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Phase 2 Report (FINAL)

Madoc Water, Wastewater and Stormwater Master Plan

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

Value through **service** and **commitment**

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1.0 Introduction

1.1 Background

The Municipality of Centre Hastings (the Municipality) and Ontario Clean Water Agency (OCWA) initiated a Class Environmental Assessment (Class EA) Master Plan exercise to identify existing conditions, residual capacity in the current system, and future upgrades to the water, wastewater and stormwater infrastructure to accommodate future growth in Madoc. This Master Plan is being completed in accordance with the Municipal Engineers Association (MEA) Class EA Approach 1 master planning process. The ultimate objective of the Master Plan is to develop a strategy to accommodate future growth within Madoc for the next 20-years that can be implemented in a prioritized fashion to improve the overall performance and reliability of the water, wastewater and stormwater systems.

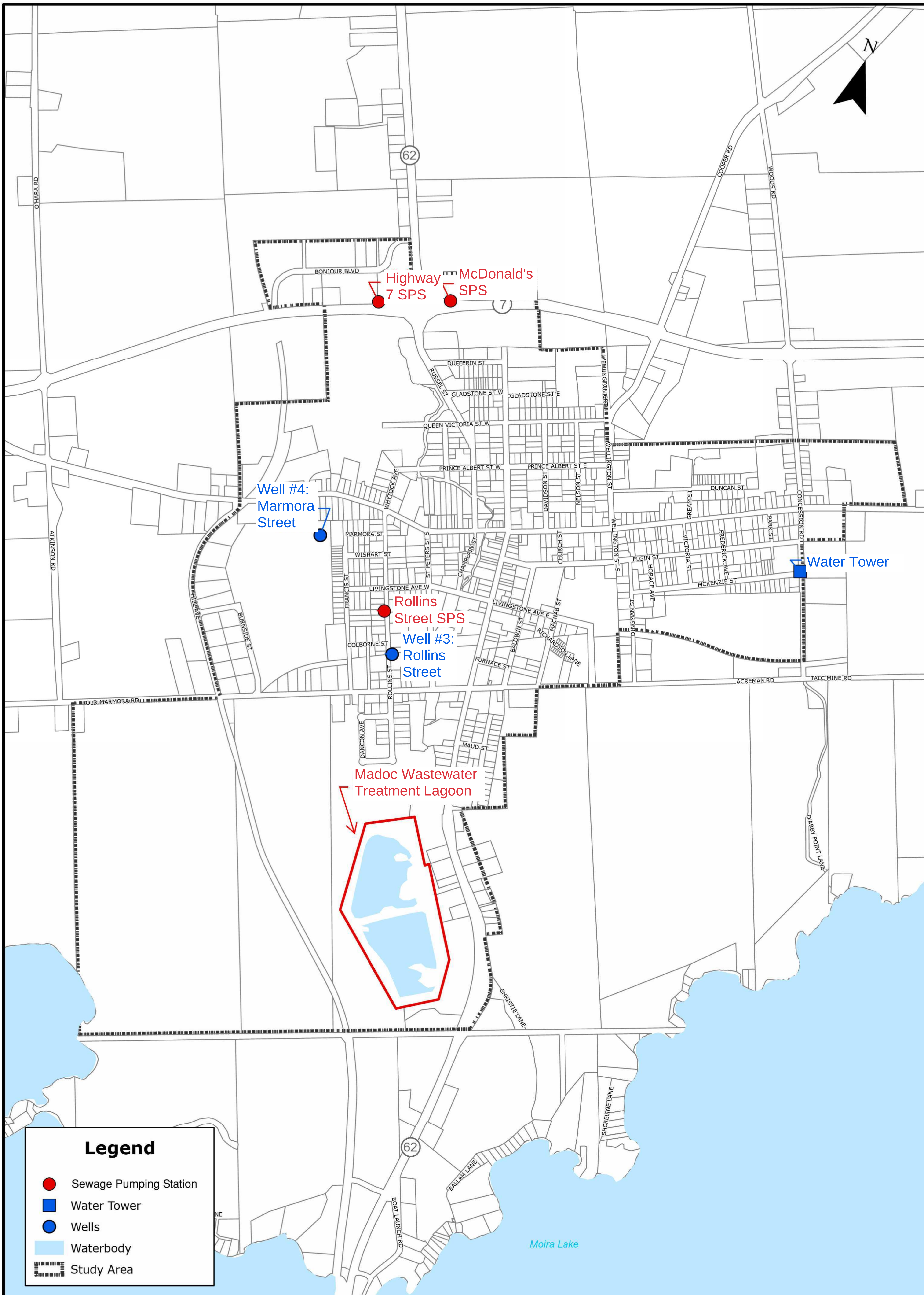
The Village of Madoc is located within the Municipality of Centre Hastings, at the intersection of Trans-Canada Highway 7 and Provincial Highway 62 and is bordered by the rural Township of Madoc. The water and wastewater infrastructure in Madoc is owned by the Municipality and operated by OCWA. The stormwater infrastructure is owned and operated by the Municipality. The Study Area includes the urban boundary of the Village of Madoc and potential future developments located within the Township of Madoc and the Municipality of Centre Hastings, as shown in Figure 1.

Madoc’s water supply and distribution system consists of two groundwater wells and pumphouses, one elevated storage tank, and over 16 km of watermains. Well #3, located on Rollins Street, has a maximum daily rated capacity of 1,150 m^3/day and includes filtration and disinfection. Well #4 located on Marmora Street, has a maximum daily rated capacity of 1,470 m^3/day and includes an ion-exchange arsenic removal system in addition to filtration and disinfection. Both wells are defined as groundwater under the direct influence of surface water (GUDI). There is an elevated water storage tank with a total volume of 1,250 m^3 that maintains the hydraulic grade line and required water storage within the distribution system. The Madoc Drinking Water System is operated under the Ministry of Environment, Conservation and Parks (MECP) Municipal Drinking Water License (MDWL) Number 153-101 and Drinking Water Works Permit (DWWP) Number 153-201.

The wastewater collection and treatment system consist of over 16 km of sanitary mains, three sewage pumping stations, one aluminum sulfate storage tank, and one wastewater treatment lagoon. The Wastewater Treatment System consists of a two-celled facultative lagoon (the ‘Lagoon’), operates in series, with an average daily rated capacity of 1,008 m^3/day and a total volume of 184,000 m^3. The Lagoon is used to treat municipal sanitary sewage collected from Madoc’s sewer system and hauled sewage. The final effluent is discharged seasonally from the Lagoon to Deer Creek, which leads to Moira Lake. The lagoon is operated under the Environmental Compliance Approval Number 1652-BRKT58.

Main road corridors in Madoc, including St. Lawrence Street West, St. Lawrence Street East, Durham Street, Elgin Street, Russel Street, and Wellington Street are serviced by minor storm sewers. Roadside ditches are routed to catch basins in low-lying areas in the road system to protect residential properties.

The purpose of the Phase 2 Report is to summarize findings from Phase 2 of the Master Plan process. The Phase 2 report documents the work completed following the completion of the Phase 1 report and includes identification of possible servicing strategies to address the deficiencies, growth projections and the Problem and Opportunity statement identified in Phase 1 of the Master Plan. Phase 2 of the Master Plan also provides an evaluation of the various alternatives, and recommendation of preferred servicing strategies and associated costs and timing.



MADOC WATER, WASTEWATER, AND STORMWATER MASTER PLAN

MADOC, ONTARIO

KEY INFRASTRUCTURE AND MASTER PLAN STUDY AREA

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ENGINEERS · ARCHITECTS · PLANNERS

DESIGN:	CK
DRAWN:	CK
CHECKED:	RC
JLR #:	32508-000.1

FIGURE 1

File Location: P:\32000\32508-000 - Madoc W-WW-SW MP\05-Production\01-Civil\GIS\32508_ArcGIS_Pro\32508_ArcGIS_Pro.aprx

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1.2 Phase 1 Problem and Opportunity Statement

The Master Plan Phase 1 report was finalized on April 1st, 2024, and posted on the Municipality's website (Madoc Water, Wastewater and Stormwater Master Plan - Municipality of Centre Hastings. Based on the work completed in Phase 1 of the Master Plan process, the following Problem and Opportunity Statement was developed:

"Madoc is serviced by communal water and wastewater systems consisting of Well #3 and Well #4, a water tower, over 16km of watermains, a sewage treatment system, three sewage pumping stations, over 16km of sanitary sewers, and minor storm systems on main road corridors. Water supply, treatment, treated water storage and lagoon treatment systems will not be sufficient to support projected growth within the Madoc servicing area for the next 20 years and beyond. In addition, there are various locations within the sanitary sewer and storm sewer systems that currently experience capacity constraints.

There is an opportunity through the Master Planning process to review the water, wastewater, and stormwater systems holistically and develop a strategic plan that can be prioritized and implemented logically with the intended goal of addressing future servicing needs and ensuring appropriate performance and reliability of Madoc's water, wastewater, and stormwater systems for the upcoming planning period of 20 years and beyond."

1.3 Summary of Deficiencies Identified in Phase 1 Report

As established in Phase 1 of the Master Plan, population and flow projections (residential and industrial, commercial, and institutional (ICI)) have been categorized for the short-term (0-5 years; 2024 to 2029), mid-term (5-10 years; 2029 to 2034), and long-term (10-20 years; 2034 to 2044) planning horizons. Note that the Phase 2 Master Plan will not include the build-out (20-30 years) planning horizon. The following section provides a high-level summary of the key deficiencies and challenges associated with each type of infrastructure. Refer to the Phase 1 Report for further details.

Infrastructure	Findings/Deficiency/Challenges Identified in Phase 1
Water Supply and Treatment	• There are currently no site-backup generators at the well pumphouses. • Marmora Well #4 is currently designated as a standby well under the Permit to Take Water (PTTW). It was assumed in the Phase 1 report that administrative changes can be made to the PTTW to remove the stand-by designation for Well #4, and that both wells can operate concurrently. • 90% of the WTP rated capacity will be reached in 2034 and 100% of the WTP rated capacity will be reached in 2036.
Water Storage	• The elevated storage tank will be insufficient in 0 to 5 Years.
Water Distribution	• Based on the model results, the overall existing water distribution system is operating in general accordance with pressure and flow recommendations of MECP Design Guidelines for Drinking-Water Systems.

Wastewater Treatment System	• The minimum 21-day discharge requirement can be challenging to meet during the spring discharge window (April 1 to May 20) because the lagoon must be substantially free of ice cover at the time of discharge. There was one occurrence of discharge under ice cover in 2021. • 80% rated capacity will be reached in 2024, 90% rated capacity will be reached in 2026 and 100% will be reached in 2028.
Wastewater Collection System and Sewage Pumping Stations	• Under existing conditions, there are 28 sewer segments with insufficient capacity to convey peak design flow. These sewer segments are generally located on the trunk sanitary sewer located along Champlain Street and parallel to Durham Street North and Durham Street South. • Several sewer segments have a slope and velocity which do not meet current MECP guidelines.
Stormwater Sewer System	• Under existing conditions, there are 32 sewer segments with insufficient capacity to convey the design flow. • Four (4) storm sewer segments with negative slope were identified. • There are storm sewers that outlets to private land. • There is a storm sewer running underneath the school which should be redirected immediately due to safety concerns.

1.4 Phase 2 Objectives

The objective of this Phase 2 report is to identify and evaluate alternative solutions to determine a preferred solution to the Problem and Opportunity Statement identified in Phase 1 (and presented in Section 1.1). This Report also outlines the evaluation methodology used to evaluate the alternatives and identifies their potential impacts and mitigation measures. Options considered include new construction, potential retrofits, and/or upgrades to optimize existing water, wastewater and stormwater infrastructure, in order to accommodate 20-year growth within Madoc.

The objectives of the Phase 2 Report are:

- To model future water distribution, wastewater collection, and stormwater sewer systems for the Master Planning period of 20-years and establish required upgrades.

- To present an evaluation matrix with criteria by which servicing alternatives are evaluated against the natural, social/cultural, technical and financial considerations.

- To identify and evaluate alternative solutions to address treatment, capacity and storage issues associated with the linear infrastructure, water treatment system, water storage, wastewater treatment system and three sewages pumping stations' within Madoc.

- To recommend an overall implementation plan with proposed timelines and associated costs each of the planning timeframe.

- To provide mitigation measures and identify potential impacts associated with preferred alternatives, as well as any required permits or approvals.

- To conduct a council meeting and public information centre (PIC) to present proposed alternatives and recommended preferred solutions.

- To update and finalize the Master Plan Report based on comments received throughout the process and place on record for a 30-day review period.

2.0 Climate Change

Climate change has the potential to alter weather patterns that can affect the water, wastewater, and stormwater infrastructure and facilities in Madoc. Climate change can affect the quality and quantity of the drinking water supply, collected wastewater and stormwater stream and the reliability of the local utilities (including electricity systems and natural gas services). A technical memorandum was prepared to outline the potential effects of climate change on Madoc's Water Treatment Plant (WTP) and distribution, lagoons and collection, and stormwater infrastructure and potential areas of concern that should be addressed in future designs and upgrades of these facilities/systems. The Climate Change Technical Memorandum is available in Appendix A.

It is recommended that the Municipality consider the following aspects during future project planning to mitigate climate change risks and adapt to potential future climate change events:

- Implement backup power systems at Well #3 and #4;
- Implement backup power systems at sewage pump stations and wastewater treatment lagoon;
- Consider upsizing sanitary and stormwater infrastructure to accommodate increased wet weather flows and Inflow & Infiltration (I&I);
- Undertake an I&I study and flow monitoring program to identify areas of high I&I;
- Disconnect roof leaders, combine storm sewer connections, and combine sanitary sewer connections to reduce peak flows, and
- Promote water conservation during summer and/or drought conditions;
- Consider climate change effects during the detailed design of projects to be implemented.

In addition to the above recommendations, the Municipality may also wish to implement other construction and design frameworks with a focus on climate change and GHG emissions, such as Leadership in Energy and Environmental Design (LEED) and Institute for Sustainable Infrastructure's Envision Program.

It is also recommended that the Municipality seek funding opportunities for climate change related projects.

3.0 Overall Evaluation Methodology

In order to facilitate the evaluation and selection of the preferred solutions during Phase 2, a transparent and logical three-part assessment process was established. This process included:

- Initial screening of alternative solutions.
- Detailed evaluation of screened alternative solutions.
- Selection of a preferred alternative solution.

The initial screening process considers the overall feasibility of the potential alternative solutions and identifies which alternative fully address the Problem and Opportunity Statement as identified in Phase 1 Report. This step ensures that unsuitable alternatives are not carried forward to a more detailed evaluation stage.

Based on the initial screening process, a detailed assessment of the short-listed alternatives was conducted. Evaluation criteria were developed based on a review of the background information, experience on similar assessments, stakeholder comments, and in consultation with the Municipality/OCWA.

The evaluation criteria are described in Table 1.

Table 1: Summary of Evaluation Criteria

Criteria	Description
Natural Environment Considerations	Natural features, natural heritage areas, areas of natural and significant interest, designated natural areas, watercourses and aquatic habitat.
Climate Change and Resiliency	Effects of climate change (e.g., impact of extreme weather events on water supply and wastewater generation), ability to mitigate climate change effects (e.g., contribution to greenhouse gas emissions, impacts on carbon sinks), ability to adapt to climate change impacts, i.e., resiliency and security of infrastructure.
Social and Cultural Environment Considerations	Proximity of facilities to residential, commercial and institutions, archaeological resources, areas of archaeological potential, known and potential built heritage resources, cultural heritage landscapes, and source water protection areas (i.e., intake protection zones and wellhead protection areas), land-use and planning designations.
Technical Feasibility	Constructability, maintaining or enhancing water/wastewater treatment, reliability and security of distribution/conveyance system, ease of connection to existing infrastructure and operating and maintenance requirements, addresses aging infrastructure, expandability.
Financial Considerations	Capital costs, Operation and Maintenance costs.

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 2. The option that has the least negative impact (or has the strongest positive impact) was recommended as the preferred solution. The five (5) major criteria were assigned equal weights as they were considered to have equal importance in this evaluation at the Master Plan stage.

Table 2: 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

Alternatives were developed for the Madoc's water supply and wastewater treatment lagoon. Alternatives for Madoc's Water Storage was completed as a Schedule 'B' Municipal Class Environmental Assessment for a New Treated Water Storage in Madoc. Evaluation of servicing strategies for linear infrastructure (water distribution, wastewater collection, and storm sewers) was completed through water modeling and excel design sheets.

4.0 Identification, Evaluation and Recommendation of Servicing Strategies

4.1 Water Supply and Treatment

Refer to Section 4.0 of the Phase 1 Master Plan for existing conditions of the Water Supply and Treatment System.

Table 3 below provides a summary of the future water demand and the rated capacity of Well #3 and #4 from the Phase 1 Report. Refer to Phase 1 Report Table 14 for additional information.

Table 3: Future Water Demands

Demand Scenario	Existing Conditions (2023)	Short-Term	Mid-Term	Long-Term
		(2024-2029)	(2029-2034)	(2034-2044)
Maximum Day (m^3/day) Cumulative	922	1,544	2,324	3,979
Rated Capacity (m^3/day)	2,620			
Deficit (m^3/day)	n/a	n/a	n/a	1,359

4.1.1 Description of Alternatives

There are a number of options to achieve the required future water demand to support 20-year growth within Madoc. The following alternatives have been identified to address the deficiencies and challenges associated with the existing water supply and treatment.

4.1.1.1 Alternative 1: Status Quo

The Status Quo alternative represents what would likely occur if the well intake quantity remained the same for the future scenarios, i.e., no increase to water supply and water treatment. The "status quo" option is always included in the evaluation as the basis for comparison.

The Status Quo alternative assumes that the Permit to Take Water (PTTW) can be updated to re-designate Well #4 as a duty well, and that both wells can operate at the same time to supply maximum daily flow. As such, this alternative provides a rated capacity of 2,620 m^3/day, which is sufficient for mid-term (5-10 Year) water demand. Other alternatives will need to be considered to supply water demand for long-term (10-20 Year) growth which is equivalent to an additional 1,400 m^3/day of water supply.

Recommendation: Alternative 1 will not be sufficient for projected long-term water demand; therefore, it is not recommended to carry Alternative 1 forward. However, it is recommended to seek MECP approval to update PTTW and designate both Wells #3/#4 as duty wells.

4.1.1.2 Alternative 2: Increase Water Supply from Existing Well #3 and Well #4

Alternative 2 assumes that more groundwater can be withdrawn from the aquifer beyond the current PTTW capacity and that the aquifer can support the long-term growth.

A hydrogeological study will be required to determine the feasibility of this option. The study will involve field testing and review the effects of increasing water taking quantity on raw water quality and aquifer recharge, and the effects of water quality and quantity for private wells which draw from the same aquifer as Well #3 and Well #4.

If the capacity from existing wells can be increased, a Schedule 'C' Class EA will be required to assess the treatment plant capacity expansion and the treatment technologies to meet drinking water quality standards.

Recommendation: Alternative 2 <u>may be feasible</u> to support the long-term water demands. A hydrogeological study is recommended in order to determine the feasibility of this alternative. If the hydrogeological study confirms sufficient aquifer to support long-term water demands, a Schedule 'C' Class EA will be triggered to evaluate water treatment plant alternatives.

4.1.1.3 Alternative 3: Maintain Existing Water Supply from Well #3 and Well #4 and Supplement with Water from a New Well

Alternative 3 is based on the assumption that the Well #3 and Well #4 are at capacity and no more groundwater can be withdrawn from these locations. The current water intake from Well #3 and Well #4 up to the existing rated capacity of 2,620 m^3/day will need to be supplemented from a new water source with a capacity of 1,400 m^3/day.

A Schedule 'B' Water Supply Class EA (including water supply feasibility study and field hydrogeological assessment) should be completed to establish the feasibility and preferred location of a new well.

A 2013 Village of Madoc Municipal Water System Expansion Alternatives Report (Greer Galloway Group) referenced a 2007 Dillon assessment on groundwater flow paths in the vicinity of the existing wells. The groundwater movement is generally from the north to south and that the area to the west of Madoc shows expected high groundwater yields. The 2013 report concluded that it is viable to develop a new well at a new location potentially to the west of the village boundary. Anecdotal information also indicated a potential well location east of Madoc or at the monitoring well operated by Quinte Conservation Authority. The exact site location will be determined through the hydrogeological study.

With this alternative, a new well will be drilled at a new site; However, this new site will likely require land acquisition by the Municipality. A water treatment plant, along with transmission watermains will be designed and constructed to connect the new water source to the existing system.

Recommendation: Alternative 3 will be sufficient for projected long-term water demand; therefore, it is recommended to carry Alternative 3 forward. A Water Supply Feasibility Study, Hydrogeological Study and a Schedule ‘B’ Water Supply Class EA is recommended to confirm the location of the new well and level of treatment requirements. Land acquisition and negotiation with nearby municipality is anticipated.

4.1.1.4 Alternative 4: Discontinue Water Supply from Well #3 and Well #4 and Obtain Water from Surface Water Source

Alternative 4 presents an option for the Municipality to discontinue use of Well #3 and Well #4 as a water source. This option was previously explored in the 2013 Greer Galloway Group report and was not considered further. The available surface water source near Madoc includes Moira Lake and unused mine workings to the east of the Village.

Recommendation: Alternative 4 is not recommended due to the existing aquifer capacity and extensive work required to establish a new drinking water source. If in the future, hydrogeological study finds existing aquifer cannot support build-out growth or that the groundwater quality deteriorates, this option may be reconsidered.

4.1.2 Summary of Initial Screening

Table 4: Initial Screening Summary - Water Supply

Alternative #	Alternative Solution Identified	Initial Screening Result	
1	Status Quo	×	Not feasible. Not carried forward
2	Increase Water Supply from Existing Well #3 and Well #4	✓	May be feasible if confirmed by hydrogeological study. Carried forward.
3	Maintain Existing Water Supply from Well #3 and Well #4 and Supplement with Water from a New Well	✓	May be feasible if confirmed by hydrogeological study. Carried forward.
4	Discontinue Water Supply from Well #3 and Well #4 and	×	Not recommended. Not carried forward.

	Obtain Water from Surface Water Source		

4.1.3 Servicing Options

Table 5: Evaluation Matrix - Water Supply

Evaluation Criteria	Alternative #2 Increase Water Supply from Existing Well #3 and Well #4	Alternative #3 Maintain Existing Water Supply from Well #3 and Well #4 and Supplement with Water from a New Well
Natural Environment Considerations	• No changes to existing site boundary. • Potential effects on nearby private wells. Effects to be determined by hydrogeological study.	• Additional site required for new well. • Construction activities may affect natural environment. Potential location may be located near environmentally sensitive lands.
Evaluation	**Preferred**	**Less Preferred**
Climate Change Resiliency	• Potentially vulnerable supply during drought conditions.	• Additional well provides redundancy and additional supply during drought conditions.
Evaluation	**Less Preferred**	**Preferred**
Social and Cultural Environment Considerations	• If supply can be confirmed by hydrogeological study, community can be serviced for the long-term. • It is not anticipated that the increase in water taking will affect built heritage resources and cultural heritage landscapes from existing wells.	• If supply can be confirmed by hydrogeological study, community can be serviced for the long-term. • Depending on the conditions of the new well site, this option has potential impact to built heritage resources and cultural heritage landscapes.
Evaluation	**Preferred**	**Less Preferred**
Technical Feasibility	• Technical feasibility to service long term growth to be determined by hydrogeological study	• Technical feasibility to service long-term growth to be determined by hydrogeological study.
Evaluation	**Preferred**	**Preferred**
Financial Considerations	• There will be additional cost to complete a hydrogeological study. • There will be additional cost to install new well pumps and associated treatment system.	• There will be additional cost to complete a hydrogeological study. • There will be significant cost to design, drill and commission new well, along with construction of new transmission main, process building and purchase of new equipment. Land acquisition may be required.

Evaluation	Preferred	Less Preferred
Final Evaluation	Preferred (Pending Hydrogeological Study)	Less Preferred (Pending Hydrogeological Study)

Alternatives 2 and 3 both appear feasible to support the long-term growth. However, additional hydrogeological study will need to be undertaken to confirm the aquifer capacity and water taking limits. Detailed evaluation was not undertaken during this Master Plan process and should be completed during the future Schedule 'B' and Schedule 'C' Class EAs once additional hydrogeological studies have been completed.

4.2 Water Storage

The Phase 1 Report identified the need to expand the existing elevated water storage tank to meet the short-term growth. Table 6 provides a summary of the Phase 1 report assessment of storage volume requirements.

Table 6: Future Water Storage Requirements

Parameter	Existing (2023)	Short-Term (2024-2029)	Mid-Term (2029-2034)	Long-Term (2034-2044)
Total Storage Requirement (m^3)	993	1,401	1,804	3,428
Existing Available Storage (m^3)	1,250	1,250	1,250	1,250
Deficit (m^3)	n/a	151	554	2,178

4.2.1 Description of Configurations

4.2.1.1 Configuration 1: Below Grade Reservoir and Pumping Station

Below-grade reservoirs are constructed underground, then covered by earth and vegetation. This hides the reservoir from view, which improves visual aesthetics. However, excessive costs can be incurred depending on the depth of bedrock. This also enables the reservoir to have two or more cells that can be taken offline independently, which allows for maintenance or inspection activities to proceed without losing the facility's entire storage capacity. These reservoirs are typically constructed with concrete.

The associated pumping station can be to be at-grade or below-grade, but at-grade buildings are more operator friendly and are typically used. The usage of a pumping station increases the complexity of this solution relative to others, such as an elevated tower. It incurs higher operational and maintenance costs. The new pumping station would require redundant pumping capacity to allow flexible operations if a pump is removed from service for routine maintenance or a potential equipment failure.

Pumping capacity is also required to meet the full range of everyday domestic demands up to fire protection demands. Maintaining a constant, adequate water distribution system pressure requires higher electrical consumption from continual pump operation. The pumping station will also require a backup power supply, such as natural gas generators.

The below-grade and pumping station will have the highest capital and life cycle costs among the configurations considered.

4.2.1.2 Configuration 2: At-Grade Reservoir with Pumping Station

At-grade reservoirs are typically made of coated/glass-fused-to steel. Glass-fused-to-steel (GFS) tanks are preferred due to ease of installation, longevity, lower maintenance, and lower cost. During maintenance or inspection, all storage capacity is unavailable since there are no internal baffles that would allow some capacity to remain in service.

However, these reservoirs can be constructed in phases. Instead of constructing a large reservoir to meet the entire storage required to supply the long term, an initial reservoir module can be constructed that meets the short and mid-term needs. As the water storage needs increase in the long term, a second phase of construction can commence, where a second module is added to the short-term storage to increase its capacity to satisfy long-term requirements. This is a cost-effective method that prevents storage from being unused in the short term, which may cause water quality issues, and allows for flexibility in timing in case developments do not proceed as projected.

The footprint of an at-grade steel tank is flexible, as there are a wide variety of diameters and heights available. This means they usually take up less space than a below-grade reservoir of comparable volume. The cost of at-grade reservoirs is also less depending on the bedrock depth than that of a below-grade reservoir. Therefore at-grade reservoirs have slightly lower capital and life cycle costs compared to a below-grade reservoir.

Like a below-grade reservoir, an at-grade reservoir configuration requires pumping station infrastructure. As discussed in Configuration 1, these operational and maintenance costs are higher than that of an elevated tank, due to their higher complexity.

4.2.1.3 Configuration 3: Decommission Existing Tank and Build New Composite Elevated Tank.

Composite elevated tanks are located at the top of a support structure such as a pedestal. The water level in the elevated tank sets the pressure in the water distribution system. The usable capacity of an elevated tank is the volume of water that can be stored in the tank between the high and low water levels. Therefore, the diameter determines the functional capacity. No additional pumping station is required to maintain the head beyond the existing well pumps that fill the elevated tank.

4.2.1.4 Configuration 4: Standpipe

Standpipes are storage tanks constructed at ground level to a height that will provide adequate system pressure in the operating range. They are entirely filled with water, i.e., for the entire height. They can be made of glass-fused-to-steel or coated steel. As with the other configurations, glass-fused-to-steel tanks are easier to install, last longer, and require less maintenance.

The taller design of a standpipe allows for water above the operating range to provide gravity-fed pressure, and chlorine contact time, if it is located before users in the distribution system. Standpipes are often used in small systems where less volume is needed, or in situations where the site has a high ground elevation relative to the system pressure.

4.2.2 Summary of Recommendations

Subsequent to the completion of Master Plan Phase 1, JLR was retained to advance the Schedule 'B' Class EA for Treated Water Storage Facility. The identification, evaluation and recommendation of a preferred alternative for Madoc's Water Storage was completed as a separate Schedule 'B' Class EA. Refer to the Schedule 'B' Class EA Project File, in Appendix B, for complete information on the recommendations related to water storage.

4.3 Water Distribution System

4.3.1 Short-, Mid-, and Long-Term Future Conditions

Refer to Section 6.0 of the Phase 1 Master Plan for a description of the existing water distribution system.

The future growth areas were modelled based on future growth projections (Figures 2 to 9 of the Phase 1 Master Plan Report), which defined the areas, hectares, and numbers of units in each new future development area. The development areas were distributed over the short-term (2024-2029), mid-term (2029-2034), and long-term (2034-2044) scenarios.

The watermains for new developments in the future conditions were assumed to be PVC with a nominal diameter of 200 mm. These areas were modelled using representative watermain loops for new developments with over 50 homes, with junctions at connection points between pipes. Demand was typically modelled on a singular representative node located near the center of the development area. Connections to the existing system were assumed to illustrate the capacity of the current system to support development and determine the need for upgrades.

Population projections were taken from Tables 2 to 9 of the Phase 1 Master Plan Report. These projections were used with the peaking factors listed in the table below to determine the future demands. The peaking factors were based on the Phase 1 Master Plan Report, where the maximum day peaking factor was determined based on annual data and the peak hour peaking factor was based on the MECP design guidelines.

Table 7: Peaking Factors for Future Development Areas

Land Use Type	Maximum Day Demand	Peak Hour Demand
Residential, Industrial, and Commercial	2.08 x Average Day	1.50 x Maximum Day

The Peak Hour Demand peaking factor is applied to the Maximum Day Demand, and the Maximum Day Demand peaking factor is applied to the Average Day Demand. The Average Day Demand was determined using the populations and development areas from Table 1 of the Phase 1 Master Plan Report and the per unit consumption rates listed in Table 8.

Table 8: Average Day Demands for Future Development Areas

Land Use Type	Average Day Demand (L/d)
Residential	300 per capita
Typical Industrial	45,000 per hectare
Light Industrial	35,000 per hectare

Hospital and Long Term Care	1,400 per bed
Commercial	28,000 per hectare

Refer to Appendix C for the future demands input into the model. Intensification demands were distributed to six (6) junctions equally across the model (J-19, J-51, J-98, J-60, J-27, and J-56).

The Average Day, Maximum Day, and Peak Hour conditions were modelled for future growth areas using the same system operating parameters as the existing areas (Water tower HGL= 218.76 m with Well #3 pump on).

The results are summarized in the tables below, followed by the results of the water model simulations.

4.3.2 Recommended Upgrades

It is recommended that the existing 100 mm diameter pipes on St. Lawrence Street East (~100m east of Concession Road and ~115m west of Concession Road) be upgraded to 200 mm diameter pipes in the long-term (10-20 years) scenario to adequately service the future development nearby. This future development consists of a watermain loop to service 100 residential units. The 200 mm pipe upgrades on St. Lawrence Street East would be necessary to provide reasonable fire flow supply to this future development. It is understood that some of this work is already underway. The tables below represent the results with and without this recommended upgrade.

4.3.2.1 Future Conditions: Average Day Demand

Table 9: Hydraulic Water Model Results - Average Day Demand

Average Day Demand			**Percentage of Junctions**				
Pressure Range (kPa)			**Existing (2023)**	**Short-Term (0-5 years)**	**Mid-Term (5-10 years)**	**Long-Term (10-20 years) – No Upgrades**	**Long-Term (10-20 years) - Upgrades**
	Less than	276	0.0%	0.0%	0.0%	0.0%	0.0%
276	up to	350	3.8%	3.8%	3.8%	4.5%	4.5%
350	up to	400	12.5%	12.5%	13.2%	12.7%	12.6%
400	up to	450	24.0%	24.0%	24.5%	27.3%	27.0%
450	up to	500	29.8%	31.7%	34.9%	30.9%	31.5%
500	up to and incl.	552	26.0%	25.0%	20.8%	21.8%	21.6%
	Greater than	552	3.8%	2.9%	2.8%	2.7%	2.7%

Under average day demand for future conditions, Table 9 shows that most junction nodes experience pressures between 350 kPa and 552 kPa, and a smaller percentage of the junction nodes experience pressures above 552 kPa. System pressures under existing and future conditions are found to be above the minimum recommended pressure of 276 kPa (40 psi), in accordance with the MECP Design Guidelines, and the existing level of service is generally expected to be maintained. Under existing conditions, four (4) junction nodes located on Durham

Street South (J-60, J-62, and J-70) and Seymour Street West (J-36) experience pressures above 552 kPa due to their low topographic elevations. In short-term and mid-term conditions, three (3) of those junctions (J-36, J-62, AND J-70) experience pressures above 552 kPa. In the long-term condition, two (2) of those junctions (J-36 and J-70) plus one (1) junction on Durham Street South (J-112) , along the proposed watermain extension, experience pressures above 552 kPa due to their low topographic elevations.

Figure 2

Short-Term (0-5 yrs) Conditions - Average Day Demand

1 Pump On, Water Tower HGL= 218.76 m

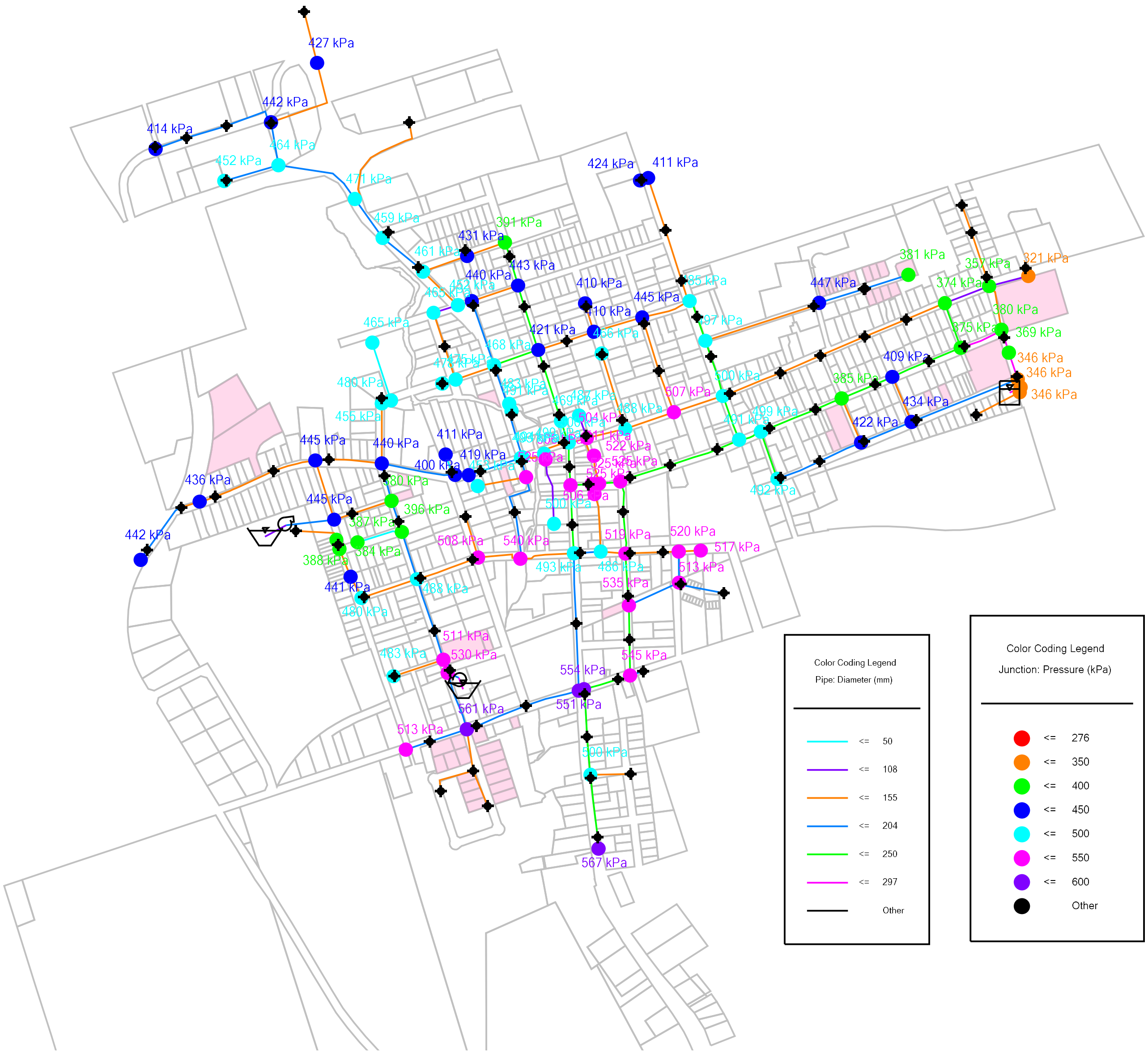


Figure 3

Mid-Term (5-10 yrs) Conditions - Average Day Demand

1 Pump On, Water Tower HGL= 218.76 m

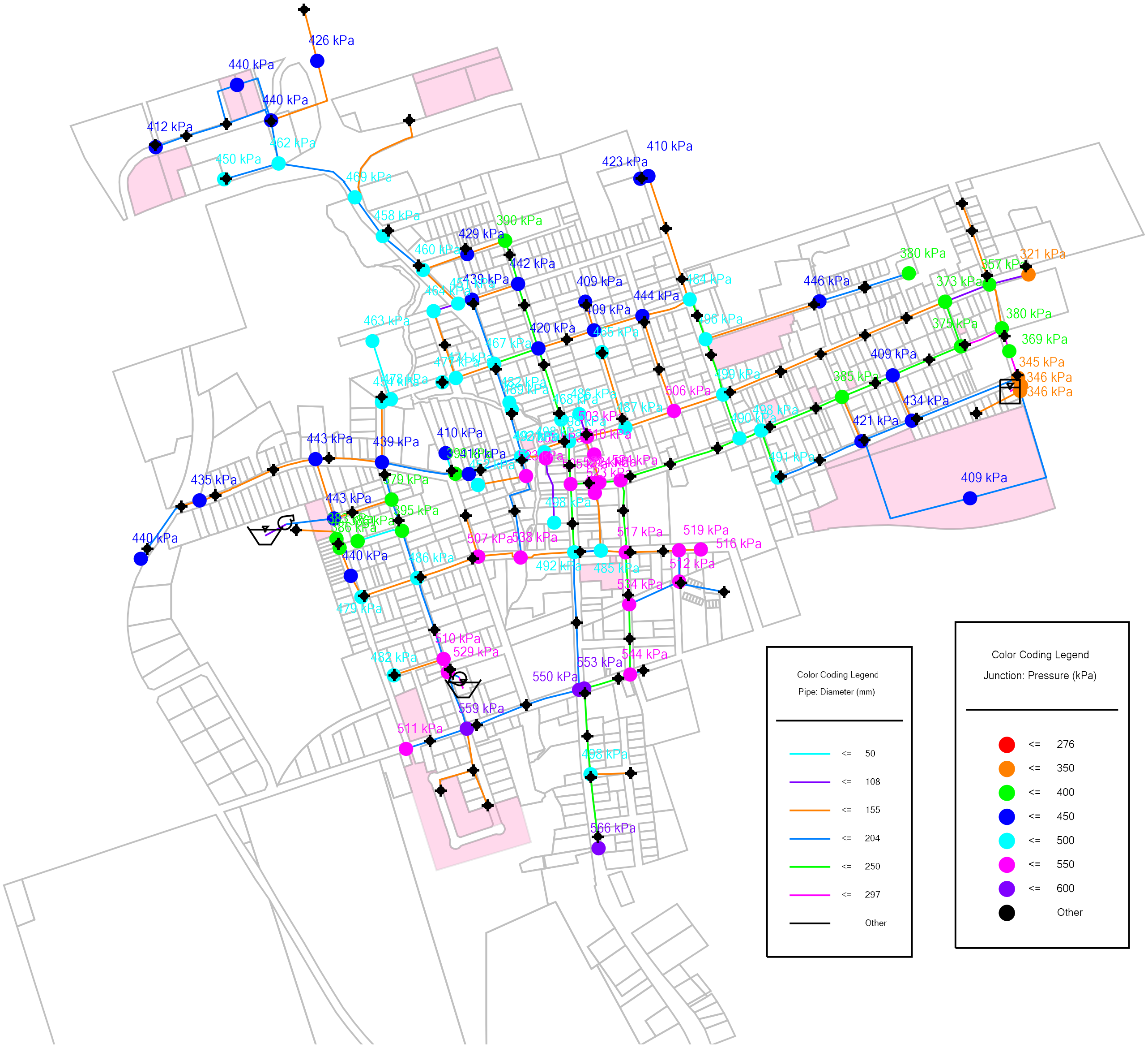


Figure 4

Long-Term (10-20 yrs) Conditions - Average Day Demand
1 Pump On, Water Tower HGL= 218.76 m
No Upgrades

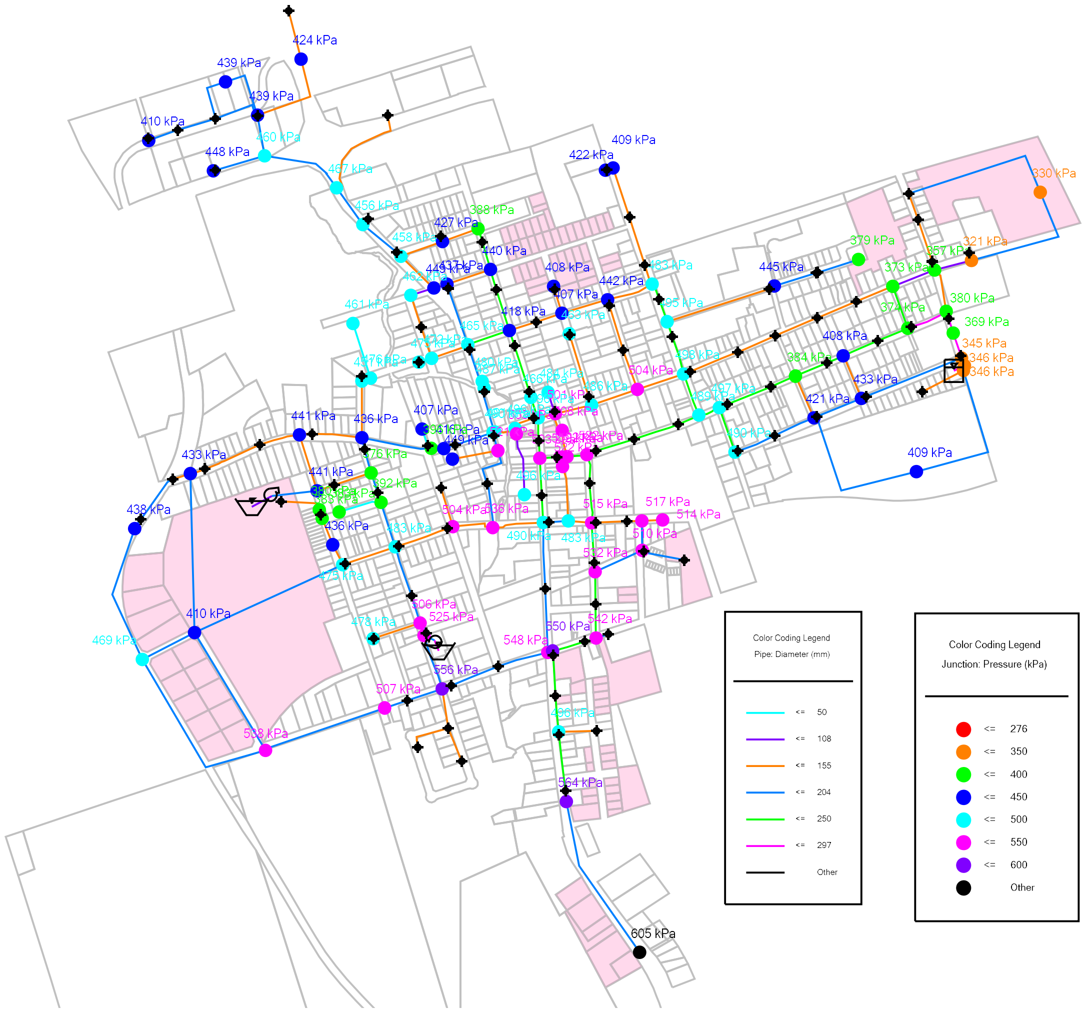
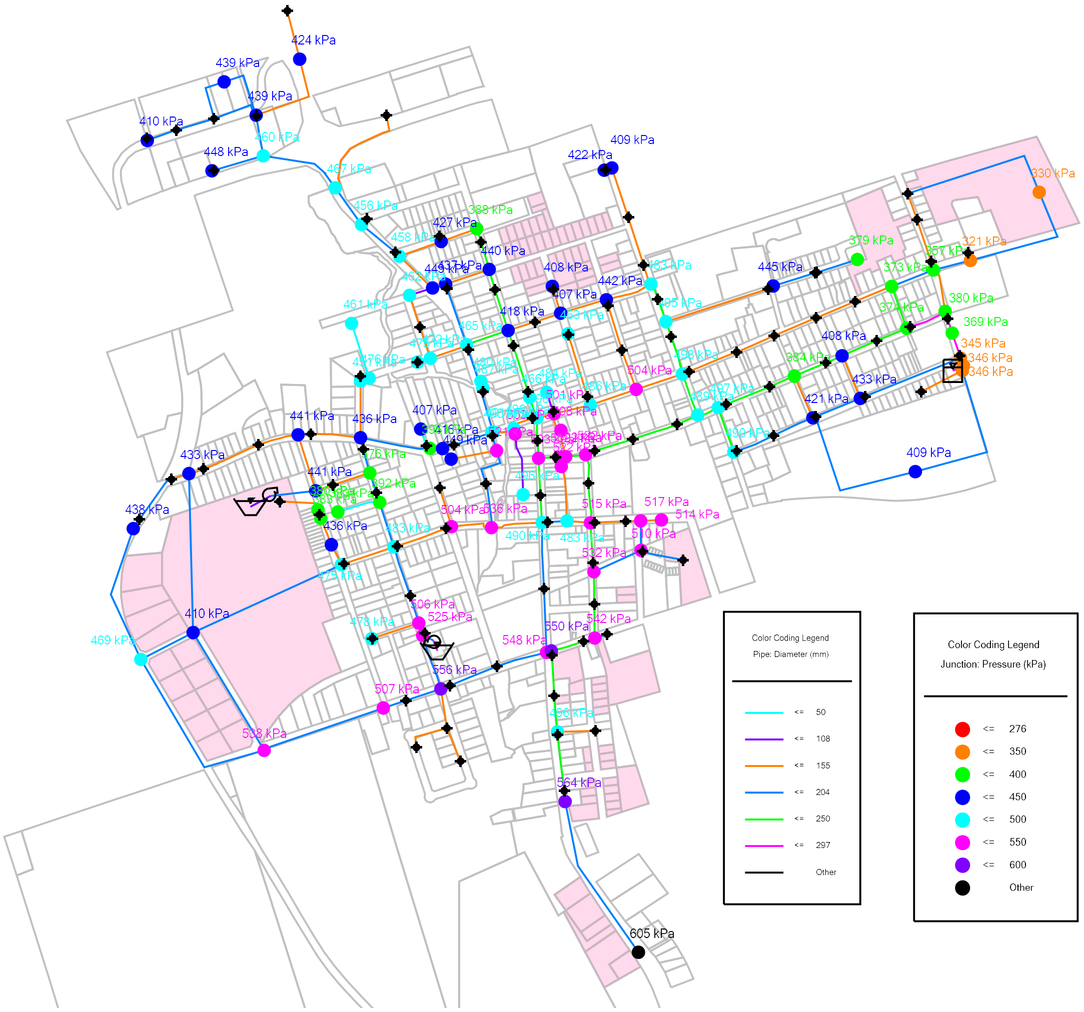


Figure 5

Long-Term (10-20 yrs) Conditions - Average Day Demand

1 Pump On, Water Tower HGL= 218.76 m

Upgrades



4.3.2.2 Future Conditions: Maximum Day Demand with Fire Flow

Table 10: Hydraulic Water Model Results – Maximum Day Demand + Fire Flow

Maximum Day Demand + Fire Flow			**Percentage of Fire Flow Nodes**				
Fire Flow Range (L/s)			**Existing**	**Short-Term (0-5 years)**	**Mid-Term (5-10 years)**	**Long-Term (10-20 years) No Upgrades**	**Long-Term (10-20 years) - Upgrades**
	Less than	30	0.9%	0.9%	0.9%	0.9%	0.9%
30	up to	45	1.9%	1.9%	1.8%	0.9%	0.9%
45	up to	67	13.9%	13.9%	15.5%	13.2%	10.5%
67	up to	83	8.3%	8.3%	7.3%	9.6%	7.0%
83	up to	100	6.5%	6.5%	8.2%	10.5%	8.8%
100	up to	117	9.3%	9.3%	7.3%	8.8%	15.8%
117	up to	150	13.0%	14.8%	13.6%	20.2%	20.2%
150	up to and incl.	200	33.3%	32.4%	31.8%	23.7%	23.7%
	Greater than or equal to	200	13.0%	12.0%	13.6%	12.3%	12.3%

Under maximum day demand plus fire flow for future conditions, Table 10 shows that most hydrant nodes experience fire flows above 45 L/s, which is the minimum required fire flow per the Ontario Building Code (OBC) for a typical two-storey home. A smaller percentage of the hydrant nodes experience fire flows below the minimum OBC requirement. These hydrant nodes have low fire flow availability as they are located at dead end watermains on Russel Street (H-5), St. Lawrence Street East (H-2) and St. Peters Street North (H-54) which is present under existing conditions. As shown in the table, the available fire flows decrease slightly over time. This is due to the increased demands from the new developments. However, there are also some fire flow increases under mid-term and long-term conditions due to increased looping in the system for new developments.

With the proposed 200 mm pipe upgrade in the long-term (10-20 years) scenario, more fire flow will be available at the future development on St. Lawrence Street East. The fire flow at this future development (J-12) with this upgrade increases to 106 L/s compared to a fire flow of 59 L/s without upgrades.

The fire flow requirements for future developments are unknown. In the absence of this criteria, a general fire flow of 100 L/s was targeted for the identified new development areas with over 50 units. The system is expected to provide the fire flows shown in Figure 9 . These available fire flows would be the supply parameters for any new development.

Figure 6

Short-Term (0-5 yrs) Conditions - Maximum Day Demand + Fire Flow

1 Pump On, Water Tower HGL= 218.76 m

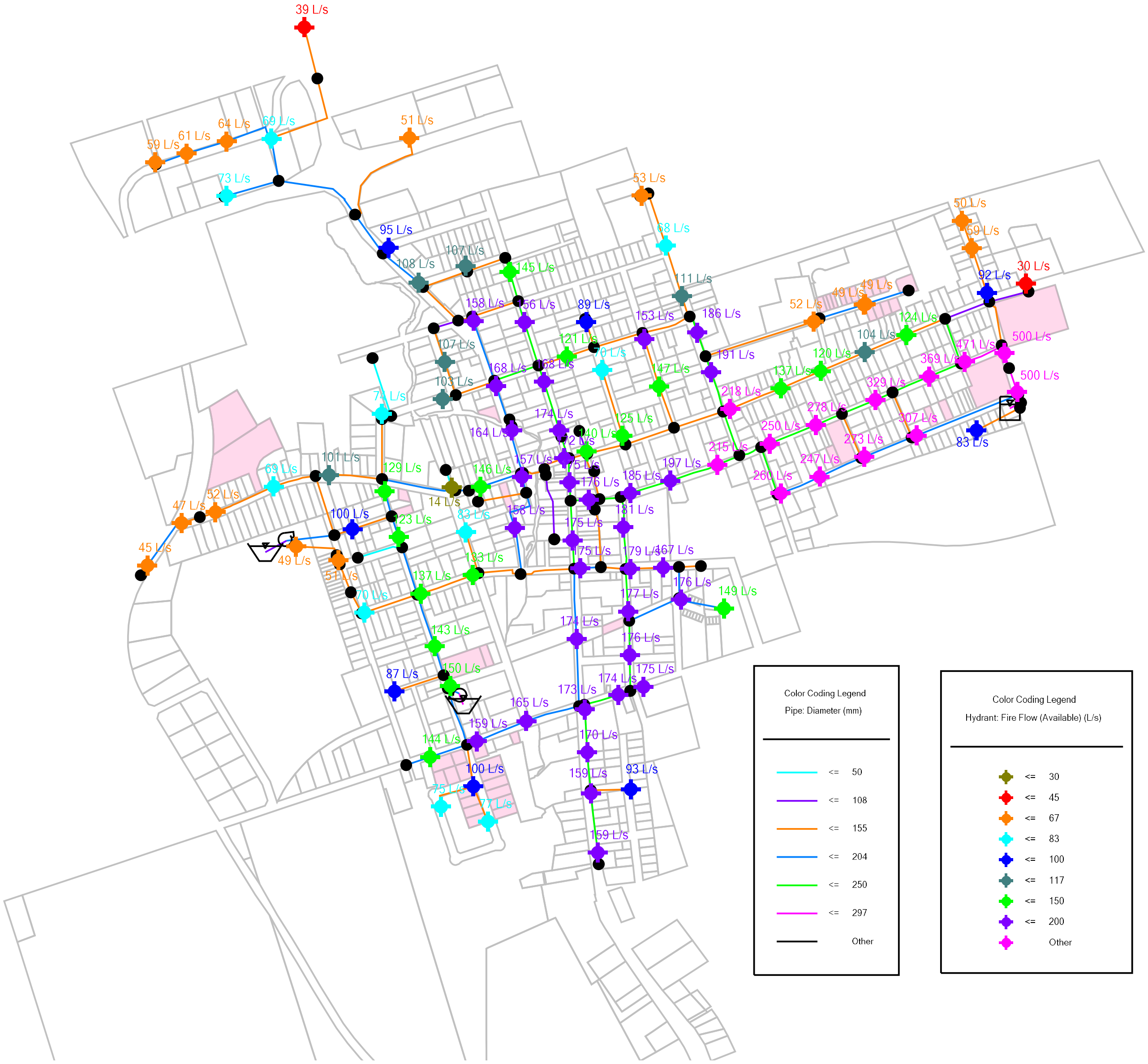


Figure 7

Mid-Term (5-10 yrs) Conditions - Maximum Day Demand + Fire Flow

1 Pump On, Water Tower HGL= 218.76 m

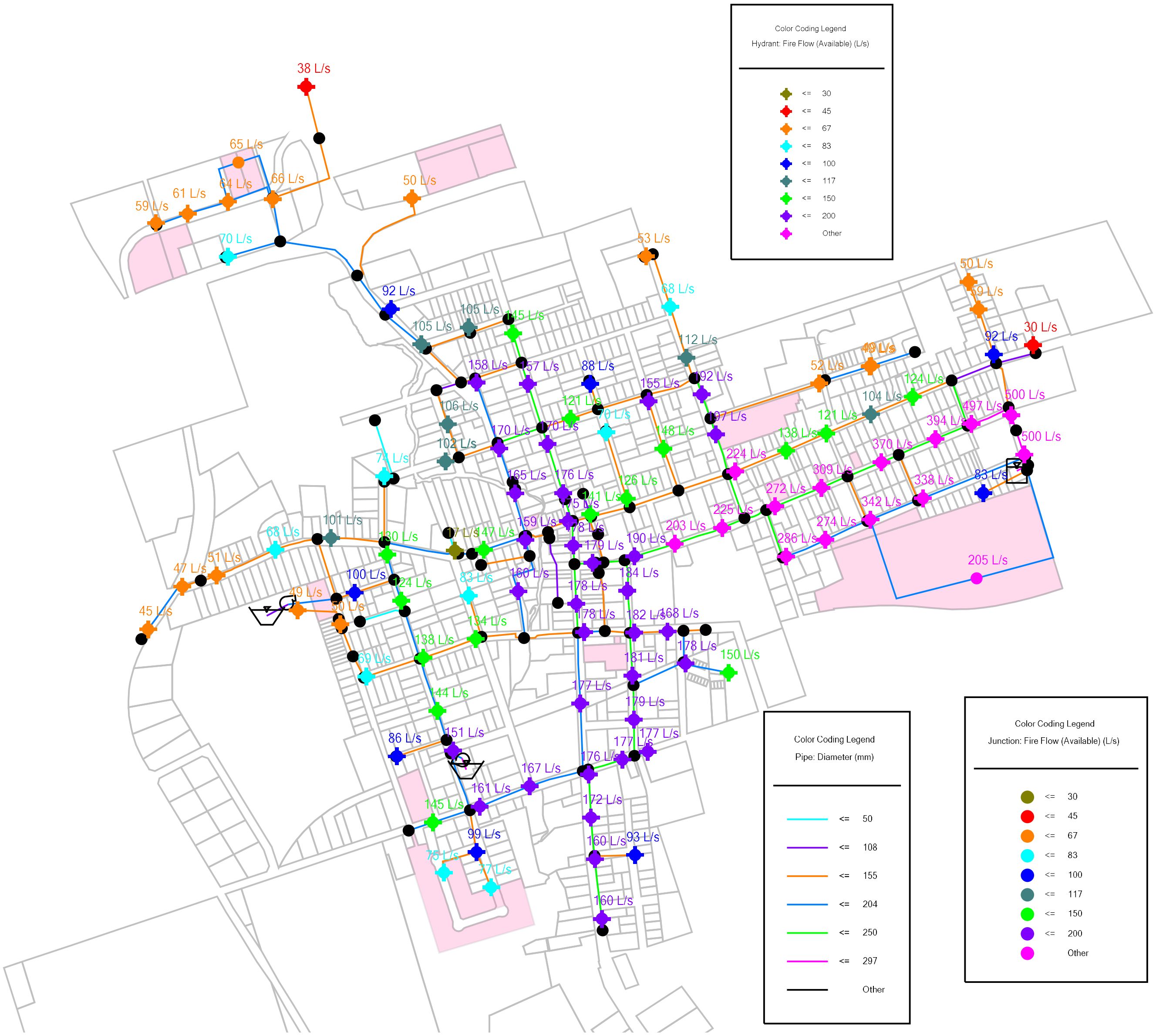


Figure 8

Long-Term (10-20 yrs) Conditions - Maximum Day Demand + Fire Flow

1 Pump On, Water Tower HGL= 218.76 m

No Upgrades

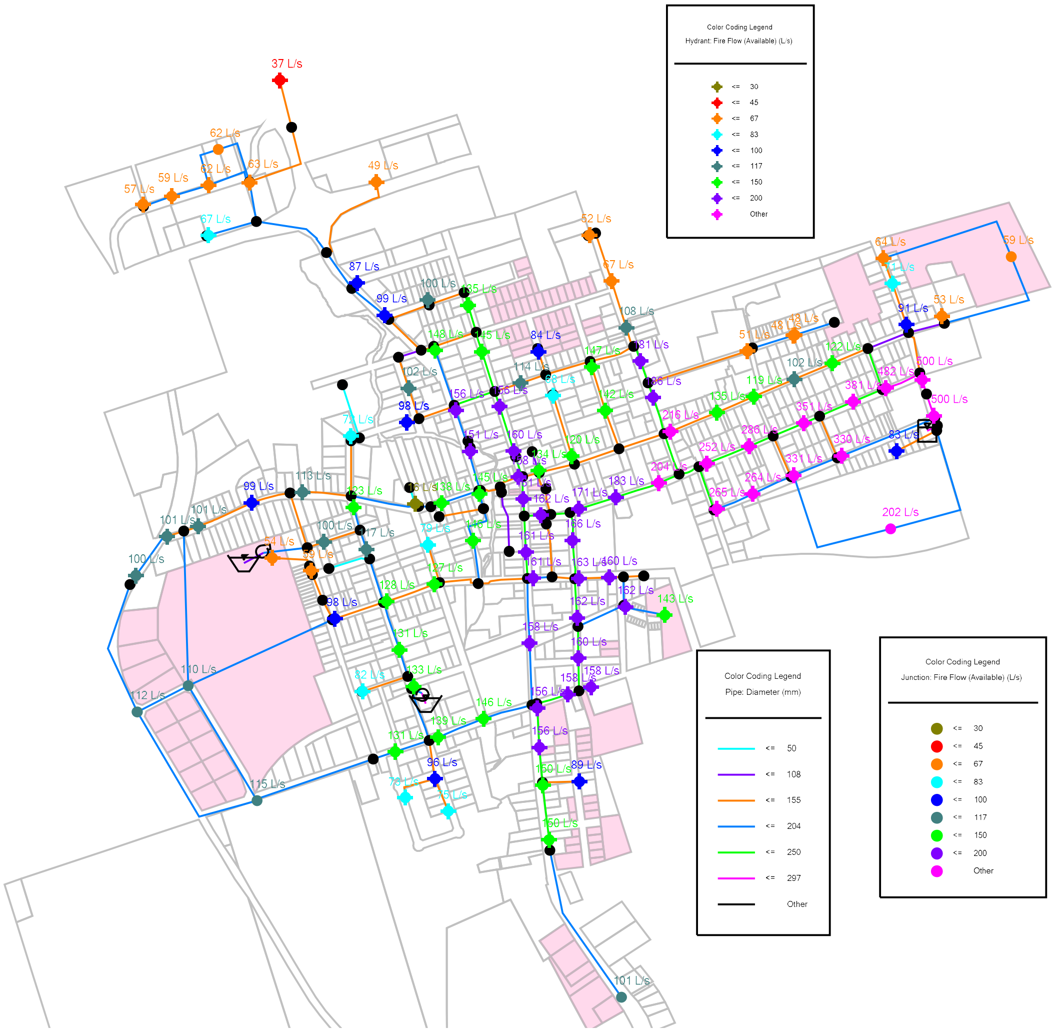
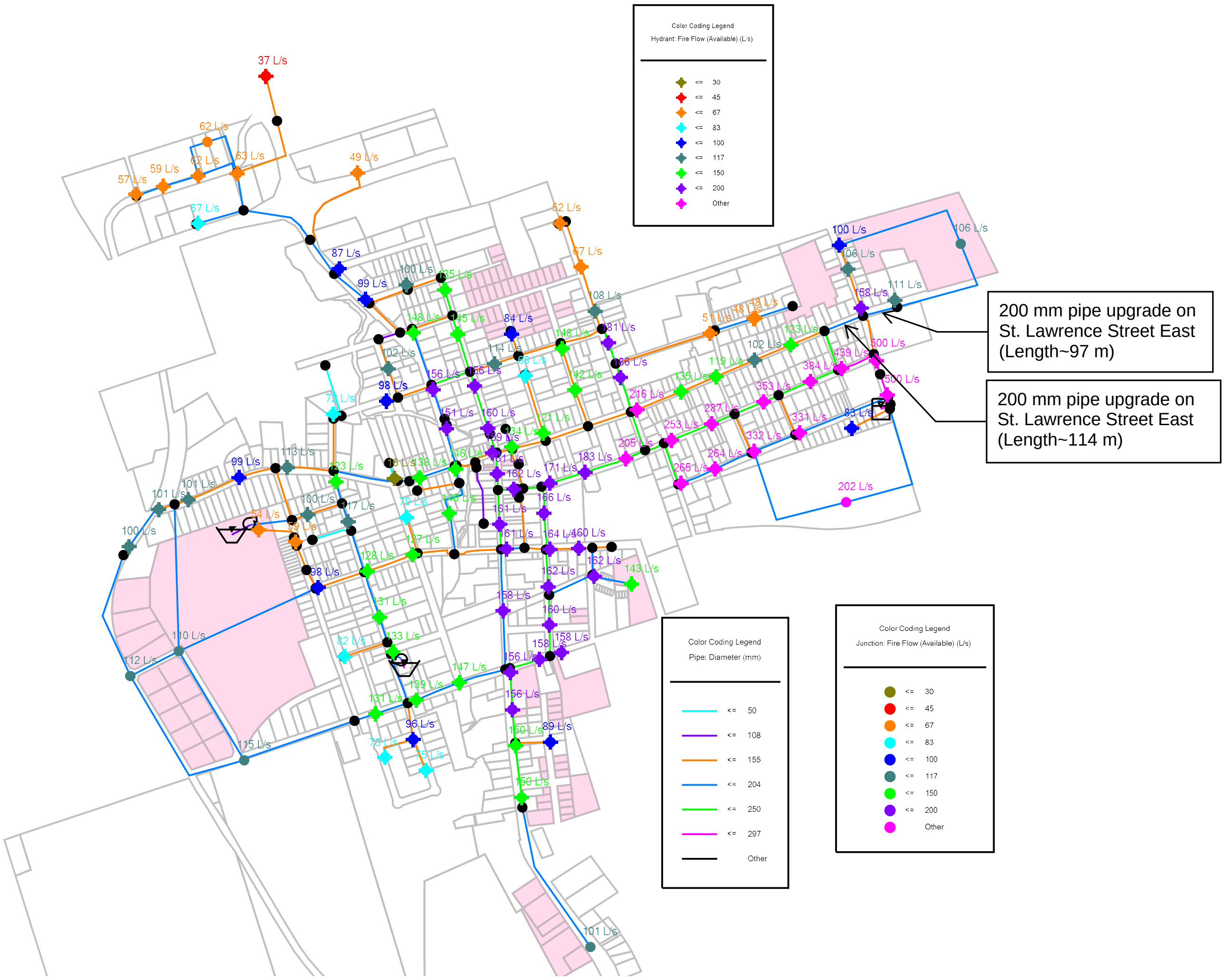


Figure 9

Long-Term (10-20 yrs) Conditions - Maximum Day Demand + Fire Flow

1 Pump On, Water Tower HGL= 218.76 m

200 mm Pipe Upgrades (St. Lawrence Street East)



4.3.2.3 Future Conditions: Peak Hour Demand

Table 11: Hydraulic Water Model Results - Peak Hour Demand

Peak Hour Demand			Percentage of Junctions				
Pressure Range (kPa)			Existing	Short-Term (0-5 years)	Mid-Term (5-10 years)	Long-Term (10-20 years) - No Upgrades	Long-Term (10-20 years) - Upgrades
	Less than	276	0.0%	0.0%	0.0%	0.0%	0.0%
276	up to	350	3.8%	3.8%	3.8%	4.5%	4.5%
350	up to	400	13.5%	13.5%	13.2%	17.3%	17.1%
400	up to	450	23.1%	26.0%	28.3%	27.3%	27.0%
450	up to	500	35.6%	32.7%	31.1%	33.6%	34.2%
500	up to and incl.	552	21.2%	22.1%	21.7%	15.5%	15.3%
	Greater than	552	2.9%	1.9%	1.9%	1.8%	1.8%

Under peak hour demand, Table 11 shows that most junction nodes experience pressures between 350 kPa and 552 kPa, and a smaller percentage of the junction nodes experience pressures below 350 kPa or above 552 kPa. System pressures under existing and future conditions are found to be above the minimum recommended pressure of 276 kPa (40 psi), in accordance with the MECP Design Guidelines, and the existing level of service is generally expected to be maintained. Under existing, short-term, and mid-term conditions, two (2) junction nodes located on Durham Street S (J-70) and Seymour Street W (J-36) experience pressures above 552 kPa due to their low topographic elevations. Under long-term conditions, two (2) junction nodes located on Durham Street S (J-70 and J-112) experience pressures above 552 kPa due to their low topographic elevations.

Figure 10

Short-Term (0-5 yrs) Conditions - Peak Hour Demand

1 Pump On, Water Tower HGL= 218.76 m

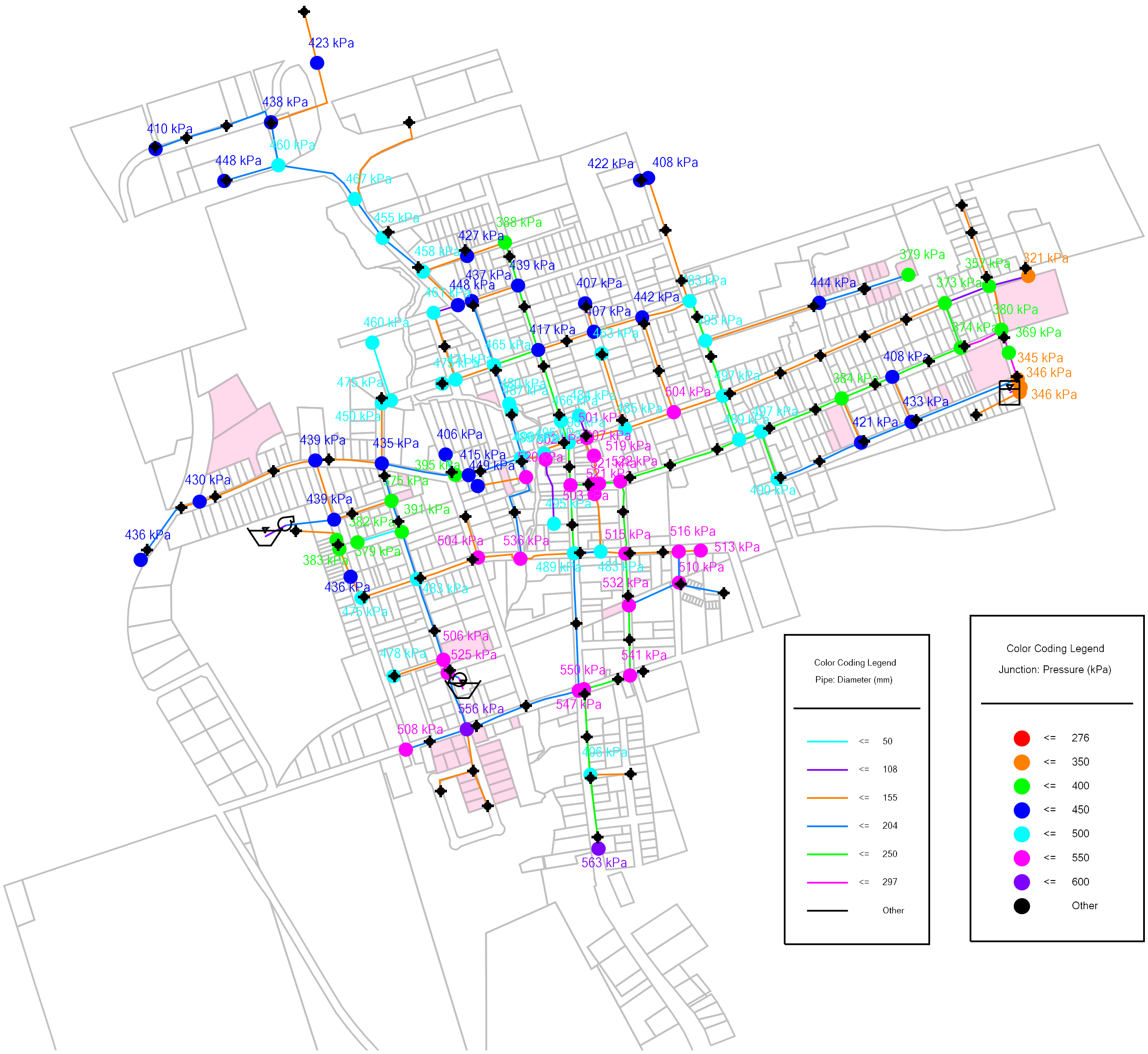


Figure 11

Mid-Term (5-10 yrs) Conditions - Peak Hour Demand

1 Pump On, Water Tower HGL= 218.76 m

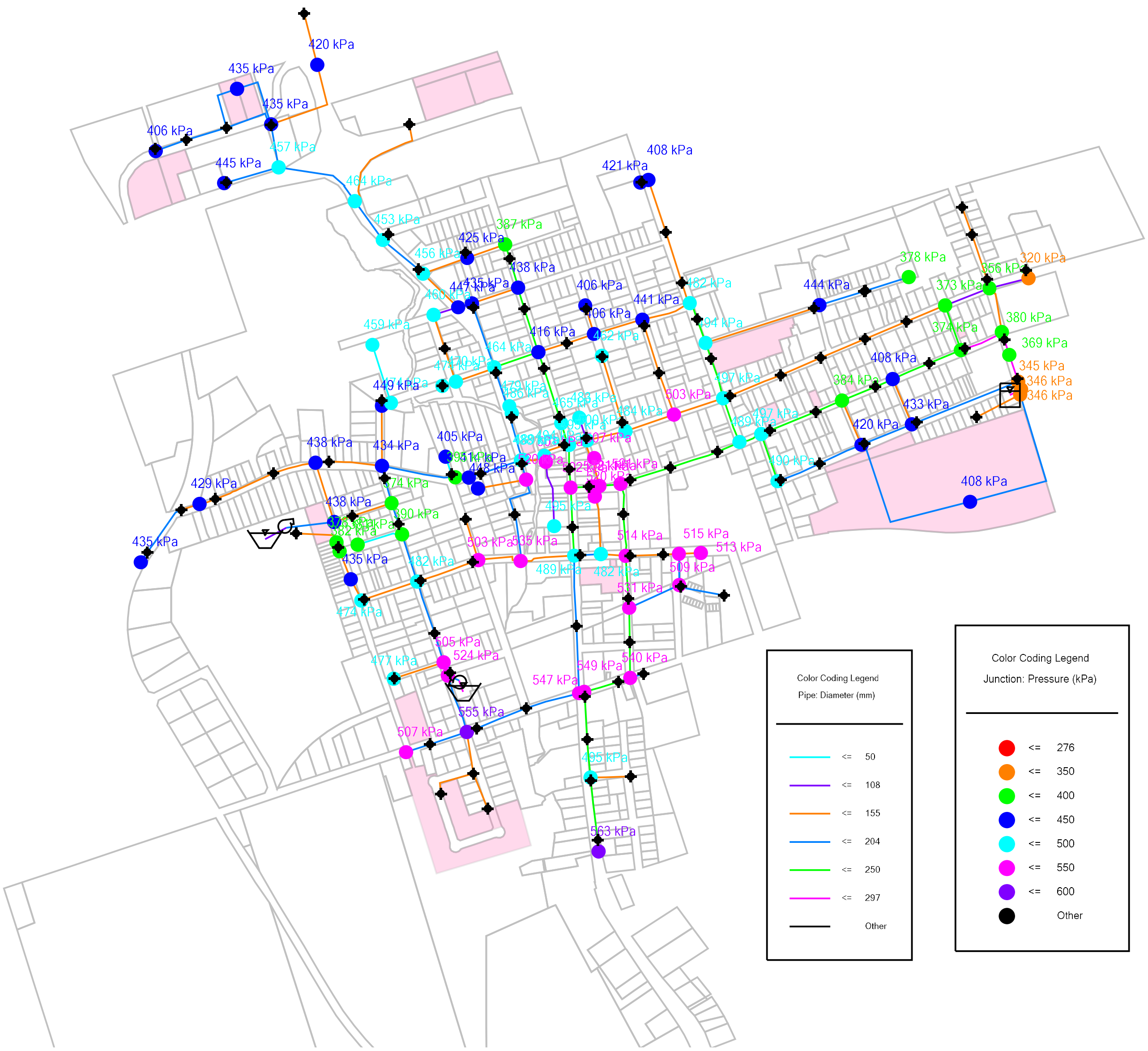


Figure 12

Long-Term (10-20 yrs) Conditions - Peak Hour Demand

1 Pump On, Water Tower HGL= 218.76 m

No Upgrades

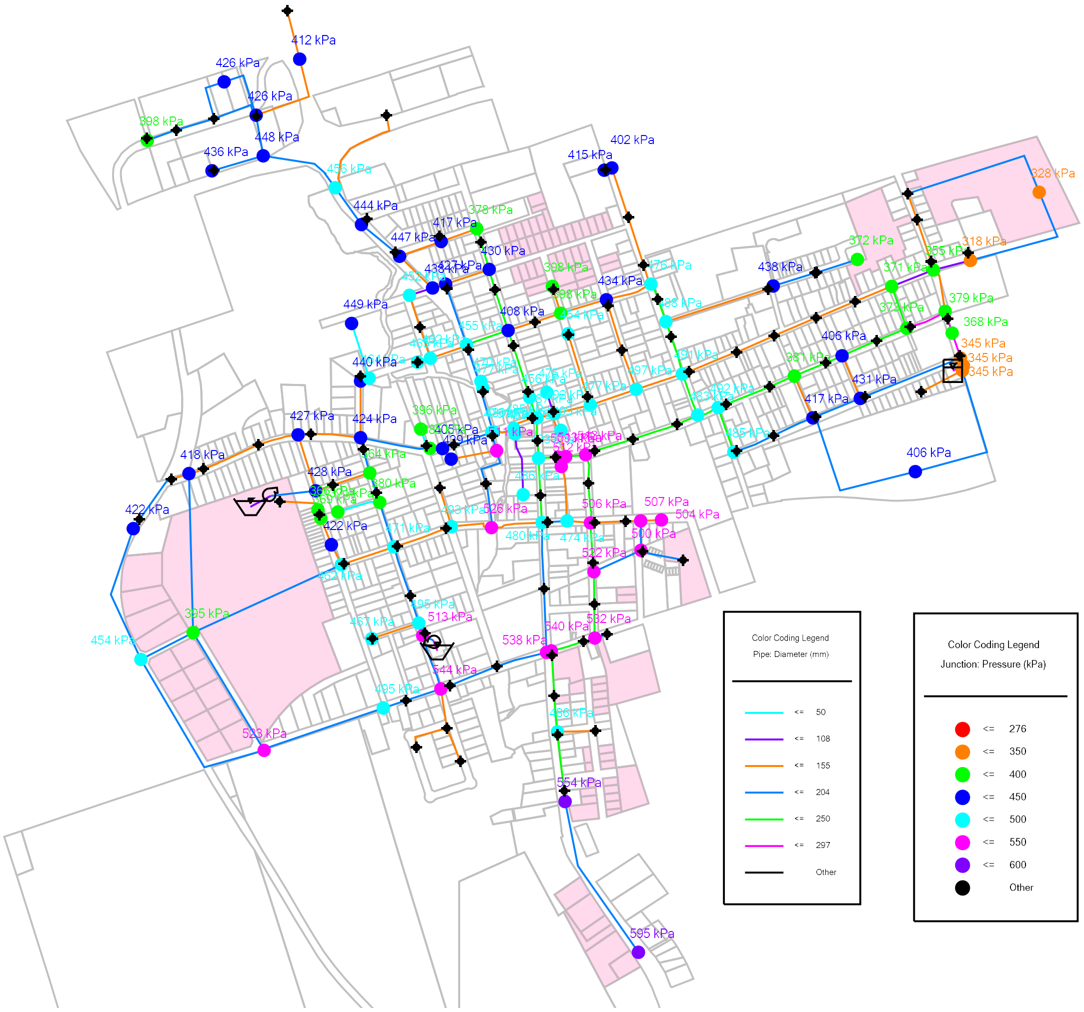
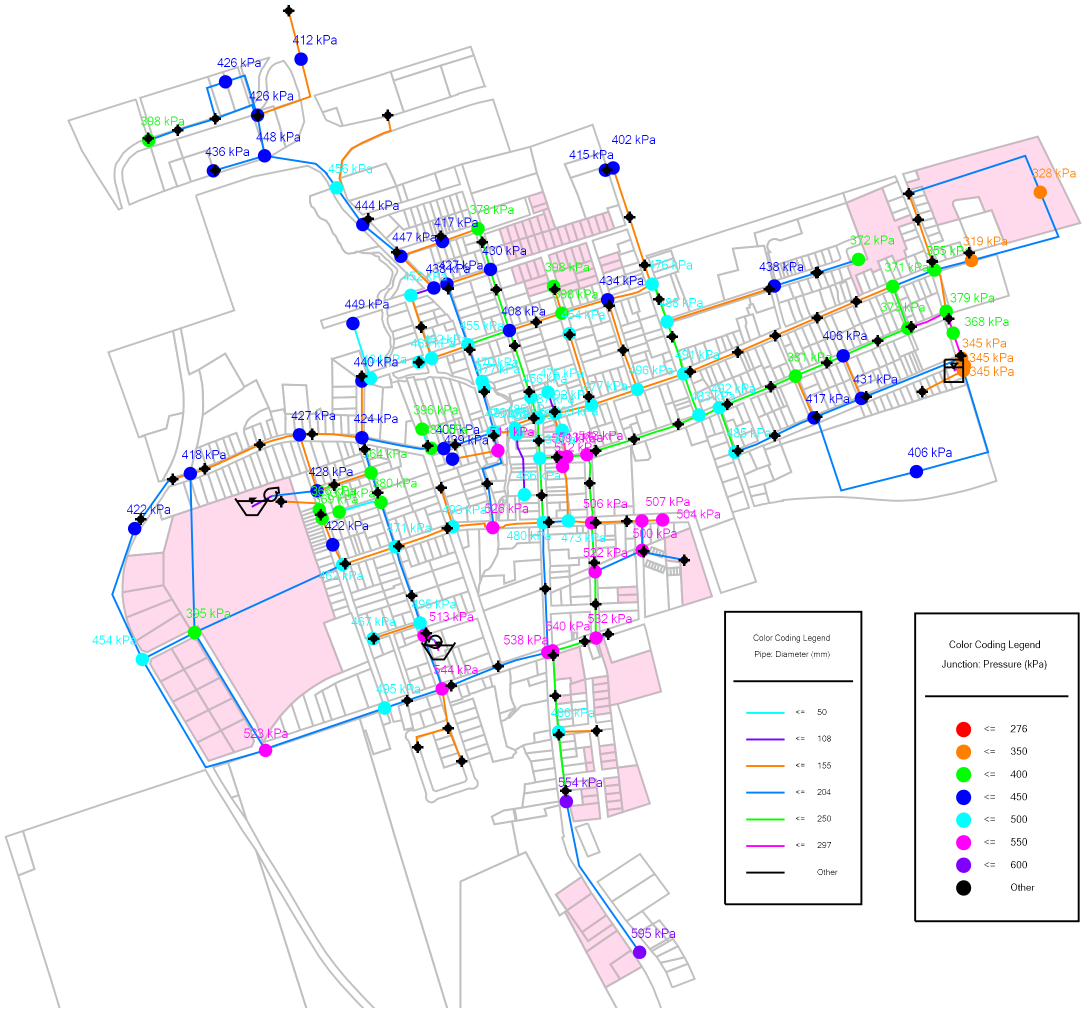


Figure 13
Long-Term (10-20 yrs) Conditions - Peak Hour Demand
1 Pump On, Water Tower HGL= 218.76 m
Upgrades



4.3.2.4 Summary of Recommendations

A summary of the results for the future conditions is provided in the table below. Generally speaking, the Madoc water distribution system is able to support the long-term growth with minimal upgrades on St. Lawrence Street East.

Table 12: Hydraulic Water Model Results

Demand Scenario	General Results	Notes
Average Day	Good. Pressure Range: 276- 569 kPa	Most junction nodes experience pressures between 350 kPa and 552 kPa.
Maximum Day + Fire Flow	Good. Fire Flow Availability: 22-500 L/s	Most hydrant nodes experience fire flows above 45 L/s, which is the minimum required fire flow per the Ontario Building Code (OBC) for a typical two-storey home.
Peak Hour	Good. Pressure Range: 276-566 kPa	Most junction nodes experience pressures between 350 kPa and 552 kPa.

4.4 Wastewater Treatment System

Phase 1 of the Master Plan determined that the lagoon rated capacity will be insufficient in the short-term (0-5 years). The treated effluent from the lagoons have historically met and exceeded the required level of treatment by the ECA. Table 13 provides a summary of the Phase 1 report wastewater flow for existing and future conditions.

Table 13: Future Wastewater Flows

Demand Scenario	Existing Conditions	Short-Term	Mid-Term	Long-Term
	(2023)	(2024-2029)	(2029-2034)	(2034-2044)
Average Day (m^3/day) Cumulative	734	1,053	1,473	2,346
Rated Capacity (m^3/day)	1,008			
Deficit (m^3/day)	n/a	45	465	1,338

4.4.1 Lagoon Storage Assessment

It was estimated in Phase 1 of the Master Plan that the Lagoon rated capacity (1,008 m^3/day) would be exceeded by 2028 in the short-term based on projected average day flows.

A lagoon storage assessment was completed to review the existing total storage volume (184,000 m^3) with consideration of projected influent flows, storage periods and seasonal discharge windows under ECA 1652-BRKT58.

The Lagoon is seasonally discharged to Deer Creek. The spring discharge occurs from April 1st to May 20th for a minimum of 21 days and a maximum of 45 days. The Lagoon must be substantially free of ice cover before spring discharge can commence. The fall discharge occurs from November 1st to December 15th for a minimum of 21-days and a maximum of 45-days.

The overall storage assessment is based on the following considerations:

1. Influent up to May 20th is treated and fully discharged in the spring discharge window.
2. The lagoons are empty on May 21st of each assessment year.
3. The lagoons can be discharged for 45 days for the spring discharge and 45 days for the fall discharge, which meets the maximum number of days for discharge.
4. Based on the current discharge windows, the maximum storage volume is required between May 21 and October 31.
5. The storage volume assessment considered a 0.3 m sludge layer at the bottom of each lagoon cell.
6. It was noted in the Madoc Sewage Lagoon Capacity Re-Rating Study Status Update (October 2021) that the Lagoon generally maintains 1.07 m (42 in.) of freeboard depth which is greater than the 0.3 m MECP minimum freeboard requirement. It has been assumed that the 0.3 m minimum freeboard depth is excluded from the overall 184,000 m^3 total storage volume.
7. This assessment did not consider the effects of evaporation and precipitation.
8. The effective storage volume taken up by the rock outcrop is unknown.
9. The existing effluent pumping station will not be expanded and can maintain the instantaneous discharge flow of 101 L/s.
10. The average daily allowable discharge flow rate is calculated to be 4,067 m^3/d based on the final effluent discharge loading limits and concentration limits as shown in Table 14.

Table 14: Existing Effluent Discharge Compliance Limits per Current ECA

Final Effluent Parameter	Concentration Limit (mg/L)	Loading Limit (kg/d)	Allowable Effluent Discharge Flow Limit (m^3/d)
$CBOD_5$	30	122	4,067
TSS	30	122	4,067
Total Phosphorus	0.5	4	8,000

The following sections will analyze seasonal storage requirements under development growth conditions.

4.4.1.1 Summer/Fall Storage Assessment

The projected monthly raw wastewater flow between May 21st and October 31st must be evaluated for the current discharge window to ensure that there is adequate storage available in the Lagoon prior to the fall discharge. The results of the assessment are summarized in Table 15.

The results indicate that estimated storage volume required for the short-term demand scenario (193,752 m^3) will exceed the Lagoon's total effective storage volume (148,000 m^3) before the end of the summer storage period. Therefore, the Lagoon capacity will be insufficient for short-term demand and beyond.

Table 15: Summer/Fall Storage Volume Assessment (May 21st to October 31st)

Demand Scenario	Existing Conditions (1) (2023)	Short-Term (2024-2029)	Mid-Term (2029-2034)	Long-Term (2034-2044)
Total Summer/Fall Storage required (m^3)	95,000	172,000	240,000	454,000
Approximate Lagoon Effective Storage Capacity (m^3) (2)	148,000			
Deficit (m^3)	n/a	24,000	92,000	306,000

(1) 5-year monthly average influent data obtained from OCWA Annual Water Quality Reports.
(2) Sludge volume removed from the total 184,000 m^3. Assumes a 0.3 m sludge layer at bottom of each lagoon cell. Rock outcrop volume is unknown and not accounted for - the lagoon storage capacity could be less.

4.4.1.2 Winter Storage and Fall Discharge Assessment

The influent volume accumulated between May 21st and October 31st will be released during the fall discharge from November 1st to December 15th, for a maximum of 45-days. Table 16 summarizes the volume remaining in the Lagoon after the fall discharge.

The results indicate that the summer/fall volume can be fully depleted under the existing discharge windows. The Lagoon, however, cannot be fully depleted for the short-term flow and beyond.

Table 16: Estimated Volume Remaining Prior to Winter Storage

Demand Scenario	Existing Conditions(2) (2023)	Short-Term (2024-2029)	Mid-Term (2029-2034)	Long-Term (2034-2044)
Summer/Fall Influent (m^3)	95,000	172,000	240,000	454,000
Fall Influent (m^3)(1)	24,000	47,000	66,000	106,000
Fall Discharge Volume (m^3)(1)(3)	183,000	183,000	183,000	183,000
Wastewater Volume Remaining After Discharge (m^3)	-	36,000	123,000	377,000

(1) November 1st to December 15th
(2) 5-year monthly average influent data obtained from OCWA Annual Water Quality Reports.
(3) Effluent discharge flow limit 4,067 m^3/d multiplied by 45-days of discharge.
(4) Sludge volume removed from the total 184,000 m^3. Assumes a 0.3 m sludge layer at bottom of each lagoon cell. Rock outcrop volume is unknown and not accounted for - the lagoon storage capacity could be less.

Table 17 summarizes the influent volume accumulated in the Lagoon between December 16th and March 31st, in addition to the volume accumulated after the fall discharge. The results indicate that, following the spring discharge, the Lagoon cannot be depleted under long-term flow.

Table 17: Winter Storage (December 16th to March 31st) and Spring Discharge Assessment

Demand Scenario	Existing Conditions(5)	Short-Term	Mid-Term	Long-Term
	(2023)	(2024-2029)	(2029-2034)	(2034-2044)
Winter Influent (m^3)(1)	88,000	111,000	155,000	246,000
Winter Storage Requirement (m^3)	88,000	147,000	278,000	623,000
Spring Effluent (m^3)(2)(6)	183,000	183,000	183,000	183,000
Volume remaining After Spring Discharge (m^3)	0	0	95,000(3)	440,000(4)
Approximate Lagoon Effective Storage Capacity (m^3) (5)	148,000			
Deficit (m^3)	n/a	n/a	n/a	292,000

(1) December 16th to March 31st
(2) 45 days of discharge; Occurring between April 1st to May 20th
(3) Volume remaining after the spring discharge of the first year of the mid-term scenario (2029). Volume accumulation will begin compounding for following years.
(4) Volume remaining after the spring discharge of the first year of the long-term scenario (2034). Does not include volume accumulated during the mid-term. Volume accumulation will begin compounding for following years.
(5) 5-year monthly average influent data obtained from OCWA Annual Water Quality Reports.
(6) Effluent discharge flow limit 4,067 m^3/d multiplied by 45-days.

4.4.1.3 Volume Accumulation Due to Extended Storage Periods

Figure 14 illustrates the potential volume accumulation due to extended storage period in the short-term.

4.4.1.4 Recommended Discharge Window Modifications

The Lagoon storage assessment demonstrates the need to expand the Lagoon discharge windows to avoid lagoon overflow. The most critical time period is the summer/fall during which the accumulated wastewater volume will exceed the total effective lagoon storage volume, particularly close to November 1st.

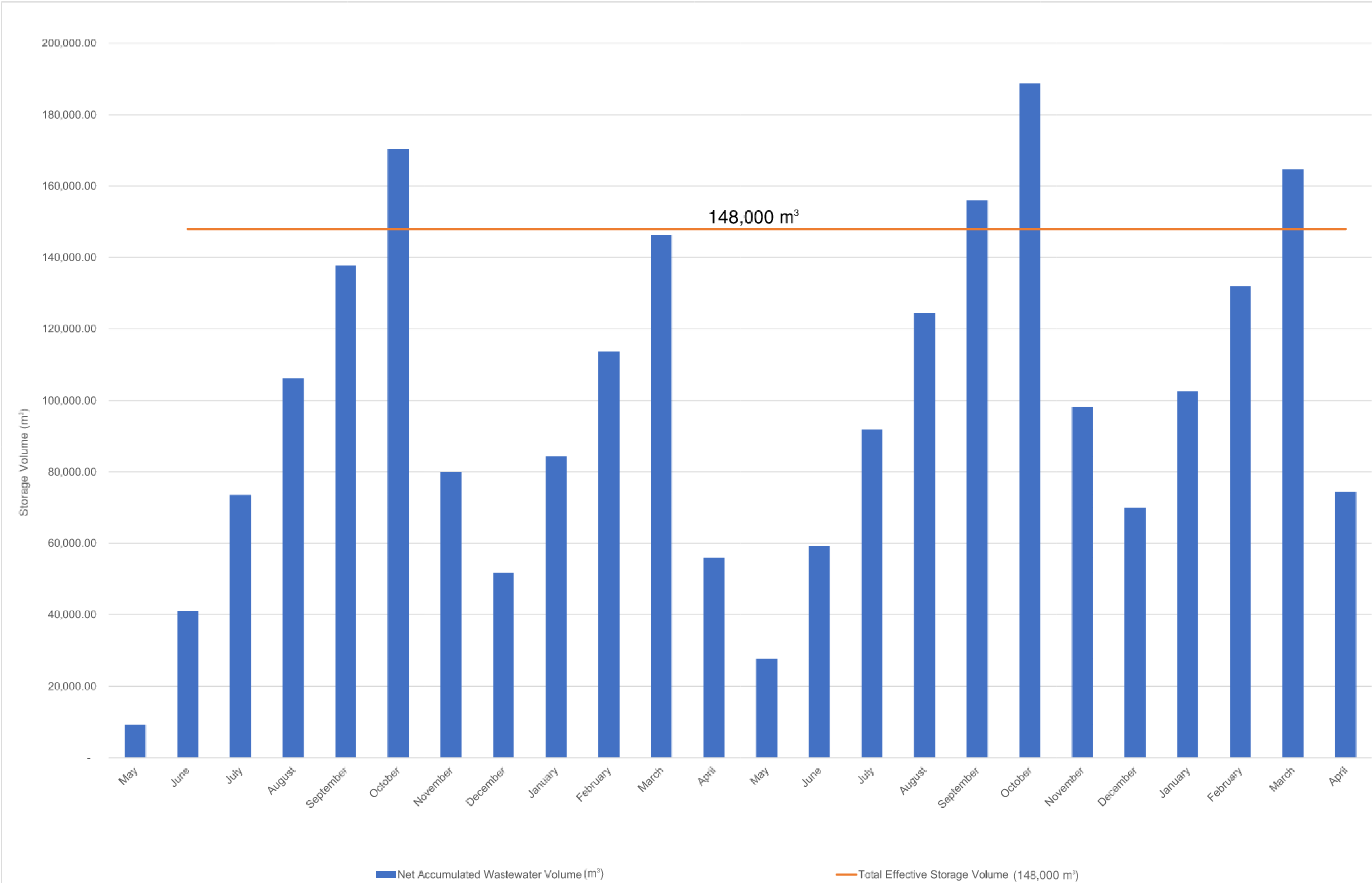
Table 18 summarizes the additional number of discharge weeks required to release the wastewater without increasing the Lagoon storage volume (i.e., no additional lagoon cell). Additional studies should be completed in order to confirm the proposed extension of discharge windows, its effects on the receiving stream and any new ECA loading and concentration limits.

The studies will be completed as part of the upcoming Schedule ‘C’ Class EA to expand the lagoon capacity.

Table 18: Additional Discharge Weeks Required

Demand Scenario	Existing Conditions (2023)	Short-Term (2024-2029)	Mid-Term (2029-2034)	Long-Term (2034-2044)
Additional Discharge Volume (m^3)	0	24,000	92,000	306,000
Allowable Average Daily Effluent Flow (m^3/d)	4,067			
Additional discharge weeks	0	1	4	12

Figure 14: Potential Volume Accumulation Due to Extended Storage Period during Short-Term (Based on 2029 Projected Average Day Flow)



4.4.2 Wastewater Treatment System – Alternative Solutions

The results of the Lagoon's seasonal storage analysis showed that the Lagoon's effective storage volume is insufficient for the short-term and beyond. The following alternatives are being considered to increase the Lagoon's rated capacity to accommodate long-term wastewater flow.

4.4.2.1 Alternative 1: Status Quo

The Status Quo alternative represents what would likely occur if the existing Sewage Treatment System (STS) was not expanded nor upgraded to accommodate wastewater flows. This alternative assumes that there are no changes to the existing discharge window.

It was identified in the Phase 1 Master Plan analysis of future conditions that the STS rated capacity would be exceeded in 0-5 Years. The seasonal storage assessment discussed in Section 4.4.1 revealed that the lagoon volume would be exceeded before the November 1st fall discharge period in the short-term demand scenario. Furthermore, the 10-20 Year wastewater flow is anticipated to be more than double of the existing STS rated capacity.

Recommendation: Alternative 1 is not feasible as the anticipated developments within the study area cannot be accommodated by the existing STS capacity. Alternative 1 is not recommended to be carried forward for detailed evaluation.

4.4.2.2 Alternative 2: Maintain Lagoon-Based Treatment System and Implement a New Third Lagoon Cell

Alternative 2 increases the rated capacity of the Lagoon by adding a third lagoon cell. Alternative 2 assumes that there are no changes to the existing discharge windows and treatment systems.

A total storage volume of 490,000 m^3 in order to meet long-term demand, as demonstrated in Section 4.4.1, which is equivalent to an additional 306,000 m^3 of storage. Assuming a fixed depth of 2.4 m[1], 127,000 m^2 (or 13 hectares) of land is required for a third lagoon cell. The area required is not available within the existing Lagoon parcel. Nearby parcels are located within a flood line, designated as unevaluated wetland, or located near future potential developments.

In addition, per MECP Guideline D-2 "Compatibility between Sewage Treatment and Sensitive Land Use", an additional 150m of buffer land area is recommended for separation from facility producing odours to the property line of sensitive land uses. The Municipality does not own land near the Lagoon. This alternative is contingent on the Municipality's ability to acquire nearby lands to the existing site.

Recommendation: Alternative 2 is anticipated to have the largest impact to the natural and social environment in comparison to other alternatives. Also, this Alternative alone will not address the potential increase in level of treatment imposed by MECP due to capacity expansion. Therefore, Alternative 2 is not recommended to be carried forward for detailed evaluation.

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[1] Average water depth of 6.8 ft to 7.8 ft. *Madoc Sewage Lagoon Capacity Re-Rating Study Status Update*.

4.4.2.3 Alternative 3: Add-On Treatment System

According to the current ECA, there are TSS, $CBOD_5$ and TP loading and concentration compliance limits.

With a treatment facility capacity expansion, MECP will be requiring the project team to complete an assimilative capacity assessment to support the future level of treatment requirements based on the receiver water quality. It is our experience that when increasing the flow output to a receiver, MECP will generally be requiring the loading limits be maintained (or reduced) which in turn reduces the concentration limits.

Facultative lagoons are natural-based treatment systems and are efficient at treating municipal wastewater up to a certain level. According to the MECP Design Guidelines for Sewage Works, sewage treatment lagoons are capable of achieving equivalent to secondary treatment (annual average concentration of 25 mg/L $CBOD_5$ and 30 mg/L TSS) or better. Madoc Lagoon's current ECA compliance limits are representative of this treatment level.

However, as the growth happens in the Village and the future wastewater flow rates increase, there is a need to review add-on treatment options to supplement the existing lagoon-based treatment system. These add-on treatment systems will generally reduce TSS, $CBOD_5$ and total ammonia nitrogen (TAN – a potential future requirement) effluent concentrations.

Table 19 provides a summary of potential add-on systems that may be considered in the future Schedule 'C' Class EA for lagoon expansion. Other options should also be explored as the technologies become commercially available.

Recommendation: Additional treatment will allow the Lagoon effluent to meet potential future effluent requirements as deemed necessary by an assimilative capacity assessment (part of the Schedule 'C' Class EA for Lagoon expansion). Alternative 3 will need be combined with other alternatives to be carried forward for detailed evaluation, as this alternative alone does not address storage volume constraint.

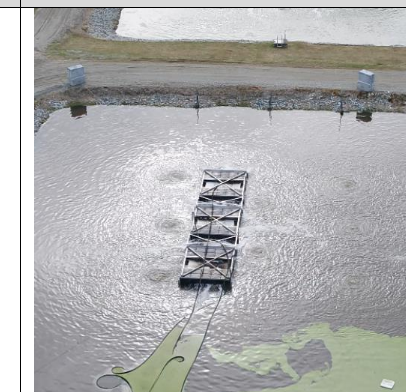
4.4.2.4 Alternative 4: Convert to a Mechanical Treatment Plant

Another alternative to increase the STS rated capacity would be to abandon the existing lagoon-based treatment system, covert to a mechanical treatment plant and expand the discharge window to year-round. Generally, a mechanical treatment plant could provide more effective treatment than the current lagoon STS for a much smaller footprint. However, mechanical systems run on a continuous basis and discharge instantaneously to the receiver stream as soon as the wastewater is treated, so this alterative would require an ECA amendment to allow for continuous discharge all year around.

This option presents significant capital investment as a mechanical treatment plant involves a multitude of unit processes that are not typically required in a lagoon-based treatment system, such as screening, grit removal, concrete tanks for biological treatment (e.g., aeration tanks and clarifiers), sludge treatment and disposal.

Recommendation: Alternative 4 is being carried forward into the detailed evaluation as it provides the level of treatment requirement for the long-term projection and is able to provide treatment beyond long-term growth scenario.

Table 19: Lagoon Add-On Treatment System Option Examples

ENGINEERING AND TECHNICAL CONSIDERATIONS	BIOLAC ® - LONG SLUDGE AGE TREATMENT PROCESS	SUBMERGED ATTACHED GROWTH REACTOR (SAGR)	MOVING BED FILM BIOREACTOR (MBBR)	FIXED FILM IN-LAGOON TREATMENT TECHNOLOGY
				
Proven Cold Weather Installations	Canadian/ and cold weather installations available, however, process subject to extreme environmental conditions.	Several Canadian/ and cold weather installations, in Eastern and Southern Ontario.	Several Canadian/ and cold weather installations, however, subject to extreme environmental conditions.	Several Canadian/ and cold weather installations, however, subject to extreme environmental conditions.
Ability to Meet Effluent Criteria	High quality effluent will be produced that is better than the ECA limits for all parameters.	High quality effluent will be produced that is better than the ECA limits for all parameters. This is a polishing step that may be added to the existing lagoon basin.	High quality effluent will be produced that is better than the ECA limits for all parameters. This is a polishing step that may be added after the lagoons. Generally requires a filtration process to remove TSS and TP.	Good quality effluent will be produced that is between than the ECA limits for all parameters. This is an in-lagoon retrofit solution that increases the lagoon treatment abilities.
Degree of Process Control & Availability of Performance Guarantee	There are a number of process variables that can be controlled. The existing lagoon may be retrofitted or converted for treatment.	Submerged attached growth reactors have a higher degree of control then a lagoon alone, however, process control is limited. Performance guarantee is available.	There are a number of factors that can be controlled in the fixed film biological process; however, the lagoon is still required for treatment.	There are a number of factors that can be controlled in the process.
Ease of Operation	Automated process that may require more regular operator input.	Limited operator input is required once established.	Automated process that may require periodic operator input.	Relatively easy to operate and maintain with periodic operator input. Relatively low energy consumption.
Opportunities for Future Expansion	If a treatment capacity increase is required additional aeration tubes can be added to the modules without the need for additional basins.	The number of process cells may be increased to meet future expansion requirements. However, due to SAGR's ability to polish lagoon effluent, design considerations may be given to design/construct cells to meet future treatment level.	If a treatment capacity increase is required the quantity of the media in the basin can be increased at a low cost and without the need for additional basins. Additional filtration trains may also be required.	If a treatment capacity increase is required the number of treatment modules can be increased. There is limitation to the level of treatment with this type of system for future expansion.

4.4.2.5 Alternative 5: Extend Discharge Window

Alternative 5 will include extending the discharge window and assumes that the existing Lagoon volume will be maintained. Refer to Section 4.4.1 for the complete lagoon storage assessment.

Recommendation: Alternative 5 should be carried forward into the detailed evaluation as it addresses the storage volume constraints. However, this alternative alone will not address treatment constraints and should be combined with another alternative.

4.4.2.6 Alternative 6: Direct Discharge to Moira Lake

The Lagoon currently discharges to Deer Creek and is governed by the effluent loading limits which maintain the quality of the receiver. Alternative 6 will include the construction of an outfall pipe to convey the treated effluent to Moira Lake. As a larger receiver, Moira Lake will potentially have the assimilative capacity to accept higher concentration of TSS, $CBOD_5$, TP and TAN (potential future requirement) and to accommodate a higher effluent flow. Additional studies will be required to determine acceptable effluent concentrations for Moira Lake and to amend the Lagoon ECA.

This alternative will generally involve 1,300 m of underground sewer installed at a typical depth of 2 to 3 m below ground surface and an additional 500 m outfall pipe to extend to the middle of Moira Lake, as shown in Figure 15. Alternative 6 is estimated to cost approximately $3.6M for the above noted sewer section with a 25% contingency.

Recommendation: It is recommended to carry this alternative forward as this provides the Municipality with the opportunity to potentially further increase the treatment capacity. Note that this discharge location only applies to Alternative 4 (Mechanical Plant) and a continuous discharge scenario.

PROJECT:

Madoc Water, Wastewater and Stormwater Phase 2 Master Plan

Madoc, ON

DRAWING:

Alternative 5 - Potential Sanitary Sewer for Direct Discharge to Moira Lake

J.L.Richards ENGINEERS · ARCHITECTS · PLANNERS		DESIGN:	JLR NO: 32508-000
		DRAWN: RC	DRAWING NO: **Figure 15**
		CHECKED: SJS	

4.4.3 Summary of Initial Screening

Table 20: Initial Screening Summary

Alternative #	Alternative Solution Identified	Initial Screening Result	
1	Status Quo	✗	Not feasible. Not carried forward
2	Maintain lagoon-based treatment and add third lagoon cell	✗	Not feasible. Not carried forward
3	Add-on treatment system	✓	Feasible if combined with other alternatives. Carried forward.
4	Convert to Mechanical Treatment Plant	✓	Feasible if combined with other alternatives. Carried forward.
5	Extend Discharge Window	✓	Feasible. Carried forward.
6	Direct Discharge to Moira Lake	✓	Feasible. Carried forward.

4.4.4 Servicing Options

The following servicing options have been developed based on the feasible alternatives identified from initial screening:

Servicing Option 1: Extend Discharge Window
Servicing Option 2: Extend Discharge Window and Implement Add-On Treatment Systems
Servicing Option 3: Extend Discharge Window to Continuous Discharge, Implement Mechanical Treatment Plant, and Direct Discharge to Moira Lake.

The preferred servicing option will be selected through a detailed evaluation in Table 21.

Table 21: Evaluation Matrix – Wastewater Treatment System

Evaluation Criteria	Servicing Option 1 Extend Discharge Window	Servicing Option 2 Extend Discharge Window + Add-On Treatment System	Servicing Option 3 Extend to Continuous Discharge + Direct Discharge to Moira Lake + Mechanical Treatment Plant
Natural Environment Considerations	• No changes to existing site boundary. No significant disturbance anticipated for terrestrial environment. • Aquatic life and river quality will be adversely affected due to increased effluent loading due to extension to discharge window.	• No changes to existing site boundary. No significant disturbance anticipated for terrestrial environment. • Add-on treatment options will benefit aquatic life and river quality. • Construction activities may temporarily affect natural environment. However, mitigation measures can be employed to avoid sensitive time periods.	• No changes to existing site boundary. • Largest impact to natural and terrestrial environment due to new install of outfall sewer to Moira Lake. • Sewer likely to be installed within unevaluated wetlands. Wastewater effluent concentrations removed from Deer Creek (smaller receiver) and added to Moira Lake (larger receiver). • Mechanical plant will provide the best quality effluent compared to lagoon-based treatment options.
Evaluation	**Least Preferred**	**Preferred**	**Less Preferred**
Climate Change Resiliency	• Extended discharge window provides resiliency during changing ambient temperatures, such as substantial ice cover extending into the spring discharge period. • No treatment systems to be damaged by climate change. • Higher effluent loading concentrations will adversely affect Deer Creek during drought and low water level conditions.	• Treatment systems may be susceptible to damage under extreme weather events (e.g., flood, rising ambient temperatures). • GHG emissions due to energy consumption required for additional treatment systems. • Extended discharge window provides resiliency during changing ambient temperatures, such as substantial ice cover extending into the spring discharge period. • Extended discharge window provides resiliency against increased rainfall intensity by allowing more volume discharged each season.	• Continuous discharge window provides resiliency during changing ambient temperatures, such as substantial ice cover extending into the spring discharge period. • Continuous discharge window provides resiliency against increased rainfall intensity by allowing volume continuously discharged. • Treatment systems may be susceptible to damage under extreme weather events (e.g., flood, rising ambient temperatures). • Largest GHG emissions impact due to construction and continuous operation of the treatment plant.
Evaluation	**Least Preferred**	**Preferred**	**Less Preferred**
Social and Cultural Environment Considerations	• Alternative can accommodate future wastewater flows anticipated in the Master Plan timeframe. • Alternative involves least construction and most efficient use of existing infrastructure. • Potential impact in the long-term to land-use planning, cultural heritage, source water protection, archaeological resources due to higher effluent parameter concentrations. • No impact to built heritage and archaeological resources.	• Alternative can accommodate future wastewater flows anticipated in the Master Plan timeframe. • Additional studies required to determine add-on systems required to allow STS to meet future wastewater flows. • Minimal anticipated impact to land-use planning, cultural heritage, source water protection, archaeological resources in comparison to other options. • No impact to built heritage and archaeological resources.	• STS can accommodate future wastewater flow anticipated for long-term scenario and even beyond. • Additional archaeological and environmental studies will be required for installation of a new outfall to Moira Lake. • Outfall relocated to a new receiver. Extensive consultation is anticipated with stakeholder agencies and residents. • Potential impact to archaeological resources. Marine archaeology will need to completed for the new outfall during Schedule C Class EA.
Evaluation	**Less Preferred**	**Preferred**	**Least Preferred**
Technical Feasibility	• Long-term scenario requires an additional 21-weeks of discharge (Table 18). Effluent discharge requirements are not likely to be met without additional treatment systems, therefore this option is not feasible.	• Consultation with MECP will be required to confirm feasibility of increasing effluent flow rate on Deer Creek, as well as future treatment levels. • Additional discharge days can be increased incrementally as the community grows. • Additional discharge days will be required for growth beyond the master plan time frame.	• Consultation with MECP and conservation authority will be required to confirm feasibility of continuous discharge to a new receiver. • Additional studies required to confirm feasibility for installation of new sewer.
Evaluation	**Least Preferred**	**Preferred**	**Less Preferred**
Financial Considerations	• No capital cost anticipated. • Additional O&M cost for extended operation of effluent pump. • Costs or fines may be incurred from failure to treat wastewater according to ECA requirements.	• Capital cost will include installation of add-on treatment systems. • Additional costs for O&M for new treatment systems and extended operation of effluent pump.	• Additional O&M cost for additional treatment systems and year-round operation of effluent pump. • Largest cost impact out of all servicing options.
Evaluation	**Preferred**	**Less Preferred**	**Least Preferred**
Final Evaluation	**Least Preferred**	**Preferred**	**Less Preferred**

4.4.5 Summary of Recommendation

Servicing Option 2 - Extend Discharge Window and Implement Add-On Treatment Systems is being recommended as the preferred alternative. Future Schedule 'C' Class EA for the lagoon expansion should consider the following, but not limited to:

- An assimilative capacity assessment to evaluate the Deer Creek receiver capacity, establish recommendations for extended discharge windows, and the proposed effluent compliance requirements and corresponding maximum allowable discharge flow rates.
- Consultation with MECP and conservation authority to gain approval for the proposed new limits.
- Evaluation and selection of the preferred add-on treatment option to meet compliance requirements.

4.5 Sanitary Sewer System

Refer to Section 6.2 of the Phase 1 Master Plan for existing conditions of the sanitary sewer system.

The typical approach for determining the system upgrades required in the sanitary network is to determine the requirements in the scenario with the highest development (10-20 Years) and work backwards. In the development of alternative solutions, the main principle considered is to determine if the infrastructure will be able to adequately convey the projected flow from developments, then progressively work backwards through the other analysis period to determine the timing of these upgrades. This ensures that the upgrades recommended for the 0-5 Year time-period would not need to be revised to meet the 5-10 Year and 10-20 Year requirements.

4.5.1 Future Condition Design Parameters

The methodology employed to ascertain the system's capacity under the projected future conditions was in alignment with the Ministry of the Environment, Conservation and Parks (MECP) guidelines. The average residential flow utilized to calculate the domestic flows, standing at 350 L/cap/day, remained consistent with the existing conditions. Moreover, to factor in the impact of wet weather inflow and infiltration, a general allowance of 0.14 L/s was incorporated into the calculation of peak extraneous flow.

The design parameters utilized to determine the capacity in the system under future conditions were also aligned with the guidelines stipulated by the Ministry of the Environment, Conservation and Parks (MECP). The design parameters for the Industrial, Commercial, and Institutional (ICI) Developments are as follows:

Table 22: Institutional, Commercial, and Industrial Sewage Generation Design Parameters

Development Type	Average Day Flow
Industrial	35,000 L/ha/day
Commercial	28,000 L/ha/day
Institutional - School	100 L/student/day
Institutional – Hospital/Long Term Care	1,400 L/bed/day

The future residential flow downstream of each sewer reach was calculated using the densities listed in the Population Density by Development Type (Table 1) cited in Phase 1 report. The number of residential units for different development time periods i.e. Short-Term (0-5 years), Mid-term (5-10 years), Long Term (10-20 years), listed in Tables 2, 3, and 4 of the Phase 1 Report, were used for the calculation of the future residential flows. The data pertaining to future developments within the ICI Sector, as outlined in Tables 6, 7, and 8 of the Phase 1 report, served as the basis for computing projected ICI flow indicative of forthcoming growth.

4.5.2 Sanitary Sewer Capacity Improvements

4.5.2.1 Due to Existing Conditions

Pipe segments were isolated for the capacity enhancements in cases where the sewer had no remaining capacity or the specific pipe segment exceeded its maximum capacity threshold of 100%.

Under the existing conditions there are 27 pipe segments recognized as requiring upgrades to meet the operating standards. These upgrades determined based on the existing conditions, have been evaluated to ensure they are sufficient for up to the 10-20 Year (Long-Term) Development period. Table 23 summarizes the upgrades identified using the Future development design sheets in Appendix D.

Table 23: Sanitary Sewer Upgrades due to Existing Conditions

MH From – MH To	Location	Existing Diameter (mm)	Proposed Diameter (mm) (1)	Approximate Length (m)
24-21	Russel St. between Dufferin St. & Gladstone St.	250	300	25
34-35	Intersection of Russel St. & Queen Victoria St. E	250	375	15
35-45	Queen Victoria St. W between Madawaska St. & Russel St.	200	250	65
45-44	Madawaska St. between Queen Victoria St. W. & Prince Albert St. W	200	250	85
41-47	Russel St. between Prince Albert St. W & St. Lawrence St. W	250	350	80
48-49	Russel St. between Prince Albert St. W & St. Lawrence St. W	250	375	25
49-50	Russel St. between Prince Albert St. W & St. Lawrence St. W	250	350	15
50-53	Russel St. between Prince Albert St. W & St. Lawrence St. W	250	300	100
120-119	Champlain St. between St. Lawrence St. W. & Livingstone Ave W.	200	300	65
119-118	Champlain St. between St. Lawrence St. W. & Livingstone Ave W.	200	350	50
118-117	Champlain St. between St. Lawrence St. W. & Livingstone Ave W.	200	300	90
117-122	Champlain St. between St. Lawrence St. W. & Livingstone Ave W.	200	300	60
125-261	ROW South of Livingstone Ave W.	300	350	60
261-126	ROW South of Livingstone Ave W.	300	350	100

MH From – MH To	Location	Existing Diameter (mm)	Proposed Diameter (mm) (1)	Approximate Length (m)
126-262	ROW South of Livingstone Ave W.	300	350	70
262-99	ROW South of Livingstone Ave W.	300	350	65
99-95	ROW South of Livingstone Ave W.	300	375	60
95-100	Seymour St. W. between Durham St. S. & Rollins St.	350	600	10
100-142	ROW South of Seymour St. W	350	450	125
142-141	ROW South of Seymour St. W	350	525	75
141-140	ROW South of Seymour St. W	350	450	80
140-138	ROW South of Seymour St. W	350	450	90
138-139	ROW- Trunk leading to Lagoon	350	450	55
139-263	ROW- Trunk leading to Lagoon	350	450	5
263-254	ROW- Trunk leading to Lagoon	350	525	130
254-255	ROW- Trunk leading to Lagoon	350	525	155
255-256	ROW- Trunk leading to Lagoon	350	525	155
(1) The proposed new diameter for the pipe segment is calculated based on achieving approximately 10% residual capacity.				

4.5.2.2 Due to Future Growth Conditions

In the 0-5 Year and 5-10 Year Planning Period, no additional pipes, other than those identified in the existing condition, require upgrades. Design sheets for these development periods are contained in Appendix D.

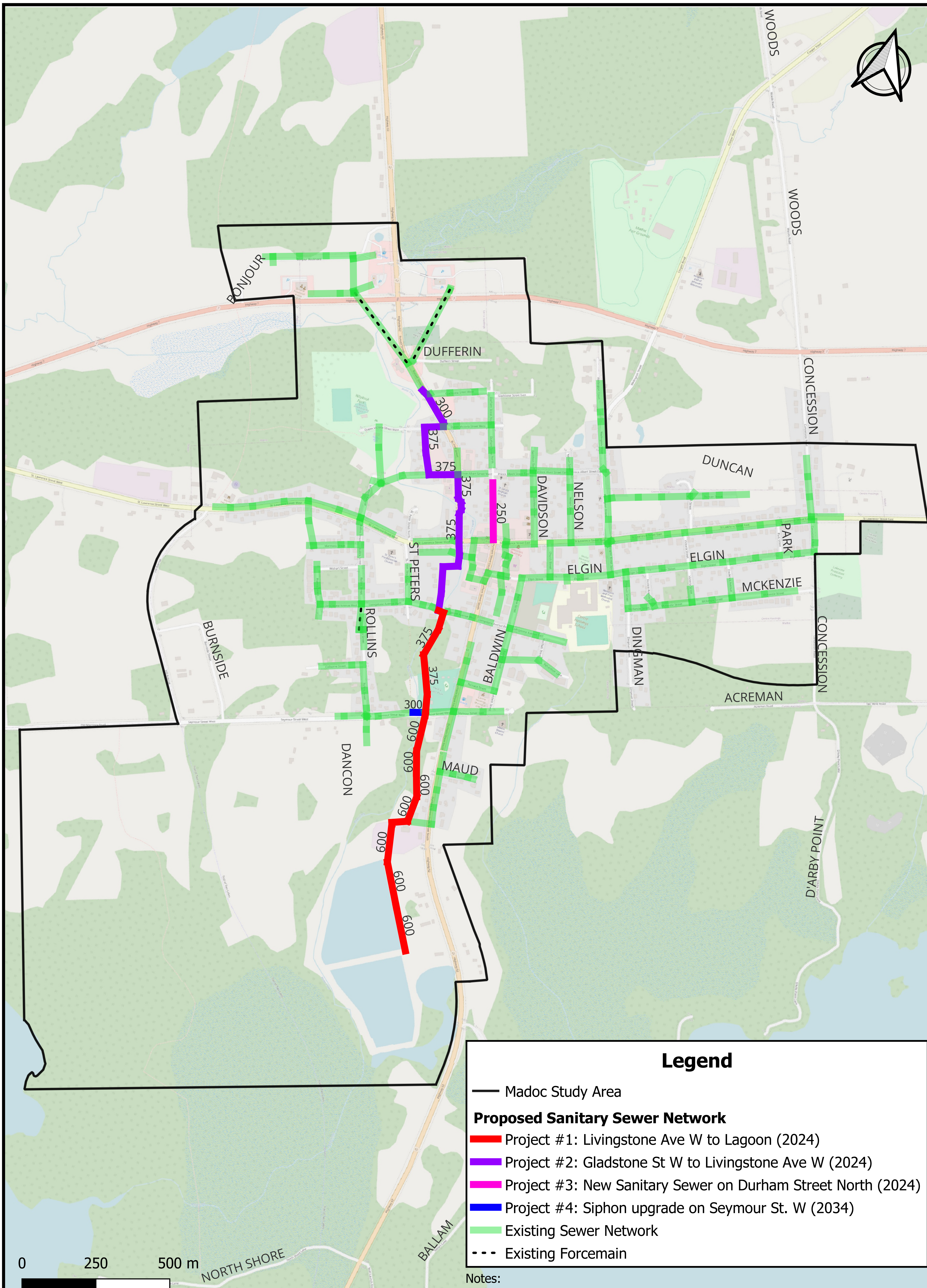
Under the 10-20 Year Planning Period, one (1) additional pipe was identified as requiring capacity improvements. This upgrade is an inverted siphon located on Seymour St. West which services the south-west region of Madoc. Table 24 below summarizes the upgrades identified using the Future development design sheets in Appendix D.

Table 24: Sewer Upgrades due to Long Term (10-20) Year Development Growth

MH From – MH To	Location	Existing Diameter (mm)	Proposed Diameter (mm)	Triggering Development	Approximate Length (m)
101-96	Seymour St. W between Durham St. S. & Rollins St.	150(2)	300(1)(2)	Developments on South-West region of Madoc	50
(1) The proposed new diameter for the pipe segment is calculated based on achieving approximately 10% residual capacity. (2) Note that the mentioned diameter is for both the barrels of the inverted siphon.					

4.5.3 Summary of Sanitary Sewer Upgrades

Refer to the figure below for the recommended sanitary sewer upgrades.



Notes:
1. Proposed sewer size (mm) indicated on each pipe segment.

PROJECT:

MADOC WATER, WASTEWATER & STORMWATER MASTER PLAN
Madoc, ON

DRAWING:

Proposed Sanitary Sewer Upgrades

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

DESIGN:	PSC	JLR NO:	32508-000
DRAWN:	RC	DRAWING NO:	Figure 16
CHECKED:	SJS		

4.6 Stormwater System

4.6.1 Stormwater Sewer System

Madoc's current stormwater management infrastructure incorporates sewers and ditches to convey stormwater runoff. The depiction of its network, encompassing all identified storm infrastructure in Madoc, is provide in Figure 27, of the Phase 1 report. Madoc hosts distinct minor stormwater systems, each draining into various areas within and around Madoc, as indicated in Figure 28, in Phase 1 report. The majority of these system discharge into Deer Creek, traversing the Village. Surcharged pipe segments under existing conditions were identified in Table 42 of the Phase 1 Master Plan.

4.6.1.1 Servicing Requirements under Existing Conditions

Pipe segments were singled out for the capacity enhancements in cases where either the sewer had no remaining capacity or the specific pipe segment exceeded its maximum capacity threshold of 100%. The pipe segments summarized in the following table are recommended to be upsized in order to meet operating standards.

Table 25: Storm Sewer Upgrades Required Under Existing Conditions

MH From	MH To	Location	Existing Diameter (mm)	Proposed Diameter (mm)	Approximate Length (m)
STO-87	STO-88	St. Lawrence St. E	375	400	70
STO-88	STO-89	St. Lawrence St. E	375	400	63
STO-91	STO-93	St. Lawrence St. E	450	600	91
STO-93	STO-96	St. Lawrence St. E	450	675	83
STO-431	STO-104	Duncan St.	250	375	106
STO-104	STO-457	ROW	350	375	42
STO-104	STO-457	ROW	400	450	58
STO-450	STO-448	Durham St. N	300	375	39
STO-448	CB-33	Durham St. N	400	450	21
CB-33	CB-31	Durham St. N	400	450	24
STO-5	STO-6	Russel St.	450	525	33
STO-6	STO-7	Russel St.	450	600	50
CB-209	CB-208	Davidson St.	300	450	36
CB-208	CB-300	Davidson St.	300	600	38
CB-300	CB-204	Davidson St.	300	600	34
CB-204	CB-202	Davidson St.	300	675	19
CB-202	STO-438	Davidson St.	300	675	14
STO-96	Creek Outlet	St. Lawrence St.	Various	1350	468
STO-47 (NEW)	STO-436	Elgin St.	-	450	197

MH From	MH To	Location	Existing Diameter (mm)	Proposed Diameter (mm)	Approximate Length (m)
STO-44	STO-436	Elgin St.	300	375	70
STO-436	STO-139	Baldwin St.	400	525	21
STO-139	STO-137	Baldwin St.	450	525	31
STO-40	CB-133	Baldwin St.	750	Decommission	37
CB-133	STO-35	Baldwin St.	750	Decommission	69
CB-133	STO-454	Baldwin St.	750	Decommission	35
STO-112	STO-113	Whytock Ave.	450	525	101
CB-3	CB-4	ROW	400	450	22
CB-4	CB-5	ROW	400	450	5
CB-5	STO-434	ROW	400	450	1
STO-40	STO-440	Baldwin St. & Furnace St.	-	750	351
STO-440	STO434	Durham St. S	500	750	15
STO-434	CB-6	Durham St. S	500	750	30
CB-6	CB-8	Durham St. S	600	825	7
CB-8	STO-445	ROW	600	825	105
STO-445	STO-446	ROW	600	825	31
STO-435	CB-129	Durham St. S	300	375	16
CB-129	STO-12	Durham St. S	300	375	23
STO-122	STO-124	Rollins St.	450	525	41
STO-48	STO-55	Centre Hastings School	650	Decommission	292
STO-55	STO-455	Centre Hastings School	650	Decommission	11

4.6.1.2 Alignment Improvements due to Existing conditions

Specific minor systems were identified as discharging flow onto the private land or areas earmarked for future development. Currently, under the prevailing conditions, two minor systems have been pinpointed for discharging onto private land:

- Minor System associated with Drainage Areas – STO 454 Outlet (Figure 28, Phase 1 Report).
- Minor System associated with Drainage Areas – STO 55 Outlet (Figure 28, Phase 1 Report).

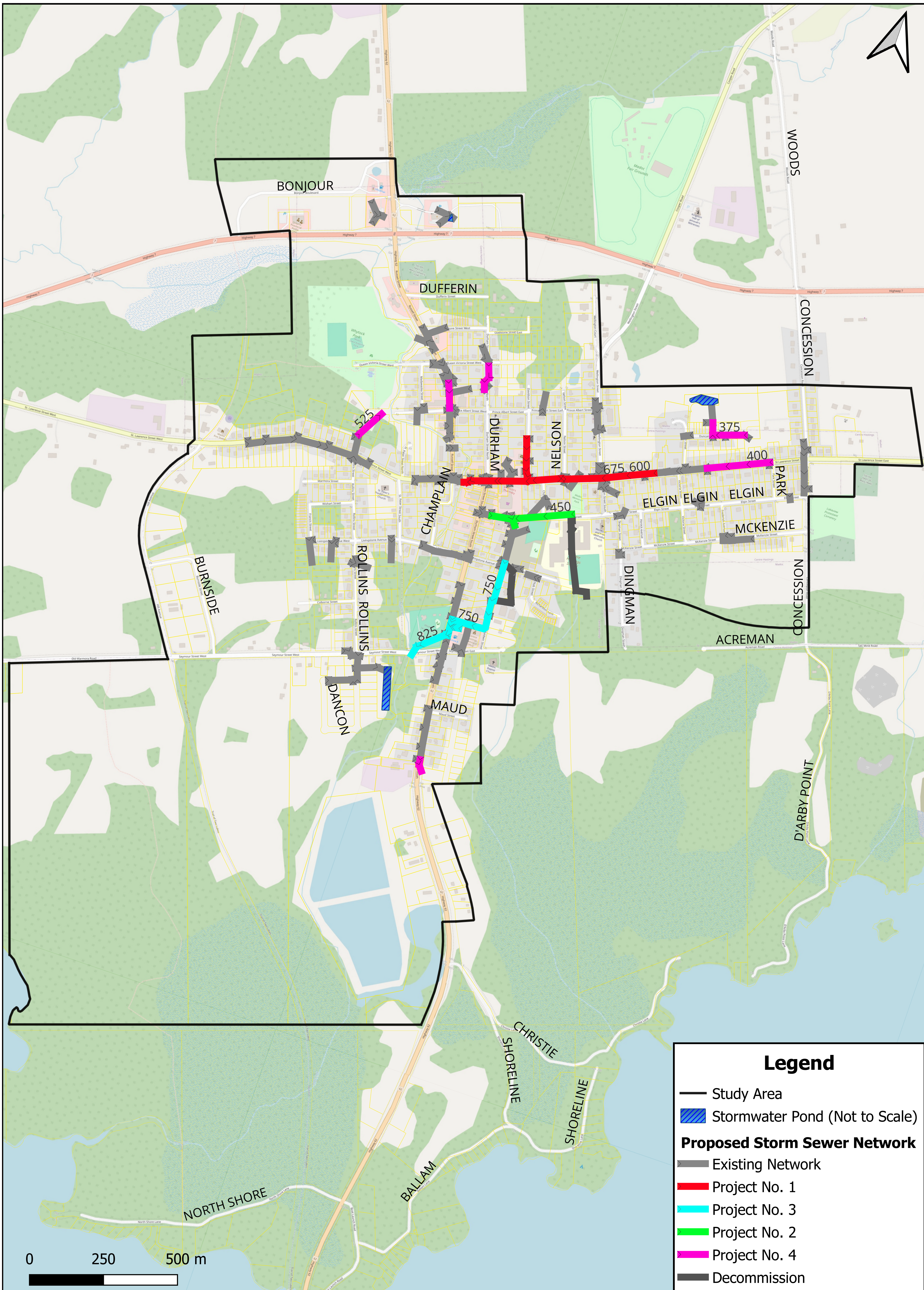
It's recommended that the existing storm sewer network be utilized to redirect flow from the above-noted outlets to an approved outlet, such as Deer Creek.

4.6.1.3 Servicing Requirements due to Future Growth Conditions

The future developments must include water quantity controls to limit post-development runoff flows to pre-development levels. There should therefore be no reduction in level of service of the stormwater sewer system as a result of future development.

4.6.2 Summary of Storm Sewer Upgrades

Refer to the figure below for the recommended storm sewer upgrades.



PROJECT:

MADOC WATER, WASTEWATER & STORMWATER MASTER PLAN

Madoc, ON

DRAWING:

Proposed Storm Sewer Network

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

DESIGN:	PSC	JLR NO:	32508-000
DRAWN:	RC	DRAWING NO:	**Figure 17**
CHECKED:	SS		

5.0 Recommended Servicing Strategy, Implementation and Timing

There are a number of projects for water, wastewater and stormwater infrastructure that have been identified as a result of this Master Plan. Considering the combined overall costs of these projects and that various projects are based on a number of evaluation factors; it is reasonable to expect that the projects identified would be implemented in a prioritized fashion.

Based on the various evaluations including overall problem identification, Table 26 has been developed to allow the Municipality to appropriately plan and phase the identified projects. A brief summary of the rationale and assumptions have also been included so that the list can also be potentially re-visited in the future as conditions may change and a re-ordering of the Municipality's priorities can be considered based on changing conditions and available information or previous upgrade projects that could affect future projects. It should be noted that certain projects could be advanced sooner if the Municipality deems this to be feasible.

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 **2024** 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 +/- 30%. 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 Master Plan 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 COVID-19. JLR shall not be responsible for any variation in the estimate caused by the foregoing factors but will notify the Municipality of any conditions which JLR believes may cause such variation upon delivery of the estimate.

Table 26: Overall Implementation Plan

Infrastructure Type	Initiation Date	Project	Description	Opinion of Probable Cost (+/- 30%)
PROPOSED SHORT-TERM PROJECTS (INITIATE IN 0-5 YEARS)				
Water Supply, Water Treatment, Water Storage	2024	Schedule 'B' Class EA for Treated Water Storage Facility	It is recommended that the Municipality to initiate a Schedule 'B' Class EA for the Treated Water Storage facility. The EA shall involve identification, evaluation and recommendation of a preferred storage configuration and location.	$25,000
	2024	Design and Construction of New Treated Water Storage Facility (Phase 1)	It is recommended that following the completion of Schedule 'B' Class EA for treated water storage, the Municipality initiate design and construction phase of the new facility in a phase approach.	$7,300,000
Water Distribution	2024 / Ongoing	Watermain Upgrade - Project 1	It is recommended to upgrade 210 m of watermain on St. Lawrence Street East.	$410,000
Wastewater Collection	2024	Sanitary Sewer Upgrades – Project 1	It is recommended to upgrade sanitary sewer sections from Livingstone Avenue West to Seymour Street West (375mm) and Seymour Street West to the Lagoon (600mm).	$3,500,000
	2024	Sanitary Sewer Upgrades – Project 2	It is recommended to upgrade sanitary sewer sections from Queen Victoria Street West to Livingstone Avenue West (375mm) and Gladstone Street West to Queen Victoria Street West (300mm). This project also includes allowance for local service connections.	$3,000,000
	2024	Sanitary Sewer Upgrades – Project 3	It is recommended to install a new 250mm sewer on Durham Street North from Prince Albert Street East to St Lawrence Street East and decommission existing sanitary sewers located on private properties. This project also include allowance for downtown construction.	$400,000
Wastewater Treatment System	2024	Madoc Lagoon Schedule 'C' Class EA	It is recommended to initiate a Schedule 'C' Class EA for the proposed expansion at the Madoc Lagoon. The Class EA will involve assimilative capacity assessment to extend discharge windows and technology evaluation to select the preferred treatment option for add-on treatment.	$200,000
	2026	Design and Construction of Madoc Lagoon Upgrades	It is recommended that following the completion of Schedule 'C' Class EA for Madoc Lagoon upgrades, the Municipality initiate the design and construction of the recommendation.	$10,000,000
Stormwater System	2024	Storm Sewer Upgrades – Project 1	It is recommended to connect St. Lawrence Street East sewer to St. Lawrence Street West sewer and upsize the St Lawrence Street East storm sewer from Wellington Street to Deer Creek.	$3,200,000
	2024	Storm Sewer Upgrades – Project 2	It is recommended to decommission existing storm sewer under Madoc Public School and connect the Elgin Street sewer to the Baldwin Street Sewer.	$1,300,000
	2024	Storm Sewer Upgrades – Project 3	It is recommended to connect the Baldwin Street storm sewer from Livingston Avenue West to Durham Street South and decommission existing storm sewers located on private property.	$2,100,000
	2024	Storm Sewer Upgrades – Project 4	It is recommended to upsize various local surcharged pipes.	$2,400,000
			TOTAL SHORT-TERM COSTS (+/- 30%)	**$ 34,000,000**
PROPOSED MID-TERM PROJECTS (INITIATE IN 5-10 YEARS)				
Infrastructure Type	**Initiation Date**	**Project**	**Description**	**Opinion of Probable Cost**
Water Supply, Water Treatment, Water Storage	2032	Water Supply Schedule 'B' Class EA Water Treatment Schedule 'C' Class EA	A water supply feasibility study, hydrogeological study and a Schedule 'B' Water Supply Class EA is recommended to confirm existing well taking capacity, potential new well location and level of treatment. A transmission watermain alignment should also be reviewed and recommended. A Schedule 'C' Class EA will be initiated after the Schedule 'B' Water Supply EA to confirm treatment technologies.	$400,000
			TOTAL MID-TERM COSTS (+/- 30%)	**$400,000**
PROPOSED LONG-TERM PROJECTS (INITIATE IN 10+ YEARS)				
Infrastructure Type	**Initiation Date**	**Project**	**Description**	**Opinion of Probable Cost**
Water Supply, Water Treatment, Water Storage	2034	Design and construction of a new well and treatment plant	It is recommended that following the completion of Schedule 'B' and Schedule 'C' Class EAs, the Municipality initiate the design and construction of the recommended new well and its associated treatment system.	$8,500,000
	2034	Design and Construction of New Treated Water Storage Facility (Phase 2)	The Municipality shall initiate design and construction phase of the new facility in a phase approach. This project represents Phase 2 storage capacity expansion to meet long-term growth.	$4,400,000
Wastewater Collection	2034	Sanitary Sewer Upgrades – Project 3	It is recommended to upsize the siphon on Seymour Street West (300mm).	$500,000
			TOTAL LONG-TERM COSTS (+/- 30%)	**$13,400,000**

6.0 Environmental Impacts and Mitigation Measures

The proposed works in Table 26 will lead to potential impacts to the environment, construction strategy and site management, and/or cultural heritage resources. Table 27 below presented below summarizes potential environmental impacts, along with mitigation measures. It is recommended that impacts and mitigation measures be further reviewed and updated during the Class EA project specific planning and design stages.

Table 27: Summary of Environmental Impacts and Mitigation Measures

Impact	Mitigation Measure
The Environment	
Source Water Protection	Vulnerable areas, where drinking water sources are most at risk, were reviewed within the study area. These areas have been depicted in Figure 10 in the Phase 1 Master Plan Report. At this time there are two existing groundwater wells within the study area. Well #3, located on Rollins Street, has a maximum daily rated capacity of 1,150 m^3/day and includes filtration and disinfection. Well #4 located on Marmora Street, has a maximum daily rated capacity of 1,470 m^3/day and includes an ion-exchange arsenic removal system in addition to filtration and disinfection. Both wells are defined as groundwater under the direct influence of surface water (GUDI). The recommended projects and studies resulting from completion of this Master Plan are intended to improve the performance and reliability of the drinking water systems in the 20-years planning horizon. For the proposed Water Supply Schedule 'B' Class EA in the mid-term to increase water taking, additional hydrogeological studies and consultation with Conservation Authority and MECP will be undertaken to delineate future wellhead protection areas (WHPAs).
Climate Change	Climate change mitigation measures reduce the project's impacts on climate change, such as greenhouse gas (GHG) emissions and changes to the landscape that negatively affect its carbon sequestration and storage capacity. The project's GHG emissions can be categorized as operating carbon (emitted during the operation phase) and embodied carbon (emitted during the manufacturing and construction phase). Operating carbon consists of direct emissions from combustion of fossil fuels on site while indirect emissions are from consuming energy (ex. electricity) that was generated from off-site combustion of fossil fuels. The operating carbon of the Madoc Water and Wastewater Treatment System may be reduced through energy efficiency measures, fuel switching and on-site renewable energy generation.

	Adjustments in specifications for materials can enable major reductions in embodied carbon as the infrastructure is upgraded. Climate change adaptation refers to the impact of climate change on a project, i.e., the resilience or vulnerability of infrastructure to changing climatic conditions. Impacts of climate change on municipal water, wastewater and stormwater projects include property-specific concerns such as flooding and system-wide impacts on water demand and electricity consumption. The recommended projects with additional treatment processes may be considered and will enhance the Municipality's climate adaptation. Future expansions on WTP and storage facilities may evaluate the water demand and fire requirements based on local drivers, rather than meeting the minimum of standard practices. This will ensure the availability of water supply for climate events.
Contaminated Sites	Additional studies to identify waste disposal sites, contaminated sites and underground storage tanks and excess material management may be required as part of specific Class EAs or during project design.
Ecosystem Protection and Restoration	In general, any construction activities that may impact ecosystem form and function must be avoided where possible. Existing natural environmental features within the Master Plan study area are detailed in the Figure 10 of the Phase 1 Report. There are no ecosystem features of note within or located near the study area and the recommended long-term strategy will not propose risk posed to the immediate surrounding areas of the current water facilities. Consultation with the Ministry of Natural Resources and Forestry (MNRF), Fisheries and Oceans Canada (DFO) and applicable, local conservation authorities should be completed during the Class EA projects to determine if special measures or additional studies will be necessary to preserve and protect sensitive features within the projects area.
Species at Risk	In general, investigation of species at risk should be completed during the project's Class EA or design and mitigation measures should be embedded in the design and implemented during project construction. For instance, construction activities can be maintained within the existing site boundary or right-of-way to minimize disruption to wildlife habitat; work can be staged to avoid spawning and breeding periods. The proponent/ consultant retained to complete the proposed Class EA projects should review the "Client's Guide to Preliminary

	Screening for Species at Risk" (MECP, May 2019) identified within the MECP letter (see correspondence in Appendix G).
Surface Water	Known surface waters within the Master Plan study area include the the Deer Creek that runs through the Municipality of Centre Hastings. Details on the location of surface waters and other existing natural environmental features have been detailed Figure 10 of the Phase 1 Report. Measures should be included in the planning and design process to ensure that any impacts to watercourses from construction or operational activities (e.g., spills, erosion, pollution) are mitigated as part of the proposed undertakings. For instance, a stormwater management plan should be developed during the design and implementation stage and sedimentation and erosion control should be implemented during construction. The recommended long-term strategy of adding another well (or increase capacity of existing wells) of water supply will not cause any risk posed to surface waters within Madoc. The proponent/ consultant retained to complete the proposed Class EA projects should review the requirements identified within the MECP letter (see correspondence in Appendix G).
Groundwater	There are areas designated groundwater recharge and groundwater quality vulnerability within the Municipality. These areas have been depicted in Figure 10 in the Phase 1 Master Plan Report. At this time there are two existing groundwater wells within the study area. Well #3, located on Rollins Street, has a maximum daily rated capacity of 1,150 m^3/day and includes filtration and disinfection. Well #4 located on Marmora Street, has a maximum daily rated capacity of 1,470 m^3/day and includes an ion-exchange arsenic removal system in addition to filtration and disinfection. Both wells are defined as groundwater under the direct influence of surface water (GUDI). The potential for impacts related to groundwater conditions will be assessed through geotechnical/ hydrogeological studies during the Class EA and/or design phase for the proposed works.
Construction Strategy and Site Management	
Excess Material Management	Projects activities involving the management of excess soil should be completed in accordance with O. Reg. 406/19 and the MECP's current guidance document titled "Management of Excess Soil – A Guide for Best Management Practices" (2014). All waste generated during construction must be disposed of in accordance with Ministry requirements.

Air Quality, Dust and Noise	Increased dust and noise can be anticipated from the various construction works of the proposed projects; impacts to air quality may occur during proposed wastewater treatment plant, sewage pumping station, or sanitary sewer upgrades projects. The potential for impacts related to air quality, dust, and noise will be assessed during the Class EA and/or design phase for the proposed works. Dust and noise control mitigation measures (ex. the MECP recommends non-chloride dust-suppressants) should be addressed and included in the construction plans to ensure that nearby residential and other sensitive land uses within the projects area are not adversely affected during construction activities.
Servicing, Utilities and Facilities	In consultation with Hydro One, it was noted that there are existing distribution assets within the study area. This Master Plan did not identify any proposed projects which would encroach on Ministry of Ontario (MTO) infrastructure. Should projects which impacts Highway 7 be identified in future studies, please refer to the Highway Corridor Management Manual (2022). Early consultation with the MTO is highly recommended for activities within the control area. Pre-consultation requests with the MTO can be submitted online using the Highway Corridor Management Online Services. Hydro One should be consulted on individual projects during the Class EA and/or during design. Moreover, all underground and overhead infrastructure (transmission lines, telephone/internet, oil/gas, etc.) and/or potential disturbances to crossings should be identified as part of the Class EA projects and during design.
Mitigation and Monitoring	Design and construction reports/plans for the proposed projects should be based on a best management approach that centers on the prevention of impacts, protection of the existing environment, and opportunities for rehabilitation and enhancement of any impacted areas. A list of proposed mitigation and monitoring measures should be developed during the Class EA projects and/or during design for projects.
Permits and Approvals	The projects identified in this Master Plan may require specific permits and approvals; these will be identified and obtained during the projects specific Class EA and/or design. These may include: • Environmental Compliance Approval (ECA) Sewage and Air/Noise • Drinking Water Works Permit Amendment • Municipal Drinking Water License Amendment • Permit to Take Water • Environmental Activity and Sector Registry (EASR) • Conservation authority permits • Species at risk permits

	• MTO permits • Building Permit • Site Plan Approval • Official Plan Amendment and Approvals • Approvals under the Impact Assessment Act, 2019 (if triggered). The proponent/ consultant retained to complete the proposed Class EA projects should complete this consultation to obtain the required permits/approvals. There are potential developments identified in the Master Plan (e.g., Bonjour Boulevard and McKenzie Development) that are located outside of Municipality of Centre Hasting's urban boundary, but within Madoc Servicing Area. Centre Hastings Bylaw No. 2024-11 is in place as a cross-municipal servicing agreement between the Municipality of Centre Hastings (Urban Madoc) and the Township of Madoc to provide sanitary sewer collection and water distribution services to properties with frontage on Bonjour Boulevard (PIN 40621-0204). A small group of parcels with frontage on Seymour Street West, between Hill Avenue and Rollins Street West is not located within Madoc's urban servicing boundary. There were no identified potential developments in this area. There are no watermains and sanitary sewers on this section of Seymour Street West. It is recommended that consultation be undertaken with the Township of Madoc for future servicing to these parcels. Official Plan Amendment may be triggered if the Municipality wishes to extend the urban boundary to include these properties.
Cultural Heritage Resources	
Disturbance or destruction of archaeological resources and displacement of known and/or potential built heritage resources and/or cultural heritage landscapes by removal and/or demolition and/or disruption.	• Undertake archaeological assessment(s) to identify and evaluate resources. All archaeological assessment work must be carried out by licensed archaeologists. • Identify and evaluate Built Heritage Resources and Cultural Heritage Landscapes. • Avoidance, through alternative route selection. • Demolition shall be considered a last resort.

7.0 Cultural Heritage and Archaeological Conditions

Cultural heritage resources, which includes archaeological resources, built heritage resources and cultural heritage landscapes, is an important aspect of the cultural environment and may be impacted by the proposed undertaking.

Ministry of Citizenship and Multiculturalism (MCM) form 4078e – Criteria for Evaluating Archaeological Potential was completed to determine if the study area has archaeological potential. Upon initiation of the Class EA projects identified in Table 26, archaeological screening should be completed to determine if an archaeological assessment is to be undertaken. The completed form 4078e is included in Appendix F.

By going through the screening questions, an archaeological assessment is required for some projects since the MCM noted one and only known archaeological site within the study area and was described as an obscured and provided with a generalized box on a map: the area occupies an approximately 400 m by 400 m area along Durham St. S between Livingstone Avenue East/West and Seymour Street West.

For all proposed projects, the potential for disruption to cultural heritage resources is dependent on the preferred alternative. As the Master Plan provides high level solutions for water and wastewater infrastructure needs, in some instances, the exact location for implementation has not been defined as part of this Master Plan. When applicable, the assessment should be completed by an archaeologist licensed under the Ontario Heritage Act and the archaeological assessment report must be submitted for MCM review prior to the completion of the Class EA and prior to any ground disturbance.

The recommended sanitary sewer upgrades (Figure 16) and storm sewer upgrades (Figure 17) are within the general area of archaeological potential noted above. As the proposed sewer upgrades are located within the existing infrastructure corridor, it is anticipated that there will be minimal impact to archaeological and cultural heritage resources. An archaeological assessment completed by a licensed archaeologist under the Ontario Heritage Act must be completed prior to the proposed sewer upgrades.

MCM form 500e - Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes was completed to determine if the study area consist of known or potential cultural heritage resources. There were no areas of known or potential cultural heritage within the proposed project areas listed in Table 26.

The preferred solutions for the WTP and lagoons will be contained within their existing sites, therefore it's anticipated that there will be minimal impact to archaeological and cultural resources.

Cultural heritage and archeological impacts of the proposed water storage expansion is detailed in Appendix B – Schedule 'B' Municipal Class Environmental Assessment for a New Treated Water Storage Facility in Madoc.

8.0 Public Consultation

8.1 Stakeholder and Review Agency Consultation Activities

Consultation includes project initiation notification to the public and potential stakeholders, one council presentation, notification, and completion of a public information center (PIC), notice of Master Plan completion and 30-day review period at the end of the study.

A Notice of PIC #2 was posted on the Municipality's website (https://centrehastings.com/our-municipality/water-resources/madoc-water-wastewater-and-stormwater-master-plan/) and distributed to stakeholders on May 17, 2024. The PIC #2 was completed on June 11, 2024.

Refer to Appendix G for a copy of all Notices, council presentation and PIC #2 slides, stakeholder responses received to date and an updated stakeholder tracking list. Table 28 below provides a summary of all written comments received to date and how they have been addressed in the Master Plan.

Table 28: Summary of Stakeholder Comments

Stakeholder	Summary of Comment	Summary of Action
Hydro One	2024-03-12 – Letter response with preliminary comments in response to the Madoc Water, Wastewater and Stormwater Master Plan, which included: • Confirmation that Hydro One has existing distribution assets within the study area. • Request for continued consultation throughout during all stages of the project including Master Plan and subsequent Class EAs.	Noted and comments have been addressed in Table 27 of this report.
Ministry of Citizenship and Multiculturalism (MCM)	2024-03-07 – JLR inquired on archeological potential in the vicinity of the key infrastructure within the municipal boundary. 2024-04-10 – MCM responded with the following: • The only reported archaeological site in the study area is provided with a generalized box on the map: the area occupies approximately 400 m by 400 m along Durham St. S between Livingstone Ave and Seymour St. 2024-06-20 – MCM response to PIC No.2 Notice highlighted the requirements to address archaeological resources and built heritage resources and cultural heritage landscapes.	Comments have been addressed in Section 7.0 of this report. Noted in Section 7.0 of this report.
Transport Canada	2024-05-27, 2023-12-15 Transport Canada response with instruction to self-assess whether the project will	Noted and self-assessed.

Stakeholder	Summary of Comment	Summary of Action
	interact with federal property/ waterway and whether the project will require approval and/or authorization under any Acts administered by Transport Canada.	
Quinte Conservation	2023-12-15 – Quinte Conservation responded by the Notice of Commencement with the following: • Quinte Conservation has floodplain modelling, mapping and reports available for review for Deer Creek and the unnamed creek in the northeast quadrant study area. • Quinte Conservation does not maintain any natural heritage reports, mapping or inventories for the study area. However, staff have been involved in baseflow/water quality monitoring and the Provincial Groundwater Monitoring network (PGMN). Information may be made available upon request. • The area falls within the Village of Madoc's WHPA A and B for source water protection. • Quinte Conservation no longer provides comments on water quality as part of their stormwater management review. Municipalities must continue to follow the MECP Stormwater Management Planning and Design Manual March 2023 for stormwater quality requirements. Staff will continue to provide comments on stormwater quantity.	Noted.
Ministry of Environment, Conservation and Parks (MECP)	2023-12-04/ 2023-12-14 MECP issued a letter response to the Notice of commencement outlining their expectations on various aspects to be addressed in the Approach 1 Master Plan.	Noted and addressed throughout the Master Plan work.
Moira Lake Property Owner's Association (MLPOA)	2023-12-06 – the MLPOA responded to the Notice of Study Commencement by expressing interest in receiving study findings.	Noted.

Stakeholder	Summary of Comment	Summary of Action
Ministry of Tourism, Culture, and Sport (MTCS)	2023-12-15 – MTCS responded to the Notice of Study Commencement by expressing interest in being added to the email list for future project updates.	Noted. Added to email list
MDTR Group	2023-12-05 – MDTR responded to the Notice of Study Commencement by \ expressing interest in being added to the mailing list for future project updates.	Noted. Added to email list.

8.2 Future Consultation Requirements

Future public and stakeholder consultation will be undertaken for the projects in Table 26 in accordance with the consultation requirements of their identified project Schedule, as detailed in the Phase 1 Report.

Future public consultations will be undertaken with the County of Hastings and Township of Madoc to identify necessary Official Plan amendments requirements to expand the urban boundary and to expand the municipal servicing boundary.

9.0 Notice of Completion and Filing on Public Record

This Master Plan is being placed on public record for 30 calendar days for review by the public, stakeholder agencies, Indigenous communities, and other interested parties.

A notice indicating the completion of the Master Plan and its filing on public record has been issued to the public, and all interested parties that have previously been contacted and that have indicated interest to stay involved in the planning process.

The review period is intended to resolve any outstanding concerns regarding the project between the Municipality and the party expressing concerns. The Master Plan will be reviewed and revised, taking into consideration any comments received from the public.

Any information collected during the planning process is managed in accordance with the Freedom of Information and Protection Act. Apart from personal information, all comments become part of the public record. Proprietary information (i.e., equipment manufacturers) and pricing could provide competitors with some advantages and is not released in detail as part of the Freedom of Information and Protection Act.

Subject to comments received, the Municipality can choose to proceed with the recommended projects in the Master Plan after the 30-day review period. Projects that have been identified as Class EA Schedule 'B' or 'C' will proceed into project-specific Class EA studies during which the public will be consulted for their input.

This report has been prepared by J.L. Richards & Associates Limited for Ontario Clean Water Agency and Municipality of Centre Hastings' exclusive use. Its discussions and conclusions are summary in nature and cannot properly be used, interpreted or extended to other purposes without a detailed understanding and discussions with the client as to its mandated purpose, scope and limitations. This report is based on information, drawings, data, or reports provided by the named client, its agents, and certain other suppliers or third parties, as applicable, and relies upon the accuracy and completeness of such information. Any inaccuracy or omissions in information provided, or changes to applications, designs, or materials may have a significant impact on the accuracy, reliability, findings, or conclusions of this report.

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Appendix A

Climate Change
Technical Memorandum

Appendix B

Project File – Schedule B Municipal Class Environmental Assessment for a New Treated Water Storage Facility in Madoc, Ontario

Appendix C

Water Model

Appendix D

Sanitary Sewer Design Sheets

Appendix E

Storm Sewer Design Sheets

Appendix F

Archaeological Screening Forms

Appendix G

Public Consultation Documents

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