

**Prepared for**  
**Municipality of Lambton Shores**

**Report for**  
**Wet Weather Flow Assessment**



**September 9, 2024**



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September 9, 2024

**CIVICA Ref: Nor24-0002**

The Municipality of Lambton Shores  
9577 Port Franks Road  
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Attention: Sam Shannon, Infrastructure Manager

**RE: Wet Weather Flow Assessment**

Dear Mr. Shannon,

Civica Infrastructure Inc. (Civica) has been retained by The Municipality of Lambton Shores (Municipality) to work on the Wet Weather Flow Assessment. To fulfill the CLI-ECA requirement, Civica has completed the wet weather flow assessment within the five (5) authorized sanitary sewer networks. Historical rainfall data from January 1, 2012, to December 31, 2021, was used to complete an assessment of the wet and dry weather flow within the sanitary sewers. This data was used to assess the Inflow and Infiltration severity and also reviewed the Municipal flow reports to summarize the overflow events that occurred during this period. Recommendations on actions and timelines to help guide the Municipality to meet the Procedure F-5-1 are provided.

Do not hesitate to contact us with any comments.

Sincerely,

**CIVICA INFRASTRUCTURE INC.**



Matthew Malone, M.Sc., MBA  
Project Manager

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## 1.0 Introduction

The Municipality of Lambton Shores (the Municipality) received their Combined Linear Infrastructure - Environmental Compliance Approval (CLI-ECA) for their Municipal Sewage Collection System on November 7, 2022. A condition of the CLI-ECA required the Municipality to complete an assessment of the dry and wet weather flows in the sanitary system over a ten (10) year period between January 1, 2012 and December 31, 2021. Civica Infrastructure Inc. (Civica) was retained by the Municipality to review the available flow and rainfall monitoring data to complete this assessment and fulfill the requirements of the CLI-ECA. This report summarizes the methodologies, analysis, results, and recommendations from the assessment.

### 1.1 Objective

The following were the three main objectives of the project:

1. Complete an assessment of the wet weather flows compared to dry weather flows over the prescribed ten (10) year period.
2. Review characteristics of wet weather events that have caused any overflows or bypasses to occur and assess if these have occurred during an “average year” as defined by the Ministry of Environment, Conservation and Parks (MECP).
3. Provide recommendations to the Municipality where further analysis and/or investigations are required to ultimately comply with the requirements of the CLI-ECA.

### 1.2 Study Area

The study area consists of the five communities within the Municipality serviced by sanitary sewers: Arkona, Forest, Grand Bend, Indian Hills and Thedford. Each community has its own standalone treatment facility with lagoons in Thedford and Wastewater Treatment Plants (WWTP) in Arkona, Forest, Grand Bend and Indian Hills. These five (5) collection systems are dispersed across the Municipality and illustrated in **Figure 1-1**.

### 1.3 Flow and Rainfall Monitoring Data

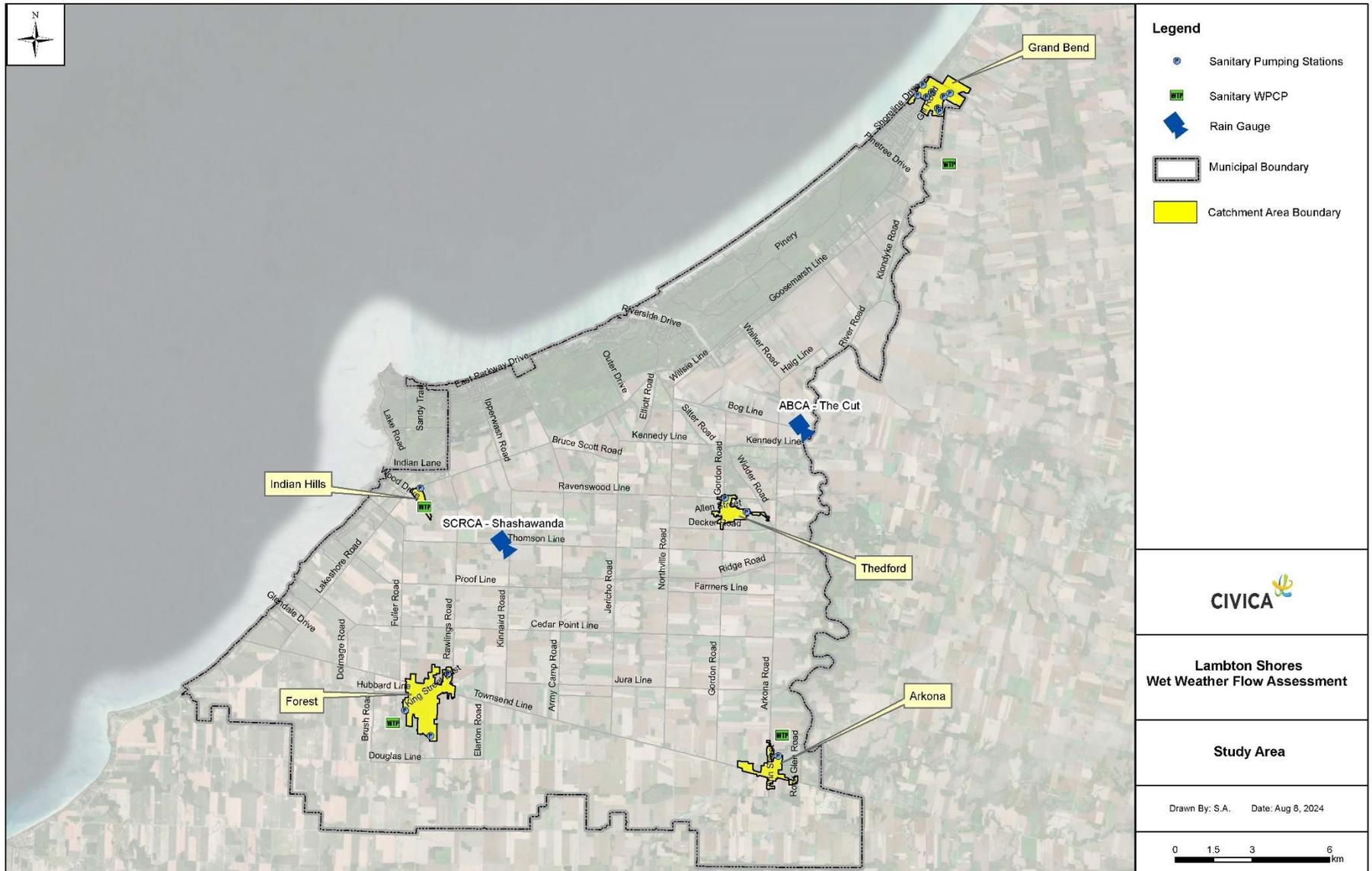
All available flow monitoring data collected over the prescribed ten (10) year period by the Municipality was included in the assessment. The Municipality has not previously had a network of flow monitors within the collection system, and all available data came via SCADA at treatment facilities or through manual recordings at flow meters with outputs.

Historical rainfall data was available from two (2) conservation authorities that operate within the Municipality’s borders: the Ausable-Bayfield Conservation Authority (ABCA) and the St. Clair Region Conservation Authority (SCRCA). Combined, the conservation authorities were able to provide data from two (2) rain gauges located within the Municipality. Environment and Climate Change Canada (ECCC) did not have any rain gauges located within the Municipality, with the nearest rain gauge located approximately 30km from the centre of the municipality. The two (2) rain gauges from the conservation authorities were determined to be the most appropriate for assessing rainfall.

**Table 1-1** provides a summary of the flow and rainfall data that was available and used in the analysis.

**Table 1-1: Available Flow and Rainfall Monitoring Data**

Location	From	To	Data Interval
Arkona WWTP	Jan-2012	Dec-2022	Daily Volumes
Forest WWTP	Jan-2012	Dec-2022	Daily Volumes
Grand Bend WWTP	Jan-2012	Dec-2022	Monthly Volumes (2012-2016) Daily Volumes (2016-2022)
Indian Hills WWTP	Jan-2012	Dec-2022	Monthly Volumes
Thedford Lagoons	Jan-2012	Dec-2022	Monthly Volumes
Grand Bend Main Lift Sanitary Pumping Station (Forcemain)	Aug-2016	Mar-2024	5-min Flow
Forest Main Lift Sanitary Pumping Station (Clyde St)	Jan-2017	Dec-2023	Daily Volumes
ABCA – The Cut	Jan-2012	Dec-2022	1-hr Rainfall Depths
SCRCA - Shashawandah	Jan-2012	Dec-2022	1-hr Rainfall Depths



**Figure 1-1: Study Areas**

## 2.0 Methodology

### 2.1 Rainfall Analysis

Data from rain gauges located within the borders of the Municipality: ABCA - The Cut and SCRCA – Shashawandah were used in the analysis. Daily precipitation depth was compared between the two rain gauges and used to delineate wet and dry weather days. Data from ABCA - The Cut and SCRCA – Shashawandah was reviewed for any data gaps and data quality issues prior to analysis. Data from October 13<sup>th</sup> – Dec 7<sup>th</sup>, 2019, from ABCA - The Cut was substituted with data from SCRCA - Shashawandah due to apparent issues with the rain gauge during that period.

Civica’s data hosting platform, DataCurrent, was used to delineate the rainfall events and summarize statistics for each significant event, including total precipitation, peak hourly intensity, peak 6 hr intensity and return period. To assess whether overflow events had occurred during an average year storm, an Intensity-Duration-Frequency (IDF) curve analysis was completed for the area to estimate the intensity of a 1-year storm (i.e., the “average year storm”). The results of that analysis are discussed in detail in **Section 3.1.1**.

### 2.2 Flow Monitoring Data

#### 2.2.1 Analysis of Flow Monitoring Data

A sanitary sewer system receives two flow components that have been analyzed during this project:

- 1) Dry-Weather Flow (DWF); and
- 2) Wet-Weather Flow (WWF).

The DWF component is separated into population generated sewage flow and groundwater infiltration (GWI). Population derived sewage flow is produced by routine water usage in the residential, commercial, and industrial areas of a given sanitary collection system. Dry-weather GWI will enter the collection system when the relative depth of the groundwater table is higher than the elevation of the sewer, and when the condition of the sanitary sewer pipe allows infiltration through defects, such as cracks, misaligned joints, and broken pipelines. GWI is not specific to a single rainfall event. Instead, it affects the collection system over an entire year (including the dry-weather season).

The following GWI generation thresholds were used to compare the Municipality results to acceptable limits:

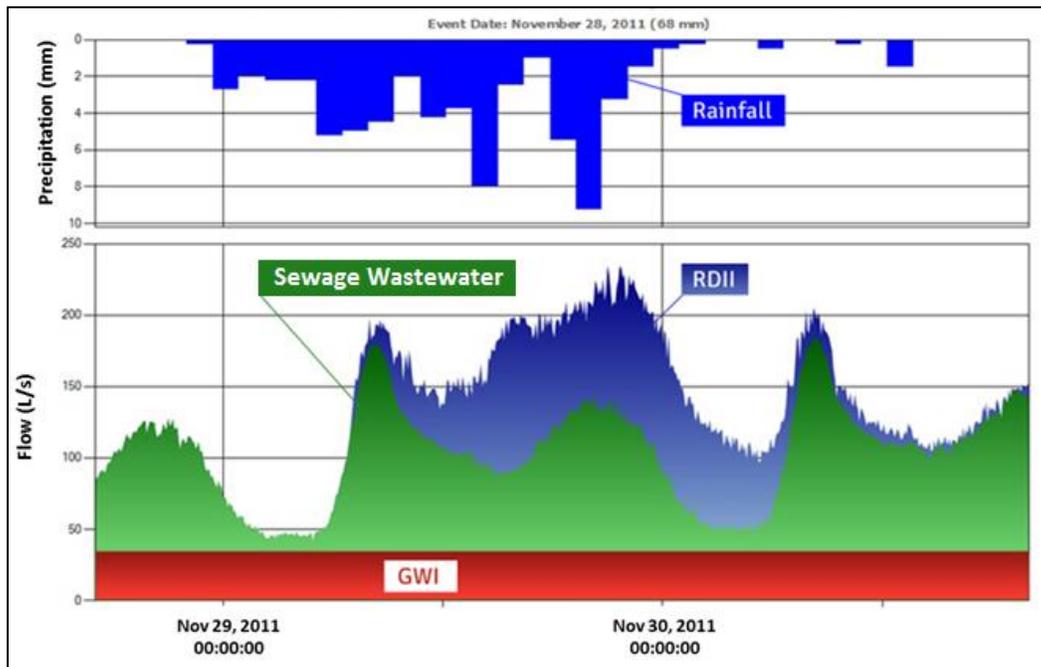
Percent of GWI in Average DWF – The percentage of estimated GWI is assumed based on 85 percent of the minimum flow measured between 2 and 6 AM where the ratio of GWI to the average DWF is as evaluated as follows. The following evaluation ranges for I&I prioritization have been adopted from York Region’s Inflow and Infiltration Reduction Strategy Report (2021):

I&I Severity	Base Infiltration (%)
Low	<40%
Medium	40-60%
High	>60%

The WWF component includes stormwater inflow, trench infiltration, and groundwater infiltration. WWF is generally a response to a meteorological change within the study area. The WWF is often divided into two (2) different components based on the ambient temperature and precipitation within a study area. The WWF components are as follows:

- 1) Rainfall Derived I-I (RDII); and,
- 2) Snowmelt Derived I-I (SDII).

There are several physical and residual factors that impact the rate of extraneous flow into the sanitary sewer after a wet-weather event. The analysis completed within the study focuses on the factors that are easily measured and quantifiable, such as sanitary flow and rainfall. **Figure 2-1** illustrates the flow monitoring response to rainfall.



**Figure 2-1: Sanitary Flow Components**

### 2.3 Overflow Analysis

The overflow analysis involved summarizing statistics about the rainfall events that occurred prior to each overflow event. The analysis involved summarizing precipitation depth, peak intensity at timesteps of 60 and 360 mins and summarizing the five (5)-day preceding precipitation depth. The goal was to understand the preceding conditions that caused the overflows and assess if overflows were occurring during regular circumstances (i.e., during an average year storm) or only under unique circumstances. The Municipality's flow reports were used to extract overflow occurrences and corresponding data such as start date, start time, volume and reported cause of the overflow event.

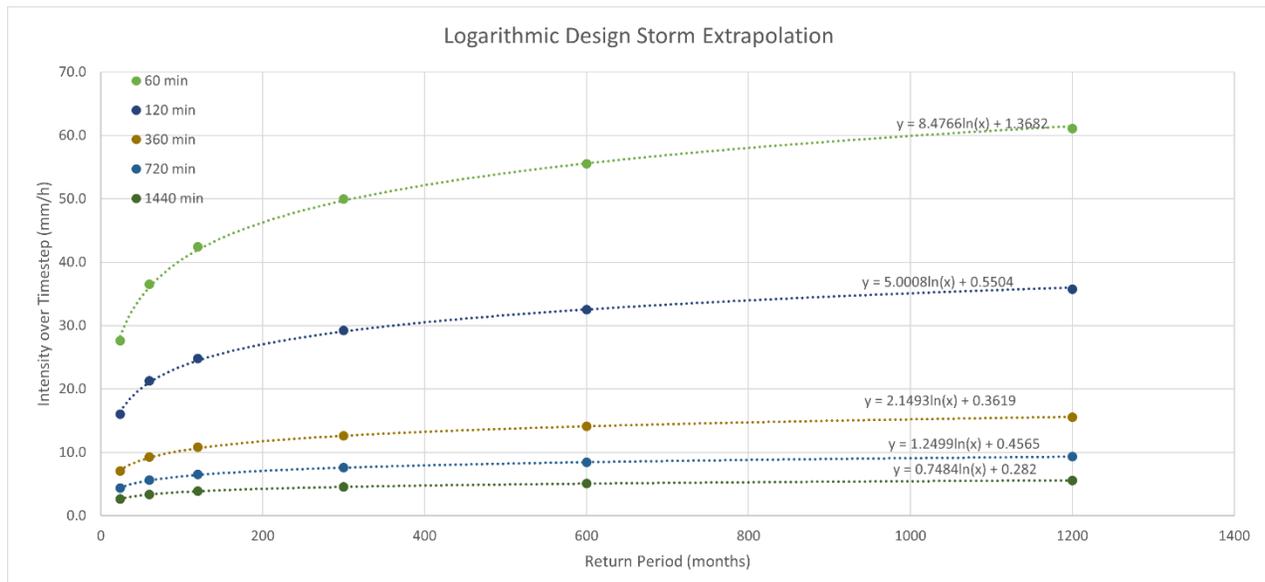
## 3.0 Data Results

### 3.1 Rainfall Analysis

The number and magnitude of significant storms is important for assessing the suitability of the data for WWF analysis. The greater the number, and the greater the range in magnitude of storms, the more reliable and accurate the assessment of wet-weather flow. Rainfall analysis was completed to summarize the characteristics of the rainfall events that caused overflows or bypasses. The concept of an “average year storm” was used to understand if storms that would be expected to occur every year were causing overflows.

#### 3.1.1 IDF Design Storm Analysis

An assessment of the average year storm was made by using the existing Environment and Climate Change Canada (ECCC) IDF curve for the City of Sarnia as it is the closest to the study area locations. The ECCC IDF curves provide peak rainfall intensity for storms equal to or greater than a two-year return period. To estimate the intensity of higher frequency storms, a logarithmic design storm extrapolation was completed to determine the peak rainfall intensities of a 3-month, 6-month and 1-year storm. **Figure 3-1** illustrates the logarithmic design storm extrapolation over various timesteps. **Figure 3-1** below provides the results of the IDF design storm analysis and peak intensities over multiple timesteps for each return period. All rain events causing overflows were compared to this table and characterized by the respective return period.



**Figure 3-1: Logarithmic Design Storm Extrapolation**

**Table 3-1: IDF Design Storm Results**

Design Storm	Intensity over Timestep (mm/h)				
	60 min	120 min	360 min	720 min	1440 min
3 Month Storm	10.7	6.0	2.7	1.8	1.1
6 Month Storm	16.6	9.5	4.2	2.7	1.6
1 Year Storm	22.4	13.0	5.7	3.6	2.1
2 Year Storm	27.6	16.0	7.0	4.4	2.6
5 Year Storm	36.5	21.3	9.3	5.6	3.4
10 Year Storm	42.5	24.8	10.8	6.5	3.9
25 Year Storm	49.9	29.2	12.6	7.6	4.6
50 Year Storm	55.6	32.5	14.1	8.5	5.1
100 Year Storm	61.1	35.8	15.5	9.3	5.6

### 3.1.2 Summary of Largest Rainfall Events

In this report, a 6-month return period was used as a cutoff point to summarize the largest rain events and are provided in **Table 3-2**. Events with equal to or higher than 6-month return period were plotted on an IDF chart provided in **Appendix I**. The highest intensity rain event over the ten year period was recorded on July 7, 2014 and was between a 25 and 50 year storm over the 1-hour timestep.

**Table 3-2: Summary of Events Greater than 6-months Return Period**

Event	Duration (hr)	Return Period (60 min timestep)	Total Precipitation (mm)	Peak Intensity at Timestep (mm/hr)				
				60 min	120 min	360 min	720 min	1440 min
2012-07-27	10	0.5-1 Year	30	12.6	9.4	4.4	2.5	1.3
2012-09-07	39	0.5-1 Year	34	10.0	8.5	4.5	2.7	1.4
2013-04-09	82	0.5-1 Year	76	12.0	10.2	5.3	3.1	2.1
2013-05-28	32	0.5-1 Year	49	9.8	9.7	4.0	3.2	1.9
2013-05-30	1	0.5-1 Year	21	18.6	10.3	3.4	1.7	0.9
2013-07-03	3	1-2 Year	32	24.2	15.8	5.4	2.7	1.4
2013-07-31	16	0.5-1 Year	44	10.2	10.1	5.0	3.3	1.8
2013-08-27	13	0.5-1 Year	37	11.8	6.5	4.1	3.1	1.6
2013-09-20	47	0.5-1 Year	51	14.0	9.4	3.7	2.7	1.9
2013-10-05	1	0.5-1 Year	22	20.4	10.8	3.6	1.8	0.9
2014-07-08	3	25-50 Year	54	50.2	26.6	9.0	4.5	2.2
2014-07-27	30	0.5-1 Year	39	18.4	10.1	3.7	2.0	1.6
2014-09-05	28	2-5 Year	80	13.8	13.7	7.6	4.7	2.9
2014-09-10	15	0.5-1 Year	32	13.4	10.4	5.2	2.6	1.3
2015-05-30	35	0.5-1 Year	51	11.0	7.8	2.6	2.4	1.8
2015-06-07	25	2-5 Year	70	25.8	12.9	4.4	3.6	2.8
2015-07-25	15	5-10 Year	40	39.0	19.9	6.6	3.3	1.7
2015-09-07	18	0.5-1 Year	28	10.0	7.8	4.6	2.4	1.2

Event	Duration (hr)	Return Period (60 min timestep)	Total Precipitation (mm)	Peak Intensity at Timestep (mm/hr)				
				60 min	120 min	360 min	720 min	1440 min
2016-03-23	37	0.5-1 Year	56	8.2	6.9	5.1	3.0	1.9
2016-03-27	26	0.5-1 Year	44	9.0	4.5	2.8	2.7	1.6
2016-05-29	2	1-2 Year	31	16.6	14.2	5.2	2.6	1.3
2016-08-16	9	0.5-1 Year	26	10.4	8.3	4.2	2.2	1.1
2016-08-24	3	0.5-1 Year	24	17.2	10.1	4.0	2.0	1.0
2017-04-20	13	0.5-1 Year	41	7.6	6.6	4.7	3.4	1.7
2017-05-21	14	0.5-1 Year	31	13.6	10.6	3.6	2.1	1.3
2017-08-17	13	1-2 Year	27	18.6	13.0	4.4	2.2	1.1
2018-07-31	16	0.5-1 Year	26	12.8	11.4	4.0	2.1	1.1
2018-08-08	7	0.5-1 Year	31	12.6	10.8	4.4	2.6	1.3
2019-05-25	14	1-2 Year	37	13.2	10.1	6.0	3.1	1.6
2019-10-01	45	0.5-1 Year	49	13.0	6.6	3.9	2.3	1.7
2020-01-10	36	0.5-1 Year	51	6.6	6.5	4.0	2.5	1.9
2020-06-23	4	2-5 Year	38	19.8	17.6	6.4	3.2	1.6
2020-08-16	8	1-2 Year	37	16.0	14.7	5.5	3.1	1.5
2021-06-08	8	0.5-1 Year	23	19.8	11.1	3.7	1.9	0.9
2021-07-13	15	0.5-1 Year	32	19.2	9.7	4.9	2.6	1.3
2021-07-29	2	0.5-1 Year	24	15.2	11.4	4.0	2.0	1.0
2021-09-21	34	0.5-1 Year	52	7.2	5.4	3.8	2.9	2.0

### 3.2 Overflow Analysis

The overflow analysis included a review and summary of the annual overflow reports provided by the Municipality for each of the sewer networks. Rainfall statistics for any rainfall event that occurred within the two (2) previous days of the overflow event were summarized for each event (rainfall depth, peak hourly intensity and return period, 5-day preceding precipitation volume). This data was used to summarize the preceding conditions and severity of rain events that led to the overflows. The tables in the following sections list all the overflow events that occurred over the ten (10) year period for each area. Reasons for overflows were provided by the Municipality in the overflow reports, and the rainfall event analysis was used to corroborate where equipment or pipe failure was the reason and not wet weather. No overflow events were recorded in Indian Hills. **Appendix II** provides screenshots of overflow events that were reported in the Municipal overflow reports used in the analysis.

### 3.2.1 Overflow Events in Arkona

**Table 3-3** below presents the details of the overflow events that occurred in Arkona. Based on the overflow reports, two (2) overflow events occurred in 2021 on February 6, 2021 and April 6, 2021. The first event lasted four (4) hours and the second event lasted for two (2) hours. Causes for the overflows events as reported by the Municipality are summarized in the table. For both overflows the reason was reported to be due to pipe failures (ex. break, leak and plugged). For both events a rainfall analysis was performed to determine the peak intensity over timestep for 60 mins (1 hour) and 360 mins (6 hours). The first overflow event had a 5-day preceding precipitation of 4 mm with a return frequency of less than 3 months. The second event had a 5-day preceding precipitation of 3 mm with a return frequency of less than 3-month storm. Both overflow events occurred for small storm events due to equipment failure. No overflows due to wet weather were reported. Improvements in operations and maintenance are suggested to implement preventative measures for equipment and mechanical failures.

**Table 3-3: Overflow Events in Arkona**

Arkona													
Overflows - 2012-2021								Rainfall Analysis during Overflow events					
Year	Location	Community	Start Time	End Time	Minutes	Total Volume (m <sup>3</sup> )	Reason Provided by Municipality	Date	Precipitation (mm)	Peak Intensity over Timestep (mm/hr)		5-Day Preceding Precipitation (mm)	Return Frequency
										60min	360min		
2021	Ann Street force main	Arkona	2021-02-06 10:00	2021-02-06 14:00	240	N/A <sup>1</sup>	Pipe Failure (break/leak/plugged)	2021-02-06	0	0.0	0.0	4	<3 Month Storm
2021	Ann Street force main	Arkona	2021-04-06 9:26	2021-04-06 11:30	120	1	Pipe Failure (break/leak/plugged)	2021-04-05	2	0.8	0.3	3	<3 Month Storm

<sup>1</sup>Data not provided in the overflow report

### 3.2.2 Overflow Event in Forest

**Table 3-4** presents the details of the overflow events that occurred in Forest that were recorded by the Municipality. In this area, seven (7) overflow events occurred between 2013 to 2021 during winter, spring and summer months at the Clyde Street Pumping Station. The event that occurred on April 10, 2013 was due to equipment failure. The remaining six (6) overflow events were caused by precipitation events. As the table indicates, the duration and total volume vary. The rainfall analysis was performed for each overflow event and the return periods (3-month, 6-month and 1-year) were quantified. It is notable that overflows occurred during smaller events, but did not occur during other more significant events, such as a July 8<sup>th</sup>, 2014 which had a 25-50 year return frequency and a 1-hour intensity that was four (4) times higher than the May 25<sup>th</sup>, 2019 event intensity. May 25<sup>th</sup>, 2019 was an event which caused an overflow, but there were 17 events which had greater total precipitation volume. This phenomenon requires further investigation. The nearest rain gauge available for use in this analysis (SCRCA - Shashawandah) is located approximately 7km from the center of Forest and may not always represent the rain that fell in Forest, particularly during high intensity summer thunderstorms that can be very localized. Further analysis to understand the capacity and peak flows at the pumping station is required to determine where improvements need to be made to prevent overflows from occurring during wet weather. On two (2) occasions, rain events with a return period less than the average year storm (1-year return period) caused overflows to occur at the Clyde Street Pumping Station.

**Table 3-4: Overflow Event in Forest**

Forest													
Forest Overflow Report - 2012-2021								Rainfall Analysis during Overflow events					
Year	Location	Community	Start Time	End Time	Minutes	Total Volume (m <sup>3</sup> )	Reason Provided by Municipality	Date	Precipitation (mm)	Peak Intensity over Timestep (mm/hr)		5-Day Preceding Precipitation (mm)	Return Frequency
										60min	360min		
2013	Clyde Street Pumping Station	Forest	2013-04-10 18:30	2013-04-10 20:00	90	15	Equipment Failure	2013-04-09	69	18.2	6.8	76	2-5 Year Storm

Forest													
2013	Clyde Street Pumping Station	Forest	2013-08-01 1:00	2013-08-01 7:00	420	50	Heavy Precipitation and Equipment Failure	2013-07-31	38	10.2	3.8	29	6-12 Month Storm
2014	Clyde Street Pumping Station	Forest	2014-09-10 18:30	2014-09-10 19:10	40	5	Heavy Precipitation	2014-09-10	42	18.6	6.8	86	1-2 Year Storm
2016	Clyde Street Pumping Station	Forest	2016-03-24 19:00	2016-03-24 20:25	85	0.01	Heavy Precipitation	2016-03-23	50	7.2	4.5	51	6-12 Month Storm
2019	Clyde Street Pumping Station	Forest	2019-05-25 7:30	2019-05-25 11:50	260	390	Precipitation	2019-05-25	45	18	7.3	49	2-5 Year Storm
2020	Clyde Street Pumping Station	Forest	2020-01-11 11:30	2020-01-11 17:30	360	43	Precipitation	2020-01-10	70	10.2	5.4	59	1-2 Year Storm
2021	Clyde Street Pumping Station	Forest	2021-03-26 7:20	2021-03-26 8:00	40	<100	Precipitation	2021-03-25	41	16.4	6.3	41	1-2 Year Storm

### 3.2.3 Overflow Events in Grand Bend

**Table 3-5** presents the overflow events that occurred within Grand Bend. For this area, several overflow events have been captured in the overflow reports. The overflow events occurred between 2015 to 2021. The Municipal overflow report for Grand Bend documented that the overflows occurred at forcemains, roads and a lagoon. Causes to these overflow events were documented to be due to server problem, equipment and mechanical failure and wind. None of the events were the result of precipitation, which is corroborated by the rainfall analysis which indicates overflow events occurred when there was zero or minimal precipitation. Improvements in operations and maintenance are suggested to implement preventative measures for equipment and mechanical failures.

**Table 3-5: Overflow Events in Grand Bend**

Grand Bend													
Grand Bend Overflow Report - 2012-2021								Rainfall Analysis during Overflow events					
Year	Location	Community	Start Time	End Time	Minutes	Total Volume (m <sup>3</sup> )	Reason Provided by Municipality	Date	Precipitation (mm)	Peak Intensity over Timestep (mm/hr)		5-Day Preceding Precipitation (mm)	Return Frequency
										60min	360min		

Grand Bend													
2015	91 River Rd Forcemain Leak	Grand Bend	2015-05-11 8:00	2015-05-11 16:00	480	0.01	Server Problems	2015-05-11	2	1.6	0.3	12	<3 Month Storm
2016	Mollard Line forcemain.	Grand Bend	2016-04-18 10:30	2016-04-18 11:30	60	41	Equipment Failure	2016-04-18	0	0.0	0.0	0	<3 Month Storm
	Pumping Station 2 overflow	Grand Bend	2016-05-24	N/A	N/A	11	Equipment Failure	2016-05-24	0	0.0	0.0	0	<3 Month Storm
	Goosemarsh air release spill	Grand Bend	2016-06-08 13:40	N/A	<60	6	Equipment Failure	2016-06-08	1	1.0	0.2	40	<3 Month Storm
	55 River Rd overflow	Grand Bend	2016-06-30	N/A	N/A	N/A	Equipment Failure	2016-06-30	0	0.0	0.0	10	<3 Month Storm
	75 River Rd overflow	Grand Bend	2016-07-06 11:00	2016-07-06 12:00	60	<1	Equipment Failure	2016-07-06	0	0.2	0.0	1	<3 Month Storm
2017	Mollard Forcemain	Grand Bend	2017-01-18 11:00	2017-01-19 15:20	N/A	N/A	Equipment failure	2017-01-16	17	3.2	1.5	17	<3 Month Storm
	Mollard Forcemain	Grand Bend	2017-04-16 14:30	2017-04-17 18:45	N/A	N/A	Equipment failure	2017-04-15	5	2.4	0.7	5	<3 Month Storm
	HC Playhouse Forcemain	Grand Bend	2017-12-14 15:00	2017-12-14 17:30	150	4	Equipment failure	2017-12-14	0	0.0	0.0	0	<3 Month Storm
2020	River Road	Grand Bend	2020-07-19 10:00	2020-07-19 14:00	N/A (240min)	N/A	Wind	2020-07-19	7	2.8	1.1	14	<3 Month Storm
	Mollard Line	Grand Bend	2020-11-12 10:07	2020-11-12 11:30	N/A (83min)	2	Mechanical/Equipment Failure	2020-11-11	3	2.6	0.5	7	<3 Month Storm
2021	Lagoon 1	Grand Bend	2021-03-23 12:30	N/A	N/A	Unknown	Mechanical/Equipment Failure	2021-03-23	0	0.0	0.0	0	<3 Month Storm

### 3.2.4 Overflow Events in Thedford

**Table 3-6** summarizes the overflow events that occurred within Thedford that were recorded by the Municipality. Overflow events occurred within Thedford between 2013 – 2021 during the winter, spring and summer months at both the Ravenswood and Main Street Pumping Stations. The table provides details on the total volume of flow and the causes of the overflow event. The overflow incident that occurred on July 8, 2018 at Main Street Pumping Station and January 13, 2021 were caused by equipment/pipe failure. The remaining 16 events were due to precipitation. When reviewing the rainfall analysis, overflows that occurred due to equipment failure happened when there was no precipitation. Reasons for overflow documented due to precipitation occurred during storms that had return frequencies of a <3 month, 6-12 month and 1-2 year storm. Out of all the events listed below, the event which occurred on July 3<sup>rd</sup>, 2013 had the highest peak intensity of 24.2mm/hr and a 1-2 year return frequency storm. It is notable that overflows occurred during smaller events, but did not occur during other significant events, such as a July 8<sup>th</sup>, 2014 which had a 25-50 year return frequency and a 1-hour intensity that was two (2) times higher than the July 3<sup>rd</sup>, 2013 event intensity. 11 of the 16 precipitation related overflows occurred following storms with an intensity less than the average year storm (1-year return period). Of note, is the apparent increasing frequency of overflows with 14 of the 16 precipitation related overflows occurring in the most recent four (4) year period between 2018 and 2021. Further analysis to understand the capacity and peak flows at the pumping station is required to determine where improvements need to be made to prevent overflows from occurring during wet weather.

**Table 3-6: Overflow Events in Thedford**

Thedford													
Thedford Overflow Report - 2012-2021								Rainfall Analysis during Overflow events					
Year	Location	Community	Start Time	End Time	Minutes	Total Volume (m <sup>3</sup> )	Reason	Date	Precipitation (mm)	Peak Intensity over Timestep (mm/hr)		5-Day Preceding Precipitation (mm)	Return Frequency
										60min	360min		
2013	Ravenswood Pumping Station	Thedford	2013-07-03	2013-07-03	210	1864	Heavy Precipitation	2013-07-03	32	24.2	5.4	33	1-2 Year Storm
2016	Main Street Pumping Station	Thedford	2016-03-24 18:30	2016-03-24 23:30	300	98	Heavy Precipitation	2016-03-24	56	8.2	5.1	57	6-12 Month Storm
2018	Ravenswood Pumping Station	Thedford	2018-02-20 7:00	2018-02-20 16:30	510	61	Precipitation	2018-02-19	37	3.6	2.2	32	<3 Month Storm
	Ravenswood Pumping Station	Thedford	2018-08-08 11:40	2018-08-08 13:05	85	90	Precipitation	2018-08-08	31	12.6	4.4	53	6-12 Month Storm
	Main Street Pumping Station	Thedford	2018-07-08 15:00	2018-07-09 11:30	1230	70	Equipment Failure	2018-07-08	0	0.0	0.0	11	<3 Month Storm
	Main Street Pumping Station	Thedford	2018-08-08 11:25	2018-08-08 12:40	75	70	Precipitation	2018-08-08	31	12.6	4.4	53	6-12 Month Storm
2019	Ravenswood Pumping Station	Thedford	2019-05-25 7:42	2019-05-25 11:05	213	64	Precipitation	2019-05-25	37	13.2	6.0	50	1-2 Year Storm
	Main Street Pumping Station	Thedford	2019-05-25 7:51	2019-05-25 10:15	144	43	Precipitation	2019-05-25	37	13.2	6.0	50	1-2 Year Storm
2020	Ravenswood Pumping Station	Thedford	2020-01-11 8:40	2020-01-11 17:35	535	64	Precipitation	2020-01-10	51	6.6	4	59	6-12 Month Storm
	Main Street Pumping Station	Thedford	2020-01-11 8:40	2020-01-11 18:05	565	68	Precipitation	2020-01-10	51	6.6	4	59	6-12 Month Storm
	Ravenswood Pumping Station	Thedford	2020-01-12 1:45	2020-01-12 4:30	165	20	Precipitation	2020-01-10	51	6.6	4	59	6-12 Month Storm
	Main Street Pumping Station	Thedford	2020-01-12 1:45	2020-01-12 4:00	135	16	Precipitation	2020-01-10	51	6.6	4	59	6-12 Month Storm

Thedford													
	Ravenswood Pumping Station	Thedford	2020-08-09 12:15	2020-08-09 13:00	45	5	Precipitation	2020-08-09	15	8.2	2.6	17	3-6 Month Storm
	Ravenswood Pumping Station	Thedford	2020-08-16 10:00	2020-08-16 11:46	106	13	Precipitation	2020-08-16	37	16.0	5.5	43	1-2 Year Storm
	Main Street Pumping Station	Thedford	2020-08-16 10:00	2020-08-16 11:25	85	10	Precipitation	2020-08-16	37	16.0	5.5	43	1-2 Year Storm
2021	8040 Ravenswood Line - Lagoon Valve	Thedford	2021-01-13 9:25	2021-01-13 10:00	35	1	Pipe Failure (break/leak/plugged)	2021-01-13	0	0.0	0.0	0	<3 Month Storm
	Ravenswood Pumping Station	Thedford	2021-03-26 6:50	2021-03-26 8:00	70	100	Precipitation	2021-03-25	26	12.0	4.1	41	3-6 Month Storm
	Ravenswood Pumping Station	Thedford	2021-06-08 18:30	2021-06-08 20:15	105	77	Precipitation	2021-06-08	23	19.8	3.7	22	6-12 Month Storm

### 3.3 System Wide Dry-Weather Flow Analysis

Flows during dry days were selected to characterize the dry-weather flow (DWF) rates. The following DWF parameters have been calculated and included in **Table 3-7**:

- Average Dry-Weather Flow (m<sup>3</sup>/d)
- Average Dry-Weather Groundwater Infiltration (GWI) (m<sup>3</sup>/d) and (m<sup>3</sup>/d/ha)
- % of GWI in Average DWF

The average DWF is a combination of sewage and groundwater infiltration, with sewage typically being the largest proportion. The Minimum DWF typically occurs at night-time (between 1:00 am and 3:00 am), and for smaller sewersheds it is typically 70-90% groundwater infiltration (GWI). (The percentage of GWI is typically less in large sewersheds, due to a larger proportion of the customer sewage flow arriving at the treatment facility after a longer delay in transit).

For the purposes of this study, the GWI is calculated as "Flow during Dry Weather Days" minus "Sewage Flow". After consulting with the Municipality, it was agreed that daily sewage flow would be estimated by using water consumption records from winter months. Dry-weather days were defined as a day with less than one (1) mm of rainfall and the previous day had less than one (1) mm rainfall. Dry-weather GWI will enter the sewer system when the depth of the groundwater table is higher than the elevation of the pipeline, and reaches joint, or pipe defects; as well as, when the condition of the sewer pipe allows for infiltration (e.g. water level outside of the pipe is higher than inside). Seasonal variations of GWI occur due to changes in groundwater table elevations and soil saturation. Typically, rates increase during springtime after snowmelt, and can remain relatively constant over weeks, and months thereafter. The results are shown in **Table 3-7**. **Figure 3-2** presents the thematic map for the GWI percentages for each area.

**Table 3-7: Summary of DWF Results**

DRY-WEATHER SUMMARY (2012-2021)					
Site	Area (ha)	Average Dry-Weather Flow (m <sup>3</sup> /d)	AVG GWI (m <sup>3</sup> /d)	AVG GWI (m <sup>3</sup> /d/ha)	%GWI in Avg DWF
Arkona	113	187	90	0.8	48%
Forest	303	1,112	610	2.0	55%
Grand Bend	182	801	572	3.1	71%
Indian Hills	9 <sup>1</sup>	6	1	0.1	12%
Thedford	95	236	107	1.1	45%

<sup>1</sup>Estimated based on sewer layout and satellite imagery

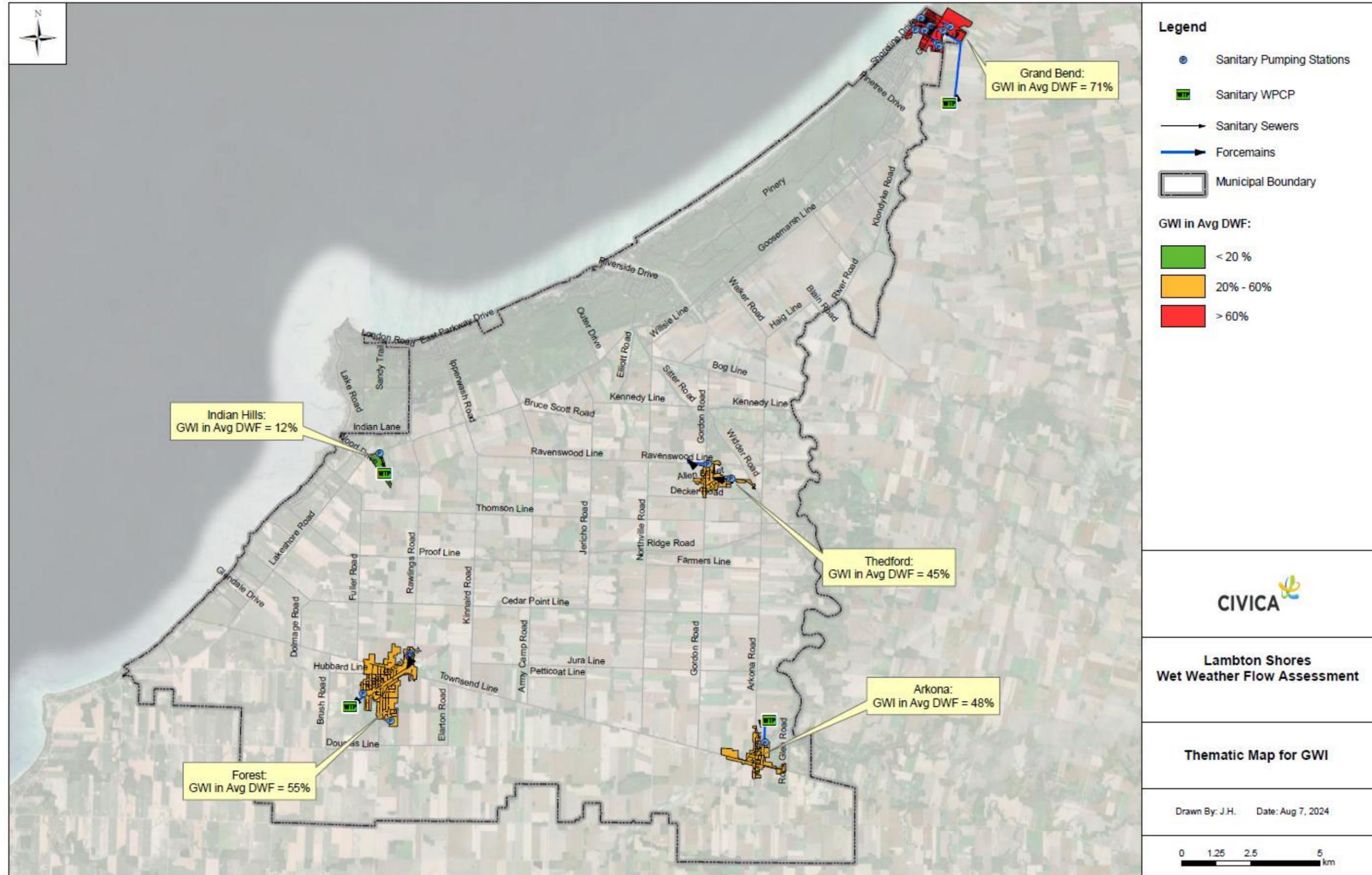


Figure 3-2: Thematic Map for GWI

### 3.4 Wet-Weather Flow Analysis

Wet-weather flow analysis separates the dry and wet-weather contributions to each catchment area. The peak wet-weather response is compared with the peak rainfall intensity. Wet-weather flow (WWF) includes stormwater inflow, trench infiltration, and groundwater infiltration, and is generally a response to a rain event within the study areas. Analysis of the individual I&I responses, highest daily I&I volume (m<sup>3</sup>/d and m<sup>3</sup>/d/ha), percentage I&I in total flow (%), and Highest Peaking Factor, recorded during monitor period for each study area.

Using water consumption records from each community the “Total I&I” in each system was calculated by subtracting the estimated sewage flow from total wastewater flow recorded at the treatment facilities. The following sections summarize a monthly and annual analysis of the percentage I&I in the total wastewater. It also includes a summary of the highest daily peaking factor (Highest Daily Flow divided by the Average Daily Flow). A total wet-weather analysis for the 10-year monitoring period is summarized in **Table 3-8**.

**Table 3-8: I&I Summary (2012-2021)**

Study Area	Total Flow (m <sup>3</sup> )	Total I&I (m <sup>3</sup> )	% of I&I in Total Flow	Total GWI (m <sup>3</sup> )	Avg GWI (m <sup>3</sup> /d)	% of I&I as GWI	Highest Daily I&I Flow (m <sup>3</sup> /d)	Highest Daily I&I Flow (m <sup>3</sup> /d/ha)	Highest Daily Peaking Factor
Arkona	732,756	378,448	52%	192,158	90	51%	969	9	5.3
Forest	4,322,880	2,491,818	58%	1,271,667	610	51%	4,455	15	4.2
Grand Bend	3,227,206	2,382,387	74%	1,014,246	572	43%	2,497	14	2.9
Indian Hill	25,096	4,591	18%	1,794	1	39%	N/A <sup>1</sup>	N/A <sup>1</sup>	N/A <sup>1</sup>
Thedford	875,369	403,580	46%	227,331	107	56%	N/A <sup>1</sup>	N/A <sup>1</sup>	N/A <sup>1</sup>

<sup>1</sup>Only monthly volumes of wastewater at the treatment facilities were available for analysis. As such peak daily volumes could not be calculated.

**Figure 3-3** illustrates the percentage of I&I within the total flow for each area. As the figure illustrates Indian Hills has the least I&I present in the total flow with a percentage of 18%. Arkona, Forest and Thedford were estimated to have 20-60% I&I present in the total flow and Grand Bend had the highest percentage at 74%.

**Figure 3-4** presents a thematic map showing the highest peaking factor measured over the 10-year period. The peaking factor is a value that represent the ratio of the peak flow rates to the average flow and describes the severity of the peak daily flows induced during wet weather.



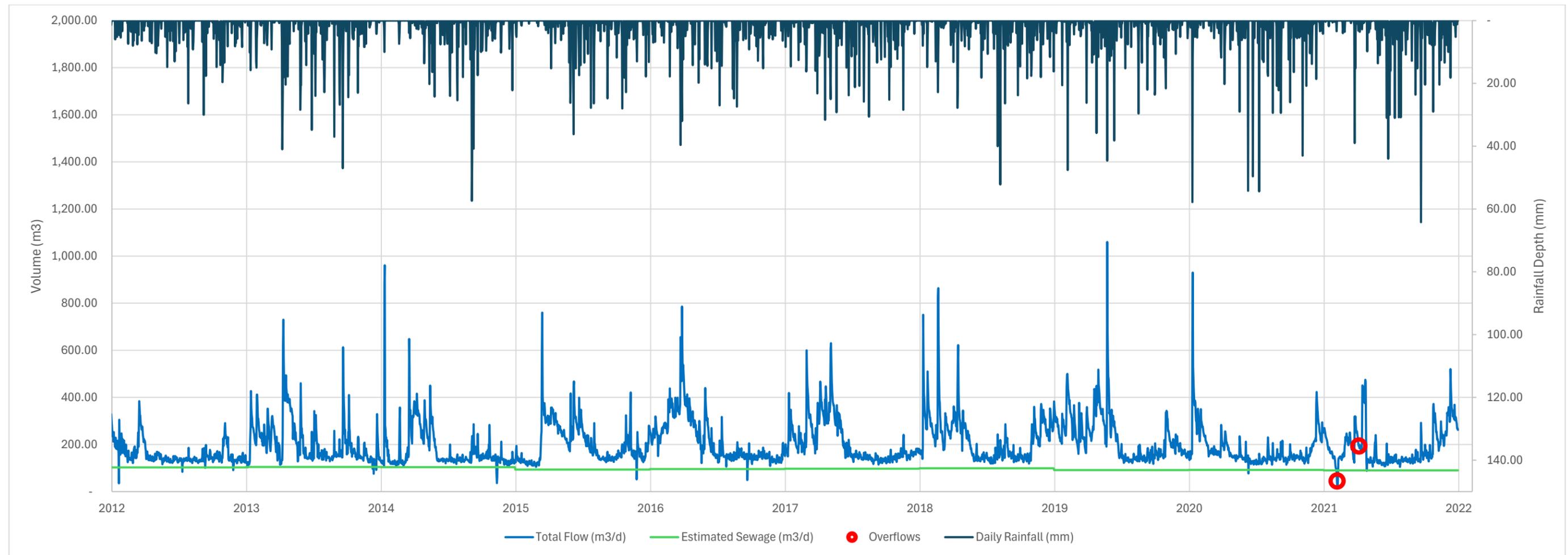


### 3.4.1 Arkona WWF Analysis

The annual wet-weather analysis for Arkona is summarized in **Table 3-9** and a monthly wet weather analysis is summarized in **Table 3-10**. As shown in **Table 3-8** I&I makes up 52% of the total wastewater volume and the highest daily peak I&I recorded between 2012-2021 was 969 m<sup>3</sup>/day with a highest daily peaking factor of 5.3. Average GWI is 90 m<sup>3</sup>/day which represents 51% of the total I&I. **Figure 3-5** presents the wet-weather analysis for Arkona from 2012-2021. The graph presents: Total Flow (m<sup>3</sup>/d), Estimated Sewage flow (m<sup>3</sup>/d), Overflow events, and Daily Rainfall (mm).

**Figure 3-6** illustrates the % I&I volume (i.e. percentage of total flow that is I&I) plotted with the annual rainfall. This chart shows that the percentage of I&I within the total flow has remained relatively constant throughout the ten-year period with only a slight increasing trend. Without any rehabilitation work, I&I rates would be expected to increase over time as infrastructure ages and deteriorates.

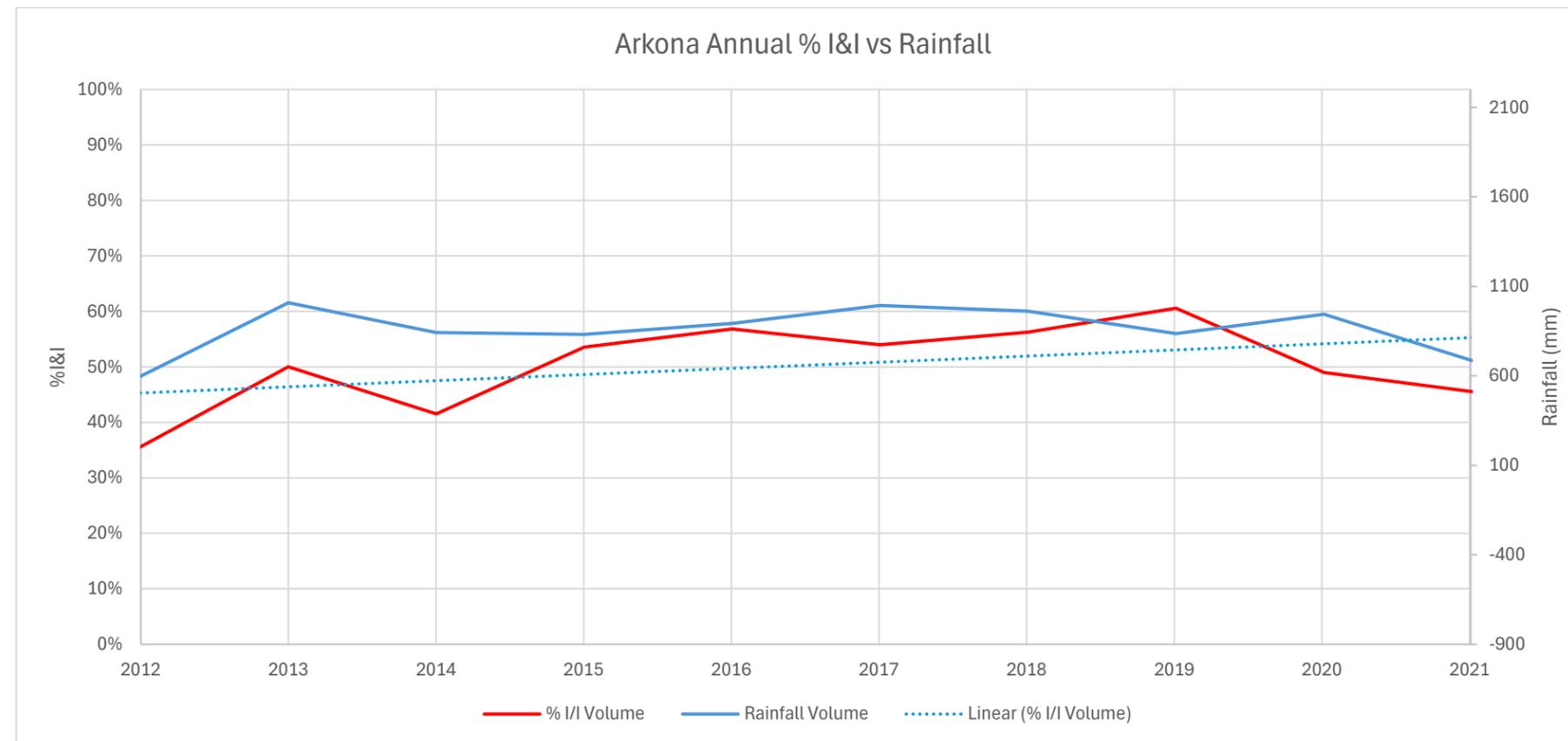
**Figure 3-7** presents monthly % I&I volume from 2012-2021. This chart shows that the percentage of I&I within the total flow fluctuates significantly between seasons, with an average around 60% in winter/spring when soil conditions are wet and closer to 40% during summer months when conditions are dry. This indicates that infiltration (which is strongly influenced by soil conditions) may be a large component of the total I&I in the system.



**Figure 3-5: Arkona Wet-Weather Analysis (2012-2021)**

**Table 3-9: Arkona Annual WWF Analysis**

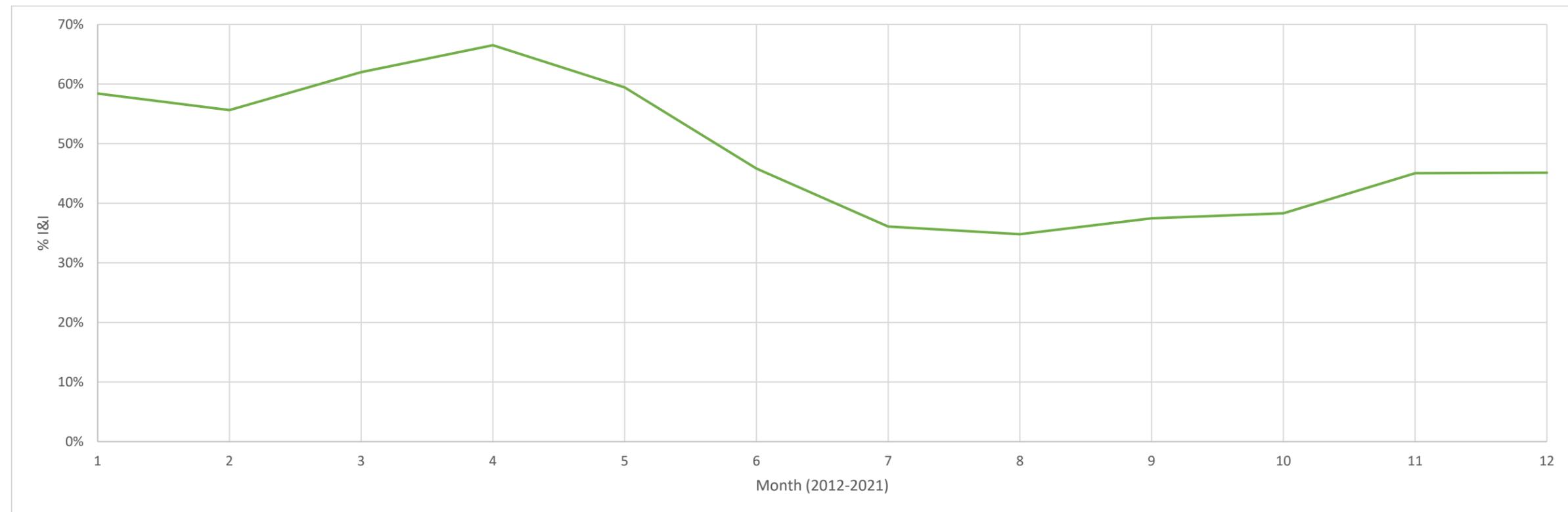
Annual Wet-Weather Analysis (2012-2021)						
Year	Average GWI (m <sup>3</sup> /d)	Average Dry Weather Flow (m <sup>3</sup> /d)	Peak Daily I&I (m <sup>3</sup> /d)	Total I&I (m <sup>3</sup> )	Total Wastewater (m <sup>3</sup> )	% I&I in Total Flow
2012	55	158	281	20,743	58,316	36%
2013	88	192	625	38,182	76,331	50%
2014	52	156	857	26,885	64,761	42%
2015	95	189	666	39,439	73,645	54%
2016	116	212	690	46,074	81,081	57%
2017	106	203	533	41,575	77,024	54%
2018	113	212	765	46,437	82,532	56%
2019	115	207	969	51,235	84,586	61%
2020	79	171	838	32,304	65,952	49%
2021	74	164	385	20,755	45,584	46%



**Figure 3-6: Arkona Annual % I&I vs Rainfall**

**Table 3-10: Arkona Monthly WWF Analysis**

Monthly Wet-Weather Analysis (2012-2021)						
Year	Average GWI (m <sup>3</sup> /d)	Average Dry Weather Flow (m <sup>3</sup> /d)	Peak Daily I&I (m <sup>3</sup> /d)	Total I&I (m <sup>3</sup> )	Total Wastewater (m <sup>3</sup> )	% I&I in Total Flow
Jan (2012-2021)	111	208	857	42,210	72,277	58%
Feb (2012-2021)	95	193	765	34,406	61,854	56%
Mar (2012-2021)	143	240	690	49,037	79,104	62%
Apr (2012-2021)	170	267	625	57,783	86,880	67%
May (2012-2021)	115	212	969	44,038	74,105	59%
Jun(2012-2021)	73	171	374	24,609	53,706	46%
Jul (2012-2021)	49	145	237	16,982	47,049	36%
Aug (2012-2021)	43	140	197	16,052	46,119	35%
Sep (2012-2021)	49	145	508	17,433	46,530	37%
Oct (2012-2021)	53	151	305	17,048	44,497	38%
Nov (2012-2021)	68	166	327	21,617	48,006	45%
Dec (2012-2021)	70	168	331	22,417	49,685	45%



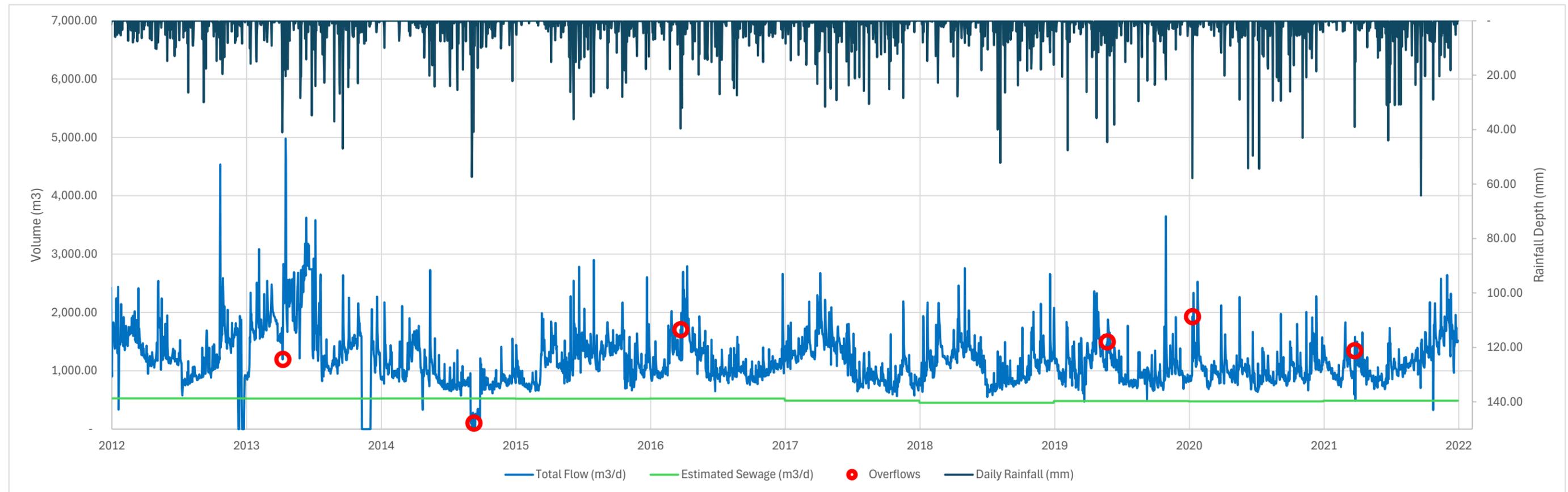
**Figure 3-7: % I&I Volume by Month**

### 3.4.2 Forest WWF Analysis

The annual wet-weather analysis for Forest is summarized in **Table 3-11** and a monthly wet weather analysis is summarized in **Table 3-12**. As mentioned in **Table 3-8** I&I makes up 58% of total flow volume and the maximum peak I&I recorded between 2012-2021 is 4,455 m<sup>3</sup>/day with a maximum Peaking Factor of 9. Average GWI is 610 m<sup>3</sup>/day and 51% of I&I is considered infiltration for Forest. **Figure 3-8** presents the wet-weather analysis for Forest from 2012-2021. The graph presents: Total Flow (m<sup>3</sup>/d), Estimated Sewage flow (m<sup>3</sup>/d), Overflow events, GWI (m<sup>3</sup>/d) and Daily Rainfall (mm).

**Figure 3-9** illustrates the % I&I volume (i.e. percentage of total flow that is I&I) plotted with the annual rainfall. This chart shows that the percentage of I&I within the total flow has remained relatively constant throughout the ten-year period and the levels of I&I have not increased or decreased significantly over that time.

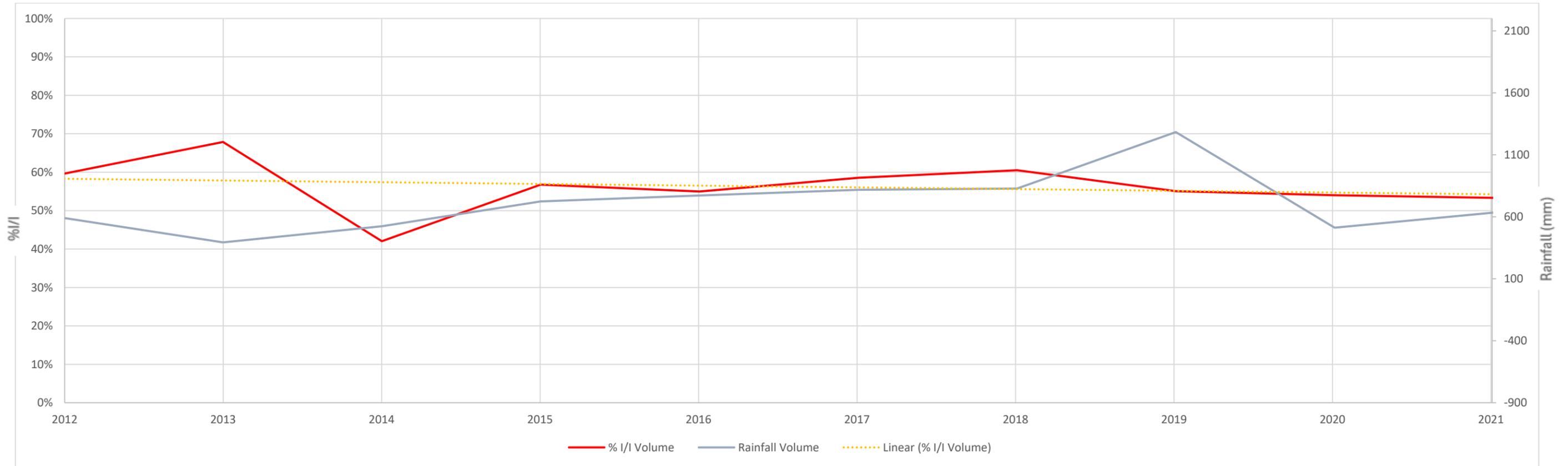
**Figure 3-10** presents monthly %I&I volume from 2012-2021. This chart shows that the percentage of I&I within the total flow has a moderate fluctuation between seasons, with an average slightly higher than 60% in the winter/spring when soil conditions are wet and closer to 50% during summer months when conditions are dry.



**Figure 3-8: Forest Wet-Weather Analysis (2012-2021)**

**Table 3-11: Forest Annual WWF Analysis**

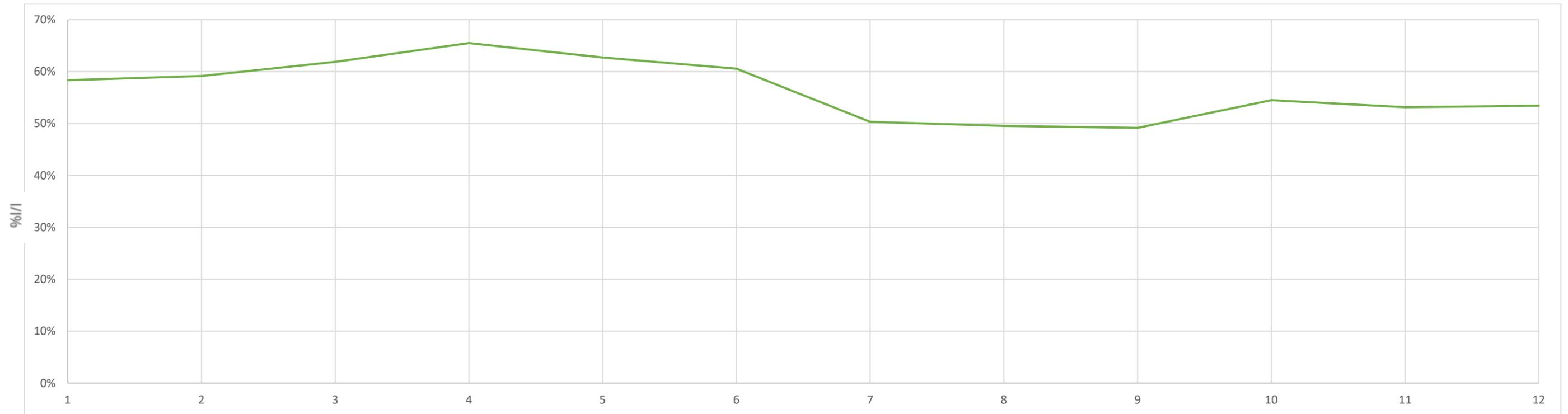
Annual Wet-Weather Analysis (2012-2021)						
Year	Average GWI (m <sup>3</sup> /d)	Average Dry Weather Flow (m <sup>3</sup> /d)	Peak Daily I&I (m <sup>3</sup> /d)	Total I&I (m <sup>3</sup> )	Total Wastewater (m <sup>3</sup> )	% I&I in Total Flow
2012	702	1,231	4,008	285,729	479,158	60%
2013	1,050	1,575	4,455	404,538	596,127	68%
2014	375	901	2,202	139,253	331,207	42%
2015	598	1,120	2,379	249,846	440,260	57%
2016	584	1,109	2,268	234,621	426,811	55%
2017	600	1,089	2,187	251,825	430,198	59%
2018	605	1,058	2,308	253,177	418,346	61%
2019	484	966	3,167	215,548	391,410	55%
2020	460	936	2,051	204,583	378,807	54%
2021	513	1,000	1,344	153,018	287,022	53%



**Figure 3-9: Forest Annual %I&I vs Rainfall**

**Table 3-12: Forest Monthly WWF Analysis**

Monthly Wet-Weather Analysis (2012-2021)						
Year	Average GWI (m <sup>3</sup> /d)	Average Dry Weather Flow (m <sup>3</sup> /d)	Peak Daily I&I (m <sup>3</sup> /d)	Total I&I (m <sup>3</sup> )	Total Wastewater (m <sup>3</sup> )	% I&I in Total Flow
Jan (2012-2021)	607	1,110	2,051	217,576	372,961	58%
Feb (2012-2021)	634	1,138	2,560	205,348	347,225	59%
Mar (2012-2021)	778	1,281	2,171	252,242	407,627	62%
Apr (2012-2021)	830	1,331	4,455	285,411	435,784	65%
May (2012-2021)	773	1,276	2,308	261,437	416,822	63%
Jun(2012-2021)	680	1,181	3,100	230,877	381,250	61%
Jul (2012-2021)	450	950	3,057	157,370	312,755	50%
Aug (2012-2021)	433	937	2,379	152,549	307,934	50%
Sep (2012-2021)	456	957	2,114	145,384	295,757	49%
Oct (2012-2021)	509	1,014	4,008	169,064	310,318	54%
Nov (2012-2021)	502	1,007	1,701	153,972	289,726	53%
Dec (2012-2021)	496	1,000	2,207	160,908	301,187	53%



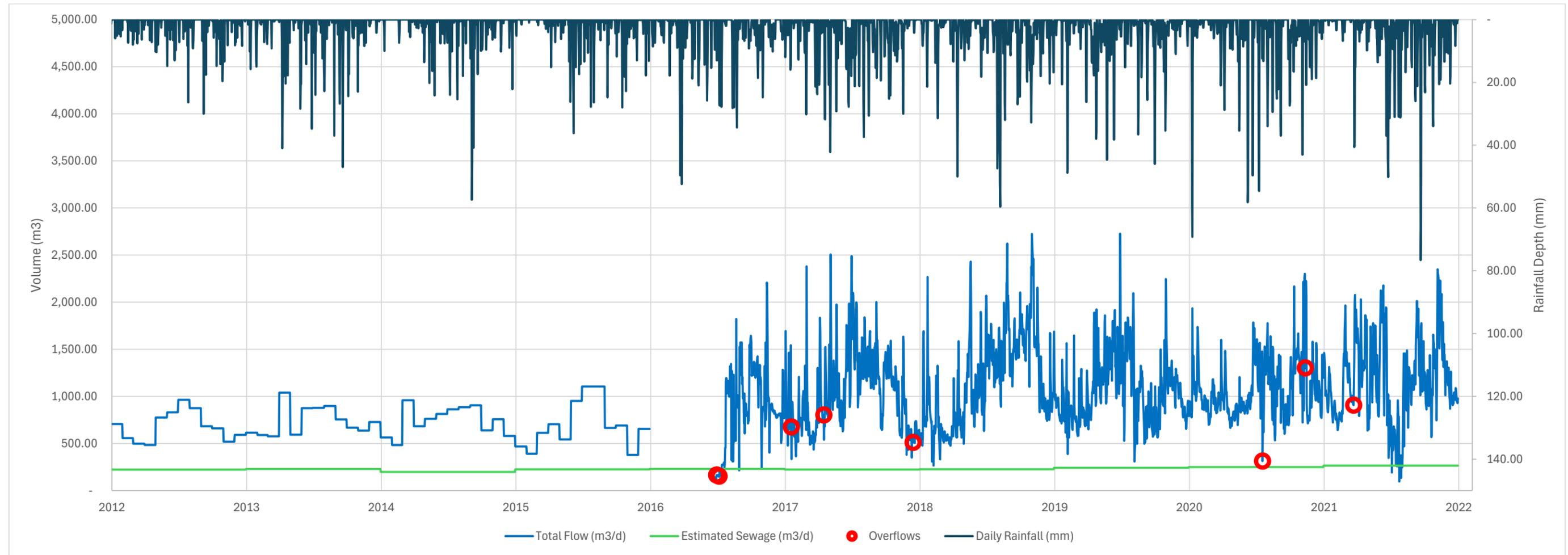
**Figure 3-10: %I&I Volume by Month**

### 3.4.3 Grand Bend WWF Analysis

The annual wet-weather analysis for Grand Bend is summarized in **Table 3-13** and a monthly wet weather analysis is summarized in **Table 3-14**. As mentioned in **Table 3-8** I&I makes up 74% of total flow volume and the maximum peak I&I recorded between 2012-2021 is 2,497 m<sup>3</sup>/day with a maximum daily peaking factor of 2.9. Average GWI is 572 m<sup>3</sup>/day and 43% of I&I is considered infiltration for Grand Bend. **Figure 3-11** presents the wet-weather analysis for Grand Bend from 2012-2021. The graph presents: Total Flow (m<sup>3</sup>/d), Estimated Sewage flow (m<sup>3</sup>/d), Overflow events, and Daily Rainfall (mm). The differences in the appearance of the Total Flow in the figure is because monthly volumes were recorded between 2012-2016 and daily volumes recorded from 2016 onwards.

**Figure 3-12** illustrates the % I&I volume (i.e. percentage of total flow that is I&I) plotted with the annual rainfall. This chart shows that the percentage of I&I within the total flow has been trending upwards throughout the ten-year period with an increase of approximately 10%. A combination of ageing infrastructure and/or new developments may explain this trend.

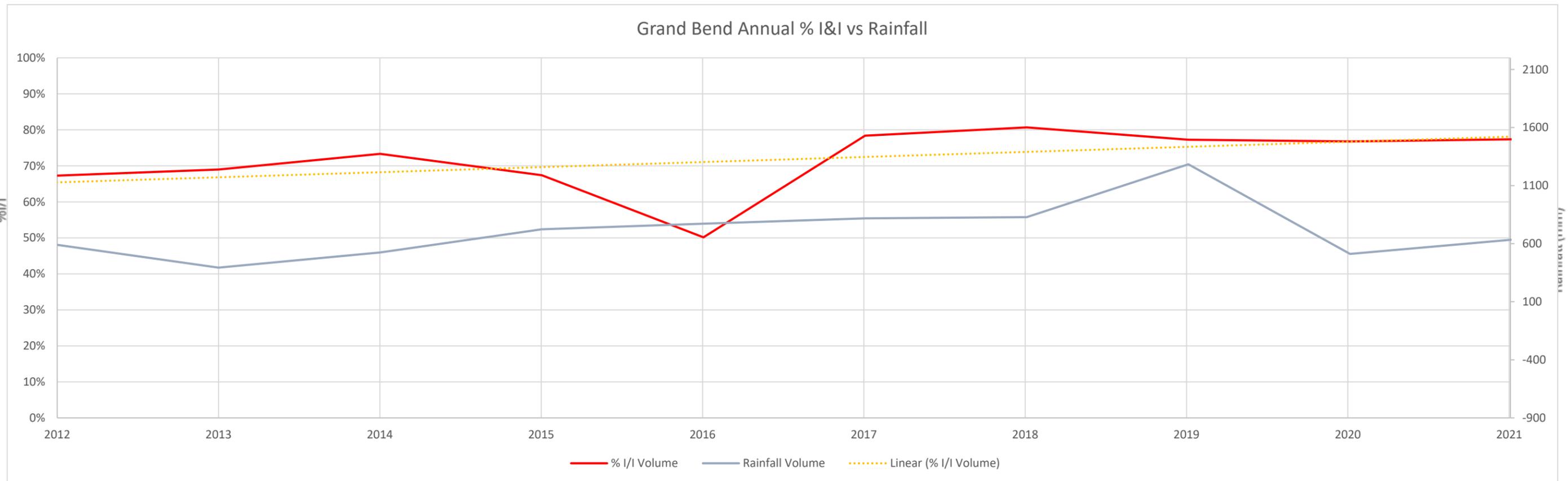
**Figure 3-13** presents monthly % I&I volume from 2012-2021. This chart shows that the percentage of I&I within the total flow is relatively constant between seasons, with slightly higher I&I actually being recorded during summer months compared to winter/spring months. This indicates that inflow sources that are very active during high intensity large rain events in summer months may be a large contributor of the I&I in the system.



**Figure 3-11: Grand Bend Wet-Weather Analysis (2012-2021)**

**Table 3-13: Grand Bend Annual WWF Analysis**

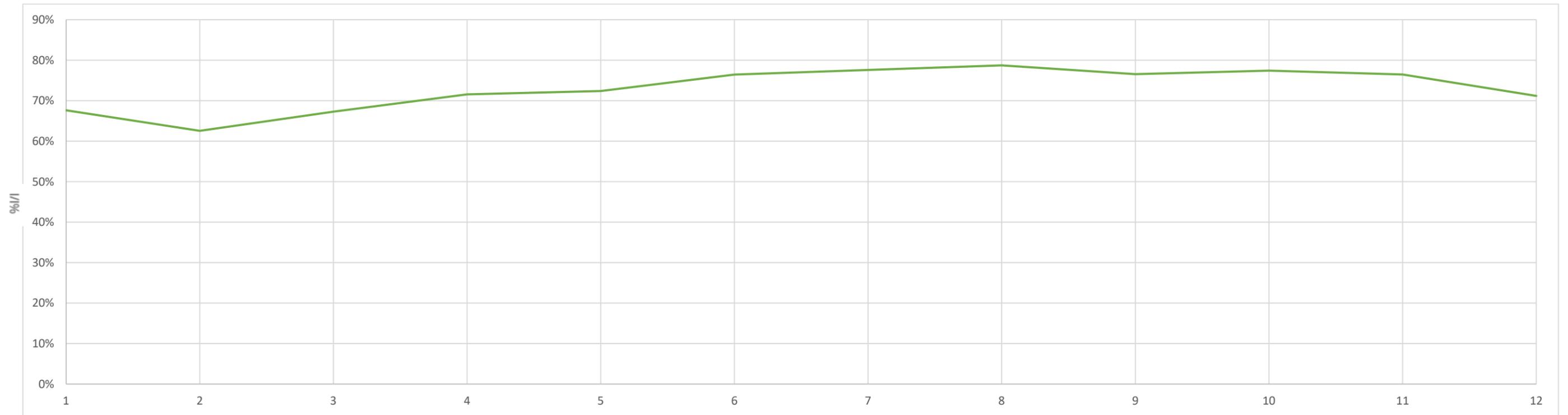
Annual Wet-Weather Analysis (2012-2021)						
Year	Average GWI (m <sup>3</sup> /d)	Average Dry Weather Flow (m <sup>3</sup> /d)	Peak Daily I&I (m <sup>3</sup> /d)	Total I&I (m <sup>3</sup> )	Total Wastewater (m <sup>3</sup> )	% I&I in Total Flow
2012	464	687	741	167,478	248,895	67%
2013	493	722	811	185,845	269,366	69%
2014	523	721	761	198,806	271,076	73%
2015	446	671	879	170,149	252,467	67%
2016	136	366	1,978	84,834	169,151	50%
2017	686	910	2,282	296,328	378,064	78%
2018	803	1,030	2,497	345,563	428,294	81%
2019	725	967	2,485	300,340	388,750	77%
2020	752	1,002	2,051	302,238	393,589	77%
2021	899	1,164	2,084	330,805	427,554	77%



**Figure 3-12: Grand Bend Annual %I&I vs Rainfall**

**Table 3-14: Grand Bend Monthly WWF Analysis**

Monthly Wet-Weather Analysis (2012-2021)						
Year	Average GWI (m <sup>3</sup> /d)	Average Dry Weather Flow (m <sup>3</sup> /d)	Peak Daily I&I (m <sup>3</sup> /d)	Total I&I (m <sup>3</sup> )	Total Wastewater (m <sup>3</sup> )	% I&I in Total Flow
Jan (2012-2021)	398	627	2,040	149,776	221,468	68%
Feb (2012-2021)	341	570	1,553	109,332	174,789	63%
Mar (2012-2021)	485	716	2,156	147,408	219,100	67%
Apr (2012-2021)	542	772	1,765	174,484	243,863	72%
May (2012-2021)	487	717	2,282	187,960	259,652	72%
Jun (2012-2021)	662	891	2,485	225,139	294,518	76%
Jul (2012-2021)	839	1,068	2,266	248,185	319,877	78%
Aug (2012-2021)	811	1,040	2,395	265,231	336,923	79%
Sep (2012-2021)	669	900	1,777	226,408	295,787	77%
Oct (2012-2021)	616	843	2,148	245,862	317,554	77%
Nov (2012-2021)	627	856	2,497	225,505	294,884	76%
Dec (2012-2021)	506	733	1,446	177,099	248,791	71%



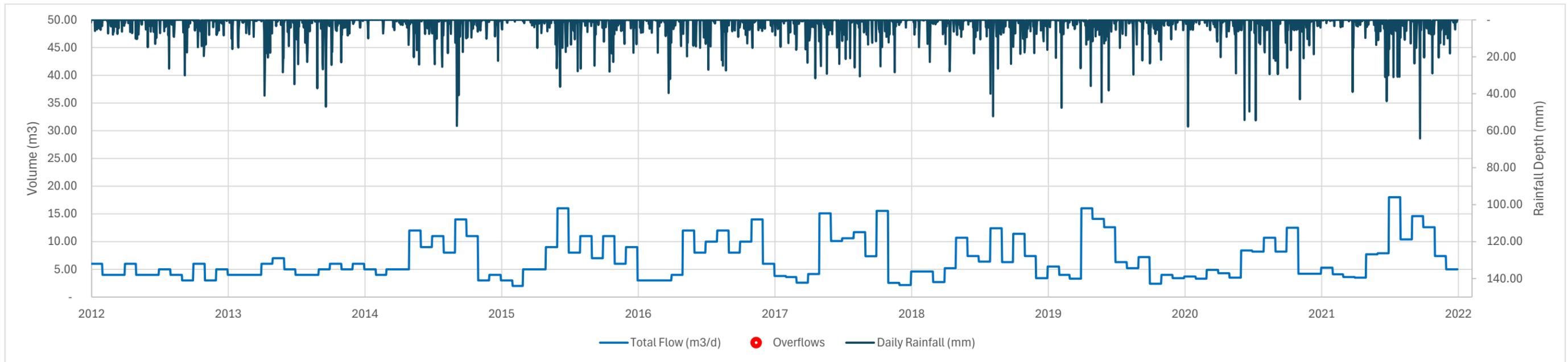
**Figure 3-13: %I&I Volume by Month**

### 3.4.4 Indian Hills WWF Analysis

The annual wet-weather analysis for Indian Hills is summarized in **Table 3-15** and a monthly wet weather analysis is summarized in **Table 3-16**. As mentioned in **Table 3-8** I&I makes up 18% of total flow volume. Average GWI is 1 m<sup>3</sup>/day and 39% of I&I is considered infiltration for Indian Hills. The data analysis excludes the year 2013 due to incorrect sewage flow data. **Figure 3-14** presents the wet-weather analysis for Indian Hills from 2012-2021. The graph presents: Total Flow (m<sup>3</sup>/d), Estimated Sewage flow (m<sup>3</sup>/d), Overflow events, and Daily Rainfall (mm).

**Figure 3-15** presents annual Indian Hills %I&I volume plotted with the annual rainfall.

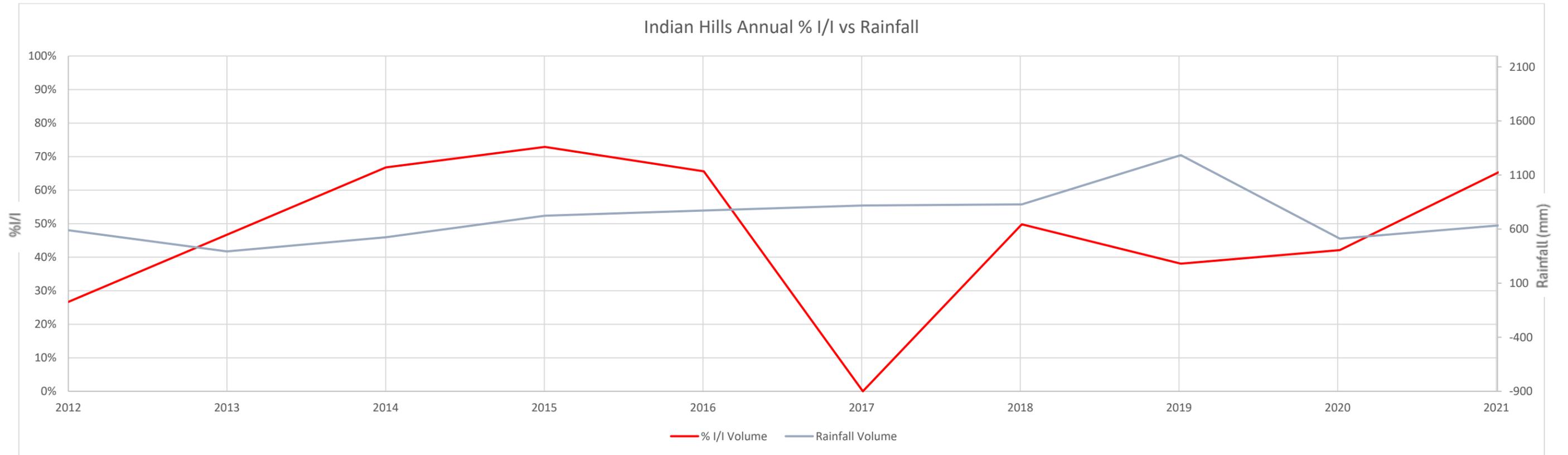
**Figure 3-16** presents monthly %I&I volume from 2012-2021.



**Figure 3-14: India Hills Wet-Weather Analysis (2012-2021)**

**Table 3-15: Indian Hills Annual WWF Analysis**

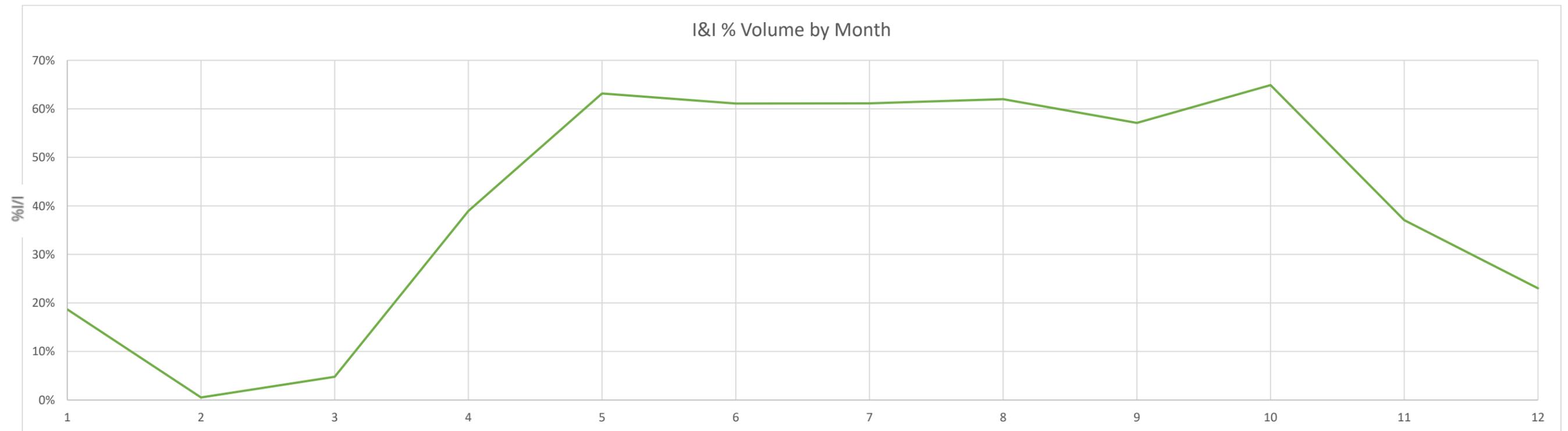
Annual Wet-Weather Analysis (2012-2021)						
Year	Average GWI (m <sup>3</sup> /d)	Average Dry Weather Flow (m <sup>3</sup> /d)	Peak Daily I&I (m <sup>3</sup> /d)	Total I&I (m <sup>3</sup> )	Total Wastewater (m <sup>3</sup> )	% I&I in Total Flow
2012	1	4	3	439	1,650	27%
2014	4	7	11	1,855	2,778	67%
2015	5	7	14	2,050	2,812	73%
2016	5	8	11	1,866	2,843	66%
2017	0	7	8	1	2,732	0%
2018	3	7	9	1,254	2,517	50%
2019	2	6	12	972	2,552	38%
2020	2	6	9	980	2,327	42%
2021	5	8	15	1,998	3,057	65%



**Figure 3-15: Indian Hills Annual %I/I vs Rainfall**

**Table 3-16: Indian Hills Monthly WWF Analysis**

Monthly Wet-Weather Analysis (2012-2021)						
Year	Average GWI (m <sup>3</sup> /d)	Average Dry Weather Flow (m <sup>3</sup> /d)	Peak Daily I&I (m <sup>3</sup> /d)	Total I&I (m <sup>3</sup> )	Total Wastewater (m <sup>3</sup> )	% I&I in Total Flow
Jan (2012-2021)	1	4	3	231	1237	19%
Feb (2012-2021)	0	4	1	5	923	1%
Mar (2012-2021)	0	4	3	51	1056	5%
Apr (2012-2021)	2	6	12	621	1595	39%
May (2012-2021)	6	9	10	1725	2731	63%
Jun(2012-2021)	5	9	14	1528	2502	61%
Jul (2012-2021)	5	9	15	1583	2589	61%
Aug (2012-2021)	6	9	9	1641	2647	62%
Sep (2012-2021)	4	8	12	1296	2270	57%
Oct (2012-2021)	7	10	10	1860	2866	65%
Nov (2012-2021)	2	6	11	573	1547	37%
Dec (2012-2021)	1	5	7	301	1307	23%



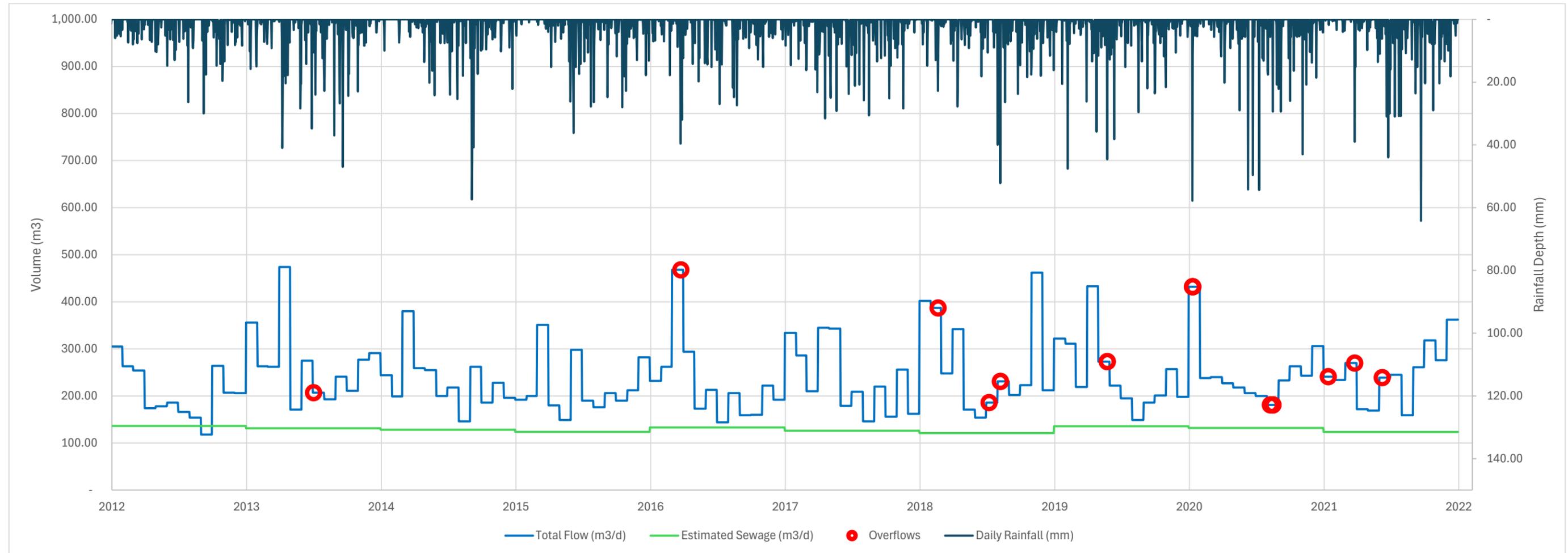
**Figure 3-16: %I&I Volume by Month**

### 3.4.5 Thedford WWF Analysis

The annual wet-weather analysis for Thedford is summarized in **Table 3-17** and a monthly wet weather analysis is summarized in **Table 3-18**. As mentioned in **Table 3-8** I&I makes up 46% of total flow volume and the maximum peak I&I recorded between 2012-2021 is 343 m<sup>3</sup>/day with a maximum Peaking Factor of 3. Average GWI is 107 m<sup>3</sup>/day and 56% of I&I is considered infiltration for Thedford. **Figure 3-17** presents the wet-weather analysis for Thedford from 2012-2021. The graph presents: Total Flow (m<sup>3</sup>/d), Estimated Sewage flow (m<sup>3</sup>/d), Overflow events, GWI (m<sup>3</sup>/d) and Daily Rainfall (mm).

**Figure 3-18** illustrates the % I&I volume (i.e. percentage of total flow that is I&I) plotted with the annual rainfall. This chart shows that the percentage of I&I within the total flow has been relatively constant throughout the ten-year period.

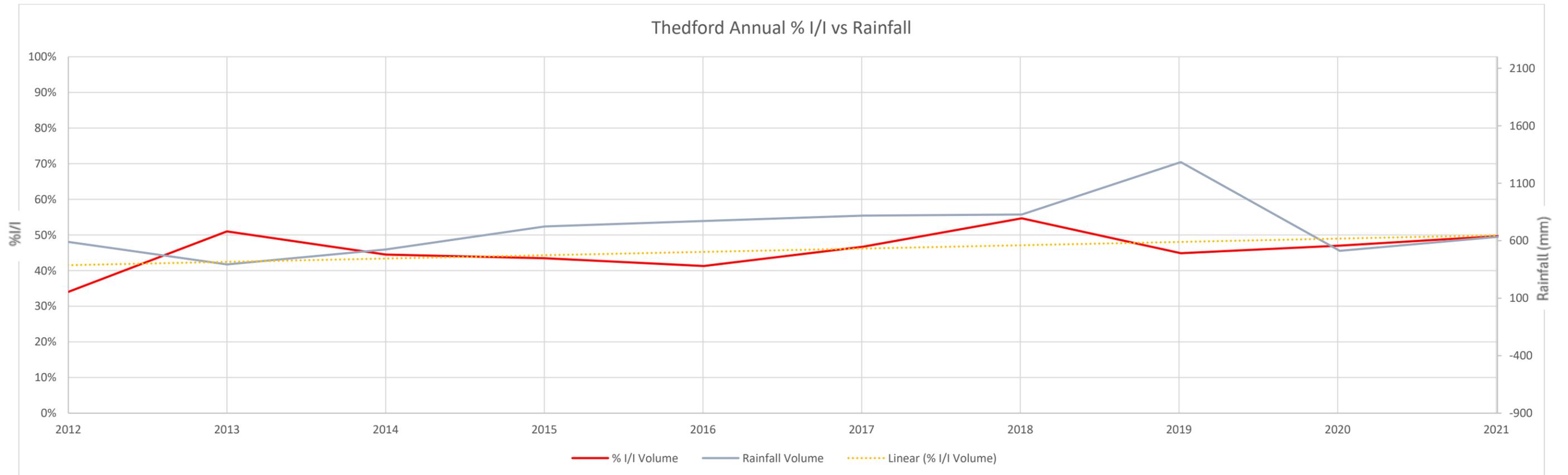
**Figure 3-19** presents monthly % I&I volume from 2012-2021. This chart shows that the percentage of I&I within the total flow fluctuates significantly between seasons, with an average around 55% in winter/spring when soil conditions are wet and closer to 35% during summer months when conditions are dry. This indicates that infiltration (which is strongly influenced by soil conditions) may be a large component of the total I&I in the system.



**Figure 3-17: Thedford Wet-Weather Analysis (2012-2021)**

**Table 3-17: Thedford Annual WWF Analysis**

Annual Wet-Weather Analysis (2012-2021)						
Year	Average GWI (m <sup>3</sup> /d)	Average Dry Weather Flow (m <sup>3</sup> /d)	Peak Daily I&I (m <sup>3</sup> /d)	Total I&I (m <sup>3</sup> )	Total Wastewater (m <sup>3</sup> )	% I&I in Total Flow
2012	63	199	169	25,674	75,514	34%
2013	135	266	343	49,880	97,795	51%
2014	103	232	252	37,573	84,417	45%
2015	97	221	227	34,730	79,910	43%
2016	93	227	335	34,309	83,063	41%
2017	102	228	219	40,334	86,368	47%
2018	144	265	341	53,306	97,499	55%
2019	104	240	297	40,355	89,915	45%
2020	112	244	300	42,872	91,212	47%
2021	118	242	238	44,548	89,676	50%

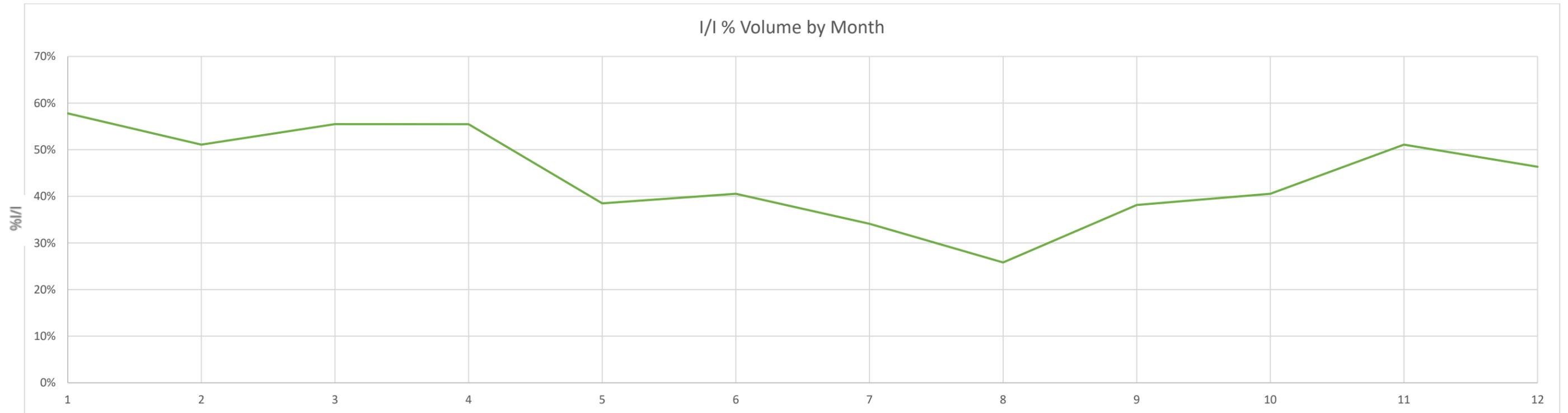


**Figure 3-18: Thedford Annual %I&I vs Rainfall**

**Table 3-18: Thedford Monthly WWF Analysis**

Monthly Wet-Weather Analysis (2012-2021)						
Year	Average GWI (m <sup>3</sup> /d)	Average Dry Weather Flow (m <sup>3</sup> /d)	Peak Daily I&I (m <sup>3</sup> /d)	Total I&I (m <sup>3</sup> )	Total Wastewater (m <sup>3</sup> )	% I&I in Total Flow
Jan (2012-2021)	167	296	300	54,824	94,860	58%
Feb (2012-2021)	126	255	266	38,204	74,767	51%
Mar (2012-2021)	161	289	335	49,926	89,962	55%
Apr (2012-2021)	150	279	343	48,256	87,000	55%
May (2012-2021)	71	200	217	25,064	65,100	39%
Jun (2012-2021)	84	214	174	26,416	65,160	41%
Jul (2012-2021)	65	194	121	20,724	60,760	34%
Aug (2012-2021)	41	171	110	13,935	53,971	26%
Sep (2012-2021)	75	205	137	23,896	62,640	38%
Oct (2012-2021)	82	211	194	27,296	67,332	41%
Nov (2012-2021)	126	256	341	40,456	79,200	51%
Dec (2012-2021)	107	236	238	34,581	74,617	46%

I/I % Volume by Month



**Figure 3-19: %I&I Volume by Month**

## 4.0 Conclusions and Recommendations

- The flow and rainfall monitoring data available for use in this assessment was very coarse both spatially and temporally and therefore additional monitoring is the key next step to better understand system performance and how to best tackle capacity constraints and overflows at a more local level. In tandem with flow monitoring, it is also recommended that rain gauges be installed within each community to increase confidence and accuracy in I&I analysis as the distance to existing rain gauges is insufficient for such analysis. Once these systems have been monitored and analyzed in smaller sub catchment areas with higher resolutions data, then suitable I&I field investigations can be conducted to identify the I&I sources and develop the appropriate rehabilitation plan to mitigate the existing I&I sources and reduce the occurrence of wet weather overflows.
- It can be concluded based on the table below that base groundwater infiltration in Grand Bend is of High Severity. The base groundwater infiltration in Thedford, Forest and Arkona are considered Medium Severity, and Low Severity in Indian Hills. The same conclusions can be made regarding the total I&I volumes within the systems.

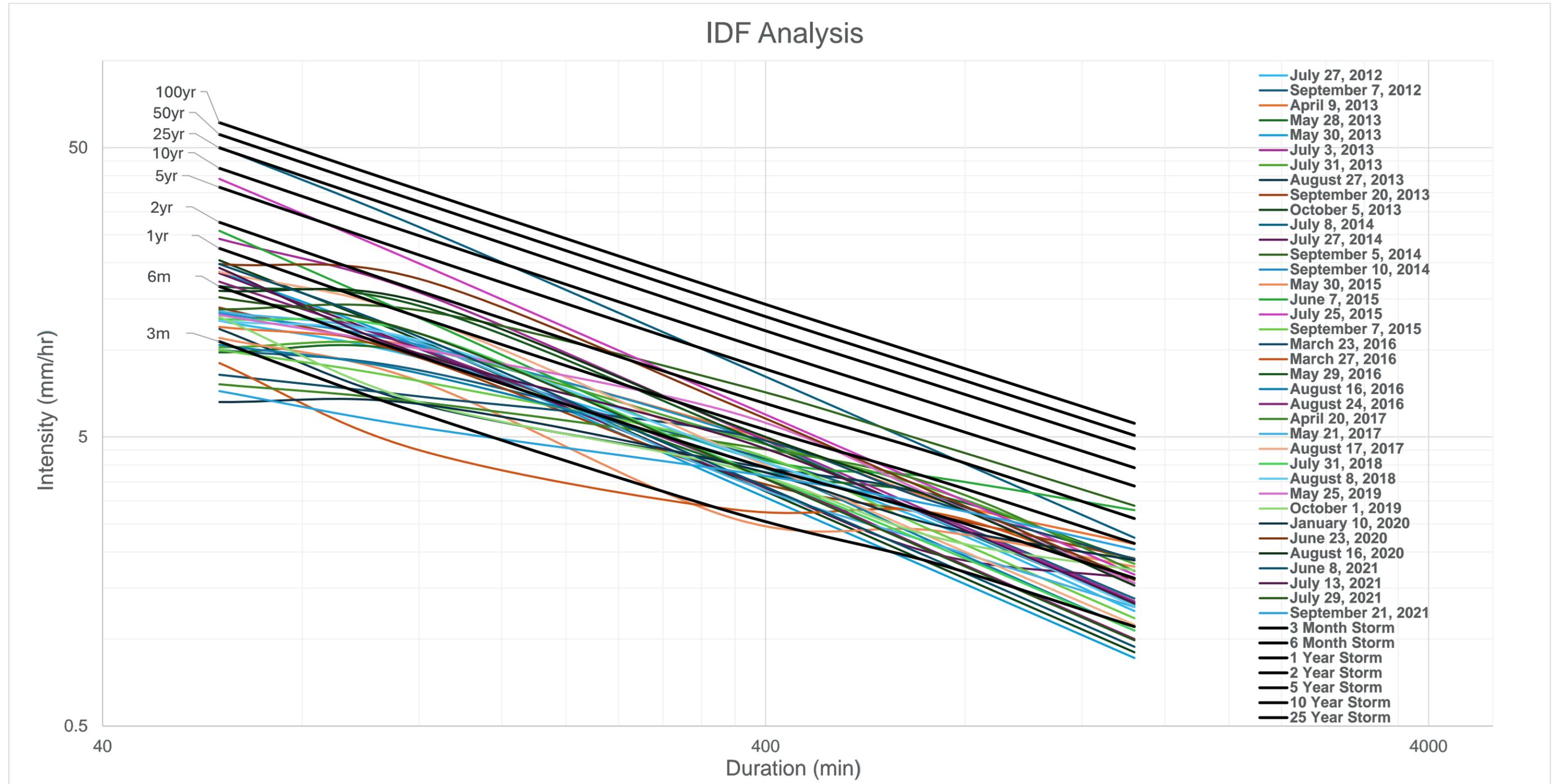
Site	% GWI in Avg DWF	% I&I in Total Flow
Arkona	48%	52%
Forest	55%	58%
Grand Bend	71%	74%
Indian Hills	12%	18%
Thedford	45%	46%

- Municipal overflow reports were used to summarize and assess the overflow events in Arkona, Forest, Grand Bend and Thedford. No overflow events were reported for Indian Hills. In **Section 3.2** an overflow analysis for each catchment area was provided along with the analysis of any rainfall that preceded each overflow event. The causes for the overflow events were a result of various equipment failures and precipitation. The precipitation related overflows in Forest and Thedford occurred during storm events that had a return frequency that ranged from less than 3 months to 1-2 year. There were five (5) rain events that had a return frequency equal to or greater than a 2-year return period, but no overflows occurred during these events.
- Conducting condition assessments of the sanitary infrastructure is recommended to inspect the sanitary sewer lines, manholes, pumping stations and treatment facilities. Completing condition assessments would allow the identification of any defects causing overflows and prepare suitable rehabilitation methods.
- A review of Operation and Maintenance inspection schedules can help to rectify some of the equipment failure issues that caused overflow events. Increasing the scheduled inspections for areas with repeated equipment failure can be applied as preventative measures.
- According to the F-5-1 Determination of Treatment Requirements for Municipal and Private Sewage Treatment Works, Section 3.6 Non-compliance of Existing Sewerage Systems states that existing municipal and private sewerage systems that do not comply with the F-5-1 guidelines should be upgraded to meet the requirements to meet the guidelines as soon as possible. Some overflows occurred during small storms but didn't occur during larger events, which makes it difficult to assess performance under the F-5-1 requirements. As such, additional monitoring and modelling should be undertaken to quantify the peak flows being received at these stations and develop strategies to prevent overflows through I&I reduction and/or equipment upgrades.
- Civica has built a sanitary model for the five (5) authorized sanitary sewer networks. Modeling the sanitary network allows assessment of the system response to different design storm scenarios and to determine the pipe capacities. Understanding how the sanitary collection system will respond to rain events can help guide the Municipality by identifying where improvements are needed. The flow monitoring data can be used to calibrate the sanitary model and improve accuracy. The existing conditions of the sanitary system can be analyzed and determine any system constraints. Running the model under different scenarios can be used to analyze how the sanitary network responds. Solutions for capacity constraints can be developed especially for locations where overflows occurred due to precipitation events.
- Flow and rainfall monitoring is recommended for a period of at least eight (8) months to gather sufficient rainfall events for I&I analysis and model calibration. In general, one (1) flow monitor is recommended to be installed for at least 100 hectares for the initial monitoring period. Additional monitors may be recommended upstream of pumping stations with known capacity constraints in Thedford and Forest.
- The table below provides a cost breakdown for the recommended actions for the Municipality to consider as next steps to be taken. A price range has been provided for budgetary and planning purposes to provide an estimate for these services. For the sewer and manhole condition assessments, municipalities commonly plan to inspect infrastructure on a 5-10 year schedule (with only 10% - 20% being inspected each year). The costs to assess pumping stations and treatment facilities will vary depending on the scope of the assessments and, particularly with treatment facilities, the design and size. The provided costs can be further refined if the Municipality plans to proceed with the recommended work and more information about the sites and scope of work are provided.

Recommendation	Item	Description	Estimate Cost
Monitoring	Flow Monitoring	Installation, monitoring and calibration for 8 flow monitors: 1 in Arkona, 3 in Forest, 2 in Grand Bend, 1 in Thedford 1, and 1 in Indian Hills (\$1,200 / monitor / month)	\$9,600/month
	Rainfall Monitoring	Installation, monitoring and calibration for 5 rain gauges: 1 rain gauge will be installed for each sanitary network (\$500 / monitor / month)	\$2,500/month
Condition Assessments	Flushing	Hydraulic flushing of the sanitary mainline	\$3-\$6 per meter
	CCTV Inspection	CCTV inspection of the sanitary mainline	\$3-\$6 per meter
	Manhole Inspection	Level 1 manhole inspections	\$150 – \$300 per manhole
	Pumping Stations	Assessment of the general condition and operation of the station	\$10,000 - \$20,000 per station
	Treatment Facilities	Due to the large variability of treatment facility designs and size, cost estimates would need to be site specific.	-
Modelling	Sanitary Model Calibration	Calibration of the five (5) sanitary models using data from eight (8) flow monitors	\$15,000- \$20,000

## Appendix I – IDF Chart

# IDF Analysis



## Appendix II – Overflow Reports

Overflow Reports:

Arkona:

**BYPASS AND/OR OVERFLOW EVENT REPORT**

Facility: Arkona

Waterworks Number: 120002567

Year: 2021

Location	Date	Event Start Time	Event End Time	Event Duration (mins)	Total Volume (m3)	Sampled	Flow Mes/Mod/Est	Level of Treatment Received	Disinfection status	Reason(s)	SAC Ref #	
Q1												
Ann St force main	6-Feb	10:00	14:00	N/A	N/A	Yes	N/A	Raw	No	5	7277-BXYMKJ	Start time is when we were notified
Q2												
Ann St Force main	6-Apr	9:26	11:30	120	0.5	Yes	Est	Raw	No	5	1-C3LXR	Start time is when we were notified
Q3												
No events this quarter												
Q4												
No events this quarter												

Flow	Level of Treatment	Disinfection	Reason
Mod = Modelled	Sewage, Raw	No	1 = Precipitation
Mes = Measured	Sewage, Primary Treatment rec'd	Yes, Chlorinated	2 = Spring Thaw / Snow Melt
Est = Estimated	Sewage, Secondary treatment rec'd	Yes, UV	3 = Infiltration
	Sewage, Tertiary	Yes, Ozone	4 = Mechanical/Equipment Failure
	Sewage, Final Effluent		5 = Pipe Failure (break/leak/plugged)
			6 = Process Upsets
			7 = Power Failure
			8 = Planned Maintenance
			9 = Exceed Design Capacity
			10 = Other





**BYPASS AND/OR OVERFLOW EVENT REPORT**

Facility: Forest

Waterworks Number: 110001346

Year: 2019

Location	Date	Event Start Time	Event End Time	Event Duration (mins)	Total Volume (m3)	Sampled	Flow Mes/Mod/Est	Level of Treatment Received	Disinfection status	Reason(s)	SAC Ref #
Q1											
No events this quarter											
Q2											
Clyde St PS	25-May	7:30	11:50	260	390	Yes	Est	Raw	No	1	903362
Q3											
No events this quarter											
Q4											
No events this quarter											

Flow	Level of Treatment	Disinfection	Reason
Mod = Modelled	Sew age, Raw	No	1 = Precipitation
Mes = Measured	Sew age, Primary Treatment rec'd	Yes, Chlorinated	2 = Spring Thaw / Snow Melt
Est = Estimated	Sew age, Secondary treatment rec'd	Yes, UV	3 = Infiltration
	Sew age, Tertiary	Yes, Ozone	4 = Mechanical/Equipment Failure
	Sew age, Final Effluent		5 = Pipe Failure (break/leak/plugged)
			6 = Process Upsets
			7 = Power Failure
			8 = Planned Maintenance
			9 = Exceed Design Capacity
			10 = Other

**BYPASS AND/OR OVERFLOW EVENT REPORT**

**Facility: Forest**

**Waterworks Number: 110001346**

**Year: 2020**

Location	Date	Event Start Time	Event End Time	Event Duration (mins)	Total Volume (m3)	Sampled	Flow Mes/Mod/Est	Level of Treatment Received	Disinfection status	Reason(s)	SAC Ref #	
Q1												
Clyde St PS	11-Jan	11:30	17:30	360	43	Yes	Est	Raw	No	1	903969	
Q2												
No events this quarter												
Q3												
No events this quarter												
Q4												
No events this quarter												

<b>Flow</b>	<b>Level of Treatment</b>	<b>Disinfection</b>	<b>Reason</b>
Mod = Modelled	Sewage, Raw	No	1 = Precipitation
Mes = Measured	Sewage, Primary Treatment rec'd	Yes, Chlorinated	2 = Spring Thaw / Snow Melt
Est = Estimated	Sewage, Secondary treatment rec'd	Yes, UV	3 = Infiltration
	Sewage, Tertiary	Yes, Ozone	4 = Mechanical/Equipment Failure
	Sewage, Final Effluent		5 = Pipe Failure (break/leak/plugged)
			6 = Process Upsets
			7 = Power Failure
			8 = Planned Maintenance
			9 = Exceed Design Capacity
			10 = Other

**BYPASS AND/OR OVERFLOW EVENT REPORT**

**Facility: Forest**

**Waterworks Number: 110001346**

**Year: 2021**

Location	Date	Event Start Time	Event End Time	Event Duration (mins)	Total Volume (m3)	Sampled	Flow Mes/Mod/Est	Level of Treatment Received	Disinfection status	Reason(s)	SAC Ref #
Q1											
Clyde St PS	26-Mar	7:20	8:00	40	<100	Yes	Est	Raw	No	1	904963
Q2											
No events this quarter											
Q3											
No events this quarter											
Q4											
No events this quarter											
<b>Flow</b>	<b>Level of Treatment</b>			<b>Disinfection</b>			<b>Reason</b>				
Mod = Modelled	Sewage, Raw			No			1 = Precipitation				
Mes = Measured	Sewage, Primary Treatment rec'd			Yes, Chlorinated			2 = Spring Thaw / Snow Melt				
Est = Estimated	Sewage, Secondary treatment rec'd			Yes, UV			3 = Infiltration				
	Sewage, Tertiary			Yes, Ozone			4 = Mechanical/Equipment Failure				
	Sewage, Final Effluent						5 = Pipe Failure (break/leak/plugged)			8 = Planned Maintenance	
							6 = Process Upsets			9 = Exceed Design Capacity	
							7 = Power Failure			10 = Other	



Facility Name: Grand Bend

Year: 2016

Date dd/mm/yy	Location	Type P/S	Start Time	Duration Hours	Volume m3	Disinfection Y/N/U	Reason Code	Sample Results			
								BOD mg/l	TSS mg/l	TP mg/l	Ecoli / 100 ml
4/18/2016	Mollard Forcemain	P	10:30	1	41	N	3	No samples collected per MOECC			
SAC Ref # 7232-A95LKH											
5/24/2016	PS2 Overflow	P			10.5	N	3	5	22	0.36	220
	Upstream							6	19	<0.03	84
	Downstream							4	24	<0.03	2100
SAC Ref # 1321-AA9JXF											
6/8/2016	Pinery Forcemain	P	13:40	<1	6	N	3	152	304	15.7	450000
SAC Ref # 3168-AAQRX5											
6/30/2016	55 River road	P				N	3	2090	722	13.5	1150000
	Upstream							6	10	0.04	330
	Downstream							<4	10	<0.03	400
SAC Ref # 6160ABEL4J											
7/6/2016	75 River Rd	P	11:00	1	<1	N	3	999	282	22.2	4400000
SAC Ref # 7438-ABLDDK											

Primary Bypass - P - the discharge of raw sewage subject to no treatment except grit removal and or chlorination

Y=Yes

Reason Codes

N=No

1 = Heavy Precipitation 5 = Sewer Problems

U=Unknown

2 = Snow Melt 6 = Power Failure

Secondary Bypass - S - the discharge of sewage that has undergone solids removal at the primary clarifiers but bypassed the secondary treatment process

3 = Equipment Failure 7 = Exceed design capacity

4 = Equipment Maintenance

Facility Name: Grand Bend

Year: 2017

Date dd/mm/yy	Location	Type P/S	Start Time	Duration Hours	Volume m3	Disinfection Y/N/U	Reason Code	Sample Results			
								BOD mg/l	TSS mg/l	TP mg/l	Ecoli / 100 ml
1/18/2017	Mollard Forcemain	P				N	3	no samples collected			
SAC Ref # 6374-AHQMPJ											
Start time not known. Leak reported to CH2M about 1100 Jan 18. Repairs complete by 1520 on Jan 19.											
4/16/2017	Mollard Forcemain	P				N	3	42	153	3.67	620000
SAC Ref # 2085-ALGNVL											
Start time not known. Leak reported to CH2M about 1430 Apr 16. Repairs complete by 1845 on Apr 17.											
12/14/2017	HC Playhouse forcemain	P	1500	2.5	4	N	3	no samples collected			
SAC Ref# 1586-AV3269											
Force main break repaired by South Huron staff. CH2M was notified after the repair was complete											

Primary Bypass - P - the discharge of raw sewage subject to no treatment except grit removal and or chlorination

Secondary Bypass - S - the discharge of sewage that has undergone solids removal at the primary clarifiers but bypassed the secondary treatment process

Y=Yes  
N=No  
U=Unknown

Reason Codes  
1 = Heavy Precipitation  
2 = Snow Melt  
3 = Equipment Failure  
4 = Equipment Maintenance  
5 = Sewer Problems  
6 = Power Failure  
7 = Exceed design capacity

**BYPASS AND/OR OVERFLOW EVENT REPORT**

Facility: Grand Bend Waterworks Number: 110002452

Year: 2020

Location	Date	Event Start Time	Event End Time	Event Duration (mins)	Total Volume (m3)	Sampled	Flow Mes/Mod/Est	Level of Treatment Received	Disinfection status	Reason(s)	SAC Ref #	
Q1												
No events this quarter												
Q2												
No events this quarter												
Q3												
River Road	19-Jul	10:00	14:00	N/A	N/A	No	N/A	N/A	N/A	wind	0384BRNP5B	times estimated
Q4												
Mollard Line	12-Nov	10:07	11:30		2	Yes	Est	None	None	4	5760-BVAR6L	Start time is when we were notified by South Huron

<b>Flow</b>	<b>Level of Treatment</b>	<b>Disinfection</b>	<b>Reason</b>
Mod = Modelled	Sewage, Raw	No	1 = Precipitation
Mes = Measured	Sewage, Primary Treatment rec'd	Yes, Chlorinated	2 = Spring Thaw / Snow Melt
Est = Estimated	Sewage, Secondary treatment rec'd	Yes, UV	3 = Infiltration
	Sewage, Tertiary	Yes, Ozone	4 = Mechanical/Equipment Failure
	Sewage, Final Effluent		5 = Pipe Failure (break/leak/plugged)
			6 = Process Upsets
			7 = Power Failure
			8 = Planned Maintenance
			9 = Exceed Design Capacity
			10 = Other

**BYPASS AND/OR OVERFLOW EVENT REPORT**

**Facility: Grand Bend Waterworks Number: 110002452**

**Year: 2021**

Location	Date	Event Start Time	Event End Time	Event Duration (mins)	Total Volume (m3)	Sampled	Flow Mes/Mod/Est	Level of Treatment Received	Disinfection status	Reason(s)	SAC Ref #	
Q1												
Lagoon 1	23-Mar	12:30	N/A	N/A	Unknown	Yes	N/A	Secondary	No	4	2366-BZDNT5	Start time is when we were notified
Q2												
No events this quarter												
Q3												
No events this quarter												
Q4												
No events this quarter												

<b>Flow</b>	<b>Level of Treatment</b>	<b>Disinfection</b>	<b>Reason</b>
Mod = Modelled	Sewage, Raw	No	1 = Precipitation
Mes = Measured	Sewage, Primary Treatment rec'd	Yes, Chlorinated	2 = Spring Thaw / Snow Melt
Est = Estimated	Sewage, Secondary treatment rec'd	Yes, UV	3 = Infiltration
	Sewage, Tertiary	Yes, Ozone	4 = Mechanical/Equipment Failure
	Sewage, Final Effluent		5 = Pipe Failure (break/leak/plugged)
			6 = Process Upsets
			7 = Power Failure
			8 = Planned Maintenance
			9 = Exceed Design Capacity
			10 = Other

Theford:

## Theford Wastewater System 2013 Annual Report of Operations

The Theford wastewater system consists of two (2) lagoon cells that are annually discharged to a municipal drain. One lagoon was discharged in 2013. Lab results of the discharge samples are attached. One pump station bypass occurred in July 2013 due to heavy rainfall. On September 29 2013, a meeting was held with the municipality and the MOE to discuss Total Phosphorus removal at the Theford lagoons. A copy of the meeting minutes are attached with this report. Quarterly reports are the S1 and S2 forms for lagoons, and are submitted to the Sarnia MOE office by the 30<sup>th</sup> of the following month for each quarter. All 2013 S1 and S2 forms are attached. The flow meter was calibration checked in November 2013; the results are attached.

Maintenance tasks completed this year include:

1. CT Environmental cleaned out both pump stations and the lagoon outflow on June 6.
2. The service entrance wiring at the Main Street pump station was replaced.
3. Indicator lights at the pump stations were replaced.

### Bypass

One pump station bypass occurred at the Ravenswood pump station on July 3 2013 due to heavy rainfall. SAC was notified, AWQI#112080. Estimated bypass duration 3.5 hours. Estimated volume of bypass 1863.75 m<sup>3</sup>.

Facility Name: Thedford Main St Pump Station

Year: 2016

Date dd/mm/yy	Location	Type P/S	Start Time	Duration Hours	Volume m3	Disinfection Y/N/U	Reason Code	Sample Results			
								BOD mg/l	TSS mg/l	TP mg/l	Ecoli / 100 ml
24/03/2016	Main St P S	P	1830	5	98	N	1	40	120	0.47	40000
	Upstream							<12	533	0.43	200
	Downstream							<12	420	0.39	660
SAC Ref # 128724											

Primary Bypass - P - the discharge of raw sewage subject to no treatment except grit removal and or chlorination

Y=Yes  
N=No  
U=Unknown

Reason Codes  
1 = Heavy Precipitation    5 = Sewer Problems  
2 = Snow Melt                6 = Power Failure  
3 = Equipment Failure      7 = Exceed design capacity  
4 = Equipment Maintenance

Secondary Bypass - S - the discharge of sewage that has undergone solids removal at the primary clarifiers but bypassed the secondary treatment process



**BYPASS AND/OR OVERFLOW EVENT REPORT**

Facility: Thedford

Waterworks Number: 110002336

Year: 2019

Location	Date	Event Start Time	Event End Time	Event Duration (mins)	Total Volume (m3)	Sampled	Flow Mes/Mod/Est	Level of Treatment Received	Disinfection status	Reason(s)	SAC Ref #	
Q1												
No events this quarter												
Q2												
Ravensw ood PS	25-May	7:42	11:05	213	63.9	Yes	Est	Raw	No	1	903363	
Main St PS	25-May	7:51	10:15	144	43.2	Yes	Est	Raw	No	1	903363	
Q3												
No events this quarter												
Q4												
No events this quarter												

<b>Flow</b>	<b>Level of Treatment</b>	<b>Disinfection</b>	<b>Reason</b>
Mod = Modelled	Sew age, Raw	No	1 = Precipitation
Mes = Measured	Sew age, Primary Treatment rec'd	Yes, Chlorinated	2 = Spring Thaw / Snow Melt
Est = Estimated	Sew age, Secondary treatment rec'd	Yes, UV	3 = Infiltration
	Sew age, Tertiary	Yes, Ozone	4 = Mechanical/Equipment Failure
	Sew age, Final Effluent		5 = Pipe Failure (break/leak/plugged)
			6 = Process Upsets
			7 = Power Failure
			8 = Planned Maintenance
			9 = Exceed Design Capacity
			10 = Other

**BYPASS AND/OR OVERFLOW EVENT REPORT**

Facility: Thedford

Waterworks Number: 110002336

Year: 2020

Location	Date	Event Start Time	Event End Time	Event Duration (mins)	Total Volume (m3)	Sampled	Flow Mes/Mod/Est	Level of Treatment Received	Disinfection status	Reason(s)	SAC Ref #
Q1											
Ravenswood PS	11-Jan	8:40	17:35	535	64	Yes	Est	Raw	No	1	903950
Main St PS	11-Jan	8:40	18:05	565	68	Yes	Est	Raw	No	1	903951
Ravenswood PS	12-Jan	1:45	4:30	165	20	Yes	Est	Raw	No	1	904073
Main St PS	12-Jan	1:45	4:00	135	16	Yes	Est	Raw	No	1	904073
Q2											
No events this quarter											
Q3											
Ravenswood PS	9-Aug	12:15	13:00	45	5.4	Yes	Est	Raw	No	1	904661
Ravenswood PS	16-Aug	10:00	11:46	106	12.7	Yes	Est	Raw	No	1	904678
Main St PS	16-Aug	10:00	11:25	85	10.2	Yes	Est	Raw	No	1	904677
Q4											
No events this quarter											

<b>Flow</b>	<b>Level of Treatment</b>	<b>Disinfection</b>	<b>Reason</b>
Mod = Modelled	Sewage, Raw	No	1 = Precipitation
Mes = Measured	Sewage, Primary Treatment rec'd	Yes, Chlorinated	2 = Spring Thaw / Snow Melt
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	Sewage, Final Effluent		5 = Pipe Failure (break/leak/plugged)
			6 = Process Upsets
			7 = Power Failure
			8 = Planned Maintenance
			9 = Exceed Design Capacity
			10 = Other

**BYPASS AND/OR OVERFLOW EVENT REPORT**

**Facility: Thedford**

**Waterworks Number: 110002336**

**Year: 2021**

Location	Date	Event Start Time	Event End Time	Event Duration (mins)	Total Volume (m3)	Sampled	Flow Mes/Mod/Est	Level of Treatment Received	Disinfection status	Reason(s)	SAC Ref #	
Q1												
8040 Ravenswood Line - Lagoon Valve	13-Jan	9:25	10:00	35	1	Yes	Est	Raw	No	5	2080-BX8N5A	Start time is when it was discovered
Ravenswood PS	26-Mar	6:50	8:00	70	100	Yes	Est	Raw	No	1	904959	
Q2												
Ravenswood PS	8-Jun	18:30	20:15	105	77	Yes	Est	Raw	No	1	1HPQD9	
Q3												
No events this quarter												
Q4												
No events this quarter												

<b>Flow</b>	<b>Level of Treatment</b>	<b>Disinfection</b>	<b>Reason</b>
Mod = Modelled	Sewage, Raw	No	1 = Precipitation
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