Village of Caroline
Capital Infrastructure Plan

Stantec

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Village of Caroline

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1 GROWTH RATE

The Village of Caroline commissioned Stantec Consulting Ltd. to complete the following Capital Infrastructure Plan to assess the existing infrastructure and its need for future improvements.

The Village of Caroline is a hub for the surrounding area and provides a range of convenient amenities, services and attractions. The natural setting contributes to the community's appeal and the business and properties are architecturally attractive, clean and well kept. The community has access through and around the Village through a network of open spaces and trail systems.

1.1 PROJECTED GROWTH

To assist in predicting future growth, the Village of Caroline 2019 Municipal Development Plan was reviewed. This study determined a low growth scenario rate of 1.72%, a medium growth scenario rate of 2.20% and a high growth scenario rate of 5.18%. The Village of Caroline 2019 Intermunicipal Development Plan projected that if Caroline experiences growth, it will be one of the following:

Table 1.1: Annual Growth Rates and Population Data (2019 MDP (Clearwater County))

Year	Historical Population		
2016	512		
2021	489		
	Projected Population		
	Low (1.72%)	Medium (2.20%)	High (5.18%)
2026	607	636	848
2031	661	710	1,092
2033	684	742	1,208

Population fluctuation is often observed in Villages the size of Caroline. The population of Caroline has fluctuated greatly from 407 in 1991 to 512 in 2016 and 444 in 2017. The population did decline significantly between 2016 and 2018. The decreased population remained relatively constant until 2021 where the population was 489. The population has increased since 2021 and the 2023 population is 507.

Due to the overall negative trend in population since 2009, a static population estimation (0% growth rate) or a low 1.72% growth rate is used in this study.

The Village anticipates ultimate growth to 2,500 people which will require a phased design for the existing and proposed infrastructure improvements.

1.2 REPLACEMENT PRIORITY AND FUTURE DEVELOPMENT

As a result of the static or low growth rate population the impact of future development on this Capital Infrastructure Plan is negated. For the purpose of this report the proposed infrastructure rehabilitation is based on the condition and performance of the sanitary sewer, storm sewer, roadways, and water distribution networks. Upgrades to the infrastructure due to growth of the Village are not anticipated and are not recommended as part of this study.

The proposed Northeast County Development will require upgrades to the current water distribution system and sanitary collection system. The Northeast County Development Servicing Study Update (2021) includes the analysis of the proposed developments' water demand and sanitary loading and can be found in **Appendix H.** The document also includes a Class D cost estimate. The infrastructure upgrades outlined in the memo will not be included in this study and will require additional investigation for detailed design.

2 METHODOLOGY

2.1 TIME FRAME

For this study, the total time frame considered is 2024 to 2033.

2.2 DATA SOURCES

To evaluate the existing infrastructure and to create a strategy for future infrastructure improvements, the following information has been gathered:

- Previous studies completed including:
  - 2009 Village of Caroline Capital Infrastructure Plan (Stantec)
  - 2019 Municipal Development Plan (Clearwater County)
- Sanitary sewer ratings for each pipe section based on the previous CCTV review (CIP, 2009).
- Information, documents and records provided by Village staff.
- Site visits and analysis including the Village water treatment plant, lagoons, and roadway network.

2.3 REPLACEMENT RATES

The following replacement rates were utilized to determine the budget for annual infrastructure improvements. The unit rates for replacements can be found in **Appendix F**. These rates are in 2024 dollars and were determined using tender results of projects completed in the area from 2020 to the present. Cost breakdowns for the replacement of each infrastructure category are included in the Appendices with a summary found in **Appendix A**. Note that all prices include 35% for professional services and contingency.

Table 2.1: Sanitary Sewer Replacement Rates

Pipe Size	Estimated Unit Rate (per lineal metre)
200mm PVC DR35	$1,309.00
250mm PVC DR35	$1,372.00
300mm PVC DR35	$1,435.00

Note: Costs do not include roadway trench repair

Table 2.2: Roadway Replacement Rates

Rehabilitation Alternative	Estimated Unit Rate (per lineal metre)
Mill and 40mm Overlay	$60.00
Local Road Total Road Reconstruction	$180.00
Local Road Trench Repair	$180.00
Arterial Road Total Reconstruction	$300.00
Arterial Road Trench Repair	$300.00

Table 2.3: Watermain Replacement Rates

Pipe Size and Type	Estimated Unit Rate (per lineal metre)
150mm PVC DR18	$1,576.00
200mm PVC DR18	$1,638.00
250mm PVC DR18	$1,717.00
300mm PVC DR18	$1,826.00

Note: Costs do not include roadway trench repair

Table 2.4: Storm Sewer Replacement Rates

Pipe Size and Type	Estimated Unit Rate (per lineal metre)
450mm PVC DR35	$734.00

Note: Costs do not include roadway trench repair

3 SANITARY SYSTEM

3.1 INVENTORY

The Village of Caroline's current inventory of sanitary sewers is as follows:

- Gravity Sewer: 5,280m
- Force Mains: 291m
- Trailer Park (Gravity): 318m

3.2 PREVIOUS STUDIES

3.2.1 Growth and Infrastructure Master Plan – Stantec Consulting Ltd.

The following milestones were noted in the 2009 CIP for the sanitary sewer system:

- Wastewater treatment facility (WWTF) has a current capacity for a population of approximately 1,000 persons which is beyond the 2033 study period.
- The entire lagoon system is to be desludged when the population reaches 622 persons (approximately 2027) or when the sludge quantities require removal.
- Existing lift station will not need to be upgraded prior to a population of 1,122 persons which is beyond the 2033 study period.

The sanitary system issues and recommendations noted in the 2009 CIP are:

- Upgrade WWTF aeration system. The aeration system was originally installed in 1998 by Nelson River and upgrades to the system were completed in 2012.
- Replace the influent gravity main from 48 Avenue to Manhole 1 (lagoon). This work was completed in 2012.
- Upgrade WWTF lagoon berms. This work is currently scheduled to be completed in 2025 and 2026, completing one lagoon cell per year.
- Upgrade WWTF discharge system. This work is currently scheduled to be completed in 2027 or 2028. The WWTF Discharge Concept Plan can be found in **Appendix G.**

3.3 EXISTING INFRASTRUCTURE

3.3.1 Lagoon Influent Gravity Main

There is approximately 820m of existing lagoon influent gravity main carrying the raw sewage from the Village to the lagoon, consisting of 750m of pipe from the corner of 49 Street and 48 Avenue to the lagoon. The full length of 820m of influent gravity main was replaced in 2012.

3.3.2 Lagoon

The original design of the wastewater lagoon system has the capacity to treat the wastewater for 1,000 people with a total design flow of 400 m^3/day (per capita design rate of 400 Lcpd).

Based on annual reports 2005-2022 that were sent to AEPA, the discharge effluent has met the 25 mg/L BOD target except for one instance in April 2006 (28 mg/L). To resolve this problem, the Village had the aeration line replaced in 2012. After the aeration line replacement, the BOD has met the effluent standard.

Two new 20 HP blowers and a backup diesel driven blower were installed at the wastewater lagoon site in 2023. The diesel driven blower Wastewater Lagoon was installed to supply air to the aeration line during power outages. In previous years winter power outages cause ice formation which has clogged the pore lines causing impaired function of the lagoon. The installation of the backup diesel driven blower has eliminated the ice formation. The aeration system is currently operating at 7 psi pressure and is operating as intended with no issues.

The Village lagoon cells were desludged by Lambourne Environmental in 2005. The next sludge removal program is scheduled to be undertaken in 2027, or when the sludge quantities require removal.

3.4 REHABILITATION STRATEGY

3.4.1 Methodology

The Village previously provided CCTV video footage for the CIP completed in 2009 and reports for all sanitary sewer pipes with a preliminary review undertaken by Cues High Pressure Flushing. The videos were reviewed by Stantec, and a rating was given to each section of pipe based on the condition observed during CCTV inspection and reports. The condition of each pipe section is based on the rating system listed below.

Table 3.1: Sanitary Sewer Rating System

Rating	Description
5	Sound physical condition. Asset likely to perform adequately without major work for 25 years.
4	Acceptable physical condition; minimal short term failure risk and minimal potential for deterioration within 10 years. Minor work required.
3	Acceptable physical condition with occasional deterioration evident. Failure unlikely in the short term (next two years) but further deterioration likely and major replacement likely in 10 to 15 years. Minor components or isolated sections need replacement or repair in the short term but asset still serviceable.
2	Significant deterioration evident; failure possible in the short term (next two years) and further deterioration and major replacement likely within 10 years. Minor components or isolated sections need replacement or repair in the short term but asset still serviceable.
0 - 1	Failure is likely in the short term. Likely need to replace a large amount of the asset within two years. Substantial work required in the short term; asset barely serviceable.
6	Asset not assessed due to lack of information.
FM	Sanitary force main not assessed.

Since sections with a rating of 3 or higher pose minimal risk for the next 10 years, sections rated as a 2 or lower are the priority for replacement. A complete list of the sanitary sewer condition ratings can be found in Table 3.3 in **Appendix B.** A list of sanitary sewer sections with a rating of 2 or lower is as listed below.

Table 3.2: Sanitary Sewer Sections in Very Poor to Poor Condition

Pipe Size and Type	From	To	Rating
51 Avenue	52 Street	50 Street	0
48 Avenue	52 Street	51 Street	1
51 Street	51 Avenue	51 Street Close	1
51 Street Close	52 Street	51 Street	2
50 A Street	Alley	52 Avenue	2
49 Street	47 Avenue	50 Avenue	2

It should be noted that for the sanitary sewer replacement method, a blended rating was given for each Village block of sanitary main rather than a rating between each manhole. This is because it is not cost efficient to replace pipe sections between manholes and increased efficiency can be achieved if an entire block is completed as part of the same upgrades.

3.4.2 Rehabilitation Schedule

The sanitary sewer system Figure 3.1 in **Appendix B** outlines the sanitary sewer conditions. The approximate construction costs for the sanitary sewer replacement are based on the schedule provided in **Appendix B**. Where possible; sanitary sewer replacements for specific locations will be coordinated with watermain and roadway replacement to increase spending efficiency. Pipe sections with the lowest rating should be the priority for improvements.

3.5 REHABILITATION COSTS

The unit prices used to estimate the rehabilitation costs for each segment of sanitary sewer have been taken from recent tender prices from various communities in Central Alberta, the unit prices used can be found in **Appendix F**. The unit prices provided have been broken down into costs per linear metre based on size of pipe to be installed for the sanitary sewer replacement.

Unit prices have also been provided for miscellaneous items related to the sanitary sewer replacement and calculated as part of the total cost. These miscellaneous items were calculated based on a typical 100 metres of utility replacement. In detailed design for replacements the quantities of each miscellaneous item will be determined as the total number or area of each miscellaneous item will vary from one section to the next.

Roadway trench repair including subbase, base and asphalt have not been included in the sanitary sewer replacement costs but can be found in the roadway unit price schedule and can be added as required.

The cost estimates provided include a standard contingency plus professional services estimated at approximately 35% of the total construction cost.

4 TRANSPORTATION NETWORK

4.1 OBJECTIVE

The Village of Caroline commissioned Stantec Consulting Ltd. to complete the following:

- Complete a visual inspection of the roadway network to analyze the overall condition and type of deficiencies in each area;
- Summarize the findings of the inspection; and
- Provide a recommended staging plan for roadway rehabilitation that will be incorporated into this 10-year Capital Infrastructure Plan.

4.2 VISUAL ROADWAY INSPECTION AND RATING

In April 2009, Stantec completed a detailed visual pavement inspection of the roadway network. Pavement distresses were measured, recorded, photographed, and the severity of each pavement distress was noted. The visual inspection also included measurements of all roadway widths, curb and gutter dimensions, sidewalks, and boulevards.

In November 2024, Stantec completed an updated on-site analysis of the roadway network.

A list of the roadway segments most in need of improvements is shown below:

Asphalt

- 52 Street (51 Avenue to North Limit) (Currently being designed)
- 52 Street Crescent (All Three Legs) (Currently being designed)
- 48 Avenue (50 Street to 52 Street) (Currently being designed)
- 49 Street (50 Avenue to 51 Avenue)

Gravel

All Gravel Roads should be reviewed for maintenance yearly.

- 52 Avenue (50 Street to 51 Street)
- 51 Street Close
- 51 Avenue (48 Street to 50 Street)
- 48 Street (50 Avenue to 51 Avenue)
- 48 Avenue (West Limit to 52 Street)
- 49 Street (South Limit to 48 Avenue)
- 49 Street (51 Avenue to North Limit)

Most of the roadway network has been divided per block of roadway; however, some sections include multiple blocks of roadway in one segment based on the continuity of the existing type of asphalt, curb and gutter, and sidewalks.

Table 4.3 in **Appendix C** provides an overview of the visual pavement inspection and a condensed list of the type of pavement distress noted on each segment of roadway along with the measurements taken. Also provided are the overall visual assessment ratings for each segment of roadway.

To better understand Table 4.3 and the details provided in it, an outline has been provided below which describes the data and provides the necessary definitions to interpret the findings.

Int – Is the intersection at each limit included in the evaluation of that segment of roadway (Y = Yes), (N = No). Note: Each intersection has been evaluated as part of the adjacent segment with the most similar qualities.

Width (m) – Is the measured average roadway width in metres. All measurements are taken from the lip of the existing concrete gutter or from the shoulder edge in locations with no curb and gutter.

Length (m) –Each length has been measured to the edge of property adjacent to the intersection and is shown in metres. (If the intersection has been evaluated as part of that segment of roadway, the length shown includes the intersection). All lengths have been measured from the existing Village legal plan.

Existing Surface – Is constructed of Asphalt Concrete Pavement (ACP), gravel, or a combination of the two surface types.

Primary Distresses – Are generally the most notable distresses in each segment of roadway which are found in multiple locations or continually found throughout the entire segment being evaluated. These distresses may also include extremely severe distresses found in isolated locations.

Secondary Distresses – Are minor to moderate distress and are found in isolated locations or scattered locations throughout the segment being evaluated.

Note: A definition and a photo of each distress type can be found in Section 4.3.

Curb and Gutter (Side-Type-Width)

- **Side** – is the side of the roadway the curb is located (N,E,S,W – North, East, South, West).
- **Type** – Two types of curbs and gutters exist in Caroline (S = Standard Curb and Gutter, R = Rolled Curb and Gutter). If either the S or R is accompanied by an M this indicates that the sidewalk is monolithic (The curb is attached to the sidewalk i.e. MR – Monolithic Rolled Curb and Gutter).
- **Width** - Is the width of the curb and gutter not including any attached sidewalk.

Sidewalk (Side-Width)

- **Side** – is the side of the roadway the sidewalk is located (N,E,S,W – North, East, South, West).
- **Width** - Is the width of the sidewalk not including any attached curb and gutter.

Boulevard (Side-Width)

- **Side** – is the side of the roadway the boulevard is located (N,E,S,W – North, East, South, West).
- **Width** - Is the width of the boulevard in metres measured from the back of the curb (or road shoulder) to the sidewalk.

Overall Ratings

This is an objective rating of the overall roadway condition for each roadway segment based on the visual inspection completed. The overall rating considers the types, severity, and frequency of distresses found on each segment of roadway. In addition to the distresses observed the overall shape and apparent condition of the roadway has been considered and engineering judgment has been implemented to provide the final rating. The pavement assessment rating scale used for the paved roadways is outlined below.

Table 4.1: Pavement Rating System

Rating	Description
5	Excellent Condition – Generally only found on a freshly paved roadway, no need for any improvements.
4	Good Condition – Only minor distresses identified with few or no isolated moderate distresses, no immediate need for roadway improvements.
3	Average Condition – Minor distresses throughout with some moderate distresses identified and no or few severe distresses, may need to be improved within the next 5-10 years.
2	Poor Condition – Many severe distresses or moderate and minor distresses identified throughout, will need to be rehabilitated within the next 10 years.
1	Very Poor Condition – Many severe and moderate distresses identified throughout, severe need for roadway rehabilitation.
0	Severely deteriorated roadway with little evidence of any ACP.

All gravel roadways are rated on a scale of 0 - 3. The ratings are outlined below.

Table 4.2: Gravel Road Rating System

Rating	Description
3	Excellent Condition – Gravel roadway is in excellent condition, typical of a newly constructed gravel roadway.
2	Average Condition – This rating is given to gravel roads that are characteristic of aged roadways in acceptable condition with some minor intermittent distresses. The general shape and ride of the road is in acceptable condition.
1	Poor Condition – Continuous distresses throughout the roadway section. Generally resulting in potholes and poor ride conditions.
0	No granular surface – i.e. dirt road or path.

The curb, gutter and sidewalks (concrete) were also inspected during the visual assessment. No direct ratings for the concrete inspected are provided due to the variation in concrete conditions within each identified section of roadway. Overall, Caroline's concrete was found to be generally in good condition.

4.3 DISTRESS TYPES

The following is a brief summary and a photographic example of each type of pavement distress identified in Table 4.1.

Fatigue Cracking

Occurs in areas subjected to repeated traffic loadings and can be a series of smaller interconnected cracks in early stages development which further develop into many sided pieces usually less than 0.3 metres on the longest side. In later stages chicken wire/alligator patter cracking is generally apparent. In extreme cases of fatigue cracking individual pieces of asphalt may move when subjected to traffic loading. The photo below is an example of moderate to severe fatigue cracking.

Transverse Cracking

Cracks that are predominantly perpendicular to the centerline of the roadway. The photo below is an example of moderate transverse cracking.

Longitudinal Cracking

Cracks that are predominantly parallel to the roadway centre line. The photo below is an example of moderate longitudinal cracking.

Pumping (Water Bleeding)

Seeping or ejection of water from beneath the pavement through cracks. In some cases, detectable by deposits of fine material residue on the pavement surface where were eroded (pumped) from the granular support structure of the roadway onto the surface. The photo below is an example of moderate pumping.

Edge Deterioration

Applies to areas typically within 0.6 metres of the pavement edge. This type of distress is typically found in locations where on-street parking lanes have been provided. The photo below is an example of moderate to severe edge deterioration.

Patching and Patch Deterioration

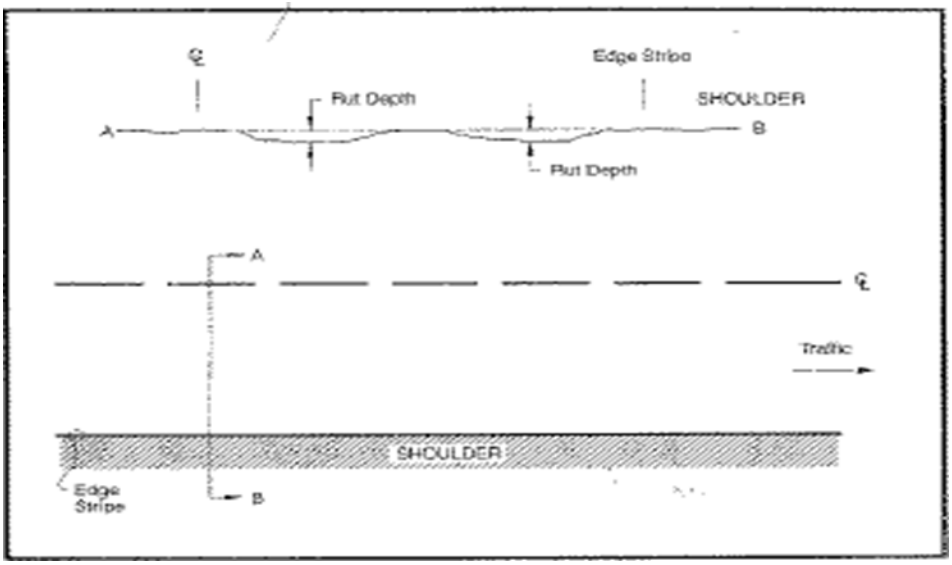
Portions of the pavement surface, greater than 0.1 square metres that have been removed and replaced or additional material applied after the original construction. The photo below is an example of patching with minor deterioration.

Potholes

Bowl-shaped holes of various sizes in the surface, often resulting in standing water and water infiltration into the base of the road structure. The photo below is an example of a roadway with many moderate to severe potholes where the roadway surface is heavily deteriorated.

Rutting

A rut is a longitudinal surface depression in the wheel path which may have associated transverse displacements.



The photo below is an example of severe rutting.

4.4 REHABILITATION STRATEGY

4.4.1 Methodology

The visually assessed roadway sections should be improved in order of priority based on the ratings provided for each section. However, the purpose of this Capital Infrastructure Plan is to provide the most economic strategy for total infrastructure replacements within the Village. This strategy will employ logical tactics for infrastructure rehabilitation which will help ensure that the underground infrastructure will not fail or require upgrades shortly after a roadway has been rehabilitated, requiring removal and reconstruction of the roadway to repair the underground infrastructure.

The roadway rehabilitation strategy is heavily dependent on the required underground infrastructure rehabilitation that is required. As a result, the recommended roadway rehabilitation strategy and schedule generally coincides with the planned underground infrastructure upgrades recommended.

In some locations with extremely deteriorated roadway conditions, roadway repairs have been recommended prior to underground repairs or in locations where no immediate underground work is needed. Recommendations provided by Village staff have also been considered to help identify these locations.

4.4.2 Rehabilitation Schedule

Figure 4.1 located in **Appendix C** outlines the priority of roadway sections identified for rehabilitation. The overall rehabilitation priority schedule based on the underground infrastructure and roadway ratings is presented in the Summary (Section 7) and the associated figure is in **Appendix A**.

4.5 REHABILITATION COSTS

The unit prices used to estimate the rehabilitation costs for each segment of roadway have been taken from recent tender prices in various communities in central Alberta and Alberta Transportation and Economic Corridors (TEC) unit price listings. The unit prices used can be found in **Appendix F**. The unit prices provided have been broken down into cost per square metre of roadway to be rehabilitated. Unit prices have also been provided for concrete work and other miscellaneous items.

4.5.1 Roadway Structure and Pavement Surfacing

The roadway structure and driving surface rehabilitation costs for each section of roadway are shown in Table 4.4 in **Appendix C** and are based on the per square metre costs estimations provided in **Appendix F.** At this time, it is not possible to determine the precise type of rehabilitation that will be required for each section of roadway due to a lack of geotechnical information. As such two cost estimates for roadway rehabilitation have been included for each roadway segment:

- Full reconstruction of the roadway including an entirely new granular base and asphalt road structure; and
- Edge milling with asphalt overlay.

In addition to the two cost estimations provided, a third estimate has been developed to approximate the cost of roadway reconstruction required where trenching has taken place for replacement of deep utilities. For this estimation the same unit price as full roadway reconstruction has been utilized and the area is equivalent to the total length of trenching multiplied by a standard five-metre-wide trench. In most locations where trench repair is required it would be advisable to also complete milling and overlay of the full roadway once the trench repair has been completed.

The cost estimates provided include a standard contingency plus professional services estimated at approximately 35% of the total construction cost. The two options presented are considered an upper and lower approximation of what the potential roadway rehabilitation costs will be (in 2024 dollars).

Prior to any roadway rehabilitation design a geotechnical investigation should be completed to determine the existing roadway structure and in-situ conditions. At that time, it will be determined whether an overlay, full roadway reconstruction, or a combination of the two options will be required. The costs for a geotechnical investigation are included in the 35% professional services and contingency estimate provided. The geotechnical investigation will be completed as part of the preliminary and detailed design for the particular section of roadway to be rehabilitated.

It should be noted that the edge milling and overlay option is not available for gravel roadways. In addition, any paved roadway that is severely deteriorated will not likely be a candidate for the milling and overlay option, however this will be confirmed upon completion of the geotechnical investigations.

4.5.2 Concrete and Miscellaneous Items

The curb, gutter, and sidewalks will require replacement or new construction only in select locations which should be identified as part of the design of a roadway section to be rehabilitated. A list of unit prices has been provided in for concrete replacement and construction which could be added to the total estimated roadway rehabilitation costs provided. In addition to concrete items other miscellaneous item unit prices (i.e. valve adjustments, grass seeding, etc.) are also provided in **Appendix F** which could be added to the total rehabilitation costs depending on the number or area of items affected by the proposed construction. The total number or area of each miscellaneous item will vary from one section of roadway to the next.

4.5.3 Gravel Roadways

Grading of graveled roadways should be completed on a yearly basis at minimum, and more often if wet weather and/or large traffic volumes deteriorate the road surface on a consistent basis. Regular grading will help to maintain the roadway shape and ability to shed water which will in turn help prolong and maintain the structure and subgrade conditions. In addition, regular maintenance will remove potholes, improve ride quality, and reduce damage to vehicles. Yearly grading should be completed as part of the Village's general maintenance program and therefore this report does not provide costs associated with grading of gravel roadways.

4.5.4 Roadway Rehabilitation Economics

When roadway reconstruction is planned it is recommended that the potential to reuse existing materials be explored. In situations when a full or partial rebuild of the roadway is required, a large percentage of the existing road structure material could potentially be reused, if found to be in acceptable condition, to help lower the total roadway rehabilitation costs.

5 WATER SYSTEM

5.1 PREVIOUS STUDIES

5.1.1 Village of Caroline Growth and Infrastructure Master Plan

The water system issues and recommendations noted in the 2009 CIP are outlined and addressed as follows:

Raw Water Supply

- The raw water supply will be adequate for a population of 911 people which is beyond the 2033 study period.
- The Village Water Treatment Plant has two raw water wells 402 and 403, and three pumps 401, 402 and 403. At a population of 792 people, which is beyond the 2033 study period, pumps 401 and 402 will need to be replaced with a pump of similar or greater flow capacity than pump 403.
- The raw water filters (green sand filters for iron and manganese) will not need to be replaced until the population reaches 911 persons, which is beyond the 2033 study period.

Water Treatment Plant, Storage and Pumping

- No additional distribution pumps will be required until the population reaches a population of 1,122 people, however the motor should be upgraded from a 10 hp to 15 hp when the population reaches 736 people. Both populations are beyond the 2033 study period. It is also noted that the distribution pumps will exceed their life expectancy prior to 2026 and should be tested, serviced and replaced as necessary.
- The existing storage reservoir will require an upgrade to increase the usable water capacity from 820 m^3 to 945 m^3 prior to a population of 847 persons, which is beyond the 2033 study period.
- The fire pump will need to be upgraded to 235 L/s prior to reaching a population of 640 (approximately 2029) to fulfill the commercial and industrial fire flow requirements.

Water Distribution Network

- Provide watermain loops as recommended in the 2009 CIP. This looping is required to improve the servicing and fire protection and to meet the minimum Alberta Environment and Protected Areas (AEPA) water distribution system design guidelines.

5.2 WATER SUPPLY AND TREATMENT SYSTEM

5.2.1 Existing infrastructure

The water system analysis summarized in Section 5.1 as well as the information provided by the Village were reviewed to gather information pertaining to the water wells, the water treatment plant, and the existing pumping systems.

Raw Water Supply

Formerly, Caroline had three water wells, numbered 401, 402, and 403. Well 401 was abandoned and the casing was pulled in 2007. Currently Well 402 is only used as a backup well. The primary water source for the Village is Well 403, which is pumped approximately 5 hours per day (varying by season) producing about 130 m^3/day per day in 2023 and meets the Village water requirements without difficulty. Water is treated to remove slightly excessive iron and manganese.

The population of Caroline hit a low of about 433 people in 2020 but has increased since then however there has been a consistent drop in total water demand, from 118,000 m^3 to less than 50,000 m^3 per year in 2023. Because of the reduced demand, the documented water levels in Well 403 have risen from an initial 12 metres below ground in 2003 to about 6 metres below ground in 2023.

The water in Well 402 has a higher manganese concentration than Well 403, which requires a more intensive removal process so the manganese removal process for 403 is not adequate to treat water from Well 402. For this reason, the Village pumps from Well 402 as little as possible using it only as a backup well.

With one well not in use and the other in use just as a backup well, the Village still has a more than adequate supply of water. The Village foreman indicated that there has been no decline in pumping or non-pumping water levels in Well 403, and no evidence of a decline of productive capacity. The water supply wells have sufficient capacity for the population of the Village to exceed 1,000 persons and therefore future review of the system is not required.

Water Treatment Plant, Storage and Pumping

The Water Treatment Plant (WTP) is located on 52 Avenue between 50 Street and 50A Street. The WTP treats raw water from the raw water wells at a current treatment capacity of 655 m^3/day. Treated water is stored in a reservoir near the WTP which has capacity of 818 m^3.

There are currently two 10 hp vertical turbine distribution pumps located at the WTP along with one 125 hp fire flow pump connected to an eight-cylinder diesel engine.

Treatment Process

Oxidation/Filtration

Each filter tank has a capacity of 329 m^3/day (227.5 Liters per minute), with the combined capacity of the two filters being 655 m^3/d. The filters have sufficient capacity to handle the maximum daily demand for this study scope.

The average raw water and treated water Manganese (Mn) concentration is 0.040 mg/L and 0.012 mg/L respectively. The Mn concentration in treated water complies with the Canadian drinking water standard (A.O. < 0.05 mg/L). The treatment results indicate that the oxidation and filtration process is functioning very well.

Backwashing of the filters is conducted on a biweekly basis. The backwash process consumes approximately 22 m^3 per cycle with each cycle lasting 15 minutes for each filter. To avoid using too much water in the reservoir during the daytime, the operators always schedule the timing of the backwash for each filter on different days. When the population reaches 670, the treated water capacity will meet and exceed the maximum daily demand but cannot meet the backwash volume requirement. Therefore, the filter backwash should be scheduled to avoid maximum demand days.

A timer for backwash controls is not currently being used by Village operators. Instead, the backwash is controlled manually as preferred by the operators. At this time the method is acceptable, however a more advanced control system should be considered in the future.

Chlorination

As required by AEPA Guidelines, the disinfection process in the Caroline WTP should be able to achieve a 4-log reduction of virus. The drinking water standard National Sanitation Foundation (NSF) 60 requires a 12% concentration of Sodium Hypochlorite (NaClO). This concentration is achieved by the Village of Caroline's WTP and is used as the primary and only disinfectant in the WTP. The free Chlorine residuals before entering the distribution system are controlled at an average value of 0.65 mg/L, with an upper limit of 1 mg/L and lower limit of 0.2 mg/L. According to the operators, the water temperature is about 6ºC, and the pH value is approximately 7-8 throughout the year.

Based on the above parameters, and assuming the baffle factor of 10% in the treated water reservoir, the CT (Chlorine Concentration Contact Time) value was calculated to be 29 at the Peak Hour flow rate. This CT value is much larger than the required value of 10 and therefore confirms the ability to claim the 4-log virus reduction credit (Code of Practice).

Projected flow rates were used to verify the CT value. The CT values range from 29 with a population of 550 people to 23 with a population of 680 people. These values indicate that the free Chlorine is at the average value of the acceptable range (0.2 – 1.0 as mentioned above) and the disinfection process can meet the 4-log virus reduction.

Process Mechanical

Overall, the mechanical components in the WTP are very well maintained. Regular painting on the pumps, pipeline and other mechanical parts protects the metals from corrosion keeping them in good working order. The operators have replaced the pressure gauges as required.

5.3 WATER DISTRIBUTION SYSTEM

5.3.1 Existing Infrastructure

The water study summarized in Section 5.1 as well as the information provided by the Village were reviewed to gather information pertaining to the water distribution system for the Village.

Distribution Mains

The Village of Caroline's current inventory of water mains is constructed primarily of Asbestos Cement (AC) pipe and PVC pipe. The total length of known water pipeline in the Village is as follows:

- Watermain (majority is 150 mm Asbestos Cement): 5,456m
- Trailer Park to Property Line (150 mm): 330m

No fire hydrant leads, or service connections have been incorporated into these totals. The above totals assume all existing water lines in the Village are AC pipe or PVC pipe, with exception of the lines in the trailer park and main connecting the trailer park to the Village network.

Asbestos Cement Pipe

Asbestos Cement (AC) Pipe is lightweight pipe made of asbestos fibers, silica sand, and Portland cement. AC pipe was installed throughout Canada primarily in the 1940's -1970's as a strong, lightweight, non-corrosive, cost effective alternative to cast iron. AC piping has since been all but eliminated from standard production because of the readily available PVC pipe as well as the potential health and safety concerns relating to asbestos. Health Canada and the World Health Organization have concluded that there is no consistent, convincing evidence that asbestos ingested through water is harmful.

The Village has indicated that most of the water distribution network was installed in 1962 with some watermains installed later at 51 Street Close in 1978. This would indicate that the majority of the watermain network is now 60+ years old. The typical life expectancy for AC pipe is 40 to 60 years but has been shown to last up to 100 years depending on several factors including acidity of the surrounding soils, exposure to ground water, and softness of the enclosed water.

Although the water distribution network within the Village is currently functioning at acceptable levels most of the existing water distribution network is at the end of the expected service life (60 years). It is probable that much of the AC pipe installed in 1962 will experience failures throughout the system over a period of 5 -10 years near the end of the AC pipe design life.

Keeping in mind that most of the water distribution network was installed in the span of a couple of years, it would be prudent to replace the majority of watermain network prior to the end of the AC design life, and thus, a replacement program commencing soon is highly recommended. Implementing a replacement program will help to minimize large scale impacts to the distribution system by replacing the AC pipe prior to failure.

5.4 REHABILITATION STRATEGY

5.4.1 Methodology

It is recommended that a full-scale water distribution main replacement strategy be carried out by the Village of Caroline. Typical strategies of this nature would focus on initially replacing pipe segments where the most historical problems have occurred, followed by areas with less or no past problems.

However there is little known historical data within the Village making it impractical to complete the water main replacement strategy in this manner.

It is therefore recommended that the watermain replacement strategy in the Village be subject to required maintenance of other infrastructure in the area as well as priorities of the Village.

As per previous discussions with Village operators, the watermain along 50 Avenue and in other areas had required repairs in the past and required additional repairs to the service connections. As this water main services most of the commercial property in the Village, the replacement was recommended to be a top priority. The existing watermain along 50 Avenue was replaced. In summary, in the last 15 years (2009 – 2024), there have been six water service leaks requiring replacement or repair. They are as follows:

- Two on 50 Avenue.
- Two on 49 Street.
- One on 51 Street.
- One of 52 Street.

In addition to the above, there was one above ground fill hose incident requiring repair at the Bulk Water House. The Village has only had water issues caused by service leaks, not water main leaks.

The recommended water main looping is to be completed in conjunction with road and sanitary improvements in the area however looping should be given special consideration before Village expansion. As noted above, 150mm mains should be upsized to 200mm or 250mm mains as recommended. The size of the watermain will be confirmed at the detailed design phase and additional modeling is recommended to verify the existing conditions at the time of design.

In addition to the recommendations provided above watermain replacements should be completed in conjunction with other infrastructure work in the area, mainly with the sanitary sewer replacement and will be assessed by the priority rating of the other infrastructure such as:

- Replacement or new installation of sanitary sewer in the area;
- Prior to any paving or roadway construction in the area;
- Replacement or new installation of storm sewer in the area.

To elaborate; in any area where sanitary or storm sewer upgrades are being completed, the watermain parallel to the other utility being upgraded is recommended to be replaced at the same time. This system will allow for the most cost-effective replacement strategy as the mobilization, trenching, and backfilling costs for the watermain replacement can be shared between multiple utilities. Likewise, watermain replacement should be completed prior to roadway construction or paving to ensure that new road structures or asphalt will not have to be removed for replacement or maintenance of watermains.

5.4.2 Rehabilitation Schedule

Figure 5.1 located in **Appendix D**, outlines the water system in the Village of Caroline. The priority of watermain sections to be replaced was not identified in detail as discussed in Section 5.4.1 above.

5.5 REHABILITATION COSTS

The unit prices used to estimate the rehabilitation costs for each segment of watermain have been taken from recent tender prices from various communities in central Alberta. The unit prices used can be found in **Appendix F**. The unit prices provided have been broken down into costs per lineal metre based on size of pipe to be installed for the watermain replacement.

Unit prices have also been provided for miscellaneous items related to watermain replacement and have been calculated as part of the total cost. These miscellaneous items were calculated based on a typical 100 metres of utility replacement. In detailed design for replacements the quantities of each miscellaneous item will be determined as the total number or area of each miscellaneous item will vary from one section to the next.

Roadway trench repair including subbase, base and asphalt have not been included in the watermain replacement costs but can be found in the roadway unit price schedule and can be added as required.

The cost estimates provided include a standard contingency plus professional services estimated at approximately 35% of the total construction cost.

6 STORM SYSTEM

6.1 INVENTORY

The existing length of storm sewers in the Village of Caroline is approximately 980 metres composed primarily of Corrugated Metal Pipe (CMP) with some newer areas constructed from PVC pipe. The two primary outfall drainage locations are:

- The west ditch of 50 Street, North of 51 Avenue which flows north out of the Village; and
- The drainage ditch east of 49 Street and 48 Avenue intersection which disperses east and south into the adjacent fields.

6.2 ANALYSIS

Typical of most small communities, Caroline relies heavily on overland drainage with a segmented system of underground stormwater infrastructure and strategically located ditches. For smaller communities the cost to fully implement underground stormwater infrastructure is not economical to complete due to a relatively small infrastructure spending to population ratio.

The current drainage conditions within the Village appear to be adequate at this time. A figure of the Village storm system can be found in **Appendix E.**

6.3 REHABILITATION STRAGETY AND FUTURE STORM IMPROVEMENTS

The current outfall east of the 49 Street and 48 Avenue intersection releases approximately 40% of the Village drainage. At this time the outfall location and ditch appear to be providing adequate dispersion of the stormwater collected; however, this ditch is restricting the potential development of the adjacent land. It is recommended that a storm line be installed extending the sewer from the intersection of 49 Street and 48 Avenue south to the Village boundary, and east to where it would outfall into the ditch of 50 Street (Range Road 61). These upgrades should be completed with the proposed upgrades and re-alignment of the sanitary sewer in the same location. The average cost per linear metre for the proposed storm upgrade is found in **Appendix F**.

Further storm sewer upgrades could be implemented throughout the Village; however it is recommended that available capital funds be used for higher priority upgrades needed for the sanitary, water, and roadway networks.

Upgrades will be required with future development areas within the Village. Since storm system improvements and stormwater management requirements are a direct result of new land development, future areas cannot be predicted. New developments are required to provide a stormwater management plan; at which time any stormwater issues created by the development should be addressed.

7 CONCLUSIONS AND RECOMMENDATIONS

This Village of Caroline Capital Infrastructure Plan (CIP) has provided a review of each vital piece of the Village's existing infrastructure. This review has concluded that the most vital parts of your community such as water well supply, water treatment, sanitary collection system and wastewater treatment are currently in good condition within the Village of Caroline.

Conversely, this infrastructure review has led to the conclusion that some of the slightly less critical, but still very important portions of the Village infrastructure such as the water distribution network, select sanitary mains, and roadways are deteriorating due to age, and are in need of rehabilitation.

In general terms, most of the water distribution network (with asbestos cement pipes) within the Village is due for replacement within the next 10 years, when comparing the pipe type to the typical design life. Due to available funds, it may not be feasible to complete replacement of the entire water distribution network within this timeframe; however, the low level of maintenance that has been required to date indicates that the existing water distribution mains may last several years beyond the typical design life. It is still recommended that a watermain replacement program commence immediately to avoid multiple repairs simultaneously. It is also recommended to complete watermain replacement in conjunction with sanitary sewer replacements and prior to roadway rehabilitation. In addition, it is recommended that each watermain be upsized from the existing 150mm to either 200mm or 250mm as recommended to ensure adequate fire flow to various areas in the Village is achieved and to provide the opportunity for future Village expansion without the need for additional upgrades in the future. The extra cost for installing larger water pipeline is approximately $62/metre for 200mm diameter pipe or $141/metre for 250mm diameter pipe (or 4 to 8% of the total construction cost).

The recommendations provided in this report are focused on the vital portions of the deteriorating infrastructure which include the required water and sanitary sewer upgrades (deep utilities). Most of the roadway upgrades are recommended to take place following completion of the deep utilities in any given area. However, consideration was also given to the avoidance of removing roadways in good condition simply to replace deep utilities that may be in poor condition. Some areas with extreme roadway deterioration have also been considered for rehabilitation prior to the deep utility replacement while some areas have been considered for deep utility replacement where no roadway work is needed.

In some circumstances, paving that may be needed in an area where little or no deep utility work is required or deep utility replacement where no roadway work is required has been presented as an area of special consideration (covered in Section 7.1.5).

7.1 OVERALL PRIORITY RATING

The following is a description of each proposed rehabilitation and a list of the work to be completed in the area, based on the priority rankings developed (Table 7.2 of **Appendix A** and illustrated on Figure 7.1). A top priority number indicates degraded or inadequate infrastructure in the area. In addition, the areas top priority will generally provide enhancements for larger portions of the Village, conversely areas with lower

priority ratings will generally only result in enhancements to the localized area where the improvement is completed.

The ratings established are:

Table 7.1: Priority Level Ratings

Priority Level	Description
1	Immediate Attention Required
2	Critical Rehabilitation Required
3	Standard Upgrades Required
4	Future Upgrades Required
5	Long Term Upgrades
*	Areas of special consideration

The upgrades recommended in each priority category are listed sequentially and are generally based on condition of existing infrastructure. At the time of design, it is recommended that the Village monitor local conditions to properly decipher which upgrades should be completed in that given year. The recommendations provided are to be implemented at the Village's discretion and may be subject to external factors such as user impact, funding and changing conditions. If an increased number of issues are noticed in a single location the urgency for upgrades in that area could push that location to the top project within the priority category, or even move it up to a higher priority ranking. This idea should be strongly considered with regards to the watermains.

It is known that most of the AC pipe within the Village is in the last years of its design life; however, the actual condition of the pipe is unknown. Each time a section of the AC water pipe is removed for replacement, a careful inspection of the pipe should be completed to help determine the overall condition of the pipe removed as well as the pipe in the adjacent locations.

A cost breakdown for each section of recommended upgrades is presented in Table 7.2 of **Appendix A.**

Note: All costs provided in this section of the report include the cost for total roadway reconstruction. Following the completion of a geotechnical investigation, it may be determined that only trench repairs and/or an overlay may be required, which would significantly reduce the cost of each project.

In some locations the sanitary sewer appears to be in good condition however costs are still included into the total cost for the rehabilitation recommended. It is recommended that an additional camera inspection be completed on each section of sewer before rehabilitation is completed in the area to verify the condition of the sewer main. In cases where the infrastructure will not need upgrading the allocated funds can be used for additional upgrades or distributed elsewhere.

7.1.1 Priority 1 - Immediate Attention Required

49 Street, from 48 Avenue to 47 Avenue

- Upgrade the sanitary sewer from the intersection of 48 Avenue and 49 Street, south, to 47 Avenue. This upgrade should reduce or eliminate the sewer backups that have been occurring within the Village.
- Replace the watermain along 49 Street.
- Install a storm sewer in this location to eliminate the drainage ditch on the east side of the roadway. The extension of the storm sewer will provide the opportunity to outfall the storm system in the ditch of Range Road 61 which will in turn provide the opportunity to develop the land east of 49 Street. The eradication of the existing drainage ditch will also eliminate potential negative effects on the roadway and surrounding areas such as minor flooding and undermining of the roadway.
- Paving the roadway to be completed after the deep utility installation.
- The total approximated cost for these upgrades is $915,527.

7.1.2 Priority 2 - Critical Rehabilitation

48 Avenue from 52 Street to 50 Street

- This sanitary sewer is in very poor condition and should be replaced.
- The watermain in this section should be replaced as part of the upgrades to be completed.
- Currently this roadway is slightly below average condition, and it is anticipated that this roadway will degrade to poor condition by the time these upgrades are implemented.
- The total approximated cost for these upgrades is $1,816,817.

52 Street from 51 Avenue to the North End and 52 Street Cresent

- The visual roadway assessment completed pointed out that this section of the roadway is the worst stretch of pavement in Village, especially at the northern end of the roadway.
- The VCT sanitary sewer in this location should be replaced during construction but the PVC sewer in the area appears to be in good condition so it should be further evaluated at the time of repair. The VCT sanitary sewer extending north of 52 Street Crescent (north leg) should be abandoned and any services connected to that pipeline should be attached to the adjacent PVC sewer line.
- Watermain replacement will be needed as part of the rehabilitation in this area.
- The total approximated cost for these upgrades is $2,385,565.

7.1.3 Priority 3 - Standard Upgrades

51 Avenue from 50 Street to 51 Street

- The sanitary sewer is in very poor condition and should be replaced.
- The watermain should be replaced during rehabilitation of the sanitary sewer.
- Once the deep utilities replacements are completed the roadway will have to be repaired.

- The total approximated cost for these upgrades is $762,679.

51 Street from 51 Avenue to 52 Avenue

- The sanitary sewer in this location is in very poor condition and will require replacing.
- Watermain replacement will be needed as part of the rehabilitation in this area.
- The roadway in this area ranges from average condition at the southern end and degrades to very poor condition at the northern end. Roadway repair will be needed once replacement of the deep utilities has been completed.
- If this work is not completed in conjunction with these recommended 51 Street repairs, this special consideration item should be considered a top Priority 3 item.
- The total approximated cost for these upgrades is $1,339,066.

51 Avenue from 49 Street to 48 Street and 48 Street from 50 Avenue to 51 Avenue

- Looping of the watermain in this area will improve fire flow demands and assist in servicing future developments.
- Paving of the roadway should be completed from 50 Avenue to the location of the bulk fueling station, at very least. This road structure should also be enhanced beyond standard local roadway. If the Village feels it would be beneficial to the transportation network this entire roadway could be paved after the installation of the watermain.
- Special consideration should be given to 51 Avenue from 50 Street to 49 Street. The watermain in this location could be replaced and the roadway is in very poor condition and should be reconstructed.
- The total approximated cost for these upgrades is $310,734. The approximated cost to include the area of special consideration is an additional $319,748.

52 Avenue from 50 Street to 51 Street

- This roadway is in very poor condition and will likely require full reconstruction.
- The sanitary sewer in this location is in fairly good condition and a CCTV inspection should be completed prior to design. If found in poor condition at that time it should be replaced. If found in good condition the funds could be distributed elsewhere.
- Watermain replacement will be needed as part of the rehabilitation in this area. The watermain replacement will also provide the opportunity to replace the intake pipe which provides the flow corridor from well 402 to the water treatment plant.
- As a portion of this work, special consideration should also be given to the potential completion of the sewer, roadway, and watermain upgrades along the northern 45m of 50 A Street in order to complete full upgrades from well 402 (52 Avenue) to the water treatment plant.
- This area has also been proposed for water main looping. It is recommended that the extension of the watermain be completed to 50 Street during this stage.
- The total approximated cost for these upgrades (not including the area for special consideration is $1,142,465.

51 Street Close

- The sanitary sewer in this location is in poor condition and will require replacing. Upgrades in this area would allow replacement of the sanitary sewer running from west of 51 Street Close to 52 Street.
- Watermain replacement will be needed as part of the rehabilitation in this area and watermain looping from 52 Street to 51 Street is recommended. At this time the watermain looping is shown in the back alley north of 51 Street Close however if room is available, consideration should be given to installing the watermain loop in the same location as the sanitary sewer. The common trench and shorter pipe distance would result in cost saving if the watermain could be added in the same location as the sanitary sewer (note that the price shown below does not include this potential cost reduction).
- The roadway in this area is also in poor condition. Roadway repair will be needed once replacement of the deep utilities has been completed.
- The total approximated cost for these upgrades is $820,010.

49 Street from 50 Avenue to 51 Avenue

- The watermain in this location has been identified as having a previous service leak. This likely indicates that the watermain in this area may be in poor condition; therefore this is an important area for watermain replacement.
- This roadway has been identified as the second worst section of pavement in the Village. As such roadway rehabilitation should take place.
- This sanitary sewer is currently in good condition. Ideally this sewer will not have to be replaced at the time of construction; however the sewer should be inspected prior to the rehabilitation of the area to determine if it is still in good condition.
- The total approximated cost for these upgrades is $777,851.

7.1.4 Priority 4 and 5 - Future / Long Term Upgrades

All priority 4 and 5 locations are displayed on Figure 7.1. Although portions of the infrastructure in these areas do require rehabilitation it is anticipated that the Village will not have the available capital funds to complete the upgrades needed within the ten-year scope of this Capital Infrastructure Plan. It is important to note that all areas of the Village should be monitored for deficiencies and adequate records of all repairs be documented. If multiple problems are encountered in a single area, it is likely that the area of reoccurring problems should be moved up in the priority ranking. All approximated costs for the infrastructure replacement for each priority 4 and 5 area are listed in Table 7.2.

7.1.5 Areas of Special Consideration

Several areas of special consideration have been outlined throughout Section 7.1. Most areas of special consideration noted are in a location were a generally smaller and slightly less important area of infrastructure rehabilitation is needed, or only select parts of the overall rehabilitation schedule are required (ie. only paving is required with no deep utilities).

Three categories of special consideration have been developed which are outlined below.

1. Primary Areas of Special Consideration

These areas have been identified with the top priority items listed in Sections 7.1.1 to 7.1.3. The critical areas of special consideration include areas that would not be required as a part of the rehabilitation but are strongly recommended and would enhance the effectiveness of the work being completed. Completing the recommended upgrades in these areas while completing the recommended top priority rehabilitation would allow for the construction to be completed in a cost-effective manner.

2. General Areas of Special Consideration

Each of these general areas of special consideration could be included in the planned repairs of the adjacent location if extra capital funds are available in the given year. These areas could be ideal for upgrades should the planned construction costs come in lower than expected in a given year. Completing infrastructure repairs in these locations will allow the Village to accomplish rehabilitation of the infrastructure of these smaller areas in the most cost-effective way.

However, all areas of special consideration should have a final review completed by the Village and the engineer prior to initiating design for the rehabilitation in any given year. This final assessment will be to ensure the area of special consideration recommended is a satisfactory usage of capital funds for the given year, and that there is not a more critical area where the funds could be allocated.

3. Coordinated Areas of Special Consideration

The coordinated areas of special consideration are along 50 Street and 50 Avenue and in locations where no underground utilities are currently located (near the edges of the Village). Roadway rehabilitation should be coordinated in these areas when the Province or County is completing general maintenance to the Highway or County roadway network. This will likely allow the Village to have roadway repairs completed in these locations only requiring the Village to pay for a fraction of the total construction costs. Watermain looping that may be required in any area of special consideration should also be completed prior to any roadway upgrades.

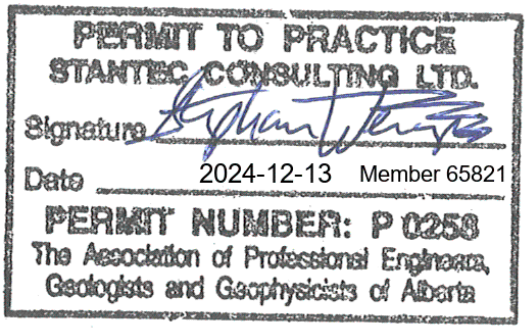
8 CORPORATE AUTHORIZATION

This document entitled “Village of Caroline Capital Infrastructure Plan” was prepared by Stantec Consulting Ltd. for the Village of Caroline. The material in it reflects Stantec Consulting Ltd.’s best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or reliance on or decisions made based on it, are the responsibilities of such third parties. Stantec Consulting Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Civil

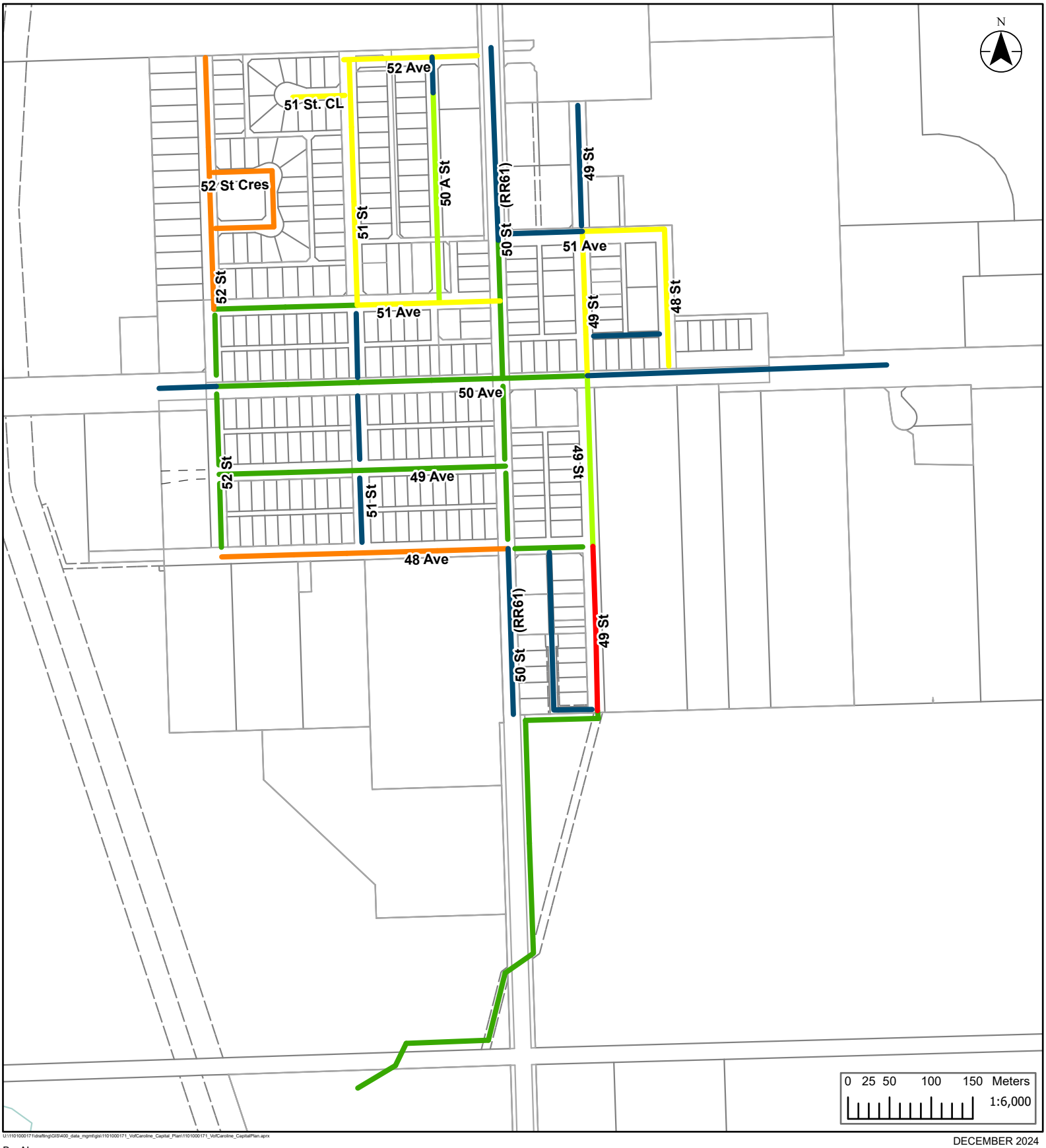
Member 65821
2024-12-13

Permit to Practice



Appendix A Improvement Strategy

VILLAGE OF CAROLINE: OVERALL PRIORITY RATING



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By: AL

DECEMBER 2024
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Legend

- Long Term Upgrades
- Critical Upgrades
- Future Upgrades
- Immediate Attention Required
- Standard Upgrades
- Areas of Special Consideration

Village of Caroline
Prospering at Nature's Doorstep

Client/Project:
VILLAGE OF CAROLINE

Figure No:
7.1

Title:
OVERALL PRIORITY RATING

Table 7.2 - Priority Rating

Roadway Section #	Location	From	To	Sanitary Rating	Overall Visual Pavement Rating	Overall Gravel Roadway Rating	Overall Rating	Watermain Replacement Required (Y/N)	Additional Information and Considerations	Relative Priority Rating	Rehabilitation Costs				
											Sanitary	Roadway	Water	Storm	Total.
1.1	52 St	48 Ave	49 Ave	N/A	3.5	N/A	3.5	Y		2	$0	$172,870	$182,309	$0	$355,179
1.2	53 St	49 Ave	50 Ave	N/A	3.5	N/A	3.5	Y		2	$0	$179,930	$165,929	$0	$345,859
1.3	52 St	50 Ave	51 Ave	N/A	3.5	N/A	3.5	Y		2	$0	$223,200	$148,567	$0	$371,767
1.4	52 St	51 Ave	52 St Cr S	3	1.5	N/A	2.25	Y		2	$121,737	$142,200	$162,162	$0	$426,099
1.5	52 St	52 St Cr S	52 St Cr N	3	1	N/A	2	Y		2	$133,256	$138,600	$97,133	$0	$368,989
1.6	52 St	52 St Cr N	North End	5	1	N/A	3	Y		2	$181,166	$189,000	$237,674	$0	$607,840
2.1	51 St	48 Ave	49 Ave	N/A	2	N/A	2	N		*	$0	$160,200	$0	$0	$160,200
2.2	51 St	49 Ave	50 Ave	N/A	3	N/A	3	N		*	$0	$156,600	$0	$0	$156,600
2.3	51 St	50 Ave	51 Ave	N/A	3	N/A	3	N		*	$0	$205,200	$0	$0	$205,200
2.4	51 St	51 Ave	52 Ave	2	2	N/A	2	Y	South 2/3 of Sanitary = 1 North 1/3 of Street = 3	3	$442,049	$442,800	$454,217	$0	$1,339,066
3.1	51 St. CL	51 St	52 St	2	N/A	1.5	1.75	Y		3	$259,967	$153,000	$407,043	$0	$820,010
4.1	50 A St	51 Ave	52 Ave	2	2	N/A	2	Y		4	$306,044	$507,600	$442,096	$0	$1,255,740
5.1	50 St	South End	48 Ave	N/A	2	N/A	2	Y		*	$0	$576,000	$358,231	$0	$934,231
5.2	50 St	48 Ave	50 Ave	4	3	N/A	3.5	Y		5	$129,984	$387,000	$153,317	$0	$670,301
5.3	50 St	49 Ave	50 Ave	4	3	N/A	3.5	Y		5	$102,233	$387,000	$165,766	$0	$654,999
5.4	50 St	50 Ave	51 Ave	3	2.5	N/A	2.75	Y		5	$217,556	$675,000	$148,403	$0	$1,040,959
5.5	50 St	51 Ave	52 Ave	3	3	N/A	3	Y	Sanitary and Water Line Only Runs From 51 Ave to 51 Ave in this location	*	$0	$579,000	$119,902	$0	$698,902
6.1	Lagoon Intake	Lagoon	South End of 49 Street	5	N/A	N/A	5	Y	No Roadway In this Section, Storm Sewer to be Installed as Part of Upgrades	5	$792,981	$0	$185,585	$88,080	$1,066,646
6.2	49 St	South End	48 Ave	2	N/A	0.5	1.25	Y		1	$259,182	$329,400	$326,945	$0	$915,527
6.3	49 St	48 Ave	50 Ave	2	3	N/A	2.5	Y		4	$259,182	$306,600	$350,204	$132,120	$1,048,106
6.4	49 St	50 Ave	51 Ave	4	2	N/A	3	Y	South 1/3 of Sanitary = 3 North 2/3 of Sanitary = 4	3	$217,425	$261,000	$299,426	$0	$777,851
6.5	49 St	51 Ave	North End	N/A	N/A	0.5	0.5	Y		N/A	$268,738	$219,600	$263,227	$0	$751,565
7.1	48 St	50 Ave	51 Ave	N/A	N/A	1	1	N	Watermain Looping Included	2	$0	$273,600	$187,895	$0	$461,495
8.1	52 Ave	50 St	50A St	5	N/A	1	3	N	Sanitary Price Includes Replacement of Sanitary Line to Lift Station, Watermain	3	$160,614	$77,860	$469,287	$0	$707,761
8.2	52 Ave	50A St	51 St	5	N/A	1	3	Y	Replace Intake Line From Well	3	$139,147	$132,740	$162,817	$0	$434,704
9.1	52 St Cr	52 St	East Leg	5	1	N/A	3	N		*	$92,546	$162,000	$124,488	$0	$379,034
9.2	52 St Cr	North Leg	South Leg	5	1	N/A	3	N		*	$88,488	$84,600	$95,659	$0	$268,747
9.3	52 St Cr	52 St	East Leg	5	1	N/A	3	N		*	$48,040	$162,000	$124,816	$0	$334,856
10.1	51 Ave	52 St	51 St	2	2	N/A	2	Y		4	$225,933	$246,600	$283,538	$0	$756,071
10.2	51 Ave	51 St	50 A St	0	2.5	N/A	1.25	Y		3	$145,823	$135,000	$161,998	$0	$442,821
10.3	51 Ave	50 A St	50 St	0	2.5	N/A	1.25	Y		3	$111,920	$88,200	$119,738	$0	$319,858
10.4	51 Ave	50 St	49 St	N/A	N/A	1	1	Y		*	$0	$153,000	$166,748	$0	$319,748
10.5	51 Ave	49 St	48 St	N/A	N/A	1	1	N	Watermain Looping Included	2	$0	$142,200	$168,534	$0	$310,734

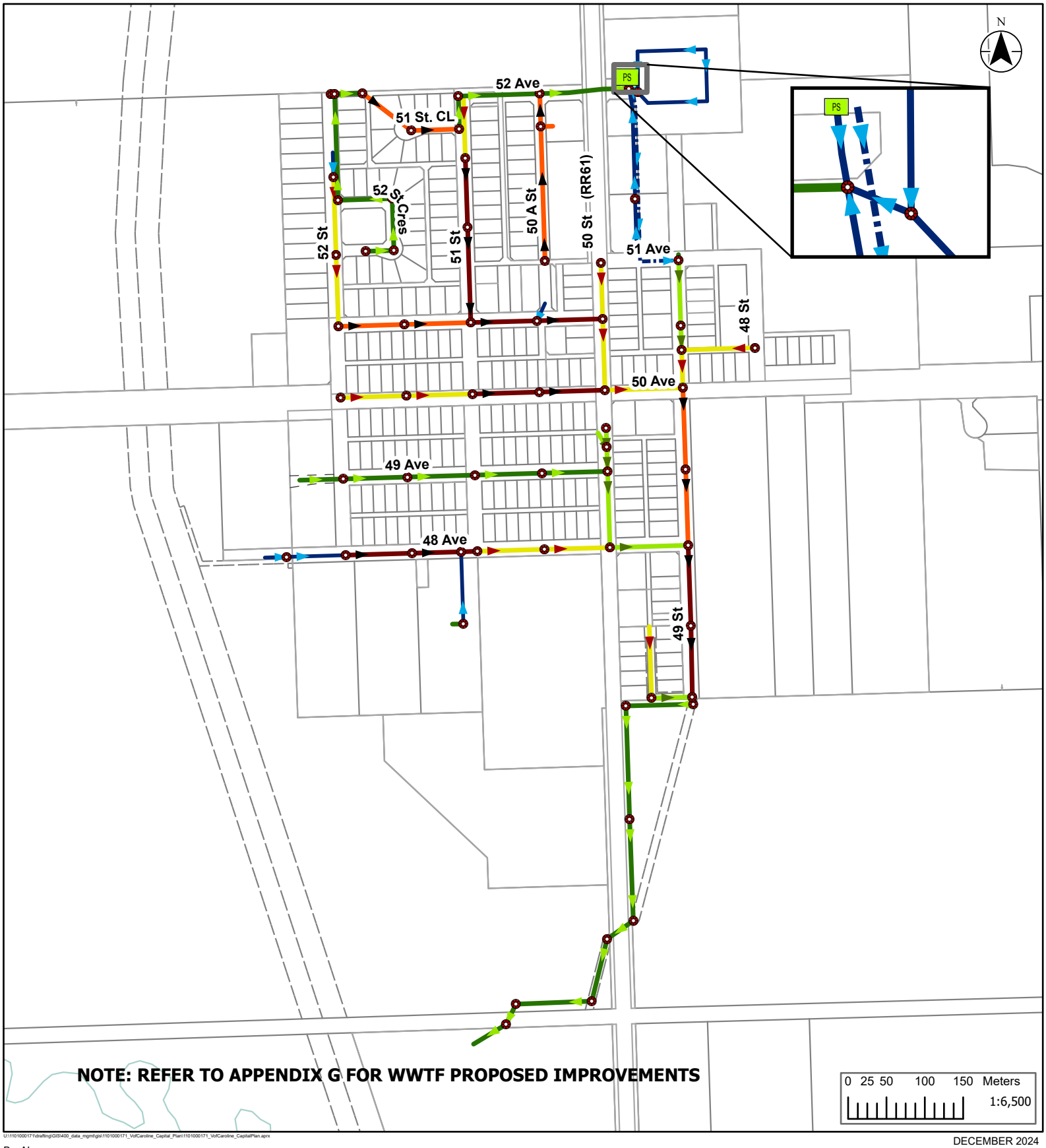
Table 7.2 - Priority Rating

Roadway Section #	Location	From	To	Sanitary Rating	Overall Visual Pavement Rating	Overall Gravel Roadway Rating	Overall Rating	Watermain Replacement Required (Y/N)	Additional Information and Considerations	Relative Priority Rating	Rehabilitation Costs				
											Sanitary	Roadway	Water	Storm	Total.
11.1	Alley	49 St	48 St	3	N/A	N/A	3	Y		5	$125,533	$0	$146,437	$0	$271,970
12.1	50 Ave	West of 52 St	51 St	5	3.5	N/A	4.23	Y		*	$225,279	$1,125,000	$249,140	$0	$1,599,419
12.2	50 Ave	51 St	50 St	5	3	N/A	4	Y	Watermain Replacement in this Location will Help Determine if Other Watermain	4	$225,933	$687,000	$295,495	$0	$1,208,428
12.3	50 Ave	50 St	49 St	5	3	N/A	4	Y		5		$549,000	$147,748		$696,748
12.4	50 Ave	49 St	48 St	N/A	3.5	N/A	3.5	N		5	$133,125	$387,000		$0	$520,125
12.5	50 Ave	48 St	East	N/A	3.5	N/A	3.5	N		4	$0	$2,730,000	$0	$0	$2,730,000
13.1	49 Ave	52 St	51 St	5	N/A	5	5	Y	Reconstructed in 2020	5	$225,148	$288,000	$289,107	$0	$802,255
13.2	49 Ave	51 St	50 St	5	N/A	5	5	Y	Reconstructed in 2020	5	$226,064	$288,000	$243,407	$0	$757,471
14.1	48 Ave	West End	52 St	NR	N/A	1	1	Y	The Sewer in this Area is Dry	5	$0	$199,800	$149,058	$0	$348,858
14.2	48 Ave	52 St	51 St	1	2.5	N/A	1.75	Y		2	$225,017	$367,200	$296,969	$0	$889,186
14.3	48 Ave	51 St	50 St	3	2	N/A	2.5	Y		2	$226,195	$446,400	$255,036	$0	$927,631
14.4	48 Ave	50 St	49 St	4	3.5	N/A	3.75	Y		5	$133,649	$145,800	$167,731	$0	$447,180
15.1	Alley	49 St	48 St	3	N/A	N/A	3	Y	Watermain Looping Included	*	$191,638	$0	$326,945	$0	$518,583

Note: * incicates an area of special consideration

Appendix B Sanitary System

VILLAGE OF CAROLINE: SANITARY SYSTEM



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By: AL

DECEMBER 2024
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Legend

Sanitary (Gravity Mains) - By Rating

- 0 - 1 - Very Poor Condition
- 2 - Poor Condition
- 3 - Average Condition
- 4 - Good Condition
- 5 - Excellent Condition
- 6 - Not Rated

- Sanitary (Forcemain)
- Sanitary Manholes
- PS — Sanitary Lift Station

Village of Caroline — Prospering at Nature's Doorstep

Client/Project:
VILLAGE OF CAROLINE

Figure No:
3.1

Title:
SANITARY SYSTEM (PIPE RATING)

Table 3.3 - Sanitary Sewer Evaluation

ID No.	From MH	To MH	Pipe Size	Length (m)	Condition Assessment
1	2	1	300	108	5
2	3	2	300	100	5
3	4	3	300	42	5
4	5	4	300	101	5
5	6	5	300	100	5
6	7	6	300	97	5
7	END	65	200	14	5
8	END	66	200	29	6
9	END	19	200	22	4
10	END	31	200	25	6
11	64	19	200	25	4
12	65	39	200	94	6
13	42	49	200	41	5
14	43	7	300	4	5
15	END	13	200	7	5
16	49	50	200	80	2
17	50	51	200	63	2
18	51	52	200	43	5
19	END	38	200	93	3
20	38	7	200	53	4
21	61	62	200	96	3
23	55	13	200	233	FM
24	25	11	200	102	5
25	13	12	200	85	4
26	12	62	200	32	4
27	62	11	200	49	3
28	11	10	200	106	2
29	10	9	200	99	2
30	9	8	200	105	2
31	8	7	200	93	2
32	18	17	200	87	1
33	17	39	200	64	1
34	66	18	200	77	6
35	39	16	200	21	1
36	16	15	200	87	3
37	15	14	200	85	3
38	14	9	200	102	4
39	19	20	200	32	4
40	20	14	200	99	4
41	21	20	200	85	5
42	22	21	200	87	5
43	23	22	200	88	5
44	24	23	200	84	5

Table 3.3 - Sanitary Sewer Evaluation

ID No.	From MH	To MH	Pipe Size	Length (m)	Condition Assessment
45	29	28	200	86	5
46	28	27	200	86	5
47	27	26	200	87	5
48	26	25	200	85	5
49	58	60	200	175	2
50	53	55	200	123	5
51	52	53	200	106	5
52	30	25	200	93	3
53	32	30	200	73	3
54	35	34	200	86	2
55	34	33	200	86	2
56	33	31	200	87	0
57	31	30	200	85	0
58	42	41	200	108	6
59	41	40	200	102	3
60	40	35	200	93	3
61	60	60	200	16	2
62	60A	53	200	43	2
63	END	37	200	80	3
64	37	36	200	90	1
65	36	33	200	125	1
66	48	47	200	37	5
67	47	46	200	68	5
68	46	45	200	71	5
69	45	44	200	138	5
70	END	54	200	0	6
71	57	59	200	216	6
72	55	54	200	13	6
73	67	55	200	53	6
74	68	67	200	89	6
75	68	69	200	68	6
76	69	70	200	77	6
77	70	55	200	19	6
78	59	54	200	216	6

Table 3.4 - Sanitary Sewer Replacement Strategy

							Existing Pipe			Replacement Pipe			
ID No.	Location	From	To	From MH	To MH	Length (m)	Material	Diameter	Rating	Material	Diameter	Unit Price	Cost
1	To Lagoon	47 Ave	End	2	1	108.4	PVC	300	5	PVC	300	$1,435	$155,554
2	To Lagoon	47 Ave	End	3	2	100.2	PVC	300	5	PVC	300	$1,435	$143,787
3	To Lagoon	47 Ave	End	4	3	42	PVC	300	5	PVC	300	$1,435	$60,270
4	To Lagoon	47 Ave	End	5	4	101.2	PVC	300	5	PVC	300	$1,435	$145,222
5	To Lagoon	47 Ave	End	6	5	100.3	PVC	300	5	PVC	300	$1,435	$143,931
6	To Lagoon	47 Ave	End	7	6	96.6	PVC	300	5	PVC	300	$1,435	$138,621
14	To Lagoon	47 Ave	End	7	43	3.9	PVC	300	5	PVC	300	$1,435	$5,597
59	52 St	52 St Ct N	52 St Cr S	41	40	101.8	VCT	200	3	PVC	200	$1,309	$133,256
60	52 St	51Ave	52 St Cr S	40	35	93	VCT	200	3	PVC	200	$1,309	$121,737
69	52 St	52 St Cr N	North End	45	44	138.4	PVC	200	5	PVC	200	$1,309	$181,166
64	51 St	52 Ave	51 Ave	37	36	89.7	VCT	200	1	PVC	200	$1,309	$117,417
65	51 St	52 Ave	51 Ave	36	33	124.7	VCT	200	1	PVC	200	$1,309	$163,232
63	51 St	52 Ave	51 Ave	END	37	80.3	VCT	200	3	PVC	200	$1,309	$105,113
18	51 St	51 St Cl	52 Ave	51	52	43	PVC	200	5	PVC	200	$1,309	$56,287
49	50A St	Alley	52 Ave	58	60	175.2	PVC	200	2	PVC	200	$1,309	$229,337
61	50A St	Alley	52 Ave	END	60	15.6	PVC	200	2	PVC	200	$1,309	$20,420
62	50A St	Alley	52 Ave	60A	53	43	PVC	200	2	PVC	200	$1,309	$56,287
52	50 St	51 Ave	50 Ave	30	25	93	VCT	200	3	PVC	200	$1,309	$121,737
53	50 St	51 Ave	51 Ave	32	30	73.2	VCT	200	3	PVC	200	$1,309	$95,819
9	50 St	50 Ave	49 Ave	END	19	21.7	VCT	200	4	PVC	200	$1,309	$28,405
11	50 St	50 Ave	49 Ave	64	19	24.7	VCT	200	4	PVC	200	$1,309	$32,332
39	50 St	50 Ave	49 Ave	19	20	31.7	VCT	200	4	PVC	200	$1,309	$41,495
40	50 St	49 Ave	48 Ave	20	14	99.3	VCT	200	4	PVC	200	$1,309	$129,984
28	49 St	50 Ave	48 Ave	11	10	106.1	VCT	200	2	PVC	200	$1,309	$138,885
29	49 St	50 Ave	48 Ave	10	9	99.2	VCT	200	2	PVC	200	$1,309	$129,853
27	49 St	51 Ave	50 Ave	62	11	49.2	VCT	200	3	PVC	200	$1,309	$64,403
30	49 St	48 Ave	47 Ave	9	8	105.2	VCT	200	2	PVC	200	$1,309	$137,707
31	49 St	48 Ave	47 Ave	8	7	92.8	VCT	200	2	PVC	200	$1,309	$121,475
25	49 St	51 Ave	50 Ave	13	12	85.1	VCT	200	4	PVC	200	$1,309	$111,396
26	49 St	51 Ave	50 Ave	12	62	31.8	VCT	200	4	PVC	200	$1,309	$41,626

Table 3.4 - Sanitary Sewer Replacement Strategy

							Existing Pipe			Replacement Pipe			
ID No.	Location	From	To	From MH	To MH	Length (m)	Material	Diameter	Rating	Material	Diameter	Unit Price	Cost
15	49 St			END	13	7.5	VCT	200	5	PVC	200	$1,309	$9,818
16	51 St CL	52 St	51 St	49	50	80.3	PVC	200	2	PVC	200	$1,309	$105,113
17	51 ST CL	52 St	51 St	50	51	62.6	PVC	200	2	PVC	200	$1,309	$81,943
50	52 Ave	50A St	Lift Sta.	53	55	122.7	PVC	200	5	PVC	200	$1,309	$160,614
51	52 Ave	51 St	50A St	52	53	106.3	PVC	200	5	PVC	200	$1,309	$139,147
10	51 Ave	50 A St	50 St	END	31	24.8	VCT	200	0	PVC	200	$1,309	$32,463
56	51 Ave	51 St	50A St	33	31	86.6	VCT	200	0	PVC	200	$1,309	$113,359
57	51 Ave	50 A St	50 St	31	30	85.5	VCT	200	0	PVC	200	$1,309	$111,920
54	51 Ave	52 St	51 St	35	34	86.1	VCT	200	2	PVC	200	$1,309	$112,705
55	51 Ave	52 St	51 St	34	33	86.5	VCT	200	2	PVC	200	$1,309	$113,229
66	52 St Cr	East Leg	52 St S	48	47	36.7	PVC	200	5	PVC	200	$1,309	$48,040
67	52 St Cr	North Leg	South Leg	47	46	67.6	PVC	200	5	PVC	200	$1,309	$88,488
68	52 St Cr	East Leg	52 St N	46	45	70.7	PVC	200	5	PVC	200	$1,309	$92,546
47	50 Ave	51 St	50 St	27	26	87.1	PVC	200	5	PVC	200	$1,309	$114,014
48	50 Ave	51 St	50 St	26	25	85.5	PVC	200	5	PVC	200	$1,309	$111,920
24	50 Ave	50 St	49 St	25	11	101.7	PVC	200	5	PVC	200	$1,309	$133,125
45	50 Ave	52 St	51 St	29	28	85.9	PVC	200	5	PVC	200	$1,309	$112,443
46	50 Ave	52 St	51 St	28	27	86.2	PVC	200	5	PVC	200	$1,309	$112,836
43	49 Ave	52 St	51 St	23	22	88.1	PVC	200	5	PVC	200	$1,309	$115,323
44	49 Ave	52 St	51 St	24	23	83.9	PVC	200	5	PVC	200	$1,309	$109,825
41	49 Ave	51 St	50 St	21	20	85.5	PVC	200	5	PVC	200	$1,309	$111,920
42	49 Ave	51 St	50 St	22	21	87.2	PVC	200	5	PVC	200	$1,309	$114,145
32	48 Ave	52 St	51 St	18	17	86.6	VCT	200	1	PVC	200	$1,309	$113,359
33	48 Ave	52 St	51 St	17	39	63.9	VCT	200	1	PVC	200	$1,309	$83,645
35	48 Ave	52 St	51 St	39	16	21.4	VCT	200	1	PVC	200	$1,309	$28,013
36	48 Ave	51 St	50 St	16	15	87.3	VCT	200	3	PVC	200	$1,309	$114,276
37	48 Ave	51 St	50 St	15	14	85.5	VCT	200	3	PVC	200	$1,309	$111,920
38	48 Ave	50 St	49 St	14	9	102.1	VCT	200	4	PVC	200	$1,309	$133,649
7	N/A	End	52 St	END	65	14.3	VCT	200	5	PVC	200	$1,309	$18,719
21	Alley	48 St	49 St	61	62	95.9	VCT	200	3	PVC	200	$1,309	$125,533

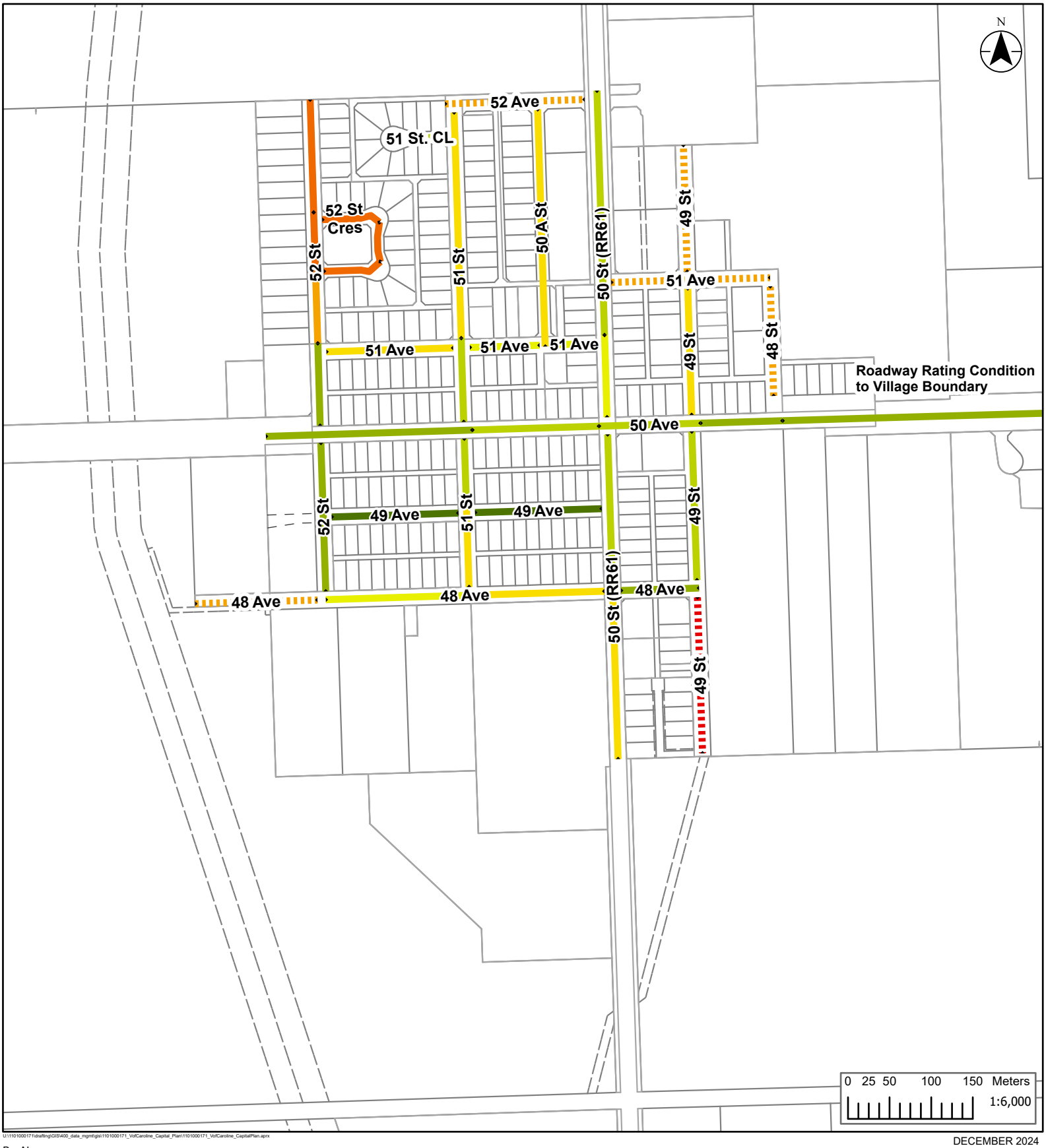
Table 3.4 - Sanitary Sewer Replacement Strategy

							Existing Pipe			Replacement Pipe			
ID No.	Location	From	To	From MH	To MH	Length (m)	Material	Diameter	Rating	Material	Diameter	Unit Price	Cost
19	Alley (49St)	Alley S	Alley N	END	38	93.2	VCT	200	3	PVC	200	$1,309	$121,999
20	Alley	Alley	49 St	38	7	53.2	VCT	200	4	PVC	200	$1,309	$69,639
13	Alley	52 St	51 St	42	49	41.4	VCT	200	5	PVC	200	$1,309	$54,193

Notes: Replacement costs are based on 2024 dollars and include 35% for professional services and contingency.
Costs do not include roadway trench repair

Appendix C Transportation Network

VILLAGE OF CAROLINE: TRANSPORTATION NETWORK



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By: AL

DECEMBER 2024
1101000171

Legend

Roadway (ACP)

- 0 - Pavement Ruined
- 0.5
- 1 - Very Poor Condition
- 1.5
- 2 - Poor Condition
- 2.5
- 3 - Average Condition
- 3.5
- 4 - Good Condition
- 4.5
- 5 - Excellent Condition

Roadway (Gravel)

- 0 - No Granular Surface
- 0.5
- 1 - Poor Condition
- 1.5
- 2 - Average Condition
- 2.5
- 3 - Excellent Condition

Client/Project:
VILLAGE OF CAROLINE

Figure No:
4.1

Title:
TRANSPORTATION NETWORK (ROADWAY RATING)

Village of Caroline
Prospering at Nature's Doorstep

Table 4.3 - Roadway Evaluation

Roadway Section #	Location	From	Int	To	Int	Width (m)	Length (m)	Existing Surface	Primary Distresses	Secondary Distresses	Additional Notes	Curb & Gutter Type-Width (m)) (Side-		Sidewalk (Side-Width(m))		Boulevard (Side-Width(m))	Overall Gravel Roadway Rating	Overall Visual Pavement Assessment Rating
1.1	52 St	48 Ave	N	50 Ave	N	11	178.6	ACP	N/A	N/A	Roadway Rebuilt 2008	W-N/A	E-N/A	W-N/A	E-N/A	N/A	N/A	3.5
1.2	52 St	50 Ave	N	51 Ave	Y	12.5	99.5	ACP	N/A	N/A	Roadway Rebuilt 2008	W-R-0.6	E-R-0.6	W-N/A	E-N/A	N/A	N/A	3.5
1.3	52 St	51 Ave	N	52 St Cr S	N	10	79.3	ACP	Fatigue Cracking, Potholes	Rutting	ACP Over Lip of Gutter in South East Section	W-MR-0.65	E-R-0.6	W-1.1	E-N/A	N/A	N/A	1.5
1.4	52 St	52 St Cr S	Y	52 St Cr N	Y	10	77.3	ACP	Fatigue Cracking, Missing ACP, Potholes	Rutting, Pumping	Standing Water in Areas of Missing ACP	W-MR-0.65	E-S-0.375	W-1.1	E-N/A	N/A	N/A	1.0
1.5	52 St	52 St Cr N	N	North End	N/A	8	131.1	ACP/Gravel	Areas of No ACP, Fatigue Cracking	Deteriorated Patch Work Pot Holes	Extensive Pavement Removal (~40%)	W-N/A	E-R-0.6	W-N/A	E-N/A	N/A	N/A	1.0
2.1	51 St	48 Ave	N	49 Ave	N	9	99.4	ACP	Longitudinal Cracking, Potholes, Fatigue Cracking	Pumping	Sections of Broken Sidewalk, Deteriorated Patch Work	W-S-0.375	E-S-0.375	W-N/A	E-1.3	E-3.2	N/A	2.0
2.2	51 St	49 Ave	N	50 Ave	N	11	79.3	ACP	Fatigue Cracking	Potholes, Longitudinal Cracking	N/A	W-S-0.375	E-S-0.375	W-N/A	E-1.3	E-3.2	N/A	3.0
2.3	51 St	50 Ave	N	51 Ave	Y	11.5	99.4	ACP	Transverse Cracking	Patching, Fatigue Cracking	1.0m Wide Concrete Swale E-W at North End of Street	W-R-0.6	E-M-0.65	W-N/A	E-1.1	N/A	N/A	3.0
2.4	51 St	51 Ave	N	52 Ave	N	9	273.7	ACP	Fatigue Cracking, Transverse Cracking, Edge Deterioration	Patching, Potholes	Majority of Deterioration is on the North 1/2 of the Block	W-RM-0.6	E-RM-0.6	W-1.1	E-1.1	N/A	N/A	2.0
3.1	51 St. CL	51 St	N	N/A	N/A	10	70	Gravel	Potholes	N/A	Potholes and some roadway surface deflections, over all shape has been maintained	N-R-0.65	S-R-0.65	N-N/A	S-N/A	N/A	1.5	N/A
4.1	50 A St	51 Ave	Y	52 Ave	N	9.6	293.9	ACP	Edge Deterioration, Fatigue Cracking	Potholes, Rutting	Majority of Deficiencies are Located Near each Intersection, Severe Fatigue Cracking Along the Majority of the Gutter Lengths.	W-RM-0.65	E-R-0.65	W-1.1	E-N/A	N/A	N/A	2.0
5.1	50 St (RR61)	South End	N/A	48 Ave	N	10 to 13	192.3	ACP	Transverse Cracking, Fatigue Cracking	Potholes, Rutting	Grade Separated Side Walk at North End of West Side, Remainder of Roadway has a Rural Cross Section with 2-3m gravel shoulders	W-S-0.375	E-N/A	W-1.1	E-N/A	W-1.3	N/A	2.0
5.2	50 St (RR61)	48 Ave	Y	50 Ave	N	13	198.7	ACP	Longitudinal Cracking	Transverse Cracking	Partial Reconstruction and Overlay 2006, West Curb (50 Ave - 49 Ave) Extends Only 1/2 Block South of 50 Ave (Deteriorated)	W-S-0.375	E-MS-0.375	W-N/A	E-1.1	N/A	N/A	3.0
5.3	50 St (RR61)	50 Ave	N	51 Ave	Y	13	172.8	ACP	Transverse Cracking, Longitudinal Cracking	Rutting, Fatigue Cracking	N/A	W-S-0.375	E-S-0.375	W-N/A	E-1.1	E-1.9	N/A	2.5
5.4	50 St (RR61)	51 Ave	Y	52 Ave	Y	8.5	227.3	ACP	Rutting Throughout	Fatigue Cracking, Transverse Cracking, Longitudinal Cracking	N/A	W-N/A	E-N/A	W-N/A	E-N/A	N/A	N/A	3.0
6.1	49 St	South End	N/A	48 Ave	N	9.5	192.4	Gravel	N/A	N/A	Looks like coldmix used for previous repair, deteriorating severely	W-MR-0.65	E-N/A	W-1.1	E-N/A	N/A	0.5	N/A
6.2	49 St	48 Ave	N	50 Ave	N	9.5	178.6	ACP	Transverse Cracking, Localized Edge Deterioration	Fatigue Cracking, Potholes, Pumping, Patching	Access on South East portion of Road in Poor Condition	W-MR-0.65	E-S-0.375	W-1.1	E-N/A	N/A	N/A	3.0
6.3	49 St	50 Ave	N	51 Ave	N	9.5	152.4	ACP	Transverse Cracking, Fatigue Cracking, Potholes	Pumping, Patching	N/A	W-MR-0.65	E-MR-0.65	W-1.1	E-1.1	N/A	N/A	2.0
6.4	49 St	51 Ave	N	North End	N/A	8	153.1	Gravel	Potholes	N/A	Appears to Provided Access to only 2 Residents and Looks to be Constructed as a Lane	N-N/A	S-N/A	N-N/A	S-N/A	N/A	1.0	N/A
7.1	48 St	50 Ave	N	51 Ave	N	13 to 9	152.4	Gravel	Potholes	N/A	Has Never Been Paved, Used by Many Heavy Trucks to Access Refueling Station	N-N/A	S-N/A	N-N/A	S-N/A	N/A	1.0	N/A
8.1	52 Ave	50 St	N	51 St	Y	7	167.4	Gravel	Potholes	N/A	Has Never Been Paved, Some Minor Evidence of Very Old Pavement	N-N/A	S-R-0.6	N-N/A	S-N/A	N/A	1.0	N/A
9.1	52 St Cr	52 St N	N	East Leg	Y	10	78.5	Gravel/ACP	Potholes, Fatigue Cracking	Rutting	Some Evidence of Old Cold mix Asphalt Binder, Grass Growing in Gutter	N-R-0.6	S-S-0.375	N-N/A	S-N/A	N/A	N/A	1.0
9.2	52 St Cr	North Leg	N	South Leg	N	10	46.9	Gravel/ACP	Potholes	N/A	Grass Growing on SE Section of the Roadway	E-R-0.6	W-S-0.375	N-N/A	S-N/A	N/A	N/A	1.0
9.3	52 St Cr	52 St S	N	East Leg	Y	10	78.5	Gravel/ACP	Many Severe Potholes	N/A	Some Evidence of Old Cold mix Asphalt Binder, Grass Growing in Gutter	N-S-0.375	S-R-0.6	N-N/A	S-N/A	N/A	N/A	1.0
10.1	51 Ave	52 St	N	51 St	N	9	152.4	ACP	Transverse Cracking, Rutting, Deteriorated Patching	Rutting, Fatigue Cracking, Longitudinal Cracking, Pumping	Some Aged Crack Repairs	N-MR-0.65	S-MR-0.65	N-1.1	S-1.1	N/A	N/A	2.0
10.2	51 Ave	51 St	N	50 A St	N	9	82.9	ACP	Transverse Cracking	Potholes, Patching	N/A	N-MR-0.65	S-MR-0.65	N-1.1	S-1.1	N/A	N/A	2.5
10.3	51 Ave	50 A St	N	50 St	N	9	54.2	ACP	Transverse Cracking	Longitudinal Cracking	N/A	N-N/A	S-N/A	N-N/A	S-N/A	N/A	N/A	2.5
10.4	51 Ave	50 St	N	49 St	Y	8	106.4	Gravel	Potholes, Rutting	N/A	Evidence of Very Old ACP	N-N/A	S-N/A	N-N/A	S-N/A	N/A	1.0	N/A
10.5	51 Ave	49 St	N	48 St	Y	8	99.3	Gravel	Potholes, Rutting	N/A	Appears to be Constructed as a Lane.	N-N/A	S-N/A	N-N/A	S-N/A	N/A	1.0	N/A

Table 4.3 - Roadway Evaluation

Roadway Section #	Location	From	Int	To	Int	Width (m)	Length (m)	Existing Surface	Primary Distresses	Secondary Distresses	Additional Notes	Curb & Gutter (Side-Type-Width (m))		Sidewalk (Side-Width(m))		Boulevard (Side-Width(m))	Overall Gravel Roadway Rating	Overall Visual Pavement Assessment Rating
11.1	50 Ave (Hwy 54)	W of 52 St	Y	51 St	Y	15	249.8	ACP	Transverse Cracking	Fatigue Cracking, Potholes, Pumping, Rutting	Highway 22 & 54, Rebuilt in 2018	N-MS-0.375	S-MS-0.375	N-1.5	S-1.5	N/A	N/A	3.5
11.2	50 Ave (Hwy 54)	51 St	N	50 St	N	15	152.4	ACP	Transverse Cracking	Fatigue Cracking, Rutting, Pumping, Edge Deterioration	Highway 22 & 54, Rebuilt in 2018	N-MS-0.376	S-MS-0.376	N-1.5	S-1.5	N/A	N/A	3.0
11.3	50 Ave (Hwy 54)	50 St	Y	49 St	Y	15	121.9	ACP	Localized Edge Deterioration	Transverse Cracking, Fatigue Cracking	Highway 22 & 54, Rebuilt in 2018	N-MS-0.375	S-MS-0.375	N-1.5	S-1.5	N/A	N/A	3.0
11.4	50 Ave (Hwy 54)	49 St	N	48 St	Y	13	99.3	ACP	Transverse Cracking	Rutting	Highway 22 & 54, Rebuilt in 2018	N-N/A	S-N/A	N-N/A	S-N/A	N/A	N/A	3.5
11.5	50 Ave (Hwy 54)	48 St	N	East	N/A	13	700	ACP	Longitudinal Cracking	Fatigue Cracking, Rutting, Extensive Crack Repairs in Good Condition	Highway 22 & 54, Rebuilt in 2018	N-N/A	S-N/A	N-N/A	S-N/A	N/A	N/A	3.5
12.1	49 Ave	52 St	N	51 St	Y	10.5	152.4	ACP	N/A		Rebuilt in 2020	N-RM-0.65	S-RM-0.65	N-1.1	S-1.1	N/A	N/A	5.0
12.2	49 Ave	51 St	N	50 St	N	10.5	152.4	ACP	N/A		Rebuilt in 2020	N-RM-0.65	S-RM-0.65	N-1.1	S-1.1	N/A	N/A	5.0
13.1	48 Ave	West End	N/A	52 St	N	7.5	147.5	Gravel	Large Pothole	Some Surface Deterioration	Standing Water	N-N/A	S-N/A	N-N/A	S-N/A	N/A	1.0	N/A
13.2	48 Ave	52 St	Y	51 St	N	11.8	172.5	ACP	Fatigue Cracking, Longitudinal Cracking, Fatigue Cracking	Patched Areas, Pumping	Major Deficiencies in Localized Areas	N-RM-0.65	S-N/A	N-1.1	S-N/A	N/A	N/A	2.5
13.3	48 Ave	51 St	Y	50 St	N	14.4	172.5	ACP	Fatigue Cracking, Transverse Cracking	Longitudinal Cracking, Rutting, Patches	Some Distress Have Been Patched	N-R-0.6	S-SM-0.375	N-1.1	S-1.1 to 2.2	N-1.4	N/A	2.0
13.4	48 Ave	50 St	N	49 St	Y	8	101.8	ACP	N/A	Transverse, Longitudinal, and Fatigue Cracking, Pumping	Partial Rebuild and Overlay 2006	N-RM-0.65	S-0.6	N-1.1	S-N/A	N/A	N/A	3.0

Table 4.4 - Roadway Rehabilitation Costs

Roadway Section #	Location	From	Int	To	Int	Width (m)	Length (m)	Approximate Area (m^2)	Existing Surface	Roadway Designation	Approximate Full Reconstruction Costs	Approximate Mill & Overlay Costs	Approximate Trench Repair Costs
1.1	52 St	48 Ave	N	50 Ave	N	11	178.6	1960	ACP	Local	$352,800	$121,600	$160,700
1.2	52 St	50 Ave	N	51 Ave	Y	12.5	99.5	1240	ACP	Local	$223,200	$76,800	$89,500
1.3	52 St	51 Ave	N	52 St Cr S	N	10	79.3	790	ACP	Local	$142,200	$49,300	$71,400
1.4	52 St	52 St Cr S	Y	52 St Cr N	Y	10	77.3	770	ACP	Local	$138,600	$48,100	$69,600
1.5	52 St	52 St Cr N	N	North End	N/A	8	131.1	1050	ACP/Gravel	Local	$189,000	N/A	N/A
2.1	51 St	48 Ave	N	49 Ave	Y	9	99.4	890	ACP	Local	$160,200	$55,700	$89,500
2.2	51 St	49 Ave	N	50 Ave	N	11	79.3	870	ACP	Local	$156,600	$54,100	$71,400
2.3	51 St	50 Ave	N	51 Ave	Y	11.5	99.4	1140	ACP	Local	$205,200	$70,800	$89,500
2.4	51 St	51 Ave	N	52 Ave	N	9	273.7	2460	ACP	Local	$442,800	$153,600	$246,300
3.1	51 St. CL	51 St	N	N/A	N/A	10	70	850	Gravel	Local	$153,000	N/A	N/A
4.1	50 A St	51 Ave	Y	52 Ave	N	9.6	293.9	2820	ACP	Local	$507,600	$175,700	$264,500
5.1	50 St	South End	N/A	48 Ave	N	10 to 13	192.3	1920	ACP	Arterial	$576,000	$119,500	$288,500
5.2	50 St	48 Ave	Y	50 Ave	N	13	198.7	2580	ACP	Arterial	$774,000	$159,300	$298,100
5.3	50 St	50 Ave	N	51 Ave	Y	13	172.8	2250	ACP	Arterial	$675,000	$138,900	$259,200
5.4	50 St	51 Ave	Y	52 Ave	Y	8.5	227.3	1930	ACP	Arterial	$579,000	$120,800	$341,000
6.1	49 St	South End	N/A	48 Ave	N	9.5	192.4	1830	Gravel	Local	$329,400	N/A	N/A
6.2	49 St	48 Ave	N	50 Ave	N	9.5	178.6	1700	ACP	Local	$306,000	$106,000	$160,700
6.3	49 St	50 Ave	N	51 Ave	N	9.5	152.4	1450	ACP	Local	$261,000	$90,400	$137,200
6.4	49 St	51 Ave	N	North End	N/A	8	153.1	1220	Gravel	Local	$219,600	N/A	N/A
7.1	48 St	50 Ave	N	51 Ave	N	13 to 9	152.4	1520	Gravel	Local	$273,600	N/A	N/A
8.1	52 Ave	50 St	N	51 St	Y	7	167.4	1170	Gravel	Local	$210,600	N/A	N/A
9.1	52 St Cr	52 St	N	52 St Cr East Leg	Y	10	78.5	900	Gravel/ACP	Local	$162,000	N/A	N/A
9.2	52 St Cr	52 St Cr North Leg	N	52 St Cr South Leg	N	10	46.9	470	Gravel/ACP	Local	$84,600	N/A	N/A
9.3	52 St Cr	52 St	N	52 St Cr East Leg	Y	10	78.5	900	Gravel/ACP	Local	$162,000	N/A	N/A

Table 4.4 - Roadway Rehabilitation Costs

Roadway Section #	Location	From	Int	To	Int	Width (m)	Length (m)	Approximate Area (m^2)	Existing Surface	Roadway Designation	Approximate Full Reconstruction Costs	Approximate Mill & Overlay Costs	Approximate Trench Repair Costs
10.1	51 Ave	52 St	N	51 St	N	9	152.4	1370	ACP	Local	$246,600	$85,600	$137,200
10.2	51 Ave	51 St	N	50 A St	N	9	82.9	750	ACP	Local	$135,000	$47,000	$74,600
10.3	51 Ave	50 A St	N	50 St	N	9	54.2	490	ACP	Local	$88,200	$30,700	$48,800
10.4	51 Ave	50 St	N	49 St	Y	8	106.4	850	Gravel	Local	$153,000	N/A	N/A
10.5	51 Ave	49 St	N	48 St	Y	8	99.3	790	Gravel	Local	$142,200	N/A	N/A
11.1	50 Ave	West of 52 St	Y	51 St	Y	15	249.8	3750	ACP	Arterial	$1,125,000	$230,600	$374,700
11.2	50 Ave	51 St	N	50 St	N	15	152.4	2290	ACP	Arterial	$687,000	$141,000	$228,600
11.3	50 Ave	50 St	Y	49 St	Y	15	121.9	1830	ACP	Arterial	$549,000	$112,700	$182,900
11.4	50 Ave	49 St	N	48 St	Y	13	99.3	1290	ACP	Arterial	$387,000	$79,800	$149,000
11.5	50 Ave	48 St	N	East	N/A	13	700	9100	ACP	Arterial	$2,730,000	$561,200	$1,050,000
												$0	$0
12.1	49 Ave	52 St	N	51 St	N	10.5	152.4	1600	Gravel	Local	$288,000	$99,500	$228,600
12.2	49 Ave	51 St	N	50 St	N	10.5	152.4	1600	Gravel	Local	$288,000	$99,500	$228,600
13.1	48 Ave	West End	N/A	52 St	N	7.5	147.5	1110	Gravel	Local	$199,800	$69,900	$132,700
13.2	48 Ave	52 St	Y	51 St	N	11.8	172.5	2040	ACP	Local	$367,200	$126,300	$155,200
13.3	48 Ave	51 St	Y	50 St	N	14.4	172.5	2480	ACP	Local	$446,400	$152,800	$155,200
13.4	48 Ave	50 St	N	49 St	Y	8	101.8	810	ACP	Local	$145,800	$50,900	$91,600

Appendix D Water System

VILLAGE OF CAROLINE: WATER SYSTEM

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By: AL

DECEMBER 2024
1101000171

Legend

- Existing Watermain
- Proposed Watermain Looping
- Fitting
- Hydrant
- Plug
- Valve
- Well
- Well (Abandoned)

Client/Project:
VILLAGE OF CAROLINE

Figure No:
5.1

Title:
WATER SYSTEM

Village of Caroline
Prospering at Nature's Doorstep

Table 5.1 - Watermain Replacement Strategy

				Existing Pipe		Replacement Pipe			
Location	From	To	Length (m)	Material	Diameter	Material	Diameter	Unit Price	Cost
52 St	End	52 St Cr N	145.1	AC	150	PVC	200	$1,638	$237,674
52 St	52 St Cr N	52 St Cr S	59.3	AC	150	PVC	200	$1,638	$97,133
52 St	52 St Cr S	51 Ave	99	AC	150	PVC	200	$1,638	$162,162
52 St	51 Ave	50 Ave	90.7	AC	150	PVC	200	$1,638	$148,567
52 St	50 Ave	49 Ave	101.3	AC	150	PVC	200	$1,638	$165,929
52 St	49 Ave	48 Ave	111.3	AC	150	PVC	200	$1,638	$182,309
51 St	52 Ave	51 Ave	277.3	AC	150	PVC	200	$1,638	$454,217
51 St Cl	51 St	End	75.9	AC	150	PVC	200	$1,638	$124,324
50A St	52 Ave	51 Ave	269.9	AC	150	PVC	200	$1,638	$442,096
50 St	51 Ave	51 Ave	73.2	AC	150	PVC	200	$1,638	$119,902
50 St	51 Ave	50 Ave	90.6	AC	150	PVC	200	$1,638	$148,403
50 St	50 Ave	49 Ave	101.2	AC	150	PVC	200	$1,638	$165,766
50 St	49 Ave	48 Ave	93.6	AC	150	PVC	200	$1,638	$153,317
50 St	48 Ave	South End	218.7	AC	150	PVC	200	$1,638	$358,231
49 St	North End	51 Ave	160.7	AC	150	PVC	200	$1,638	$263,227
49 St	51 Ave	50 Ave	182.8	AC	150	PVC	200	$1,638	$299,426
49 St	50 Ave	48 Ave	213.8	AC	150	PVC	200	$1,638	$350,204
49 St	48 Ave	South End	199.6	AC	150	PVC	200	$1,638	$326,945
49 St	South Alley	North End	113.3	AC	150	PVC	200	$1,638	$185,585
52 Ave	50A St	51 St	99.4	AC	150	PVC	200	$1,638	$162,817
51 Ave	52 St	51 St	173.1	AC	150	PVC	200	$1,638	$283,538
51 Ave	51 St	50A St	98.9	AC	150	PVC	200	$1,638	$161,998
51 Ave	50A St	50 St	73.1	AC	150	PVC	200	$1,638	$119,738
51 Ave	50 St	49 St	101.8	AC	150	PVC	200	$1,638	$166,748
52 St Cr	52 St N	East Leg	76	PVC	150	PVC	200	$1,638	$124,488
52 St Cr	North Leg	South Leg	58.4	PVC	150	PVC	200	$1,638	$95,659
52 St Cr	52 St S	East Leg	76.2	PVC	150	PVC	200	$1,638	$124,816
50 Ave	52 St	51 St	152.1	PVC	200	PVC	200	$1,638	$249,140
50 Ave	51 St	50 St	180.4	PVC	200	PVC	200	$1,638	$295,495
50 Ave	50 St	49 St	90.2	PVC	200	PVC	200	$1,638	$147,748

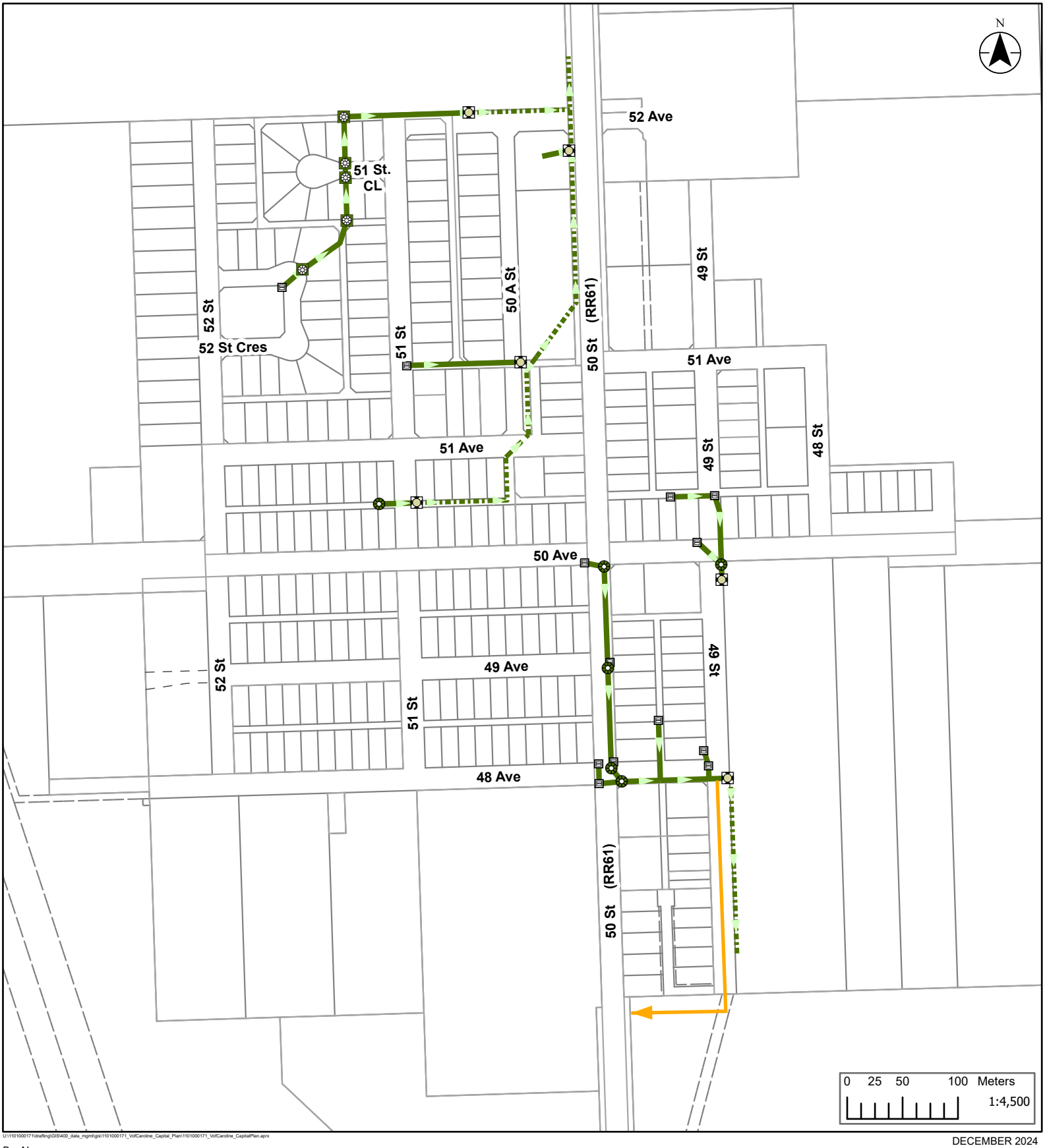
Table 5.1 - Watermain Replacement Strategy

				Existing Pipe		Replacement Pipe			
Location	From	To	Length (m)	Material	Diameter	Material	Diameter	Unit Price	Cost
49 Ave	52 St	51 St	176.5	PVC	150	PVC	200	$1,638	$289,107
49 Ave	51 St	50 St	148.6	PVC	150	PVC	200	$1,638	$243,407
48 Ave	West End	52 St	91	AC	150	PVC	200	$1,638	$149,058
48 Ave	52 St	51 St	181.3	AC	150	PVC	200	$1,638	$296,969
48 Ave	51 St	50 St	155.7	AC	150	PVC	200	$1,638	$255,037
48 Ave	50 St	49 St	102.4	AC	150	PVC	200	$1,638	$167,731
48 Ave	48 Ave	Arena	82.4	AC	150	PVC	200	$1,638	$134,971
Alley	48 St	49 St	89.4	AC	150	PVC	200	$1,638	$146,437
Alley (49 St)	Alley S	Alley N	113.3	AC	150	PVC	200	$1,638	$185,585
Alley	49 St S	Alley	47.7	AC	150	PVC	200	$1,638	$78,133
Watermain Looping									
Alley (49 St)	Alley	48 Ave	86.3	N/A	N/A	PVC	200	$1,638	$141,359
51 Ave and 48 St	49 St	50 Ave	217.6	N/A	N/A	PVC	200	$1,638	$356,396
52 Ave / Alley	50A St	49 St	238.8	N/A	N/A	PVC	200	$1,638	$391,119
Alley (52 Ave)	52 St	51 St	172.6	N/A	N/A	PVC	200	$1,638	$282,693

Notes:
Replacement costs are based on 2024 dollars and include 35% for professional services and contingency.
Costs do not include roadway trench repair

Appendix E Storm System

VILLAGE OF CAROLINE: STORM SYSTEM



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By: AL

DECEMBER 2024
1101000171

Legend

- Storm Mains
- Storm Culverts
- Primary Storm Ditches
- CatchBasin/Manhole
- Catchbasin
- Manhole
- Outlet
- Proposed

Client/Project:
VILLAGE OF CAROLINE

Figure No:
6.1

Title:
STORM SYSTEM

Village of Caroline
Prospering at Nature's Doorstep

Appendix F Unit Cost Breakdown

Water and Sanitary Replacement Unit Cost Breakdown

Item No.	Item of Work	Measurement Unit	Est. Quantity	Unit Price	Amount
A. WATERMAIN REPLACEMENT					
Notes: All prices are in 2024 dollars					
	Assume a 5.0m wide trench is required to determine road and excavation quantities				
	Costs are per lineal metre				
	Costs do not include roadway trench repair				
150mm PVC DR18					
0.1	Mobilization	% of Total Cost	1.0	~12%	$120.70
0.2	Traffic Accommodation	% of Total Cost	1.0	~4%	$40.25
0.3	Remove and dispose of ex. Pipe	m	1.0	$20.00	$20.00
0.4	Miscellaneous Items	L.S.	1.0	$416.00	$416.00
0.5	Excavate, backfill and compact	m	1.0	$450.00	$450.00
0.6	Install pipe and bedding	m	1.0	$120.00	$120.00
	Subtotal				**$1166.95**
	Professional Services and Contingency (~35%)				$409.05
	Total 150mm Water Main Replacement				**$1,576.00**
200mm PVC DR18					
0.1	Mobilization	% of Total Cost	1.0	~12%	$125.50
0.2	Traffic Accommodation	% of Total Cost	1.0	~4%	$41.85
0.3	Remove and dispose of ex. Pipe	m	1.0	$20.00	$20.00
0.4	Miscellaneous Items	L.S.	1.0	$416.00	$416.00
0.5	Excavate, backfill and compact	m	1.0	$450.00	$450.00
0.6	Install pipe and bedding	m	1.0	$160.00	$160.00
	Subtotal				**$1,213.35**
	Professional Services and Contingency (~35%)				$424.65
	Total 200mm Water Main Replacement				**$1,638.00**
250mm PVC DR18					
0.1	Mobilization	% of Total Cost	1.0	~12%	$131.50
0.2	Traffic Accommodation	% of Total Cost	1.0	~4%	$43.85
0.3	Remove and dispose of ex. Pipe	m	1.0	$20.00	$20.00
0.4	Miscellaneous Items	L.S.	1.0	$416.00	$416.00
0.5	Excavate, backfill and compact	m	1.0	$450.00	$450.00
0.6	Install pipe and bedding	m	1.0	$210.00	$210.00
	Subtotal				**$1,271.35**
	Professional Services and Contingency (~35%)				$445.65
	Total 250mm Water Main Replacement				**$1,717.00**
300mm PVC DR18					
0.1	Mobilization	% of Total Cost	1.0	~12%	$140.00
0.2	Traffic Accommodation	% of Total Cost	1.0	~4%	$46.50
0.3	Remove and dispose of ex. Pipe	m	1.0	$20.00	$20.00
0.4	Miscellaneous Items	L.S.	1.0	$416.00	$416.00
0.5	Excavate, backfill and compact	m	1.0	$450.00	$450.00
0.6	Install pipe and bedding	m	1.0	$280.00	$280.00
	Subtotal				**$1,352.50**
	Professional Services and Contingency (~35%)				$473.50
	Total 300mm Water Main Replacement				**$1,826.00**

Water and Sanitary Replacement Unit Cost Breakdown

Item No.	Item of Work	Measurement Unit	Est. Quantity	Unit Price	Amount
B. SANITARY SEWER REPLACEMENT					
Notes: Assume a 5.0m wide trench is required to determine road and excavation quantities					
	Costs are per lineal metre				
	Costs do not include roadway trench repair				
200mm PVC DR35					
0.1	Mobilization	% of Total Cost	1.0	~12%	$100.00
0.2	Traffic Accommodation	% of Total Cost	1.0	~4%	$33.50
0.3	Remove and dispose of ex. Pipe	m	1.0	$20.00	$20.00
0.4	Miscellaneous Items	L.S.	1.0	$266.00	$266.00
0.5	Excavate, backfill and compact	m	1.0	$450.00	$450.00
0.6	Install pipe and bedding	m	1.0	$100.00	$100.00
	Subtotal				**$969.50**
	Professional Services and Contingency (~35%)				$339.50
	Total 200mm Sanitary Sewer Replacement				**$1,309.00**
250mm PVC DR35					
0.1	Mobilization	% of Total Cost	1.0	~12%	$105.10
0.2	Traffic Accommodation	% of Total Cost	1.0	~4%	$35.00
0.3	Remove and dispose of ex. Pipe	m	1.0	$20.00	$20.00
0.4	Miscellaneous Items	L.S.	1.0	$266.00	$266.00
0.5	Excavate, backfill and compact	m	1.0	$450.00	$450.00
0.6	Install pipe and bedding	m	1.0	$140.00	$140.00
	Subtotal				**$1,016.10**
	Professional Services and Contingency (~35%)				$355.90
	Total 250mm Sanitary Sewer Replacement				**$1,372.00**
300mm PVC DR35					
0.1	Mobilization	% of Total Cost	1.0	~12%	$109.90
0.2	Traffic Accommodation	% of Total Cost	1.0	~4%	$36.65
0.3	Remove and dispose of ex. Pipe	m	1.0	$20.00	$20.00
0.4	Miscellaneous Items	L.S.	1.0	$266.00	$266.00
0.5	Excavate, backfill and compact	m	1.0	$450.00	$450.00
0.6	Install pipe and bedding	m	1.0	$180.00	$180.00
	Subtotal				**$1,062.55**
	Professional Services and Contingency (~35%)				$372.45
	Total 300mm Sanitary Sewer Replacement				**$2,497.00**

Water and Sanitary Replacement Unit Cost Breakdown - Miscellaneous Items

Item No.	Item of Work	Measurement Unit	Est. Quantity	Unit Price	Amount
A. WATER MAIN REPLACEMENT					
Notes: The following items are assumed for a typical length of **100m** of water main replacement. The purpose is to calculate an accurate miscellaneous items cost to be incorporated in to the rehab and replacement unit rates. All prices are in 2024 dollars.					
Miscellaneous Items					
0.1	Adjust valve prior to paving	each	2.0	$550.00	$1,100.00
0.2	Temp. water service (100m / 20m = 5)	each	5.0	$2,000.00	$10,000.00
0.3	Hydrovac existing utilities	each	1.0	$1,000.00	$1,000.00
0.4	Remove and dispose existing hydrant (1 per 150m)	each	0.67	$1,00.00	$670.00
0.5	Hydrant	each	0.67	$7.000.00	$4,690.00
0.6	Fittings	each	2.0	$600.00	$1,200.00
0.7	Valves	each	1.0	$3,000.00	$3,000.00
0.8	Connection to existing pipe	each	1.0	$4,000.00	$4,000.00
0.9	Main stops	each	5.0	$600.00	$3,000.00
0.10	Service connections	each	5.0	$2,000.00	$10,000.00
0.11	Screened Rock	m^3	25.0	$120.00	$3,000.00
	Total for 100m				$41,660.00
	Miscellaneous Cost per metre of pipe				**$416.00**

B. SANITARY SEWER REPLACEMENT

The following items are assumed for a typical length of **100m** of sanitary sewer replacement. The purpose is to calculate an accurate miscellaneous items cost to be incorporated in to the rehab and replacement unit rates.

Miscellaneous Items					
0.1	Adjust manhole prior to paving	each	2.0	$850.00	$1,700.00
0.2	Hydrovac existing utilities	each	1.0	$1,000.00	$1,000.00
0.3	Remove and dispose of existing manhole	each	1.0	$1,400.00	$1,400.00
0.4	Manhole	v.m.	3.5	$2,100.00	$7,350.00
0.5	Sanitary service in-line tee	each	5.0	$300.00	$1,500.00
0.6	Frame and Cover	each	1.0	$600.00	$600.00
0.7	Service connections	each	5.0	$2,000.00	$10,000.00
0.8	Screened Rock	m^3	25.0	$120.00	$3,000.00
	Total for 100m				$26,550.00
	Miscellaneous Cost per metre of pipe				**$266.00**

Roadway Rehabilitation Cost Breakdown

Item No.	Item of Work	Measurement Unit	Est. Quantity	Unit Price	$ / m2 of Roadway
C. ROADWAY REHABILITATION					
Notes: All prices are in 2024 dollars.					
A. EDGE MILLING and OVERLAY					
0.1	Mobilization	% of Total Cost	1.0	~12%	$6.00
0.2	Traffic Accommodation	% of Total Cost	1.0	~4%	$2.00
0.3	Edge and End Asphalt Milling ($3m^2$ per m of Road)	m^2	1.0	$10.64	Not Extended
0.4	Asphalt Leveling Course	tonne	0.028	$266.00	$7.45
0.5	Asphalt – 40mm Lift	tonne	0.11	$266.00	$29.26
	Subtotal				$44.71
	Engineering and Contingency (~35%)				$15.29
	Total Edge Milling and Overlay				**$60.00**
	Note: Required edge milling has Not been included in the total $/m2 but has been included in the overall Costs				
B. LOCAL ROADWAY RECONSTRUCTION					
0.1	Mobilization	% of Total Cost	1.0	~12%	$13.81
0.2	Traffic Accommodation	% of Total Cost	1.0	~4%	4.60
0.3	Remove and Dispose Asphalt	m^2	1.0	$12.40	$12.40
0.4	Waste excavation	m^3	0.35	$29.00	$10.15
0.5	Subgrade preparation	m^2	1.0	$5.80	$5.80
0.6	Pitrun Sub base – 250mm	tonne	0.6463	$39.20	$25.33
0.7	Gravel base – 100mm	tonne	0.2585	$53.60	$13.86
0.8	Asphalt – 65mm lift	tonne	0.1788	$266.00	$47.56
	Subtotal				$133.52
	Engineering and Contingency (~35%)				$46.48
	Total Reconstruction – Local Road				**$180.00**
C. ARTERIAL ROADWAY RECONSTRUCTION					
0.1	Mobilization	% of Total Cost	1.0	~12%	$22.60
0.2	Traffic Accommodation	% of Total Cost	1.0	~6%	$10.40
0.3	Remove and Dispose Asphalt	m^2	1.0	$12.40	$12.40
0.4	Waste excavation	m^3	1.0	$29.00	$15.95
0.5	Subgrade preparation	m^2	1.0	$5.80	$5.80
0.6	Pitrun Sub base – 350mm	tonne	0.9048	$39.20	$35.47
0.7	Gravel base – 200mm	tonne	0.5170	$53.60	$27.71
0.8	Asphalt – 125mm lift	tonne	0.3438	$266.00	$91.45
	Subtotal				$221.78
	Engineering and Contingency (~35%)				$78.22
	Total Reconstruction – Arterial Road				**$300.00**

Roadway Rehabilitation Cost Breakdown

Item No.	Item of Work	Measurement Unit	Est. Quantity	Unit Price	$ / m2 of Roadway
D. ADDITIONAL MISCELLANEOUS COSTS					
Notes: All prices are in 2024 dollars.					
	1.0 CONCRETE				
	Construct New				
1.1	Standard Curb and Gutter	m	1.0	$164.00	
1.2	Rolled Curb and Gutter	m	1.0	$190.00	
1.3	Monolithic Standard Curb and Gutter with Sidewalk	m	1.0	$460.00	
1.4	Monolithic Rolled Curb and Gutter with Sidewalk	m	1.0	$490.00	
1.5	Separate Sidewalk	m	1.0	$288.00	
	Remove and Replace				
1.6	Standard Curb and Gutter	m	1.0	$230.00	
1.7	Rolled Curb and Gutter	m	1.0	$276.00	
1.8	Monolithic Standard Curb and Gutter with Sidewalk	m	1.0	$483.00	
1.9	Monolithic Rolled Curb and Gutter with Sidewalk	m	1.0	$510.00	
1.10	Separate Sidewalk	m	1.0	$311.00	
	2.0 UTILITY ADJUSTMENTS				
2.1	Hydrovac Utilities	hr	1.0	$1,000.00	
2.2	Adjust Manhole	each	1.0	$850.00	
2.3	Adjust Valve	each	1.0	$550.00	
2.4	Adjust Catch Basin	each	1.0	$1,000.00	
	3.0 LANDSCAPING and EARTHWORKS				
3.0	Common Excavation	m^3	1.0	$14.00	
3.1	Import Fill	m^3	1.0	$38.00	
3.2	Import Topsoil and Fine Grading	m^3	1.0	$18.00	
3.3	Grass Seeding	m^2	1.0	$16.00	

Storm Sewer Unit Cost Breakdown

Item No.	Item of Work	Measurement Unit	Est. Quantity	Unit Price	Amount
E. STORM SEWER UPGRADES					
Notes: All prices are in 2024 dollars Assume a 5.0m wide trench is required to determine road and excavation quantities Costs are per lineal metre Costs do not include roadway trench repair					
450mm PVC DR35					
0.1	Mobilization	% of Total Cost	1.0	~12%	$16,700.00
0.2	Traffic Accommodation	% of Total Cost	1.0	~4%	$5,600.00
0.3	Excavate, backfill and compact	m	1.0	$510.00	$510.00
0.4	Connection to existing pipe or Manhole	each	1.0	$4,000.00	$4,000.00
0.5	Install pipe and bedding (450mm)	m	300.0	$240.00	$72,000.00
0.6	Screened Rock	m^3	25.0	$120.00	$3,000.00
0.7	Manhole	v.m.	9.0	$2,100.00	$18,900.00
0.8	Frame and Cover	each	3.0	$600.00	$1,800.00
0.9	Catch Basin	each	4.0	$9,600.00	$38,400.00
0.10	Catch Basin Leads	m	24.0	$90.00	$2,160.00
	Subtotal				**$163,070.00**
	Professional Services and Contingency (~35%)				$57,075.00
	Total 450mm Storm Sewer Installation				**$220,145.00**
	Average Cost Per Linear Metre of Storm Sewer				**$734.00**

Appendix G WWTF Discharge Concept Plan

Stantec

Technical Memorandum

To:	Village of Caroline Craig Curtis	From:	Stantec Consulting Ltd. Jeff Elliott
File:	1101000171	Date:	September 19, 2024

Reference: Village of Caroline-Wastewater Treatment Facility Discharge Concept Plan

1.0 INTRODUCTION

The Village of Caroline (the Village) has been communicating with Alberta Municipal Affairs (AMA). AMA has indicated, in a letter dated May 28, 2024, the Alberta Community Partnership grant program and the Local Government Fiscal Framework provides capital funding to municipalities such as the Village for upgrades to their Wastewater Treatment Facility (WWTF). The Village is currently working with Stantec Consulting Ltd. (Stantec) on a feasibility study involving the possible use of wastewater to irrigate a biomass crop, likely alfalfa. By doing so, current wastewater effluent discharge into the Raven River would be reduced and/or eliminated, thus achieving a sustainable means to meet both the needs of the Village, as well as regulatory Alberta Environment and Protected Areas (AEPA) requirements. The use of this technology represents a feasible alternative to more traditional options (e.g. upgrading existing wastewater treatment lagoons) and would result in a positive impact to the environment. The implementation of a pilot project would meet the eligibility criteria and as such, this memorandum recommends this be considered for funding.

1.1 EXISTING TREATED EFFLUENT DISCHARGE SYSTEM AND CHALLENGES

The Village has had a stable population of approximately 500 persons over the last decade, with an average effluent discharge rate of 114 m^3/day. This rate was determined by examining the available recorded annual wastewater flows between 2017 and 2022, excluding 2020, which was not available. The 114 m^3/day rate was reported for the year 2022. This value is the highest average rate during that period and represents future rates.

However, the Village anticipates ultimate growth to 2,500 people and development of an industrial park. Other communities are planning for similar growth scenarios. This will necessitate a phased design approach for existing and proposed wastewater improvements.

The existing WWTP consists of a two-cell aerated lagoon system with continuous discharge to the Raven River, operating under Alberta Environmental and Protection and Enhancement Act (EPEA) Approval #494-03-00. The current system has adequate capacity to treat up to 400 m^3/day of effluent, however based on previous discussions between the Village and Alberta Environment and Parks (now AEPA) and a 2021 letter, the existing level of wastewater treatment does not meet current and more stringent discharge regulations.

Based on the above, and as per subsequent discussions with Natural Resources Canada (NRC), the Village is currently exploring alternate wastewater treatment and discharge solutions that would ultimately reduce and/or eliminate the discharge of effluent to the Raven River.

The Village has conducted numerous studies regarding the effluent discharge system issue, including:

Reference: **Village of Caroline-Wastewater Treatment Facility Discharge Concept Plan**

November 2023	Village of Caroline – WWTF Discharge Feasibility Study, and Alberta Municipal Water/Wastewater Partnership Funding Application (Stantec)
August 2022	Caroline Wastewater Flow and Loading Summary (Stantec)
April 2018	Village of Caroline Lagoon Upgrade Feasibility Study (Stantec)
November 2017	Village of Caroline – Northeast County Development Servicing Study Update (Revision 1) (Stantec)

2.0 EXISTING/PROPOSED TREATED EFFLUENT DISCHARGE SYSTEM

The existing WWTP is an aerated lagoon system, which consists of two aerated lagoon ponds. The lagoons currently discharge into the Raven River located in the NE 11-36-6-W5M. The following table presents the design parameters of the two aerated cells.

Table 1 Existing Caroline Lagoon Cells

Cell No.	Cell Type	Water Depth (m)	Water Volume (m^3)
1	Partial Mix Aerated	2.5	11,792
2	Partial Mix Aerated	2.5	19,051
Total			**30,843**

The aeration system consists of submerged lineal aeration tubes and three 20 HP blowers in a blower building onshore. The aeration system was upgraded in 2023-2024. The aerated lagoons were designed to treat 400 m^3/day wastewater from the Village.

The Village is operating the existing aerated lagoon system according to an AEPA approval. The approval stipulates that the Village aerated lagoon WWTP shall treat the wastewater collected to meet the following criteria before it is discharged continuously to Raven River:

Table 2 Limits for Treatment Wastewater

Parameter	Limit
CBOD	≤ 25 mg/L monthly arithmetic mean of weekly samples

Reference: **Village of Caroline-Wastewater Treatment Facility Discharge Concept Plan**

It is proposed that the treated effluent can be used as an irrigation source for a crop such as alfalfa instead of discharging to the river. Utilizing current effluent discharge rates (plus a 1% annual growth rate) and considering the Guidelines for Municipal Wastewater Irrigation (wastewater irrigation limited to 5 months - May 1st to September 30th), wastewater storage must be accounted for in the design. Continuous discharge will no longer be allowed.

The Guidelines for Municipal Wastewater Irrigation also indicates additional restrictions will apply (e.g. application must not occur in below freezing temperatures, or during prolonged precipitation events). Therefore, it is recommended that the pilot project and future phases always account for two full years of wastewater storage in the event irrigation can occur for a period of less than the maximum of 5 months. Ideally, the additional storage could be constructed south of the Raven River and adjacent to the pilot irrigation fields.

Additionally, a second source of irrigation water is required to manage receiving soil limits by way of alternating the irrigation of the biomass crop between effluent and irrigation water (good practice to meet the water requirements of the crop and avoid the accumulation of negative constituents, which could ultimately exceed regulatory limits). Using the calculated annual effluent volume, along with assumed supplemental irrigation values for alfalfa (per growing season), a required land area can be calculated. It is envisioned that the pilot project would utilize the majority of quarter sections NW 1/4, 11, 36, 06, W5 and NE 1/4, 11, 36, 06, W5, both of which are crown land currently utilized as grazing leases.

For a proposed pilot project, it is envisioned that effluent/water would be pumped from a storage pond to a drip irrigation distribution system. The below-ground (subsurface) drip irrigation system pipes are typically small in diameter and their orifices are very small, such that the incorporation of an effluent filtration system is recommended to mitigate a clogging potential. An above-ground fixed pivot spray system will be considered if the drip irrigation system is not feasible. A fixed pivot spray system would have proportionally larger diameter pipes and the potential to discharge more effluent over a short period of time. However, climatic conditions such as excessive winds could limit application time periods.

3.0 REVIEW OF REGULATIONS

As per the Guidelines for Municipal Wastewater Irrigation (Alberta Environment, April 2000), various parameters must be met to reduce the overall risk to public health and the environment. To facilitate the disposal of treated effluent through wastewater irrigation (during summer months), AEPA authorization through a formal approval process is required to confirm the following:

- wastewater effluent quality/parameters
- land/soil suitability, including water table considerations
- crop viability
- irrigation loading rates
- storage capacity
- climatic conditions/restrictions

- quality assurance/quality control of system operation

Specific parameters regarding soil suitability such as particle size distribution, moisture holding capacity, pH, electrical conductivity, and sodium adsorption ratio would need to be determined through a soil sampling program to determine the land viability. This information is normally identified during a Level II land irrigability classification investigation and associated report.

Other factors to consider include required setbacks and buffers from adjacent areas, detailed design of the conveyance piping from treatment and storage to irrigation lands (using underground force main), design of conveyance at irrigation land, availability of water for alternating irrigation, general access to the area for operations and maintenance, as well as the ability to harvest and utilize the biomass crop.

4.0 PROPOSED TREATED EFFLUENT DISCHARGE SYSTEM

Layout presented in Appendix A

4.1 COMPONENTS OF THE TREATED EFFLUENT DISCHARGE SYSTEM

4.1.1 Treated Effluent Transfer System

Currently the effluent is discharged to the Raven River through a gravity bio-channel located adjacent to the second aerated lagoon pond. The effluent is proposed to be pumped from a proposed lift station adjacent to the second aerated pond, under the Raven River and to a proposed storage lagoon located on the south side of the river.

4.1.2 Treated Effluent Storage Lagoon

The effluent will be stored in a storage lagoon located on the south side of the Raven River. The size of the lagoon shall have a capacity of two full years of wastewater storage.

4.1.3 Stored Treated Effluent Pumping

The effluent is proposed to be pumped from a proposed lift station adjacent to the storage lagoon, and to the proposed irrigation sites located on the south side of the river.

4.1.4 Irrigation System

1. Land to be irrigated needs to be deep, well-drained soil. Well-drained soils are loams (clay, silt and sand).
2. A Level II Land Irrigability Classification of the site and associated report would be required.
3. Alfalfa is a great crop to use for receiving effluent. There is a potato processor east of Vauxhall (which is northeast of Lethbridge) who has successfully used this approach for over 20 years. Alfalfa has a very long and robust root system that pulls the water table down to allow flushing through the soil profile, is tolerant of a wide range of water constituents with good uptake, and has high water use capability (will grow proportional to the water available). The multiple cuts per year allows regular harvesting and removal of nutrients and other constituents from the land within the biomass. This is also a high demand crop for animal feed (observing for high potassium in bale cores as this is not good for dairy cattle).

4. A drip irrigation system is being considered as a disposal method. A fine screen filtration system would be required to prevent plugging of the drip orifice openings. Continuous drip irrigation would have the benefit of being able to operate outside the window of wind restrictions.
5. A 133-acre center pivot sprinkler can irrigate a quarter section of land. Standard flow rates for sprinklers requires 3.4 m^3/min (900 US gpm). Screen filtration may be required to prevent plugging of sprinkler nozzles.
6. 500 mm per acre (18-inches per acre) would be a typical annual irrigation rate requirement. Again, the daily flow rate from the lagoons would not supply enough water to meet the alfalfa requirements, so storage would be required. For preliminary design purposes, 500mm over a typical 133-acre quarter section pivot system would be about 200 ac-ft, so two quarter sections totaling 266 acres, would be needed.
7. Approximately 55,000 cubic meters could be supplied during the initial 150-day growing period.
8. Based on the above assumed volumes, it is anticipated approximately 5,500m^3 of irrigation would need to be applied per day over the full 266-acre area, on the following alternating monthly schedule:

- Week 1: 5,500 effluent/5,500 water/5,500 water/5,500 water (Monday/Wednesday/Friday/Sunday)
- Week 2: 5,500 water/5,500 water/5,500 water/5,500 water (Monday/Wednesday/Friday/Sunday)
- Week 3: 5,500 effluent/5,500 water/5,500 water/5,500 water (Monday/Wednesday/Friday/Sunday)
- Week 4: 5,500 water/5,500 water/5,500 water/5,500 water (Monday/Wednesday/Friday/Sunday)

The above 5,500m^3/day equates to 6.25L/m^2 per day, a realistic and practical amount.

9. Over the course of one month, this amounts to a total of 88,000m^3, comprised of 11,000 m^3 of effluent and 77,000m^3 of water. Over the course of 5 months, this will allow for the disposal of 55,000m^3 of effluent.

   Alfalfa as noted is typically harvested 3 times per season as per the estimated schedule:

- May 1 to June 30: first cut
- July 1 to August 15: second cut
- August 16 to September 30: third cut

Note the above daily/monthly irrigation volumes are estimated and the various cuts will require different daily/monthly irrigation volumes (e.g. first cut being the most irrigation intensive).

4.1.5 Alfalfa Hay Fields

The use of alfalfa has been proposed as a biomass crop by utilizing the treated effluent as an irrigation source. Alfalfa is known to be an ideal crop for receiving effluent, as it is very tolerant of a wide range of water constituents and has a robust root system that promotes soil flushing. Capable of high-water use, alfalfa will grow proportionally to the level of irrigation provided, allowing multiple cuts (typically 3) per growing season and regular harvesting and removal of nutrients and other constituents from the soil. Alfalfa is also a high demand crop for animal feed, which can be utilized in the communities adjacent to the Village.

Reference: **Village of Caroline-Wastewater Treatment Facility Discharge Concept Plan**

5.0 CONCLUSIONS AND RECOMMENDATIONS

A high-level analysis has indicated that implementing a treated wastewater irrigation system represents a feasible option for the Village of Caroline. This practical and environmentally sustainable technology would allow the Village to meet regulatory requirements and showcase the forward-thinking of the Village through a pilot project.

It is recommended that capital funding be considered for the land acquisition component of the pilot project, and the storage cell and irrigation system design and construction.

Stantec Consulting Ltd.

Jeff Elliott
Consultant

Phone: 403-596-4610
Jeff.Elliott@stantec.com

Attachment: Attachment

c. L.W.

TOWNSHIP ROAD 360

RANGE ROAD 62

RANGE ROAD 61

RAVEN RIVER

PROPOSED BERM RECONSTRUCTION

PROPOSED LIFT STATION

EXISTING WASTE WATER TREATMENT FACILITY

PROPOSED FORCE MAIN TO STORAGE

PROPOSED STORAGE (2x ANNUAL FLOW) AND FUTURE LAGOON ANAEROBIC FACULTATIVE CELLS

PROPOSED LIFT STATION

10.2 ha (25.2 ac)

PHASE 2
64.3 ha (158.9 ac)

PHASE 3
FUTURE CELLS
14.9 ha (36.8 ac)

PILOT PHASE
21.8 ha (53.9 ac)

CONNECTION TO PHASE 3 - LONG TERM EXPANSION

CONNECTION TO PHASE 3 - LONG TERM EXPANSION

CONNECTION TO PHASE 3 - LONG TERM EXPANSION

N

LEGEND

Proposed Irrigation System

Proposed Phase Boundary

Existing Waste Water Treatment Facility

1:5000 0 50 100 250

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2024/06/13 11:44 AM By: Stafford, Shane

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WASTE WATER TREATMENT FACILITY DISCHARGE CONCEPT PLAN

VILLAGE OF CAROLINE

Appendix H NE County Development Servicing Study

Stantec

Memo

To:	Village of Caroline	From:	Stantec Consulting Ltd.
File:	113927090_04	Date:	January 29, 2021

Reference: **Village of Caroline – Northeast County Development Servicing Study Update (Revision 2)**

INTRODUCTION

Stantec was requested by the Village of Caroline to assess the capacity of the existing water and wastewater infrastructure and to identify if there's any upgrades required to service the proposed Northeast County Development located just outside the Village boundary. A technical memorandum was prepared and sent to the Village on July 25, 2017. After a review with the County of Clearwater, the County's consultant updated the servicing requirements to better reflect the requirements seen in municipalities of similar size and the Village of Caroline itself. This memo (Revision 1) has investigated the updated servicing requirements provided for by the County's consultant and revised the hydraulic water and wastewater models.

As per the previous study, the Capital Infrastructure Plan (CIP), prepared by Stantec in 2009, was reviewed and adopted in this technical memorandum. The hydraulic WaterCAD model developed for the aforementioned study was used as the basis for water infrastructure analysis. The sanitary sewers that would convey flow from the future development to the sanitary lagoon was modeled in PCSWMM to determine if the residual capacity is sufficient to accommodate future flows from Northeast County Development.

DESIGN FLOW OF NORTHEAST COUNTY DEVELOPMENT

The revised water and wastewater design basis from the developer are summarized in **Table 1** and **Table 2**. Design water demands for Average Day Demand (ADD), Maximum Day Demand (MDD) and Peak Hour Demand (PHD) scenarios and design peak wet weather sanitary flow (PWWF) for the Northeast County Development are summarized in **Table 3** and **Table 4**.

Table 1: Water Design Basis

Design Parameters	Revised Design Value	Unit
Average Daily Consumption Rate	0.15	L/s/ha
MDD to PHD Peaking Factor	2	
PHD to MDD Peaking Factor	2	

Table 2: Wastewater Design Basis

Design Parameters	Revised Design Value	Unit
Average Daily Flow	0.135	L/s/ha
Peak Day Dry Weather Design Flow	90 % of the PHD (Peak Hour Water Demand)	
Inflow/Infiltration	0.2	L/s/ha

Reference: Village of Caroline – Northeast County Development Servicing Study Update (Revision 2)

Table 3: Northeast Development Design Water Demand

	Phase 2A Commercial	Phase 2B Commercial	Phase 2C Commercial	Phase 2D Commercial	Total
Development (ha)	5.15	2.48	5.2	12.15	24.98
ADD (L/s)	0.8	0.4	0.8	1.8	3.7
MDD (L/s)	1.5	0.7	1.6	3.6	7.5
PHD (L/s)	3.1	1.5	3.1	7.3	15.0
Fire Flow (L/s)			75		-

Table 4: Northeast Development Design Sanitary Flow Breakdown

	Phase 2A Commercial	Phase 2B Commercial	Phase 2C Commercial	Phase 2D Commercial	Total
Development Area (ha)	5.15	2.48	5.2	12.15	25.0
Average Flow (L/s)	0.7	0.3	0.7	1.6	3.4
Peak Day Dry Weather (L/s)	2.8	1.3	2.8	6.6	13.5
Inflow/Infiltration (L/s)	1.0	0.5	1.0	2.4	5.0
Peak Design Flow (Peak Day Wet Weather Flow) (L/s)	3.8	1.8	3.8	9.0	18.5

CAPACITY ASSESSMENT OF EXISTING WATER DISTRIBUTION SYSTEM AND WATER TREATMENT PROCESS

Water demands for ADD, MDD and PHD conditions are summarized in **Table 5** and are available in a WaterCAD hydraulic model. It is suggested in the 2009 Capital Infrastructure Plan (CIP) that the average day demand of treated water consumption is 470 LPCD based on the available potable water consumption data from 2005 to 2008. The per capital consumption rate will remain at 470 LPCD from 2009 to 2019 considering there is no large commercial and industrial development in the short term for the Village. The available existing model scenario demand was previously developed with a total population of 540 using water consumption rate of 470 LPCD. The total demands of the existing system plus the Northeast County Development is summarized in **Table 5**. The equivalent population in Northeast County Development will reach 680 using a consumption rate of 470 LPCD. The total equivalent population in the Village of Caroline will become 1,220 when the Northeast County Development area is fully developed. This value is conservative since the current 2016 Caroline's population of 512 is lower than the simulated population in the existing model.

Table 5: Water Demand Summary

	Existing System Demand	Northeast Development Demand	Grand Total Existing System plus Northeast County Development
Average Day Demand (L/s)	2.94	3.7	6.64
Maximum Day Demand (L/s)	5.88	7.5	13.4
Peak Hour Demand (L/s)	12.03	15	27.0
*Treated Water Consumption Rate (Lcpd)	470	470	470
Population /Equivalent Population	540	680	1,220

Reference: Village of Caroline – Northeast County Development Servicing Study Update (Revision 2)

Note that since the Northeast County Development will be primarily a commercial and industrial subdivision, the treated water consumption rate is most likely to be lower than 470 LPCD. From our understanding, service meters have been installed in the Village since the 2009 CIP study. A water consumption audit/analysis is recommended to be conducted to examine the actual water consumption rate within the Village to better quantify the requirements of the water system.

As identified in the 2009 CIP, the Village has three water wells (Well 401, 402 and 403). Well 401 was abandoned in 2007. Well 403 is being used frequently and was recorded to pump approximately 300 m^3/day, at 5 hours per day (varies by season). The level of manganese concentration in Well 402 was recorded to be high, thus the current manganese removal process used in Well 403 didn't work efficiently in Well 402. As recorded in the 2009 CIP, the water level in Well 403 remained stable whether the pumps were kicked on or not. Also, the capacity of the current water supply wells were identified as sufficient to service more than 1,000 persons. In this study, the total population is projected to reach approximate 1,220 with full build-out of Northeast County development. It is recommended that the water level in Well 403 is observed/monitored by the Village to ensure the level remains stable as future growth occurs.

Regarding the water treatment filtration process, the combined capacity of the two existing filter tanks were recorded at a total of 655 m^3/d (7.6 L/s) in the 2009 CIP study. The two filter tanks could not handle the total design MDD of 13.4 L/s for the full build-out of the Northeast County development. As the existing projected MDD is 508 m^3/d (5.88 L/s), the current two filter tanks could still provide additional 149 m^3/d (1.72 L/s) for new developments in the development. Hence, an additional filtration capacity of 501m^3/d (5.8 L/s) is needed to service the Village and the proposed Northeast County Development.

The CT value (Chlorine Concentration Contact time) was calculated to be 38 at PHD condition (27.0 l/s), assuming a baffle factor of 10% and 0.5 mg/L free chlorine entering the distribution system. This value is higher than the required value of 10, thus meeting the ability to claim the 4-log reduction of virus's credit, as required by AEP guidelines.

New model scenarios for the Northeast County Development were created for ADD, MDD and PHD analysis. The level of service design criteria for this study is summarized in **Table 6,** developed based on typical industrial standard.

Table 6: Level of Service Design Criteria

	Value	Unit
Minimum System Pressure for PHD	43.5	psi
Maximum Allowable Pressure	123	psi
Minimum Pressure in a fire flow condition	21.8	psi
Maximum Allowable Velocity in normal operation	1.5	m/s
Maximum Allowable Velocity for Future Pipes in a fire flow condition	2.5	m/s
Fireflow for Commercial/Industrial Area*	75	L/s

* Note the proposed 75 l/s is revised and agreed by the County and the County's consultant.

Reference: Village of Caroline – Northeast County Development Servicing Study Update (Revision 2)

As recorded in 2009 CIP, the existing pump system of the Town consists of two 10 hp vertical turbine distribution pumps along with one 125 hp fire flow pump connected to an eight cylinder diesel engine. There is also one backwash pump to pump water back to the filter tanks for filtration purposes. Alberta Environment and Parks (AEP) standard recommends the pump station should provide adequate pumping capacity when the largest pump is taken off line. In order to accommodate total PHD flow of 27 L/s, the two existing distribution pumps are recommended to be replaced with bigger pumps rated at 27 L/s,42 m head with approximate 18 hp based on ground elevation to meet the specified minimum pressure criteria shown in **Table 6**. It is recommended that this proposed pump design set point be further reviewed and confirmed in the design stage. A conceptual water servicing strategy developed in the Northeast County Development is presented in **Figure 1.** The proposed watermains consist of approximate 1,675 m of 200 mm. The existing 265 m of 150 mm watermains will be required to upsize to 200 mm to supply an adequate fire flow of 75 L/s to the new development area, as shown in **Figure 1**.

The looping around the Northeast County Development is proposed to ensure an adequate fire flow of 75 L/s being supplied. Based on the aforementioned water servicing strategy, all level of service (LOS) of design criteria summarized in **Table 6** can be met.

As the required fire flow was revised to 75 L/s, the existing reservoir does have fire storage for 1.75 hours at 75 L/s, equivalent to 473 m^3. The effective volume of the existing reservoir is 820 m^3. Based upon Alberta Environment and Parks (AEP) standard, **Table 7** summarizes the existing and future storage requirements. As such, the existing reservoir could provide sufficient storage volume for the existing water supply system.

From **Table 7**, it is calculated that an additional 208 m^3 of storage is required to provide sufficient capacity to service the Northeast County Development to meet AEP standard. Considering the effective volume of the existing reservoir of 820 m^3, there's only 26 m^3 (3%) storage deficiency in servicing the existing system plus the Northeast County development. Based on our past design experiences, this 3% storage deficiency can be deemed negligible. Therefore the effective volume of the existing reservoir of 820 m^3 is sufficient to provide servicing to the Northeast County development.

Table 7: Existing and Future Storage Requirements

	Existing Storage Requirement (m^3)	Future Storage Requirement (m^3)
A = Fire Storage	[1]473	[1]473
B = Equalization on Storage (25% MDD)	127	287
C = Emergency Storage (15% ADD)	38	86
Total Required Storage	638	846
Existing Storage	820	820
Additional Storage Required	**-182**	**26**

Note:

1. The existing fire storage was calculated based on 75 L/s for 1.75 hours, equivalent to 473 m^3.

Reference: Village of Caroline – Northeast County Development Servicing Study Update (Revision 2)

CAPACITY ASSESSMENT OF SANITARY LAGOON TRUNK

Based on the available as-built drawings for the wastewater collection system, a sanitary model was developed using PCSWMM to determine the residual capacity of the existing sewer trunk along 49th Street, beginning from north of 50th Ave to the downstream sanitary lagoon, identified in **Figure 2**. Note that the existing sanitary trunk was replaced with 300 mm PVC pipes from the end of 49th Street to the sanitary lagoon in 2012.

The existing sanitary peak wet weather flow (PWWF) was projected using the assumed design parameters summarized in **Table 8**. The projected PWWF is summarized in **Table 9** considering current 2016 village's population of 512. Note that the existing PWWF is calculated using typical industrial standards. It is recommended an on-going flow monitoring program to be conducted to investigate the actual sanitary flows to facilitate future design/planning studies in a long run.

Based on the modeling results, the PWWF Hydraulic Grade Line (HGL) profile was presented in **Appendix Figure B-1**. With a total design sanitary flow of 33.3 L/s, no surcharging was observed along the identified sanitary sewer trunk with consideration of design PWWF flow of 18.5 L/s in Northeast County Development; however, a condition assessment was completed as part of the 2009 Capital Infrastructure Plan and it noted the condition of the sanitary mains along 49 Street from Main Street south was in poor to very poor condition.

Table 8: Existing Wastewater System Design Parameters

	Assumed Design Parameters	Unit
Average Dry Weather Flow Rate (Residential)	300	Liter per capita per day
ICI Flow Generation Rate	0.1	Liters per second per hectare
Peaking Factor	2.5	
I&I Allowance	0.2	Liters per second per hectare

Table 9: Total Design Peak Wet Weather Flow

	Projected PWWF (L/s)
Existing System	14.8
Northeast County Development	18.5
Grand Total	**33.3**

Wastewater Treatment

It was noted in the 2009 Capital Infrastructure Plan, the sewage treatment facility had capacity for a population of approximately 879 persons using the existing aerated lagoon and a continuous discharge system at the time the 2009 study was conducted. AEP recently required further studies with more stringent requirements as noted in more detail below. Therefore the

aerated lagoon system will not have sufficient capacity to treat the existing wastewater let alone the added flows from the new development with an equivalent population of 1,220.

As requested by Alberta Environment and Parks, the Village is in the process of conducting a "receiving water study" on the existing sewage treatment lagoon system, as per the Wastewater System Effluent Regulation under Fishery Act (WSER 2012). This study will determine if the existing lagoon system has the capacity to treat the wastewater requirements laid out in the WSER standard. The receiving water study might lead to treatment technology changes to effectively lower the ammonia level all year round to ensure the treated effluent can pass the lethal tests using rainbow trout. New treatment system based on proper technology has to be sized with the total 1,220 equivalent population.

OPINION OF PROBABLE COSTS

Based on the information in the aforementioned sections, an opinion of probable costs has been presented in the below table. The costs below are for the Village of Caroline's portion of the required upgrades. The represented costs are a Class D level estimation of the expected costs.

Item	Item Description	Cost
1.	**WTP Upgrades**	**$190,000**
1.1	Electrical Upgrades (incl. MCC upgrade, VFD replacement, Programming, Cabling)	$70,000
1.2	Pumps and Pump Bases	$120,000
2.	**Water Mains Replacement/Installation (1.2km)**	**$1,200,000**
3.	**Sanitary Mains Replacement (0.5km)**	**$920,000**
	Subtotal 1	**$2,310,000**
4	Engineering (10%)	$181,000
5	Contingency (30%)	$693,000
	Total (excl. GST)	**$3,184,000**

Reference: Village of Caroline – Northeast County Development Servicing Study Update (Revision 2)

CONCLUSIONS AND RECOMMENDATIONS

Based on the updated design water demands using revised design basis and capacity assessment of the existing water infrastructure in the Village of Caroline through hydraulic WaterCAD model, our findings are summarized as follows:

- As the servicing meters were installed after 2008, it is recommended to do a water consumption audit/analysis to examine the actual water consumption rate after the installation of the service meters;
- To service the Northeast County Development, the proposed watermains consist of approximate 1,200 m of 200 mm new watermains outside the development boundary. The existing 265 m of 150 mm watermains will be required to upsize to 200 mm to supply an adequate fire flow of 75 L/s to the new development area.
- As the water well capacity in Well 403 was identified as sufficient to service more than 1,000 persons, it is recommended that the water level in Well 403 is continually observed/monitored by the Village to ensure water level remains stable as future growth occurs;
- The two existing water distribution 10 hp pumps are recommended to be replaced with bigger pumps rated at 27 L/s with 42 m head with approximate 18 hp from ground elevation to provide firm pumping capacity at PHD scenario with demands from the existing system and Northeast County Development. It is recommended that this proposed pump design set point be further reviewed and confirmed in the design stage;
- With revised fire flow requirement of 75 L/s for future commercial and industrial customers in the Northeast County Development, the current storage volume of 820 m^3 is deemed sufficient;
- The combined capacity of the two filter tanks in the water treatment process could not handle the total design MDD demand. Potential upgrade on the two filter tanks is recommended. It is suggested the Village to conduct a treatment process upgrade study to identify the scope and detailed requirements of the upgrades.

Reference: Village of Caroline – Northeast County Development Servicing Study Update (Revision 2)

Based on the updated design wastewater flows using revised wastewater design basis from the county's consultant's and capacity assessment of the existing sewer trunk along 49th Street starting from 50th Ave to downstream sanitary lagoon in the Village of Caroline through PCSWMM model, our findings are summarized as follows:

- With the total design sanitary flow of 33.3 L/s, no surcharging was observed along the identified sanitary sewer trunk with consideration of design PWWF flow of 18.5 L/s from the Northeast County Development; however, the mains along this section is in very poor condition and it is recommended to replace the infrastructure prior to increasing the flow through; and
- The existing lagoon system doesn't have sufficient capacity to support the full build-out of Northeast County Development. The required sewage treatment capacity upgrades will be determined by the on-going receiving water study. The receiving water study might lead to the changes of treatment technology to effectively lower the ammonia level all year round to ensure the treated effluent can pass the lethal tests using rainbow trout. New treatment system with proper technology will be sized to accommodate the total population of 1,220 with total projected PWWF flow of 33.3 L/s in this study.

The Opinion of Probable Costs (Class D Estimate) for the upgrades noted in this study is $3,184,000

REFERENCE

- Village of Caroline Capital Infrastructure Plan, Stantec, 2009

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Attachment: Figure 1 – Proposed water servicing
Figure 2 – Wastewater Servicing Capacity Analysis
Figure B-1 - Sanitary Sewer Trunk HGL Profile with Total Design PWWF

cc. Joel Sawatzky, Sophie Sadowski

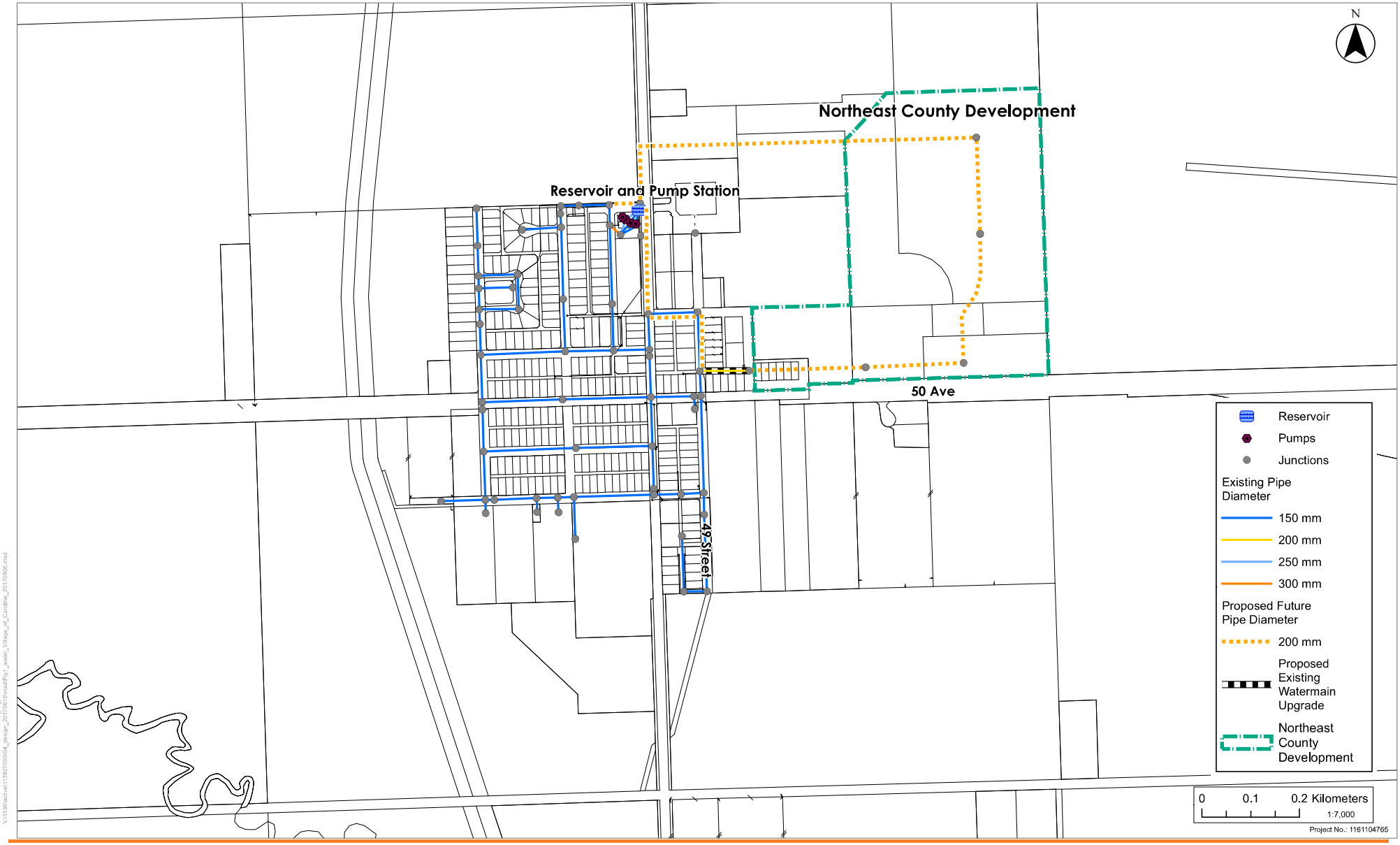


Figure 1 Northeast County Development Proposed Water Servicing

Village of Caroline

Stantec

Future Alignments are intended to be conceptual.

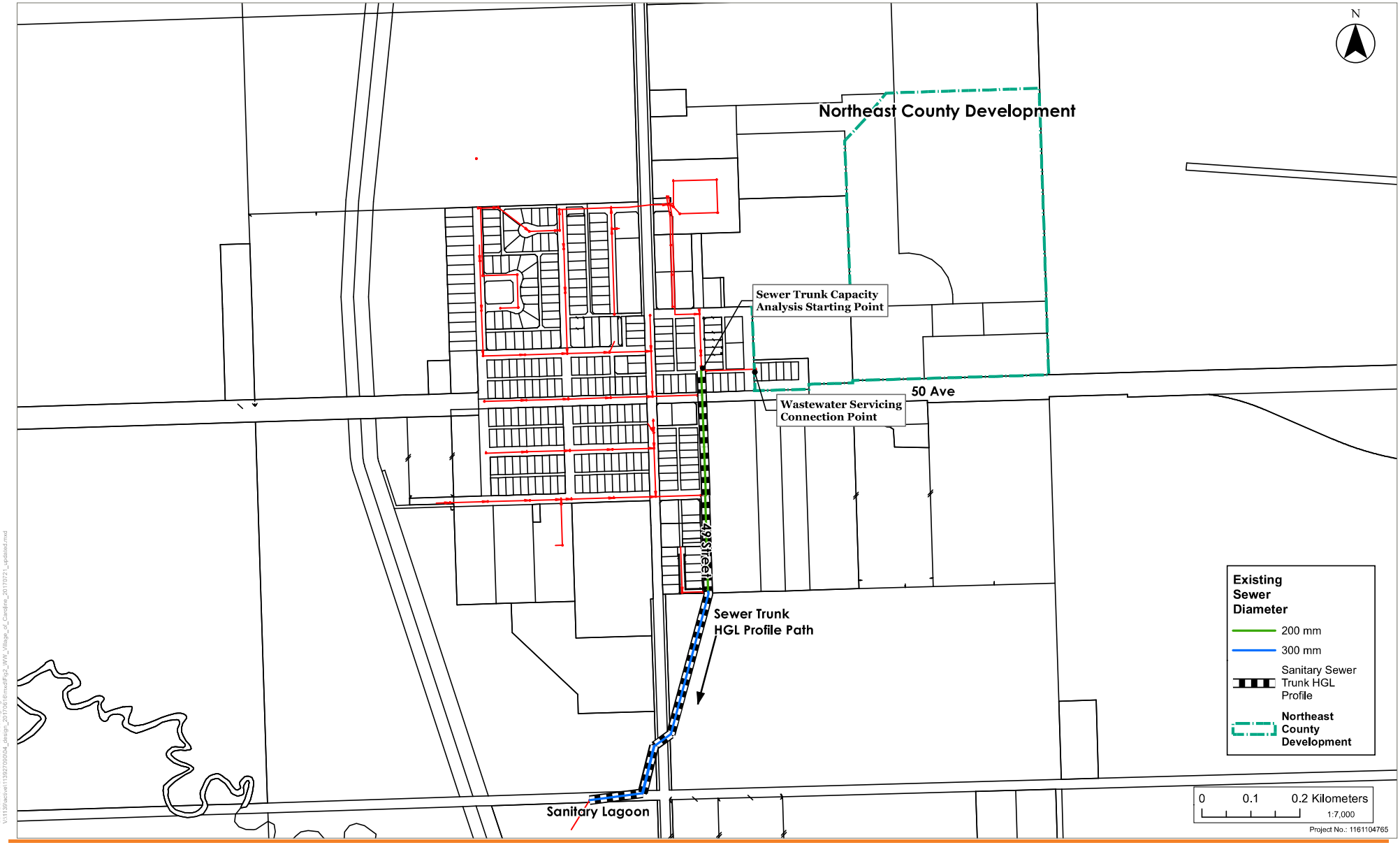
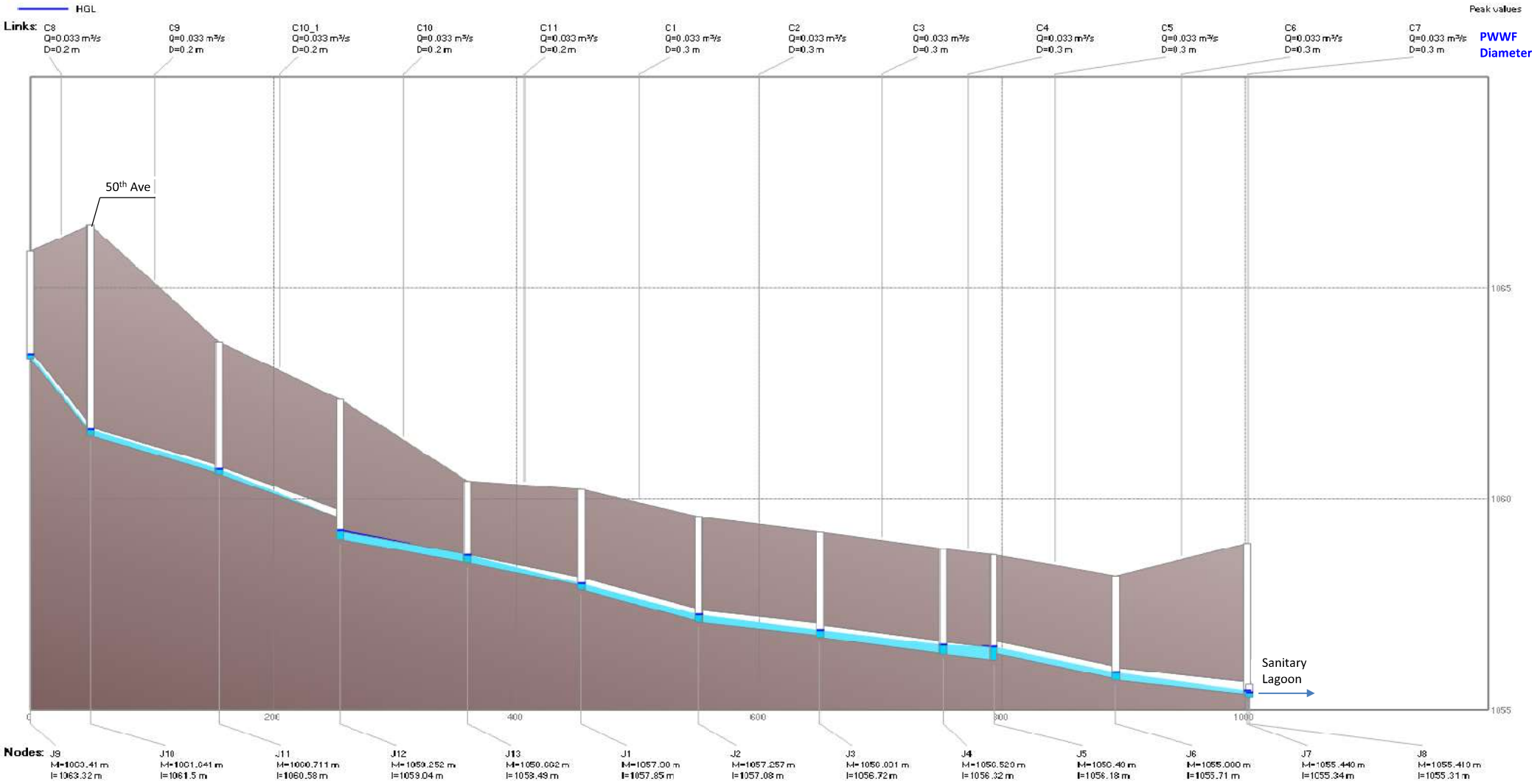


Figure 2 Northeast County Development Wastewater Servicing Capacity Analysis Layout

Village of Caroline



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Client/Project
Village of Caroline
Sanitary Sewer Trunk Capacity Assessment

Figure No.
B-1

Title
Sanitary Sewer Trunk HGL Profile with Total Design PWWF (Sewer Trunk along 49th Street from north of 50th Ave to Sanitary Lagoon)

With every community, we redefine what's possible.

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