Notice of Meeting and Meeting Agenda

Ganges Sewer Local Service Commission

Thursday, June 4, 2026 | **1:00 PM** | **SIMS Boardroom 124 Rainbow Road Salt Spring Island BC**

Annual General Meeting

MS Teams Meeting Link

M. de Carle, G. Holman, D. Toynbee, C. Whyte

The Capital Regional District strives to be a place where inclusion is paramount and all people are treated with dignity. We pledge to make our meetings a place where all feel welcome and respected.

Purpose of the Annual General Meeting

The agenda for the Annual General Meeting (AGM) is approved by the members of the Commission. The purposes (and hence the agenda items) of the meeting are:

• To have the last year's AGM minutes approved (by Commission members), and to present reports on the work of the Commission on the past year's operation, maintenance, capital upgrades and financial information of the service to the service residents and owners,
• To nominate members for appointment to the Commission, and
• To enable the public to share comments on subjects which relate to the work of the Commission. The Commission can identify (under "new business") issues on which it wants feedback at the meeting. Motions raised by the public at the AGM will be considered by the commission at a subsequent regular meeting.

The Annual General Meeting is for the 2025 fiscal year.

1. Territorial Acknowledgment

2. Election of Chair

3. Approval of Agenda

4. Adoption of Minutes

4.1. 26-0481 Minutes of June 10, 2025 the Ganges Sewer Local Service Commission

Recommendation: That the minutes of the June 10, 2025 meeting be adopted as circulated.

Attachments: Minutes: June 10, 2026

5. Director and Chair's Report

6. Senior Manager's Report

7. Report

7.1. 26-0482 Ganges Sewer Local Service Annual Report 2025

Recommendation: There is no recommendation. This report is for information only.

Attachments:
Ganges Sewer Local Service Annual Report 2025
Appendix A: Ganges 2025 Capital Projects List – Financial Summary
Appendix B: Ganges 2025 Statement of Operations and Reserve Balances

8. Election of Commissioner

2 Positions

9. New Business

9.1. 26-0673 Ganges Sewer Inclusion Request Fulford-Ganges across from Drake

Recommendation: The Ganges Sewer Commission recommends that Lot 1, 2 and 231 Fulford-Ganges Road be granted permission to proceed with an application to be included in the Ganges Sewer Local Service Area.

Attachments:
Staff Report: Ganges Sewer Inclusion Request Fulford-Ganges across from Dra
Appendix A: Report - Ganges Sewer Service Area Modelling, Model Update, Ca
Appendix B: Inclusion Request Letter, Dated Oct. 17, 2025
06-04-2026Appendix C Design Brief

9.2. 26-0675 Ganges Sewer Inclusion Request - 160 Upper Ganges Road

Recommendation: That the Ganges Sewer Commission recommends that Lot A, Plan VIP61558, Section 3 Range 4E, Cowichan Land District, 160 Upper Ganges Road (Hastings House) be granted permission to proceed with an application to be included in the Ganges Sewer Local Service Area.

Attachments:
Staff Report: Ganges Sewer Inclusion Request - 160 Upper Ganges Road
Appendix A: Inclusion Request Letter (Design Brief)
Appendix B: Report - Ganges Sewer Service Area Modelling, Model Update, Ca
Appendix C: Technical Memorandum (Modelling Report)

10. Outstanding Business

None

11. Adjournment

Next Meeting:

-Budget meeting TBA

Capital Regional District

625 Fisgard St.,
Victoria, BC V8W 1R7

Meeting Minutes - Draft

Ganges Sewer Local Service Commission

Tuesday, June 10, 2025 **10:00 AM** **SIMS Boardroom**
124 Rainbow Road
Salt Spring Island BC

Annual General Meeting

PRESENT:

COMMISSION MEMBERS: G. Holman, M. de Carle, D. Toynbee, C. Whyte

STAFF: S. Henderson, Senior Manager, Real Estate and SGI Administration (EP), D. Ovington, Senior Manager, SSI Administration, J. Bilodeau, Manager, Local Services Water and Wastewater Ops, C. Hopp, Manager SSI Engineering, L. Xu, Manager, Local Service, Finance Services (EP), K. Vincent, Senior Financial Advisor, Finance Services (EP), A. Elliyon Financial Analyst, Finance Services (EP), and M. Williamson, Committee Clerk, (Recorder)

Electronic Participation- (EP)

These minutes follow the order of the agenda although the sequence may have varied.

The meeting was called to order at 10:06 am.

1. Territorial Acknowledgement

D. Ovington provided a Territorial Acknowledgement.

2. Election of Chair

The Senior Manager, SSI Administration called for nominations for the position of Chair of the Ganges Sewer Local Services Commission for 2025.

Commissioner Toynbee nominated Commissioner De Carle, Commissioner De Carle accepted the nomination.

D. Ovington called for nominations a second time.

D. Ovington called for nominations a third time.

Hearing no further nominations, the Senior Manager, SSI Administration declared Commissioner De Carle Chair of the Ganges Sewer Local Services Commission by acclamation.

3. Approval of Agenda

**MOVED By Director Holman, SECONDED by Commissioner Whyte,
That agenda for the June 10, 2025, Annual General Meeting of the Ganges Sewer Local Services Commission be approved as amended with the following additions:
-Agenda item 8.2. Kings Lane Housing Project
-Agenda item 9.1. Ganges Rate Restructuring Update
CARRIED**

4. Adoption of Minutes

4.1. Minutes of November 7, 2024 the Ganges Sewer Local Service Commission

**MOVED By Commissioner Toynbee, SECONDED by Commissioner Whyte,
That the minutes of the November 7, 2024 be adopted as amended by replacing the words "Fernwood and Highland Water" with the words "Ganges Sewer Local" after the words "That the" and before the words "Service Commission adjourn"
CARRIED**

5. Director and Chair's Report

Director Holman spoke regarding:
-Ganges hill project nearing completion
-Stephen Henderson being appointed as the General Manager for Electoral Area Services
-Carolyn Hopp being appointed as the SSI Engineering Manager

6. Report

6.1. Ganges Sewer Local Service 2024 Annual Report

D. Ovington presented the report.

This report was received for information.

- Membrane replacement expected soon as equipment reaches end-of-life; funding reserved
- Sewer network modeling completed to support possible new connections and identify bottlenecks

7. Election of Commissioner

Request for volunteers was advertised as per the requirements and staff confirmed no new nominations were received.

Commissioners De Carle and Toynbee have emailed their intent to serve on the commission for the January 1, 2026 to December 31, 2027 term. Their names will be submitted to the Board for appointment by acclamation.

8. New Business

8.1. Request Additional Funds to Complete the Detailed Design for the Ganges Wastewater Treatment Plant Aeration System Upgrade Design

MOVED By Commissioner Toynbee, SECONDED by Director Holman,
That the Ganges Sewer Local Services Commission recommends to the Capital Regional District Board that the Ganges Sewer Utility Service 2025 Capital Plan be amended to increase the budget for project (21-06), the Aeration System improvement design, by the amount of $14,248 from $130,000 to $144,248, to be funded from Capital Reserve Fund.
CARRIED

8.2. Kings Lane Housing Project

Discussion ensued regarding Kings Lane Housing Project potential sewer main extension and addition to system.

9. Outstanding Business

9.1. Ganges Rate Restructuring Update

Discussion ensued regarding potential rate restructuring methodology.

MOVED By Commissioner Toynbee, SECONDED by Commissioner Whyte,
That the Ganges Sewer Local Service Commission request staff not pursue user rate restructure options for further consideration.
CARRIED

10. Adjournment

MOVED By Commissioner Toynbee, SECONDED by Commissioner Whyte,
That the Ganges Sewer Local Service Service Commission adjourn the meeting at 11:53am.
CARRIED

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CHAIR

____

SENIOR MANAGER

Ganges Sewer Service

2025 Annual Report

CRD | **Sewer Service**

INTRODUCTION

This report provides a summary of the Ganges Sewer Service for 2025. It includes a description of the service, summary of the treatment plant performance, volume of sewage treated, operations highlights, capital project updates and financial report.

The service is administered by the Ganges Sewer Local Services Commission.

SERVICE DESCRIPTION

The Ganges Sewer Service was established in 1985. Ganges is the island's core area providing the majority of commercial services as well as several residential pockets. In addition to the commercial and residential customers, other customers include the hospital, three schools, swimming pool and several senior and affordable housing sites. The system is owned and operated by the Capital Regional District (CRD) and services the Ganges Sewer Service Area, shown in Figure 1. is comprised of 481 parcels, of which 416 were taxable and with 682 single-family equivalents (SFE) as the use on some parcels represents more than one dwelling.

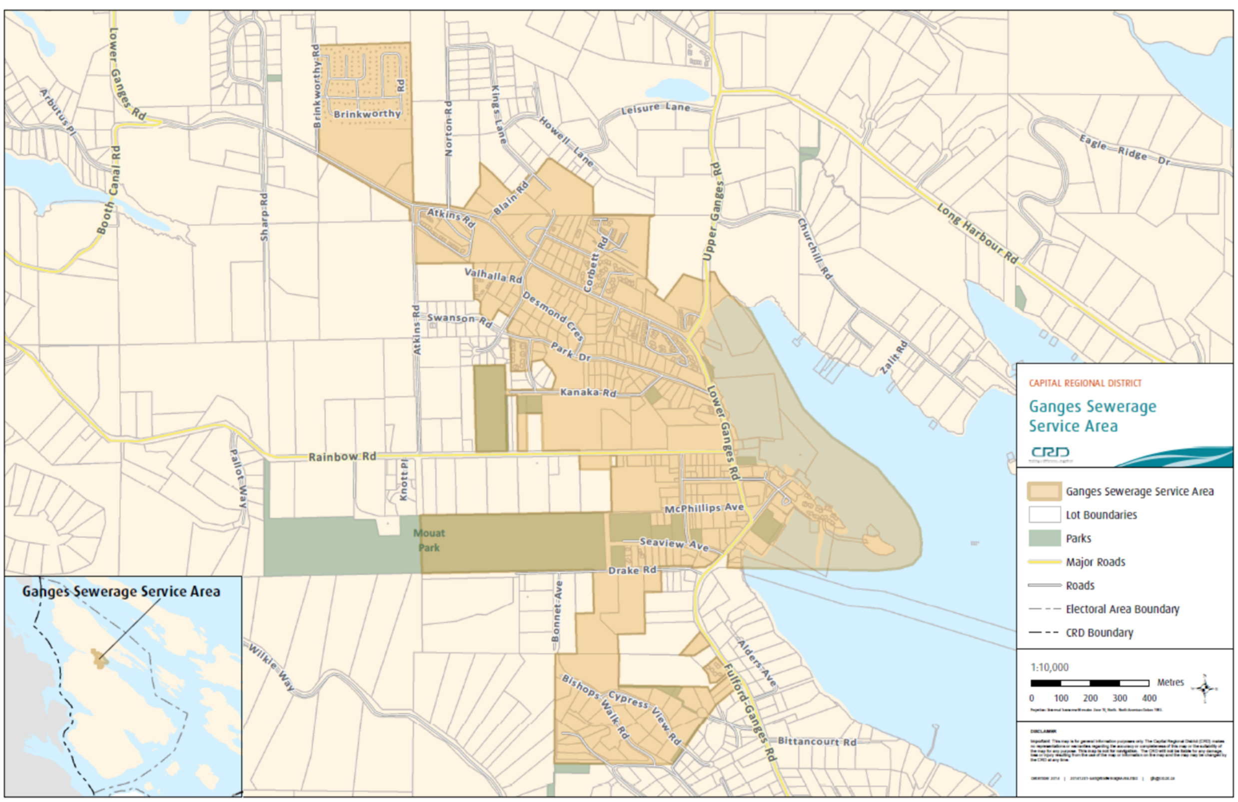


Figure 1: Ganges Sewer Service Area

The majority of the sewer system was built over a period between 1982 and 1988. Collecting and treating sewage began in 1985. Since 1998 there have been significant upgrades to the wastewater treatment plant.

The wastewater system consists of:

- 8,000 m of 150 mm to 250 mm gravity sewer collection main pipes and manholes
- 140 m of 75 mm pressure main pipe
- 2 collection system pump stations
- 5,200 m of 200 mm polyvinyl chloride (PVC) and polyethylene (PE) outfall pipe
- 1,090 m3/day Membrane Bioreactor (MBR) secondary wastewater treatment plant

The system discharges treated effluent into the Ganges Harbour in Swanson Channel under the authorization of the *Municipal Wastewater Regulation (MWR)*.

SEWER SYSTEM

Ganges Sewer Regulatory Compliance – Wastewater

The Ganges wastewater treatment plant is regulated by both the provincial and federal governments based on flow and monthly effluent quality limits for parameters including total suspended solids (TSS), fecal coliforms (FC), carbonaceous biochemical oxygen demand (CBOD), and un-ionized ammonia. Daily effluent flows were below the allowable maximum throughout the year. However, there were four effluent quality exceedances including one month when TSS exceeded the limit (August) and three months when FC exceeded the limit (May, July, August). All remaining samples met provincial and federal regulatory requirements. Operations staff endeavor to operate the system in full compliance; all non-compliance events are investigated and operational parameters are adjusted as required.

Wastewater influent and effluent were also analyzed for a list of conventional and priority substances to assess treatment system performance, and risk to human health and the environment. In 2025, of the 200 priority substances analyzed, 83 were detected at standard detection limits in effluent. Substances detected in 2025 included conventionals, nutrients, metals, total phenols, and trichloromethane. These parameters have been detected at similar concentrations in previous years.

As in previous years, all but three priority substances in the effluent were below the *BC Water Quality Guidelines* (*BC WQG*) before application of the predicted minimum near surface initial environmental dilution of 419:1. Only cyanide WAD, copper, and zinc exceeded *BC WQG* in undiluted effluent. These substances, and all others, were well below the *BC WQG* after the minimum initial dilution factor was applied. Minimum near-surface dilution represents the predicted concentration of effluent in the marine water column at a distance of 100 m away from the outfall. Overall, the results indicate that the treatment system is performing well, and that risk to human health and the environment is low.

Toxicity Testing

Effluent was also tested for acute toxicity to assess risk to organisms living around the outfall. The effluent sample from July was toxic to fish during the 96-hour Rainbow trout acute toxicity test. The test was rerun using the ammonia stabilized method and passed, demonstrating that the failure was due to ammonia accumulation. The stabilized method will be used going forward. The sample also passed the 48-hour Daphnia acute toxicity test with 100% survival, consistent with 2011-2024.

Sludge (Mixed Liquor)

Ganges Harbour WWTP sludge (mixed liquor) is monitored to inform the CRD Regional Source Control Program (RSCP). All 2025 monthly sample results met the criteria for BC Organic Matter Recycling Regulations (OMRR) Class A Biosolids.

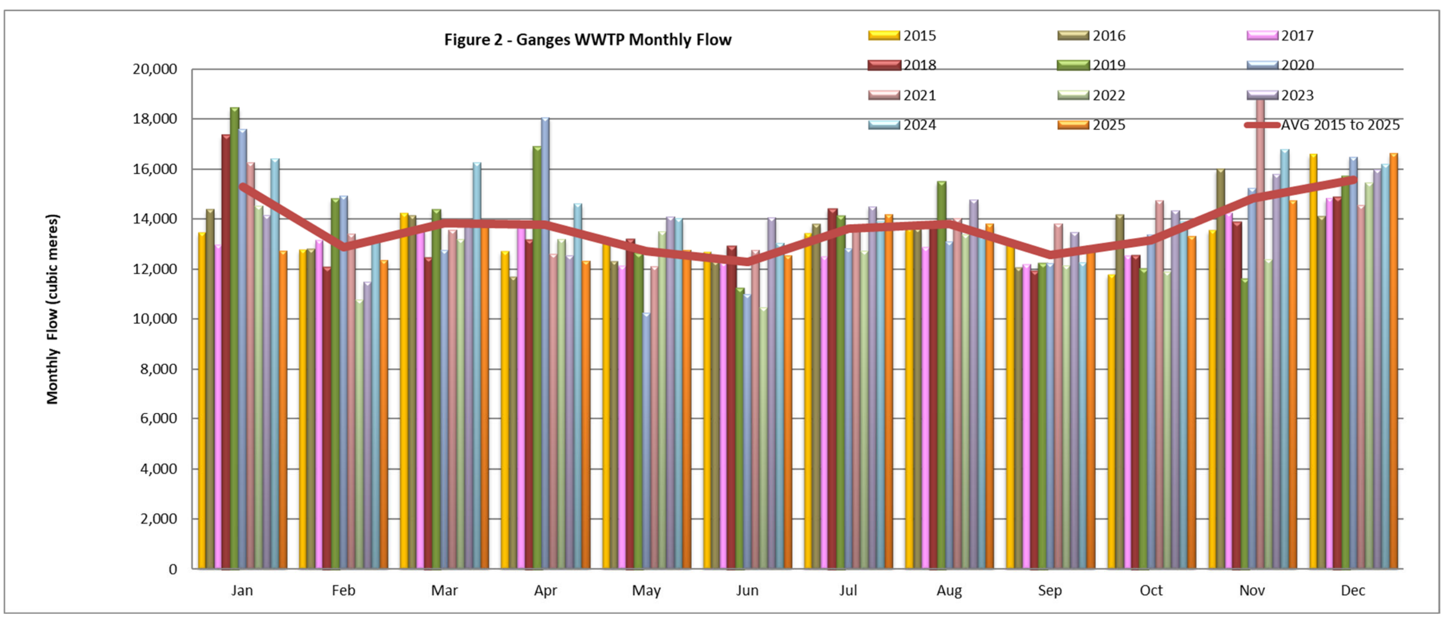
Receiving Water

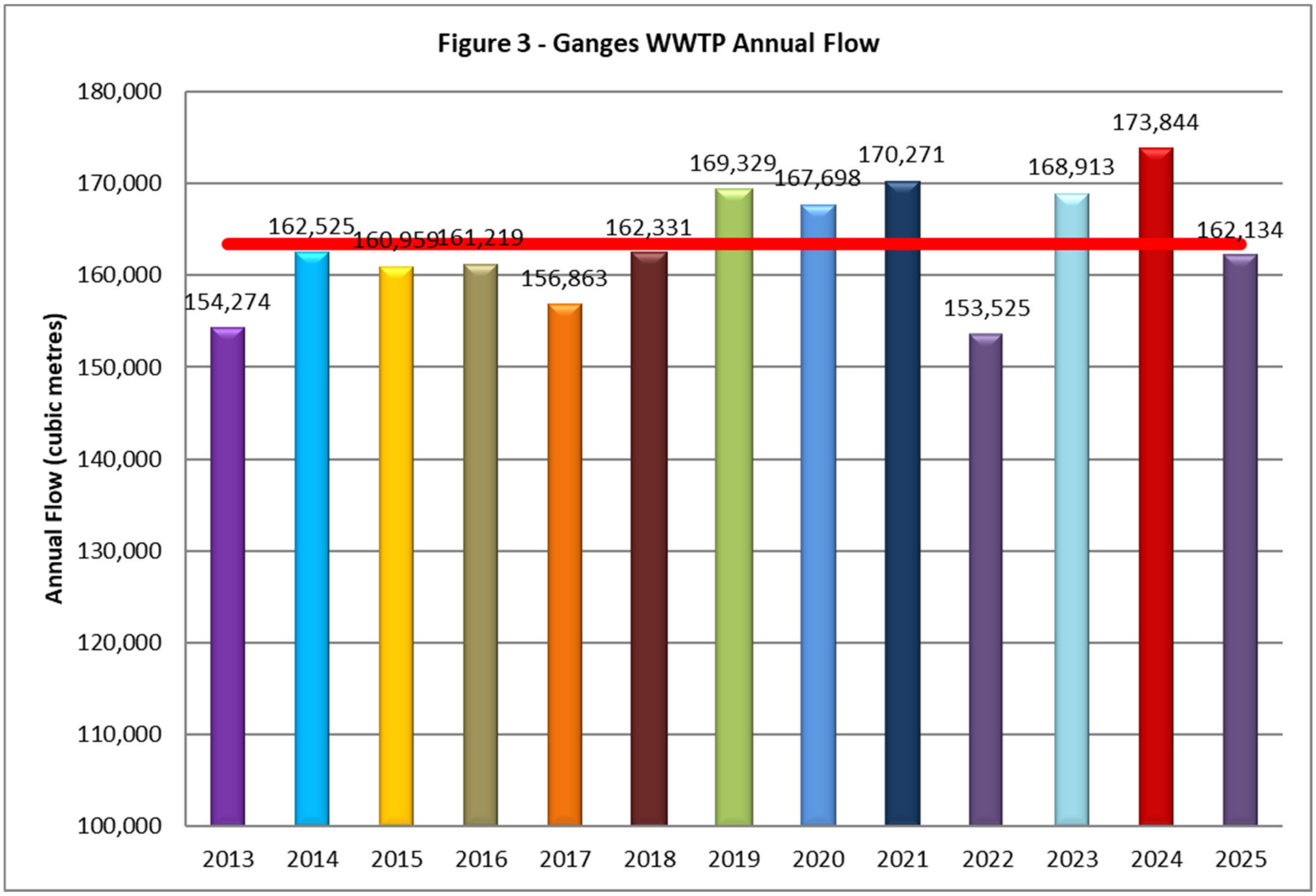
Routine receiving water monitoring sampling involves collecting 5 samples in a 30-day period for comparison to provincial guidelines set to protect people who are recreating in the vicinity of the marine outfall. Monitoring was not required in 2025 at Ganges WWTP and is scheduled next in 2028 unless there are planned bypasses, plant failures/overflows, or wet weather overflows that exceed 3 days duration in the winter or 1-day duration in the summer. There was no emergency/non-routine sampling required in 2025.

Annual Flow

The monthly flows and the total annual flow over the past 10 years are shown in Figures 2 and 3 below. The graphs indicate that the 2025 wastewater flows were about 1% lower than the 10-year average. The monthly flows show seasonal variations due to peak tourist times (in the summer) and inflow and infiltration (in the winter), but generally, the average monthly flow is fairly stable, and inflow and infiltration appear to be reasonable.

The *MWR* contains requirements for the treatment, reuse and discharge of municipal wastewater effluent. The regulation includes a requirement that sewer flows reaching treatment plants should not exceed 2.0 times the "average dry weather flow" during storm events with less than a 5-year return period. Based on the measured flow rates, the Ganges sewer system meets that requirement.





OPERATIONAL HIGHLIGHTS

The following is a summary of the major operational issues that were addressed during the 2025 operating period:

- Wastewater Treatment Plant
  - Permeate pump 1 oil seal replacement due to failure
  - Permeate pump 2 variable drive replacement due to failure
  - Permeate pump cable replacement due to ground fault failure
  - Blower motor replacement due to failure
  - Reuse service water pump replacement due to failure
  - Blower 87 motor coupling replacement
  - Replaced several MBR cassette aeration skirts due to failure

- Wastewater Collection System
  - Drake Road sewer backup operational response
  - Rebuild Harbour House Lift Station pump 2 due to failure
  - Manson Lift Station PLC reprogramming following power failure
  - 320 Lower Ganges Road lateral blockage. Dug and repaired service connection.

- Compliance data is reported to provincial regulators monthly, with individual environmental incident reports (EIR) issued if there was an incident at the plant that requires an emergency response. There were 4 EIR's issued for Ganges in 2025.
  - 4 x Effluent Quality Exceedances
    - Fecal Coliform - May
    - Toxicity – July
    - Fecal Coliform - July
    - Fecal/TSS - August

CAPITAL IMPROVEMENTS

The following are capital projects in progress or completed in 2025:

21-03 VFD Installation for EQ Tanks
Procurement and installation of Variable Frequency Drive (VFD) motors for the EQ tank pumps to improve process control and performance.

21-06 Aeration System – Ganges WWTP
Design of a new aeration system to improve process performance for the Ganges WWTP. The final design was received and the project was closed.

21-02 Reclaimed Water Study
Study to determine the feasibility of reclaiming water from the effluent discharged from the Ganges WWTP.

24-04 Network Modelling
Study to model sewer conveyance system to determine present and future capacity and areas needing upgrading; 75% funded through the Growing Communities Fund. The report was received. We continue to work with the contractor for capacity items.

24-05 Ganges WWTP Performance Improvement Study
Study to perform overview of WWTP for process improvement; 75% funded through the Growing Communities Fund. Report with recommendations received, project completed and closed.

24-02 Sludge thickener membrane replacement
Membranes in sludge thickener unit need periodic replacement. Will be replaced when degraded.

23-01 Generator Trailer
Portable generator trailer for emergency power for pump stations. The generator has been received and tested. The project is completed and will be closed.

24-03 Ganges WWTP E&IC Replacement Design and Installation
Project to design and install replacements and upgrades of failing and outdated Electrical & Instrumentation, Controls (E&IC) equipment; 75% funded through the Growing Communities Fund.

25-03 Ganges Pump Stations Fall Protection
The installation of fall protection for access to Manson and Harbour House pump stations. Fall protection has been installed and the project is closed.

22-01 Electoral Assent for Borrowing
This project will support public engagement and the loan authorization process for projects requiring debt funding.

The Capital Projects Financial Summary for 2025 can be found in Appendix A.

Upcoming Projects in 2026 include:

- 25-02 Design of 100% surcharged lines
- 21-04 The design/construction and temporary procurement of chemical storage, lab room, central facility
- 26-04 Replacement of the Ultra-filtration (UF) membranes
- 26-05 The installation of grates and safety rails required by OH&S

2025 FINANCIAL REPORT

Please refer to the attached 2025 Statement of Operations and Reserve Balances.

Revenue includes parcel taxes (Transfers from Government), fixed user fees (User Charges), interest on savings (Interest earnings), transfers from the Operating Reserve Fund, and miscellaneous revenue such as late payment charges (Other revenue).

Expenses include all costs of providing the service. General Government Services include budget preparation, financial management, utility billing and risk management services. CRD Labour and Operating Costs include CRD staff time as well as the costs of equipment, tools, and vehicles. Debt servicing costs are interest and principal payments on long-term debt. Other Expenses include all other costs to administer and operate the sewer system, including insurance, waste sludge disposal, and electricity.

The difference between Revenue and Expenses is reported as Net revenue (expenses). Any transfers to or from capital or reserve funds for the service (Transfers to own funds) are deducted from this amount, and it is then added to any surplus or deficit carried forward from the prior year, yielding an Accumulated Surplus (or deficit). In alignment with *Local Government Act* Section 374 (11), any deficit must be carried forward and included in next year's financial plan.

WASTEWATER SYSTEM PROBLEMS – WHO TO CALL:

To report any event or to leave a message regarding the Ganges Wastewater System, call either:

CRD wastewater system *emergency call* centre:	**1-855-822-4426 (toll-free)** **1-250-474-9630 (toll)**
CRD wastewater system *general enquiries* (toll-free):	**1-800-663-4425**

When phoning about an emergency, please specify to the operator the service area in which the emergency has occurred.

Submitted by:	Dan Ovington, BBA , Senior Manager, Salt Spring Island Electoral Area
Concurrence:	Jason Dales, B.Sc, WD IV, Senior Manager, Infrastructure Operations
Concurrence:	Glenn Harris, Ph.D., R.P.Bio., Senior Manager, Environmental Protection
Concurrence:	Varinia Somosan, CPA, CGA, Sr. Mgr., Financial Services / Deputy CFO
Concurrence:	Stephen Henderson, MBA, P.G.Dip.Eng, BSc, General Manager, Electoral Area Services
Concurrence:	Ted Robbins, B. Sc., C. Tech., Chief Administrative Officer

Appendix A: 2025 Capital Projects List – Financial Summary
Appendix B: 2025 Statement of Operations and Reserve Balances

For questions related to this Annual Report please email saltspring@crd.bc.ca

3.810 - Ganges Sewer (SSI)

Capital Projects - Financial summary
Updated @ 31/12/2025

Year	Project#	Capital Plan#	Status	Capital Project Description	Total Project Budget	Spending		Funding Sources			Total Funding in Place
						Expenditure Actuals	Remaining Spending	CRF	CWF	GCF	
2022	CE.800.8301	21-03	Open	VFD Installation for EQ Tank	50,000	25	49,975	50,000			50,000
2022	CE.798.8301	21-06	Closed	Aeration System - Ganges WWTP	144,248	139,029	5,219	144,248			144,248
2022	CE.801.8001	21-02	Open	Reclaimed Water Study	57,500	1,345	56,155	57,500			57,500
2024	CE.857.7501	24-04	Open	Network Modeling Ganges WW 24-04	57,500	53,164	4,336	14,375		43,125	57,500
2024	CE.857.4501	24-05	Closed	Ganges WWTP Performance Improvement Study	115,000	112,245	2,755	28,750		86,250	115,000
2024	CE.755.1602	24-02	Open	Sludge tickener membrane replacement	27,000	162	26,838	27,000			27,000
2024	CE.755.1604	23-01	Open	Generator Trailer	82,000	81,965	35		82,000		82,000
2024	CE.857.8301	24-03	Open	Ganges WWTP E&I Replacement Design & Installation	575,000	220,504	354,496	143,750		431,250	575,000
2025	CE.755.8101	25-03	Closed	Ganges Pump stations Fall Protection	20,000	15,373	4,628	20,000			20,000
2025	CE.755.4501	22-01	Open	Electoral Assent for Borrowing	50,000	-	50,000	50,000			50,000
				Totals	**1,178,248**	**623,813**	**554,437**	**535,623**	**82,000**	**560,625**	**1,178,248**

CRF *Capital Reserve Fund*
CWF *Community Works Fund*
GCF *Growing Community Fund*

CAPITAL REGIONAL DISTRICT

GANGES SEWER
Statement of Operations (Unaudited)
For the Year Ended December 31, 2025

		2025	2024
Revenue			
Transfers from government		64,000	62,134
User Charges		1,229,569	1,120,290
Other revenue from own sources:			
Interest earnings		1,803	547
Transfer from Operating Reserve		-	80,000
Other revenue		3,272	2,556
Total Revenue		1,298,644	1,265,527
Expenses			
General government services		44,644	40,993
Contract for Services		69,331	61,492
CRD Labour and Operating costs		466,453	457,287
Debt Servicing Costs		247,189	247,359
Capital purchases		-	42,378
Supplies		17,351	41,197
Other expenses		372,921	346,599
Total Expenses		1,217,889	1,237,305
Net revenue (expenses)		80,755	28,222
Transfers to own funds:			
Capital Reserve Fund		27,755	8,222
Operating Reserve Fund		3,000	20,000
Equipment Replacement Fund		50,000	-
Annual surplus/(deficit)		-	-
Accumulated surplus/(deficit), beginning of year		-	-
Accumulated surplus/(deficit), end of year	$	-	-

CAPITAL REGIONAL DISTRICT

GANGES SEWER
Statement of Reserve Balances (Unaudited)
For the Year Ended December 31, 2025

	Capital Reserves	
	2025	**2024**
Beginning Balance	389,302	571,220
Transfer from Operating Budget	27,755	8,222
Transfer from Completed Capital Projects	12,601	7,517
Transfer to Capital Project	(84,248)	(234,375)
Expansion charges	86,164	14,989
Interest Income	15,021	21,729
Ending Balance	446,595	389,302

	Operating Reserve	
	2025	**2024**
Beginning Balance	3,275	60,660
Transfer from Operating Budget	3,000	20,000
Transfer to Operating Budget	-	(80,000)
Interest Income	304	2,615
Ending Balance	6,579	3,275

	Equipment Replacement Fund	
	2025	**2024**
Beginning Balance	152,035	151,214
Transfer from Operating Budget	50,000	-
Purchases from ERF	-	-
Interest Income	1,342	821
Ending Balance	203,377	152,035

Making a difference...together

REPORT TO GANGES LOCAL SEWER SERVICE COMMISSION
MEETING OF THURSDAY, JUNE 4, 2026

SUBJECT **Ganges Sewer Inclusion Request Fulford-Ganges across from Drake**

ISSUE SUMMARY

The purpose of this report is to consider including the proposed Lot 1, 2 and 231 Fulford-Ganges Road in the Ganges Sewer Local Service Area and to make a recommendation in that regard.

BACKGROUND

The Ganges Sewer Service provides wastewater collection and treatment for residential and commercial properties within the Ganges Sewer Service Area. The Service Area is defined by Bylaw 1923 and doesn't currently include Lot 1, 2 and 231 Fulford-Ganges Road.

Capacity restrictions originate from the effluent permit, wastewater treatment plant (WWTP) equipment, and from the collection system. The current effluent permit is for 1090 m^3/day. The nameplate capacity for the WWTP is nominally 1040 m^3/day. The capacity of the system was analyzed in 2025 for current conditions and buildout estimates. The report by GeoAdvice is attached in Appendix A.

A proposed residential development on the combined properties of Lot 1, 2 and 231 Fulford-Ganges Road is in early stage of design and permitting. The proponents of the development request inclusion of the three lots into the Ganges Sewer Service. The request for inclusion is attached as Appendix B.

The proposed design is phased, with phase 1 including 90 residential units and phase 2 is up to an additional 90 residential units for a total of 180 residential units. This proposal contains calculations for phase 1, 90 units. The estimated contribution to the sanitary flow is 254 m^3/day or 2.94 L/s. The design brief received from the proponent's engineer is attached as Appendix C. The proponent will be required to show modelling to support existing capacity of the collection system.

ALTERNATIVES

Alternative 1
The Ganges Sewer Service Commission recommends that Lot 1, 2 and 231 Fulford-Ganges Road be granted permission to proceed with an application to be included in the Ganges Sewer Local Service Area.

Alternative 2
The Ganges Sewer Service Commission recommends to the Capital Regional District Board that Lot 1, 2 and 231 Fulford-Ganges Road be denied permission to proceed with an application to be included in the Ganges Sewer Local Service Area.

Alternative 3
That this report be referred back to staff for additional information.

IMPLICATIONS

Alignment with Existing Plans & Strategies
The CRD Local Community Commission (LCC) are implementing the SSI Integrated Housing Strategy Action Plan. This housing may meet goals associated with the strategy for affordability and density near Ganges.

Climate Implications
Densification of housing near Ganges and on public transit routes may reduce greenhouse gas emissions from transportation.

Financial Implications
The proponent is responsible for covering costs due to the application process. The application fee has been received, $2,100. If the development proceeds, the connection will be contracted by the developer and those costs covered. The capacity purchase bylaw, 3262, provides for the payment of $2,474 per unit of residential multi-family. The total fee would be $222,660.

First Nations Implications
No ground disturbances by CRD staff are expected for this process. The sewer main is in place and the proponent is responsible for the service connection.

Service Delivery Implications
The proponent will be required to provide the connection design as well as proof of capacity through modelling for the design. The modelling will show if capacity in the collection system and the WWTP currently exists. The additional flow will be added into the existing model.

CONCLUSION

The inclusion of Lot 1, 2 and 231 Fulford-Ganges Road into the Ganges Sewer Service could advance housing development near central Ganges. There is build out capacity reported that likely supports the size of development proposed. The existing sewer main spans the frontage of the lots. If included in the service, connection capacity is not guaranteed but further review of the detail design can be progressed when received.

RECOMMENDATION

The Ganges Sewer Commission recommends that Lot 1, 2 and 231 Fulford-Ganges Road be granted permission to proceed with an application to be included in the Ganges Sewer Local Service Area.

Submitted by:	Carolyn Hopp, P.Eng., Manager Engineering, Salt Spring Island
Concurrence:	Dan Ovington, BBA, Senior Manager, Salt Spring Island Administration
Concurrence:	Stephen Henderson, MBA, P.G.Dip.Eng, BSc, General Manager, Electoral Area Services

ATTACHMENTS

Appendix A: Report - Ganges Sewer Service Area Modelling, Model Update, Calibration, and Capacity Analysis, Ganges, BC
Appendix B: Inclusion Request Letter- Dated Oct. 17, 2025
Appendix C: Design Brief

Ganges Sewer Service Area Modelling
Model Update, Calibration, and Capacity Analysis
Ganges, BC

Report
FINAL

Prepared for:
Capital Regional District
108 – 121 McPhillips Avenue
Salt Spring Island, BC V8K 2T6

Prepared by:
GeoAdvice Engineering Inc.
Unit 203, 2502 St. Johns Street
Port Moody, BC V3H 2B4

Submission Date: January 27, 2025
Contact: Dr. Werner de Schaetzen, Ph.D., P.Eng.
Project ID: 2024-057-CRD

Document History and Version Control

Revision No.	Date	Document Description	Revised By	Reviewed By
R0	January 10, 2025	Draft	Sean Zoschke	Werner de Schaetzen
R1	January 27, 2025	Final	Sean Zoschke	Werner de Schaetzen

Statement of Qualifications and Limitations

This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty expressed or implied is made.

Table of Contents

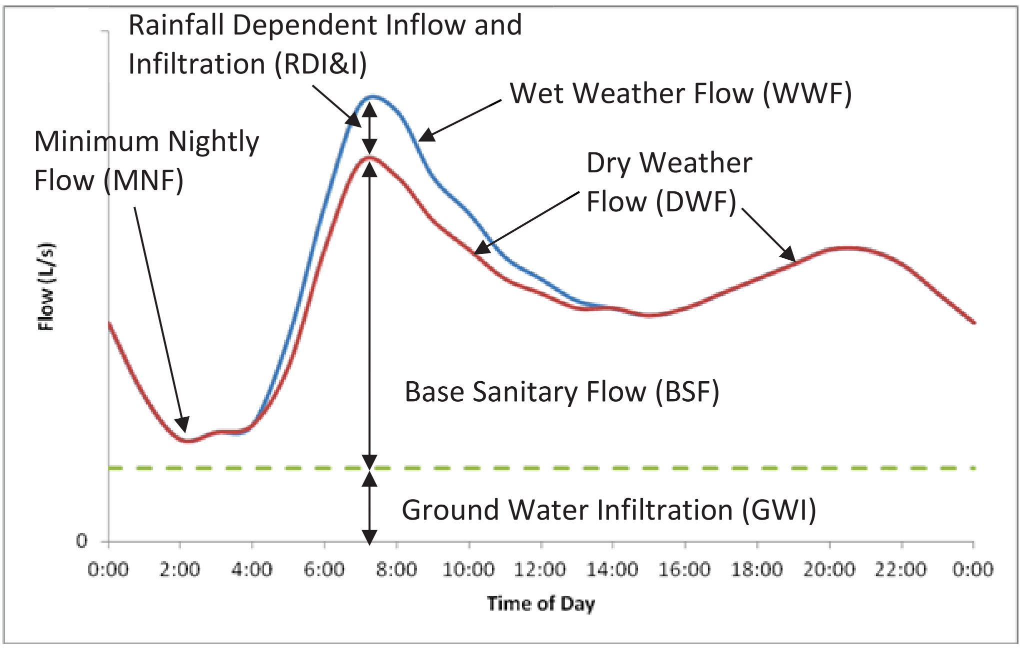
Definitions

Daily flow conveyed in a sanitary sewer system can be generally divided into six (6) components:

1. Ground Water Infiltration (GWI)
2. Base Sanitary Flow (BSF)
3. Dry Weather Flow (DWF)
4. Rainfall Dependent Inflow and Infiltration (RDI&I)
5. Wet Weather Flow (WWF)
6. Minimum Nightly Flow (MNF)

Their relationship is shown in **Figure 1**.

Figure 1: Flow Components Hydrograph



Ground Water Infiltration (GWI) – Ground water infiltration results from the movement of ground water in the saturated zone into the sewer system through defects in the components of the sewer system located below the water table.

Base Sanitary Flow (BSF) – All wastewater from residential, commercial, institutional, and industrial sources that the sanitary sewer system is intended to convey.

Dry Weather Flow (DWF) – The portion of the total flow that is composed of BSF and GWI. DWF = GWI + BSF.

Average Dry Weather Flow (ADWF) – The value of the diurnally varying Dry Weather Flow, averaged over a 24-hour period.

Rainfall Dependent I&I (RDI&I) – Rainfall dependent inflow and infiltration equals rainfall-induced infiltration plus all sources of inflow.

Wet Weather Flow (WWF) – All flow contributions carried by the sanitary sewer system during wet weather. WWF = GWI + BSF + RDI&I.

Peak Wet Weather Flow (PWWF) – All flow contributions carried by the sanitary sewer system during peak wet weather.

Minimum Nightly Flow (MNF) – The lowest flow rate observed within the sanitary sewer system during the night hours, typically occurring during periods of minimal water usage.

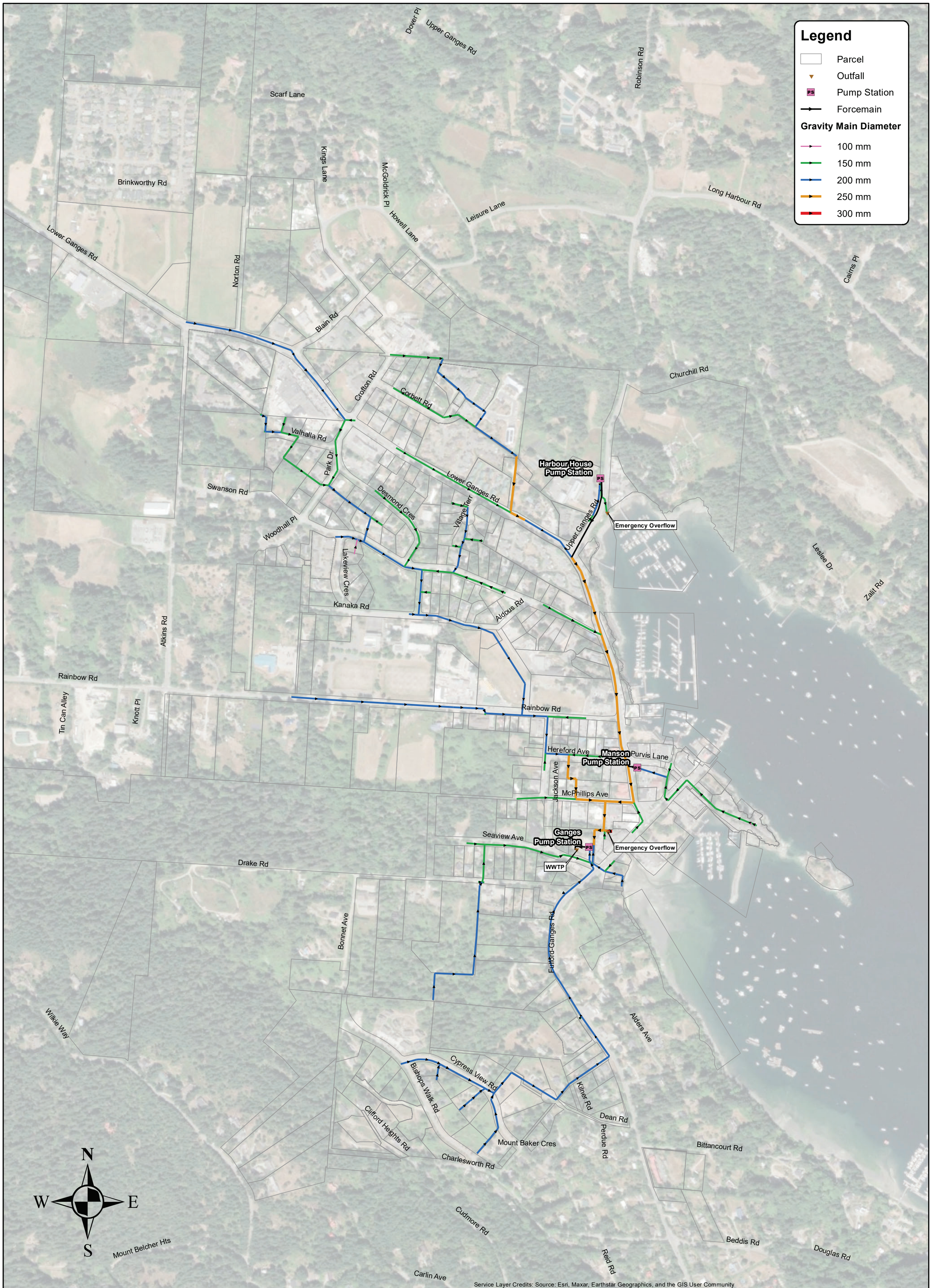
1 Introduction

GeoAdvice Engineering Inc. (GeoAdvice) was retained by the Capital Regional District, BC (CRD) to complete the Ganges Sewer Service Area Modelling, which involved updating and calibrating the Ganges sewer hydraulic model and conducting a sewer system capacity analysis. This report summarizes the sewer model development, including the methodology and assumptions used to update and calibrate the Ganges sewer model. In addition, this report describes the methodology, assumptions and results of the future scenario development, hydraulic capacity analysis, and system improvement recommendations.

The sewer model was developed using the InfoSWMM software program (Innovyze/Autodesk). InfoSWMM is a sanitary sewer system modeling and management software application.

In the preparation of this report, GeoAdvice would like to acknowledge the support of the following CRD and Islands Trust Staff:
- Doug Weihing (CRD)
- Dean Olafson, P.Eng., MBA (CRD)
- Chris Buchan (Islands Trust)
- Chris Hutton, MPA, MCIP, RPP (Islands Trust)

The Ganges sewer system is shown in **Figure 1.1** on the following page.



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Project: Ganges Sewer Service Area Modelling
Project ID: 2024-057-CRD
Client: Capital Regional District
Date: January 2025
Created by: SZ
Reviewed by: WdS

GeoAdvice Engineering Inc.

Ganges Sewer System

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0 0.1 0.2 0.4
Kilometers

Figure 1.1

2 Model Update

The hydraulic model update was divided into multiple tasks as follows:

- Task 1: Data Collection and Review
- Task 2: GIS Model Update
- Task 3: Data Gaps and Connectivity Analysis
- Task 4: Node Elevation Extraction
- Task 5: Primary System Components
- Task 6: Existing Base Sanitary Flow (BSF) Calculation and Allocation
- Task 7: Future Base Sanitary Flow (BSF) Calculation and Allocation
- Task 8: Field Data Review and Analysis
- Task 9: Inflow & Infiltration Allocation

Table 2.1 summarizes the main components of the sanitary sewer collection system model.

Table 2.1: Model Statistics of Current System

Component	Total
Manholes	203
Gravity Mains	9.4 km
Forcemains	0.2 km
Pump Stations	3
Area	99.2 ha

2.1 Data Collection and Review

Prior to building the model, information on the Ganges sewer system was compiled, collected and reviewed. This included reviewing the following pertinent information:

- Previous InfoSWMM hydraulic model
- GIS database
- As-built drawings
- Wastewater Treatment Plant influent flow data
- BOT Corp flow monitoring and rainfall data
- Open data rainfall and intensity-duration-frequency (IDF) curves
- Ganges water billing consumption data
- DEM elevation data
- Pump station operations
- Background reports
- Land-use and zoning maps
- Growth projection data

2.2 GIS Model Update

The CRD GIS data, as-built drawings, and previous InfoSWMM model were the key sources of information on the Ganges system to update the pipe and node network topology model. Attributes of the sewer mains such as nominal diameter, inlet and outlet invert elevations, depth, grade, material, age, status, were extracted from both the GIS database, as-built drawings and previous InfoSWMM model. Minor updates were made to the model pipe network to align it with the current GIS. Pump station dimensions, settings, and pump curves were updated to match the provided specifications. The coordinate system used in the model is UTM NAD 83 Zone 10.

2.3 Data Gaps and Connectivity Analysis

The next task involved reviewing the GIS sewer data, identifying data gaps (e.g. missing diameter) and checking system connectivity (e.g. orphan pipe). As much as possible, a one-to-one relationship between the model and GIS data was maintained to facilitate future model updates.

2.4 Node Elevation Extraction

The collected DEM elevation data was used to validate ground elevations in the model and to determine missing ground elevations.

2.5 Primary System Components

The hydraulic modeling data for all the primary system components are summarized in a series of tables provided in **Appendix A**. CRD operates and maintains three (3) pump stations throughout the sanitary network.

2.6 Existing Base Sanitary Flow Calculation and Allocation

The existing sewer base sanitary flow (BSF) was calculated using the 2023 average water demand for each sewer-serviced parcel from the water billing data, and water-sewer conversion factors determined during calibration. Different conversion factors were applied for Industrial, Commercial, and Institutional (ICI) and residential land uses for each of the three calibration catchments to achieve a good match with the field data at each location. There was a large variance in conversion factors between catchments, and in some cases a higher BSF than water demand was required to achieve a good match. This is likely due to differences between the 2023 average water demand and water demand during sewer flow monitoring, or error in the water billing data or sewer flow data. The scaling of water demand to match dry weather flow data for each catchment is the best way to allocate BSF as it allows for a match with the field sewer flow data while maintaining the distribution of water demands within each catchment. **Table 2.2** summarizes the existing BSF loading for residential and ICI land uses.

Table 2.2: Calibrated Existing BSF Load Summary

Land Use	Base Sanitary Flow (L/s)
Residential	2.15
ICI	0.47
Total	**2.62**

Based on the estimated sewer-serviced residential population from *Ganges Sewage System – Condition Assessment and Engineering Study* (Stantec, November 2011) of 1,524 capita (based on 508 residential units and 3 capita/unit), the calibrated residential BSF rate is approximately 122 L/capita/day, which is within the normal range of BSF rates for small municipalities in BC.

2.7 Build-Out Base Sanitary Flow Calculation and Allocation

Future growth data was provided by Islands Trust and included potential maximum densities for parcels expected to have future high-density development in the Ganges Village Area based on OCP land use designations. These maximum potential densities were used to develop build-out scenario loads. Some of the Ganges Village Area growth parcels provided by Islands Trust are outside of the sanitary sewer service area; however, these parcels were included in the future scenario to be conservative. Lastly, loads for two parcels identified by the CRD as known areas of potential future institutional growth not accounted for in the Islands Trust data were also included in the build-out scenario.

Table 2.3 summarizes the assumed rates used to calculate the future sanitary sewer loads.

Table 2.3: Sewer Design Rates

Load Type	Design Rate
Residential Density	2.5 capita/unit*
Institutional Density	50 capita/ha**
Base Sanitary Flow (BSF)	240 L/cap/day**
Inflow and Infiltration (I&I)	11,200 L/ha/day**

***Based on *Ganges Sanitary System – InfoSWMM Model Creation (Stantec, May 2018)*.**
****Based on 2022 MMCD Design Guidelines.**

The residential and institutional density rates were used to convert the Islands Trust residential densities and CRD institutional parcel areas to equivalent populations. The MMCD design BSF rate of 240 L/cap/day was then applied to these equivalent populations to calculate the future BSF for each of the growth parcels. The maximum of the existing BSF and future BSF for each parcel was used in the build-out scenario. In addition, I&I loads were added for future expansion parcels that are not currently serviced (parcels that have a future BSF load and not an existing

BSF load) using the MMCD design I&I rate of 11,200 L/ha/day. This is less than the calibrated existing 5-year I&I rate of 49,000 L/ha/day which is discussed in **Section 2.9.2**; however, it is standard practice to apply the MMCD design rate for new infrastructure that will have lower I&I. The future expansion parcels had a total area of 23.5 ha and added 3.05 L/s of future I&I to the system.

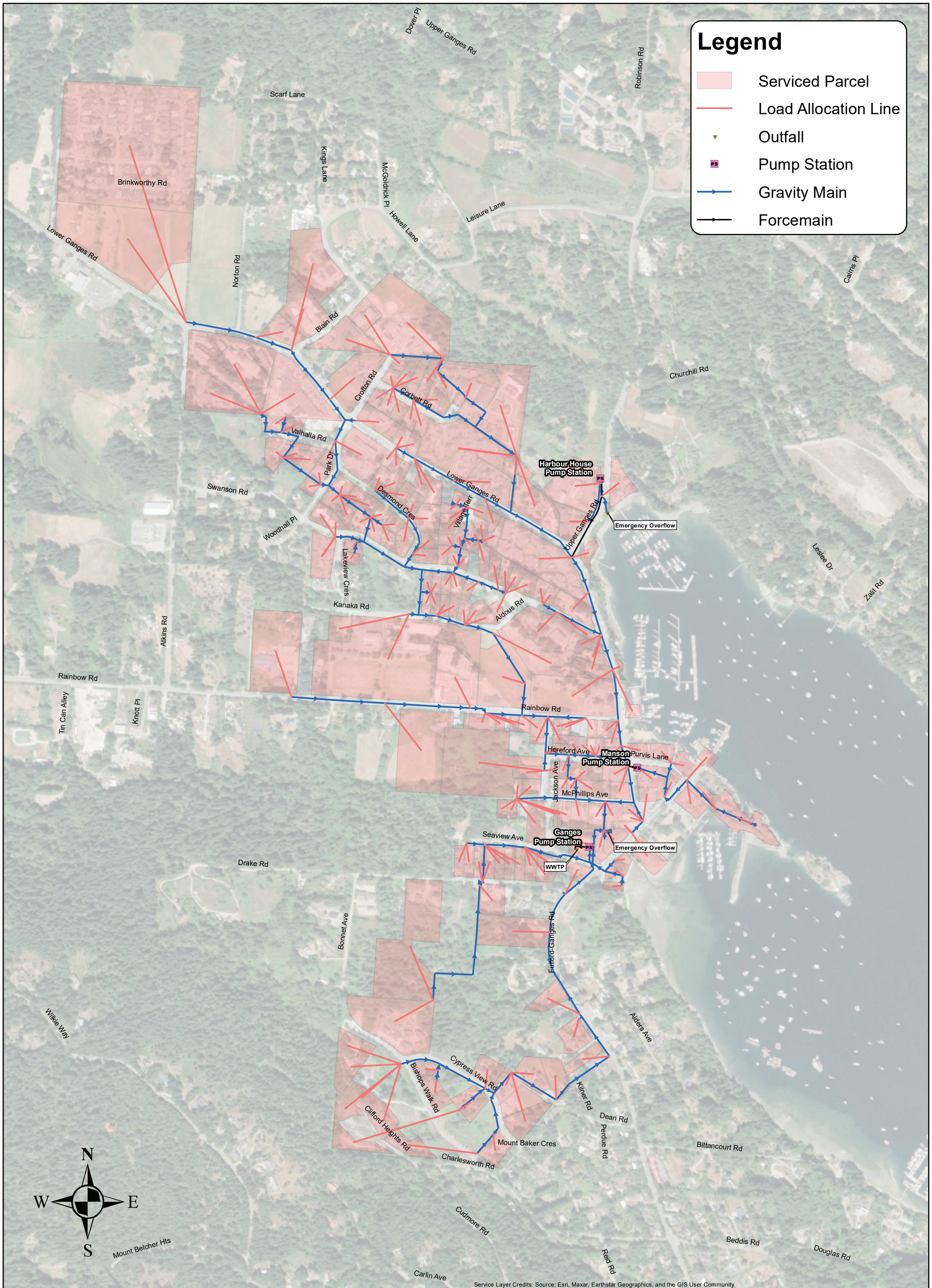
Table 2.4 summarizes the BSF loads for the model scenarios.

Table 2.4: Existing and Future BSF Load Summary

Load Type	Existing (L/s)	Build-Out Growth (L/s)
Existing Residential	2.15	2.15
Existing ICI	0.47	0.47
Growth Residential	-	9.70
Growth ICI	-	0.30
Total	**2.62**	**12.62**

The estimated existing sewer-serviced residential population is 1,524 capita, while the estimated build-out sewer-serviced residential population is 5,016 capita (assuming a population growth of 3,492 capita with a sewer BSF rate of 240 L/cap/day). A graph showing the potential time horizons for this estimated build-out population to be reached under different annual growth rates is provided in **Appendix B**.

The existing scenario load allocation is shown in **Figure 2.1**, while the future build-out scenario growth load allocation is shown **Figure 2.2**.



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Project ID: 2024-057-CRD
Client: Capital Regional District
Date: January 2025
Created by: SZ
Reviewed by: WdS

GeoADVICE
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Existing Sewer Load Allocation

Figure 2.1

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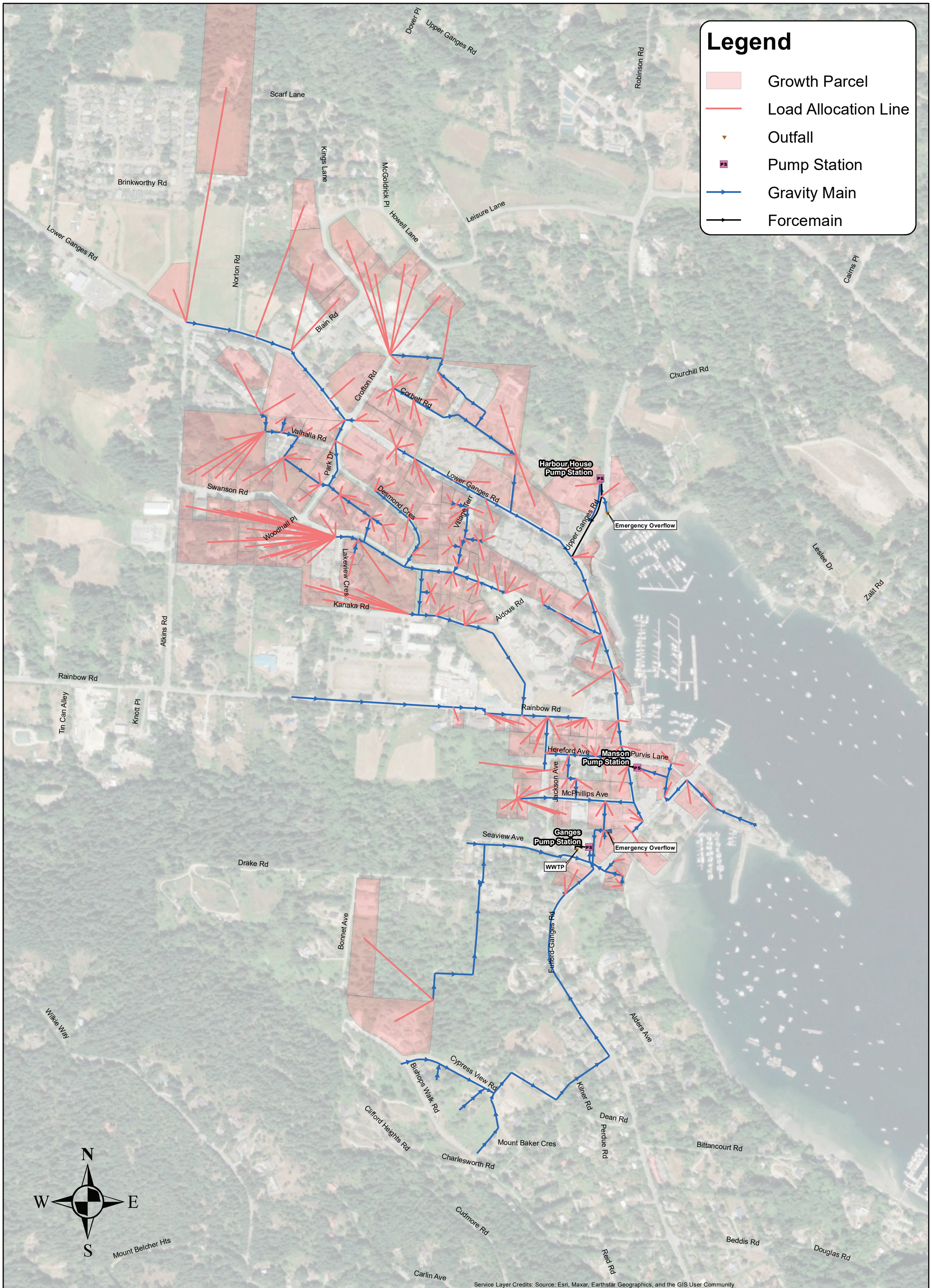

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Project ID:	2024-057-CRD
Client:	Capital Regional District
Date:	January 2025
Created by:	SZ
Reviewed by:	WdS

GeoADVICE

GeoAdvice Engineering Inc.

Build-Out Growth Sewer Load Allocation

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Kilometers

Figure 2.2

2.8 Field Data Review and Analysis

Flow data from two (2) temporary flow monitoring sites and rainfall data from one (1) temporary rain gauge site were provided by BOT Corp. Flow Site 1 was located in manhole S8055 at Rainbow Rd and Lower Ganges Rd, and flow Site 2 was located in manhole S8035 at Mc Phillips Ave west of Lower Ganges Rd, while the rain gauge was stationed at the Wastewater Treatment Plant (WWTP). Additionally, the CRD provided inflow data from the WWTP, and open-source rainfall data was obtained from a rain gauge in Fulford Harbour for analyzing WWTP inflows outside of the BOT Corp monitoring period. Together these three (3) flow sites were used for model calibration.

Representative dry field days were selected for each location for dry weather calibration. For wet weather calibration, the 2-year storm event during October 18-20, 2024 captured by the BOT Corp flow monitors and WWTP inflow monitor was compared to the 100-year storm event during November 11-18, 2021 captured by only the WWTP inflow monitor. The percentage of rainfall volume converted to I&I was significantly higher for the November 2021 event than for the October 2024 event. This is due to higher saturation conditions during the November 2021 event, often associated with extreme storms, which reduces surface storage, soil infiltration, and evaporation, leading to stormwater system overflow and a higher amount of rainfall volume entering the sanitary sewer system as I&I. Since the November 2021 event is larger and more conservative, it was used for model calibration. Although there was only flow data from the WWTP for this event, a comparison of Site 1, Site 2, and WWTP flows for the October 2024 event showed that the I&I responses are approximately the same at all sites. **Table 2.5** summarizes the average dry weather flow (ADWF) and peak wet weather flow (PWWF) at each flow monitoring site.

Table 2.5: Flow Monitor Locations and Flow Summary

Flow Monitor	Date Range	Manhole ID	Average Dry Weather Flow	Peak Wet Weather Flow
Site 1	Oct 7, 2024 to Nov 4, 2024	S8055	1.51 L/s	N/A
Site 2	Oct 7, 2024 to Nov 4, 2024	S8035	1.89 L/s	N/A
WWTP Inflow	Oct 7, 2024 to Nov 4, 2024 and Nov 1, 2021 to Nov 31, 2021	S8015	3.84 L/s	41.77 L/s

2.9 Inflow & Infiltration Allocation

Inflow and Infiltration (I&I) represent additional loading on the sanitary sewer system during dry and wet weather. They are categorized into the following:

- Ground Water Infiltration (GWI)
- Rainfall Dependent Inflow and Infiltration (RDI&I)

2.9.1 Ground Water Infiltration

Ground water infiltration loads were estimated for each flow monitoring catchment using the Stevens – Schultzbach Method. The Stevens – Schultzbach method uses a curve fitting technique to estimate ground water infiltration for a wide range of catchment sizes. This method is based on average dry weather flow (ADWF) and minimum nightly flow (MNF) experienced in typical residential flow patterns. The Stevens – Schultzbach equation is included below:

$$GWI = \frac{0.4\,MNF}{1 - 0.6\left(\frac{MNF}{ADWF}\right)^{ADWF^{0.7}}}$$

Table 2.6 summarizes the GWI allocated to each flow monitoring catchment. Total GWI loads and GWI rates were calculated at the catchment level. GWI loads were then spatially distributed to each serviced parcel based on the respective area.

Table 2.6: GWI Allocation per Flow Monitoring Catchment

Flow Monitor	MNF (L/s)	ADWF (L/s)	GWI (L/s)	Catchment Area (ha)	GWI (L/ha/day)
Site 1	0.44	1.65	0.37	24.2	**1,300**
Site 2	0.65	2.13	0.54	81.6	**600**
WWTP Inflow	1.33	4.18	1.03	99.2	**900**

The GWI rate of 900 L/ha/day at the WWTP represents the average Ganges GWI rate, since this site captures the entire system.

2.9.2 Rainfall Dependent Inflow & Infiltration

The RTK method was used to quantify the rainfall dependent inflow & infiltration for the wet weather flow calibration. Refer to **Section 3.2** for further details regarding the RTK method.

Design storms with and without climate change were created using Ganges intensity-duration-frequency (IDF) curves generated by the IDF-CC tool, and the calibrated RTK parameters were used to quantify the RDI&I in the Ganges network. I&I rates under a 5-year and a 25-year design storms with and without climate change are summarized in **Table 2.7**. As with GWI, I&I rates were calculated at the catchment level and I&I loads were then spatially distributed to each serviced parcel based on the respective area. Note that the WWTP inflow I&I rates represent the average Ganges I&I rates.

Table 2.7: I&I Allocation per Flow Monitoring Catchment (GWI + RDI&I)

Flow Monitor	Catchment Area (ha)	Without Climate Change		With Climate Change	
		I&I 5-yr (L/ha/day)	I&I 25-yr (L/ha/day)	I&I 5-yr (L/ha/day)	I&I 25-yr (L/ha/day)
Site 1	24.2	53,000	68,700	56,500	70,400
Site 2	81.6	49,200	66,400	51,700	66,700
WWTP Inflow	99.2	49,000	64,300	51,300	67,700

3 Model Calibration

Before describing how the model was calibrated, it is useful to examine why a hydraulic model may not match the field data. Most of the sources of errors or mismatches are:

- Input data errors
- System loading errors
- Operational control errors
- Poorly calibrated measuring equipment
- Outdated data

The cumulative effect of these areas of uncertainty or "approximation" is that, without verification and validation of the model's ability to recreate known conditions, it is likely that the modeling results would be grossly misleading.

The main reasons for and benefits of a well calibrated model are listed below:

- Confidence: Demonstrate the model's ability to reproduce existing conditions.
- Understanding: Confirm the understanding of the performance of the system.
- Troubleshooting: Uncover missing information and misinformation or anomalies about the system.

3.1 Dry Weather Flow Calibration Results

Modeling results were first reviewed, and then key model parameters were adjusted until the model results closely matched the dry weather flow field data. A summary of the calibration changes is shown in **Table 3.1**.

Table 3.1: Calibration Adjustments

Parameter	Description
BSF	Adjusted sanitary sewer residential and ICI loading rates (see **Table 2.2**)
GWI	Adjusted GWI rates (see **Table 2.6)**
Pattern	Calibrated diurnal patterns

Table 3.2 summarizes the dry weather flow (DWF) calibration results.

Table 3.2: Dry Weather Flow Calibration Results

Flow Monitor	Average Flow (L/s)			Peak Flow (L/s)		
	Field	Model	Difference	Field	Model	Difference
Site 1	1.51	1.56	+ 0.04	2.83	3.52	+ 0.69
Site 2	1.89	2.00	+ 0.11	3.38	4.48	+ 1.10
WWTP Inflow	3.84	3.70	+ 0.13	7.18	8.66	+ 1.49

The dry weather flow calibration hydrographs are shown in **Appendix C**.

Overall, the model predicts a good agreement with the dry weather field data. Modeled average dry weather flows are within 0.2 L/s and peak dry weather flows are within 1.5 L/s of the field data.

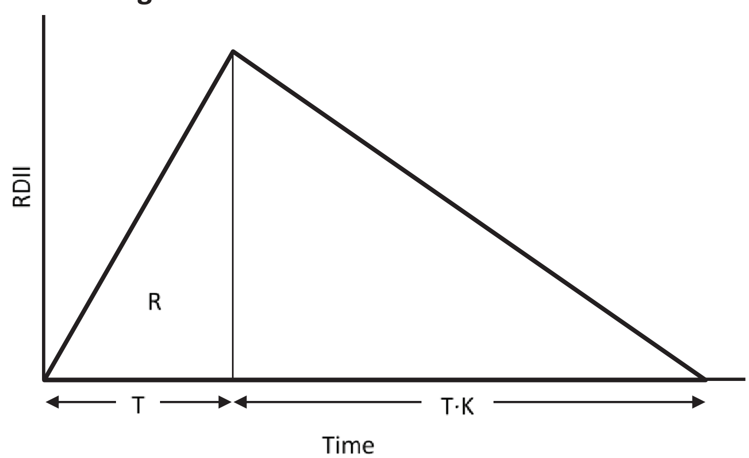
3.2 RTK Wet Weather Flow Calibration Results

The RTK method was used to quantify the rainfall dependent inflow & infiltration (RDI&I) for the wet weather flow calibration. With the RTK method, RDI&I is simulated using three triangular unit hydrographs representing fast, medium, and slow responses to rainfall. The shape of each triangle is quantified by three parameters:

R: the fraction of effective rainfall volume over the watershed that enters the sewer system.
T: the time to peak in hours.
K: the ratio of the time to recession to the time to peak.

The relationship between the R, T, and K parameters is shown in **Figure 3.1**.

Figure 3.1: RTK Method Parameters

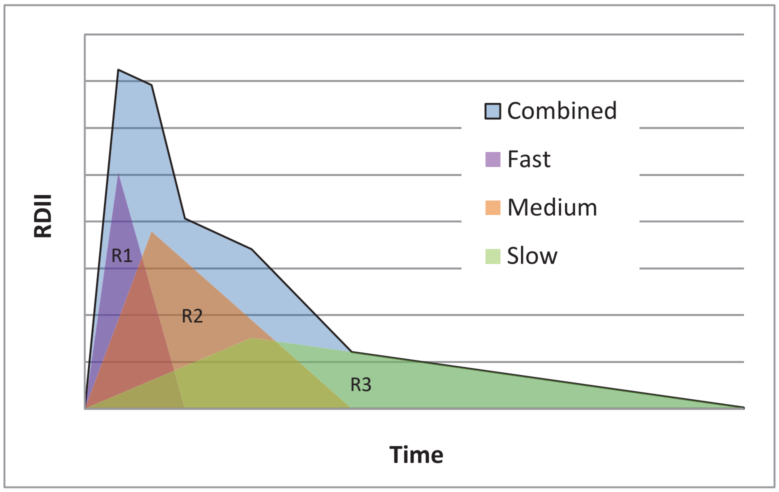


The sum of the three R-values (R1, R2, and R3) equals to the total fraction of rainfall volume over the watershed that enters the sewer system:

$$R = R1\ (\text{fast}) + R2\ (\text{medium}) + R3\ (\text{slow})$$

The total RDI&I represents the sum of the three components, as shown in **Figure 3.2**. In this figure, R1, R2, and R3 represent the areas of the fast, medium, and slow response triangles, respectively.

Figure 3.2: RTK Method for Representing RDI&I



WWTP flow from the 100-year storm event between November 11, 2021 and November 18, 2021 was used for wet weather flow calibration. This site captures the entire Ganges sewer system, so the RTK parameters determined from this data were applied to the entire system. Since Site 1 and Site 2 had no data for this event, the model was only calibrated to the WWTP flows. However, a comparison of the Site 1, Site 2, and WWTP flows for the October 2024 event showed that the I&I rates are approximately the same at all sites.

The wet weather flow calibration results for the WWTP are summarized in **Table 3.3**. Wet weather flow hydrographs comparing the model and field results can be found in **Appendix D**. The calibrated RTK parameters can be found in **Appendix E**.

Table 3.3: RTK Wet Weather Flow Calibration Results Summary (Nov 11-18, 2023)

Flow Monitor	Average Flow (L/s)			Peak Flow (L/s)		
	Field	Model	Difference	Field	Model	Difference
WWTP	14.40	13.83	- 0.57	41.77	46.46	+ 4.69

Overall, the model predicts a good agreement with the wet weather field data.

4 Sanitary Sewer Hydraulic Performance Analysis

4.1 Hydraulic Level of Service Criteria

The criteria outlined in **Table 4.1** and **Table 4.2** were used to assess the hydraulic capacity of each gravity main and to assign hydraulic level of service (HLoS) ratings. The HLoS methodology below is based on q/Q results (peak flow/full pipe flow) rather than d/D results (depth/Diameter). The q/Q methodology provides a better picture of the hydraulic condition of each gravity main and how the HLoS is impacted by downstream conditions.

Table 4.1: Gravity Main Hydraulic Level of Service Criteria Scoring

Criteria	Score
Hydraulic Capacity (q/Q)	
q/Q < 0.85	1
0.85 ≤ q/Q < 1.0	2
q/Q ≥ 1.0	3
Hydraulic Grade Line (HGL)	
HGL < Crown	1
Crown ≤ HGL < Rim Elevation	2
HGL ≥ Rim Elevation	3
Velocity (v)	
v < 0.6 m/s	Fail
v ≥ 0.6 m/s	Pass

Table 4.2: Gravity Main Hydraulic Level of Service Ratings

HLoS Rating	Capacity	HGL	Velocity	Description
A	1	1	Pass	Gravity Main performing as designed
B	1	1	Fail	Adequate capacity, low velocity indicates potential sedimentation
C	1	2 or 3	Pass or Fail*	Adequate capacity, backwater caused by downstream conditions
D	2	1, 2 or 3	Pass or Fail*	Marginal capacity, backwater caused by downstream conditions
	3	1	Pass or Fail*	
E	**3**	**2**	**Pass or Fail***	**Capacity exceeded and surcharging likely**
F	**3**	**3**	**Pass or Fail***	**Capacity exceeded and flooding likely**

***HLoS ratings from ‘C’ to ‘F’ are independent of velocity criteria.**

In general, HLoS ratings of 'A', 'B', 'C' and 'D' will not trigger an upgrade as there is capacity available in the gravity main to convey flows. Gravity mains receiving a HLoS rating of 'C' or 'D' may show surcharging or flooding on connected nodes; however, these cases would indicate that the surcharged condition is due to downstream hydraulic deficiencies.

Only gravity mains receiving a HLoS rating of 'E' and 'F' were considered for upgrade. A gravity main receiving an 'E' rating requires an upgrade as the hydraulic capacity has been exceeded and is likely causing surcharging to occur. A gravity main receiving an 'F' rating indicates that surcharging to the manhole rim is likely, increasing the priority of the upgrade.

Table 4.3 and **Table 4.4** outline the criteria used to assign hydraulic level of service ratings to each pump station.

Table 4.3: Pump Station Hydraulic Level of Service Criteria Scoring

Criteria	Score
Pump Capacity	
PWWF* ≤ Firm Capacity	Pass
PWWF* > Firm Capacity	Fail
Wet Well Capacity	
Max. Operating Level < Inlet Pipe Invert	A
Max. Operating Level ≥ Inlet Pipe Invert	B
Max. Operating Level >= Max. Physical Depth	C
Forcemain Velocity	
v < 0.9 m/s	Fail
0.9 m/s ≤ v ≤ 3.5 m/s	Pass
v > 3.5 m/s	Fail

***PWWF = Peak Wet Weather Flow.**

Table 4.4: Pump Station Hydraulic Level of Service Ratings

HLoS Rating	Pump Capacity	HGL	Velocity	Description
A	Pass	A	Pass	Pump station performing as designed
B	Pass	A	Fail	Forcemain velocity outside of design range
C	Pass	B	N/A	Inlet pipe invert within pump operating range and backup likely (submerged inlet)
D	Fail	A	N/A	Pump capacity exceeded but sufficient wet well capacity to attenuate additional flow
E	Fail	B	N/A	Pump capacity exceeded and backup likely
F	N/A	C	N/A	Wet well capacity exceeded and overflow likely

A pump station receiving a HLoS rating of ‘A’, ‘B’, or ‘C’ will not trigger an upgrade as the pump capacity is sufficient to convey the PWWF entering the station; however, HLoS ratings of ‘B’ and ‘C’ indicate operating conditions that should be reviewed by the CRD.

Pump stations receiving a HLoS rating of ‘D’, ‘E’, or ‘F’ indicate that the pump capacity has been exceeded with varying levels of surcharge risk.

4.2 Analysis Scenarios

Table 4.5 summarizes the modeling scenarios used to assess the Ganges sewer system capacity.

Table 4.5: Analysis Scenarios

Scenario	Population Used	I&I Design Storm	Purpose
EXISTING-PWWF-5	Existing population	5yr, 24 Hour No Climate Change	Identify existing system deficiencies
BUILD-OUT-PWWF-5	Existing population + build-out growth	5yr, 24 Hour With Climate Change	Identify build-out system deficiencies and timing of upgrades
BUILD-OUT-PWWF-25	Existing population + build-out growth	25yr, 24 Hour With Climate Change	Size system improvements

4.3 Gravity Main Capacity Analysis

Table 4.6 summarizes the existing and build-out gravity main HLoS results under each scenario.

Table 4.6: Gravity Main HLoS Results (Number of Gravity Mains)

HLoS Rating	EXISTING-PWWF-5	BUILD-OUT-PWWF-5
A	105	107
B	70	57
C	19	24
D	3	2
E	**5**	**11**
F	**0**	**1**

The capacity analysis results show that there are five (5) gravity main deficiencies (HLoS rating of 'E' or 'F') in the existing scenario, and there are twelve (12) gravity main deficiencies in the build-out scenario.

The 12 deficiencies are as follows:

- Pipe ID S8025X – 250 mm – On right-of-way northeast of WWTP
- Pipe ID S8035X – 250 mm – On right-of-way northeast of WWTP
- Pipe ID S8370X – 250 mm – On right-of-way between Hereford Ave and Mc Phillips Ave
- Pipe ID S8375X – 250 mm – On right-of-way between Hereford Ave and Mc Phillips Ave
- Pipe ID S8380X – 250 mm – On right-of-way between Hereford Ave and Mc Phillips Ave
- Pipe ID S8385X – 200 mm – On Hereford Ave east of Jackson Ave
- Pipe ID S8390X – 200 mm – On Jackson Ave between Rainbow Rd and Hereford Ave
- Pipe ID S8395X – 200 mm – On Rainbow Rd west of Jackson Ave
- Pipe ID S8400X – 200 mm – On Salt Spring Elementary School Access Road
- Pipe ID S8410X – 200 mm – On Kanaka Rd by Aldous Rd
- Pipe ID S8425X – 200 mm – On right-of-way between Park Dr and Kanaka Rd
- Pipe ID S8430X – 200 mm – On right-of-way between Park Dr and Kanaka Rd

Note that all of these deficiencies are driven by the high I&I rate, which may be conservative since the model was calibrated to a 100-year storm event. Extreme events like this tend to minimize surface ponding, soil infiltration, and evaporation, and lead to greater stormwater system overflow and higher I&I rates than 5-year or 25-year storm events. It is recommended that continuous flow monitoring is completed until several 5-year to 25-year storm events are captured, and that the model calibration is fine-tuned to verify the gravity main deficiencies.

Detailed modeling results for the gravity mains receiving HLoS ratings of 'E' or 'F' can be found in **Appendix F**.

4.4 Pump Station Capacity Analysis

Table 4.7 and **Table 4.8** summarize the pump station HLoS results under the existing and future scenarios.

Table 4.7: EXISTING-PWWF-5 Pump Station HLoS Ratings

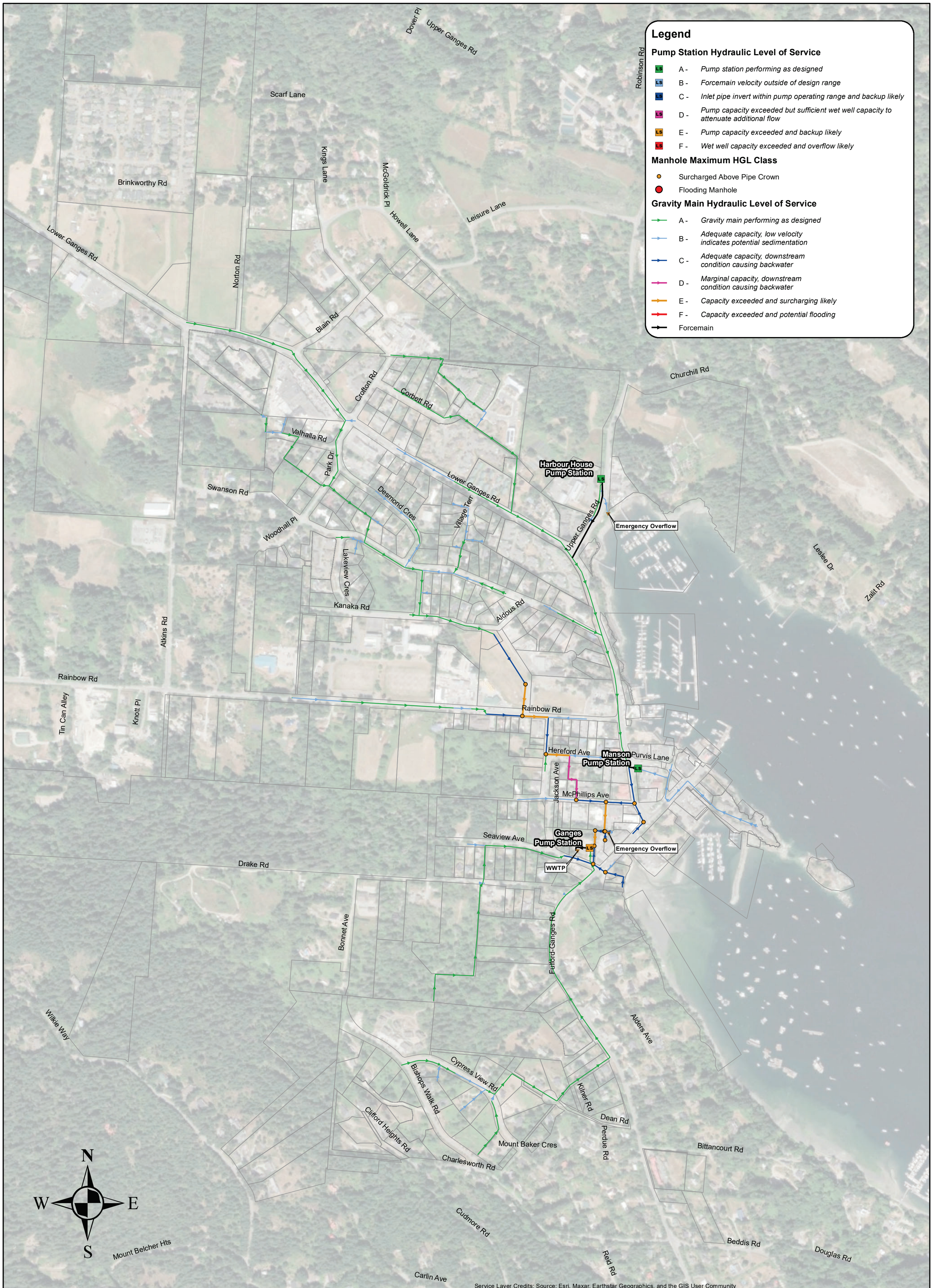
Pump Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Forcemain Velocity (m/s)	HLoS Rating
Ganges	29.0	57.0	**-28.0**	1.8	**E**
Harbour House	6.6	1.6	5.0	1.5	A
Manson	5.0	1.3	3.7	1.1	A

Table 4.8: BUILD-OUT-PWWF-5 Pump Station HLoS Ratings

Pump Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Forcemain Velocity (m/s)	HLoS Rating
Ganges	29.0	58.4	**-29.4**	1.9	**E**
Harbour House	6.6	2.4	4.2	1.5	A
Manson	5.0	1.6	3.4	1.1	A

The pump station capacity results show that the Ganges Pump Station is deficient under the existing and build-out scenarios.

Figure 4.1 and **Figure 4.2** illustrate the gravity main and pump station HLoS ratings for the existing and future scenarios.



Making a difference...together

Project: Ganges Sewer Service Area Modelling
Project ID: 2024-057-CRD
Client: Capital Regional District
Date: January 2025
Created by: SZ
Reviewed by: WdS

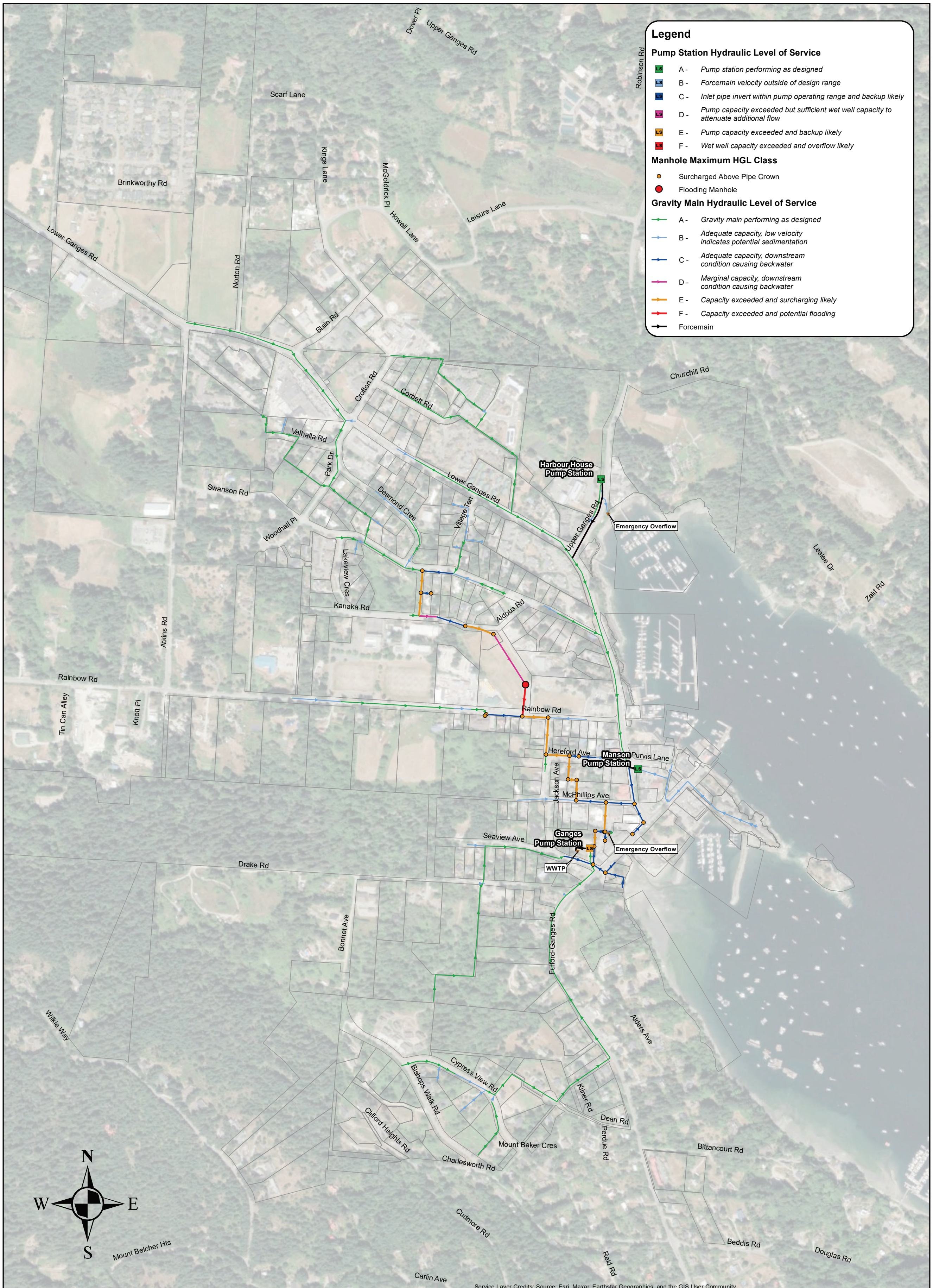
GeoAdvice Engineering Inc.

Existing Scenario
5-Year 24-Hour I&I
HLoS Model Results

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.1 0.2 0.4
Kilometers

Figure 4.1



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Project: Ganges Sewer Service Area Modelling
Project ID: 2024-057-CRD
Client: Capital Regional District
Date: January 2025
Created by: SZ
Reviewed by: WdS

GeoAdvice Engineering Inc.

Build-Out Scenario 5-Year 24-Hour I&I HLoS Model Results

0 0.1 0.2 0.4
Kilometers

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Figure 4.2

5 Infrastructure Criticality Scores

As discussed with the CRD, criticality scores were assigned to gravity mains and pump stations based on adjacent land use. The criteria summarized in **Table 5.1** were used to give each gravity main and pump station a criticality score.

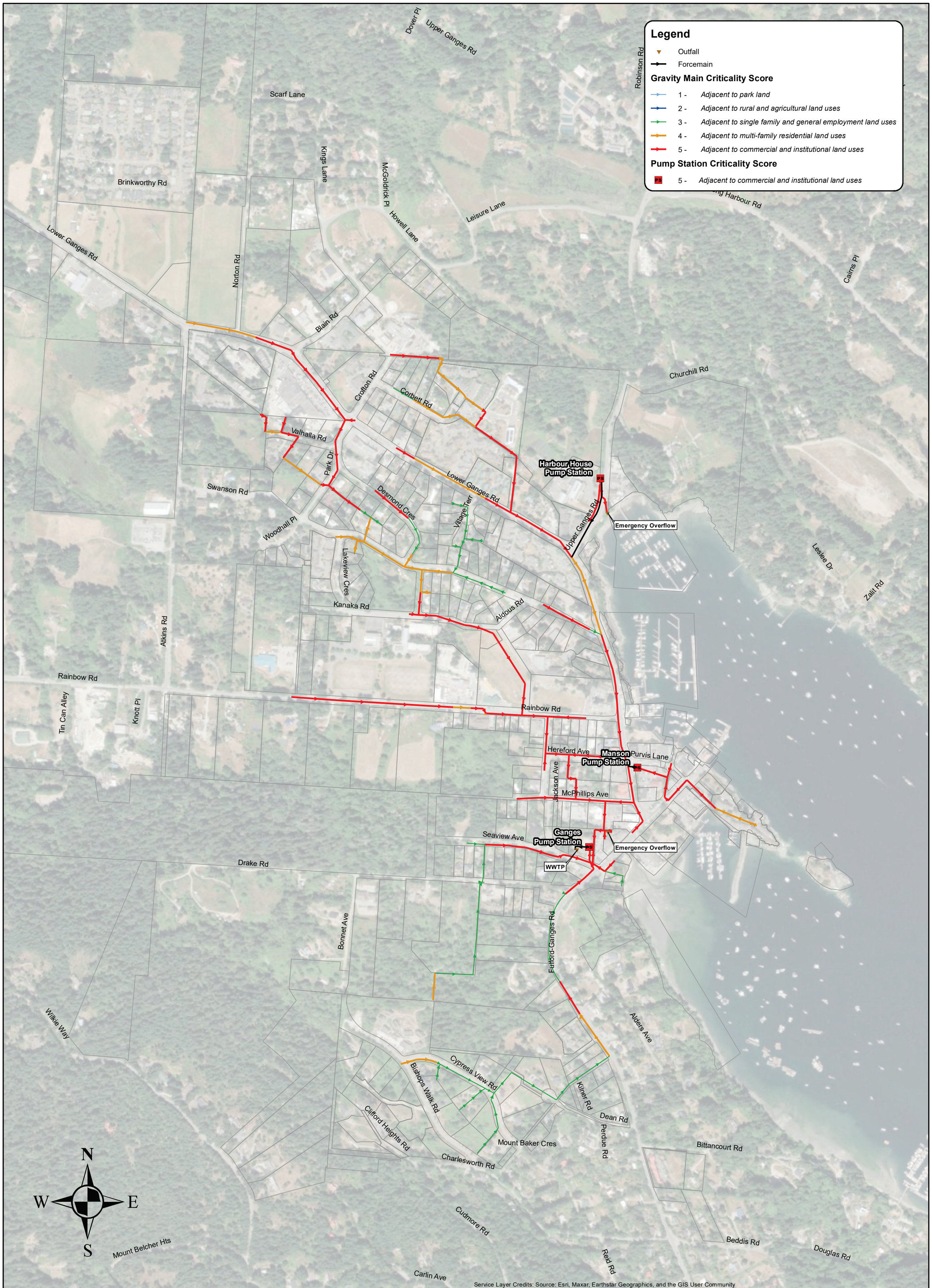
Table 5.1: Infrastructure Criticality Scoring

Criteria	Score
Located adjacent to park land	1
Located adjacent to rural and agricultural land	2
Located adjacent to single family and general employment land	3
Located adjacent to multi-family land	4
Located adjacent to commercial and institutional land	5

The infrastructure criticality scores are summarized in **Table 5.2** and shown in **Figure 5.1**. Note that since all improvement projects have a maximum criticality score of 5 (as shown in **Section 6**), project prioritization does not need refinement based on criticality scores.

Table 5.2: Infrastructure Criticality Scores

Criticality Score	# Gravity Mains	# Pump Stations
1	0	0
2	0	0
3	54	0
4	44	0
5	104	3



Making a difference...together

Project: Ganges Sewer Service Area Modelling
Project ID: 2024-057-CRD
Client: Capital Regional District
Date: January 2025
Created by: SZ
Reviewed by: WdS

GeoAdvice Engineering Inc.

Infrastructure Criticality Scores

0 0.1 0.2 0.4
Kilometers

Figure 5.1

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

6 Proposed System Improvements

This section identifies the required improvement projects along with their recommended order.

- Gravity mains with a HLoS rating of either 'E' or 'F' were considered "deficient" and proposed upgrades were considered to eliminate these deficiencies.
- Pump stations with a HLoS rating of either 'D', 'E', or 'F' were considered "deficient" and proposed pump, wet well and forcemain upgrades were considered to eliminate these deficiencies.

Based on the 2022 MMCD Design Guidelines and standard sewer design practice, the design and sizing criteria shown in **Table 6.1** were used.

Table 6.1: Design and Sizing Criteria

Facility	Criterion	Parameter Value
Gravity Main	Design Flow/Sizing Scenario	BUILD-OUT-PWWF-25
	Max. depth/Diameter ratio	d/D < 0.7
	Min. Velocity	v ≥ 0.6 m/s
	Max. Velocity	v ≤ 2.5 m/s
	Min. Diameter	D = 200 mm
	Manning Roughness Coefficient	n = 0.013
Forcemain	Min. Velocity	v ≥ 0.9 m/s
	Max. Velocity	v ≤ 3.5 m/s
	Hazen-Williams Roughness	C = 120
Pump	Design Flow	BUILD-OUT-PWWF-25
	Maximum Pump Flow	PWWF ≤ Firm Capacity

***d= flow depth, D = Diameter, n = Manning coefficient, v = velocity, c = Hazen-Williams roughness coefficient**

The proposed system improvements were grouped into projects. Each improvement project was assigned an ID, which also represents the ranking of the project. The ranking order of the projects is the recommended order in which the projects should be implemented.

The proposed improvements projects are summarized in **Table 6.2** and illustrated in **Figure 6.1**. Unit costs shown in **Appendix G** were used to estimate project costs. These are class D unit cost estimates based on construction cost indices published by the Engineering News Record (ENR) for nearby markets and include construction, engineering design, and contingency costs. Upgrade project details can be found in **Appendix H**.

Table 6.2: Sanitary System Improvement Work Plan

Project ID	Trigger Scenario	Project Description	Quantity	Maximum Criticality Score	Cost*
1	EXISTING-PWWF-5	Upgrade the Ganges Pump Station to a minimum firm capacity of 110 L/s. Note that the high required firm capacity is driven by the high I&I rate, which may be conservative since the model was calibrated to a 100-year storm event. Extreme events like this tend to minimize surface ponding, soil infiltration, and evaporation, and lead to greater stormwater system overflow and higher I&I rates than 5-year or 25-year storm events. It is recommended that continuous flow monitoring is completed until several 5-year to 25-year storm events are captured, and that the model calibration is fine-tuned to verify the required firm capacity.	1 Pump Station	5	$1,373,000
2	EXISTING-PWWF-5	Upgrade pipes from the end of the Salt Spring Elementary School Access Road to the intersection of Jackson Ave and Hereford Ave to 300 mm, and upgrade pipes from the intersection of Jackson Ave and Hereford Ave to Ganges Pump Station to 375 mm.	602 m	5	$2,421,000
3	BUILD-OUT-PWWF-5	Upgrade pipes from south of Park Dr to the the end of the Salt Spring Elementary School Access Road to 250 mm.	423 m	5	$1,414,000

***Class D unit costs based on construction cost indices published by the Engineering News Record (ENR) for nearby markets (see Appendix G). Cost estimates provided are not a guarantee of actual construction costs. All costs are in 2024 dollars with no allowance for inflation.**

CRD Making a difference...together

Project: Ganges Sewer Service Area Modelling
Project ID: 2024-057-CRD
Client: Capital Regional District
Date: January 2025
Created by: SZ
Reviewed by: WdS

GeoAdvice Engineering Inc.

System Improvement Recommendations

0 0.0325 0.065 0.13
Kilometers

Figure 6.1

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7 Summary

GeoAdvice Engineering Inc. (GeoAdvice) was retained by the Capital Regional District, BC (CRD) to complete the Ganges Sewer Service Area Modelling, which involved updating and calibrating the sewer model for Ganges and conducting a sewer system capacity analysis.

The following is a list of key conclusions drawn while performing the sewer model update:

- The CRD GIS data, as-built drawings, and previous InfoSWMM model were the key sources of information on the Ganges system to update the pipe and node network topology model.
- The sewer model includes the following elements:
    - 203 junctions
    - 205 pipes
    - 3 outfalls
    - 3 pump stations
- Existing sewer load was determined based on 2023 water billing data and sewer flow monitoring data. The calibrated Ganges existing BSF load is 2.62 L/s, and the estimated residential BSF rate is 122 L/cap/day.
- The model was calibrated against three (3) flow monitoring locations. Overall, the model predicts a good correlation with the observed dry weather and wet weather field data.
- A build-out model scenario was created based on future population growth information provided by Islands Trust.
- The EXISTING-PWWF-5 and BUILD-OUT-PWWF-5 scenarios were used to determine existing and future infrastructure deficiencies. The BUILD-OUT-PWWF-25 scenario was used to determine sizes and capacities for system improvement recommendations.
- The estimated existing sewer-serviced residential population is 1,524 capita, while the estimated build-out sewer-serviced residential population is 5,016 capita.
- The gravity main capacity analysis results show that there are five (5) gravity main deficiencies (HLoS rating of ‘E’ or ‘F’) in the existing scenario, and there are twelve (12) gravity main deficiencies in the build-out scenario.
- The pump station capacity results show that the Ganges Pump Station is deficient under the existing and build-out scenarios.
- The 1,025 m of gravity main upgrades, and the Ganges Pump Station upgrade have been proposed to eliminate system capacity deficiencies and service the future population.
- Note that the gravity main upgrades and high required Ganges Pump Station firm capacity are driven by the high I&I rate, which may be conservative since the model was calibrated to a 100-year storm event. Extreme events like this tend to minimize surface ponding, soil infiltration, and evaporation, and lead to greater stormwater system overflow and higher I&I rates than 5-year or 25-year storm events. It is recommended that continuous flow monitoring is completed until several 5-year to 25-year storm events are captured, and that the model calibration is fine-tuned to verify gravity main an pump station upgrades.

8 Recommendations

Based upon the findings from this analysis, GeoAdvice recommends that the CRD plan to undertake the projects in the proposed system improvements to relieve system deficiencies and prepare for future development. In addition, GeoAdvice recommends the following:

1. **Field Verification of Ganges Pump Station Capacity**
   Due to the capacity deficiency at Ganges Pump Station predicted by the model, it is recommended that pumping rates are field-verified and that datalogging is done during the next winter season as a first step to verifying the Ganges Pump Station capacity.

2. **Continuous Flow Monitoring and Verification of I&I Rates**
   It is recommended that continuous flow monitoring is completed until several 5-year to 25-year storm events are captured, and that the model calibration is fine-tuned to verify the required gravity main and pump station upgrades.

3. **Smoke Testing**
   Smoke testing should be conducted to determine the cause of the high infiltration rates across the system.

4. **Verification of Unit Costing**
   The CRD should verify the unit costs used in the costing analysis.

5. **Model Conversion from InfoSWMM to InfoWorks ICM**

6. **User's Guide for Land Development Applications**
   GeoAdvice will develop a User's Guide to assist the CRD in performing land development application reviews for the sanitary sewer utility.

7. **Extended Modeling Support Services**
   GeoAdvice will assist the CRD in maintaining and operating the updated model for a period of one (1) year from the date of completion of this assignment and update the CRD of its operational status on a quarterly basis via a written status report. It is understood that during this period, we will have to respond to specific queries to model scenarios from the CRD for capital planning and operational needs.

Submission

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Reviewed and Approved by:

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2025-01-27

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Project Manager

Appendix A Primary System Components

Table A.1: Pump Modeling Data

Pump Station	Model ID	Type	Firm Capacity (L/s)*	Pump On Level (m)**	Pump Off Level (m)**
Ganges	PMP-GANGES-1	Lead	29.0	1.400	0.700
	PMP-GANGES-2	Lag		1.500	0.700
Harbour House	PMP-HARBOUR-1	Lead	6.6	0.900	0.500
	PMP-HARBOUR-2	Lag		1.000	0.500
Manson	PMP-MANSON-1	Lead	5.0	0.850	0.500
	PMP-MANSON-2	Lag		0.950	0.500

***Firm capacities were based on the pump capacities specified in *CRD Integrated Water Services Supply of Submersible Pumps for Ganges Sewer Service* (Precision, 2018). The modeled pump capacities were slightly higher than these 2018 specification capacities, but to be conservative the capacities from the specifications were used.**

****The CRD provided the lead pump on/off levels, and the lag pump on/off levels were assumed.**

Table A.2: Wet Well Modeling Data

Pump Station	Wet Well ID	Bottom Elevation (m)	Maximum Elevation (m)	Equivalent Diameter (m)
Ganges	WW-GANGES	0.250	6.250	2.630
Harbour House	WW-HARBOUR	1.950	6.070	1.167
Manson	WW-MANSON	1.070	5.300	1.167

Appendix B Population Growth Information

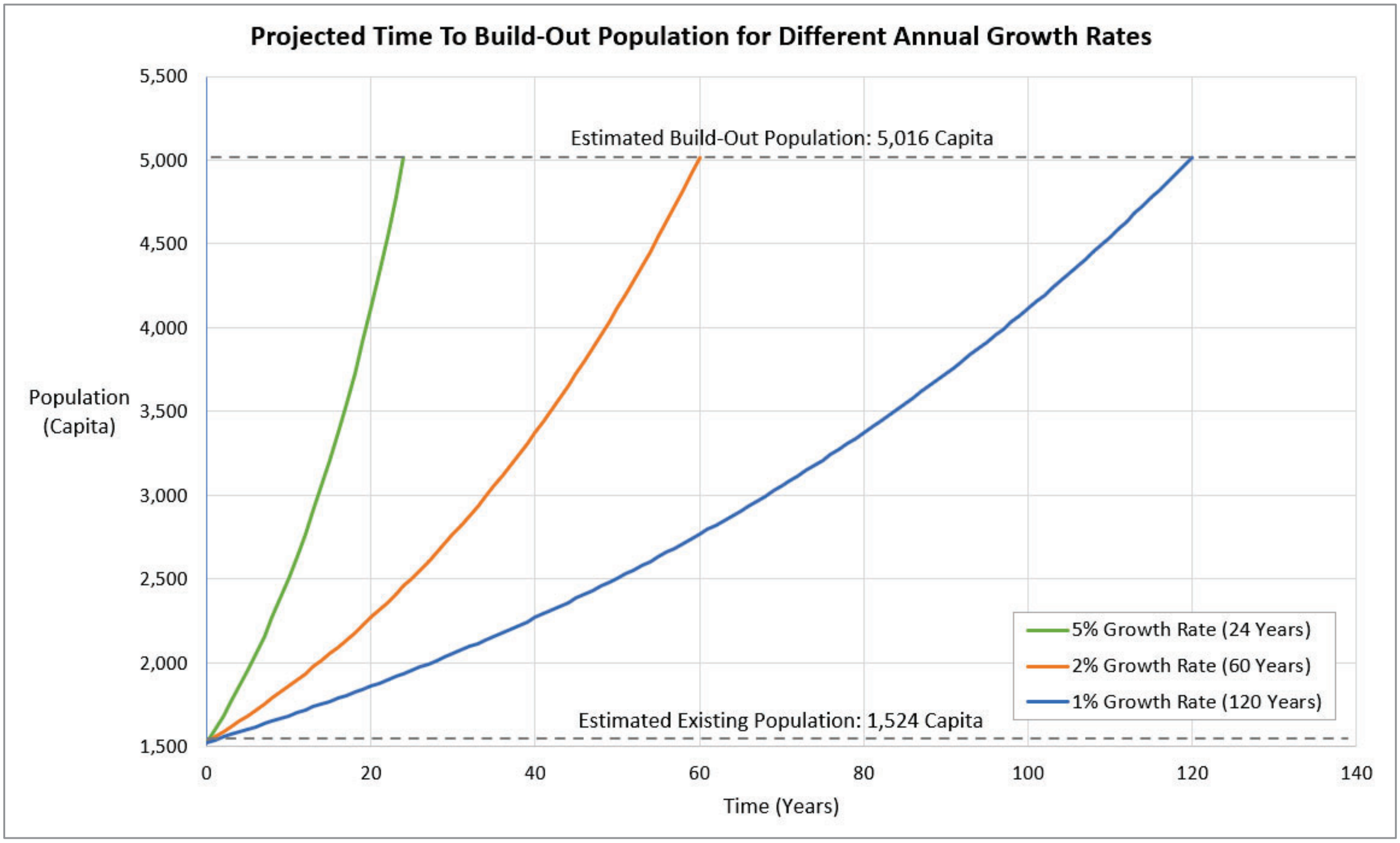


Table B.1: Parcel Growth Information

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
004-696-131	268 Park Dr	Residential	0.173	6	1	2.5	2.0
007-511-566	A - 125 Rainbow Rd	Residential	0.083	3	1	2.5	2.4
004-997-956	134 McPhillips Ave	Residential	0.080	3	1	2.5	2.4
000-094-811	208 Park Dr	Residential	0.148	5	1	2.5	2.2
007-511-205	120 Hereford Ave	Residential	0.079	3	1	2.5	2.2
005-339-707	116 Hereford Ave	Residential	0.084	3	1	2.5	1.9
028-856-112	129 Kanaka Rd	Residential	0.131	5	1	2.5	2.3
017-460-581	136 Lower Ganges Rd	Residential	0.070	3	1	2.5	1.4
000-274-119	134 Hereford Ave	Residential	0.040	1	1	2.5	2.5
005-884-411	157 Kanaka Rd	Residential	0.121	4	1	2.5	2.2
003-766-373	136 Desmond Cres	Residential	0.159	6	1	2.5	2.2
026-288-524	238 Park Dr	Residential	0.188	7	1	2.5	2.0
007-509-723	108 Hereford Ave	Residential	0.024	1	1	2.5	2.4
000-035-319	146 Desmond Cres	Residential	0.150	6	1	2.5	1.8
018-614-400	110 Lower Ganges Rd	Residential	0.176	7	1	2.5	1.6
003-766-365	122 Desmond Cres	Residential	0.145	5	1	2.5	2.3
003-899-845	116 Fulford-Ganges Rd	Residential	0.049	2	1	2.5	2.4
007-511-167	132 Lower Ganges Rd	Residential	0.057	2	1	2.5	1.2
028-856-104	143 Kanaka Rd	Residential	0.131	5	1	2.5	2.1
007-509-472	129 Hereford Ave	Residential	0.080	3	1	2.5	2.4
017-460-573	112 Hereford Ave	Residential	0.077	3	1	2.5	2.5
028-999-878	122 Hereford Ave	Residential	0.090	3	1	2.5	2.0
018-590-861	124 McPhillips Ave	Residential	0.311	12	4	10.0	9.8
002-748-223	130 McPhillips Ave	Residential	0.080	3	1	2.5	2.5
007-513-917	127 Rainbow Rd	Residential	0.080	3	1	2.5	2.5
003-766-390	224 Park Dr	Residential	0.186	7	1	2.5	2.3
000-291-498	212 Park Dr	Residential	0.153	6	1	2.5	2.4
000-440-400	274 Park Dr	Residential	0.193	7	1	2.5	2.2
026-288-532	230 Park Dr	Residential	0.120	4	1	2.5	2.3
007-509-456	133 Hereford Ave	Residential	0.080	3	1	2.5	2.5
028-999-860	123 Jackson Ave	Residential	0.074	3	1	2.5	2.4
003-766-110	200 Park Dr	Residential	0.231	9	2	5.0	4.8
003-766-403	220 Park Dr	Residential	0.165	6	1	2.5	2.3
002-078-627	128 Desmond Cres	Residential	0.147	5	1	2.5	2.4
028-856-082	167 Park Dr	Residential	0.100	4	1	2.5	2.5

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
000-131-920	101 - 111 Rainbow Rd	Residential	0.082	3	1	2.5	2.4
001-992-708	161 Fulford-Ganges Rd	Residential	0.069	3	1	2.5	0.7
028-104-269	A - 176 Bishops Walk Rd	Residential	1.994	74	148	370.0	261.2
018-951-767	Lower Ganges Rd	Residential	0.041	2	1	2.5	0.3
006-261-493	131 McPhillips Ave	Residential	0.122	4	1	2.5	2.5
005-280-729	100 Lower Ganges Rd	Residential	0.097	4	1	2.5	2.4
016-027-752	108 - 121 McPhillips Ave	Residential	0.241	9	2	5.0	3.8
006-262-988	103 - 109 McPhillips Ave	Residential	0.202	7	1	2.5	2.0
005-229-138	106 Lower Ganges Rd	Residential	0.059	2	1	2.5	2.2
005-280-737	104 Lower Ganges Rd	Residential	0.080	3	1	2.5	2.4
000-067-962	135 McPhillips Ave	Residential	0.061	2	1	2.5	2.5
005-829-437	161 McPhillips Ave	Residential	0.099	4	1	2.5	2.4
005-829-372	155 McPhillips Ave	Residential	0.098	4	1	2.5	2.4
004-677-706	127 Lower Ganges Rd	Residential	0.170	6	1	2.5	1.4
024-838-349	201 - 110 Purvis Lane	Residential	0.208	8	2	5.0	3.5
005-882-354	142 Park Dr	Residential	0.158	6	1	2.5	2.3
024-842-591	105 Village Terr	Residential	0.110	4	1	2.5	2.5
005-882-273	158 Park Dr	Residential	0.191	7	1	2.5	2.3
003-504-611	130 Park Dr	Residential	0.126	5	1	2.5	2.1
024-842-630	108 Village Terr	Residential	0.110	4	1	2.5	2.3
000-114-901	111 Desmond Cres	Residential	0.146	5	1	2.5	2.4
024-842-605	102 Village Terr	Residential	0.110	4	1	2.5	2.3
000-019-470	152 Park Dr	Residential	0.180	7	1	2.5	2.2
003-766-039	184 Park Dr	Residential	0.188	7	1	2.5	2.2
024-842-567	113 Village Terr	Residential	0.112	4	1	2.5	2.4
024-842-559	114 Village Terr	Residential	0.110	4	1	2.5	2.4
024-842-575	111 Village Terr	Residential	0.110	4	1	2.5	2.1
024-842-541	112 Village Terr	Residential	0.110	4	1	2.5	2.2
024-842-648	110 Village Terr	Residential	0.111	4	1	2.5	2.3
018-161-642	110 Park Dr	Residential	0.428	16	7	17.5	14.5
000-908-045	134 Park Dr	Residential	0.197	7	1	2.5	2.3
003-141-331	115 Desmond Cres	Residential	0.360	13	5	12.5	12.4
024-024-651	268 Lower Ganges Rd	Residential	0.093	3	1	2.5	1.0
000-019-551	124 Park Dr	Residential	0.112	4	1	2.5	0.4
024-842-583	107 Village Terr	Residential	0.110	4	1	2.5	2.5
005-882-338	148 Park Dr	Residential	0.168	6	1	2.5	2.3
024-842-621	106 Village Terr	Residential	0.110	4	1	2.5	2.1
005-893-194	155 Rainbow Rd	Residential	0.072	3	1	2.5	2.3

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
000-677-990	122 Jackson Ave	Residential	0.050	2	1	2.5	2.3
005-893-143	151 Rainbow Rd	Residential	0.071	3	1	2.5	2.4
005-937-965	108 Jackson Ave	Residential	0.204	8	2	5.0	4.7
000-410-624	106 Jackson Ave	Residential	0.143	5	1	2.5	2.5
000-444-243	152 McPhillips Ave	Residential	0.070	3	1	2.5	2.5
005-938-031	141 Rainbow Rd	Residential	0.103	4	1	2.5	2.5
010-145-591	135 Rainbow Rd	Residential	0.151	6	1	2.5	2.3
003-141-322	300 Lower Ganges Rd	Residential	0.206	8	2	5.0	3.2
004-696-018	267 Park Dr	Residential	0.133	5	1	2.5	2.3
003-855-635	135 Desmond Cres	Residential	0.282	10	3	7.5	7.3
023-505-249	374 Lower Ganges Rd	Residential	1.599	59	94	235.0	232.0
003-482-839	108 Valhalla Rd	Residential	0.231	9	2	5.0	3.8
003-887-430	141 Desmond Cres	Residential	0.173	6	1	2.5	2.5
004-644-212	127 Valhalla Rd	Residential	0.146	5	1	2.5	2.1
004-644-344	114 Valhalla Rd	Residential	0.184	7	1	2.5	2.4
004-695-968	281 Park Dr	Residential	0.107	4	1	2.5	2.4
004-696-000	275 Park Dr	Residential	0.156	6	1	2.5	2.0
001-274-520	340 Lower Ganges Rd	Residential	0.850	31	26	65.0	62.4
003-765-954	127 Desmond Cres	Residential	0.183	7	1	2.5	2.4
001-340-468	306 Lower Ganges Rd	Residential	0.162	6	1	2.5	1.7
000-194-417	121 Valhalla Rd	Residential	0.163	6	1	2.5	1.6
004-931-793	324 Lower Ganges Rd	Residential	0.089	3	1	2.5	0.2
005-270-669	6 - 323 Lower Ganges Rd	Residential	0.151	6	1	2.5	0.9
005-270-588	116 Corbett Rd	Residential	0.141	5	1	2.5	1.7
005-270-685	315 Lower Ganges Rd	Residential	0.133	5	1	2.5	2.4
005-270-600	126 Corbett Rd	Residential	0.136	5	1	2.5	2.3
005-270-596	122 Corbett Rd	Residential	0.146	5	1	2.5	2.1
002-436-604	265 Lower Ganges Rd	Residential	0.309	11	3	7.5	5.7
003-826-902	275 Lower Ganges Rd	Residential	0.692	26	18	45.0	34.3
005-884-888	173 Park Dr	Residential	0.144	5	1	2.5	2.1
027-534-855	Park Dr	Residential	0.127	5	1	2.5	2.3
023-782-048	166 Park Dr	Residential	0.110	4	1	2.5	2.3
005-884-357	165 Kanaka Rd	Residential	0.107	4	1	2.5	2.3
023-782-030	174 Park Dr	Residential	0.111	4	1	2.5	2.4
005-883-105	185 Park Dr	Residential	0.101	4	1	2.5	2.3
005-883-326	175 Kanaka Rd	Residential	0.094	3	1	2.5	2.3
027-534-863	112 Lakeview Cres	Residential	0.127	5	1	2.5	1.9
000-495-093	1 - 173 Kanaka Rd	Residential	0.095	4	1	2.5	2.2

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
005-290-210	175 Park Dr	Residential	0.110	4	1	2.5	2.3
023-782-021	180 Park Dr	Residential	0.110	4	1	2.5	2.4
000-535-567	179 Park Dr	Residential	0.101	4	1	2.5	2.2
005-883-768	169 Kanaka Rd	Residential	0.112	4	1	2.5	2.4
006-261-434	137 McPhillips Ave	Residential	0.061	2	1	2.5	2.4
003-106-756	154 Kings Lane	ICI	1.387	50	0	69.4	68.1
005-996-830	103 Park Dr	Residential	0.113	4	1	2.5	1.0
003-827-569	101 - 111 Corbett Rd	Residential	0.209	8	2	5.0	3.7
003-873-811	115 Corbett Rd	Residential	0.238	9	2	5.0	4.5
000-698-865	132 Corbett Rd	Residential	1.998	74	148	370.0	331.2
026-073-081	120 Crofton Rd	Residential	1.028	38	39	97.5	95.3
025-674-463	131 Corbett Rd	Residential	0.168	6	1	2.5	0.7
000-492-523	131 Crofton Rd	Residential	0.106	4	1	2.5	1.2
003-765-989	121 Desmond Cres	Residential	0.173	6	1	2.5	2.5
004-654-561	116 Rainbow Rd	Residential	0.278	10	3	7.5	6.6
025-019-571	129 Corbett Rd	Residential	0.287	11	3	7.5	6.3
001-522-027	128 Hereford Ave	Residential	0.039	1	1	2.5	2.3
004-950-208	3204 - 115 Fulford-Ganges Rd	Residential	0.103	4	1	2.5	2.4
000-555-843	149 Fulford-Ganges Rd	Residential	0.423	16	7	17.5	16.3
023-680-610	115 Fulford-Ganges Rd	Residential	0.291	11	3	7.5	6.9
004-677-714	109 Purvis Lane	Residential	0.395	15	6	15.0	14.7
003-046-885	106 Purvis Lane	Residential	0.228	8	2	5.0	4.6
005-656-150	255 Lower Ganges Rd	Residential	0.830	31	26	65.0	62.0
004-909-721	121 Upper Ganges Rd	Residential	1.188	44	52	130.0	113.0
025-861-816	13 - 107 Atkins Rd	Residential	0.668	25	17	42.5	42.2
004-696-042	261 Park Dr	Residential	0.185	7	1	2.5	2.5
006-030-041	119 Rainbow Rd	Residential	0.080	3	1	2.5	2.5
003-106-772	130 Blain Rd	Residential	0.412	15	6	15.0	15.0
003-122-611	145 King Rd	Residential	0.259	10	3	7.5	7.5
018-951-775	161 Lower Ganges Rd	Residential	0.095	4	1	2.5	2.5
003-122-689	173 Howell Lane	Residential	0.199	7	1	2.5	2.5
000-201-685	128 Lower Ganges Rd	Residential	0.079	3	1	2.5	2.5
003-122-701	181 Howell Lane	Residential	0.181	7	1	2.5	2.5
003-106-721	188 Kings Lane	Residential	0.651	24	16	40.0	40.0
027-249-794	145 Lower Ganges Rd	Residential	0.017	1	1	2.5	2.5
003-122-590	151 Kings Lane	Residential	0.260	10	3	7.5	7.5
004-997-964	136 McPhillips Ave	Residential	0.080	3	1	2.5	2.5
000-616-915	159 Kings Lane	Residential	0.606	22	13	32.5	32.5

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
000-119-792	115 Rainbow Rd	Residential	0.079	3	1	2.5	2.5
028-856-091	161 Park Dr	Residential	0.090	3	1	2.5	2.5
003-122-646	155 Howell Lane	Residential	0.244	9	2	5.0	5.0
000-213-730	128 Lower Ganges Rd	Residential	0.151	6	1	2.5	2.5
004-443-489	210 Norton Rd	Residential	4.774	48	229	572.5	572.5
003-122-671	161 Howell Lane	Residential	0.230	9	2	5.0	5.0
029-253-217	455 Lower Ganges Rd	ICI	0.801	50	0	40.1	40.1
016-341-643	174 Fulford-Ganges Rd	Residential	0.194	7	1	2.5	2.5
030-706-891	171 Fulford-Ganges Rd	Residential	0.056	2	1	2.5	2.5
018-951-759	201 - 229 Lower Ganges Rd	Residential	0.110	4	1	2.5	2.5
005-829-313	155 McPhillips Ave	Residential	0.100	4	1	2.5	2.5
024-842-613	102 Village Terr	Residential	0.110	4	1	2.5	2.5
023-782-056	166 Park Dr	Residential	0.111	4	1	2.5	2.5
031-451-969	118 Jackson Ave	Residential	0.273	10	3	7.5	7.5
031-451-977	116 Jackson Ave	Residential	0.088	3	1	2.5	2.5
003-421-040	1 - 148 Swanson Rd	Residential	0.157	6	1	2.5	2.5
000-140-589	1 - 114 Swanson Rd	Residential	0.499	18	9	22.5	22.5
000-904-732	140 Swanson Rd	Residential	0.179	7	1	2.5	2.5
003-421-139	132 Swanson Rd	Residential	0.183	7	1	2.5	2.5
004-931-815	316 Lower Ganges Rd	Residential	0.097	4	1	2.5	2.5
004-644-298	108 - 124 Valhalla Rd	Residential	0.193	7	1	2.5	2.5
003-421-147	116 Swanson Rd	Residential	0.269	10	3	7.5	7.5
003-420-990	154 Swanson Rd	Residential	0.144	5	1	2.5	2.5
003-421-082	142 Swanson Rd	Residential	0.168	6	1	2.5	2.5
005-790-191	141 Atkins Rd	Residential	2.428	74	180	450.0	450.0
004-644-301	124 Valhalla Rd	Residential	0.215	8	2	5.0	5.0
005-270-626	343 Lower Ganges Rd	Residential	0.147	5	1	2.5	2.5
005-270-618	343 Lower Ganges Rd	Residential	0.130	5	1	2.5	2.5
005-270-642	343 Lower Ganges Rd	Residential	0.148	5	1	2.5	2.5
004-242-670	136 Lakeview Cres	Residential	0.149	6	1	2.5	2.5
004-242-637	136 Lakeview Cres	Residential	0.227	8	2	5.0	5.0
005-893-615	191 Rainbow Rd	Residential	0.087	3	1	2.5	2.5
004-255-500	193 Park Dr	Residential	1.327	49	65	162.5	162.5
004-253-931	122 Lakeview Cres	Residential	0.214	8	2	5.0	5.0
023-566-388	121 Woodhall Pl	Residential	0.093	3	1	2.5	2.5
023-566-361	127 Woodhall Pl	Residential	0.083	3	1	2.5	2.5
003-421-848	151 Swanson Rd	Residential	0.194	7	1	2.5	2.5
023-566-311	114 Woodhall Pl	Residential	0.116	4	1	2.5	2.5

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
023-566-353	129 Woodhall Pl	Residential	0.085	3	1	2.5	2.5
004-242-599	123 Lakeview Cres	Residential	0.155	6	1	2.5	2.5
023-566-337	118 Woodhall Pl	Residential	0.108	4	1	2.5	2.5
023-566-299	243 Park Dr	Residential	0.113	4	1	2.5	2.5
003-421-198	121 Swanson Rd	Residential	0.238	9	2	5.0	5.0
003-421-201	131 Swanson Rd	Residential	0.151	6	1	2.5	2.5
023-566-281	106 Woodhall Pl	Residential	0.103	4	1	2.5	2.5
023-566-400	113 Woodhall Pl	Residential	0.083	3	1	2.5	2.5
002-907-968	143 Swanson Rd	Residential	0.170	6	1	2.5	2.5
023-566-302	110 Woodhall Pl	Residential	0.119	4	1	2.5	2.5
023-566-329	116 Woodhall Pl	Residential	0.101	4	1	2.5	2.5
003-421-163	115 Swanson Rd	Residential	0.191	7	1	2.5	2.5
004-091-451	125 Lakeview Cres	Residential	0.206	8	2	5.0	5.0
023-566-370	125 Woodhall Pl	Residential	0.095	4	1	2.5	2.5
023-566-345	22 Woodhall Pl	Residential	0.084	3	1	2.5	2.5
023-566-396	117 Woodhall Pl	Residential	0.107	4	1	2.5	2.5
009-598-758	201 Atkins Rd	Residential	1.410	52	73	182.5	182.5
003-422-771	137 Swanson Rd	Residential	0.157	6	1	2.5	2.5
004-002-342	231 Kanaka Rd	Residential	0.187	8	1	2.5	2.5
006-914-021	103 Bonnet Ave	Residential	1.544	57	88	220.0	220.0
005-976-383	100 Upper Ganges Rd	Residential	0.019	1	1	2.5	2.5
023-566-281	106 Woodhall Pl	Residential	0.125	4	1	2.5	2.5
023-566-281	106 Woodhall Pl	Residential	0.017	4	1	2.5	2.5

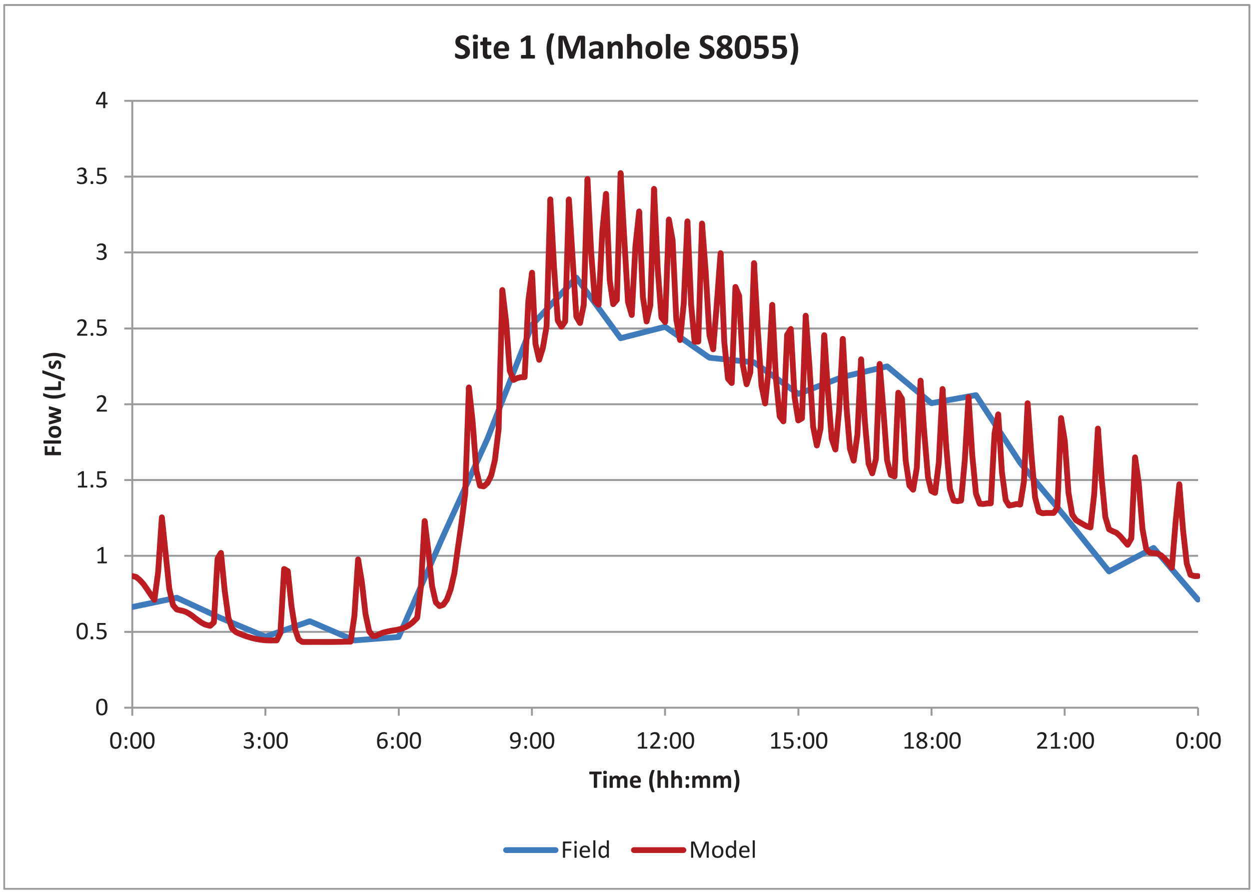
***The maximum potential parcel density provided by Islands Trust.**

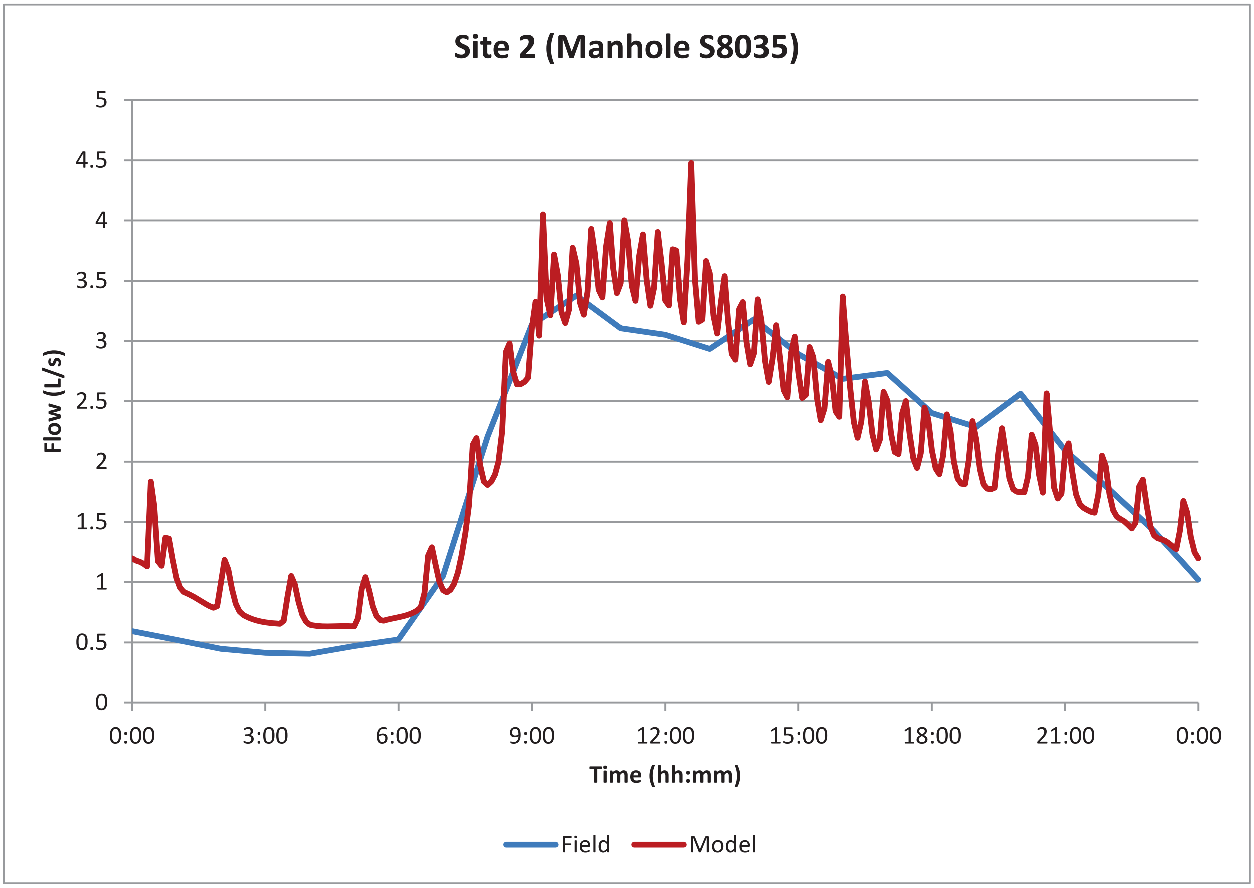
****Calculated as the parcel area x build-out density, assuming a minimum of 1 units.**

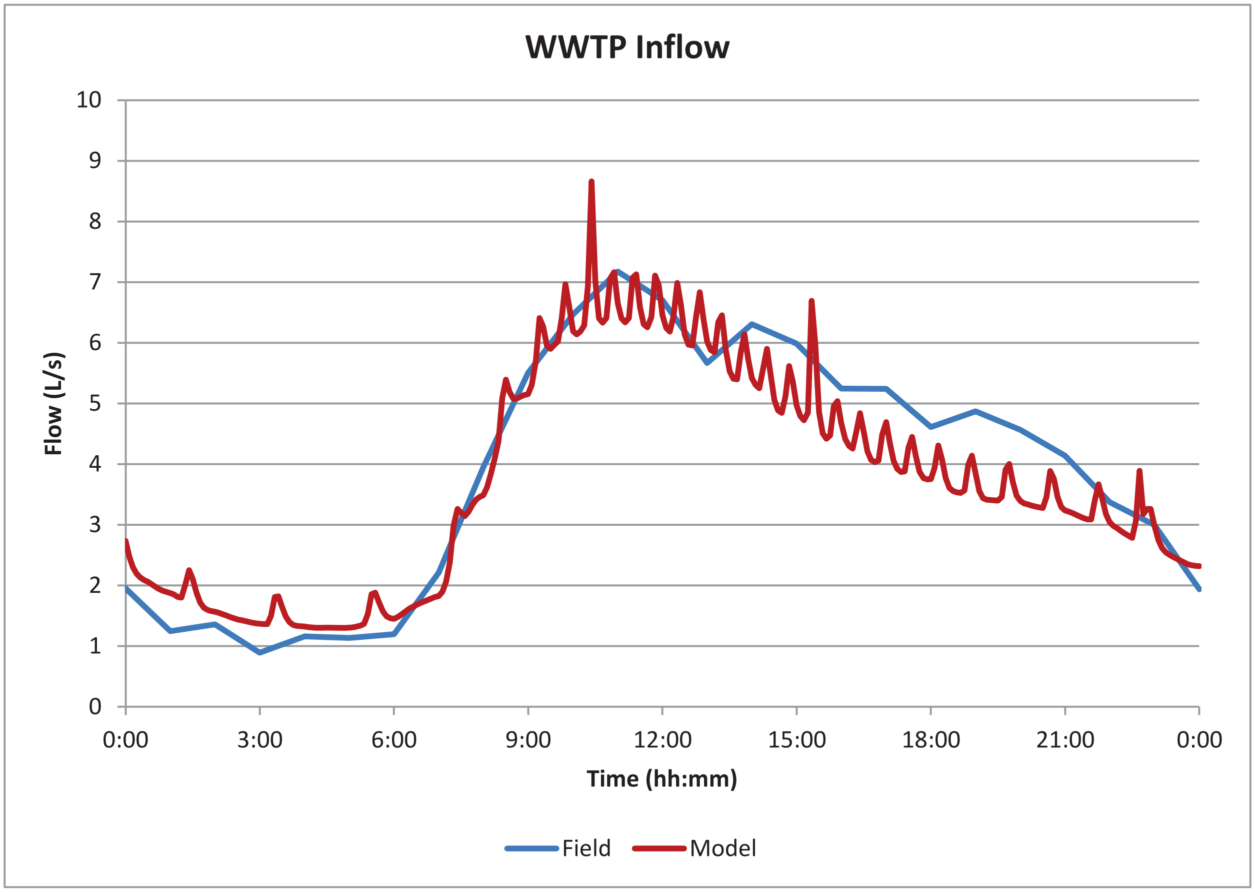
*****Calculated based on the number of build-out units and 2.5 capita/unit.**

******Estimated by subtracting the calibrated existing BSF from the future build-out population BSF, assuming a future BSF rate of 240 L/capita/day.**

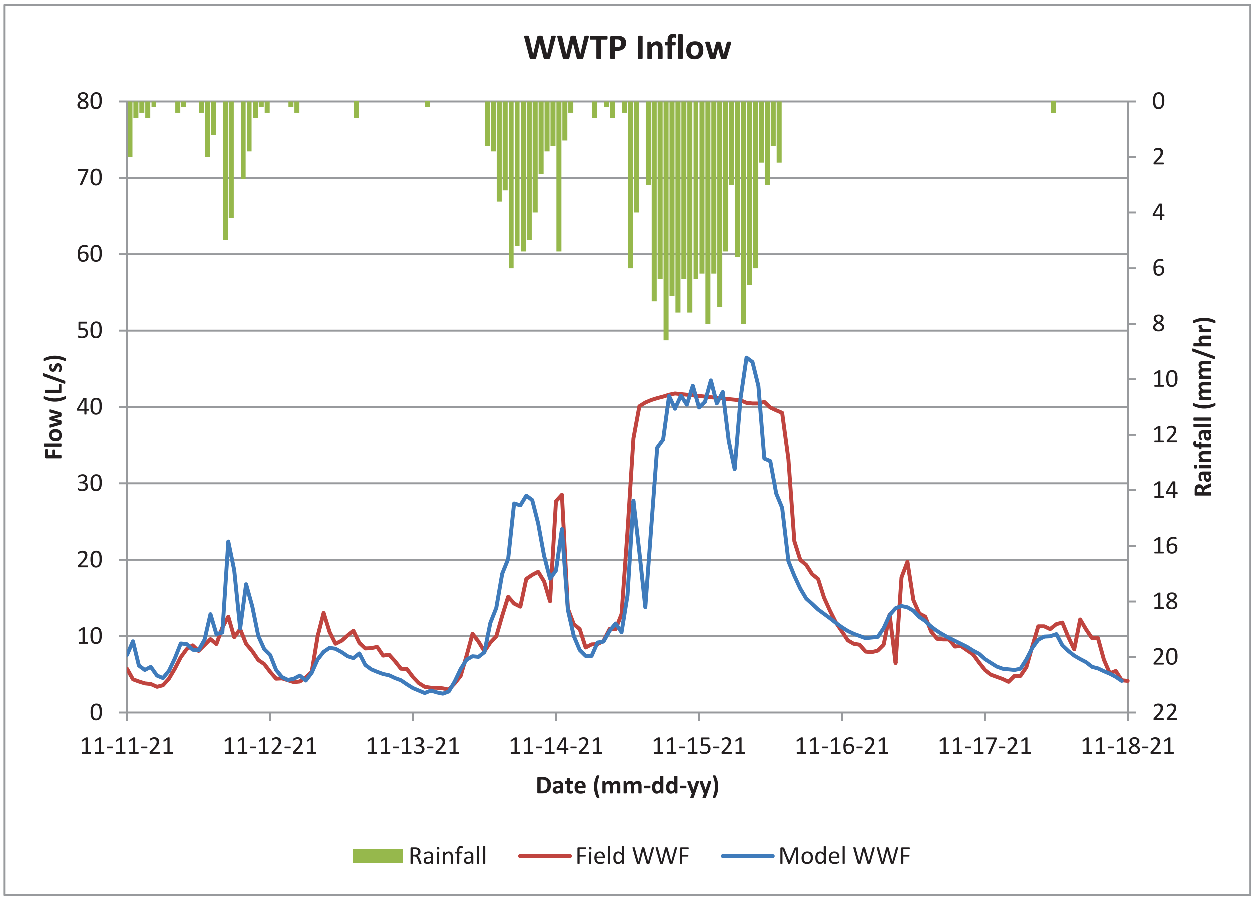
Appendix C Dry Weather Flow Calibration Hydrographs




Site 2 (Manhole S8035)
Flow (L/s)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time (hh:mm)
Field
Model


WWTP Inflow
10
9
8
7
6
5
4
3
2
1
0
Flow (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time (hh:mm)
Field
Model

Appendix D Wet Weather Flow Calibration Hydrograph (November 11, 2021 – November 18, 2021)



Appendix E Calibrated RTK Parameters

Table E.1: Ganges RTK Parameters

Parameter	Value
Catchment Area (ha)	99.2
R Total	0.028
R1	0.012
R2	0.006
R3	0.010
T1 (hrs)	0.5
T2 (hrs)	3.0
T3 (hrs)	12.0
K1	1.0
K2	2.0
K3	6.0

Appendix F Deficient Gravity Mains (HLoS = ‘E’ or ‘F’)

Table F.1: EXISTING-PWWF-5 Gravity Main Deficiencies (HLoS = ‘E’ or ‘F’)

Pipe ID	Length (m)	Slope (%)	Diameter (mm)	PWWF-5 (L/s)	q/Q	d/D	HLoS
S8025X	35.9	0.7	250	49.1	1.01	1.00	E
S8035X	68.6	0.4	250	49.4	1.26	1.00	E
S8385X	54.9	0.5	200	28.5	1.20	1.00	E
S8395X	59.7	0.6	200	27.0	1.06	0.86	E
S8400X	73.4	0.4	200	24.0	1.15	0.97	E

Table F.2: BUILD-OUT-PWWF-5 Gravity Main Deficiencies (HLoS = ‘E’ or ‘F’)

Pipe ID	Length (m)	Slope (%)	Diameter (mm)	PWWF-5 (L/s)	q/Q	d/D	HLoS
S8025X	35.9	0.7	250	49.1	1.01	1.00	E
S8035X	68.6	0.4	250	65.9	1.68	1.00	E
S8370X	47.2	0.3	250	38.7	1.24	1.00	E
S8375X	20.2	0.3	250	38.1	1.18	1.00	E
S8380X	54.6	0.3	250	38.1	1.22	1.00	E
S8385X	54.9	0.5	200	37.6	1.58	1.00	E
S8390X	85.6	1.0	200	35.8	1.08	1.00	E
S8395X	59.7	0.6	200	35.4	1.39	1.00	E
S8400X	73.4	0.4	200	33.1	1.58	1.00	F
S8410X	68.7	1.3	200	40.3	1.07	1.00	E
S8425X	53.3	0.6	200	36.2	1.47	1.00	E
S8430X	51.4	1.0	200	35.9	1.09	1.00	E

Appendix G Improvement Class D Unit Cost Rates

Unit cost rates below are class D unit cost estimates based on construction cost indices published by the Engineering News Record (ENR) for nearby markets and include construction, engineering design, and contingency costs. All costs are in 2024 dollars with no allowance for inflation.

Table G.1: Gravity Main (1.5-3 m depth)

Diameter (mm)	Unit Cost Per Road Type ($/m)			
	Special*	Local	Collector	Arterial
250	$3,197	$3,762	$4,702	$5,642
300	$3,327	$3,915	$4,893	$5,872
375	$3,522	$4,144	$5,180	$6,216

*Includes service roads, lanes, and right-of-ways.

Table G.2: Gravity Main (3-6 m depth)

Diameter (mm)	Unit Cost Per Road Type ($/m)			
	Special*	Local	Collector	Arterial
250	$4,724	$5,557	$6,947	$8,336
300	$4,854	$5,710	$7,138	$8,566
375	$5,049	$5,940	$7,425	$8,910

*Includes service roads, lanes, and right-of-ways.

Table G.3: Pump Station

Pump Ratings	0-5 HP	5-20 HP	20-50 HP	50-100 HP	100+ HP
Cost*	$948,000	$1,057,000	$1,373,000	$1,893,000	$2,689,000

Appendix H Detailed Improvement Recommendations

Table H.1: Proposed Pump Station Improvements

Project ID	Pump Station	Existing Firm Capacity (L/s)	Proposed Firm Capacity (L/s)*	Proposed Downstream Forcemain Velocity @ Firm Capacity (m/s)	Estimated Pump Requirements	Cost
1	Ganges Pump Station	29.0	110.0	3.5	2 x 48 hp pumps	$1,373,000

***Flows from BUILD-OUT-PWWF-25 (with upgrades) scenario.**

Table H.2: Proposed Gravity Main Improvements

Project ID	Pipe ID	Length (m)	Slope (%)	Existing Diameter (mm)	Proposed Diameter (mm)	Upgrade Type	Design Flow (L/s)**	Design d/D	Road Type	Cost
2	S8020X	11.8	0.9	300	375	**Continuity**	102.4	0.56	Special***	$59,684
2	S8025X	35.9	0.7	250	375	Capacity	91.8	0.57	Special***	$126,390
2	S8030X	20.8	1.0	250	375	**Continuity**	91.8	0.52	Special***	$73,303
2	S8035X	68.6	0.4	250	375	Capacity	91.3	0.64	Special***	$241,539
2	S8365X	69.5	0.8	250	375	**Continuity**	59.8	0.49	Local	$287,991
2	S8370X	47.2	0.3	250	375	Capacity	58.7	0.53	Special***	$238,479
2	S8375X	20.2	0.3	250	375	Capacity	58.1	0.51	Special***	$102,217
2	S8380X	54.6	0.3	250	375	Capacity	58.0	0.53	Special***	$192,146
2	S8385X	54.9	0.5	200	375	Capacity	57.6	0.47	Local	$227,348
2	S8390X	85.6	1.0	200	300	Capacity	55.3	0.54	Local	$335,253
2	S8395X	59.7	0.6	200	300	Capacity	54.8	0.62	Collector	$292,332
2	S8400X	73.4	0.4	200	300	Capacity	49.9	0.65	Special***	$244,315
3	S8405X	138.5	1.6	200	250	**Continuity**	48.7	0.59	Special***	$442,724
3	S8410X	68.7	1.3	200	250	Capacity	48.2	0.61	Special***	$219,675
3	S8415X	69.8	4.7	200	250	**Continuity**	47.8	0.42	Local	$262,655
3	S8420X	41.0	1.8	200	250	**Continuity**	47.6	0.52	Local	$154,340
3	S8425X	53.3	0.8*	200	250	Capacity	42.9	0.68	Special***	$170,381
3	S8430X	51.4	1.0	200	250	Capacity	42.5	0.62	Special***	$164,275

***Should be regraded to a minimum grade of 0.8%.**
****Flows from BUILD-OUT-PWWF-25 (with upgrades) scenario.**
*****Includes service roads, lanes, and right-of-way.**

October 17, 2025

Carolyn Hopp, P.Eng
Engineering Manager
Capital Regional District
Salt Spring Island Administration

RE: CRD Local Service Area Inclusion

This letter accompanies our Design Brief to support inclusion of three referenced parcels within the Local Service area for both Septic and Water. They are located on the boundary of the Septic Service area on Fulford Ganges Road, just outside the Village of Ganges.

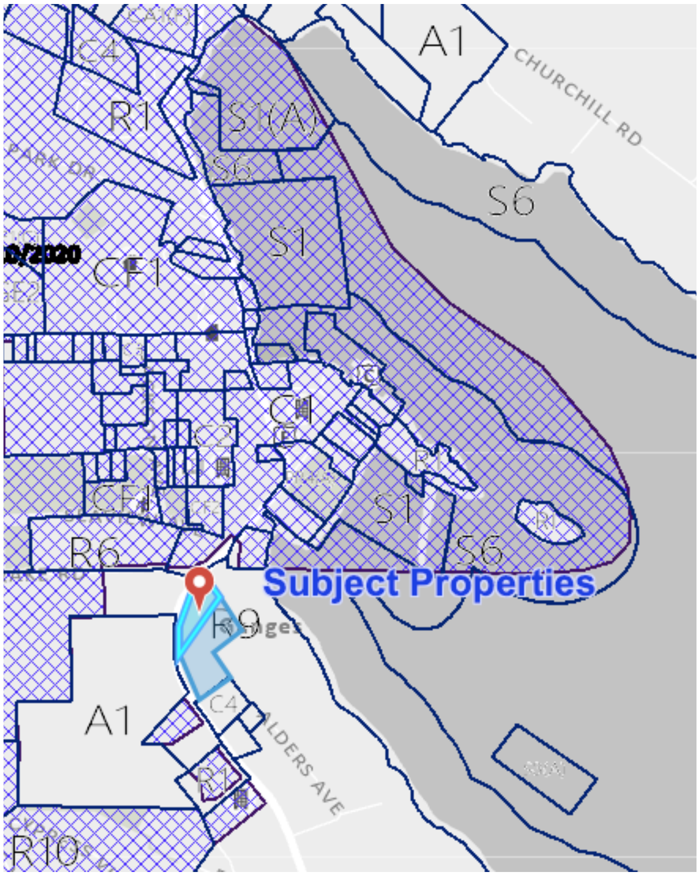
Proposed Inclusion Lots:

Address/Use	PID	Legal	Current Zone	Size m2
Not Assigned (Vacant)	017-759-561	LOT 1 PLAN VIP54155 SECTION 20 COWICHAN PORTION NORTH SALT SPRING RGE 3&4E	Gulf Islands Rural	3891.6786
Not Assigned (Vacant)	017-759-579	LOT 2 PLAN VIP54155 SECTION 20 RANGE 3 COWICHAN PORTION NORTH SALT SPRING &RGE4E	Gulf Islands Rural	5277.4421
231 Fulford Ganges Road (Residence)	005-264-367	LOT 2 PLAN VIP10572 SECTION 20 RANGE 3E COWICHAN PORTION NORTH SALT SPRING & RGE 4E	Gulf Islands Rural	3138.711

The site is proposed to host a 90 unit residential complex comprised of multiple structures varying in height, with a square footage of 9642.5m2. The population estimate is approximately 243 persons.

Figure 1 (following) demonstrates the location of the parcels in proximity to the Sewer Service area (purple hatched), and the Village of Ganges. A view of the three parcels is provided as an Appendices.

Figure 1: Sewer Inclusion Area



Further detail and design assumptions are contained within the enclosed Design Brief letter from JEA Anderson.
Thank you for confirming the next steps, if additional information is sought, and confirming the fee associated with proposal review:

Please contact me at 250-589-9657 with any questions or to arrange a meeting.

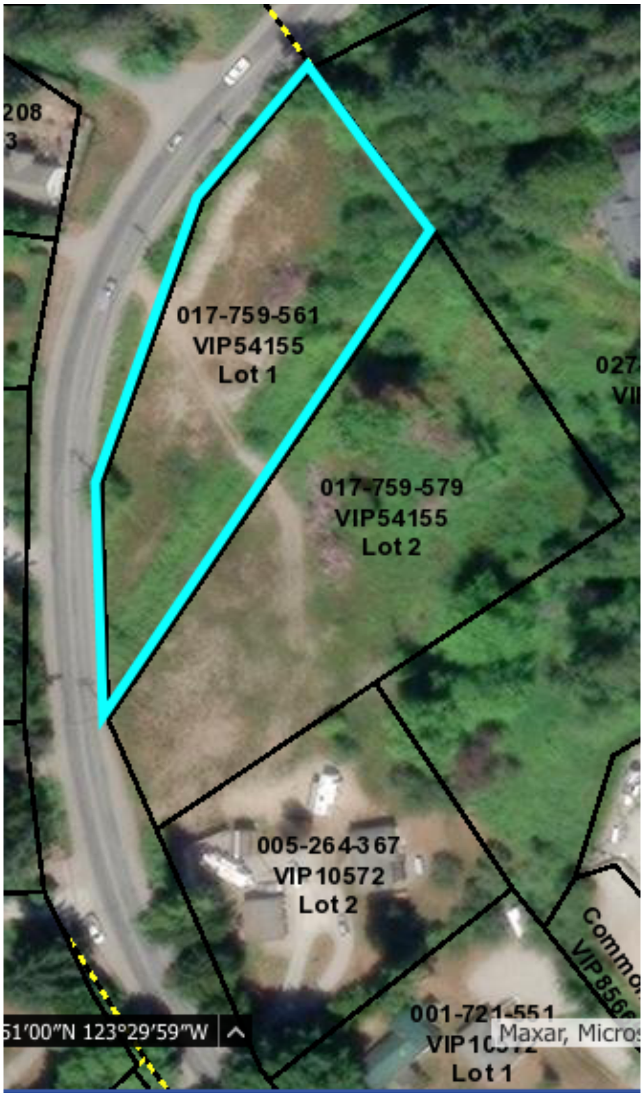
Sincerely,

Ellen Frisch on behalf of

Ganges Hill Development Company

Enclosure: JEA Design Brief

Appendix: Subject Parcel Configuration



LAND SURVEYING
CIVIL AND MUNICIPAL ENGINEERING
LAND DEVELOPMENT CONSULTING

J.E. ANDERSON & ASSOCIATES SURVEYORS - ENGINEERS SINCE 1959

October 17, 2025

File No. 34621

North Salt Spring Waterworks District NSSWD)
761 Upper Ganges Road
Salt Spring Island, BC
V8K 1S1

Capital Regional District (CRD
625 Fisgard Street
Victoria, BC
V8W 1R7

Re: Sewer and Water Calculations – Salt Spring Sewer Area Inclusion Request
PID 017-759-561
PID 017-759-579
PID 005-264-367 (231 Fulford-Ganges Road

The following calculations have been prepared by J.E. Anderson & Associates as requested by the developer in support of their application of inclusion in the local service area.

1.0 Introduction

As per the CRD Local Service Area Inclusion Requests Guideline, the following calculations are required:

a) Equivalent population for the whole property to be served
b) Average daily flow, peak hourly flow, and inflow and infiltration allowance (for sanitary sewer connection only)
c) Domestic water peak demand based on total fixture units water service connection only)

2.0 Development

The three parcels are proposed to be treated as a single parcel for development purposes. They are zoned as RN (Residential Neighborhoods). The parcels border the existing Sewer Inclusion area at the boundary of Drake Road and Fulford Ganges Road.

Reference	Parcel ID PID)	Legal Description	Size
A	017-759-561	Lot 1, Section 20, Ranges 3 and 4 East, North Salt Spring Island, Cowichan District, Plan VIP54155	0.390 ha
B	017-759-579	Lot 2, Section 20, Ranges 3 and 4 East, North Salt Spring Island, Cowichan District, Plan VIP54155	0.528 ha
C (231 Fulford-Ganges Road)	005-264-367	Lot 2, Section 20, Ranges 3 and 4 East, North Salt Spring Island, Cowichan District, Plan 10572	0.314 ha

The proposal is based on two scenarios considering a minimum build and a phased maximum opportunity. Assumptions include residential units: 20% one bedroom, 60% two bedroom and 20% three bedroom with progressive construction over time. While initially planned at 3 stories, the final designs will consider allowable heights, the topography and landscape and future demand. Scenario 1 proposal would be for 90 residential units and Scenario 2 proposal would be for up to a total of 180 residential units.

For the purposes of this report, the calculation will be based on Scenario 1, 90 residential units.

3.0 Design Criteria

MMCD 2022 Design Criteria for Population equivalence and sanitary flows.
National Plumbing Code

4.0 Sanitary

Population Equivalence PE) Per 2022 MMCD Design Criteria:

- Residential Area = 2.7 persons/unit

Lot Area (A) = 1.22 ha
Total residential units   90
Total GFA = 9642.5 m^2
Residential Population (P) = 90 units x 2.7 persons/unit   243 persons
Peaking Factor PF) = $1+(14/(4+(P/1000)^{1/2})) = 4.12$
Average Dry Weather Flow ADWF) = 240 L/c/day

Infiltration I I   11,200 L/ha/day x 1.22 ha   13,664 L/day

Q ADF)   ADWF x PE = 240 x 243 = 58,320 L/day

Q PHF)   ADWF x PF x P)   240 x 4.12 x 243 = 240,278.4 L/day   10,012 L/hr

Q(PWWF) = (ADWF x PF x P) + I&I
Q PWWF) = 240 x 4.12 x 243 + 13,664 = 253,942.4 L/day = **2.94 L/s**

5.0 Water

The following are the assumed fixture breakdown associated with the development:

- 163 bathroom groups 6.0 FU/group)
- 90 kitchen sinks (2.0 FU/sink)
- 90 clothes washers 1.4 FU/machine)
- 90 dishwashers (1.4 FU/machine)
- 12 hose bibbs 2.5 FU/hose bibb)

Total FU = 1440 (approximately 16.5 L/s)

6.0 Conclusion

Although the project is in early planning stages, the values provided will provide a basis to the review of considering the inclusion of the development to the existing service areas.

If you have any questions, please feel free to contact the undersigned at your convenience.

Yours truly,
J.E. Anderson and Associates

M. D. E. PUSZKA
49258
BRITISH COLUMBIA
EGBC# 1001272
2025-10-17

Mike Puszka, P.Eng.

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Email parksville@jeanderson.com

☐ Unit F – 1250 Cedar Street
Campbell River, BC V9W 2W5
Phone 250-287-4865
Email info@jeanderson.com

Making a difference...together

REPORT TO GANGES LOCAL SEWER SERVICE COMMISSION
MEETING OF THURSDAY, JUNE 4, 2026

SUBJECT **Ganges Sewer Inclusion Request - 160 Upper Ganges Road**

ISSUE SUMMARY

The purpose of this report is to consider including the proposed Lot A, Plan VIP61558, Section 3 Range 4E, Cowichan Land District, 160 Upper Ganges Road (Hastings House) in the Ganges Sewer Local Service Area and to make a recommendation in that regard.

BACKGROUND

The Ganges Sewer Service provides wastewater collection and treatment for residential and commercial properties within the Ganges Sewer Service Area. The Service Area is defined by Bylaw 1923 and doesn't currently include Lot A, Plan VIP61558, Section 3 Range 4E, Cowichan Land District. The property currently consists of 18 existing suites and cabins, accompanied by a restaurant and spa.

Ganges Sewer Service capacity restrictions originate from the effluent permit, wastewater treatment plant (WWTP) equipment, and from the collection system. The current effluent permit is for 1090 m^3/day. The nameplate capacity for the WWTP is nominally 1040 m^3/day. The capacity of the system was analyzed in 2025 by GeoAdvice (Appendix B) for current conditions and buildout estimates.

In addition to the 18 existing suites and cabins, restaurant and spa, the proponents are planning for an initial expansion of six (6) cabins, and an additional two (2) cabins to be completed under a future expansion. The proponents request and their calculations include the existing units and commercial space that is not currently connected to the sewer and the proposed development of 6+2 cabins. The development is in the early stages of design and permitting. The proponents of the development request inclusion of the property into the Ganges Sewer Service (Appendix A).

This proposal contains calculations for the estimated contribution to the sanitary flow, peak flow of up to 1.15 L/second.

The projected flows were modeled to assess the capacity of the existing system to convey the additional flows from the entire property. The modeling results can be found in the Technical Memorandum, (Appendix C). The results highlight two pipelines that do not have sufficient capacity to accommodate additional flows, *'requires an upgrade as the hydraulic capacity has been exceeded and is likely causing surcharging to occur'* however surcharging to the manhole rim is unlikely. A 2026 Capital Project is currently underway to address existing pipe capacity deficiencies.The design brief received from the proponent's engineer is outlined in the request for inclusion letter.

ALTERNATIVES

Alternative 1
That the Ganges Sewer Service Commission recommends that proposed Lot A, Plan VIP61558, Section 3 Range 4E, Cowichan Land District, 160 Upper Ganges Road (Hastings House) be granted permission to proceed with an application to be included in the Ganges Sewer Local Service Area.

Alternative 2
That the Ganges Sewer Service Commission recommends that proposed Lot A, Plan VIP61558, Section 3 Range 4E, Cowichan Land District, 160 Upper Ganges Road (Hastings House) be denied permission to proceed with an application to be included in the Ganges Sewer Local Service Area.

Alternative 3
That this report be referred back to staff for additional information.

IMPLICATIONS

Alignment with Existing Plans & Strategies
Inclusion into the service area will allow for additional revenue via sewer service fees and charges.

Climate and Environmental Implications
Transitioning from septage field discharge to discharge to reticulated sewer system will likely result in more favorable environmental impact.

Financial Implications
The proponent is responsible for covering costs due to the application process. The initial application fee has been received, $5,000. If the development proceeds, the developer is required to extend the existing sanitary sewer pipeline to the far extents of the property frontage. This work and the installation of the service connection will be contracted by the developer and those costs covered.

The capacity purchase bylaw, 3262, provides for the payment for non residential use as follows: X / 1000 x $2,390/m3 ($1,890/m^3/d for plant upgrade plus $500/m3d for outfall) where X represents the design flows of the property in L/day. The capacity purchase fee for this connection would be $237,470.40 as calculated from 99,360 L/day.

First Nations Implications
Ground disturbances will be necessary for the extension of the sewer and the service connection to the property and this may trigger First Nations consultation and Archeological investigation.

Service Delivery Implications
The proponent will be required to provide the design for pipeline extension as well as for the service connection. The proponent has already provided a capacity modeling report for the proposed new discharge to the existing sewer. Two pipelines that do not have sufficient capacity to accommodate additional flows, *‘requires an upgrade as the hydraulic capacity has been*

exceeded and is likely causing surcharging to occur' however surcharging to the manhole rim is unlikely. A 2026 Capital Project is currently underway to address pipe capacity deficiencies.

CONCLUSION

Inclusion of 160 Upper Ganges Road in the Ganges Sewer Local Service Area would support a transition from on-site wastewater management to centralized treatment, with associated environmental and service delivery benefits. While capacity constraints have been identified within portions of the existing collection system, planned capital upgrades are underway to address these deficiencies. The proposal would also result in additional revenue to the service through user fees and capacity charges, with all servicing and connection costs borne by the proponent. The Commission must consider system capacity, timing of infrastructure upgrades, and alignment with service objectives when determining whether to support the requested inclusion.

RECOMMENDATION

That the Ganges Sewer Commission recommends that Lot A, Plan VIP61558, Section 3 Range 4E, Cowichan Land District, 160 Upper Ganges Road (Hastings House) be granted permission to proceed with an application to be included in the Ganges Sewer Local Service Area.

Submitted by:	Carolyn Hopp, P.Eng., Manager Engineering, Salt Spring Island
Concurrence:	Dan Ovington, BBA, Senior Manager, Salt Spring Island Administration
Concurrence:	Stephen Henderson, MBA, P.G.Dip.Eng, BSc, General Manager, Electoral Area Services

ATTACHMENTS

Appendix A: Inclusion Request Letter (Design Brief)
Appendix B: Report - Ganges Sewer Service Area Modelling, Model Update, Calibration, and Capacity Analysis, Ganges, BC
Appendix C: Technical Memorandum (Modelling Report)

May 26, 2026

Ganges Local Sewer Service Commission
c/o Capital Regional District
108-121 McPhillips Ave
Salt Spring Island, BC, V8K 2T6

Re: Request for Inclusion into the Ganges Sewerage Local Service Area

To Whom it May Concern,

The Hastings House Country House Hotel is located at 160 Upper Ganges Road on Salt Spring Island, BC, and is requesting inclusion into the Ganges Sewerage Service Area. The property has 18 existing suites and cabins, accompanied by a restaurant and spa. Plans for expansion will add 6 new cabins, for a total of 24 suites and cabins.

The legal description of the property is Lot A, Plan VIP61558, Section 3 Range 4E, Cowichan Land District, Portion Salt Spring Island, Hastings House, and the PID is: 023-109-114. According to Islands Trust Land Use Bylaw Schedules and Maps (Land Use Bylaw #355); Salt Spring Island Sch A - Zoning Map - Ganges & Fulford, and Salt Spring Island Map 3 – Zoning Map, the property is split-zoned between A1: Agriculture 1, CA1: Commercial Accommodation 1, and R7: Residential 7, as shown in Figure 1.

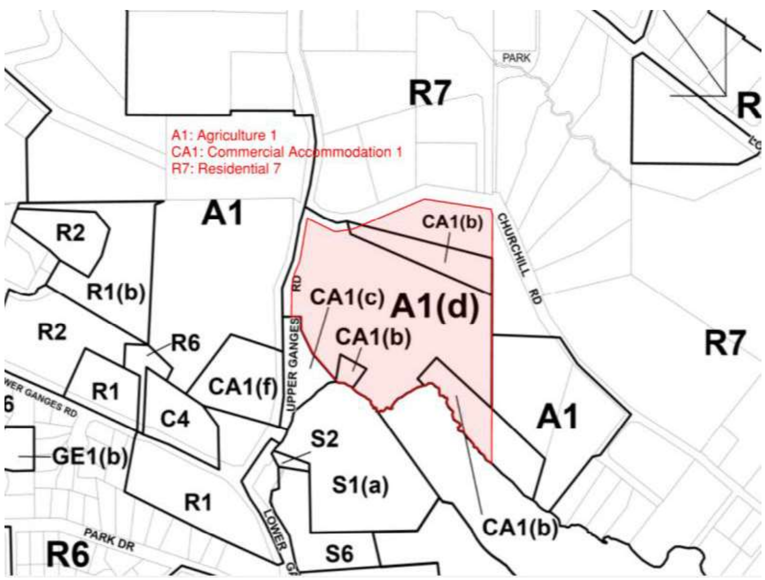

Figure 1: Property Zoning

It has been communicated by the CRD that the policy is for the developer to extend the sewer main the extents of the frontage of the property. The sewer main will therefore require an extension from the pump station on Upper Ganges Road, following the western property line to the far extents of the property approximately 225 m to Churchill Road.

Sewage Flow Summary

The Hotel is currently open from mid-March until the end of October with peak occupancy occurring while fully booked for four to five months out of the year, from mid-May to the end of September. Future plans include potentially opening the hotel all year round with another potential peak occupancy occurring during the holidays in December. Sewage flows are estimated according to BC Sewerage System Standard Practice Manual (SPM), Version 3, 2014. The SPM estimates the flow according to the number of bedrooms in the suites and cabins, and publishes estimated design flows for the restaurant, spa, laundry, and washrooms. Sewage flow calculations are provided in Table 1.

Table 1: Sewage Flow Calculations

Source	Quantity	Capita	Flow per Capita (L/d)	Total (L/d)
1-Bedroom Suite [A]	16	Suites	700	11,200
2-Bedroom Suite [A]	7	Suites	1,000	7,000
3-Bedroom Suite [A]	1	Suites	1,300	1,300
Restaurant [B]	70	Seats	90	6,300
Spa [C]	8	Uses	38	304
Laundry Machines [D]	2	Machines	1,560	3,120
Washrooms [E]	180	Uses	12	2,160
			Total	**31,384**

[A] *Flows based on SPM V3 Table II-8.*
[B] *Flows based on SPM V3 Table III-11 - Restaurant (full service), per seat.*
[C] *Flows based on SPM V2 Table 2-3 - Beauty Salon, per person.*
[D] *Flows estimated from Metcalf & Eddy Wastewater Engineering: Treatment and Resource Recovery, 5th Edition.*
[E] *Flows based on an estimated toilet flush volume and hand washing, public and staff.*

The Maximum Daily Demand (MDD) is therefore estimated at 31,384 L which is generally two times the average daily flows (15,700 L).

The estimated population is calculated by the same methodology as the design flows, per the SPM Table II-8. The 18 existing suites and cabins at full capacity would have an estimated population of 42 people, with up to 60 staff members at a time. After expansion, with the addition of 6 new cabins, there would be an estimated 59 people in the 25 suites.

In addition to the MDD, sewage flows must consider Inflow and Infiltration (I&I). Master Municipal Construction Document (MMCD) Standards provide I&I estimates for existing and new infrastructure, as existing infrastructure is generally more susceptible to I&I and is therefore calculated differently. Refer to Table 2 for the calculated I&I allowance in Peak Wet Weather Flow (PWWF) conditions, based on an area of 1.2 ha containing old piping and an additional 1.2 ha containing new piping.

Table 2: I&I Calculations

	Rate (m^3/ha/day)	Estimated Area (ha)	Total (m^3/day)
Inflow and Infiltration Allowance - Old Piping	22.5	1.2	27.0
Inflow and Infiltration Allowance - New Piping	11.2	1.2	13.4
		Total	**40.4**

The total I&I is estimated at 40.4 m^3/day and is applied to the estimated PWWF as determined in Table 3.

Table 3: Peak Wet Weather Flow Calculations

Parameter	Value	Units
Maximum Daily Demand [A]	31.4	m^3/day
MDD plus 10% Safety Factor	34.5	m^3/day
Inflow and Infiltration Allowance [B]	40.4	m^3/day
Peak Wet Weather Flow	**74.9**	**m^3/day**

[A] *Total sewage flow estimated, obtained from Table 1.*
[B] *Obtained from Table 2.*

The calculated PWWF is 74.9 m^3/day, which equates to 0.9 L/s. When applying a safety factor of 10% the estimated peak base sanitary flow is 34.5 m^3/day.

An Inflow and Infiltration allowance has been included in the system assessment to determine the PWWF at the request of the CRD; however, I&I is usually only associated with wet winter conditions when occupancy is at its lowest. Therefore, combining the peak sewage flows with peak I&I conditions does not represent a realistic scenario based on current operation and is considered overly conservative. If the hotel moves to operate year-round then this situation may occur during potential peak occupancy during December holidays.

Ganges Sewer Model Results

GeoAdvice Engineering Inc. holds the Ganges sewer model, and therefore, the CRD requested that flow modeling be performed by GeoAdvice to confirm the existing system can handle the proposed flows generated by the development. A 10% factor of safety was introduced in the flow calculations to ensure that the model results conservatively represent the estimated flows to the Ganges Sewer System.

Attached to this letter is the report completed by GeoAdvice which includes pump and wet well capacity calculations using proposed design flows, Harbour House pump station calculations, and calculations to show that the existing system including pumps, wet well and pipelines have the capacity to accept the new design sewer flows. Pump specifications attached were provided by CRD.

GeoAdvice modelled two case scenarios. This scope of work is considered and referred to within the report as the first option, “Current Buildout and 6 Cabin Expansion” for the inclusion of 35.3 m^3/day (0.4 L/s) of peak base sanitary flow, plus and 40.4 m^3/day (0.5 L/s) of I&I, for a total PWWF of 75.7 m^3/day (0.9 L/s).

Model results indicated two mains that do not meet requirements for the sewage flows (Pipe ID S8035X and S8025X) and insufficient capacity at the Ganges Pump Station. These system components are located between McPhillips Avenue and the Wastewater Treatment Plant at 103 Jackson Avenue. However, these inadequacies are present under current operating conditions before the addition of 160 Upper Ganges Road to the service area.

The development results in a minor increase in flow relative to existing system conditions and does not introduce new deficiencies or materially impact overall system performance, based on a comparison of Tables 2.7 and 2.8 in the GeoAdvice report.

Sewage Flows, Water Consumption, and Model Considerations

The sewage estimates have been prepared in accordance with the SPM methodology, which represents peak day conditions. A fully booked scenario at 100% occupancy already reflects a peak operational scenario and, when compared against water consumption records, the estimated peak sewage flows generally exceed observed peak operating season water usage.

Based on water bills from May through August over the last two years, the average daily consumption between May 1st, and August 31st, is approximately 17,942 L/d in 2024, and 23,802 L/d in 2025. The highest water consumption reached 27,616 L/d in July and August 2025.

The difference in observed water consumption relative to the calculated sewage DDF of 32,084 L/d, can be explained by two primary contributing factors:

1. Within the development, multiple uses are effectively served by the same user group (i.e., guests occupying suites are also those using spa facilities, benefitting from washing machines for suite laundry, and using public washrooms), resulting in overlapping sewage components. Eliminating overlapping sewage components from the estimated DDF could reduce the calculated peak sewage flows by 10%-15%.
2. The calculated sewage DDF considers 6 new suites that are not yet reflected in the recorded water consumption. The new suites will account for 15%-20% of the calculated sewage DDF.

Taking these two factors into consideration when assessing the discrepancies between estimated peak sewage flows and actual water consumption, the water records become an accurate representation of the estimated sewage demands for the development. The adjusted sewage DDF is reduced to approximately 23,000 L/d, which is similar to the average daily consumption between May 1st, and August 31st in 2025. Note that an additional consideration not affecting the sewage estimates yet impacting the water records, is irrigation.

Regarding annual sewer user fees, the Ganges Sewer System operates on a cost allocation model under CRD Bylaw No. 3864. For Business Properties, the Business Share is split 50% based on building floor area and 50% based on relative water consumption across all business users. Water consumption on the property therefore provides a reasonable comparative for the charges incurred by the sewage demands.

We thank you for your consideration in including Hastings House into the Ganges Sewer Service Area. We look forward to your approval.

Regards,

MSR Solutions Inc.

Association of Professional Engineers and Geoscientists of the Province of British Columbia
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Ganges Sewer Service Area Modelling
Model Update, Calibration, and Capacity Analysis
Ganges, BC

Report
FINAL

Prepared for:
Capital Regional District
108 – 121 McPhillips Avenue
Salt Spring Island, BC V8K 2T6

Prepared by:
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Submission Date: January 27, 2025
Contact: Dr. Werner de Schaetzen, Ph.D., P.Eng.
Project ID: 2024-057-CRD

Document History and Version Control

Revision No.	Date	Document Description	Revised By	Reviewed By
R0	January 10, 2025	Draft	Sean Zoschke	Werner de Schaetzen
R1	January 27, 2025	Final	Sean Zoschke	Werner de Schaetzen

Statement of Qualifications and Limitations

This document represents the best professional judgment of GeoAdvice Engineering Inc. based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty expressed or implied is made.

Table of Contents

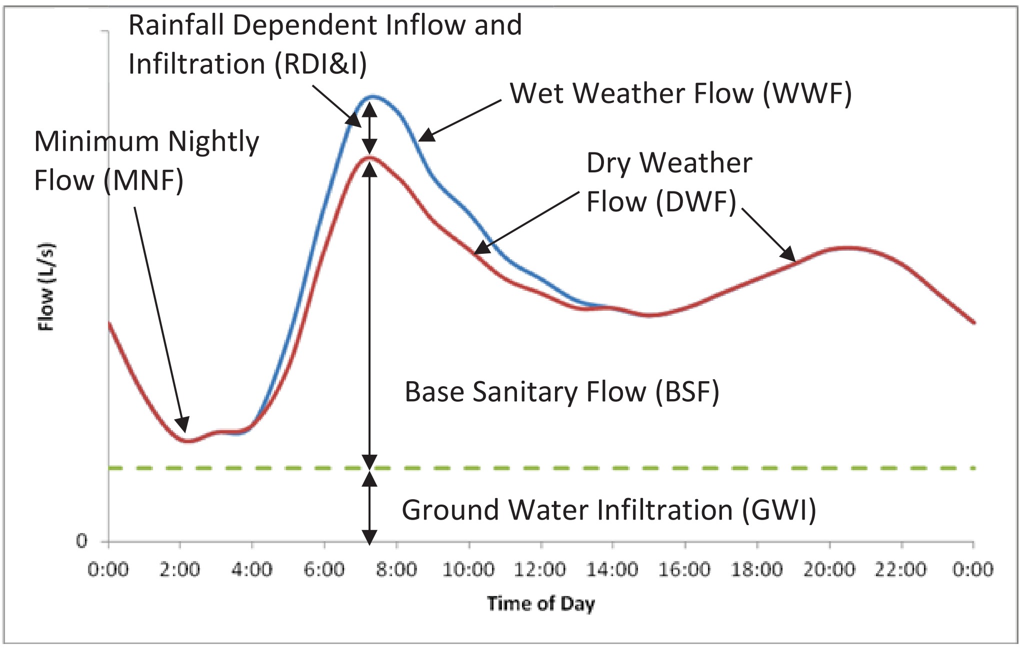
Definitions

Daily flow conveyed in a sanitary sewer system can be generally divided into six (6) components:

1. Ground Water Infiltration (GWI)
2. Base Sanitary Flow (BSF)
3. Dry Weather Flow (DWF)
4. Rainfall Dependent Inflow and Infiltration (RDI&I)
5. Wet Weather Flow (WWF)
6. Minimum Nightly Flow (MNF)

Their relationship is shown in **Figure 1**.

Figure 1: Flow Components Hydrograph



Ground Water Infiltration (GWI) – Ground water infiltration results from the movement of ground water in the saturated zone into the sewer system through defects in the components of the sewer system located below the water table.

Base Sanitary Flow (BSF) – All wastewater from residential, commercial, institutional, and industrial sources that the sanitary sewer system is intended to convey.

Dry Weather Flow (DWF) – The portion of the total flow that is composed of BSF and GWI. DWF = GWI + BSF.

Average Dry Weather Flow (ADWF) – The value of the diurnally varying Dry Weather Flow, averaged over a 24-hour period.

Rainfall Dependent I&I (RDI&I) – Rainfall dependent inflow and infiltration equals rainfall-induced infiltration plus all sources of inflow.

Wet Weather Flow (WWF) – All flow contributions carried by the sanitary sewer system during wet weather. WWF = GWI + BSF + RDI&I.

Peak Wet Weather Flow (PWWF) – All flow contributions carried by the sanitary sewer system during peak wet weather.

Minimum Nightly Flow (MNF) – The lowest flow rate observed within the sanitary sewer system during the night hours, typically occurring during periods of minimal water usage.

1 Introduction

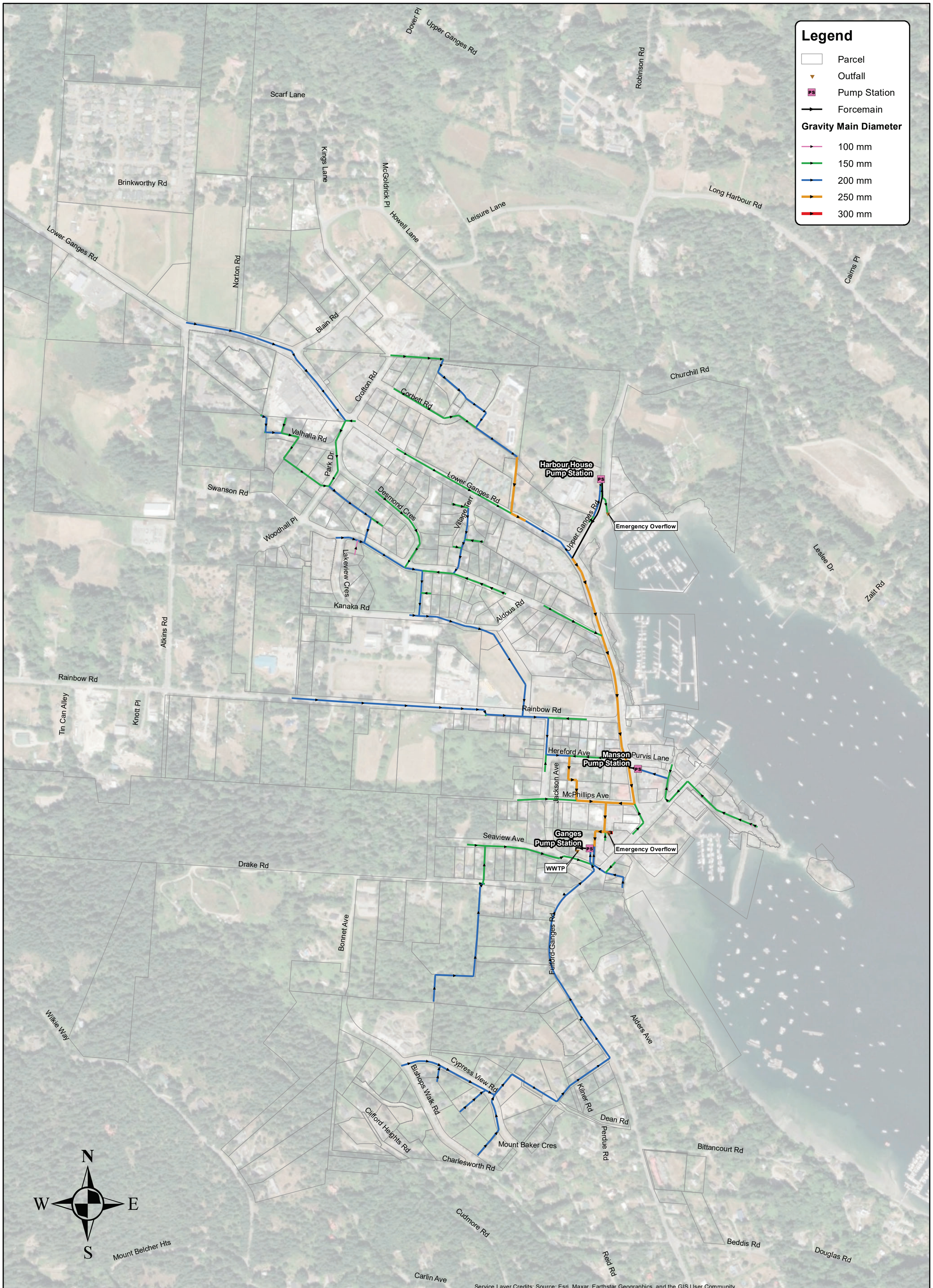
GeoAdvice Engineering Inc. (GeoAdvice) was retained by the Capital Regional District, BC (CRD) to complete the Ganges Sewer Service Area Modelling, which involved updating and calibrating the Ganges sewer hydraulic model and conducting a sewer system capacity analysis. This report summarizes the sewer model development, including the methodology and assumptions used to update and calibrate the Ganges sewer model. In addition, this report describes the methodology, assumptions and results of the future scenario development, hydraulic capacity analysis, and system improvement recommendations.

The sewer model was developed using the InfoSWMM software program (Innovyze/Autodesk). InfoSWMM is a sanitary sewer system modeling and management software application.

In the preparation of this report, GeoAdvice would like to acknowledge the support of the following CRD and Islands Trust Staff:

- Doug Weihing (CRD)
- Dean Olafson, P.Eng., MBA (CRD)
- Chris Buchan (Islands Trust)
- Chris Hutton, MPA, MCIP, RPP (Islands Trust)

The Ganges sewer system is shown in **Figure 1.1** on the following page.



Project: Ganges Sewer Service Area Modelling
Project ID: 2024-057-CRD
Client: Capital Regional District
Date: January 2025
Created by: SZ
Reviewed by: WdS

CRD Making a difference...together

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Ganges Sewer System

0 0.1 0.2 0.4
Kilometers

Figure 1.1

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

2 Model Update

The hydraulic model update was divided into multiple tasks as follows:

- Task 1: Data Collection and Review
- Task 2: GIS Model Update
- Task 3: Data Gaps and Connectivity Analysis
- Task 4: Node Elevation Extraction
- Task 5: Primary System Components
- Task 6: Existing Base Sanitary Flow (BSF) Calculation and Allocation
- Task 7: Future Base Sanitary Flow (BSF) Calculation and Allocation
- Task 8: Field Data Review and Analysis
- Task 9: Inflow & Infiltration Allocation

Table 2.1 summarizes the main components of the sanitary sewer collection system model.

Table 2.1: Model Statistics of Current System

Component	Total
Manholes	203
Gravity Mains	9.4 km
Forcemains	0.2 km
Pump Stations	3
Area	99.2 ha

2.1 Data Collection and Review

Prior to building the model, information on the Ganges sewer system was compiled, collected and reviewed. This included reviewing the following pertinent information:

- Previous InfoSWMM hydraulic model
- GIS database
- As-built drawings
- Wastewater Treatment Plant influent flow data
- BOT Corp flow monitoring and rainfall data
- Open data rainfall and intensity-duration-frequency (IDF) curves
- Ganges water billing consumption data
- DEM elevation data
- Pump station operations
- Background reports
- Land-use and zoning maps
- Growth projection data

2.2 GIS Model Update

The CRD GIS data, as-built drawings, and previous InfoSWMM model were the key sources of information on the Ganges system to update the pipe and node network topology model. Attributes of the sewer mains such as nominal diameter, inlet and outlet invert elevations, depth, grade, material, age, status, were extracted from both the GIS database, as-built drawings and previous InfoSWMM model. Minor updates were made to the model pipe network to align it with the current GIS. Pump station dimensions, settings, and pump curves were updated to match the provided specifications. The coordinate system used in the model is UTM NAD 83 Zone 10.

2.3 Data Gaps and Connectivity Analysis

The next task involved reviewing the GIS sewer data, identifying data gaps (e.g. missing diameter) and checking system connectivity (e.g. orphan pipe). As much as possible, a one-to-one relationship between the model and GIS data was maintained to facilitate future model updates.

2.4 Node Elevation Extraction

The collected DEM elevation data was used to validate ground elevations in the model and to determine missing ground elevations.

2.5 Primary System Components

The hydraulic modeling data for all the primary system components are summarized in a series of tables provided in **Appendix A**. CRD operates and maintains three (3) pump stations throughout the sanitary network.

2.6 Existing Base Sanitary Flow Calculation and Allocation

The existing sewer base sanitary flow (BSF) was calculated using the 2023 average water demand for each sewer-serviced parcel from the water billing data, and water-sewer conversion factors determined during calibration. Different conversion factors were applied for Industrial, Commercial, and Institutional (ICI) and residential land uses for each of the three calibration catchments to achieve a good match with the field data at each location. There was a large variance in conversion factors between catchments, and in some cases a higher BSF than water demand was required to achieve a good match. This is likely due to differences between the 2023 average water demand and water demand during sewer flow monitoring, or error in the water billing data or sewer flow data. The scaling of water demand to match dry weather flow data for each catchment is the best way to allocate BSF as it allows for a match with the field sewer flow data while maintaining the distribution of water demands within each catchment. **Table 2.2** summarizes the existing BSF loading for residential and ICI land uses.

Table 2.2: Calibrated Existing BSF Load Summary

Land Use	Base Sanitary Flow (L/s)
Residential	2.15
ICI	0.47
Total	**2.62**

Based on the estimated sewer-serviced residential population from *Ganges Sewage System – Condition Assessment and Engineering Study* (Stantec, November 2011) of 1,524 capita (based on 508 residential units and 3 capita/unit), the calibrated residential BSF rate is approximately 122 L/capita/day, which is within the normal range of BSF rates for small municipalities in BC.

2.7 Build-Out Base Sanitary Flow Calculation and Allocation

Future growth data was provided by Islands Trust and included potential maximum densities for parcels expected to have future high-density development in the Ganges Village Area based on OCP land use designations. These maximum potential densities were used to develop build-out scenario loads. Some of the Ganges Village Area growth parcels provided by Islands Trust are outside of the sanitary sewer service area; however, these parcels were included in the future scenario to be conservative. Lastly, loads for two parcels identified by the CRD as known areas of potential future institutional growth not accounted for in the Islands Trust data were also included in the build-out scenario.

Table 2.3 summarizes the assumed rates used to calculate the future sanitary sewer loads.

Table 2.3: Sewer Design Rates

Load Type	Design Rate
Residential Density	2.5 capita/unit*
Institutional Density	50 capita/ha**
Base Sanitary Flow (BSF)	240 L/cap/day**
Inflow and Infiltration (I&I)	11,200 L/ha/day**

***Based on *Ganges Sanitary System – InfoSWMM Model Creation (Stantec, May 2018)*.**
****Based on 2022 MMCD Design Guidelines.**

The residential and institutional density rates were used to convert the Islands Trust residential densities and CRD institutional parcel areas to equivalent populations. The MMCD design BSF rate of 240 L/cap/day was then applied to these equivalent populations to calculate the future BSF for each of the growth parcels. The maximum of the existing BSF and future BSF for each parcel was used in the build-out scenario. In addition, I&I loads were added for future expansion parcels that are not currently serviced (parcels that have a future BSF load and not an existing

BSF load) using the MMCD design I&I rate of 11,200 L/ha/day. This is less than the calibrated existing 5-year I&I rate of 49,000 L/ha/day which is discussed in **Section 2.9.2**; however, it is standard practice to apply the MMCD design rate for new infrastructure that will have lower I&I. The future expansion parcels had a total area of 23.5 ha and added 3.05 L/s of future I&I to the system.

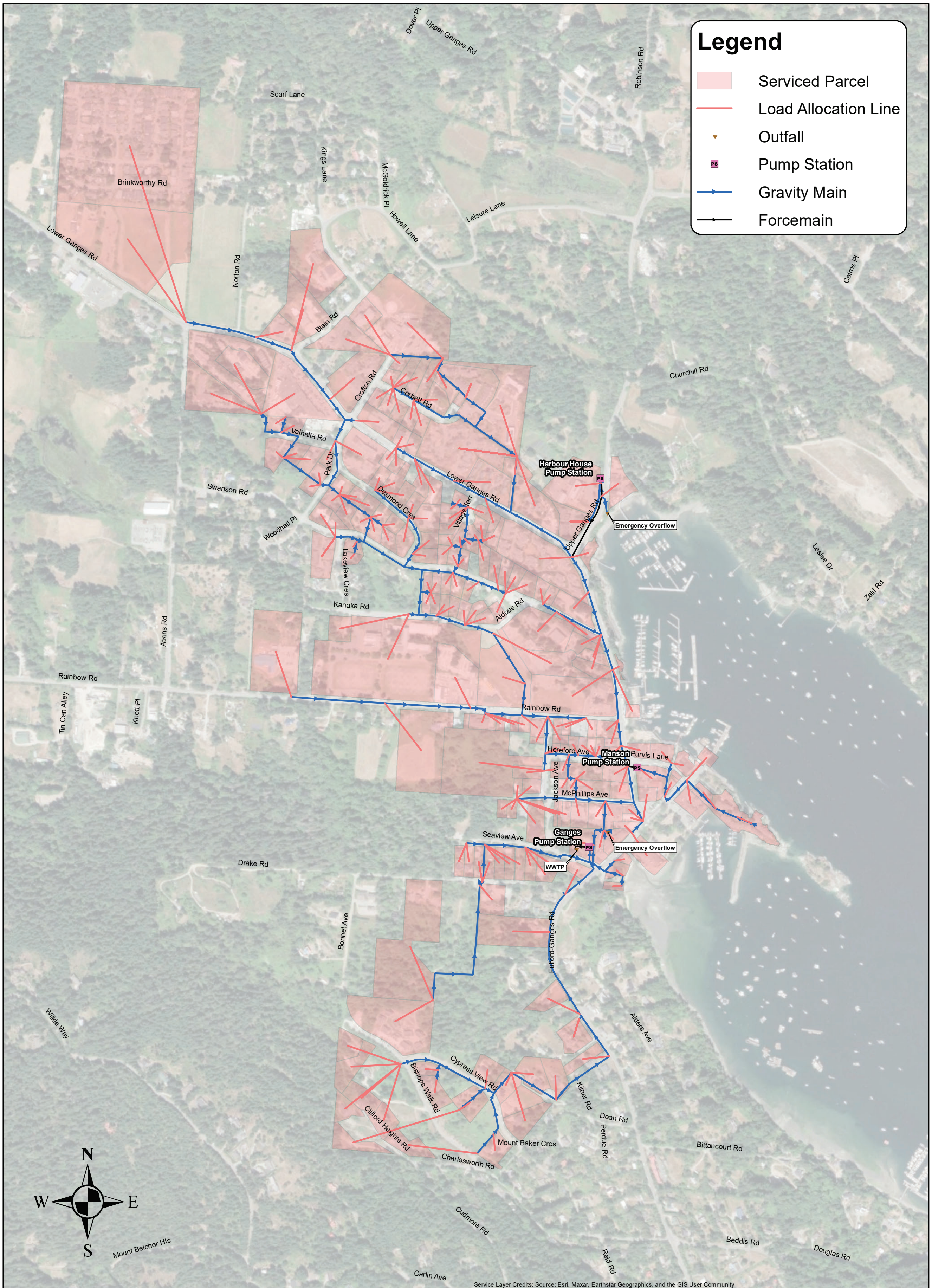
Table 2.4 summarizes the BSF loads for the model scenarios.

Table 2.4: Existing and Future BSF Load Summary

Load Type	Existing (L/s)	Build-Out Growth (L/s)
Existing Residential	2.15	2.15
Existing ICI	0.47	0.47
Growth Residential	-	9.70
Growth ICI	-	0.30
Total	**2.62**	**12.62**

The estimated existing sewer-serviced residential population is 1,524 capita, while the estimated build-out sewer-serviced residential population is 5,016 capita (assuming a population growth of 3,492 capita with a sewer BSF rate of 240 L/cap/day). A graph showing the potential time horizons for this estimated build-out population to be reached under different annual growth rates is provided in **Appendix B**.

The existing scenario load allocation is shown in **Figure 2.1**, while the future build-out scenario growth load allocation is shown **Figure 2.2**.



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GeoAdvice Engineering Inc.

Existing Sewer Load Allocation

0 0.1 0.2 0.4
Kilometers

Figure 2.1

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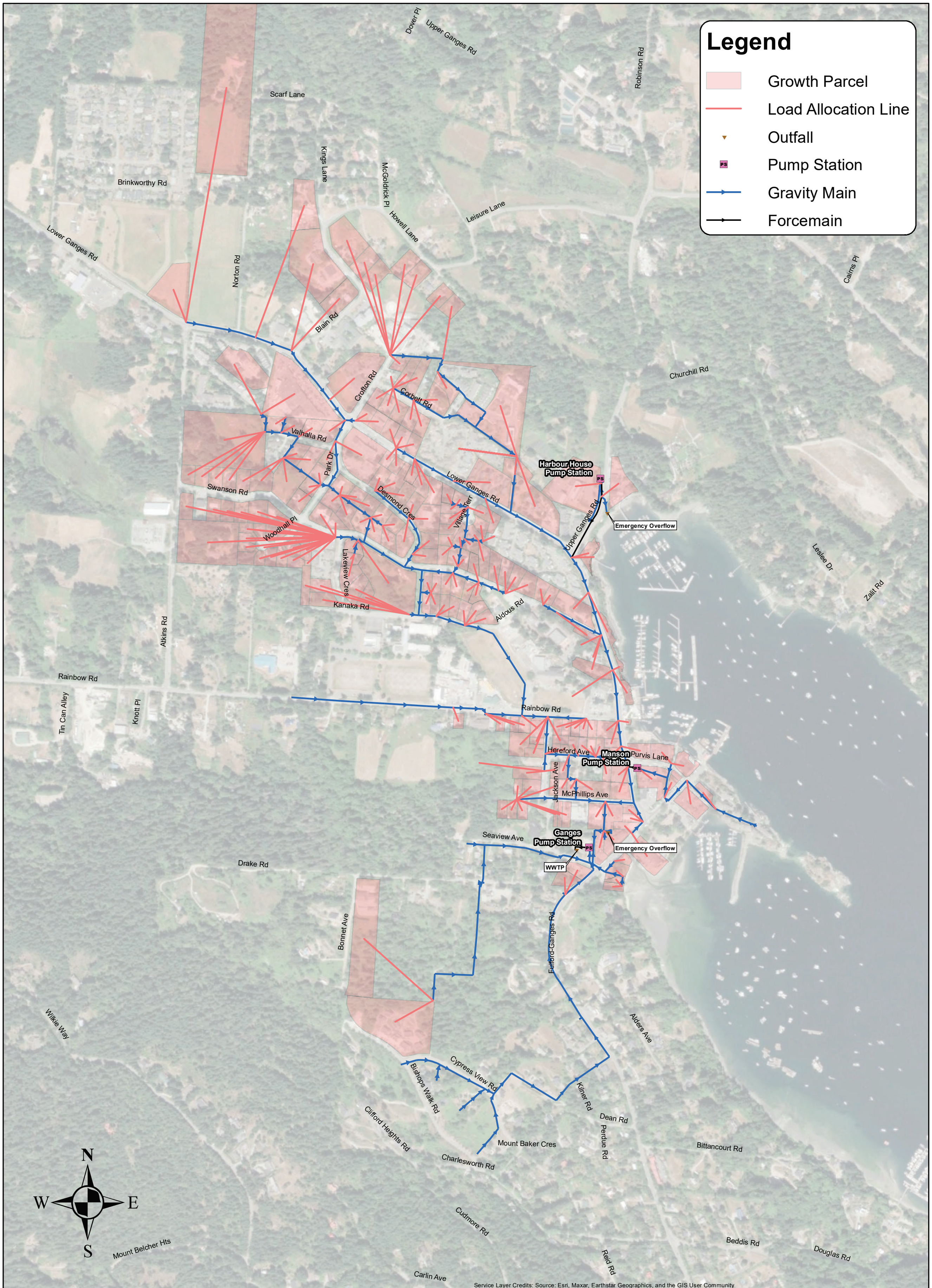

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Reviewed by:	WdS

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Build-Out Growth Sewer Load Allocation

0 0.1 0.2 0.4
Kilometers

Figure 2.2

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2.8 Field Data Review and Analysis

Flow data from two (2) temporary flow monitoring sites and rainfall data from one (1) temporary rain gauge site were provided by BOT Corp. Flow Site 1 was located in manhole S8055 at Rainbow Rd and Lower Ganges Rd, and flow Site 2 was located in manhole S8035 at Mc Phillips Ave west of Lower Ganges Rd, while the rain gauge was stationed at the Wastewater Treatment Plant (WWTP). Additionally, the CRD provided inflow data from the WWTP, and open-source rainfall data was obtained from a rain gauge in Fulford Harbour for analyzing WWTP inflows outside of the BOT Corp monitoring period. Together these three (3) flow sites were used for model calibration.

Representative dry field days were selected for each location for dry weather calibration. For wet weather calibration, the 2-year storm event during October 18-20, 2024 captured by the BOT Corp flow monitors and WWTP inflow monitor was compared to the 100-year storm event during November 11-18, 2021 captured by only the WWTP inflow monitor. The percentage of rainfall volume converted to I&I was significantly higher for the November 2021 event than for the October 2024 event. This is due to higher saturation conditions during the November 2021 event, often associated with extreme storms, which reduces surface storage, soil infiltration, and evaporation, leading to stormwater system overflow and a higher amount of rainfall volume entering the sanitary sewer system as I&I. Since the November 2021 event is larger and more conservative, it was used for model calibration. Although there was only flow data from the WWTP for this event, a comparison of Site 1, Site 2, and WWTP flows for the October 2024 event showed that the I&I responses are approximately the same at all sites. **Table 2.5** summarizes the average dry weather flow (ADWF) and peak wet weather flow (PWWF) at each flow monitoring site.

Table 2.5: Flow Monitor Locations and Flow Summary

Flow Monitor	Date Range	Manhole ID	Average Dry Weather Flow	Peak Wet Weather Flow
Site 1	Oct 7, 2024 to Nov 4, 2024	S8055	1.51 L/s	N/A
Site 2	Oct 7, 2024 to Nov 4, 2024	S8035	1.89 L/s	N/A
WWTP Inflow	Oct 7, 2024 to Nov 4, 2024 and Nov 1, 2021 to Nov 31, 2021	S8015	3.84 L/s	41.77 L/s

2.9 Inflow & Infiltration Allocation

Inflow and Infiltration (I&I) represent additional loading on the sanitary sewer system during dry and wet weather. They are categorized into the following:

- Ground Water Infiltration (GWI)
- Rainfall Dependent Inflow and Infiltration (RDI&I)

2.9.1 Ground Water Infiltration

Ground water infiltration loads were estimated for each flow monitoring catchment using the Stevens – Schultzbach Method. The Stevens – Schultzbach method uses a curve fitting technique to estimate ground water infiltration for a wide range of catchment sizes. This method is based on average dry weather flow (ADWF) and minimum nightly flow (MNF) experienced in typical residential flow patterns. The Stevens – Schultzbach equation is included below:

$$GWI = \frac{0.4\,MNF}{1 - 0.6\left(\frac{MNF}{ADWF}\right)^{ADWF^{0.7}}}$$

Table 2.6 summarizes the GWI allocated to each flow monitoring catchment. Total GWI loads and GWI rates were calculated at the catchment level. GWI loads were then spatially distributed to each serviced parcel based on the respective area.

Table 2.6: GWI Allocation per Flow Monitoring Catchment

Flow Monitor	MNF (L/s)	ADWF (L/s)	GWI (L/s)	Catchment Area (ha)	GWI (L/ha/day)
Site 1	0.44	1.65	0.37	24.2	**1,300**
Site 2	0.65	2.13	0.54	81.6	**600**
WWTP Inflow	1.33	4.18	1.03	99.2	**900**

The GWI rate of 900 L/ha/day at the WWTP represents the average Ganges GWI rate, since this site captures the entire system.

2.9.2 Rainfall Dependent Inflow & Infiltration

The RTK method was used to quantify the rainfall dependent inflow & infiltration for the wet weather flow calibration. Refer to **Section 3.2** for further details regarding the RTK method.

Design storms with and without climate change were created using Ganges intensity-duration-frequency (IDF) curves generated by the IDF-CC tool, and the calibrated RTK parameters were used to quantify the RDI&I in the Ganges network. I&I rates under a 5-year and a 25-year design storms with and without climate change are summarized in **Table 2.7**. As with GWI, I&I rates were calculated at the catchment level and I&I loads were then spatially distributed to each serviced parcel based on the respective area. Note that the WWTP inflow I&I rates represent the average Ganges I&I rates.

Table 2.7: I&I Allocation per Flow Monitoring Catchment (GWI + RDI&I)

Flow Monitor	Catchment Area (ha)	Without Climate Change		With Climate Change	
		I&I 5-yr (L/ha/day)	I&I 25-yr (L/ha/day)	I&I 5-yr (L/ha/day)	I&I 25-yr (L/ha/day)
Site 1	24.2	53,000	68,700	56,500	70,400
Site 2	81.6	49,200	66,400	51,700	66,700
WWTP Inflow	99.2	49,000	64,300	51,300	67,700

3 Model Calibration

Before describing how the model was calibrated, it is useful to examine why a hydraulic model may not match the field data. Most of the sources of errors or mismatches are:

- Input data errors
- System loading errors
- Operational control errors
- Poorly calibrated measuring equipment
- Outdated data

The cumulative effect of these areas of uncertainty or "approximation" is that, without verification and validation of the model's ability to recreate known conditions, it is likely that the modeling results would be grossly misleading.

The main reasons for and benefits of a well calibrated model are listed below:

- Confidence: Demonstrate the model's ability to reproduce existing conditions.
- Understanding: Confirm the understanding of the performance of the system.
- Troubleshooting: Uncover missing information and misinformation or anomalies about the system.

3.1 Dry Weather Flow Calibration Results

Modeling results were first reviewed, and then key model parameters were adjusted until the model results closely matched the dry weather flow field data. A summary of the calibration changes is shown in **Table 3.1**.

Table 3.1: Calibration Adjustments

Parameter	Description
BSF	Adjusted sanitary sewer residential and ICI loading rates (see **Table 2.2**)
GWI	Adjusted GWI rates (see **Table 2.6)**
Pattern	Calibrated diurnal patterns

Table 3.2 summarizes the dry weather flow (DWF) calibration results.

Table 3.2: Dry Weather Flow Calibration Results

Flow Monitor	Average Flow (L/s)			Peak Flow (L/s)		
	Field	Model	Difference	Field	Model	Difference
Site 1	1.51	1.56	+ 0.04	2.83	3.52	+ 0.69
Site 2	1.89	2.00	+ 0.11	3.38	4.48	+ 1.10
WWTP Inflow	3.84	3.70	+ 0.13	7.18	8.66	+ 1.49

The dry weather flow calibration hydrographs are shown in **Appendix C**.

Overall, the model predicts a good agreement with the dry weather field data. Modeled average dry weather flows are within 0.2 L/s and peak dry weather flows are within 1.5 L/s of the field data.

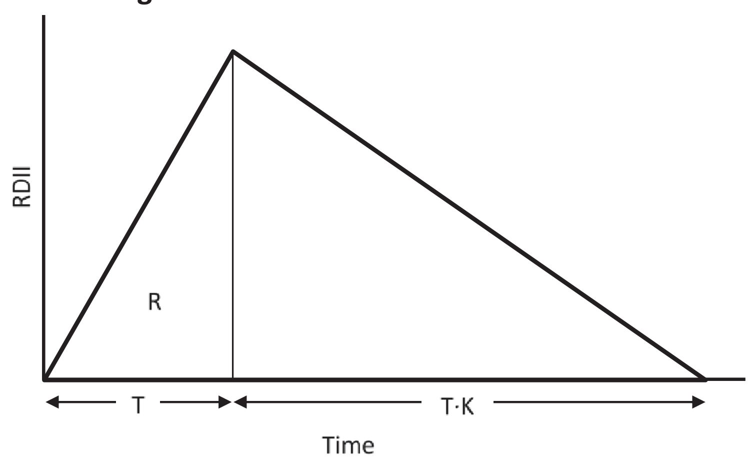
3.2 RTK Wet Weather Flow Calibration Results

The RTK method was used to quantify the rainfall dependent inflow & infiltration (RDI&I) for the wet weather flow calibration. With the RTK method, RDI&I is simulated using three triangular unit hydrographs representing fast, medium, and slow responses to rainfall. The shape of each triangle is quantified by three parameters:

R: the fraction of effective rainfall volume over the watershed that enters the sewer system.
T: the time to peak in hours.
K: the ratio of the time to recession to the time to peak.

The relationship between the R, T, and K parameters is shown in **Figure 3.1**.

Figure 3.1: RTK Method Parameters

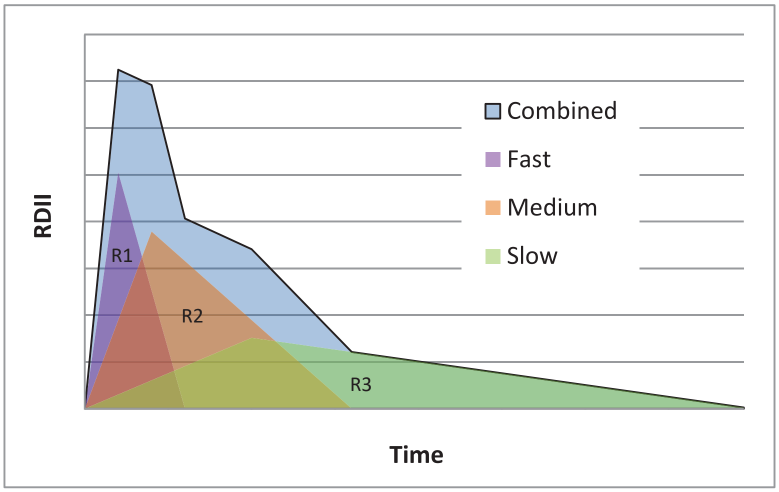


The sum of the three R-values (R1, R2, and R3) equals to the total fraction of rainfall volume over the watershed that enters the sewer system:

$$R = R1\ (\text{fast}) + R2\ (\text{medium}) + R3\ (\text{slow})$$

The total RDI&I represents the sum of the three components, as shown in **Figure 3.2**. In this figure, R1, R2, and R3 represent the areas of the fast, medium, and slow response triangles, respectively.

Figure 3.2: RTK Method for Representing RDI&I



WWTP flow from the 100-year storm event between November 11, 2021 and November 18, 2021 was used for wet weather flow calibration. This site captures the entire Ganges sewer system, so the RTK parameters determined from this data were applied to the entire system. Since Site 1 and Site 2 had no data for this event, the model was only calibrated to the WWTP flows. However, a comparison of the Site 1, Site 2, and WWTP flows for the October 2024 event showed that the I&I rates are approximately the same at all sites.

The wet weather flow calibration results for the WWTP are summarized in **Table 3.3**. Wet weather flow hydrographs comparing the model and field results can be found in **Appendix D**. The calibrated RTK parameters can be found in **Appendix E**.

Table 3.3: RTK Wet Weather Flow Calibration Results Summary (Nov 11-18, 2023)

Flow Monitor	Average Flow (L/s)			Peak Flow (L/s)		
	Field	Model	Difference	Field	Model	Difference
WWTP	14.40	13.83	- 0.57	41.77	46.46	+ 4.69

Overall, the model predicts a good agreement with the wet weather field data.

4 Sanitary Sewer Hydraulic Performance Analysis

4.1 Hydraulic Level of Service Criteria

The criteria outlined in **Table 4.1** and **Table 4.2** were used to assess the hydraulic capacity of each gravity main and to assign hydraulic level of service (HLoS) ratings. The HLoS methodology below is based on q/Q results (peak flow/full pipe flow) rather than d/D results (depth/Diameter). The q/Q methodology provides a better picture of the hydraulic condition of each gravity main and how the HLoS is impacted by downstream conditions.

Table 4.1: Gravity Main Hydraulic Level of Service Criteria Scoring

Criteria	Score
Hydraulic Capacity (q/Q)	
q/Q < 0.85	1
0.85 ≤ q/Q < 1.0	2
q/Q ≥ 1.0	3
Hydraulic Grade Line (HGL)	
HGL < Crown	1
Crown ≤ HGL < Rim Elevation	2
HGL ≥ Rim Elevation	3
Velocity (v)	
v < 0.6 m/s	Fail
v ≥ 0.6 m/s	Pass

Table 4.2: Gravity Main Hydraulic Level of Service Ratings

HLoS Rating	Capacity	HGL	Velocity	Description
A	1	1	Pass	Gravity Main performing as designed
B	1	1	Fail	Adequate capacity, low velocity indicates potential sedimentation
C	1	2 or 3	Pass or Fail*	Adequate capacity, backwater caused by downstream conditions
D	2	1, 2 or 3	Pass or Fail*	Marginal capacity, backwater caused by downstream conditions
	3	1	Pass or Fail*	
E	**3**	**2**	**Pass or Fail***	**Capacity exceeded and surcharging likely**
F	**3**	**3**	**Pass or Fail***	**Capacity exceeded and flooding likely**

***HLoS ratings from ‘C’ to ‘F’ are independent of velocity criteria.**

In general, HLoS ratings of ‘A’, ‘B’, ‘C’ and ‘D’ will not trigger an upgrade as there is capacity available in the gravity main to convey flows. Gravity mains receiving a HLoS rating of ‘C’ or ‘D’ may show surcharging or flooding on connected nodes; however, these cases would indicate that the surcharged condition is due to downstream hydraulic deficiencies.

Only gravity mains receiving a HLoS rating of ‘E’ and ‘F’ were considered for upgrade. A gravity main receiving an ‘E’ rating requires an upgrade as the hydraulic capacity has been exceeded and is likely causing surcharging to occur. A gravity main receiving an ‘F’ rating indicates that surcharging to the manhole rim is likely, increasing the priority of the upgrade.

Table 4.3 and **Table 4.4** outline the criteria used to assign hydraulic level of service ratings to each pump station.

Table 4.3: Pump Station Hydraulic Level of Service Criteria Scoring

Criteria	Score
Pump Capacity	
PWWF* ≤ Firm Capacity	Pass
PWWF* > Firm Capacity	Fail
Wet Well Capacity	
Max. Operating Level < Inlet Pipe Invert	A
Max. Operating Level ≥ Inlet Pipe Invert	B
Max. Operating Level >= Max. Physical Depth	C
Forcemain Velocity	
v < 0.9 m/s	Fail
0.9 m/s ≤ v ≤ 3.5 m/s	Pass
v > 3.5 m/s	Fail

***PWWF = Peak Wet Weather Flow.**

Table 4.4: Pump Station Hydraulic Level of Service Ratings

HLoS Rating	Pump Capacity	HGL	Velocity	Description
A	Pass	A	Pass	Pump station performing as designed
B	Pass	A	Fail	Forcemain velocity outside of design range
C	Pass	B	N/A	Inlet pipe invert within pump operating range and backup likely (submerged inlet)
D	Fail	A	N/A	Pump capacity exceeded but sufficient wet well capacity to attenuate additional flow
E	Fail	B	N/A	Pump capacity exceeded and backup likely
F	N/A	C	N/A	Wet well capacity exceeded and overflow likely

A pump station receiving a HLoS rating of 'A', 'B', or 'C' will not trigger an upgrade as the pump capacity is sufficient to convey the PWWF entering the station; however, HLoS ratings of 'B' and 'C' indicate operating conditions that should be reviewed by the CRD.

Pump stations receiving a HLoS rating of 'D', 'E', or 'F' indicate that the pump capacity has been exceeded with varying levels of surcharge risk.

4.2 Analysis Scenarios

Table 4.5 summarizes the modeling scenarios used to assess the Ganges sewer system capacity.

Table 4.5: Analysis Scenarios

Scenario	Population Used	I&I Design Storm	Purpose
EXISTING-PWWF-5	Existing population	5yr, 24 Hour No Climate Change	Identify existing system deficiencies
BUILD-OUT-PWWF-5	Existing population + build-out growth	5yr, 24 Hour With Climate Change	Identify build-out system deficiencies and timing of upgrades
BUILD-OUT-PWWF-25	Existing population + build-out growth	25yr, 24 Hour With Climate Change	Size system improvements

4.3 Gravity Main Capacity Analysis

Table 4.6 summarizes the existing and build-out gravity main HLoS results under each scenario.

Table 4.6: Gravity Main HLoS Results (Number of Gravity Mains)

HLoS Rating	EXISTING-PWWF-5	BUILD-OUT-PWWF-5
A	105	107
B	70	57
C	19	24
D	3	2
E	**5**	**11**
F	**0**	**1**

The capacity analysis results show that there are five (5) gravity main deficiencies (HLoS rating of 'E' or 'F') in the existing scenario, and there are twelve (12) gravity main deficiencies in the build-out scenario.

The 12 deficiencies are as follows:

- Pipe ID S8025X – 250 mm – On right-of-way northeast of WWTP
- Pipe ID S8035X – 250 mm – On right-of-way northeast of WWTP
- Pipe ID S8370X – 250 mm – On right-of-way between Hereford Ave and Mc Phillips Ave
- Pipe ID S8375X – 250 mm – On right-of-way between Hereford Ave and Mc Phillips Ave
- Pipe ID S8380X – 250 mm – On right-of-way between Hereford Ave and Mc Phillips Ave
- Pipe ID S8385X – 200 mm – On Hereford Ave east of Jackson Ave
- Pipe ID S8390X – 200 mm – On Jackson Ave between Rainbow Rd and Hereford Ave
- Pipe ID S8395X – 200 mm – On Rainbow Rd west of Jackson Ave
- Pipe ID S8400X – 200 mm – On Salt Spring Elementary School Access Road
- Pipe ID S8410X – 200 mm – On Kanaka Rd by Aldous Rd
- Pipe ID S8425X – 200 mm – On right-of-way between Park Dr and Kanaka Rd
- Pipe ID S8430X – 200 mm – On right-of-way between Park Dr and Kanaka Rd

Note that all of these deficiencies are driven by the high I&I rate, which may be conservative since the model was calibrated to a 100-year storm event. Extreme events like this tend to minimize surface ponding, soil infiltration, and evaporation, and lead to greater stormwater system overflow and higher I&I rates than 5-year or 25-year storm events. It is recommended that continuous flow monitoring is completed until several 5-year to 25-year storm events are captured, and that the model calibration is fine-tuned to verify the gravity main deficiencies.

Detailed modeling results for the gravity mains receiving HLoS ratings of 'E' or 'F' can be found in **Appendix F**.

4.4 Pump Station Capacity Analysis

Table 4.7 and **Table 4.8** summarize the pump station HLoS results under the existing and future scenarios.

Table 4.7: EXISTING-PWWF-5 Pump Station HLoS Ratings

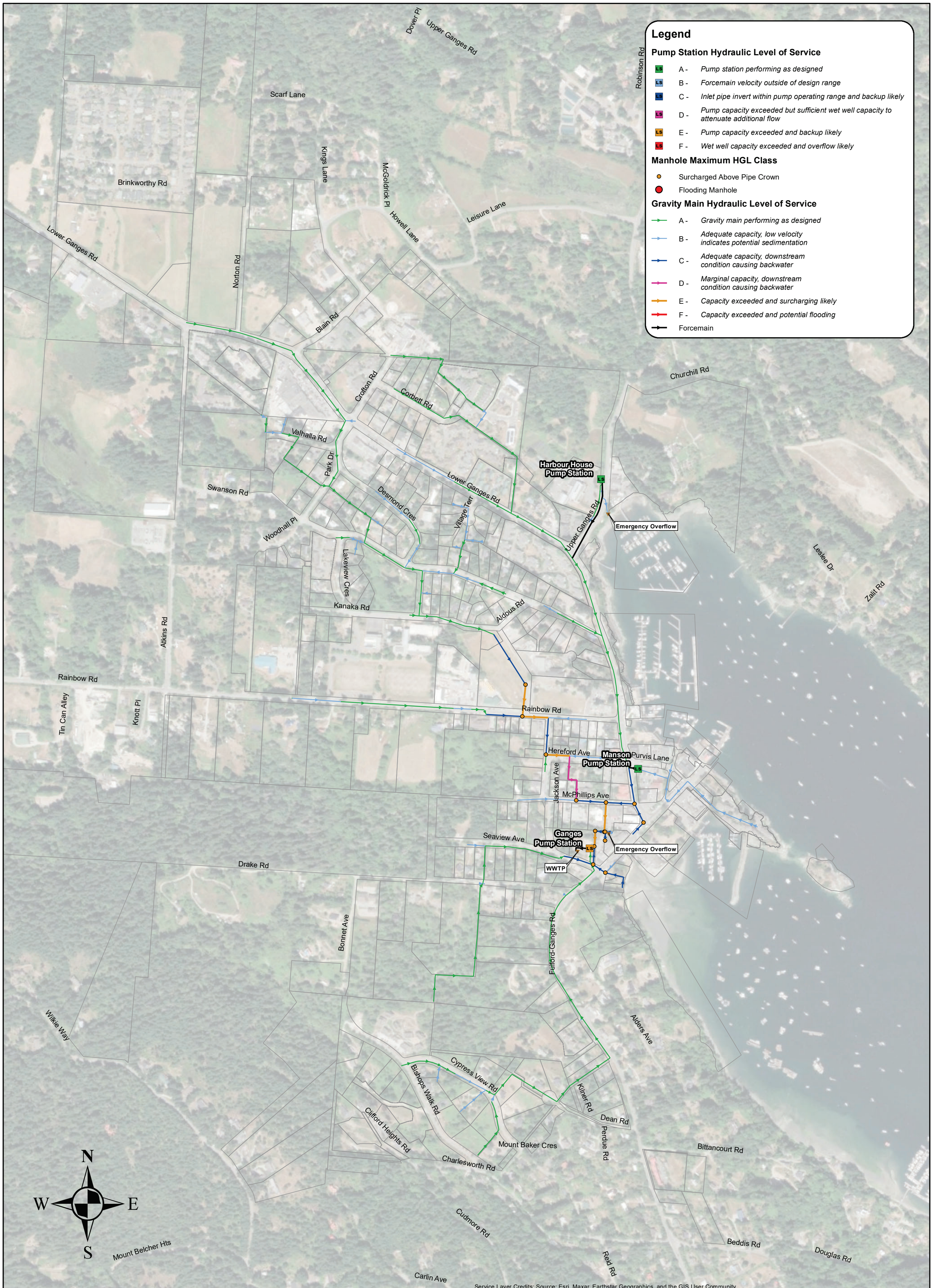
Pump Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Forcemain Velocity (m/s)	HLoS Rating
Ganges	29.0	57.0	**-28.0**	1.8	**E**
Harbour House	6.6	1.6	5.0	1.5	A
Manson	5.0	1.3	3.7	1.1	A

Table 4.8: BUILD-OUT-PWWF-5 Pump Station HLoS Ratings

Pump Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Forcemain Velocity (m/s)	HLoS Rating
Ganges	29.0	58.4	**-29.4**	1.9	**E**
Harbour House	6.6	2.4	4.2	1.5	A
Manson	5.0	1.6	3.4	1.1	A

The pump station capacity results show that the Ganges Pump Station is deficient under the existing and build-out scenarios.

Figure 4.1 and **Figure 4.2** illustrate the gravity main and pump station HLoS ratings for the existing and future scenarios.



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Project ID: 2024-057-CRD
Client: Capital Regional District
Date: January 2025
Created by: SZ
Reviewed by: WdS

GeoADVICE
GeoAdvice Engineering Inc.

Existing Scenario
5-Year 24-Hour I&I
HLoS Model Results

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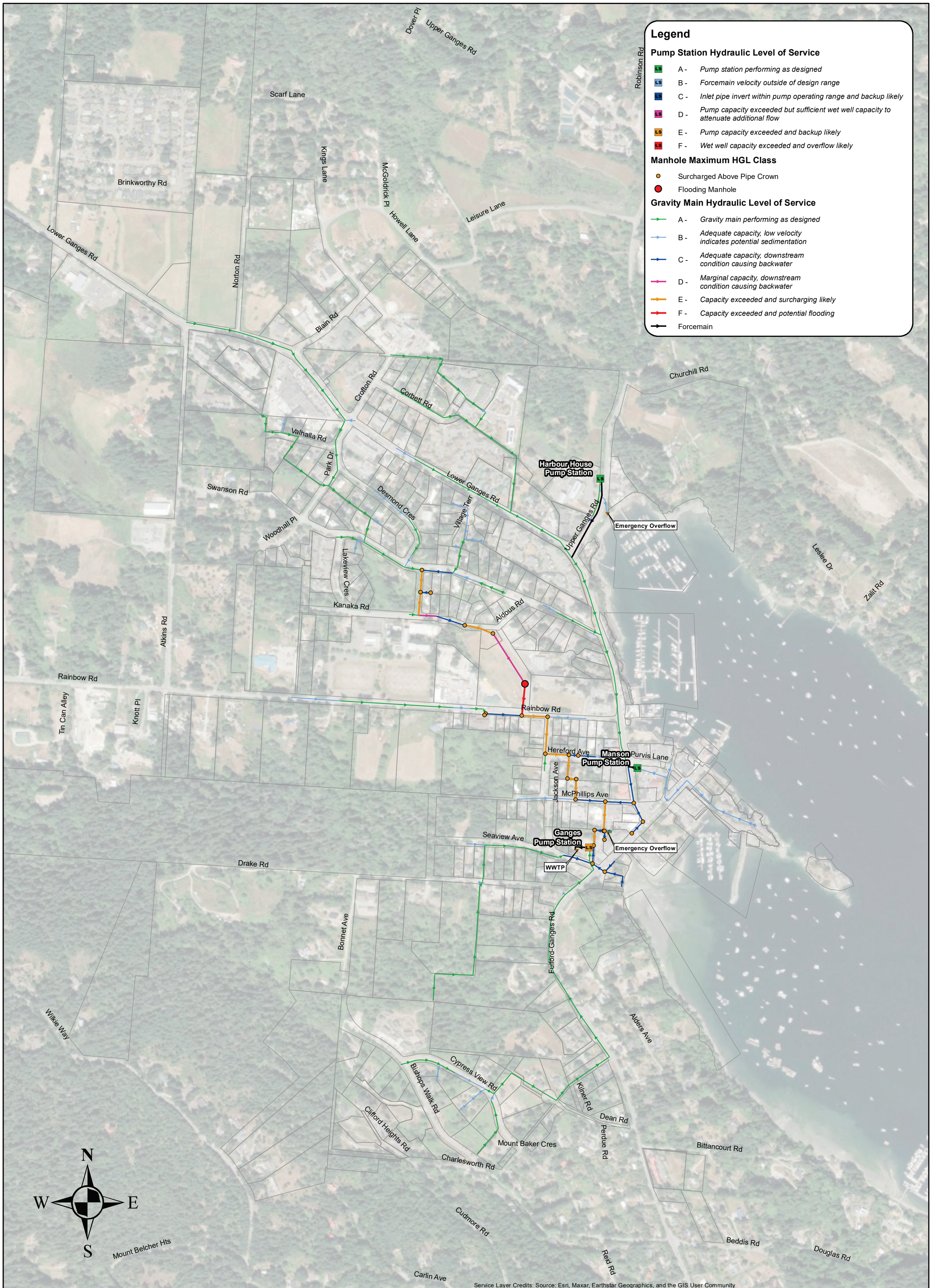
0 0.1 0.2 0.4
Kilometers

Figure 4.1



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GeoAdvice Engineering Inc.

Build-Out Scenario 5-Year 24-Hour I&I HLoS Model Results

0 0.1 0.2 0.4
Kilometers

Figure 4.2

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5 Infrastructure Criticality Scores

As discussed with the CRD, criticality scores were assigned to gravity mains and pump stations based on adjacent land use. The criteria summarized in **Table 5.1** were used to give each gravity main and pump station a criticality score.

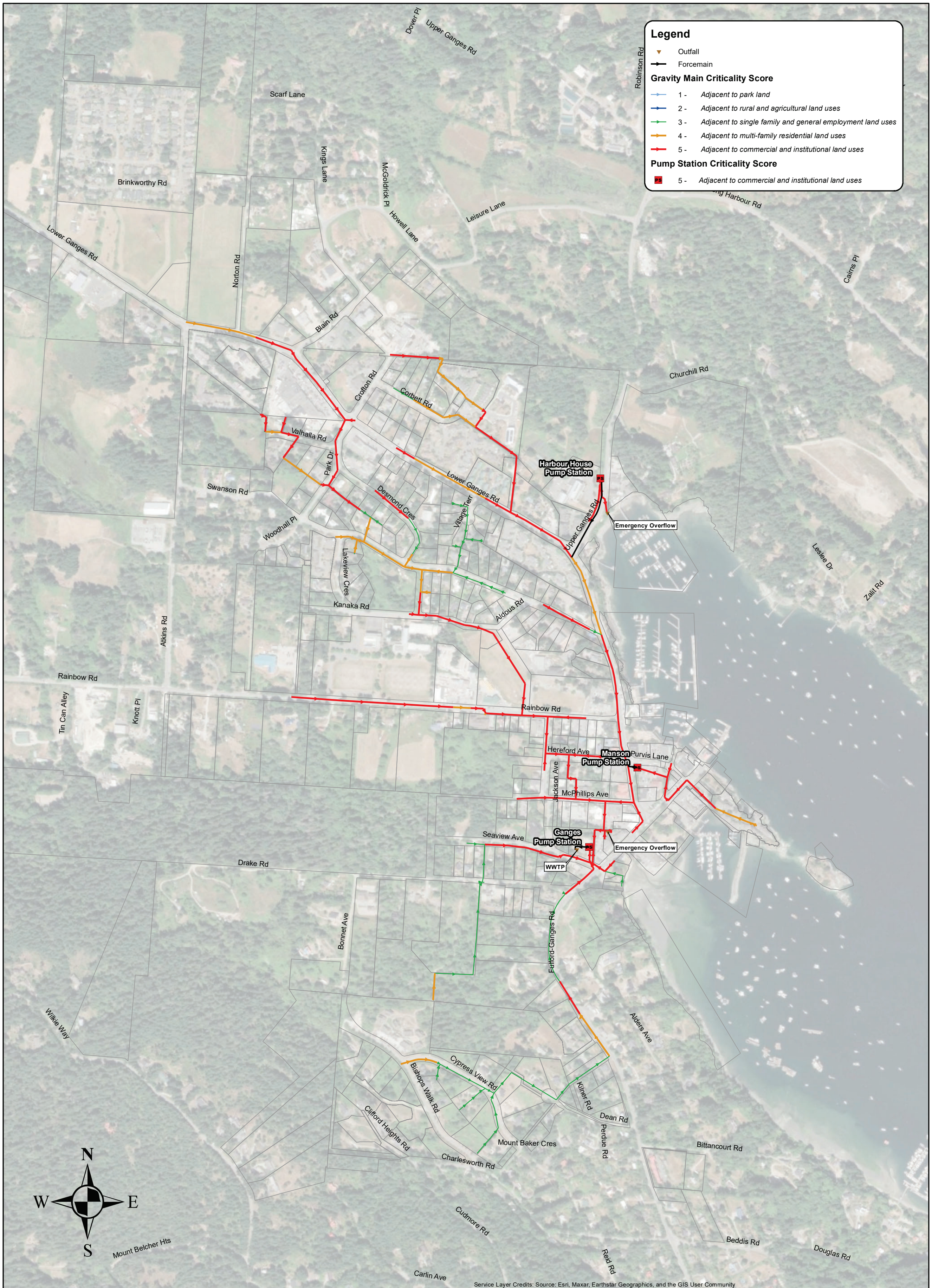
Table 5.1: Infrastructure Criticality Scoring

Criteria	Score
Located adjacent to park land	1
Located adjacent to rural and agricultural land	2
Located adjacent to single family and general employment land	3
Located adjacent to multi-family land	4
Located adjacent to commercial and institutional land	5

The infrastructure criticality scores are summarized in **Table 5.2** and shown in **Figure 5.1**. Note that since all improvement projects have a maximum criticality score of 5 (as shown in **Section 6**), project prioritization does not need refinement based on criticality scores.

Table 5.2: Infrastructure Criticality Scores

Criticality Score	# Gravity Mains	# Pump Stations
1	0	0
2	0	0
3	54	0
4	44	0
5	104	3



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Infrastructure Criticality Scores

0 0.1 0.2 0.4
Kilometers

Figure 5.1

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6 Proposed System Improvements

This section identifies the required improvement projects along with their recommended order.

- Gravity mains with a HLoS rating of either 'E' or 'F' were considered "deficient" and proposed upgrades were considered to eliminate these deficiencies.
- Pump stations with a HLoS rating of either 'D', 'E', or 'F' were considered "deficient" and proposed pump, wet well and forcemain upgrades were considered to eliminate these deficiencies.

Based on the 2022 MMCD Design Guidelines and standard sewer design practice, the design and sizing criteria shown in **Table 6.1** were used.

Table 6.1: Design and Sizing Criteria

Facility	Criterion	Parameter Value
Gravity Main	Design Flow/Sizing Scenario	BUILD-OUT-PWWF-25
	Max. depth/Diameter ratio	d/D < 0.7
	Min. Velocity	v ≥ 0.6 m/s
	Max. Velocity	v ≤ 2.5 m/s
	Min. Diameter	D = 200 mm
	Manning Roughness Coefficient	n = 0.013
Forcemain	Min. Velocity	v ≥ 0.9 m/s
	Max. Velocity	v ≤ 3.5 m/s
	Hazen-Williams Roughness	C = 120
Pump	Design Flow	BUILD-OUT-PWWF-25
	Maximum Pump Flow	PWWF ≤ Firm Capacity

***d= flow depth, D = Diameter, n = Manning coefficient, v = velocity, c = Hazen-Williams roughness coefficient**

The proposed system improvements were grouped into projects. Each improvement project was assigned an ID, which also represents the ranking of the project. The ranking order of the projects is the recommended order in which the projects should be implemented.

The proposed improvements projects are summarized in **Table 6.2** and illustrated in **Figure 6.1**. Unit costs shown in **Appendix G** were used to estimate project costs. These are class D unit cost estimates based on construction cost indices published by the Engineering News Record (ENR) for nearby markets and include construction, engineering design, and contingency costs. Upgrade project details can be found in **Appendix H**.

Table 6.2: Sanitary System Improvement Work Plan

Project ID	Trigger Scenario	Project Description	Quantity	Maximum Criticality Score	Cost*
1	EXISTING-PWWF-5	Upgrade the Ganges Pump Station to a minimum firm capacity of 110 L/s. Note that the high required firm capacity is driven by the high I&I rate, which may be conservative since the model was calibrated to a 100-year storm event. Extreme events like this tend to minimize surface ponding, soil infiltration, and evaporation, and lead to greater stormwater system overflow and higher I&I rates than 5-year or 25-year storm events. It is recommended that continuous flow monitoring is completed until several 5-year to 25-year storm events are captured, and that the model calibration is fine-tuned to verify the required firm capacity.	1 Pump Station	5	$1,373,000
2	EXISTING-PWWF-5	Upgrade pipes from the end of the Salt Spring Elementary School Access Road to the intersection of Jackson Ave and Hereford Ave to 300 mm, and upgrade pipes from the intersection of Jackson Ave and Hereford Ave to Ganges Pump Station to 375 mm.	602 m	5	$2,421,000
3	BUILD-OUT-PWWF-5	Upgrade pipes from south of Park Dr to the the end of the Salt Spring Elementary School Access Road to 250 mm.	423 m	5	$1,414,000

***Class D unit costs based on construction cost indices published by the Engineering News Record (ENR) for nearby markets (see Appendix G). Cost estimates provided are not a guarantee of actual construction costs. All costs are in 2024 dollars with no allowance for inflation.**

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System Improvement Recommendations

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0 0.0325 0.065 0.13
Kilometers

Figure 6.1

7 Summary

GeoAdvice Engineering Inc. (GeoAdvice) was retained by the Capital Regional District, BC (CRD) to complete the Ganges Sewer Service Area Modelling, which involved updating and calibrating the sewer model for Ganges and conducting a sewer system capacity analysis.

The following is a list of key conclusions drawn while performing the sewer model update:

- The CRD GIS data, as-built drawings, and previous InfoSWMM model were the key sources of information on the Ganges system to update the pipe and node network topology model.
- The sewer model includes the following elements:
  - 203 junctions
  - 205 pipes
  - 3 outfalls
  - 3 pump stations
- Existing sewer load was determined based on 2023 water billing data and sewer flow monitoring data. The calibrated Ganges existing BSF load is 2.62 L/s, and the estimated residential BSF rate is 122 L/cap/day.
- The model was calibrated against three (3) flow monitoring locations. Overall, the model predicts a good correlation with the observed dry weather and wet weather field data.
- A build-out model scenario was created based on future population growth information provided by Islands Trust.
- The EXISTING-PWWF-5 and BUILD-OUT-PWWF-5 scenarios were used to determine existing and future infrastructure deficiencies. The BUILD-OUT-PWWF-25 scenario was used to determine sizes and capacities for system improvement recommendations.
- The estimated existing sewer-serviced residential population is 1,524 capita, while the estimated build-out sewer-serviced residential population is 5,016 capita.
- The gravity main capacity analysis results show that there are five (5) gravity main deficiencies (HLoS rating of 'E' or 'F') in the existing scenario, and there are twelve (12) gravity main deficiencies in the build-out scenario.
- The pump station capacity results show that the Ganges Pump Station is deficient under the existing and build-out scenarios.
- The 1,025 m of gravity main upgrades, and the Ganges Pump Station upgrade have been proposed to eliminate system capacity deficiencies and service the future population.
- Note that the gravity main upgrades and high required Ganges Pump Station firm capacity are driven by the high I&I rate, which may be conservative since the model was calibrated to a 100-year storm event. Extreme events like this tend to minimize surface ponding, soil infiltration, and evaporation, and lead to greater stormwater system overflow and higher I&I rates than 5-year or 25-year storm events. It is recommended that continuous flow monitoring is completed until several 5-year to 25-year storm events are captured, and that the model calibration is fine-tuned to verify gravity main an pump station upgrades.

8 Recommendations

Based upon the findings from this analysis, GeoAdvice recommends that the CRD plan to undertake the projects in the proposed system improvements to relieve system deficiencies and prepare for future development. In addition, GeoAdvice recommends the following:

1. **Field Verification of Ganges Pump Station Capacity**
   Due to the capacity deficiency at Ganges Pump Station predicted by the model, it is recommended that pumping rates are field-verified and that datalogging is done during the next winter season as a first step to verifying the Ganges Pump Station capacity.

2. **Continuous Flow Monitoring and Verification of I&I Rates**
   It is recommended that continuous flow monitoring is completed until several 5-year to 25-year storm events are captured, and that the model calibration is fine-tuned to verify the required gravity main and pump station upgrades.

3. **Smoke Testing**
   Smoke testing should be conducted to determine the cause of the high infiltration rates across the system.

4. **Verification of Unit Costing**
   The CRD should verify the unit costs used in the costing analysis.

5. **Model Conversion from InfoSWMM to InfoWorks ICM**

6. **User's Guide for Land Development Applications**
   GeoAdvice will develop a User's Guide to assist the CRD in performing land development application reviews for the sanitary sewer utility.

7. **Extended Modeling Support Services**
   GeoAdvice will assist the CRD in maintaining and operating the updated model for a period of one (1) year from the date of completion of this assignment and update the CRD of its operational status on a quarterly basis via a written status report. It is understood that during this period, we will have to respond to specific queries to model scenarios from the CRD for capital planning and operational needs.

Submission

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Reviewed and Approved by:

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2025-01-27

Werner de Schaetzen, Ph.D., P.Eng.
Project Manager

Appendix A Primary System Components

Table A.1: Pump Modeling Data

Pump Station	Model ID	Type	Firm Capacity (L/s)*	Pump On Level (m)**	Pump Off Level (m)**
Ganges	PMP-GANGES-1	Lead	29.0	1.400	0.700
	PMP-GANGES-2	Lag		1.500	0.700
Harbour House	PMP-HARBOUR-1	Lead	6.6	0.900	0.500
	PMP-HARBOUR-2	Lag		1.000	0.500
Manson	PMP-MANSON-1	Lead	5.0	0.850	0.500
	PMP-MANSON-2	Lag		0.950	0.500

***Firm capacities were based on the pump capacities specified in *CRD Integrated Water Services Supply of Submersible Pumps for Ganges Sewer Service* (Precision, 2018). The modeled pump capacities were slightly higher than these 2018 specification capacities, but to be conservative the capacities from the specifications were used.**

****The CRD provided the lead pump on/off levels, and the lag pump on/off levels were assumed.**

Table A.2: Wet Well Modeling Data

Pump Station	Wet Well ID	Bottom Elevation (m)	Maximum Elevation (m)	Equivalent Diameter (m)
Ganges	WW-GANGES	0.250	6.250	2.630
Harbour House	WW-HARBOUR	1.950	6.070	1.167
Manson	WW-MANSON	1.070	5.300	1.167

Appendix B Population Growth Information

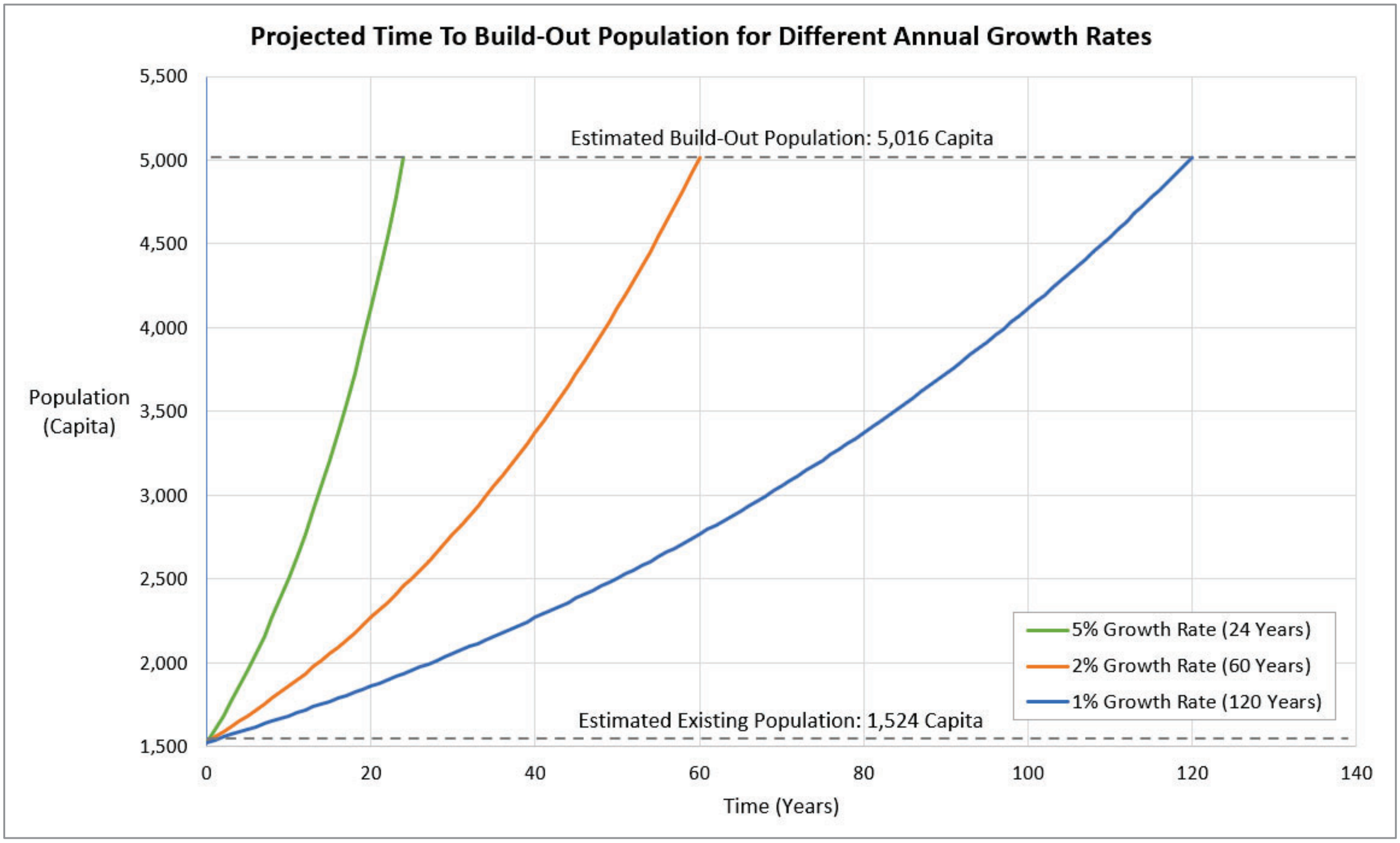


Table B.1: Parcel Growth Information

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
004-696-131	268 Park Dr	Residential	0.173	6	1	2.5	2.0
007-511-566	A - 125 Rainbow Rd	Residential	0.083	3	1	2.5	2.4
004-997-956	134 McPhillips Ave	Residential	0.080	3	1	2.5	2.4
000-094-811	208 Park Dr	Residential	0.148	5	1	2.5	2.2
007-511-205	120 Hereford Ave	Residential	0.079	3	1	2.5	2.2
005-339-707	116 Hereford Ave	Residential	0.084	3	1	2.5	1.9
028-856-112	129 Kanaka Rd	Residential	0.131	5	1	2.5	2.3
017-460-581	136 Lower Ganges Rd	Residential	0.070	3	1	2.5	1.4
000-274-119	134 Hereford Ave	Residential	0.040	1	1	2.5	2.5
005-884-411	157 Kanaka Rd	Residential	0.121	4	1	2.5	2.2
003-766-373	136 Desmond Cres	Residential	0.159	6	1	2.5	2.2
026-288-524	238 Park Dr	Residential	0.188	7	1	2.5	2.0
007-509-723	108 Hereford Ave	Residential	0.024	1	1	2.5	2.4
000-035-319	146 Desmond Cres	Residential	0.150	6	1	2.5	1.8
018-614-400	110 Lower Ganges Rd	Residential	0.176	7	1	2.5	1.6
003-766-365	122 Desmond Cres	Residential	0.145	5	1	2.5	2.3
003-899-845	116 Fulford-Ganges Rd	Residential	0.049	2	1	2.5	2.4
007-511-167	132 Lower Ganges Rd	Residential	0.057	2	1	2.5	1.2
028-856-104	143 Kanaka Rd	Residential	0.131	5	1	2.5	2.1
007-509-472	129 Hereford Ave	Residential	0.080	3	1	2.5	2.4
017-460-573	112 Hereford Ave	Residential	0.077	3	1	2.5	2.5
028-999-878	122 Hereford Ave	Residential	0.090	3	1	2.5	2.0
018-590-861	124 McPhillips Ave	Residential	0.311	12	4	10.0	9.8
002-748-223	130 McPhillips Ave	Residential	0.080	3	1	2.5	2.5
007-513-917	127 Rainbow Rd	Residential	0.080	3	1	2.5	2.5
003-766-390	224 Park Dr	Residential	0.186	7	1	2.5	2.3
000-291-498	212 Park Dr	Residential	0.153	6	1	2.5	2.4
000-440-400	274 Park Dr	Residential	0.193	7	1	2.5	2.2
026-288-532	230 Park Dr	Residential	0.120	4	1	2.5	2.3
007-509-456	133 Hereford Ave	Residential	0.080	3	1	2.5	2.5
028-999-860	123 Jackson Ave	Residential	0.074	3	1	2.5	2.4
003-766-110	200 Park Dr	Residential	0.231	9	2	5.0	4.8
003-766-403	220 Park Dr	Residential	0.165	6	1	2.5	2.3
002-078-627	128 Desmond Cres	Residential	0.147	5	1	2.5	2.4
028-856-082	167 Park Dr	Residential	0.100	4	1	2.5	2.5

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
000-131-920	101 - 111 Rainbow Rd	Residential	0.082	3	1	2.5	2.4
001-992-708	161 Fulford-Ganges Rd	Residential	0.069	3	1	2.5	0.7
028-104-269	A - 176 Bishops Walk Rd	Residential	1.994	74	148	370.0	261.2
018-951-767	Lower Ganges Rd	Residential	0.041	2	1	2.5	0.3
006-261-493	131 McPhillips Ave	Residential	0.122	4	1	2.5	2.5
005-280-729	100 Lower Ganges Rd	Residential	0.097	4	1	2.5	2.4
016-027-752	108 - 121 McPhillips Ave	Residential	0.241	9	2	5.0	3.8
006-262-988	103 - 109 McPhillips Ave	Residential	0.202	7	1	2.5	2.0
005-229-138	106 Lower Ganges Rd	Residential	0.059	2	1	2.5	2.2
005-280-737	104 Lower Ganges Rd	Residential	0.080	3	1	2.5	2.4
000-067-962	135 McPhillips Ave	Residential	0.061	2	1	2.5	2.5
005-829-437	161 McPhillips Ave	Residential	0.099	4	1	2.5	2.4
005-829-372	155 McPhillips Ave	Residential	0.098	4	1	2.5	2.4
004-677-706	127 Lower Ganges Rd	Residential	0.170	6	1	2.5	1.4
024-838-349	201 - 110 Purvis Lane	Residential	0.208	8	2	5.0	3.5
005-882-354	142 Park Dr	Residential	0.158	6	1	2.5	2.3
024-842-591	105 Village Terr	Residential	0.110	4	1	2.5	2.5
005-882-273	158 Park Dr	Residential	0.191	7	1	2.5	2.3
003-504-611	130 Park Dr	Residential	0.126	5	1	2.5	2.1
024-842-630	108 Village Terr	Residential	0.110	4	1	2.5	2.3
000-114-901	111 Desmond Cres	Residential	0.146	5	1	2.5	2.4
024-842-605	102 Village Terr	Residential	0.110	4	1	2.5	2.3
000-019-470	152 Park Dr	Residential	0.180	7	1	2.5	2.2
003-766-039	184 Park Dr	Residential	0.188	7	1	2.5	2.2
024-842-567	113 Village Terr	Residential	0.112	4	1	2.5	2.4
024-842-559	114 Village Terr	Residential	0.110	4	1	2.5	2.4
024-842-575	111 Village Terr	Residential	0.110	4	1	2.5	2.1
024-842-541	112 Village Terr	Residential	0.110	4	1	2.5	2.2
024-842-648	110 Village Terr	Residential	0.111	4	1	2.5	2.3
018-161-642	110 Park Dr	Residential	0.428	16	7	17.5	14.5
000-908-045	134 Park Dr	Residential	0.197	7	1	2.5	2.3
003-141-331	115 Desmond Cres	Residential	0.360	13	5	12.5	12.4
024-024-651	268 Lower Ganges Rd	Residential	0.093	3	1	2.5	1.0
000-019-551	124 Park Dr	Residential	0.112	4	1	2.5	0.4
024-842-583	107 Village Terr	Residential	0.110	4	1	2.5	2.5
005-882-338	148 Park Dr	Residential	0.168	6	1	2.5	2.3
024-842-621	106 Village Terr	Residential	0.110	4	1	2.5	2.1
005-893-194	155 Rainbow Rd	Residential	0.072	3	1	2.5	2.3

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
000-677-990	122 Jackson Ave	Residential	0.050	2	1	2.5	2.3
005-893-143	151 Rainbow Rd	Residential	0.071	3	1	2.5	2.4
005-937-965	108 Jackson Ave	Residential	0.204	8	2	5.0	4.7
000-410-624	106 Jackson Ave	Residential	0.143	5	1	2.5	2.5
000-444-243	152 McPhillips Ave	Residential	0.070	3	1	2.5	2.5
005-938-031	141 Rainbow Rd	Residential	0.103	4	1	2.5	2.5
010-145-591	135 Rainbow Rd	Residential	0.151	6	1	2.5	2.3
003-141-322	300 Lower Ganges Rd	Residential	0.206	8	2	5.0	3.2
004-696-018	267 Park Dr	Residential	0.133	5	1	2.5	2.3
003-855-635	135 Desmond Cres	Residential	0.282	10	3	7.5	7.3
023-505-249	374 Lower Ganges Rd	Residential	1.599	59	94	235.0	232.0
003-482-839	108 Valhalla Rd	Residential	0.231	9	2	5.0	3.8
003-887-430	141 Desmond Cres	Residential	0.173	6	1	2.5	2.5
004-644-212	127 Valhalla Rd	Residential	0.146	5	1	2.5	2.1
004-644-344	114 Valhalla Rd	Residential	0.184	7	1	2.5	2.4
004-695-968	281 Park Dr	Residential	0.107	4	1	2.5	2.4
004-696-000	275 Park Dr	Residential	0.156	6	1	2.5	2.0
001-274-520	340 Lower Ganges Rd	Residential	0.850	31	26	65.0	62.4
003-765-954	127 Desmond Cres	Residential	0.183	7	1	2.5	2.4
001-340-468	306 Lower Ganges Rd	Residential	0.162	6	1	2.5	1.7
000-194-417	121 Valhalla Rd	Residential	0.163	6	1	2.5	1.6
004-931-793	324 Lower Ganges Rd	Residential	0.089	3	1	2.5	0.2
005-270-669	6 - 323 Lower Ganges Rd	Residential	0.151	6	1	2.5	0.9
005-270-588	116 Corbett Rd	Residential	0.141	5	1	2.5	1.7
005-270-685	315 Lower Ganges Rd	Residential	0.133	5	1	2.5	2.4
005-270-600	126 Corbett Rd	Residential	0.136	5	1	2.5	2.3
005-270-596	122 Corbett Rd	Residential	0.146	5	1	2.5	2.1
002-436-604	265 Lower Ganges Rd	Residential	0.309	11	3	7.5	5.7
003-826-902	275 Lower Ganges Rd	Residential	0.692	26	18	45.0	34.3
005-884-888	173 Park Dr	Residential	0.144	5	1	2.5	2.1
027-534-855	Park Dr	Residential	0.127	5	1	2.5	2.3
023-782-048	166 Park Dr	Residential	0.110	4	1	2.5	2.3
005-884-357	165 Kanaka Rd	Residential	0.107	4	1	2.5	2.3
023-782-030	174 Park Dr	Residential	0.111	4	1	2.5	2.4
005-883-105	185 Park Dr	Residential	0.101	4	1	2.5	2.3
005-883-326	175 Kanaka Rd	Residential	0.094	3	1	2.5	2.3
027-534-863	112 Lakeview Cres	Residential	0.127	5	1	2.5	1.9
000-495-093	1 - 173 Kanaka Rd	Residential	0.095	4	1	2.5	2.2

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
005-290-210	175 Park Dr	Residential	0.110	4	1	2.5	2.3
023-782-021	180 Park Dr	Residential	0.110	4	1	2.5	2.4
000-535-567	179 Park Dr	Residential	0.101	4	1	2.5	2.2
005-883-768	169 Kanaka Rd	Residential	0.112	4	1	2.5	2.4
006-261-434	137 McPhillips Ave	Residential	0.061	2	1	2.5	2.4
003-106-756	154 Kings Lane	ICI	1.387	50	0	69.4	68.1
005-996-830	103 Park Dr	Residential	0.113	4	1	2.5	1.0
003-827-569	101 - 111 Corbett Rd	Residential	0.209	8	2	5.0	3.7
003-873-811	115 Corbett Rd	Residential	0.238	9	2	5.0	4.5
000-698-865	132 Corbett Rd	Residential	1.998	74	148	370.0	331.2
026-073-081	120 Crofton Rd	Residential	1.028	38	39	97.5	95.3
025-674-463	131 Corbett Rd	Residential	0.168	6	1	2.5	0.7
000-492-523	131 Crofton Rd	Residential	0.106	4	1	2.5	1.2
003-765-989	121 Desmond Cres	Residential	0.173	6	1	2.5	2.5
004-654-561	116 Rainbow Rd	Residential	0.278	10	3	7.5	6.6
025-019-571	129 Corbett Rd	Residential	0.287	11	3	7.5	6.3
001-522-027	128 Hereford Ave	Residential	0.039	1	1	2.5	2.3
004-950-208	3204 - 115 Fulford-Ganges Rd	Residential	0.103	4	1	2.5	2.4
000-555-843	149 Fulford-Ganges Rd	Residential	0.423	16	7	17.5	16.3
023-680-610	115 Fulford-Ganges Rd	Residential	0.291	11	3	7.5	6.9
004-677-714	109 Purvis Lane	Residential	0.395	15	6	15.0	14.7
003-046-885	106 Purvis Lane	Residential	0.228	8	2	5.0	4.6
005-656-150	255 Lower Ganges Rd	Residential	0.830	31	26	65.0	62.0
004-909-721	121 Upper Ganges Rd	Residential	1.188	44	52	130.0	113.0
025-861-816	13 - 107 Atkins Rd	Residential	0.668	25	17	42.5	42.2
004-696-042	261 Park Dr	Residential	0.185	7	1	2.5	2.5
006-030-041	119 Rainbow Rd	Residential	0.080	3	1	2.5	2.5
003-106-772	130 Blain Rd	Residential	0.412	15	6	15.0	15.0
003-122-611	145 King Rd	Residential	0.259	10	3	7.5	7.5
018-951-775	161 Lower Ganges Rd	Residential	0.095	4	1	2.5	2.5
003-122-689	173 Howell Lane	Residential	0.199	7	1	2.5	2.5
000-201-685	128 Lower Ganges Rd	Residential	0.079	3	1	2.5	2.5
003-122-701	181 Howell Lane	Residential	0.181	7	1	2.5	2.5
003-106-721	188 Kings Lane	Residential	0.651	24	16	40.0	40.0
027-249-794	145 Lower Ganges Rd	Residential	0.017	1	1	2.5	2.5
003-122-590	151 Kings Lane	Residential	0.260	10	3	7.5	7.5
004-997-964	136 McPhillips Ave	Residential	0.080	3	1	2.5	2.5
000-616-915	159 Kings Lane	Residential	0.606	22	13	32.5	32.5

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
000-119-792	115 Rainbow Rd	Residential	0.079	3	1	2.5	2.5
028-856-091	161 Park Dr	Residential	0.090	3	1	2.5	2.5
003-122-646	155 Howell Lane	Residential	0.244	9	2	5.0	5.0
000-213-730	128 Lower Ganges Rd	Residential	0.151	6	1	2.5	2.5
004-443-489	210 Norton Rd	Residential	4.774	48	229	572.5	572.5
003-122-671	161 Howell Lane	Residential	0.230	9	2	5.0	5.0
029-253-217	455 Lower Ganges Rd	ICI	0.801	50	0	40.1	40.1
016-341-643	174 Fulford-Ganges Rd	Residential	0.194	7	1	2.5	2.5
030-706-891	171 Fulford-Ganges Rd	Residential	0.056	2	1	2.5	2.5
018-951-759	201 - 229 Lower Ganges Rd	Residential	0.110	4	1	2.5	2.5
005-829-313	155 McPhillips Ave	Residential	0.100	4	1	2.5	2.5
024-842-613	102 Village Terr	Residential	0.110	4	1	2.5	2.5
023-782-056	166 Park Dr	Residential	0.111	4	1	2.5	2.5
031-451-969	118 Jackson Ave	Residential	0.273	10	3	7.5	7.5
031-451-977	116 Jackson Ave	Residential	0.088	3	1	2.5	2.5
003-421-040	1 - 148 Swanson Rd	Residential	0.157	6	1	2.5	2.5
000-140-589	1 - 114 Swanson Rd	Residential	0.499	18	9	22.5	22.5
000-904-732	140 Swanson Rd	Residential	0.179	7	1	2.5	2.5
003-421-139	132 Swanson Rd	Residential	0.183	7	1	2.5	2.5
004-931-815	316 Lower Ganges Rd	Residential	0.097	4	1	2.5	2.5
004-644-298	108 - 124 Valhalla Rd	Residential	0.193	7	1	2.5	2.5
003-421-147	116 Swanson Rd	Residential	0.269	10	3	7.5	7.5
003-420-990	154 Swanson Rd	Residential	0.144	5	1	2.5	2.5
003-421-082	142 Swanson Rd	Residential	0.168	6	1	2.5	2.5
005-790-191	141 Atkins Rd	Residential	2.428	74	180	450.0	450.0
004-644-301	124 Valhalla Rd	Residential	0.215	8	2	5.0	5.0
005-270-626	343 Lower Ganges Rd	Residential	0.147	5	1	2.5	2.5
005-270-618	343 Lower Ganges Rd	Residential	0.130	5	1	2.5	2.5
005-270-642	343 Lower Ganges Rd	Residential	0.148	5	1	2.5	2.5
004-242-670	136 Lakeview Cres	Residential	0.149	6	1	2.5	2.5
004-242-637	136 Lakeview Cres	Residential	0.227	8	2	5.0	5.0
005-893-615	191 Rainbow Rd	Residential	0.087	3	1	2.5	2.5
004-255-500	193 Park Dr	Residential	1.327	49	65	162.5	162.5
004-253-931	122 Lakeview Cres	Residential	0.214	8	2	5.0	5.0
023-566-388	121 Woodhall Pl	Residential	0.093	3	1	2.5	2.5
023-566-361	127 Woodhall Pl	Residential	0.083	3	1	2.5	2.5
003-421-848	151 Swanson Rd	Residential	0.194	7	1	2.5	2.5
023-566-311	114 Woodhall Pl	Residential	0.116	4	1	2.5	2.5

PID	Address	Growth Type	Parcel Area (ha)	Build-Out Density (Unit/ha)*	Build-Out Units (Unit)**	Build-Out Population (Capita)***	Build-Out Growth Population (Capita)****
023-566-353	129 Woodhall Pl	Residential	0.085	3	1	2.5	2.5
004-242-599	123 Lakeview Cres	Residential	0.155	6	1	2.5	2.5
023-566-337	118 Woodhall Pl	Residential	0.108	4	1	2.5	2.5
023-566-299	243 Park Dr	Residential	0.113	4	1	2.5	2.5
003-421-198	121 Swanson Rd	Residential	0.238	9	2	5.0	5.0
003-421-201	131 Swanson Rd	Residential	0.151	6	1	2.5	2.5
023-566-281	106 Woodhall Pl	Residential	0.103	4	1	2.5	2.5
023-566-400	113 Woodhall Pl	Residential	0.083	3	1	2.5	2.5
002-907-968	143 Swanson Rd	Residential	0.170	6	1	2.5	2.5
023-566-302	110 Woodhall Pl	Residential	0.119	4	1	2.5	2.5
023-566-329	116 Woodhall Pl	Residential	0.101	4	1	2.5	2.5
003-421-163	115 Swanson Rd	Residential	0.191	7	1	2.5	2.5
004-091-451	125 Lakeview Cres	Residential	0.206	8	2	5.0	5.0
023-566-370	125 Woodhall Pl	Residential	0.095	4	1	2.5	2.5
023-566-345	22 Woodhall Pl	Residential	0.084	3	1	2.5	2.5
023-566-396	117 Woodhall Pl	Residential	0.107	4	1	2.5	2.5
009-598-758	201 Atkins Rd	Residential	1.410	52	73	182.5	182.5
003-422-771	137 Swanson Rd	Residential	0.157	6	1	2.5	2.5
004-002-342	231 Kanaka Rd	Residential	0.187	8	1	2.5	2.5
006-914-021	103 Bonnet Ave	Residential	1.544	57	88	220.0	220.0
005-976-383	100 Upper Ganges Rd	Residential	0.019	1	1	2.5	2.5
023-566-281	106 Woodhall Pl	Residential	0.125	4	1	2.5	2.5
023-566-281	106 Woodhall Pl	Residential	0.017	4	1	2.5	2.5

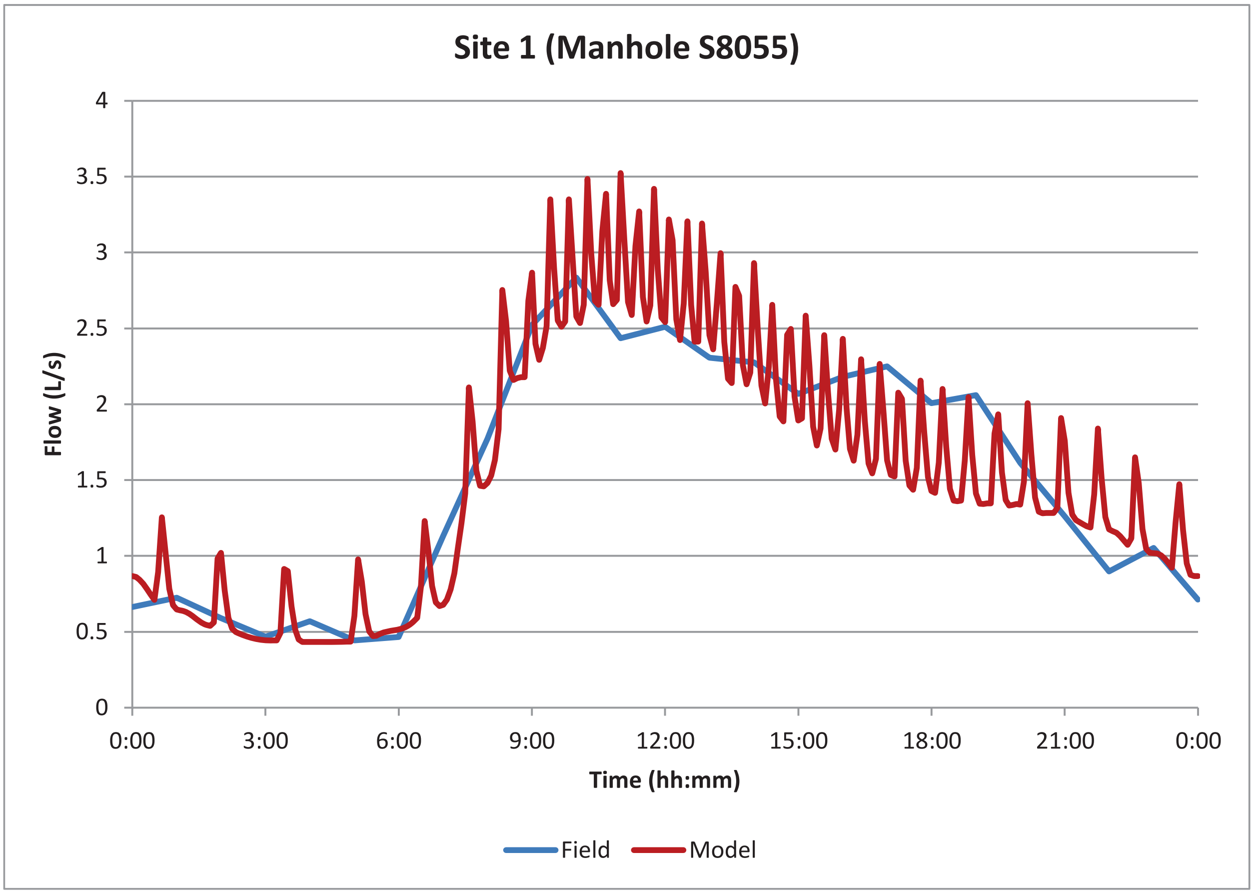
***The maximum potential parcel density provided by Islands Trust.**

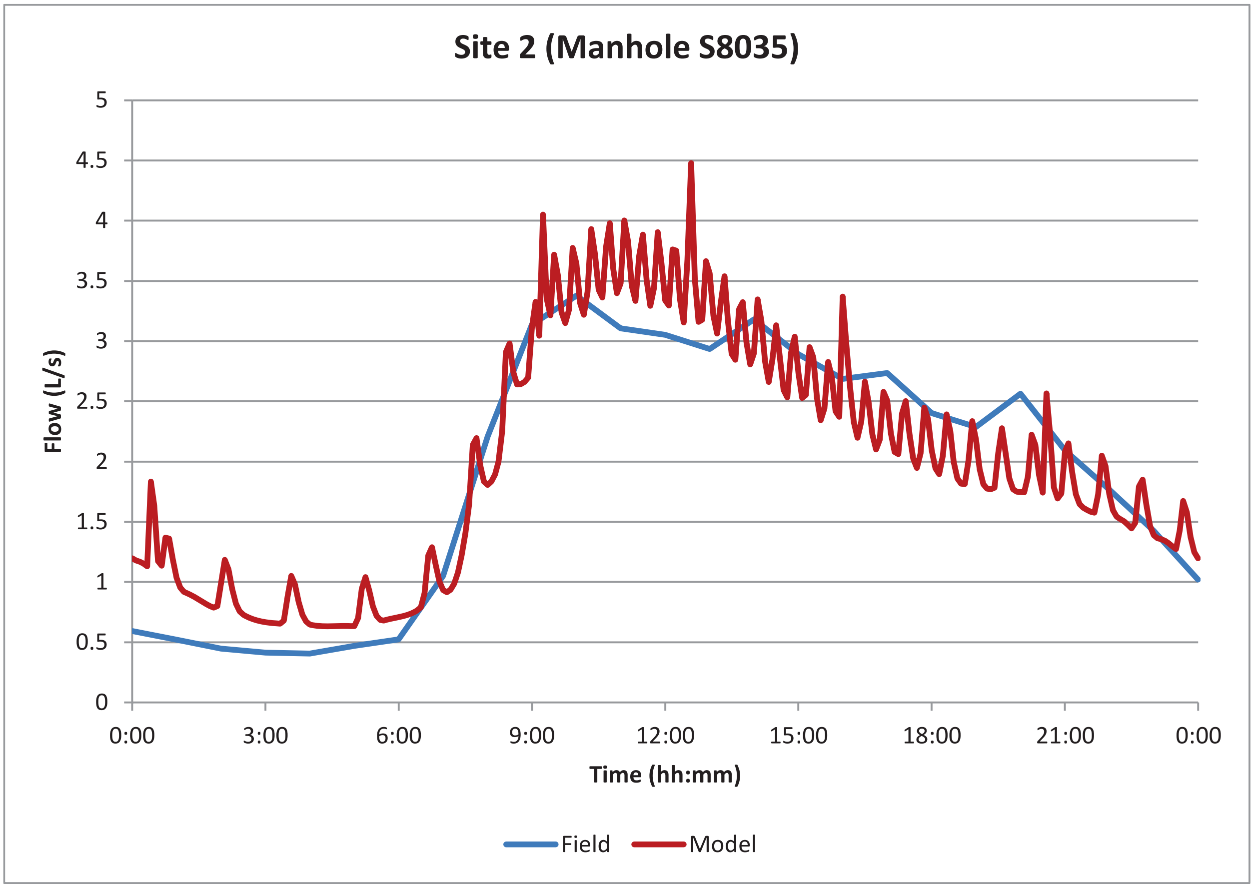
****Calculated as the parcel area x build-out density, assuming a minimum of 1 units.**

*****Calculated based on the number of build-out units and 2.5 capita/unit.**

******Estimated by subtracting the calibrated existing BSF from the future build-out population BSF, assuming a future BSF rate of 240 L/capita/day.**

Appendix C Dry Weather Flow Calibration Hydrographs




Site 2 (Manhole S8035)
Flow (L/s)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
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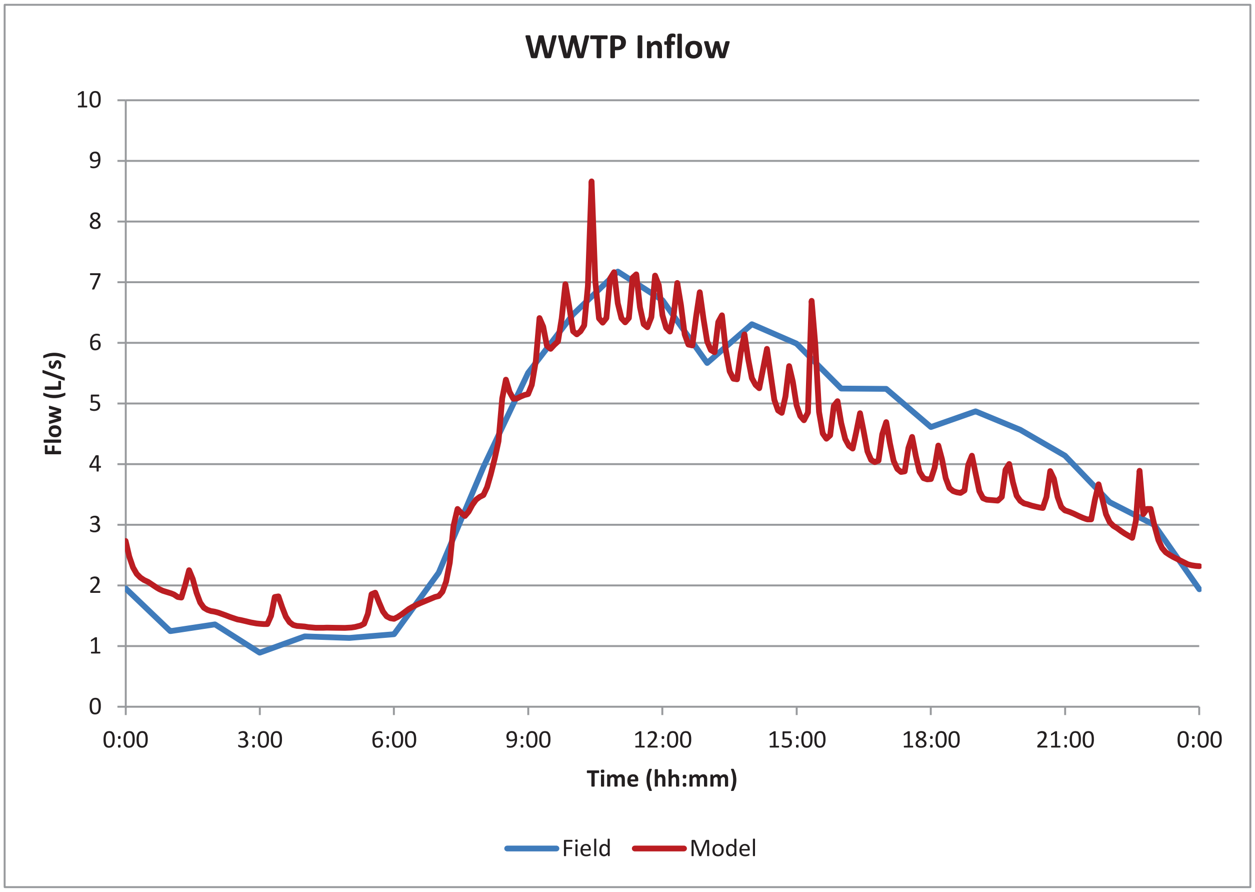
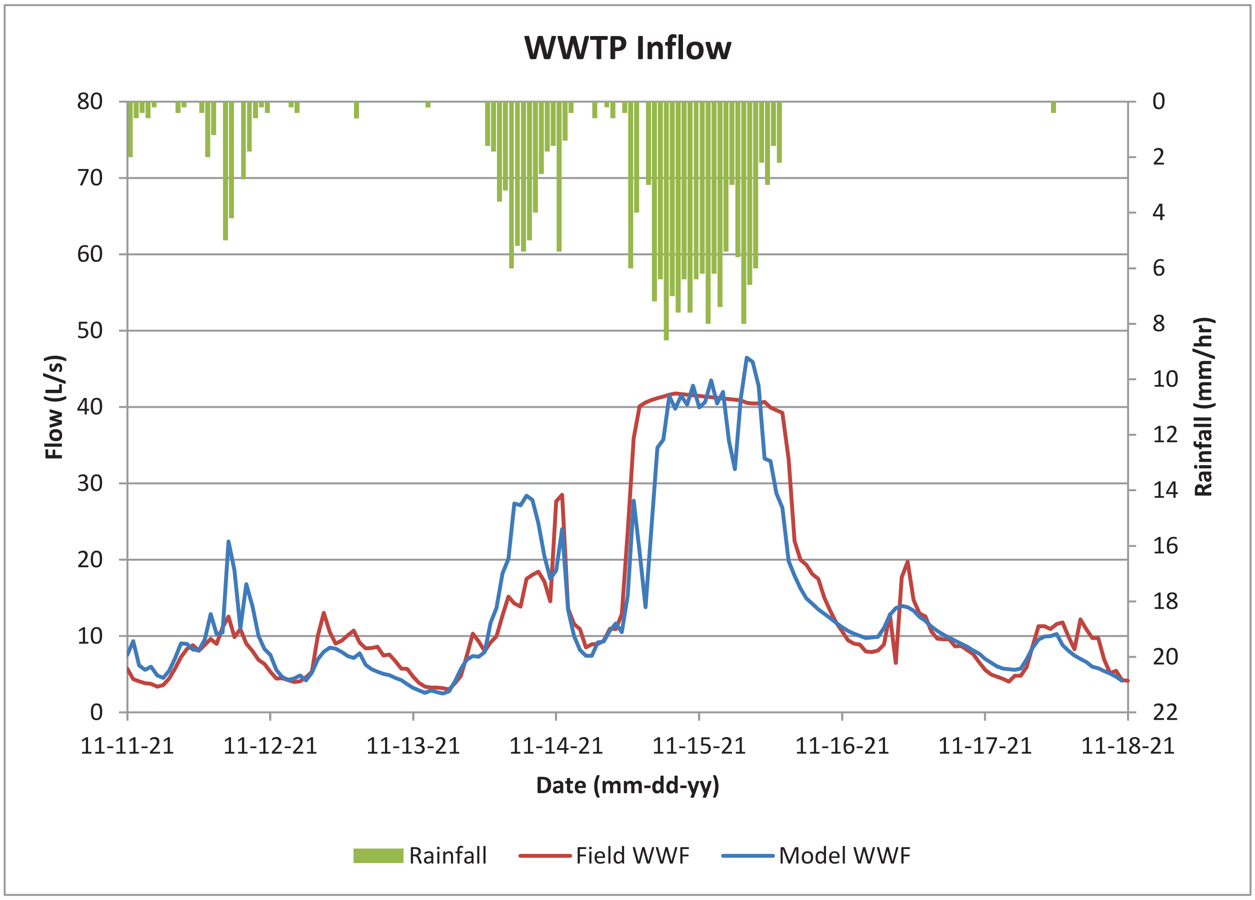
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time (hh:mm)
Field
Model


WWTP Inflow
10
9
8
7
6
5
4
3
2
1
0
Flow (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time (hh:mm)
Field
Model

Appendix D Wet Weather Flow Calibration Hydrograph (November 11, 2021 – November 18, 2021)



Appendix E Calibrated RTK Parameters

Table E.1: Ganges RTK Parameters

Parameter	Value
Catchment Area (ha)	99.2
R Total	0.028
R1	0.012
R2	0.006
R3	0.010
T1 (hrs)	0.5
T2 (hrs)	3.0
T3 (hrs)	12.0
K1	1.0
K2	2.0
K3	6.0

Appendix F Deficient Gravity Mains (HLoS = ‘E’ or ‘F’)

Table F.1: EXISTING-PWWF-5 Gravity Main Deficiencies (HLoS = ‘E’ or ‘F’)

Pipe ID	Length (m)	Slope (%)	Diameter (mm)	PWWF-5 (L/s)	q/Q	d/D	HLoS
S8025X	35.9	0.7	250	49.1	1.01	1.00	E
S8035X	68.6	0.4	250	49.4	1.26	1.00	E
S8385X	54.9	0.5	200	28.5	1.20	1.00	E
S8395X	59.7	0.6	200	27.0	1.06	0.86	E
S8400X	73.4	0.4	200	24.0	1.15	0.97	E

Table F.2: BUILD-OUT-PWWF-5 Gravity Main Deficiencies (HLoS = ‘E’ or ‘F’)

Pipe ID	Length (m)	Slope (%)	Diameter (mm)	PWWF-5 (L/s)	q/Q	d/D	HLoS
S8025X	35.9	0.7	250	49.1	1.01	1.00	E
S8035X	68.6	0.4	250	65.9	1.68	1.00	E
S8370X	47.2	0.3	250	38.7	1.24	1.00	E
S8375X	20.2	0.3	250	38.1	1.18	1.00	E
S8380X	54.6	0.3	250	38.1	1.22	1.00	E
S8385X	54.9	0.5	200	37.6	1.58	1.00	E
S8390X	85.6	1.0	200	35.8	1.08	1.00	E
S8395X	59.7	0.6	200	35.4	1.39	1.00	E
S8400X	73.4	0.4	200	33.1	1.58	1.00	F
S8410X	68.7	1.3	200	40.3	1.07	1.00	E
S8425X	53.3	0.6	200	36.2	1.47	1.00	E
S8430X	51.4	1.0	200	35.9	1.09	1.00	E

Appendix G Improvement Class D Unit Cost Rates

Unit cost rates below are class D unit cost estimates based on construction cost indices published by the Engineering News Record (ENR) for nearby markets and include construction, engineering design, and contingency costs. All costs are in 2024 dollars with no allowance for inflation.

Table G.1: Gravity Main (1.5-3 m depth)

Diameter (mm)	Unit Cost Per Road Type ($/m)			
	Special*	Local	Collector	Arterial
250	$3,197	$3,762	$4,702	$5,642
300	$3,327	$3,915	$4,893	$5,872
375	$3,522	$4,144	$5,180	$6,216

*Includes service roads, lanes, and right-of-ways.

Table G.2: Gravity Main (3-6 m depth)

Diameter (mm)	Unit Cost Per Road Type ($/m)			
	Special*	Local	Collector	Arterial
250	$4,724	$5,557	$6,947	$8,336
300	$4,854	$5,710	$7,138	$8,566
375	$5,049	$5,940	$7,425	$8,910

*Includes service roads, lanes, and right-of-ways.

Table G.3: Pump Station

Pump Ratings	0-5 HP	5-20 HP	20-50 HP	50-100 HP	100+ HP
Cost*	$948,000	$1,057,000	$1,373,000	$1,893,000	$2,689,000

Appendix H Detailed Improvement Recommendations

Table H.1: Proposed Pump Station Improvements

Project ID	Pump Station	Existing Firm Capacity (L/s)	Proposed Firm Capacity (L/s)*	Proposed Downstream Forcemain Velocity @ Firm Capacity (m/s)	Estimated Pump Requirements	Cost
1	Ganges Pump Station	29.0	110.0	3.5	2 x 48 hp pumps	$1,373,000

***Flows from BUILD-OUT-PWWF-25 (with upgrades) scenario.**

Table H.2: Proposed Gravity Main Improvements

Project ID	Pipe ID	Length (m)	Slope (%)	Existing Diameter (mm)	Proposed Diameter (mm)	Upgrade Type	Design Flow (L/s)**	Design d/D	Road Type	Cost
2	S8020X	11.8	0.9	300	375	**Continuity**	102.4	0.56	Special***	$59,684
2	S8025X	35.9	0.7	250	375	Capacity	91.8	0.57	Special***	$126,390
2	S8030X	20.8	1.0	250	375	**Continuity**	91.8	0.52	Special***	$73,303
2	S8035X	68.6	0.4	250	375	Capacity	91.3	0.64	Special***	$241,539
2	S8365X	69.5	0.8	250	375	**Continuity**	59.8	0.49	Local	$287,991
2	S8370X	47.2	0.3	250	375	Capacity	58.7	0.53	Special***	$238,479
2	S8375X	20.2	0.3	250	375	Capacity	58.1	0.51	Special***	$102,217
2	S8380X	54.6	0.3	250	375	Capacity	58.0	0.53	Special***	$192,146
2	S8385X	54.9	0.5	200	375	Capacity	57.6	0.47	Local	$227,348
2	S8390X	85.6	1.0	200	300	Capacity	55.3	0.54	Local	$335,253
2	S8395X	59.7	0.6	200	300	Capacity	54.8	0.62	Collector	$292,332
2	S8400X	73.4	0.4	200	300	Capacity	49.9	0.65	Special***	$244,315
3	S8405X	138.5	1.6	200	250	**Continuity**	48.7	0.59	Special***	$442,724
3	S8410X	68.7	1.3	200	250	Capacity	48.2	0.61	Special***	$219,675
3	S8415X	69.8	4.7	200	250	**Continuity**	47.8	0.42	Local	$262,655
3	S8420X	41.0	1.8	200	250	**Continuity**	47.6	0.52	Local	$154,340
3	S8425X	53.3	0.8*	200	250	Capacity	42.9	0.68	Special***	$170,381
3	S8430X	51.4	1.0	200	250	Capacity	42.5	0.62	Special***	$164,275

***Should be regraded to a minimum grade of 0.8%.**
****Flows from BUILD-OUT-PWWF-25 (with upgrades) scenario.**
*****Includes service roads, lanes, and right-of-way.**

Appendix C

Technical Memorandum

Capital Regional District Sewer Collection System Hydraulic Impact Analysis of the Hastings House Country Hotel Development

FINAL

Municipality: Capital Regional District, BC
Project ID: 2026-054-CRD
Requested by: MSR Solutions Inc.
Date: May 12, 2026
Location: 160 Upper Ganged Rd, Salt Spring Island

1. Introduction

GeoAdvice Engineering Inc. (GeoAdvice) was retained by MSR Solutions Inc. (Client) to assess the hydraulic impact of a proposed development located at 160 Upper Ganges Rd, Salt Spring Island, on the Capital Regional District's (CRD) sanitary sewer collection system. The proposed development includes the existing Hastings House hotel buildings with an initial expansion of six (6) cabins, and an additional two (2) cabins to be completed under a future expansion.

This memo describes the assumptions and results of the hydraulic modeling and capacity analysis using InfoSWMM (Autodesk). InfoSWMM is a GIS-based sewer collection system modeling and management software application.

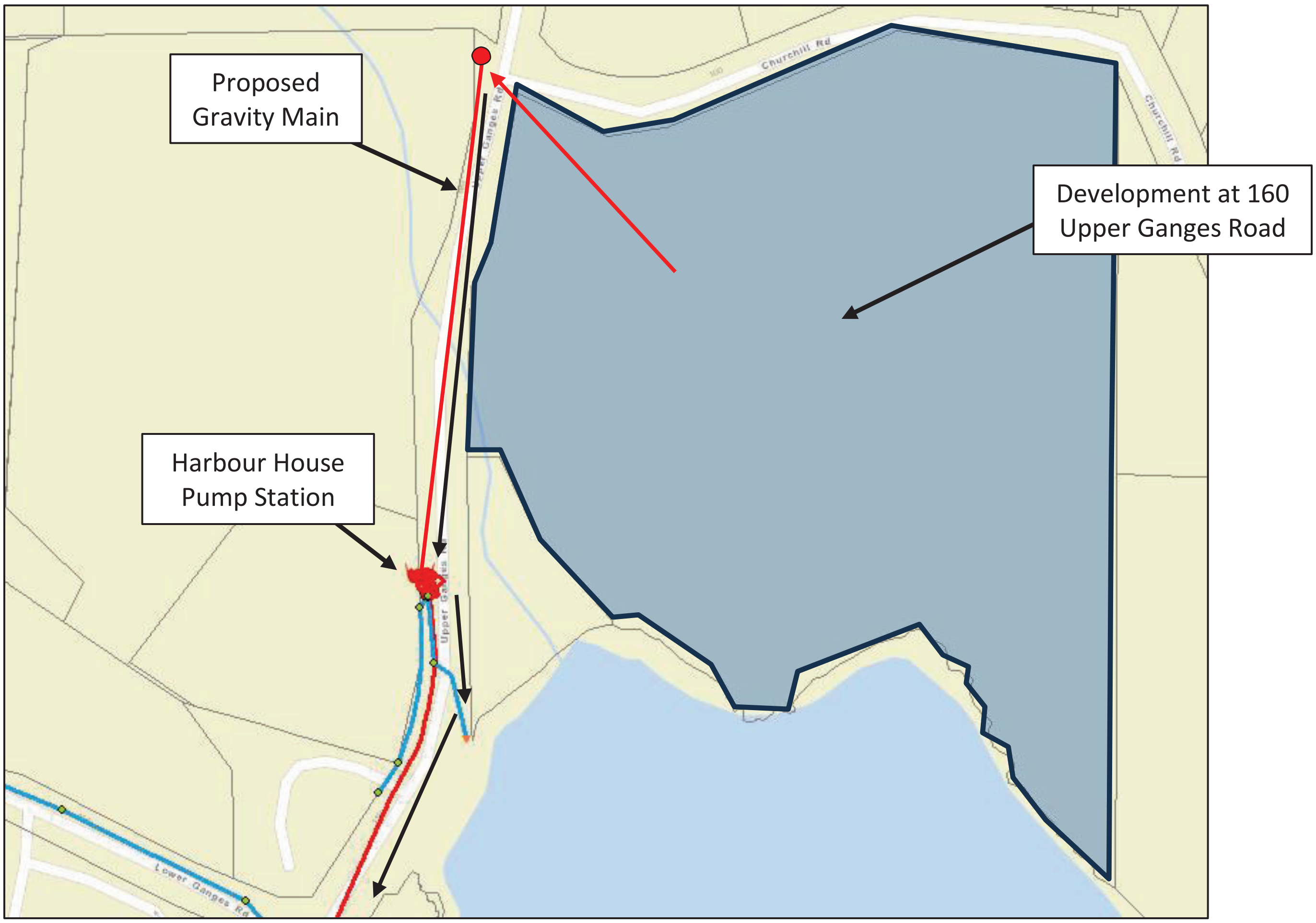
The CRD's InfoSWMM model (updated January 2025) was used to complete the hydraulic modeling and capacity analysis.

2. Sanitary Sewer Collection Analysis

The development will be connected to a proposed gravity main extension along Upper Ganges Road that discharges directly into the Harbour House Pump Station. All sanitary flows from the development will be conveyed by gravity to the Harbour House pump station, then to the Ganges pump station, and finally to the wastewater treatment plant (WWTP).

Figure 2.1 shows the development location.

Figure 2.1: Development Site – Sewer Network



2.1. Sanitary Sewer Load

The sewer load calculations were provided by MSR Solutions Inc. and reviewed by GeoAdvice. The sanitary sewer loads are summarized in **Table 2.1**

Table 2.1: Development Sanitary Sewer Loads

Parameter	Current Buildout and 6 Cabin Expansion	Current Buildout and 6 + 2 Cabin Expansion
Peak Base Sanitary Flow (PBSF)	0.40 L/s	0.58 L/s
Inflow & Infiltration*	0.47 L/s	0.57 L/s
Peak Wet Weather Flow (PWWF)	0.87 L/s	1.15 L/s

***Per MMCD standard of 22,500 l/ha/day (old systems) and 11,200 L/ha/day (new systems).**

2.2. Sanitary Sewer Capacity Analysis

The extent of the analysis was limited to the downstream pipes from the development to the WWTP, shown in red in **Figure 2.2.**

Figure 2.2: Pipe Capacity Analysis Extent

Simulation results from the model were compared under the existing scenario with the six (6) cabin expansion and the build-out scenario with the full eight (8) cabin expansion (6+2). Only the pipes downstream of the development's discharge location to the WWTP were included in the comparison below, as these are the only pipes affected by the development's discharge.

2.2.1. Level of Service Criteria

The criteria outlined in **Table 2.2** and **Table 2.3** were used to assess the hydraulic capacity of each gravity main and to assign hydraulic level of service (HLoS) ratings. The HLoS methodology below is based on q/Q results (peak flow/full pipe flow) rather than d/D results (depth/Diameter). The q/Q methodology provides a better picture of the hydraulic condition of each gravity main and how the HLoS is impacted by downstream conditions.

Table 2.2: Gravity Main Hydraulic Level of Service Criteria Scoring

Criteria	Score
Hydraulic Capacity (q/Q)	
q/Q < 0.85	1
0.85 ≤ q/Q < 1.0	2
q/Q ≥ 1.0	3
Hydraulic Grade Line (HGL)	
HGL < Crown	1
Crown ≤ HGL < Rim Elevation	2
HGL ≥ Rim Elevation	3
Velocity (v)	
v < 0.6 m/s	Fail
v ≥ 0.6 m/s	Pass

Table 2.3: Gravity Main Hydraulic Level of Service Ratings

HLoS Rating	Capacity	HGL	Velocity	Description
A	1	1	Pass	Gravity Main performing as designed
B	1	1	Fail	Adequate capacity, low velocity indicates potential sedimentation
C	1	2 or 3	Pass or Fail*	Adequate capacity, backwater caused by downstream conditions
D	2	1, 2 or 3	Pass or Fail*	Marginal capacity, backwater caused by downstream conditions
	3	1	Pass or Fail*	
E	**3**	**2**	**Pass or Fail***	**Capacity exceeded and surcharging likely**
F	**3**	**3**	**Pass or Fail***	**Capacity exceeded and flooding likely**

***HLoS ratings from 'C' to 'F' are independent of velocity criteria.**

In general, HLoS ratings of 'A', 'B', 'C' and 'D' will not trigger an upgrade as there is capacity available in the gravity main to convey flows. Gravity mains receiving a HLoS rating of 'C' or 'D' may show surcharging or flooding on connected nodes; however, these cases would indicate that the surcharged condition is due to downstream hydraulic deficiencies.

Only gravity mains receiving a HLoS rating of 'E' and 'F' were considered for upgrade. A gravity main receiving an 'E' rating requires an upgrade as the hydraulic capacity has been exceeded and is likely causing surcharging to occur. A gravity main receiving an 'F' rating indicates that surcharging to the manhole rim is likely, increasing the priority of the upgrade.

Table 2.4 and **Table 2.5** outline the criteria used to assign hydraulic level of service ratings to each pump station.

Table 2.4: Pump Station Hydraulic Level of Service Criteria Scoring

Criteria	Score
Pump Capacity	
PWWF* ≤ Firm Capacity	Pass
PWWF* > Firm Capacity	Fail
Wet Well Capacity	
Max. Operating Level < Inlet Pipe Invert	A
Max. Operating Level ≥ Inlet Pipe Invert	B
Max. Operating Level >= Max. Physical Depth	C
Forcemain Velocity	
v < 0.9 m/s	Fail
0.9 m/s ≤ v ≤ 3.5 m/s	Pass
v > 3.5 m/s	Fail

***PWWF = Peak Wet Weather Flow.**

Table 2.5: Pump Station Hydraulic Level of Service Ratings

HLoS Rating	Pump Capacity	HGL	Velocity	Description
A	Pass	A	Pass	Pump station performing as designed
B	Pass	A	Fail	Forcemain velocity outside of design range
C	Pass	B	N/A	Inlet pipe invert within pump operating range and backup likely (submerged inlet)
D	**Fail**	**A**	**N/A**	**Pump capacity exceeded but sufficient wet well capacity to attenuate additional flow**
E	**Fail**	**B**	**N/A**	**Pump capacity exceeded and backup likely**
F	**N/A**	**C**	**N/A**	**Wet well capacity exceeded and overflow likely**

A pump station receiving a HLoS rating of 'A', 'B', or 'C' will not trigger an upgrade as the pump capacity is sufficient to convey the PWWF entering the station; however, HLoS ratings of 'B' and 'C' indicate operating conditions that should be reviewed by the CRD.

Pump stations receiving a HLoS rating of 'D', 'E', or 'F' indicate that the pump capacity has been exceeded with varying levels of surcharge risk.

2.2.2. Gravity Main Level of Service Analysis

Table 2.6 summarizes the existing gravity main HLoS results under each scenario.

Table 2.6: Gravity Main HLoS Results
(Number of Gravity Mains Downstream of Proposed Development)

HLoS Rating	Existing PWWF* 5 year I&I Without Development	Existing PWWF* 5 year I&I With 6 Cabin Expansion	Build-out PWWF* 5 year I&I Without Development	Build-out PWWF* 5 year I&I With 6 + 2 Cabin Expansion
A	7	7	7	7
B	0	0	0	0
C	4	4	4	4
D	0	0	0	0
E	**2**	**2**	**2**	**1**
F	**0**	**0**	**0**	**1**

***PWWF-5 = Peak Wet Weather Flow under a 5-year Storm Event.**

Table 2.6 shows that there are two (2) existing HLoS = 'E' deficiencies both with and without the six (6) cabin expansion under the existing scenario. Under the build-out scenario without development, these deficiencies remain as HLoS = 'E', however with the full eight (6 + 2) cabin expansion, one worsens to an HLoS = 'F' deficiency.

The two (2) deficiencies are summarized in **Table 2.7**, **Table 2.8**, **Table 2.9**, **and 2.10** below:

Table 2.7: EXISTING-PWWF-5 Without Development Gravity Main Deficiencies

Pipe ID	Length (m)	Slope (%)	Diameter (mm)	PWWF (L/s)	q/Q	d/D	HLoS
S8035X	68.6	0.44	250	49.1	1.25	1.00	E
S8025X	35.9	0.67	250	48.9	1.01	1.00	E

Table 2.8: EXISTING-PWWF-5 With 6-Cabin Expansion Gravity Main Deficiencies

Pipe ID	Length (m)	Slope (%)	Diameter (mm)	PWWF (L/s)	q/Q	d/D	HLoS
S8035X	68.6	0.44	250	49.3	1.25	1.00	E
S8025X	35.9	0.67	250	49.3	1.01	1.00	E

Table 2.9: BUILD-OUT-PWWF-5 Without Development Gravity Main Deficiencies

Pipe ID	Length (m)	Slope (%)	Diameter (mm)	PWWF (L/s)	q/Q	d/D	HLoS
S8035X	68.6	0.44	250	66.0	1.68	1.00	E
S8025X*	35.9	0.67	250	49.3	1.01	1.00	E

***No increase under BUILD-OUT scenario due to upstream emergency overflow outfall (Figure 2.3).**

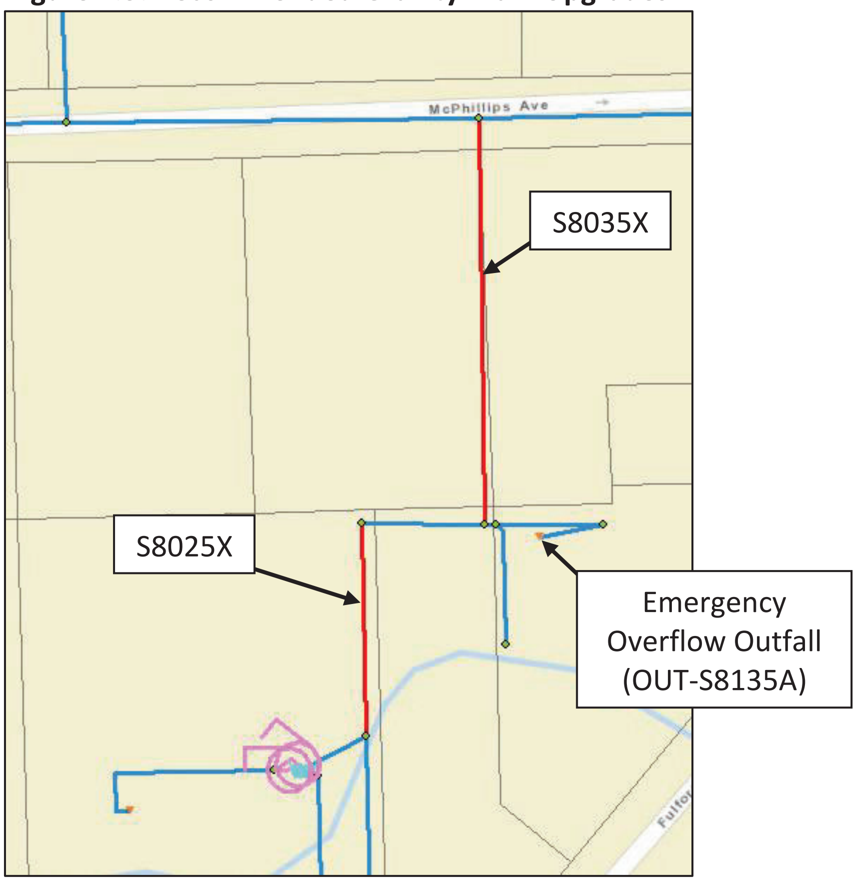
Table 2.10: BUILD-OUT-PWWF-5 With 6 + 2-Cabin Expansion Gravity Main Deficiencies

Pipe ID	Length (m)	Slope (%)	Diameter (mm)	PWWF (L/s)	q/Q	d/D	HLoS
S8035X	68.6	0.44	250	66.9	1.70	1.00	F
S8025X*	35.9	0.67	250	49.3	1.01	1.00	E

***No increase under BUILD-OUT scenario due to upstream emergency overflow outfall (Figure 2.3).**

The locations of the two (2) deficiencies are shown in **Figure 2.3**.

Figure 2.3: Recommended Gravity Main Upgrades



Refer to **Appendix A** for the modeling results of the downstream pipes from the development to the WWTP.

2.3. Pump Station Capacity Analysis

Table 2.11, **Table 2.12**, **Table 2.13**, **and Table 2.14** summarize the pump station HLoS results under the existing and future scenarios.

Table 2.11: EXISTING-PWWF-5 Without Development Pump Station HLoS Ratings

Pump Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Forcemain Velocity (m/s)	HLoS Rating
Ganges*	29.0	57.0	**-28.0**	1.8	**E**
Harbour House	6.6	1.6	5.0	1.5	A

***Ganges PWWF unchanged from the *Model Update, Calibration, and Capacity Analysis Ganges, BC* (January 2025), as the upstream deficiencies and emergency overflow outfall limit additional flow to the wet well.**

Table 2.12: EXISTING-PWWF-5 With 6-Cabin Expansion Pump Station HLoS Ratings

Pump Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Forcemain Velocity (m/s)	HLoS Rating
Ganges*	29.0	57.0	**-28.0**	1.8	**E**
Harbour House	6.6	2.4	4.2	1.5	A

***Ganges PWWF unchanged from the *Model Update, Calibration, and Capacity Analysis Ganges, BC* (January 2025), as the upstream deficiencies and emergency overflow outfall limit additional flow to the wet well.**

Table 2.13: BUILD-OUT-PWWF-5 Without Development Pump Station HLoS Ratings

Pump Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Forcemain Velocity (m/s)	HLoS Rating
Ganges*	29.0	58.4	**-29.4**	1.9	**E**
Harbour House	6.6	2.4	4.2	1.5	A

***Ganges PWWF unchanged from the *Model Update, Calibration, and Capacity Analysis Ganges, BC* (January 2025), as the upstream deficiencies emergency overflow outfall limit additional flow to the wet well.**

Table 2.14: BUILD-OUT-PWWF-5 With 6 + 2-Cabin Expansion Pump Station HLoS Ratings

Pump Station	Firm Capacity (L/s)	PWWF (L/s)	Reserve Capacity (L/s)	Forcemain Velocity (m/s)	HLoS Rating
Ganges*	29.0	58.4	**-29.4**	1.9	**E**
Harbour House	6.6	3.5	3.1	1.5	A

***Ganges PWWF unchanged from the *Model Update, Calibration, and Capacity Analysis Ganges, BC* (January 2025), as the upstream deficiencies emergency overflow outfall limit additional flow to the wet well.**

The pump station capacity results show that the Ganges Pump Station is deficient under the existing and build-out scenarios.

2.4. System Improvement Recommendations

This section identifies the required upgrades.

- Gravity mains with a HLoS rating of either 'E' or 'F' were considered "deficient" and proposed upgrades were considered to eliminate these deficiencies.
- Pump stations with a HLoS rating of either 'D', 'E', or 'F' were considered "deficient" and proposed pump, wet well and forcemain upgrades were considered to eliminate these deficiencies.

Based on the 2022 MMCD Design Guidelines and standard sewer design practice, the design and sizing criteria shown in **Table 2.15** were used.

Table 2.15: Design and Sizing Criteria

Facility	Criterion	Parameter Value
Gravity Main	Design Flow/Sizing Scenario	BUILD-OUT-PWWF-25
	Max. depth/Diameter ratio	d/D < 0.7
	Min. Velocity	v ≥ 0.6 m/s
	Max. Velocity	v ≤ 2.5 m/s
	Min. Diameter	D = 200 mm
	Manning Roughness Coefficient	n = 0.013
Forcemain	Min. Velocity	v ≥ 0.9 m/s
	Max. Velocity	v ≤ 3.5 m/s
	Hazen-Williams Roughness	C = 120
Pump	Design Flow	BUILD-OUT-PWWF-25
	Maximum Pump Flow	PWWF ≤ Firm Capacity

***d= flow depth, D = Diameter, n = Manning coefficient, v = velocity, c = Hazen-Williams roughness coefficient**

The recommended gravity main upgrades are summarized in **Table 2.16**.

Table 2.16: Recommended Gravity Main Upgrades

Gravity Main ID	Existing Diameter (mm)	Proposed Diameter (mm)	Design Flow* (L/s)	Design d/D	Upgrade Type	Length (m)
S8035X	250	375	92.5	0.65	Deficiency	68.58
S8030X	250	375	93.0	0.52	Continuity	20.81
S8025X	250	375	93.0	0.58	Deficiency	35.89
S8020X	300	375	103.6	0.57	Continuity	11.82

***Increase from analysis due to alleviating upstream bottlenecks.**

The recommended gravity main upgrades are shown in **Figure 2.4**.

Figure 2.4: Recommended Gravity Main Upgrades

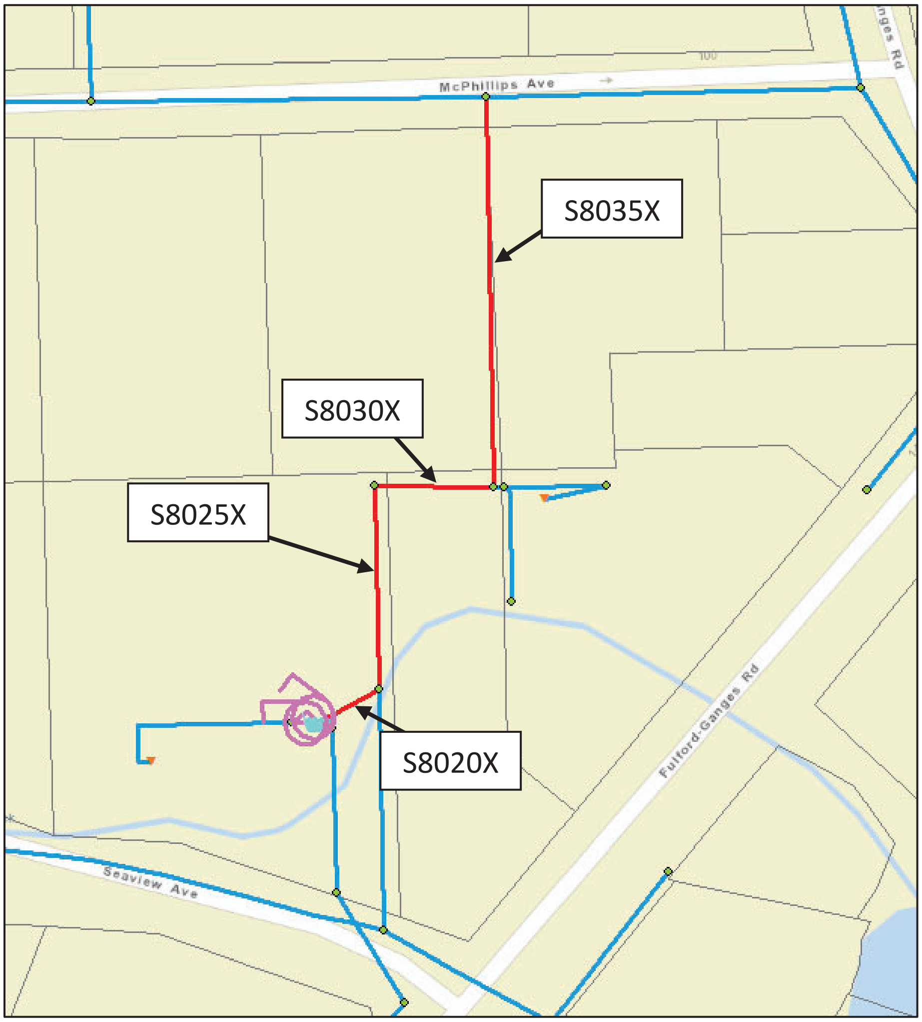


Table 2.17 summarizes the Ganges pump station results under the BUILD-OUT-PWWF-25 scenario.

Table 2.17: Proposed Pump Station Improvements

Pump Station	Existing Firm Capacity (L/s)	Proposed Firm Capacity* (L/s)	Existing Forcemain Diameter (mm)	Existing Downstream Forcemain Velocity @ Firm Capacity (m/s)	Proposed Downstream Forcemain Diameter (mm)	Proposed Downstream Forcemain Velocity @ Firm Capacity (m/s)
Ganges	29.0	112.1	200	3.57	250	2.28

***Increase from analysis due to alleviating upstream bottlenecks.**

Submission

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Senior Modeling Review

Revision No.	Date	Document Description	Revised By	Reviewed By
R0	April 22, 2026	Draft	Noah Wright	Werner de Schaetzen
R1	May 12, 2026	Final	Noah Wright	Werner de Schaetzen

Statement of Qualifications and Limitations

This document represents GeoAdvice Engineering Inc. best professional judgment based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by a member of the engineering profession currently practicing under similar conditions. No warranty, express or implied is made.

Sewer Hydraulic Modeling Results

Appendix A

Existing PWWF Gravity Main Hydraulic Modeling Results

Gravity Main ID	Install Year	Length (m)	Diameter (mm)	Material	Slope (%)	Full Flow Capacity (L/s	Existing Without Development				Existing With 6-Cabin Expansion				Build-Out Without Development				Build-Out With 6 + 2-Cabin Expansion			
							PWWF(L/s)	d/D	q/Q	HLoS Rating	PWWF (L/s)	d/D	q/Q	HLoS Rating	PWWF(L/s_	d/D	q/Q	HLoS Rating	PWWF (L/s)	d/D	q/Q	HLoS Rating
S8075X	1985	39.3	250	PVC	1.78	79.3	18.2	0.33	0.23	A	18.4	0.33	0.23	A	23.1	0.37	0.29	A	23.4	0.37	0.30	A
S8072X	1985	51.5	250	PVC	1.65	76.4	17.2	0.32	0.23	A	17.5	0.33	0.23	A	22.2	0.37	0.29	A	22.6	0.37	0.30	A
S8070X	1985	103.1	250	PVC	0.27	31.0	16.3	0.52	0.53	A	16.6	0.52	0.54	A	21.2	0.61	0.69	A	21.9	0.63	0.71	A
S8065X	1985	85.0	250	PVC	0.27	30.9	16.7	0.49	0.54	A	17.1	0.50	0.55	A	21.7	0.58	0.70	A	22.7	0.60	0.73	A
S8060X	1985	118.2	250	PVC	0.72	50.4	17.5	0.38	0.35	A	18.0	0.38	0.36	A	22.7	0.44	0.45	A	23.8	0.45	0.47	A
S8055X	1985	60.0	250	PVC	1.60	75.2	17.6	0.33	0.23	A	18.1	0.34	0.24	A	22.8	0.38	0.30	A	23.9	0.39	0.32	A
S8050X	1985	49.9	250	PVC	1.58	74.8	17.6	0.34	0.24	A	18.5	0.35	0.25	A	23.4	0.40	0.31	A	24.6	0.41	0.33	A
S8045X	1985	85.7	250	PVC	1.94	82.8	22.2	0.73	0.27	C	23.1	0.80	0.28	C	29.3	1.00	0.35	C	30.6	1.00	0.37	C
S8040X	1985	65.9	250	PVC	0.64	47.5	22.6	1.00	0.48	C	22.6	1.00	0.48	C	30.3	1.00	0.64	C	31.6	1.00	0.67	C
S8035X	1985	68.6	375	PVC	0.44	39.3	49.1	1.00	1.25	E	49.3	1.00	1.25	E	66.0	1.00	1.68	E	66.9	1.00	1.70	F
S8030X	1985	20.8	375	PVC	0.96	58.3	48.9	1.00	0.84	C	49.4	1.00	0.85	C	49.4	1.00	0.85	C	49.4	1.00	0.85	C
S8025X	1985	35.9	375	PVC	0.67	48.6	48.9	1.00	1.01	E	49.3	1.00	1.01	E	49.3	1.00	1.01	E	49.3	1.00	1.01	E
S8020X	1985	11.8	375	PVC	0.93	93.3	52.1	1.00	0.56	C	52.6	1.00	0.56	C	52.6	1.00	0.56	C	52.7	1.00	0.56	C