, as well as their catchment areas are shown in Figure 3-1. Table 3-1 summarizes the characteristics of each flow monitoring location. Note that the commercial area south of Gerber Road is within Wilmott Township and it is assumed sanitary flow from this location is not captured by the Wellesley sanitary collection system.

Table 3-1. Flow Monitor Catchment Area Summary

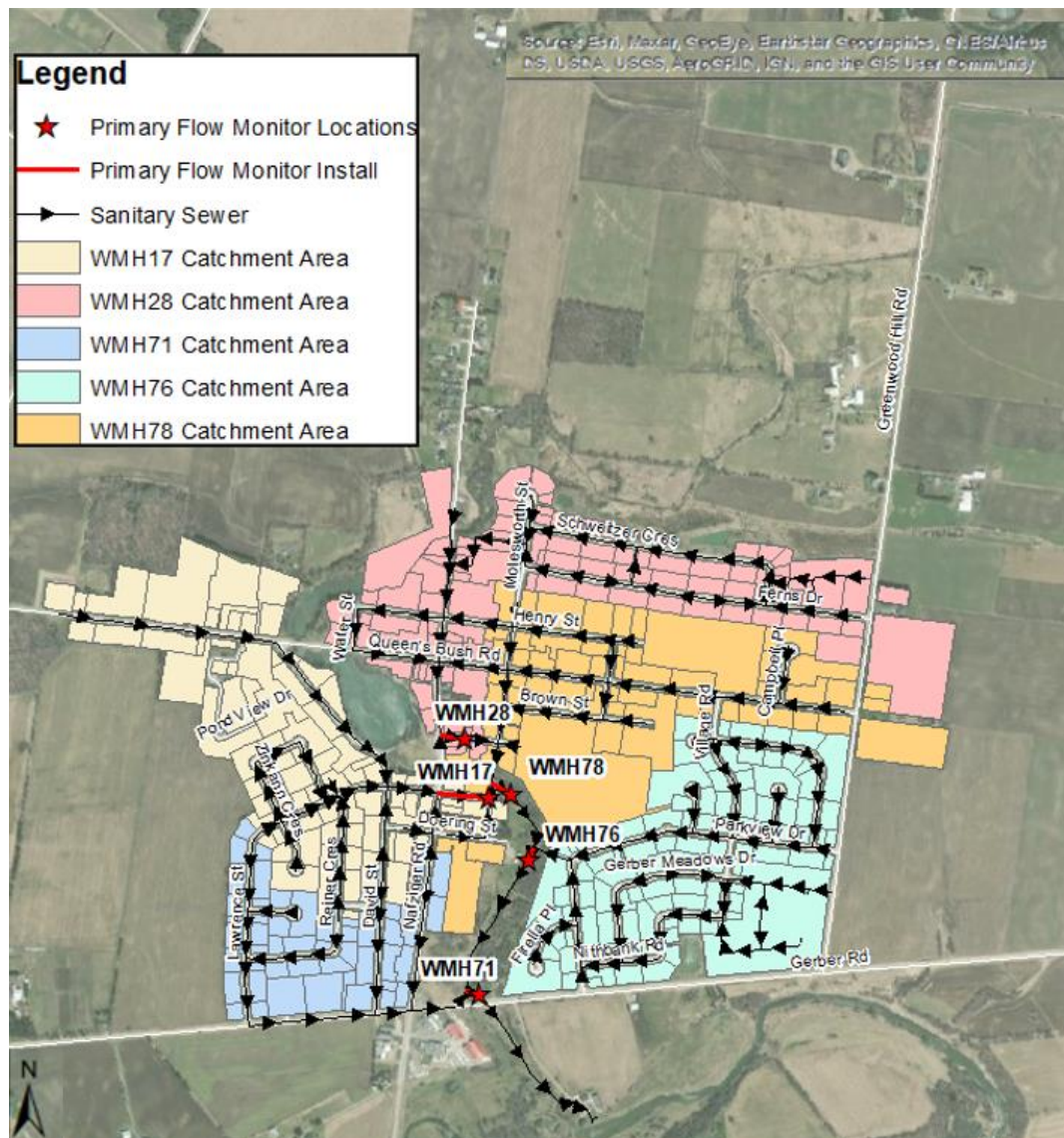
Flow Monitor Node ID	Modelled Pipe ID / Region Pipe ID	Catchment Area (ha) ^a	Upstream Monitor Sites
WMH17	MH0065.1/ WP092	27.0	N/A

Memorandum

Flow Monitor Node ID	Modelled Pipe ID / Region Pipe ID	Catchment Area (ha) ^a	Upstream Monitor Sites
WMH28	MH0067/WP087	29.4	N/A
WMH78	MH0096.1/ WP170	32.2	WMH17, WMH28
WMH76	MH0132.1/ WP173	28.3	WMH17, WMH28, WMH78
WMH71	MH0048.1/ WP047	12.0	WMH17, WMH28, WMH78, WMH76
Notes: ^a Catchment area does not include upstream monitor catchment areas			

Monitors were installed in the downstream end of the pipes indicated in Table 3-1. Flow monitors at WMH78, WMH76, and WMH71 were installed along the trunk to avoid installing at steeply sloped pipes draining to the trunk sewer. Based on the AMG's data quality report (see Attachment A), all site conditions were determined to be fair, with an additional inflow from a 100 mm diameter pipe observed at WMH76. It's possible this pipe is a sanitary lateral connection to the Firella Creek Trunk Sewer from a nearby residential building. The data quality at WMH17 and WMH28 were also determined to be fair, with a surcharge event occurring on April 1, 2023, and decreased flows reported during May and June due to less frequent and relatively small rain events. The data quality at the remaining flow monitor locations (WMH78, WMH76, and WMH71) was determined to be good in the AMG data quality report, with multiple surcharge events reported. However, a data gap was reported at WMH71 for three days from April 28, 2023 to May 1, 2023.

Figure 3-1. Flow Monitor Locations



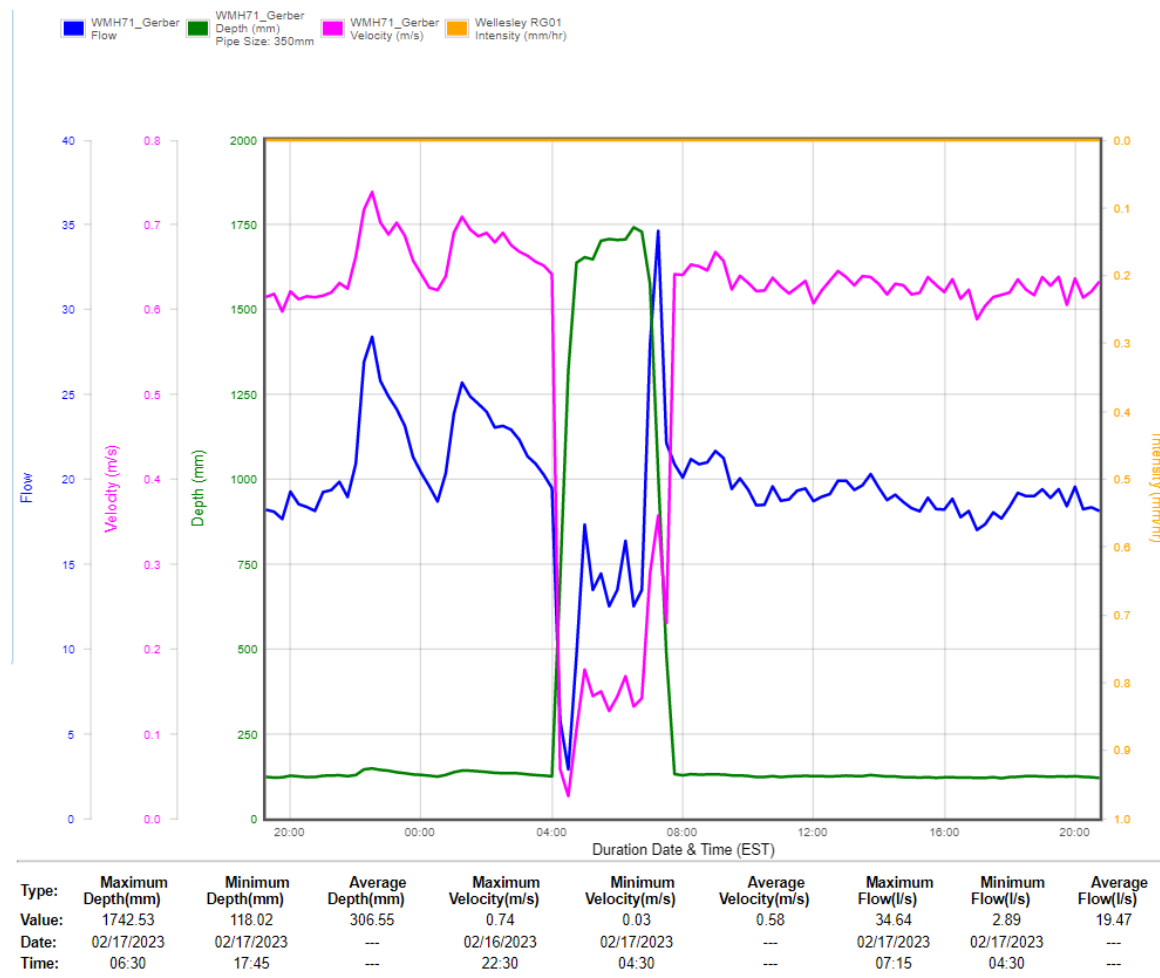
3.2 Flow Monitoring and Rainfall Data Analysis

3.2.1 Dry Weather Flow Analysis

DWF periods were selected by evaluating the longest observed periods without rain based on rain gauge results. For the selected periods, the period start date was selected to ensure that a minimum of three previous dry weather days were observed to ensure the collection system was operating under dry weather conditions. The DWF period selected was from May 23, 2023 through June 11, 2023, which is a duration of 19 days.

Regular spikes of flow consisting of approximately 72 m³ of volume over one hour were observed at WMH71. Following discussions with Region staff, it is suspected that these spikes of flow can be attributed to the emptying of the backwash holding tank at the Wellesley Water Treatment Plant (WTP) into WMH132. However, of note is a surcharge event that occurred on February 17, 2023, as shown in Figure 3-2. During this event, surcharging was observed along Fireella Creek Trunk Sewer during DWF. The cause of the February 17, 2023 event is unknown.

Figure 3-2. Flow and Depth Spike at WMH71



Source (AMG, 2023)

3.2.2 Wet Weather Flow Analysis

Storm events to be used for wet weather calibration were selected by identifying the largest observed events at the rain gauge in terms of both depth and intensity. Each identified event was evaluated using event selection criteria from the WaPUG guidelines (WaPUG, 2002) to determine the suitability of each event for performing calibration. The following are the criteria used to evaluate suitable wet weather events:

- Minimum intensity of 6 mm/hour for a duration of more than 4 minutes
- Minimum depth of 5 mm

- The period prior to the event must be sufficient for flow to return to dry weather conditions
- The durations of the selected events should vary to capture a spectrum of storm durations.

A summary of several rainfall events recorded at the rain gauge is provided in Table 3-2.

Table 3-2. Rainfall Event Summary

Event	Start Date	End Date	Depth (mm)	Maximum Intensity (mm/hour)	Duration (minutes)	Depth greater than 5 mm?	Period greater than 6mm/hour (min)	# of Dry Days Prior
CE1	03/31/2023 02:40:00	04/01/2023 02:55:00	38.1	12.19	1455	Yes	41	1.4
CE2	04/21/2023 13:15:00	04/22/2023 13:15:00	31.5	12.19	1440	Yes	20	1.3
CE3a (WMH17, WMH28, WMH78, WMH76)	4/30/2023 3:50	4/30/2023 12:25	12.7	12.19	515	Yes	12	0.5
CE3b (WMH71)	4/5/2023 4:20	4/5/2023 16:25	9.4	9.14	725	Yes	9	0.9
CE4	6/11/2023 16:20	6/12/2023 9:35	32	6.1	1035	Yes	8	22.5 ^a
^a With the exception of 0.25 mm of rain recorded on 6/11/2023 at 7:30 AM								

The selected rainfall events meet the minimum criteria. CE3b is an additional event selected since there is a data gap at WMH71 during CE3a.

It should be noted that from approximately mid-March to mid-April, 2023, the GWI appeared to be substantially higher than the remaining days in the monitoring period. For instance, a DWF period in April (April 6 through April 16, 2023) saw an average flow of approximately two times the average flow recorded during the May 20 through June 11 DWF period at four of the five flow monitors. The high GWI could be due to a combination of snow melt and high ground water table levels due to a large number of rainfall events occurring within the mid-March to mid-April time period. CE1 and CE3b occur during the period of high GWI, which may impact wet weather flow calibration results. Conversely, the GWI during CE4 is relatively low due to CE4 occurring after a 22-day DWF period in the summer months. The low GWI observed during CE4 may also impact wet weather flow calibration results.

An analysis was performed for each flow monitoring site to evaluate the quality of the response of each monitor to observed wet weather events using the WaPUG, 2002. The following are the criteria used to evaluate each flow monitoring site:

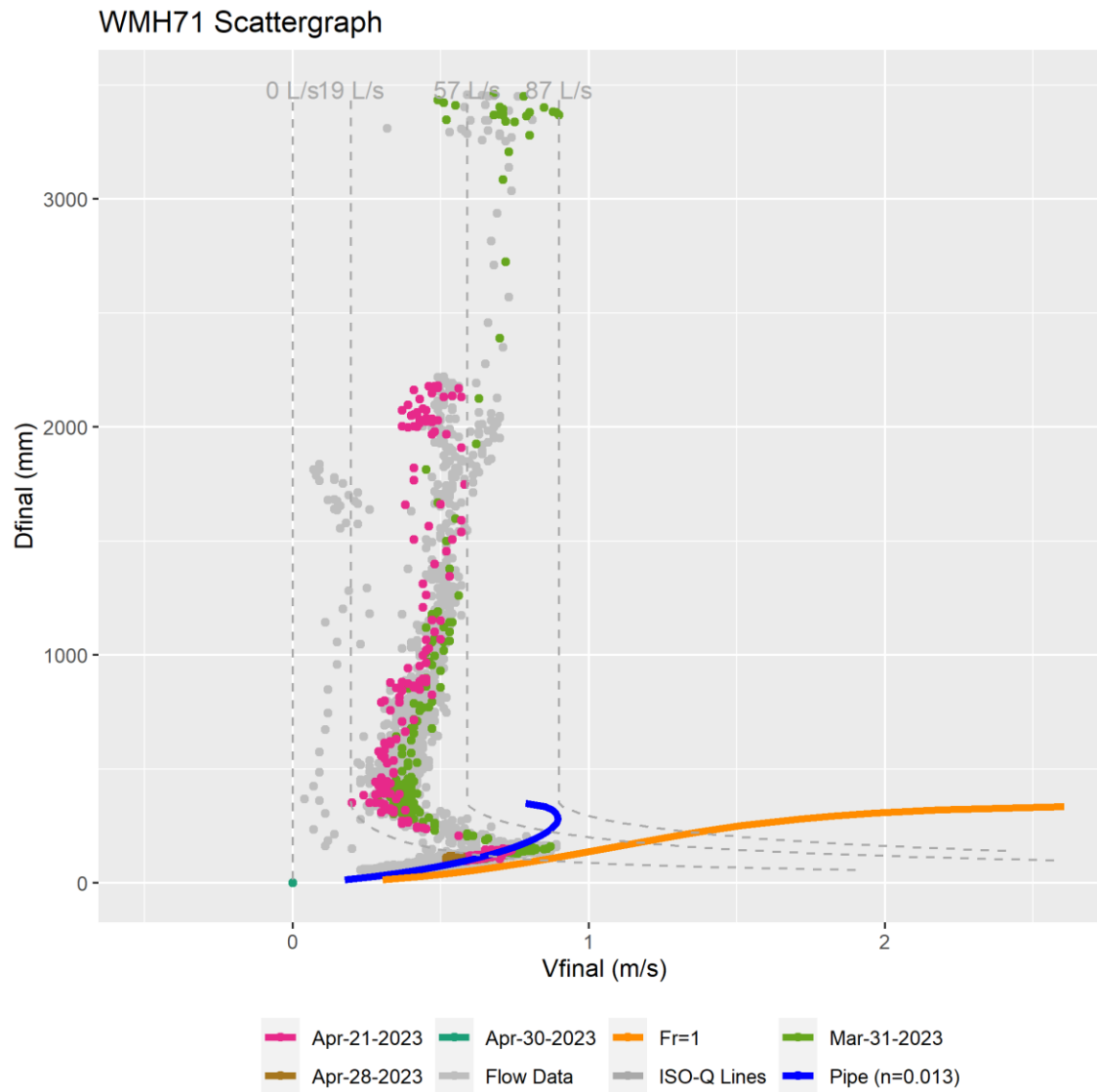
- Depth of flow should exceed 100 mm and velocity should exceed 0.2 m/s for at least 75% of the storm duration.
- The minimum acceptable peak depth of flow should be calculated based on the ratio of the base depth of flow to the pipe diameter. These required peak depths of flow for each flow monitor site is provided in Attachment B.
- The ratio of peak velocity to the base flow velocity should exceed 2

The quality of the response at each monitor during the selected wet weather events is summarized in Attachment B. In general, the minimum recommended depth criterion was met for the majority of the locations for each event, with some exceptions at WMH17 and WMH28. The criterion for velocity

exceeding 0.2 m/s for 75 percent of the storm duration was met for all flow monitoring locations for each selected storm. The ratio peak velocity to base velocity exceeded 2 for the majority of the flow monitoring locations during each storm, except during CE4. As well, surcharging was observed at all flow monitoring locations during CE1.

Scatter graphs, located in Attachment C, were prepared using the data collected at each monitor. Generally, on the scatter graph the flow data is to the left of the Manning's curve. This may indicate that a roughness of 0.013, which is typically assumed for smoother concrete or PVC sewers, may be lower than the average roughness of the existing sanitary sewers, particularly at monitors WMH28 and WMH76. However, no adjustments were made to the assumed roughness within the model. Also, the scatter graphs clearly indicate that the largest observed event occurred on March 31, 2023. Surcharging was observed at the flow monitors along the Firella Creek Trunk Sewer (WMH78, WMH76, WMH71) during the April 21, 2023 and March 31, 2023 rainfall events, and surcharging was observed at WMH17 and WMH28 during the March 31, 2023 rainfall event. Figure 3-3 shows the scatter graph for WMH71 data and the surcharge characteristics observed during the April 21, 2023 and March 31, 2023 rainfall events are suggestive of a downstream flow restriction based on a collection of real-world graphs documented in 'Scattergraph Principles and Practice' (ADS, 2017).

Figure 3-3. WMH71 Scattergraph



Review of the photos taken during the installation of the flow monitors revealed a likely cause of a flow restriction downstream of the flow monitors. As shown in Figure 3-4, the 350 mm diameter outgoing sewer at WMH71 (Region Pipe ID of WP178; model ID of MH0049.1) has a substantial blockage. Visually, this appears to be a blockage of approximately one third of the diameter of the pipe.

Figure 3-4. Downstream Restriction Observed at WMH71

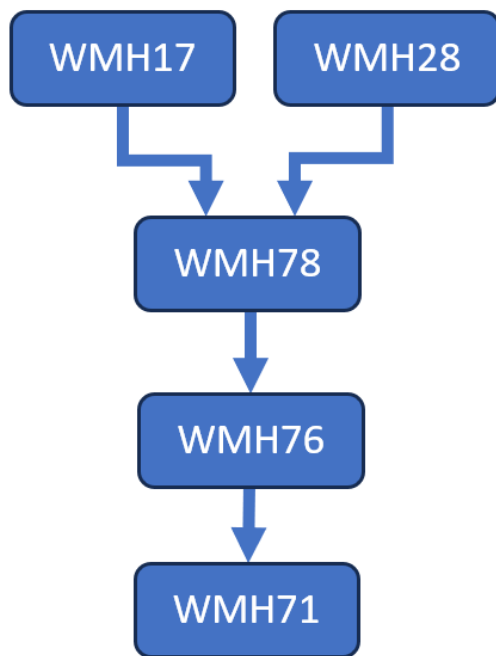


Source (AMG, 2023)

3.2.3 Flow Balance

As shown in Figure 3-1 in Section 3.1, the flow from WMH17 drains into Firella Creek Trunk Sewer. The flow from WMH28 combines with the flow from the catchment area east of Molesworth Street, and flows south from Molesworth Street to the Firella Creek Trunk Sewer. WMH78 receives flow from WMH17, WMH28, and the WMH78 catchment area. WMH76 receives flow from WMH78 and the WMH76 catchment area draining from Parkview Drive. WMH71 receives flow from WMH76 and the WMH71 catchment area draining from Gerber Road. A schematic of the flow monitor locations and dependencies are shown in Figure 3-5.

Figure 3-5. Flow Monitor Schematic Map



A flow balance was completed at the flow monitoring locations to check for discrepancies during the May 23, 2023 through June 11, 2023, DWF period. A flow balance was also completed for a second DWF period, April 6 through April 16, 2023. This flow balance is shown in Table 3-3.

Table 3-3. Flow Balance Summary

	WMH17	WMH28	WMH78	WMH76	WMH71
Catchment Area (ha)	27.0	29.4	32.2	28.3	12.0
Catchment Area Modelled Equivalent Population	871	1034	1021	1026	474
June DWF Period Average Flow (L/s)	1.6	2.3	0.4 ^a	2.1 ^a	1.4 ^a
April DWF Period Average Flow (L/s)	2.2	3.8	0.6 ^a	5.2 ^a	3.0 ^a
^a Excludes flow from upstream catchment areas					

As shown in Table 3-3 above, the average flow from the WMH78 catchment area for both the June and April DWF periods is substantially lower than the flow from the remaining four catchment areas. The cause of the flow discrepancy is unknown and additional flow monitoring for the WMH78 catchment area is recommended.

4. Model Calibration

4.1 Dry Weather Flow Calibration

Diurnal patterns were created using a tool in PCWMM and checked against the observed data. Weekday and weekend observed diurnal patterns appeared similar and therefore diurnal patterns were not differentiated between weekdays and weekends. Groundwater inflow (GWI) was input as baseflow in the model. GWI was determined for each subcatchment area using the Stevens - Schutzbach Method. Per capita wastewater generation rates were established according to best fit compared to the observed data. Table 4-1 shows the per capita flow rates in litres per capita per day (LPCD) used for each catchment area in the model. As a comparison, the per capita generation rate using 2021 water billing data from Wellesley is also shown in Table 4-1.

Table 4-1. Wastewater Generation Rates

Catchment Area	Wastewater Generation Rate (LPCD)	Per Capita Generation Rate Using 2021 Water Billing Data
WMH17	160	119
WMH28	200	144
WMH78	25	76
WMH76	125	169
WMH71	100	117

The per capita flow rates in Table 4-1 are generally lower than expected as typical design values are 225-450 LPCD (MECP, 2019). As a comparison, the five-year rolling average water demand is 179 LPCD (Region of Waterloo, 2024). The 179 LPCD includes ICI flows but is calculated based solely on residential population, and is therefore expected to be higher than the modelled per capita wastewater flows that separate residential and ICI flows. Regardless, WMH78 has an exceptionally low per capita flow rate. The reason for the low flow rate remains unknown but flagged during this model calibration.

The regular flow spikes observed at WMH71 as discussed in Section 3.2 were incorporated into the model as a daily flow rate of 20 L/s from 12 am to 1 am. Figure 4-1 shows an example of how the added flow compares with observed flow at WMH71 during DWF.

Figure 4-1. Observed versus Modelled Flow Spikes at WHM71



As shown in Figure 4-1, the modelled flow spikes do not always overlap with the observed flow spikes due to the inconsistent timing of the observed flow spikes.

Criteria used to assess the DWF calibration was referenced from WaPUG (2002) and includes the following:

- The timing of the peaks and troughs should be within 1 hour.
- The peak flow rate should be in the range $\pm 10\%$.
- The volume of flow should be in the range $\pm 10\%$. Care should be taken to exclude periods of missing or inaccurate data.

The resulting DWF observed versus predicted figures are located in Attachment D, and the calibration results for one weekday and one weekend day are summarized in Table 4-2. The results for WHM71 are shown from 12 PM to 12 PM on each selected day to capture the flow spikes from the WTP.

The diurnal patterns of the modelled DWF match well with the observed DWF. The DWF volumes at the flow monitors generally meet the DWF calibration criteria, with a few exceptions as noted in Table 4-2. The model does not meet the peak flow criteria. However, since the DWF rate is relatively low, many of the peak flow differences can be attributed to local roughness and slope conditions or noise in the observed data.

WHM71 captures flow from all flow monitors and modelled versus observed flows at this location can therefore be representative of overall system calibration. The weekday modelled versus observed DWF volume at WHM71 is within the 10 percent threshold. The model is overpredicting the weekend DWF volume, which is in part due to discrepancies in the WTP backwash volume modelled. The modelled versus observed DWF peak flows at WHM71 are slightly outside of the 10 percent threshold. The modelled DWF depth is higher than the observed DWF depth at WHM71. The high modelled depth is the result of the

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modelled obstruction in the pipe downstream of WMH71 (Modelled ID: MH0049.1; ROWID: WP178) that was discussed in Section 3.2.2. This obstruction may be slightly oversized in the model, as discussed further in Section 4.2, which could result in higher modelled depths at WMH71 compared to observed depths during DWF.

Table 4-2. DWF Calibration Results Summary

	DWF Period	Observed Peak DWF (L/S)	Modelled Peak DWF (L/s)	Difference in Peak DWF (%)	Peak DWF Criteria Met (+/-10%)	Observed DWF Volume	Modelled DWF Volume	Difference in Volume (%)	DWF Volume Criteria Met (+/-10%)
WMH17	May 25 (Weekday)	4	2	-50%	No	144	148	3%	Yes
	May 27 (Weekend)	4	2	-50%	No	142	148	4%	Yes
WMH28	May 25 (Weekday)	5	4	-20%	No	215	215	0%	Yes
	May 27 (Weekend)	5	4	-20%	No	218	215	-1%	Yes
WMH78	May 25 (Weekday)	8	7	-13%	No	357	401	12%	No
	May 27 (Weekend)	9	7	-22%	No	435	401	-8%	Yes
WMH76	May 25 (Weekday)	12	10	-17%	No	590	584	-1%	Yes
	May 27 (Weekend)	12	10	-17%	No	614	584	-5%	Yes
WMH71	May 23 at 12pm (Weekday)	27	24	-11%	No	736	764	4%	Yes
	June 3 at 12 pm (Weekend)	28	24	-14%	No	629	764	21%	No

4.2 Wet Weather Flow Calibration

The RTK (R-Response Ratio, T – Time to Peak, K -Recession Limb Ratio) method was used to calibrate the model to the wet weather events presented in Section 3.2. The RTK method is a method of generating a hydrograph to determine the rainfall derived inflow and infiltration from a modelled subcatchment. Values 1, 2, and 3 represent hydrographs for short, medium, and long response times, respectively. Typical T1, T2, and T3 values are 1-2, 4-8, and 10-24, respectively (Innovyze, 2021). Typical K values generally range from 2-4 (Innovyze, 2021).

Initial RTK parameters were extracted from the previous data analysis performed on the 2017 data (GMBLuePlan, 2017) and were manually adjusted in an iterative process to better fit the 2023 data. The CE2 and CE3a events were prioritized during the wet weather model calibration due to the GWI variations discussed in Section 3.2.2 observed during CE1, CE3b, and CE4 events. In addition to GWI influence, system response could have been further exacerbated due to soil conditions potentially being saturated during the CE1 and CE3b events, and dry during the CE4 event. Calibrating with a focus on the CE2 and CE3a events resulted in balancing the high response observed during CE1 and CE3b with the low response observed during CE4. The resulting RTK parameters are listed in Table 4-3.

Table 4-3. RTK Parameters

Flow Monitor	R1	T1	K1	R2	T2	K2	R3	T3	K3
WMH28	0.025	0.5	2	0.04	2	3	0.06	10	4
WMH17	0.015	0.5	2.4	0.02	2.5	1.6	0.05	14.2	3
WMH78	0.004	1.3	1.9	0.05	3.3	2.5	0.005	13.2	2.8
WMH76	0.06	1	3	0.075	2	3	0.1	10	4
WMH71	0.015	0.5	2.4	0.02	2.5	1.6	0.05	14.2	3

The short, medium, and long-term responses occur sequentially as expected and most with comparatively longer recession periods. The RTK parameters fall within expected ranges with some exceptions as follows:

- The T1 and T2 values are relatively low compared to what would generally be expected.
- The sum of the response ratios at WMH78 is low compared to the sum of the response ratios at the other flow monitoring locations. R1 and R3 in particular are an order of magnitude lower at WMH78 compared to the other flow monitoring locations.
- The sum of the response ratios at WMH76 is high compared to the sum of the response ratios at the other flow monitoring locations.

As noted in Section 3.2, there is a partial blockage downstream of flow monitor WMH71. This blockage was represented as a reduced pipe size in the north half of the pipe segment downstream of WMH71 (Modelled ID: MH0049.1; ROWID: WP178). Model run iterations were completed to determine the pipe diameter reduction that corresponded best with the depths observed at the flow monitoring locations. The diameter used in the model was 210 mm (for a length of 63.8 m), which is approximately a one third reduction in pipe diameter and aligns with the visually estimated blockage size described in Section 3.2.2. However, it is also possible that the obstruction size is smaller compared to the representation in the model, and that the flow restriction is in part due to the Wellesley Wastewater Treatment Plant influent pump station operating less efficiently than modelled.

The response of each wet weather event was evaluated against wet weather flow (WWF) criteria referenced from WaPUG (2002) and are as follows:

- The timing of the peaks and troughs should be similar with regard to the event duration.

- The peak flow rates at the significant peaks should be in the range of +25 percent to -15 percent and should be generally similar throughout the event.
- The volume of flow should be in the range of +20 percent to -10 percent, and care should be taken to ensure that periods of inaccurate or missing data are excluded from analysis.
- The depth of surcharge should be in the range of +0.5 m to -0.1 m.
- The unsurcharged depth at key points should be within the range of ± 100 millimeters

The resulting WWF observed versus predicted reports are provided in Attachment E and WWF calibration summary is provided in Table 4-4.

The WWF volume criteria is generally met for the CE2 and CE3a storm, with some exceptions including discrepancies in surcharged depths observed at WMH78, WMH76, and WMH71 during CE2. As expected, the observed volume, depth, and peak flows are substantially underestimated in the model for CE1 due to GWI influence and possible saturated soil conditions. During CE4, the observed volume, depth, and peak flows are substantially overestimated at most locations due to low GWI and possible dry soil conditions impacting the observed data. The response pattern is matched fairly well at all monitoring locations. Further flow monitoring is recommended to verify system response to larger rainfall events.

Table 4-4. WWF Calibration Summary

	Storm Event	Observed Peak WWF (L/S)	Modelled Peak WWF (L/s)	Peak WWF Percent Difference (%)	Peak WWF Criteria Met (-15 to 25%)	Observed WWF Volume	Modelled WWF Volume	WWF Volume Percent Difference (%)	WWF Volume Criteria Met (-10 to 20%)	Observed Peak WWF Depth (mm)	Modelled Peak WWF Depth (mm)	Difference in Depth (mm)	WWF Peak Depth Criteria Met
WMH17	March 31- April 1 (CE1)	30	10	-67%	No	1121	515	-54%	No	1735	80	-1655	No
	April 21-22 (CE2)	11	9	-18%	No	574	499	-13%	No	86	77	-9	Yes
	April 30 (CE3a)	7	7	0%	Yes	223	270	21%	No	67	67	0	Yes
	June 11-13 (CE4)	8	7	-13%	Yes	368	584	59%	No	83	69	-14	Yes
WMH28	March 31- April 1 (CE1)	31	17	-45%	No	1766	1155	-35%	No	351	118	-233	No
	April 21-22 (CE2)	19	16	-16%	No	796	861	8%	Yes	118	116	-2	Yes
	April 30 (CE3a)	13	12	-8%	Yes	385	436	13%	Yes	97	98	1	Yes
	June 11-13 (CE4)	8	13	63%	No	607	1367	125%	No	83	103	20	Yes
WMH78	March 31- April 1 (CE1)	68	32	-53%	No	3817	2304	-40%	No	2894	1334	-1560	No
	April 21-22 (CE2)	29	30	3%	Yes	1412	1719	22%	No	637	159	-478	No
	April 30 (CE3a)	21	22	5%	Yes	793	867	9%	Yes	136	108	-28	Yes
	June 11-13 (CE4)	15	34	127%	No	1233	2690	118%	No	114	122	8	Yes
WMH76	March 31- April 1 (CE1)	84	64	-24%	No	5046	3991	-21%	No	2494	1742	-752	No
	April 21-22 (CE2)	57	52	-9%	Yes	2562	2972	16%	Yes	927	605	-322	No
	April 30 (CE3a)	40	41	3%	Yes	1532	1458	-5%	Yes	183	180	-3	Yes
	June 11-13 (CE4)	24	48	100%	No	1603	3282	105%	No	139	328	189	No
WMH71	March 31- April 1 (CE1)	87	69	-21%	No	6779	4550	-33%	No	3459	2471	-988	No
	April 21-22 (CE2)	56	56	0%	Yes	3157	3368	7%	Yes	2180	1654	-526	No
	April 5 (CE3b)	42	29	-31%	No	2123	1435	-32%	No	690	473	-217	No
	June 11-13 (CE4)	27	52	93%	No	1894	3784	100%	No	139	1404	1265	No

4.3 Model Limitations

The following model limitations apply to the 2024 calibrated model which should be considered when undertaking future studies:

- Residential populations within the model were assumed low-density with a population density of 3 people per parcel, unless an obvious difference was observed during aerial imagery investigation. ICI equivalent populations were assumed based on a density of 62 people per hectare.
- Seasonal variations in inflow and infiltration due to groundwater conditions will vary the actual flow in the sanitary system. Therefore, model results may be skewed for exceptionally wet or dry soil conditions.
- The DWF wastewater generation rate for each catchment area is relatively low, with WMH78 catchment area having an exceptionally low wastewater generation rate of 25 LPCD. WMH78 also has relatively low R values. Further investigation, including flow monitoring in a local sewer that isolates the WMH78 catchment area, is recommended. Prior to additional monitoring being completed, a wastewater generation rate from a neighbouring catchment area is recommended to be used for the WMH78 catchment area during the WWWMP.
- The flow monitor at WMH71 was unresponsive during CE3a. Since calibration at CE1, CE3b, and CE4 may be influenced by GWI and soil saturation conditions, wet weather flow calibration parameters in the WMH71 catchment area are uncertain. RTK parameters from the neighbouring WMH17 catchment area were used in the WMH71 catchment area.
- Since the rain gauge location used for this model was at the southern portion of the Wellesley sewershed, it's possible rainfall data may not be accurately represented the upstream flow monitors (WMH17, WMH28, and WMH78).
- Additional flow monitoring to capture larger storms and verify conditions after the obstruction at WMH71 is removed is recommended. This additional flow monitoring will also support the determination of the impact of the Wellesley Wastewater Treatment Plant influent pump station on the conveyance system. This additional flow monitoring is also recommended prior to any wastewater treatment plant or influent pump station upgrades.
- The WWTP influent PS is modelled with a lead pump capacity of 52 L/s, an effective lag pump capacity of 28.5 L/s, and on and off set points as discussed in Section 2.3. When the pipe restriction modelled at WPO47 is removed, the modelled pump capacity will become the main boundary condition within the model and influence upstream water levels. Flow monitoring or drawdown testing is recommended to confirm the capacity of the pump station.
- I/I contributing areas within the model are based on parcels with wastewater servicing, with few exceptions. Therefore, RTK parameters do not take into account surrounding land uses.

5. Conclusions

A wet weather flow model was determined to be necessary to complete the Wellesley WWWMP. Flow monitoring was completed from February to June 2023 at five flow monitoring locations and rainfall data was concurrently collected at one rain gauge location. The flow and rainfall data were analyzed to select an appropriate DWF period and rainfall events. Subcatchments were delineated for the model calibration update, and suitable wastewater generation rates and profiles as well as RTK parameters were selected to perform DWF and wet weather flow calibration.

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Additional flow monitoring to capture larger storms and verify conditions after the obstruction at WMH71 is removed is recommended. This additional flow monitoring will also support finding the impact of the Wellesley Wastewater Treatment Plant influent pump station on Wellesley's collection system. This additional flow monitoring is also recommended prior to any wastewater treatment plant or influent pump station upgrades.

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Appendix A. Data Quality Report

Appendix B. Data Evaluation

Appendix C. Scattergraphs

Appendix D. Dry Weather Flow Calibration Graphs

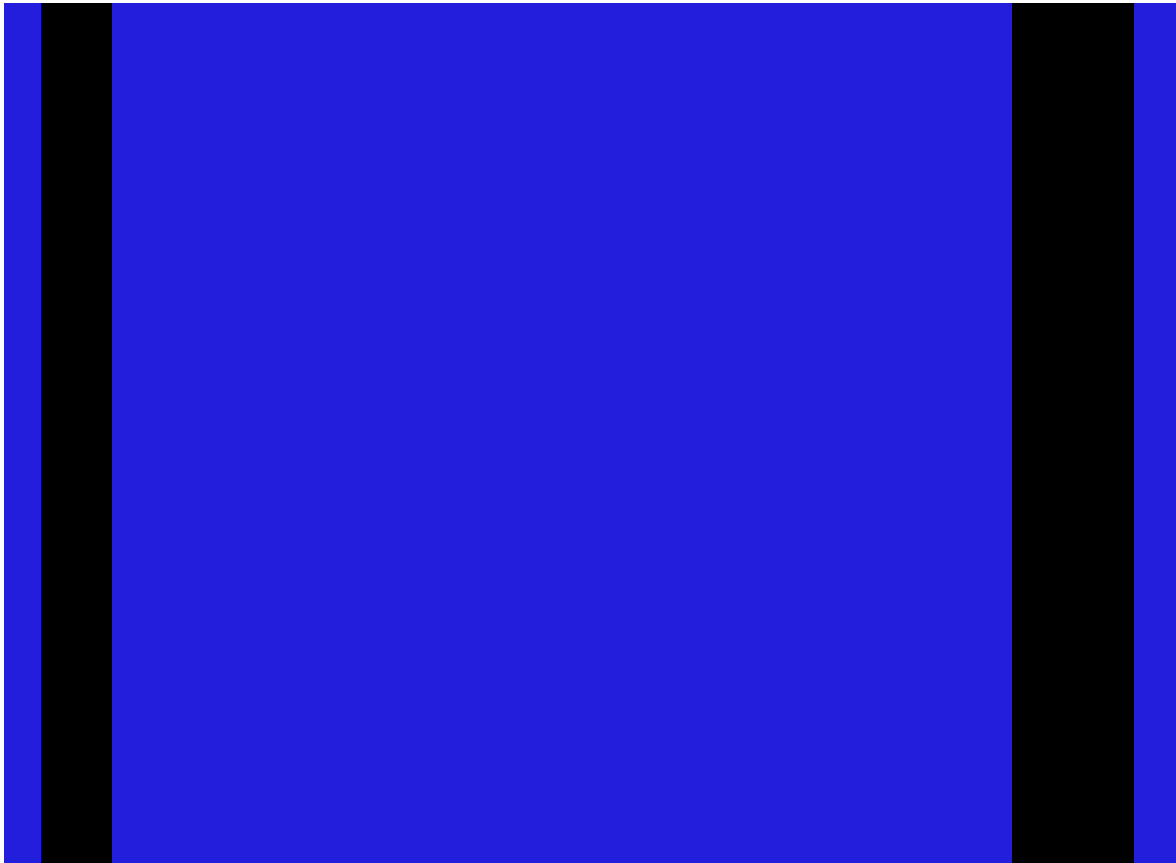
Appendix E. Wet Weather Flow Calibration Graphs

TM5: Preliminary Preferred Water and Wastewater Alternative

Document no:
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Region of Waterloo
Kaoru Yajima

Wellesley Water and Wastewater Master Plan



TM5: Preliminary Preferred Water and Wastewater Alternative

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Jacobs Consultancy Canada Inc.

Kitchener, ON Canada

T +1.519.579.3500

www.jacobs.com

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Acronyms and abbreviations

AADF	Annual Average Daily Flow
AGS	Aerobic granular sludge
ANSI	Areas of Natural and Scientific Interest
ASI	Archaeological Services Inc.
CT	Contact Time
CET	Composite Elevated Tank
CLI	Consolidated Linear Infrastructure
DFO	Fisheries and Oceans Canada
DWF	Dry Weather Flow
DWWP	Drinking Water Works Permit
EA	Environmental Assessment
ECA	Environmental Compliance Approval
EIS	Environmental Impact Study
ESA	Electrical Safety Authority
ESR	Environmental Study Report
FF	Fire Flow
GHG	Greenhouse gasses
GRCA	Grand River Conservation Authority
ICI	Industrial, commercial, and institutional
I/I	Inflow and infiltration
IUS	Integrated Urban System
L/s	litres per second
m ³	cubic metres
m ³ /d	cubic metres per day
MABR	Membrane Aerated Biofilm Reactors
MBCA	Migratory Birds Convention Act
MCEA	Municipal Class Environmental Assessment

TM5: Preliminary Preferred Water and Wastewater Alternative

MDD	Maximum Day Demand
MDWL	Municipal Drinking Water License
MNRF	Ministry of Natural Resources and Forestry
PHD	Peak Hour Demand
PHF	Peak Hour Flow
PS	Pump Station
PSW	Provincially Significant Wetland
PTTW	Permit to Take Water
PWQO	Provincial Water Quality Objectives
Region	Region of Waterloo
RWQA	Receiving Water Quality Assessment
SOR	Surface Overflow Rate
SRT	Solids retention time
SVI	Sludge volume index
TM	Technical Memorandum
Township	Township of Wellesley
TSSA	Technical Standards and Safety Act
UV	Ultraviolet
UVT	Ultraviolet transmittance
WTP	Water Treatment Plant
WWF	Wet Weather Flow
WWFT	Wet Weather Flow Treatment
WWTP	Wastewater Treatment Plant
WWWMP	Wellesley Water and Wastewater Master Plan

1. Introduction

The Township of Wellesley (Township) is one of seven area municipalities in the Region of Waterloo (Region). The Township is a rural community comprised of eleven settlement areas, including the Wellesley Urban Area. The Wellesley Urban Area is currently the only settlement area with both municipal wastewater and water servicing. The Region is responsible for maintaining existing levels of service within the water and wastewater systems to provide capacity to the existing population, as well as planning for new growth in the service area and meeting regulatory requirements. To plan and budget for water and wastewater upgrades and new infrastructure to address existing issues and meet future needs to 2051, the Region is undertaking the Wellesley Water and Wastewater Master Plan (WWWMP).

The purpose of the WWWWMP is to address anticipated water and wastewater infrastructure needs over the next 30 years, and in doing so, to improve the reliability and resiliency of its water and wastewater assets. The goals of the WWWWMP include identifying projects required to meet Wellesley's desired water and wastewater system levels of service, and systematically developing a prioritized implementation plan for those projects that is endorsed by the Region and project stakeholders. The WWWWMP will fulfill the requirements of Phase 1 and Phase 2 of the Municipal Class Environmental Assessment (MCEA) process for Water and Wastewater Projects.

The purpose of this WWWWMP Technical Memorandum (TM5) is to establish the preliminary preferred alternatives that will address the constraints identified in TM3 for water supply and distribution and in TM4 for wastewater treatment and conveyance.

The specific objectives of TM5 are to:

- Evaluate the alternative solutions identified in TM3 and TM4 against the criteria established in TM2 to determine a relative score for each alternative.
- Complete a sensitivity analysis on the criteria weightings to determine the impacts of different priorities on the scoring outcomes.
- Identify a preliminary preferred alternative for water supply and distribution and for wastewater treatment and conveyance, to address the previously identified constraints.

2. Drinking Water System Short-Listed Alternatives

TM3: Water Infrastructure Alternatives Development included identification of constraints for the drinking water system as well as development and screening of alternatives to generate a short list of alternatives. Please refer to TM3 for more information. The Wellesley Water Treatment Plant (WTP) capacity and water quality were evaluated as well as future needs for storage, pumping and disinfection. The Wellesley WTP is currently supplied by three wells with a total well taking capacity of 1,503 cubic metres per day (m^3/d). There is an existing reservoir at the Wellesley WTP with 902.3 cubic metres (m^3) capacity and an existing high lift pump station with total pumping capacity of 166.5 litres per second (L/s). The pump station serves as the sole source of supply in the distribution system. There is no separate contact time (CT) tank for primary disinfection, therefore the reservoir must provide the CT volume as well as all other treated water storage for fire, emergency and equalization needs.

The key issues identified include:

- **Water Distribution:** Modelling was completed to identify needs in the Wellesley Urban Area water distribution system throughout the planning horizon. ICI fire flow needs were identified but can be mitigated by maintaining the implementation of the current fire-fighting practice which includes supplying additional fire flows via tanker trucks. Residential fire flow requirements (at 75 L/s) are met with the exception of two locations at dead-end streets under existing and future conditions.
- **Contact Time (CT) Volume:** The existing reservoir at the Wellesley WTP provides a maximum CT volume of 902.3 m^3 . Based on the current operating strategy with the pump station as the sole source of supply, this volume is sufficient to meet the current CT volume regulatory requirement for 2-log virus inactivation. To achieve the projected future CT volume for 4-log virus inactivation, the addition of 160 m^3 of CT volume would be recommended. Because the pump station is the sole source of supply, the maximum pumping rate for determining CT volume is calculated as the sum of MDD and fire flow. Providing the fire flow impacts the additional future projected CT volume requirements.
- **Treated Water Storage Capacity:** The existing reservoir at the Wellesley WTP represents the total storage capacity as there is no floating storage in the distribution system. This volume is insufficient to meet the projected future CT volume for 4-log virus inactivation as well as fire, equalization and emergency storage recommendations.
- **Firm Pumping Capacity for Emergency Demand:** The pump station serves as the sole source of supply; therefore, the pumps should meet both the fire flow and MDD in an emergency scenario per the MECP Design Guidelines (MECP, 2019). The pumping capacity of 166.5 L/s with all five pumps in operation cannot meet the future fire flow demand of 175 L/s. Upgrading the pump station may not be feasible due to the practical limitations of the existing water distribution system capacity. Fire flows can be supplemented from the fire department's tanker truck as being currently practiced. Firm pumping capacity for domestic use, however, is sufficient to meet PHD throughout the planning horizon.
- **Well Capacity:** The current maximum well taking capacity is 1,503 m^3/d . The projected MDD is expected to exceed this capacity by 2034, therefore a plan for obtaining a minimum of 196 m^3/d additional well capacity should be initiated around 2025. The Wellesley WTP, however, has sufficient capacity (3,006 m^3/d) for treatment throughout the planning horizon.
- **Water Quality:** The Wellesley WTP treated water is currently in compliance with all regulatory limits in Ontario. However, should strontium become regulated within the planning horizon, alternative approaches for treatment will need to be considered. The potential impacts to strontium and fluoride concentrations are considered in the evaluation of alternatives through criteria such as public health and safety, and meeting existing and future needs.

Alternatives were developed separately to address the following constraints:

- Well Capacity – The current well taking capacity is expected to be exceeded by the projected MDD by 2034. A plan for obtaining a minimum additional supply of 196 m³/d should be initiated around 2025.
- Future Disinfection and Water Pumping & Storage Needs – Currently, additional pumping capacity, additional CT volume, and additional treated water storage are identified in the planning horizon (to 2051).

2.1 Well Capacity

The existing permitted well taking capacity of 1,503 m³/d is expected to be exceeded by 2034. The following alternatives were short-listed to meet future water supply needs:

1. Do Nothing (kept as a baseline) – Maintain existing well supply.
2. Increase Existing Well Supply – Explore additional water taking from existing production wells.
3. Supplement Existing Wells with New Well Supply – Maintain existing well supply and supplement with a new well that is pumped to the WTP.
4. Supplement Existing Wellesley Water System with External Supply – Maintain existing well supply and provide additional treated water supply from another drinking water system such as the Integrated Urban System (IUS).

Full-scale capacity testing is recommended to confirm the actual well taking capacity. Additional well supply capacity may be needed if the current maximum well taking capacity is below the permitted rate in the Permit to Take Water (PTTW) of 1,503 m³/d.

2.1.1 Alternative 1: Do Nothing

In this alternative, the existing well supply with 1,503 m³/d capacity would be maintained. The Township would not be able to accept residential growth beyond 2034 as the maximum day demand (MDD) is projected to exceed the well supply capacity at that point. No construction would be required for this alternative.

2.1.2 Alternative 2: Increase Existing Well Supply

This alternative involves exploring the opportunity to increase water taking from the existing wells for a minimum additional capacity of 196 m³/d. Past hydrogeological studies on the existing wells WY1, WY5, and WY6, have not confirmed whether or not the capacities can be expanded.

An updated hydrogeological study would need to be undertaken to confirm the water taking capacity for the existing wells. There is a risk that the findings from the study may not support increasing the water taking capacity or that the actual water taking capacity may be lower than the 1,503 m³/d limit in the current Permit to Take Water (PTTW). For the purposes of evaluation, it is assumed the well taking capacity could be increased. The existing well pumping system currently has a capacity of 4,510 m³/d which is sufficient for the future well supply needs. No construction would be required for this alternative.

2.1.3 Alternative 3: Supplement Existing with New Well Supply

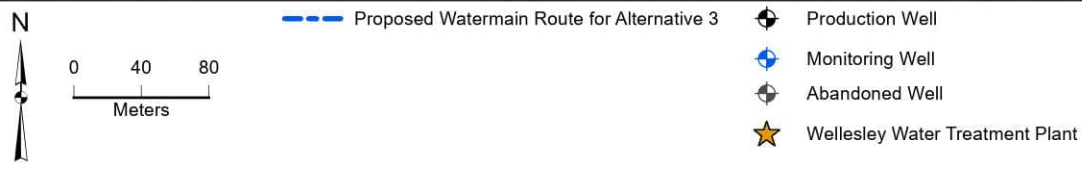
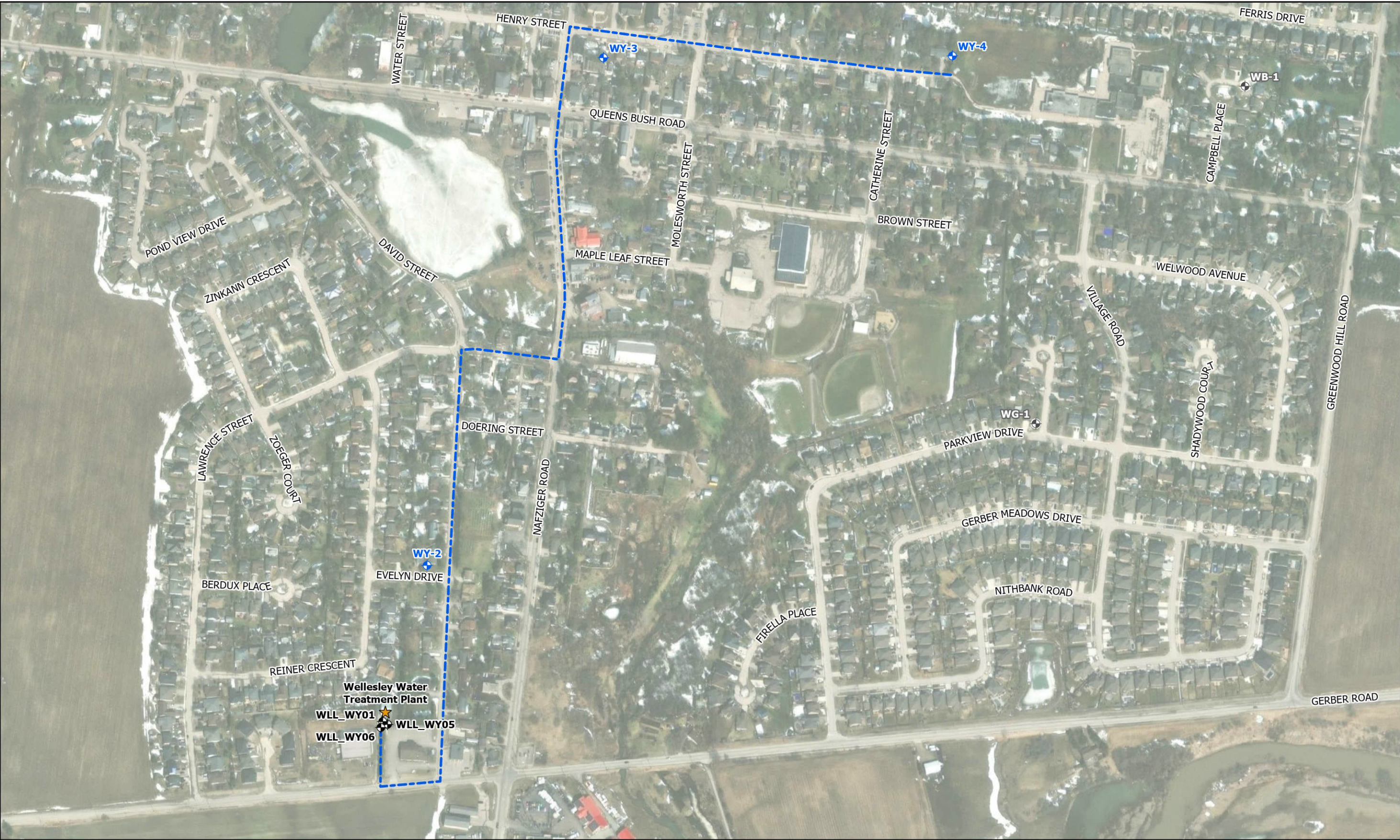
In this alternative, the existing well supply with 1,503 m³/d capacity would be maintained and supplemented with a new well with a minimum capacity of 196 m³/d that is pumped to the existing WTP.

This alternative is evaluated in the following sub-alternatives:

- Alternative 3A: the new well is to be constructed within the urban boundary, with the watermain connection crossing through the downtown section of the Village.
- Alternative 3B: the new well is to be constructed at a new site located outside the urban boundary near the south-east end of the Village with a watermain connection that would not cross through the downtown section of the village.

Potential sites for a new well represented here as Alternative 3A were investigated in the Region of Waterloo 2020 strontium treatment study (CH2M HILL Canda Limited, 2020). Several historical wells were identified and are documented in the 1992 groundwater study conducted by Gartner Lee (Gartner Lee Limited, 1992) and Village of Wellesley water supply pre-design report conducted by Paragon Engineering (Paragon Engineering, 1991). The historical wells described in both reports are referred to as Wagner wells (WY-2, WY-3 & WY-4), Brick well (WB-1) and Village well (WG-1). Locations of the historical wells and the production wells are shown in Figure 2-1.

Wells WG-1 and WB-1 were abandoned and have since been developed into residential properties. Wells WY-2, WY-3 and WY-4 were decommissioned in 1996 to 1997. The Region owns the Well WY-4 property but does not own the Well WY-3 property. For the purposes of the WWWMP, it is assumed the new well will be developed in the vicinity of the WY-4 property. Figure 2-1 also shows the proposed watermain route connecting the WY-4 property to the Wellesley WTP which forms the basis for Alternative 3A. A hydrogeological study would be required to identify a specific location for the new Alternative 3A well.



Notes:
1. Basemaps Source: Maxar

Figure 2-1
Wellesley Existing and Historical Well Locations and
Proposed Water Route for Alternative 3
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Alternative 3A may also provide an opportunity to improve treated water quality for strontium and fluoride. The historical data available from 1992 for WY-3 and WY-4 indicates significantly lower strontium concentrations compared to the current production wells (Paragon Engineering, 1991). Note that this data is dated, and the hydrogeological conditions may have changed since the 1992 studies.

Alternative 3B is the second alternative for the development of a new well source that would provide the additional capacity. , Alternative 3B could be located outside of the urban boundary but in an area in close proximity to the existing WTP. The determination of a specific location for the well supply in Alternative 3B was outside the scope of this Master Plan but would be located near the south-east end of the Village within an area that would provide the opportunity to construct a watermain connection that would be shorter than the watermain connection required for Alternative 3A, have fewer constructability issues because of the surrounding land use, and therefore be more cost effective than the watermain connection required for Alternative 3A. Detailed siting studies including a hydrogeological study would be required to identify a specific location for the new Alternative 3A well.

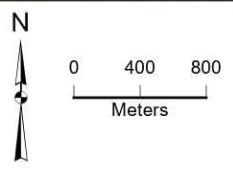
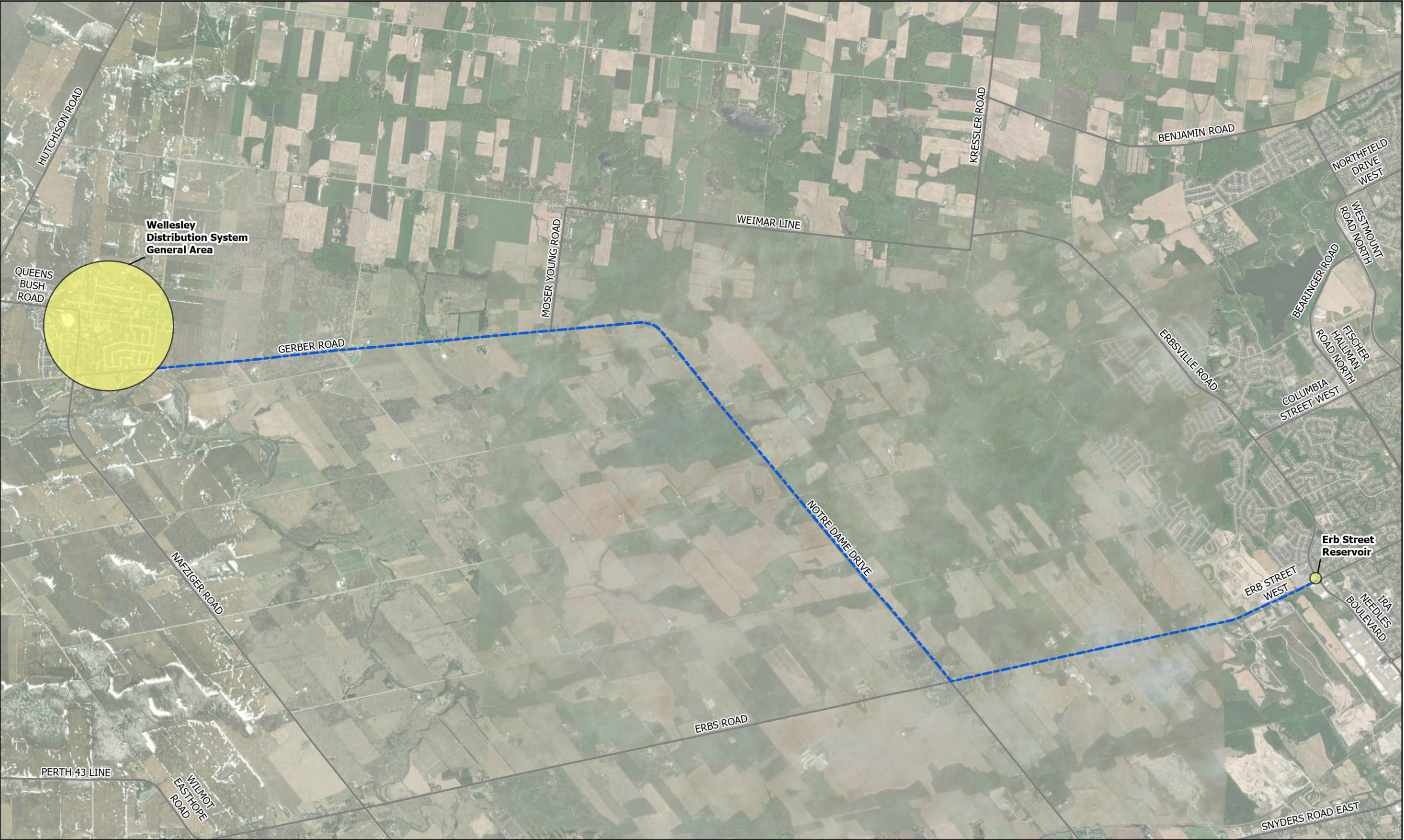
The scope of work to implement either Alternative 3A or Alternative 3B includes the following:

- Installation of one new well, including hydrogeological study and Class EA for the new well site.
- Construction of a new well house and foundation.
- Submersible pumps, process piping, instrumentation & controls, electrical, programming, HVAC and plumbing for the new well and well house.
- Specific to Alternative 3A - Installation and road works for 50 mm diameter watermain approximately 1,750 m in length and buried at 5 to 6-foot depth to connect the new well to the existing Wellesley WTP.
- Specific to Alternative 3B - Installation and road works for 50 mm diameter watermain approximately 1,000 m in length and buried at 5 to 6-foot depth to connect the new well to the existing Wellesley WTP

2.1.4 Alternative 4: Supplement Existing with External Supply

In this alternative, the existing well supply with 1,503 m³/d capacity would be maintained and would be supplemented by additional treated water supply from another drinking water system. For the purposes of evaluation, connection to the Integrated Urban System (IUS) was assumed. The IUS consists of surface water supply from the Mannheim WTP and groundwater supplies located throughout the Region. The IUS is owned and operated by the Region and currently services the Area Municipalities of Kitchener, Waterloo, and Cambridge, as well as several areas within the surrounding Townships including Woolwich, Wilmot, and North Dumfries. The closest connection point to the Wellesley distribution system was assumed to be the Erb Street Reservoir located at 960 Erb Street West. Figure 2-2 shows the proposed watermain route along the existing right of way. The potential impact to the IUS water supply is expected to be minimal given the relatively small additional flow that would be needed from IUS of 196 m³/d.

The scope of this alternative includes installation and road works for 50 mm diameter watermain approximately 17 km in length and buried at 5 to 6-foot depth to connect the existing Wellesley distribution system to the IUS.



--- Proposed Watermain Route for Alternative 4

Notes:
1. Basemaps Source: Earthstar Geographics

Figure 2-2
Proposed Watermain Route for Alternative 4
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Waterloo, Ontario

2.2 Future Disinfection, Water Pumping, and Storage Needs

The following alternatives were short-listed to address future disinfection, water pumping and storage constraints at the Wellesley WTP and in the distribution system.

1. Do Nothing (kept as a baseline) – Maintain existing reservoir and pump station with the pump station as the sole source of supply for domestic and emergency use.
2. New Storage Off-Site – Maintain existing reservoir for disinfection. Construct floating storage, such as an elevated tank, to provide additional storage for emergency use (i.e., fire demand). Maintain existing pump station for domestic use.

2.2.1 Alternative 1: Do Nothing

This alternative includes the following:

- Maintain existing on-site storage reservoir with a useful volume of 902.3 m³.
- Maintain the five existing high lift pumps providing a firm pumping capacity of 166.5 L/s for emergency demand and firm pumping capacity of 47 L/s for domestic use. Pump station to remain as the sole source of supply. Any flows beyond the distribution system capacity are to be supplemented by the fire department's own supply and delivered via tanker truck.

Alternative 1 was eliminated in the long-list screening in TM3 but carried forward as a baseline. Alternative 1 does not address future disinfection, water pumping, and storage constraints.

2.2.2 Alternative 2: New Storage Off-Site

This alternative includes the following:

- Maintain on-site storage reservoir with a useful volume of 902.3 m³. Existing reservoir to provide a dedicated CT volume of 145 m³ for primary disinfection needs and to offset the treated water storage for fire, equalization, and emergency demand.
- Construct off-site floating storage, such as an elevated tank, to provide the additional storage for fire, equalization, and emergency demand. A total treated water storage of 2,204 m³ will be provided for fire, equalization, and emergency demand, 758 m³ will be provided through the on-site reservoir after meeting primary disinfection needs and 1,447 m³ will be provided through the off-site floating storage.
- Maintain existing high lift pumps to provide firm pumping capacity of 47 L/s for domestic use.

The construction scope for this alternative includes a new elevated tank as floating storage and connection to the existing watermain. Elevated tank scope of work includes:

- Water storage vessel – assumed to be a Composite Elevated Tank (CET)
- Concrete pedestal and foundation
- Piping (inlet, outlet, overflow, valves)
- Siteworks and utility works (water/storm, sanitary)
- Electrical and HVAC
- Fencing, paving, landscaping

3. Wastewater System Short-Listed Alternatives

3.1 Wastewater Collections

The Wellesley wastewater conveyance system consists of approximately 16km of gravity sewers draining to the Wastewater Treatment Plant (WWTP) Influent Pump Station (PS). The sewers range in diameter from 200mm to 350mm. A sanitary hydraulic model was calibrated and used as a tool to identify the existing and future (2051) constraints. Calibration results are described in TM4 and the Sanitary Hydraulic Model Documentation Memorandum.

As described in TM1, the level of service for the wastewater collection system is no surcharging during dry weather periods and no surcharging during wet weather periods up to and including the 5-year design storm, and hydraulic freeboard greater than 1.8 m during wet weather periods greater than the 5-year design storm. Hydraulic freeboard is the difference between the hydraulic grade line elevation and the ground elevation. Typical basement elevations are 1.8 m in depth, and therefore having a freeboard greater than 1.8 m is suggestive of a lower risk of basement flooding.

The sanitary hydraulic model results indicate that the Firella Creek Trunk Sewer is a constraint under existing and future wet weather flow conditions. Surcharging within the trunk sewer is compounded by insufficient capacity at the WWTP Influent PS. Additionally, there are numerous local pipe constraints, including constraints along Schweitzer Crescent, Nafziger Road, Lawrence Street, Maple Leaf Street, Gerber Road, David Street, Queens Bush Road, Nithbank Road, and Parkview Drive. Surcharging within the local sewers is amplified by the surcharging along the Firella Creek Trunk Sewer.

The hydraulic model has the following model limitations:

- The model was calibrated using relatively small observed storm events (which were the only events recorded during the 2023 flow monitoring period) and it is recommended that further flow monitoring and model validation using larger storms is completed.
- The calibration was completed using the RTK method and the 2023 recorded flow monitoring data suggested relatively high 'R' values ('R' reflects the proportion of rainfall falling on the subcatchment that then enters the sanitary system). These 'R' values were applied to existing subcatchments as well as subcatchments representing future developments. In actuality, the 'R' value for new developments may be lower.
- The contributing area (area that drains into the system) of the future parcels modelled includes the entire Plum Zone contained within the study area. In reality, it is possible the contributing area may be smaller. A sensitivity analysis on the contributing area should be completed during subsequent design stages.
- The modelled per capita dry weather flow (DWF) rates for the future residential population is 275 litres per capita per day based on the Design Guidelines and Supplemental Specifications for Municipal Services (Region of Waterloo et. al, 2022), which is approximately double the existing DWF per capita flow rate as obtained through collection system flow monitoring and described in TM4.

Overall, considering the model limitations, the sanitary hydraulic model may be conservative. Additional flow monitoring will be carried out in September through October 2024 in order to collect additional data for model validation to larger storm events and a sensitivity analysis on contributing areas. Consequently, sanitary sewer sizing presented in this TM5 is subject to change. Preliminary wastewater collection system and WWTP influent pump station sizes presented in this TM5 are based on the 5-year design storm only,

allowing for modelled surcharging along the Firella Creek Trunk Sewer. However, appropriate sizing is to be confirmed during subsequent design stages with consideration that there is an existing lateral connected to the Firella Creek Trunk Sewer. The impact of the 25-year storm could also be considered during future design stages in order to determine the level of resilience to more extreme rainfall events.

Wastewater collection system alternatives were developed separately for the Firella Creek Trunk Sewer (Group A) and the local sewer constraints (Group B). The Group A and Group B alternatives are described in Section 3.1.1 and Section 3.1.2 respectively.

3.1.1 Group A – Firella Creek Trunk Sewer Alternatives

The capacity of the Firella Creek Trunk Sewer is currently constrained under existing wet weather flow conditions.

The following are short-listed alternatives to address the Firella Creek Trunk Sewer needs:

- Group A – Alternative 1. Do Nothing (kept as baseline – does not meet level of service criteria)
- Group A – Alternative 2. Implement inflow and infiltration (I/I) reduction measures, WTP backwash mitigation measures, offline storage locations to equalize flows along the Firella Creek Trunk Sewers.
- Group A - Alternative 3. Implement I/I reduction measures, WTP backwash mitigation measures, upsize or twin Firella Creek Trunk Sewer.

3.1.1.1 Alternative 1: Do Nothing

The do nothing alternative involves maintaining the existing Firella Creek Trunk Sewer capacity (350mm diameter). Under this alternative, all flows would continue to be conveyed to the WWTP Influent PS through the existing trunk sewer. The Township would not be able to accept new growth, and there would remain a high risk of flooding to surface along the Firella Creek Trunk Sewer during wet weather flow conditions. No construction would be required for this alternative.

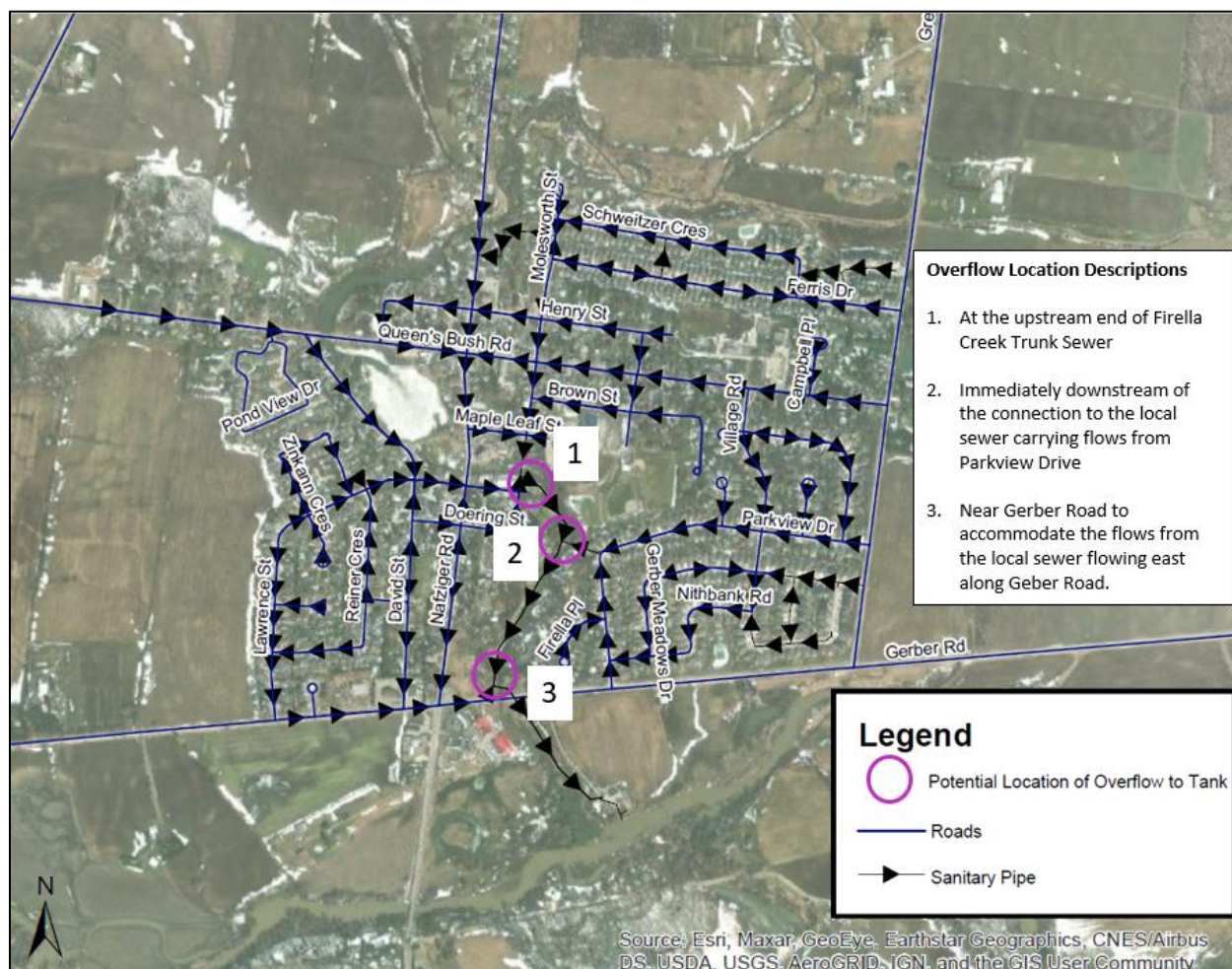
3.1.1.2 Alternative 2: Offline Storage

Conveyance Group A, Alternative 2 includes offline storage that totals a storage volume of approximately 5,000m³. This storage volume would satisfy the level of service criteria along the trunk sewer for the 5-year design storm, according to modelling results. However, as described in Section 3.1, sizing is to be confirmed via future flow monitoring. It is anticipated that three storage tanks would be required to capture flows at constrained locations along the Firella Creek Trunk Sewer. Based on the modelling analysis, the potential overflow diversion locations from the trunk sewer to the storage tanks are:

1. At the upstream end of the trunk sewer.
2. Immediately downstream of the connection to the local sewer carrying flows from Parkview Drive.
3. Near Gerber Road to accommodate the flows from local sewer flowing east along Gerber Road.

These potential locations are shown in Figure 3-1. The storage tanks would capture wet weather flow and would require pumping to return storage volumes to the trunk sewer.

Figure 3-1. Potential Locations of Storage Tanks



This alternative would substantially decrease the flow to the WWP Influent PS during peak wet weather flow conditions compared to Alternative 1 and Alternative 3.

I/I reduction measures would also be part of Alternative 2. Potential I/I reduction measures include downspout disconnection, weeping tile (foundation drain) disconnection, sewer lining, and cross-connection disconnection if required. As described in TM4, sources of I/I are often difficult to isolate and reduction measures are often difficult to implement due to the dispersed nature of the sources and construction limitations. However, if successful, I/I mitigation could substantially reduce the wet weather flow entering the collection system and could therefore reduce the volume of storage required.

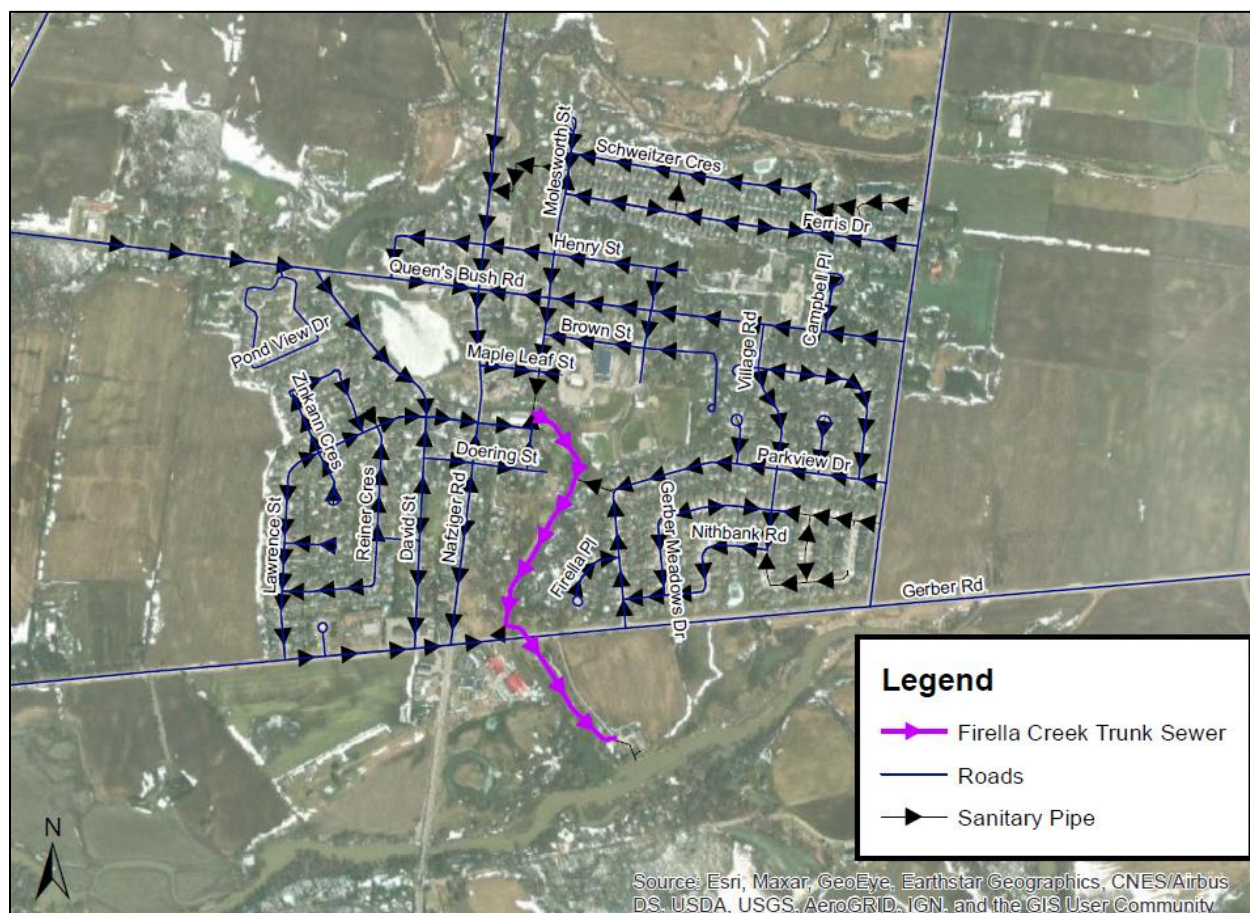
Additionally, as described in TM4, regularly observed flow spikes, likely caused by the WTP backwash tank emptying into the sanitary sewer, is contributing to surcharging within Wellesley's wastewater collection system. However, the source of the flow spikes needs to be investigated and confirmed. Currently, the Region does not have data on the emptying of the backwash tank. As part of Alternative 2 it is recommended that the source of the flow spikes be investigated and confirmed, and mitigation measures would follow confirmation of the source of the flow spikes.

3.1.1.3 Alternative 3: Increase Capacity of Firella Creek Trunk Sewer

This alternative would involve increasing the capacity of the trunk sewer to convey flows to the WWTP Influent PS. This could be accomplished by upsizing or twinning the Firella Creek Trunk Sewer to provide the additional required capacity. Increasing the size of the existing trunk sewer or adding a twin sewer along the same existing alignment would result in similar impacts, therefore, for the purposes of this analysis, it is assumed that upsizing the trunk sewer would be selected as the method of providing additional capacity.

To achieve the level of service described in Section 3.1, the Firella Creek Trunk Sewer would need to be upsized to a diameter of 750mm. However, as described in Section 3.1, sizing will be confirmed based on the results of the additional flow monitoring. It is anticipated that the trunk sewer would maintain its existing route along Firella Creek. Sewer upsizing would be required for approximately 970m from north of Lawrence Street to the WWTP Influent PS as shown in Figure 3-2. Construction along this route would generally avoid roads, with one crossing of Gerber Road required.

Figure 3-2. Firella Creek Trunk Sewer Upgrade Extent



Similar to Alternative 2, I/I reduction measures and investigation into the flow spikes (potentially caused by the WTP backwash tank emptying) with subsequent measures to mitigate the flow spikes would also be included in this alternative. Although difficult to implement, I/I mitigation could substantially reduce the wet weather flow entering the collection system and could therefore reduce the recommended required diameter of the new trunk sewer.

3.1.2 Group B – Local Sewer Constraints Alternatives

Various local sewers have capacity constraints under existing and future wet weather flow conditions. The following are short-listed alternatives to address the local pipe capacity needs:

1. Group B – Alternative 1. Do Nothing (kept as baseline – does not meet level of service criteria)
2. Group B – Alternative 2. Implement I/I reduction measures, pipe capacity increases as necessary for local sewers
3. Group B – Alternative 3. Implement I/I reduction measures, new trunk/sub-trunk sewers to collect flows from future developments on the east and west extents of the study area, pipe capacity increases as necessary for local sewers.

Section 3.1.2.1 to Section 3.1.2.3 describe these alternatives in more detail.

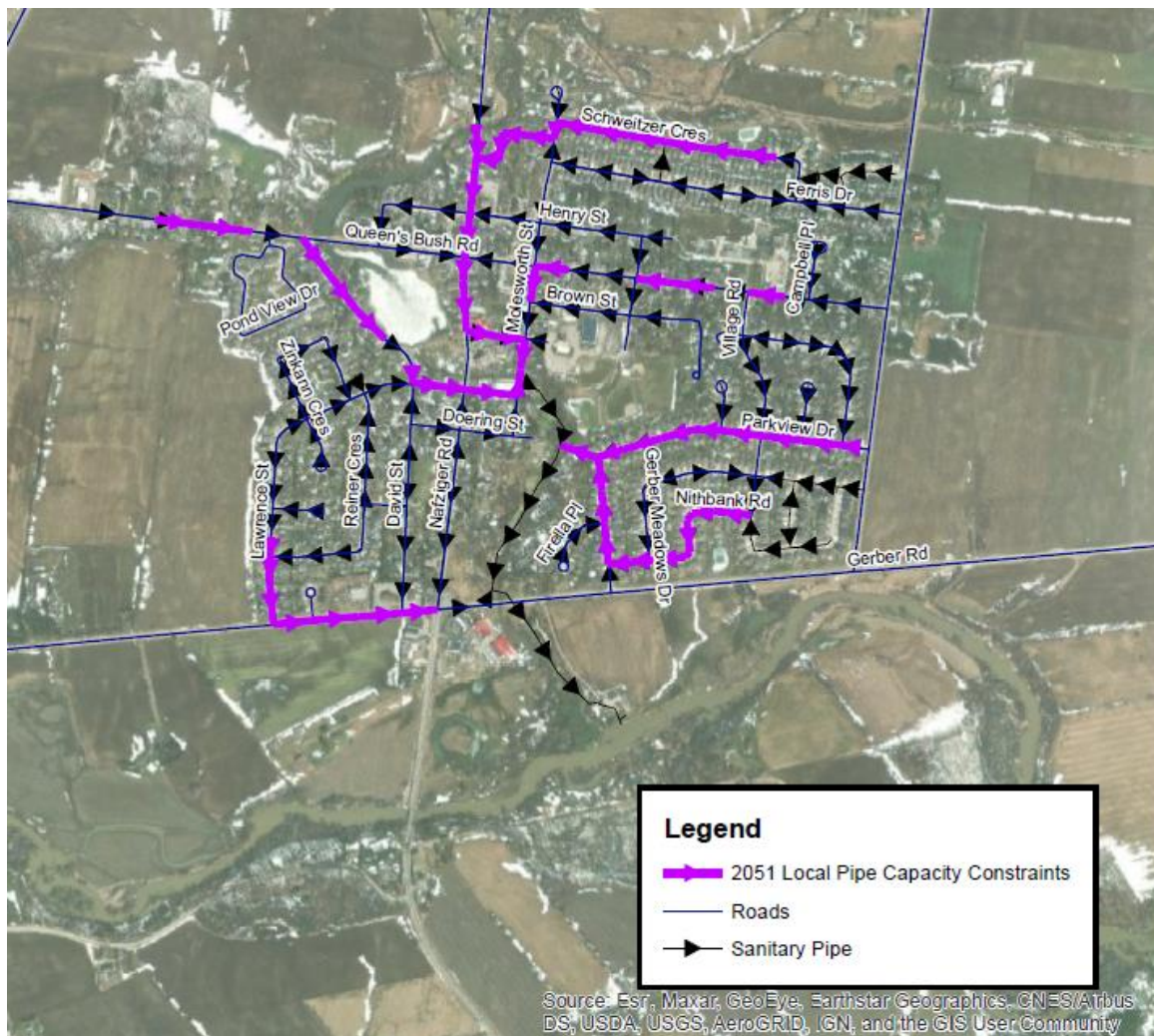
3.1.2.1 Alternative 1: Do Nothing

The do nothing alternative involves maintaining the existing local sewer capacity. The Township would not be able to accept new growth, and there would remain a high risk of basement flooding and flooding to surface during rainfall events larger than and including the 5-year design storm. No construction would be required for this alternative.

3.1.2.2 Alternative 2: Local Pipe Capacity Increases

This alternative involves replacing and upsizing the local sewers that have capacity constraints, based on the level of service described in Section 3.1. The local sewer constraints are along Schweitzer Crescent, Nafziger Road, Lawrence Street, Maple Leaf Street, Gerber Road, David Street, Queens Bush Road, Nithbank Road, and Parkview Drive under the projected 2051 flow conditions. Figure 3-3 shows the 2051 local sewer capacity constraints.

Figure 3-3. 2051 Local Sewer Capacity Constraints



Similar to the Group A, Alternative 2 and Alternative 3, I/I reduction measures are included in Group B Alternative 2. The results shown in Figure 3-3 do not account for potential I/I reduction. The results shown in Figure 3-3 are based on the assumption that existing pipe slopes would remain the same. However, invert elevations, velocity requirements, and pipe diameters should be confirmed during future design stages.

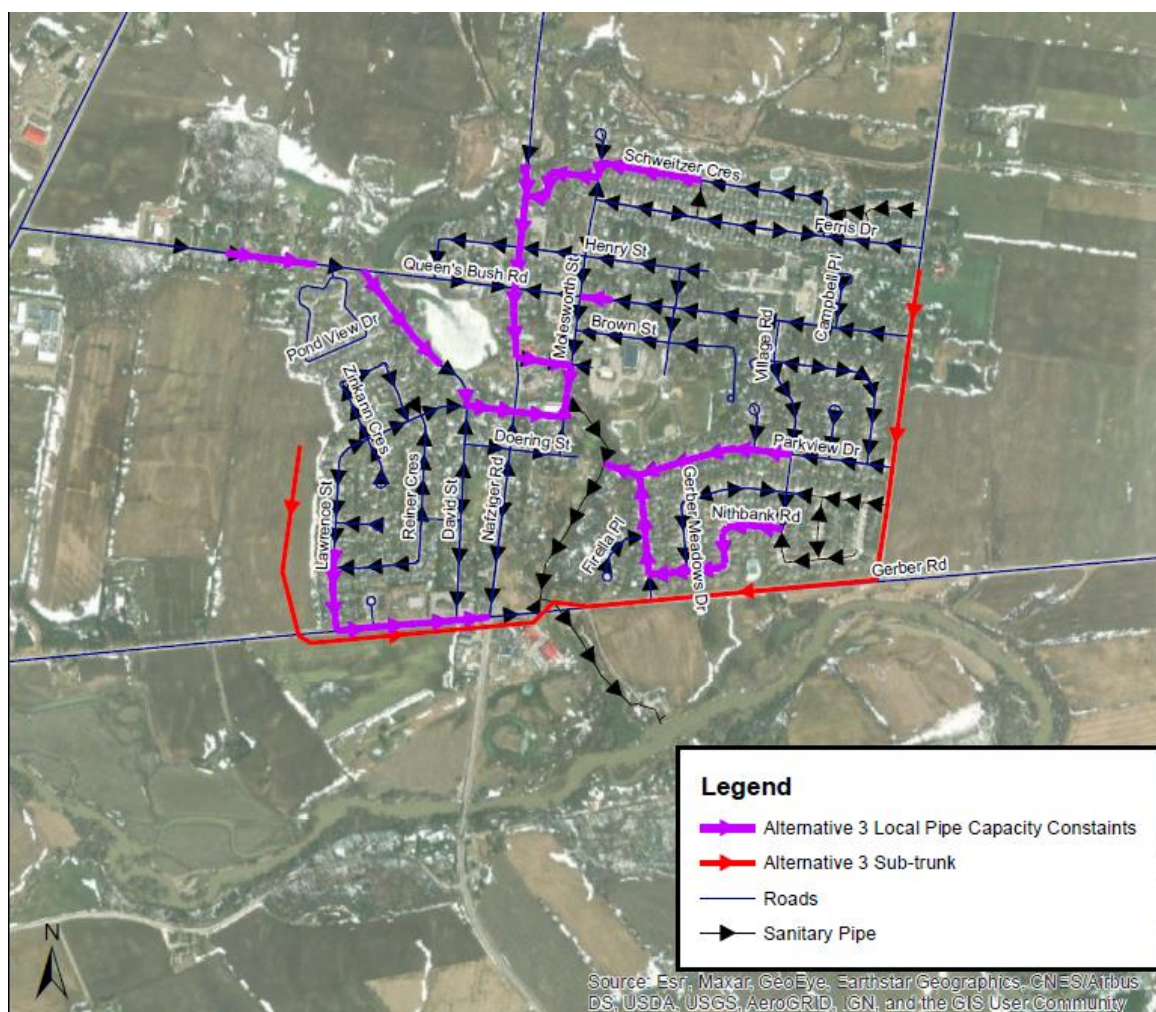
3.1.2.3 Alternative 3: New Sub-Trunk Sewers

The purpose of this alternative is to collect and convey the wastewater flows generated from the anticipated future developments on the west and east extents of the study area away from the existing sewers. The flows would be conveyed via two new sub-trunks as follows:

1. Sub-trunk west of Lawrence Street to Gerber Road, and then along Gerber Road to connect to the Firella Creek Trunk Sewer
2. Sub-trunk along Greenwood Hill Road to Gerber Road, and then along Gerber Road to connect to the Firella Creek Trunk Sewer.

It is anticipated that these sub-trunks would be less than 375mm in diameter, however as described in Section 3.1, sizing will be refined and confirmed based on the results of the additional flow monitoring and refinement on number of tie-ins if this alternative is selected as the preferred alternative. Although this alternative will reduce the total length of local sewer upgrades required along Queens Bush Road, Parkview Road, and Lawrence Street, local sewer upgrades will still be required as shown in Figure 3-4.

Figure 3-4. 2051 Group B Alternative 3 Sewer Upgrades



Similar to Alternative 2, I/I reduction measures are included in Group B Alternative 3. The results shown in Figure 3-4 do not account for potential I/I reduction. The results shown in Figure 3-4 are based on the assumption that existing pipe slopes would remain the same. However, invert elevations, velocity requirements, and pipe diameters should be confirmed during future design stages.

3.2 Wastewater Treatment

Several constraints for the wastewater collection system and treatment plant were identified in TM4: Wastewater Infrastructure Alternatives Development. The Wellesley WWTP consists of fine screening for preliminary treatment, two package extended aeration plants for secondary treatment (Plant No. 1 and Plant No. 2), cloth media filtration for tertiary treatment, chemical phosphorus precipitation with alum, and ozone disinfection prior to discharge to the Nith River. An ongoing project to replace the ozone

system with UV is currently at the 90 percent detailed design stage. It is anticipated that the UV design will provide sufficient capacity for growth to 2051. Waste activated sludge (WAS) is stored in an aerated sludge holding tank prior to haulage to the Waterloo WWTP for further processing. The plant has a rated annual average daily flow (AADF) capacity of 1,100 m³/d. Capacity constraints were identified by assessing the firm capacity of each major treatment process against the planning period (2051) AADF (1,345 m³/d) and peak hourly flow. As shown in Table 3-1, all major unit processes are anticipated to require upgrade or expansion. It should be noted that the influent pumping capacity is based on the duty/standby configuration as specified in ECA No. 6542-AJCJC9. However, recently recorded flows at the WWTP are above the capacity of one pump (4,400 m³/d), indicating that the pumps operate in a lead/lag regime during peak flow conditions. The influent pumping firm (one unit out of service) capacity is assumed to be 4,400m³/d (52 L/s) for wastewater treatment analysis to be consistent with the design of the downstream processes.

Table 3-1: Wellesley WWTP Unit Process Firm Capacity Assessment Summary

Unit Process	Capacity (m ³ /d) ^a	Basis	Projected Flow (m ³ /d)	Upgrade/Expansion Needed for Planning
Influent Pumping	4,400 ^a	PHF	5,370	Yes
Screening	4,490 ^a	PHF	5,370	Yes
Secondary Treatment (Bioreactors and Clarifiers)	1,100	AADF	1,345	Yes
Aeration Blowers ^b	1,100	AADF	1,345	Yes
Tertiary Filtration	1,260	AADF	1,345	Yes
Alum System	Storage tank: 13,450 m ³ Metering Pumps: 1,140	AADF	1,345	No Yes
Disinfection Contact Tank ^c	1,250	AADF	1,345	Yes
Sludge Storage Tank	580	AADF	1,345	Yes
Outfall ^d	8,640 ^a	PHF	5,370	No

Notes:

^a Influent pumping, screening and outfall capacity is provided based on peak hourly capacity.

^b A technology review was completed in January 2024 which recommended blowers that could provide additional capacity to handle ADF up to 1320 m³/d by installing an additional blower.

^c The capacity of the disinfection contact tank was evaluated in TM1 based on ozone disinfection. The Region has selected UV disinfection as the preferred strategy for disinfection upgrades in an ongoing project. Consideration may be given to an equalization basin at the pump station to store the peak flows to maintain the disinfection process capacity without exceedance.

^d A high-level hydraulic assessment was performed for the outfall based on available information. The hydraulic analysis demonstrated that the outfall capacity can handle the projected flows. The peak outfall capacity is 8,640 m³/d (2,160 m³/d AADF capacity), per the plant's hydraulic profile. It is recommended that a detailed evaluation be undertaken during conceptual design to verify the hydraulic capacity of the outfall, considering recent water elevations in the Nith River.

3.2.1 Influent Pumping

The existing influent pumping station firm capacity is 4,400 m³/d (based on duty/standby configuration). Flow monitoring within the collection system was completed in June 2023 for the purposes of wastewater collection system model calibration. The flow monitoring and hydraulic model calibration revealed that the WWTP influent pump station is a constraint under existing and future wet weather flow (WWF) conditions (based on the 5-year design storm assessed). The modelling also suggests that mitigation of the pipe capacity constraints within the collection system has the potential to substantially increase peak flows to the Wellesley WWTP during wet weather events. The results of the Wastewater Collections Group A alternatives evaluation influences the development of the WWTP influent PS alternatives. The WWTP influent PS alternatives were developed based on the decision that Wastewater Collections Alternative 3 - Increase Capacity of Firella Creek Trunk Sewer was the preferred collection system alternative and that addressing the additional peak flow volumes was more effectively addressed through WWTP alternatives than collection system alternatives because of the constructability, cost and operational constraints of off-line collection system storage. Evaluation of the Wastewater Collections Group A alternatives are presented in Section 6.1.1.

The predicted future (2051) peak daily and hourly flows are approximately 11,300 m³/d and 31,850 m³/d during the 5-year design storm, respectively, once the Firella Creek Trunk Sewer capacity constraint is mitigated. These flows are significantly higher than the existing pumping station capacity. Given that these peak flows occur infrequently, considering an equalization tank would be preferred compared to upsizing all processes within Wellesley WWTP to handle such high peak flows. Therefore, an equalization tank is considered in developing alternatives for the influent pumping to resolve future constraints. The following alternatives were shortlisted to meet future growth needs:

1. Do Nothing (kept as baseline for comparison purposes).
2. Replace Existing Pumps/Equalization Tank.
3. New Pump Station/ Equalization Tank.

3.2.1.1 Alternative 1: Do Nothing

This alternative would not allow the facility to treat future projected peak flows. Moreover, upgrading the collection system without considering capacity expansion would result in hydraulic grade lines within the collection system that indicate a high risk of basement flooding. The existing influent pumps are designed, based on duty/standby operation, to handle flows up to 4,400 m³/d. Even if the two pumps are being operated in Lead/Lag operation mode, the pump station will not allow the facility to handle flows above 8,800 m³/d (not accounting for additional head loss from the pumps simultaneously pumping, resulting in reduced pumping capacity), which will be exceeded if the collection system is upgraded.

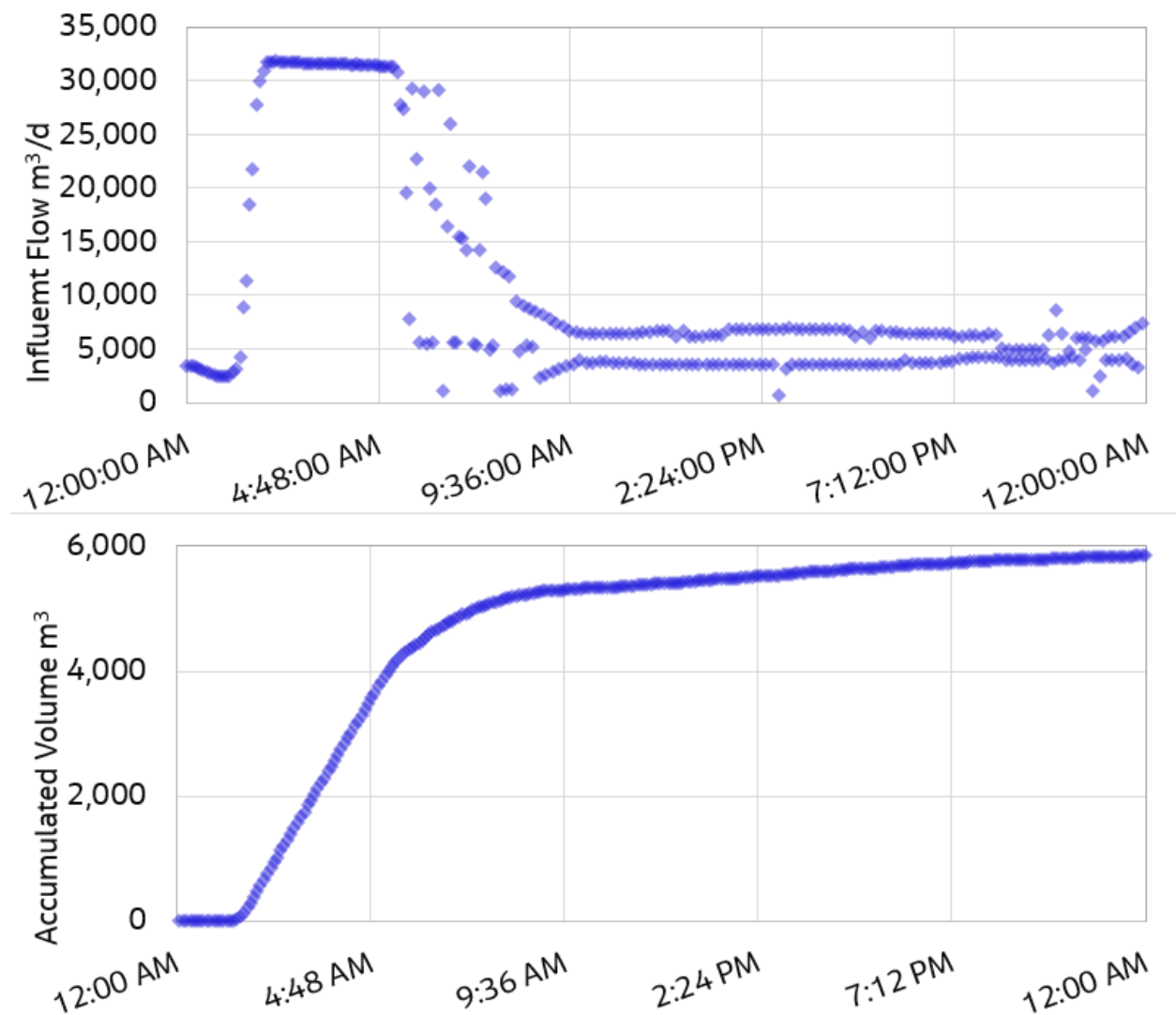
3.2.1.2 Alternative 2: Replace Existing Pumps/Equalization Tank

Alternative 2 is to increase the existing influent pump capacity and install an equalization tank. Currently, there are two pumps (1 duty/1 standby), each with a capacity of 52 L/s. A 16-m³ wet well is included in the existing pump station. With the predicted future peak hourly flow (PHF) of 31,850 m³/d (during the 5-year design storm) and considering the equalization basin, the capacity of each pump needs to be increased to 65 L/s. Replacement of the existing pumps and discharge piping would be required to handle the predicted future peak flows.

The increase in PHF would significantly derate the capacity of the existing wet well, resulting in rapid pump cycling. Construction of an equalization basin will be required to store flows above 5,400 m³/d (4×AADF) that will be diverted from treatment processes during peak flow events. The estimated flow diverted to the equalization tank, and the accumulated wastewater volume during the largest sustained peak flow event is presented in Figure 3-5.

Figure 3-5 illustrates that the most significant sustained event would last approximately 4 hours and then flows would begin to decrease. The accumulated volume in the tank would be 5,900 m³ during the peak daily flow event, requiring a storage volume of 5,900 m³. This volume would provide approximately 4.5 hours of retention time to store flows above the PHF capacity for the downstream treatment processes (5,400 m³/d). As described in Section 3.1, storage sizing is to be confirmed based on future flow monitoring.

Figure 3-5. Projected Instantaneous Flows to the Facility during the 5-Year Design Storm (Top), and Projected Accumulated Volume in the Equalization Tank during the 5-Year Design Storm (Bottom)



The required footprint for the equalization basin is approximately 1,000 m² (25 m × 40 m), assuming a side water depth of 6 m. Given the significant storage volume, a footprint to allocate the basin within the wastewater facility setbacks line is not possible. The Region would need to acquire additional land adjacent to the plant site. The optimal location for the equalization basin would be north of the existing administration and control building beyond the existing setback line, as shown in Figure 3-6.

Figure 3-6. Potential Location for the Storage Basin



3.2.1.3 Alternative 3: New Pump Station/ Equalization Tank

Alternative 3 is to construct a new influent pump station and equalization tank. The existing influent pump station would be decommissioned. A new 3-m wet well can be constructed with a total depth of 8.5 m. Three pumps (2 duty, 1 standby) are recommended for this alternative. Pump capacity would be 35 L/s. Storage requirements for this alternative would be the same as for Alternative 2. The preliminary selected equalization basin and new pump station location is illustrated in Figure 3-7.

Figure 3-7. Potential Location for the New Pump Station and Storage Basin



3.2.2 Headworks (Screening)

The existing influent screening capacity is 4,490 m³/d. Considering storage tank in the influent pump station, the predicted future peak hourly flows are approximately 5,400 m³/d. Therefore, a screening capacity expansion is required. The following alternatives were shortlisted to meet future growth needs:

1. Do Nothing (kept as baseline for comparison purposes).
2. Existing Screen Replacement.
3. Construction of New Headworks Facility.

3.2.2.1 Alternative 1: Do Nothing

The plant would not be able to provide sufficient screening capacity in this scenario. Screened wastewater quality would deteriorate and would have a negative impact on downstream process performance. The lifespan of the screen would be shortened by overloading the screen with flows beyond its capacity.

3.2.2.2 Alternative 2: Existing Screen Replacement

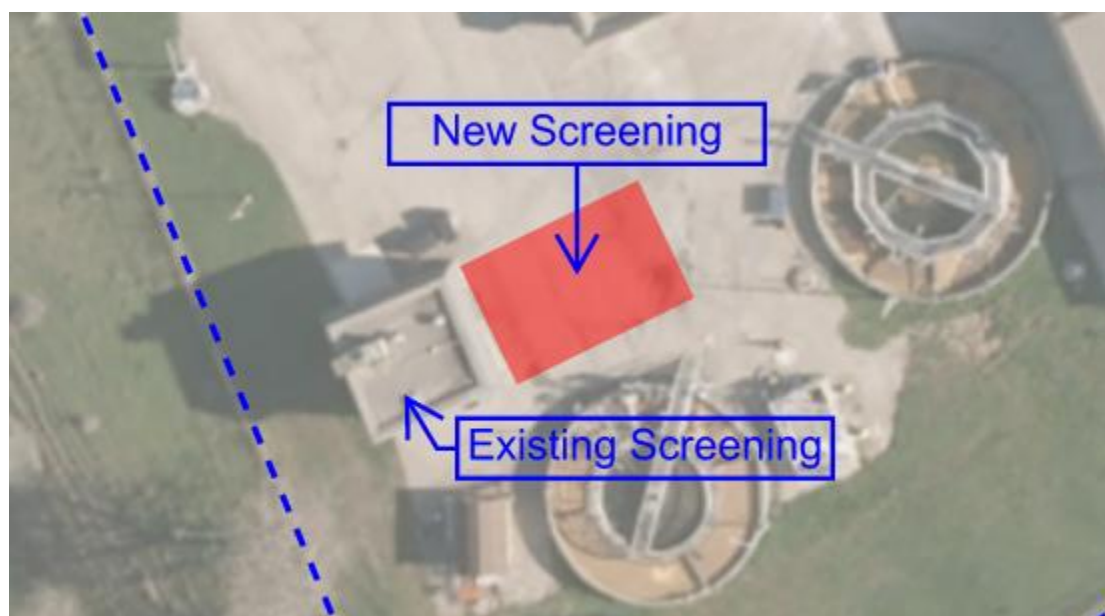
Alternative 2 involves upgrading the existing screen with a new screen to increase the screening capacity to 5,400 m³/d without the need for new expansion. Modifications to inlet piping would not be required as exiting piping can deliver the future PHF. No extra footprint will be required for this alternative. The flow splitter box is designed to divert flow to the future Phase 2 Secondary Treatment Plant 3. Therefore, no additional capacity is required for the splitter box. This alternative will not impact the footprint allocated for the future Phase 2 expansion. Phase 2 expansion was planned to increase headworks capacity from

4,400 m³/d to 6,400 m³/d. With increasing Phase 1 screening capacity, Phase 2 capacity would increase to 7,400 m³/d.

3.2.2.3 Alternative 3: Construction of New Headworks Facility

Alternative 3 is to construct a new headworks facility with a capacity of 5,400 m³/d and demolish the existing headworks facility. Two screens (1 duty/1 standby) are recommended. Similar to Alternative 2, this alternative will not impact footprint allocated for the future Phase 2 expansion and Phase 2 capacity would increase to 7,400 m³/d. The approximate footprint requirement for Alternative 3 would be 96 m² (8 m × 12 m) adjacent to the existing screening facility location, as shown in Figure 3-8.

Figure 3-8. Potential Location for the New Headworks Facility



3.2.3 Secondary Treatment

The existing secondary treatment consists of two packaged secondary treatment plants with annular configurations. Each plant consists of an aeration tank (25:75 percent volume split between anoxic and aerated zones) in the outside ring and a secondary clarifier in the interior. Secondary treatment was originally designed to provide a rated capacity of 1,100 m³/d as AADF and 4,400 m³/d PHF.

The secondary treatment capacity assessment demonstrates that the process is not limited by solids loadings. However, the process would be limited by the secondary clarifiers' hydraulic loading rate at peak hourly flow according to Ministry of the Environment, Conservation and Parks (MECP) design guidelines for maximum allowable hourly surface overflow (SOR) rate (37 m³/m²/d). The SOR at the current plant PHF capacity (4,400 m³/d) is 43 m³/m²/d. Given that the maximum allowable SOR depends on sludge settleability, which is site-specific. Historical data analysis for secondary treatment demonstrates good sludge settling characteristics (defined by the measured sludge volume index [SVI]). The historical maximum SVI was estimated to be 90 mL/g, which is significantly lower than typical SVIs for conventional activated sludge (120 to 150 mL/g). The good settling characteristics observed at Wellesley WWTP could be attributed to alum addition. Using the concept of flux curve analysis, the maximum allowable SOR for Wellesley secondary clarifiers would be 46 m³/m²/d, which is higher than the peak hourly SOR of 43

$\text{m}^3/\text{m}^2/\text{d}$. Therefore, considering a peak factor of 4, the clarifier's capacity can handle the rated capacity of 1,100 m^3/d AADF and PHF up to 4,400 m^3/d .

The peak hourly SOR for the secondary clarifiers at 2051 projected PHF would be 53 $\text{m}^3/\text{m}^2/\text{d}$. Therefore, additional secondary treatment capacity via intensification of the existing two plants or a new expansion would be required. The following alternatives were shortlisted to meet future growth needs:

1. Do Nothing (kept for comparison purposes).
2. New Secondary Treatment Plant Construction.
3. Existing Secondary Treatment Intensification.
4. Wet Weather Management Implementation.

3.2.3.1 Alternative 1: Do Nothing

This alternative does not consider any increase in process capacity and assumes future projected flows and loadings would be treated by the existing two secondary treatment plants. As mentioned, the peak hourly SOR for the secondary clarifiers at 2051 projected PHF would be 53 $\text{m}^3/\text{m}^2/\text{d}$, which is higher than the estimated maximum allowable SOR of 46 $\text{m}^3/\text{m}^2/\text{d}$. Overloading the secondary treatment would result in clarification failure and solids washout, resulting in performance loss. Moreover, solids washout would negatively impact the downstream processes (tertiary filtration and UV disinfection) performance. Therefore, this alternative was not shortlisted during TM4 evaluation and provided in this TM only for comparison purposes with the other shortlisted alternatives.

3.2.3.2 Alternative 2: New Secondary Treatment Plant Construction

Alternative 2 is to construct a new secondary treatment plant. Construction of a new secondary treatment plant was considered in the original design for secondary treatment for Phase 2 expansion. Plant 3 would increase the secondary treatment rated capacity from 1,100 m^3/d to 1,600 m^3/d , allowing the process to handle peak flows up to 6,400 m^3/d . To provide a capacity to handle the projected flows and loadings for Year 2051 (1,345 m^3/d AADF and 5,400 m^3/d PHF), a footprint required for the new plant construction would be 65 m^2 (8 m diameter) as shown in Figure 3-9.

Figure 3-9. Potential Location for the Secondary Treatment Plant 3



3.2.3.3 Alternative 3: Existing Secondary Treatment Intensification

Alternative 3 includes future proofing technologies to increase secondary treatment capacity and minimize the construction required to accommodate future flows. Upgrading the existing secondary treatment process with a process intensification technology such as densification with aerobic granular sludge (AGS) or membrane aerated biofilm reactors (MABR) could provide a lower cost alternative to increase secondary treatment capacity.

Densification with AGS involves the selective retention of “heavy” flocs of bacteria in the mixed liquor, referred to as “granular sludge”. Due to the fast-settling velocity of granular particles, the SVI is low compared to conventional activated sludge. Because of the low SVI achieved with sludge granulation, secondary treatment capacity can increase. This alternative involves the implementation of inDENSE® as a selective sludge wasting approach. Sludge would be directed to a hydrocyclone unit at approximately twice the sludge pumping rate compared to a typical secondary treatment process without hydrocyclone installation. The underflow (denser solids) from the hydrocyclone would be returned to the aeration tanks, while the overflow (less dense solids) would discharge to the storage tank.

In the MABR process, membranes are submerged in the anoxic zones of the aeration tank. Air is supplied to the interior of the hollow membrane fibres at pressures sufficient to maintain the presence of oxygen at the exterior wall of the fibre, but not ejecting bubbles into the bulk liquid. Oxygen transfer from these units is very efficient, and the air pressure at which they operate is significantly lower than conventional aeration systems. Therefore, significant energy savings can be achieved. The MABR process appears to selectively encourage the growth of nitrifying bacteria on the membrane fibre surface, shortening the required apparent aerobic solids retention time (SRT) by 20 to 30 percent and increasing secondary treatment capacity relative to conventional secondary treatment processes. MABR is currently implemented at the Elmira and Hespeler WWTPs. Given the annular configuration for the existing aeration tanks, retrofitting

with MABR would be complex. If this alternative is selected, further detailed evaluation needs to be conducted to investigate the applicability of this technology at the Wellesley WWTP.

Depending on the implemented technology, the overall increase in secondary treatment would be 20 to 30 percent, allowing the existing secondary treatment to handle the increase in flows and loadings projected for the Year 2051. Space required for the additional equipment required for this alternative (either densification or MABR technology) would be 20 m² (4 m × 5 m) and could potentially be located as shown in Figure 3-10.

Figure 3-10. Potential Location for Additional Ancillary Equipment Required for Alternative 3



3.2.3.4 Alternative 4: Wet Weather Management Implementation

Implementing a wet weather management technology eliminates the need to oversize the secondary treatment to handle infrequent wet weather flows. There are different technologies that can be implemented for wet weather flow treatment (WWFT) including, filtration, high rate clarification and inclined plate settlers. Cloth media filtration is included in the existing infrastructure for tertiary filtration. Given the operator's familiarity with this technology, cloth media filtration is recommended as the preferred wet weather technology for concept development purposes at the Wellesley WWTP. It should be noted that this technology is being considered for implementation at the Elmira WWTP for WWFT.

At the Wellesley WWTP, flows exceeding the capacity of the two secondary treatment plants (4,400 m³/d) would be diverted to the wet weather filtration process. The existing facility design includes a bypass weir and piping in the splitter box building to bypass flow from the Headworks to the tertiary filtration building. This bypass can be utilized to bypass diverted flows to a WWFT process. Compared to other alternatives, this alternative would provide lower effluent quality compared to biological secondary treatment. However, effluent quality will not exceed effluent limits. The main concern associated with implementing WWFT would be its impact on the new UV system. With the higher solids in WWFT effluent, influent quality for the UV system would require a higher ultraviolet transmittance (UVT) compared to the current UVT considered for disinfecting only secondary treatment effluent. Therefore, this alternative would require upsizing the UV system that the Region is currently implementing at Wellesley or considering a separate

disinfection system for the WWFT effluent. The wet weather filtration process building could be located in proximity to the existing tertiary filtration process as shown in Figure 3-11. The required footprint would be 15 m² (3 m × 5 m).

Figure 3-11. Potential Location for Wet Weather Flow Treatment



3.2.4 Sludge Storage

Wasted sludge from both secondary treatment plants is pumped into one 72-m³ storage tank. Sludge is hauled to the Waterloo WWTP for digestion and further processing. Currently, the sludge is hauled once a week. The average historical storage time is approximately 5 days. With 5 days of storage time, the existing storage tank would provide a capacity of up to 580 m³/d (equivalent AADF capacity), which is significantly lower than the required capacity to handle an equivalent AADF capacity of 1,345 m³/d. The following alternatives were shortlisted to meet sufficient storage capacity to handle future projected loadings:

1. Do Nothing (kept for comparison purposes).
2. Replace Existing Storage Tank with a New Larger Storage Tank.
3. Construct a Second Storage Tank.

3.2.4.1 Alternative 1: Do Nothing

Alternative 1 is to do nothing. This alternative does not consider any increase in process capacity and assumes future projected flows and loadings would be stored by the existing storage tank. The existing storage capacity would only provide two days of storage capacity at the future projected AADF of 1,345 m³/d, requiring a more frequent sludge hauling schedule. Therefore, this alternative was not shortlisted during TM4 evaluation and provided in this TM only for comparison purposes with the other shortlisted alternatives.

3.2.4.2 Alternative 2: Replace Existing Storage Tank with a New Larger Storage Tank

Alternative 2 involves demolishing the existing storage tank and constructing a new larger tank that provides a sludge storage capacity of 5 days at the projected AADF of 1,345 m³/d. A total storage volume of 160 m³ would be required for this alternative. The preliminary sizing for the storage tank would be 6 m x 6 m x 4.5 m and can be located adjacent to the existing storage tank location as shown in Figure 3-12.

Figure 3-12. Expansion of Existing Sludge Storage Tank



3.2.4.3 Alternative 3: Construct a Second Storage Tank

Alternative 3 involves utilizing the existing storage tank capacity and constructing a second storage tank to provide a total sludge storage capacity of 5 days at the projected AADF of 1,345 m³/d. An additional storage volume of 95 m³ would be required for this alternative. The preliminary sizing for the storage tank would be 6 m x 3.5 m x 4.5 m and can be located south of the existing storage tank location as shown in Figure 3-13.

Figure 3-13. Potential Location for New Storage Tank



3.2.5 Tertiary Filtration

The Region recently upgraded the tertiary filtration process. Four new cloth media filters (3 duty/1 standby) were implemented to filter secondary effluent flow up to 4,400 m³/d. Alum is dosed upstream of the four filters for chemical phosphorus removal. The following alternatives were shortlisted to meet future growth needs:

1. Do Nothing (kept for comparison purposes).
2. Existing Tertiary Filtration Expansion.

3.2.5.1 Alternative 1: Do Nothing

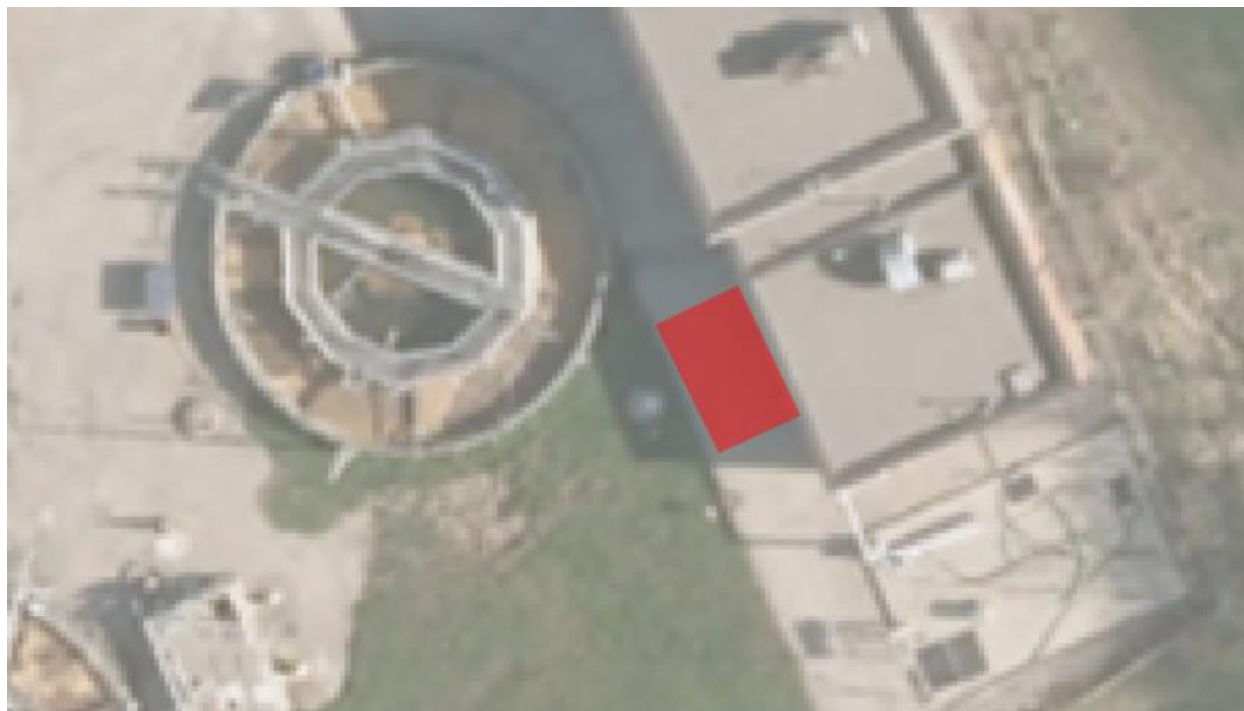
Alternative 1 is to do nothing. This alternative does not consider any increase in process capacity and assumes future projected flows and loadings would be treated by the existing filtration process. Each filter is designed based on a peak hydraulic loading rate of 203 L/m²/min. The firm capacity of the filters is 4,400 m³/d. The peak hourly hydraulic loading rate for the filters at 2051 projected PHF would be 250 L/m²/min, which is higher than the design peak of 203 L/m²/min. If all four filters are in operation, the filters can provide sufficient capacity to handle the future PHF of 5,400 m³/d (peak hydraulic loading rate of 186 L/m²/min). However, if one unit is offline for maintenance, overloading the three operating filters would result in deterioration in filtration loss, impacting UV system performance. Therefore, this alternative was not shortlisted during TM4 evaluation and provided in this TM only for comparison purposes with the other shortlisted alternatives.

3.2.5.2 Alternative 2: Existing Tertiary Filtration Expansion

This alternative considers the expansion of the existing tertiary filtration building to provide sufficient capacity to handle peak flows while considering redundancy requirements. One additional filter would be required to handle the future projected PHF of 5,400 m³/d. This alternative involves replacing the existing alum meeting pumps (3 duty/ one standby) with new pumps (each has a capacity of 21 L/s) to provide a

firm capacity of 63 L/s The building would be expanded 3 m x 5 m adjacent to the existing building as shown in Figure 3-14.

Figure 3-14. Tertiary Filtration Expansion Alternative



4. Summary of Evaluation Criteria

The alternatives were evaluated based on relative benefit/impact on criteria from the following categories: Environmental, Social, Technical or Financial. The evaluation criteria are presented in Table 4-1. Alternatives were assigned a score according to a performance scale ranging from very well aligned with criteria to low alignment with criteria. The performance scale is presented in Table 4-2. Following the alternative scoring, each criteria category was weighted equally to calculate an overall scoring for each alternative. A sensitivity analysis using the weightings described in Table 4-3 was also completed to determine the impact different weighting have on the evaluation outcome. The full methodology is described in TM-2: Evaluation Framework and Evaluation Criteria.

Table 4-1: Evaluation Criteria

Category	Criteria	Description
Environmental	Protects environmental features	Impact of alternative on environmental features including natural areas, designated ANSI, Wetlands, Designated PSWs, and other project specific defined environmental features.
	Protects wildlife and species at risk	Impact of alternative on wildlife and wildlife habitat, including birds, fish, herptiles,

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Category	Criteria	Description
		mammals, and insects and any other project specific defined wildlife and their project specific habitats.
	Protects groundwater, streams and river	Impact of alternative on groundwater quantity and quality, surface water quantity and quality and fluvial geomorphic function of streams and rivers.
	Minimizes climate change impacts	Impact of alternative on climate scale temperature, wind, precipitation and any other project specific climate scale. Measured through qualitative estimates of relative GHG emissions.
Social	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.	Impact of alternative over long term on the levels of noise, odour, traffic, and aesthetics in the study area.
	Minimizes impacts to businesses	Impact of alternative on long term business operations related to closures, access, and any other project specific disturbances.
	Manages and minimizes construction impacts	Impact of alternative on short term business operations during construction related to closures, access, and including noise, traffic, environment and any other project specific disturbances.
	Conserves built heritage and/or cultural heritage landscapes	Impact of alternative to adjacent sites/properties of built or cultural value or interest.
	Conserves archaeological resources	Impact of alternative on heritage resources of value or interest.
	Protects health and safety	Impact of alternative over short term during construction and long term on health and safety of construction and operations personnel and the public.
Technical	Provides reliable service	Resilience of the alternative to impacts from natural and man-made disturbances.
	Meets existing and future needs	Ability of the alternative to meet the existing and future needs as defined by the problem and opportunity statement.

Category	Criteria	Description
	Aligns with existing and planned infrastructure	Alignment of the alternative with existing infrastructure in terms of integration and operations and ability to accommodate future upgrades to meet projected needs.
	Aligns with existing and future land use	Ability of the impact to accommodate future anticipated land uses.
	Aligns with approval and permitting process	Ability of the alternative to receive permitting and approvals
	Manages and minimizes construction risks	Ability of the alternative to avoid technical risks and adhere to constructability requirements.
	Ability to adapt to climate change	Resilience of the alternative to changes in climate related factors including temperature, wind, precipitation and any other project defined specific climate factors.
Financial	Requires low lifecycle costs	Alternative cost comparison on life cycle costs.

Table 4-2: Performance Scale

Rating	Description	Symbol
5	Very well aligned with criteria	
4	Well aligned with criteria	
3	Somewhat aligned with criteria	
2	Not well aligned with criteria	
1	Low alignment with criteria	

Table 4-3: Proposed Evaluation Weighting Approaches

	Even Weighting	Excluding Cost	High Social	High Environmental	High Technical
Technical	25%	33%	20%	20%	40%
Environmental	25%	33%	20%	40%	20%
Social	25%	33%	40%	20%	20%
Financial	25%	0%	20%	20%	20%
Total	100%	100%	100%	100%	100%

5. Drinking Water System Alternatives Evaluation

5.1 Well Capacity

The alternative scoring is summarized in Table 5-1. Overall weighted scores and rankings are presented in Table 5-2 for the various weighting approaches proposed in TM-2. Refer to Appendix A for the full rationale and scoring breakdown.

Alternative 2: Increase Existing Well Supply consistently ranked first throughout all five weighting approaches. In general, this alternative outperformed the others in the environmental, social, and financial categories. Increasing the existing well supply would be the least disruptive to the environment and surrounding community as no construction would be required. Costs would also be significantly lower as the existing assets could continue to be used without any new construction. There is uncertainty, however, regarding the ability to acquire MECP approvals for increasing the existing well supply because the potential impact to groundwater quantity and quality from increasing the water taking rate has not yet been studied adequately.

In the technical criteria, Alternative 2 generally scored lower, because although it would be able to meet the future capacity needs, it does not provide the same level of redundancy and resiliency as the other alternatives. Alternatives 3A and 3B would involve developing a new well source which would provide further redundancy over the three existing wells. Alternative 4 would greatly improve resiliency as it involves connecting a completely redundant and independent treated water supply. Whereas Alternative 2 only provides the same level of redundancy as the existing operations.

Alternative 3B: Supplement Existing with New Well Supply (Outside Urban Boundary) consistently ranked second throughout all five weighting approaches, followed by Alternative 3A: Supplement Existing with New Well Supply (Inside Urban Boundary) which was ranked third. Alternatives 3A and 3B generally outperformed Alternative 4 in the environmental and financial categories. The construction scope for Alternative 4 is significantly more disruptive than Alternatives 3A and 3B as it impacts a much larger area and there are many unknowns as the majority of construction would occur outside of the study area for the WWWMP. An impacts assessment would be required to determine any potential impacts to environmental features, wildlife and habitats, groundwater, surface water and fluvial geomorphic function.

Alternative 1: Do Nothing and Alternative 4: Supplement Existing with External Supply both generally performed poorly in comparison to the other alternatives. Alternative 1 was eliminated in the long-list screening in TM3 but carried forward as a baseline. This alternative would not meet the projected capacity needs. Alternative 4 was more expensive compared to the other alternatives despite performing well in the technical and social categories.

The sensitivity analysis in Table 5-2 shows the impact of different weighting approaches on the scores and preferred alternative. Regardless of weighting approach, Alternative 2: Increase Existing Well Supply consistently scored highest and is the first ranked alternative. Alternative 3B: Supplement Existing with New Well Supply (Outside Urban Boundary) was consistently ranked as the second alternative throughout all five weighting approaches, followed by Alternative 3A: Supplement Existing with New Well Supply (Inside Urban Boundary) which was consistently ranked third. Alternative 1: Do Nothing and Alternative 4: Supplement Existing with External Supply were both ranked either fourth or fifth throughout the five weighting approaches. These results indicate Alternative 2: Increase Existing Well Supply is the clear preferred alternative. Alternative 3B: Supplement Existing with New Well Supply (Outside Urban Boundary) is the next preferred alternative, followed by Alternative 3A: Supplement Existing with New

Well Supply (Inside Urban Boundary). Both Alternative 1: Do Nothing and Alternative 4: Supplement Existing with External Supply are equally the least preferred alternatives.

Based on the overall evaluation rankings, Alternative 2: Increase Existing Well Supply is the preliminary preferred alternative to address future well capacity constraints. This alternative is preferred, however, subject to further hydrogeological study. Overall, Alternative 3B: Supplement Existing with New Well Supply (Outside Urban Boundary) ranked very similarly to Alternative 2 and is recommended to be considered as a preferred alternative should the hydrogeological study on Alternative 2 provide negative results. Therefore, the recommended preliminary preferred alternative that can be taken forward for further study and selection includes both Alternative 2: Increase Existing Well Supply, and Alternative 3B: Supplement Existing with New Well Supply (Outside Urban Boundary).

Table 5-1. Alternatives Scoring for Well Capacity Constraint

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Increase Existing Well Supply	Alternative 3A: Supplement Existing with New Well Supply (Inside Urban Boundary)	Alternative 3B: Supplement Existing with New Well Supply (Outside Urban Boundary)	Alternative 4: Supplement Existing with External Supply
Environmental	Protects environmental features					
	Protects wildlife and species at risk					
	Protects groundwater, streams and rivers					
	Minimizes climate change impacts					
Social	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.					
	Minimizes impacts to businesses					
	Manages and minimizes construction impacts					

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Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Increase Existing Well Supply	Alternative 3A: Supplement Existing with New Well Supply (Inside Urban Boundary)	Alternative 3B: Supplement Existing with New Well Supply (Outside Urban Boundary)	Alternative 4: Supplement Existing with External Supply
	Conserves built heritage and/or cultural heritage landscapes					
	Conserves archaeological resources complexity					
	Protects health and safety					
Technical	Provides reliable service					
	Meets existing and future needs					
	Aligns with existing and planned infrastructure					
	Aligns with existing and future land use					

TM5: Preliminary Preferred Water and Wastewater Alternative

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Increase Existing Well Supply	Alternative 3A: Supplement Existing with New Well Supply (Inside Urban Boundary)	Alternative 3B: Supplement Existing with New Well Supply (Outside Urban Boundary)	Alternative 4: Supplement Existing with External Supply
	Aligns with approval and permitting process					
	Manages and minimizes construction risks					
	Ability to adapt to climate change					
Financial	Provides low lifecycle costs					

Table 5-2. Well Capacity Alternatives Evaluation Scores per the Five Weighting Approaches

Average Score or Rank	Alternative 1: Do Nothing	Alternative 2: Increase Existing Well Supply	Alternative 3A: Supplement Existing with New Well Supply (Inside Urban Boundary)	Alternative 3B: Supplement Existing with New Well Supply (Outside Urban Boundary)	Alternative 4: Supplement Existing with External Supply
Environmental Criteria Category					
Social Criteria Category					
Technical Criteria Category					
Financial Criteria Category					
Even Weighting Approach Overall Average					
Even Weighting Approach Rank	4	1	3	2	5
Exclude Cost Approach Overall Average					
Exclude Cost Approach Rank	5	1	3/4	2	3/4
High Social Approach Overall Average					
High Social Approach Rank	4	1	3	2	5
High Environmental Approach Overall Average					
High Environmental Approach Rank	4	1	3	2	5

Average Score or Rank	Alternative 1: Do Nothing	Alternative 2: Increase Existing Well Supply	Alternative 3A: Supplement Existing with New Well Supply (Inside Urban Boundary)	Alternative 3B: Supplement Existing with New Well Supply (Outside Urban Boundary)	Alternative 4: Supplement Existing with External Supply
High Technical Approach Overall Average					
High Technical Approach Rank	5	1	3	2	4

5.2 Future Disinfection, Water Pumping, and Storage Needs

Detailed evaluation was not completed as Alternative 1: Do Nothing is incompatible with the future disinfection, water pumping and storage needs. Only Alternative 2: New Storage Off-Site will meet the future needs. Evaluation was instead completed for the floating storage location alternatives.

Alternative 2: New Storage Off-Site is the preferred alternative to address future disinfection, water pump, and storage needs. This alternative requires construction of a new elevated tank. The alternative locations for the proposed elevated tank are shown in Figure 2-3 and include the following general locations:

1. Bill Gies Recreation Centre lands to the west of the Village
2. Undeveloped land to the north of the Village
3. Centrally located near the former arena lands
4. Undeveloped land in the north-east area of the Village
5. Developed land to the south of the Village

The alternative scoring is summarized in Table 5-3. Overall weighted scores and rankings are presented in Table 5-4 for the various weighting approaches proposed in TM-2. Refer to Appendix A for the full rationale and scoring breakdown. For the purposes of evaluation and design concept development, it is assumed the floating storage would be in the form of an elevated tank.

Locations 1 and 3 were preferred under the environmental criteria. The locations were compared against the natural environment features identified in TM-1 which included various wooded areas within and surrounding the study area, wetlands to the west of the study area, and major water bodies including Firella Creek crossing through the center of the study area and the Nith River to the south of the study area. Locations 1 and 3 were relatively isolated from existing wooded areas, wetlands and water bodies compared to the other locations and the elevated tank could be located well away from any known features to mitigate impacts. Location 2 to the north of the Village is near an existing wooded area and Firella Creek. Location 4 to the north-east of the Village is near the floodplain of the Stroh drain. Location 5 to the south of the Village is near the Nith River. An impacts assessment would be required

regardless of the preferred location, however it is possible additional mitigation measures may be required for the locations closer to identified environmental features.

Location 1 was generally preferred in the social criteria while Location 3 was least preferable. Location 3 is the most central and would therefore cause a more noticeable change to community aesthetics and short-term impacts during construction due to traffic, noise, or odour. Location 1 is located further from the developed residential and commercial areas and would therefore have a less disruptive impact on current residents. For archaeology and cultural heritage, scoring was based on the findings from the Stage 1 Archaeology Baseline Conditions report completed by Archaeological Services Inc. (ASI) in 2023 (ASI, April 2023), and the Cultural Heritage desktop review completed by ASI in 2023 (ASI, February 2023) and verified following the completion of the Stage 1 Archaeological Assessment (ASI, 2025) and Cultural Heritage Report: Existing Conditions and Preliminary Impact Assessment (ASI, 2025). All of the potential locations are adjacent to or intersect with an area of archaeological potential. Locations 2, and 3 are located near or within cultural heritage landscapes or known or potential built heritage resources. The Cultural Heritage Report: Existing Conditions and Preliminary Impact Assessment (ASI, 2025) indicated that Location 4 would result in a direct adverse impact to a Cultural Heritage Landscape (CHL).

Hydraulic modelling was completed to evaluate the locations from a technical perspective. For the purposes of evaluation, no watermain upgrades were assumed. Modelling was developed for each potential location for both the current (2021) and future (2051) conditions with the following assumptions:

- Two existing 60 L/s pumps not in operation
- No watermain upgrades compared to existing system
- Demand equal to the sum of MDD and fire flow (FF)

System pressures did not change significantly with the elevated tank location. The main factor considered for scoring was FF availability based on the following for different property types:

- The availability to meet industrial/commercial/institutional (ICI) FF of 175 L/s.
- The availability to meet residential FF of 125 L/s as minimum preferred.
- The availability to meet residential FF of 75 L/s as minimum acceptable.

Location 3 was preferred from a technical perspective. With the ET in Location 3, the distribution system model was able to meet the FF conditions for approximately 89 percent of ICI nodes and 91 percent of residential nodes. Location 4 was ranked second as in this case the FF conditions were met at 78 percent of ICI nodes and 86 percent of residential nodes. The full results for 2051 are presented in Table 5-5.

From a financial perspective, the alternatives were ranked based on the relative capital cost. Capital costs are preliminary and were scaled based on the expected height of the elevated tank in each location and exclude land acquisition costs. Geotechnical properties were not taken into consideration. Additional investigative studies would be needed for the preferred location to develop an accurate estimate of cost. This TM only includes equipment costs and some civil works for the preferred location. Locations 1 and 2 were the most preferred from a financial perspective while Location 5 was the least preferred.

The sensitivity analysis in Table 5-4 shows the impact of different weighting approaches on the scores and preferred alternative. The sensitivity analysis shows the impact of different weighting approaches on the scores and preferred alternative. Location 1 scored highest in four of the five weighting approaches and is the first ranked alternative. Location 1 was preferable in the financial and social criteria as it is located further from the developed residential and commercial areas and would therefore have a less disruptive

impact. Location 1 scored relatively low in the technical category as the location is more isolated and would need to rely more on the fire department's supply to meet fire flow needs for both residential and ICI properties at several nodes in the distribution system. Location 3 performed poorly under the social criteria as it is the most central location and would therefore cause a more noticeable change to community aesthetics and short-term impacts during construction due to traffic, noise, or odour. Location 4 performed poorly under the social criteria since it would result in a direct adverse impact to a CHL. Location 2 had an average score in most criteria other than financial. Location 5 ranked lowest in four of the five weighting approaches. The results of the sensitivity analysis indicate Location 1 is the preferred alternative.

Location 1 in the Bill Geis Recreation Centre lands ranked first in four of the five weighting approaches and is the preferred location for the new elevated tank.

Table 5-3. Scoring for Floating Storage Location Alternatives

Category	Criteria	Location 1	Location 2	Location 3	Location 4	Location 5
Environmental	Protects environmental features					
	Protects wildlife and species at risk					
	Protects groundwater, streams and rivers					
	Minimizes climate change impacts					
Social	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.					
	Minimizes impacts to businesses					
	Manages and minimizes construction impacts					
	Conserves built heritage and/or cultural heritage landscapes					
	Conserves archaeological resources complexity					
	Protects health and safety					
	Provides reliable service					

TM5: Preliminary Preferred Water and Wastewater Alternative

Category	Criteria	Location 1	Location 2	Location 3	Location 4	Location 5
Technical	Meets existing and future needs					
	Aligns with existing and planned infrastructure					
	Aligns with existing and future land use					
	Aligns with approval and permitting process					
	Manages and minimizes construction risks					
	Ability to adapt to climate change					
Financial	Provides low lifecycle costs					

Table 5-4. Floating Storage Location Alternatives Evaluation Scores per the Five Weighting Approaches

Category	Location 1	Location 2	Location 3	Location 4	Location 5
Environmental Criteria Category					
Social Criteria Category					
Technical Criteria Category					
Financial Criteria Category					
Even Weighting Approach Overall Average					
Even Weighting Approach Rank	1	2	4	3	5
Exclude Cost Approach Overall Average					
Exclude Cost Approach Rank	2	5	1	3	4
High Social Approach Overall Average					
High Social Approach Rank	1	2	4	3	5
High Environmental Approach Overall Average					
High Environmental Approach Rank	1	4	2	3	5
High Technical Approach Overall Average					
High Technical Approach Rank	1	4	2	3	5

Table 5-5. Distribution System Modelling Performance for Providing 2051 Fire Demand

Performance ^a	Location 1	Location 2	Location 3	Location 4	Location 5
Percent of ICI Nodes above 175 L/s	11	44	89	78	56
Percent of Residential Nodes above 125 L/s	11	65	91	86	90
Percent of Residential Nodes above 75 L/s	96	99	99	99	99

Notes:

^a Results are based on a new watermain addition from the elevated tank location to connect to the existing distribution system, but excludes upgrades to the existing distribution system

6. Wastewater System Alternatives Evaluation

6.1 Wastewater Collections

6.1.1 Group A – Firella Creek Trunk Sewer Alternatives Evaluation

The alternative scoring for the Group A Wastewater Collections Alternatives is summarized in **Error! Reference source not found.** using the scoring methodology summarized in Section 4. Detailed rationale is included in Appendix A.

Alternative 1 scored low under environmental and technical criteria relative to the other alternatives. This is primarily because doing nothing would result in a high risk of basement and surface flooding. Flooding to surface would result in direct flow of sanitary sewerage into the Firella Creek, which would consequently have wildlife impacts and risk of groundwater contamination. Alternative 1 is not able to accommodate growth since the trunk sewer is already constrained under existing wet weather flow conditions. This alternative scored high under social criteria mainly due to construction not being required. No construction minimizes impacts to businesses, archaeological resources, built heritage and cultural heritage landscapes, and impacts to traffic and aesthetics. However, this alternative does pose a health and safety risk due to the high risk of basement and surface flooding during wet weather events. Alternative 1 scored moderately high under economic criteria because there is no capital cost associated with this alternative, however operation and maintenance costs are expected to increase as a result of aging infrastructure.

Alternative 2 scored higher than Alternative 1 and lower than Alternative 3 overall. Although Alternative 2 reduces the risk of basement flooding and surcharging to surface, implementing this alternative would require a large footprint with a likely impact on nearby woodlots. This alternative would also require pumping, which would increase greenhouse gas emissions compared to existing conditions. This alternative scored lowest under the social criteria largely due to the potential risk of odour generation from offline storage tanks and due to the impact the tanks would have on community aesthetics. Due to the large volume of storage required (approximately 5,000 m³), this alternative would be difficult to construct and implement. Additionally, the offline storage tanks do not align with the current operating regime within the Village, and would require additional operation and maintenance effort. The capital cost would be lower compared to Alternative 3, however the operation and maintenance costs would be higher than Alternative 3.

Alternative 3 is the preferred Group A alternative. This alternative reduces the risk of basement and surface flooding compared to Alternative 1 which reduces the risk of impact to the environment and public health and safety. This alternative is compatible with existing infrastructure and the existing operating regime and does not require land acquisition. Although this alternative requires one creek crossing, the impacts on Firella Creek can be mitigated during construction. Alternative 3 is expected to have a high capital cost relative to Alternative 1 and Alternative 2, but a relatively low operations and maintenance cost. Alternative 3 does not reduce the impact of peak flows at the WWTP but managing the additional flows at the plant was deemed to be a better option than Alternative 2, which stores peak flows off-line, because of the need for land acquisition, the implementation of new operation and maintenance practices and the increase in ongoing operation and maintenance costs associated with that alternative. Alternative 3 scored higher than Alternative 1 and Alternative 2 under the environmental, social, and technical criteria categories, and scored highest overall.

Table 6-1. Alternatives Scoring for Wastewater Collections Group A

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Offline Storage	Alternative 3: Firella Creek Capacity Increase
Environmental	Protects environmental features			
	Protects wildlife and species at risk			
	Protects groundwater, streams and rivers			
	Minimizes climate change impacts			
Social	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.			
	Minimizes impacts to businesses			
	Manages and minimizes construction impacts			
	Conserves built heritage and/or cultural heritage landscapes			

TM5: Preliminary Preferred Water and Wastewater Alternative

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Offline Storage	Alternative 3: Firella Creek Capacity Increase
	Conserves archaeological resources complexity			
	Protects health and safety			
Technical	Provides reliable service			
	Meets existing and future needs			
	Aligns with existing and planned infrastructure			
	Aligns with existing and future land use			
	Aligns with approval and permitting process			
	Manages and minimizes construction risks			
	Ability to adapt to climate change			

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Offline Storage	Alternative 3: Firella Creek Capacity Increase
Financial	Provides low lifecycle costs			

Table 6-2. Wastewater Collections Group A Alternatives Evaluation Scores per the Five Weighting Approaches

Category	Alternative 1	Alternative 2	Alternative 3
Environmental Criteria Category			
Social Criteria Category			
Technical Criteria Category			
Financial Criteria Category			
Even Weighting Approach Overall Average			
Even Weighting Approach Rank	3	2	1
Exclude Cost Approach Overall Average			
Exclude Cost Approach Rank	3	2	1
High Social Approach Overall Average			
High Social Approach Rank	2	2	1
High Environmental Approach Overall Average			
High Environmental Approach Rank	3	2	1
High Technical Approach Overall Average			
High Technical Approach Rank	3	2	1

6.1.2 Group B-Local Sewer Constraints Alternatives Evaluation

The alternative scoring for the Group B Local Sewer Constraints Alternatives is summarized in Table 6-3 using the scoring methodology summarized in Section 4. Detailed rationale is included in Appendix B.

Alternative 1 scored low under environmental and technical criteria relative to the other alternatives. This is primarily because doing nothing would result in a high risk of basement and surface flooding. Flooding to surface could result in direct contamination of the watercourses running through the study area, which would consequently have wildlife impacts and risk of groundwater contamination. Alternative 1 is not able to accommodate growth since the local sewers are already constrained under existing wet weather flow conditions. This alternative scored high under social criteria mainly due to construction not being required. No construction minimizes impacts to businesses, archaeological resources, built heritage and cultural heritage landscapes, and impacts to traffic and aesthetics. However, this alternative does pose a health and safety risk due to the high risk of basement and surface flooding during wet weather events. Alternative 1 scored moderately high under economic criteria because there is no capital cost associated with this alternative, however operation and maintenance costs are expected to increase as a result of aging infrastructure.

Alternative 2 is the preferred Group B alternative. This alternative reduces the risk of basement and surface flooding compared to Alternative 1 which reduces the risk of impact to the environment and public health and safety. Alternative 2 includes three watercourse crossings where impacts will require mitigation measures during construction. This alternative is compatible with existing infrastructure and the existing operating regime and does not require land acquisition. This alternative requires construction within the ROW that will disrupt traffic and has the potential to disrupt businesses in the commercial and industrial area in the vicinity of Nafziger Road. Relatively small stretches of construction is required along main roads (Geber Road and Nafziger Road) which will impact traffic. Alternative 2 is expected to have a moderate capital cost relative to Alternative 1 and Alternative 3, and a relatively low operations and maintenance cost. Alternative 2 scored higher than Alternative 1 and Alternative 3 under the environmental and technical criteria categories, and scored highest overall.

Alternative 3 scored similarly to Alternative 1 overall. Although Alternative 3 reduces the risk of basement flooding and surcharging to surface, it involves five watercourse crossings where impacts will require mitigation measures during construction. This alternative requires construction within the ROW that will disrupt traffic and has the potential to disrupt businesses in the commercial and industrial area in the vicinity of Nafziger Road. This alternative also requires construction along main roads, including Geber Road, Greenwood Hill Road, and Nafziger Road, which will contribute to traffic disruption. Although Alternative 3 will reduce the length of local sewer upgrades required compared to Alternative 2 along Queens Bush Road, Parkview Drive, and Lawrence Street, local sewer upgrades will still be required. Alternative 3 will require a greater length of new or replaced piping compared to Alternative 2 and will therefore have a higher capital cost compared to Alternative 2. The operation and maintenance cost for Alternative 3 will also be higher than Alternative 2 due to the additional assets added.

The analysis of results was completed without accounting for and quantifying potential I/I reduction. However it is recommended that I/I reduction strategies be investigated further prior to implementing any infrastructure upgrades.

Table 6-3. Alternatives Scoring for Wastewater Collections Group B

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Pipe Capacity Increases	Alternative 3: New Sub-trunk Sewers
Environmental	Protects environmental features			
	Protects wildlife and species at risk			
	Protects groundwater, streams and rivers			
	Minimizes climate change impacts			
Social	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.			
	Minimizes impacts to businesses			
	Manages and minimizes construction impacts			
	Conserves built heritage and/or cultural heritage landscapes			
	Conserves archaeological resources complexity			
	Protects health and safety			
Technical	Provides reliable service			
	Meets existing and future needs			
	Aligns with existing and planned infrastructure			

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Pipe Capacity Increases	Alternative 3: New Sub-trunk Sewers
	Aligns with existing and future land use			
	Aligns with approval and permitting process			
	Manages and minimizes construction risks			
	Ability to adapt to climate change			
Financial	Provides low lifecycle costs			

Table 6-4. Wastewater Collections Group B Alternatives Evaluation Scores per the Five Weighting Approaches

Category	Alternative 1	Alternative 2	Alternative 3
Environmental Criteria Category			
Social Criteria Category			
Technical Criteria Category			
Financial Criteria Category			
Even Weighting Approach Overall Average			
Even Weighting Approach Rank	3	1	2
Exclude Cost Approach Overall Average			
Exclude Cost Approach Rank	3	1	2
High Social Approach Overall Average			
High Social Approach Rank	2	1	3

Category	Alternative 1	Alternative 2	Alternative 3
High Environmental Approach Overall Average			
High Environmental Approach Rank	3	1	2
High Technical Approach Overall Average			
High Technical Approach Rank	3	1	2

6.2 Wastewater Treatment

6.2.1 Influent Pumping

The evaluation criteria methodology summarized in Section 4 was used to assess the shortlisted alternatives for the influent pumping process. A summary of the alternative scoring is included in Table 6-5 and overall weighted scores and rankings are presented in Table 6-6 for the various weighting approaches. Detailed scoring rationales are included in Appendix A.

Except for the economic criteria, Alternative 1 scored low under all evaluation criteria compared to other alternatives. Leaving the pump station without a capacity increase would result in a high risk of overloading the sewer system, resulting in potential basement and surface flooding. Flooding would be associated with wildlife impacts, groundwater contamination and potential climate change due to greenhouse gasses (GHG) emissions. Potential flooding events would negatively impact society due to the risk of increasing odour and traffic issues. Also, Alternative 1 would pose a risk to occupational health and safety due to odour and contamination issues.

Alternative 2 scored higher than Alternative 1 and lower than Alternative 3 overall. Although Alternative 2 reduces the risk of surface flooding and minimizes the negative impacts on the environment and society compared to Alternative 1, it requires a very large storage tank. Given the limited space within the facility, the Region will need to purchase land in the rural area north of the existing administration building, resulting in an impact on agricultural land. This alternative would be associated with a potential impact on the surrounding wildlife and species due to locating the open equalization basin in the rural area. This alternative would require the shutdown of the entire facility during pump and discharge piping replacement, resulting in significant interruption to the existing facility operation.

Alternative 3 scored the highest. Similar to Alternative 2, this alternative reduces the risk of surface flooding in the collection system and its associated impacts on the environment and society. As mentioned for Alternative 2, Alternative 3 will require a very large storage tank. Unlike Alternative 2, this alternative would be associated with minimal construction risks. The facility can remain in operation during the construction of the new pump station. Alternative 3 is expected to have a slightly high capital cost relative to Alternative 1 and Alternative 2 but a relatively lower operations and maintenance cost. Therefore, Alternative 3 is recommended for influent pumping upgrade.

Table 6-5. Alternatives Scoring for Influent Pumping

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Replace Existing Pumps/Equalization Tank	Alternative 3: New Pump Station/Equalization Tank
Environmental	Protects environmental features			
	Protects wildlife and species at risk			
	Protects groundwater, streams and rivers			
	Minimizes climate change impacts			
Social	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.			
	Minimizes impacts to businesses			
	Manages and minimizes construction impacts			
	Conserves built heritage and/or cultural heritage landscapes			
	Conserves archaeological resources complexity			
	Protects health and safety			
Technical	Provides reliable service			
	Meets existing and future needs			

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Replace Existing Pumps/Equalization Tank	Alternative 3: New Pump Station/Equalization Tank
	Aligns with existing and planned infrastructure			
	Aligns with existing and future land use			
	Aligns with approval and permitting process			
	Manages and minimizes construction risks			
	Ability to adapt to climate change			
Financial	Requires low lifecycle costs			

Table 6-6. Influent Pumping Alternatives Evaluation Scores per the Five Weighting Approaches

Category	Alternative 1	Alternative 2	Alternative 3
Environmental Criteria Category			
Social Criteria Category			
Technical Criteria Category			
Financial Criteria Category			
Even Weighting Approach Overall Average			
Even Weighting Approach Rank	3	2	1
Exclude Cost Approach Overall Average			
Exclude Cost Approach Rank	3	2	1

Category	Alternative 1	Alternative 2	Alternative 3
High Social Approach Overall Average			
High Social Approach Rank	3	2	1
High Environmental Approach Overall Average			
High Environmental Approach Rank	3	2	1
High Technical Approach Overall Average			
High Technical Approach Rank	3	2	1

6.2.2 Headworks

The evaluation criteria methodology summarized in Section 4 was used to assess the shortlisted alternatives for the screening process. A summary of the alternative scoring is presented in Table 6-7 and overall weighted scores and rankings are presented in Table 6-8 for the various weighting approaches. Detailed scoring rationales is included in Appendix A.

Alternative 1 scored low under all evaluation criteria compared to other alternatives. The increase in the required screening process capacity without screening expansion would result in deterioration in downstream processes performance, resulting in lower final effluent quality and potential risks for wildlife habitat and exceeding ECA limits associated with receiving water quality deterioration. Also, Alternative 1 would be associated with an increase in GHG emissions due to equipment aging and deterioration in secondary treatment performance. The increase in GHG emissions would negatively impact operator health and safety due to a greater risk of temperature increase and air pollution.

Alternative 2 scored higher than Alternative 1 and Alternative 3 overall. Alternative 2 scored high for environmental criteria due to the minimal impacts on environmental features and climate change. Compared to Alternative 3, this alternative scored lower in the technical criterion mainly due to the interruption to the existing processes operation during construction stage. Economically, this alternative scored higher compared to Alternative 3.

Alternative 3 scored lower than Alternative 2 due to the higher lifecycle cost. Other than the economic criterion, this alternative scored either higher or comparable to Alternative 2.

Overall, Alternative 2 is recommended for the screening facility upgrade.

Table 6-7. Alternatives Scoring for Headworks

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Existing Screen Replacement	Alternative 3: New Headworks Facility
Environmental	Protects environmental features			
	Protects wildlife and species at risk			
	Protects groundwater, streams and rivers			
	Minimizes climate change impacts			
Social	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.			
	Minimizes impacts to businesses			
	Manages and minimizes construction impacts			
	Conserves built heritage and/or cultural heritage landscapes			
	Conserves archaeological resources complexity			
	Protects health and safety			
Technical	Provides reliable service			
	Meets existing and future needs			
	Aligns with existing and planned infrastructure			

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Existing Screen Replacement	Alternative 3: New Headworks Facility
	Aligns with existing and future land use			
	Aligns with approval and permitting process			
	Manages and minimizes construction risks			
	Ability to adapt to climate change			
Financial	Provides low lifecycle costs			

Table 6-8. Headworks Alternatives Evaluation Scores per the Five Weighting Approaches

Category	Alternative 1	Alternative 2	Alternative 3
Environmental Criteria Category			
Social Criteria Category			
Technical Criteria Category			
Financial Criteria Category			
Even Weighting Approach Overall Average			
Even Weighting Approach Rank	3	1	2
Exclude Cost Approach Overall Average			
Exclude Cost Approach Rank	3	2	1
High Social Approach Overall Average			

Category	Alternative 1	Alternative 2	Alternative 3
High Social Approach Rank	3	1	2
High Environmental Approach Overall Average			
High Environmental Approach Rank	3	1	2
High Technical Approach Overall Average			
High Technical Approach Rank	3	1	2

6.2.3 Secondary Treatment

Secondary treatment needs are impacted by peak flows. As described in Section 6.2.1, the preferred Influent Pumping alternative is Alternative 3: Construct a new pump station/equalization tank. The equalization tank would be part of the plant's wet weather management strategy and provide storage for flows in excess of the future peak hourly flow capacity considering a peaking factor of 4.0 (i.e., flows in excess of 5,370 m³/d) during wet weather events. The size of the equalization tank can be optimized and may be paired with wet weather management technology to handle excess flow, which will be confirmed as part of a Schedule C Class EA. Therefore, it is recommended that Alternative 4: Implement wet weather management technology be eliminated from further analysis under Secondary Treatment but be evaluated as part of an overall wet weather management strategy in conjunction with the equalization tank as part of a Schedule C Class EA.

After removing Alternative 4, the short-listed alternatives to address the needs for secondary treatment include:

- Alternative 1: Do Nothing
- Alternative 2: New Secondary Treatment Plant Construction
- Alternative 3: Implement an alternative process intensification technology into Plants 1 and 2 (Densification with AGS or MABR)

The key impact to secondary treatment concepts from implementing an upstream wet weather management strategy is for peak flows. Peak flows in excess of 5,370 m³/d will be managed through a separate stream, so the secondary treatment alternatives were developed based on treating an AADF of 1,345 m³/d and a PIF/PHF of 5,370 m³/d.

The evaluation criteria methodology summarized in Section 4 was used to assess the shortlisted alternatives for the secondary treatment process. A summary of the alternative scoring is presented in Table 6-9 and overall weighted scores and rankings are presented in Table 6-10 for the various weighting approaches. Detailed scoring rationales are presented in Appendix A.

Alternative 1: Do Nothing was carried forward for comparison purposes and generally received low scores compared to the other alternatives. This alternative would not meet the projected capacity needs and would have significant environmental, social and technical impacts.

Alternative 2: New Secondary Treatment Plant Construction received the highest scores in the social and technical criteria. The main disadvantage of this alternative is the large footprint relative to the other alternatives, increasing lifecycle cost. Therefore, it scored the lowest in the financial category. Excluding the financial category, Alternative 2 scored higher than the other alternatives.

Alternative 3: Existing Secondary Treatment Intensification, scored the highest overall but similarly to Alternative 2. Alternative 3 has the lowest lifecycle cost compared to other alternatives. However, excluding the financial category, this alternative scored lower compared to Alternative 1 and Alternative 2 due to the uncertainties associated with the reliability of this alternative. Incorporating emerging technology such as intensification with AGS or MABR would require additional process modelling and/or piloting to confirm capacity increase prior to obtaining approvals and permitting.

Therefore, a multi-step approach is recommended for secondary treatment with further evaluation as part of a Schedule C Class EA:

1. Complete additional process modelling and evaluation to confirm if process intensification is feasible to increase secondary treatment capacity at the Wellesley WWTP. The Region has successfully implemented MABR for process intensification at the Elmira WWTP and Hespeler WWTP to date. If process intensification is confirmed as a feasible strategy, proceed with implementation within the necessary timeframe.
2. If process intensification is confirmed as not feasible through the evaluation completed within the Schedule C Class EA, proceed with a secondary treatment expansion. A secondary treatment expansion was carried forward for costing and potential impacts in Section 7 (Preliminary Recommended Alternatives) as a conservative approach.

Both alternatives will be carried forward as potential preferred solutions as part of this Master Plan. Alternative 2: Secondary Treatment Expansion will be used for costing purposes, as it is the most conservative concept from a cost perspective.

Table 6-9. Alternatives Scoring for Secondary Treatment

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: New Secondary Treatment Plant Construction	Alternative 3: Existing Secondary Treatment Intensification
Environmental	Protects environmental features			
	Protects wildlife and species at risk			
	Protects groundwater, streams and rivers			

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Category	Criteria	Alternative 1: Do Nothing	Alternative 2: New Secondary Treatment Plant Construction	Alternative 3: Existing Secondary Treatment Intensification
	Minimizes climate change impacts			
Social	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.			
	Minimizes impacts to businesses			
	Manages and minimizes construction impacts			
	Conserves built heritage and/or cultural heritage landscapes			
	Conserves archaeological resources complexity			
	Protects health and safety			
Technical	Provides reliable service			
	Meets existing and future needs			
	Aligns with existing and planned infrastructure			
	Aligns with existing and future land use			
	Aligns with approval and permitting process			

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: New Secondary Treatment Plant Construction	Alternative 3: Existing Secondary Treatment Intensification
	Manages and minimizes construction risks			
	Ability to adapt to climate change			
Financial	Provides low lifecycle costs			

Table 6-10. Secondary Treatment Alternatives Evaluation Scores per the Five Weighting Approaches

Category	Alternative 1	Alternative 2	Alternative 3
Environmental Criteria Category			
Social Criteria Category			
Technical Criteria Category			
Financial Criteria Category			
Even Weighting Approach Overall Average			
Even Weighting Approach Rank	3	1/2	1/2
Exclude Cost Approach Overall Average			
Exclude Cost Approach Rank	3	1	2
High Social Approach Overall Average			
High Social Approach Rank	3	2	1
High Environmental Approach Overall Average			

Category	Alternative 1	Alternative 2	Alternative 3
High Environmental Approach Rank	3	2	1
High Technical Approach Overall Average			
High Technical Approach Rank	3	1/2	1/2

6.2.4 Sludge Storage

The evaluation criteria methodology summarized in Section 4 was used to assess the shortlisted alternatives for sludge storage. A summary of the alternative scoring is presented in and overall weighted scores and rankings are presented in Table 6-12 for the various weighting approaches. Detailed scoring rationales are included in Appendix A.

Alternative 1 generally received low scores compared to the other alternatives. It was eliminated in the long-list screening in TM4 but carried forward only for comparison purposes. This alternative would not meet the projected capacity needs and would cause negative environmental, social and technical impacts.

Alternative 2 scored higher than Alternative 1 and lower than Alternative 3 overall. However, it scored slightly higher compared to Alternative 3 in the environmental and social categories, given that the existing storage tank would be completely demolished and all existing equipment would be replaced, resulting in lower odour, GHG emissions and health and safety issues. Technically, this alternative would be associated with some reliability concerns if the tank or pumps are offline for maintenance. No redundancy is provided by this alternative. Economically, this alternative would require higher lifecycle cost compared to Alternative 3.

Alternative 3 outperformed the other alternatives overall. It scored slightly lower compared to Alternative 2 in the environmental and social categories due to potential higher odour risks and GHG emissions associated with existing tank equipment aging with anticipated cracks and leaks. Technically, this alternative would be considered the most reliable alternative since it would provide 50 percent redundancy if one tank is taken offline for maintenance. Economically, Alternative 3 would require higher operation and maintenance costs due to additional equipment associated with building a second storage tank. However, the capital cost would be lower for Alternative 3, given the smaller footprint required for the new construction scope compared to Alternative 2, resulting in lower lifecycle costs.

Given all the benefits provided by Alternative 3, Alternative 3 is recommended for the Wellesley WWTP.

Table 6-11. Alternatives Scoring for Sludge Storage

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Replace Existing Storage Tank with a New Larger Storage Tank	Alternative 3: Construct a Second Storage Tank
Environmental	Protects environmental features			
	Protects wildlife and species at risk			
	Protects groundwater, streams and rivers			
	Minimizes climate change impacts			
Social	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.			
	Minimizes impacts to businesses			
	Manages and minimizes construction impacts			
	Conserves built heritage and/or cultural heritage landscapes			
	Conserves archaeological resources complexity			
	Protects health and safety			
Technical	Provides reliable service			
	Meets existing and future needs			

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Replace Existing Storage Tank with a New Larger Storage Tank	Alternative 3: Construct a Second Storage Tank
	Aligns with existing and planned infrastructure			
	Aligns with existing and future land use			
	Aligns with approval and permitting process			
	Manages and minimizes construction risks			
	Ability to adapt to climate change			
Financial	Provides low lifecycle costs			

Table 6-12. Sludge Storage Alternatives Evaluation Scores per the Five Weighting Approaches

Category	Alternative 1	Alternative 2	Alternative 3
Environmental Criteria Category			
Social Criteria Category			
Technical Criteria Category			
Financial Criteria Category			
Even Weighting Approach Overall Average			
Even Weighting Approach Rank	3	2	1
Exclude Cost Approach Overall Average			

Category	Alternative 1	Alternative 2	Alternative 3
Exclude Cost Approach Rank	3	1	2
High Social Approach Overall Average			
High Social Approach Rank	3	2	1
High Environmental Approach Overall Average			
High Environmental Approach Rank	3	2	1
High Technical Approach Overall Average			
High Technical Approach Rank	3	2	1

6.2.5 Tertiary Filtration

The evaluation criteria methodology summarized in Section 4 was used to assess the shortlisted alternatives for the tertiary filtration process. A summary of the alternative scoring is presented in and overall weighted scores and rankings are presented in Table 6-13 for the various weighting approaches. Detailed scoring rationales are presented in Appendix A.

Alternative 1 generally scored poorly compared to Alternative 2 except for the economic category. This alternative would meet the projected capacity needs when all existing filters are in operation. However, when one filter is out of service for maintenance, it will not meet the projected future growth needs for 2051.

Alternative 2 scored higher compared to Alternative 1 overall. It received higher scores than Alternative 1 in environmental, social and technical categories. The high score is attributed to the benefits offered by this alternative, including service reliability and potentially lower odour and GHG. Economically, Alternative 2 would require higher lifecycle costs given the required new building extension, even though Alternative 1 would require higher operation and maintenance costs due to more frequent maintenance and repairs.

Given all the environmental, social and technical benefits provided by Alternative 2, Alternative 2 was selected as the preferred solution for tertiary filtration at the Wellesley WWTP.

Table 6-13. Alternatives Scoring for Tertiary Filtration

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Existing Tertiary Filtration Expansion
Environmental	Protects environmental features		

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Existing Tertiary Filtration Expansion
	Protects wildlife and species at risk		
	Protects groundwater, streams and rivers		
	Minimizes climate change impacts		
Social	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.		
	Minimizes impacts to businesses		
	Manages and minimizes construction impacts		
	Conserves built heritage and/or cultural heritage landscapes		
	Conserves archaeological resources complexity		
	Protects health and safety		
Technical	Provides reliable service		
	Meets existing and future needs		
	Aligns with existing and planned infrastructure		

Category	Criteria	Alternative 1: Do Nothing	Alternative 2: Existing Tertiary Filtration Expansion
	Aligns with existing and future land use		
	Aligns with approval and permitting process		
	Manages and minimizes construction risks		
	Ability to adapt to climate change		
Financial	Provides low lifecycle costs		

Table 6-14. Tertiary Filtration Alternatives Evaluation Scores per the Five Weighting Approaches

Category	Alternative 1	Alternative 2
Environmental Criteria Category		
Social Criteria Category		
Technical Criteria Category		
Financial Criteria Category		
Even Weighting Approach Overall Average		
Even Weighting Approach Rank	2	1
Exclude Cost Approach Overall Average		
Exclude Cost Approach Rank	2	1
High Social Approach Overall Average		

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Category	Alternative 1	Alternative 2
High Social Approach Rank	2	1
High Environmental Approach Overall Average		
High Environmental Approach Rank	2	1
High Technical Approach Overall Average		
High Technical Approach Rank	2	1

7. Preliminary Recommended Alternatives

7.1 Drinking Water System

7.1.1 Well Capacity

The preferred alternative to meeting future well capacity needs consists of two similarly ranked preferred alternatives:

1. Increase Existing Well Supply; or
2. Supplement Existing with New Well Supply (Outside Urban Boundary)

The first alternative involves hydrogeological exploration of the opportunity to increase water taking from the existing wells. The second alternative involves hydrogeological exploration to determine the preferred site for a new well, and constructing a new well at the new site located outside the urban boundary near the south-east end of the Village. A new watermain would be constructed to convey flow from the new well to the existing Wellesley WTP.

The above solutions would provide a minimum additional capacity of 196 m³/d to meet future needs. The engineering and capital scope to select and implement the final alternative includes the following steps:

- Hydrogeological study to confirm the water taking capacity for the existing wells.
- If the hydrogeological study confirms the ability to provide the additional and sufficient raw water, the additional approvals and permitting from the MECP would be completed.
- In case that the hydrogeological study confirms that the existing wells would not be able to provide additional and sufficient raw water, construction of one new well supply is required and initiated by performing a Class EA study for the new well site.
- Hydrogeological study to identify a new well supply.
- Construction of a new well and well house, including submersible pump, process piping, instrumentation & controls, electrical, programming, HVAC and plumbing for the new well and well house.
- Installation of 50 mm diameter watermain to connect the new well to the existing Wellesley WTP.

For the second alternative, the only capital scope at the Wellesley WTP would be connection of the supplemental well to the existing plant facilities. The three existing well pumps currently have a capacity of 4,510 m³/d each which is sufficient for the future well supply needs. Further, the WTP treatment capacity is not expected to be exceeded throughout the planning horizon.

Potential impacts and mitigation measures for increasing Existing Well Supply include the following:

- Natural Environment
 - Uncertainty regarding impacts to groundwater quantity and quality from the proposed increased water taking rate. An updated hydrogeological study will first need to be conducted to confirm that the water taking capacity for the existing wells could be increased to 1,699 m³/d. Impacts and mitigation measures to protect groundwater quantity and quality would be determined through this study.
- Social, Cultural, and Economic Environments

There are minimal impacts to the social, cultural, and economic environments as this alternative would avoid construction and make use of existing infrastructure, minimizing costs and impacts to the surrounding community. However, note that increasing the existing well taking may lead to elevated strontium and fluoride concentrations, which remains to be determined as a part of the hydrogeological study.

Potential impacts and mitigation measures for a new supplement well supply include the following:

- **Natural Environment**
 - An Environmental Impact Study (EIS), species at risk assessment, and arborist surveys (if required) will be completed to support the detailed design stage, and measures will be identified and implemented to protect species at risk and associated habitat during construction activities.
 - The project will be screened for species at risk occurrences to determine setback or restricted activity periods. Screening will be conducted by a consultant using data provided by the MECP and with MECP approval of the screening outcomes.
 - Vegetation removal, grading, and heavy equipment use will only occur within the project footprint where these areas have been previously demarcated and construction works is approved. Silt fencing will be erected, where appropriate.
 - A site-specific Erosion and Sediment Control Plan will be developed by a qualified person and updated as required.
 - Stockpiled material will be covered to prevent erosion and potential sedimentation into natural features. Staging access areas are planned to be located primarily within existing open and disturbed areas.
 - Access and movement of vehicles and equipment will be controlled to limit the introduction and spread of invasive species. Vehicles and equipment will be inspected prior to entering and leaving the construction site to verify the equipment is clean and free of invasive species. Equipment will be inspected and used only if in good working order by the contractor.
 - A designated and lined refuelling area with appropriate spill containment will be established a minimum of 30 m from any watercourse. A spill response team member (from the contractor's team) will be appointed as a point of contact in the case of an accident or spill to verify the proper and timely implementation of site response controls as required.
 - Absorbent materials and equipment required to control and clean up spills of deleterious substances will be available onsite.
 - If possible, tree and shrub removal, and vegetation clearing will be avoided from early April to late August, conforming to the general nesting period at the site, corresponding to the Migratory Birds Convention Act (MBCA) (Government of Canada, 2023).
- **Social, Cultural, and Economic Environments**
 - **Community Health and Safety:** Development and construction activities may increase the type and volume of traffic on surrounding roadways (e.g., construction vehicles and equipment) or introduce additional hazards to the environment (e.g., material spill). Vehicles and equipment used during construction will follow traffic laws and multi-passenger vehicles will be used, when possible, to reduce traffic associated with construction activities.
 - **Noise:** Construction noise will be temporary and short-term in nature. Construction activities will generally be carried out during the day where traffic and human activity are occurring.

- **Odour:** Odour is not expected to increase substantially during construction.
- **Infrastructure and Services:**
 - **Traffic:** During construction, a small increase in traffic to and from the project site is anticipated to transport crews and equipment. No increase in traffic is expected during normal operation.
 - **Utilities:** Additional utilities may be needed to support the operation of the new well house. In the event existing utilities are disrupted during construction activities, it is expected that this will be short-term in duration. Utility locates, consisting of subsurface utility engineering (SUE) during design and Ontario One-Call locates prior to construction, will be done to reduce the potential for service disruptions.
 - **Services:** All waste materials from construction will be disposed of off-site in accordance with applicable legislation and guidelines. Construction and operation of the well is not anticipated to increase demand on local or regional services (e.g., emergency or health care services).
- **Archaeological Resources:** The following general recommendations and mitigation measures are identified to protect cultural heritage resources:
 - Should previously undocumented archaeological resources be discovered, they are subject to Section 48(1) of the Ontario Heritage Act. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out an archaeological assessment, in compliance with Section 48(1) of the Ontario Heritage Act.
 - The Funeral, Burial and Cremation Services Act, 2002, S.O. 2002, c.33 requires that any person discovering human remains must cease all activities immediately and notify the police or coroner. If the coroner does not suspect foul play in the disposition of the remains, in accordance with Ontario Regulation 30/11 the coroner shall notify the Registrar, Ontario Ministry of Public and Business Service Delivery, which administers provisions of that Act related to burial sites. In situations where human remains are associated with archaeological resources, the Ministry of Citizenship and Multiculturalism should also be notified (at archaeology@ontario.ca) to ensure that the archaeological site is not subject to unlicensed alterations which would be a contravention of the Ontario Heritage Act.
 - Before a development project can proceed, an archaeological assessment of all lands that are part of the project is required where land has a known archaeological site or the potential to have archaeological sites (Ministry of Heritage, Sport, Tourism and Culture Industries, 2022).
 - Construction within a previously disturbed site reduces the potential to uncover archaeological resources during construction. However, ground disturbance (e.g., soil handling, grading) may uncover previously unidentified artifacts. Disturbing these resources in a controlled, scientific excavation is considered an acceptable, and in some cases, the only method to collect in situ information to add to the historic record. The removal of these resources is offset by the recovery of knowledge about the site when catalogued and preserved in compliance with provincial guidelines. In the event an artifact is encountered during construction, work should be suspended, and the Ministry of Tourism, Culture and Sport should be contacted. Construction and City personnel are not permitted to collect or disturb artifacts in accordance with the Ontario Heritage Act R.S.O. 1990 c 0.18.

The cost of Increasing Existing Well Supply is included in Table 7-1. There is no capital scope for this alternative. The main costs would be for the hydrogeological study (approximately \$400k) to confirm water taking capacity.

Capital costs for Supplement Existing with New Well Supply (Outside Urban Boundary) are summarized in Table 7-1.

Table 7-1. Estimated Costs for Preferred Well Capacity Alternative

Description	Total Cost
Well Installation	\$285,000
Submersible Pumps	\$57,000
Process Piping, Valves, & Fittings	\$56,000
Instrumentation and Control	\$150,000
Electrical	\$214,000
Programming	\$36,000
Well House Foundation	\$132,000
Well House	\$49,000
HVAC & Plumbing	\$10,000
Raw Water Pipe (200 mm)	\$1,033,000
Road Restoration	\$15,000
Subtotal	\$2,037,000
Legal & Permitting (5%)	\$102,000
Contractor Mobilization, Demobilization, Bond & Insurance (15%)	\$306,000
Contractor Overhead & Profit (10%)	\$204,000
Estimating Contingencies (50%)	\$1,019,000
Total	\$3,668,000
Hydrogeological Study for New Well Supply (10%)	\$367,000
Class EA (5%)	\$184,000
Engineering Design & Construction Services (20%)	\$734,000
Grand Total	\$5,320,000

A Schedule C Class EA would need to be undertaken for development of a new well site.

The proposed implementation schedule for the preferred well capacity alternative is presented in Figure 7-1. The maximum day demand (MDD) is projected to exceed the current capacity by 2034. Therefore, the new well taking capacity will need to be investigated, approved and on-line prior to 2034. The new well facility will need to be designed, construction, and on-line prior to 2034 as well. Initiating the project early is recommended to mitigate the risk that the hydrogeological study results do not support increasing the well taking capacity. In this case, the additional well supply would be met by the new well facility.

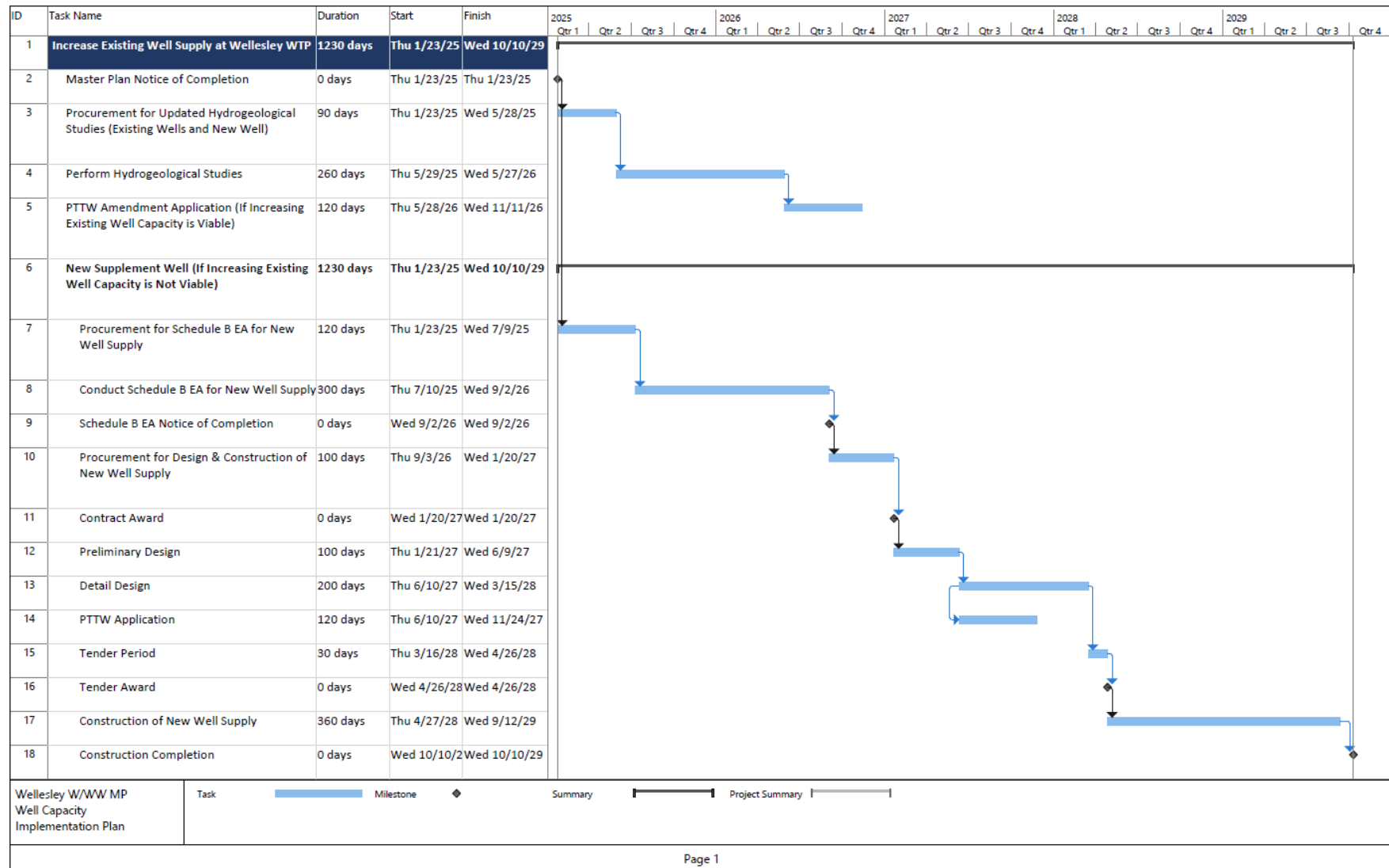
Anticipated approvals and permits required for this alternative include the following:

- PTTW Application Groundwater - Category 3

- An updated hydrogeological study would need to be undertaken to confirm that the water taking capacity for the existing wells could be increased to 1,699 m³/d. The study must be conducted by a qualified person which includes a licensed professional geoscientist or accepted professional engineer per the *Professional Geoscientists Act, 2000* of Ontario. The hydrogeological study would be used to support a PTTW amendment. A Category 3 application would be required as the change would increase the current capacity and be a long-term, regular occurrence (Province of Ontario, 2022). There is a risk that the findings from the study may not support increasing the water taking capacity or that the actual water taking capacity may be lower than the 1,503 m³/d limit in the current PTTW.
 - A separate hydrogeological study would be required for the new well supply located outside of the urban boundary. The study must be conducted by a qualified person which includes a licensed professional geoscientist or accepted professional engineer per the *Professional Geoscientists Act, 2000* of Ontario. The study would be required to support a new Category 3 PTTW application for the new well supply.
- Drinking Water Works Permit (DWWP) Amendment
 - Municipal Drinking Water License (MDWL) Amendment
 - Municipal Site Plan Approval
 - Municipal Building Permit
 - Permit from Grand River Conservation Authority (GRCA) for work in Regulated Areas

TM5: Preliminary Preferred Water and Wastewater Alternative

Figure 7-1. Implementation Schedule for Preferred Well Capacity Alternative



7.1.2 Future Disinfection, Water Pumping, and Storage

The preferred alternative is New Storage Off-site and includes the following:

- Maintain on-site storage reservoir with a useful volume of 902.3 m³. Existing reservoir to provide a dedicated CT volume of 145 m³ for primary disinfection needs and to offset the treated water storage requirements for fire, equalization, and emergency demand.
- Construct off-site floating storage in the form of an elevated tank, to provide the additional storage for fire, equalization, and emergency demand. A total treated water storage of 2,204 m³ will be provided for fire, equalization, and emergency demand, 758 m³ will be provided through the on-site reservoir after meeting primary disinfection needs and 1,447 m³ will be provided through the elevated tank.
- Maintain existing high lift pumps to provide firm pumping capacity of 47 L/s for domestic use.

The preferred location for the new elevated tank is the Bill Gies Recreation Centre lands in the west area of the Village, indicated by Location 1 in Figure 2-3. The required finished footprint is estimated to be around 60 m² at the pedestal for an elevated tank of 1,500 m³ and is to be refined further in Conceptual and Detail Design.

The construction scope for this alternative includes a new elevated tank as floating storage and connection to the existing watermain. Elevated tank scope of work includes:

- Water storage vessel – assumed to be a Composite Elevated Tank (CET)
- Concrete pedestal and foundation
- Piping (inlet, outlet, overflow, valves)
- Ladder from ground to roof access with fall arrest
- Siteworks and utility works (water/storm, sanitary)
- Electrical and HVAC
- Fencing, paving, landscaping

For the watermain connection, 1,000 m of 200 mm diameter watermain was assumed to be required from the water tower location to connect to the existing system, and buried at 5 to 6-foot depth.

Potential impacts and mitigation measures include, but are not limited, to the following:

- Natural Environment
 - An Environmental Impact Study (EIS), species at risk assessment, and arborist surveys (if required) will be completed to support the detailed design stage, and measures will be identified and implemented to protect species at risk and associated habitat during construction activities.
 - The project will be screened for species at risk occurrences to determine setback or restricted activity periods. Screening will be conducted by a consultant using data provided by the MECP and with MECP approval of the screening outcomes.
 - Vegetation removal, grading, and heavy equipment use will only occur within the project footprint where these areas have been previously demarcated and construction works is approved. Silt fencing will be erected, where appropriate.

- A site-specific Erosion and Sediment Control Plan will be developed by a qualified person and updated as required.
- Stockpiled material will be covered to prevent erosion and potential sedimentation into natural features. Staging access areas are planned to be located primarily within existing open and disturbed areas.
- Access and movement of vehicles and equipment will be controlled to limit the introduction and spread of invasive species. Vehicles and equipment will be inspected prior to entering and leaving the construction site to verify the equipment is clean and free of invasive species. Equipment will be inspected and used only if in good working order by the contractor.
- A designated and lined refuelling area with appropriate spill containment will be established a minimum of 30 m from any watercourse. A spill response team member (from the contractor's team) will be appointed as a point of contact in the case of an accident or spill to verify the proper and timely implementation of site response controls as required.
- Absorbent materials and equipment required to control and clean up spills of deleterious substances will be available onsite.
- If possible, tree and shrub removal, and vegetation clearing will be avoided from early April to late August, conforming to the general nesting period at the site, corresponding to the Migratory Birds Convention Act (MBCA) (Government of Canada, 2023).
- Social, Cultural, and Economic Environments
 - **Community Health and Safety:** Development and construction activities may increase the type and volume of traffic on surrounding roadways (e.g., construction vehicles and equipment) or introduce additional hazards to the environment (e.g., material spill). Vehicles and equipment used during construction will follow traffic laws and multi-passenger vehicles will be used, when possible, to reduce traffic associated with construction activities.
 - **Noise:** Construction noise will be temporary and short-term in nature. Construction activities will generally be carried out during the day where traffic and human activity are occurring.
 - **Odour:** Odour is not expected to increase substantially during construction.
 - **Infrastructure and Services:**
 - **Traffic:** During construction, a small increase in traffic to and from the project site is anticipated to transport crews and equipment. No increase in traffic is expected during normal operation.
 - **Utilities:** Additional utilities may be needed to support the operation of the new elevated tank. In the event existing utilities are disrupted during construction activities, it is expected that this will be short-term in duration. Utility locates, consisting of subsurface utility engineering (SUE) during design and Ontario One-Call locates prior to construction, will be done to reduce the potential for service disruptions.
 - **Services:** All waste materials from construction will be disposed of off-site in accordance with applicable legislation and guidelines. Construction and operation of the elevated tank is not anticipated to increase demand on local or regional services (e.g., emergency or health care services).
 - **Aesthetics:** The elevated tank is a permanent infrastructure change that will alter the community aesthetics and viewshed. These impacts were considered in detailed evaluation to select a location that minimizes impacts to current residents and businesses.

- **Archaeological Resources:** The following general recommendations and mitigation measures are identified to protect cultural heritage resources:
 - Should previously undocumented archaeological resources be discovered, they are subject to Section 48(1) of the Ontario Heritage Act. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out an archaeological assessment, in compliance with Section 48(1) of the Ontario Heritage Act.
 - The Funeral, Burial and Cremation Services Act, 2002, S.O. 2002, c.33 requires that any person discovering human remains must cease all activities immediately and notify the police or coroner. If the coroner does not suspect foul play in the disposition of the remains, in accordance with Ontario Regulation 30/11 the coroner shall notify the Registrar, Ontario Ministry of Public and Business Service Delivery, which administers provisions of that Act related to burial sites. In situations where human remains are associated with archaeological resources, the Ministry of Citizenship and Multiculturalism should also be notified (at archaeology@ontario.ca) to ensure that the archaeological site is not subject to unlicensed alterations which would be a contravention of the Ontario Heritage Act.
 - Before a development project can proceed, an archaeological assessment of all lands that are part of the project is required where land has a known archaeological site or the potential to have archaeological sites (Ministry of Heritage, Sport, Tourism and Culture Industries, 2022).
 - Construction within a previously disturbed site reduces the potential to uncover archaeological resources during construction. However, ground disturbance (e.g., soil handling, grading) may uncover previously unidentified artifacts. Disturbing these resources in a controlled, scientific excavation is considered an acceptable, and in some cases, the only method to collect in situ information to add to the historic record. The removal of these resources is offset by the recovery of knowledge about the site when catalogued and preserved in compliance with provincial guidelines. In the event an artifact is encountered during construction, work should be suspended, and the Ministry of Tourism, Culture and Sport should be contacted. Construction and City personnel are not permitted to collect or disturb artifacts in accordance with the Ontario Heritage Act R.S.O. 1990 c 0.18.
- **Technical Environment**
 - A chlorine demand or decay test is recommended during design to confirm the current system water age and determine if chlorine boosting could be required at the elevated tank. Preliminary hydraulic modelling suggests that water age may be an issue. Operating an ET with useful volume of 1,500 m³ between 30 and 95 percent with respect to water level was estimated to require approximately 106 hours to complete a full tank emptying and filling cycle. At this rate, it is likely that chlorine boosting would be required at the ET facility. Chlorine boosting was not included in the capital costs at this stage.
 - The WTP has a single discharge pipe with no redundancy. Therefore, there is no flexibility to allow this line to be taken offline for maintenance. Constructing the elevated tank, will provide buffer capacity should the discharge pipe need to be taken offline. The elevated tank will also provide more flexibility in pump control and pressure management which makes it easier to operate the high lift pumping system compared to a closed zone. The Region should also consider constructing a discharge pipe bypass line to provide redundancy should the main discharge line need to be taken offline for maintenance. This constraint is a design level issue and is recommended to be addressed in the design phase.

Capital costs are summarized in Table 7-2.

Table 7-2. Estimated Costs for Preferred Alternative: New Storage Off-Site

Description	Total Cost
Elevated Tank	\$5,890,000
Raw Water Pipe (200 mm)	\$1,350,000
Road Restoration	\$75,000
Subtotal	\$7,315,000
Contractor Mobilization, Demobilization, Bond & Insurance (15% of subtotal)	\$1,098,000
Contractor Overhead & Profit (10% of subtotal)	\$732,000
Design Development Contingency (30% of subtotal)	\$2,195,000
Design and Engineering Fees (20% of subtotal)	\$1,463,000
Total	\$12,803,000

The proposed implementation schedule for the preferred well capacity alternative is presented in Figure 7-2. The main driver for this project is the anticipated future regulatory requirements for primary disinfection. Providing additional storage for fire demand is a secondary driver as these flows can be met by the fire department's own supply. Construction of the elevated tank will allow for de-coupling fire demand from the on-site storage reservoir such that the reservoir can be dedicated for primary disinfection. There is no specific deadline for when the project should be constructed, however it is recommended to initiate the project early in preparation for any regulatory changes.

There are identified constraints within the distribution system related to fire flows but it is understood that, within the planning horizon, any additional fire flow needed beyond the distribution system capacity limits can be provided through the fire department's own supply and delivered via tanker trucks, consistent with the current practice. However, when the anticipated future development within Wellesley is undertaken, there may be additional requirements for improvements to the water distribution system that would provide additional value in regard to servicing.

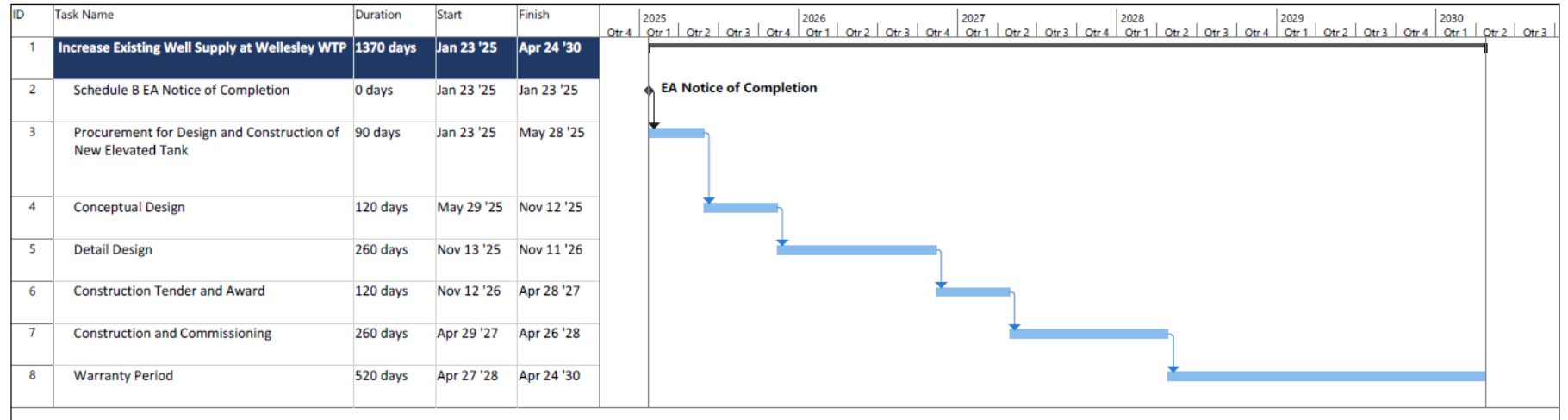
The following watermain upgrades are recommended, based on modelling results carried out under the WWWMP, to be further investigated for implementation as additional planning information is made available to the Region in regard to the anticipated future development:

- **Residential Fire Flow Needs.** The needs for residential fire flow were identified where FFA is less than 75 L/s. These correspond to watermain dead-ends ranging in size from 50 mm to 100 mm in diameter (Pond View Drive dead-end and Village Place). These dead-end watermains should be upgraded to a size of 150 mm in diameter. By doing so, the FFA increases to 110 L/s, according to the modelling results.
- **ICI Fire Flow Needs.** The needs for ICI fire flow were identified where FFA is less than 175 L/s. It is recommended that the 200 mm diameter watermain on Queen's Bush Road from David Street (approximately 510 m in length) be upgraded to 250 mm diameter for better efficiency and service for the proposed water tower near the Bill Gies Recreation Centre located at Queen's Bush Road and Hutchison Road. The proposed water tower provides enough FFA to meet the requirements for the Bill Gies Recreation Centre due to its close proximity. However, to meet the fire flow required for the other ICI locations evaluated, upgrading the 200 mm diameter

watermain on Queen's Bush Road from Nafziger Road to the Bill Gies Recreation Centre (approximately 900 m in length) to 300 mm diameter is required.

- Based on the additional planning information that is made available to the Region in regard to the anticipated future development, other watermain upgrades that may provide additional distribution needs should also be further investigated for implementation through additional hydraulic modelling.

Figure 7-2. Implementation Schedule for Preferred Alternative: New Storage Off-Site



The following approvals and permits are anticipated to be required for the new elevated tank:

- Drinking Water Works Permit (DWWP) Amendment
- Municipal Drinking Water License (MDWL) Amendment
- Municipal Site Plan Approval
- Municipal Building Permit
- Construction Permit from Grand River Conservation Authority (GRCA)

7.2 Wastewater System

7.2.1 Wastewater Collections

7.2.1.1 Group A - Firella Creek Trunk Sewer

The preferred alternative is to increase the capacity of the Firella Creek Trunk Sewer. The trunk sewer would need to be replaced with a 750mm diameter sewer. It is anticipated that the trunk sewer route would follow the existing easement along Firella Creek. These diameters are to be validated and refined through additional flow monitoring and future design stages as described in Section 3.1. The infrastructure required is as follows:

- 972m of 750 mm diameter sanitary sewer (to be refined through subsequent design stages and model validation)
- 14 1500mm diameter maintenance holes (Nine manholes are required based on spacing of a maintenance hole every 120m for pipes in the range of 750mm per the Design Guidelines and Supplemental Specifications for Municipal Services Guidelines (Region of Waterloo et. al, 2022). However, 14 maintenance holes are included to accommodate trunk sewer bends.

The trunk replacement also requires tie-ins to the local sanitary sewers. There is an opportunity during project implementation to correct the approximately 90 degree angle of connection between the local sewer on Gerber Street and the Firella Creek Trunk Sewer. However, further investigation would be required to determine feasibility and need.

Potential impacts and mitigation measures in the following:

- Natural Environment
 - The potential impacts and mitigation measures included in Section 7.1.2.
 - Since the construction works are anticipated to be alongside Firella Creek and include one creek crossing, consultation with GRCA and DFO will be required.
- Social, Cultural, and Economic Environments
 - **Community Health and Safety:** Development and construction activities may increase the type and volume of traffic on surrounding roadways (e.g., construction vehicles and equipment) or introduce additional hazards to the environment (e.g., material spill). Vehicles and equipment used during construction will follow traffic laws and multi-passenger vehicles will be used, when possible, to reduce traffic associated with construction activities.
 - **Noise:** Construction noise will be temporary and short-term in nature. Construction activities will generally be carried out during the day where traffic and human activity are occurring. Bypass pumping

during construction may increase noise levels during the construction period. There is no anticipated increase in noise following project implementation.

- **Odour:** Odour is not expected to increase substantially during construction.
- **Infrastructure and Services:**
 - **Traffic:** During construction, a small increase in traffic to and from the project site is anticipated to transport crews and equipment. No increase in traffic is expected during normal operation.
 - **Utilities:** It is expected that any utilities disruption during construction are disrupted during construction activities, it is expected that this will be short-term in duration. Utility locates, consisting of subsurface utility engineering (SUE) during design and Ontario One-Call locates prior to construction, will be done to reduce the potential for service disruptions.
 - **Services:** All waste materials from construction will be disposed of off-site in accordance with applicable legislation and guidelines. Construction and operation of the elevated tank is not anticipated to increase demand on local or regional services (e.g., emergency or health care services).
- **Aesthetics:** The trunk sewer will be underground and will not impact aesthetics. The number of manholes are anticipated to be similar to existing conditions.
- **Cultural Heritage:** The general recommendations and mitigation measures identified in Section 7.1.2 to protect built heritage resources and cultural heritage landscapes also apply to the Firella Creek Trunk Sewer Capacity Upgrades.
- **Technical Environment**
 - Bypass pumping will be required during construction.
 - Previous CCTV investigations have revealed grease build-up along the trunk sewer (GM BluePlan, 2018). Consideration should be given to reduce the likelihood of grease build-up during subsequent design stages.
 - A 2024 project completed by the Region included raising five manhole lids along Firella Creek Trunk Sewer. It was identified that eight additional manholes remain below the floodplain elevation.
 - During subsequent design stages, refinement of the recommended trunk sewer diameter should consider a sensitivity analysis on the contributing area of future parcels. Currently, the plum zone area within the study area bounds is included in the modelled contributing area. Contributing area directly impacts modelled wet weather flow generation.
 - It is recommended that the hydraulic model be validated against the larger design storm to confirm the recommended trunk sewer diameter sizing if there is an opportunity to capture a larger storm through additional flow monitoring.

Capital costs are summarized in Table 7-3.

Table 7-3. Estimated Costs for Preferred Alternative: Upsizing Firella Creek Trunk Sewer

Description	Total Cost ^{a, b}
Pipe	\$2,721,000
Manhole	\$374,000
Road Restoration	\$3,000

Description	Total Cost ^{a, b}
Subtotal	\$3,098,000
Contractor Mobilization, Demobilization, Bond & Insurance (15% of subtotal)	\$465,000
Contractor Overhead & Profit (10% of subtotal)	\$310,000
Design Development Contingency (30% of subtotal)	\$929,000
Design and Engineering Fees (20% of subtotal)	\$620,000
Total	\$5,421,000

Notes:

^a Costs are excluding I/I mitigation studies and works

^b Capital costs presented are at a planning level of detail with a confidence of +50%/-30%

The Firella Creek Trunk Sewer is constrained under existing wet weather flow conditions, and it is recommended that this alternative is implemented in the near-term (within 5-years). During subsequent design stages, refinement of the recommended trunk sewer diameter should consider the impact of the contributing area of future development parcels through a sensitivity analysis. Additionally, if there is an opportunity it is recommended that the hydraulic model be validated against a larger design storm.

The following approvals and permits are anticipated to be required for the new trunk sewer:

- Consolidated Linear Infrastructure (CLI) ECA for sewage works amendment.
- Permit to Take Water. A Permit to Take Water from the MECP is required if it is necessary to take more than 50,000 litres of water in a day from the environment.
- Endangered Species Act (Environment Canada and Climate Change). The removal of bird nests or eggs from trees and nesting sites are regulated under the Fish and Wildlife Conservation Act.
- A permit for the Development Interference with Wetlands and Alteration to Watercourse and Shoreline Regulation (Ontario Regulation 150/06) will be required from the GRCA.
- Utility conflicts must be confirmed during preliminary design. Review and Approval must be received.
- A review letter from the Ministry of Citizenship and Multiculturalism (MCM) indicating that the archaeological assessment reports, recommending no further assessment, have been entered into the Ontario Public Register of Archaeological Reports is required before construction.
- Fish and Wildlife Conservation Act. A License to Collect Fish for Scientific Purposes from the Ministry of Natural Resources and Forestry (MNRF) is required if fish must be relocated to outside the work area is required. A Wildlife Collector's Authorization will be required if wildlife must be relocated to outside of the work area.
- Public Lands Act & Lakes and Rivers Improvements Act. The project may require land tenure under the Public Lands Act. Consultation with the Aurora MNRF is required during detailed design.

Consultation with Fisheries and Oceans Canada (DFO) is recommended. Consultation, coordination, and permits from the Township will also be required.

7.2.1.2 Group B – Local Sewer Constraints

There is substantial I/I within Wellesley's wastewater collection system based on flow monitoring and modelled results. The I/I reduction component of the Wastewater Collection System Group B -Local Sewer Constraints preferred alternative (Alternative 2) should be further explored prior to implementing the recommended infrastructure upgrades associated with Alternative 2. Reducing I/I could substantially decrease the number of recommended local sewer upgrades with the Study Area. After I/I implementation strategies are investigated and implemented, the wet weather flow and sewer constraints within Wellesley's wastewater collection system should be reassessed.

The new recreation centre was not developed at the time of the flow monitoring and model calibration but was in operation at the time of this implementation plan analysis. Therefore, the new recreation centre was considered as an existing development for the implementation plan. Modelled flows from the new recreation centre are based on DGSS design criteria and may differ in reality.

Assumed tie-in locations for future developments in the hydraulic model were based on the nearest manhole. These tie-in locations should be confirmed prior to preliminary design. Local sewer capacity results may differ if site plans reveal alternative tie-in locations.

Impacts and mitigation measures for pipe works required for I/I reduction or future pipe upsizing are anticipated to be similar to those described in Section 7.2.1.1, with additional considerations for temporary sanitary service interruptions during construction and road closures or reductions during construction. The permits and approvals required for local sewer works are expected to be the same permits and approvals described in section 7.2.1.1.

7.2.2 Wastewater Treatment

7.2.2.1 Influent Pumping

The recommended alternative is to construct a new influent pump station and equalization basin to provide a reliable solution to handle future growth and upgrades in the collection system. The existing pump station will need to be demolished, and a new station will need to be constructed. Sizing is subject to future conveyance system model refinements. Major upgrades for this include:

- New 5,900 m³ equalization basin to store flows that exceed the rated capacity of the Wellesley WWTP during wet weather events. The required footprint for the equalization basin is approximately 1,000 m² (25 m × 40 m) based on a 6 m side water depth. The footprint would be confirmed/refined during design. The Region would need to purchase some space beyond the facility setback line. The preliminary preferred location for the equalization basin would be north of the existing administration and control building beyond the existing setback line.
- New influent pump station, including a new 3-m wet well, three pumps and their associated piping and ancillary equipment. The new pump station will be tied into the existing infrastructure upstream of the screening process.

Potential impacts and mitigation measures include the following:

- Potential environmental and social impacts and mitigation measures are associated with the construction of the new equalization basin in a rural area outside the facility. Potential impacts to surrounding wildlife due to potential contamination and GHG emissions are anticipated since the basin will be an open tank. However, the storage of the peak sustained event would not last more than one day. Therefore, the impact would be minimal.

Existing infrastructure can handle flows up to Year 2032. The process will need to be expanded and commissioned before 2032. The capital cost for this alternative is summarized in Table 7-4.

Table 7-4. Estimated Costs for Preferred Alternative: New Pump Station and Equalization Basin

Description	Total Cost ^a
Influent Pump Station, including pumps and piping	\$4,250,000
Equalization Basin, including coarse bubble diffuser system and piping ^b	\$2,255,000
Subtotal	\$6,505,000
Contractor Mobilization, Demobilization, Bond & Insurance (15% of subtotal)	\$975,750
Contractor Overhead & Profit (10% of subtotal)	\$650,500
Contingency (30% of subtotal)	\$1,951,500
Design and Engineering Fees (20% of subtotal)	\$1,301,000
Total	\$11,383,750

Notes:

^a Capital costs are based on Class 4 Cost Estimate (confidence of +50%/-30%)

^b Not including land purchase cost

The following approvals and permits are anticipated to be required for the influent pumping:

- Since facility needs to be expanded beyond its current rated treatment capacity, a Schedule C Class Environmental Assessment (EA) will be required. The Schedule C EA involves preparation of an Environmental Study Report (ESR), including an evaluation of alternative design concepts and development of an implementation plan. Consultation with the public and regulatory agencies is required so that stakeholders are aware of the project and any concerns can be addressed in the ESR. Projects may only proceed with implementation once there are no outstanding concerns from those directly affected. A Receiving Water Quality Assessment (RWQA), in which the receiving water's waste assimilative capacity is evaluated based on the Provincial Water Quality Objectives (PWQO). The results of the RWQA will inform the specific effluent quality objectives and limits for the Wellesley WWTP after expansion.
- Environmental Compliance Approval (ECA) amendment will be required depending. The ECA amendment application needs to be submitted following the completion of the detailed design.
- Work permit from the Ministry of Natural Resources and Forestry may be required under the Public Lands Act.
- Other approval and permits required include approval from the local conservation authority, site plan approvals, demolition permits, building permits, utility permits, and approvals under the Electrical Safety Authority (ESA) and Technical Standards and Safety Act (TSSA).

7.2.2.2 Headworks

The recommended alternative is to replace the existing bar screen with a new screen that can handle future projected flows for Year 2051 to provide a reliable solution to handle future growth and align with future land use. The existing screen with the 52 L/s capacity would be replaced with a new screen that has a capacity of 63 L/s.

Potential impacts and mitigation measures include the following:

- Environmental and social impacts associated with the increase in energy consumption.
- Technical impacts and mitigation measures are associated with taking the bar screen offline during construction (if temporary screening is not provided during construction) or maintenance. Deterioration in secondary treatment performance is anticipated during construction, resulting in potential effluent quality impacts to Nith River.

Existing infrastructure can handle flows up to Year 2032. The process will need to be expanded and commissioned before 2032. The capital cost for this alternative is summarized in Table 7-5.

Table 7-5. Estimated Costs for Preferred Alternative: Replace Existing Bar Screen

Description	Total Cost ^a
Bar Screen	\$600,000
Subtotal	\$600,000
Contractor Mobilization, Demobilization, Bond & Insurance (15% of subtotal)	\$90,000
Contractor Overhead & Profit (10% of subtotal)	\$60,000
Contingency (30% of subtotal)	\$180,000
Design and Engineering Fees (20% of subtotal)	\$120,000
Total	\$1,050,000

Notes:

^a Capital costs are based on Class 4 Cost Estimate (confidence of +50%/-30%)

The permits and approvals included in Section 7.2.2.1 are expected to be the same permits and approvals required for the screening process expansion.

7.2.2.3 Secondary Treatment

The recommended alternative is to construct a new packaged secondary treatment plant west of existing Secondary Plant 1 or process intensification to provide secondary treatment capacity to future projected flows and loadings through 2051 (refer to Section 6.2.3 for future details). Secondary treatment expansion was carried forward for costing and potential impacts identification purposes as it is the more conservative approach compared to process intensification.

The new package secondary plant includes the following:

- 8 m x 4.5 m SWD aeration tank in the annular ring around a 5 m diameter sedimentation tank. The aeration tank consists of a 25/75 volume split between the anoxic and aeration zones and is equipped with one mixer in the anoxic zone and a fine bubble diffuser. Mixed liquor recycle (MLR) pump with a capacity of 750 m³/d to recycle ML to the anoxic zone.
- 5 m x 4.5 m SWD secondary clarifier, equipped with sludge, scum removal mechanisms.
- One air-lift pump to return activated sludge (RAS) to the aeration tank and one waste activated sludge (WAS) pump to pump a fraction of RAS to the sludge storage tanks.

Potential impacts and mitigation measures associated with this alternative include the following:

- Minimal environmental and social impacts associated with the increase in energy consumption due to population growth.

- This alternative takes advantage of the allocated footprint for the future Secondary Plant 3 and planned inlet piping. Future land use would be limited. For future expansion (beyond 1,345 m³/d AADF), Alternative 3 (process intensification) or 4 (WWFT), as evaluated in this study, would be potential solutions for restoring the reduction of the available footprint. For future expansion, piloting Alternative 3 is recommended to validate the maximum capacity gain with this alternative.

Existing infrastructure has capacity to treat projected flows through 2032. Major upgrades are recommended to be completed by 2032. The capital cost for this alternative is summarized in Table 7-6.

Table 7-6. Estimated Costs for Preferred Alternative: New Secondary Treatment Plant

Description	Total Cost ^a
Package Secondary Treatment Plant, including mixers, diffusers, clarifier mechanism and pumps	\$2,250,000
Subtotal	\$2,250,000
Contractor Mobilization, Demobilization, Bond & Insurance (15% of subtotal)	\$337,500
Contractor Overhead & Profit (10% of subtotal)	\$225,000
Contingency (30% of subtotal)	\$675,000
Design and Engineering Fees (20% of subtotal)	\$450,000
Total	\$3,937,500

Notes:

^a Capital costs are based on Class 4 Cost Estimate (confidence of +50%/-30%)

The permits and approvals included in Section 7.2.2.1 are expected to be the same permits and approvals required for the secondary treatment process expansion.

7.2.2.4 Sludge Storage

The recommended alternative is to construct a new sludge holding tank south of the existing sludge tank to allow the facility to handle sludge production associated with the Year 2051 loadings. Major upgrades for this alternative include:

- 6 m x 3.5 m x 4.5 m SWD storage tank equipped with a one jet aerator mixer and supernatant decanting pipe.
- Tie-in the discharge pipe to the existing gravity-fed piping for waste sludge hauling to Waterloo Wastewater Treatment Plant for digestion and further processing.

Potential impacts and mitigation measures associated with this alternative include the following:

- Minimal environmental and social impacts in terms of health and safety associated with managing the increase in sludge production and odour due to population growth. However, providing the storage tank with jet aerator will provide sufficient mixing to minimize odour.

Currently, the sludge is hauled once a week. The average historical storage time is approximately 5 days. With 5 days of storage time, the existing storage tank would provide a capacity of up to 580 m³/d (equivalent AADF capacity). The construction timeline for the new storage tank would best align with the secondary treatment upgrade timeline (Year 2032) to provide the required storage capacity for the generated sludge

from the two existing and new secondary treatment plants. Therefore, more frequent sludge hauling (2 to 3 days) would be required in the short-term. The capital cost for this alternative is summarized in Table 7-7.

Table 7-7. Estimated Costs for Preferred Alternative: New Sludge Holding Tank

Description	Total Cost ^a
Sludge Holding Tank, including jet aerator and piping	\$400,000
Subtotal	\$400,000
Contractor Mobilization, Demobilization, Bond & Insurance (15% of subtotal)	\$60,000
Contractor Overhead & Profit (10% of subtotal)	\$40,000
Contingency (30% of subtotal)	\$120,000
Design and Engineering Fees (20% of subtotal)	\$80,000
Total	\$700,000

Notes:

^a Capital costs are based on Class 4 Cost Estimate (confidence of +50%/-30%)

Except for Schedule C EA, the permits and approvals included in Section 7.2.2.1 are expected to be the same permits and approvals required for the sludge handling tank expansion.

7.2.2.5 Tertiary Filtration

A tertiary filtration expansion was selected as the preferred alternative to increase the facility service reliability and provide sufficient treatment capacity for future growth needs. Major upgrades for this alternative include:

- Extend the existing building south by 3 m x 5 m.
- Construct a new cloth media (3-disk model) with one backwash pump.
- Tie-in the new filter to the existing inlet and effluent pipe.
- Replace existing alum meeting pumps (3 duty/ one standby) with new pumps (each has a capacity of 21 L/s) to provide a firm capacity of 63 L/s.

Potential impacts and mitigation measures associated with this alternative include the following:

- Temporary interruption to the existing process operation while extending the existing building and connecting the new filter to the combined discharge pipe. The existing bypass pipe can be used to divert secondary effluent directly to UV system during construction. The risk can be mitigated by utilizing a temporary filtration system.

The existing tertiary filtration process has sufficient capacity to treat projected flows through 2036. Therefore major upgrades need to be completed by 2036. The capital cost for this alternative is summarized in Table 7-8.

Table 7-8. Estimated Costs for Preferred Alternative: Tertiary Filtration Building Expansion

Description	Total Cost ^a
Cloth Media Filtration Expansion, including building expansion, upgrading alum meeting pumps, one filter, backwash pump	\$1,150,000

Description	Total Cost ^a
Subtotal	\$1,150,000
Contractor Mobilization, Demobilization, Bond & Insurance (15% of subtotal)	\$172,500
Contractor Overhead & Profit (10% of subtotal)	\$115,000
Contingency (30% of subtotal)	\$345,000
Design and Engineering Fees (20% of subtotal)	\$230,000
Total	\$2,012,500

Notes:

^a Capital costs are based on Class 4 Cost Estimate (confidence of +50%/-30%)

The permits and approvals included in Section 7.2.2.1 are expected to be the same permits and approvals required for the secondary treatment process expansion.

8. Summary of Preliminary Recommended Alternatives

Table 8-1 summarizes the recommended water and wastewater system alternatives.

Table 8-1. Summary of Recommended Alternatives

System Type	Constraint Group	Preferred Alternative Description	Cost ^a	EA Schedule	Recommended Implementation Year ^b
Drinking Water	Well Capacity	Increase existing well supply or supplement existing with a new well (outside urban boundary)	\$5,320,000	Schedule C Class EA	Before 2034
Drinking Water	Future Disinfection, Water Pumping, and Storage	New storage off-site	\$12,803,000 & \$250k to \$400k for chlorine boosting (if needed)	Schedule B Class EA	Near-Term (within 5 years)
Drinking Water	Water Distribution	Watermain upgrades to provide additional fire flow servicing	TBD ^c	Exempt	TBD ^c
Wastewater Collections	Group A – Firella Creek Trunk Sewer	Increase capacity of Firella Creek Trunk Sewer	\$5,421,000	Exempt	Near-Term (within 5 years)
Wastewater Collections	Group B – Local Sewer Constraints	Investigate and implement I/I reduction strategies	TBD ^d	TBD ^d	2025
Wastewater Collections	Group B – Local Sewer Constraints	Reassess local sewer constraints	TBD ^d	Exempt	Near-Term (within 5 years)
Wastewater Treatment	Not Applicable	Assimilative Capacity Study	\$150,000	Not Applicable	2025

TM5: Preliminary Preferred Water and Wastewater Alternative

System Type	Constraint Group	Preferred Alternative Description	Cost ^a	EA Schedule	Recommended Implementation Year ^b
Wastewater Treatment	Influent Pumping	New pump station and equalization tank	\$11,383,750	Schedule C Class EA	Near-term (within 5 years) ^f
Wastewater Treatment	Headworks	Replace existing bar screen	\$1,050,000	Schedule C Class EA	2032
Wastewater Treatment	Secondary treatment	Construct new secondary treatment plant ^g	\$3,937,500	Schedule C Class EA	2032
Wastewater Treatment	Sludge Storage	Construct new storage tank	\$700,000	Exempt	2032
Wastewater Treatment	Tertiary Filtration	Expand existing filtration process	\$2,012,500	Schedule C Class EA	2036

Notes:

^a Land acquisition costs are not included in cost. Costs are in 2024 dollars.

^b Refer to individual sections for additional information and assumptions.

^c TBD = To be determined pending further investigation for implementation as additional planning information for anticipated future development is made available to the Region.

^d TBD = To be determined pending I/I investigation results

^e Assimilative capacity study to be completed prior to Wellesley WWTP Schedule C EA

^f The equalization tank is required in the near-term to manage peak flows from the collection system that are conveyed to the Wellesley WWTP. The preferred equalization tank concept (sizing, hydraulics, etc.) will be determined during the future Schedule C Class EA and design. A new influent pumping station will be constructed as part of this contract with the same peak rated capacity as the Wellesley WWTP, with provisions for expansion when the remainder of the WWTP is expanded and following a Schedule C Class EA. The pumping station may include separate wet weather pumps to convey flows to the equalization tank, however, these will not impact the overall rated capacity of the pumping station (i.e., the flow rate that can be pumped through the Wellesley WWTP). The construction of the equalization tank is a Schedule B activity, but is recommended to be incorporated into the Wellesley WWTP Schedule C Class EA.

^g Secondary treatment expansion was carried forward for costing as a conservative approach. A pilot study is recommended to first be completed to determine the feasibility of process intensification, however these secondary treatment recommendations will be confirmed during the subsequent Schedule C EA. Refer to Section 6.2.3 for further details.

As described in Section 3.1, the wastewater collection system, WWTP Influent PS, and equalization tank recommended sizes are subject to change as a result of I/I reduction strategies and the possibility that the collection system hydraulic model may be conservative. Additional flow monitoring and collection system model validation to a larger design storm is recommended. Additionally, a sensitivity analysis on the contributing areas for the future parcels should be considered in future design stages.

9. References

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Appendix A. Detailed Evaluation Matrices

Appendix A.1. Table A1-1: Well Capacity Alternatives Evaluation

ID#	Evaluation Criteria	Rationale				
		Do Nothing	Increase Existing Well Supply	Supplement Existing with New Well Supply (Inside Urban Boundary)	Supplement Existing with New Supply (Outside Urban Boundary)	Supplement Existing with External Supply
1.0	Environmental					
1.01	Protects environmental features	No change to current impact on environmental features.	No impact to environmental features expected as any significant environmental features are located outside of the study area.	No impact to environmental features expected as any significant environmental features are located outside of the study area.	No impact to environmental features expected as any significant environmental features are located outside of the study area.	Potential impacts to environmental features as watermain would need to extend outside the study area bounds to connect to the integrated urban system (IUS). Watermain to be routed along existing roads to minimize impacts. An impacts assessment would need to be completed along the proposed watermain route to confirm.
1.02	Protects wildlife and species at risk	No change to current impact on wildlife and wildlife habitat	No change to current impact on wildlife and wildlife habitat	No impacts to wildlife and wildlife habitat expected. Existing monitoring well to be developed into production well and connecting watermain to be constructed along existing roadways.	No impacts to wildlife and wildlife habitat expected. Existing monitoring well to be developed into production well and connecting watermain to be constructed along existing roadways.	Potential impacts to wildlife and habitats as watermain would need to extend outside the study area bounds to connect to the integrated urban system (IUS). Watermain to be routed along existing roads to minimize impacts. An impacts assessment would need to be completed along the proposed watermain route to confirm.
1.03	Protects groundwater, streams and rivers	No change to current groundwater quantity and quality, surface water quantity and quality, and fluvial geomorphic function.	No impacts expected to surface water quantity and quality and fluvial geomorphic function. Uncertainty regarding impact to groundwater quantity and quality from increasing the water taking rate.	No impacts expected to surface water quantity and quality and fluvial geomorphic function. Uncertainty regarding impact to groundwater quantity and quality from new well source.	No impacts expected to surface water quantity and quality and fluvial geomorphic function. Uncertainty regarding impact to groundwater quantity and quality from new well source.	Potential impacts to groundwater, surface water and fluvial geomorphic function as watermain would need to extend outside the study area bounds to connect to the integrated urban system (IUS). Watermain to be routed along existing roads to minimize impacts. An impacts assessment would need to be completed along the proposed watermain route to confirm. Potential stream crossings (up to 3 or 4).
1.04	Minimizes climate change impacts	No change to current climate change impacts.	No substantial change to current climate change impacts.	Additional energy requirements for new well facility (well pumps, etc.) impacts GHG emissions potential. Impacts expected to be relatively minor.	Additional energy requirements for new well facility (well pumps, etc.) impacts GHG emissions potential. Impacts expected to be relatively minor.	No long-term climate change impacts expected. Additional energy use for pumping impacts GHG emissions potential.
2.0	Social					
2.01	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.	Long-term impacts to residents if future water supply needs cannot be met. Possible disruption in service, inability to accept new connections.	No change to current impacts due to noise, odour, traffic, or aesthetics.	No long-term impacts due to noise, odour, traffic or aesthetics expected.	No long-term impacts due to noise, odour, traffic or aesthetics expected.	No long-term impacts due to noise, odour, traffic or aesthetics expected.

2.02	Minimizes impacts to businesses	Long-term business impacts if future water supply needs cannot be met. Insufficient service, will not be able to accept new business/ connections.	No change to current business impacts.	No long-term business impacts expected.	No long-term business impacts expected.	No long-term business impacts expected.
2.03	Manages and minimizes construction impacts	No construction required therefore no short-term disruptions expected.	No construction required therefore no short-term disruptions expected.	Short-term traffic impacts due to watermain construction. Short-term local impacts due to construction at the new well site (noise, traffic). Mitigation measures required during construction to minimize impacts. Watermain construction through downtown Village expected to cause more of a disturbance than Alternative 4 which will be primarily rural roads.	Short-term traffic impacts due to watermain construction. Short-term local impacts due to construction at the new well site (noise, traffic). Mitigation measures required during construction to minimize impacts. Watermain construction to location outside urban boundary to minimize impacts compared to Alternative 3A.	Short-term traffic and construction impacts due to watermain construction. Significant distance of roadway expected to be impacted (~17 km) but largely in rural area. Mitigation measures required during construction to minimize impacts.
2.04	Conserves built heritage and/or cultural heritage landscapes	Little to no impact on documented cultural heritage resources as no new areas are impacted.	Little to no impact on documented cultural heritage resources as no new areas are impacted.	Potential impacts due to development of new well source. Potential well sites are located within cultural heritage landscapes and near both known and potential built heritage resources. Impacts assessment of new site would be needed to confirm any potential impacts on cultural heritage resources.	Potential well sites located outside of urban boundary. Low potential for impacts to cultural heritage.	The watermain will be routed along roads that have previously been disturbed and outside of the downtown Village area. Low potential for impacts to cultural heritage.
2.05	Conserves archaeological resources complexity	Little to no impact on documented archaeologically significant features as no new areas are impacted.	Little to no impact on documented archaeologically significant features as no new areas are impacted.	Potential impacts due to development of new well source. Potential well sites are located within areas of archaeological potential or the historical core. Impacts assessment of new site would be needed to confirm any potential impacts on archaeological resources.	Potential well sites located outside of urban boundary. Low potential for impacts to archaeological resources.	The watermain will be routed along roads that have previously been disturbed and outside of the downtown Village area. Low potential for impacts to archaeological resources.
2.06	Protects health and safety	Moderate risk to occupational health and safety due to aging equipment. Potential public safety impacts if water supply needs cannot be met.	Potential impact to public health and safety due to increased taking from source containing strontium and fluoride. Potential for higher concentrations with increased taking.	Minor risks during construction. No long-term impact to occupational or public health and safety. Potential benefit as supply can be supplemented with a new well that contains lower concentrations of strontium or fluoride.	Minor risks during construction. No long-term impact to occupational or public health and safety. Potential benefit as supply can be supplemented with a new well that contains lower concentrations of strontium or fluoride.	Minor risks during construction. No long-term impact to occupational or public health and safety. Potential benefit as supply can be supplemented with a new source that contains lower concentrations of strontium or fluoride.
3.0	Technical					
3.01	Provides reliable service	Poor reliability/ resilience due to capacity limitations and aging equipment.	Provides some reliability and resilience. Relies on existing well sources which provides some redundancy as there are three wells connected to the WTP.	Provide good reliability and resiliency. Adding a fourth well source provides additional redundancy to the three wells already connected to the WTP.	Provide good reliability and resiliency. Adding a fourth well source provides additional redundancy to the three wells already connected to the WTP.	Provides high reliability and resiliency. Completely redundant independent treated water supply separate from the existing wells and WTP.

3.02	Meets existing and future needs	Capacity is not sufficient for the planning horizon and will be exceeded by 2034.	Likely provide sufficient capacity for the planning horizon, subject to future hydrogeological study.	Provides sufficient capacity for the planning horizon and potential to expand further. Opportunity to explore well sources with lower strontium concentrations if this becomes regulated in the future.	Provides sufficient capacity for the planning horizon and potential to expand further. Opportunity to explore well sources with lower strontium concentrations if this becomes regulated in the future.	Provides sufficient capacity for the planning horizon and potential to expand further. More opportunity for future expandability as Wellesley could become part of the IUS. Opportunity to use a water source with lower strontium concentrations if this becomes regulated in the future.
3.03	Aligns with existing and planned infrastructure	No change to existing infrastructure. No flexibility to accommodate future upgrades as the water supply needs will not be met.	Make use of existing infrastructure to meet future needs. WTP has excess capacity to accommodate future upgrades.	Make use of existing WTP infrastructure to meet future needs. WTP has excess capacity to accommodate future upgrades. Depending on PTTW limit for new well source may have additional raw water capacity.	Make use of existing WTP infrastructure to meet future needs. WTP has excess capacity to accommodate future upgrades. Depending on PTTW limit for new well source may have additional raw water capacity.	Alternative would maintain the existing WTP and well supply and supplement with an entirely separate treated water source. No changes to operations at existing WTP.
3.04	Aligns with existing and future land use	No change to existing land uses, however additional residential/ business growth may not be accepted if future well capacity needs cannot be met.	No change to existing land uses. Continues to use existing WTP site.	No change to existing land uses if an existing monitoring well is modified to a production well. Continue to use existing WTP site.	No change to existing land uses if an existing monitoring well is modified to a production well. Continue to use existing WTP site.	No changes to land use. Watermain would be routed along existing roadways. Continue to use existing WTP site.
3.05	Aligns with approval and permitting process	Acquiring future permits (i.e., PTTW renewal) is relatively simple but will not have reliable capacity for the planning horizon.	Requires expanding the existing PTTW water taking limit to meet future needs. Uncertainty and risk in obtaining approval.	New PTTW must be acquired for the new well.	New PTTW must be acquired for the new well.	Permitting from multiple authorities to connect to IUS.
3.06	Manages and minimizes construction risks	No construction involved.	No construction involved.	Potential for disruption and constructability issues due to watermain construction through downtown Village and at existing WTP to connect new well source.	Potential for disruption and constructability issues due to watermain construction and at existing WTP to connect new well source. Watermain to be routed outside of urban boundary to minimize impacts compared to Alternative 3A	Constructability challenges with watermain construction along right of way (~17 km of road impacted). No disruption to existing WTP expected.
3.07	Ability to adapt to climate change	Poor adaptability due to capacity limitations and aging equipment.	Some resilience to climate change. Relies on existing well sources which provides some redundancy as there are three wells connected to the WTP.	Provides good resilience to climate change. Adding a fourth well source provides additional redundancy to the three wells already connected to the WTP.	Provides good resilience to climate change. Adding a fourth well source provides additional redundancy to the three wells already connected to the WTP.	Provides high resilience to climate change. Completely redundant independent treated water supply separate from the existing wells and WTP.
4.0	Financial					
4.01	Provides low lifecycle costs	Ranked based on relative costs	Ranked based on relative costs	Ranked based on relative costs	Ranked based on relative costs	Ranked based on relative costs

Appendix A.1. Table A1-2: Floating Storage Location Alternatives Evaluation

ID#	Evaluation Criteria	Rationale				
		Location 1	Location 2	Location 3	Location 4	Location 5
1.0	Environmental					
1.01	Protects environmental features	Located near two existing wooded areas and existing wetlands. However, the area has been developed for the new recreation centre. It is anticipated that the ET be located in the area of development, and away from the wooded areas and wetlands. An impacts assessment would need to be completed in the proposed location to confirm any impacts and mitigation measures needed.	Located near an existing wooded area and near Firella Creek. An impacts assessment would need to be completed in the proposed location to confirm any impacts and mitigation measures needed.	Located centrally within the developed Township area. No impact to environmental features expected as any significant environmental features are located outside of the study area.	Located near the floodplain of the Stroh drain. An impacts assessment would need to be completed in the proposed location to confirm any impacts and mitigation measures needed.	Located near the Nith River. An impacts assessment would need to be completed in the proposed location to confirm any impacts and mitigation measures needed.
1.02	Protects wildlife and species at risk	Located near two existing wooded areas and existing wetlands. An impacts assessment would need to be completed in the proposed location to confirm any impacts and mitigation measures needed. This land was recently developed for the new recreation centre.	Located near an existing wooded area. An impacts assessment would need to be completed in the proposed location to confirm any impacts and mitigation measures needed.	Located centrally within the developed Township area. No impact to environmental features expected as any significant environmental features are located outside of the study area.	Not located near any significant environmental features. No impact to environmental features expected as any significant environmental features are located outside of the study area.	Located near the Nith River. An impacts assessment would need to be completed in the proposed location to confirm any impacts and mitigation measures needed.
1.03	Protects groundwater, streams and rivers	Not located near any major water bodies or well sites. Not expected to impact groundwater quantity and quality, surface water quantity and quality, and fluvial geomorphic function.	Located near Firella Creek. An impacts assessment would need to be completed in the proposed location to confirm any impacts and mitigation measures needed.	Located near minor streams/ tributaries. Not expected to impact groundwater quantity and quality, surface water quantity and quality, and fluvial geomorphic function.	Located near minor streams/ tributaries. Not expected to impact groundwater quantity and quality, surface water quantity and quality, and fluvial geomorphic function.	Located near Nith River. An impacts assessment would need to be completed in the proposed location to confirm any impacts and mitigation measures needed.
1.04	Minimizes climate change impacts	Additional energy use for intermittent pumping (i.e., to fill ET). Similar climate change impacts for all locations.	Additional energy use for intermittent pumping (i.e., to fill ET). Similar climate change impacts for all locations.	Additional energy use for intermittent pumping (i.e., to fill ET). Similar climate change impacts for all locations.	Additional energy use for intermittent pumping (i.e., to fill ET). Similar climate change impacts for all locations.	Additional energy use for intermittent pumping (i.e., to fill ET). Similar climate change impacts for all locations.
2.0	Social					
2.01	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.	Permanent change to community aesthetics. No long-term impacts on noise, odour, traffic. Location is relatively isolated from existing residential areas which may minimize the perceived impacts on community aesthetics. Primary agricultural and institutional land use in adjacent	Permanent change to community aesthetics. No long-term impacts on noise, odour, traffic. Location is adjacent to existing residential areas on the central-northern end of the Township, however is relatively isolated from the central urban residential core.	Permanent change to community aesthetics. No long-term impacts on noise, odour, traffic. Location is central, surrounded by existing residential and institutional areas and relatively close to the urban core which may increase the perceived impacts on community aesthetics.	Permanent change to community aesthetics. No long-term impacts on noise, odour, traffic. Location is adjacent to existing residential areas on the north-eastern end of the Township, however is relatively isolated from the central urban residential core. Also located near agricultural land use.	Permanent change to community aesthetics. No long-term impacts on noise, odour, traffic. Location is adjacent to existing residential areas on the south-eastern end of the Township, however is relatively isolated from the central urban residential core. Also located near agricultural land use.

2.02	Minimizes impacts to businesses	No long-term business impacts expected.	No long-term business impacts expected.	No long-term business impacts expected.	No long-term business impacts expected.	No long-term business impacts expected.
2.03	Manages and minimizes construction impacts	Short-term impacts to traffic, noise, odour, expected from construction. Mitigation measures may be required during construction to minimize impacts. Location is relatively isolated from sensitive land uses (e.g., residential) which minimizes potential impacts.	Short-term impacts to traffic, noise, odour, expected from construction. Mitigation measures may be required during construction to minimize impacts. Location is adjacent to existing residential areas on the central-northern end of the Township but is relatively isolated from the central urban core which mitigates some potential impacts.	Short-term impacts to traffic, noise, odour, expected from construction. Mitigation measures may be required during construction to minimize impacts. Location is surrounded by existing residential areas and is relatively close to the urban core which may increase the perceived impacts.	Short-term impacts to traffic, noise, odour, expected from construction. Mitigation measures may be required during construction to minimize impacts. Location is adjacent to existing residential areas on the north-eastern end of the Township but is relatively isolated from the central urban core which mitigates some potential impacts.	Short-term impacts to traffic, noise, odour, expected from construction. Mitigation measures may be required during construction to minimize impacts. Location is adjacent to existing residential areas on the south-eastern end of the Township but is relatively isolated from the central urban core which mitigates some potential impacts.
2.04	Conserves built heritage and/or cultural heritage landscapes	Not located near any cultural heritage landscapes. No impacts are expected.	Location is near one cultural heritage landscape. Impacts assessment would be needed to confirm any potential impacts on cultural heritage resources.	Location is near several existing cultural heritage landscapes as well as known and potential built heritage resources. Impacts assessment would be needed to confirm any potential impacts on cultural heritage resources.	Will result in direct adverse impacts related to disturbance and alteration of agricultural fields to Cultural Heritage Landscape.	Not located near any cultural heritage landscapes. No impacts are expected.
2.05	Conserves archaeological resources complexity	Location is in a disturbed area and previously assessed area due to the new recreation center which helps mitigate the risk.	Location is adjacent to but not directly located in any areas of archaeological potential. Impacts assessment would be needed to confirm any potential impacts on archaeological resources.	Location crosses areas of archaeological potential. Impacts assessment would be needed to confirm any potential impacts on archaeological resources.	Location crosses areas of archaeological potential. Impacts assessment would be needed to confirm any potential impacts on archaeological resources.	Location crosses areas of archaeological potential. Impacts assessment would be needed to confirm any potential impacts on archaeological resources.
2.06	Protects health and safety	Minor risks during construction. No long-term impact to occupational or public health and safety.	Minor risks during construction. No long-term impact to occupational or public health and safety.	Minor risks during construction. No long-term impact to occupational or public health and safety.	Minor risks during construction. No long-term impact to occupational or public health and safety.	Minor risks during construction. No long-term impact to occupational or public health and safety.
3.0	Technical					
3.01	Provides reliable service	Location impacts ability to provide reliable service throughout the distribution system, especially at nodes located further out in the system. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Location impacts ability to provide reliable service throughout the distribution system, especially at nodes located further out in the system. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Location impacts ability to provide reliable service throughout the distribution system, especially at nodes located further out in the system. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Location impacts ability to provide reliable service throughout the distribution system, especially at nodes located further out in the system. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Location impacts ability to provide reliable service throughout the distribution system, especially at nodes located further out in the system. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)

3.02	Meets existing and future needs	Future needs will be met regardless of location. Any additional fire flow needed will be provided by the fire department's supply delivered via tanker truck	Future needs will be met regardless of location. Any additional fire flow needed will be provided by the fire department's supply delivered via tanker truck	Future needs will be met regardless of location. Any additional fire flow needed will be provided by the fire department's supply delivered via tanker truck	Future needs will be met regardless of location. Any additional fire flow needed will be provided by the fire department's supply delivered via tanker truck	Future needs will be met regardless of location. Any additional fire flow needed will be provided by the fire department's supply delivered via tanker truck
3.03	Aligns with existing and planned infrastructure	Different locations can make better use of existing distribution system infrastructure to meet fire flow needs. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Different locations can make better use of existing distribution system infrastructure to meet fire flow needs. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Different locations can make better use of existing distribution system infrastructure to meet fire flow needs. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Different locations can make better use of existing distribution system infrastructure to meet fire flow needs. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Different locations can make better use of existing distribution system infrastructure to meet fire flow needs. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)
3.04	Aligns with existing and future land use	The area is currently owned by the Township, and used for development of new recreation centre. A part of land may be rezoned to build the ET.	The area is currently privately owned, and zoned as agricultural. Land acquisition is required. The area may be rezoned to build the ET.	The area is currently owned by the Township, and zoned as institutional. A part of land may be rezoned to build the ET.	The area is currently privately owned, and zoned as agricultural. Land acquisition is required. The area may be rezoned to build the ET.	The area is currently privately owned, and zoned as agricultural. Land acquisition is required. The area may be rezoned to build the ET.
3.05	Aligns with approval and permitting process	No issues expected with permits and approvals. Similar permitting process regardless of location.	No issues expected with permits and approvals. Similar permitting process regardless of location.	No issues expected with permits and approvals. Similar permitting process regardless of location.	No issues expected with permits and approvals. Similar permitting process regardless of location.	No issues expected with permits and approvals. Similar permitting process regardless of location.
3.06	Manages and minimizes construction risks	Similar construction risks regardless of location.	Similar construction risks regardless of location.	Similar construction risks regardless of location.	Similar construction risks regardless of location.	Similar construction risks regardless of location.
3.07	Ability to adapt to climate change	Climate change adaptability was considered based on the ability to provide service throughout the distribution system. Service at any individual node is less likely to be disrupted if reliable service can be provided at most or all nodes. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Climate change adaptability was considered based on the ability to provide service throughout the distribution system. Service at any individual node is less likely to be disrupted if reliable service can be provided at most or all nodes. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Climate change adaptability was considered based on the ability to provide service throughout the distribution system. Service at any individual node is less likely to be disrupted if reliable service can be provided at most or all nodes. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Climate change adaptability was considered based on the ability to provide service throughout the distribution system. Service at any individual node is less likely to be disrupted if reliable service can be provided at most or all nodes. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)	Climate change adaptability was considered based on the ability to provide service throughout the distribution system. Service at any individual node is less likely to be disrupted if reliable service can be provided at most or all nodes. Ranked based on ability to meet fire flow needs for both residential and ICI properties (i.e., % of ICI nodes above 175 L/s and % of residential nodes above 75-125 L/s)
4.0	Financial					
4.01	Provides low lifecycle costs	Ranked based on relative costs	Ranked based on relative costs	Ranked based on relative costs	Ranked based on relative costs	Ranked based on relative costs

Appendix A.2. Table A2-1: Firella Creek Trunk Sewer Alternatives Evaluation

ID#	Evaluation Criteria	Rationale		
		Alternative 1 -Do Nothing	Alternative 2 - Offline Storage	Alternative 3 - Firella Creek Capacity Increase
1.0	Environmental			
1.01	Protects environmental features	There is a high risk of flooding to surface along the Firella Creek Trunk Sewer during wet weather flow. Sanitary sewerage flooding to surface results in direct contamination of the nearby Firella Creek which has the potential to impact local environmental features such as the creek and woodlot.	This alternative would reduce the risk of flooding to surface and therefore reduce the risk of environmental contamination. However, the footprint of the storage tanks has the potential to impact the woodlot along Firella Creek.	This alternative would reduce the risk of flooding to surface and therefore reduce the risk of environmental contamination. However, the construction of the upsized Firella Trunk has the potential to impact the woodlot along Firella Creek and also includes one creek crossing that may result in impacts.
1.02	Protects wildlife and species at risk	There is a high risk of flooding to surface along the Firella Creek Trunk Sewer during wet weather flow. Sanitary sewerage flooding to surface results in direct contamination of the nearby Firella Creek which could impact habitat through contamination of the surface waters that wildlife and aquatic species utilize.	Construction of one of the offline storage tanks would likely be located within the vicinity of the wooded area along Firella Creek, with the potential for tree/habitat disruption. However, this alternative reduces the risk of surface water contamination within Firella Creek which could improve the quality of the wildlife habitat.	Construction of the upsized Firella Creek Trunk Sewer would route through a wooden area, with the potential for tree/habitat disruption during construction. However, this alternative reduces the risk of surface water contamination within Firella Creek which could improve the quality of the wildlife habitat.
1.03	Protects groundwater, streams and rivers	There is a high risk of flooding to surface along the Firella Creek Trunk Sewer during wet weather flow. Sanitary sewerage flooding to surface results in direct contamination of the nearby Firella Creek. Flooding to surface could also result in contamination of aquifers.	This alternative reduces the risk of basement flooding and flooding to surface compared to existing conditions. Ground water may be impacted during construction. This alternative includes sanitary storage tanks in the Firella Creek floodplain which could result in moderate impacts to surface water quality and quantity if there is a flood event.	This alternative reduces the risk of basement flooding and flooding to surface compared to existing conditions. Groundwater may be impacted during construction. This alternative includes construction and a sanitary pipe in the Firella Creek floodplain which could result in moderate impacts to surface water quality and quantity if there is a flood event.
1.04	Minimizes climate change impacts	This alternative is not expected to increase GHG emissions. Climate change has the potential to increase the frequency and magnitude of wet weather events which may increase inflow and infiltration into the sanitary sewer system, thereby further increasing flows and risk of basement and surface flooding.	This alternative is not expected to substantially increase GHG emissions, however the storage tanks would require pumping which would increase GHG emissions slightly. Climate change has the potential to increase the frequency and magnitude of wet weather events which may increase inflow and infiltration into the sanitary sewer system, thereby further increasing flows and risk of basement and surface flooding. However, this alternative provides the ability to store wet weather flow, resulting in decreased risk of basement and surface flooding compared to the do nothing alternative.	This alternative is not expected to increase GHG emissions. Climate change has the potential to increase the frequency and magnitude of wet weather events which may increase inflow and infiltration into the sanitary sewer system, thereby further increasing flows and risk of basement and surface flooding. However, this alternative provides the additional capacity to convey wet weather flow, resulting in decreased risk of basement and surface flooding compared to the do nothing alternative.
2.0	Social			
2.01	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.	Noise, traffic levels, and aesthetics are not anticipated to be impacted by this alternative. There is the potential of increased odour generation as increased development will further increase the sanitary flow into the system thereby increasing the risk of surcharging.	This alternative will require an emergency backup generator at the offline storage tanks that are anticipated to generate noise during power outages that can be mitigated. This alternative has greater odour generating potential. The storage tanks will be situated near residential properties and will require odour mitigation measures. Traffic may be moderately impacted during construction of the upstream storage tank. The remaining storage tanks are not near the ROW. Above ground tanks are generally not considered to be aesthetically pleasing, but can me mitigated with architectural design (which can impact capital costs).	This alternative is not anticipated to impact noise and aesthetics compared to existing conditions. This alternative may improve the risk of odour generation over existing conditions by reducing the risk of sanitary sewer surcharging. Traffic may be moderately impacted during construction of the upstream end of the trunk sewer.
2.02	Minimizes impacts to businesses	Business operation is not anticipated to be impacted under this alternative.	Business operation is not anticipated to be impacted under this alternative.	Business operation is not anticipated to be impacted under this alternative.
2.03	Manages and minimizes construction impacts	This alternative requires no construction.	Traffic may be moderately impacted during construction of the upstream storage tank. The remaining storage tanks are not near the ROW. Noise generated during construction would require some level of mitigation.	Traffic may be moderately impacted during construction of the upstream end of the trunk sewer. Noise generated during construction would require some level of mitigation.
2.04	Conserves built heritage and/or cultural heritage landscapes	There is no impact on built heritage and/or cultural heritage landscapes since this alternative does not include construction.	Sanitary storage tanks could be located such that there are no impacts to built heritage and/or cultural heritage landscapes.	There is the potential for construction to impact two cultural heritage landscapes.
2.05	Conserves archaeological resources complexity	There is no impact to archaeological potential since this alternative does not include construction.	There is archaeological potential along the Firella Creek. Since storage tanks would be located in the vicinity of Firella Creek, there is risk of impact to archaeological resources.	There is archaeological potential along the Firella Creek. Since construction would be located near Firella Creek as per the existing trunk route, there is risk of impact to archaeological resources.

2.06	Protects health and safety	Health and safety is at risk as a result of surcharging within the sanitary sewer system causing basement flooding and surface flooding events.	This alternative reduces the risk of basement flooding and flooding to surface compared to existing conditions thereby reducing the risk to public health and safety compared to existing conditions.	This alternative reduces the risk of basement flooding and flooding to surface compared to existing conditions thereby reducing the risk to public health and safety compared to existing conditions.
3.0	Technical			
3.01	Provides reliable service	This alternative results in continued risk of basement flooding and flooding to surface under wet weather flow conditions.	This alternative reduces the risk of basement flooding and flooding to surface during wet weather flow compared to existing conditions.	This alternative reduces the risk of basement flooding and flooding to surface during wet weather flow compared to existing conditions.
3.02	Meets existing and future needs	This alternative results in continued risk of surcharging and basement flooding during wet weather flow events under existing conditions and increases the potential for more substantial flooding under future conditions.	This alternative reduces the risk of basement flooding during wet weather flow events under existing and future conditions and is better able to accommodate growth compared to existing conditions.	This alternative reduces the risk of basement flooding during wet weather flow events under existing and future conditions and is better able to accommodate growth compared to existing conditions.
3.03	Aligns with existing and planned infrastructure	This alternative is compatible with the existing infrastructure and operations but does not support improvements in any other collection system or treatment infrastructure.	This alternative will likely require additional pumping which is not in line with the existing operational regime. In general, storage tanks are not common assets the Region currently owns, and therefore they do not align with existing infrastructure and operations. However, this alternative reduces the peak flow to the wastewater treatment plant during wet weather events compared to Alternative 1 and Alternative 3. Reduced peak flow to the plant will mitigate capacity impacts at the	This alternative is compatible with the existing infrastructure and operations since it includes replacing existing pipes with larger pipes. However, this alternative increases the peak flow to the wastewater treatment plant during wet weather events compared to Alternative 1 and Alternative 2. Increased peak flow to the plant will increase capacity impacts at the wastewater treatment plant.
3.04	Aligns with existing and future land use	This alternative will not be able to accommodate future landuse/growth.	This alternative is expected to be able to accommodate future landuse/growth from a capacity perspective. However, land use acquisition is expected to be required for the placement of the storage tanks which will be inconsistent with planning.	This alternative is expected to be able to accommodate future landuse/growth and does not require land acquisition.
3.05	Aligns with approval and permitting process	This alternative does not require additional approvals.	Permitting for storages of sewage and odour considerations could result in additional approvals. However, there are no creek crossings required with this alternative.	One creek crossing would require permits with additional environmental conditions.
3.06	Manages and minimizes construction risks	There is no construction required for this alternative.	Due to the large volume of storage required (~5000m3), it is anticipated that the constructability of this alternative will be complex, therefore increasing the construction risk.	This alternative includes one creek crossing that adds environmental management and technical complexity during construction. Substantial bypassing would be required during construction.
3.07	Ability to adapt to climate change	This alternative does not accommodate additional wet weather flow anticipated from climate change.	This alternative can provide additional capacity to accommodate wet weather flow from climate change.	This alternative can provide additional capacity to accommodate wet weather flow from climate change.
4.0	Financial			
4.01	Provides low lifecycle costs	Although there is no capital cost associated with this alternative, it is anticipated that O&M costs related to repair will increase the annual O&M costs.	This alternative will have a lower capital cost compared to Alternative 3, however the O&M costs associated with maintenance of the storage tanks and pumping are expected to be relatively high.	This alternative is expected to have a relatively high capital cost with a low O&M cost.

Appendix A.2. Table A2-2: Local Sewer Constraints Alternatives Evaluation

ID#	Evaluation Criteria			
		Alternative 1 -Do Nothing	Alternative 2 -Pipe Capacity Increases	Alternative 3 -New Sub-trunk Sewers
1.0	Environmental			
1.01	Protects environmental features	Basement flooding and flooding to surface is simulated within the local sewers in the model under the existing infrastructure scenario. Sanitary sewerage flooding to surface could result in direct contamination of watercourses running through the study area.	The local sewers requiring upsizing are largely within the ROW. However, three creek crossings would be required. Impacts to watercourses would require mitigation.	The local sewers requiring upsizing are largely within the ROW. However, five creek crossings would be required. Impacts to watercourses would require mitigation.
1.02	Protects wildlife and species at risk	Basement flooding and flooding to surface is simulated within the local sewers in the model under the existing infrastructure scenario. Sanitary sewerage flooding to surface could result in direct contamination of watercourses running through the study area which could contaminate the surface waters that wildlife and aquatic species utilize.	This alternative reduces the risk of surface water contamination which could improve the quality of the wildlife habitat.	This alternative reduces the risk of surface water contamination which could improve the quality of the wildlife habitat.
1.03	Protects groundwater, streams and rivers	Basement flooding and flooding to surface is simulated within the local sewers in the model under the existing infrastructure scenario. Sanitary sewerage flooding to surface could result in direct contamination of watercourses running through the study area. Flooding to surface could also result in contamination of aquifers.	This alternative reduces the risk of basement flooding and flooding to surface compared to existing conditions. Ground water may be impacted during construction. This alternative includes some construction within the floodplain which could result in moderate impacts to surface water quality and quantity if there is a flood event.	This alternative reduces the risk of basement flooding and flooding to surface compared to existing conditions. Ground water may be impacted during construction. This alternative includes some construction within the floodplain which could result in moderate impacts to surface water quality and quantity if there is a flood event.
1.04	Minimizes climate change impacts	This alternative is not expected to increase GHG emissions. Climate change has the potential to increase the frequency and magnitude of wet weather events which may increase inflow and infiltration into the sanitary sewer system, thereby further increasing flows and risk of basement and surface flooding.	This alternative is not expected to increase GHG emissions. Climate change has the potential to increase the frequency and magnitude of wet weather events which may increase inflow and infiltration into the sanitary sewer system, thereby further increasing flows and risk of basement and surface flooding. However, this alternative provides the additional capacity to convey wet weather flow, resulting in decreased risk of basement and surface flooding compared to the do nothing alternative.	This alternative is not expected to increase GHG emissions. Climate change has the potential to increase the frequency and magnitude of wet weather events which may increase inflow and infiltration into the sanitary sewer system, thereby further increasing flows and risk of basement and surface flooding. However, this alternative provides the additional capacity to convey wet weather flow, resulting in decreased risk of basement and surface flooding compared to the do nothing alternative.
2.0	Social			
2.01	Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.	Noise, traffic levels, and aesthetics are not anticipated to be impacted by this alternative. There is the potential of increased odour generation as increased development will further increase the sanitary flow into the system thereby increasing the risk of surcharging.	This alternative is not anticipated to impact noise and aesthetics compared to existing conditions. This alternative may improve the risk of odour generation over existing conditions by reducing the risk of sanitary sewer surcharging. Since construction would be required along main roads (a small stretch of Gerber Road and Nafziger Road), traffic will be minimally impacted during construction.	This alternative is not anticipated to impact noise and aesthetics compared to existing conditions. This alternative may improve the risk of odour generation over existing conditions by reducing the risk of sanitary sewer surcharging. Since construction would be required along main roads (Gerber Road, Greenwood Hill Road, and Nafziger Road), traffic will be moderately impacted during construction.
2.02	Minimizes impacts to businesses	Business operation is not anticipated to be impacted under this alternative.	Businesses may be moderately and temporarily impacted during construction along Nafziger (ICI area of the study area).	Businesses may be moderately and temporarily impacted during construction along Nafziger (ICI area of the study area).
2.03	Manages and minimizes construction impacts	This alternative requires no construction.	Since construction would be required along main roads (a small stretch of Gerber Road and Nafziger Road), traffic will be moderately impacted during construction, however less impacted compared to Alternative 3. Noise generated during construction would require some level of mitigation.	Since construction would be required along main roads (Gerber Road, Greenwood Hill Road, and Nafziger Road), traffic will be moderately impacted during construction. Noise generated during construction would require some level of mitigation.
2.04	Conserves built heritage and/or cultural heritage landscapes	There is no impact on built heritage and/or cultural heritage landscapes since this alternative does not include construction.	There is the potential for construction to impact cultural heritage landscapes along David Street, Nafziger Road, and Queens Bush Road. This alternative also overlaps a built heritage resource along Nafziger Road.	There is the potential for construction to impact cultural heritage landscapes along David Street, Nafziger Road, and Queens Bush Road. This alternative also overlaps a built heritage resource along Nafziger Road.
2.05	Conserves archaeological resources complexity	There is no impact to archaeological potential since this alternative does not include construction.	Construction would be largely within the road right of way, no archaeological potential identified.	Construction would be largely within the road right of way, no archaeological potential identified.

2.06	Protects health and safety	Health and safety is at risk as a result of surcharging within the sanitary sewer system causing high risk of basement flooding and surface flooding events.	This alternative reduces the risk of basement flooding and flooding to surface compared to existing conditions thereby reducing the risk to public health and safety compared to existing conditions.	This alternative reduces the risk of basement flooding and flooding to surface compared to existing conditions thereby reducing the risk to public health and safety compared to existing conditions.
3.0	Technical			
3.01	Provides reliable service	This alternative results in a risk of basement flooding and flooding to surface under wet weather flow conditions.	This alternative reduces the risk of basement flooding and flooding to surface during wet weather flow compared to existing conditions.	This alternative reduces the risk of basement flooding and flooding to surface during wet weather flow compared to existing conditions.
3.02	Meets existing and future needs	This alternative results in substantial surcharging and basement flooding during wet weather flow events under existing and future conditions according to modelled results.	This alternative reduces the risk of basement flooding during wet weather flow events under existing and future conditions and is better able to accommodate growth compared to existing conditions.	This alternative reduces the risk of basement flooding during wet weather flow events under existing and future conditions and is better able to accommodate growth compared to existing conditions.
3.03	Aligns with existing and planned infrastructure	This alternative is compatible with the existing infrastructure and operations.	This alternative is compatible with the existing infrastructure and operations since it includes replacing existing pipes with larger pipes.	This alternative is compatible with the existing infrastructure and operations, however would include new assets and pipe routes.
3.04	Aligns with existing and future land use	This alternative is not anticipated to be able to accommodate future landuse/growth.	This alternative is expected to be able to accommodate future landuse/growth and does not require land acquisition.	This alternative is expected to be able to accommodate future landuse/growth and does not require land acquisition.
3.05	Aligns with approval and permitting process	This alternative does not require additional approvals.	Three creek crossings would require permits with environmental management conditions.	Five creek crossings would require permits with environmental management conditions.
3.06	Manages and minimizes construction risks	There is no construction required for this alternative.	This alternative includes three creek crossings that add environmental management and technical complexity during construction. Bypassing would also be required during construction.	This alternative includes five creek crossings that add environmental management and technical complexity during construction. Bypassing would also be required during construction.
3.07	Ability to adapt to climate change	This alternative does not accommodate additional wet weather flow anticipated from climate change.	This alternative can provide additional capacity to accommodate wet weather flow from climate change.	This alternative can provide additional capacity to accommodate wet weather flow from climate change.
4.0	Financial			
4.01	Provides low lifecycle costs	Although there is no capital cost associated with this alternative, it is anticipated that O&M costs related to repair will increase the annual O&M costs.	This alternative is expected to have a relatively high capital cost with a low O&M cost. However, the capital cost is expected to be less than that of Alternative 3.	This alternative is expected to have a relatively high capital cost with a low O&M cost.

Appendix A3. Table A3-1: Raw Wastewater Pumping Alternatives

Evaluation Criteria	Rationale		
	Raw Wastewater Pumping		
	Do nothing	Replace Existing Duty/Standby Pumps with Larger Capacity Pumps/ Equalization Tank	Construct a New Pump Station/ Equalization Tank
Environmental			
Protects environmental features	Flooding in the collection system due to pumping capacity limitation has the potential to negatively impact environmental features (such as, natural areas).	Requires very large storage tank , limited space within facility. City will need to purchase land in rural area which may result in a potential impact for the environment.	Requires very large storage tank , limited space within facility. City will need to purchase land in rural area which may result in a potential impact for the environment.
Protects wildlife and species at risk	Flooding in the collection system due to pumping capacity limitation has the potential to negatively impact wildlife and species at risk.	Due to open storage there is potential for an impact on the surrounding wildlife and species.	Due to open storage there is potential for an impact on the surrounding wildlife and species.
Protects groundwater, streams and rivers	Flooding in the collection system due to pumping capacity limitation has potential to negatively impact groundwater and water bodies quality.	Minimal potential for impact on groundwater, streams and rivers due to storage being above ground. Following storage, will be treated downstream.	Minimal potential for impact on groundwater, streams and rivers due to storage being above ground. Following storage, will be treated downstream.
Minimizes climate change impacts	Sewage accumulation in the collection system due to pumping capacity limitation would increase GHG emissions.	Minimum impact due to aging equipment. An increase in GHG emissions would be attributed to increasing energy requirements.	Minimal impact due to GHG emissions. An increase in GHG emissions would be attributed to increasing in energy requirements.
Social			
Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.	Increase in odour impacts and traffic impacts due to potential increased frequency of flooding events due to pumping capacity limitation.	Minimal impact on residents related to noise, odour, traffic and aesthetics during shut down/closure of facility for pump replacement.	Minimal impact on residents related to noise, odour, traffic and aesthetics during construction of new pump station and equalization tank.
Minimizes impacts to businesses	Moderate risk of temporary business closures due to potential increased frequency of flooding events due to pumping capacity limitation.	Minimal impact on surrounding businesses.	Minimal impact on surrounding businesses.
Manages and minimizes construction impacts	No construction required therefore no short-term disruptions expected.	Minimal impact on managing and minimizing construction impacts due to potential closure or activity of road access to the facility.	Minimal impact on managing and minimizing construction impacts due to potential closure or activity of road access to the facility.
Conserves built heritage and/or cultural heritage landscapes	Little to no increase in potential impact on documented cultural heritage resources as no new areas are impacted.	Minimal impact on build heritage and/or cultural heritage landscapes.	Minimal impact on build heritage and/or cultural heritage landscapes.
Conserves archaeological resources complexity	Little to no increase in potential impact on documented archaeologically significant features as no new areas are impacted.	Stage 2 Archaeological assessment required.	Stage 2 Archaeological assessment required.
Protects health and safety	Moderate risk to occupational health and safety to odour and contamination issues during flooding events due to pumping capacity limitation.	Equalization basin located outside and there is a potenial increase in impacts in the event of accumulation although considered a minimal potential impact. Remaining older components and equipment within the existing pump station could result in higher risk to health and safety compared to Alternative 3.	Equalization basin located outside and there is a potenial increase in impacts in the event of accumulation although considered a minimal potential impact. A new pump station provides the opportunity to replace aging components, which reduces health and safety risk compared to Alternative 2.
Technical			
Provides reliable service	Poor reliability/ resilience due to capacity limitations and aging facilities/equipment.	Minimal impact on reliability of service during shutdown of facility for replacement of pumps.	Minimal impact on reliability of service as construction of new facilities can be completed without shutdown.
Meets existing and future needs	Capacity is not sufficient for the existing need and for forecast growth over the planning horizon.	Meets existing and future needs.	Meets existing and future needs.

Aligns with existing and planned infrastructure	Significantly impacts existing collection system capacity and any potential future collection system upgrades because of existing capacity constraints and anticipated increase in capacity constraints over the planning horizon.	Aligns with existing and planned infrastructure.	Aligns with existing and planned infrastructure.
Aligns with existing and future land use	No change to existing land use.	Will require land acquisition for equalization tank and rezoning of argricultural land.	Will require land acquisition for equalization tank and rezoning of argricultural land.
Aligns with approval and permitting process	No additional permits are required, however, existing permits and approvals may be in jeopardy without reliable capacity for the existing collection system and future growth forecast within the planning horizon.	Aligns with approval and permitting process. Minimal impact of obtaining permits and approvals.	Aligns with approval and permitting process. Minimal impact of obtaining permits and approvals.
Manages and minimizes construction risks	No risk potential due to construction since no construction involved.	Facility operations will be impacted during pump replacement, cannot stay in full operation during construction. Minimal impact on potential road closure, impacting access to existing facility.	Minimal impact on construction risks. Facility can remain in operation. Minimal impact on potential road closure, impacting access to existing facility.
Ability to adapt to climate change	Poor adaptability to increased wet weather events and other climate risks such as temperature exstremes due to existing and future capacity limitations and aging faciltiies/equipment.	Minimal impact on GHG, increase in capacity will reduce risk of flooding increasing adaptability to climate change.	Minimal impact on GHG, increase in capacity will reduce risk of flooding increasing adaptability to climate change.
Financial			
Provides low lifecycle costs	No capital cost increase. However, it is anticipated that O&M costs related to repair will increase the annual O&M costs.	Lower capital cost compared to Alternative 3. However, O&M cost would be higher due to piping aging. Overall, slightly lower lifecycle cost	Higher capital cost compared to Alternative 2. However, O&M cost would be lower Overall. slightly higher lifecycle cost

Appendix A3. Table A3-2: Headworks (Screening) Alternatives

Evaluation Criteria	Rationale		
	Headworks (Screening)		
	Do nothing	Replace Existing Screen and Retrofit Channel to Increase Capacity	Construct a New Headworks Facility
Environmental			
Protects environmental features	No potential impact anticipated on environmental features. No construction activities in alternative.	Minimal impact anticipated on environmental features due to retrofit activities in alternative.	Minimal impact anticipated on environmental features due to localized construction activities in alternative.
Protects wildlife and species at risk	Some impacts may be anticipated due to deterioration in downstream processes performance.	Minimal impact anticipated on wildlife and species.	Minimal impact anticipated on wildlife and species.
Protects groundwater, streams and rivers	Some impacts may be anticipated due to deterioration in downstream processes performance.	Minimal impact anticipated on groundwater, streams and rivers.	Minimal impact anticipated on groundwater, streams and rivers.
Minimizes climate change impacts	Minimal impact on climate change impacts due to equipment aging.	Minimal impact on climate change impact, due to the increase in energy consumption.	Minimal impact on climate change impact, due to the increase in energy consumption.
Social			
Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.	Some impacts on the residents related to noise, odour, traffic and aesthetics due to anticipated higher odour-related issues.	Minimal impact to residents related to noise, odour, traffic and aesthetics due to potential shutdown or reduced capacity during replacement.	Minimal impact to residents related to noise, odour, traffic and aesthetics during new construction.
Minimizes impacts to businesses	No impact anticipated on surrounding businesses.	No impact anticipated on surrounding businesses.	No impact anticipated on surrounding businesses.
Manages and minimizes construction impacts	No impact anticipated on managing and minimizing construction impacts since no construction planned.	Minimal impact anticipated on managing and minimizing construction impacts due to potential closure or increased activity of road access to the facility.	Minimal impact anticipated on managing and minimizing construction impacts due to potential closure or increased activity of road access to the facility.
Conserves built heritage and/or cultural heritage landscapes	Little to no impact anticipated on documented cultural heritage resources as no new areas are impacted.	Little to no impact anticipated on documented cultural heritage resources as no new areas are impacted.	Little to no impact anticipated on documented cultural heritage resources as no new areas are impacted.
Conserves archaeological resources complexity	Little to no impact on documented archaeologically significant features as no new areas are impacted.	Minimal impact anticipated as there is still some archeological potential that has yet to be fully defined.	Minimal impact anticipated as there is still some archeological potential that has yet to be fully defined.
Protects health and safety	Some risk to occupational health and safety due to aging equipment. Potential public safety impacts due to odour and contamination issues.	Minor impact on occupational health and safety due to aging equipment.	No anticipated impact on occupational health and safety due to new construction.
Technical			
Provides reliable service	Major impact on reliability of service. Reduced service due to inability to maintain capacity demand.	Improves reliability of service.	Improves reliability of service..
Meets existing and future needs	Capacity is not sufficient for the existing need and for forecast growth over the planning horizon.	Meets existing and future needs.	Meets existing and future needs.

Aligns with existing and planned infrastructure	Major impact on existing and planned infrastructure, current equipment cannot handle increase capacity demands.	Aligns with existing and planned infrastructure.	Aligns with existing and planned infrastructure.
Aligns with existing and future land use	No change to existing land uses.	Minimal impact , aligns with existing and future land use.	Some impact, Region will have to invest in additional land.
Aligns with approval and permitting process	Magor impacts acquiring applications for approval and permitting because equipment is not able to handle the expected increase in growth.	Some impact anticipated due to bypassing unscreened flow during construction.	Minimal impact anticipated , aligns with approvals and permitting process.
Manages and minimizes construction risks	No risk potential due to construction since no construction involved.	Impact anticipated on managing and minimizing construction risks. Screening process will be out of service during construction, impacting the downstream process. This will need to be completed in stages	Minimal impact, connection of the new building to the existing infrastructure. Related construction should not have an impact on existing infrastructure or increase construction risks.
Ability to adapt to climate change	Poor adaptability due to capacity limitations and aging equipment.	No anticipated issues to adapt to climate change	No anticipated issues to adapt to climate change
Financial			
Provides low lifecycle costs	No capital cost increase. However, it is anticipated that O&M costs related to repair will increase the annual O&M costs.	Lower lifecycle cost compared to Alternative 3.	Higher lifecycle cost compared to Alternative 3.

Appendix A3. Table A3-3 Secondary Treatment Alternatives

Evaluation Criteria	Rationale		
	Secondary Treatment		
	Do nothing	Construct New Extended Aeration Plant No. 3	Implement an Alternative Process Intensification Technology into Plants 1 and 2 (AGS or MABR)
Environmental			
Protects environmental features	Some impacts due to deterioration in downstream processes performance	Minimal to no impacts anticipated on environmental features.	Minimal to no impacts anticipated on environmental features.
Protects wildlife and species at risk	Some impacts due to deterioration in downstream processes performance	Minimal to no impacts anticipated on surrounding wildlife and species.	Minimal to no impacts anticipated on surrounding wildlife and species.
Protects groundwater, streams and rivers	Some impacts due to deterioration in downstream processes performance	Minimal impacts anticipated on surrounding groundwater, streams, and rivers.	Minimal impacts anticipated on surrounding groundwater, streams, and rivers.
Minimizes climate change impacts	Significantly increase GHG emissions and will have a major impact on climate change.	Minimal climate change impacts.	Potential GHG emission reduction with process intensification.
Social			
Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.	Has the potential for major impacts due to increase in odour and GHG emissions.	Minor impacts may be anticipated to residents.	Minor impacts may be anticipated to residents.
Minimizes impacts to businesses	No impact anticipated on surrounding businesses.	Minimal impact anticipated on surrounding businesses.	Minimal impact anticipated on surrounding businesses.
Manages and minimizes construction impacts	No impact on managing and minimizing construction impacts.	Minor impact anticipated due to construction.	Minor impact anticipated due to construction.
Conserves built heritage and/or cultural heritage landscapes	Minimal to no impact anticipated on built heritage and/or cultural heritage landscapes since no construction planned.	Minimal impact anticipated on built heritage and/or cultural heritage landscapes due to construction.	Minimal impact anticipated on built heritage and/or cultural heritage landscapes due to construction.
Conserves archaeological resources complexity	Little to no increase in potential impact on documented archaeologically significant features as no new areas are impacted.	Minimal impact anticipated as there is still some archeological potential that has yet to be fully defined.	Minimal impact anticipated as there is still some archeological potential that has yet to be fully defined.
Protects health and safety	Major impact, increases health and safety risks due to secondary treatment process.	Minimal or no impact anticipated on health and safety.	Minimal or no impact anticipated on health and safety.
Technical			
Provides reliable service	Major impact on reliability of service, due to facility inability to maintain capacity demands and lack of secondary treatment process.	Minimal impact on reliability of service, increase reliability of service once implemented. Technology is well-proved.	New technology - still in pilot phase, will have an impact on reliability. Due to operation , any complications with the process will result in a delay to allow time to recover steady state performance.
Meets existing and future needs	Major impact on meeting existing and future needs, unable to meet future needs or requirements.	Minimal impact, meets existing and future needs.	Minimal impact, meets existing and future needs.

Aligns with existing and planned infrastructure	Major impact, does not align with existing and planned infrastructure.	Minimal impact, aligns with existing and planned infrastructure.	Incorporating MABR or AGS into the existing packaged plant configuration would be complex
Aligns with existing and future land use	Some impact; no further land use is required for secondary treatment. However, a larger footprint would be required for tertiary filtration and a UV system due to lower secondary effluent quality.	Minor impact on existing and future land use. Secondary Plant 3 is already considered in the original design. However, this option requires bigger compared to other options.	Minimal impact on existing and future land use, a smaller footprint is required for this option.
Aligns with approval and permitting process	Major impact on ability to obtain future approvals and permitting with current option, lack of meeting future requirements.	Minimal impact anticipated, aligns with approval and permitting process.	Emerging technology will have a potential negative mpact on obtaining approvals and permitting.
Manages and minimizes construction risks	Minimal impact on managing and minimizes construction risks.	Only impacts when connecting to the new existing plant	Impacts due to operations required to being stopped in order to implement service.
Ability to adapt to climate change	Poor ability to adapt to climate change, no solution provided.	Minimal impact on GHG emissions.	Potential GHG emission reduction with process intensification
Financial			
Provides low lifecycle costs	No capital cost increase. However, it is anticipated that O&M costs related to repair will increase the annual O&M costs.	Higest capital cost compared to other alternatives. However, O&M cost would be lower thank Alternative 1	Lowest lifecycle cost comapred to Alternative 2

Appendix A3. Table A3-4: Sludge Storage Alternatives

Evaluation Criteria	Rationale		
	Sludge Storage		
	Do nothing	Replace Existing Storage Tank with a New Larger Storage Tank	Construct a Second Storage Tank
Environmental			
Protects environmental features	Minimal impact on environmental features.	Minimal impact on environmental features.	Minimal impact on environmental features.
Protects wildlife and species at risk	Minimal impact on wildlife and species in the surrounding area.	Minimal impact on wildlife and species in the surrounding area.	Minimal impact on wildlife and species in the surrounding area.
Protects groundwater, streams and rivers	Minimal impact on groundwater, streams and rivers.	Minimal impact on groundwater, streams and rivers.	Minimal impact on groundwater, streams and rivers.
Minimizes climate change impacts	Major impact on climate change, increased GHG emissions due to lack of storage and accumulation of sludge.	Minimal impact on climate change impact.	Minimal impact on climate change impact due to equipment aging in the existing storage tank
Social			
Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.	Major impact on odour due to insufficient storage capacity requirements.	Minimal impact on residents related to noise, odour, traffic and aesthetics.	Minimal impact on residents related to noise, odour, traffic and aesthetics.
Minimizes impacts to businesses	Minimal impact on surrounding businesses.	Minimal impact on surrounding businesses.	Minimal impact on surrounding businesses.
Manages and minimizes construction impacts	Minimal impact on managing and minimizes construction impacts.	Minimal impact on construction, potential shut down or delay to install replacement storage tank. Access to roads may be limited.	Minimal impact on managing and minimizes construction impacts.
Conserves built heritage and/or cultural heritage landscapes	Minimal impact on build heritage and/or cultural heritage landscapes.	Minimal impact on build heritage and/or cultural heritage landscapes.	Minimal impact on build heritage and/or cultural heritage landscapes.
Conserves archaeological resources complexity	Little to no increase in potential impact on documented archaeologically significant features as no new areas are impacted.	Minimal impact anticipated as there is still some archeological potential that has yet to be fully defined.	Minimal impact anticipated as there is still some archeological potential that has yet to be fully defined.
Protects health and safety	Major impact on health and safety due to lack of storage capacity.	Minimal or no impact anticipated on health and safety.	Minor impact on health and safety due to equipment aging in the existing storage tank
Technical			
Provides reliable service	Major impact on the reliability of the service due to lack of storage capacity.	Minimal impacts on reliability of service. No redundancy is provided if the tank is taken offline for maintenance	No impact on reliability service. 50% redundancy is provided if one tank is taken offline for maintenance
Meets existing and future needs	Major impact, current storage capacity does not meet existing and future needs.	Minimal impacts, meets existing and future needs.	Minimal impact, meets existing and future needs.

Aligns with existing and planned infrastructure	Major impact, does not align with existing and planned infrastructure.	Minimal impacts, aligns with existing and planned infrastructure.	Minimal impacts, aligns with existing and planned infrastructure. Need for additional filters, increase overall footprint.
Aligns with existing and future land use	Minimal impact, aligns with existing and future land use.	Minimal impact, aligns with existing and future land use.	Minimal impacts, Region will potentially need to increase footprint and invest in more land.
Aligns with approval and permitting process	Major impact anticipated, does not align with existing and planned infrastructure.	Minimal impact anticipated, aligns with approval and permitting process.	Minimal impact anticipated, aligns with approval and permitting process.
Manages and minimizes construction risks	Minimal impact on managing and minimizes construction impacts.	Impact on managing and minimizes construction risks, due to shut down or delay in process to install replacement storage tanks.	Minimal impact on managing and minimizes construction impacts when connecting the second storage tank to the existing system.
Ability to adapt to climate change	Major impact on ability to adapt to climate change. Limit storage capacity, increase GHG emissions from sitting sludge.	Minimal impact on the adaptation to climate change.	Minor impact on the adaptation to climate change due to equipment aging in the existing storage tank
Financial			
Provides low lifecycle costs	No capital cost increase. However, it is anticipated that O&M costs related to repair will increase the annual O&M costs.	Highest capital cost, resulting in highest lifecycle cost	Higher O&M cost due to the additional equipment, but Lowest capital cost, resulting in lowest lifecycle cost

Appendix A3. Table A3-5: Tertiary Filtration Alternatives

Evaluation Criteria	Rationale	
	Tertiary Filtration	
	Do nothing	Process Extension to install a new filter
Environmental		
Protects environmental features	Minimal impact on environmental features.	Minimal impact on environmental features.
Protects wildlife and species at risk	Minimal impact on wildlife and species at risk, additional filters will reduce exposure to contaminants.	Minimal impact on wildlife and species.
Protects groundwater, streams and rivers	Minimal impact on wildlife and species at risk, additional filters will reduce exposure to contaminants.	Minimal impact on groundwater, streams and rivers.
Minimizes climate change impacts	Minor impact on climate change impact	Minimal impact on climate change impact.
Social		
Minimizes impacts to residents related to noise, odour, traffic, and aesthetics.	Minimal impact on residents related to noise, odour, traffic, and aesthetics.	Minimal impact on residents related to noise, odour, traffic, and aesthetics.
Minimizes impacts to businesses	Minimal impact on surrounding businesses.	Minimal impact on surrounding businesses.
Manages and minimizes construction impacts	Minimal impact on managing and minimizing construction impacts.	Minor impact on managing and minimizing construction impacts when additional filters are installed. Limited access to roads at facility.
Conserves built heritage and/or cultural heritage landscapes	Minimal impact on build heritage and/or cultural heritage landscapes.	Minimal impact on build heritage and/or cultural heritage landscapes.
Conserves archaeological resources complexity	Little to no increase in potential impact on documented archaeologically significant features as no new areas are impacted.	Minimal impact anticipated as there is still some archeological potential that has yet to be fully defined.
Protects health and safety	Minor impact on health and safety. Less filtration and potential solids washout would allow for more contaminants.	Minimal or no impact anticipated on health and safety.
Technical		
Provides reliable service	Major impact on reliability of service due to capacity limitations.	Minimal impact on reliability of service.
Meets existing and future needs	Major impact, does not meet existing and future needs.	Minimal impact, meetings existing and future needs.

Aligns with existing and planned infrastructure	Major impact, does not align with existing and planned infrastructure.	Minimal impact, aligns with existing and planned infrastructure.
Aligns with existing and future land use	Minimal impact, aligns with existing and future land use.	Minimal impact, aligns with existing and future land use. Region will need to increase footprint to install additional filters.
Aligns with approval and permitting process	Minimal impact anticipated, aligns with approvals and permitting process. Impact on this process will increase as equipment ages.	Minimal impact anticipated, aligns with approvals and permitting process.
Manages and minimizes construction risks	Minimal impact on managing and minimizing construction risks.	Minimal impacts on managing and minimizing construction risks, potential shut down of process may be required to install additional filters.
Ability to adapt to climate change	Minimal impact on the ability to adapt to climate change.	No impact on ability to adapt to climate change.
Financial		
Provides low lifecycle costs	No capital cost increase. However, it is anticipated that O&M costs related to repair will increase the annual O&M costs.	Highest capital cost and O&M costs, resulting in highest lifecycle cost