APPENDIX F

TECHNICAL MEMORANDUM #2

City-wide Sanitary Servicing Master Plan Update: FINAL Technical Memorandum No. 2

Task 1: GIS Sanitary Quality Control and Field Verification
(Task 1.2: Develop Current State Geodatabase for Model Input)

Prepared for:
City of Waterloo

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Sign-off Sheet

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1.0 Introduction

The City of Waterloo (City) has retained Stantec Consulting Ltd. (Stantec) to complete the Waterloo Sanitary Servicing Master Plan (Master Plan). The purpose of the Master Plan is to provide an update to the 2002 City Wide Sanitary Sewer System Update – Master Plan (WSSS) (AECOM, 2002) to account for updated population and employment growth projections up to a 2031 planning horizon, with consideration for the 2041 mature state boundary. Priority and strategic projects will be evaluated to efficiently and effectively continue to operate the system, implement best management practices (including Infiltration/Inflow (I/I) monitoring and mitigation approaches), and optimize staging of the sanitary capital program.

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

- Task 1: GIS Sanitary Quality Control and Field Verification
- Task 2: Hydraulic Needs Assessment
- Task 3: Hydraulic Model Benefit/Cost Analysis
- Task 4: Hydraulic Model Development, Train, and Implement
- Task 5: Flow Monitoring and Inflow/Infiltration
- Task 6: Public Consultation
- Task 7: Master Plan

Task 1 included data review and validation of the existing sanitary system and the development of a current state geodatabase for model input. The geodatabase provided by the City has been reviewed by Stantec and updates have been made based on drawing review, field verification, and inferring data for physical attributes required for the model. Details regarding the data review and verification process are documented in Technical Memorandum #1.

The purpose of this memo is to summarize how the infrastructure data from the geodatabase will be transferred into the model, and to provide an overview of the additional modeling information that will be required in the model development stages. The model software selected for the purposes of the Master Plan, based on the Model Needs Assessment, is PCSWMM. Section 2 outlines the specific model data fields required for each model element (e.g. gravity mains, manholes, etc.). Section 3 discusses the outstanding data required to facilitate model development.

2.0 Hydraulic Model Data Fields

2.1 GRAVITY MAINS

Attributes for gravity mains that are important for hydraulic modeling include upstream manhole, downstream manhole, slope, upstream invert, downstream invert, diameter, and length. All of these attributes provide information required to determine sewer capacity. For the purposes of tracking assets within the model, the unique identifier is required which also enables seamless transfer of information between departments or organizations. Additional data may be input into a hydraulic model depending on the approach, level of analysis required, or the level of information available regarding the asset.

In PCSWMM, gravity mains are input as conduits. Table 1 summarizes input attributes for conduits that are categorized as gravity mains, as well as the input information source or recommended entry for applicable fields.

Table 1: Overview of Gravity Main Input Attributes

Conduit Attribute	Description	Data Source/Entry
Name	User assigned name of Conduit. Note that the name must be a unique identifier.	Geodatabase, Gravity Mains, MXASSETNUM Field
Inlet Node	Name of node on the inlet end of the conduit (i.e. the upstream manhole).	Geodatabase, Gravity Mains, FROMMH Field
Outlet Node	Name of node on the outlet end of the conduit (i.e. the downstream manhole).	Geodatabase, Gravity Mains, TOMH Field
Description	Optional comment or description. Not required for modeling purposes.	Recommended Entry: Geodatabase, Gravity Mains, ENTNAME Field
Tag	Optional category or classification. Not required for modeling purposes.	Recommended Entry: 'Sanitary'
Length (m)	Conduit length (m).	Geodatabase, Gravity Mains, SHAPE_Leng Field
Roughness	Manning's roughness coefficient.	Entry = 0.013[1]
Initial Elev. (m)/ Inlet Offset (m)	Attribute field title is dependent on the setting for Offsets: Elevation (corresponds to Initial Elev. (m)) or Depth (corresponds to Inlet Offset (m)). Elevation is to be used for this application. **Initial Elev. (m) is the elevation of the conduit at inlet end (i.e. upstream invert of the conduit).** Inlet Offset (m) is the depth of the conduit invert above node invert at inlet end (i.e. the distance between the bottom elevation of the upstream manhole and the conduit upstream invert).	Geodatabase, Gravity Mains, UPSTREAMIN Field

Conduit Attribute	Description	Data Source/Entry
Outlet Elev. (m)/ Outlet Offset (m)	Attribute field title is dependent on the setting for Offsets: Elevation (corresponds to Outlet Elev. (m)) or Depth (corresponds to Outlet Offset (m)). Elevation is to be used for this application. **Outlet Elev. (m) is the elevation of the conduit at outlet end (i.e. downstream invert of the conduit).** Outlet Offset (m) is the depth of the conduit invert above node invert at outlet end (i.e. the distance between the bottom elevation of the downstream manhole and the conduit downstream invert).	Geodatabase, Gravity Mains, DOWNSTREAM Field
Initial Flow (m^3/s)	Initial flow in the conduit, typically used to test model functionality prior to assigning node/ subcatchment flows.	N/A
Flow Limit (m^3/s)	Maximum flow allowed. This is an optional input that can be used to simulate hydraulic structures, such as flow splitters, without having to input structure details. An entry of zero is to be used if it is not applicable.	Structure specific, to be input as appropriate based on Geodatabase, Control Valves
Entry Loss Coeff.	Coefficient for energy losses at the entrance of the conduit. Energy losses may be related factors such as benching, flow control structures, or infrastructure conditions.	Not required at Master Plan scale
Exit Loss Coeff.	Coefficient for energy losses at the exit of the conduit. Energy losses may be related factors such as benching, flow control structures, or infrastructure conditions.	Not required at Master Plan scale
Avg. Loss Coeff.	Coefficient for energy losses along the length of the conduit. Energy losses may be related factors such as flow control structures or infrastructure conditions.	Not required at Master Plan scale
Flap Gate	Simulates if a flap gate prevents reverse flow through a conduit. Entry is Yes if a Flap gate is installed, no if otherwise.	No
Cross-Section	Conduit cross-section geometry, to be selected from a pull down menu.	Circular
Geom1 (m)	Maximum depth of cross-section (m), which represents the diameter for circular pipes.	Geodatabase, Gravity Mains, DIAMETER Field
Geom2 (m)	Width parameter (m), to be used if required based on the cross-sectional geometry of the conduit.	N/A

Conduit Attribute	Description	Data Source/Entry
Geom3 (m)	Left slope, to be used if required based on the cross-sectional geometry of the conduit.	N/A
Geom4 (m)	Right slope, to be used if required based on the cross-sectional geometry of the conduit.	N/A
Barrels	Number of barrels in a conduit, which allows the user to twin a pipe without having to represent the asset as two individual pipes.	1
Transect	Name of transect applied to conduit, used for irregular geometry (such as rivers).	N/A
Shape Curve	Name of shape curve applied to conduit, used for irregular geometry (such as rivers).	N/A
Culvert Code	Culvert type code, used for stormwater modeling.	N/A

Note 1: Based on Region of Waterloo Design Guidelines and Supplemental Specifications for Municipal Servicing (2013), Section B.3.1.5.

2.2 MANHOLES

The attribute for manholes that is the most important for hydraulic modeling is the top of manhole elevation. In the event a sewer surcharges, the top of manhole provides the context to evaluate whether the surcharge is likely to be an issue. For example, if a sewer is surcharged but the water level is 6 m below the top of manhole it is not likely to present a concern; however, if the water level is 1 m below the top of manhole, it is likely to cause basement flooding. For model linkage to asset data, the unique asset ID is assigned to the manhole ID. Additional data may be input into a hydraulic model depending on the software, level of analysis required, or the level of information available regarding the asset.

In PCSWMM, manholes are input as junctions. Table 2 summarizes input attributes for junctions, as well as the input information source or recommended entry for applicable fields.

Table 2: Overview of Manhole Input Attributes

Junction Attribute	Description	Data Source/Entry
Name	User assigned name of Manhole. Note that the name must be a unique identifier.	Geodatabase, Manholes, MXASSETNUM Field
X-Coordinate	X coordinate of junction.	Automatically populated during shapefile imported into model.
Y-Coordinate	Y coordinate of junction.	Automatically populated during shapefile imported into model.
Description	Optional comment or description. Not required for modeling purposes.	Recommended Entry: Geodatabase, Manholes, ENTNAME Field

Junction Attribute	Description	Data Source/Entry
Tag	Optional category or classification. Not required for modeling purposes.	Recommended Entry: 'Sanitary'
Inflows	Used to specify any external inflows received at the junction. The user can specify a direct, dry weather or RDII flow and input parameters as appropriate based on the inflow type. This field is an indicator of how junction flows are generated in the model, as per the Junction Inflows inputs (refer to Table 3).	Flows to be determined based on population data, diurnal patterns, flow monitoring, and hydrographs. Refer to Table 3 for details regarding Inflows inputs.
Treatment	Used to specify pollutant removal measures provided at junction. The user can input the mathematical expression that represents the treatment provided.	No
Invert Elev. (m)	Elevation of junction's invert (m) (i.e. the elevation at the bottom of the manhole).	To be automatically populated based on lowest conduit invert elevation for incoming/outgoing pipes.
Rim Elev. (m)	Rim (ground) elevation of junction (m) (i.e. the elevation for top of manhole).	Geodatabase, Manholes, TOPOFMH
Depth (m)	Maximum water depth (i.e. the distance from the invert to ground surface) (m). This distance is the difference between the Rim Elev. and the Invert Elev.	To be automatically populated based on the Rim Elev. and Invert Elev.
Initial Depth (m)	Initial water depth in junction (m), used to represent permanent water or boundary conditions (such as ponds or storage tanks).	N/A
Surcharge Depth (m)	Depth in excess of maximum depth before flooding occurs. This input is used to trigger simulation outputs identifying flood conditions and the duration.	Assume 1.8 m below Rim Elev.
Ponded Area (m^2)	Area of ponded water when flooded to surface (m^2). Used to represent surface area from which water is stored on the surface until such time the flow re-enters the sewer.	N/A

For forcemains, intermediary connections representing elevation changes or important connectivity must be coded differently than regular manholes. See Section 2.3 for more information regarding forcemains.

In addition to the above attributes, inputs are also specified for manhole Inflows, which represents the wastewater flows to be applied in the model simulations. Table 3 summarizes the inflow information to be input, however, it is noted that this data is to be collected during the model development stage.

Table 3: Overview of Manhole Input Inflows

Junction Inflows	Description
Baseline (m^3/s)	Baseline value in direct inflow (m^3/s), used to represent groundwater infiltration flows. The baseline flows are input based on flow monitoring data (where available) or design values (inflow per unit area).
Baseline Pattern	Baseline time pattern in direct inflow. This pattern is an optional input that can vary the baseflow over time (hourly, daily, or monthly).
Time Series	Time series name in direct inflow. If left blank, no direct inflow will be applied at the specified node.
Scale Factor	Scale factor in direct inflow. This factor is applied to the Time Series, not the baseline flow. The Scale Factor can be used for several purposes, such as easily adjusting the magnitude of a hydrograph without changing its shape, or adjusting the inflows of a group of nodes in a time-synchronized fashion while maintaining unique magnitudes.
Average Value (m^3/s)	Average value in dry weather inflow (m^3/s). The dry weather flow is calculated based on population and per capita rates derived from flow monitoring or design rates.
Time Pattern 1	The first time pattern in dry weather inflow. Time patterns are used to vary the average dry weather flows over time (monthly, daily, hourly). Time patterns are to be developed based on flow monitoring data where available.
Time Pattern 2	The second time pattern in dry weather inflow. Time patterns are used to vary the average dry weather flows over time (monthly, daily, hourly). Time patterns are to be developed based on flow monitoring data where available.
Time Pattern 3	The third time pattern in dry weather inflow. Time patterns are used to vary the average dry weather flows over time (monthly, daily, hourly). Time patterns are to be developed based on flow monitoring data where available.
Time Pattern 4	The fourth time pattern in dry weather inflow. Time patterns are used to vary the average dry weather flows over time (monthly, daily, hourly). Time patterns are to be developed based on flow monitoring data where available.
Hydrograph	Unit hydrograph group in Rainfall Derived Infiltration & Inflow (RDII) inflow. Developed based on flow monitoring when using the RTK approach.
Sewershed Area (ha)	Sewershed area in RDII inflow (ha). This area is to be used in conjunction with the unit hydrograph to generate the RDII contributions to the sewer.

2.3 FORCEMAINS (PRESSURIZED MAINS)

Attributes for forcemains (pressurized mains) that are important for hydraulic modeling include upstream invert, downstream invert, diameter, length, and material (friction factor). These attributes provide information required to determine the capacity of the forcemain and to determine the operating head at the upstream pump stations. For the purposes of tracking assets, the unique identifier is applied as the conduit ID. Additional data may be input into a hydraulic model depending on the software, level of analysis required, or the level of information available regarding the asset.

Similar to gravity mains, forcemains are input as conduits in PCSWMM. Forcemains are differentiated from gravity mains through the input specified for 'Cross-Section' attribute field. Table 4 summarizes input attributes for forcemain conduits, as well as the input information source or recommended entry for applicable fields.

Table 4: Overview of Forcemain Input Attributes

Conduit Attribute	Description	Data Source/Entry
Name	User assigned name of Conduit. Note that the name must be a unique identifier.	Geodatabase, Pressurized Main, MXASSETNUM Field
Inlet Node	Name of node on the inlet end of the conduit (i.e. the upstream junction)	To be input based on the Pump Station configuration to be represented in model space.
Outlet Node	Name of node on the outlet end of the conduit (i.e. the downstream junction)	To be input based on the Pump Station configuration to be represented in model space.
Description	Optional comment or description. Not required for modeling purposes.	Recommended Entry: Input name of corresponding pump station.
Tag	Optional category or classification. Not required for modeling purposes.	Recommended Entry: 'Sanitary'
Length (m)	Conduit length (m)	Geodatabase, Pressurized Mains, SHAPE_Leng Field
Roughness	Not applicable for pressurized flow, however, a valid entry must be specified.	Entry = 0.013
Initial Elev. (m)/ Inlet Offset (m)	Attribute field title is dependent on the setting for Offsets (see Conduits Table 1). Initial Elev. (m) is the elevation of the conduit at inlet end (i.e. upstream invert of the conduit).	Geodatabase, Presurized Mains, UPSTREAMIN Field
Outlet Elev. (m)/ Outlet Offset (m)	Attribute field title is dependent on the setting for Offsets (see Conduits Table 1). Initial Elev. (m) is the elevation of the conduit at outlet end (i.e. downstream invert of the conduit).	Geodatabase, Pressurized Mains, DOWNSTREAM Field
Initial Flow (m^3/s)	Initial flow in the conduit, typically used to test model functionality prior to assigning node/ subcatchment flows.	N/A
Flow Limit (m^3/s)	Maximum flow allowed. Not applicable for forcemains.	N/A
Entry Loss Coeff.	Coefficient for energy losses at the entrance of the conduit. Energy losses for forcemains may be related to bends, valves, and other appurtenances if required.	0

Conduit Attribute	Description	Data Source/Entry
Exit Loss Coeff.	Coefficient for energy losses at the exit of the conduit. Energy losses for forcemains may be related to bends, valves, and other appurtenances if required.	0
Avg. Loss Coeff.	Coefficient for energy losses along the length of the conduit. Not used for forcemains.	0
Flap Gate	Simulates if a flap gate prevents reverse flow through a conduit. Not typically applicable for forcemains.	No
Cross-Section	Conduit cross section geometry, to be selected from a pull down menu.	FORCE_MAIN. Note the Roughness (Hazen-Williams C-factor) must be specified to allow this option to be selected. Roughness is typically based on conduit material.
Geom1 (m)	Maximum depth of cross section (m), which represents the diameter for circular pipes.	Geodatabase, Pressurized Mains, DIAMETER Field
Geom2 (m)	Indicates the roughness input that is entered when the FORCE_MAIN cross-section is specified.	Entered through dialogue box for Cross-Section when FORCE_MAIN is specified, entry is based on conduit material
Geom3 (m)	Not applicable for forcemains.	N/A
Geom4 (m)	Not applicable for forcemains.	N/A
Barrels	Number of barrels in a conduit, which allows the user to twin a pipe without having to represent the asset as two individual pipes.	1
Transect	Name of transect applied to conduit, used for irregular geometry (such as rivers).	N/A
Shape Curve	Name of shape curve applied to conduit, used for irregular geometry (such as rivers).	N/A
Culvert Code	Culvert type code. Not applicable to forcemains.	N/A

Specific to forcemains, of there are intermediary junction nodes along its profile representing elevation differences or other appurtenances (bends, values), these must be defined specially to simulate a pressurized pipe situation and prevent water from existing the system at these locations under surcharge. This is accomplished by assigning the Maximum Depth field to zero, and arbitrarily assigning the Surcharge Depth to a high number.

2.4 PUMP STATIONS

Pump stations can be represented different ways in a hydraulic model depending on the preference of the user. The way in which the stations are represented indicates the information required for the purposes on modeling.

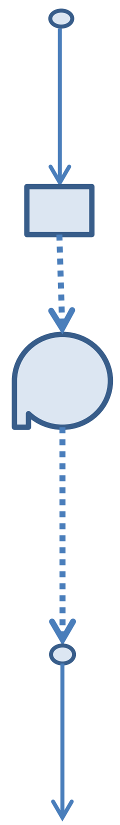
Figure 1 illustrates a simple pump station representation (Option A) and a detailed pump station representation (Option B). In Option A, a single pump element is assigned an operating curve or design point for flow and discharge head that is representative of the overall station response. The forcemain is not directly simulated and the hydraulic impact is either incorporated into the simulated pump station response or considered negligible. In Option B, individual pumps are modeled at the pump station and connect downstream at a dummy node. The forcemain is input as a connection from the dummy node to the receiving manhole in the collection system. For Option B, the individual pump responses and forcemain are simulated.

For this application, Option B is recommended as it will accurately represent the forcemain and correspond with the pressurized main geodatabase. Currently, a direct connection does not exist between the geodatabase fields and the modeling fields for forcemains and pump stations elements; however, the majority of the outstanding information can be inferred from the geodatabase or obtained from design reports and Certificates of Approval. To allow direct connectivity in the future, additional fields and dummy infrastructure would need to be added to the geodatabase. As the dummy infrastructure would be used only for the purposes of modeling, they would be coded as ‘fictitious’ to signify they do not represent actual infrastructure assets. An example of ‘fictitious’ infrastructure that would be required in the geodatabase to allow a direct connection is the dummy ‘sealed’ node shown in Option B, that connects pump(s) at the station and the downstream forcemain.

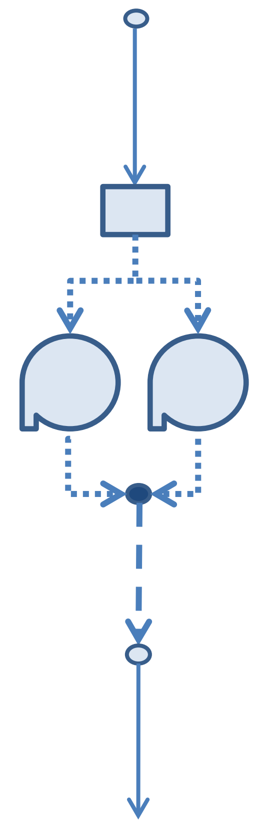
Three main categories of input information are required to model pump stations based on Option B:

- Wet Well Information
- Pump Information
- Forcemain Information (Refer to Section 2.3 for model input details)

Information regarding the pump station locations and naming conventions are stored in the geodatabase under Network Structures and forcemain information is stored in the geodatabase under Pressurized Mains. Additional information will need to be collected to populate the required modeling information for data gaps or missing fields. Appendix A provides a summary of the pump station information provided to date that was in addition to the data included in the geodatabase files. Here, both existing and future upgrades are identified, alongside uncertain information that will need to be determined for the model-building stage.



Option A: Simple Representation



Option B: Detailed Representation

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Drawing is not to be used for construction

Legend

- Sanitary Manhole
- Simulated Pump Station Response
- Dummy 'Sealed' Node
- Wet Well
- Forcemain
- Sanitary Sewer

Figure No. 1

Title **Hydraulic Model Pump Station Configuration Options**

Client/Project City of Waterloo
City-wide Sanitary Servicing Master Plan

2.4.1 Wet Wells

Wet wells are represented in PCSMM as Storage Units, which are a special junction type with additional fields to represent dimensions. Table 5 summarizes input attributes for Storage Units, as well as the input information source or recommended entry for applicable fields.

Table 5: Overview of Wet Well Input Attributes

Storage Attribute	Description	Data Source/Entry
Name	User assigned name of wet well. Note that the name must be a unique identifier.	Geodatabase, Network Structures, MXASSETNUM field
X-Coordinate	X-coordinate of wet well (centroid).	Automatically populated when Network Structure shape file is imported into the model.
Y-Coordinate	Y-coordinate of wet well (centroid).	Automatically populated when Network Structure shape file is imported into the model.
Description	Optional comment or description. Not required for modeling purposes.	Geodatabase, Network Structures, ENTNAME field
Tag	Optional category or classification. Not required for modeling purposes.	Recommended Entry: 'Sanitary'
Inflows	Used to specify any external inflows received at the storage unit (refer to Table 3). In general, flows are typically applied at manholes rather than storage units.	Recommended Entry: 'No' (i.e. flows will be specified at junctions rather than storage units).
Treatment	Used to specify any pollutant removal measures supplied at the storage unit. The user can input the mathematical expression that represents the treatment provided.	No
Invert Elev. (m)	Elevation at the bottom of the storage unit.	Specific to station, data to be obtained from available As Recorded drawings and design reports.
Rim Elev. (m)	Rim (ground) elevation of storage (m). In the case of the wet well, this will be the top of operating level of the wet well.	Specific to station, data to be obtained from available As Recorded drawings and design reports.
Depth	Maximum depth of storage unit (m). This distance is the difference between the Rim Elev. and the Invert Elev.	To be automatically populated based on the Rim Elev. and Invert Elev.

Storage Attribute	Description	Data Source/Entry
Initial Depth (m)	Initial water depth in storage unit (m), used to represent permanent water or boundary conditions. The initial depth can be used to represent the low operating level in the wet well, or an initial operating level based on SCADA data.	Specific to station, low operating level to be obtained from available As Recorded drawings and design reports. This level may be adjusted based on SCADA data should alternate model boundary conditions be more suitable.
Ponded Area (m^2)	Area of ponded water when flooded (m^2). Not required for Wet Wells.	N/A
Evap. Factor (fraction)	Fraction of evaporation rate realized (e.g. enter 1 for full evaporation or 0 for no evaporation) (fraction). In the case of closed wet well, it is assumed that no evaporation will occur.	0
Storage Curve	Method of describing the geometric shape of the storage unit. The user can select 'FUNCTIONAL' or 'TABULAR'. A Functional curve determines depth (m) based on a standard expression for area (Area = $A*Depth^B+C$). When 'FUNCTIONAL' is specified for the Storage Curve, attribute fields are available to input the values for A (Coefficient), B (Exponent), and C (Constant (m^2)). A Tabular Curve determines depth based on a unique curve input by the user. When 'TABULAR' is specified, an attribute field is available to input a Curve Name. Through the Curve Name field, the user is able to select a pre-existing curve or create a new curve where the Area (m^2) is x and depth (m) is y.	Specific to station, data to be obtained from available As Recorded drawings and design reports. Recommended input is TABULAR, based on the Stage/Area relationship per wet well.

In addition to the above attributes, inputs are also specified for Inflows and Infiltration parameters for storage units (not to be confused with RDII). The Infiltration parameters for storage units are not applicable for concrete chambers, as they represent the slow percolation of the storage element into a pervious medium. Therefore they are set to zero for wet wells. In the case of the Inflows, the inputs for storage units are identical to those described in Table 3 for Manholes; however flows are typically applied at manholes (junctions) rather than storage units and therefore will be set to zero.

2.4.2 Pumps

Pumps are simulated as a special conduit element in PCSWMM. As noted, pump stations can be simulated as a representative curve of the overall station or in more detail with each pump defined. Data includes a head-flow relationship and corresponding operational start and stop settings. Table 6 summarizes the input attributes for pumps and the probable source or recommended entry for the information for applicable fields.

Table 6: Overview of Pump Input Attributes

Pump Attribute	Description	Data Source/Entry
Name	User assigned name of pump. Note that the name must be a unique identifier.	Assigned based on Well MXASSETNUM plus sequential "#" to denote pump number.
Inlet Node	Name of node on the inlet end of the pump. In the case of pump stations, the upstream node will be the wet well.	Wet Well MXASSETNUM.
Outlet Node	Name of node on the outlet end of the pump.	As indicated in Figure 1, Option B, this node will be a dummy node created in the model to connect to the downstream forcemain. Name denoted as MXASSETNUM of Wet Well plus "D#".
Description	Optional comment or description. Not required for modeling purposes.	Pump Station Name and Pump Name (e.g. Beaver Creek PS, P1)
Tag	Optional category or classification. Not required for modeling purposes.	Recommended Entry: 'Sanitary'
Pump Curve	Name of pump curve (or * for ideal pump). After specifying a curve, you can click the ellipsis button to edit or create a new curve. Four types of pump curves are available, allowing a relationship between flow and depth, head or volume.	Specific to pump, data to be obtained from available pump curves, design reports, or operating data.
Initial Status	Initial status of the pump (ON or OFF).	OFF
Startup Depth (m)	Depth at inlet node when pump turns on (m).	Specific to pump, data to be obtained from available design reports or operating data.
Shutoff Depth (m)	Depth at inlet node when pump turns off (m).	Specific to pump, data to be obtained from available design reports or operating data.

2.5 ADDITIONAL MODELING INFORMATION

The focus of Section 2 was to outline the specific inputs for physical attributes in the hydraulic model. An overview of how dry weather and weather loads will be applied is also provided, however, the loading input data will follow in subsequent technical memoranda. In order to generate the loading data and allocate it in the model, the following information will need to be processed:

- Existing and future population data
- Water meter records
- Flow monitoring data (groundwater infiltration, average flow, per capita flow rates, wet weather inflow and infiltration response parameters)
- Pump station SCADA data
- Pump station control set points
- Design I/I rates

Based on the information above, the model loading inputs will be determined during the model development stage.

The physical sewer asset data information was validated and determined through Technical Memo #1, as outlined in Meeting #5a. The Consultant's Existing State Geodatabase was developed and issued to the City with recommendations for data closure. Therefore the node-link relationship for model development is in good standing, with only local validation errors remaining in the geodatabase that are flagged for follow-up. These are not anticipated to be part of the initial model build since they are not part of the trunk system and are outside anticipated redevelopment or intensification areas. Over time, these elements can be brought into the model by way of direct import from the geodatabase based on Maximo ID. Similarly, data updates to existing model element attributes can be directly imported on a field-by-field basis (i.e. just diameter change), or the whole element can be deleted and re-imported should geometry or connectivity change. A model tracking document will be proposed to facilitate model maintenance activities, which will be linked directly within PCSWMM.

Stantec has requested information, from the City, that is required for the model development phase of the project. The majority of the required information has been requested and provided to Stantec for processing; however, a list of additional or outstanding information that will be required for the model development will be summarized in a request letter following the submission of this technical memo.

3.0 Closing

The geodatabase information provided can be associated with the model inputs primarily by way of the Maximo asset ID for each physical data element. The format of the available data is readily translatable to the model environment through the defined mapping of the geodata to model fields as demonstrated in the preceding tables per element type. In the case of pump stations, additional coding is required that can be associated with geodatabase assets by way of reference to the wet well Maximo ID, and the use of super or subscript notation along with reference in PCSWMM's "Description" field. Within the model itself, the series of curves used to define the wet well shapes and pump station flow response are catalogued in specified editors that are referenced by the model elements.

Details of the model building process including flow generation and final element configurations will be outlined in the Technical Memorandum #6: Model Design & Development Manual.

Appendix A : Overview of Provided Network Structure (Pump Station) Geodata

Existing Beaver Creek SPS		
Parameter	**Data**	**Data Source**
Wet Well Dimensions (length/width)	9.3 m / 5.4 m	As Recorded Drawings
Wet Well Floor Elevation	333.45 mASL	As Recorded Drawings
Influent Sewer Invert Elevation	336.15 mASL	As Recorded Drawings
Pump Station Capacity	114 L/s	Beaver Creek Sewage Pumping Station and Forcemain Capacity and Condition Assessment (Gamsby and Mannerow Limited, 2012)
Pump Station Configuration	2 Duty, 1 Standby	Beaver Creek Sewage Pumping Station and Forcemain Capacity and Condition Assessment (Gamsby and Mannerow Limited, 2012)
Pump Curves	Provided	412003_Appendix C-Pump Curve 3201 180 63 641 26 kW (SharePoint)
Pump Operation	High Level Alarm - 334.95 mASL (1.50 m) Low Level Alarm - 334.10 mASL (0.65 m) Standby Pump Start - 334.90 mASL (1.45 m) Lag Pump Start - 334.85 mASL (1.40 m) Duty Pump Star - 334.75 mASL (1.30 m) Pump Stop (normal) - 334.20 mASL (0.75 m)	Beaver Creek Sewage Pumping Station and Forcemain Capacity and Condition Assessment (Gamsby and Mannerow Limited, 2012)

- Existing Condition
- Subject to planned upgrades (See Future Beaver Creek SPS)

Future Beaver Creek SPS		
Parameter	**Data**	**Data Source**
Wet Well Dimensions (length/width)	Information Not Currently Available	Information Not Currently Available
Wet Well Floor Elevation	Information Not Currently Available	Information Not Currently Available
Influent Sewer Invert Elevation	336.15 mASL (To be Verified)	As Recorded Drawings
Pump Station Capacity	576 L/s	Beaver Creek Sewage Pumping Station and Forcemain Capacity and Condition Assessment (Gamsby and Mannerow Limited, 2012)
Pump Station Configuration	3 Duty, 1 Standby	Beaver Creek Sewage Pumping Station and Forcemain Capacity and Condition Assessment (Gamsby and Mannerow Limited, 2012)
Pump Curves	Information Not Currently Available	Information Not Currently Available
Pump Operation	Information Not Currently Available	Information Not Currently Available

- Future Condition, uncertain of actual upgrade dates.
    - Projected flows to increase to 284 (avg) & 439 (peak) L/s by 2022, considered the ultimate condition for the sewershed.
- Pump Station to increase capacity by construction of new 500mm forcemain and eventual pump upgrades.
- A 2,860m^3 emergency storage structure is recommended.
- Existing invert elevation from as-recorded drawings conflicts with tender drawings for new forcemain (June 25, 2013).
- Pump On/Off Levels to be determined or assumed from Existing.

Colonial SPS		
Parameter	**Data**	**Data Source**
Wet Well Dimensions (length/width)	27m² average area	Colonial Sanitary Pumping Station Upgrades -Draft Design Report (CIMA, June 2013)
Wet Well Floor Elevation	Information Not Currently Available	Information Not Currently Available
Influent Sewer Invert Elevation	319.97m	As-built Dwg. 5-1673
Pump Station Capacity	225 L/s (To Be Verified)	Certificate of Approval, Amended March 1994
Pump Station Configuration	2 Duty, 1 Standby	Certificate of Approval, Amended March 1994
Pump Curves	Information Not Currently Available 3x 120L/s @ 12.5m TDH	Certificate of Approval, Amended March 1994
Pump Operation	Design Details Not Currently Available - Float Table	Information Not Currently Available

- Subject to Future Upgrades - Reference Report: Colonial Wastewater Pumping Station - Schedule 'B' Class Environmental Assessment - Final Report (AECOM, October 26, 2010) & Colonial Sanitary Pumping Station Upgrades -Draft Design Report (CIMA, June 2013).
- Receives flow from four (4) other pumping stations:
  - Frobisher SPS
  - Northlands SPS
  - Millennium SPS
  - Malabar SPS

Future Colonial SPS		
Parameter	**Data**	**Data Source**
Wet Well Dimensions (length/width)	27m² average area.	Colonial Sanitary Pumping Station Upgrades -Draft Design Report (CIMA, June 2013)
Wet Well Floor Elevation	317.843 mASL (Wet Well Elevation)	Colonial Wastewater Pumping Station Conceptual Design Report (AECOM, 2010)
Influent Sewer Invert Elevation	319.935 mASL (AECOM) 319.97 mASL (Dwg. 5-1673) 320.00 mASL (CIMA)	Colonial Sanitary Pumping Station Upgrades -Draft Design Report (CIMA, June 2013)
Pump Station Capacity	340 L/s 3x min. 170L/s @ 15.8 m TDH	Colonial Sanitary Pumping Station Upgrades -Draft Design Report (CIMA, June 2013)
Pump Station Configuration	3 Duty, 1 Standby	Colonial Sanitary Pumping Station Upgrades -Draft Design Report (CIMA, June 2013)
Pump Curves	Figure 1 of CIMA - design.	Colonial Sanitary Pumping Station Upgrades -Draft Design Report (CIMA, June 2013)
Pump Operation	Duty Pump 2 Start: 319.70 mASL Duty Pump 1 Start: 319.40 mASL All Duty Pumps Stop: 318.69 mASL	Colonial Sanitary Pumping Station Upgrades -Draft Design Report (CIMA, June 2013)

- Future Condition, uncertain of actual detail design & construction dates.
  - Projected 340 L/s by 2031, considered the ultimate condition for the sewershed.
- Pump Station capacity upgraded by replacement of 3 pumps, installation of 2 475mm I.D. forcemains, and modification to the active wet well volume.

Bridgeport SPS - Not Owned by City of Waterloo		
Parameter	**Data**	**Data Source**
Wet Well Dimensions (length/width)	Information Not Currently Available	Information Not Currently Available
Wet Well Floor Elevation	Information Not Currently Available	Information Not Currently Available
Influent Sewer Invert Elevation	Information Not Currently Available	Information Not Currently Available
Pump Station Capacity	205 L/s - Confirm	Certificate of Approval
Pump Station Configuration	2 Duty, 1 Standby	Certificate of Approval
Pump Curves	Information Not Currently Available	Information Not Currently Available
Pump Operation	Information Not Currently Available	Information Not Currently Available

- Discharges to 400 mm forcemain

Frobisher SPS		
Parameter	**Data**	**Data Source**
Wet Well Dimensions (length/width)	2.4 m diameter	Certificate of Approval
Wet Well Floor Elevation	Information Not Currently Available	Information Not Currently Available
Influent Sewer Invert Elevation	Information Not Currently Available	Information Not Currently Available
Pump Station Capacity	39.5 L/s	Certificate of Approval
Pump Station Configuration	1 Duty, 1 Standby	Certificate of Approval
Pump Curves	Information Not Currently Available	Information Not Currently Available
Pump Operation	Information Not Currently Available	Information Not Currently Available

Malabar SPS		
Parameter	**Data**	**Data Source**
Wet Well Dimensions (length/width)	2.4 m diameter	Certificate of Approval
Wet Well Floor Elevation	310 mASL (Design Value)	Malabar Sewage Pumping Station Capacity Design (MTE Consulting Inc., 1989)
Influent Sewer Invert Elevation	311.5 mASL (Design Value)	Malabar Sewage Pumping Station Capacity Design (MTE Consulting Inc., 1989)
Pump Station Capacity	3.8 L/s	Certificate of Approval
Pump Station Configuration	1 Duty, 1 Standby	Certificate of Approval
Pump Curves	Information Not Currently Available	Information Not Currently Available
Pump Operation	Information Not Currently Available	Information Not Currently Available

Millennium SPS		
Parameter	**Data**	**Data Source**
Wet Well Dimensions (length/width)	5 m / 3.5 m	Certificate of Approval
Wet Well Floor Elevation	311.75 m (Design Value)	Millennium Park Sewage Pumping Station and Forcemain Design Brief (Stantec, 2000)
Influent Sewer Invert Elevation	313.25 (Design Value)	Millennium Park Sewage Pumping Station and Forcemain Design Brief (Stantec, 2000)
Pump Station Capacity	109 L/s (To Be Verified)	Certificate of Approval
Pump Station Configuration	2 Duty, 1 Standby	Certificate of Approval
Pump Curves	Provided	Millennium Park Sewage Pumping Station and Forcemain Design Brief (Stantec, 2000)
Pump Operation	Start Lead Pump (Full Speed) - 312.85 mASL Start Lead Pump (70%) - 312.70 mASL Start Lag Pump - 313.15 mASL Stop Lag Pump - 312.65 mASL Stop Lead Pump (LWL) - 312.35 mASL High Waterlevel Alarm - 313.25 mASL Low Level Cut off/Alarm - 312.25 mASL Overflow - 314.00 mASL	Millennium Park Sewage Pumping Station and Forcemain Design Brief (Stantec, 2000)

Northlands SPS		
Parameter	**Data**	**Data Source**
Wet Well Dimensions (length/width)	3.5 m / 3.5 m (Cell 1) 3.5 m / 3.5 m (Cell 2) (Design Values)	Tender Drawings (P1.1) (MTE, 2011)
Wet Well Floor Elevation	321.2 mASL (Design Value)	Tender Drawings (P1.3) (MTE, 2011)
Influent Sewer Invert Elevation	324.2 mASL (Design Value)	Tender Drawings (P1.3) (MTE, 2011)
Pump Station Capacity	105 L/s (Design Value)	Design Brief: Northland Sewage pumping Station (MTE, 2011)
Pump Station Configuration	2 Duty, 1 Standby	Tender Drawings (P1.3) (MTE, 2011)
Pump Curves	Provided	Design Brief: Northland Sewage pumping Station (MTE, 2011)
Pump Operations	High Level Alarm - 323.80 mASL Duty Pump 3 On - 323.2 mASL Duty Pump 2 On - 322.90 mASL Duty Pump 1 On - 322.60 mASL Pumps Off - 322.10 mASL	Tender Drawings (P1.3/P1.4) (MTE, 2011)

- Pump operating levels to be verified. Levels indicated on Drawing P1.3 and P1.4 are conflicting

Falconridge SPS		
Parameter	**Data**	**Data Source**
Wet Well Dimensions (length/width)	5.5m x 3.5m	Bridgeport North Wastewater Pumping Station and Forcemain (Stantec, 2000)
Wet Well Floor Elevation	298.04 mASL	Bridgeport North Wastewater Pumping Station and Forcemain (Stantec, 2000)
Influent Sewer Invert Elevation	299.49 mASL	Bridgeport North Wastewater Pumping Station and Forcemain (Stantec, 2000)
Pump Station Capacity	205 L/s	Certificate of Approval
Pump Station Configuration	2 Duty, 1 Standby	Certificate of Approval
Pump Curves	Figure 2 / Appendix A, Stantec Report 3 x 38.9L/s @ 53.7 TDH	Bridgeport North Wastewater Pumping Station and Forcemain (Stantec, 2000)
Pump Operation	Duty Pump 3 Start: 299.19 mASL Duty Pump 2 Start: 298.99 mASL Duty Pump 1 Start: 298.79 mASL Duty Pump 3 Stop: 298.86 mASL Duty Pump 2 Stop: 298.69 mASL Duty Pump 1 Stop: 298.49 mASL	Bridgeport North Wastewater Pumping Station and Forcemain (Stantec, 2000)