# Appendix E

Wastewater Conveyance System
Technical Memorandum
(JLR, 2023)

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Prepared for:

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# Wastewater Conveyance System Technical Memorandum

# Mississippi Mills Infrastructure Master Plan

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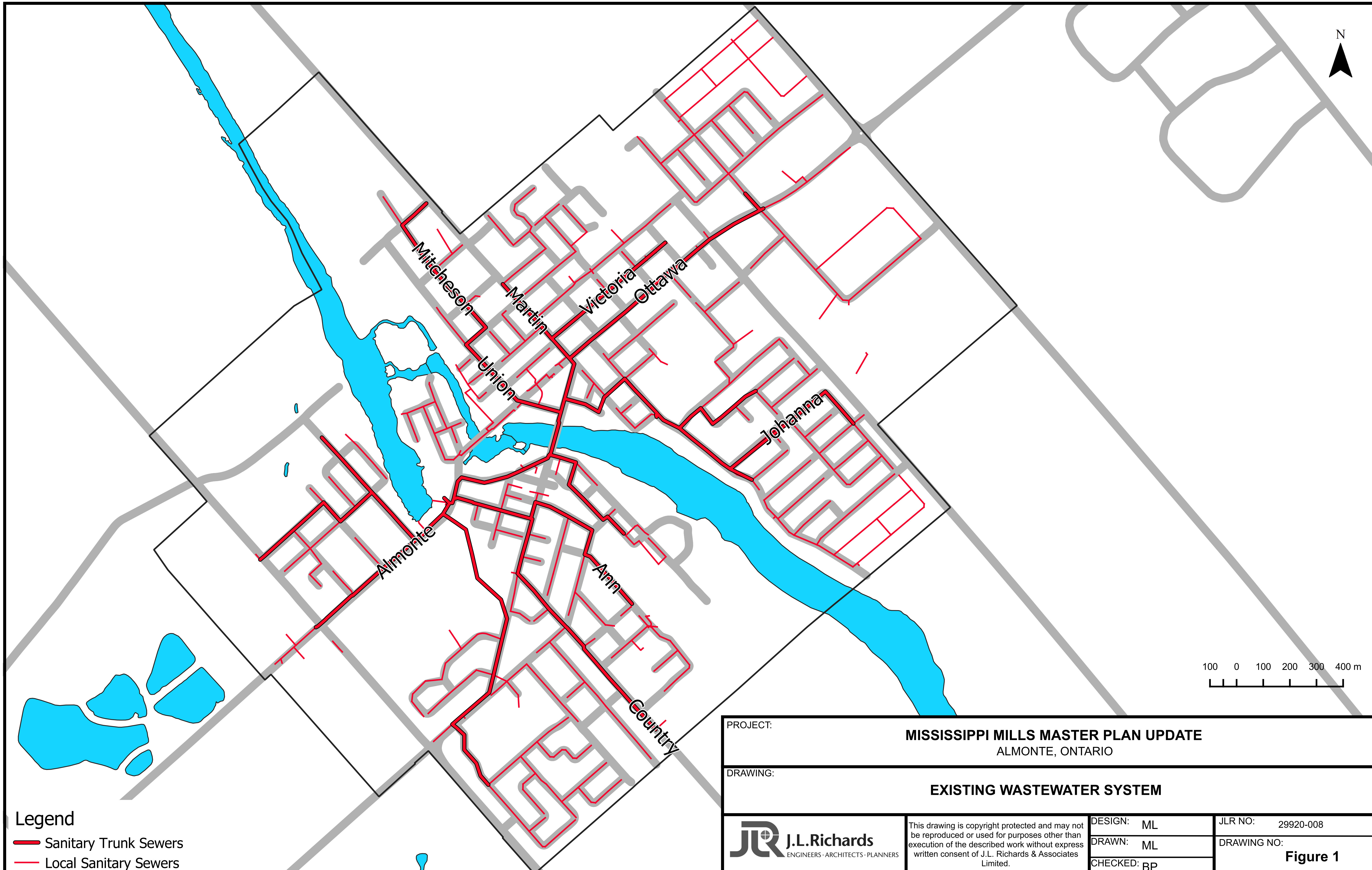
# 1.0 Introduction

## 1.1 Background

The Municipality of Mississippi Mills completed a Water and Wastewater Master Plan in 2012, in accordance the Municipality Engineers Association (MEA) Class EA master planning process, for the Almonte Ward, one of three Wards found in the amalgamated Municipality. The Master Plan was subsequently updated in 2018 to reaffirm the preferred servicing alternatives to ensure the system can be relied on based on community growth and completed projects since the original Master Plan in 2012. Since then, changes within the municipality have initiated a request for an updated Water and Wastewater Infrastructure Master Plan for the Almonte Ward to reflect these new changes. The ultimate objective of this Infrastructure Master Plan (IMP) is to develop water and wastewater servicing strategies that align with updated growth projections. The intent of this IMP is to follow Approach No.1 within the remit of the project.

The Municipality of Mississippi Mills is located along Highway 49, approximately three kilometres from the City of Ottawa limits or 46 kilometres from its downtown core. The settlement of Mississippi Mills is bisected by the Mississippi Mills River. The community is serviced by a wastewater conveyance system that consists of 11 kilometres of gravity sewer, 130 meters of pressure sewer, one main pump station and a single wastewater treatment plan (WWTP) that provides secondary treatment and disinfection to wastewater prior to discharging into the Mississippi River (Figure 1).

This Technical Memorandum sets out the work undertaken to assess the current wastewater sewer system in terms of capacity and level of service. A calibrated dynamic sewer system model has been developed based on flow monitoring data undertaken for the project. The model provides an assessment of the status of the existing network. The overall sewershed area of the model, which represents the serviced extents of the Mississippi Mills community, is 370 hectares and currently holds a population of 6,098 residents.




PROJECT:

**MISSISSIPPI MILLS MASTER PLAN UPDATE**

ALMONTE, ONTARIO

DRAWING:

**EXISTING WASTEWATER SYSTEM**

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# 2.0 Modelling Approach

## 2.1 Summary and Inputs

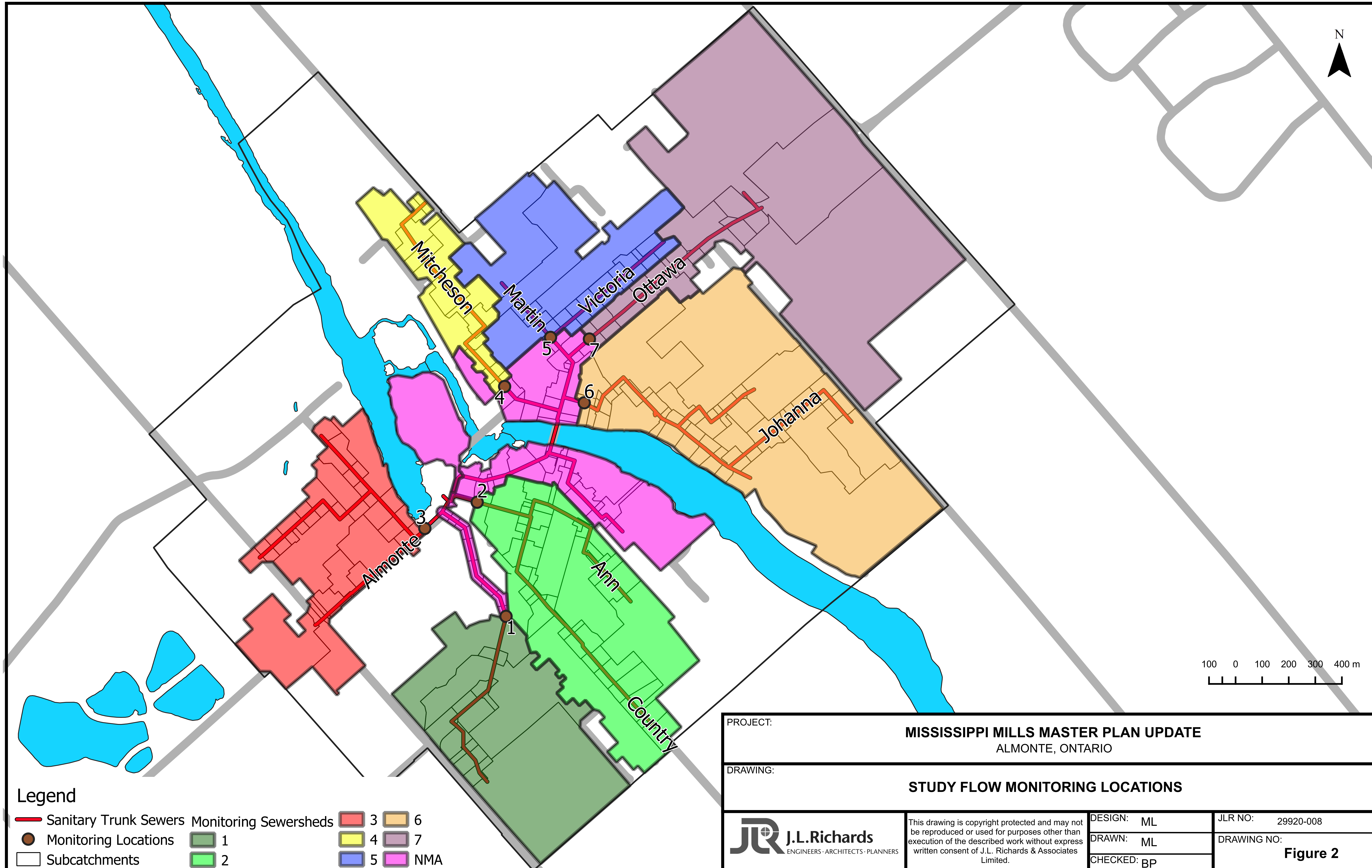
PCSWMM was used for modeling of the sanitary sewer collection system. PCSWMM uses the EPA SWMM computational simulation engine and has a GIS based graphical user interface for data input and analysis.

The base sewage flows and infiltration components of SWMM operates on a collection of subareas that generate sewage flow inputs. The routing portion of SWMM transports this flow through a system of pipes, pump stations and other flow conveyance infrastructure. SWMM tracks the quantity generated within each subarea and the flow rate and flow depth of water in each pipe during a simulation period that is comprised of multiple time steps.

The system network was entered into the model based on available GIS data, additional as-constructed drawings, and discussions with the Municipality. Electronic model files are contained in Appendix A.

## 2.2 Flow Monitoring Areas

Each flow monitor has an upstream sewershed area from which all sanitary flows entering the system are captured by the monitor. The sewersheds for the flow monitors in this project are as shown in Figure 2, along with the key infrastructure components including the Spring Street Pump Station and the Wastewater Treatment Plant (WWTP). These flow monitors have been installed at the downstream manholes of trunk sections of the sanitary pipe network. To cover a majority of the study area, seven monitors were strategically placed to account for the majority of flows while not being subject to backwater from the downstream system.




PROJECT:

**MISSISSIPPI MILLS MASTER PLAN UPDATE**
ALMONTE, ONTARIO

DRAWING:

**STUDY FLOW MONITORING LOCATIONS**

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# 3.0 Flow Modeling and Calibration

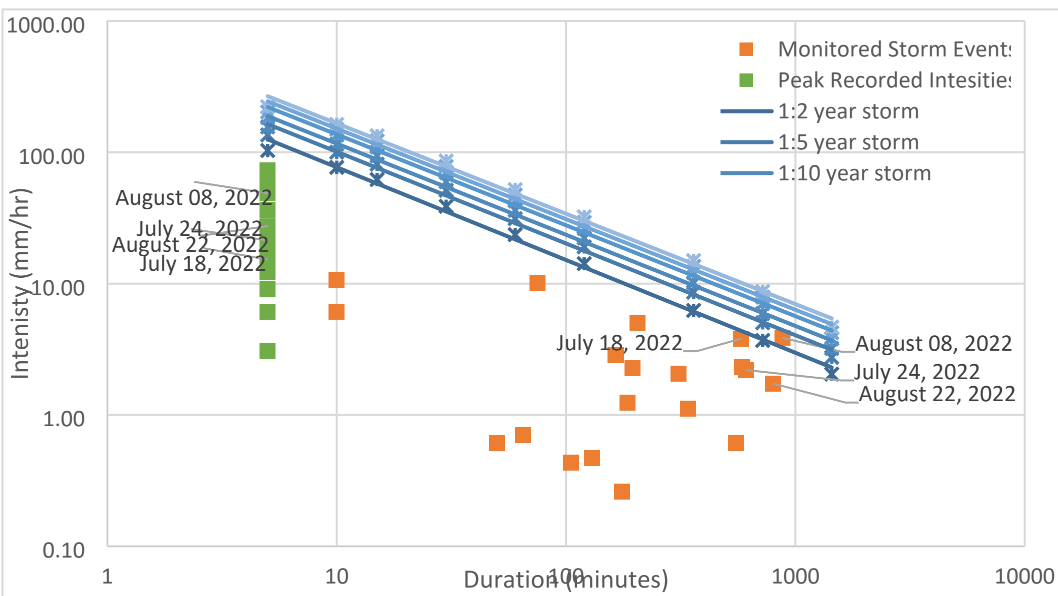
## 3.1 Flow Monitoring Data Collection

### 3.1.1 Rainfall Data

The rain data monitoring was carried out for a two-month period starting June 29, 2022, and finishing on August 31, 2022.

During the monitoring period, 20 wet weather events were identified. The highest intensity peak rainfall recorded was 54.86 mm/hr in 5 minutes on August 7th, 2022, which compares with a peak 5-minute intensity during a 1:2-year event of 125 mm/hr according to the Environment and Climate Change Canada (ECCC) intensity duration frequency (IDF) curve at the Ottawa Airport weather station. The event with the highest volume occurred over a 15-hour period starting in the afternoon of August 8, 2022, and 56.64 mm of rainfall accumulated over the duration of the storm. This is more than the 48.2 mm of rainfall expected during a 1:2-year event of similar duration. The events recorded during the monitoring period are graphed on Figure 3 along with the ECCC IDF curves and the peak 5-minute intensities during the events. Although the events are relatively small, they were considered sufficient for validation purposes.

**Figure 3: Rainfall Monitoring Results compared with Environment Canada IDF curve**




### 3.1.2 Dry Weather Flow (DWF)

Flow monitoring was undertaken throughout the City's sanitary sewer system for the purposes of calibrating the dynamic simulation of the model. Flow monitoring was limited to seven locations across the sanitary sewer network over an approximate 2-month period between the end of June 2022 and the beginning of September 2022. The seven sites are shown in Figure 2 and are listed in Table 1 below.

**Table 1: Flow Monitoring Locations**

| Flow Monitor | Manholes | Final Location Address | Final Location Closest Intersection |
|---|---|---|---|
| FM01 | SA3MH-307 | 224 Bridge Street | Bridges Street at Parkview Boulevard |
| FM02 | SA3MH-005 | 29 Farm Street | Farm Street at Charles Street |
| FM03 | SA1MH-003 | 300 Almonte Street | Almonte Street at Malcolm Street |
| FM04 | SA2MH-114 | 25 Union Street North | Union Street North at Princess Street |
| FM05 | SA2MH-207 | 24 Martin Street North | Martin Street North at Victoria Street |
| FM06 | SA4MH-465 | 70 Clyde Street | Clyde Street at Brougham Street |
| FM07 | SA4MH-001 | 21 Spring Street | Ottawa Street at Spring Street |

The seven flow monitoring locations were located on main trunk sewers with upstream catchment areas sufficiently large enough to collect flow to efficiently calibrate the model. The raw results from the flow monitoring are contained in Appendix A.

Population and parcel fabric was provided by the Municipality. The flow monitoring areas were cross-refenced with the parcel fabric to establish land usage within. The summary of land usage is presented in Table 2 below. Also included in the table is the remaining area which was not captured in any of the flow monitoring locations (noted as 'NMA' in the table).

**Table 2: Flow Monitoring Characteristics**

| Flow Monitor | Net Sewershed Area (ha) | % Residential Land Use | % ICI Land Use | % Open Space |
|---|---|---|---|---|
| FM01 | 42.3 | 75% | 22% | 3% |
| FM02 | 45.5 | 74% | 19% | 8% |
| FM03 | 34.4 | 75% | 15% | 10% |
| FM04 | 14.8 | 90% | 6% | 4% |
| FM05 | 31.0 | 87% | 7% | 6% |
| FM06 | 74.4 | 69% | 14% | 17% |
| FM07 | 88.8 | 26% | 40% | 34% |
| NMA | 37.0 | 55% | 35% | 10% |
| Total | 368.3 | | | |

An analysis of the dry weather flows was carried out in PCSWMM to determine the daily dry weather flow patterns. The periods of dry weather and where no impacts of wet weather events were present on the system, were identified in the flow monitoring results. The PCSWMM software was used to create an average pattern of the recorded dry weather flows for each flow monitor for daily, hourly and weekend periods.

To determine the extent of dry weather inflow and infiltration it was assumed that at the low point in the dry weather flow pattern around 15% of the flow is from population loading and the remainder is from dry weather inflow and infiltration. The low point of the dry weather flow pattern is typically in the early morning when it is likely that only overnight operations such as laundries or manufacturing processes with low sanitary loading is operating. Table 3 summarizes the results of the dry weather analysis.

**Table 3: Recorded Flows per Capita**

| Flow Monitor | Net Catchment Area (ha) | Average DWF Flow (l/s) | Dry Weather I&I (l/s/ha) | Dry Weather Peaking Factor |
|---|---|---|---|---|
| FM01 | 42.3 | 3.98 | 0.05 | 1.4 |
| FM02 | 45.5 | 4.08 | 0.06 | 1.2 |
| FM03 | 34.4 | 1.87 | 0.02 | 1.3 |
| FM04 | 14.8 | 0.62 | 0.01 | 1.5 |
| FM05 | 31.0 | 3.83 | 0.05 | 1.3 |
| FM06 | 74.4 | 4.55 | 0.02 | 1.6 |
| FM07 | 88.8 | 3.10 | 0.01 | 1.6 |
| NMA | 37.0 | 2.46 | 0.03 | 1.4 |
| Total / Average | 368.3 | 24.50 | 0.03 | 1.4 |

Based on a serviced population of 6,098 persons, the overall flow rate is around 250 l/cap/day in the system during dry weather. The overall dry weather I&I is around 0.03 l/s/ha, which is lower than the design value of 0.05 l/s/ha used in the City of Ottawa.

The daily usage of the WWTP during the same period (June, July, August) in 2021 amounted to an average of 2,214 m³/day or 363 l/cap/day. Assessing the flow monitoring results over the entire period, including wet weather events, the average value is 304 l/cap/day. Therefore, these results support the flow monitoring as being consistent with the system as currently operating.

### 3.1.3 Wet Weather Flow (WWF)

The WWF calibration involves calibrating the rainfall dependent inflow and infiltration (RDII) in the model sewer system to enable the simulation of the response to the wet weather events. There is usually an initial short-term response due to any inflow from cross connections or similar. The medium term and long-term responses are from infiltration and act over a longer period after the storm.

To calibrate to each flow monitoring site, the upstream catchment nodes are assigned an inflow unit hydrograph which represents the wet weather response in the system. The unit hydrograph is created using RTK values which represent the volume of inflow, time to peak and the ratio of the time of recession to the time to peak respectively. The RTK values for the short-, medium- and long-term responses are used for the calibration. The calibration process completed for this model have resulted in the final RTK values.

The calibration envelope to be achieved through the variation of the RTK values is outlined in the CIWEM (Chartered Institute of Water and Environmental Management) Urban Drainage Group Code of Practice for the Hydraulic Modelling of Sewer Systems. The CIWEM Urban Drainage Group guidance is referred to in calibration reports in Canada as well as internationally. The envelope criteria are for:

- The timing of the peaks and troughs should be similar having regard to the duration of the event.

- The peak flow rates at each significant peak should be in the range + 25% to - 15% and should be generally similar throughout the event.
- The volume of flow should be in the range +20% to -10%.

The Code suggests that at least two of three events are calibrated to, and a fourth event is used for validation of the calibration. The discussion on the rainfall during the flow monitoring period in Section 3.1 highlighted events of significance that occurred during the flow monitoring. These have been combined into four events for calibration purposes and listed in Table 4. The events were selected based on the level of response in the system as well as the size of the event.

The flow monitoring did not capture any 1:5-year return period storm events or greater and therefore the resulting calibration will be affected by the limited flow monitoring data collected during the period.

Calibration was carried out on sections of the model so that each flow monitoring location can be calibrated independently and the response from each area isolated to determine appropriate RTK values for the sewershed draining to the flow monitoring location.

The results of the calibration are shown in the graphs in Figure 4 thru to Figure 9. The results are shown in each graph at the calibration value of observed versus calibrated peak flow or volume for each flow monitoring location with the calibration envelope shown in a green shade.

**Table 4: Wet Weather Calibration Events**

| Event | Start of Event | Calibration Period (hours) | Peak Intensity (mm/hr) | Total Volume (mm) |
|---|---|---|---|---|
| Calibration 1 | July 18, 2022 9:00 am | 35 | 15.2 | 36.8 |
| Calibration 2 | July 24, 2022 2:00 pm | 33 | 27.4 | 22.4 |
| Calibration 3 | August 8, 2022 1:15 pm | 55.75 | 48.8 | 56.6 |
| Validation | August 22, 2022 2:20 pm | 28.17 | 21.3 | 23.1 |

**Figure 4: Peak Flow Calibration Graph – July 18 Event**

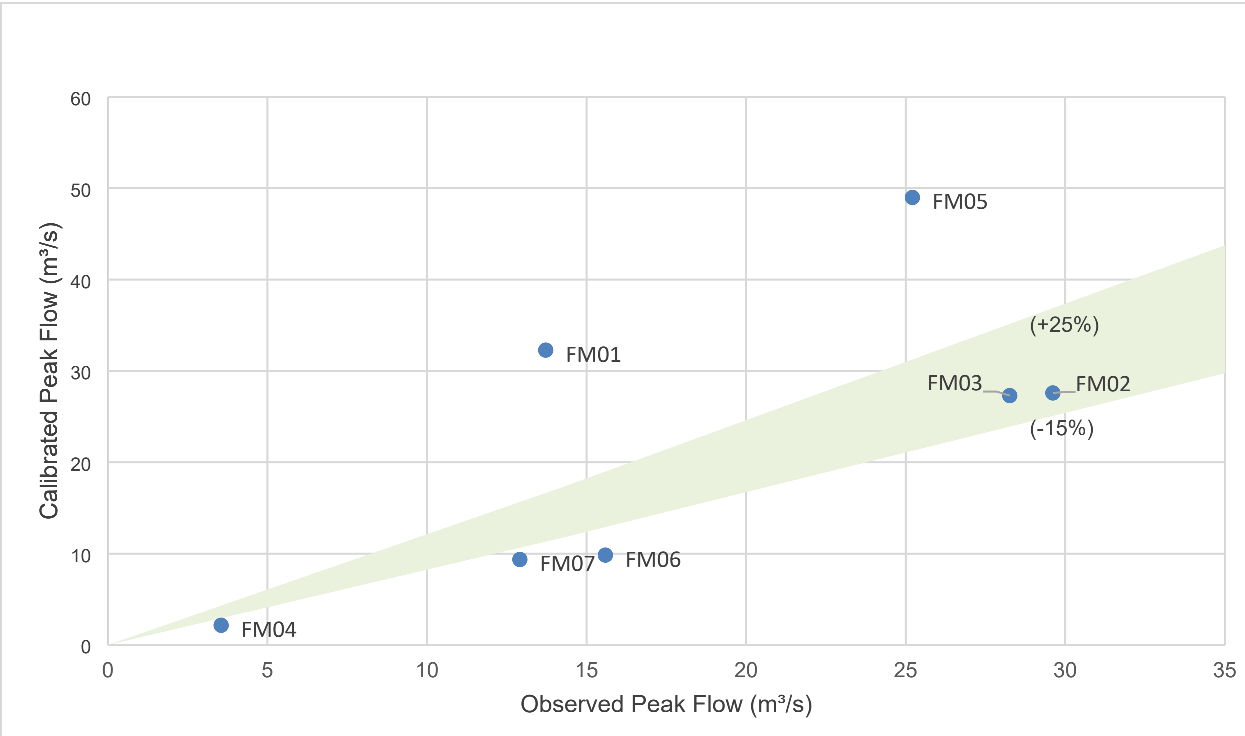



**Figure 5: Volume Calibration Graph – July 18 Event**

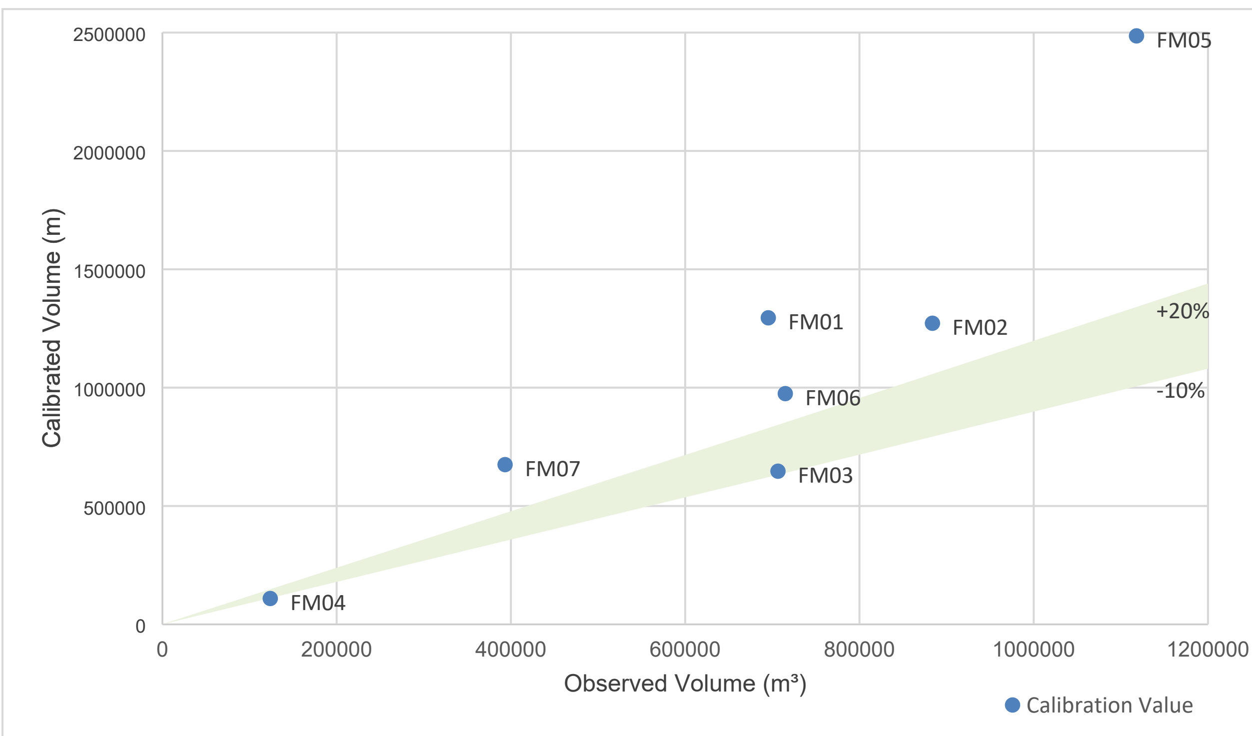


**Figure 6: Peak Flow Calibration Graph – July 24 Event**

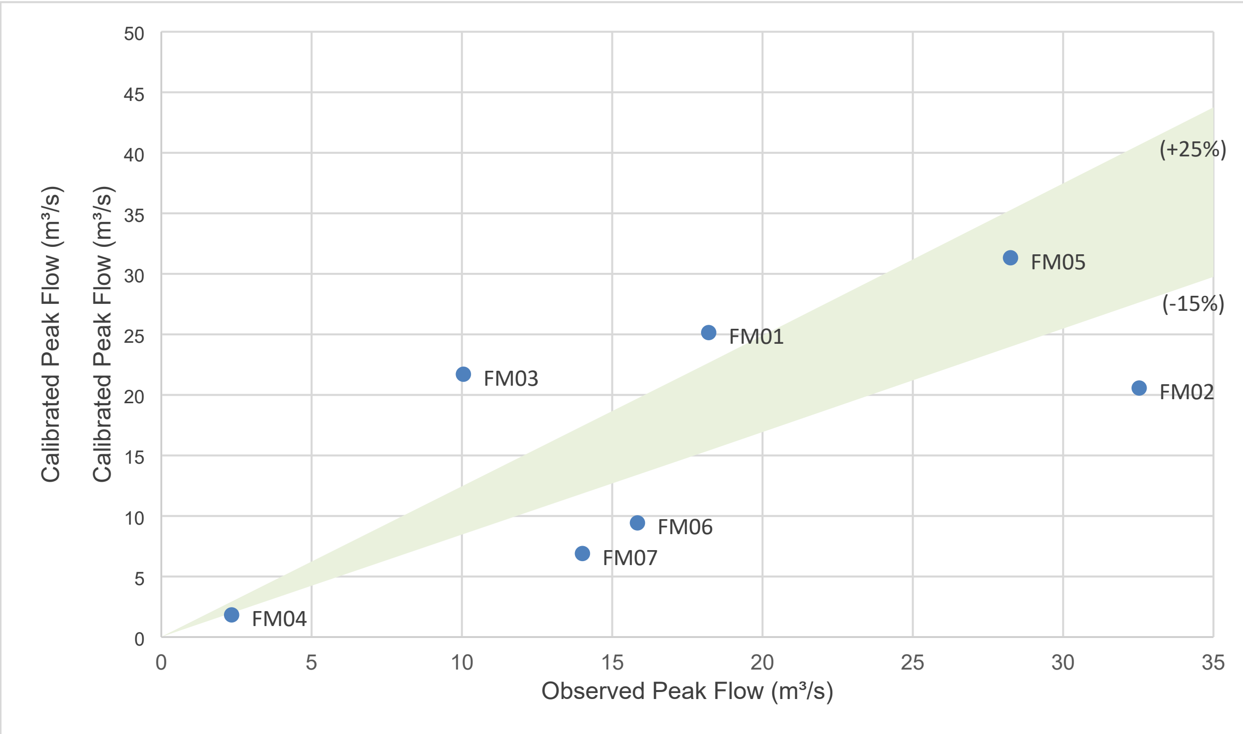



**Figure 7: Volume Calibration Graph – July 24 Event**

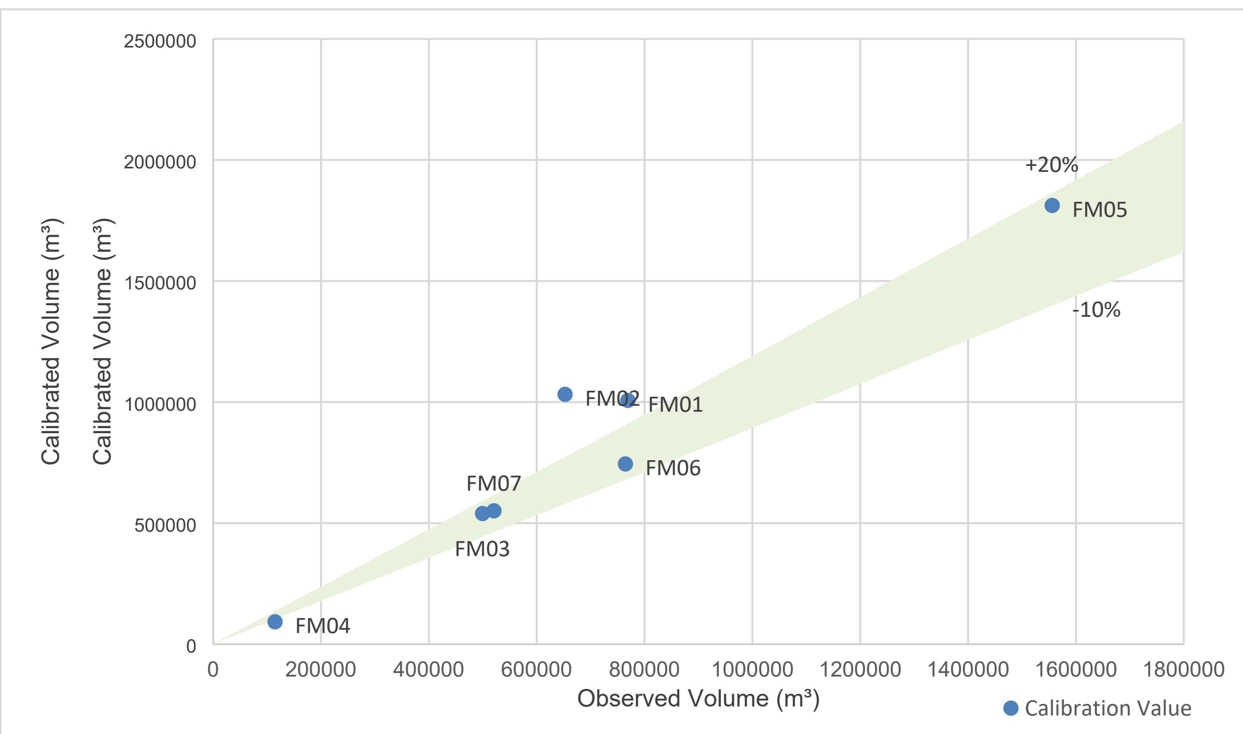


**Figure 8: Peak Flow Calibration Graph – August 8 Event**

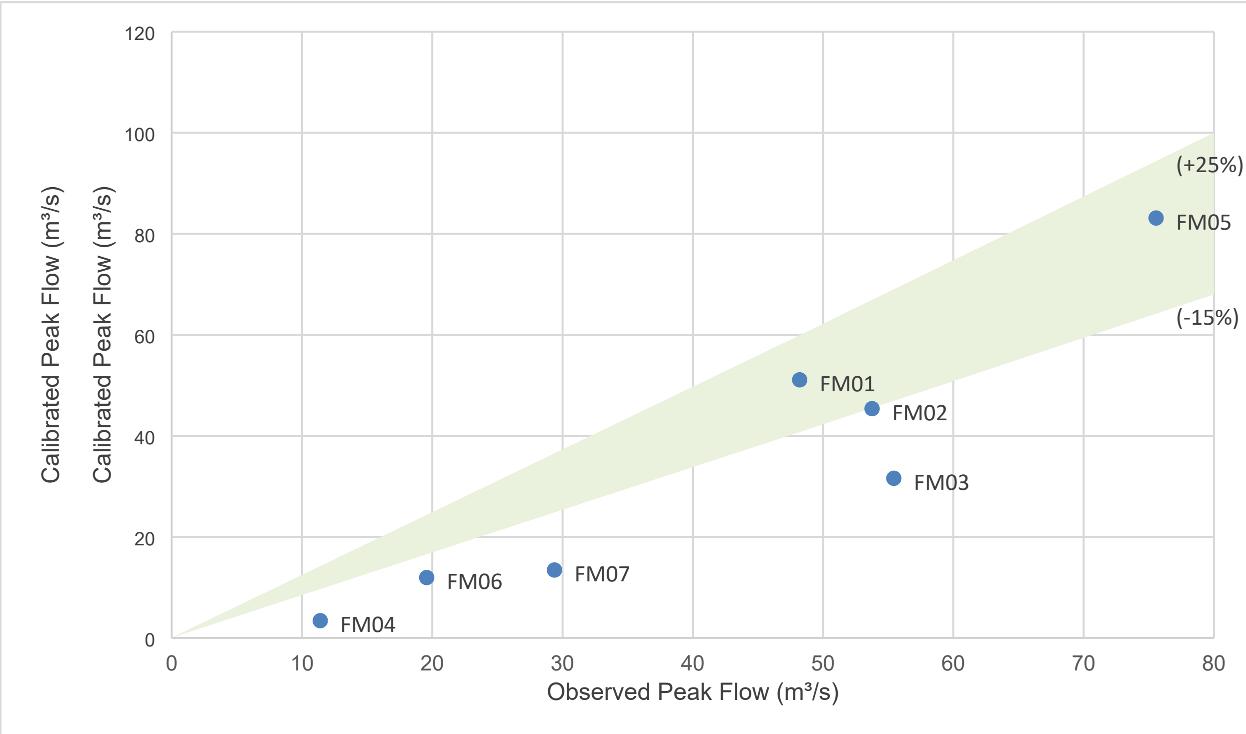
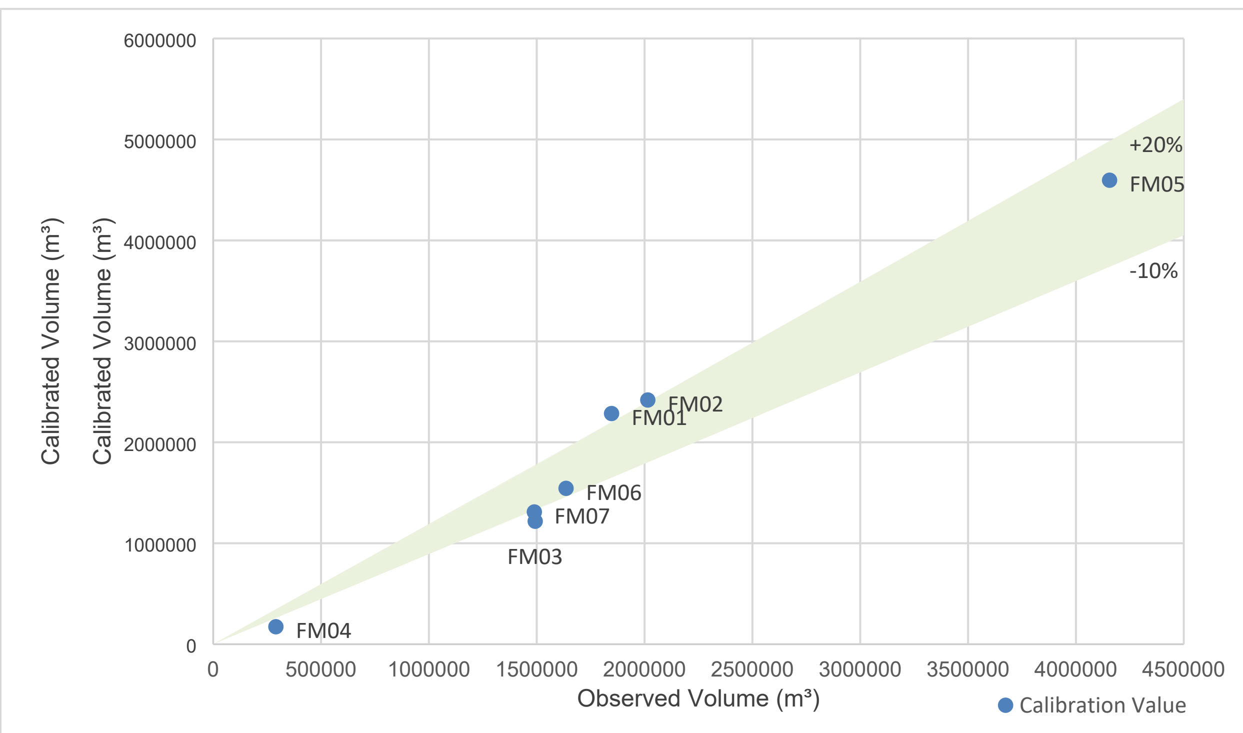



**Figure 9: Volume Calibration Graph – August 8 Event**



The graphs show that calibration to the events in July 18 and July 24 were not ideal, but a good calibration fit, within the green calibration envelope, was achieved for the August 8th event.

In the July 18 event, most peak flow calibrated values are significantly higher or slightly lower than observed with very few values within the green envelope. As for the calibrated volume values, most values are significantly higher than observed.

The reaction of the system to the event of July 24 is not entirely consistent. The July 24 event tended to have a higher or lower response to the event compared to the calibrated model but very little response falling within the green calibration envelope.

Seeing as though the calibration was focused on the largest of the events and closest to the design storm, it was deemed that the August 8th event was a good fit for calibration. In fact, this event's maximum rainfall attained 48.77 mm/hr and yielded the greatest response in comparison to other storms, some with greater rainfall such as the August 7th rainfall. The calibrated volume, for the most part, fell within the calibration envelope whereas the observed peak flows tend to be higher than the calibrated flows.

Validation of the calibration was carried out by running the August 22nd event on the complete model. The event on August 22nd had a peak intensity and overall volume slightly inferior to half of those from the August 8th event.

The results of the validation are shown in Figure 10 and Figure 11. For the validation of the peak flow, monitoring locations FM01, FM02 and FM03 recorded higher modelled peak flows than observed and FM06 and FM07 recorded lower modelled peak flows than observed however the remaining flow monitoring locations had peak flows within or close to the validation envelope.

**Figure 10: Peak Flow Validation Graph**

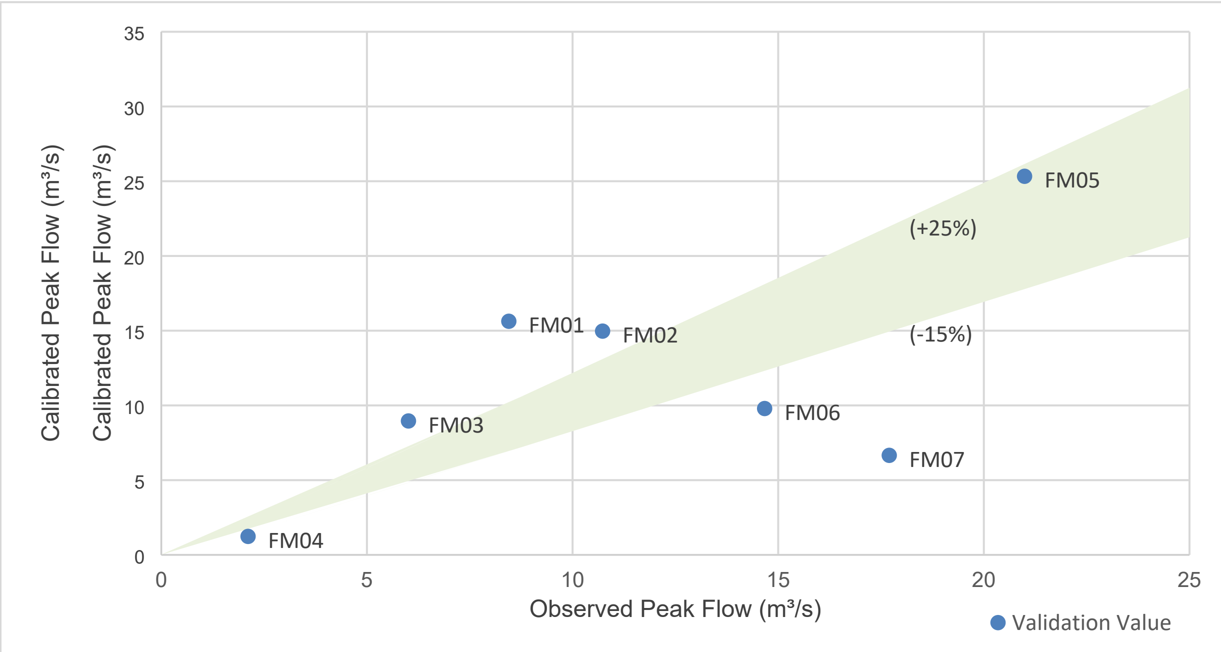
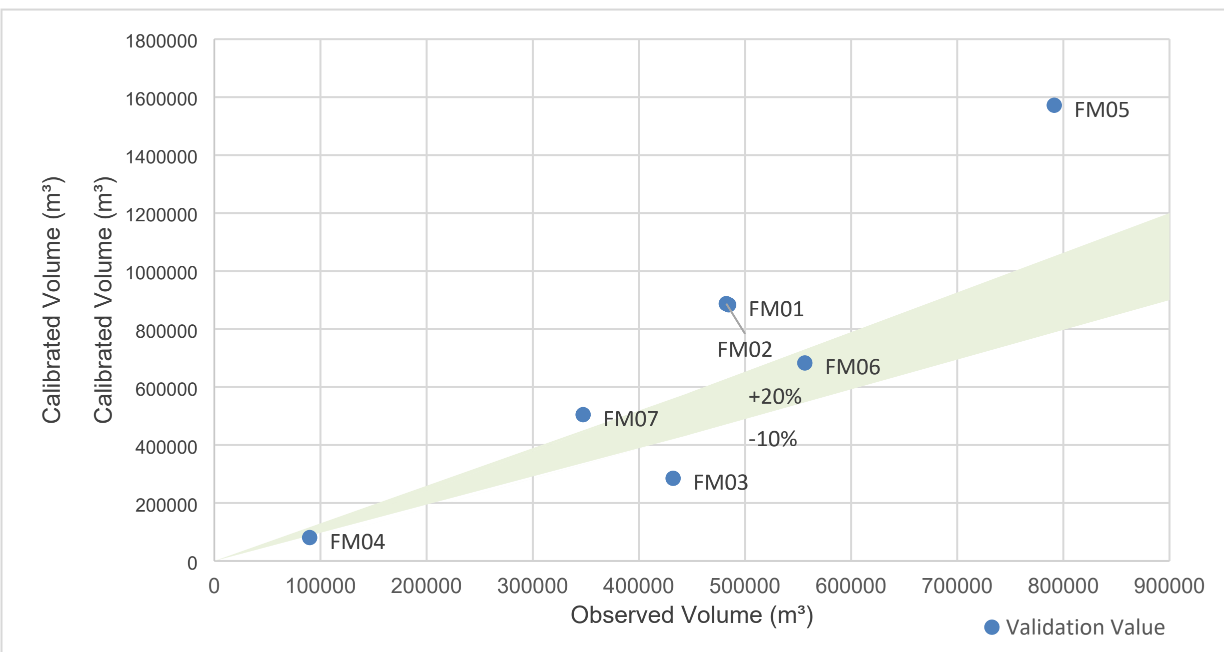



**Figure 11: Volume Validation Graph**



The higher modelled volume from inflow and infiltration was present in monitoring locations FM01, FM05 and FM07 during the validation period. The lower modelled volume was present at FM03 and the volume at FM04 and FM06 were a good calibration fit. These three areas are furthest from the Mississippi river and had 14 days separating the validation storm from a previous significant storm meaning that the soils were drier and had more capacity to retain runoff and thus reduce inflow and infiltration into the system. At the monitoring location FM03 it is likely that the smaller intermittent storms had a greater impact on the area. The more forested/vegetated area and river boundary can lead to soils retaining water and humidity for longer periods of time.

# 4.0 Design Criteria and Level of Service

Wastewater generation patterns vary between municipalities. The variations are primarily influenced by the habits and characteristics of system users. Volume as well as diurnal patterns will tend to fluctuate depending on servicing requirements such as the size of the serviced population, type and extent of industrial lands and the condition of the existing infrastructure.

The Ministry of the Environment and Climate Change (MOECC) Design Guidelines for Sewage Works (MOE, 2008) have accounted for variations in flow generation by permitting acceptable ranges for design calculations. As a result of this flexibility, many municipalities in Ontario have set standard flow generation criteria for their jurisdiction. The set design flow is typically within the MOECC's accepted range; however, it is often based on the historical flows observed by the municipality.

The calibration process identified an average dry weather flow infiltration allowance, peaking factor, residential loadings, and ICI loadings. The values obtained through the calibration procedure were in line with the expectations compared to the current City of Ottawa and Mississippi Mills design criteria. The values obtained are summarized in Table 5 below.

**Table 5: Monitored Wastewater System Flows**

| Parameter | Residential Areas |
|---|---|
| Average Daily Flow | 185 L/c/day |
| Infiltration Allowance (DWF) | 0.03 L/s/ha |
| Peaking Factor (DWF) | 1.42 |

For future development areas the sizing requirements for extended water and wastewater system will be based on the generation rates in Table 6. In order to simulate a 24-hour period of wastewater loadings in the system, an hourly loading pattern will be used in the model. These hourly loading patterns will be based on the calibrated loading patterns created based on the flow monitoring.

**Table 6: Design Criteria Future Wastewater Flow Generation**

| Parameter | Average Day Flow | Extraneous Flows | Peaking Factor |
|---|---|---|---|
| Residential | 350 L/cap/day | 0.33 L/s/ha | Monitored Pattern |
| Commercial | 28,000 L/s/ha | 0.33 L/s/ha | Monitored Pattern |
| Light Industrial | 35,000 L/s/ha | 0.33 L/s/ha | Monitored Pattern |

It is understood that the existing network should not necessarily be expected to achieve the level of service required by new development areas. The existing network was constructed based on different design criteria which may not be consistent with the design criteria today. In recognition of differing design criteria, the age of some of the network and resources required to implement infrastructure upgrades, an attainable level of service has been defined for the Infrastructure Master Plan assessment. The attainable level of service will reduce risk for existing neighborhoods while being achievable within the resource limitations of the Municipality (e.g., budget and schedule). The expected level of service for this Infrastructure Master Plan seeks to achieve for the sanitary network is:

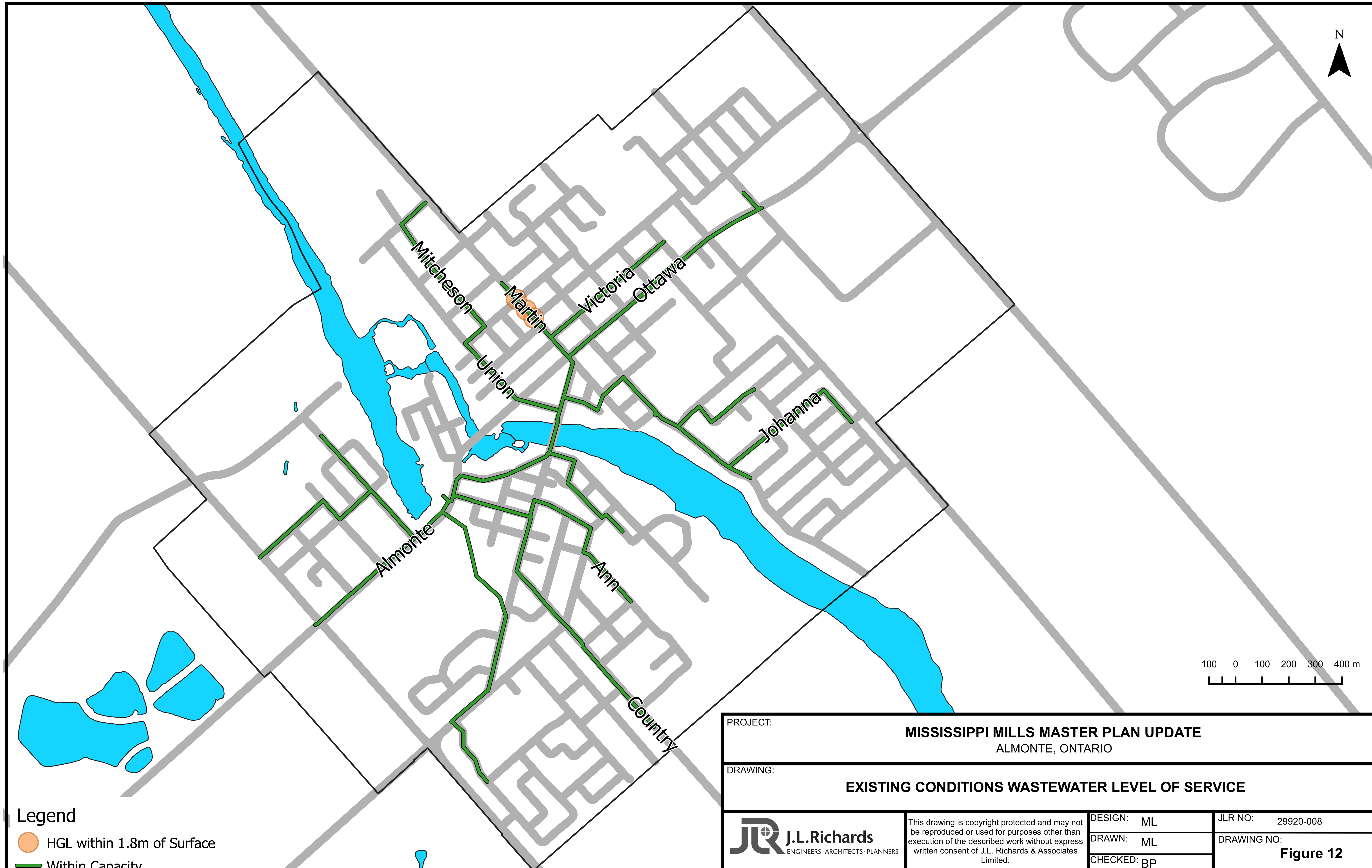
- **Flow Criteria:**
  - Free flow conditions in sewers during dry weather flow (DWF)

- **HGL Criteria:**
  - HGL to remain 1.8 meters below ground surface (provide 1.8 m freeboard) during 1:25 year event where there is a basement flood risk.
  - HGL to remain within 300 mm of the pipe obvert if the pipe is within 1.8 meters of the surface.

# 5.0 Existing Conditions

The model was tested for its capacity under existing conditions without initiating any upgrades or considering any future loading. Different scenarios were used to evaluate its efficiency starting with the DWF (Dry Weather Flow) event and followed by multiple storm events (5, 10, 25, 50 and 100-year with the 3-hour Chicago storm distribution). For this study the DWF and 25-year events will be assessed against the level of service criteria.

Operation of the system under dry weather flow is good with the required level of service being achieved across the trunk network. Under the 25-year event model 3 trunk manholes were identified with level of service issues: SA2MH-300, SA2MH-301 and SA2MH-236. The HGL in the system at these nodes in the 1:25 year event is such that there is a risk of basement flooding in connected properties. The system is illustrated in Figure 12.




PROJECT:

**MISSISSIPPI MILLS MASTER PLAN UPDATE**

ALMONTE, ONTARIO

DRAWING:

**EXISTING CONDITIONS WASTEWATER LEVEL OF SERVICE**

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# Appendix A

Electronic Files

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