Appendix A Technical Note 1

TECHNICAL NOTE #1 – MODEL NETWORK UPDATES

City of Waterloo Sanitary Master Plan Update

January 10, 2022

Prepared for:
City of Waterloo

Prepared by:
Stantec Consulting Ltd.
300 Hagey Blvd., Suite 100
Waterloo, ON N2L 0A4

Project Number:
165640363

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Prepared by: ______________________________
Helene Boulanger, ing.

Reviewed by: ______________________________
Ashley LeMasurier, P.Eng.

Approved by: ______________________________
Dave Eadie, P.Eng.

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Acronyms / Abbreviations

ADSF	Average Dry Weather Sewage Flow
GIS	Geographic Information System
ICM	Integrated Catchment Modelling (Software)
I/I	Inflow/Infiltration
MH	Maintenance Hole
MP	Master Plan
O&M	Operation & Maintenance
PCN	Process Control Narrative
PCSWMM	Personal Computer Storm Water Management Model (Software)
RTK	RTK Unit Hydrograph Method
SPS	Sewage Pumping Station
SCADA	Supervisory Control and DATA Acquisition
WWTP	Wastewater Treatment Plant

1 Introduction

The City of Waterloo (City) has retained Stantec Consulting to complete the Waterloo Sanitary Servicing Master Plan Update (Master Plan Update). The purpose of the Master Plan Update is to revise the 2014 Sanitary Master Plan (Stantec, 2015) to account for updated infrastructure, and population and employment growth. There are two growth scenarios: Priority Scenario, which includes projections up to a 2031 planning horizon, and Strategic Scenario, representing projections up to a 2051 planning horizon. Priority and strategic projects will be evaluated to operate the system efficiently and effectively, to implement best management practices (including Infiltration/Inflow (I/I) monitoring and mitigation approaches), and to optimize staging of the sanitary capital program.

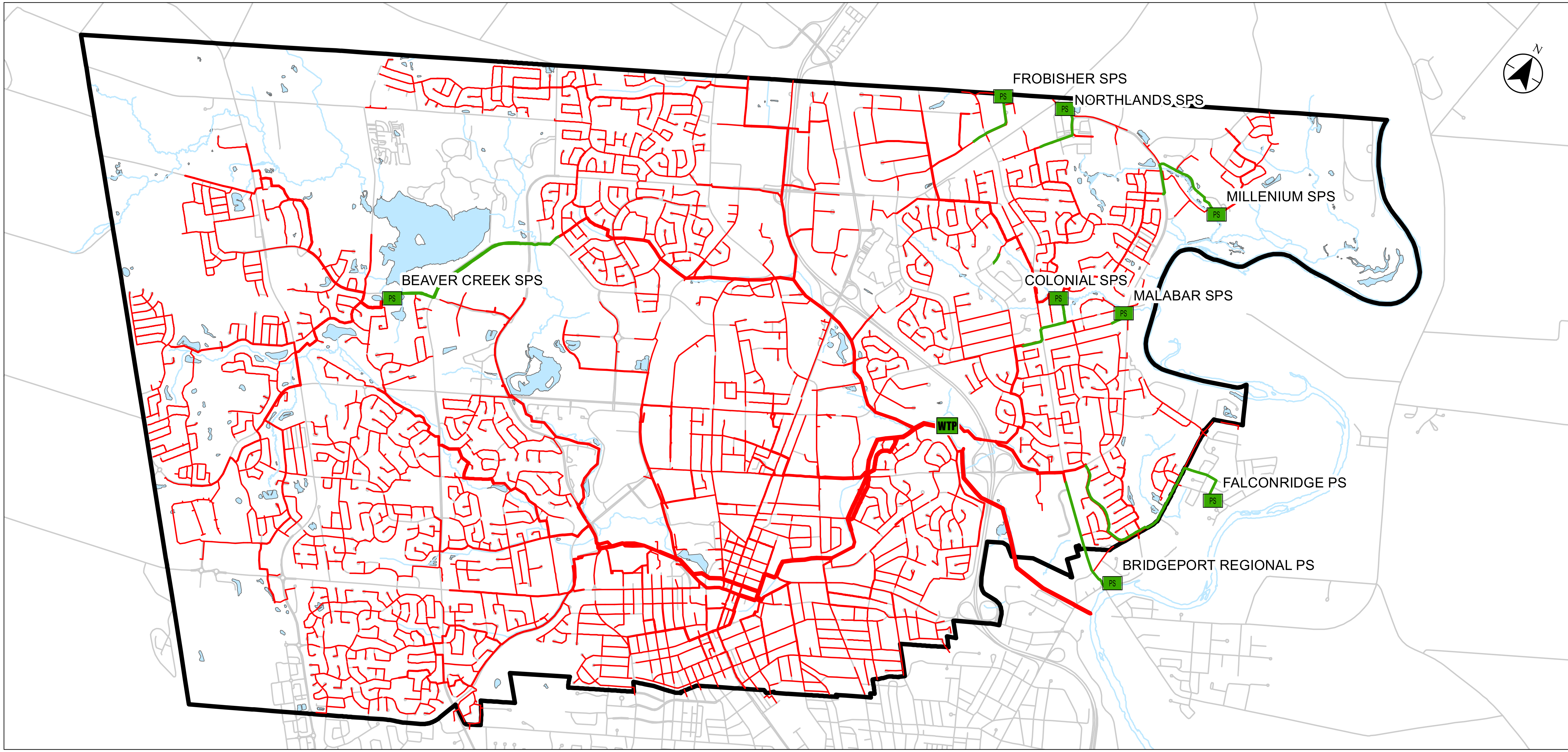
The following tasks will be carried out for the completion of the Master Plan:

- **Task 1: Model Infrastructure Updates**
- Task 2: Existing/Future Conditions Flow Assessment
- Task 3: Preparation of Modelling Tools
- Task 4: Model Analysis – Identification of Problem Areas
- Task 5: Detailed Analysis of Solutions
- Task 6: Conclusions & Recommendations – Capital Planning and Execution
- Task 7: Finalize Master Plan Update

Task 1 includes the background data review to consolidate and analyse the existing information for model update purposes. The data provided for Task 1 includes the existing PCSWMM model, historic flow/rainfall monitoring data, Pump Station data, GIS layers, trunk assets, capital projects completed since the last Master Plan update, cross-border agreements, current development applications, water billing records, and planning population data / projections. The flow monitoring data is used to evaluate the collection system characteristic flow responses, and to support model recalibration. An overview of time-varying data is provided in this technical note; however, it will be addressed in greater detail in the Task 2.

The purpose of this **Technical Note #**1 (**TN#1**) is to summarize and document the review of the City's most recent wastewater infrastructure updates. It also identifies additional information required to update the hydraulic model and to complete the existing and future condition system assessments in the next tasks. This review includes gap and data consistency assessments for model applications. The sewer data provided from the City is in a geodatabase format and was subsequently converted into individual shapefiles for transfer to the modelling environment.

The study area is based on the provided Boundary shapefile and encompasses the entirety of the City of Waterloo. It is generally bounded by Benjamin Rd/Bridge St W/University Ave E/Country Squire Rd to the north, by Wilmot Line to the west, by the Grand River and Woolwich St to the east, and by the City of Kitchener to the south. The study area and sanitary collection system are presented in **Figure 1-1**.



Legend

Sanitary Sewers

- 100 - 250 mm
- 300 - 450 mm
- 500 - 675 mm
- 750 - 900 mm
- 1050 - 1200 mm

- PS Sewage Pump Station
- Forcemain
- WTP Wastewater Treatment Plant
- City Boundary

0 500 1,000 metres

1:40,000 (At original document size of 11x17)

Stantec

Project Location
City of Waterloo

165640363
Prepared by HB on 2022-09-20

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
1-1

Title
Study Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

2 System Review and Data Gap Analysis

2.1 Background Documents & Reports

The City of Waterloo provided various background documents and reports, which will be used throughout this Master Plan Update and are summarized in this section. The reports pertain to the following topics:

- Previous Master Plan
- Water Billing and land use
- Infrastructure master planning
- Flow monitoring
- Population updates & growth

Table 2-1 summarizes the background reports and documents that are relevant to the existing and future sanitary collection system for the Master Plan Update. All documents and reports from the previous Master Plan (Stantec, 2015) that are still relevant can be used, but are not summarized in this table.

Table 2-1: Summary of Background Documents & Reports

	Source	Synopsis	Relevance
1	Waterloo Sanitary Master Plan (Stantec, 2015)	Previous Sanitary Master Plan.	Basis of update for the current Master Plan.
2	Sewage Pumping Station Information (City of Waterloo, 2022)	Detailed information on pump station design and operation (wet well volume, rated capacity, etc.).	Updating the sewage pumping stations in the model.
3	City of Waterloo Official Plan (City of Waterloo, 2022)	City planning information including land use, cultural heritage landscapes, sensitive environments, forest, wetlands, and zoning.	Context for growth, sewage flows, and alternative solution constraints.
4	2020 Data Quality Review (City of Waterloo, 2022)	A high-level data review of the rain gauge and the flow monitoring data (January 2020 to December 2020).	Provides input into the flow monitoring data review.
5	Major Intensification Projects (City of Waterloo, 2022)	Information on major intensification projects, identifying the site area, the number of units, the density, and the status.	Used to inform the development of population growth scenarios.

	Source	Synopsis	Relevance
6	2021 Census Release 2 Information Report (City of Waterloo, 2021)	Findings from the second Census data release (age distribution, population change 2016 to 2021, proportion of single-detached houses, private households by household size).	The census data provides the 2021 populations which forms the basis of the Master Plan model update, and this report provides the key findings regarding demographics from the census data.
7	Cross Border Agreement Information (City of Waterloo, 2022)	Specifics on inter-municipal agreements for sewage flow exchange across borders.	Validate/add boundary conditions representing the Cross Border data in the model.
8	Water Billing Information (City of Waterloo, 2022)	Spreadsheet with the water billing information per address and land use, in m^3 units.	To corroborate monitored per capita sewer flow generation rates and to distribute census populations by general land use.
9	Sanitary Scores Spreadsheet (City of Waterloo, 2022)	Asset management condition scoring of the conduits (score 1 to 5; assumed to be NASSCO).	Informs the understanding of the existing collection system condition and will factor into alternative solution development and Capital prioritization.
10	Flow Monitoring Data (City of Waterloo, 2022)	Temporary monitoring program data files (depth, velocity, calculated flow) in CSV format for years 2014 to 2021, and rainfall in CSV format for years 2020 and 2021 (see **Section 2.4.1**).	Collection system characterization and supports model calibration.

2.2 Previous Master Plan Hydraulic Model

The City of Waterloo sanitary sewer model was developed as part of the 2014 Master Plan in PCSWMM. The model was originally built based on geographic information system (GIS) data provided by the City. It is an all-pipe sanitary sewer model in the uptown core area, and a trunk-level sanitary sewer model in the remainder of the system. The model also includes the City's 6 sewage pumping stations. This model forms the basis of this Master Plan Update, and is adjusted to include infrastructure upgrades or replacements occurring since the last Master Plan based on the new GIS data and record drawings provided by the City (further discussed in **Section 2.3.3**). Flow allocations will be adjusted through recalibration with recent flow monitoring data, and the existing conditions and growth scenarios will be updated and evaluated.

2.3 Sanitary Sewer Network Data

The City provided updated GIS shapefiles. The physical asset data was reviewed to evaluate data gaps and erroneous values, as well as the difference between the updated GIS data and the previous Master Plan data. For the Master Plan Update, the year of installation provided within the shapefiles is used to inform the infrastructure upgrades occurring since the last Master Plan (i.e., 2014 and newer). The gap analysis of the active physical asset data is presented in **Section 2.3.1**.

2.3.1 PHYSICAL ASSET DATA

The following physical asset data was received from the City, by way of GIS shapefiles:

- Maintenance Holes
- Gravity Mains
- Lateral Lines
- Pressurized Mains
- Control Valves
- Network Structures (Pump Stations)

The physical asset data is presented in **Figure 2-1**.

2.3.1.1 Maintenance Holes

The maintenance hole (MH) shapefile contains several attribute fields to identify the MHs and to provide relevant information. For the purposes of hydraulic modelling, the most important attribute is the top of MH elevation (or rim elevation).

It is noted that there are 7,182 active MHs and 50 abandoned MHs, for a total of 7,232 MHs in the City's sanitary geodatabase. A summary of the relevant attribute fields and the initial gap assessment for all active maintenance holes, as per the provided shapefile, is presented in **Table 2-2**.

Table 2-2: Overview and Initial Assessment of Active MH GIS Data

Field Name	Description	Input Notes	Gap Assessment
MXASSETNUM	Identifier (former Maximo Asset Number)	Numeric ID	1,432 blanks (19.9%) 4 duplicates (0.06%)
ASSET ID	Unique Asset identifier	Numeric ID	No blanks, no duplicates
ENTNAME	Former unique identifier, MH reference name	Letter/Numeric ID	12 blanks (0.17%) 5 duplicates (0.07%)
TOPOFMH	Top of MH elevation (mASL)	Numeric Entry	351 blanks (4.9%) 151 unknown entries (2.1%)

Field Name	Description	Input Notes	Gap Assessment
LIFECYCLEs	Indicates if the MH is active or abandoned	Letter Entry (Active/Abandoned)	No blanks 7182 “Active” (100%)
INSTALLDAT	The date of installation	Numeric Entry (dates)	44 blanks (0.6%) 111 unknown entries (1.55%)
POSITION	Description indicating the quality of the source position (x,y) data	Text Entry	N/A

The MXASSETNUM is the unique identifier for maintenance holes (MHs) used in the 2014 Master Plan. This field is needed to import data into the modelling software, to track attributes updates, and to transfer information between Stantec and the City. For the blank MXASSETNUMs that were assigned an identifier in the 2014 Master Plan, the same ID is kept for this Master Plan Update. There were 176 MHs in the uptown core and along the trunks (i.e., modelled) with missing entries for MXASSETNUM. For these maintenance holes, the ASSET ID was used as a unique identifier.

For the MHs along the trunk sewers and in the uptown core area, the elevation of the top of the MH is used in hydraulic modelling to assess the impact of potential surcharges in the sanitary system. Therefore, an elevation is generated from LiDAR data for the MHs with blank or “111.111” entries. Refer to **Section 2.5** for more information on the LiDAR data used.

2.3.1.2 Gravity Mains

The gravity main shapefile contains several attribute fields. For the purposes of hydraulic modelling, the attributes of interest include upstream MH, downstream MH, slope, upstream invert, downstream invert, diameter, length, material, and the date of the installation.

Based on the data provided, there are 6,791 active gravity mains and 71 abandoned gravity mains, for a total of 6,862 gravity mains in the City’s sanitary geodatabase. A summary of the relevant attribute fields and the initial gap assessment for all active gravity mains, as per the provided shapefile, is presented in **Table 2-3**Error! Reference source not found..

Table 2-3: Overview and Initial Assessment of the Active Gravity Main GIS Data

Field Name	Description	Input Notes	Gap Assessment
MXASSETNUM	Identifier	Numeric ID	8 blanks (0.12%) 20 duplicates (0.29%)
ASSET ID	Unique identifier,	Numeric ID	No blanks, no duplicates
ENTID	Former unique identifier, pipe reference name	Numeric ID	2 blanks (0.03%)
ENTNAME	Identifier corresponding to the upstream to downstream MH reference based on MH ENTNAME field, i.e., "FROMMHtoTOMH"	Letter/Numeric IDs for upstream and downstream MH ENTNAME	618 blanks (9.1%)
FROMMH	Upstream MH reference (based on MH ENTNAME field)	Letter/Numeric ID	527 blanks (7.8%)
TOMH	Downstream MH reference (based on MH ENTNAME field)	Letter/Numeric ID	522 blanks (7.7%)
UPSTREAM	Upstream invert elevation (mASL)	Numeric Entry	138 blanks (2%) 38 unknown entries (0.56%)
DOWNSTREAM	Downstream invert elevation (mASL)	Numeric Entry	128 blanks (1.9%) 35 unknown entries (0.52%)
SHAPE_Leng	Pipe length (m)	Numeric Entry	No blanks, 36 pipes with a length less than 5 m (<1%)
SLOPE	Pipe slope (%) calculated based on upstream invert, downstream invert, and length.	Numeric Entry	708 blanks (10.4%) 14 unknown entries (0.2%) 8 negative slope (0.12%) 218 slopes > 5% (3.2%)

Field Name	Description	Input Notes	Gap Assessment
DIAMETER	Pipe diameter (mm)	Numeric Entry	5 blanks (0.07%)
MATERIAL	The material of the gravity main	Text Entry	14 blanks (0.2%) 35 unknown (0.5%)
INSTALLDAT	The date of installation	Numeric Entry (dates)	4 blanks (0.06%) 58 unknown entries (0.85%)
POSITION	Description indicating the quality of the source position (x,y) data	Text Entry	N/A

Similar to the MH data, the MXASSETNUM is also the unique identifier for gravity mains used in the 2014 Master Plan, and this field is needed to enable data transfer between the GIS data and model, to track attributes updates, and to transfer information between Stantec and the City. It is also important that these values are unique with no duplications. Gravity mains with missing or duplicate entries for MXASSETNUM in the uptown core area and along the trunks (i.e., modelled pipes) were reviewed to determine the unique ID. For the blank MXASSETNUMs that were assigned an identifier in the 2014 Master Plan, that same ID is kept for this Master Plan Update.

Entries for FROMMH, TOMH, UPSTREAM, DOWNSTREAM, and DIAMETER fields are needed to complete the hydraulic modelling and assess the capacity of the sanitary sewers. Blank entries for the upstream and downstream nodes are fixed based on the connectivity methodology described in **Section 2.3.3.1**. Blank or erroneous upstream and downstream inverts or diameters are fixed based on drawing reviews or necessary inferences, as described in **Section 2.3.3.2**.

2.3.1.3 Lateral Line

The lateral line shapefile contains several attribute fields to identify the laterals and to provide relevant information. For the purposes of Master Plan hydraulic modelling, the lateral information can be used to infer connections from specific properties, if available; however, modelling laterals from the building to the sewer is not required, and thus the provided data is not assessed for gaps.

2.3.1.4 Pressurized Mains

The pressurized mains (forcemain) shapefile contains several attribute fields to identify the pressurized mains and to provide relevant information. For pressurized mains, the upstream invert, downstream invert, diameter, length, installation date, and material are used for hydraulic modelling purposes.

It can be noted that based on the data provided, there are 68 active pressurized mains and 6 abandoned pressurized mains, for a total of 74 pressurized mains in the City's sanitary geodatabase.

A summary of the relevant attribute fields and the initial gap assessment for all active pressurized mains, as per the provided shapefile, is presented in **Table 2-4**.

Table 2-4: Overview and Initial Assessment of Active Pressurized Main Data

Field Name	Description	Input Notes	Gap Assessment
MXASSETNUM	Unique identifier	Numeric ID	54 blanks (79,4%) 1 duplicate (1.5%)
ASSET ID	Unique identifier	Numeric ID	2 blanks (2.9%) No duplicates
UPSTREAM IN	Upstream invert elevation (mASL)	Numeric Entry	55 blanks (80.9%) 9 unknown entries (13.2%)
DOWNSTREAMIN	Downstream invert elevation (mASL)	Numeric Entry	53 blanks (77.9%) 7 unknown entries (10.2%)
DIAMETER	Pipe diameter (mm)	Numeric Entry	No blanks
INSTALLDAT	The date of installation	Numeric Entry (dates)	2 blanks (2.9%) 1 unknown entries (1.47%)
MATERIAL	Description of pipe material	Text Entry	1 blank (1.47%) 1 unknown (1.47%)
SHAPE_Leng	Pipe length (m)	Numeric Entry	No blanks
POSITION	Description indicating the quality of the source position (x,y) data	Text Entry	N/A

In the previous Master Plan, the name of the forcemains was generated by adding “FM” as a prefix to the pumping station’s MXASSETNUM. For the Master Plan Update, the same IDs derived as part of the previous MP are used.

The pressurized mains included in the model are only those for the City’s 6 sewage pumping stations. The entries for the UPSTREAMIN, DOWNSTREAMIN, DIAMETER, and MATERIAL are critical for hydraulic modelling and assessing the capacity of the forcemains; therefore, they are validated and updated (if necessary) for the Master Plan Update.

2.3.1.5 Control Valves

Control valves in a sanitary collection system are related to the operation of pump stations and pressurized mains. The City has provided information regarding control valves; however, this data is not generally required for the purposes of the hydraulic model. The data files will be referred to for background information, however, a data gap assessment and data validation are not required at this time.

2.3.1.6 Network Structures

For the purposes of hydraulic modelling, the majority of the physical parameters required for hydraulic modelling are not included in the network structure shapefile. A summary of the relevant attribute fields and the initial gap assessment for network structures, as per the provided shapefile, is presented in **Table 2-5**.

Table 2-5: Overview and Initial Assessment of Network Structure

Field Name	Description	Input Notes	Gap Assessment
ASSET ID	Unique identifier	Numeric ID	2 blanks (4.2%) No duplicates
ASSET TYPE	Description of the network structure	Text	19 Chambers (39.6%) 1 Chamber meter (2.1%) 2 Outlet chambers (4.2%) 8 Overflow outlets (16.7%) 11 Pumping stations (22.9%) 1 Sediment oil separator (2.1%) 4 Storage basins (8.3%) 2 Treatment plants (4.2%)
INSTALLDAT	The date of installation	Numeric Entry (dates)	9 blanks (18.8%) 3 unknown entries (6.3%)
OWNER	The owner of the network structure	Text	No Blanks
POSITION	Description indicating the quality of the source position (x,y) data	Text Entry	N/A

The private network structures are not included in the hydraulic model; therefore, they are not described in this report. Also, for the hydraulic model, only the pumping stations, the overflows and the treatment plants are included and elaborated on further in this report. The treatment plant and the pumping station overflows are described in the **Section 2.3.2.** For the pumping stations, the network structure shapefile contains 6 Sewage Pumping Stations (SPSs) within the City of Waterloo, 2 SPSs in the City of Kitchener, and 3 Private SPSs. This section describes the received information for the pumping stations within the City, and for the pumping station in the City of Kitchener.

Additional information regarding the pump stations has been provided to collect the necessary hydraulic modelling data for the physical attributes. A summary of the information that has been collected for the Master Plan (Stantec, 2015), and the available information that has been collected for the Master Plan Update is summarized in **Table 2-6**. There are differences between the pump station capacity in the Master Plan (Stantec, 2015) and the capacity in the sewage pumping station information received for the Master Plan Update, and therefore validation is required. The information for sewage pumping stations in the hydraulic model includes:

- Wet well dimensions (depth and area)
- Pump curve(s) and the system curve(s)
- Overflow details (invert elevation, diameter)
- Emergency storage (invert elevation, storage volume)

As-built drawings and Operation & Maintenance manuals have been provided by the City for the pumping station upgrades at Colonial SPS and Beaver Creek SPS. The pumping station facility drawings are requested for Frobisher SPS, Malabar SPS, Millennium SPS, and Northlands SPS, to validate the dimensions and invert information. Also, the Process Control Narratives (PCNs) or Operation & Maintenance (O&M) manuals, and/or recent Condition Assessment Reports for all pumping stations except Beaver Creek are requested to verify the discrepancies observed between the previous and current data sets.

Table 2-6: Overview of Network Structure Data

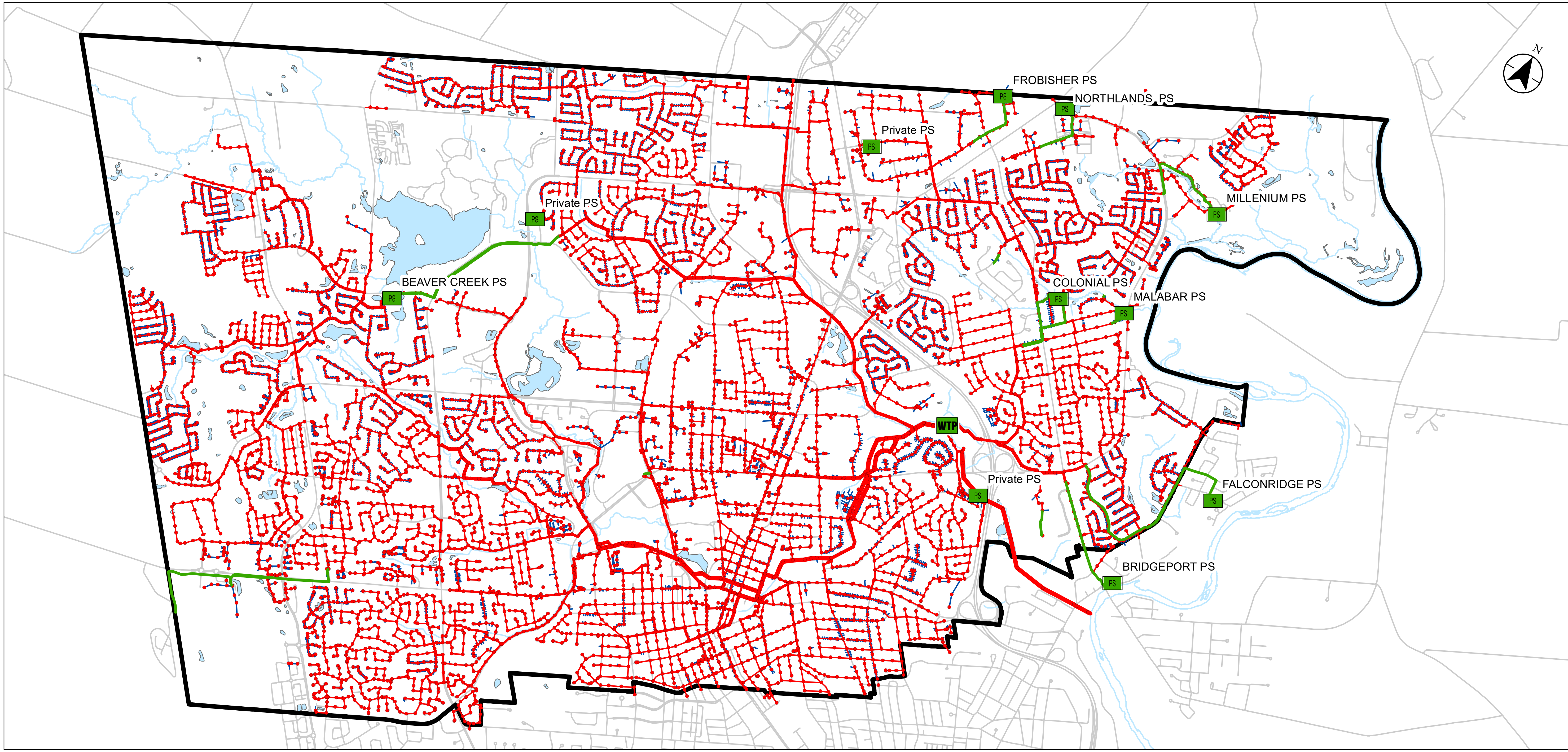
Parameter	Master Plan (Stantec, 2015)		Master Plan Update	
	Data	Data Source	Data	Data Source
Beaver Creek SPS (Asset ID: 10101267)				
Wet Well Dimensions	9.3 m / 5.4 m	As Recorded Drawings	552.42 m^3 (102 m^3 to inlet invert)	07 – Sewage Pumping Station Information – City of Waterloo
Emergency Storage	N/A		905 m^3 (bottom elevation of overflow chamber = 335 m)	Operation & Maintenance Manual - Beaver Creek SPS (May 2016)
Wet Well Floor Elevation	333.45 mASL	As Recorded Drawings	333.45 mASL	Operation & Maintenance Manual - Beaver Creek SPS (May 2016)
Influent Sewer Invert Elevation	336.15 mASL	As Recorded Drawings	336.15 mASL	As-Built Drawing: 07-11-16_085512_412106-BEAVERCREEK 5
Pump Station Capacity	114 L/s	Beaver Creek Sewage Pumping Station and Forcemain Capacity and Condition Assessment (Gamsby and Mannerow Limited, 2012)	370 L/s	07 – Sewage Pumping Station Information – City of Waterloo
			500 L/s	Operation & Maintenance Manual - Beaver Creek SPS (May 2016)
Overflow	N/A		None	07 – Sewage Pumping Station Information – City of Waterloo
Colonial SPS (Asset ID: 10101273)				
Wet Well Dimensions (length/width)	Information Not Currently Available	Information Not Currently Available	376 m^3	07 – Sewage Pumping Station Information – City of Waterloo

<table>
<tr><th rowspan="2">Parameter</th><th colspan="2">Master Plan (Stantec, 2015)</th><th colspan="2">Master Plan Update</th></tr>
<tr><th>Data</th><th>Data Source</th><th>Data</th><th>Data Source</th></tr>
<tr><td>Emergency Storage</td><td>N/A</td><td></td><td>600 m^3 (Overflow discharge to the storage tank: Upstream = 321.21 m, Downstream = 321.00 m)</td><td>07 – Sewage Pumping Station Information – City of Waterloo and As-Built Drawing: 10-123</td></tr>
<tr><td>Wet Well Floor Elevation</td><td>Information Not Currently Available</td><td>Information Not Currently Available</td><td>317.43 mASL</td><td>As-Built Drawing: 10-143</td></tr>
<tr><td>Influent Sewer Invert Elevation</td><td>Information Not Currently Available</td><td>Information Not Currently Available</td><td>320.00 mASL</td><td>As-Built Drawing: 10-143</td></tr>
<tr><td>Pump Station Capacity</td><td>225 L/s (To Be Verified)</td><td>Certificate of Approval</td><td>372 L/s</td><td>07 – Sewage Pumping Station Information – City of Waterloo</td></tr>
<tr><td>Overflow</td><td>N/A</td><td></td><td>Overflow discharge location at Asset ID 10265199</td><td>Overflow Discharge in Storage Tank (As-Built Drawing: 10-122)</td></tr>
<tr><td colspan="5">Bridgeport SPS</td></tr>
<tr><td>Wet Well Dimensions (length/width)</td><td rowspan="3">Information Not Currently Available</td><td rowspan="3">Information Not Currently Available</td><td rowspan="4">Not in Sewage Pumping Station Information</td><td rowspan="4">Information Not Currently Available</td></tr>
<tr><td>Wet Well Floor Elevation</td></tr>
<tr><td>Influent Sewer Invert Elevation</td></tr>
<tr><td>Pump Station Capacity</td><td>205 L/s</td><td>Certificate of Approval</td></tr>
</table>

Parameter	Master Plan (Stantec, 2015)		Master Plan Update	
	Data	Data Source	Data	Data Source
Falconridge SPS				
Wet Well Dimensions (length/width)	Information Not Currently Available	Information Not Currently Available	Not in Sewage Pumping Station Information	Information Not Currently Available
Wet Well Floor Elevation				
Influent Sewer Invert Elevation				
Pump Station Capacity				
Frobisher SPS (Asset ID: 10101278)				
Wet Well Dimensions (length/width)	2.4 m diameter	Certificate of Approval	33.93 m^3 capacity (9.4 m^3 to inlet invert, 25 m^3 to overflow invert).	07 – Sewage Pumping Station Information – City of Waterloo
Emergency Storage	N/A		Unknown	07 – Sewage Pumping Station Information – City of Waterloo
Wet Well Floor Elevation	Information Not Currently Available	Information Not Currently Available	N/A	
Influent Sewer Invert Elevation	Information Not Currently Available	Information Not Currently Available	N/A	
Pump Station Capacity	39.5 L/s	Certificate of Approval	35 L/s	07 – Sewage Pumping Station Information – City of Waterloo
Overflow	N/A		Overflow discharge location at Asset ID: 10265200	07 – Sewage Pumping Station Information – City of Waterloo

Parameter	Master Plan (Stantec, 2015)		Master Plan Update	
	Data	**Data Source**	**Data**	**Data Source**
Malabar SPS (Asset ID: 10101284)				
Wet Well Dimensions (length/width)	2.4 m diameter	Certificate of Approval	34.47 m^3 capacity. (17.91 m^3 to overflow, 7.83 m^3 to inlet).	07 – Sewage Pumping Station Information – City of Waterloo
Emergency Storage	N/A		Unknown	07 – Sewage Pumping Station Information – City of Waterloo
Wet Well Floor Elevation	310 mASL (Design Value)	Malabar Sewage Pumping Station Capacity Design (MTE Consulting Inc., 1989)	N/A	
Influent Sewer Invert Elevation	311.5 mASL (Design Value)	Malabar Sewage Pumping Station Capacity Design (MTE Consulting Inc., 1989)	N/A	
Pump Station Capacity	3.8 L/s	Certificate of Approval	7.4 L/s	07 – Sewage Pumping Station Information – City of Waterloo
Overflow	N/A		Overflow discharge location at Asset ID:10265278	07 – Sewage Pumping Station Information – City of Waterloo
Millennium SPS (Asset ID: 10101270)				
Wet Well Dimensions (length/width)	5 m / 3.5 m	Certificate of Approval	123.73 m^3 capacity (22.7 m^3 to invert of inlet, 86.8 m^3 to overflow)	07 – Sewage Pumping Station Information – City of Waterloo
Emergency Storage	N/A		Unknown	07 – Sewage Pumping Station Information – City of Waterloo
Wet Well Floor Elevation	318.5 m (Design Value)	Millennium Park Sewage Pumping Station and Forcemain Design Brief (Stantec, 2000)	N/A	

Parameter	Master Plan (Stantec, 2015)		Master Plan Update	
	Data	Data Source	Data	Data Source
Influent Sewer Invert Elevation	313.25 (Design Value)	Millennium Park Sewage Pumping Station and Forcemain Design Brief (Stantec, 2000)	N/A	
Pump Station Capacity	109 L/s (To Be Verified)	Certificate of Approval	86 L/s	07 – Sewage Pumping Station Information – City of Waterloo
Overflow	N/A		Overflow discharge location at Asset ID:10265197	07 – Sewage Pumping Station Information – City of Waterloo
Northlands SPS (Asset ID: 10101281)				
Wet Well Dimensions (length/width)	3.5 m / 3.5 m (Cell 1) 3.5 m / 3.5 m (Cell 2) (Design Values)	Tender Drawings (P1.1) (MTE, 2011)	39.8 m^3 capacity (13 m^3 to invert of inlet, 25.4 m^3 to invert of overflow)	07 – Sewage Pumping Station Information – City of Waterloo
Emergency Storage	N/A		Unknown	07 – Sewage Pumping Station Information – City of Waterloo
Wet Well Floor Elevation	321.2 mASL (Design Value)	Tender Drawings (P1.3) (MTE, 2011)	323.0	As Recorded Drawing
Influent Sewer Invert Elevation	324.2 mASL (Design Value)	Tender Drawings (P1.3) (MTE, 2011)	325.37	As Recorded Drawing
Pump Station Capacity	63 L/s (Design Value)	Design Brief: Northland Sewage pumping Station (MTE, 2011)	57 L/s	07 – Sewage Pumping Station Information – City of Waterloo
Overflow	N/A		Overflow discharge location at Asset ID: 10265198	07 – Sewage Pumping Station Information – City of Waterloo



Legend

Gravity Mains

- 100 - 250 mm
- 300 - 450 mm
- 500 - 675 mm
- 750 - 900 mm
- 1050 - 1200 mm
- Pressurized Mains
- Maintenance Holes
- Lateral Lines
- Network Structures (Pump Stations)
- Wastewater Treatment Plant

0 500 1,000 metres

1:40,000 (At original document size of 11x17)

Stantec

Project Location: City of Waterloo

165640363

Prepared by HB on 2022-09-20

Client/Project: CITY OF WATERLOO SANITARY MASTER PLAN

Figure No. **2-1**

Title: **Physical Asset Data**

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

C:\GIS\Waterloo_TN1_Figure\WaterlooSANMP_fig2-1_assetData.mxd Revised: 2022-09-20 By: hboulanger

2.3.2 OTHER SPECIAL HYDRAULIC STRUCTURES AND BOUNDARY CONDITIONS

Special hydraulic structures represent points in the system that have a potential impact on flow distribution and/or resulting water levels, such as weirs, overflows, the Wastewater Treatment Plants, and bifurcation nodes.

There is one (1) weir within the study area; located in the Maple Hill Trunk at the intersection of Thorndale Drive and Westvale Drive. This weir allows for excess flows to discharge into the Westvale Dr sewers. Flow predominantly travels northeast in the Thorndale Dr sewers until depths within the sewer rise above the weir elevation.

Bifurcation nodes (flow splits and high points) were identified as part of the Engineering Validation of the hydraulic model (see **Section 2.3.3**). In total, 76 bifurcation locations were identified. These locations will be closely reviewed in preparation for calibration as they may have impacts on the distribution of flow within the flow metershed.

As presented in **Section 2.3.1.6**, the City has 5 sewage pumping stations with an overflow. A preliminary assumption will be that these overflows are free-flowing outfalls to nearby waterbodies. However, this will be reviewed based on the results of the model update and calibration. **Table 2-7** presents information for the overflows in the hydraulic model (invert elevation and diameter). The overflow information is from the Gravity Mains shapefile received from the City. The invert elevations are missing for the Malabar SPS overflow.

Table 2-7: Overview of Sewer Pumping Station Overflow

SPS Overflow	Inverts Elevation	Diameter	Information Needed
Colonial SPS Overflow	Upstream = 321.21 m, Downstream = 321.00 m	600 mm	-
Frobisher SPS Overflow	Upstream = 328.8 m, Downstream = 228.7 m	250 mm	-
Malabar SPS Overflow	Unknown	200 mm	Invert elevations
Millennium SPS Overflow	Upstream = 316.91 m, Downstream = 316.3 m	300 mm	-
Northlands SPS Overflow	Upstream = 327.5 m, Downstream = 325.382 m	250 mm	-

Wastewater in the City is conveyed to the Wastewater Treatment Plant (WWTP) located at 340 University Avenue. The WWTP facility and treatment processes are not modelled in the hydraulic model and is instead represented as a simplified free outfall, as per the previous Master Plan. A second, private WWTP (St. Jacob's), located at 35 Northland Rd, is provided in the network structures shapefile, but is not modelled. Based on the previous Master Plan, this WWTP is expected to be decommissioned in 2029, and thus, its flows will be diverted to the sanitary sewer system. The previous Master Plan accounted for this additional inflow at model node 11904 (MH FWL-43) in the 2024 and 2029 scenarios (refer to **Table 2-8** for details). For the Master Plan Update, these inflows will be accounted for in the 2031 and 2051 scenarios. Confirmation of flow rates will be requested within the next stage.

Other boundary conditions are applied to represent the inflows or discharge points to adjacent sewer systems, and are often based on the Cross-Border Agreements. The boundary condition at a discharge point represents the water level in the downstream system to which the Kitchener model is draining. Applying a downstream water level can improve the legitimacy of the upstream results, creating realistic imitation of potential backwater conditions that can propagate upstream. An inflow point can receive an incoming 'inflow' hydrograph or constant inflow rate representative of each modelled event.

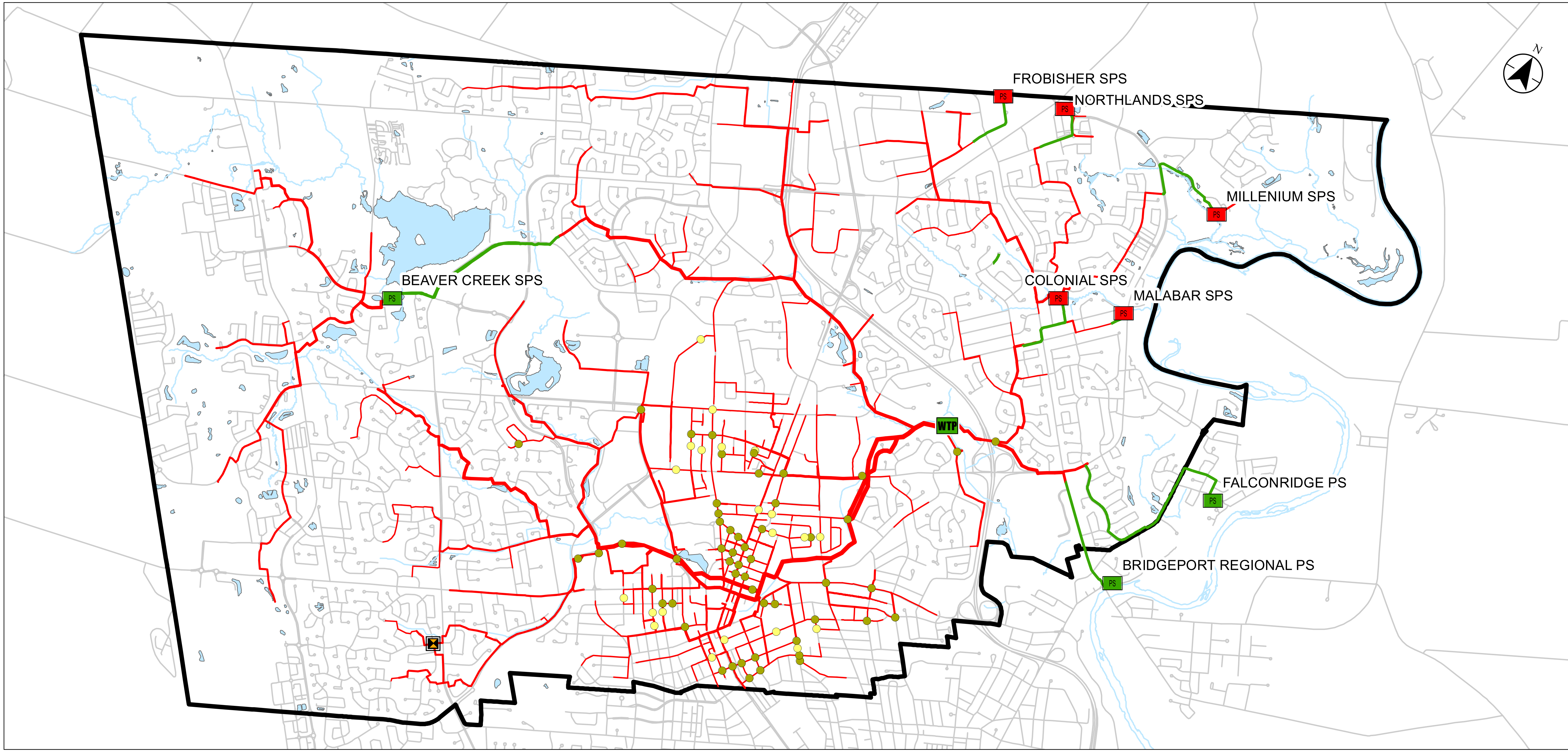
The cross-border agreements for each of these locations are reviewed and used to assess the impact of these connections. Based on this review and if the adjacent system's conditions are determined to be influential to the Waterloo system, the corresponding water levels or inflows can be obtained and used in the model. If adjacent water levels are unknown, a conservative boundary condition equivalent to pipe obvert can be applied and assessed for sensitivity during calibration. If inflow hydrographs or peak flows from adjacent areas are not available, high-level subcatchments with estimated flow generation parameters can be applied. If the adjacent system's water levels or inflows are found to be negligible in magnitude, they may be excluded from the model. The following **Table 2-8** documents the Cross-Border Agreements provided and discharge/inflows noted in the previous Master Plan that will be further reviewed for use as boundary conditions in the next stage, if found relevant. Other agreements may be identified and reviewed as we progress the model updates and will be documented in the next stage.

Table 2-8: Overview of Cross-Border Agreements and Discharge/Inflows Noted in the Previous Master Plan

ID	Municipality	Location	Discharge	Maximum Sewage Flow (L/s)	Notes
1	Township of Woolwich Stockyards Area	MH 15639 (F38-4B)	Inflow to Waterloo (Forwell Trunk)	ADSF ranges from 2.9 to 4.4 L/s, Baseflow ranges from 1.2 to 1.8 L/s	From the previous Master Plan
2		MH 11908 (F47-1)		ADSF is 2.3 L/s, Baseflow is 2.8 L/s	
3		MH 11904 (FWL-43) Flows from St. Jacob's WWTP		2024 is 14.8 L/s 2029 is 16.12 L/s	
7	City of Kitchener	Various Residential	Inflow to Kitchener and Outflow to Waterloo	None Reported	1996. Sewage treatment paid based on water consumption. 34 Kitchener properties to Waterloo; 105 Waterloo properties to Kitchener.
8		Bridgeport North (Falconridge SPS)	Inflow to Kitchener and Pumped Outflow to Waterloo	45.5 L/s (Condition Assessment Draft Report)	2000. Falconridge PS to Bridgeport PS (Region) to Waterloo system. Kitchener pays for volume treated in Waterloo.

ID	Municipality	Location	Discharge	Maximum Sewage Flow (L/s)	Notes
9		Bridgeport SPS	Pumped Outflow to Waterloo	205 L/s (Certificate of Approval)	1996. Kitchener pays servicing fee equal to Regional Treatment Rate for the portion of actual metered sewage flows based on water usage ratio between Waterloo and Kitchener to Bridgeport PS.

The locations of special hydraulic structures within the study area are presented in **Figure 2-2.**



Legend

- PS Sewage Pumping Station Without Overflow
- PS Sewage Pumping Station With Overflow
- Forcemain
- Bifurcation Node - Hight Point
- Bifurcation Node - Flow Split

Modelled Sanitary Sewers

- 150 - 250 mm
- 300 - 450 mm
- 500 - 675 mm
- 750 - 900 mm
- 1050 - 1200 mm

- Weir
- WTP Wastewater Treatment Plant

0 500 1,000 metres

1:40,000 (At original document size of 11x17)

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Project Location
City of Waterloo

165640363
Prepared by HB on 2022-09-20

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
2-2

Title
Sanitary Sewer Network Special Hydraulic Structures

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

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2.3.3 ENGINEERING VALIDATION

Data validation is the process of confirming the hydraulic continuity and suitability of physical sewer data in terms of connectivity and profile. Most modern modelling software packages include routines and queries to help perform engineering validations. The engineering validation process was completed in InfoWorks ICM for this Master Plan Update, due to its robust queries, engineering validation tools, and for ease of documentation. The previous Master Plan's 2019 scenario model (2019_2002DesignStorm-10yr) was used as a basis for the Master Plan Update, and was updated to include GIS data for new infrastructure with a year of installation greater than or equal to 2014 in the uptown core area and along the trunks. **Figure 2-3** illustrates the previous model extent and the new and updated infrastructure included in the current model. The engineering validation process was completed for this updated hydraulic model. The following section summarizes the connectivity review and the profile data review.

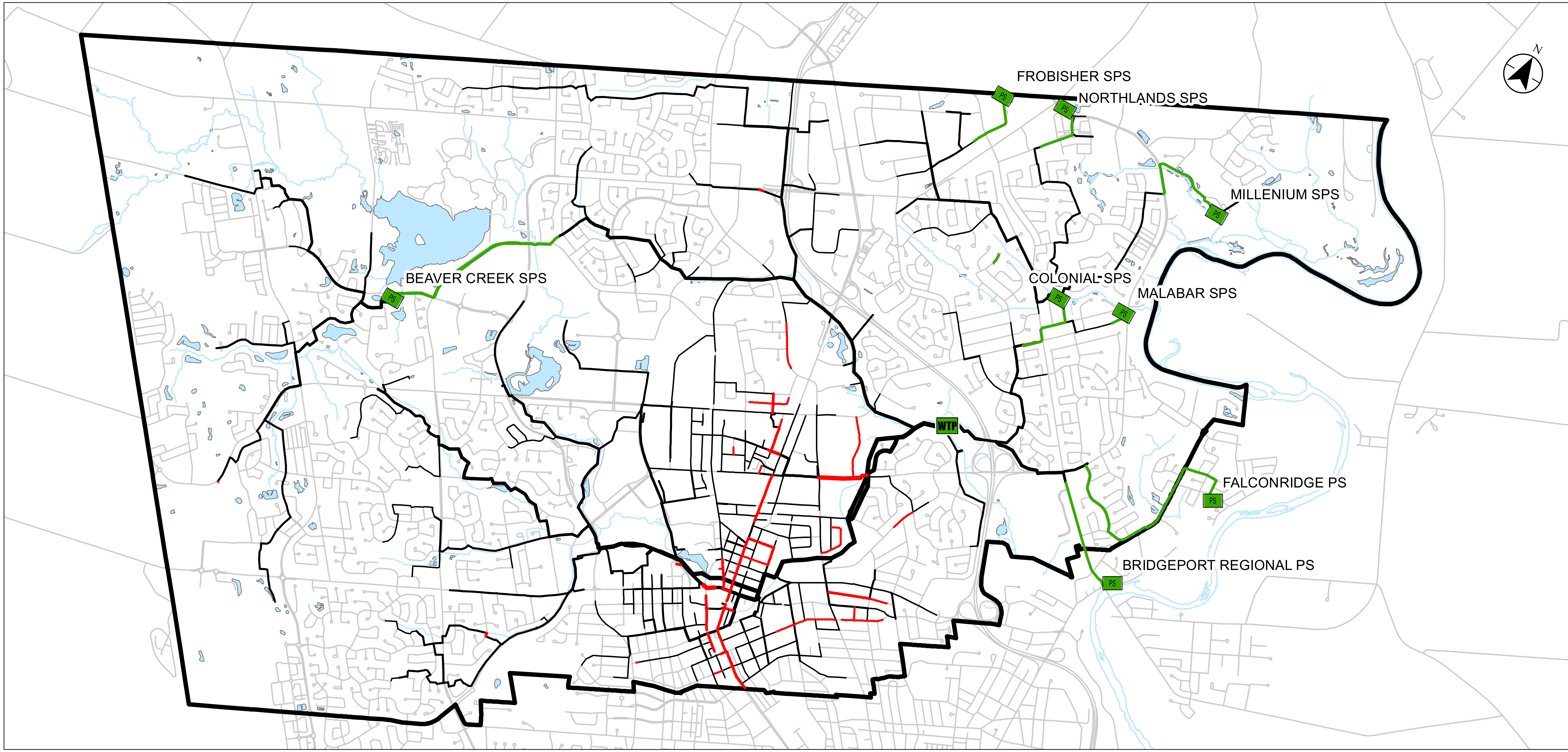
2.3.3.1 Connectivity Review

Unique maintenance hole IDs are critical in modelling software to provide identification for both nodes and conduits. The Master Plan (Stantec, 2015) used the MXASSETNUM field as the unique identifier and is therefore used for the node ID and the conduit ID in the Master Plan Update. As indicated in **Section 2.1.1.1**, the modelled sewers (trunk and uptown core area) with no MXASSETNUM field are assigned new IDs.

Also, the "TOMH" and "FROMMH" fields in the geodatabase for gravity mains are based on the old unique identifiers ENTNAME, rather than MXASSETNUM. A correlation between the ENTNAME and MXASSETNUM fields were completed in Excel to correct the discrepancy. For the conduits with blanks in the upstream and/or downstream MH ID, these fields were automatically entered using the PCSWMM connectivity tool that computes the inlet and outlet nodes based on proximity. Then, a connectivity review was completed by selecting isolated nodes and validating the network connectivity.

2.3.3.2 Profile Data Review

Once the connectivity is confirmed and repaired within the model, routine engineering validations of the profiles are completed, looking for data gaps, errors, warnings, and inconsistencies or erroneous data that may require correcting as part of this Master Plan Update, as well as hydraulically significant connections that could affect our understanding of the system. This evolving query-based engineering validation methodology is performed in InfoWorks ICM, which has robust validation and documentation tools. The engineering validation errors and warnings for the hydraulic model are summarized and quantified in Error! Reference source not found.. Note that the total number of links in the hydraulic model is 2,111, and the total number of nodes is 2,030.



Legend

Modelled Sanitary Sewers
- 150 - 250 mm
- 300 - 450 mm
- 500 - 675 mm
- 750 - 900 mm
- 1050 - 1200 mm

New and Updated Sanitary Sewers (2014 and Newer)
- 200 - 250 mm
- 300 - 450 mm
- 525 - 600 mm
- 825 - 900 mm
- PS Sewage Pump Station
- Forcemain

WTP Wastewater Treatment Plant

0 500 1,000 metres

1:40,000 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

Stantec

Project Location 165640363
City of Waterloo Prepared by HB on 2022-09-28

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
2-3

Title
New and Updated Sanitary Sewer Infrastructure

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Table 2-9: Engineering Validation Errors & Warnings for the Modelled Links and Nodes

Missing Data and Potential Concerns	Error Code Used in Model	Description	Error Severity	Priority Ranking(s)	Error Severity Rationale	Applied to	Quantity of Errors in the Hydraulic Model	% Error
Inconsistent Profile based on inverts	IPI	Downstream invert > upstream invert	Error	1 & 2	Typically not valid and indicates surrounding invert(s) are incorrect.	Node	69	3.4%
Slope - Adverse (<0%)	AS	Negative sloped pipe	Warning	1 & 2	May be valid; however, could be indicative of incorrect inverts or a reversed pipe.	Link	8	0.4%
Slope - Flat (0%)	FS	Pipe w/ 0% slope	Warning	3 & 4	May be valid; however, may be indicative of incorrect inverts and may result in capacity constraints.	Link	3	0.1%
Slope - Steep (>5%)	SS	Pipe slope > 5%	Warning	3 & 4	May be valid; however, may result in model instabilities.	Link	32	1.5%
Bifurcation Node - Flow Split	BNFS	Flow split (2+ outgoing pipes)	Warning	-	Helps to identify where flow splits may affect the contributing drainage areas used in calibration.	Node	55	2.7%
Bifurcation Node - High Point	BNHP	System high point w/ 2+ outgoing pipes	Warning	-	Helps to identify where backwater over high points may affect the contributing drainage areas used in calibration.	Node	21	1.0%

Missing Data and Potential Concerns	Error Code Used in Model	Description	Error Severity	Priority Ranking(s)	Error Severity Rationale	Applied to	Quantity of Errors in the Hydraulic Model	% Error
Pipe Diameter Inconsistency	IPD	Downstream diameter < upstream diameter	Warning	3 & 4	May be valid; however, could indicate that surrounding diameter(s) may be incorrect.	Node	84	4.1%
Missing Upstream Invert(s)	MUSI	Upstream invert = 0	Error	1 & 2	Pipe inverts must be inputted.	Link	33	1.6%
Missing Downstream Invert(s)	MDSI	Downstream invert = 0	Error	1 & 2	Pipe inverts must be inputted.	Link	31	1.5%
Missing Pipe Diameter	MD	Diameter = 0	Error	1 & 2	Pipe diameters must be inputted.	Link	0	0%
Pipe Above Ground	PAG	Pipe obvert (and possibly invert) above ground elevation	Error	1 & 2	Ground levels and/or pipe inverts are incorrect and must be adjusted.	Link	10	0.5%
Missing Ground Elevation	MGE	Ground elevation = 0	Error	1 & 2	Node ground elevations must be inputted.	Node	53	2.6%

The most predominant errors/warnings within the study area's model are Inconsistent Profiles (3.4%) and Inconsistent Pipe Diameter (4.1%). Missing Upstream Invert(s), Missing Downstream Invert(s), and Pipes Above Ground are also found for approximately 2% of the modelled pipes. Some of these issues were generated when updating the model with GIS data (i.e., 2014 and newer), where ground elevation or pipe invert information was missing. The Pipe Above Ground error is mostly generated by a missing ground elevation for the maintenance hole (MH) and is often corrected by applying the ground elevation. Other issues are warnings, which may have been generated for a valid configuration, and will require a review. Forcemains for instance, typically include adverse-sloped segments and thus will register with an Adverse Slope error. These are reviewed and considered valid and thus, not changed/fixed.

For the errors/warnings and missing data, a verification of the following model inputs is required:

- Pipe inverts and pipe diameter: these will be verified using the following data sources (listed from higher to lower level of certainty):
    - As-built or as-designed drawings – for those available
    - GIS database
    - Inferences based on pipe slopes or obvert matching
    - Assumptions based on standard pipe slopes and required cover

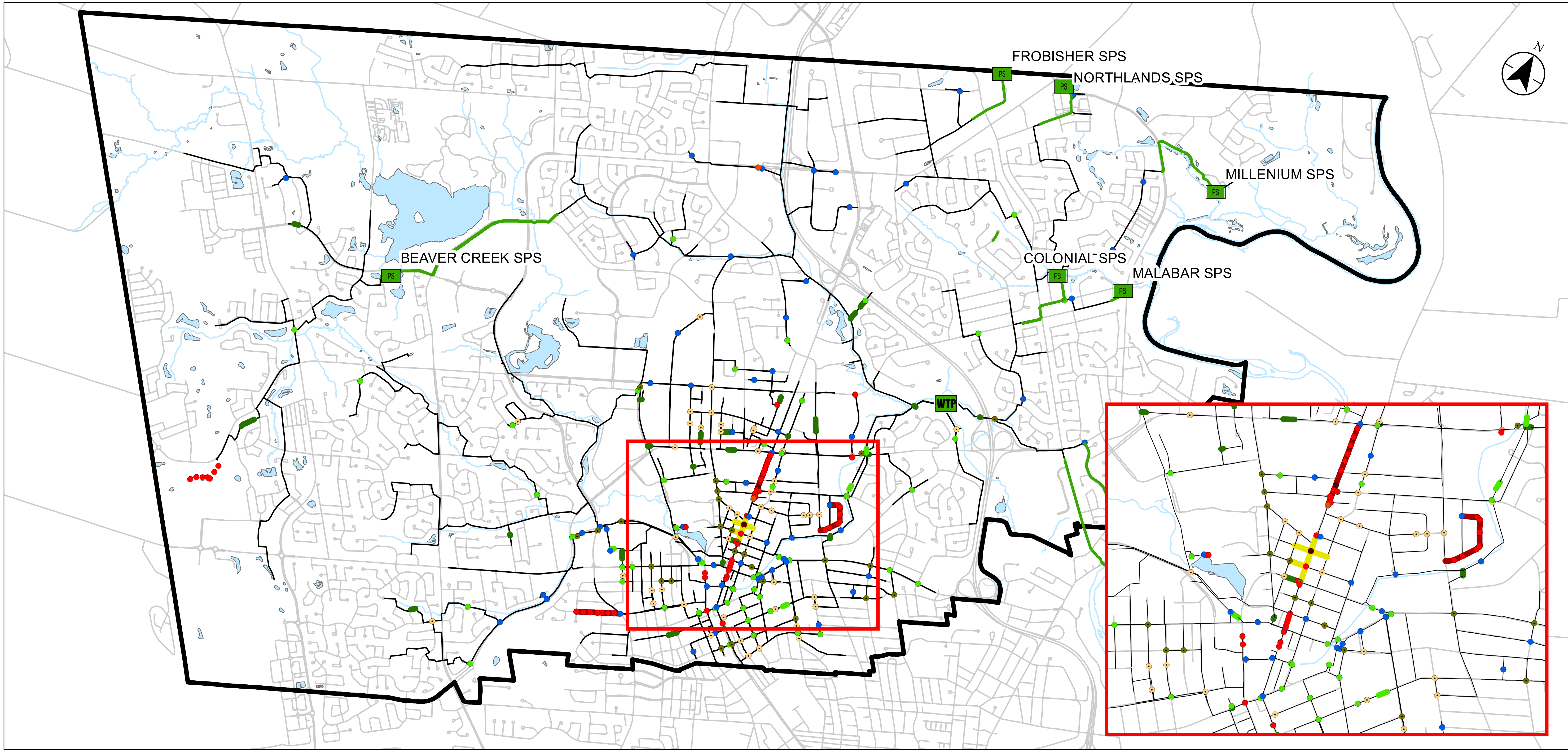
- Ground elevation at MH: these will be verified using the following data sources (listed from higher to lower level of certainty):
    - As-built or as-designed drawings – for those available
    - High-resolution LiDAR

As-built or as-designed drawings were requested based on a prioritization considering the severity of the error or warning, and whether it resides at the upstream or downstream end of the system. Errors located near the downstream end of the system are often more influential to the system and are thus prioritized over errors located in the upstream portion. Drawings were requested for Priorities 1 to 4, which are defined as follows:

- Priority 1: Highest priority errors in uptown core area or downstream area;
- Priority 2: Highest priority errors in upstream area;
- Priority 3: High priority errors/warnings in uptown core area or downstream area; and,
- Priority 4: High priority errors/warnings in upstream area.

Priorities 5 to 8 consist of discrepancies observed between the model and the GIS data only that do not coincide with an error or warning identified through engineering validation and were not reviewed at this time. The available drawings requested for Priorities 1 to 4 have been reviewed to ensure that the profiles are appropriately represented in the hydraulic model. If the drawings do not include the necessary information, the validation has been made with the GIS data. A total of 13% of the system has been reviewed.

The **Figure 2-4** illustrates the engineering validation errors and warnings found.



Legend

- Missing Upstream/Downstream Invert
- Missing Downstream Invert
- Missing Upstream Invert
- Pipe Above Ground
- Adverse Slope
- Flat Slope
- Steep Slope
- Modelled Sanitary Sewers
- Missing Ground Elevation
- Missing Ground Elevation And Bifurcation
- Missing Ground Elevation And Inconsistent Profile
- Inconsistent Profile
- Pipe Size Inconsistency
- Bifurcation
- Bifurcation And Inconsistent Profile
- PS Sewage Pump Station
- WTP Wastewater Treatment Plant
- Forcemain

0 500 1,000 metres

1:40,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

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Project Location	165640363
City of Waterloo	Prepared by HB on 2022-09-20

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
2-4

Title
Engineering Validation Errors & Warnings

2.4 Time-Varying Data

2.4.1 DATA INVENTORY

Time-varying data received from the City for the Master Plan Update includes flow monitoring data. The **Table 2-10** presents the flow monitoring data from 2014 to 2021, for different locations.

Table 2-10: Overview of the Flow Monitoring Data

Flow Monitoring ID	Location	Year(s)
C29-8	602 ROLLING HILLS DR	2014 - 2020
CLR-1	96 MCDOUGALL RD	2014 - 2018
CLR-36	0 CLAIR CREEK BLVD	2016 - 2018
CNR-1	0 SEAGRAM DR	2014 - 2017
L23-4A	25 WEBER ST N	2014 - 2018
L34-3A	9 WILLOW ST	2015 - 2018
LE28-1	475 DENHOLM ST	2014 - 2018
NRL-7	422 EASTBRIDGE BLVD	2014 - 2018
FWL-13	60 BLUE SPRINGS DR	2019 - 2021
FWL-14	500 KING ST N	2019
FWL-34	585 KUMPF DR	2019 - 2021
LEE-55	162 WISSLER RD 108	2019 - 2021
LWD-5	210 PINELAND CRT	2019 - 2021
MPL-63	436 THORNDALE DR	2019 - 2021
U7-45	231 WEBER ST N	2019 - 2021
UNI-5	115 UNIVERSITY AVE E	2019 - 2021

System Control and Supervisory Data Acquisition (SCADA) data documenting pump station levels and discharge flows is also requested for all modelled pumping stations. The duration of the SCADA data required will be informed through the first steps of the calibration task. The data will be reviewed as it becomes available.

2.5 Base Mapping

The following GIS layers have been provided for background information:

- Road Network
- Water Bodies (Grand River Conservation Authority)

- Creeks
- Rivers
- Property Fabric (parcels)
- Parks
- Building Footprints
- Addresses
- Municipal Boundary
- Wetlands
- Regional Recharge Area
- Forests
- Environmentally Sensitive Areas

2.6 Water Billing Records and Land Use

The water billing records from 2021 were received from the City. The received spreadsheet includes the following information:

- Address
- X, Y Coordinates
- Land use (property type)
- Stormwater Tier (i.e., the size of the property type: large, medium, or small)
- Water meter records (January to December 2021).

The data within this spreadsheet was imported into GIS and georeferenced based on address. It was then joined to the census data shapefile to distribute populations based on land use (see **Section 2.7**).

The next step for the Master Plan Update is to recalibrate the model based on the new flow monitoring data and the new populations and infrastructure. The comparison with the water billing records is useful in calibration to corroborate monitored per capita sewer flow generation rates.

2.7 Populations

The 2021 census data was provided in shapefile format and includes the dissemination area populations. This shapefile joined with the consumption points provides the population per node in the model for the residential and the employment distributions.

The projected future flows will be added to the future conditions hydraulic models using the population projections received in shapefile format. Based on the City description, the projected population growth for 2031 includes the Major Intensification Projects, BCM District Plan, and Erbsville Block Plan. The projected population growth for 2051 includes the additional MTSA Official Plan area, and the Nodes and Corridors based on the NC Density Mapping data.

The **Table 2-11** presents the total population for the 2021 census data, and the projected population growth for 2031 and 2051 based on the received shapefile from the City. The total projected population growth to 2051 is 56,224.

Table 2-11: Existing Population (2021) and Projected Population Growth for 2031 and 2051

Scenario	Population Growth	Total Population
Existing (2021)	0	121,436
Projected Growth to 2031	28,674	150,110
Projected Growth to 2051	27,550	177,660

The existing and projected populations are used in conjunction with the flow monitoring sewage generation rates to establish domestic sanitary flows.

3 Conclusions

The background review is a critical task to capture existing information and projected growth that will be utilized to complete the Master Plan Update. This report presents the background review and data gap analysis for the City of Waterloo Master Plan Update, including the following discussions:

- Review of background documents & reports, including the previous Master Plan hydraulic model (**Sections 2.1** and **2.2**);
- Review of sanitary sewer network data (**Section 2.3**);
- Review of time-varying data (**Section 2.4**);
- Review of base mapping features (**Section 2.5**);
- Review of water billing records and land use information (**Section 2.6**); and, the
- Review of the provided existing and future population data (**Section 2.7**).

To complete the wastewater model update, the following items are requested:

- Pumping station facility drawings for Frobisher SPS, Malabar SPS, Millennium SPS, and Northlands SPS;
- Process Control Narratives or Operation & Maintenance manuals, and/or recent Condition Assessment Reports for Colonial SPS, Frobisher SPS, Malabar SPS, Millennium SPS, and Northlands SPS; and,
- SCADA data for all sanitary SPSs (duration for which will be confirmed once we enter the calibration stage).

Flow generation rates and the calibration process and results will be discussed in the next technical note, **TN#2 - Model Flow Updates**.

Appendix B Technical Note 2-3

TECHNICAL NOTE #2-3 – MODEL CALIBRATION

City of Waterloo Sanitary Master Plan Update

January 31, 2024

Prepared for:

City of Waterloo

Prepared by:

Stantec Consulting Ltd.
300 Hagey Blvd., Suite 100
Waterloo, ON N2L 0A4

Revision	Description	Author	Quality Check	Independent Review
0	Draft TN2-3	HB	DE	JP
1	Final TN2-3	HB	DE	JP

Sign-off Sheet

This document entitled Technical Note #2-3 – Model Calibration was prepared by Stantec Consulting Ltd. ("Stantec") for the account of City of Waterloo (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ______________________________
(signature)

Helene Boulanger, P.Eng., ing.

Reviewed by ______________________________
(signature)

Dave Eadie, P.Eng.

Approved by ______________________________
(signature)

Jeff Paul, P.Eng.

Table of Contents

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LIST OF APPENDICES

Abbreviations

ADSF	Average Dry Weather Sewage Flow
DWF	Dry Weather Flow
DEM	Digital Elevation Model
EA	Environmental Assessment
EMP	Employment
FM	Flow Meter
FS	Flow Split
GIS	Geographic Information System
GWI	Groundwater Infiltration
HGL	Hydraulic Grade Line
HP	High Point
ICI	Industrial – Commercial – Institutional (Land Use)
IDF	Intensity – Duration - Frequency
I/I	Inflow/Infiltration
MH	Maintenance Hole
MP	Master Plan
O&M	Operation & Maintenance
PCSWMM	Personal Computer Storm Water Management Model (Software)
RDII	Rainfall-Derived Infiltration and Inflow
RES	Residential
RTK	RTK Unit Hydrograph Method
RG	Rain Gauge
SAN	Sanitary
SCADA	Supervisory Control and Data Acquisition
SPS	Sewage Pumping Station
TN	Technical Note
WWF	Wet Weather Flow
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

The City of Waterloo (City) has retained Stantec Consulting to complete the Waterloo Sanitary Servicing Master Plan Update (Master Plan Update). The purpose of the Master Plan Update is to revise the 2014 Sanitary Master Plan (Stantec, 2015) to account for updated infrastructure, and population and employment growth. There are two growth scenarios: Priority Scenario, which includes projections up to a 2031 planning horizon, and Strategic Scenario, representing projections up to a 2051 planning horizon. Priority and strategic projects will be evaluated to operate the system efficiently and effectively, to implement best management practices (including Infiltration/Inflow (I/I) monitoring and mitigation approaches), and to optimize staging of the sanitary capital program.

The following tasks will be carried out for the completion of the Master Plan:

- Task 1: Model Infrastructure Updates
- **Task 2: Model Flow Updates**
- **Task 3: Model Calibration**
- Task 4: Model Analysis – Identification of Problem Areas
- Task 5: Detailed Analysis of Solutions
- Task 6: Conclusions & Recommendations – Capital Planning and Execution
- Task 7: Finalize Master Plan Update

The purpose of this **Technical Note #2-3** (**TN#2-3**) is to summarize the next steps in the hydraulic modelling tool build, including development of flow generation parameters and model calibration using collected rainfall and flow monitoring data. This TN is structured around these main components as follows:

- Section 2: Model Flow Generation Methodology
- Section 3: Flow Monitoring Program
- Section 4: Rainfall Data Collection and Analysis
- Section 5: Sanitary System Calibration and Validation

2.0 MODEL FLOW GENERATION METHODOLOGY

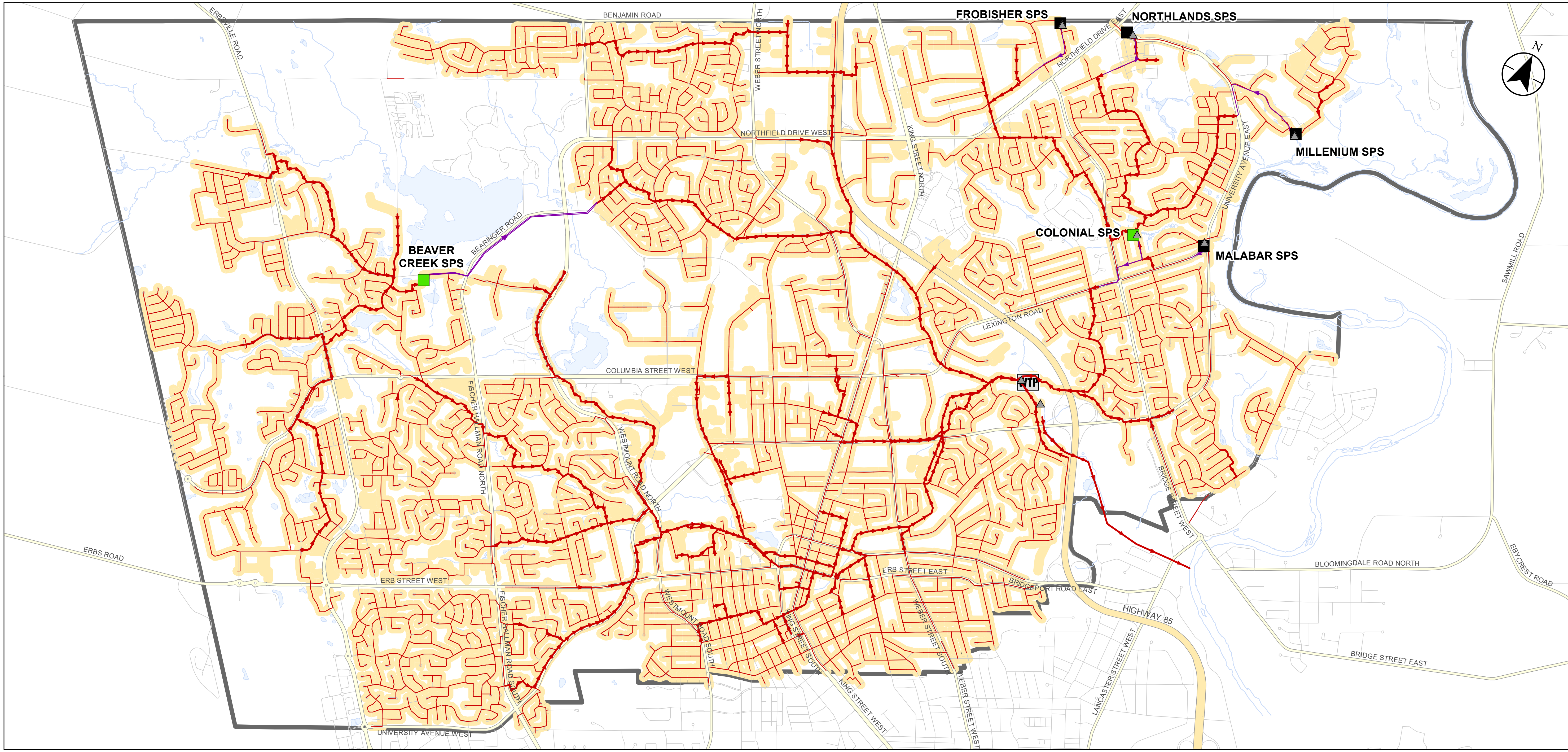
TN#1 provided an overview of the updates completed on the PCSWMM sanitary hydrologic/hydraulic model network for Waterloo.

Total flow within a separated sanitary sewer system is comprised of two major categories: dry weather flow (DWF) and wet weather flow (WWF). To model these two different conditions, a number of inputs and assumptions need to be considered. Sewage flows are generally the result of people and industry, requiring input on population, water use and land use, and extraneous flows are often the result of groundwater and/or rainfall migration into the system via cross-connections or structural deficiencies. The following sections detail the data and considerations that inform the dry weather and wet weather flow generation methodology in PCSWMM, which is consistent with the 2014 Master Plan.

2.1 SUBCATCHMENTS

The basis for establishing flow contributions to the sanitary system was established in the 2014 Master Plan. For the current update, the subcatchment extents were reviewed and expanded as necessary to account for new infrastructures. Sanitary subcatchment drainage areas were based on a 45 m buffer on both sides of the sanitary sewers, as per the 2014 Master Plan. **Figure 2-1** illustrates the delineation of sanitary subcatchments in the City.

The subcatchments area are assigned to the receiving nodes as sewershed areas. Those areas impact the groundwater infiltration and the wet weather flows, as described in **Section 2.3.3** and **Section 2.4**, respectively.



Legend

- WTP WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Local Sewer
- Trunk Sewer
- Sanitary Subcatchment Area

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

Stantec

Project Location
City of Waterloo

165640363 REVA
Prepared by HB on 2023-07-24

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
2-1

Title
Sanitary Catchment Areas

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

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2.2 BOUNDARY CONDITIONS

Boundary conditions help to define the operation of an area or feature that is decidedly excluded from the model for simplification or due to municipal boundaries. They are often used at points of discharge into adjacent systems/municipalities and watercourses, or where the modelled system is receiving inflows from adjacent areas. Boundary conditions can also be used to define downstream hydraulic grade line (HGL) conditions in complex facilities, such as WWTPs, that are not typically modelled in detail at this scale. The boundary condition at a discharge point represents the water level in the downstream system to which the Waterloo model is draining. Applying a downstream water level better reflects system hydraulics such as backwater conditions that propagate upstream. An inflow point can receive an incoming 'inflow' hydrograph representative of each modelled event, or a constant inflow, if applicable. Boundary conditions are often obtained from data sources such as background documents or reports, adjacent area models, pipe obverts, SCADA, or facility drawings.

In the Waterloo Master Plan model, there are several discharge and inflow points into and from adjacent systems. The reviewed for each of these locations have been used to assess the impact of these sources. Based on this review and the adjacent system's conditions, a total of six (6) inflow locations identified.

In addition to these inflow points, 4 areas residing within the City of Kitchener contribute to the City of Waterloo sanitary sewer system based on the Cross-Border Agreement review. These areas have been integrated into the Waterloo model using estimated populations based on unit counts and the 3.5 persons per unit (ppu) design rate.

There are also three pumping stations located within the City of Kitchener that discharge in the City of Waterloo sewer. In the Waterloo Master Plan model the outflow of the forcemain has been added as a time variating inflow.

The validity of this assumption was reviewed during calibration and did not suggest any required adjustments. There is also one potential boundary condition at the WWTP, although a free-flowing outfall is initially applied at this location in the model (i.e., no water level boundary applied) and verified during calibration. **Table 2-1**Error! Reference source not found. presents the boundary conditions applied in the model.

Table 2-1: Boundary Conditions

Location (Sewershed)	Node ID	Second Party in Cross Border Agreement	FM Metershed	Scenario	Value Applied
350 Conservation Drive (Laurel WTP)	7519	Woolwich	FWL-34	Future	9.00 L/s
Stockyards[1]	15639	Woolwich	FWL-34	Existing & Future	Existing: 0.87 L/s 2031: 17.3 L/s 2051: 21.5 L/s

Location (Sewershed)	Node ID	Second Party in Cross Border Agreement	FM Metershed	Scenario	Value Applied
Stockyards[1]	11908	Woolwich	FWL-34	Existing & Future	Existing: 2.12 L/s 2031: 30.3 L/s 2051: 37.8 L/s
Falconridge SPS	9302	Kitchener	Unmonitored	Existing & Future	SPS Outflow
Bridgeport SPS	7918	Kitchener	Unmonitored	Existing & Future	SPS Outflow
Moore St SPS	12399	Kitchener	Unmonitored	Future	SPS Outflow
Margaret Ave	10095130	Kitchener	Unmonitored	Existing & Future	7 Units x 3.5 PPU
Herbert St	10231771	Kitchener	Unmonitored	Existing & Future	12 Units x 3.5 PPU
Silvercrest Drive	10096109	Kitchener	Unmonitored	Existing & Future	1 Unit x 3.5 PPU
Esson St	10099049	Kitchener	Unmonitored	Existing & Future	29 Units x 3.5 PPU
Notes: [1] Existing flow is an average from flow monitoring data provided by the Township of Woolwich.					

It is important to note that the boundary conditions used may be conservative and may result in overestimation of downstream flows. Additionally, for the other 4 locations where the inflow data was not provided, downstream modelled flows may be underestimated. This could include underestimations of GWI, per capita flow rates and RTK parameters, which may affect the calibration parameters downstream of these locations.

2.3 DRY WEATHER FLOWS

Dry weather flow represents the flow contributions to the sanitary system on a typical day that is not under the influence of precipitation or snowmelt. The two DWF components are population-derived sewage flows, which are a combination of industrial, commercial, and institutional (ICI) and residential flows, and groundwater infiltration (GWI). In PCSWMM, these parameters are added to the 'node', which often represents the physical sanitary maintenance hole. These flow contributions are further discussed below. DWF is evaluated in **Section 3** and applied to model calibration in **Section 5.2**.

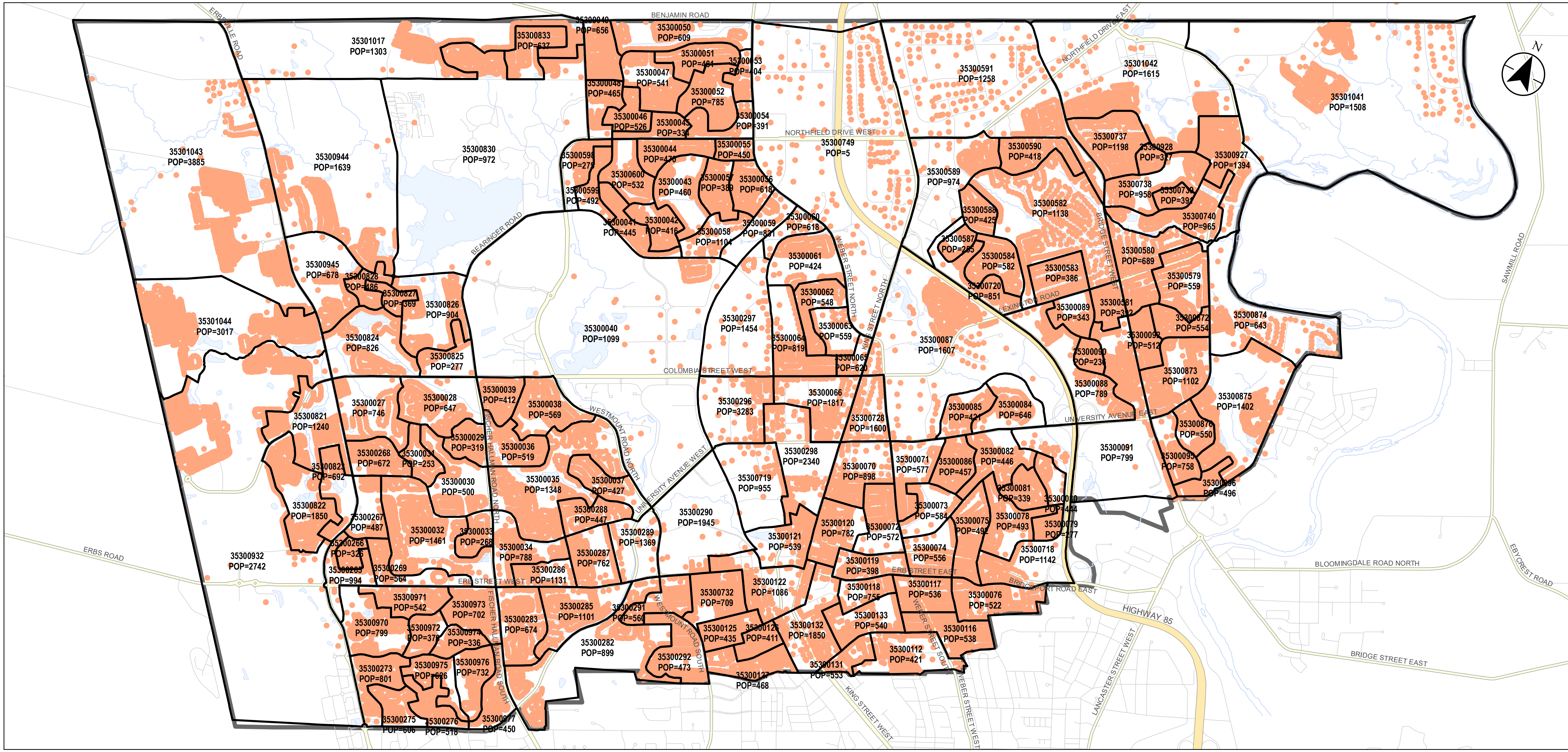
2.3.1 Population Estimations

Population estimations are used within the modelled environment coupled with a per capita flow rate to produce an average sewage flow per subcatchment. Total population per subcatchment is a combination of residential population as well as student and employment contributions. For the model build, residential population estimates are based on 2021 Census data which has a total population for Waterloo of

121,436. Additionally, the transient student and employment populations are based on the City of Waterloo population projections (City of Waterloo; Hemson Consulting Ltd. Development Charges Background Study 2020; Statistics Canada, Census of Canada 2016), which are 18,083 and 72,125, respectively.

For the model build, the population includes population from Kitchener that are contributing to the Waterloo sewer system and excludes population from Waterloo serviced via Kitchener's system. Therefore, the total "existing" population considered in the model is 201,771.

The 2021 census data was provided in shapefile format and includes the dissemination area populations. This shapefile joined with the consumption points provides the population per node in the model for the residential and the employment distributions. These populations are used to generate average sanitary flows, as discussed in the following section.



Legend

- Water Billing Point
- 2021 Census Data

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Project Location: City of Waterloo

165640363 REVA

Prepared by HB on 2023-07-24

Client/Project

CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.

2-2

Title

2021 Census Data Polygons with Water Billing Points

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

V:\01656\active\165640363\preliminary\analysis\gis\mxd\TN2-3\WaterlooSANMP_TN2-3_Fig2-2_POP.mxd Revised: 2023-07-24 By: kebuchanan

2.3.2 Average Sanitary Flows

Average sanitary flows are based on population estimates for both residential and ICI parcels within each provided sanitary system subcatchment boundary and are exclusive of GWI. The per capita flow generation rate (L/c/day) is extracted per metershed based on flow monitoring data, multiplied by the contributing population draining to each receiving node, and applied as an average sewage flow rate per node. These average sanitary flows vary throughout the day, which is represented in the model by a diurnal pattern. These patterns are also derived from flow monitor data, in that each metershed has its own unique diurnal pattern. Due to variations in water usage between the work week and the weekend, two separate patterns are generated per metershed and applied accordingly in the model. As per the 2014 Master Plan, the subcatchments, baseline flow and population distributions were conducted at the all-pipe scale, then aggregated to the next receiving node in the trunk-level model.

2.3.3 Groundwater Infiltration

Groundwater infiltration (GWI) in the pipe system occurs from groundwater working its way into the system from the surrounding soil through leakage at joints, cracked pipes, etc. GWI rates (L/s/ha) are established per metershed based on flow monitoring data. The calculated GWI is normalized by the flow monitoring sewershed area and applied to each sewershed based on the resulting L/s/ha rate. In area not covered by the 2021 flow monitors, GWI rates from 2014 Master Plan model were applied to the updated sewershed areas. The DWF parameters (per capita sewage rate, GWI, and average diurnal patterns) are determined for each sanitary flow meter using the US EPA flow monitoring data analysis software SSOAP. The GWI is derived using the Stevens-Schutzbach formula based on the average and minimum dry weather flows. This represents the dry weather infiltration into the sewer and is applied as a constant baseflow. The Stevens-Schutzbach formula calculates the GWI component (in L/s) as follows, where MDF is the minimum dry weather flow (in L/s) and ADF is the average dry weather flow (in L/s):

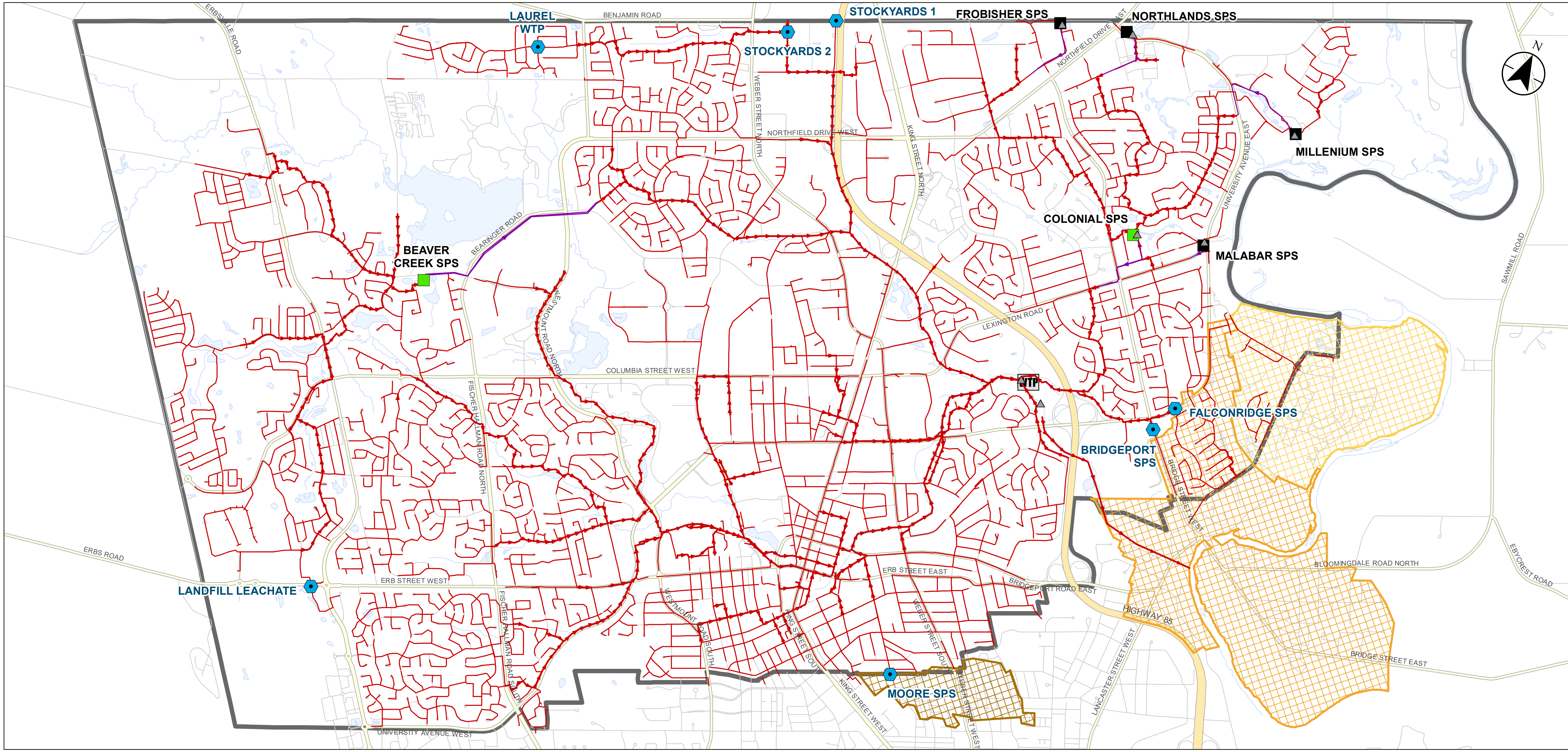
$$GWI = \frac{0.4 \times MDF}{1 - \left(\left(0.6 \times \left(\frac{MDF}{ADF}\right)\right)^{ADF^{0.7}}\right)}$$

2.3.4 External Contributions

As per the 2014 Master Plan, the external contributions beyond the City's municipal boundary were added as inflow in the model. External contributions include the following:

- Region of Waterloo Landfill Leachate Pump Discharge
- Township of Woolwich St. Jacobs Market Area Discharge and Stockyards
- City of Kitchener Sanitary Pump Stations
- City of Kitchener residents service by the Waterloo system

Figure 2-3 illustrates the location of the external contributions. Refer to **Section 2.2** for each inflow added in the model.



Legend

- WTP WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Local Sewer
- Trunk Sewer
- External Contribution

Kitchener Drainage Areas

- Bridgeport Pump Station
- Falconridge Pump Station
- Moore Pump Station

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Project Location
City of Waterloo

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SANITARY MASTER PLAN

Figure No.
2-3

Title
External Contributions

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

2.4 WET WEATHER FLOWS

Wet weather flow (WWF) contributing to the sanitary system via rainfall-derived infiltration and inflow. The inflow portion of RDII is due to direct connections of downspouts, sump pumps, foundation drains, etc. The infiltration portion is representative of the increase of subsurface water through sewer deficiencies above what is normally entering and accounted for by GWI, due to a higher volume of water in the surrounding soils. The RDII in a sanitary system is often estimated using the RTK method, where the "R" is the percentage of rainfall in a given metershed that is observed in the sewer, the "T" is the time it takes to see the peak flow response to a rainfall occurrence (Time to Peak), and the "K" is the ratio of the Time to Peak to the recession time. **Figure 4.2** shows how these parameters work together to create three distinct unit hydrograph responses, representing the fast initial inflow response (R1, T1, K1), moderate infiltration response (R2, T2, K2) and slow infiltration response (R3, T3, K3). The fast response is attributed to cross-connections such as roof downspouts or catchbasins; the moderate response is associated with foundation drains or low-lying MHs; and the slow response is via migrating surface water through the ground into cracks and pipe/MH deficiencies.

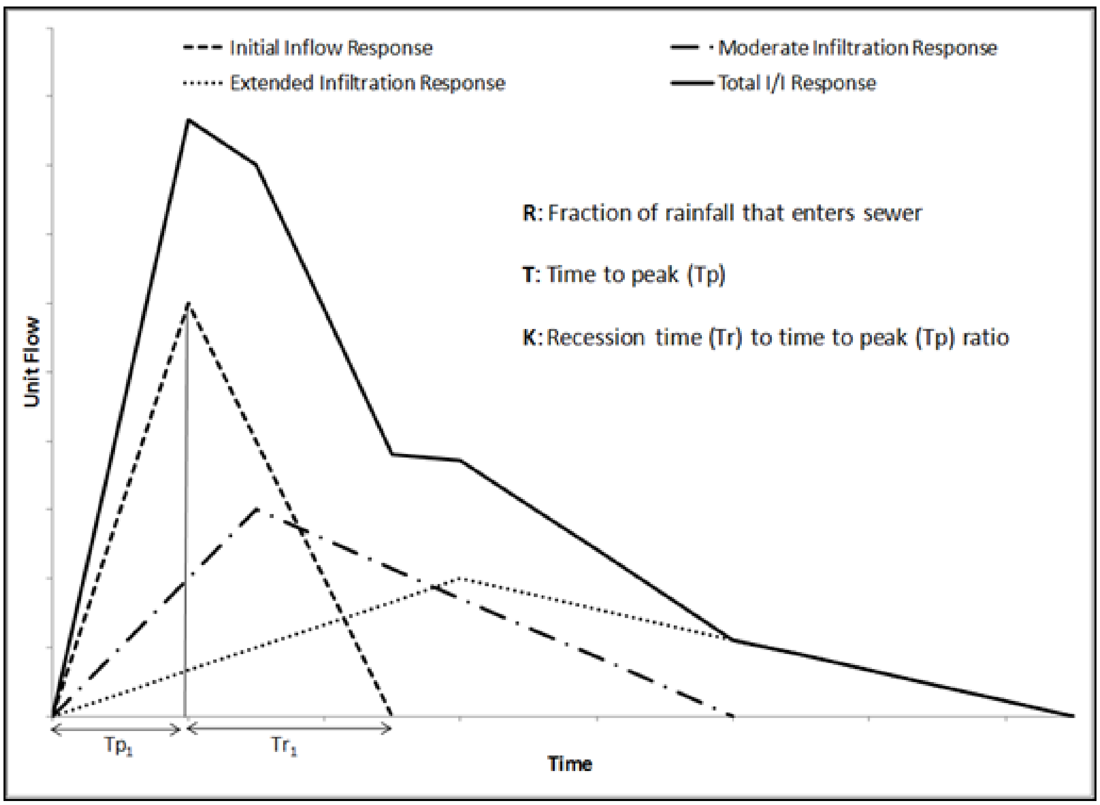


Figure 2-4: Definition of RTK Parameters

PCSWMM requires these RTK parameters to be applied to nodes, combined with the sewershed area. The rainfall applied on the contributing sewershed area associated to each node is used to generate the wet weather response.

RTK parameters are derived from monitoring data and applied on a metershed basis. Through hydrograph separation, the wet weather hydrograph is isolated per rain event. The volume under the curve represents the wet weather volume, which is compared to the total rainfall depth over the effective tributary area to the FM (i.e., total rainfall volume) to generate the Total R, or volumetric runoff coefficient. The value becomes the target for distributing the R1, R2 and R3 parameters per unit hydrograph. The combination of RTKs is adjusted within a range per characteristic response to generate the overall RDII response. Generally, the “R” values are adjusted to match the shape/volumes of the WWF events, and the “T” and “K” values adjusted to improve peak timing.

Separated sewer areas are expected to have Total R values typically below 4% to 6%, while partially separated areas can have R values up to 20%, depending on the magnitude of the storm event and degree of foundation drain and roof downspout connections. As the magnitude of the storm event increases, a maximum capture rate (R value) will be reached as there is a limitation on the infiltration rate of the soil, and there are capacity restrictions of the sewers.

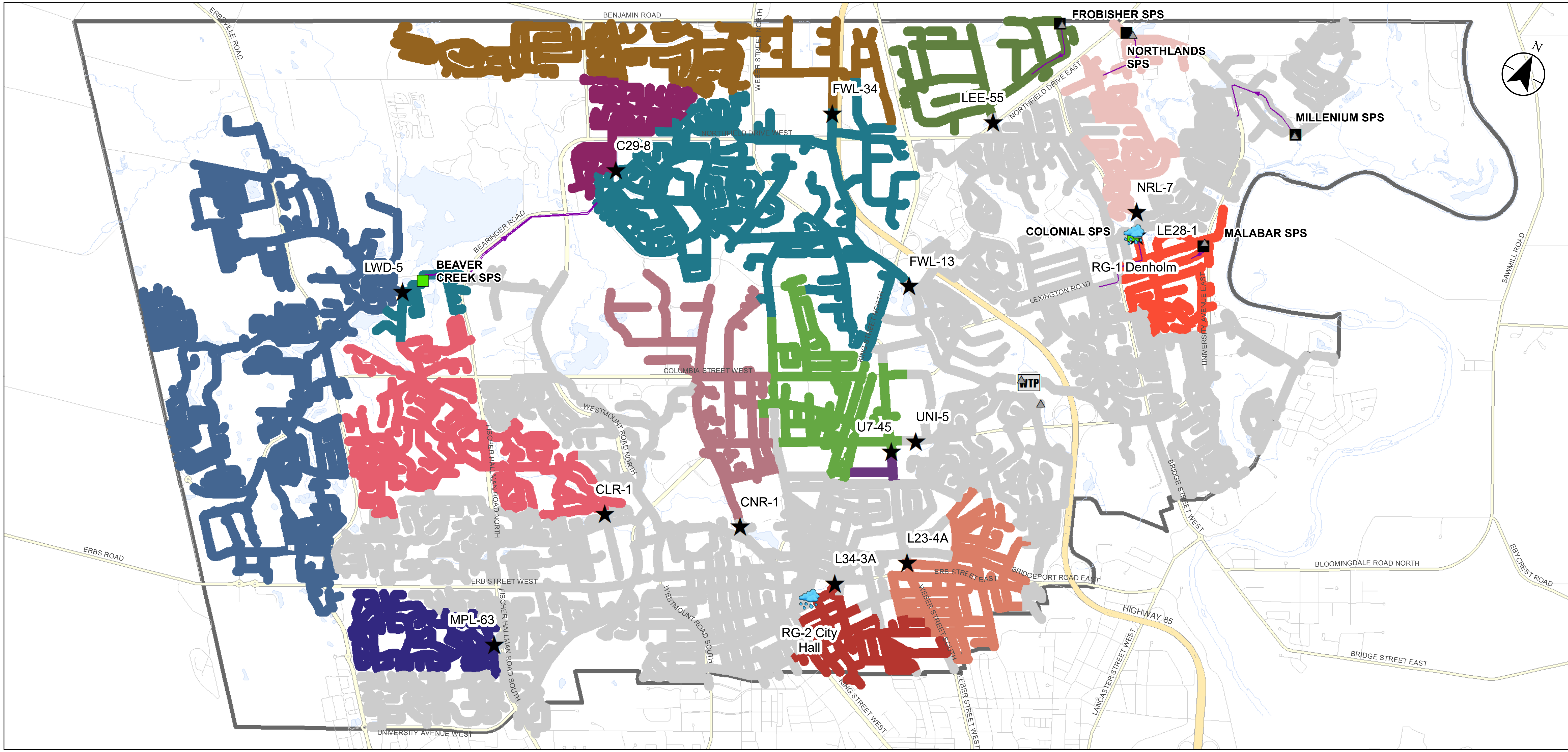
Wet weather parameters are evaluated in **Section 4.0** and applied to model calibration in **Section 5.3**.

3.0 FLOW MONITORING DATA

The 2014 Master Plan model parameters were based on flow monitoring data collected throughout 2013 and 2014 from 13 select monitors. To support the updated system characterization and model recalibration process, additional rainfall and flow monitoring data collected by the City was reviewed. The flow monitoring consisted of 7 flow meters from 2014 to 2018, and 8 flow meters installed from January 2021 to December 2021. Data from the 2021 flow meters was used for the sanitary model calibration, in conjunction with the relevant rain gauge data, and data from the 2018 flow meters was used for validation. Moreover, the 2014 Master Plan recommended flow monitoring in additional locations:

1. Downtown Core as part of the Optimization and Rehabilitation Program.
2. Clair Trunk.
3. Cedar Trunk.
4. Forwell Trunk.

The Downtown Core area is partially cover by the flow monitors CNR-1 (2018), U7-45 (2021) and UNI-5 (2021). Clair Trunk area flow monitor is CLR-1 (2018), Cedar Trunk is C29-8 (2018 & 2021), and Forwell Trunk is cover by FWL-34 (2021) and FWL-13 (2021). Error! Reference source not found. illustrates the geospatial distribution of the 2018 and 2021 monitors with the rain gauges.



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Flow Monitor
- Rain Gauge

2021 Metershed

- C29-8
- FWL-13
- FWL-34
- LEE-55
- LWD-5
- MPL-63
- U7-45
- UNI-5
- Unmonitored

2018 Metershed

- CLR-1
- CNR-1
- L23-4A
- L34-3A
- LE28-1
- NRL-7

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Project Location
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Figure No.
3-1

Title
2018 & 2021 Flow Monitoring Program with Rain Gauge Locations

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

3.1 2021 FLOW METER

The PCSWMM model was used to trace the contributing metersheds and create a schematic illustrating the 2021 flow meters and their connectivity, as shown in **Figure 3-2**.

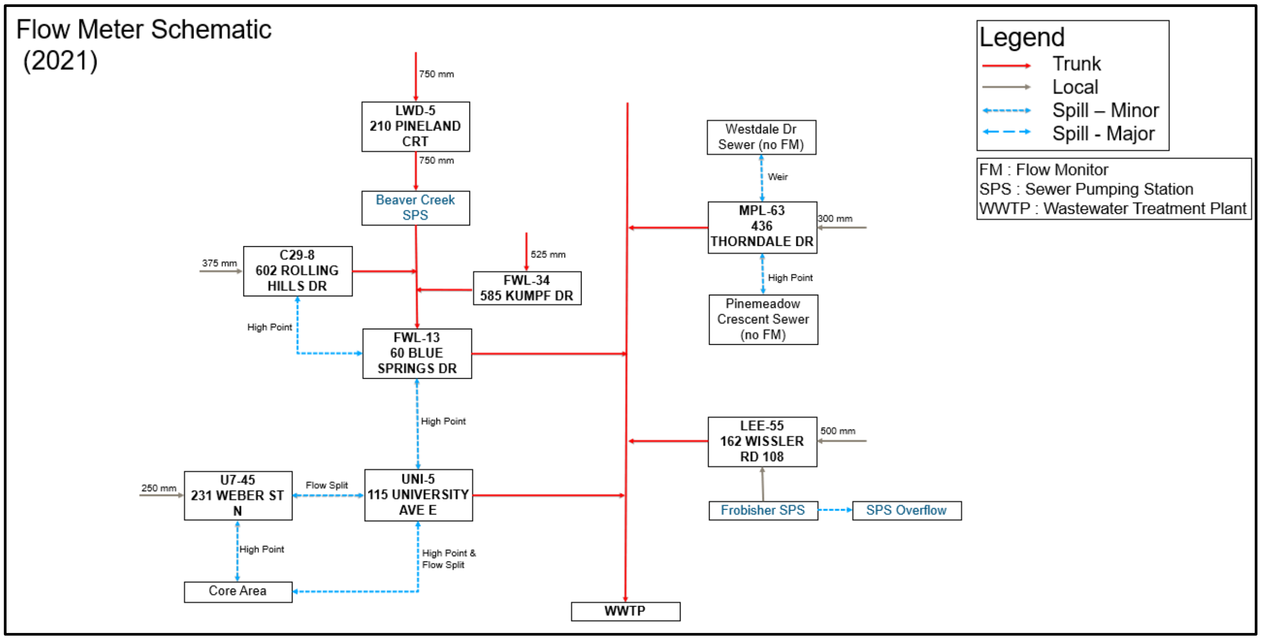


Figure 3-2: 2021 Flow Meter Schematic

There are flow monitors that are aligned in series, such that a downstream monitor receives flow from one or more upstream monitors. As shown in **Figure 3-2**, meters C29-8, FWL-34 and LWD-5 are upstream of FWL-13, and meter U7-45 is upstream of UNI-5.

Metersheds include bifurcations manholes (more than 1 outgoing pipe) that define flow splits or high points within the system. If located along the metershed boundary, these bifurcations can result in hydraulic connectivity between sub-systems depending on the chamber and pipe orientation, and the flow conditions observed. The flow schematic indicates the presence of spill points between metersheds that could result in hydraulic connectivity. The spill points identified between metersheds, can prove challenging calibration due to the contributing upstream area varying with fluctuating flow conditions. It is noted that the basis of invert and connectivity data is the hydraulic model based on GIS, which at the local level may have erroneous data (see **Section 5.4**).

The following **Table 3-1** details the 8 flow meters (FMs) used for the 2021 calibration; meter locations, pipe sizes, and contributing area characteristics.

In additional to the 8 FMs, the flow at the Parshall Flume, upstream of the WWTP was provided. The flow was used to validate the fits of the entire sanitary system.

3.0 Flow Monitoring Data

Table 3-1 : Flow Meter & Metershed Characteristics

FM ID	Location	Rain Gauge ID	Pipe Size (mm)	Total[1] Contributing Area (ha)	Incremental[2] Contributing Area (ha)	Total[1] Population	Incremental[2] Population	Predominant Land Use Classification[3]	General Metershed Age
C29-8	602 ROLLING HILLS DR	RG2	375	59.23	59.23	2,278	2,278	Res	< 2000
FWL-13*	60 BLUE SPRINGS DR	RG1	825	973.17	315.61	51,425	19,793	Mixed Use	Mixed
FWL-34	585 KUMPF DR	RG1	525	171.78	171.78	9,779	9,779	Mixed Use	Mixed
LEE-55	162 WISSLER RD 108	RG1	500	72.31	72.31	4,712	4,712	ICI	< 2000
LWD-5	210 PINELAND CRT	RG2	750	426.55	426.55	19,575	19,575	Res	Mixed
U7-45	231 WEBER ST N	RG2	250	5.19	5.19	505	505	ICI	< 2000
UNI-5*	115 UNIVERSITY AVE E	RG2	825	113.18	107.99	14,680	14,175	Mixed Use	Mixed
MPL-63	436 THORNDALE DR	RG2	300	78.12	78.12	3,859	3,859	Res	Mixed

Notes:

1. Total Contributing Areas and Total Populations include area/populations draining to upstream FMs (FM in series).
2. Incremental area and populations refer to only the area between the upstream FM and the FM of focus.
3. Land Use Classification is generalized based on the percentage of incremental residential population per metershed with < 50% is considered ICI, between 50% and 70% is considered Mixed, and > 50% is considered Residential.

* FM is downstream of one or more other FMs (FM in series) based on primary flow direction.

3.2 FLOW METER DATA QUALITY REVIEW

The meter data for all flow meters between January 2021 and December 2021 was reviewed on a macro-level to identify periods of missing data, questionable readings (depth/velocity), backwater, and surcharge. This review is the first step in identifying the most appropriate periods of data for the selection of the DWF periods and WWF events.

3.2.1 Flow Monitor C29-8

This monitor is installed in the 375 mm on Cedar Trunk sewer. The scatterplot indicates a relatively strong correlation of depth and velocity, with few anomalies throughout the time period. The highest peak levels and flows are seen on September 21st where the pipe is surcharging, and backwater is occurring. There is missing data at the end of August and beginning of September. Wet weather responses are apparent in the data after significant rainfalls. Overall, this site has good data quality that can be used to create model calibration parameters and I/I characteristics. Refer to **Figure 3-3** for FM C29-8 Flow, Depth and Velocity Data. **Figure 3-4** present the depth and velocity scatterplot and the pipe curve described by the Manning Equation.

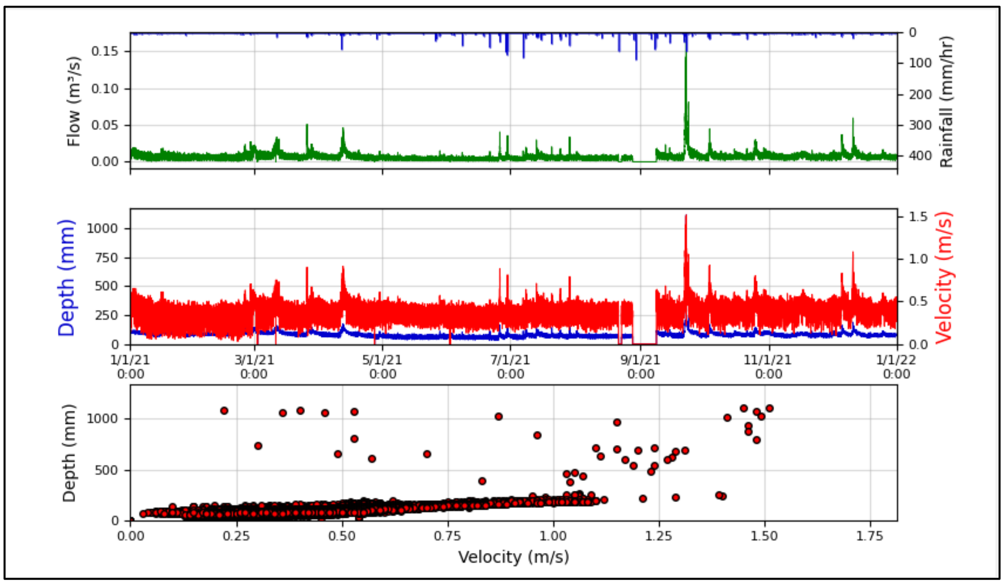


Figure 3-3: FM C29-8 Flow, Depth and Velocity Data

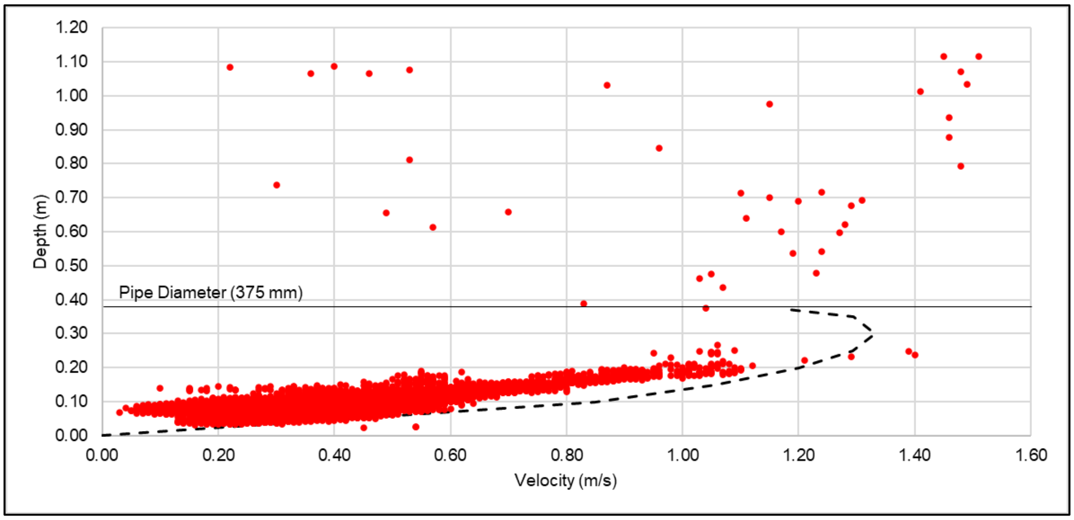


Figure 3-4: FM C29-8 Data Quality

3.2.2 Flow Monitor FWL-13

This monitor is installed in an 825 mm pipe on Forwell Trunk sewer. The scatterplot indicates a relatively strong correlation of depth and velocity, with few anomalies throughout the time period. The highest peak levels and flows are seen in September 21 with the pipe surcharging, and backwater is occurring. Wet weather responses are apparent in the data after significant rainfalls. Overall, this site has good data quality that can be used to create model calibration parameters and I/I characteristics. Refer to **Figure 3-5** for FM FWL-13 Flow, Depth and Velocity Data. **Figure 3-6** present the depth and velocity scatterplot and the pipe curve described by the Manning Equation. The increase in depth without a corresponding increase in velocity suggests a possible overflow occurred during the peak wet weather event.

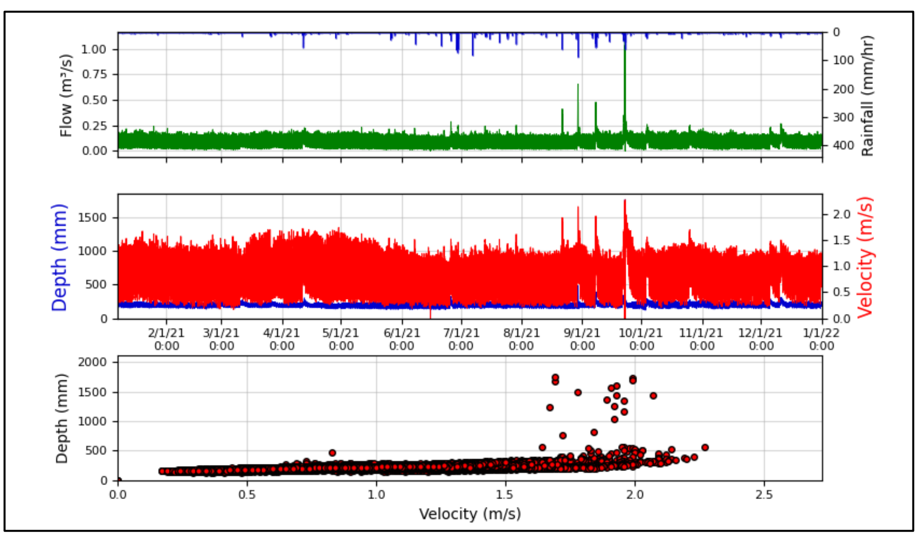


Figure 3-5: FM FWL-13 Flow, Depth and Velocity Data

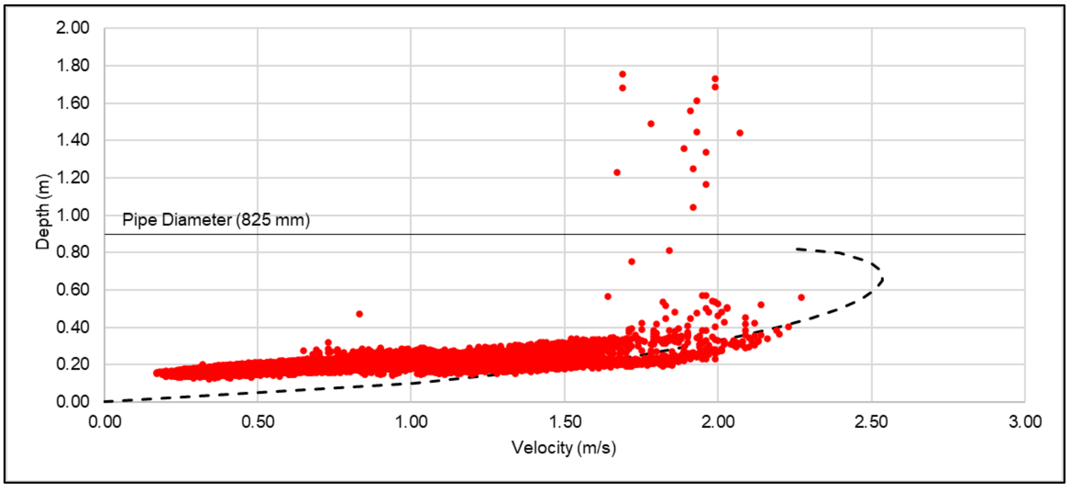


Figure 3-6: FM FWL-13 Data Quality

3.2.3 Flow Monitor FWL-34

This monitor is installed in a 525 mm pipe on the upstream end of Forwell Trunk sewer. The scatterplot indicates a relatively strong correlation of depth and velocity. Wet weather responses are apparent in the data after significant rainfalls, with maximum depth ratio of less than 50%. Overall, this site has good data quality that can be used to create model calibration parameters and I/I characteristics. Refer to **Figure 3-7** for FM FWL-34 Flow, Depth and Velocity Data. **Figure 3-8** present the depth and velocity scatterplot and the pipe curve described by the Manning Equation. Here, the pipe never surcharged and there's no indication of spill like in the downstream FWL-13.

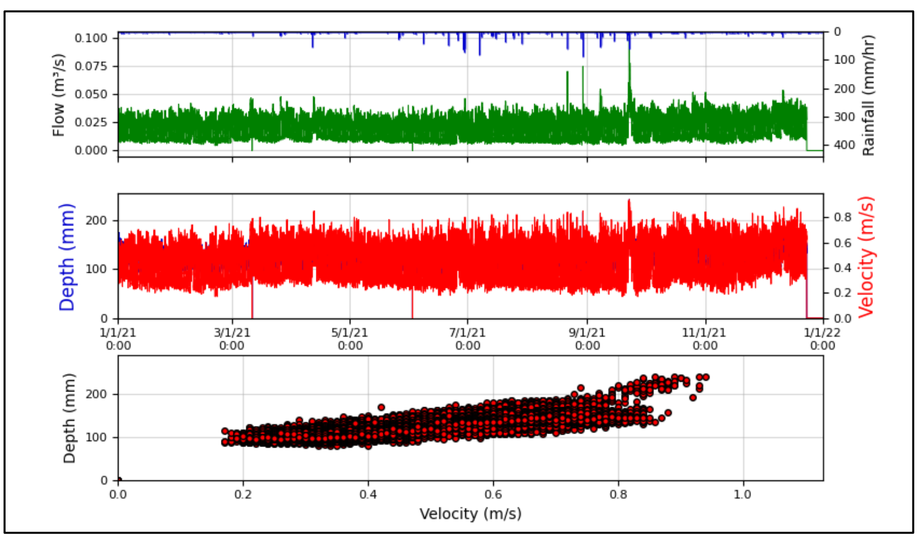


Figure 3-7: FM FWL-34 Flow, Depth and Velocity Data

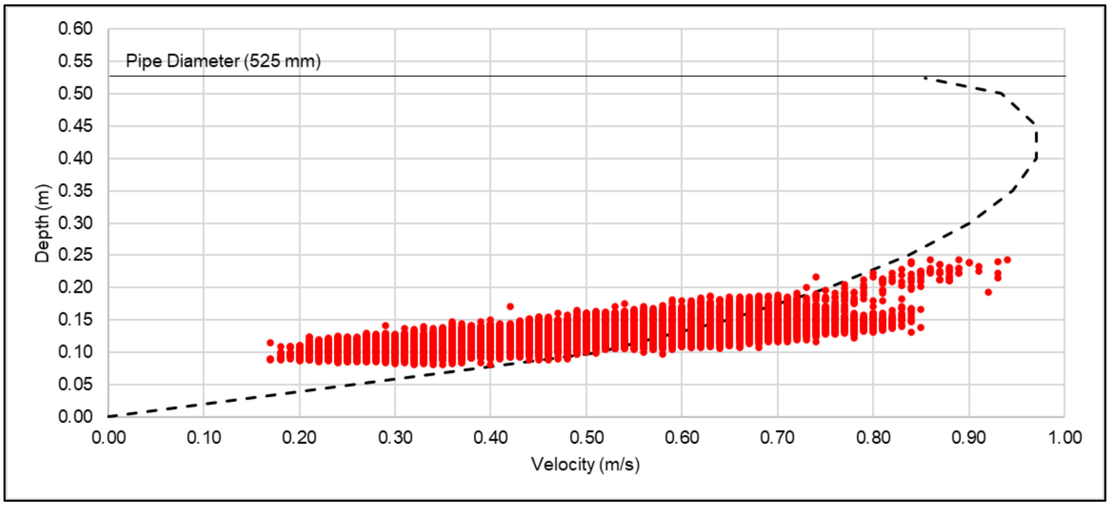


Figure 3-8: FM FWL-34 Data Quality

3.2.4 Flow Monitor LEE-55

This monitor is installed in a 500 mm pipe on the Lee Trunk sewer. The flow meter is downstream of Frobisher SPS, therefore the data is more variable due to on/off times. Overall, the data quality is good and will be used to establish model calibration parameters and I/I characteristics, due to an absence of additional data within the catchment area. Refer to **Figure 3-9** for FM LEE-55 Flow, Depth and Velocity Data. **Figure 3-10** present the depth and velocity scatterplot and the pipe curve described by the Manning Equation.

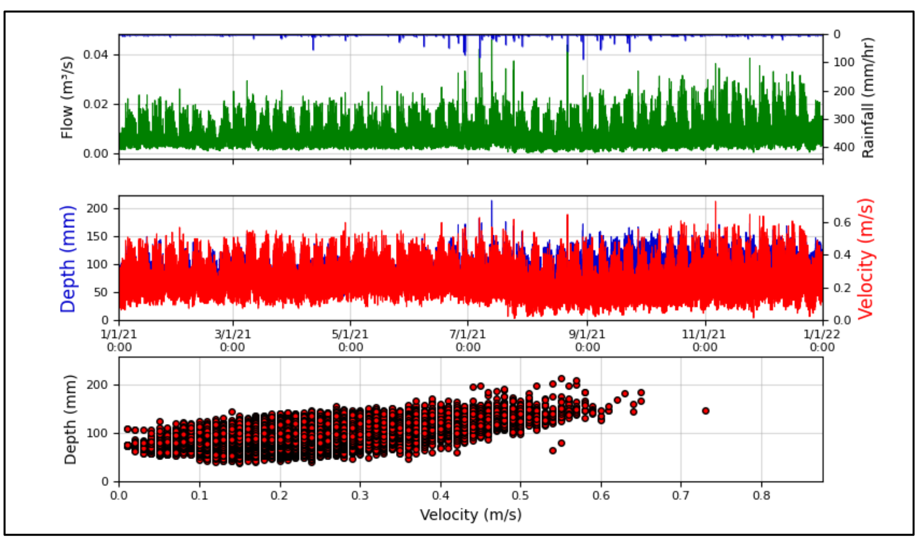


Figure 3-9: FM LEE-55 Flow, Depth and Velocity Data

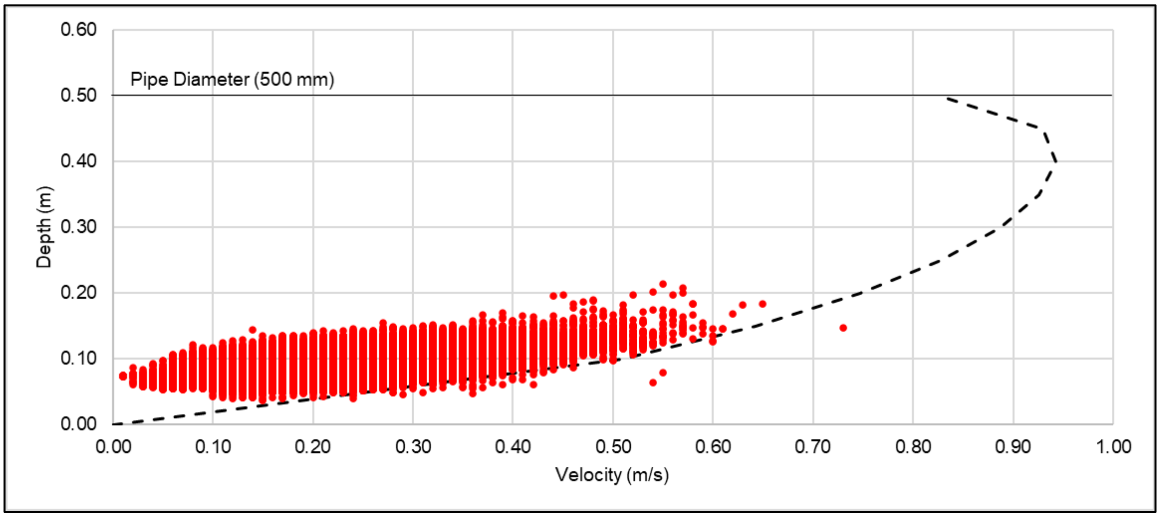


Figure 3-10: FM LEE-55 Data Quality

3.2.5 Flow Monitor LWD-5

This monitor is installed in a 750 mm pipe on the Laurelwood Trunk sewer, which represents a younger part of the sewer system. The scatterplot indicates a strong correlation between the velocity and depth. The data shows a noticeable response to wet weather but was contained within 50% pipe full in 2021. This data can therefore be used to generate model calibration parameters and I/I characteristics. Refer to **Figure 3-11** for FM LWD-5 Flow, Depth and Velocity Data. **Figure 3-12** present the depth and velocity scatterplot and the pipe curve described by the Manning Equation.

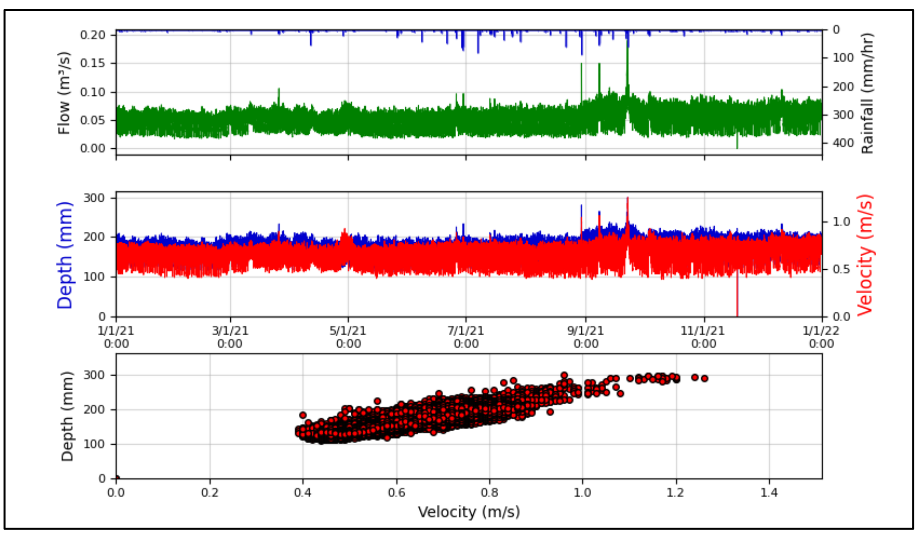


Figure 3-11: FM LWD-5 Flow, Depth and Velocity Data

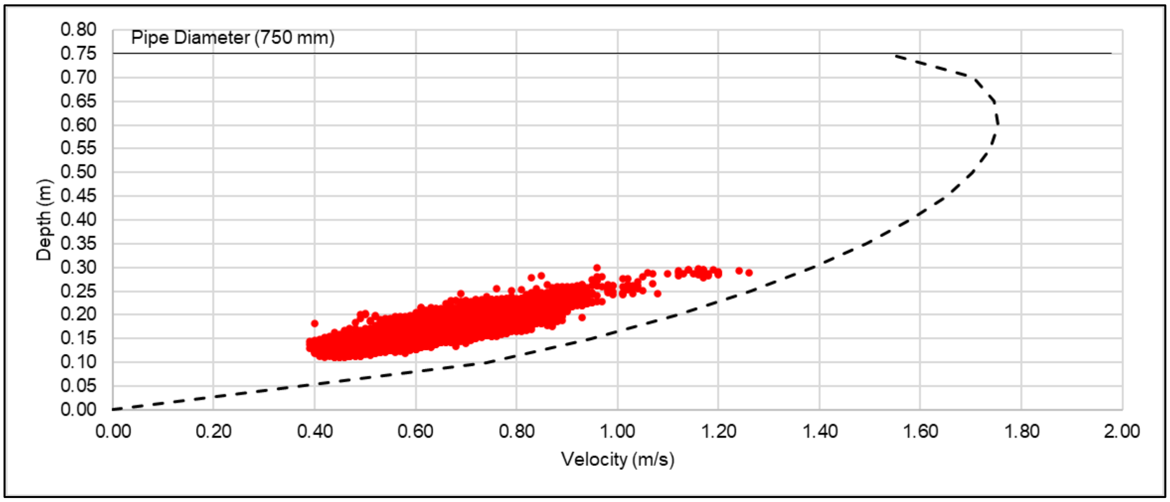


Figure 3-12: FM LWD-5 Data Quality

3.2.6 Flow Monitor U7-45

This monitor is installed in a 250 mm pipe on a local sewer in University Area. The metershed is small, hence the flow in sewer is low, thus that can impact the depth and velocity readings due to technological limitation. Additionally, the low depth and velocity of this sewer could cause blockage which can results in flow monitor outages.

The data experiences a change in flow pattern, and which consisted of an increased in depth and velocity readings. The velocity and depth scatterplot also indicates different trends observed. Moreover, there are missing depth and velocity data in June, October, November, and December. Overall, the data quality is moderate but can be used to construct model calibration parameters. Refer to **Figure 3-13** for FM U7-45 Flow, Depth and Velocity Data. **Figure 3-14** present the depth and velocity scatterplot and the pipe curve described by the Manning Equation.

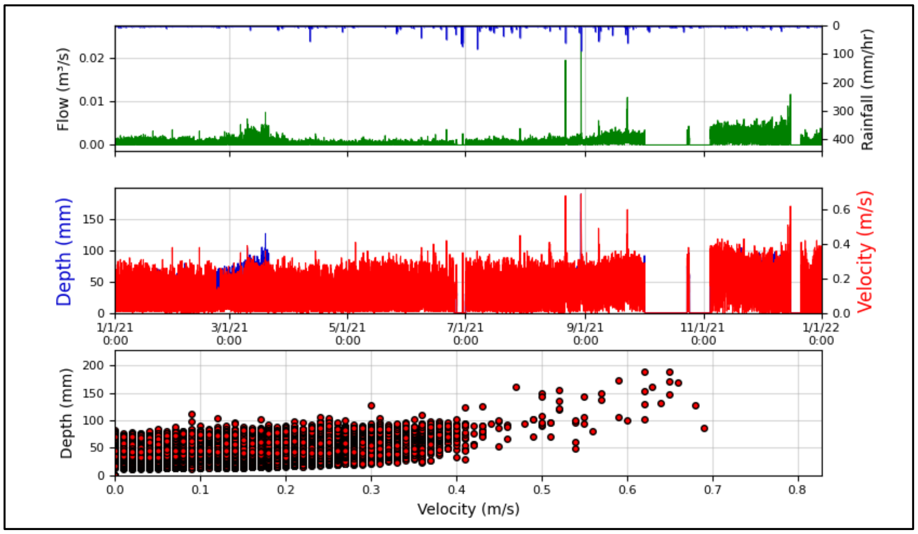


Figure 3-13: FM U7-45 Flow, Depth and Velocity Data

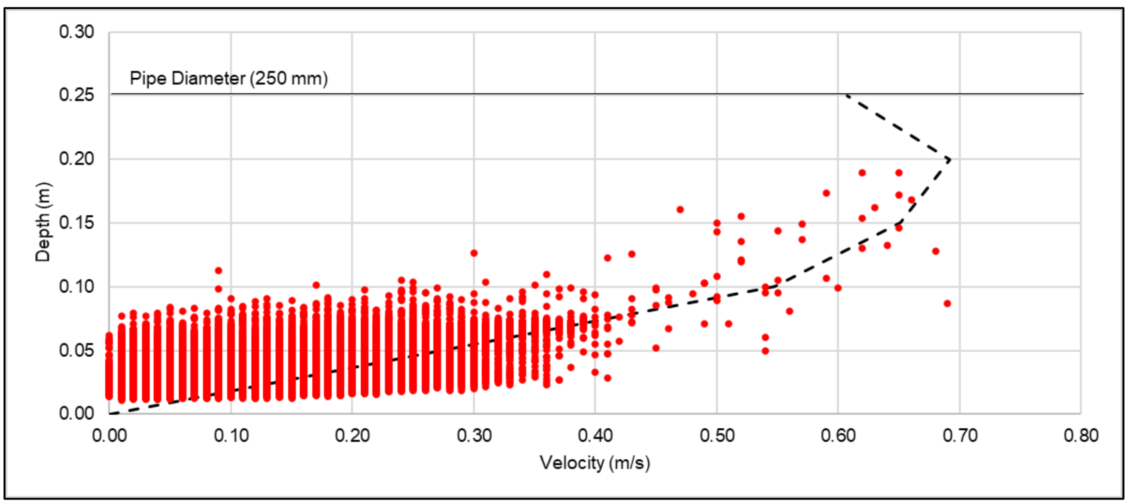


Figure 3-14: FM U7-45 Data Quality

3.2.7 Flow Monitor UNI-5

This monitor is installed in an 825 mm pipe on the University Trunk. The scatterplot indicates a relatively strong correlation of depth and velocity, with few anomalies throughout the time period such as questionable flow variation consisting of noise in the velocity readings and general increasing trend. Surcharge was recorded with a decrease in velocity, suggesting backwater in the September 21, 2021 event. Overall, the data quality is relatively good and can be used to construct model calibration parameters and I/I characteristics. Refer to **Figure 3-15** for FM UNI-5 Flow, Depth and Velocity Data. **Figure 3-16** present the depth and velocity scatterplot and the pipe curve described by the Manning Equation.

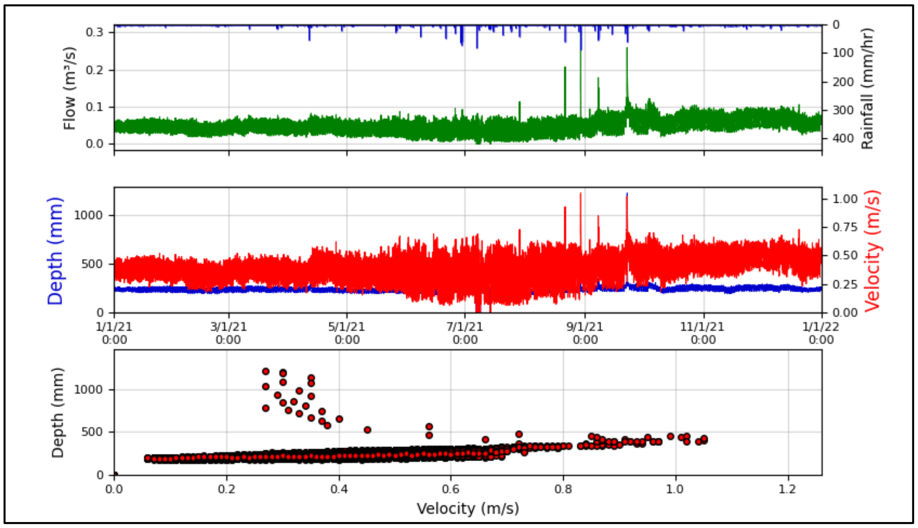


Figure 3-15: FM UNI-5 Flow, Depth and Velocity Data

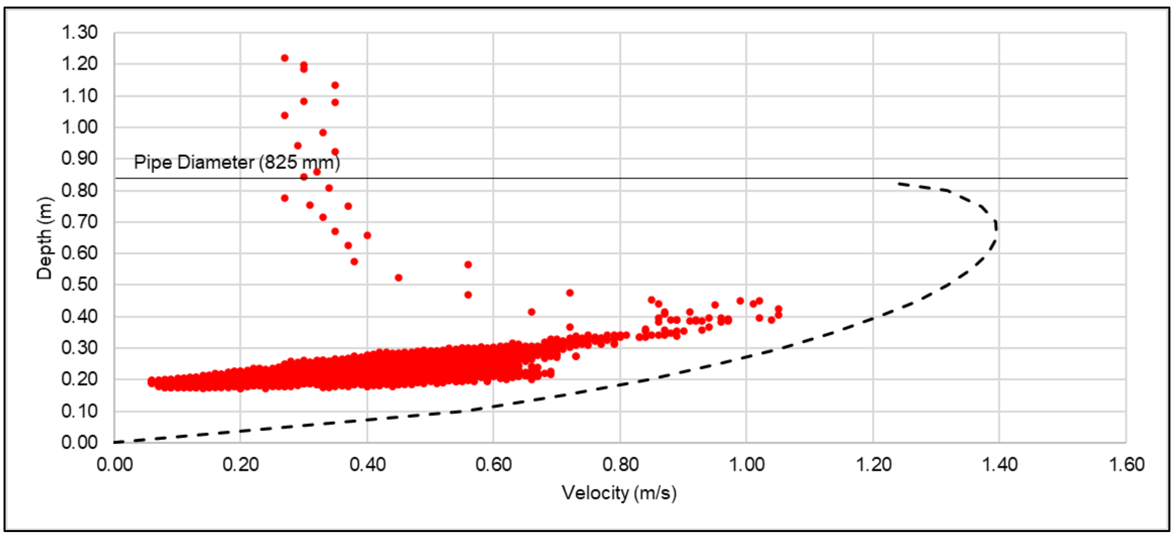


Figure 3-16: FM UNI-5 Data Quality

3.2.8 Flow Monitor MPL-63

This monitor is installed in a local 300 mm pipe tributary to the Maple Hill Trunk. The maintenance hole upstream of the flow meter has a weir, and the upstream flow can split if the depth reaches ~157 mm. The level and velocity are low which can contribute to the variable pattern and dropouts observed. Depth readings indicate the pipe never reach 50% pipe full, despite indications of variable wet weather response. Refer to **Figure 3-17** for FM MPL-63 Flow, Depth and Velocity Data. **Figure 3-18** present the depth and velocity scatterplot and the pipe curve described by the Manning Equation.

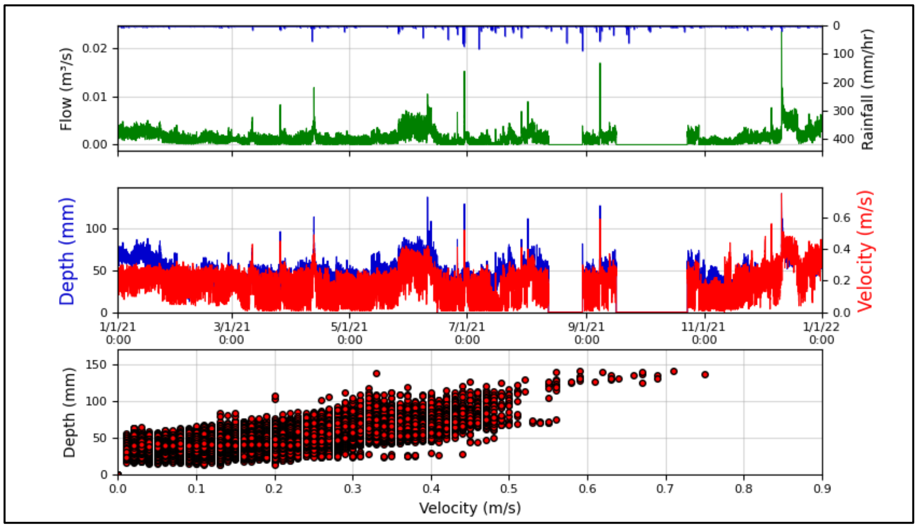


Figure 3-17: FM MPL-63 Flow, Depth and Velocity Data

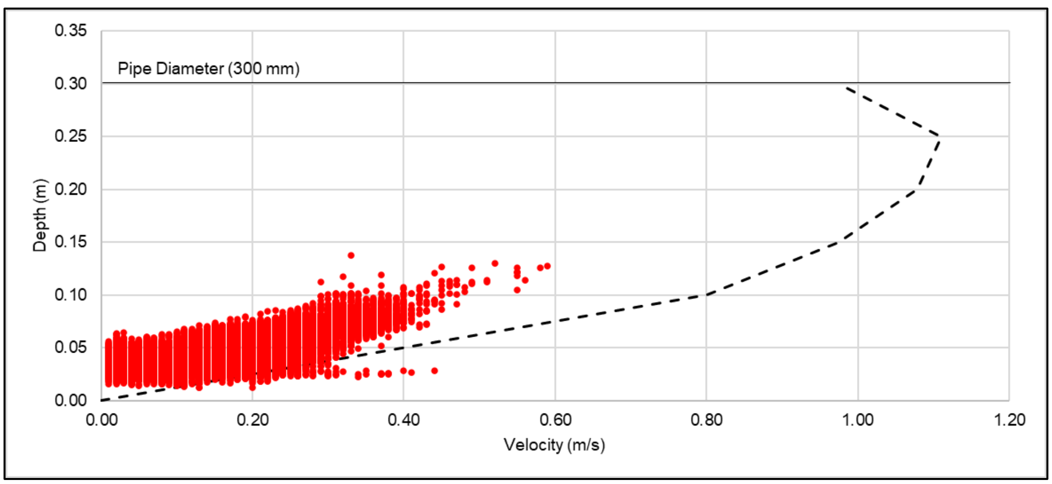


Figure 3-18: FM MPL-63 Data Quality

4.0 RAINFALL DATA COLLECTION AND ANALYSIS

The rainfall data collected from the two (2) applicable rain gauges was assessed and used to select the two (2) dry weather flow (DWF) periods and three (2) wet weather flow (WWF) events used for calibration. A third, significant WWF event was observed on September 21st, 2021 which generated substantial backwater and flooding on the Forwell Trunk and was thus used as a validation event for the model calibration. The following sections detail the assessment findings and selected periods.

4.1 RAIN GAUGE LOCATION

There are two (2) rain gauges (RGs) located at Denholm St near Colonial SPS, and at City Hall (RG1 and RG2, respectively). Due to their location, spatial coverage is split relatively evenly across the City with RG2 covering the northern portion of the modelled area and RG1 covering the southern portion. This results in the RGs being relatively evenly assigned to the metersheds when using the Thiessen Polygons Method. RG1 is assigned to three metersheds and RG2 is assigned to the remaining five metersheds, as seen in **Table 3-1**. **Table 4-1** presents an overview while **Figure 3-1** illustrate their locations.

Table 4-1: Available 2021 Rain Gauge Network

ID	Location	Notes
RG1	Denholm St near Colonial SPS	Existing Permanent Gauge
RG2	City Hall	City Hall rainfall is missing data: • From 2021-04-03 to 2021-06-29 • From 2021-08-30 to 2021-12-31

The Grand River Conservation Authority (GRCA), Region of Waterloo and University of Waterloo rain gauges are not used in this analysis.

4.2 RAINFALL DATA QUALITY AND QUANTITY REVIEW

Figure 4-1 presents the cumulative rainfall measured at the two RGs during the flow monitoring program from January 1st to December 31st of 2021. Wet weather is not always uniform per flow monitor metershed or event, which can add an extra layer of complexity during calibration since only one rain gauge is typically assigned per metershed in the model.

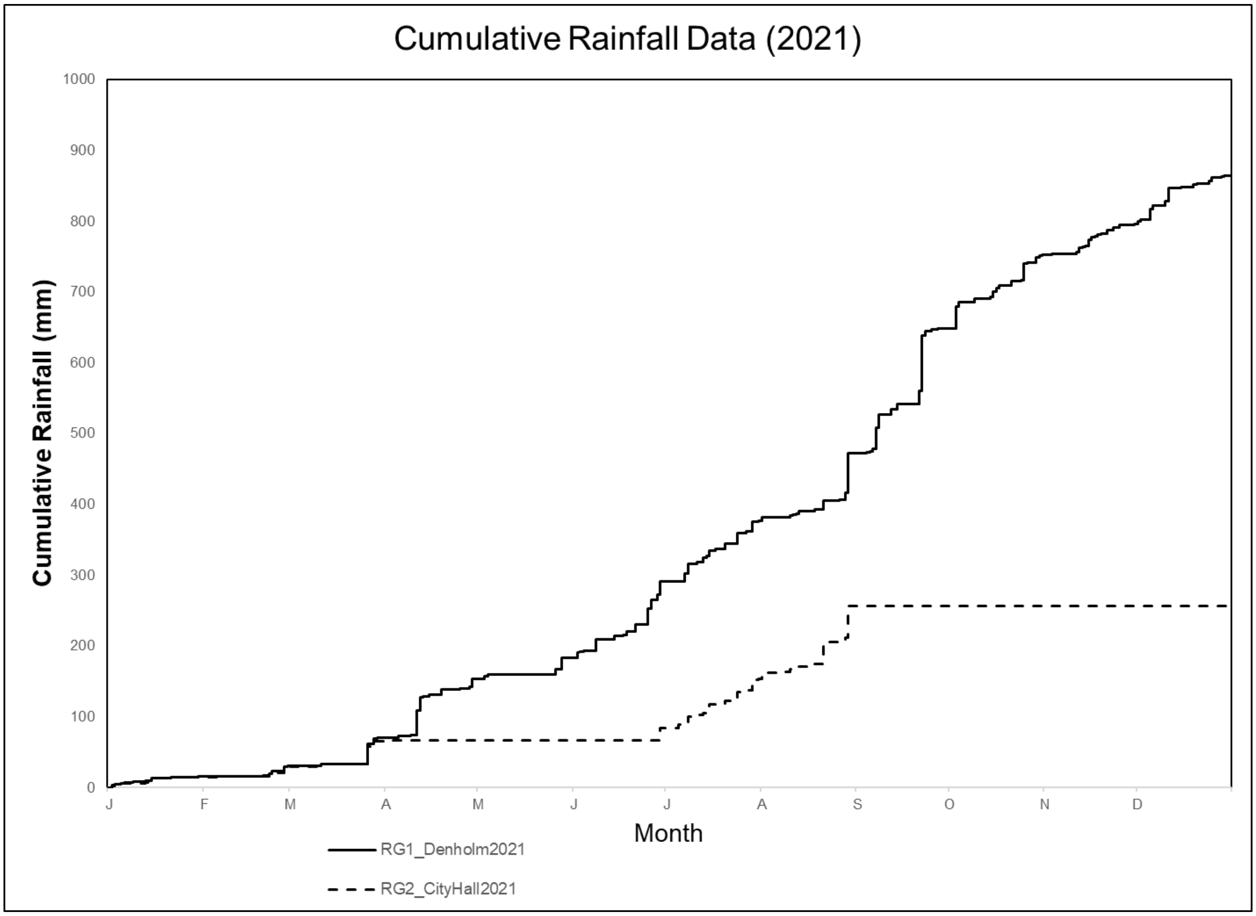


Figure 4-1: Cumulative Rainfall Volume

Overall, the two RGs observed very similar cumulative rainfall amounts from January to April, with RG1 and RG2 observing 70.4 mm and 66.3 mm, respectively. And from July to September the cumulative rainfall amounts are also similar, with RG1 and RG2 observing 180.9 mm and 172.2 mm, respectively. The City Hall rain gauge is missing rainfall data from April 3rd to June 29th, 2021, and beyond August 30th 2021, making it a challenge to assess the overall rain gauge variability over the City.

4.3 DRY WEATHER FLOW RECALIBRATION PERIODS

Periods of DWF were defined by no more than 2 mm of rain in the recalibration period, no more than 5 mm of rain in the previous two days, and no more than 50 mm of rain in the previous 7 days. Ideally a period of five days of dry weather was to be selected for calibration. Periods were given further preference based on the following criteria:

- Periods that included weekdays and weekends;
- Periods that were reasonably spaced from each other to capture any seasonable variability; and,
- Periods without significant outages/poor data quality at flow meters.

There was an average of 19 DWF days per rain gauge between April 2022 and early October 2022. Three of these periods meet all of these criteria and allowed for seven consecutive days with DWF conditions, and were therefore shortlisted for calibration. These DWF periods are as follows:

- DWF Period 1: May 07th, 2021 (00:00) to May 14th, 2021 (00:00); and,
- DWF Period 2: August 3rd 2021 (00:00) to August 9th, 2021 (00:00).

4.4 STORM EVENT SUMMARY

As described in **Section 4.2**, two (2) rain gauges were processed for storm event identification. Storm events were defined by a minimum 5 mm of rainfall, and generally calibration seeks events with depths greater than 15 mm. Peak intensities were also considered when identifying potential events for use in calibration. An average of 42 rainfall events were observed in Denholm rain gauge, between June 2021 and early October 2021. **Table 4-2** presents a summary of the three (3) rainfall events chosen based on magnitude, duration, and monitor response. It is noted that the third event was a very significant volumetric event spanning a long duration, and thus important to include. Unfortunately, RG 2 malfunctioned during this event.

Table 4-2: Storm Event Characteristics

Rain Gauge	Event	Start Time	End Time	Duration (hr)	Average Depth (mm)	5-Minute Peak Intensity (mm/hr)
RG1 Denholm	**1**	2021/06/29 12:00	2021/06/29 16:55	4.9	18.3	73.1
	2	2021/08/29 18:00	2021/08/29 22:05	4.2	55.1	88.4
	3	2021/09/21 5:10	2021/09/23 6:15	49.2	100.8	61.0
RG2 City Hall	**1**	2021/06/29 12:50	2021/06/29 16:35	3.8	17.8	54.8
	2	2021/08/29 18:40	2021/08/29 22:00	3.4	44.2	128.0
Notes: • The September 21st rainfall event was not observed at RG2.						

4.5 WET WEATHER FLOW RECALIBRATION EVENTS

In keeping with the original Master Plan methodology, the objective for recalibration was to define two (2) WWF events with at least 15 mm of rainfall depth. Consequently, the wet weather events selected for recalibration are as follows (see accurate start and ends times in **Table 4-2**):

- WWF Event 1: June 29th, 2021; and,

- WWF Event 2: August 29th, 2021.

The long duration WWF Event 3 on September 21st, 2021, to September 23rd, 2021, was selected for model validation only given the magnitude of this event and the potential for additional extraneous sources to contribute to the wet weather response.

The selected WWF events were plotted against the City's Intensity-Duration-Frequency (IDF) curves, with most gauges measuring rainfall events with a 1:2-year return period or less. In WWF Event 2 however, RG1 experienced a 1:10-year return period, while RG2 observed a 1:5-year event. While WWF Event 3 generated the most significant response in the system, it still classifies as only a 1:2-year storm. Therefore, there were limited significant events captured in the shortened monitoring period from which to base the wet weather flow calibration. See **Figure 4-2** for the IDF curves for the 3 WWF events.

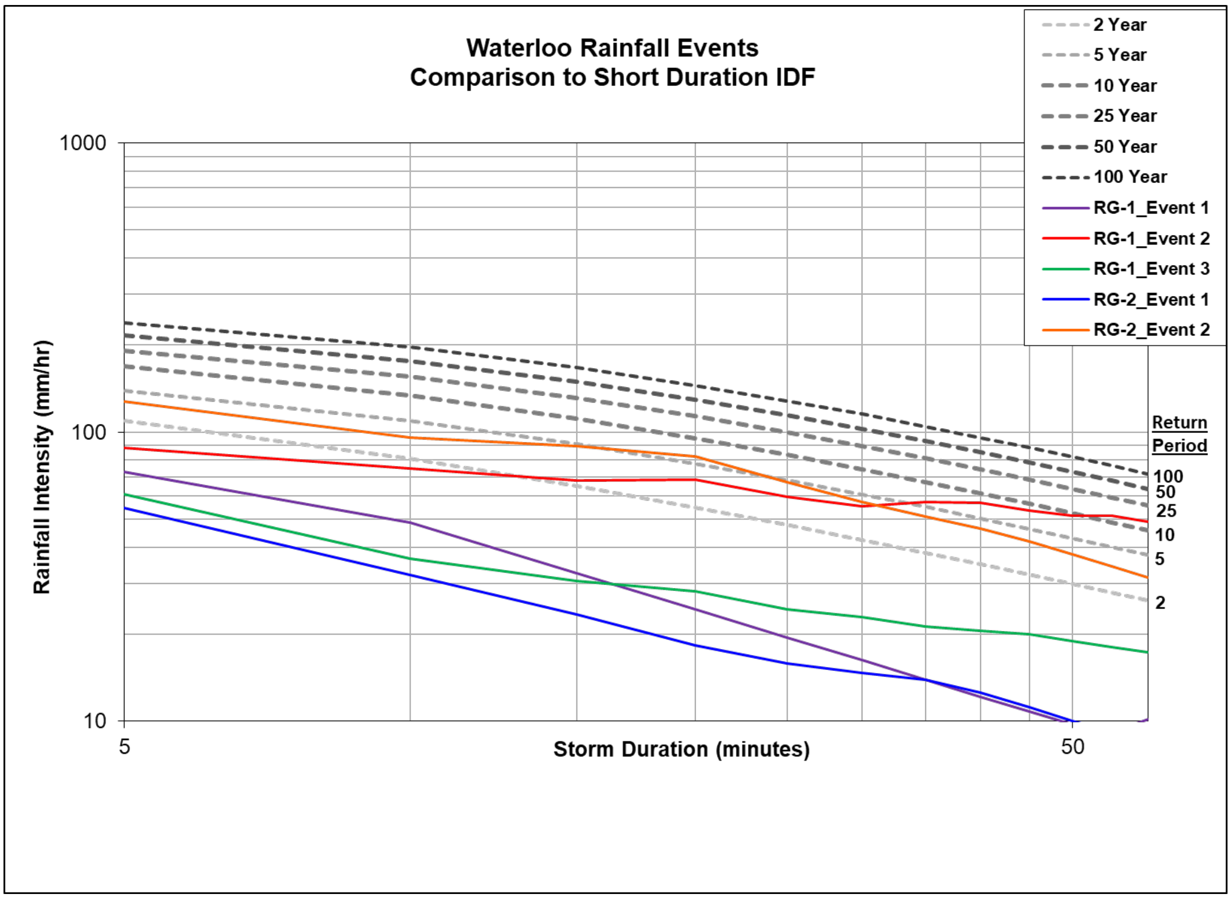


Figure 4-2: Wet Weather Flow Events Return Period

5.0 SANITARY MODEL VALIDATION AND RECALIBRATION

The selected 2021 flow monitoring periods / events are used to establish the updated DWF and WWF parameters for the available monitors, including the per capita sewage generation rates, diurnal patterns, GWI rates, resulting baseflows, and RDII. A total of 2 DWF and 2 WWF events have been selected for recalibration. Areas without 2021 monitor coverage are allocated the rates from the 2014 Master Plan, and generally correspond to areas where limited change has occurred in the system.

Once the model network updates were complete (see TN1), the monitoring (or observed) data and the rain gauge data were imported into the updated PCSWMM model for comparison to the modelled results of the previous parameters with 2021 periods/events. This initial review is considered model validation, to observe how well the original model parameters match current monitoring data. The process of adjusting model parameters to better correlate results with observed data is referred to as model recalibration. This recalibration process was achieved using an iterative approach until an acceptable fit to the observed flow was obtained. Dry and wet weather targets have been adopted in accordance with the *Wastewater Planning Users Group (WAPUG, now CIWEM) Code of Practice for the Hydraulic Modelling of Sewer Systems,"* ver. 3.001, dated November 2002. The target guidelines are outlined in **Section 5.2.1** and **Section 5.3.1**.

5.1 MODEL VALIDATION

For the Master Plan update, the average flow was adjusted based on the 2014 Parameters and the updated population. The GWI and the RDII parameters was also adjusted based on updated sewershed areas. The 2021 flow monitors are located in areas where changes were planned or previous I/I problems, as presented in 2014 Master Plan. The validation demonstrated that the existing model is able to reflect the general flow conditions in the system, but that it would benefit from additional recalibration in some locations based on changes in growth, infrastructure and water usage.

5.2 DRY WEATHER RECALIBRATION

5.2.1 Approach

Parameters extracted from the available flow monitoring data analysis are initially applied to the residential population and ICI areas for wastewater generation, and to the effective areas for GWI. The flow hydrograph produced by the model at each meter site is compared to the monitored (or observed) flow. The parameters are then adjusted within a reasonable range (if possible) until an acceptable fit to the observed flow is obtained. This is completed for the two separate periods, consisting of 8 dry weather days (192 hrs) and 7 dry weather days (168 hrs), respectively, with weekdays and weekends. In addition to matching the overall general response, the flow hydrographs should meet the following CIWEM criteria for goodness-of-fit:

- The alignment of the peaks and valleys of the time series should be within 1 hour;

- The peak flows should be within ± 10% of each other; and,
- The volume should be within ± 10%. Care should be taken to exclude periods of missing or inaccurate data.

Calibration is intended to establish a representative model of the system, but often does not perfectly reflect real-life conditions. Differences can be observed for various reasons, including varying system hydraulics, inconsistent field conditions (e.g., sediment depth, minor defects, and obstructions, and/or differences between the actual pipe condition, size, or slope and the available data applied in the model), or downstream boundary conditions which may affect flow depths.

5.2.2 Recalibration Challenges and Assumptions

The following outline challenges and assumptions encountered during DWF recalibration:

- Monitor Installation reports was not provided; therefore, the flow monitoring data wasn't compared to the field information for discrepancy and interpretation;
- In dry weather flow, the magnitude of the flows tends to be small. With smaller flows, under- or overestimating the peak flows in the model by even a few L/s can result in percent fits that fall outside of the targeted range but are not considered significant differences when reviewing the meter calibration as a whole. The magnitudes should be considered to provide context for the suitability of the DWF recalibration fits presented;
- The differences in the volumetric percent fit can sometimes be attributed to variations in the diurnal pattern over the flow monitoring period. Only one diurnal flow pattern is generated per meter and represents the average pattern observed over the monitoring period, excluding any questionable days. This may result in a slightly better fit in one period than the other. For example, diurnal pattern variations could be attributed to impacts observed with the start of the school year and return from summer holiday season. This is always a challenge for calibration, where the best balance of parameters is applied given the number of inherent contributing variables;
- All provided Pumping Station information was reviewed and incorporated into the model. The actual pump station operation is not consistent, and could add a layer of uncertainty;
- GWI rates can vary substantially depending on the soil condition, climate, location, and season. It is important to consider the DWF period over which the calibration is being completed. Since the calibration period extends from May to September, the GWI rates are expected to vary, with wetter periods (such as the spring melt) and dryer periods (such as the summer). Typical GWI rates can range anywhere from 0.02 to 0.12 L/s/ha (approx. 1,000 L/ha/d to 11,000 L/ha/d). However, higher or lower rates are also possible;
- The ICI areas are accounted for in the Waterloo model using equivalent populations; however, the per capita rate established per metershed represents both residential and ICI contributions. This value can be compared to water consumption rates per metershed based on the same criteria to validate wastewater flows. It should be noted though, that water consumption is not

necessarily a direct equivalent to sewage generated, as water use can be lost during certain activities, such as lawn watering or industrial processes. These water consumption rates are reported in **Table 5-1**;

- Residential wastewater per capita rates can also vary based on age of area, demographic of residents and dwelling type. There is a high-level understanding of population distribution throughout the metersheds, with land uses from GIS data, as discussed in **Section 2.3.1**. Water consumption records, again, are used as a reference to validate wastewater flows, but there are still uncertainties surrounding the actual population distribution within and between these metersheds.

5.2.3 Results

Table 5-1 presents the final DWF parameters derived through model calibration for each metershed and **Table 5-2** presents the DWF parameters from the previous master plan model, for each unmonitored area. Additionally, **Figure 5-1** present the GWI rate distribution per metershed.

Table 5-1: Final Dry Weather Flow Parameters for Monitored Areas

Flow Monitor	Metershed Characteristics						Calibrated Parameters[3]			
	Total[1] Tributary Area for GWI	Incremental[1] Tributary Area for GWI	Total[1] Existing Population	Incremental[1] Existing Population	Incremental Water Consumption Rates[2]		Incremental Groundwater Infiltration		Incremental Average Sewage Flow	
	(ha)	(ha)			(L/s)	(L/c/d)	(L/s)	(L/s/ha)	(L/s)	(L/c/d)
C29-8	59.2	59.2	2,278	2,278	8.65	328	1.48	0.025	3.14	119
FWL-13*	973.2	315.6	51,425	19,793	54.54	92	26.10	0.032	77.38	67
FWL-34	171.8	171.8	9,779	9,779	30.91	273	1.72	0.010	22.64	200
LEE-55	72.3	72.3	4,712	4,712	9.14	168	1.45	0.020	3.82	70
LWD-5	426.5	426.5	19,575	19,575	67.50	298	12.80	0.030	36.25	160
U7-45	5.2	5.2	505	505	1.36	233	0.04	0.007	0.47	80
UNI-5*	113.2	108.0	14,680	14,175	60.88	358	10.19	0.094	33.98	204
MPL-63	78.1	78.1	3,859	3,859	12.31	276	0.30	0.004	0.81	18
Average	-	-	-	***9,335***	-	***253***	-	***0.028***	-	***115***
Total	***1899.5***	***1236.8***	***106,813***	-	***245.29***	-	***54.07***	-	***178.49***	-

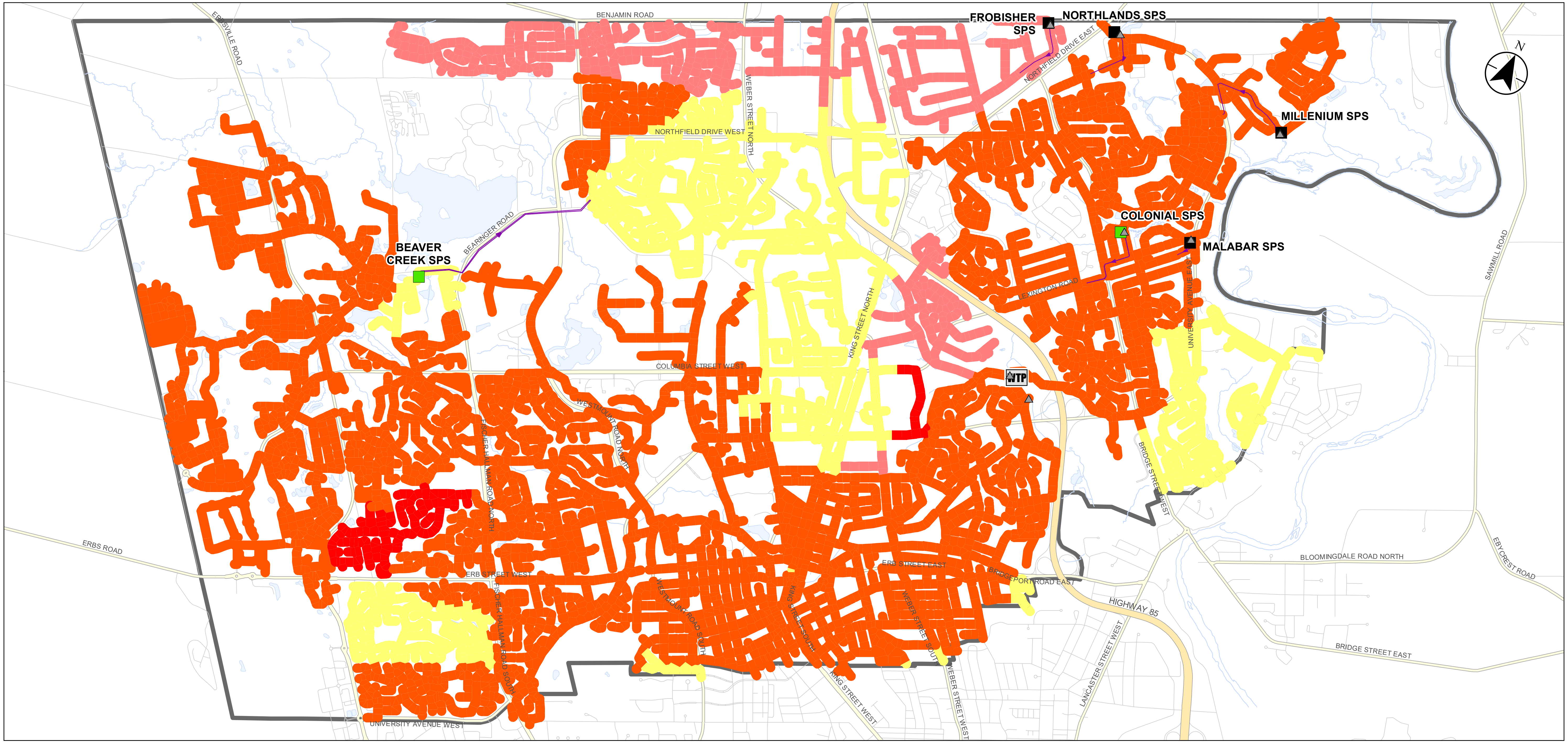
Notes:

1. Total Tributary Area and Total Existing Population includes all area/population draining to upstream FMs (FM in series). Incremental Tributary Area and Incremental Existing Population include only the area between the upstream FM and the FM of focus.
2. The Water Consumption Rates presented are based on the average water consumption rates for January to December 2021.
3. Calibrated parameters are shown on an incremental metershed basis and thus, do not represent the parameters applied to upstream metersheds, if applicable.

* FM is downstream of one or more other FMs (FM in series) based on primary flow direction.

Table 5-2: Dry Weather Flow Parameters for Remaining 2014 Parameters

2014 MP Metershed	Metershed Characteristics		Parameters			
	Total Tributary Area for GWI	Total Existing Population	Incremental Groundwater Infiltration		Incremental Average Sewage Flow	
	(ha)		(L/s)	(L/s/ha)	(L/s)	(L/c/d)
FWL-4A	62.93	3,442	1.20	0.019	12.43	312
GLN-4	60.70	3,445	2.97	0.049	7.87	197
KEA-30	53.81	2,485	3.16	0.059	6.06	211
LEE-9	530.42	25,062	17.50	0.033	43.52	150
LEX-8A	21.16	1,824	0.70	0.033	2.11	100
LRL-19	454.18	49,061	10.67	0.023	96.53	170
LRL-56	463.42	24,009	20.48	0.044	53.84	194
UNI-4	10.10	427	1.10	0.109	1.03	208
WLM-1B	108.83	9,931	4.59	0.042	21.77	189
Unmntrd_MPL-63	175.54	7,407	5.53	0.032	9.44	110
Average	**-**	**-**	**-**	***0.044***	**-**	***184***
Total	***1941.1***	***127,094***	***67.89***	**-**	***254.60***	**-**



Legend

- WTP WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain

GWI Rates

- 0.000 - 0.005 L/s/ha
- 0.005 - 0.020 L/s/ha
- 0.020 - 0.050 L/s/ha
- 0.050 - 0.100 L/s/ha

0 500 1,000 metres

1:37,560 (At original document size of 11x17)

Stantec

Project Location
City of Waterloo

165640363 REVA
Prepared by HB on 2023-07-24

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
5-1

Title
GWI Rates Per Sewershed

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

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The GWI rates range, for the calibrated metershed presented in **Table 5-1**, is between 0.004 L/s/ha and 0.094 L/s/ha, with an average of 0.028 L/s/ha. Metershed MPL-63 exhibited the lowest GWI rate within the system (0.004 L/s/ha); however, MPL-63 is downstream of a MH with a flow split that can direct flow on Westvale Dr or continue to Thorndale Dr, as shown on the **Figure 5-2**. Therefore, it is recommended to monitor flow upstream of the weir and in each direction, to confirm the system hydraulics.

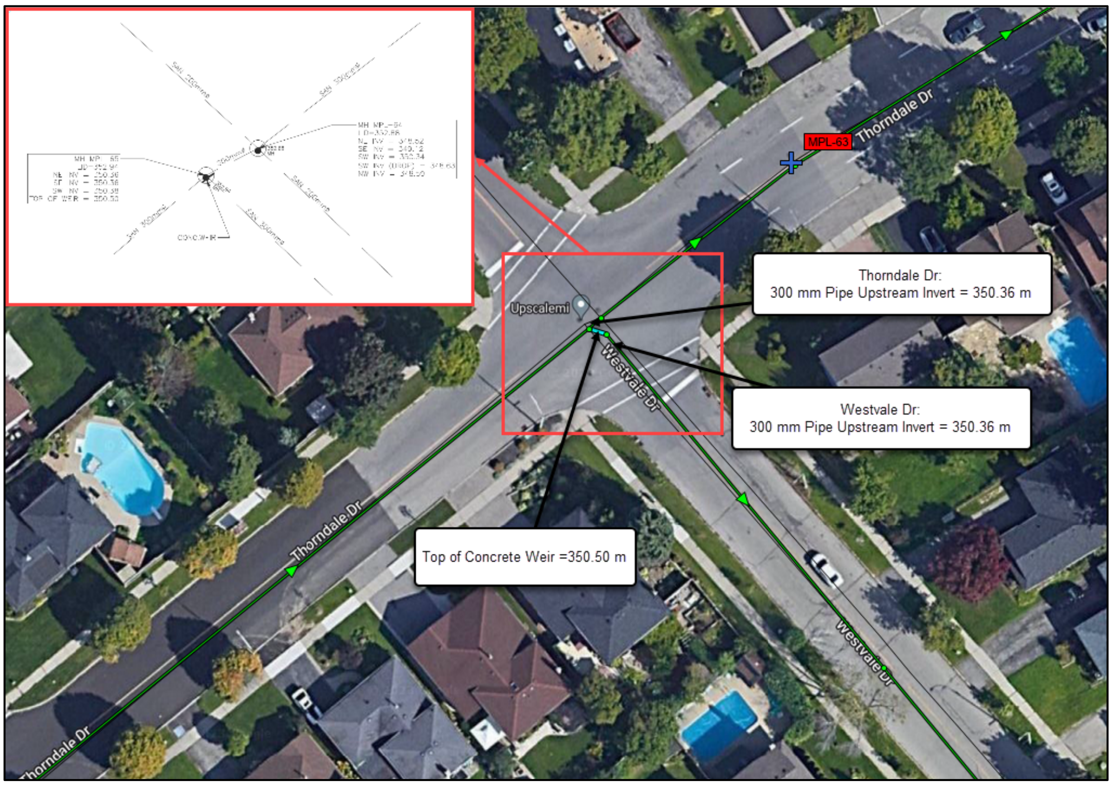


Figure 5-2: Weir at MH MPL-63

The flow per capita rates for the combined and sanitary metershed are between 18 L/c/d and 204 L/c/d, with an average of 115 L/c/d. The per capita rates are lower than the design rate used for new infrastructure (350 L/c/d), which is expected as design rates are considered conservative. The lowest per capita rate is observed in metershed MPL-63, for the same reason mentioned for the low GWI rates. Lower per capita rates (< 100 L/c/d) are observed in metersheds FWL-13, LEE-55, and U7-45. The incremental consumption rate for FWL-13 is also low (< 100 L/c/d), therefore the incremental sewage rate for this metershed is considered representative. Moreover, LEE-55 is downstream of the Frobisher SPS and even if the inflow at the pump station is low, the head on the pump curve results in a high instantaneous peak flow observed in the model downstream of the forcemains. Thus, to compensate for the high peak flow upstream of LEE-55, the metershed requires lower rates to fit the flow monitor observed values. It is recommended to verify the Frobisher PS operation and pump curve. Furthermore, the metershed of U7-45 is small, with low observed flow data, therefore the per capita is low.

5.2.3.1 Calibration Fits

Table 5-3 and **Table 5-4** present the calibration fits for DWF Period 1 (May 7th - 15th, 2021) and DWF Period 2 (August 3rd - 9th, 2022), respectively. DWF Period 1 have higher peak flow, due to increased flows observed as a result of seasonal variability, the fits for this period are generally low, as expected. The peak flow and volume percent fits are colour-coded based on the following:

Peak flow:

- Green: falls within the targeted range of -10% to +10%;
- Yellow: falls within -10% to -15% or +10% to +15%; and,
- Red: less than -15% or greater than +15%.

Volume:

- Green: falls within the targeted range of -10% to +10%;
- Yellow: falls within -10% to -15% or +10% and +15%; and,
- Red: less than -15% and greater than +15%.

Refer to **Appendix D** for the corresponding DWF calibration and validation graphs.

Table 5-3: Dry Weather Recalibration Results for Period 1 (May) – Peak Flow & Volume

FM Name	Link ID	Calibration Notes	Monitored Peak Flow (L/s)	Modelled Peak Flow (L/s)	Peak Flow Percent Fit	Monitored Volume (m^3)	Modelled Volume (m^3)	Volume Percent Fit
C29-8	12101.1	Reasonable / Noisy	12.8	6.1	-52.2%	3,114	2,986	-4.1%
FWL-13	9205.1	Reasonable / Noisy	230.6	169.4	-26.5%	68,143	67,522	-0.9%
FWL-34	10068.1	Conservative	36.1	42.8	18.4%	13,751	17,498	27.2%
LEE-55	11773.1	Impact of U/S SPS	24.9	12.3	-50.5%	3,738	3,399	-9.1%
LWD-5	9343.1	Reasonable	74.5	77.1	3.5%	30,413	31,347	3.1%
U7-45	8492.1	Noisy	1.9	0.9	-53.2%	193	325	68.7%
UNI-5	10099124.1	Reasonable / Noisy	69.6	54.4	-21.8%	28,080	27,886	-0.7%
MPL-63	11895.1	Uncertainties	3.1	2.3	-25.5%	713	712	-0.2%
Parshall Flume	PS_WWTP.1	Reasonable	869.0	647.7	-25.5%	292,568	333,900	14.1%

Table 5-4: Dry Weather Recalibration Results for Period 2 (August) – Peak Flow & Volume

FM Name	Link ID	Calibration Notes	Monitored Peak Flow (L/s)	Modelled Peak Flow (L/s)	Peak Flow Percent Fit	Monitored Volume (m^3)	Modelled Volume (m^3)	Volume Percent Fit
C29-8	12101.1	Reasonable	9.4	8.2	-13.0%	3,038	2,830	-6.8%
FWL-13	9205.1	Reasonable	184.2	170.1	-7.6%	49,695	63,567	28.3%
FWL-34	10068.1	Conservative	41.4	42.8	3.3%	12,724	16,506	29.8%
LEE-55	11773.1	Impact of U/S SPS	22.3	12.1	-45.6%	3,047	3,180	4.4%
LWD-5	9343.1	Reasonable	79.7	77.1	-3.3%	30,389	29,385	-3.3%
U7-45	8492.1	Noisy	2.3	1.4	-40.3%	246	310	25.9%
UNI-5	10099124.1	Reasonable / Noisy	74.3	54.5	-26.6%	26,630	26,185	-1.6%
MPL-63	11895.1	Uncertainties	5.4	2.6	-51.2%	1,140	681	177.5%
Parshall Flume	PS_WWTP.1	Reasonable	910.0	683.9	-24.9%	246,750	308,900	25.2%

While the overall calibration is reasonable at many flow monitors, some locations have peak flow and/or volume fits that fall outside of the desired ranges, as per **Table 5-3** and **Table 5-4**. Along with the data quality and calibration challenges described in **Sections 3.2** and **5.2.2**, key observations regarding the monitored data that help to explain these complexities are described below:

- There is noise observed in the monitored data during DWF conditions for many of the meters. This can often be attributed to the low flows observed and corresponding measurement inaccuracies that can occur in these conditions. In some cases, this noise can also be due to nearby pumping station influence. This noise results in several instantaneous elevated readings for many of these metered locations. In order to generate the diurnal patterns for calibration, the hourly flows are averaged, essentially smoothing out the flow pattern and reducing the noise generated in the modelled response. If the observed peak flow is adjusted to account for removal of this noise, the observed and modelled peak flows are closer than Table 5-3 and Table 5-5 suggest, and generally fall within the targeted fits. These adjustments, however, are not included in the tables presented above and therefore, the majority of peak flows are reported as outside of the targets. An example of this noise can be seen in Figure 5-3 for FM LEE-55 (DWF Period 1), where the smoothed simulated results essentially average the highs and lows of the observed flow fluctuations. In this example, the volumetric calibration fit is good, and the peak flow fit falls below the targeted range.

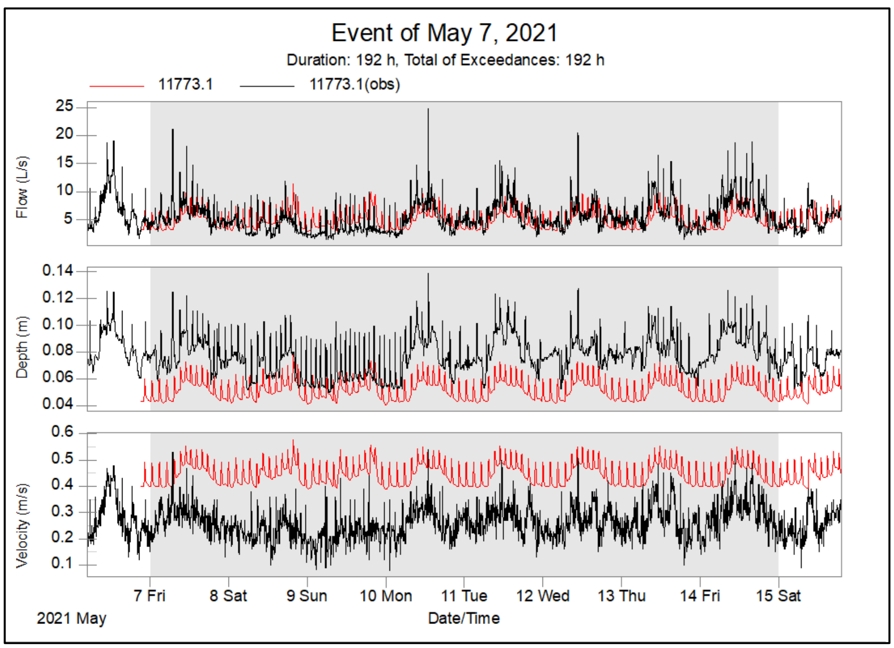


Figure 5-3: DWF Period 1 LEE-55 Modelled vs Observed Results

- As many of these meters see low-magnitude DWFs (<50 L/s), even a small discrepancy of only 5 L/s or less between the modelled and observed flows can result in calibration fits that fall outside of the targeted range, which is a contributing factor to the low peak flow calibration fits observed, but is not a significant difference at the master planning metershed parameter scale;

- The differences in the volumetric percent fit can sometimes be attributed to variations in the diurnal pattern over the flow monitoring period. Only one diurnal flow pattern is generated per meter and represents the average pattern observed over the monitoring period, excluding any questionable days. This may result in a slightly better fit in one period than the other. Diurnal pattern variations could be attributed to impacts observed with the start of the school year.

The overall DWF calibration fits are illustrated in **Figure 5-4** (peak flow) and **Figure 5-5** (volume). As depicted, the fits for most monitors tend to straddle the 1:1 line, resulting in generally reasonable fits throughout.

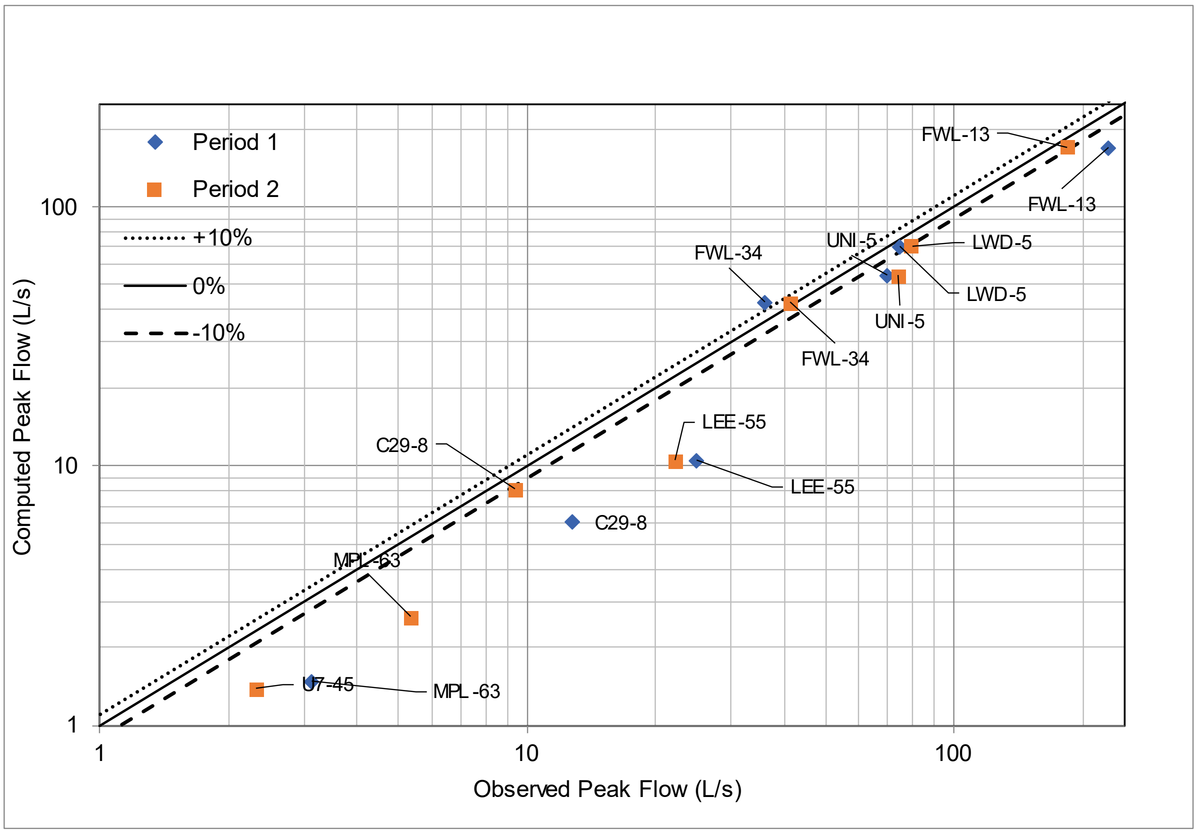


Figure 5-4: Dry Weather Calibration Results – Peak Flow

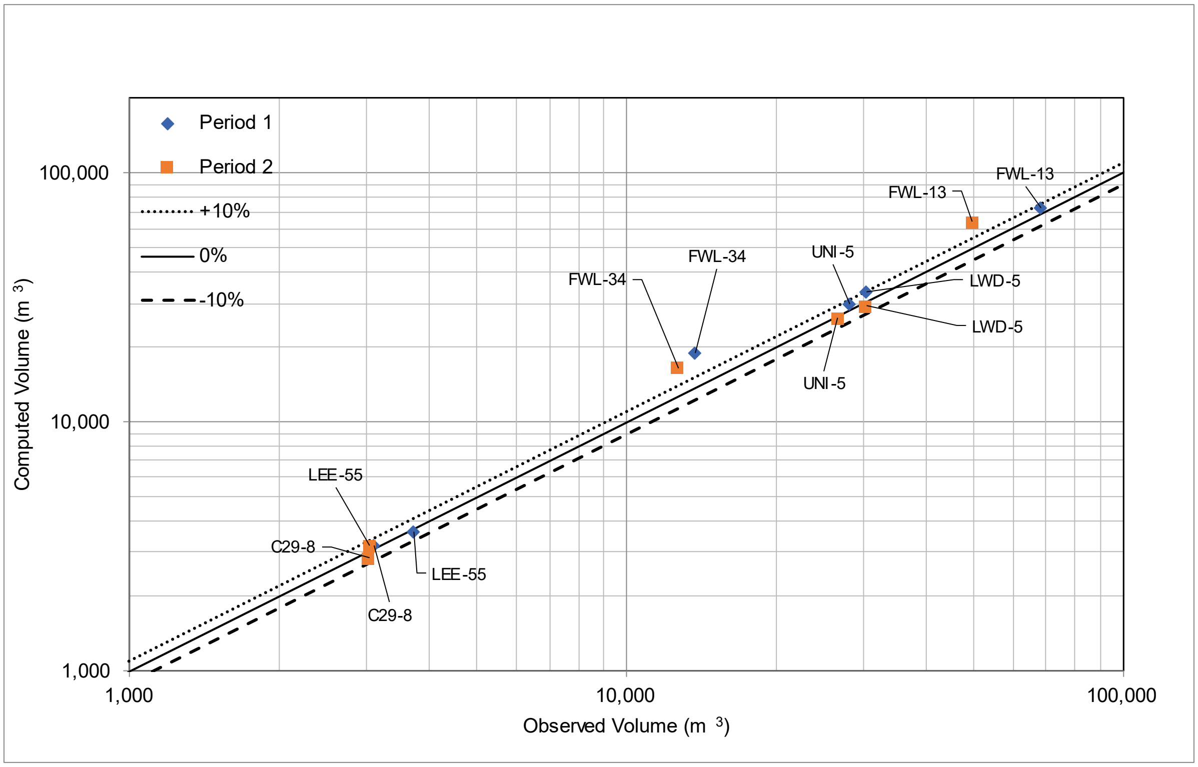


Figure 5-5: Dry Weather Calibration Results – Volume

5.3 WET WEATHER RECALIBRATION

5.3.1 Approach

The WWF event-based recalibration was carried out for the two (2) selected events, discussed in **Section 4.5**. WWF Event 3 was considered the largest event as it consisted of the greatest amount of rainfall observed over one of the longest event durations, thus the event is only used as validation. Ideally, one set of WWF calibration parameters would produce perfect fits in all events, but this is not likely due to the variance in rain, as well as other model limitations. Therefore, peak WWF is prioritized across as many monitors as possible to inform the conveyance-based capacity recommendations of the Master Plan update.

Upstream monitors were calibrated first, with the process systematically working downstream. This iterative process continued, with due consideration given to the flow data quality and model assumptions and uncertainties, until a reasonable representation of the various captured storm events was achieved.

The modelled flow rates, volumes, and depths are compared to the observed values from the corresponding rainfall event to determine the calibration fits. The hydrographs should closely follow each other both in shape and in magnitude, until the flow has substantially returned to DWF conditions. In addition to the shape, the observed and modelled hydrographs are targeted to meet the following criteria for the majority of the events considered:

- The timing of the peaks and valleys should be similar for the duration of the event;
- The peak flow rates at each significant peak should be in the range of -15% to +25%;
- The volume of flow should be within -10% to +20%;
- The surcharge depths should be in the range of -0.1 m to +0.5 m; and,
- Where data of high confidence is available, the non-surcharged depths at key points should be within the range ±0.1 m.

5.3.2 Recalibration Challenges and Assumptions

Beyond the targets mentioned in **Section 5.3.1**, several other factors should be considered during the WWF recalibration process:

- The 2021 flow monitors provide limited monitor coverage; however, the previously calibrated data was used in the other areas. Therefore, the recalibration focus was on areas of changes or previous I/I problems;
- The presence of surcharging makes recalibration more difficult. It is crucial that the correct diameters, slopes, and materials are being applied in the model to be able to replicate the same backflow conditions at the same time as the monitored data. This is not unique to the pipe where the flow monitor is located, but also the pipes upstream and downstream which may be contributing to the surcharged conditions;
- The recalibration focuses on matching peak flow. When an event has a long duration, it can consist of multiple rainfall peaks. This presents an opportunity for volume discrepancies due to attempting to meet the largest peak flow values and over or under-estimating smaller peaks observed earlier or later in the event;
- As discussed in **Section 5.3.1**, WWF Event 1 & 2 are selected as the primary recalibration events, due to the severe surcharging experienced throughout the system in the WWF Event 3 (100-year event). Event 3 is instead used as validation; and,
- In select circumstances where the data is identified as variable or questionable during the primary event (WWF Event 1 & 2), recalibration is completed focusing on WWF Event 3;
- As mentioned, the City Hall rain gauge (RG2) is missing rainfall data, making it a challenge to assess the overall rain gauge variability over the City.

5.3.3 Results

The final RTK parameters for the WWF recalibration are presented in **Table 5-5** and **Table 5-6** presents the RTK parameters from the 2014 Master Plan model. The final Total R distribution is shown per modelled metershed in **Figure 5-6**.

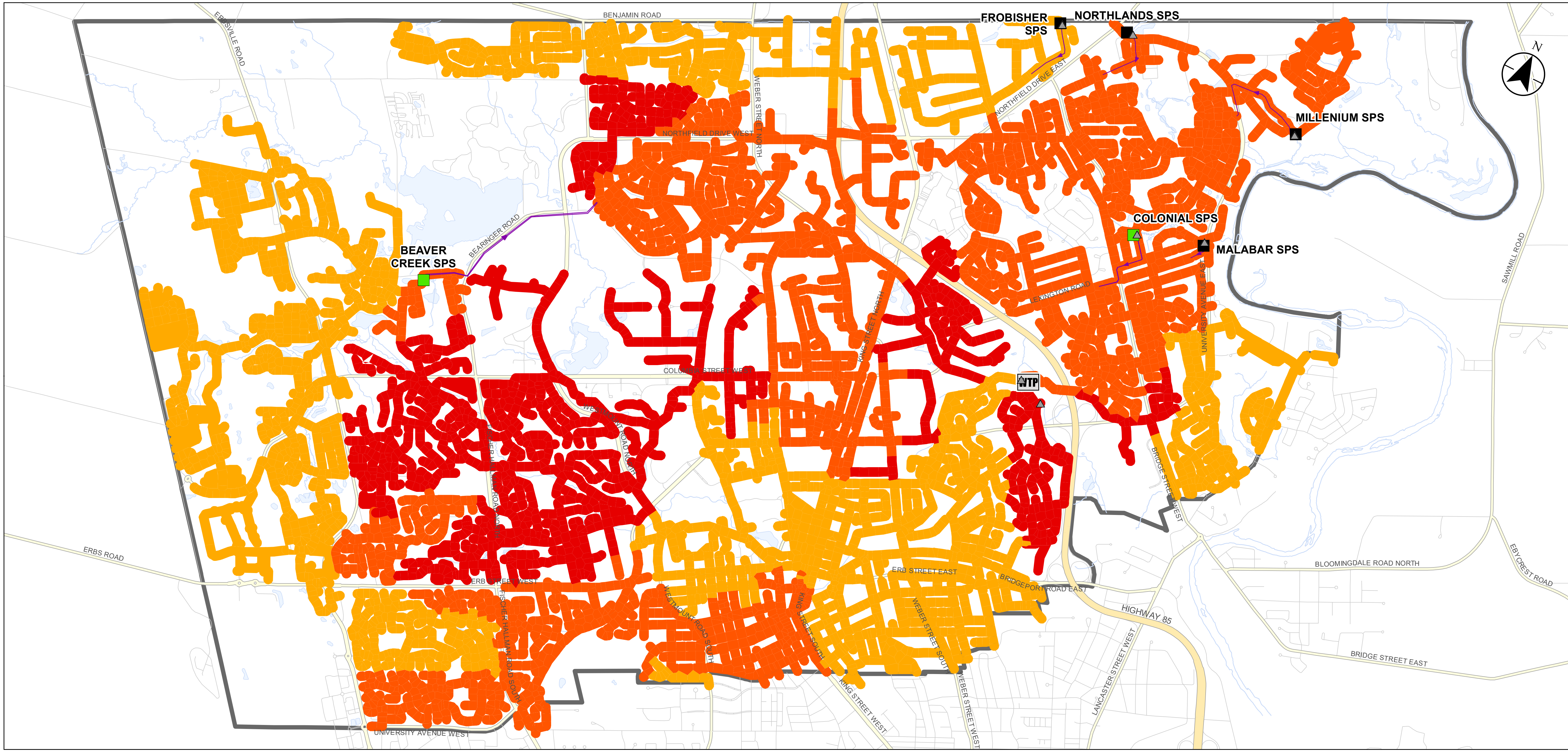
Table 5-5: Final Wet Weather RTK Calibration Parameters

Flow Monitor	Total R	R1	T1	K1	R2	T2	K2	R3	T3	K3
C29-8	3.90%	0.009	0.5	1.0	0.020	1.0	5.0	0.010	5.0	7.0
FWL-13	2.30%	0.010	0.5	2.0	0.010	3.0	5.0	0.003	5.0	7.0
FWL-34	0.60%	0.002	0.5	1.0	0.002	2.0	4.0	0.002	5.0	10.0
LEE-55	0.90%	0.005	0.5	1.0	0.003	1.0	3.0	0.001	3.0	7.0
LWD-5	0.50%	0.002	0.5	1.0	0.002	2.0	3.0	0.001	5.0	7.0
U7-45	5.60%	0.030	0.4	1.0	0.025	1.0	1.0	0.001	5.0	3.0
UNI-5	2.80%	0.013	0.5	0.5	0.010	1.0	3.0	0.005	3.0	5.0
MPL-63	1.10%	0.005	0.6	1.0	0.004	2.0	3.0	0.002	7.0	3.0

Table 5-6: Wet Weather Flow Parameters for 2014 MP Parameters

2014 MP Metershed	Total R	R1	T1	K1	R2	T2	K2	R3	T3	K3
FWL-4A	3.10%	0.025	0.2	28.0	0.005	12.0	5.0	0.001	24.0	4.0
GLN-4	5.00%	0.020	0.2	35.0	0.020	10.0	10.0	0.010	24.0	4.0
KEA-30	1.26%	0.001	0.2	33.0	0.005	20.5	20.0	0.007	24.0	4.0
LEE-9	3.00%	0.010	0.3	38.0	0.010	7.0	6.0	0.010	24.0	4.0
LEX-8A	5.00%	0.020	0.2	35.0	0.020	10.0	10.0	0.010	24.0	4.0
LRL-19	0.37%	0.003	0.2	46.4	0.000	22.8	4.6	0.001	24.0	4.0
LRL-56	3.70%	0.012	0.2	30.0	0.018	12.0	10.0	0.007	24.0	4.0
UNI-4	5.10%	0.030	0.3	20.0	0.020	12.0	5.0	0.001	24.0	5.0
WLM-1B	1.50%	0.009	0.2	20.0	0.005	12.0	6.0	0.001	24.0	4.0
Unmntrd_MPL-63	2.60%	0.020	0.3	24.0	0.005	12.0	5.0	0.001	24.0	4.0

The total R's, for the calibrated metershed presented in **Table 5-5** range from 0.5% to 5.6%, with an overall average of 2.2%. Generally, the lower Total R values are established in smaller metersheds with newer developments (pipe ages 1980 +), which in theory results in less infiltration to the piping network and likely employs newer design guidelines that prevent roof and foundation drain connections to sanitary sewers. The highest total R values were established in metersheds C29-8, FWL-13, U7-45 and UNI-5, where the system is noted to have generally older pipes (1960 – 1980) with a greater possibility of having legacy roof and foundation connections to the sanitary system. The City also mentioned that the areas with higher R values are the areas with known Sump Pumps. Overall, the total R increases as you move towards the center of the City where it generally aligns with the older, downtown areas.



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain

Total R Value

- 0.0 % - 1.1 %
- 1.1 % - 3.0 %
- 3.0 % - 5.6 %

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

Stantec

Project Location 165640363 REVA
City of Waterloo Prepared by HB on 2023-07-24

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
5-6

Title
Total R Per Sewershed

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

V:\01656\active\165640363\preliminary\analysis\gis\mxd\TN2-3\WaterlooSANMP_TN2-3_Fig5-7_TotalR.mxd Revised: 2023-07-24 By: kebuchanan

5.3.3.1 Calibration Fits

Table 5-7 and **Table 5-8** show the resulting calibration fits between the modelled and monitored data for WWF Event 1 (June 29th, 2021) and WWF Event 2 (August 29th, 2021), respectively. **Table 5-9** show the resulting validation fits between the modelled and monitored data for WWF Event 3 (September 21st, 2021). These calibration and validation fits are colour-coded based on the following:

- Peak flow:
  - **Green**: if it falls within the targeted range of -15% to +25%;
  - **Yellow:** if it falls within -25% to -15% or +25% to +35%; and,
  - **Red**: if it is less than -25% or greater than +35%.
- Volume:
  - **Green**: if it falls within the targeted range of -10% to +20%;
  - **Yellow**: if it falls within -20% to -10% or +20% and +30%; and,
  - **Red**: when it is less than -20% and greater than 30%.

Table 5-7: 2021 Wet Weather Recalibration Results for Event 1

FM ID	Link ID	Calibration Notes	Monitored Peak Flow (L/s)	Modelled Peak Flow (L/s)	Peak Flow Percent Fit	Monitored Volume (m^3)	Modelled Volume (m^3)	Volume Percent Fit
C29-8	12101.1	Reasonable	35.5	32.4	-8.9%	1,153	1,182	2.6%
FWL-13	9205.1	Reasonable	250.4	264.3	5.6%	16,734	20,763	24.1%
FWL-34	10068.1	Straddle between Events	46.5	40.4	-13.0%	3,960	4,942	24.8%
LEE-55	11773.1	Straddle between Events	33.3	21.6	-35.0%	1,242	1,069	-13.9%
LWD-5	9343.1	Reasonable	96.4	77.2	-19.9%	9,491	8,624	-9.1%
U7-45	8492.1	Poor Quality Observed Data	-	7.5	-	-	138	-
UNI-5	10099124.1	Reasonable	92.6	112.6	21.6%	7,674	8,059	5.0%
MPL-63	11895.1	Uncertainties	15.2	14.3	-6.2%	258	342	33.0%
Parshall Flume	PS_WWTP.1	Straddle between Events	933.3	996.4	6.8%	83,026	100,333	20.8%

Table 5-8: 2021 Wet Weather Recalibration Results for Event 2

FM ID	Link ID	Calibration Notes	Monitored Peak Flow (L/s)	Modelled Peak Flow (L/s)	Peak Flow Percent Fit	Monitored Volume (m^3)	Modelled Volume (m^3)	Volume Percent Fit
C29-8	12101.1	Poor Quality Observed Data	-	93.2	-	-	1,521	-
FWL-13	9205.1	Reasonable	653.9	654.3	0.1%	15,861	19,731	24.4%
FWL-34	10068.1	Straddle between Events	75.1	84.7	12.8%	2,889	3,864	33.7%
LEE-55	11773.1	Straddle between Events	31.6	84.9	168.4%	481	1,093	126.9%
LWD-5	9343.1	Reasonable	149.5	179.1	19.8%	7,130	7,116	-0.2%
U7-45	8492.1	Noisy	26.0	26.5	2.2%	235	196	-16.6%
UNI-5	10099124.1	Reasonable	304.5	285.1	-6.4%	7,527	6,978	-7.3%
MPL-63	11895.1	Poor Quality Observed Data	-	51.0	-	-	512	-
Parshall Flume	PS_WWTP.1	Straddle between Events	2977.8	1778.6	-40.3%	72,525	91,900	26.7%

Table 5-9: 2021 Wet Weather Validation Results for Event 3

FM ID	Link ID	Validation Notes	Monitored Peak Flow (L/s)	Modelled Peak Flow (L/s)	Peak Flow Percent Fit	Monitored Volume (m^3)	Modelled Volume (m^3)	Volume Percent Fit
C29-8	12101.1	Backwater in Observed Data	166.8	66.1	-60.4%	9,397	3,954	-57.9%
FWL-13	9205.1	Backwater in Observed Data	1106.5	413.8	-62.6%	66,776	49,094	-26.5%
FWL-34	10068.1	Straddle between Events	100.8	55.7	-44.8%	12,397	10,470	-15.5%
LEE-55	11773.1	Straddle between Events	25.9	30.6	18.0%	2,761	2,476	-10.3%
LWD-5	9343.1	Straddle between Events	198.5	127.5	-35.8%	27,926	18,687	-33.1%
U7-45	8492.1	Noisy	10.9	13.5	23.7%	635	470	-26.0%
UNI-5	10099124.1	Straddle between Events	258.2	173.2	-32.9%	30,110	18,308	-39.2%
MPL-63	11895.1	Poor Quality Observed Data	-	26.7	-	-	1,262	-
Parshall Flume	PS_WWTP.1	Straddle between Events	3846.8	1689.4	-56.1%	303,136	243,239	-19.8%

The WWF recalibration fits are affected by the DWF fits and therefore, the key observations regarding the monitored data mentioned in **Section 5.2.3** are observed in WWF calibration.

WWF Event 3 is challenging to match due to surcharge pipes and backwater, resulting in fits that generally fall outside of the targeted range for this event. As noted, this event is used predominantly for validation. WWF Event 1 and Event 2 are therefore the focus of calibration, with the resulting fits generally straddling the targeted ranges for these events.

Key observations regarding the monitored data that help to explain where the calibration fits fall outside of the targeted ranges are described herein:

- Generally, WWF Event 3 validation fits are higher than the WWF Event 1 and 2 calibration fits, which typically fall within the targeted ranges. This is due to WWF Event 3 being the largest event, as WWF Event 1 and Event 2 are smaller events in volume and duration compared to this event. Due to the volume of rainfall observed prior to the peak rain during WWF Event 3, the ground is likely saturated before the largest peak rain occurs, which results in a more instantaneous response to the rain in the latter half of the event. This same saturation is likely not present during the smaller, shorter WWF events;

- Flow monitor LEE-55 peak flow are straddling between events. In the observed data, the flow observed during the smallest event (Event 1) is higher than the flow observed during the two bigger events (Event 2 & 3). In the model, the RTK is applied for the entire calibration period, hence the response in the model is proportional to the rainfall. Therefore, the peak flow fits are low for Event 1 and high for Event 2, as shown in **Figure 5-7**. This difference could be due to the upstream Frobisher SPS; therefore it is recommended to confirm the flow at the pumping station.

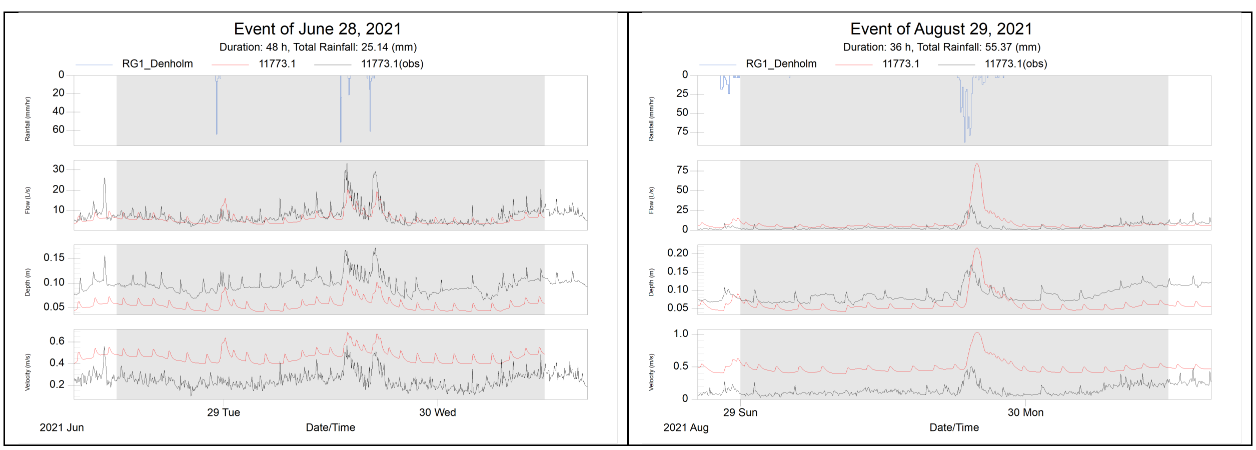


Figure 5-7: Modelled vs. Observed Flow at LEE-55 (Event 1 & 2)

Overall, the WWF calibration is reasonable, with the peak flow observed at the Parshall Flume straddling between events. The WWF calibration fits graphs are shown in **Figure 5-8** (peak flow) and **Figure 5-9** (volume). As depicted, the fits for most monitors tend to straddle the 1:1 line, resulting in generally reasonable fits throughout bearing in mind the challenges described above.

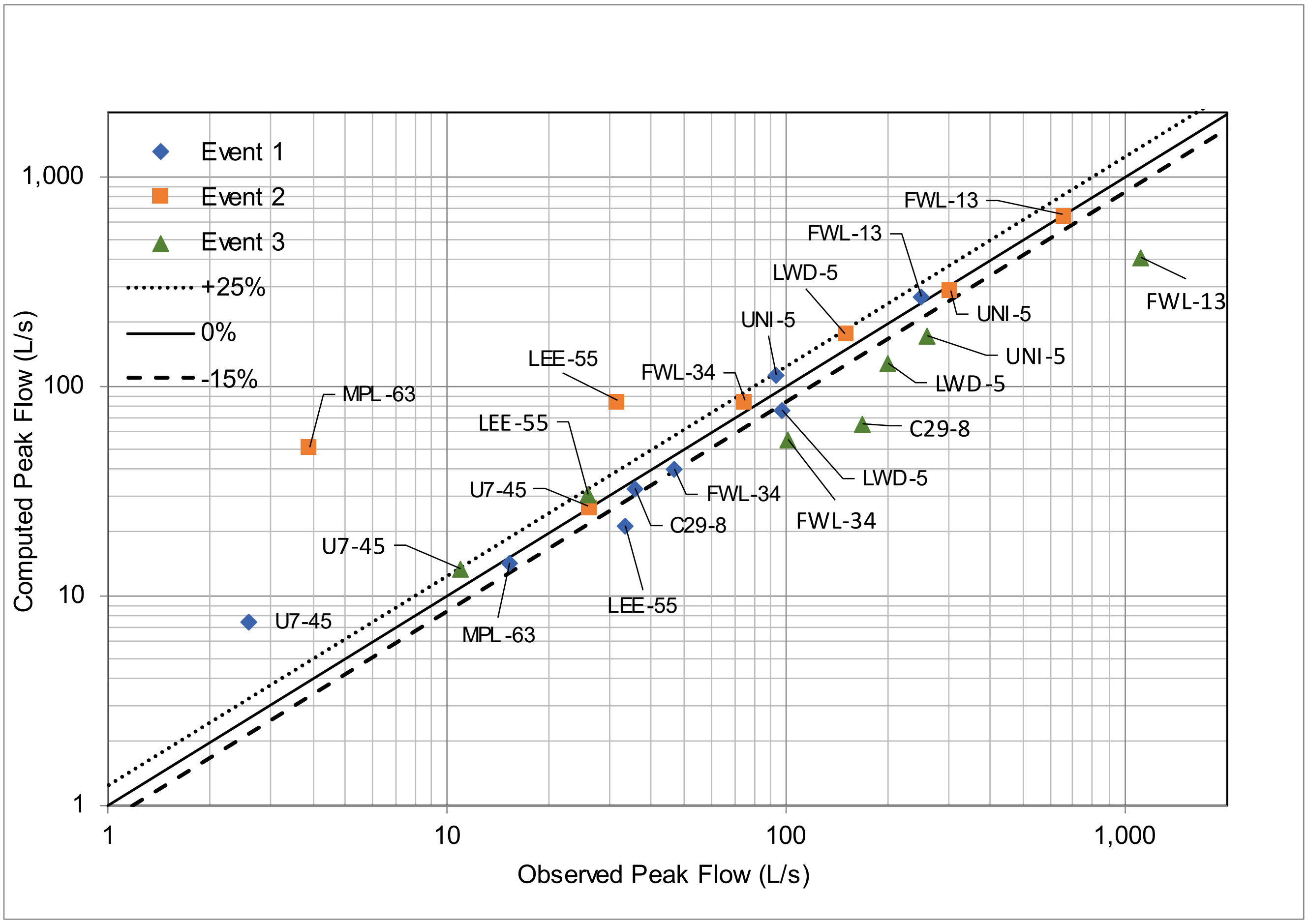


Figure 5-8: Wet Weather Calibration Results – Peak Flow

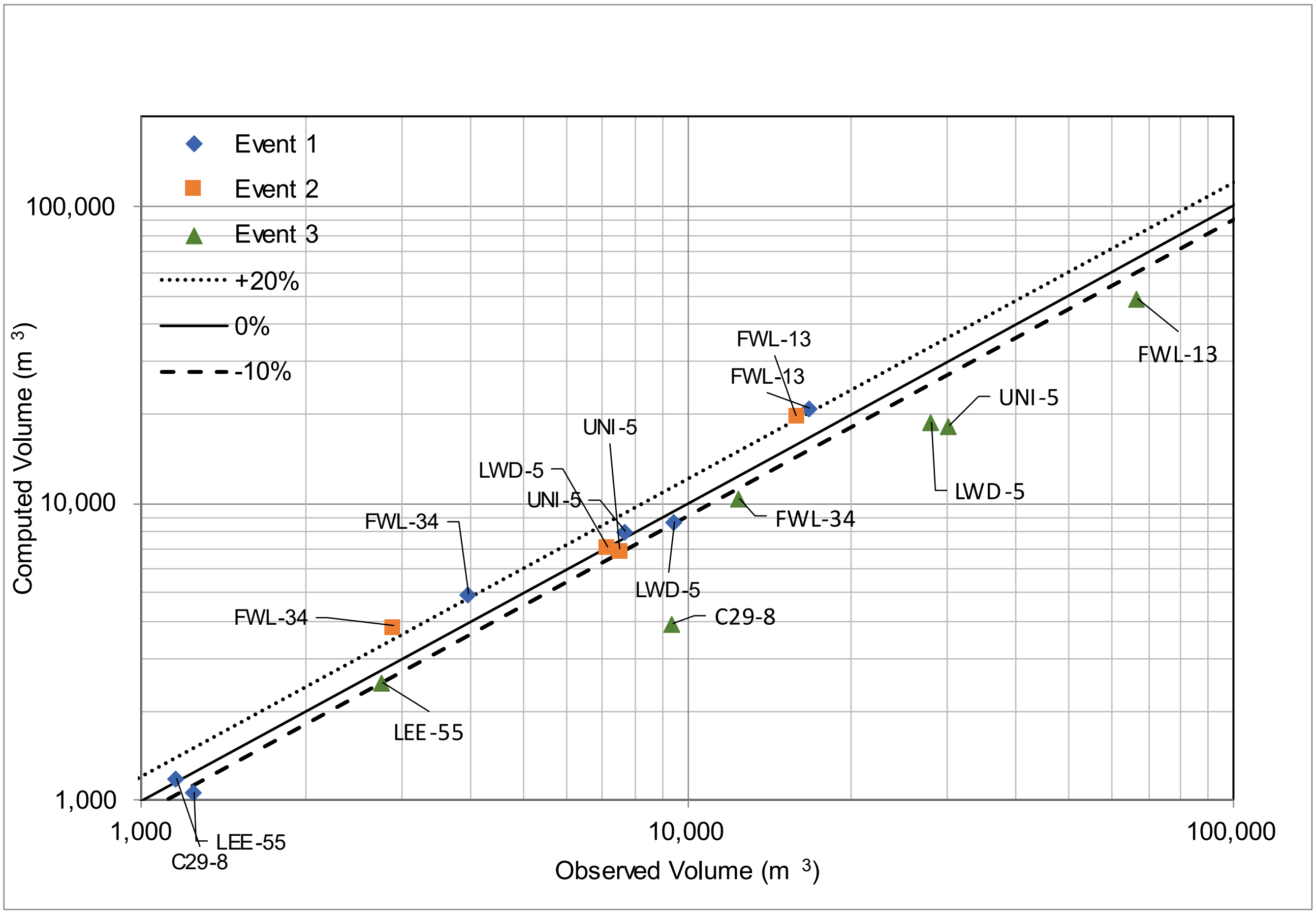


Figure 5-9: Wet Weather Calibration Results – Volume

5.4 MODEL LIMITATIONS

Notwithstanding the recalibration challenges and assumptions discussion in the preceding sections, the model development is within the normal application of large-scale planning studies and therefore all subsequent results should be interpreted according to this level of detail currently available. The following describes limitations within the model in reference to the recalibration:

- Uncertainty in the boundary conditions can impact the recalibration. The boundary conditions applied generally represent the maximum discharge rates agreed to in the Cross-Border Agreements. This could produce higher modelled results than what was observed in the dry or wet weather flow period in question. Subsequently, the DWF parameters may have required additional reductions to account for the conservative boundary conditions applied. In the cases where no value was assigned to the inflow and thus, the inflows were not accounted for in the model, it is possible that the DWF parameters were artificially increased to account for missing inflow;

- The residential diurnal pattern typically has an early-morning and early-evening peak with a slight late-morning dip and late-night/early-morning drop. This pattern corresponds with the sleep and work schedule of the majority of the general population. However, this may vary in the flow monitoring completed between 2020 - 2022, as effects from the COVID-19 pandemic and working-from-home initiatives may be evident. Existing conditions populations may not account for recent and continual changes in residential and ICI-based habits due to the pandemic. The diurnal pattern could also vary from the start of the flow monitoring period (January) to the end (December) due to a potential response from the student population returning to school;

- The effects of the DWF recalibration are carried forward into WWF recalibration. Though the magnitude is minimal in comparison to heavy rainfall events, when the DWF recalibration did not fall within the targeted fit, it is possible that poor fits carry over or influence the results of WWF recalibration;

- A variation of event magnitudes were captured in the 2021 flow monitoring period. While the WWF Event 3 in September provided context regarding the system's surcharge during a long event (49.2 hours), the complexity of the response led to its use for only validation. Future model updates and recalibration are recommended to continually improve the model's ability to predict system response and operation;

- Though the model was updated with recent infrastructure (2014 or newer), it is possible that previous network upgrades have not been included. Additionally, it is also possible that the record drawings do not perfectly match the real site conditions, and thus do not completely capture the site hydraulics. Adjustments in pipe inverts and sizes were needed to resolve Engineering Validation errors deemed critical for recalibration, as presented in TN1. The model adjustments and the remaining issues should be investigated, to further improve the representativeness of the model for future model updates and calibration efforts; and,

- Sediment may be present in the pipes, which is not represented in the model. This can result in discrepancies between the modelled and observed depths but is often temporary in nature due to flushing programs and large WWF events potentially dislodging debris and build-up. Providing frequent sewer flushing programs for City sewers can help to reduce sediment and its impact to flow conditions. As part of the City's monitoring programs, including documented summaries and labelled photographs of all site entries along with the overall data and field visit reporting can be beneficial information supporting the interpretation of flow monitoring data and model results.

6.0 CONCLUSIONS AND RECOMMENDATIONS

This technical note (TN#2-3) outlines the flow monitoring and hydraulic model recalibration for the Waterloo Master Plan update, including the following discussions:

- The flow monitoring data including the flow meter and rain gauge locations and related metershed characteristics (**Section 3.1 & Section** Error! Reference source not found.**C**);
- The flow metershed schematic and system connectivity (**Section** Error! Reference source not found.);
- Flow meter data availability and quality (**Section 3.2**);
- Rainfall data quality and quantity (**Section 4.2**);
- Dry weather flow recalibration periods (**Section 4.3**);
- Rain gauge and storm event summary (**Section 4.4**);
- Wet weather flow recalibration events (**Section 4.5**);
- Applicable boundary conditions and their potential affects in recalibration (**Section** Error! Reference source not found.);
- Dry weather recalibration approach, challenges, and results (**Section 5.2**); and,
- Wet weather recalibration approach, challenges, and results (**Section 5.3**).

In general, the following main considerations result from the foregoing TN:

- Most flow monitors have valid data for the flow monitoring period of interest. It should be noted that U7-45, C29-8 and MPL-63 have poor quality data for some part of the recalibration period;
- The Denholm rain gauge have good quality data and no major gaps. However, The City Hall rain gauge is missing rainfall data from April 3rd to June 29th 2021, and beyond August 30th 2021.
- Two periods in 2021 were selected for DWF recalibration, including May 07th to May 14th (DWF Period 1) and August 03rd to August 09th (DWF Period 2);
- Three storm events in 2021 were selected for WWF recalibration, including June 29th (WWF Event 1), August 29th (WWF Event 2), and September 21st to September 23rd (WWF Event 3). During recalibration, WWF Event 3 was subject to uncertainties due to backwater in the observed data, resulting from the long duration and antecedent moisture conditions. Therefore, Event 3 was used only for validation;

- Overall, there is a good fit for pattern and volume for both DWF periods. The modelled peak flows are generally lower than the observed, due to noise present in the monitored data. When this noise is smoothed out by averaging techniques, a much better DWF fit is achieved;
- The established GWI rates, ranging from 0.004 L/s/ha and 0.094 L/s/ha, with an average of 0.028 L/s/ha, are comparatively low in general, indicating that the dry weather infiltration into the sewer is low. The established per capita flow rates range between 18 L/c/d and 204 L/c/d, with an overall average of 115 L/c/d. These values are generally reasonable, with a few falling below 100 L/c/d in the MPL-63, FWL-13, LEE-55, and U7-45 metersheds, which may suggest uncertainties within these metersheds;
- Flow monitor MPL-63 recalibrated per capita (18 L/c/d) is lower than the 2014 Master Plan calibration at MPL-63 (110 L/c/d). Therefore, for the model assessment, a per capita of 110 L/c/d will be use for MPL-63 Metershed.
- Generally, the WWF recalibration for WWF Event 1 and 2 peak flows and volumes are reasonable with most monitors straddling the targeted fit ranges;
- During WWF Event 3, there is backwater observed at flow monitors C29-8, FWL-13 and UNI-5. The reproduction of the high level in the sewer was not achieved with the calibration, therefore the potential for additional extraneous sources to contribute to the wet weather response on Forwell trunk should be investigate, and;
- The final total R values, ranging from 0.5% to 5.6%, with an overall average of 2.2%, also suggest the system is newer in vintage and separated, with limited connections from roofs, foundation drains, and/or other instantaneous inflow sources. The highest R values are in areas with known Sump Pumps.

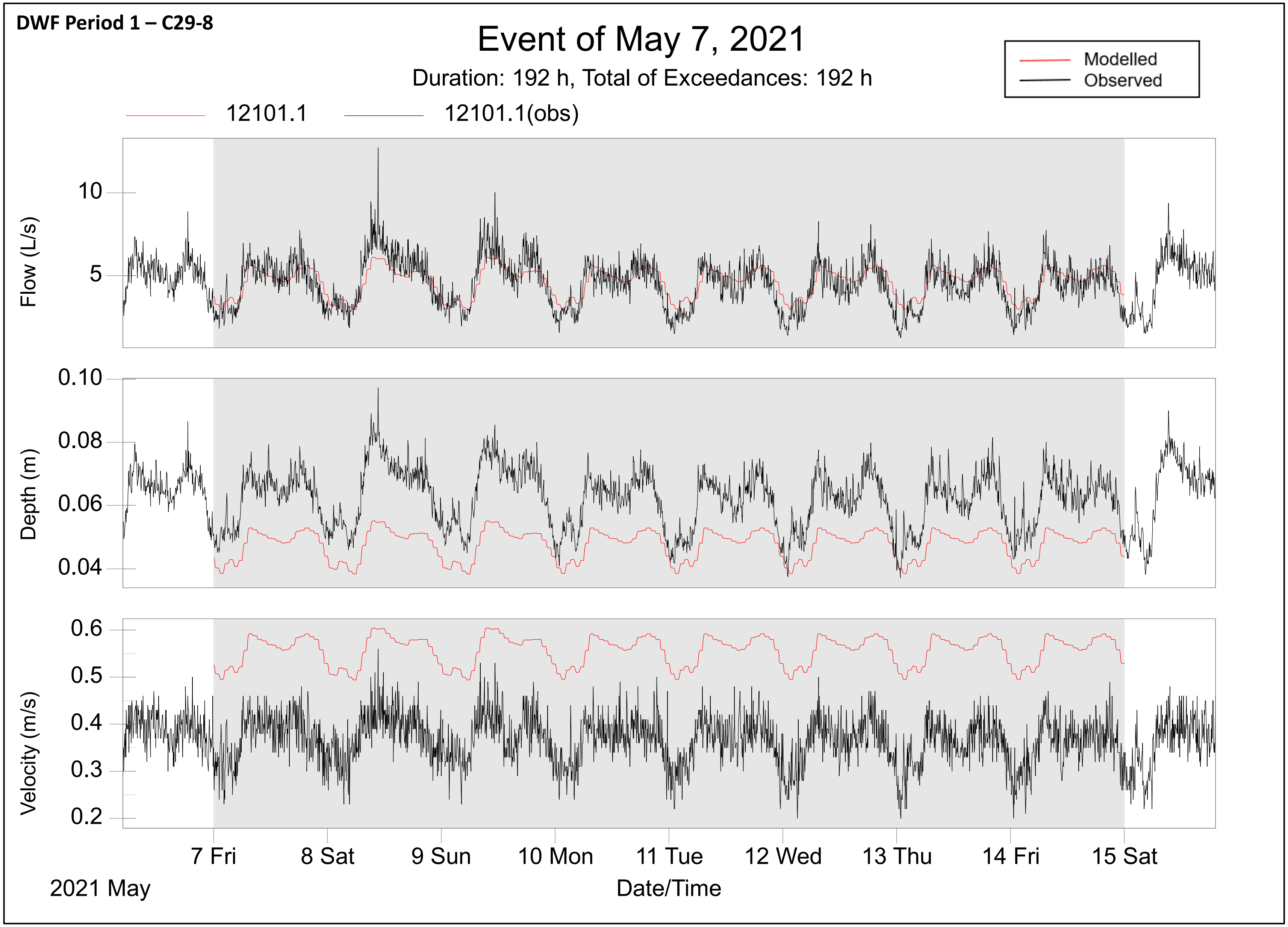
It is recommended that the model parameters derived through the 2021 recalibration be considered alongside the 2014 Master Plan parameters as suitable for use in the update of system remediation measures. Sensitivity analyses can be completed when evaluating solutions that can further improve confidence with selected capital planning recommendations. It is recommended, however, that additional information continue to be collected by the City regarding network details and required model updates, population distributions, the performance of the existing system, and the condition of all assets, to further improve the resolution of this model in the future. The remaining Engineering Validation Errors identified should also be reviewed and updated when possible, and calibration results reconfirmed.

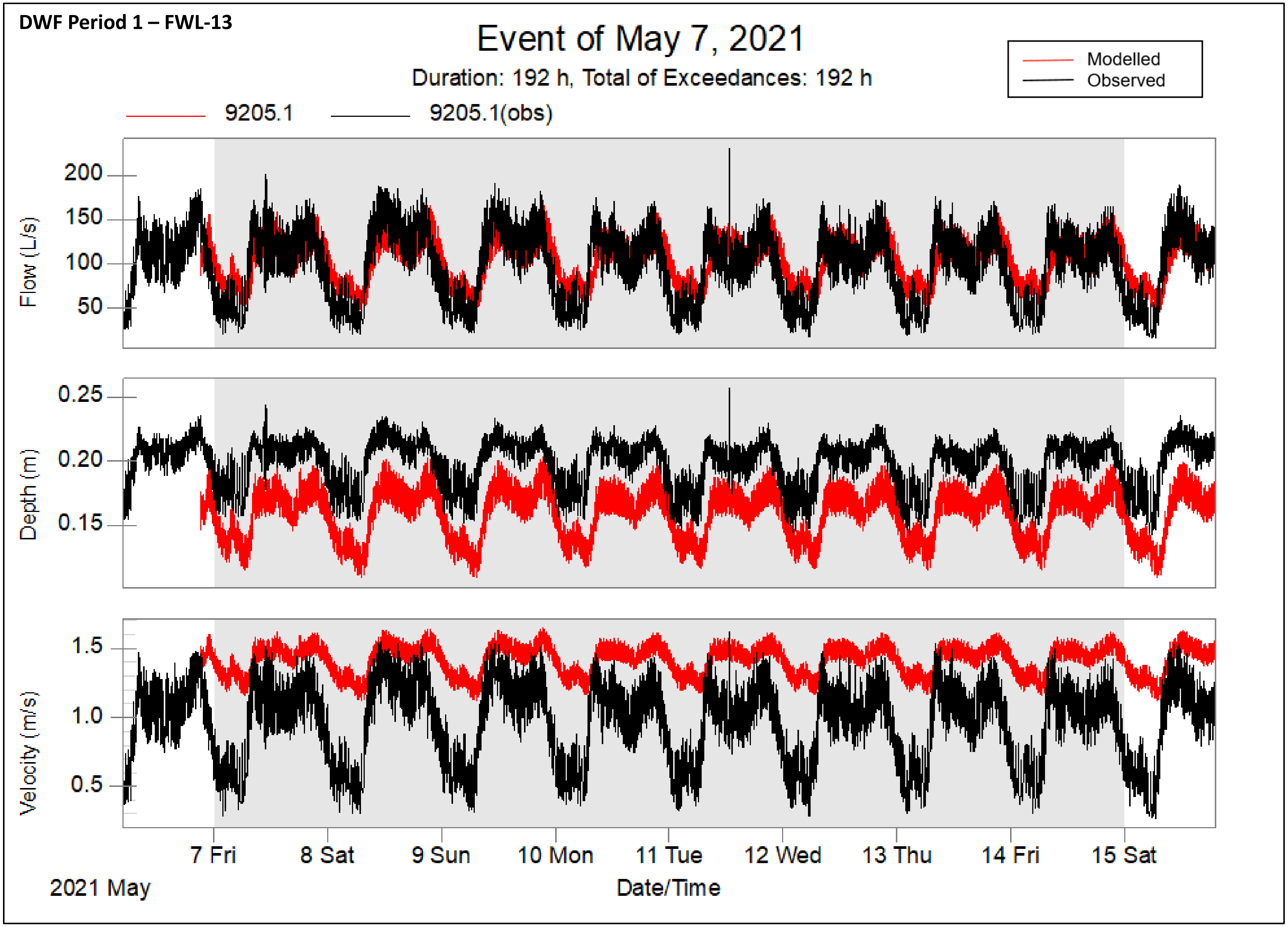
With the completion of the model calibration, remaining updates to the network can be implemented in the model to account for system upgrades that occurred after the recalibration period. Once completed, the existing conditions sanitary system performance can be assessed using design storm events. The growth scenarios can then be evaluated, incorporating future system upgrades such as the commissioning of Moore SPS, and additional growth area servicing and intensification.

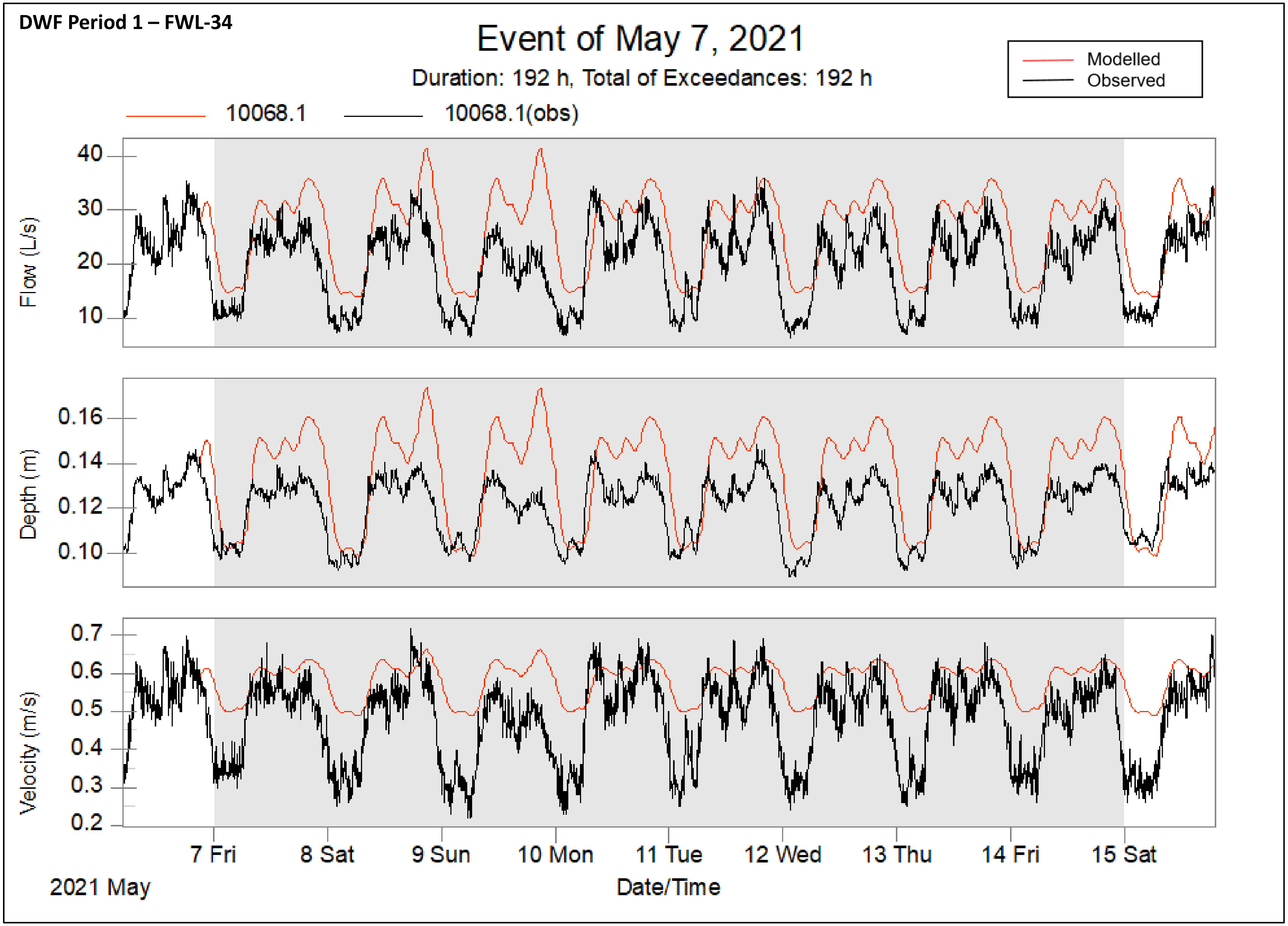
APPENDICES

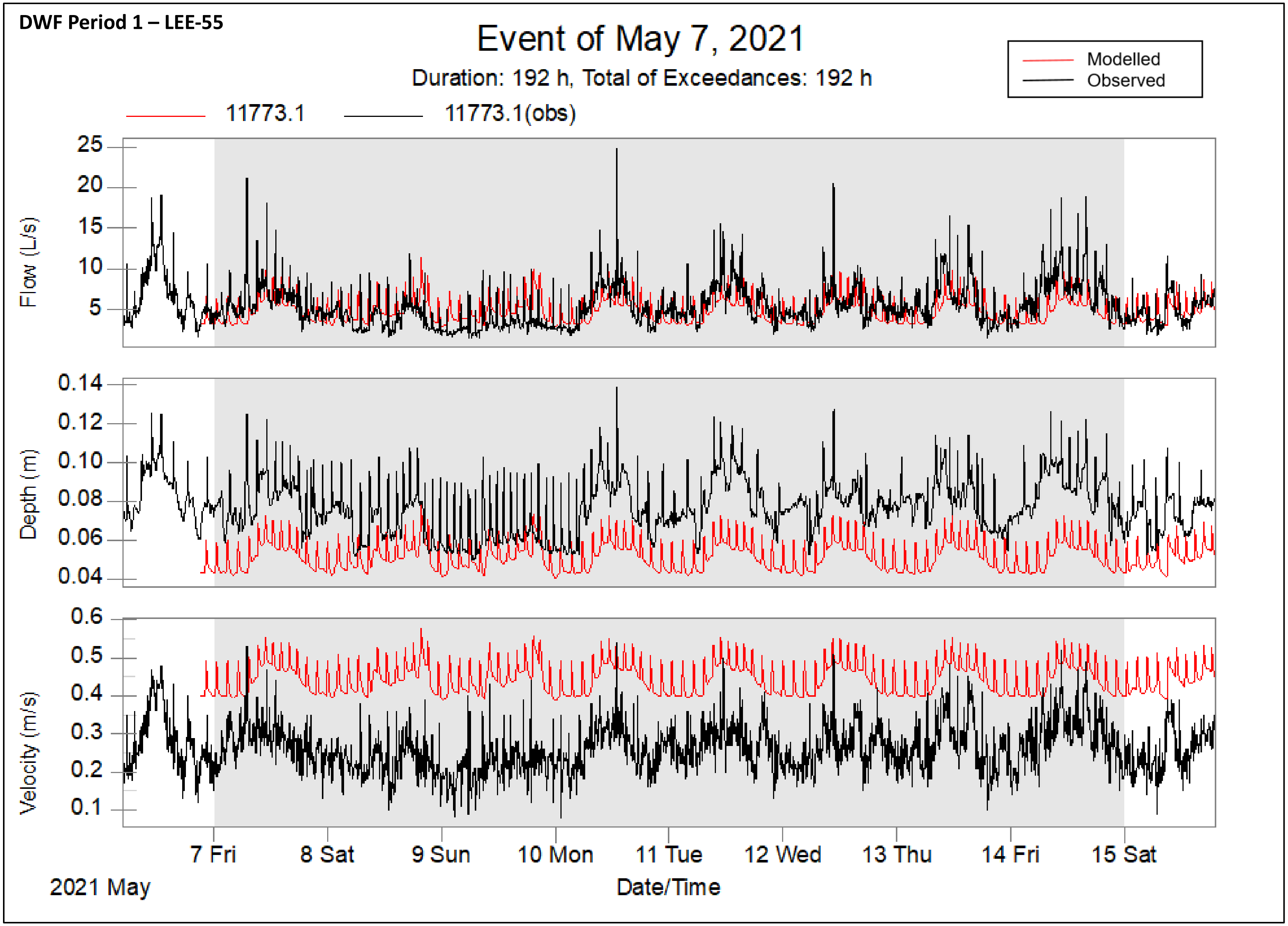
Appendix A CALIBRATION GRAPHS

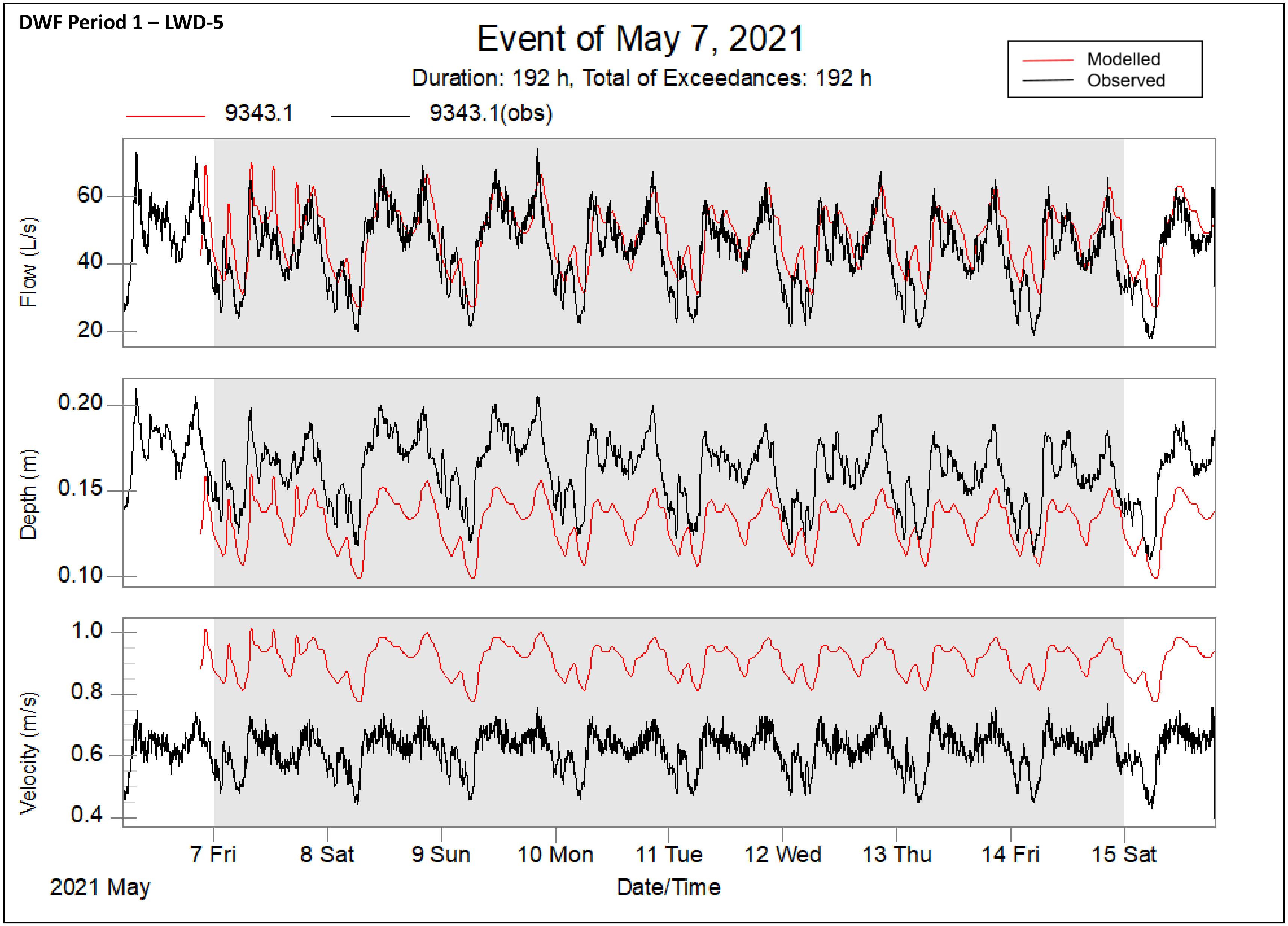
DWF PERIOD 1 – CALIBRATION GRAPHS


DWF Period 1 – C29-8
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
Modelled
Observed
12101.1
12101.1(obs)
Flow (L/s)
10
5
Depth (m)
0.10
0.08
0.06
0.04
Velocity (m/s)
0.6
0.5
0.4
0.3
0.2
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time

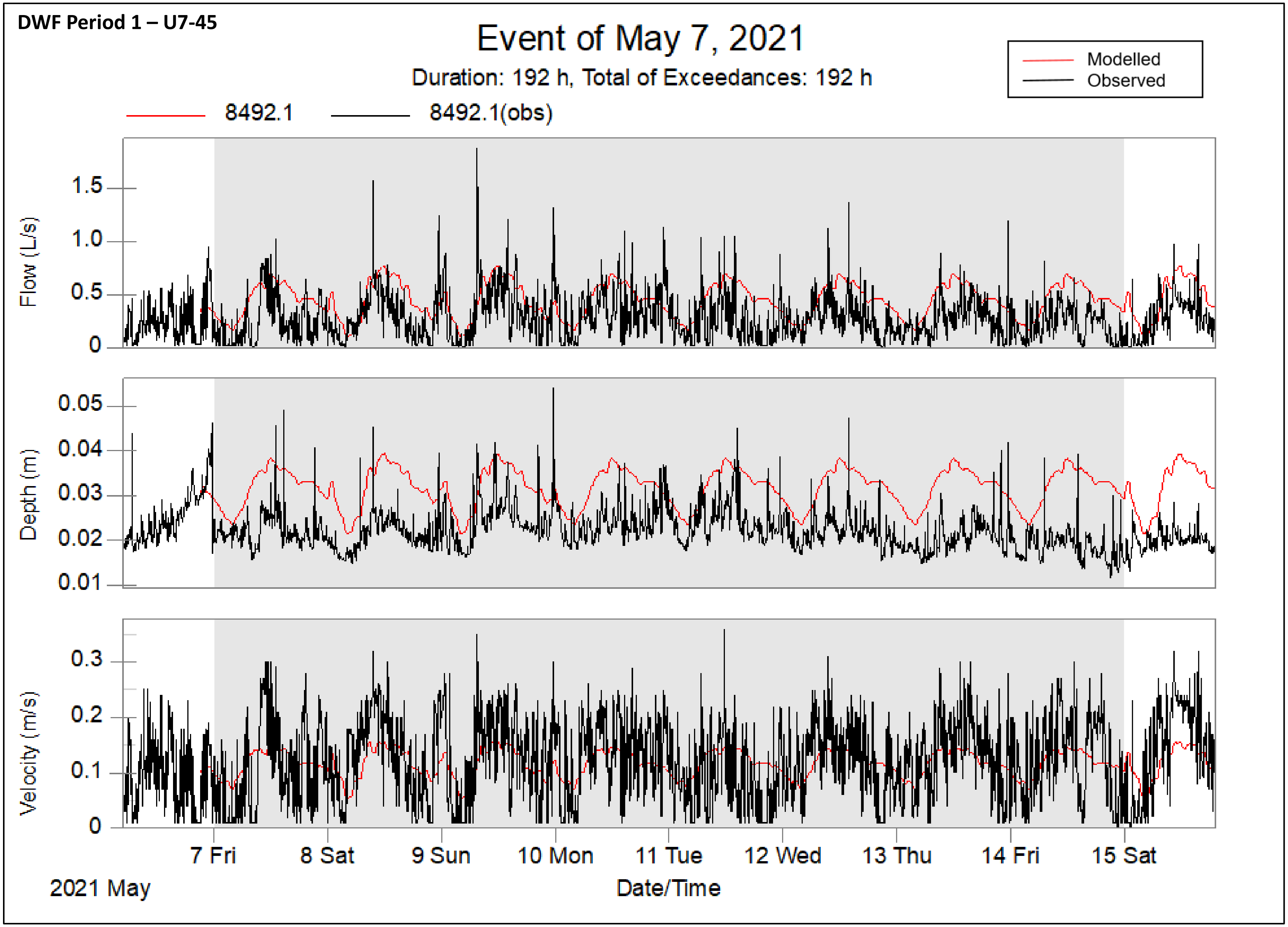

DWF Period 1 – FWL-13
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
Modelled
Observed
9205.1
9205.1(obs)
Flow (L/s)
200
150
100
50
Depth (m)
0.25
0.20
0.15
Velocity (m/s)
1.5
1.0
0.5
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time

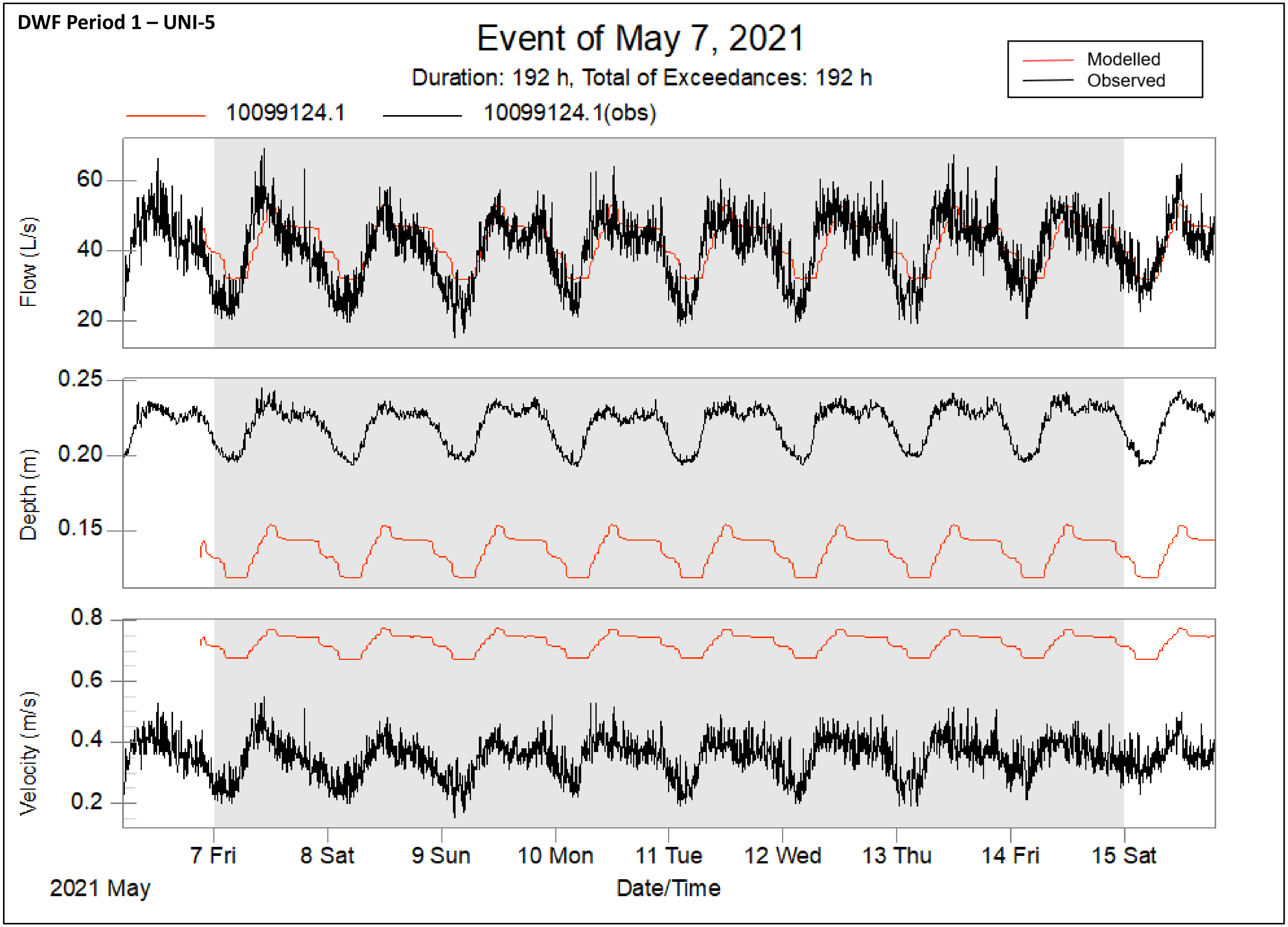

DWF Period 1 – FWL-34
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
Modelled
Observed
10068.1
10068.1(obs)
Flow (L/s)
40
30
20
10
Depth (m)
0.16
0.14
0.12
0.10
Velocity (m/s)
0.7
0.6
0.5
0.4
0.3
0.2
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time


DWF Period 1 – LEE-55
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
Modelled
Observed
11773.1
11773.1(obs)
Flow (L/s)
25
20
15
10
5
Depth (m)
0.14
0.12
0.10
0.08
0.06
0.04
Velocity (m/s)
0.6
0.5
0.4
0.3
0.2
0.1
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time

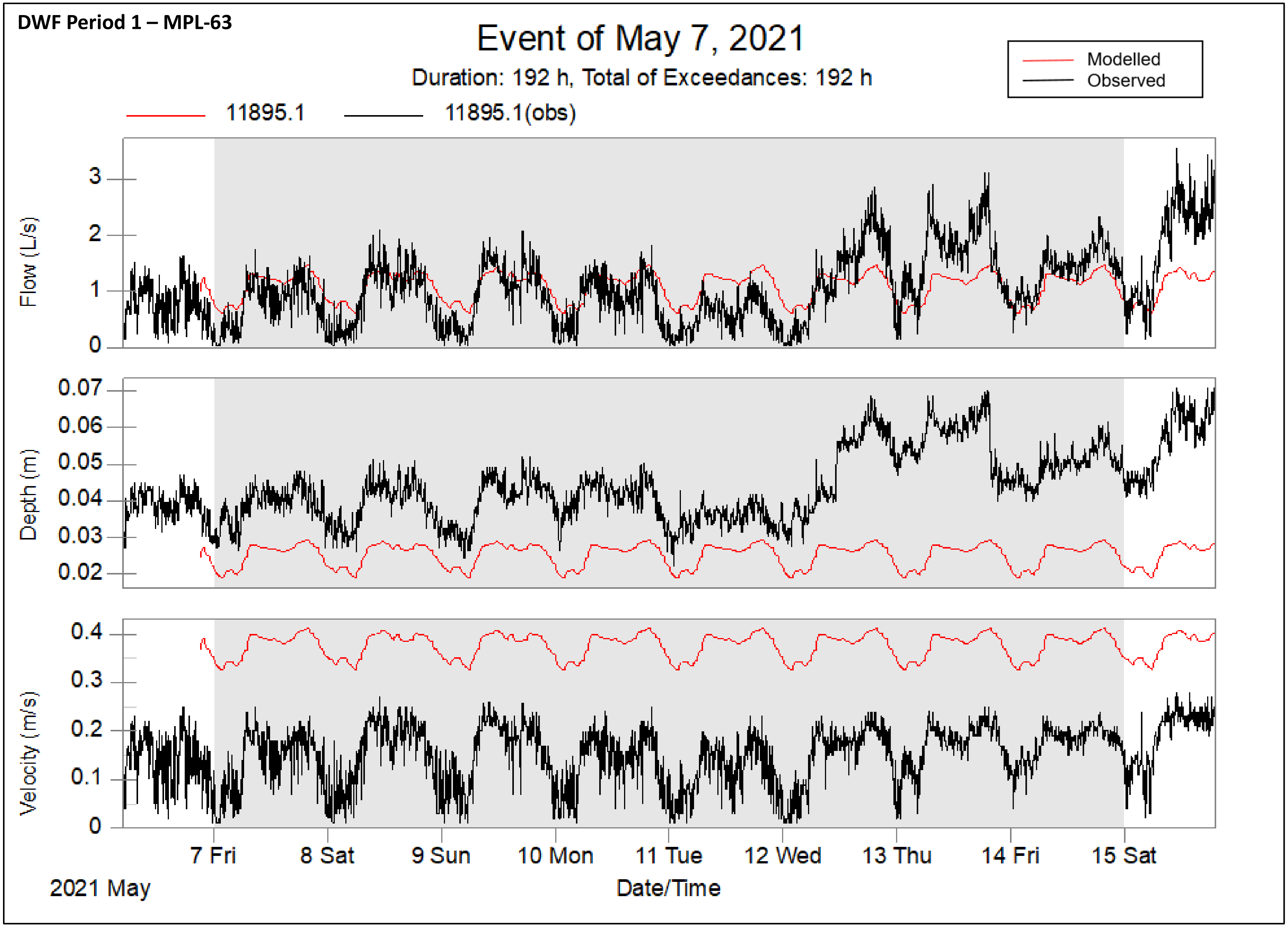


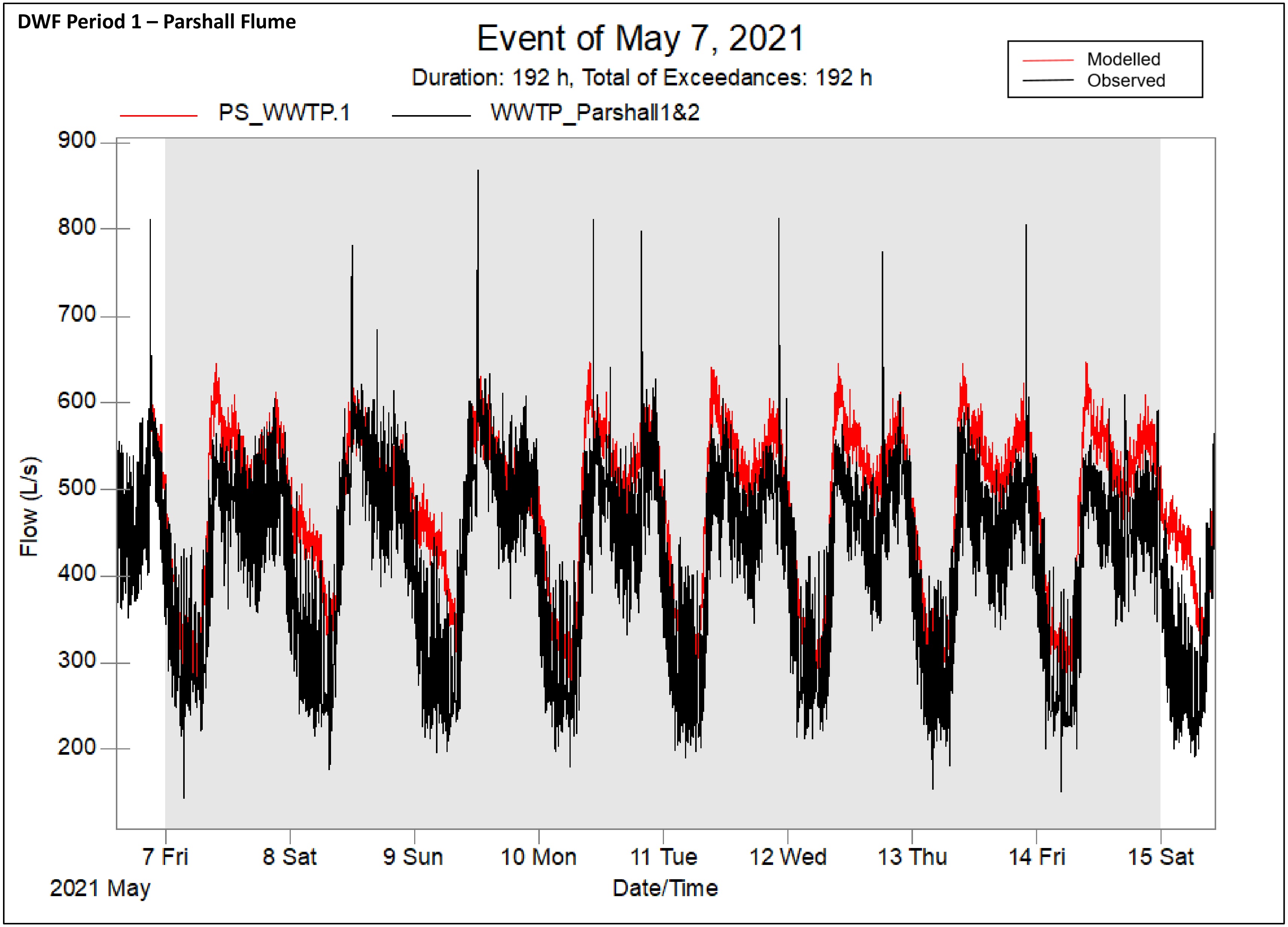
DWF Period 1 – LWD-5
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
Modelled
Observed
9343.1
9343.1(obs)
Flow (L/s)
20
40
60
Depth (m)
0.10
0.15
0.20
Velocity (m/s)
0.4
0.6
0.8
1.0
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time


DWF Period 1 – U7-45
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
Modelled
Observed
8492.1
8492.1(obs)
Flow (L/s)
1.5
1.0
0.5
0
Depth (m)
0.05
0.04
0.03
0.02
0.01
Velocity (m/s)
0.3
0.2
0.1
0
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time

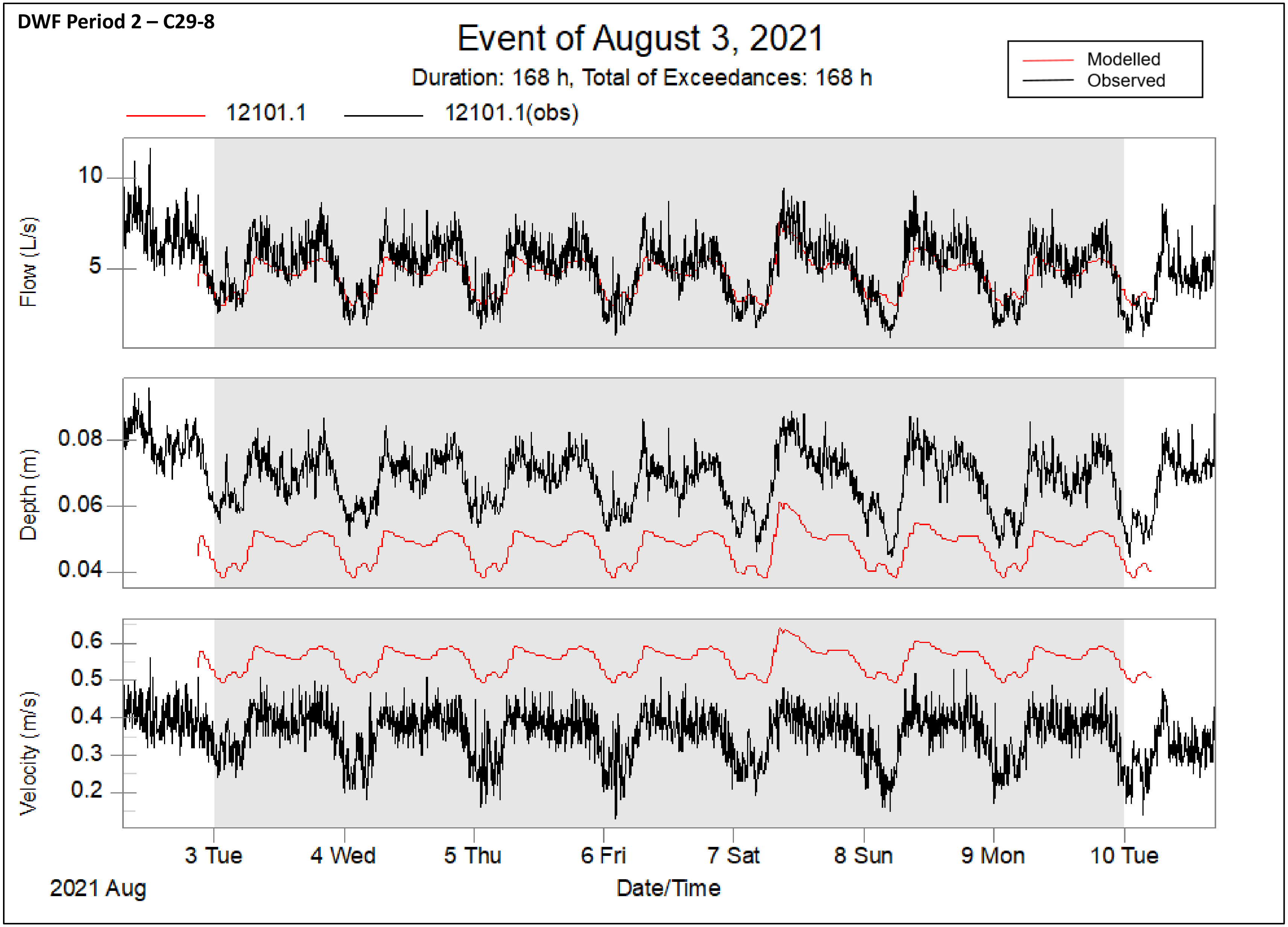


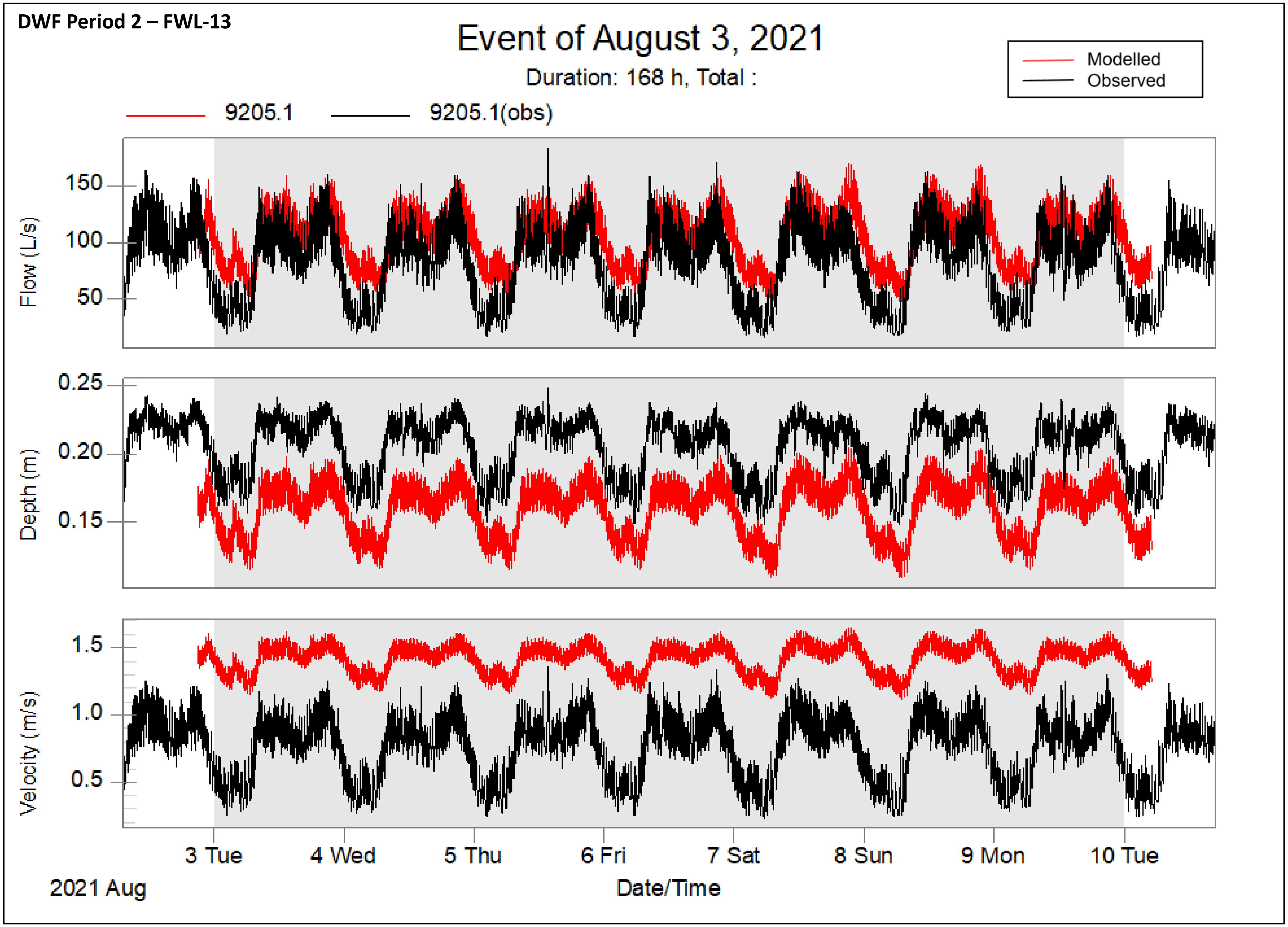
DWF Period 1 – UNI-5
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
Modelled
Observed
10099124.1
10099124.1(obs)
Flow (L/s)
60
40
20
Depth (m)
0.25
0.20
0.15
Velocity (m/s)
0.8
0.6
0.4
0.2
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time


DWF Period 1 – MPL-63
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
Modelled
Observed
11895.1
11895.1(obs)
Flow (L/s)
0
1
2
3
Depth (m)
0.02
0.03
0.04
0.05
0.06
0.07
Velocity (m/s)
0
0.1
0.2
0.3
0.4
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time

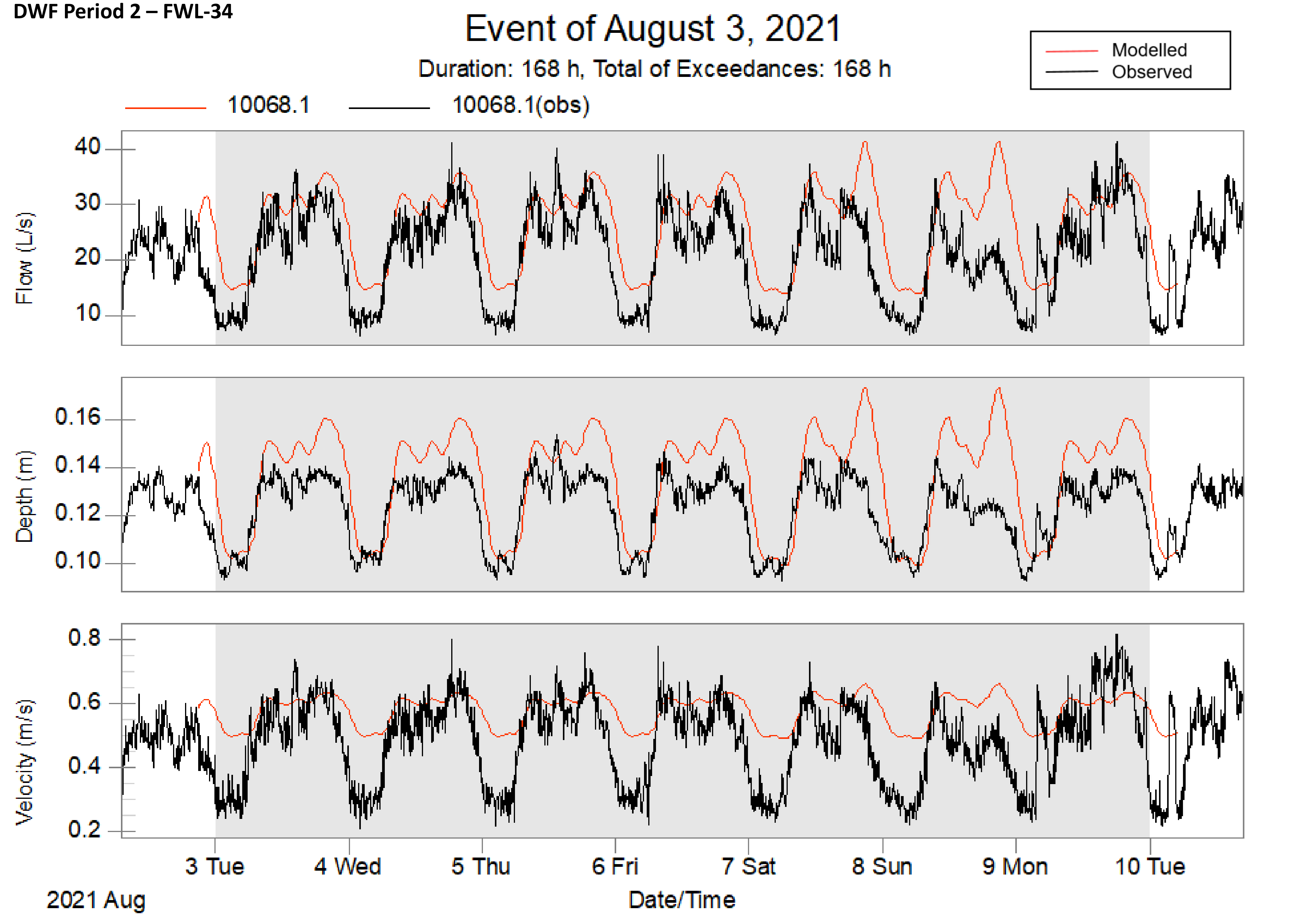

DWF Period 1 – Parshall Flume
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
Modelled
Observed
PS_WWTP.1
WWTP_Parshall1&2
900
800
700
600
500
400
300
200
Flow (L/s)
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time

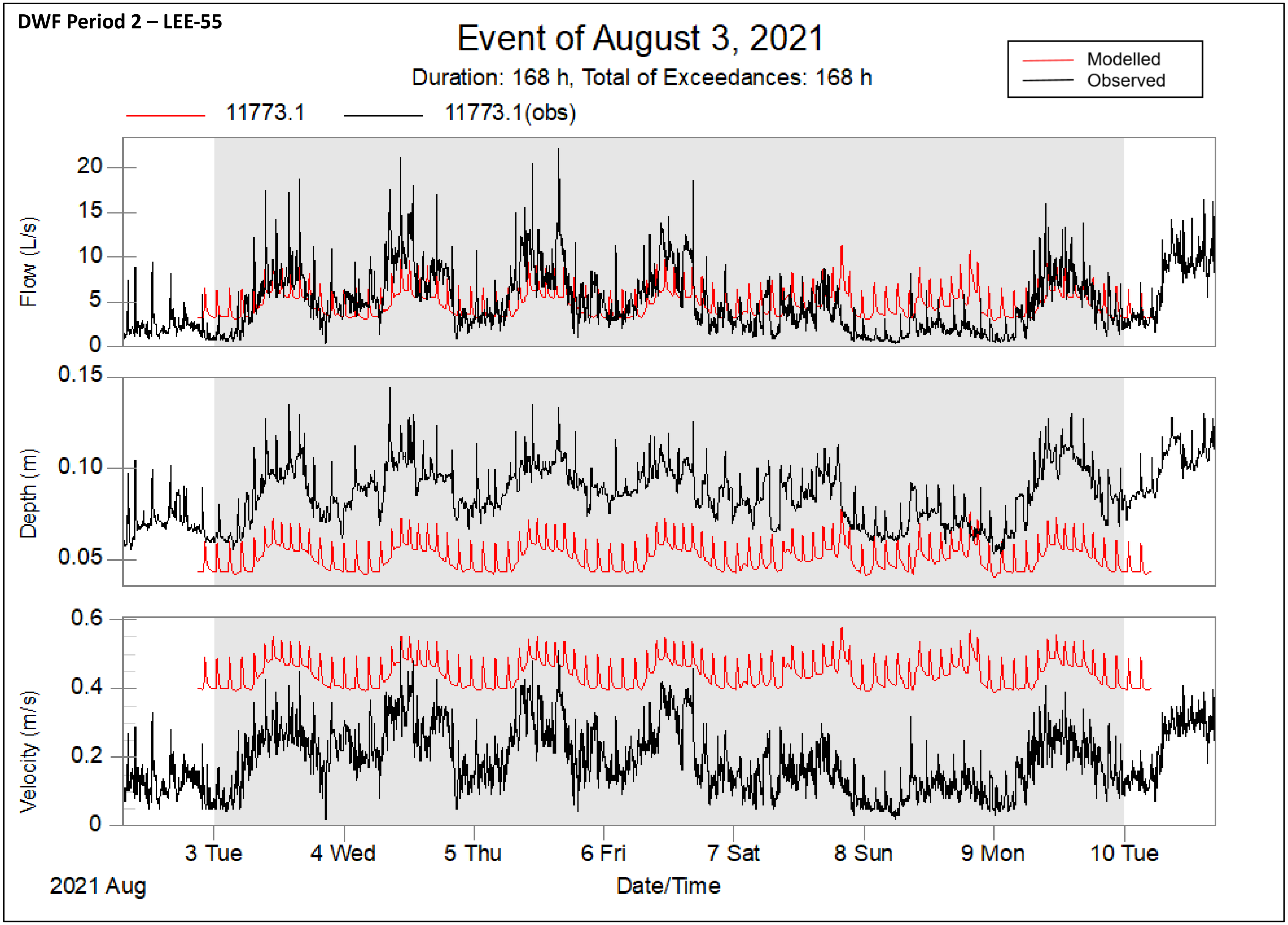
DWF PERIOD 2 – CALIBRATION GRAPHS

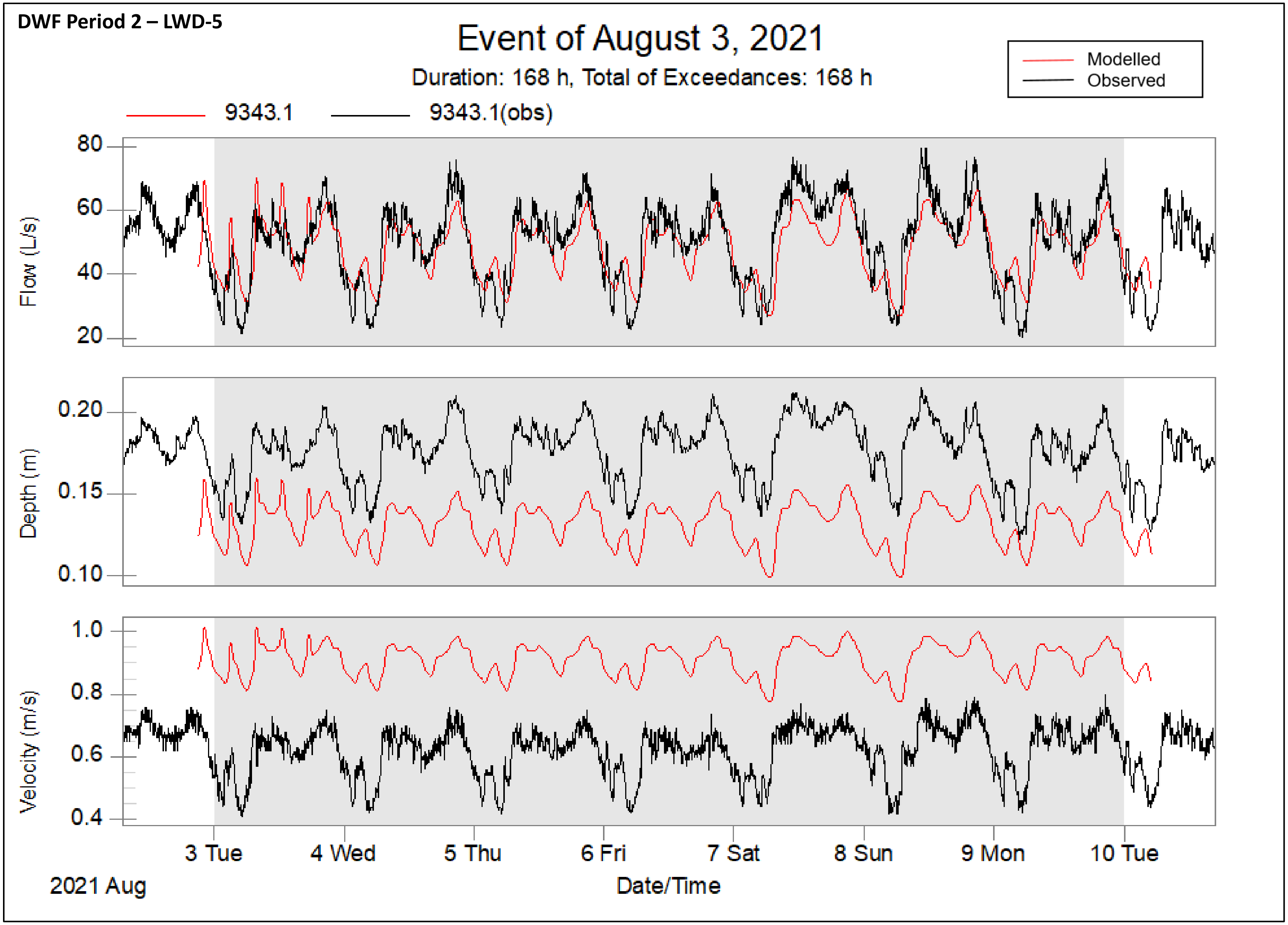

DWF Period 2 – C29-8
Event of August 3, 2021
Duration: 168 h, Total of Exceedances: 168 h
Modelled
Observed
12101.1
12101.1(obs)
Flow (L/s)
10
5
Depth (m)
0.08
0.06
0.04
Velocity (m/s)
0.6
0.5
0.4
0.3
0.2
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time


DWF Period 2 – FWL-13
Event of August 3, 2021
Duration: 168 h, Total :
Modelled
Observed
9205.1
9205.1(obs)
Flow (L/s)
150
100
50
Depth (m)
0.25
0.20
0.15
Velocity (m/s)
1.5
1.0
0.5
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time

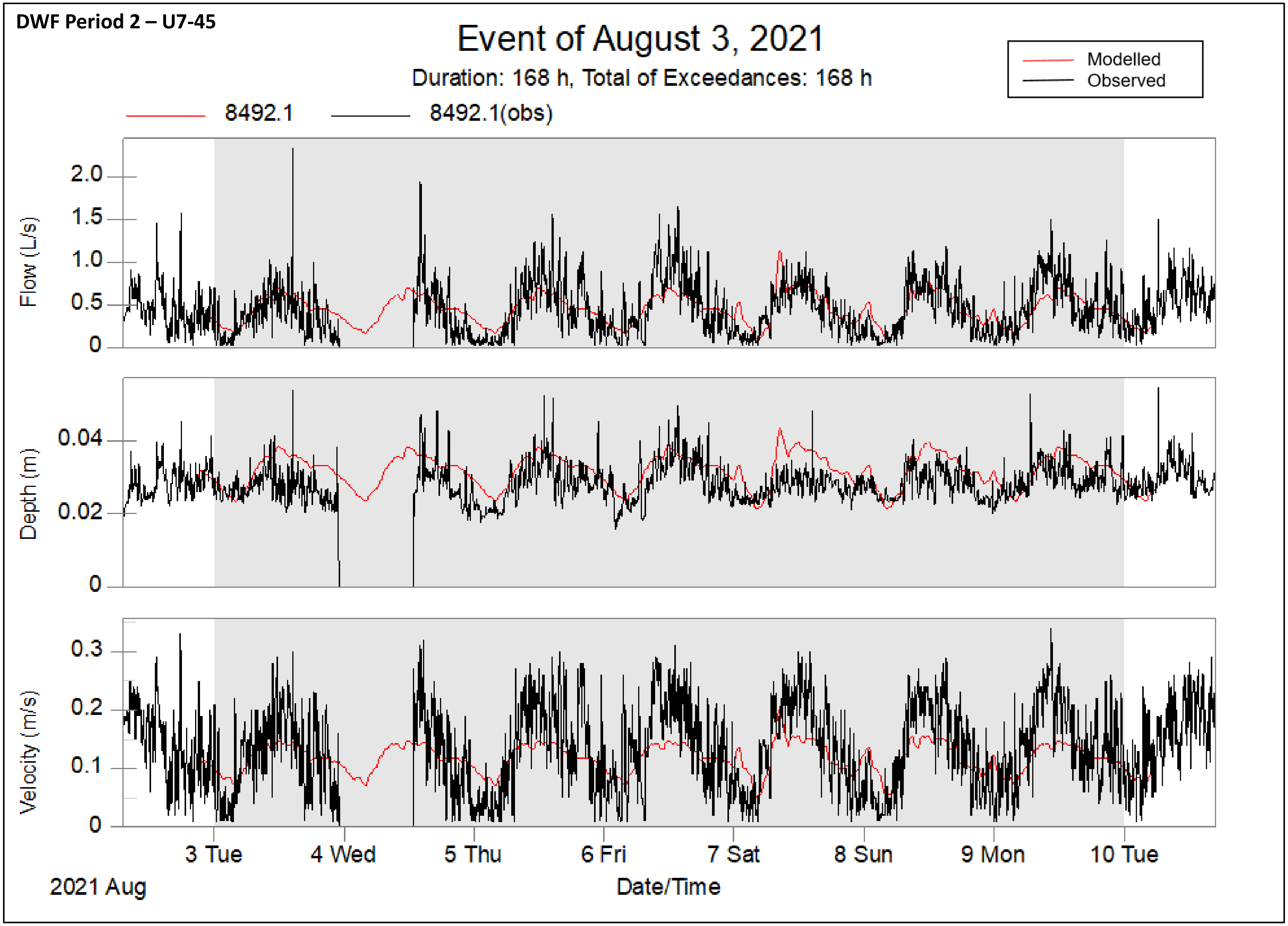
DWF Period 2 – FWL-34



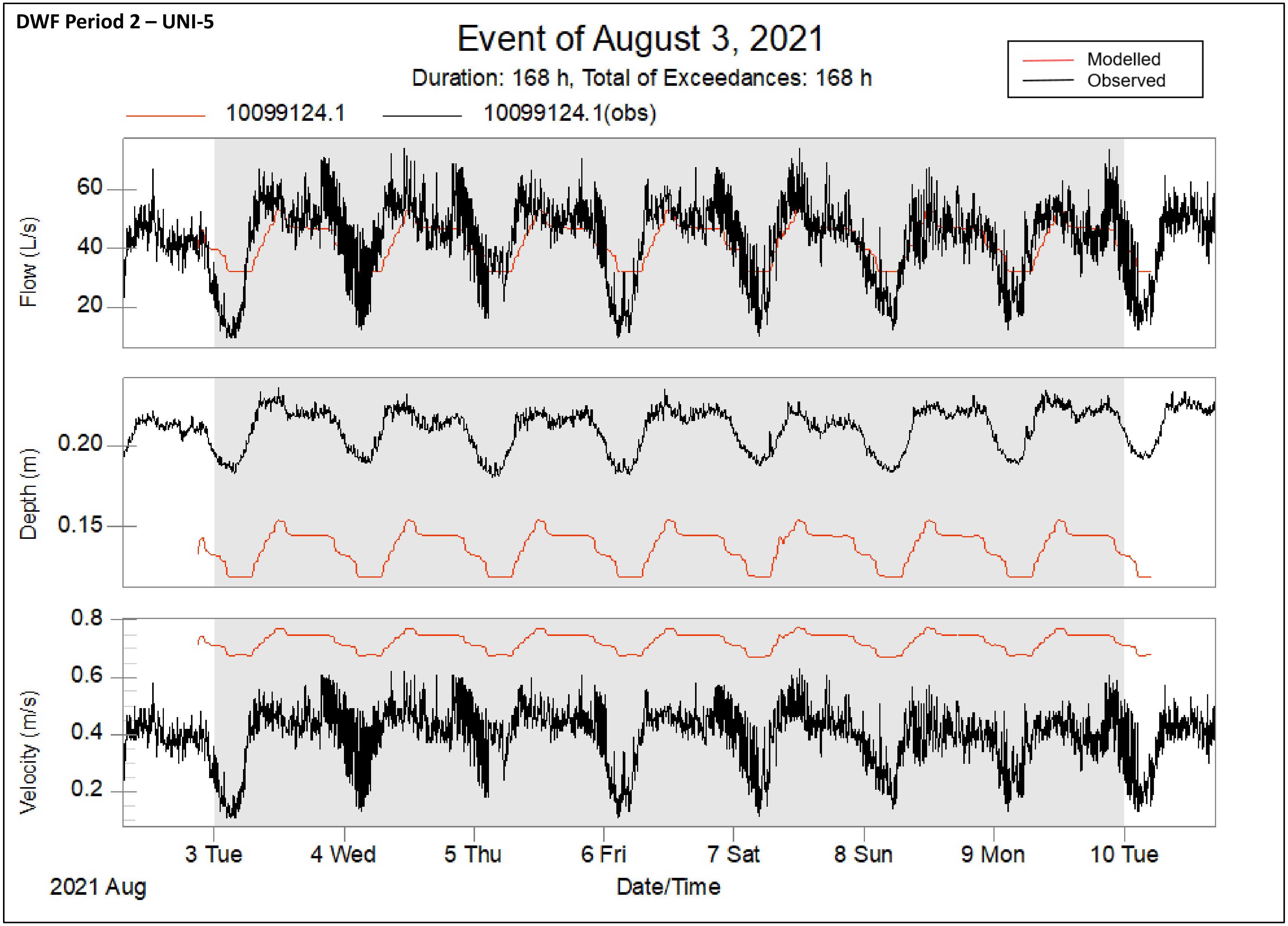

DWF Period 2 – LEE-55
Event of August 3, 2021
Duration: 168 h, Total of Exceedances: 168 h
Modelled
Observed
11773.1
11773.1(obs)
Flow (L/s)
20
15
10
5
0
Depth (m)
0.15
0.10
0.05
Velocity (m/s)
0.6
0.4
0.2
0
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time

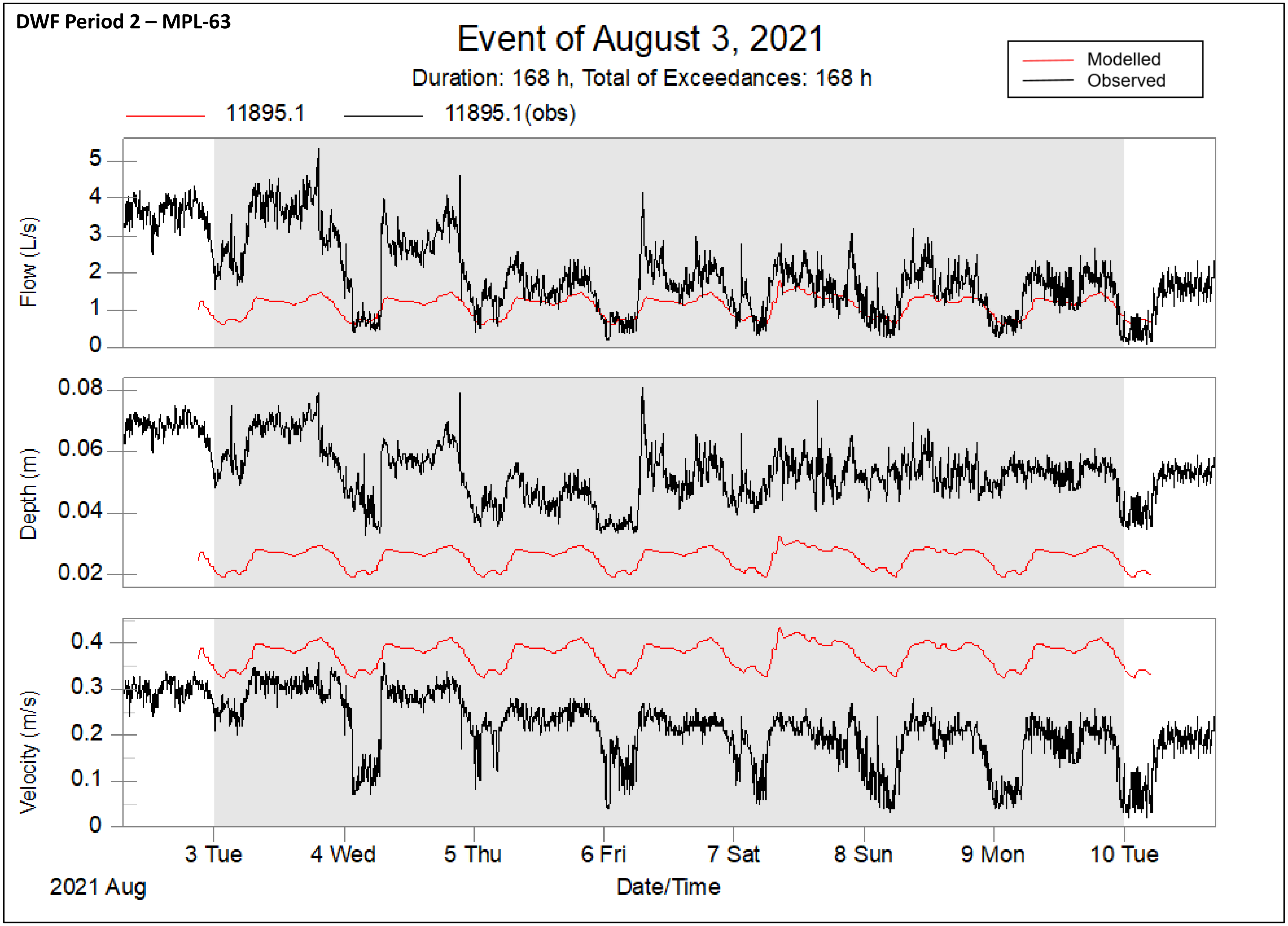


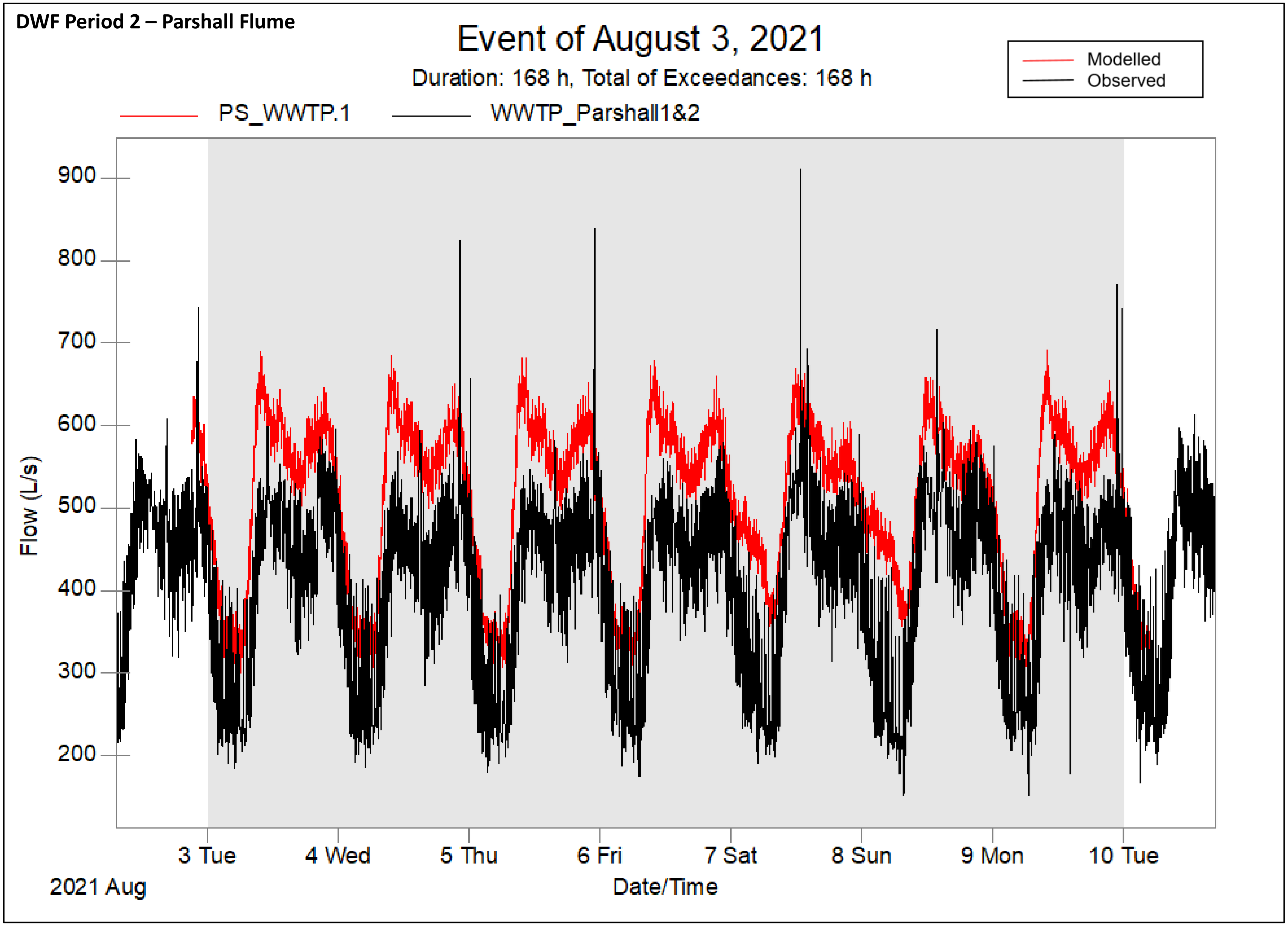
DWF Period 2 – LWD-5
Event of August 3, 2021
Duration: 168 h, Total of Exceedances: 168 h
Modelled
Observed
9343.1
9343.1(obs)
Flow (L/s)
80
60
40
20
Depth (m)
0.20
0.15
0.10
Velocity (m/s)
1.0
0.8
0.6
0.4
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time



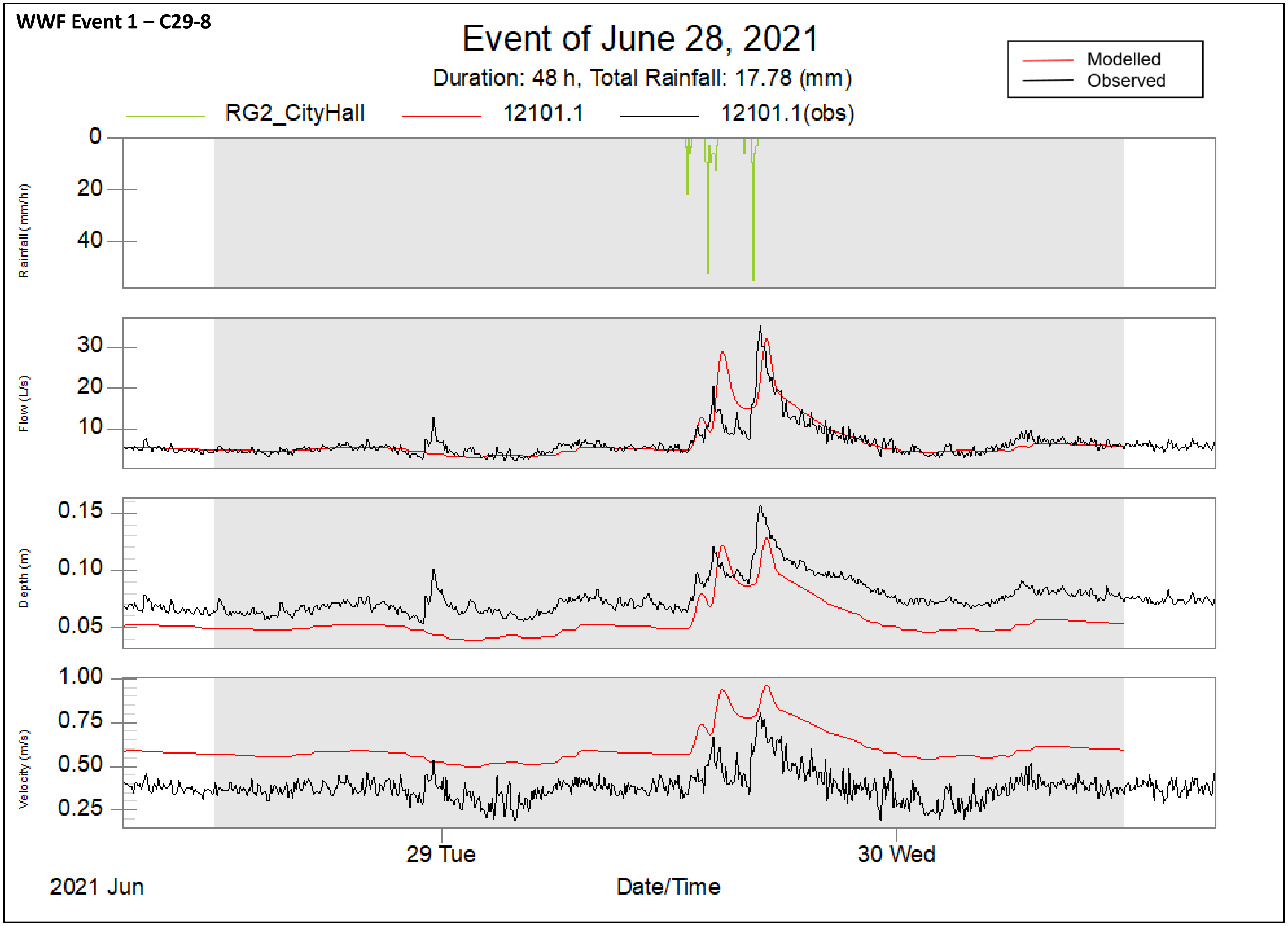
DWF Period 2 – U7-45
Event of August 3, 2021
Duration: 168 h, Total of Exceedances: 168 h
Modelled
Observed
8492.1
8492.1(obs)
Flow (L/s)
2.0
1.5
1.0
0.5
0
Depth (m)
0.04
0.02
0
Velocity (m/s)
0.3
0.2
0.1
0
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time

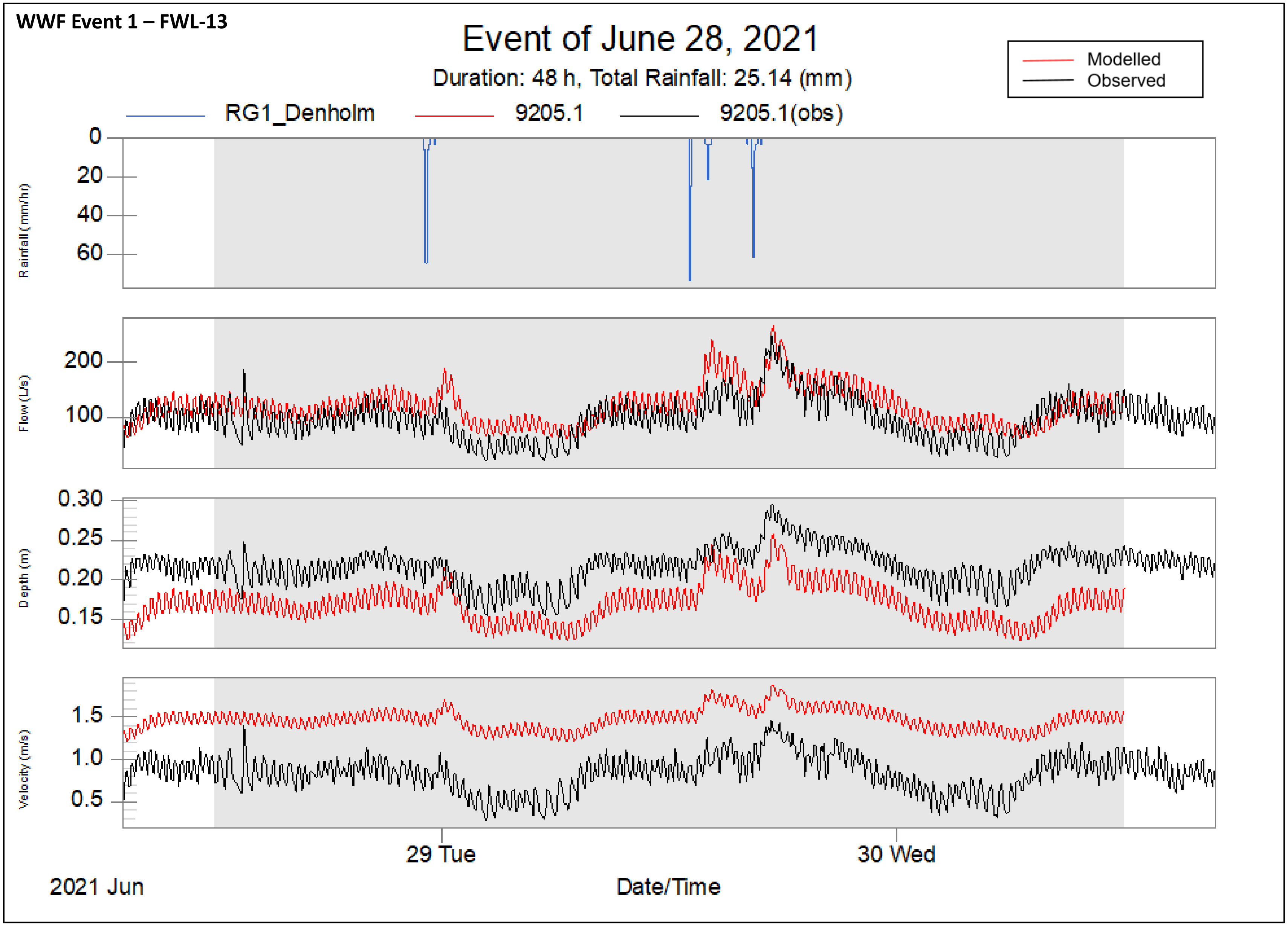

DWF Period 2 – UNI-5
Event of August 3, 2021
Duration: 168 h, Total of Exceedances: 168 h
Modelled
Observed
10099124.1
10099124.1(obs)
Flow (L/s)
60
40
20
Depth (m)
0.20
0.15
Velocity (m/s)
0.8
0.6
0.4
0.2
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time

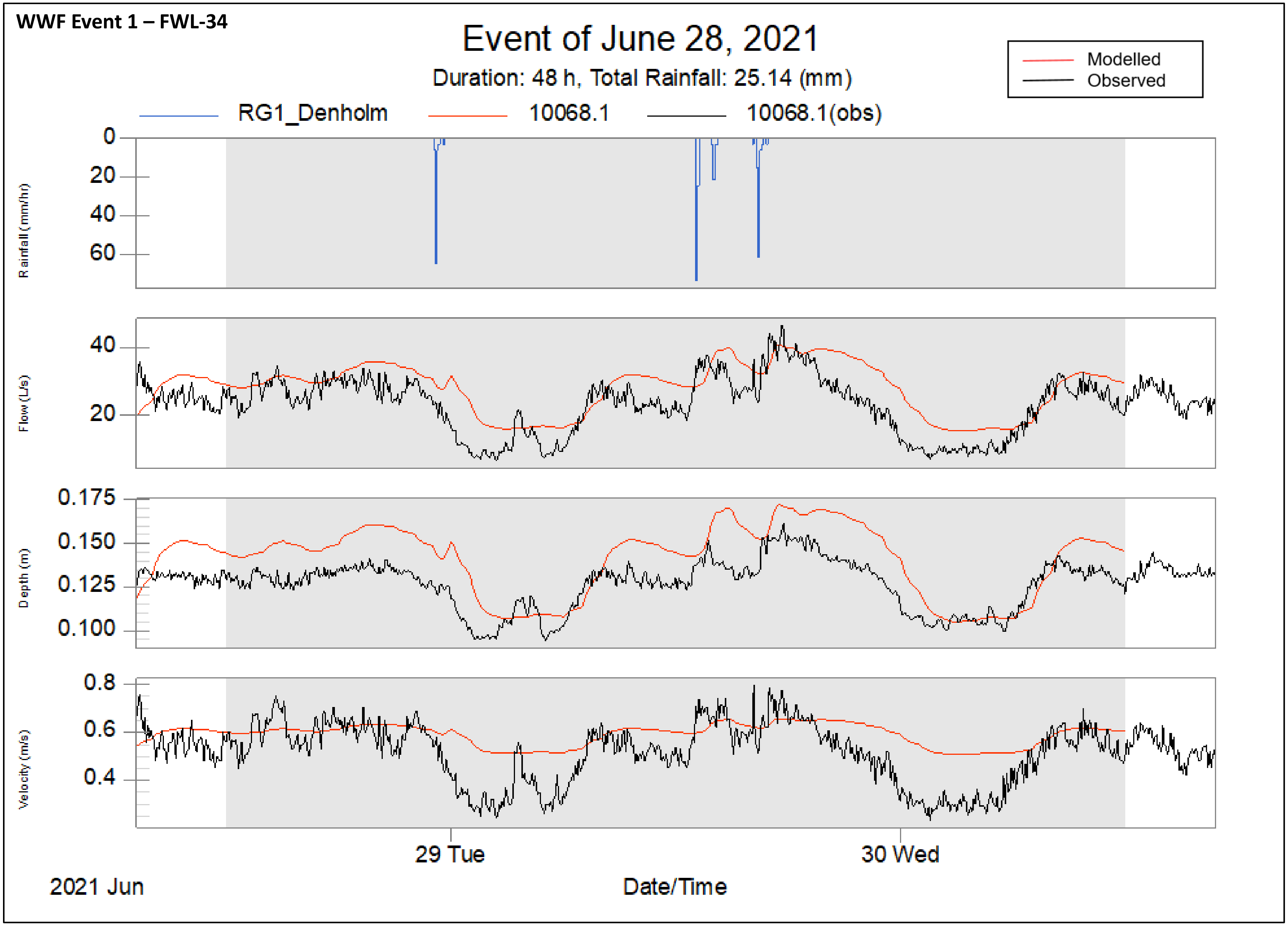

DWF Period 2 – MPL-63
Event of August 3, 2021
Duration: 168 h, Total of Exceedances: 168 h
11895.1
11895.1(obs)
Modelled
Observed
Flow (L/s)
Depth (m)
Velocity (m/s)
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time

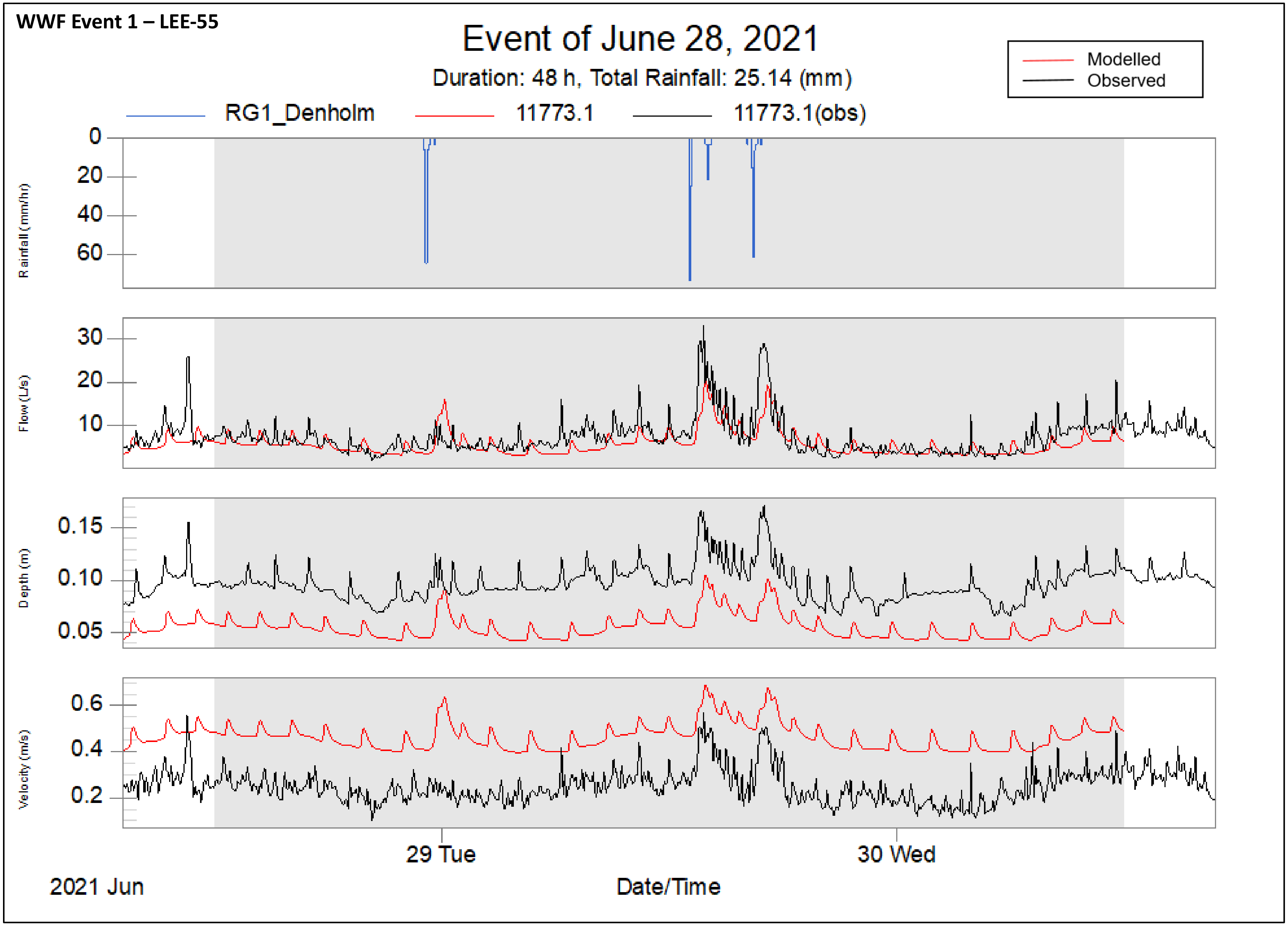

DWF Period 2 – Parshall Flume
Event of August 3, 2021
Duration: 168 h, Total of Exceedances: 168 h
Modelled
Observed
PS_WWTP.1
WWTP_Parshall1&2
Flow (L/s)
900
800
700
600
500
400
300
200
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time

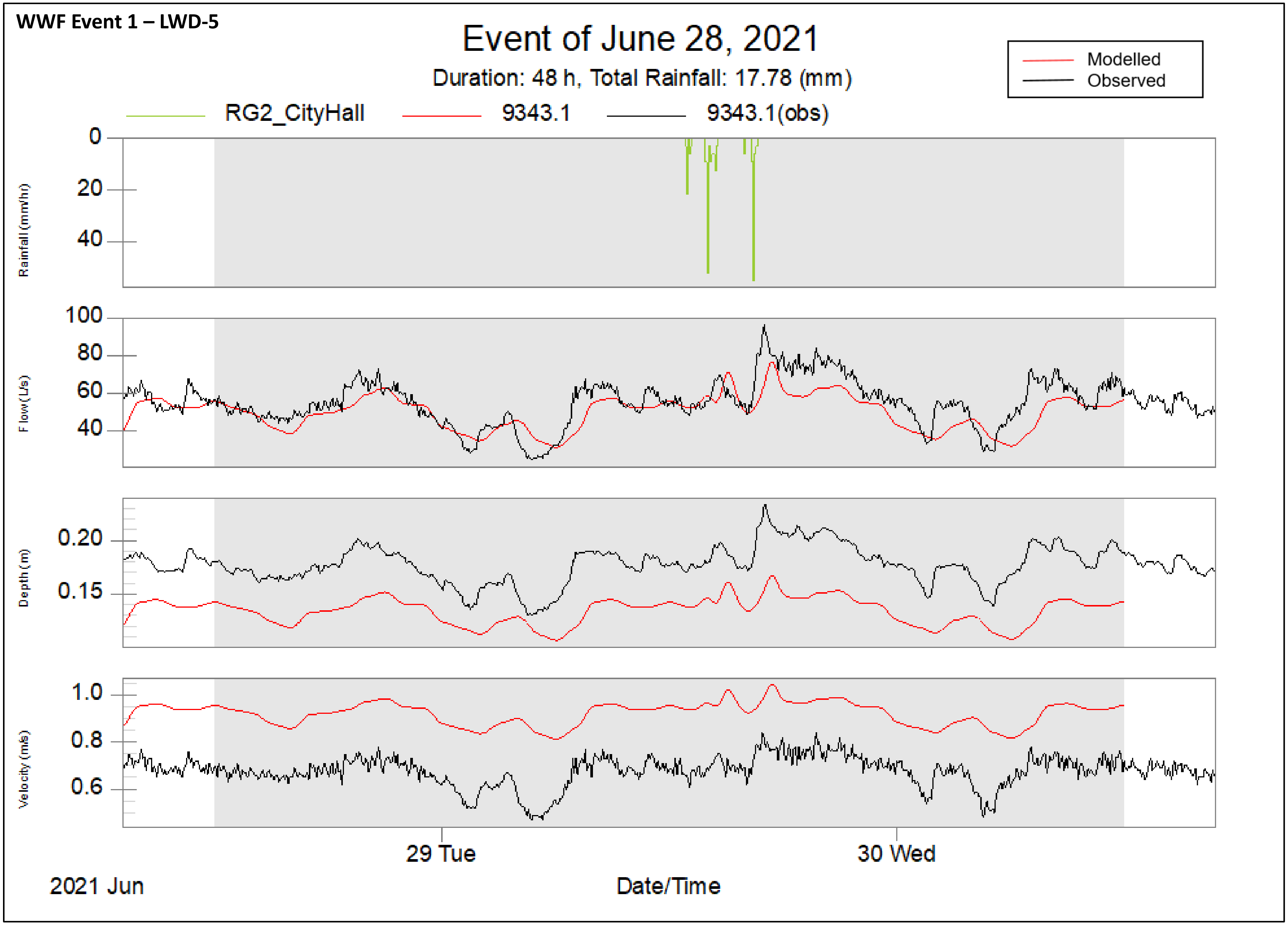
WWF EVENT 1 - CALIBRATION GRAPHS

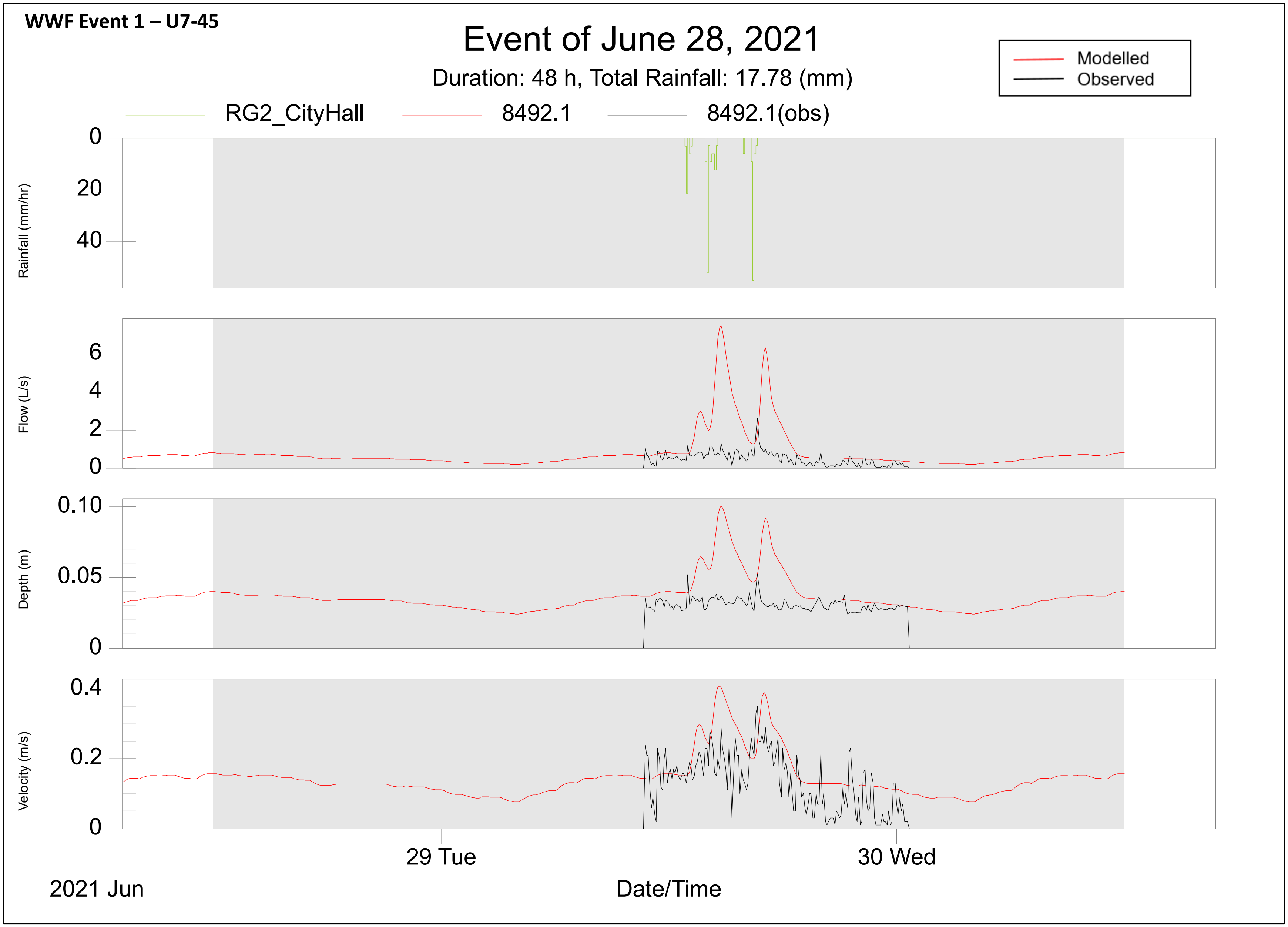

WWF Event 1 – C29-8
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 17.78 (mm)
Modelled
Observed
RG2_CityHall
12101.1
12101.1(obs)
Rainfall (mm/hr)
0
20
40
Flow (L/s)
30
20
10
Depth (m)
0.15
0.10
0.05
Velocity (m/s)
1.00
0.75
0.50
0.25
29 Tue
30 Wed
2021 Jun
Date/Time

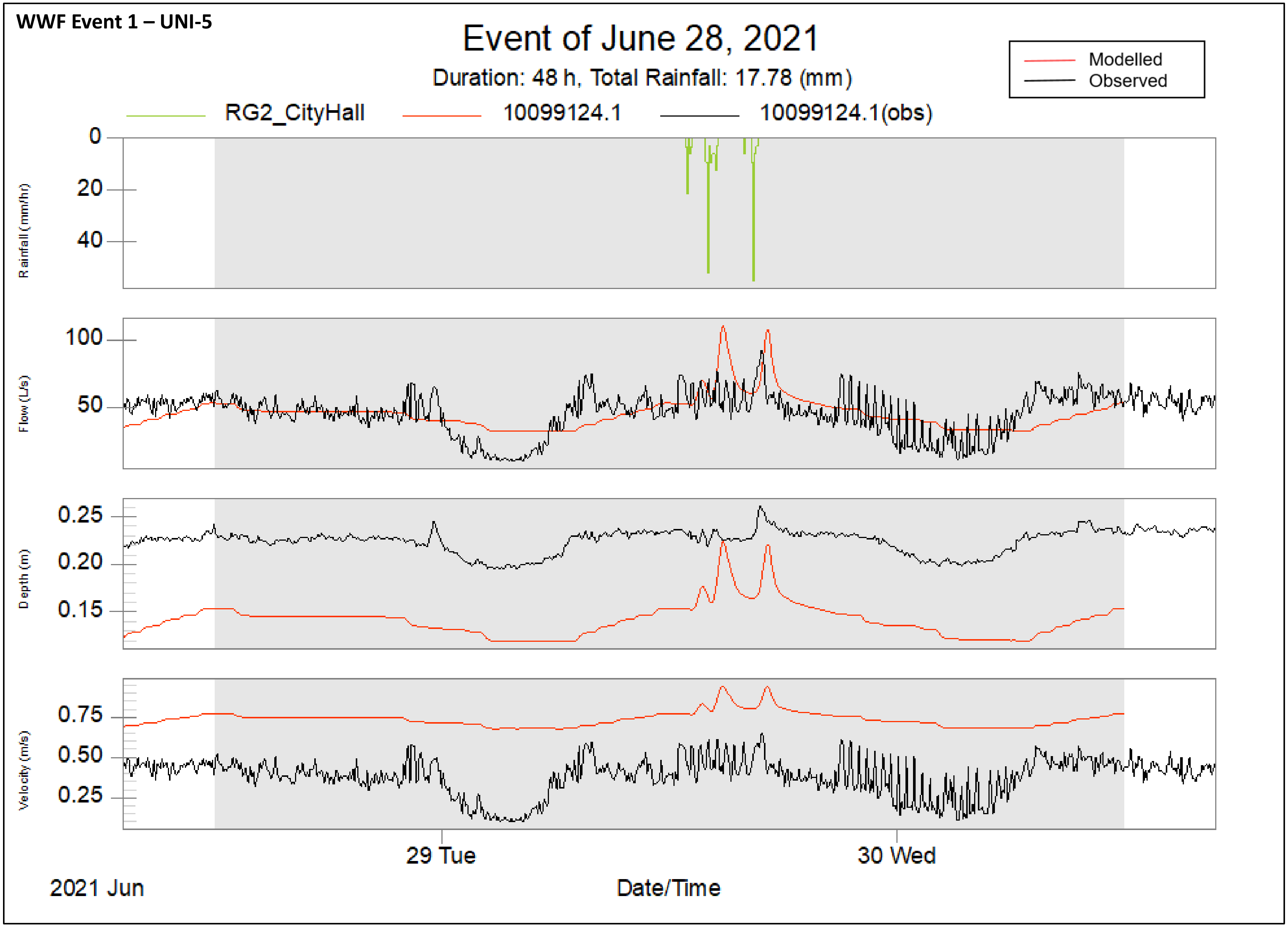

WWF Event 1 – FWL-13
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 25.14 (mm)
Modelled
Observed
RG1_Denholm
9205.1
9205.1(obs)
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
200
100
Depth (m)
0.30
0.25
0.20
0.15
Velocity (m/s)
1.5
1.0
0.5
29 Tue
30 Wed
2021 Jun
Date/Time


WWF Event 1 – FWL-34
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 25.14 (mm)
Modelled
Observed
RG1_Denholm
10068.1
10068.1(obs)
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
40
20
Depth (m)
0.175
0.150
0.125
0.100
Velocity (m/s)
0.8
0.6
0.4
29 Tue
30 Wed
2021 Jun
Date/Time

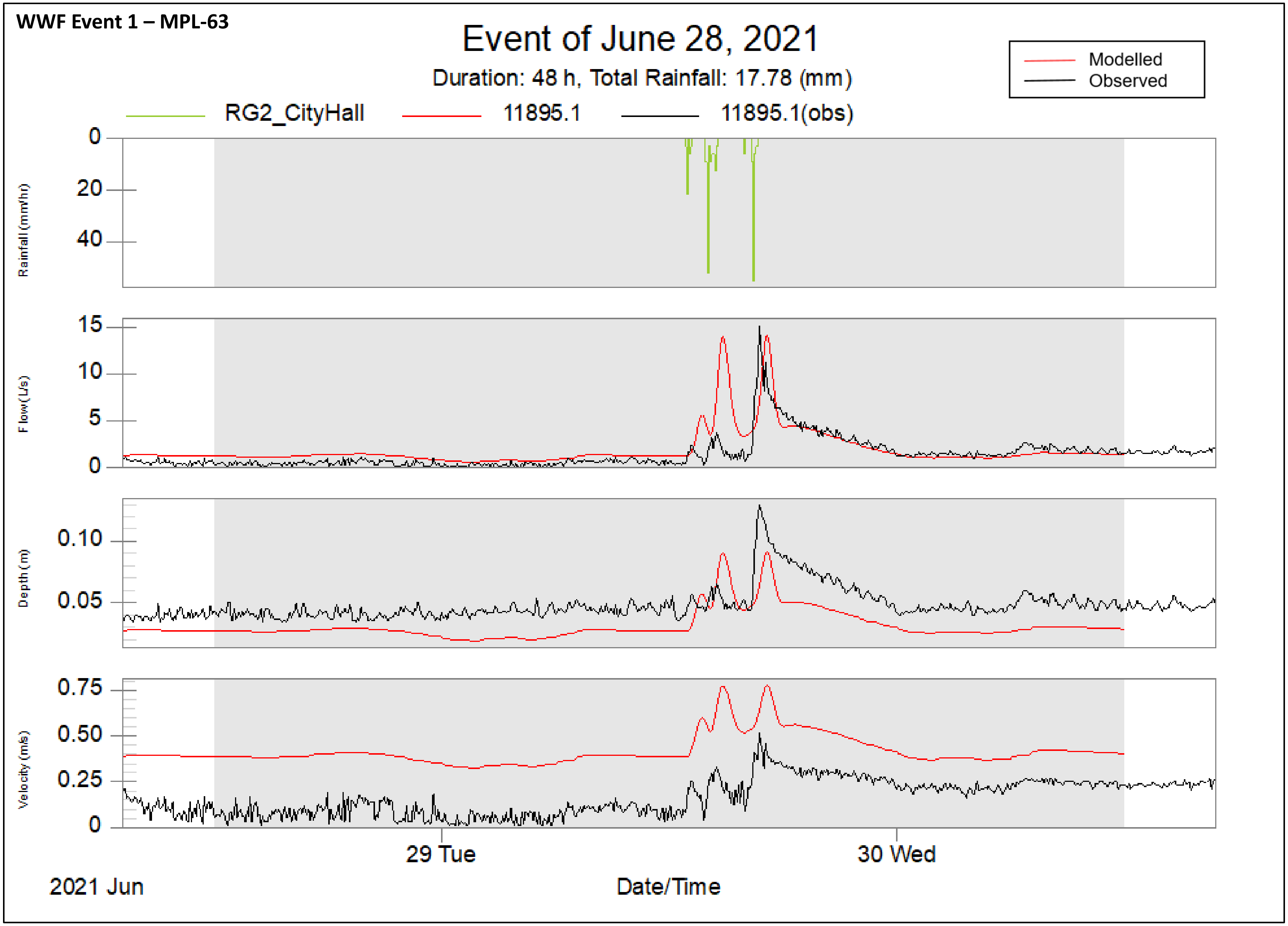

WWF Event 1 – LEE-55
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 25.14 (mm)
Modelled
Observed
RG1_Denholm
11773.1
11773.1(obs)
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
30
20
10
Depth (m)
0.15
0.10
0.05
Velocity (m/s)
0.6
0.4
0.2
29 Tue
30 Wed
2021 Jun
Date/Time

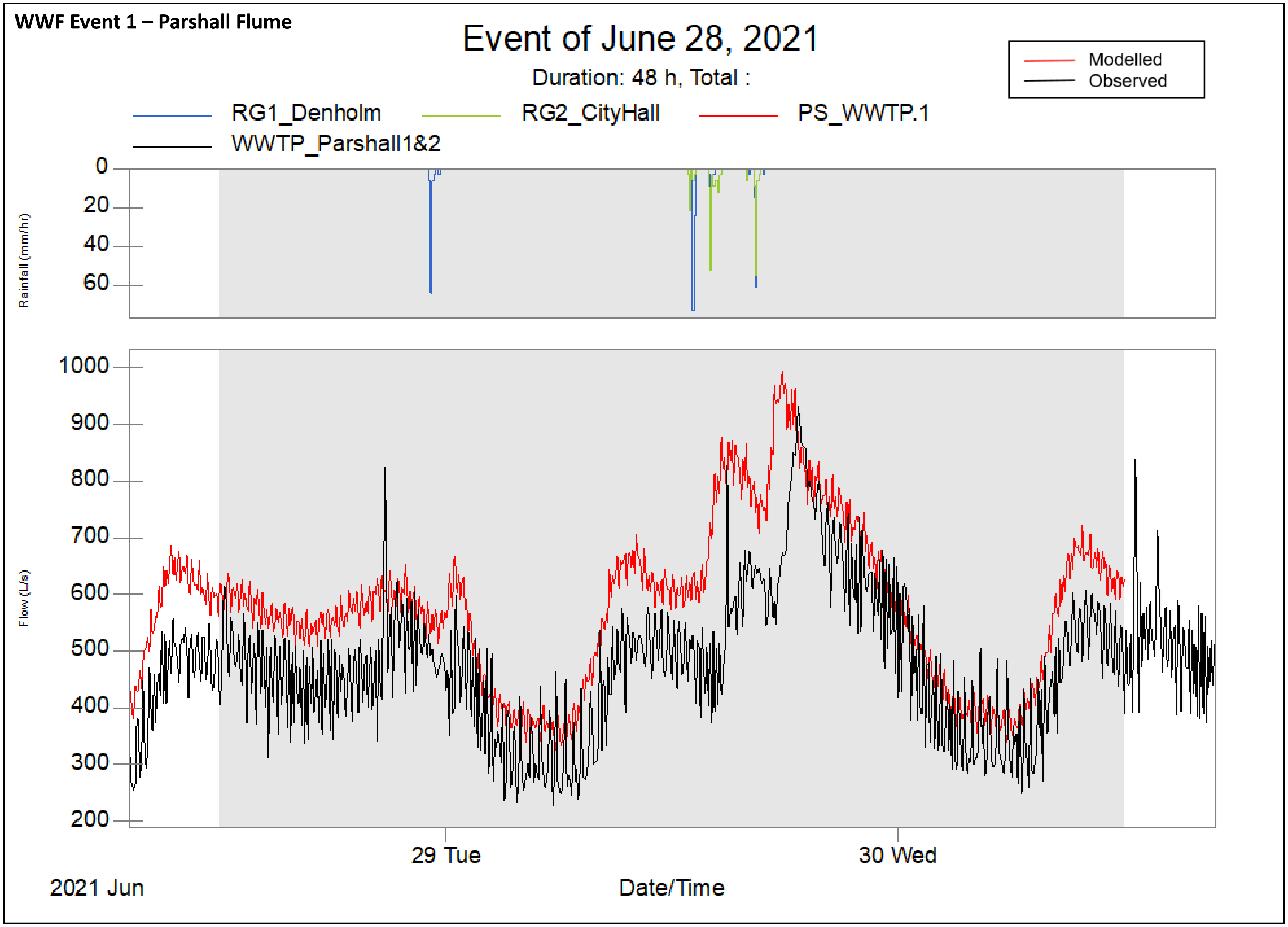

WWF Event 1 – LWD-5
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 17.78 (mm)
Modelled
Observed
RG2_CityHall
9343.1
9343.1(obs)
Rainfall (mm/hr)
0
20
40
Flow (L/s)
100
80
60
40
Depth (m)
0.20
0.15
Velocity (m/s)
1.0
0.8
0.6
29 Tue
30 Wed
2021 Jun
Date/Time


WWF Event 1 – U7-45
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 17.78 (mm)
Modelled
Observed
RG2_CityHall
8492.1
8492.1(obs)
Rainfall (mm/hr)
0
20
40
Flow (L/s)
6
4
2
0
Depth (m)
0.10
0.05
0
Velocity (m/s)
0.4
0.2
0
29 Tue
30 Wed
2021 Jun
Date/Time

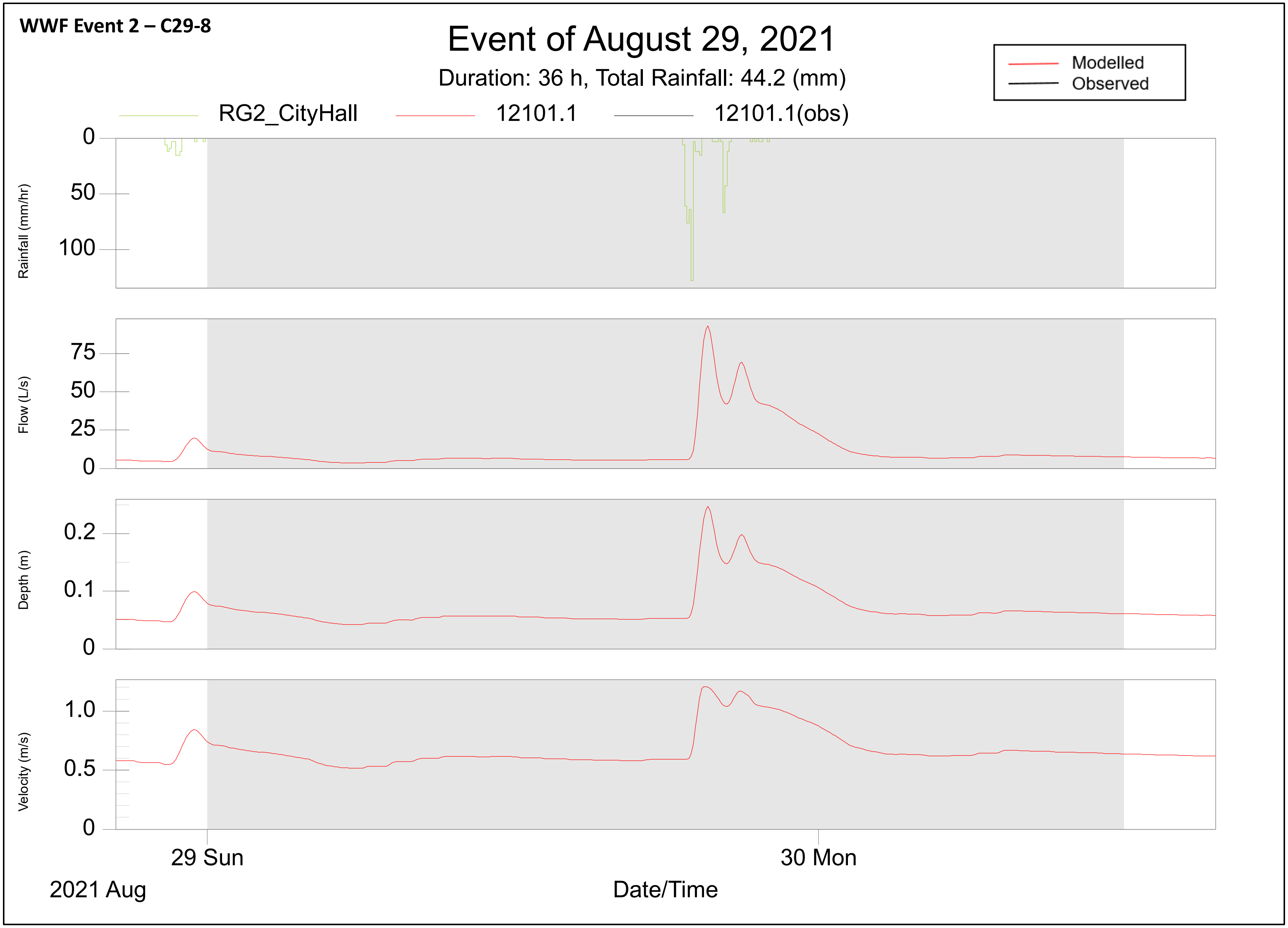


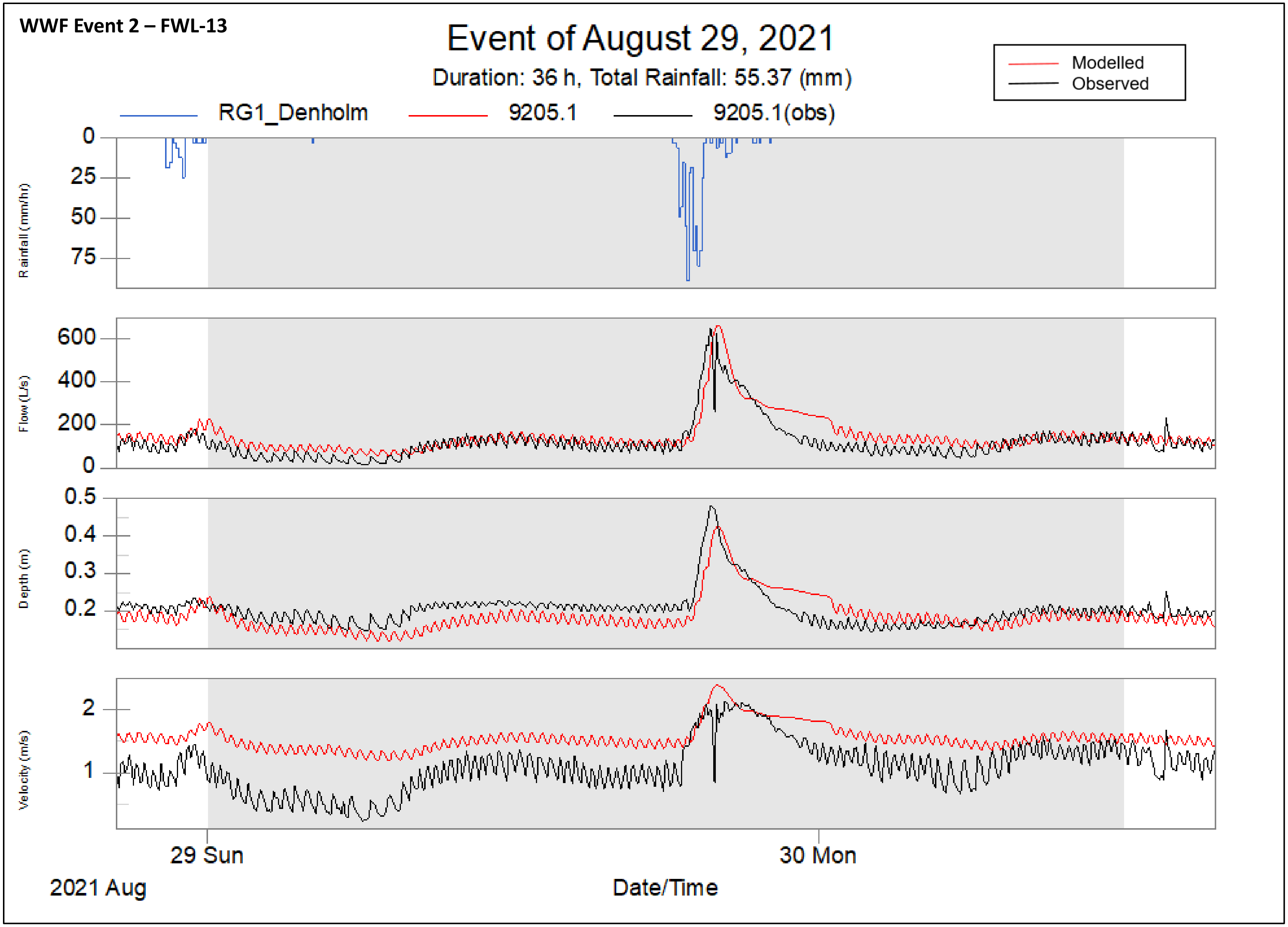
WWF Event 1 – UNI-5
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 17.78 (mm)
Modelled
Observed
RG2_CityHall
10099124.1
10099124.1(obs)
Rainfall (mm/hr)
0
20
40
Flow (L/s)
100
50
Depth (m)
0.25
0.20
0.15
Velocity (m/s)
0.75
0.50
0.25
29 Tue
30 Wed
2021 Jun
Date/Time

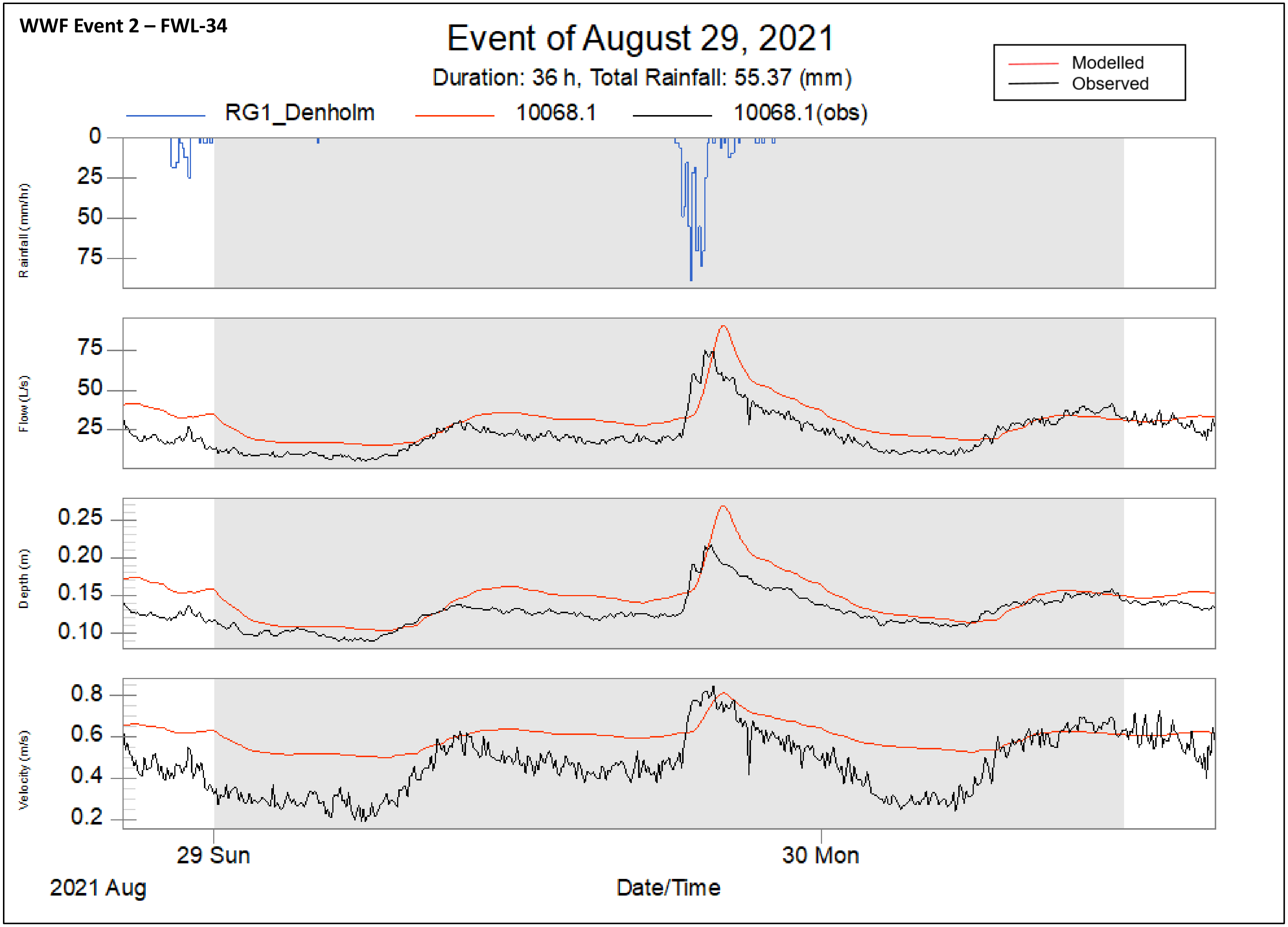

WWF Event 1 – MPL-63
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 17.78 (mm)
Modelled
Observed
RG2_CityHall
11895.1
11895.1(obs)
Rainfall (mm/hr)
0
20
40
Flow (L/s)
15
10
5
0
Depth (m)
0.10
0.05
Velocity (m/s)
0.75
0.50
0.25
0
29 Tue
30 Wed
2021 Jun
Date/Time

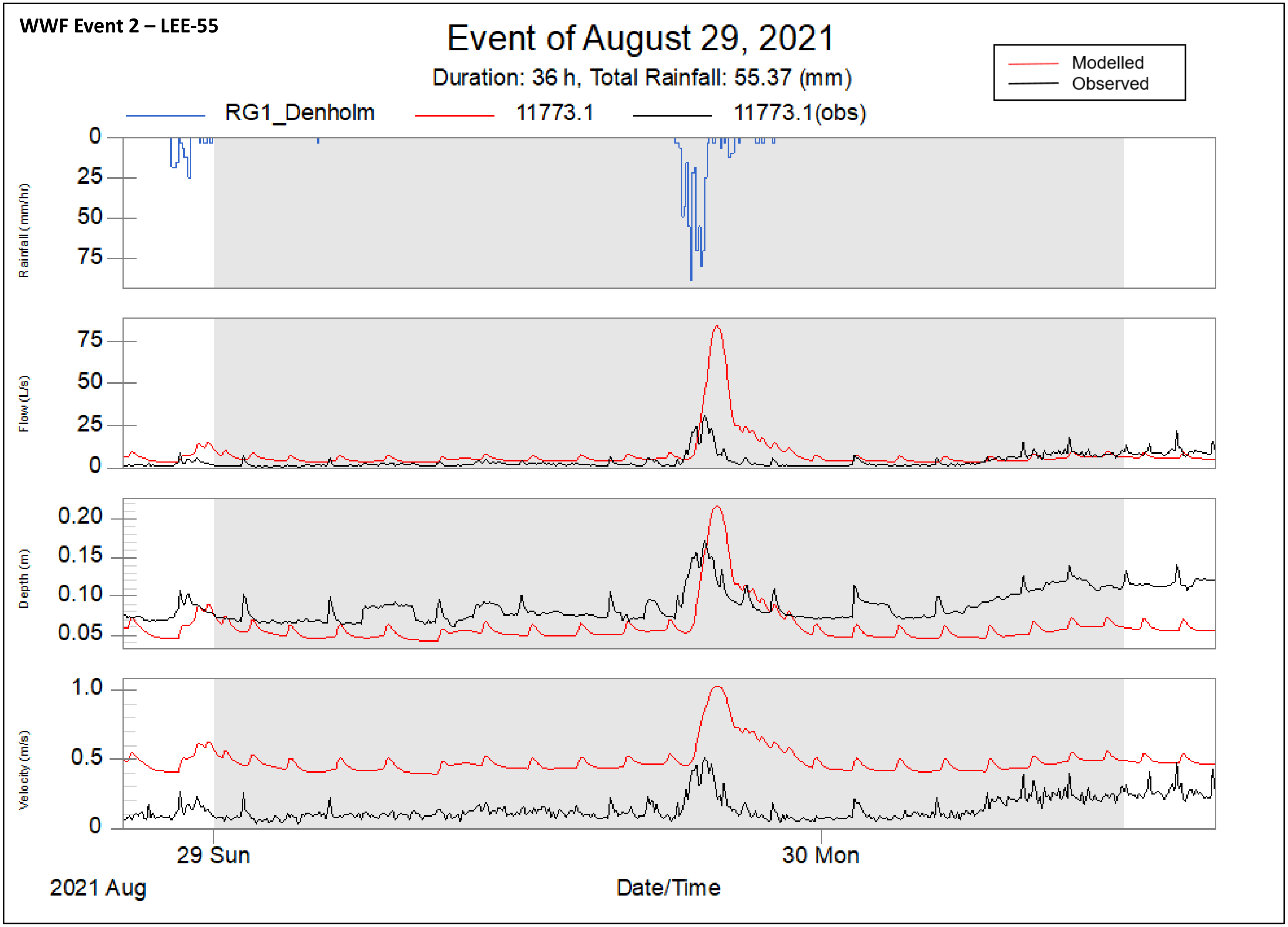

WWF Event 1 – Parshall Flume
Event of June 28, 2021
Duration: 48 h, Total :
Modelled
Observed
RG1_Denholm
RG2_CityHall
PS_WWTP.1
WWTP_Parshall1&2
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
1000
900
800
700
600
500
400
300
200
29 Tue
30 Wed
2021 Jun
Date/Time

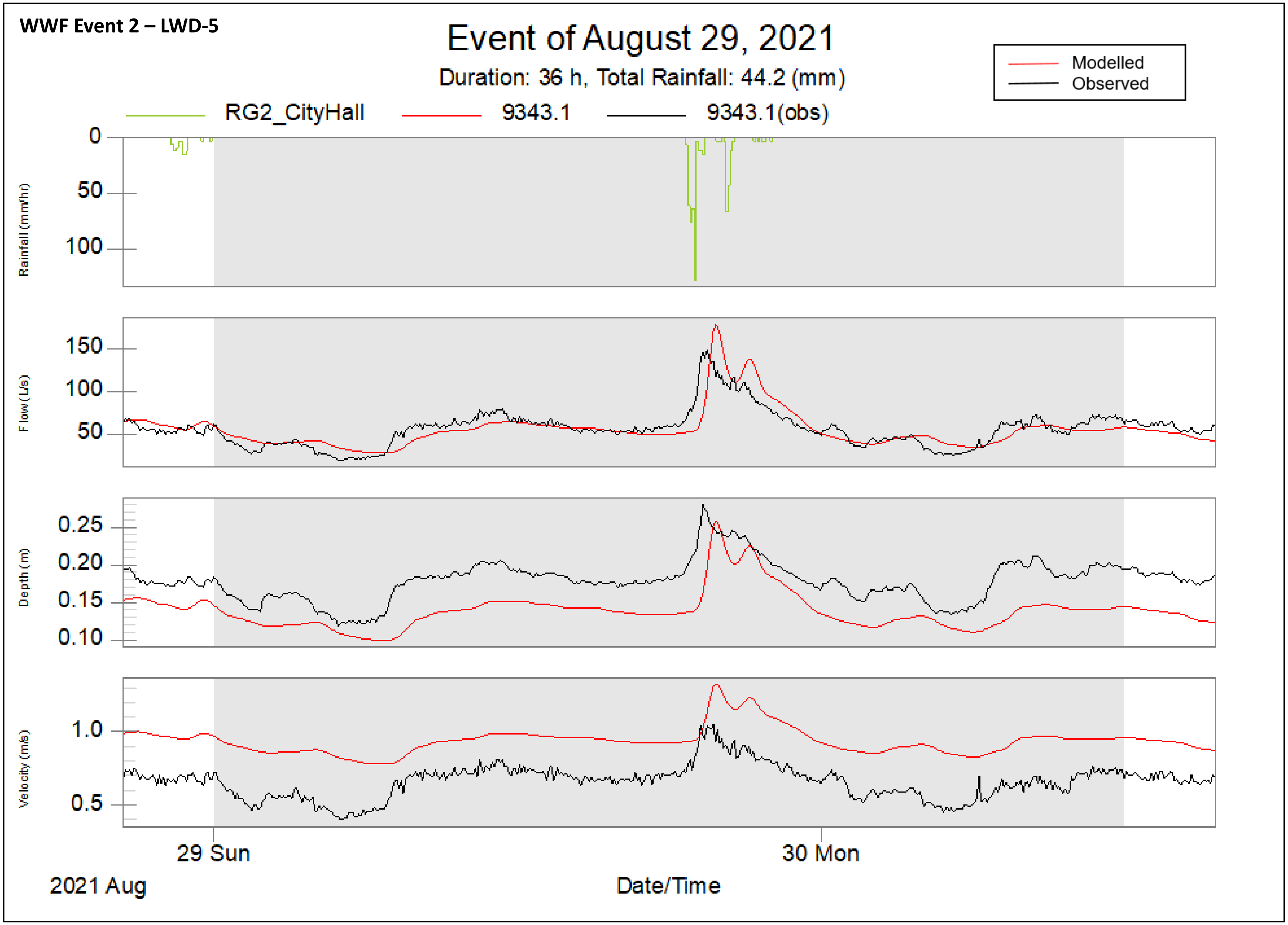
WWF EVENT 2 - CALIBRATION GRAPHS

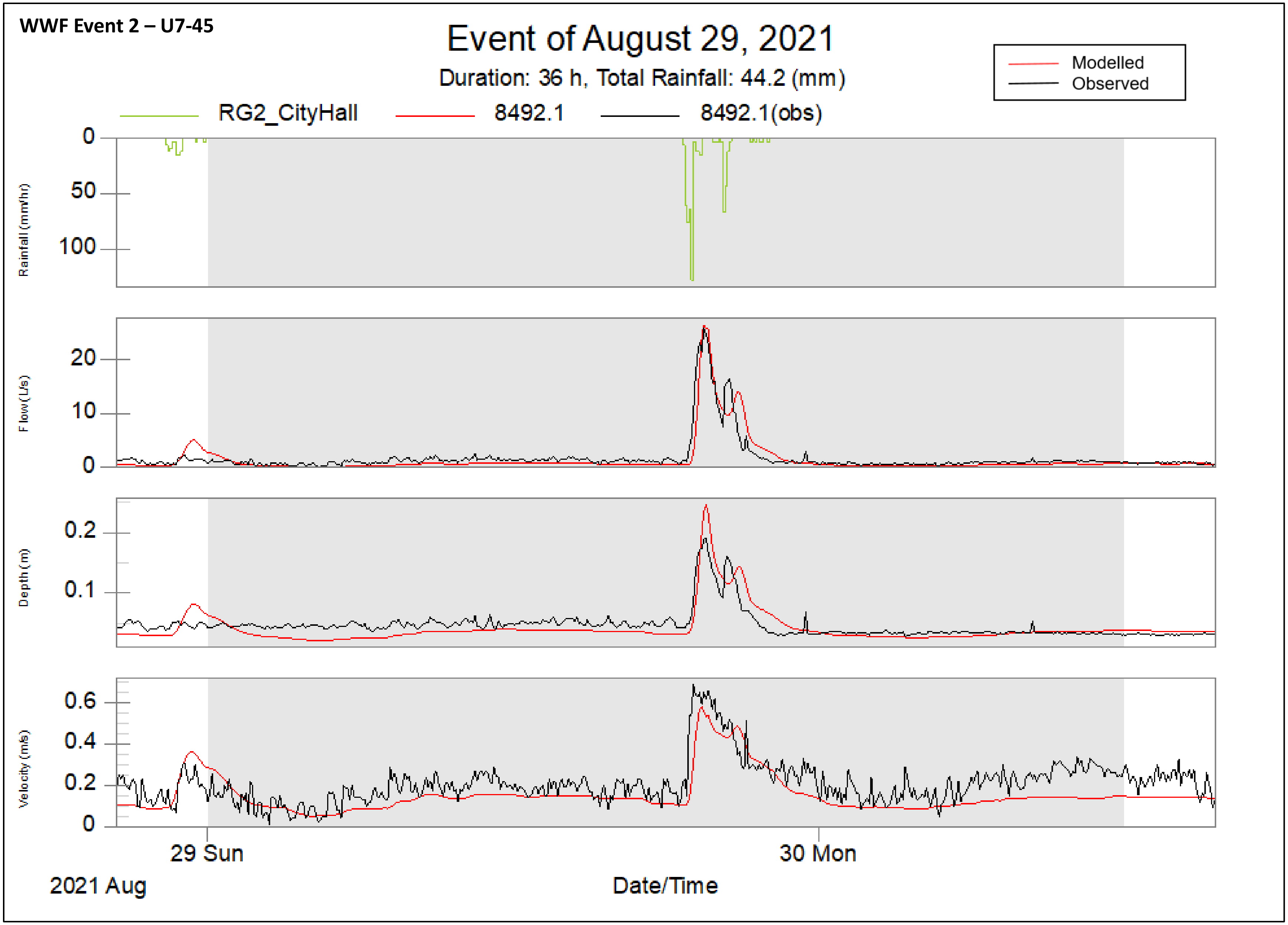

WWF Event 2 – C29-8
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 44.2 (mm)
Modelled
Observed
RG2_CityHall
12101.1
12101.1(obs)
Rainfall (mm/hr)
0
50
100
Flow (L/s)
75
50
25
0
Depth (m)
0.2
0.1
0
Velocity (m/s)
1.0
0.5
0
29 Sun
30 Mon
2021 Aug
Date/Time

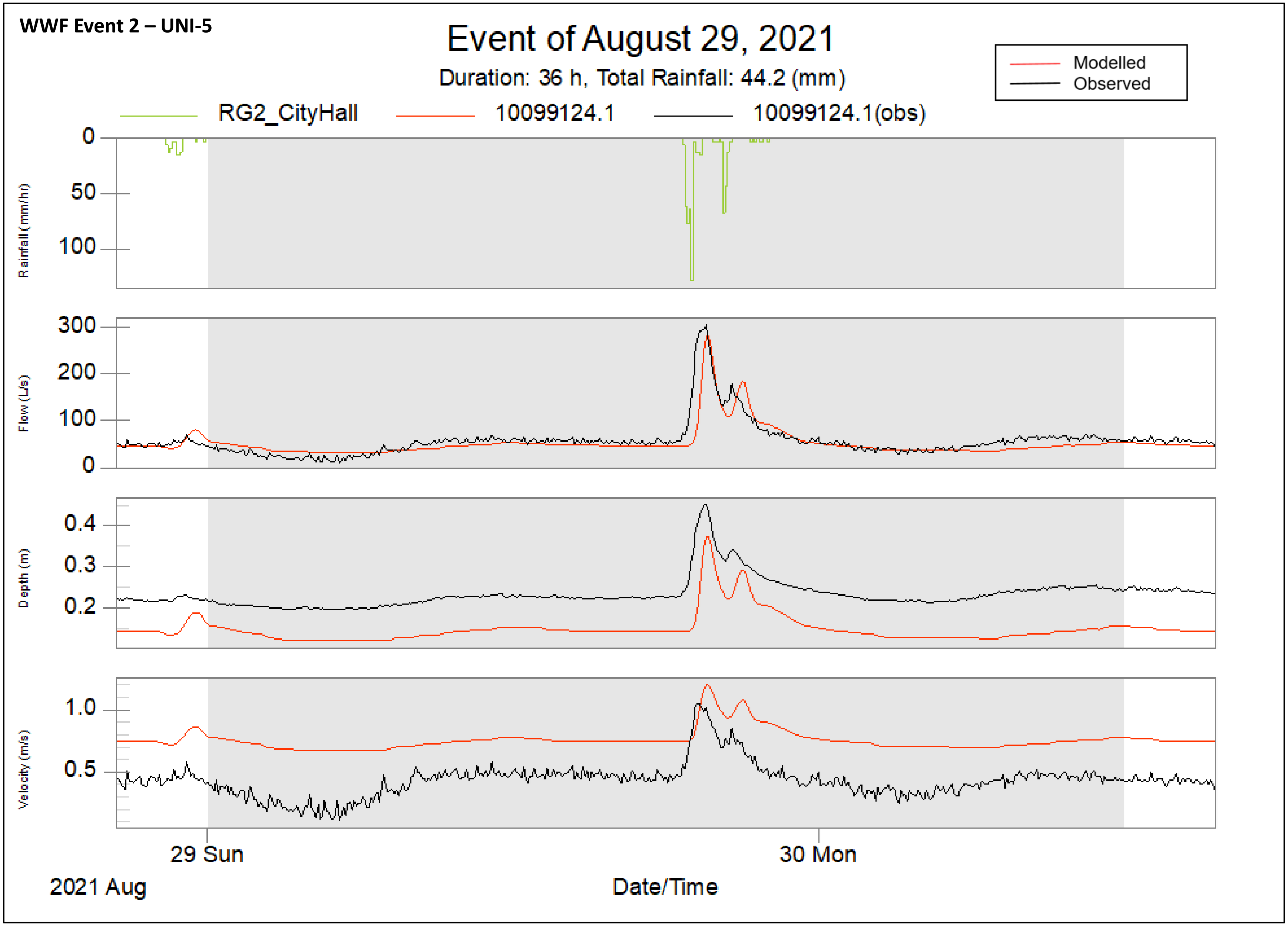

WWF Event 2 – FWL-13
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 55.37 (mm)
Modelled
Observed
RG1_Denholm
9205.1
9205.1(obs)
Rainfall (mm/hr)
0
25
50
75
Flow (L/s)
600
400
200
0
Depth (m)
0.5
0.4
0.3
0.2
Velocity (m/s)
2
1
29 Sun
30 Mon
2021 Aug
Date/Time


WWF Event 2 – FWL-34
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 55.37 (mm)
Modelled
Observed
RG1_Denholm
10068.1
10068.1(obs)
Rainfall (mm/hr)
0
25
50
75
Flow (L/s)
75
50
25
Depth (m)
0.25
0.20
0.15
0.10
Velocity (m/s)
0.8
0.6
0.4
0.2
29 Sun
30 Mon
2021 Aug
Date/Time

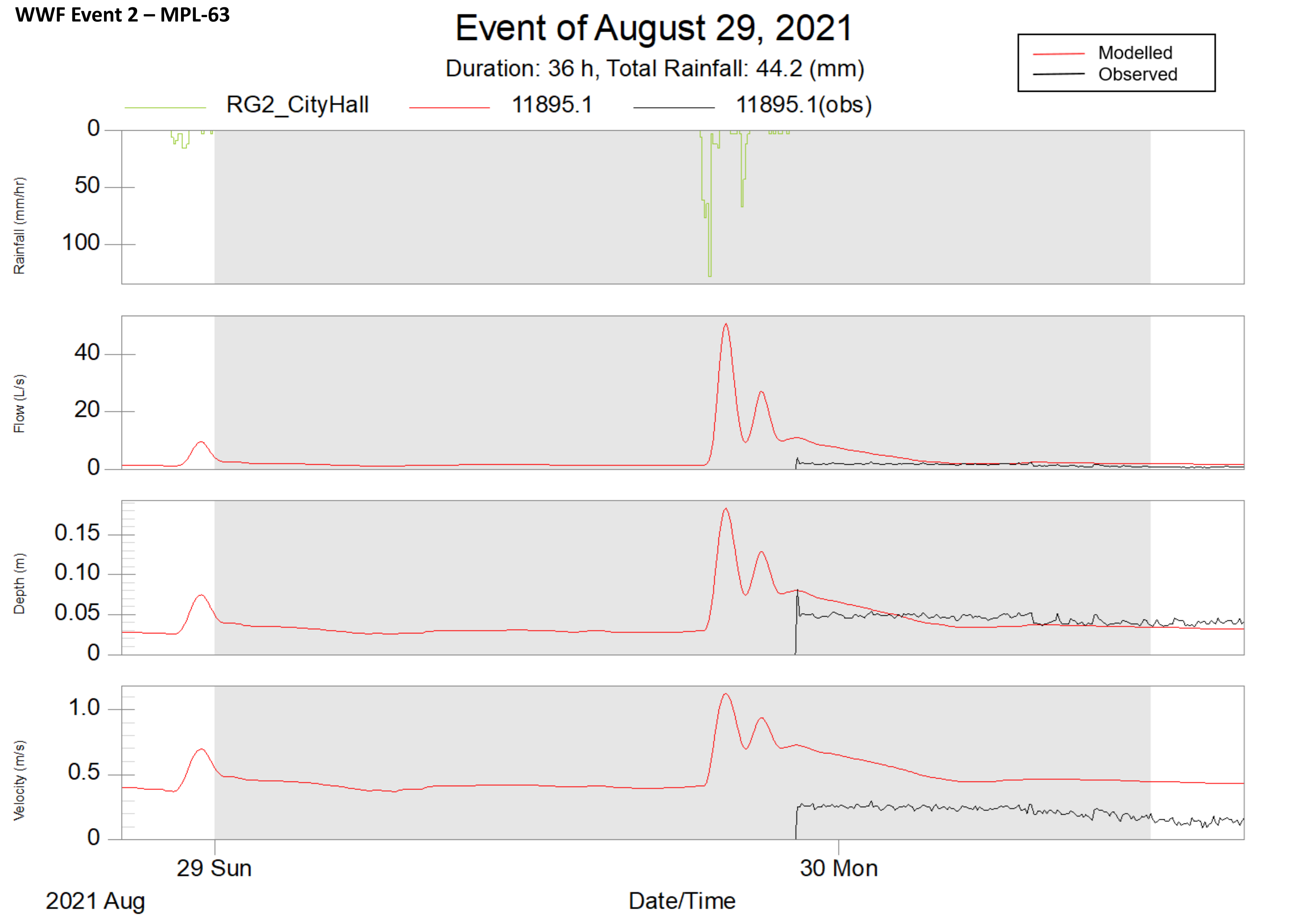

WWF Event 2 – LEE-55
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 55.37 (mm)
Modelled
Observed
RG1_Denholm
11773.1
11773.1(obs)
Rainfall (mm/hr)
0
25
50
75
Flow (L/s)
75
50
25
0
Depth (m)
0.20
0.15
0.10
0.05
Velocity (m/s)
1.0
0.5
0
29 Sun
30 Mon
2021 Aug
Date/Time

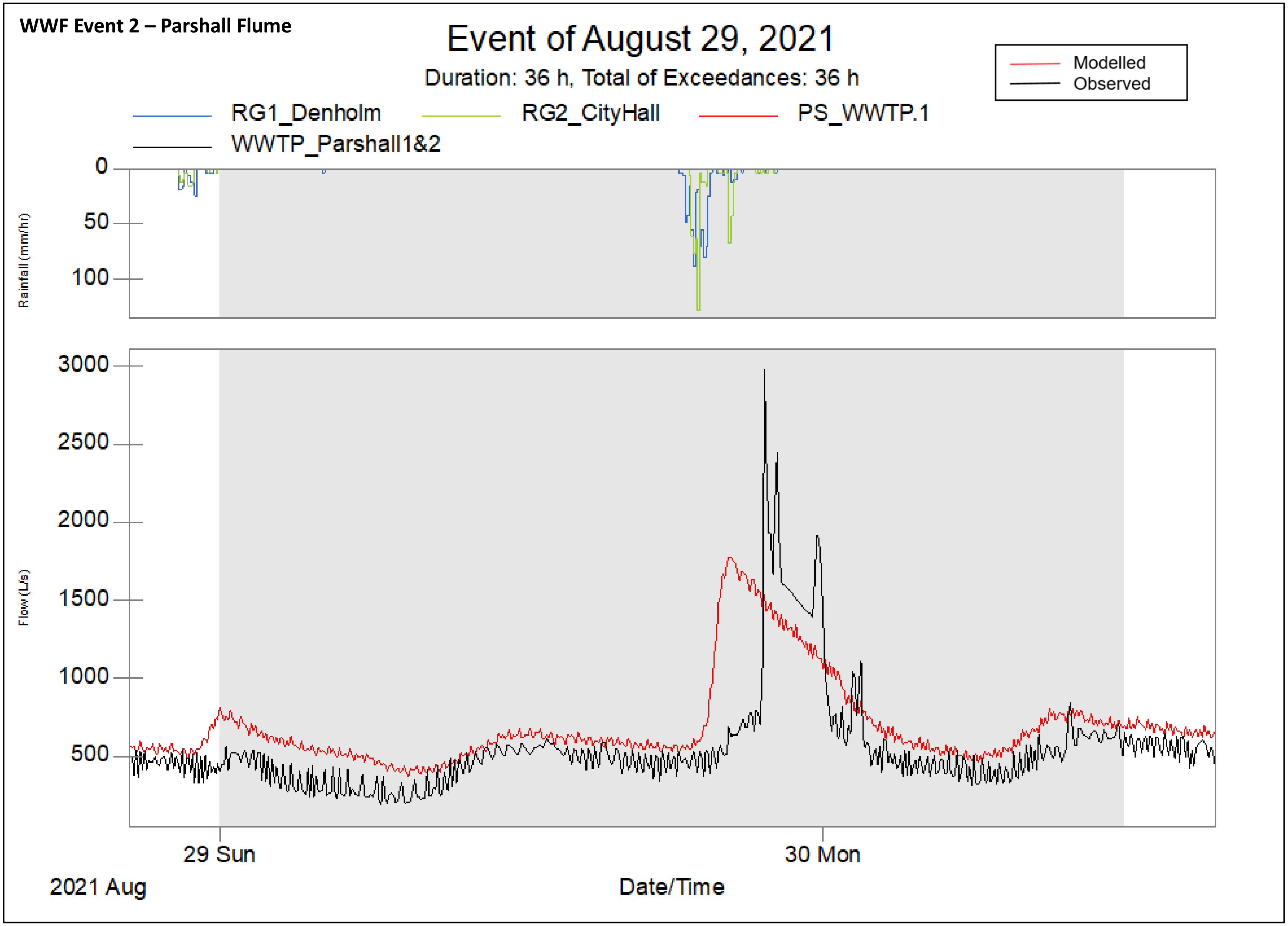

WWF Event 2 – LWD-5
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 44.2 (mm)
Modelled
Observed
RG2_CityHall
9343.1
9343.1(obs)
Rainfall (mm/hr)
0
50
100
Flow (L/s)
150
100
50
Depth (m)
0.25
0.20
0.15
0.10
Velocity (m/s)
1.0
0.5
29 Sun
30 Mon
2021 Aug
Date/Time


WWF Event 2 – U7-45
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 44.2 (mm)
Modelled
Observed
RG2_CityHall
8492.1
8492.1(obs)
Rainfall (mm/hr)
0
50
100
Flow (L/s)
20
10
0
Depth (m)
0.2
0.1
Velocity (m/s)
0.6
0.4
0.2
0
29 Sun
30 Mon
2021 Aug
Date/Time

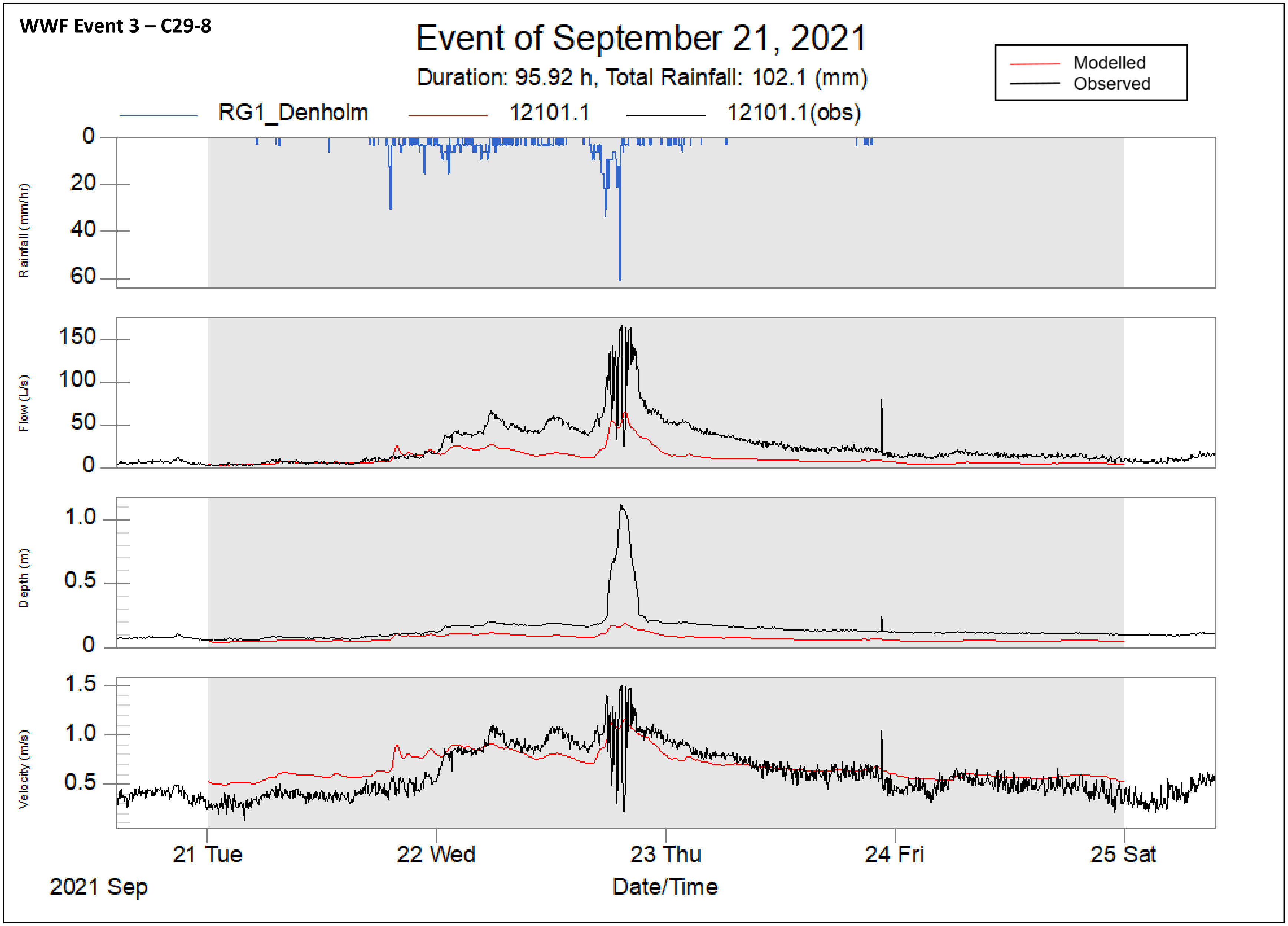

WWF Event 2 – UNI-5
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 44.2 (mm)
Modelled
Observed
RG2_CityHall
10099124.1
10099124.1(obs)
Rainfall (mm/hr)
0
50
100
Flow (L/s)
300
200
100
0
Depth (m)
0.4
0.3
0.2
Velocity (m/s)
1.0
0.5
29 Sun
30 Mon
2021 Aug
Date/Time

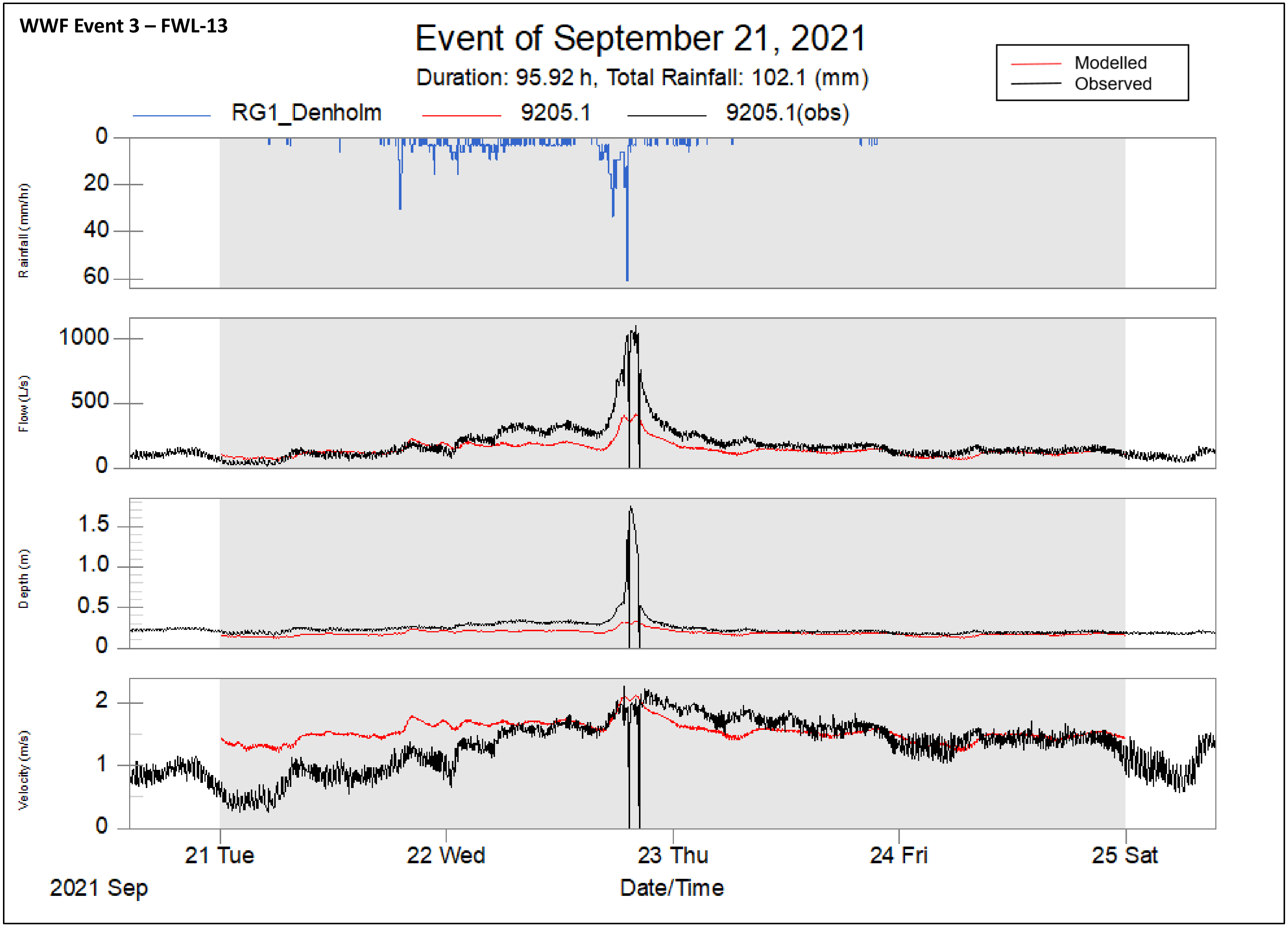
WWF Event 2 – MPL-63

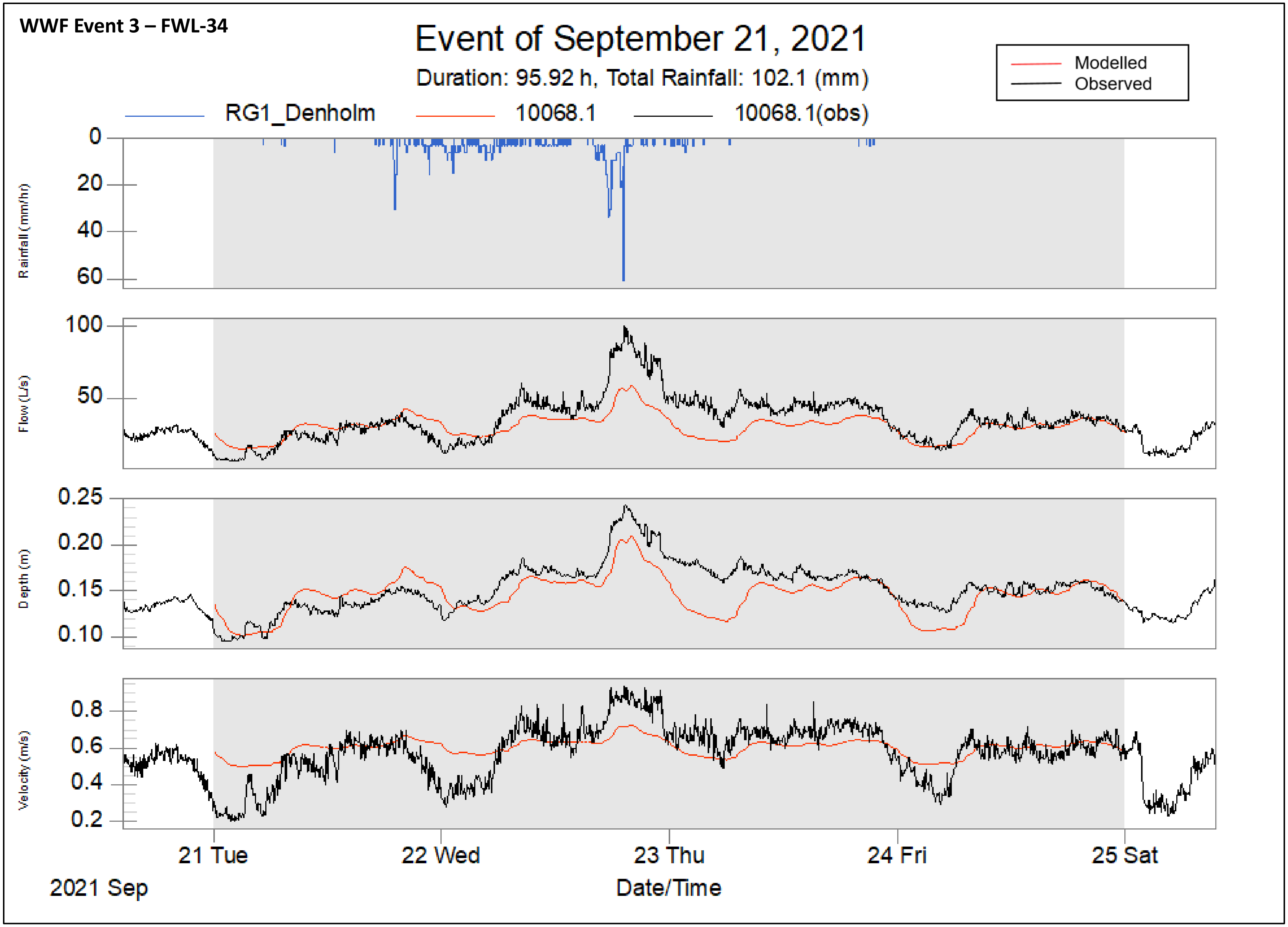


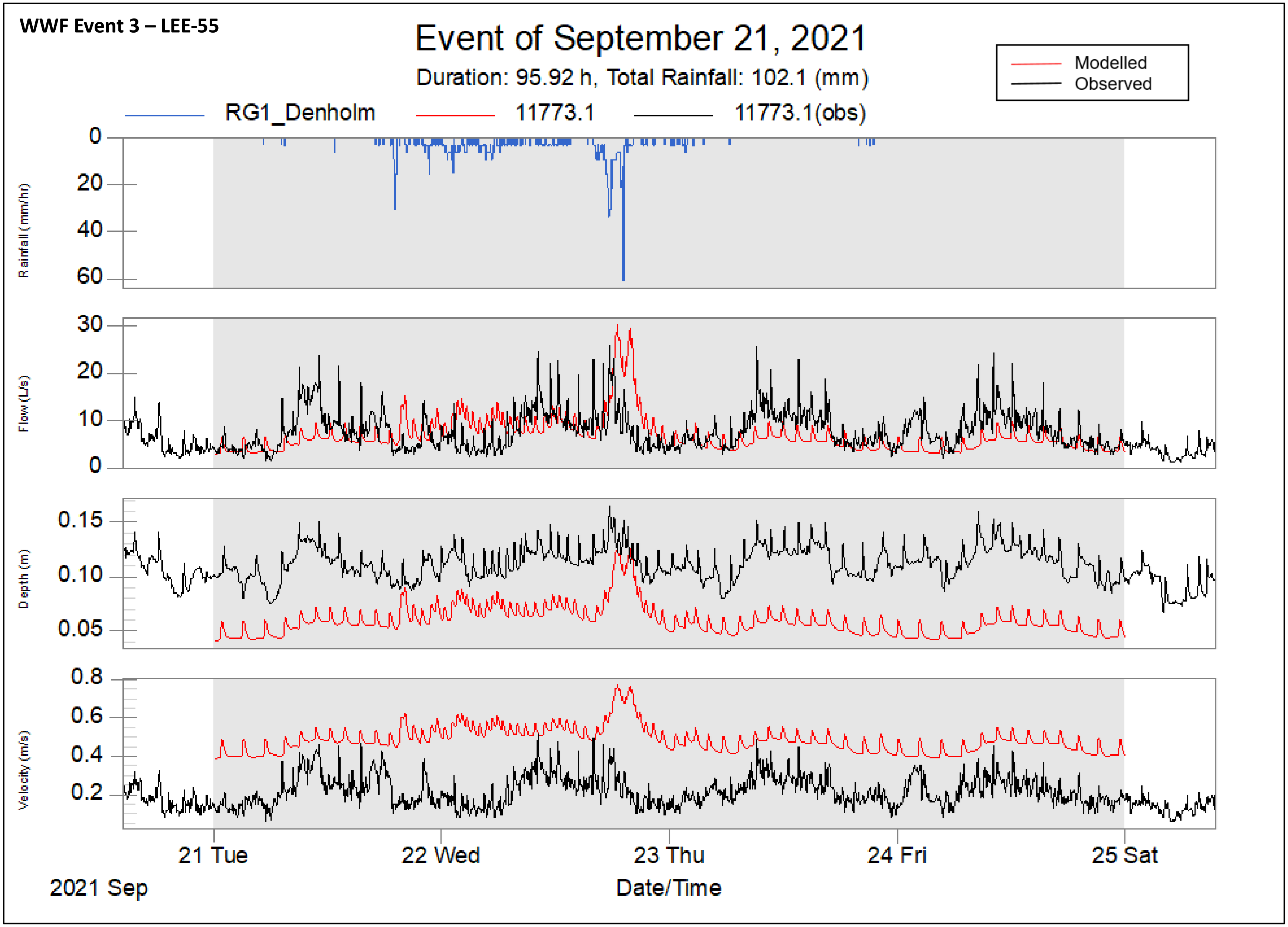

WWF Event 2 – Parshall Flume
Event of August 29, 2021
Duration: 36 h, Total of Exceedances: 36 h
Modelled
Observed
RG1_Denholm
RG2_CityHall
PS_WWTP.1
WWTP_Parshall1&2
Rainfall (mm/hr)
0
50
100
Flow (L/s)
3000
2500
2000
1500
1000
500
29 Sun
30 Mon
2021 Aug
Date/Time

WWF EVENT 3 - CALIBRATION GRAPHS

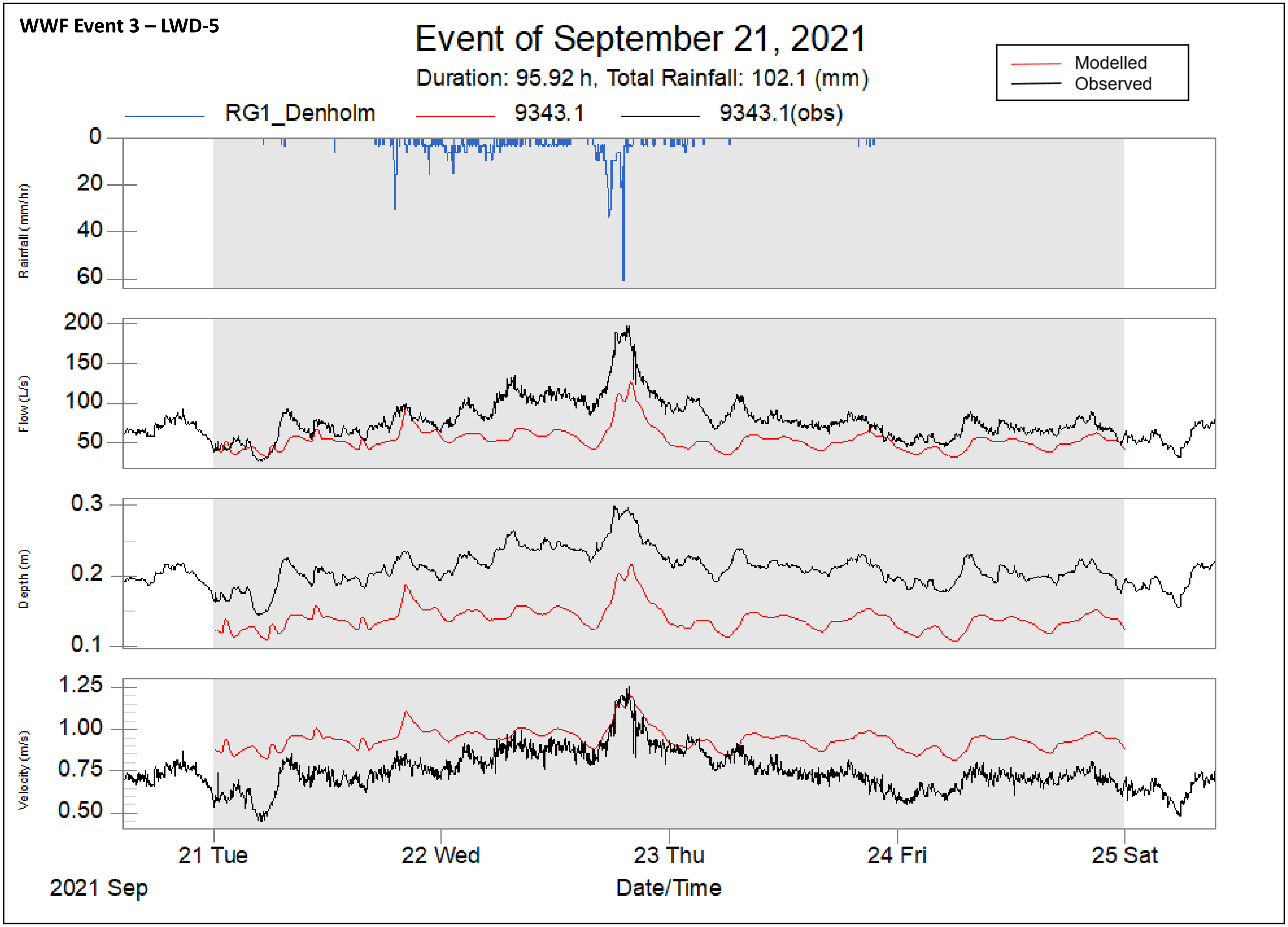

WWF Event 3 – C29-8
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
RG1_Denholm
12101.1
12101.1(obs)
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
150
100
50
0
Depth (m)
1.0
0.5
0
Velocity (m/s)
1.5
1.0
0.5
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time


WWF Event 3 – FWL-13
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
RG1_Denholm
9205.1
9205.1(obs)
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
1000
500
0
Depth (m)
1.5
1.0
0.5
0
Velocity (m/s)
2
1
0
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time

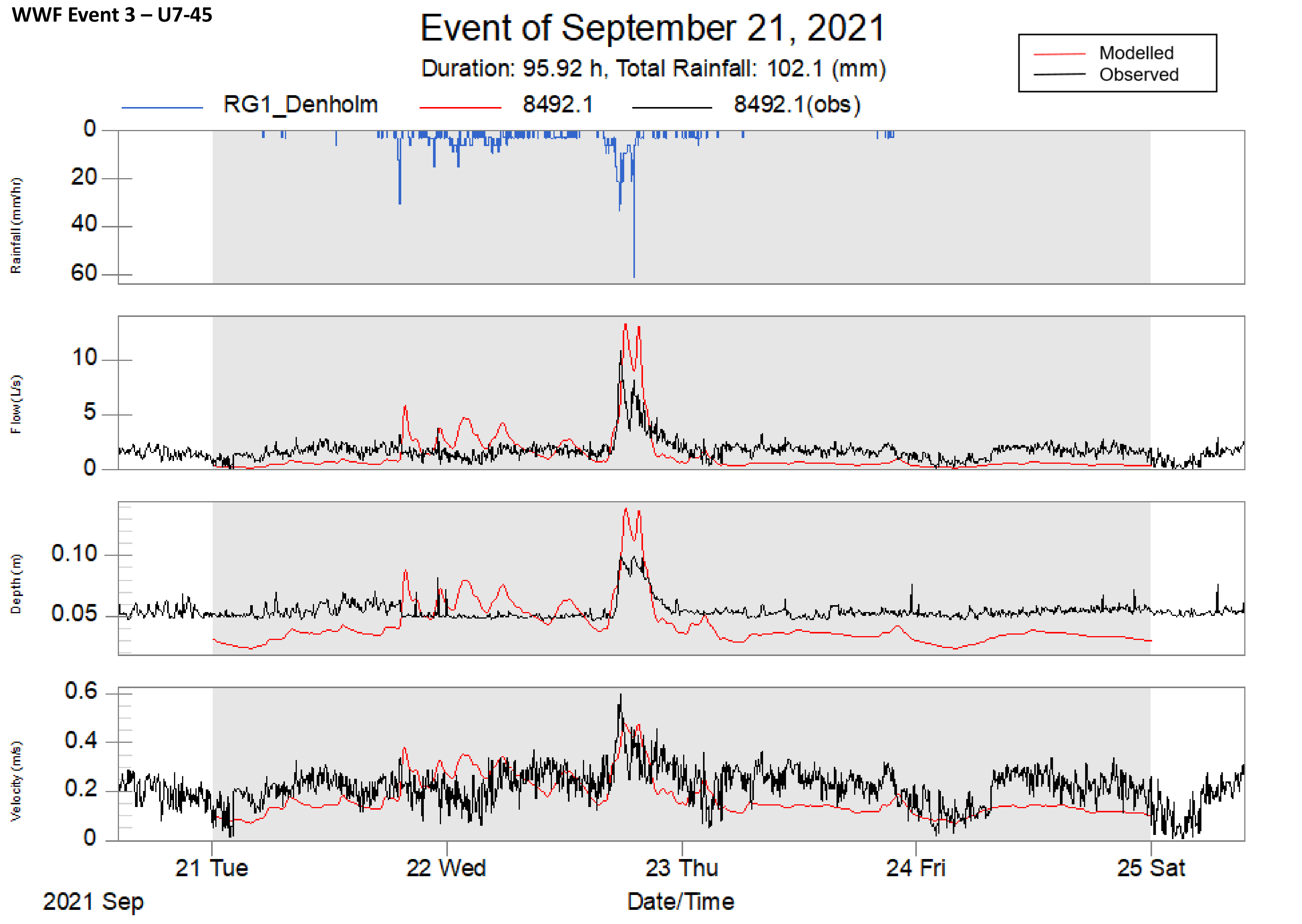

WWF Event 3 – FWL-34
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
RG1_Denholm
10068.1
10068.1(obs)
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
100
50
Depth (m)
0.25
0.20
0.15
0.10
Velocity (m/s)
0.8
0.6
0.4
0.2
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time

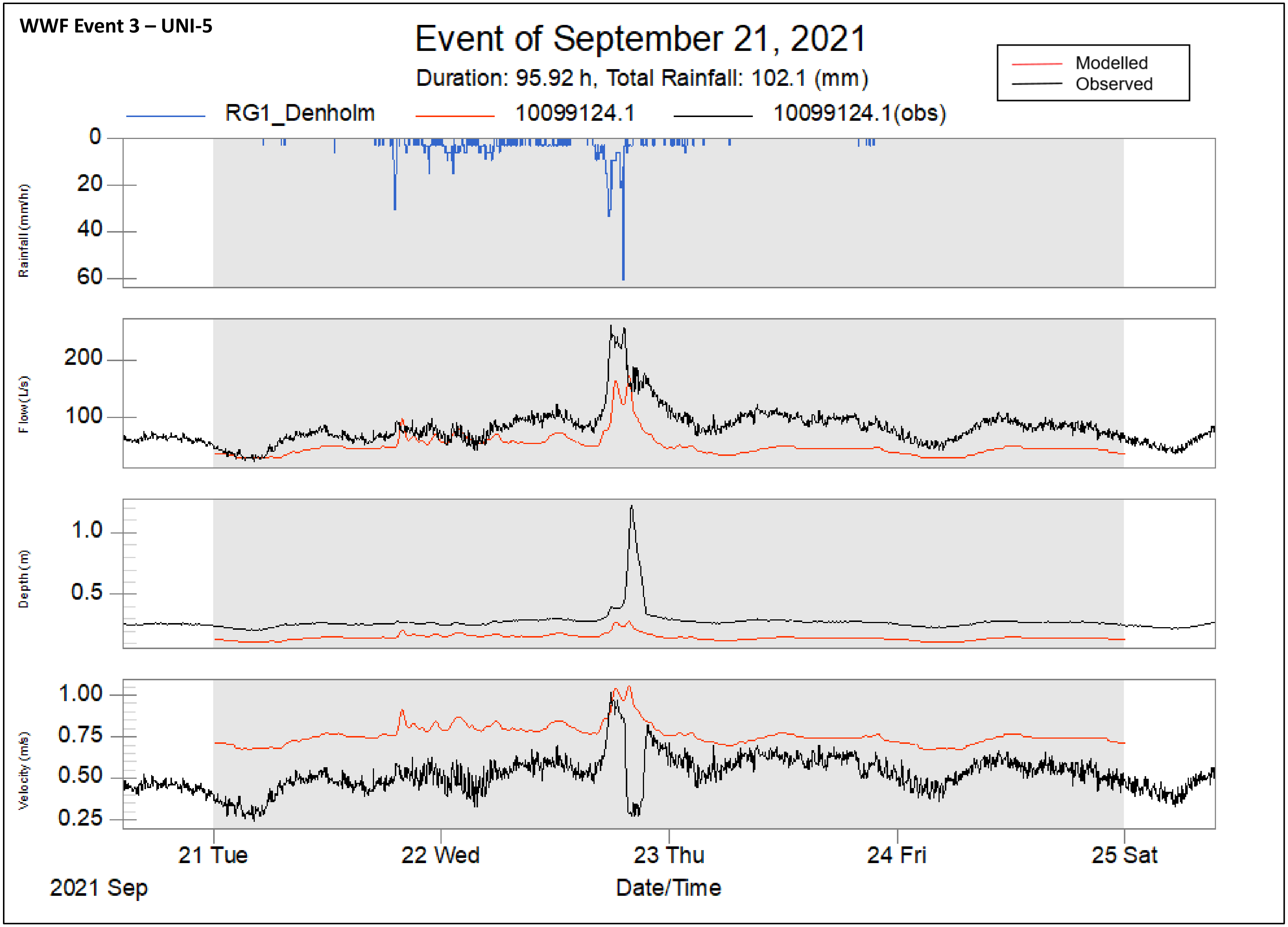


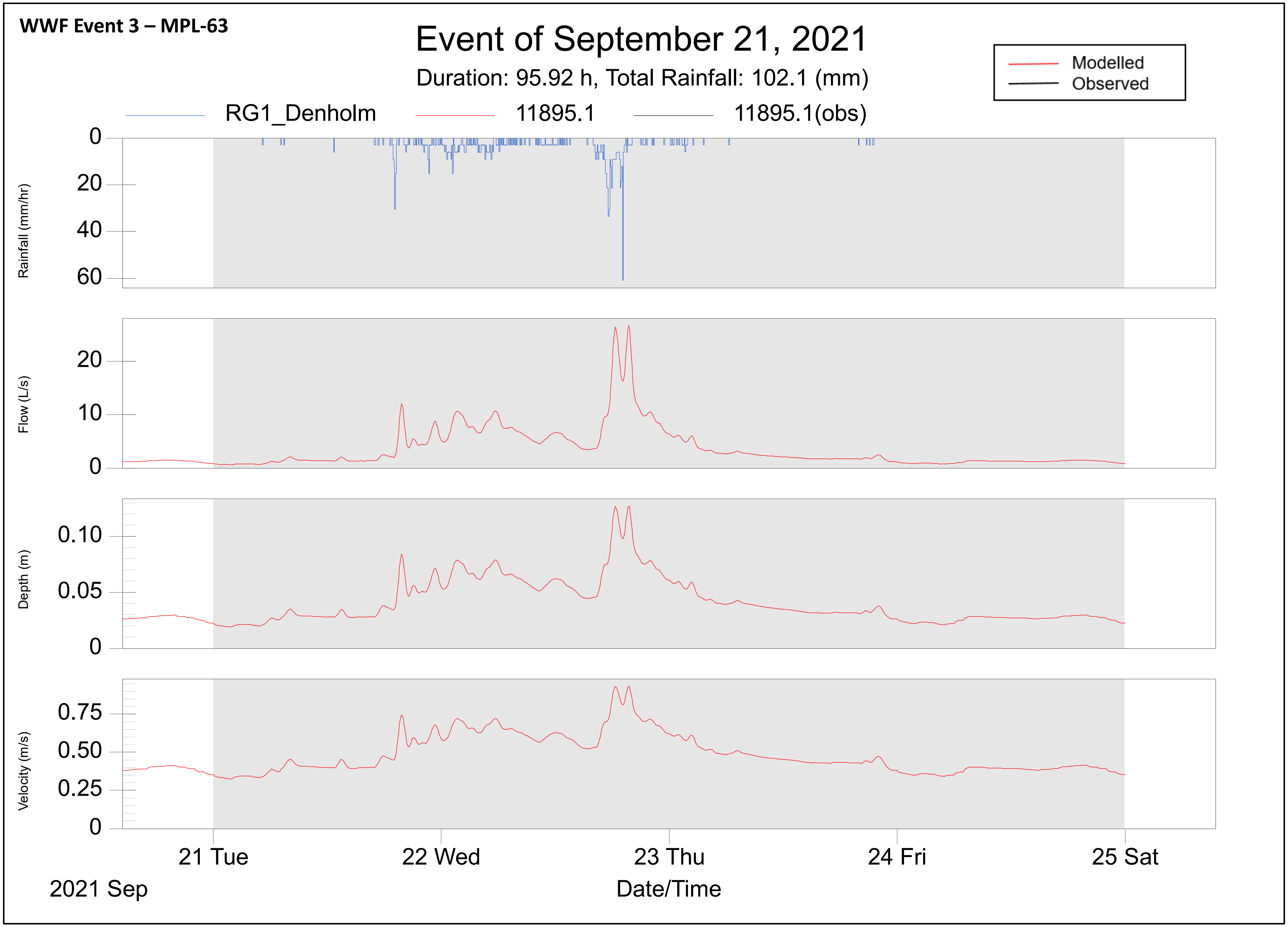
WWF Event 3 – LEE-55
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
RG1_Denholm
11773.1
11773.1(obs)
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
30
20
10
0
Depth (m)
0.15
0.10
0.05
Velocity (m/s)
0.8
0.6
0.4
0.2
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time

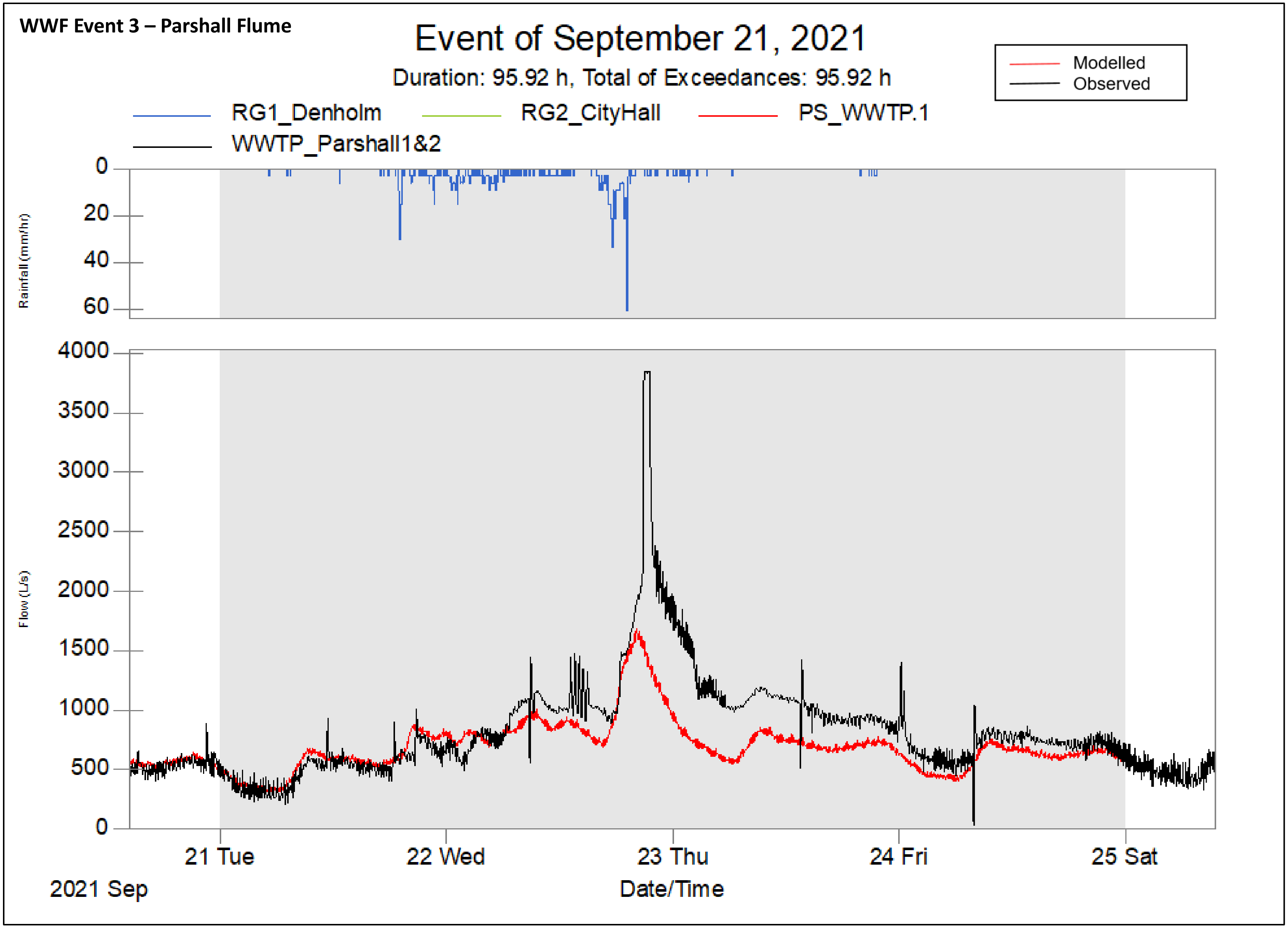

WWF Event 3 – LWD-5
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
RG1_Denholm
9343.1
9343.1(obs)
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
200
150
100
50
Depth (m)
0.3
0.2
0.1
Velocity (m/s)
1.25
1.00
0.75
0.50
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time

WWF Event 3 – U7-45



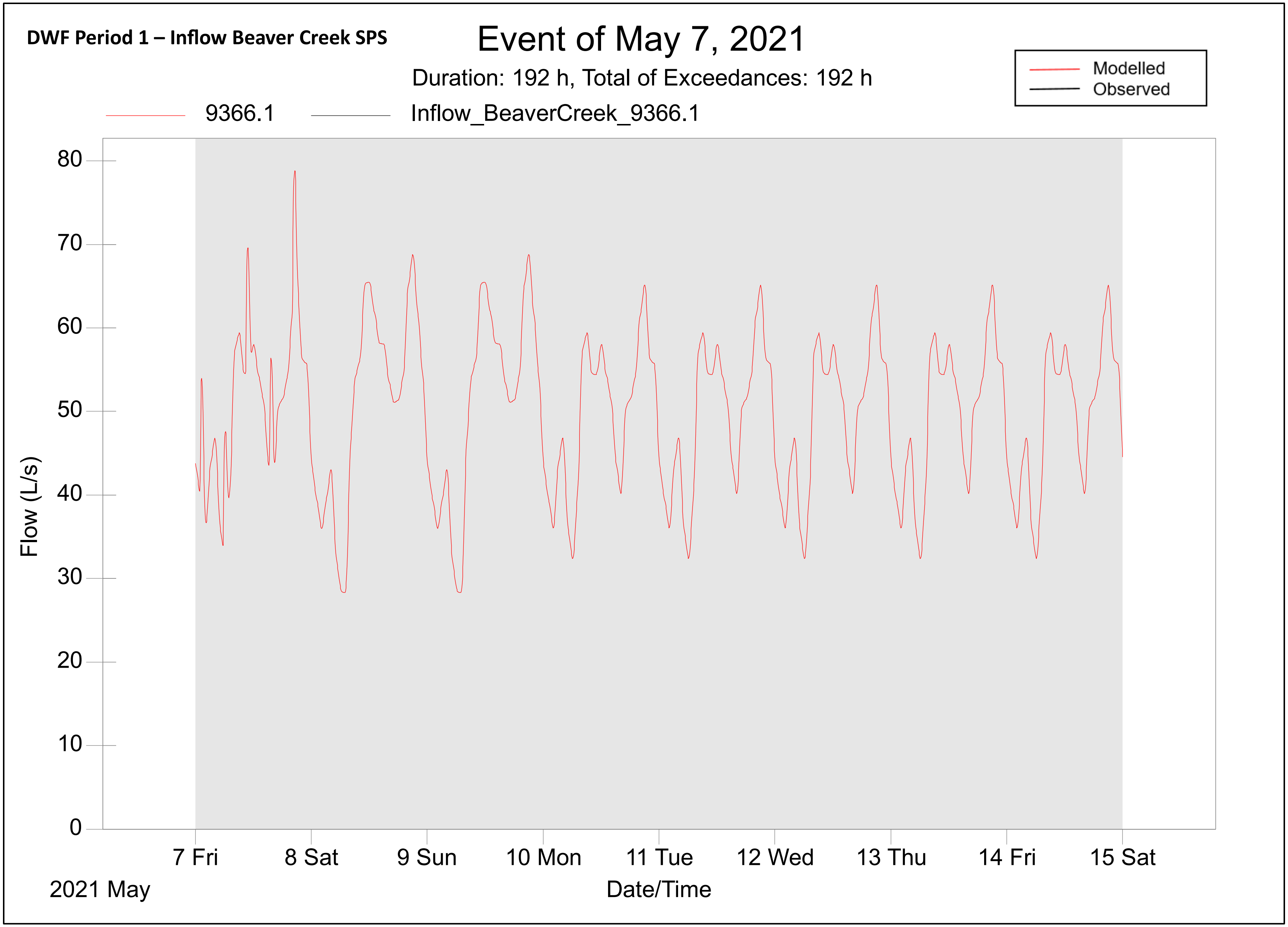

WWF Event 3 – UNI-5
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
RG1_Denholm
10099124.1
10099124.1(obs)
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
200
100
Depth (m)
1.0
0.5
Velocity (m/s)
1.00
0.75
0.50
0.25
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time

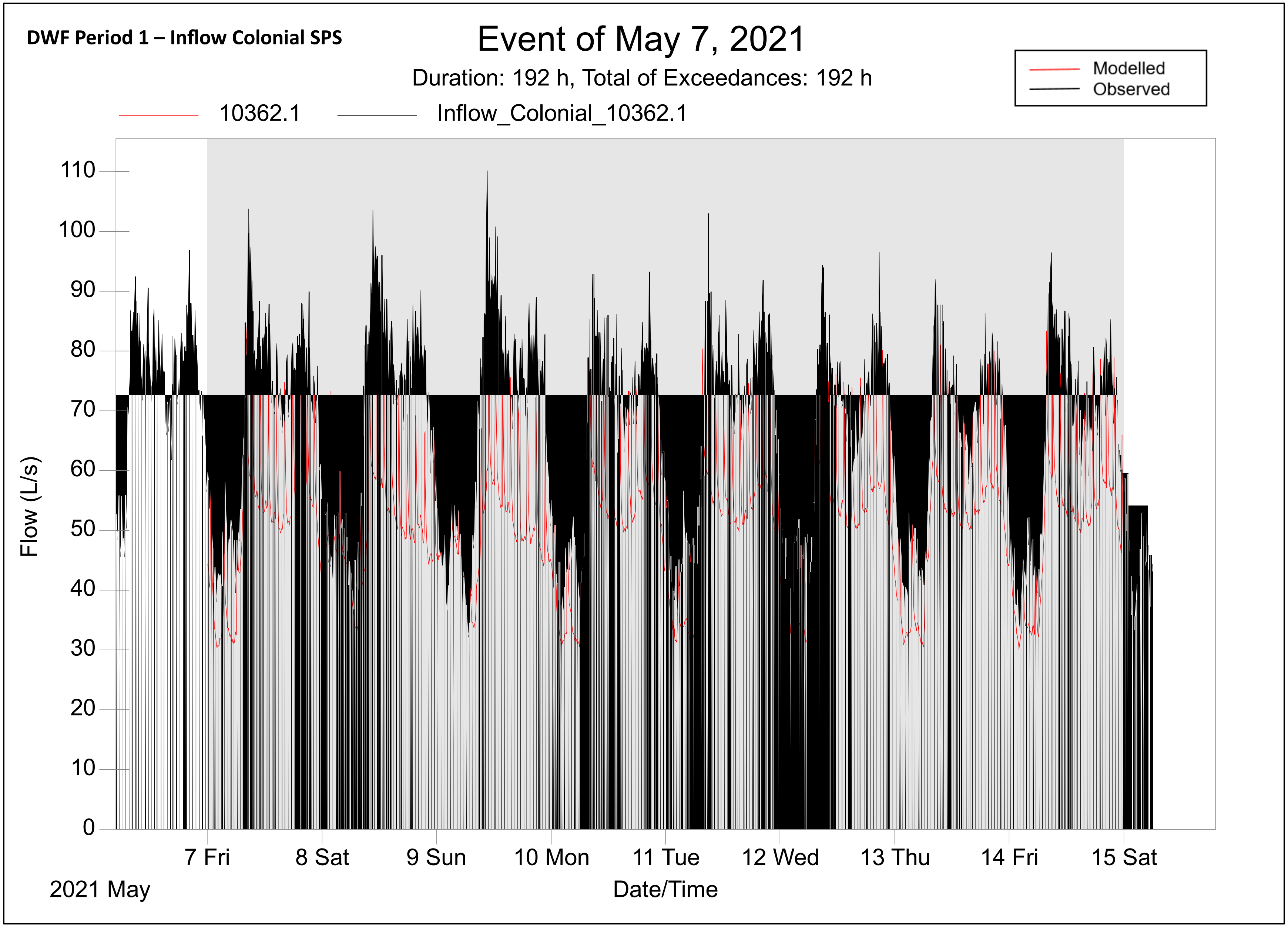

WWF Event 3 – MPL-63
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
RG1_Denholm
11895.1
11895.1(obs)
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
20
10
0
Depth (m)
0.10
0.05
0
Velocity (m/s)
0.75
0.50
0.25
0
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time


WWF Event 3 – Parshall Flume
Event of September 21, 2021
Duration: 95.92 h, Total of Exceedances: 95.92 h
Modelled
Observed
RG1_Denholm
RG2_CityHall
PS_WWTP.1
WWTP_Parshall1&2
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
4000
3500
3000
2500
2000
1500
1000
500
0
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time

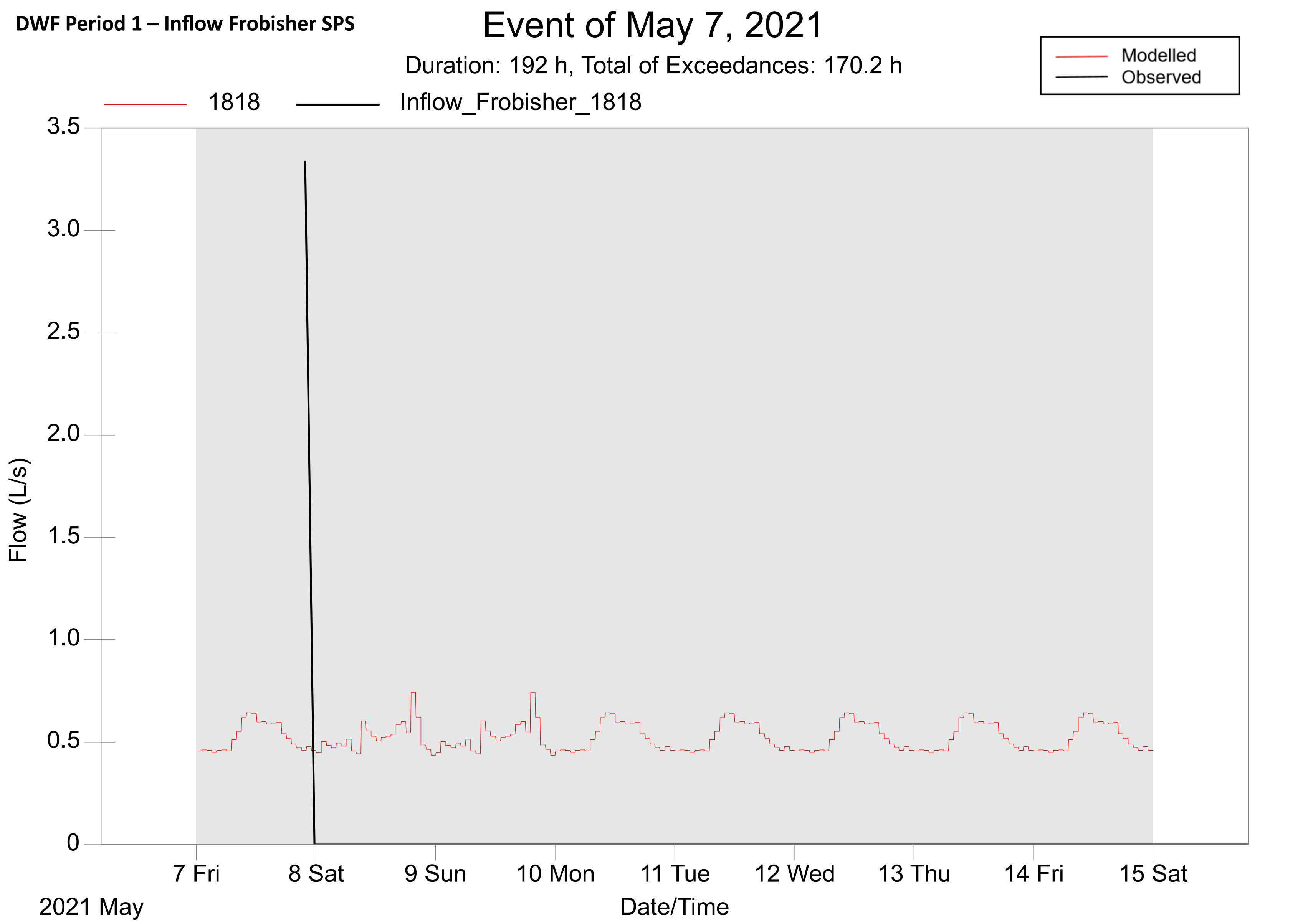
Appendix B PUMPING STATION VALIDATION GRAPHS

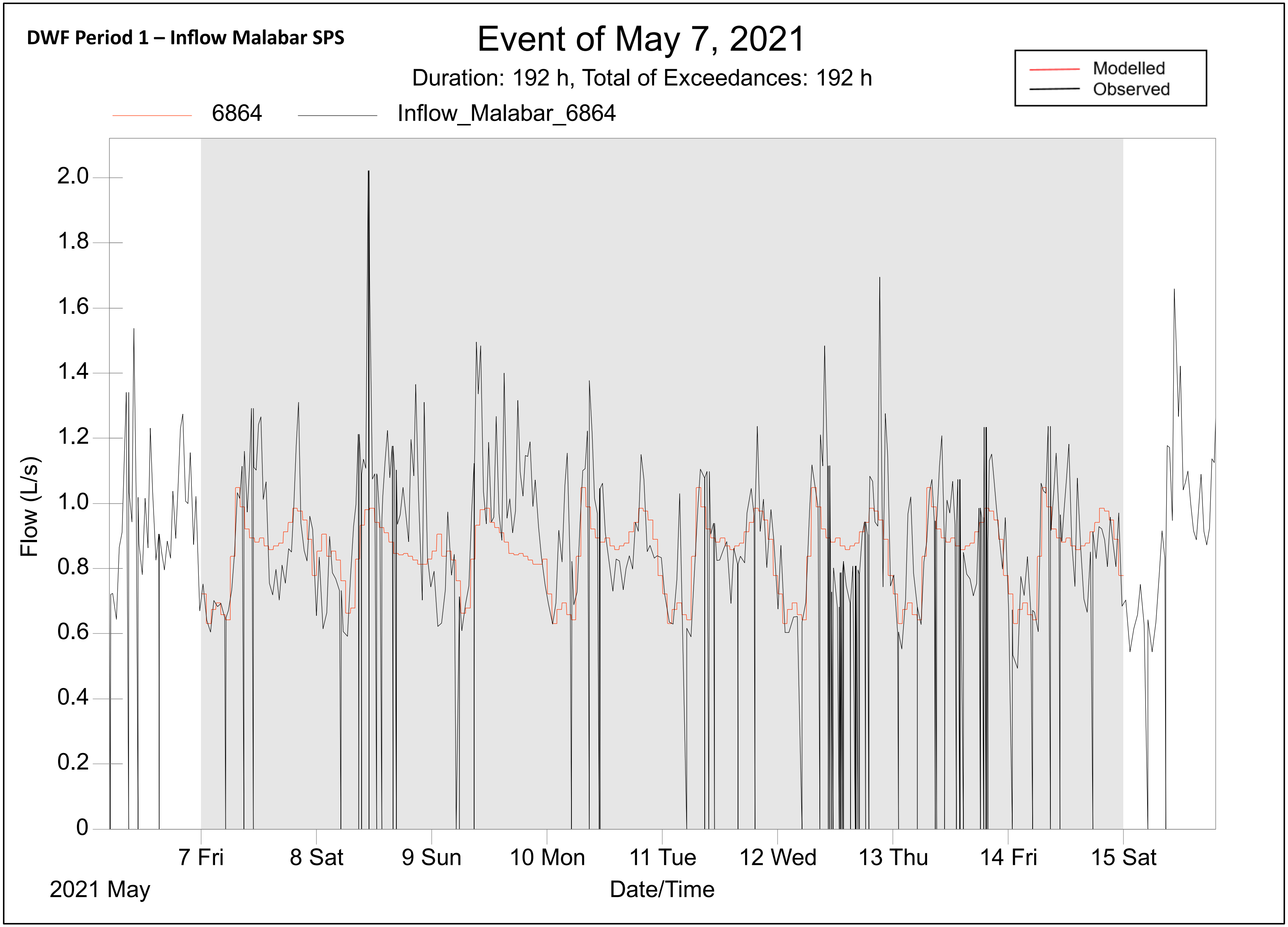
DWF PERIOD 1 – PUMPING STATION VALIDATION

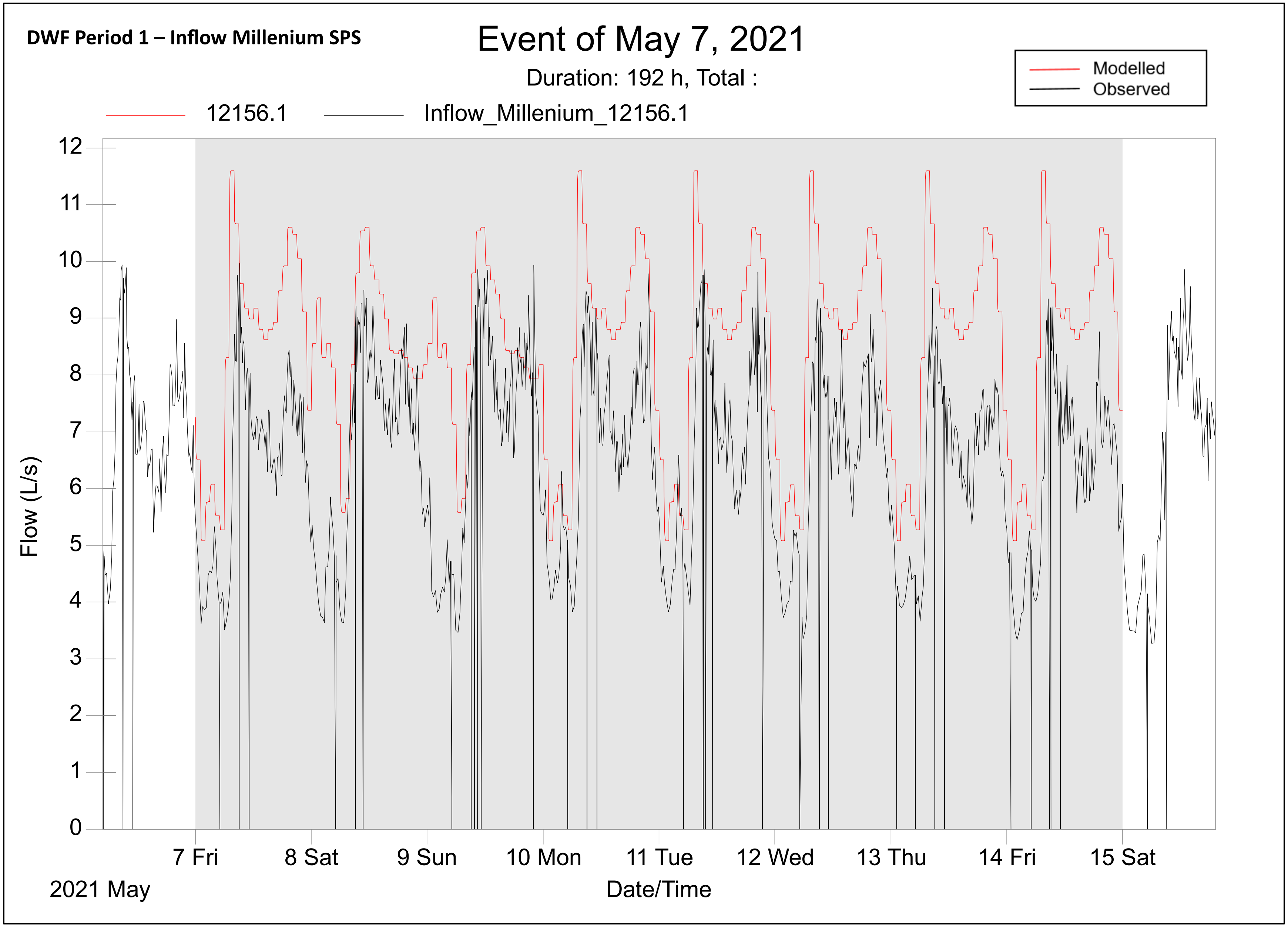

DWF Period 1 – Inflow Beaver Creek SPS
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
9366.1
Inflow_BeaverCreek_9366.1
Modelled
Observed
Flow (L/s)
80
70
60
50
40
30
20
10
0
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time

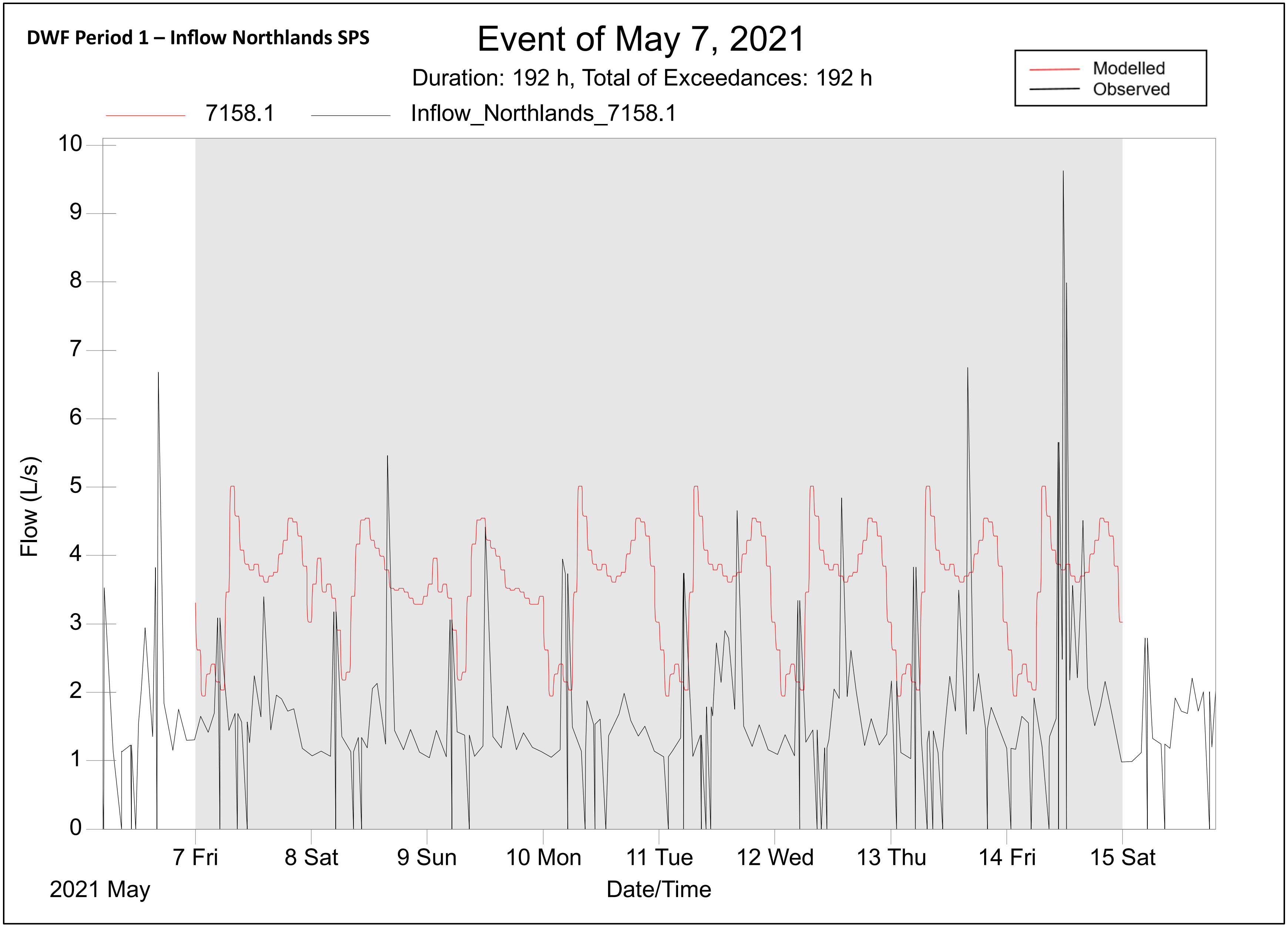

DWF Period 1 – Inflow Colonial SPS
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
10362.1
Inflow_Colonial_10362.1
Modelled
Observed
Flow (L/s)
110
100
90
80
70
60
50
40
30
20
10
0
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time

DWF Period 1 – Inflow Frobisher SPS

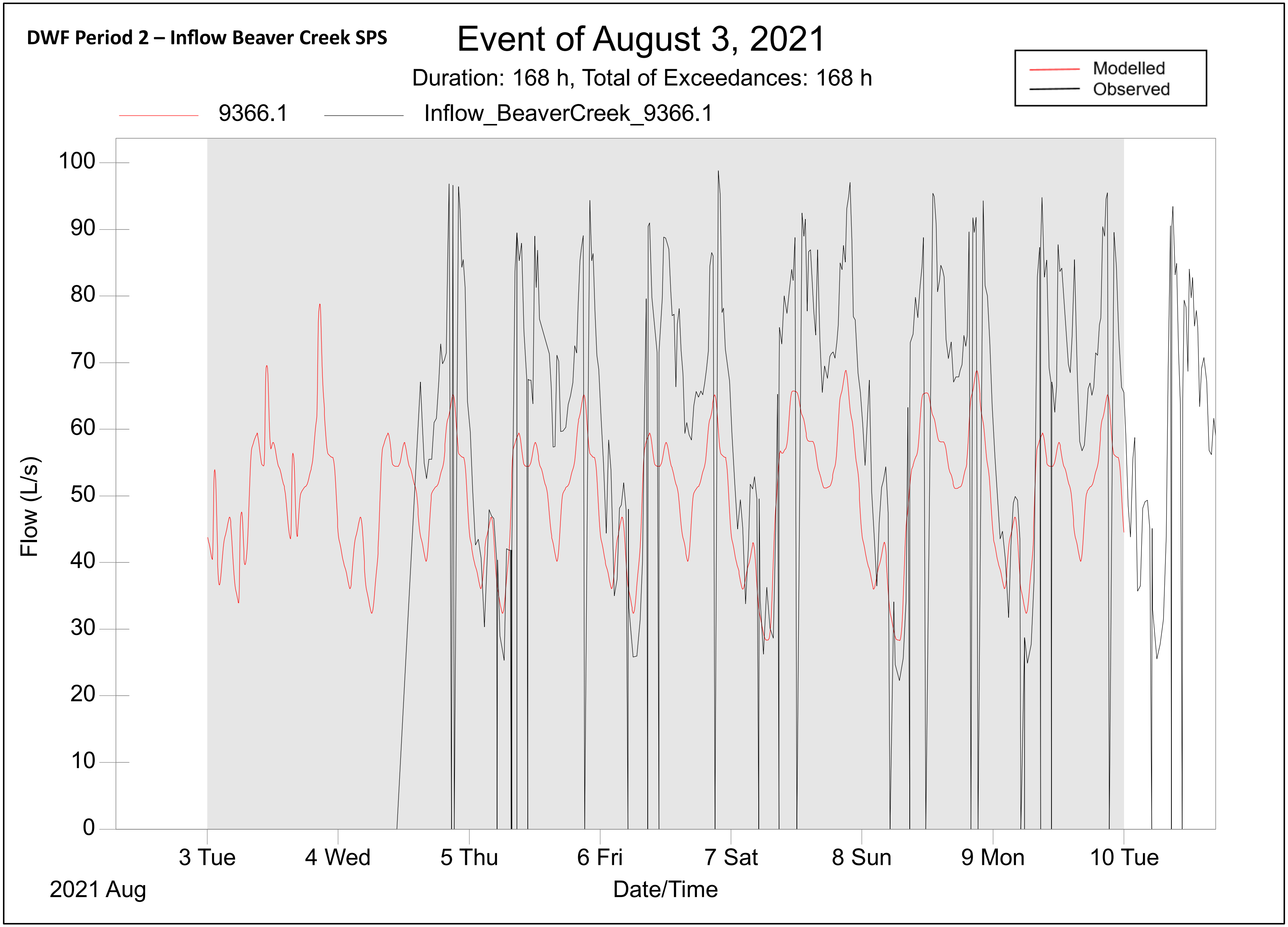


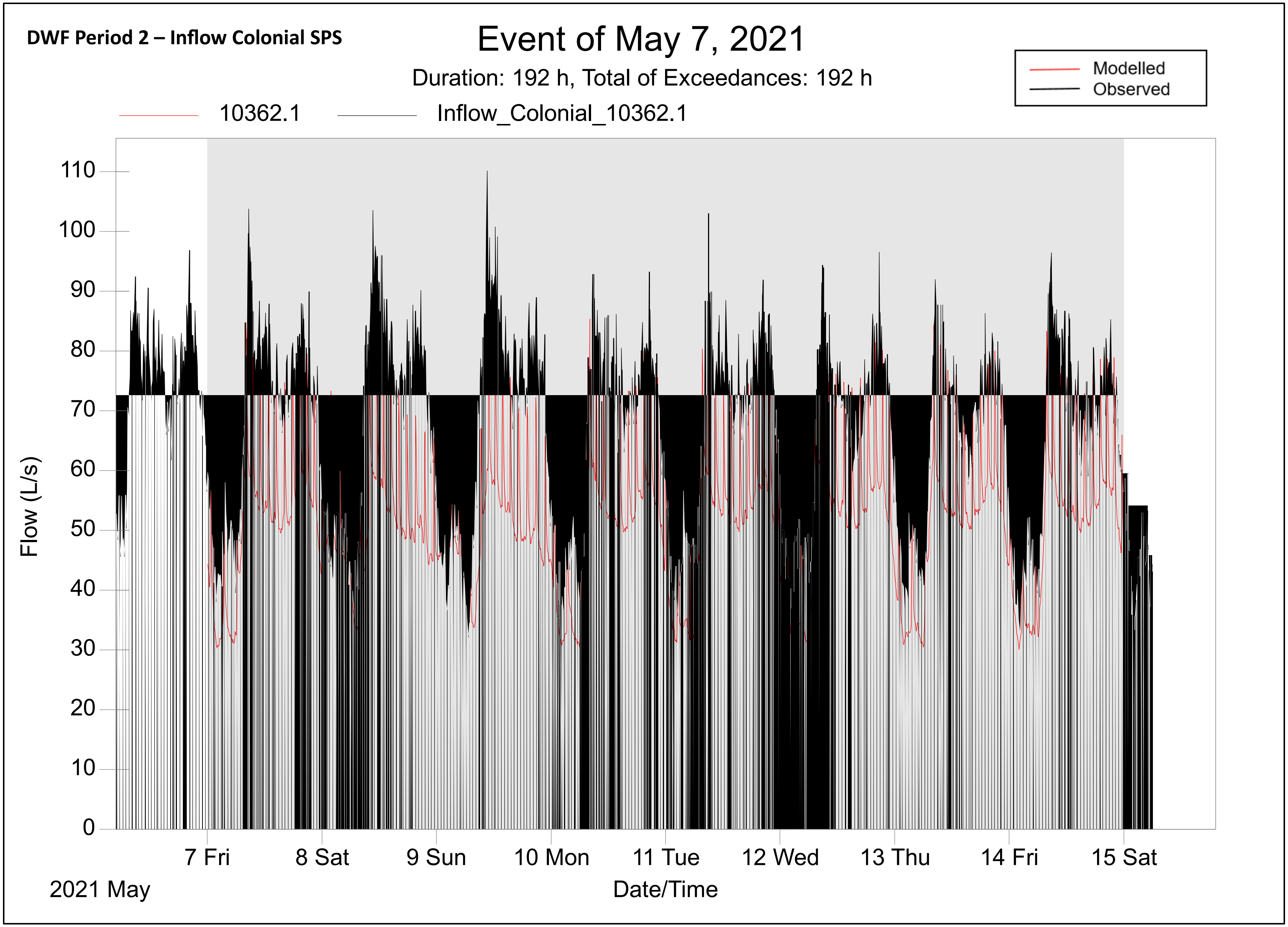

DWF Period 1 – Inflow Malabar SPS
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
Modelled
Observed
6864
Inflow_Malabar_6864
Flow (L/s)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time

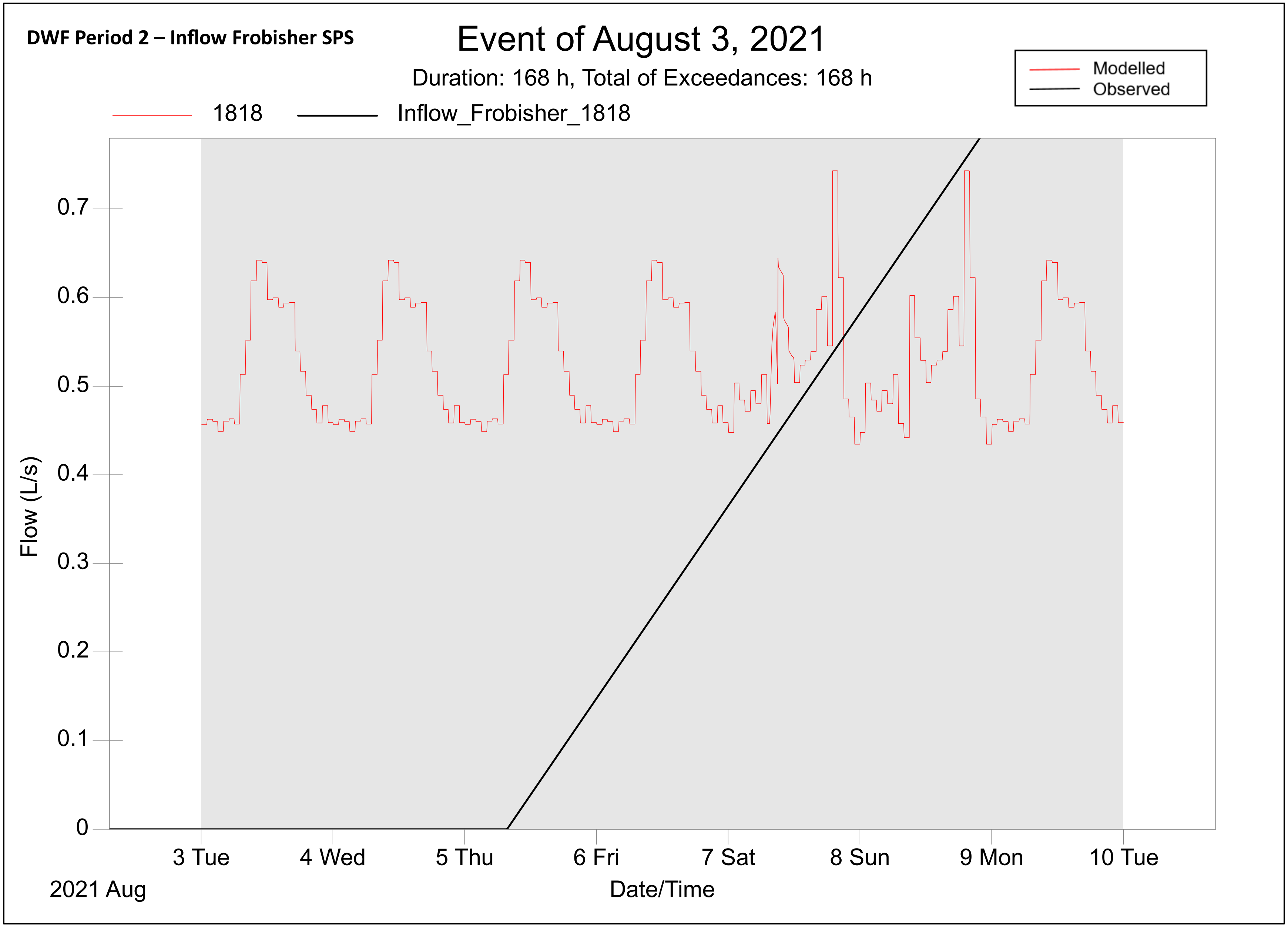

DWF Period 1 – Inflow Millenium SPS
Event of May 7, 2021
Duration: 192 h, Total :
12156.1
Inflow_Millenium_12156.1
Modelled
Observed
Flow (L/s)
0
1
2
3
4
5
6
7
8
9
10
11
12
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time


DWF Period 1 – Inflow Northlands SPS
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
Modelled
Observed
7158.1
Inflow_Northlands_7158.1
Flow (L/s)
0
1
2
3
4
5
6
7
8
9
10
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time

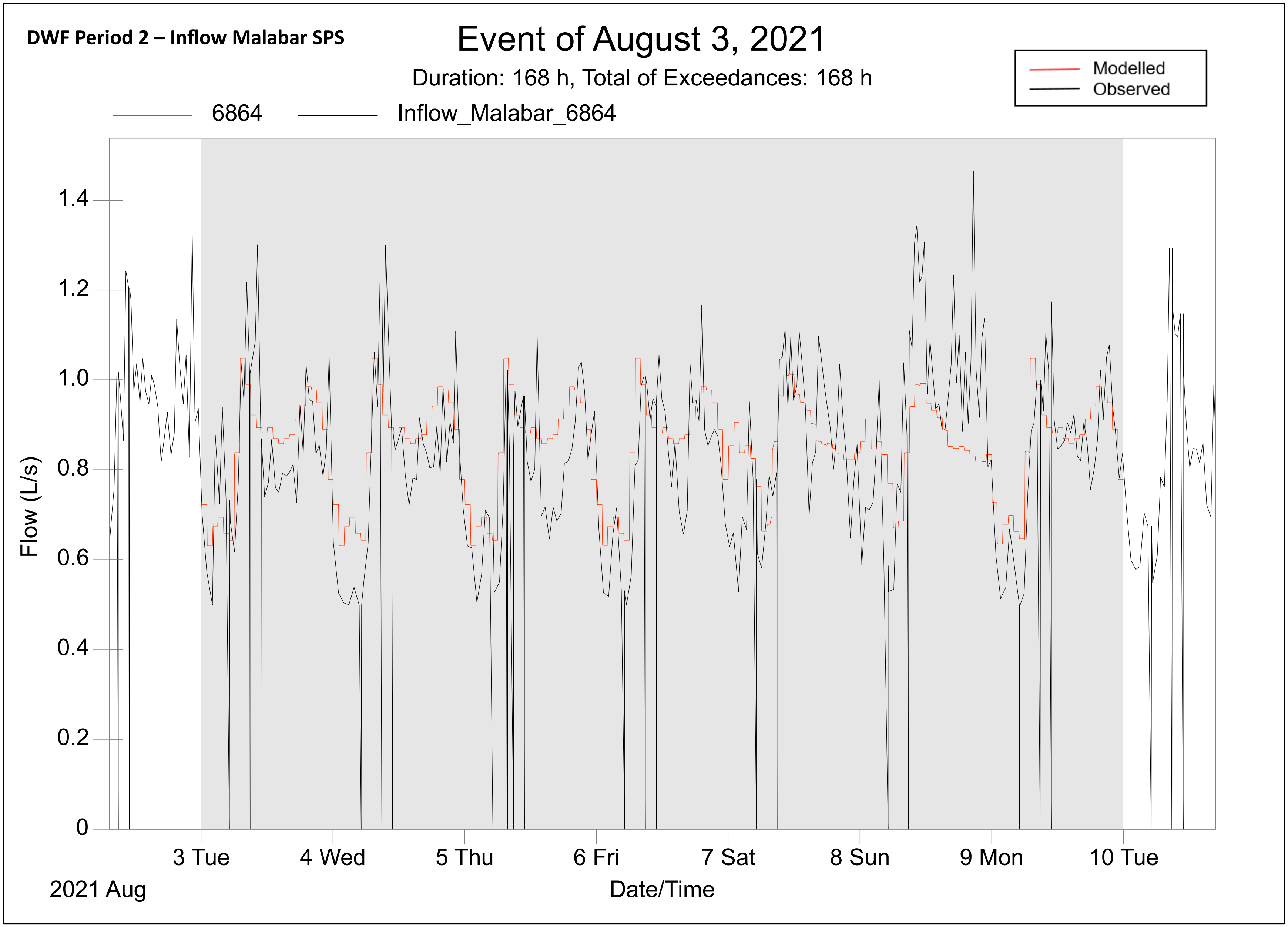
DWF PERIOD 2 – PUMPING STATION VALIDATION

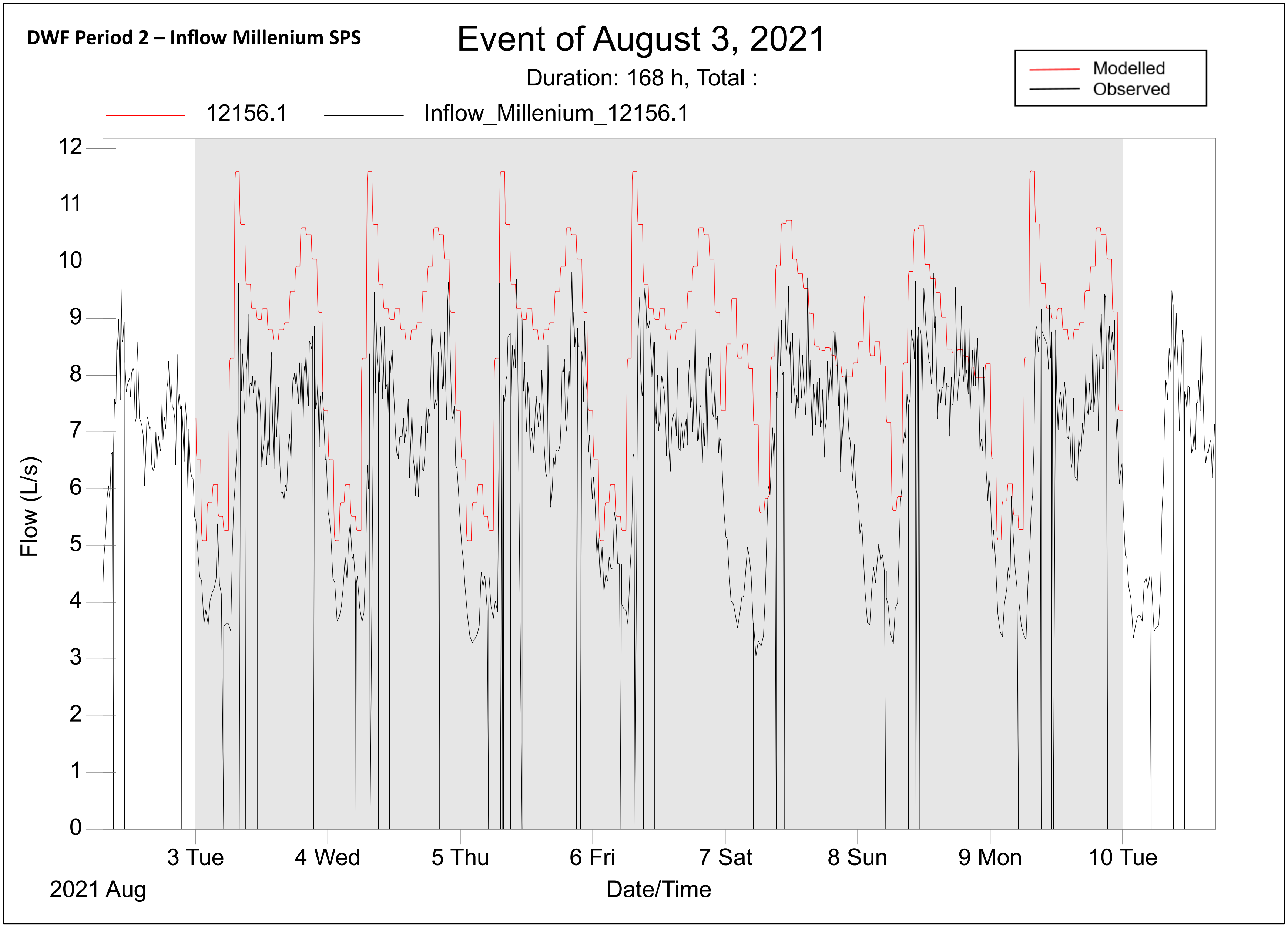

DWF Period 2 – Inflow Beaver Creek SPS
Event of August 3, 2021
Duration: 168 h, Total of Exceedances: 168 h
9366.1
Inflow_BeaverCreek_9366.1
Modelled
Observed
Flow (L/s)
100
90
80
70
60
50
40
30
20
10
0
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time

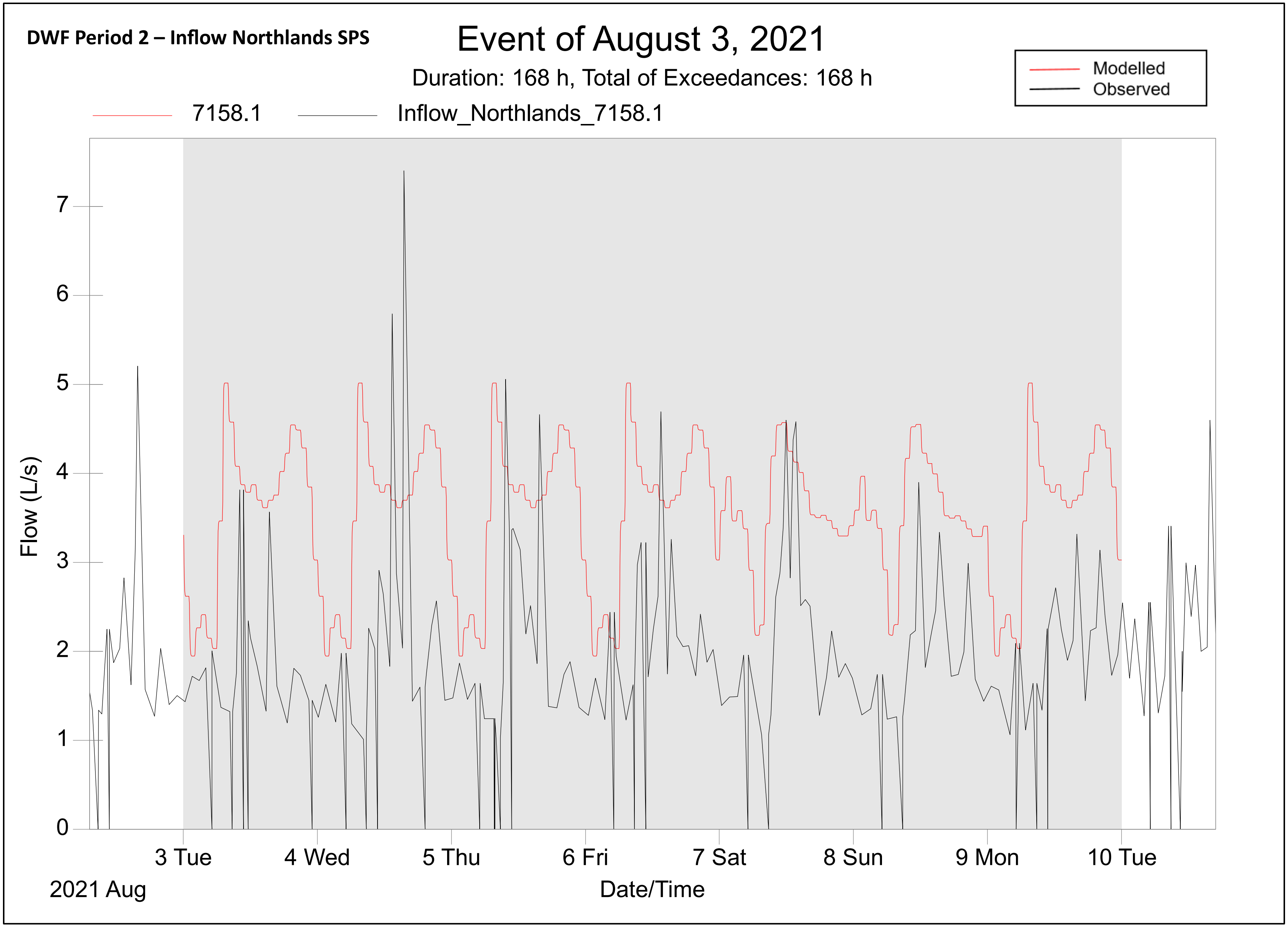

DWF Period 2 – Inflow Colonial SPS
Event of May 7, 2021
Duration: 192 h, Total of Exceedances: 192 h
10362.1
Inflow_Colonial_10362.1
Modelled
Observed
Flow (L/s)
110
100
90
80
70
60
50
40
30
20
10
0
7 Fri
8 Sat
9 Sun
10 Mon
11 Tue
12 Wed
13 Thu
14 Fri
15 Sat
2021 May
Date/Time



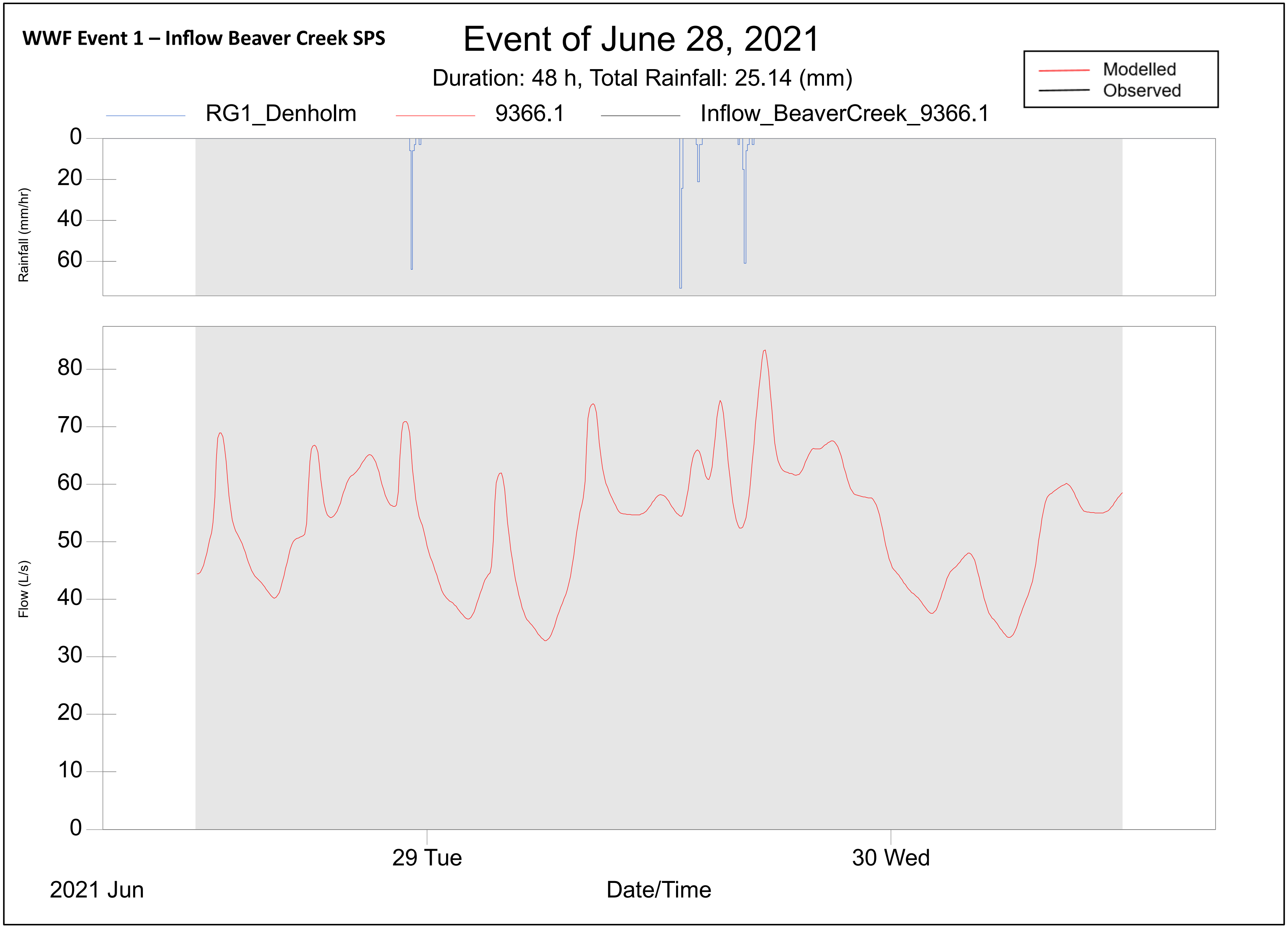
DWF Period 2 – Inflow Frobisher SPS
Event of August 3, 2021
Duration: 168 h, Total of Exceedances: 168 h
1818
Inflow_Frobisher_1818
Modelled
Observed
Flow (L/s)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time

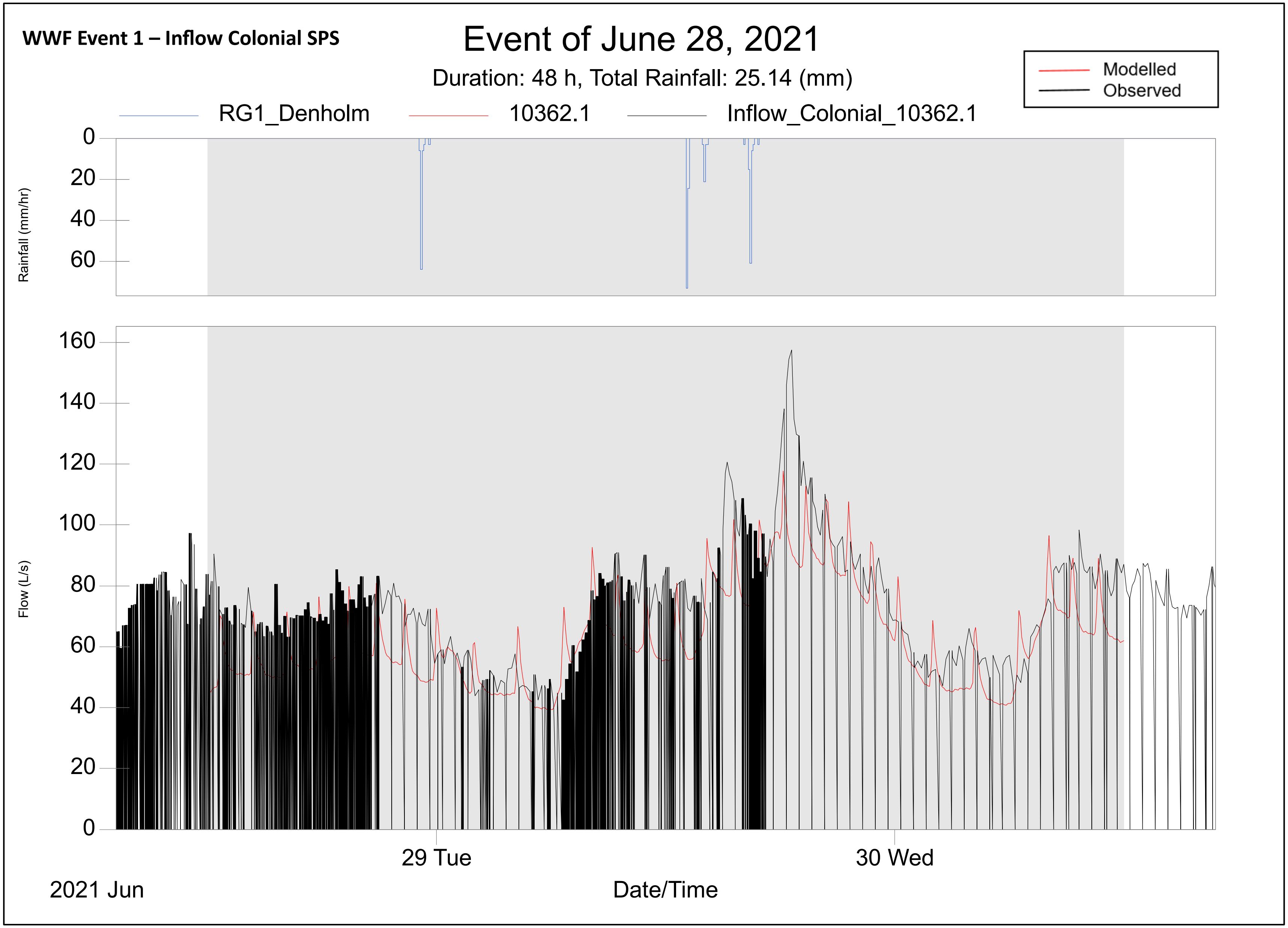

DWF Period 2 – Inflow Malabar SPS
Event of August 3, 2021
Duration: 168 h, Total of Exceedances: 168 h
6864
Inflow_Malabar_6864
Modelled
Observed
Flow (L/s)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time

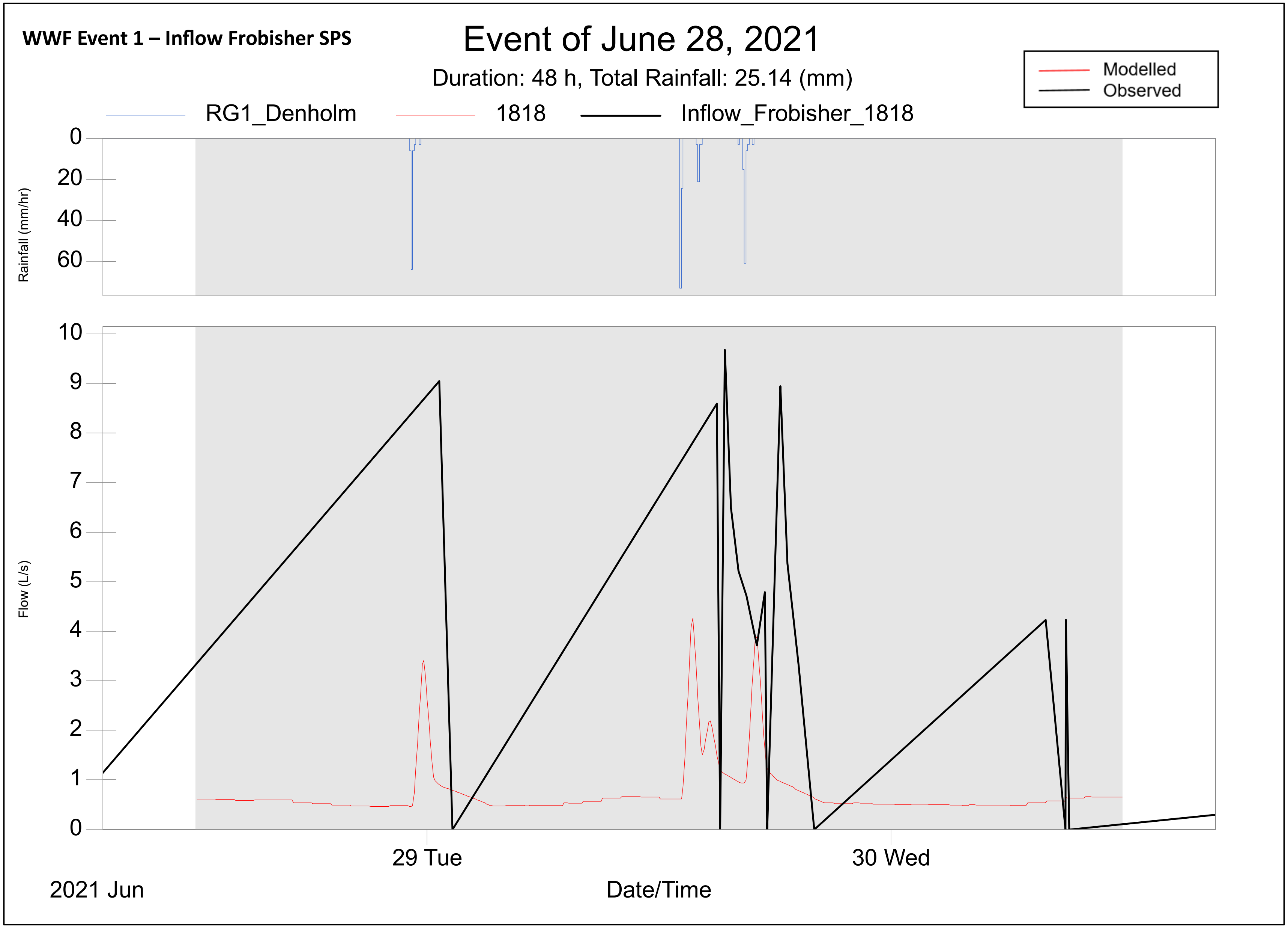

DWF Period 2 – Inflow Millenium SPS
Event of August 3, 2021
Duration: 168 h, Total :
12156.1
Inflow_Millenium_12156.1
Modelled
Observed
Flow (L/s)
12
11
10
9
8
7
6
5
4
3
2
1
0
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time

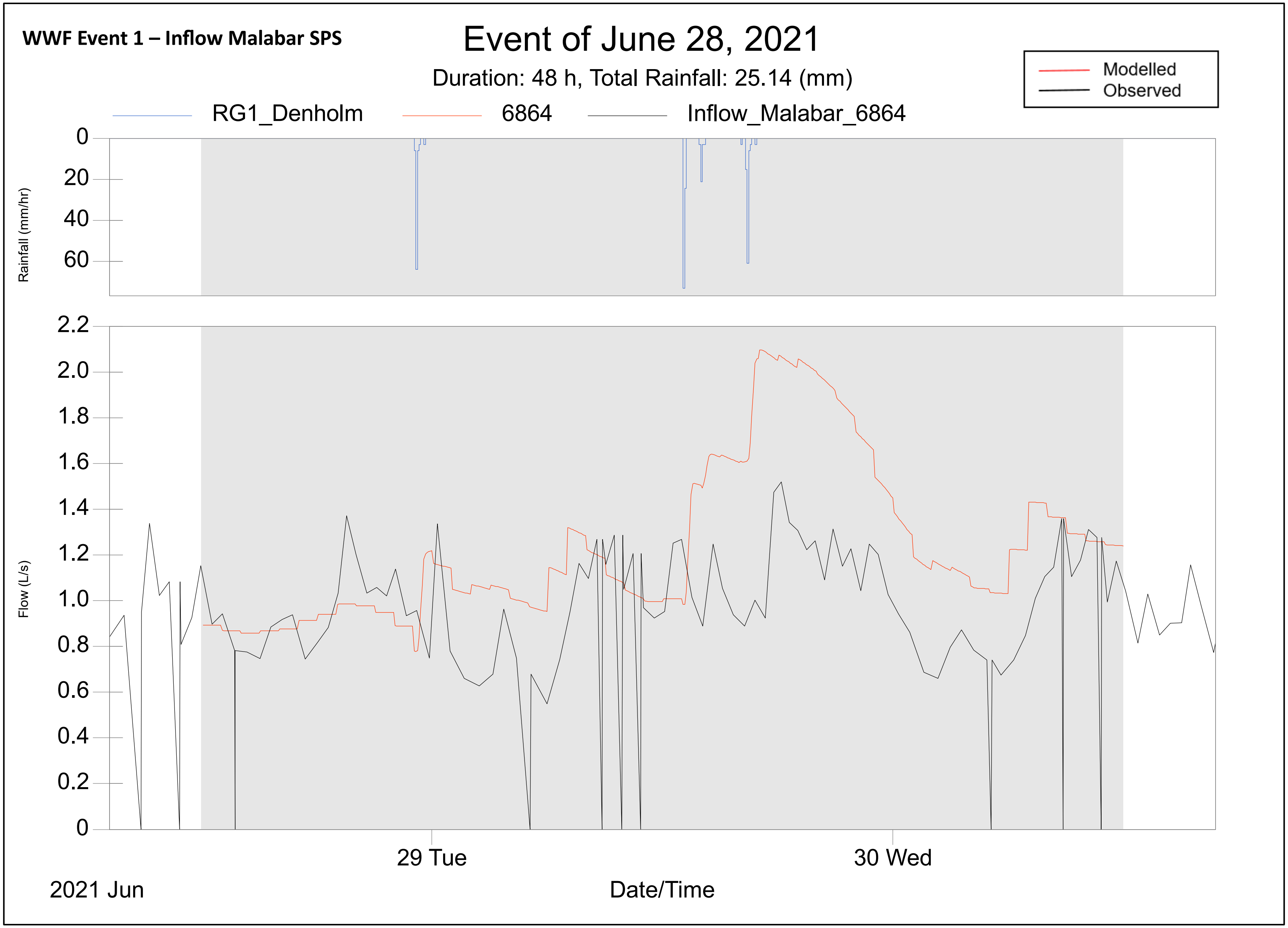

DWF Period 2 – Inflow Northlands SPS
Event of August 3, 2021
Duration: 168 h, Total of Exceedances: 168 h
Modelled
Observed
7158.1
Inflow_Northlands_7158.1
Flow (L/s)
0
1
2
3
4
5
6
7
3 Tue
4 Wed
5 Thu
6 Fri
7 Sat
8 Sun
9 Mon
10 Tue
2021 Aug
Date/Time

WWF EVENT 1 – PUMPING STATION VALIDATION

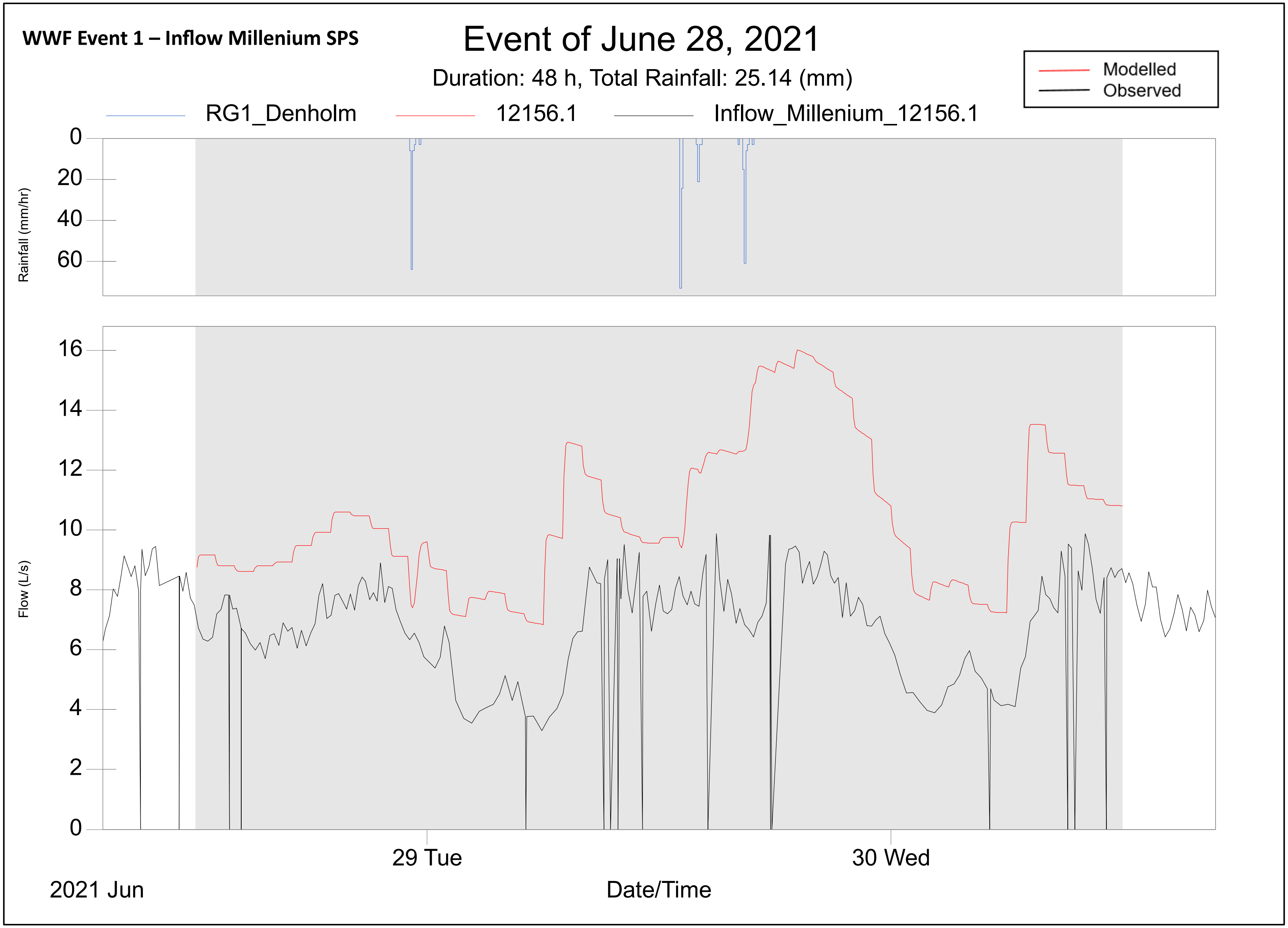

WWF Event 1 – Inflow Beaver Creek SPS
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 25.14 (mm)
Modelled
Observed
RG1_Denholm
9366.1
Inflow_BeaverCreek_9366.1
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
80
70
60
50
40
30
20
10
0
29 Tue
30 Wed
2021 Jun
Date/Time

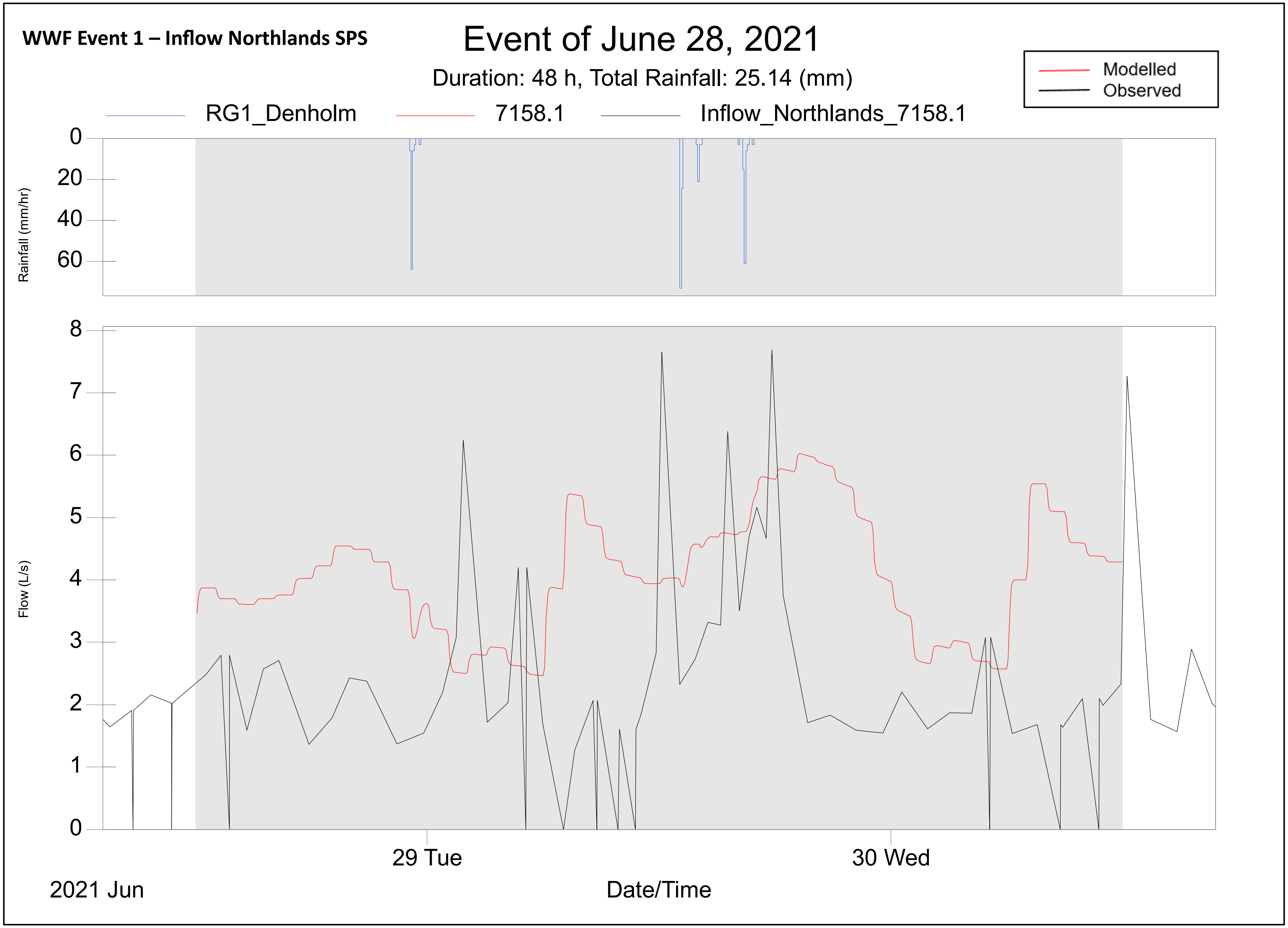

WWF Event 1 – Inflow Colonial SPS
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 25.14 (mm)
Modelled
Observed
RG1_Denholm
10362.1
Inflow_Colonial_10362.1
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
160
140
120
100
80
60
40
20
0
29 Tue
30 Wed
2021 Jun
Date/Time


WWF Event 1 – Inflow Frobisher SPS
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 25.14 (mm)
Modelled
Observed
RG1_Denholm
1818
Inflow_Frobisher_1818
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
10
9
8
7
6
5
4
3
2
1
0
29 Tue
30 Wed
2021 Jun
Date/Time

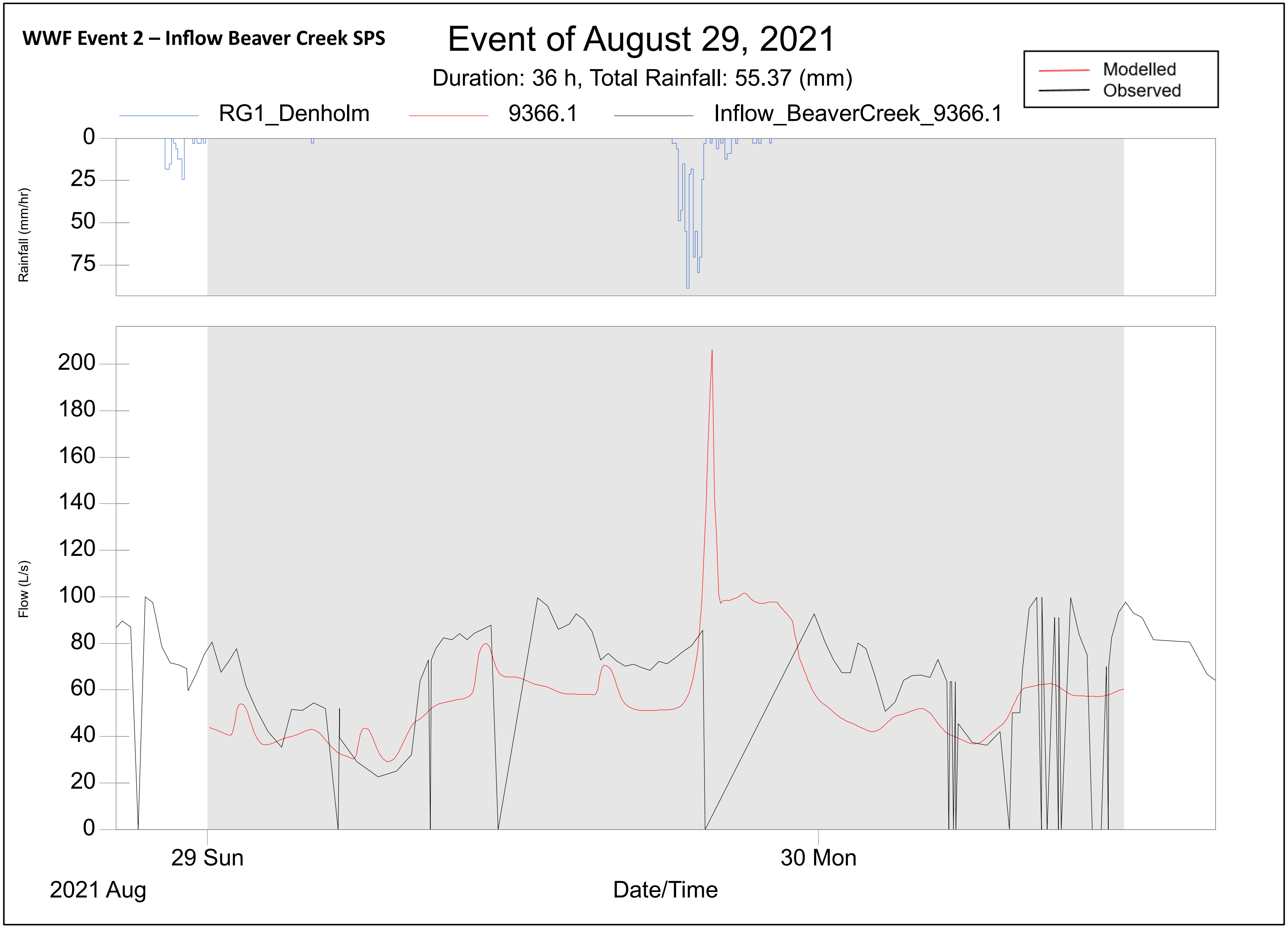


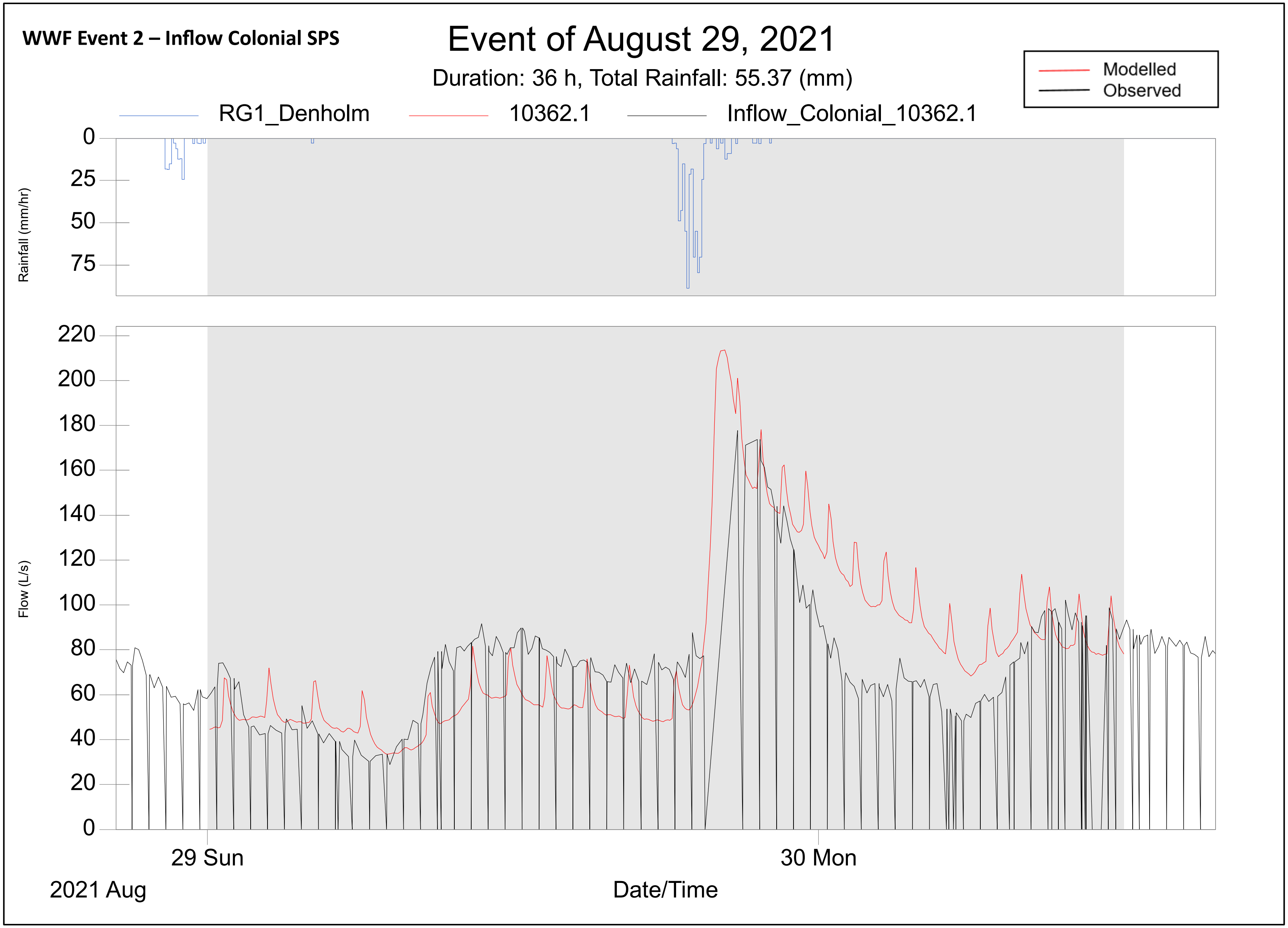
WWF Event 1 – Inflow Malabar SPS
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 25.14 (mm)
Modelled
Observed
RG1_Denholm
6864
Inflow_Malabar_6864
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
29 Tue
30 Wed
2021 Jun
Date/Time


WWF Event 1 – Inflow Millenium SPS
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 25.14 (mm)
Modelled
Observed
RG1_Denholm
12156.1
Inflow_Millenium_12156.1
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
16
14
12
10
8
6
4
2
0
29 Tue
30 Wed
2021 Jun
Date/Time

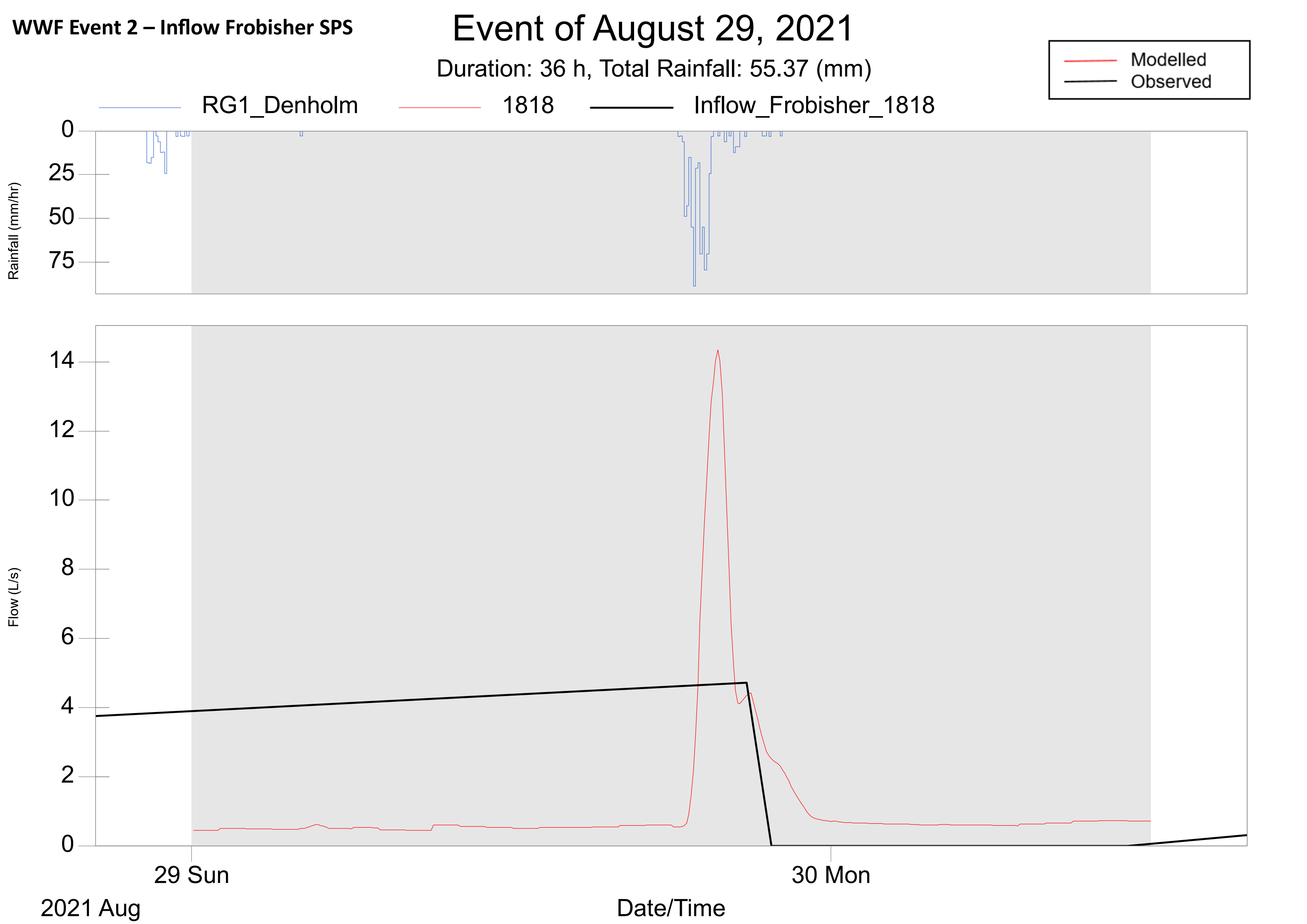

WWF Event 1 – Inflow Northlands SPS
Event of June 28, 2021
Duration: 48 h, Total Rainfall: 25.14 (mm)
Modelled
Observed
RG1_Denholm
7158.1
Inflow_Northlands_7158.1
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
8
7
6
5
4
3
2
1
0
29 Tue
30 Wed
2021 Jun
Date/Time

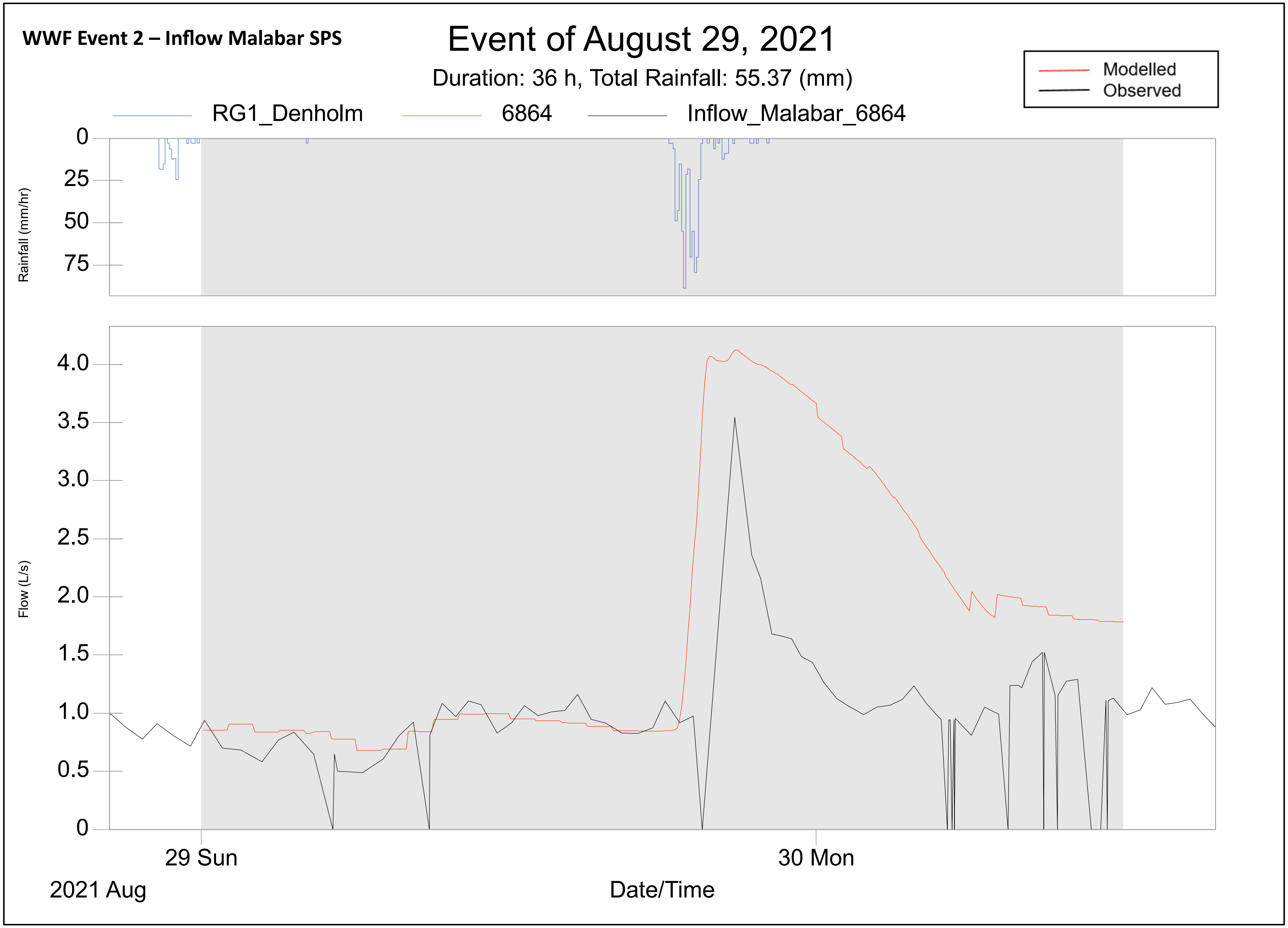
WWF EVENT 2 – PUMPING STATION VALIDATION

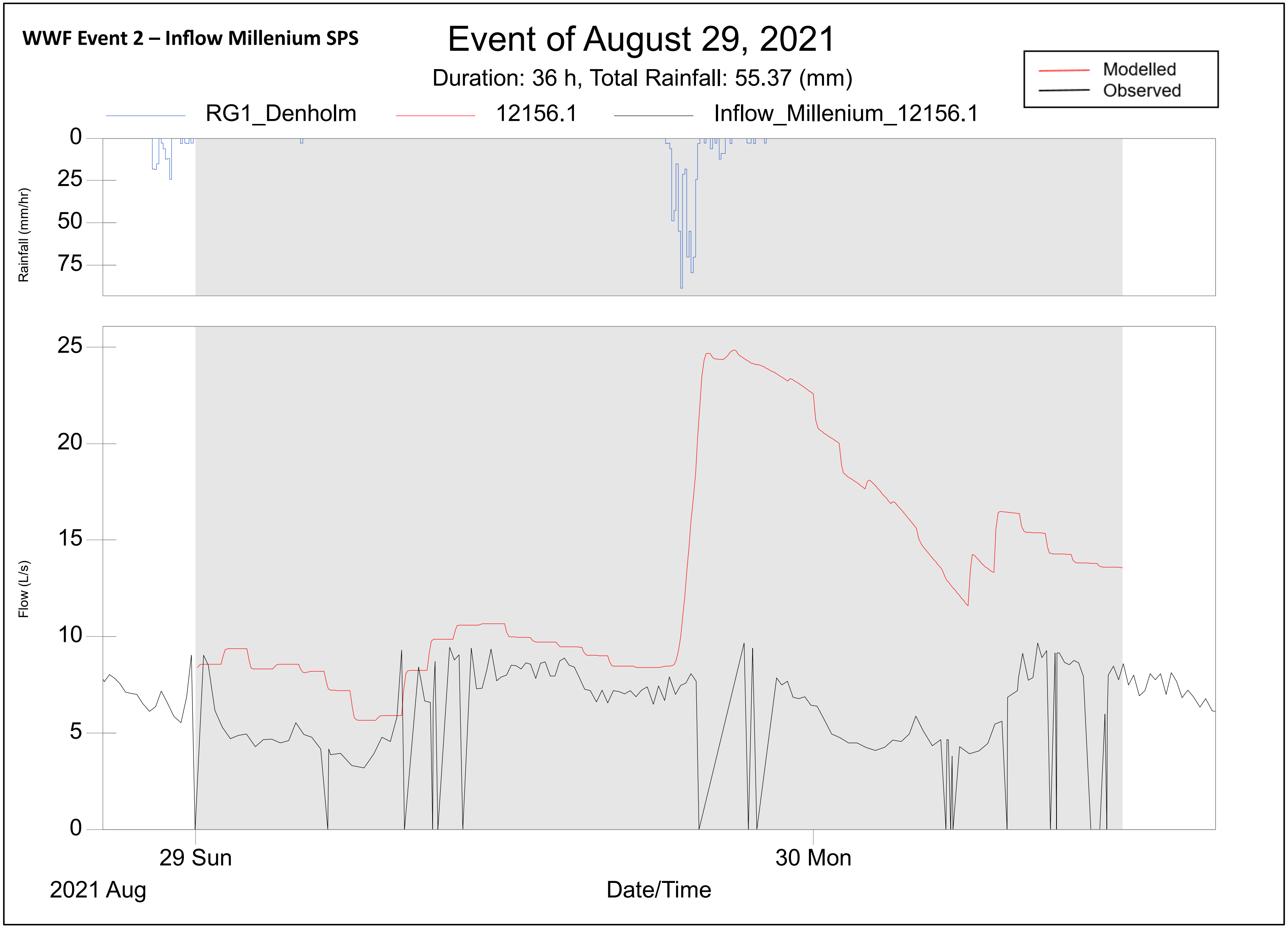

WWF Event 2 – Inflow Beaver Creek SPS
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 55.37 (mm)
Modelled
Observed
RG1_Denholm
9366.1
Inflow_BeaverCreek_9366.1
Rainfall (mm/hr)
0
25
50
75
Flow (L/s)
200
180
160
140
120
100
80
60
40
20
0
29 Sun
30 Mon
2021 Aug
Date/Time

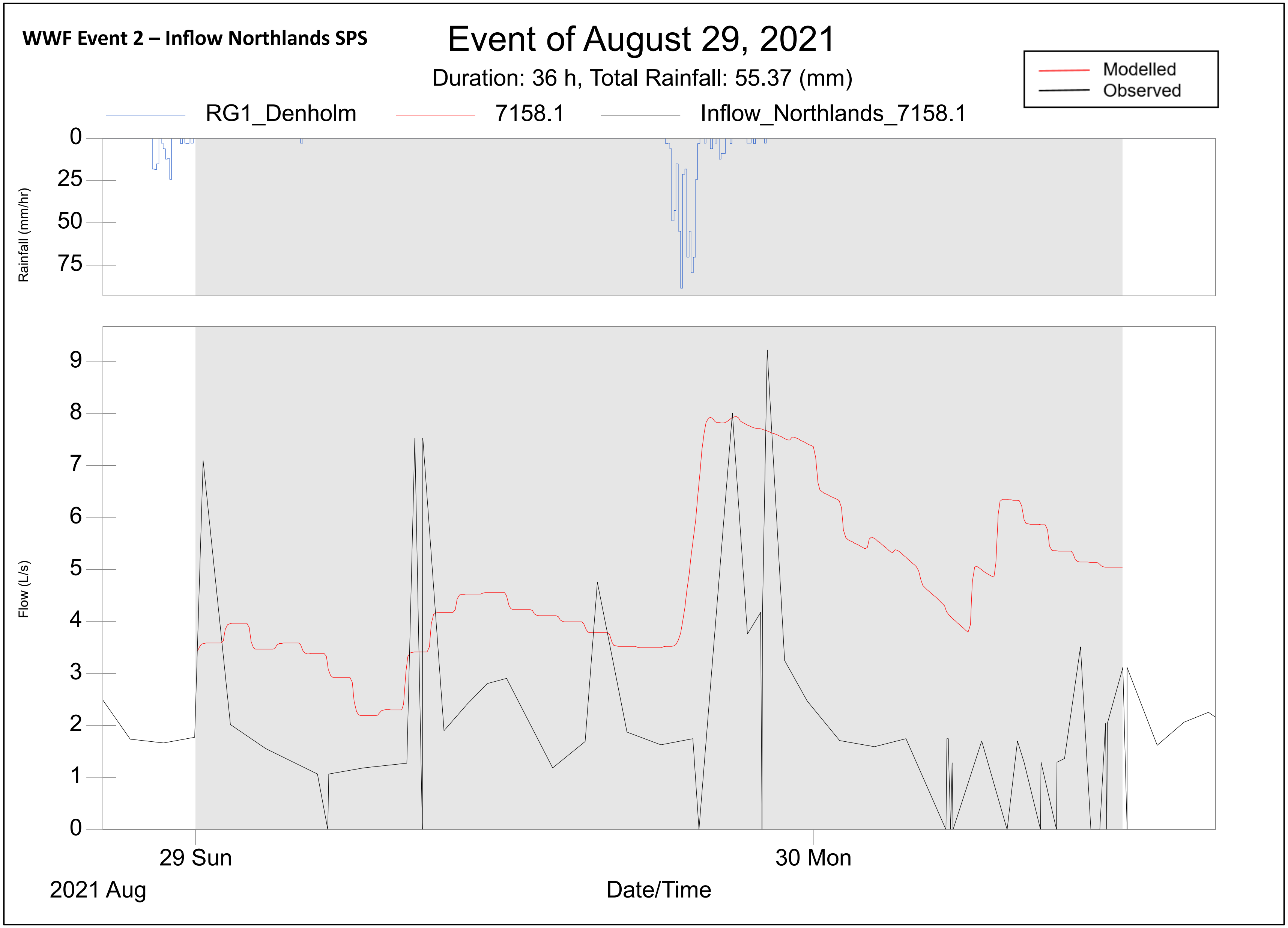

WWF Event 2 – Inflow Colonial SPS
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 55.37 (mm)
Modelled
Observed
RG1_Denholm
10362.1
Inflow_Colonial_10362.1
Rainfall (mm/hr)
0
25
50
75
Flow (L/s)
220
200
180
160
140
120
100
80
60
40
20
0
29 Sun
30 Mon
2021 Aug
Date/Time

WWF Event 2 – Inflow Frobisher SPS



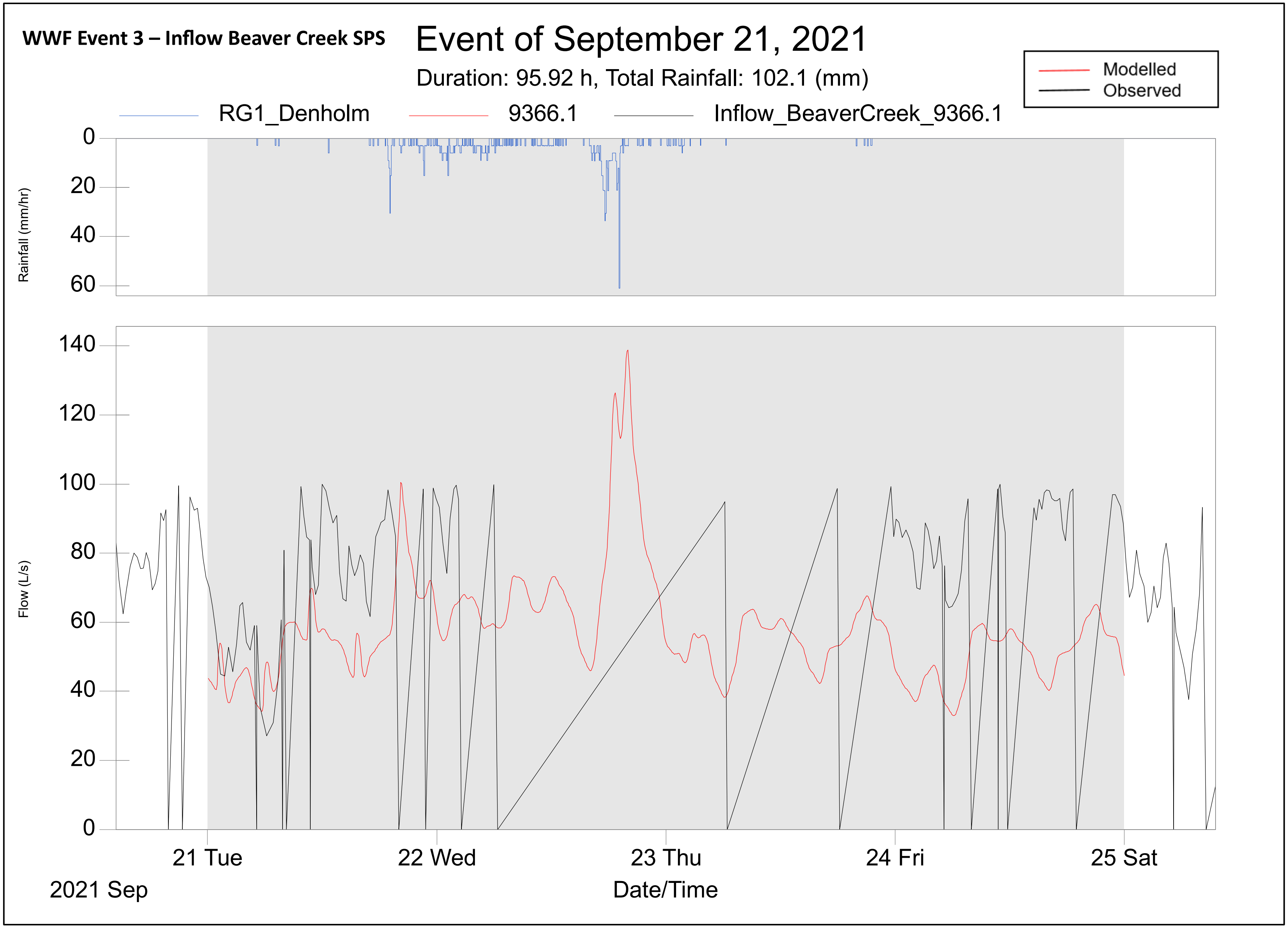

WWF Event 2 – Inflow Malabar SPS
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 55.37 (mm)
Modelled
Observed
RG1_Denholm
6864
Inflow_Malabar_6864
Rainfall (mm/hr)
0
25
50
75
Flow (L/s)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
29 Sun
30 Mon
2021 Aug
Date/Time


WWF Event 2 – Inflow Millenium SPS
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 55.37 (mm)
Modelled
Observed
RG1_Denholm
12156.1
Inflow_Millenium_12156.1
Rainfall (mm/hr)
0
25
50
75
Flow (L/s)
25
20
15
10
5
0
29 Sun
30 Mon
2021 Aug
Date/Time

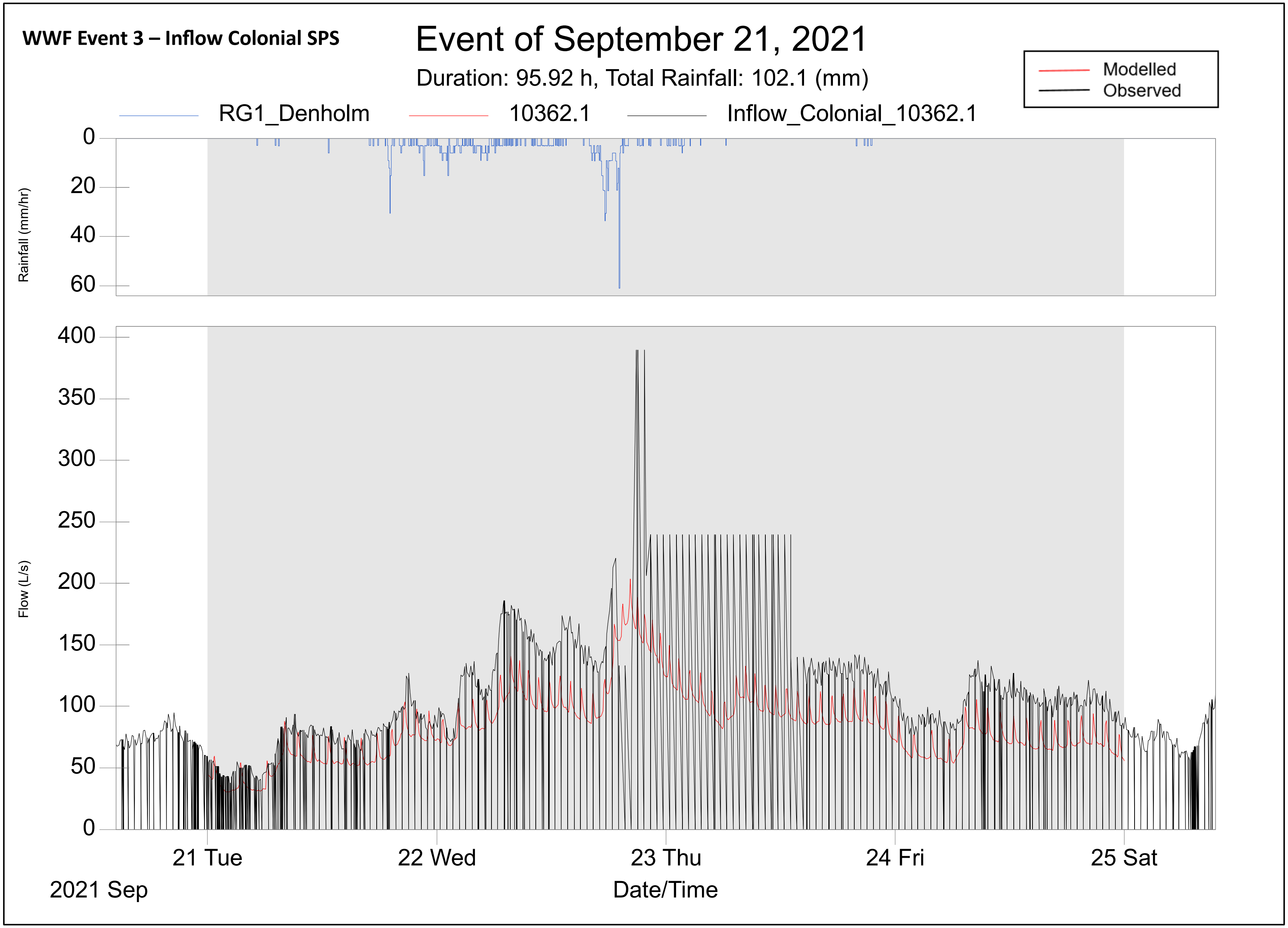


WWF Event 2 – Inflow Northlands SPS
Event of August 29, 2021
Duration: 36 h, Total Rainfall: 55.37 (mm)
Modelled
Observed
RG1_Denholm
7158.1
Inflow_Northlands_7158.1
Rainfall (mm/hr)
0
25
50
75
Flow (L/s)
9
8
7
6
5
4
3
2
1
0
29 Sun
30 Mon
2021 Aug
Date/Time

WWF EVENT 3 – PUMPING STATION VALIDATION



WWF Event 3 – Inflow Beaver Creek SPS
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
RG1_Denholm
9366.1
Inflow_BeaverCreek_9366.1
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
140
120
100
80
60
40
20
0
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time


WWF Event 3 – Inflow Colonial SPS
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
RG1_Denholm
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Inflow_Colonial_10362.1
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
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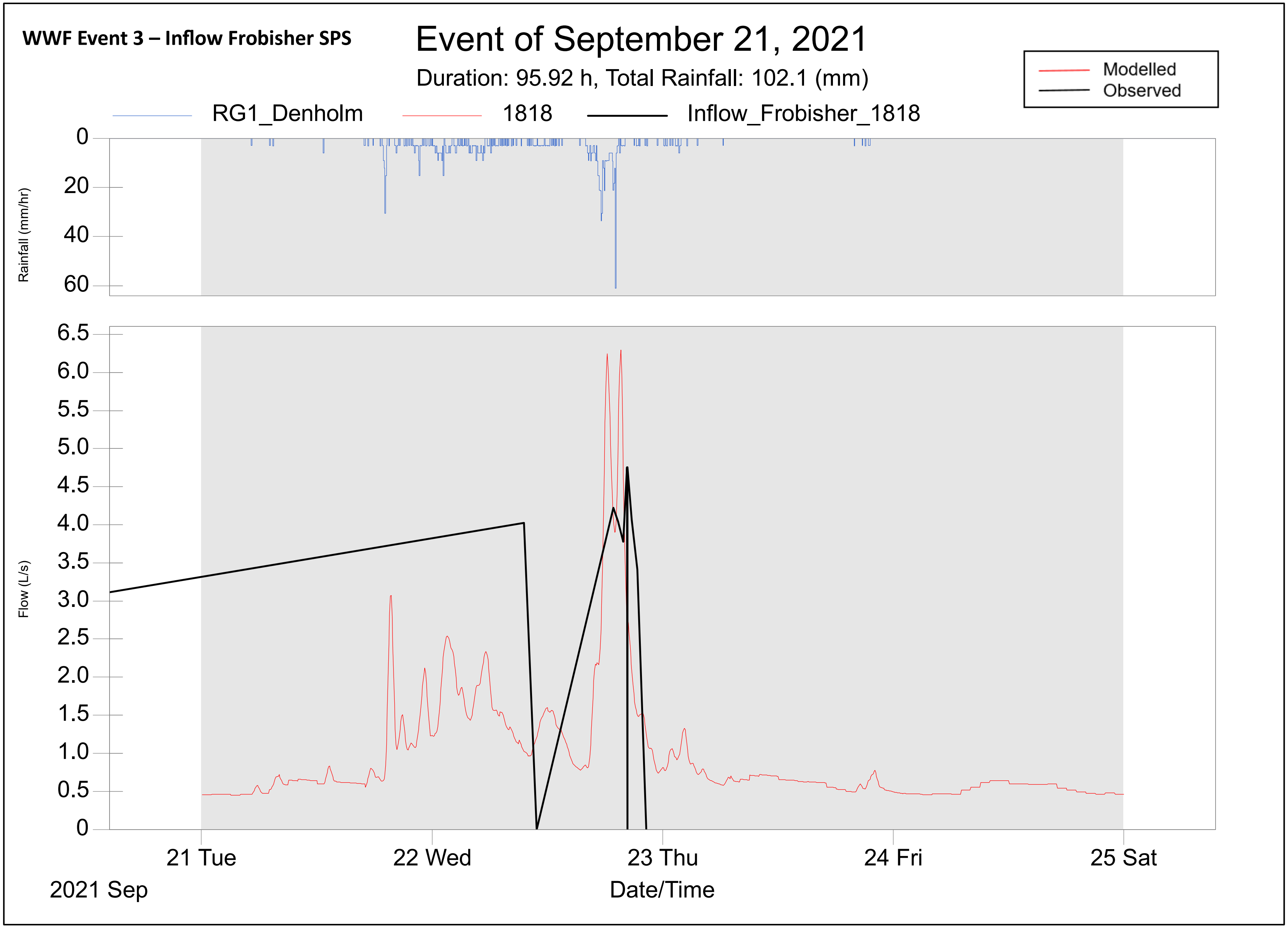
350
300
250
200
150
100
50
0
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time


WWF Event 3 – Inflow Frobisher SPS
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Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
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Rainfall (mm/hr)
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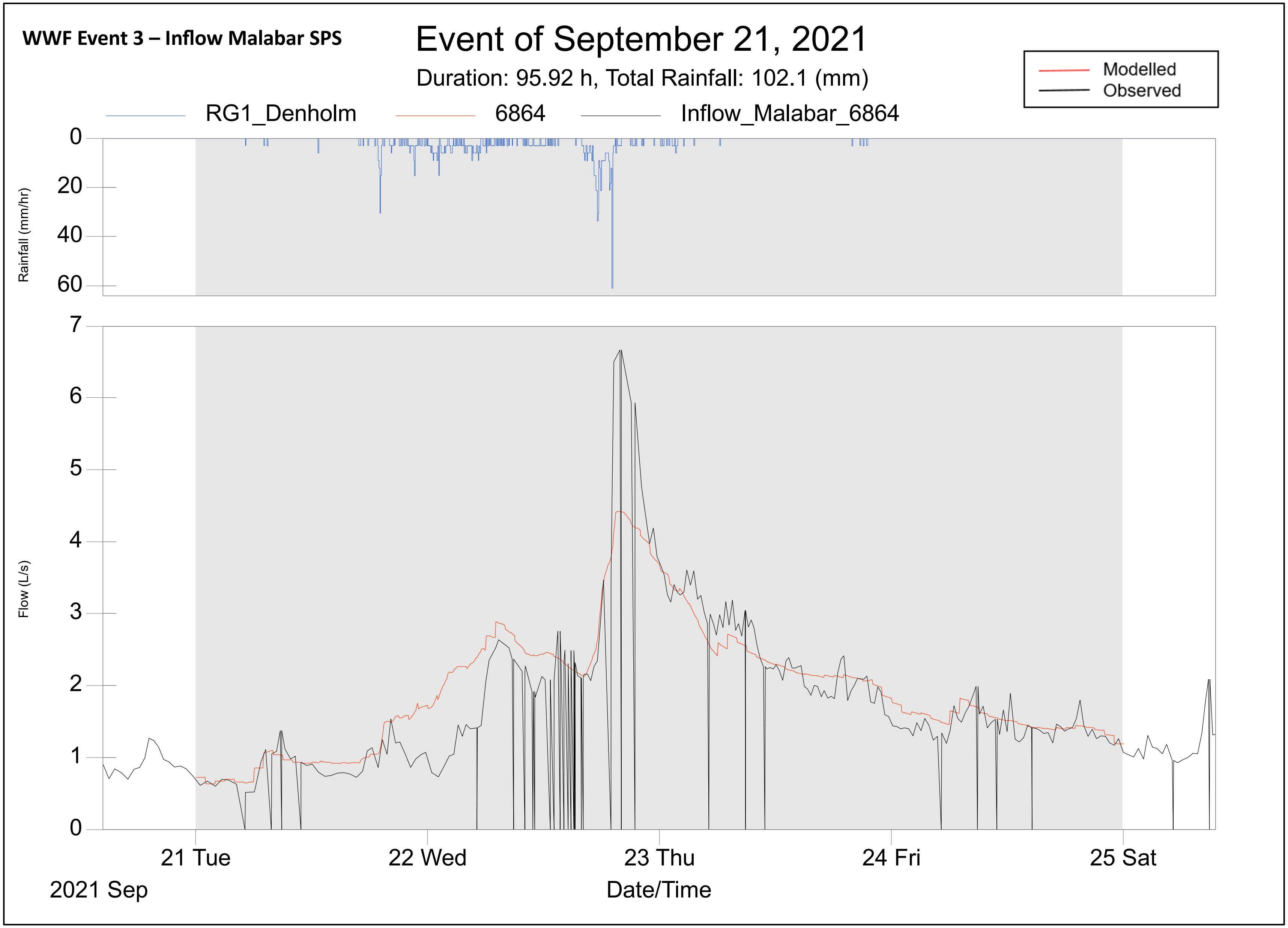
20
40
60
Flow (L/s)
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time


WWF Event 3 – Inflow Malabar SPS
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
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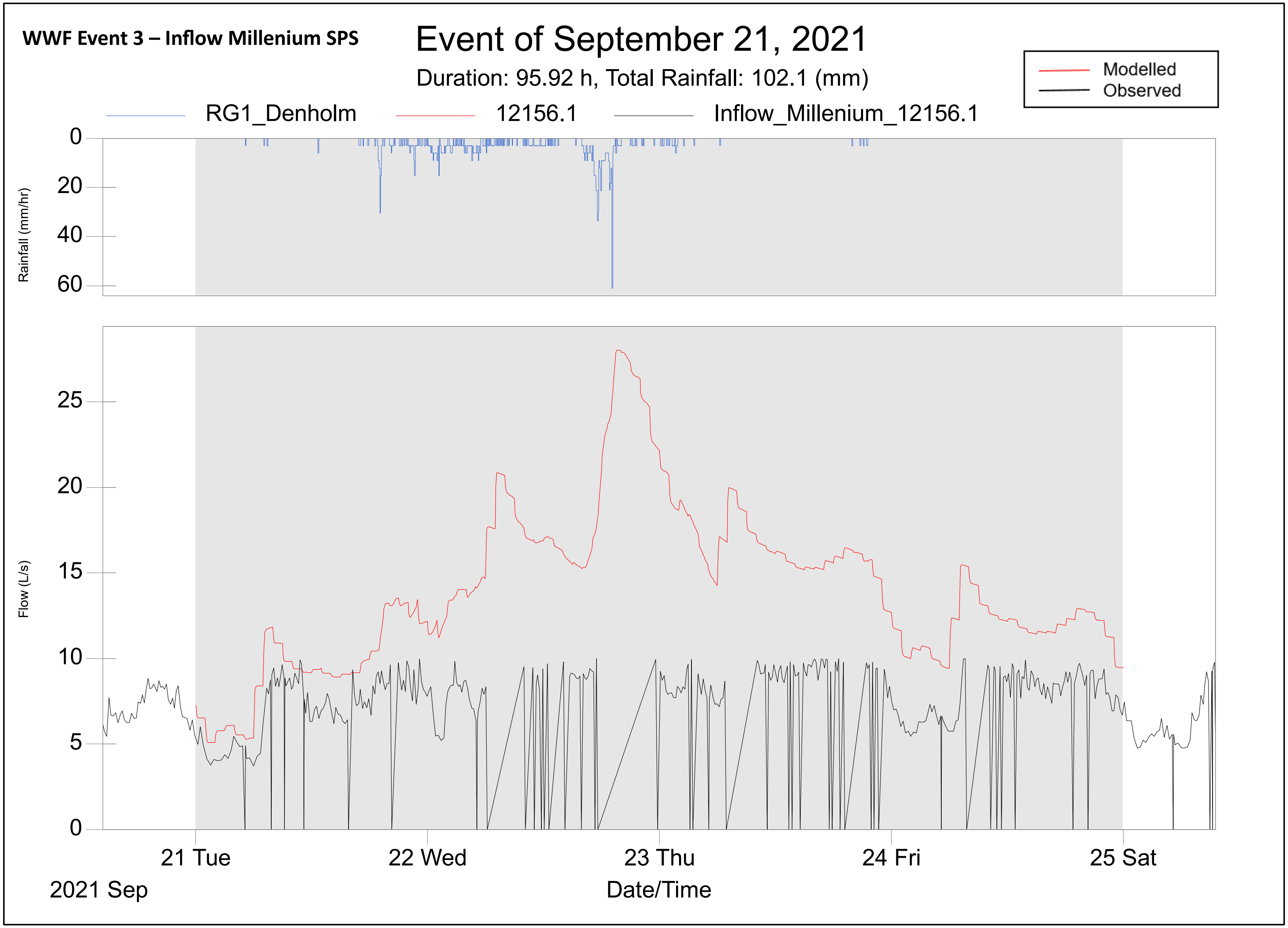
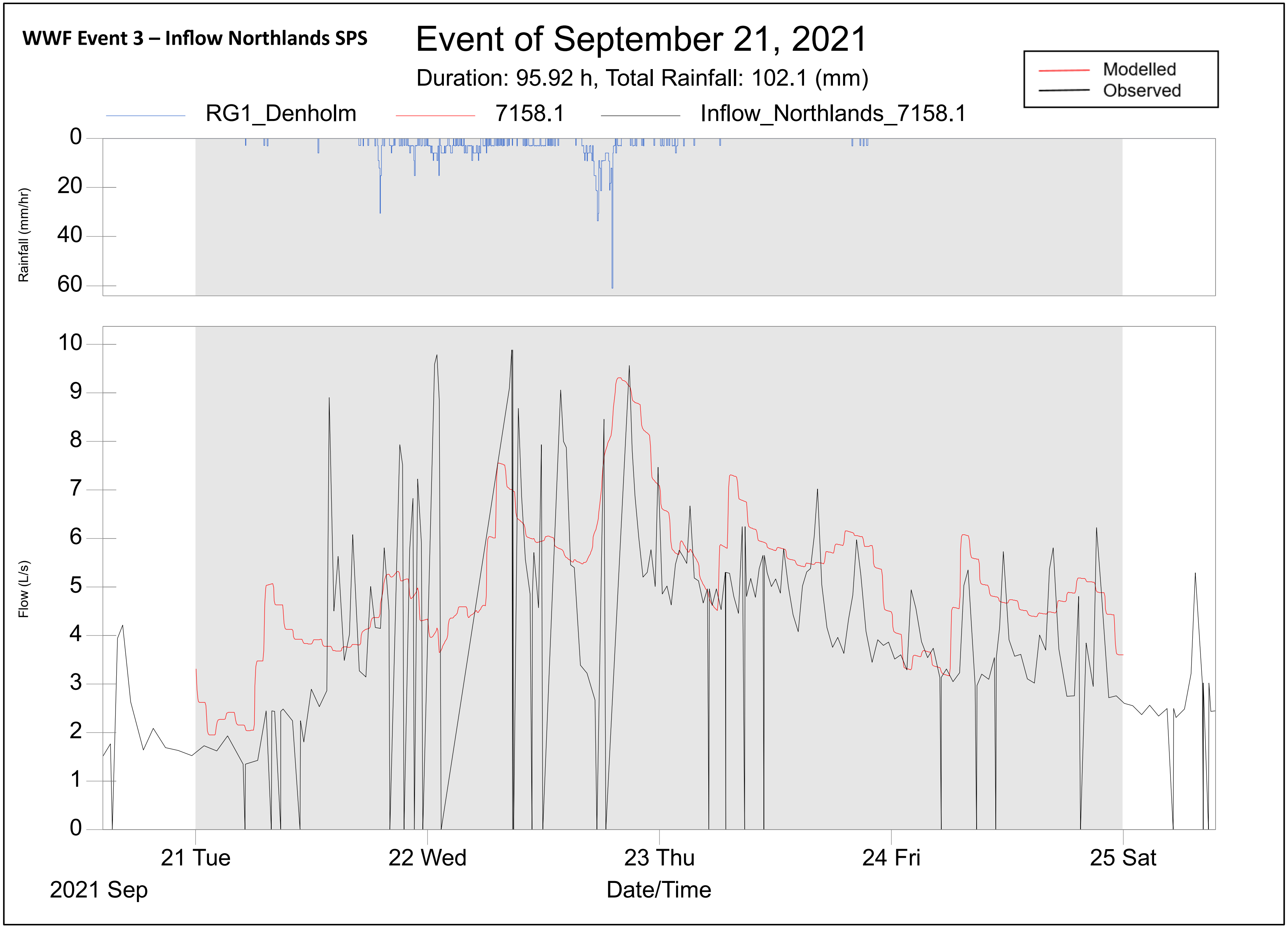
6864
Inflow_Malabar_6864
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
7
6
5
4
3
2
1
0
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time


WWF Event 3 – Inflow Millenium SPS
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
RG1_Denholm
12156.1
Inflow_Millenium_12156.1
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
25
20
15
10
5
0
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time


WWF Event 3 – Inflow Northlands SPS
Event of September 21, 2021
Duration: 95.92 h, Total Rainfall: 102.1 (mm)
Modelled
Observed
RG1_Denholm
7158.1
Inflow_Northlands_7158.1
Rainfall (mm/hr)
0
20
40
60
Flow (L/s)
10
9
8
7
6
5
4
3
2
1
0
21 Tue
22 Wed
23 Thu
24 Fri
25 Sat
2021 Sep
Date/Time

Appendix C Technical Note 4

TECHNICAL NOTE #4 – MODEL ANALYSIS – IDENTIFICATION OF PROBLEM AREAS

City of Waterloo Sanitary Master Plan Update

January 10, 2024

Prepared for:

City of Waterloo

Prepared by:

Stantec Consulting Ltd.
300 Hagey Blvd., Suite 100
Waterloo, ON N2L 0A4

Revision	Description	Author	Quality Check	Independent Review
0	Draft TN#4	HB	DE	JP
1	Final TN#4	HB	DE	JP

Sign-off Sheet

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Prepared by ______________________________
(signature)

Helene Boulanger, P.Eng., ing.

Reviewed by ______________________________
(signature)

Dave Eadie, P.Eng.

Approved by ______________________________
(signature)

Jeff Paul, P.Eng.

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Abbreviations

ADF	Average Dry Weather Flow
DWF	Dry Weather Flow
DEM	Digital Elevation Model
EA	Environmental Assessment
EMP	Employment
FM	Flow Meter
FS	Flow Split
GIS	Geographic Information System
GWI	Groundwater Infiltration
HGL	Hydraulic Gradeline
HP	High Point
ICI	Industrial – Commercial – Institutional (Land Use)
IDF	Intensity – Duration - Frequency
I/I	Inflow/Infiltration
MH	Maintenance Hole
MP	Master Plan
O&M	Operation & Maintenance
PCSWMM	Personal Computer Storm Water Management Model (Software)
RDII	Rainfall-Derived Infiltration and Inflow
RES	Residential
RTK	RTK Unit Hydrograph Method
RG	Rain Gauge
SAN	Sanitary
SCADA	Supervisory Control and DATA Acquisition
SPS	Sewage Pumping Station
SCADA	Supervisory Control and DATA Acquisition
TN	Technical Note
WWF	Wet Weather Flow
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

The City of Waterloo (City) has retained Stantec Consulting to complete the Waterloo Sanitary Servicing Master Plan Update (Master Plan Update). The purpose of the Master Plan Update is to revise the 2014 Sanitary Master Plan (Stantec, 2015) to account for updated infrastructure, and population and employment growth. There are two growth scenarios: Priority Scenario, which includes projections up to a 2031 planning horizon, and Strategic Scenario, representing projections up to a 2051 planning horizon. Priority and strategic projects will be evaluated to operate the system efficiently and effectively, to implement best management practices (including Infiltration/Inflow (I/I) monitoring and mitigation approaches), and to optimize staging of the sanitary capital program.

The following tasks will be carried out for the completion of the Master Plan:

- Task 1: Model Infrastructure Updates
- Task 2: Model Flow Updates
- Task 3: Model Calibration
- **Task 4: Model Analysis – Identification of Problem Areas**
- Task 5: Detailed Analysis of Solutions
- Task 6: Conclusions & Recommendations – Capital Planning and Execution
- Task 7: Finalize Master Plan Update

The purpose of this **Technical Note #4** (**TN#4**) is to summarize the proposed modelling scenarios for existing and future conditions sanitary sewer system assessments and to identify the problem areas.

2.0 HYDRAULIC ANALYSIS

Using the calibrated model detailed in TN#2-3, the existing and future condition scenarios were developed and assessed for system performance. The following sections outline the flow generation, infrastructure updates, and design criteria involved in these assessments, in addition to climate change and sensitivity analyses.

2.1 MODEL LIMITATIONS AND APPLICATION

The calibrated model is intended to represent the existing system performance as closely as possible given the available information and resources for the purpose of this study. In addition, there are inherent limitations with the application and use of any calibrated model, including the following:

- Given the size of the study area, it was not feasible to field survey all sewer assets and ground elevations. As-Recorded drawings were reviewed where available, but data inference based on engineering judgment was still required in some locations. Refer to TN#1 for model updates.
- 2014 calibrated parameters were used with the updated population and sewershed areas, outside of 2021 flow monitors coverage. Therefore, flow could be underestimated due to changes in the system including growth and sewer system aging.
- Given the complexity of surface, storm and sanitary sewer interaction both on the private and public side, extrapolation of observed frequent flow calibration parameters to extreme events must be interpreted with caution.

Notwithstanding the typical limitations above, the model development is within the normal application of large-scale planning studies and results should be interpreted according to this level of detail.

2.2 METHODOLOGY

To evaluate system performance, the criteria for capacity assessments are similar to the 2014 Master Plan. The following sections provide a summary of the level of service (LOS) criteria and the design storms considered in this Master Plan Update. All inflows and boundary conditions used during calibration are maintained for the model assessment. The outflow of the Kitchener forcemain has been added as different time variating inflow for each scenario. The assumption of free discharge at the SPS overflows and at the plant is applied for all design storm events. Refer to TM#2-3 for the remaining boundary condition details.

For shallow sewers that are within 1.8 m from the surface, any water level in the pipe will indicate an HGL infraction. In this case, the target LOS is for the water level to remain within the pipe.

2.2.1 Design Storm Events

The 3-hour Chicago storm events were used in the 2014 Master Plan to provide conservative results and allow a degree of comparison to the historic work completed for previous MP. In an effort to be conservative and acknowledge the trend of increasing intensity associated with climate change (CC) impacts, the 10-yr and 25-yr storms were selected for capacity assessments, and a stress-test on the system was incorporated using the 25-yr, 3-hour Chicago storm with an increase of 20%.

Table 2-1 present an overview of the differences between the 2014 MP and the Update MP assessment for the design storm events.

Table 2-1: Overview of Design Storm Events

Master Plan	Design Storm Events
2014 MP	<u>All Scenarios:</u> 10-yr, 3-hour Chicago Distribution design storm; 25-yr, 3-hour Chicago event reviewed as a stress-test on the system.
MP Update	<u>Pumping Station Assessment:</u> 10-yr, 3-hour Chicago Distribution design storm; <u>Sewer System Assessment:</u> 25-yr, 3-hour Chicago event and 25-yr + CC, 3-hour Chicago event reviewed as a stress-test on the system.

2.2.2 Level of Service Criteria - Sewers

The target level of service is based on the capacity in the collection system and the risk of surcharging that could result in basement flooding. For dry weather flow (DWF) analysis, the ratio of maximum depth versus full depth (d/D) is used to identify capacity constraints. The d/D ratio is more appropriate than the maximum flow versus full flow (q/Q) as it is more representative of system capacity for a dynamic model. In dynamic models, the slope of the hydraulic grade line (HGL) can be different than the pipe slope, thereby giving a false indication of capacity if only looking at flow ratio. Based on industry best practices, any sewers with a d/D equal to or greater than 0.8 (80%) is identified as having capacity constraints. As an assessment of operational issues, the peak DWF velocity is also assessed and compared to MECP Design Guidelines for the minimum scour velocity of 0.6 m/s.

For wet weather flow (WWF) events, surcharging (d/D greater than 1) is considered acceptable provided the water level remains at least 1.8 m below ground elevation, as measured at the model node (often coinciding with a maintenance hole). A water level of 1.8 m below ground elevation, also known as the HGL Freeboard, is intended to represent the depth to a typical basement elevation for homes with direct or indirect connections to the sewer. An increase in water level beyond this would present a risk for basement flooding. Locations without house connections may further experience surcharge without risk of flooding, such as trunk sewers in ravines; however, these shall be identified case-by-case and be considered an exception. **Figure 2-2** illustrates the targeted level-of-service for WWF events in relation to the sewer water elevation and typical basement elevations.

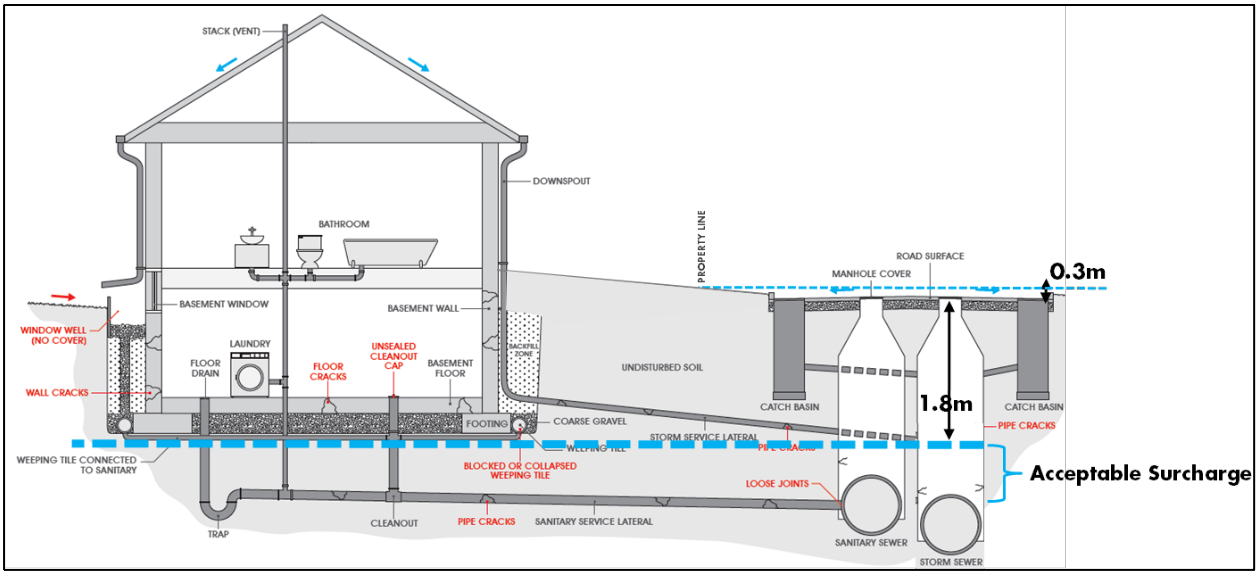


Figure 2.1: Definition of Flooding in Separated Sewer Systems

2.2.3 Level of Service Criteria – Pump Stations

The pumping station assessment consists of comparing the incoming peak flow during the 10-Year design event to the pumping station's firm capacity to identify the need for upgrades. The firm capacity of a pumping station is defined as the maximum pumping capacity with the largest pump offline. The firm capacity was obtained for each pumping station from pump curves based on pump serial number on plate. The operation of the pumps (number of duty and standby pumps) informed the firm capacity used in this analysis. While the current operating capacity of the pumps may be lower than the theoretical capacities due to deteriorating conditions, it is assumed that the theoretical capacity will be achieved through planned maintenance.

2.3 EXISTING CONDITIONS

Existing conditions modelling scenarios represent 2021 populations and infrastructure, which includes infrastructure updates completed since the calibration period in Summer/Fall of 2021 and presented in TN#1. These populations were used during the calibration of the model and in the derivation of the calibrated per capita flow rates used in DWF generation, as presented in TN#2-3. All DWF and WWF parameters derived through calibration are maintained in the existing condition analysis, except for the MPL-63 Metershed. As mentioned in TN#2-3, the observed flow at the flow monitor MPL-63 is low, thus that can impact the depth and velocity readings due to technological limitations. The recalibrated per capita is 18 L/c/d, which is lower than the 2014 Master Plan calibration at MPL-63 (110 L/c/d). Therefore, for the model assessment, a per capita of 110 L/c/d was used for MPL-63 metershed, for a more conservative approach.

2.3.1 Pumping Station Assessment

All sewage pumping facilities should be designed to pump the 10-year peak flow with the largest pump offline (herein referred to as 'firm capacity'). Thus, the peak flow conveyed through the pump station during the 10-year event is compared to the pumping station's firm capacity, as described in **Section 2.2.3**. The pumping station's performance is then based on this comparison; pumping stations receiving 10-year peak flows greater than the station's firm capacity are considered to have capacity constraints. Additionally, pumping station performance is evaluated with respect to overflows, in that overflows should not occur in events smaller than the 25-year. The occurrence of an overflow in events smaller than the 25-year indicates inadequate pumping station capacity. **Table 2-2** lists the pumping station's ECA and firm capacities used in this analysis.

Table 2-2: Existing Pumping Station Firm & Rated Capacity (Theoretical Operation)

Pumping Station	ECA Capacity (L/s)	Firm Capacity (L/s)	Pump Operation
Beaver Creek	370.0	550.0	4 pumps (3 duty, 1 standby)
Colonial	372.0	540.0*	3 pumps (2 duty, 1 standby)
Frobisher	35.0	60.0	2 pumps (1 duty, 1 standby)
Malabar	7.4	6.2	2 pumps (1 duty, 1 standby)
Millenium	86.0	152.0	2 pumps (1 duty, 1 standby)
Northlands	57.0	90.0	2 pumps (1 duty, 1 standby)

Notes:
* Firm capacity at Colonial SPS is estimated based on adding 2 duty pump capacities, i.e., does not consider reduction in capacity associated to 2+ simultaneously running pumps

It is noted that the ECA capacity for Frobisher SPS, Millenium SPS, and Northlands SPS are less than their firm capacity. Therefore, it is recommended that the ECAs are updated for those pumping stations.

The results of the incoming peak flow at the pumping station under 10-year design event are presented in **Table 2-3**.

Table 2-3: Exisisting Pumping Stations Results

Pumping Station	10yr Incoming Peak Flow (L/s)	ECA Capacity (L/s)	Firm Capacity (L/s)
Beaver Creek	290.9	370.0	550.0
Colonial	257.5	372.0	540.0*
Frobisher	20.3	35.0	60.0
Malabar	4.8	7.4	6.2
Millenium	28.6	86.0	152.0
Northlands	9.1	57.0	90.0

Notes:
* Firm capacity at Colonial SPS is estimated based on adding 2 duty pump capacities, i.e., does not consider reduction in capacity associated to two or more simultaneously running pumps

The 10-Year incoming peak flow is lower than the firm capacity for all pumping stations. Therefore, there is no capacity constraints at the pumping stations for the existing conditions.

There is no pump station overflow occurring in the existing 25-Year scenario. Additionally, the emergency storage at Beaver Creek and Colonial pump stations are not used in existing conditions with the 25-Year design storm. Long term monitoring can be considered to corroborate emergency storage operation.

2.3.2 Sewer System Assessment

Both the DWF and WWF conditions are reviewed as part of the sanitary sewer system performance assessment, as outlined in **Section 2.2.2**. The system is evaluated for velocity and surcharge issues in DWF conditions, and for HGL freeboard during the 25-year Chicago, 3-hour storm event. Sewer performance is reviewed in conjunction with the slope of the HGL to determine the cause of the issue and inform possible solutions.

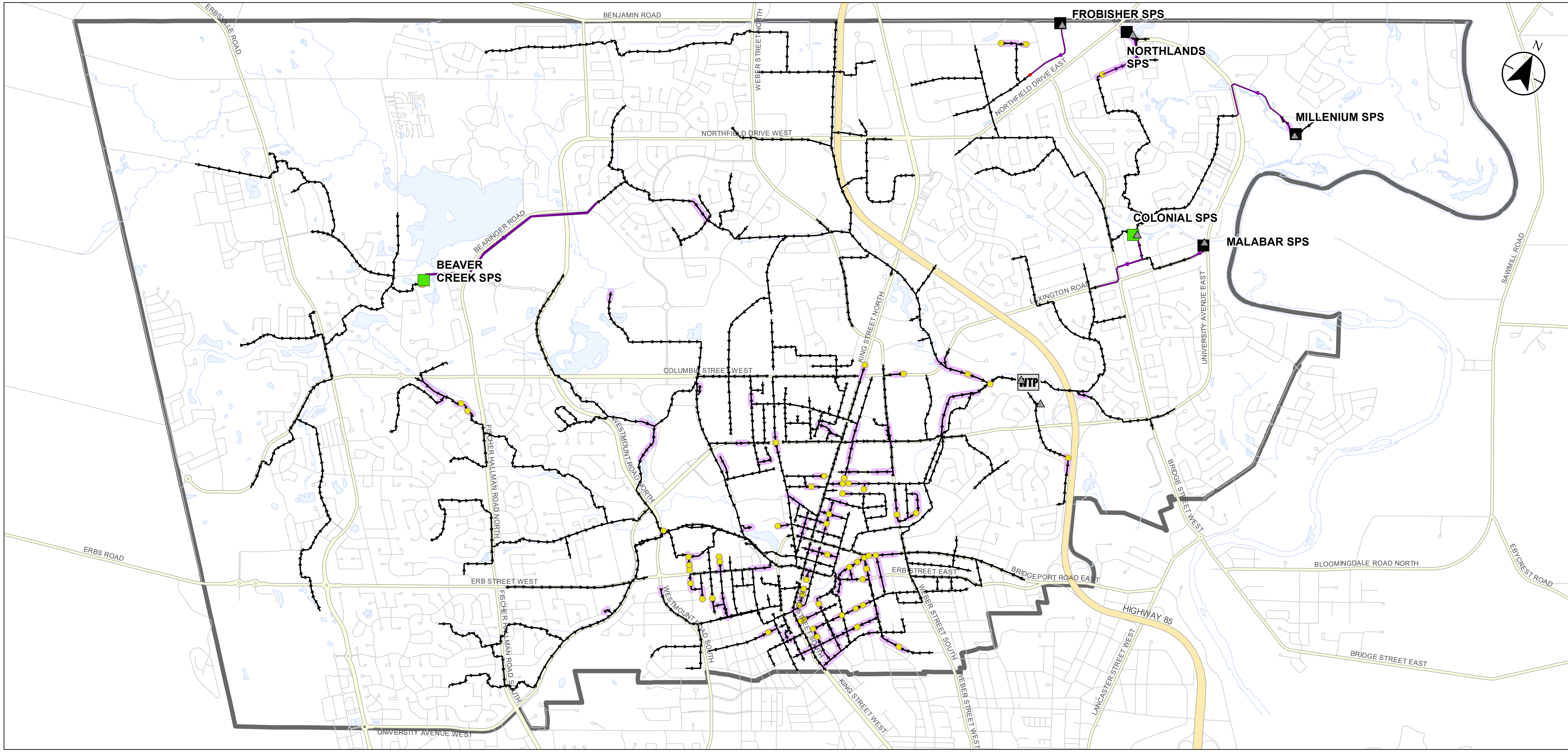
The Surcharge State in pipes is used to assess sewer performance, which is defined by both the d/D (depth of flow over pipe diameter) and q/Q (flow through pipe over full pipe capacity) ratios. When the d/D is less than 1, the pipe is free flowing. When the d/D is greater than 1, the pipe is surcharged. In this case when the q/Q is less than 1, the pipe is under backwater conditions (slope of the HGL is less than the slope of the pipe). When the d/D and q/Q are greater than 1, the pipe itself is undersized (slope of the HGL is greater than that of the pipe).

To visually present the LOS, to following symbology for maintenance holes (MH) and pipe are used:

- MH HGL Freeboard:
  - **Black**: HGL is more than 1.8 m below ground surface (i.e., low risk of basement flooding);
  - **Yellow**: HGL is within 1.8 m of ground surface (i.e., potential for basement flooding); and,
  - **Red**: HGL is above ground surface (i.e., potential for basement and surface flooding).
- Pipe Surcharge State:
  - **Black**: free flow within sewer;
  - **Yellow**: sewer surcharged, peak flow within free-flow capacity of the sewer (i.e., under backwater conditions);
  - **Red**: sewer surcharged, peak flow greater than free-flow capacity of the sewer (i.e., sewer is under capacity and causing bottleneck); and,
  - **Purple** halo: shallow sewers with less than 1.8 m between the sewer obvert and the ground surface.

Figure 2-2 illustrates the existing DWF condition results. Under DWF conditions, all pipes are free flowing, except the sewer downstream of the Frobisher SPS forcemain (consistent with 2014 MP). The firm capacity of the pump station is greater than the capacity of the sewers; therefore, the downstream sewer is expected to surcharge. There are several instances of shallow sewers where the HGL criterion cannot be met; however, none of the pipes are surcharged. There is no known servicing issue with the identified locations, suggesting there is no servicing lateral at these pipes, the laterals themselves are also shallow due to lack of basement or significant grading offset to the property. Of the 2,101 trunk and core area sewers, approximately 46% experience peak velocities less than 0.6 m/s in DWF conditions. There is less confidence with the local system pipes in the model due to identified engineering validation errors and inferred data. These issues were resolved only where needed, as local sewers are not considered the focus of this MP.

Figure 2-3 presents the 25-year wet weather existing condition results, indicating some isolated locations of pipe surcharge and very few pockets of elevated HGL within theoretical basement elevation, including one location of flow to the surface on the residential Austin Drive. It is noted that shallow sewers without surrounding pipe surcharge are not discussed further.



Legend

- WTP WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharging State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

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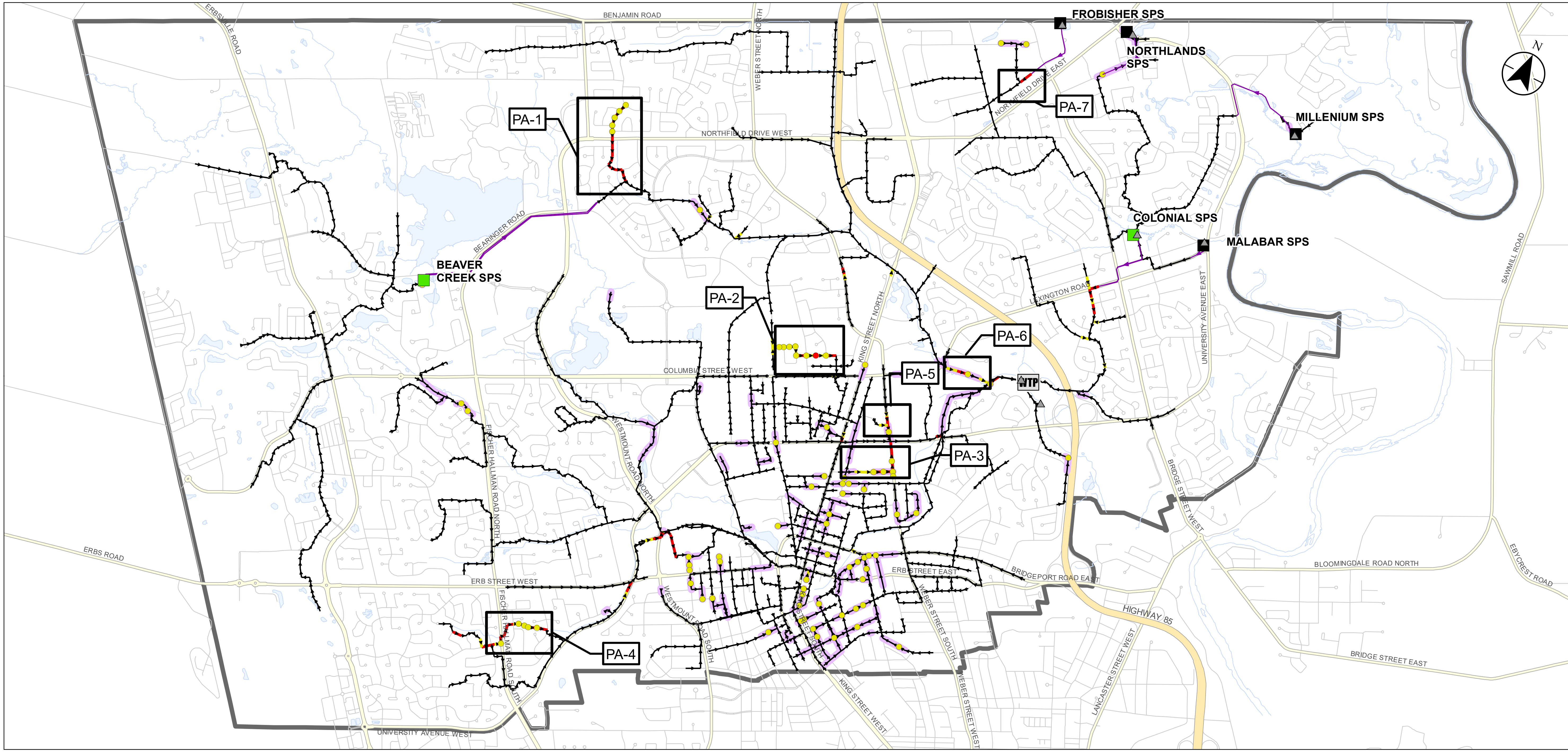
Project Location
City of Waterloo

165640363 REVA
Prepared by HB on 2023-08-01

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
2-2

Title
Existing Conditions Sanitary Sewer System DWF Results



Legend

- WTP WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

Stantec

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City of Waterloo

165640363 REVA
Prepared by HB on 2023-09-12

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
2-3

Title
Existing Conditions Sanitary Sewer System
25-Year HGL & Surcharge Results

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

\\cd1004-f01\work_group\01656\active\165640363\preliminary\analysis\gis\mxd\TM4\WaterlooSANMP_25yr_Existing_v3.mxd Revised: 2023-09-12 By: hboulanger

There are seven (7) Problem Areas (areas of observed sewer capacity constraints) identified under existing conditions, which are shown in **Figure 2-3** and described in **Table 2-4** by Problem Area ID, where "PA" refers to Problem Area. All other areas with HGL infractions are in shallow sewers with no pipe surcharge, and therefore are considered exempt from this criterion.

Table 2-4: Existing Conditions Sanitary Sewer Problem Areas

Problem Area ID	Location	Capacity Constraint Description
PA-1 Cedar Highpoint Ave	Highpoint Ave, between Northfield Dr W and Northlake Dr	HGLs within 1.8 m of surface due to undersized pipes. High risk of basement flooding and risk of surface flooding.
PA-2 University Austin Dr	From the intersection of Albert St and Cardill Crescent to the intersection of Austin Dr and Holly St	Risk of basement flooding (HGLs within 1.8 m of surface) and surface flooding due to undersized pipes along Austin Dr.
PA-3 Laurel 2 Lodge St / Weber	From Lodge St to the intersection of Weber St N and University Ave E	Risk of basement and surface flooding due to undersized pipes on Lodge St and Weber St N
PA-4 Maple Hill Maple Hill Creek	From the weir at Thorndale/Westvale to Roosevelt Ave	Risk of basement flooding (HGLs within 1.8 m of surface) due to undersized pipes on private property.
PA-5 Laurel 2 Weber St N	Weber St N, at the intersection of Hickory St E	Surcharging pipes upstream of shallow pipes resulting of an HGL within 1.8 m of surface. Low risk of basement flooding as it is an ICI area.
PA-6 Forwell Trunk Conestoga College	From Lexington Rd to the WWTP	HGLs within 1.8 m of surface due to undersized pipes and shallow pipes. Low risk of basement flooding as no building connections are anticipated along these sewers.
PA-7 Lee 1 Downstream of Frobisher SPS	Sewers directly downstream of Frobisher forcemain	Capacity constraints in DWF conditions due to undersized pipes, but no risk of basement flooding.

2.4 FUTURE CONDITIONS

As outlined in TN#1, two growth horizons have been assessed in this Master Plan Update: 2031 and 2051 horizons. The following outlines the analysis approach and capacity assessment results.

2.4.1 Infrastructure Updates

No additional infrastructure nor pumping stations updates are assumed for the future conditions, to evaluate the impact of growth on the existing system. The pumping station details used in the existing model scenario are maintained for 2031 & 2051 horizons.

2.4.2 Modelling Approach

Growth is anticipated to occur as infill, intensification, and new developments. The modelling approach for the sewage flow is to consider a per capita rate of 275 L/cap/day for both residential and ICI growth, as per the DGSSMS, and to apply the diurnal patterns from model calibration based on the sewershed receiving flows from the proposed development. The modelling approach for the wet weather flow for the two types of growth are discussed in the following sub-sections. **Figure 2-4** present the new development and the external contributions.

2.4.2.1 Infill & Intensification

Within urban environments, infill is described as the redevelopment of land, and commonly includes the conversion of open space to new residential or ICI construction. Intensification includes the redevelopment of properties to accommodate higher densities of populations. Because the adjacent properties are often previously serviced by nearby municipal sanitary sewers, infill and intensification typically does not require additional City-owned infrastructure (i.e., only requires internal site servicing). For this reason, GWI and RDII parameters are already accounted for and do not require adjustments for infill development. Only population is adjusted per planning horizon for identified infill & intensification properties.

2.4.2.2 New Developments

Differing from infill, new developments are generally situated in undeveloped areas within the study area and often require new City-owned sanitary infrastructure for servicing. Population for these new developments are used to generate the average flow. Area-based contributions (GWI and RDII) are included in the node near new developments as they are not previously accounted for by surrounding subcatchments. As per the 2014 Master Plan, the inflow and infiltration allowance of 0.15 L/s/ha to account for wet weather flows had been considered for the new developments, with the total area of the parcel assumed equivalent to the contributing area. The **Table 2-5** presents the growth polygons considered as new development for the future scenarios.

Table 2-5: New Development

Horizon	Name	Area (ha)	Extraneous Flows (L/s)	Population
2031	Erbsville	29.6	4.4	2,000
2031	BCM District Plan	157.4	23.6	7,500
2051	UW Research Park	73.4	11.0	50
2051	Ira Needles	17.7	2.7	200
2051	Erb/Ira Needles	19.0	2.9	150

2.4.2.3 External Contributions

There is identified growth in the external tributary are outside the City's boundaries. The external contributions are presented in this Section.

Stockyards

Information regarding the Stockyards Area growth was obtained from the Master Servicing and Stormwater Management Report (SCS Consulting Group Ltd, 2020) on the Woolwich Township website. The growth areas provided in the report was assumed to be for the 2031 scenario. The future sanitary inflow was determined with the following design criteria:

- Retail: 0.50 L/s/ha
- Hotel: 225 L/bed/d (with 2 beds/room)
- Restaurant: 0.95 L/s/ha
- Peak Factor:
  - Hotel = Harmon Peaking Factor
  - Retail / Restaurant = 2.5
- Extraneous Flows: 0.25 L/s/ha
- For 2051 scenario, assumed a growth intensification of 25% from 2031 Scenario

Table 2-6 present the design flows for Stockyards area added as constant inflow in the future scenarios.

Table 2-6: Design Flows for Stockyards Area

Horizon	Model Node	Peak Flow (L/s)	Extraneous Flow (L/s)	Total Inflow (L/s)
2031	MH 15639 (F38-4B)	25.6	4.8	30.3
	MH 11908 (FWL-47)	13.9	3.4	17.3
2051	MH 15639 (F38-4B)	31.9	5.9	37.8
	MH 11908 (FWL-47)	17.3	4.2	21.5

Conservation Drive

Based on discussion with the City, the assumed Laurel Water Treatment Plant peak flow was added as a constant inflow of 9 L/s to MH 7519 (F78-33), as assessed by Jacobs consulting.

Village of St. Jacobs

The 2018 Wastewater Treatment Master Plan (CIMA, 2018) recommended to convert the St Jacobs WWTP to a pumping station and divert flow to the Waterloo WWTP for treatment. Table 2-7 presents the projected peak flow from St Jacobs WWTP which is assumed to be applied at MH 11904 (FWL-43) as per the2014 Master Plan.

Table 2-7: Peak Inflow from St.Jacobs WWTP

Horizon	Population	ADF (m^3/s)	Peak Flow[1] (m^3/s)	Peak Flow (L/s)
2031	2,670	1,330	4,751	55.0
2051	3,080	1,600	5,716	66.2
Note: 1- Peaking factor of 3.6, based on the Historic Flow to the St Jacobs WWTP (2012-2014) presented in 2018 WWTP MP; Peak Flow divided by Average Daily Flow (ADF)				

Moore Avenue Tributary Area

Through negotiations with the City of Kitchener, additional inflow from the Moore Ave pump station tributary area will be tributary to the Moore Ave sanitary sewer. In the model the inflow was incorporated at the intersection of Moore Ave S and Spur Line Trail (MH L30-23). **Table 2-8** presents the future peak inflow from those SPS, for the 25-year Chicago 3-hour storm event.

Table 2-8: Peak Inflow from Moore Avenue Tributary Area

Model Node	Owner	Horizon	Peak Inflow (L/s)
			25-Year Chicago, 3-Hour Storm
MH 10095703 (L30-23)	City of Kitchener	2031	36.3
		2051	36.6
Note: Peak flow was provided by the City of Kitchener as inflow hydrographs from their Master Plan model (2023)			

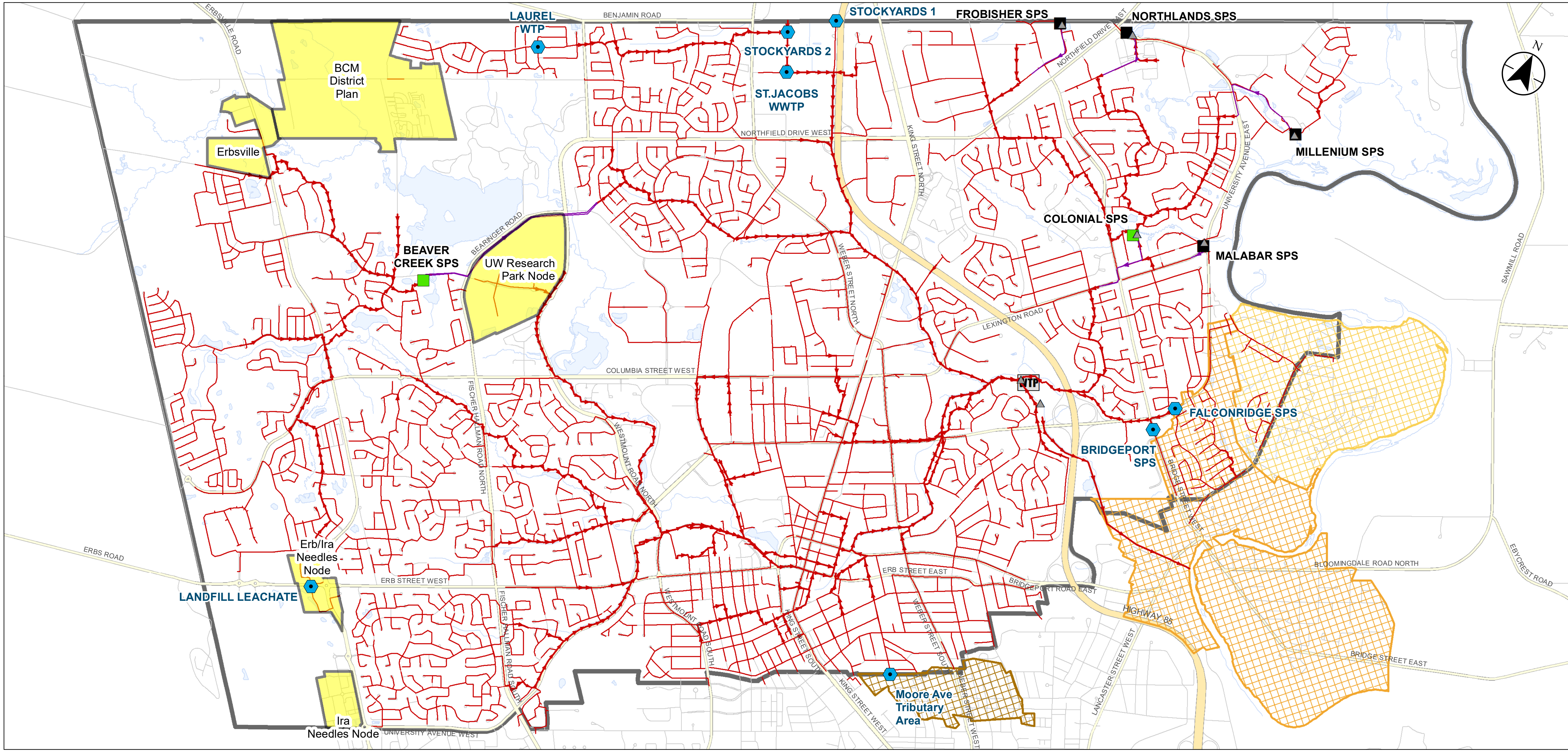
Pumping Stations

For the future scenarios, the two external inflows from Kitchener pumping stations into the Waterloo system need to be reflected for growth. **Table 2-9** presents the future peak inflow from those SPS, for the 25-year Chicago 3-hour storm event. The hydrographs for the different horizon were added in the Waterloo model.

Table 2-9: Peak Inflow from Pump Stations

Pump Station	Model Node	Owner	Horizon	Peak Inflow (L/s)
				25-Year Chicago, 3-Hour Storm
Falconridge	MH 9302 (LX11-1A)	City of Kitchener	2031	31.8
			2051	32.1
Bridgeport	MH 7918 (LEX-14)	Region of Waterloo	2031	135.8
			2051	135.8

Note:
Pump station information was provided by the City of Kitchener as inflow hydrographs from their Master Plan model (2023)



Legend

- WTP WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Local Sewer
- Trunk Sewer
- New Development
- External Contribution

Kitchener Drainage Areas

- Bridgeport Pump Station
- Falconridge Pump Station
- Moore Pump Station

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

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Project Location
City of Waterloo

165640363 REVA
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CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
2-4

Title
New Development and External Contributions

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

2.4.3 2031 Horizon

2.4.3.1 Flow Generation

For the 2031 modelling scenarios, the City provided growth polygons in shapefile format. The populations from Major Intensification Projects, BCM District Plan, and Erbsville Block Plan were assumed to count towards the 2031 growth scenario. Based on a discussion with the City, the Former Kraus lands development was also included in the 2031 scenario, with a design population of 7,005 persons. The **Figure 2-5** present the 2031 growth polygons provided by the City.

The growth population was distributed evenly between nodes within a growth area. Moreover, if the population was provided with zone change applications within a growth polygon, the population was assigned to the nearest node. The residual growth population, if applicable, was evenly distributed between each receiving node.

The City's projected 2031 population forecast is approximately 229,500, including residential, student and employment populations, as provided by the City of Waterloo population projections (City of Waterloo; Hemson Consulting Ltd. Development Charges Background Study 2020; Statistics Canada, Census of Canada 2016). Refer to **Appendix A** for the Planning Department detailing these forecasts.

Based on the provided growth polygons and the Former Kraus Lands, the total population included in the model for the 2031 horizon is approximately 237,450, including residential, student and employment equivalents. The **Table 2-10** present the existing population and the 2031 projected population consider in each scenario.

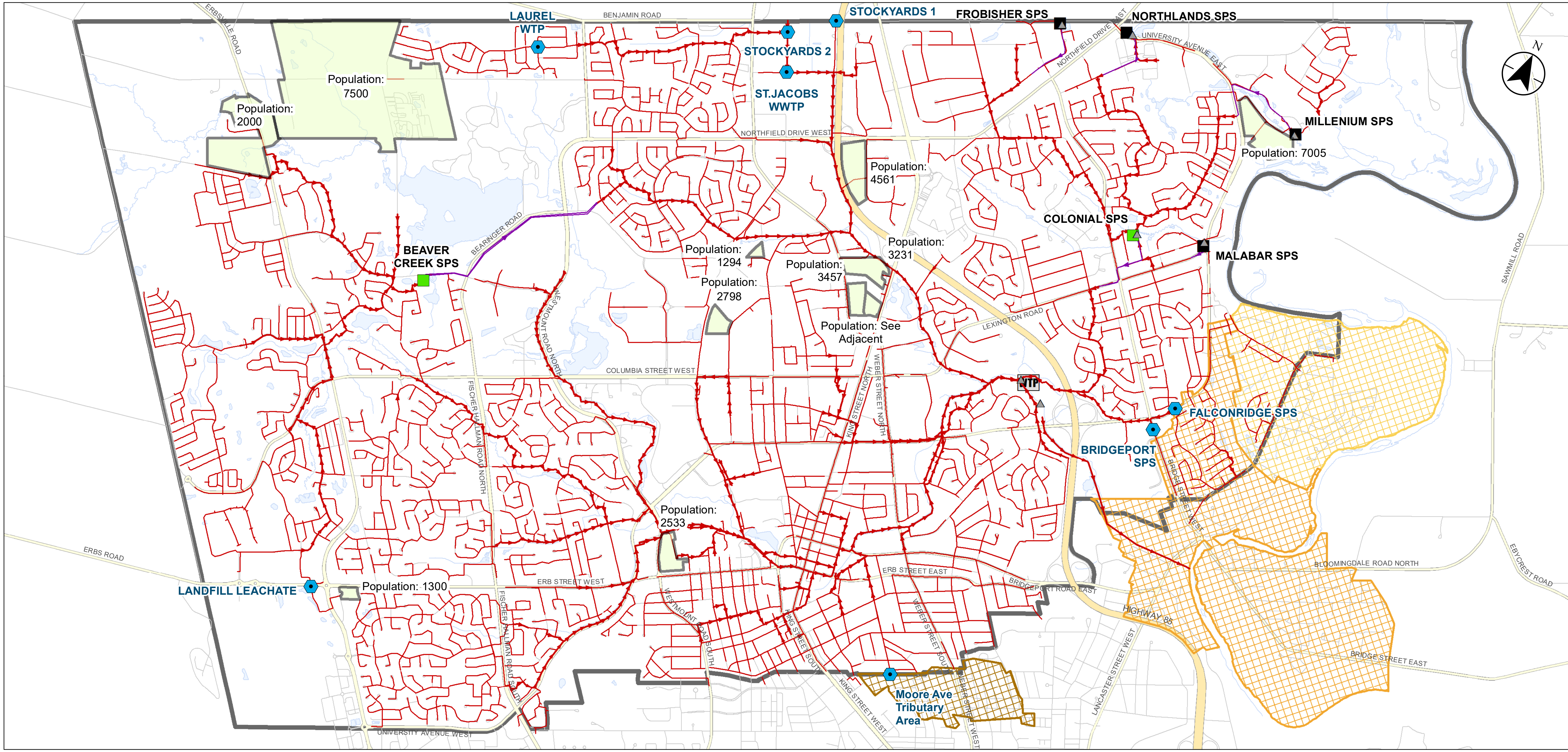
Table 2-10: Existing Population (2021) and Projected Population Growth for 2031

Scenario	Population Growth	Total Population
Existing (2021)	0	201,771
Projected Growth to 2031	35,679	237,450
Note: Existing population includes population from Kitchener to Waterloo sewer system, and excludes population from Waterloo connected to Kitchener sewer system		

2.4.3.2 System Assessment Results

The design events and criteria outlined in **Section 2.2** remain applicable for the 2031 horizons.

Figure 2-6 illustrates the DWF results for the 2031 scenario, where pipes remain free flowing and do not experience surcharge, except the pipes downstream of Frobisher SPS as per existing conditions. And **Figure 2-7** presents the 25-year conditions for the sanitary systems.



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Local Sewer
- Trunk Sewer
- 2031 Growth Polygons
- External Contribution

Kitchener Drainage Areas

- Bridgeport Pump Station
- Falconridge Pump Station
- Moore Pump Station

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

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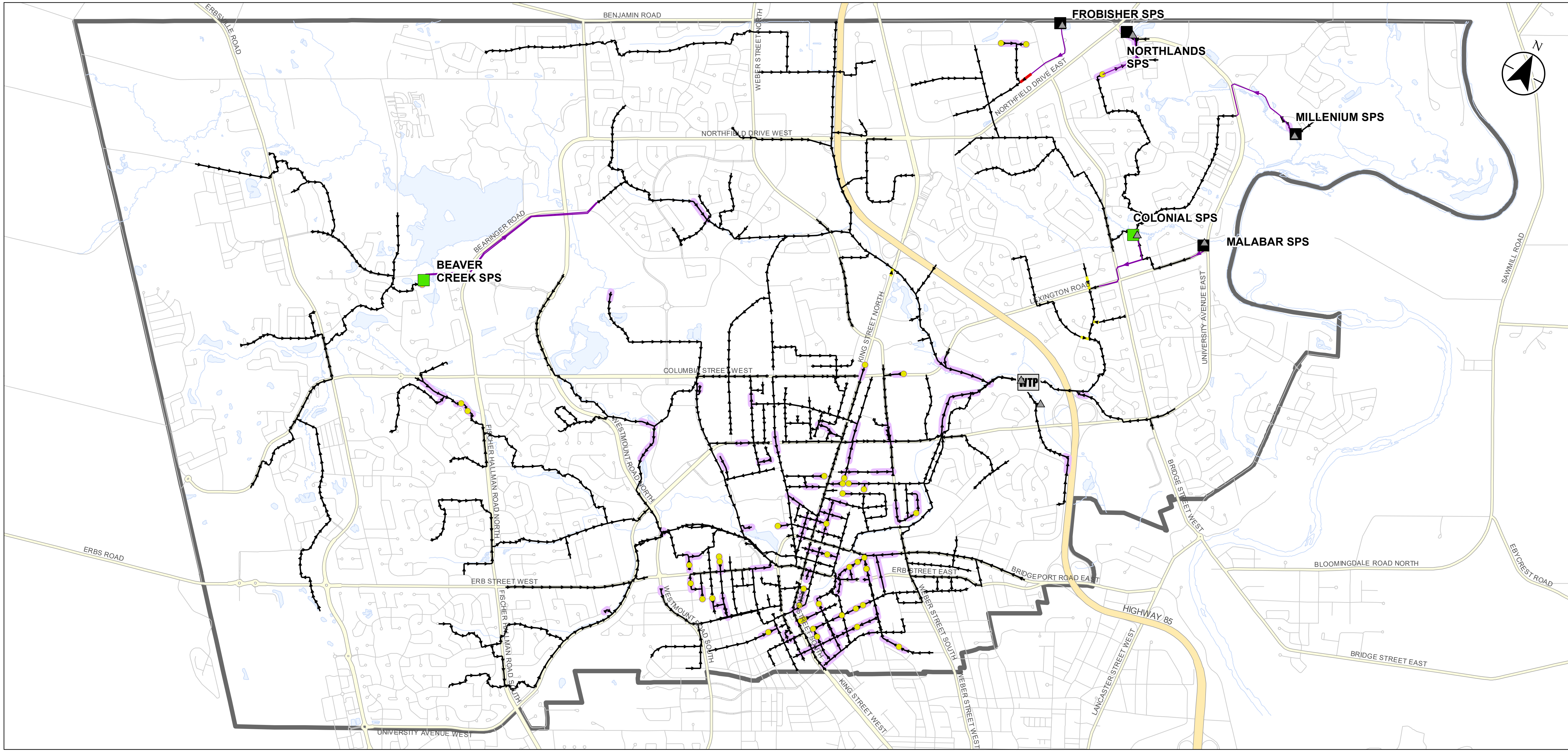
Figure No.
2-5

Title
2031 Growth Polygons

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

\\cd1004-f01\work_group\01656\active\165640363\preliminary\analysis\gis\mxd\TM4\WaterlooSANMP_GrowthPolygons_V2.mxd Revised: 2023-09-12 By: hboulanger



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

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Figure No.
2-6

Title
2031 Conditions Sanitary Sewer System DWF Results

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

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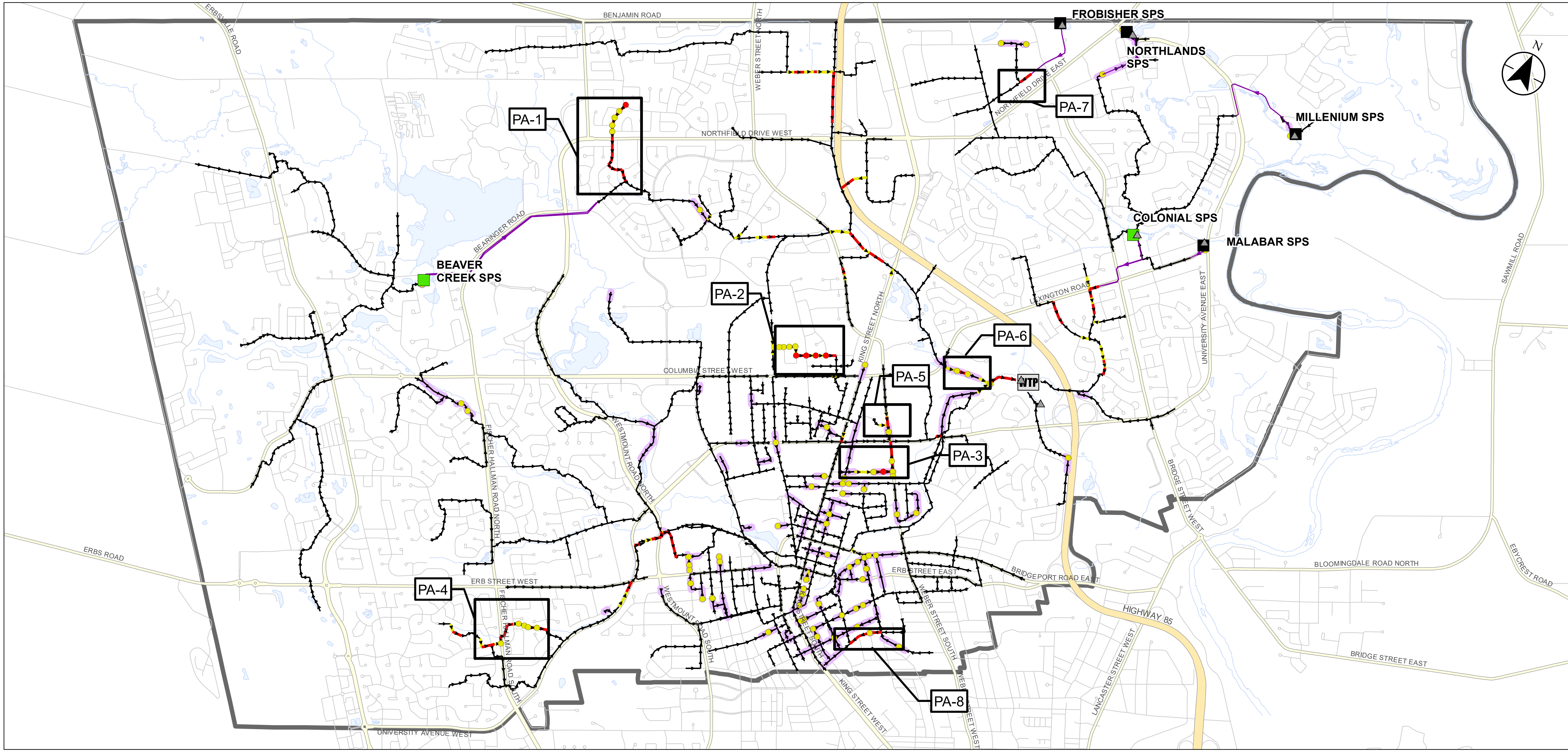

Legend

WTP	WWTP
	Storage
	Storage & Emergency Storage
	Overflow
	Forcemain
	Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

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Figure No.
2-7

Title
2031 Conditions Sanitary Sewer System
25-Year HGL & Surcharge Results

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

Based on the presented modelling results, no capacity constraints resulting in HGL issues are observed in the DWF conditions. In the 25-year design event, eight (8) Problem Areas are identified. **Table 2-11** presents the existing problem areas that still have capacity constraints in the 2031 scenario, as well as the additional problem area (PA-8) occurring in the future scenario.

Table 2-11: 2031 Scenario Sanitary Sewer Problem Areas

Problem Area ID	Location	Capacity Constraint Description
PA-1 Cedar Highpoint Ave	Highpoint Ave, between Northfield Dr W and Northlake Dr	HGLs within 1.8 m of surface due to undersized pipes. High risk of basement flooding and risk of surface flooding.
PA-2 University Austin Dr	From the intersection of Albert St and Cardill Crescent to the intersection of Austin Dr and Holly St	Risk of basement flooding (HGLs within 1.8 m of surface) and surface flooding due to undersized pipes along Austin Dr.
PA-3 Laurel 2 Lodge St / Weber	From Lodge St to the intersection of Weber St N and University Ave E	Risk of basement and surface flooding due to undersized pipes on Lodge St and Weber St N
PA-4 Maple Hill Maple Hill Creek	From the weir at Thorndale/Westvale to Roosevelt Ave	Risk of basement flooding (HGLs within 1.8 m of surface) due to undersized pipes on private property.
PA-5 Laurel 2 Weber St N	Weber St N, at the intersection of Hickory St E	Surcharging pipes upstream of shallow pipes resulting of an HGL within 1.8 m of surface. Low risk of basement flooding as it is an ICI area.
PA-6 Forwell Trunk Conestoga College	From Lexington Rd to the WWTP	HGLs within 1.8 m of surface due to undersized pipes and shallow pipes. Low risk of basement flooding as no building connection is anticipated along these sewers.
PA-7 Lee 1 Downstream of Frobisher SPS	Sewers directly downstream of Frobisher forcemain	Capacity constraints in DWF conditions due to undersized pipes, but no risk of basement flooding.
New Problem Area: PA-8 Laurel 2 Downstream of Moore SPS	Union St E; from Moore St S to Willow St	HGL within 1.8 m of surface (1.75 m) due to undersized pipes on Moore St S, and additional flow from the conveyance of Moore SPS to Waterloo sewer system.

The results of the incoming peak flow at the pumping station under 10-year design event are present in **Table 2-12**.

Table 2-12: 2031 Pumping Stations Results

Pumping Station	10yr Incoming Peak Flow (L/s)	ECA Capacity (L/s)	Firm Capacity (L/s)
Beaver Creek	350.3	370.0	550.0

Pumping Station	10yr Incoming Peak Flow (L/s)	ECA Capacity (L/s)	Firm Capacity (L/s)
Colonial	320.4	372.0	540.0*
Frobisher	30.4	35.0	60.0
Malabar	5.2	7.4	6.2
Millenium	52.8	86.0	152.0
Northlands	12.5	57.0	90.0

Notes:
* Firm capacity at Colonial SPS is estimated based on adding 2 duty pump capacities, i.e., does not consider reduction in capacity associated to two or more simultaneously running pumps

The 10-Year incoming peak flow is lower than the firm capacity for all pumping stations. Therefore, there is no capacity constraint at the pumping stations for the 2031 Scenario.

There is no pump station overflow occurring in the 2031, 25-Year scenario. Additionally, the emergency storage at Beaver Creek and Colonial pump stations are not used for the 2031 scenario with the 25-Year design storm.

2.4.4 2051 Horizon

2.4.4.1 Flow Generation

For the 2051 modelling scenarios, the City has provided growth polygons in shapefile format. The MTSA Official Plan area, and the Nodes and Corridors based on the NC Density Mapping data were assumed to count towards the 2051 growth scenario. The **Figure 2-8** present the 2031 growth polygons provided by the City. The approach to update the model with the 2051 population is the same as detailed in **Section 2.4.2** and **2.4.2.2**.

The total population included in the model for the 2051 horizon based on the provided growth polygon is approximately 265,000, including residential, student and employment equivalents.

Table 2-13: Existing Population (2021) and Projected Population Growth for 2051

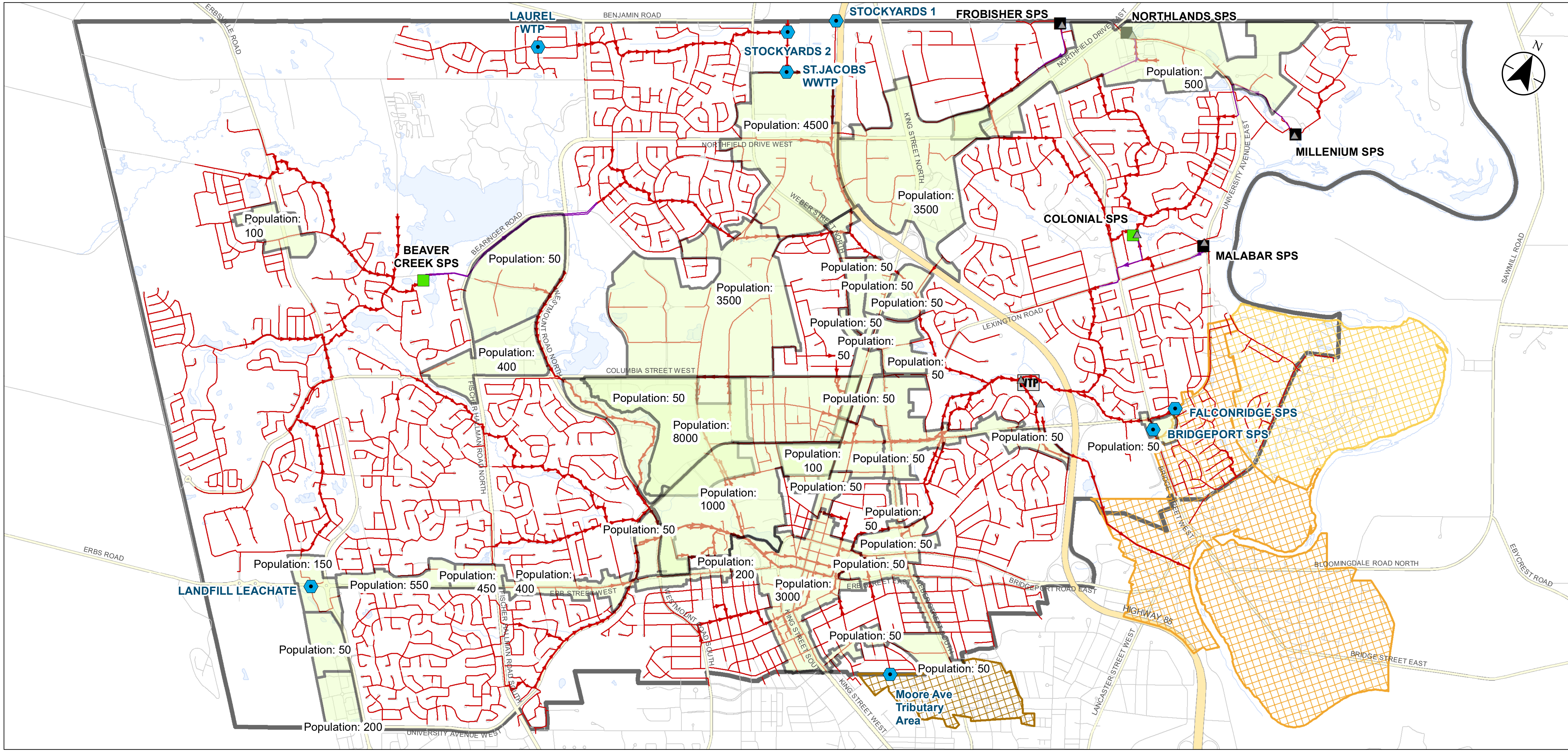
Scenario	Population Growth	Total Population
Existing (2021)	0	201,771
Projected Growth to 2031	35,679	237,450
Projected Growth to 2051	27,550	265,000

Note:
Existing population includes population from Kitchener to Waterloo sewer system, and excludes population from Waterloo connected to Kitchener sewer system

2.4.4.2 System Assessment Results

Figure 2-9 illustrates the DWF results for the 2051 scenario.

Figure 2-10 presents the 25-year conditions for the sanitary systems. There are eight (8) Problem Areas (areas of observed sewer capacity constraints) identified within the 2051 scenario system; these areas are shown in the Figure. There is no additional problem area from the 2031 scenario, thus refer to **Table 2-11** for Problem Area list.



Legend

WTP	WWTP
	Storage
	Storage & Emergency Storage
	Overflow
	Forcemain
	Local Sewer
	Trunk Sewer
	2051 Growth Polygons
	External Contribution

Kitchener Drainage Areas

- Bridgeport Pump Station
- Falconridge Pump Station
- Moore Pump Station

0 500 1,000 metres

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Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

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Figure No.
2-8

Title
2051 Growth Polygons

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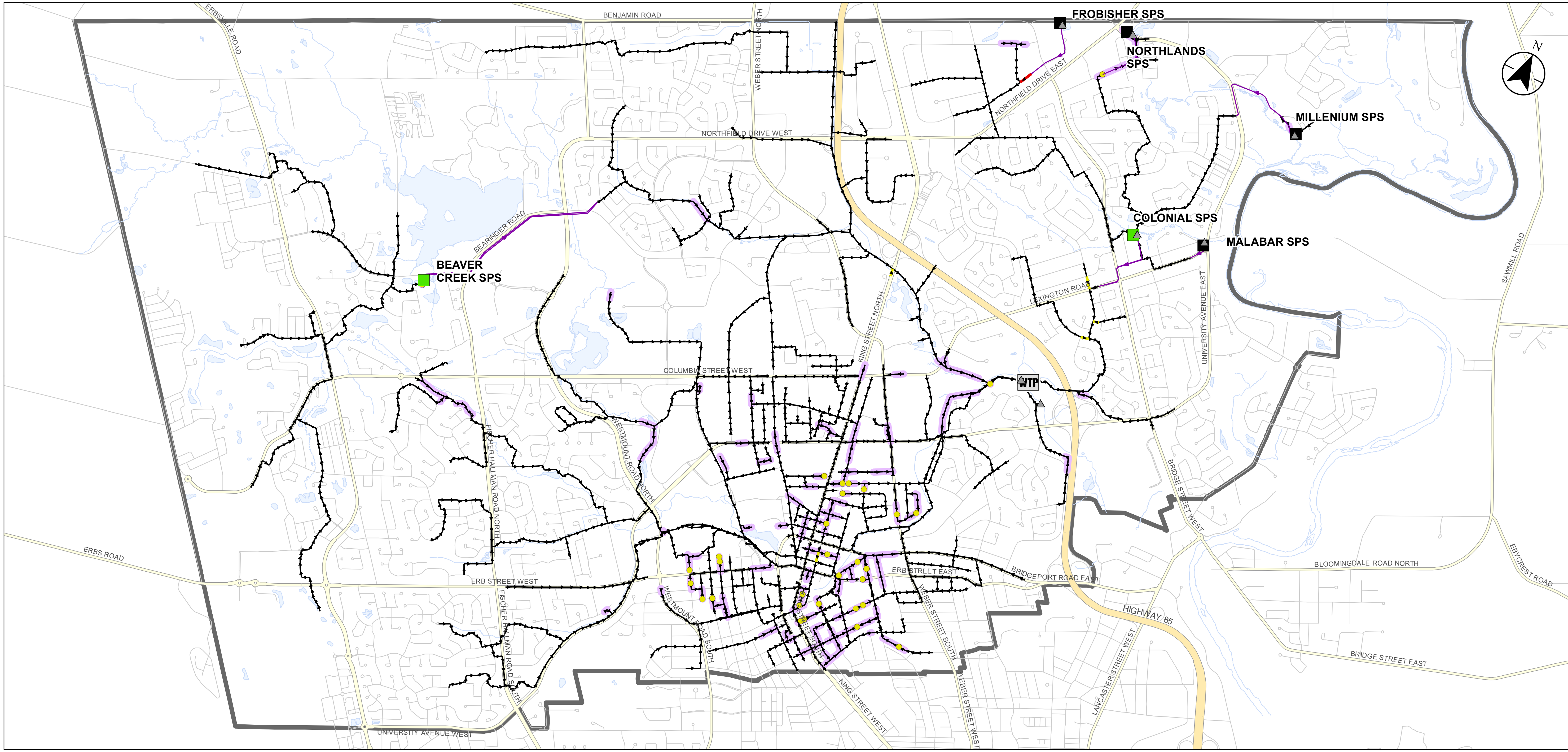

Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 500 1,000 metres

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Notes

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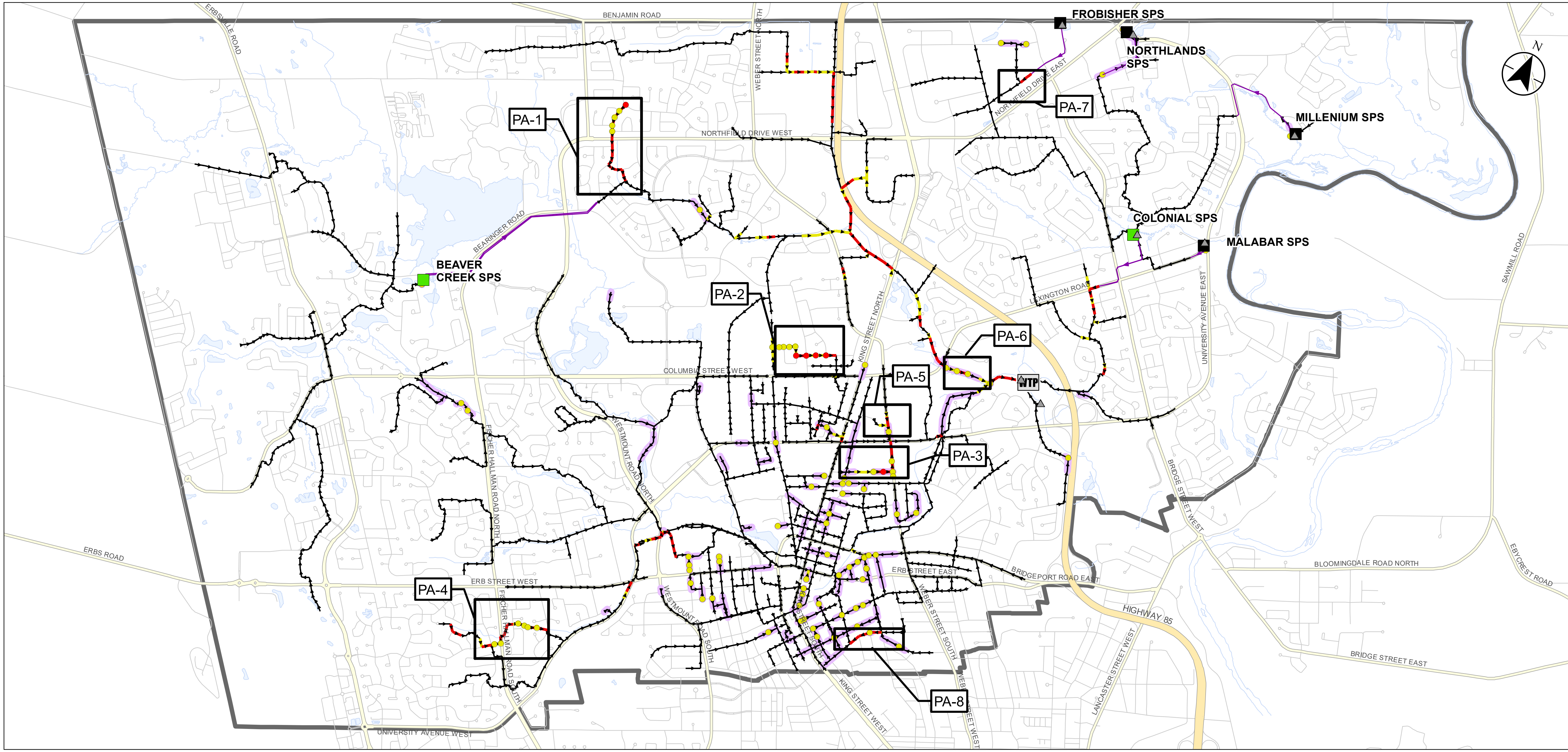
Figure No.
2-9

Title
2051 Conditions Sanitary Sewer System DWF Results



Legend

- WTP WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

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Figure No.
2-10

Title
2051 Conditions Sanitary Sewer System
25-Year HGL & Surcharge Results

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

\\cd1004-f01\work_group\01656\active\165640363\preliminary\analysis\gis\mxd\TM4\WaterlooSANMP_25yr_2051_v3.mxd Revised: 2023-09-12 By: hboulanger

The results of the incoming peak flow at the pumping station under 10-year design event are present in **Table 2-14.**

Table 2-14: 2051 Pumping Stations Results

Pumping Station	10yr Incoming Peak Flow (L/s)	ECA Capacity (L/s)	Firm Capacity (L/s)
Beaver Creek	407.4	370.0	550.0
Colonial	353.4	372.0	540.0*
Frobisher	33.9	35.0	60.0
Malabar	6.0	7.4	6.2
Millenium	56.5	86.0	152.0
Northlands	15.3	57.0	90.0
Notes: * Firm capacity at Colonial SPS is estimated based on adding 2 duty pump capacities, i.e., does not consider reduction in capacity associated to two or more simultaneously running pumps			

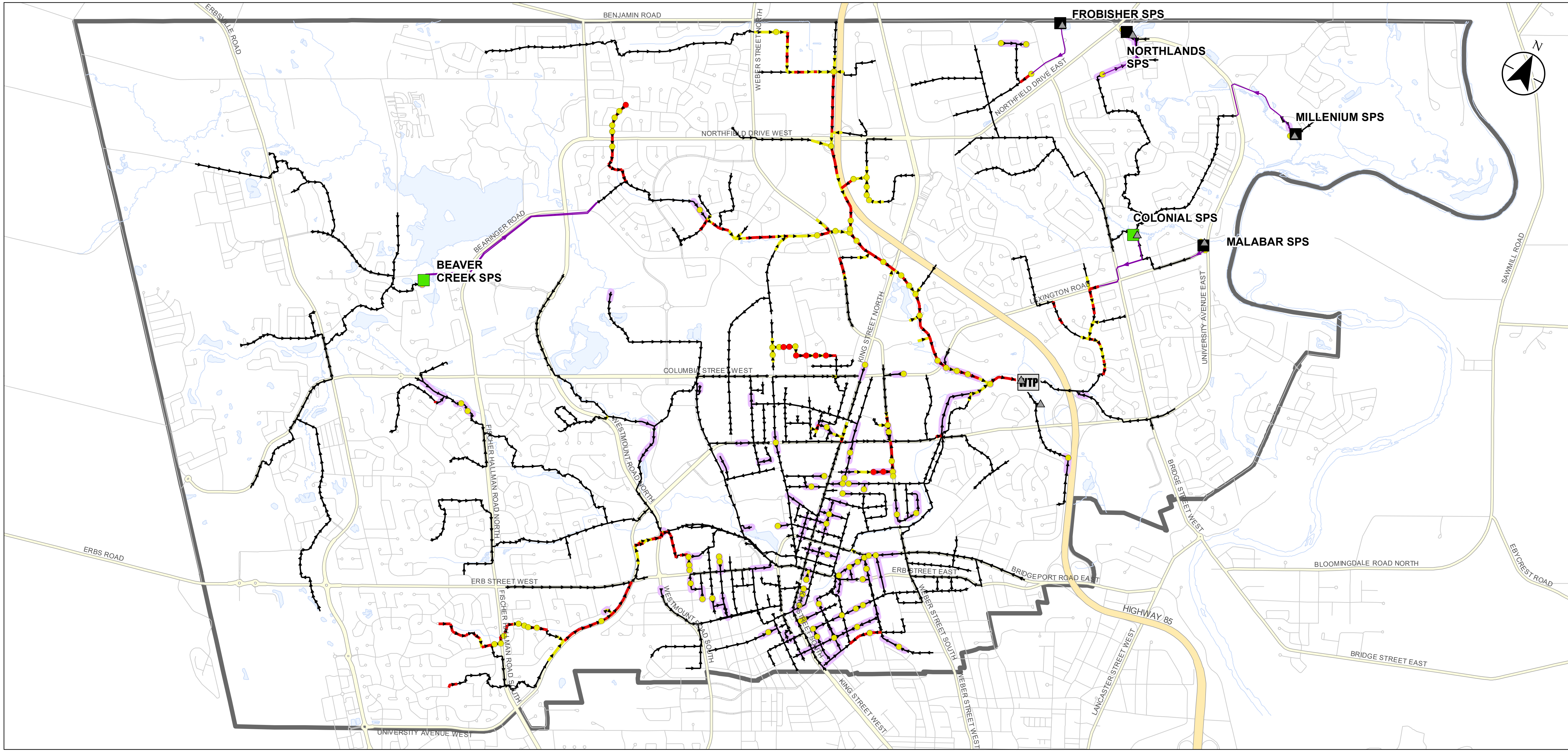
The 10-Year incoming peak flow is lower than the firm capacity for all pumping stations. Therefore, there is no capacity constraints at the pumping stations for the 2051 Scenario.

There is no pump station overflow occurring in the 2051, 25-Year scenario. Additionally, the emergency storage at Beaver Creek and Colonial pump stations are not used for the 2051 scenario with the 25-Year design storm.

2.5 CLIMATE CHANGE

Typically, climate change (CC) predictions result in rainfall increases closer to 20% from current design storms for the same RG. Therefore, the 25-year Chicago, 3-hour design storm rainfall timeseries was increased by 20% and used as the 25-year including the anticipated effect of climate change event (25-year + CC). The climate change model results is used to test the sensitivity of the sanitary system. **Figure 2-11** presents the 25-year + CC conditions. Under climate change conditions, pipe surcharge, and risk of basement and surface flooding increase slightly from the 25-yr scenarios; however, the sewer system remains resilient to these impacts with little change to level of service. Moreover, in the 2051 25-year + CC conditions, Malabar SPS overflows, and Beaver Creek SPS needs additional emergency storage.

It is noted that the simulations do not directly reflect the potential influences of external water sources such as the storm drainage system and watercourse floodplains, which could have more isolated and concentrated impacts where the collection system infrastructure is submerged due to surface flooding. These potential impacts should be considered as part of infrastructure mitigation planning in high-risk areas.



Legend

- WTP WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 500 1,000 metres

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Figure No.
2-11

Title
2051 Conditions Sanitary Sewer System 25-Year + Climate Change HGL & Surcharge Results

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

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3.0 CONCLUSIONS AND RECOMMENDATIONS

This technical note (TN#4) outlines the existing and future scenarios assessed for the Waterloo sanitary Master Plan update, including the following discussions:

- Existing conditions model setup and design criteria (**Section 2.3**);
- Future conditions model setup and design criteria for both the 2031 and 2051 horizons (**Section 2.4**);
- Climate change considerations and assessment (**Section 2.5**); and the,

In general, the following main considerations result from the foregoing TN:

- Existing conditions,
  - The overall system operates similar to that presented in the 2014 Master Plan
  - A total of seven (7) sewer problem areas are identified based on existing conditions modelling results:
    - Sewer on Highpoint Ave;
    - Sewer on Austin Dr;
    - Sewer on Lodge St / Weber;
    - The Maple Hill Creek area;
    - Sewer on Weber St N;
    - Downstream sewer of Forwell Trunk; and,
    - Sewer segments located downstream of Frobisher SPS.
- Future conditions (2031 and 2051 growth scenarios),
  - Criteria for future sewage flow:
    - 275 L/cap/day for both residential and ICI growth (DGSSMS); and
    - Diurnal patterns from model calibration.
  - Criteria for RDII:
    - Infill & Intensification: Already accounted for in existing conditions.

        - New Developments: Inflow and infiltration allowance of 0.15 L/s/ha.

    - The decommissioning of Moore SPS own by Kitchener will redirect flow from the tributary areas of Kitchener to the sanitary sewer on Moore Ave.

    - An additional sewer problem area is identified:

        - Sewers on Union St E, downstream of Moore Ave SP tributary area of Kitchener.

    - Forwell trunk capacity:

        - Upstream inflow assumption:

            - The assumed flow from Laurel WTP was added as a constant inflow of 9 L/s;

            - The St. Jacobs inflow was obtained from the 2018 WWTP MP; and,

            - The Stockyards growth areas was obtained from the Master Servicing and Stormwater Management Report on the Woolwich Township website, and conservative criteria were use for the sanitary loads.

        - Lower Forwell trunk was identified as a capacity constraint due to undersized pipes and shallow pipes. However, there is a low risk of basement flooding as no building connection is anticipated along these sewers.

    - Climate Change stress-testing was completed indicating system resiliency due to little change to provided level of service.

With the completion of the sanitary sewer assessment, the next step is the detailed analysis of solutions. TN#5 will present the alternative solution evaluation and selection of preferred solution for each problem area.

Appendix A PLANNING AND LAND USE DATA

APPENDICES

Planning and land use data

Waterloo is home to a young and growing population. Planning for this involves tracking growth trends and information.

Use this page to find out more about population and land use trends. You can also download a data set that's updated annually.

On this page

- Data use disclaimer

Census bulletin

View the summary document of the most recent Census release. This census bulletin focuses on the City of Waterloo and its people by their demographic, social and economic characteristics, according to the 2021 Census of Population.

Population

The City of Waterloo is located in the Region of Waterloo. The region is amongst the fastest growing communities in Canada.

At the end of 2021:

- the estimated population of Waterloo was 147,520
- this includes 28,390 students and 119,130 permanent residents

These numbers will be updated when the Region of Waterloo releases its Year-End Population and Household Estimates Report for 2022. The stats above are based on data from the 2021 Census and includes adjustments for new homes and apartments, students and temporary residents, census undercount and vacancy rates.

Growth rate

Along with the rest of southern Ontario, the City of Waterloo's population growth rate is among the fastest in Canada. Since the release of the previous census in 2016, the city has grown faster than the regional and provincial average.

From 2016 to 2021:

- the City of Waterloo's grew 15.7%.
- the Region of Waterloo grew 9.7%
- the Province of Ontario grew 5.8%.

Projections by 2041

Based on projections from the 2016 Census, there will be 140,500 permanent residents living in Waterloo by 2041. This does not include students.

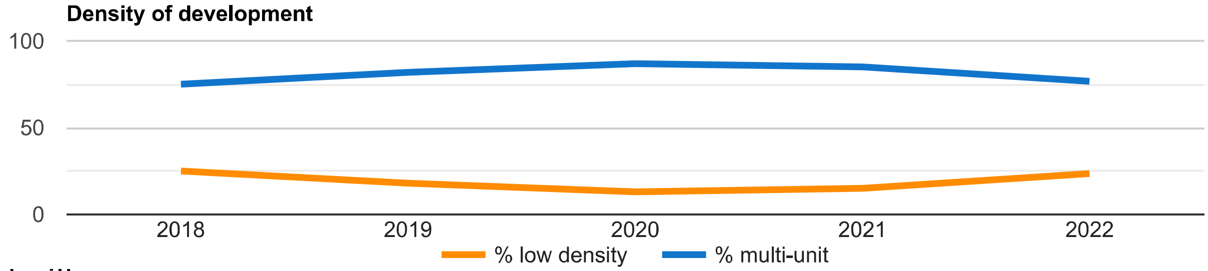
Residential development

We track the amount and type of residential development taking place across the city. Residential development is the construction of places for people to live.

Density

Residential development can be categorized based on how many people can live in a unit. This measure is called density.

Buildings such as detached homes and townhouses have low numbers of units while apartment- style 'multi-residential' buildings have many more. The more units in a building the greater the density.



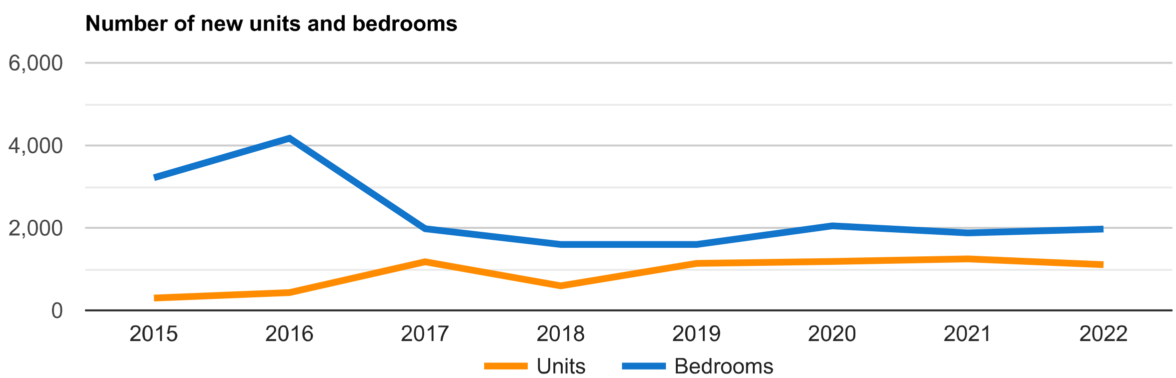
Units built per year

The amount of residential development can be measured by the number of:

- units - such as a house or condo
- bedrooms - places to sleep inside a unit

A detached home with 3 bedrooms would count as 1 unit and 3 bedrooms, for example.

Since 2015, new units have gradually increased while the number of overall bedrooms has decreased. This is due to increasing construction of multi-unit buildings with a lower number of bedrooms per unit.

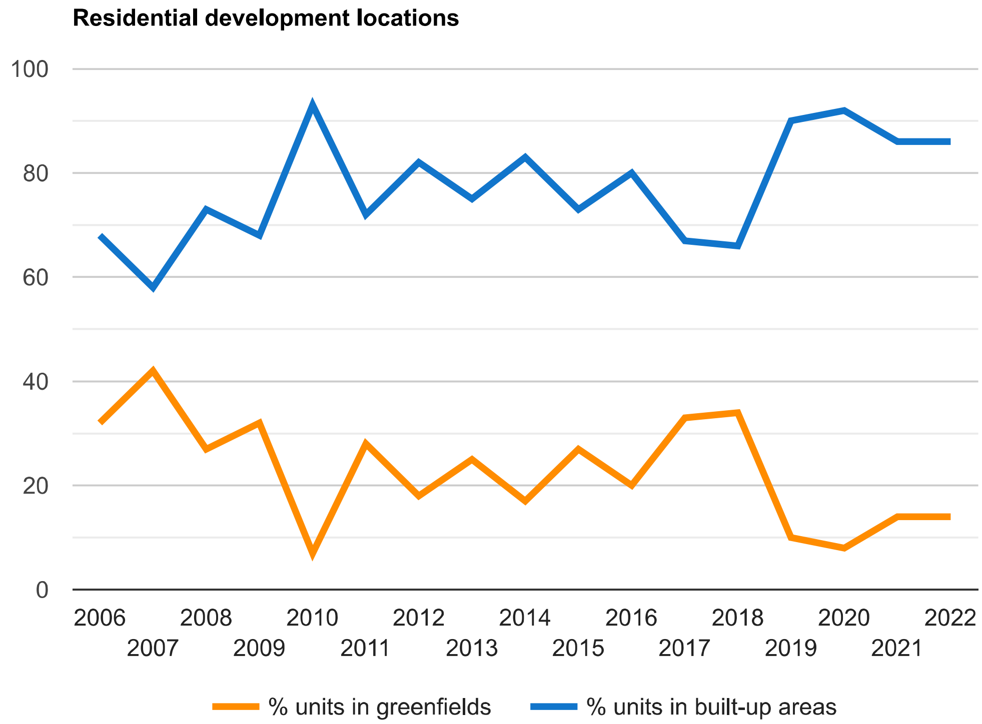


Building locations

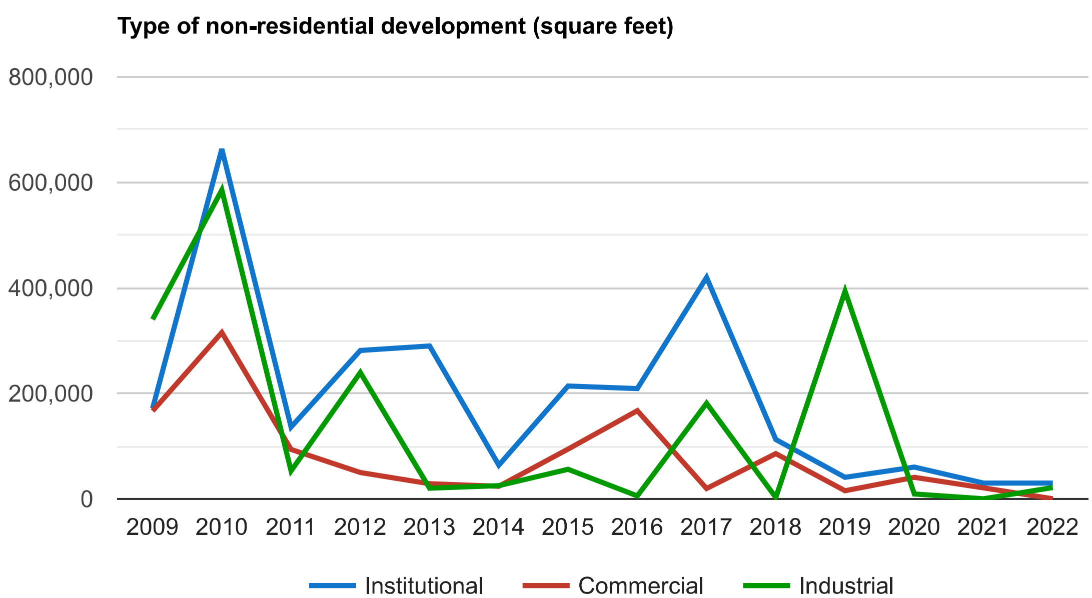
Land where new units are built is put into two categories:

- built-up areas - where development has historically occurred, such as uptown and older neighbourhoods
- designated greenfield areas - previously undeveloped land

As the supply of greenfield becomes limited, provincial and city policy has focused on 'intensification' in built-up areas. Over the last 15 years (2007 to 2022), there has been a 28% increase in the percentage of units constructed in the built-up area.



- industrial - such as factories
- commercial - such as retail stores
- institutional - such as religious buildings



Download data set

The city's planning division updates population and land use data annually.

It was last updated at the end of 2022 and is currently in Excel spreadsheet format.

City of Waterloo Population Stats

Source: Region of Waterloo Year-End Population and Household Estimates Report

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total Population Year-end*	**121,700**	**123,000**	**124,600**	**129,100**	**131,100**	**132,300**	**133,700**	**134,600**	**137,420**	**139,490**	**146,010**	**147,350**	**147,520**	
Population in Regular Households	111,100	114,000	115,400	119,300	121,100	121,600	122,400	123,100	125,830	127,830	134,290	135,570	137,650	
Population in Collective Dwellings***	10,570	8,980	9,200	9,800	9,930	10,690	11,240	11,530	11,590	11,660	11,720	11,780	9,870	
Total Population Year-end (previous year)*	120,500	121,900	122,900	126,400	127,600	130,700	131,800	132,900	134,600	137,420	143,500	146,270	147,350	
Additional Population	1,200	1,100	1,700	2700	3,500	1,600	1,900	1,700	2,820	2,070	2,510	1,080	170	
Population Change from previous year (%)	1.0	0.9	1.4	2.1	2.74	1.2	1.44	1.3	2.1	1.5	1.7	0.7	0.1	
Households Year-end*	**40,550**	**40,890**	**39,980**	**41,530**	**41,930**	**42,730**	**43,580**	**43,330**	**43,890**	**44,710**	**45,570**	**46,180**	**50,380**	
Households Year-end (previous year)*	39,940	40,530	39,510	40,400	40,720	41,800	42,590	42,920	43,330	43,890	44,710	45,770	46,180	
Additional Households	610	360	470	1,130	1,210	930	990	410	560	820	860	410	4200	
Household Change from previous year (%)	1.5	0.9	1.2	2.8	2.97	2.2	2.32	1.0	1.3	1.9	1.9	0.9	9.1	
Persons per Unit+	2.74	3	2.89	2.87	2.89	2.85	2.81	2.84	2.87	2.86	2.95	2.94	2.73	
Student Population (included above)	**26,150**	**28,890**	**32,920**	**23,460**	**24,660**	**24,760**	**25,060**	**25,560**	**25,940**	**26,260**	**29,490**	**30,820**	**28,390**	
Students Arriving	-	-	-	24,740	25,930	26,040	26,480	27,120	27,490	27,800	31,030	32,330	29,990	
Living in Student Residences	8,920	7,400	7,570	8,210	8,210	8,960	9,320	9,160	9,900	9,900	9,900	9,900	7,920	
Living in Other Accommodations	15,990	20,240	24,100	16,530	17,730	17,090	17,160	17,960	17,590	17,900	21,130	22,430	22,070	
Students Leaving++	-	-	-	-1,280	-1,270	-1,280	-1,420	-1,560	-1,550	-1540	-1,530	-1,510	-1590	
Living at home	1,250	1,250	1,250	-	-	-	-	-	-	-	-	-	-	

*2022 numbers not available yet

* Based on available data from the 2016 Census and 2021 Census, includes adjustments for recent residential development, students and other foreign/temporary residents, net Census undercount, and vacancy rates.

Due various corrections and adjustments, direct comparison to previous years estimates are not valid.

** Municipal totals may not add due to independent rounding.

*** Collective dwellings include student residences, nursing homes, group homes, hospitals, larger lodging houses, etc.

+ 'Persons per Unit' (PPU) calculation is based on the 'Population in Regular Households', not on 'Total Population'

++ These are students who leave home to attend school. They represent the reverse flow of the temporary students arriving in the Region from elsewhere.

City of Waterloo Population Projections

Source: City of Waterloo; Hemson Consulting Ltd. Development Charges Background Study 2020; Statistics Canada, Census of Canada 2016.

Mid-Year	Permanent Population	(F/T) Student Population	Total Population Incl. Students	Households	Employment	Household Size	Activity Rate
2016	**109,185**	**17,960**	**127,145**	**40,381**	**68,433**	**2.70**	**62.7%**
2017	111,234	17,985	129,219	41,084	69,156	2.71	62.2%
2018	113,321	18,010	131,331	41,787	69,887	2.71	61.7%
2019	115,447	18,035	133,482	42,490	70,625	2.72	61.2%
2020	117,613	18,060	135,673	43,193	71,371	2.72	60.7%
2021	**119,820**	**18,083**	**137,903**	**43,896**	**72,125**	**2.73**	**60.2%**
2022	120,893	18,163	139,056	44,612	72,887	2.71	60.3%
2023	121,975	18,243	140,218	45,329	73,657	2.69	60.4%
2024	123,067	18,323	141,390	46,045	74,435	2.67	60.5%
2025	124,169	18,403	142,572	46,761	75,222	2.66	60.6%
2026	**125,282**	**18,483**	**143,765**	**47,478**	**76,017**	**2.64**	**60.7%**
2027	126,298	18,563	144,861	48,257	76,820	2.62	60.8%
2028	127,323	18,643	145,966	49,037	77,632	2.60	61.0%
2029	128,356	18,723	147,079	49,816	78,452	2.58	61.1%
2030	129,397	18,803	148,200	50,596	79,281	2.56	61.3%
2031	**130,447**	**1,883**	**149,330**	**51,375**	**80,119**	**2.54**	**61.4%**
2032	131,500	18,963	150,463	52,062	80,966	2.53	61.6%
2033	132,561	19,043	151,604	52,749	81,822	2.51	61.7%
2034	133,650	19,123	152,753	53,436	82,687	2.50	61.9%
2035	134,708	19,203	153,911	54,123	83,561	2.49	62.0%
2036	**135,795**	**19,283**	**155,078**	**54,810**	**84,444**	**2.48**	**62.2%**
2037	136,723	19,363	156,086	55,501	85,336	2.46	62.4%
2038	137,658	19,443	157,101	56,193	86,238	2.45	62.6%
2039	138,599	19,523	158,122	56,884	87,149	2.44	62.9%
2040	139,546	19,603	159,149	57,576	88,070	2.42	63.1%
2041	**140,500**	**19,683**	**160,183**	**58,268**	**89,000**	**2.41**	**63.3%**

Note 1: Forecast includes Census undercount of 3.3%.

Note 2: Accounts for students living in off-campus housing.

Population Forecast for Dwelling Type in the City of Waterloo

Source: Region of Waterloo; Statistics Canada

Note: Mid-year (MY) Places to Grow (P2G) Population (Census + 4%, and does not include foreign or temporary residents)

	MY2006	MY2011	MY2016	MY2021	MY2026	MY2031	MY2036	MY2041
Population in Occupied Singles *	65,155	65,486	66,582	68,595	69,609	70,991	71,958	72,166
Population in Occupied Semis *	7,380	7,142	7,059	7,483	7,809	8,073	8,305	8,512
Population in Occupied Townhouses *	11,391	11,660	12,135	13,925	15,164	15,828	16,489	17,145
Population in Occupied Apartments *	16,083	16,193	20,996	24,074	28,136	31,637	34,758	37,810
Population in Collective Dwellings	1,116	1,131	1,291	1,514	1,844	2,297	2,805	3,350

*including people in dwellings occupied solely by foreign and/or temporary residents

Non-Residential Building Permits - Sq. Ft.
(Excludes mixed-use)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total: 2012-2022	Average: 2012-2022
Commercial (New)	117,126.00	7,882.00	38,758.00	227,998.00	179,089.45	0.00	71,378.00	2,059.00	30,881.0	11,269.0	0.0	686,440.45	62,403.68
Commercial (Additions)	3,661.00	21,365.00	2,307.00	7,722.00	918.00	10,827.00	3,694.00	17,385.00	9,683.86	9,276.0	0.0	86,838.86	7,894.44
Commercial (Total)	120,787.00	29,247.00	41,065.00	235,720.00	180,007.45	10,827.00	75,072.00	19,444.00	40,564.86	20,545.00	0.00	773,279.31	77,327.93
Industrial (New)	0.00	0.00	0.00	22,964.00	291.00	66,574.00	0.00	353,356.00	2,121.00	312.00	21,521.00	467,139.00	42,467.18
Industrial (Additions)	5,096.00	8,654.00	7,407.00	31,035.00	14,995.00	3,952.00	0.00	673.00	7,321.00	0.00	0.00	79,133.00	7,193.91
Industrial (Total)	5,096.00	8,654.00	7,407.00	53,999.00	15,286.00	70,526.00	0.00	354,029.00	9,442.00	312.00	21,521.00	546,272.00	49,661.09
Institutional (New)	212,512.00	173,332.00	0.00	70,191.00	0.00	1,444.00	7,072.00	27,024.00	31,116.00	1,776.00	20,162.00	544,629.00	52,446.70
Institutional (Additions)	63,917.00	260,642.00	61,026.00	105,827.00	245,734.00	418,512.00	4,834.00	8,421.00	29,038.00	28,163.00	9,738.00	1,235,852.00	122,611.40
Institutional (Total)	276,429.00	433,974.00	61,026.00	176,018.00	245,734.00	419,956.00	11,906.00	35,445.00	60,154.00	29,939.00	29,900.00	1,780,481.00	175,058.10
Office (New)	145,454.00	0.00	0.00	104,146.00	23,125.95	109,792.00	100,807.00	27,896.00	0.00	0.00	0.00	511,220.95	46,474.63
Office(Addition)	15,414.00	25,467.00	1,637.00	15,557.00	53,992.00	1,012.00	2,852.00	885.00	1,560.50	366.00	0.00	118,742.50	10,794.77
Office (Total)	160,868.00	25,467.00	1,637.00	119,703.00	77,117.95	110,804.00	103,659.00	28,781.00	1,560.50	366.00	0.00	629,963.45	62,996.35
Non-Residential Totals (Additions + New) *(Excludes mixed-use)*	563,180.00	497,342.00	111,135.00	585,440.00	518,145.40	612,113.00	190,637.00	437,699.00	111,721.36	51,162.00	51,421.00	3,729,995.76	367,857.48

Mixed-Use Non-Residential Permits Only - Sq. Ft.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total: 2012-2022	Average: 2012-2022
Mixed-Use Commercial (New)	4,232.00	0.00	39,755.00	29,419.00	24,816.00	8,690.00	6,736.00	15,133.00	13,952.29	12,927.00	3,961.00	159,621.29	15,566.03
Mixed-Use Commercial (Addition)	0.00	0.00	0.00	0.00	344.00	0.00	4,066.00	0.00	2,432.64	0.00	0.00	6,842.64	684.26
Mixed-Use Commercial (Total)	4,232.00	0.00	39,755.00	29,419.00	25,160.00	8,690.00	10,802.00	0.00	16,384.93	12,927.00	3,961.00	151,330.93	14,736.99
Mixed-Use Industrial (New)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixed-Use Industrial (Addition)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixed-Use Industrial (Total)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixed-Use Institutional (New)	0.00	0.00	0.00	0.00	67,522.00	0.00	0.00	0.00	0.00	0.00	0.00	67,522.00	6,752.20
Mixed-Use Institutional (Addition)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixed-Use Institutional (Total)	0.00	0.00	0.00	0.00	67,522.00	0.00	0.00	0.00	0.00	0.00	0.00	67,522.00	6,752.20
Mixed-Use Office (New)	0.00	0.00	16,624.00	0.00	0.00	0.00	0.00	0.00	8,317.06	0.00	212,323.00	237,264.06	2,494.11
Mixed-Use Office (Addition)	0.00	0.00	72.00	0.00	7,913.00	0.00	0.00	0.00	0.00	0.00	0.00	7,985.00	798.50
Mixed-Use Office (Total)	0.00	0.00	16,696.00	0.00	7,913.00	0.00	0.00	0.00	8,317.06	0.00	212,323.00	245,249.06	3,292.61
Mixed-Use Only Total (Additions + New)	4,232.00	0.00	56,451.00	29,419.00	100,595.00	8,690.00	10,802.00	15,133.00	24,701.99	12,927.00	216,284.00	479,234.99	27,780.44

Non-Residential + Mixed-Use (New BPs Only)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total: 2012-2022	Average: 2012-2022
Commercial (New)	117,126.00	7,882.00	38,758.00	227,998.00	179,089.45	0.00	71,378.00	2,059.00	30,881.00	11,269.00	0.00	686,440.45	62,403.68
Commercial Mixed-Use (New)	4,232.00	0.00	39,755.00	29,419.00	24,816.00	8,690.00	6,736.00	15,133.00	13,952.29	12,927.00	3,961.00	159,621.29	14,511.03
Commercial Total	121,358.00	7,882.00	78,513.00	257,417.00	203,905.45	8,690.00	78,114.00	17,192.00	44,833.29	24,196.00	3,961.00	846,061.74	76,914.70
Industrial (New)	0.00	0.00	0.00	22,964.00	291.00	66,574.00	0.00	353,356.00	2,121.00	312.00	21,521.00	467,139.00	42,467.18
Industrial Mixed-Use (New)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
Industrial Total	0.00	0.00	0.00	22,964.00	291.00	66,574.00	0.00	353,356.00	2,121.00	312.00	21,521.00	467,139.00	42,467.18
Institutional (New)	212,512.00	173,332.00	0.00	70,191.00	0.00	1,444.00	7,072.00	27,024.00	31,116.00	1,776.00	20,162.00	544,629.00	49,511.73
Institutional Mixed-Use (New)	0.00	0.00	0.00	0.00	67,522.00	0.00	0.00	0	0.00	0.00	0.00	67,522.00	6,138.36
Institutional Total	212,512.00	173,332.00	0.00	70,191.00	67,522.00	1,444.00	7,072.00	27,024.00	31,116.00	1,776.00	20,162.00	612,151.00	55,650.09
Office (New)	145,454.00	0.00	0.00	104,146.00	23,125.95	109,792.00	100,807.00	27,896.00	0.00	0.00	0.00	511,220.95	46,474.63
Office Mixed-Use (New)	0.00	0.00	16,624.00	0.00	0.00	0.00	0.00	0	8,317.06	0.00	212,323.00	237,264.06	21,569.46
Office Total	145,454.00	0.00	16,624.00	104,146.00	23,125.95	109,792.00	100,807.00	27,896.00	8,317.06	0.00	212,323.00	748,485.01	68,044.09
Combined New BPs Only, Totals	479,324.00	181,214.00	95,137.00	454,718.00	294,844.40	186,500.00	185,993.00	425,468.00	86,387.35	26,284.00	257,967.00	2,673,836.75	243,076.07

Non-Residential + Mixed-Use (Additions BPs Only)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total: 2012-2022	Average: 2012-2022
Commercial (Additions)	3,661.00	21,365.00	2,307.00	7,722.00	918.00	10,827.00	3,694.00	2,045.00	9,683.86	9,276.00	0.00	71,498.86	6,499.90
Commercial Mixed-Use (Additions)	0.00	0.00	0.00	0.00	344.00	0.00	4,066.00	0.00	2,432.64	0.00	0.00	6,842.64	622.06
Commercial Total	3,661.00	21,365.00	2,307.00	7,722.00	1,262.00	10,827.00	7,760.00	2,045.00	12,116.50	9,276.00	0.00	78,341.50	7,121.95
Industrial (Additions)	5,096.00	8,654.00	7,407.00	31,035.00	14,995.00	3,952.00	0.00	0.00	7,321.00	0.00	0.00	78,460.00	7,132.73
Industrial Mixed-Use (Additions)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industrial Total	5,096.00	8,654.00	7,407.00	31,035.00	14,995.00	3,952.00	0.00	0.00	7,321.00	0.00	0.00	78,460.00	7,132.73
Institutional (Additions)	63,917.00	260,642.00	61,026.00	105,827.00	245,734.00	418,512.00	4,834.00	5,221.00	29,038.00	28,163.00	9,738.00	1,232,652.00	112,059.27
Institutional Mixed-Use (Additions)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Institutional Total	63,917.00	260,642.00	61,026.00	105,827.00	245,734.00	418,512.00	4,834.00	5,221.00	29,038.00	28,163.00	9,738.00	1,232,652.00	112,059.27
Office (Additions)	15,414.00	25,467.00	1,637.00	15,557.00	53,992.00	1,012.00	2,852.00	0.00	1,560.50	366.00	0.00	117,857.50	10,714.32
Office Mixed-Use (Additions)	0.00	0.00	72.00	0.00	7,913.00	0.00	0.00	0.00	0.00	0.00	0.00	7,985.00	725.91
Office Total	15,414.00	25,467.00	1,709.00	15,557.00	61,905.00	1,012.00	2,852.00	0.00	1,560.50	366.00	0.00	125,842.50	11,440.23
Combined Additions BPs Only, Totals	88,088.00	316,128.00	72,449.00	160,141.00	323,896.00	434,303.00	15,446.00	7,266.00	50,036.00	37,805.00	9,738.00	1,515,296.00	137,754.18

Overall Totals (Non-Residential + Mixed-Use)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total: 2012-2022	Average: 2012-2022
Overall Total (New BPs only)	479,324.00	181,214.00	95,137.00	454,718.00	294,844.40	186,500.00	185,993.00	425,468.00	86,387.35	26,284.00	257,967.00	2,673,836.75	243,076.07
Total (New + Additions)	567,412.00	497,342.00	167,586.00	614,859.00	618,740.40	620,803.00	201,439.00	432,734.00	136,423.35	64,089.00	267,705.00	4,189,132.75	380,830.25

New Builds and Additions

Residential Unit and Bedroom Development:

Source: City of Waterloo Building Permits

Residential Building Permits (# of Units)								
Typology	2015	2016	2017	2018	2019	2020	2021	2022
New								
Single Detached Dwelling	226	342	253	161	120	73	171	18
Semi Detached Dwelling	10	46	2	2	4	12	8	4
Townhouse	59	40	59	8	7	73	5	239
Duplex	0	0	0	0	0	0	0	0
Triplex	0	0	0	0	0	0	0	0
Apartment*	0	0	0	0	0	0	0	0
Boarding House/Lodging House	0	0	0	0	0	0	0	0
Mixed-Use	891	977	569	8	327	665	775	106
Multi-Unit	251	738	292	415	683	358	290	775
TOTAL	295	428	1,175	594	1,141	1,181	1,249	1,142
Addition								
Single Detached Dwelling	0	0	0	0	2	6	2	4
Semi Detached Dwelling	0	0	0	0	0	0	1	1
Townhouse	0	0	0	0	0	0	0	0
Duplex	0	0	0	0	0	0	0	0
Triplex	0	0	0	0	0	0	0	0
Apartment*	0	0	0	0	0	0	0	0
Boarding House/Lodging House	0	0	0	0	0	0	0	0
Mixed-Use	0	0	0	188	0	0	0	0
Multi-Unit	0	0	0	152	41	0	0	100
TOTAL	0	0	0	340	43	6	3	105
Alteration/Interior Finish								
Single Detached Dwelling	0	0	0	7	28	49	71	72
Semi Detached Dwelling	0	0	1	1	1	3	5	7
Townhouse	0	0	0	0	0	0	0	3
Duplex	0	0	1	2	0	0	0	1
Triplex	0	0	0	0	0	0	3	0
Apartment*	0	0	0	0	0	0	0	0
Boarding House/Lodging House	0	0	0	0	0	0	0	0
Mixed-Use	0	19	1	0	0	4	5	0
Multi-Unit	1	0	22	4	2	0	1	0
TOTAL	1	19	25	14	31	56	85	83
Demo								
Single Detached Dwelling	-31	-37	-32	-23	-32	-13	-21	-37
Semi Detached Dwelling	0	0	0	-2	0	0	0	0
Townhouse	0	0	0	0	0	0	0	0
Duplex	-2	0	-2	0	0	-2	-2	0
Triplex	-6	0	0	-3	0	0	0	-3
Apartment*	0	-42	0	0	0	0	0	0
Boarding House/Lodging House	0	0	0	-1	0	-1	0	0
Mixed-Use	0	0	-1	0	0	0	-5	0
Multi-Unit	-4	-42	-4	0	-20	-19	-54	-19
TOTAL	-43	-121	-39	-29	-52	-35	-82	-59
GRAND TOTAL (excluding demos)	253	447	1,200	948	1,215	1,243	1,337	1,330

Residential Building Permits (# of Beds)								
	2015	2016	2017	2018	2019	2020	2021	2022
New								
Single Detached Dwelling	843	1,265	963	624	470	282	649	70
Semi Detached Dwelling	30	151	6	9	14	36	26	18
Townhouse	161	116	0	24	21	219	15	640
Duplex	0	0	0	0	0	0	0	0
Triplex	0	0	0	0	0	0	0	0
Apartment*	0	0	0	0	0	0	0	0
Boarding House/Lodging House	539	0	0	0	0	0	0	0
Mixed-Use	1,267	1,412	610	24	405	1037	785	157
Multi-Unit	374	1,224	402	518	683	477	401	1087
TOTAL	3,214	4,168	1,981	1,199	1,593	537	1,876	1972
Addition								
Single Detached Dwelling	26	14	34	27	17	28	31	27
Semi Detached Dwelling	0	1	0	0	0	0	4	3
Townhouse	0	1	0	0	0	0	0	0
Duplex	1	0	0	0	0	0	0	0
Triplex	0	0	2	0	0	0	0	0
Apartment*	0	0	0	0	0	0	0	0
Boarding House/Lodging House	0	0	0	0	0	0	0	0
Mixed-Use	0	74	0	214	0	0	1	0
Multi-Unit	0	0	0	208	124	0	1	100
TOTAL	27	90	36	449	141	28	37	130
Alteration/Interior Finish								
Single Detached Dwelling	20	26	32	41	69	120	140	146
Semi Detached Dwelling	4	1	7	0	3	3	6	14
Townhouse	4	7	6	1	6	6	7	8
Duplex	-2	0	-1	4	0	1	0	3
Triplex	0	4	0	0	0	0	8	0
Apartment*	0	0	0	0	0	0	0	0
Boarding House/Lodging House	0	0	0	0	0	3	0	0
Mixed-Use	0	23	-2	0	0	4	9	0
Multi-Unit	-17	115	58	15	7	2	2	0
TOTAL	9	176	100	61	85	133	172	171
Demo								
Single Detached Dwelling	-117	0	-134	-85	-127	-41	-58	-140
Semi Detached Dwelling	0	0	0	-10	0	0	0	0
Townhouse	0	0	0	0	0	0	0	0
Duplex	-5	0	3	0	-6	-10	-4	0
Triplex	-28	0	0	-15	0	0	0	-3
Apartment*	0	0	0	0	0	0	0	0
Boarding House/Lodging House	0	0	0	-15	0	-12	0	0
Mixed-Use	0	0	-1	0	0	0	-8	0
Multi-Unit	-7	0	-4	-15	-63	-92	0	-49
TOTAL	-157	0	-136	-140	-196	-155	-70	-192
GRAND TOTAL	3,093	4,434	1,981	1,569	1,623	543	2,015	2,081

Residential Development

Source: City of Waterloo Building Permits

	Percentage of units built within a Designated Greenfield Area	Percentage of units built within Built Up Area
2006	32	68
2007	42	58
2008	32	68
2009	27	73
2010	7	93
2011	28	72
2012	18	82
2013	25	75
2014	17	83
2015	27	73
2016	20	80
2017	33	67
2018	34	66
2019	10	90
2020	8	92
2021	14	86
2022	14	86
Total:	388	1312

Percent Determination				
	Year	DGA Unit Total	BUA Unit Total	City Wide
Total new units	2017 YE	391	811	1202
Percent Determination		33%	67%	100%
Total new units	2018 YE	255	497	752
Percent Determination		34%	66%	100%
Total new units	2019 YE	123	1092	1215
Percent Determination		10%	90%	100%
Total new units	2020 YE	90	1091	1181
Percent Determination		8%	92%	100%
Total new units	2021 YE	121	767	888
Percent Determination		14%	86%	100%
Total new units	2022 YE	165	977	1142
Percent Determination		14%	86%	100%

Low Density vs Multi-Unit Development

Source: City of Waterloo Building Permits

	2022 YE	2021 YE	2020 YE	2019 YE	2018 YE
Low Density	23.5%	15.0%	13.4%	18.5%	24.6%
Multi-Unit	76.5%	85.0%	86.6%	81.5%	75.4%

Average Bedroom Count per Multiple Residential Units (4 or more units)

Source: City of Waterloo Building Permits

Average Number of Bedrooms Per Unit Per Year	
2009	3.6
2010	2.1
2011	3.2
2012	4.3
2013	3.8
2014	2
2015	2
2016	1.5
2017	1.2
2018	1.3
2019	1.3
2020	1.5
2021	1.5
2022	1.5
Total	26.3
Average	2.39

Average Residential Units Created in New Developments*

**Multi-Res, Mixed-use, and Low Density*

Source: City of Waterloo Building Permits

Average Number of Bedrooms Per Unit Per Year	
2012	3.2
2013	3.3
2014	3.0
2015	1.8
2016	2.7
2017	3.6
2018	3.3
2019	8.1

2020	7.2
2021	2.6
2022	13.9
Total	26.3
Average	2.39

Demolition Permits

Source: City of Waterloo, building permit data

Total GFA (sq. ft.) Summary - Demo (Non-Res)	2019	2020	2021	2022
Industrial	-59,398.4	0.0	-1,459.0	0.0
Commercial	-2,482.5	-11,948.0	-37,771.0	0.0
Office	-1,274.0	-2,939.0	0.0	-26,841.0
Institutional	0.0	-530.0	-27,578.0	-58,350.0
TOTAL	-63,154.8	-15,417.0	-66,808.0	-85,191.0

Total units and bed Demos	2019		2020		2021		2022	
	# units	**# beds**	**# units**	**# beds**	**# units**	**# beds**	**# units**	**# beds**
Singles	-34	-127	-13	-41	-21	-58	-37	-140
Semis	0	0	0	0	0	0	0	0
Townhouse	0	0	0	0	0	0	0	0
Duplex	-8	-26	-2	-10	-2	-4	0	0
Triplex	0	0	0	0	0	0	-3	-3
Apartment	0	0	0	0	0	0	0	0
Mixed-Use	0	0	0	0	-5	-8	0	0
Boarding/Rooming/Lodging House	0	0	-1	-12	0	0	0	0
Multi-Unit	-20	-63	-19	-92	-54	0*	-19	-49
TOTAL	-62	-216	-35	-155	-82	-70	-59	-192

*No bedrooms recorded as being associated with multi-unit demo permits

Number of permits issued by dwelling type & permit work proposed.

2019 YE Data Summary

Source: City of Waterloo building permits

Note 1: * Was not counted, only permits adding GFA are captured.

Number of permits issued by type and work proposed.	New Permits	Addition Permits	Demo Permits	Interior Work	Total Permits Issued
Low Density Residential	131	2	42	29	204
Multi-Residential	5	2	3	1	11
Mixed-Use	3	0	0	1	4
Industrial	5	5	4	N/A*	14
Commercial	1	3	2	N/A*	6
Institutional	1	3	0	N/A*	4
				TOTAL:	**243**

2020 YE Data Summary

Source: City of Waterloo building permits

Note 1: * Was not counted, only permits adding GFA are captured.

Number of permits issued by type and work proposed.	New Permits	Addition Permits	Demo Permits	Interior Work	Total Permits Issued
Low Density Residential	158	21	13	104	296
Multi-Residential	3	0	5	2	10
Mixed-Use	4	0	0	3	7
Industrial	1	1	0	N/A*	2
Commercial	2	5	4	N/A*	11
Institutional	2	3	1	N/A*	6
				TOTAL:	**332**

2021 YE Data Summary

Source: City of Waterloo building permits

Note 1: * Was not counted, only permits adding GFA are captured.

Number of permits issued by type and work proposed.	New Permits	Addition Permits	Demo Permits	Interior Work	Total Permits Issued
Low Density Residential	162	95	25	297	579
Multi-Residential	3	0	0	0	3
Mixed-Use	1	1	2	5	9
Industrial	2	0	2	N/A*	4
Commercial	2	3	2	N/A*	7
Institutional	1	3	2	N/A*	6
Office	0	1	0	N/A*	1
				TOTAL:	**609**

2022 YE Data Summary

Source: City of Waterloo building permits

Note 1: * Was not counted, only permits adding GFA are captured.

Number of permits issued by type and work proposed.	New Permits	Addition Permits	Demo Permits	Interior Work	Total Permits Issued
Low Density Residential	69	68	38	243	418
Multi-Residential	10	0	2	21	33
Mixed-Use	3	2	0	5	10
Industrial	2	0	0	N/A*	2
Commercial	0	1	0	N/A*	1
Institutional	3	2	0	N/A*	5
Office	0	0	0	N/A*	0
				TOTAL:	**469**

Inventory of Dwelling Units in Plans of Subdivision, for the City of Waterloo

Source: Region of Waterloo, Inventory of Dwelling Units in Plans of Subdivision

	Pending Units	Draft Approved Units	Registered Unbuilt units	Total Units
2018 YE				
Waterloo	1,414	884	1,199	3,497
Single Detached Units	731	446	200	1,377
Semi-Detached Units	0	31	8	39
Townhouse Units	482	277	136	894
Apartment Units	202	131	856	1,188
2019 YE				
Waterloo	1,480	752	886	3,118
Single Detached Units	680	450	75	1,205
Semi-Detached Units	0	37	8	45
Townhouse Units	521	225	152	898
Apartment Units	280	41	651	971
2020 YE				
Waterloo	1,573	752	846	3,171
Single Detached Units	699	450	39	1,188
Semi-Detached Units	0	37	8	45
Townhouse Units	0	37	8	45
Apartment Units	354	41	678	1,072
2021 YE				
Waterloo	3,686	341	884	4,911
Single Detached Units	681	166	41	888
Semi-Detached Units	0	11	8	19
Townhouse Units	549	69	227	844
Apartment Units	2,457	96	608	3,160
2022 YE *2022 numbers not available yet				
Waterloo				
Single Detached Units				
Semi-Detached Units				
Townhouse Units				
Apartment Units				

Source: Region of Waterloo

Notes:
1. The midpoint between the maximum and minimum number of units is reported where ranges are present on Pending and Draft Approved plans. Registered Unbuilt Units are similarly treated; however, these are adjusted as additional evidence becomes available, such as building permits, parcel fabric, or Site Plans.
2. Flexible zoning may permit single detached, semi-detached, or townhouse units on Blocks in plans. Unspecified units reported in these circumstances are treated as consisting of 75 per cent single detached units, and the balance as townhouses. For Registered Unbuilt Units, this assumption is modified to reflect building permit activity after development begins.
3. Units recorded as ‘multi-residential’ on Plans of Subdivision are initially assumed to represent 50 per cent apartments and 50 per cent townhouses, with further adjustments being made as additional information becomes available.
4. Vacant Land Condominiums are included in this inventory.

CMHC: Canada Mortgage and Housing Corporation Data

Source: Canada Mortgage and Housing Corporation (CMHC)

Note: have removed the 'Unknown' and the 'Co-Op' categories from the charts as all values are 0

Waterloo (CY) — Historical Starts by Intended Market							
Year	**Homeowner**	**Homeowner (%)**	**Rental**	**Rental (%)**	**Condo**	**Condo (%)**	**All**
2006	340	68.5%	156	31.5%	0	0.0%	496
2007	309	59.5%	191	36.8%	19	3.7%	519
2008	265	36.6%	437	60.4%	22	3.0%	724
2009	141	43.8%	161	50.0%	20	6.2%	322
2010	123	19.8%	354	57.1%	143	23.1%	620
2011	96	9.1%	653	62.1%	302	28.7%	1,051
2012	133	11.8%	352	31.2%	644	57.0%	1,129
2013	195	34.4%	333	58.7%	39	6.9%	567
2014	204	11.6%	548	31.1%	1,012	57.4%	1,764
2015	262	21.5%	632	52.0%	322	26.5%	1,216
2016	325	21.6%	949	63.0%	233	15.5%	1,507
2017	325	40.0%	0	0.0%	487	60.0%	812
2018	234	16.2%	357	24.7%	857	59.2%	1,448
2019	140	21.0%	211	31.6%	317	47.5%	668
2020	308	22.5%	460	33.6%	600	43.9%	1,368
2021	172	17.3%	0	0.0%	825	82.7%	997
2022	261	28.1%	487	52.5%	180	19.4%	928

Waterloo (CY) — Historical Completions by Intended Market							
Year	**Homeowner**	**Homeowner (%)**	**Rental**	**Rental (%)**	**Condo**	**Condo (%)**	**All**
2006	394	69.1%	164	28.8%	12	2.1%	570
2007	275	55.7%	219	44.3%	0	0.0%	494
2008	306	64.6%	113	23.8%	55	11.6%	474
2009	125	20.5%	282	46.2%	204	33.4%	611
2010	154	44.9%	173	50.4%	16	4.7%	343
2011	89	15.9%	389	69.7%	80	14.3%	558
2012	117	19.1%	280	45.7%	216	35.2%	613
2013	176	23.6%	479	64.3%	90	12.1%	745
2014	181	20.7%	459	52.4%	236	26.9%	876
2015	236	19.4%	680	55.8%	302	24.8%	1,218
2016	243	12.9%	971	51.5%	673	35.7%	1,887
2017	354	34.9%	551	54.4%	108	10.7%	1013
2018	293	21.0%	821	58.8%	283	20.3%	1,397
2019	138	19.5%	448	63.5%	120	17.0%	706
2020	119	12.0%	561	56.5%	313	31.5%	993
2021	154	14.7%	488	46.7%	404	38.6%	1046
2022	142	12.8%	693	62.4%	275	24.8%	1110

Waterloo (CY) — Historical Starts by Dwelling Type									
Year	**Single**	**Single (%)**	**Semi-Detached**	**Semi-Detached (%)**	**Row**	**Row (%)**	**Apartment**	**Apartment (%)**	**All**
2006	53	26.0%	6	2.9%	33	16.2%	112	54.9%	204
2007	93	40.6%	8	3.5%	44	19.2%	84	36.7%	229
2008	48	10.0%	0	0.0%	45	9.4%	386	80.6%	479
2009	48	25.4%	0	0.0%	23	12.2%	118	62.4%	189
2010	28	5.9%	0	0.0%	12	2.5%	437	91.6%	477
2011	33	3.4%	0	0.0%	12	1.2%	929	95.4%	974
2012	34	2.3%	4	0.3%	35	2.3%	1417	95.1%	1,490
2013	44	3.4%	2	0.2%	48	3.7%	1218	92.8%	1312
2014	80	3.6%	2	0.1%	19	0.9%	2099	95.4%	2,200
2015	87	4.0%	8	0.4%	43	2.0%	2060	93.7%	2,198
2016	164	10.2%	14	0.9%	54	3.4%	1372	85.5%	1,604
2017	155	11.0%	8	0.6%	41	2.9%	1199	85.5%	1403
2018	71	4.9%	4	0.3%	66	4.5%	1314	90.3%	1,455
2019	131	19.6%	2	0.3%	30	4.5%	505	75.6%	668
2020	77	5.6%	14	1.0%	38	2.8%	1239	90.6%	1368
2021	118	11.8%	6	0.6%	48	4.8%	825	82.7%	997
2022	80	8.6%	10	1.1%	184	19.8%	654	70.5%	928

Waterloo (CY) — Historical Completions by Dwelling Type									
Year	**Single**	**Single (%)**	**Semi-Detached**	**Semi-Detached (%)**	**Row**	**Row (%)**	**Apartment**	**Apartment (%)**	**All**
2006	304	53.3%	30	5.3%	72	12.6%	164	28.8%	570
2007	192	38.9%	12	2.4%	71	14.4%	219	44.3%	494
2008	253	53.4%	8	1.7%	82	17.3%	131	27.6%	474
2009	105	17.2%	0	0.0%	65	10.6%	441	72.2%	611
2010	135	39.4%	0	0.0%	35	10.2%	173	50.4%	343
2011	81	14.5%	0	0.0%	33	5.9%	444	79.6%	558
2012	104	17.0%	0	0.0%	26	4.2%	483	78.8%	613
2013	152	20.4%	4	0.5%	52	7.0%	537	72.1%	745
2014	142	16.2%	8	0.9%	64	7.3%	662	75.6%	876

2015	217	17.8%	4	0.3%	23	1.9%	974	80.0%	1,218
2016	213	11.3%	12	0.6%	32	1.7%	1,630	86.4%	1,887
2017	308	30.4%	32	3.2%	58	5.7%	615	60.7%	1,013
2018	276	19.8%	10	0.7%	12	0.9%	1,099	78.7%	1,397
2019	113	16.0%	2	0.3%	54	7.6%	527	74.6%	706
2020	110	11.1%	2	0.2%	30	3.0%	851	85.7%	993
2021	70	6.7%	16	1.5%	73	7.0%	887	84.8%	1046
2022	122	10.9%	4	0.4%	21	1.9%	968	86.8%	1115

City of Waterloo, Historical Universe by Bedroom Type

Source: Canada Mortgage and Housing Corporation (CMHC)

Waterloo (CY) — Historical Universe by Bedroom Type 2006 to 2021					
Year	**Bachelor**	**1 Bedroom**	**2 Bedroom**	**3 Bedroom +**	**Total**
2006	73	1,656	3,842	1,099	6,670
2007	74	1,668	3,751	840	6,333
2008	75	1,697	3,697	797	6,266
2009	77	1,715	3,689	788	6,269
2010	84	1,697	3,724	797	6,302
2011	81	1,696	3,602	721	6,100
2012	76	1,656	3,538	694	5,964
2013	80	1,646	3,516	738	5,980
2014	81	1,635	3,600	728	6,044
2015	80	1,752	3,648	700	6,180
2016	80	1,738	4,065	900	6,783
2017	121	2,095	4,745	1,034	7,995
2018	121	2,363	5,325	1,193	9,002
2019	122	2,570	4,501	770	7,963
2020	141	2,809	5,862	1,349	10,161
2021	141	2,676	5,779	1,346	9,942
2022	130	2,656	5,899	1,332	10,017

CMA Vacancy Rate of Primary Rental Units

CMA - Kitchener, Cambridge Waterloo

Source: Canada Mortgage and Housing Corporation (CMHC)

Private Row (Townhouse) and Apartment Vacancy Rates (%)		Heathy Vacancy Rate
2006	2.0%	3.0%
2007	1.1%	
2008	1.2%	
2009	1.4%	
2010	1.8%	
2011	1.4%	
2012	3.2%	
2013	3.1%	
2014	2.8%	
2015	2.2%	
2016	1.6%	
2017	2.1%	
2018	2.9%	
2019	1.60%	
2020	2.80%	
2021	2.50%	
2022	1.2%	

Average Market Rent, City of Waterloo

Source: Canada Mortgage and Housing Corporation (CMHC)

Average Market Rent (City of Waterloo)	
2006	935
2007	826

2008	884
2009	893
2010	908
2011	929
2012	950
2013	987
2014	978
2015	1,030
2016	1,132
2017	1,150
2018	1,356
2019	1,296
2020	1,370
2021	1,523
2022	1,547

Average House Sales Prices, City of Waterloo

Source: Waterloo Region Association of Realtors (WRAR)

Average House Sales Prices					
	Total Overall Average	Single	Townhouse	Condo	Semi-Detached
2008	$287,405	$329,698	$223,352	$205,410	$214,955
2009	$296,508	$335,140	$236,138	$215,089	$221,760
2010	$319,019	$363,507	$247,176	$236,098	$234,184
2011	$335,555	$382,412	$255,386	$250,794	$244,705
2012	$341,824	$392,515	$264,225	$242,521	$251,089
2013	$351,340	$401,583	$260,598	$255,743	$256,328
2014	$360,293	$409,146	$267,646	$262,768	$262,027
2015	$375,376	$425,348	$284,152	$276,761	$267,316
2016	$390,673	$450,175	$299,536	$272,418	$290,187
2017	$471,514	$564,164	$350,253	$291,298	$368,140
2018	$499,801	$598,079	$379,735	$323,976	$391,972
2019	$534,905	$641,704	$402,889	$357,136	$434,013
2020	$629,084	$744,978	$485,413	$417,859	$522,257
2021	$779,271	$991,911	$645,741	$465,199	$695,295
2022	$833,969	$1,034,041	$701,978	$545,440	$833,969

*Overall average calculated based on a 12 month rolling average for ales prices within the City of Waterloo

Average Number of Houses Sold by Type in the City of Waterloo

Source: Waterloo Region Association of Realtors (WRAR)

Average Number of House Sales by Type					
	Total Overall Average	Single	Townhouse	Condo	Semi-Detached
2009	1,578	1,021	172	270	115
2010	1,482	976	141	264	101
2011	1,455	931	259	156	109
2012	1,493	943	281	182	87
2013	1,620	1,071	272	171	106
2014	1,581	1,064	259	179	79
2015	1,709	1,093	309	183	124
2016	2,050	1,277	406	252	115
2017	1,888	1,150	333	274	131
2018	1,686	971	311	304	98
2019	1,607	960	261	299	85
2020	1,721	1,054	257	325	85
2021	2,044	1,067	360	490	125
2022	1,482	768	225	383	106

*Overall total calculated based on a 12 month period (Jan to Dec) for all sales within the City of Waterloo

Residential Intensification Rates in Waterloo Region, by Municipality

Source: Region of Waterloo

New Residential Units in Waterloo Region, by Municipality, 2006-2020

*2022 numbers not available yet

Cambridge	213	376	655	741	615	432	299	446	463	391	678	555	575	1,029	360	1188	
Kitchener	670	1,747	1,089	1,046	1,379	1,447	1,171	1,144	2,017	1,596	2,683	1,166	1,313	3,498	3,148	3021	
North Dumfries	14	15	25	37	42	105	76	34	38	30	91	77	57	28	49	126	
Wellesley	30	46	64	74	75	51	44	33	36	26	34	19	17	28	41	30	
Wilmot	119	179	150	169	181	162	105	107	110	67	73	115	91	82	43	47	
Woolwich	89	250	241	276	280	241	127	71	94	45	180	90	95	412	242	255	
Region Total	**1,408**	**3,112**	**2,968**	**2,778**	**4,167**	**3,599**	**2,412**	**2,646**	**4,013**	**3,604**	**5,718**	**3,224**	**2,931**	**6,292**	**5,126**	**6,009**	

**Since effective date of Places to Grow, June 16, 2006*

New Residential Units in Built Up Area, by Municipality, 2006-2020

*2022 numbers not available yet

Cambridge	93	267	76	233	321	256	142	302	351	52	364	122	109	636	120	1093	
Kitchener	241	777	343	385	518	798	507	548	1,082	604	901	702	690	2,688	2,157	1746	
North Dumfries	11	2	2	3	3	3	0	1	2	15	38	1	46	25	6	7	
Wellesley	8	7	10	6	9	7	6	2	1	2	0	2	1	5	0	6	
Wilmot	38	31	12	51	27	6	4	7	52	9	3	19	15	30	7	19	
Woolwich	30	58	27	34	18	46	18	18	34	4	33	2	7	83	13	11	
Region Total	**608**	**1,430**	**974**	**1,032**	**2,394**	**1,947**	**1,160**	**1,489**	**2,567**	**1,754**	**2,902**	**1,659**	**1,401**	**4,559**	**3,389**	**4,069**	

**Since effective date of Places to Grow, June 16, 2006*

Percentage of New Residential Units in Built Up Area, by Municipality, 2006-2020

*2022 numbers not available yet

Cambridge	44%	71%	12%	31%	52%	59%	47%	68%	76%	13%	54%	22%	19%	62%	33%	92%	
Kitchener	36%	44%	31%	37%	38%	55%	43%	48%	54%	38%	34%	60%	53%	77%	69%	58%	
North Dumfries	79%	13%	8%	8%	7%	3%	0%	3%	5%	50%	42%	1%	81%	89%	12%	6%	
Wellesley	27%	15%	16%	8%	12%	14%	14%	6%	3%	8%	0%	11%	6%	18%	0%	20%	
Wilmot	32%	17%	8%	30%	15%	4%	4%	7%	47%	13%	4%	17%	16%	37%	16%	40%	
Woolwich	34%	23%	11%	12%	6%	19%	14%	25%	36%	9%	18%	2%	7%	20%	5%	4%	
Region Total	**43%**	**46%**	**33%**	**37%**	**57%**	**54%**	**48%**	**56%**	**64%**	**49%**	**51%**	**51%**	**48%**	**72%**	**66%**	**68%**	

**Since effective date of Places to Grow, June 16, 2006*

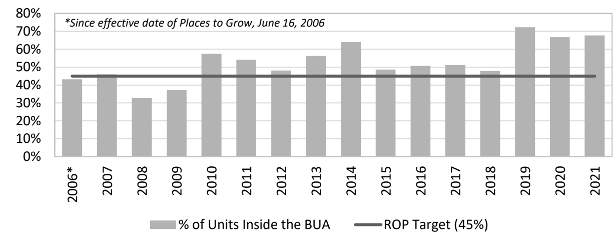
Residential Intensification Rates in Waterloo Region, by Municipality

Source: Region of Waterloo

Year	Total Units in Waterloo Region	Units Inside the Built Up Area	% of Units Inside the BUA	ROP Target (45%)
2006*	1,408	608	43%	45%
2007	3,112	1,430	46%	45%
2008	2,968	974	33%	45%
2009	2,778	1,032	37%	45%
2010	4,167	2,394	57%	45%
2011	3,599	1,947	54%	45%
2012	2,412	1,160	48%	45%
2013	2,646	1,489	56%	45%
2014	4,013	2,567	64%	45%
2015	3,604	1,754	49%	45%
2016	5,718	2,902	51%	45%
2017	3,224	1,659	51%	45%
2018	2,931	1,401	48%	45%
2019	6,292	4,559	72%	45%
2020	5,126	3,389	66%	45%
2021	6,009	4,069	68%	45%

Since effective date of Places to Grow, June 16, 2006

Percentage of Residential Units in the Built Up Area, 2006-2021



Download data set

Data use disclaimer

This collection of data is intended to provide general information, and reasonable efforts have been made to ensure the data are correct.

When addressing a specific issue or question, data should be verified with technical experts in the appropriate field.

The City of Waterloo does not accept responsibility for the accuracy or completeness of the data set, and shall not be liable for any loss or damage associated with the direct or indirect use of, or reliance on, the contents this collection of planning and land use data.

For more information contact torin.whitnell@waterloo.ca.

Last updated on February 21, 2023

Appendix D Technical Note 5-6

TECHNICAL NOTE #5-6 – EVALUATION OF ALTERNATIVES, CONCLUSIONS & RECOMMENDATIONS

City of Waterloo Sanitary Master Plan Update

January 31, 2024

Prepared for:

City of Waterloo

Prepared by:

Stantec Consulting Ltd.
300 Hagey Blvd., Suite 100
Waterloo, ON N2L 0A4

Revision	Description	Author	Quality Check	Independent Review
0	Draft TN#5-6	HB	DE	JP
1	Final TN#5-6	HB	DE	JP

Sign-off Sheet

This document entitled Technical Note #5-6 – Evaluation of Alternatives, Conclusions & Recommendations was prepared by Stantec Consulting Ltd. ("Stantec") for the account of City of Waterloo (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ______________________________
(signature)

Helene Boulanger, P.Eng., ing.

Reviewed by ______________________________
(signature)

Dave Eadie, P.Eng.

Approved by ______________________________
(signature)

Jeff Paul, P.Eng.

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Abbreviations

ADSF	Average Dry Weather Sewage Flow
DWF	Dry Weather Flow
DEM	Digital Elevation Model
EA	Environmental Assessment
EMP	Employment
FM	Flow Meter
FS	Flow Split
GIS	Geographic Information System
GWI	Groundwater Infiltration
HGL	Hydraulic Grade Line
HP	High Point
ICI	Industrial – Commercial – Institutional (Land Use)
IDF	Intensity – Duration - Frequency
I/I	Inflow/Infiltration
MH	Maintenance Hole
MP	Master Plan
O&M	Operation & Maintenance
PCSWMM	Personal Computer Storm Water Management Model (Software)
RDII	Rainfall-Derived Infiltration and Inflow
RES	Residential
RTK	RTK Unit Hydrograph Method
RG	Rain Gauge
SAN	Sanitary
SCADA	Supervisory Control and DATA Acquisition
SPS	Sewage Pumping Station
TN	Technical Note
WWF	Wet Weather Flow
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

The City of Waterloo (City) has retained Stantec Consulting to complete the Waterloo Sanitary Servicing Master Plan Update (Master Plan Update). The purpose of the Master Plan Update is to revise the 2014 Sanitary Master Plan (Stantec, 2015) to account for updated infrastructure, and population and employment growth. There are two growth scenarios: Priority Scenario, which includes projections up to a 2031 planning horizon, and Strategic Scenario, representing projections up to a 2051 planning horizon. Priority and strategic projects will be evaluated to operate the system efficiently and effectively, to implement best management practices (including Infiltration/Inflow (I/I) monitoring and mitigation approaches), and to optimize staging of the sanitary capital program.

The following tasks will be carried out for the completion of the Master Plan:

- Task 1: Model Infrastructure Updates
- Task 2: Model Flow Updates
- Task 3: Model Calibration
- Task 4: Model Analysis – Identification of Problem Areas
- **Task 5: Detailed Analysis of Solutions**
- **Task 6: Conclusions & Recommendations – Capital Planning and Execution**
- Task 7: Finalize Master Plan Update

Based on discussions with the City, **Task 5** has been compiled with **Task 6** for this submission and involves the detailed analysis of solutions as well as the capital planning and execution.

2.0 IDENTIFICATION AND EVALUATION OF ALTERNATIVES

The alternative solutions are assessed following Approach 2 of the Municipal Class Environmental Assessment (MCEA, or EA) process. The following sub-sections present the sanitary sewer problem areas, design criteria, the development of alternative solutions, the evaluation methodology, the results of evaluation, the opinion of probable cost and the climate change considerations.

2.1 SYSTEM MANAGEMENT STRATEGIES

2.1.1 Shaping Community Growth

Community growth results in an increase in sanitary flows in the downstream system and can therefore lead to the creation or worsening of sanitary sewer capacity constraints. Community growth can thus be shaped to limit negative impacts to the downstream system by encouraging growth in areas that drain to portions of the system that can handle the additional flows without restriction. Sewer upgrades can however be implemented if needed to allow for the upstream growth to occur, if the required upgrades are reasonable in cost, benefit, and extent. This review is most valuable on a trunk level, as local pipe restrictions can be resolved relatively easily. Based on existing conditions, 2031 and 2051 system assessment results, there are no significant concerns with trunk sewer capacity within the sanitary system. Thus, the need to shape growth is not proposed under this study. Proposed infrastructure solutions are further discussed in **Section 2.3.2**.

Growth reviews should occur regularly to confirm that no major restrictions arise in the future and to confirm that the growth patterns and projections continue to match the assumptions used in this study. The best approach to accomplish this is to continue to regularly engage in Master Planning updates where infrastructure upgrades are incorporated along with potential growth predictions.

2.1.2 I/I Reduction, Water Conservation & Re-Use

It is also possible to implement water conservation measures to reduce water consumption rates. Examples of water conservation measures include implementing a bylaw to control outdoor water use during the spring and summer months, installing water meters at all service connections for residential, commercial, industrial, and institutional properties to raise the users' awareness on water saving, and establishing water re-use program to optimize the overall water use.

The resulting reduced water usage is expected to reduce the volume of sanitary flows produced. However, the City cannot rely on water efficiency measures alone to offset the larger contributing factor of wet weather infiltration and inflow (I/I). I/I remains a contributor to elevated flows during wet weather and during spring melt conditions. I/I reduction alone might not resolve existing conveyance deficiencies nor offset future growth demands. Nonetheless, I/I reduction and mitigation are a prudent measure of collection system management that complements conveyance system upgrades, building in resiliency to uncertain implications of climate change. Potential I/I reduction areas are further discussed in **Section 4.0**.

2.2 DESIGN CRITERIA

2.2.1 Evaluation Criteria

The selection of the evaluation criteria was informed by the 2014 MP and the EA guidance document. **Table 2-1** outlines the criteria used for the evaluation of the recommended servicing alternatives. Depending on comments received from agencies, Indigenous communities, stakeholders and members of the public, criteria may be added or refined.

Table 2-1: Evaluation Criteria

Category	Description
Socio-Economic Environment	• Potential to impact existing residences, businesses, and community features • Potential effect on approved/planned land uses • Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features • Potential to accommodate planned significant population and job growth in strategic growth areas
Natural Environment	• Potential to impact fish and aquatic habitat • Potential to impact water resources including surface water (i.e., rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas • Potential to impact significant natural heritage features (i.e., woodlands, parks, etc.) • Potential to impact significant wildlife habitat and species at risk
Technical Considerations	• Potential land requirements including land purchase and temporary/permanent easements • Constructability • Effect on existing utilities and infrastructure • Ability to coordinate with existing and planned infrastructure improvements • System resiliency and system suitability
Financial	• Lifecycle operations and maintenance costs • Estimated capital cost

Identification and Evaluation of Alternatives

A review was conducted at the location of each constraint to allow utility conflicts to be avoided during the development of servicing alternatives. The Procedure F-6-1 published by the MECP requires watermain to be aligned with a minimum horizontal separation from sanitary sewers of 2.5 m. Alternative solutions for addressing the identified capacity constraints are presented in the following sections.

2.2.2 Solutions Design Criteria

Solutions to the identified capacity constraints outlined in **Section 2.3.2**, are sized based on the following criteria, where feasible, as per the Region of Waterloo and Area Municipalities Design Guidelines for Supplemental Specifications for Municipal Sewers (DGSSMS; 2021) and the Ministry of the Environment, Conservation and Parks Design Guidelines for Sewage Works (MECP, 2018):

- Depth of flow to diameter (d/D) ratio is no higher than 80% in DWF conditions (lower d/D ratios may be considered in trunks to facilitate maintenance activities);
- Full flow velocity is appropriate to provide scour and peak flow velocity is less than the maximum allowable (0.6 m/s > v > 3 m/s);
- No HGL issues observed due to capacity constraints in the 25-year Chicago design event; and,
- Pumping stations have adequate firm capacity to convey the 10-year Chicago peak flows, and do not experience overflows in events smaller than the 25-year Chicago storm event.

The proposed solutions are designed based on the criteria outlined below, as per the MECP and the DGSSMS, as referenced above.

Parameter	MECP	DGSSMS
Minimum Sewer Size	200 mm	In accordance with MECP Design Guidelines
Minimum Sewer Slope	Minimum slope to achieve minimum flow velocity of 0.6 m/s	Minimum slope shall be 0.5% and 1% for the first reach of permanent dead end
Minimum Drop Across Maintenance Holes	3 – 6 cm	In accordance with MECP Design Guidelines
Minimum Cover	Sufficiently deep to receive sewage from basements and to prevent freezing and damage due to frost.	2.8 m
Minimum Vertical Clearance at Sewer Crossings	0.5 m	In accordance with MECP Design Guidelines

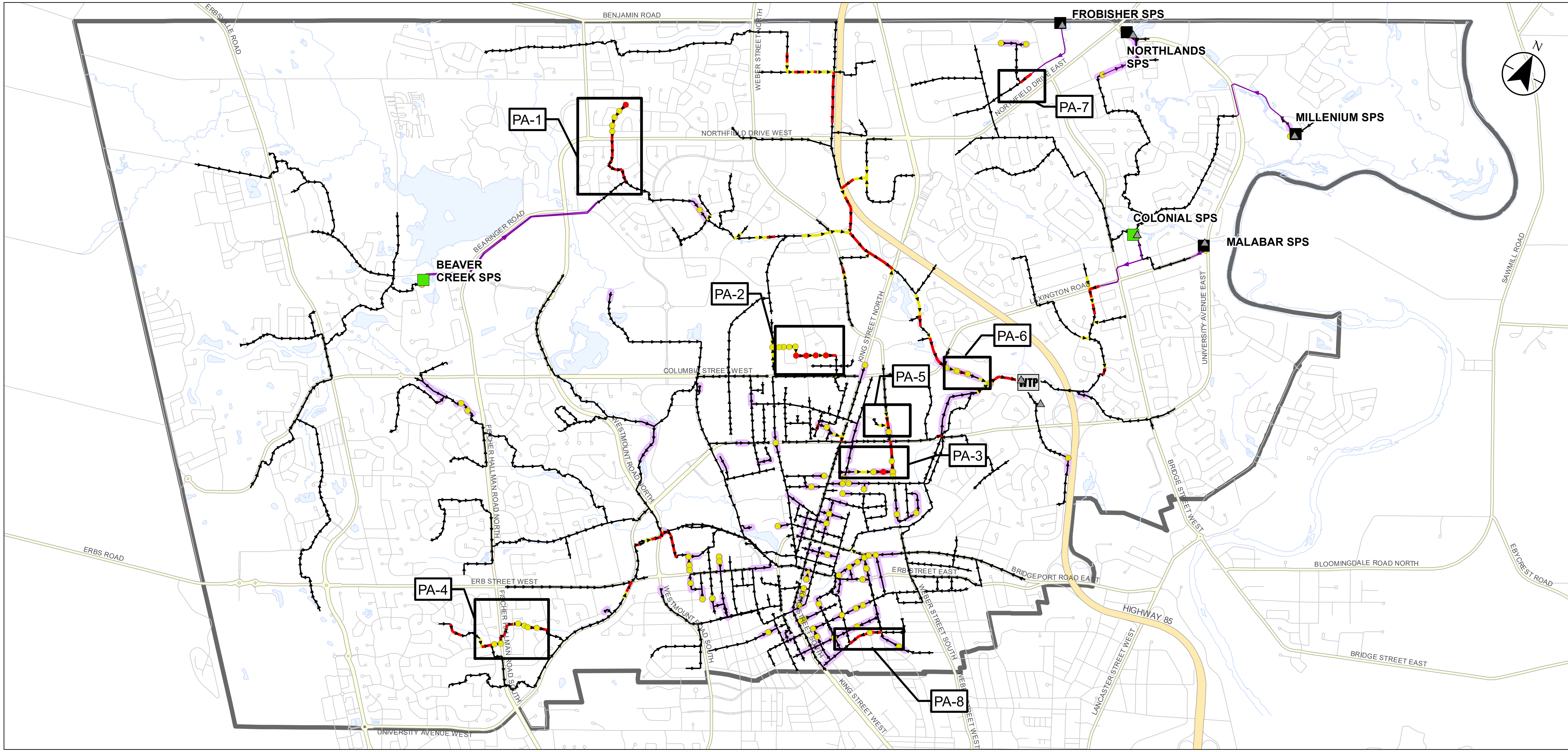
2.3 DEVELOPMENT OF ALTERNATIVES

2.3.1 System Capacity Constraints

Infrastructure alternatives consist of capacity-based upgrades recommended to resolve system capacity restrictions. **Figure 2-1** and **Table 2-2** presents the constraints identified during the modelling of the existing and future growth scenarios in Technical Note (TN) #4.

Table 2-2: Sanitary Sewer Problem Areas

Problem Area ID	Horizon	Location	Capacity Constraint Description
PA-1 Cedar Highpoint Ave	Existing (Near-Term)	Highpoint Ave, between Northfield Dr W and Northlake Dr	HGLs within 1.8 m of surface due to undersized pipes. High risk of basement flooding and risk of surface flooding.
PA-2 University Austin Dr	Existing (Near-Term)	From the intersection of Albert St and Cardill Crescent to the intersection of Austin Dr and Holly St	Risk of basement flooding (HGLs within 1.8 m of surface) and surface flooding due to undersized pipes along Austin Dr.
PA-3 Laurel 2 Lodge St / Weber	Existing (Near-Term)	From Lodge St to the intersection of Weber St N and University Ave E	Risk of basement and surface flooding due to undersized pipes on Lodge St and Weber St N
PA-4 Maple Hill Maple Hill Creek	Existing (Near-Term)	From the weir at Thorndale/Westvale to Roosevelt Ave	Risk of basement flooding (HGLs within 1.8 m of surface) due to undersized pipes on private property.
PA-5 Laurel 2 Weber St N	Existing (Near-Term)	Weber St N, at the intersection of Hickory St E	Surcharging pipes upstream of shallow pipes resulting of an HGL within 1.8 m of surface. Low risk of basement flooding as it is an ICI area.
PA-6 Forwell Trunk Conestoga College	Existing (Near-Term)	From Lexington Rd to the WWTP	HGLs within 1.8 m of surface due to undersized pipes and shallow pipes. Low risk of basement flooding as no building connection is anticipated along these sewers.
PA-7 Lee 1 Downstream of Frobisher SPS	Existing (Near-Term)	Sewers directly downstream of Frobisher forcemain	Capacity constraints in DWF conditions due to undersized pipes, but no risk of basement flooding.
PA-8 Laurel 2 Downstream of Moore SPS	2031 (Medium-Term)	Union St E; from Moore St S to Willow St	HGL within 1.8 m of surface (1.75 m) due to undersized pipes on Moore St S, and additional flow from the conveyance of Moore SPS to Waterloo sewer system.



Legend

WTP	WWTP
■	Storage
■	Storage & Emergency Storage
△	Overflow
	Forcemain
	Shallow Sewer

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

Stantec

Project Location
City of Waterloo

165640363 REVA
Prepared by HB on 2023-09-12

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
2-1

Title
2051 Conditions Sanitary Sewer System
25-Year HGL & Surcharge Results

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

2.3.2 Evaluation of Alternatives

The following sections present the results of evaluating alternatives for each of the problem areas presented in **Table 2-2**. Refer to **Appendix A** for further solution details, including close-up plan views and profiles of each of the proposed solutions.

2.3.2.1 Highpoint Avenue

The area of Highpoint Avenue is at risk of experiencing basement flooding under extreme rainfall events. The existing sewers on Highpoint Avenue require improvements to the sewer capacity.

Three alternatives were evaluated for this area, and are detailed in **Table 2-3**:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity).

Additionally, the Cedar trunk has been identified as observing extraneous flows. Therefore, possible infiltration and inflow reduction, this will be further discussed in **Section 4.1.1**.

Table 2-3: Evaluation Alternative - Highpoint Avenue

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses and community features	High potential to impact residents due to risk of basement flooding. Population growth increases basement flooding risk.	Mitigates risk of basement flooding. Temporary construction impacts to the residences on Highpoint Ave. Accommodates population growth.	Mitigates risk of basement flooding. Temporary construction impacts to the residences on Highpoint Ave. Accommodates population growth.
	Potential effect on approved/planned land uses			
	Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features			
	Potential to accommodate planned significant population and job growth in strategic growth areas			
Natural Environment	Potential to impact fish and aquatic habitat	No disturbance to Laurel Creek Conservation Area. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Laurel Creek Conservation Area, as the proposed solution crosses Cedar Creek. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.	Possible impact on Laurel Creek Conservation Area, as the proposed solution crosses Cedar Creek. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.
	Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas			
	Potential to impact significant natural heritage features (i.e., Laurel Creek Conservation Area)			
	Potential to impact significant wildlife habitat and species at risk			

Identification and Evaluation of Alternatives

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no anticipated impacts on existing utilities.	Upgrades infrastructure and improves hydraulics in the sewer system. No land acquisition required, and no anticipated impacts on existing utilities.	Upgrades infrastructure and improves hydraulics in the sewer system. Requires higher maintenance and operation costs than Alternative 2. No land acquisition required, and no anticipated impacts to existing utilities.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

The preferred solution for the Highpoint Avenue area is to upgrade and reprofile 10 lengths of the existing sewer, as present in **Figure 2-2** and **Figure 2-3**. This will include replacing the existing sanitary sewer pipe along Highpoint Avenue, from Northfield Drive West to Fallingbrook Drive to provide additional capacity and improve water flow.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth. Crossing of Cedar Creek is recommended to be completed by trenchless techniques in order to mitigate potential impacts. Furthermore, the first recommended upgrade pipe intersects a 600 mm watermain. It is recommended to examine the as-built drawings to ascertain if there is a potential for interference.

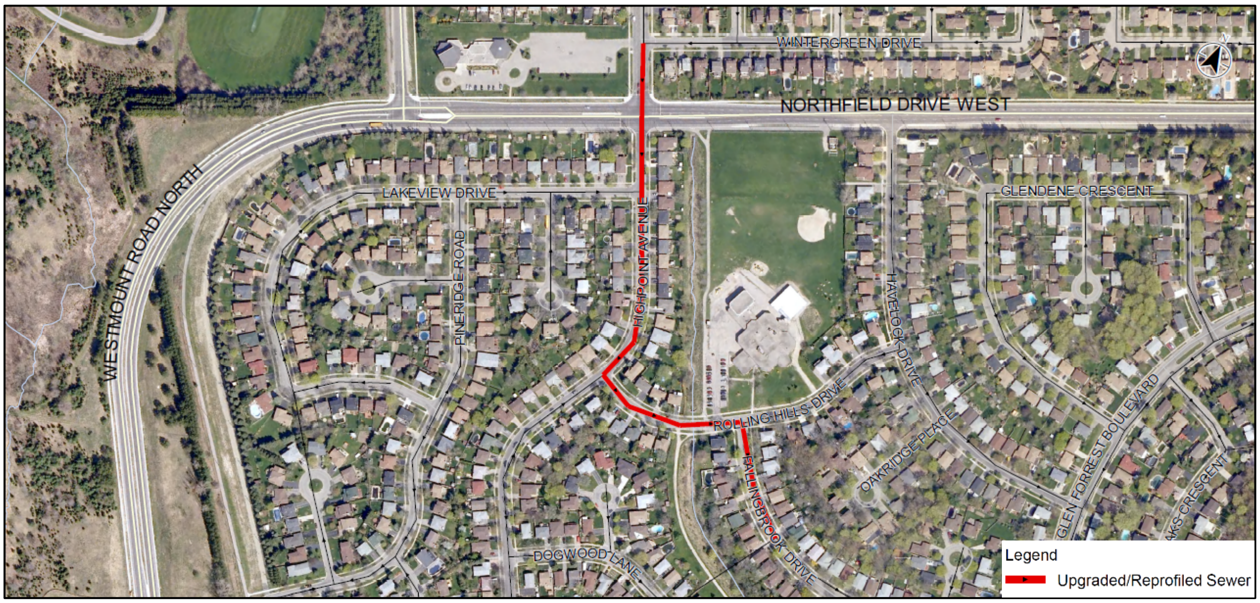


Figure 2-2: Preferred Solution - Highpoint Avenue

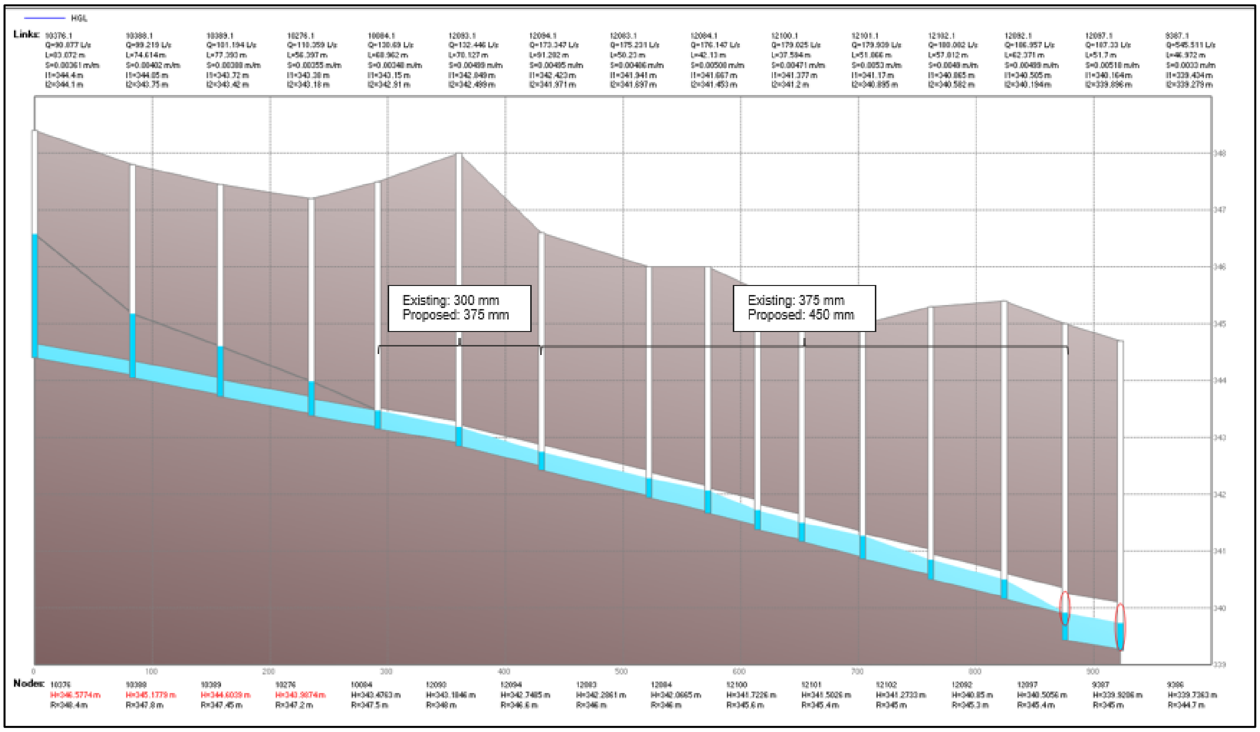


Figure 2-3: HGL Profile with Solution - Highpoint Avenue

2.3.2.2 Austin Drive

There are capacity constraints and risk of surface flooding identified on Austin Drive under existing and future model conditions, and as such alternatives have been generated to address these constraints.

Three alternatives were evaluated for this area, and are detailed in **Table 2-4**:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity).

Table 2-4: Evaluation Alternative - Austin Drive

<table>
<tr><th>Category</th><th>Evaluation Criteria</th><th>Do Nothing</th><th>Upgrade/Reprofile Sewer</th><th>Twin Sewer</th></tr>
<tr><td rowspan="4">Socio-Economic</td><td>Potential to impact existing residences, businesses and community features</td><td rowspan="4">High potential to impact residents due to risk of basement flooding. Population growth increases basement flooding risk.</td><td rowspan="4">Mitigates risk of basement flooding, although potential construction impacts to the residences on Austin Dr. Accommodates population growth.</td><td rowspan="4">Mitigates risk of basement flooding, although potential construction impacts to the residences on Austin Dr. Accommodates population growth.</td></tr>
<tr><td>Potential effect on approved/planned land uses</td></tr>
<tr><td>Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features</td></tr>
<tr><td>Potential to accommodate planned significant population and job growth in strategic growth areas</td></tr>
<tr><td rowspan="4">Natural Environment</td><td>Potential to impact fish and aquatic habitat</td><td rowspan="4">No disturbance; no natural environment near the area. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.</td><td rowspan="4">Low impact; no natural environment near the area, as the proposed solution is located on Austin Dr. Low potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.</td><td rowspan="4">Low impact; no natural environment near the area, as the proposed solution is located on Austin Dr. Low potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.</td></tr>
<tr><td>Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas</td></tr>
<tr><td>Potential to impact significant natural heritage features</td></tr>
<tr><td>Potential to impact significant wildlife habitat and species at risk</td></tr>
</table>

Identification and Evaluation of Alternatives

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no anticipated impacts on existing utilities.	Upgrades infrastructure and improves hydraulics in the sewer system. No land acquisition required, and impacts on existing utilities can be mitigated.	Upgrades infrastructure and improves hydraulics in the sewer system. Requires higher maintenance and operation costs than Alternative 2. No land acquisition required, and impacts on existing utilities can be mitigated.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

The preferred solution for the Austin Drive area is to upgrade and reprofile 4 lengths of the sewer, as present in **Figure 2-4** and **Figure 2-5**. This will include the replacement of the existing sanitary sewer pipe along Cardill Crescent and Austin Drive to provide additional sewer capacity.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth.

Figure 2-4: Preferred Solution - Austin Drive

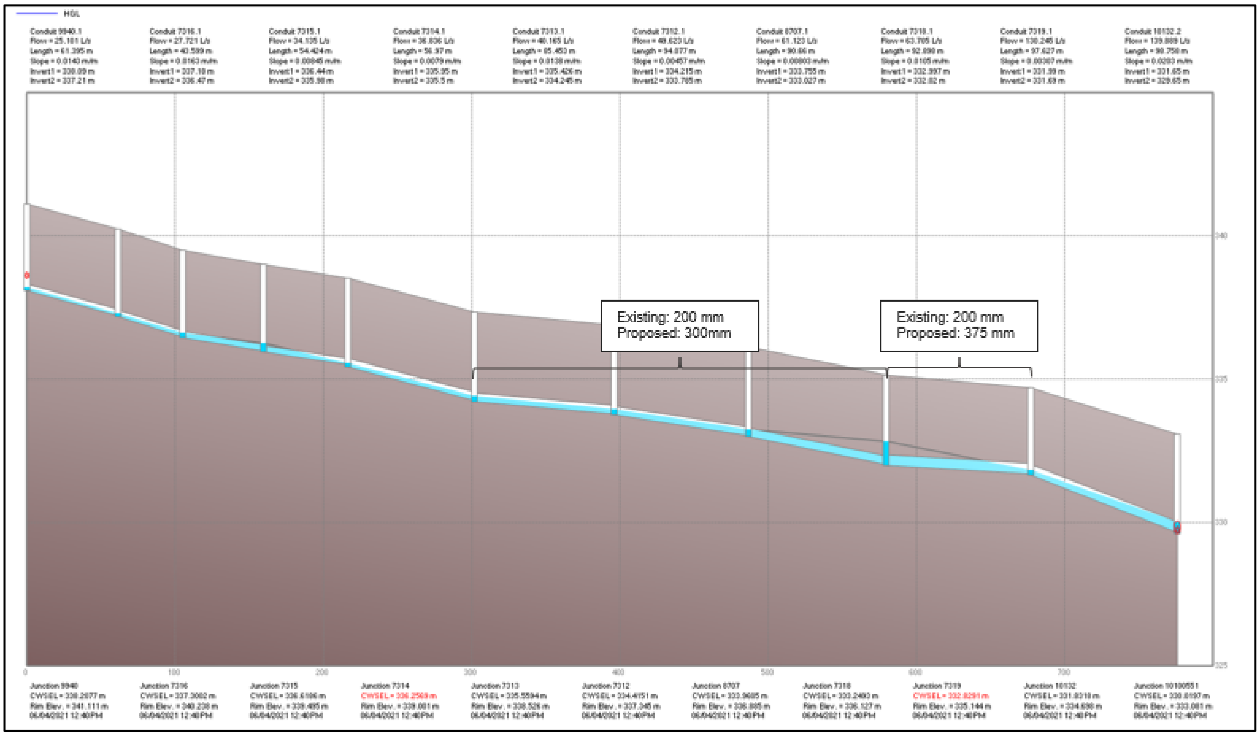


Figure 2-5: HGL Profile with Solution – Austin Drive

2.3.2.3 Lodge Street

The area of Lodge Street is at risk of experiencing basement flooding under extreme rainfall events, due to the existing undersized sewer on Lodge Street and Weber Street North. The sewers do not have capacity to convey the flows under these conditions.

Three alternatives were evaluated for this area, and are detailed in **Table 2-5**:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity).

Table 2-5: Evaluation Alternative - Lodge Street

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses, and community features Potential effect on approved/planned land uses Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features Potential to accommodate planned significant population and job growth in strategic growth areas	High potential to impact residents due to risk of basement flooding. Population growth increases basement flooding risk.	Mitigates risk of basement flooding, although potential construction impacts to the businesses on Lodge St and Weber St N. Accommodates population growth.	Mitigates risk of basement flooding, although potential construction impacts to the businesses on Lodge St and Weber St N. Accommodates population growth.
Natural Environment	Potential to impact fish and aquatic habitat Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas Potential to impact significant natural heritage features (i.e., Laurel Creek) Potential to impact significant wildlife habitat and species at risk	No disturbance to Laurel Creek. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Laurel Creek, as the proposed solution is located within the Laurel Creek floodplain. Low potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Laurel Creek, as the proposed solution is located within the Laurel Creek floodplain. Low potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.

<table>
<tr><th>Category</th><th>Evaluation Criteria</th><th>Do Nothing</th><th>Upgrade/Reprofile Sewer</th><th>Twin Sewer</th></tr>
<tr><td rowspan="5">Technical Considerations</td><td>Potential land requirements including land purchase and temporary/permanent easements</td><td rowspan="5">No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no anticipated impacts on existing utilities.</td><td rowspan="5">Upgrades infrastructure and improves hydraulics in the sewer system. No land acquisition required, and impacts on existing utilities can be mitigated.</td><td rowspan="5">Upgrades infrastructure and improves hydraulics in the sewer system. Requires higher maintenance and operation costs than Alternative 2. No land acquisition required, and impacts on existing utilities can be mitigated.</td></tr>
<tr><td>Constructability</td></tr>
<tr><td>Effect on existing utilities and infrastructure</td></tr>
<tr><td>Ability to coordinate with existing and planned infrastructure improvements</td></tr>
<tr><td>System resiliency and system suitability</td></tr>
<tr><td rowspan="2">Financial</td><td>Lifecycle operations and maintenance costs</td><td rowspan="2">No capital cost.</td><td rowspan="2">Estimated capital cost and operation & maintenance costs lower than Alternative 3.</td><td rowspan="2">Highest estimated capital cost and operation & maintenance costs of all alternatives.</td></tr>
<tr><td>Estimated capital cost</td></tr>
<tr><td>Summary Ranking</td><td>Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.</td><td>Least Preferred</td><td>Most Preferred</td><td>Moderately Preferred</td></tr>
</table>

The preferred solution for the Lodge Street area is to upgrade and reprofile 5 lengths of the existing sewer, as present in **Figure 2-6** and **Figure 2-7**. This will include the replacement of the existing sanitary sewer pipe along Lodge Street and Weber Street North to provide additional sewer capacity.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth.

Figure 2-6: Preferred Solution - Lodge Street

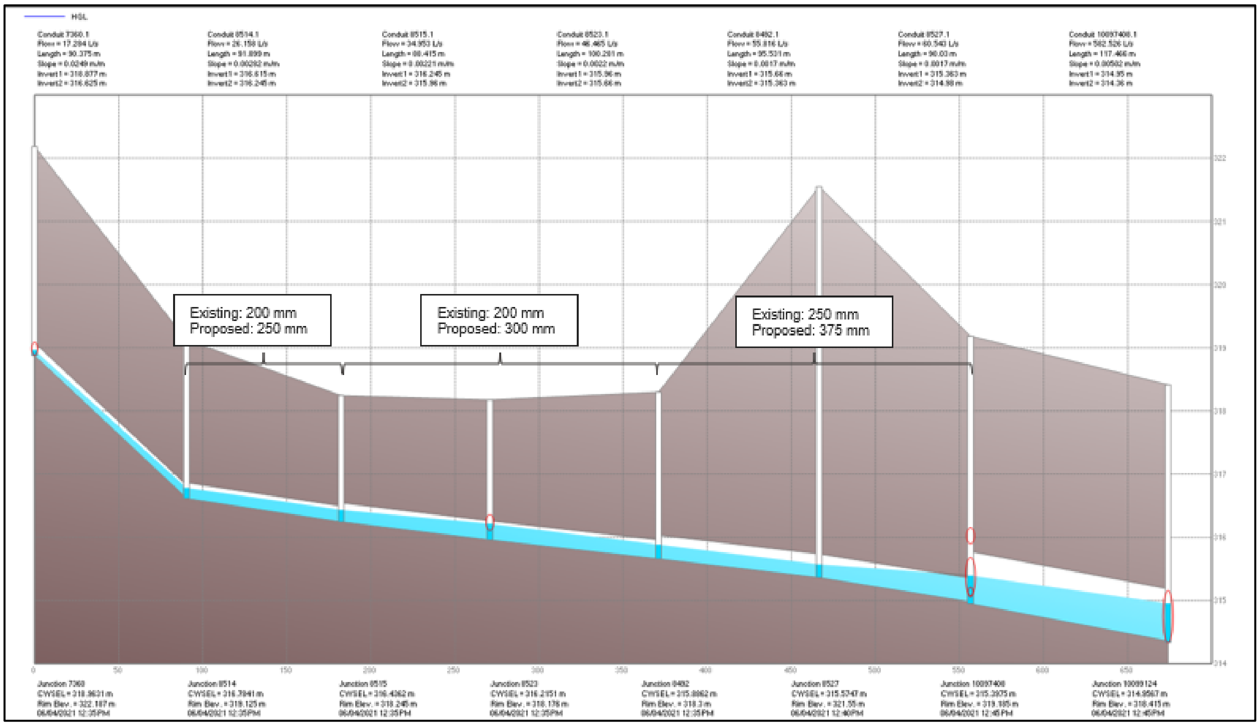


Figure 2-7: HGL Profile with Solution – Lodge Street

2.3.2.4 Thorndale Drive & Westvale Drive

The sanitary sewers on Maple Hill Creek do not have capacity for the flows under extreme rainfall event conditions. The location of the capacity constraint along the Maple Hill Trunk is in an existing easement. There is a weir in a MH at the intersection of Thorndale Drive & Westvale Drive currently directing the flow primarily to Thorndale Drive sewer, upstream of the location of the capacity constraint.

Four alternatives were evaluated for this area to address the capacity constraint:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)
- Alternative 4 – Weir Adjustment (overflow structure) to divert flows along an alternate route and potentially utilize available capacity.

Table 2-6: Evaluation Alternative - Thorndale Drive & Westvale Drive

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer	Weir Adjustment
Socio-Economic	Potential to impact existing residences, businesses and community features Potential effect on approved/planned land uses Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features Potential to accommodate planned significant population and job growth in strategic growth areas	High potential to impact residents due to risk of basement flooding. Population growth increases basement flooding risk.	Mitigates risk of basement flooding. Construction impacts to the residences, as the proposed upgrade sewers are located on private properties. Accommodates population growth.	Mitigates risk of basement flooding. Construction impacts to the residences, as the proposed upgrade sewers are located on private properties. Accommodates population growth.	Mitigates risk of basement flooding, and minimal impact to residences. Accommodates population growth.
Natural Environment	Potential to impact fish and aquatic habitat Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas Potential to impact significant natural heritage features (i.e., Maple Hill Creek) Potential to impact significant wildlife habitat and species at risk	No disturbance to Maple Hill Creek. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Maple Hill Creek, as the proposed solution is located near the Creek. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.	Possible impact on Maple Hill Creek, as the proposed solution is located near the Creek. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.	No disturbance to Maple Hill Creek as project is distant from the Creek. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.

Identification and Evaluation of Alternatives

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer	Weir Adjustment
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements Constructability Effect on existing utilities and infrastructure Ability to coordinate with existing and planned infrastructure improvements System resiliency and system suitability	No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no anticipated impacts on existing utilities.	Improves infrastructure and hydraulics but requires construction through easement. Impacts on existing utilities can be mitigated.	Improves infrastructure and hydraulics but requires construction through easement. Requires higher maintenance and operation than Alternative 2. Impacts on existing utilities can be mitigated.	Well, Aligned with Criteria; improves hydraulics in sewer system and ease of access for maintenance and operation. No land acquisition required, and no anticipated impacts on existing utilities. Well, aligned, ease of access for maintenance and operation.
Financial	Lifecycle operations and maintenance costs Estimated capital cost	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3, but higher than Alternative 4	Highest estimated capital cost and operation & maintenance costs of all alternatives.	Estimated capital cost and operation & maintenance costs lower than Alternative 2 and 3.
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Least Preferred**	**Moderately Preferred**	**Least Preferred**	**Most Preferred**

The preferred solution for the Thorndale Drive & Westvale Drive area is to implement weir adjustments. The weir is located at the intersection of Thorndale Drive & Westvale Drive (MH: MPL-65), as shown in **Figure 2-8**. The improvements will include the removal of the existing concrete weir upstream of the Westvale Drive sewer, and the addition of a new concrete weir upstream of the Thorndale Drive sewer. This solution will redirect the primary flow from the Thorndale Drive sewer to the Westvale Drive sewer.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth. This alternative also reduces potential impacts to adjacent residents.

Figure 2-8: Preferred Solution - Thorndale Drive & Westvale Drive

2.3.2.5 Weber Street North

The sewers on Weber Street North have capacity constraints, but the HGL issue is mainly due to shallow sewer.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Table 2-7: Evaluation Alternative - Weber Street North

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses and community features Potential effect on approved/planned land uses Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features Potential to accommodate planned significant population and job growth in strategic growth areas	Sewer operates under surcharge condition; however, the commercial area would not have basement connections to this section, thus low risk of basement flooding. Growth increases surcharge but can be accommodated.	Mitigates risk of basement flooding, although potential construction impacts to the businesses on Weber St N. Accommodates population growth.	Mitigates risk of basement flooding, although potential construction impacts to the businesses on Weber St N. Accommodates population growth.
Natural Environment	Potential to impact fish and aquatic habitat Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas Potential to impact significant natural heritage features Potential to impact significant wildlife habitat and species at risk	No disturbance; no natural environment near the area. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Laurel Creek, as the proposed solution is located within the Laurel Creek floodplain. Low potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Possible impact on Laurel Creek, as the proposed solution is located within the Laurel Creek floodplain. Low potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.

Identification and Evaluation of Alternatives

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No land acquisition required, and no anticipated impacts on existing utilities.	Improves infrastructure and hydraulics. No land acquisition required, and impacts on existing utilities can be mitigated.	Improves infrastructure and hydraulics. Requires higher maintenance and operation costs than Alternative 2. No land acquisition required, and impacts on existing utilities can be mitigated.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Most Preferred**	**Moderately Preferred**	**Least Preferred**

The surcharging pipe (asset ID: 6020) on Weber Street North is shallow, therefore, the target LOS is for the water level to remain within the pipe. **Figure 2-9** presents that the pipe is free flowing at the location of the MH with the HGL Freeboard less than 1.8 m, thus the existing sanitary sewer along Weber Street North operates effectively, and there are no concerns related to flooding within this area. The location of the surcharging pipe is shown in **Figure 2-10**.

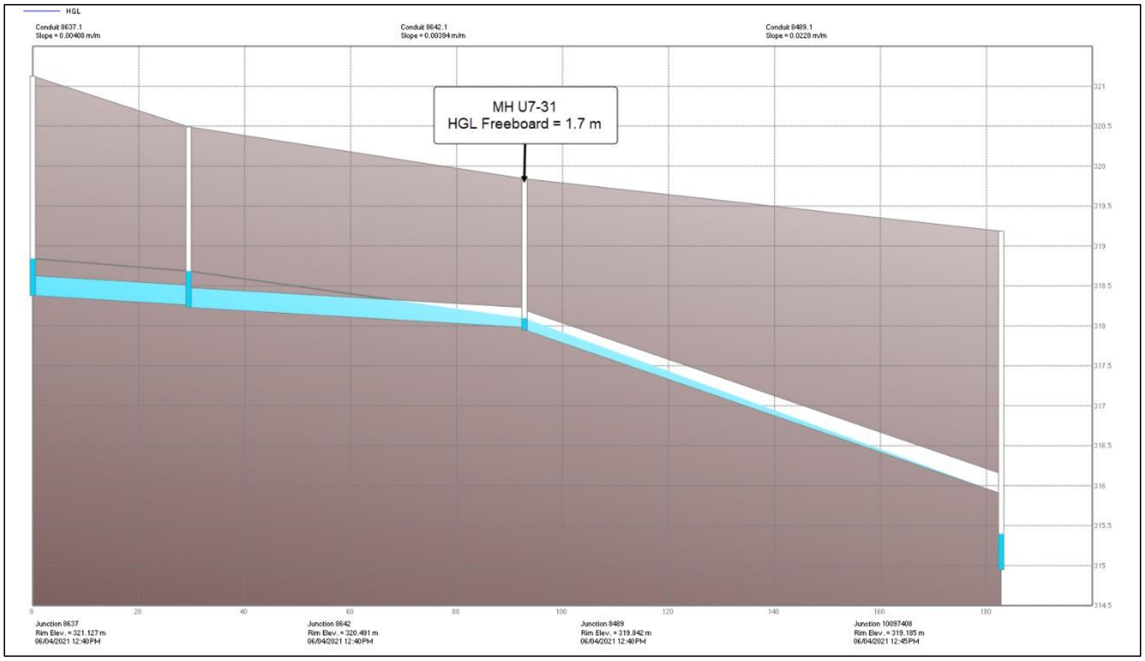


Figure 2-9: HGL Profile on Weber St N

Figure 2-10: Preferred Solution - Weber Street North

2.3.2.6 Forwell Trail

The area of Forwell Trail has high water levels in the sanitary sewer under extreme rainfall events. The pipes are undersized and shallow. However, there is a low risk of basement flooding as no building connection are present along these sewers.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Table 2-8: Evaluation Alternative - Forwell Trail

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses and community features	Sewer operates in a surcharge condition, however, there are no basement connections to this section so low risk of basement flooding. Growth increases surcharge but can be accommodated.	Mitigates high water levels in the sanitary sewer, although potential construction impacts. Accommodates population growth.	Mitigates high water levels in the sanitary sewer, although potential construction impacts. Accommodates population growth.
	Potential effect on approved/planned land uses			
	Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features			
	Potential to accommodate planned significant population and job growth in strategic growth areas			
Natural Environment	Potential to impact fish and aquatic habitat	No disturbance to Hillside Park Reserve. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	Potential impact on Hillside Park Reserve, as the solution is located in the Park. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.	Potential impact on Hillside Park Reserve, as the solution is located in the Park. Potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk due to proximity to the Creek.
	Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas			
	Potential to impact significant natural heritage features (i.e., Hillside Park Reserve)			
	Potential to impact significant wildlife habitat and species at risk			

Identification and Evaluation of Alternatives

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	Shallow pipes and no residential basement connections. No land acquisition required, and no anticipated impacts on existing utilities.	Improves infrastructure and hydraulics. No land acquisition required, and no anticipated impacts on existing utilities.	Improves infrastructure and hydraulics. Requires higher maintenance and operation costs than Alternative 2. No land acquisition required, and no anticipated impacts on existing utilities.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Most Preferred**	**Moderately Preferred**	**Least Preferred**

Identification and Evaluation of Alternatives

The sewer in this section is shown to have capacity issues, however, on a detailed review there is no risk to adjacent landowners of sewer backups and work on this sewer would impact the natural environment. Therefore, the preferred solution for the Forwell Trail – East of Lexington Road area is to do nothing. The location of the surcharging pipe is shown in **Figure 2-11**.

Figure 2-11: Preferred Solution - Forwell Trail

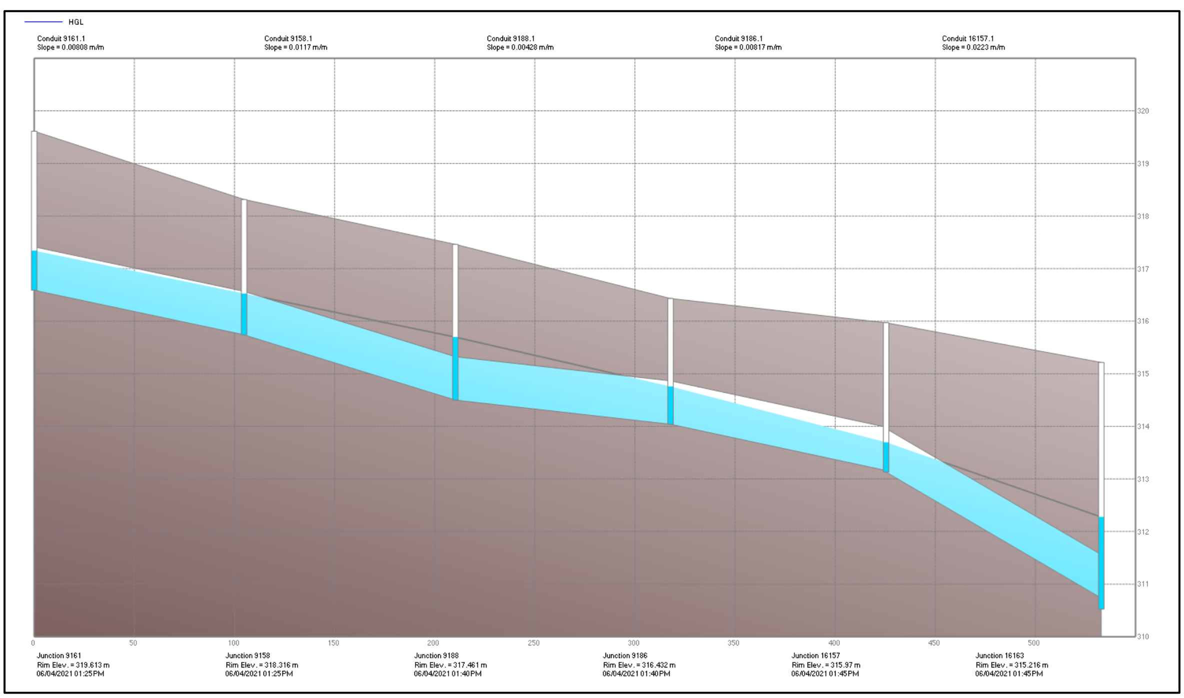


Figure 2-12: HGL Profile on Forwell Trail

2.3.2.7 Frobisher Drive

Capacity constraints have been identified on Frobisher Drive under dry weather flow. There is no HGL issue under extreme event, however as presented in TM4, capacity constraints under DWF conditions were also considered as problem area.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Table 2-9: Evaluation Alternative – Frobisher Drive

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Potential to impact existing residences, businesses and community features Potential effect on approved/planned land uses Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features Potential to accommodate planned significant population and job growth in strategic growth areas	Potential to impact residents due to sewer capacity constraints under DWF. Population growth increases capacity constraints.	Mitigates capacity constraints, although potential construction impacts to the businesses on Frobisher Dr. Accommodates population growth.	Mitigates capacity constraints, although potential construction impacts to the businesses on Frobisher Dr. Accommodates population growth.
Natural Environment	Potential to impact fish and aquatic habitat Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas Potential to impact significant natural heritage features Potential to impact significant wildlife habitat and species at risk	No disturbance; no natural environment near the area. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	No natural environment near the area, as the proposed solution is located on Frobisher Dr. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.	No natural environment near the area, as the proposed solution is located on Frobisher Dr. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.

Identification and Evaluation of Alternatives

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no impacts on existing utilities.	Upgrades infrastructure and improves hydraulics in the sewer system. No land acquisition required, and impacts on existing utilities can be mitigated.	Upgrades infrastructure and improves hydraulics in the sewer system. Requires higher maintenance and operation than the sewer upgrade alternative. No land acquisition required, and impacts on existing utilities can be mitigated.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

The preferred solution for the Frobisher Drive area is to upgrade and reprofile two lengths of sewer, as present in **Figure 2-13** and **Figure 2-14**. This will include replacement of the existing sanitary sewer pipe along Frobisher Drive to improve the sewer capacity.

These improvements will mitigate the capacity constraints, reduce future maintenance and operations costs, and accommodate current and future growth.

Figure 2-13: Preferred Solution – Frobisher Drive

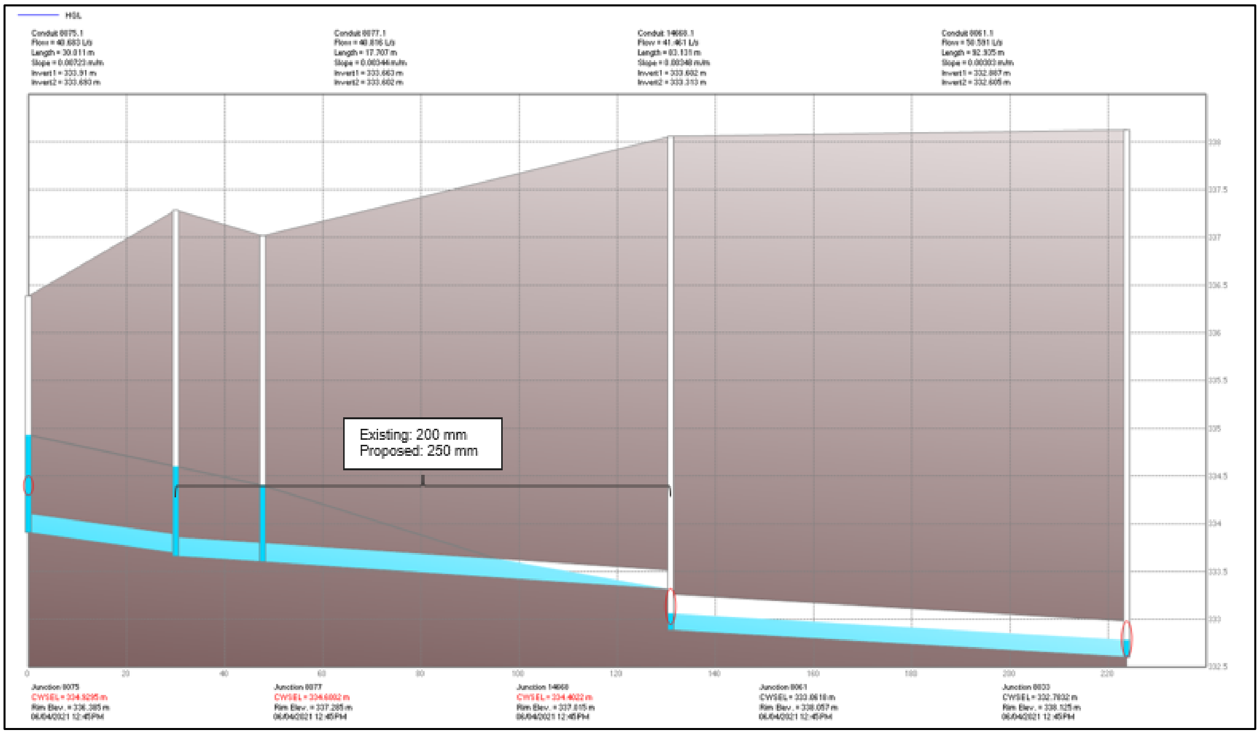


Figure 2-14: HGL Profile with Solution – Frobisher Drive

2.3.2.8 Union Street East

Additional inflow from the Moore Ave pump station tributary area in Kitchener will be tributary to the Moore Ave sanitary sewer in Waterloo. In the model the inflow was incorporated at the intersection of Moore Ave S and Spur Line Trail (MH L30-23). In the future conditions, the area of Union Street East is at risk of basement flooding under extreme rainfall events.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Table 2-10: Evaluation Alternative – Union Street East

<table>
<tr><th>Category</th><th>Evaluation Criteria</th><th>Do Nothing</th><th>Upgrade/Reprofile Sewer</th><th>Twin Sewer</th></tr>
<tr><td rowspan="4">Socio-Economic</td><td>Potential to impact existing residences, businesses and community features</td><td rowspan="4">Potential to impact residents due to risk of basement flooding. Population growth increases basement flooding risk.</td><td rowspan="4">Mitigates risk of basement flooding and align with the City's planned infrastructure upgrade on Union St E. Accommodates population growth.</td><td rowspan="4">Mitigates risk of basement flooding and align with the City's planned infrastructure upgrade on Union St E. Accommodates population growth.</td></tr>
<tr><td>Potential effect on approved/planned land uses</td></tr>
<tr><td>Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features</td></tr>
<tr><td>Potential to accommodate planned significant population and job growth in strategic growth areas</td></tr>
<tr><td rowspan="4">Natural Environment</td><td>Potential to impact fish and aquatic habitat</td><td rowspan="4">No disturbance; no natural environment near the area. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.</td><td rowspan="4">No natural environment near the area, as the proposed solution is located on Union St E. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.</td><td rowspan="4">No natural environment near the area, as the proposed solution is located on Union St E. No potential to impact fish and aquatic habitat, water resources, and significant wildlife habitat and species at risk.</td></tr>
<tr><td>Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas</td></tr>
<tr><td>Potential to impact significant natural heritage features</td></tr>
<tr><td>Potential to impact significant wildlife habitat and species at risk</td></tr>
</table>

Identification and Evaluation of Alternatives

Category	Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Technical Considerations	Potential land requirements including land purchase and temporary/permanent easements	No improvement to infrastructure or hydraulics of the sewer system. No land acquisition required, and no impacts on existing utilities.	Upgrades infrastructure and improves hydraulics in the sewer system. No land acquisition required, and impacts on existing utilities can be mitigated.	Upgrades infrastructure and improves hydraulics in the sewer system. Requires higher maintenance and operation than the sewer upgrade alternative. No land acquisition required, and impacts on existing utilities can be mitigated.
	Constructability			
	Effect on existing utilities and infrastructure			
	Ability to coordinate with existing and planned infrastructure improvements			
	System resiliency and system suitability			
Financial	Lifecycle operations and maintenance costs	No capital cost.	Estimated capital cost and operation & maintenance costs lower than Alternative 3.	Highest estimated capital cost and operation & maintenance costs of all alternatives.
	Estimated capital cost			
Summary Ranking	**Green is the most well aligned with the criterions, Yellow is somewhat aligned with the criterions, and red is the least well aligned with the criterions.**	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

Identification and Evaluation of Alternatives

The preferred solution for the Union Street East area is to upgrade and reprofile 1 length of sewer, as shown in **Figure 2-15** and **Figure 2-16**. This will include replacement of the existing sanitary sewer pipe along Union Street East to improve the sewer capacity. This solution is aligned with the City's planned infrastructure upgrade on Union Street East.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth.

Figure 2-15: Preferred Solution – Union Street East

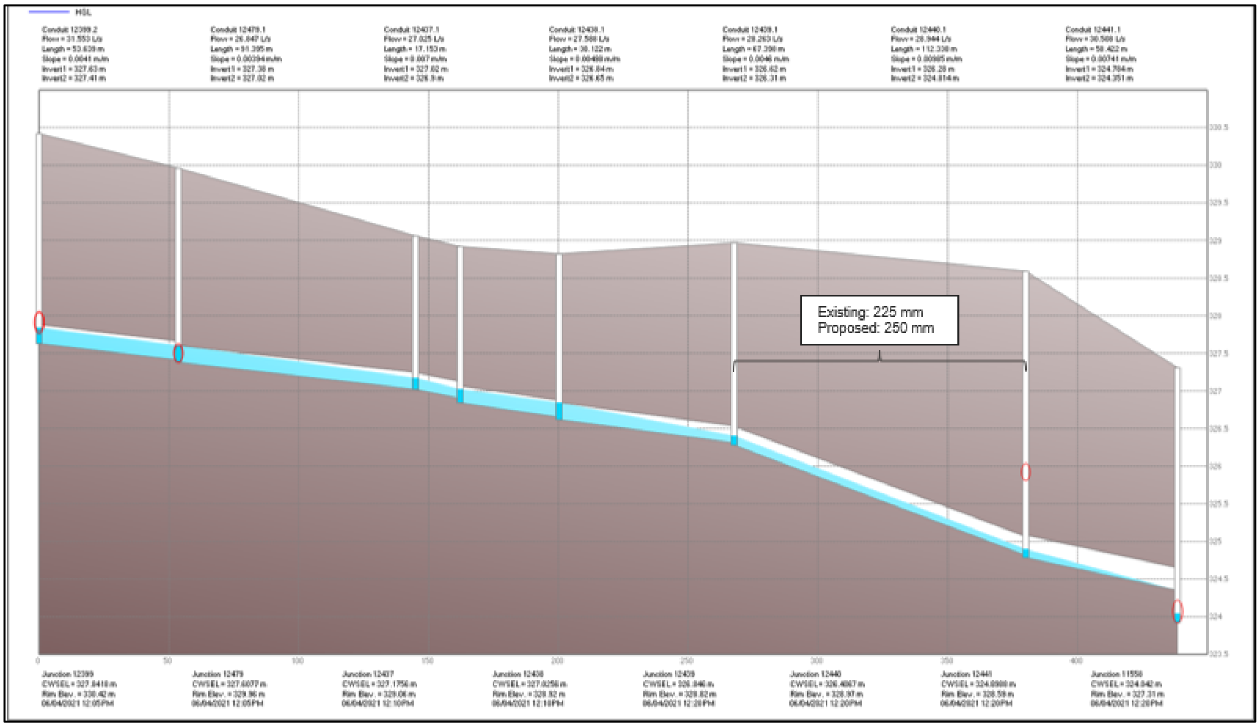


Figure 2-16: HGL Profile with Solution - Union Street East

2.3.3 Opinion of Probable Cost

The proposed solutions are presented in **Table 2-11**, along with the estimated Opinion of Probable Cost (OPC) per solution. Solutions are listed by their Project ID (PA-#, where PA refers to Problem Area solutions).

The solutions are ordered based on a high-level assessment of priority, which predominately focuses on prioritizing solutions that are required in the near-term to resolve issues experienced in existing conditions and in the medium-term to resolve issues that are triggered under 2031 conditions. Within each horizon however, the prioritization is assumed equal.

The OPCs are considered Class D estimates (+/- 25-30%) and are provided based on 2023 dollars. These costs and have been rounded to the nearest thousand for the recommended budgetary estimate. These OPCs can be used to help inform the City's budgeting process that occurs every 5 years. Thus, all near-term projects should be included within the next budgeting process (2027-2030 budget), while the medium-term solution should be accounted for in future budgets.

In most cases, the required solutions are simple in nature, in that only a few pipe segment upgrades within City-owned Right-of-Way (ROW) are required to reduce HGLs below 1.8 m from surface.

The following **Figure 2-17** illustrates the locations of the proposed solution. Refer to **Appendix A** for further solution details, including close-up plan views and profiles of each of the proposed solutions.

Table 2-11: Existing and Future Conditions Capacity-Based Sewer Solutions

Problem Area ID	Scenario Triggered	Preferred Alternative	Solution Description	Estimated Opinion of Probable Cost	Contingency Allowance (30%)	Engineering Allowance (20%)	Recommended Budgetary Estimate
PA-1: Highpoint Avenue	Existing (Near-Term Priority)	Alt 2	Replacement of 10 lengths of sewer - upsize 2 lengths of sewer from 300 mm diameter to 375 mm diameter sewer, and 8 lengths of sewer from 375 mm diameter to 450 mm diameter sewer	$1,925,190	$577,557	$500,549	$3,004,000
PA-2: Austin Drive	Existing (Near-Term Priority)	Alt 2	Replacement of 4 lengths of sewer - upsize 3 lengths of sewer from 200 mm diameter to 300 mm diameter sewer, and 1 length of sewer from 200 mm diameter to 375 mm diameter sewer	$759,290	$227,787	$197,415	$1,185,000
PA-3: Lodge Street	Existing (Near-Term Priority)	Alt 2	Replacement of 5 lengths of sewer - upsize 1 length of sewer from 200 mm diameter to 250 mm diameter sewer, 2 lengths of sewer from 200 mm diameter to 300 mm diameter sewer, and 2 lengths of sewer from 250 mm diameter to 375 mm diameter sewer	$1,321,000	$396,300	$343,460	$2,061,000
PA-4: Thorndale Drive & Westvale Drive	Existing (Near-Term Priority)	Alt 4	Option A - In-place reconfiguration of the concrete weir (MH MPL-65)	$67,000	$20,100	$17,420	$105,000
			Option B - Full removal and replacement of the concrete weir (MH MPL-65)	$382,923	$114,877	$99,560	$598,000
PA-5: Weber Street North	Existing (Near-Term Priority)	Alt 1	Do nothing	$-	$-	$-	$-

Identification and Evaluation of Alternatives

Problem Area ID	Scenario Triggered	Preferred Alternative	Solution Description	Estimated Opinion of Probable Cost	Contingency Allowance (30%)	Engineering Allowance (20%)	Recommended Budgetary Estimate
PA-6: Forwell Trail	Existing (Near-Term Priority)	Alt 1	Do nothing	$-	$-	$-	$-
PA-7: Frobisher Drive	Existing (Near-Term Priority)	Alt 2	Replacement of 2 lengths of sewer downstream of the forcemain - upsizing from 200 mm diameter to 250 mm diameter sewer	$442,025	$132,608	$114,927	$690,000
PA-8: Union Street East	2031 (Medium-Term Priority)	Alt 2	Replacement of 1 length of sewer downstream of the inflow from Kitchener (decommission of Moore PS) - upsizing from 225 mm diameter to 250 mm diameter sewer	$392,074	$117,622	$101,939	$612,000

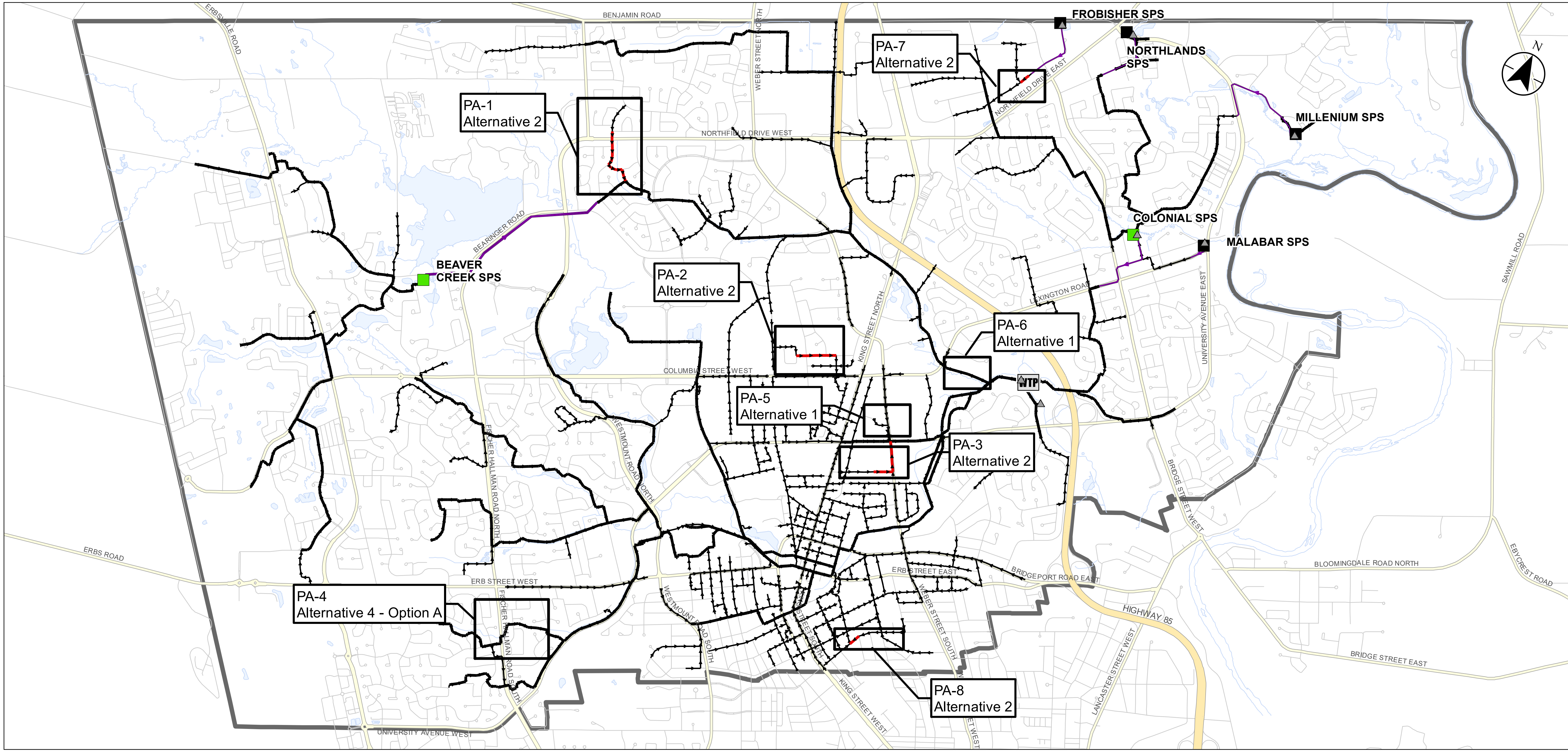
2.3.3.1 Alternatives Review

As presented in **Table 2-11**, there are two options for the Thorndale Drive & Westvale Drive Avenue. The comparison and the preferred option are present in **Table 2-12**.

Table 2-12: Alternatives Evaluation

Evaluation Element	Option A	Option B
Project ID	CB-4	
Location	Thorndale Drive & Westvale Drive	
Description	In-place reconfiguration of the concrete weir (MH MPL-65)	Full removal and replacement of the concrete weir (MH MPL-65)
Opinion of Probable Cost	$105,000	$598,000
Pros	• Avoids easement/private property upgrades resulting in fewer permitting requirements • Reduces HGL concerns in Maple Hill Area • Lower immediate cost	• Avoids easement/private property upgrades resulting in fewer permitting requirements • Reduces HGL concerns in Maple Hill Area • Higher life cycle
Recommendation	Option A – Due to the minimization of the cost	

As the table above indicates, Option A is recommended for Thorndale Drive & Westvale Drive problem area. The total recommended budgetary estimate for all proposed solutions, including only the recommended alternatives for CB-4, is **$7,657,000**, as per **Table 2-11** and **Table 2-12**.



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain

Modelled Sanitary Sewers

- Local Main
- Trunk Main
- Upgraded/Reprofiled Sewer

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

Stantec

Project Location: City of Waterloo

165640363 REVA
Prepared by HB on 2023-10-20

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
2-17

Title
Proposed Capabity-Based Solutions

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

\\cd1004-f01\work_group\01656\active\165640363\preliminary\analysis\gis\mxd\TN5-6\WaterlooSANMP_PreferredSolutions.mxd Revised: 2023-10-20 By: hboulanger

2.3.4 Climate Change Considerations

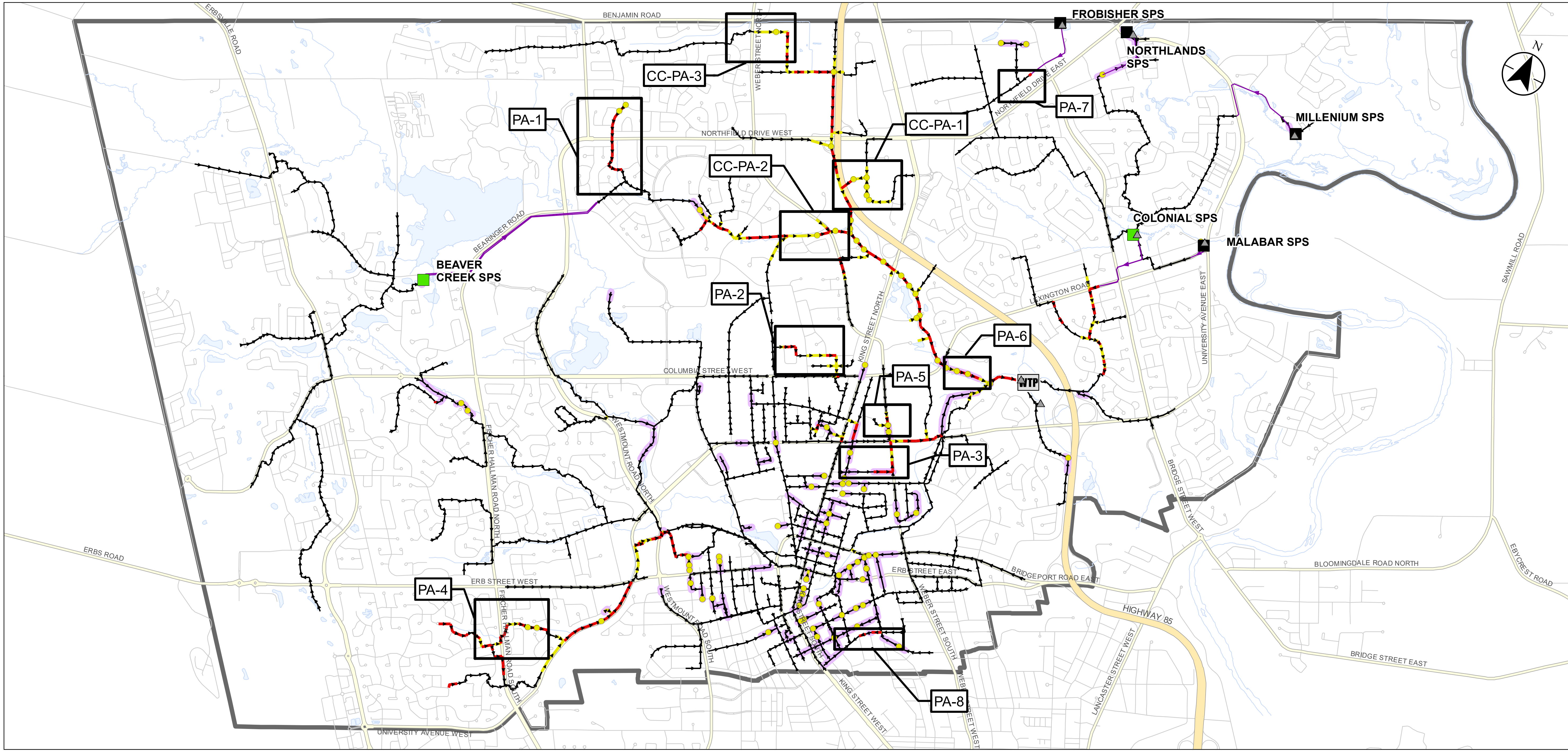
Typically, climate change predictions results in rainfall increases up to 20% from current design storms. Therefore, the 25-year Chicago, 3-hour design storm rainfall timeseries was simply increased by 20% and used as the 25-year with climate change event to generate the climate change/stress-test event (herein referred to as CC). This event was then used to test the sensitivity of proposed capacity-based solutions as defined in **Section 2.3.2,** under the 2051 growth scenario. As anticipated, the higher intensity/volume rainfall results in the expansion of four (4) of the existing problem areas and the development of three (3) new problem areas. The sensitivity of the proposed solutions for each problem area is documented in the following **Table 2-13**, which also includes the list of new problem areas and the estimated magnitude of solutions required to solve the HGL concerns observed in the climate change event. Sensitivities are presented in red font and categorized by Minor Sensitivity and **Significant Sensitivity**, where minor sensitivities would require minor, simple upgrades to resolve, while significant sensitivities would require major, more complex upgrades. The preferred alternatives under climate change conditions results are illustrated in **Figure 2-18.**

Table 2-13: Climate Change Impacts to Proposed Solutions

Problem Area	Existing vs. New Problem Area	Solutions Sensitivity in Climate Change Event	Trunk vs. Local	Comments
PA-1 Cedar Highpoint Ave	Existing	**Significant sensitivity**	Trunk	Capacity constraint and HGL issues on Cedar Trunk sewers requiring significant additional upgrade(s)
PA-2 University Austin Dr	Existing	Not sensitive	Local	Capacity constraint and backwater on sewers, no HGL issue
PA-3 Laurel 2 Lodge St / Weber	Existing	Not sensitive	Local	Capacity constraint and backwater on sewers, no HGL issue
PA-4 Maple Hill Maple Hill Creek	Existing	**Significant sensitivity**	Local	Backwater, capacity constraint and HGL issues on local sewers, including pipes on private property, requiring significant additional upgrade(s)
PA-5 Laurel 2 Weber St N	Existing	Minor Sensitivity	Local	Backwater and HGL issues on local sewers with shallow pipes, requiring minor upgrades
PA-6 Forwell Trunk Conestoga College	Existing	**Significant sensitivity**	Trunk	Backwater and HGL issues on trunk & local sewers requiring significant additional upgrade(s)
PA-7 Lee 1 Downstream of Frobisher SPS	Existing	Not sensitive	Local	Capacity constraint on local sewers, no HGL issue
PA-8 Laurel 2 Downstream of Moore SPS	Existing	Not sensitive	Local	Capacity constraint on local sewers, no HGL issue

Problem Area	Existing vs. New Problem Area	Solutions Sensitivity in Climate Change Event	Trunk vs. Local	Comments
CC-PA-1 Conestoga Road West	New	**Significant sensitivity**	Local	Backwater and HGL issues on local sewers due to the capacity constraints on Forwell Trunk, requiring significant additional upgrade(s)
CC-PA-2 Albert Street (Cedar Trunk)	New	**Significant sensitivity**	Trunk	Backwater and HGL issues on trunk sewers due to the capacity constraints on Forwell Trunk, requiring significant additional upgrade(s)
CC-PA-3 Conrad Pl	New	**Significant sensitivity**	Trunk	Backwater and HGL issues on trunk sewers due to the capacity constraints on Forwell Trunk, requiring significant additional upgrade(s)
Note: "CC-PA-#" refers to new sanitary problem areas observed due to climate change ("CC") impacts only, i.e., in addition to the previously identified capacity-based "PA" solutions.				

While some sensitivities are observed, no changes or additional proposed solutions are recommended at this time considering the uncertainty involved with not only climate change predictions, but also accurate growth predictions for the 2051 horizon. Alternatives regarding additional/continual data acquisitions, flow monitoring and I/I mitigation programs can help reduce sensitivities in these areas instead.



Legend

- WWTP
- Storage
- Storage & Emergency Storage
- Overflow
- Forcemain
- Shallow Sewer

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.8 m of Surface)

0 500 1,000 metres

1:37,500 (At original document size of 11x17)

Stantec

Project Location
City of Waterloo

165640363 REVA
Prepared by HB on 2023-10-17

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
2-18

Title
Capacity-Based Solutions Sensitivity – 25-Year Climate Change HGL & Surcharge

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

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3.0 IMPLEMENTATION PLAN

The Implementation Plan identifies works recommended in the Priority 5-year timeframe which are considered in more detail, separately from works identified for the Strategic 5-30-year window which are outlined at a higher level. The implementation plan consists of the timing of projects that were present in the previous sections. Moreover, the implementation plan spreads the capital works based on criticality to provide an annualized cost for the City's consideration. The project prioritization for the implementation strategy was formulated with a focus on areas that are most vulnerable to basement flooding. These high-risk zones were identified as critical problem areas. In addition, areas where the maximum number of residences could be impacted were also given priority. This approach ensures that the most at-risk and densely populated areas are addressed first in our plan.

Table 3-1 presents the prioritization (with 1 indicating highest priority) and annual costing for the short-term Capital Projects. Refer to **Sections 2.3.2** for details on the Capital Projects.

Table 3-1: Priority 5-year Timeframe Prioritization & Annual Costing

Project ID	Scenario Triggered	Recommended Budgetary Estimate	Priority	Priority 5-year					Strategic 5-30-year
				2027	2028	2029	2030	2031	
PA-1: Highpoint Avenue	Existing (Near-Term Priority)	$3,004,000	1	$3,004,000	$-	$-	$-	$-	$-
PA-2: Austin Drive	Existing (Near-Term Priority)	$1,185,000	1	$-	$1,185,000	$-	$-	$-	$-
PA-3: Lodge Street	Existing (Near-Term Priority)	$2,061,000	2	$-	$-	$2,061,000	$-	$-	$-
PA-4: Thorndale Drive & Westvale Drive	Existing (Near-Term Priority)	$105,000	3	$-	$-	$-	$105,000	$-	$-
PA-5: Weber Street North	Existing (Near-Term Priority)	$-	-	$-	$-	$-	$-	$-	$-
PA-6: Forwell Trail	Existing (Near-Term Priority)	$-	-	$-	$-	$-	$-	$-	$-
PA-7: Frobisher Drive	Existing (Near-Term Priority)	$690,000	4	$-	$-	$-	$-	$690,000	$-
PA-8: Union Street East	**2031 (Medium-Term Priority)**	$612,000	5	$-	$-	$-	$-	$-	$612,000
Total				**$3,004,000**	**$1,185,000**	**$2,061,000**	**$105,000**	**$690,000**	**$612,000**

4.0 DATA ACQUISITION, FLOW MONITORING AND I/I MITIGATION RECOMMENDATIONS

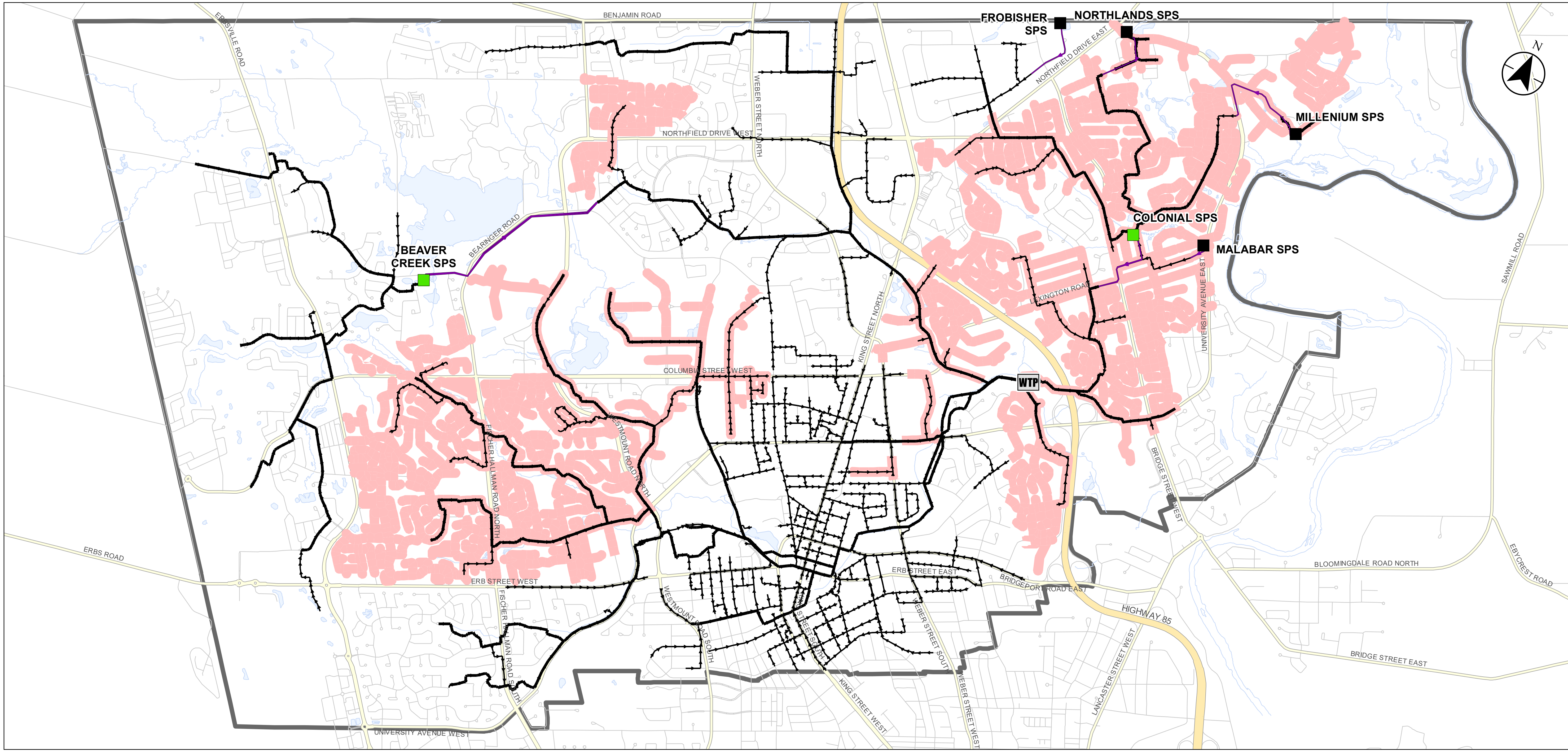
The programs for data acquisition, flow monitoring, and I/I mitigation are not included in the alternative's evaluation. However, they are mentioned in the following sections as a recommended practice to enhance the understanding of the sanitary sewer system and its improvement.

4.1.1 Infiltration/Inflow Reduction & Mitigation Programs

The infiltration and inflow (I/I) of extraneous stormwater and groundwater sources into sanitary sewers can overwhelm conveyance capacity and can be a significant cause of surcharge leading to premature pipe deterioration, system backups, basement flooding, and overflows, which can result in unnecessary and significant operating costs for conveying and treating excess groundwater and stormwater, and take away capacity that was planned and designed to accommodate future growth. Aging infrastructure, illicit cross-connections with the surface, storm sewer or riverine systems, and changes in weather patterns can all contribute to the observed increasing trend in extraneous flow reaching the treatment plant.

Inflow and Infiltration into the sanitary system in the hydraulic model are represented as groundwater infiltration (GWI rate) and wet weather inflows using the RTK method (Total R). Therefore, **Figure 4-1** presents the I/I reduction target areas based on the calibrated GWI rates and Total R per sewershed. Refer to **TM2-3** for wet weather calibration methodology and parameters.

As a result, Best in Class municipalities follow the best practices recently outlined in the *Guideline to Developing an Efficient and Cost-Effective Inflow and Infiltration (I/I) Reduction Program: A Foundational Document* (Robinson, B., and Sandink, D. 2021) as available on the Standards Council of Canada website: https://www.scc.ca/en/system/files/publications/Norton-ICLR-SCC_-_Efficient_and_Cost_Effective_I-I_Reduction_Programs_-_2021_EN.pdf. This outlines the base components required to develop an I/I Program, which should be established through development of an I/I Strategy, to define the vision, objectives, program drivers, and alignment to Corporate initiatives, through review and holistic evaluation of inter-departmental operations, opportunities, and co-benefits. Comprehensive I/I Programs are synergistically tied to other municipal infrastructure programs such as asset renewal (replacement and/or rehabilitation), capital works planning, operational improvements, and growth management/capacity assurance programs. Establishing, maintaining, and sustaining a successful strategy thus means securing long-term capacity while monitoring and assuring the structural condition of the assets is maintained. On-going data collection, performance monitoring, enforcement of design and construction standards, sewer integrity/condition assessment, hydraulic performance assessments, and overall data management and analytics are all fundamental components within a sustaining and optimized I/I Program.



Legend

- WTP WWTP
- Storage
- Storage & Emergency Storage
- Forcemain

Modelled Sanitary Sewers

- Local Main
- Trunk Main

I/I Reduction Target Area

GWI Rates Greater or Equal to 0.05 L/s/ha and/or Total R Value Greater or Equal to 3%

0 500 1,000 metres

1:37,560 (At original document size of 11x17)

Stantec

Project Location
City of Waterloo

165640363 REVA
Prepared by HB on 2023-10-20

Client/Project
CITY OF WATERLOO
SANITARY MASTER PLAN

Figure No.
4-1

Title
I/I Reduction Target Areas

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Contains information provided by the City of Waterloo under licence.

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4.1.2 Rainfall and Flow Monitoring

To support long-term data trending in keeping with the goal of proactive system management, a formal Rainfall and Flow Monitoring Program is recommended. This program is intended to manage all the rainfall and flow monitoring equipment and contracts, and strategically plan, coordinate, and manage the data collection activities that are fit-for-purpose to support the various Business Drivers and Stressors impacting the existing and future collection system. These include Hydraulic Model maintenance, Infiltration and Inflow Reduction/Mitigation, Operations and Maintenance activities/frequencies, Operational Alarming/Emergency Response/Forensic evaluation, Capital Project planning and design, Asset Management, and Growth Management Planning.

Category	Drivers & Stressors	
Program Planning	Hydraulic Model Maintenance	Infiltration / Inflow Reduction
System Operation	Sewer Performance Trending	Facility Operation (RTC, PS)
Growth Planning	Master/PPC Planning	Development Capacity Reviews
Capital Projects	Capital Project Integration	Design Support
Compliance Reporting	Overflow Reporting	Bylaw Contravention

Example Categorization of Typical Monitoring Functions

4.1.3 Sanitary Hydraulic Model Updates & Maintenance

Best in Class utilities use hydraulic modelling as a key element of their capital planning, operations, and management decision-making activities. Appropriate investment is required in the continual maintenance and upkeep of this important assessment tool. As was noted through the hydraulic model build, calibration, and assessment phases that the model has been updated and calibrated at the trunk level based on the limited flow monitoring coverage available through this project. As such, this represents a functional tool for the master planning level, that should be continuously updated and refined based on priority of needs in the areas where no monitoring coverage was available and in the local system. Model maintenance activities will include items such as Physical Network Improvements (based on drawing review, asset data findings, and field investigations), Validation and/or Recalibration (based on ongoing Rainfall and Flow Monitoring Program data collection), and Annual Updates (to reflect changes due to sewer construction or pump station operation, and updates based on population growth/new developments).

5.0 CONCLUSIONS AND RECOMMENDATIONS

This technical note (TN#5-6) outlines the detailed development and evaluation of solutions as well as the capital planning and execution for the Waterloo sanitary Master Plan update, including the following discussions:

- System Capacity Constraints, Evaluation Criteria and Design Criteria (**Section 2.1**);
- Evaluation of Alternatives, Opinion of Probable Cost and Climate Change Considerations (**Section 2.3.2**);
- Data Acquisition, Flow Monitoring, and I/I Mitigation Recommendations (**Section 4.0**); and the,
- Implementation Plan (**Section 3.0**).

Alternative solutions are assessed and recommended with the intention of improving the City's sanitary sewer infrastructure. Based on 2051 growth scenario results, a total of eight (8) capacity-based projects are recommended to resolve HGL and surcharge issues, as presented in **Table 2-11**. The total recommended budgetary estimation for these solutions is **$7,657,000**, which includes contingency (30%) and engineering (20%) allowances in 2023 dollars. As presented in **Table 2-13,** some of these solutions and other locations within the system are sensitive to climate change and may result in additional upgrade costs in the future if I/I mitigation programs are not implemented.

APPENDIX A
SOLUTIONS DETAILS

PA-1 Highpoint Avenue

2051 Conditions Solution- 25yr Results

2051 Conditions Solution- 25yr Results
PA-1 Highpoint Avenue
Cedar Trunk
Alternative 1

Legend

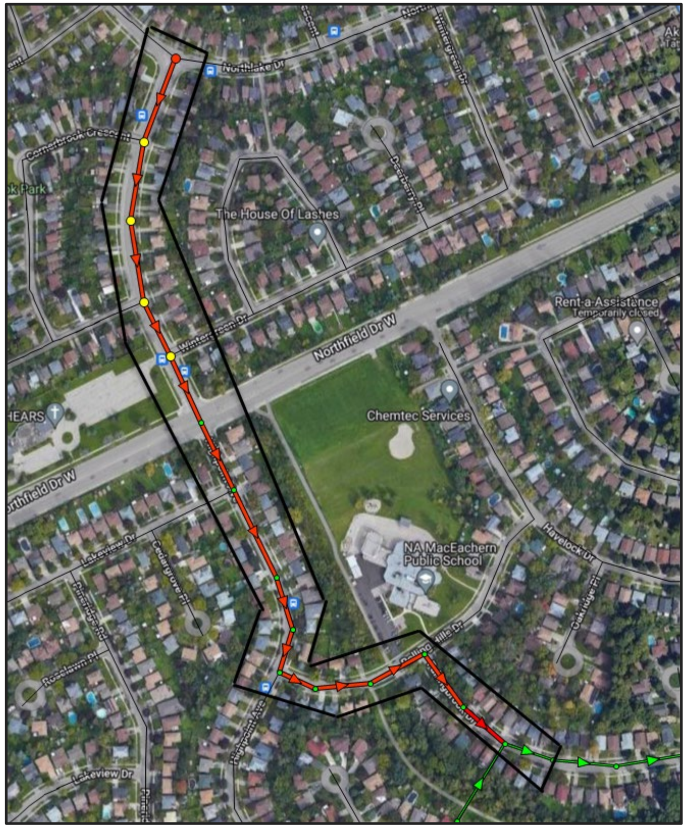
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

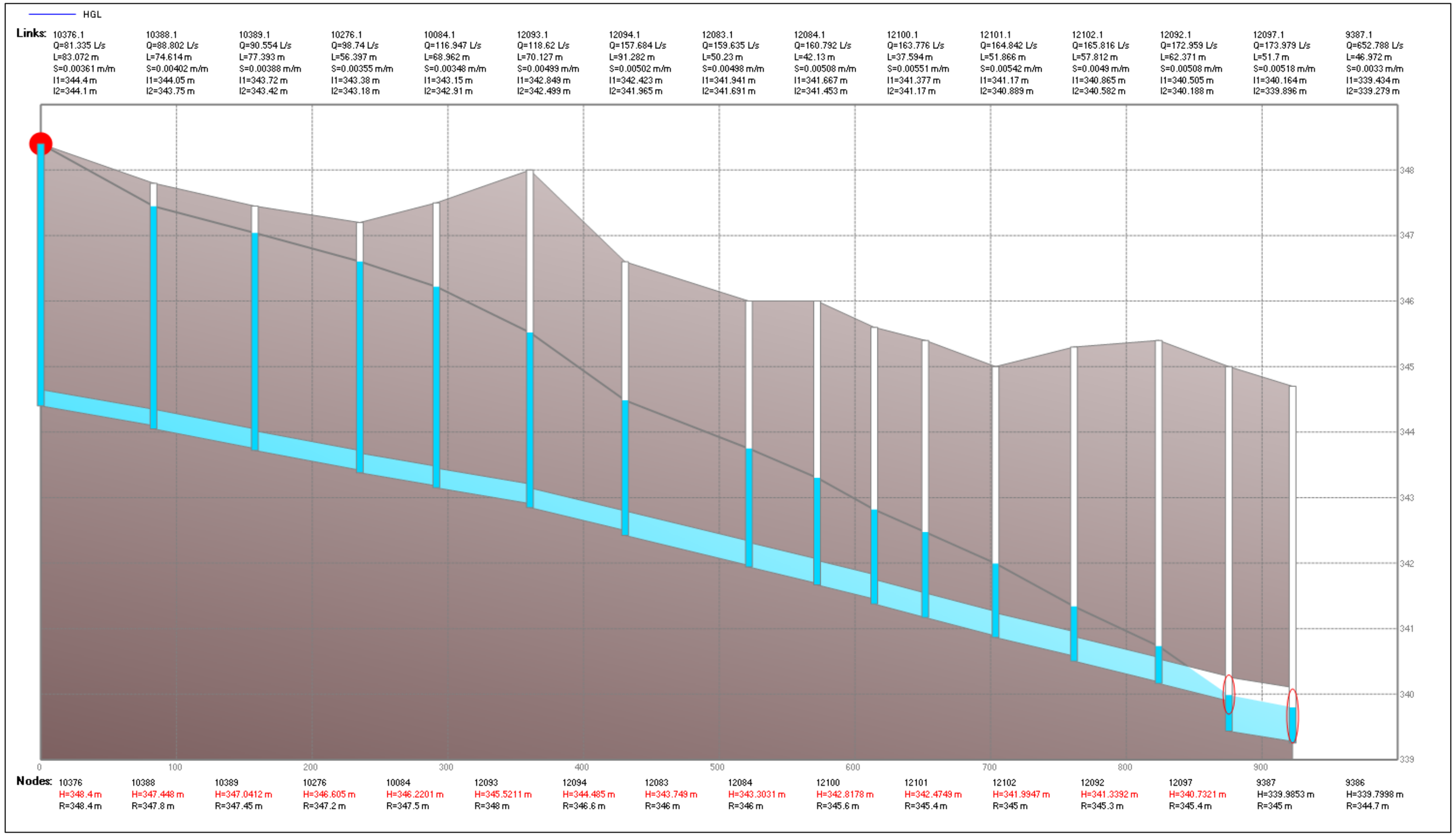
HGL Freeboard

- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions





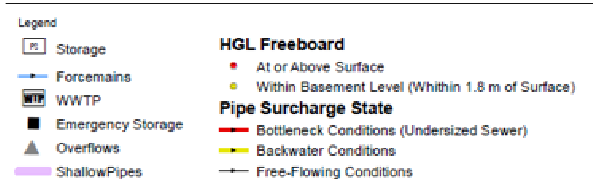
Note:

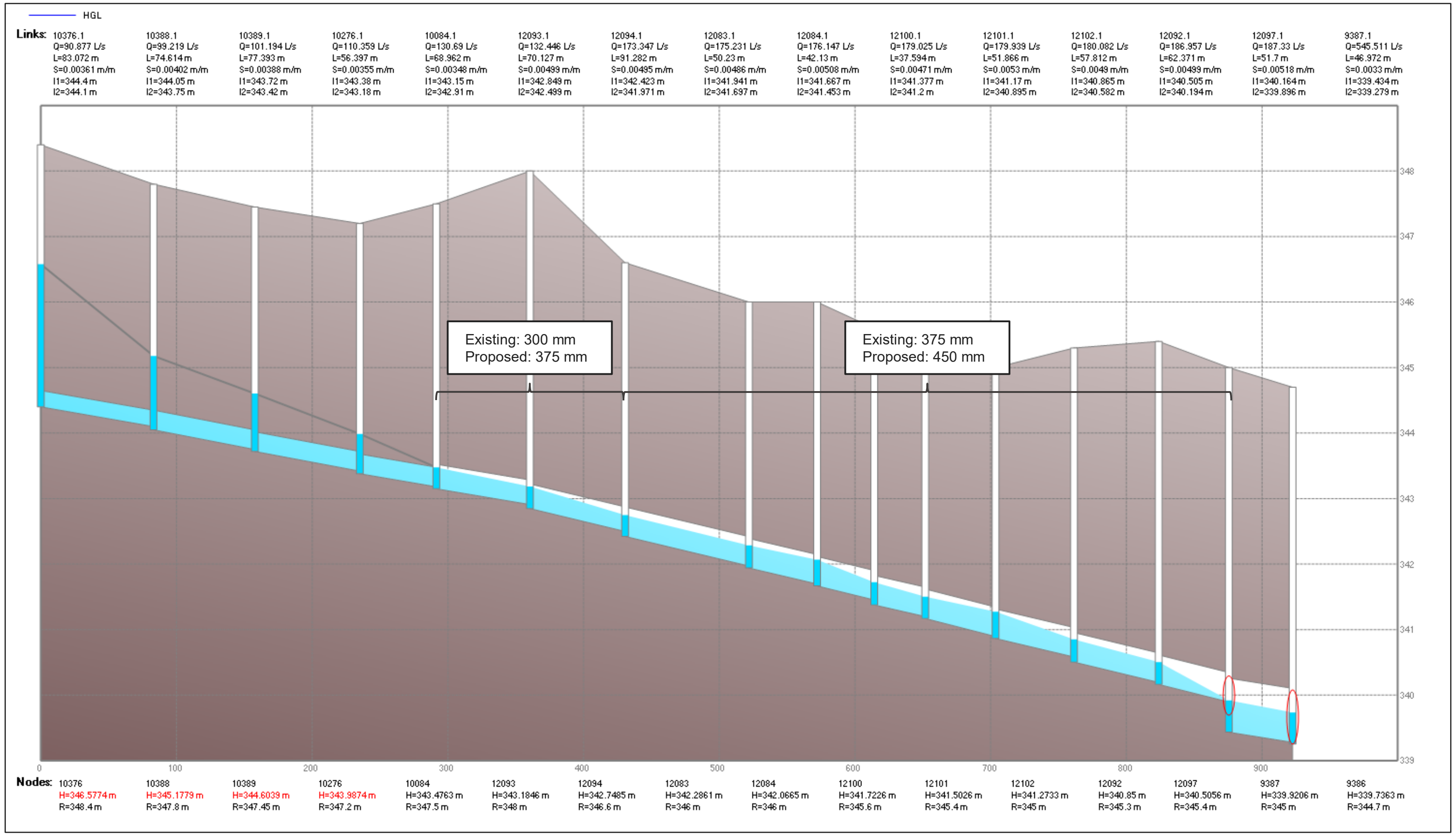
Undersized pipes on Cedar Trunk

Alternative 1:

Do Nothing; risk of basement flooding

2051 Conditions Solution- 25yr Results
PA-1 Highpoint Avenue
Cedar Trunk
Alternative 2





<u>Note:</u>

The pipes are surcharging in the 25yr event, but there is no HGL issues

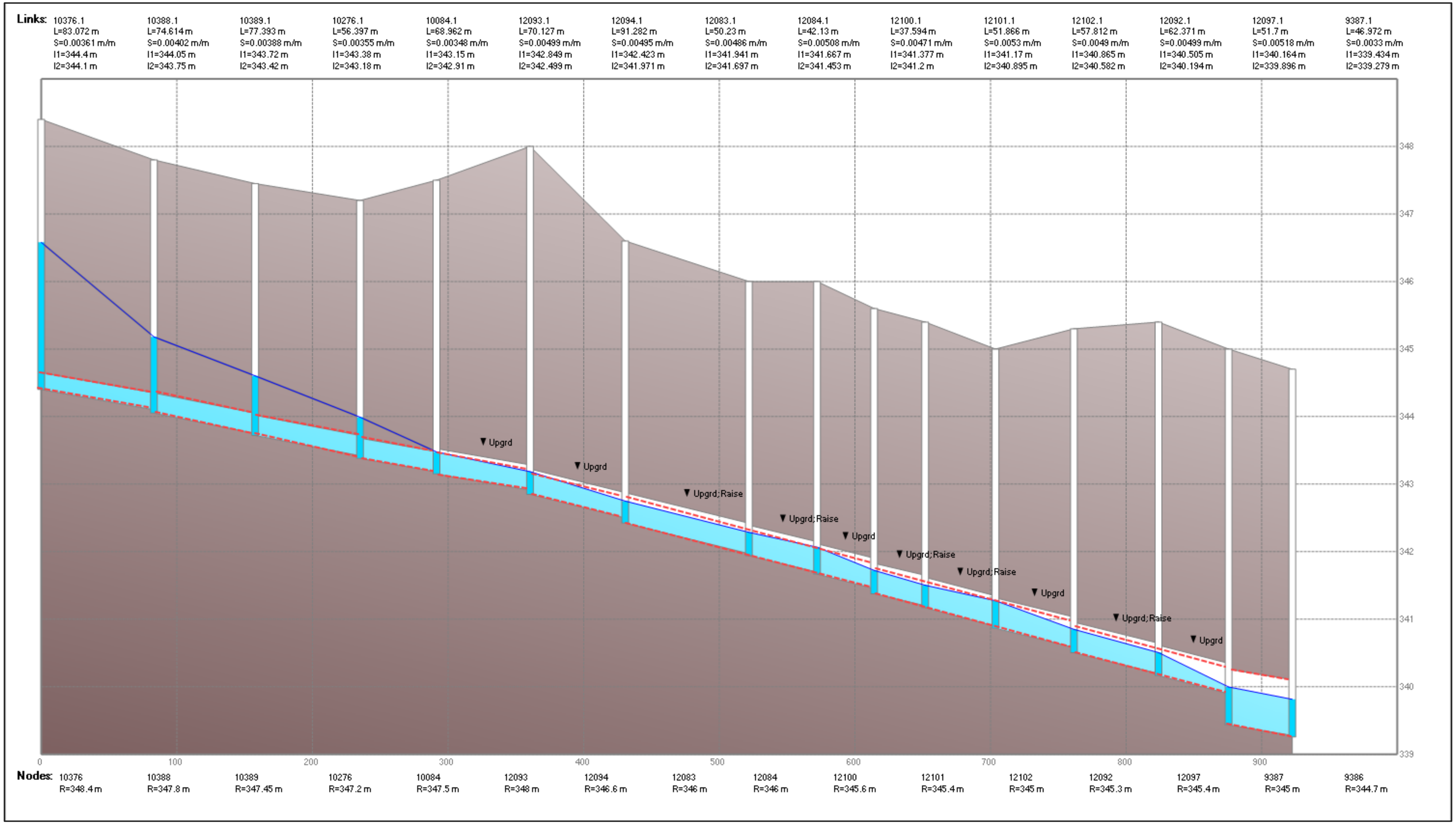
<u>Alternative 2 (Preferred Alternative):</u>

Replacement of 10 lengths of sewer - upsize 2 lengths of sewer from 300 mm diameter to 375 mm diameter sewer, and 8 lengths of sewer from 375 mm diameter to 450 mm diameter sewer

2051 Conditions Solution- 25yr Results

PA-1 Cedar
U/S of Highpoint Ave
Alternative 2 – Preferred Alternative

HGL
Existing Infrastructure
Proposed Upgrade



2051 Conditions Solution- 25yr Results
PA-1 Highpoint Avenue
Cedar Trunk
Alternative 3

Legend

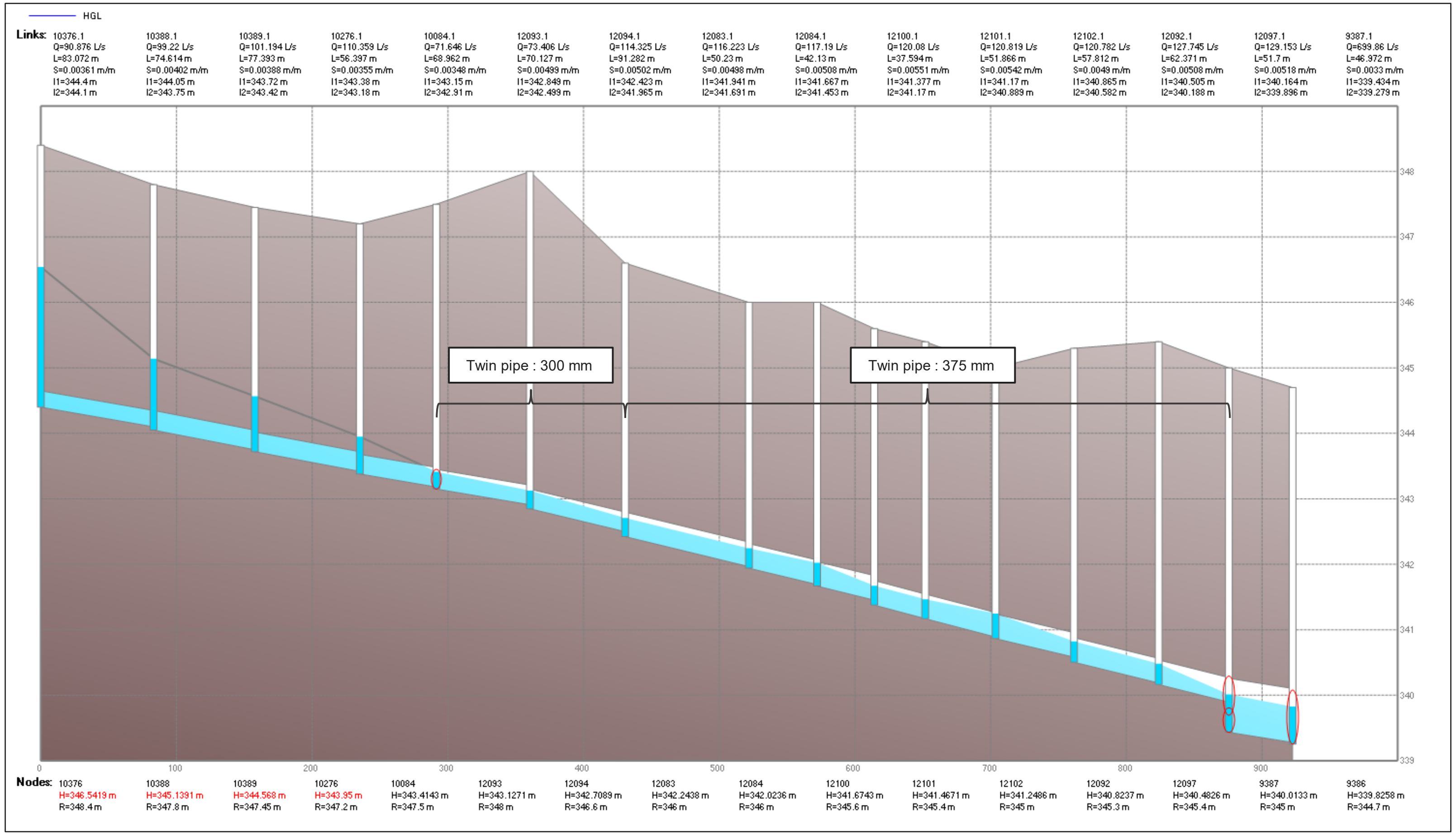
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

HGL Freeboard

- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions



Note:
The pipes are surcharging in the 25yr event, but there is no HGL issues

Alternative 3:
Twin Sewer (584 m) from Wintergreen Dr to the connection to the trunk sewer on Fallingbrook Dr

PA-2 Austin Drive

2051 Conditions Solution- 25yr Results

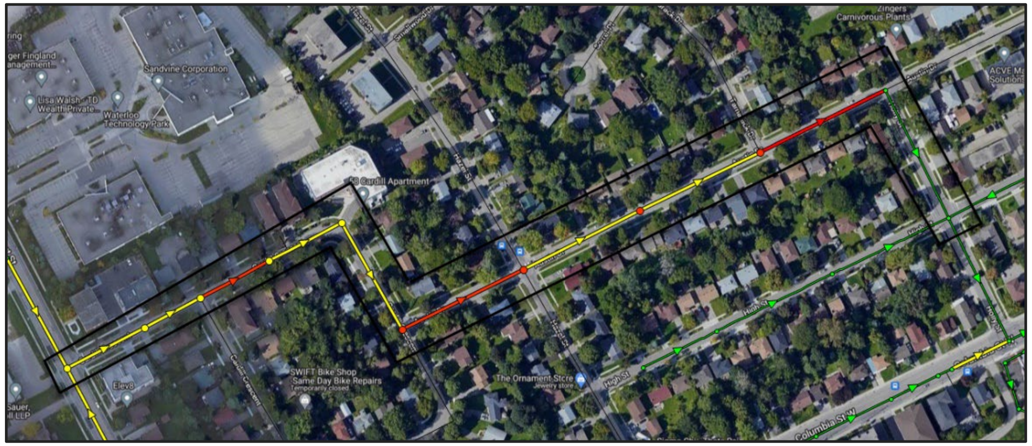
2051 Conditions Solution- 25yr Results

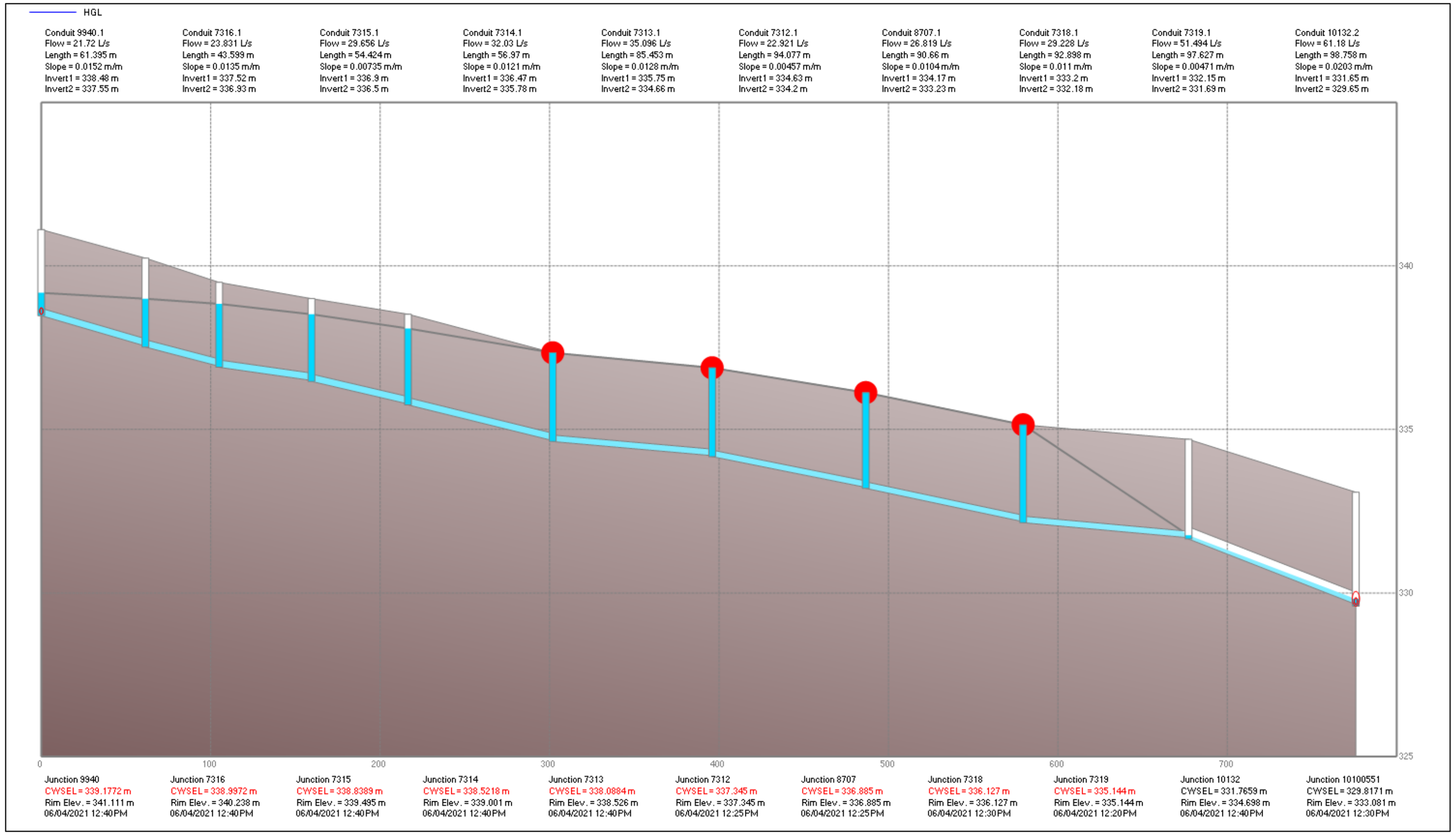
PA-2 Austin Drive
University
Alternative 1

Legend
Storage
Forcemains
WWTP
Emergency Storage
Overflows
ShallowPipes

HGL Freeboard
At or Above Surface
Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State
Bottleneck Conditions (Undersized Sewer)
Backwater Conditions
Free-Flowing Conditions





Note:
Undersized pipes

Alternative 1:

Do Nothing; risk of surface flooding

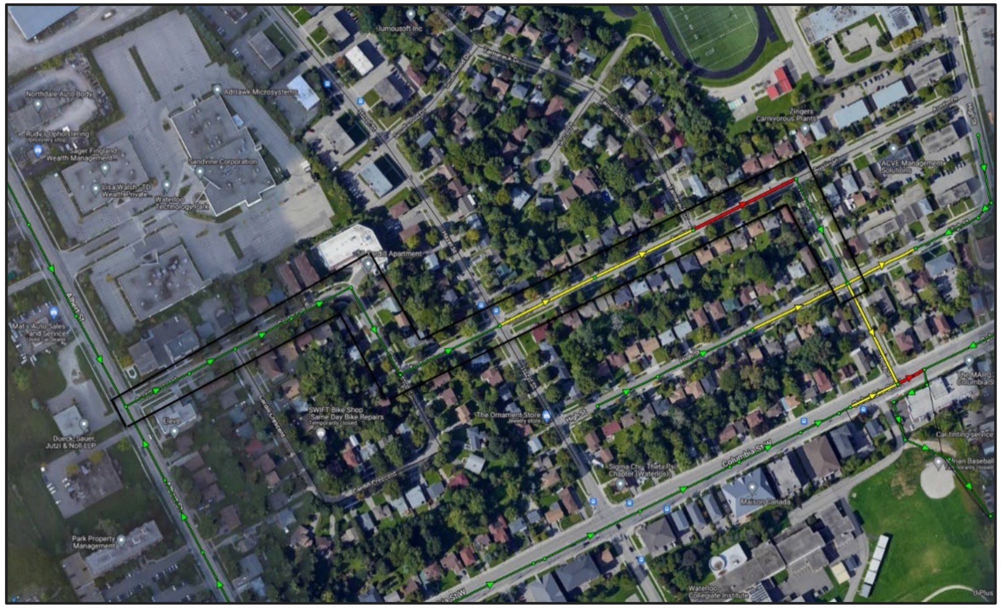
2051 Conditions Solution- 25yr Results

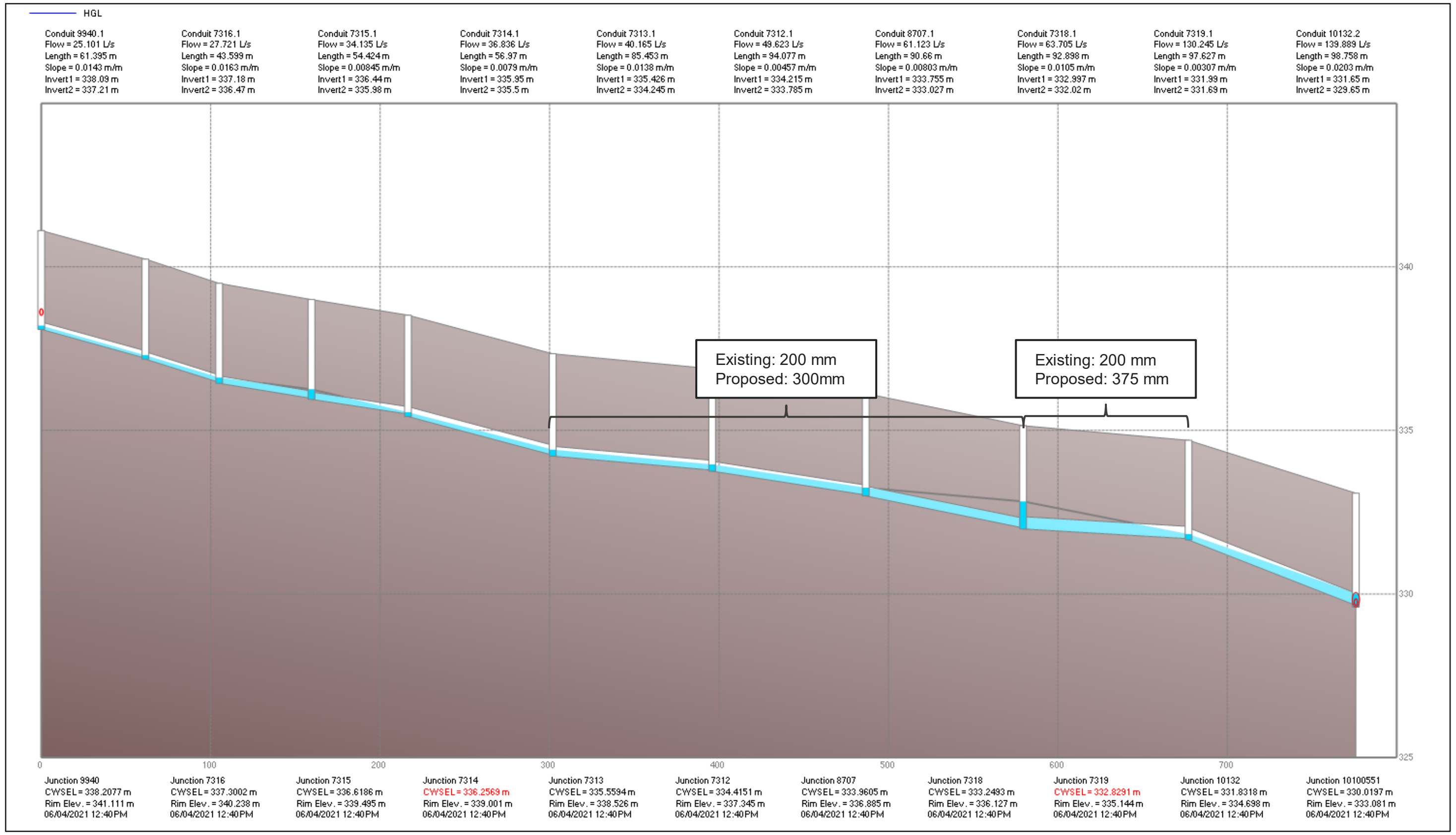
PA-2 Austin Drive
University
Alternative 2

Legend
Storage
Forcemains
WWTP
Emergency Storage
Overflows
ShallowPipes

HGL Freeboard
At or Above Surface
Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State
Bottleneck Conditions (Undersized Sewer)
Backwater Conditions
Free-Flowing Conditions





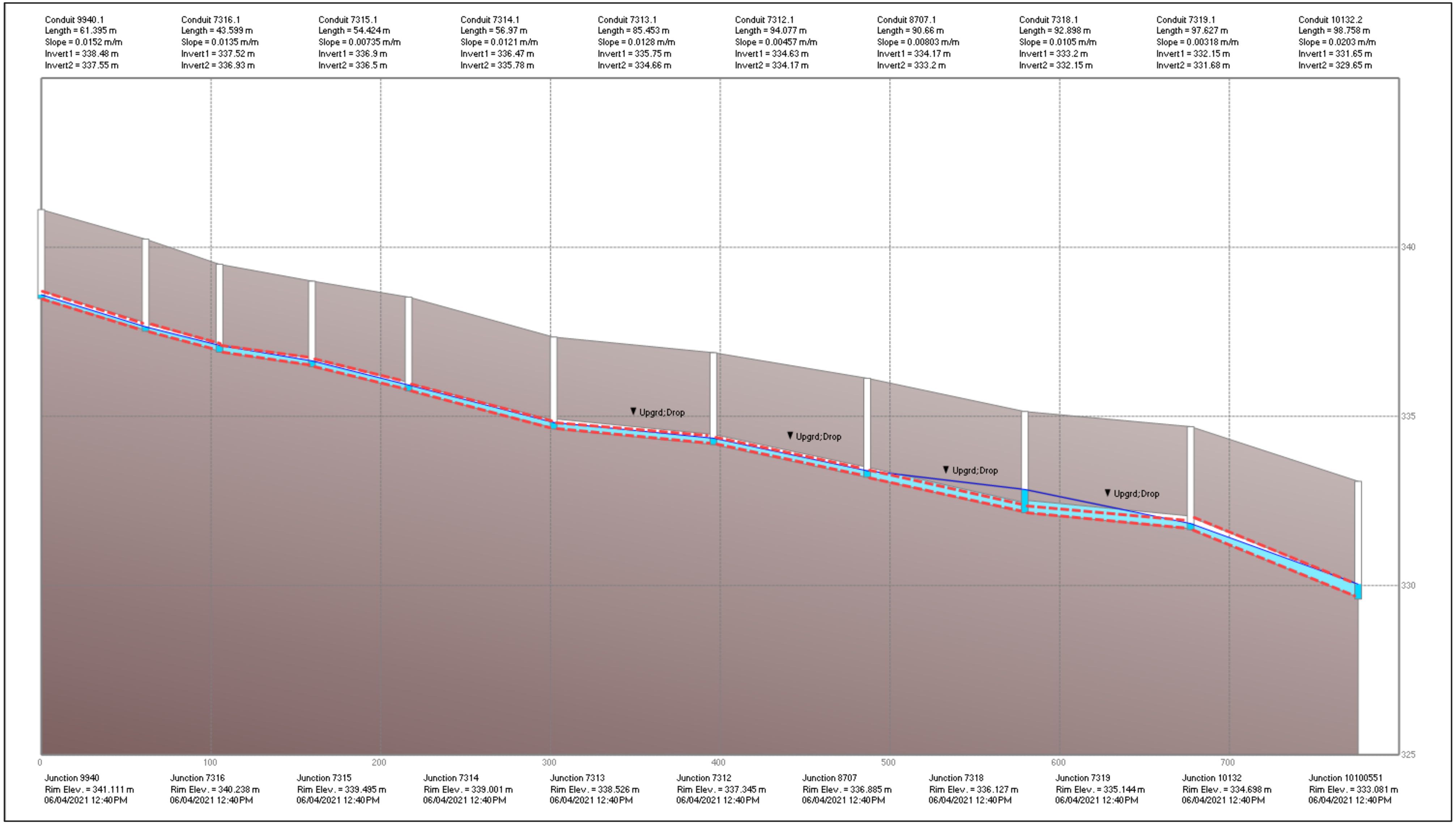
Note:
One pipe is still surcharging in the 25yr event, but there is no HGL issues

Alternative 2 (Preferred Alternative):
Replacement of 4 lengths of sewer - upsize 3 lengths of sewer from 200 mm diameter to 300 mm diameter sewer, and 1 length of sewer from 200 mm diameter to 375 mm diameter sewer

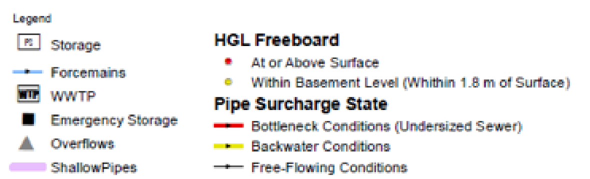
2051 Conditions Solution- 25yr Results

PA-2 University
Austin Dr
Alternative 2 – Preferred Alternative

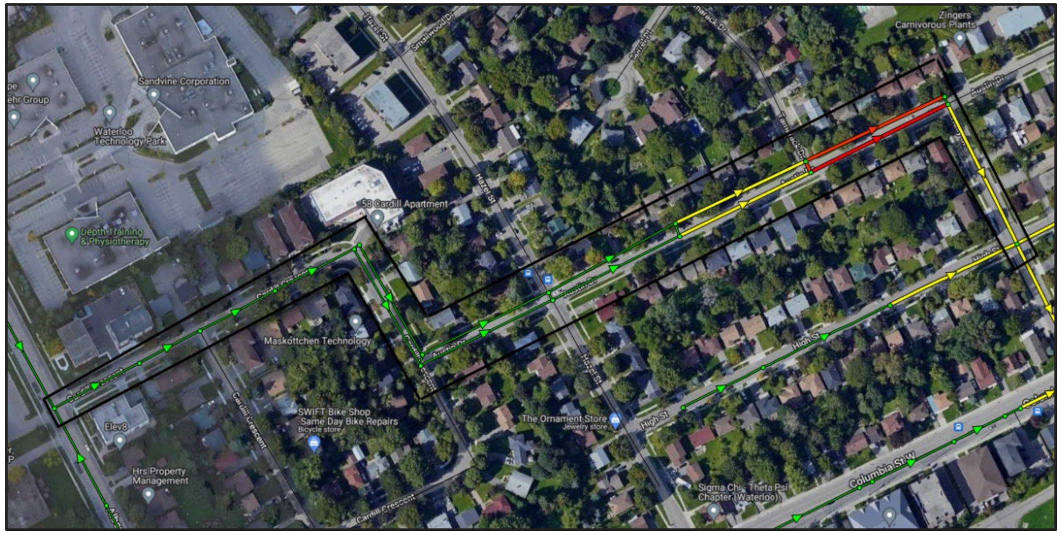
HGL
Existing Infrastructure
Proposed Upgrade

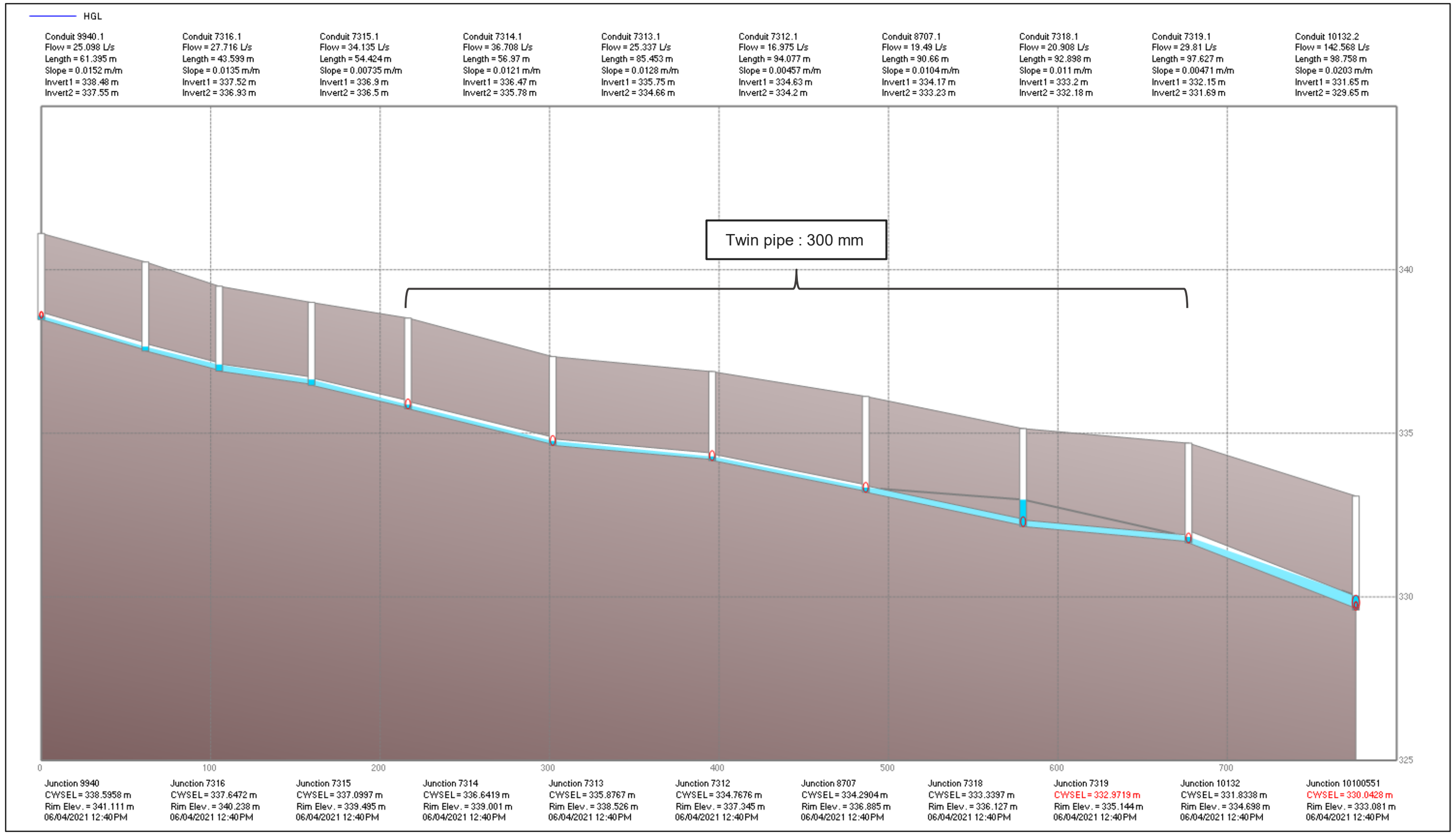


2051 Conditions Solution- 25yr Results



PA-2 Austin Drive
University
Alternative 3





<u>Note:</u>
Pipes are still surcharging in the 25yr event, but there is no HGL issues

<u>Alternative 3:</u>
Twin Sewer (461 m) from Cardill Crescent to Holly St

PA-3 Lodge Street

2051 Conditions Solution- 25yr Results

2051 Conditions Solution- 25yr Results
PA-3 Lodge Street
Laurel 2
Alternative 1

Legend

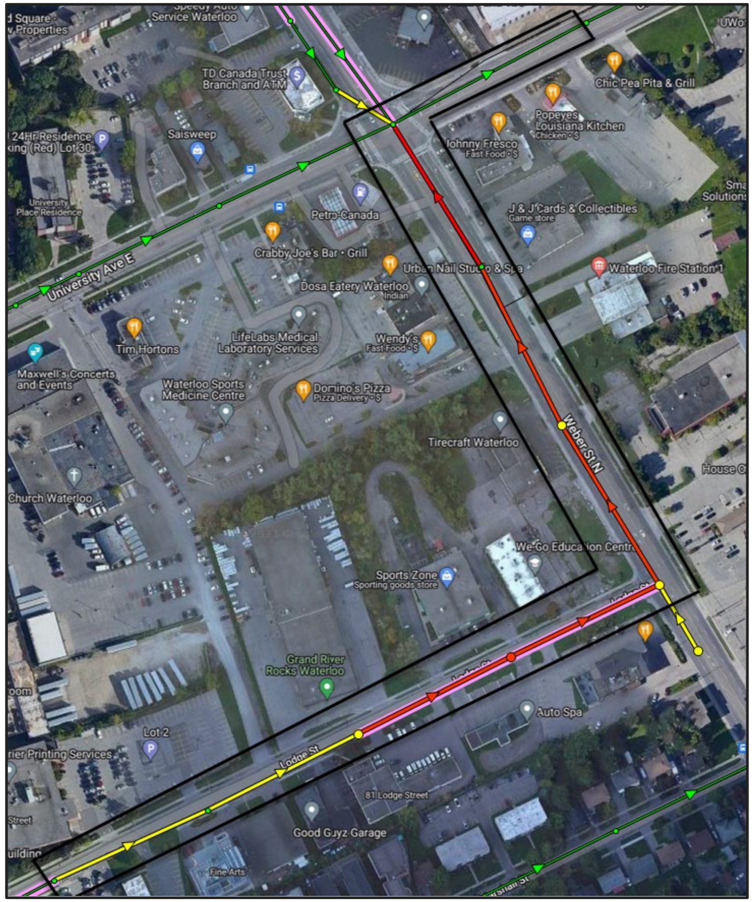
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

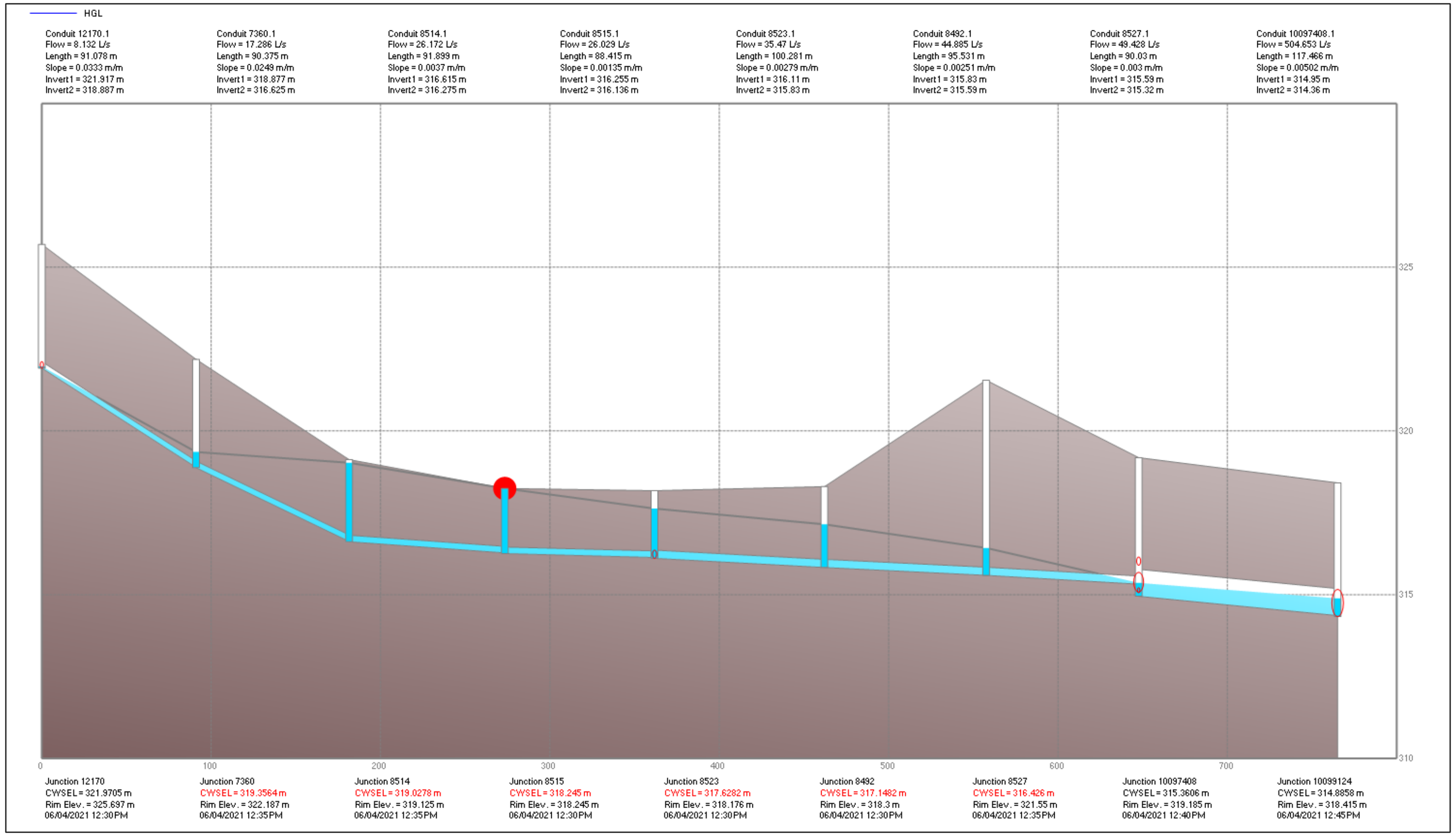
HGL Freeboard

- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions





Note:

Undersized pipes; shallow sewer

Alternative 1:

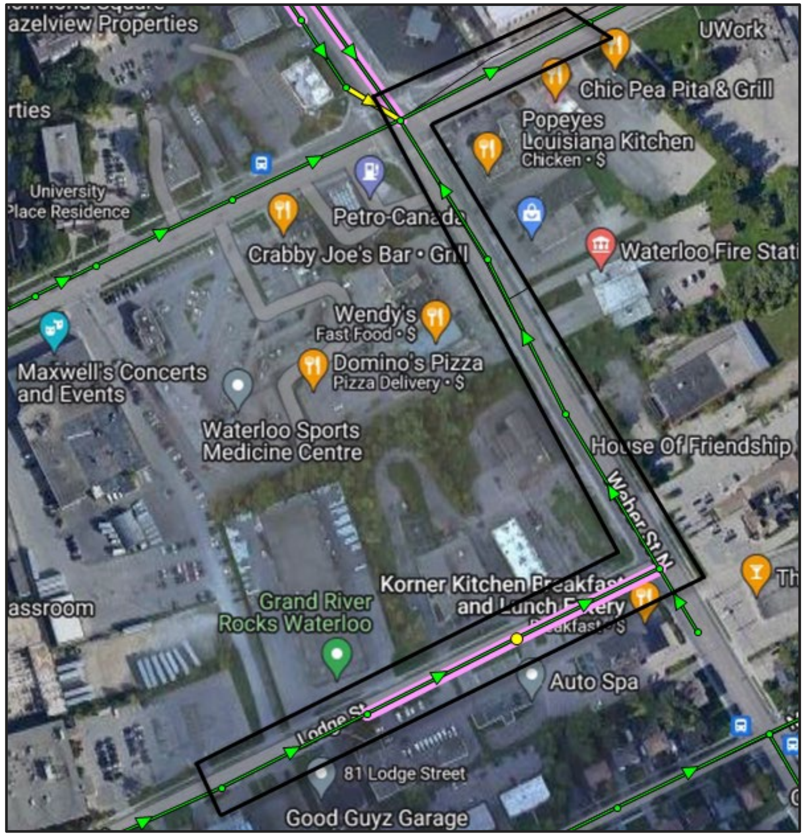
Do Nothing; risk of surface flooding

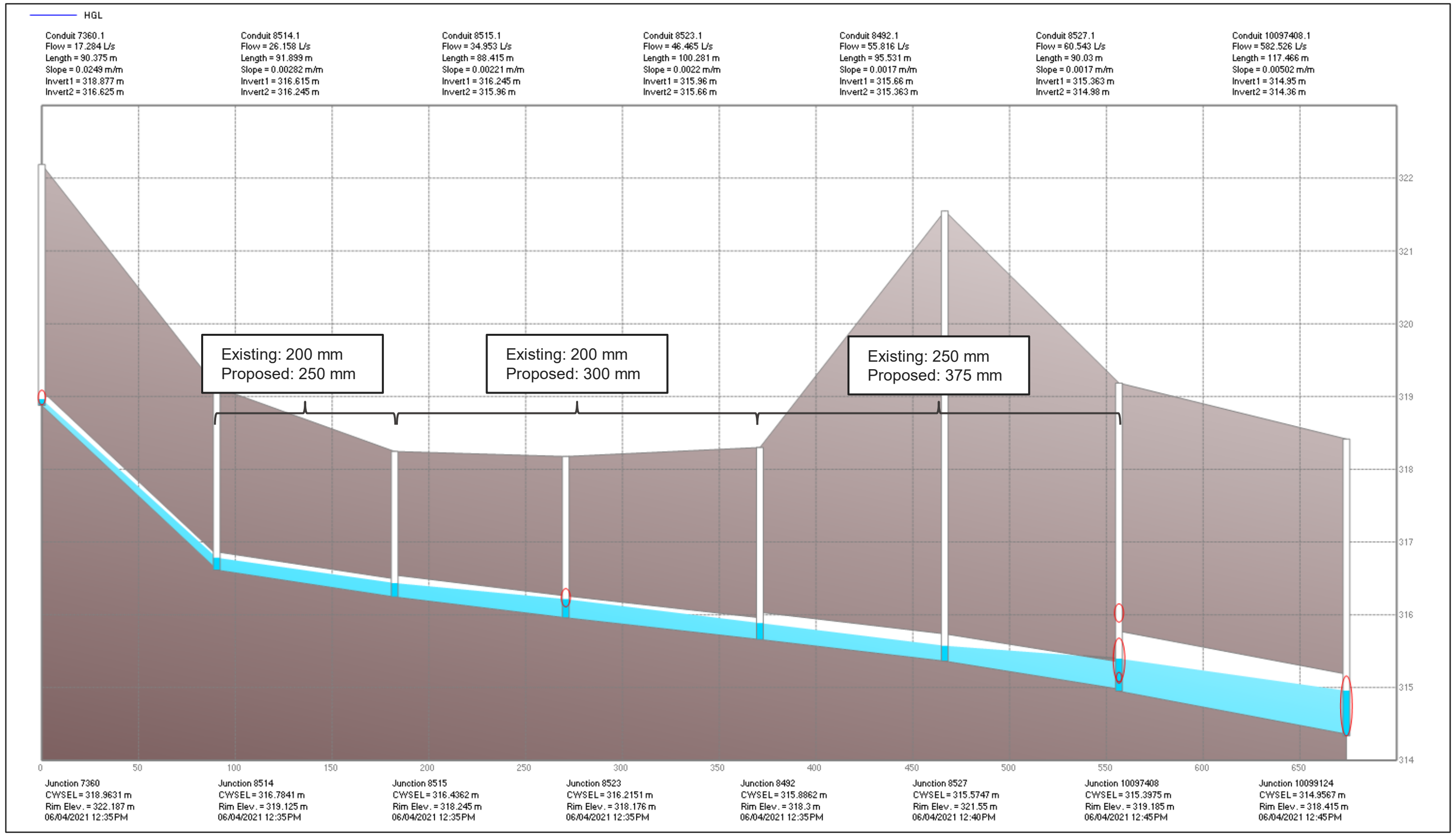
2051 Conditions Solution- 25yr Results
PA-3 Lodge Street
Laurel 2
Alternative 2

Legend
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

HGL Freeboard
- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State
- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions





Note:

The pipes are free-flowing, the remaining HGL issue is due to Shallow pipes

Alternative 2 (Preferred Alternative):

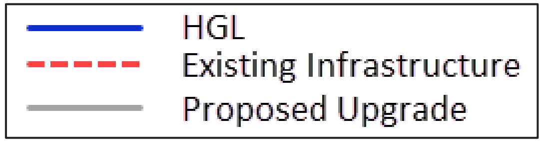
Replacement of 5 lengths of sewer - upsize 1 length of sewer from 200 mm diameter to 250 mm diameter sewer, 2 lengths of sewer from 200 mm diameter to 300 mm diameter sewer, and 2 lengths of sewer from 250 mm diameter to 375 mm diameter sewer

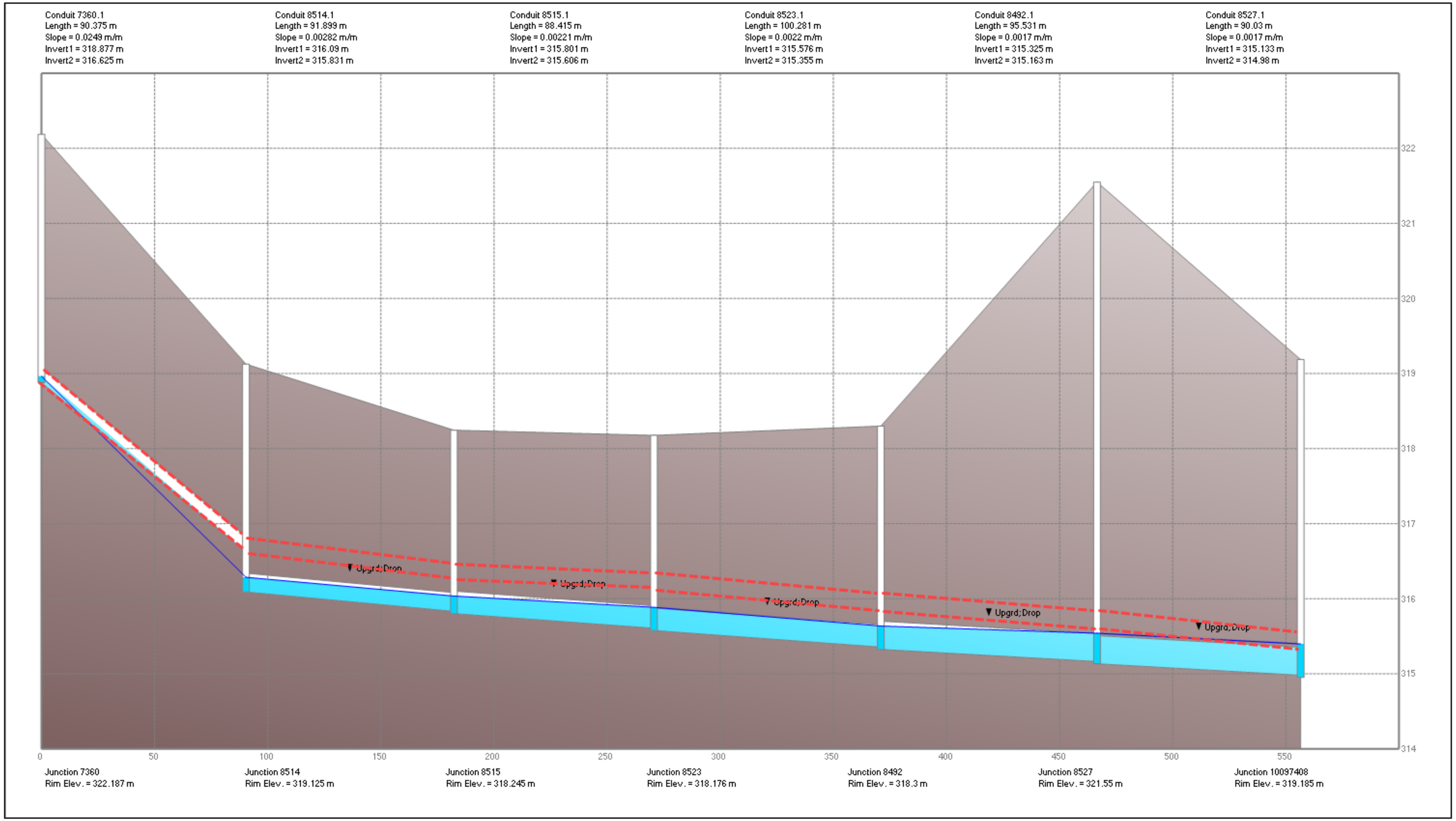
2051 Conditions Solution- 25yr Results

PA-3 Laurel 2

Lodge St / Weber St N

Alternative 2 – Preferred Alternative





2051 Conditions Solution- 25yr Results
PA-3 Lodge Street
Laurel 2
Alternative 3

Legend

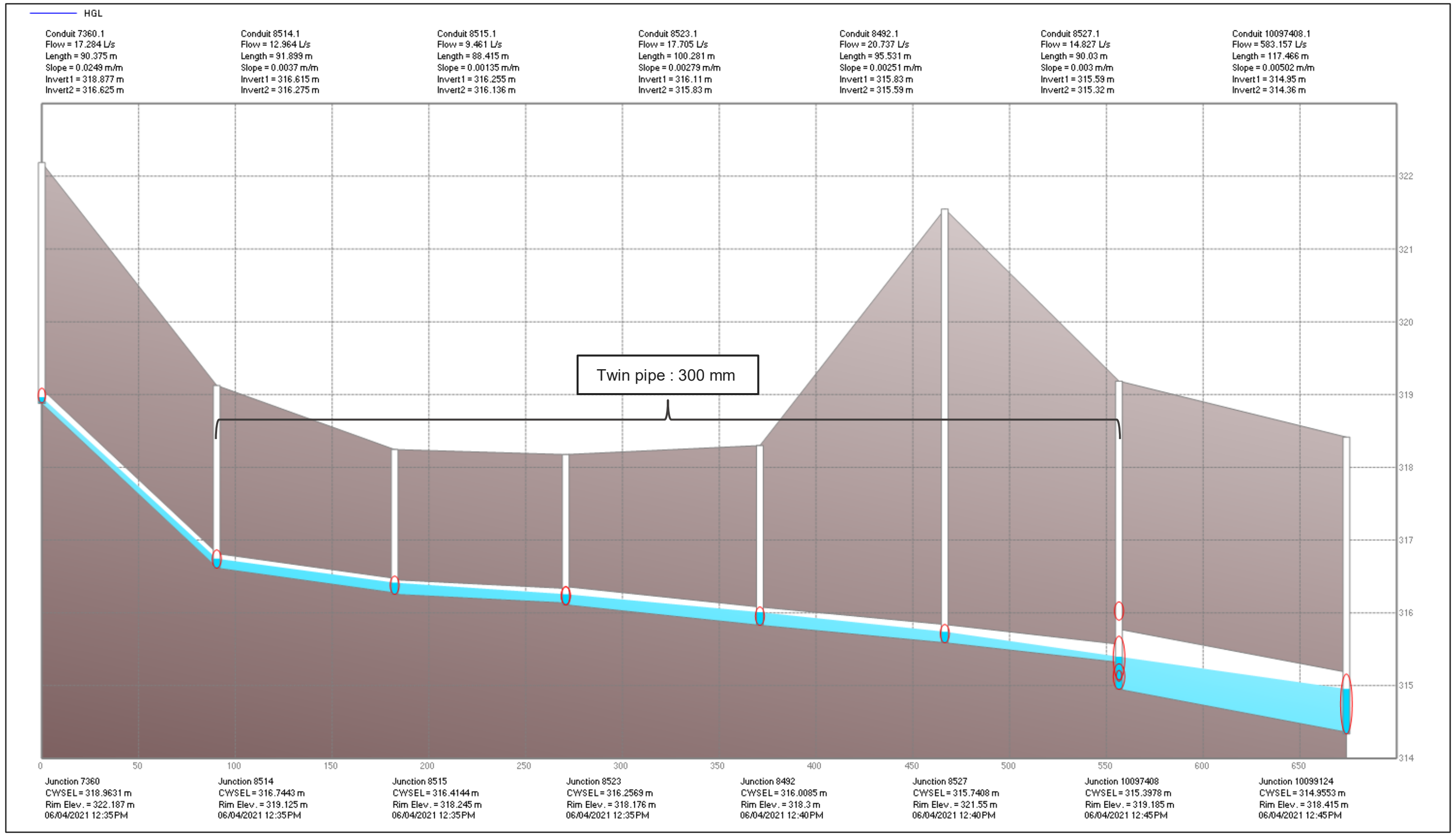
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

HGL Freeboard

- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions



Note:

The downstream pipe is still surcharging in the 25yr event, but there is no HGL issues

Alternative 3:

Twin Sewer (466 m) from Lodge St to the trunk connection on University Ave E

PA-4 Thorndale Drive & Westvale Drive

2051 Conditions Solution- 25yr Results

2051 Conditions Solution- 25yr Results

PA-4 Thorndale Drive & Westvale Drive
Maple Hill Creek
Alternative 1

Legend

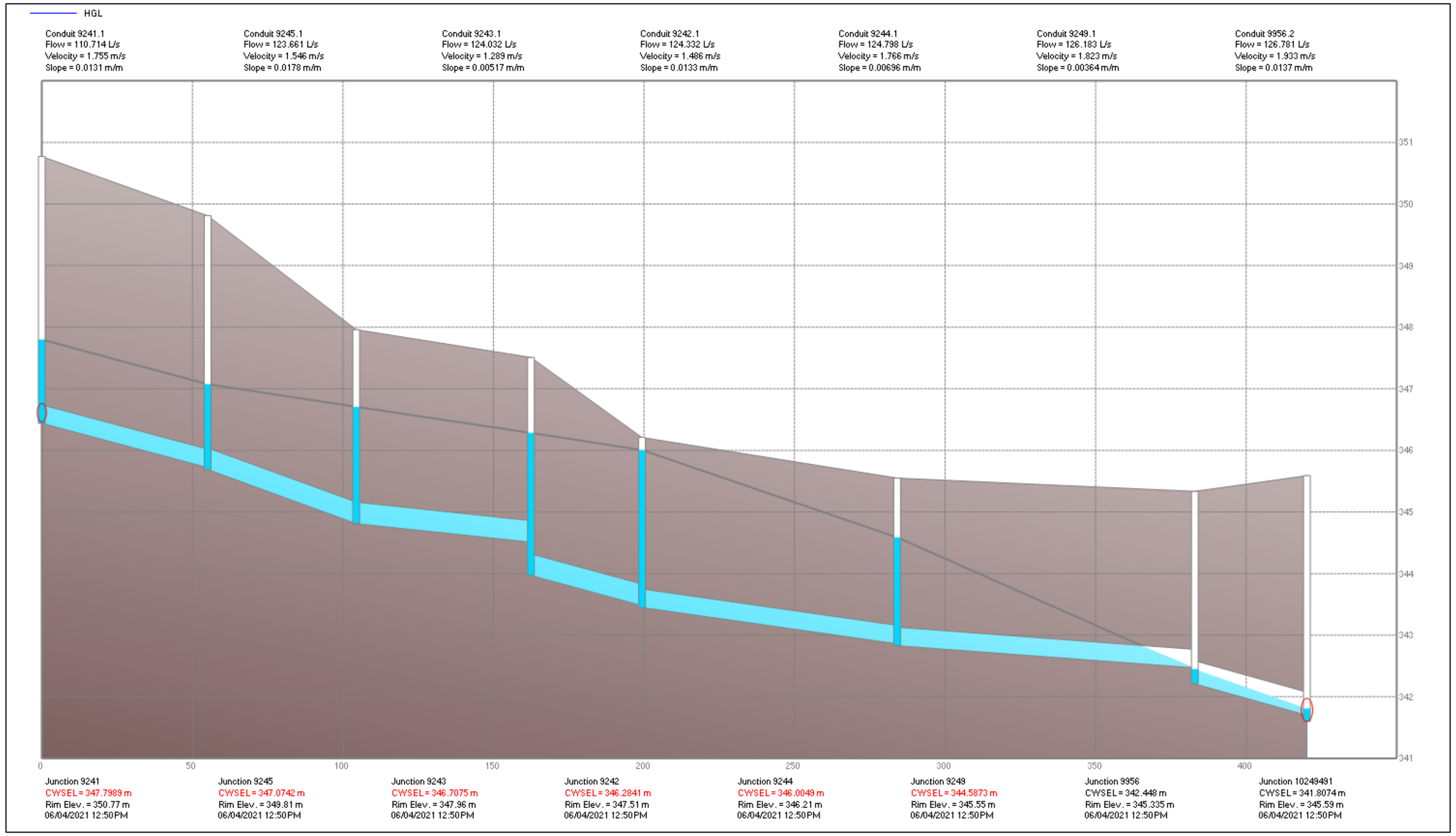
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

HGL Freeboard

- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions



Note:

Undersized pipes outside of ROW (with updated elevation form survey results for the weir at Thorndale/Westvale)

Alternative 1:

Do Nothing; risk of surface flooding

PA-4 Thorndale Drive & Westvale Drive

Maple Hill Creek

Concrete Weir

Legend

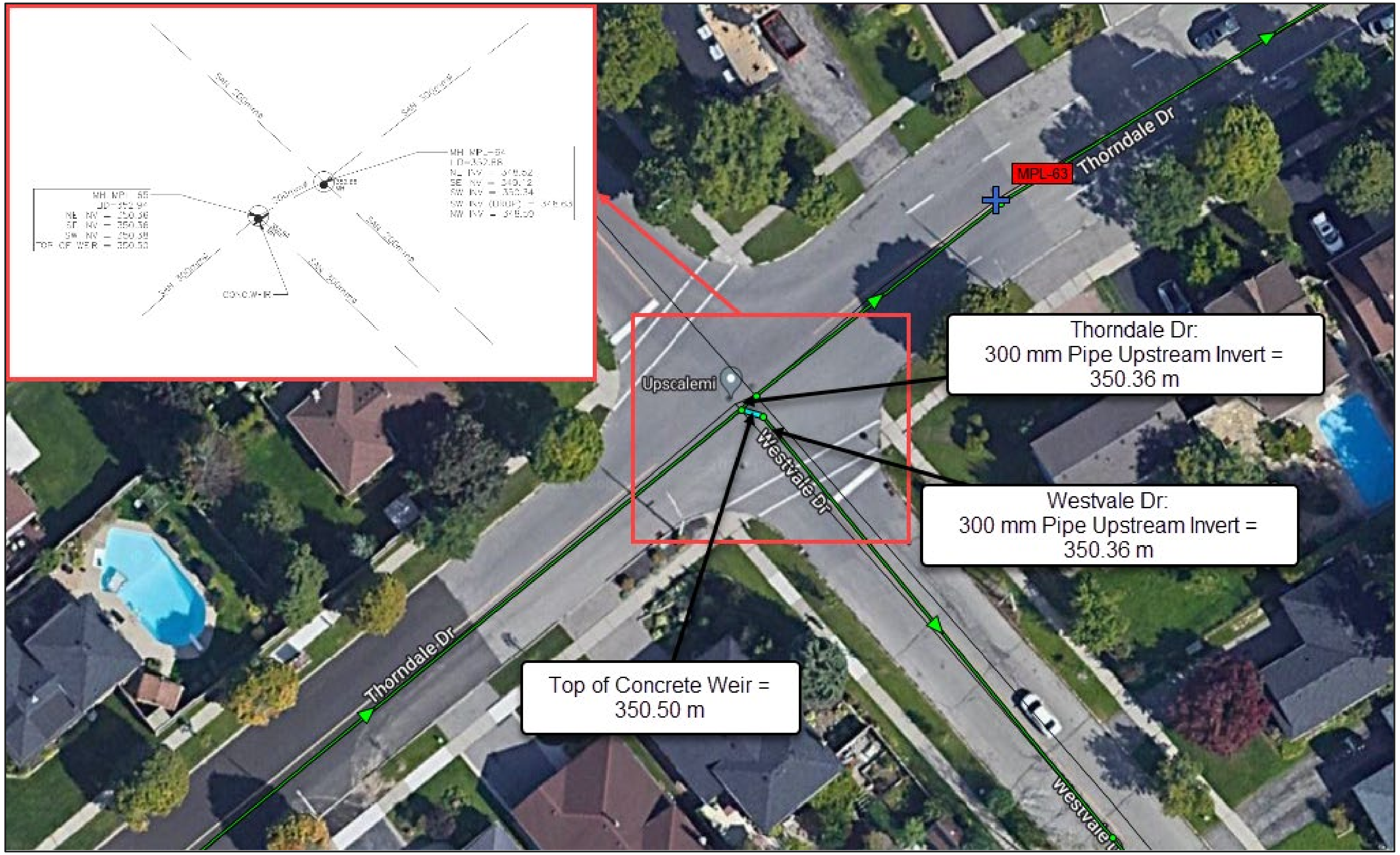
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

HGL Freeboard

- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions



Note:
Existing concrete weir configuration

2051 Conditions Solution- 25yr Results

PA-4 Thorndale Drive & Westvale Drive
Maple Hill Creek
Alternative 2

Legend

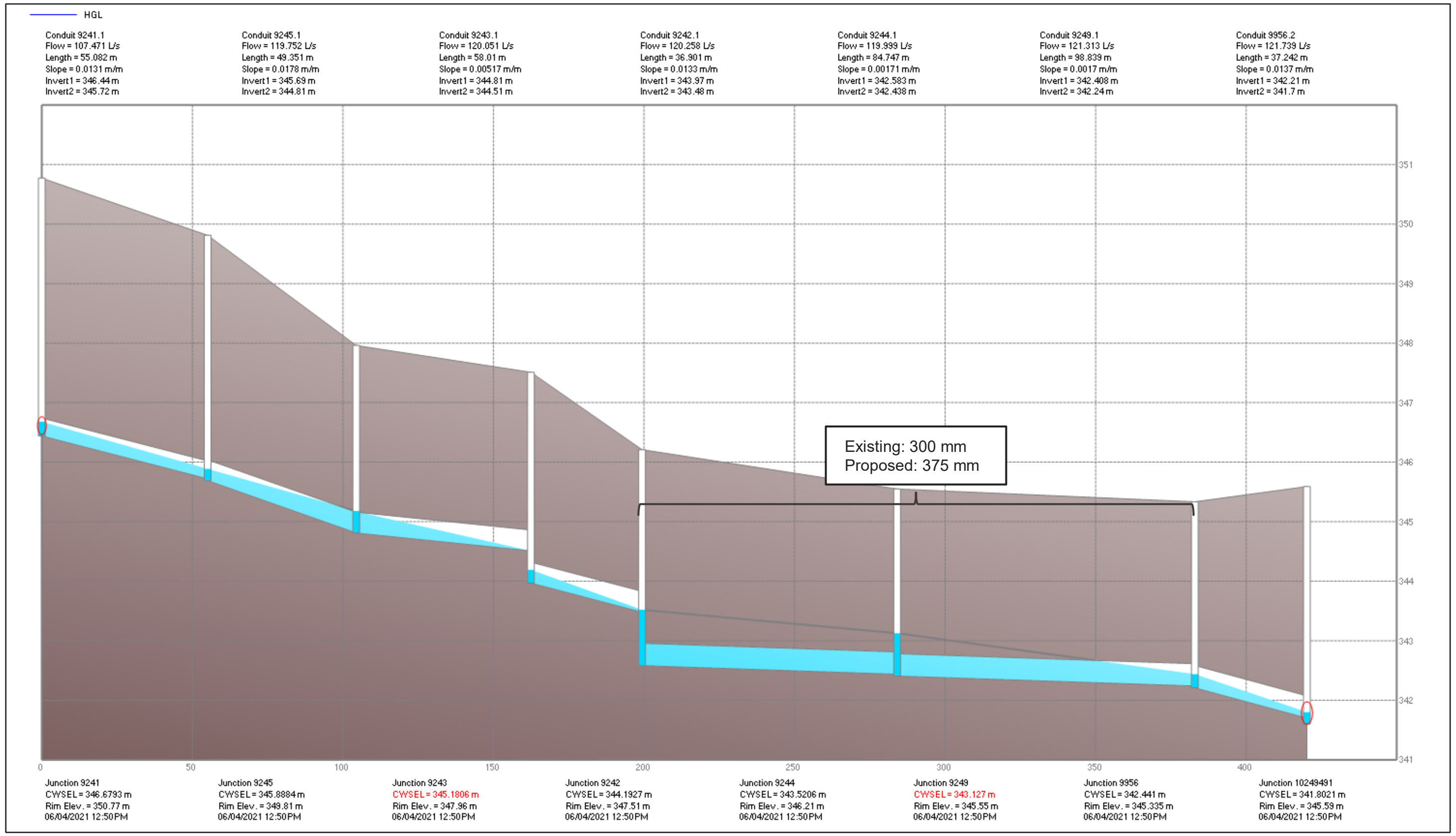
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

HGL Freeboard

- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions



<u>Note:</u>

Pipes recommended for upgrade are on private property parcels

<u>Alternative 2:</u>

Upgrade and reprofile 2 pipes. There is uncertainties regarding the flow split at the U/S and D/S of the weir.

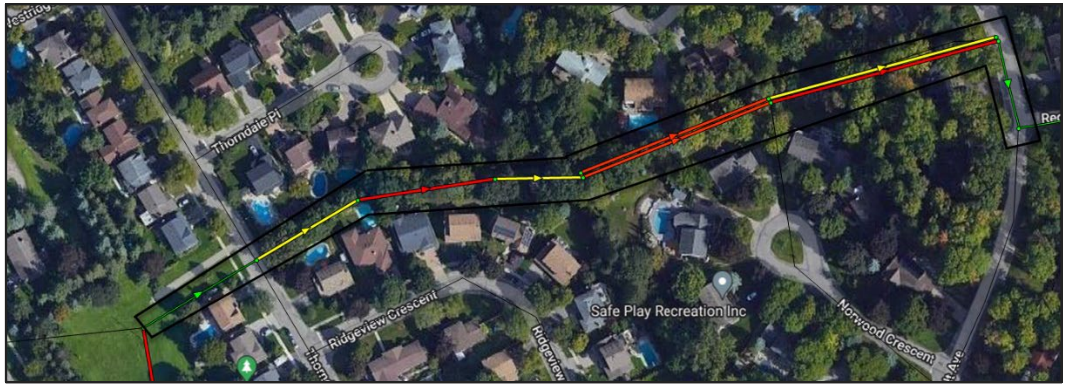
2051 Conditions Solution- 25yr Results

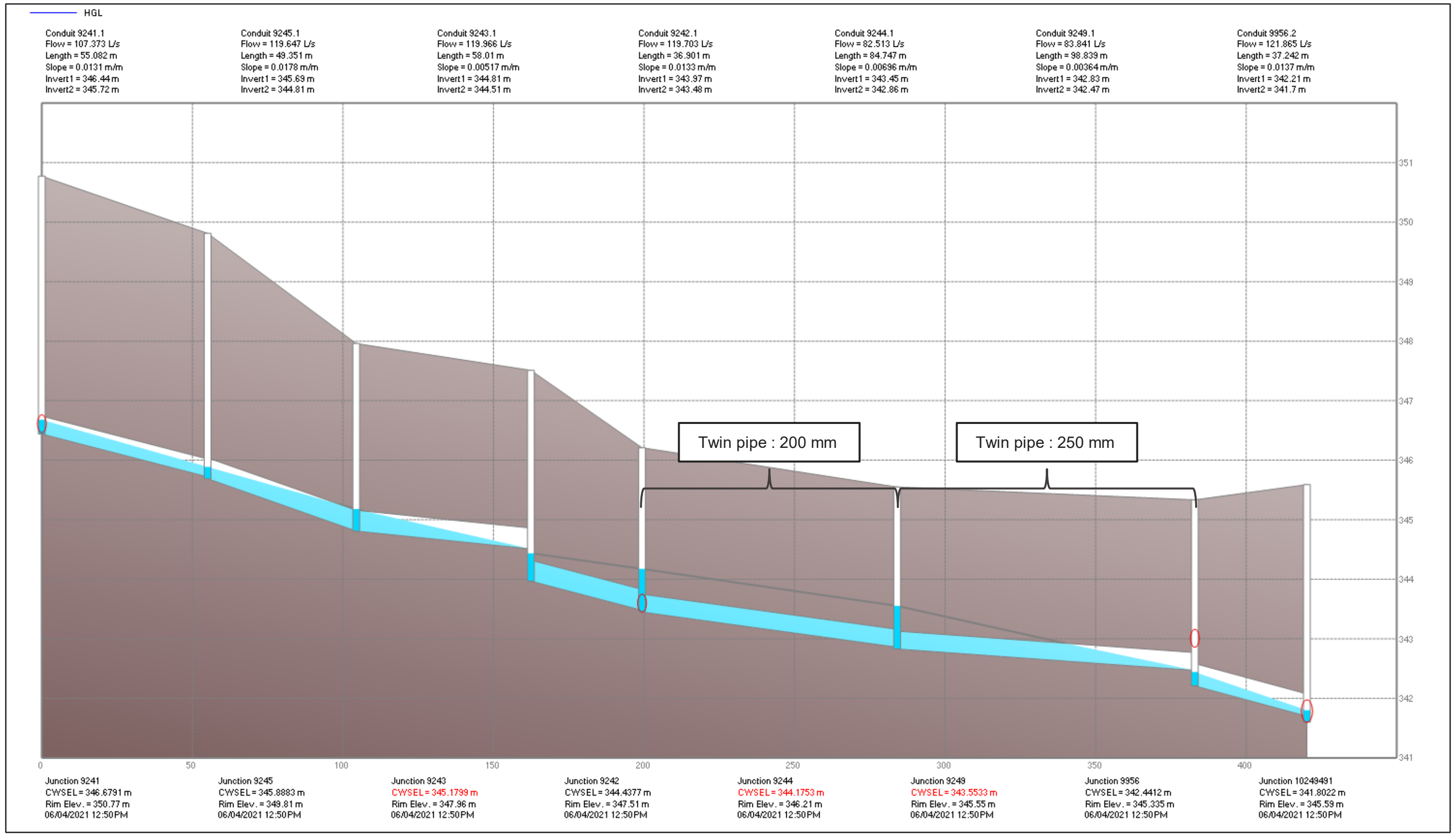
PA-4 Thorndale Drive & Westvale Drive
Maple Hill Creek
Alternative 3

Legend
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

HGL Freeboard
- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State
- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions





Note:
Twin sewer recommended are on private property parcels

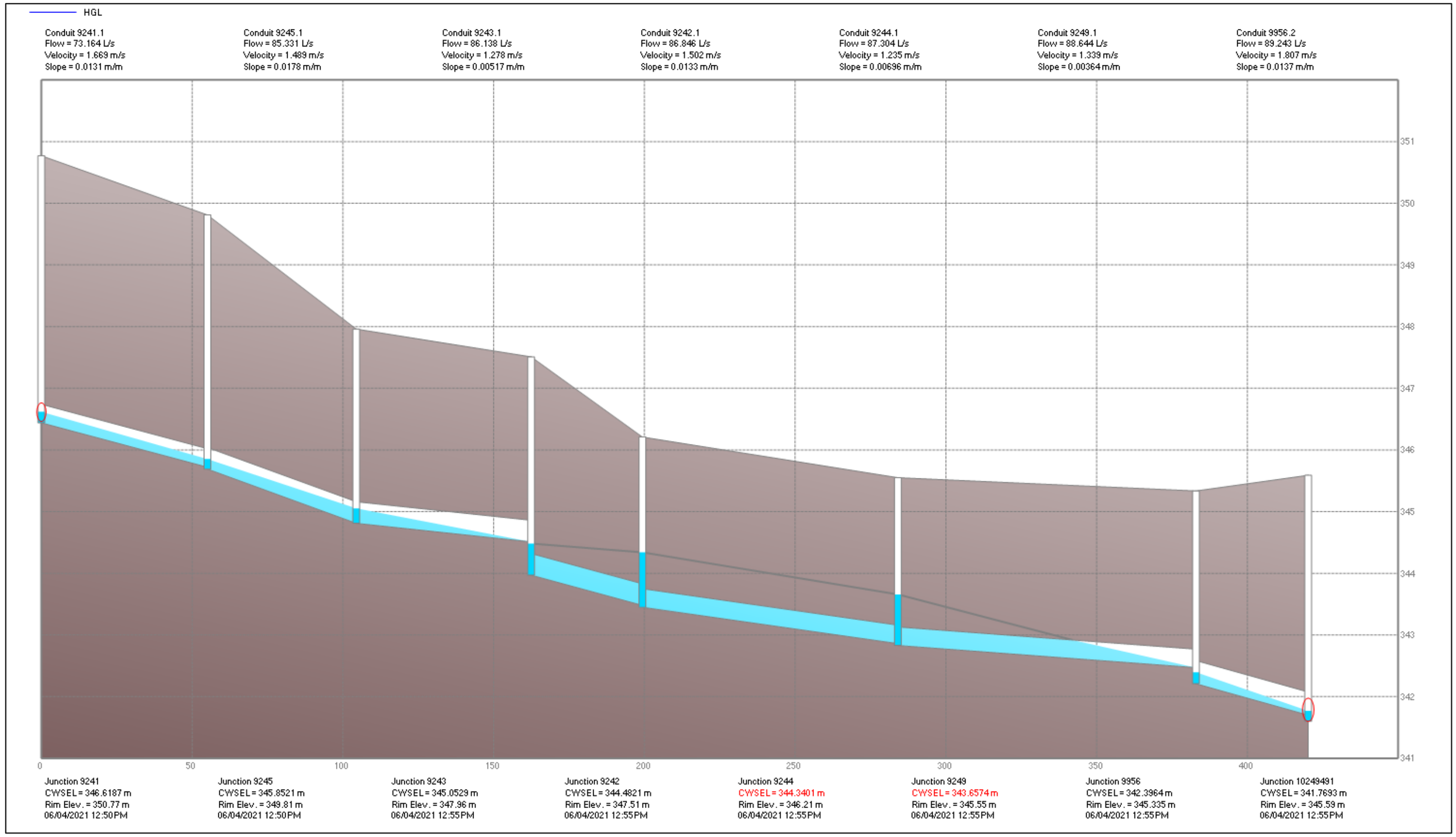
Alternative 3:
Twin Sewer (184 m) on private property parcels

2051 Conditions Solution- 25yr Results

PA-4 Thorndale Drive & Westvale Drive
Maple Hill Creek
Alternative 4 (1 of 2)

Legend

Storage		**HGL Freeboard**	
Forcemains		At or Above Surface	
WWTP		Within Basement Level (Whithin 1.8 m of Surface)	
Emergency Storage		**Pipe Surcharge State**	
Overflows		Bottleneck Conditions (Undersized Sewer)	
ShallowPipes		Backwater Conditions	
		Free-Flowing Conditions	



<u>Note:</u>

There is uncertainties regarding the flow split at the U/S and D/S of the weir

<u>Alternative 4 (Preferred Alternative):</u>

Re-bench weir at MH MPL-65 (i.e., remove weir U/S of Westvale Dr sewer, and add weir U/S of Thorndale Dr Sewer)

2051 Conditions Solution- 25yr Results

PA-4 Thorndale Drive & Westvale Drive
Maple Hill Creek
Alternative 4 (2 of 2)

Legend

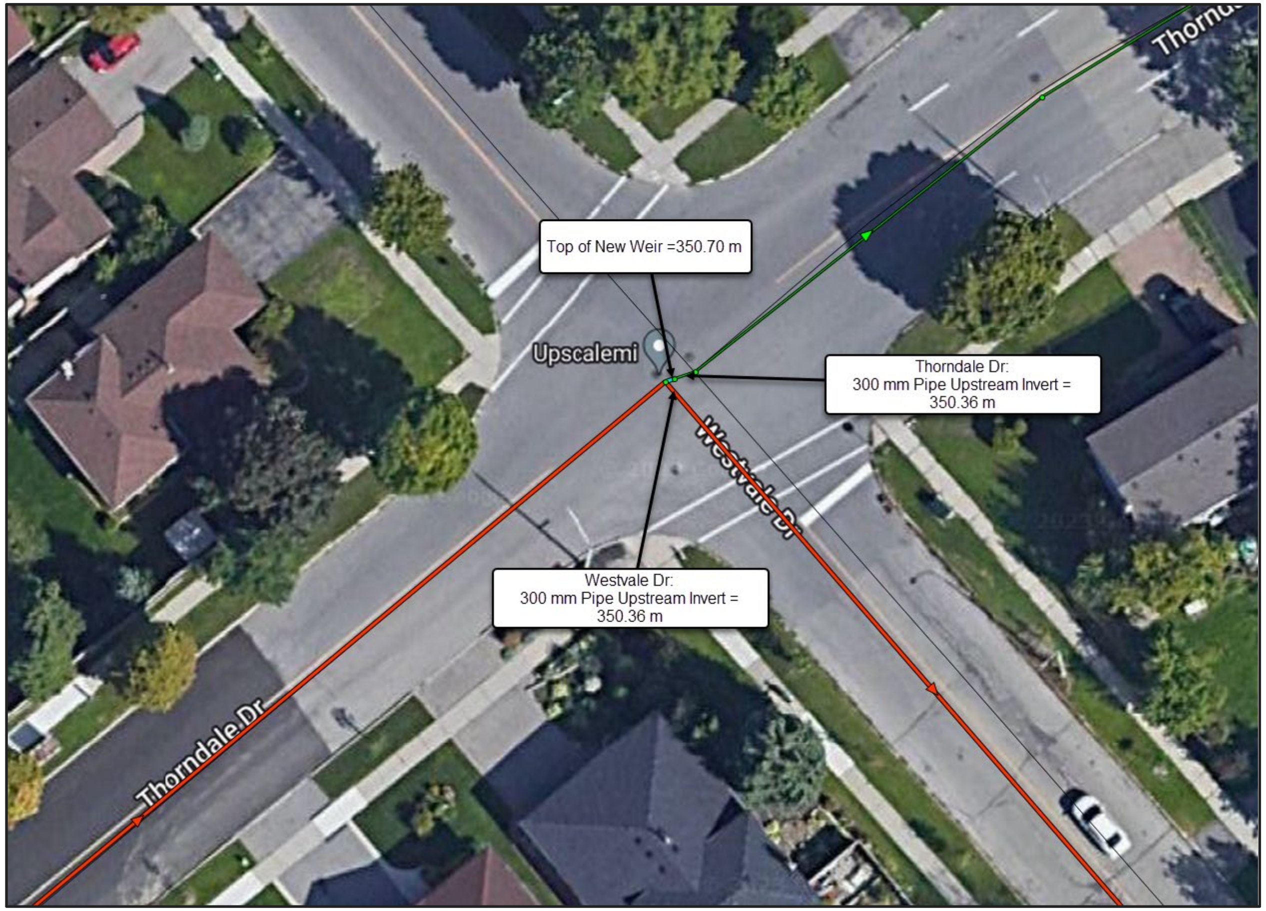
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

HGL Freeboard

- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions



Note:
There is uncertainties regarding the flow split at the U/S and D/S of the weir

Alternative 4 (Preferred Alternative):
Re-bench weir at MH MPL-65 (i.e., remove weir U/S of Westvale Dr sewer, and add weir U/S of Thorndale Dr Sewer)

PA-5 Weber Street North

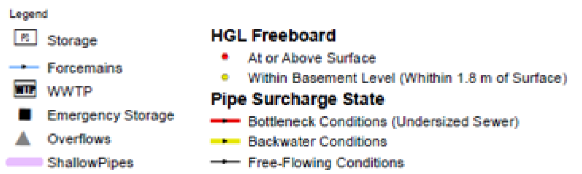
2051 Conditions Solution- 25yr Results

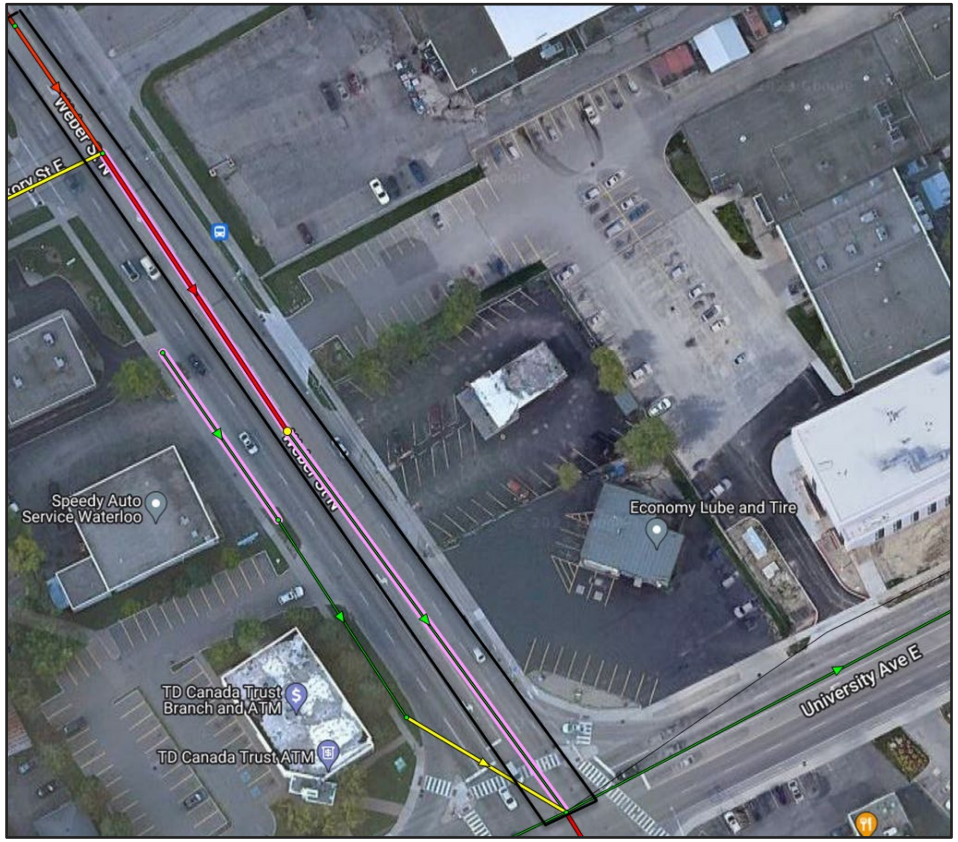
2051 Conditions Solution- 25yr Results

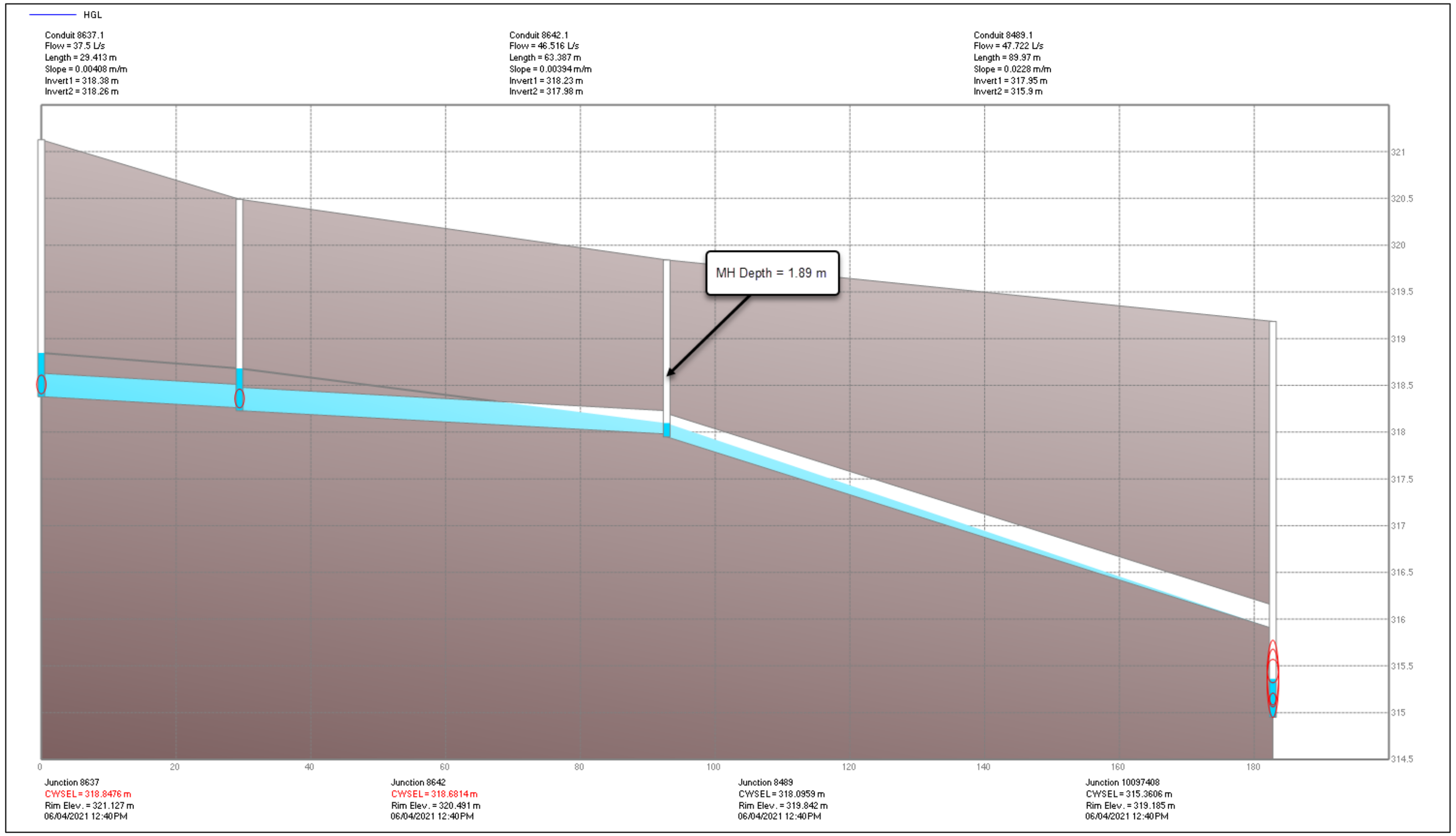
PA-5 Weber St North

Laurel 2

Alternative 1







<u>Note:</u>

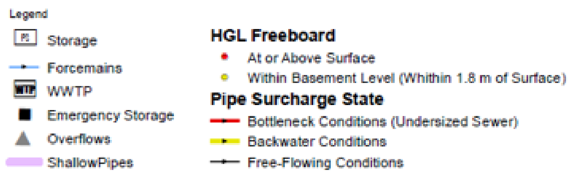
The surcharging pipe (asset ID : 6020) on Weber Street North is shallow, therefore, the target LOS is for the water level to remain within the pipe

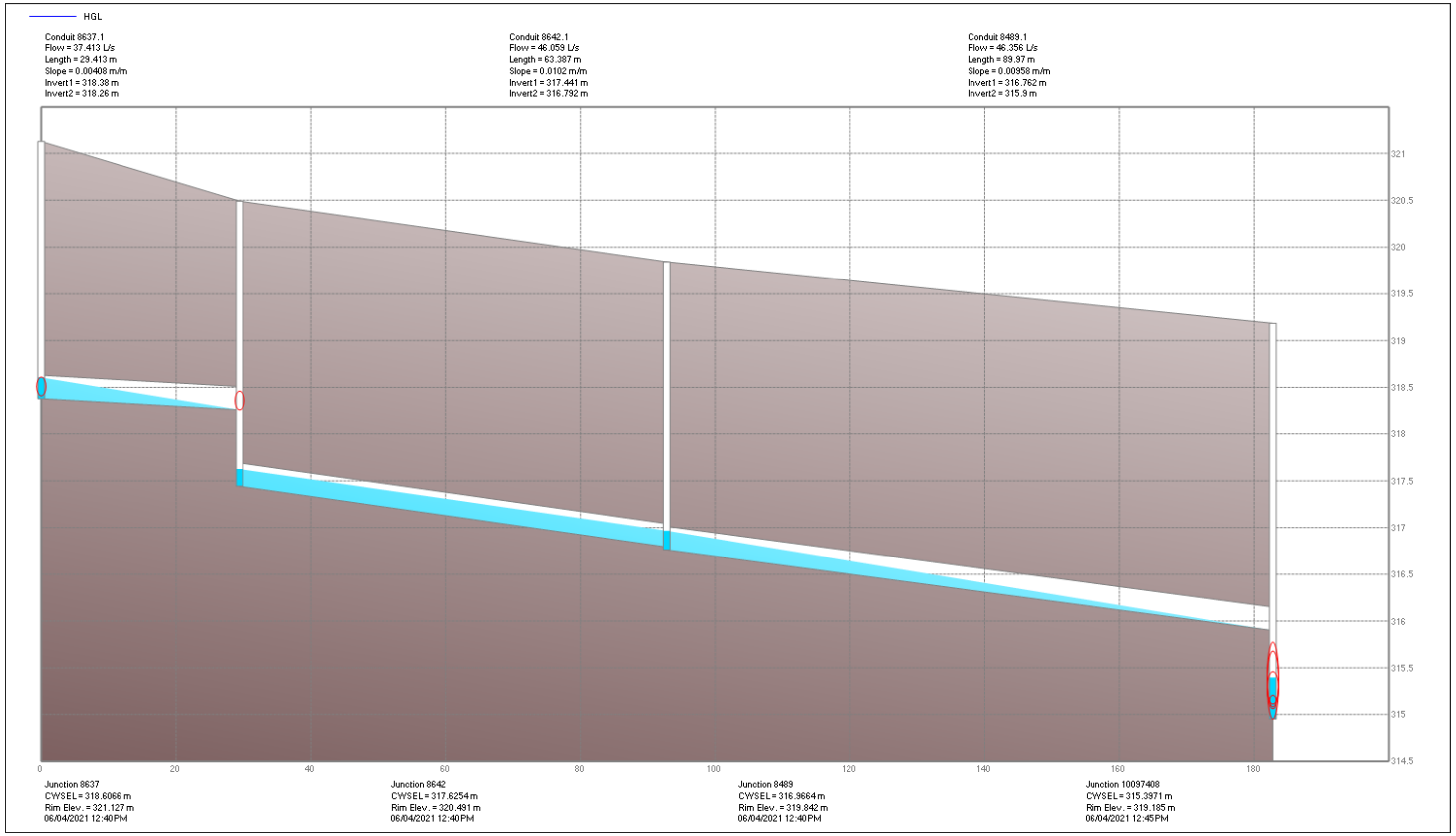
<u>Alternative 1 (Preferred Alternative):</u>

Do Nothing

2051 Conditions Solution- 25yr Results

PA-5 Weber St North
Laurel 2
Alternative 2





<u>Note:</u>

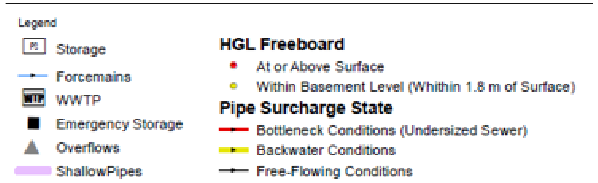
Pipes are free-flowing with no HGL issue

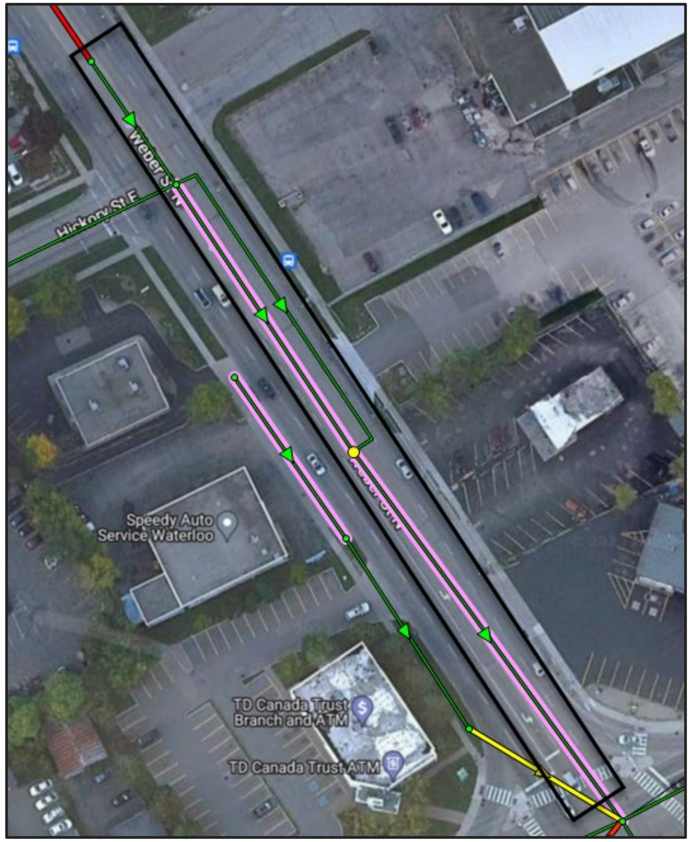
<u>Alternative 2:</u>

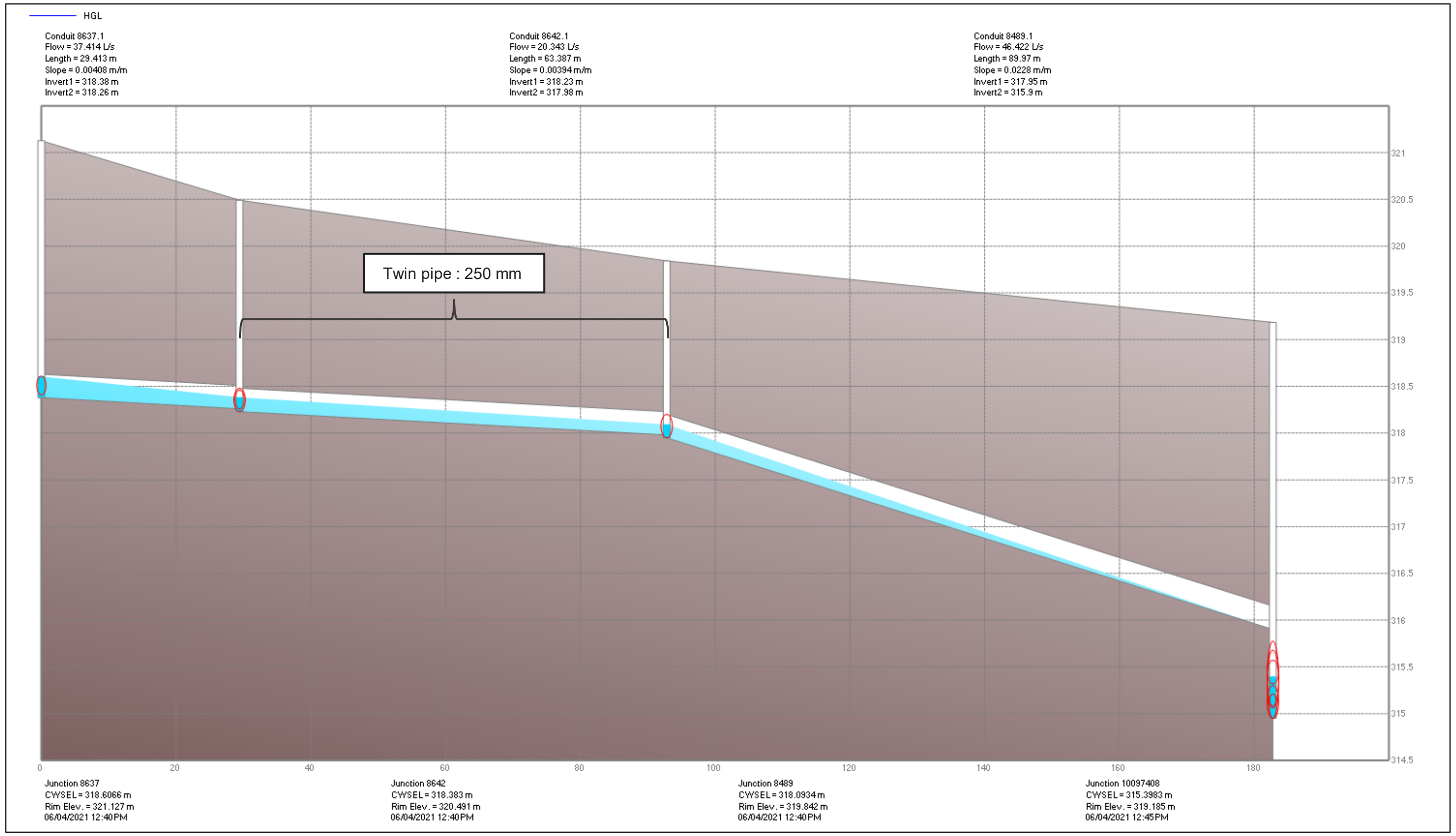
Reprofile 2 pipes on Weber St N

2051 Conditions Solution- 25yr Results

PA-5 Weber St North
Laurel 2
Alternative 3







<u>Note:</u>

The HGL freeboard less than 1.8 m is due to shallow pipes

<u>Alternative 3:</u>

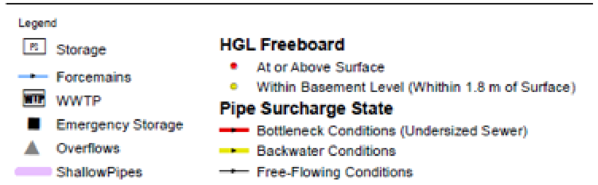
Twin Sewer (63 m) on Weber St N

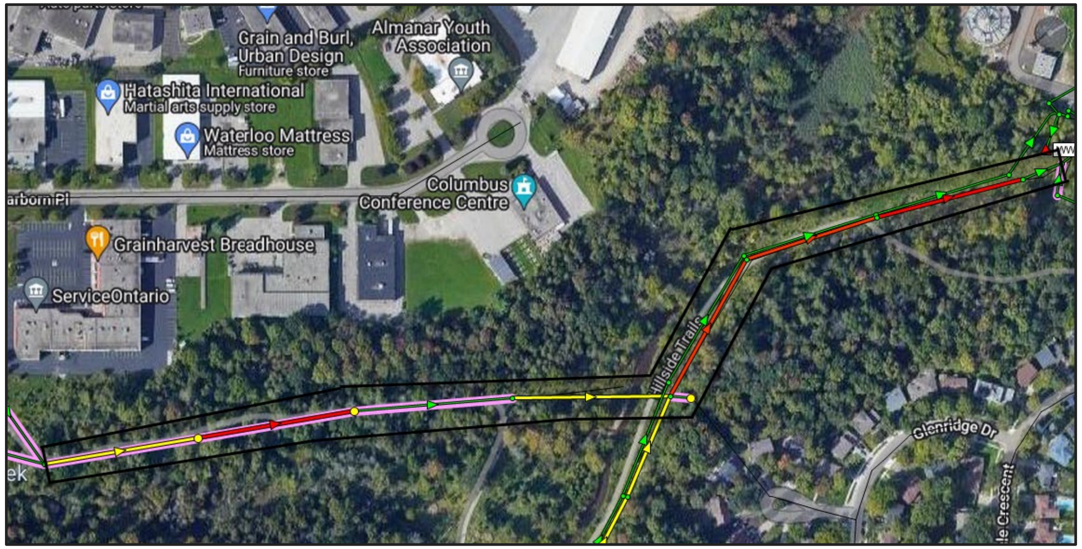
PA-6 Forwell Trail

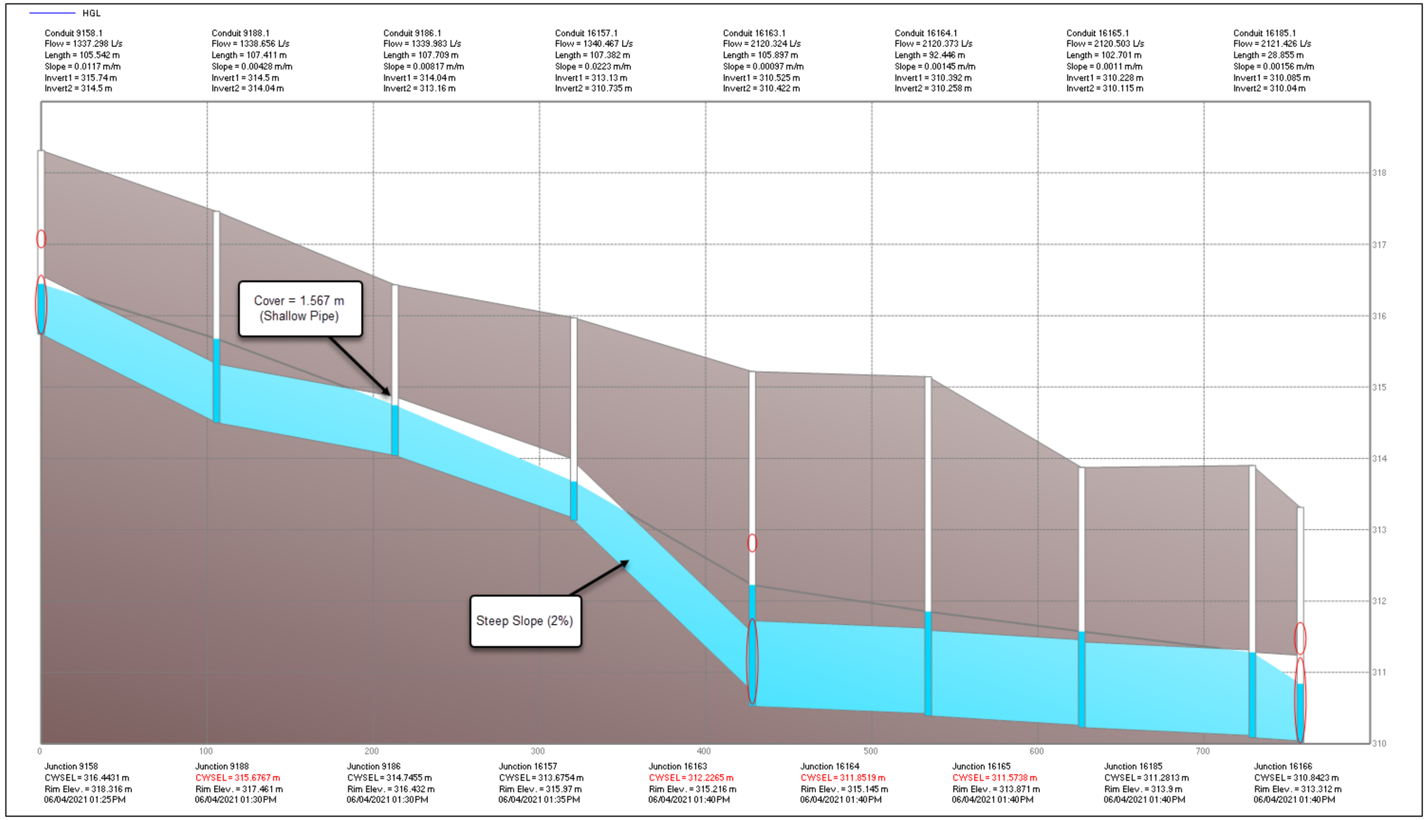
2051 Conditions Solution- 25yr Results

2051 Conditions Solution - 25yr Results

PA-6 Forwell Trail
Near Conestoga College
Alternative 1







Note:

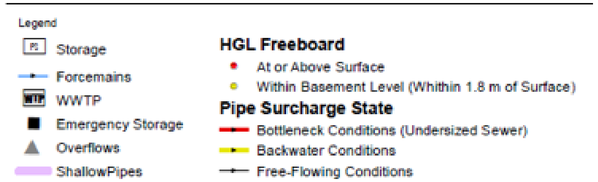
The pipes are undersized and shallow. There is a low risk of basement flooding as no building connection are present along these sewers

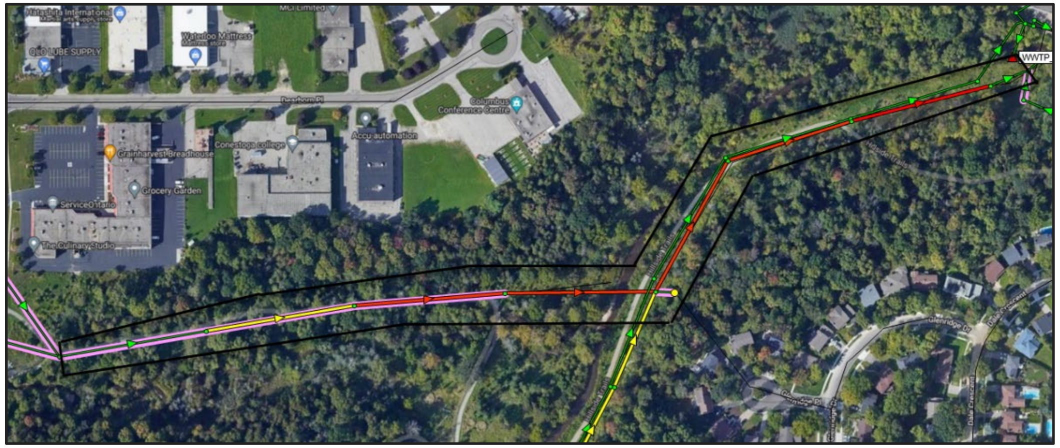
Alternative 1 (Preferred Alternative):

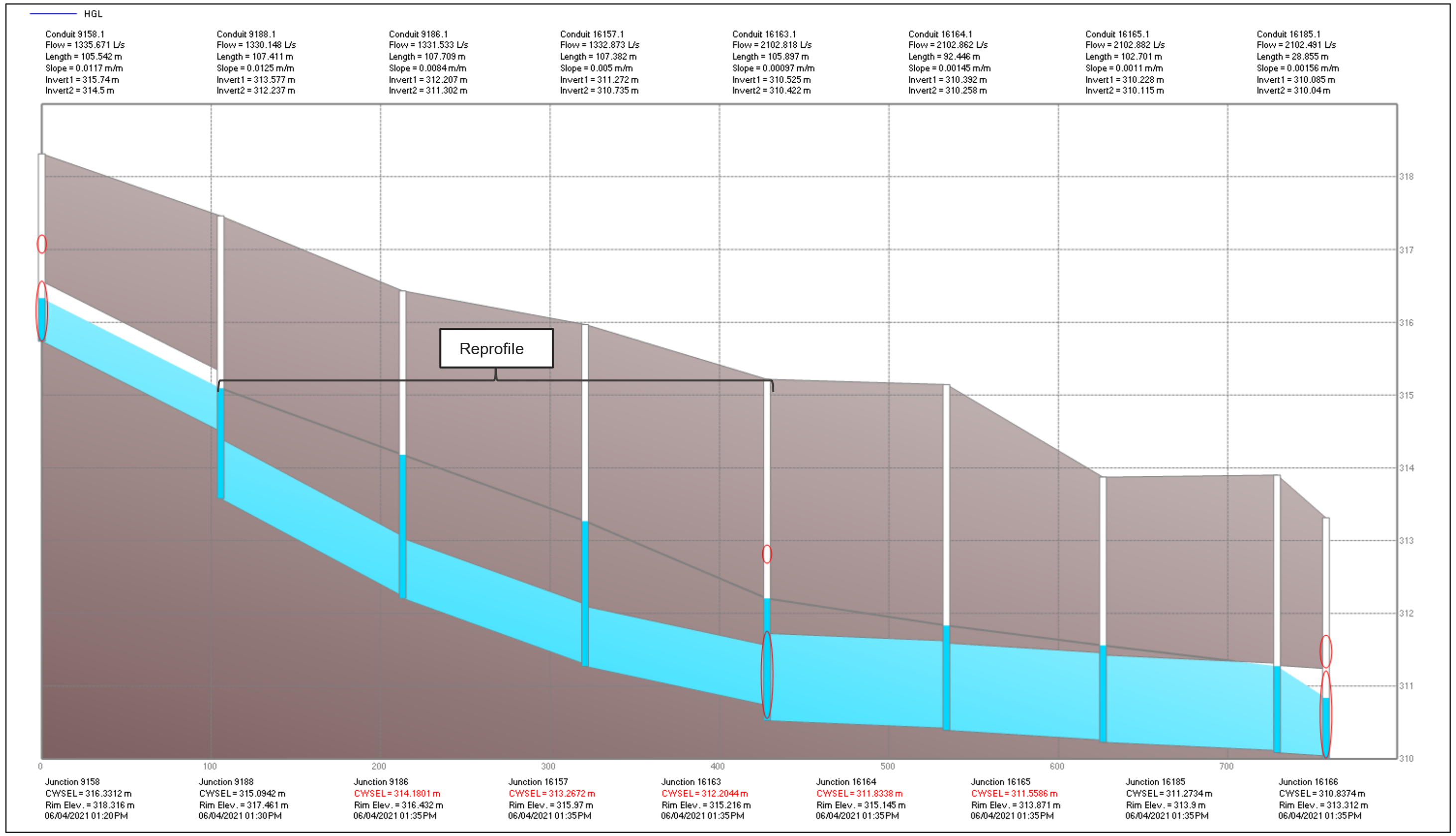
Do Nothing

2051 Conditions Solution - 25yr Results

PA-6 Forwell Trail
Near Conestoga College
Alternative 2







<u>Note:</u>

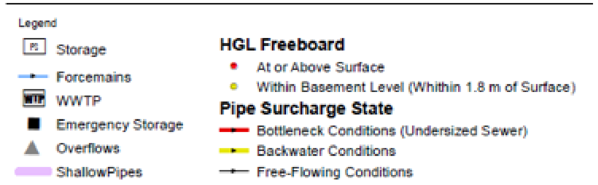
The pipes are still surcharging, but there is no HGL issue

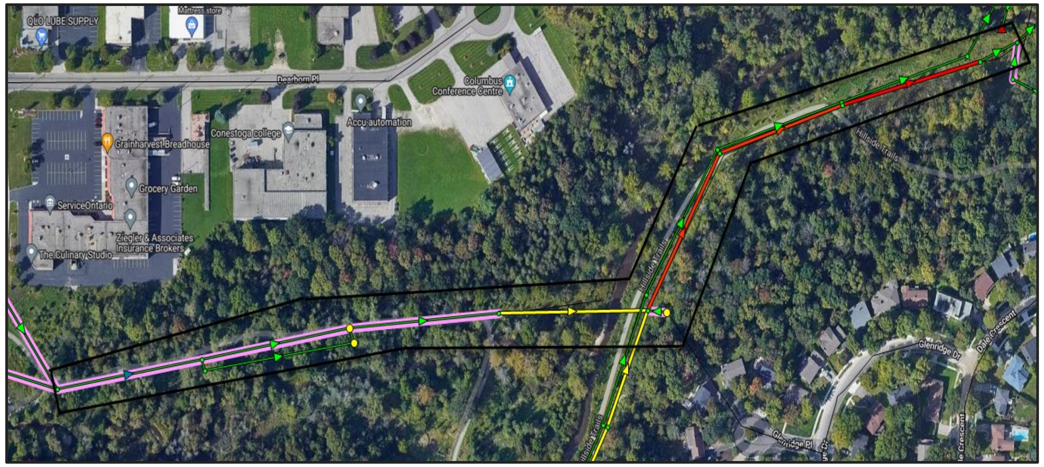
<u>Alternative 2:</u>

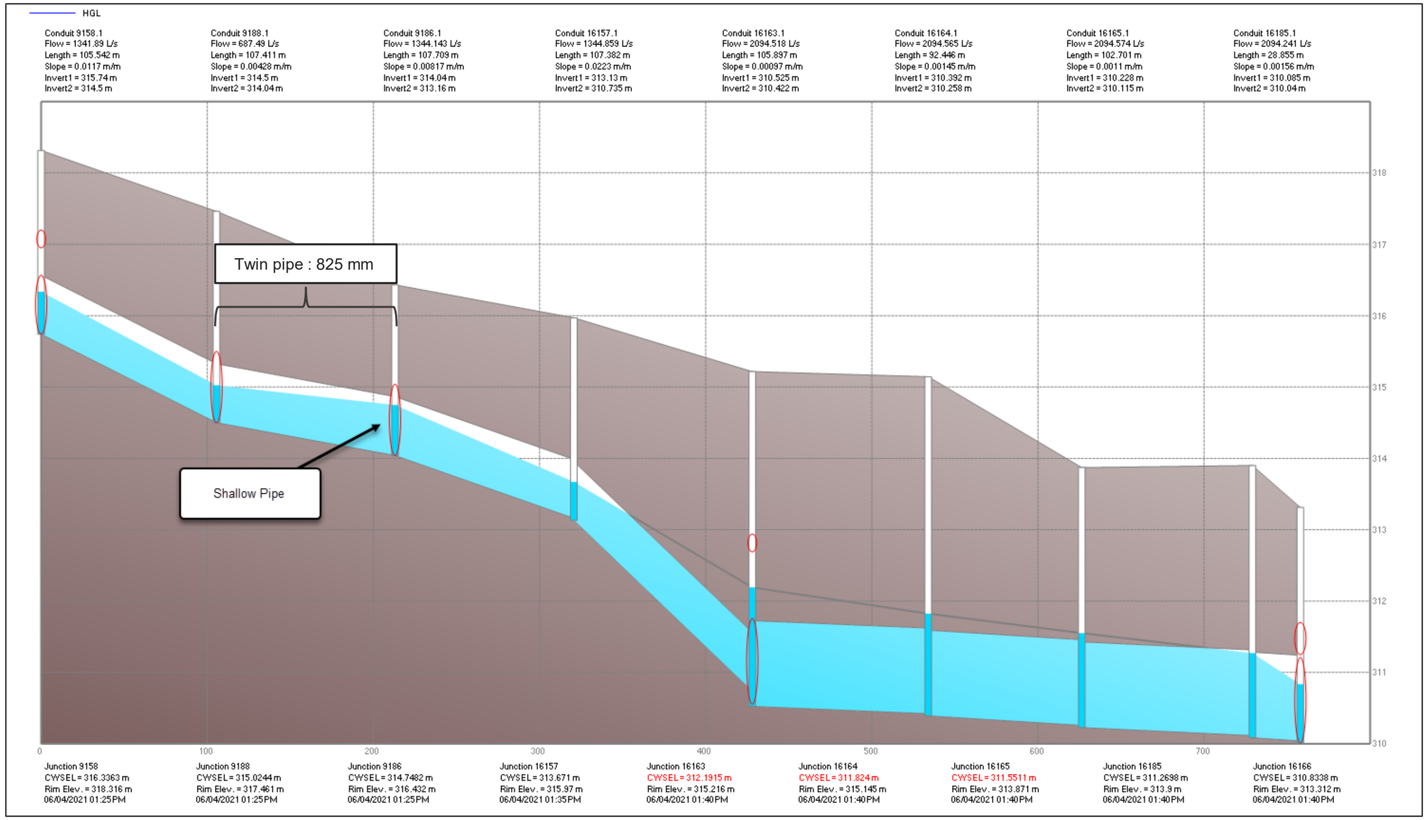
Reprofile 3 pipes on Forwell Trunk

2051 Conditions Solution - 25yr Results

PA-6 Forwell Trail
Near Conestoga College
Alternative 3







<u>Note:</u>

The HGL issue is due to shallow pipes, the pipes are free-flowing

<u>Alternative 3:</u>

Twin Sewer (108 m) on Forwell Trunk

PA-7 Frobisher Drive

2051 Conditions Solution- 25yr Results

2051 Conditions Solution - 25yr Results

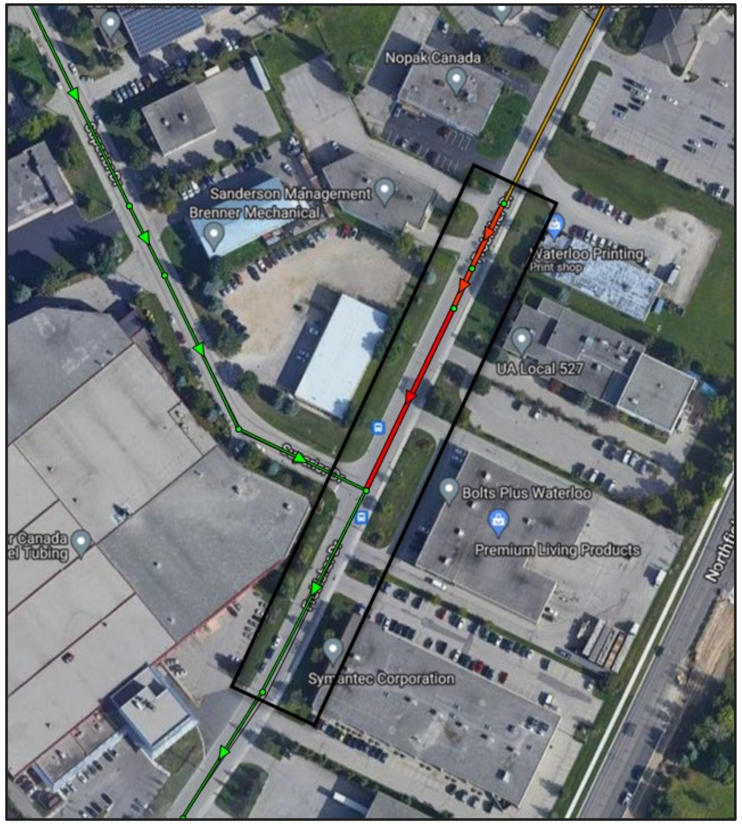
PA-7 Frobisher Drive

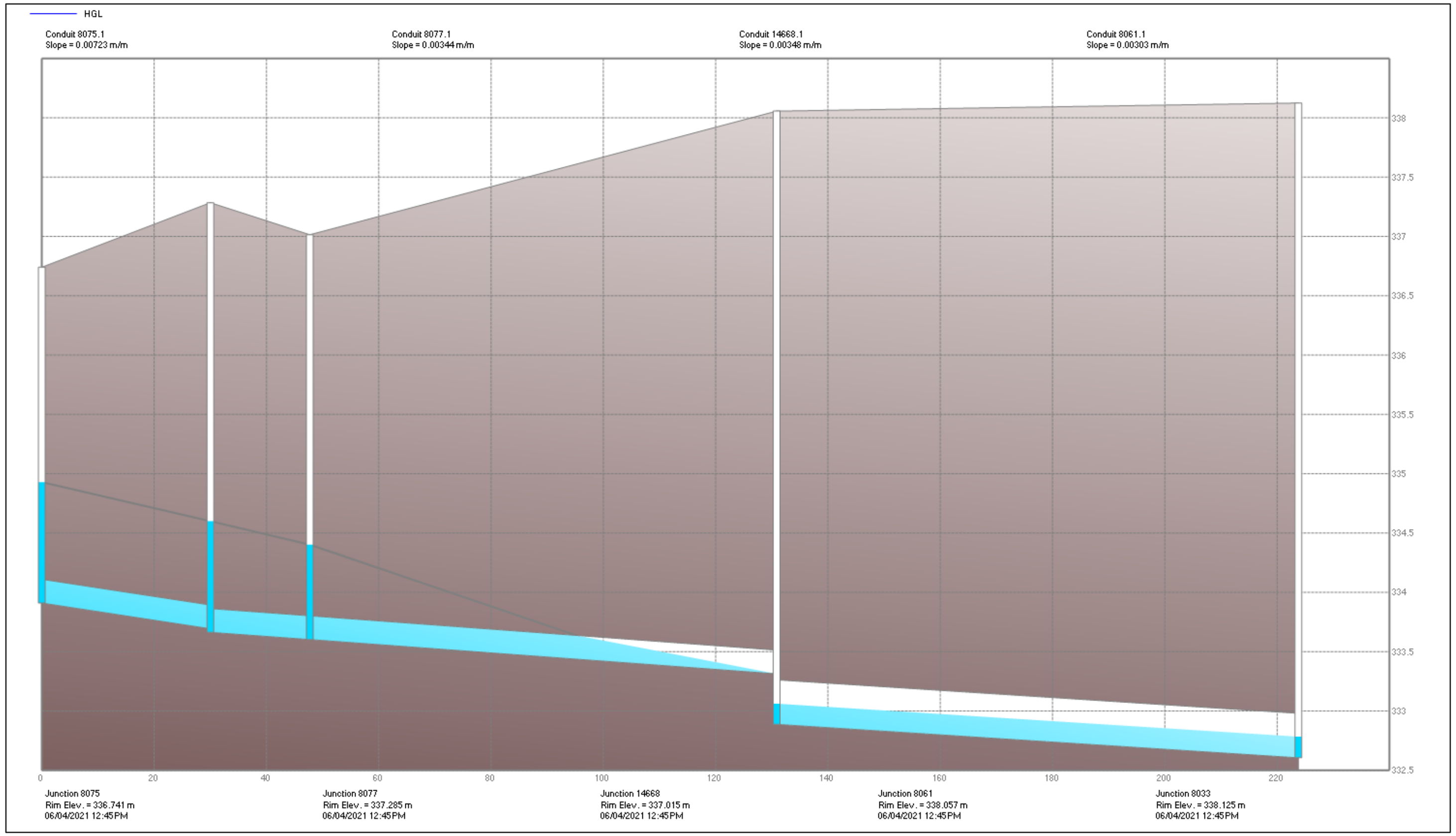
LEE 1

Alternative 1

Legend

Storage	**HGL Freeboard**
Forcemains	At or Above Surface
WWTP	Within Basement Level (Whithin 1.8 m of Surface)
Emergency Storage	**Pipe Surcharge State**
Overflows	Bottleneck Conditions (Undersized Sewer)
ShallowPipes	Backwater Conditions
	Free-Flowing Conditions





<u>Note:</u>

Capacity constraints have been identified on Frobisher Drive under dry weather flow

<u>Alternative 1:</u>

Do Nothing; capacity constraints under dry weather flow

2051 Conditions Solution - 25yr Results

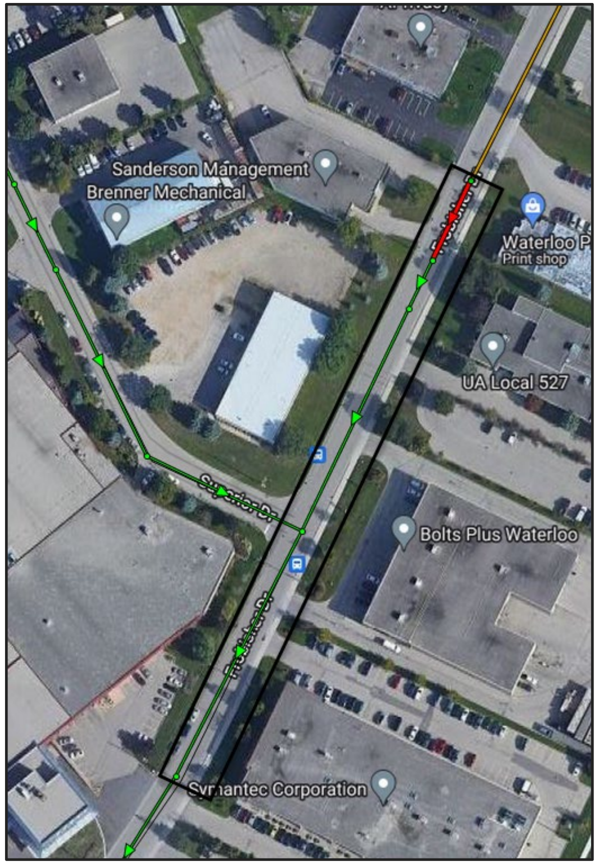
PA-7 Frobisher Drive

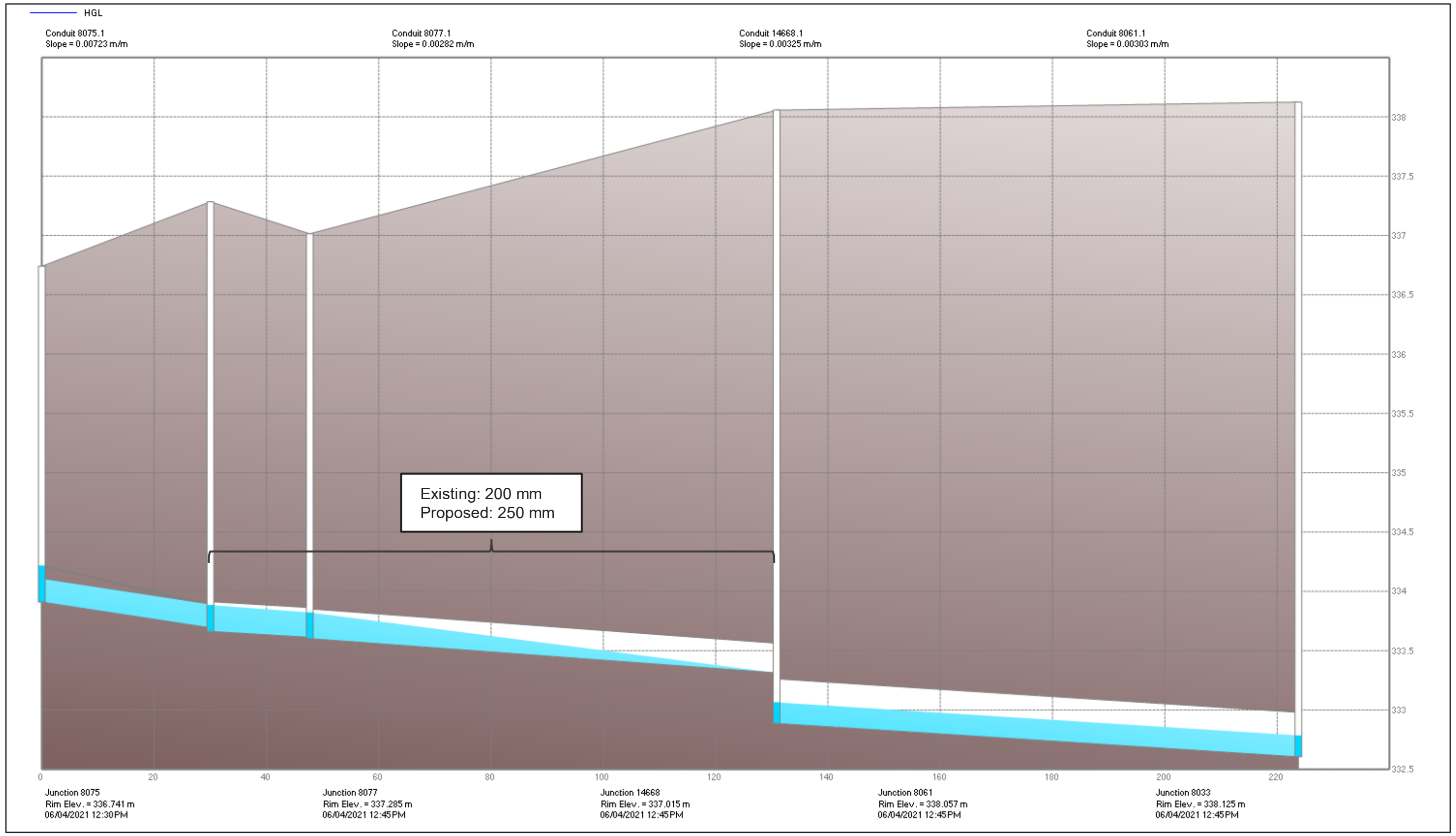
LEE 1

Alternative 2

Legend

Storage		**HGL Freeboard**	
Forcemains		At or Above Surface	
WWTP		Within Basement Level (Whithin 1.8 m of Surface)	
Emergency Storage		**Pipe Surcharge State**	
Overflows		Bottleneck Conditions (Undersized Sewer)	
ShallowPipes		Backwater Conditions	
		Free-Flowing Conditions	





Note:

One pipe is surcharging, but there is no HGL issue

Alternative 2 (Preferred Alternative):

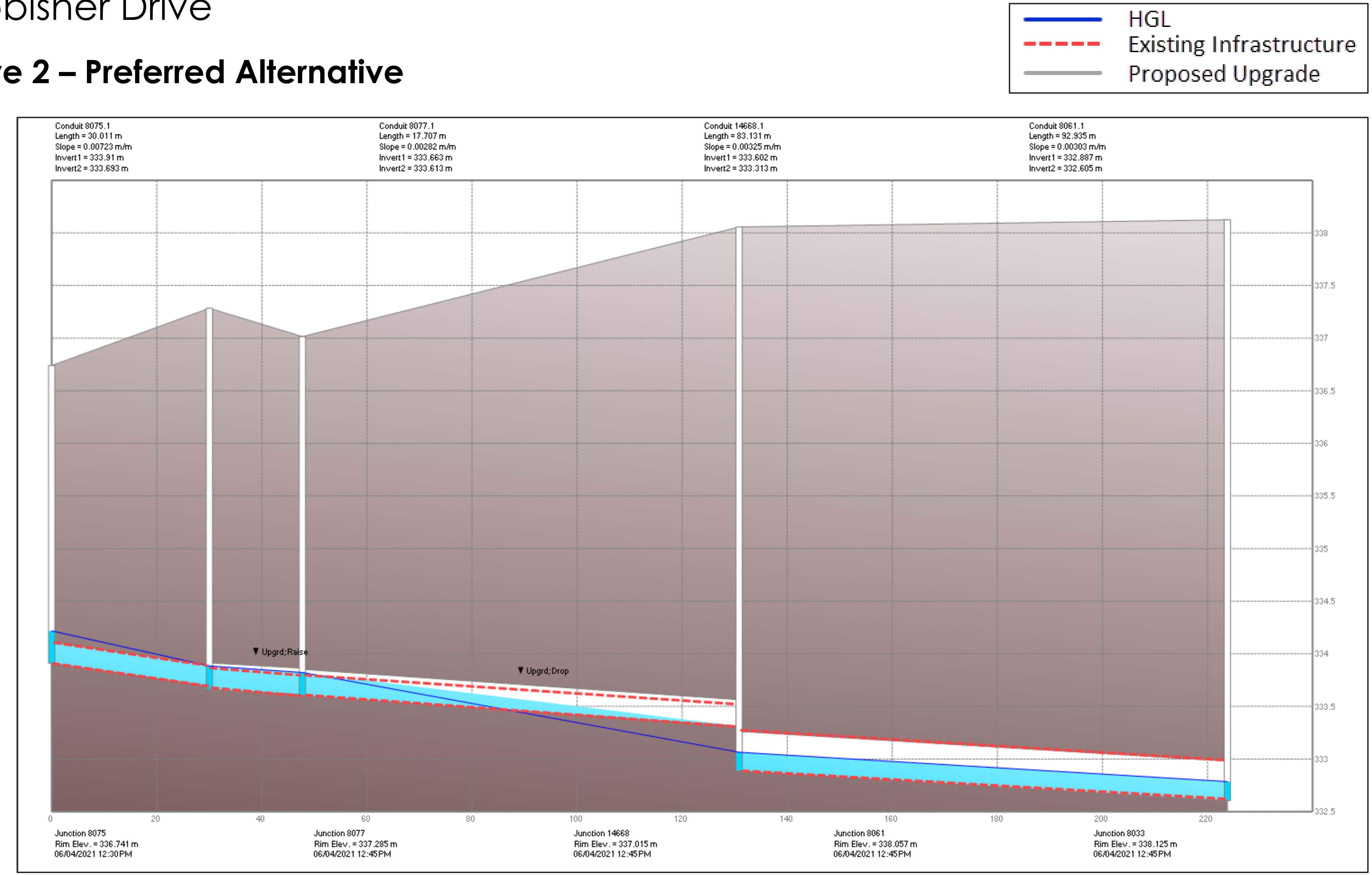
Replacement of 2 lengths of sewer downstream of the forcemain - upsizing from 200 mm diameter to 250 mm diameter sewer

2051 Conditions Solution - 25yr Results

PA-7 Frobisher Drive

LEE 1

Alternative 2 – Preferred Alternative



2051 Conditions Solution - 25yr Results

PA-7 Frobisher Drive

LEE 1

Alternative 3

Legend

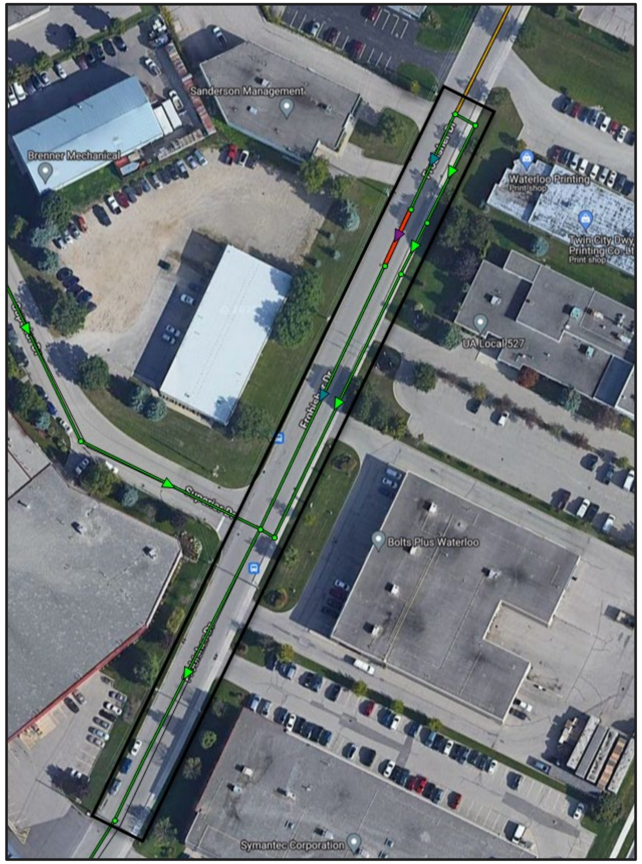
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

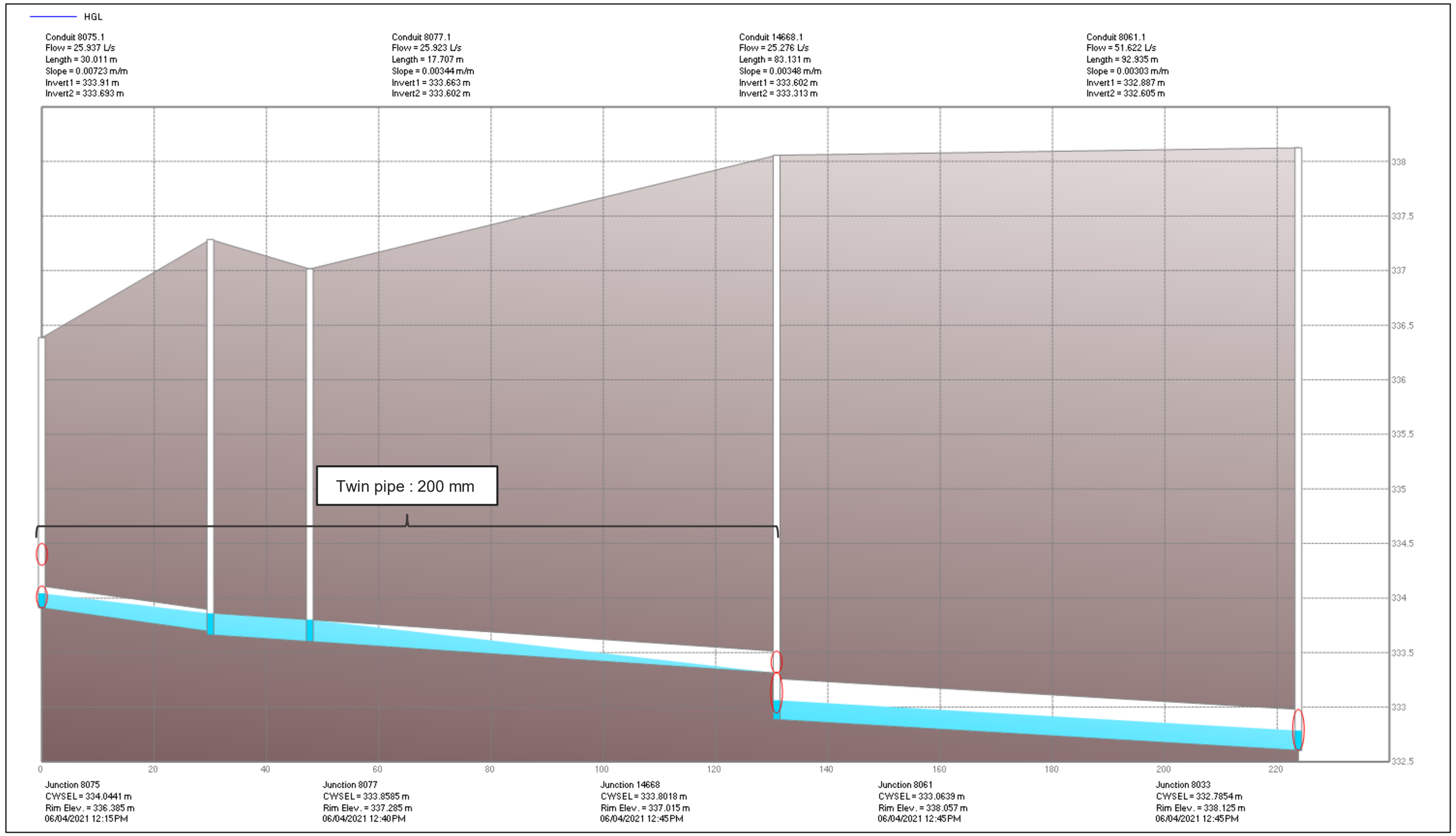
HGL Freeboard

- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions





Note:

One pipe is surcharging, but there is no HGL issue

Alternative 3:

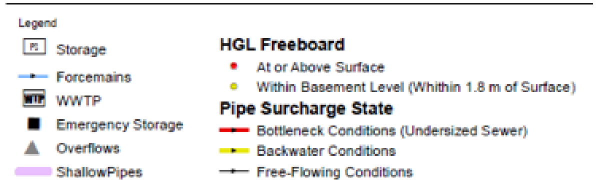
Twin Sewer (131 m) downstream of Frobisher SPS forcemain

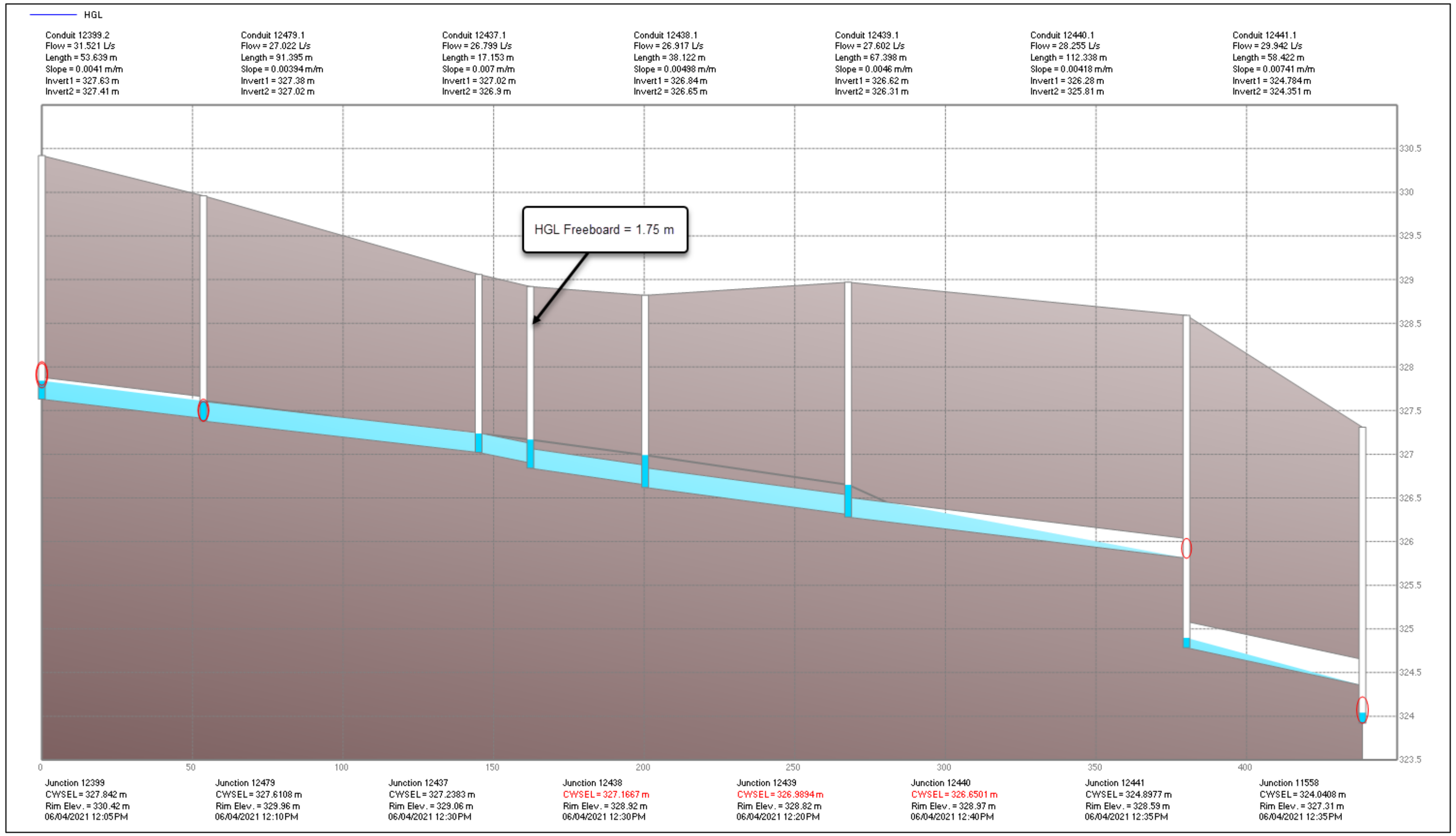
PA-8 Union Street East

2051 Conditions Solution- 25yr Results

2051 Conditions - 25yr Results

PA-8 Union Street East
Laurel 2
Alternative 1





<u>Note:</u>

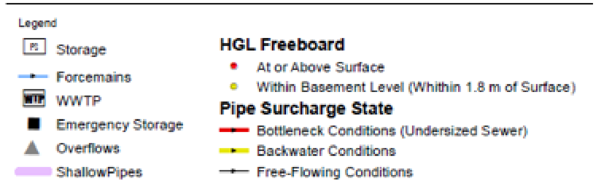
Surcharging pipes and HGL issue due Moore SPS inflow

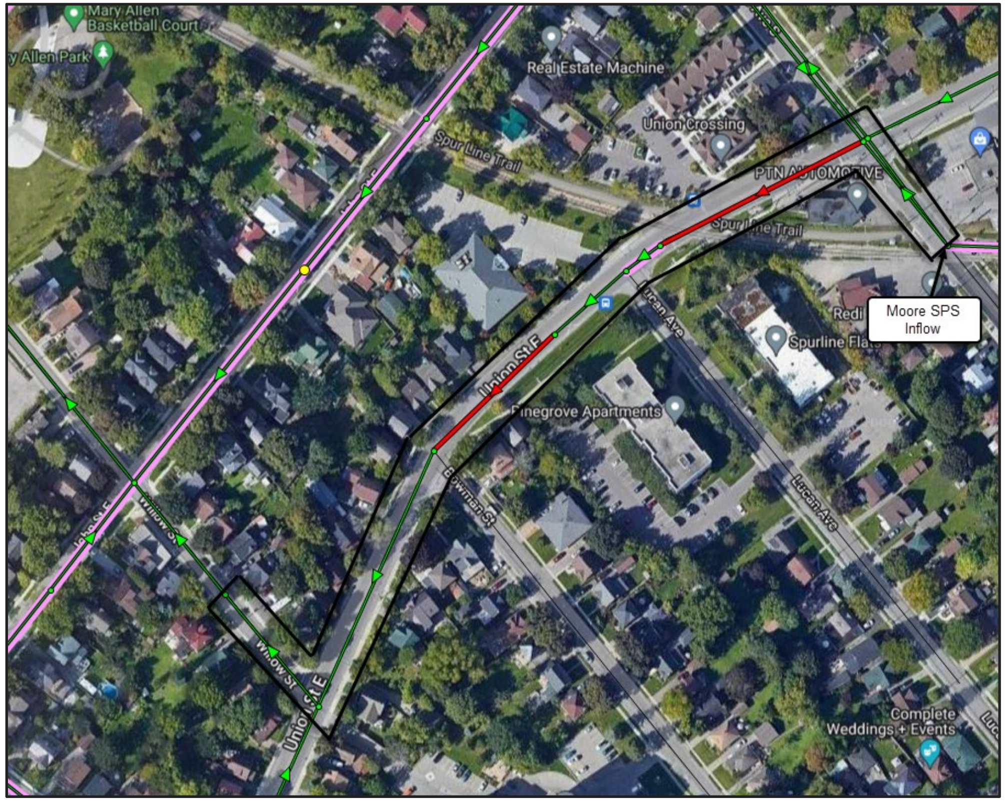
<u>Alternative 1:</u>

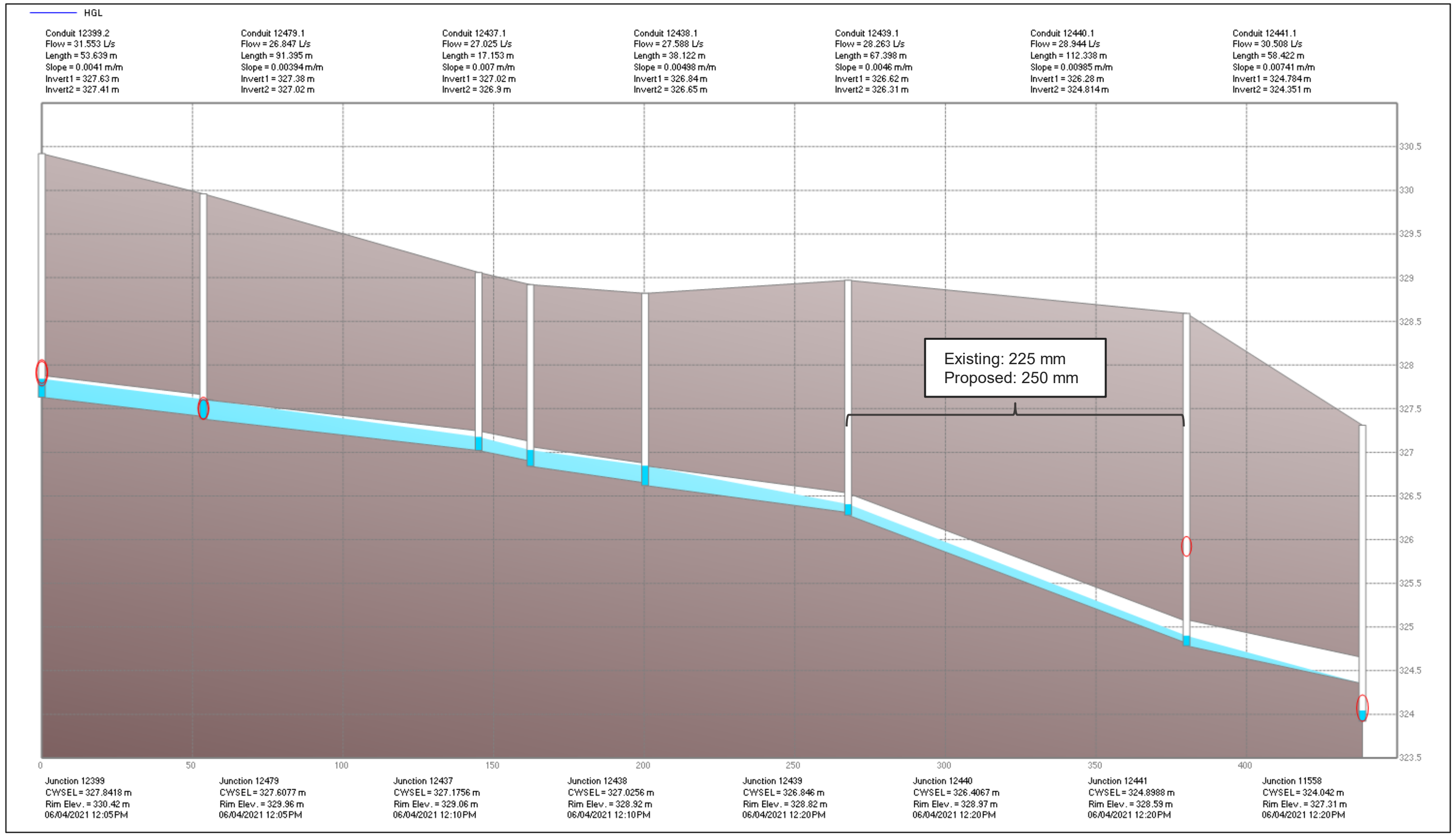
Do Nothing; risk of basement flooding

2051 Conditions - 25yr Results

PA-8 Union Street East
Laurel 2
Alternative 2







<u>Note:</u>
HGL issue due to undersized pipe.

<u>Alternative 2 (Preferred Alternative):</u>
Replacement of 1 length of sewer downstream of the inflow from Kitchener (decommission of Moore PS) - upsizing from 225 mm diameter to 250 mm diameter sewer

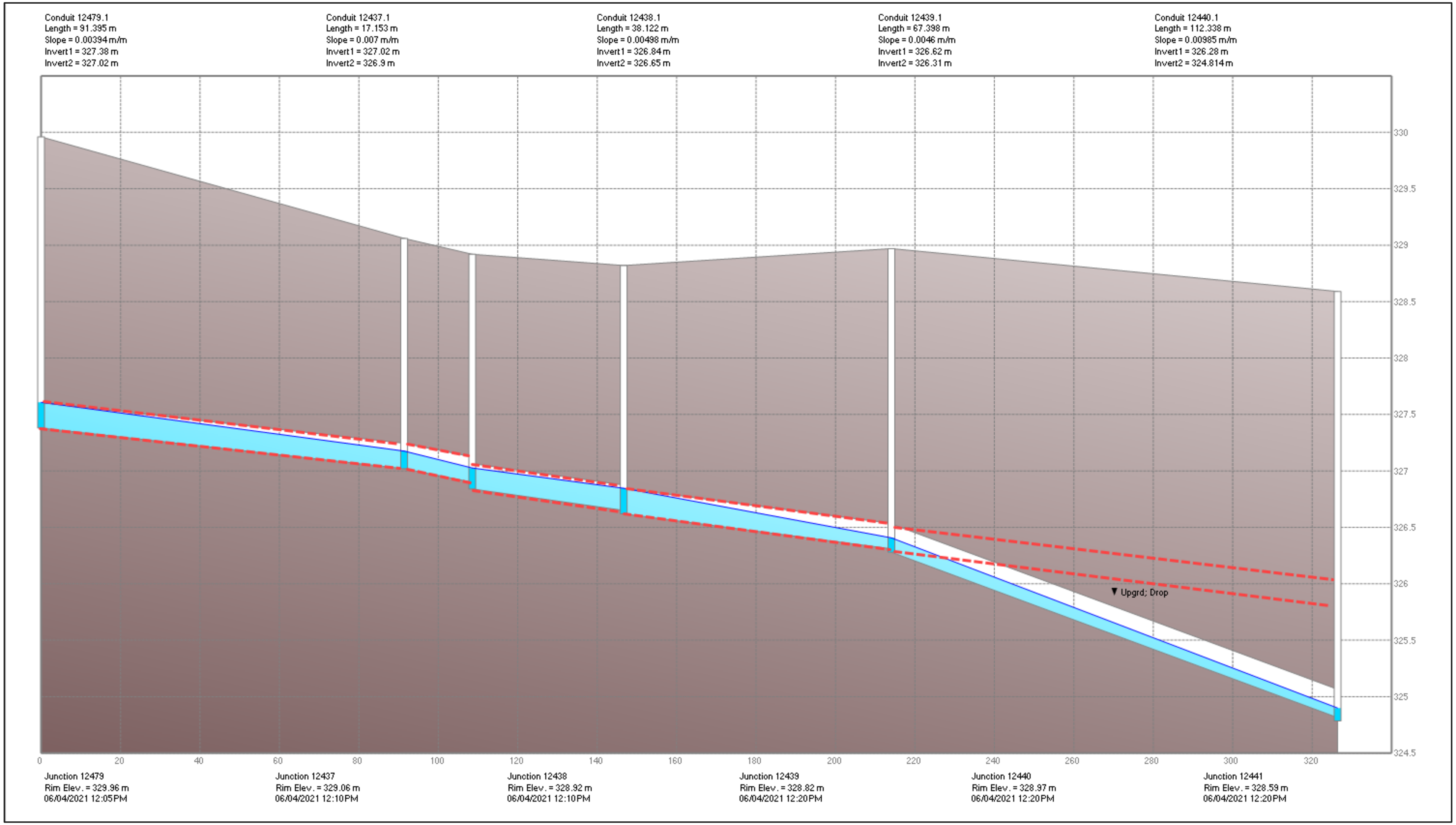
2051 Conditions - 25yr Results

PA-8 Union Street East

Laurel 2

Alternative 2 – Preferred Alternative

HGL
Existing Infrastructure
Proposed Upgrade



2051 Conditions - 25yr Results

PA-8 Union Street East

Laurel 2

Alternative 3

Legend

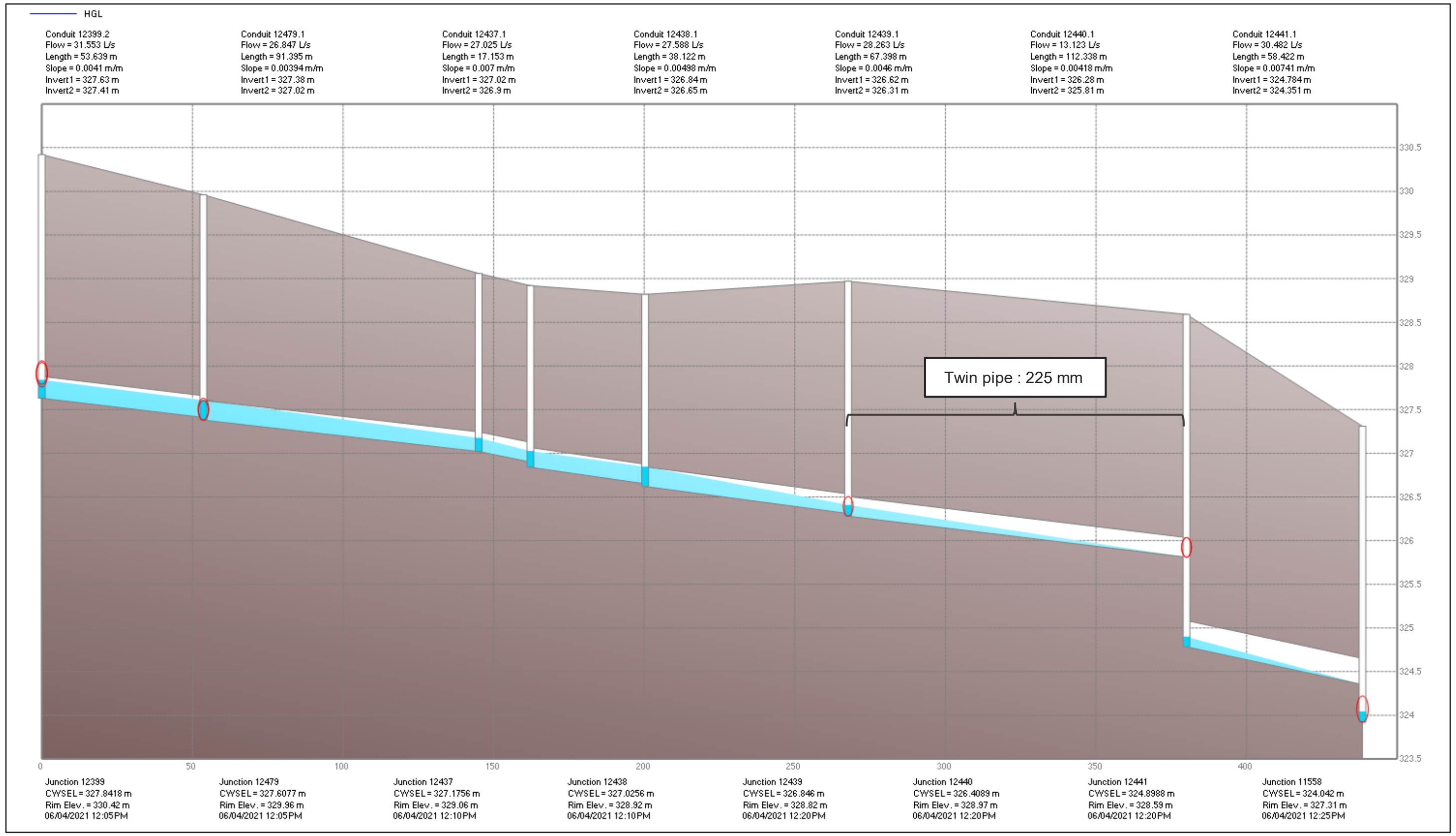
- Storage
- Forcemains
- WWTP
- Emergency Storage
- Overflows
- ShallowPipes

HGL Freeboard

- At or Above Surface
- Within Basement Level (Whithin 1.8 m of Surface)

Pipe Surcharge State

- Bottleneck Conditions (Undersized Sewer)
- Backwater Conditions
- Free-Flowing Conditions



<u>Note:</u>
HGL issue due to undersized pipe

<u>Alternative 3:</u>
Twin Sewer (113 m) downstream on Union St E

APPENDIX B
RECOMMENDED SOLUTIONS – RELEVANT PIPE IDS

Pipe Asset ID	Problem Area ID	Preferred Alternative
2118	PA-1	Alternative 2: Upgrade Sewer and Reprofile
3523	PA-1	Alternative 2: Upgrade Sewer and Reprofile
3524	PA-1	Alternative 2: Upgrade Sewer and Reprofile
3513	PA-1	Alternative 2: Upgrade Sewer and Reprofile
3527	PA-1	Alternative 2: Upgrade Sewer and Reprofile
3526	PA-1	Alternative 2: Upgrade Sewer and Reprofile
2150	PA-1	Alternative 2: Upgrade Sewer and Reprofile
2148	PA-1	Alternative 2: Upgrade Sewer and Reprofile
2147	PA-1	Alternative 2: Upgrade Sewer and Reprofile
3514	PA-1	Alternative 2: Upgrade Sewer and Reprofile
2379	PA-8	Alternative 2: Upgrade Sewer and Reprofile
14667	PA-7	Alternative 2: Upgrade Sewer and Reprofile
6729	PA-2	Alternative 2: Upgrade Sewer and Reprofile
6726	PA-2	Alternative 2: Upgrade Sewer and Reprofile
5938	PA-2	Alternative 2: Upgrade Sewer and Reprofile
1789	PA-7	Alternative 2: Upgrade Sewer and Reprofile
6823	PA-3	Alternative 2: Upgrade Sewer and Reprofile
6885	PA-3	Alternative 2: Upgrade Sewer and Reprofile
6884	PA-3	Alternative 2: Upgrade Sewer and Reprofile
6824	PA-3	Alternative 2: Upgrade Sewer and Reprofile
6882	PA-3	Alternative 2: Upgrade Sewer and Reprofile
6727	PA-2	Alternative 2: Upgrade Sewer and Reprofile

Appendix E Consultation

Region of Waterloo
Baden - New Hamburg Water and Wastewater Servicing Review
Stakeholder List

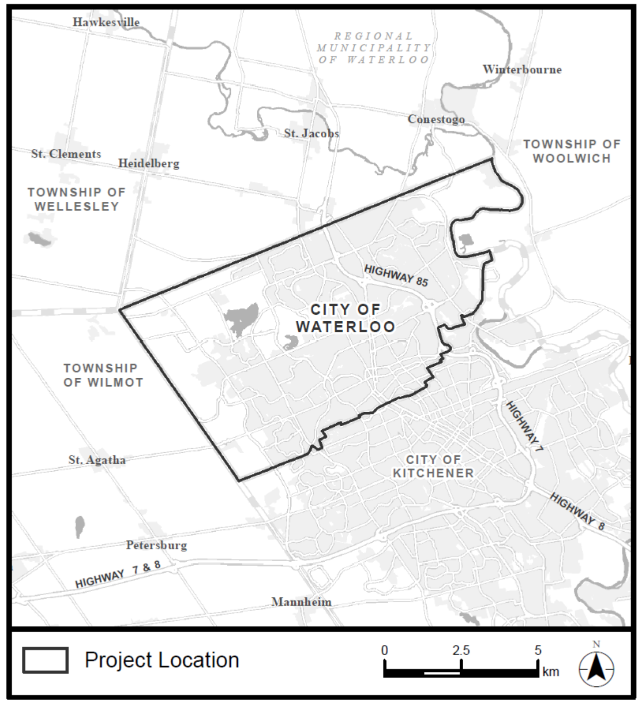
Contact	Company/Organization	Job Title	Street	City	Postal Code	Telephone	Email	Comments
INDIGENOUS COMMUNITIES								
City has internal team to contact First Nations	Six Nations of the Grand River							City has internal team to contact First Nations
	Haudenosaunee Confederacy Chiefs Council							City has internal team to contact First Nations
	Mississaugas of the Credit First Nation							City has internal team to contact First Nations
FEDERAL AGENCIES								
Cynthia Mitton-Wilkie	Fisheries and Oceans Canada	Senior Biologist, Ontario - Great Lakes Area	3027 Harvester Road, Burlington	Burlington	L7R 4K3	905-639-1632	cynthia.mitton-wilkie@dfo-mpo.gc.ca	
PROVINCIAL AGENCIES								
David Marriott	Ministry of Agriculture, Food and Rural Affairs	Rural Planner	1 Stone Road West	Guelph	N1G 4Y2	519-766-5990	david.marriott@ontario.ca	
Erick Boyd	Ministry of Municipal Affairs and Housing	Team Lead, Regional Planning	659 Exeter Road	London	N6E 1L3	519-873-4025	erick.boyd@ontario.ca	
Lisa Myslicki	Infrastructure Ontario	Environmental Specialist	1 Dundas Street West, Suite 2000	Toronto	M5G 2L5	416-212-3768	lisa.myslicki@infrastructureontario.ca	
Geddges Mahabir	Ministry of Transportation	Manager, Highway Operations	659 Exeter Road, 2nd Floor	London	N6E 1L3	519-873-4222	geddes.mahabir@ontario.ca	
Karla Barboza	Ministry of Heritage, Sport, Tourism and Culture Industries	Team Lead, Heritage	401 Bay Street, Suite 1700	Toronto	M7A 0A7	416-314 7120	karla.barboza@ontario.ca	
Ian Thornton	Ministry of Northern Development, Mines, Natural Resources and Forestry	Supervisor	1 Stone Road West	Guelph	N1G 4Y2	519-826-4828	ian.thornton@ontario.ca	
Joan Del Villar Cuicas	Ministry of the Environment, Conservation and Parks	Environmental Resource Planner & EA Coordinator					joan.delvillarcuicas@ontario.ca	
	Ministry of the Environment, Conservation and Parks						eanotification.wcregion@ontario.ca	
	Ontario Clean Water Agency (OCWA)							
CONSERVATION AUTHORITIES								
Beth Brown	Grand River Conservation Authority	Supervisor	400 Clyde Road P.O. Box 729	Cambridge	N1R 5W6	519-621-2763 x 2307	bbrown@grandriver.ca	
Trevor Heywood	Grand River Conservation Authority	Conservation Planner	400 Clyde Road P.O. Box 729	Cambridge	N1R 5W6		theywood@grandriver.ca	main contact for GRCA
Mark Anderson	Grand River Conservation Authority	Water Quality Engineer	400 Clyde Road P.O. Box 729	Cambridge	N1R 5W6	519-621-2763 x 2226	manderson@grandriver.ca	
REGIONAL DEPARTMENTS								
Bruce Lauckner	Region of Waterloo	CAO	150 Frederick Street	Kitchener	N2G4J3		blauckner@regionofwaterloo.ca	
Jenn Rose	Region of Waterloo	Commisioner of Engineering and Environmental Services					JennRose@regionofwaterloo.ca	
~~Thomas Schmidt~~	~~Region of Waterloo~~	~~Transportation and Environmental Services~~	~~150 Frederick Street~~	~~Kitchener~~	~~N2G4J3~~	~~519-575-4734~~	~~tschmidt@regionofwaterloo.ca~~	
Sharon Chambers	Township of Wilmot	CAO					sharon.chambers@wilmot.ca	
David Brenneman	Township of Woolwich	CAO					dbrenneman@woolwich.ca	
UTILITIES								
	Enbridge Pipeline			Waterloo	N2V 1K3		est.reg.crossing@enbridge.com	
Ted Hancocks	Rogers Cable		85 Grand Crest Place, P.O. Box 488	Kitchener	N2G 4A8	519-893-4400	ted.hancocks@rci.rogers.com	
Janet Cleghorn	Bell Canada						janet.cleghorn@bell.ca	
	Hydro One Networks						secondarylanduse@hydroone.com	
Engineering Clerk	Waterloo North Hydro						eclerk@wnhydro.com	
Domenic Bonaldo	Canadian Pacific Railway	Specialist Public Works	1290 Central Parkway West, Suite 700	Mississauga	L5C 4R3	(905) 803-5989	dominic_bonaldo@cpr.ca	
MUNICIPAL AGENCIES								
	Waterloo Catholic District School Board						planning@wcdsb.ca	
	Waterloo District School Board						planning@wrdsb.ca	
	Waterloo Regional Police Service						publicinfo@wrps.on.ca	
	Region of Waterloo Paramedic Health and Emergency Services						publichealth@regionofwaterloo.ca	
Pat Treloar	Waterloo Fire Rescue	Chief					fire.chief@waterloo-ia.org	
INTEREST GROUPS								
Ian McLean	Greater KW Chamber of Commerce	President					admin@greaterkwchamber.com	
Janet Ozaruk	Waterloo Region Nature						president@waterlooregionnature.ca	
~~Kate Hagerman~~	~~Region of Waterloo Ecological and Environmental Advisory Committee~~		~~150 Frederick Street, 8th Floor~~	~~Kitchener~~	~~N2G4J3~~	~~519-575-4501~~	~~KHagerman@regionofwaterloo.ca~~	
Bridget Coady	Region of Waterloo Heritage Planning Advisory Committee		150 Frederick Street, 8th Floor	Kitchener	N2G4J3	519-575-4500 x3112	bcoady@regionofwaterloo.ca	
~~**Michele Sergi**~~	~~**Region of Waterloo**~~	~~**Director of Community Planning**~~	~~**150 Frederick Street, 8th Floor**~~	~~**Kitchener**~~	~~**N2G4J3**~~	~~**519-575-4521**~~	~~**msergi@regionofwaterloo.ca**~~	
Maria Kyveris	Waterloo Region Home Builders Association	President	625 King Street East, Suite 1C	Kitchener	N2G4V4	519-404-3971	maria.kyveris@rogers.com	
	City of Waterloo Committees						committees@waterloo.ca	

Notice of Study Commencement

CITY OF WATERLOO
NOTICE OF STUDY COMMENCEMENT
Municipal Class Environmental Assessment Study
Integrated Sanitary Master Plan

THE STUDY:

The City of Waterloo (City) is undertaking an Addendum to the existing 2015 Waterloo Sanitary Master Plan. The purpose of this Addendum is to examine the City's infrastructure needs considering new planning policies, growth projections, and the current needs and issues that exist in our community. The Integrated Sanitary Master Plan will review improvements to existing sanitary infrastructure, the installation of new sanitary infrastructure, and consideration of private services to municipal servicing, through to the year 2051.The Study is being undertaken within the City limits, as shown on the map.



THE PROCESS:

This EA Study is being undertaken as an Addendum to a Master Plan in accordance with the planning and design process as outlined in the Municipal Class EA document (2000, as amended) which is an approved process under the Ontario Environmental Assessment Act. This Master Plan is intended to satisfy the documentation and consultation requirements for Phase 1 and 2 of the Municipal Class EA process.

HOW CAN I PARTICIPATE IN THIS STUDY?

Public Participation will form an integral part of the Class EA Study so that the ongoing concerns of the public and affected groups in the study area are identified, documented, and assessed. An Engage Waterloo site has been set up to provide information and for the public to provide input on the Project. https://www.engagewr.ca/sanitary-master-plan. The website will be used to share information about the Project and for the public to provide feedback.

A public consultation centre (PCC) will be held in the fall of 2022. Notice for the PCC will be provided in advance, to enable the public to meet the project team and to provide feedback on the project. Furthermore, any parties that wish to comment on or to be involved in the EA study should indicate their interest to:

Veronica Kroess
Project Manager
City of Waterloo
100 Regina Street South
P.o. Box 337, Station Waterloo
Waterloo, ON N2J 4A8
Phone: 519-886-2310 x 78563
Email: veronica.kroess@waterloo.ca

Jeff Paul, P.Eng.
Project Manager
Stantec Consulting Ltd.
600-171 Queens Avenue
London ON N6A 5J7
Phone: 519-319-5806
Email: Jeff.Paul@stantec.com

If you have any accessibility requirements in order to participate in this study, please contact the City of Waterloo Project Manager. Information will be collected in accordance with the Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.

This notice was first issued on August 10, 2022.

From: Micks, Sarah
To: EA Notices to WCRegion (MECP); Del Villar Cuicas, Joan (MECP)
Cc: Hohner, Paula; Paul, Jeff; Veronica Kroess
Subject: City of Waterloo, Integrated Sanitary Master Plan Addendum, Municipal Class Environmental Assessment
Date: Friday, August 25, 2023 2:58:00 PM
Attachments: streamlined_ea_project_information_form.xlsx
Notice of Commencement - Waterloo ISMP.pdf
Notice of PCC 1 - Waterloo ISMP.pdf

Good Afternoon Joan,

I'm emailing in regards to a Master Plan Municipal Class Environmental Assessment (EA) study being undertaken by the City of Waterloo. The City is completing an Addendum to the existing 2015 Waterloo Sanitary Master Plan, to examine the City's infrastructure needs considering new planning policies, growth projections, and the current needs and issues that exist in the community.

Upon reviewing materials from the onset of the study (August 2022), we noticed that the Notice of Commencement and PIF were not sent to MECP, and the Notice of Public Consultation Centre (PCC) #1 was sent to the incorrect EA Regional Coordinator. I apologize that these were not sent to you originally.

Please find the PIF, Notice of Study Commencement, and Notice of PCC #1 documents attached to this email.

The study is approaching PCC #2, currently scheduled for September. We will ensure you are included in the distribution of the notice for the PCC, and, in addition, we will provide the Addendum report to MECP for 30-day review prior to issuing the Notice of Completion.

Please don't hesitate to let me know if you have any questions or concerns, and I apologize for the delay in getting these documents to you.

Thank you!

Sarah Micks
Environmental Planner
sarah.micks@stantec.com
Direct: 519-432-4292

Stantec

What to do:
Step 1: Look for the type of EA project in column B that applies to you.
Step 2: Complete columns C to J for that project.
Step 3: Send this form in Excel format to the MECP regional office email address where the project is located.
MECP regional office email addresses are listed at
www.ontario.ca/page/preparing-environmental-assessments

	Class EA/Streamlined EA	Proponent Name	Proponent Contact	Project Name	Project Schedule	Project Type	Project Location	MOECC Region	Project Initiation Date
1	CO - Remedial flood and erosion control projects								
2	GO Transit - Class EA								
3	Hydro One - Minor transmission facilities								
4	MEA - Class EA for municipal infrastructure projects	City of Waterloo	Veronica Kroess (veronica.kroess@waterloo.ca)	INTEGRATED SANITARY MASTER PLAN	Master plan	Municipal water and wastewater projects	Waterloo, City of	West Central	8/10/2022
5	Ministry of Infrastructure - Public work								
6	MNDM - Activities of the Ministry of Northern Development and Mines under the Mining Act								
7	MNRF - Provincial parks and conservation reserves								
8	MNRF - Resource stewardship and facility development projects								
9	MTO - Provincial transportation facilities								
10	O. Reg. 101/07 - Waste management projects								
11	O. Reg. 116/01 - Electricity projects								
12	OWA - Waterpower projects								
		Enter the proponent's name.	Enter the name and email address of the person who the MECP should contact about your project. This should be the same contact person who is listed on the notice.	Enter the project name as it appears on the notice.	Select the project schedule from the drop-down menu.	Select the project type from the drop-down menu.	Select the name of the municipality or unorganized/unsurveyed area where your project is located from the drop-down menu.	Select the MECP region from the drop-down menu. Read the "MECP regions" worksheet to find the MECP region where your project is located.	Enter the date that the streamlined EA process was initiated (e.g. notice of commencement). This date may be when the project notice was first published.

From:	Del Villar Cuicas, Joan (MECP)
To:	Veronica Kroess; Paul, Jeff
Cc:	Micks, Sarah; Todd, Aaron (MECP)
Subject:	RE: City of Waterloo, Integrated Sanitary Master Plan Addendum, Municipal Class Environmental Assessment
Date:	Friday, October 13, 2023 1:35:19 PM
Attachments:	MECP Acknowledgement of NOC -City of Waterloo Integrated Sanitary Addendum.pdf Client Guide to Preliminary Screening-May 2019.pdf

Good afternoon,

Sincere apologies for the delay.

Please find attached MECP's Letter of Acknowledgement and attachment in response to the Notice of Commencement for the City of Waterloo, Integrated Sanitary Master Plan Addendum.

Please do not hesitate to contact me if you have any questions.

Regards,

Joan Del Villar Cuicas (she/her)
Regional Environmental Planner
Project Review Unit | Environmental Assessment Branch
Ontario Ministry of the Environment, Conservation and Parks
Joan.delvillarcuicas@ontario.ca|Phone: 365-889-1180

From: Micks, Sarah <Sarah.Micks@stantec.com>
Sent: August 25, 2023 2:59 PM
To: EA Notices to WCRegion (MECP) <eanotification.wcregion@ontario.ca>; Del Villar Cuicas, Joan (MECP) <Joan.DelVillarCuicas@ontario.ca>
Cc: Hohner, Paula <Paula.Hohner@stantec.com>; Paul, Jeff <jeff.paul@stantec.com>; Veronica Kroess <Veronica.Kroess@waterloo.ca>
Subject: City of Waterloo, Integrated Sanitary Master Plan Addendum, Municipal Class Environmental Assessment

Good Afternoon Joan,

I'm emailing in regards to a Master Plan Municipal Class Environmental Assessment (EA) study being undertaken by the City of Waterloo. The City is completing an Addendum to the existing 2015 Waterloo Sanitary Master Plan, to examine the City's infrastructure needs considering new planning policies, growth projections, and the current needs and issues that exist in the community.

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Please don't hesitate to let me know if you have any questions or concerns, and I apologize for the delay in getting these documents to you.

Thank you!

Sarah Micks
Environmental Planner
sarah.micks@stantec.com
Direct: 519-432-4292

Stantec

Ontario

Ministry of the Environment, Conservation and Parks

Ministère de l'Environnement, de la Protection de la nature et des Parcs

Environmental Assessment Branch

Direction des évaluations environnementales

1st Floor
135 St. Clair Avenue W
Toronto ON M4V 1P5
Tel.: 416 314-8001
Fax.: 416 314-8452

Rez-de-chaussée
135, avenue St. Clair Ouest
Toronto ON M4V 1P5
Tél. : 416 314-8001
Téléc. : 416 314-8452

October 13, 2023

Veronica Kroess
Project Manager
City of Waterloo
veronica.kroess@waterloo.ca

Jeff Paul
Project Manager
Stantec Consulting Ltd.
Jeff.Paul@stantec.com

BY EMAIL ONLY

Re: **Integrated Sanitary Master Plan**
City of Waterloo
Municipal Class Environmental Assessment Addendum, Schedule
Acknowledgement of Notice of Commencement

Dear Project Team,

This letter is in response to the Notice of Commencement for the addendum to the above noted project. The Ministry of the Environment, Conservation and Parks (MECP) acknowledges that the proponent (City of Waterloo) has indicated that the addendum is following the approved environmental planning process for a Master Plan following Phases 1-2 under the Municipal Class Environmental Assessment (Class EA).

The **updated (August 2022)** attached "Areas of Interest" document provides guidance regarding the ministry's interests with respect to the Class EA process. Please address all areas of interest in the EA documentation at an appropriate level for the EA study. Proponents who address all the applicable areas of interest can minimize potential delays to the project schedule. **Further information is provided at the end of the Areas of Interest document relating to recent changes to the Environmental Assessment Act through Bill 197, Covid-19 Economic Recovery Act 2020.**

The Crown has a legal duty to consult Aboriginal communities when it has knowledge, real or constructive, of the existence or potential existence of an Aboriginal or treaty right and contemplates conduct that may adversely impact that right. Before authorizing this project, the Crown must ensure that its duty to consult has been fulfilled, where such a duty is triggered. Although the duty to consult with Aboriginal peoples is a duty of the Crown, the Crown may delegate procedural aspects of this duty to project proponents while retaining oversight of the consultation process.

The proposed project may have the potential to affect Aboriginal or treaty rights protected under Section 35 of Canada's *Constitution Act* 1982. Where the Crown's duty to consult is triggered in relation to the proposed project**, the MECP is delegating the procedural aspects of rights-based consultation to the proponent through this letter.** The Crown intends to rely on the delegated consultation process in discharging its duty to consult and maintains the right to participate in the consultation process as it sees fit.

Based on information provided to date and the Crown`s preliminary assessment the proponent is required to consult with the following communities who have been identified as potentially affected by the addendum to the proposed project

- **Mississaugas of the Credit First Nation**
- **Six Nations of the Grand River (both Elected Council, and Traditional Council (Haudenosaunee Confederacy Chiefs Council (HCCC) / Haudenosaunee Development Institute (HDI)).**

Steps that the proponent may need to take in relation to Aboriginal consultation for the proposed project are outlined in the "Code of Practice for Consultation in Ontario's Environmental Assessment Process". Additional information related to Ontario's Environmental Assessment Act is available online at: www.ontario.ca/environmentalassessments.

Please also refer to the attached document "A Proponent's Introduction to the Delegation of Procedural Aspects of consultation with Aboriginal Communities" for further information, including the MECP's expectations for EA report documentation related to consultation with communities.

The proponent must contact the Director of Environmental Assessment Branch (EABDirector@ontario.ca) under the following circumstances after initial discussions with the communities identified by the MECP:

- Aboriginal or treaty rights impacts are identified to you by the communities;
- You have reason to believe that your proposed project may adversely affect an Aboriginal or treaty right;
- Consultation with Indigenous communities or other stakeholders has reached an impasse; or
- A Section 16 Order request is expected based on impacts to Aboriginal or treaty rights

The MECP will then assess the extent of any Crown duty to consult for the circumstances and will consider whether additional steps should be taken, including what role you will be asked to play should additional steps and activities be required.

Should you or any members of your project team have any questions regarding the material above, please contact me at joan.delvillarcuicas@ontario.ca.

Sincerely,

Joan Del Villar Cuicas
Regional Environmental Planner – West Region
Project Review Unit, Environmental Assessment Branch

Cc: Aaron Todd, Manager, Guelph District Office, MECP
Sarah Micks, Environmental Planner, Stantec

Enclosed: Areas of Interest

Attached: Client's Guide to Preliminary Screening for Species at Risk

A Proponent's Introduction to the Delegation of Procedural Aspects of Consultation with Aboriginal Communities

AREAS OF INTEREST (v. August 2022)

It is suggested that you check off each section after you have considered / addressed it.

☐ **Planning and Policy**

- Applicable plans and policies should be identified in the report, and the proponent should describe how the proposed project adheres to the relevant policies in these plans.
    - Projects located in MECP Central, Eastern or West Central Region may be subject to **A Place to Grow: Growth Plan for the Greater Golden Horseshoe (2020)**.
    - Projects located in MECP Central or Eastern Region may be subject to the **Oak Ridges Moraine Conservation Plan (2017)** or the **Lake Simcoe Protection Plan (2014)**.
    - Projects located in MECP Central, Southwest or West Central Region may be subject to the **Niagara Escarpment Plan (2017)**.
    - Projects located in MECP Central, Eastern, Southwest or West Central Region may be subject to the **Greenbelt Plan (2017)**.
    - Projects located in MECP Northern Region may be subject to the **Growth Plan for Northern Ontario (2011).**

- The **Provincial Policy Statement (2020)** contains policies that protect Ontario's natural heritage and water resources. Applicable policies should be referenced in the report, and the proponent should describe how the proposed project is consistent with these policies.

- In addition to the provincial planning and policy level, the report should also discuss the planning context at the municipal and federal levels, as appropriate.

☐ **Source Water Protection**

The *Clean Water Act*, 2006 (CWA) aims to protect existing and future sources of drinking water. To achieve this, several types of vulnerable areas have been delineated around surface water intakes and wellheads for every municipal residential drinking water system that is located in a source protection area. These vulnerable areas are known as a Wellhead Protection Areas (WHPAs) and surface water Intake Protection Zones (IPZs). Other vulnerable areas that have been delineated under the CWA include Highly Vulnerable Aquifers (HVAs), Significant Groundwater Recharge Areas (SGRAs), Event-based modelling areas (EBAs), and Issues Contributing Areas (ICAs). Source protection plans have been developed that include policies to address existing and future risks to sources of municipal drinking water within these vulnerable areas.

Projects that are subject to the Environmental Assessment Act that fall under a Class EA, or one of the Regulations, have the potential to impact sources of drinking water if they occur in designated vulnerable areas or in the vicinity of other at-risk drinking water systems (i.e.

systems that are not municipal residential systems). MEA Class EA projects may include activities that, if located in a vulnerable area, could be a threat to sources of drinking water (i.e. have the potential to adversely affect the quality or quantity of drinking water sources) and the activity could therefore be subject to policies in a source protection plan. Where an activity poses a risk to drinking water, policies in the local source protection plan may impact how or where that activity is undertaken. Policies may prohibit certain activities, or they may require risk management measures for these activities. Municipal Official Plans, planning decisions, Class EA projects (where the project includes an activity that is a threat to drinking water) and prescribed instruments must conform with policies that address significant risks to drinking water and must have regard for policies that address moderate or low risks.

- In October 2015, the MEA Parent Class EA document was amended to include reference to the Clean Water Act (Section A.2.10.6) and indicates that proponents undertaking a Municipal Class EA project must identify early in their process whether a project is or could potentially be occurring with a vulnerable area. **Given this requirement, please include a section in the report on source water protection.**

    - The proponent should identify the source protection area and should clearly document how the proximity of the project to sources of drinking water (municipal or other) and any delineated vulnerable areas was considered and assessed. Specifically, the report should discuss whether or not the project is located in a vulnerable area and provide applicable details about the area.

    - If located in a vulnerable area, proponents should document whether any project activities are prescribed drinking water threats and thus pose a risk to drinking water (this should be consulted on with the appropriate Source Protection Authority). Where an activity poses a risk to drinking water, the proponent must document and discuss in the report how the project adheres to or has regard to applicable policies in the local source protection plan. This section should then be used to inform and be reflected in other sections of the report, such as the identification of net positive/negative effects of alternatives, mitigation measures, evaluation of alternatives etc.

- While most source protection plans focused on including policies for significant drinking water threats in the WHPAs and IPZs it should be noted that even though source protection plan policies may not apply in HVAs, these are areas where aquifers are sensitive and at risk to impacts and within these areas, activities may impact the quality of sources of drinking water for systems other than municipal residential systems.

- In order to determine if this project is occurring within a vulnerable area, proponents can use Source Protection Information Atlas, which is an online mapping tool available to the public. Note that various layers (including WHPAs, WHPA-Q1 and WHPA-Q2, IPZs, HVAs, SGRAs, EBAs, ICAs) can be turned on through the “Map Legend” bar on the left. The mapping tool will also provide a link to the appropriate source protection plan in order to identify what policies may be applicable in the vulnerable area.

- For further information on the maps or source protection plan policies which may relate to their project, proponents must contact the appropriate source protection authority. **Please consult with the local source protection authority to discuss potential impacts on drinking water. Please document the results of that consultation within the report and include all communication documents/correspondence.**

More Information

For more information on the *Clean Water Act*, source protection areas and plans, including specific information on the vulnerable areas and drinking water threats, please refer to Conservation Ontario's website where you will also find links to the local source protection plan/assessment report.

A list of the prescribed drinking water threats can be found in section 1.1 of Ontario Regulation 287/07 made under the *Clean Water Act*. In addition to prescribed drinking water threats, some source protection plans may include policies to address additional "local" threat activities, as approved by the MECP.

- **Climate Change**

The document "Considering Climate Change in the Environmental Assessment Process" (Guide) is now a part of the Environmental Assessment program's Guides and Codes of Practice. The Guide sets out the MECP's expectation for considering climate change in the preparation, execution and documentation of environmental assessment studies and processes. The guide provides examples, approaches, resources, and references to assist proponents with consideration of climate change in EA. Proponents should review this Guide in detail.

- **The MECP expects proponents of Class EA projects to:**

    1. Consider during the assessment of alternative solutions and alternative designs, the following:
        a. the project's expected production of greenhouse gas emissions and impacts on carbon sinks (climate change mitigation); and
        b. resilience or vulnerability of the undertaking to changing climatic conditions (climate change adaptation).
    2. Include a discrete section in the report detailing how climate change was considered in the EA.

How climate change is considered can be qualitative or quantitative in nature and should be scaled to the project's level of environmental effect. In all instances, both a project's impacts on climate change (mitigation) and impacts of climate change on a project (adaptation) should be considered.

- The MECP has also prepared another guide to support provincial land use planning direction related to the completion of energy and emission plans. The "Community Emissions Reduction Planning: A Guide for Municipalities" document is designed to educate stakeholders on the municipal opportunities to reduce energy and greenhouse gas emissions, and to provide guidance on methods and techniques to incorporate consideration of energy and greenhouse gas emissions into municipal activities of all types. We encourage you to review the Guide for information.

Air Quality, Dust and Noise

- If there are sensitive receptors in the surrounding area of this project, a quantitative air quality/odour impact assessment will be useful to evaluate alternatives, determine impacts and identify appropriate mitigation measures. The scope of the assessment can be determined based on the potential effects of the proposed alternatives, and typically includes source and receptor characterization and a quantification of local air quality impacts on the sensitive receptors and the environment in the study area. The assessment will compare to all applicable standards or guidelines for all contaminants of concern. **Please contact this office for further consultation on the level of Air Quality Impact Assessment required for this project if not already advised.**

- If a quantitative Air Quality Impact Assessment is not required for the project, the MECP expects that the report contain a qualitative assessment which includes:

    - A discussion of local air quality including existing activities/sources that significantly impact local air quality and how the project may impact existing conditions;
    - A discussion of the nearby sensitive receptors and the project's potential air quality impacts on present and future sensitive receptors;
    - A discussion of local air quality impacts that could arise from this project during both construction and operation; and
    - A discussion of potential mitigation measures.

- As a common practice, "air quality" should be used an evaluation criterion for all road projects.

- Dust and noise control measures should be addressed and included in the construction plans to ensure that nearby residential and other sensitive land uses within the study area are not adversely affected during construction activities.

- The MECP recommends that non-chloride dust-suppressants be applied. For a comprehensive list of fugitive dust prevention and control measures that could be applied, refer to *Cheminfo Services Inc. Best Practices for the Reduction of Air Emissions from*

Construction and Demolition Activities report prepared for Environment Canada. March 2005.

- The report should consider the potential impacts of increased noise levels during the operation of the completed project. The proponent should explore all potential measures to mitigate significant noise impacts during the assessment of alternatives.

- **Ecosystem Protection and Restoration**

- Any impacts to ecosystem form and function must be avoided where possible. The report should describe any proposed mitigation measures and how project planning will protect and enhance the local ecosystem.

- Natural heritage and hydrologic features should be identified and described in detail to assess potential impacts and to develop appropriate mitigation measures. The following sensitive environmental features may be located within or adjacent to the study area:
  - Key Natural Heritage Features: Habitat of endangered species and threatened species, fish habitat, wetlands, areas of natural and scientific interest (ANSIs), significant valleylands, significant woodlands; significant wildlife habitat (including habitat of special concern species); sand barrens, savannahs, and tallgrass prairies; and alvars.
  - Key Hydrologic Features: Permanent streams, intermittent streams, inland lakes and their littoral zones, seepage areas and springs, and wetlands.
  - Other natural heritage features and areas such as: vegetation communities, rare species of flora or fauna, Environmentally Sensitive Areas, Environmentally Sensitive Policy Areas, federal and provincial parks and conservation reserves, Greenland systems etc.

We recommend consulting with the Ministry of Natural Resources and Forestry (MNRF), Fisheries and Oceans Canada (DFO) and your local conservation authority to determine if special measures or additional studies will be necessary to preserve and protect these sensitive features. In addition, for projects located in Central Region you may consider the provisions of the Rouge Park Management Plan if applicable.

- **Species at Risk**

- The Ministry of the Environment, Conservation and Parks has now assumed responsibility of Ontario's Species at Risk program. Information, standards, guidelines, reference materials and technical resources to assist you are found at https://www.ontario.ca/page/species-risk.

- The Client's Guide to Preliminary Screening for Species at Risk (Draft May 2019) has been attached to the covering email for your reference and use. Please review this document for next steps.

- For any questions related to subsequent permit requirements, please contact SAROntario@ontario.ca.

- **Surface Water**

- The report must include enough information to demonstrate that there will be no negative impacts on the natural features or ecological functions of any watercourses within the study area. Measures should be included in the planning and design process to ensure that any impacts to watercourses from construction or operational activities (e.g. spills, erosion, pollution) are mitigated as part of the proposed undertaking.

- Additional stormwater runoff from new pavement can impact receiving watercourses and flood conditions. Quality and quantity control measures to treat stormwater runoff should be considered for all new impervious areas and, where possible, existing surfaces. The ministry's Stormwater Management Planning and Design Manual (2003) should be referenced in the report and utilized when designing stormwater control methods. **A Stormwater Management Plan should be prepared as part of the Class EA process** that includes:

    - Strategies to address potential water quantity and erosion impacts related to stormwater draining into streams or other sensitive environmental features, and to ensure that adequate (enhanced) water quality is maintained
    - Watershed information, drainage conditions, and other relevant background information
    - Future drainage conditions, stormwater management options, information on erosion and sediment control during construction, and other details of the proposed works
    - Information on maintenance and monitoring commitments.

- Ontario Regulation 60/08 under the *Ontario Water Resources Act* (OWRA) applies to the Lake Simcoe Basin, which encompasses Lake Simcoe and the lands from which surface water drains into Lake Simcoe. If a proposed sewage treatment plant is listed in Table 1 of the regulation, the report should describe how the proposed project and its mitigation measures are consistent with the requirements of this regulation and the OWRA.

- Any potential approval requirements for surface water taking or discharge should be identified in the report. A Permit to Take Water (PTTW) under the OWRA will be required for any water takings that exceed 50,000 L/day, except for certain water taking activities that have been prescribed by the Water Taking EASR Regulation – *O. Reg. 63/16*. These prescribed water-taking activities require registration in the EASR instead of a PTTW. Please review the Water Taking User Guide for EASR for more information. Additionally, an Environmental Compliance Approval under the OWRA is required for municipal stormwater management works.

- [ ] **Groundwater**

- The status of, and potential impacts to any well water supplies should be addressed. If the project involves groundwater takings or changes to drainage patterns, the quantity and quality of groundwater may be affected due to drawdown effects or the redirection of existing contamination flows. In addition, project activities may infringe on existing wells such that they must be reconstructed or sealed and abandoned. Appropriate information to define existing groundwater conditions should be included in the report.

- If the potential construction or decommissioning of water wells is identified as an issue, the report should refer to Ontario Regulation 903, Wells, under the OWRA.

- Potential impacts to groundwater-dependent natural features should be addressed. Any changes to groundwater flow or quality from groundwater taking may interfere with the ecological processes of streams, wetlands or other surficial features. In addition, discharging contaminated or high volumes of groundwater to these features may have direct impacts on their function. Any potential effects should be identified, and appropriate mitigation measures should be recommended. The level of detail required will be dependent on the significance of the potential impacts.

- Any potential approval requirements for groundwater taking or discharge should be identified in the report. A Permit to Take Water (PTTW) under the OWRA will be required for any water takings that exceed 50,000 L/day, with the exception of certain water taking activities that have been prescribed by the Water Taking EASR Regulation – *O. Reg. 63/16*. These prescribed water-taking activities require registration in the EASR instead of a PTTW. Please review the Water Taking User Guide for EASR for more information.

- Consultation with the railroad authorities is necessary wherever there is a plan to use construction dewatering in the vicinity of railroad lines or where the zone of influence of the construction dewatering potentially intercepts railroad lines.

- [ ] **Excess Materials Management**

- In December 2019, MECP released a new regulation under the Environmental Protection Act, titled "On-Site and Excess Soil Management" (O. Reg. 406/19) to support improved management of excess construction soil. This regulation is a key step to support proper management of excess soils, ensuring valuable resources don't go to waste and to provide clear rules on managing and reusing excess soil. New risk-based standards referenced by this regulation help to facilitate local beneficial reuse which in turn will reduce greenhouse gas emissions from soil transportation, while ensuring strong protection of human health and the environment. The new regulation is being phased in over time, with the first phase in effect on January 1, 2021. For more information, please visit https://www.ontario.ca/page/handling-excess-soil.

- The report should reference that activities involving the management of excess soil should be completed in accordance with O. Reg. 406/19 and the MECP's current guidance document titled "Management of Excess Soil – A Guide for Best Management Practices" (2014).

- All waste generated during construction must be disposed of in accordance with ministry requirements

Contaminated Sites

- Any current or historical waste disposal sites should be identified in the report. The status of these sites should be determined to confirm whether approval pursuant to Section 46 of the EPA may be required for land uses on former disposal sites. We recommend referring to the MECP's D-4 guideline for land use considerations near landfills and dumps.
  - Resources available may include regional/local municipal official plans and data; provincial data on large landfill sites and small landfill sites; Environmental Compliance Approval information for waste disposal sites on Access Environment.

- Other known contaminated sites (local, provincial, federal) in the study area should also be identified in the report (Note – information on federal contaminated sites is found on the Government of Canada's website).

- The location of any underground storage tanks should be investigated in the report. Measures should be identified to ensure the integrity of these tanks and to ensure an appropriate response in the event of a spill. The ministry's Spills Action Centre must be contacted in such an event.

- Since the removal or movement of soils may be required, appropriate tests to determine contaminant levels from previous land uses or dumping should be undertaken. If the soils are contaminated, you must determine how and where they are to be disposed of, consistent with *Part XV.1 of the Environmental Protection Act* (EPA) and Ontario Regulation 153/04, Records of Site Condition, which details the new requirements related to site assessment and clean up. Please contact the appropriate MECP District Office for further consultation if contaminated sites are present.

☐ **Servicing, Utilities and Facilities**

- The report should identify any above or underground utilities in the study area such as transmission lines, telephone/internet, oil/gas etc. The owners should be consulted to discuss impacts to this infrastructure, including potential spills.

- The report should identify any servicing infrastructure in the study area such as wastewater, water, stormwater that may potentially be impacted by the project.

- Any facility that releases emissions to the atmosphere, discharges contaminants to ground or surface water, provides potable water supplies, or stores, transports or disposes of waste must have an Environmental Compliance Approval (ECA) before it can operate lawfully. Please consult with MECP's Environmental Permissions Branch to determine whether a new or amended ECA will be required for any proposed infrastructure.

- We recommend referring to the ministry's environmental land use planning guides to ensure that any potential land use conflicts are considered when planning for any infrastructure or facilities related to wastewater, pipelines, landfills or industrial uses.

☐ **Mitigation and Monitoring**

- Contractors must be made aware of all environmental considerations so that all environmental standards and commitments for both construction and operation are met. Mitigation measures should be clearly referenced in the report and regularly monitored during the construction stage of the project. In addition, we encourage proponents to conduct post-construction monitoring to ensure all mitigation measures have been effective and are functioning properly.

- Design and construction reports and plans should be based on a best management approach that centres on the prevention of impacts, protection of the existing environment, and opportunities for rehabilitation and enhancement of any impacted areas.

- The proponent's construction and post-construction monitoring plans must be documented in the report, as outlined in Section A.2.5 and A.4.1 of the MEA Class EA parent document.

☐ **Consultation**

- The report must demonstrate how the consultation provisions of the Class EA have been fulfilled, including documentation of all stakeholder consultation efforts undertaken during the planning process. This includes a discussion in the report that identifies concerns that were raised and **describes how they have been addressed by the proponent** throughout the planning process. The report should also include copies of comments submitted on the project by interested stakeholders, and the proponent's responses to these comments (as directed by the Class EA to include full documentation).

- Please include the full stakeholder distribution/consultation list in the documentation.

Class EA Process

- If this project is a Master Plan: there are several different approaches that can be used to conduct a Master Plan, examples of which are outlined in Appendix 4 of the Class EA. **The Master Plan should clearly indicate the selected approach for conducting the plan**, by identifying whether the levels of assessment, consultation and documentation are sufficient to fulfill the requirements for Schedule B or C projects. Please note that any Schedule B or C projects identified in the plan would be subject to Part II Order Requests under the Environmental Assessment Act, although the plan itself would not be. **Please include a description of the approach being undertaken (use Appendix 4 as a reference).**

- If this project is a Master Plan: Any identified projects should also include information on the MCEA schedule associated with the project.

- The report should provide clear and complete documentation of the planning process in order to allow for transparency in decision-making.

- The Class EA requires the consideration of the effects of each alternative on all aspects of the environment (including planning, natural, social, cultural, economic, technical). The report should include a level of detail (e.g. hydrogeological investigations, terrestrial and aquatic assessments, cultural heritage assessments) such that all potential impacts can be identified, and appropriate mitigation measures can be developed. Any supporting studies conducted during the Class EA process should be referenced and included as part of the report.

- Please include in the report a list of all subsequent permits or approvals that may be required for the implementation of the preferred alternative, including but not limited to, MECP's PTTW, EASR Registrations and ECAs, conservation authority permits, species at risk permits, MTO permits and approvals under the *Impact Assessment Act*, 2019.

- Ministry guidelines and other information related to the issues above are available at http://www.ontario.ca/environment-and-energy/environment-and-energy. We encourage you to review all the available guides and to reference any relevant information in the report.

Amendments to the EAA through the Covid-19 Economic Recovery Act, 2020
Once the EA Report is finalized, the proponent must issue a Notice of Completion providing a minimum 30-day period during which documentation may be reviewed and comment and input can be submitted to the proponent. The Notice of Completion must be sent to the appropriate MECP Regional Office email address.

The public can request a higher level of assessment on a project if they are concerned about potential adverse impacts to constitutionally protected Aboriginal and treaty rights. In addition, the Minister may issue an order on his or her own initiative within a specified time period. The Director (of the Environmental Assessment Branch) will issue a Notice of Proposed Order to the proponent if the Minister is considering an order for the project within 30 days after the conclusion of the comment period on the Notice of Completion. At this time, the Director may request additional information from the proponent. Once the requested information has been received, the Minister will have 30 days within which to make a decision or impose conditions on your project.

Therefore, the proponent cannot proceed with the project until at least 30 days after the end of the comment period provided for in the Notice of Completion. Further, the proponent may not proceed after this time if:

- a Section 16 Order request has been submitted to the ministry regarding potential adverse impacts to constitutionally protected Aboriginal and treaty rights, or
- the Director has issued a Notice of Proposed order regarding the project.

Please ensure that the Notice of Completion advises that outstanding concerns are to be directed to the proponent for a response, and that in the event there are outstanding concerns regarding potential adverse impacts to constitutionally protected Aboriginal and treaty rights, Section 16 Order requests on those matters should be addressed in writing to:

Minister David Piccini
Ministry of Environment, Conservation and Parks
777 Bay Street, 5th Floor
Toronto ON M7A 2J3
minister.mecp@ontario.ca

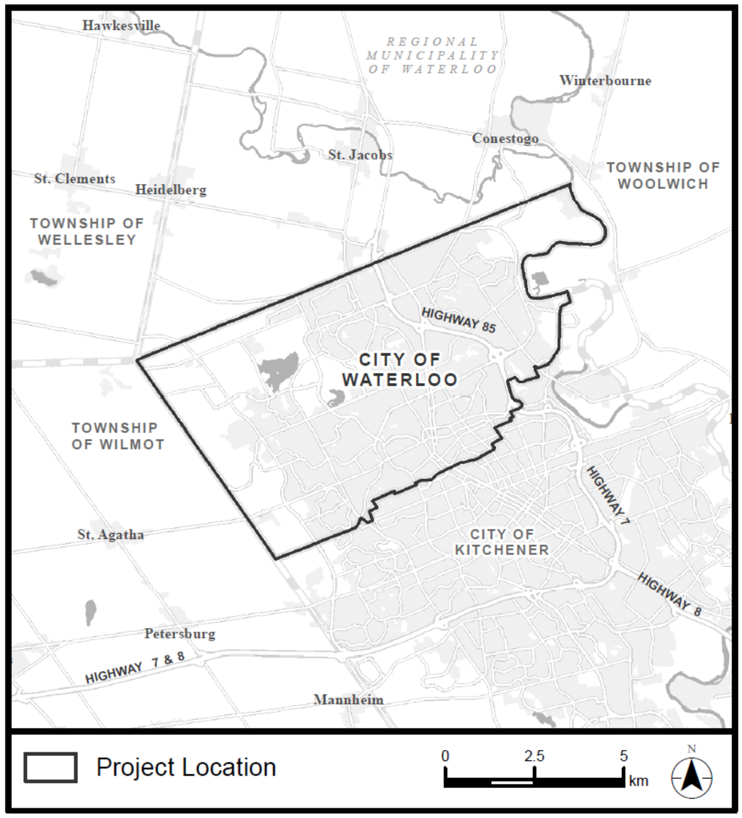
and

Director, Environmental Assessment Branch
Ministry of Environment, Conservation and Parks
135 St. Clair Ave. W, 1st Floor
Toronto ON, M4V 1P5
EABDirector@ontario.ca

Public Consultation Centre 1

CITY OF WATERLOO
NOTICE OF ONLINE PUBLIC CONSULTATION CENTRE #1
Municipal Class Environmental Assessment Study
Integrated Sanitary Master Plan

The City of Waterloo (City) is undertaking an Addendum to the existing 2015 Waterloo Sanitary Master Plan. The purpose of this Addendum is to examine the City's infrastructure needs considering new planning policies, growth projections, and the current needs and issues that exist in our community. The Integrated Sanitary Master Plan will review improvements to existing sanitary infrastructure, the installation of new sanitary infrastructure, and consideration of private services to municipal servicing, through to the year 2051. The Study is being undertaken within the City limits, as shown on the map.



HOW CAN I PARTICIPATE IN THIS STUDY?

An Online Public Consultation Centre (PCC) is being held through the City's Engage Waterloo website to present background information on the study. The PCC materials will be available on the City's Engage Waterloo website starting on September 15, 2022.

Website: https://www.engagewr.ca/sanitary-master-plan

Please provide comments through the Engage Waterloo website, or to a member of the project team by October 12, 2022 using the contact information below.

Veronica Kroess
Project Manager
City of Waterloo
100 Regina Street South
P.O. Box 337, Station Waterloo
Waterloo, ON N2J 4A8
Phone: 519-886-2310 x 78563
Email: veronica.kroess@waterloo.ca

Jeff Paul, P.Eng.
Project Manager
Stantec Consulting Ltd.
600-171 Queens Avenue
London ON N6A 5J7
Phone: 519-319-5806
Email: Jeff.Paul@stantec.com

If you have any accessibility requirements in order to participate in this study, please contact the City of Waterloo Project Manager. Information will be collected in accordance with the Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.

This notice was first issued on September 7, 2022.

From: Lang, Sarah
Cc: veronica.kroess@waterloo.ca; Karky, Apurba; Paul, Jeff; Hohner, Paula
Bcc: david.marriott@ontario.ca; erick.boyd@ontario.ca; lisa.myslicki@infrastructureontario.ca; geddes.mahabir@ontario.ca; karla.barboza@ontario.ca; ian.thornton@ontario.ca; mark.badali1@ontario.ca; EA Notices to SWRegion (MECP); bbrown@grandriver.ca; theywood@grandriver.ca; manderson@grandriver.ca; blauckner@regionofwaterloo.ca; tschmidt@regionofwaterloo.ca; sharon.chambers@wilmot.ca; dbrenneman@woolwich.ca; est.reg.crossing@enbridge.com; ted.hancocks@rci.rogers.com; janet.cleghorn@bell.ca; secondarylanduse@hydroone.com; eclerk@wnhydro.com; michael.vallins@cn.ca; dominic_bonaldo@cpr.ca; planning@wcdsb.ca; planning@wrdsb.ca; admin@greaterkwchamber.com; president@waterlooregionnature.ca; KHagerman@regionofwaterloo.ca; bcoady@regionofwaterloo.ca; msergi@regionofwaterloo.ca; maria.kyveris@rogers.com; committees@waterloo.ca; publicinfo@wrps.on.ca; publichealth@regionofwaterloo.ca; fire.chief@waterloo-ia.org
Subject: Notice of Public Consultation Centre #1 - City of Waterloo, Integrated Sanitary Master Plan
Date: Thursday, September 15, 2022 1:25:00 PM
Attachments: not_waterloo_sanitaryMP_PCC1_AODA.pdf

Hello,

Please see the attached Notice of Public Consultation Centre (PCC) #1 for the City of Waterloo, Integrated Sanitary Master Plan, Municipal Class Environmental Assessment. This study is being undertaken as an Addendum to the existing 2015 Waterloo Sanitary Master Plan to examine the City's infrastructure needs considering new planning policies, growth projections, and the current needs and issues that exist in the community.

The first PCC is being held through the City's Engage Waterloo website to present background information on the study. **The PCC materials will be available for review on the City's Engage Waterloo website from September 15, 2022 to October 12, 2022.**

City's Engage Waterloo Website: https://www.engagewr.ca/sanitary-master-plan

Please contact a member of the project team identified on the attached Notice if you have any questions, comments or concerns.

Thank you,

Sarah Lang
Environmental Planner
sarah.lang@stantec.com

Stantec

From:	Harvey, Joseph (MTCS)
To:	Veronica Kroess
Cc:	Paul, Jeff; Lang, Sarah
Subject:	FW: File 0017623: Notice of Public Consultation Centre #1 - City of Waterloo, Integrated Sanitary Master Plan
Date:	Friday, October 7, 2022 11:02:21 AM
Attachments:	not_waterloo_sanitaryMP_PCC1_AODA.pdf 2022-10-07_WaterlooSanitaryPlan-MTCS-Ltr.pdf

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Veronica Kroess,

Please see attached MTCS's initial advice on the above referenced undertaking. Do not hesitate to contact me with any questions or concerns.

Regards,

Joseph Harvey | Heritage Planner
Heritage, Tourism and Culture Division | Programs and Services Branch | Heritage Planning Unit
Ministry of Tourism, Culture, and Sport
613.242.3743
Joseph.Harvey@ontario.ca

From: Lang, Sarah <Sarah.Lang@stantec.com>
Sent: September-15-22 1:26 PM
Cc: Veronica Kroess <Veronica.Kroess@waterloo.ca>; Karky, Apurba <Apurba.Karky@stantec.com>; Paul, Jeff <jeff.paul@stantec.com>; Hohner, Paula <Paula.Hohner@stantec.com>
Subject: Notice of Public Consultation Centre #1 - City of Waterloo, Integrated Sanitary Master Plan

Hello,

Please see the attached Notice of Public Consultation Centre (PCC) #1 for the City of Waterloo, Integrated Sanitary Master Plan, Municipal Class Environmental Assessment. This study is being undertaken as an Addendum to the existing 2015 Waterloo Sanitary Master Plan to examine the City's infrastructure needs considering new planning policies, growth projections, and the current needs and issues that exist in the community.

The first PCC is being held through the City's Engage Waterloo website to present background information on the study. **The PCC materials will be available for review on the City's Engage Waterloo website from September 15, 2022 to October 12, 2022.**

City's Engage Waterloo Website: https://www.engagewr.ca/sanitary-master-plan

Please contact a member of the project team identified on the attached Notice if you have any questions, comments or concerns.

Thank you,

Sarah Lang
Environmental Planner
sarah.lang@stantec.com

Stantec

Ministry of Tourism, Culture and Sport

Programs and Services Branch
400 University Ave, 5th Flr
Toronto, ON M7A 2R9
Tel: 613.242.3743

Ministère du Tourisme, Culture et Sport

Direction des programmes et des services
400, av. University, 5e étage
Toronto, ON M7A 2R9
Tél: 613.242.3743

Ontario

October 7, 2022 EMAIL ONLY

Veronica Kroess
Project Manager
City of Waterloo
100 Regina Street South
P.O. Box 337, Station Waterloo
Waterloo, ON N2J 4A8
veronica.kroess@waterloo.ca

MTCS File	**:**	**0017623**
Proponent	**:**	**City of Waterloo**
Subject	**:**	**Notice of Online Public Consultation - Master Plan Addendum**
Project	**:**	**Integrated Sanitary Master Plan**
Location	**:**	**City of Waterloo**

Dear Veronica Kroess:

Thank you for providing the Ministry of Tourism, Culture and Sport (MTCS) with the Notice of Online Public Consultation. MTCS's interest in this master plan relates to it's mandate of conserving Ontario's cultural heritage, which includes archaeological resources, built heritage resources and cultural heritage landscapes.

MTCS understands that master plans are long range plans which integrate infrastructure requirements for existing and future land use with environmental assessment planning principles. The Municipal Class Environmental Assessment (MCEA) outlines a framework for master plan and associated studies which should recognize the planning and design Process of this Class EA, and should incorporate the key principles of successful environmental assessment planning identified in Section A.1.1. The master planning process will, at minimum, address Phases 1 and 2 of the Planning and Design Process of the MCEA.

This letter provides advice on how to incorporate consideration of cultural heritage in the above-mentioned master planning process by outlining the technical cultural heritage studies and the level of detail required to address cultural heritage in master plans. In accordance with the MCEA, cultural heritage resources should be identified early in the process in order to determine known and potential resources and potential impacts.

Master Plan Summary
The City of Waterloo (City) is undertaking an Addendum to the existing 2015 Waterloo Sanitary Master Plan. This Environmental Assessment (EA) Study is being undertaken as an Addendum to a Master Plan in accordance with the planning and design process as outlined in the Ontario Municipal Class EA document (2000, as amended)(External link) which is an approved process under the Ontario Environmental Assessment Act. This Master Plan is intended to satisfy the documentation and consultation requirements for Phase 1 and 2 of the Municipal Class EA process.

Identifying Cultural Heritage Resources
MTCS understands that the final public notice for the master plan could become the notice of completion for the Schedule B and C MCEAs within it and that this approach would likely result in extensive documentation should the master plan include numerous Schedule C MCEA undertakings. In regards to cultural heritage resources the Master Plan Document should;

- identify existing baseline environmental conditions,
- identify expected environmental impacts and,
- Include measures to mitigate potential negative impacts.

Archaeological Resources
Any undertakings as part of the master plan should be screened using the MTCS *Criteria for Evaluating Archaeological Potential* and *Criteria for Evaluating Marine Archaeological Potential* to determine if an archaeological assessment is needed. If the EA project area exhibits archaeological potential, then an archaeological assessment (AA) should be undertaken by an archaeologist licensed under the Ontario Heritage Act and submitted for MTCS review prior to the completion of the master plan.

Built Heritage Resources and Cultural Heritage Landscapes
A Cultural Heritage Report: Existing Conditions and Preliminary Impact Assessment will be undertaken for the entire study area during the planning phase and will be summarized in the EA Report. This study will:

1. Describe the existing baseline cultural heritage conditions within the study area by identifying all known or potential built heritage resources and cultural heritage landscapes, including a historical summary of the study area. MTCS has developed screening criteria that may assist with this exercise: *Criteria for Evaluating for Potential Built Heritage Resources and Cultural Heritage Landscapes*.

2. Identify preliminary potential project-specific impacts on the known and potential built heritage resources and cultural heritage landscapes that have been identified. The report should include a description of the anticipated impact to each known or potential built heritage resource or cultural heritage landscape that has been identified.

3. Recommend measures to avoid or mitigate potential negative impacts to known or potential built heritage resources and cultural heritage landscapes. The proposed mitigation measures are to inform the next steps of project planning and design.

Where a known or potential built heritage resource or cultural heritage landscape may be directly and adversely impacted, and where it has not yet been evaluated for Cultural Heritage Value or Interest (CHVI), completion of a Cultural Heritage Evaluation Report (CHER) is required to fully understand its CHVI and level of significance. The CHER must be completed as part of the final EA report. If a potential resource is found to be of CHVI, then a Heritage Impact Assessment (HIA) will need to be undertaken and included in the final EA report. Our Ministry's *Info Sheet #5: Heritage Impact Assessments and Conservation Plans* outlines the scope of HIAs. Please send the HIA to MTCS for review and make it available to local organizations or individuals who have expressed interest in review.

While some cultural heritage landscapes are contained within individual property boundaries, others span across multiple properties. For certain cultural heritage landscapes, it will be more appropriate for the CHER and HIA to include multiple properties, in order to reflect the extent of that cultural heritage landscape in its entirety.

Community input should be sought to identify locally recognized and potential cultural heritage resources. Sources include, but are not limited to, municipal heritage committees, community heritage registers, historical societies and other local heritage organizations.

Cultural heritage resources are often of critical importance to Indigenous communities. Indigenous communities may have knowledge that can contribute to the identification of cultural heritage resources, and we suggest that any engagement with Indigenous communities includes a discussion about known or potential cultural heritage resources that are of value to them.

Environmental Assessment Reporting
Technical cultural heritage studies are to be undertaken by a qualified person who has expertise, recent experience, and knowledge relevant to the type of cultural heritage resources being considered and the nature of the activity being proposed. Please advise MTCS whether any technical heritage studies will be completed for this master plan and provide them to MTCS before issuing a Notice of Completion.

Thank you for consulting MTCS on this project. Please continue to do so through the master plan process. Contact me with any questions or concerns.

Sincerely,

Joseph Harvey
Heritage Planner
joseph.harvey@ontario.ca

Copied to: Jeff Paul, Project Manager, Stantec Consulting Ltd.
Sarah Lang, Environmental Planner, Stantec Consulting Ltd.

Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48(1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out an archaeological assessment, in compliance with Section 48(1) of the *Ontario Heritage Act*.

The Funeral, Burial and Cremation Services Act, 2002, S.O. 2002, c.33 requires that any person discovering human remains must cease all activities immediately and notify the police or coroner. If the coroner does not suspect foul play in the disposition of the remains, in accordance with Ontario Regulation 30/11 the coroner shall notify the Registrar, Ontario Ministry of Public and Business Service Delivery, which administers provisions of that Act related to burial sites. In situations where human remains are associated with archaeological resources, the Ministry of Tourism, Culture and Sport should also be notified (at archaeology@ontario.ca) to ensure that the archaeological site is not subject to unlicensed alterations which would be a contravention of the *Ontario Heritage Act*.

THE CITY OF Waterloo

Integrated Sanitary Master Plan

Municipal Class Environmental Assessment Addendum

Online Public Consultation Centre #1

September 15 – October 12, 2022

Stantec

Public Consultation Centre #1

THE CITY OF Waterloo

<u>Welcome!</u>

The goals of this Online Public Consultation Centre #1:

- Provide an overview of the process that will be followed for the project
- Introduce the project and why it is being undertaken
- Provide background information on existing City of Waterloo sanitary infrastructure
- Answer any questions you may have and provide an opportunity to get involved in the project

We encourage you to get involved in this study. Comments received will help identify a recommended approach for current and future improvements within the City of Waterloo.

Stantec

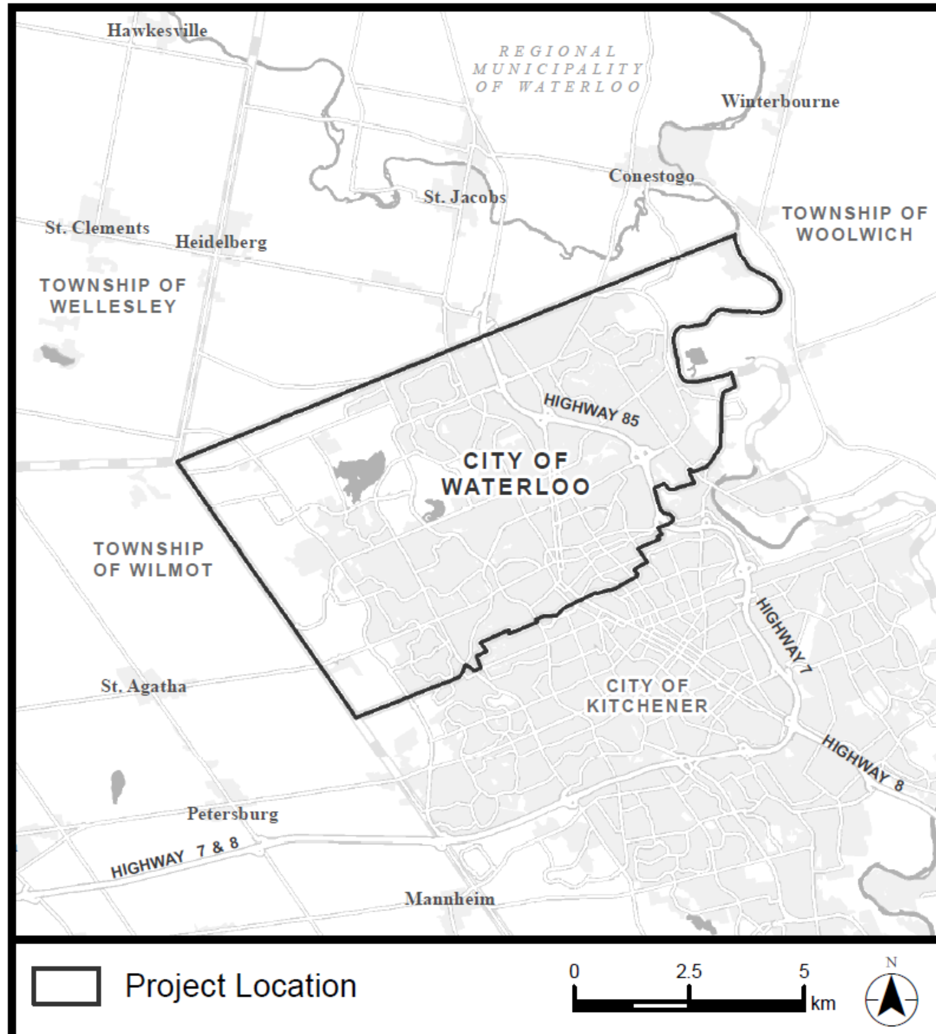
Project Summary

What are we doing?

The City of Waterloo is undertaking an Addendum to the existing 2015 Waterloo Sanitary Master Plan. The Addendum will examine the City's sanitary sewer system needs by looking at:

- New planning policies
- Growth projections
- Current needs and issues that exist in the community

The Integrated Sanitary Master Plan will review improvements to existing sanitary infrastructure, the installation of new sanitary infrastructure, and consideration of private services to municipal servicing, through to the year 2051.



Municipal Class EA Process

The Municipal Class Environmental Assessment (EA) is a process that allows for the planning and implementation of municipal infrastructure (sewers, watermains, roads, etc.) and is legislated by the Ontario EA Act. The process can be used for planning individual projects or to address groups of projects, through a Master Plan. Master Plans are long range plans which look at existing and future needs.

The City is undertaking an Addendum to the Master Plan, which will meet the documentation and consultation requirements for Phase 1 and 2 of the Municipal Class EA process. For most projects, this is sufficient study work to allow the project to proceed to design and construction. For more complex projects with greater impacts, further study is required.

Phase 1: Problem and Opportunity	• Review background planning and policy documents (e.g., Official Plan) • Identify study area needs, problems and opportunities
Phase 2: Alternative Solutions	• Inventories of socio-economic, natural and cultural environments • Identify and evaluate feasible Alternative Solutions • Select Recommended Alternative Solution • Present to public, First Nations and agencies for comment

Problem & Opportunity

The City of Waterloo has significant sanitary sewer infrastructure which needs to be managed for the community. The existing 2015 Sanitary Master Plan identified growth projections to 2031, and requires updating to reflect the new growth projections to 2051, new planning policies, and the resulting future needs of the community.

The City is undertaking an Addendum to the 2015 Sanitary Master Plan to examine the City's infrastructure needs. The Addendum will review improvements to the existing sanitary infrastructure to consider the installation of new sanitary infrastructure and conversion of private services to municipal servicing. The review will consider improvements through to the year 2051.

The City is committed to providing a reliable and sustainable sanitary servicing system.

Planning & Policy Context

THE CITY OF Waterloo

Waterloo Sanitary Master Plan (2015)

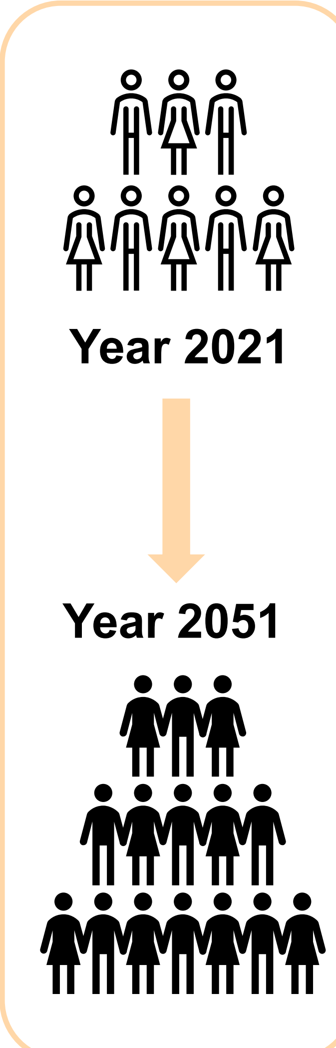
The previous Master Plan accounted for increases in population to the year 2031. The Master Plan provided an outline of priority and strategic projects which would allow the system to continue to operate efficiently and effectively. This included best management practices for Inflow/Infiltration (I/I) reduction and rehabilitation measures, and optimized staging of the sanitary capital program.

Regional Official Plan (ROP) Review

The Region of Waterloo is leading the preparation of the ROP Review to allocate population forecasts to the municipalities within the Region. Estimated future populations for the City of Waterloo in 2051 anticipate growth of 57,700 people, bringing the population to 179,136 people in the City of Waterloo.

Official Plan

The City of Waterloo Official Plan (2020) provides a long-range, comprehensive framework for decision-making in the City through to the year 2031 based on population and employment forecasts. These forecasts, along with the ROP forecasts are being used to guide the existing and future sanitary needs for this study.



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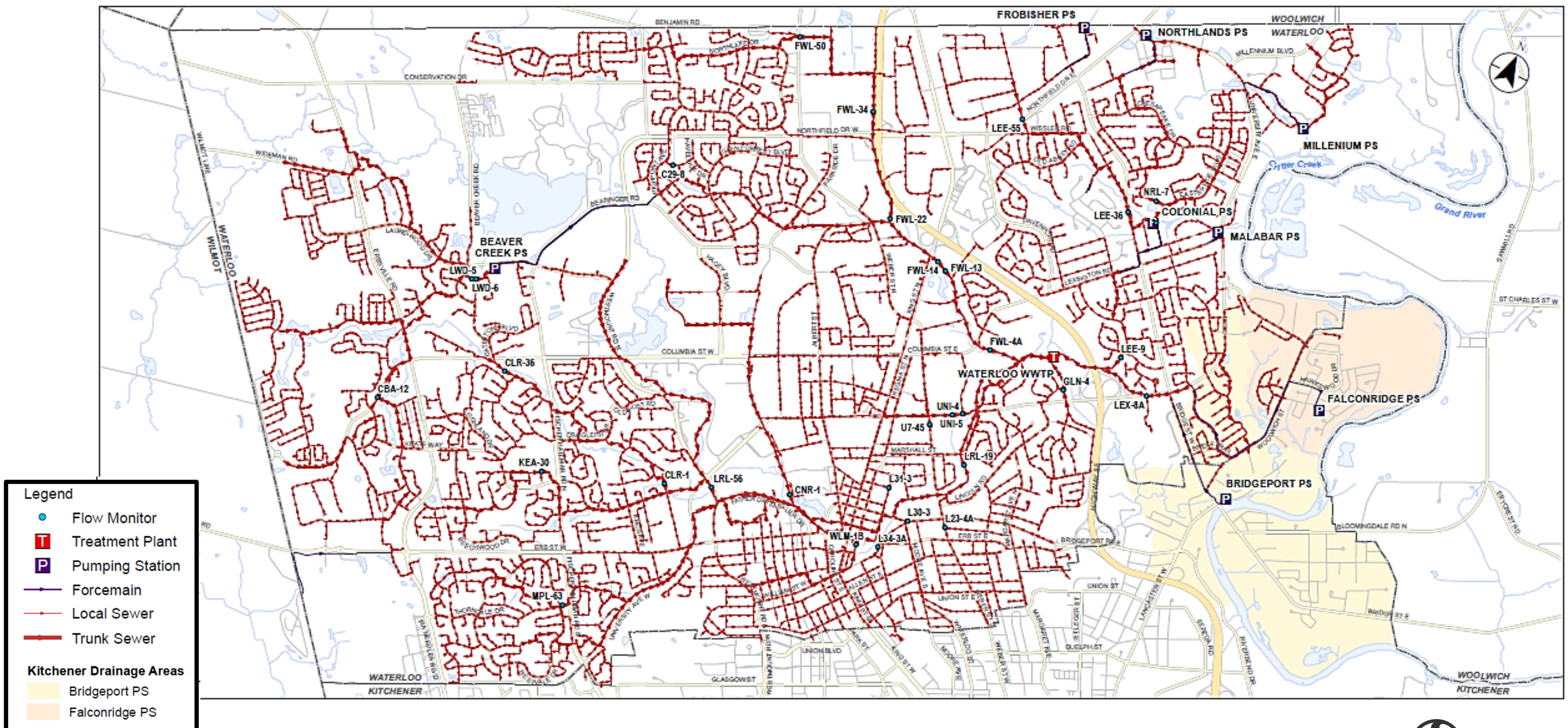
Existing Sanitary System

THE CITY OF Waterloo

Sanitary Sewer Inventory

Existing information on the City's assets (sanitary sewers and pumping stations) provide an overview of the sanitary sewer system in the City. The data provided information such as length, size, slope, material and construction date. This information forms the basis of this study.



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Cultural Heritage

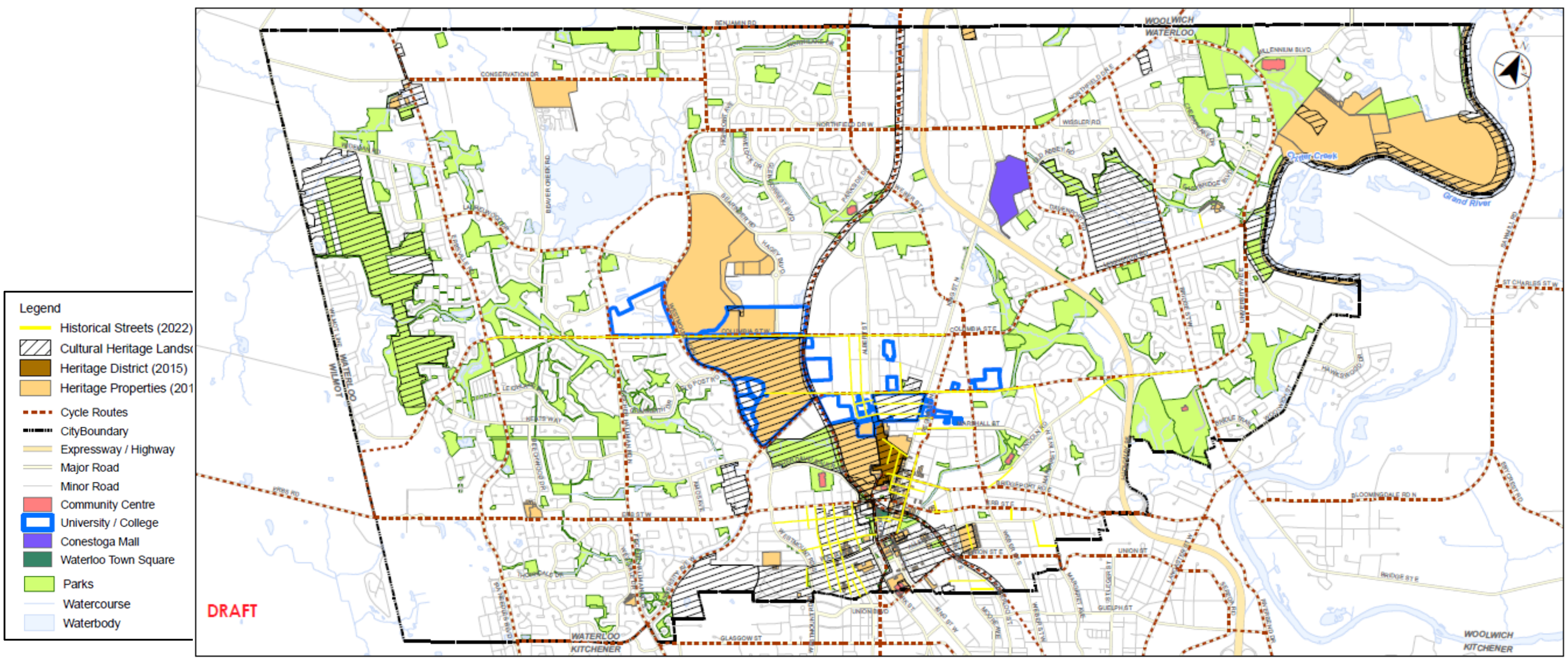
THE CITY OF Waterloo

Archaeological Resources

It is anticipated that properties within the study area will have archaeological potential. The *Ontario Public Register of Archaeological Reports* will be referenced as part of the development of alternative solutions to consider proximity to archaeological resources.

Cultural Heritage

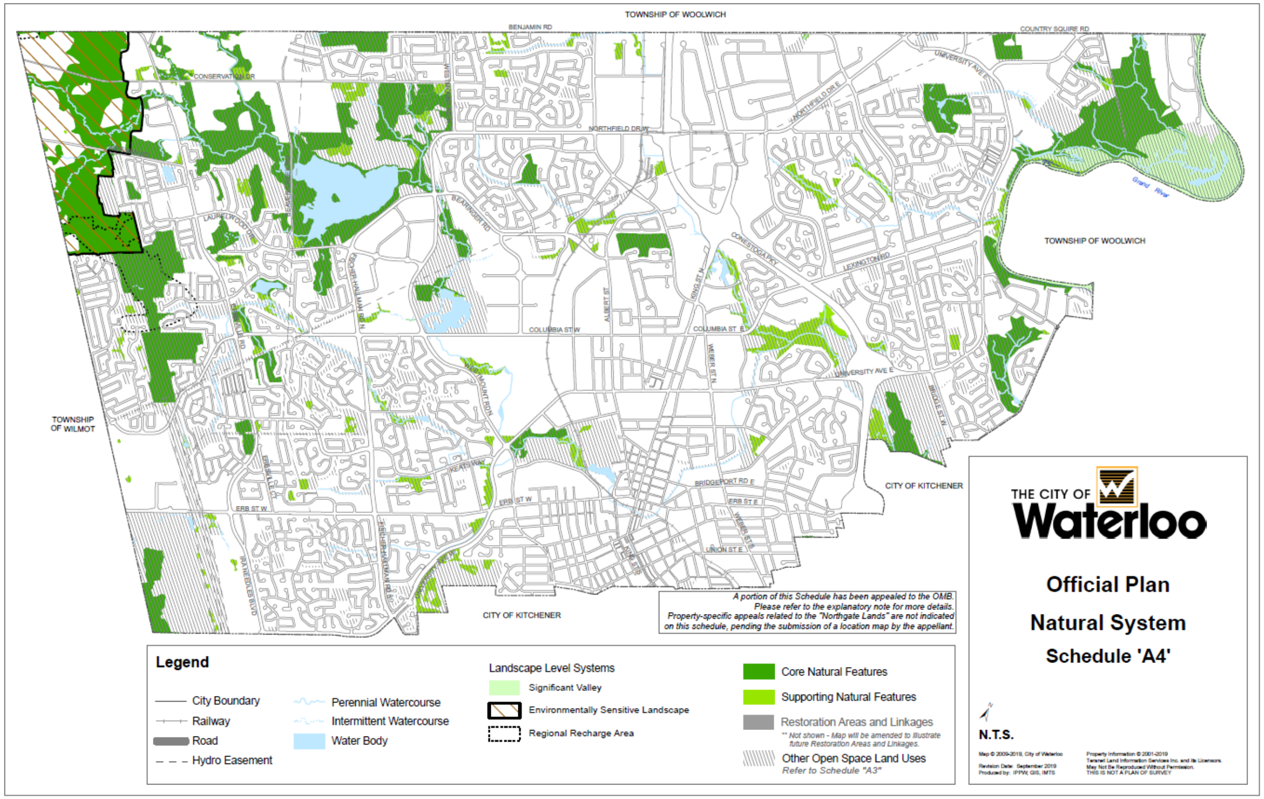
The City's diverse cultural heritage has been identified on the City's Municipal Register. The following figure displays existing cultural heritage resources within the City of Waterloo, which will be referenced as part of the development of alternative solutions.



Natural Heritage System (NHS)

Waterloo is located within the Grand River watershed and provides a diverse natural heritage system within the City. Key natural features will be considered as part of the development of alternative solutions.

There are several natural features across the City including Environmentally Sensitive Landscapes, Provincially Significant Wetlands, locally significant wetlands, Regionally and City designated woodlands, and natural hazards.

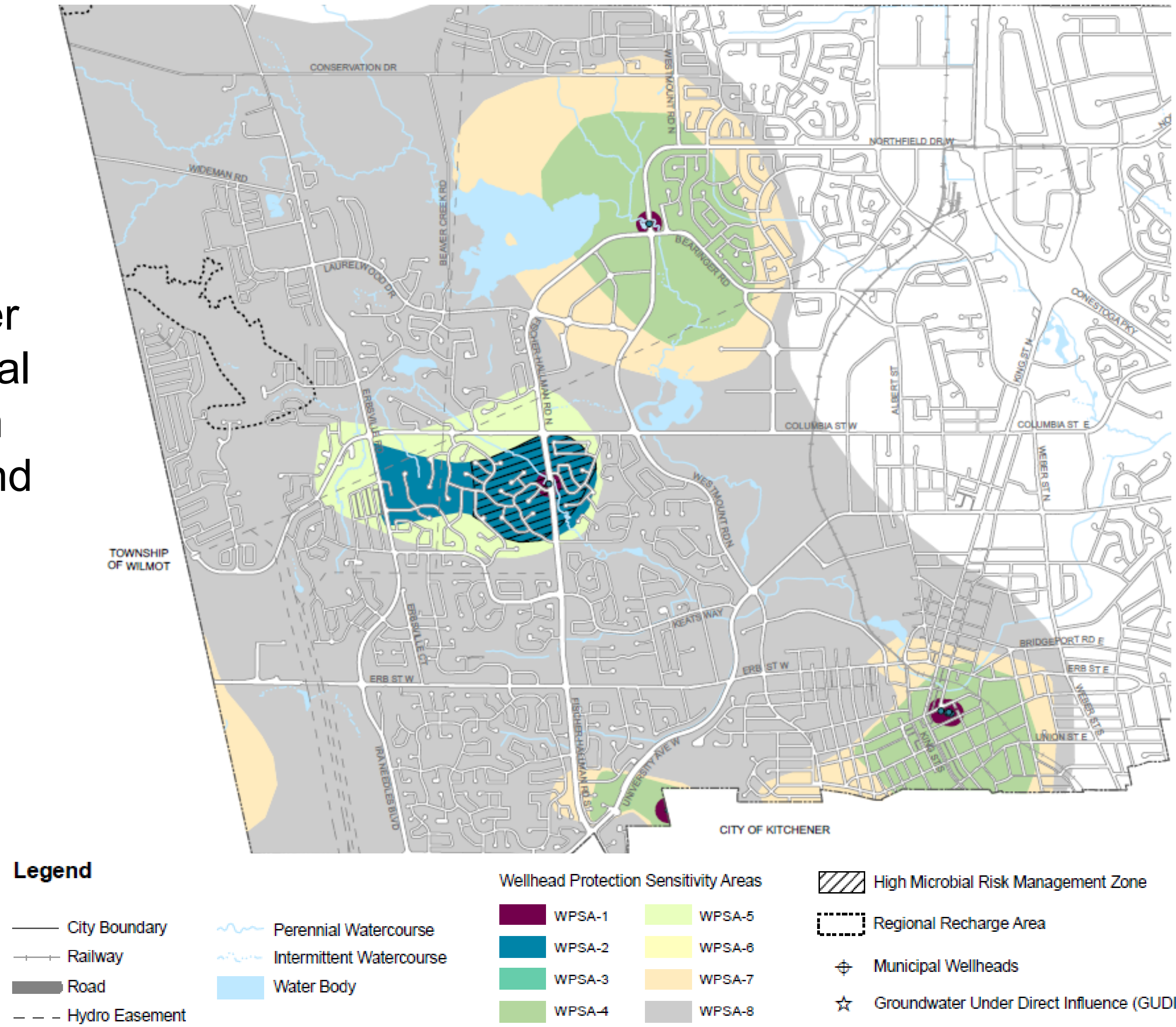


Source Water Protection

THE CITY OF Waterloo

Waterloo's drinking-water resources are drawn from the Grand River and groundwater features, also referred to as Source Water Protection Areas. It is critical to protect these areas from contamination and from land uses that could hinder surface and groundwater recharge.

The Grand River Source Protection Plan contains policies for the protection and conservation of the City's drinking water resources.



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Evaluation Criteria

THE CITY OF Waterloo

Alternative solutions will be assessed using the factors and criteria below. Depending on comments received from agencies, Indigenous communities, stakeholders and members of the public, criteria may be added or refined.

Socio-Economic

- Potential to impact existing residences, businesses and community features
- Potential effect on approved/planned land uses
- Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features
- Potential to accommodate planned significant population and job growth in strategic growth areas

Natural Environment

- Potential to impact fish and aquatic habitat
- Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas
- Potential to impact significant natural heritage features
- Potential to impact significant wildlife habitat and species at risk

Stantec

Evaluation Criteria Continued

THE CITY OF Waterloo

Technical Considerations

- Potential land requirements including land purchase and temporary/permanent easements
- Constructability
- Effect on existing utilities and infrastructure (number and type of potential conflicts)
- Ability to coordinate with existing and planned infrastructure improvements
- System resiliency and system suitability

Financial

- Lifecycle operations and maintenance costs
- Estimated capital cost

Stantec

Next Steps

THE CITY OF Waterloo

Following this public meeting, the project team will complete the next steps identified below:

- Review and respond to comments received
- Continue to engage Indigenous communities, and consult with the public and agencies
- Develop and evaluate Alternative Solutions
- Present Recommended Alternative Solution(s)
- Confirm solution and complete reporting for 30-day review

Public Consultation Centre #2

The results of these next steps will be used to help identify, develop and evaluate the alternative solutions for the Sanitary Master Plan. The evaluation of alternative solutions will identify the **Recommended Sanitary Servicing Solution**, the process of which will be presented at Public Consultation Centre #2, which is tentatively scheduled for winter 2023.

Thank you for participating!

Thank you for participating in the Public Consultation Centre for the City of Waterloo Integrated Sanitary Master Plan Addendum Municipal Class Environmental Assessment. Your feedback is valuable and appreciated.

Please provide comments through the Engage Waterloo website or by contacting a member of the project team below:

Veronica Kroess, P.Eng.
Project Manager, Engineering Services
City of Waterloo
100 Regina Street South
P.O. Box 337, Station Waterloo
Waterloo, ON N2J 4A8
Phone: 519-886-1550 ext. 78563
Email: Veronica.Kroess@waterloo.ca

Jeff Paul, P.Eng.
Project Manager
Stantec Consulting Ltd.
600-171 Queens Ave
London, ON N6A 5J7
Phone: 519-319-5806
Email: Jeff.Paul@stantec.com

Project Website: https://www.engagewr.ca/sanitary-master-plan

All information is collected in accordance with the Freedom of Information and Privacy Act.

Stantec

City of Waterloo Integrated Sanitary Master Plan
Public Consultation Centre #1 Presentation Transcript
September 2022

Slide 1 – Title Slide

Hello and thank you for joining us for the City of Waterloo, Integrated Sanitary Master Plan Municipal Class Environmental Assessment Addendum, Public Consultation Centre (or PCC) number 1.

Slide 2 – Welcome!

The goals of this Online Public Consultation Centre #1 are to:

- Provide an overview of the process that this study will follow for the project
- Introduce the project and why it is being undertaken
- Provide background information on existing City of Waterloo sanitary infrastructure
- Answer any questions you may have and provide an opportunity to get involved in the project

We encourage you to get involved in this study. Comments received will help identify a recommended approach for current and future improvements within the City of Waterloo.

Slide 3 – Project Summary

The City of Waterloo is undertaking an Addendum to the existing 2015 Waterloo Sanitary Master Plan. The Addendum will examine the City's sanitary sewer system needs by looking at:

- New planning policies
- Growth projections
- Current needs and issues that exist in the community

The Integrated Sanitary Master Plan will review improvements to existing sanitary infrastructure, the installation of new sanitary infrastructure, and consideration of private services to municipal servicing, through to the year 2051.

Slide 4 – Municipal Class EA Process

The Municipal Class Environmental Assessment (EA) is a process that allows for the planning and implementation of municipal infrastructure (sewers, watermains, roads, etc.) and is legislated by the Ontario EA Act. The process can be used for planning individual projects or to address groups of projects, through a Master Plan. Master Plans are long range plans which look at existing and future needs.

City of Waterloo Integrated Sanitary Master Plan
Public Consultation Centre #1 Presentation Transcript
September 2022

The City is undertaking an Addendum to the Master Plan, which will meet the documentation and consultation requirements for Phase 1 and 2 of the Municipal Class EA process. For most projects, this is sufficient study work to allow the project to proceed to design and construction. For more complex projects with greater impacts, further study is required.

Phase 1 and 2 of the MCEA process includes:

- Reviewing background planning and policy documents
- Identifying the problem or opportunity;
- Developing and evaluating alternative solutions; and,
- Identifying and presenting the preferred solution, potential environmental impacts and proposed mitigation measures.

Slide 5 – Problem & Opportunity

The City of Waterloo has significant sanitary sewer infrastructure which needs to be managed for the community. The existing 2015 Sanitary Master Plan identified growth projections to 2031, and requires updating to reflect the new growth projections to 2051, new planning policies, and the resulting future needs of the community.

The City is undertaking an Addendum to the 2015 Sanitary Master Plan to examine the City's infrastructure needs. The Addendum will review improvements to the existing sanitary infrastructure to consider the installation of new sanitary infrastructure and conversion of private services to municipal servicing. The review will consider improvements through to the year 2051.

The City is committed to providing a reliable and sustainable sanitary servicing system.

Slide 6 – Planning & Policy Context

Background studies were reviewed to help provide context on the existing and future conditions of the study area.

Waterloo Sanitary Master Plan (2015)

The previous Master Plan accounted for increases in population to the year 2031. The Master Plan provided an outline of priority and strategic projects which would allow the system to continue to operate efficiently and effectively. This included best management practices for Inflow/Infiltration (I/I) reduction and rehabilitation measures, and optimized staging of the sanitary capital program.

Regional Official Plan (ROP) Review

Stantec

City of Waterloo Integrated Sanitary Master Plan
Public Consultation Centre #1 Presentation Transcript
September 2022

The Region of Waterloo is leading the preparation of the ROP Review to allocate population forecasts to the municipalities within the Region. Estimated future populations for the City of Waterloo in 2051 anticipate growth of 57,700 people, bringing the population to 179,136 people in the City of Waterloo.

Official Plan

The City of Waterloo Official Plan (2020) provides a long-range, comprehensive framework for decision-making in the City through to the year 2031 based on population and employment forecasts. These forecasts, along with the ROP forecasts are being used to guide the existing and future sanitary needs for this study.

Slide 7 – Existing Sanitary System

Existing information on the City's assets (sanitary sewers and pumping stations) provide an overview of the sanitary sewer system in the City. The data provided information such as length, size, slope, material and construction date. This information forms the basis of this study.

Slide 8 – Existing Conditions – Cultural Heritage

Archaeological Resources

It is anticipated that properties within the study area will have archaeological potential. The *Ontario Public Register of Archaeological Reports* will be referenced as part of the development of alternative solutions to consider proximity to archaeological resources.

Cultural Heritage

The City's diverse cultural heritage has been identified on the City's Municipal Register. The following figure displays existing cultural heritage resources within the City of Waterloo, which will be referenced as part of the development of alternative solutions.

Slide 9 – Existing Conditions – Natural Heritage System

Waterloo is located within the Grand River watershed and provides a diverse natural heritage system within the City. Key natural features will be considered as part of the development of alternative solutions.

There are several natural features across the City including: Environmentally Sensitive Landscapes; Provincially Significant Wetlands; locally significant wetlands; Regionally and City designated woodlands, and; natural hazards.

City of Waterloo Integrated Sanitary Master Plan
Public Consultation Centre #1 Presentation Transcript
September 2022

Slide 10 – Existing Conditions – Source Water Protection

Waterloo's drinking-water resources are drawn from the Grand River and groundwater features, also referred to as Source Water Protection Areas. It is critical to protect these areas from contamination and from land uses that could hinder surface and groundwater recharge.

The Grand River Source Protection Plan contains policies for the protection and conservation of the City's drinking water resources.

Slide 11 – Evaluation Criteria

Alternative solutions will be assessed using the factors and criteria below. Depending on comments received from agencies, Indigenous communities, stakeholders and members of the public, criteria may be added or refined.

Socio-Economic

- Potential to impact existing residences, businesses and community features
- Potential effect on approved/planned land uses
- Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features
- Potential to accommodate planned significant population and job growth in strategic growth areas

Natural Environment

- Potential to impact fish and aquatic habitat
- Potential to impact water resources including surface water (i.e., rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas
- Potential to impact significant natural heritage features
- Potential to impact significant wildlife habitat and species at risk

Slide 12 – Evaluation Criteria (Continued)

Technical Considerations

- Potential land requirements including land purchase and temporary/permanent easements
- Constructability
- Effect on existing utilities and infrastructure (number and type of potential conflicts)

- Ability to coordinate with existing and planned infrastructure improvements
- System resiliency and system suitability

Financial

- Lifecycle operations and maintenance costs
- Estimated capital cost

Slide 13 – Next Steps

Following this public meeting, the project team will complete the next steps identified below:

- Review and respond to comments received
- Continue to engage Indigenous communities, and consult with the public and agencies
- Develop and evaluate Alternative Solutions
- Present Recommended Alternative Solution(s)
- Confirm solution and complete reporting for 30-day review

The results of these next steps will be used to help identify, develop and evaluate the alternative solutions for the Sanitary Master Plan. The evaluation of alternative solutions will identify the Recommended Sanitary Servicing Solution, the process of which will be presented at Public Consultation Centre #2, which is tentatively scheduled for winter 2023.

Slide 14– Thank you!

Thank you for participating in the Public Consultation Centre for the City of Waterloo Integrated Sanitary Master Plan Addendum Municipal Class Environmental Assessment. Your feedback is valuable and appreciated.

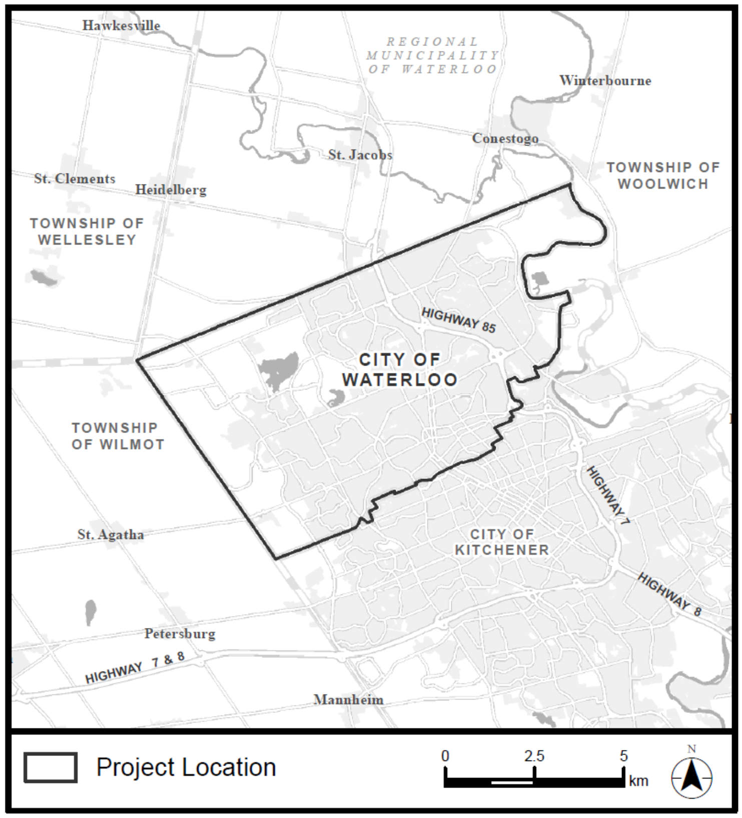
Please provide comments through the Engage Waterloo website or by contacting a member of the project team.

Thank you again for taking the time to view this presentation, and for your interest in the study.

Public Consultation Centre 2

CITY OF WATERLOO
NOTICE OF ONLINE PUBLIC CONSULTATION CENTRE #2
Municipal Class Environmental Assessment Study
Integrated Sanitary Master Plan

The City of Waterloo (City) is undertaking an Addendum to the existing 2015 Waterloo Sanitary Master Plan. The purpose of this Addendum is to examine the City's infrastructure needs considering new planning policies, growth projections, and the current needs and issues that exist in our community. The Integrated Sanitary Master Plan will review improvements to existing sanitary infrastructure, the installation of new sanitary infrastructure, and consideration of private services to municipal servicing, through to the year 2051. The Study is being undertaken within the City limits, as shown on the map.



HOW CAN I PARTICIPATE IN THIS STUDY?

An Online Public Consultation Centre (PCC) is being held through the City's Engage Waterloo website to present the evaluation process, preferred strategy and next steps. The PCC materials will be available on the City's Engage Waterloo website starting on September 14, 2023.

Website: https://www.engagewr.ca/sanitary-master-plan

Please provide comments through the Engage Waterloo website, or to a member of the project team by October 16, 2023 using the contact information below.

Veronica Kroess, P.Eng.
Project Manager
City of Waterloo
100 Regina Street South
P.O. Box 337, Station Waterloo
Waterloo, ON N2J 4A8
Phone: 519-886-2310 x 78563
Email: veronica.kroess@waterloo.ca

Jeff Paul, P.Eng.
Project Manager
Stantec Consulting Ltd.
600-171 Queens Avenue
London ON N6A 5J7
Phone: 519-319-5806
Email: Jeff.Paul@stantec.com

If you have any accessibility requirements in order to participate in this study, please contact the City of Waterloo Project Manager. Information will be collected in accordance with the Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.

This notice was first issued on September 14, 2023.

From: Micks, Sarah
Cc: Paul, Jeff; Veronica Kroess
Bcc: Karky, Apurba; cynthia.mitton-wilkie@dfo-mpo.gc.ca; david.marriott@ontario.ca; erick.boyd@ontario.ca; lisa.myslicki@infrastructureontario.ca; geddes.mahabir@ontario.ca; karla.barboza@ontario.ca; ian.thornton@ontario.ca; joan.delvillarcuicas@ontario.ca; eanotification.wcregion@ontario.ca; bbrown@grandriver.ca; theywood@grandriver.ca; manderson@grandriver.ca; blauckner@regionofwaterloo.ca; tschmidt@regionofwaterloo.ca; sharon.chambers@wilmot.ca; dbrenneman@woolwich.ca; est.reg.crossing@enbridge.com; ted.hancocks@rci.rogers.com; janet.cleghorn@bell.ca; secondarylanduse@hydroone.com; eclerk@wnhydro.com; michael.vallins@cn.ca; dominic_bonaldo@cpr.ca; planning@wcdsb.ca; planning@wrdsb.ca; publicinfo@wrps.on.ca; publichealth@regionofwaterloo.ca; fire.chief@waterloo-ia.org; admin@greaterkwchamber.com; president@waterlooregionnature.ca; KHagerman@regionofwaterloo.ca; bcoady@regionofwaterloo.ca; msergi@regionofwaterloo.ca; maria.kyveris@rogers.com; committees@waterloo.ca
Subject: Notice of Public Consultation Centre #2 - City of Waterloo Sanitary Master Plan
Date: Thursday, September 14, 2023 9:09:00 AM
Attachments: Notice of PCC #2 - City of Waterloo Sanitary Master Plan.pdf

---

Hello,

Please see the attached Notice of Public Consultation Centre (PCC) #2 for the City of Waterloo Sanitary Master Plan, Municipal Class Environmental Assessment. The study is being undertaken to update the existing Waterloo Sanitary Master Plan, to examine whether improvements are required for the existing sanitary sewer system through to the year 2051.

The second PCC is being held through the City's Engage Waterloo website to present background information on the study. **The PCC materials will be available for review online from September 14, 2023, to October 16, 2023.**

Website: https://www.engagewr.ca/sanitary-master-plan

Please contact a member of the project team identified on the attached Notice if you have any questions, comments or concerns.

Thank you,

Sarah Micks
Environmental Planner
sarah.micks@stantec.com
Direct: 519-432-4292

Stantec

From:	Trevor Heywood
To:	Veronica Kroess; Paul, Jeff
Cc:	Micks, Sarah
Subject:	RE: Notice of Public Consultation Centre #2 - City of Waterloo Sanitary Master Plan
Date:	Friday, September 29, 2023 2:07:59 PM
Attachments:	2023-09-29 Waterloo Sanitary MP GRCA comments 2.pdf GRCA Maps.pdf

Hi Veronica, Jeff,

Thank you for the slides. Our comments are attached. Please let me know if you have any additional questions.

Regards,

Trevor Heywood B.Sc.(Env.)
Resource Planner
Grand River Conservation Authority

400 Clyde Road, PO Box 729
Cambridge, ON N1R 5W6
Phone: 519-621-2761 ext. 2292
Email: theywood@grandriver.ca
www.grandriver.ca | Connect with us on social media

From: Veronica Kroess <Veronica.Kroess@waterloo.ca>
Sent: Thursday, September 14, 2023 11:12 AM
To: Trevor Heywood <theywood@grandriver.ca>; Paul, Jeff <jeff.paul@stantec.com>
Cc: Micks, Sarah <Sarah.Micks@stantec.com>
Subject: RE: Notice of Public Consultation Centre #2 - City of Waterloo Sanitary Master Plan

Hi Trevor,

PCC2 slides are attached.

Regards,

~Veronica

From: Trevor Heywood <theywood@grandriver.ca>
Sent: September 14, 2023 9:23 AM
To: Paul, Jeff <jeff.paul@stantec.com>; Veronica Kroess <Veronica.Kroess@waterloo.ca>
Cc: Micks, Sarah <Sarah.Micks@stantec.com>
Subject: [EXTERNAL] RE: Notice of Public Consultation Centre #2 - City of Waterloo Sanitary Master Plan

Hi Jeff, Veronica,

Could I get a PDF version of the PCC slides for our records and review?

Thank you.

Trevor Heywood B.Sc.(Env.)
Resource Planner
Grand River Conservation Authority

400 Clyde Road, PO Box 729
Cambridge, ON N1R 5W6
Phone: 519-621-2761 ext. 2292
Email: theywood@grandriver.ca
www.grandriver.ca | Connect with us on social media

From: Micks, Sarah <Sarah.Micks@stantec.com>
Sent: Thursday, September 14, 2023 9:10 AM
Cc: Paul, Jeff <jeff.paul@stantec.com>; Veronica Kroess <Veronica.Kroess@waterloo.ca>
Subject: Notice of Public Consultation Centre #2 - City of Waterloo Sanitary Master Plan

Hello,

Please see the attached Notice of Public Consultation Centre (PCC) #2 for the City of Waterloo Sanitary Master Plan, Municipal Class Environmental Assessment. The study is being undertaken to update the existing Waterloo Sanitary Master Plan, to examine whether improvements are required for the existing sanitary sewer system through to the year 2051.

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Please contact a member of the project team identified on the attached Notice if you have any questions, comments or concerns.

Thank you,

Sarah Micks
Environmental Planner
sarah.micks@stantec.com
Direct: 519-432-4292

Stantec

September 29, 2023

Veronica Kroess
Project Manager
City of Waterloo
100 Regina Street South, PO Box 337, STN Waterloo
Waterloo ON N2J 4A8
veronica.kroess@waterloo.ca

Jeff Paul
Project Manager
Stantec
600-171 Queens Avenue
London ON N6A 5J7
jeff.paul@stantec.com

Re: City of Waterloo Integrated Sanitary Master Plan Addendum

Dear Ms. Kroess and Mr. Paul,

The Grand River Conservation Authority (GRCA) is in receipt of the Public Consultation Centre 2 materials for the above-noted Class Environmental Assessment (Class EA).

We have scanned the eight locations where focused analysis was undertaken, and we have the following comments:

1. We understand the preferred solution for Weber Street North and Forwell Trail is to do nothing. Therefore we have no comments.

2. Austin Drive, Frobisher Drive, Thorndale Drive - Westvale Drive and Union Street East are not regulated by the GRCA. Despite this, these areas and all others have the potential to introduce sedimented runoff into storm sewers, and eventually watercourses and/or wetlands. Typical sediment control measures should be outlined in the final report. Thorndale Drive - Westvale Drive in particular could be a high risk spot.

3. Rolling Hills Drive (part of the Highpoint Avenue evaluation) crosses Cedar Creek. Impacts to the creek could be mitigated through directional drilling. If this method is not feasible, please consult with the GRCA regarding any proposed isolation / diversion plans during details design.

4. Lodge Street (as well as Weber Street North) is within the Laurel Creek floodplain. The GRCA generally does not have concerns with upgrades to public infrastructure in floodplains, assuming existing road grades will be maintained.

5. A GRCA permit will be required prior to construction of the works noted in comments 3 and 4.

Advisory Comments

Portions of Weber Street North (between University Avenue and Marshall Steet) and Lodge Street east of the Weber Street North intersection are affected by floodplain depths and velocities that exceed GRCA's residential safe access criteria. This prohibits residential or overnight accommodation (e.g. hotel / motel) uses on properties along these sections of road, as well as expansion of emergency services.

As such, the City may wish to examine the feasibility of floodplain depth improvements within the study area during detailed design. We flagged this potential with the Region of Waterloo as part of the University Avenue Improvements Class EA. Please consult further with GRCA and City Community Planning staff if there is intent to explore this further.

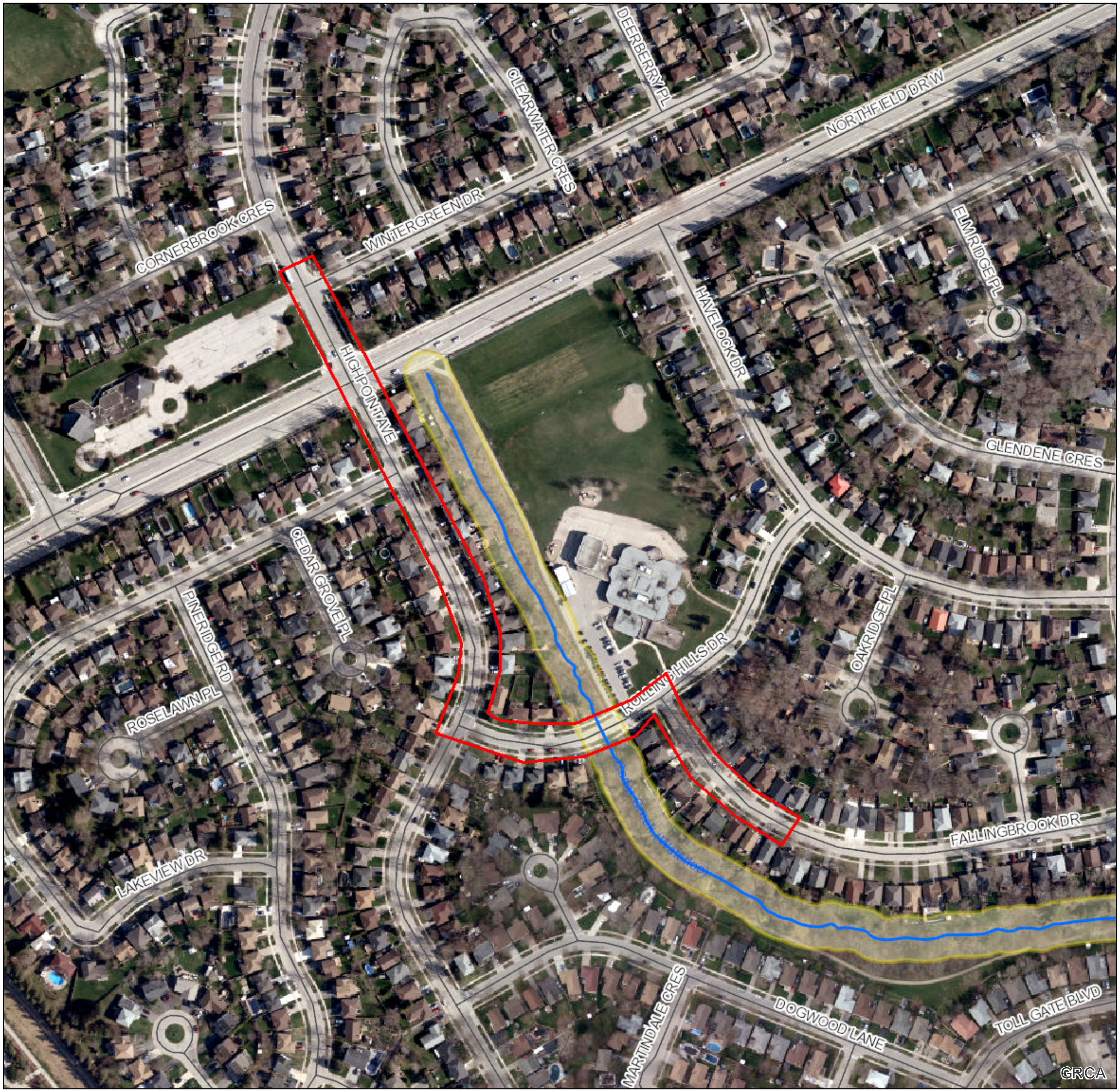
We trust this information is of assistance. If you have any questions or require additional information, please contact me at 519-621-2763 ext. 2292 or theywood@grandriver.ca.

Sincerely,

Trevor Heywood
Resource Planner
Grand River Conservation Authority

Encl. Resource Mapping

c.c. Robyn McMullen, City of Waterloo



Map Centre (UTM NAD83 z17): 535,389.50 4,815,284.97

This map is not to be used for navigation | 2022 Ortho (ROWG)

Grand River Conservation Authority

Date: Sep 18, 2023
Author: TH

Waterloo Sanitary Master Plan Addendum

Highpoint Avenue

Legend

- Regulation Limit (GRCA)
- Regulated Watercourse (GRCA)
- Regulated Waterbody (GRCA)
- Wetland (GRCA)
- Floodplain (GRCA)
  - Engineered
  - Estimated
  - Approximate
  - Special Policy Area
- Slope Valley (GRCA)
  - Steep
  - Oversteep
  - Steep
- Slope Erosion (GRCA)
  - Oversteep
  - Toe
- Lake Erie Flood (GRCA)
- Lake Erie Shoreline Reach (GRCA)
- Lake Erie Dynamic Beach (GRCA)
- Lake Erie Erosion (GRCA)
- Parcel - Assessment (MPAC/MNRF)

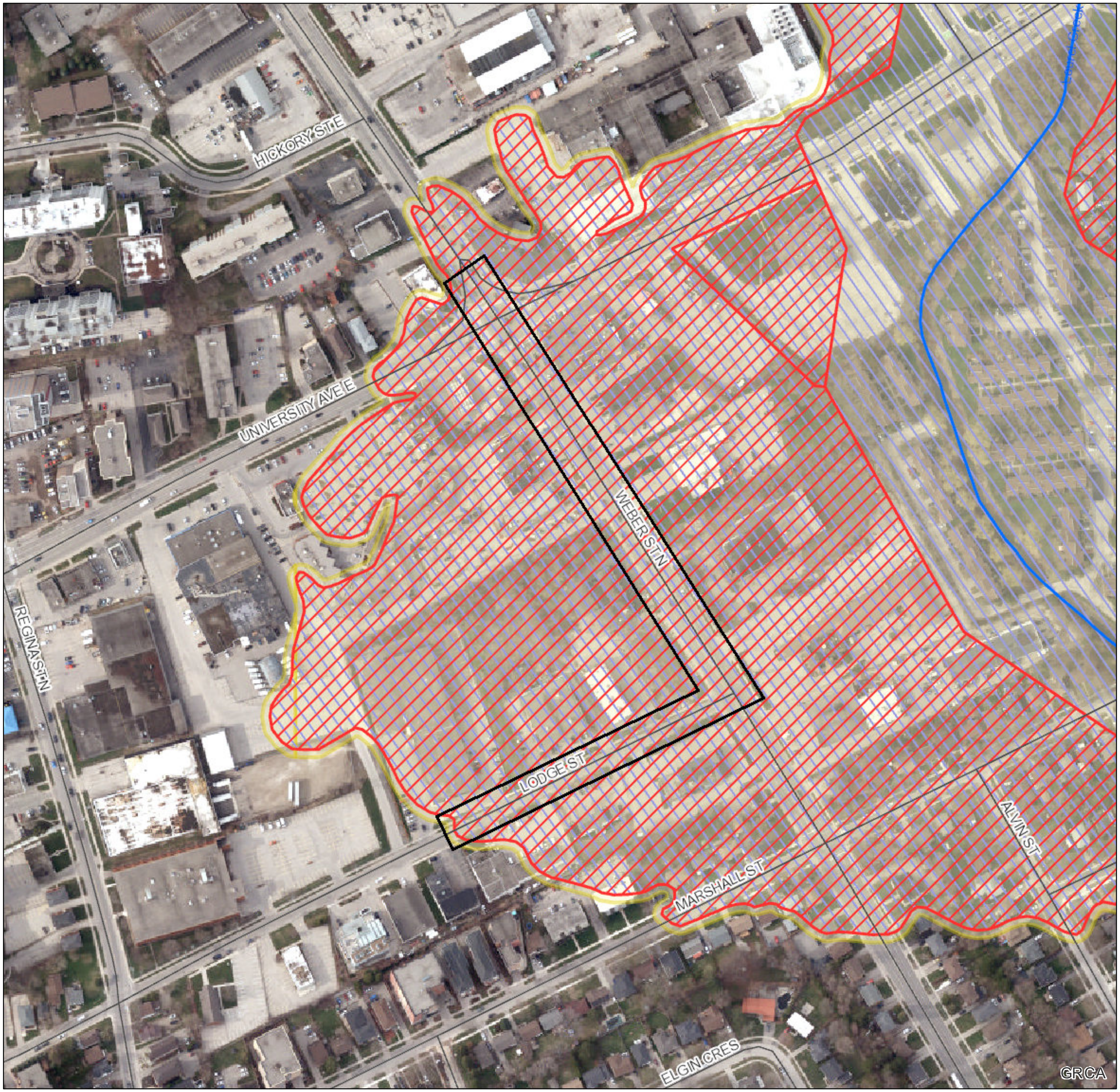
This legend is static and may not fully reflect the layers shown on the map. The text of Ontario Regulation 150/06 supercedes the mapping as represented by these layers.

0 20 40 80 120 Metres

NAD 1983 UTM Zone 17N

Scale: 3,816

N



Map Centre (UTM NAD83 z17): 538,873.62 4,813,867.28

This map is not to be used for navigation | 2022 Ortho (ROWG)

Grand River Conservation Authority

Date: Sep 18, 2023

Author: TH

Waterloo Sanitary Master Plan Addendum

Lodge Street

Legend

- Regulation Limit (GRCA)
- Regulated Watercourse (GRCA)
- Regulated Waterbody (GRCA)
- Wetland (GRCA)
- Floodplain (GRCA)
  - Engineered
  - Estimated
  - Approximate
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- Slope Valley (GRCA)
  - Steep
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0 20 40 80 120 Metres

N

NAD 1983 UTM Zone 17N

Scale: 3,583

Sanitary Master Plan

Municipal Class Environmental Assessment

Online Public Consultation Centre #2

September 14th, 2023

Public Consultation Centre #2

THE CITY OF Waterloo

<u>Welcome!</u>

The goals of this Online Public Consultation Centre #2:

- Provide an overview of the process and project background
- Present the evaluation process
- Present the preferred strategies and next steps
- Answer any questions you may have and provide an opportunity to get involved in the project

We encourage you to get involved in this study. Comments received will help identify a recommended approach for current and future improvements within the City of Waterloo.

Stantec

Project Summary

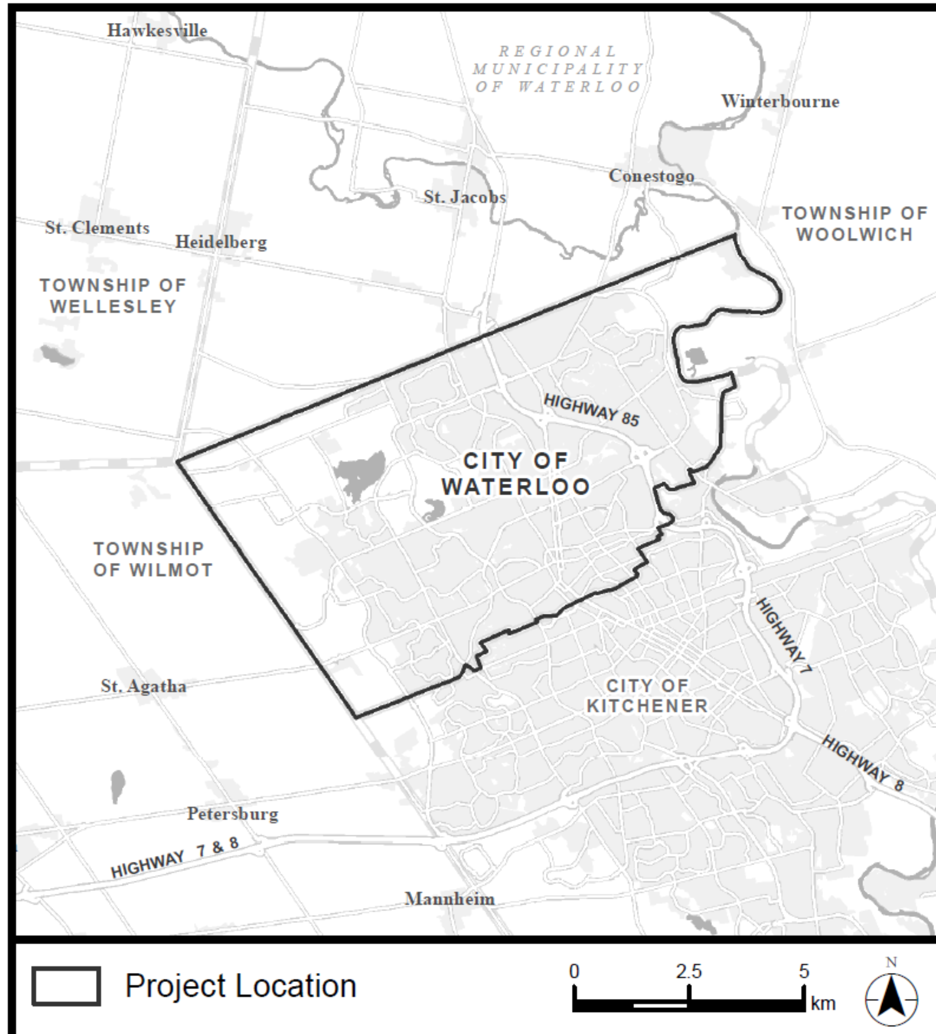
THE CITY OF Waterloo

What are we doing?

The City of Waterloo is undertaking an update to the existing 2014 Waterloo Sanitary Master Plan. This update will examine the City's sanitary sewer system needs by looking at:

- New planning policies
- Growth projections
- Current needs and issues that exist in the community

The Sanitary Master Plan will review whether improvements are required for the existing sanitary sewer system (sewers and pumping stations) through to the year 2051.



Stantec

Municipal Class EA Process

THE CITY OF Waterloo

The Municipal Class Environmental Assessment (EA) is a process that allows for the planning and construction of municipal infrastructure (sewers, watermains, roads, etc.) and is legislated by the Ontario EA Act. The process can be used for planning individual projects or to address groups of projects, through a Master Plan. Master Plans are long range plans which look at existing and future needs.

The City is undertaking an Update to the existing Master Plan, which will meet the documentation and consultation requirements for Phase 1 and 2 of the Municipal Class EA process. For most projects, this is sufficient study work to allow the project to proceed to design and construction. For more complex projects with greater impacts, further study is required.

Phase 1: Problem and Opportunity	• Review background planning and policy documents (e.g., Official Plan) • Identify study area needs, problems and opportunities
Phase 2: Alternative Solutions	• Inventories of socio-economic, natural and cultural environments • Identify and evaluate feasible Alternative Solutions • Select Recommended Alternative Solution • Present to public, First Nations and agencies for comment

Stantec

Problem & Opportunity

The City of Waterloo has significant sanitary sewer infrastructure which needs to be managed for the community. The existing 2014 Sanitary Master Plan identified growth projections to 2031, and requires updating to reflect the new growth projections to 2051, new planning policies, and the resulting future needs of the community.

The City is undertaking an Update to the 2014 Sanitary Master Plan to examine the City's infrastructure needs. The Update will review improvements to the existing sanitary infrastructure to consider the construction of new sanitary infrastructure. The review will consider improvements through to the year 2051.

The City is committed to providing a reliable and sustainable sanitary servicing system.

How did we do the Study?

The following work was completed as part of this study:

- Extensive review of previous studies completed by the City.
- Collection of rainfall data and flow data from the sanitary sewer system.
- Collection of data from the City's sanitary pumping stations.
- Updating of the computer model which simulates the sanitary sewer system to replicate real world flows.
- Running the computer model through various scenarios to simulate current conditions and future conditions (for the years 2021, 2031 and 2051) along with rainfall events which may infiltrate into the sewer.

What did we find out?

THE CITY OF Waterloo

On completion of a review of the City's sanitary system, the following are key findings of the study:

- The sanitary system has capacity for future growth and upgrades to the system to accommodate growth are minimal.
- The study has identified eight different locations where the sewer capacity is impacted.
- Surface water infiltration into the sanitary sewers are moderate and normal for most sewer systems, however, continuous efforts should be made to reduce infiltration.
- Climate change modelling indicates the sanitary system will require future upgrades to handle increased rainfall from future storm events. It is recommended that continuous improvements to reduce infiltration should be undertaken to reduce the effects of climate change and mitigate the need for future sewer upgrades.

Stantec

Infiltration / Inflow Defined

During extreme rainfall events, excess surface water and stormwater seeps into the sanitary sewer system. Infiltration is often caused by aging infrastructure with cracks and holes that need maintenance or replacement. Inflow of excess water into sewer pipes comes from yards, roofs, drains, downspouts, and manhole covers.

Inflow and infiltration reduces the capacity of the sanitary system, leaving less for existing residents and future growth. It makes sewage treatment less efficient as stormwater and excess water has entered the system and increases the risk of basement flooding.

Inflow and Infiltration, 08.22.2023, Envirosight, https://inbound.envirosight.com/inflow-and-infiltration

Alternative Solutions

THE CITY OF Waterloo

In the eight locations where the existing sanitary sewers was shown to have capacity issues, alternative solutions to improve the existing sanitary servicing system were developed.

- Highpoint Avenue
- Austin Drive
- Lodge Street
- Thorndale Drive & Westvale Drive
- Weber Street North
- Forwell Trail
- Frobisher Drive
- Union Street East

A range of alternatives were developed and considered opportunities for upgrades and expansion, rehabilitation, and adjustments to the existing system. The alternatives were evaluated against criteria to determine the preferred solution. The evaluations and criteria are presented on the next slides.

Stantec

Evaluation Criteria

THE CITY OF Waterloo

Alternative solutions will be assessed using the factors and criteria below. Depending on comments received from agencies, Indigenous communities, stakeholders and members of the public, criteria may be added or refined.

Factor	Criteria
Socio-Economic Environment	•Potential to impact existing residences, businesses and community features •Potential effect on approved/planned land uses •Potential effects on known or potential significant archaeological resources, built heritage resources and cultural landscape features •Potential to accommodate planned significant population and job growth in strategic growth areas
Natural Environment	•Potential to impact fish and aquatic habitat •Potential to impact water resources including surface water (i.e. rivers, creeks, etc.), groundwater recharge areas and wellhead protection areas •Potential to impact significant natural heritage features (i.e., woodlands, parks, etc.) •Potential to impact significant wildlife habitat and species at risk
Technical Considerations	•Potential land requirements including land purchase and temporary/permanent easements •Constructability •Effect on existing utilities and infrastructure •Ability to coordinate with existing and planned infrastructure improvements •System resiliency and system suitability
Financial	•Lifecycle operations and maintenance costs •Estimated capital cost

Stantec

Evaluation of Alternative Solutions
Highpoint Avenue

The area of Highpoint Avenue is at risk of experiencing basement flooding under extreme rainfall events. The existing sewers on Highpoint Avenue require improvements to provide additional capacity to improve water flow under wet weather conditions.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

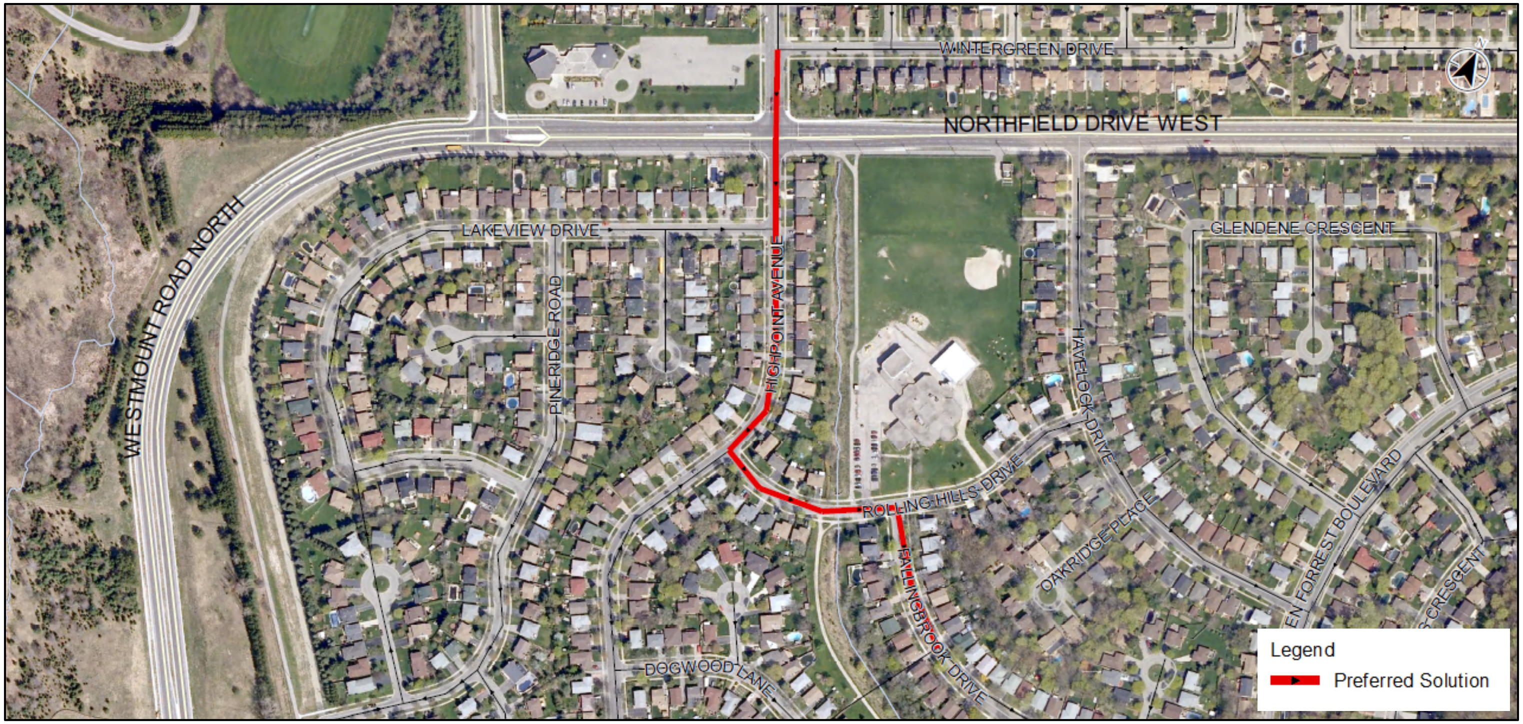
Evaluation Criteria	Do Nothing	Upgrade / Reprofile Sewer	Twin Sewer
Socio-Economic	Least Preferred	Most Preferred	Most Preferred
Natural Environment	Most Preferred	Most Preferred	Most Preferred
Technical Considerations	Least Preferred	Most Preferred	Moderately Preferred
Financial	Most Preferred	Moderately Preferred	Least Preferred
Summary Ranking	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

Preferred Solution
Highpoint Avenue

THE CITY OF Waterloo

The preferred solution for the Highpoint Avenue area is to upgrade and reprofile the existing sewer. This will include replacing the existing sanitary sewer pipe along Highpoint Avenue, from Northfield Drive West to Fallingbrook Drive to provide additional capacity and improve water flow.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth.



Stantec

Evaluation of Alternative Solutions

Austin Drive

The area of Austin Drive is at risk of experiencing basement flooding under extreme rainfall events. The sewers on Cardill Crescent and Austin Drive do not have capacity for the flows under these conditions.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Evaluation Criteria	Do Nothing	Upgrade / Reprofile Sewer	Twin Sewer
Socio-Economic	Least Preferred	Most Preferred	Most Preferred
Natural Environment	Most Preferred	Most Preferred	Most Preferred
Technical Considerations	Least Preferred	Most Preferred	Moderately Preferred
Financial	Most Preferred	Moderately Preferred	Least Preferred
Summary Ranking	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

Preferred Solution
Austin Drive

The preferred solution for the Austin Drive area is to upgrade and reprofile the sewer. This will include the replacement of the existing sanitary sewer pipe along Cardill Crescent and Austin Drive to provide additional capacity and improve water flow.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth.

Stantec

Evaluation of Alternative Solutions
Lodge Street

THE CITY OF Waterloo

The area of Lodge Street is at risk of experiencing basement flooding under extreme rainfall events, due to the existing undersized sewer on Lodge Street and Weber Street North. The sewers do not have capacity for the flows under these conditions.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Evaluation Criteria	Do Nothing	Upgrade / Reprofile Sewer	Twin Sewer
Socio-Economic	Least Preferred	Most Preferred	Most Preferred
Natural Environment	Most Preferred	Most Preferred	Most Preferred
Technical Considerations	Least Preferred	Most Preferred	Moderately Preferred
Financial	Most Preferred	Moderately Preferred	Least Preferred
Summary Ranking	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

Stantec

Preferred Solution
Lodge Street

The preferred solution for the Lodge Street area is to upgrade and reprofile the existing sewer. This will include the replacement of the existing sanitary sewer pipe along Lodge Street and Weber Street North to provide additional capacity and improve water flow.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth.

Evaluation of Alternative Solutions
Thorndale Drive & Westvale Drive

The area of Thorndale Drive & Westvale Drive is unable to effectively drain water under extreme rainfall events. The sanitary sewers on Maple Hill Creek do not have capacity for the flows under these conditions.

Four alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)
- Alternative 4 – Weir Adjustment

Evaluation Criteria	Do Nothing	Upgrade / Reprofile Sewer	Twin Sewer	Weir Adjustment
Socio-Economic	Least Preferred	Moderately Preferred	Moderately Preferred	Most Preferred
Natural Environment	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred
Technical Considerations	Least Preferred	Moderately Preferred	Moderately Preferred	Most Preferred
Financial	Most Preferred	Moderately Preferred	Least Preferred	Most Preferred
Summary Ranking	**Least Preferred**	**Moderately Preferred**	**Least Preferred**	**Most Preferred**

Preferred Solution

Thorndale Drive & Westvale Drive

THE CITY OF Waterloo

The preferred solution for the Thorndale Drive & Westvale Drive area is to implement weir adjustments. A weir is a structure inside a maintenance hole that creates a barrier to control and measure water flow and prevent flooding.

The improvements will include the removal of the existing concrete weir upstream of the Westvale Drive sewer, and the addition of a new concrete weir upstream of the Thorndale Drive sewer. This solution will redirect the flow from the Thorndale Drive sewer to the Westvale Drive sewer.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth. This alternative also reduces potential impacts to adjacent residents.

Stantec

Evaluation of Alternative Solutions
Weber Street North

THE CITY OF Waterloo

The sewers in the area of Weber Street North lack capacity, but still operate effectively for the needs of the area.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Evaluation Criteria	Do Nothing	Upgrade/Reprofile Sewer	Twin Sewer
Socio-Economic	Most Preferred	Most Preferred	Most Preferred
Natural Environment	Most Preferred	Most Preferred	Most Preferred
Technical Considerations	Most Preferred	Most Preferred	Moderately Preferred
Financial	Most Preferred	Moderately Preferred	Least Preferred
Summary Ranking	**Most Preferred**	**Moderately Preferred**	**Least Preferred**

Stantec

Preferred Solution
Weber Street North

THE CITY OF Waterloo

This area was flagged in the computer model as having capacity issues, however, with more detailed review, the sewer was shown to operate effectively and the preferred solution for the Weber Street North area is to do nothing.

The existing sanitary sewer along Weber Street North operates effectively, and there are no concerns related to flooding within this area.

Stantec

Evaluation of Alternative Solutions
Forwell Trail – East of Lexington Road

THE CITY OF Waterloo

The area of Forwell Trail has high water levels in the sanitary sewer under extreme rainfall events.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Evaluation Criteria	Do Nothing	Upgrade / Reprofile Sewer	Twin Sewer
Socio-Economic	Most Preferred	Most Preferred	Most Preferred
Natural Environment	Most Preferred	Moderately Preferred	Moderately Preferred
Technical Considerations	Most Preferred	Most Preferred	Moderately Preferred
Financial	Most Preferred	Moderately Preferred	Least Preferred
Summary Ranking	**Most Preferred**	**Moderately Preferred**	**Least Preferred**

Stantec

Preferred Solution

Forwell Trail – East of Lexington Road

THE CITY OF Waterloo

The sewer in this section is shown to have capacity issues, however, on a detailed review there is no risk to adjacent landowners of sewer backups and work on this sewer would impact the natural environment. The preferred solution for the Forwell Trail – East of Lexington Road area is to do nothing.

The existing sanitary sewer along Forwell Trail operates effectively, and there are no concerns related to flooding within this area.

Stantec

Evaluation of Alternative Solutions

Frobisher Drive

Capacity constraints have been identified on Frobisher Drive under dry weather conditions.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Evaluation Criteria	Do Nothing	Upgrade / Reprofile Sewer	Twin Sewer
Socio-Economic	Least Preferred	Most Preferred	Most Preferred
Natural Environment	Most Preferred	Most Preferred	Most Preferred
Technical Considerations	Least Preferred	Most Preferred	Moderately Preferred
Financial	Most Preferred	Moderately Preferred	Least Preferred
Summary Ranking	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

Preferred Solution
Frobisher Drive

The preferred solution for the Frobisher Drive area is to upgrade and reprofile the sewer. This will include replacement of the existing sanitary sewer pipe along Frobisher Drive to provide additional capacity and improve water flow.

These improvements will mitigate the capacity constraints, reduce future maintenance and operations costs, and accommodate current and future growth.

Stantec

Evaluation of Alternative Solutions

Union Street East

The area of Union Street East is at risk of basement flooding under extreme rainfall events.

Three alternatives were evaluated for this area:

- Alternative 1 - Do nothing
- Alternative 2 - Upgrade / Reprofile Sewer (replace the sewer to increase the capacity)
- Alternative 3 - Twin Sewer (add parallel sewer to increase capacity)

Evaluation Criteria	Do Nothing	Upgrade / Reprofile Sewer	Twin Sewer
Socio-Economic	Moderately Preferred	Most Preferred	Most Preferred
Natural Environment	Most Preferred	Most Preferred	Most Preferred
Technical Considerations	Least Preferred	Most Preferred	Moderately Preferred
Financial	Most Preferred	Moderately Preferred	Least Preferred
Summary Ranking	**Least Preferred**	**Most Preferred**	**Moderately Preferred**

Evaluation of Alternative Solutions
Union Street East

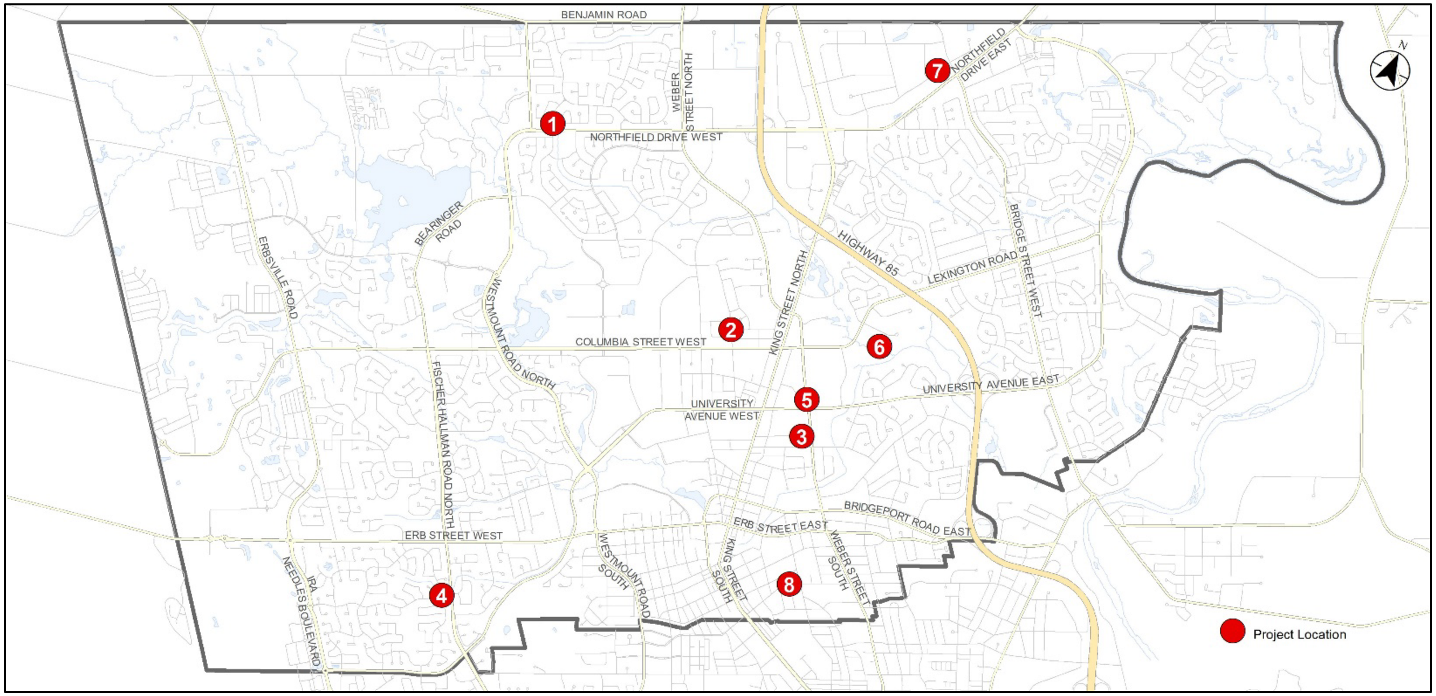
The preferred solution for the Union Street East area is to upgrade and reprofile the sewer. This will include replacement of the existing sanitary sewer pipe along Union Street East to provide additional capacity and improve water flow.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth.

Summary of Recommendations

The following solutions are recommended to be carried forward in this Master Plan. These solutions are exempt from further EA study.

1. **Highpoint Avenue**
   - Upgrade / reprofile sewer
2. **Austin Drive**
   - Upgrade / reprofile sewer
3. **Lodge Street**
   - Upgrade / reprofile sewer
4. **Thorndale Drive & Westvale Drive**
   - Weir Adjustment
5. **Weber Street North**
   - Do Nothing
6. **Forwell Trail**
   - Do Nothing
7. **Frobisher Drive**
   - Upgrade / reprofile sewer
8. **Union Street East**
   - Upgrade / reprofile sewer



Next Steps

THE CITY OF Waterloo

Following this public meeting, the project team will complete the next steps identified below:

- Review and respond to comments received
- Continue to engage Indigenous communities, and consult with the public and agencies
- Confirm Recommended Solutions and Implementation Strategy
- Prepare Sanitary Master Plan
- Provide reporting for 30-day review

The findings of this study will be documented in a Sanitary Master Plan. The Master Plan will be made available on the City of Waterloo's Engage Platform for a 30-day public review period, tentatively scheduled for winter 2023.

Stantec

Thank you for participating!

Thank you for participating in the Public Consultation Centre for the City of Waterloo Sanitary Master Plan Update Municipal Class Environmental Assessment. Your feedback is valuable and appreciated.

Please provide comments through the Engage Waterloo website or by contacting a member of the project team below:

Veronica Kroess, P.Eng.
Project Manager, Engineering Services
City of Waterloo
100 Regina Street South
P.O. Box 337, Station Waterloo
Waterloo, ON N2J 4A8
Phone: 519-886-1550 ext. 78563
Email: Veronica.Kroess@waterloo.ca

Jeff Paul, P.Eng.
Project Manager
Stantec Consulting Ltd.
600-171 Queens Ave
London, ON N6A 5J7
Phone: 519-319-5806
Email: Jeff.Paul@stantec.com

Project Website: https://www.engagewr.ca/sanitary-master-plan

All information is collected in accordance with the Freedom of Information and Privacy Act.

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City of Waterloo Sanitary Master Plan
Public Consultation Centre #2 Presentation Transcript
September 2023

Slide 1 – Title Slide

Hello and thank you for joining us for the City of Waterloo, Sanitary Master Plan Municipal Class Environmental Assessment, Public Consultation Centre (or PCC) number 2.

Slide 2 – Welcome!

The goals of this Online Public Consultation Centre #2 are to:

- Provide an overview of the process and project background
- Present the evaluation criteria
- Present the preferred strategy and next steps
- Answer any questions you may have and provide an opportunity to get involved in the project

We encourage you to get involved in this study. Comments received will help identify a recommended approach for current and future improvements within the City of Waterloo.

Slide 3 – Project Summary

The City of Waterloo is undertaking an update to the existing Waterloo Sanitary Master Plan developed in 2014. The update will examine the City's sanitary sewer system needs by looking at:

- New planning policies
- Growth projections
- Current needs and issues that exist in the community

The Sanitary Master Plan will review improvements to existing sanitary infrastructure, the installation of new sanitary infrastructure, and consideration of private services to municipal servicing, through to the year 2051.

Slide 4 – Municipal Class EA Process

This study is being completed in accordance with the Municipal Class Environmental Assessment (EA) process. This process allows for the planning and implementation of municipal infrastructure (sewers, watermains, roads, etc.) and is legislated by the Ontario EA Act. The process can be used for planning individual projects or to address groups of projects, through a Master Plan. Master Plans are long range plans which look at existing and future needs.

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City of Waterloo Sanitary Master Plan
Public Consultation Centre #2 Presentation Transcript
September 2023

The City is undertaking an update to the Master Plan, which will meet the documentation and consultation requirements for Phase 1 and 2 of the Municipal Class EA process. For most projects, this is sufficient study work to allow the project to proceed to design and construction. For more complex projects with greater impacts, further study is required.

Phase 1 and 2 of the MCEA process includes:

- Reviewing background planning and policy documents
- Identifying the problem or opportunity;
- Developing and evaluating alternative solutions; and,
- Identifying and presenting the preferred solution, potential environmental impacts and proposed mitigation measures.

Slide 5 – Problem & Opportunity

The following problem and opportunity statement has been developed to guide the study from beginning to end:

The City of Waterloo has significant sanitary sewer infrastructure which needs to be managed for the community. The existing 2014 Sanitary Master Plan identified growth projections to 2031, and requires updating to reflect the new growth projections to 2051, new planning policies, and the resulting future needs of the community.

The City is undertaking an Update to the 2014 Sanitary Master Plan to examine the City's infrastructure needs. The Update will review improvements to the existing sanitary infrastructure to consider the installation of new sanitary infrastructure and conversion of private services to municipal servicing. The review will consider improvements through to the year 2051**.**

The City is committed to providing a reliable and sustainable sanitary servicing system.

Slide 6 – How did we do the Study?

Our first Public Consultation Centre has been completed as part of this project to identify background information and provide context on how the study is being completed. Since PCC 1, the following work has been completed to identify alternative solutions and determine the preferred solution to address the problem and opportunity statement:

- Extensive review of previous studies completed by the City
- Collection of rainfall data and flow data from the sewer system
- Collection of data from the City's pumping stations

- Updating of the computer model which simulates the sanitary system to replicate real world flows
- Running the computer model through various scenarios to simulate current conditions and future conditions (for the years 2021, 2031 and 2051) along with rainfall events which may infiltrate into the sewers

Slide 7 – What did we find out?

The review of the City's sanitary system identified the following key findings:

- The sanitary system has capacity for future growth and upgrades to the system to accommodate growth are minimal
- The study has identified eight different locations where the sewer capacity is impacted
- Surface water infiltration into the sanitary sewers are moderate and normal for most sewer systems, however, continuous efforts should be made to reduce infiltration
- Climate change modelling indicates the sanitary system will require future upgrades to handle increased rainfall from future storm events. It is recommended that continuous improvements to reduce infiltration should be undertaken to reduce the effects of climate change and mitigate the need for future sewer upgrades

These findings were used to develop the alternative solutions for this study, identified later in this presentation.

Slide 8 – Infiltration / Inflow

This slide is provided to define how infiltration and inflow impacts the sewer system.

During extreme rainfall events, excess surface water and stormwater seeps into the sanitary sewer system. Infiltration is often caused by aging infrastructure with cracks and holes that need maintenance or replacement. Inflow of excess water into sewer pipes comes from yards, roofs, drains, downspouts, and manhole covers.

Inflow and infiltration reduces the capacity of the sanitary system, leaving less for existing residents and future growth. It makes sewage treatment less efficient as stormwater and excess water has entered the system and increases the risk of basement flooding.

The figure on this slide shows inflow and infiltration of excess surface water and stormwater into the sanitary system.

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City of Waterloo Sanitary Master Plan
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Slide 9 – Alternative Solutions

As a result of the findings of the review and modeling completed on the City's existing sanitary servicing system, the following eight locations in the existing sanitary sewers were shown to have capacity issues. These locations are the focus of the improvements for this study. The eight locations are as follows:

- Highpoint Avenue
- Austin Drive
- Lodge Street
- Thorndale Drive & Westvale Drive
- Weber Street North
- Forwell Trail
- Frobisher Drive
- Union Street East

A range of alternatives were developed and considered opportunities for upgrades and expansion, rehabilitation, and adjustments to the existing system. The alternatives were evaluated against criteria to determine the preferred solution. The evaluations and criteria are presented on the next slides.

Slide 10 – Evaluation Criteria

The eight locations and the alternative solutions will be assessed using the factors and criteria below to determine the preferred solution. Depending on comments received from agencies, Indigenous communities, stakeholders and members of the public, criteria may be added or refined.

The evaluation criteria considers the Socio-Economic Environment, Natural Environment, Technical Considerations, and Financial considerations. Each alternative has been evaluated against the criteria to understand the impacts of the alternative, and identify the most preferred improvement for each location.

The following slides will provide a summary of the existing conditions of the sanitary sewer system at each location, the alternative solutions considered, the completed evaluation, and the preferred solution.

Slide 11 – Evaluation of Alternative Solutions – Highpoint Avenue

The area of Highpoint Avenue is at risk of experiencing basement flooding under extreme rainfall events. The existing sewers on Highpoint Avenue require improvements to provide additional capacity to improve water flow under wet weather conditions.

Three alternatives were evaluated for this area:

1. Do nothing
2. Upgrade / Reprofile Sewer (replace the existing sewer to increase the capacity)
3. Twin Sewer (add a parallel sewer to increase the capacity)

Slide 12 – Preferred Solution – Highpoint Avenue

The preferred solution for the Highpoint Avenue area is to upgrade and reprofile the existing sewer. This will include replacing the existing sanitary sewer pipe along Highpoint Avenue, from Northfield Drive West to Fallingbrook Drive to provide additional capacity and improve water flow. These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth.

A map of the approximate area of the preferred solution is displayed on this slide.

Slide 13 – Evaluation of Alternative Solutions – Austin Drive

The area of Austin Drive is at risk of experiencing basement flooding under extreme rainfall events. The sewers on Cardill Crescent and Austin Drive do not have capacity for the flows under these conditions.

Three alternatives were evaluated for this area:

1. Do nothing
2. Upgrade / Reprofile Sewer
3. Twin Sewer

Slide 14 – Preferred Solution – Austin Drive

The preferred solution for the Austin Drive area is to upgrade and reprofile the sewer. This will include the replacement of the existing sanitary sewer pipe along Cardill Crescent and Austin Drive to provide additional capacity and improve water flow.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth.

A map of the approximate area of the preferred solution is displayed on this slide.

City of Waterloo Sanitary Master Plan
Public Consultation Centre #2 Presentation Transcript
September 2023

Slide 15 – Evaluation of Alternative Solutions – Lodge Street

The area of Lodge Street is at risk of experiencing basement flooding under extreme rainfall events, due to the existing undersized sewer on Lodge Street and Weber Street North. The sewers do not have capacity for the flows under these conditions.

Three alternatives were evaluated for this area:

1. Do nothing
2. Upgrade / Reprofile Sewer
3. Twin Sewer

Slide 16 – Preferred Solution – Lodge Street

The preferred solution for the Lodge Street area is to upgrade and reprofile the existing sewer. This will include the replacement of the existing sanitary sewer pipe along Lodge Street and Weber Street North to provide additional capacity and improve water flow.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth.

A map of the approximate area of the preferred solution is displayed on this slide.

Slide 17 – Evaluation of Alternative Solutions – Thorndale Drive & Westvale Drive

The area of Thorndale Drive & Westvale Drive is unable to effectively drain water under extreme rainfall events. The sanitary sewers on Maple Hill Creek do not have capacity for the flows under these conditions.

Four alternatives were evaluated for this area:

1. Do nothing
2. Upgrade / Reprofile Sewer
3. Twin Sewer
4. Weir Adjustment

Slide 18 – Preferred Solution – Thorndale Drive & Westvale Drive

The preferred solution for the Thorndale Drive & Westvale Drive area is to implement weir adjustments. A weir is a structure inside a maintenance hole that creates a barrier to control and measure water flow and prevent flooding.

The improvements will include the removal of the existing concrete weir upstream of Westvale Drive sewer, and the addition of a new concrete weir upstream of Thorndale Drive sewer. This solution will redirect the flow from the Thorndale Drive sewer to the Westvale Drive sewer.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth. This alternative also reduces potential impacts to adjacent residents.

A map of the approximate area of the preferred solution is displayed on this slide.

Slide 19 – Evaluation of Alternative Solutions – Weber Street North

The sewers in the area of Weber Street North lack capacity, but still operate effectively for the needs of the area.

Three alternatives were evaluated for this area:

1. Do nothing
2. Upgrade / Reprofile Sewer
3. Twin Sewer

Slide 20 – Preferred Solution – Weber Street North

This area was flagged in the computer model as having capacity issues, however, with more detailed review, the sewer was shown to operate effectively and the preferred solution for the Weber Street North area is to do nothing.

The existing sanitary sewer along Weber Street North operates effectively, and there are no concerns related to flooding within this area.

A map of the approximate area of the preferred solution is displayed on this slide.

Slide 21 – Evaluation of Alternative Solutions – Forwell Trail, East of Lexington Road

The area of Forwell Trail has high water levels in the sanitary sewer under extreme rainfall events.

Three alternatives were evaluated for this area:

1. Do nothing
2. Upgrade / Reprofile Sewer
3. Twin Sewer

Slide 22 – Preferred Solution – Forwell Trail, East of Lexington Road

The sewer in this section is shown to have capacity issues, however, on a detailed review there is no risk to adjacent landowners of sewer backups and work on this sewer would impact the natural environment. The preferred solution for the Forwell Trail – East of Lexington Road area is to do nothing.

The existing sanitary sewer along Forwell Trail operates effectively, and there are no concerns related to flooding within this area.

A map of the approximate area of the preferred solution is displayed on this slide.

Slide 23 – Evaluation of Alternative Solutions – Frobisher Drive

Capacity constraints have been identified on Frobisher Drive under dry weather conditions.

Three alternatives were evaluated for this area:

1. Do nothing
2. Upgrade / Reprofile Sewer
3. Twin Sewer

Slide 24 – Preferred Solution – Frobisher Drive

The preferred solution for the Frobisher Drive area is to upgrade and reprofile the sewer. This will include replacement of the existing sanitary sewer pipe along Frobisher Drive to provide additional capacity and improve water flow.

These improvements will mitigate the capacity constraints, reduce future maintenance and operations costs, and accommodate current and future growth.

A map of the approximate area of the preferred solution is displayed on this slide.

Slide 25 – Evaluation of Alternative Solutions – Union Street East

The area of Union Street East is at risk of basement flooding under extreme rainfall events.

Three alternatives were evaluated for this area:

1. Do nothing
2. Upgrade / Reprofile Sewer
3. Twin Sewer

City of Waterloo Sanitary Master Plan
Public Consultation Centre #2 Presentation Transcript
September 2023

Slide 26 – Preferred Solution – Union Street East

The preferred solution for the Union Street East area is to upgrade and reprofile the sewer. This will include replacement of the existing sanitary sewer pipe along Union Street East to provide additional capacity and improve water flow.

These improvements will mitigate the risk of basement flooding, reduce future maintenance and operations costs, and accommodate current and future growth.

A map of the approximate area of the preferred solution is displayed on this slide.

Slide 27 – Summary of Recommendations

The following solutions are recommended to be carried forward in this Master Plan. These solutions will occur within the existing right-of-way, and are exempt from further EA study under the Municipal Class EA document.

1. **Highpoint Avenue**
   a. Upgrade / reprofile sewer
2. **Austin Drive**
   a. Upgrade / reprofile sewer
3. **Lodge Street**
   a. Upgrade / reprofile sewer
4. **Thorndale Drive & Westvale Drive**
   a. Weir Adjustment
5. **Weber Street North**
   a. Do Nothing
6. **Forwell Trail**
   a. Do Nothing
7. **Frobisher Drive**
   a. Upgrade / reprofile sewer
8. **Union Street East**
   a. Upgrade / reprofile sewer

A map of the approximate locations of the improvements within the City of Waterloo is displayed on this slide.

Slide 28 – Next Steps

Following this public meeting, the project team will complete the next steps identified below:

- Review and respond to comments received
- Continue to engage Indigenous communities, and consult with the public and agencies
- Confirm Recommended Solutions and Implementation Strategy
- Prepare the Sanitary Master Plan report
- Provide reporting for 30-day public review

The findings of this study will be documented in a Sanitary Master Plan. The Master Plan will be made available on the City of Waterloo's Engage Platform for a 30-day public review period, tentatively scheduled for winter 2023.

Slide 29– Thank you!

Thank you for participating in the Public Consultation Centre for the City of Waterloo Sanitary Master Plan Municipal Class Environmental Assessment. Your feedback is valuable and appreciated.

Please provide comments through the Engage Waterloo website or by contacting a member of the project team.

Thank you again for taking the time to view this presentation, and for your interest in the study.

Indigenous Engagement

THE CITY OF Waterloo

ADDRESSES

Sohuwesyoklati (Brian Hill)
Indigenous Initiatives Advocate
Reconciliation, Equity, Diversity and Inclusion (READI)
100 Regina St. S
PO Box 337, Station Waterloo
Waterloo ON N2J 4A8

Jeff Paul, P. Eng.
Stantec
600-171 Queens Avenue
London ON N6A 5J7

~~Six Nations of the Grand River Territory~~
~~Ms Ava Hill, Chief~~
~~1695 Chiefswoods Road, PO Box 5000~~
~~Ohsweken ON N0A 1M0~~

Six Nations of the Grand River Territory
Chief Mark B. Hill
1695 Chiefswoods Road, PO Box 5000
Ohsweken ON N0A 1M0

~~Mississaugas of the New Credit~~
~~Mr. Bryan LaForme, Chief~~
~~2789 Mississauga Rd. RR#6~~
~~Hagersville ON N0A 1H0~~

Mississaugas of the Credit First Nation
Chief R. Stacey Laforme
2789 Mississauga Rd. RR#6
Hagersville ON N0A 1H0

~~Haudenosaunee Confederacy Chiefs Council~~
~~Mr. Hohahes Hill, Secretary to Haudenosaunee Confederacy~~
~~2634 6th Line Road RR#2~~
~~Ohsweken ON N0A 1M0~~

Haudenosaunee Chiefs Council
Mr. Hohahes Hill, Secretary to Haudenosaunee Confederacy
16 Sunrise Court
Suite 600 P.O Box 714
Ohsweken ON N0A 1M0

Metis Nation of Ontario
~~Ms Melanie Paradis~~
~~Director of Lands, Resources, and Consultation~~
~~500 Old St. Patrick St. Unit 3~~
~~Ottawa ON K1N 9G4~~
President Margaret Froh
Suite 1100 – 66 Slater Street
Ottawa, ON K1P 5H1

Ministry of Aboriginal Affairs
Ms Pam Wheaton
Director, Policy and Relationships Branch
720 Bay Street, 4th Floor
Toronto ON M5G 2K1

~~Aboriginal Affairs~~
~~Environmental Unit Re: Environmental Assessment Coordination~~
~~25 St. Clair Avenue East, 8th Floor~~
~~Toronto ON M4T 1M2~~

Ontario Secretariat for Aboriginal Affairs
Mr. David Pickles
Senior Policy Advisor
720 Bay Street, 4th Floor
Toronto ON M5G 2K1

~~Ministry of Aboriginal Affairs~~
~~160 Bloor Street East, 4th Floor~~
~~Toronto ON M7A 2E6~~

Ministry of Indigenous Affairs
Minister – Hon. Greg Rickford
160 Bloor Street East, 4th Floor
Toronto ON M7A 2E6

Ministry of the Environment, Conservation and Parks
Minister – Hon. David |Piccini
5th Floor, 777 Bay Street
Toronto, ON M7A 2J3

August 31, 2023

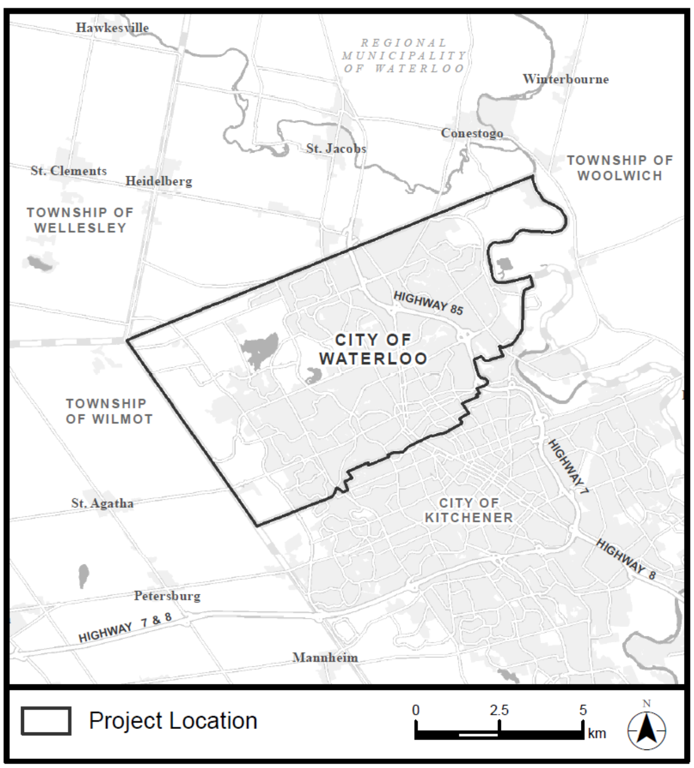
Indigenous Initiatives Advocate Sohuwesyoklati (Brian Hill)
City of Waterloo
100 Regina St. S
PO Box 337, Station Waterloo
Waterloo ON N2J 4A8

Dear Sohuwesyoklati (Brian Hill),

Re:

NOTICE OF ONLINE PUBLIC CONSULTATION CENTRE #2
Municipal Class Environmental Assessment Study
Integrated Sanitary Master Plan

The City of Waterloo (City) is undertaking an Addendum to the existing 2015 Waterloo Sanitary Master Plan. The purpose of this Addendum is to examine the City's infrastructure needs considering new planning policies, growth projections, and the current needs and issues that exist in our community. The Integrated Sanitary Master Plan will review improvements to existing sanitary infrastructure, the installation of new sanitary infrastructure, and consideration of private services to municipal servicing, through to the year 2051. The Study is being undertaken within the City limits, as shown on the map.



This second Public Consultation Centre (PCC) will focus on the recommendations resulting from the study. In brief, the primary recommendations of the draft study to date comprises infrastructure updates to five existing sanitary sewers, including size upgrades and sewer reprofiling. It also recommends one weir adjustment inside of an existing maintenance hole. All of the recommendations relate to existing infrastructure upgrades and pose minimal impacts to the environment. None of the proposed recommendations propose new sewers on undeveloped land.

The Virtual PCC is being held through the City's Engage Waterloo website to present the evaluation process, preferred strategy, and next steps. The PCC materials will be available to the public on the City's Engage Waterloo website starting on September 14, 2023.

Website: https://www.engagewr.ca/sanitary-master-plan

Stantec Consulting Ltd. (Stantec) is working on behalf of the City in completing the study and preparing the PCC documentation. The City would like to welcome any members of your community to provide any comments or concerns through the Engage Waterloo website, or to City staff undersigned below. The City has requested all comments and concerns by October 16th. Please contact the City's project manager if accessing material online is unavailable to you, or if you have any accessibility requirements to participate in this study.

We welcome any comments or concerns you may have. Please do not hesitate to reach out with any questions.

Sincerely,

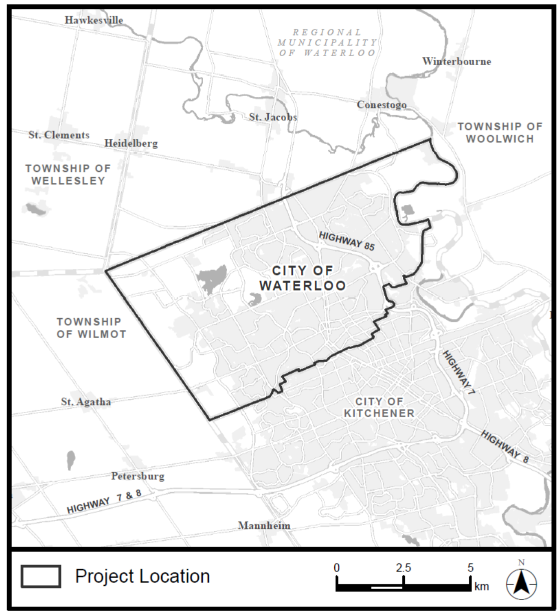
Francis Reyes, P. Eng.
Director, Engineering Services
Integrated Planning & Public Works
100 Regina St. S.
PO Box 337, Station Waterloo
Waterloo ON N2J 4A8
P: 519-747-8741 TTY: 1-866-786-3941
E: francis.reyes@waterloo.ca

VKroess
Veronica Kroess, P. Eng.
Project Manager
Engineering Infrastructure
100 Regina St. S.
PO Box 337, Station Waterloo
Waterloo ON N2J 4A8
P: 519-886-1550 ext. 78563
E: veronica.kroess@waterloo.ca

cc: Sohuwesyoklati (Brian Hill), Indigenous Initiatives Advocate, City of Waterloo
Jeff Paul, P. Eng., Project Manager, Stantec Consulting
Ms. Ava Hill, Chief, Six Nations of the Grand River Territory
Mr. Bryan Laforme, Chief, Mississaugas of the New Credit
Ms. Melanie Paradis, Metis Nation of Ontario
Mr. Hohahes Hill, Secretary to Haudenosaunee Confederacy, Haudenosaunee Confederacy Chiefs Council
Ms. Pam Wheaton, Director, Policy and Relationships Branch, Ministry of Aboriginal Affairs
Mr. David Pickles, Senior Policy Advisor, Ontario Secretariat for Aboriginal Affairs
Aboriginal Affairs Environmental Unit
Ministry of Aboriginal Affairs

Notice of Study Completion

CITY OF WATERLOO
NOTICE OF COMPLETION
Municipal Class Environmental Assessment Study
Sanitary Master Plan Update



THE STUDY:

The City of Waterloo (City) undertook an Update to the existing 2015 Waterloo Sanitary Master Plan. The purpose of this Update was to examine the City's infrastructure needs considering new planning policies, growth projections, and the current needs and issues that exist in our community. The Sanitary Master Plan Update reviewed improvements to existing sanitary infrastructure, the installation of new sanitary infrastructure, and consideration of private services to municipal servicing, through to the year 2051. The Study was undertaken within the City limits, as shown on the map.

THE PROCESS

This EA Study was undertaken as a Master Plan in accordance with the *Municipal Class Environmental Assessment* (MCEA) (2000, as amended in 2007, 2011, 2015, 2023) which is an approved process under the Ontario Environmental Assessment Act. As such, the Sanitary Master Plan Update has addressed Phases 1 and 2 of the MCEA process.

NOTICE OF REVIEW PERIOD

A Sanitary Master Plan report has been prepared that documents the findings of the study. This notice announces the start of the comment review period for the Sanitary Master Plan Update in accordance with the requirements of the EA process.

The Sanitary Master Plan be available for review from December 18, 2024 to January 31, 2025, online at https://www.engagewr.ca/sanitary-master-plan

Please provide written comments by January 31, 2025, to the study team members noted below.

Veronica Kroess, P.Eng.
Project Manager
City of Waterloo
100 Regina Street South
P.O. Box 337, Station Waterloo
Waterloo, ON N2J 4A8
Phone: 519-886-2310 x 78563
Email: veronica.kroess@waterloo.ca

Jeff Paul, P.Eng.
Project Manager
Stantec Consulting Ltd.
600-171 Queens Avenue
London ON N6A 5J7
Phone: 519-319-5806
Email: Jeff.Paul@stantec.com

If you have any accessibility requirements in order to participate in this study, please contact the City of Waterloo Project Manager. Information will be collected in accordance with the Freedom of Information and Protection of Privacy Act. With the exception of personal information, all comments will become part of the public record.

This notice was first issued on December 18, 2024.