Bible Hill Sanitary Sewer System Study
Final Report

March 18, 2021

Prepared for:

BIBLE HILL
Plant Your Roots

arva

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Prepared for:
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RVA 205335

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APPENDICES

1.0 INTRODUCTION

The Village of Bible Hill owns a sanitary sewer system to provide wastewater collection services to local residents and businesses. Sanitary sewerage is collected by the Village and conveyed to the Central Colchester Wastewater Treatment Facility in Truro where it is treated to meet Federal Wastewater discharge regulations. The Village's sanitary sewer system is comprised of approximately:

- 3 pumping stations,
- 42.0 km of gravity sewers,
- 1.4 km of forcemains, and
- 516 manholes

The Village retained R. V. Anderson Associates (RVA) in June 2020 to conduct a comprehensive assessment of its sanitary sewer system and develop a long-term capital needs assessment with written recommendations to return the system to a state of good repair. As part of the scope of work, RVA completed the following activities to document the quality of Village sanitary sewer infrastructure:

- Development of asset inventory and condition assessment standards.
- Development of a complete inventory of sanitary sewer, manhole and pumping station assets.
- Condition assessments of sewers, manholes and pump stations.
- Identification of rehabilitation strategies for sanitary sewer infrastructure and development of a 10-year capital plan based on recommendations.

Results of each stage of work are captured in Technical Memorandums 1 – 3. The purpose of this final report is to present the sanitary sewer network's current state of infrastructure, summarize the results of the short and long-term needs assessment, and satisfy the Federation of Canadian Municipalities (FCM) funding requirements.

2.0 CURRENT STATE OF INFRASTRUCTURE

The current state of infrastructure summarizes the size, scope, value, condition, and risk of the Village's sanitary sewer infrastructure. The section provides a snapshot of where the Village's sewer infrastructure is today and is presented in the following categories:

- Inventory – summarizes the size and scope of the Village's sanitary sewer infrastructure and the sources of information used to populate the asset database,
- Valuation – establishes the current replacement value for infrastructure captured in the asset inventory,
- Condition – presents the current condition of sanitary sewer infrastructure and the methods used to estimate current condition,
- Risk – identifies the risk of failure associated with sanitary sewer infrastructure.

2.1 Inventory

An accurate and up-to date inventory of assets is critical in the assessment of system requirements and deployment of resources. This is a fundamental requirement to operate and maintain an effective asset management program, and the results of such a program will be reliant on the quality of data it is based on.

As mentioned above the Village of Bible Hill owns an extensive sanitary sewer system to provide wastewater collection services to the Village. Asset types included in the scope of this study are gravity sewers, forcemains, manholes, and pump stations. Other minor sewer infrastructure such as lateral service connections were not included. Moreover, the Village does not own or operate any wastewater treatment facilities – all sewerage is conveyed to the Central Colchester Wastewater Treatment Facility. Figure 1 illustrates a typical sanitary network with wastewater being collected from residential homes and businesses and conveyed through sanitary sewer pipes and pumping stations to a wastewater treatment plant.

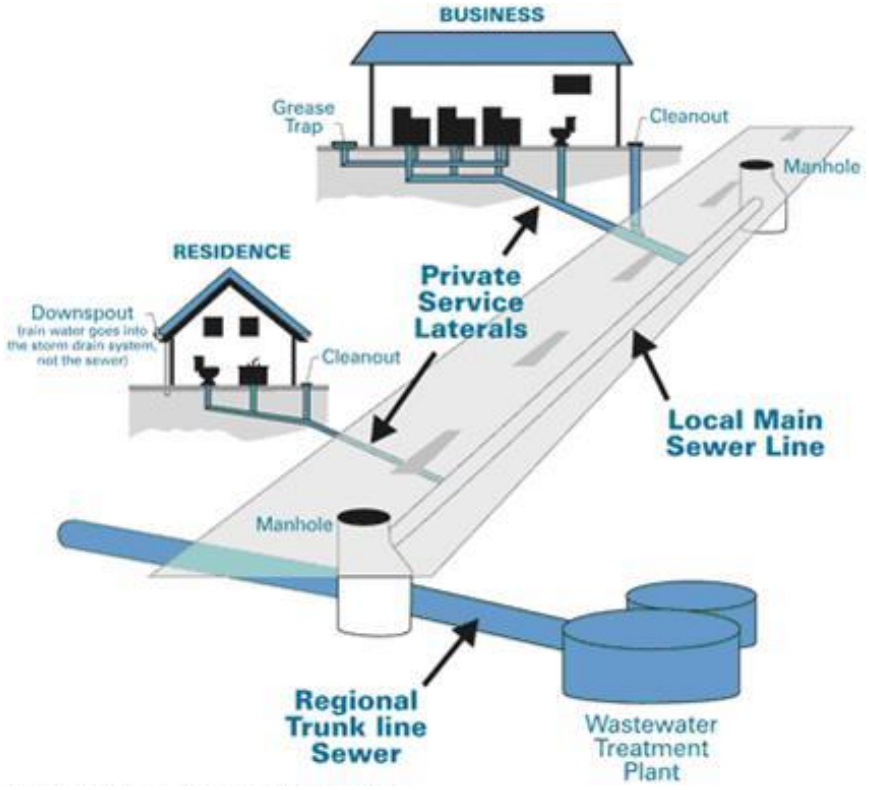


Figure 1: Sanitary Sewer System Diagram (Source – LA County Public Works Department)

This section provides a brief overview of the methodologies and sources of data used to generate the asset inventory and presents the total quantity of sanitary sewer infrastructure owned by the Village.

2.1.1 Methodology

The asset inventory database is generated from several sources of information. Sanitary sewer and manhole data are stored in an ESRI Shapefile, while pumping station data is managed in a Microsoft Excel workbook. Where possible, existing asset information was leveraged to be consistent with Municipality of Colchester records. During the review period all sources and forms of data available to RVA were reviewed to confirm and/or update existing asset information based on the data framework established in previous phases of work. This iterative methodology allowed RVA to replace asset information as required once more appropriate data became available. The flow chart presented in Figure 2 illustrates the process used to assemble the Village's asset inventory.

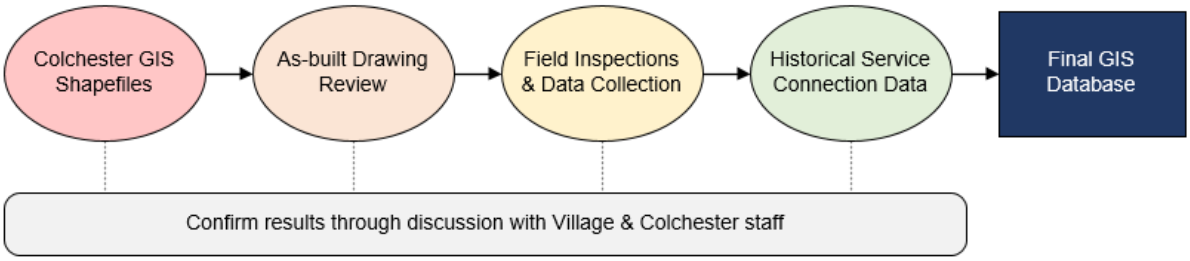


Figure 2: Asset Inventory Update Methodology

In summary, RVA began with the ESRI shapefiles provided by the Municipality of Colchester, validated and/or replaced existing asset information based on the review of as-built drawings provided by Village and Colchester staff, supplemented existing asset information using data collected during field inspections, and lastly used historical service connection data provided to address remaining gaps.

During this review process, several sources and types of data were used to update the asset inventory depending on the infrastructure type. Table 1 summarizes the sources of data and information used for each asset type and identifies significant features of each relevant data source.

A detailed description of the methods used to develop the asset inventory is provided in *Technical Memorandum #2 – Data Quality Assessment and Condition Summary*.

Table 1: Manhole, Sewer and Pump Station Data Sources

Data Source	Notes
Colchester GIS Shapefiles	GIS shapefiles maintained by the Municipality of Colchester which illustrates asset locations with corresponding asset information.
Colchester Excel CCTV Inspection Workbook	Excel workbook used to track the results of sanitary sewer system CCTV inspections completed by Colchester in previous years.

As-built Drawings	Record drawings provided by the Municipality of Colchester and the Village of Bible Hill which capture infrastructure details including dimensions, date of installation and/or infrastructure material type.
Service Connection Data	Residential and commercial sanitary service connection data provided by the Municipality of Colchester which is referenced to establish the ages of manholes and sewers.
Manhole Field Inspections	Field inspections completed by RVA staff to evaluate manhole condition and verify inventory data.
Pump Station Field Inspections	Field inspections completed by RVA staff to evaluate pumping station condition and performance and to collect relevant asset data.
CCTV Inspections	CCTV inspections of approximately 5.5 km of sewer pipe completed by RVA sub-contractors to validate asset data and evaluate pipe condition.

Pumping Stations

Sanitary pumping stations are unique and complex assets and were broken down into individual components / elements to facilitate reporting and long-term planning. Figure 3 demonstrates graphically the different component categories used for the Village's pumping station .

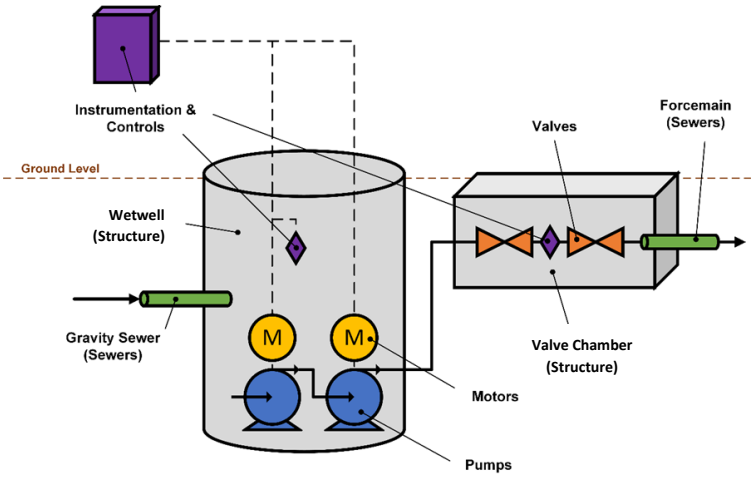


Figure 3: Sanitary Sewer Pump Station Component Breakdown

2.1.2 Results

The total quantity of sanitary sewer infrastructure owned by the Village of Bible Hill is summarized in Table 2.

Table 2. Inventory Quantity Summary

Asset Type	Quantity
Gravity Sewers	42,027m
Unknown	*173m*
150mm	*499m*
200mm	*30,039m*
250mm	*5,211m*
300mm	*3,017m*
375mm	*2,194m*
450mm	*894m*
Forcemains	1,366m
Manholes	516
Pumping Stations	3

A map illustrating the extent of the sanitary sewer system is shown in Figure 4.

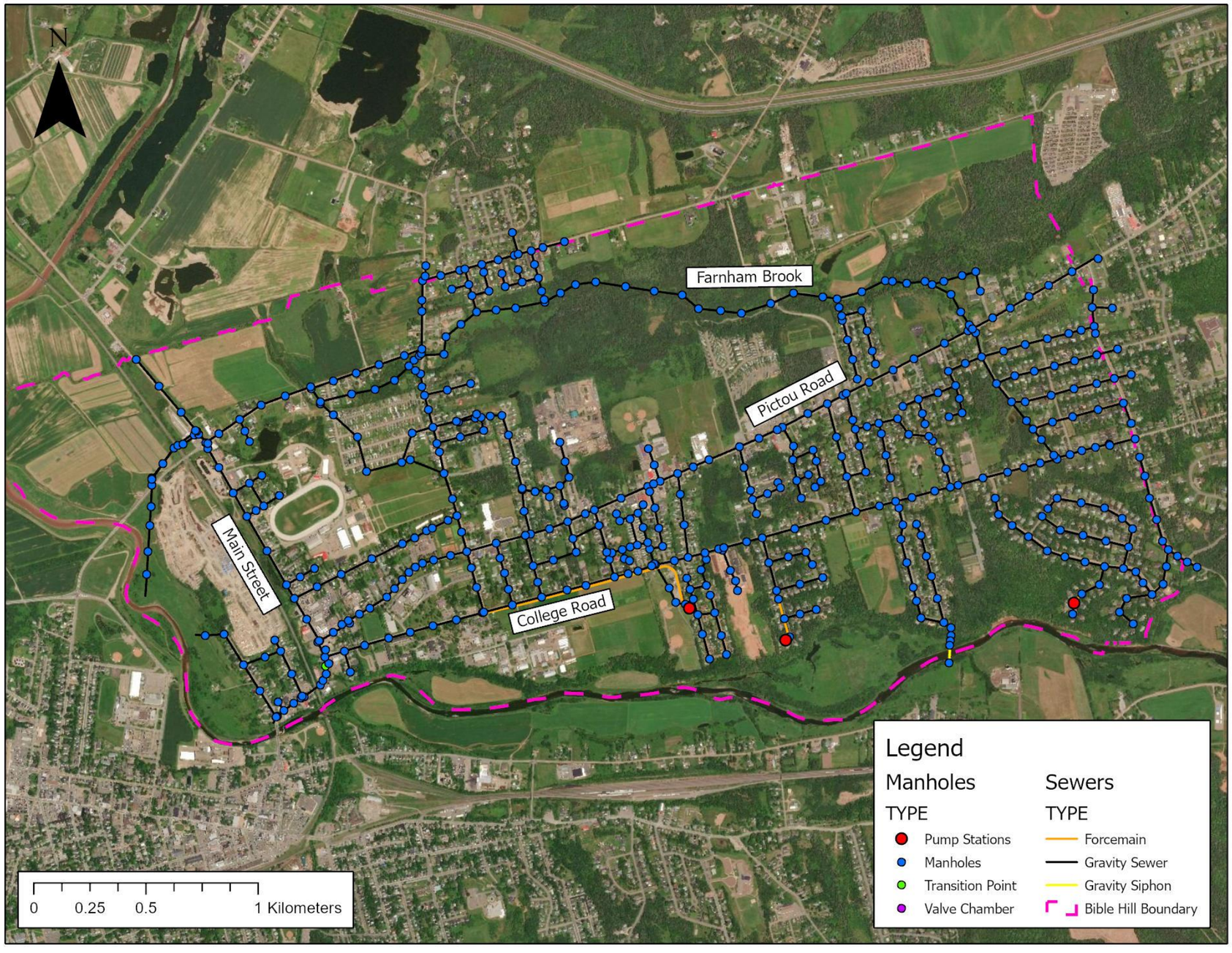


Figure 4: Sanitary Sewer System Map

2.2 Replacement Value

2.2.1 Methodology

The current replacement value (CRV) of infrastructure represents the total cost to replace each asset. CRVs are often used to better understand the size and scope of a community's infrastructure and forecast potential long-term investment needs (see section 3.0).

The CRV of the Village's infrastructure is calculated using a bottom-up approach, where each individual asset's replacement cost is estimated assuming the asset is replaced *like-for-like*. CRVs should be used with caution as their accuracy and level of detail is only sufficient to support benchmarking, financial reporting, and long-term financial planning. The estimates should not be relied on for short-term capital budgeting or as an engineer's estimate. Influencing factors such as local conditions, market trends, and system capacity assessments should be considered to ensure budgeting cost estimates reflect the true cost of replacement and/or upgrade.

CRVs for the Village's sanitary infrastructure are estimated using a combination of unit prices and engineering estimates. Linear infrastructure (sewers and manholes) costs are estimated using unit rates (Table 3 and Table 4), while pumping stations replacement costs are determined by summing the replacement cost of each component together. These estimates are determined on a case-by-case basis.

All estimates include labor, material, equipment, engineering (10%), and contingency (20%). They do not include HST.

Table 3. Sewer Unit Rates

Pipe Diameter (mm)	Unit Cost ($/m)		
	Depth < 3.0m	Depth 3.0 to 4.5m	Depth 4.5m to 6.0m
100	$670	$720	$840
150	$670	$730	$850
200	$670	$730	$850
250	$710	$770	$910
300	$760	$840	$1,000
375	$760	$840	$1,000
450	$770	$850	$1,010

Table 4. Manhole Unit Rates

Manhole Diameter (mm)	Unit Cost ($/m)		
	Depth < 3.0m	Depth 3.0 to 4.5m	Depth 4.5m to 6.0m
Field / Easement			
1050	$9,000	$9,700	$11,000
1500	$10,000	$10,800	$12,500
1800	$11,100	$12,100	$14,200
Roadway / Driveway / Shoulder / Sidewalk			
1050	$9,960	$10,660	$11,960
1500	$10,960	$11,760	$13,460
1800	$12,060	$13,060	$15,160

2.2.2 Results

The total replacement value of the Village's sanitary sewer infrastructure is summarized in Figure 5.

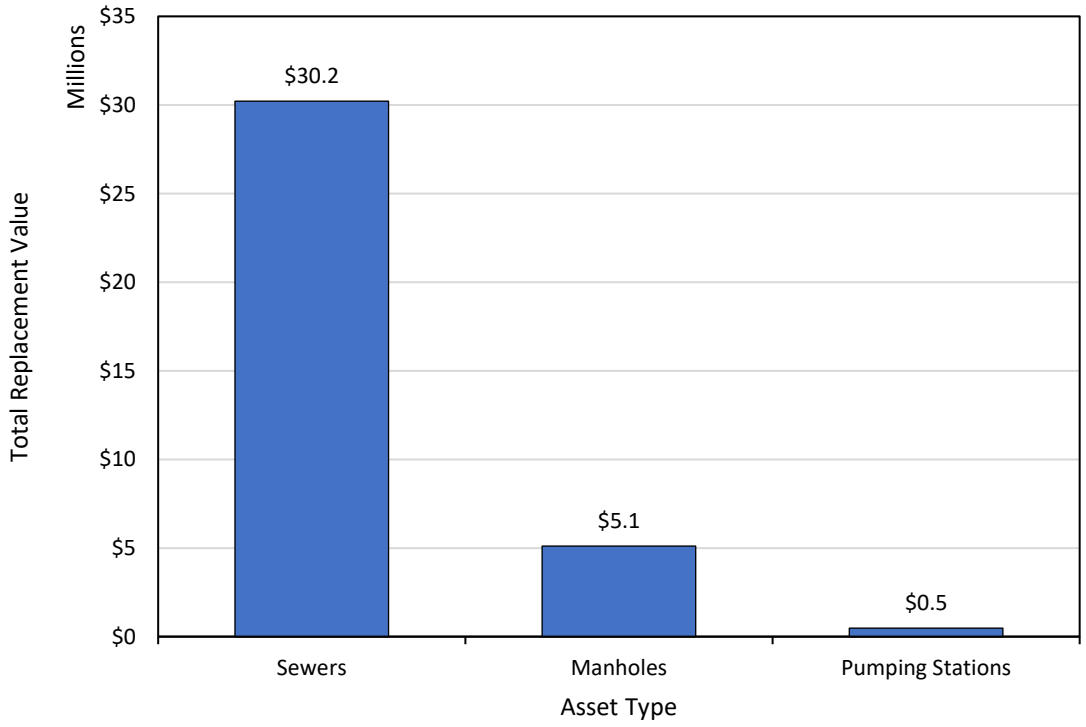


Figure 5. Current Replacement Value

The total replacement value of the Village's infrastructure is approximately **$35.8 million**. A significant majority (84%) of this value is located within the gravity sewer and forcemain infrastructure.

2.3 Condition

The current condition of the Village's sanitary sewer infrastructure was estimated using a combination of techniques, described below. This section describes the methodologies used to evaluate the condition of sanitary infrastructure and summarizes the overall state of repair of each asset type (sewers (including forcemains), manholes and pumping stations).

2.3.1 Methodology

Sewers

The condition of sanitary sewers is estimated using one of three sources of information, ranked in order of preference:

1. RVA Sewer CCTV Inspections
2. Colchester Sewer CCTV Inspections
3. Theoretical, Age-based Estimates

The most reliable method to evaluate the condition of sewers is the utilization of Closed-Circuit Television (CCTV) cameras which generate videos when passed through the sewer segment. CCTV videos allow engineering staff to locate and assess deficiencies and identify areas requiring repair or rehabilitation. In October 2020, RVA completed approximately 5.6 km of sanitary sewer inspections using CCTV. This quantity was established during the proposal submission stage for the project and agreed to by the Village of Bible Hill. Additionally, Colchester staff have conducted several CCTV studies in recent years, totalling 13.8 kms of the existing network. In total, 19.4 kms of gravity sewer have been inspected by CCTV representing 45% of the Village's sanitary sewer network.

Lastly, in the absence of CCTV inspections, or if insufficient information is available to make a reasonable estimate, pipe segment condition can be estimated using a simple, age-based estimate. Age-based estimates assume a pipe segment deteriorates at a standard deterioration rate and can be used to predict pipe condition. For assets with unknown dates of installation, their age was estimated using the as-built drawings provided by Colchester and Bible Hill as well as the service connection data for buildings within the Village. This approach ensured the remaining 55% of the pipe network which were not part of recent inspections had appropriate condition estimates to facilitate long-term planning. This process follows standard practices established by Municipal Affairs in the Province of Nova Scotia.

A breakdown showing the different methodologies used to estimate sewer pipe condition is presented in Table 5.

Table 5: Sewer Condition Rating Sources

Source	Total Length (m)	% of Total
RVA CCTV Inspection	5,635	13%
Colchester CCTV Inspection	13,851	32%
Age-based Estimate	23,905	55%
TOTAL	**43,392**	**100%**

Manholes

The condition of manholes is estimated using one of three sources of information, ranked in order of preference:

1. RVA Manhole Inspection Records
2. Colchester Manhole Inspection Records
3. Theoretical, Age-based Estimates

Inspections completed by RVA were used as the top priority for assigning final condition ratings in the inventory as they were most recently completed. RVA completed 294 manhole inspections for the purposes of this work, including 57 incomplete inspections due to structures not being found or had limited access during field inspections.

The remaining manhole structures which were not inspected by RVA (approximately 200) were assigned condition ratings based on the records provided by the Municipality of Colchester and the Village of Bible Hill. In the event a manhole was not inspected by either RVA or Colchester staff, condition rating was estimated by using age as a proxy (i.e., recently constructed manholes assumed to be in a Good condition). The breakdown of condition rating sources used is summarized in Table 6.

Table 6: Manhole Condition Rating Sources

Source	Total Count	% of Total
RVA Inspection	219	42%
Colchester Inspection	263	51%
Age-based Estimate	34	7%
TOTAL	**520**	**100%**

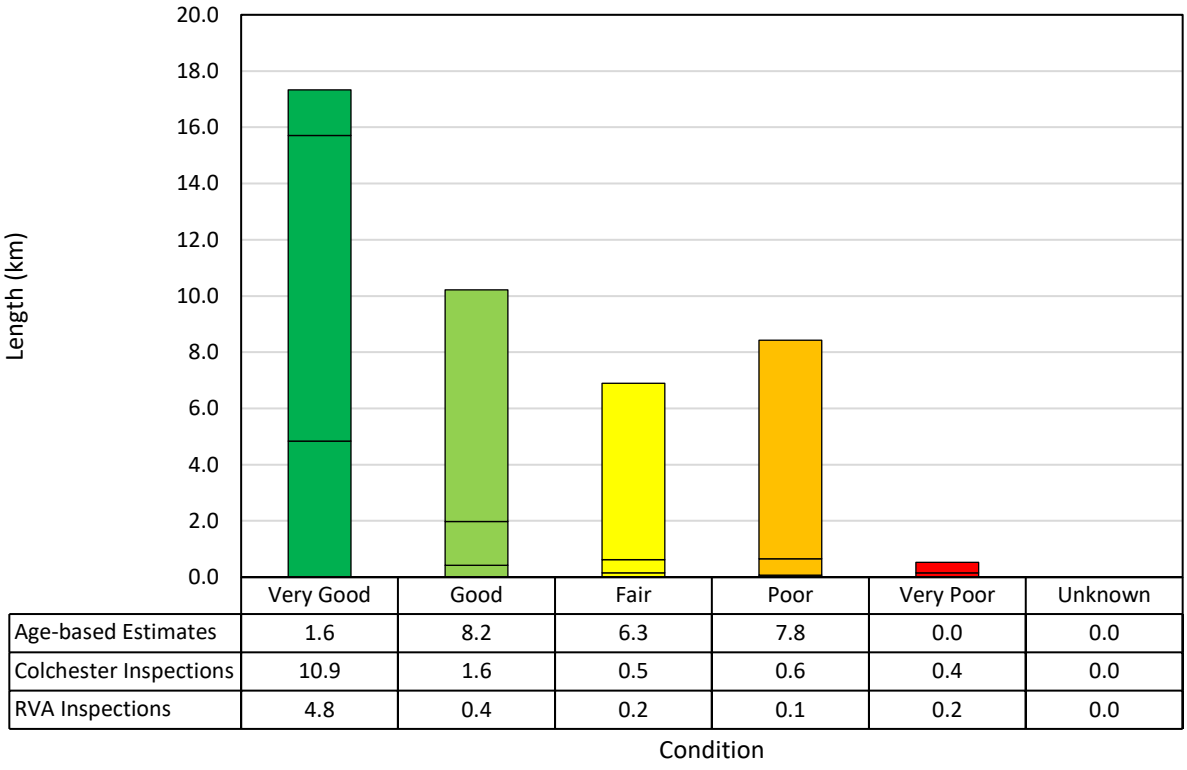
Pump Stations

On September 30, 2020, RVA conducted site visits of each pumping station to evaluate the condition of station elements and perform a pump draw down assessment to evaluate pump performance. The condition of each pumping station component was evaluated using a standardized condition rating matrix, with various distresses observed depending on the component type. The standardized condition rating matrices used for each component are documented in *Technical Memorandum #2 – Data Quality Assessment and Condition Summary*.

2.3.2 Results

Sewers

Sewer condition rating results (and the sources of data used to estimate condition) are summarized in Figure 6 and a map demonstrating the condition of each sewer is presented in Figure 8.

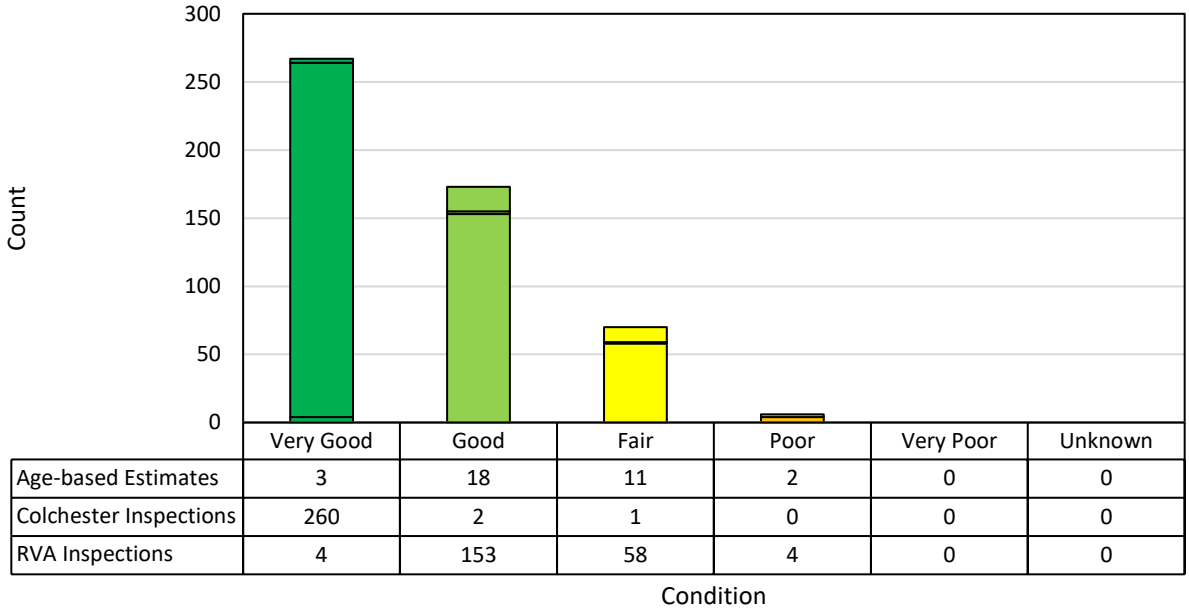


	Very Good	Good	Fair	Poor	Very Poor	Unknown
Age-based Estimates	1.6	8.2	6.3	7.8	0.0	0.0
Colchester Inspections	10.9	1.6	0.5	0.6	0.4	0.0
RVA Inspections	4.8	0.4	0.2	0.1	0.2	0.0

Figure 6: Sewer Condition Rating Summary

Manholes

Manhole condition rating results are summarized in Figure 7 and a map demonstrating the condition of each individual manhole is presented in Figure 9.



	Very Good	Good	Fair	Poor	Very Poor	Unknown
Age-based Estimates	3	18	11	2	0	0
Colchester Inspections	260	2	1	0	0	0
RVA Inspections	4	153	58	4	0	0

Condition

Figure 7: Manhole Condition Rating Summary

Pump Stations

PS02 – Recreation Park

Overall, the Recreation Park pumping station is in Good condition and requires very little attention. The station is well maintained and cleaned regularly. There is some grease build up at the normal start level on the inside perimeter of the wet well chamber. Float sensors (2) have been replaced recently but transducers may require calibration.

The pump drawdown assessment indicates both pumps are performing adequately. It is noted at the time of drawdown inflow to the station was occurring, as such actual drawdown depth in the wetwell is expected to be slightly greater than that observed.

The forcemain exiting the pumping is a 200mm diameter, 1.1km long, HDPE pipe constructed in 2010. No deficiencies were reported for the forcemain and we expect the pipe to be performing adequately based on its age and material type.

PS04 – Osprey Ridge

Overall, the Osprey Ridge pumping station is in Fair condition. There are some apparent issues with Pump No. 2, affecting its capacity to discharge sewerage. In addition to the issues observed with Pump No. 2, the valves in the station are beginning to show significant rust and should be cleaned and painted.

The pump drawdown assessment indicates Pump No. 2 is not performing adequately. Pump No. 1 appears to drawdown the wet well however not at the rate identified on the pump curve. During the drawdown test inflow was observed, as such actual drawdown may have been slightly greater. When comparing drawdown to the performance curve it was found that Pump No. 1 does not discharge in accordance with the expected rate and additional investigation is required.

The forcemain exiting the pumping is a 100mm diameter, 237m long, PVC pipe constructed in 2001. No deficiencies were reported for the forcemain and we expect the pipe to be performing adequately based on its age and material type.

PS19 – Somerset

Overall, the Somerset pumping station is in Poor condition and several components require replacement or major rehabilitation in the short-term. Built in 1990, most components are 30-years old with valves exhibiting significant rust and have not been operated in many years.

The pump drawdown assessment indicates whether a pump station is performing in accordance with design intent. Drawings and design information for this station is not known. The on-site pump test indicated that the pumps evacuate the wet well within a reasonable timeframe, however power draw for the motors is known to be increasing suggesting there may be wear issues with the pump and motor assemblies.

The forcemain exiting the pumping is a 100mm diameter, 54m long, PVC pipe constructed in 1990. No deficiencies were reported for the forcemain and we expect the pipe to be performing adequately based on its age and material type.

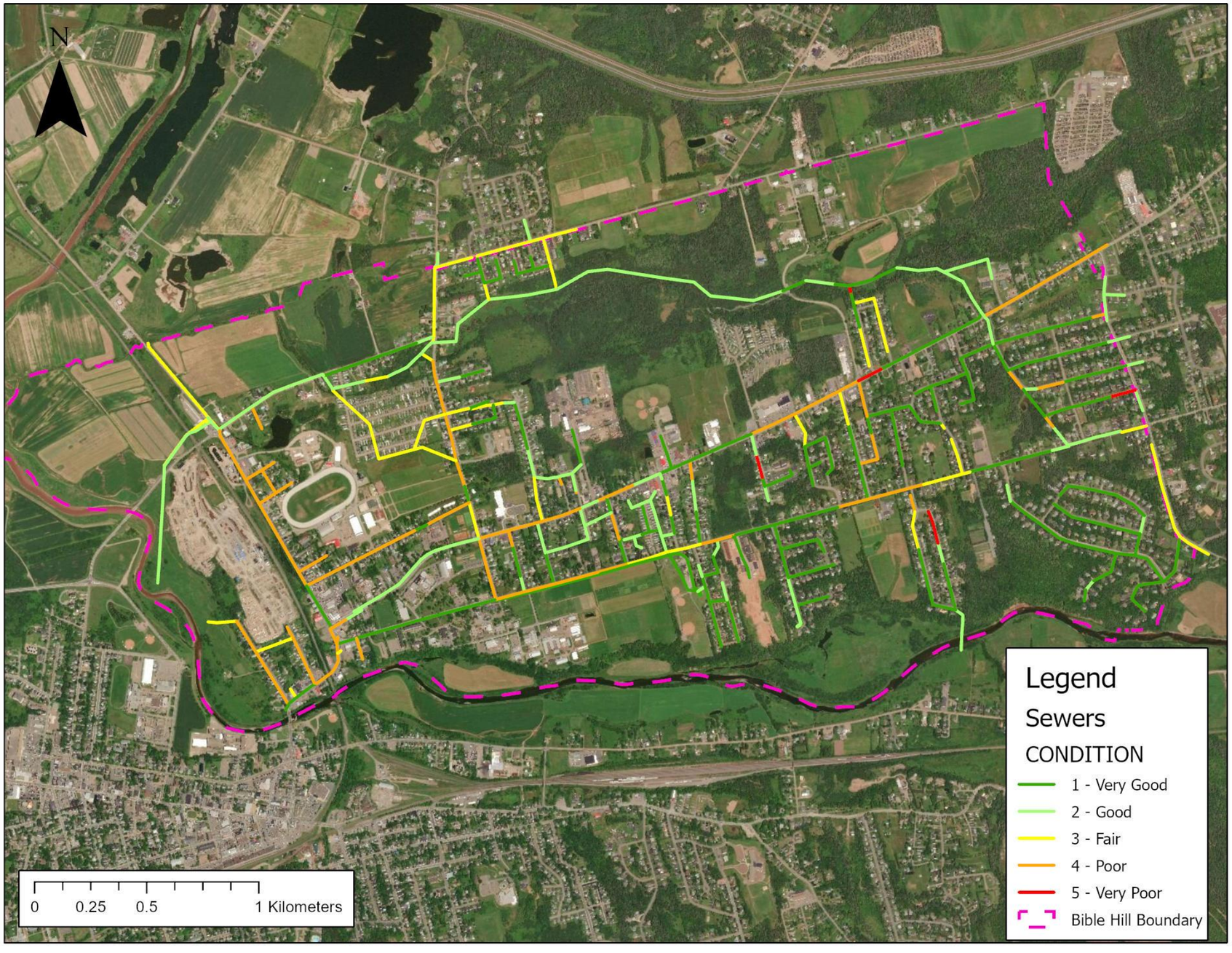


Figure 8: Sewer Condition Rating Map

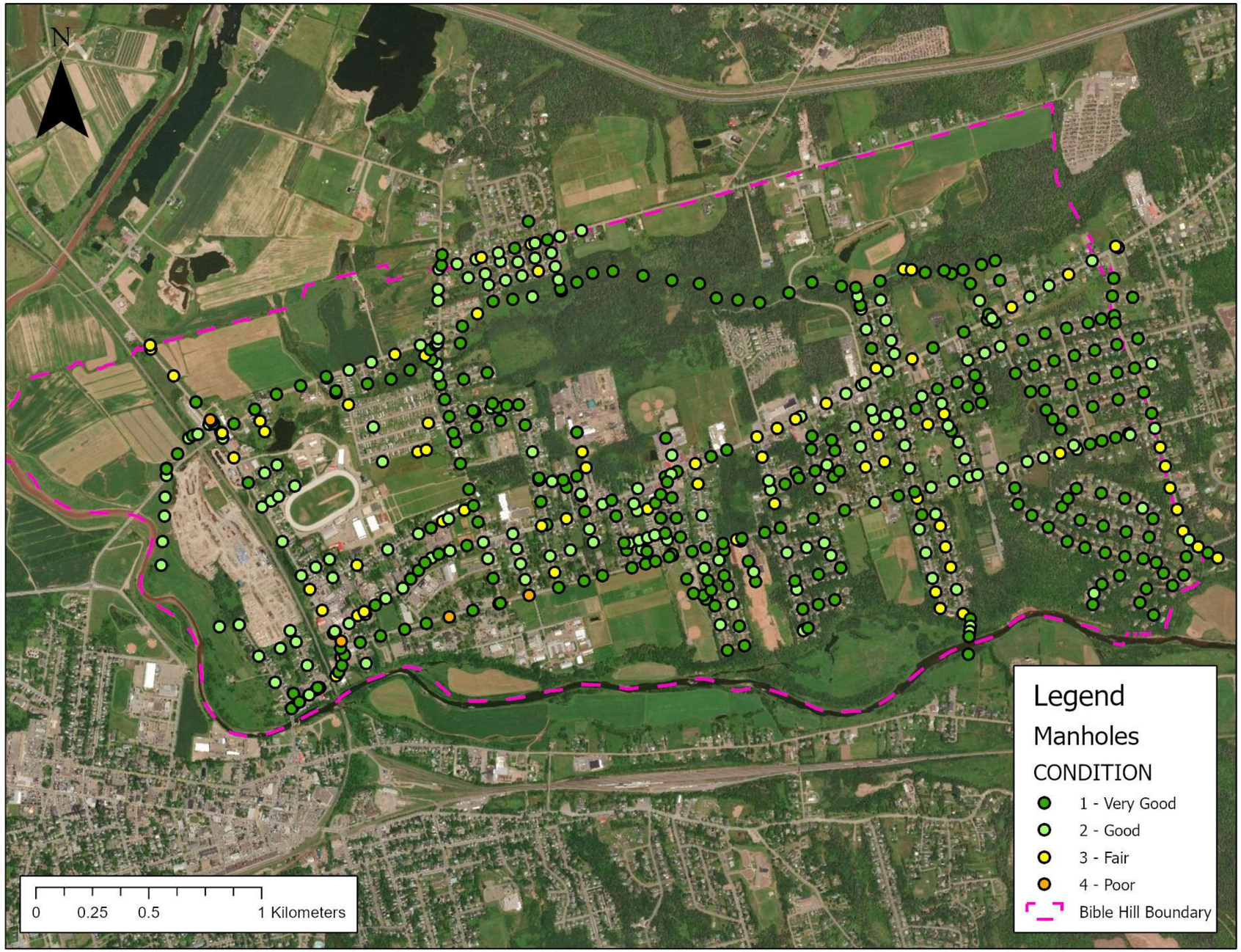


Figure 9: Manhole Condition Rating Map

2.4 Risk

In addition to evaluating the condition of each asset, RVA has conducted a high-level risk assessment to evaluate the risks of asset failure due to deterioration. The purpose of the risk evaluations in the context of asset management planning is to provide the Village with a consistent and systematic approach to identify, evaluate, and mitigate asset risks across the organization. Risk ratings also serve as a valuable indicator to identify high-priority capital expenditures.

The following sections describe the methodology used to calculate risk ratings and summarizes the results of the analysis.

2.4.1 Methodology

Infrastructure risk ratings are calculated using a simple 5 x 5 risk rating matrix, as presented in Table 7. This matrix allows each risk event to be analyzed in a systematic and consistent way. The risk rating of an asset depends on both the **probability** and **consequence** of the risk event under consideration.

This framework requires that both the probability and consequence of a risk event be scored on a 1 – 5 scale. Multiplying these two values will yield a risk rating for each asset. The 1 – 5 rating scale simplifies the risk evaluation process, synchronizing probability and consequence with asset condition, and is the most common framework used by Canadian municipalities including Municipal Affairs in Nova Scotia.

Table 7: Risk Rating Matrix

		Consequence				
		1 Insignificant	2 Minor	3 Moderate	4 Severe	5 Catastrophic
Probability	1 Improbable	1	2	3	4	5
	2 Unlikely	2	4	6	8	10
	3 Possible	3	6	9	12	15
	4 Likely	4	8	12	16	20
	5 Highly Probable	5	10	15	20	25

Probability

The probability of a risk event occurring represents the likelihood the risk event will occur in a given year. The probability of risk events can be estimated using qualitative (e.g. improbable vs. highly probable) or quantitative (e.g. will occur in next 5 years or has a 20% chance of occurring or being exceeded any year) measures. For this study, RVA has assumed an asset's probability

of failure is **equal to its condition**. This simplifies the risk evaluation process while still providing the Village with sufficient data to make informed decisions.

Consequence

The consequence of a risk event represents the severity of impacts if a risk event were to occur (i.e. the asset was to fail). Often, organizations will assign criticality ratings to each asset to identify what this impact will be.

Criteria to estimate consequence ratings were established for each asset type through engineering experience and discussion with Village staff. For sewers, consequence ratings were largely based on pipe diameter and pipe type, however, those sewer segments which are located within 10 m of a watercourse were automatically assigned a rating of Severe (4). Consequence ratings for manholes were established in a similar manner with all structures located within 10 m of a watercourse given a rating of Severe (4), structures located on high volume roadways (i.e. Main Street, College Road, Pictou Road) assigned a rating of Moderate (3) and all others assigned a rating of Minor (2). Pump stations and associated components consequence ratings were established based on their relative importance to the operation and safety of the station.

Consequence rating criteria for sewers, manholes and pumping stations are described in detail in *Technical Memorandum #3 – Analysis and Recommendations*.

2.4.2 Results

Sewers

Final risk analysis results for sewers are presented in Figure 10.

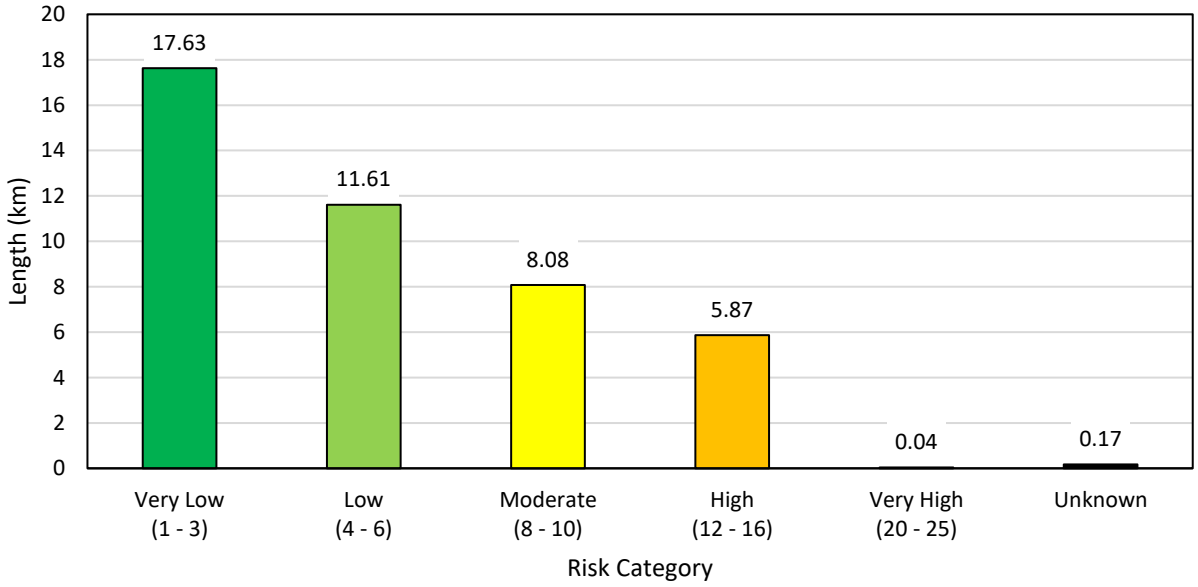


Figure 10: Sewer Risk Distribution

Overall, the Village's sewer system exhibits a Moderate degree of risk. While 37.3 km (86%) of the Village's sewers are in a Very Low to Moderate risk category, approximately 5.9 km (14%) of sewers exhibit a High or Very High risk. Approximately 0.17 km of sewers risks could not be estimated as the pipe diameters were unknown and were not located within 10 m of a watercourse. The single pipe segment within the Very High risk category is located at the Farnham Brook crossing, north of Coupar Terrace.

Manholes

Risk analysis results for Village's manholes are presented in Figure 11.

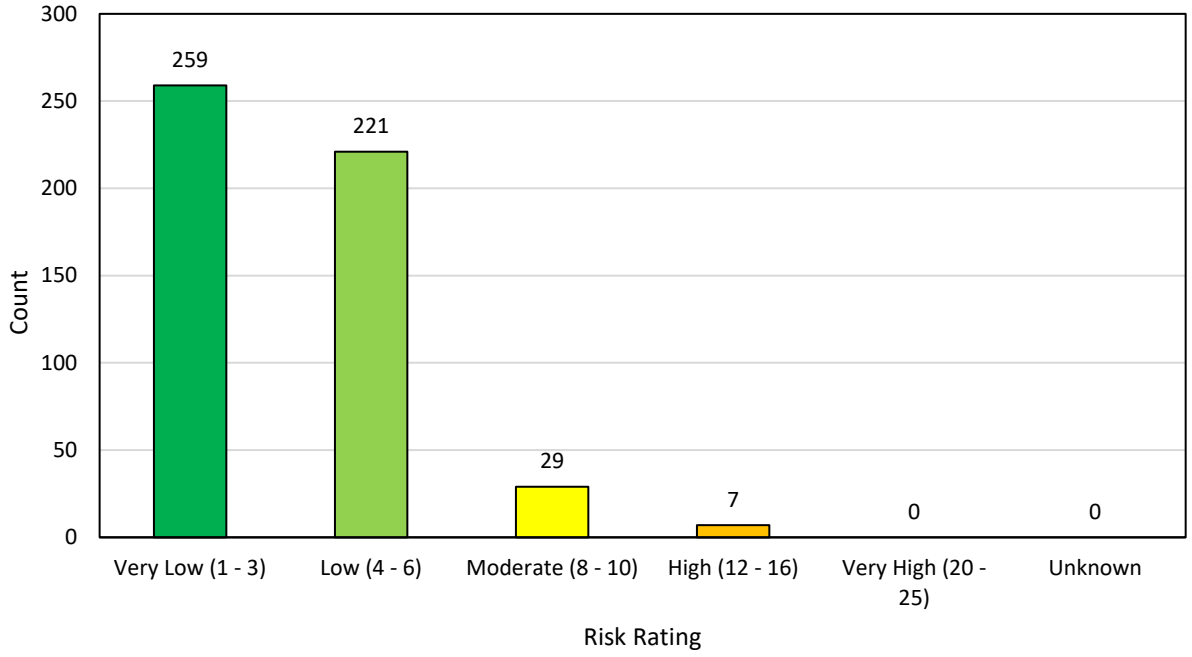


Figure 11: Manhole Risk Rating Distribution

Overall, the Village's manholes exhibit a Low degree of risk. Based on the risk analysis completed by RVA, 480 manhole structures (93%) exhibit a Low or Very Low risk rating, while only 36 manhole structures (7%) exhibit a risk of Moderate and High. No manhole assets were found to be a Very High risk rating based on the risk rating criteria established.

Pump Stations

Risk analysis results for Village's pumping stations are presented in Figure 12.

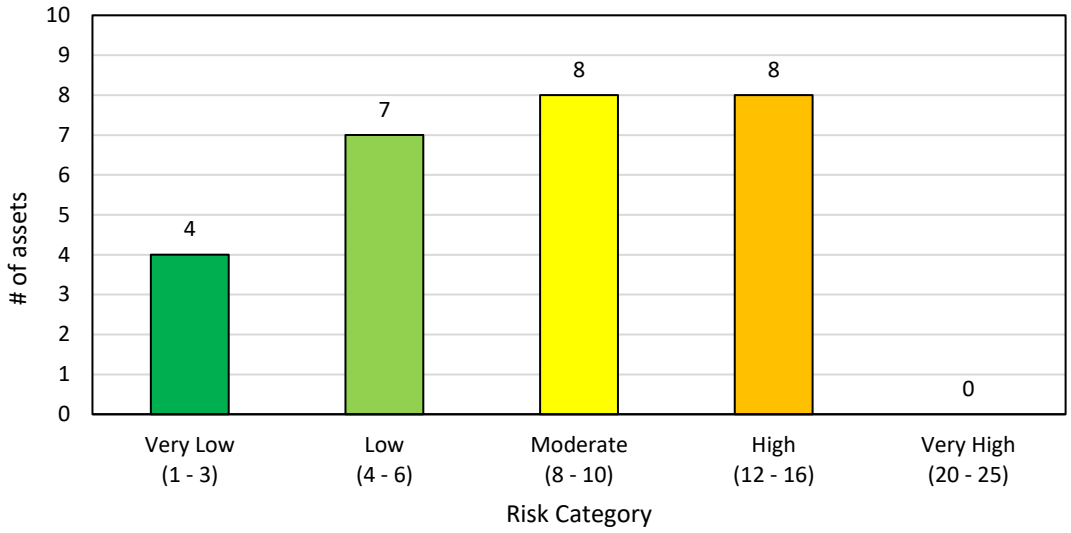


Figure 12: Pumping Station Risk Distribution

Overall, the Village's pumping stations exhibit a High degree of risk. 8 assets within the 3 stations are in a High-risk category. Notable inclusions are the Somerset station pumps & valves and Osprey Ridge station pumps & valves.

3.0 CAPITAL NEEDS ASSESSMENT

Sanitary sewer infrastructure capital needs are identified using a combination of field inspection, condition & risk assessments, and engineering judgement. Sanitary infrastructure needs are divided into short (< 10 years) and long-term time horizons. Infrastructure needs are limited to capital works and exclude minor operation and maintenance costs.

3.1 Short Term (< 10 Years)

Short-term needs are identified for all sewers and manholes which were found to be in a Poor or worse condition. Where appropriate, recommendations have also been identified for manholes assets in a Fair condition.

CCTV videos and inspection reports were reviewed and RVA prepared recommendations depending on the extent and severity of deficiencies reported. Table 8 thru Table 10 summarize assets warranting repair as well as their associated needs and costs. Detailed recommendation reports, including asset details, observations, and further descriptions of recommendations are included in *Technical Memorandum #3 – Analysis and Recommendations*.

Table 8: Manhole Recommendation Summary Table

MH ID	Recommendation	Cost*
BHMH3580	Grade ring replacement, benching improvements, spot repairs (sealing or grouting).	$5,000
BHMH0740	Replace manhole.	$12,000
BHMH0130	Replace manhole.	$7,500
BHMH3850	Confirm manhole is abandoned.	$0
BHMH4700	Grade ring replacement.	$2,500
BHMH0760	Raise and repair cover (buried under asphalt).	$2,500
BHMH0460	Cover replacement.	$1,000
BHMH3750	Cover replacement, grade ring replacement, spot repairs (sealing or grouting).	$5,000
BHMH3040	Grade ring replacement, benching improvements, spot repairs (sealing or grouting).	$5,000
BHMH3280	Benching improvements.	$3,000
BHMH4330	Benching improvements.	$3,000

* Costs include labor, materials, equipment, engineering, and contingency. HST is excluded.

Table 9: Sewer Recommendation Summary Table

Pipe ID	Recommendation	Cost*
BHGR14501440	Complete excavation and replacement.	$62,000
BHGR17301720	Localized excavation and replacement.	$18,000
BHGR46004590	Localized excavation and replacement.	$15,000
BHGR50105000	CCTV cutter to trim gasket.	$2,000

BHGR32103180	Localized excavation and replacement.	$19,000
BHGR07100700	Clean and re-video.	$300
BHGR41504130	Localized excavation and replacement.	$8,000
BHGR50905080	Localized excavation and replacement.	$9,000

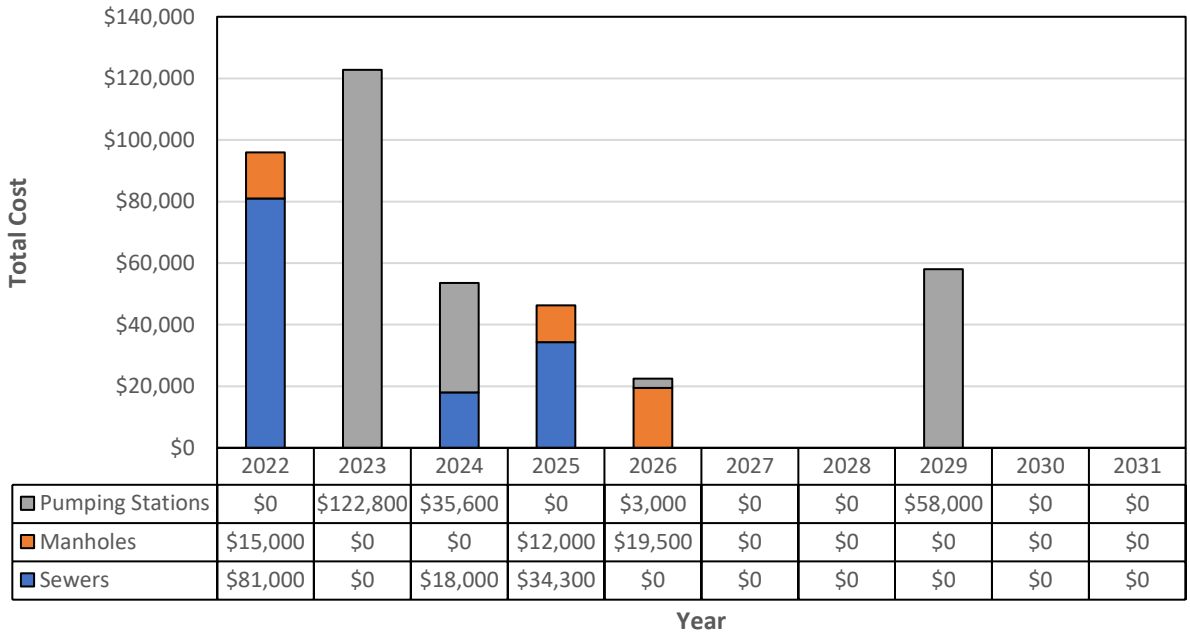
* Costs include labor, materials, equipment, engineering, and contingency. HST is excluded.
** Six (6) pipe segments omitted from table as no remedial action was recommended.

Table 10. Pumping Station Recommendation Summary Table

Recommendation	Cost
PS02 – Recreation Park	
Sensor calibration checks.	$1,000
Clean and paint valves.	$1,000
PS02 Subtotal	*$2,000*
PS04 – Osprey Ridge	
Clean wet well chamber.	$500
Fix seal leak at frame of valve chamber.	$3,000
Replace safety grating.	$3,500
Investigate pump No. 1 issues.	$5,000
Replace pump No. 2.	$20,600
Paint and clean valves.	$1,000
Clean backflow prevention valve.	$1,000
Replace panel	$55,000
Replace level sensors.	$3,000
Check power draw on both motors.	$2,500
PS04 Subtotal	*$95,100*
PS19 - Somerset	
Replace both pumps	$24,000
Replace guide bars	$4,000
Replace piping	$2,000
Replace bolts, brackets, and chains	$6,600
Replace access hatch and safety grating	$5,000
Clean wet well chamber	$500
Replace valves and construct new valve chamber	$17,000
Replace control panel	$55,000
Replace float sensors	$3,000
New level sensor and transmitter	$5,200
PS19 Subtotal	*$122,300*

RVA has prepared a 10-year capital plan which outlines the recommended timing and sequencing of proposed renewal activities. The timing of each activity is determined based on a combination of risk (incorporating current condition and consequence of failure), budget constraints, competing infrastructure priorities, and engineering judgment. RVA urges the Village to review the proposed timing of the various activities and adjust where appropriate. Total annual investment requirements for the Village's sanitary sewer infrastructure are presented in Figure 13. A detailed

listing of each recommendation and cost is shown in Table 11. In total, RVA estimates the short term (2022 to 2031) investment needs of Bible Hill pump stations, manholes and sewers to be approximately $399,200.



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Pumping Stations	$0	$122,800	$35,600	$0	$3,000	$0	$0	$58,000	$0	$0
Manholes	$15,000	$0	$0	$12,000	$19,500	$0	$0	$0	$0	$0
Sewers	$81,000	$0	$18,000	$34,300	$0	$0	$0	$0	$0	$0

Figure 13: Proposed 10-Year Capital Plan

No-corrode Service Laterals

While sanitary sewer lateral service connections were outside of the scope of this study and not included in the needs assessment, there is the possibility of bitumen coated wood fibre pipes (no-corrode) used as service laterals. Specifications from the original sewer system installation (1950s) indicate this pipe has been installed extensively in the area. No-corrode laterals were not readily evident during RVA's inspections during this project and no observations of their current condition or presence within the system have been made. Research suggests these pipes have a service life of approximately 30 to 50 years. This would indicate any existing "no-corrode" laterals within the system are well past their design life. More investigation and a comprehensive lateral service connection inspection program is recommended to determine the extent and current condition of potential "no-corrode" laterals as they pose a risk to residential homes and the functionality of the entire pipe network.

3.2 Long Term (> 10 Years)

The short-term needs assessment indicates the Village's sanitary sewer infrastructure is in relatively good condition and requires limited investment when compared to its total replacement value. Only 1 pipe segment warrants full replacement. However, long-term, there is the potential for significant investment requirements over the next 20 to 30 years as the Village's original sewer system (installed in the 1950s and 1960s) approaches the end of its useful life.

Despite recent CCTV inspections showing limited evidence of acute defects within older pipe segments, we do observe chronic stresses (e.g. spalling of concrete pipes, shown in Figure 14) which can increase a pipe's likelihood of failure. Given these distresses, there is the potential that the original sanitary sewer system's linear infrastructure will require replacement over the next 20 to 30 years. Replacement of this infrastructure should be dependent on the outcomes of regular CCTV inspections and assessments.

Figure 14. Example of Concrete Pipe Spalling

Industry standards suggest underground infrastructure can (conservatively) expect an 80 year-useful life. Other studies suggest this infrastructure could last up to 120 years and there are anecdotal examples of infrastructure surviving much longer. There are many different factors which can influence a sewer or manhole's useful life such as soil conditions, sewage characteristics, and environmental impacts. For long-term planning purposes, we recommend the Village use an 80-year useful life to forecast future capital needs. Combining the current replacement costs established in section 2.2 with an 80-year useful life estimate yields a long-term investment needs forecast for existing sewers and manholes shown in Figure 15. A time-horizon of 80 years is used for the long-term needs assessment to capture a full lifecycle of recently installed infrastructure. Note, the costs in this forecast are expressed in 2020-year dollars and do not account for inflation.

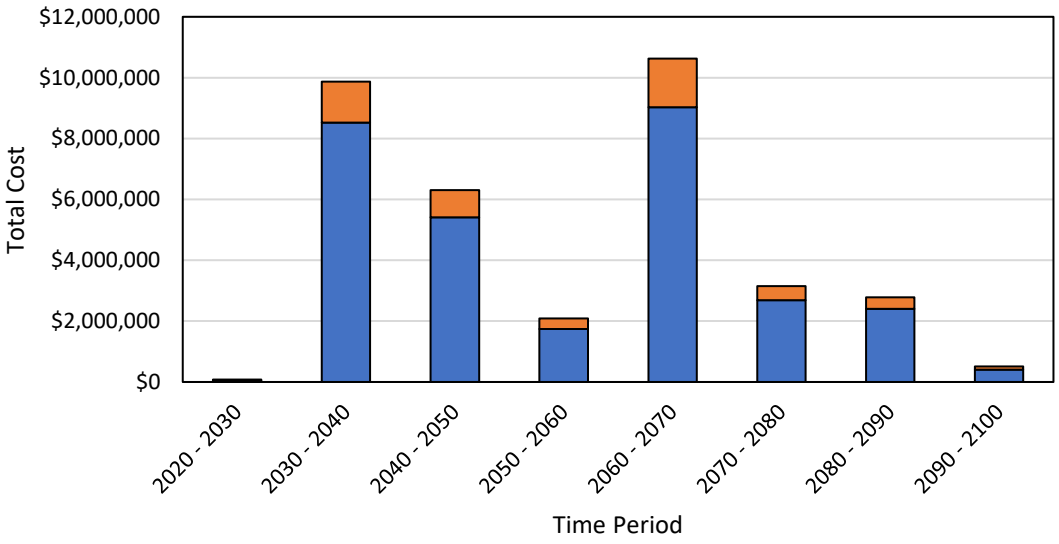


Figure 15. Long-Term Sewer and Manhole Replacement Costs

As shown above, there is the potential for significant investment needs in the future. From 2030 to 2050, there is a potential total capital investment requirement of **$16.2 million**. This forecast is primarily driven by sewers and manholes installed pre-1970, shown graphically in Figure 17.

From the year 2050 to 2100, an additional $19.2 million of investment is potentially required. However, we caution the Village on using these estimates for long-term planning purposes as advances in technology and changes in local demographics/conditions will likely have a significant impact on needs & costs.

In addition to the replacement needs of sewers and manholes, we anticipate all three pumping stations will require major renewal over the next 30 years. As described in section 3.1, a majority of the Somerset station components and some components of the Osprey Ridge station will require repair/renewal over the next 10 years. The Osprey Ridge and Recreation Park stations are generally still in good or fair condition, but there is the potential for major renewal over the next 30 years. Typical useful life estimates for major pumping station components (pumps, motors, panels, valves) is approximately 25-30 years. Given this estimate, there is the potential that additional replacements of Osprey Ridge pumping station components and a full replacement of Recreation Park pumping station components will be required. Structural elements of these stations (wet wells and valve chambers) are likely to still be in good condition over the next 30 years and replacement is unlikely. The total replacement value for components warranting replacement over the next 10 to 30 years is between $250,000 and $300,000 (depending on the timing of Osprey Ridge pump replacement). A breakdown of future potential costs is presented in Figure 16.

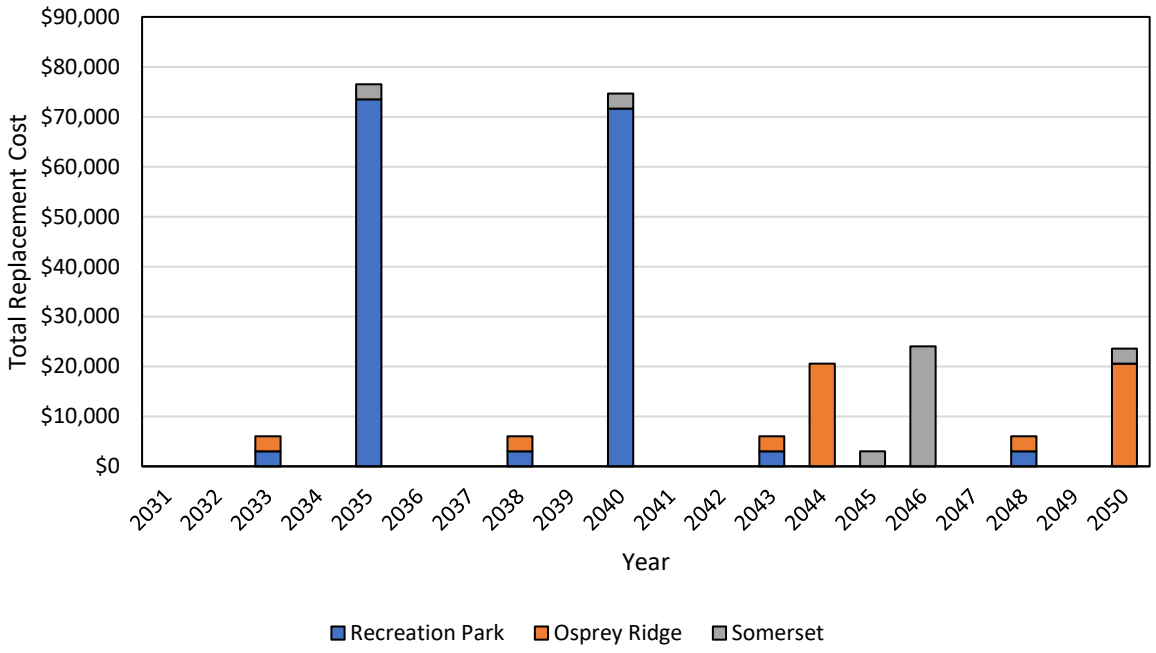


Figure 16. Potential Replacement Costs of Pumping Stations (2031 to 2050)

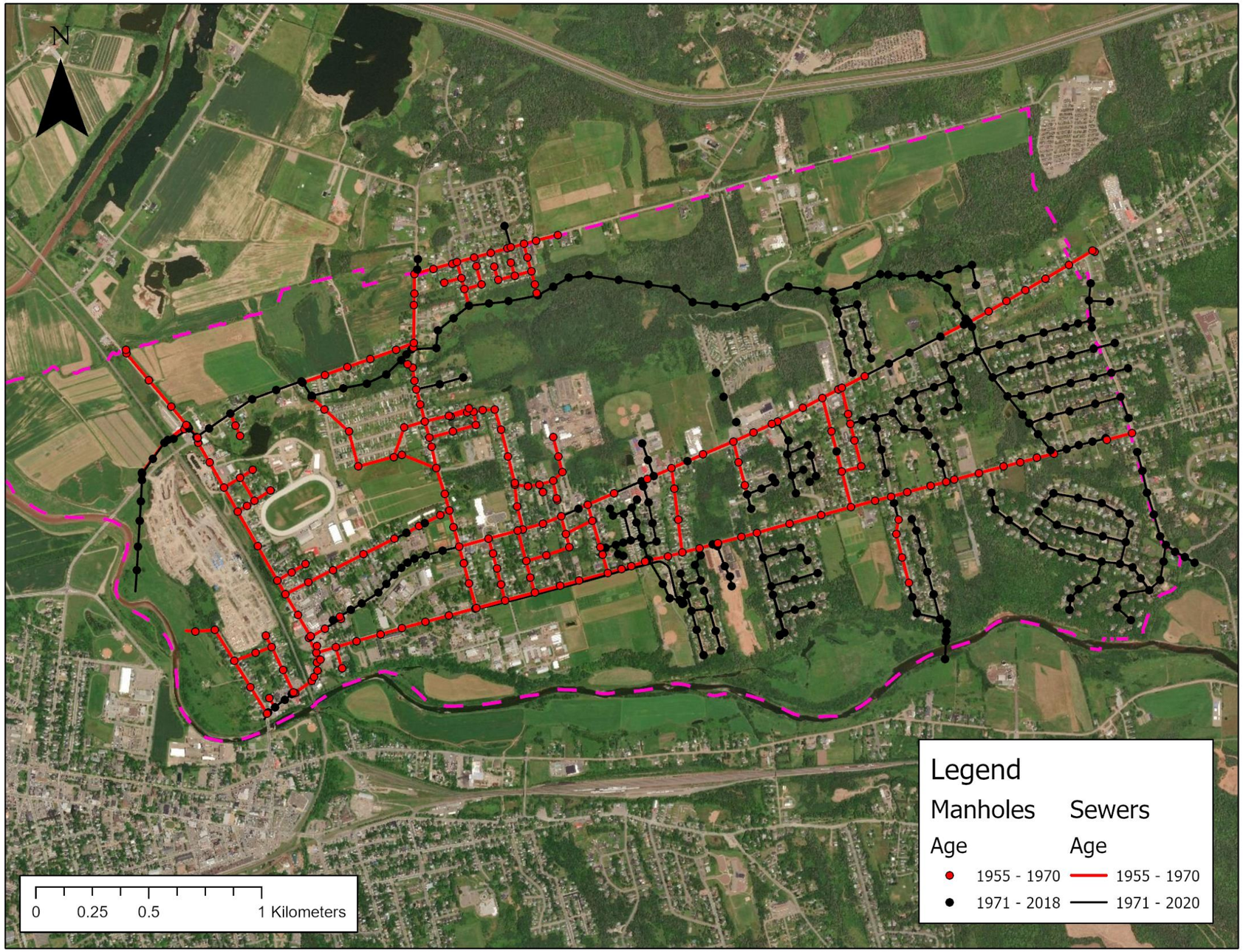


Figure 17: Map of Sanitary Sewer Network Age Distribution

Table 11: Detailed 10-Year Capital Plan

Activity				Expenditures										
ID	Asset ID(s)	Asset Description	Recommendation	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	TOTAL
Sewers				-	-	-	-	-	-	-	-	-	-	-
S1	BHGR14501440	Crossing Farnham Brook	Complete excavation and replacement.	$62,000										$62,000
S2	BHGR17301720	Pictou	Localized excavation and replacement.			$18,000								$18,000
S3	BHGR46004590	Dunrommin	Localized excavation and replacement.				$15,000							$15,000
S4	BHGR50105000	Scenic	Minor repair (gasket protruding).				$2,000							$2,000
S5	BHGR32103180	Main	Localized excavation and replacement.	$19,000										$19,000
S6	BHGR07100700	Allison	Clean and re-video.				$300							$300
S7	BHGR50905080	Maple	Localized excavation and replacement.				$9,000							$9,000
S8	BHGR41504130	Bigney	Localized excavation and replacement.				$8,000							$8,000
			Sewers Subtotal	*$81,000*	*$0*	*$18,000*	*$34,300*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$133,300*
Manholes				-	-	-	-	-	-	-	-	-	-	-
MH1	BHMH0130	Main	Excavate and replace.	$7,500										$7,500
MH2	BHMH0460		Cover replacement.					$1,000						$1,000
MH3	BHMH0740	Allison	Excavate and replace.				$12,000							$12,000
MH4	BHMH0760	St. Davids	Raise and repair cover.					$2,500						$2,500
MH5	BHMH3040	Murdock	Cover and grade ring replacement, spot repairs.					$5,000						$5,000
MH6	BHMH3280	Ryland	Benching improvements.					$3,000						$3,000
MH7	BHMH3580	College	Cover and grade ring replacement, spot repairs.	$5,000										$5,000
MH8	BHMH3750	Riverside	Cover and grade ring replacement, spot repairs.					$5,000						$5,000
MH9	BHMH4330	Pictou	Benching improvements.					$3,000						$3,000
MH10	BHMH4700	Main	Grade ring replacement.	$2,500										$2,500
			Manholes Subtotal	*$15,000*	*$0*	*$0*	*$12,000*	*$22,500*	*$0*	*$0*	*$0*	*$0*	*$0*	*$46,500*
Pumping Stations				-	-	-	-	-	-	-	-	-	-	-
PS1	PUMP-005,6	Somerset-Pumps	Replace both pumps.		$24,000									$24,000
PS2	PUMP-005,6	Somerset-Pumps	Replace piping.		$2,000									$2,000
PS3	PUMP-005,6	Somerset-Pumps	Replace guide bars.		$4,000									$4,000
PS4	PUMP-005,6	Somerset-Pumps	Replace bolts, brackets and chains.		$6,600									$6,600
PS5	STR-005	Somerset-Wetwell	Replace access hatch and safety grating.		$5,000									$5,000
PS6	STR-005	Somerset-Wetwell	Clean wet well chamber.		$500									$500
PS7	VALVE-011,12	Somerset-Valves	Replace valves and construct new valve chamber.		$17,000									$17,000
PS8	IC-007	Somerset-Panel	Replace control panel.		$55,000									$55,000
PS9	IC-008	Somerset-Sensors	Replace float sensors.		$3,000									$3,000
PS10	IC-008	Somerset-Sensors	New level sensor and transmitter.		$5,200									$5,200
PS11	STR-003	Osprey Ridge-Wetwell	Clean wet well chamber		$500									$500
PS12	STR-004	Osprey Ridge-Valve Chamber	Fix seal leak at frame of valve chamber.					$3,000						$3,000
PS13	STR-004	Osprey Ridge-Valve Chamber	Replace safety grating.			$3,500								$3,500
PS14	PUMP-003	Osprey Ridge-Pump 1	Investigate pump No. 1 issues.			$5,000								$5,000
PS15	PUMP-004	Osprey Ridge-Pump 2	Replace pump No. 2.			$20,600								$20,600
PS16	VALVE-007,8,9,10	Osprey Ridge-Valves	Paint and clean valves.			$1,000								$1,000
PS17	VALVE-006	Osprey Ridge-Valves	Clean backflow prevention valve.			$1,000								$1,000
PS18	IC-005	Osprey Ridge-Panel	Replace panel								$55,000			$55,000
PS19	IC-006	Osprey Ridge-Sensors	Replace level sensors.								$3,000			$3,000
PS20	MOTOR-003,4	Osprey Ridge-Motors	Check power draw on both motors.			$2,500								$2,500
PS21	VALVE001,2,5	Rec Park-Valves	Paint and clean valves.			$1,000								$1,000
PS22	VALVE003	Rec Park-Sensors	Sensor calibration check.			$1,000								$1,000
			Pumping Station Subtotal	*$0*	*$122,800*	*$35,600*	*$0*	*$3,000*	*$0*	*$0*	*$58,000*	*$0*	*$0*	*$219,400*
			TOTAL	**$96,000**	**$122,800**	**$53,600**	**$46,300**	**$25,500**	**$0**	**$0**	**$58,000**	**$0**	**$0**	**$399,200**

4.0 CONTINUOUS IMPROVEMENT

In addition to preparing tactical recommendations for the Village's sanitary sewer system, RVA has also prepared strategic recommendations for the Village to improve its asset management program and enhance its ability to make informed decisions regarding its infrastructure.

4.1 Asset Management Program

The Village has made significant progress improving its ability to manage and make decisions regarding its sanitary sewer infrastructure. The Village should look to build upon this work and implement a comprehensive asset management program for all assets owned by the municipality. Expanding the understanding of all other asset types will improve the Village's ability to prepare long-term capital plans which consider competing priorities from various asset groups.

While the Province of Nova Scotia does not have minimum requirements established for municipal asset management plans, we urge the Village to move forward with its asset management program. Being one of the first municipalities to develop a comprehensive asset management plan will demonstrate due diligence and improve the Village's ability to secure infrastructure funding from senior levels of government.

Recommended next steps for the Village's asset management program include the following:

1. Develop and adopt an Asset Management Policy, securing the Commission's commitment to asset management planning and making evidence-based decisions.
2. Establish an Asset Management Steering Committee, consisting of staff from various departments in the Village (e.g. Public Works, Finance, etc.). The steering committee will be responsible for implementing the asset management program and leveraging data and information generated to prepare and update long-term capital plans.
3. Prepare complete asset inventories of other significant asset types (watermains, sidewalks, buildings, vehicles, etc.). Additionally, conduct condition assessments of these assets to better understand short-and long-term investment requirements.
4. Develop a Level of Service framework to guide the development and evaluation of infrastructure performance. Once the framework is established, the Village should consider developing and measuring the performance of its services / infrastructure for annual reporting to the Commission.
5. Develop 3 to 10-year capital plans (including operation and maintenance activities such as re-inspection, flushing, repairs, etc.) which includes recommended expenditures for all asset types and considers the Village's ability to pay.

4.2 Inventory and Data Management Practices

The Village's inventory of sanitary sewer assets is primarily managed by the Municipality of Colchester in a Geographic Information System (GIS). This approach is justifiable as the Municipality has significantly more resources to manage the database and is the organization

which typically manages any significant upgrades or improvements to the system. This allows the Municipality to have the relevant information to make timely updates of the databases,

However, as the infrastructure owner, it is important that Village have access to the database to validate the information contained, identify discrepancies, and use the data to prepare reports for internal or external purposes. RVA recommends the Village request that the Municipality grant access to the inventory using a user-friendly platform such as ESRI's ArcGIS Online. ESRI permits organizations to acquire "Viewer" licenses, granting specific users access to view and download the information within the database through a web-browser application.

4.3 Condition Assessments / Inspections

As part of this study, RVA conducted approximately 5.6km of sanitary sewer CCTV inspections, 294 manhole inspections, and comprehensive condition assessments of all 3 pumping stations. In addition to the inspections completed by RVA, the Municipality of Colchester has completed an additional 13.8km of sanitary sewer CCTV inspection and have performed a complete inspection of the Village's manholes. This represents a significant portion of the entire inventory, but gaps still exist. In the absence of CCTV inspection records, the Village can only rely on age to estimate sewer condition. To overcome this gap, RVA recommends the Village conduct additional CCTV inspections of the remaining sewer segments to better estimate the condition of its sanitary sewer network.

Additionally, we recommend the Village work in collaboration with the Municipality of Colchester to prepare a comprehensive condition assessment program, specifying the frequency of future condition assessments, the methodologies to follow when conducting the assessments, and communication protocols to ensure the Village is adequately informed of any issues identified. The Village should leverage the results of RVA's inspection program to specify an appropriate methodology. For example, the Village may seek to inspect 10% of its sanitary sewer system each year, resulting in a turnover period of 10 years for each segment.

4.4 Financial Planning

One of the primary outputs of this study is a list of recommended expenditures to ensure the Village's sanitary sewer system can reliably provide wastewater collection services for future generations. However, expenditures only represent one side of the equation, and consideration must be made for the Village's ability to pay for future rehabilitation of the system.

RVA recommends the Village specify the sources of funding which will be used to satisfy its investment needs. The process of specifying funding sources will allow the Village to highlight potential funding gaps and inform the Commission of additional measures which must be taken to ensure the sanitary system can continue to meet its desired goals and objectives. We have included several columns in the 10-year capital plan spreadsheet which the Village can use to track and manage funding sources for each investment.

5.0 CONCLUSIONS

The following conclusions have been reached for Village's sanitary sewer infrastructure:

- The Village owns 3 pumping stations, 42.0 km of gravity sewers, 1.3 km of forcemains, and 516 manholes,
- The total current replacement value of these assets is approximately $35.8 million,
- Overall, the Village's sanitary sewer infrastructure is in Good condition, however some deficiencies exist:
    - Approximately 9.1km of the Village's sewer is estimated to be in a Poor or worse condition, however additional investigation and CCTV inspections is warranted to confirm,
    - 6 manholes are in a Poor or worse condition, and another 70 are in a Fair condition, and
    - the Somerset pumping station is in a Poor condition and the Osprey Ridge station is approaching the end of its useful life.
- Approximately 5.9km of the Village's sewers currently exhibit a high degree of risk and should be a priority for renewal. The Somerset and Osprey Ridge pumping stations also have a high degree of risk and major renewal is recommended in the short-term.
- Over the next 10 years, approximately $399,200 of capital investment is required to ensure the Village's sanitary system can reliably provide wastewater collection services.
- Over the next 10 to 30 years, there is the potential need for approximately $16.2 million of investment to replace the Village's original sanitary system constructed in the 1950s and 1960s.
- While RVA did not identity any "no-corrode" laterals during this work, it is evident further investigation is required to determine the extent and current condition of these pipes. The design life of "no-corrode" laterals is approximately 30 to 50 years. Assuming they were installed in the 1950s era (according to the original system specification documents), any existing "no-corrode" laterals are likely in a poor state of repair. It is recommended the Village investigate further and consider a comprehensive lateral service connection condition assessment program to determine the extent and current condition of such pipes.