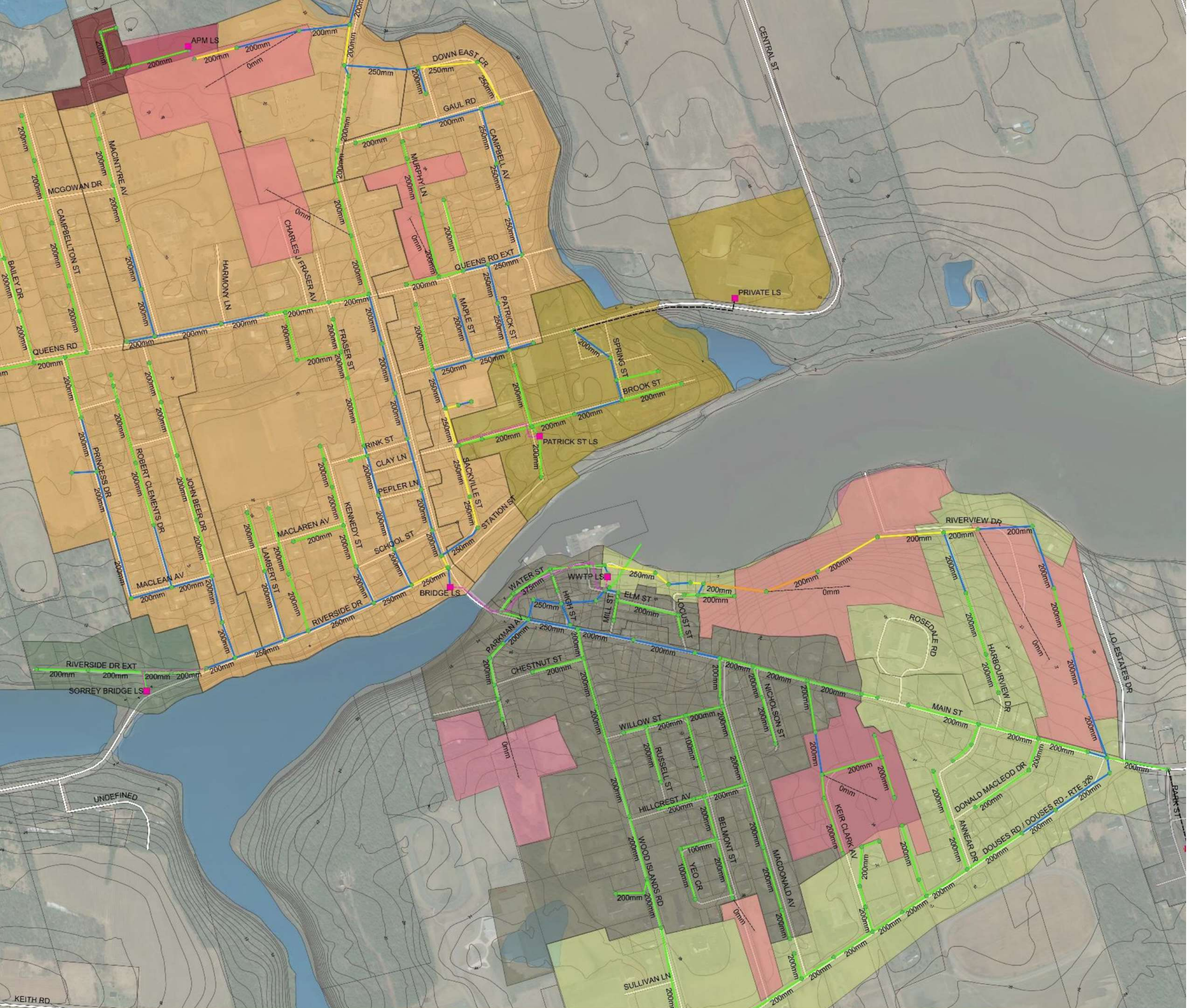

Town of Three Rivers

Water and Wastewater Master Plans

Final Report

212621.00 • August 2022

3	Final Report	P.Hughes	Aug 12/22	P.Hughes
2	Draft Final Report	P.Hughes	July 6/22	P.Hughes
1	Draft Finding Report	P.Hughes, T. LeLacheur	May 13/22	P.Hughes
Issue or Revision		**Reviewed By:**	**Date**	**Issued By:**

CBCL

Project No. 212621.00

August 12, 2022

Dorothy MacDonald
Manager of Community Services
Town of Three Rivers
PO Box 89
Georgetown, PE C0A 1L0

Dear Ms. MacDonald:

RE: Town of Three Rivers Water and Wastewater Master Plans

Enclosed is the final report for the above noted project. The report contains five (5) chapters outlining background information collected, existing system findings, potential future development scenarios and conclusions and recommendations for future system planning.

Yours very truly,

CBCL Limited

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Project No: 212621.00

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List of Abbreviations

ACWGM	Atlantic Canada Wastewater Guidelines Manual
ADD	Average Day Demand
ADF	Average Daily Flow
AO	Aesthetic Objective
BOD	Biochemical Oxygen Demand
CN	Canadian National
DEM	Digital Elevation Model
ft/s	Feet per Second
GIS	Geographical Information System
HGL	Hydraulic Grade Line
I/C/I	Industrial/Commercial/Institutional
IGPM	Imperial Gallons per Minute
HP	Horsepower
Kg/d	Kilogram per day
km	kilometer
kPa	Kilo Pascal
L/min	Litres per minute
L/c·day	Litres per capita per day
m^3/d	Cubic metres per day
m^2/d	Square metres per day
m/s	Metres per second
MDD	Maximum Day Demand
ML	Mega Litres
mg/L	Milligram per liter
ml	Millilitre
mm	Millimeter
MPN	Most Probable Number
ND	Non detect
N/A	Not applicable
PHF	Peak Hourly Flow
psi	Pounds per square inch
PRVs	Pressure Reducing Valves
TSS	Total Suspended Solids
TWL	Top Water Level
USGal	US Gallons
µg/L	micrograms per liter
USGPM	US Gallons per minute

1 Introduction

1.1 Project Overview

In 2021 the Town of Three Rivers engaged CBCL to prepare Water and Wastewater Master Plans for the Communities of Montague, Georgetown, and Cardigan. The objective of this report is to identify existing issues within the various water and wastewater systems and plan for future growth. Estimated future growth rates, water demands, and wastewater flow projections have been determined based on previous Statistics Canada Census data and the zoning of suspected growth areas as well as existing operational data. This master plan will provide direction and insight to assist the Town in planning for the future.

1.2 Background

In 2018 the Town of Three Rivers was formed through the amalgamation of several towns, communities, and rural areas. The Town of Three Rivers is generally comprised of the Communities of Brudenell, Cardigan, Georgetown, Montague, Lower Montague, Lorne Valley, Valleyfield, and the surrounding rural areas. The Town has a current population of 7,883 (2021 Statistics Canada Census Profile) and continues to see steady growth. In recent years the Town has seen yearly population increases of 2.0%, it is expected that this growth will continue as the communities within the Town continue to support one another.

The Community of Montague has a population of 1,896 (2021 Statistics Canada Census Profile) and is largest community that makes up the Town of Three Rivers, Prince Edward Island. The Community has seen a total growth of 8.9% since 2011, which is in line with the provincial growth rate of 10% since 2011. Montague is centrally located within the Town of Three Rivers and has a geographical size of approximately 2.0 square kilometers. The Montague River extends from the Georgetown harbour bisecting the community to the North and South. Adjacent communities include the Brudenell to the North, Valleyfield to the West and Lower Montague to the South. Elevations within the community are generally higher inland, sloping to the lowest elevations along the Montague River. Montague has a central water system consisting of 21.5kms of watermains which supply domestic water to its customers as well as fire flow using a 1000USGPM fire rated pump. Montague also has centralized sanitary sewer collection and treatment, the construction of this system began in 1969 and included the installation of concrete sewer mains, two sewage pumping stations and a sewage treatment plant. Upgrades to the plant have been completed over the years including a 2001 addition of a secondary clarifier, 2015 addition of a geotextile sludge dewatering system and 2021 addition of a sludge storage tank.

The Community of Georgetown is located north-east of Montague and is the Capital of Kings County. In recent years, the population of Georgetown has seen a steady decline dropping from 675 to 555 (2011 & 2016 Statistics Canada Census Profiles respectively). Prince Edward Island's Environmental Industrial Services Incorporated owns and operates a water utility in the Community of Georgetown that includes a domestic water system which began in 1965 and was originally constructed to service the shipyard, ports and seafood processing facilities present at that time. The original intent of the system was not to provide water for residential customers however some nearby homes are serviced by the central water system. The water system is for domestic use only and is currently assumed to service approximately 165 properties located adjacent to the existing system. This system is not designed to provide fire flows within the community. The original Georgetown wastewater collection system dates back to 1965 as well when the Atlantic Development Board project was designed for Public Works Canada to provide basic facilities for fisheries development in the area. Over the years, the original system has been extended and now includes wastewater treatment and the recent 2019 upgrade of the sewage lift station on West Street.

The Community of Cardigan has seen previous water supply studies for potential options for servicing residents with a central domestic water supply, however the village does not currently have a water supply system. Similar to the water supply, the community does not currently contain a central sanitary collection/treatment system. Instead, residents rely on individual on site wells and disposal systems. Not unlike several small coastal communities on PEI, Cardigan is challenged with potential saltwater intrusion with reports of some wells within a cluster of 10 to 15 homes on the north side of the Community experiencing problems, and a mix of lot sizes and soil types, some of which are less suitable for on site wastewater disposal.

1.3 Purpose of Study

In general, the Water and Wastewater Master Plans have been prepared to provide the Town with a long-term understanding of their Municipal Systems and to support decision making for new developments and expanding servicing boundaries.

The Project's focus was:

- Understand the existing water and wastewater infrastructure (physical attributes, condition, age, operational philosophy).
- Identify issues with existing infrastructure meeting current needs such as undersized pipes, infrastructure age beyond useful life, fire flow requirements, pumping system capacities, and the like.

- Continue to provide customers with a safe, effective, and efficient supply of water and wastewater services, balanced with responsible financial planning.
- Review potential growth areas and future servicing areas (geographical, demands, loads).
- Understand how growth may affect the future municipal and servicing boundaries.
- Understand what the future infrastructure needs will be for the Town's infrastructure systems.
- Develop a list of recommendations to meet current and future needs.

1.4 Population and Development Projections

After reviewing the available census data from 2011 to 2021 for the Town of Three Rivers, and the communities of Montague, Georgetown, and Cardigan the following population trends were observed.

Table 1.1: Historical Population Numbers

Statistics Canada Census Year	Town of Three Rivers	Community of Montague	Community of Georgetown	Community of Cardigan
2011	Data not available[1]	1741	675	332
2016	7169	1834	555	269
2021	7883	1896	Data not available[1]	Data not available[1]

[1] The former municipality of Georgetown and community of Cardigan became part of the Town of Three Rivers in 2018. Therefore, no data for the 2021 Census was provided by Statistics Canada.

Reviewing the available Statistics Canada population statistics from 2011 to 2021, The Town of Three Rivers has seen an average population growth of 2.0% per year, Montague has seen an average population growth 0.9% per year, Georgetown has seen an average population decline of 3.5% per year, and Cardigan has seen an average population decline of 3.8%. For master planning purposes, a reasonable population growth for Montague was assumed to be 1% per year and a high population growth of 2% per year was assumed to align with the Town of Three Rivers' growth rate. To avoid being short sighted, the Town's growth projections have been distributed throughout the communities by assuming a population growth of 1% per year for Georgetown and Cardigan even though they have seen a decline in population in recent years.

With reasonable population growth projections established, future development densities were estimated to assess the existing systems under future conditions. Development densities were calculated in conjunction with the current draft official plan zoning schedules. Table 1.2 below summarizes the selected development densities used for this master plan.

Table 1.2: Assumed Development Densities

Development Zone	Development Density (persons/hectare)
Open Space	0
Community Space	55
High Profile Residential	40
Medium Profile Residential	20
Low Profile Residential	5
Highway Commercial	85
Mixed Use	52
Residential Mobile Home Park	37

The Atlantic Canada Wastewater Guideline Manual (ACWGM) was used to establish an equivalent population for the highway commercial areas. Light industrial areas were determined to contribute a flow of 35m^3/hectare/day.

2 Condition and Needs Assessment

2.1 Condition Assessment Overview

A high-level desktop condition assessment limited to age of infrastructure in conjunction with a small sample of field condition verifications of the existing linear infrastructure was completed as part of the scope of this project. Condition ratings of existing infrastructure should continuously be updated as system components are upgraded, any maintenance is completed and proactive continued physical assessments. Additionally, a needs assessment for the Community of Cardigan was completed since there is currently no existing municipal infrastructure within the community. Condition assessments provide valuable information for determining when assets will need to be renewed or replaced by assessing their physical condition. These assessments help:

- Identify assets that are failing or underperforming.
- Estimate when potential asset failures may occur.
- Identify steps required and a time frame for implementing these steps to prolong the life of assets, save costs and reduce risks.

In general, the asset condition for this project is based on the asset's age relative to the estimated design life of the asset type and material. The condition ratings range from 1 (the asset is in very good condition) to 5 (the asset is in very poor condition). The assumed design life of each type of pipe material is summarized in Table 2.1 and the condition rating scale is based on the qualitative scale summarized in Table 2.2.

Table 2.1: Assumed Material Design Life

Pipe Material	Assumed Design Life
Unknown Pipe Material	30
Concrete Steel	50
Cast Iron Ductile Iron Asbestos Concrete PVC	100

Table 2.2: Condition Rating Scale

Rating	Condition Details	Estimated Design Life Remaining (%)
1	**Very Good Condition** Normal maintenance required	80-100%
2	**Good Condition** Minor maintenance required	60-79%
3	**Moderate Condition** Major maintenance required to meet LOS requirements	40-59%
4	**Poor Condition** Major upgrade/renewal required on 20-40% of asset	20-39%
5	**Very Poor Condition** More than 50% of the asset requires replacement	0-19%

2.2 Sanitary System

The general condition of the sanitary network for the communities of Montague and Georgetown are shown in Figure 2.1 and Figure 2.2, respectfully. The condition rating for the piping was prorated based on km of pipe. Maps showing the age and the location of the field assessments is included in Appendix A.

It should be noted that assets with an unknown installation year were assumed to be installed in 1971 in Montague and 1965 in Georgetown. Without a known installation year, it was assumed that the asset was installed when the system was first being constructed to predict a worst-case scenario. Assets of unknown material type were assigned a design life of 30 years per Table 2.1 and have been shown separately on the below graphics regardless of their installation year. This is because without a known material it is difficult to classify the condition of the asset and when future replacement may be warranted. It is suggested that further investigation be conducted to confirm the material types in order to predict the asset conditions more accurately.

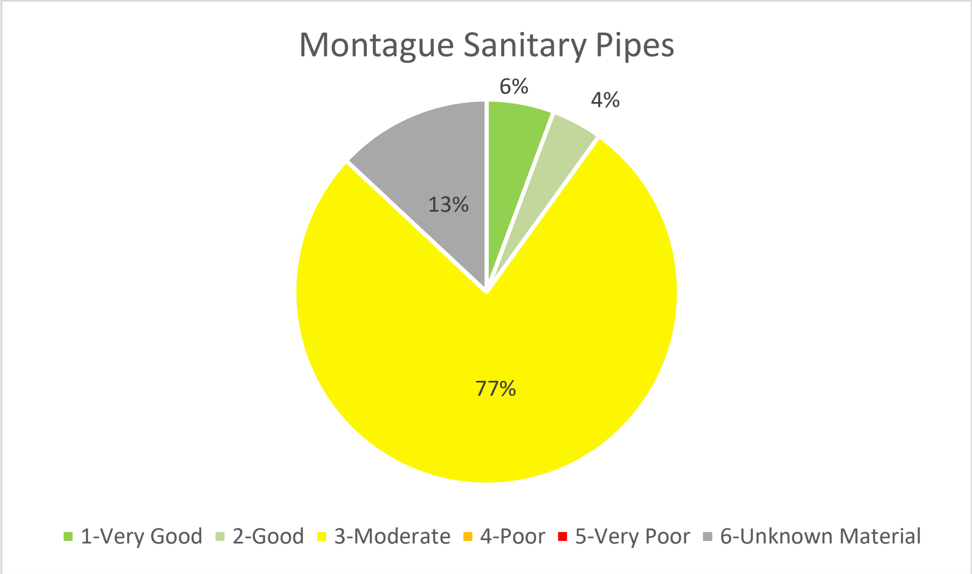


Figure 2.1: Condition Assessment of the Sanitary Pipes in Montague

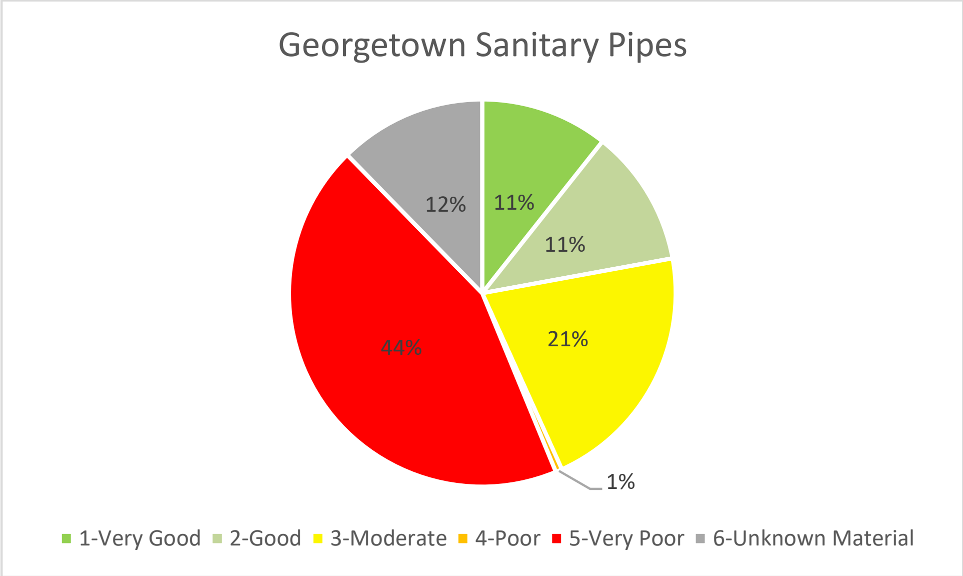


Figure 2.2: Condition Assessment of the Sanitary Pipes in Georgetown

2.3 Water System

The general condition of the water system linear infrastructure for the communities of Montague and Georgetown are shown in Figure 2.3 and Figure 2.4, respectfully. The condition rating for the piping was prorated based on length of pipe. Maps showing the age of the water system piping is shown in Appendix A.

For the Montague water system, assets with an unknown installation year were assumed to be installed in 1996.Two small independent water systems existed prior to 1996, however the majority of the water distribution piping began installation in 1996. Any assets for the

Georgetown water system with an unknown installation year were assumed to be installed in 1965 when community's water system installation began. Much of the Georgetown system that was installed in 1965 is steel pipe, as noted in the above table steel has an assumed design life of 50 years causing most of the Georgetown water system to appear to be in very poor condition. The below pie charts are based on the information received and what is known about the age and materials in both systems.

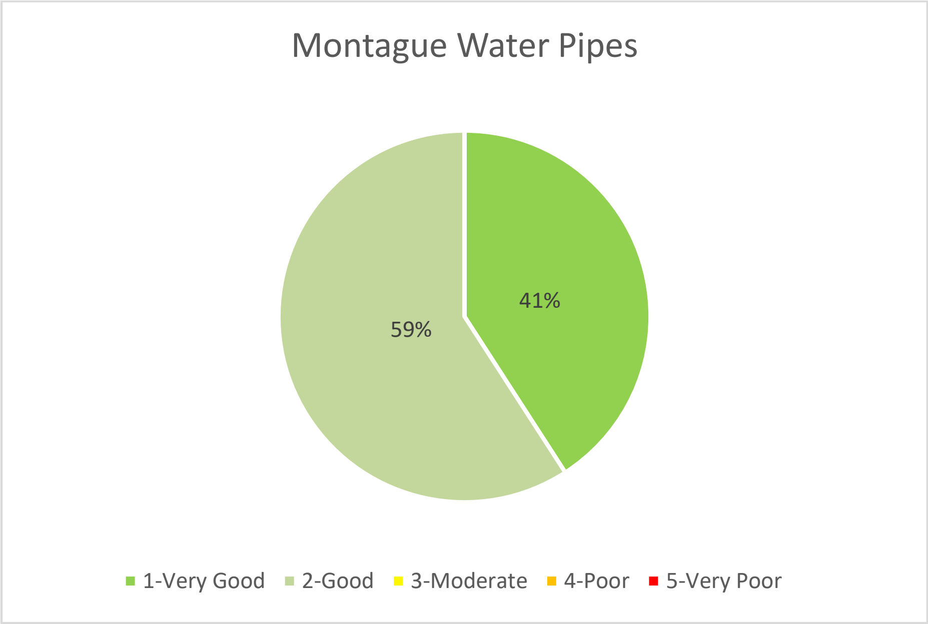


Figure 2.3: Condition Assessment of the Water Pipes in Montague

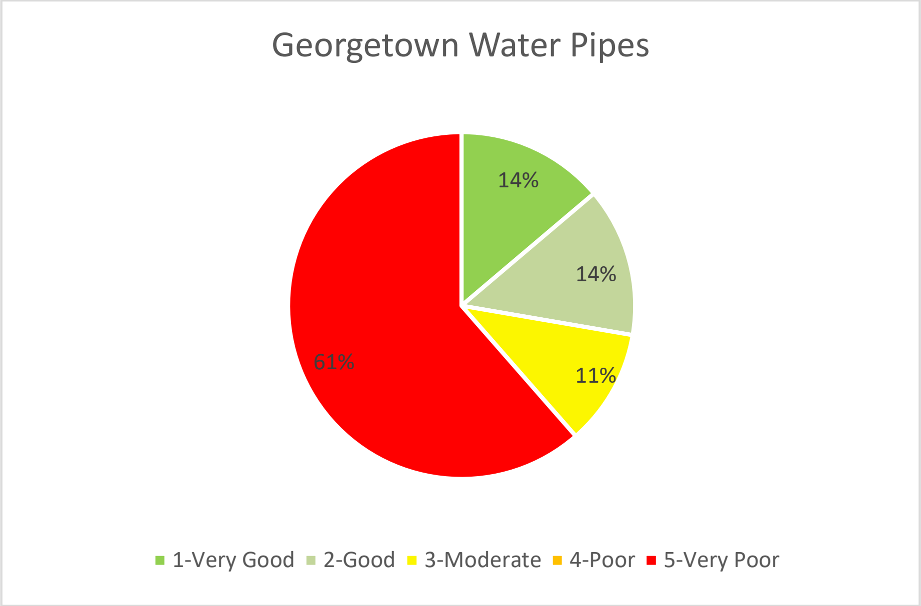


Figure 2.4: Condition Assessment of the Water Pipes in Georgetown

2.4 Community of Cardigan

The former Village of Cardigan does not currently have a municipal water or sanitary system servicing the 269 residents (2016 Statistics Canada Census Profile). Instead, residents rely on individual wells and on-site septic systems. A previous study completed in October 2018, identified potential saltwater intrusion issues along the north side of the Cardigan River.

At the request of the Town of Three Rivers, a high level desktop review of the Community of Cardigan was completed, and a servicing concept was developed. The intent of the servicing concept is to provide a high level option for a potential municipal water and wastewater system for the community. Further analysis should be completed prior to implementing any water distribution or wastewater collection system for the Community.

Due to the relatively low number of residents of the community, the construction and operation of a large water and wastewater system containing water storage, providing fire flow, and mechanical wastewater treatment is not feasible. Instead a domestic use only water distribution system utilizing a common wellfield site in conjunction with a small diameter gravity effluent collection system discharging to a common disposal field could be a more realistic option. The results of the servicing concept exercise are summarized on Map A5 in Appendix A.

2.4.1 Potential Sanitary System

The central core area of Cardigan was the primary focus for a municipal sanitary system. In order to develop a wastewater collection system concept, the following assumptions were made:

- Aerial imagery was used to establish that the service area contains approximately 57 homes and businesses.
- Using the 2016 census average household size of 2.2 people per dwelling, an approximate serviced population of 125 was established.
- Using the ACWGM average daily per capita flow of 340L, an approximate wastewater generation of 42500L (42.5m^3) was assumed.
- LIDAR ground elevation data from the year 2020 was used to develop sanitary catchment areas.
- A suitable common disposal site was chosen based on vacant land and soil type suitable for wastewater disposal as identified by PEI Land Online.

Based on the assumptions outlined above, and a desktop review of the Community, a sanitary collection system could include the following:

- A 150mm diameter gravity collection system on the north side of the Cardigan River discharging to a sanitary lift station at the intersection of Water Street and Wharf Road and subsequently pumped to a common disposal field located to the north along the Chapel Road.

- A 150mm diameter gravity collection system on the south side of the Cardigan River discharging to a sanitary lift station at the Cardigan Marina and subsequently pumped across the bridge to the first lift station.

The existing topography around the community is challenging for a gravity collection system due to various ridges along the Cardigan River. Individual residential pumps would be required for two residences north of Pleasant Street and would be required along Owen's Wharf Road.

Some common wastewater disposal systems are listed below and have been proven effective at treating residential sewage and are easily implemented in small communities like Cardigan.

- Mechanical package treatment plants.
- Septic tank and septic effluent disposal systems.
- Recirculating textile filter systems.

The most common type of mechanical package plant currently in use in the Maritimes is the Sequencing Batch Reactor (SBR). SBR treatment plants are typically constructed of steel or concrete tanks to treat flows greater than 100m^3/day and require mechanical equipment such as blowers, actuated valves, and disinfection. This type of treatment plan is designed to treat raw wastewater and therefore would require the abandonment of the existing septic tanks and the construction of a 200mm diameter collection system. Maintenance and operations costs are high for SBR plants when compared to septic tank and effluent disposal systems and recirculating textile filter systems.

Septic tank and septic effluent disposal systems utilize a small diameter sewer collection system and discharges the septic effluent into a recirculation tank followed by a dosing tank and subsequently pumped to a communal contour or sloping sand filter raised dispersal system. This type of system requires less operation and maintenance than an SBR and could be well suited for the Community of Cardigan.

Recirculating textile filter systems (RTF) are packed bed biological filtration units. These systems use naturally occurring microorganisms attached to a rack of filter cloth to biodegrade the contaminants in septic tank effluent. These systems are modular and are easily expanded to accommodate increased growth in the community. Furthermore, these systems have relatively low operating and maintenance requirements when compared to mechanical package plants.

Based on local knowledge of the Community, experience, and a desktop needs assessment, it is recommended that a hybrid system be explored for the Community. This system would contain a small diameter gravity collection sewer that collects the septic tank effluent and discharges to a RTF treatment system containing a reduced size disposal field. This type of system has proven successful elsewhere on PEI, however further assessment of the existing soils, available land and effluent strength would need to be completed prior to the implementation of any community sanitary system.

2.4.2 Potential Water System

Focusing primarily on the central core of the community for the development of a conceptual water distribution system, the following assumptions were made:

- Expected population services 125 people.
- Using the ACWWA average daily per capita consumption rates of 350L, the ADD was determined to be 43,750L/day.
- MDD and peak hour factors of 4.9 and 7.4 respectively were used based on the ACWWA Water System Guidelines.
- Peak hour consumption was used to determine number of wells/production capacity based on a peak flow rate of 227L/min (60USGPM).
- Wellfield location is based off a study completed by a previous consultant.

Based on the assumptions outlined above, the domestic water distribution system could include the following:

- Pipes ranging from 19mm – 100mm (3/4” – 4”).
- Pressures ranging from 45 – 80psi.
- Two (2) common wells each rated for 150L/min (60 USGPM).
- Hydro-pneumatic pressure tanks housed in a small control building with chemical disinfection, instrumentation, and controls.

The ground elevations throughout the system generally range from 0m to 23.5m. The elevation at the previously recommended wellfield site is approximately 22m. Pressures inside the control building at the pressure tanks would need to be set at approximately 50 psi, this allows for pressures within the system to range from approximately 45psi at the highest points serviced to 80 psi at the low-lying areas. The expected pressures for the study area align with the recommendations laid out in the ACWWA Guidelines.

Elevations along the south side of Station Road, beyond the pipe network shown on the servicing concept located in Appendix A, are generally higher than what can be serviced while still providing a 40psi residual pressure. If the initial network were constructed, extending services to this area in the future could be challenging and should be considered in the preliminary design stage.

3 Sanitary Sewer Master Plan

3.1 Summary of Available Information

In the early stages of the project, data requests were made to the Town for all available information on the existing sanitary sewer system for Montague and Georgetown. This included the following:

- "As-built" drawings of the collection system and any modifications made to components following the initial construction.
- Digital files of sewer system database.
- Any available GIS data related to the wastewater collection system, catchment areas, populations, meter data, etc.
- Previously completed reports and other documents related to the existing systems.
- Historical flow and performance data collected within the drainage basins.
- Land Use mapping, aerial photographs, and Lidar Ground Elevation Data.
- Influent and effluent samples for the respective treatment facilities.

3.2 System Components

The following table summarizes the various components of the existing sanitary systems for the communities of Montague and Georgetown:

Table 3.1: Existing Sanitary System Components

System Component	Community of Montague	Community of Georgetown
Length of Gravity Sanitary Main	20.70km	9.87km
Length of Sanitary Forcemain	0.76km	0.52km
Number of Sanitary Lift Stations	5	1
Type of Treatment Facility	Extended aeration activated sludge plant.	Partially mixed two cell facultative lagoon with UV disinfection.

3.3 Existing Conditions

After receiving all available data, an existing conditions GIS network of the existing sanitary collection system was established. Unfortunately, there were many gaps in the Town's available GIS data, such as missing pipes, manholes, pipe invert elevations, pipe sizes and pipe materials. Record drawings where available were used to fill in as many gaps as possible, in conjunction with internal direct local knowledge of the sanitary systems. However, many assumptions still needed to be made to complete the existing conditions network.

A summary of the assumptions are as follows:

- Missing inverts were estimated by offsetting from the Lidar Ground Data down typical sanitary sewer depth of 2.5m.
- Matching upstream and downstream pipe sizes where pipes sizes were missing.
- Matching upstream and downstream pipe material where pipe material information was missing.
- Pipe roughness coefficients were assumed where pipe materials were unknown. A standard pipe roughness coefficient of 0.013 was used where no pipe roughness coefficient was known.

In many cases after the initial 2.5m offset from the Lidar Data, multiple inverts needed to be edited to ensure the assumed inverts did not obstruct flow (i.e., did not back grade the piping). All vertical data used in the plan was CGVD1928 datum.

Available lift station data such as start/stop elevation settings, pump curves and force main information were input into the existing conditions data from record drawings and design briefs. Field measurements were taken at the APM lift station due to missing record information.

Any estimated values have been flagged with a unique attribute in the existing conditions GIS as being estimated, so once better data is available, the estimated values can be updated in the future.

3.4 Model Development

PCSWMM modelling software was used to create a hydraulic model of the existing sanitary systems for Montague and Georgetown. The following sections outline the methodology used to develop the sanitary models.

3.4.1 Pipes and Structures

Further QA/QC was performed on the piping network and system to confirm all pipes and structures had the attributes that could be imported into the hydraulic modelling software. This included pipe sizes, pipe material, invert data at pipe ends and at structures.

3.4.2 Sewersheds

Existing sewershed data was not provided, therefore existing sanitary sewersheds were delineated to the lift stations. This was completed using LIDAR elevation data, aerial imagery, and property line information to establish existing development limits that contribute sanitary flow to the system.

3.4.3 Sanitary Flows

Daily flow readings at the Montague treatment plant, weekly flow readings at the Georgetown Lagoon and monthly pump runtimes for the lift stations was provided by the Town for the period of April 2021 to February 2022.

Sanitary loads were developed for the model using design flows based on the Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment, and Disposal of Sanitary Sewerage (ACWGM).

The following sections outline the flows that were used and the methodology of how they were distributed and calibrated throughout the sanitary sewer system model.

Average Direct Inflow

Generally, the Province's free online civic address point layer was utilized to assign flow rates to each of the developed parcels that are connected to Montague's and Georgetown's sanitary system.

Below describes the steps that were taken for the Montague's sanitary system:

- By default, each address was assumed to be a single-family dwelling. It was assumed that each dwelling housed 2.0 people based on the average household size for Montague from the 2016 census. A sanitary flow of 340 L/person/day was then used to calculate the flow generated by each household in accordance with the ACWGM.
- Multi unit residential buildings were identified by using Bing Maps ortho imagery and were adjusted to account for a reasonably estimated number of units.
- Schools in the community were assigned a flow of 90 L/student/day based on ACWGM. Student populations for each school were taken from 2020-2021 school year enrolment data published by the PEI Department of Education and Lifelong Learning.
- Hospitals and nursing homes were assigned flows of 950 and 450 L/bed/day respectively based on ACWGM. Hospital capacity data was gathered from the Health PEI website.
- Commercial and industrial addresses were assumed to contribute sanitary flow based on an equivalent population and an average flow of 340L/person/day. An equivalent population of 85 people per hectare of commercial area was using based on ACWGM.

The same steps were taken for Georgetown's average direct sanitary inflow, except that each single-family dwelling was assumed to house 2.4 people based on the average household size for Georgetown from the 2016 census.

Using the modelling software tools, the flows from each of the civic address points were distributed to the nearest sanitary sewer structure within the model. Using this tool provided a realistic flow distribution throughout the system.

Dry Weather Flow Pattern

Since the only available data was at daily intervals, daily flow patters were not able to be generated. Instead, a theoretical daily flow pattern was generated using a peaking factor of 3.6 to establish peak daily flows. Due to this simplification, the capacity results in the model may not fully represent the actual peak flows experienced in the system, however it will provide a reasonable estimation of the peak flows.

Inflow and Infiltration (I&I)

Inflow and infiltration was estimated using the pipe method in accordance with ACWGM. Due to the existing low density developed areas within both the communities of Montague and Georgetown, the pipe method from the ACWGM was used to estimate inflow and infiltration. An allowance of $0.48m^3$/cm of pipe diameter/km of pipe/day was used and spatially weighted though all the manholes in the system as a baseline input. Additional inflow and infiltration was added at each identified sag manhole with an allowance of 0.4 L/s in accordance with ACWGM.

Typically, to accurately quantify the actual inflow and infiltration in the system, a flow monitoring program would take place in sewers upstream of the lift stations to determine dry weather and wet weather inflow rates in the system. The flow meters ideally are installed upstream of any overflows in the system so that the true wet weather flows are recorded. This allows for the estimated quantity of wet weather flows to be determined and calibrated within the system model.

Model Calibration

Numerous model runs were completed, for both wet weather and dry weather events to calibrate the model to the daily flows provided by the Town. The following tables compare the modelled daily flows to the measured daily flows from the Montague treatment plant, Georgetown lagoon and major lift stations. It should be noted that further calibration of the flume at the Georgetown lagoon was completed June 28th, 2022, therefore the measured flow at the lagoon could potentially be higher than the data used below. It is recommended that the sanitary model be re-visited after such a time that flow data for both wet weather and dry weather periods has been collected following the calibration of the flume.

Table 3.2: Average Dry Day Sanitary System Flow Comparisons

Average Dry Day			
Flow Location	**Measured Flow (m^3)**	**Modelled Flow (m^3)**	**Difference**
Montague WWTP	1023	1130	10%
Montague Bridge Lift Station	676	764	13%
Georgetown Lagoon	135	179	33%
Georgetown West Street Lift Station	101	106	5%

Table 3.3: Wet Weather Sanitary System Flow Comparisons

Wet Weather Flow			
Flow Location	**Measured Flow (m^3)**	**Modelled Flow (m^3)**	**Difference**
Montague WWTP	1468	1740	18%
Montague Bridge Lift Station	1140	1180	4%
Georgetown Lagoon	365	413	13%
Georgetown West Street Lift Station	274	283	3%

The above results indicate that the hydraulic model of the sanitary system is giving a relatively accurate representation of the peak flows in the system under existing average dry weather flow conditions. Furthermore, the above results indicate that the theoretical I&I assigned in the model would be in line with what would have been experienced during the period of April 2021 to February 2022 inclusive.

3.5 Wastewater Treatment

The Town of Three Rivers has two (2) main wastewater treatment facilities, one for the community of Georgetown and one for the community of Montague.

3.5.1 Montague WWTP

The Montague wastewater treatment plant (WWTP) is an extended aeration activated sludge plant providing treatment of sanitary sewage for the community of Montague. CBCL Limited has been involved in several upgrades to the Montague WWTP and has a thorough understanding of its design parameters. The evolution of the Montague WWTP is as follows:

- 1971 – Extended air activated sludge package plant constructed.
- 1991 – Aerated sludge holding tank constructed.
- 2002 – Addition of a new concrete secondary clarifier, addition of a new control building, conversion of existing clarifier into an aerated digester, increased blower capacity, conversion from chlorine to ultraviolet disinfection and the addition of a back-up generator.

- 2007 – Second inlet added with a bar rack for North Side pumped flows.
- 2016 – Geotextile tube sludge dewatering facility constructed.
- 2021 – New sludge storage tankage constructed, extended air reactor converted from course air aeration to fine bubble aeration and new plant PLC and SCADA control added

The current design parameters for the Montague WWTP are summarized in Table 3.4 below.

Table 3.4: Montague WWTP design parameters

Design Parameter	Value
Population Served (2021 Census)	1,896
ADF (m^3/d) Flowmeter (6 month average)	1,023
ADF (m^3/d) Hydraulic design capacity	1,514
PHF (m^3/d) Hydraulic design capacity	3,028
Influent BOD (at average flow) (mg/L)	200
Influent TSS (at average flow) (mg/L)	220
Influent BOD (at peak hourly flow) (mg/L)	150
Influent TSS (at peak hourly flow) (mg/L)	150
BOD Loading Rate (at average flow) (kg/d)	303
BOD Loading Rate (at peak hourly flow) (kg/d)	454
TSS Loading Rate (at average flow) (kg/d)	333
TSS Loading Rate (at peak hourly flow) (kg/d)	454
Effluent Requirements	
cBOD (mg/L)	25
TSS (mg/L)	25
Faecal Coliforms (MPN/100ml)	200

The Montague WWTP currently meets its effluent requirement with 2021 test results reporting no exceedances. The average sampled cBOD was less than 10 mg/L, average sampled TSS was 9 mg/L and the average sampled faecal was 23 MPN/100ml.

Recently, The Town collected a couple of influent grab samples at the Montague WWTP on October 20, 2021, and March 30, 2022. Both samples have a higher recorded TSS than what would be considered typical for municipal sewage and the march sample has a higher BOD result than what would be considered normal. Table 3.5 below summarizes the grab sample test results.

Table 3.5: Montague WWTP Influent Loading

Parameter	October 20, 2021, Value	March 30, 2021, Value
BOD (mg/L)	180	330
TSS (mg/L)	352	482
BOD Loading (kg/d)	184	338
TSS Loading (kg/d)	360	493

The potential impacts of these high influent loading rates on the wastewater treatment facility are they consume available treatment capacity therefore reducing the biological daily flow capacity that can be treated by the facility. In particular, the March 30th BOD and TSS loadings of 338 kg/d and 493 kg/d are both noticeably above the design daily treatment loading rates of 303 kg/d and 333 kg/d as set by the IRAC regulations. In addition the March BOD influent results exceed the PEI Municipal Sewerage Utility general rules and regulations prohibited sewage limit of 300 mg/l. Another impact on treatment facility performance is that the volume of sludge being retained for treatment and disposal increases, thus reducing the available capacity of the recently upgraded sludge handling system. Additional monitoring should be conducted to determine if these high strength samples are an anomaly or are consistent. If the strength is consistently high, then the options for treatment are to have the loads reduced at the source (it is suspected that the fish plant and breweries are a root source of the strength) or increase the facility's ability to treat the increased load on a normal basis. These high loads essential remove any extra treatment capacity available at the existing treatment facility.

3.5.2 Georgetown Lagoon

The Georgetown wastewater treatment plant (WWTP) is a partially mixed two (2) cell facultative lagoon with UV disinfection providing treatment of sanitary sewage for the community of Georgetown. Over the years this lagoon has had several upgrades improving the effectiveness of the hydraulic retention time. The latest treatment upgrade, two (2) Solar-Bee mixers, were assumed to have been installed in response to a treatment concern. While we do not have a complete picture of the effluent quality, the limited results indicate it is meeting the treatment objective.

- 1973 – Single cell facultative lagoon with centre inlet constructed.
- 1995 – Lagoon cleaned, and inlet pipe shortened by 60 metres.
- 1997 – Edge vegetation/bullrushes removed and top of berm regraded.
- 2006 – Shoreline protection added.
- 2010 – Floating baffle curtain (wall) added, new effluent manhole installed, and a new ultraviolet disinfection facility constructed.
- 2018 – Two (2) SolarBee mixers added, one in each cell (each side of curtain).
- 2020 – Effluent flow measurement added.

Historical design information for the Georgetown Lagoon was not available, however the following observations and design parameters have been concluded.

Table 3.6: Georgetown Lagoon Design Parameters

Design Parameter	Value
Population Served (2016 Census)	555
Per-Capita Flow Rate (L/p/d)	340
ADF (m^3/d) – Calculated on Per-Capita Flow Rate	189
ADF (m^3/d) – Flowmeter (6 month average)[1]	135
Influent BOD (at average flow) (mg/L)	190
Influent TSS (at average flow) (mg/L)	200
Lagoon Operating Depth (m)	1.2
Lagoon Surface Area (m^2)	22,000
Lagoon Volume (m^3)	24,000
Hydraulic Retention Time (days) – Calculated	127
Hydraulic Retention Time (days) – Flow meter	178
Organic Loading Rate (kg/ha/d) – Calculated	18.0
Organic Loading Rate (kg/ha/d) – Flowmeter	11.7
Organic Loading Rate (kg/ha/d) – Typical	11-22
Effluent Requirements	
BOD (mg/L)	25
TSS (mg/L)	25
Faecal Coliforms (MPN/100ml)	200

[1]Further calibration of the flowmeter at the Lagoon was completed June 28, 2022. Measured flow results following the calibration may vary from previous collected data

The Georgetown Lagoon currently meets its effluent requirements with 2021 test results reporting no exceedances. The average sampled cBOD was 14 mg/L, average sampled TSS was 13 mg/L and the average sampled faecal was 4 MPN/100ml.

Recently, The Town collected a grab sample from the influent flow at the Lagoon on March 30, 2022, which showed lower normal TSS and BOD results. The results of the influent grab samples are summarized in Table 3.7 below.

Table 3.7: Georgetown Lagoon Influent Loading

Parameter	March 30, 2021 Values
BOD (mg/L)	78
TSS (mg/L)	47
BOD Loading (kg/d)	15
TSS Loading (kg/d)	9

The loadings and flows at the Georgetown Lagoon are low from what would be considered expected results. Facultative lagoons operate based on hydraulic retention time to treat the wastewater flows, and when flows increase the hydraulic retention time decreases. Typical cold climate facultative lagoons operate with 180 days of hydraulic retention. Bases on the flow meter recorded results, then the lagoons hydraulic retention appears suitable for the current flows.

3.6 Existing System Constraints

After a historical review, model development and model calibration the results were reviewed under existing conditions to highlight any potential constraints within the system. Due to the theoretical nature of the sanitary flows and assumptions made to create the sanitary system model, an 80% flow capacity was set as an acceptable level of service before considering the pipes to have a capacity limitation. This will be the screening limits used under the future growth scenario flows to flag areas that may need upgrades to convey the increased flows or at a minimum have further investigation completed to confirm available capacities prior to moving forward with any major upstream developments.

3.6.1 Community of Montague

After reviewing the model results for Montague, no significant capacity issues in the system were identified. The results are displayed in drawing B1 in Appendix B. At the worst location, the peak flow in the gravity system was found to utilize 56% of the available capacity which is within acceptable tolerances for peak flow conditions. Two areas were identified to be between 40%-60% full under peak flow conditions, these areas are displayed in Figures 3.1 and 3.2 below.

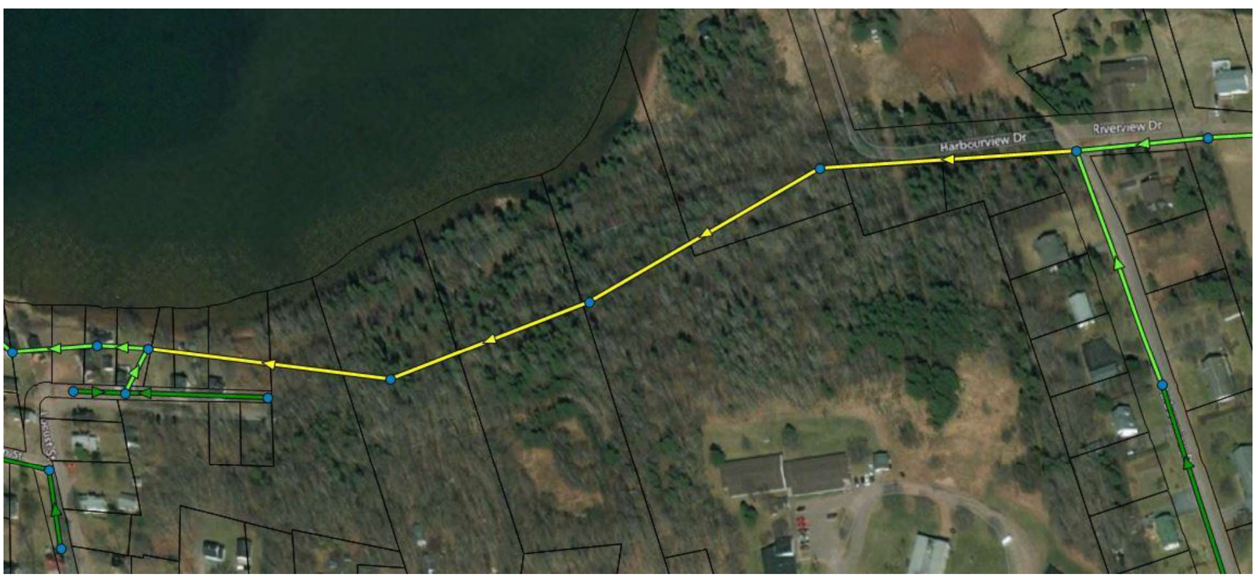


Figure 3.1: Existing 200mm Sanitary Trunk Sewer along the River to the Montague WWTP

Figure 3.2: Existing 250mm Sanitary Main along Riverside Drive

Additionally, the existing sanitary lift stations were analyzed under existing peak flow conditions. The results are displayed in Table 3.8 below.

Table 3.8: Montague Existing Sanitary Lift Station Capacity

Sanitary Lift Station	Estimated Design Capacity (L/s)	Estimated Existing Conditions Maximum Inflow (L/s)	Estimated Remaining Capacity (L/s)	Estimated Remaining Capacity
APM (Wightman Street)	6.3	0.5	5.8	92%
Sorrey Bridge	6.3	3.3	3.0	48%
Patrick Street	9.5	7.4	2.08	22%
Montague Bridge	44.4	38.5	5.86	13%
Montague WWTP	12.6	9.27	3.33	26%

Currently, the estimated maximum inflow at each lift station does not exceed the design capacity of the station. However, according to the model results, the peak inflow to Bridge lift station is nearing its design capacity. As the north side of Montague continues to grow, this lift station should be monitored for capacity issues.

3.6.2 Community of Georgetown

After reviewing the model results for Georgetown, no capacity issues in the system were identified. The result of this analysis is shown on drawing B2 in Appendix B. The peak capacity for the gravity system was found to be 38% full which is within acceptable tolerances for peak flow conditions. Additionally, no capacity issue was identified at the West Street lift station.

Table 3.9: Georgetown Existing Sanitary Lift Station Capacity

Sanitary Lift Station	Estimated Design Capacity (L/s)	Estimated Existing Conditions Maximum Inflow (L/s)	Estimated Remaining Capacity (L/s)	Estimated Remaining Capacity
West Street	16.0	6.54	9.46	59%

3.7 Analysis of Future System

3.7.1 Montague Servicing Extension Buildout

Before developing growth scenarios to analyze the impacts to the existing system, potential servicing extension areas were reviewed. These areas were established based on the following criteria and the results can be seen on drawing B3 in Appendix B.

- Areas that can be serviced by extending the limits of the existing system and flow by gravity.
- Areas that can be serviced by the construction of a single sanitary lift station.
- A high-level review of the full buildout of each potential lift station was completed.

A sanitary system is driven by existing topography and can be extended to the high points along existing ridges before a sanitary lift station is required to pump the wastewater uphill. Reviewing the results of the Montague Full Buildout Map, it can be seen that the gravity network on the south side of the Montague has been extended to its current topographic limits. Therefore, any development that were to occur outside the existing service boundary would require the installation of a sanitary lift station. Furthermore, the existing topography to the south contains various ridges resulting in small potential catchment areas. It can be concluded that from a cost perspective expansion of the existing service boundary on the south side should not be the preferred scenario.

Moving to the north side of the Montague River, expansion of the gravity network to the west is possible and could be a potential area for development. Specifically, in the Sorrey Bridge catchment area as the existing lift station contains capacity to receive additional flow from a gravity network expansion in this area. Development to the east, however, would result in small lift station catchment areas and would be less feasible than other areas that will flow by gravity to the existing system.

Finally, expansion of the existing system into the Brudenell area would be a more feasible option with the highest potential for cost effective growth. A portion of the lands could be serviced with extensions of the existing gravity network and with the addition of a single lift station at the approximate location of the existing Kings County Chrysler dealership, the area up to the MacDonald Road could be serviced. After discussion with the Town and local knowledge of the area, this would be the preferred area for an extension of the servicing boundary.

3.7.2 Montague Infill Development Growth Scenario

The first development scenario looked at infilling within the current servicing limits of Montague. This scenario was analyzed before any development occurs outside the existing servicing limits to determine the available system capacity to accommodate a servicing boundary extension. Eight (8) potential infill locations were identified by using aerial imagery, these locations are shown on drawing B4 located in Appendix B. Using the development densities noted in Table 1.2 above in conjunction with the draft official plan zoning map, this scenario results in an equivalent projected population growth of 1182 people. Assuming that all new development is limited to within the existing serviced areas and no servicing boundary extensions are considered, growth within the community could be accommodated for 48 yeas at a historical growth rate of 1% before any future servicing boundary expansions are required.

New flow rates were generated from these infill areas and assigned to the closest downstream sewer in the model. An average domestic wastewater generation flow rate of 340L/person/day was used for the increase in population, and an inflow and infiltration component was estimated using the area method with a flow rate of 0.14L/s/hectare as per the ACWGM.

Model results from the infill growth scenario show capacity issues at one location in the system, at the south trunk sewer to the WWTP. This section of gravity main is flowing 79% full under peak flow conditions. The following figure displays this section of sanitary system. Drawing B4 located in Appendix B shows the capacity results under this growth scenario.

Figure 3.3: Existing 200mm Sanitary Trunk Sewer along the River to the Montague WWTP Under Infill Growth Scenario Flows

The infill growth scenario flow results indicate that the bridge lift station and WWTP lift station would begin to show capacity issues under peak flow conditions. The following table estimates the existing design flow capacity compared to the modelled design flows under the infill growth scenario.

Table 3.10: Montague Infill Growth Scenario Sanitary Lift Station Capacity

Sanitary Lift Station	Estimated Design Capacity (L/s)	Estimated Infill Conditions Maximum Inflow (L/s)	Estimated Remaining Capacity (L/s)	Estimated Remaining Capacity
APM (Wightman Street)	6.3	0.5	5.8	92%
Sorrey Bridge	6.3	3.3	3.0	48%
Patrick Street	9.5	7.4	2.08	22%
Montague Bridge	44.4	47.8	-3.4	-8%
Montague WWTP	12.6	16.14	-3.54	-28%

3.7.3 Montague Infill Plus Extension to the MacDonald Road

Building on the infill growth scenario presented in the previous section, a second growth scenario looked at expanding the servicing boundary towards the MacDonald Road in Brudenell. In this scenario, the current serviced area of Montague was assumed to be fully developed and services were extended to include the existing developed lands up to the MacDonald Road along the AA MacDonald Highway. Using aerial imagery and equivalent population densities for commercial and mixed-use areas, this scenario resulted in an additional residential population growth of approximately 120 people and a total equivalent population growth of 882 people. At a 1% growth per year this equates to a 38-year time horizon. Therefore, if sanitary servicing were to be extended to the MacDonald

Road and the existing developed areas immediately contribute flow to the system, this would result in an estimated reduction of 38 years of growth capacity within the existing service boundary resulting in a remaining available infill growth capacity of 300 people.

New flow rates were generated from the existing developed areas in Brudenell and were assigned to the closest downstream sewer in the existing sanitary system. An average domestic wastewater generation flow rate of 340L/person/day was used for the increase in population, and an inflow and infiltration component was estimated using the area method with a flow rate of 0.14L/s/hectare as per the ACWGM.

Model results from the infill plus servicing extension to the MacDonald Road growth scenario shows the north truck sewer beginning to reach capacity along the low slope sections of gravity main. This section of gravity main would be flowing at 88% full under peak flow conditions. The following figure displays this section of sanitary system. Drawing B5 located in Appendix B and shows the capacity results under this growth scenario.

Figure 3.4: Main Street 200mm Sewer and Down East Crescent 250mm Sewer Showing Over 80% Full Under Infill Plus Extension to MacDonald Road Growth Scenario

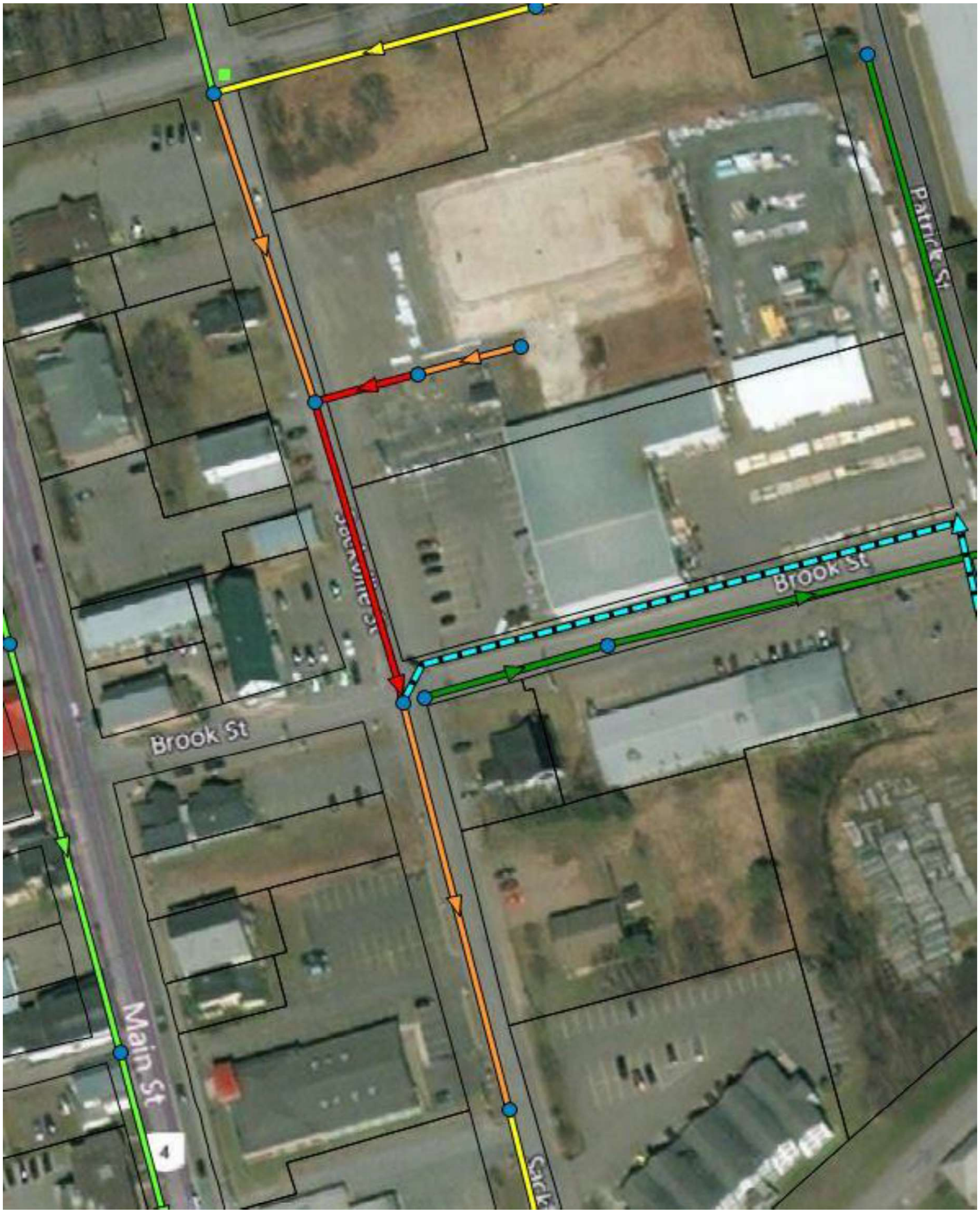


Figure 3.5: Existing 250mm Trunk Sewer on Sackville Street Showing Over 80% Full Under Infill Plus Extension to the MacDonald Road Growth Scenario

The infill plus extension to the MacDonald Road growth scenario flow results indicate that the bridge lift station will have capacity issues under peak flow conditions. The following table estimates the existing design flow capacity compared to the modelled design flows under the infill growth scenario.

Table 3.11: Montague Infill Plus Extension to the MacDonald Road Growth Scenario Sanitary Lift Station Capacity

Sanitary Lift Station	Estimated Design Capacity (L/s)	Estimated Infill Conditions Maximum Inflow (L/s)	Estimated Remaining Capacity (L/s)	Estimated Remaining Capacity
APM (Wightman Street)	6.3	0.5	5.8	92%
Sorrey Bridge	6.3	3.3	3.0	48%
Patrick Street	9.5	7.4	2.08	22%
Montague Bridge	44.4	63.74	-19.34	-44%
Montague WWTP	12.6	16.14	-3.54	-28%

3.7.4 Montague Future Treatment Review

Although the existing wastewater treatment plant contains additional hydraulic capacity, bases on the influent test results, the current facility does not contain any biological capacity to treat additional flows and is limited in redundancy with respect to secondary biological treatment. It should be noted that only a limited influent sample size is available, and that further sampling should be performed to verify the influent loading at the facility.

Based on the influent loading samples provided, continued upgrades will be required at the treatment facility as the community continues to grow. In the short term, potential upgrades could include the following:

- Fine screen facility to improve the efficiency and effectiveness of the removal of inorganic material from the raw sewage (i.e. wipes, plastics, rags and floatable).
- Increased secondary treatment capacity with the construction of an additional secondary clarifier.
- Increased aeration capacity and upgrades to the existing reactor. The existing reactor (steel package plant) is in good overall condition; however, it requires continuous monitoring and periodic repairs to increase its lifespan.

3.7.5 Georgetown Servicing Extension Buildout

A high-level review of the servicing limits for the Town of Georgetown was completed to identify potential locations for future growth outside the existing sanitary system limits. The approach used the same criteria that were used for Montague for determining suitable areas of expansion. The results of this review can be found on drawing B6 in Appendix B.

The topography to the north and east of the existing sanitary service boundary permits the existing system to be expanded without the installation of a new lift station. Additionally, a 56-hectare sanitary catchment area could be developed with the installation of a single lift station to the east of Grafton Street. Extension of the existing gravity network that flows directly to the lagoon would be the most economical approach to growth for the community.

3.7.6 Georgetown Business Park Development Growth Scenario

With the currently proposed business park development at the corner of Georgetown Road and East Royalty Road, the potential affects of this development were analyzed. This area is currently zoned as heavy industrial, however it is expected to undergo rezoning to become all or partially mixed-use. For the purposes for this study a light industrial demand of 35m^3/day/hectare was assumed as per ACWGM, this corresponds to slightly higher flows than those expected from areas of mixed-use zoning. Additional flow rates for this area were assigned to the closest existing receiving sewer in the model based on topography. This resulted in half of the proposed development area entering the West Street lift station catchment and half entering the lagoon gravity catchment.

The gravity system from the West Street lift station forcemain discharge location to the lagoon is displaying 70% capacity at peak flow under this scenario. This section of sanitary system should be reviewed during detailed design of the proposed business park for potential upgrades. The following figure highlights this section of main under this scenario.

Figure 3.6: Existing 250mm Sanitary Main Under the Business Park Development Scenario

Further analysis of the model results shows the West Street lift station performs sufficiently well under this development scenario. The current estimated design capacity of the lift station is 16.0L/s and the maximum peak inflow during modelling was 12.2L/s, resulting in 24% capacity remaining.

Overall, the existing sanitary system can accommodate the additional flows from the proposed business park development, however it reduces the remaining capacity of the system for future growth of the Community. The results of this analysis are shown on drawing B7 in Appendix B.

3.7.7 Georgetown Full Buildout Development Growth Scenario

The second development scenario for the Community of Georgetown looked at full buildout of the existing sanitary system with the addition of the proposed business park development. Using the development densities noted in Table 1.2 above in conjunction with the draft official plan zoning map, this scenario results in an equivalent projected population growth of 845 people. At a 1% growth per year this equates to a 93-year time horizon. Therefore, assuming no servicing boundary extension is constructed, and all development occurs within the current available service boundary, it is estimated that the current municipal boundary can accommodate a 1% annual growth for a 93-year time horizon before a service boundary extension would be required.

New flow rates were generated from these infill areas and assigned to the closest sewer in the model. An average domestic wastewater generation flow rate of 340L/person/day was used for the increase in population, and an inflow and infiltration component were estimated using the area method with a flow rate of 0.14L/s/hectare as per the ACWGM.

Model results from the buildout growth scenario show capacity issues in the gravity sewer network from the West Street lift station discharge point to the lagoon with surcharging of the system occurring at peak flow conditions. The maximum computed surcharge depth is approximately 0.375m above the obvert of the pipe. Additionally, the maximum modelled inflow to the West Street lift station is 15.2L/s resulting in only 5% capacity remaining under peak flow conditions. The full results from this analysis can be found on drawing B8 in Appendix B and the following figure highlights the capacity issue.

Figure 3.7: Existing Section of 250mm Sanitary Main Surcharging Under the Full Buildout Development Scenario

3.7.8 Georgetown Future Treatment Review

In order to provide substantive recommendations for wastewater treatment in Georgetown further investigation should take place. Flow meter calibration should be confirmed as the flows are lower than what would typically be expected. The low influent loads should be validated with increased influent sampling along with conducting composite sampling.

Following the completion of an influent sampling program, a study to review the need and projected timing of treatment upgrade options such as increased mixing, addition of aeration and blowers, or the replacement with a mechanical plant such as a sequencing batch reactor (SBR) should be conducted.

4 Water System Master Plan

4.1 Summary of Available Information

The water system information has been collected from multiple sources, including CBCL record information, information from government of PEI sources, operational and design information for ongoing upgrades provided by the Georgetown water system utility operator (EISI), and Data received from the Town which includes the following:

- Geographical Information System (GIS) data for the Town zoning:
  - Property Zoning layers.
- Montague Flow measurements (wellfield daily production data):
  - Totalizer meter readings, from April to September 2021.
  - Water Meter Reading – Commercial Customers 2019.
- Montague Pressure readings and Hydrant flow tests:
  - CBCL fire flow test December 10, 2008, at Wood Islands Road.
- Montague Booster pump running hours recorded daily from April to September 2021:
  - Received Well Pump make and size.
  - Received Booster Pump make and size.
  - Received Fire Pump make and size.
- Georgetown Water System Proposed Operating Parameters (as described by the Georgetown Water System Assessment).
- Georgetown Commercial Meter Readings.
- Georgetown Total Wellfield Quarterly Flows.

All vertical data used in the hydraulic model including pump hydraulic grade lines, tank operating levels, node elevations assigned are all based on the CGVD1928 datum.

4.2 System Components

The following table summarizes the various components of the existing water systems for the communities of Montague and Georgetown:

Table 4.1: Existing Water System Components

System Component	Community of Montague	Community of Georgetown[1]
Length of Watermain	21.5km	7.9km
Number of Active Wells	2	4
Extraction Permit Capacity[2]	360USGPM (~1950m^3/d)	725USGPM (~3950m^3/d)
Well Pumps	2@15HP – each 795L/min (210USGPM) @41.15m TDH	1@10hp, 3@15hp
Booster Pumps	2@20HP – each 984L/min (260USGPM) @76 psi	N/A
Storage	Reinforced Concrete Cistern	Hydro-Pneumatic Tanks
Storage Volume	454m^3 (120,000US Gal)	3@7.5m^3 (1,980US Gal)
Fire Pump	1@75HP	N/A
Fire Pump Rating	3785L/min @ 515 Kpa (1,000USGPM @75 psi)	N/A[3]

[1]The Georgetown water system is owned by Prince Edward Island and operated by Environmental Industrial Services Incorporated (a division of Island Waste Management Incorporated).
[2]Extraction permit capacity information has been obtained from third party sources, no extraction permits have been provided for review in the preparation of this report.
[3]Domestic water system only.

4.3 Existing Conditions

Montague's existing water system consists almost entirely of 100-200mm diameter PVC pipe. The system was not originally intended to be a fire rated system, sometime after its conception the decision was made to provide fire protection, as such the system includes some streets with 100mm watermains which are not capable of providing basic fire flows. The distribution system is generally well gridded with good redundancy except for the single 150mm watermain connecting the North and South portions of the system at the Main Street bridge. The system operates by the well pumps pumping groundwater into the underground reservoir and then the domestic booster pumps raising the hydraulic grade line (HGL) to an elevation of 83.5m - 88.5m for pump start and stop respectively. This HGL provides customers with pressures ranging from 70-125psi under static conditions.

Georgetown's existing water system consists of a mix of steel and PVC pipe, most watermains within the community were originally sized to accommodate large demands created by the shipyard and process type businesses along the waterfront. The original intent of the system was not to provide domestic water to residents of the community, however, over the years some residential customers have been connected to the water system. The distribution system generally consists of a large loop around the outside of the community core with very little infilling on existing streets.

4.4 Model Development

A hydraulic water model was created for both Montague and Georgetown's water systems using Bentley's WaterGEMS®software. Both models were created using available GIS data, information from record drawings provided by the Town of Three Rivers, previous water model information and design briefs provided by others. A Digital Terrain Model (DTM) was created using 50cm contour shapefiles obtained from the province, and elevations of water system nodes were assigned based on this DTM.

In both systems pump information was used to determine the targeted hydraulic grade lines and flow capabilities of the pumps. Montague's system is modelled with booster pumps and a fire pump which are turned on and off under different model scenarios to determine if the current operating parameters could meet the current and future MDD's as well as provide insight on the models predicted available fire flows. In Georgetown, the system has been modelled with a simulated reservoir with a top water level representing the target HGL (operating pressure) of the system. This was done to simplify the hydraulic model, since Georgetown's water system appears to have excess pumping capacity and all pumps are reported to run on variable frequency drives (VFD's) it is assumed that the four well pumps are able to satisfy the systems domestic demands and will provide water at the target HGL under all scenarios considered. This was done to predict the adequacy of flow and residual pressures throughout the water distribution system under the scenarios considered.

Most pipe size and material information is based on record information, the following assumptions were made where no record information existed.

- Pipe depth of bury is consistent throughout the system, elevations were assigned based on ground elevations observed in the DTM.
- Where pipe sizes are unknown the size was assumed to match upstream and/or downstream pipes.
- Where pipe materials are unknown the pipe material was assumed to match upstream and/or downstream pipes.
- Where no production or consumption data is available theoretical residential and commercial consumption rates were used.
- The distribution of flows assigned in the model was assumed to match the distribution of residential and commercial civic addresses within each sewer catchment area. This was done to coordinate the water and sanitary flows within the system.

Water meter data for 2019 was used to calculate the average day demand (ADD) and max day demand (MDD), the commercial meter data was then used to determine the distribution of demand as well as the allocation of commercial vs residential demands within the system.

4.4.1 Basis of Design

Under normal/daily conditions (e.g., not a fire or emergency), the service pressure in a water system should typically be between 276-552 KPa (40-80 psi) and not higher than 655 KPa (95 psi) during minimum demand periods. Georgetown's water system falls between these operating pressures partly because of relatively low changes in elevation within the community. Montague however experiences significant elevation changes as the ground slopes down to the Montague River which bisects the community. Montagues distribution piping is regularly under higher pressures than those recommended in the ACWWA Water Guidelines. However, the community bylaws require customers to have PRV's installed to protect household plumbing.

Furthermore, we have used the following criteria as the basis for design (based on the ACWWA Water Guidelines) is summarized as follows:

Maximum Velocity:	1.5 m/s (5 fps) 3.0 m/s (10 fps)	Under MDD Under fire scenario
Minimum Pressure:	276 kPa (40 psi) 152 kPa (20 psi)	Under MDD Under fire scenario
Maximum Pressure:	552 kPa (80 psi) 655 kPa (95 psi)	In the distribution system In the transmission system
Fire Flows:[1]	3785L/min (1000USGPM)	Available fire flows vary

[1]Montague's existing fire pump is rated for 3785L/min (1000USGPM) at 515 KPa (75 psi). Georgetown's system is not rated for fire flow.

4.4.2 Pipe Networks

The pipe networks within these two systems are a mix of PVC, ductile iron, and steel with a wide range of installation dates. C Factors have been assigned to the pipes in accordance with their age and material as follows.

Table 4.2: Assumed C Factors

Hazen Williams Pipe Roughness Coefficients		
Pipe Type	Age and Size	"C" Factor
Ductile Iron	≤ 10 years	120
	> 10 years	110
PVC	≤ 10 years	150
	> 10 years	130
Steel	All	100

For design purposes new piping has been assigned a C Factor of 120 to mimic future conditions when the roughness of the pipes increases.

4.4.3 Demands

In Montague daily flows were provided from each pumps' flow meter from April to September of 2021. Using this information, the average day demand (ADD) and max day demand (MDD) was determined. The flow meter information provided is summarized in Table 4.3.

Table 4.3: Montague Water Production Rates

2021	Total Production (m3)	ADD (m3/day)	MDD (m3/day)
April	19,507	673	1,035
May	21,067	702	971
June	22,523	751	1,015
July	23,638	763	1,210
August	27,170	876	1,201
September	23,654	845	1,352
April – September 2021		**764**	**1,352**

Using information from the provincial GIS database the number of residential civic addresses within Montague was determined, then an average density of 2.0people/household (2016 Statistics Canada Census Profile) was applied resulting in a theoretical population of 1452. This equated to an average theoretical residential demand of 508m^3/day. When comparing the theoretical domestic demand to the above wellfield production rate of 764m^3/day we are left with 256m^3/day unassigned. This was assigned as the community's commercial demands. The number of residential and commercial civic addresses located within each sewer sub-catchment were determined and their respective demands were assigned to the water system nodes based on the civic address density for each sewer sub-catchment. The same process was done to determine the MDD using the above production rate.

In Georgetown it was assumed that the wellfield production was equal to residential and commercial consumption. Commercial water meter data and total wellfield production data was available for 2019. An average daily residential usage rate of 350L/c. day was assumed to supplement the available commercial meter data. With this information the ratio of residential to commercial water usage was determined. This information was then used to assign demands across system nodes.

4.4.4 Wellfields and Source Water

Both communities' source their water from wellfields consisting of multiple wells equipped with submersible pumps and programmable logic controllers (PLC).

Montague's water system is supplied water from two (2) wells located in the northern portion of the community. Well #1 has a submersible 15hp Grundfos pump installed in

2019, well #2 has a submersible 15hp Grundfos pump installed in 2001. These pumps are each rated for 210USGPM @ 135' TDH. The maximum permitted extraction rate for these wells is a combined average 360USGPM (~1950m^3/d) from provincial data on high-capacity wells in PEI.

The Georgetown water system is supplied by four (4) wells located along the northern boundary of the community. These wells were upgraded in 2013, 2017, and 2021. Wells #1, #2, and #4 are equipped with 15HP pumps while well #3 has a 10HP pump. All four of these wells are equipped with variable frequency drives (VFDs) to modulate the pump speed in an attempt to match system demands and reduce short cycling of the pumps. The VFDs can slow the pumps to 50% of their normal operating speed. The maximum permitted extraction of these four wells is a combined 725USGPM (~3950m^3/d) based on previous water supply upgrade reports.

4.4.5 Storage

In Montague, the extracted groundwater is pumped into a 454m^3 (120,000US Gallon) underground reservoir that was constructed in 2000. The reinforced concrete reservoir measures 15m x 11m x 4m with 300mm thick walls and was originally sized to provide average domestic water and a fire flow of 850USGPM for a 60-minute duration. The use of domestic and fire booster pumps to provide water to the system allows for all stored water to be considered usable at any time to meet domestic or fire fighting demands. The table below outlines the operating points of the booster pumps based on reservoir levels.

Table 4.4: Booster Pump Operation

Year	Total	
	Elevation (m)	Reservoir Level (m)
High Water Level	27.97	3.35
Pump Off	27.81	3.20
Pump On	26.29	1.68
Low Level Alarm	26.14	1.52
Transducer Setting	24.61	0.00
Sump Floor	24.00	-0.61

Based on Montagues current population and consumption rate and using a standard formula for determining recommended reservoir storage we calculate the recommended storage for the Community of Montague to be 775m^3. This is approximately double the current volume stored within the community. Under MDD conditions the total volume of water in the reservoir is changed over every 8 hours. If a fire were to occur requiring 1000USGPM for a duration of 90 minutes (recommended duration for Montagues fire pump capabilities) under MDD conditions nearly the entire 454m^3 tank volume would be used within that 90-minute duration.

In Georgetown, the extracted well water is pumped to a main control building where it will be stored in three (3) 1,980US Gallon (7.5m^3) Hydro-pneumatic tanks that are expected to be installed by the end of 2022. The well pumps are called on as needed and the VFD's regulate pump speeds to target a setpoint of 50psi at the main control building.

4.4.6 Standby Power Generation

Montague's water station is equipped with a standby generator to provide emergency power to the station. The 250 kw Caterpillar diesel generator is located in the control building and is capable of powering the two submersible well pumps, fire pump, booster pumps, and the building's emergency lighting. The generator is programmed to turn on automatically if the station loses power, an automatic transfer switch (ATS) switches the control building over to emergency power allowing the system to continue to operate. This generator is fueled by a 500US Gallon fuel tank located outside the control building.

The Georgetown water system is currently undergoing upgrades which include the addition of standby emergency power generation for the main control building and for wells #1 and #4. These upgrades include the installation of three (3) diesel generators, a 30kw generator for the main control building, and 80kw generators at well#1 and well #4 control buildings. Each standby generator will be equipped with an ATS to ensure the system is able to continue to produce water in the even of a power failure.

4.5 Existing System Constraints

Inputting pipe size, age, materials, assigning ground elevations, and system parameters into the WaterGEMS®software created the existing conditions hydraulic models. The hydraulic model was run based on three (3) existing conditions scenarios for Montague's existing distribution system (ADD, MDD, and MDD + fire flow). A single existing conditions MDD scenario was considered for Georgetown's existing water distribution system. These scenarios were considered to obtain an understanding of any limitations within the existing systems prior to considering future growth.

4.5.1 Montague Existing System

The first scenario considered for Montague was the existing average day demand (ADD) scenario. This was run to ensure no areas within the servicing boundary experienced low or high pressures under normal daily operating conditions. The system performed well under this scenario, experiencing pressures ranging from 77 – 132psi (530-910kPa). Although the highest pressures observed are above the recommended maximum pressures within the distribution piping. This is an operational philosophy that the community implemented years ago to allow for higher pressures and fire flows on the south side of the system farthest from the source and booster pumps. The overall system demand under this scenario was 762m^3/day (140USGPM). This scenario did not see any noticeable drops in pressure due to restrictions within the system. Velocities within the system remained low indicating that there was adequate capacity within the pipes to provide the average daily demands.

The second scenario considered was the max day demand (MDD) scenario. The MDD was calculated using the daily production data provided by the Town and resulted in a total system MDD of 1350m^3/day (248USGPM). Under this scenario the system performed well with slight decreases in pressure due to the increased demands, pressure ranged from 61 – 115psi (420-793kPa) and the maximum velocity experienced was 0.48m/s. These pressures are still well above the expected typical lower limit of 40psi (275kPa) under normal conditions. The velocity was also well below the maximum acceptable velocity of 1.5m/s under maximum day demands.

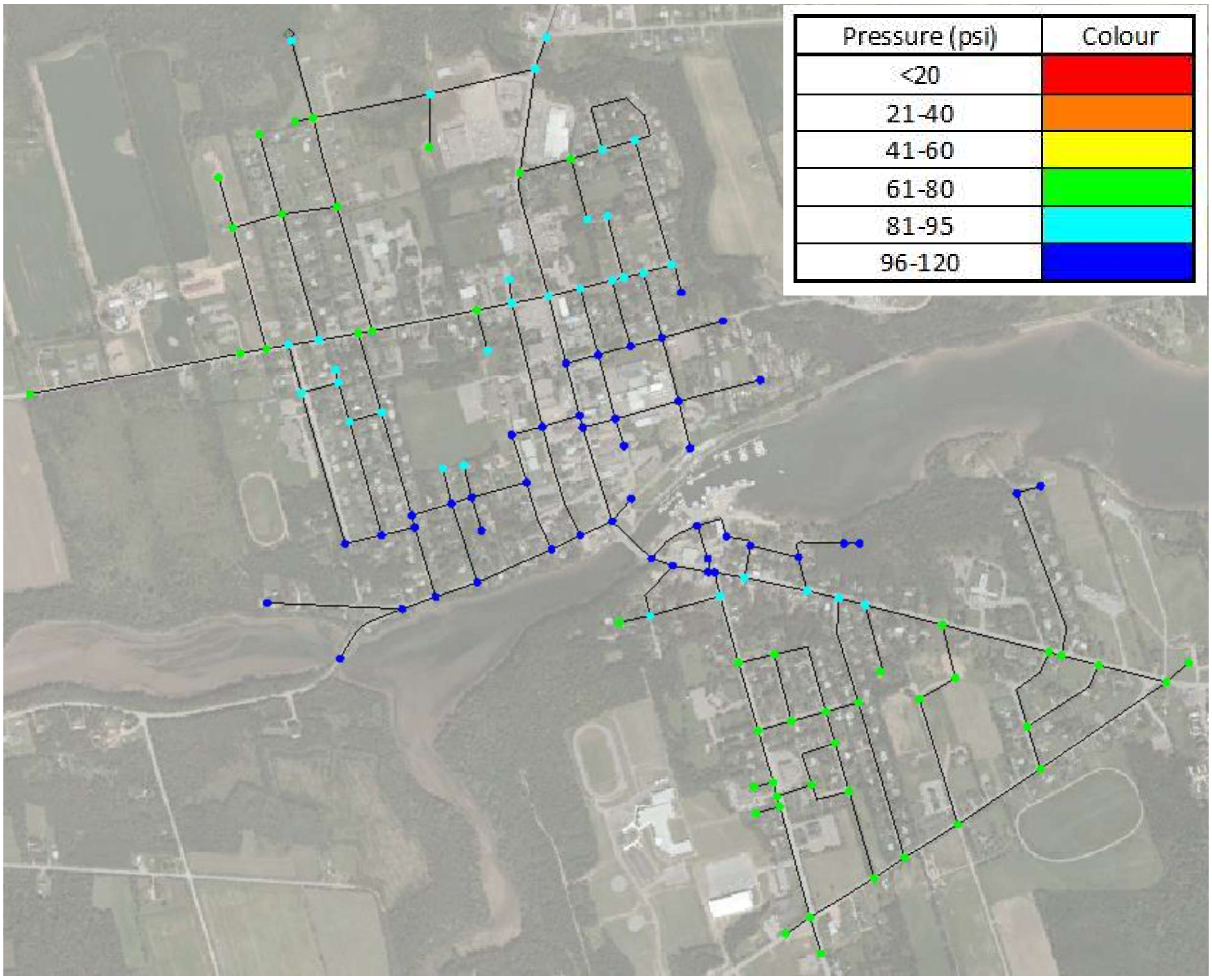


Figure 4.1: Montague Existing System Pressures (MDD)

The third scenario considered was how the system responded to fire flows. Since Montagues system has a fire pump the available fire flow at each node was predicted when modelling the MDD + fire flows. This was done under the following constraints:

- The residual pressure anywhere in the system did not drop below 20psi (138kPa).
- The residual pressure at the fire did not drop below 20psi (138kPa).
- The maximum velocity in any pipe in the system did not exceed 3.0m/s.

When running the model with the MDD + fire flows the constraint that stopped the simulation was the system residual pressure dropping below 20psi (138kPa). In nearly all cases the nodes experiencing the lowest residual pressure under fire flow simulations was located at the top of the hill on Wood Islands Road. These nodes have an approximate elevation of 39m.

The available fire flows within the system ranged from 1,446L/min (380USGPM) to 4,906L/min (1296USGPM). Under this scenario some locations experienced higher available fire flows than the rated capacity of the fire pump of 3875L/min (1000USGPM) this is in part due to excess capacity in the community's booster pumps contributing to fire flows. As the population and demands increase this available fire flows will decrease as some capacity from the domestic booster pumps is used up by a higher MDD. Figure 4.2 below shows the predicted available fire flows under the current MDD scenario. When viewing the fire flow results it is important to keep in mind that the predicted available fire flow for each node is for the general area. Because an area has a predicted fire flow of 2,000L/min that does not mean that each hydrant will be capable of delivering this flow simultaneously, rather it is the available fire flow for the entire area.

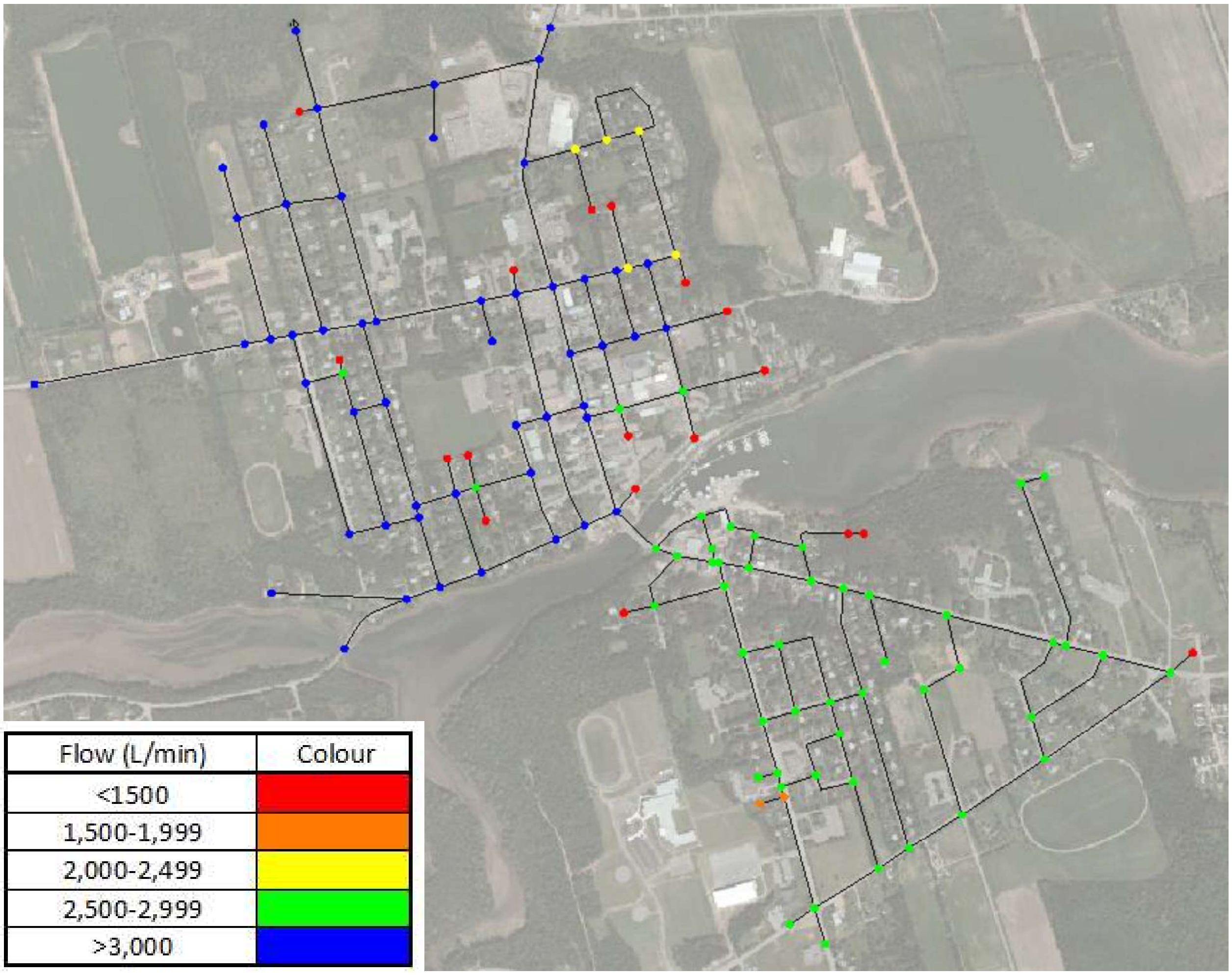


Figure 4.2: Montague Available Fire Flow Results (MDD)

4.5.2 Georgetown Existing Conditions

The first scenario considered for Georgetown was the existing max day demand (MDD) scenario. This was run to ensure no areas within the servicing boundary experienced low or high pressures under normal operating conditions. The system performed well under this scenario, experiencing pressures ranging from 49-75psi (338-517kPa). The overall system demand under this scenario was 1073m^3/day (197USGPM). This scenario did not see any noticeable drops in pressure due to restrictions within the system. Velocities within the system remained low indicating that there was adequate capacity within the pipes to distribute the maximum day demands. Figure 4.3 shows typical pressures experienced throughout the system.

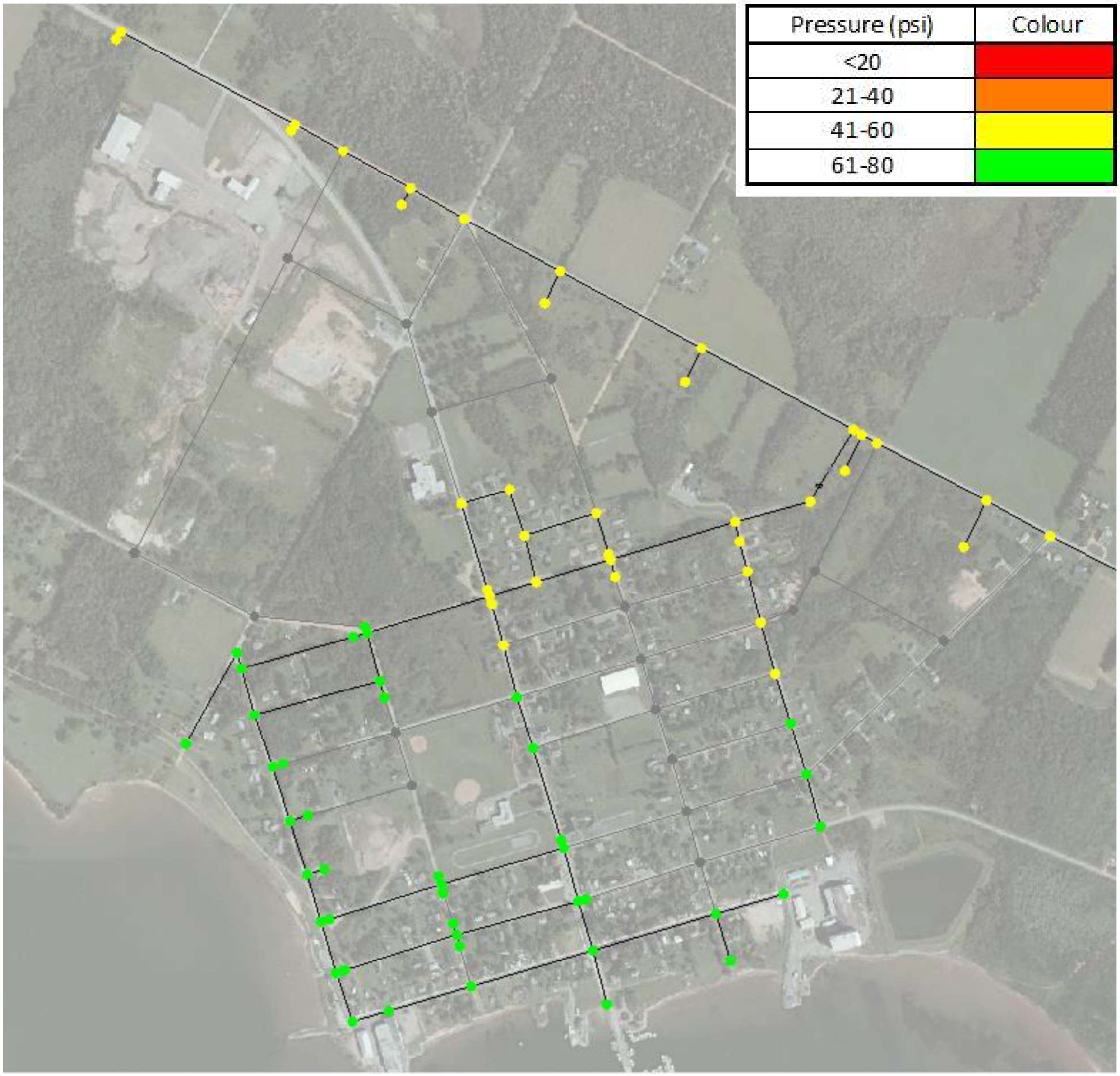


Figure 4.3: Georgetown Residual Pressure Results (MDD)

4.6 Analysis of Future System

4.6.1 Montague Servicing Limits

Prior to considering areas of potential future growth, a high-level assessment was completed to determine what area could be serviced by the water systems under their current operating parameters. The elevation was determined when the HGL would allow for a 40psi(275kPa) residual while ignoring future piping system losses. This elevation corresponds to the absolute highest elevations the water system could service without operational changes.

In Montague, the control building sits at an elevation of 23.75m (78ft) with operating pressures ranging from 85-92psi (586-634kPa) at the pumps. This corresponds to the lowest HGL produced at the control building of 83.5m (274ft). When considering the service area should typically not have a residual pressure of less than 40psi (275kPa) it was determined the maximum serviceable elevation, ignoring pipe losses, to be 55m (180ft). Without altering operating parameters, the Montague water system can not service elevations above 55m (180ft). The closest area that experiences ground elevations as high as 55m is more than 3km northwest of the current system limits (beyond the limits of the Macdonald Road). The areas considered in this study do not reach this elevation. Depending on system losses, topography and demand, the areas considered for this study should all be within the serviceable area under the systems current operating parameters. The below figure shows the unserviceable areas with elevations above the 55m contour.

Figure 4.4: Montague Water System Potential Servicing Area

4.6.2 Montague Infill Development Growth Scenario

The first development scenario looked at infilling within the current servicing limits of Montague. This is the same scenario as modeled in section 3.7.2 of the sewer analysis and shown in the Infill Growth Scenario on Drawing C2 in Appendix C. This results in an equivalent population increase of 1182 people and a time horizon of 48 years based on 1% annual growth before an expansion of the servicing boundary is required.

A new MDD was calculated for these infill areas and distributed evenly throughout each area based on the number of system nodes within each of the eight (8) infill areas. Demands within each infill area were assumed to be uniform as no data was available to indicate otherwise.

The MDD scenario was then modelled with the new demands created from infilling in addition to the existing max day demands previously modelled. This resulted in a total system demand of 2,154m^3/day (395USGPM). For this scenario the existing booster pumps were left unchanged as they have a combined capacity of 2,834m^3/day (520USGPM). No areas of low pressure were predicted in the model due to infilling. System pressures ranged from 57psi(393kPa) at the high point on Wood Island Road to 112psi(772kPa) at areas nearest to the Montague River.

The model was then used to predict available fire flows under the effects of infilling. The available fire flows were calculated throughout the existing system using the previously discussed pressure and velocity constraints. Similar to the original MDD + fire flow scenario the constraint that resulted in the model to stop the simulation was always the low system pressure constraint. In almost all cases the node at the top of the hill on Wood Islands Road dropping below 20psi was the constraining factor. The increased demands from infilling resulted in slightly lower available fire flows of 1,388L/min (366USGPM) to 4,347L/min (1148USGPM) Figure 4.5. shows the available fire flows predicted in this scenario.

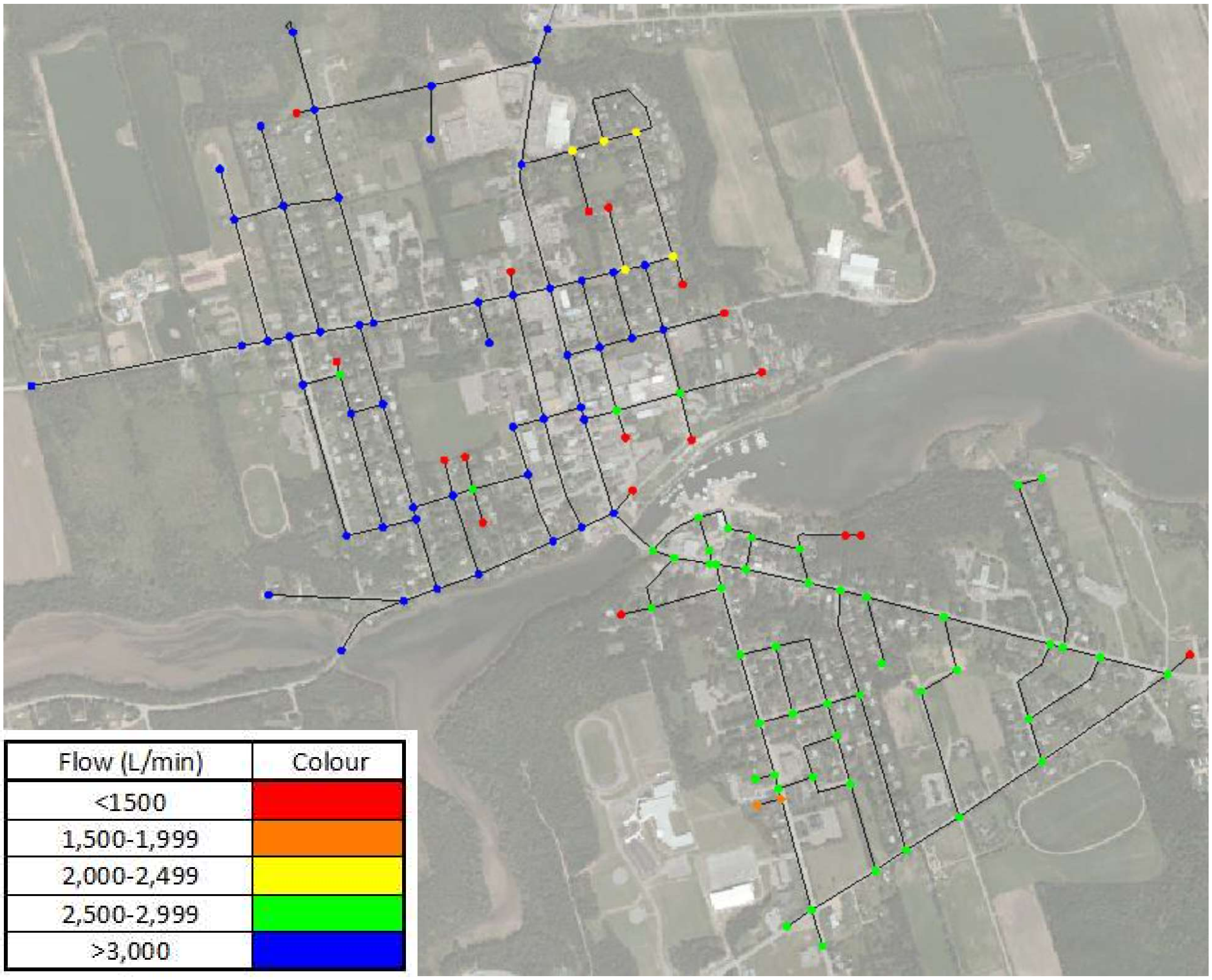


Figure 4.5: Montague Available Fire Flow Results (MDD + Infill)

4.6.3 Montague Infill Plus Extension to the MacDonald Road

Building on the infill growth scenario presented in the previous section and in section 3.7.3, a second growth scenario looked at expanding the servicing boundary towards the MacDonald Road in Brudenell. In this scenario, the current serviced area of Montague was assumed to be fully developed and services were extended to include the existing developed lands up to the MacDonald Road along the AA MacDonald Highway. Using aerial imagery and equivalent population densities for commercial and mixed-use areas, this scenario resulted in an additional residential population growth of approximately 120 people and a total equivalent population growth of 882 people. At a 1% growth per year this equates to a 38-year time horizon. Therefore, if sanitary servicing were to be extended to the MacDonald Road and the existing developed areas immediately contribute flow to the system, this would result in an estimated reduction of 38 years of growth capacity within the existing service boundary. This is based on typical usage and equivalent populations based on the zoning in the areas considered. The actual demands on the water system could vary significantly between the typical demands associated with the zoning type and the demands of existing businesses.

Based on the above we predict the existing water system will be able to achieve the immediate demands created by the AA MacDonald Highway extension without the need for pump or storage upgrades. Based on the current system configuration with domestic booster pumps it is the instantaneous demand that ultimately determines system capacity. One way to consider the instantaneous demands within a system is to look at peak hourly demands. A peak hour factor of 3.38 for systems servicing an equivalent population of 2000-3000 people (ACWWA Guidelines for the Supply, Treatment, Storage, Distribution, and Operation of Drinking Water Supply Systems) was used. This assumption was used in place of hourly consumption or production data which was not available. Using Montague's current ADD (2021) of 762m^3/day in combination with this peak hour factor we calculate a peak demand of 2,575m^3/day. If this extension were completed, it is recommended that additional flow metering be conducted to determine actual booster pump capacity and monitor water usage. This additional data will allow the community to more accurately gauge system capacity and better forecast future water supply and distribution upgrades.

4.6.4 Georgetown Servicing Limits

Prior to considering areas of potential future growth, a high-level assessment was completed to determine what area could be serviced by the water system under the current operating parameters. The elevation at which the existing HGL would allow for a 40psi (275kPa) residual pressure was used. This elevation corresponds to the absolute highest elevations the community could service with the existing system operating parameters.

In Georgetown, the control building has an approximate elevation of 19.5m (64ft) and has a typical operating pressure of 50psi (345kPa). This corresponds to a HGL of 54.66m (179ft). When considering any serviced area should have a 40psi (275kPa) residual pressure under normal operating conditions and ignoring pipe losses within the system we calculate the maximum serviceable elevation to be 26.5m (87ft). Without additional pumping, the Georgetown system cannot service ground above this elevation. Similarly, to Montague, the closest land with elevations as high as 26.5m are nearly 2km northwest of the current pipe network. The community water system is not expected to extend this far beyond the current zoning boundaries and the growth scenarios considered all fall within this area and are expected to be serviced without adjustment to the systems operating parameters. The below figure shows the unserviceable areas with elevations above the 26.5m contour.

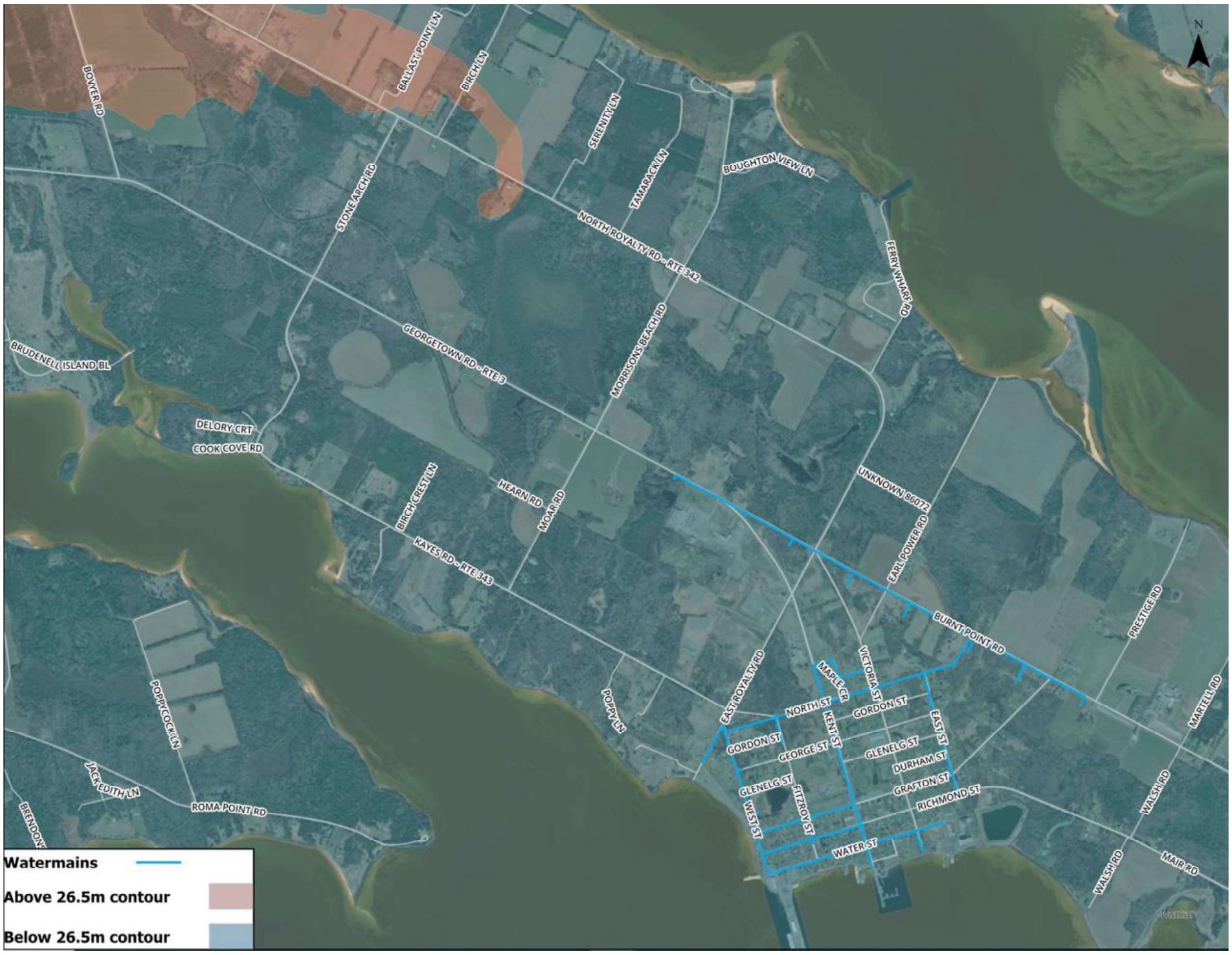


Figure 4.6: Georgetown Water System Potential Servicing Area

4.6.5 Georgetown Business Park Development and Infilling Growth Scenario

With the current proposed business park development at the corner of Georgetown Road and East Royalty Road, the potential affects of this development were analyzed. This area is currently zoned as heavy industrial; however, it is expected to undergo rezoning to become all or partially mixed-use. For the purposes for this study a light industrial demand of 35m^3/day/hectare was assumed as per ACWGM, this corresponds to demands slightly higher than those expected from areas of mixed-use zoning. The demand for this area was assigned to a new node created in the middle of the business park that connected to the existing transmission main along Burnt Point Road. This initial connection to the water system is expected to be accompanied by additional future connections through Georgetown Road and East Royalty Road under the full buildout scenario.

This scenario also looked at the effects of applying the MDD of all existing homes within the community as well as the full buildout of the proposed business park. This was done by infilling the remaining un-serviced streets and distributing the demands generated by the future connection of all adjacent homes to the community water system with 150mm (6") watermain. This scenario resulted in a MDD of 3,944m^3/day (724USGPM) with minor decreases in the pressure to 43-75psi (296-517kPa). A maximum velocity of 0.91m/s was experienced in the single pipe supplying the 1,777L/min (470USGPM) demand at the business park. The business park is located outside the original community of Georgetown and demands have been calculated based on a Light Industrial zoning with a suggested consumption rate of 35m^3/day/hectare. When constructed, this business park will likely be supplied water from multiple locations as opposed to a single point on the system. The looping of the business park will be explored more in the subsequent scenario. Infilling the existing streets and gridding the system will create a very strong pipe network with good redundancy. This gridded network will allow for good flow and circulation of water within the system.

The demands generated from connecting the existing homes to the system have near negligible effects on the permitted wellfield extraction capacity, well pumping capacity, or the transmission main capacity. It is expected that the system would benefit from the additional demands generated by these customers as water quality could improve with higher flow rates and more movement of water, these additional demands would also help with short cycling of the well pumps. The high-level demands predicted from the full buildout of the business park in this scenario are significant, resulting in a predicted MDD of 2,556m^3/day (470USGPM) for the business park alone. The total flow of 3,950m^3/day (725USGPM) from the business park and connection of all the existing homes in theory maxes out the extraction capacity of the four wells. If flows were as high as those assumed for this model the system operator would need to consider additional pumping capacity or water storage to buffer the supply and demand of water within the system. This is not to say that infilling and the development of the business park cannot be done but that flow monitoring should accompany these projects to better understand the limitations and available capacities within the system. As system demands increase the system operator should consider adding water storage. A volume of water stored and available at system operating pressures would buffer periods of peak demands. Figure 4.7 shows the residual pressures under MDD for the Business Park Development and Infilling Scenario.

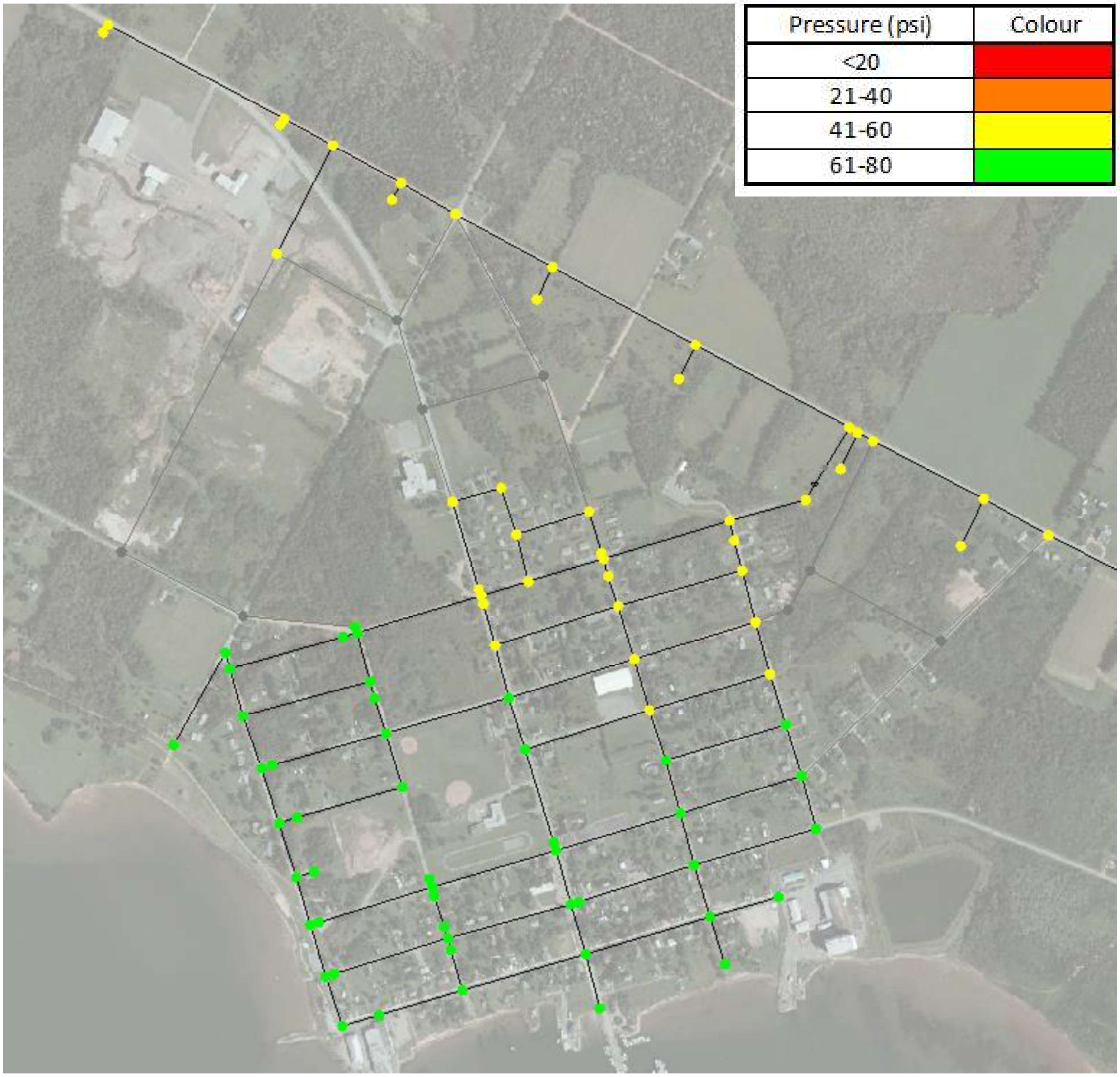


Figure 4.7: Georgetown Residual Pressure Results (MDD + Infill)

4.6.6 Georgetown Full Buildout Development Growth Scenario

The second development scenario for Georgetown looked at full buildout of the existing water system to the limits of the existing municipal boundary with the addition of the proposed business park development. Using the development densities noted Table 1.2 above in conjunction with the draft official plan zoning map, this scenario results in an equivalent projected population growth of 845 people. At a 1% growth per year this equates to a 93-year time horizon. Therefore, assuming no extension to the municipal servicing boundary and that all development occurs within the existing municipal boundary, it is estimated that the community can accommodate a 1% annual growth for a 93-year time horizon before an extension to the servicing boundary would be required.

This scenario is different from the scenario above in that it includes more watermains to the Northeast and Northwest and future demands have been assigned based on area and zoning rather than population or number of homes. This resulted in a higher future MDD of 7,578m^3/day (1,390USGPM) for this to be achieved the water system operator would need to increase water storage capacity, upgrade pumps, and undergo significant operational changes to the water extraction and supply systems. The distribution system however if constructed as proposed would be able to distribute the future MDDs for domestic use in all areas operating at the current HGL. Pressures within the system ranged from 47-74psi (342-510kPa) with a maximum velocity of 0.62m/s.

When considering the full buildout of the community of Georgetown there are four main aspects to consider, water extraction, water storage, water distribution and the addition of a fire rated water supply and distribution. As discussed in the previous scenario the water distribution is robust and if all existing and future streets were serviced there would be good redundancy throughout the community. The permitted extraction rate of 725USGPM (3950m^3/day) is likely adequate to supply water to the community for the foreseeable future. Water storage should be added to buffer the periods of peak demand. Water storage will allow for the permitted wellfield extraction to provide adequate water to the community for the longest possible time horizon before an additional wellfield is required.

The full buildout scenario has an expected MDD of 7,578m^3/day (1390USGPM). With expected consumption rates this high it is not feasible to provide reliable water to customers without the addition of a storage reservoir. The time horizon for the full buildout of the community is very far into the future. CBCL suggests that additional water storage be added before additional wellfields are considered.

The pressures observed throughout the system under these future MDDs are shown in Figure 4.8. As you can see minimal changes in system pressures are experienced within the distribution system under these predicted future demands.

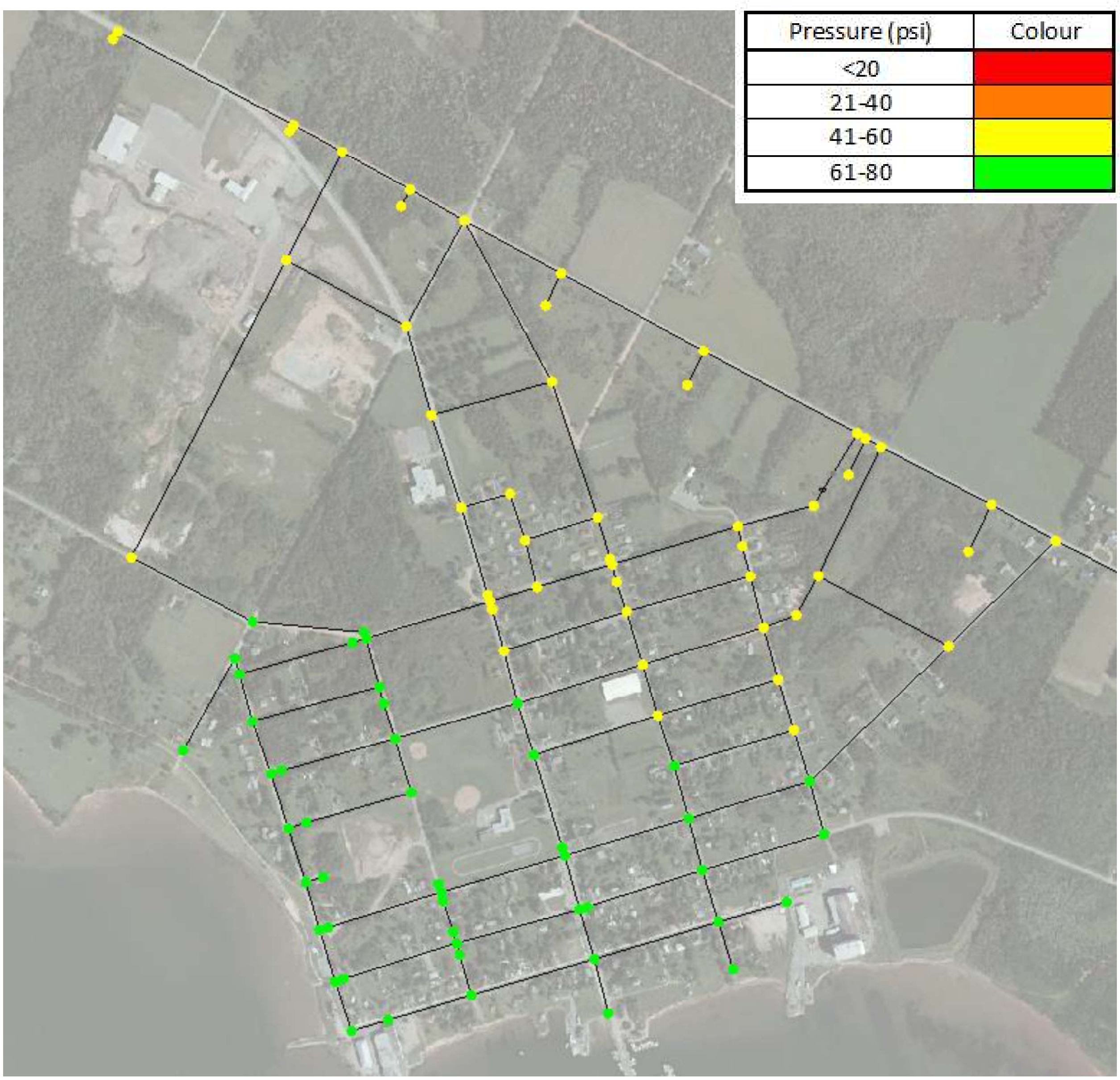


Figure 4.8: Georgetown Residual Pressure Results (MDD + Full Buildout)

5 Recommendations & Conclusions

5.1 General

5.1.1 Capital Maintenance, Monitoring and Data Collection Budget

Any municipal water and wastewater system requires continued maintenance as its components age. It is recommended that the Town adopt a capital maintenance budget with a fixed annual amount that can be used to budget for monitoring, data collection, and small maintenance upgrades. This budget is invaluable to maintenance supervisors and operators so a proactive approach to repairs can be undertaken instead of emergency reactive repairs.

5.1.2 Flow Monitoring Program

As noted previously, the flow data available during the model building and calibration for this project was relatively limited and flows are largely based on theoretical calculations. It is recommended that a system wide water and sanitary sewer flow monitoring program be implemented to refine ADD and MDD consumption values, existing dry weather flows, and wet weather flows. Such programs and instrumentation will aid in both water and sanitary model calibration and provide invaluable information for the sanitary system regarding the impact and general location of extraneous flows. Reducing extraneous flows will increase the available capacity in the existing system to accommodate future growth. Water system flow monitoring will allow for tracking and trending of water distribution. This flow monitoring in combination with a domestic metering plan can indicate leaks in both utility owned and privately owned infrastructure.

It is recommended that flow meters be installed at each sanitary lift station with real time SCADA capability to refine the observed flow for each sanitary catchment. This will further aid in locating areas receiving high extraneous flows and provide additional information on lift station performance to plan for future upgrades. Probable costs for the installation of flowmeters at each sanitary lift station could be in the order of $50,000 + tax per station.

If further flow monitoring is warranted to pinpoint extraneous flows, flow monitors can be installed at strategic locations upstream of the sanitary lift stations directly in the gravity system. A typical flow monitoring period would be a minimum of 4 weeks during wet weather periods, either spring or early fall. A rain gauge would also be installed to record real time rainfall data that would be used to correlate to the flow meter data.

Flow monitoring program costs are dependant on the number of flow meters installed and rainfall events captured. Typically, within four weeks there would be a relatively significant rainfall experienced that would give the results required for calibration. In some cases, flow metering periods would need to be extended if a significant rainfall event did not occur during the typical 4-week metering period. CBCL has recently completed similar flow monitoring programs for other municipalities in the Maritimes and would estimate a budget price per flow meter in the order of $2,000 + Tax per 4-week period for rental. There would also be costs associated to installation / removal, data downloads / checks during metering period (typically twice weekly), and final data review and analysis costs.

Probable cost to complete a flow monitoring program could range in the order of $50,000-$100,000 + Tax depending on number of flow meters, length of installation time, etc.

It is recommended that a flow meter and pressure transmitter be placed at the water control building to measure the water pumped into the system and system pressure. This instrumentation should be connected to the communities' SCADA system and be capable of providing flows in real time as well as daily flows. Collecting and storing data in real time will allow for a more accurate ADDs and MDDs to be determined, it will also allow for peak hour factors to be determined and show critical information required to forecast when booster pumps or well pumps are nearing their capacity. Costs for retrofitting a flow meter and pressure transmitter in the existing control buildings can vary depending on space available and integration work required for the flow meter to communicate with the existing SCADA system. We expect the installation of a flow meter to be in the order of $50,000 + Tax per station.

5.1.3 Domestic Water Metering

Many cities, towns and communities across the country have benefitted from the implementation of customer metering program. Customer metering is a way to track water usage on a per customer basis and bill accordingly. Many places that have switched to customer metering have seen a reduction in per capita water usage. The implementation of a domestic metering program could result in years of additional service from infrastructure related to both the water and wastewater systems. The lifespan of systems requiring capacity upgrades could be prolonged through the reduction of per capita water usage.

Regardless of whether a utility chooses universal metering with the intent of implementing a rate structure based on full cost recovery, metering provides the additional benefits of monitoring such that the water commodity is wisely consumed and not wasted. Finding alternative sources of water for uses such as lawn/garden watering from rainwater can occur because of conservation due to metering.

Metering of customers also allows utility staff to reconcile water produced to water consumed and identify abnormal usage and correct operational issues, resulting in reduced water losses. Delayed spending on expansion of both water and sewer treatment plants can also be a result of water conservation caused by metering. The estimated cost to supply and install a universal flow metering in the Montague water system is $700/meter.

In addition to conservation and system monitoring, another principle that is fully supported by metering is that of rate setting based on full cost recovery of water and sewer system costs for the formulation of user tariffs.

The National Guide to Sustainable Municipal Infrastructure (InfraGuide) states:

> *"Full cost recovery requires the generation of sufficient revenues through appropriate pricing of the services to cover the full cost of water and sewerage services. These include operating, maintenance, administration (OM&A), research and development (R&D), expenditures, financial costs, and capital investments in facilities (including depreciation, interest and equity return at a level sufficient to sustain the systems in perpetuity and achieve the mandated level of service as a minimum)."*

Full cost recovery for a utility means that the Water and Sewer rates are structured to cover all of the costs of operating and maintaining the water and sewer systems, financing the existing and future debts of each system and the financing of the replacement of aging infrastructure of each system. The primary purpose of full cost recovery is that it will ensure that water and sewer systems are adequately financed for sustainability over the long term.

The following list, taken from the InfraGuide program, summarizes some of the main benefits of identifying full costs and implementing a full cost recovery plan for water and sewer systems:

- *"Represents a sound business practice.*
- *Ensures sustainability of the water and sewer services.*
- *Improves knowledge of the urgency of investments and allows budget components to be effectively prioritized and financed.*
- *Provides a technically defensible financing plan (i.e., the municipality can demonstrate accountability to its customers).*
- *Helps municipal councils, utility commissions or utility regulators evaluate budget and rate requests in a more informed manner and to develop long term financial plans.*
- *Can be used to promote water efficiency.*
- *Facilitates rate stability by reducing the risk of sudden large increases or decreases in water and sewer rates.*
- *Facilitates "buy-in" from customers for proposed rate increases.*

- *Provides notice to high use customers of future rate increases, thus supporting economic stability for the community.*
- *Enables more accurate comparisons (e.g. benchmarking) between municipalities.*
- *Extends the life of assets since managers can better balance maintenance costs against capital replacement.*
- *Reduces the risk of non-compliance with regulations (i.e. municipality can demonstrate due-diligence).*
- *Helps to maintain (or improve) service levels (e.g. public health and safety) and demonstrates sound fiscal management, well-planned systems, and a vision for the future."*

Based on past rate studies for PEI utilities that have considered the principle of full cost recovery facilitated by universal metering and identified and established rates to meet present and future needs while providing fairness, a budget of $65,000 is suggested.

5.1.4 Condition Assessment Program

The existing sanitary system in the Community of Montague is aging, with a large portion of the system nearing or past its anticipated theoretical design life. This does not mean that the system is not performing to an acceptable level of service, however it indicates that further investigation into the condition of the existing piping is warranted.

It is recommended, at a minimum, that a condition assessment program involve the following:

- Visual inspections of all sanitary structures.
- Video inspections of the gravity mains.
- Data logging into an asset management program and mapping of the visual and video inspections.

The Town should implement a condition assessment program that begins with known problem areas followed by inspections of the oldest underground infrastructure. The results will aid the Town in making informed decisions on completing upgrades to the existing system, locating anticipated areas of concern for inflow and infiltration, and plan for future upgrades.

A budget cost for completing video inspections of gravity piping is in the order of $10 per lineal metre of sewer. Additional costs would be incurred for any visual inspections, data logging, and mapping.

The water system in Montague and Georgetown are quite different in terms of age, material, size, and original purpose, however both systems would benefit from the collection and logging of data regarding their physical conditions. The Town and Georgetown water system operator should begin a condition assessment program for their respective systems. Data collected for the water system could include the following:

- Locations and date of watermain leaks/breaks.
- Record of maintenance completed.
- Age, material, condition, and location of watermains, valves, hydrants, curb stops, etc. as encountered.

All data collected should be logged and mapped for ease of reference for future planning. This information can be obtained when maintenance is completed, when repairs are completed, when new services are connected to the existing system, and when projects interact with the existing system. Valve, hydrant, and curb stop information can be collected at any time. One of the first steps in any good maintenance program is determining how the information collected will be stored and/or mapped.

5.1.5 Valve and Hydrant Maintenance Programs

As mentioned, the two water systems are quite different in terms of age and use. However, a valve exercising and hydrant flushing programs could benefit both systems. With the Montague system being relatively new, the risk of breaks or leaks as a result of the implementation of a new valve exercising and flushing program is relatively low. The Georgetown system is significantly older, much of it being constructed in the 1960s and 1970s, if valves and hydrants have not been exercised regularly, components inside may have become seized and may leak when attempted to be exercised.

Exercising valves helps to determine if they are functioning properly and allows the system operator to replace components inside the valve body rather than replace the entire valve. This work can give the system operator better control and increases the ability to isolate future leaks or breaks. It also gives the operator more confidence in knowing that the valves in place will function as intended when needed. Valve exercising programs should be conducted yearly. For a system the size of Montague's we estimate that it would take approximately 100 hours to locate and exercise all valves at a rate of $100/hour this would cost $10,000/year plus an additional allowance of $25,000/year for repairs assuming 3% of valves would need some additional work at a rate of $2,000 per valve. This could be valve repairs, replacements, breaks in the system, leaks, valve box cleaning, etc. bringing the total estimated valve exercising cost to $35,000/year.

A hydrant flushing program accomplishes a number of tasks and is one of the most beneficial maintenance exercises that a system operator can perform. Hydrant flushing can be done the conventional way, where the hydrant is open, and flow is allowed to travel from all directions to the hydrant or unidirectional flushing can be performed by isolating a single line and only allowing flow to pass through that section of the system before exiting the fire hydrant. These methods help to remove debris and sediment build-up from pipes while also testing the hydrants' function. Flushing of hydrants also allows the operator to check for perceived available fire flow. Flushing programs are typically completed in the spring over a period of a few weeks. We estimate that a hydrant flushing program for a system the size of Montague's would take approximately 70 hours to complete, at a rate of

$150/hr this would cost $10,000/year plus an additional repair allowance assuming 1% of hydrants required repairs at a rate of $10,000 per hydrant bringing the total estimated hydrant flushing cost to $30,000/year.

5.1.6 Asset Management Plan

An Asset Management Plan (AMP) is a powerful tool for any system operator to possess. The purpose of developing an AMP is to set appropriate priorities and objectives to continue to foster growth and development. AMPs should be developed by the owner of the system to aid in strategic decision making. AMPs provide the owner with a better understanding of the assets they own, operate, and maintain, as well as the condition and level of service each asset provides.

The AMP governs the actions and processes that create consistent and stable asset management practices and policies. This will ensure a robust, transparent, and accountable approach to managing assets and will promote the long-term sustainability of service delivery.

The Province of PEI owns the water system assets in Georgetown with operation and maintenance responsibility residing with Environmental Industrial Services Inc (EISI). The Town of Three Rivers is responsible for invoicing water system customers with Town staff being the public face of the municipal water system. This unique ownership model can be perceived to be a barrier to growth in the Town, although the water system itself can be perceived as an asset for future developments. It has been observed that an improved working relationship could provide benefits to all parties involved.

It is recommended that a joint water service committee (or similar organization) be established with representation from both the municipality and the province to provide a mutually beneficial structure to assist both parties in their roles related to the water system. The committee could include representatives from the Town of Three Rivers, the Town's Sewer and Water Corporations, the Province of PEI, and EISI. The objectives of the committee (or similar organizational structure) could be to establish expected level of service for customers, monitor the level of service indicators, improve communications among the Town, Province and water system customers, coordinate management of the water system with other Town assets, along with keeping the water utility informed of development pressures and expected future needs.

An AMP can be developed to track any desired asset and be as simple or complicated as the owner would like. It is recommended that the Town develop an initial asset management framework that tracks the following information at a minimum:

- Inventory of all municipal infrastructure including but not limited to:
  - The sanitary collection system.
  - Wastewater treatment system.
  - Water distribution system.

- Water supply and storage system.
- Condition of existing municipal infrastructure.
- Upgrades completed, and new municipal infrastructure installed.
- The location and date of any repairs completed on the water system.
- The location and date of any repairs completed on the sanitary system.
- The location and date of any maintenance completed on the sanitary system.
- The location and date of any maintenance completed on the water system.
- Location, date, and description of any complaints received regarding municipal infrastructure.

Some of the benefits of an active approach to asset management are as follows:

- Provide a way to turn observations into something meaningful.
- Provide a framework for prioritizing monitoring and maintenance of infrastructure.
- Change reactive repairs to proactive maintenance, asset management and planning.
- Forecast potential failures.
- Provide guidance on prioritizing capital projects.
- Provide 50-year projections for yearly replacement costs.

5.2 Three Rivers Existing Infrastructure

5.2.1 Montague Sanitary System Recommendations

To determine when potential upgrades should be completed, an acceptable level of service for the various components of the wastewater system must be established. For the purposes of this Master Plan, an acceptable level of service of 80% utilization of the asset's design capacity will be used. In other words, planning for upgrades should be started when the system component (gravity pipe, lift station pump, sanitary forcemain, etc.) reaches 80% capacity under peak flow conditions.

Sanitary Collection System

The existing sanitary system for the Community of Montague is currently meeting its requirements and is sufficiently collecting the community's wastewater and conveying the flow to the wastewater treatment plan. The Town has not reported any issues with surcharging in the system and the model results indicate no major issues under peak flow conditions. The existing system is beginning to approach its anticipated theoretical design life and it is recommended that further condition assessment of the aging infrastructure is completed to inform potential upgrade decisions.

As the Community continues to grow into the future, some sections of the gravity network will need to be upgraded to larger diameter sewers in order to accommodate the increase in flow. The location of upgrades will be largely dependant on the type and location of development; however, it is anticipated that two sections of sanitary main will display capacity issues first, the trunk sewer on the north side of Montague (starting at the intersection of Main Street and Robertson Road, flowing along Down East Crescent and down to the Bridge Lift Station) and the trunk sewer from Riverview Drive to the WWTP. The following table summarizes the sections of gravity main expected to reach 80% capacity as a result of the growth scenarios developed as part of this master plan and order of magnitude opinion of probable costs for replacement.

Table 5.1: Potential Capacity Upgrades to the Existing Gravity Collection System

Location	Existing Pipe Diameter (mm) and Capacity (L/s)	Estimated Future Peak Flow (L/s)	Proposed Pipe Diameter (mm) and Estimated Capacity (L/s)	Estimated Population Growth before Upgrades Required	Estimated Replacement Length (m)	Order of Magnitude Opinion of Probable Cost[3,4]
Connection to Brudenell to Down East Mall	200 (25)	23.3	375 (60)	1461[1,2]	150	$135,000
Down East Mall to Campbell Avenue	250 (20 to 35)	25.1	375 (60)	1461[1,2]	400	$360,000
Intersection of Central/Sackville Street to Intersection of Water/Sackville Street	250 (35)	38.5	375 (104)	1581[1,2]	300	$270,000
Intersection of Riverview Drive and Harbour View Drive to Locust Street	200 (16)	15.1	300 (43)	485[1]	500	$430,000

[1] Estimated population growth upstream of gravity sewer section.
[2] Proposed Servicing extensions to Brudenell are estimated to contribute an equivalent population flow of 882 people into the system immediately, therefore a growth potential of 579 people will remain.
[3] Opinions of probable cost exclude applicable taxes.
[4] Opinions of probable cost include a 15% design development contingency, 15% construction continency and 10% allowance for Engineering.

Sanitary Lift Stations

The five (5) sanitary lift stations that pump raw sewage for the Community of Montague currently contain some additional capacity for future growth. However, model results indicate that the Bridge lift station is approaching its theoretical design capacity, with only 13% remaining under existing peak conditions. Additionally, the sanitary lift station at the WWTP, which was installed in 1971, has exceeded its design life. It is assumed that the pumps have been replaced since initial construction, however it is recommended that this lift station be assessed and upgraded with new pumps and piping and necessary repairs completed to the wet well.

As Montague continues to grow, it is anticipated that capacity issues will be observed at the Bridge Lift Station and the WWTP lift station. Furthermore, it is recommended that a capacity assessment of all downstream sanitary infrastructure be completed prior to the approval and construction of any major development. It is estimated that the remaining three (3) lift stations (Sorrey Bridge, Patrick Street and APM) will not surpass 80% capacity under peak flow conditions. However, there has been discussion around a potential large development in the Sorrey Bridge catchment, if this major development proceeds it is recommended the Sorrey Bridge lift station and Bridge lift station be evaluated and upgraded as required to convey the additional flows. It is recommended that flow meters be installed at each lift station to continually assess and record the capacity and performance of the lift stations and that the Patrick Street station be monitored closely as the peak flow is heavily dependant on the amount of wastewater the Fish Plant discharges into the system.

Table 5.2: Opinion of Probable Costs for the Montague Sanitary Lift Station Upgrades

Proposed Upgrade	Estimated Design Capacity (L/s)	Estimated Remaining Capacity (L/s)	Estimated Population Growth before Upgrades Required	Opinion of Probable Cost[1,2]
Upgrade capacity to the Bridge Lift Station	44.4	5.9	414	$300,000.00
Partial upgrade to the WWTP lift station	12.6	3.3	233	$300,000.00

[1] Opinions of probable cost exclude applicable taxes.

[2] Opinions of probable cost include a 15% design development contingency, 15% construction continency and 10% allowance for Engineering.

Wastewater Treatment

The existing wastewater treatment plant for Montague contains additional hydraulic capacity, however based on influent test results, the facility does not contain any biological capacity to treat additional flows. The results of two recent grab sample indicate that the influent wastewater contains higher strength than typical municipal sewage and is above the design parameters of the plant. It is assumed that the increased strength is due, in part, to the following:

- Presence of breweries that discharge wastewater into the collection system.
- Wastewater from the Fish Plant discharging into the system.

With the proposed servicing extension to the MacDonald Road in Brudenell, it is recommended that further sampling, in addition to the Provincial requirements, be completed immediately to provide more results to determine if the two grab samples are an anomaly or a regularity. A proposed sampling program is outlined below:

- Collect influent and effluent samples at bi-weekly intervals at the WWTP for a period of 2 months.
- Collect a series of grab samples at the fish plant lift station and brewery discharge manholes.
- Sampling should be done during the summer months during dry weather conditions.
- Composite sampling for influent and effluent is preferred.
- General observations of the influent and effluent at the time of sampling for fats, oils, greases, and any other abnormalities.
- All samples are to be tested for TSS, cBOD and total ammonia.

After the completion of additional sampling, a detailed approach to address the assumed biological capacity issues can be established. Depending on the results of additional sampling, the Town could take two approaches to a solution.

- Reduce the strength of the influent at the source through policy.
- Upgrade the existing treatment plant to accommodate the increased strength influent and provide additional biological capacity.

Based on limited sample results it appears some customers are exceeding the acceptable BOD limit of 300 mg/l as defined by PEI IRAC Municipal Sewerage Utility's general rules and regulations. It is recommended that the Town plan for continued upgrades at the Montague WWTP as the community continues to grow.

In addition to biological treatment, the existing plant lacks redundancy in secondary treatment and could benefit from an improved screening system. The current WWTP property contains additional land to accommodate future upgrades without the need of a property expansion. The following table summarizes the recommended upgrades for the WWTP.

Table 5.3: Summary of Recommendations for the Montague WWTP

Recommendation	Time Horizon[1]
Influent and Effluent Sampling Program	Short Term
Continued maintenance of the existing aging primary reactor	Short Term
Fine screen facility to improve the removal of inorganic material from the raw sewage	Medium Term
Construction of another secondary clarifier	Medium Term
Increased aeration capacity for primary treatment	Medium Term

[1] *Short term time horizon is 0 to 5 years and medium term time horizon is 5 to 10 years.*

5.2.2 Georgetown Sanitary System Recommendations

Sanitary Collection System

The gravity collection system for the Community of Georgetown is an aging system that dates back to 1965. The existing system is currently operating successfully however it is evident in the sanitary lift station pump runtimes and the lagoon flow data that inflow and infiltration is an issue in the community. Inflow and infiltration reduces the available capacity of a sanitary network as overland runoff and groundwater flows through the system. It further reduces available capacity in wastewater treatment systems since stormwater is essentially treated as it flows through the plant. In particular, the West Street sanitary lift station catchment contains a high amount inflow and infiltration as seen in high level alarms during large rain events. Not unlike many well established small communities across Canada, aging underground piping, lack of a well connected storm system, and residential sump pump connections to the sanitary network contribute to inflow and infiltration issues. It is recommended that following steps be completed to further assess and address inflow and infiltration:

- Perform visual inspections in manholes during rain events to visually assess areas of high inflow and infiltration.
- Implement a condition assessment program that includes video inspection and documentation of results for aging sanitary pipes.
- Assess the number of homes with sump pumps connected to the sanitary system.
- Upgrade sections of sanitary main that suggest high levels of infiltration through the condition assessment program.
- Install a dedicated storm system in areas of high residential sump pump connectivity to the sanitary system.

Based on model results, there are no current capacity issues in the Georgetown sanitary collection system. As the Town and Community grow, and if development expands into all currently serviced areas, it is anticipated that the trunk sewer from the intersection of Kent Street and Grafton Street to the intersection of Richmond Street and East Street will need upsizing. The following table summarizes potential future capacity upgrades to the existing gravity collection network and order of magnitude opinion of probable costs for replacement.

Table 5.4: Potential Capacity Upgrades to the Existing Sanitary Collection System

Location	Existing Pipe Diameter (mm) and Capacity (L/s)	Estimated Future Peak Flow (L/s)	Proposed Pipe Diameter (mm) and Estimated Capacity (L/s)	Estimated Population Growth before Upgrades Required	Estimated Replacement Length (m)	Order of Magnitude Opinion of Probable Cost[3,4]
Intersection of Kent/Grafton Street to the intersection of Richmond/East Street	250 (35)	40.5	375 (104)	2150[1,2]	600	$550,000

[1] Estimated population growth upstream of gravity sewer section.
[2] Proposed development of the Georgetown Business Park is estimated to contribute an equivalent population flow of 1763 people when fully developed. Therefore a growth potential of 387 people will remain upstream gravity sewer section.
[3] Opinions of probable cost exclude applicable taxes.
[4] Opinions of probable cost include a 15% design development contingency, 15% construction continency and 10% allowance for Engineering.

It should be noted that the available capacity of the sanitary collection system will be heavily dependant on the amount of wastewater flow generated from the proposed business park development. It is recommended the flow from the business park be measured as the park develops in order for the Town to make informed decisions on when upgrades to the existing system will be required.

Sanitary Lift Stations

The single lift station located on West Street currently contains capacity to accommodate growth within the Community based on model results. Furthermore, the lift station is able to accommodate the increase in flow from all development scenarios examined as part of this master plan. However, the available capacity of the lift station is dependant on inflow and infiltration and the development of the business park. It is recommended that this catchment be a priority for a reduction in inflow and infiltration as it is evident that the system experiences a high volume of extraneous flows during rain events.

Although not an immediate need, it is recommended the existing forcemain be flushed and CCTV inspected if size permits and that replacement of the existing sanitary forcemain for the West Street lift station be evaluated as the age of the piping indicates the forcemain is approaching its design life expectancy. Probable costs for the replacement of the forcemain would be in the order of $450,000 + Tax.

Wastewater Treatment

Based on the information available, it appears that the Georgetown Lagoon contains additional capacity to accommodate growth within the Community. However, due to limited data available, it is recommended that further sampling be completed. This is especially important with the proposed business park development. A proposed sampling program is outlined below:

- Collect influent and effluent samples at bi-weekly intervals at the Lagoon for a period of 2 months.
- Sampling should be completed during the summer months during dry weather conditions.
- Composite sampling for influent and effluent is preferred.
- General observations of the influent and effluent at the time of sampling for fats, oils, greases, and any other abnormalities.
- All samples are to be tested for TSS, BOD and TKN.

In order to provide substantive recommendations for wastewater treatment in Georgetown further investigation should take place. Flow meter calibration should be confirmed as the flows are lower than what would typically be expected based on the assumed serviced population. Recent flowmeter calibration/investigation suggests initial flow results may not be accurate.

Based on the influent loading result from the March 30th, 2022, sample, a study to review treatment upgrade options such as increased mixing, addition of aeration and blowers, or the replacement with a mechanical plant such as a sequencing batch reactor (SBR) should be conducted.

5.2.3 Montague Water System Recommendations

To guide the water system recommendations, the design capacity of the assets were first determined, this design capacity was then compared to the assets level of utilization. The recommendations in this report are largely based on theoretical consumption rates and should be verified through the implementation of the above noted pressure and flow metering projects prior to completing larger system upgrades based on projected utilization. For the purposes of this Master Plan an acceptable level of service of 80% utilization of the asset’s design capacity has been used. In other words, planning for upgrades should be started when the system component (watermain, well pumps, booster pumps, storage reservoirs, etc.) reaches 80% of their capacity under peak flow conditions.

Water Distribution System

The existing water distribution system is currently functioning as intended, no reports have been presented from customers experiencing low water pressure or water quality issues. Under normal MDD scenarios there were no areas in the model that experience low water pressures. High system pressures are observed at locations with low ground elevations; however, the Town has a bylaw requiring the use of customer owned PRV's. Running the model under MDD conditions with fire flows revealed some areas that experienced high velocities and thus create additional head loss and cause a reduction in available fire flow. Pipes generally experience high velocities for a few reasons, the pipe is now undersized for the downstream demand or there is a lack of redundancy in the system causing large amount of flow to go through a single pipe with no alternative routes. These areas generally experience high velocities due to a lack of redundancy in a portion of the system. The two areas below are recommended for twinning of watermains to reduce head loss, increase system reliability and redundancy, and to improve available fire flows.

The first area noted is located just south of the wellfield and control building. The single 200mm (8") watermain leaving the booster pumps heading south on MacIntyre Avenue feeds the entire water system. With the velocity constraint turned off in the model this single pipe experiences velocities of approximately 4 m/s (13ft/s) under fire flow conditions. It is recommended that this pipe be twinned to provide lower velocities and create redundancy in the community's access to their water supply. Twinning this pipe will allow for future maintenance or repairs to occur without disrupting customer water supply.

The second area is located at the Main Street bridge, this single link connects the north and south portions of the community. If the velocity constraint is ignored, this pipe experiences velocities of approximately 4 m/s (13 ft/s) during all fire flows analyzed on the south side of the bridge. This single pipe restricts flow and reduces the available fire flow south of the bridge. In addition to high velocities and reduced fire flows, this pipe lacks redundancy. If this pipe were to break, freeze, become damaged or overwise require maintenance, the south portion of the system would be without potable water. If twinned the velocities in this pipe would decrease to an acceptable recommended velocity and fire flows would be improved for all areas south of the bridge until the system became constrained by low pressures at the top of the hill along Wood Islands Road.

Table 5.5: Potential Capacity Upgrades to the Existing Water Distribution System

Location	Existing Pipe Diameter (mm)	Estimated Velocity Under Maximum Fire Flow (m/s)	Proposed Pipe Diameter (mm)	Estimated Pipe Length (m)	Order of Magnitude Opinion of Probable Cost[23]
MacIntyre Ave North of Wightman	200	3.95	200	125	$120,000
Main Street Bridge[1]	150	3.94	200	120	$450,000

[1] The existing bridge configuration, condition and loading capacity will need to be analysed to determine if the bridge can accommodate an additional watermain. The opinion of probable costs excludes bridge capacity costs.
[2] Opinions of probable cost exclude applicable taxes.
[3] Opinions of probable cost include a 15% design development contingency, 15% construction contineny and 10% allowance for Engineering.

Source Water

When thinking of the community's source of water there are two main considerations, quality, and quantity. The quantity aspect is the amount of water the community can extract from the ground on any given day. The quality aspect can be thought of terms of bacteriological quality. Increasing source water through the development of a new wellfield can be a fairly long process involving the following:

- Hydrological assessments.
- Drilling numerous test wells.
- Performing pump tests and hydrological modeling.
- Purchasing land.
- Entering into land agreements.
- Developing and implementing wellfield protection programs.
- Design and construction of the necessary wells, pumps and controls and transmission mains required to connect a new wellfield to the existing pipe network.

From a quantity perspective Montague's existing wellfield appears to have excess capacity when comparing the permitted extraction to both the ADD and MDD. The two wells are permitted for a combined extraction limit of 1,963m^3/day (518,500USGPD). The existing MDD was recorded as 1,352m^3/day (357,160 USGPD) or approximately 69% of the permitted extraction. As for quality, no reports have been presented showing bad quality water from the Montague wells. However, it is suspected that both wells source water from the same aquifer, should something happen to this aquifer the community would be left without any source of potable water. With the existing water reservoir full the community has enough water available to meet the current MDD for a period of 8 hours before the tank is emptied.

It is recommended that the Town review the community's current wellfield protection documents to ensure everything recommended for the protection of the existing source water is being done to ensure the longevity of the existing wells. It is also recommended that the Town start to think about obtaining land and doing the preliminary work required for a second wellfield. The ideal location for a second wellfield is somewhere close to the existing water system and that sources water from a different aquifer. This will improve not only the communities water production capacity but also improve redundancy in the sourcing of water for its residents. The town should start this process by reviewing previously completed reports and studies to determine if considerations had been made for additional sources of water.

Assuming a hydrological assessment and investigation is successful in determining a favourable wellfield location that could be obtained by the community within approximately 1km of the existing distribution system, the opinion of probable cost to add an additional water supply source is $2,200,000 + Tax.

Fire Underwriters Survey Water Audit

This report has looked at storage volume, pumping capacities, and available fire flows based on the existing fire pumps output capacity. The adequacy of the existing fire pump, its ratings, or adequacy of the available fire flows within the Community of Montague were not quantified as part of this report. While the Fire Underwriters Survey (FUS) considers a water distribution supply system to be fully adequate for fire insurance grading purposes if it can deliver the necessary Required Fire Flow (RFF) at any point in the distribution grid iron for the appropriate durations, it is not always practical or economically feasible to provide for every RFF. While the Town's water supply is an important part of its fire protection services, it makes up 30% of the overall PFPC grade, other aspects such as fire department review and fire prevention are also considered key.

It was within this context the existing and future water system has been studied.

The Community Montague is growing, and development types have/are changing since the initial fire pump was sized and installed. The Town should consider having an audit completed to determine the recommended target system fire flows. The Fire Underwriters Survey does conduct audits of municipal fire protection services as part of the service they provide for insurance underwriters. Along with the audit may come suggestions for additional upgrades whose capital costs cannot be quantified at this time.

Water Storage

As mentioned above Montague does have excess capacity in their water production from the wells. However, it was also noted that under MDD conditions the existing underground water storage reservoir has enough volume to provide water to the Community for a period of 8 hours without the wells. Using a standard formula, the total storage requirements were determined for the Montague system. Using the current MDD and fire flow requirements the recommended storage volume for Montague was calculated to be $775m^3$. With Montague's existing storage capacity of $454m^3$ it appears as though the community does not meet the recommended minimum storage volumes based on the existing demands. If the community were to build a new storage reservoir it should be sized to accommodate future demands. We recommend that the Town consider constructing a new reservoir to meet the future demands after conducting the above-mentioned water audit to obtain updated fire flow recommendation from the Fire Underwriters Survey. The existing fire flows and immediate increase in demands expected to be generated from the MacDonald Road Extension plus a 1% growth rate over the next 50 years was used to determined that a new reservoir with a volume of 750m3 would be required. This reservoir size should be confirmed with the implementation of flow monitoring equipment before the preliminary design stage. For costing/budgeting purposes a storage reservoir size of $750m^3$ (200,000US Gal) was used to serve the community along side the existing cistern. We expect a reservoir of this size to cost in the range of $750,000.

5.2.4 Short Term Future Planning

At the request of the Town, the above noted recommendations for each of the systems owned and operated by the Town have been prioritised. The following table summarizes the recommendations and programs that should be implemented within the next 5 years.

Table 5.6: Town of Three Rivers Short Term Future Planning Summary

Recommendation	Priority
Montague Sanitary System	
Development of a capital maintenance and monitoring budget.	High
Additional influent and effluent sampling at the Montague WWTP as well as at strategic serviced locations assumed to contain high strength and reduce the loading to within allowable limits.	High
Implementation of a condition assessment program primarily focused on aging infrastructure.	Low
Execution of a flow monitoring program or installation of flow metering at all sanitary lift stations.	High
Upgrade the existing WWTP sanitary lift station.	High
Further assessment and capacity upgrade of the Bridge lift station.	Low
Georgetown Sanitary System	
Development of a capital maintenance and monitoring budget.	High
Additional influent and effluent sampling at the Georgetown Lagoon.	High
Implementation of a condition assessment program focussing primarily on aging infrastructure.	Low
Execution of a flow monitoring program to locate areas of high inflow and infiltration.	High
Replacement of the existing forcemain for the West Street Lift Station.	Low
Montague Water System	
Development of a capital maintenance and monitoring budget.	High
Installation of a flow and pressure monitoring system capable of data collection and logger c/w remote access through either the communities Mission system or SCADA.	High
Develop and implement a valve and hydrant flushing and maintenance program.	Low
Start to consider a secondary wellfield location and have preliminary land acquisition discussions and agreements for the eventual future need for additional source water.	Low
Fire Underwriters Survey Water Audit.	High

5.3 Provincial Existing Infrastructure

5.3.1 Georgetown Water System Recommendations

As noted previously, an acceptable level of service of 80% utilizations of an asset's design capacity has been used. In other words, planning for upgrades should be started when the system component (watermain, well pumps, booster pumps, storage reservoirs, etc.) reaches 80% of their capacity under peak flow conditions.

The existing water distribution system in Georgetown appears to function as intended. The community cites complaints from one resident near the existing water control building who claims to experience low pressures suspected to be caused by ship filling at the wharf. As the system is currently undergoing upgrades to the water storage tanks it is assumed that this will become a non-issue with the installation of three (3) new hydro-pneumatic tanks. Operating pressures modelled throughout the system are all within the recommended pressure ranges. Under MDD scenarios no significant pressure drop was observed in the model assuming the pumps are able to start when required to keep up with the system demand. The Georgetown system has excess pumping capacity from their four (4) wells and should not experience losses in pressure under daily operation.

Water Distribution System

The water distribution system is comprised of some larger diameter piping around the perimeter of the Georgetown core with minimal infilling taking place on existing streets. If the utility operator would like to expand the system and grow a larger customer base it could be done by infilling existing streets. This would create a well gridded network of pipes with excellent redundancy throughout the distribution system. Before the utility operator would begin servicing existing residents through the expansion of the distribution system, it is recommended that a capital maintenance budget and financial analysis of the system be completed. These types of studies will help guide decision making and ensure capital projects are financially feasible.

We expect a financial analysis study for a community the size of Georgetown to cost in the range of $50,000. If it was determined that infilling the community was a viable option and the utility wanted to go ahead with this option, we expect the cost to infill the roughly 4.5kms of unserviced streets identified in section 4.6.5 to cost in the range of $3.6 million.

Water Storage

As mentioned above Georgetown is currently undergoing upgrades to their water storage facilities. These upgrades include the installation of three (3) hydro-pneumatic tanks to help prevent short cycling of the well pumps under varying system demands. If it were found that future demands warranted additional storage or if the utility had the desire to provide fire protection to the community, the system could be upgraded to allow for this through the installation of an appropriately sized storage reservoir. Since the well pumps in Georgetown are designed to pump into the pressure tanks at the system's HGL, no upgrades to the existing well pumps would be expected. If this option were to be pursued, we recommend that a water audit be completed to determine what fire flows should be provided based on the existing and expected future development within the service area. The Fire Underwriters Survey can provide an audit for the community. A reservoir sized to provide a similar fire flow as the Montague system and service the current and future population at a 50-year growth projection at 1% would be expected to cost in the range of $1 million.

5.3.2 Short Term Future Planning

At the request of the Town, the above noted recommendations for the Community of Georgetown have been prioritised for each of the systems. The following table summarizes the recommendations and programs that should be implemented within the next 5 years.

Table 5.7: Georgetown Short Term Future Planning Summary

Recommendation	Priority
Water System	
Development of a capital operations and monitoring budget.	High
Implementation of flow and pressure monitoring systems at the control building capable of recording and storing data.	High
Implementation of a condition assessment program.	Low
Fire Underwriters Survey Water Audit.	Low

5.4 Three Rivers Future Infrastructure Considerations

As noted previously in this report, due to the relatively low number of residents of the community, the construction and operation of a large water and wastewater system containing water storage, providing fire flow, and mechanical wastewater treatment is not feasible. Instead, a small central water distribution system for domestic use only, utilizing a common wellfield site in conjunction with a small diameter gravity collection wastewater system discharging to a common disposal field could be a more realistic option. It is recommended that further assessment of the existing septic systems and wells in the

Community of Cardigan be completed if the Town chooses to proceed with the construction of a domestic water and/or wastewater system. Further assessment should focus on the individual homes that report issues with water quality and/or wastewater disposal to determine the extent of any issues and determine if the residents of the Community are interested in a municipal system.

The following table provides order of magnitude costs to construct a municipal water and wastewater based on the servicing concept located in Appendix A (Map A5) that is projected to include 57 customers.

Table 5.8: Opinion of Probable Costs for the Community of Cardigan

System Component	Estimated Quantity	Order of Magnitude Cost (tax not included)[1]
Sanitary System		
Residential Pumps	8	$120,000.00
Effluent Collection System	2200m	$1,000,000.00
Effluent Pumping Stations	2	$1,200,000.00
Effluent Forcemain	350m	$260,000.00
Effluent Disposal Field	1	$1,100,000.00
Subtotal		**$3,680,000.00**
Water System		
Water distribution system	3300m	$2,200,000.00
Water storage, control, domestic pumps etc..	1	$1,100,000.00
Water supply wells (including well pumps)	2	$250,000.00
Subtotal		**$3,550,000.00**

[1] Opinions of probable cost include a 15% design development contingency, 15% construction continency and 10% allowance for Engineering.

5.5 Closing

The objective of this report is to identify any issues, constraints and/or limitations within the various water and wastewater systems and plan for future growth within the communities that form the Town of Three Rivers. Thank you for the opportunity to assist the Town in the development of this Master Plan, and to assist the Town in planning for the future.

5.6 References

Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution, and Operation of Drinking Water Supply Systems (2004), ACWWA.

Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment, and Disposal, 2006, Environment Canada.

Prepared by:
Avery Gilks, P.Eng
Civil Engineer

Timothy Gallant, P.Eng
Municipal Engineer

Reviewed by:
Pat Hughes, P.Eng
Senior Municipal Engineer

APPENDIX A

Condition and Needs Assessment Maps

PROJECT TITLE

THREE RIVERS
WATER AND WASTEWATER
MASTER PLANS

DRAWING TITLE

MONTAGUE
SANITARY SYSTEM
CONDITION ASSESSMENT

Three Rivers
· WHERE HISTORY IS MADE ·

CBCL PROJECT #:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 6, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:4000

LEGEND

Background Data
- Provincial Mapped Wetland
- Street Outline
- Property Lines

Sanitary Pipe Condition
- Very Poor
- Moderate
- Good
- Very Good

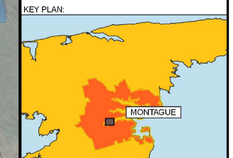
Sanitary Forcemain Condition
- Moderate
- Good
- Very Good
- Private
- Lift Station
- Field Observed Manholes

NOTES:
1. CONDITION RATING BASED ON AGE OF ASSET AND ASSUMED MATERIAL DESIGN LIFE.

2. ANY ASSET LABELLED "UNKNOWN" DOES NOT HAVE A MATERIAL TYPE IN THE GIS SYSTEM AND WERE ASSUMED TO HAVE A DESIGN LIFE OF 30 YEARS.

3. ANY ASSET WITHOUT A KNOWN INSTALLED DATE WAS ASSUMED TO BE PAST ITS DESIGN LIFE.

KEY PLAN:



CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

A1

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

GEORGETOWN SANITARY SYSTEM CONDITION ASSESSMENT

Three Rivers · WHERE HISTORY IS MADE ·

CBCL PROJECT #:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 6, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:2500

LEGEND

Background Data
- Provincial Mapped Wetlands
- Street Outline
- Property Lines

Sanitary Pipe Condition
- Very Poor
- Moderate
- Good
- Very Good

Sanitary Forcemain Condition
- Moderate
- Sanitary Lift Station
- Field Observed Manholes

NOTES:

1. CONDITION RATING BASED ON AGE OF ASSET AND ASSUMED MATERIAL DESIGN LIFE.

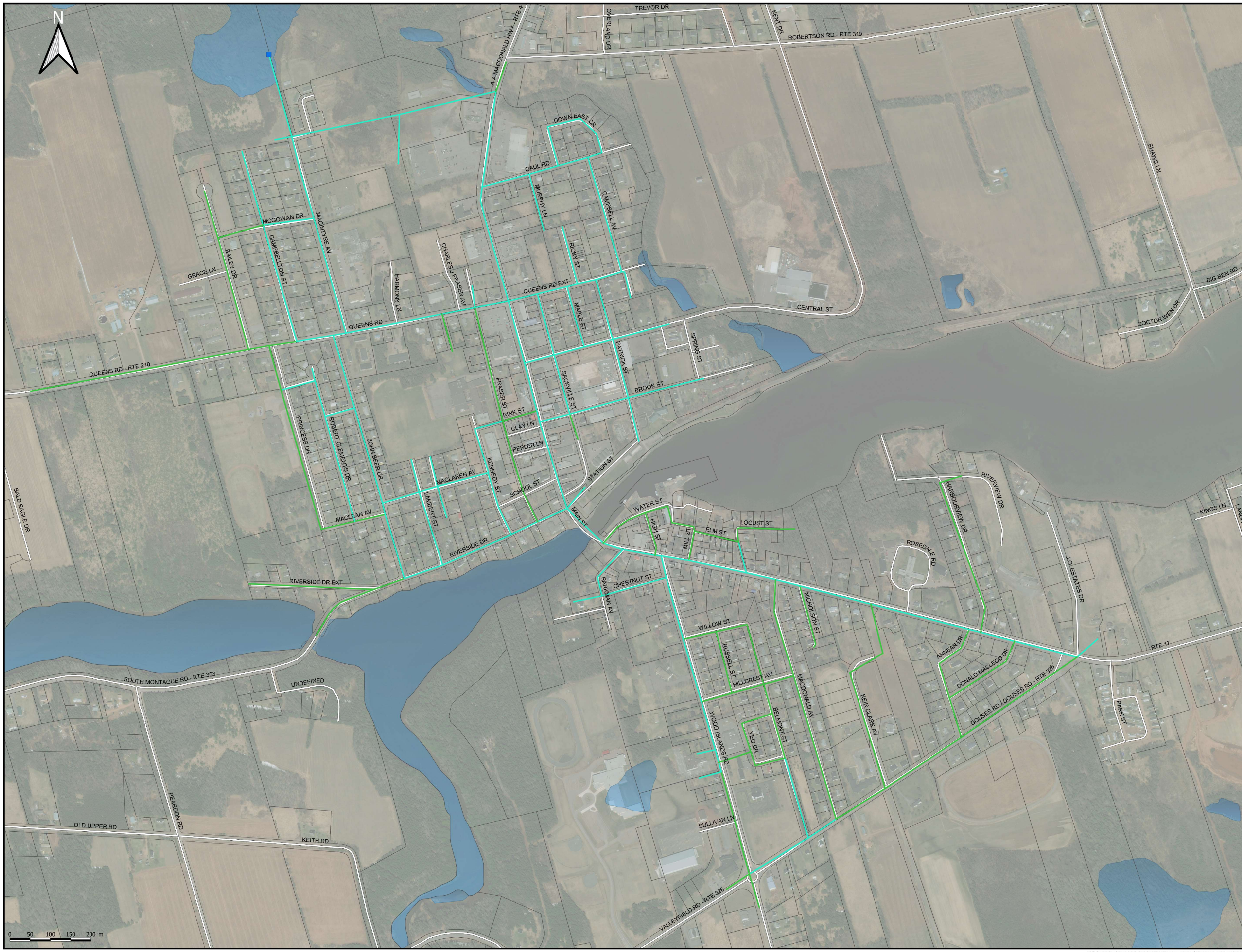
2. ANY ASSET LABELLED "UNKNOWN" DOES NOT HAVE A MATERIAL TYPE IN THE GIS SYSTEM AND WERE ASSUMED TO HAVE A DESIGN LIFE OF 30 YEARS.

3. ANY ASSET WITHOUT A KNOWN INSTALLED DATE WAS ASSUMED TO BE PAST ITS DESIGN LIFE.

KEY PLAN:

CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

A2



KEY PLAN:

CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

MONTAGUE WATER SYSTEM CONDITION ASSESSMENT

Three Rivers
· WHERE HISTORY IS MADE ·

CBCL PROJECT #:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 6, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:4000

LEGEND

Background Data
- Provincial Mapped Wetland
- Street Outline
- Property Lines

Water Pipe Condition
- Good
- Very Good
- Reservoirs

NOTES:

1. CONDITION RATING BASED ON AGE OF ASSET AND ASSUMED MATERIAL DESIGN LIFE.

2. ANY ASSET WITHOUT A KNOWN INSTALLED DATE WAS ASSUMED TO BE PAST ITS DESIGN LIFE.

CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

A3

Y:\Charlottetown\Data\CBCL Job Folders\2021\212621.00 Three Rivers - Water and Wastewater Master Plans\04 CAD-GIS\GIS\Condition Assessment\212621.00 Three Rivers GIS (Montague).qgz

CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

GEORGETOWN WATER SYSTEM CONDITION ASSESSMENT

Three Rivers
· WHERE HISTORY IS MADE ·

CBCL PROJECT #:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 6, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:3500

LEGEND

Background Data
- Provincial Mapped Wetlands
- Street Outline
- Property Lines

Water Pipe Condition
- Very Poor
- Moderate
- Good
- Very Good
- Georgetown Reservoirs
- Georgetown Wells

NOTES:

1. CONDITION RATING BASED ON AGE OF ASSET AND ASSUMED MATERIAL DESIGN LIFE.

2. ANY ASSET WITHOUT A KNOWN INSTALLATION DATE WAS ASSUMED TO BE PAST ITS DESIGN LIFE.

KEY PLAN:

CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

A4

CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

COMMUNITY OF CARDIGAN SERVICING CONCEPT

Three Rivers · WHERE HISTORY IS MADE ·

CBCL PROJECT NO.:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 6, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:2000

LEGEND

Background Data
- Provincial Mapped Wetlands
- Street Outline
- Property Lines

Elevation Data
- 2m-10m Contours

Community of Cardigan
- Potential Well
- Potential Watermain
- Potential Effluent Gravity Main
- Potential Effluent Forcemain
- Potential Residential Effluent Pump
- Potential Effluent Lift Station
- Potential Effluent Disposal Field

NOTES:

1. CONCEPT HAS BEEN DEVELOPED USING 2020 LIDAR DATA BASED ON THE VERTICAL GEODETIC DATUM OF 2013.

2. THE WASTEWATER SYSTEM IS A COMBINED SEPTIC TANK EFFLUENT GRAVITY SYSTEM AND SPETIC TANK EFFLUENT PUMP SYSTEM.

3. THE LOCATION OF THE TREATMENT SITE IS BASED ON SOIL CLASSIFICATION FROM PEI LAND ONLINE AND SHOULD BE VERIFIED BY ON SITE SUITABILITY INVESTIGATION PRIOR TO ANY WORK.

4. THE WELL LOCATION IS BASED ON A PREVIOUS WATER SUPPLY STUDY.

KEY PLAN:

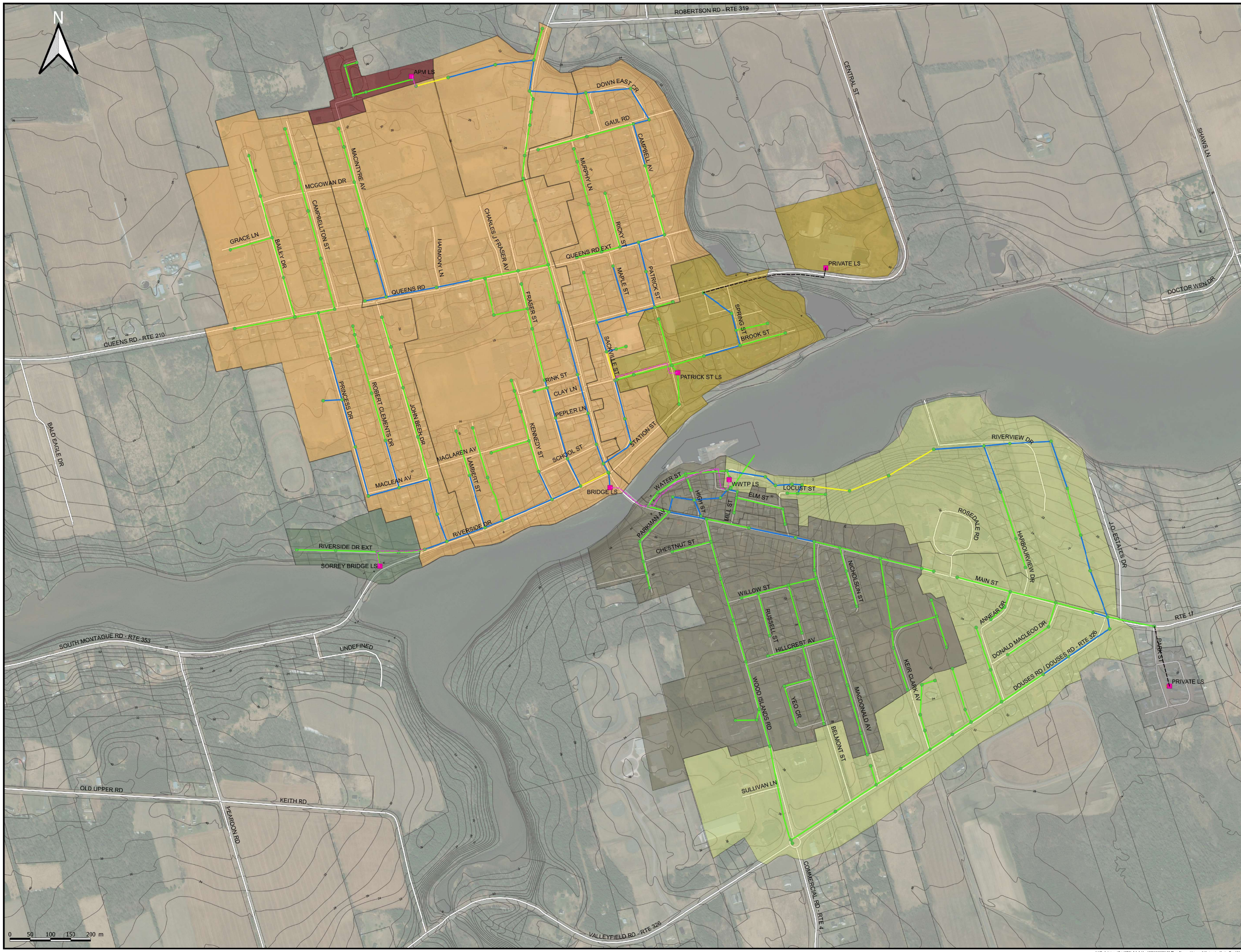
CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

A5

Y:\Charlottetown\Data\CBCL Job Folders\2021\212621.00 Three Rivers - Water and Wastewater Master Plans\44 CAD\08 GIS\212621.00 Cardigan.qgz 212621.00 Cardigan.qgz

APPENDIX B

Sanitary System Master Plan Maps



CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

MONTAGUE SANITARY SYSTEM EXISTING CONDITIONS

Three Rivers
· WHERE HISTORY IS MADE ·

CBCL PROJECT #:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 6, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:4000

LEGEND

Background Data
- Street Outline
- Property Lines

Elevation Data
- 2m-10m Contours

Sanitary Manholes
- Surcharge
- No Surcharge

Sanitary Pipes
- 0%-19% Capacity
- 20% - 39% Capacity
- 40%-59% Capacity

Existing Sanitary Catchments
- Bridge Lift Station
- APM Lift Station
- Sorrey Bridge
- Patrick Street
- Private
- WWTP Lift Station
- WWTP Gravity

Sanitary Forcemain
- Municipal Forcemain
- Private Forcemain
- Sanitary Lift Station

NOTES:

1. SANITARY MAP DISPLAYING MAXIMUM MODELLED FLOW UNDER PEAK FLOW CONDITIONS. A PEAKING FACTOR OF 3.6 WAS USED FOR MODELLING.

2. A PEAK DAY 24-HOUR FLOWOF 1740m3 RESULTED FROM THE ANALYSIS.

KEY PLAN:

CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

B1

CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

GEORGETOWN SANITARY SYSTEM EXISTING CONDITIONS

Three Rivers · WHERE HISTORY IS MADE ·

CBCL PROJECT#:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	AUGUST 12, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:2500

LEGEND

Background Data
- Provincial Mapped Wetland
- Street Outline
- Property Lines

Elevation Data
- 2m-10m Contours

Sanitary Manholes
- Surcharge
- No Surcharge

Sanitary Pipes
- 0%-19% Capacity
- 20% - 39% Capacity
- 80% - 100% Capacity
- Storm Pipe
- Sanitary Forcemain
- Lift Station

Sanitary Catchments
- West Street
- Lagoon Gravity

NOTES:

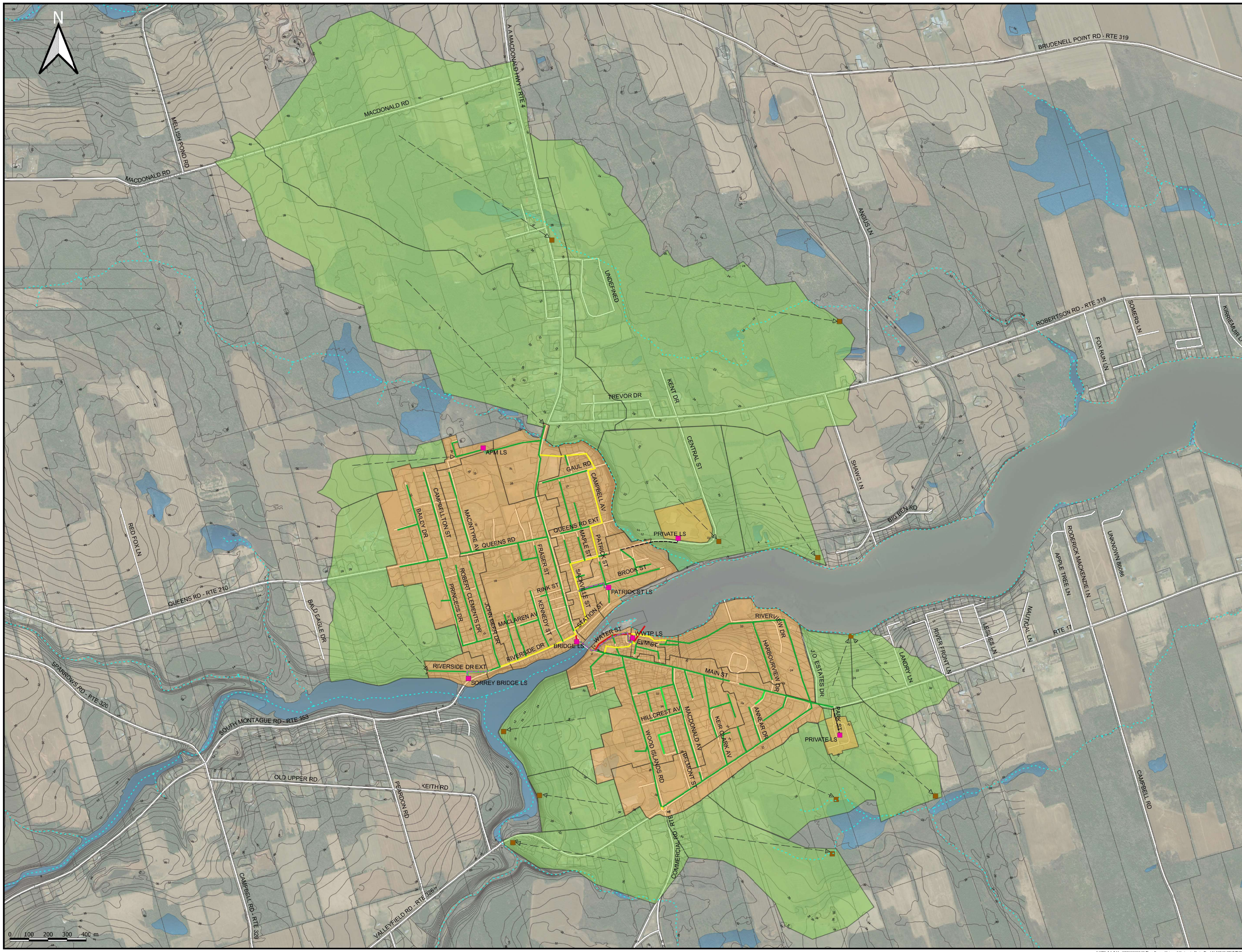
1. SANITARY MAP DISPLAYING MAXIMUM MODELLED FLOW UNDER PEAK FLOW CONDITIONS. A PEAKING FACTOR OF 3.6 WAS USED FOR MODELLING.

2. A PEAK DAY 24-HOUR FLOW OF 417m3 RESULTED FROM THE ANALYSIS.

KEY PLAN:

CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

B2



CBCL

PROJECT TITLE

THREE RIVERS
WATER AND WASTEWATER
MASTER PLANS

DRAWING TITLE

MONTAGUE
SANITARY SYSTEM
FULL BUILDOUT

Three Rivers
WHERE HISTORY IS MADE

CBCL PROJECT #: 212621.00
CREATED BY: AHG
REVIEWED BY: PSH
APPROVED BY: PSH
ISSUE DATE: JULY 6, 2022
LASTEST REVISION: ISSUED FOR FINAL REPORT
MAP SCALE: 1:8500

LEGEND

Background Data
- Existing Wetland
- Street Outline
- Property Lines
- Existing Watercourse

Elevation Data
- 2m-10m Contours

Sanitary Forcemain
- Municipal Forcemain
- Private Forcemain
- Existing Lift Station
- Potential Lift Station

Sanitary Subcatchment
- Potential Subcatchment
- Existing Subcatchment

Santiary Pipes
- Less Than 200mm
- 200mm
- 250mm
- Greater Than 300mm

NOTES:

1. MAP DISPLAYING POTENTIAL SANITARY SERVICING EXTENSION BOUNDARIES.

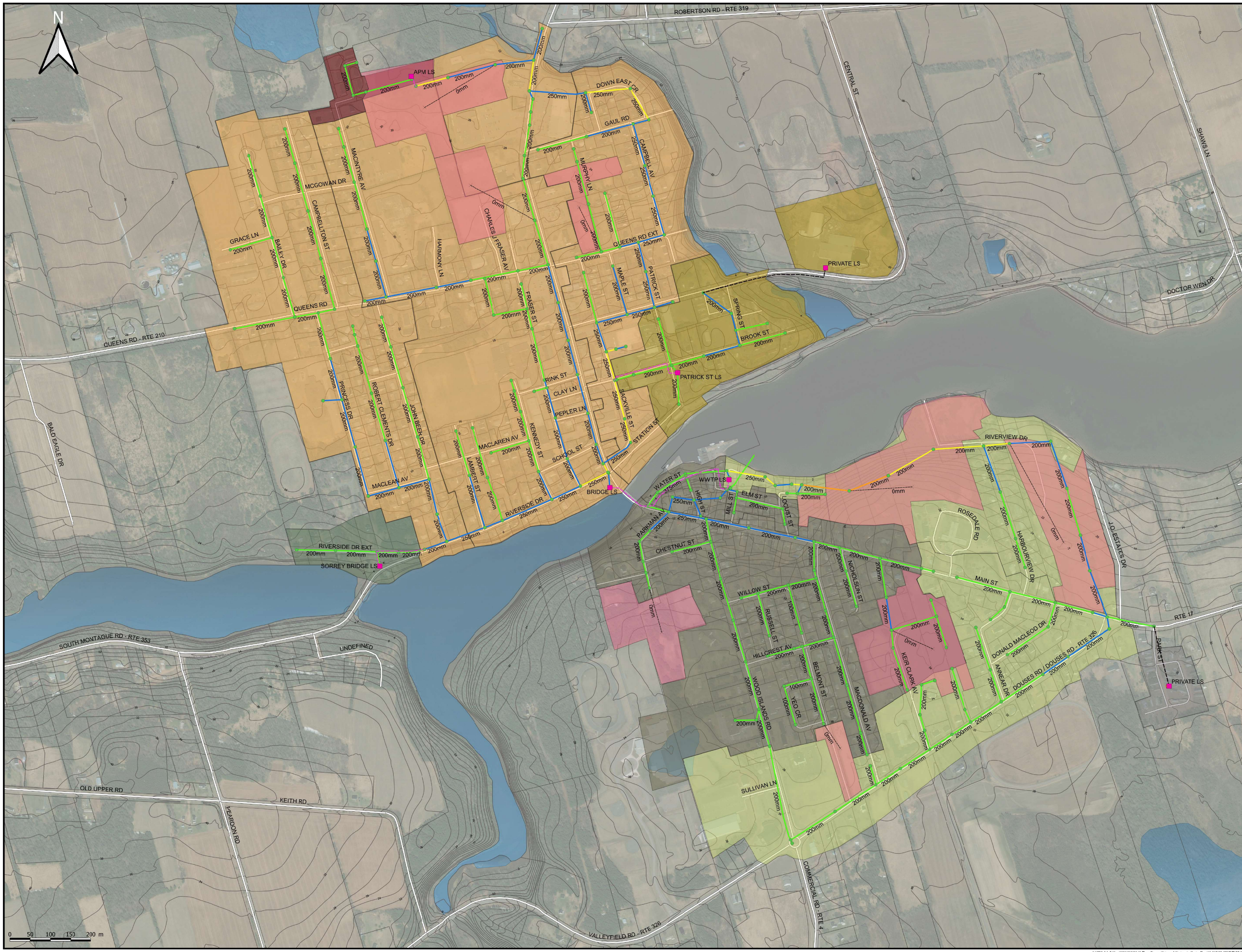
2. EXISTIN SANITARY PIPES ARE RENDERED BASED ON SIZE OF PIPE.

KEY PLAN:

MONTAGUE

CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

B3



CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

MONTAGUE SANITARY SYSTEM INFILL GROWTH SCENARIO

Three Rivers · WHERE HISTORY IS MADE ·

CBCL PROJECT#:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 6, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:4000

LEGEND

Background Data
- Provincial Mapped Wetland
- Street Outline
- Property Lines

Elevation Data
- 2m-10m Contours

Sanitary Manholes
- Surcharge
- No Surcharge
- FUTURE

Sanitary Pipes
- 0%-19% Capacity
- 20% - 39% Capacity
- 40%-59% Capacity
- 60% - 79% Capacity
- FUTURE

Sanitary Subcatchments
- Bridge Lift Station
- APM Lift Station
- Sorrey Bridge
- Patrick Street
- Private
- WWTP Lift Station
- WWTP Gravity
- Infill Areas

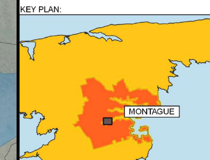
Sanitary Forcemain
- Municipal Forcemain
- Private Forcemain
- Existing Sanitary Lift Station

NOTES:

1. SANITARY MAP DISPLAYING MAXIMUM MODELLED FLOW UNDER PEAK FLOW CONDITIONS. A PEAKING FACTOR OF 3.6 WAS USED FOR MODELLING.

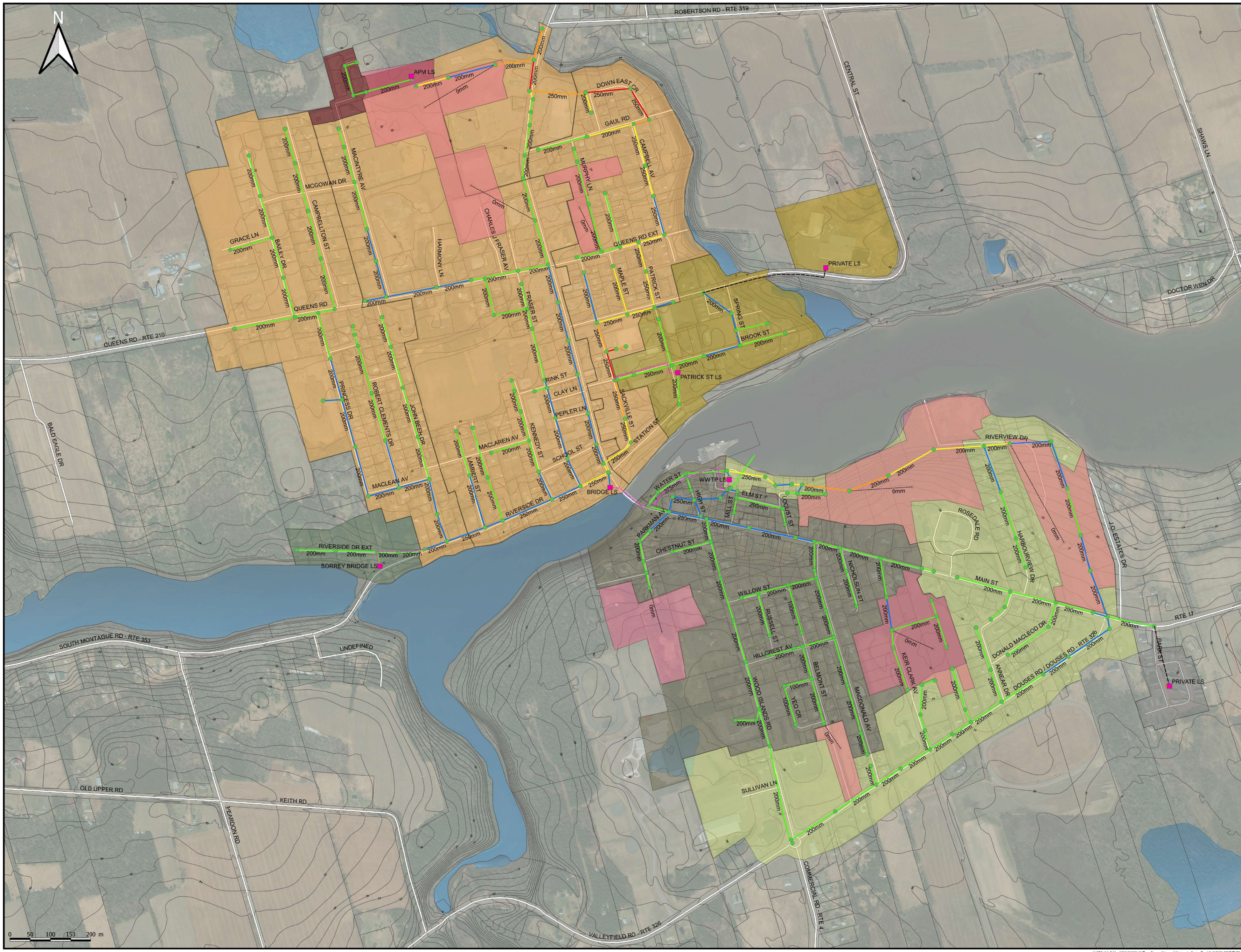
2. A PEAK DAY 24-HOUR FLOW OF 2510m3 RESULTED FROM THE ANALYSIS.

KEY PLAN:



CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

B4



CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

MONTAGUE SANITARY SYSTEM INFILL + MACDONALD ROAD EXTENSION SCENARIO

Three Rivers
WHERE HISTORY IS MADE

CBCL PROJECT #:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 6, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:4000

LEGEND

Background Data
- Provincial Mapped Wetland
- Street Outline
- Property Lines

Elevation Data
- 2m-10m Contours

Sanitary Manholes
- Surcharge
- No Surcharge
- Future

Sanitary Pipes
- 0%-19% Capacity
- 20% - 39% Capacity
- 40%-59% Capacity
- 60% - 79% Capacity
- 80% - 100% Capacity
- FUTURE

Existing Sanitary Catchments
- Bridge Lift Station
- APM Lift Station
- Sorrey Bridge
- Patrick Street
- Private
- WWTP Lift Station
- WWTP Gravity
- Infill Areas

Sanitary Forcemain
- Municipal Forcemain
- Private Forcemain
- Sanitary Lift Stations

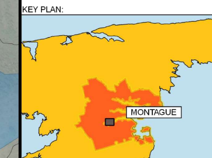
NOTES:

1. ASSUMED ALL EXISTING DEVELOPED AREAS TO THE MACDONALD ROAD ARE CONTRIBLTING TO THE SANITARY SYSTEM.

2. SANITARY MAP DISPLAYING MAXIMUM MODELLED FLOW UNDER PEAK FLOW CONDITIONS. A PEAKING FACTOR OF 3.6 WAS USED FOR MODELLING.

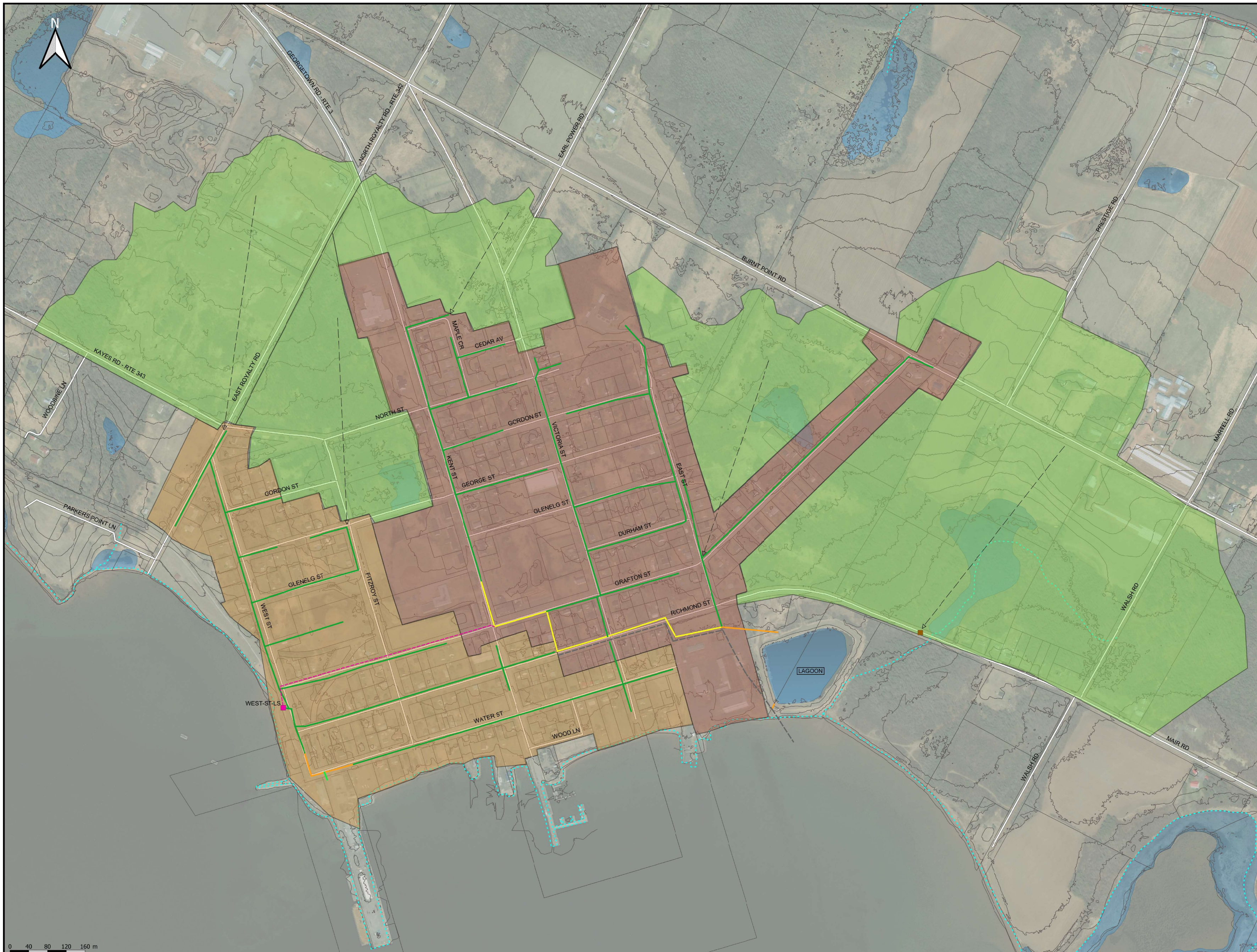
3. A PEAK DAY 24-HOUR FLOW OF 3150m3 RESULTED FROM THE ANALYSIS.

KEY PLAN:



CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

B5



CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

GEORGETOWN SANITARY SYSTEM FULL BUILDOUT

Three Rivers
· WHERE HISTORY IS MADE ·

CBCL PROJECT #:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	AUGUST 12, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:3500

LEGEND

Background Data
- Provincial Mapped Wetland
- Street Outline
- Property Line
- Existing Watercourse

Elevation Data
- 2m-10m Contours

Sanitary Pipes
- Less Than 200mm
- 200mm
- 250mm
- 300mm
- Storm Pipe

Sanitary Forcemain
- Existing Forcemain
- Existing Lift Station
- Potential Lift Station

Sanitary Subcatchment
- West Street
- Lagoon Gravity
- Potential Subcatchment

NOTES:

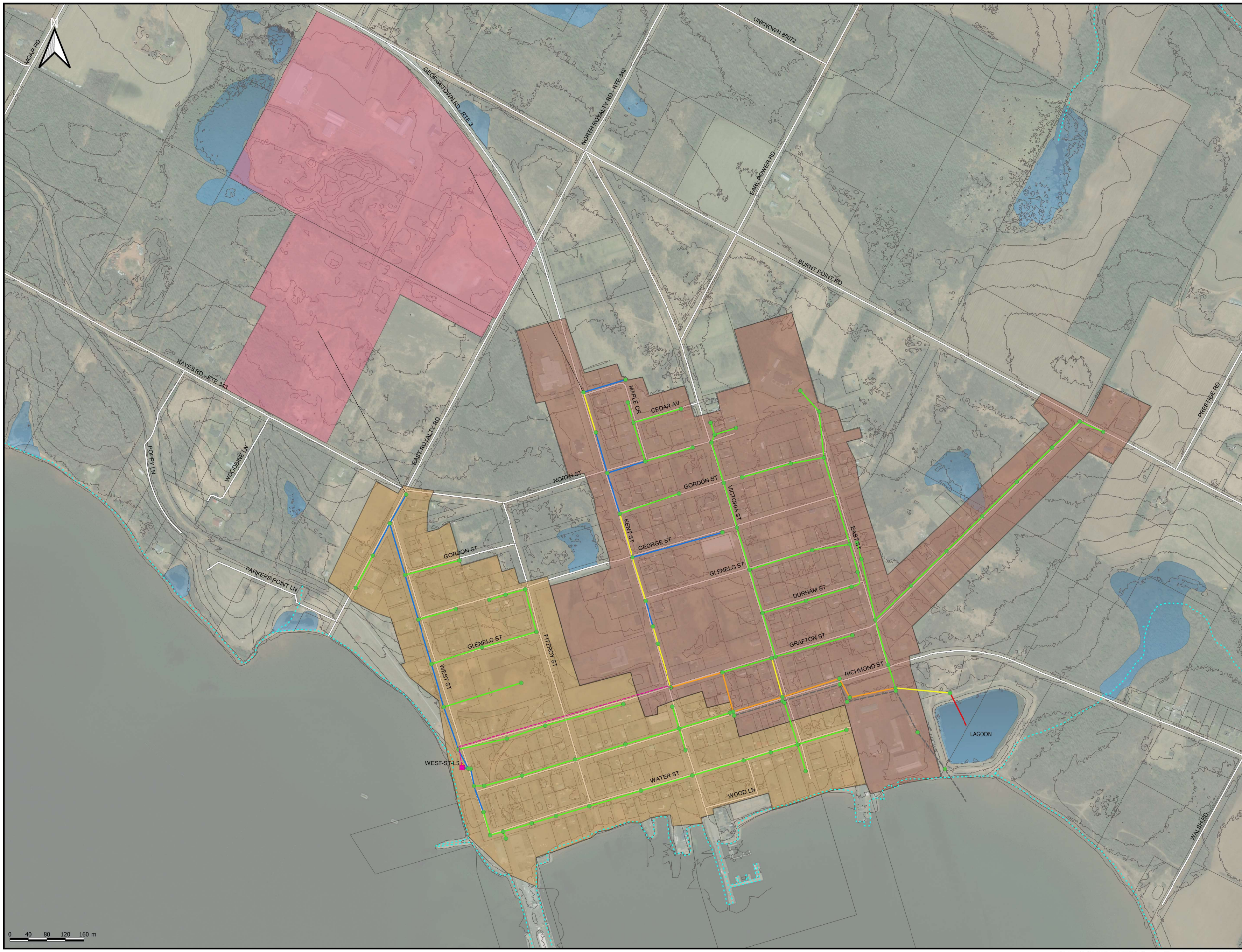
1. MAP IS DISPLAYING POTENTIAL SANITARY SERVICING EXTENSION BOUNDARIES.

2. EXISTING SANITARY PIPES ARE RENDERED BASED ON PIPE SIZE.

KEY PLAN:

CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

B6



CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

GEORGETOWN SANITARY SYSTEM EX. CONDITIONS PLUS BUSINESS PARK

Three Rivers · WHERE HISTORY IS MADE ·

CBCL PROJECT#:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	AUGUST 12, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:3500

LEGEND

Background Data
- Provincial Mapped Wetland
- Street Outline
- Property Lines
- Existing Watercourse

Elevation Data
- 2m-10m Contours

Sanitary Subcatchments
- West Street
- Lagoon Gravity
- Business Park

Sanitary Manholes
- Surcharge
- No Surcharge
- Future

Sanitary Pipes
- 0%-19% Capacity
- 20% - 39% Capacity
- 40%-59% Capacity
- 60% - 79% Capacity
- 80% - 100% Capacity
- Storm Pipe
- FUTURE

Sanitary Forcemain
- Forcemain
- Lift Station

NOTES:

1. ASSUMING FULL DEVELOPMENT OF THE PROPOSED BUSINESS PARK AND NO ADDITIONAL GROWTH.

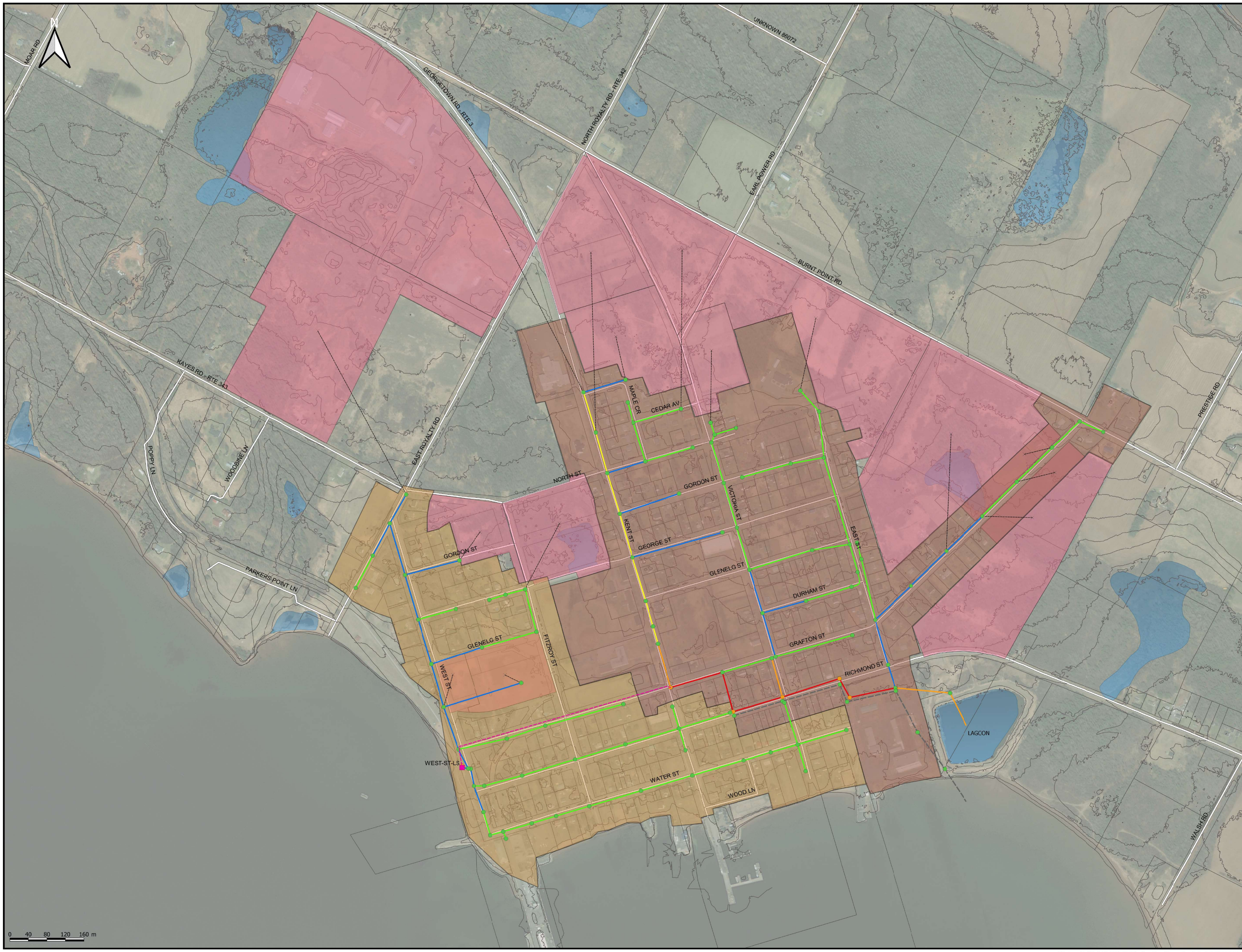
2. SANITARY MAP DISPLAYING MAXIMUM MODELLED FLOW UNDER PEAK FLOW CONDITIONS. A PEAKING FACTOR OF 3.6 WAS USED FOR MODELLING.

3. A PEAK DAY 24-HOUR FLOW OF 1800m3 RESULTED FROM THE ANALYSIS.

KEY PLAN:

CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

B7



CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

GEORGETOWN SANITARY SYSTEM BUSINESS PARK PLUS FULL BUILDOUT

Three Rivers · WHERE HISTORY IS MADE ·

CBCL PROJECT #:	212621.00
CREATED BY:	AHG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	AUGUST 12, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:3500

LEGEND

Background Data
- Provincial Mapped Wetland
- Street Outline
- Property Lines

Elevation Data
- 2m-10m Contours

Sanitary Subcatchments
- West Street
- Lagoon Gravity
- Potential Growth

Sanitary Forcemain
- Forcemain
- Lift Station

Sanitary Manholes
- Surcharge
- No Surcharge
- Future

Sanitary Pipes
- 0%-19% Capacity
- 20% - 39% Capacity
- 40%-59% Capacity
- 60% - 79% Capacity
- 80% - 100% Capacity
- Storm Pipe
- FUTURE

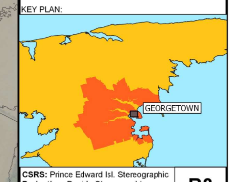
NOTES:

1. ASSUMING FULL DEVELOPMENT OF THE PROPOSED BUSINESS PARK AND FULL DEVELOPMENT OF EXISTING SERVICE BOUNDARY.

2. SANITARY MAP DISPLAYING MAXIMUM MODELLED FLOW UNDER PEAK FLOW CONDITIONS. A PEAKING FACTOR OF 3.6 WAS USED FOR MODELLING.

3. A PEAK DAY 24-HOUR FLOW OF 2700m3 RESULTED FROM THE ANALYSIS.

KEY PLAN:

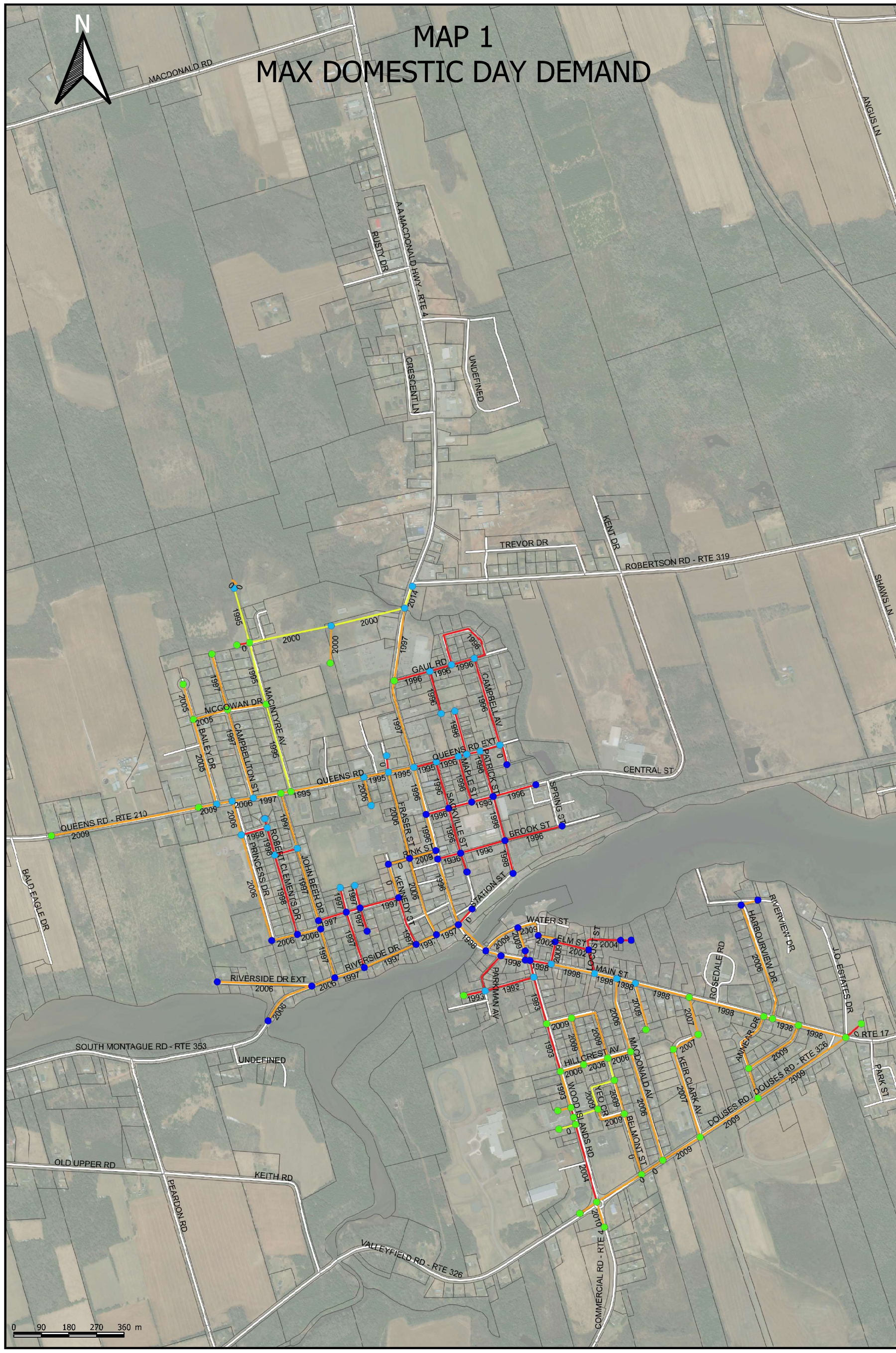


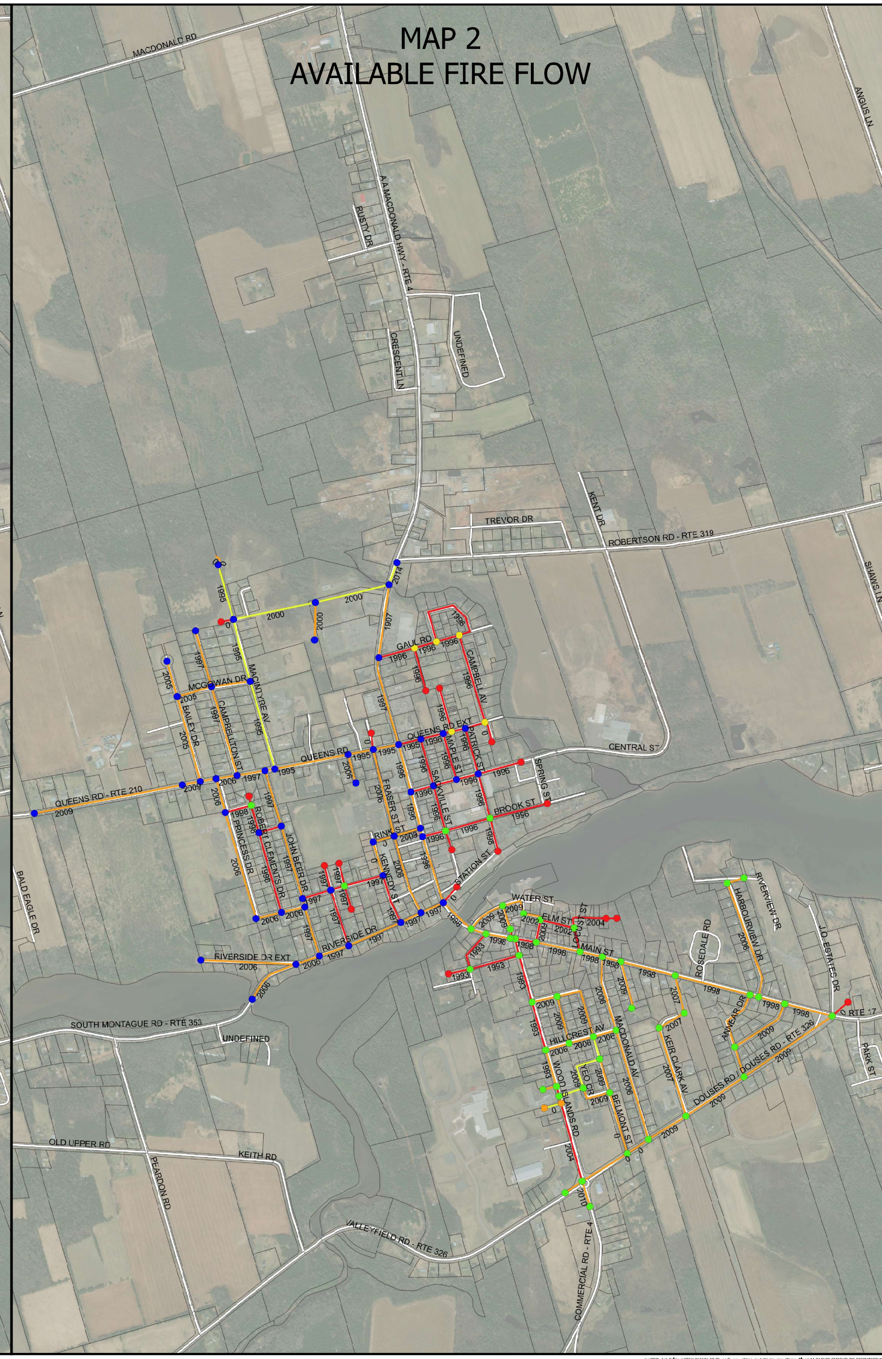
CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

B8

APPENDIX C

Water System Master Plan Maps





CBCL

PROJECT TITLE

THREE RIVERS
WATER AND WASTEWATER
MASTER PLANS

DRAWING TITLE

MONTAGUE
WATER SYSTEM
EXISTING CONDITIONS

Three Rivers
WHERE HISTORY IS MADE

CBCL PROJECT #:	212621.00
CREATED BY:	TDG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 6, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:7500

LEGEND

Background Data
- Street Outline
- Property Line

Watermains
- 100mmØ (D.I.)
- 150mmØ (D.I.)
- 200mmØ (D.I.)
- 250mmØ (D.I.)
- 300mmØ (D.I.)
- 350mmØ (D.I.)
- 100mmØ (PVC)
- 150mmØ (PVC)
- 200mmØ (PVC)
- 250mmØ (PVC)
- 300mmØ (PVC)
- 350mmØ (PVC)

Junctions
- Less than 20psi
- 20psi-40psi
- 40psi-60psi
- 60psi - 80psi
- 80psi - 95psi
- 950psi - 120psi
- Greater than 120

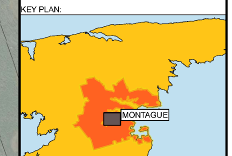
Available Fire Flow
- Less than 1500LPM
- 1500-2000LPM
- 2000-2500LPM
- 2500-3000LPM
- Greater than 3000LPM

NOTES:

1. MAP 1 DISPLAYING RESIDUAL PRESSURES AT MAX DOMESTIC DAY DEMAND AND NO FIRE FLOW.

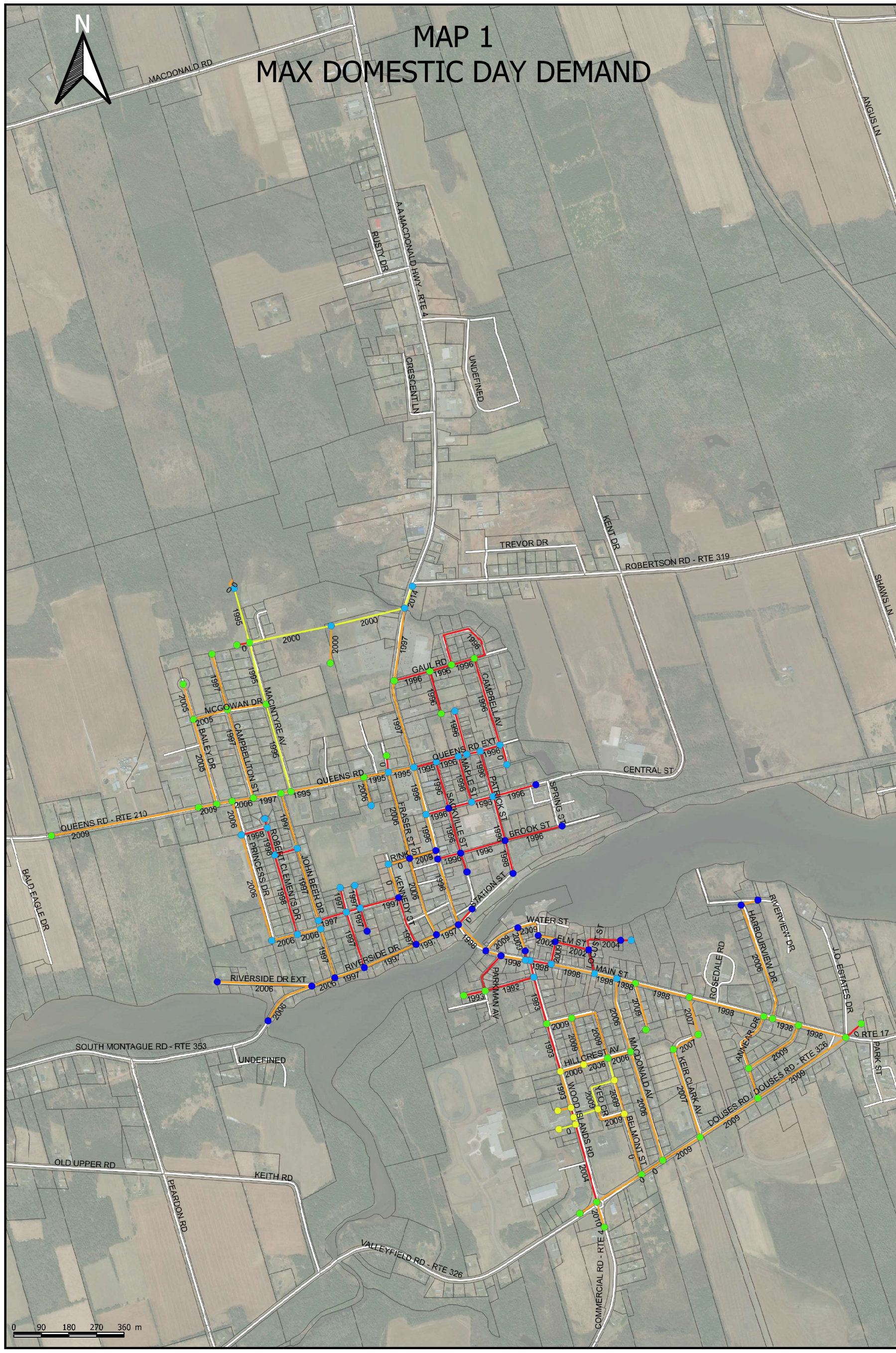
2. MAP 2 DISPLAYING AVAILABLE FIRE FLOW BY NODE ASSUMING DOMESTIC BOOSTER PUMPS AND FIRE PUMP ARE ALL ACTIVE.

KEY PLAN:



CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

C1



CBCL

PROJECT TITLE

THREE RIVERS
WATER AND WASTEWATER
MASTER PLANS

DRAWING TITLE

MONTAGUE
WATER SYSTEM
INFILL GROWTH SCENARIO

Three Rivers
WHERE HISTORY IS MADE

CBCL PROJECT #:	212621.00
CREATED BY:	TDG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 6, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:7500

LEGEND

Background Data
- Street Outline
- Property Lines

Watermains
- 100mmØ (D.I.)
- 150mmØ (D.I.)
- 200mmØ (D.I.)
- 250mmØ (D.I.)
- 300mmØ (D.I.)
- 350mmØ (D.I.)
- 100mmØ (PVC)
- 150mmØ (PVC)
- 200mmØ (PVC)
- 250mmØ (PVC)
- 300mmØ (PVC)
- 350mmØ (PVC)

Junctions
- Less than 20psi
- 20psi-40psi
- 40psi-60psi
- 60psi - 80psi
- 80psi - 95psi
- 950psi - 120psi
- Greater than 120

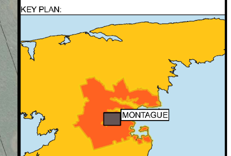
Available Fire Flow
- Less than 1500LPM
- 1500-2000LPM
- 2000-2500LPM
- 2500-3000LPM
- Greater than 3000LPM

NOTES:

1. MAP 1 DISPLAYING RESIDUAL PRESSURES AT MAX DOMESTIC DAY DEMAND AND NO FIRE FLOW.

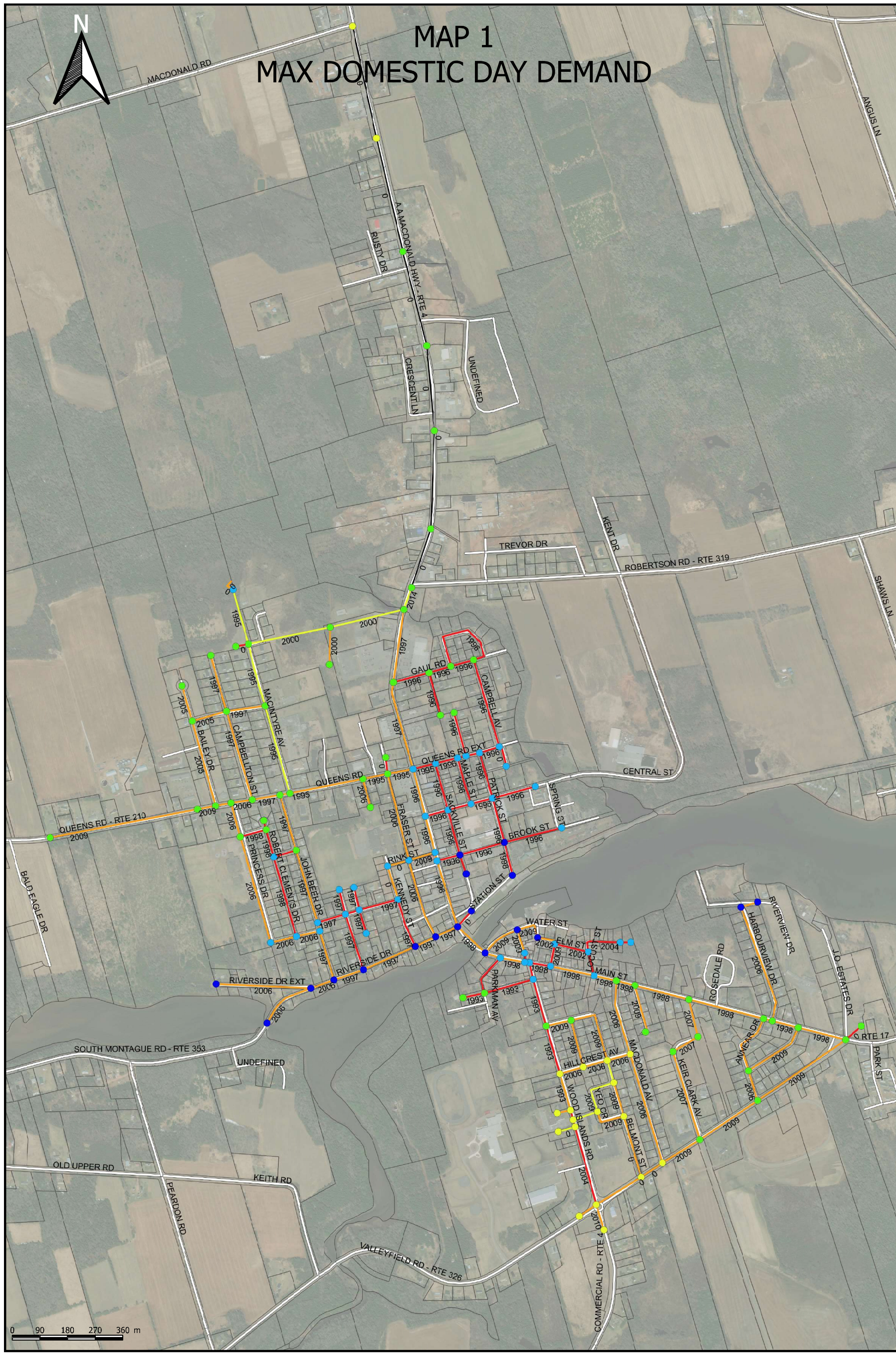
2. MAP 2 DISPLAYING AVAILABLE FIRE FLOW BY NODE WITH FIRE PUMP ACTIVE AND ASSUMING DOMESTIC BOOSTER PUMPS ARE ONLY ABLE TO PROVIDE FLOW FOR DOMESTIC DEMANDS.

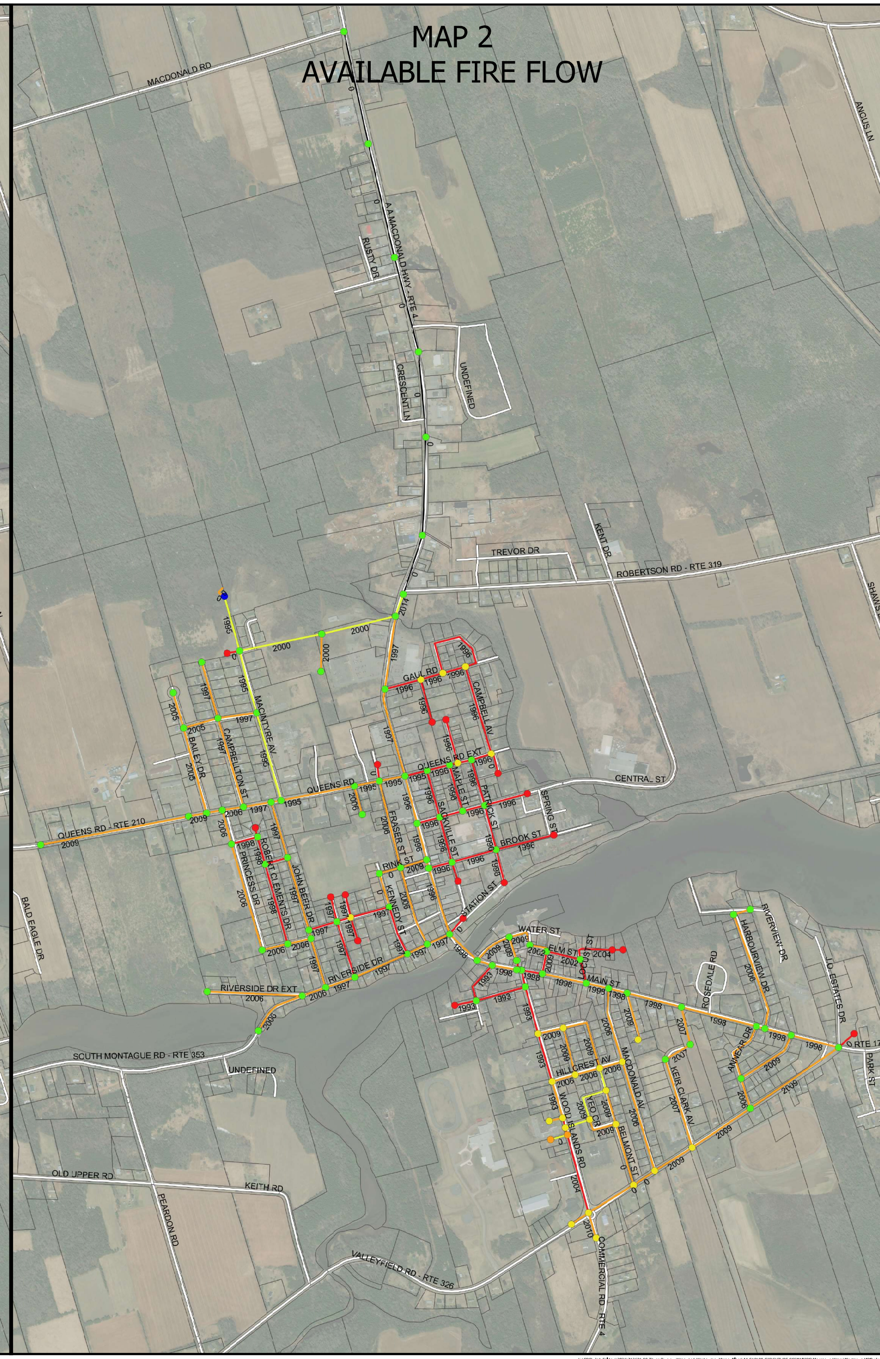
KEY PLAN:



CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

C2





CBCL

PROJECT TITLE

THREE RIVERS
WATER AND WASTEWATER
MASTER PLANS

DRAWING TITLE

MONTAGUE
WATER SYSTEM
INFILL + MACDONALD ROAD
SCENARIO

Three Rivers
WHERE HISTORY IS MADE

CBCL PROJECT#:	212621.00
CREATED BY:	TDG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 6, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:7500

LEGEND

Background Data
- Street Outline
- Property Lines

Watermains
- Future Pipes
- 100mmØ (D.I.)
- 150mmØ (D.I.)
- 200mmØ (D.I.)
- 250mmØ (D.I.)
- 300mmØ (D.I.)
- 350mmØ (D.I.)
- 100mmØ (PVC)
- 150mmØ (PVC)
- 200mmØ (PVC)
- 250mmØ (PVC)
- 300mmØ (PVC)
- 350mmØ (PVC)

Junctions
- Less than 20psi
- 20psi-40psi
- 40psi-60psi
- 60psi - 80psi
- 80psi - 95psi
- 950psi - 120psi
- Greater than 120

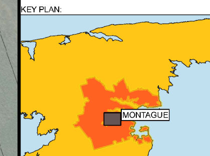
Available Fire Flow
- Less than 1500LPM
- 1500-2000LPM
- 2000-2500LPM
- 2500-3000LPM
- Greater than 3000LPM

NOTES:

1. MAP 1 DISPLAYING RESIDUAL PRESSURES AT MAX DOMESTIC DAY DEMAND AND NO FIRE FLOW.

2. MAP 2 DISPLAYING AVAILABLE FIRE FLOW BY NODE WITH FIRE PUMP ACTIVE AND ASSUMING DOMESTIC BOOSTER PUMPS ARE ONLY ABLE TO PROVIDE FLOW FOR DOMESTIC DEMANDS.

KEY PLAN:



CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

C3

CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

GEORGETOWN WATER SYSTEM EXISTING CONDITIONS

Three Rivers

WHERE HISTORY IS MADE

CBCL PROJECT#:	212621.00
CREATED BY:	TDG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 5, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:3500

LEGEND

Background Data
- Street Outline
- Property Lines

Watermains
- 100mmØ (Steel)
- 150mmØ (Steel)
- 200mmØ (Steel)
- 250mmØ (Steel)
- 300mmØ (Steel)
- 350mmØ (Steel)
- 100mmØ (PVC)
- 150mmØ (PVC)
- 200mmØ (PVC)
- 250mmØ (PVC)
- 300mmØ (PVC)
- 350mmØ (PVC)

Junctions
- Less than 20psi
- 20psi-40psi
- 40psi-60psi
- 60psi - 80psi
- 80psi - 95psi
- 950psi - 120psi
- Greater than 120

NOTES:

1. MAP DISPLAYING RESIDUAL PRESSURES AT MAX DAY DOMESTIC DEMAND AND NO FIRE FLOW.

KEY PLAN:

CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

C4

CBCL

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

GEORGETOWN WATER SYSTEM INFILL GROWTH SCENARIO

Three Rivers
WHERE HISTORY IS MADE

CBCL PROJECT #:	212621.00
CREATED BY:	TDG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 5, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:3500

LEGEND

Background Data
- Street Outline
- Property Lines

Watermains
- Future Pipes
- 100mmØ (Steel)
- 150mmØ (Steel)
- 200mmØ (Steel)
- 250mmØ (Steel)
- 300mmØ (Steel)
- 350mmØ (Steel)
- 100mmØ (PVC)
- 150mmØ (PVC)
- 200mmØ (PVC)
- 250mmØ (PVC)
- 300mmØ (PVC)
- 350mmØ (PVC)

Junctions
- Less than 20psi
- 20psi-40psi
- 40psi-60psi
- 60psi - 80psi
- 80psi - 95psi
- 950psi - 120psi
- Greater than 120

NOTES:

1. MAP DISPLAYING RESIDUAL PRESSURES AT MAX DAY DOMESTIC DEMAND AND NO FIRE FLOW.

KEY PLAN:

CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

C5

PROJECT TITLE

THREE RIVERS WATER AND WASTEWATER MASTER PLANS

DRAWING TITLE

GEORGETOWN WATER SYSTEM FULL BUILDOUT

Three Rivers · WHERE HISTORY IS MADE ·

CBCL PROJECT #:	212621.00
CREATED BY:	TDG
REVIEWED BY:	PSH
APPROVED BY:	PSH
ISSUE DATE:	JULY 5, 2022
LASTEST REVISION:	ISSUED FOR FINAL REPORT
MAP SCALE:	1:3500

LEGEND

Background Data
- Street Outline
- Property Lines

Watermains
- Future Pipes
- 100mmØ (Steel)
- 150mmØ (Steel)
- 200mmØ (Steel)
- 250mmØ (Steel)
- 300mmØ (Steel)
- 350mmØ (Steel)
- 100mmØ (PVC)
- 150mmØ (PVC)
- 200mmØ (PVC)
- 250mmØ (PVC)
- 300mmØ (PVC)
- 350mmØ (PVC)

Junctions
- Less than 20psi
- 20psi-40psi
- 40psi-60psi
- 60psi - 80psi
- 80psi - 95psi
- 950psi - 120psi
- Greater than 120

NOTES:

1. MAP DISPLAYING RESIDUAL PRESSURES AT MAX DAY DOMESTIC DEMAND AND NO FIRE FLOW.

KEY PLAN:

CSRS: Prince Edward Isl. Stereographic
Projection: Double Stereographic
Datum: North American 1983

C6

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