Stantec

Memo

To:	Guy Bourgon, P. Eng.	From:	Christene Razafimaharo, EIT Ashley LeMasurier, P.Eng.
	Town of Carleton Place		Stantec Consulting, Ottawa
File:	Water & Wastewater Master Plan	Date:	January 13, 2022

Reference: Technical Memorandum #1 - Sanitary Trunk Model Update & Phase 1 Report Addendum

Introduction & Background

Stantec Consulting has been retained by the Town of Carleton Place (the Town) to prepare a Master Plan for the expansion of the Town's Water Treatment Plant (WTP), Wastewater Treatment Plant (WWTP), and water reservoir following the Municipal Class Environmental Assessment (MCEA) process. In addition to assessing these facility expansions, the Master Plan also evaluates the Town's water and wastewater infrastructure needs in existing conditions, and over 5-year, 10-year and 20-year horizons.

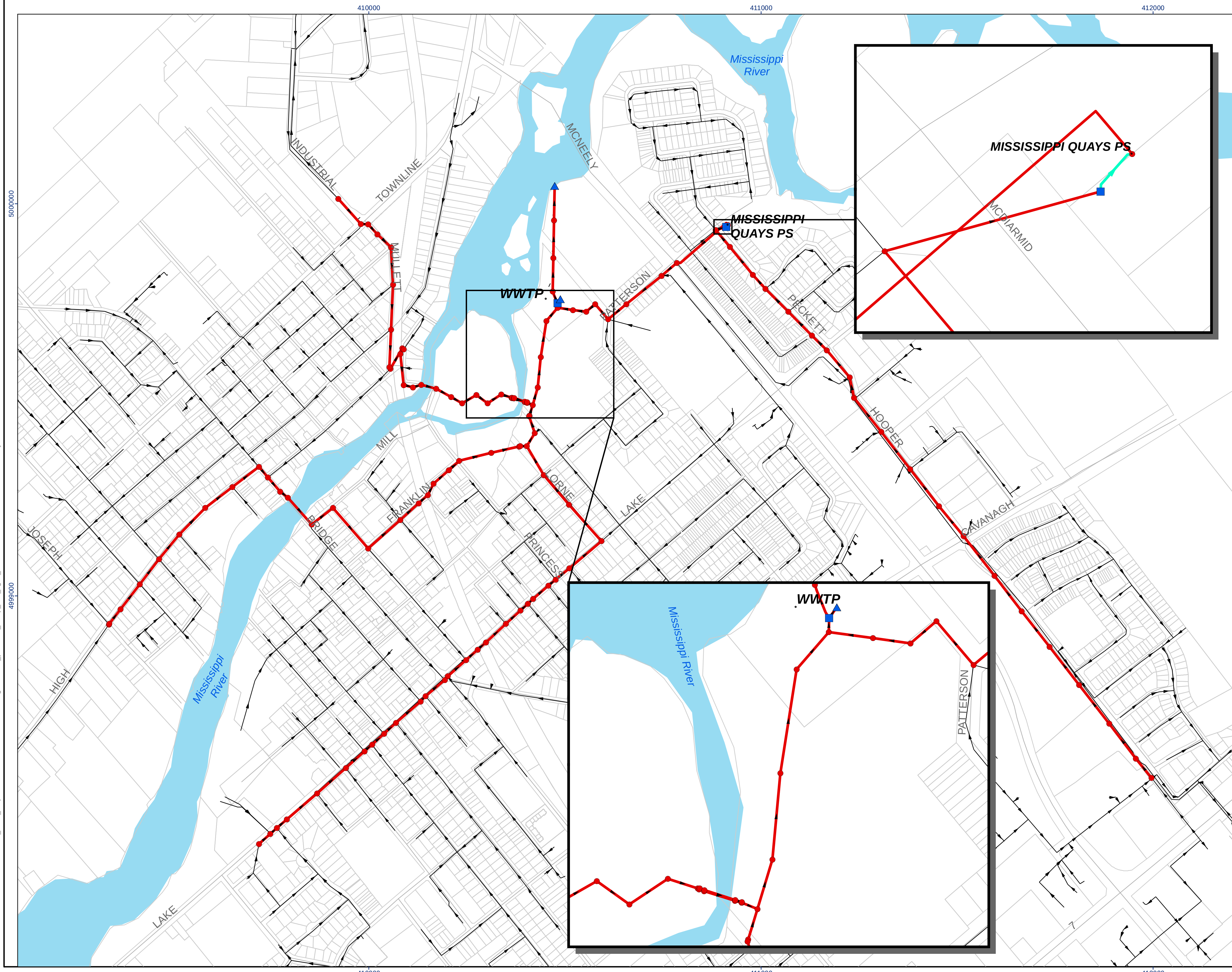
As part of this Master Plan, a *Design Basis Memo* (July 12, 2021) and *Phase 1 Report* (August 31, 2021; draft) have been completed. The *Design Basis Memo* documents the intended approach and guidelines to be used in assessing and designing infrastructure upgrades. It includes the recommendation to use the City of Ottawa's 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 in the assessment of the Town's wastewater collection system. This approach has been used by Stantec in studies for nearby municipalities of similar size to the Town of Carleton Place. The 2018 Technical Bulletin recommends stress-testing the system and assessing the resulting hydraulic gradelines (HGLs) in an "annual" and "rare" event with failed or as-designed pumping station operations (respectively), in addition to assessing capacity during the design event.

The Town's previous approach to assessing their wastewater collection system included the use of a sanitary sewer design spreadsheet (SSDS), which provides an assessment of the free flow capacity (q/Q) of the collection system based on the Manning's equation. The *Phase 1 Report* presents updated capacity assessment results of the Town's wastewater collection infrastructure in existing (2021) and future (2026, 2031, and 2041) conditions. The approach identified in the *Design Basis Memo* was applied to this updated assessment, but due to missing pipe inverts and maintenance hole (MH) cover elevations, an HGL analysis could not be conducted at the time. This information was subsequently requested from the Town.

The purpose of this technical memorandum (TM) is to append the *Phase 1 Report's* collection system assessment with an updated trunk level capacity and HGL analysis completed in PCSWMM for existing and future conditions in the design, annual and rare events. The development of this PCSWMM model is also documented in this TM, which includes updates to the collection system infrastructure data, as provided by the Town. The model is intended to aid in identifying possible deficiencies within the system based on system constraints in existing and future conditions, help to define areas where further information is required, and provide an enhanced understanding of the potential hydraulic conditions at the Town's significant structures (siphon, pumping station, twin sewers).

Refer to the *Design Basis Memo* and *Phase 1 Report* for further details regarding the assessment criteria and preliminary results and limitations of the SSDS model update.

The Town's sanitary sewer network is illustrated in **Figure 1**, showing the trunk collection system and the local collection system (not modelled).



Legend

- ▲ Outfall/Outlet
- ■ Wet Well
- ● Trunk Sanitary Maintenance Holes
- Trunk Sewers
- Local Sanitary Collection System (Not Modelled)
- Pumps

N

0 200 400 metres

(At original document size of 11x17)
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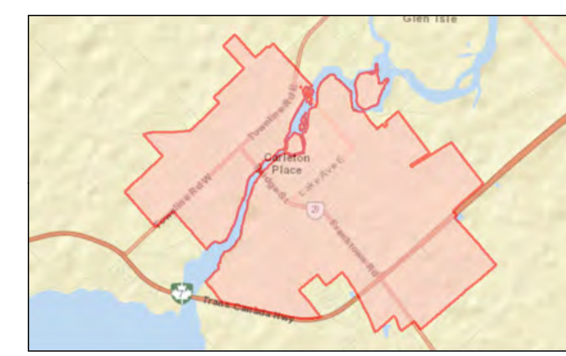
Notes

1. Coordinate System: NAD 1983 UTM Zone 18N

2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results

3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Project Location Prepared by CR on 2021-10-08

Carleton Place, ON

Client/Project 163401646 REVA

Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.

1

Title

Sanitary Sewer Network

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Model Development

Modelling Software

The trunk-level sanitary collection system model was developed in PCSWMM (Computational Hydraulics International, 2021), which consists of a local platform and uses SWMM input files to store information about the model's structure and options. PCSWMM is used by many consultants throughout Ontario and is relatively cost effective. Its SWMM engine also provides flexibility to the client for future use, as SWMM input files can be used with other modelling software.

Modelling Approach

Data Collection & Review

The geographic information system (GIS) shapefile data and drawings provided by the Town as part of the Master Plan's original Request for Information in May 2021 were used as inputs into PCSWMM. The main inputs required to build the model are the sewers (conduits) and maintenance hole (MH; junction) data. Additionally, the Town reviewed and confirmed the trunk's pipe inverts and MH elevations based on drawings (when available), and the data was provided in July 2021. Where limited information was available, inferences were made based on information available in the SSDS. Finally, the Town also provided a digital elevation model (DEM) from LIDAR data in August 2021.

Table 1 presents a list of data sources used to build the model, and the abbreviations used in the PCSWMM model to refer to those data sources. The data sources are presented based on a hierarchy reflecting the level of confidence in the data source relative to other data sources available. This information is included within the user-defined fields in PCSWMM and is structured to define the parameter that was corrected/confirmed or inferred/assumed, and the data source from which it was taken. There is a higher level of confidence in drawings, information from the Town, DEM elevations and GIS shapefile data, which are used to correct or confirm the model inputs. In the absence of data from these sources, inferences based on the SSDSs, or assumptions are made, whereby the level of confidence is relatively lower.

Once imported into PCSWMM, the model was checked to identify (and, if possible, correct) inconsistencies or errors, and address remaining data gaps. These were tagged in an error code field; when verified and/or corrected, tags were added to a fix code field. **Figure 2** illustrates the locations of data gaps and **Figure 3** the locations of errors. **Figure 4** shows how these gaps were addressed and the errors corrected, whether by confirming or correcting the inputs based on drawings, information from the Town, DEM, or GIS data (higher confidence) or by inferring the input based on the SSDS or other assumptions (lower confidence). **Table 2** shows the different types of errors and data gap types, and the number identified in the provided data.

Table 3 shows the different types of fixes that were applied (in order of level of confidence in the data, from highest to lowest confidence) and the number of uses.

Most conduit errors or data gaps were due to missing upstream (14% of all conduits) or downstream (18% of all conduits) invert information, followed by missing diameters (18% of all conduits). The information is missing along Patterson Cres, Franklin St, upstream of the siphon, and upstream of the WWTP. Most junction errors or data gaps were linked to missing cover (ground) elevation data (29% of all junctions missing ground elevation, mainly along Hooper St).

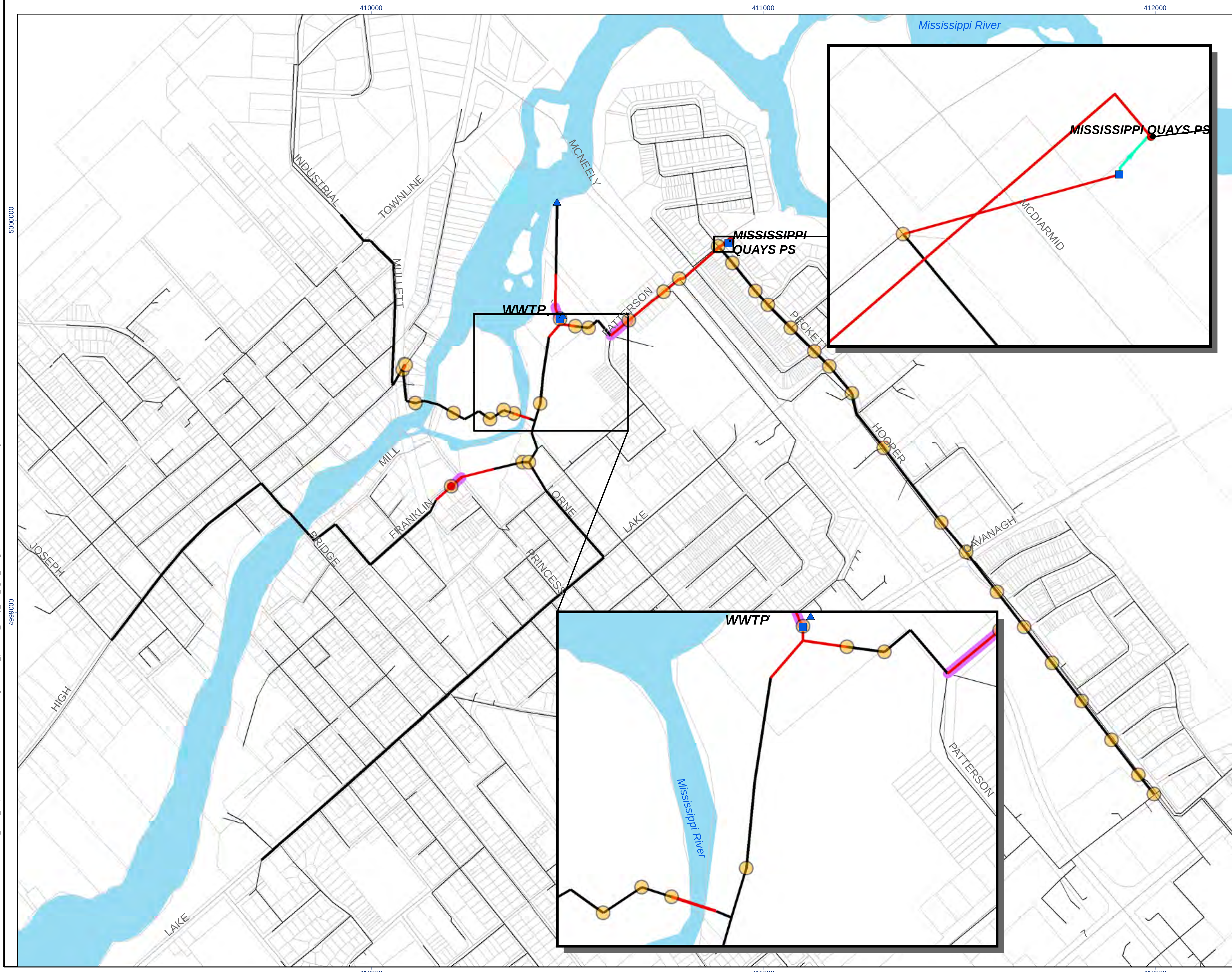
Most of the missing data or errors could be resolved using information provided by the Town (9% of all elements), as-built drawings (10% of all elements), as-designed drawings (1% of all elements) and digital elevation model data (13% of all elements). The remaining gaps or errors (approximately 5% of all elements; notably along Patterson Cres) were inferred or assumed.

Table 1: Data Sources for Model Build and Abbreviations

Hierarchy	Name	Description	Abbreviation(1)
1	As-Built Drawings	Invert(s), diameter, and/or special structure dimension(s) extracted from as-built drawings	AB
2	Town Pipe Data	Invert(s), diameter, and/or special structure dimension(s) reviewed and provided by the Town(2)	PIP-TWN
3	Town MH Data	MH cover elevation and/or connected pipe inverts reviewed and provided by the Town(1)	MH-TWN
4	Digital Elevation Model	Ground elevation from Digital Elevation Model(3)	DEM
5	As-Designed Drawings	Invert(s), diameter, and/or special structure dimension(s) extracted from as-designed drawings	AD
6	GIS Shapefiles	Invert(s), diameter, and/or special structure dimension(s) extracted from Town's GIS database(4)	GIS
	MH ID Field	Information extracted from Town's GIS database; MH ID field	GIS[MNID]
	GIS ID Field	Information extracted from Town's GIS database; GIS ID field	GIS[GISID]
	Cover Elevation Field	Information extracted from Town's GIS database; cover elevation field	GIS[MH_COV_ELE]
	Pipe Diameter	Information extracted from Town's GIS database; diameter field	GIS[DIAMETER]

Hierarchy	Name	Description	Abbreviation[1]
	Pipe Length	Information extracted from Town's GIS database; length field	GIS[length]
	Upstream Invert	Information extracted from Town's GIS database; upstream invert field	GIS[USINV]
	Downstream Invert	Information extracted from Town's GIS database; downstream invert field	GIS[DSINV]
7	Sanitary Sewer Design Spreadsheet	Information originally provided in sanitary sewer design spreadsheet (SSDS)[5]	SSDS
8	Known US or DS Invert & SSDS Slope	Invert inferred from slope from SSDS	SL-SSDS
9	Known US or DS Invert & Assumed Slope	Invert inferred from assumed slope	SL-AS
10	Assumed	Invert(s), diameter, and/or special structure dimension(s) assumed	AS

Notes
(1) Abbreviations used to form data source portion of fix codes; applied in user defined Fix Code field in PCSWMM model.
(2) GIS information reviewed by the Town in July 2021 or confirmed via email communication.
(3) Digital Elevation Model from LIDAR data provided by the Town in September 2021.
(4) GIS data received from original request for information (RFI).
(5) SSDS from *Update to Wastewater Trunk Sanitary Sewer Model* memo (J.L. Richards, March 2021).



Legend

- Outfall/Outlet
- Wet Well
- Missing Node
- Missing Ground Elevation
- Missing Invert
- Missing Pipe
- Missing Diameter
- Trunk Sewers
- Local Sanitary Collection System (Not Modelled)
- Pumps

N

0 200 400 metres
(At original document size of 11x17)
1:10,000

Notes

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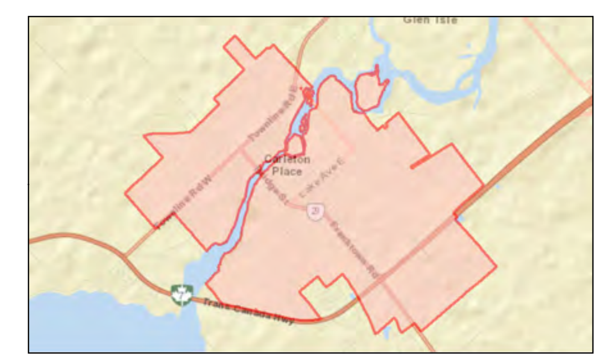
3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Project Location Prepared by CR on 2021-10-08

Carleton Place, ON

Client/Project 163401646 REVA

Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.

2

Title

Trunk System Data Gaps

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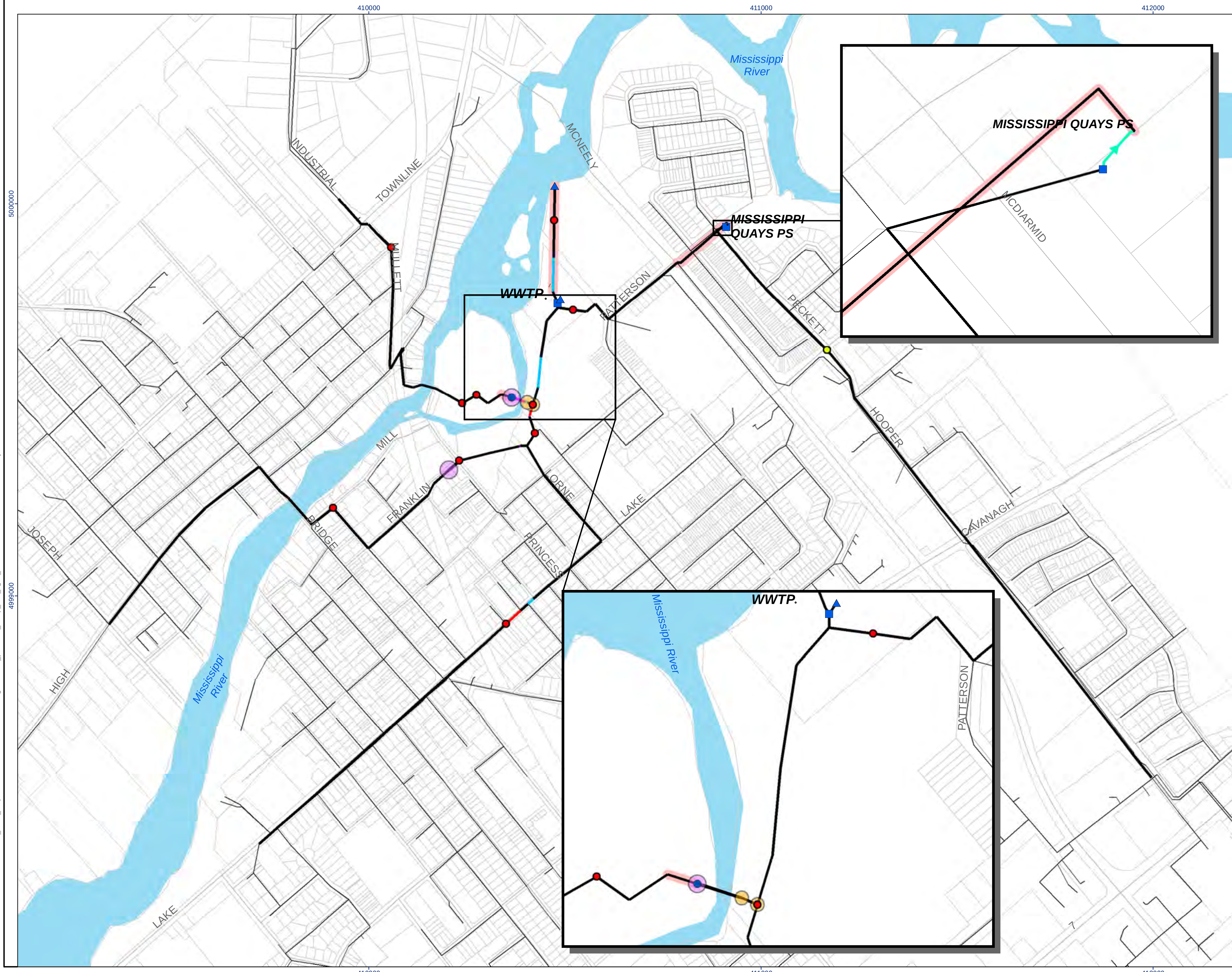

Legend

- Outfall/Outlet
- Wet Well
- Inconsistent Profile Based on Inverts
- Inconsistent Profile Based on Diameters
- Mislocated Node (Node Geometry Error)
- Erroneous Ground Elevation
- Bifurcation Node
- Flat Slope (Slope = 0%)
- Adverse Slope (Slope < 0%)
- Steep Slope (Slope > 5%)
- Erroneous Pipe Layout, Length or Diameter (Pipe Geometry Error)
- Trunk Sewers
- Local Sanitary Collection System (Not Modelled)
- Pumps

N

0 200 400 metres

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Notes

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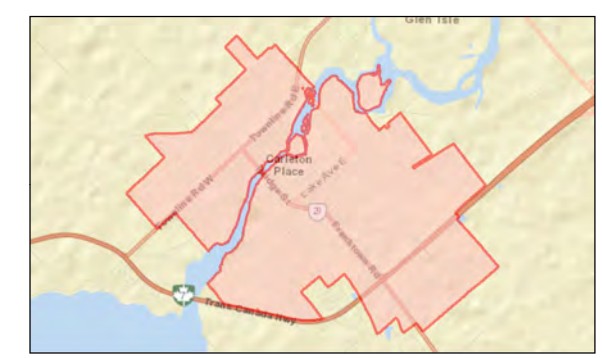

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Carleton Place, ON

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Figure No.

3

Title

Trunk System Engineering Validation Errors

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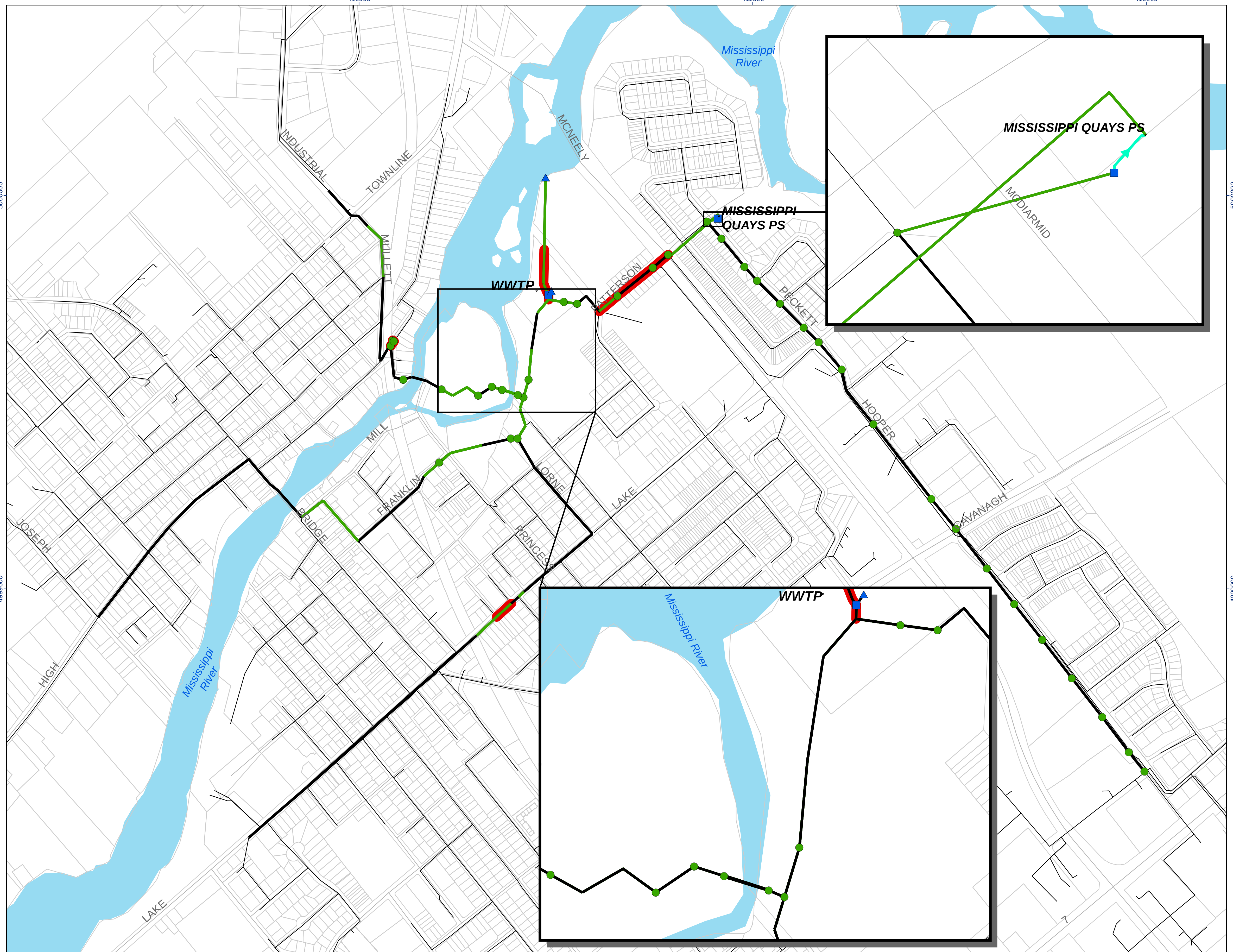

Stantec

Carleton PLACE

Legend

- Outfall/Outlet
- Wet Well
- Confirmed Node Information/Corrected Error (Drawings, Information from Town, DEM, GIS)
- Node Inference/Assumptions
- Confirmed Conduit Information/Corrected Error (Drawings, Information from Town, DEM, GIS)
- Conduit Inference (SSDS)/Assumptions
- Trunk Sewers
- Local Sanitary Collection System (Not Modelled)
- Pumps

N

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Notes

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2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results

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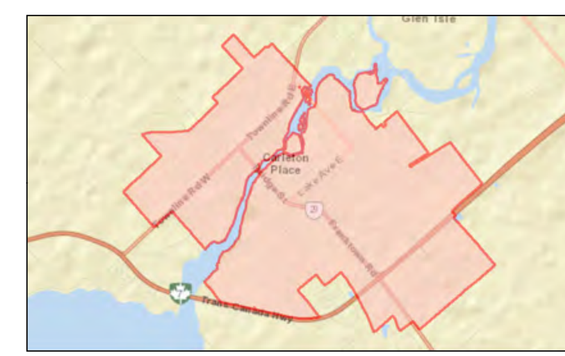

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Carleton Place, ON

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Figure No.

4

Title

Trunk System Error Fixes

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Reference: Technical Memorandum #1 - Sanitary Trunk Model Update & Phase 1 Report Addendum

Table 2: Engineering Validation Errors

Engineering Validation Error	Object Type	Number of Occurrences	# of Elements of Object Type	% of All Elements
Missing Pipe	Conduit	4	125	3%
Missing US Invert	Conduit	18	125	14%
Missing DS Invert	Conduit	22	125	18%
Missing Diameter	Conduit	23	125	18%
Inconsistent Profile - Inverts	Junction	10	123	8%
Adverse Slope	Conduit	6	125	5%
Flat Pipe	Conduit	4	125	3%
Steep Slope	Conduit	6	125	5%
Missing Ground Elevation	Junction	36	123	29%
Bifurcation Node - Flow Split	Junction	2	123	2%
Inconsistent Profile - Diameter	Junction	2	123	2%
Isolated Nodes	Junction	1	123	1%
Missing Downstream Node	Conduit	4	125	3%
Missing Upstream Node	Conduit	5	125	4%
Missing Pump	Pump	2	2	100%
Missing Pump On/Off	Pump	2	2	100%
Missing Pump Discharge Rate	Pump	2	2	100%
Missing Wet Well	Storage	2	2	100%
Missing Wet Well Invert	Storage	2	2	100%
Missing Wet Well Volume	Storage	2	2	100%
Missing Siphon	Conduit	10	125	8%
Reversed Pipe	Conduit	1	125	1%
Pipe Geometry Error	Conduit	5	125	4%
Missing Node	Junction	2	123	2%
Node Geometry Error	Junction	2	123	2%
Error Ground Elevation	Junction	2	123	2%
	Total	**177**		

Reference: Technical Memorandum #1 - Sanitary Trunk Model Update & Phase 1 Report Addendum

Table 3: Engineering Validation Fixes

Fix Approach Type	Data Source	Engineering Validation Fix	Number of Occurrences (1)	Total # of Elements	% of All Elements
Data gap or error confirmed or corrected	AB	Invert(s), diameter, and/or special structure dimension(s) extracted from as-built drawings	24	252	10%
	TWN	Invert(s), diameter, and/or special structure dimension(s) reviewed and provided by the Town	23		9%
	AD	Invert(s), diameter, and/or special structure dimension(s) extracted from as-designed drawings	3		1%
	DEM	Ground elevation from digital elevation model	32		13%
Data gap or error addressed by inference or assumptions	AB	No direct information available for specific element and error. However, information inferred from as-built drawings of upstream/downstream sections	1		<1%
	SSDS	Information inferred from SSDS	8		3%
	O2O	Invert assumed from alignment of obvert with upstream/downstream obvert.	3		1%
	AS	Invert(s), diameter, and/or special structure dimension(s) assumed	1		<1%
		Total	**95**		

Notes

(1) A fix occurrence count can include multiple data errors or gaps that were fixed for one element (e.g., both the upstream and downstream inverts of one pipe were confirmed through as-built drawings = 1 occurrence).

Modelling of Special Structures

The PCSWMM model allows for a more accurate representation of special structures and their operation. Drawings referenced as part of the model development are provided in **Appendix A1**.

Mississippi Quays Pumping Station (PS) and Forcemain

The Mississippi Quays PS is the only pumping station in the trunk system. It discharges into a 200 mm diameter forcemain along Patterson Cres. The PS's wet well was modelled as a storage element, and relevant elevations were obtained from the PS's design drawings (drawing reference: 95-10147-PSI, see **Appendix A1**).

As per the Certificate of Authorization (dated August 2nd, 1995) and the drawings, there are two pumps at the Mississippi Quays PS; each with a capacity of 52.2 L/s. Thus, the PS's ultimate capacity is 104.4 L/s. It is equipped with an emergency pump-out system; however, limited information on this was available.

As this analysis was completed with a steady-state model, there are no variations in the inflows and the wet well levels during the simulations. Therefore, the pumps were modelled with constant/fixed pump rates, as specified in **Table 4** in the following section (**Model Scenarios & System Assessment Criteria**), depending on the model scenario. To simplify the modelling, the capacities of the two pumps were combined and modelled as a single pump; either as ideal (unrestricted, flow in = flow out), or with a constant flow rate of 104.4 L/s, depending on the scenario (see **Model Scenarios & System Assessment Criteria** section below).

McArthur Island Siphon

There is a siphon crossing the Mississippi River, east of McArthur Island. This two-barreled siphon was modelled with a 400 mm diameter pipe on McArthur Island, bifurcating into a 150 mm diameter pipe and a 300 mm diameter pipe crossing the river, and merging into a 400 mm diameter pipe east of the river. Pipe invert and MH cover elevations were obtained from as-built drawings (drawing reference: U-072, see **Appendix A1**). The MH upstream of the siphon was specified as being locked in the Town's GIS database and was thus modelled as a sealed MH, eliminating the opportunity for lost flow/volume at this location.

Anecdotal evidence was provided by the Town that indicated that surface flooding is experienced upstream of the siphon in large events. The most recent occurrence being the December 25, 2020 rainfall event, which was also indicated to have triggered a bypass at the WWTP, as per OCWA's 2020 Annual Report (*Carleton Place Wastewater System – 2020 Annual Report*, OCWA, 2021).

Franklin St Twin Sewers

The Town has reviewed drawings and indicated that a ~50 m stretch of what was identified as 600 mm diameter sewer on Franklin St in the SSDS, is actually twinned 450 mm sewers. This layout was directly modelled in the PCSWMM model, using the pipe inverts provided by the Town. Twinned sewers were likely installed to improve cover in this area, as even the 450 mm sewers are shallow (< 1.8 m of cover).

Wastewater Treatment Plant (WWTP)

As this assessment targets the performance of the sanitary trunk collection system and not the functionality within the WWTP itself, the WWTP's internal workings are not included in the model. For the purposes of this modelling assignment, the WWTP represents a boundary condition in the model, and is instead modelled with a simplified layout to represent the head conditions generated through the wet well and raw sewage pumps before treatment of the influent. The water level in the wet well is assumed to be the governing boundary condition at the WWTP. The wet well's invert elevation and dimensions were obtained from the WWTP's as-built drawings (drawing reference: MOE-3-0692-S9/32, see **Appendix A1**) and information provided by the Ontario Clean Water Agency (OCWA; **Appendix A2**). There is a 750 mm diameter emergency overflow, through which excess flows bypass the wet well and are conveyed directly to the WWTP's effluent sewer, where it receives UV disinfection. The overflow and effluent sewer layouts were integrated into the model based on the Town's GIS database, with inverts obtained or inferred from as-built drawings (drawing reference: S-66-517, see **Appendix A1**). The effluent sewer discharges to an outfall in the Mississippi River. Due to the provided UV disinfection, overflows from the wet well will herein be defined as bypasses.

The WWTP is equipped with three raw sewage pumps (lead, lag and standby), with individual capacities of 150.5 L/s (13,000 m^3/d) each (*Facility Optimization Report for the Carleton Place Water Pollution Control Plant* draft memo, OCWA, 2021). Based on the above-noted report, the firm capacity of the WWTP pumps is 300.9 L/s (26,000 m^3/d), which assumes the standby is not in operation. As noted in the *Phase 1 Report*, although the pumps have individual capacities of 150.5 L/s (13,000 m^3/d) totaling a firm capacity of 300.9 L/s (26,000 m^3/d), the existing WWTP itself is understood to have a peak design flow of 254.6 L/s (22,000 m^3/d), as specified in the WWTP's *Certificate of Approval* (dated October 3rd, 2008). This constraint is understood to occur within the treatment process where additional storage (tanks, etc.) is also provided to attenuate peak flows. Since the available storage volumes and internal workings of the plant are not included within the model, this additional constraint is also not incorporated.

To represent the raw sewage pump capacities in the treatment plant, an artificial or 'dummy' conduit is used in the model, which drains from the wet well to a dummy outfall node. Varying flow limits are applied to this dummy conduit to represent the design, annual and rare events. These flow limit conditions are discussed in the **Model Scenarios & System Assessment Criteria** section of this memo and are summarized in **Table 4**. OCWA also provided anecdotal information on levels typically observed in the wet well during dry weather days, high flows (wet weather), and major storms (see **Appendix A3**). These wet well levels are discussed further in the **Discussion and Validation of Results** section under **Results**.

Sanitary Flow Generation

Existing and future populations and contributing areas were used to calculate the anticipated sanitary flow generation in the SSDSs presented in the *Phase 1 Report*, using the parameters and forecasts presented in the *Design Basis Memo*. The SSDS methodology uses the cumulated contributing populations, an estimated per capita rate (392 L/cap/day for Carleton Place; higher than most design rates which typically range from 200 – 350 L/cap/day), and the Harmon's peaking factor equation to estimate the peak dry weather flow (DWF) for residential contributions. The Harmon's peaking factor equation is also based on the cumulated contributing population at each receiving MH, which can result in reasonable, yet conservative estimations of DWF. Because the formula incorporates the cumulated population as the denominator, larger populations result in lower peaking factors, and vice versa.

Hydraulic models typically include diurnal patterns that define the daily fluctuation and peaking factors of the DWF within the system and are commonly derived through the analysis of representative flow monitoring data. Since recent flow monitoring data is not available, it is currently not possible to apply a representative diurnal pattern in the model. Instead, a steady-state approach was applied, and is based on the cumulated SSDS flows.

There are, however, limitations in the conversion of SSDS dry weather flows (residential and ICI flows) into model inputs, as most hydraulic models require inputs on a "per MH" basis (i.e., non-cumulated). With non-cumulated (smaller) populations, the calculated Harmon peaking factors are higher and thus, the modelled DWFs required adjustment so that the downstream end of each main trunk branch and the total inflows to the WWTP matched those of their corresponding line items within the SSDS. This does, however, result in slight variations of flow within some of the branches (< 15 % in the 2021 design event), but overall provides a reasonable representation of the system's flows.

The domestic flows (peak residential and ICI sanitary flows) and extraneous flows (GWI & I/I) were imported into the PCSWMM junctions table's "Average Value (L/s)" and "Baseline (L/s)" fields, respectively. Additionally, the drainage areas were imported into the PCSWMM junctions table's "MH Sewershed Area (ha)" custom field for reference. **Appendix B** shows the inflows and areas for each MH.

Model Scenarios & System Assessment Criteria

As established in the *Design Basis Memo* and presented in the *Phase 1 Report*, the sanitary trunk collection system is assessed under three scenarios (design, annual, and rare), for each planning horizon (2021, 2026, 2031, and 2041). Besides the flow generated, the boundary conditions in the PCSWMM model are also adapted to represent these scenarios. The design event typically represents an event similar to the 1:25 year and is widely used in the design of sanitary collection systems and their pumping facilities. Sewer infrastructure is typically designed to operate under free-flowing conditions during this event, while pumping stations operate at their firm capacity (largest pump offline). The annual and rare events are used to stress the system and assess the HGLs with respect to building Underside of Footings (USFs). The annual event represents the highest I/I within a typical year during which critical pump station(s) have failed, and the rare event represents conditions of high extraneous flows with pump stations operating as designed (assumed equivalent to the 1:100-yr I/I). The criteria for each event is expanded upon in the following sections. Table 4 below summarizes the criteria and boundary conditions applied per scenario.

Design Event

For the design event, the collection system performance is evaluated based on pipe capacity using a combination of the flow capacity utilization within the pipe (q/Q) and the depth ratio (d/D), which can be interpreted to identify the pipe surcharge state. Pipes can either be bottlenecked (undersized and flowing above the pipe's capacity), experiencing backwater conditions due to downstream bottlenecks, or free flowing. All pumps (Mississippi Quays PS and the WWTP) are unrestricted in modelled design event scenarios, and a capacity assessment for these facilities is completed comparing the flow through the facility in each scenario to their respective capacities. The design event's targeted condition is for all pipes to flow freely and the pumping stations' firm capacity (largest pump offline) to be able to convey the incoming flow.

Annual & Rare Events

For both the annual and rare events, the resultant HGLs are assessed to identify if basement or surface flooding risks are generated. To assess the risk of basement flooding, the HGLs are compared to an assumed elevation of the Underside of Footing (USF) for connected buildings. Commonly, when USF elevations are unknown, a depth of 1.5 m from the crown of the road is assumed based on standard road cross-slopes and lateral connection slopes. The risk of basement flooding is often evaluated based on a depth of 1.8 m from crown, which includes a 0.30 m buffer below the USF. The MH cover elevation is assumed representative of the crown of the road, as most MHs are located along the centerline of the roadway. For the annual event, when critical pump stations fail, the HGLs must be below the assumed USF, i.e., the *freeboard* is 1.5 m or greater. For the rare event, when pumping stations are operating normally, the HGLs must be greater than 0.3 m below the USF, i.e., the *freeboard* is 1.8 m or greater. Surface flooding occurs when the HGL is at or above surface. HGL issues are defined by locations that do not meet the freeboard criteria for the relevant event (i.e., freeboard is < 1.5 m and < 1.8 m in the annual and rare events, respectively).

Since HGLs are the primary focus of the annual and rare events, the boundary condition representing the WWTP capacity's impact on the upstream sewer system is applied for the annual and rare event assessments. As presented in the **Wastewater Treatment Plant (WWTP)** section above, the raw sewage pump capacities in the treatment plant were modelled using varying flow limits to represent the required criteria per event. A flow limit of 0 L/s is applied in the annual event to represent complete pump failure, and a flow limit of 300.9 L/s (26,000 m^3/d) is applied in the rare event representing the firm capacity of the raw sewage pumps. No flow limit was applied in the design event so as not to create backwater conditions in the upstream sewer system and allow for a proper assessment of pipe capacities relative to the generated flows.

The flow limits result in wet well levels higher than those provided anecdotally by OCWA (**Appendix A3**) that were used to define high wet weather flow and major storm event levels. The pump capacities were therefore determined to govern the boundary condition at the WWTP, indicating that the calculated flows for all events exceed the conditions for which the wet well levels were provided. Wet well levels corresponding to larger events should be obtained and confirmed in future progressions of this model, once the flows into the system are better understood with flow monitoring. The 0 L/s and 300.9 L/s flow limits were maintained as the boundary condition representing the WWTP in all modelled annual and rare event scenarios, respectively.

Reference: Technical Memorandum #1 - Sanitary Trunk Model Update & Phase 1 Report Addendum

Table 4: Model Configuration and Assessment Criteria per Scenario

Scenario & Description	Model Configuration	Assessment Criteria
Design Event Free flow conditions	Mississippi Quays PS operates unrestricted[1] (Flow in = flow out) WWTP flow limit = N/A[2]	• Mississippi Quays PS inflow ≤ PS firm capacity (largest pump offline, Q = 52.2 L/s) • WWTP inflow ≤ Raw Sewage pumps' firm capacity (largest/standby pump offline, Q = 300.9 L/s) • Pipe capacity based on depth ratio (d/D) and flow capacity utilization (q/Q).[3] • **Red Conduits:** Sewer surcharged, peak flow greater than free flow capacity of the sewer (i.e., sewer is under capacity and causing bottleneck; d/D ≥ 1 and q/Q ≥ 1) • **Amber Conduits**: Sewer surcharged, peak flow within free flow capacity of the sewer (i.e., under backwater conditions; d/D ≥ 1 and q/Q < 1) • **Black Conduits**: Free flow within sewer (d/D < 1)
Annual Event Failure of a PS	Mississippi Quays PS fails (constant flow rate = 0 L/s) WWTP pumps fail (flow limit = 0 L/s)	• HGL assessment; maximum HGL should not touch the underside of footing.[3] This is typically considered to be 1.5 m from centerline of road (assumed equivalent to MH cover elevation). • **Red Junctions**: HGL is above ground surface (i.e., surface flooding) • **Amber Junctions**: HGL is within 1.5 m of ground surface (Freeboard[4] < 1.5 m) • **All Other Junctions** (not shown, for figure clarity): HGL is more than 1.5 m below ground surface (Freeboard[4] ≥ 1.5 m). • Pipe surcharge state can help define the issues within the system but is not considered in the criteria for this event. Rendering of surcharge state is provided in the accompanying figures however, with symbology as defined under the Design event section of this table.
Rare Event High flow event during normal operating conditions	Mississippi Quays PS operates at ultimate capacity (constant flow rate = 104.4 L/s) WWTP operates with both pumps on (flow limit = 300.9 L/s)	• HGL assessment; maximum HGL should be no greater than 0.3 m below the underside of footing.[3] This is typically considered to be 1.8 m from centerline of road (assumed equivalent to MH cover elevation). • **Red Junctions**: HGL is above ground surface (i.e., surface flooding) • **Amber Junctions**: HGL is within 1.8 m of ground surface (i.e., potential for basement flooding; Freeboard[4] < 1.8 m) • **All Other Junctions** (not shown, for figure clarity): HGL is more than 1.8 m below ground surface (Freeboard[4] ≥ 1.8 m). • Pipe surcharge state can help define the issues within the system but is not considered in the criteria for this event. Rendering of surcharge state is provided in the accompanying figures however, with symbology as defined under the Design event section of this table.

Notes

(1) For modelling purposes, the Mississippi Quays PS was modelled as ideal (unrestricted) in the design event to prevent restrictions at the pump station, increasing flow conveyed downstream. This enables a more conservative downstream capacity assessment.

(2) No flow limit at the WWTP was applied in the design event in order to assess the sewer system's capacity to handle flows without downstream restrictions.

(3) Criteria as outlined in the City of Ottawa Technical Bulletin ISTB-2018-01.

(4) Freeboard is calculated by subtracting the HGL elevation from the MH ground level (Freeboard = Ground – HGL)

Results

Existing Conditions

Based on the previously described parameters and boundary conditions, the modelling results for the existing (2021) conditions are shown in **Figure 5** (design event), **Figure 6** (annual event) and **Figure 7** (rare event). All the figures illustrate the wet weather flow conditions only (i.e., including I/I), however relevant observations from dry weather runs are also provided. DWF results are not presented due to their magnitude in comparison to the WWF flow results. The resulting levels and flows of the Mississippi Quays PS and WWTP are summarized in **Table 5**.

Design Event

Under the dry weather design event (not illustrated) and wet weather design event, all sewers are free-flowing other than those within the siphon, which are designed to operate under pressurized conditions (i.e., shown in red in the results figures).

The Mississippi Quays PS design event incoming flow (50.7 L/s) is just less than its firm capacity (52.2 L/s), thus meeting the design event criteria.

The WWTP design event incoming flow (349.2 L/s) however, exceeds the firm capacity of the raw sewage pumps (300.9 L/s), indicating that the pump capacity is not adequate to handle the calculated design event flows and that a bypass may occur in this event. To test this theory, the 300.9 L/s flow limit was applied to the WWTP in the design event, resulting in surface flooding upstream of the siphon (on McArthur Island) as well as wet well levels of 6.1 m; high enough to trigger a bypass at a rate of 43.7 L/s. Resulting wet well levels and bypass flow rates are presented in **Table 5.**

Annual Event

If the Mississippi Quays PS fails (annual event assessment), backwater is observed along McDiarmid Ln, Peckett St and Hooper St, with risks of surface flooding and basement flooding, both under dry and wet weather conditions.

With complete pump failure at the WWTP, HGL issues are also observed from upstream of the McArthur Island siphon, down to the WWTP, including surface flooding just upstream of the siphon in wet weather conditions (and HGLs within 1.5 m of surface in dry conditions). While building connections are not anticipated within the green space surrounding the Mississippi Riverwalk Trail, future developments on McArthur Island were identified in the *Carleton Place Comprehensive Review, Council Report* (Town of Carleton Place / J.L.

Richards, March 2021). The Town has indicated that the existing ICI building on the island is being redeveloped into a residential building. If this building is connected to the sewer lines conveying flows to the siphon and depending on its USF, the annual event criteria (HGL under USF) may not be met in existing conditions. The Town has indicated that the building will require a backwater valve on its sanitary service line.

Additional HGL issues are also identified on Lake Ave and on Franklin St (upstream and downstream of the twin sewers) in the annual event. However, these are not associated with any flow constraints in the sewers, but rather with relatively shallow pipes (≤ 1.8 m of cover). A bypass is also observed at the WWTP in this scenario (at a rate of 206.7 L/s).

Rare Event

Under the rare event with pumping station operating at ultimate capacity, bottlenecks along High St lead to surface flooding and basement flooding upstream, which can only be observed in the model during wet weather conditions where I/I is high. The Town's sanitary collection system is fully separated, however previous assessments (most recently, *Update to Wastewater Trunk Sanitary Sewer Model* memo; J.L. Richards, March 2021) have used higher I/I rates in the areas tributary to High St, based on flow monitoring observations from 2013. These higher flows may be attributable to illegal sump pump connections or other factors causing increased flows; however, this has not been confirmed. Therefore, the City of Ottawa Sewer Design Guidelines' I/I rate for "partially separated" areas was used in this area in order to be conservative (3 L/s/ha in the rare event). While this conservative analysis identifies potential surface flooding on High St due to this higher rate, no surface flooding has been observed by the Town in this area. The I/I rate in this area should therefore be confirmed with a new flow monitoring program, and the model updated to confirm these flooding risks. These issues, however, are not seen propagating downstream, as the sewers along Bridge St to Franklin St appear to be adequately sized to handle these high flows.

The sewers from McArthur Island to the WWTP also show backwater due to the pumping capacity at the plant in wet weather conditions, with HGL issues (risk of surface and basement flooding) observed throughout this stretch of sewers. A bypass is also observed at the WWTP in this scenario (at a rate of 145.6 L/s).

All flows into the Mississippi Quays PS wet well can be conveyed by the two pumps (ultimate capacity) and thus, no HGL issues are observed upstream of this pumping station.

HGL issues are once again observed on Lake Ave and Franklin St, and now on Lorne St, and Mullet St as well, all due to relatively shallow pipes (≤ 1.8 m of cover).

Reference: Technical Memorandum #1 - Sanitary Trunk Model Update & Phase 1 Report Addendum

Table 5: Model Results at the Mississippi Quays PS and WWTP for Existing Conditions (2021)

Model Results		2021		
		Design[(1)]	Annual[(2)]	Rare[(3)]
Mississippi Quays PS	Total Generated Flow (L/s)	50.7	44.6	69.1
	Maximum Allowable Pumping Rate (L/s)	52.2	-[(2)]	104.4
	Wet Well Water Elevation (m)	-[(5)]	130.02	121.44
	Wet Well Invert (m)[(4)]	121.44		
	Wet Well Depth (m)	-[(5)]	8.6	0.0
	Wet Well Height (m)	9.6		
WWTP	Total Generated Flow (L/s)	349.2	272.0	652.2
	Maximum Allowable Pumping Rate (L/s)	300.9	-[(2)]	300.9
	Wet Well Water Elevation (m)	-[(7)]	130.03	129.97
	Wet Well Invert (m)[(6)]	123.75		
	Wet Well Water Depth (m)	-[(7)]	6.3	6.3
	Wet Well Height (m)	8.8		
	Bypass Flow Rate (L/s)	-[(7)]	206.7	145.6

<u>Notes</u>

(1) Design event includes pump stations operating at firm capacity (largest pump offline). The results from the scenario in which no flow limit was applied to the Mississippi Quays PS and the WWTP is presented in the above table, as it enables capacity assessments of the upstream system instead of generating backwater conditions, allows for a more conservative downstream capacity assessment, and aligns to the results presented in **Figure 5**.

(2) Annual event includes failure of both the Mississippi Quays PS and the raw sewage pumps in the WWTP.

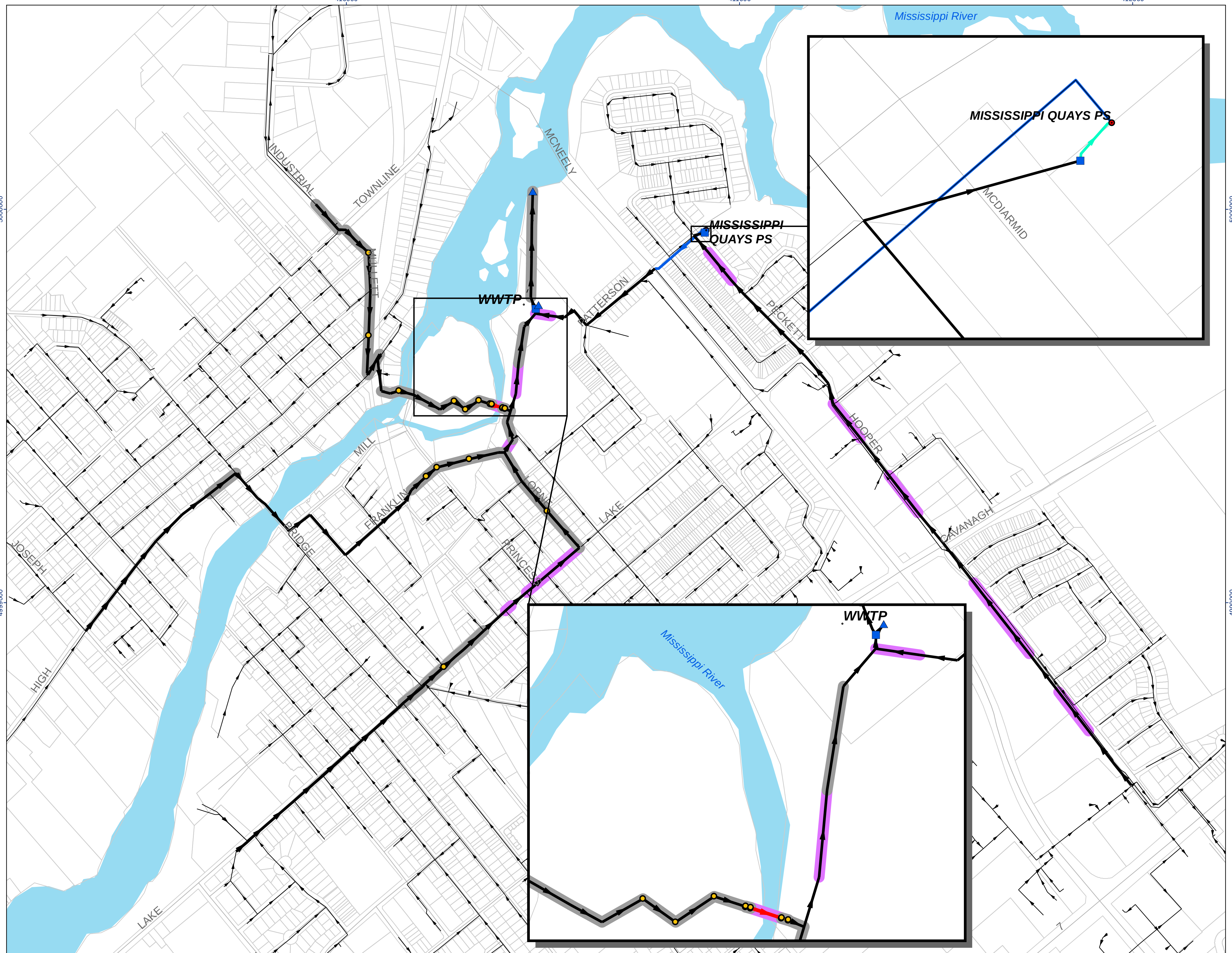
(3) Rare event includes pump stations operating at ultimate capacity (all pumps on, excluding standby at WWTP).

(4) Mississippi Quays PS wet well invert from as-designed drawings (drawing reference: 95-10147-PSI, see **Appendix A1**).

(5) When the Mississippi Quays pump rate is reduced to its firm capacity (52.2 L/s) in the design event, a wet well level of 0 m is observed (incoming flows are less than the PS's firm capacity and are conveyed downstream).

(6) WWTP wet well invert from as-built drawings (drawing reference: MOE-3-0692-S9/32, see **Appendix A1**).

(7) When a flow limit of the WWTP's firm capacity (300.9 L/s) is applied in the design event, a wet well level of 6.1 m and a bypass flow rate of 43.7 L/s is observed.



Legend

- Outfall/Outlet
- Wet Well

HGL Freeboard

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

Pipe Surcharge State

- Bottleneck (Undersized Sewer)
- Backwater Condition
- Free-Flowing Condition
- Forcemain
- Pumps
- Local Sanitary Collection System (Not Modelled)

Pipe Exemptions

- Shallow Pipe (Obvert within 1.8 m of Surface)
- Flat Pipe (Slope < 0.10%)

Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

N

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(At original document size of 11x17)
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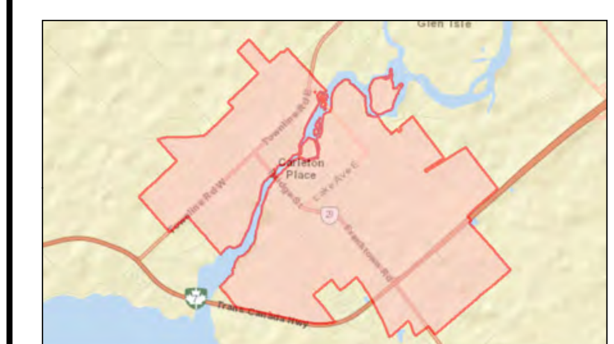
Notes

1. Coordinate System: NAD 1983 UTM Zone 18N

2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results

3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Project Location Prepared by CR on 2021-10-08

Carleton Place, ON

Client/Project 163401646 REVA

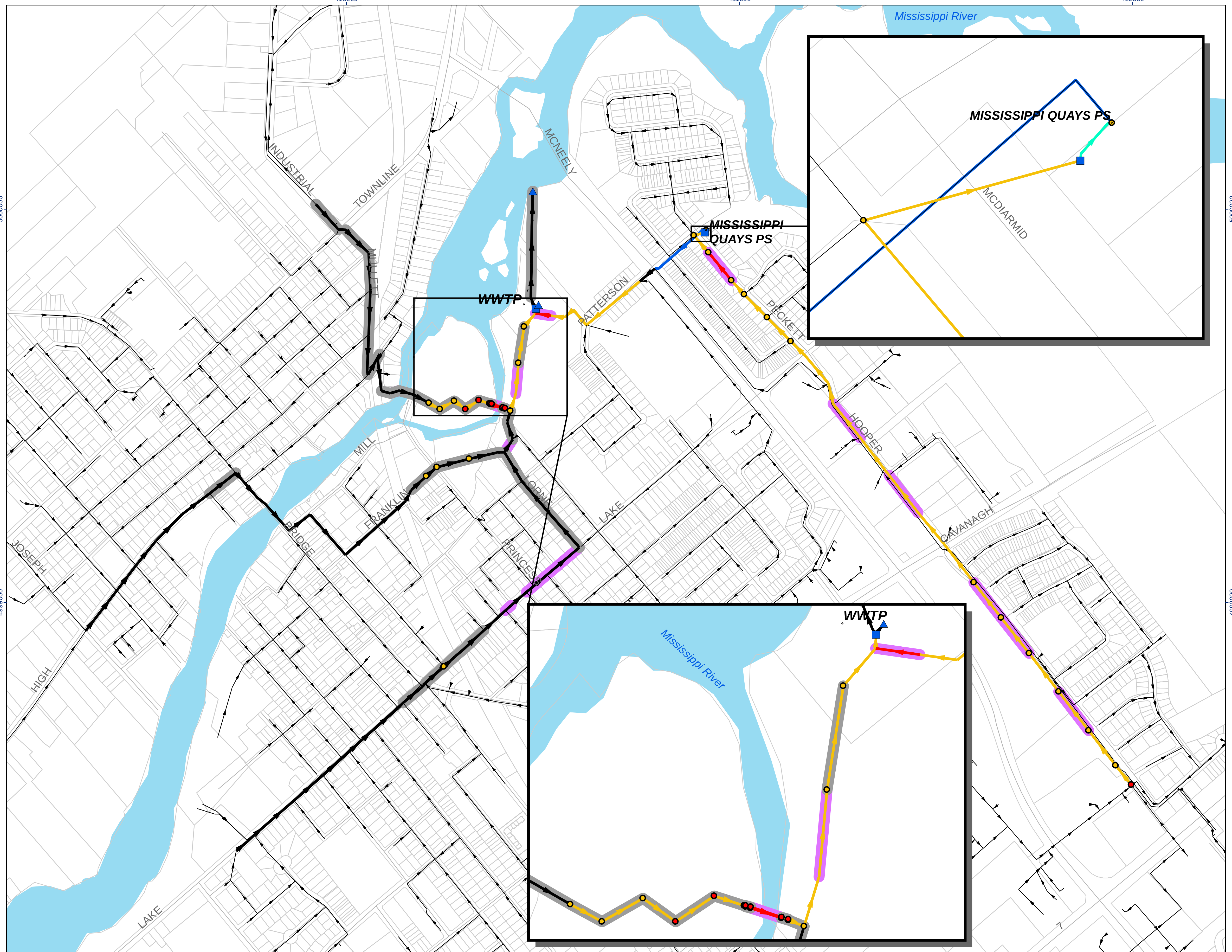
Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.

5

Title

Trunk System 2021 Design Event Results



Legend

- Outfall/Outlet
- Wet Well

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.5 m of Surface)

Pipe Surcharge State

- Bottleneck (Undersized Sewer)
- Backwater Condition
- Free-Flowing Condition
- Forcemain
- Pumps
- Local Sanitary Collection System (Not Modelled)

Pipe Exemptions

- Shallow Pipe (Obvert within 1.8 m of Surface)
- Flat Pipe (Slope < 0.10%)

Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

N

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(At original document size of 11x17)
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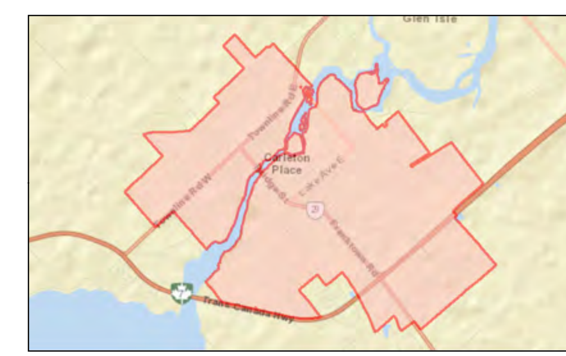
Notes

1. Coordinate System: NAD 1983 UTM Zone 18N
2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results
3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Project Location Prepared by CR on 2021-10-08

Carleton Place, ON

Client/Project 163401646 REVA

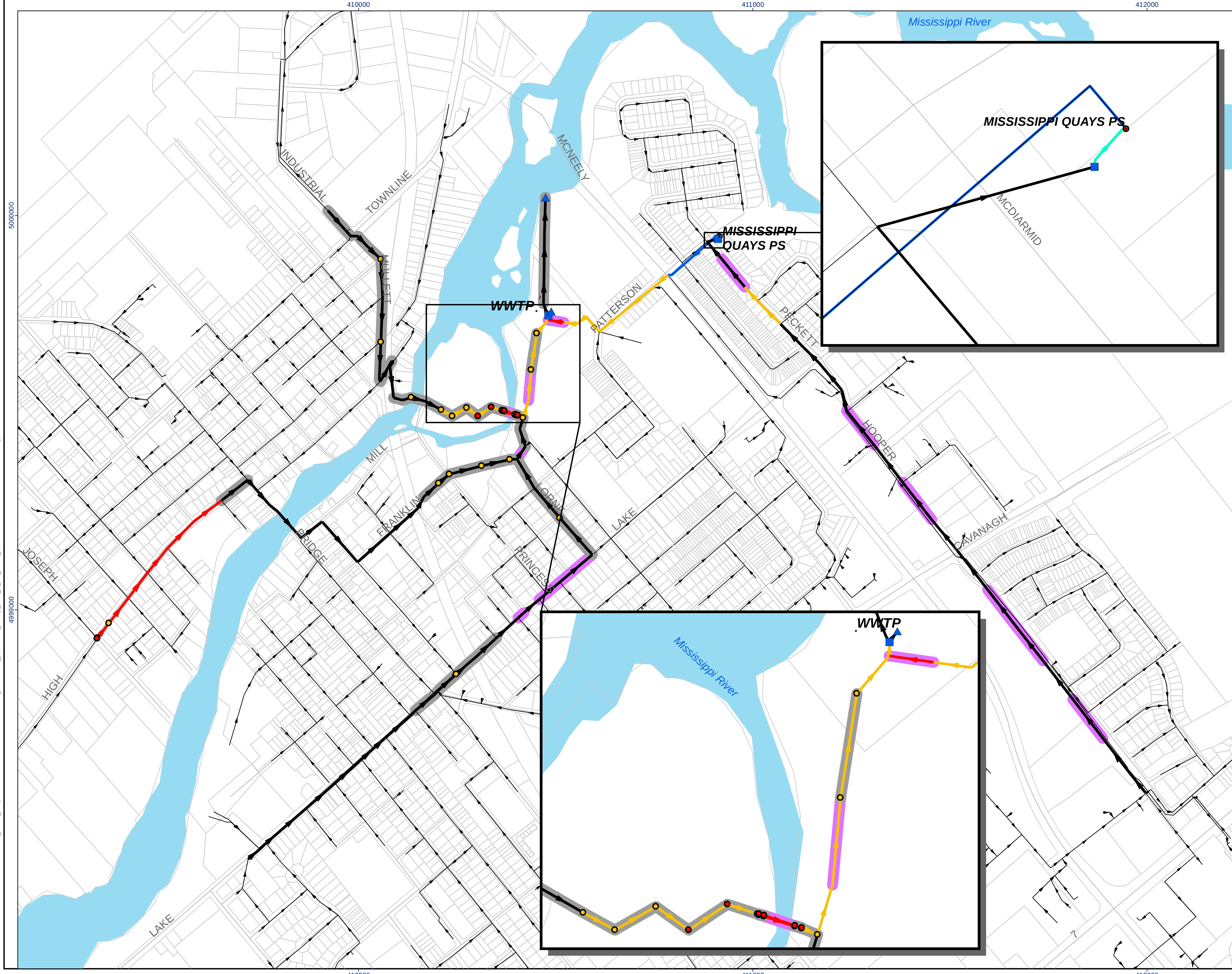
Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.

6

Title

Trunk System 2021 Annual Event Results



Stantec

Carleton PLACE

Legend

- Outfall/Outlet
- Wet Well

HGL Freeboard

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

Pipe Surcharge State

- Bottleneck (Undersized Sewer)
- Backwater Condition
- Free-Flowing Condition
- Forcemain
- Pumps
- Local Sanitary Collection System (Not Modelled)

Pipe Exemptions

- Shallow Pipe (Obvert within 1.8 m of Surface)
- Flat Pipe (Slope < 0.10%)

Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

N

0 200 400 metres

(At original document size of 11x17)
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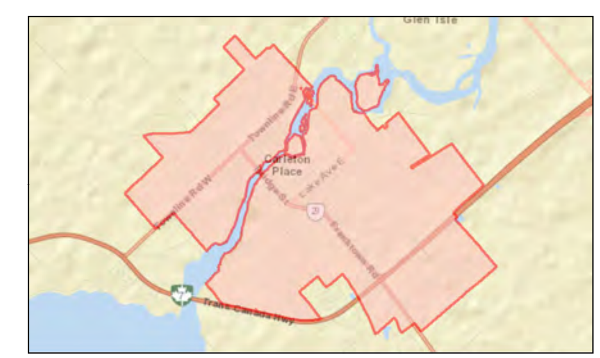
Notes

1. Coordinate System: NAD 1983 UTM Zone 18N
2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results
3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Project Location Prepared by CR on 2021-10-08

Carleton Place, ON

Client/Project 163401646 REVA

Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.

7

Title

Trunk System 2021 Rare Event Results

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Reference: Technical Memorandum #1 - Sanitary Trunk Model Update & Phase 1 Report Addendum

Future Conditions

The sanitary collection system's performance was assessed in the design, annual and rare events for future planning horizons using the projected flows. The resulting levels and flows observed at the Mississippi Quays PS and WWTP for the different planning horizons and scenarios are summarized in **Table 6**. The constraints identified under existing (2021) conditions persist. Only new constraints are discussed in the following sections.

Short-Term Horizon (2026)

The modelling results for the short-term (2026) planning horizon are shown in **Figure 8** (design event), **Figure 9** (annual event) and **Figure 10** (rare event).

Design Event

In the design event, no additional pipe capacity constraints have been identified. Flows into the Mississippi Quays PS (53.0 L/s) now exceed the PS's firm capacity (52.2 L/s) and therefore do not meet the criteria for the design event. Applying a flow limit of 52.2 L/s at the Mississippi Quays PS yields wet well levels of 4.6 m, which are within the wet well's maximum height (9.6 m).

The WWTP design event inflow (395.4 L/s) continues to exceed the firm capacity of the existing raw sewage pumps (300.9 L/s). Similarly to the test completed for the existing conditions design event, a flow limit equivalent to the firm capacity of the raw sewage pumps (300.9 L/s) was applied resulting in continued surface flooding upstream of the siphon (on McArthur Island), and an increased wet well level (6.1 m) and bypass (65.1 L/s). These results are not illustrated in the provided figures.

Annual Event

In the annual event, if the Mississippi Quays PS fails, backwater continues along McDiarmid Ln, Peckett St and Hooper St. HGLs increase, however risks of surface and basement flooding occur at the same locations as in existing conditions (i.e., no new HGL issues arise in this planning horizon).

With complete pump failure at the WWTP, HGL issues from upstream of the McArthur Island siphon down to the WWTP persist with elevated HGL levels. Flooding at an additional MH directly upstream of the siphon is observed in this planning horizon. The WWTP wet well bypass continues at an increased rate of 227.1 L/s.

Rare Event

In the rare event, while HGLs increase along High St, no new HGL issues are observed in this area. All flows into the Mississippi Quays PS wet well (70.9 L/s) can be conveyed by the two pumps (ultimate capacity) and no HGL issues are observed upstream of this pumping station.

The sewers from McArthur Island to the WWTP continue showing backwater due to the pumping capacity at the plant in wet weather conditions. The HGL issues identified in existing conditions persist, with an additional MH flooding directly downstream of the siphon. The WWTP wet well bypass continues at an increased rate of 174.4 L/s.

Medium-Term Horizon (2031)

Refer to **Figure 11** (design event), **Figure 12** (annual event) and **Figure 13** (rare event) for the medium-term (2031) planning horizon results.

Design Event

An additional pipe constraint is observed in the design event along McDiarmid Ln/Peckett St, which experiences backwater. This backwater is caused by the downstream sewer on McDiarmid Ln, which has a relatively flat slope (<0.10%).

All flows to the Mississippi Quays PS in the design event (57.3 L/s) exceed the PS's firm capacity (52.2 L/s) and therefore do not meet the criteria for the design event. Applying a flow limit of 52.2 L/s at the Mississippi Quays PS yields wet well levels of 7.7 m, which are within the wet well's maximum height (9.6 m).

The WWTP design event incoming flow (437.5 L/s) continues to exceed the firm capacity of the existing raw sewage pumps (300.9 L/s). Applying a flow limit equivalent to the firm capacity of the raw sewage pumps (300.9 L/s), surface flooding upstream of the siphon (on McArthur Island) continues, and an increased wet well level (6.2 m) and bypass at the WWTP are observed (78.6 L/s). The results of this "test run" are not illustrated in the provided figures.

Annual Event

In the annual event, if the Mississippi Quays PS and WWTP fail, HGLs increase, no new risks of surface and basement flooding arise in this planning horizon. The WWTP wet well bypass continues at an increased flow rate of 245.4 L/s.

Rare Event

In the rare event, no new HGL issues are observed. All flows into the Mississippi Quays PS wet well (75.4 L/s) can be conveyed by the two pumps (ultimate capacity). The WWTP wet well bypass continues at an increased flow rate of 192.7 L/s.

Long-Term Horizon (2041)

For the long-term (2041) planning horizon (see in **Figure 14** (design event), **Figure 15** (annual event) and **Figure 16** (rare event)), additional constraints were identified in the design event only.

Design Event

In the design event, the sewer along McDiarmid Ln/Peckett St continues to experience backwater from the flat downstream sewer. Additionally, the sewer directly upstream is bottlenecked, as its incoming flow now exceeds its capacity.

All flows to the Mississippi Quays PS in the design event (66.0 L/s) exceed the PS's firm capacity (52.2 L/s) and therefore do not meet the criteria for the design event. Applying a flow limit of 52.2 L/s at the Mississippi Quays PS yields wet well levels of 7.8 m, which are within the wet well's maximum height (9.6 m).

The WWTP design event inflow (509.4 L/s) continues to exceed the firm capacity of the existing raw sewage pumps (300.9 L/s). Applying a flow limit equivalent to the firm capacity of the raw sewage pumps (300.9 L/s), surface flooding upstream of the siphon (on McArthur Island) continues, and an increased wet well level and bypass at the WWTP are observed (6.2 m and 116.6 L/s, respectively). These results are not presented in the provided figures.

Annual Event

In the annual event, if the Mississippi Quays PS fails, backwater continues along McDiarmid Ln, Peckett St and Hooper St. HGLs increase, and new risks of basement flooding arise at Hooper St and Cavanagh Rd.

With complete pump failure at the WWTP, no new HGL issues arise in this planning horizon. The WWTP wet well bypass continues at an increased rate of 283.6 L/s.

Rare Event

In the rare event, no new HGL issues are identified for this planning horizon upstream of the Mississippi Quays PS. Flows coming into the Mississippi Quays PS wet well (85.2 L/s) can be conveyed by the two pumps (ultimate capacity). However, new HGL issues arise downstream of the Mississippi Quays PS forcemain along Patterson Cres, and further along Patterson Cres, towards the WWTP. The sewer directly downstream of the forcemain is bottlenecked, which leads to risks of basement flooding at its upstream MH. The bottlenecks coming into the WWTP (from the southeast) lead to backwater, with HGLs rising within basement level.

No new HGL issues are identified in this planning horizon along the sewers from McArthur Island to the WWTP. The WWTP wet well bypass continues at an increased rate of 221.3 L/s.

Reference: Technical Memorandum #1 - Sanitary Trunk Model Update & Phase 1 Report Addendum

Table 6: Model Results at the Mississippi Quays PS and WWTP for Future Planning Horizons

Model Results		2026			2031			2041		
		Design(1)	Annual(2)	Rare(3)	Design(1)	Annual(2)	Rare(3)	Design(1)	Annual(2)	Rare(3)
Mississippi Quays PS	Total Generated Flow (L/s)	53.0	46.1	70.9	57.3	49.1	75.4	66.0	55.5	85.2
	Max. Allowable Pumping Rate (L/s)	52.2	0.0(2)	104.4	52.2	0.0(2)	104.4	52.2	0.0(2)	104.4
	Wet Well Head (m)	-(5)	130.04	121.44	-(5)	130.07	121.44	-(5)	130.16	121.44
	Wet Well Invert (m)(4)	121.44								
	Wet Well Level (m)	-(5)	8.6	0.0	-(5)	8.7	0.0	-(5)	8.8	0.0
	Wet Well Height (m)	9.6								
WWTP	Total Generated Flow (L/s)	395.4	303.9	704.1	437.5	331.9	754.8	509.4	384.2	934.7
	Max. Allowable Pumping Rate (L/s)	300.9	0.0(2)	300.9	300.9	0.0(2)	300.9	300.9	0.0(2)	300.9
	Wet Well Head (m)	-(7)	130.05	130.00	-(7)	130.07	130.02	-(7)	130.10	130.05
	Wet Well Invert (m)(6)	123.75								
	Wet Well Level (m)	-(7)	6.4	6.3	-(7)	6.4	6.3	-(7)	6.4	6.3
	Wet Well Height (m)	8.8								
	Bypass Flow Rate (L/s)	-(7)	227.1	174.4	-(7)	245.4	192.7	-(7)	283.6	221.3

Notes

(1) Design event includes pump stations operating at firm capacity (largest pump offline). The results from the scenario in which no flow limit was applied to the Mississippi Quays PS and the WWTP is presented in the table above, as it enables capacity assessments of the upstream system instead of generating backwater conditions, allows for a more conservative downstream capacity assessment, and aligns to the results presented in **Figure 8**, **Figure 11** and **Figure 14**.

(2) Annual event includes failure of both the Mississippi Quays PS and the raw sewage pumps in the WWTP.

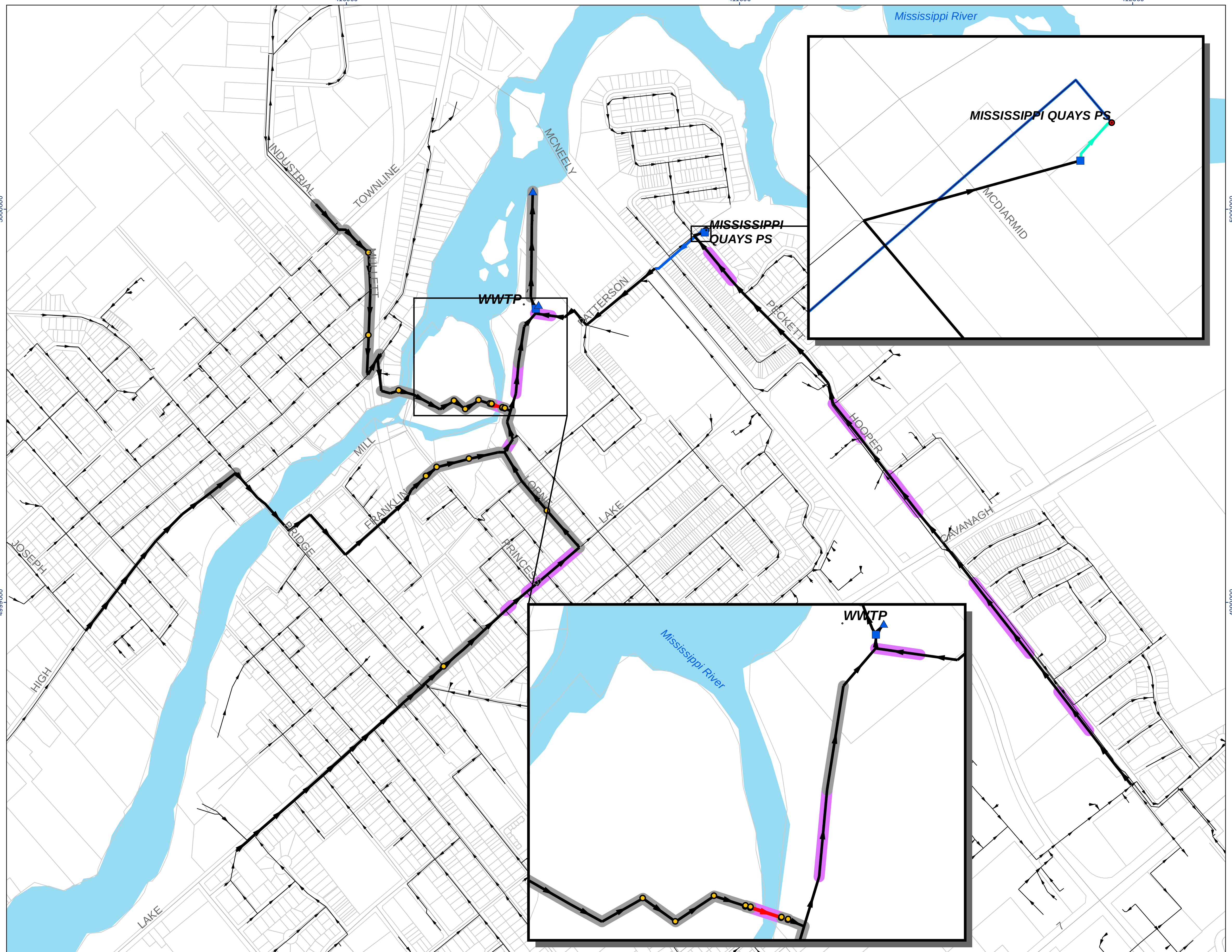
(3) Rare event includes pump stations operating at ultimate capacity (all pumps on, excluding standby at WWTP).

(4) Mississippi Quays PS wet well invert from as-designed drawings (drawing reference: 95-10147-PSI, see **Appendix A1**).

(5) When the Mississippi Quays pump rate is reduced to its firm capacity (52.2 L/s) in the design event, wet well levels of 4.5 m, 7.7 m and 7.8 m are observed in the 2026, 2031 and 2041 scenarios, respectively.

(6) WWTP wet well invert from as-built drawings (drawing reference: MOE-3-0692-S9/32, see **Appendix A1**).

(7) When a flow limit of the WWTP's firm capacity (300.9 L/s) is applied in the design event, wet well levels of 6.1 m, 6.2 m, and 6.2 m, and bypass flow rates of 65.1 L/s, 78.6 L/s, and 116.6 L/s are observed in the 2026, 2031 and 2041 scenarios, respectively.



Legend

- Outfall/Outlet
- Wet Well

HGL Freeboard

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

Pipe Surcharge State

- Bottleneck (Undersized Sewer)
- Backwater Condition
- Free-Flowing Condition
- Forcemain
- Pumps
- Local Sanitary Collection System (Not Modelled)

Pipe Exemptions

- Shallow Pipe (Obvert within 1.8 m of Surface)
- Flat Pipe (Slope < 0.10%)

Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

N

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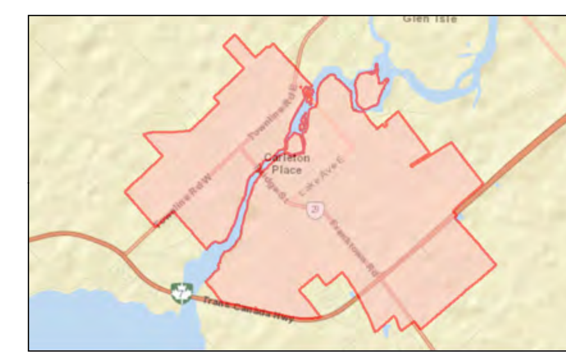
(At original document size of 11x17)
1:10,000

Notes

1. Coordinate System: NAD 1983 UTM Zone 18N

2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results

3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Project Location Prepared by CR on 2021-10-08

Carleton Place, ON

Client/Project 163401646 REVA

Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.

8

Title

Trunk System 2026 Design Event Results

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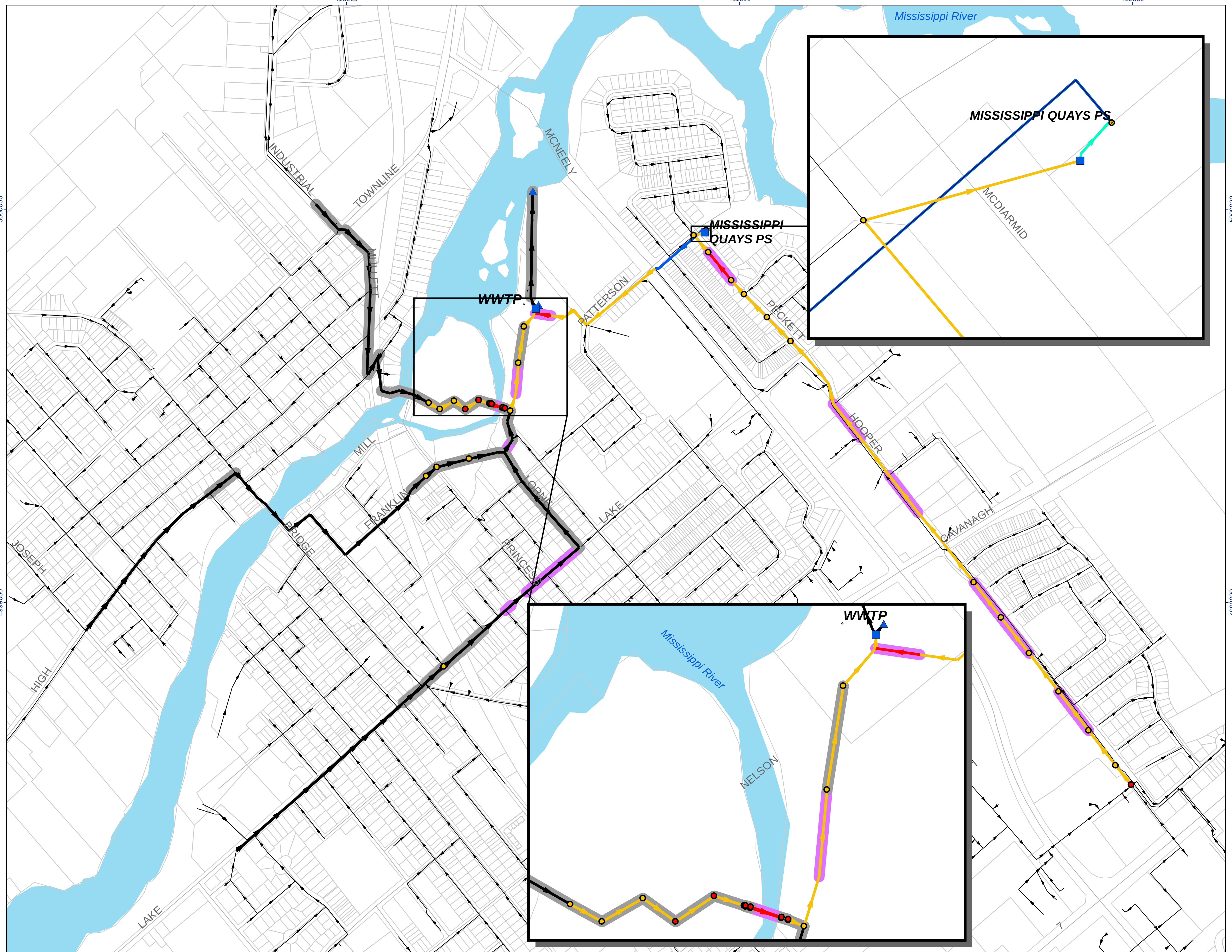

Legend

- Outfall/Outlet
- Wet Well

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.5 m of Surface)

Pipe Surcharge State

- Bottleneck (Undersized Sewer)
- Backwater Condition
- Free-Flowing Condition
- Forcemain
- Pumps
- Local Sanitary Collection System (Not Modelled)

Pipe Exemptions

- Shallow Pipe (Obvert within 1.8 m of Surface)
- Flat Pipe (Slope < 0.10%)

Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

N

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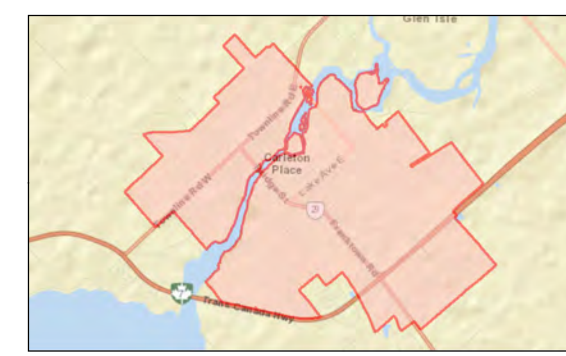
(At original document size of 11x17)
1:10,000

Notes
1. Coordinate System: NAD 1983 UTM Zone 18N
2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results
3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

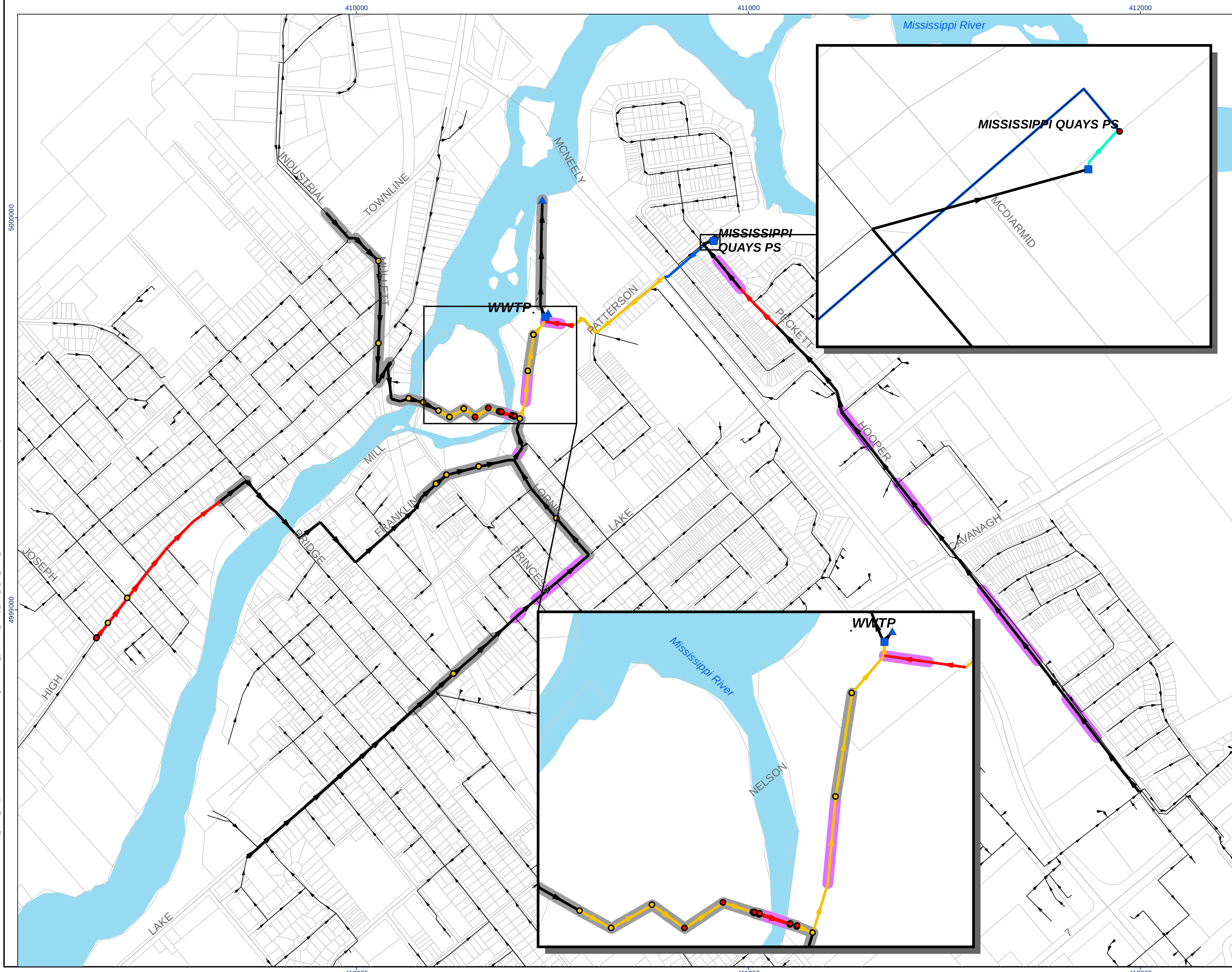


Project Location — Prepared by CR on 2021-10-08
Carleton Place, ON

Client/Project — 163401646 REVA
Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.
9

Title
Trunk System 2026 Annual Event Results



Legend

- Outfall/Outlet
- Wet Well

HGL Freeboard

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

Pipe Surcharge State

- Bottleneck (Undersized Sewer)
- Backwater Condition
- Free-Flowing Condition
- Forcemain
- Pumps
- Local Sanitary Collection System (Not Modelled)

Pipe Exemptions

- Shallow Pipe (Obvert within 1.8 m of Surface)
- Flat Pipe (Slope < 0.10%)

Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

N

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(At original document size of 11x17)
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Notes
1. Coordinate System: NAD 1983 UTM Zone 18N
2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results
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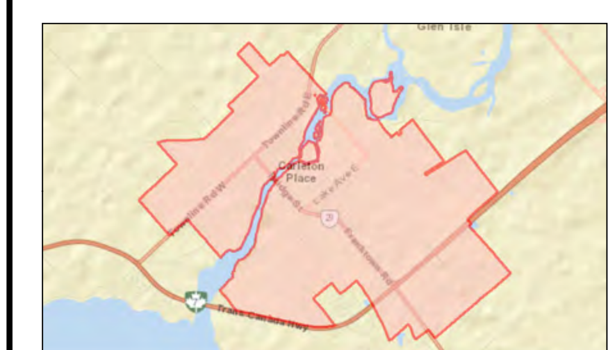
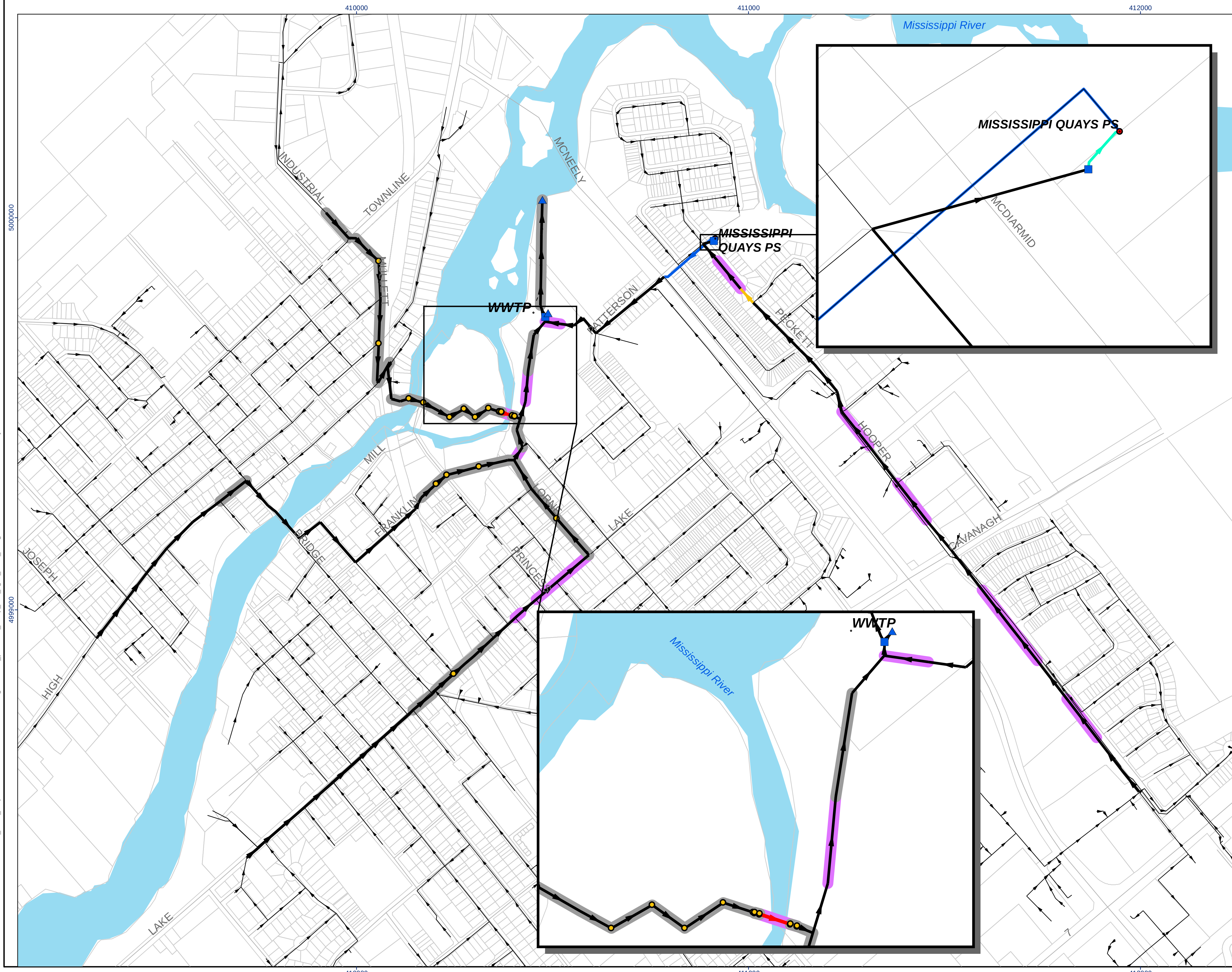


Project Location — Prepared by CR on 2021-10-08
Carleton Place, ON

Client/Project — 163401646 REVA
Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.
10

Title
Trunk System 2026 Rare Event Results



Stantec

Carleton PLACE

Legend

- Outfall/Outlet
- Wet Well

HGL Freeboard

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

Pipe Surcharge State

- Bottleneck (Undersized Sewer)
- Backwater Condition
- Free-Flowing Condition
- Forcemain
- Pumps
- Local Sanitary Collection System (Not Modelled)

Pipe Exemptions

- Shallow Pipe (Obvert within 1.8 m of Surface)
- Flat Pipe (Slope < 0.10%)

Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

N

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(At original document size of 11x17)
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Notes

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2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results

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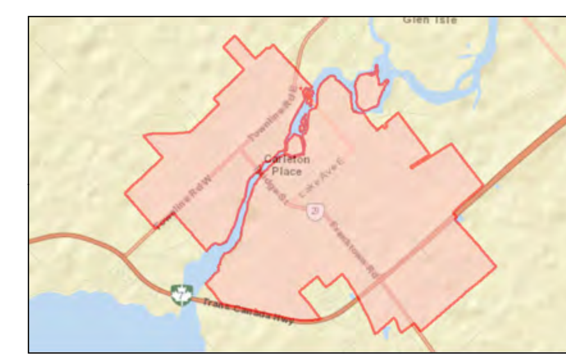

Project Location — Prepared by CR on 2021-10-08

Carleton Place, ON

Client/Project — 163401646 REVA

Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.

11

Title

Trunk System 2031 Design Event Results

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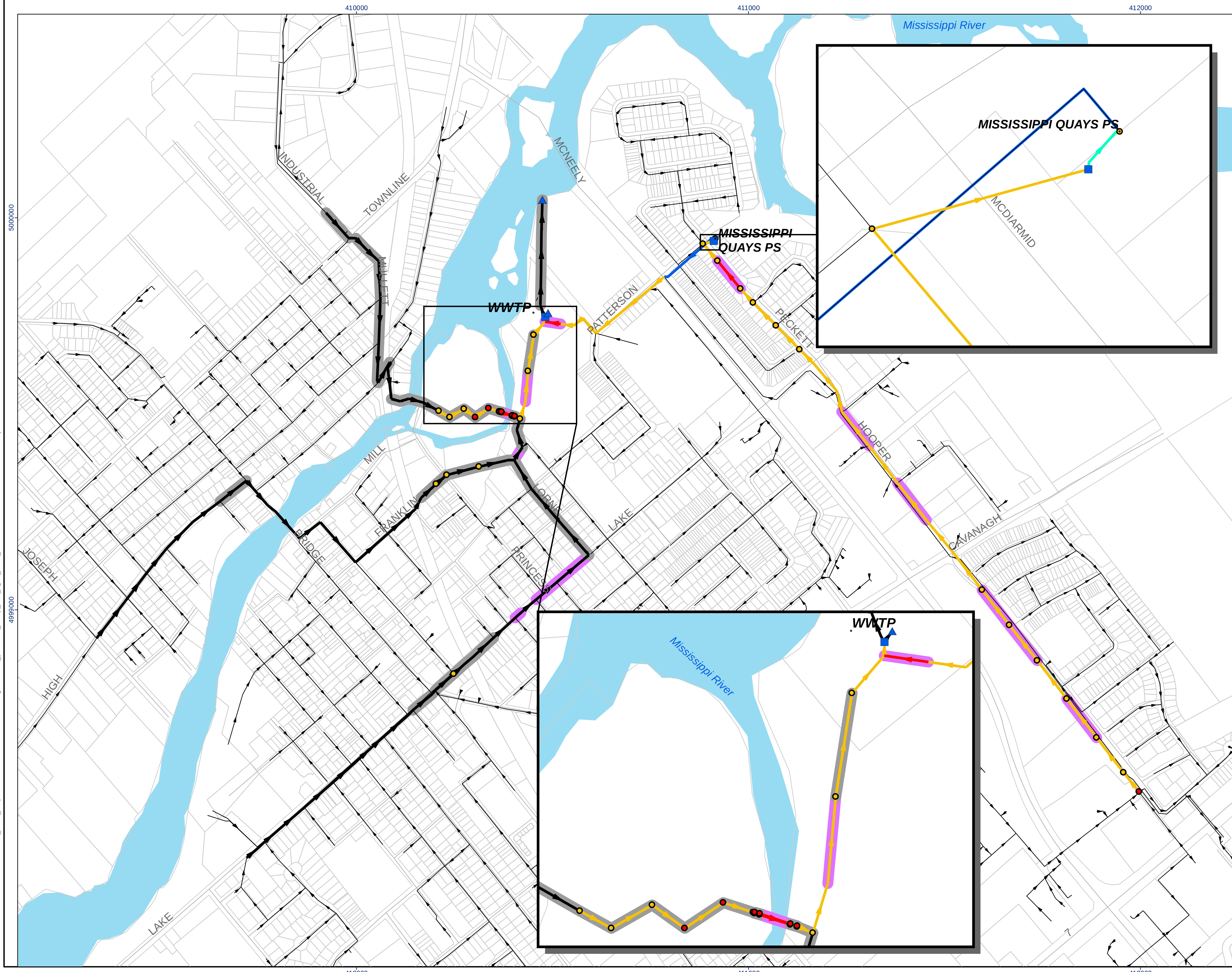

Legend

- Outfall/Outlet
- Wet Well

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.5 m of Surface)

Pipe Surcharge State

- Bottleneck (Undersized Sewer)
- Backwater Condition
- Free-Flowing Condition
- Forcemain
- Pumps
- Local Sanitary Collection System (Not Modelled)

Pipe Exemptions

- Shallow Pipe (Obvert within 1.8 m of Surface)
- Flat Pipe (Slope < 0.10%)

Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

N

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(At original document size of 11x17)
1:10,000

Notes

1. Coordinate System: NAD 1983 UTM Zone 18N
2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results
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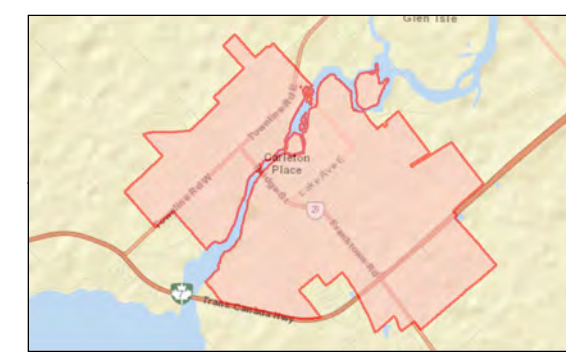

Project Location Prepared by CR on 2021-10-08

Carleton Place, ON

Client/Project 163401646 REVA

Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.

12

Title

Trunk System 2031 Annual Event Results

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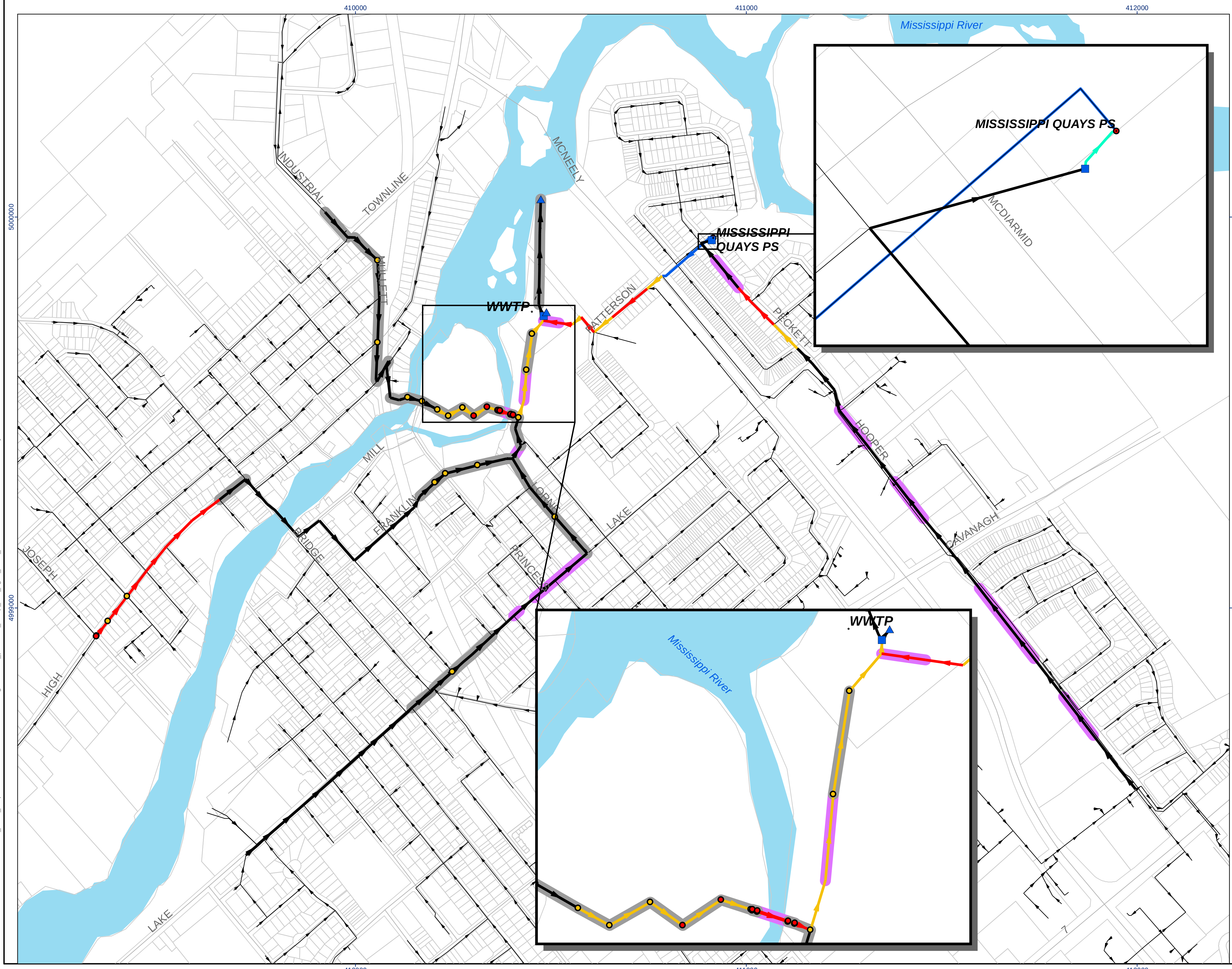


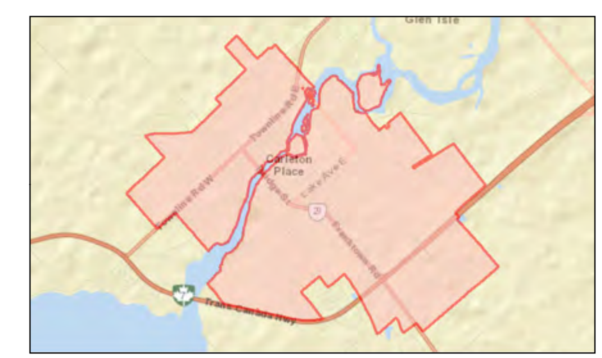
Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

Notes

1. Coordinate System: NAD 1983 UTM Zone 18N

2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results

3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Project Location — Prepared by CR on 2021-10-08

Carleton Place, ON

Client/Project — 163401646 REVA

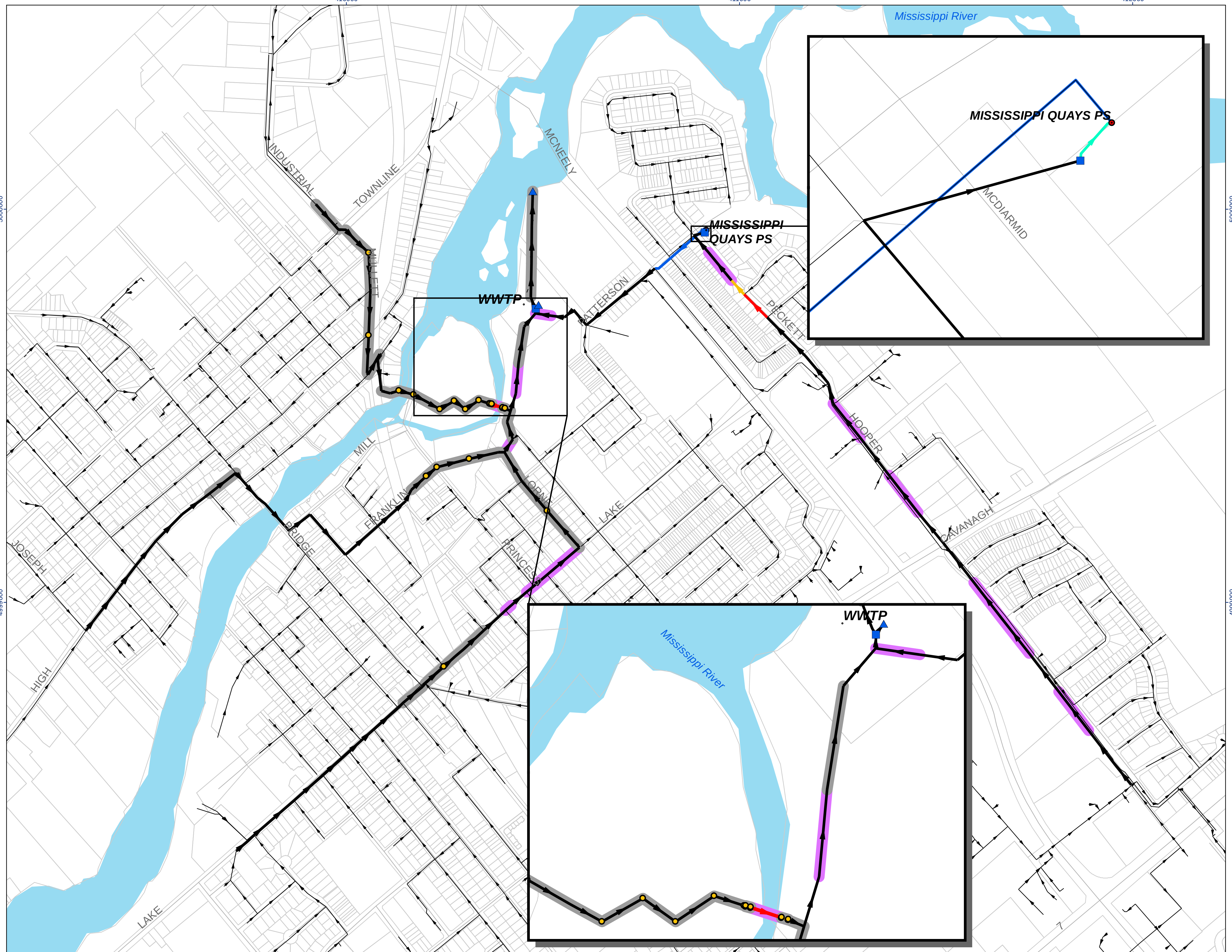
Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.

13

Title

Trunk System 2031 Rare Event Results



Stantec

Carleton PLACE

Legend

- Outfall/Outlet
- Wet Well

HGL Freeboard

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

Pipe Surcharge State

- Bottleneck (Undersized Sewer)
- Backwater Condition
- Free-Flowing Condition
- Forcemain
- Pumps
- Local Sanitary Collection System (Not Modelled)

Pipe Exemptions

- Shallow Pipe (Obvert within 1.8 m of Surface)
- Flat Pipe (Slope < 0.10%)

Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

N

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(At original document size of 11x17)
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Notes

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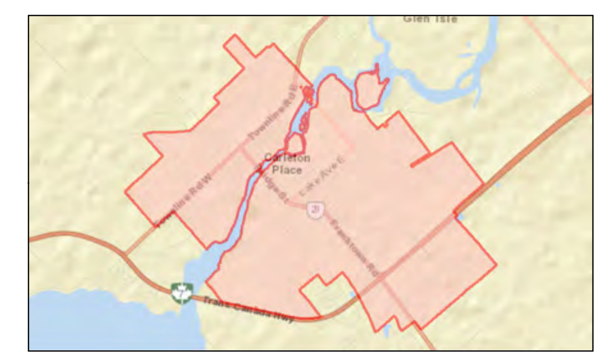
3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Project Location Prepared by CR on 2021-10-08

Carleton Place, ON

Client/Project 163401646 REVA

Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.

14

Title

Trunk System 2041 Design Event Results

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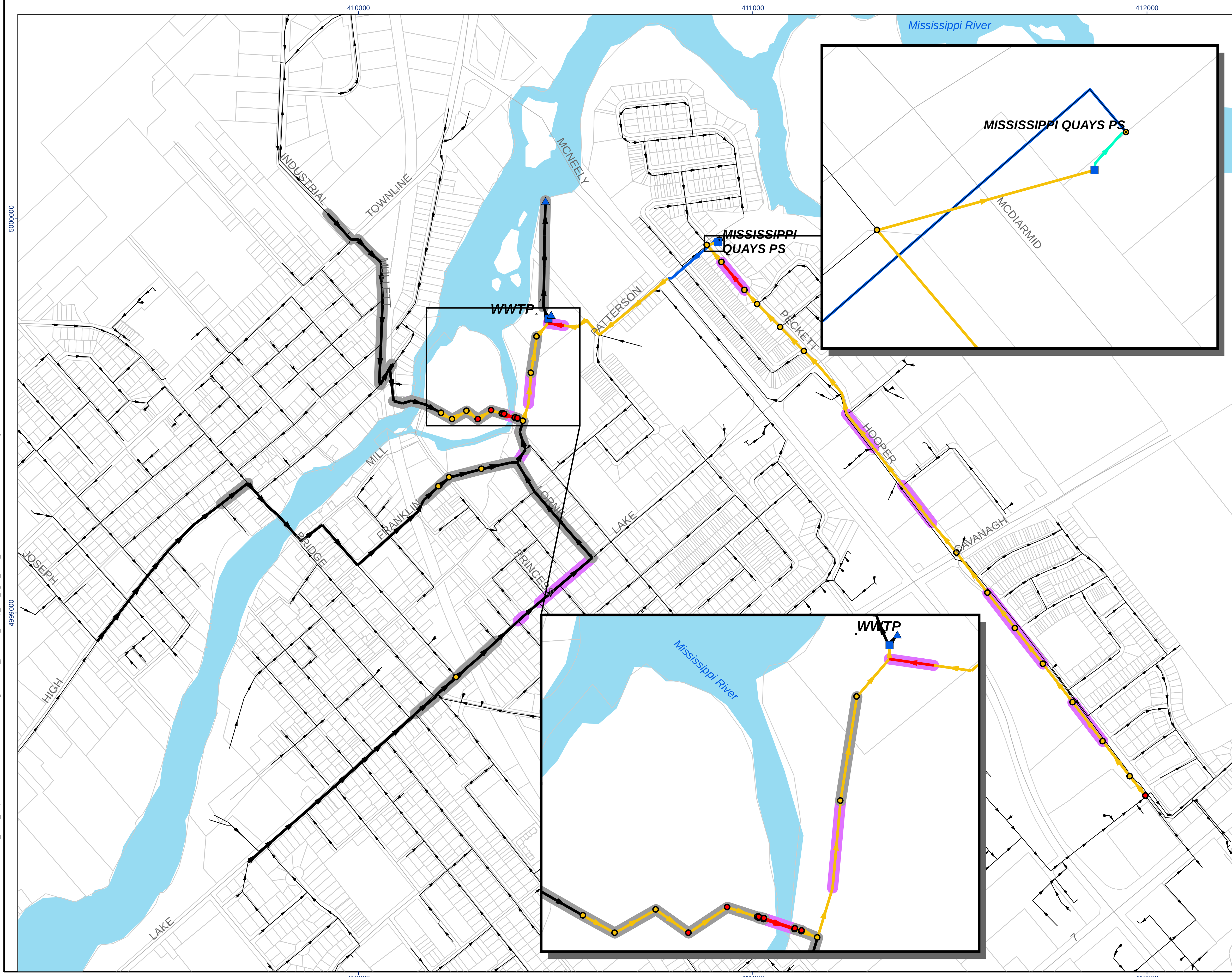


Legend

- Outfall/Outlet
- Wet Well

HGL Freeboard

- At or Above Surface
- Within Basement Level (Within 1.5 m of Surface)

Pipe Surcharge State

- Bottleneck (Undersized Sewer)
- Backwater Condition
- Free-Flowing Condition
- Forcemain
- Pumps
- Local Sanitary Collection System (Not Modelled)

Pipe Exemptions

- Shallow Pipe (Obvert within 1.8 m of Surface)
- Flat Pipe (Slope < 0.10%)

Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

N

0 200 400 metres

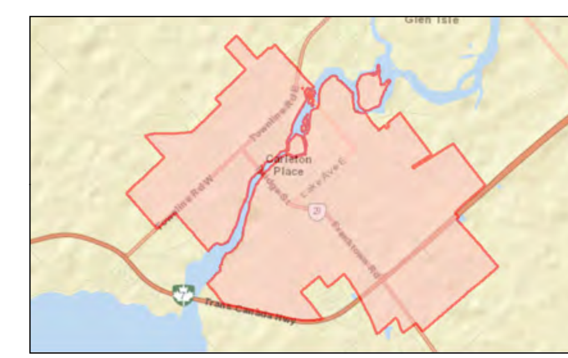
(At original document size of 11x17)
1:10,000

Notes

1. Coordinate System: NAD 1983 UTM Zone 18N

2. Data Sources: *parcelfabric.shp*, *Road_CL.shp*, *DP_landuse.shp* and *sanisewer.shp* provided by the Town of Carleton Place; *Water File - Lakes and Rivers (polygons) - 2006 Census* provided by Statistics Canada; PCSWMM modelling results

3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Project Location — Prepared by CR on 2021-10-08

Carleton Place, ON

Client/Project — 163401646 REVA

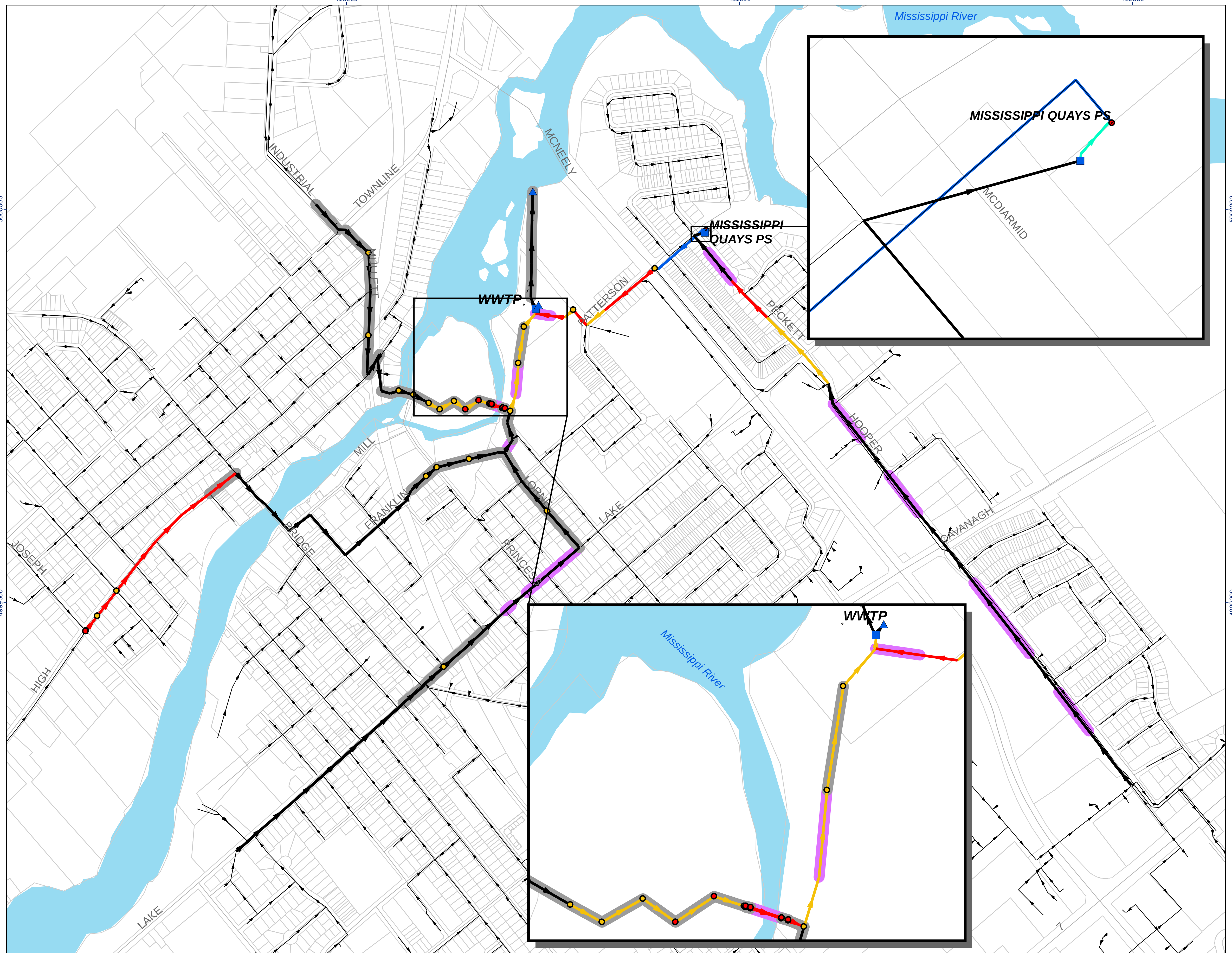
Town of Carleton Place
Carleton Place W&WW Master Plan
PCSWMM Modelling Technical Memorandum

Figure No.

15

Title

Trunk System 2041 Annual Event Results



Stantec

Carleton PLACE

Legend

- Outfall/Outlet
- Wet Well

HGL Freeboard

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

Pipe Surcharge State

- Bottleneck (Undersized Sewer)
- Backwater Condition
- Free-Flowing Condition
- Forcemain
- Pumps
- Local Sanitary Collection System (Not Modelled)

Pipe Exemptions

- Shallow Pipe (Obvert within 1.8 m of Surface)
- Flat Pipe (Slope < 0.10%)

Results are based on City of Ottawa 2012 Sewer Design Guidelines and 2018 Technical Bulletin ISTB-2018-01 parameters, and should be confirmed with flow monitoring.

N

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(At original document size of 11x17)
1:10,000

Notes
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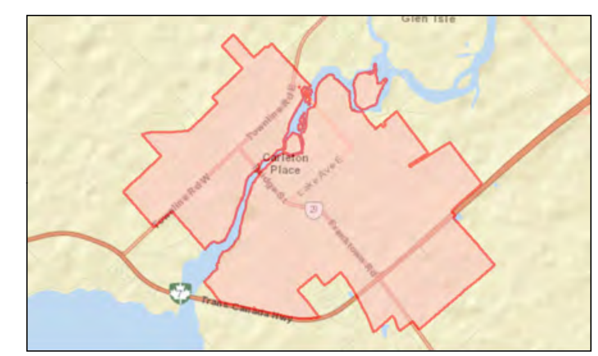
3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Project Location Prepared by CR on 2021-10-08
Carleton Place, ON

Client/Project 163401646 REVA
Town of Carleton Place
Carleton Place W&WW Master Plan
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Figure No.
16

Title
Trunk System 2041 Rare Event Results

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Reference: Technical Memorandum #1 - Sanitary Trunk Model Update & Phase 1 Report Addendum

Discussion and Validation of Results

The following sections compare the modelled results presented in previous sections to provided anecdotal or measured data. A comparison to the Phase 1 Report SSDS results is also provided below.

Mississippi Quays PS

This analysis uses a steady-state model where the pumps are modelled at their ultimate capacity (see configuration in Model Scenarios & System Assessment Criteria and their on/off levels are not used. Since all incoming flows to the PS in the design and rare events are less than the PS's ultimate capacity, they are conveyed downstream with no storage observed in the wet well (0 water levels in the model). OCWA provided wet well cumulative flows (reset daily) and level measurements for 2017 to 2020 for the Mississippi Quays PS, however, due to the configuration used in the model, a comparison with the wet well level data for these events is not feasible. This validation can be done when the model is further developed into a dynamic model, once flow monitoring data is available.

McArthur Island Siphon

The Town has reported surface flooding on McArthur Island (upstream of the siphon) in large events (i.e., December 25, 2020), which OCWA has explained is connected with constraints at the WWTP wet well. The modelled raw sewage pump capacity leads to backwater in the upstream system in all modelled events and generates HGL issues upstream of the siphon. While surface flooding is observed in the modelled scenarios in this same general location (MHs immediately upstream of the siphon), the Town identified flooding at more MHs than seen in the model. Thus, along with upstream flows, the MH cover elevations should be confirmed in this area, as this discrepancy could be due to an inaccuracy in the DEM/MH cover elevations. The overall correlation of modelled results to observed flooding in this general location, however, indicates that the flows used in this analysis are reasonably representative of an event similar to that of December 25, 2020. The relation between the December 2020 event and the design, annual and rare events should be further assessed when flows are better understood via flow monitoring.

WWTP

The WWTP pump capacity was determined to govern the boundary condition at the WWTP and was therefore represented via a flow limit in the model, as discussed in previous sections. The design, annual and rare scenarios are meant to stress the system. As per the City of Ottawa Technical Bulletin ISTB-2018-01, the design and rare flows are derived based on events typically ranging between the 1:25yr to the 1:100yr, when bypasses and high wet well levels are likely. Based on the calculated flow generation and WWTP firm capacity used in this analysis, assuming the standby pump is off and only 2 pumps are operating, bypasses are identified in all three events in existing conditions. Due to the significance of these results, flow monitoring and rain gauge installation and monitoring is therefore recommended to better understand the flows in the sanitary sewer system, including areas and magnitudes of high I/I, population and ICI distributions, diurnal patterns, and per capita rates.

OCWA has advised anecdotally that larger storm events typically result in wet well levels of 4.5 m to 5.0 m (**Appendix A3**). The modelled wet well levels in all events analysed were higher and triggered bypasses at the overflow invert depth of 5.9 m above the wet well invert. This suggests that the storms reported by OCWA are smaller than the events analysed, and cannot be used to validate the results obtained. It is recommended that the wet well levels and incoming flows continue to be monitored by OCWA to improve the confidence in the model's representation of the Town's system, with attention to larger events.

Comparison with Phase 1 Report Findings

The analysis in the *Phase 1 Report* was solely based on the sewers' flow capacity utilization (q/Q) as provided in the Town's existing SSDS. This SSDS provides the theoretical sewer capacities in the design events based on capacity utilization (q/Q) and the depth ratio (d/D). This approach does not include hydraulic grade lines, thus, only a limited comparison of the capacity constraints identified in this assessment to those identified in the *Phase 1 Report* SSDS is possible. The SSDS does not provide HGLs to compare to those produced in this updated modelling approach for the assessment of the Town's collection system.

Variations are occasionally observed between the design event SSDS and PCSWMM models. These variations were evaluated for validity and were attributed to the following reasons. Firstly, the *Phase 1 Report*'s SSDS uses the pipe diameters and slopes provided by the Town. Pipe slopes are calculated in PCSWMM however, based on the inputted inverts and pipe lengths. In some cases, variations in pipe slopes between the two models are observed, resulting in differing pipe capacities. There is often more certainty in inverts than with slopes obtained from drawings, and thus, the PCSWMM model pipe capacities are considered with more confidence.

Additionally, the full flow capacity in the SSDS was calculated based on the pipe's actual internal diameter (assuming all concrete pipes), whereas the nominal pipe diameter was used in PCSWMM. It is standard practice to use the actual pipe diameter in SSDS assessments due to their typically detailed level of analysis, and the nominal pipe diameter in hydraulic modelling analyses due to their higher-level use. Since this is an analysis on the Town's trunk sanitary system, the nominal diameter is used in the PCSWMM model, which is smaller than the actual diameter used in the SSDS, and thus, the hydraulic model yields a more conservative assessment of capacity.

Finally, due to the non-cumulated nature of the hydraulic model loading, slight variations in flows are observed between the SSDS and the PCSWMM model along the two incoming branches into the WWTP from Patterson Cres and Mississippi River Walk Trail. This relates back to the peaking factor discussion surrounding cumulated populations (discussed in the **Sanitary Flow Generation** section) and is due to the Harmon's peaking factor equation used. The total flows from each upstream branch, and the incoming flow into the WWTP, do however match those of the SSDS. This is a limitation of using this approach for flow generation calculations, which can be overcome once flow monitoring data is available.

Conclusions and Recommendations

This Technical Memorandum presents the development of a sanitary trunk hydraulic model for the Town of Carleton Place and the resultant system assessment results under various planning horizons provided as part of the ongoing 2021 Water & Wastewater Master Plan. Based on the *Phase 1 Report* recommendations, an updated analysis was completed which considers the hydraulic grade lines throughout the trunk sanitary network and includes the considerations for basement and surface flooding. This developed PCSWMM model was used to assess and identify possible deficiencies within the system based on system constraints, as well as areas where more information is required.

While there is greater confidence in this updated model than in the previous SSDS due to updated pipe inverts and diameters and facilitation of HGL assessments, there are also limitations. This tool is a steady-state model, which conservatively assumes the instantaneous peak rate throughout the system. These peak flows are also calculated based on uncalibrated per capita rates, peaking factors and I/I rates that were generated as part of the Phase 1 assessment and may not be representative of the actual flows or their distributions observed within the system during events of these magnitudes. Thus, the following steps are recommended to further improve the confidence in this model and yield a tool that can be used to develop alternative solutions to resolve confirmed system constraints.

- Implement a flow monitoring program to collect flow and rain data for the Town, which should then be used to calibrate the model. Updated populations and ICI distributions, and calibrated per capita rates, diurnal patterns, baseflows (or Ground Water Infiltration (GWI) rates), and wet weather I/I rates can be determined and used to improve the Town's understanding of their sanitary system (i.e., leaky areas, variation in flow distributions, etc.);

- Obtain additional data at the WWTP including wet well levels during large events to improve the confidence in the boundary conditions applied; and,
- Include the local system pipes in the model. This would allow the model to identify local constraints or areas at risk that are currently unknown. Flow monitoring can also be used to help understand the characteristics of flows within local systems throughout the Town.

This model and the accompanying HGL analysis nonetheless provide preliminary insights into the Town's sanitary trunk system's performance (i.e., opportunities and constraints). Sewer constraints are observed in the design event in the 2041 planning horizon only; however, the Mississippi Quays PS does not meet the respective criteria for the design event in the 2026, 2031 and 2041 planning horizons. In the annual event (pump failure), HGL issues (basement and surface flooding) arise upstream of the Mississippi Quays PS under all planning horizons. Because the ultimate pump capacity is used in the rare event analyses, the Mississippi Quays PS does not present capacity constraints in the rare event under all planning horizons.

The WWTP is unable to convey the modelled flows in the design and rare event scenarios under all planning horizons. Notably, HGL issues are observed in all annual and rare events from upstream of the McArthur Island siphon, down to the WWTP, including surface flooding just upstream of the siphon. The Town has previously observed similar occurrences of flooding. Future developments on McArthur Island were identified in the *Carleton Place Comprehensive Review, Council Report* (Town of Carleton Place / J.L. Richards, March 2021). The Town has indicated that the existing ICI building on the island is being redeveloped into a residential building, which will require a backwater valve on its sanitary service line. It is also recommended that the wet well levels and incoming flows continue to be monitored by OCWA to improve the confidence in the model's representation of the Town's system, with particular attention to larger events.

It is also recommended that MH cover elevations be surveyed and inspected upstream of the siphon surrounding McArthur Island to confirm the elevations used in the model. Surveys to obtain the inverts of the Patterson Cres sewers are also recommended to improve the confidence in this area and its resulting sewer capacity constraints.

Reference: Technical Memorandum #1 - Sanitary Trunk Model Update & Phase 1 Report Addendum

Closure

We trust this information is satisfactory for your purposes. If you have any questions, please contact the undersigned.

Stantec Consulting Ltd.

Digitally signed by Razafimaharo, Christene
Date: 2022.04.21 12:31:24 -04'00'

Christène Razafimaharo M.Sc., EIT
Water Resources Engineering Intern

Phone: 343 996 7086
Christene.Razafimaharo@stantec.com

Ashley LeMasurier P.Eng.
Water Resources Engineer

Cell: 343 998 3458
Ashley.LeMasurier@stantec.com

Attachments: Appendix A: Drawings & Data for Model Development
Appendix B: Sanitary Flow Generation per MH

References

Computational Hydraulics International (2021). PCSWMM. https://www.chiwater.com/Home.

Council Report for Comprehensive Review (Town of Carleton Place / J.L. Richards, March 2021).

Carleton Place Wastewater System – 2020 Annual Report (OCWA, 2021).

Facility Optimization Report for the Carleton Place Water Pollution Control Plant draft memo (OCWA, September 2021).

Carleton Place Water Pollution Control Pant Certificate of Approval Number 5001-7FZT4A, (MOE, October 3, 2008.

Update to Wastewater Trunk Sanitary Sewer Model memo (J.L. Richards, March 2021).

River Crossing Plan & Profile as-built drawing (J.L. Richards, July 1969; drawing reference: U-072).

Reference: Technical Memorandum #1 - Sanitary Trunk Model Update & Phase 1 Report Addendum

Pumping Station Details as-designed drawings (Oliver Mangione McCalla & Associates Limited, May 1995; drawing reference: 95-10147-PSI).

Outfall Sewer as-built drawing (J.L. Richards, October 1970; drawing reference: S-66-517).

Yard Piping as-built drawing (J.L. Richards, June 1991; drawing reference: MOE-3-0692-C4/7).

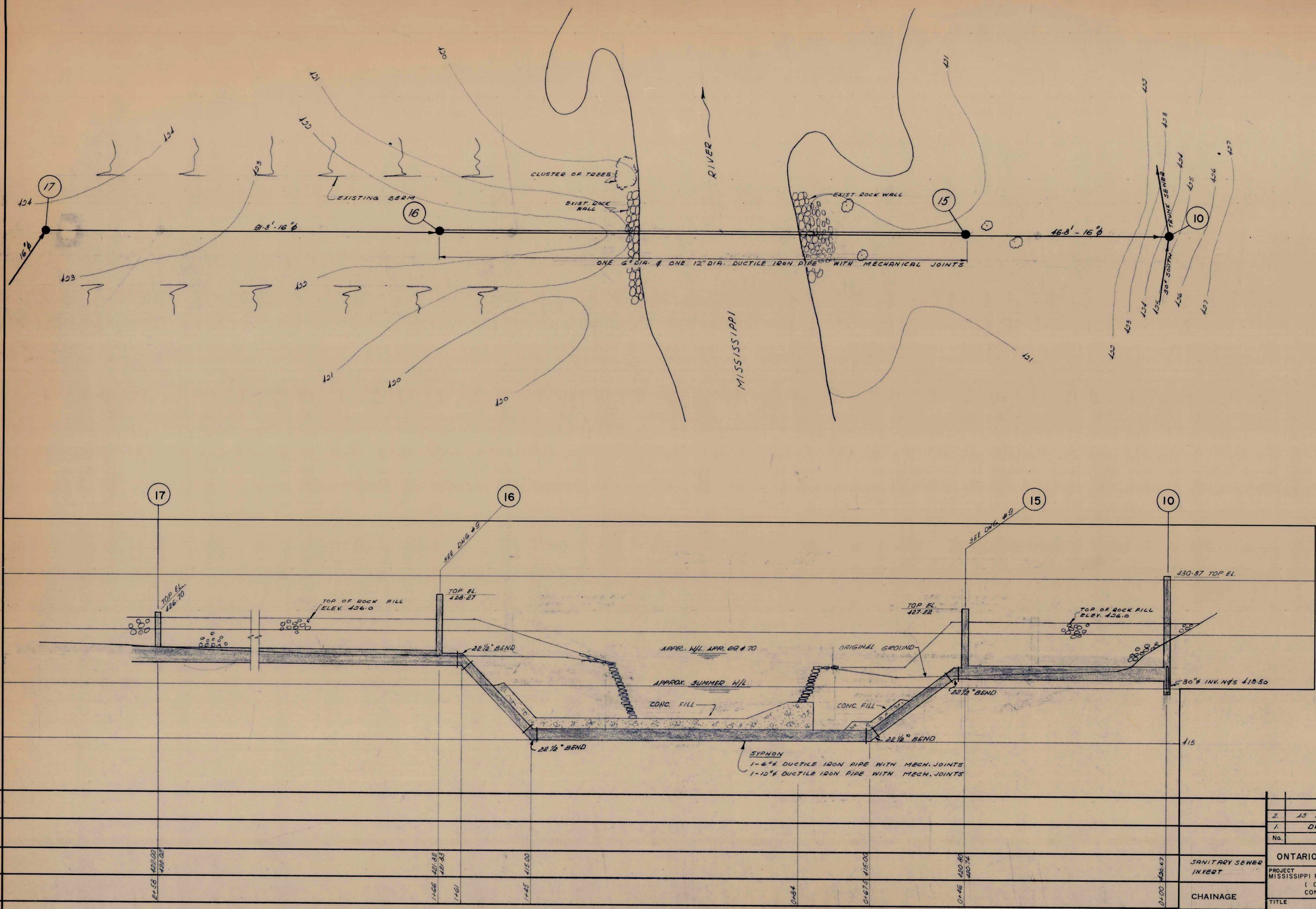
Control Building Part Plan & Sections, Headworks, Emerg. Gen. Rm., Boiler Rm. & Blower Rm as-built drawing (J.L. Richards, June 1994; drawing reference: MOE-3-0692-M6/32).

Control Building Sewage Lift Pump Room Plan & X-Section Aeration Tanks Plan as-built drawing (J.L. Richards, June 1994; drawing reference: MOE-3-0692-M7/32).

Control Building Foundations Section Sheet No.3 as-built drawing (J.L. Richards, November 1993; drawing reference: MOE-3-0692-S9/32).

Appendix A Drawings & Data for Model Development

Appendix A1 Drawings



AS BUILT
J. L. RICHARDS & ASSOCIATES LIMITED

No.	REVISIONS	DATE
2.	AS BUILT (COMPLETE PROFILE & MH. LOC'S ON PLAN RE-DRAWN)	JUNE /71
1.	DWG. NO. CHANGED	OCT. 15/70

ONTARIO WATER RESOURCES COMMISSION

PROJECT
MISSISSIPPI RIVER POLLUTION CONTROL SYSTEM No. 1
(CARLETON PLACE, ONTARIO)
CONTRACT No. 2 — TRUNK SEWER

TITLE
RIVER CROSSING
PLAN & PROFILE

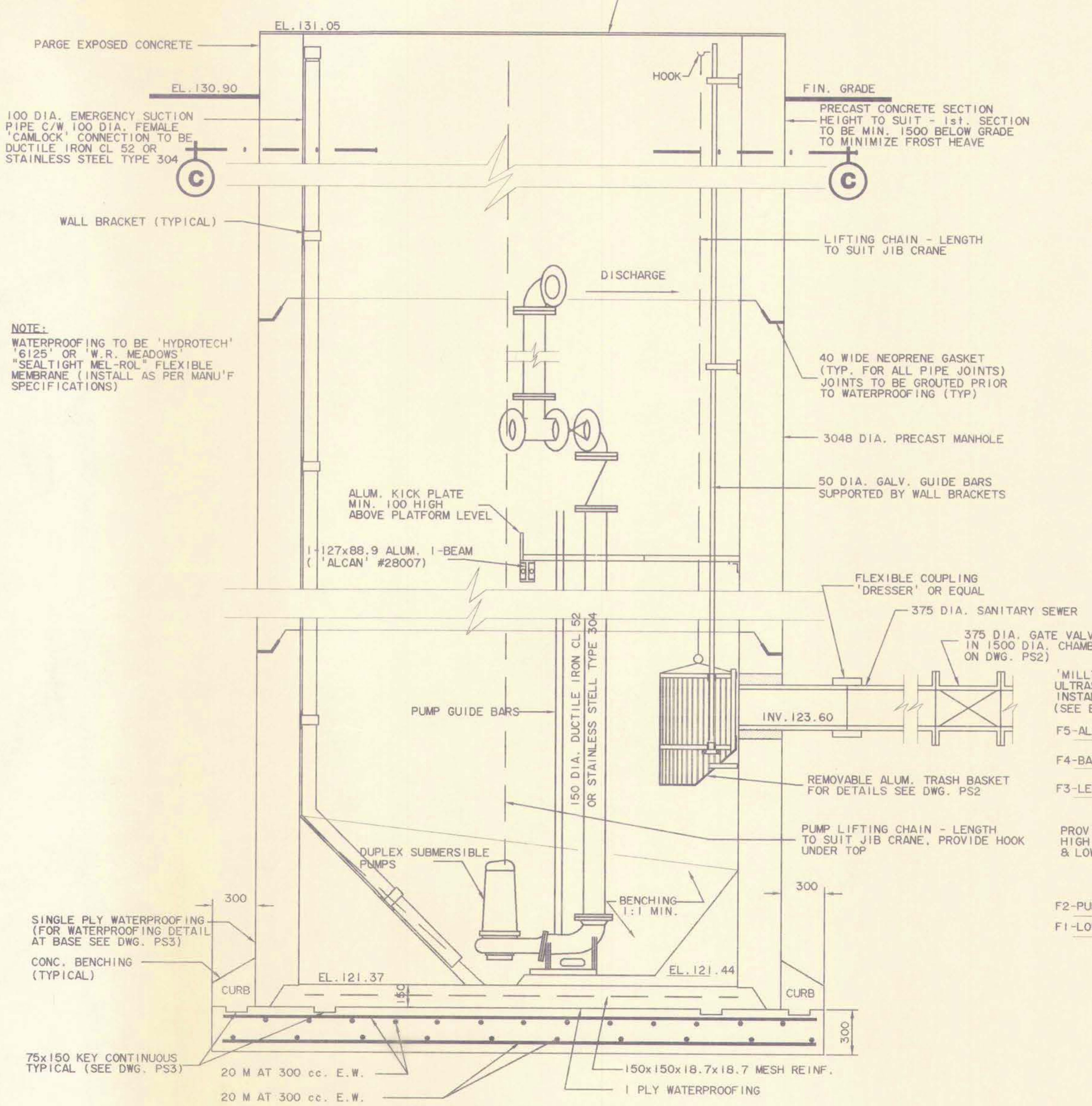
DATE	SCALE	DESIGN
JULY , 1969	HOR. 1" = 10" VERT. 1" = 4"	DRAWN G. J. R. APPROVED S.V.I.S.

REGISTERED PROFESSIONAL ENGINEER W. H. KERR PROVINCE OF ONTARIO

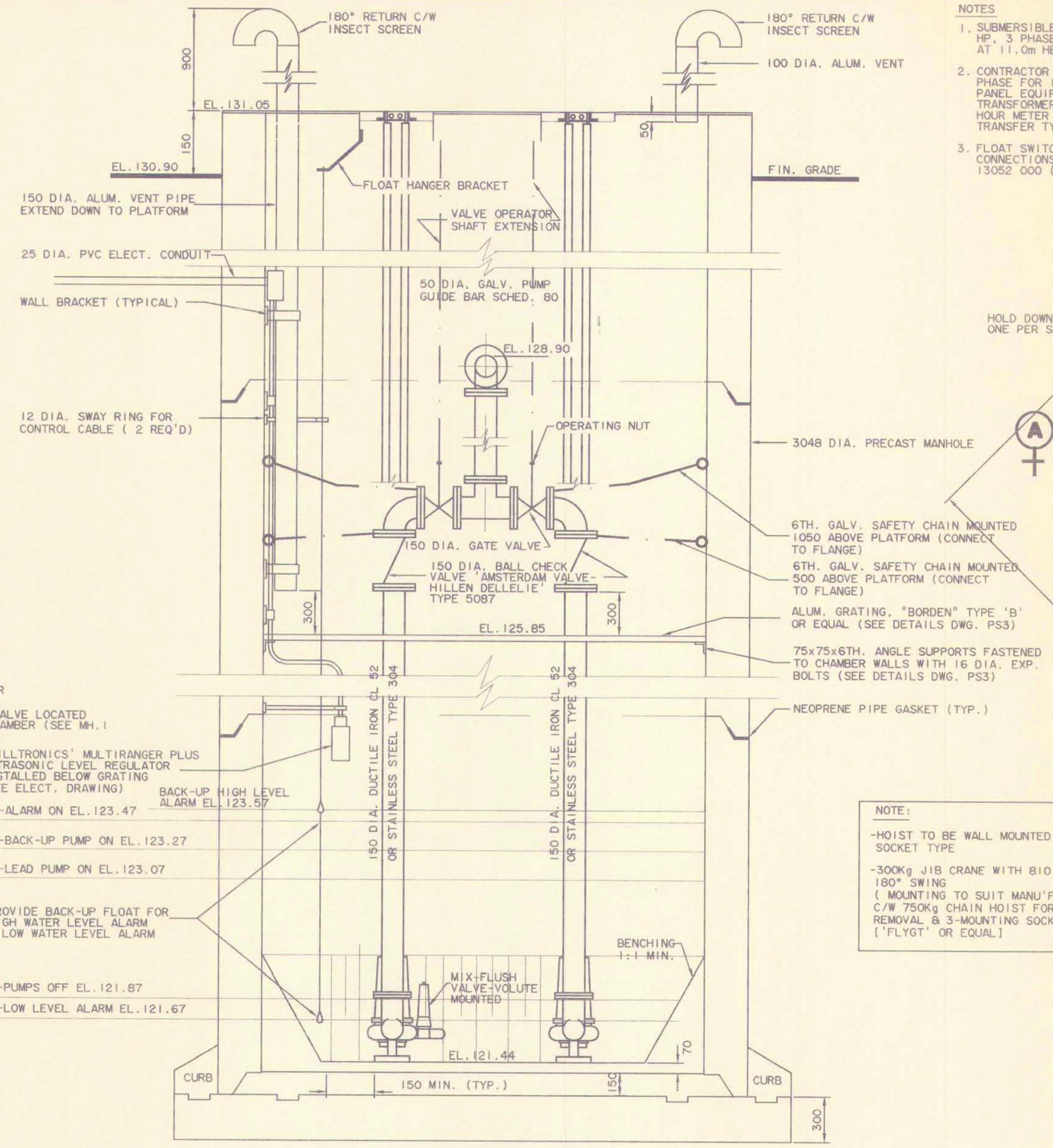
J·L·RICHARDS & ASSOCIATES LIMITED
CONSULTING ENGINEERS OTTAWA, ONTARIO

OWRC PROGRAMME No. 1-0009-66
DWG. No. S-66-517- 4

U-072



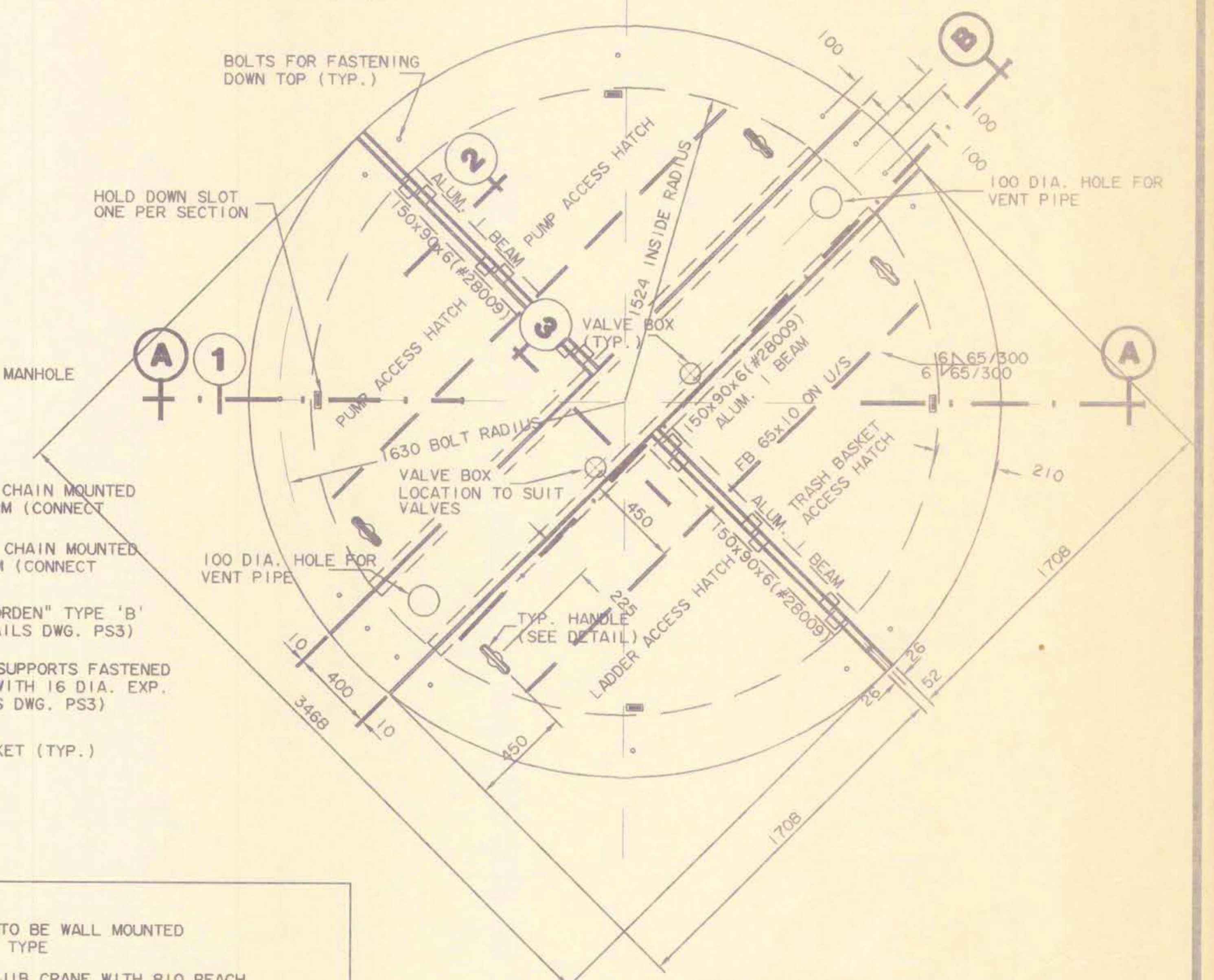
SECTION 'A - A'



SECTION 'B - B'

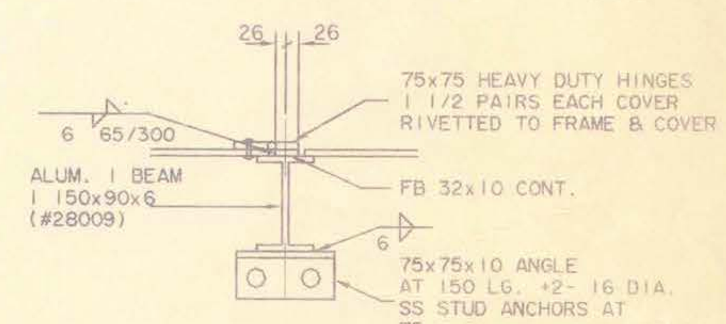
NOTES

1. SUBMERSIBLE PUMPS TO BE 2 - 'FLYGT' MODEL CP 3140 MT ,150 DIA. 15 HP, 3 PHASE, 1745 RPM IMPELLER # 436 (OR APPROVED EQUAL) 52.2 L/s AT 11.0m HEAD
2. CONTRACTOR TO PROVIDE 'FLYGT' CUSTOM DUPLEX PUMP PANEL CONTROL,3 PHASE FOR INSTALLATION IN GENERATOR BUILDING FOR OPERATING PUMPS. PANEL EQUIPPED WITH MANUAL LEAD/LAG SELECTOR SWITCH,CURRENT TRANSFORMER, AMP METER, PHASE SELECT SWITCH, TOTALIZING DIGITAL HOUR METER FOR EACH PUMP. STARTERS TO BE REDUCED VOLTAGE AUTO TRANSFER TYPE. REFER TO ELECTRICAL DWGS.
3. FLOAT SWITCH SHALL BE OF SUFFICIENT LENGTH TO PROVIDE SPLICE FREE CONNECTIONS TO WIREWAY, AND BE SUSPENDED ON 'FLYGT' FLOAT HANGER # 13052 000 (OR APPROVED EQUAL)
4. CONTRACTOR SHALL BE RESPONSIBLE FOR COMPLETE COORDINATION OF ELECT. & MECHANICAL SUBCONTRACTORS & FOR OBTAINING HYDRO INSPECTION & APPROVAL.
5. ALL PIPING SHALL BE FLANGED
6. PRIMARY LIQUID LEVEL CONTROLLERS TO BE 'MILLTRONICS' MULTIRANGER PLUS AS SHOWN ON ELECT. DWG.

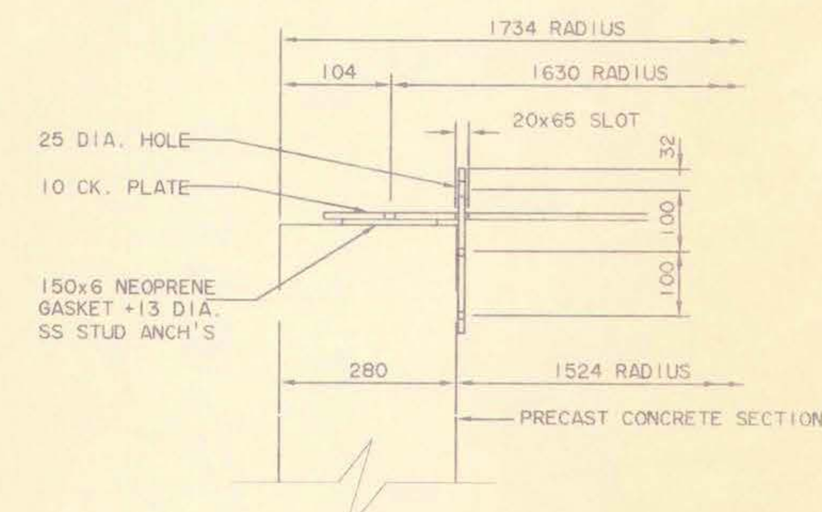


NOTE:
-HOIST TO BE WALL MOUNTED SOCKET TYPE
-300Kg JIB CRANE WITH BIO REACH 180° SWING (MOUNTING TO SUIT MANU'F REQUIREMENTS) C/W 750Kg CHAIN HOIST FOR PUMP REMOVAL & 3-MOUNTING SOCKETS PROVIDED ['FLYGT' OR EQUAL]

TOP VIEW
METAL TOP DETAIL
N.T.S.

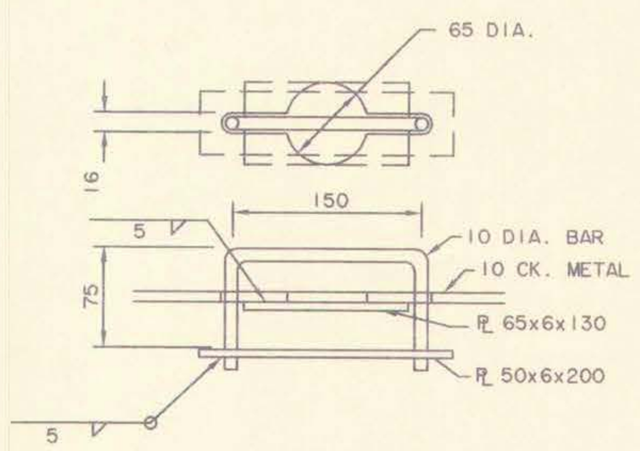


SECTION 2
N.T.S.

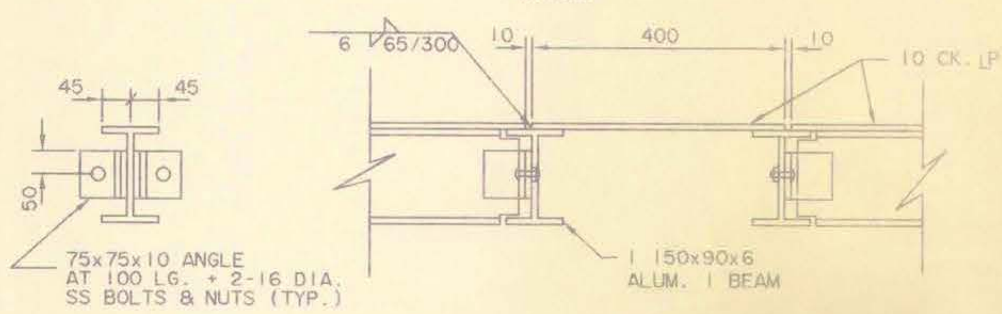


SECTION 1
N.T.S.

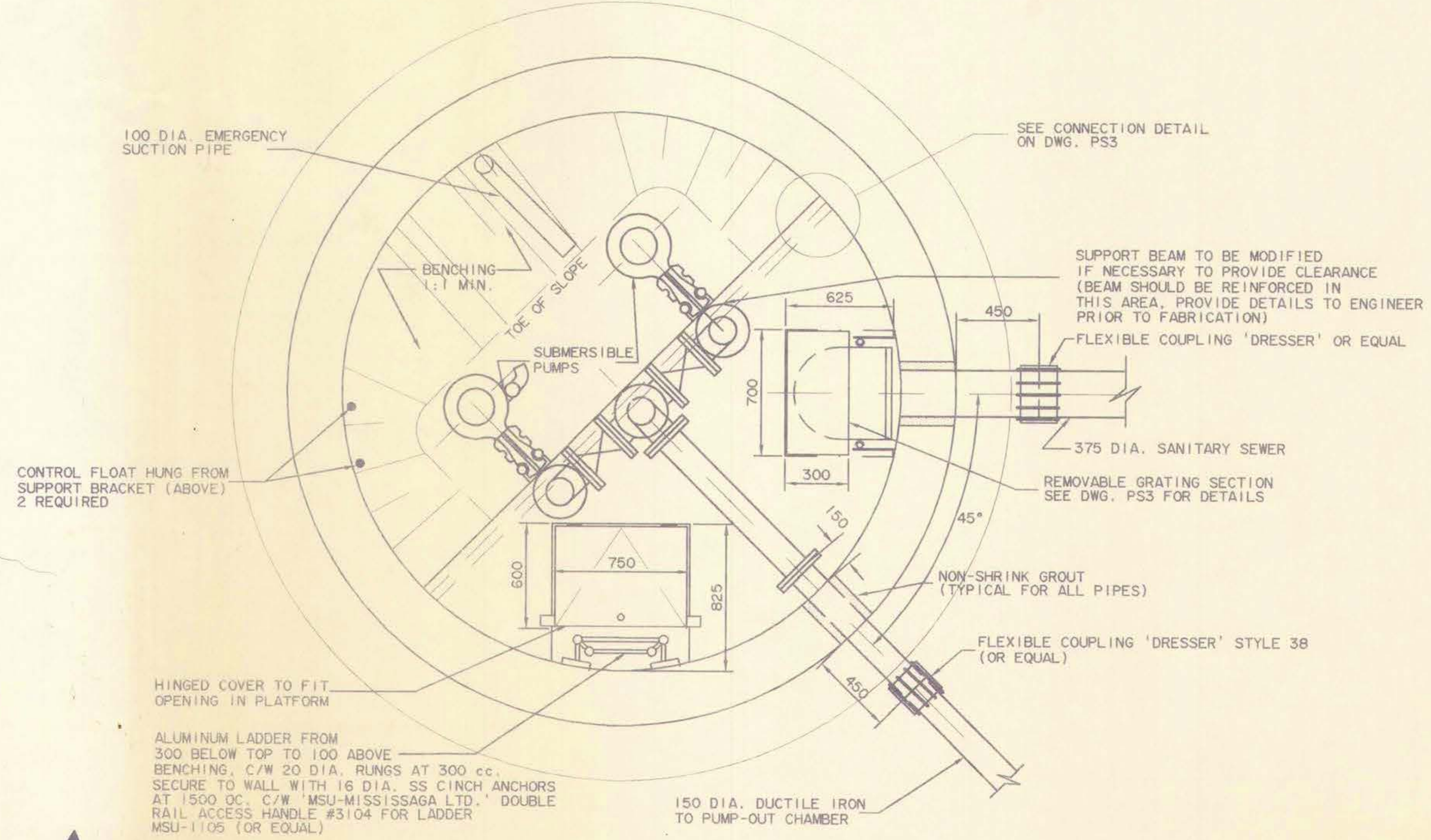
NOTE:
ALL ALUMINUM IN CONTACT WITH CONCRETE SHALL HAVE 'MIDCO' R8-1010 COATING



TYPICAL HANDLE DETAIL
N.T.S.



SECTION 3
N.T.S.



SECTION 'C - C'

NO.	REVISIONS	DATE	BY
3	REVISED AS PER OCWA COMMENTS	11/7/95	GJR
2	GENERAL REVISIONS	15/06/95	GJR
1	REVISED AS PER G & M HOMES	12/06/95	GJR

LICENCED PROFESSIONAL ENGINEER — K. P. EADEY — PROVINCE OF ONTARIO

APP'D

CLIENT	G & M HOMES
PROJECT	MISSISSIPPI QUAYS
TITLE	PUMPING STATION DETAILS

OLIVER MANGIONE McCALLA & ASSOCIATES LIMITED
Consulting Engineers
Nepean, Ontario

DESIGN	DRAWN	CHECKED	DATE	SCALE	DRAWING NO.
K.P.E.	G.J.R. (ACAD)	J.W.M.	MAY, 1995	1 : 25	95-10147-PS1

Thu Jul 13 10:27 55 1995

2	'AS BUILT' *	JUNE/71
1	REDRAWN	OCT.15/70
No.	REVISIONS	DATE

SANITARY SEWER INVERT

CHAINAGE

ONTARIO WATER RESOURCES COMMISSION

PROJECT
MISSISSIPPI RIVER POLLUTION CONTROL SYSTEM No. 1
(CARLETON PLACE, ONTARIO)
CONTRACT No2 TRUNK SEWER

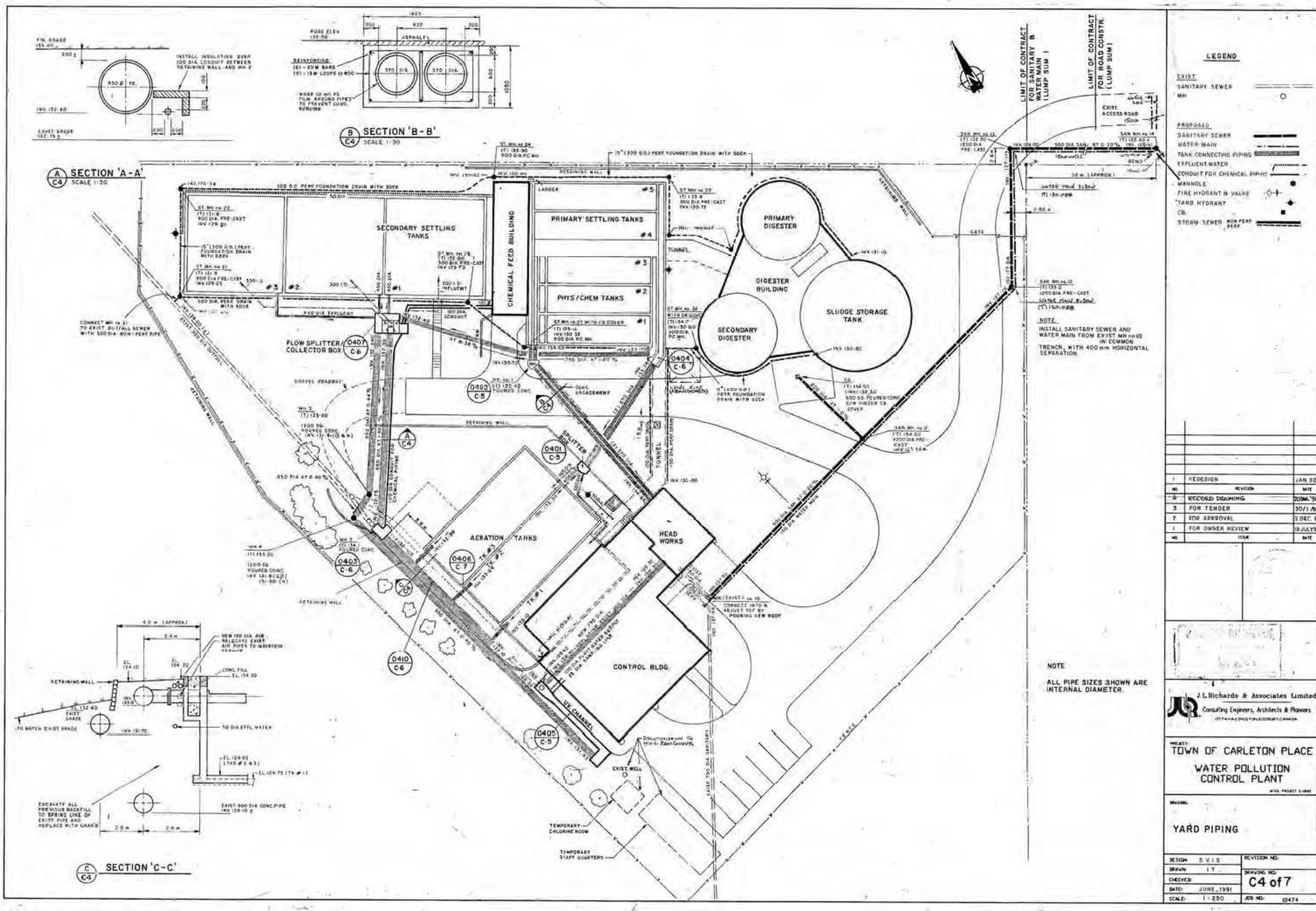
TITLE
OUTFALL SEWER

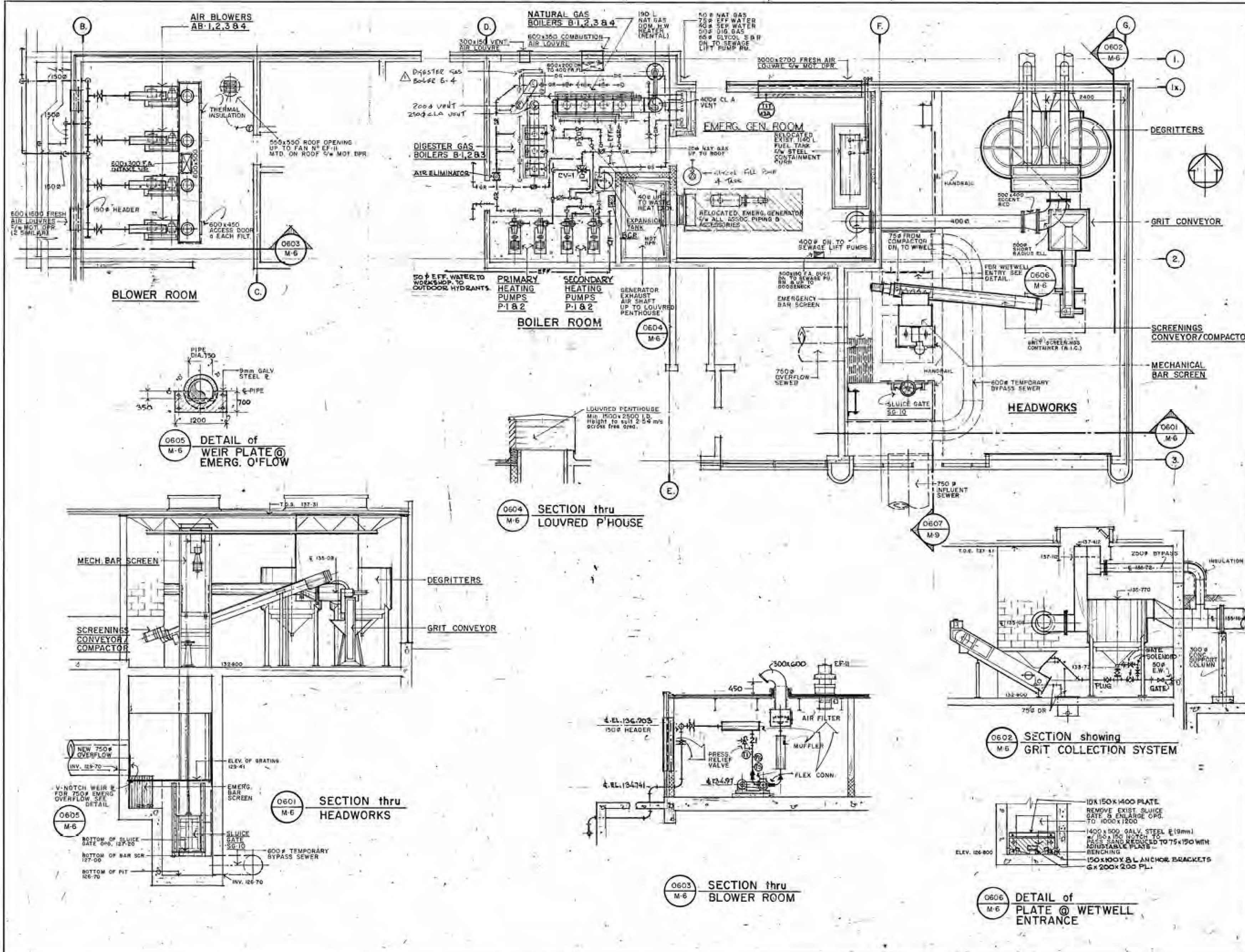
DATE	SCALE	DESIGN / DRAWN / APPROVED
OCT., 1970	HOR. 1" = 40' VER. 1" = 4'	DESIGN W.H.K. DRAWN G.J.R. APPROVED W.H.K.

J·L·RICHARDS & ASSOCIATES LIMITED
CONSULTING ENGINEERS & PLANNERS OTTAWA ONTARIO

O.W.R.C. PROGRAMME No. 1-0009-66

DWG. No. S-66-517- 5


SECTION 'A-A'
SCALE 1:30
SECTION 'B-B'
SCALE 1:30
SECTION 'C-C'
SECONDARY SETTLING TANKS
CHEMICAL FEED BUILDING
PRIMARY SETTLING TANKS
PHYS/CHEM TANKS
PRIMARY DIGESTER
DIGESTER BUILDING
SECONDARY DIGESTER
SLUDGE STORAGE TANK
FLOW SPLITTER/COLLECTOR BOX
AERATION TANKS
HEAD WORKS
CONTROL BLDG.
UV CHANNEL
TUNNEL
SPLITTER BOX
RETAINING WALL
EXIST. WELL
TEMPORARY CHLORINE ROOM
TEMPORARY STAFF QUARTERS
FENCE
GATE
EXIST. ACCESS ROAD
LIMIT OF CONTRACT FOR SANITARY & WATER MAIN (LUMP SUM)
LIMIT OF CONTRACT FOR ROAD CONSTR. (LUMP SUM)
NOTE
INSTALL SANITARY SEWER AND WATER MAIN FROM EXIST MH no10 IN COMMON TRENCH, WITH 400 mm HORIZONTAL SEPARATION.
NOTE
ALL PIPE SIZES SHOWN ARE INTERNAL DIAMETER.
LEGEND
EXIST
SANITARY SEWER
MH
PROPOSED
SANITARY SEWER
WATER MAIN
TANK CONNECTING PIPING
EFFLUENT WATER
CONDUIT FOR CHEMICAL PIPING
MANHOLE
FIRE HYDRANT & VALVE
YARD HYDRANT
CB
STORM SEWER
REDESIGN JAN 92
RECORD DRAWING
FOR TENDER
FOR APPROVAL
FOR OWNER REVIEW
J.L. Richards & Associates Limited
Consulting Engineers, Architects & Planners
TOWN OF CARLETON PLACE
WATER POLLUTION CONTROL PLANT
YARD PIPING
DESIGN: S.V.I.S.
DATE: JUNE, 1991
SCALE: 1:250
C4 of 7
10474



RECORD DRAWING JUN 28 1994

NO.	REVISION	DATE
△	ADD DIGEST BOILER No 4	2016
4	RECORD DRAWING	28JUNE'94
3	FOR TENDER	30 JAN. '92
2	FOR APPROVAL	DEC '91
1	FOR OWNER REVIEW	JULY '91

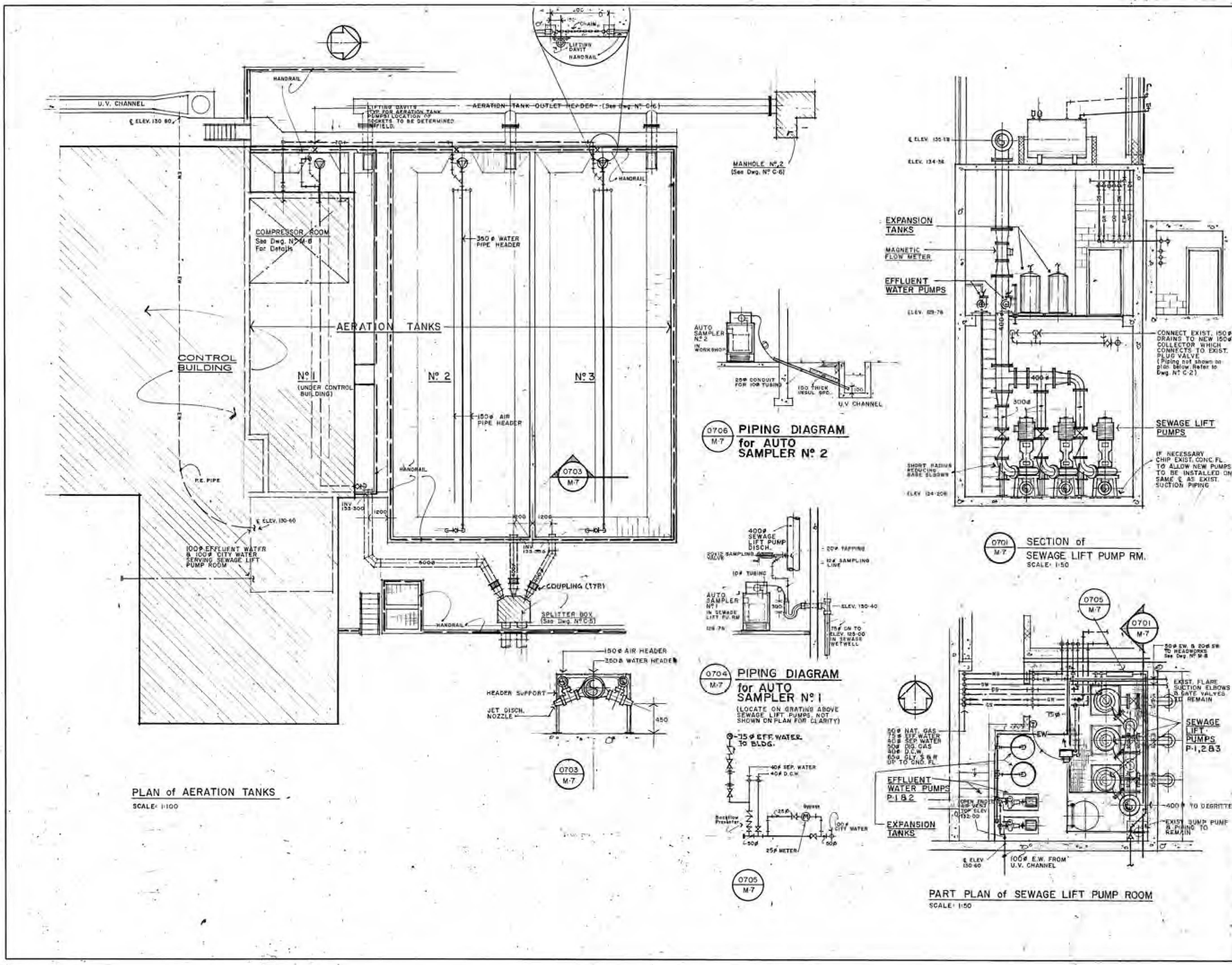
J.L. Richards & Associates Limited
Consulting Engineers, Architects & Planners
OTTAWA, KINGSTON, SUDBURY, CANADA

PROJECT: TOWN OF CARLETON PLACE

WATER POLLUTION CONTROL PLANT

DRAWING: CONTROL BUILDING
PART PLAN & SECTIONS
HEADWORKS, EMERG. GEN. RM., BOILER RM & BLOWER RM.

DESIGN:	P.D.D.	REVISION NO.:	
DRAWN:	P.D.D.	DRAWING NO.:	M-6 of 32
CHECKED:	S.V.I.S.		
DATE:	JULY 1991		
SCALE:	1:50	JOB NO.:	10474



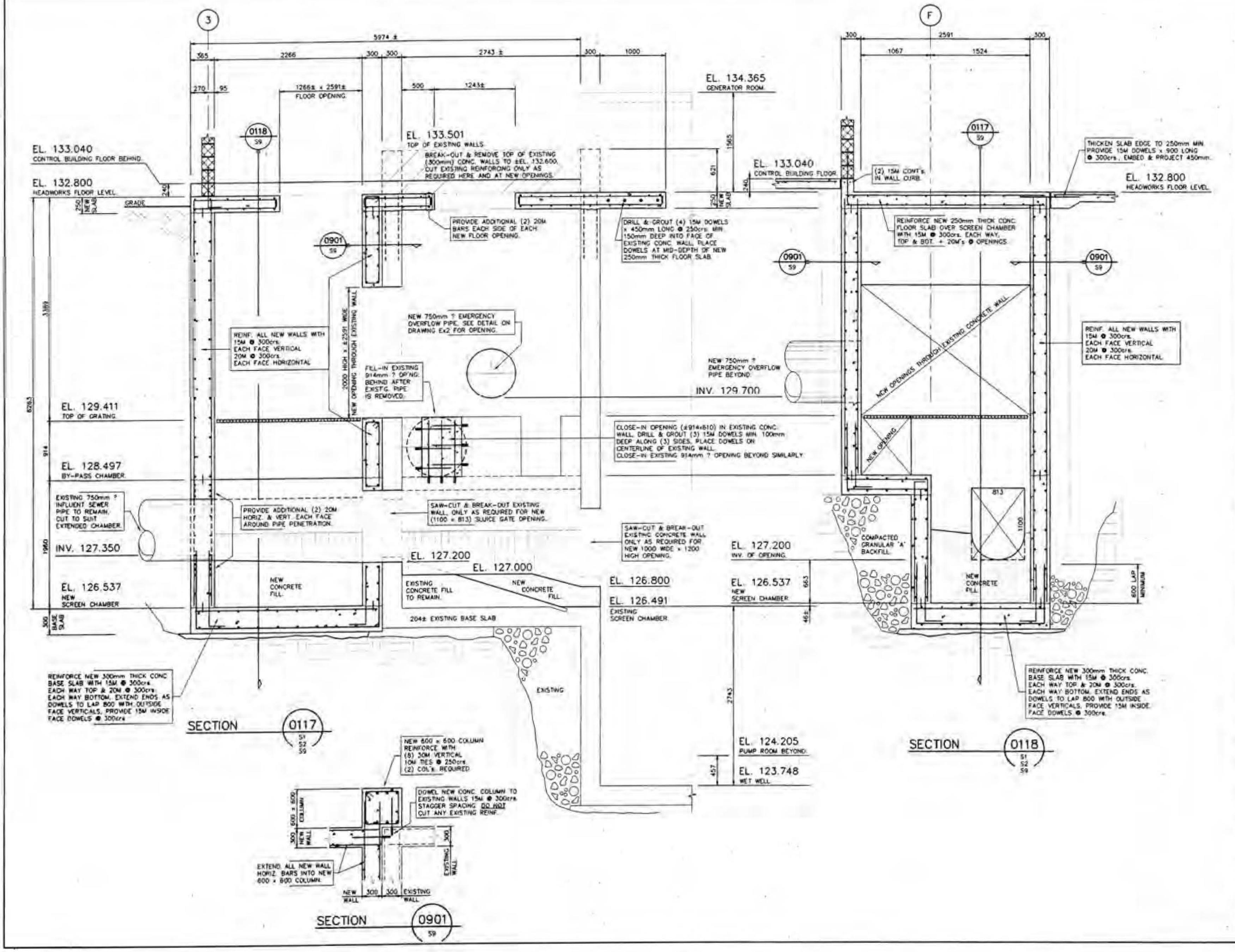
NO.	REVISION	DATE
A.	RECORD DRAWING	28 JUNE '9?
3	FOR TENDER	30 JAN.'92
2	FOR APPROVAL	DEC.'91
1.	FOR OWNER REVIEW	JULY '91
NO.	ISSUE	DATE

J.L. Richards & Associates Limited
Consulting Engineers, Architects & Planners

PROJECT:
TOWN OF CARLETON PLACE
WATER POLLUTION CONTROL PLANT

DRAWING:
CONTROL BUILDING·
SEWAGE LIFT PUMP ROOM
PLAN & X SECTION
AERATION TANKS · PLAN

DESIGN:	P.D.D.	REVISION NO:	
DRAWN:	P.D.D.	DRAWING NO:	M·7 of 32
CHECKED:	S.V.I.S.		
DATE:	JULY 1991		
SCALE:	AS NOTED	JOB NO:	10474



RECORD DRAWING
DATE NOV 1993
J. L. RICHARDS & ASSOCIATES LIMITED

NO.	REVISION	DATE
1	AS RECORDED	NOV., 93

NO.	ISSUE	DATE
3	FOR TENDER	30JAN.92
2	FOR APPROVAL	2DEC.91

J.L.Richards & Associates Limited
Consulting Engineers, Architects & Planners
OTTAWA, KINGSTON, SUDBURY, CANADA

PROJECT
TOWN OF CARLETON PLACE
WATER POLLUTION CONTROL PLANT
M.O.E. PROJECT 3-0692

DRAWING
CONTROL BUILDING
HEADWORKS
SECTIONS & DETAILS

DESIGN:	J.D.K.	REVISION NO.:	
DRAWN:	D.W.E.	DRAWING NO.:	S9of32
CHECKED:	J.D.K.		
DATE:	OCTOBER, 1991		
SCALE:	1:25U.O.N.	JOB NO.:	10474

Appendix A2 Wet Well Dimensions

Razafimaharo, Christene

From:	Wilder, Pierre
Sent:	Thursday, September 23, 2021 1:58 PM
To:	Razafimaharo, Christene
Cc:	LeMasurier, Ashley; Alemany, Kevin
Subject:	FW: WWTP wet well footprint

Christene,

Please see below wet well measurements for the sanitary model.

Thanks,

Pierre Wilder P. Eng
Environmental Engineer

~~Direct: 613 724-4352~~
Mobile: 613 790-7690
Pierre.Wilder@stantec.com

Stantec
400 - 1331 Clyde Avenue
Ottawa ON K2C 3G4

From: Robert LeBlanc <RLeBlanc@ocwa.com>
Sent: Thursday, September 23, 2021 1:48 PM
To: Wilder, Pierre <Pierre.Wilder@stantec.com>
Cc: Guy Bourgon <gbourgon@carletonplace.ca>; Alemany, Kevin <kevin.alemany@stantec.com>; Trader, Mike <mike.trader@stantec.com>; Andrew Trader <ATrader@ocwa.com>; Austin Mitchell <AMitchell@ocwa.com>
Subject: Re: WWTP wet well footprint

Austin grabbed some physical measurements:

> Wet well dimensions are:
>
> 16’6’’ (length) x 4’10’’ (width) x 27’6’’ (height)
> TOTAL VOLUME = 2236.85 ft3 or 63.34 m3
>
> Drawings did not show this, this was done by physical measurement.

Hope this helps....

From: Wilder, Pierre <Pierre.Wilder@stantec.com>
Sent: Wednesday, September 22, 2021 11:20 AM
To: Robert LeBlanc
Cc: Guy Bourgon; Alemany, Kevin; Trader, Mike; Andrew Trader
Subject: WWTP wet well footprint

Hi Bob,

You mentioned the centrifuge project may have some drawings that show the WWTP wet well footprint. I've attached a few drawings, is this the project you had in mind?

It looks to me like the wet well is actually a bit further north from the project area (off the top of the page on AS002 and AS003). Am I missing some drawings that would show it, or were you thinking of another project?

Thanks,

Pierre Wilder P. Eng

Environmental Engineer

~~Direct: 613 724-4352~~
Mobile: 613 790-7690
Pierre.Wilder@stantec.com

Stantec
400 - 1331 Clyde Avenue
Ottawa ON K2C 3G4

Appendix A3 Wet Well Levels

Razafimaharo, Christene

Subject: RE: Wet Well Data

From: Austin Mitchell <AMitchell@ocwa.com>
Sent: Thursday, October 14, 2021 11:57 AM
To: Wilder, Pierre <Pierre.Wilder@stantec.com>
Cc: Andrew Trader <ATrader@ocwa.com>; Robert LeBlanc <RLeBlanc@ocwa.com>
Subject: Wet Well Data

Hi Pierre,

Regarding your questions about the Wet Well level data, the milltronics head for the Wet Well is installed after the barscreen at the top of the Wet Well (Basically floor level in headworks). There is also a milltronics head prior to the barscreen as well and that is for differential. With that being daif, the Wet Well level is governed by the milltronics head AFTER the Barscreen. In regards to our Wet Well, the pumps are in a drywell (not submerged) and pull water from the Wet Well on the other side of the wall.

As for Wet Well levels, we typically aim for a level of 3.0m. A typical "dry weather" day the Wet Well level will range from 2.70m-3.0m. High flows the Wet Well will be around 3.5m and if it is a major storm and close to bypass levels the Wet Well will be in the 4.5-5.0m range. As Bob mentioned previously, the pump control narrative speaks to this, if you have any further questions please let us know.

Thank you,

Austin Mitchell
Senior Operations Manager | Mississippi Cluster
Cell: (613) 257-9188
Email: AMitchell@ocwa.com

OCWA
ONTARIO CLEAN WATER AGENCY
AGENCE ONTARIENNE DES EAUX

Appendix B Sanitary Flow Allocation

163401646 - Town of Carleton Place W/WW MP
Sanitary - PCSWMM Junctions Flow Allocation

Import from Model
For Lookup/Checks
Export to Model

	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)	Peak I/I (L/s)	Peak DWF (L/s)	Total Drainage Area (ha)
Phase 1 Report Peak Values	195	154	591	185	131	591	521	131	591	216	180	653	204	146	653	558	146	653	236	202	715	223	158	715	597	158	715	276	234	835	263	177	835	758	177	835
Total PCSWMM Inputs	195	154	591	185	131	591	521	131	591	216	180	653	204	146	653	558	146	653	236	202	715	223	158	715	597	158	715	276	234	835	263	177	835	758	177	835

		2021									2026								
		Design			Annual			Rare			Design			Annual			Rare		
		2021-Design			2021-Annual			2021-Rare			2026-Design			2026-Annual			2026-Rare		
Name	MH ID in SSDS	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)
A2M022	201	10.5	5.9	31.8	9.5	4.9	31.8	17.5	4.9	31.8	10.5	5.7	31.8	9.5	4.8	31.8	17.5	4.8	31.8
A2M023	202	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A2M053	204	0.0	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.1
A2M057	200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M002	115	1.6	1.7	4.7	1.4	1.4	4.7	2.6	1.4	4.7	1.6	1.7	4.7	1.4	1.4	4.7	2.6	1.4	4.7
B2M005	113	0.3	0.4	1.0	0.3	0.4	1.0	0.5	0.4	1.0	0.3	0.4	1.0	0.3	0.4	1.0	0.5	0.4	1.0
B2M006	114	0.6	0.5	1.7	0.5	0.4	1.7	0.9	0.4	1.7	0.6	0.5	1.7	0.5	0.4	1.7	0.9	0.4	1.7
B2M014	118	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M015	117	0.2	0.3	0.6	0.2	0.2	0.6	0.3	0.2	0.6	0.2	0.3	0.6	0.2	0.2	0.6	0.3	0.2	0.6
B2M015A	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M016	116	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.1
B2M018	115A	0.2	0.1	0.5	0.2	0.1	0.5	0.3	0.1	0.5	0.2	0.1	0.5	0.2	0.1	0.5	0.3	0.1	0.5
B2M034	208	0.8	0.8	2.4	0.7	0.7	2.4	1.3	0.7	2.4	0.8	1.8	2.4	0.7	1.2	2.4	1.3	1.2	2.4
B2M035	207	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M048	101	18.9	16.8	57.2	22.9	14.1	57.2	171.6	14.1	57.2	19.1	17.1	57.9	23.2	14.3	57.9	173.6	14.3	57.9
B2M049	102A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M050	103	4.3	3.4	13.0	5.2	2.8	13.0	38.9	2.8	13.0	4.3	3.4	13.0	5.2	2.8	13.0	38.9	2.8	13.0
B2M051	102	2.2	4.4	6.7	2.7	3.6	6.7	20.0	3.6	6.7	2.2	4.4	6.7	2.7	3.6	6.7	20.0	3.6	6.7
B2M052	104	0.5	4.3	1.5	0.6	3.6	1.5	4.6	3.6	1.5	0.5	4.3	1.5	0.6	3.6	1.5	4.6	3.6	1.5
B2M054	105	0.2	0.6	0.5	0.2	0.5	0.5	1.4	0.5	0.5	0.2	0.6	0.5	0.2	0.5	0.5	1.4	0.5	0.5
B2M056	106	0.2	0.2	0.5	0.2	0.2	0.5	1.4	0.2	0.5	0.3	0.5	1.0	0.4	0.4	1.0	3.0	0.4	1.0
B2M057	107	0.2	0.3	0.7	0.3	0.2	0.7	2.0	0.2	0.7	0.2	0.3	0.7	0.3	0.2	0.7	2.0	0.2	0.7
B2M086	108	11.7	13.2	35.5	10.6	11.1	35.5	19.5	11.1	35.5	11.7	13.2	35.5	10.6	11.0	35.5	19.5	11.0	35.5
B2M087	109	0.1	0.4	0.2	0.1	0.3	0.2	0.1	0.3	0.2	0.1	0.4	0.2	0.1	0.3	0.2	0.1	0.3	0.2
B2M088	110	0.1	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.3
B2M089	111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M090	112	5.5	6.1	16.8	5.0	5.1	16.8	9.2	5.1	16.8	5.5	6.1	16.8	5.0	5.1	16.8	9.2	5.1	16.8
B3M001	206	1.6	2.8	4.8	1.5	2.3	4.8	2.7	2.3	4.8	1.6	2.7	4.8	1.5	2.2	4.8	2.7	2.2	4.8
B3M002	205	1.6	2.4	4.8	1.4	2.0	4.8	2.6	2.0	4.8	1.8	2.7	5.5	1.6	2.1	5.5	3.0	2.1	5.5
B3M013	209	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M015	211	0.1	0.0	0.3	0.1	0.0	0.3	0.2	0.0	0.3	0.1	0.0	0.3	0.1	0.0	0.3	0.2	0.0	0.3
B3M016	213	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M017	214	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	7.1	2.5	0.8	4.1	2.5	1.4	4.1	2.5
B3M019	23	0.2	0.4	0.7	0.2	0.4	0.7	0.4	0.4	0.7	0.2	0.4	0.7	0.2	0.3	0.7	0.4	0.3	0.7
B3M020	24	1.9	2.6	5.7	1.7	2.2	5.7	3.1	2.2	5.7	1.9	2.6	5.7	1.7	2.2	5.7	3.1	2.2	5.7
B3M025	127	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M026	126	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M027	124	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M028	123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M029	122	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M030_CN_AB	220	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M033	121	18.8	6.8	57.1	17.1	6.8	57.1	31.4	6.8	57.1	19.2	7.5	58.2	17.5	7.1	58.2	32.0	7.1	58.2
B3M034	128	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M036	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M037	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M039	216	0.2	0.1	0.6	0.2	0.1	0.6	0.3	0.1	0.6	0.2	0.1	0.6	0.2	0.1	0.6	0.3	0.1	0.6
B3M040	217	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M041	221	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M043	212	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M044	218	0.1	0.1	0.4	0.1	0.1	0.4	0.2	0.1	0.4	0.1	0.1	0.4	0.1	0.1	0.4	0.2	0.1	0.4
B3M045	219	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M053	215	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M054	211A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M055	125	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M056	119A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M057	119	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M058	210	3.4	3.5	10.4	3.1	2.9	10.4	5.7	2.9	10.4	3.5	3.5	10.5	3.2	2.9	10.5	5.8	2.9	10.5
C1M001	3	0.6	0.3	1.8	0.5	0.3	1.8	1.0	0.3	1.8	0.6	0.3	1.8	0.5	0.3	1.8	1.0	0.3	1.8
C1M002	2	11.7	14.1	35.6	10.7	11.9	35.6	19.6	11.9	35.6	11.7	13.9	35.6	10.7	11.7	35.6	19.6	11.7	35.6
C1M003	2A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C1M004	1	1.8	2.1	4.9	1.5	1.8	4.9	2.7	1.8	4.9	6.7	9.4	20.3	6.1	6.1	20.3	11.2	6.1	20.3
C2M048	22	0.3	0.3	0.8	0.3	0.2	0.8	0.5	0.2	0.8	0.3	0.3	0.8	0.3	0.2	0.8	0.5	0.2	0.8
C2M049	21	4.1	4.6	12.3	3.7	3.9	12.3	6.8	3.9	12.3	4.6	5.5	14.1	4.2	4.4	14.1	7.7	4.4	14.1
C2M050	20	0.1	0.1	0.3	0.1	0.1	0.3	0.2	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.3	0.2	0.1	0.3
C2M051	19	0.5	0.8	1.6	0.5	0.7	1.6	0.9	0.7	1.6	0.6	0.9	1.7	0.5	0.7	1.7	0.9	0.7	1.7
C2M052	18	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
C2M053	17	1.2	2.0	3.6	1.1	1.7	3.6	2.0	1.7	3.6	1.2	2.0	3.6	1.1	1.7	3.6	2.0	1.7	3.6
C2M054	16	0.6	0.5	1.7	0.5	0.4	1.7	0.9	0.4	1.7	0.6	0.5	1.7	0.5	0.4	1.7	0.9	0.4	1.7
C2M055	15	0.3	0.5	1.0	0.3	0.4	1.0	0.5	0.4	1.0	0.3	0.5	1.0	0.3	0.4	1.0	0.5	0.4	1.0
C2M056	15A	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
C2M057	15B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2M058	14	0.7	0.6	2.1	0.6	0.5	2.1	1.2	0.5	2.1	0.7	0.6	2.1	0.6	0.5	2.1	1.2	0.5	2.1
C2M068	4	0.1	0.4	0.4	0.1	0.3	0.4	0.2	0.4	0.4	0.1	0.8	0.4	0.1	0.4	0.4	0.2	0.4	0.4
C2M069	5	1.5	1.3	4.5	1.4	1.1	4.5	2.5	1.1	4.5	1.5	1.3	4.5	1.4	1.1	4.5	2.5	1.1	4.5
C2M070	6	0.4	0.7	1.1	0.3	0.6	1.1	0.6	0.6	1.1	0.4	0.7	1.1	0.3	0.6	1.1	0.6	0.6	1.1
C2M071	7	10.9	10.2	33.1	9.9	8.6	33.1	18.2	8.6	33.1	11.2	10.6	34.0	10.2	8.8	34.0	18.7	8.8	34.0
C2M072	8	0.6	1.2	1.8	0.6	1.0	1.8	1.0	1.0	1.8	0.6	1.2	1.8	0.6	1.0	1.8	1.0	1.0	1.8
C2M073	9	1.8	2.9	5.5	1.6	2.4	5.5	3.0	2.4	5.5	1.8	2.8	5.5	1.6	2.4	5.5	3.0	2.4	5.5
C2M075	10	1.2	1.9	3.8	1.1	1.6	3.8	2.1	1.6	3.8	1.2	1.8	3.8	1.1	1.5	3.8	2.1	1.5	3.8
C2M076	11	0.6	0.6	1.7	0.5	0.5	1.7	0.9	0.5	1.7	0.6	0.6	1.7	0.5	0.5	1.7	0.9	0.5	1.7
C2M125	13	0.2	0.3	0.7	0.2	0.2	0.7	0.4	0.2	0.7	0.3	0.9	0.9	0.3	0.5	0.9	0.5	0.5	0.9
C2M124	12	5.9	2.5	17.8	5.3	2.1	17.8	9.8	2.1	17.8	5.9	2.5	17.8	5.3	2.1	17.8	9.8	2.1	17.8
D10365-999504866	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10365-999505768	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10369-999503587	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10370-999504459	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10397-999494852	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10397-999495523	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10403-999493051	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10403-999493512	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10468-999776801	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10479-99975037	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10915-999945601	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-1005	119B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-1006	120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-1112	302	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9
SA-MH-1113	303	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9
SA-MH-1135	301	16.6	1.2	50.3	15.1	1.0	50.3	27.6	1.0	50.3	16.6	1.2	50.3	15.1	1.0	50.3	27.6	1.0	50.3
SA-MH-1136	304	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9
SA-MH-1137	305	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9
SA-MH-1138	306	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9
SA-MH-1139	307	0.4	0.2	1.1	0.3	0.1	1.1	0.6	0.1	1.1	0.4	0.2	1.1	0.3	0.1	1.1	0.6	0.1	1.1
SA-MH-580	320	8.7	10.4	26.5	8.0	8.6	26.5	14.6	8.6	26.5	8.7	10.1	26.5	8.0	8.5	26.5	14.6	8.5	26.5
SA-MH-589	322	4.7	3.4	14.4	4.3	3.4	14.4	7.9	3.4	14.4	5.0	3.9	15.3	4.6	3.6	15.3	8.4	3.6	15.3
SA-MH-590	323	0.1	0.0	0.2	0.1	0.0	0.2	0.1	0.0	0.2	0.1	0.0	0.2	0.1	0.0	0.2	0.1	0.0	0.2
SA-MH-591	324	1.8	0.4	5.5	1.7	0.4	5.5	3.0	0.4	5.5	1.8	0.4	5.5	1.7	0.4	5.5	3.0	0.4	5.5
SA-MH-593	325	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-601	318	0.3	0.8	0.8	0.2	0.6	0.8	0.5	0.6	0.8	0.3	0.8	0.8	0.2	0.6	0.8	0.5	0.6	0.8
SA-MH-691	326	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-692	327	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-729	203	0.4	0.4	1.1	0.3	0.3	1.1	0.6	0.3	1.1	0.4	0.4	1.1	0.3	0.3	1.1	0.6	0.3	1.1
SA-MH-751	321	24.8	5.0	75.0	22.5	5.0	75.0	41.3	5.0	75.0	36.7	9.9	111.2	33.4	8.0	111.2	61.2	8.0	111.2
SA-MH-778	319	0.1	0.2	0.3	0.1	0.2	0.3	0.2	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3	0.2	0.2	0.3
SA-MH-779	315	0.2	0.3	0.5	0.2	0.3	0.5	0.3	0.3	0.5	0.2	0.3	0.5	0.2	0.3	0.5	0.3	0.3	0.5
SA-MH-780	316	1.1	2.0	3.4	1.0	1.6	3.4	1.9	1.6	3.4	1.2	2.1	3.7	1.1	1.7	3.7	2.0	1.7	3.7
SA-MH-781	317	0.7	1.4	2.2	0.7	1.1	2.2	1.2	1.1	2.2	0.7	1.3	2.2	0.7	1.1	2.2	1.2	1.1	2.2
SA-MH-794	308	0.3	0.2	1.0	0.3	0.2	1.0	0.6	0.2	1.0	0.3	0.2	1.0	0.3	0.2	1.0	0.6	0.2	1.0
SA-MH-795	310	0.5	0.2	1.6	0.5	0.2	1.6	0.9	0.2	1.6	0.5	0.2	1.6	0.5	0.2	1.6	0.9	0.2	1.6
SA-MH-796	311	0.3	0.2	1.0	0.3	0.2	1.0	0.5	0.2	1.0	0.3	0.2	1.0	0.3	0.2	1.0	0.5	0.2	1.0
SA-MH-798	312	0.2	0.2	0.5	0.1	0.1	0.5	0.2	0.1	0.5	0.5	2.2	1.7	0.5	1.2	1.7	0.9	1.2	1.7
SA-MH-799	313	0.7	0.3	2.0	0.6	0.3	2.0	1.1	0.3	2.0	0.7	0.3	2.0	0.6	0.3	2.0	1.1	0.3	2.0
SA-MH-800	314	0.1	0.2	0.4	0.1	0.1	0.4	0.2	0.1	0.4	0.1	0.2	0.4	0.1	0.1	0.4	0.2	0.1	0.4
SA-MH-801	309	0.6	0.3	1.8	0.5	0.2	1.8	1.0	0.2	1.8	0.6	0.3	1.8	0.5	0.2	1.8	1.0	0.2	1.8

	2031									2041								
	Design			Annual			Rare			Design			Annual			Rare		
	2031-Design			2031-Annual			2031-Rare			2041-Design			2041-Annual			2041-Rare		
Name	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)	Baseline (L/s)	Average Value (L/s)	Sewershed Area (ha)
A2M022	10.5	5.6	31.8	9.5	4.7	31.8	17.5	4.7	31.8	10.5	5.6	31.8	9.5	4.7	31.8	17.5	4.7	31.8
A2M023	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A2M053	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1
A2M057	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M002	1.6	1.8	5.0	1.5	1.5	5.0	2.7	1.5	5.0	1.7	1.9	5.2	1.6	1.6	5.2	2.9	1.6	5.2
B2M005	0.3	0.4	1.0	0.3	0.4	1.0	0.5	0.4	1.0	0.3	0.4	1.0	0.3	0.4	1.0	0.5	0.4	1.0
B2M006	0.6	0.5	1.7	0.5	0.4	1.7	0.9	0.4	1.7	0.6	0.5	1.7	0.5	0.4	1.7	0.9	0.4	1.7
B2M014	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M015	0.2	0.3	0.6	0.2	0.2	0.6	0.3	0.2	0.6	0.2	0.3	0.6	0.2	0.2	0.6	0.3	0.2	0.6
B2M015A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M016	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.1
B2M018	0.2	0.1	0.5	0.2	0.1	0.5	0.3	0.1	0.5	0.2	0.1	0.5	0.2	0.1	0.5	0.3	0.1	0.5
B2M034	0.8	2.4	2.5	0.7	1.4	2.5	1.4	1.4	2.5	0.8	2.8	2.5	0.8	1.6	2.5	1.4	1.6	2.5
B2M035	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M048	19.5	17.8	59.2	23.7	14.7	59.2	177.6	14.7	59.2	32.0	26.4	96.9	38.8	19.6	96.9	290.7	19.6	96.9
B2M049	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M050	4.3	3.4	13.0	5.2	2.8	13.0	38.9	2.8	13.0	4.3	3.4	13.0	5.2	2.8	13.0	38.9	2.8	13.0
B2M051	2.2	4.4	6.7	2.7	3.6	6.7	20.0	3.6	6.7	2.2	4.4	6.7	2.7	3.6	6.7	20.0	3.6	6.7
B2M052	0.5	4.3	1.5	0.6	3.6	1.5	4.6	3.6	1.5	0.5	4.3	1.5	0.6	3.6	1.5	4.6	3.6	1.5
B2M054	0.2	0.6	0.5	0.2	0.5	0.5	1.4	0.5	0.5	0.2	0.6	0.5	0.2	0.5	0.5	1.4	0.5	0.5
B2M056	0.5	0.9	1.5	0.6	0.6	1.5	4.6	0.6	1.5	0.9	1.5	2.6	1.0	0.9	2.6	7.7	0.9	2.6
B2M057	0.2	0.3	0.7	0.3	0.2	0.7	2.0	0.2	0.7	0.2	0.3	0.7	0.3	0.2	0.7	2.0	0.2	0.7
B2M086	12.2	13.7	36.9	11.1	11.4	36.9	20.3	11.4	36.9	12.7	14.3	38.4	11.5	11.7	38.4	21.1	11.7	38.4
B2M087	0.1	0.4	0.2	0.1	0.3	0.2	0.1	0.3	0.2	0.1	0.4	0.2	0.1	0.3	0.2	0.1	0.3	0.2
B2M088	0.1	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.3
B2M089	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B2M090	5.6	6.1	16.9	5.1	5.1	16.9	9.3	5.1	16.9	5.6	6.2	17.0	5.1	5.1	17.0	9.3	5.1	17.0
B3M001	1.7	2.8	5.2	1.6	2.3	5.2	2.9	2.3	5.2	1.8	3.0	5.6	1.7	2.4	5.6	3.1	2.4	5.6
B3M002	2.5	3.6	7.6	2.3	2.7	7.6	4.2	2.7	7.6	3.4	5.0	10.4	3.1	3.5	10.4	5.7	3.5	10.4
B3M013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M015	0.1	0.0	0.3	0.1	0.0	0.3	0.2	0.0	0.3	0.1	0.0	0.3	0.1	0.0	0.3	0.2	0.0	0.3
B3M016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M017	1.3	11.0	4.0	1.2	6.4	4.0	2.2	6.4	4.0	1.7	13.4	5.0	1.5	7.9	5.0	2.8	7.9	5.0
B3M019	0.2	0.4	0.7	0.2	0.3	0.7	0.4	0.3	0.7	0.2	0.4	0.7	0.2	0.3	0.7	0.4	0.3	0.7
B3M020	1.9	2.6	5.7	1.7	2.2	5.7	3.1	2.2	5.7	1.9	2.6	5.7	1.7	2.1	5.7	3.1	2.1	5.7
B3M025	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M026	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M027	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M028	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M029	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M030_CN_AB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M033	19.7	8.1	59.7	17.9	7.3	59.7	32.8	7.3	59.7	20.6	8.6	62.3	18.7	7.7	62.3	34.3	7.7	62.3
B3M034	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M036	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M037	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M039	0.2	0.1	0.6	0.2	0.1	0.6	0.3	0.1	0.6	0.2	0.1	0.6	0.2	0.1	0.6	0.3	0.1	0.6
B3M040	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M041	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M043	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M044	0.1	0.1	0.4	0.1	0.1	0.4	0.2	0.1	0.4	0.1	0.1	0.4	0.1	0.1	0.4	0.2	0.1	0.4
B3M045	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M053	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M054	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M055	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M056	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M057	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B3M058	3.5	3.5	10.7	3.2	2.9	10.7	5.9	2.9	10.7	3.6	3.7	11.0	3.3	3.0	11.0	6.0	3.0	11.0
C1M001	0.6	0.3	1.8	0.5	0.3	1.8	1.0	0.3	1.8	0.6	0.3	1.8	0.5	0.3	1.8	1.0	0.3	1.8
C1M002	11.7	13.8	35.6	10.7	11.7	35.6	19.6	11.7	35.6	11.7	13.7	35.6	10.7	11.6	35.6	19.6	11.6	35.6
C1M003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C1M004	10.2	13.9	30.8	9.2	8.8	30.8	16.9	8.8	30.8	13.8	18.5	41.7	12.5	11.6	41.7	22.9	11.6	41.7
C2M048	0.3	0.3	0.8	0.3	0.2	0.8	0.5	0.2	0.8	0.3	0.3	0.8	0.3	0.2	0.8	0.5	0.2	0.8
C2M049	5.2	6.4	15.8	4.7	4.9	15.8	8.7	4.9	15.8	6.4	8.1	19.3	5.8	5.9	19.3	10.6	5.9	19.3
C2M050	0.1	0.1	0.3	0.1	0.1	0.3	0.2	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.3	0.2	0.1	0.3
C2M051	0.6	0.9	1.9	0.6	0.7	1.9	1.0	0.7	1.9	0.7	1.1	2.1	0.6	0.8	2.1	1.2	0.8	2.1
C2M052	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
C2M053	1.2	2.0	3.6	1.1	1.7	3.6	2.0	1.7	3.6	1.2	2.0	3.6	1.1	1.7	3.6	2.0	1.7	3.6
C2M054	0.6	0.5	1.7	0.5	0.4	1.7	0.9	0.4	1.7	0.6	0.5	1.7	0.5	0.4	1.7	0.9	0.4	1.7
C2M055	0.3	0.5	1.0	0.3	0.4	1.0	0.5	0.4	1.0	0.3	0.5	1.0	0.3	0.4	1.0	0.5	0.4	1.0
C2M056	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
C2M057	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C2M058	0.8	0.7	2.3	0.7	0.6	2.3	1.3	0.6	2.3	0.8	0.8	2.5	0.8	0.6	2.5	1.4	0.6	2.5
C2M068	0.1	1.0	0.4	0.1	0.5	0.4	0.2	0.5	0.4	0.1	1.2	0.4	0.1	0.5	0.4	0.2	0.5	0.4
C2M069	1.5	1.3	4.5	1.4	1.1	4.5	2.5	1.1	4.5	1.5	1.3	4.5	1.4	1.1	4.5	2.5	1.1	4.5
C2M070	0.4	0.7	1.1	0.3	0.6	1.1	0.6	0.6	1.1	0.4	0.7	1.1	0.3	0.6	1.1	0.6	0.6	1.1
C2M071	11.8	11.3	35.7	10.7	9.2	35.7	19.6	9.2	35.7	12.5	12.2	37.8	11.3	9.7	37.8	20.8	9.7	37.8
C2M072	0.6	1.1	1.8	0.6	1.0	1.8	1.0	1.0	1.8	0.6	1.1	1.8	0.6	1.0	1.8	1.0	1.0	1.8
C2M073	1.8	2.8	5.5	1.6	2.4	5.5	3.0	2.4	5.5	1.8	2.8	5.5	1.6	2.4	5.5	3.0	2.4	5.5
C2M075	1.3	1.9	4.0	1.2	1.6	4.0	2.2	1.6	4.0	1.4	2.0	4.1	1.2	1.6	4.1	2.3	1.6	4.1
C2M076	0.6	0.6	1.7	0.5	0.5	1.7	0.9	0.5	1.7	0.6	0.6	1.7	0.5	0.5	1.7	0.9	0.5	1.7
C2M125	0.3	1.3	1.0	0.3	0.6	1.0	0.5	0.6	1.0	0.3	1.5	1.0	0.3	0.7	1.0	0.6	0.7	1.0
C2M124	5.9	2.5	17.8	5.3	2.1	17.8	9.8	2.1	17.8	5.9	2.5	17.8	5.3	2.1	17.8	9.8	2.1	17.8
D10365-999504866	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10365-999505768	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10369-999503587	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10370-999504459	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10397-999494852	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10397-999495523	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10403-999493051	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10403-999493512	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10468-999776801	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10479-99975037	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D10915-999945601	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-1005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-1006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-1112	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9
SA-MH-1113	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9
SA-MH-1135	16.6	1.1	50.3	15.1	1.0	50.3	27.6	1.0	50.3	16.6	1.1	50.3	15.1	0.9	50.3	27.6	0.9	50.3
SA-MH-1136	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9
SA-MH-1137	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9
SA-MH-1138	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9	0.3	0.1	0.9	0.3	0.1	0.9	0.5	0.1	0.9
SA-MH-1139	0.4	0.2	1.1	0.3	0.1	1.1	0.6	0.1	1.1	0.4	0.1	1.1	0.3	0.1	1.1	0.6	0.1	1.1
SA-MH-580	8.7	10.0	26.5	8.0	8.4	26.5	14.6	8.4	26.5	8.7	9.9	26.5	8.0	8.3	26.5	14.6	8.3	26.5
SA-MH-589	5.3	4.2	16.2	4.9	3.8	16.2	8.9	3.8	16.2	5.9	4.6	18.0	5.4	4.0	18.0	9.9	4.0	18.0
SA-MH-590	0.1	0.0	0.2	0.1	0.0	0.2	0.1	0.0	0.2	0.1	0.0	0.2	0.1	0.0	0.2	0.1	0.0	0.2
SA-MH-591	1.8	0.4	5.5	1.7	0.4	5.5	3.0	0.4	5.5	1.8	0.4	5.5	1.7	0.4	5.5	3.0	0.4	5.5
SA-MH-593	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-601	0.3	0.7	0.8	0.2	0.6	0.8	0.5	0.6	0.8	0.3	0.7	0.8	0.2	0.6	0.8	0.5	0.6	0.8
SA-MH-691	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-692	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA-MH-729	0.4	0.4	1.1	0.3	0.3	1.1	0.6	0.3	1.1	0.4	0.4	1.1	0.3	0.3	1.1	0.6	0.3	1.1
SA-MH-751	46.9	14.1	142.1	42.6	10.6	142.1	78.1	10.6	142.1	60.0	19.0	181.9	54.6	13.8	181.9	100.1	13.8	181.9
SA-MH-778	0.1	0.2	0.3	0.1	0.2	0.3	0.2	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3	0.2	0.2	0.3
SA-MH-779	0.2	0.3	0.5	0.2	0.3	0.5	0.3	0.3	0.5	0.2	0.3	0.5	0.2	0.2	0.5	0.3	0.2	0.5
SA-MH-780	1.3	2.2	3.9	1.2	1.8	3.9	2.1	1.8	3.9	1.4	2.4	4.4	1.3	1.9	4.4	2.4	1.9	4.4
SA-MH-781	0.7	1.3	2.2	0.7	1.1	2.2	1.2	1.1	2.2	0.7	1.3	2.2	0.7	1.1	2.2	1.2	1.1	2.2
SA-MH-794	0.3	0.2	1.0	0.3	0.2	1.0	0.6	0.2	1.0	0.3	0.2	1.0	0.3	0.2	1.0	0.6	0.2	1.0
SA-MH-795	2.1	1.6	6.4	1.9	1.0	6.4	3.5	1.0	6.4	6.2	5.0	18.9	5.7	3.0	18.9	10.4	3.0	18.9
SA-MH-796	0.3	0.2	1.0	0.3	0.2	1.0	0.5	0.2	1.0	0.3	0.2	1.0	0.3	0.2	1.0	0.5	0.2	1.0
SA-MH-798	0.8	3.3	2.4	0.7	1.8	2.4	1.3	1.8	2.4	0.9	4.0	2.9	0.9	2.2	2.9	1.6	2.2	2.9
SA-MH-799	0.7	0.3	2.0	0.6	0.3	2.0	1.1	0.3	2.0	0.7	0.3	2.0	0.6	0.3	2.0	1.1	0.3	2.0
SA-MH-800	0.1	0.2	0.4	0.1	0.1	0.4	0.2	0.1	0.4	0.1	0.1	0.4	0.1	0.1	0.4	0.2	0.1	0.4
SA-MH-801	0.6	0.3	1.8	0.5	0.2	1.8	1.0	0.2	1.8	0.6	0.3	1.8	0.5	0.2	1.8	1.0	0.2	1.8