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Revision: R01

June 20, 2025

Phase 2: Servicing Study Report (FINAL)

Black Bear Ridge Development Servicing

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

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Table of Contents

List of Figures

List of Tables

List of Appendices

1.0 Introduction

1.1 Background

J.L. Richards & Associates Limited (JLR) was retained by the City of Belleville (Belleville / City) to complete the Black Bear Ridge (BBR) Servicing Study. The Servicing Study identified existing conditions of Belleville's water and wastewater infrastructure and future upgrades needed to accommodate future growth in Belleville and potential future service connection areas. This Servicing Study was completed in accordance with the Ministry of Environment, Conservation and Parks (MECP) Guidelines for Drinking Water Systems and MECP Design Guidelines for Sewage Works. The ultimate objective of the Servicing Study was to develop a strategy to accommodate future growth in the City and future service connection areas, such as Foxboro, Corbyville Village (Corbyville), Harmony School, and BBR, from 2023 to 2051 and beyond.

In 2019, JLR completed the Belleville Wet Weather and Wastewater Servicing Master Plan which assessed the impact of projected future development to existing wastewater infrastructure and identified conceptual-level upgrade requirements. The Belleville Wet Weather and Wastewater Servicing Master Plan was used as the basis of reference for the wastewater conveyance, pumping and treatment components of this Servicing Study.

The Design Basis Report (Phase 1) of the Servicing Study was prepared to document future growth projections and potential future service areas and analyze existing water demands and wastewater flows generated within the City of Belleville. This Servicing Study Report (Phase 2) includes anticipated water and wastewater infrastructure projects recommended to service future growth.

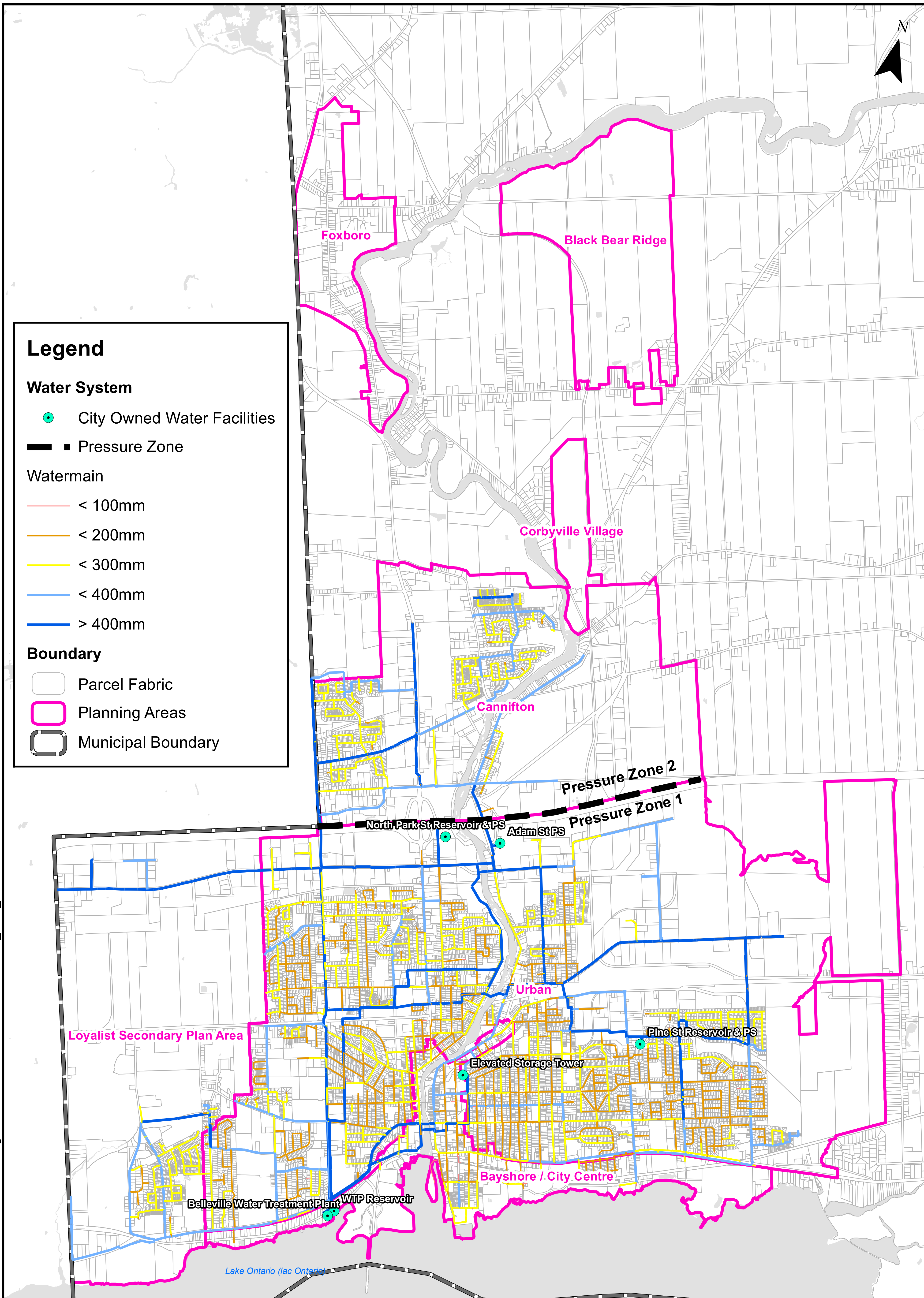
Belleville is located along the Highway 401 corridor, on the Moira River and Bay of Quinte. Belleville borders the City of Quinte West and the Township of Tyendinaga in Hastings County. The primary source of drinking water for Belleville is the Bay of Quinte. The Belleville Drinking Water System is operated under Drinking Water Works Permit No. 151-201, Issue No.4, dated December 16th, 2020, and Municipal Drinking Water License No. 151-101, Issue No. 5, dated December 16th, 2020. The Belleville Drinking Water System includes one water treatment plant: the Gerry O'Connor Water Treatment Plant (WTP). The City's WTP draws raw water from the Bay of Quinte through intake pipes located at 2 Sidney Street, it has a maximum daily rated capacity of 72,700 m^3/day and includes filtration and disinfection. Belleville's water supply and distribution system consists of:

- Gerry O'Connor Water Treatment Plant with In-Ground Reservoir
- The John Street Elevated Water Storage Tank
- The North Park Street In-Ground Reservoir and Booster Pumping Station
- The Pine Street In-Ground Reservoir and Booster Pumping station
- The Adam Street Booster Pumping Station
- Over 224 km of watermains and 1,254 hydrants

The treated water distribution system consists of two main pressure zones: Pressure Zone 1 and Pressure Zone 2, which generally refers to serviced areas south and north of Highway 401, respectively. Pressure Zone 1 includes the John Street Elevated Tank, North Park Street

Reservoir and BPS, and Pine Street Reservoir and BPS. The John Street Elevated Tank maintains the hydraulic grade line and required water storage within the distribution system. Pressure Zone 2 is serviced by the Adam Street BPS. Belleville's existing key water infrastructure is shown in Figure 1.

The City's wastewater system consists of approximately 200 km of gravity sewer, one major pressure sewer, three main pumping stations, 10 smaller sub-area pumping stations, and a single wastewater treatment plant that provides secondary treatment and disinfection to wastewater prior to discharging to the Bay of Quinte. Refer to Figure 2 for an overview of key wastewater infrastructure. The Belleville Wastewater Treatment Plant (WWTP) is owned by the City and is located at 131 St. Paul Street in Belleville, ON. The WWTP is currently operated by the Ontario Clean Water Agency (OCWA), has a rated average day capacity of 54,500 m^3/d. The WWTP is operated under Amended Environmental Compliance Approval (ECA) No. 2178-B2ZLM8, dated May 30th, 2019. The City's wastewater collection system is made up of sanitary sewer ranging in diameters from 100 mm to 1500 mm. The municipal sewage collection system operates under ECA No. 151-W601, dated October 6, 2022.



PROJECT:

Black Bear Ridge Servicing Study

Belleville, Ontario

DRAWING:

Belleville Drinking Water Distribution System and Key Infrastructure

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DESIGN:	RC
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CHECKED:	SS
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Figure 1

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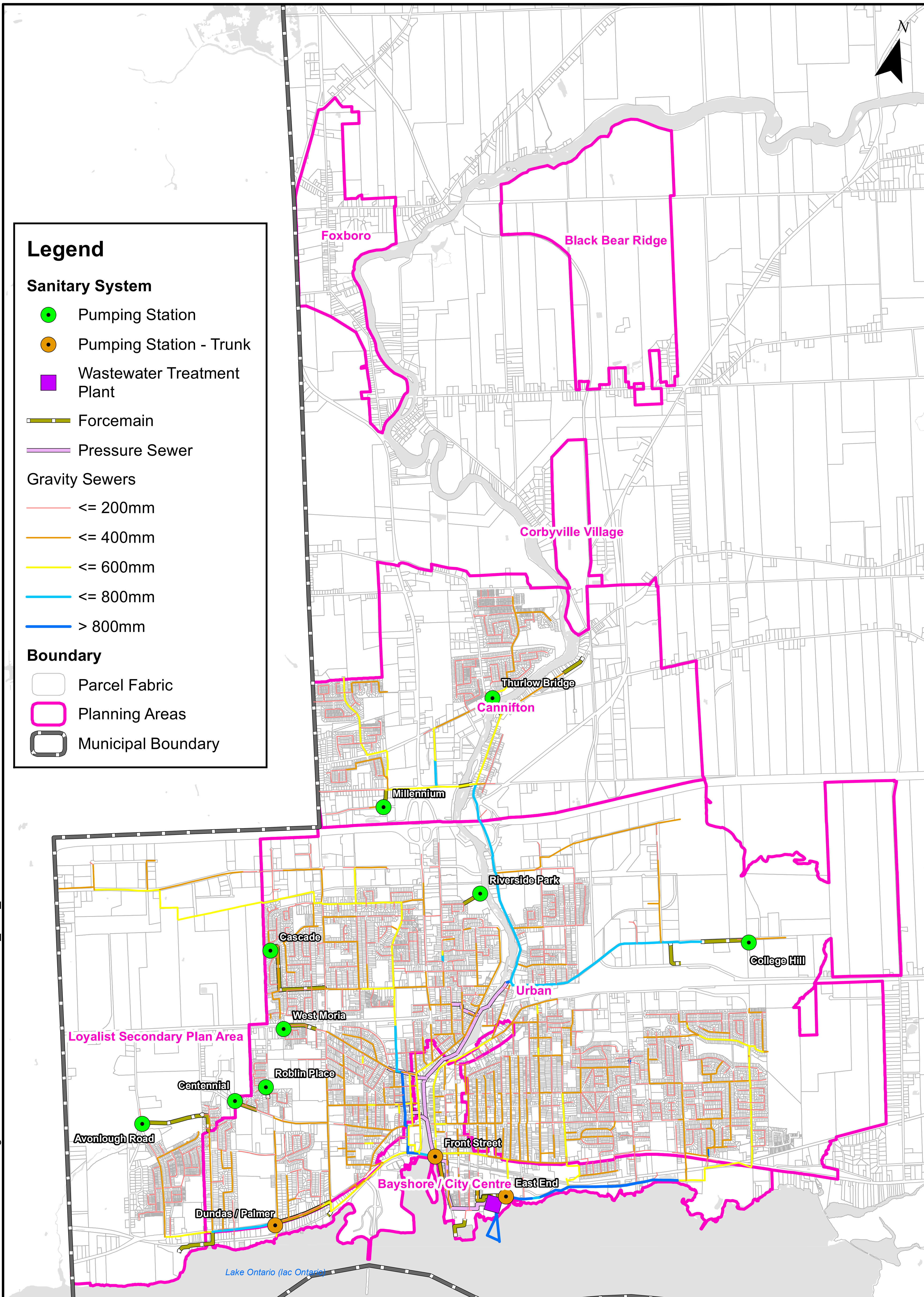

PROJECT:

Black Bear Ridge Servicing Study
Belleville, Ontario

DRAWING:

Wastewater Treatment and Collection Network - Key Infrastructure

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DRAWING #:
Figure 2

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1.2 Objectives of Servicing Study

The objective of this Servicing Study is to identify and evaluate alternative solutions to determine the preferred servicing solution for the City, Black Bear Ridge (BBR), and potential future service areas. Options considered include new construction, potential retrofits, and/or potential upgrades to the City's water and wastewater infrastructure.

The objectives of the Servicing Study are:

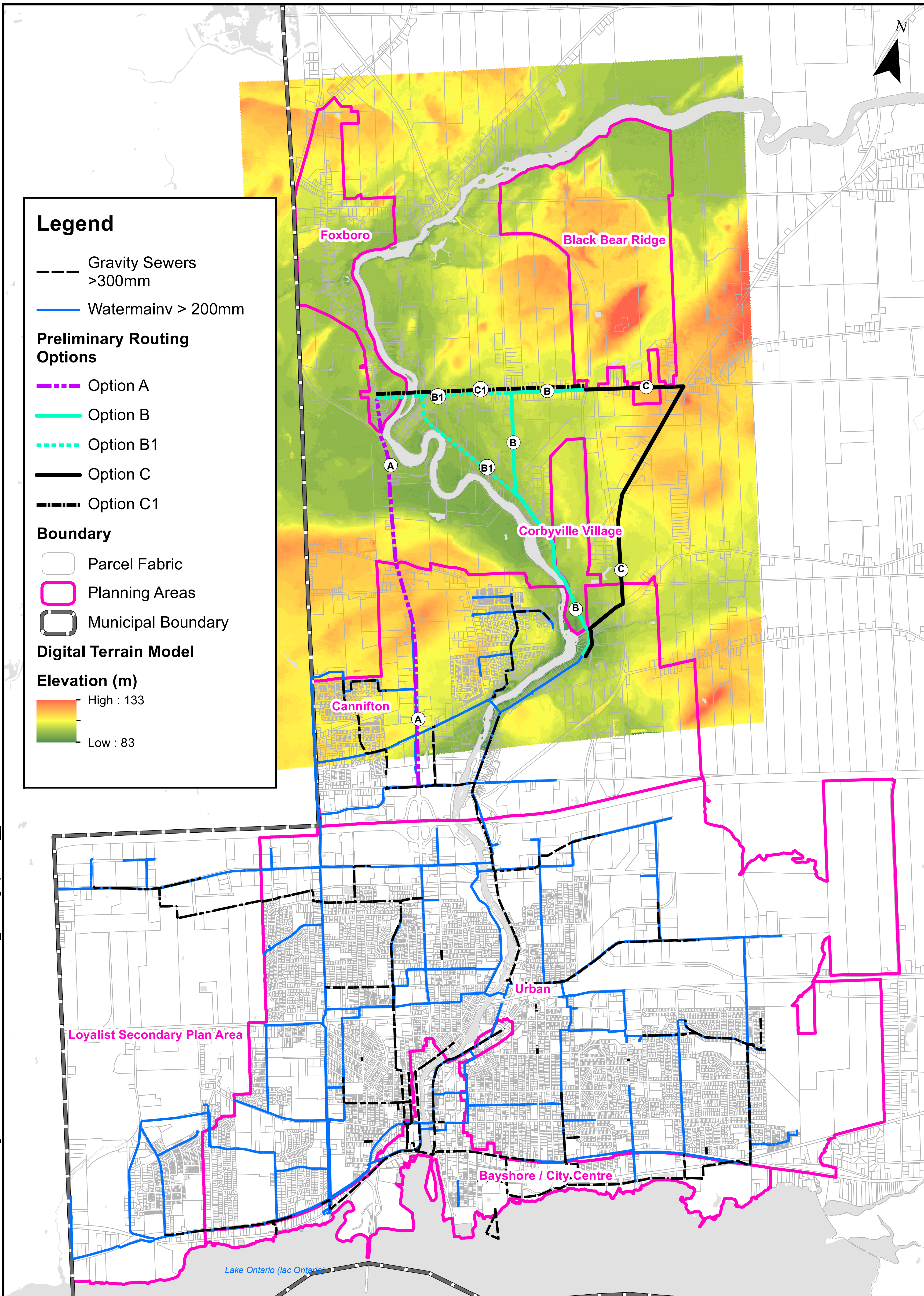
- To determine the feasibility of water and wastewater service routing to future service areas (including BBR, Harmony School, Corbyville Village, and Foxboro) and update the Design Basis population and demand/flow projections.
- To identify proposed water distribution pressure zone delineation for the City, Black Bear Ridge, and future service areas.
- To identify residual capacity for the City's booster pumping stations and establish upgrades required in the short-, mid-, and long-term.
- To model future water distribution and wastewater collection under **Scenario 1** (Projected growth within the City and Corbyville) and **Scenario 2** (Scenario 1 with connection to Black Bear Ridge, Foxboro, and Harmony School).
- To identify required upgrades to the water and wastewater systems in the short-, mid, and long-term.
- To identify required upgrades triggered by Black Bear Ridge in the short-, mid-, and long-term.
- To identify and evaluate alternative water distribution and wastewater collection alignments for connection to future service areas.
- To utilize an evaluation matrix to evaluate alignment options according to technical, financial, and environmental considerations.
- To recommend an overall implementation plan with associated cost estimates and proposed timelines.
- To quantify cost-sharing of infrastructure projects between the City, Black Bear Ridge, and others.

2.0 Preliminary Water and Sanitary Service Route

2.1 Preliminary Routing Options

The extent of existing water distribution and sanitary collection systems includes Cannifton and planning areas south of Highway 401. The evaluation of preliminary routing options considered future servicing to Black Bear Ridge, Foxboro, and Corbyville Village.

Preliminary water and wastewater service routes were developed and evaluated based on (1) technical feasibility of providing water and sanitary services beyond the current servicing boundary using topography and existing right-of-way and easements, and (2) ability to reach the greatest service population. According to a project team meeting between JLR, City and Black Bear Ridge on November 18, 2024, it has been agreed that the same alignment would be used for water and sanitary routing. It was also discussed that topography change affects sanitary servicing more than water servicing.



PROJECT:

Black Bear Ridge Servicing Study
Belleville, Ontario

DRAWING:

PRELIMINARY WATER AND SANITARY ROUTING OPTIONS

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Figure 3

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2.2 Initial Screening

- **Option A - Connection to Foxboro via County Road 62**: Sanitary collection from Foxboro would need to be conveyed to Cannifton, which lies at a higher elevation. A steep elevation change occurs north of the Cannifton boundary. **Option A was not recommended** due to topographical challenges. This option also only provides servicing to Foxboro, which has the lowest population out of all potential service areas.

- **Option B - Connection to Corbyville Village and Black Bear Ridge via River Road, Plumpton Road, and Harmony Road:** Sanitary collection can generally be accommodated by gravity, to be verified by sanitary modelling in Section 10.0 of this Report. **Option B was recommended to be carried forward.**
    - **Option B1** includes a connection to Foxboro via River Road and Harmony Road. An additional 2km is needed to include Foxboro to provide servicing to 307 people. **Option B1 was not recommended** to prioritize servicing to Corbyville and Black Bear Ridge.

- **Option C - Connection to Corbyville Village and Black Bear Ridge via Highway 37**: This option provides servicing to priority service areas. Sanitary collection from Black Bear Ridge would need to be forced up to the higher elevations on the east end of Black Bear Ridge. Black Bear Ridge's preliminary sanitary plan currently includes sewage pumping stations at the existing golf course entrance (501 Harmony Road) and approximately 450m east of the existing golf course entrance. Sanitary collection from Corbyville Village can generally be accommodated by gravity, to be verified by sanitary modelling in Section 10.0 of this Report. **Option C was recommended to be carried forward.**

    - **Option C1:** includes an extension on Harmony Road to service Foxboro. An additional 2km is needed to include Foxboro to provide servicing to 307 people. **Option C1 was not recommended** to prioritize servicing to Corbyville and Black Bear Ridge.

Table 1 summarizes the results of initial screening presented to the City and Black Bear Ridge. Through initial screening, it was recommended that **servicing to Foxboro should not be carried forward at this time but may be considered in the future.**

Table 1: Initial Screening Summary – Service Routing Options

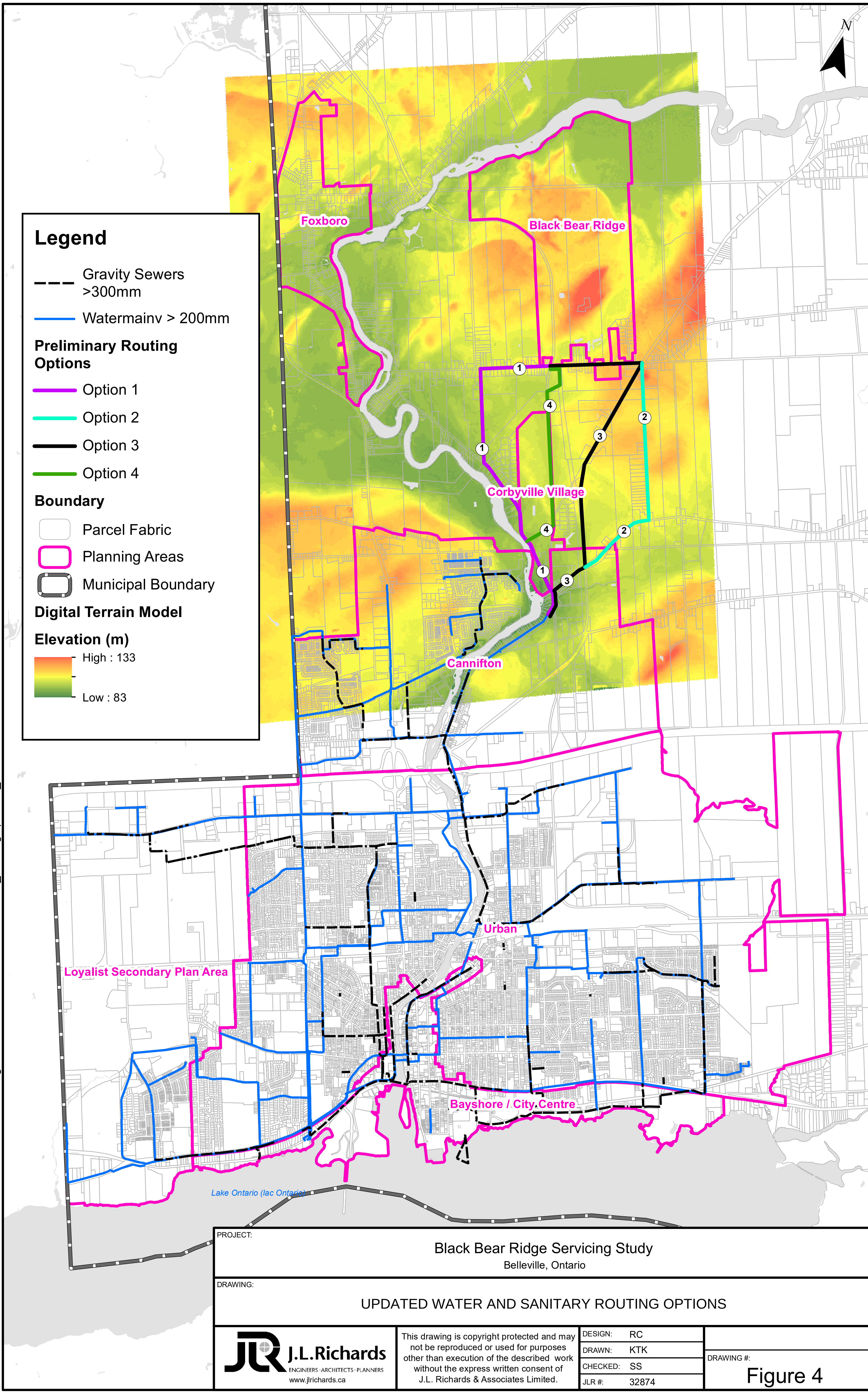
Option	Description	Initial Screening Result	
A	Connection to Foxboro via County Road 62.	✗	Not feasible. Small service population added. Servicing to Foxboro and option not carried forward
B	Connection to Corbyville Village and Black Bear Ridge via River Road, Plumpton Road, and Harmony Road.	✓	Carried forward. Feasibility to be verified in water and wastewater model
B1	Option B with connection to Foxboro via Harmony Road.	✗	Small service population added. Servicing to Foxboro and option not carried forward
C	Connection to Corbyville Village and Black Bear Ridge via Highway 37	✓	Carried forward. Feasibility to be verified in water and wastewater model
C1	Option C with connection to Foxboro via Harmony Road.	✗	Small service population added. Not carried forward.

2.3 Updated Routing Options

Following the November 18, 2024 meeting, City has provided JLR with the following updated service routing options, shown in Figure 4, in order to optimize servicing routing options to Black Bear Ridge and Corbyville Village:

- Option 1: Plumpton Road
- Option 2: Ritz Road
- Option 3: Highway 37
- Option 4: Through Corbyville.

A detailed evaluation and selection of a preferred option will be completed in Section 1.1.



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3.0 Design Basis (Phase 1 Report) Update

3.1 Zone Delineation for Water Distribution

The City's existing water distribution system is divided into two pressure zones; Zone 1 includes serviced areas south of Highway 401 and Zone 2 includes serviced areas north of Highway 401 (Cannifton). The addition of Corbyville Village and Black Bear Ridge to the City's existing servicing areas required review of the City's pressure zone delineation. Boosting would be required for all proposed alignment options in order to convey water to Black Bear Ridge, which is situated on a higher elevation relative to Corbyville Village. Therefore, it has been proposed that Black Bear Ridge be placed in a separate pressure zone, and that the City's water distribution system be divided into three zones:

- **Zone 1:** Bayshore / City Centre, Urban Area, Loyalist Secondary Plan Area, and Avonlough (No change to existing Zone 1 boundary);
- **Zone 2:** Cannifton and Corbyville Village, and
- **Zone 3:** Black Bear Ridge and Harmony School.

The pressure zone delineation as described above was used to identify water storage, booster station, and watermain upgrades.

3.2 Population Projection

The population projection from the Design Basis (Phase 1) Report has been updated to align with the future servicing boundary and to identify water and sanitary servicing requirements from each zone. Table 2 summarizes the serviced population projection under Scenario 1 (City) and Table 3 summarizes the serviced population projection under Scenario 2 (City + BBR).

There were no updates to the Institutional, Commercial, and Industrial (ICI) growth. Refer to the Phase 1: Design Basis Report for ICI design basis and methodology.

3.2.1 Alternate Projection for Black Bear Ridge

For the purposes of this study, 3 P.P.U. was used to project the Black Bear Ridge serviced population, in alignment with the Functional Servicing Report (Jewell Engineering, 2024). Population projections for BBR applying the same population densities used for the City was also considered. Further refinements to ICI development plans were also provided by BBR. A sensitivity analysis was done to provide a high-level summary of impacts of the alternate population and ICI projection on recommended projects listed in Section 11.0. The sensitivity analysis is provided in Appendix D.

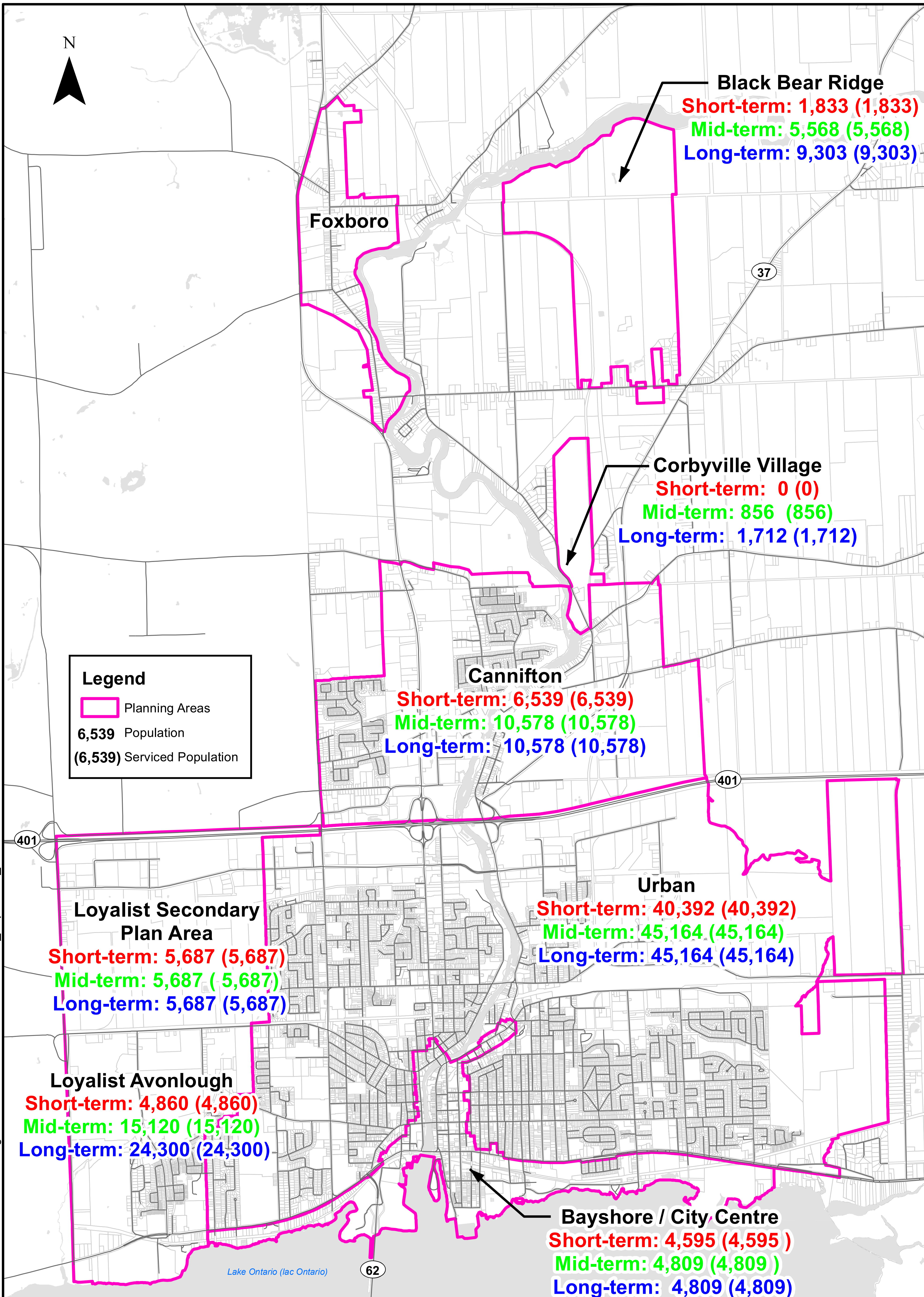
The population projection listed in Table 2 and 3 and the ICI projections provided in the Design Basis Report were used for this Servicing Study.

Table 2: Updated Serviced Population (cap.) – Scenario 1: City

	Existing	Short-Term	Mid-Term	Long-Term
	(2023)	**(2023-2033)**	**(2033-2043)**	**(2043-2051)**
Zone 1				
Bayshore / City Centre	3,325	4,595	4,809	4,809
Urban Area	37,292	40,392	45,164	45,164
Loyalist Secondary Plan Area	2,894	5,687	5,687	5,687
Avonlough	-	4,860	15,120	24,300
Sub-total (Zone 1)	**43,511**	**55,534**	**70,780**	**79,960**
Zone 2				
Cannifton	5,471	6,539	10,578	10,578
Corbyville Village	-	0	856	1,712
Sub-total (Zone 2)	**5,471**	**6,539**	**11,434**	**12,290**
Zone 3				
Black Bear Ridge	-	-	-	-
Sub-total (Zone 3)	**0**	**0**	**0**	**0**
TOTAL	**48,982**	**62,073**	**82,214**	**92,250**

Table 3: Updated Serviced Population (cap.) – Scenario 2: City + BBR

	Existing	Short-Term	Mid-Term	Long-Term
	(2023)	**(2023-2033)**	**(2033-2043)**	**(2043-2051)**
Zone 1				
Bayshore / City Centre	3,325	4,595	4,809	4,809
Urban Area	37,292	40,392	45,164	45,164
Loyalist Secondary Plan Area	2,894	5,687	5,687	5,687
Avonlough	-	4,860	15,120	24,300
Sub-total (Zone 1)	**43,511**	**55,534**	**70,780**	**79,960**
Zone 2				
Cannifton	5,471	6,539	10,578	10,578
Corbyville Village	-	0	856	1,712
Sub-total (Zone 2)	**5,471**	**6,539**	**11,434**	**12,290**
Zone 3				
Black Bear Ridge	-	1,833	5,568	9,303
Sub-total (Zone 3)	**0**	1,833	5,568	9,303
TOTAL	**48,982**	**63,906**	**87,782**	**101,553**



Footnotes:
1) Population counts are cumulative.
2) Counts do not include Statistics Canada undercoverage rate.
3) Black Bear Ridge Population Serviced under Scenario 2 only.

PROJECT:

Black Bear Ridge Servicing Study
Belleville, Ontario

DRAWING:

UPDATED RESIDENTIAL POPULATION PROJECTION

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DESIGN:	RC
DRAWN:	KTK
CHECKED:	SS
JLR #:	32874

DRAWING #: Figure 5

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4.0 Water Treatment Plant Expansion Update

There were no updates to the water demand for Scenario 1 – City Growth. For reference, the water demand calculation results from Phase 1 are shown in Table 5. Demand from Foxboro was eliminated from Scenario 2. The design parameters in Table 4 were used to calculate the updated future water demand for Scenario 2 - City+BBR (Table 6).

Table 4: Design Parameters – Future Water Demand

Parameter	Residential	Industrial / Commercial / Institutional (ICI)
Average Day Flow (1)	350 L/cap/day	Industrial (35,000 L/ha/day)
		Commercial (28,000 L/ha/day)
		Institutional (28,000 L/ha/day)
		School (105 L/student/day)
		Hotel (225 L/bed space/day)
Maximum Day Flow	1.4 x Average Day	1.4 x Average Day
Peak Hour Flow (3)	1.5 x Maximum Day	1.5 x Maximum Day
(1) MECP Design Guidelines for Drinking Water Systems Table 3-2 for ICI water demand and Section 3.4.2 for residential water demand. (2) MECP Design Guidelines for Drinking Water Systems Table 3-1		

Table 5: Future Water Demand - Scenario 1: City

	Existing (2023)	Short-Term (2023-2033)	Mid-Term (2033-2043)	Long-Term (2043-2051)
Total Population (cap)	48,982	62,073	82,214	92,250
Total Population Growth (cap)		13,091	20,141	10,036
Institutional, Commercial, Industrial (ICI) Growth (ha)			484	
Residential Average Day Demand (ADD) Growth (m^3/d)		4,582	7,049	3,513
ICI ADD Growth (m^3/d)			13,615	0
Total ADD Growth (m^3/d)		4,582	20,664	3,513
Total ADD (m^3/d)	21,589	26,170	46,834	50,347
Total Maximum Day Demand (MDD) (m^3/d)	30,310	36,639	65,568	70,486
WTP Rated Capacity (m^3/d)	72,700			
Surplus (m^3/d)	42,390	36,061	7,132	2,214

Table 6: Future Water Demand – Scenario 2: City + BBR

	Existing (2023)	Short-Term (2023-2033)	Mid-Term (2033-2043)	Long-Term (2043-2051)
Total Population (cap)	48,982	63,906	87,782	101,553
Population Growth (cap)		14,924	23,876	13,771
Institutional, Commercial, Industrial (ICI) Growth (ha)		18	484	
School (Students)		900		
Hotel (Bed Spaces)		500		
Residential Average Day Demand (ADD) Growth (m^3/d)		5,223	8,357	4,820
ICI ADD Growth (m^3/d)		711	13,565	
Total ADD Growth (m^3/d)		5,934	21,921	4,820
Total ADD (m^3/d)	21,589	27,523	49,444	54,264
Total Maximum Day Demand (MDD) (m^3/d)	30,310	38,532	69,222	75,970
WTP Rated Capacity (m^3/d)	72,700			
Surplus (m^3/d)	**42,390**	**34,168**	**3,478**	**-3,270**

The rated capacity of the Water Treatment Plant (WTP) can accommodate anticipated growth in the City (Scenario 1). The additional demand from BBR (Scenario 2) will result in a WTP expansion in the long-term. Figure 6 represents the projected maximum day water demand and anticipated timing to reach 80%, 90% and 100% of the WTP capacity:

- Under Scenario 1:
    - 80% capacity will be reached in 2040
    - 90% capacity will be reached in 2043
    - 100% capacity will not be reached by 2051, based on projected growth.
- Under Scenario 2:
    - 80% capacity will be reached in 2039
    - 90% capacity will be reached in 2042
    - 100% capacity will be reached in 2046.

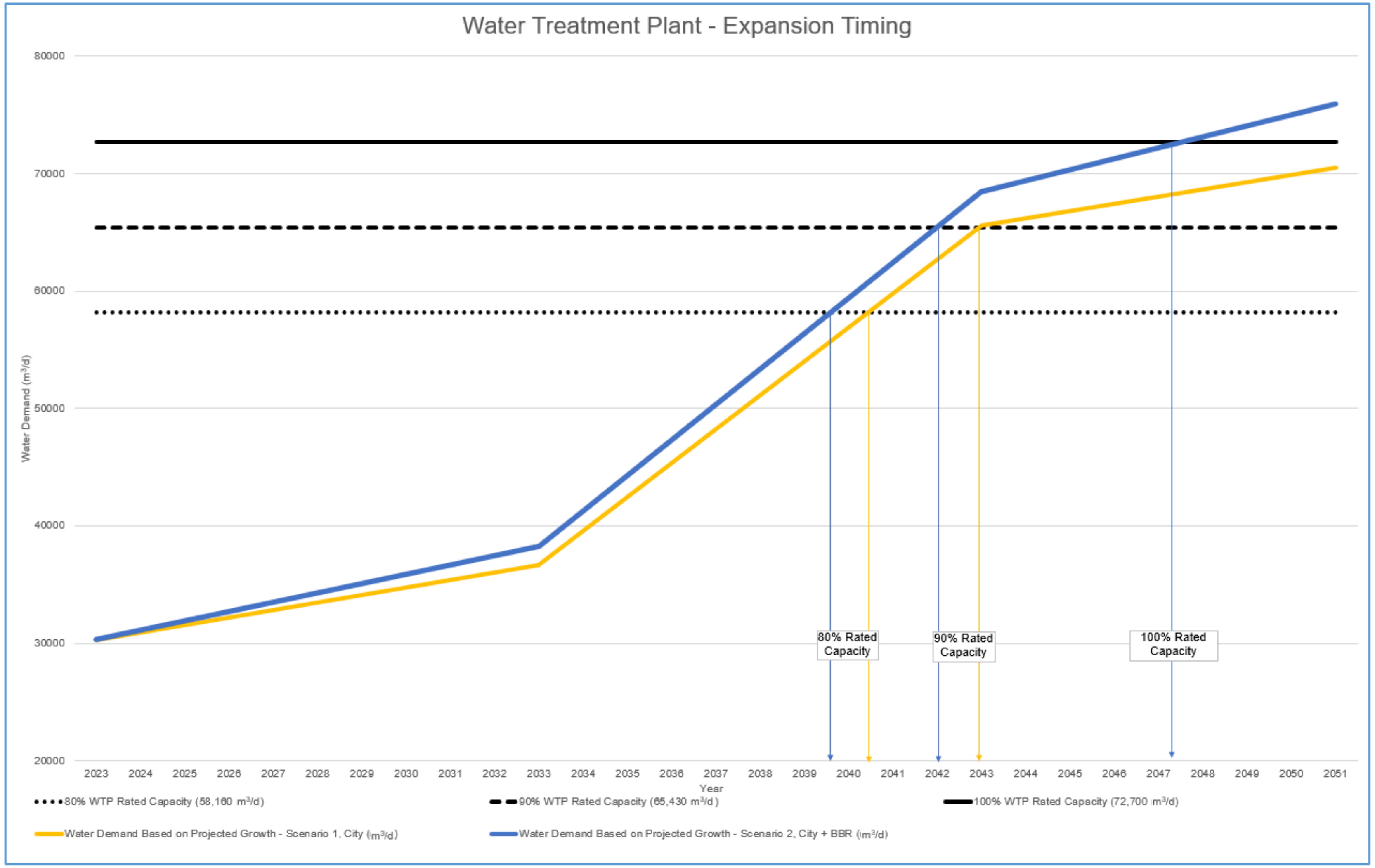

Figure 6: Water Treatment Plant Expansion Timing

5.0 Wastewater Treatment Plant Expansion Update

There were no updates to the wastewater flows for Scenario 1 – City Growth. For reference, the wastewater flow calculation results from Phase 1 are shown in Table 7. Wastewater flows from Foxboro was eliminated from Scenario 2 – City + BBR. The updated wastewater flows are shown in Table 8.

Table 7: Future Wastewater Demand – Scenario 1: City

	Existing (2023)	Short-Term (2023-2033)	Mid-Term (2033-2043)	Long-Term (2043-2051)
Total Population (cap)	48,982	62,073	82,214	92,250
Total Population Growth (cap)		13,091	20,141	10,036
Institutional, Commercial, Industrial (ICI) Growth (ha)			484	
Residential Average Day Flow (ADF) Growth (m^3/d)		4,582	7,049	3,513
ICI ADF Growth (m^3/d)			13,565	
Total ADF Growth (m^3/d)		4,582	20,614	3,513
Total ADF (m^3/d)	29,997	34,579	55,193	58,705
WWTP Rated Capacity (m^3/d)	54,500			
Surplus (m^3/d)	**24,503**	**19,921**	**-693**	**-4,205**

Table 8: Future Wastewater Generation – Scenario 2: City + BBR

	Existing (2023)	Short-Term (2023-2033)	Mid-Term (2033-2043)	Long-Term (2043-2051)
Total Population (cap)	48,982	63,906	87,782	101,553
Total Population Growth (cap)		14,924	23,876	13,771
Institutional, Commercial, Industrial (ICI) Growth (ha)		18	484	
School (Students)		900		
Hotel (Bed Spaces)		500		
Residential Average Day Flow (ADF) Growth (m^3/d)		5,223	8,357	4,820
ICI ADF Growth (m^3/d)		711	13,565	
Total ADF Growth (m^3/d)		5,934	21,921	4,820
Total ADF (m^3/d)	29,997	35,931	57,853	62,672
WWTP Rated Capacity (m^3/d)	54,500			
Surplus (m^3/d)	24,503	18,569	-3,353	-8,172

The rated capacity of the WWTP will be exceeded in the mid-term under both scenarios. Figure 7 represents the projected maximum day wastewater flows and anticipated timing to reach 80%, 90% and 100% of the WWTP capacity:

- Under Scenario 1:
  - 80% capacity will be reached in 2037;
  - 90% capacity will be reached in 2040, and
  - 100% capacity will be reached in 2042.
- Under Scenario 2:
  - 80% capacity will be reached in 2036;
  - 90% capacity will be reached in 2039, and
  - 100% capacity will be reached in 2041.

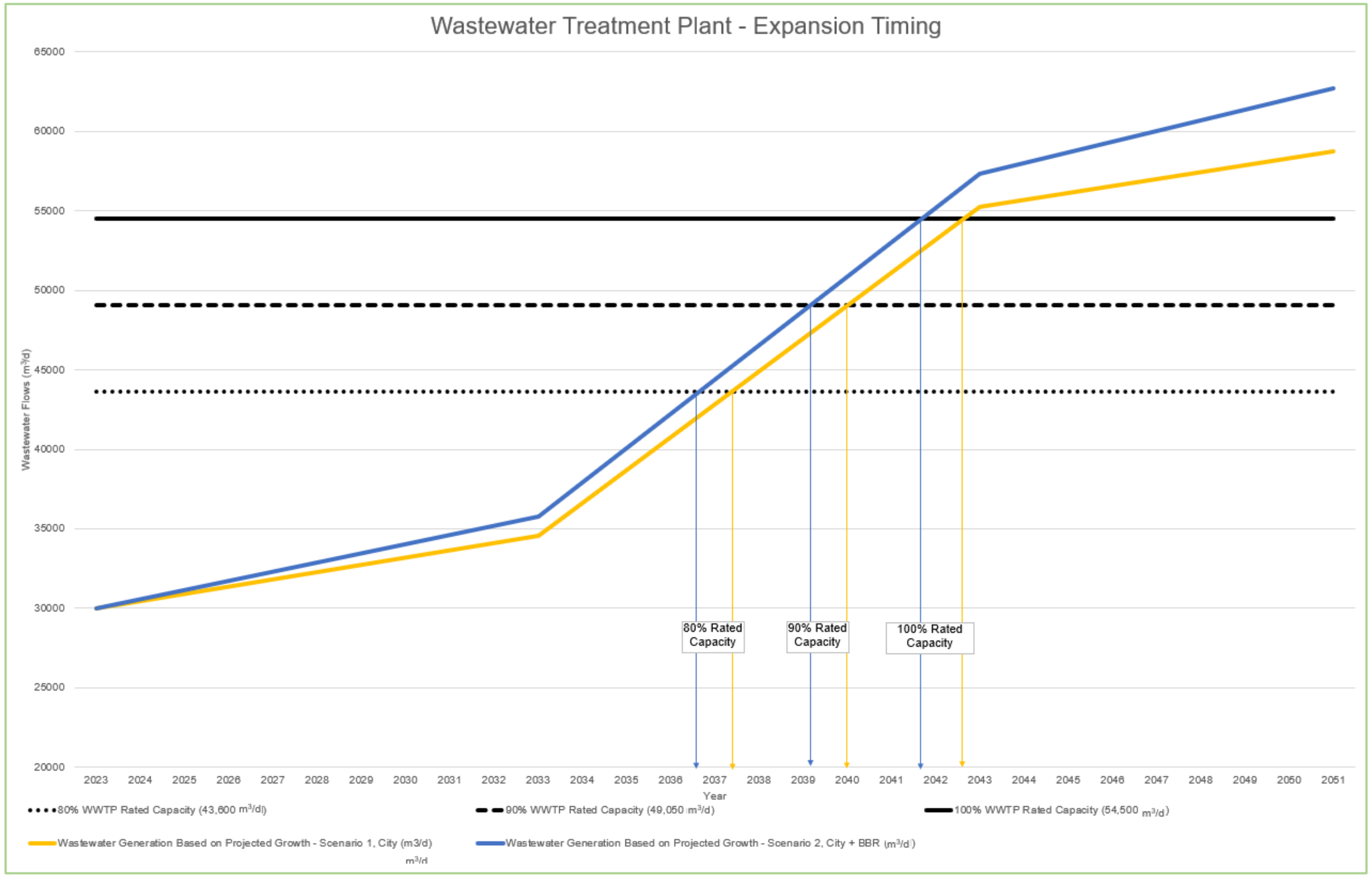

Figure 7: Wastewater Treatment Plant Expansion Timing

6.0 Treated Water Storage

6.1 Existing Conditions

Refer to the Phase 1 report for a detailed description of the City's current water storage infrastructure. Pressure Zone 1 storage exists at the WTP reservoir and high lift pump wells, John Street Elevated Tank, North Park Street Reservoir, and Pine Street Reservoir. Pressure Zone 2 draws from Zone 1 through the Adam Street BPS and does not have a dedicated treated water storage facility.

This Servicing Study considered alternatives, such as storage downstream of Adam Street BPS (i.e., Zone 3), to identify a strategy that will provide adequate storage for the City and BBR. The same methodology described in Section 4.0 of the Design Basis Report was used to calculate the total treated water storage requirement for each pressure zone, however this report will calculate storage requirements for each zone separately. Per MECP Design Guidelines for Drinking-Water Systems (2008), total available treated water storage within the system should at least amount to the sum of the required fire storage (A), equalization storage (B), and emergency storage (C) allowances. The storage requirement under existing conditions was updated with the following assumptions:

- The total existing average daily demand (ADD) was divided proportionally by serviced population between Zone 1 and Zone 2 to generate water demands in each zone.
- Per MECP requirements, an additional storage equivalent to 25% maximum daily demand (MDD) of the upper zone would be needed in the lower zone.

The updated storage requirement for existing conditions is shown in Table 9. Under existing conditions, the City has adequate storage in Zone 1. However, Zone 2 has a deficit of 3,292 m^3 of storage.

Table 9: Existing Treated Water Storage Requirement by Zone

	Zone 1	Zone 2	Total
Population	43,511	5,471	48,982
% of Total Population	89%	11%	100%
ADD (m^3/d)	19,178	2,411	21,589
MDD (m^3/d)	26,848	3,376	
Cumulative Equivalent Population	54,793	6,890	
Fire Flow (L/s)	378	166	
Duration (Hours)	6	3	
A – Fire Storage (m^3)	8,165	1,789	
B – Equalization Storage (m^3)	6,712	844	
C – Emergency Storage (m^3)	3,719	658	
Storage Requirement Per Zone (m^3)	18,596	3,292	
Additional Storage Requirement for Upper Zone (m^3) - 25% of MDF	844	0	
Total Required Storage	**19,440**	**3,292**	
Existing Available Storage (m^3)	26,614	0	
Surplus (m^3)	**7,174**	**-3,292**	

6.2 Future Conditions

Table 10 to Table 12 summarizes the storage requirement for each zone in the short-, mid-, and long-term. With Scenario 2 in effect, additional storage will be required in the lower zones compared to Scenario 1, due to the additional 25% MDD storage requirement. Based on the updated zone delineation, Zone 1 carries additional storage for Zone 2 and 3 and Zone 2 carries additional storage for Zone 3. Zone 1 will begin to experience storage deficiencies in the mid-term under both scenarios.

Table 10: Short-Term Treated Water Storage Requirements

	Scenario 1: City			**Scenario 2: City + BBR**		
	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
Cumulative Equivalent Population	66,815	7,957	0	66,815	7,957	3,864
Fire Flow (L/s)	378	174	0	378	174	123
Duration (Hours)	6	3	0	6	3	2
A – Fire Storage (m^3)	8,165	1,876	0	8,165	1,876	885
B – Equalization Storage (m^3)	8,185	975	0	8,185	975	473
C – Emergency Storage (m^3)	4,087	713	0	4,087	713	340
Storage Requirement Per Zone (m^3)	20,437	3,563	0	20,437	3,563	1,698
Additional Storage Requirement for Upper Zone (m^3) - 25% of MDD	975	0	0	1,448	473	0
Total Required Storage	**21,412**	**3,563**	**0**	**21,885**	**4,037**	**1,698**
Existing Available Storage (m^3)	26,614	0	0	26,614	0	0
Surplus (m^3)	**5,202**	**-3,563**	**0**	**4,729**	**-4,037**	**-1,698**

Table 11: Mid-Term Treated Water Storage Requirements

	Scenario 1: City			Scenario 2: City + BBR		
	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
Cumulative Equivalent Population (1)	100,581	33,088		100,581	33,088	7,599
Fire Flow (2) (L/s)	378	348		378	348	171
Duration (2) (Hours)	6	5		6	5	3
A – Fire Storage (3) (m^3)	8,165	6,271		8,165	6,271	1,847
B – Equalization Storage (4) (m^3)	12,321	4,053		12,321	4,053	931
C – Emergency Storage (5) (m^3)	5,121	2,581		5,121	2,581	694
Storage Requirement Per Zone (m^3)	25,607	12,905		25,607	12,905	3,472
Additional Storage Requirement for Upper Zone (m3) - 25% of MDF	4,053	0		4,984	931	0
Total Required Storage	29,661	12,905		30,592	13,836	3,472
Existing Available Storage (m^3)	26,614			26,614		
Surplus (m^3)	-3,047	-12,905		-3,978	-13,836	-3,472

Table 12: Long-Term Treated Water Storage Requirements

	Scenario 1: City			Scenario 2: City + BBR		
	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
Cumulative Equivalent Population (1)	109,761	33,944		109,761	33,944	11,692
Fire Flow (2) (L/s)	378	352		378	352	206
Duration (2) (Hours)	6	5		6	5	3
A – Fire Storage (3) (m^3)	8,165	6,337		8,165	6,337	2,230
B – Equalization Storage (4) (m^3)	13,446	4,158		13,446	4,158	1,432
C – Emergency Storage (5) (m^3)	5,403	2,624		5,403	2,624	916
Storage Requirement Per Zone (m^3)	27,013	13,119		27,013	13,119	4,578

	Scenario 1: City			Scenario 2: City + BBR		
	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
Additional Storage Requirement for Upper Zone (m3) - 25% of MDF	4,158	0		5,590	1,432	0
Existing Available Storage (m^3)	31,171	13,119		32,604	14,551	4,578
Total Required Storage	26,614			26,614		
Surplus (m^3)	-4,557	-13,119		-5,990	-14,551	-4,578

6.3 Summary of Recommendations

Table 13 summarizes the additional storage required for each zone for the short-, mid-, and long-term. Proposed implementation and phasing are presented at the end of this report.

Table 13: Summary of Additional Storage Requirements in m^3

	Short-Term (2023 – 2033)		Mid-Term (2033 – 2043)		Long-Term (2043 – 2051)	
Scenario	**1**	**2**	**1**	**2**	**1**	**2**
	City	**City + BBR**	**City**	**City + BBR**	**City**	**City + BBR**
Zone 1	-	-	-3,047	-3,978	-4,557	-5,946
Zone 2	-3,563	-4,037	-12,905	-13,836	-13,119	-14,507
Zone 3	-	-1,698	-	-3,472	-	-4,473

7.0 Booster Stations

7.1 Water Demand by Pressure Zone

In order to calculate booster station requirements, the average day water demand (ADD) and maximum day water demand (MDD) was determined for each zone. The ADD and MDD for each zone summarized in Table 16 was based on the updated water demand discussed in Section 4.0.

Table 14: Water Demand by Pressure Zone

	Existing	Short-Term (2023 – 2033)		Mid-Term (2033 – 2043)		Long-Term (2043 – 2051)	
Scenario		**1**	**2**	**1**	**2**	**1**	**2**
	City	**City**	**City + BBR**	**City**	**City + BBR**	**City**	**City + BBR**
Residential Growth ADD (m^3/d)							
Zone 1	-	4,208	4,208	5,336	5,336	3,213	3,213
Zone 2	-	374	374	1,713	1,713	300	300

Zone 3	-	-	642	-	1,307	-	1,307
Subtotal Residential ADD Growth	-	4,582	5,223	7,049	8,357	3,513	4,820
ICI Growth ADD (m^3/d)							
Zone 1	-	0	0	6,482	6,482	0	0
Zone 2	-	0	0	7,083	7,083	0	0
Zone 3	-	0	711	0	0	0	0
Subtotal ICI ADD Growth	-	0	711	13,565	13,565	0	0
Residential + ICI Growth ADD (m^3/d)							
Zone 1	-	4,208	4,208	11,818	11,818	3,213	3,213
Zone 2	-	374	374	8,796	8,796	300	300
Zone 3	-	-	1,353	-	1,307	-	1,307
Cumulative Residential + ICI ADD (m^3/d)							
Zone 1	19,177	23,385	23,385	35,203	35,203	38,416	38,416
Zone 2	2,411	2,785	2,785	11,581	11,581	11,881	11,881
Zone 3	0	-	1,353	-	2,660	-	3,967
TOTAL ADD	**21,589**	**26,170**	**27,523**	**46,784**	**49,444**	**50,297**	**54,264**
Cumulative Residential + ICI MDD (m^3/d)							
Zone 1	26,848	32,739	32,739	49,285	49,285	53,783	53,783
Zone 2	3,376	3,899	3,899	16,213	16,213	16,633	16,633
Zone 3	-	-	1,894	-	3,724	-	5,554
TOTAL MDD	**30,224**	**36,639**	**38,532**	**65,498**	**69,222**	**70,416**	**75,970**

7.2 Existing Conditions

Under the MECP Design Guidelines for Drinking Water Systems, a pumping station's firm capacity is defined as:

1. The capacity of the pumping station with the largest unit out of service if the station supplies a pressure zone with adequate storage available for fire protection and balancing; and,
2. The capacity of the pumping station with the two largest units (including fire pumps, if any) out of service if the pumping station serves a pressure zone that does not have adequate floating storage available and is the sole source of supply in the area.

Table 15 summarizes the total and firm capacities of the City's existing pump stations based on the MECP definitions. As Zone 1 currently carries storage for the City, the pump station capacities fall under definition #1 (largest pump out of service). Zone 2 does not have any existing storage and therefore, the pump capacity falls under definition #2 (two largest pumps out of service). However, the Adam St Booster Station Design Report for the last upgrades indicates that fire flow requirements will be supplemented by the second water supply feed c/w check valve on Sidney St and therefore firm capacity would fall under definition #1. Both scenario's have been shown in the table below.

Table 15: Existing Booster Pumping Station (BPS) Capacities

	Pump Configuration	Total Capacity (ML/d)	Firm Capacity (ML/d)	Standby Capacity (ML/d)
Zone 1				
Belleville WTP High Lift Pump Station[1]	5 pumps @ 240 L/s	72.70	72.70	72.70
North Park St. BPS	3 pumps @ 121.5 L/s	31.49	21.00	21.00
Pine Street BPS	1 pump @ 52.1 L/s 1 pump @ 104.2 L/s 1 pump @ 262.7 L/s	36.20	13.50	22.70
Subtotal Zone 1		**140.39**	**107.20**	**116.39**
Zone 2				
Adam Street BPS	2 pumps @ 160 L/s 1 pump @ 40 L/s	31.10	3.46 (13.8)[2]	3.46
Subtotal Zone 2		**31.10**	**3.46**	**3.46**

Notes:
[1]The indicated total and firm capacity is based on plant capacity, not pump capacity. The plant capacity is the limiting factor.
2 Adam St Booster Station Design Report indicates due to second water supply feed c/w check valve on Sidney St will supplement fire flow requirements and therefore firm capacity is with single largest pump out of commission.

Table 16 summarizes the pumping station deficiencies under future growth, without upgrades to the existing pumps and without storage in Zone 2. ADD and MDD values in Table 16 were based on the findings in Table 14. Improvements were recommended for scenarios where the BPS firm capacity is exceeded by the MDD and the standby capacity is exceeded by the ADD. Scenarios where pump capacity is exceeded are highlighted/bolded in Table 16.

Under existing conditions, the Adam Street BPS (Zone 2) is over capacity as the firm capacity is based on the two largest pumps out of commission. The Adam Street BPS capacity is further exceeded as Zone 2 experiences more growth over time.

Table 16: Existing Booster Pumping Stations under Future Demand (Status Quo)

	ADD (ML/d)	MDD (ML/d)	Floating Storage	Firm Capacity	MDD% of Firm Capacity	Standby Capacity	ADD% of Standby Capacity
Existing							
Zone 1	21.59	30.22	Yes	107.20	28%	116.39	18.5%
Zone 2	2.41	16.77	No	3.46/13.8	**485/122%**	3.46/13.8	70/17.5%
Zone 3	0.00	0.00	No	N/A	N/A	N/A	N/A
Short-Term – Scenario 1: City							
Zone 1	26.17	36.64	Yes	107.20	34%	116.39	22.5%
Zone 2	2.79	18.93	No	3.46/13.8	**548/137%**	3.46	80/20%
Zone 3	0.00	0.00	No	N/A	N/A	N/A	N/A

Short-Term – Scenario 2: City + BBR							
Zone 1	28.85	40.39	Yes	107.20	37%	116.39	25%
Zone 2	4.12	20.18	No	3.46/13.8	**602/150%**	3.46	**119/30%**
Zone 3	1.34	1.87	No	0.00	**0.0%**	0.00	**0.0%**
Mid-Term – Scenario 1: City							
Zone 1	47.49	66.48	Yes	107.20	62%	116.39	41%
Zone 2	12.25	47.99	No	3.46/13.8	**1388/347%**	3.46/13.8	**354/89%**
Zone 3	0.00	0.00	No	N/A	N/A	N/A	N/A
Mid-Term – Scenario 2: City + BBR							
Zone 1	52.78	73.89	Yes	107.20	69%	116.39	45%
Zone 2	14.90	51.70	No	3.46/13.8	**1495/431%**	3.46/13.8	**431/108%**
Zone 3	2.65	3.70	No	0.00	**0.0%**	0.00	**0.0%**
Long-Term – Scenario 1: City							
Zone 1	51.00	71.40	Yes	107.20	66%	116.39	44%
Zone 2	12.55	48.67	No	3.46/13.8	**1408/352%**	3.46/13.8	**363%**
Zone 3	0.00	0.00	No	N/A	N/A	N/A	N/A
Long-Term – Scenario 2: City + BBR							
Zone 1	58.91	71.40	Yes	107.20	77%	116.39	51%
Zone 2	11.88	47.74	No	3.46/13.8	**1568/392%**	3.46/13.8	**477/120%**
Zone 3	0.00	0.00	No	N/A	**0.00%**	0.00	**0.00%**

7.3 Future Conditions

Table 17 summarizes the BPS residual capacities under future growth, with proposed BPS upgrades. It was also assumed that Zone 2 and 3 will have adequate, dedicated treated water storage implemented in the short-term. The BPS capacities were updated and highlighted/bolded in Table 17 as a result of the upgrades listed in Section 7.4.

Table 17: Future Booster Pumping Station Residual Capacity (with Upgrades)

	ADD (ML/d)	MDD (ML/d)	Floating Storage	Firm Capacity (ML/d)	MDD% of Firm Capacity	Standby Capacity (ML/d)	ADD% of Standby Capacity
Short-Term – Scenario 1: City							
Zone 1	26.17	36.64	Yes	107.20	34%	116.39	22.5%
Zone 2	2.79	3.90	Yes	13.82	28%	13.82	20%
Zone 3	0.00	0.00	Yes	N/A	N/A	N/A	N/A
Short-Term – Scenario 2: City + BBR							
Zone 1	28.85	36.64	Yes	107.20	38%	116.39	25%
Zone 2	4.12	5.77	Yes	13.82	42%	13.82	30%
Zone 3	1.34	1.87	Yes	**4.00**	47%	**4.00**	33.5%
Mid-Term – Scenario 1: City							
Zone 1	47.49	66.48	Yes	107.20	62%	116.39	41%
Zone 2	12.25	17.15	Yes	**27.65**	62%	**27.65**	44%
Zone 3	0.00	0.00	Yes	N/A	N/A	N/A	N/A
Mid-Term – Scenario 2: City + BBR							

Zone 1	52.78	73.89	Yes	107.20	69%	116.39	45%
Zone 2	14.90	20.85	Yes	**27.65**	75.5%	**27.65**	54%
Zone 3	2.65	3.70	Yes	4.00	93%	4.00	66%
Long-Term – Scenario 1: City							
Zone 1	51.00	71.40	Yes	107.20	67%	116.39	44%
Zone 2	11.88	16.63	Yes	**27.65**	63.5%	**27.65**	45%
Zone 3	0.00	0.00	Yes	N/A	N/A	N/A	N/A
Long-Term – Scenario 2: City + BBR							
Zone 1	58.91	82.47	Yes	107.20	77%	116.39	51%
Zone 2	16.50	23.10	Yes	**27.65**	83.5%	**27.65**	60%
Zone 3	3.97	5.53	Yes	**8.00**	69%	8.00	49.5%

7.4 Summary of Recommendations

No BPS upgrades were identified in Zone 1. To accommodate future water demand in the City and BBR until 2051, the following projects were recommended to update the firm capacity of the City's booster pumping stations:

1. **Short-Term - New storage in Zone 2 and 3:** With storage in Zone 2, the Adam Street BPS firm capacity can be based on the largest pump out of commission. The Adam Street BPS firm capacity increased from 3.46 ML/d to 17.28 ML/d. Only 22.56% of the Adam Street BPS firm capacity will be used in the short-term. Additional studies are recommended to identify any modifications to the pump equipment and configuration.
2. **Short-Term – New BPS and transmission to Zone 3:** In order to service the short- and mid-term demands from Zone 3, a 4 ML/d BPS is required.
3. **Mid-Term - Zone 2 BPS Upgrades** To accommodate mid-term demands in Zone 2, it's recommended that the firm capacity of the Adam Street BPS be upgraded. This can be achieved by replacing the existing 3.46 ML/d (40 L/s) pump to a 13.82 ML/d pump (160 L/s), for example and provide to 27.65 ML/d firm capacity.
4. **Long-Term –3 BPS Upgrades:**. To accommodate build-out demand in Zone 3, it's recommended that the firm capacity of the Zone 3 BPS be upgraded to 8 ML/d. This can be achieved by adding one 4 ML/d pump, for example.

8.0 Final Water and Sanitary Service Route

8.1 Evaluation Methodology

Following the identification of boosting requirements in each zone and the initial screening process (Section 2.0), a detailed assessment of the updated alignment options (Figure 4) was completed. Evaluation criteria were developed based on a review of the background information, experience on similar projects, and input from City and BBR staff.

Table 18: Summary of Evaluation Criteria

Criteria	Description
Technical Considerations	Constructability, length of construction, risk of rock removal, reliability and security of distribution/conveyance system,
Future Servicing Considerations	Ease of connection to existing infrastructure (e.g., whether gravity sewers are possible),
Access Considerations	Accessibility to alignment during and after construction.
Environmental Impact and Risk	Proximity of works to natural features, natural heritage areas, areas of natural and significant interest, designated natural areas, watercourses and aquatic habitat.
Cost Sharing	Potential for the proposed works to be cost shared with other Developers / Developments.
Capital Cost	Initial construction and engineering costs, based on length of construction, access considerations, and additional routing.
Operation and Maintenance Cost	Asset management costs, based on length of construction and access considerations

Each criterion was assigned a colour to reflect its level of impact relative to other criteria. The relative level of impact for each criterion for each potential solution was then assessed based on the colour weighting system summarized in Table 19. The option that has the least negative impact (or has the strongest positive impact) was recommended as the preferred solution. The seven (7) major criteria were assigned equal weights as they were considered to have equal importance in this evaluation stage.

Table 19: Detailed Evaluation Impact Level and Colouring System

Impact Level	Color	Relative Impact
Strong Positive Impact	Green	Preferred
Minor Impact	Yellow	Less Preferred
Strong Negative Impact	Red	Least Preferred

8.2 Selection of Preferred Alternative

Table 20 summarizes the findings of the detailed evaluation of each alignment option. Option 1 – Servicing to BBR and Corbyville via Plumpton Road was selected as the preferred alternative.

Table 20 – Evaluation Matrix Routing Options

Criteria	Option 1 - Plumpton Road	Option 2 - Ritz Road	Option 3 - Hwy 37	Option 4 - Corbyville
Technical Considerations	• Least intermediate elevation changes. • Potential gravity option to Corbyville • Shorter distance (3.8km)	• Most intermediate elevation changes • No gravity option to Corbyville • Medium distance (4.2km)	• Moderate intermediate elevation changes • No gravity option to Corbyville • Longest Distance (4.5km)	• Least intermediate elevation changes. • Potential gravity option to Corbyville. • Shortest distance (3.6km).
Future Servicing Considerations	• Central location to service Corbyville and BBR. • Closer potential future connection to Foxboro. • Zone 3 Booster Station can be located in Corbyville development area.	• Additional watermain routing required to service Corbyville • Further future connection to Foxboro. • Zone 3 Booster Station cannot be located in Urban Boundary or known developments.	• Additional watermain routing required to service Corbyville. • Further future connection to Foxboro. • Zone 3 Booster Station cannot be located in Urban Boundary or known developments.	• Central location to service Corbyville and BBR. • Further future connection to Foxboro. • Zone 3 Booster Station can be located in Corbyville development area.
Access Considerations	• Proposed works are within the local road allowance	• Proposed works are within the local road allowance	• Proposed works are within local road allowance and Provincial road allowance.	• Proposed works are not within an existing road allowance.
Environmental Impact and Risk	• Least amount of alignment adjacent to environmentally sensitive areas.	• Moderate amount of alignment adjacent to environmentally sensitive areas.	• Moderate amount of alignment adjacent to environmentally sensitive areas.	• Most amount of alignment adjacent to environmentally sensitive areas.
Cost Sharing Considerations	• Yes	• No	• No	• Yes
Capital Cost	• $$$ • Shorter option (3.8km)	• $$$ • Additional watermain routing to service Corbyville • Longer option (4.2km).	• $$$$ • Additional watermain routing to service Corbyville. • Longest option (4.5km).	• $$$ • Shortest option (3.6km) • Limited construction access.
Operation and Maintenance Cost	• $$ • Shorter option (3.8km)	• $$$ • Longer option (4.2km)	• $$$ • Longest option (4.5km)	• $$$ • Shortest option (3.6km) • Maintenance of unopened road allowance
Final Evaluation	• **Preferred**	• **Less Preferred**	• **Least Preferred**	• **Less Preferred**

9.0 Water Distribution Model

9.1 Design Basis

The same design criteria for drinking water systems outlined in the previous Design Basis Report were used for the future system modelling and are listed below.

- The maximum pressure at any point in the distribution system in unoccupied areas shall not exceed 689 kPa (100 psi), and while in occupied areas, shall not exceed 552 kPa (80 psi).
- Maximum Day + Fire Flow: Residual pressures at any point in the distribution system shall not be less than 140 kPa (20 psi).
- Peak Hour: Pressures shall be a minimum of 276 kPa (40 psi).
- A required fire flow of 45 L/s per the OBC for a typical two-storey residential dwelling.

The design criteria were assessed under peak hour demand and maximum day demand plus fire flow scenarios. One of the purposes of this study is to determine the impacts of BBR on the City of Belleville's water distribution system. Therefore, in addition to the design criteria that was previously established, an additional criterion was used to monitor the impacts of BBR. When comparing model fire flow results with and without the demand from BBR, a reduction in available fire flow of 5% or greater was set as the trigger point to signify potential areas where system upgrades may be required.

9.2 Model Scenarios

To assess and isolate the impacts of BBR under each time period (short-term, mid-term and long-term), the following two (2) scenarios were modelled:

- Scenario 1: City growth only
- Scenario 2: City growth + BBR

This approach allows for a comparison between these two scenarios, thus identifying anticipated system deficiencies resulting directly from BBR.

9.3 Growth

As outlined in Section 3.2, the growth was distributed among three (3) time periods – short-term, mid-term and long-term, and was input into the existing model through a spatial analysis of the data provided in the City's Residential Land Supply and Development Control Area mapping. Increased demands from growth areas were added to the closest node in the water model. For the two (2) large developments, Avonlough and BBR, demands were added manually into the model to represent the approximate locations of the developments.

The demands in all growth areas were calculated using the consumption rates and peaking factors previously defined in JLR's Phase 1 Report listed below:

- A residential consumption rate of 350 L/cap/day

- A commercial consumption rate of 28,000 L/ha/day
- An industrial consumption rate of 35,000 L/ha/day
- A maximum day demand of 1.4 times the average day demand.
- A peak hour demand of 1.5 times the maximum day demand.

The total growth demands modelled for each time period are summarized in Table 21 below. The mid-term and long-term water demands are cumulative and include the demands for all previous time periods; the mid-term demand increase includes the short-term demand increase, and the long-term demand increase includes both the short-term and mid-term demand increases.

Table 21: Future Water Demands

Time Period	Pressure Zone 1		Pressure Zone 2	
	Maximum Day Demand Increase (L/s)	Peak Hour Demand Increase (L/s)	Maximum Day Demand Increase (L/s)	Peak Hour Demand Increase (L/s)
Short-term	65.4	98.1	31.1	46.0
Mid-term	261.2	391.8	206.4	309.6
Long-term	313.2	469.8	232.5	348.7

9.4 Water System Upgrades

9.4.1 Water Supply Upgrades

Upon adding future growth demands to the model, the initial model results showed significant pressure deficiencies throughout the water distribution system under peak hour demand. When comparing Figures A-1 and A-2, BBR creates significant areas of low pressure below the minimum pressure requirement of 276 kPa (40 psi) under the short-term growth scenario. BBR is shown to have minimal impact on Pressure Zone 1 in the short-term but negatively impacts the pressures in Pressure Zone 2. The pressures in Pressure Zone 2 are the most adversely affected, as Adam Street Booster Pumping Station is not capable of supplying the increased future demand, even in the short-term time period, at a high enough head to achieve pressure requirements throughout the zone. As shown in Figures A-3, A-4, A-5 and A-6, in the mid-term and long-term time periods, the majority of the system does not achieve the minimum pressure requirement regardless of the inclusion of BBR's demand.

Due to the widespread pressure deficiency that was observed in the model, it is clear that the City's current water supply and distribution system is not capable of accommodating the anticipated future growth without upgrades. Therefore, water supply upgrades were modelled to resolve the observed pressure deficiencies. Three (3) water supply upgrade configurations were modelled to determine the extent of upgrades required. The three configurations are:

- <u>Configuration 1</u>: New floating storage in Pressure Zone 2, North Park Street Booster Pumping Station (BPS) Hydraulic Grade Level (HGL) and John Street Elevated Tank HGL set to 132.9 m (the existing John Street Elevated Tank HGL) in Pressure Zone 1.

- Configuration 2: New floating storage in Pressure Zone 2, North Park Street BPS and John Street Elevated Tank HGL set to 138 m, (the maximum HGL at John Street Elevated Tank) in Pressure Zone 1.
- Configuration 3: New floating storage in Pressure Zone 2 and a new water storage reservoir at the west end of Pressure Zone 1 (near the proposed Avonlough development).

Each supply upgrade configuration was modelled separately to isolate the impacts of each configuration. In all supply upgrade configurations, the model was run under steady state conditions and Adam Street BPS was not operating in the model. Adam Street BPS was closed in the model because the new floating storage in Pressure Zone 2 would supply the entire zone under peak hour or fire flow conditions, and Adam Street BPS would only activate to fill this storage tank when the low level set point of the tank is reached. Therefore, Pressure Zones 1 and 2 were completely isolated from each other in the water supply upgrade configuration scenarios, with the water supply sources in each pressure zone only providing water to their respective zones. **It is noted that the water supply upgrades proposed for Pressure Zone 1 would need to be assessed further by the City and refined as necessary for operational feasibility.**

The new floating storage in Pressure Zone 2 was modelled near the intersection of Maitland Drive and Mineral Road with an HGL of 152 m. The connection pipe from the new storage to Pressure Zone 2 was modelled as a 1000 mm diameter pipe to minimize frictional head losses through the new watermain. The actual size and material of the connection pipe should be considered at the Class Environmental Assessment (Class EA) stage for the new floating storage. The location of the storage was selected based on land vacancy and hydraulic performance as observed from the model results. The location of the storage is designated as vacant industrial land in the City's vacant land inventory, and its central location in Pressure Zone 2 minimizes head losses and distributes water pressure more evenly throughout the zone as compared to a location at the west outer limit of Pressure Zone 2, even though the topography is higher due west. The floating storage location and all other details are not final and have only been used for conceptual modelling purposes. It is noted the HGL of 152 m was modelled based on a minimum pressure target of 276 kPa (40 psi) in Pressure Zone 2 under peak hour demand, however this HGL should be reviewed under a normal or minimum day demand scenario to assess maximum pressures in the zone. Trunk watermain updates may also be required in combination with the new storage in order to distribute the water throughout the zone. The exact location, design and operating levels for the floating storage and associated trunk watermains will need to be confirmed in the future as part of the Class EA process. Furthermore, the pumps at Adam Street BPS should be designed to adequately supply the new floating storage in Pressure Zone 2.

The resulting pressures throughout the system with BBR while implementing the three (3) upgrade configurations are shown in Figures A-7, A-8 and A-9. Configurations 1 and 2 significantly improved pressures throughout much of the system but were unable to achieve the minimum pressure requirement at the west end of Pressure Zone 1 (near the proposed Avonlough development). Configuration 3 (Figure A-9) was able to achieve the minimum pressure throughout Pressure Zone 1 and was therefore used for all subsequent modelling. The new floating storage in Pressure Zone 2 was able to achieve the minimum pressure requirement throughout the zone, except for two small areas of high topographical elevation and also along Cannifton Road North at the end of the existing system as detailed in Section 9.6.1. All pressures below the minimum requirement in Pressure Zone 2 are caused by the addition of BBR, as, without BBR, they are above the minimum requirement. The low pressure areas are attributed to high topographical elevations and are likely cost prohibitive to fully address during peak hour demand. All the pressures were within 10 kPa of the minimum requirement, and costly watermain upgrades would be required to increase pressures. More significant low pressure was observed along Cannifton Road near the end of the existing system. The pressures in this area fell significantly below the minimum requirement due to the significant head loss experienced through the existing 300 mm diameter watermain on Cannifton Road. Additional watermain upgrades were required to address this deficiency, as discussed in Section 9.6.1.

9.4.2 Water Distribution Upgrades

Two upgrades were modelled as potential solutions to the low-pressure areas in Pressure Zone 2. The two upgrade options are outlined below:

- Option 1: Increasing the watermain diameter from 300 mm to 400 mm on Cannifton Road North, from Black Diamond Road to the current eastern extent of the water distribution system near Short Street
- Option 2: Extending a new watermain across the river to connect Scott Drive to the future trunk watermain on River Road

The resulting pressures under peak hour demand conditions while implementing each upgrade option are shown in Figure A-10 and Figure A-11. Each upgrade option was modelled separately to isolate the impacts of each upgrade. The Hazen-Williams friction factor used in the model for all new and upgraded pipes were selected based on the MECP Guidelines for Drinking Water Systems (2008).

The model results showed that Option 1 is expected to increase the pressure at all junctions in the model above the minimum pressure requirement except at small sections (two junctions ±100m) of Farnham Road which is at high topographical elevations relative to the surrounding area. At this location, the pressures (~272kPa) were only slightly below the minimum pressure requirement. Option 1 is recommended to increase pressures within Pressure Zone 2 above the minimum pressure requirement when BBR's demand is added to the system. The upgrade lowers head losses from the new proposed elevated storage in Pressure Zone 2 to the area of lower pressure thus increasing pressures in the area. The Option 1 upgrade also increases pressure along the watermain to BBR above the minimum pressure requirement for a long distance, which allows the BPS that services BBR to be placed closer to BBR avoiding over-pressurizing the system to pump water a further distance.

The model results showed that while Option 2 is expected to increase the pressures on Cannifton Road above the minimum pressure requirement, some of the pressures on the west side of the river are expected to be reduced below the minimum requirement. This is due to the difference in HGL on either side of the river. For this reason, Option 2 is not recommended.

9.5 Black Bear Ridge Water Servicing

To service BBR, a trunk watermain extending from the existing watermain on Cannifton Road is required. A 400 mm watermain extension to BBR was proposed in Jewell Engineering's *Functional Servicing Report Black Bear Ridge GP Inc. – Black Bear Ridge Subdivision* (2024), which was used for this project's modelling. The model used "Routing Option 1" as shown in Figure 4. The

400 mm diameter watermain size was found to be the minimum diameter required to supply BBR based on head losses.

BBR is located in an area of higher elevation relative to Pressure Zone 2 and has been separated into its own pressure zone – Pressure Zone 3, as outlined in Section 3.1. Jewell Engineering's report outlined the servicing strategy for BBR which included an elevated storage tower at the supply entrance to BBR and a BPS to fill this tower to its high-water level. Jewell's report outlined that the high-water level for the storage tower would be an HGL of 176.5 m. This HGL was used as the target HGL to be achieved in BBR.

The location of the BPS to service BBR was assessed based on analysis of the modelled pressure results under the peak hour demand scenario. Along the watermain extension to BBR, pressures were targeted to stay above the minimum pressure requirement of 276 kPa (40 psi). The location in the model where the pressure dropped below the minimum requirement along the transmission watermain to BBR, near the intersection of Harmony Road and Plumpton Road, was used to inform the approximate location for the BPS. As the target HGL in BBR was significantly greater than the HGL in Pressure Zone 2, the discharge pressure at the BPS was targeted to stay below the maximum pressure limit of 689 kPa (100 psi) per the design basis. The model results showed that placing the BPS in the existing Pressure Zone 2 was not feasible, as it would over-pressurize the transmission watermain on the discharge side of the BPS.

9.6 Model Results

Peak hour demand and maximum day demand plus fire flow conditions were modelled for Scenarios 1 and 2 to assess the impacts of BBR on system pressure and fire flow availability. Based on the model results, some of the aforementioned upgrades to resolve inadequate pressures and fire flows are recommended.

9.6.1 Peak Hour Demand

The peak hour demand pressure results have been separated by pressure zone, as BBR can only affect results in Pressure Zone 2 due to Adam Street BPS being inactive under the presented water supply upgrade configuration. The peak hour demand pressure results under each scenario for all time periods are summarized in Figure 8 and Figure 13 below and are mapped in Figure A-12 to Figure A-18:

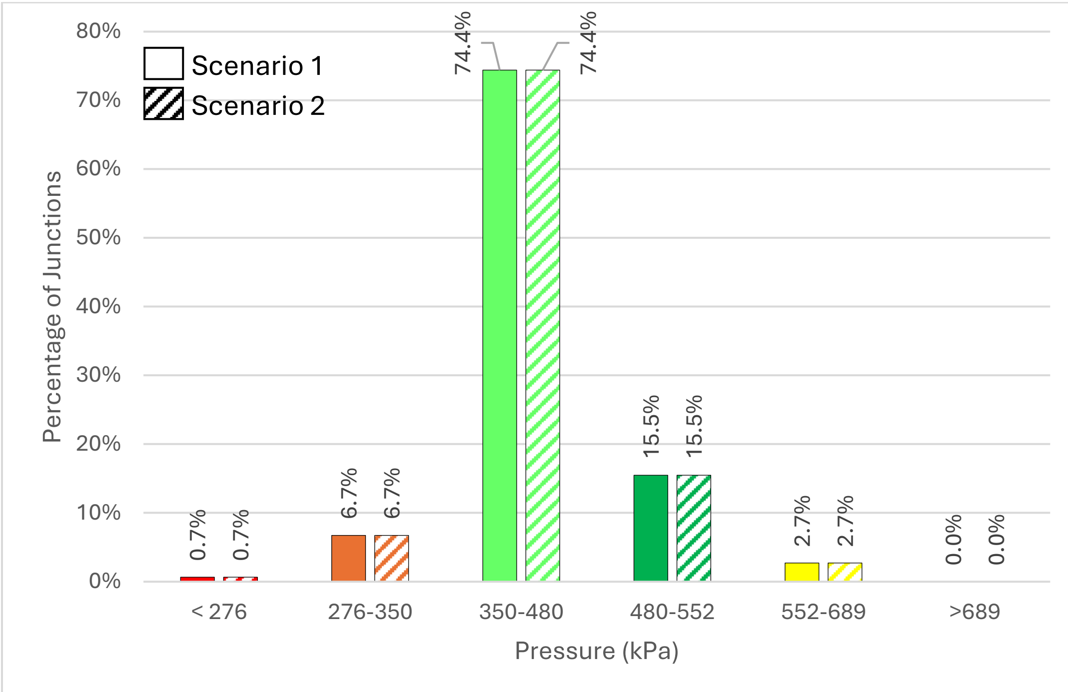

Figure 8: Peak Hour Demand Pressure Results – Pressure Zone 1 – Short-term Growth

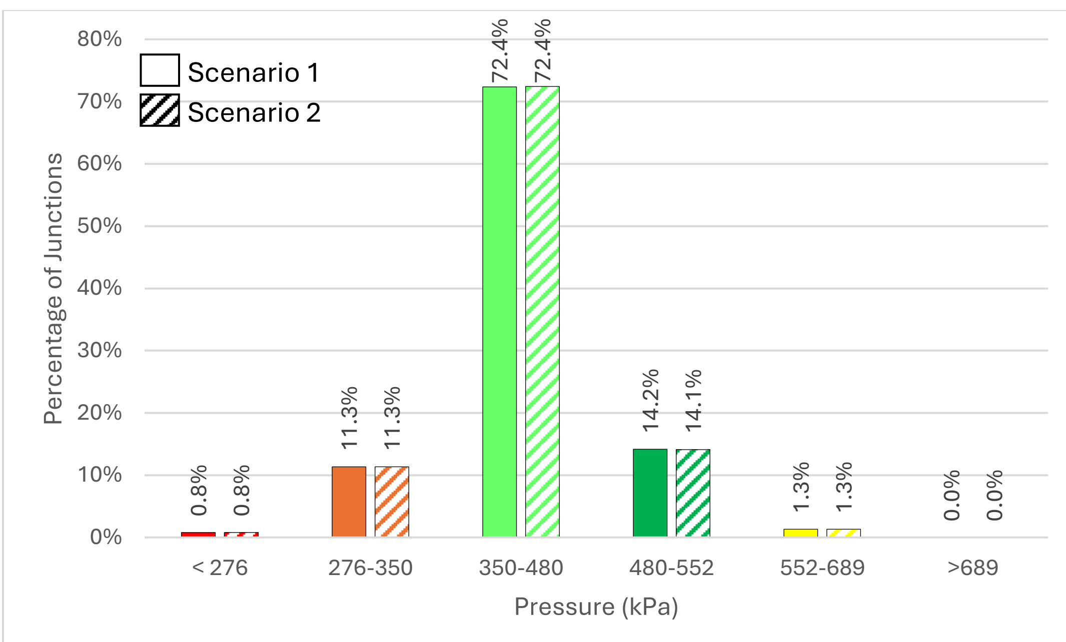

Figure 9: Peak Hour Demand Pressure Results – Pressure Zone 1 – Mid-term Growth

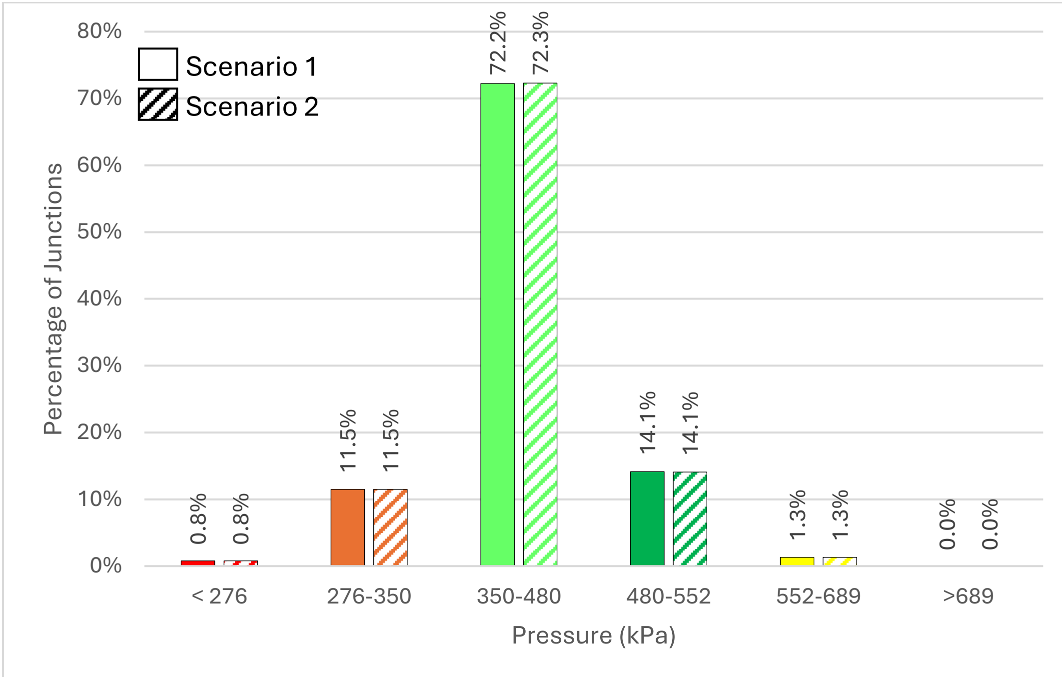

Figure 10: Peak Hour Demand Pressure Results – Pressure Zone 1 – Long-term Growth

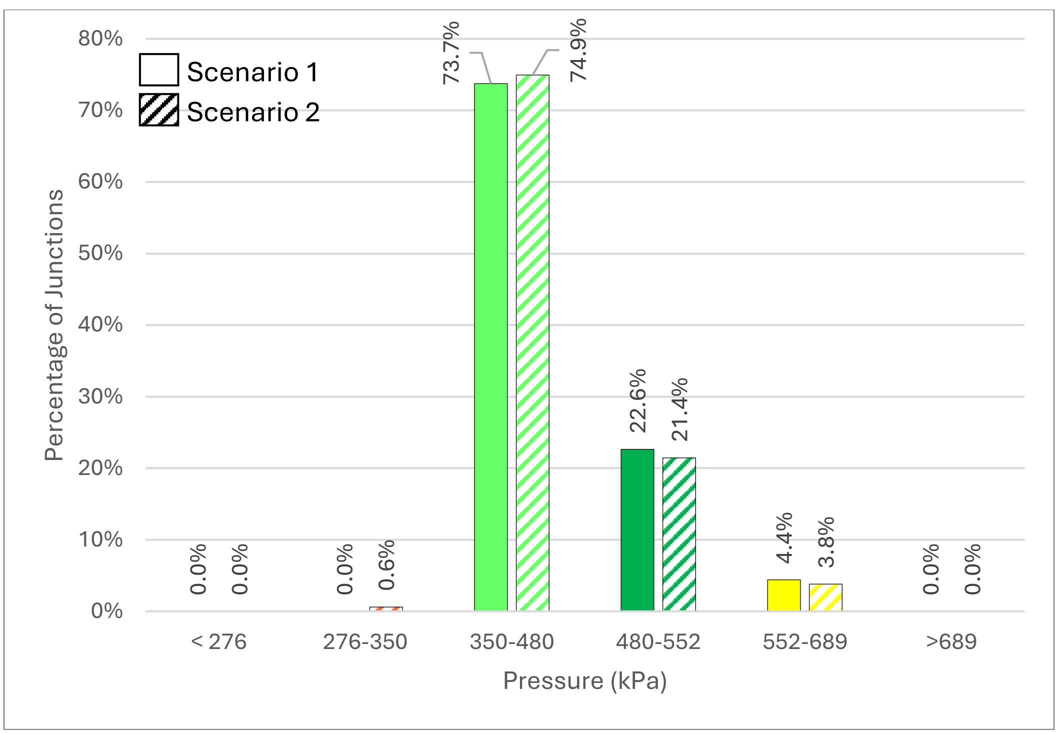

Figure 11: Peak Hour Demand Pressure Results – Pressure Zone 2 – Short-term Growth

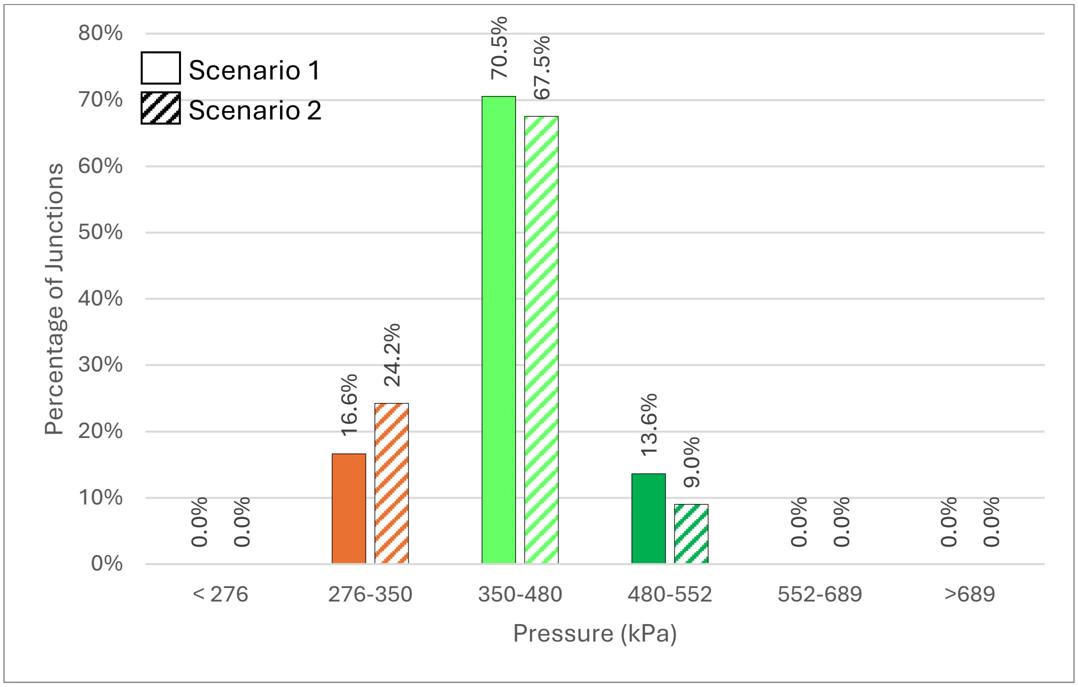

Figure 12: Peak Hour Demand Pressure Results – Pressure Zone 2 – Mid-term Growth

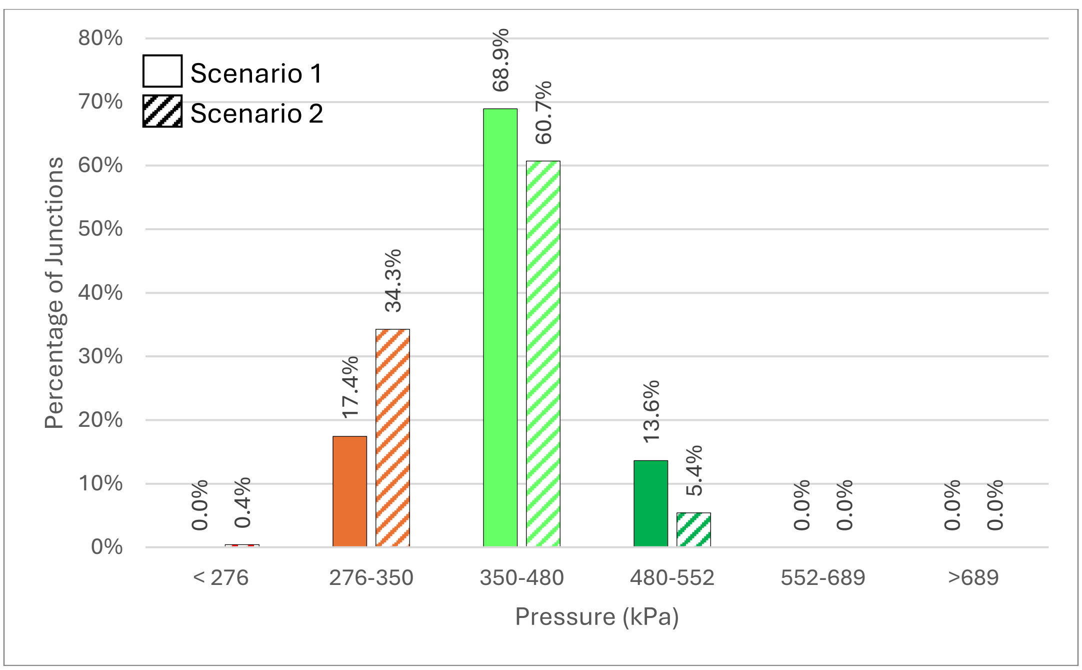

Figure 13: Peak Hour Demand Pressure Results – Pressure Zone 2 – Long-term Growth

The pressures in both pressure zones generally remain within the recommended range of 276 kPa to 552 kPa under peak hour demand conditions under all future scenarios. There are noticeable decreases in pressure in the mid and long-term time periods when BBR’s demand is included in the model. BBR’s maximum day demand has been modelled for the peak hour demand condition, as it was assumed that the peak hour demand in BBR would be supplied by a storage reservoir within BBR, and only the storage fill rate (maximum day demand) would be supplied to BBR from Pressure Zone 2. In the long-term time period, BBR’s demand reduced the pressure below the minimum requirement in a localized area of the zone. Figure A-18 shows the areas of low pressure are found in small pockets east of Farnham Road and along Cannifton Road North at the end of the existing system. The majority of the zone remains within the recommended pressure range, but upgrades to the water distribution system are required to increase pressure to these low pressure areas.

9.6.2 Maximum Day Demand Plus Fire Flow

The expected available fire flows at all model junctions under maximum day demand conditions have been separated by pressure zone. The available fire flow results for all time periods are summarized in Figure 14 to Figure 19 are mapped in Figure A-19 to Figure A-25.

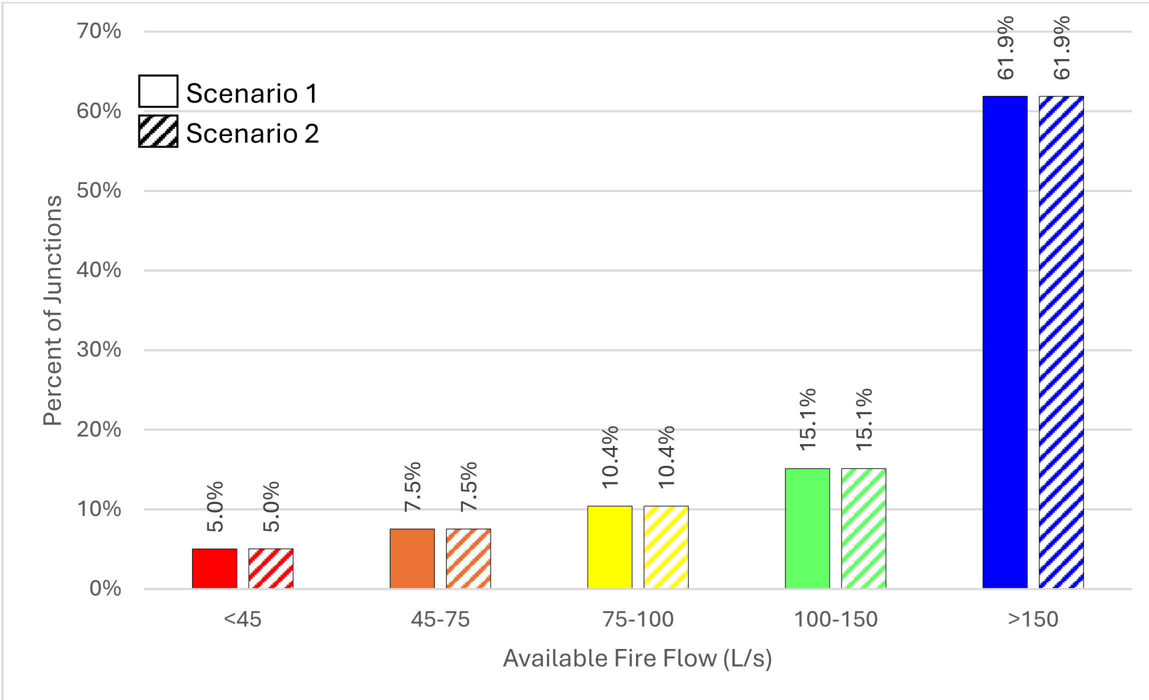

Figure 14: Maximum Day Demand Plus Fire Flow Available Fire Flow Results – Pressure Zone 1 – Short-term Growth

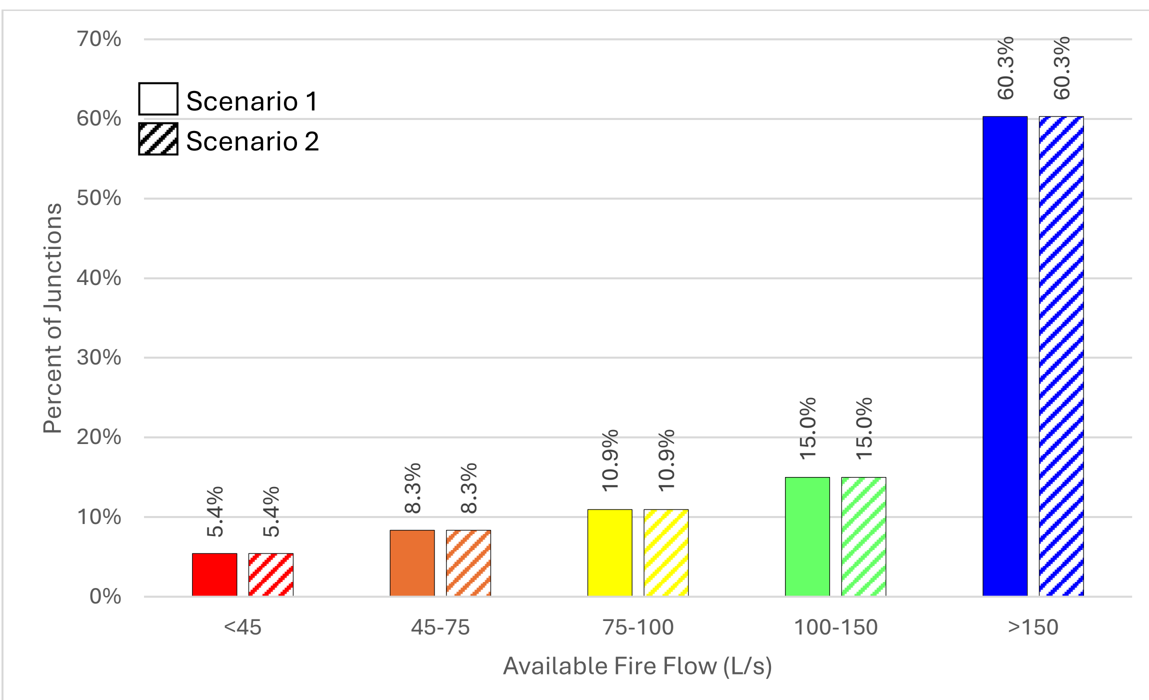

Figure 15: Maximum Day Demand Plus Fire Flow Available Fire Flow Results – Pressure Zone 1 – Mid-term Growth

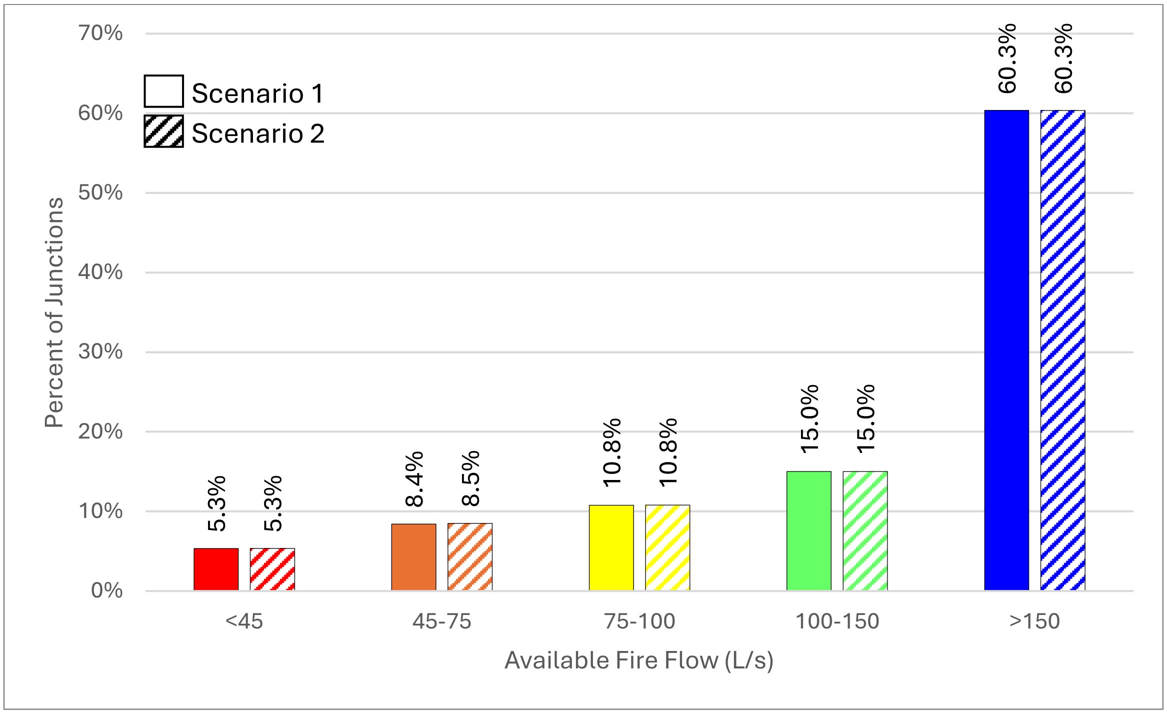

Figure 16: Maximum Day Demand Plus Fire Flow Available Fire Flow Results – Pressure Zone 1 – Long-term Growth

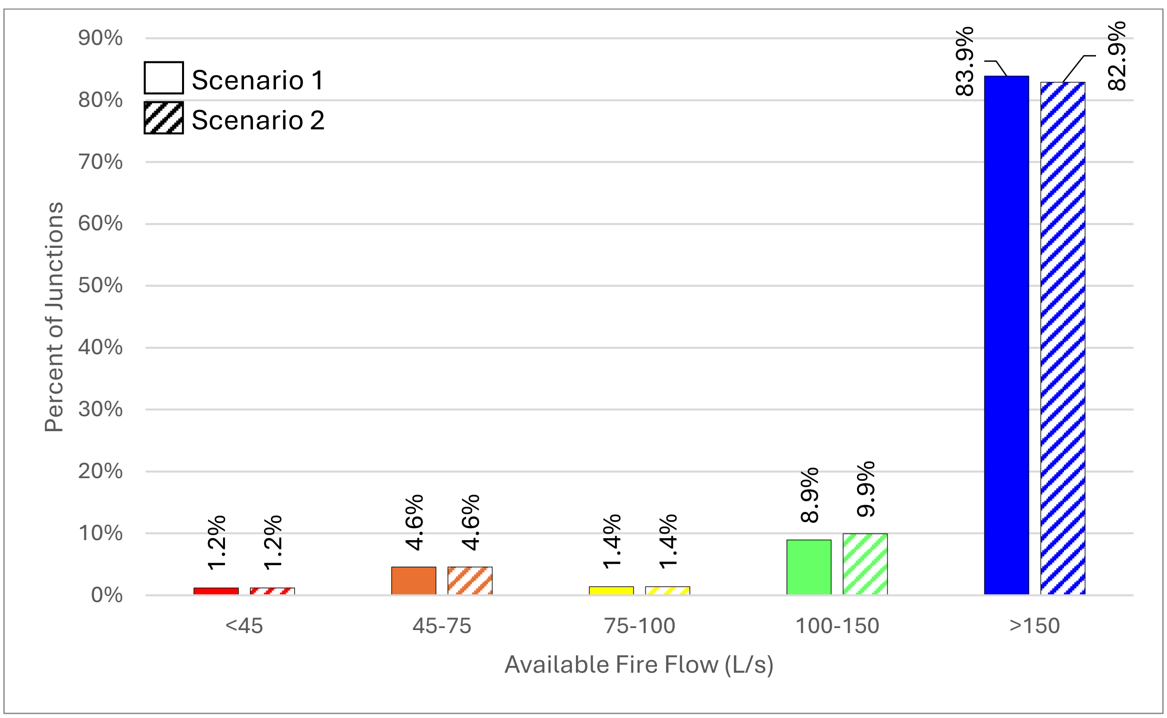

Figure 17: Maximum Day Demand Plus Fire Flow Available Fire Flow Results – Pressure Zone 2 – Short-term Growth

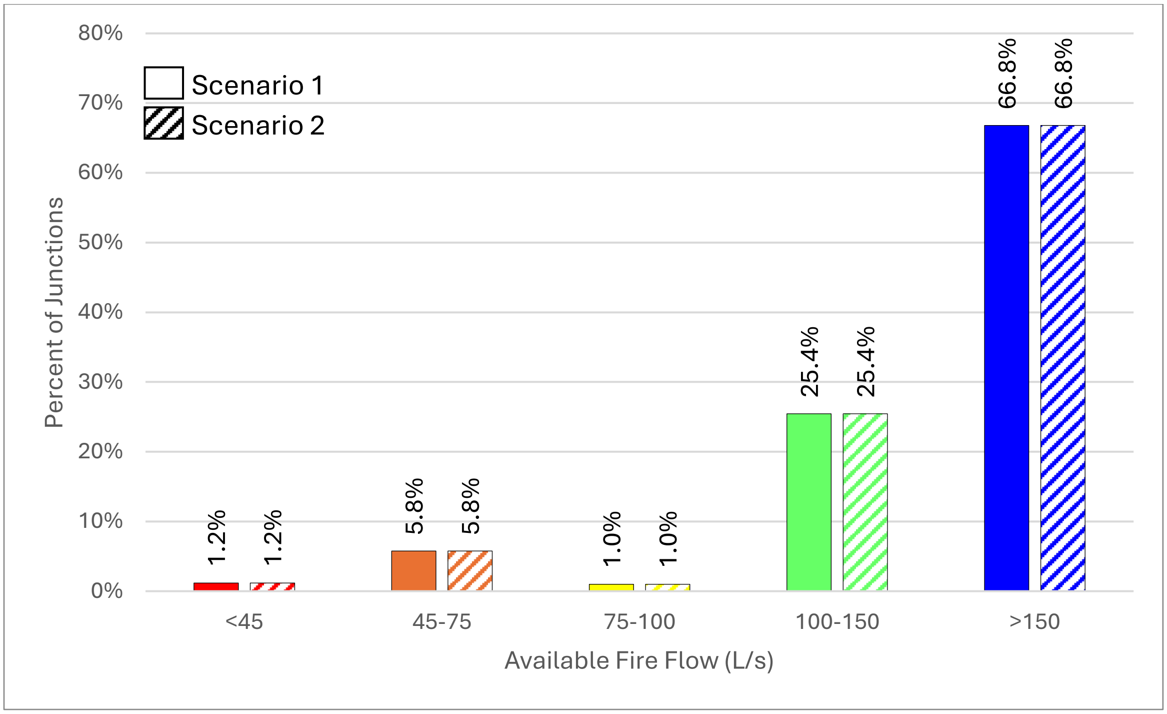

Figure 18: Maximum Day Demand Plus Fire Flow Available Fire Flow Results – Pressure Zone 2 – Mid-term Growth

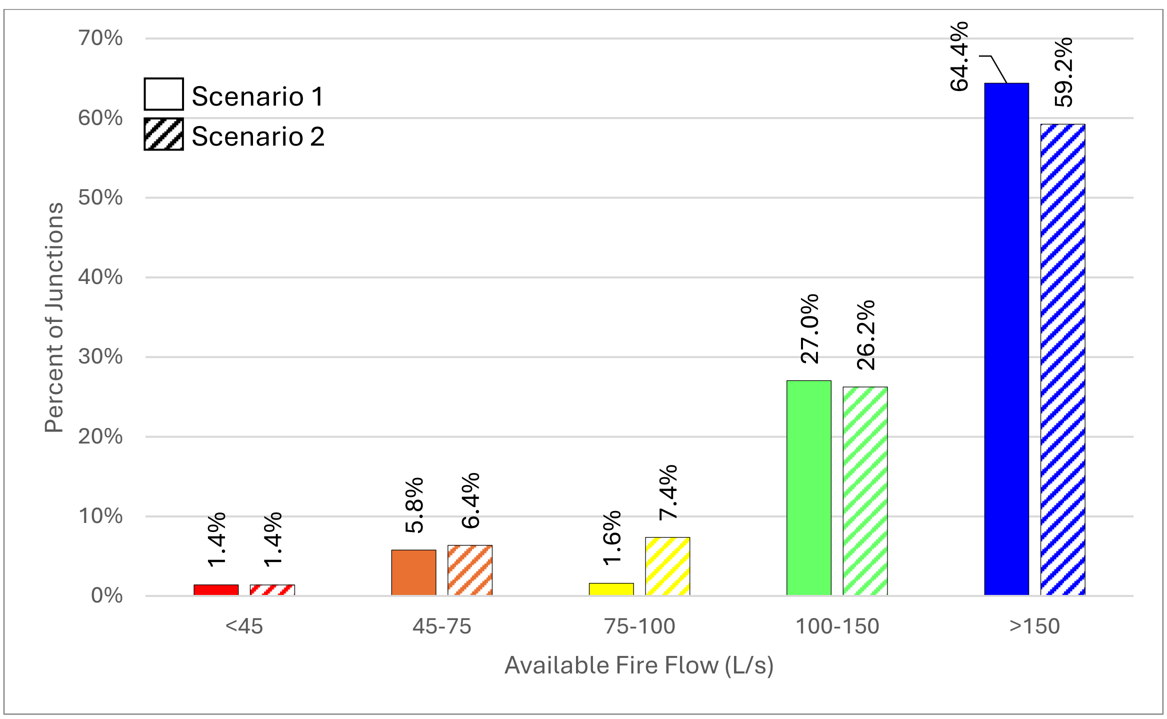

Figure 19: Maximum Day Demand Plus Fire Flow Available Fire Flow Results – Pressure Zone 2 – Long-term Growth

In all time periods under both Scenario 1 and Scenario 2, in Pressure Zone 2, nearly all (99%) of the model junctions have available fire flows greater than the Ontario Building Code (OBC) minimum requirement of 45 L/s for a typical two-storey home. All junctions which are anticipated to have fire flow availability below 45 L/s are found at the end of dead-end watermains with diameters equal to or lower than 100 mm and are not expected to supply hydrants. There is little difference between fire flows between the two scenarios, so BBR is not lowering fire flow availability within Pressure Zone 2 such that fire flow availability is below the minimum requirements.

A 5% or greater reduction in available fire flow when comparing model results with and without BBR was established as a trigger to signify potential areas where watermain upgrades may be required. Figure A-26 to Figure A-28 show the percentage reduction in fire flow for each individual model junction between Scenarios 1 and 2. In the long-term time period, a significant portion of Pressure Zone 2 is expected to experience reductions in available fire flow greater than 5% when BBR's demand is included. Of the junctions that experience a reduction in fire flow greater than 5%, 53% have expected available fire flows less than 150 L/s which is the maximum fire flow required by the OBC, and only 19% have expected available fire flows less than 100 L/s. The largest drop in available fire flow among the latter junctions was approximately 15 L/s. Although the reduction in available fire flow among these junctions exceeded the threshold of 5%, the areas affected by the reductions in fire flow are predominantly comprised of single-family dwellings where only the OBC minimum fire flow requirement would apply. The most significant reductions in fire flow are found along Cannifton Road North where reductions greater than 20% were observed. Although available fire flow reductions greater than 5% were caused by BBR's demand, the fire flows along Cannifton Road North remained high, not dropping below the OBC maximum required fire flow of 150 L/s. Fire flow modelling was carried out while including the 400 mm watermain upgrade on Cannifton Road North (Option 1 from Section 9.4.2). Without the upgrade, more significant decreases in available fire flow would have been observed which further supports the recommendation for this Option 1 upgrade. Further studies could be undertaken by the City to investigate potential watermain distribution upgrades to minimize or eliminate these fire flow reductions.

9.7 Summary of Water Servicing Recommendations

The water modelling results show that the extent of the upgrades required to achieve the minimum design criteria increases with the inclusion of BBR. The required upgrades due to City growth and additional upgrades required due to the inclusion of BBR's demand are listed below. BBR's demand lowers pressures in Pressure Zone 2, triggering the need for watermain upgrades to maintain pressure above the minimum requirement. To service BBR, a new watermain and BPS are also required.

Upgrades required based on City growth:

- New water storage reservoir at the west end of Pressure Zone 1
- New elevated storage in Pressure Zone 2 (with accommodating Adam Street BPS pump upgrades)

Additional upgrades required based on BBR:

- Cannifton Road North 400 mm watermain upgrade from Black Diamond Road to existing extent of the distribution system near Short Street (± 2,015 m)
- New 400 mm watermain extension from the extent of the existing water distribution system near Short Street to BBR
- New BPS to supply Pressure Zone 3 (BBR)

The following are also recommended based on this report:

- All water supply upgrades need to be assessed further by the City and refined as necessary for operational feasibility.
- The location, design and operating levels for all proposed water storage reservoirs and associated trunk watermains will need to be confirmed in the future as part of the Class EA process.
- The City should consider additional trunk watermain upgrades in addition to water supply upgrades to reduce frictional head losses from increased flow in the main trunks.
- The City should conduct further studies to investigate potential watermain distribution upgrades to minimize or eliminate reductions in fire flow caused by future growth.

10.0 Sanitary Collection Model

10.1 Design Basis

The same design criteria for the sanitary sewer system outlined in the Phase 1 report were used for the future system modelling and are listed below:

- Gravity Sewers:
  - Sewer capacity greater than dry weather flow
  - HGL within 300mm of the pipe obvert or greater than 2m below finished ground during the specified RDII event (1:10 year event going forward)
- Pumping Stations
  - Pump station firm capacity greater than the 1:10-year RDII flow
  - Pump station peak capacity greater than the 1:100-year RDII flow
- Pressure Sewers
  - Velocity greater than 0.9m/s in dry weather flow

An additional design criterion was established for the future system modelling. Due to large increases in wastewater flows, HGLs in the pressure sewer could potentially increase and cause overflow into the gravity sewers where there are connections between the two systems. The three (3) gravity sewer system to pressure sewer system connections are shown in Figure B-1. Overflow from the pressure sewer system to the gravity sewer system could have significant level of service implications to the gravity network and should be avoided.

The purpose of this study was not to determine the impacts of the City growth alone to the sanitary sewer system but to determine any reductions in level of service from adding the future wastewater flow from BBR in addition to City growth to the sewer system. As BBR's wastewater flow was assumed to discharge to the sewer system at the trunk sewer on Cannifton Road, impacts from BBR would be limited to this trunk, from Cannifton Road North to the WWTP including the pressure sewer system.

10.2 Model Scenarios

To isolate the impacts of BBR and monitor the effects of applying BBR's wastewater flow at different locations in the sanitary sewer system, four (4) scenarios were modelled under each time period. One of the modelled scenarios, Scenario 3, was used to monitor the impact to the sanitary sewer system of the large wastewater flow from the Avonlough development.

- Scenario 1: Only City growth (including Avonlough)
- Scenario 2A: City growth (including Avonlough) + BBR flow inserted at the existing northern limit of the sanitary sewer system on Cannifton Road North.
- Scenario 2B: City growth (including Avonlough) + BBR flow inserted at the intersection of Cannifton Road North and Black Diamond Road.
- Scenario 3: Similar to Scenario 2A but with Avonlough's flow removed from pressure sewer.

All scenarios were modelled under two (2) rainfall conditions: dry weather flow (DWF) and the 1:10-year storm event as a wet weather event scenario.

10.3 Growth

Increased wastewater flows from future growth were added into the wastewater model. The same calibrated trunk sanitary sewer model introduced and used in Phase 1 of the project was used for this modelling. Similar to the demands added to the water model, the growth added to the wastewater model was separated into three (3) time periods – short-term, mid-term and long-term. The growth was distributed throughout the existing model through a spatial analysis of the data provided in the City's Residential Land Supply and Development Control Areas. Increased flows from growth areas were added to the closest node/manhole within the model that would be servicing the development. The wastewater flow from BBR was added into the model at unique locations depending on the modelled location scenario. Two different locations were selected as two of the likely points where BBR would connect to the City's sanitary sewer system. In each location scenario, the entire BBR wastewater flow was applied at one of the two locations. The magnitude and location of the wastewater flow from the new Avonlough Development were selected based on information provided in the City's Report No. ENG-2023-22.

The new wastewater flows were calculated based on the increased population for residential areas and the area for commercial and industrial areas at the same rate as used for the water demands and consistent with MECP design criteria.

Extraneous flows (I&I) were calculated based on the area of new developments. Since the model was calibrated in 2018 rainfall dependent inflow and infiltration was captured for existing serviced areas in the calibrated RTK parameters and therefore MECP design rate extraneous flows, at 0.28 L/s/ha, were only added for all areas outside or partially outside of the existing sewershed. The extraneous flows for areas only partially outside of the existing sewershed were calculated by subtracting the area that was already included inside of the existing sewershed.

The total increase in wastewater flow in each time period is summarized in Table 22. The total wastewater flow increases throughout the City and the flow increases from the large developments, BBR and Avonlough, are separated to show the contribution of reach development.

Table 22: Future Wastewater Flow Growth

Time Period	Total Wastewater Flow Increase (L/s)	Wastewater Flow Increase from BBR (L/s)	Wastewater Flow Increase from Avonlough (L/s)
Short-term	182.7	35.8	100.0
Mid-term	638.8	92.3	380.0
Long-term	1130.3	148.8	490.0

10.4 Results

10.4.1 Scenario 1 – City Growth Only

Scenario 1 added only wastewater flows from City growth to the model. In this scenario, the future performance of the sanitary sewer system was established to have a point of comparison to observe changes resulting from servicing BBR.

The HGL profile across the trunk sewer from the northern limit of the sanitary sewer system on Cannifton Road North to the wastewater treatment plant for Scenario 1 is shown in Figure B-2 and Figure B-3. Each figure represents one of the two (2) rainfall conditions under all time periods.

10.4.1.1 Dry Weather Flow

As shown in Figure B-2, under DWF conditions, irrespective of the time period, HGLs generally remain within the sewer pipes and do not exceed the specified maximum at any manholes within the trunk sewer.

10.4.1.2 1:10-Year Storm Event

As shown in Figure B-3, there are significant increases in HGL relative to existing conditions during the 1:10-year storm event. In the short-term, HGLs generally remain within the sewer pipes and do not exceed the specified maximum at any manholes within the trunk sewer. In the mid-term and long-term, HGLs increase substantially in the trunk sewer north of Bell Boulevard. At the first manhole upstream of Black Diamond Road, the HGL in the model reaches the ground surface causing flooding in the model.

In the pressure sewer, HGLs also increased substantially beyond existing levels. As shown in Figure B-3, the HGL within the pressure sewer increased above the spill elevation into the gravity sanitary sewer at the intersection of Murney Street and Catharine Street. At this location, there is backflow from the pressure sewer into the gravity sewer. The HGL increase causing the backflow from the pressure sewer into the gravity sewer was mainly a result of the large flow in the mid-term and long-term entering the pressure sewer from the Avonlough development.

10.4.2 Scenario 2A – City + BBR Discharge at Trunk Sewer Northern Limit

Scenario 2A added BBR's wastewater flow to the model in addition to City growth. BBR's flow was added to the model at the northern limit of the trunk sewer on Cannifton Road North. In this scenario, the future performance of the sanitary sewer system while including BBR was determined to isolate the effects of BBR on the system from the rest of the City growth.

The HGL profile across the trunk sewer from the northern limit of the sanitary sewer system on Cannifton Road North to the wastewater treatment plant for Scenario 2A is shown in Figure B-4 and Figure B-5. Each figure represents one of the two (2) rainfall conditions under all time periods.

10.4.2.1 Dry Weather Flow

As shown in Figure B-4, under DWF conditions, irrespective of the time period, HGLs generally remain within the sewer pipes and do not exceed the specified maximum at any manholes within the trunk sewer.

10.4.2.2 1:10-Year Storm Event

As shown in Figure B-5, similarly to Scenario 1, there are significant increases in HGL relative to existing conditions during the 1:10-year storm event. In the short-term, HGLs generally remain within the sewer pipes and do not exceed the maximum at any manholes within the trunk sewer. In the mid-term and long-term, HGLs increase substantially in the trunk sewer north of Bell Boulevard. The HGLs in the trunk sewer north of Bell Boulevard are higher in Scenario 2A relative to Scenario 1, however, the HGL reaches the ground surface in both scenarios causing flooding in the model.

In Scenario 2A, HGLs in the pressure sewer increased above the spill elevation into the gravity sanitary sewer at the intersection of Murney Street and Catharine Street similar to Scenario 1.

10.4.3 Scenario 2B – City + BBR Discharge at Black Diamond Rd

Scenario 2B added BBR's wastewater flow to the model in addition to City growth. BBR's flow was added to the model at the intersection of Cannifton Road North and Black Diamond Road. In this scenario, the future performance of the sanitary sewer system with BBR connecting to the existing sanitary sewer system further south than in Scenario 2A was determined to compare the effects of BBR based on the location of its connection.

The HGL profile across the trunk sewer from the northern limit of the sanitary sewer system on Cannifton Road North to the wastewater treatment plant for Scenario 1 is shown in Figure B-6 and Figure B-7. Each figure represents one of the two (2) rainfall conditions under all time periods.

10.4.3.1 Dry Weather Flow

As shown in Figure B-6, under DWF conditions, irrespective of the time period, HGLs generally remain within the sewer pipes and do not exceed the specified maximum at any manholes within the trunk sewer.

10.4.3.2 1:10-Year Storm Event

The 1:10-year storm event HGL results for Scenario 2B are similar to Scenario 1 upstream of BBR's connection point to the sanitary sewer system and similar to Scenario 2A downstream of BBR's connection point. As shown in Figure B-7, there are significant increases in HGL relative to existing conditions during the 1:10-year storm event. In the short-term, HGLs generally remain within the sewer pipes and do not exceed the maximum at any manholes within the trunk sewer. In the mid-term and long-term, HGLs increase substantially in the trunk sewer north of Bell Boulevard. The HGLs in the trunk sewer north of Bell Boulevard reach the ground surface causing flooding in the model.

10.4.4 Scenario 3 – City + BBR + Avonlough Bypassed to WWTP

Scenario 3 was identical to Scenario 2A, but Avonlough's wastewater flow was removed from the model. Avonlough's large mid-term and long-term flows were the main cause of backflow from the pressure sewers to the gravity sewers. The City's Report No. ENG-2023-22 indicated that the flow from the future Avonlough sewage pumping station will eventually bypass the existing pressure sewer. Therefore, in this scenario, the future sanitary system was modelled while removing Avonlough's flow to simulate the flow bypassing the existing pressure sewer system. The results from this scenario were used to determine the reduction in HGL, if any, caused by the bypass of Avonlough's flow from the pressure sewer system.

The HGL profile across the trunk sewer from the northern limit of the sanitary sewer system on Cannifton Road North to the wastewater treatment plant for Scenario 3 is shown in Figure B-8 and Figure B-9. Each figure represents one of the two (2) rainfall conditions under all time periods.

10.4.4.1 Dry Weather Flow

As shown in Figure B-8, under DWF conditions, irrespective of the time period, HGLs generally remain within the sewer pipes and do not exceed the specified maximum at any manholes within the trunk sewer.

10.4.4.2 1:10-Year Storm Event

As shown in Figure B-9, there is a significant decrease in HGL within the pressure sewer system when Avonlough's wastewater flow is removed. Without Avonlough, there is sufficient decrease in HGL to avoid backflow from the pressure sewer system into the gravity sewer system. Since BBR was included in Scenario 3 and no backflow from the pressure sewer system to the gravity sewer system was observed, it can be concluded that the increased wastewater flow from BBR itself is not enough to cause backflow.

10.5 Summary of Future Servicing Constraints and Recommendations

The results from all modelled scenarios show that upgrades to the sanitary sewer system are required with and without BBR. The extent of upgrades required increases when BBR is included. The upgrades required in each scenario are summarized in Table 23 to Table 25 and are shown in Figure B-10 to Figure B-12.

Table 23: Recommended Sanitary Sewer Upgrades – Scenario 1

Scenario	Road Name	Existing Diameter (mm)	Upgraded Diameter (mm)	Length (m)
Scenario 1	Cannifton Road North	450	525	840
	Cannifton Road	675	825	1060

Table 24: Recommended Sanitary Sewer Upgrades – Scenario 2A/3

Scenario	Road Name	Existing Diameter (mm)	Upgraded Diameter (mm)	Length (m)
Scenario 2A/ Scenario 3	Cannifton Road North	450	600	840
	Cannifton Road	675	825	1060
	Cannifton Road	825	900	415
	Cannifton Road	825	1050	375

Table 25: Recommended Sanitary Sewer Upgrades – Scenario 2B

Scenario	Road Name	Existing Diameter (mm)	Upgraded Diameter (mm)	Length (m)
Scenario 2B	Cannifton Road North	450	525	840
	Cannifton Road	675	825	1060
	Cannifton Road	825	900	415
	Cannifton Road	825	1050	375

In all scenarios, sewer pipe upgrades were required to lower HGLs to achieve the HGL level of service criteria. Sewer pipe upgrades were required on Cannifton Road from Maitland Drive to Bell Boulevard. The upgrade on Cannifton Road North from Maitland Drive to Black Diamond Road only required a pipe upsize from 450mm to 525mm in Scenarios 1 and 2B. In Scenario 2A, BBR's wastewater flow enters the system at Maitland Drive and increased the pipe upsize required for this section of sanitary sewer from 525mm to 600mm. The two scenarios that include BBR, 2A and 2B, required additional upgrades on Cannifton Road from approximately 150 m north of McFarland Drive to College Street East. The increased flow from BBR increased HGLs along this run of pipes above the maximum limit, and pipe upgrades are required to lower HGLs. The new 1:10-year storm event HGL profile results in each scenario when including sewer pipe upgrades are shown in Figure B-13. The pipe upgrades in this area were able to reduce HGLs back below the maximum limit, except for the final pipe upstream of the pressure sewer system.

The HGL in this pipe remained above the maximum limit, as the increased HGL in the downstream pressure sewer system controlled the HGL in the pipe rather than the pipe's flow capacity.

Although Scenario 2A required larger pipe upgrades on Cannifton Road North from Maitland Drive to Black Diamond Road compared to Scenario 2B, the connection point for BBR at Maitland Drive in Scenario 2A is preferred over the connection point at Black Diamond Road used in Scenario 2B. The connection point at Maitland Drive will allow BBR to share a sanitary pump system with the Corbyville development and avoid a separate pump station and forcemain from BBR to the City.

A sewer pipe upsize from 675mm to 825mm below Highway 401 is required in all scenarios. It is likely that increasing the pipe size below the highway is not feasible, so using multiple smaller pipes with an equivalent diameter of 825mm can be used instead.

All upgrades across all scenarios are not sufficient to prevent backflow from the pressure sewer system into the gravity sewer system. The large wastewater flow from the Avonlough development raised the HGL above the spill elevation into the gravity sewer system regardless of the flow increase from BBR. To mitigate backflow from the pressure sewer system into the gravity sewer system, it is recommended that wastewater flow from the Avonlough development bypasses the pressure sewer system in the mid-term time period and beyond. A comparison between the HGL profiles of Scenarios 2A and 3 shows the HGL reduced below the spill elevation into the gravity sewer system when the flow from the Avonlough development is removed from the model.

11.0 Recommended Servicing Strategy, Implementation and Timing

The following tables provide the Opinion of Probable Costs for the proposed upgrades as outlined previously. It shall be noted that the Opinion of Probable Costs (OPC) were completed using 2025 dollars value. An OPC with a Class 'D' (Indicative Estimate) level of accuracy was developed for each alternative solution and includes allowances for design elements that have not fully been developed. Class 'D' OPCs developed for this assignment are expected to be within +/- 50%. The OPCs were developed based on past experience on similar projects, professional judgment, and equipment costs provided by suppliers. Design completed as part of this Servicing Study is conceptual in nature for the purpose of obtaining Class 'D' cost estimates. All design parameters should be confirmed during the upcoming Class EA and detailed design. Any provided estimate of costs or budget is an OPC that is based on historic construction data and does not include labour, material, equipment, manufacturing, supply, transportation or any other cost impacts in relation to outstanding market conditions. JLR shall not be responsible for any variation in the estimate caused by the foregoing factors but will notify the City and BBR of any conditions which JLR believes may cause such variation upon delivery of the estimate.

The recommended project list was discussed during a project meeting on February 12, 2025. The OPC's have since been updated to remove the Harmony Public School and Community Centre's contribution from BBR. Refer to Appendix C for the meeting materials. "Other" represents the share of costs to be borne by other benefitting developers/landowners, Harmony school and existing residences in BBR servicing area.

Table 26: Opinion of Probable Costs – Short-Term Projects

Project #	Short-Term	Project Description	OPC (+/-50%)	Zone 1 and 2 Total	City's Share	Zone 3 Total	BBR's Share	Other's Share
1	Storage (Zone 2)	New floating storage in Zone 2 (4ML), including EA, engineering and construction	$ 10,000,000	$ 8,860,000.00	$ 8,860,000.00	$ 1,140,000.00	$ 1,100,000	$ 40,000
2	Storage (Zone 3)	New floating storage in Zone 3 (4.5ML)	$ 12,000,000	$ 280,000.00	$ 280,000.00	$ 11,720,000.00	$ 11,260,000	$ 460,000
3	Booster Pumping (Zone 3)	Zone 3 Booster Station, including EA, engineering and construction	$ 2,400,000	$ 50,000.00	$ 50,000.00	$ 2,350,000.00	$ 2,260,000	$ 90,000
4	Sanitary Collection	New gravity sewer along Routing Option 1 connecting BBR to Corbyville (2.8 km of 600mm diameter sewer)	$ 12,600,000	$ 300,000.00	$ 300,000.00	$ 12,300,000.00	$ 11,810,000	$ 490,000
5	Sewage Pump Station	New sewage pump station in Corbyville (150 L/s) and new forcemain (200 mm) connecting Corbyville to northern trunk sewer along Cannifton Rd.N	$ 10,050,000	$ 1,770,000.00	$ 1,770,000.00	$ 8,280,000.00	$ 7,950,000	$ 330,000
6	Water Distribution	New watermain along Routing Option 1 connecting BBR and Cannifton Rd N. (3.8 km of 400mm dia watermain) *Assumed in common trench as sanitary and is a price adder	$ 4,560,000	$ 800,000.00	$ 800,000.00	$ 3,760,000.00	$ 3,610,000	$ 150,000
		TOTAL (SHORT-TERM)	$ 51,610,000	$ 12,060,000	$ 12,060,000	$ 39,550,000	$ 37,990,000	$ 1,560,000

Table 27: Opinion of Probable Costs – Mid-Term Projects

Project #	Mid-Term	Project Description	OPC (+/-50%)	Zone 1 and 2 total	City's Share	Zone 3 Total	BBR's Share	Other's Share
7	Storage (Zone 2)	New in-ground storage in Zone 2 (10 ML), including EA, engineering and construction *assume at Adam St. Booster Pump Station	$ 32,000,000	$ 30,540,000	$ 30,540,000	$ 1,460,000	$ 1,410,000	$ 50,000
8	Booster Pumping (Zone 2)	Adam St. Booster Pump Station Pump Modification, including engineering and construction	$ 2,500,000	$ 1,970,000	$ 1,970,000	$ 530,000.00	$ 510,000	$ 20,000
9	Sanitary Collection	Northern Trunk Sewer Upgrades along Cannifton Rd. N including HWY401 Crossing, including engineering and construction (840m of 600mm dia sewer upgrade, 1060m of 825mm dia sewer upgrade, directional drilling for new HWY401 crossing at 825 mm)	$ 15,222,000	$ 12,982,000	$ 12,982,000	$ 2,240,000	$ 2,160,000	$ 80,000
10	Water Distribution	Watermain Upgrades along Cannifton Rd. N (2km of 400mm dia watermain upgrade) *Assumed in common trench as sanitary and is a price adder	$ 2,400,000	$ 50,000	$ 50,000	$ 2,350,000	$ 2,260,000	$ 90,000
11	Sanitary Collection	Southern Trunk Sewer Upgrades south of HWY401, including engineering and construction (415m of 900mm dia sewer upgrade, 375m of 1050mm dia sewer upgrade)	$ 4,480,000	$ 100,000	$ 100,000	$ 4,380,000	$ 4,210,000	$ 170,000
12	Sewage Pump Station	Increase Corbyville Sewage Pump Station Capacity	$ 1,000,000	$ 180,000	$ 180,000	$ 820,000	$ 790,000	$ 30,000
13	Wastewater Treatment Plant	Expand Belleville WWTP to 64,000 m3/d ADF, including EA, design and construction	$ 44,620,000	$ 42,000,000	$ 42,000,000	$ 2,620,000	$ 2,520,000	$ 100,000
		TOTAL (MID-TERM)	$ 102,222,000	$ 87,822,000	$ 87,822,000	$ 14,400,000	$ 13,860,000	$ 540,000

Table 28: Opinion of Probable Costs – Long-Term Projects

Project #	Long-Term	Project Description	OPC (+/-50%)	Zone 1 and 2 total	City's Share	Zone 3 Total	BBR's Share	Other's Share
14	Water Treatment Plant	Expand Belleville WTP to 77,000 m3/d MDD, including EA, design and construction	$ 5,000,000	$ 4,650,000	$ 4,650,000	$ 350,000	$ 340,000	$ 10,000
15	Storage (Zone 1)	New at-grade storage and booster pump station in in Zone 1 (6 ML), including EA, engineering and construction	$ 16,000,000	$ 14,410,000	$ 14,410,000	$ 1,590,000	$ 1,530,000	$ 60,000
		TOTAL (LONG-TERM)	$ 21,000,000	$ 19,060,000	$ 19,060,000	$ 1,940,000	$ 1,870,000	$ 70,000

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J.L. RICHARDS & ASSOCIATES LIMITED

Prepared by:

Zach Georgitsos
Civil Engineering Graduate

Regine Climaco, P.Eng.
Civil Engineer

Reviewed by:

Annie Williams, P.Eng.
Senior Civil Engineer

Susan Shi, P.Eng., M.Eng.
Associate
Senior Environmental Engineer
Practice Lead, Regional Market

Matt Morkem, P.Eng.
Principal Associate
Director of Environmental Infrastructure Market

Ottawa
343 Preston Street
Tower II, Suite 1000
Ottawa ON Canada
K1S 1N4
613-728-3571
ottawa@jlrichards.ca

Kingston
203-863 Princess Street
Kingston ON Canada
K7L 5N4
613-544-1424
kingston@jlrichards.ca

Sudbury
314 Countryside Drive
Sudbury ON Canada
P3E 6G2
705-522-8174
sudbury@jlrichards.ca

Timmins
834 Mountjoy Street S
Timmins ON Canada
P4N 7C5
705-360-1899
timmins@jlrichards.ca

North Bay
555-501 Oak Street E
North Bay ON Canada
P1B 8E3
705-495 7597
northbay@jlrichards.ca

Guelph
107-450 Speedvale Ave. West
Guelph ON Canada
N1H 7Y6
519-763-0713
guelph@jlrichards.ca

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS