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To: Village of Caroline                                  From: Stantec Consulting Ltd.

File: 113927090\_04                                  Date: January 29, 2021

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**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

**Design with community in mind**

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**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 capita 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

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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<sup>3</sup>/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<sup>3</sup>/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<sup>3</sup>/d (5.88 L/s), the current two filter tanks could still provide additional 149 m<sup>3</sup>/d (1.72 L/s) for new developments in the development. Hence, an additional filtration capacity of 501 m<sup>3</sup>/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.

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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<sup>3</sup>. The effective volume of the existing reservoir is 820 m<sup>3</sup>. 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<sup>3</sup> 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<sup>3</sup>, there's only 26 m<sup>3</sup> (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<sup>3</sup> is sufficient to provide servicing to the Northeast County development.

**Table 7: Existing and Future Storage Requirements**

	Existing Storage Requirement (m <sup>3</sup> )	Future Storage Requirement (m <sup>3</sup> )
<b>A = Fire Storage</b>	1473	1473
<b>B = Equalization on Storage (25% MDD)</b>	127	287
<b>C = Emergency Storage (15% ADD)</b>	38	86
<b>Total Required Storage</b>	638	846
<b>Existing Storage</b>	820	820
<b>Additional Storage Required</b>	<b>-182</b>	<b>26</b>

Note:

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

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## 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 49<sup>th</sup> Street, beginning from north of 50<sup>th</sup> 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 49<sup>th</sup> 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
<b>Grand Total</b>	<b>33.3</b>

## 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

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

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## **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<sup>3</sup> 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.

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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 49<sup>th</sup> Street starting from 50<sup>th</sup> 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

## **STANTEC CONSULTING LTD.**

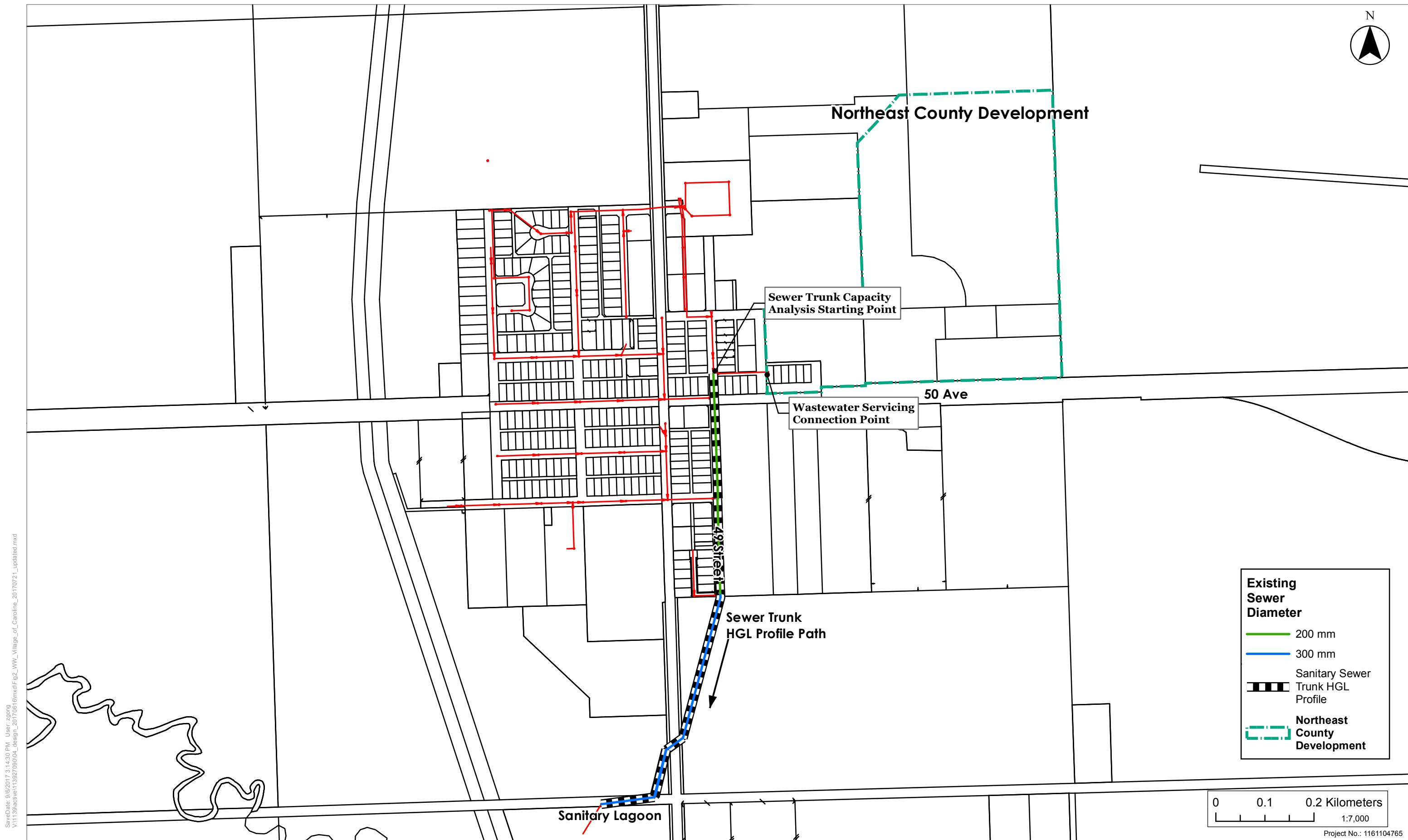
James Coates, M.Sc., P.Eng.  
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Attachment: Figure 1 – Proposed water servicing  
Figure 2 – Wastewater Servicing Capacity Analysis  
Figure B-1 - Sanitary Sewer Trunk HGL Profile with Total Design PWWF

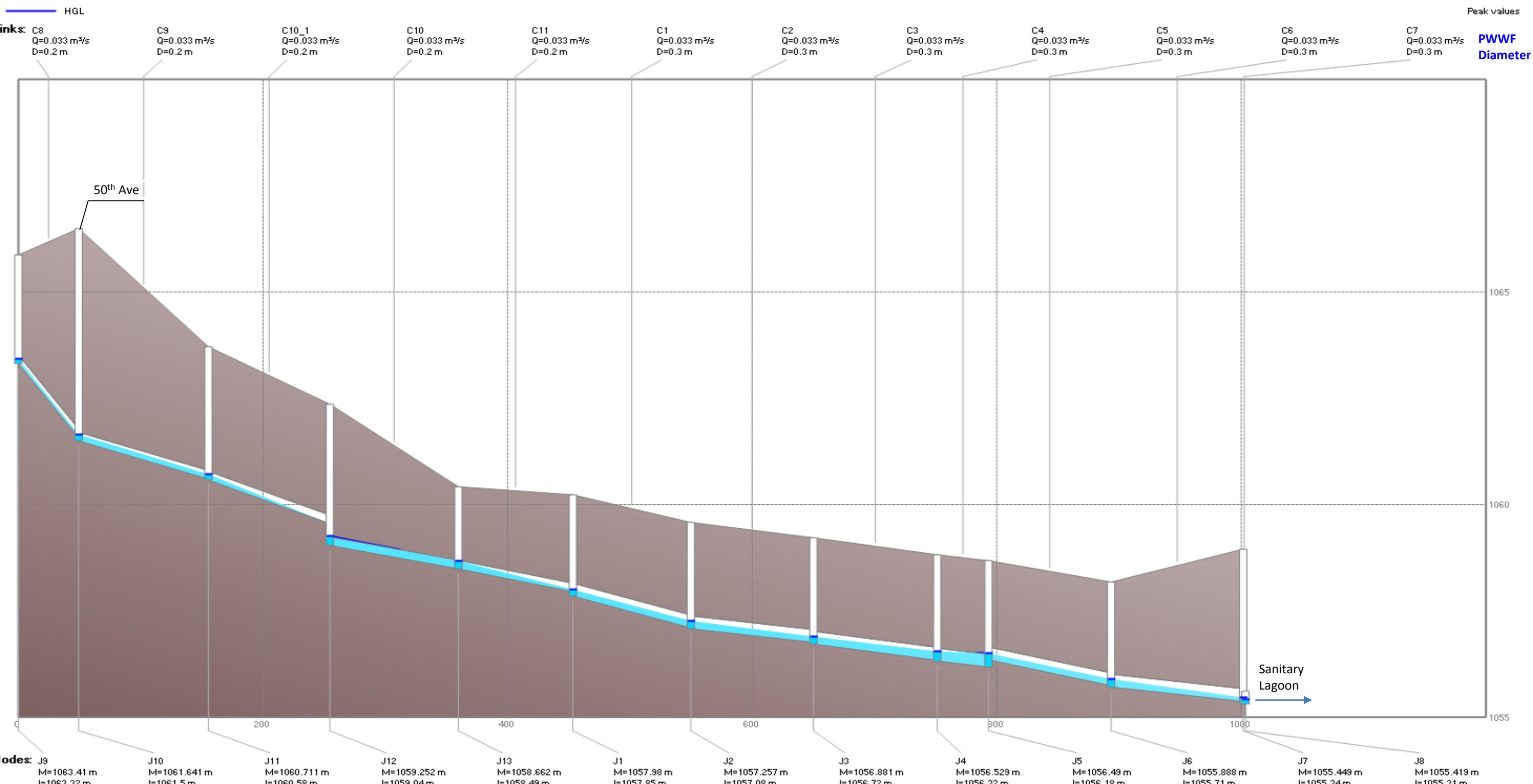
cc. Joel Sawatzky, Sophie Sadowski



**Figure 1 Northeast County Development Proposed Water Servicing**



**Figure 2 Northeast County Development Wastewater Servicing Capacity Analysis Layout**



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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 49<sup>th</sup> Street from north of 50<sup>th</sup> Ave to  
Sanitary Lagoon)