LOWELL REGIONAL WASTEWATER UTILITY
CITY OF LOWELL, MA
2024 INFILTRATION AND INFLOW ANALYSIS
SUPPLEMENTAL REPORT
KLEINFELDER PROJECT #20220166.003A

March 24, 2025

INFILTRATION AND INFLOW ANALYSIS REPORT

CERTIFICATION STATEMENT

I certify under penalty of perjury that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I have no personal knowledge that the information submitted is other than true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

3/25/2025

Aaron Fox
Executive Director
Lowell Regional Wastewater Utility

Date

A Report Prepared for:

Mr. Aaron Fox
Executive Director
Lowell Regional Wastewater Utility
451 First Street Blvd
Lowell, MA 01850

2024 INFILTRATION AND INFLOW ANALYSIS SUPPLEMENTAL REPORT
CITY OF LOWELL, NA

Prepared by:

Jillian Rossini
Project Engineer

Reviewed by:

Katherine Goyette
Senior Project Manager

KLEINFELDER
One Beacon Street, Suite 8100
Boston, MA 02108
Phone: 617.497.7800

March 24, 2025
Kleinfelder Project No: 20220166.003A

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 EXECUTIVE SUMMARY

The City of Lowell (City) implemented an ongoing Infiltration/Inflow (I/I) Identification and Removal Program compliant with Massachusetts Department of Environmental Protection (MassDEP's) regulations at 314 CMR 12.04(2). The 2023 I/I Analysis Report identified eleven (11) meter areas that had inconclusive results and needed a supplementary metering program to further evaluate. This 2024 Supplemental I/I Analysis Report provides a summary of the 2024 targeted flow re-metering program, identifies re-prioritized areas of the wastewater collection system with excessive I/I, and provides a revised schedule and estimated costs for subsequent phases of Sewer System Evaluation Surveys (SSES). These recommendations serve as a road map for the Utility to implement an ongoing plan to execute I/I investigations and reduction efforts.

Background

As the Lowell Regional Wastewater Utility (Utility) holds a National Pollution Discharge Elimination System (NPDES) permit enforced by the United States Environmental Protection Agency (USEPA) and MassDEP, the City is required to identify sources of I/I in their system. 314 CMR 12.04(2) requires phased I/I evaluations of sewer systems consistent with *MassDEP's Guidelines for Performing Infiltration/Inflow Analyses and Sanitary Sewer Evaluation Surveys*, May 2017 (MassDEP Guidelines).

The Consent Decree (CD) for the City was fully executed and filed with the U.S. District Court on May 17, 2024 (Case: 1:24-cv-10290-DJC, Document 13). The Consent Decree includes the following requirements, under Section VI. Remedial Measures, Paragraph 18:

> *The City shall develop and implement an ongoing program to identify and remove infiltration and inflow from the sewer system in accordance with 314 C.M.R. §12.04(2) and shall provide annual flow information for those communities serviced by the Lowell Regional Wastewater Utility ("LRWU"). To meet this requirement, the City shall:*
>
> *a. By January 31, 2024, submit to MassDEP for review and approval an I/I Analysis Report. The I/I Analysis Report shall be consistent with the provisions of 314 C.M.R. § 12.04(2) and, as referenced therein, the MassDEP's 2017 Guidelines for Performing*

Infiltration/Inflow Analyses and Sewer System Evaluation Surveys, and shall include a detailed assessment of flow data gathered from the 2023 sewer metering program. The I/I Analysis Report shall also include an implementation schedule, based on assessment of the flow data, for proceeding with sewer system evaluation surveys, and actions to address sources of Infiltration and Inflow.

The 2023 sewer metering program was a City-wide flow monitoring program including sixty-three (63) temporary wastewater flow meters, one hundred and ten (110) groundwater gauges, and three (3) rain gauges to quantify the magnitude to of I/I entering the collection system. Upon review of the final metering data for all sites, Kleinfelder excluded data from eleven (11) meter areas from the I/I analysis due to poor quality of data. The Utility submitted the 2023 Infiltration/Inflow (I/I) Analysis Report on January 31, 2024 in accordance with the Consent Decree which included an 8-phase Sanitary Sewer Evaluation Survey (SSES) Implementation Plan.

The Utility committed to re-metering ten of the 2023 meter areas in Spring 2024 to determine I/I volumes from these areas, and revisit the prioritized SSES investigations and phasing presented in 2023 I/I Analysis Report based on the additional I/I results and other planned system improvements by the Utility.

The Utility also completed Phase 1 SSES investigations as identified in the SSES Implementation Plan in 2024. Phase 1 consisted of CCTV and manhole investigations of some of the Utility's oldest infrastructure in the downtown area of the City (Meter Areas 51, 38, 37) and multi-sensor inspections (CCTV, laser, and sonar) of the Utility's river-front interceptor pipe, approximately 56,300 LF of sewer ranging in size from 36 to 120-inch in diameter. The field findings of Phase 1 SSES will be summarized in the SSES Phase 1 Report, to be finalized by April 2025.

2024 Flow Monitoring Program

In March 2024, Kleinfelder subcontracted with ADS Environmental Services (ADS) to conduct a targeted flow monitoring program through temporary wastewater flow metering, groundwater depth monitoring, and precipitation monitoring to quantify the magnitude of I/I entering the sewer system in areas reporting poor quality data through the 2023 City-wide flow metering program, as outlined in the 2023 I/I Analysis Report. ADS installed ten (10) temporary gravity sewer flow meters for a period of twenty-five (25) weeks from April 2, 2024 to September 24, 2024. The 10 sewer-meter areas (27, 29, 30, 41, 51, 52, 53, 54, 55, and 58) were designed to capture the same meter areas as the prior 2023 flow meter program. However, for more favorable hydraulics Meters 30 and 58 were moved to nearby manhole locations.

ADS installed a total of ten (10) manual groundwater monitoring devices (piezometers) inside shared sewer manholes housing the temporary flow meters. The intent of this supplemental groundwater monitoring was to compare the depth of ground water between 2023 and 2024 metering periods and to understand the general trends in groundwater depths throughout the 2024 metering period. In comparing groundwater levels at the 2024 metering sites with their respective groundwater levels in 2023, groundwater was consistently lower during the 2024 meter period with the exception of Meter 29, where similar groundwater water levels were observed.

Kleinfelder completed an I/I analysis for the 2024 meters in accordance with the MassDEP Guidelines. MassDEP defines an infiltration rate of 4,000 gallons per day per inch-diameter mile (gpd/idm) as the threshold at which further field investigations, including manhole inspections, flow isolation, and CCTV, should be prioritized to identify sources of infiltration. Seven of the ten re-metered areas exceeded the 4,000 gpd/idm threshold and require further investigation to identify infiltration sources per the MassDEP designation. **Table ES-1** lists infiltration rates estimated from both the 2023 and 2024 flow monitoring programs, with the 2024 meter areas shown in white rows. A total of 31 meter-areas analyzed in 2023 and 2024 exbibit infiltration rates of greater than 4,000 gpd/idm. Due to flow balance issues, it was infeasible to establish a diurnal curve for Meters 41 and 51 and therefore infiltration estimates for these areas were indeterminate. CCTV and manhole inspections were completed in Meter 51 in 2024 as part of the Utility's Phase 1 SSES investigations. Results of these investigations will be included in the Phase 1 SSES Report, anticipated in April 2025.

The flow monitoring program included the installation of one (1) rain gauge at the Warren Station. Precipitation is recorded to illustrate the impact of rainfall on groundwater levels and to determine inflow rates during different storm events for conversion to designated standard design storms. Three storm events were selected for inflow analysis and normalized to yield inflow volumes for the MassDEP's 1 year, 6-hour design storm.

Given the percentage of the system that is combined and the Utility's planned sewer separation in the Centralville and Phase 3 CSO areas, the approach for the supplemental inflow analysis is to review the design storm inflow volumes for the existing fully and partially separated areas, where inflow volumes are expected to be minimal, and prioritize those areas with the greatest inflow volumes for further investigation. Through the Phase 3 CSO Preliminary Design efforts conducted in 2024, the Utility has identified catch basins tied to the sanitary sewer in areas that were previously separated, tributary to the Warren CSO Station. Redirection of these catch basins will significantly reduce the inflow volumes in

the separated sewer areas and provide additional available capacity in downstream combined sewer interceptors.

Table ES-2 summarizes the total, direct, and delayed design storm inflow volumes for the fully and partially separated areas from the 2023 and 2024 Flow Monitoring programs. Twenty-six meter areas are comprised of fully or partially separated sewers and exhibit inflow totaling over 10 million gallons for the DEP design storm. Several fully separated areas such as Meter 10, 27, and 30 exhibit significant direct inflow volumes, indicating there may be dedicated storm drains with direct connections to the sanitary sewer.

SSES Implementation Program

The results of the I/I analysis for the 2024 flow metering program reported some of highest infiltration rates in the collection system and significant direct inflow volumes in fully and partially separated areas. These findings warrant a reassessment of the 2023 SSES Implementation Plan (2023 SSES Plan). The 2023 SSES Plan included an implementation schedule with Phase 2 field investigations beginning in Spring 2026 and completion of Phase 8 field investigations in 2032, allowing for future I/I investigations to be informed by the Updated Long-Term CSO Control Plan (Updated LTCP) to be completed by 2034 in accordance with the CD. Given the Utility's commitments to several major projects to achieve compliance with the Consent Decree over the next ten years, the updated 2024 SSES Implementation Plan (2024 SSES Plan) will be consistent with the Utility's previously planned spending and schedule.

The proposed updated 2024 SSES Plan is presented in **Table ES-3**. **Table ES-3** lists each SSES phase including the affected meter areas, proposed infiltration investigations (manhole and CCTV inspections) and proposed inflow investigations (smoke testing, building inspections, dye testing) to identify sources of I/I and determine rehabilitation and repair methods to reduce I/I contributions to the sewer collection system. Consistent with the 2023 SSES Plan, the 2024 SSES Plan includes 8-phases, with field investigations terminating in 2032. The 2024 SSES Plan notes Phase 1 SSES as completed and includes the quantities of CCTV and manhole inspections completed. SSES Phases 2 through 8 include the following scope:

- Infiltration investigations for 15 meters areas
- Inflow investigations for 10 fully and partially separated meter areas
- CCTV and manhole inspection of sewers located along the Pawtucket Canal
- Inspections of siphons

The 2023 SSES Plan included infiltration investigations for 15 meter-areas in Phases 2 through 8. As shown in Table ES-1 ranking the infiltration rates of the 2024 meter areas against the 2023 meter areas adds Meter 27, 30, and 55 within the top 15 meter-areas with highest system infiltration rates. Including these areas in the 2024 SSES Plan, subsequently removes three areas with lower infiltration rates that were previously included in the 2023 SSES Plan. Phases 4 through 8 of the 2024 SSES Plan are focused on infiltration investigations in areas with higher infiltration rates where the Utility is not planning future system investigations or improvement projects.

The 2024 SSES Plan will prioritize the direct inflow investigations for the fully separated areas exhibiting the highest direct inflow volumes in Phases 2 (2026) and 3 (2027). This includes smoke testing, building inspections, and dye testing for Meters 10, 27, 30, and 63, identified as fully separated as shown in **Table ES-2**. Inflow investigations are also recommended for Meters 37 and 45 in areas with a dedicated storm drain, as they are identified as having some areas of separated sewer and contribute the highest inflow shown in **Table ES-2**. Other meter areas identified to be mostly separated that exhibit significant inflow are also recommended for further inflow investigations including Meters 9, 19, and 44. Although the inflow analysis for Meter 41 was inconclusive, with the recent public inflow sources identified in previously separated areas, it is prudent for the Utility to conduct inflow investigations in Meter 41, identified as fully separated.

Through both prior and the recent Phase 1 SSES field investigation efforts, the Utility has identified several collection system defects allowing for a cross-connection with the Pawtucket Canal. With these findings, it is recommended the Utility complete CCTV and manhole inspections of the remaining sewers located along the Pawtucket Canal in Phase 3 of the 2024 SSES Plan. Consistent with the 2023 SSES Plan, the Utility will also prioritize inspections of the collection system's siphons and inspect one per SSES phase, beginning in Phase 4.

Figure ES-1 shows the meter areas identified for each SSES phase with colored areas representing phases of infiltration investigations and diagonal hatching representing phases of inflow investigations. Figure ES-1 also includes the extents of the Pawtucket Canal sewers to be inspected in Phase 3, siphon inspections, along with the completed Phase 1 SSES interceptor inspections.

Table ES-4 presents planning-level cost estimates for the 8-phase SSES Implementation Plan. In addition to the I/I field investigations, cost estimates include engineering, a 10% contingency, and a 4% escalation rate each year.
The implementation schedule shown in **Figure ES-2** includes an overall timeline for each proposed SSES phase, along with continuous design and construction efforts to cost-effectively address sources of I/I.

The Utility has allocated $2 Million per year for design and construction of system repair/rehabilitation to reduce I/I. System improvements will be prioritized based on cost effectiveness on reducing I/I, along with the critical nature of system defects and the potential detriment to collection system operations, and public and environmental health. The Utility plans to begin design of the Downtown Area Sewer Rehabilitation Project in 2025, which will address system deficiencies identified through SSES Phase 1 investigations in Meter Areas 51, 38, and 37. Improvements recommended as a result of the river-front interceptors inspections will be detailed in the Phase 1 SSES Report, anticipated to be completed in April 2025.

Table ES-1: Estimated Infiltration Rates from 2023 and 2024 Flow Monitoring Programs

Meter	Type	Pipe Length (LF)	IDM	Estimate Infiltration (gpm)	Estimate Infiltration Rate (gpd/IDM)	Rain Gauge	DW Day Used
60	Mostly Combined	754	3.43	56	23,444	Warren	4/10 to 4/12, 2023
17*	Mostly Combined	111,229	483.58	4,871	14,504	Warren	4/10 to 4/12, 2023
6	Mostly Combined	24,370	65.87	603	13,192	Walker	4/10 to 4/12, 2023
42	Mostly Combined	20,148	98.26	876	12,832	Warren	4/10 to 4/12 + 5/10 to 5/12, 2023
20	Both	26,326	70.77	518	10,539	Walker	4/11 to 4/13, 2023
30	Fully Separated	7,725	19.19	124	9,308	Warren	5/13 to 5/15, 2024
27	Fully Separated	23,966	65.18	416	9,190	Warren	5/13 to 5/15, 2024
55	Fully Combined	21,249	62.76	381	8,747	Warren	5/13 to 5/15, 2024
35	Mostly Combined	23,003	68.64	366	7,678	Warren	4/10 to 4/12, 2023
63	Fully Separated	53,607	100.76	518	7,405	Warren	4/10 to 4/12, 2023
61	Fully Combined	11,084	23.73	116	7,052	Warren	4/10 to 4/12, 2023
13	Fully Combined	28,672	84.73	411	6,986	Warren	4/10 to 4/12, 2023
1	Fully Separated	20,625	44.88	217	6,970	Walker	4/10 to 4/12, 2023
3	Mostly Separated	23,234	38.15	176	6,662	Walker	4/10 to 4/12, 2023
48	Mostly Combined	26,090	119.99	552	6,631	Warren	4/10 to 4/12, 2023
15	Fully Combined	11,190	28.37	128	6,520	Warren	4/10 to 4/12, 2023
39	Mostly Combined	10,163	37.80	163	6,223	Warren	5/10 to 5/12, 2023
21*	Both	67,815	201.95	858	6,116	Walker	4/11 to 4/13, 2023
4	Fully Separated	21,863	47.22	195	5,944	Walker	4/10 to 4/12, 2023
52	Both	24,794	51.56	205	5,725	Warren	5/13 to 5/15, 2024
29	Mostly Combined	22,654	72.94	282	5,577	Warren	5/13 to 5/15, 2024
19	Mostly Separated	34,194	60.29	220	5,251	Walker	4/10 to 4/12, 2023
56	Mostly Combined	18,203	39.76	135	4,899	Warren	4/10 to 4/12, 2023
36	Fully Combined	21,532	65.29	219	4,821	Warren	4/10 to 4/12, 2023
46	Fully Separated	17,165	31.12	104	4,793	River's Edge	4/10 to 4/12, 2023
54	Fully Combined	22,318	77.44	253	4,710	Warren	5/13 to 5/15, 2024
53	Both	23,743	67.02	211	4,530	Warren	5/13 to 5/15, 2024
7	Mostly Combined	17,076	49.26	151	4,424	Walker	4/10 to 4/12, 2023
14	Fully Combined	13,905	55.35	167	4,352	Warren	4/10 to 4/12, 2023
37	Both	23,360	100.40	297	4,259	Warren	5/10 to 5/12, 2023
28	Both	25,490	71.42	202	4,071	Walker	4/10 to 4/12, 2023
41	Fully Separated	20,533	101.05	INDETERMINANT	INDETERMINANT	Warren	5/13 to 5/15, 2024
51	Fully Combined	24,678	140.31	INDETERMINANT	INDETERMINANT	Warren	5/13 to 5/15, 2024

Meter	Type	Pipe Length (LF)	IDM	Estimate Infiltration (gpm)	Estimate Infiltration Rate (gpd/IDM)	Rain Gauge	DW Day Used
59	Fully Combined	9,507	24.58	60	3,514	Warren	4/10 to 4/12, 2023
23	Mostly Combined	16,116	36.51	86	3,378	Walker	4/10 to 4/12, 2023
45	Both	20,367	76.23	177	3,338	Warren	4/10 to 4/12, 2023
24	Fully Separated	21,933	36.02	83	3,321	Walker	4/10 to 4/12, 2023
44	Mostly Separated	18,806	51.04	113	3,190	River's Edge	5/10 to 5/12, 2023
12	Fully Combined	21,915	63.08	135	3,093	Warren	4/10 to 4/12, 2023
18	Fully Combined	12,216	29.51	63	3,088	Warren	5/10 to 5/12, 2023
9	Mostly Separated	20,943	49.47	102	2,967	Walker	5/10 to 5/12, 2023
8	Mostly Combined	24,940	93.45	186	2,865	Walker	4/10 to 4/12, 2023
50	Mostly Combined	20,654	54.95	107	2,811	Warren	4/10 to 4/12, 2023
11	Mostly Combined	17,039	90.13	144	2,306	Warren	4/10 to 4/12, 2023
57	Fully Combined	13,685	34.30	49	2,061	Warren	4/10 to 4/12, 2023
32	Mostly Combined	18,028	59.86	80	1,922	Walker	5/10 to 5/12, 2023
34	Fully Combined	11,989	39.97	51	1,841	Warren	4/10 to 4/12, 2023
58	Fully Combined	6,330	15.04	18	1,748	Warren	5/13 to 5/15, 2024
25	Mostly Separated	20,172	47.37	54	1,648	Warren	4/13 14:00 to 4/15 13:55, 2023
43	Fully Separated	20,902	57.04	62	1,571	River's Edge	5/10 to 5/12, 2023
47*	Both	42,485	87.91	88	1,434	River's Edge	4/10 to 4/12, 2023
2	Mostly Separated	22,790	38.93	38	1,412	Walker	5/10 to 5/12, 2023
First St	–	111,107	208.87	169	1,165	Warren	4/14 to 4/16, 2023
40	Mostly Combined	14,472	51.48	41	1,147	Warren	4/10 to 4/12, 2023
33	Mostly Combined	19,708	63.38	47	1,077	Warren	4/10 to 4/12, 2023
5	Fully Separated	13,693	26.80	20	1,059	Walker	4/10 to 4/12, 2023
16	Fully Combined	8,915	22.02	16	1,039	Warren	4/10 to 4/12, 2023
Burnham Rd	–	824,213	1600.01	796	716	Warren	4/10 to 4/12, 2023
38	Mostly Combined	22,148	87.67	41	672	Warren	4/10 to 4/12, 2023
26	Both	20,550	52.60	22	594	Warren	4/13 14:00 to 4/15 13:55, 2023
49	Mostly Combined	9,632	35.02	10	411	Warren	5/10 to 5/12, 2023
31	Mostly Combined	17,549	49.22	10	302	Walker	4/10 to 4/12, 2023
10	Fully Separated	17,707	92.73	13	207	Walker	4/10 to 4/12, 2023
62	Both	240,601	411.05	20	70	Walker	4/10 to 4/12, 2023
22	Fully Combined	1,757	5.51	0	0	Warren	4/10 to 4/12, 2023

*Combined Meter Area for analysis based on flow relationships (number of users affecting volume differences, negative flows based on close proximity of meters)

Greyed values are compiled from the 2023 I/I Analysis Report and use 2023 flow meter program data

Meter 30, 58 moved locations from the 2023 flow meter program for better hydraulic compatibility

Table ES-2: Inflow Summary for Fully/Partially Separated Areas – 2023 and 2024 Flow Monitoring Programs

Meter[1]	Type	Installed Location	[2]Design Storm Inflow (gal)	Design Storm Delayed Inflow (gal)	Design Storm Direct Inflow (gal)
41	Fully Separated	549 Lawrence St	N/A	N/A	N/A
37	Both	1 River Pl Building C	2,368,440	236,337	2,132,103
45	Both	978 Gorham St	1,269,360	237,941	1,031,419
10	Fully Separated	911 Martin St	1,020,476	226,888	793,588
27	Fully Separated	480 Chelmsford St	883,220	15	883,205
52	Both	651 Rogers St	882,704	2,353	880,351
28	Both	144 Shaw St	629,864	5,491	624,373
53	Both	306 Douglas Rd	452,532	16	452,516
9	Mostly Separated	Riverside St and Sparks St	422,776	3,206	419,570
62	Both	Middlesex St and Baldwin St	411,080	23,125	387,955
30	Fully Separated	Lowell Connector (near Leverett St)	349,332	65,855	283,477
47*	Both	Lawrence St	330,240	76,642	253,598
19	Mostly Separated	115 Hadley St	252,840	41,689	211,151
44	Mostly Separated	Gorham St and Olive St	251,120	14	251,106
20	Both	915 Pawtucket St	242,348	74,338	168,010
26	Both	Chelmsford St and Maitland St	228,416	13	228,403
63	Fully Separated	Tanner St and Canada St	146,200	14,590	131,610
2	Mostly Separated	821 Varnum Ave	141,556	23,699	117,857
46	Fully Separated	Woburn St and Carmine St	108,360	13	108,347
3	Mostly Separated	Varnum Ave and Laurie Ln	88,752	54,542	34,210
25	Mostly Separated	Chelmsford St and Jenness St	84,280	14	84,266
5	Fully Separated	391 Varnum Ave	59,168	7	59,161
24	Fully Separated	W Albert St and Baltimore Ave	54,180	31,591	22,589
4	Fully Separated	360 Varnum Ave (Varnum Ave and Delaware Ave)	38,872	27,140	11,732
1	Fully Separated	Clyde St and Pawtucket Blvd	11,180	1,182	9,998
43	Fully Separated	76 Maple St	8,600	215	8,385

[1]Meter 41 data was indeterminate due to the complicated interconnected relationship of its tributaries and therefore inflow was not evaluated

[2]Using Assumed Design Storm of 1.72

*Combined Meter Area for analysis based on flow relationships (number of users affecting volume differences, negative flows based on close proximity of meters)

Table ES-3: Proposed 2024 SSES Implementation Plan

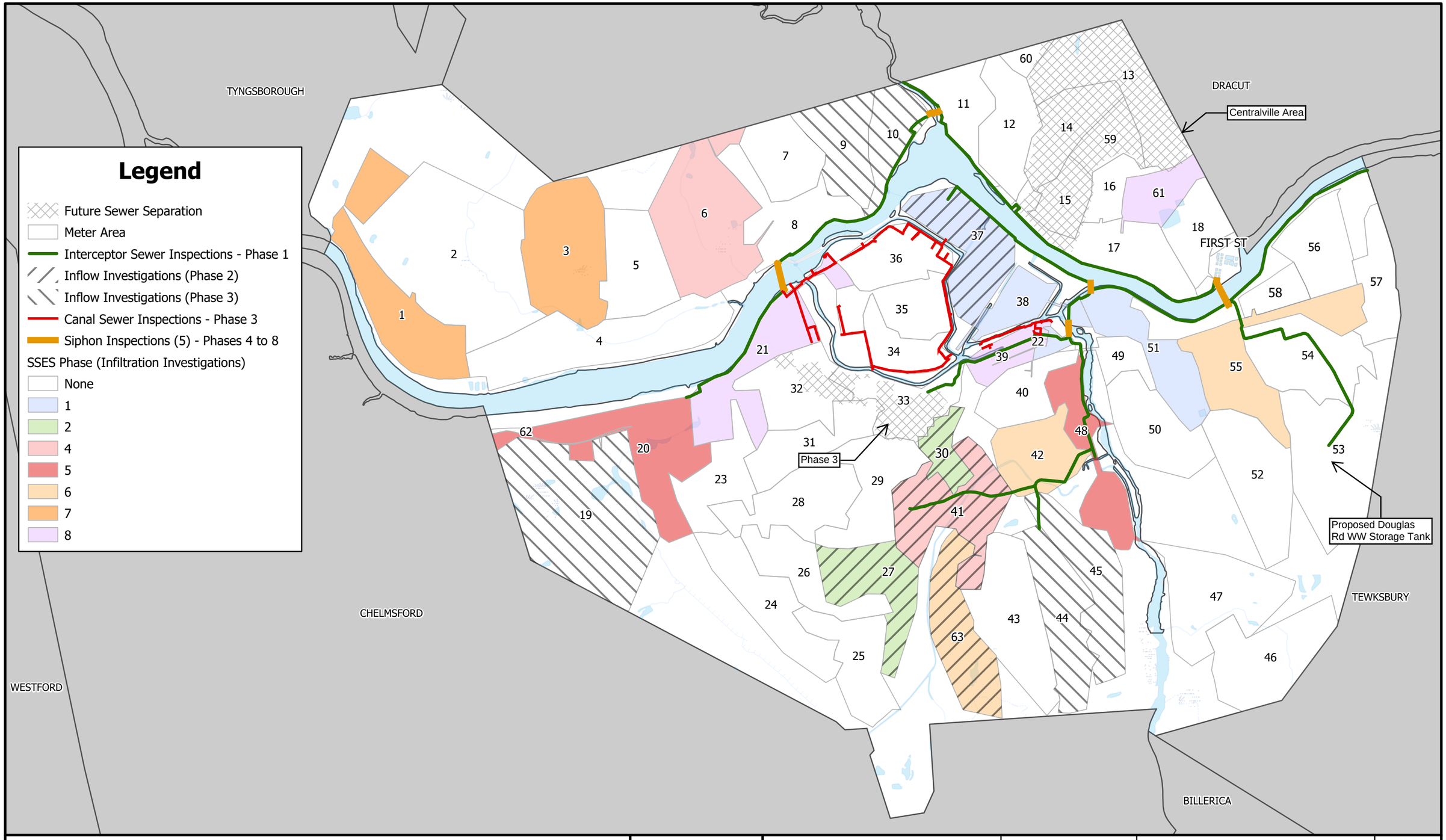
Fiscal Year[2]	Phase	Meter Area	CCTV (LF)	MH Inspections (EA)	Siphon Inspection (EA)	Flow Isolation (LF)	Smoke Testing (LF)	Building Inspections (EA)	Dye Testing (EA)
2023	0*	M38, M51	31,500	220	East Merrimack	-	-	-	-
2024	1*	M37, M38, M51	21,300	86	-	-	-	-	-
2024	1*	Interceptor	56,300	197	-	-	-	-	-
2026	2	M27[3], M30[3], M37[1], M41[1], M63[1]	31,900	180	-	31,900	89,600	310	135
2027	3	M9[1], M10[1], M19[1], M44[1], M45[1]	0	0	-	-	98,500	350	150
2027	3	Canal Pipe	23,500	0	-	23,500	-	-	-
2028	4	M6, M41	44,900	270	Walker	44,900			
2029	5	M20, M48	52,500	305	Beaver Brook	52,500	-	-	-
2030	6	M42, M55, M63	55,300	305	Merrimack River	55,300	-	-	-
2031	7	M1, M3	43,900	240	Warren	43,900	-	-	-
2032	8	M21, M22, M39, M61	48,400	275	Concord River	48,400	-	-	-
	TOTAL		**409,500**	**2,078**	**6**	**300,400**	**188,100**	**660**	**285**

**Phase 0 field inspections completed in 2023; Phase 1 field inspections completed in 2024.*

[1] Inflow investigations only (smoke testing, building inspections, dye testing).

[2] Fiscal year begins on July 1st and ends on June 30th the following year.

[3] Both infiltration and inflow investigations.



0 4,000 8,000
Feet

N

DUCK ISLAND
LOWELL REGIONAL WASTEWATER UTILITY

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT NO.	20220166.003A
CREATED:	3/18/2025
CREATED BY:	JRossini
CHECKED BY:	KGoyette
FILE NAME:	Lowell 2024 Report Figures.mxd

2024 SSES Implementation Plan

Lowell Regional Wastewater Utility
451 First Street Blvd.
Lowell, MA 01850

FIGURE
ES-1

Date: 3/18/2025 User: JRossini Path: \\azrgisstorp01\GIS_Projects\Client\MA_Lowell\20220166.003_Consent_Decree_Compliance\MXD\Lowell 2024_Field Program\Lowell 2024 Report Figures.aprx

Table ES-4: Cost Estimate for Proposed 2024 SSES Implementation Plan

Item	Phase 1 (2024)	Phase 2 (2026)	Phase 3 (2027)	Phase 4 (2028)	Phase 5 (2029)	Phase 6 (2030)	Phase 7 (2031)	Phase 8 (2032)
SSES	M37, M38, M51	M27[3], M30[3], M37[1], M41[1], M63[1]	M9[1], M10[1], M19[1], M44[1], M45[1]	M6, M41	M20, M48	M42, M55, M63	M1, M3	M21, M22, M39, M61
CCTV Inspections	$112,000	$170,000	$130,000	$240,000	$280,000	$300,000	$240,000	$260,000
MH Inspections	$38,200	$16,000	$0	$22,000	$25,000	$25,000	$20,000	$23,000
Interceptor Inspections	$479,450	$0	$0	$0	$0	$0	$0	$0
Siphon Inspections	$0	$0	$0	$104,000	$41,000	$113,000	$68,000	$41,000
Flow Isolation	$0	$15,000	$11,000	$20,000	$23,000	$24,000	$20,000	$21,000
Smoke testing	$0	$47,000	$50,000	$0	$0	$0	$0	$0
Building Inspections	$0	$109,000	$88,000	$0	$0	$0	$0	$0
Dye Testing	$0	$40,000	$44,000	$0	$0	$0	$0	$0
Engineering	$130,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000
Subtotal	***$759,650***	***$522,000***	***$448,000***	***$511,000***	***$494,000***	***$587,000***	***$473,000***	***$470,000***
Contingency 10%	*$0*	*$53,000*	*$45,000*	*$52,000*	*$50,000*	*$59,000*	*$48,000*	*$47,000*
Escalation 4%	*$0*	*$47,000*	*$62,000*	*$96,000*	*$118,000*	*$172,000*	*$165,000*	*$191,000*
TOTAL	**$759,650**	**$622,000**	**$555,000**	**$659,000**	**$662,000**	**$818,000**	**$686,000**	**$708,000**

[1] Inflow investigations only (smoke testing, building inspections, dye testing).

[2] Fiscal year begins on July 1st and ends on June 30th the following year.

[3] Both infiltration and inflow investigations.

[4]Includes Engineering Services During Construction

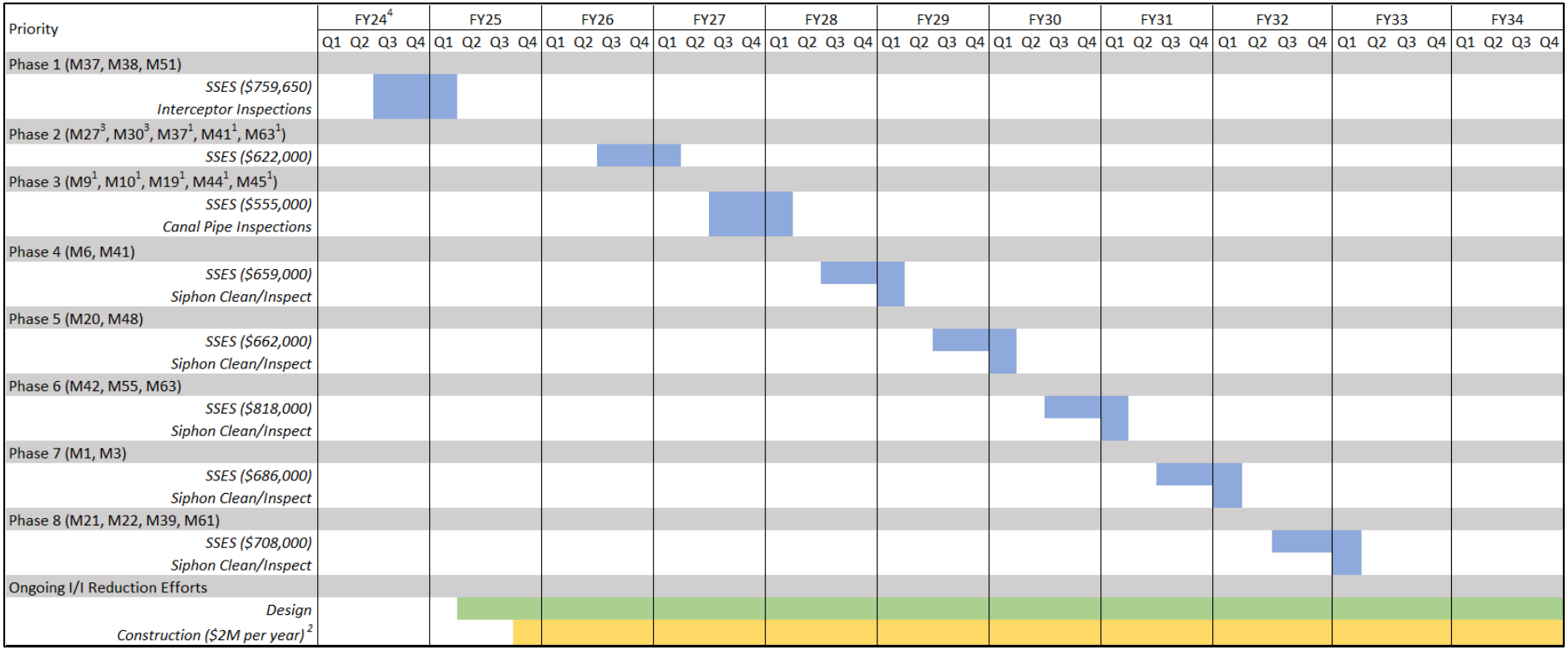


Figure ES-2: 2024 Infiltration/Inflow Implementation Schedule

[1] *Inflow investigations only (smoke testing, building inspections, dye testing)*

[2] *Includes post-construction flow monitoring*

[3] *Both infiltration and inflow investigations*

[4] *Fiscal year begins July 1st and ends June 30th*

2 BACKGROUND

The City of Lowell (City) implemented an ongoing Infiltration/Inflow (I/I) Identification and Removal Program compliant with Massachusetts Department of Environmental Protection (MassDEP's) regulations at 314 CMR 12.04(2). As the Lowell Regional Wastewater Utility (Utility) holds a National Pollution Discharge Elimination System (NPDES) permit enforced by the United States Environmental Protection Agency (USEPA) and MassDEP, the City is required to identify sources of I/I in their system.

The Consent Decree (CD) for the City was fully executed and filed with the U.S. District Court on May 17, 2024 (Case: 1:24-cv-10290-DJC, Document 13). The Consent Decree includes the following requirements, under Section VI. Remedial Measures, Paragraph 18:

> *The City shall develop and implement an ongoing program to identify and remove infiltration and inflow from the sewer system in accordance with 314 C.M.R. §12.04(2) and shall provide annual flow information for those communities serviced by the Lowell Regional Wastewater Utility ("LRWU"). To meet this requirement, the City shall:*
>
> *b. By January 31, 2024, submit to MassDEP for review and approval an I/I Analysis Report. The I/I Analysis Report shall be consistent with the provisions of 314 C.M.R. § 12.04(2) and, as referenced therein, the MassDEP's 2017 Guidelines for Performing Infiltration/Inflow Analyses and Sewer System Evaluation Surveys, and shall include a detailed assessment of flow data gathered from the 2023 sewer metering program. The I/I Analysis Report shall also include an implementation schedule, based on assessment of the flow data, for proceeding with sewer system evaluation surveys, and actions to address sources of Infiltration and Inflow.*

The 2023 sewer metering program was a City-wide flow monitoring program including sixty-three (63) temporary wastewater flow meters, one hundred and ten (110) groundwater gauges, and three (3) rain gauges to quantify the magnitude to of I/I entering the sewer system.

ADS Environmental Services (ADS) installed 63 temporary gravity sewer flow meters for a period of ten (10) weeks from March 24, 2023 to June 2, 2023. The 63 sewer-meter areas were designed to capture

the majority of the City's sewer flows and to target no more than 20,000 linear feet of sanitary/combined sewer in each area. Consideration was given to hydraulically favorable locations from the City's prior metering programs. Key locations were identified for meters in collaboration with the City's ongoing CSO planning efforts to support sewer system model calibration.

Upon review of the final metering data for all sites, Kleinfelder excluded data from eleven (11) meter areas from the I/I analysis due to poor quality of data. These meters, which accounted for 17% of the total system metered, were located upstream of the Utility's Barasford (Meters 51, 52, 53, 54, 55, and 58) and Warren (Meters 22, 27, 29, 30, and 41) CSO Stations. As Meter Area 22 consisted of only 1,700 feet of pipe, inspections of the area sewers were included within the future field investigation program to identify sources of I/I. The Utility committed to re-metering the remaining ten areas in Spring 2024 to determine I/I volumes for these meter areas.

The Utility submitted the 2023 Infiltration/Inflow (I/I) Analysis Report on January 31, 2024 in accordance with the CD. The 2023 I/I Analysis Report provides a summary of the 2023 flow metering program, identifies prioritized areas of the wastewater collection system with excessive I/I, and provides a schedule and estimated costs for subsequent phases of Sewer System Evaluation Surveys (SSES).

The 2024 Supplemental I/I Analysis Report summarizes the I/I analysis of 10 meter areas where meters were re-installed in Spring 2024, and revisits the Utility's prioritized SSES investigations and phasing presented in 2023 I/I Analysis Report based on additional I/I results and other planned system improvements by the Utility. These recommendations serve as a road map for Utility to implement an ongoing plan to execute I/I investigations and reduction efforts.

3 FLOW MONITORING PROGRAM

The following section summarizes the 2024 flow monitoring program, conducted to support an analysis of wastewater flow data to determine volumes of I/I from 10 meter areas, previously metered in 2023 as part of the Utility's City-wide flow monitoring program.

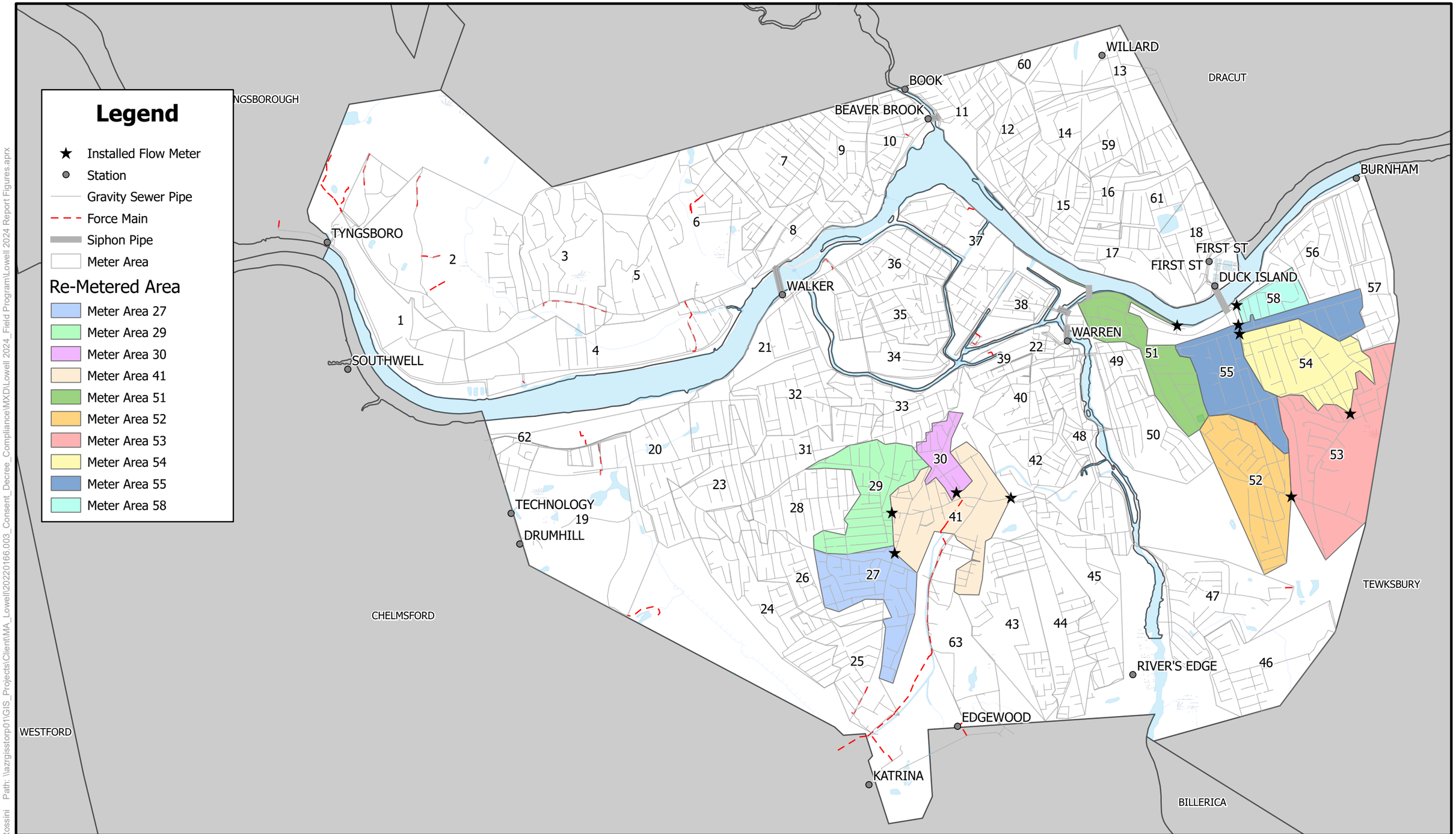
3.1 FLOW METERING PROGRAM

ADS installed ten (10) temporary gravity sewer flow meters for a period of twenty-five (25) weeks from April 2, 2024 to September 24, 2024. To support this supplementary analysis, it was pertinent to select a time period overlapping with the 2023 I/I analysis in order to establish a consistent diurnal curve of sanitary flows. Kleinfelder utilized the flow metering period from April 10, 2024 to June 2, 2024 to conduct the 2024 I/I analysis. As recommended in MassDEP's Guidelines, the metering period was conducted in the spring to coincide with anticipated high groundwater. ADS utilized continuous monitoring with ADS model Triton+ flow meters, which include both velocity and depth sensors to record data every five minutes. For eight of the 10 meters areas, meters were installed in the same manhole as the 2023 flow monitoring program to capture the same sewer tributary area. The remaining two meters (Meters 30 and 58) were moved to alternative manholes in close proximity to the 2023 locations for more favorable hydraulics, and therefore have slightly modified meter areas. The shifting of Meter 30 location posed for a better analysis of Meter 30, decreased the meter area size of Meter 30 areas but, in turn, increased the length of sewer tributary to Meter 41 as a result. The shifting of Meter 58 decreased its meter area minimally and had no other impacts to the 2024 meter areas. **Table 1** summarizes the meter installation locations and total sewer length in each meter area. Flow meter installation logs are included **in Appendix A**. The locations of the flow meters are indicated with stars in **Figure 1** and their respective relationships are depicted in the schematic displayed in **Figure 2**.

Table 1: 2024 Meter Locations

Meter No.	SMH ID	Length of Sewer (FT)*	Location	ADS Measured Pipe Size (IN.)	Sensor Location
27	SMH-001714	24,076	480 Chelmsford St	56x52	DS
29	SMH-001720	22,654	38 Nottingham St	50x49	DS
30	SMH-002212	7,725	Cambridge St at Leverett St	72x73	DS
41	SMH-002839	20,520	549 Lawrence St	86	DS
51	SMH-005081	24,514	Stackpole St at Corrigan Ave	120	US
52	SMH-006051	24,794	651 Rogers St	30.75	DS
53	SMH-004936	24,932	306 Douglas Rd	48	DS
54	SMH-005456	22,349	Andover St and Guild St	48x49	DS
55	SMH-007049	21,531	20 Barasford Ave	60	DS
58	SMH-007928	6,290	684 E Merrimack St	82	DS

*Footage indicates length of Lowell gravity sewer pipe located within each meter area.



0 4,000 8,000
Feet

N

DUCK ISLAND
LOWELL REGIONAL WASTEWATER UTILITY

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT NO.	20220166.003A
CREATED:	3/13/2025
CREATED BY:	JRossini
CHECKED BY:	KGoyette
FILE NAME:	Lowell 2024 Report Figures.mxd

2024 Installed Flow Meter Locations

Lowell Regional Wastewater Utility
451 First Street Blvd.
Lowell, MA 01850

FIGURE
1

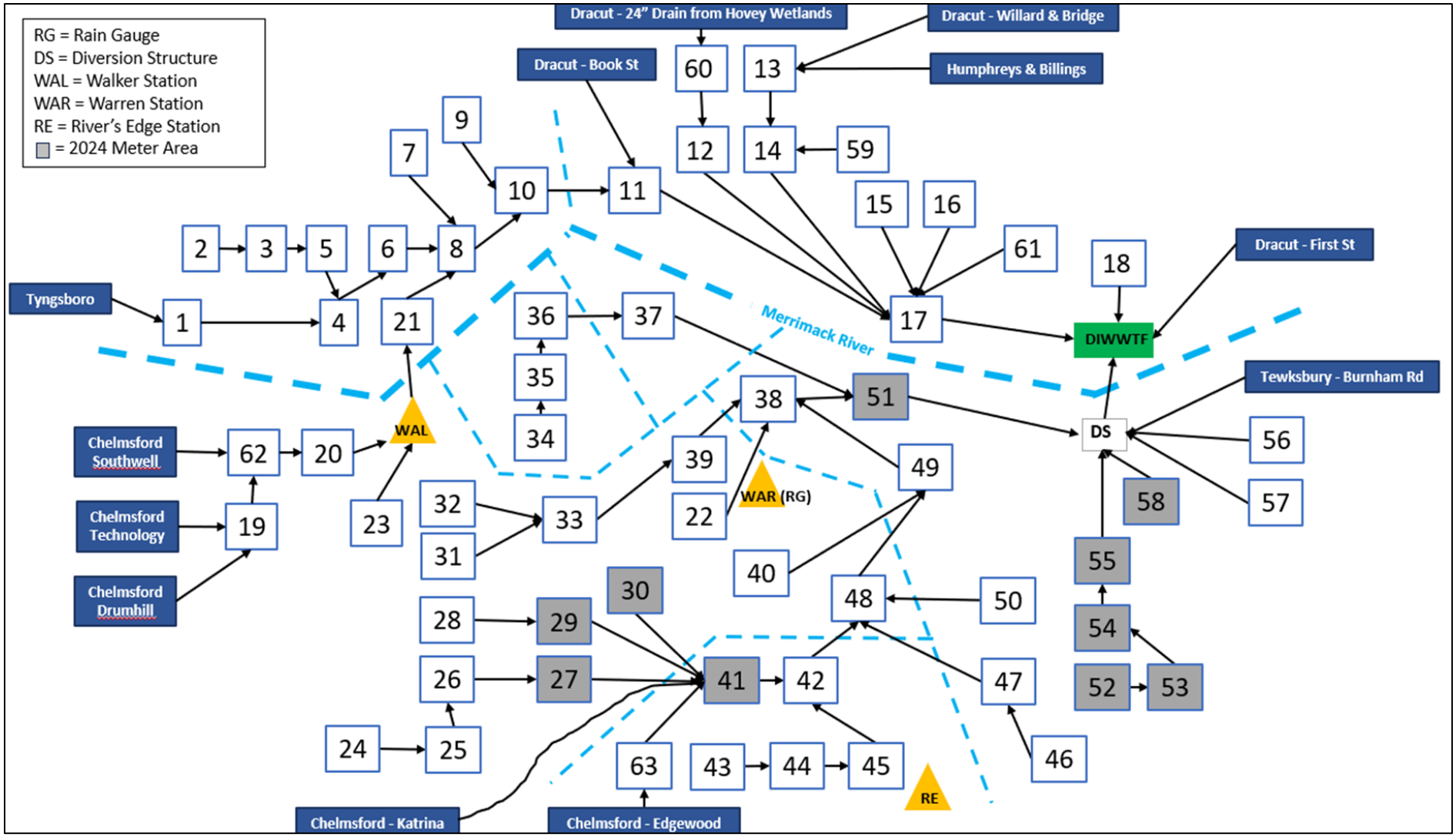


Figure 2: 2024 Flow Meter and Rain Gauge Schematic

3.2 GROUNDWATER MONITORING

As part of this flow monitoring program, ADS installed a total of ten (10) manual groundwater monitoring devices (piezometers) inside shared sewer manholes housing the temporary flow meters. The intent of this supplemental groundwater monitoring was to compare the depth of ground water between 2023 and 2024 metering periods and to understand the general trends in groundwater depths throughout the 2024 metering period. In general, groundwater gauges were installed twelve to fifteen inches above the manhole shelf. Manual groundwater measurements were taken by ADS monthly during site visits to corresponding flow meters.

Figure 3 depicts ADS's manual groundwater gauge readings (line chart on main axis) along with precipitation data (bar chart on secondary axis) throughout the 2024 metering period. Groundwater readings, measured as depth of water on top of the monitoring device, were taken on a monthly frequency on average. Although the 2024 monthly manual gauge readings result in one manual datapoint to represent the depth of groundwater over a 30-day period on average, it does provide an understanding of how water levels are trending. Groundwater gauge readings confirm the metering program was conducted during period of upward trend in groundwater levels within 2024. During the 2024 metering period, the highest groundwater period was observed between April and June 2024.

Figure 4 depicts ADS's automatic groundwater gauge readings from the 2023 flow monitoring program. The 2023 automatic gauge data is reported with 5-minute resolution. This continuous data allows for a better understanding of groundwater fluctuations from individual and compounding rain events over the metering period. The limited manual data for 2024 has a greater opportunity for less accurate data with having less datapoints to track patterns or scrub data for one-off occurrence in poor quality readings. Kleinfelder recommends automated groundwater measurement for future programs since it provides critical understanding of the water table dynamics across the monitoring period.

In comparing groundwater levels at the 2024 metering sites with their respective groundwater levels in 2023, groundwater was consistently lower during the 2024 meter period with the exception of Meter 29, where similar groundwater water levels were observed in 2023 and 2024. In general, the 2024 manually recorded depths were 1 to 4 feet lower than the levels recorded in 2023.

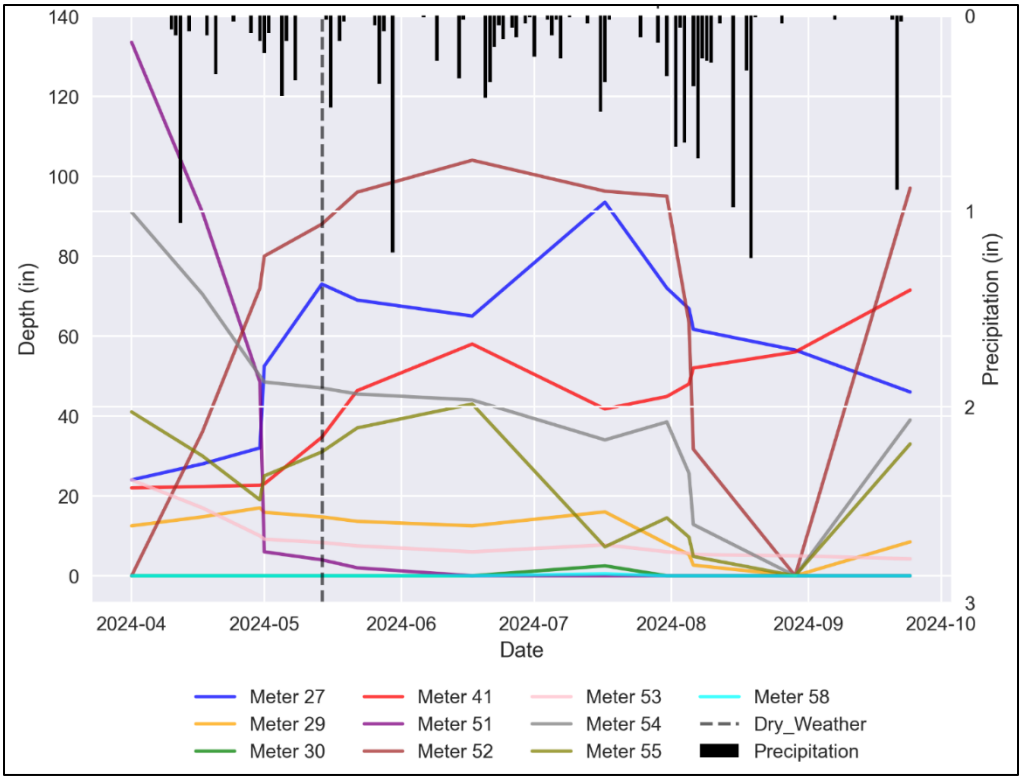


Figure 3: 2024 Manual Groundwater Gauge Readings (inches above gauge location)

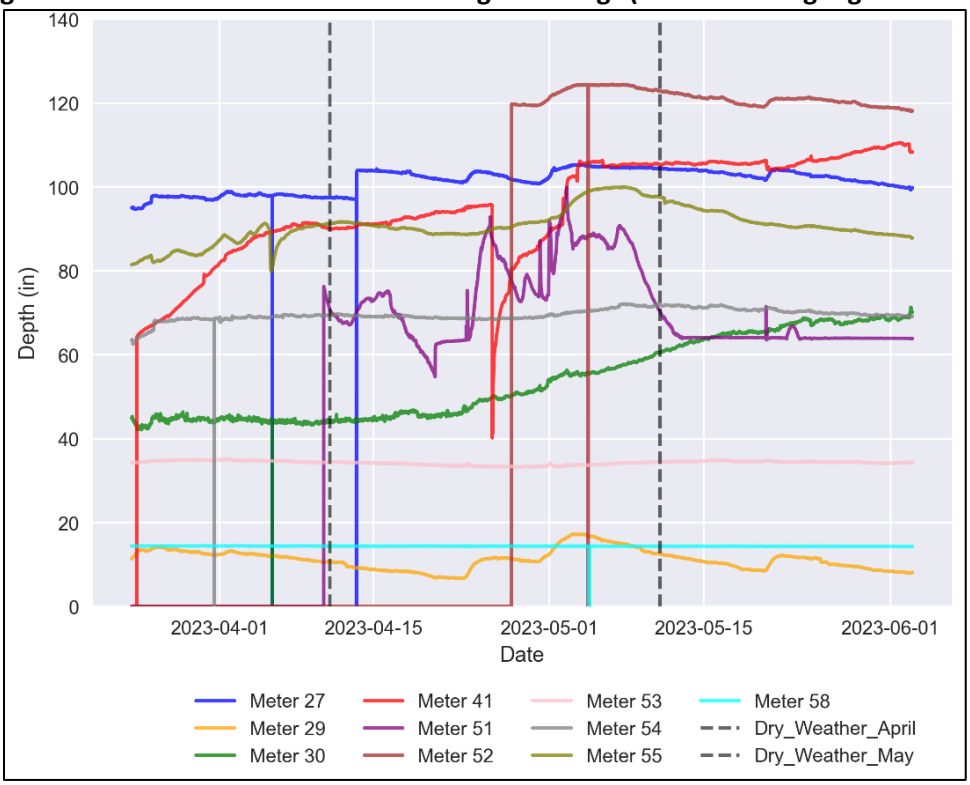


Figure 4: 2023 Automatic Groundwater Gauge Readings (inches above gauge location)

3.3 RAINFALL MONITORING

The flow meter program collected precipitation data from one (1) rain gauge, installed on April 1, 2024, at the Warren Diversion Structure, shown in **Figure 2** in Section 3.1. A rain gauge was also installed at this location to support the 2023 flow metering program. The gauge, Rain Alert III with TB-6 tipping bucket, was placed on a flat surface clear of encroaching trees or building structures. Precipitation readings were recorded in 5-minute intervals. Additionally, rain data was used for analysis from the Utility's rain gauge located at the Duck Island WWTF. Precipitation is recorded to illustrate the impact of rainfall on groundwater levels and to determine inflow rates during different storm events for conversion to designated standard design storms. **Figure 5** presents the cumulative precipitation recorded for the 2024 analysis along with the cumulative rainfall for all three (3) rain gauges used in the 2023 analysis. Precipitation totals were very similar across both years' rainfall monitoring period, approximately 8 inches, however, 2024 experienced more precipitation early in the analysis period.

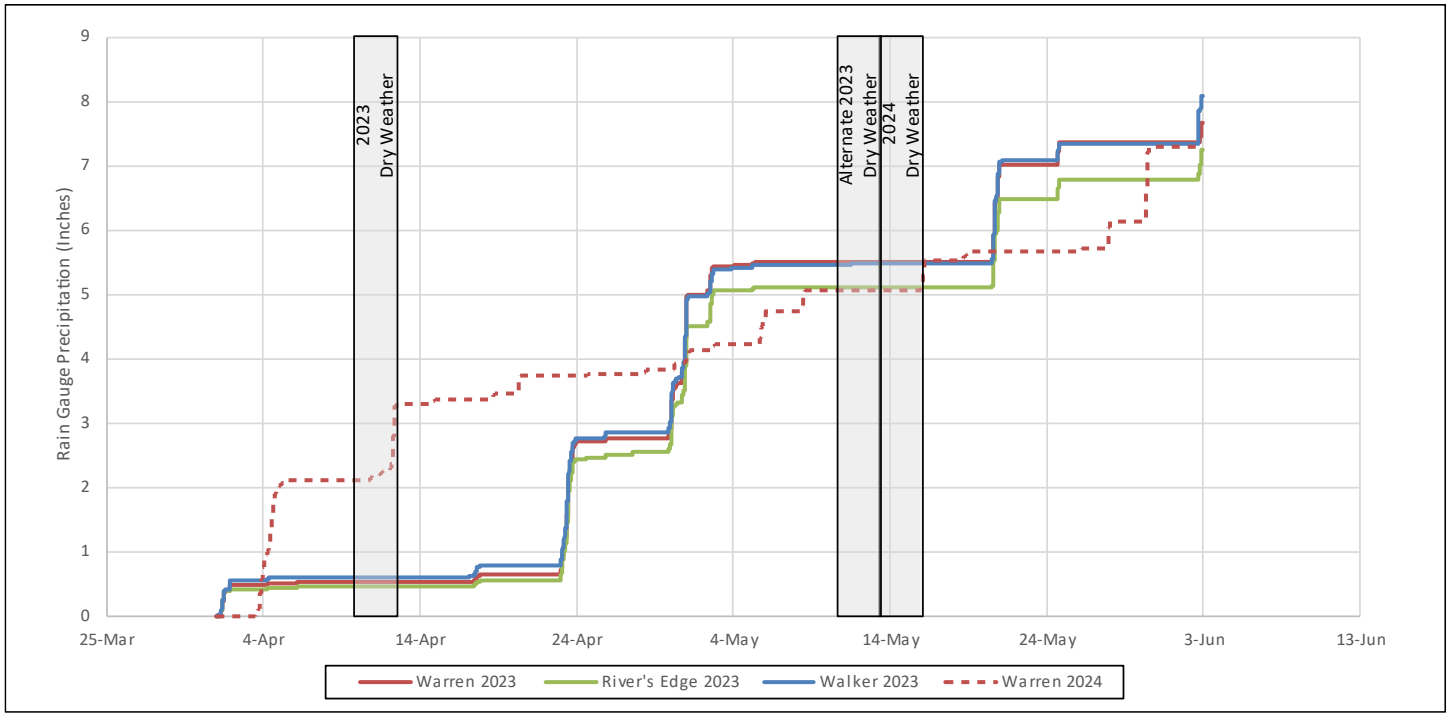


Figure 5: Rain Gauge Precipitation

Frequent short duration storms were recorded digitally in 5-minute intervals and monitored weekly. Only one (1) rain event, on May 30th, was identified as exceeded one inch of precipitation during the flow monitoring period and selected for inflow analysis. The remaining storms selected are the May 5th and May 15th events, with about half an inch of precipitation recorded. Although the April 12th event was

a 0.9 inch rain event, it was not used because the flows in the beginning of the metering period were much higher than the average established diurnal baseline which would artificially impact infiltration and inflow estimates. Dry weather and wet weather distinctions during the flow monitoring period (April 10, 2024 to June 2, 2024) are displayed in **Table 2**.

Table 2: Dry and Wet Weather Periods

No.	Duration	Rain Event	Average Intensity (in/hr)	Peak Intensity (in/hr)	Sum (in)
	2.5 days	4/9/2024 14:00 - 4/12/2024 05:10	DRY		
1	5 hrs	4/12/2024 05:15 - 4/12/2024 10:25	0.175	1.200	0.920
	7 days	4/12/2024 10:30 - 4/20/2024 06:00	DRY		
2	3 hrs	4/20/2024 06:05 - 4/20/2024 09:15	0.083	0.360	0.270
	10.5 days	4/20/2024 09:20 - 4/30/2024 22:40	DRY		
3	6.5 hrs	4/30/2024 22:45 - 5/1/2024 05:15	0.030	0.120	0.195
	3.5 days	5/1/2024 05:20 - 5/5/2024 14:00	DRY		
4	11 hrs	5/5/2024 14:05 - 5/6/2024 01:15	0.044	0.360	0.495
	2 days	5/6/2024 01:20 - 5/8/2024 08:10	DRY		
5	4 hrs	5/8/2024 08:15 - 5/8/2024 12:10	0.081	0.480	0.323
	7.5 days	5/8/2024 12:15 - 5/15/2024 22:50	DRY		
6	6.5 hrs	5/15/2024 22:55 - 5/16/2024 05:20	0.068	0.240	0.445
	11.5 days	5/16/2024 05:25 - 5/27/2024 21:00	DRY		
7	6 hrs	5/27/2024 21:05 - 5/28/2024 01:50	0.078	0.960	0.378
	2 days	5/28/2024 01:55 - 5/30/2024 05:15	DRY		
8	7.5 hrs	5/30/2024 05:20 - 5/30/2024 13:55	0.130	0.600	1.123
	10 days	5/30/2024 14:00 - 6/9/2024 08:50	DRY		

4 INFILTRATION AND INFLOW ANALYSIS

This section details Kleinfelder's I/I analysis of the 2024 flow monitoring program identified in **Figure 1** and presents the findings in coordination with the results of the I/I analysis previously conducted under the 2023 City-wide flow metering program.

4.1 INFILTRATION ANALYSIS

Infiltration is extraneous water that enters the sanitary or combined sewer system from leaks in the system due to defective pipes, pipe joints, broken service connections, or manholes. Groundwater infiltration occurs where components of the sewer system lie at or beneath the groundwater table elevation. Infiltration typically appears as a nearly constant source of flow in the collection system that fluctuates slowly to mirror the natural levels of the groundwater. Larger volumes of infiltration are anticipated in the spring when groundwater levels are high and smaller volumes are anticipated during the summer when groundwater levels are low. Rainfall-Induced Infiltration (RII) is a short-term increase in infiltration which is the direct result of storm events and enters the collection system through the same infrastructure defects as groundwater infiltration. Since RII occurs with storm events, it is difficult to differentiate this type of infiltration from inflow and is categorized as a portion of delayed inflow.

4.1.1 Infiltration and Sanitary Flow

Developing a synthetic diurnal curve (noted "avg dry weather flow" in **Figure 6**) representative of typical dry weather conditions is the first step in determining the infiltration rates for each metered area. For the synthetic diurnal curve to be most representative of a typical dry weather day, without significant influence from rain events or RII, Kleinfelder identified a three-day period of dry weather that had 5 antecedent dry weather days. The dry weather period primarily utilized for this analysis was May 13 through May 15, 2024. Infiltration rates were then estimated from overnight low flow data during each metered area of these dry-weather days during the hours of 01:00 to 02:00 multiplied by an infiltration factor that is determined based on zoning. Infiltration factors were assigned as 70% for industrial zones, 80% for commercial zones, and 90% for residential zones, calculating a range in reduction of infiltration from 30% to 10% respectively to account for minimum nighttime sanitary flow.

Sanitary flow is defined as the component of wastewater which includes domestic, commercial,

institutional, and industrial sewage, and specifically excludes infiltration and inflow. For each metered area, nighttime minimum flows were analyzed to determine the infiltration rate as described above. Sanitary flow is estimated by subtracting the base infiltration rate from metered wastewater flow during dry weather. **Figure 5** illustrates the diurnal sanitary flow curve and the baseflow attributed to infiltration, during dry weather conditions, taken from Meter 1 of the 2023 flow meter program. The corresponding dry weather hydrograph for each 2024 metered area is included in **Appendix B**.

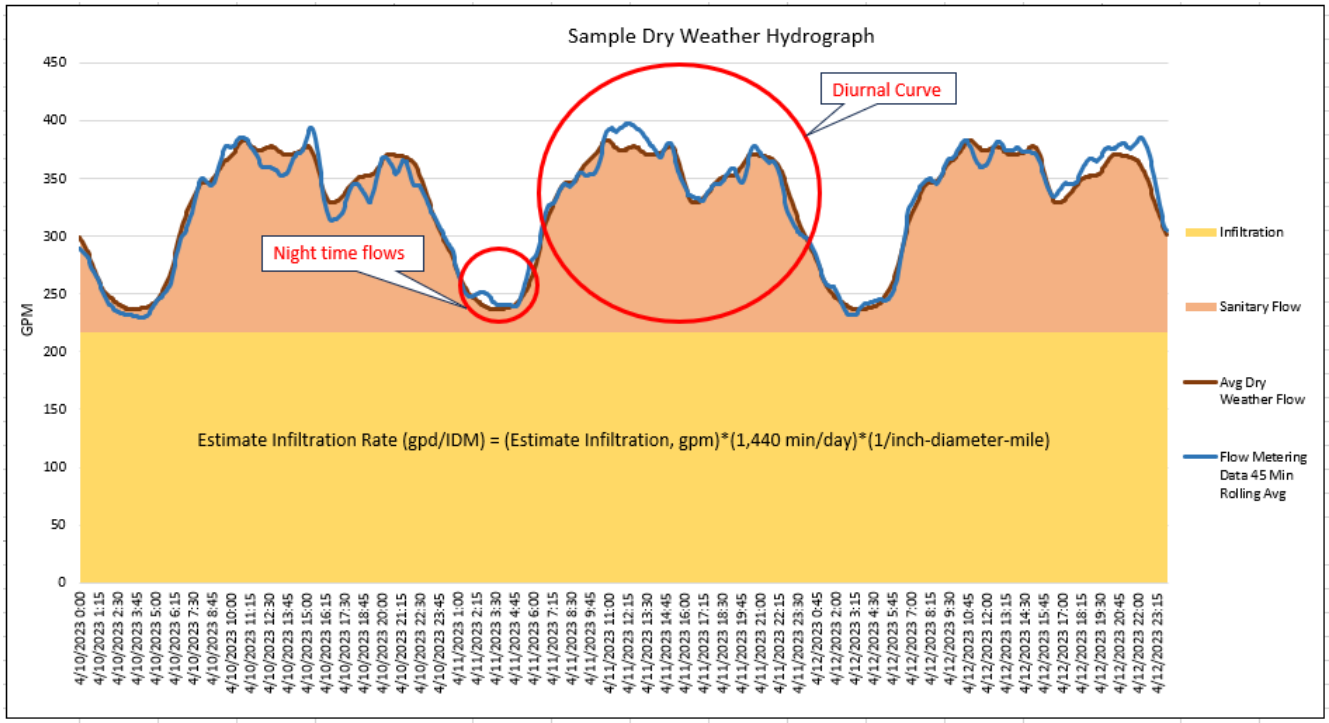


Figure 6: Sample Dry Weather Hydrograph

4.1.2 Infiltration Rates

The relative quantity of sewer pipeline within each metered area is an important consideration when comparing infiltration rates between metered areas. To make this comparison, infiltration rates are normalized by dividing the infiltration flow rate (gallons per day, gpd) by the number of “inch-diameter per mile” (idm) of sewer pipe quantity. To calculate idm for each meter area, a detailed inventory of the pipe sizes and pipe lengths for each subarea was tabulated.

MassDEP defines an infiltration rate of 4,000 gallons per day per inch-diameter mile (gpd/idm) as the threshold at which further field investigations, including manhole inspections, flow isolation, and CCTV, should be prioritized to identify sources of infiltration. Seven of the ten 2024 re-metered areas exceeded

the 4,000 gpd/idm threshold and require further investigation to identify infiltration sources per the MassDEP designation. **Table 3** lists infiltration rates estimated from both the 2023 and 2024 flow monitoring programs, with the 2024 meter areas shown in white rows. With the results from the 2024 metering program, there are now 31 of 63 meter areas identified for further investigation with greater than 4,000 gpd/idm of infiltration. Meters 30, 27, and 55 are ranked in the top eight meter areas contributing the highest infiltration rates into the collection system. The groundwater data suggests that such infiltration estimates could have been higher for the year of 2023 given the lower groundwater table for this year. **Figure 7** shows geographically where the estimated infiltration rates are located within the collection system.

Due to flow balance issues, it was infeasible to establish a diurnal curve for Meters 41 and 51 and subsequently to derive infiltration estimates. Meter 51 is too close in proximity to Meter 38 and Meter 37, making relationships between interconnected tributaries difficult to capture. Similarly, Meter 41 captures flow from Meters 27, 29, 30, 63 and a force main from Chelmsford. Although an infiltration estimate wasn't conclusive for Meter 51, infiltration investigations (CCTV and MH inspections) were completed under Phase 1 of the SSES program and observed infiltration will be summarized in the SSES Phase 1 Report along with rehabilitation recommendations. Although the 2023 analysis indicated Meter 42 among the highest infiltration areas, not being able to establish consistent results for Meter 41 could influence infiltration estimates calculated for Meter 42. Additionally, the 2024 program had a lower groundwater table than in comparison with the 2023 program, therefore the infiltration estimates from the 2024 program could be an underestimate of what their contributions would've been in the 2023 program.

Table 3: Estimated Infiltration Rates from 2023 and 2024 Flow Monitoring Programs

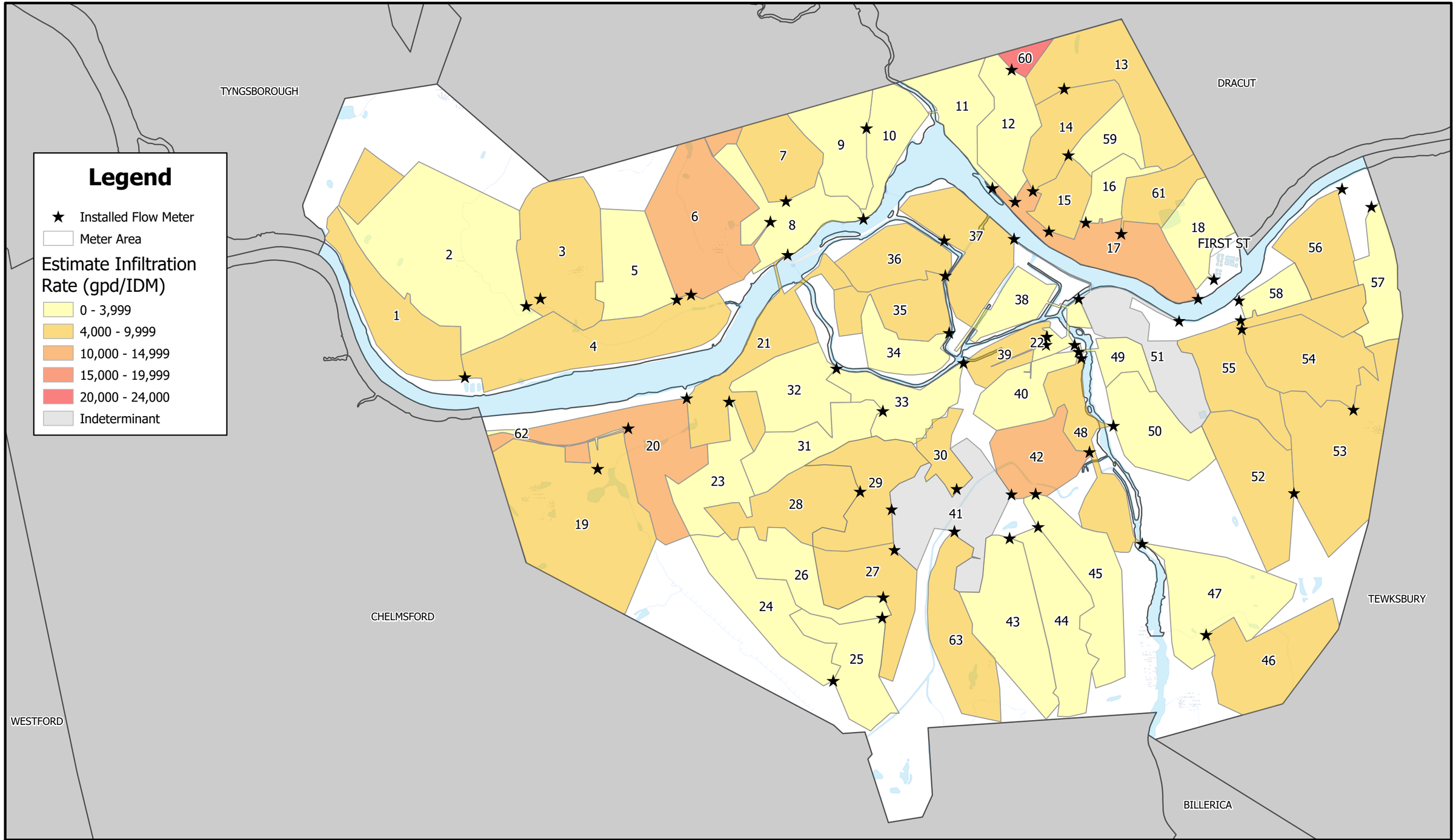
Meter	Type	Pipe Length (LF)	IDM	Estimate Infiltration (gpm)	Estimate Infiltration Rate (gpd/IDM)	Rain Gauge	DW Day Used
60	Mostly Combined	754	3.43	56	23,444	Warren	4/10 to 4/12, 2023
17*	Mostly Combined	111,229	483.58	4,871	14,504	Warren	4/10 to 4/12, 2023
6	Mostly Combined	24,370	65.87	603	13,192	Walker	4/10 to 4/12, 2023
42	Mostly Combined	20,148	98.26	876	12,832	Warren	4/10 to 4/12 + 5/10 to 5/12, 2023
20	Both	26,326	70.77	518	10,539	Walker	4/11 to 4/13, 2023
30	Fully Separated	7,725	19.19	124	9,308	Warren	5/13 to 5/15, 2024
27	Fully Separated	23,966	65.18	416	9,190	Warren	5/13 to 5/15, 2024
55	Fully Combined	21,249	62.76	381	8,747	Warren	5/13 to 5/15, 2024
35	Mostly Combined	23,003	68.64	366	7,678	Warren	4/10 to 4/12, 2023
63	Fully Separated	53,607	100.76	518	7,405	Warren	4/10 to 4/12, 2023
61	Fully Combined	11,084	23.73	116	7,052	Warren	4/10 to 4/12, 2023
13	Fully Combined	28,672	84.73	411	6,986	Warren	4/10 to 4/12, 2023
1	Fully Separated	20,625	44.88	217	6,970	Walker	4/10 to 4/12, 2023
3	Mostly Separated	23,234	38.15	176	6,662	Walker	4/10 to 4/12, 2023
48	Mostly Combined	26,090	119.99	552	6,631	Warren	4/10 to 4/12, 2023
15	Fully Combined	11,190	28.37	128	6,520	Warren	4/10 to 4/12, 2023
39	Mostly Combined	10,163	37.80	163	6,223	Warren	5/10 to 5/12, 2023
21*	Both	67,815	201.95	858	6,116	Walker	4/11 to 4/13, 2023
4	Fully Separated	21,863	47.22	195	5,944	Walker	4/10 to 4/12, 2023
52	Both	24,794	51.56	205	5,725	Warren	5/13 to 5/15, 2024
29	Mostly Combined	22,654	72.94	282	5,577	Warren	5/13 to 5/15, 2024
19	Mostly Separated	34,194	60.29	220	5,251	Walker	4/10 to 4/12, 2023
56	Mostly Combined	18,203	39.76	135	4,899	Warren	4/10 to 4/12, 2023
36	Fully Combined	21,532	65.29	219	4,821	Warren	4/10 to 4/12, 2023
46	Fully Separated	17,165	31.12	104	4,793	River's Edge	4/10 to 4/12, 2023
54	Fully Combined	22,318	77.44	253	4,710	Warren	5/13 to 5/15, 2024
53	Both	23,743	67.02	211	4,530	Warren	5/13 to 5/15, 2024
7	Mostly Combined	17,076	49.26	151	4,424	Walker	4/10 to 4/12, 2023
14	Fully Combined	13,905	55.35	167	4,352	Warren	4/10 to 4/12, 2023
37	Both	23,360	100.40	297	4,259	Warren	5/10 to 5/12, 2023
28	Both	25,490	71.42	202	4,071	Walker	4/10 to 4/12, 2023
41	Fully Separated	20,533	101.05	INDETERMINANT	INDETERMINANT	Warren	5/13 to 5/15, 2024
51	Fully Combined	24,678	140.31	INDETERMINANT	INDETERMINANT	Warren	5/13 to 5/15, 2024

Meter	Type	Pipe Length (LF)	IDM	Estimate Infiltration (gpm)	Estimate Infiltration Rate (gpd/IDM)	Rain Gauge	DW Day Used
59	Fully Combined	9,507	24.58	60	3,514	Warren	4/10 to 4/12, 2023
23	Mostly Combined	16,116	36.51	86	3,378	Walker	4/10 to 4/12, 2023
45	Both	20,367	76.23	177	3,338	Warren	4/10 to 4/12, 2023
24	Fully Separated	21,933	36.02	83	3,321	Walker	4/10 to 4/12, 2023
44	Mostly Separated	18,806	51.04	113	3,190	River's Edge	5/10 to 5/12, 2023
12	Fully Combined	21,915	63.08	135	3,093	Warren	4/10 to 4/12, 2023
18	Fully Combined	12,216	29.51	63	3,088	Warren	5/10 to 5/12, 2023
9	Mostly Separated	20,943	49.47	102	2,967	Walker	5/10 to 5/12, 2023
8	Mostly Combined	24,940	93.45	186	2,865	Walker	4/10 to 4/12, 2023
50	Mostly Combined	20,654	54.95	107	2,811	Warren	4/10 to 4/12, 2023
11	Mostly Combined	17,039	90.13	144	2,306	Warren	4/10 to 4/12, 2023
57	Fully Combined	13,685	34.30	49	2,061	Warren	4/10 to 4/12, 2023
32	Mostly Combined	18,028	59.86	80	1,922	Walker	5/10 to 5/12, 2023
34	Fully Combined	11,989	39.97	51	1,841	Warren	4/10 to 4/12, 2023
58	Fully Combined	6,330	15.04	18	1,748	Warren	5/13 to 5/15, 2024
25	Mostly Separated	20,172	47.37	54	1,648	Warren	4/13 14:00 to 4/15 13:55, 2023
43	Fully Separated	20,902	57.04	62	1,571	River's Edge	5/10 to 5/12, 2023
47*	Both	42,485	87.91	88	1,434	River's Edge	4/10 to 4/12, 2023
2	Mostly Separated	22,790	38.93	38	1,412	Walker	5/10 to 5/12, 2023
First St	–	111,107	208.87	169	1,165	Warren	4/14 to 4/16, 2023
40	Mostly Combined	14,472	51.48	41	1,147	Warren	4/10 to 4/12, 2023
33	Mostly Combined	19,708	63.38	47	1,077	Warren	4/10 to 4/12, 2023
5	Fully Separated	13,693	26.80	20	1,059	Walker	4/10 to 4/12, 2023
16	Fully Combined	8,915	22.02	16	1,039	Warren	4/10 to 4/12, 2023
Burnham Rd	–	824,213	1600.01	796	716	Warren	4/10 to 4/12, 2023
38	Mostly Combined	22,148	87.67	41	672	Warren	4/10 to 4/12, 2023
26	Both	20,550	52.60	22	594	Warren	4/13 14:00 to 4/15 13:55, 2023
49	Mostly Combined	9,632	35.02	10	411	Warren	5/10 to 5/12, 2023
31	Mostly Combined	17,549	49.22	10	302	Walker	4/10 to 4/12, 2023
10	Fully Separated	17,707	92.73	13	207	Walker	4/10 to 4/12, 2023
62	Both	240,601	411.05	20	70	Walker	4/10 to 4/12, 2023
22	Fully Combined	1,757	5.51	0	0	Warren	4/10 to 4/12, 2023

*Combined Meter Area for analysis based on flow relationships (number of users affecting volume differences, negative flows based on close proximity of meters)

Greyed values are compiled from the 2023 I/I Analysis Report and use 2023 flow meter program data

Meter 30, 58 moved locations from the 2023 flow meter program for better hydraulic compatibility



DUCK ISLAND
LOWELL REGIONAL WASTEWATER UTILITY

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT NO.	20220166.003A
CREATED:	3/17/2025
CREATED BY:	JRossini
CHECKED BY:	KGoyette
FILE NAME:	Lowell 2024 Report Figures.mxd

Estimated Infiltration Rates Keyplan for 2023 and 2024 Flow Monitoring Programs

Lowell Regional Wastewater Utility
451 First Street Blvd.
Lowell, MA 01850

FIGURE
7

4.2 INFLOW ANALYSIS

Inflow is an element of wastewater flow largely influenced by precipitation. Inflow stems from sources such as sump pumps, roof leaders, foundation and surface drains, and direct connection from catch basins as well as cross connections with the storm-sewer system. Inflow is the area between the storm event hydrograph and the synthetic dry weather diurnal curve. Since inflow is derived from storm events, it is not present during prolonged dry weather. Inflow is characterized by two different components, direct and delayed (indirect) inflow. Direct inflow quickly influences the flow in the sewer system, and it is therefore evident in the hydrograph. Direct inflow sources are typically direct connections from stormwater structures such as catch basins, drainpipe cross connections, as well as roof leaders and yard drains. Significant direct connections can quickly increase wastewater flow causing a spike during storm events and put increased stress on the sewer system. Delayed inflow is the portion of the total inflow volume generated from indirect connections to the collection system or connections which produce inflow after a significant time delay from the beginning of a storm. Delayed inflow sources include sump pumps, foundation drains, indirect sewer/drain cross-connections, etc. Through the analysis of metering data, rainfall-induced infiltration cannot be distinguished from delayed inflow. Therefore, by definition, it is included as part of delayed inflow. Delayed inflow is shown in the hydrograph which decreases gradually upon conclusion of the rainfall event and after the peak inflow caused by direct connections. It is common for delayed inflow to persist in a wastewater system for a week or longer after the end of the wet weather event.

4.2.1 Wet Weather Events

During the 2024 metering analysis period, there were a variety of storms and dry weather periods that occurred, as shown in **Table 2** in Section 3.3. Per MassDEP Guidelines, inflow shall be established for all storm events with an average rainfall of approximately 0.2 inches per hour and for any other storms for which an inflow response is readily observable. During the metering analysis, the three selected storms met these criteria for their peak intensities but not their average intensities. Storms selected for inflow evaluation in this study are presented in **Table 4** which summarizes average intensity, peak intensity, and total rainfall for each event. Although there were other qualifying storm events, they were not selected for analysis due to their timing occurring close together, making it difficult to analyze the system responses from each individual rainfall event.

Table 4: 2024 Storm Events for Inflow Analysis

Storm No.	Duration (hrs)	Rain Event (Start – Finish)	Avg Intensity (in/hr)	Peak Intensity (in/hr)	Sum (inches)
1	11	5/5 @ 14:05 - 5/6 @ 01:15	0.04	0.36	0.50
2	6.5	5/15 @ 22:55 - 5/16 @ 05:20	0.07	0.24	0.45
3	7.5	5/30 @ 05:20 - 5/30 @ 13:55	0.13	0.60	1.12

Direct and delayed inflow volumes were calculated for each of the metered areas. Inflow volumes were calculated by subtracting the synthetic dry weather diurnal curve from the storm event hydrograph. Inflow is observed when the storm event hydrograph diverges from the synthetic dry weather diurnal curve, both at the beginning of the storm event and after the storm has passed.

The hydrograph depicted in **Figure 8** was taken from Meter 6 of the 2023 flow monitoring program and was selected to illustrate the sanitary curve and the system's response to the storm event. The wet weather hydrographs for each 2024 metered area are included in **Appendix C**. Design Storm inflows are estimated from a "best fit" line that is derived from the inflow data obtained by analyzing the varied rain events observed during the metering period. The Design Storm is defined in the MassDEP Guidelines as a 1-yr, 6-hour rain event of 1.72 inches total rainfall (peak intensity of 0.87 inches per hour, average intensity of 0.29 inches per hour). By plotting the "best fit" line between the storm events for each Meter Area, the resulting equation is used to calculate the inflow volume corresponding to the Design Storm. **Table 5** reports the inflow volume for each 2024 meter area for each of the three storm events analyzed, corresponding inflow volume for the Design Storm, and also breaks down the Design Storm inflow volume by direct and delayed (or indirect) contributions.

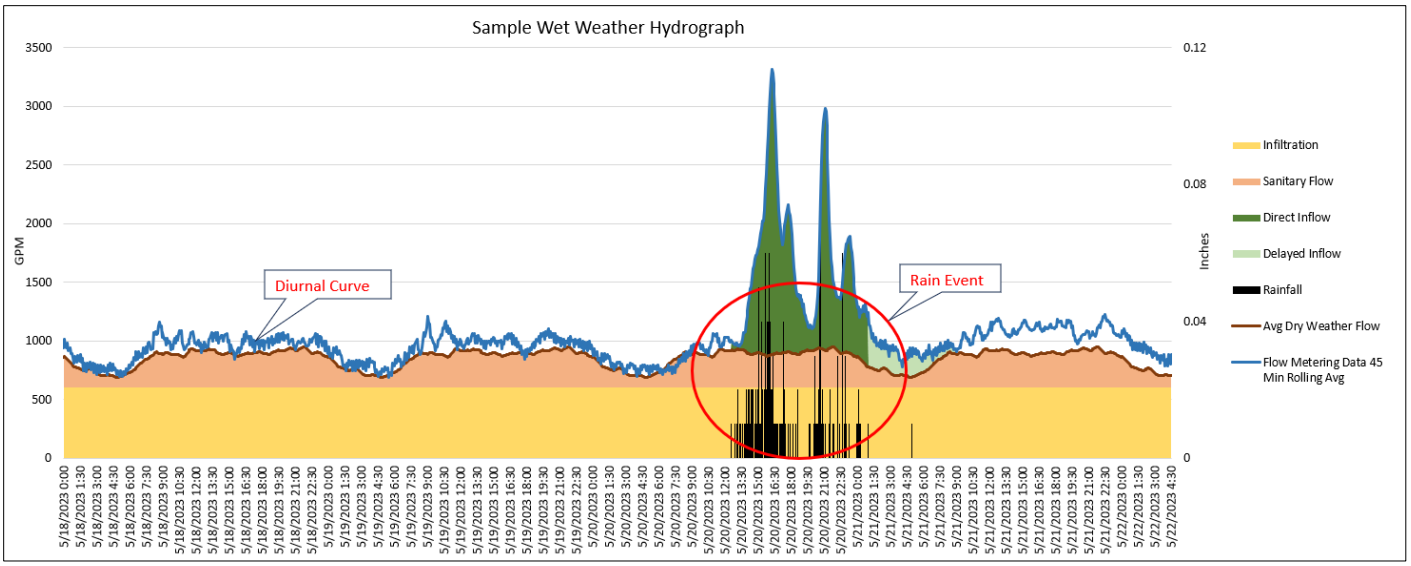


Figure 8: Sample Wet Weather Hydrograph

The "D/I ratio" compares the direct inflow volume versus the delayed (and indirect) volume. For a combined system, it is expected to see a high D/I ratio as the direct inflow will most likely be significantly higher than the delayed inflow. Meter Area 55, has a D/I ration less than 1.0, indicating a higher delayed inflow volume versus the direct inflow volume. Meter 55 is also high in infiltration as show on **Table 3**, therefore the estimated delayed inflow volume may correlate with structural defects within the collection system contributing to both dry-weather infiltration and RII.

Given the percentage of the system that is combined and the Utility's planned sewer separation in the Centralville and Phase 3 CSO areas, the approach for the supplemental inflow analysis is to review the design storm inflow volumes for the existing fully and partially separated areas, where inflow volumes are expected to be minimal, and prioritize those areas with the greatest inflow volumes for further investigation. Through the Phase 3 CSO Preliminary Design efforts conducted in 2024, the Utility has identified catch basins tied to the sanitary sewer in areas that were previously separated tributary to the Warren CSO Station. Redirection of these catch basins will significantly reduce the inflow volumes in the separated sewer areas and provide additional available capacity in downstream combined sewer interceptors. **Table 6** lists the total, direct, and delayed design storm inflow volumes for the fully and partially separated areas from the 2023 and 2024 Flow Monitoring programs. Meter areas are ranked by highest total inflow. It is important to note that Meter 10, 27, and 30 are fully separated areas with 350,000 to 1 million gallons of inflow estimated under the design storm. **Figure 9** shows the geographic locations of the fully and partially separated areas in the collection system and their respective estimated total design inflow volumes.

Table 5: 2024 Flow Monitoring Inflow Summary

			Storm Event Volume (MG)				Design Storm		
Meter[1]	Type	Installed Location	5-May	15-May	30-May	[2]Design Storm Inflow (gal)	D/I Ratio (avg)	Delayed Inflow (gal)	Direct Inflow (gal)
41	Fully Separated	549 Lawrence St	N/A[3]	N/A	N/A	N/A	N/A	N/A	N/A
51	Fully Combined	Stackpole St at Corrigan Ave	N/A	4.262	12.367	17,210,320	2,379.97	7,228	17,203,092
29	Mostly Combined	38 Nottingham St	0.516	0.507	1.506	2,036,996	168,634.53	12	2,036,984
54	Fully Combined	Andover St and Guild St	0.403	0.357	0.917	1,298,428	61,433.06	21	1,298,407
27	Fully Separated	480 Chelmsford St	0.160	0.177	0.698	883,220	57,571.78	15	883,205
52	Both	651 Rogers St	0.253	0.196	0.649	882,704	374.11	2,353	880,351
53	Both	306 Douglas Rd	0.184	0.115	0.305	452,532	29,100.67	16	452,516
30	Fully Separated	Lowell Connector (near Leverett St)	0.096	0.065	0.264	349,332	4.30	65,855	283,477
55	Fully Combined	20 Barasford Ave	0.128	0.158	0.186	321,812	0.90	169,785	152,027
58	Fully Combined	678 E Merrimack St	0.040	0.025	0.046	77,228	4,756.52	16	77,212

[1]Meter 41 data was indeterminate due to the complicated interconnected relationship of its tributaries and therefore inflow was not evaluated

[2]Using Assumed Design Storm of 1.72

[3]N/A = storm was not used for various reasons including but not limited to sensor malfunction during wet weather, sensor location change, etc.

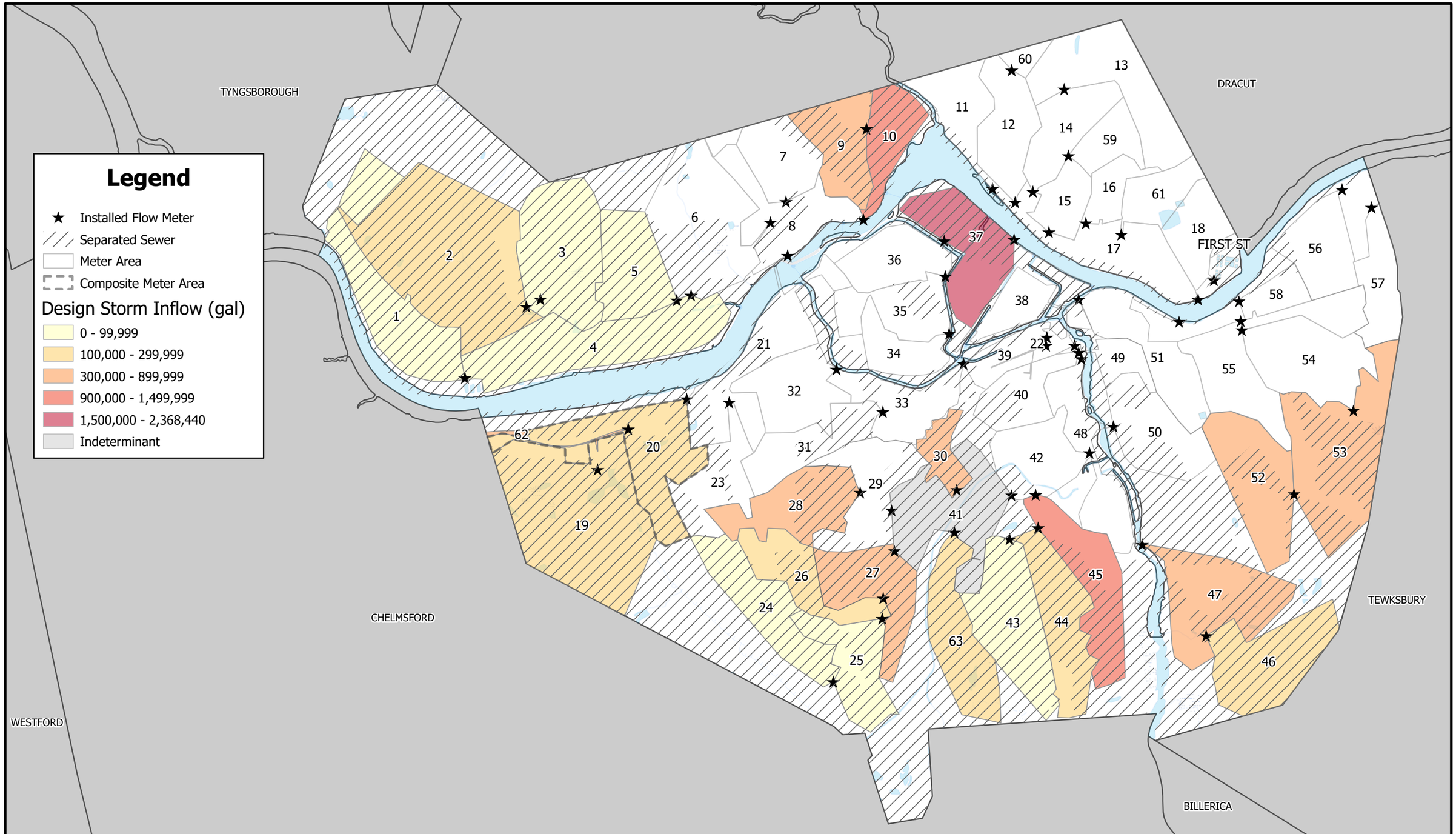
Table 6: Inflow Summary for Fully/Partially Separated Areas – 2023 and 2024 Flow Monitoring Programs

Meter[1]	Type	Installed Location	[2]Design Storm Inflow (gal)	Design Storm Delayed Inflow (gal)	Design Storm Direct Inflow (gal)
41	Fully Separated	549 Lawrence St	N/A	N/A	N/A
37	Both	1 River Pl Building C	2,368,440	236,337	2,132,103
45	Both	978 Gorham St	1,269,360	237,941	1,031,419
10	Fully Separated	911 Martin St	1,020,476	226,888	793,588
27	Fully Separated	480 Chelmsford St	883,220	15	883,205
52	Both	651 Rogers St	882,704	2,353	880,351
28	Both	144 Shaw St	629,864	5,491	624,373
53	Both	306 Douglas Rd	452,532	16	452,516
9	Mostly Separated	Riverside St and Sparks St	422,776	3,206	419,570
62	Both	Middlesex St and Baldwin St	411,080	23,125	387,955
30	Fully Separated	Lowell Connector (near Leverett St)	349,332	65,855	283,477
47*	Both	Lawrence St	330,240	76,642	253,598
19	Mostly Separated	115 Hadley St	252,840	41,689	211,151
44	Mostly Separated	Gorham St and Olive St	251,120	14	251,106
20	Both	915 Pawtucket St	242,348	74,338	168,010
26	Both	Chelmsford St and Maitland St	228,416	13	228,403
63	Fully Separated	Tanner St and Canada St	146,200	14,590	131,610
2	Mostly Separated	821 Varnum Ave	141,556	23,699	117,857
46	Fully Separated	Woburn St and Carmine St	108,360	13	108,347
3	Mostly Separated	Varnum Ave and Laurie Ln	88,752	54,542	34,210
25	Mostly Separated	Chelmsford St and Jenness St	84,280	14	84,266
5	Fully Separated	391 Varnum Ave	59,168	7	59,161
24	Fully Separated	W Albert St and Balimore Ave	54,180	31,591	22,589
4	Fully Separated	360 Varnum Ave (Varnum Ave and Delaware Ave)	38,872	27,140	11,732
1	Fully Separated	Clyde St and Pawtucket Blvd	11,180	1,182	9,998
43	Fully Separated	76 Maple St	8,600	215	8,385

[1]Meter 41 data was indeterminate due to the complicated interconnected relationship of its tributaries and therefore inflow was not evaluated

[2]Using Assumed Design Storm of 1.72

*Combined Meter Area for analysis based on flow relationships (number of users affecting volume differences, negative flows based on close proximity of meters)



0 4,000 8,000
Feet

N

DUCK ISLAND
LOWELL REGIONAL WASTEWATER UTILITY

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT NO.	20220166.003A
CREATED:	3/18/2025
CREATED BY:	JRossini
CHECKED BY:	KGoyette
FILE NAME:	Lowell 2024 Report Figures.mxd

Design Storm Inflow for Fully/Partially Separated Areas Keyplan (2023 and 2024 Flow Monitoring Programs)

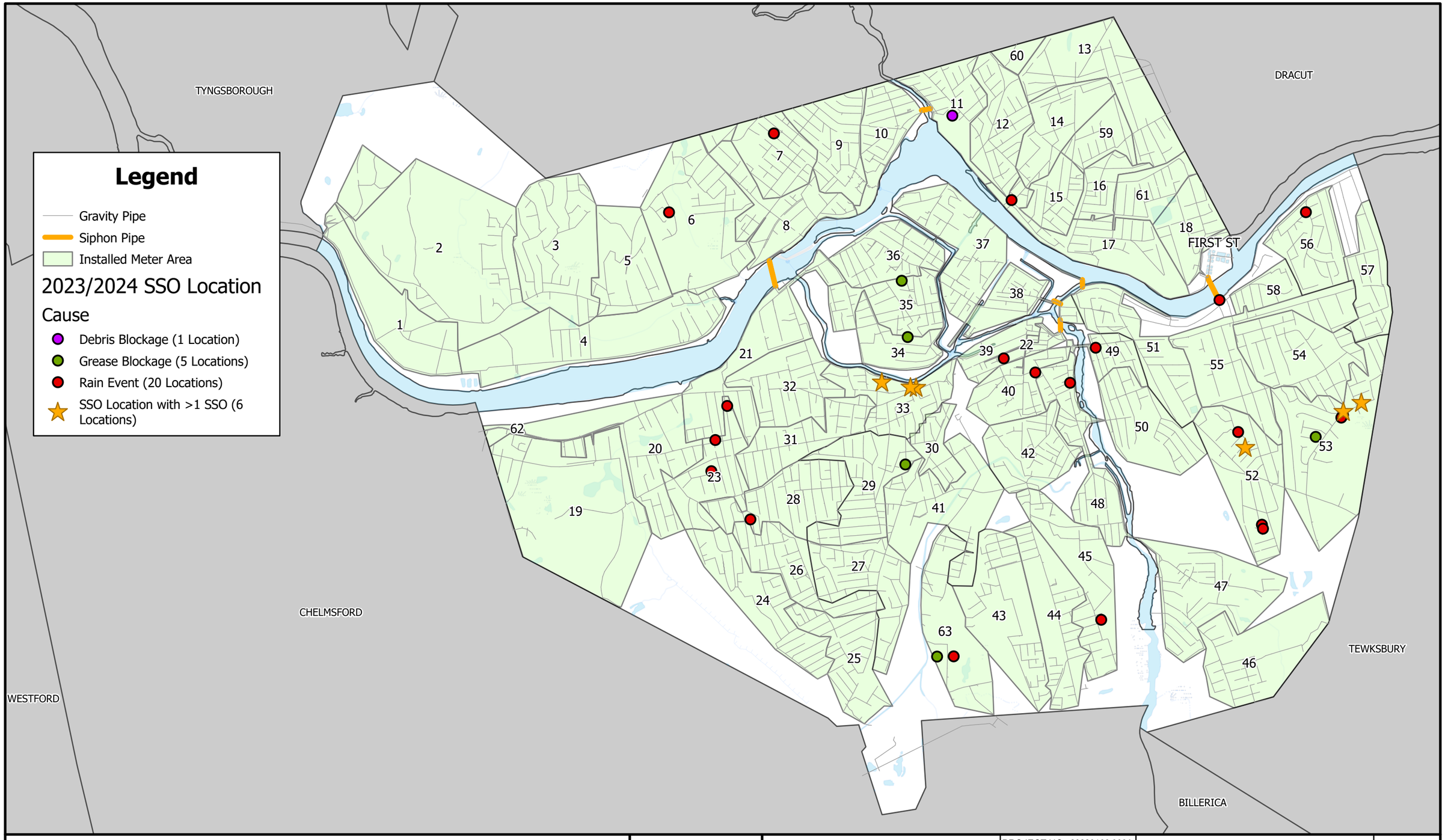
Lowell Regional Wastewater Utility
451 First Street Blvd.
Lowell, MA 01850

FIGURE
9

4.3 ASSESSMENT OF SSO RISK

As part of their assessment of the known system surcharging and street flooding in support of Utility's *2023 Centralville Sewer Separation Preliminary Design Report (Humphrey's Brook PDR)* and *2024 Phase 3 Candidate Area Sewer Separation Preliminary Design Report* (Phase 3 PDR), CDM Smith developed a GIS Shape file showing 27 unique SSO locations that occurred in 2023, as displayed and categorized by root cause in **Figure 10**. The SSOs were identified from the Commonwealth of Massachusetts SSO/Bypass Notification Forms completed by the Utility and submitted to MassDEP following each SSO occurrence.

In 2024, the Utility experienced seven SSOs at four locations within the collection system, and five back ups. The 2024 rain-induced SSOs all occurred at locations which have experienced SSOs previously during storm events of various rainfall totals and durations. The locations that have experienced more than one SSO occurrence, noted with stars in **Figure 10**, are located within the Phase 3 CSO areas with planned system improvements that will reduce system surcharging during storm events, including sewer separation projects in the Peavy area (anticipated to be completed by 2032) and construction of the Douglas Road Wet Weather Storage Tank in the Wentworth area (anticipated to be completed by 2026). Table 2.23 and 2.24 of the Phase 3 PDR details the SSO locations, cause of each event, estimate SSO volume, total rainfall, duration, and storm recurrence interval for each SSO in the Peavy and Wentworth CSO areas for 2023 and 2024.



0 4,000 8,000
Feet

N

DUCK ISLAND
LOWELL REGIONAL WASTEWATER UTILITY

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT NO.	20220166.003A
CREATED:	3/18/2025
CREATED BY:	JRossini
CHECKED BY:	KGoyette
FILE NAME:	Lowell 2024 Report Figures.mxd

2023/2024 SSO Locations

Lowell Regional Wastewater Utility
451 First Street Blvd.
Lowell, MA 01850

FIGURE
10

5 CONCLUSIONS AND RECOMMENDATIONS

The following section summarizes the recommendations from 2024 supplemental flow monitoring program, re-assessment of the 2023 Sanitary System Evaluation Survey (SSES) Implementation Plan, and details the updated 2024 SSES Implementation Plan, including estimated costs and proposed schedule.

5.1 2023 SSES IMPLEMENTATION PLAN

As detailed in the MassDEP Guidelines, upon conclusion of the flow monitoring program an SSES is performed as a follow-up to the I/I analysis to locate and identify specific I/I sources in the sewer system. By identifying the type of each I/I source, appropriate rehabilitation and repair methods can be determined. The data collected during the SSES may also be used to confirm the findings of the I/I Analysis and the extent of system improvements required.

The 2023 I/I Analysis Report included an 8-phase SSES Implementation Plan (SSES Plan), proposing SSES investigations through 2032. In accordance with the Consent Decree, the Utility shall complete an Updated Long-Term CSO Control Plan (Updated LTCP) by September 2034. An overall system assessment is anticipated to begin in 2032 in support of the Updated LTCP and future phases of the SSES Plan beyond Phase 8 will be developed in coordination with the Updated LTCP.

The Utility implemented Phase 1 of 2023 SSES Plan in 2024. The scope of Phase 1 is detailed in **Table 7** and consisted of completion of CCTV and manhole inspections of some of the Utility's oldest infrastructure in the downtown area of the City (Meter Areas 51, 38, 37). In addition to the downtown area inspections, multi-sensor inspections (CCTV, laser, and sonar) were also completed of the Utility's river-front interceptor pipe, approximately 56,300 LF of sewer ranging in size from 36 to 120-inch in diameter as shown in **Figure 11**.

Kleinfelder reviewed the results of the downtown area and interceptor inspections and provided the Utility with draft recommendations for sewer system rehabilitation and repair. In July 2024, the Utility also requested funding for construction of rehabilitation of the downtown area sewers through the MassDEP's Clean Water State Revolving Fund. The Downtown Area Sewer Improvements Project was listed on MassDEP's 2025 Intended Use Plan, with an anticipated $5 million of construction funding. The Utility intends to begin design of the Downtown Area Sewer Improvements in 2025 with an anticipated construction start by June 2026 in accordance with the 2025 CWSRF requirements. The SSES Phase 1

Report will summarize the field investigations completed and provide recommendations for sewer system rehabilitation and repair, including estimated design and construction costs and anticipated schedules. Per MassDEP Guidelines, recommendations shall also include a post-construction flow monitoring program to document the effectiveness of the I/I removal work. The Phase 1 SSES Report is anticipated to be finalized in April 2025.

As noted in the 2023 I/ Analysis Report, the remaining SSES phases would be revisited with the results from the additional 2024 metering efforts and an updated SSES Plan would be issued with the Supplemental I/I Analysis Report.

5.2 2024 SSES IMPLEMENTATION PLAN

As discussed in Section 4 the results of the I/I analysis for the 2024 flow metering program reported some of highest infiltration rates in the collection system and significant direct inflow volumes from fully and partially separated areas. These findings warrant a reassessment of the 2023 SSES Plan.
The Utility has previously committed $400,000 to $500,000 per year for field investigations and engineering associated with SSES Phases 2 through 8. Including a 10% contingency and 4% annual escalation, these costs increase to $750,000 by Phase 8 (year 2032). The 2023 SSES Plan included an implementation schedule with Phase 2 field investigations beginning in Spring 2026 and completion of Phase 8 field investigations in 2032, allowing for future I/I investigations to be informed by the Updated LTCP. Given the Utility's commitments to several major projects to achieve compliance with the Consent Decree over the next ten years, the updated 2024 SSES Plan will be consistent with the Utility's previously planned spending and schedule.

The 2023 SSES Plan included infiltration investigations for 15 meter-areas in Phases 2 through 8. Per MassDEP's guidelines, infiltration investigations such as manhole inspections, flow isolation, and CCTV inspections should be prioritized for all meter areas with an infiltration rate equal or greater than 4,000 gpd/idm. With the addition of seven (7) 2024 metered areas with infiltration rates greater than 4,000 gpd/idm, a total of 31 meter-areas analyzed in 2023 and 2024 require further investigation to identify infiltration sources. As shown in Table 3 in Section 4, ranking the infiltration rates of the 2024 meter-areas against the 2023 meter-areas adds Meter 27, 30, and 55 within the top 15 meter-areas with highest infiltration rates. Including these areas in the 2024 SSES Plan, will subsequently remove three areas with lower infiltration rates (Meter 4, 19, and 7) that were previously included in the 2023 Plan.

As discussed in the 2023 I/I Analysis Report, four of the Meter Areas (13, 14, 15, and 60) identified with excessive infiltration are included in the scope of the Utility's *Centralville Area Sewer Separation Projects*, which will reduce infiltration and inflow sources in these areas through installation of new dedicated storm drains and rehabilitation of existing sewers . The Phase 1 project is currently advertised for public bidding with an anticipated construction start in July 2025. Two additional areas identified with excessive infiltration (Meters 35 and 36) are within the Tilden CSO area. The Tilden CSO area was included in the Utility's December 2024 *Phase 3 Candidate Area Sewer Separation Preliminary Design Report* (Phase 3 PDR) and is to be considered for future sewer separation. I/I improvements to the Tilden CSO area will be revisited at the time of the LTCP Update, to be completed by 2034 per the Consent Decree.

Similarly to Meter 51, Meter 17 is located on a critical portion of the Utility's interceptor, posing challenges for analyzing flow data with its complicated inter-connection of contributing tributary meter areas. Interceptor inspections conducted as part of the 2024 field program confirmed the portion of the 96-inch interceptor spanning from the Beaver Brook Siphon crossing to the Duck Island WWTF has a substantial amount (65 joints) of leaking joints in the reinforced concrete pipe which is contributing to the Meter Area's high estimated infiltration rate.

The Utility is making significant investments throughout the collection system with improvements to reduce CSO volumes and SSO occurrences through the Centralville Area Sewer Separation Projects, Phase 3 CSO Separation Projects, and construction of the Douglas Road Wet Weather Storage Tank. As discussed in Section 4.4, areas exhibiting SSOs due to reduced system capacity during wet weather events are concentrated in the areas with other planned collection system improvements to reduce these occurrences. **Figure 11** shows the planned Phase 3 CSO sewer separation as presented in 2024 Phase 3 CSO PDR with anticipated construction completion in 2032 and the Douglas Road Wet Weather Storage Tank, currently under design with an anticipated construction completion in 2026.

For the subsequent SSES Phases, the Utility intends to prioritize inflow investigations in the fully and partially separates areas of the collection system. As shown in **Table 6** in Section 4, 26 meter areas are comprised of fully or partially separated sewers and exhibit inflow totaling over 10 million gallons for the DEP design storm. Several fully separated areas such as Meter 10, 27, and 30 exhibit significant direct inflow volumes, indicating there may be dedicated storm drains with direct connections to the sanitary sewer. The Utility identified a combined sewer remaining on Inland Street, located within the Meter 27 area, which will be separated under the future Phase 3 CSO sewer separation projects. Smoke testing, building inspections, and dye tests are successful tools for investigating public and private direct inflow sources in separated sewer areas. For areas that exhibit delayed inflow, building inspections may also

identify sump pumps discharging to the sanitary sewer, a significant source of delayed inflow. RII may also be a contributing factor to delayed inflow volumes. Potential sources of RII are best identified through manhole and CCTV inspections as they are typically structural in nature.

The 2024 Implementation Plan will prioritize the direct inflow investigations for the fully separated areas exhibiting the highest direct inflow volumes in Phases 2 (2026) and 3 (2027). This includes smoke testing, building inspections, and dye testing for Meters 10, 27, 30, and 63, identified as fully separated as shown in **Table 6**. Inflow investigations are also recommended for Meters 37 and 45 in areas with a dedicated storm drain, as they are identified as having some areas of separated sewer and contribute the highest inflow shown in **Table 6**. For Meter 37, this is primarily the area of the University of Massachusetts Lowell campus. Other meter areas identified to be mostly separated that exhibit significant inflow such as Meters 9, 19, and 44 are also recommended for further inflow investigations. As noted in Section 4.3, through the Phase 3 CSO Preliminary Design efforts conducted in 2024, the Utility has identified catch basins tied to the sanitary sewer in areas that were previously separated tributary to the Warren CSO Station. Although the inflow analysis for Meter 41 was inconclusive, with the recent public inflow sources identified in previously separated areas, it is prudent for the Utility to conduct inflow investigations in Meter 41, identified as fully separated.

Through both prior and the recent Phase 1 SSES field investigation efforts, the Utility has identified several collection system defects allowing for a cross-connection with the Pawtucket Canal. With these findings, it is recommended the Utility complete inspections of the remaining sewers located along the Pawtucket Canal. Approximately 24,700 feet of sewer is identified for inspection that has not been completed within recent years, including 1,200 feet of the Marginal Interceptor, located in the vicinity of the planned Phase 3 CSO sewer separation projects. It is recommended that inspection of this portion of the Marginal Interceptor be included with the CCTV efforts to be conducted in support of the Phase 3 sewer separation projects. The remaining 23,500 feet of sewer located along the canal will be included in a subsequent phase of the 2024 SSES Plan to identify potential infiltration/inflow sources.

The proposed updated 2024 SSES Plan is presented in **Table 7**. **Table 7** lists each SSES phase including the affected meter areas, proposed infiltration investigations (flow isolation, manhole and CCTV inspections) and proposed inflow investigations (smoke testing, building inspections, dye testing) to identify sources of I/I and determine rehabilitation and repair methods to reduce I/I contributions to the sewer collection system. Consistent with the 2023 SSES Plan, the 2024 Plan includes 8-phases, with field investigations terminating in 2032. The 2024 SSES Plan notes Phase 1 SSES as completed and includes the quantities of CCTV and manhole inspections completed in 2024. SSES Phases 2 through 8 include the following scope:

- Infiltration investigations for 15 meters areas
- Inflow investigations for 10 fully and partially separated meter areas
- CCTV and manhole inspection of sewers located along the Pawtucket Canal
- Inspections of siphons

Phases 2 and 3 prioritize inflow investigations to identify inflow sources in the fully and partially separated areas. Inflow investigations in Phase 2 and 3 include smoke testing of all sewers, a targeted number of building inspections focused on large, flat-roof buildings, along with an estimated number of dye tests to confirm discharge locations. Phase 2 includes inflow investigations for four fully- separated (Meter 27, 30, 41, and 63) and one partially separated area (Meter 37). Phase 2 also includes infiltration investigations in Meter 27 and 30 areas. Even though the observed groundwater levels at these locations were significantly lower in 2024 than 2023, these 2024 meter areas reported some of the highest infiltration rates in the collection system when compared with 2023 meter infiltration analysis.

In addition to inflow investigations in five fully and partially separated areas, Phase 3 includes flow isolation and CCTV inspections of the sewers located along the Pawtucket Canal. Phases 4 through 8 are focused on infiltration investigations in areas with higher infiltration rates where the Utility is not planning future system investigations or improvement projects. Flow isolation, CCTV, and manhole inspections of Meter Area 22, one of the 2023 meter areas with poor-quality data that was not re-metered due to the small size of its tributary area, are included within Phase 8 of the 2024 SSES Plan.

Consistent with the 2023 SSES Plan, the Utility will also prioritize inspections of the collection system's siphons and inspect one per SSES phase, beginning in Phase 4. It is recommended that the Walker Siphon be inspected first in Phase 4 as it crosses the Merrimack River and is located within Meter Area 21, which exhibited both high I/I contributions.

Figure 11 shows the meter areas identified for each SSES phase with colored areas representing phases of infiltration investigations and diagonal hatching representing phases of inflow investigations. **Figure 11** also includes the extents of the Pawtucket Canal sewers to be inspected in Phase 3, siphon inspections, along with the completed Phase 1 SSES interceptor inspections. The Centralville Area Sewer Separation Projects and proposed Phase 3 CSO sewer separation areas are also identified in **Figure 11**.

The associated costs for the 2024 SSES implementation plan are detailed in **Table 8.** Phases 2 through 5, 7, and 8 include $450,000 to $520,000 of field investigations and engineering, consistent with the Utility's previous budget commitments. Phase 6 costs are closer to $600,000 as it includes the inspection

of the Merrimack River siphon (large, triple-barrel siphon). With a 10% contingency and 4% escalation per year these total costs increase to $700,000 to $800,000 per phase.

The implementation schedule shown in **Figure 12** includes an overall timeline for each proposed SSES phase, along with continuous design and construction efforts to cost-effectively address sources of I/I. The Utility has allocated $2 Million per year for design and construction of system repair/rehabilitation to reduce I/I. System improvements will be prioritized based on cost effectiveness on reducing I/I, along with the critical nature of system defects and the potential detriment to collection system operations, and public and environmental health. As noted previously, the Utility plans to begin design of the Downtown Area Sewer Rehabilitation Project in 2025, which will address system deficiencies identified through SSES Phase 1 investigations in Meter Areas 51, 38, and 37. Improvements recommended as a result of the river-front interceptors inspections will be detailed in the Phase 1 SSES Report, anticipated to be completed in April 2025.

Table 7: Proposed 2024 SSES Implementation Plan

Fiscal Year[2]	Phase	Meter Area	CCTV (LF)	MH Inspections (EA)	Siphon Inspection (EA)	Flow Isolation (LF)	Smoke Testing (LF)	Building Inspections (EA)	Dye Testing (EA)
2023	0*	M38, M51	31,500	220	East Merrimack	-	-	-	-
2024	1*	M37, M38, M51	21,300	86	-	-	-	-	-
2024	1*	Interceptor	56,300	197	-	-	-	-	-
2026	2	M27[3], M30[3], M37[1], M41[1], M63[1]	31,900	180	-	31,900	89,600	310	135
2027	3	M9[1], M10[1], M19[1], M44[1], M45[1]	0	0	-	-	98,500	350	150
2027	3	Canal Pipe	23,500	0	-	23,500	-	-	-
2028	4	M6, M41	44,900	270	Walker	44,900			
2029	5	M20, M48	52,500	305	Beaver Brook	52,500	-	-	-
2030	6	M42, M55, M63	55,300	305	Merrimack River	55,300	-	-	-
2031	7	M1, M3	43,900	240	Warren	43,900	-	-	-
2032	8	M21, M22, M39, M61	48,400	275	Concord River	48,400	-	-	-
	TOTAL		**409,500**	**2,078**	**6**	**300,400**	**188,100**	**660**	**285**

**Phase 0 field inspections completed in 2023; Phase 1 field inspections completed in 2024.*

[1] Inflow investigations only (smoke testing, building inspections, dye testing).

[2] Fiscal year begins on July 1st and ends on June 30th the following year.

[3] Both infiltration and inflow investigations.

Table 8: Cost Estimate for Proposed 2024 SSES Implementation Plan

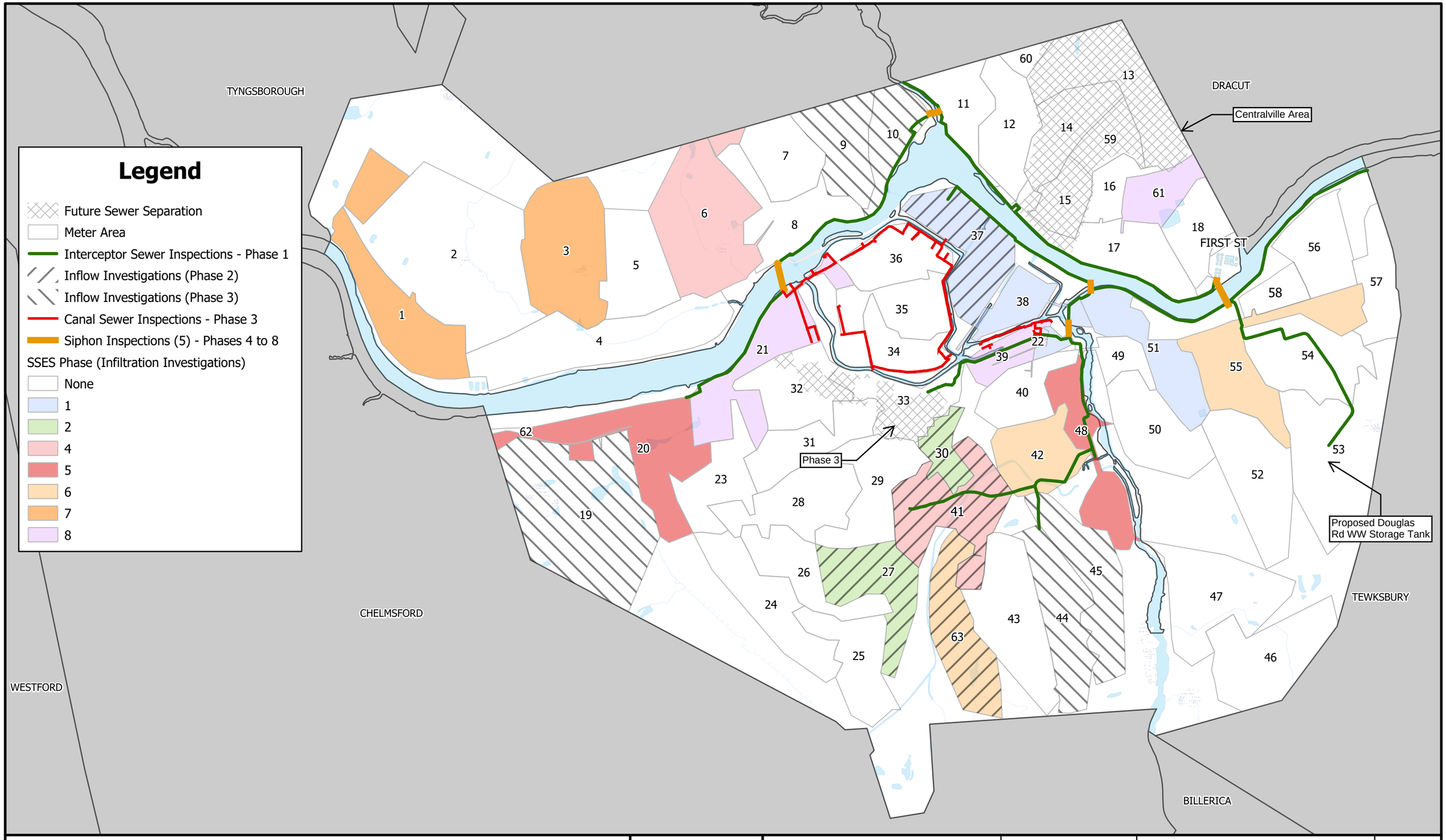
Item	Phase 1 (2024)	Phase 2 (2026)	Phase 3 (2027)	Phase 4 (2028)	Phase 5 (2029)	Phase 6 (2030)	Phase 7 (2031)	Phase 8 (2032)
SSES	M37, M38, M51	M27[3], M30[3], M37[1], M41[1], M63[1]	M9[1], M10[1], M19[1], M44[1], M45[1]	M6, M41	M20, M48	M42, M55, M63	M1, M3	M21, M22, M39, M61
CCTV Inspections	$112,000	$170,000	$130,000	$240,000	$280,000	$300,000	$240,000	$260,000
MH Inspections	$38,200	$16,000	$0	$22,000	$25,000	$25,000	$20,000	$23,000
Interceptor Inspections	$479,450	$0	$0	$0	$0	$0	$0	$0
Siphon Inspections	$0	$0	$0	$104,000	$41,000	$113,000	$68,000	$41,000
Flow Isolation	$0	$15,000	$11,000	$20,000	$23,000	$24,000	$20,000	$21,000
Smoke testing	$0	$47,000	$50,000	$0	$0	$0	$0	$0
Building Inspections	$0	$109,000	$88,000	$0	$0	$0	$0	$0
Dye Testing	$0	$40,000	$44,000	$0	$0	$0	$0	$0
Engineering	$130,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000
Subtotal	***$759,650***	***$522,000***	***$448,000***	***$511,000***	***$494,000***	***$587,000***	***$473,000***	***$470,000***
Contingency 10%	*$0*	*$53,000*	*$45,000*	*$52,000*	*$50,000*	*$59,000*	*$48,000*	*$47,000*
Escalation 4%	*$0*	*$47,000*	*$62,000*	*$96,000*	*$118,000*	*$172,000*	*$165,000*	*$191,000*
TOTAL	**$759,650**	**$622,000**	**$555,000**	**$659,000**	**$662,000**	**$818,000**	**$686,000**	**$708,000**

[1] Inflow investigations only (smoke testing, building inspections, dye testing).

[2] Fiscal year begins on July 1st and ends on June 30th the following year.

[3] Both infiltration and inflow investigations.

[4]Includes Engineering Services During Construction



0 4,000 8,000
Feet

N

DUCK ISLAND
LOWELL REGIONAL WASTEWATER UTILITY

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT NO.	20220166.003A
CREATED:	3/18/2025
CREATED BY:	JRossini
CHECKED BY:	KGoyette
FILE NAME:	Lowell 2024 Report Figures.mxd

2024 SSES Implementation Plan

Lowell Regional Wastewater Utility
451 First Street Blvd.
Lowell, MA 01850

FIGURE
11

Date: 3/18/2025 User: JRossini Path: \\azrgisstorp01\GIS_Projects\Client\MA_Lowell\20220166.003_Consent_Decree_Compliance\MXD\Lowell 2024_Field Program\Lowell 2024 Report Figures.aprx

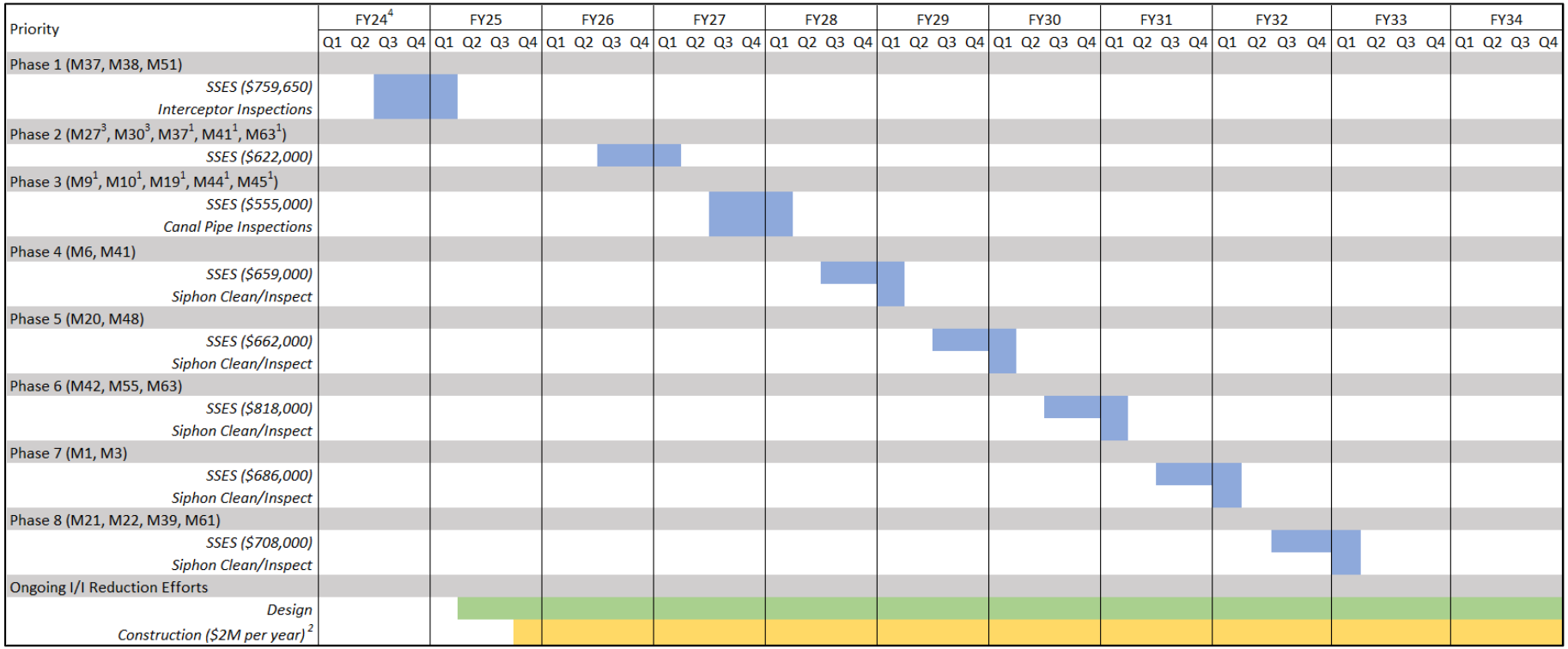


Figure 12: 2024 Infiltration/Inflow Implementation Schedule

[1] *Inflow investigations only (smoke testing, building inspections, dye testing)*

[2] *Includes post-construction flow monitoring*

[3] *Both infiltration and inflow investigations*

[4] *Fiscal year begins July 1st and ends June 30th*

APPENDIX A – ADS INSTALL LOGS

Lowell, MA

Flow Monitoring
Site Installation Report

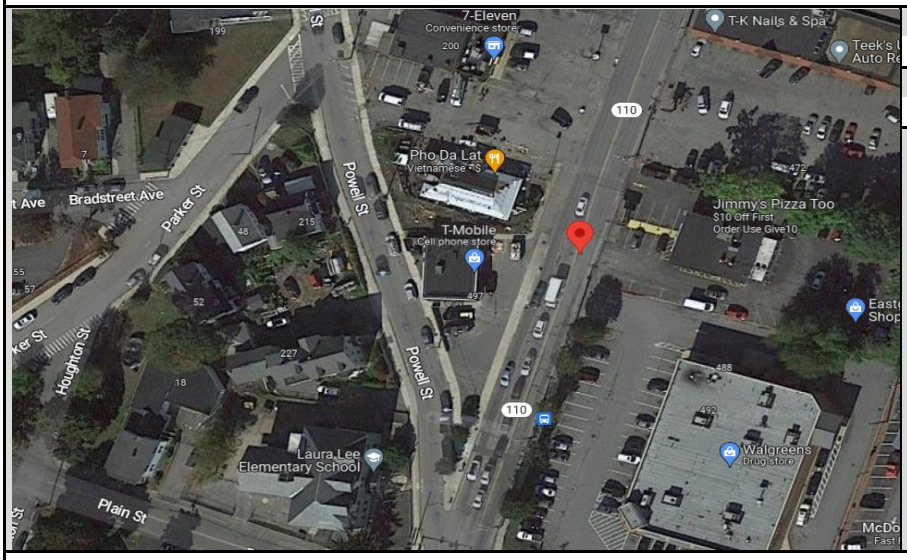
ADS ENVIRONMENTAL SERVICES®

Site I.D.

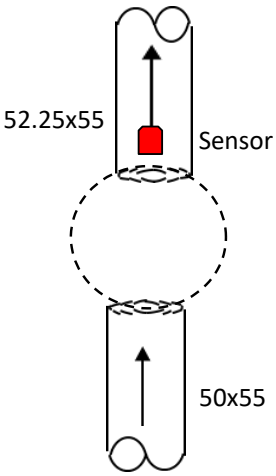
Meter-27

Site Address / Location:	480 Chelmsford St, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
52.25x55.00	Elliptical



Manhole #	System Characteristics
27	Residential
Access	**Traffic**
Drive	Heavy



Installation Information

Installation Date:	Installation Type:
Tuesday, April 2, 2024	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Downstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV|MAX/Peak Combo (CS9)/Surface Combo	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
12:44:00 PM	52.25x55.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
14.08	38.17
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
1.5	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
1.2	0.5
Silt (in)	**Silt Type**
1	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
256	Common Trench
Manhole Material:	**Manhole Condition:**
Brick	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
28	28
Manhole Cover	**Manhole Frame**
Concealed	Normal
Active Drop Connections	**Air Quality:**
No	Good
Pipe Material	**Pipe Condition:**
Brick	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

ADS Project Name:	Lowell, Ma
ADS Project Number:	

Lowell, MA

Flow Monitoring
Site Installation Report

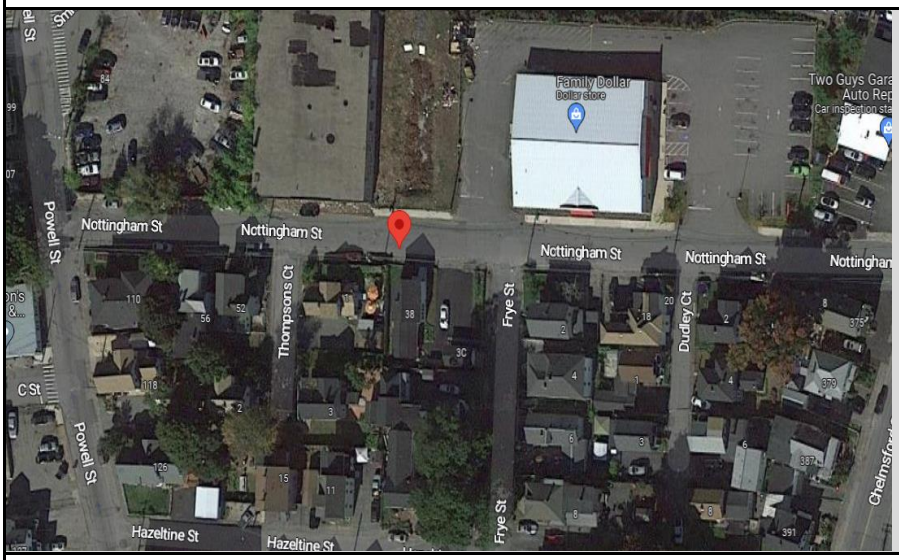
ADS ENVIRONMENTAL SERVICES®

Site I.D.

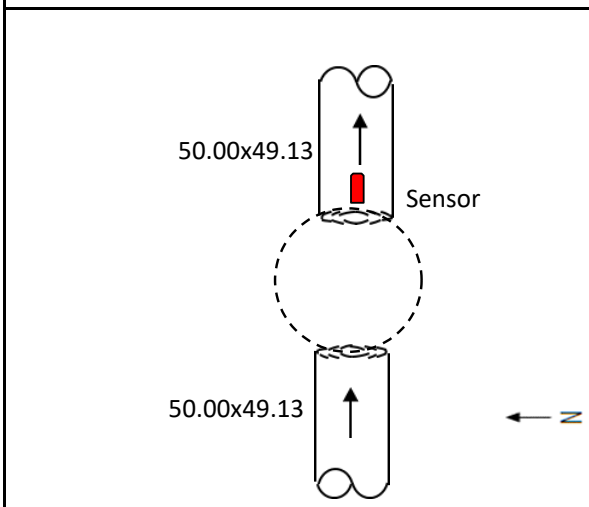
Meter-29

Site Address / Location:	38 Nottingham Street, Lowell, MA
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
50.00x49.13	Elliptical



Manhole #	System Characteristics
29	Residential
Access	Traffic
Drive	Light



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, April 2, 2024	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Downstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV|MAX/Peak Combo (CS9)/Surface Combo	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
10:27:00 AM	50.00x49.13
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
5.29	44.71
Downlooker Physical Offset (in)	Measurement Confidence (in)
1.5	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
4.86	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
170.5	Common Trench
Manhole Material:	Manhole Condition:
Brick	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
28	28
Manhole Cover	Manhole Frame
Concealed	Normal
Active Drop Connections	Air Quality:
No	Good
Pipe Material	Pipe Condition:
Brick	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

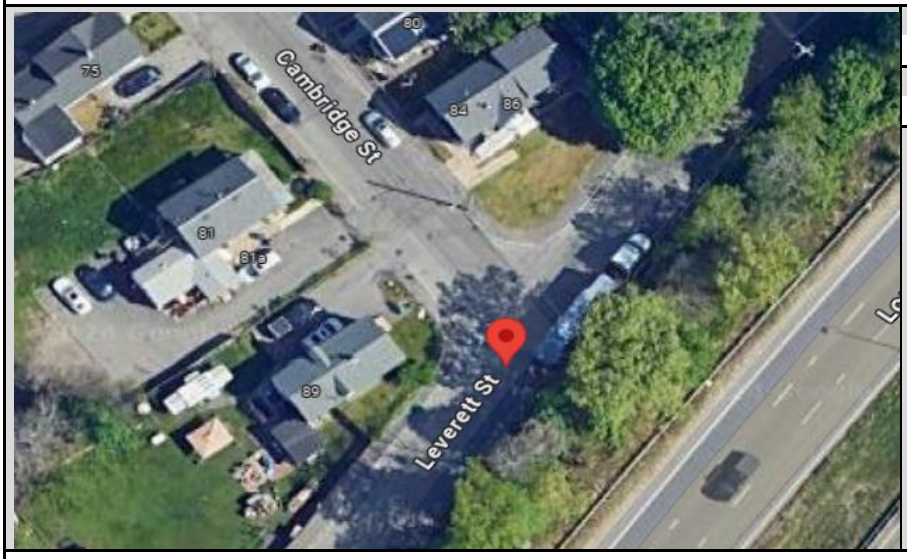
ADS ENVIRONMENTAL SERVICES®

Site I.D.

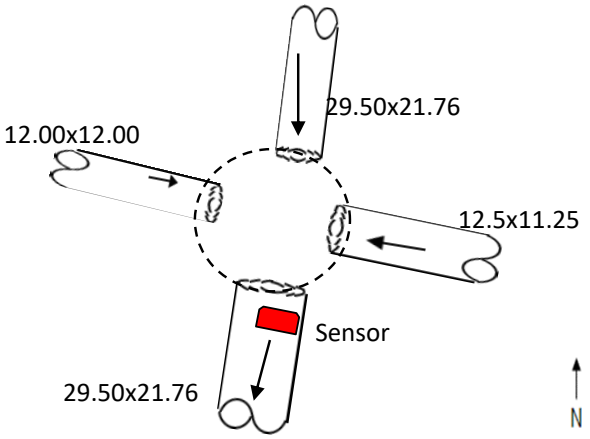
Meter-30

Site Address / Location:	Cambridge St at Leverett St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
29.50x21.75	Standard Egg



Manhole #	System Characteristics
30	Residential
Access	Traffic
Drive	None



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, April 3, 2024	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Downstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV|MAX/Peak Combo (CS9)/Surface Combo	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:29:00 AM	29.50x21.76
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
6.45	23.05
Downlooker Physical Offset (in)	Measurement Confidence (in)
1.5	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.28	0
Silt (in)	Silt Type
2	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
104	Common Trench
Manhole Material:	Manhole Condition:
Brick	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
28	28
Manhole Cover	Manhole Frame
Concealed	Normal
Active Drop Connections	Air Quality:
No	Good
Pipe Material	Pipe Condition:
Brick	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

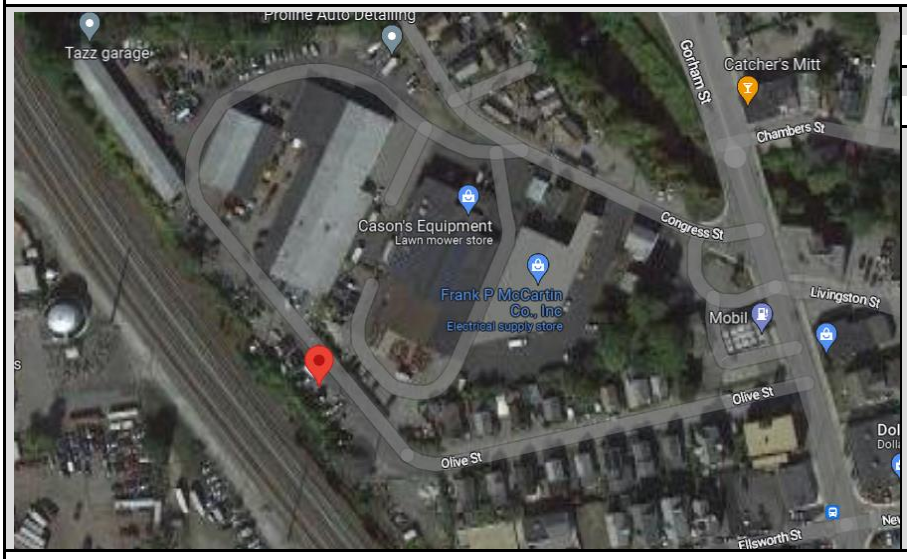
ADS ENVIRONMENTAL SERVICES®

Site I.D.

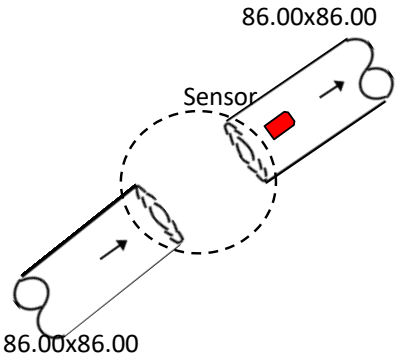
Meter-41

Site Address / Location:	Olive St (42631143,-71.310788)
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
86.00x86.00	Circular



Manhole #	System Characteristics
41	Residential
Access	**Traffic**
Drive	None



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, April 3, 2024	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Downstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV|MAX CS-9Surface Combo (CS5-V2)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
2:23:00 PM	86.00x86.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
13.83	72.17
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
3	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
3.3	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
409.13	Common Trench
Manhole Material:	**Manhole Condition:**
Brick	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
28	28
Manhole Cover	**Manhole Frame**
Concealed	Normal
Active Drop Connections	**Air Quality:**
No	Good
Pipe Material	**Pipe Condition:**
Brick	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

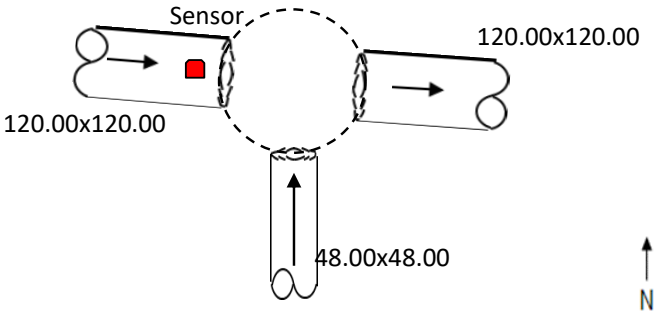
Site I.D.

Meter 51

Site Address / Location:	Stackpole St at Corrigan Ave- (42.643959, -71.293707)
Site Access:	Walk

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
120.00x120.00	Circular

Manhole #	System Characteristics
51	Residential
Access	Traffic
Walk (Wooded)	None



ADS Project Name:	Lowell. Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, April 9, 2024	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV|MAX/Peak Combo (CS9), LRD (CS6)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:22:00 AM	120.00x120.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
35.97	84.03
Downlooker Physical Offset (in)	Measurement Confidence (in)
70	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.895	20.75
Silt (in)	Silt Type
4	sandy

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
192	Common Trench
Manhole Material:	Manhole Condition:
Concrete	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
28	28
Manhole Cover	Manhole Frame
Concealed	Normal
Active Drop Connections	Air Quality:
No	Good
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

This site is located in the brush that is shown in the area photo. This picture was taken to help better understand the location of the site.

Lowell, MA

Flow Monitoring
Site Installation Report

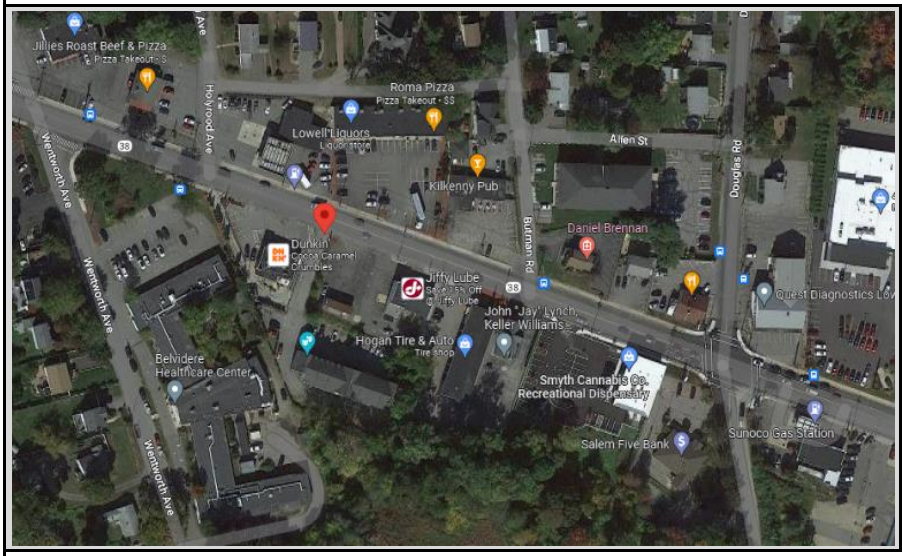
ADS ENVIRONMENTAL SERVICES®

Site I.D.

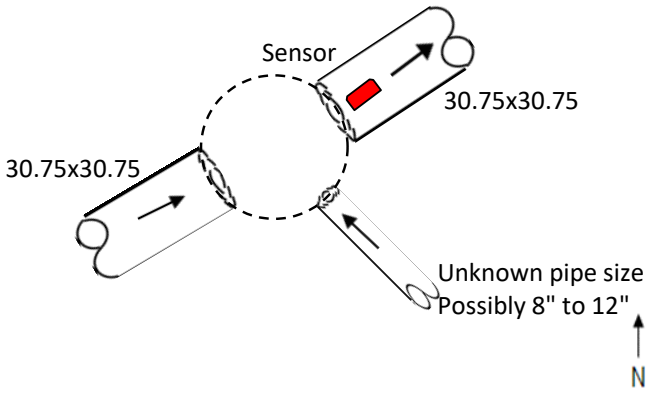
Meter-52

Site Address / Location:	651 Rogers St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
30.75x30.75	Circular



Manhole #	System Characteristics
52	Residential
Access	**Traffic**
Drive	Light



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Monday, April 1, 2024	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Downstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV|Max/Peak Combo (CS9)/Surface Combo	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
3:13:00 PM	30.75x30.75
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
3.59	27.16
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
2	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
4.45	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
212.65	Common Trench
Manhole Material:	**Manhole Condition:**
Concrete	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
28	28
Manhole Cover	**Manhole Frame**
Concealed	Normal
Active Drop Connections	**Air Quality:**
No	Good
Pipe Material	**Pipe Condition:**
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

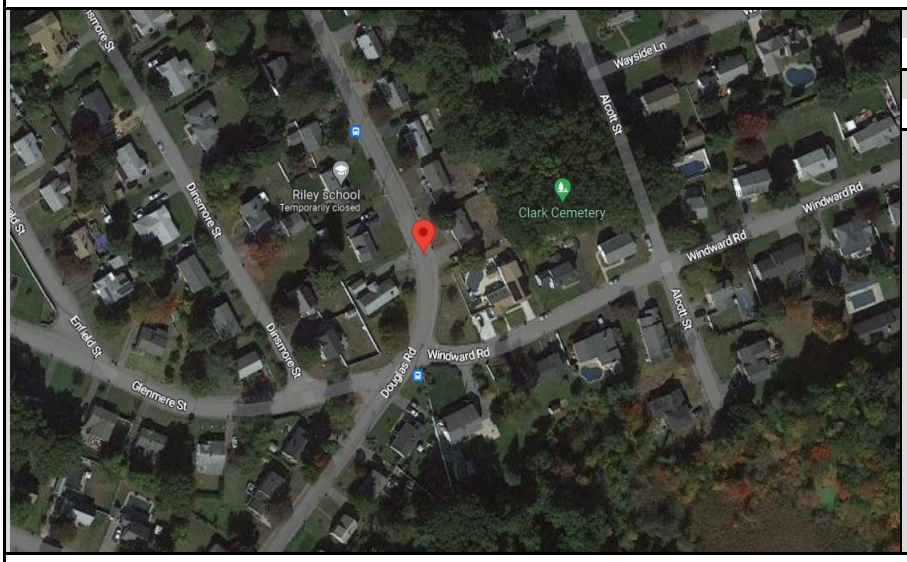
Site I.D.

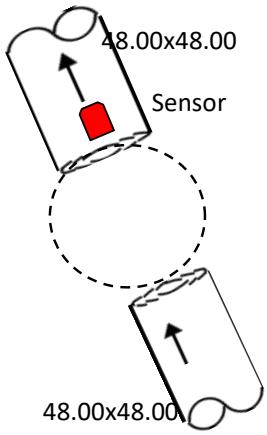
Meter-53

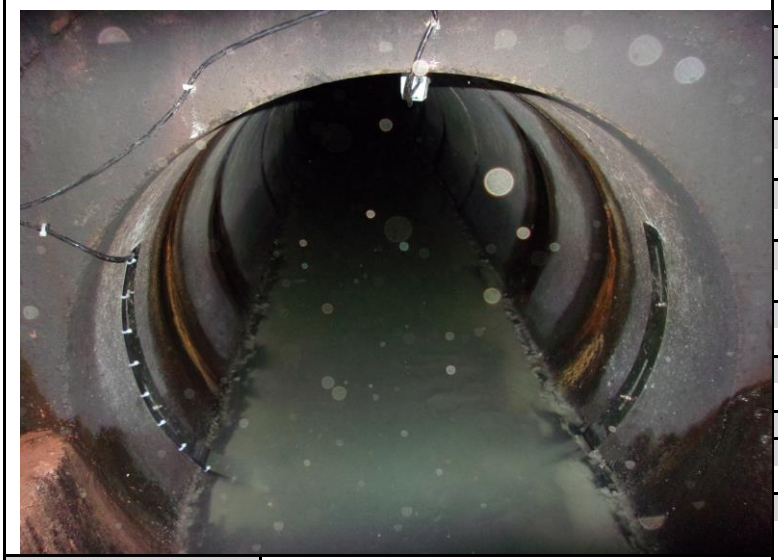
Site Address / Location:	306 Douglas Rd, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
48.00x48.00	Circular

Manhole #	System Characteristics
53	Residential
Access	Traffic
Drive	Light







ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, April 2, 2024	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Downstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV|MAX/Peak Combo (CS9)/Surface Combo	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
2:37:00 PM	48.00x48.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
10.17	38.83
Downlooker Physical Offset (in)	Measurement Confidence (in)
1.5	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.58	0.5
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
277	Common Trench
Manhole Material:	Manhole Condition:
Brick	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
28	28
Manhole Cover	Manhole Frame
Concealed	Normal
Active Drop Connections	Air Quality:
No	Good
Pipe Material	Pipe Condition:
Concrete	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

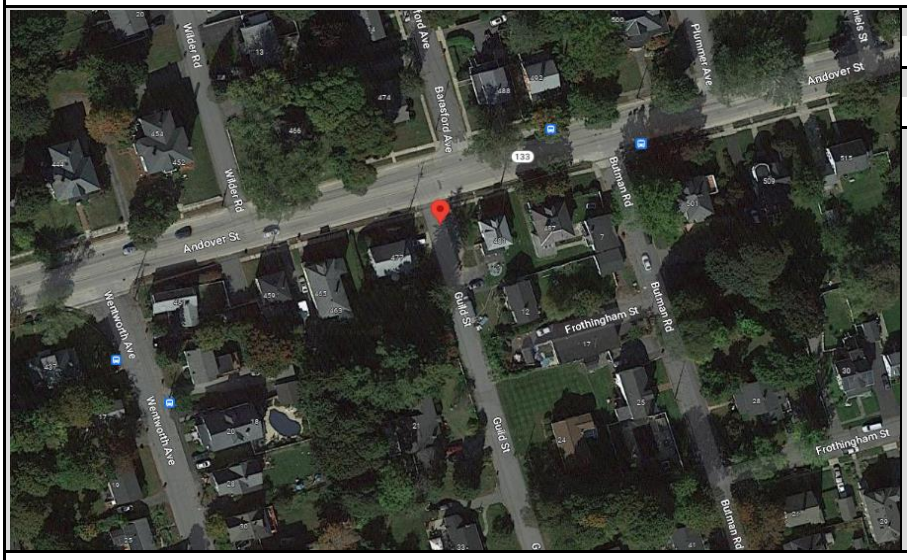
ADS ENVIRONMENTAL SERVICES®

Site I.D.

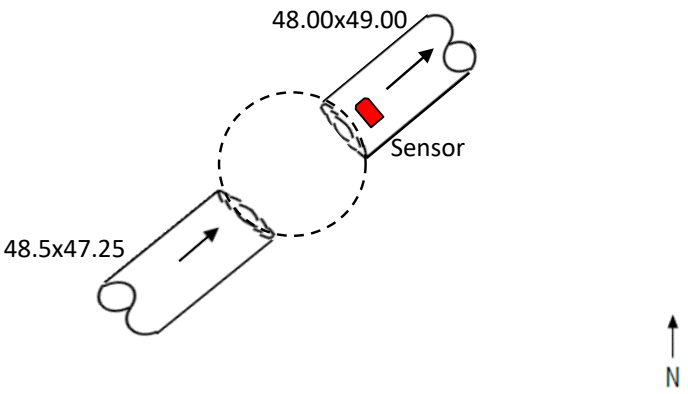
Meter-54

Site Address / Location:	Andover St at Guild St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
48.00x49.00	Elliptical



Manhole #	System Characteristics
54	Residential
Access	**Traffic**
Drive	Light



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Monday, April 1, 2024	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Downstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV|Max/Peak Combo (CS9)/Surface Combo	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
10:28:00 AM	48.00x49.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
9.15	38.85
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
1.63	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.81	0.63
Silt (in)	**Silt Type**
0	

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
301	Common Trench
Manhole Material:	**Manhole Condition:**
Brick	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
28	28
Manhole Cover	**Manhole Frame**
Concealed	Normal
Active Drop Connections	**Air Quality:**
No	Good
Pipe Material	**Pipe Condition:**
Brick	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

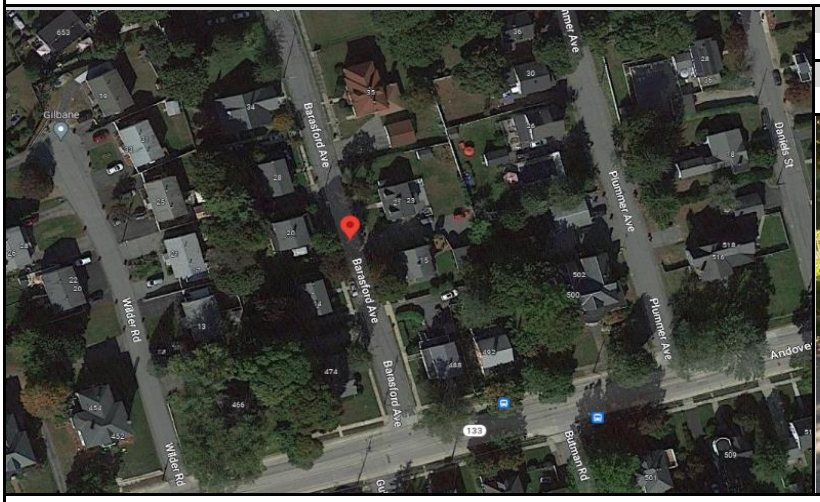
Site I.D.

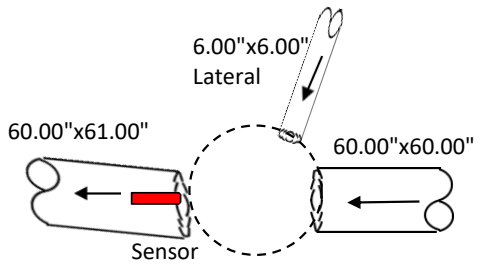
Meter-55

Site Address / Location:	20 Barasford Ave
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
60.00x61.00	Circular

Manhole #	System Characteristics
55	Residential
Access	**Traffic**
Drive	Light





N

ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, April 9, 2024	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Downstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV|Max/Peak Combo (CS9)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
1:18:00 PM	60.00x61.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
4.7	55.3
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
1.75	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
6.65	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
235.75	Common Trench
Manhole Material:	**Manhole Condition:**
Brick	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
28	28
Manhole Cover	**Manhole Frame**
Concealed	Normal
Active Drop Connections	**Air Quality:**
No	Good
Pipe Material	**Pipe Condition:**
Brick	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

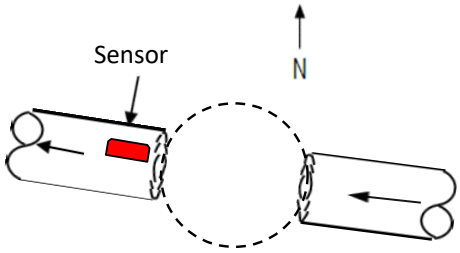
Site I.D.

Meter-58

Site Address / Location:	684 E Merrimack St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
37.00x26.00	Standard Egg

Manhole #	System Characteristics
58	Residential
Access	Traffic
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Monday, April 1, 2024	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Downstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV|Max/Peak Combo (CS9)/Surface Combo	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
10:39:00 AM	37.00x26.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
1.38	35.62
Downlooker Physical Offset (in)	Measurement Confidence (in)
2	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
4.19	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
112.25	Common Trench
Manhole Material:	Manhole Condition:
Brick	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
28	28
Manhole Cover	Manhole Frame
Concealed	Normal
Active Drop Connections	Air Quality:
No	Good
Pipe Material	Pipe Condition:
Brick	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

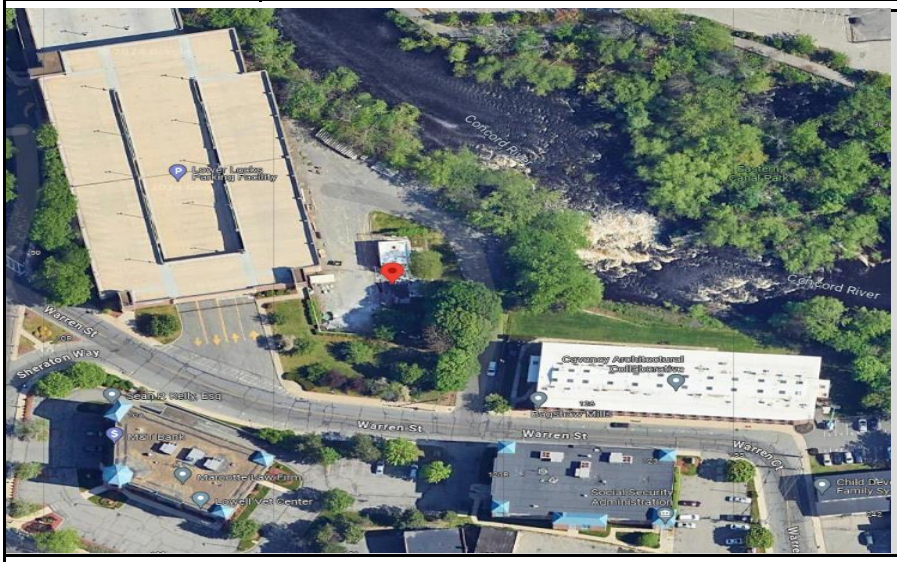
Site I.D.

Lowell RG

Site Address / Location:	Warren St PS/ 90 Warren St
Site Access:	Drive

Monitor Series	Location Type
Rain Alert III	Temporary
Pipe Size (H x W)	Pipe Shape

Manhole #	System Characteristics
RG	Residential
Access	Traffic
Drive	



Installation Information

Installation Date:	Installation Type:
Tuesday, April 9, 2024	Rain Gauge
Monitoring Location (Sensors):	Monitor Location:
Sensors / Devices:	Pressure Sensor Range (psi)
Rain Gauge Tipping Bucket	

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
2:00:00 PM	
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
Downlooker Physical Offset (in)	Measurement Confidence (in)
Peak Velocity (fps)	Velocity Sensor Offset (in)
Silt (in)	Silt Type

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
Manhole Material:	Manhole Condition:
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
Manhole Cover	Manhole Frame
Active Drop Connections	Air Quality:
Pipe Material	Pipe Condition:

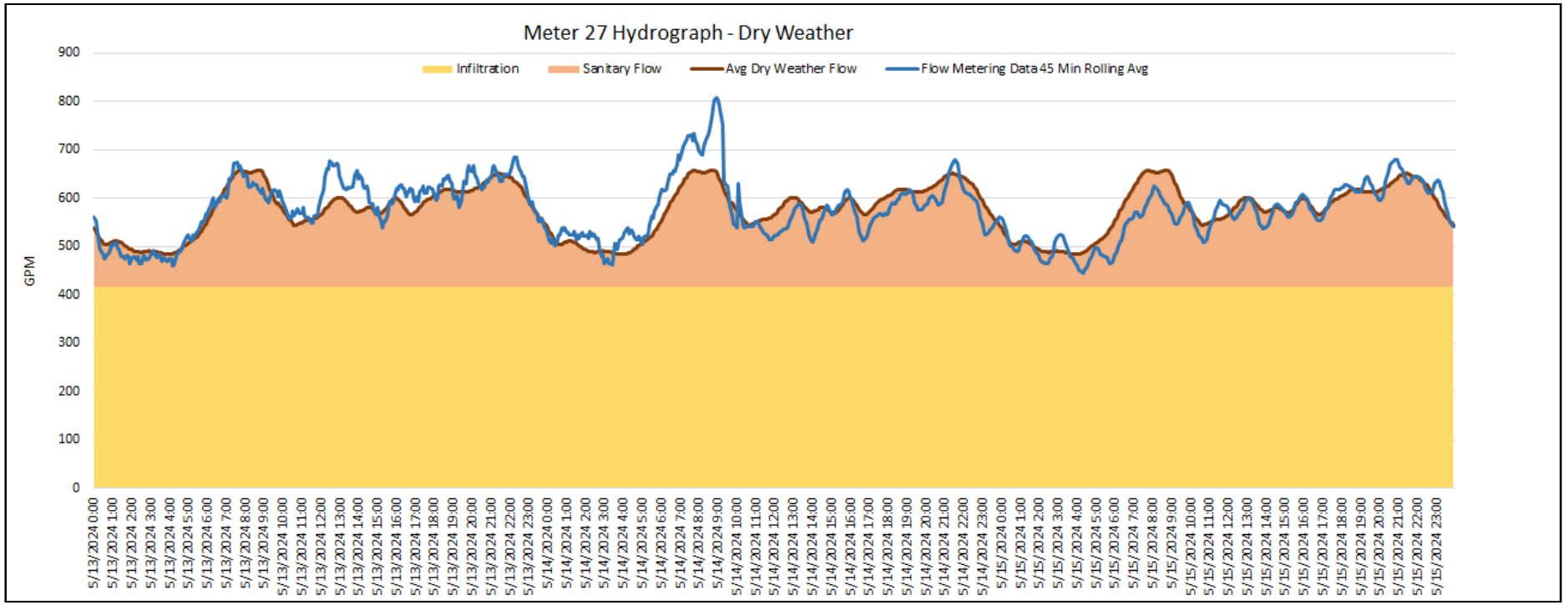
Communication Information:

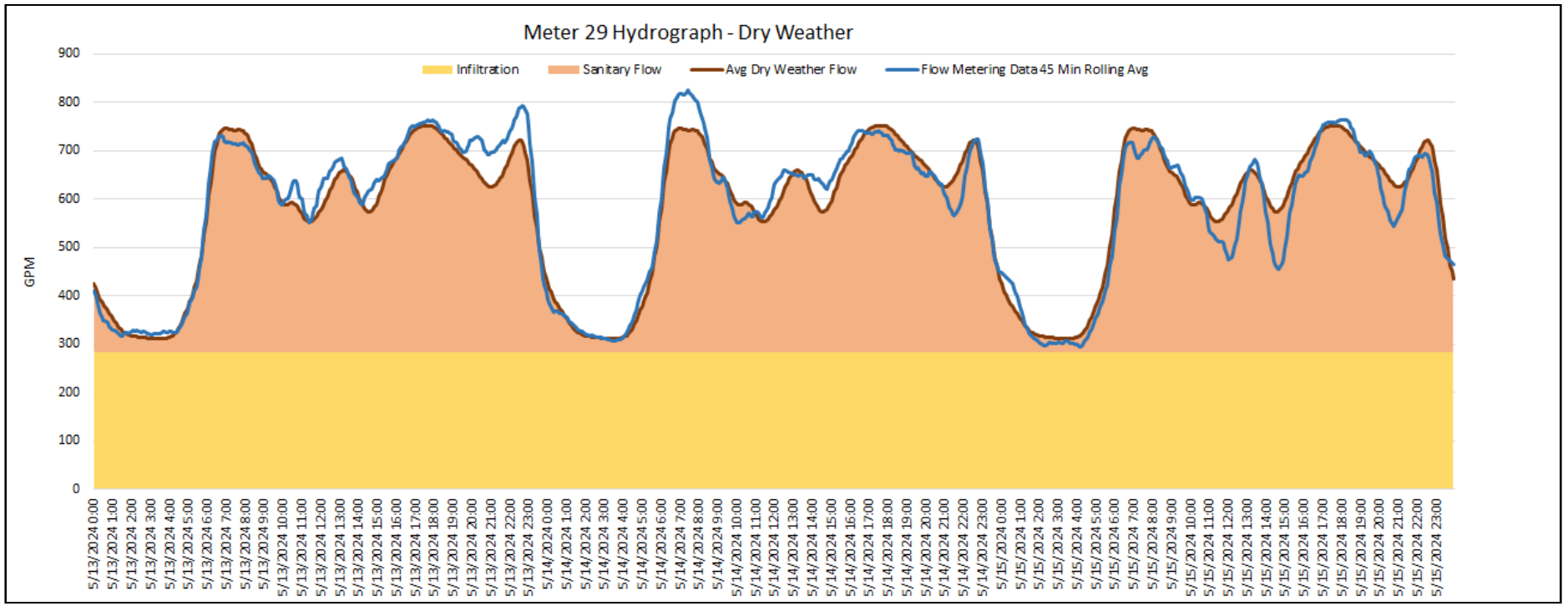
Communication Type	Antenna Location
Wireless	

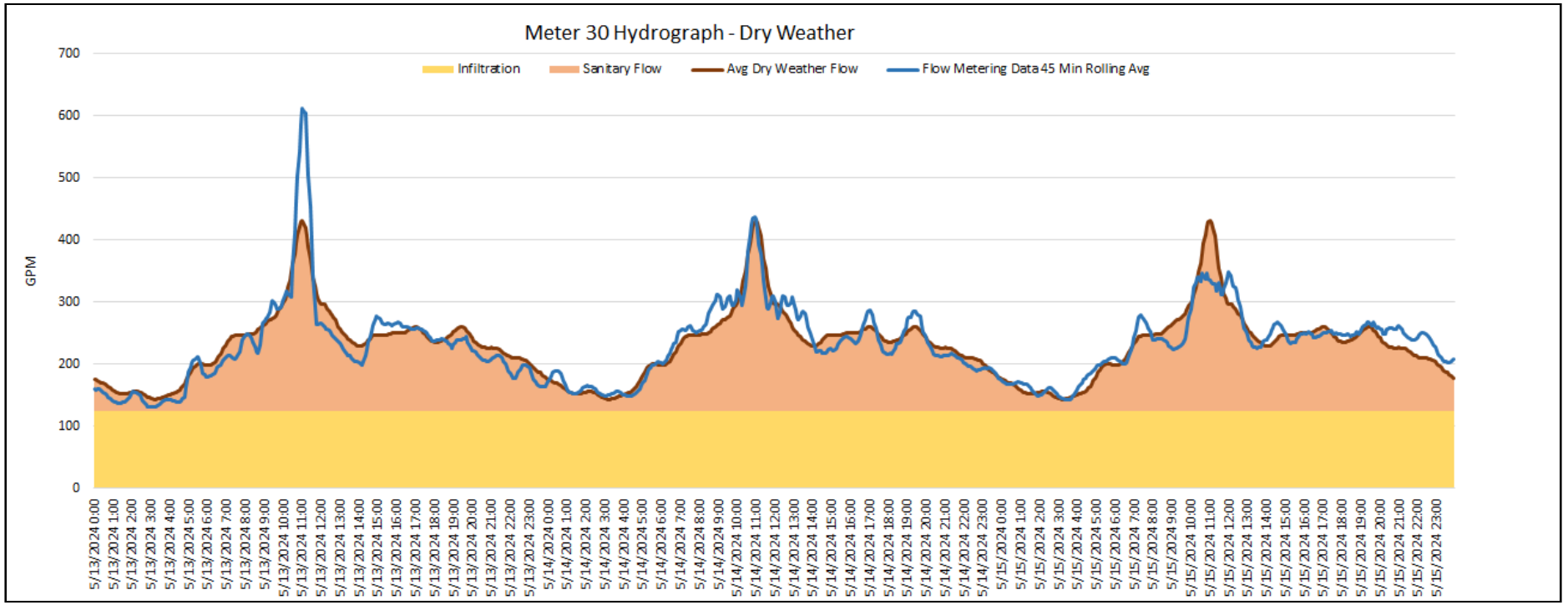
Additional Site Info. / Comments:

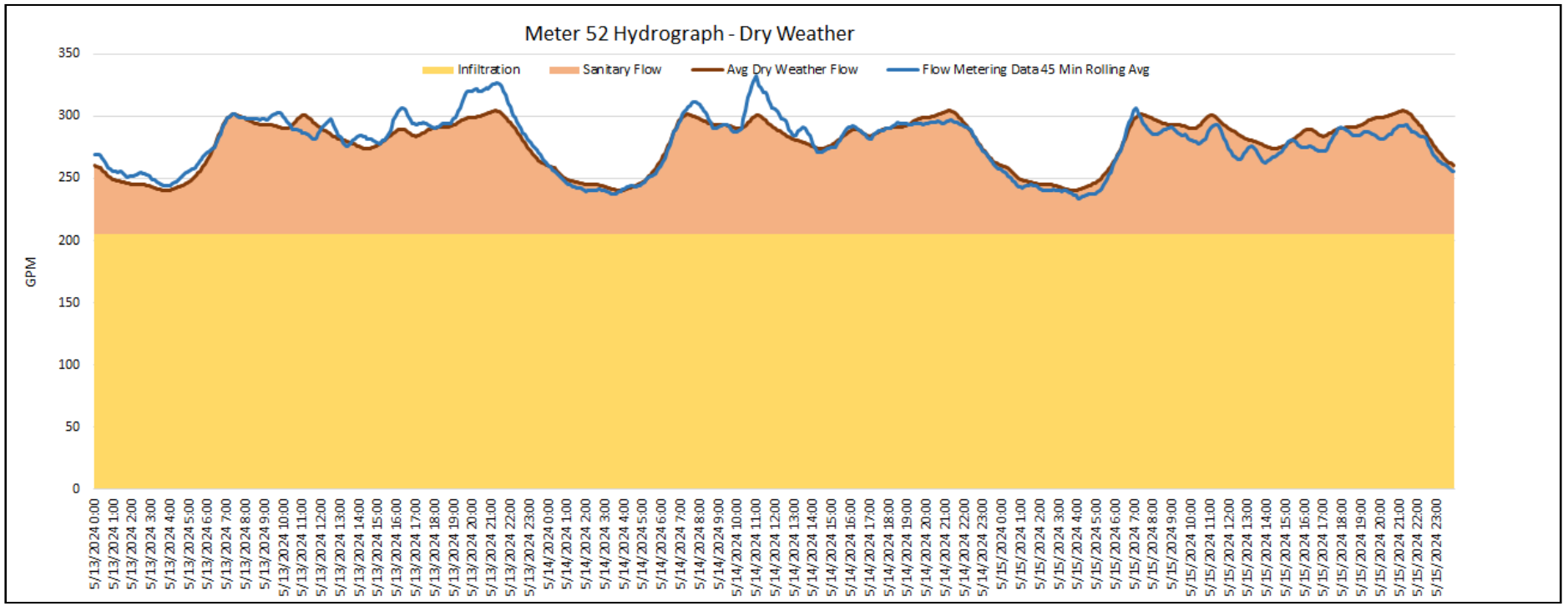
ADS Project Name:	Lowell, Ma
ADS Project Number:	

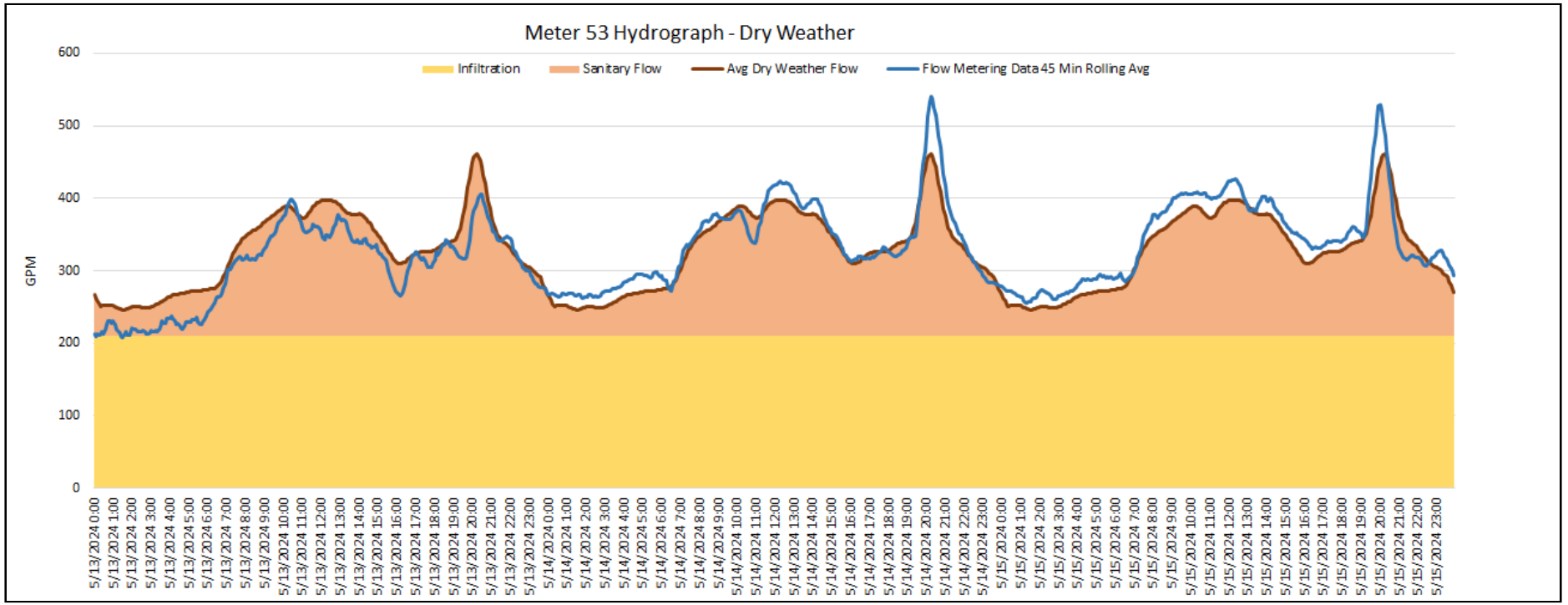
APPENDIX B – DRY WEATHER HYDROGRAPHS

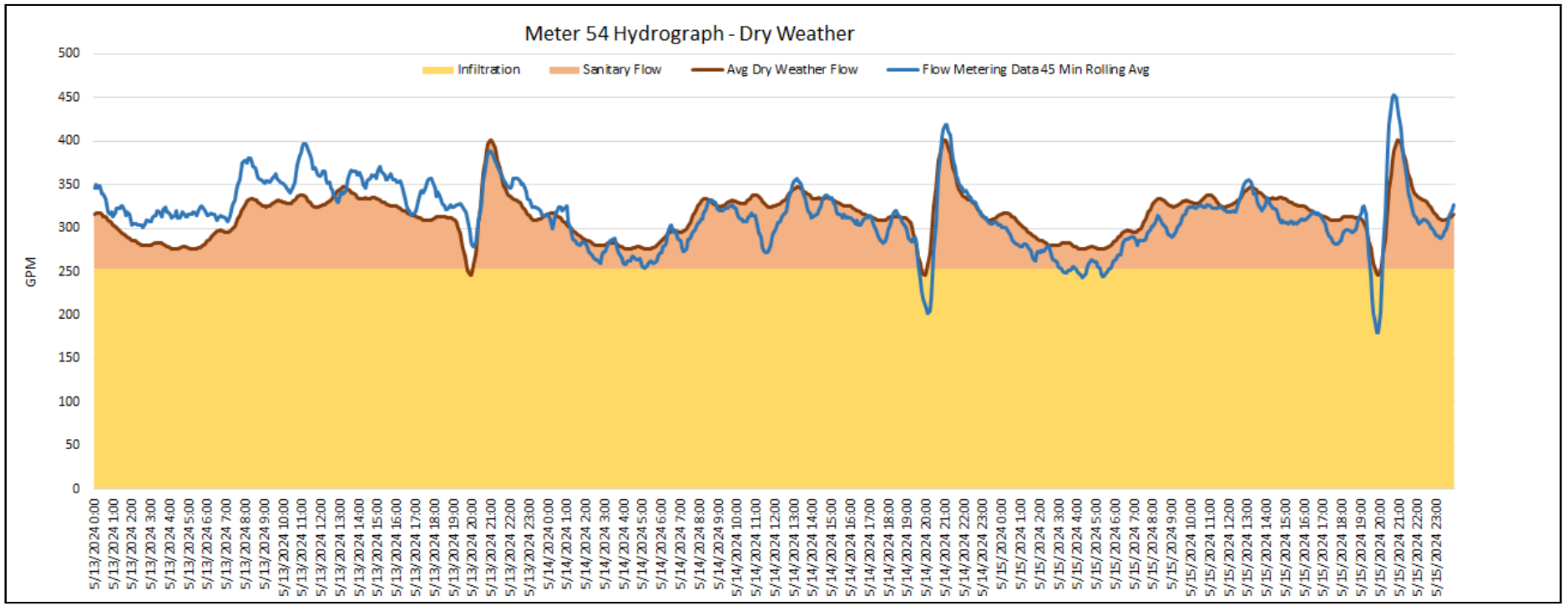

Meter 27 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
900
800
700
600
500
400
300
200
100
0
5/13/2024 0:00
5/13/2024 1:00
5/13/2024 2:00
5/13/2024 3:00
5/13/2024 4:00
5/13/2024 5:00
5/13/2024 6:00
5/13/2024 7:00
5/13/2024 8:00
5/13/2024 9:00
5/13/2024 10:00
5/13/2024 11:00
5/13/2024 12:00
5/13/2024 13:00
5/13/2024 14:00
5/13/2024 15:00
5/13/2024 16:00
5/13/2024 17:00
5/13/2024 18:00
5/13/2024 19:00
5/13/2024 20:00
5/13/2024 21:00
5/13/2024 22:00
5/13/2024 23:00
5/14/2024 0:00
5/14/2024 1:00
5/14/2024 2:00
5/14/2024 3:00
5/14/2024 4:00
5/14/2024 5:00
5/14/2024 6:00
5/14/2024 7:00
5/14/2024 8:00
5/14/2024 9:00
5/14/2024 10:00
5/14/2024 11:00
5/14/2024 12:00
5/14/2024 13:00
5/14/2024 14:00
5/14/2024 15:00
5/14/2024 16:00
5/14/2024 17:00
5/14/2024 18:00
5/14/2024 19:00
5/14/2024 20:00
5/14/2024 21:00
5/14/2024 22:00
5/14/2024 23:00
5/15/2024 0:00
5/15/2024 1:00
5/15/2024 2:00
5/15/2024 3:00
5/15/2024 4:00
5/15/2024 5:00
5/15/2024 6:00
5/15/2024 7:00
5/15/2024 8:00
5/15/2024 9:00
5/15/2024 10:00
5/15/2024 11:00
5/15/2024 12:00
5/15/2024 13:00
5/15/2024 14:00
5/15/2024 15:00
5/15/2024 16:00
5/15/2024 17:00
5/15/2024 18:00
5/15/2024 19:00
5/15/2024 20:00
5/15/2024 21:00
5/15/2024 22:00
5/15/2024 23:00

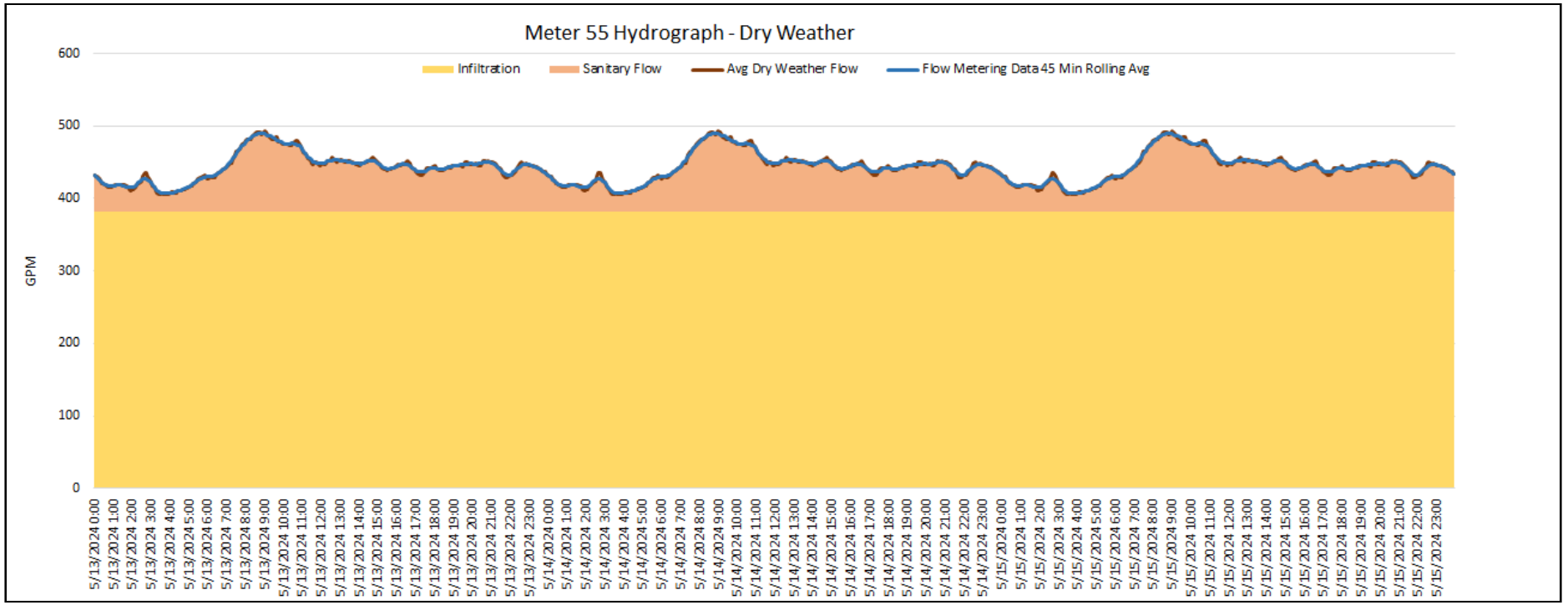

Meter 29 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
900
800
700
600
500
400
300
200
100
0
5/13/2024 0:00
5/13/2024 1:00
5/13/2024 2:00
5/13/2024 3:00
5/13/2024 4:00
5/13/2024 5:00
5/13/2024 6:00
5/13/2024 7:00
5/13/2024 8:00
5/13/2024 9:00
5/13/2024 10:00
5/13/2024 11:00
5/13/2024 12:00
5/13/2024 13:00
5/13/2024 14:00
5/13/2024 15:00
5/13/2024 16:00
5/13/2024 17:00
5/13/2024 18:00
5/13/2024 19:00
5/13/2024 20:00
5/13/2024 21:00
5/13/2024 22:00
5/13/2024 23:00
5/14/2024 0:00
5/14/2024 1:00
5/14/2024 2:00
5/14/2024 3:00
5/14/2024 4:00
5/14/2024 5:00
5/14/2024 6:00
5/14/2024 7:00
5/14/2024 8:00
5/14/2024 9:00
5/14/2024 10:00
5/14/2024 11:00
5/14/2024 12:00
5/14/2024 13:00
5/14/2024 14:00
5/14/2024 15:00
5/14/2024 16:00
5/14/2024 17:00
5/14/2024 18:00
5/14/2024 19:00
5/14/2024 20:00
5/14/2024 21:00
5/14/2024 22:00
5/14/2024 23:00
5/15/2024 0:00
5/15/2024 1:00
5/15/2024 2:00
5/15/2024 3:00
5/15/2024 4:00
5/15/2024 5:00
5/15/2024 6:00
5/15/2024 7:00
5/15/2024 8:00
5/15/2024 9:00
5/15/2024 10:00
5/15/2024 11:00
5/15/2024 12:00
5/15/2024 13:00
5/15/2024 14:00
5/15/2024 15:00
5/15/2024 16:00
5/15/2024 17:00
5/15/2024 18:00
5/15/2024 19:00
5/15/2024 20:00
5/15/2024 21:00
5/15/2024 22:00
5/15/2024 23:00

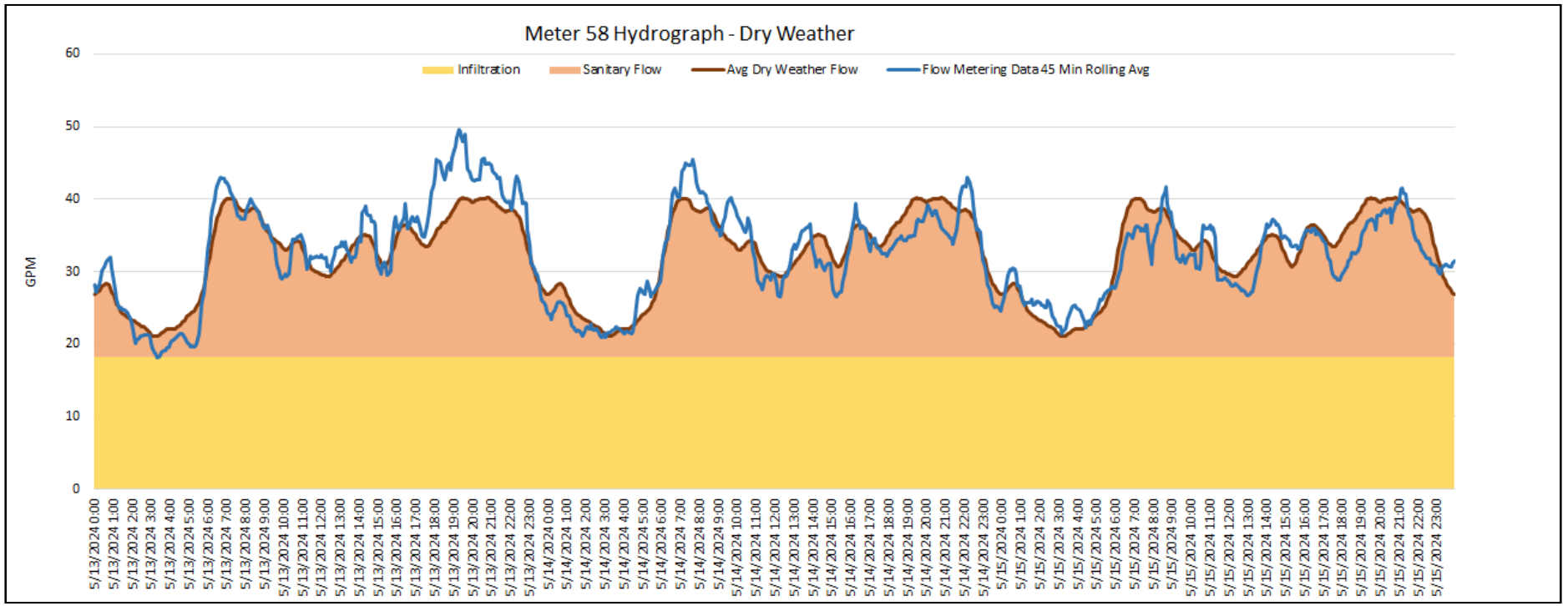

Meter 30 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
700
600
500
400
300
200
100
0
5/13/2024 0:00
5/13/2024 1:00
5/13/2024 2:00
5/13/2024 3:00
5/13/2024 4:00
5/13/2024 5:00
5/13/2024 6:00
5/13/2024 7:00
5/13/2024 8:00
5/13/2024 9:00
5/13/2024 10:00
5/13/2024 11:00
5/13/2024 12:00
5/13/2024 13:00
5/13/2024 14:00
5/13/2024 15:00
5/13/2024 16:00
5/13/2024 17:00
5/13/2024 18:00
5/13/2024 19:00
5/13/2024 20:00
5/13/2024 21:00
5/13/2024 22:00
5/13/2024 23:00
5/14/2024 0:00
5/14/2024 1:00
5/14/2024 2:00
5/14/2024 3:00
5/14/2024 4:00
5/14/2024 5:00
5/14/2024 6:00
5/14/2024 7:00
5/14/2024 8:00
5/14/2024 9:00
5/14/2024 10:00
5/14/2024 11:00
5/14/2024 12:00
5/14/2024 13:00
5/14/2024 14:00
5/14/2024 15:00
5/14/2024 16:00
5/14/2024 17:00
5/14/2024 18:00
5/14/2024 19:00
5/14/2024 20:00
5/14/2024 21:00
5/14/2024 22:00
5/14/2024 23:00
5/15/2024 0:00
5/15/2024 1:00
5/15/2024 2:00
5/15/2024 3:00
5/15/2024 4:00
5/15/2024 5:00
5/15/2024 6:00
5/15/2024 7:00
5/15/2024 8:00
5/15/2024 9:00
5/15/2024 10:00
5/15/2024 11:00
5/15/2024 12:00
5/15/2024 13:00
5/15/2024 14:00
5/15/2024 15:00
5/15/2024 16:00
5/15/2024 17:00
5/15/2024 18:00
5/15/2024 19:00
5/15/2024 20:00
5/15/2024 21:00
5/15/2024 22:00
5/15/2024 23:00


Meter 52 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
350
300
250
200
150
100
50
0
5/13/2024 0:00
5/13/2024 1:00
5/13/2024 2:00
5/13/2024 3:00
5/13/2024 4:00
5/13/2024 5:00
5/13/2024 6:00
5/13/2024 7:00
5/13/2024 8:00
5/13/2024 9:00
5/13/2024 10:00
5/13/2024 11:00
5/13/2024 12:00
5/13/2024 13:00
5/13/2024 14:00
5/13/2024 15:00
5/13/2024 16:00
5/13/2024 17:00
5/13/2024 18:00
5/13/2024 19:00
5/13/2024 20:00
5/13/2024 21:00
5/13/2024 22:00
5/13/2024 23:00
5/14/2024 0:00
5/14/2024 1:00
5/14/2024 2:00
5/14/2024 3:00
5/14/2024 4:00
5/14/2024 5:00
5/14/2024 6:00
5/14/2024 7:00
5/14/2024 8:00
5/14/2024 9:00
5/14/2024 10:00
5/14/2024 11:00
5/14/2024 12:00
5/14/2024 13:00
5/14/2024 14:00
5/14/2024 15:00
5/14/2024 16:00
5/14/2024 17:00
5/14/2024 18:00
5/14/2024 19:00
5/14/2024 20:00
5/14/2024 21:00
5/14/2024 22:00
5/14/2024 23:00
5/15/2024 0:00
5/15/2024 1:00
5/15/2024 2:00
5/15/2024 3:00
5/15/2024 4:00
5/15/2024 5:00
5/15/2024 6:00
5/15/2024 7:00
5/15/2024 8:00
5/15/2024 9:00
5/15/2024 10:00
5/15/2024 11:00
5/15/2024 12:00
5/15/2024 13:00
5/15/2024 14:00
5/15/2024 15:00
5/15/2024 16:00
5/15/2024 17:00
5/15/2024 18:00
5/15/2024 19:00
5/15/2024 20:00
5/15/2024 21:00
5/15/2024 22:00
5/15/2024 23:00

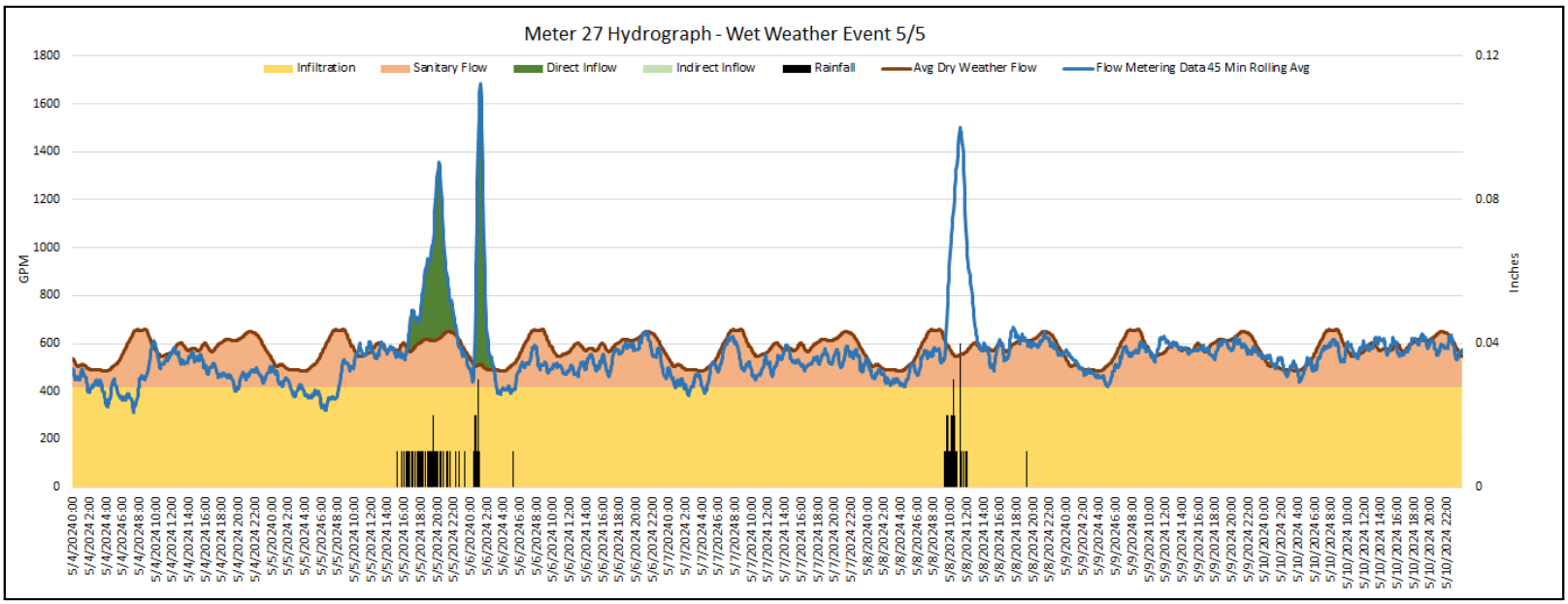

Meter 53 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
600
500
400
300
200
100
0
5/13/2024 0:00
5/13/2024 1:00
5/13/2024 2:00
5/13/2024 3:00
5/13/2024 4:00
5/13/2024 5:00
5/13/2024 6:00
5/13/2024 7:00
5/13/2024 8:00
5/13/2024 9:00
5/13/2024 10:00
5/13/2024 11:00
5/13/2024 12:00
5/13/2024 13:00
5/13/2024 14:00
5/13/2024 15:00
5/13/2024 16:00
5/13/2024 17:00
5/13/2024 18:00
5/13/2024 19:00
5/13/2024 20:00
5/13/2024 21:00
5/13/2024 22:00
5/13/2024 23:00
5/14/2024 0:00
5/14/2024 1:00
5/14/2024 2:00
5/14/2024 3:00
5/14/2024 4:00
5/14/2024 5:00
5/14/2024 6:00
5/14/2024 7:00
5/14/2024 8:00
5/14/2024 9:00
5/14/2024 10:00
5/14/2024 11:00
5/14/2024 12:00
5/14/2024 13:00
5/14/2024 14:00
5/14/2024 15:00
5/14/2024 16:00
5/14/2024 17:00
5/14/2024 18:00
5/14/2024 19:00
5/14/2024 20:00
5/14/2024 21:00
5/14/2024 22:00
5/14/2024 23:00
5/15/2024 0:00
5/15/2024 1:00
5/15/2024 2:00
5/15/2024 3:00
5/15/2024 4:00
5/15/2024 5:00
5/15/2024 6:00
5/15/2024 7:00
5/15/2024 8:00
5/15/2024 9:00
5/15/2024 10:00
5/15/2024 11:00
5/15/2024 12:00
5/15/2024 13:00
5/15/2024 14:00
5/15/2024 15:00
5/15/2024 16:00
5/15/2024 17:00
5/15/2024 18:00
5/15/2024 19:00
5/15/2024 20:00
5/15/2024 21:00
5/15/2024 22:00
5/15/2024 23:00

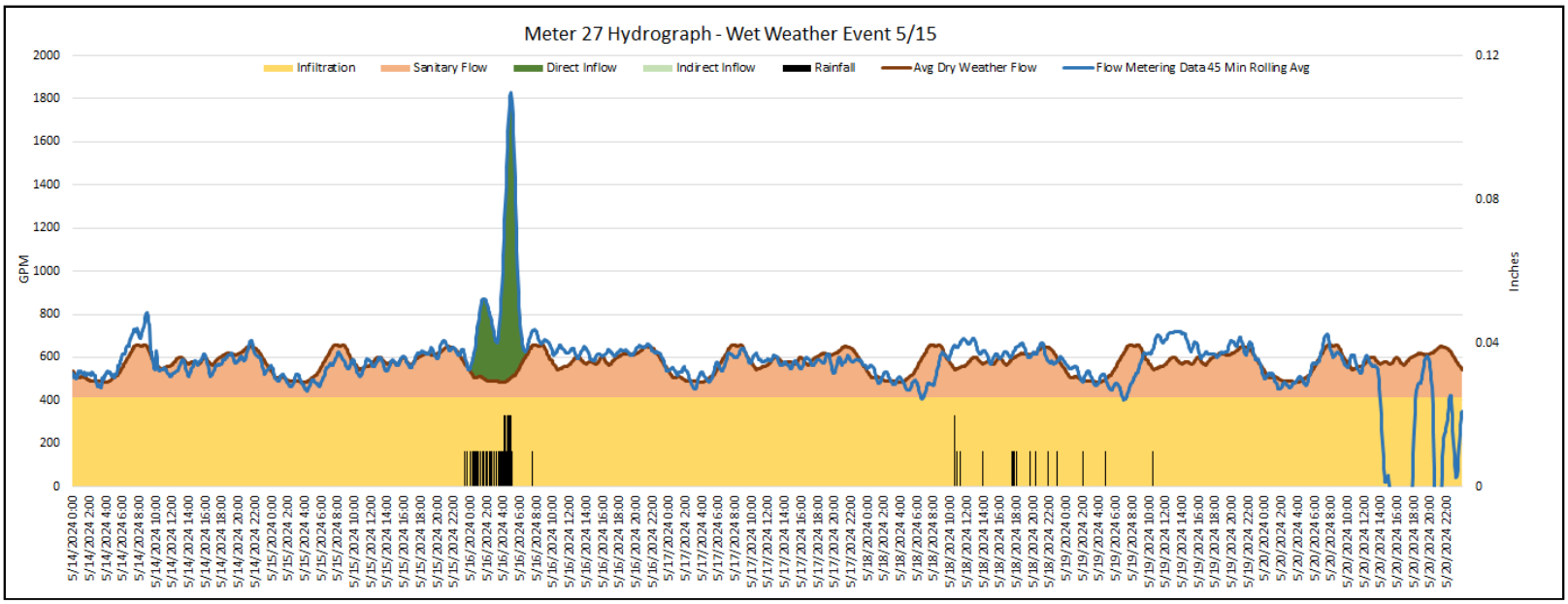

Meter 54 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
500
450
400
350
300
250
200
150
100
50
0
5/13/2024 0:00
5/13/2024 1:00
5/13/2024 2:00
5/13/2024 3:00
5/13/2024 4:00
5/13/2024 5:00
5/13/2024 6:00
5/13/2024 7:00
5/13/2024 8:00
5/13/2024 9:00
5/13/2024 10:00
5/13/2024 11:00
5/13/2024 12:00
5/13/2024 13:00
5/13/2024 14:00
5/13/2024 15:00
5/13/2024 16:00
5/13/2024 17:00
5/13/2024 18:00
5/13/2024 19:00
5/13/2024 20:00
5/13/2024 21:00
5/13/2024 22:00
5/13/2024 23:00
5/14/2024 0:00
5/14/2024 1:00
5/14/2024 2:00
5/14/2024 3:00
5/14/2024 4:00
5/14/2024 5:00
5/14/2024 6:00
5/14/2024 7:00
5/14/2024 8:00
5/14/2024 9:00
5/14/2024 10:00
5/14/2024 11:00
5/14/2024 12:00
5/14/2024 13:00
5/14/2024 14:00
5/14/2024 15:00
5/14/2024 16:00
5/14/2024 17:00
5/14/2024 18:00
5/14/2024 19:00
5/14/2024 20:00
5/14/2024 21:00
5/14/2024 22:00
5/14/2024 23:00
5/15/2024 0:00
5/15/2024 1:00
5/15/2024 2:00
5/15/2024 3:00
5/15/2024 4:00
5/15/2024 5:00
5/15/2024 6:00
5/15/2024 7:00
5/15/2024 8:00
5/15/2024 9:00
5/15/2024 10:00
5/15/2024 11:00
5/15/2024 12:00
5/15/2024 13:00
5/15/2024 14:00
5/15/2024 15:00
5/15/2024 16:00
5/15/2024 17:00
5/15/2024 18:00
5/15/2024 19:00
5/15/2024 20:00
5/15/2024 21:00
5/15/2024 22:00
5/15/2024 23:00

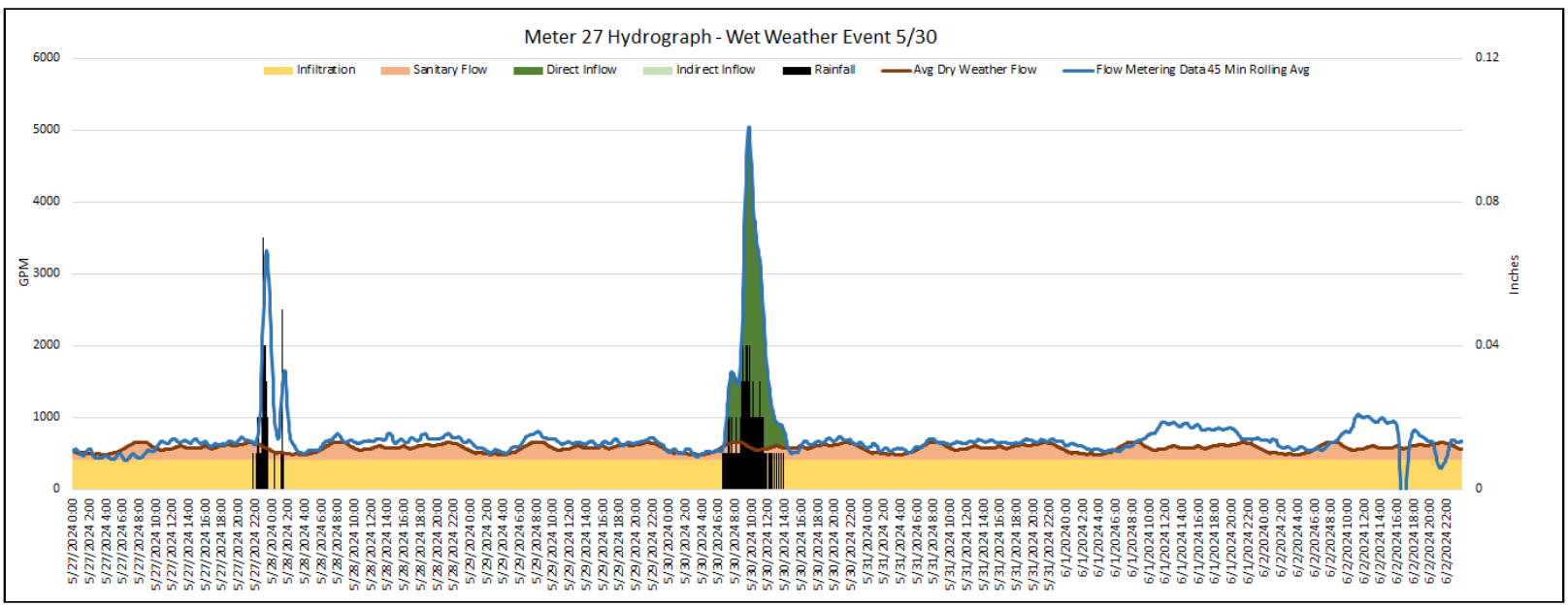

Meter 55 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
600
500
400
300
200
100
0
5/13/2024 0:00
5/13/2024 1:00
5/13/2024 2:00
5/13/2024 3:00
5/13/2024 4:00
5/13/2024 5:00
5/13/2024 6:00
5/13/2024 7:00
5/13/2024 8:00
5/13/2024 9:00
5/13/2024 10:00
5/13/2024 11:00
5/13/2024 12:00
5/13/2024 13:00
5/13/2024 14:00
5/13/2024 15:00
5/13/2024 16:00
5/13/2024 17:00
5/13/2024 18:00
5/13/2024 19:00
5/13/2024 20:00
5/13/2024 21:00
5/13/2024 22:00
5/13/2024 23:00
5/14/2024 0:00
5/14/2024 1:00
5/14/2024 2:00
5/14/2024 3:00
5/14/2024 4:00
5/14/2024 5:00
5/14/2024 6:00
5/14/2024 7:00
5/14/2024 8:00
5/14/2024 9:00
5/14/2024 10:00
5/14/2024 11:00
5/14/2024 12:00
5/14/2024 13:00
5/14/2024 14:00
5/14/2024 15:00
5/14/2024 16:00
5/14/2024 17:00
5/14/2024 18:00
5/14/2024 19:00
5/14/2024 20:00
5/14/2024 21:00
5/14/2024 22:00
5/14/2024 23:00
5/15/2024 0:00
5/15/2024 1:00
5/15/2024 2:00
5/15/2024 3:00
5/15/2024 4:00
5/15/2024 5:00
5/15/2024 6:00
5/15/2024 7:00
5/15/2024 8:00
5/15/2024 9:00
5/15/2024 10:00
5/15/2024 11:00
5/15/2024 12:00
5/15/2024 13:00
5/15/2024 14:00
5/15/2024 15:00
5/15/2024 16:00
5/15/2024 17:00
5/15/2024 18:00
5/15/2024 19:00
5/15/2024 20:00
5/15/2024 21:00
5/15/2024 22:00
5/15/2024 23:00

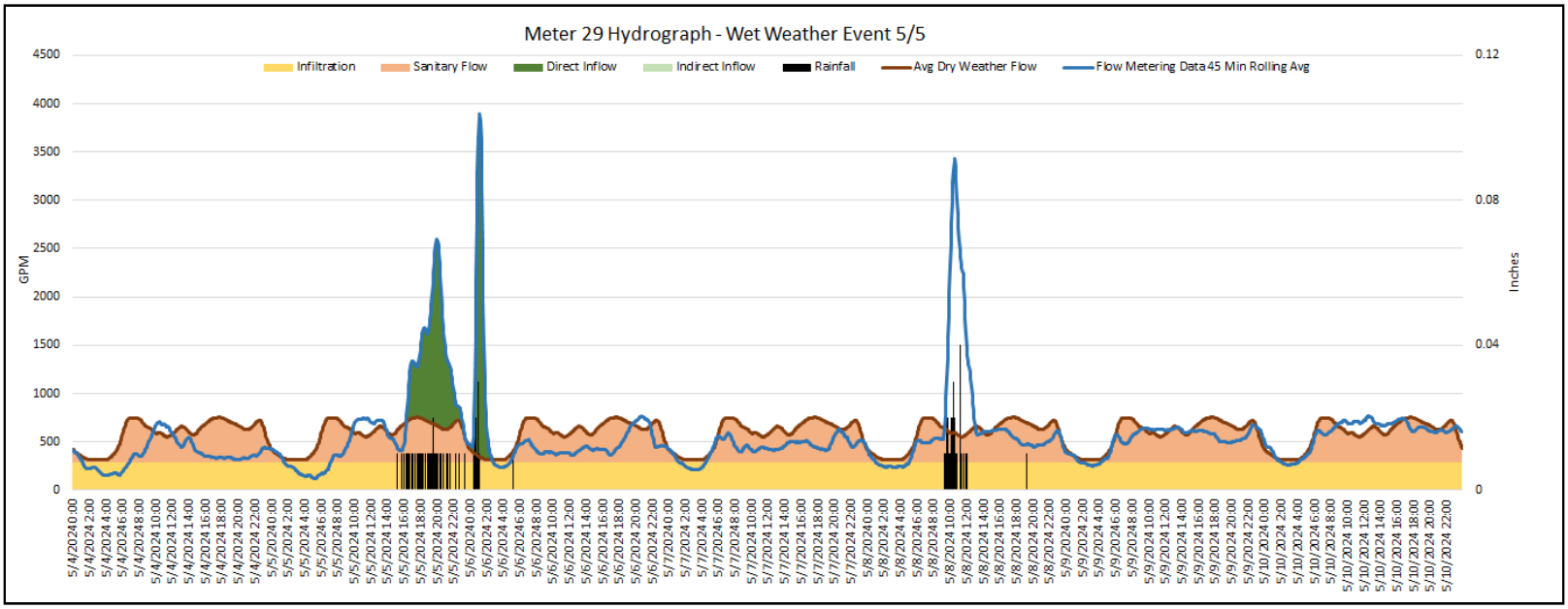

Meter 58 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
60
50
40
30
20
10
0
5/13/2024 0:00
5/13/2024 1:00
5/13/2024 2:00
5/13/2024 3:00
5/13/2024 4:00
5/13/2024 5:00
5/13/2024 6:00
5/13/2024 7:00
5/13/2024 8:00
5/13/2024 9:00
5/13/2024 10:00
5/13/2024 11:00
5/13/2024 12:00
5/13/2024 13:00
5/13/2024 14:00
5/13/2024 15:00
5/13/2024 16:00
5/13/2024 17:00
5/13/2024 18:00
5/13/2024 19:00
5/13/2024 20:00
5/13/2024 21:00
5/13/2024 22:00
5/13/2024 23:00
5/14/2024 0:00
5/14/2024 1:00
5/14/2024 2:00
5/14/2024 3:00
5/14/2024 4:00
5/14/2024 5:00
5/14/2024 6:00
5/14/2024 7:00
5/14/2024 8:00
5/14/2024 9:00
5/14/2024 10:00
5/14/2024 11:00
5/14/2024 12:00
5/14/2024 13:00
5/14/2024 14:00
5/14/2024 15:00
5/14/2024 16:00
5/14/2024 17:00
5/14/2024 18:00
5/14/2024 19:00
5/14/2024 20:00
5/14/2024 21:00
5/14/2024 22:00
5/14/2024 23:00
5/15/2024 0:00
5/15/2024 1:00
5/15/2024 2:00
5/15/2024 3:00
5/15/2024 4:00
5/15/2024 5:00
5/15/2024 6:00
5/15/2024 7:00
5/15/2024 8:00
5/15/2024 9:00
5/15/2024 10:00
5/15/2024 11:00
5/15/2024 12:00
5/15/2024 13:00
5/15/2024 14:00
5/15/2024 15:00
5/15/2024 16:00
5/15/2024 17:00
5/15/2024 18:00
5/15/2024 19:00
5/15/2024 20:00
5/15/2024 21:00
5/15/2024 22:00
5/15/2024 23:00

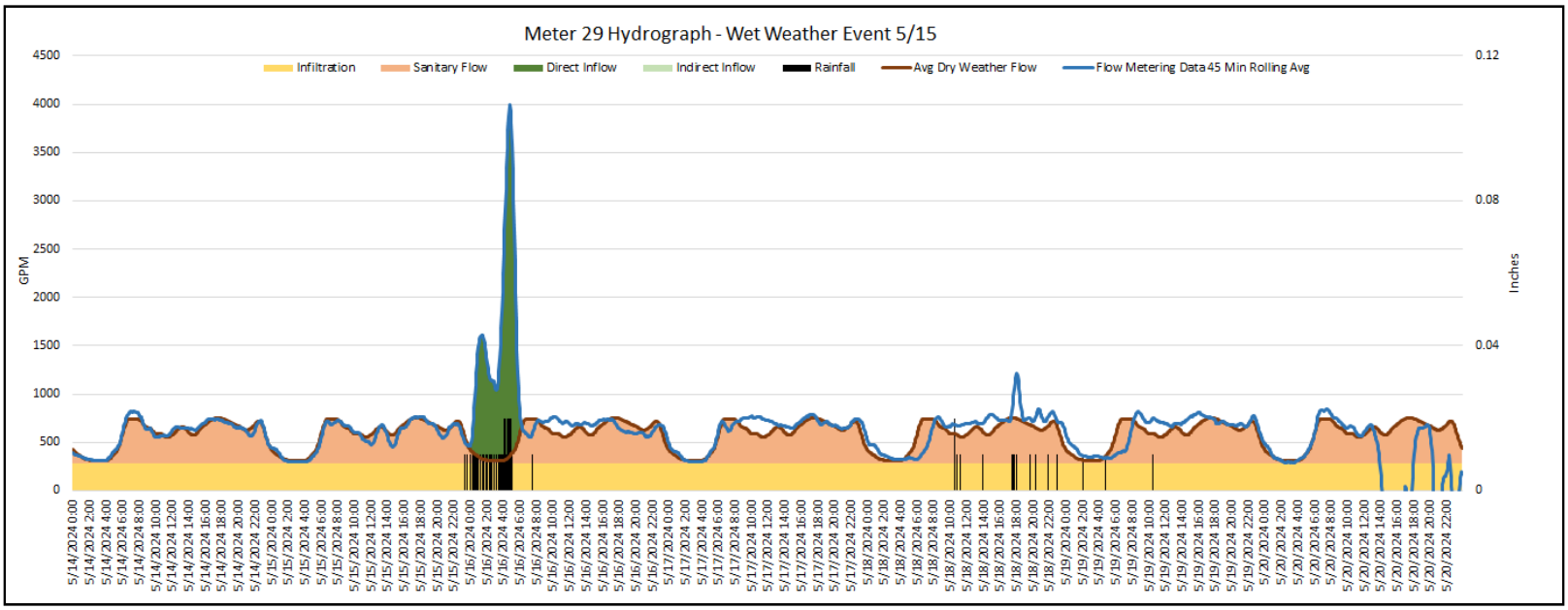
APPENDIX C – WET WEATHER HYDROGRAPHS

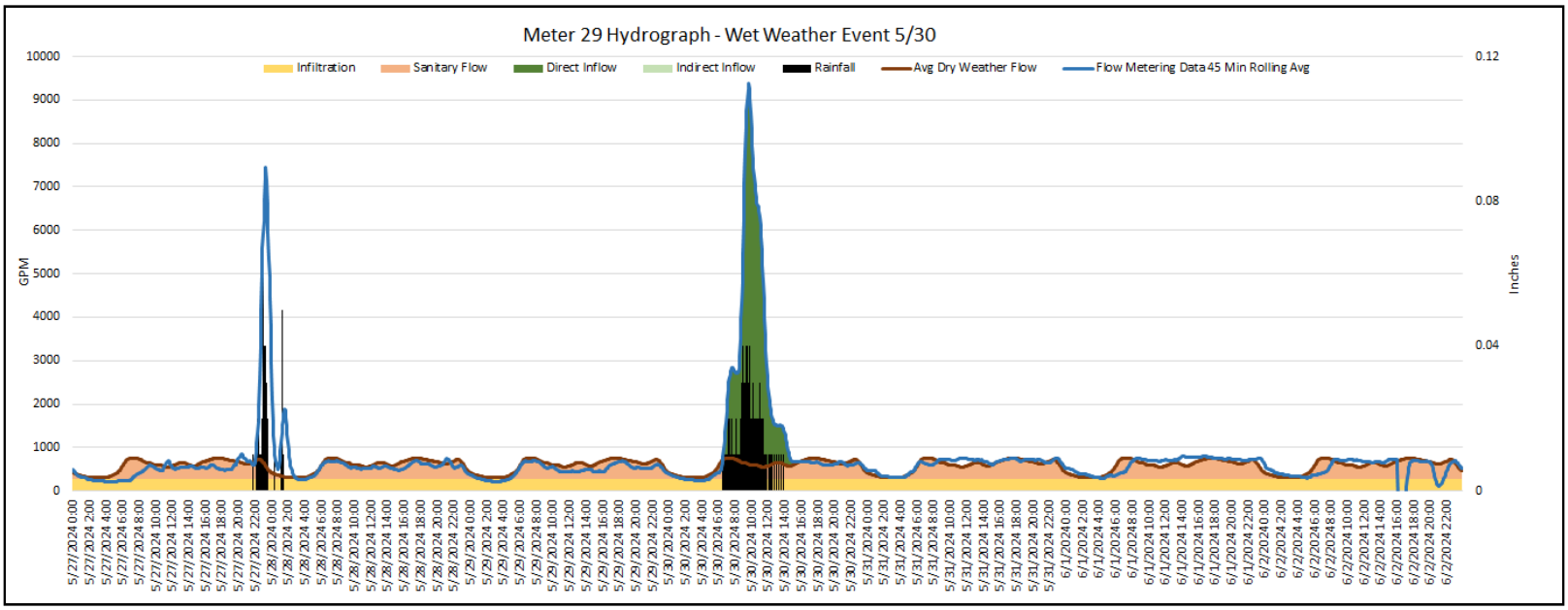

Meter 27 Hydrograph - Wet Weather Event 5/5
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

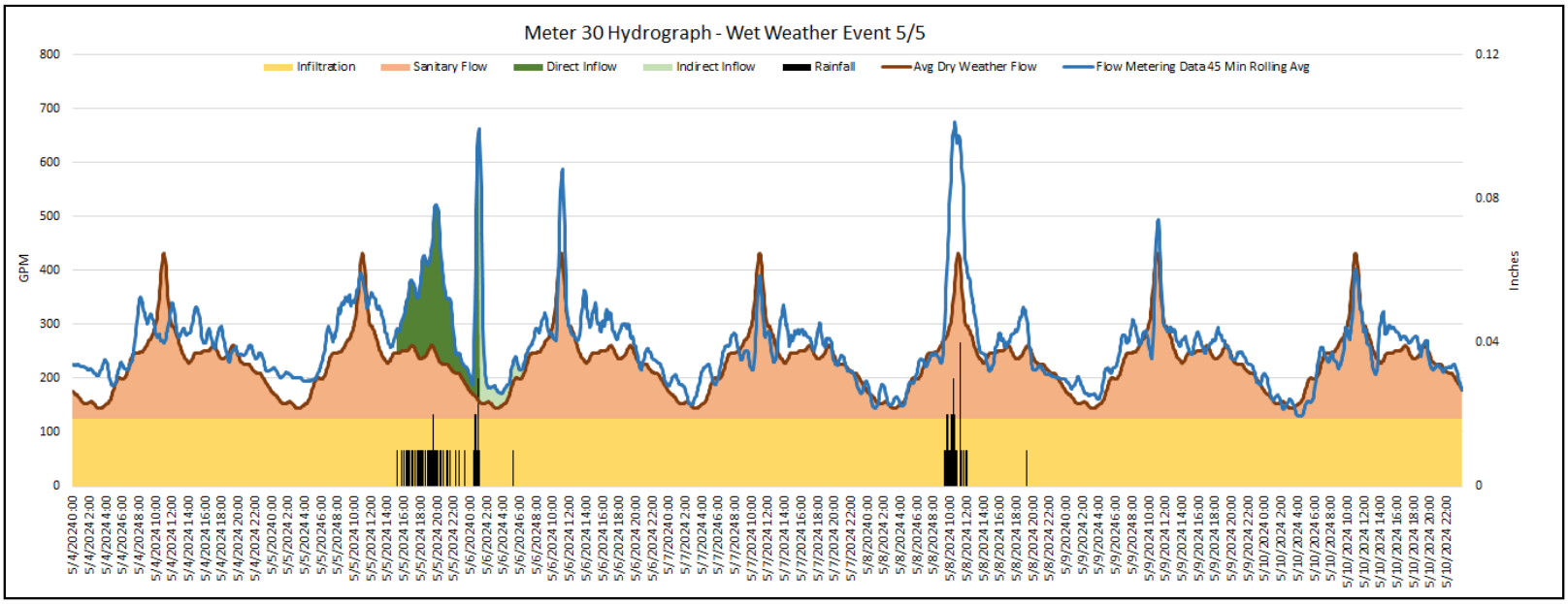

Meter 27 Hydrograph - Wet Weather Event 5/15
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

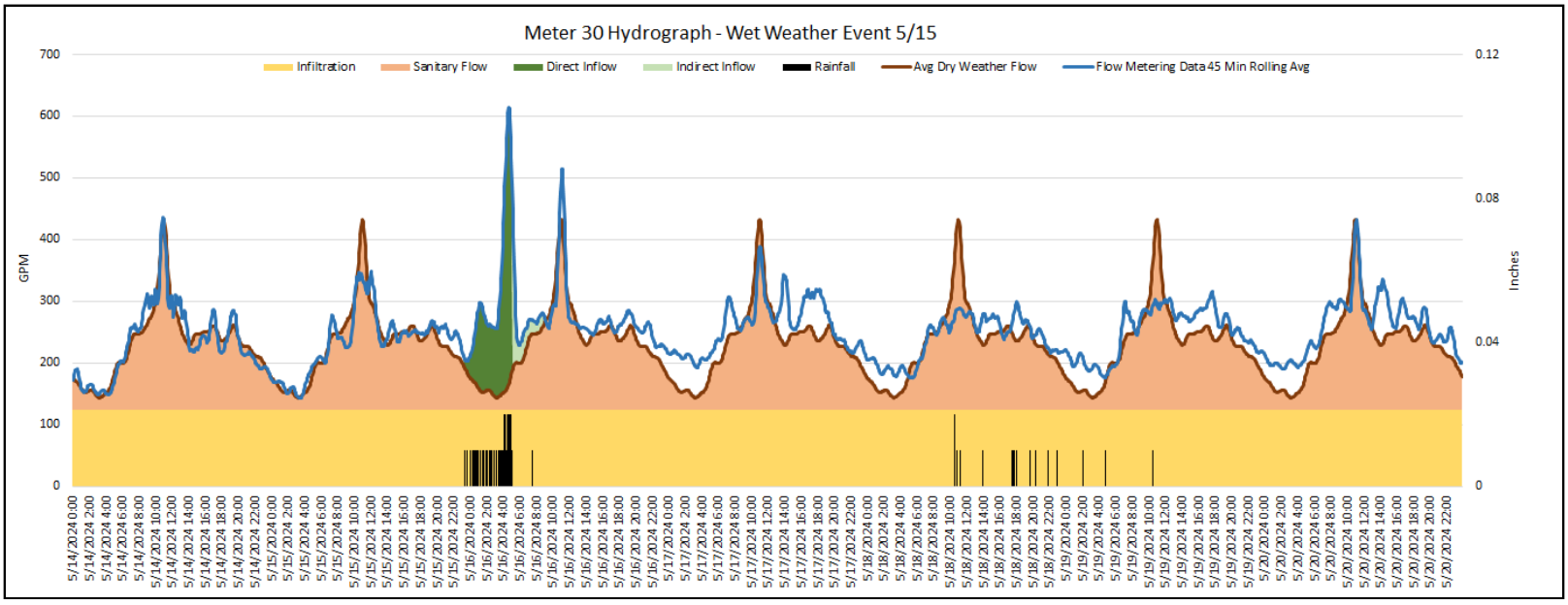

Meter 27 Hydrograph - Wet Weather Event 5/30
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

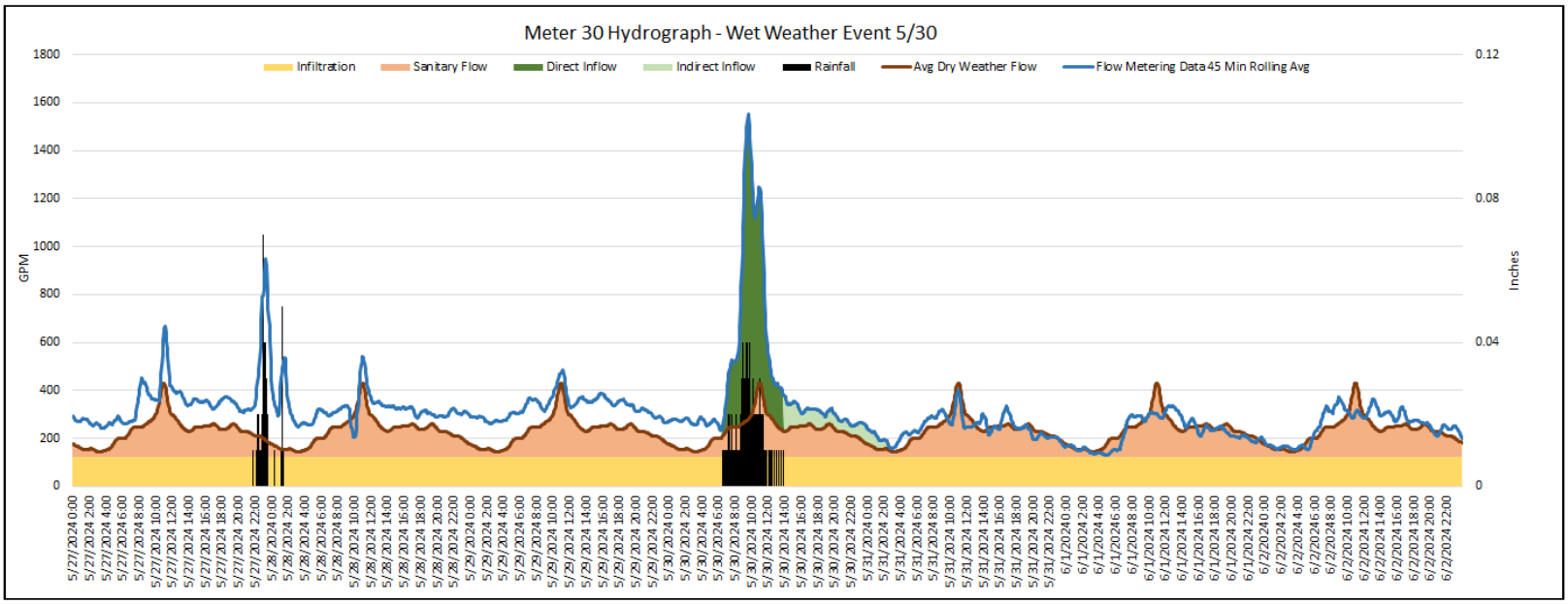

Meter 29 Hydrograph - Wet Weather Event 5/5
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

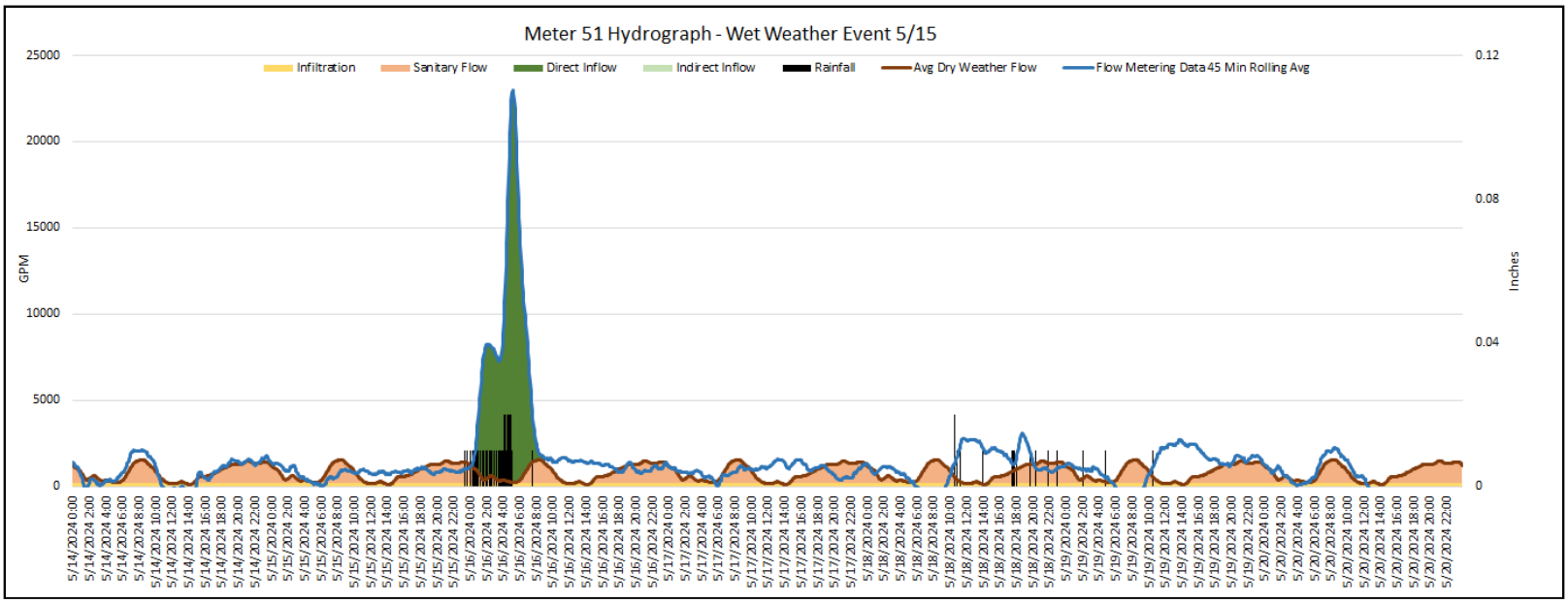

Meter 29 Hydrograph - Wet Weather Event 5/15
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

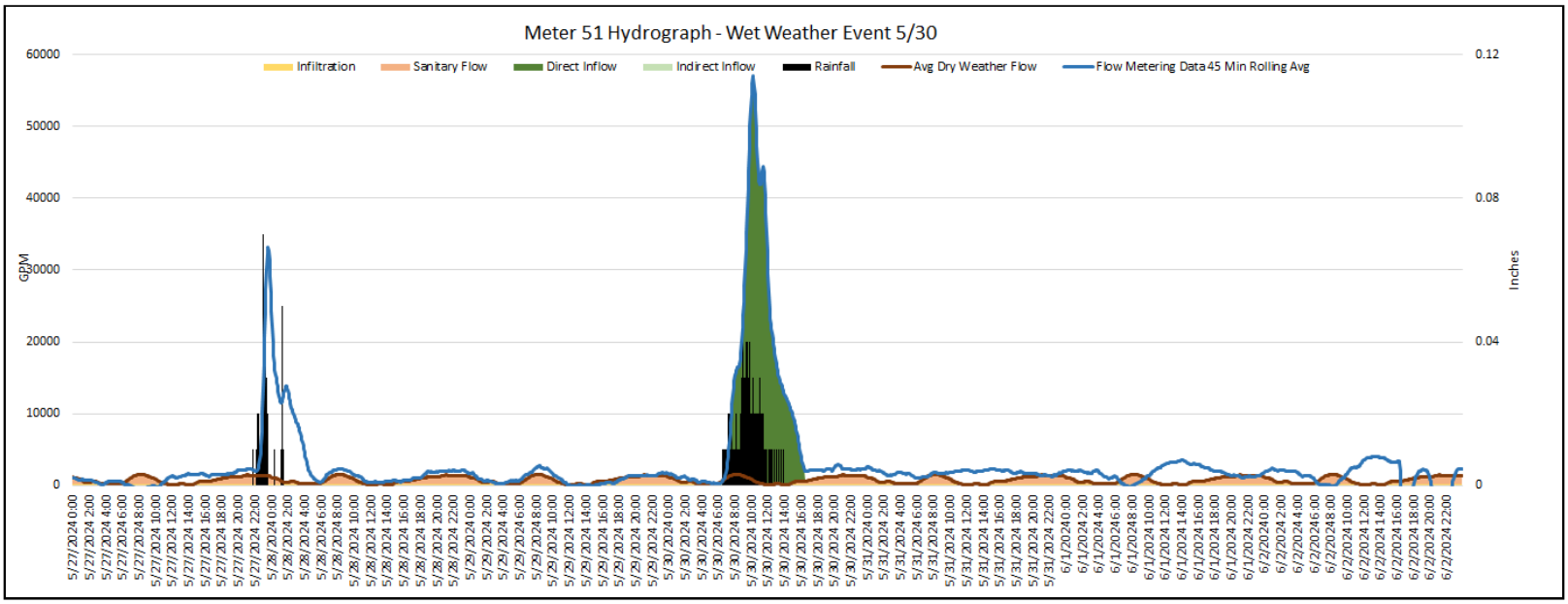

Meter 29 Hydrograph - Wet Weather Event 5/30
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

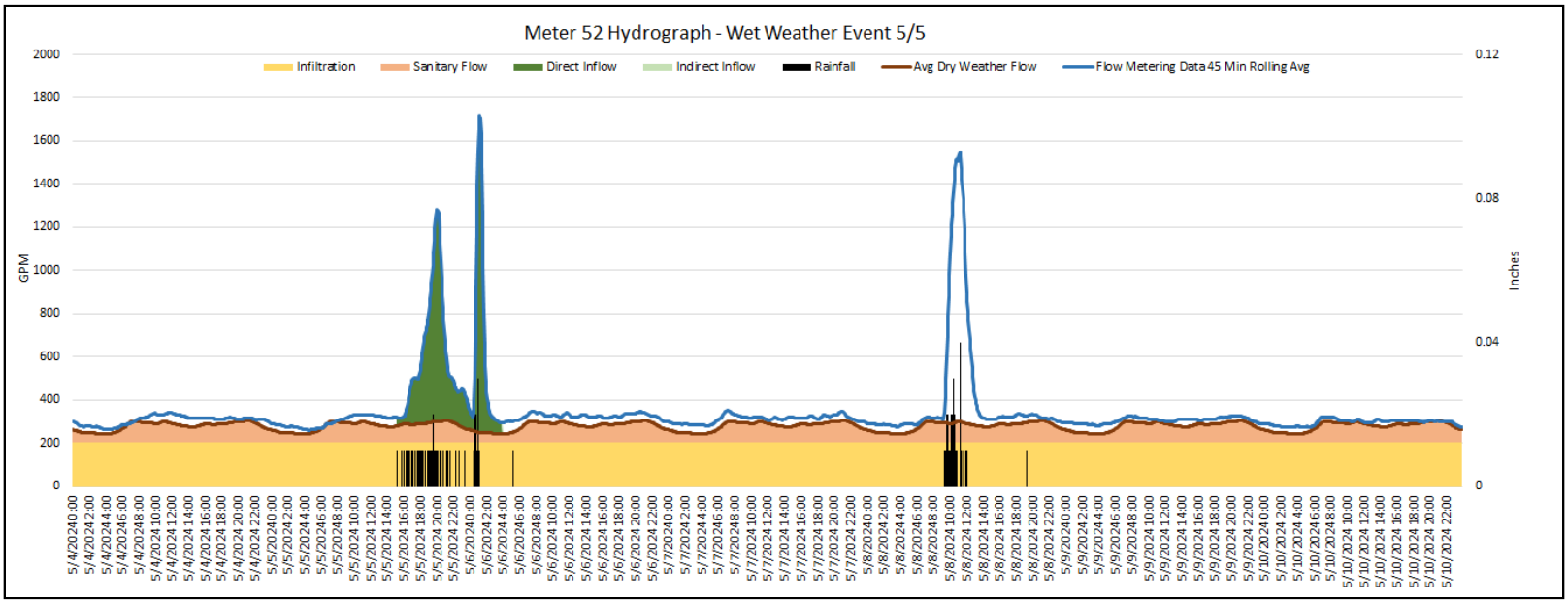

Meter 30 Hydrograph - Wet Weather Event 5/5
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

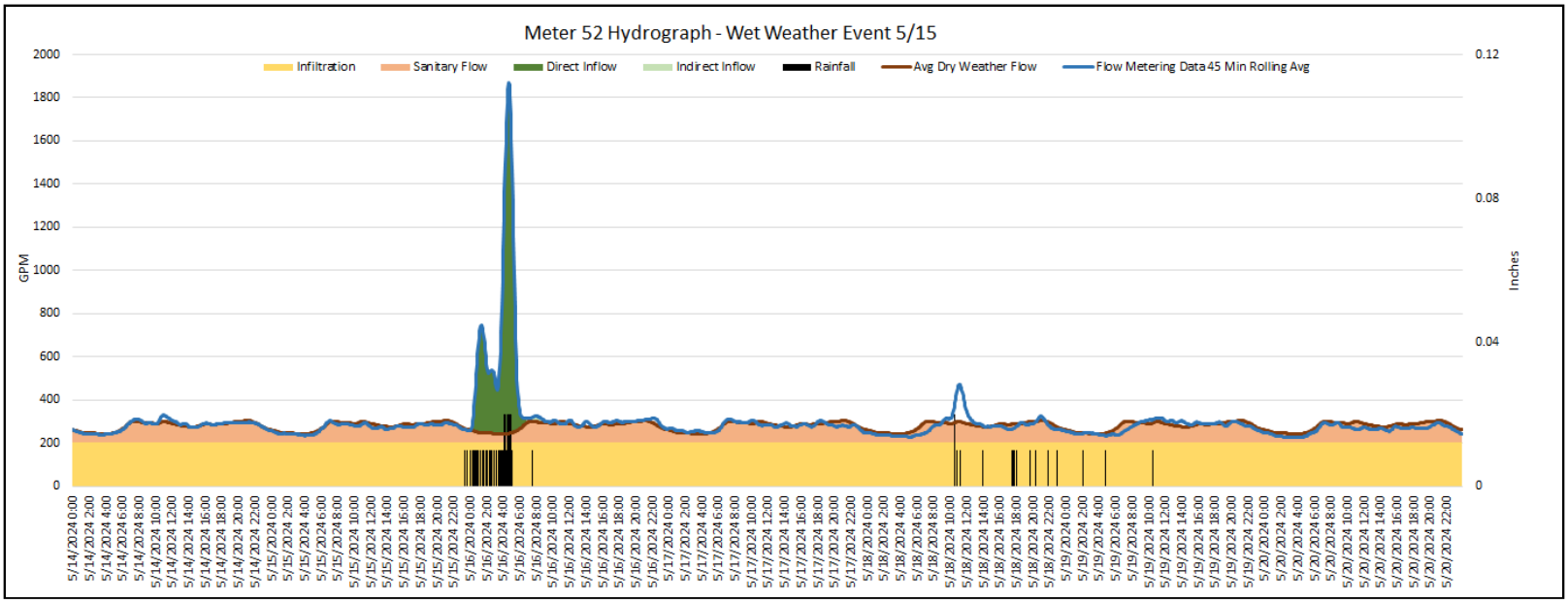

Meter 30 Hydrograph - Wet Weather Event 5/15
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

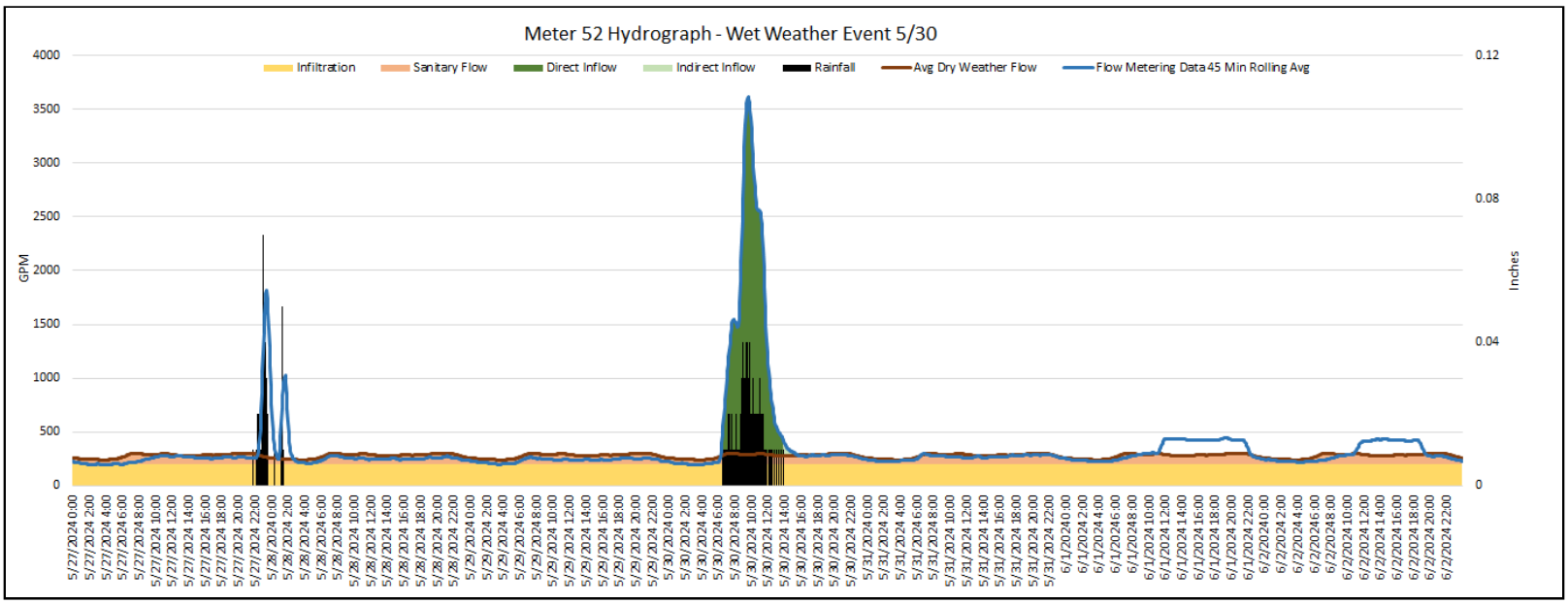

Meter 30 Hydrograph - Wet Weather Event 5/30
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

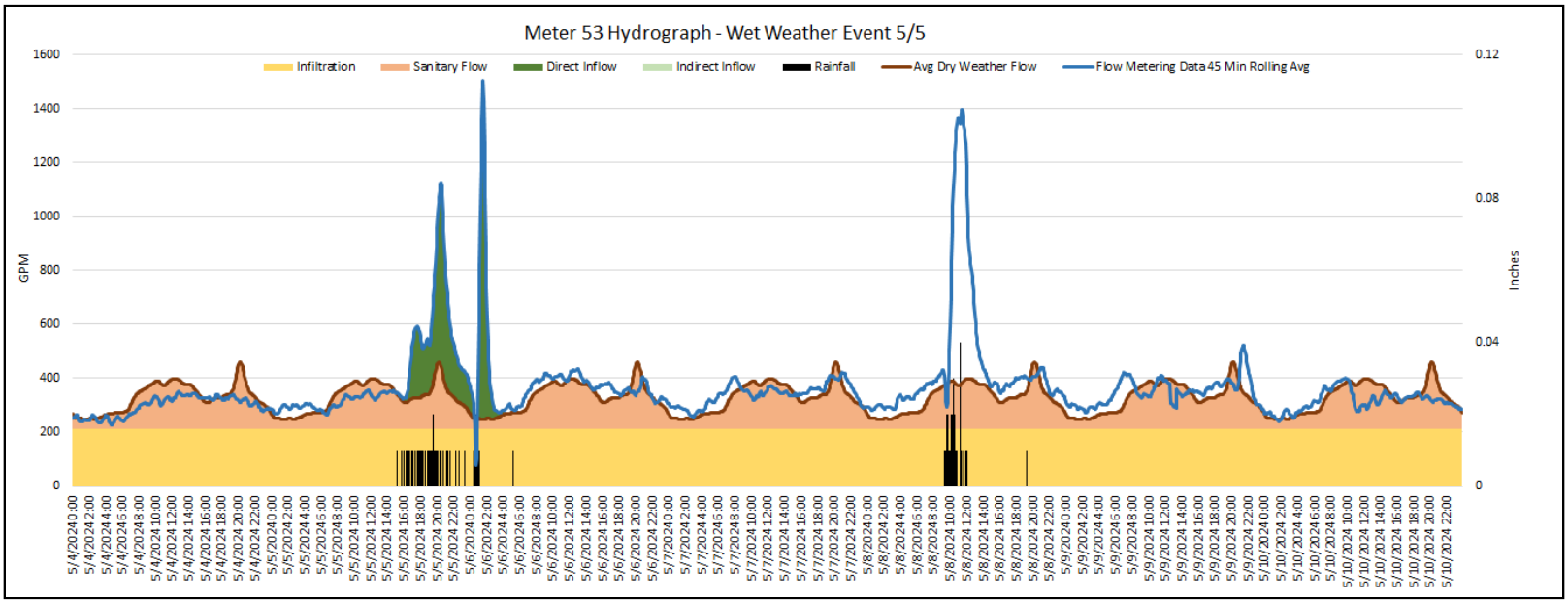

Meter 51 Hydrograph - Wet Weather Event 5/15
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches
25000
20000
15000
10000
5000
0
0.12
0.08
0.04
0

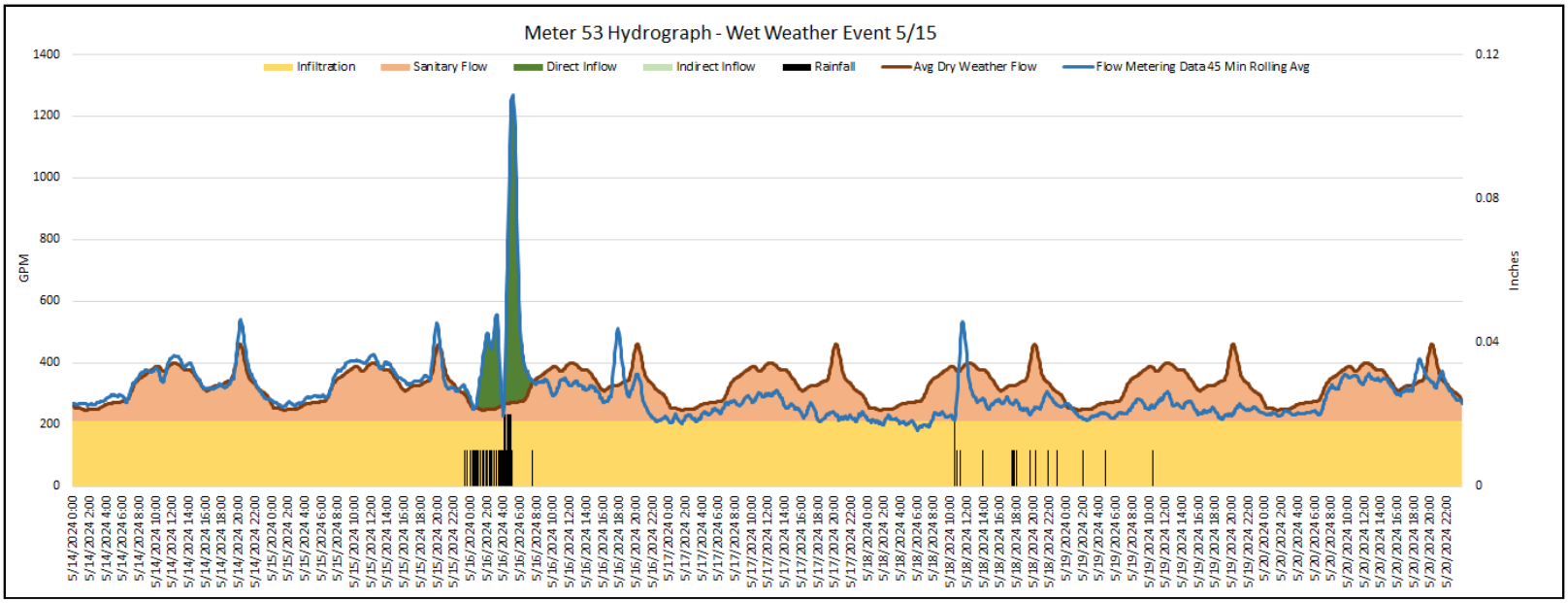

Meter 51 Hydrograph - Wet Weather Event 5/30
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches
60000
50000
40000
30000
20000
10000
0
0.12
0.08
0.04
0

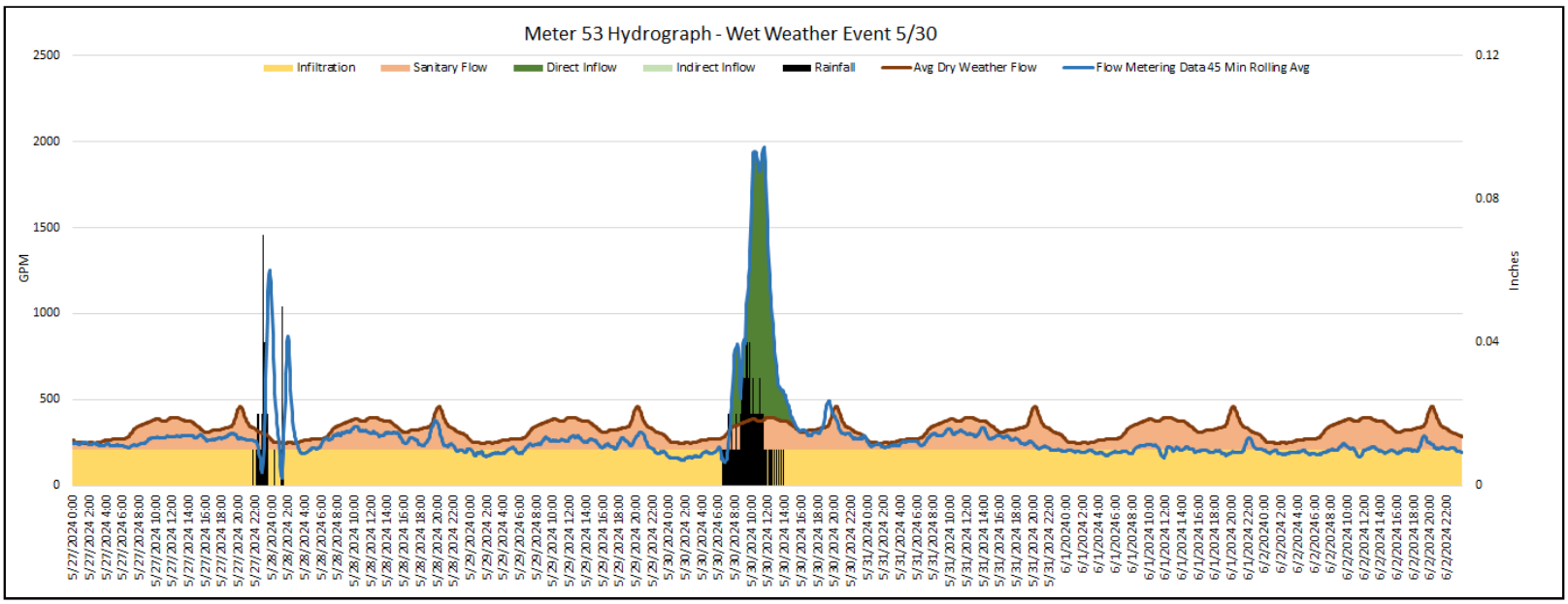

Meter 52 Hydrograph - Wet Weather Event 5/5
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

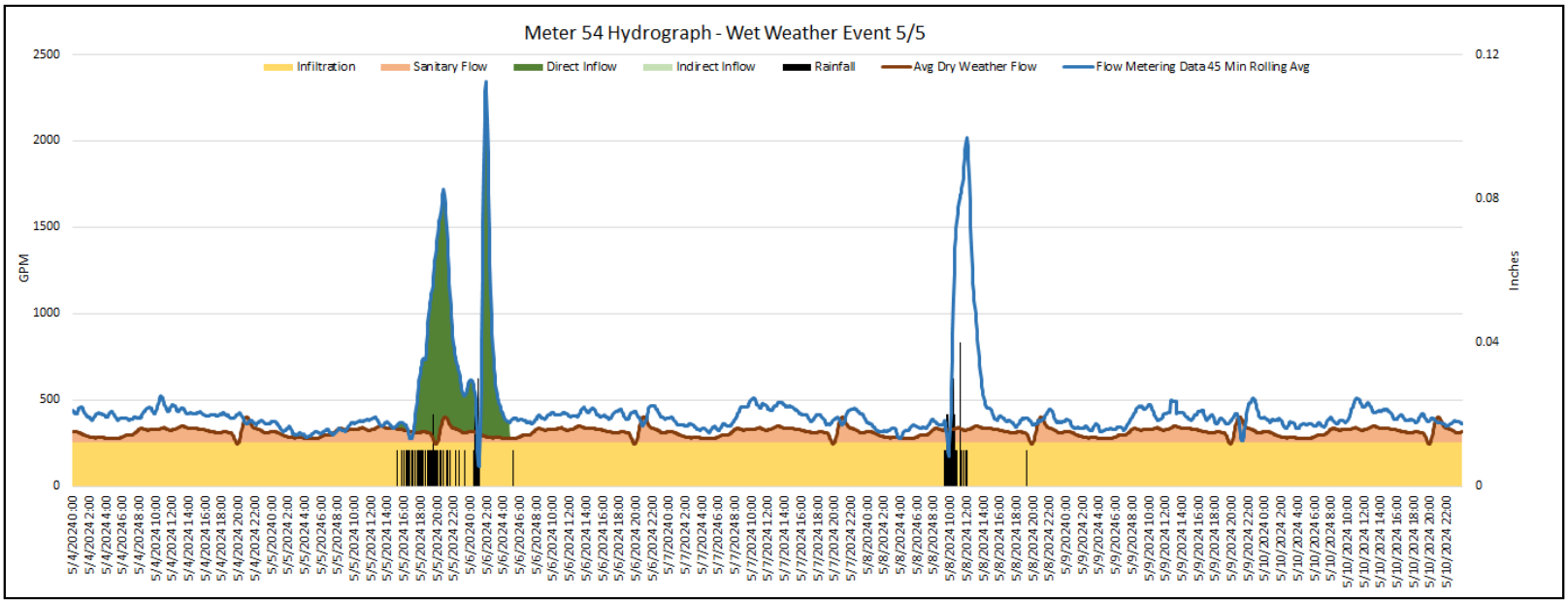

Meter 52 Hydrograph - Wet Weather Event 5/15
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

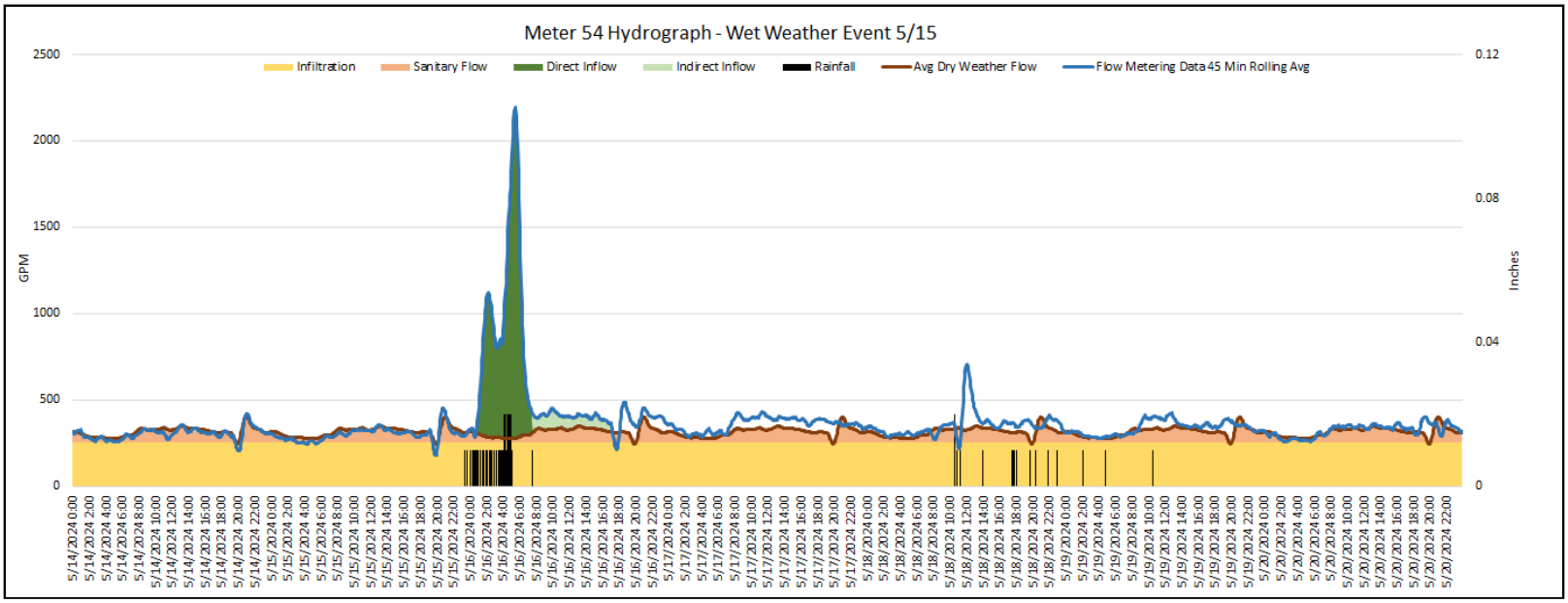

Meter 52 Hydrograph - Wet Weather Event 5/30
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

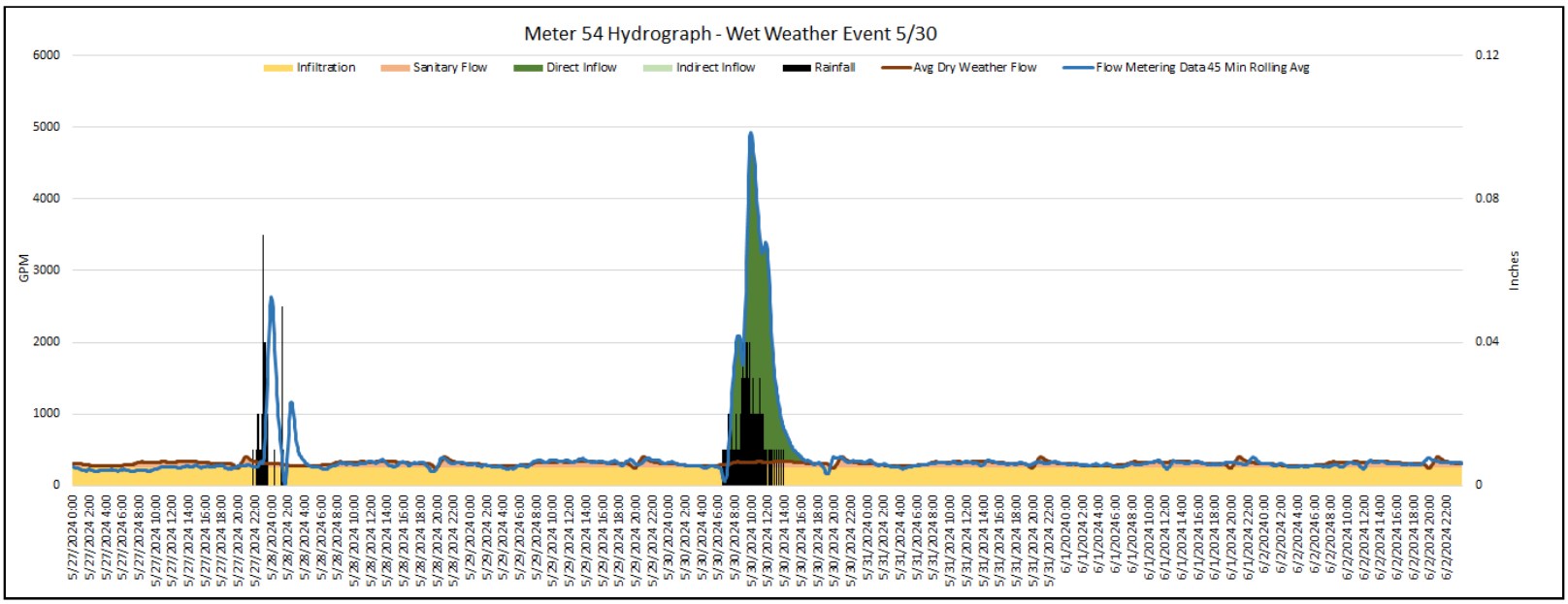

Meter 53 Hydrograph - Wet Weather Event 5/5
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

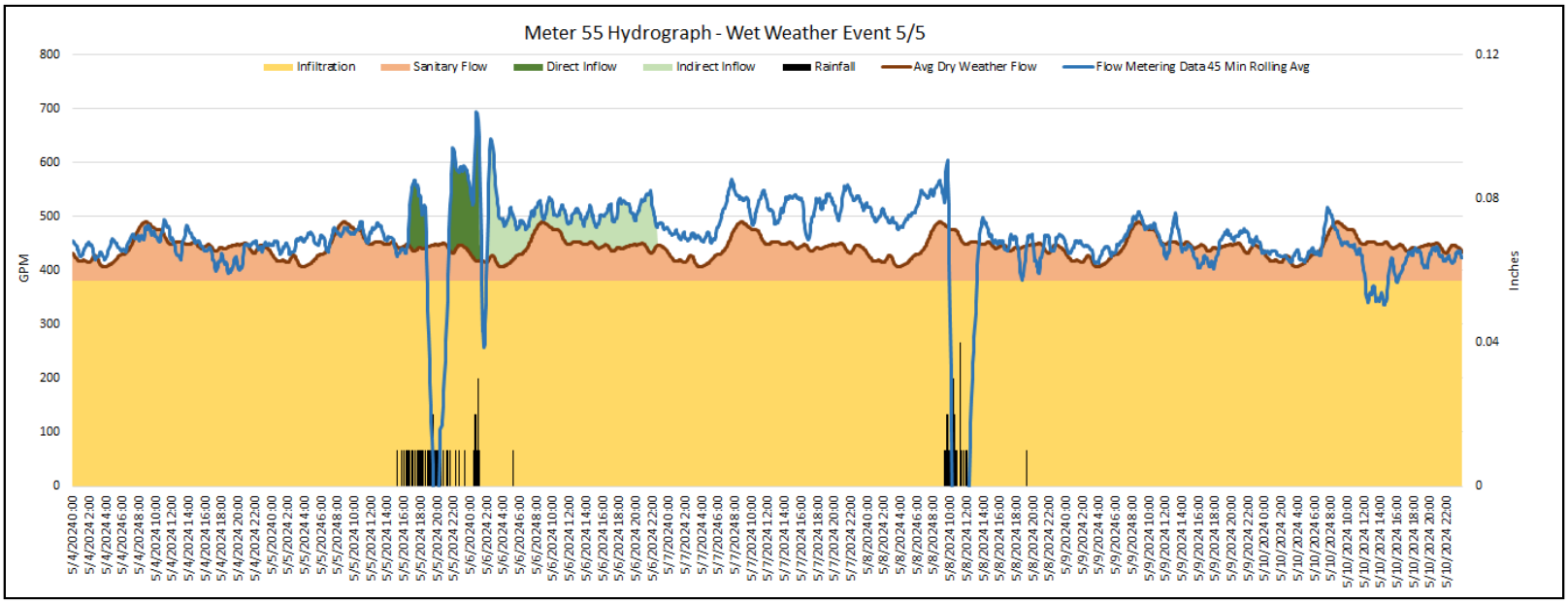

Meter 53 Hydrograph - Wet Weather Event 5/15
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

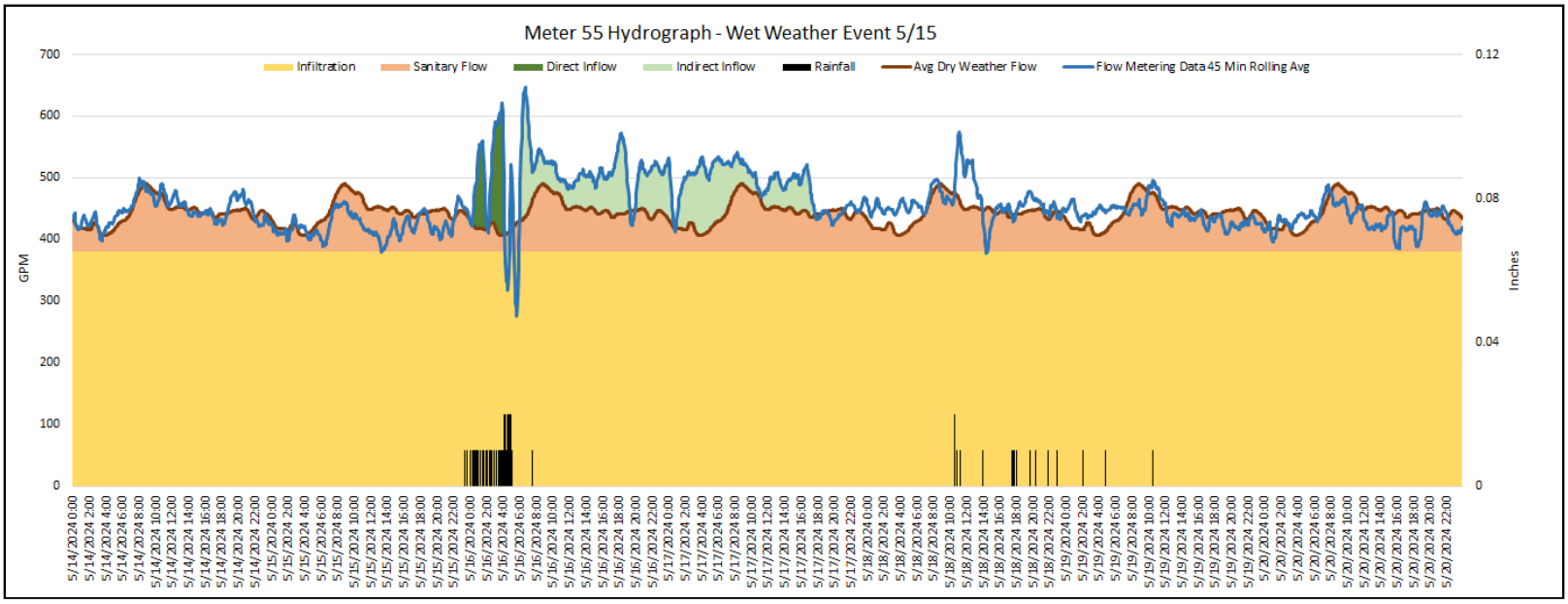

Meter 53 Hydrograph - Wet Weather Event 5/30
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

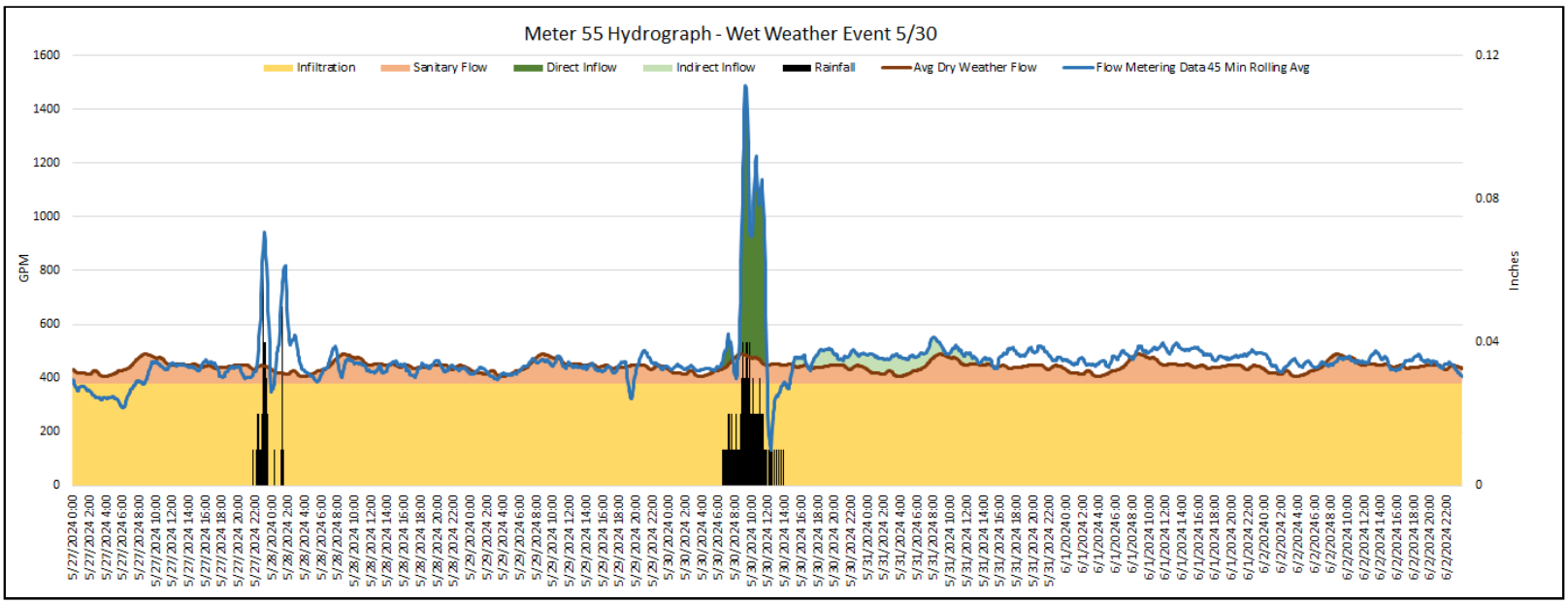

Meter 54 Hydrograph - Wet Weather Event 5/5
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

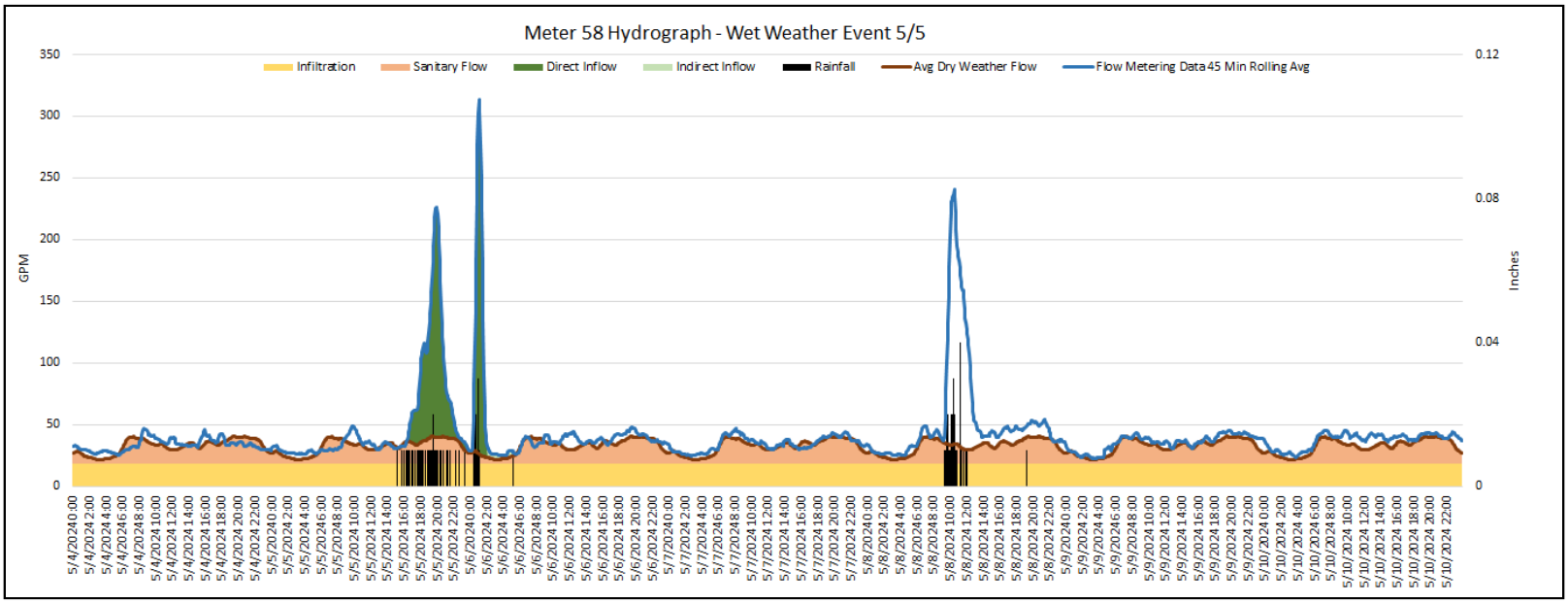

Meter 54 Hydrograph - Wet Weather Event 5/15
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

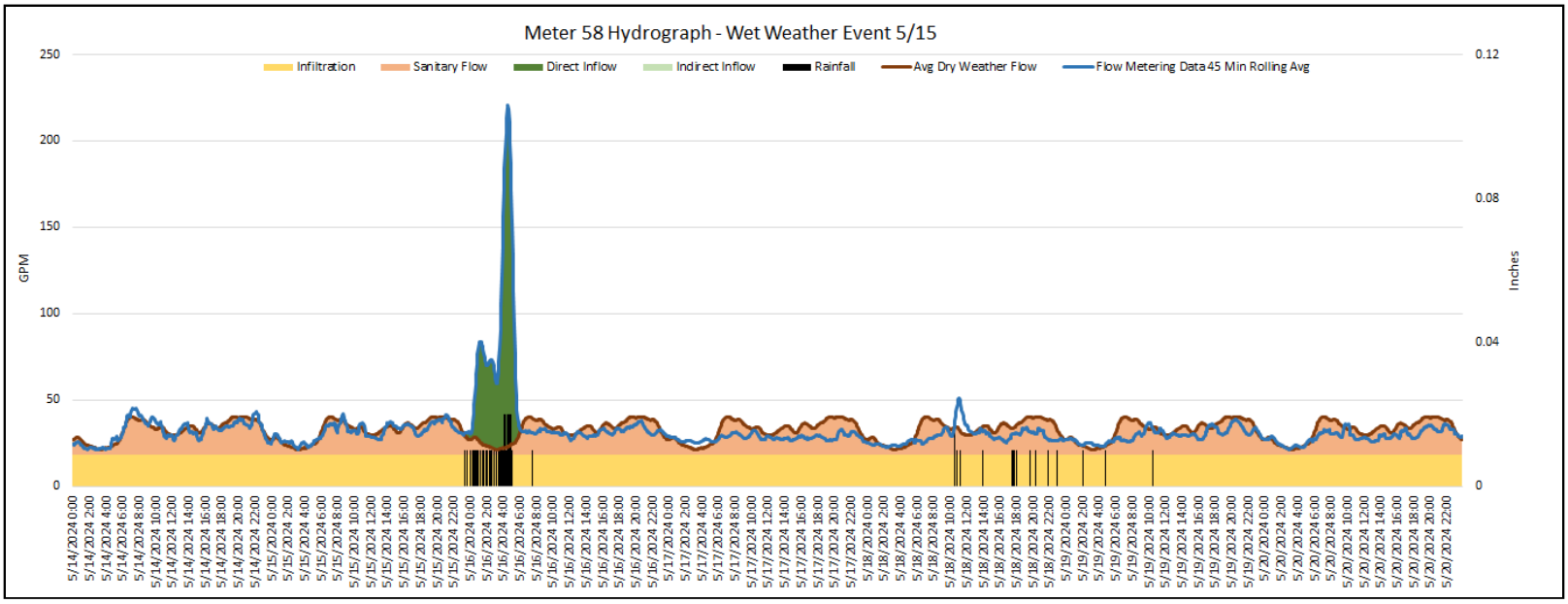

Meter 54 Hydrograph - Wet Weather Event 5/30
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

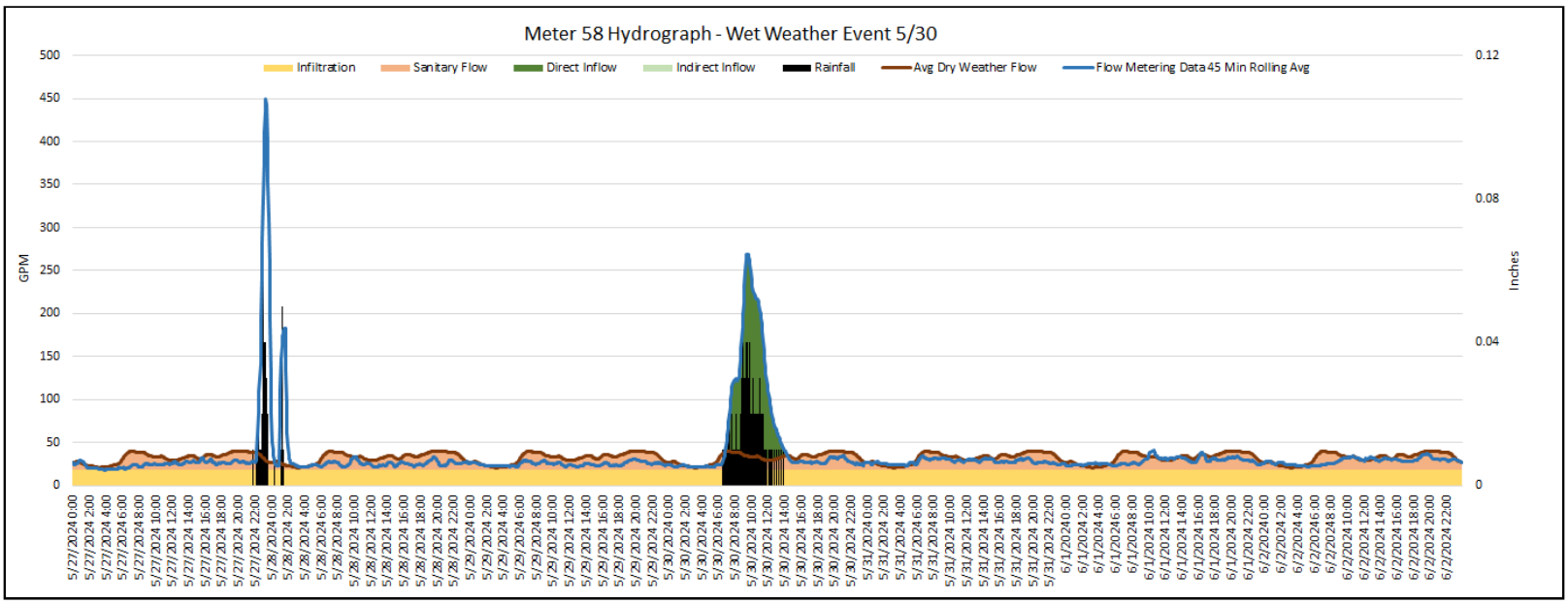

Meter 55 Hydrograph - Wet Weather Event 5/5
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches


Meter 55 Hydrograph - Wet Weather Event 5/15
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches


Meter 55 Hydrograph - Wet Weather Event 5/30
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches


Meter 58 Hydrograph - Wet Weather Event 5/5
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches


Meter 58 Hydrograph - Wet Weather Event 5/15
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches


Meter 58 Hydrograph - Wet Weather Event 5/30
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches