LOWELL REGIONAL WASTEWATER UTILITY
CITY OF LOWELL, MA
2023 INFILTRATION AND INFLOW ANALYSIS REPORT
KLEINFELDER PROJECT #20220166.003A

January 31, 2024

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.

Aaron Fox
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1/31/2024
Date

A Report Prepared for:

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LOWELL INFILTRATION AND INFLOW ANALYSIS REPORT
CITY OF LOWELL, NA

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CITY OF LOWELL, MA

INFILTRATION AND INFLOW STUDY

1 EXECUTIVE SUMMARY

The City of Lowell (City) is implementing 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). This I/I Analysis Report provides a summary of the 2023 City-wide 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). These recommendations serve as a road map for the Utility to implement an ongoing plan to execute I/I investigations and reduction efforts.

Infiltration is water other than sanitary flow that enters a sewer system (including sewer service connections and foundation drains) from the ground through means which include, but are not limited to, defective pipes, pipe joints, connections, or manholes. Infiltration is influenced by groundwater levels and is expected to fluctuate, with typically larger volumes anticipated in the spring. **Inflow** is water other than sanitary flow that enters a sewer system (including sewer service connections) from sources which include but are not limited to, sump pumps, roof leaders, cellar/foundation drains, surface/yard drains, drains from springs and swampy areas, manhole covers, catch basins, cross connections between storm sewers and sanitary sewers, or other drainage. Inflow differs from infiltration in that it is a result of direct connections of extraneous flow sources into the collection system and is largely the results of wet weather influence on the sewer system.

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).

In December 2022, Kleinfelder developed the City's *Infiltration and Inflow (I/I) Abatement Plan* summarizing the City's I/I efforts to date. A City-wide flow metering program was one of the recommendations of the I/I Abatement Plan to develop a comprehensive approach and schedule, to

identify and investigate locations of excessive I/I within the collection system. The City's last system-wide flow monitoring program was conducted in 1990 in support of the *Phase 1 Infiltration/Inflow Report* (CDM Smith).

In 2023 the USEPA and MassDEP, along with the U.S. Department of Justice and the Commonwealth of Massachusetts Department of Justice finalized a Consent Decree with the City. The 2023 Consent Decree will be submitted to Federal Court for approval in 2024.

Based on the 2023 Draft Consent Decree, 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.*

This I/I Analysis Report is prepared in accordance with the requirements of the 2023 Draft Consent Decree.

2023 Flow Monitoring Program

In March 2023, Kleinfelder subcontracted with ADS Environmental Services (ADS) to conduct a City-wide flow monitoring program through temporary wastewater flow metering, groundwater depth monitoring, and precipitation monitoring to quantify the magnitude to of I/I entering the sewer system.

ADS installed sixty-three (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 and Warren CSO Stations. Ten of these meter areas will be re-metered by ADS in Spring 2024 to determine infiltration and inflow volumes. The remaining meter area is small in size and inspections of the area sewers will be included within the future field investigation program to identify sources of I/I.

Kleinfelder completed an I/I analysis for fifty-two (52) metered areas in accordance with the MassDEP Guidelines. An infiltration rate of 4,000 gallons per day per inch-diameter mile (gpd/idm) is the threshold, defined by MassDEP, for which further field investigations such as manhole inspections, flow isolation, and CCTV should be prioritized to identify infiltration sources. **Table ES-1** details the results of the infiltration analysis with twenty-four (24) of 52 metered areas exceeded the 4,000 gpd/idm threshold, requiring further investigation to identify infiltration sources per the MassDEP designation.

The flow monitoring program included the installation of three (3) rain gauges evenly distributed throughout the City. 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. **Table ES-2** summarizes the result of the inflow analysis. MassDEP Guidelines propose further investigations to identify inflow sources for the metered areas accounting for 80% of the total inflow of the system. Within the 52 metered areas, nineteen (19) metered areas account for 80% total of the inflow. Sixteen (16) of these areas are identified through the City's Geographical Information System (GIS) mapping as fully or mostly combined sewer catchments. The remaining three areas are identified as fully or partially separated sewer catchments and are recommended for further investigation to identify extraneous inflow sources.

314 CMR12.04 requires all sewer system authorities to assess the risk of sanitary sewer overflows (SSOs) from a five-year, 24-hour storm event. The City is in the process of updating and calibrating their existing sewer system model in support of CSO planning efforts. Meter areas that experience wet-weather SSO events should also be investigated for inflow sources to determine if peak inflow rates are contributing to the SSO events in the system by reducing the capacity of the local sewers.

SSES Implementation Program

As detailed in the MassDEP I/I Guidelines, upon conclusion of the flow monitoring program a Sanitary System Evaluation Survey (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.

Meter areas where infiltration or inflow was found to be excessive during the I/I analysis are to be included in an SSES Implementation Plan. Four of the meter areas (13, 14, 15, and 60) identified with excessive I/I are included in the scope of the Utility's December 2023 *Centralville Sewer Separation Preliminary Design Report (Humphrey's Brook PDR)*, which will reduce infiltration and inflow sources for these areas. Two additional areas identified with excessive I/I (meter Areas 35 and 36) are within the Tilden CSO area included in the Utility's Phase 3 CSO Preliminary Design Report and Sewer Separation Implementation Schedule, to be completed by December 31, 2024 in accordance with the 2023 Draft Consent Decree. I/I sources in the Centralville and Tilden areas will be investigated through these CSO planning efforts and are excluded from the SSES Implementation Plan.

To address the remaining areas identified with excessive infiltration and inflow, Kleinfelder recommends an eight-phase SSES Implementation Plan, detailed below 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. **Figure ES-1** shows the meter areas identified for each SSES phase.

In accordance with the 2023 Draft Consent Decree, the Utility shall complete an Updated Long-Term CSO Control Plan (Updated LTCP) by September 2034. The 8-phase SSES Implementation Plan proposes SSES investigations through 2032. At that time, an overall system assessment is anticipated to begin in support of the Updated LTCP and future I/I identification and removal efforts will be developed in coordination with the Updated LTCP.

Phase 1 of the SSES Implementation Plan focuses on completion 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). In Spring 2023, the Utility completed CCTV of 31,500 feet of 8-inch to 36-inch diameter sewer and 220 manhole inspections in meter areas 51, 38, and 37. SSES Phase 1 incudes CCTV inspection of approximately 24,000 feet of sewer and fifty manhole inspections within these 3 subareas. In addition to CCTV and manhole inspections within the downtown area, Phase 1 of the SSES Implementation Plan

includes multi-sensor inspection (digital CCTV and sonar) of the Utility's river-front interceptor pipe, approximately 47,000 LF of sewer ranging in size from 36 to 120-inch in diameter as shown in **Figure ES-1**. These critical assets are located within ten of the meter areas identified with either high infiltration, high inflow, or both. This includes meter areas that exhibited some of the highest inflow volumes, possibly indicating the presence of system defects that allow extraneous flow to enter the system with elevated groundwater and river levels. The Utility has historically observed the increase in flows at the Duck Island Wastewater Treatment Facility (DIWWTF or Duck Island) with the increase in the Merrimack River level.

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. In Spring 2023 the Utility completed cleaning and inspection of the East Merrimack siphon, where no infiltration or structural defects were observed.

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 SSES report for each phase will include a summary of field investigations completed and recommendations for sewer system rehabilitation and repair. 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. It is anticipated that multiple design and construction contracts will be required to address system deficiencies identified through SSES Phase 1 investigations in meter areas 51, 38, and 37 and the inspections of the river-front interceptors. Therefore, field investigations in support of SSES Phase 2 are scheduled to begin in FY26.

As noted previously, a supplemental memorandum to this I/I Analysis Report will be prepared to summarize the I/I analysis of 10 meter areas where meters will be re-installed in Spring 2024. The supplemental memorandum will also include an assessment of SSO risk utilizing the City's updated sewer system model, and a reassessment of this SSES Implementation Plan based on the findings of the I/I and SSO analyses, along with the results of the Phase 1 SSES river-front interceptor inspections. These

additional system evaluations and field investigations may shift the priority areas for future SSES phases as currently planned for the Utility to identify and remove excessive volumes of I/I within the collection system.

Table ES-1: Infiltration Summary

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
17*	Mostly Combined	111,229	483.58	4,871	14,504	Warren	4/10 to 4/12
6	Mostly Combined	24,370	65.87	603	13,192	Walker	4/10 to 4/12
42	Mostly Combined	20,148	98.26	876	12,832	Warren	4/10 to 4/12 + 5/10 to 5/12
20	Both	26,326	70.77	518	10,539	Walker	4/11 to 4/13
35	Mostly Combined	23,003	68.64	366	7,678	Warren	4/10 to 4/12
63	Fully Separated	53,607	100.76	518	7,405	Warren	4/10 to 4/12
61	Fully Combined	11,084	23.73	116	7,052	Warren	4/10 to 4/12
13	Fully Combined	28,672	84.73	411	6,986	Warren	4/10 to 4/12
1	Fully Separated	20,625	44.88	217	6,970	Walker	4/10 to 4/12
3	Mostly Separated	23,234	38.15	176	6,662	Walker	4/10 to 4/12
48	Mostly Combined	26,090	119.99	552	6,631	Warren	4/10 to 4/12
15	Fully Combined	11,190	28.37	128	6,520	Warren	4/10 to 4/12
39	Mostly Combined	10,163	37.80	163	6,223	Warren	5/10 to 5/12
21*	Both	67,815	201.95	858	6,116	Walker	4/11 to 4/13
4	Fully Separated	21,863	47.22	195	5,944	Walker	4/10 to 4/12
19	Mostly Separated	34,194	60.29	220	5,251	Walker	4/10 to 4/12
56	Mostly Combined	18,203	39.76	135	4,899	Warren	4/10 to 4/12
36	Fully Combined	21,532	65.29	219	4,821	Warren	4/10 to 4/12
46	Fully Separated	17,165	31.12	104	4,793	River's Edge	4/10 to 4/12
7	Mostly Combined	17,076	49.26	151	4,424	Walker	4/10 to 4/12
14	Fully Combined	13,905	55.35	167	4,352	Warren	4/10 to 4/12
37	Both	23,360	100.40	297	4,259	Warren	5/10 to 5/12
28	Both	25,490	71.42	202	4,071	Walker	4/10 to 4/12
59	Fully Combined	9,507	24.58	60	3,514	Warren	4/10 to 4/12
23	Mostly Combined	16,116	36.51	86	3,378	Walker	4/10 to 4/12
45	Both	20,367	76.23	177	3,338	Warren	4/10 to 4/12
24	Fully Separated	21,933	36.02	83	3,321	Walker	4/10 to 4/12
44	Mostly Separated	18,806	51.04	113	3,190	River's Edge	5/10 to 5/12
12	Fully Combined	21,915	63.08	135	3,093	Warren	4/10 to 4/12
18	Fully Combined	12,216	29.51	63	3,088	Warren	5/10 to 5/12
9	Mostly Separated	20,943	49.47	102	2,967	Walker	5/10 to 5/12
8	Mostly Combined	24,940	93.45	186	2,865	Walker	4/10 to 4/12
50	Mostly Combined	20,654	54.95	107	2,811	Warren	4/10 to 4/12
11	Mostly Combined	17,039	90.13	144	2,306	Warren	4/10 to 4/12
57	Fully Combined	13,685	34.30	49	2,061	Warren	4/10 to 4/12

Meter	Type	Pipe Length (LF)	IDM	Estimate Infiltration (gpm)	Estimate Infiltration Rate (gpd/IDM)	Rain Gauge	DW Day Used
32	Mostly Combined	18,028	59.86	80	1,922	Walker	5/10 to 5/12
34	Fully Combined	11,989	39.97	51	1,841	Warren	4/10 to 4/12
25	Mostly Separated	20,172	47.37	54	1,648	Warren	4/13 14:00 to 4/15 13:55
43	Fully Separated	20,902	57.04	62	1,571	River's Edge	5/10 to 5/12
47*	Both	42,485	87.91	88	1,434	River's Edge	4/10 to 4/12
2	Mostly Separated	22,790	38.93	38	1,412	Walker	5/10 to 5/12
First St	–	111,107	208.87	169	1,165	Warren	4/14 to 4/16
40	Mostly Combined	14,472	51.48	41	1,147	Warren	4/10 to 4/12
33	Mostly Combined	19,708	63.38	47	1,077	Warren	4/10 to 4/12
5	Fully Separated	13,693	26.80	20	1,059	Walker	4/10 to 4/12
16	Fully Combined	8,915	22.02	16	1,039	Warren	4/10 to 4/12
Burnham Rd	–	824,213	1600.01	796	716	Warren	4/10 to 4/12
38	Mostly Combined	22,148	87.67	41	672	Warren	4/10 to 4/12
26	Both	20,550	52.60	22	594	Warren	4/13 14:00 to 4/15 13:55
49	Mostly Combined	9,632	35.02	10	411	Warren	5/10 to 5/12
31	Mostly Combined	17,549	49.22	10	302	Walker	4/10 to 4/12
10	Fully Separated	17,707	92.73	13	207	Walker	4/10 to 4/12
62	Both	240,601	411.05	20	70	Walker	4/10 to 4/12
52	Mostly Combined	24,794	51.33			River's Edge	
55	Fully Combined	21,531	62.71			Warren	
30*	Both	57,888	183.43			Warren/Walker	
27	Mostly Separated	24,076	64.53			Warren	
54	Fully Combined	22,349	69.59			Warren	
53	Both	24,932	68.04			Warren	
41	Fully Separated	643,810	1101.29			Warren	
51	Mostly Combined	24,514	138.59			Warren	
22	Fully Combined	1,757	5.51			Warren	
29	Mostly Combined	22,654	69.86			Walker	
58	Fully Combined	8,041	22.64			Warren	

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

Grayed out meters are values not analyzed

Table ES-2: Inflow Summary

		Storm Event Volume (MG)				Design Storm				
Meter	Type	23-Apr	20-May	24-May	[1]Design Storm Inflow (gal)	D/I Ratio (avg)	Delayed Inflow (gal)	Direct Inflow (gal)	Percent Inflow	Percent Cumulative Inflow
17*	Mostly Combined	19.161	12.375	2.057	15,202,908	2.88	3,918,275	11,284,633	26.76%	26.76%
13	Fully Combined	7.284	3.604	0.484	5,325,120	1.53	2,100,984	3,224,136	9.37%	36.14%
21*	Mostly Combined	3.386	2.514	0.429	2,852,620	9.77	264,828	2,587,792	5.02%	41.16%
37	Both	4.101	0.444	0.121	2,368,440	9.02	236,337	2,132,103	4.17%	45.33%
49	Mostly Combined	4.125	0.069	0.003	2,225,680	5.51	341,886	1,883,794	3.92%	49.25%
11	Mostly Combined	2.900	1.322	0.334	2,088,596	0.65	1,266,499	822,097	3.68%	52.92%
38	Mostly Combined	1.605	2.401	0.393	1,823,200	167.90	10,795	1,812,405	3.21%	56.13%
36	Fully Combined	[2]N/A	1.509	0.253	1,697,640	16.04	99,645	1,597,995	2.99%	59.12%
12	Fully Combined	1.956	1.553	0.282	1,670,808	144.14	11,512	1,659,296	2.94%	62.06%
45	Both	1.572	1.071	0.170	1,269,360	4.33	237,941	1,031,419	2.23%	64.30%
60	Mostly Combined	1.608	0.827	0.094	1,186,800	1.34	506,975	679,825	2.09%	66.39%
34	Fully Combined	1.390	1.004	0.193	1,147,240	16.14	66,919	1,080,321	2.02%	68.41%
42	Mostly Combined	1.696	0.537	0.126	1,123,160	8.54	117,793	1,005,367	1.98%	70.38%
40	Mostly Combined	1.317	1.019	0.166	1,112,324	19.75	53,606	1,058,718	1.96%	72.34%
10	Fully Separated	1.110	1.047	0.030	1,020,476	3.50	226,888	793,588	1.80%	74.14%
33	Mostly Combined	1.198	0.943	0.176	1,019,960	95.49	10,571	1,009,389	1.80%	75.93%
15	Fully Combined	1.031	0.720	0.118	839,876	30.47	26,687	813,189	1.48%	77.41%
48	Mostly Combined	0.602	1.051	0.253	751,640	10.38	66,039	685,601	1.32%	78.74%
57	Fully Combined	1.298	0.144	0.008	748,200	259.95	2,867	745,333	1.32%	80.05%
14	Fully Combined	0.716	0.886	0.185	742,352	2.40	218,034	524,318	1.31%	81.36%
7	Mostly Combined	0.916	0.591	0.097	733,580	382.94	1,911	731,669	1.29%	82.65%
6	Mostly Combined	0.816	0.676	0.114	717,584	7.28	86,677	630,907	1.26%	83.91%
8	Mostly Combined	0.710	0.789	0.136	710,876	23.34	29,210	681,666	1.25%	85.17%
35	Mostly Combined	0.839	0.605	0.088	689,720	26.41	25,164	664,556	1.21%	86.38%
50	Mostly Combined	0.850	0.548	0.095	674,240	13.77	45,657	628,583	1.19%	87.57%
28	Both	0.780	0.513	0.103	629,864	113.71	5,491	624,373	1.11%	88.68%
56	Mostly Combined	0.791	0.506	0.089	626,080	294.90	2,116	623,964	1.10%	89.78%
32	Mostly Combined	0.626	0.536	0.100	560,720	304.71	1,834	558,886	0.99%	90.76%
39	Mostly Combined	0.482	0.672	0.091	526,320	1.83	186,018	340,302	0.93%	91.69%
59	Fully Combined	0.550	0.385	0.096	450,640	40.57	10,839	439,801	0.79%	92.48%
9	Mostly Separated	0.635	0.205	0.040	422,776	130.88	3,206	419,570	0.74%	93.23%
62	Both	0.487	0.361	0.068	411,080	16.78	23,125	387,955	0.72%	93.95%
23	Mostly Combined	0.454	0.336	0.059	381,840	246.81	1,541	380,299	0.67%	94.62%
47*	Both	0.381	0.248	0.025	330,240	3.31	76,642	253,598	0.58%	95.21%
16	Fully Combined	0.370	0.279	0.067	311,320	39,234.87	8	311,312	0.55%	95.75%
19	Mostly Separated	0.349	0.163	0.030	252,840	5.06	41,689	211,151	0.45%	96.20%
44	Mostly Separated	0.278	0.203	0.034	251,120	18,577.27	14	251,106	0.44%	96.64%

Meter	Type	23-Apr	20-May	24-May	[1]Design Storm Inflow (gal)	D/I Ratio (avg)	Delayed Inflow (gal)	Direct Inflow (gal)	Percent Inflow	Percent Cumulative Inflow
61	Fully Combined	0.311	0.197	0.000	245,960	2.43	71,807	174,153	0.43%	97.07%
20	Both	0.335	0.156	0.028	242,348	2.26	74,338	168,010	0.43%	97.50%
18	Fully Combined	[2]N/A	0.203	0.038	229,276	15.76	13,677	215,599	0.40%	97.90%
26	Both	0.256	0.229	0.034	228,416	17,097.67	13	228,403	0.40%	98.31%
31	Mostly Combined	0.288	0.161	0.025	220,848	70.05	3,109	217,739	0.39%	98.70%
63	Fully Separated	0.206	0.085	0.031	146,200	9.02	14,590	131,610	0.26%	98.95%
2	Mostly Separated	0.162	0.128	0.040	141,556	4.97	23,699	117,857	0.25%	99.20%
46	Fully Separated	0.122	0.084	0.014	108,360	8,161.33	13	108,347	0.19%	99.39%
3	Mostly Separated	0.157	0.014	0.003	88,752	0.63	54,542	34,210	0.16%	99.55%
25	Mostly Separated	0.093	0.086	0.013	84,280	6,225.43	14	84,266	0.15%	99.70%
5	Fully Separated	0.074	0.048	0.006	59,168	8,531.60	7	59,161	0.10%	99.80%
24	Fully Separated	0.051	0.066	0.002	54,180	0.72	31,591	22,589	0.10%	99.90%
4	Fully Separated	0.058	0.013	0.047	38,872	0.43	27,140	11,732	0.07%	99.97%
1	Fully Separated	0.015	0.008	0.004	11,180	8.46	1,182	9,998	0.02%	99.98%
43	Fully Separated	0.009	0.006	0.002	8,600	38.92	215	8,385	0.02%	100.00%
First St		0.096	0.042	0.008	68,800	1.89	23,806	44,994		
Burnham Rd		0.454	1.111	0.143	686,280	0.87	366,995	319,285		
22	Fully Combined									
27	Mostly Separated									
29	Mostly Combined									
30*	Fully Separated									
41	Fully Separated									
51	Mostly Combined									
52	Mostly Combined									
53	Both									
54	Fully Combined									
55	Fully Combined									
58	Fully Combined									

[1]Using Assumed Design Storm of 1.72

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

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

Grayed out meters are values not analyzed or are not within the City's jurisdiction (First St, Burnahm Rd)

Table ES-3: Proposed 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	M38, M51, M37	24,000	50	-	-	-	-	-
2024	1	Interceptor	47,000	150	-	-	-	-	-
2026	2	M6, M39, M22, M37[1]	36,300	150	-	36,300	23,400	40	20
2027	3	M42, M48, M10[1]	46,300	280	-	46,300	17,800	220	40
2028	4	M45	20,400	130	Walker	20,400	20,400	300	50
2029	5	M20, M21	51,700	250	Beaver Brook	51,700	-	-	-
2030	6	M63, M19	34,000	170	Merrimack River	34,000	-	-	-
2031	7	M1, M3	43,900	250	Warren	43,900	-	-	-
2032	8	M4, M7, M61	50,100	270	Concord River	50,100	-	-	-
	TOTAL		**385,200**	**1,920**	**6**	**282,700**	**61,600**	**560**	**110**

**Phase 0 field inspections completed in 2023.*

[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.

Legend

- Smoke Testing / Building Inspections
- Future Sewer Separation
- ADS Re-Meter
- Meter Area
- Siphon Inspections (5) - Phases 4 to 8
- Interceptor Sewer Inspections - Year 1

SSES Phase

- None
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

TYNGSBOROUGH
DRACUT
CHELMSFORD
TEWKSBURY
WESTFORD
BILLERICA
FIRST ST

0 4,000 8,000
Feet

N

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CREATED:	1/31/2024
CREATED BY:	JRossini
CHECKED BY:	KGoyette
FILE NAME:	Lowell 2023_Flow_Meter.mxd

2023 I/I Analysis
SSES Plan
Keyplan

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

FIGURE
ES-1

Date: 1/31/2024 User: JRossini Path: \\azrgisstorp01\GIS_Projects\Client\MA_Lowell\20220166.003_Consent_Decree_Compliance\MXD\Lowell 2023_Flow_Meter\Lowell 2023_Flow_Meter.aprx

Table ES-4: Cost Estimate for Proposed 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 Meter Area	M38, M51, M37	M6, M39, M22, M37[1]	M42, M48, M10[1]	M45	M20, M21	M63, M19	M1, M3	M4, M7, M61
CCTV Inspections	$62,000	$200,000	$250,000	$110,000	$280,000	$180,000	$240,000	$270,000
MH Inspections	$6,000	$13,000	$23,000	$12,000	$21,000	$15,000	$21,000	$22,000
Interceptor Inspections	$383,000	$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	$17,000	$21,000	$10,000	$23,000	$16,000	$20,000	$22,000
Smoke testing	$0	$12,000	$9,000	$10,000	$0	$0	$0	$0
Building Inspections	$0	$14,000	$55,000	$75,000	$0	$0	$0	$0
Dye Testing	$0	$6,000	$11,000	$14,000	$0	$0	$0	$0
Engineering	$150,000	$100,000	$150,000	$100,000	$150,000	$100,000	$150,000	$150,000
Subtotal	***$601,000***	***$362,000***	***$519,000***	***$435,000***	***$515,000***	***$424,000***	***$499,000***	***$505,000***
Contingency 10%	*$61,000*	*$37,000*	*$52,000*	*$44,000*	*$52,000*	*$43,000*	*$50,000*	*$51,000*
Escalation 4%	*$0*	*$33,000*	*$72,000*	*$82,000*	*$123,000*	*$124,000*	*$174,000*	*$205,000*
TOTAL	**$662,000**	**$432,000**	**$643,000**	**$561,000**	**$690,000**	**$591,000**	**$723,000**	**$761,000**

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

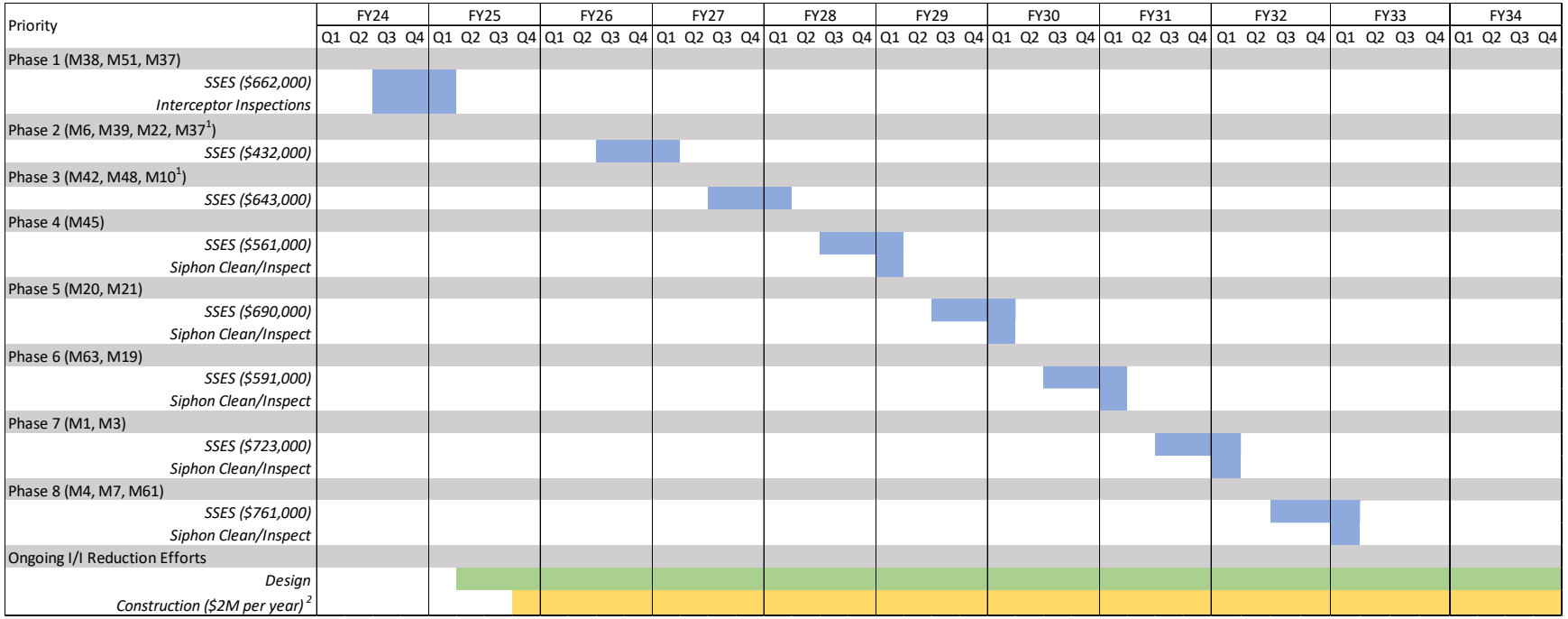


Figure ES-2: Infiltration/Inflow Implementation Schedule

Fiscal years begin July 1st and end June 30th the following year.

Priority meter areas included in SSES Phases 2 through 8 to be re-evaluated with results of Spring 2024 metering, SSO risk analysis, and results of interceptor inspections.

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

[2]Includes post-construction flow monitoring.

2 INTRODUCTION

The City of Lowell (City) is implementing 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.

Infiltration is water other than sanitary flow that enters a sewer system (including sewer service connections and foundation drains) from the ground through means which include, but are not limited to, defective pipes, pipe joints, connections, or manholes. Infiltration is influenced by groundwater levels and is expected to fluctuate, with typically larger volumes anticipated in the spring. **Inflow** is water other than sanitary flow that enters a sewer system (including sewer service connections) from sources which include, but are not limited to, sump pumps, roof leaders, cellar/foundation drains, surface/yard drains, drains from springs and swampy areas, manhole covers, catch basins, cross connections between storm sewers and sanitary sewers, or other drainage. Inflow differs from infiltration in that it is a result of direct connections of extraneous flow sources into the collection system and is largely the results of wet weather influence on the sewer system.

In April 2014, MassDEP implemented regulations requiring all sewer authorities to develop and implement an ongoing program to control extraneous flow entering sewer systems. 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. In December 2022, Kleinfelder developed the City's *Infiltration and Inflow (I/I) Abatement Plan* summarizing the City's I/I efforts to date. Kleinfelder performed a review of the Utility's available data, past reports, and existing conditions to develop a comprehensive approach and schedule to identify and investigate locations of excessive I/I within the collection system.

Through comprehensive review, the Utility experiences significant I/I in several areas and the I/I Abatement Plan included the following recommendations:

1. Conduct a City-wide flow metering program and summarize findings and recommendations in an I/I Analysis Report in accordance with MassDEP Guidelines.

2. Conduct closed-circuit television (CCTV) and manhole inspections during high groundwater periods in subareas 7, 9, 19, 20 (as defined in the City's 1990 Phase 1 Infiltration/Inflow Study). Includes approximately 60,100 feet (5% of system) of sewer inspections and 330 manhole inspections (5% of system).
3. CCTV inspections of River-front interceptors (up to 10,000 feet) and siphon (up to 1 location).
4. Repair of Kearney Square sewer.

Following the recommendations of the I/I Abatement Plan, the Utility conducted a City-wide Flow Metering Program in Spring 2023 consisting of sixty-three (63) flow meters, one hundred and ten (110) groundwater gauges, and three (3) rain gauges.

In 2023 USEPA and MassDEP, along with the U.S. Department of Justice and the Commonwealth of Massachusetts Department of Justice finalized a Consent Decree with the City. The 2023 Consent Decree will be submitted to Federal Court for approval in 2024.

Based on the 2023 Draft Consent Decree, under Section VI. Remedial Measures, Paragraph 18:

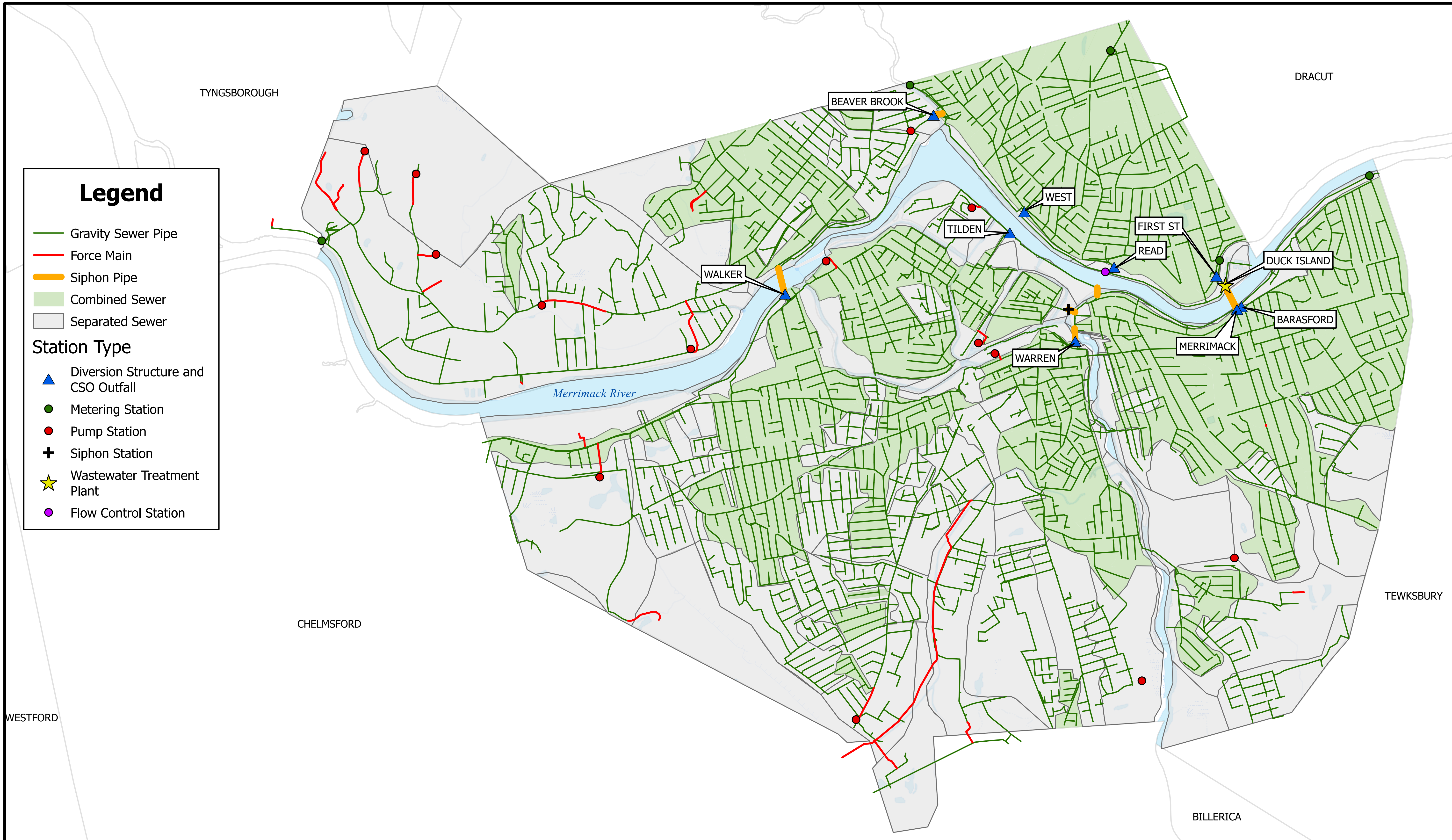
> *The City shall develop and implement an ongoing program to identify and remove infiltration and inflow from the sewer system in accordance with 314 C.M.R. §12.04(2) and shall provide annual flow information for those communities serviced by the Lowell Regional Wastewater Utility ("LRWU"). To meet 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.*

This 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) as required by the 2023 Draft

Consent Decree. These recommendations serve as a road map for Utility to implement an ongoing plan to execute I/I investigations and reduction efforts.

2.1 SEWER COLLECTION AND CONVEYANCE SYSTEM

The Utility's sewer system is 226 miles of sewer pipe comprised of portions of combined (approximately 52%) and separated (approximately 48%) sewers by linear foot dating back to the 1830s and largely developed from 1870s to the 1970s. The pipes range from 8-inch to 120-inch in diameter, with the majority of 36-inch in size or smaller. The sewer system is predominantly Vitrified Clay (VC), Concrete, Brick, and Asbestos Cement (AC) with the remaining materials including Cast Iron (CI), Ductile Iron (DI), and Polyvinyl Chloride (PVC). The system also includes six siphons (double or triple barrel), 5 miles of force main, 14 pump stations, 9 diversion structures, 1 siphon station, 5 intermunicipal meter stations, 1 flow control station, 3 permanent rain gauges (located at Duck Island Wastewater Treatment Facility, Warren CSO Station, Rivers Edge Pump Station) and the Duck Island Wastewater Treatment Facility (Duck Island). There are 6 six metering stations bordering the City that are not owned or operation by the Utility. The Utility collects and treats flows from Chelmsford, Dracut, Tewksbury, and Tyngsborough (Member Communities) under an established Inter-Municipal Agreement (IMA). **Figure 1** illustrates the Utility's sewer system.



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2023 I/I Analysis
LRWWU's Sewer System

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

FIGURE
1

2.2 MEMBER COMMUNITIES

The Member Communities respective I/I statuses have been summarized in the aforementioned *Infiltration and Inflow Abatement Plan* and yearly flow data information is detailed in the Utility's annual report. Refer to **Table 1** and **Figure 2** to review their sewer system characteristics and configurations. Note that in **Figure 2** Tyngsborough did not provide their sewer system geodatabase as their direct contribution to Lowell is one small catchment and the majority of their flow discharges to Dracut.

Table 1: Member Community Sewer System Characteristics

Member Community	Miles	Material	Age
Chelmsford	167	PVC, DI	40 years old or newer
Dracut	125	PVC, DI, RC, AC	50 years old or newer
Tewksbury	158	PVC, RC	40 years old or newer
Tyngsborough	22	AC, DI	50 years old or newer

In April 2023, Kleinfelder developed the "*Flow Data Reporting Memo*" which summarized Member Community sewer system characteristics based on the available flow data provided by the Member Communities for the 2022 calendar year. Chelmsford, Dracut, and Tewksbury were found to contribute average daily flows of 2.38 MGD, 2.37 MGD, and 1.95 MGD, respectively. A small tributary area of Tyngsborough contributed 0.02 MGD to their direct connection to Lowell along Pawtucket Boulevard.

Of the 6.7 MGD average daily flows conveyed to Duck Island from the Member Communities, at least 2.5 MGD are estimated to be I/I contributions from Dracut and Tewksbury. Chelmsford and Tyngsborough provided flows as semi-weekly totals, and therefore I/I contributions could not be determined.

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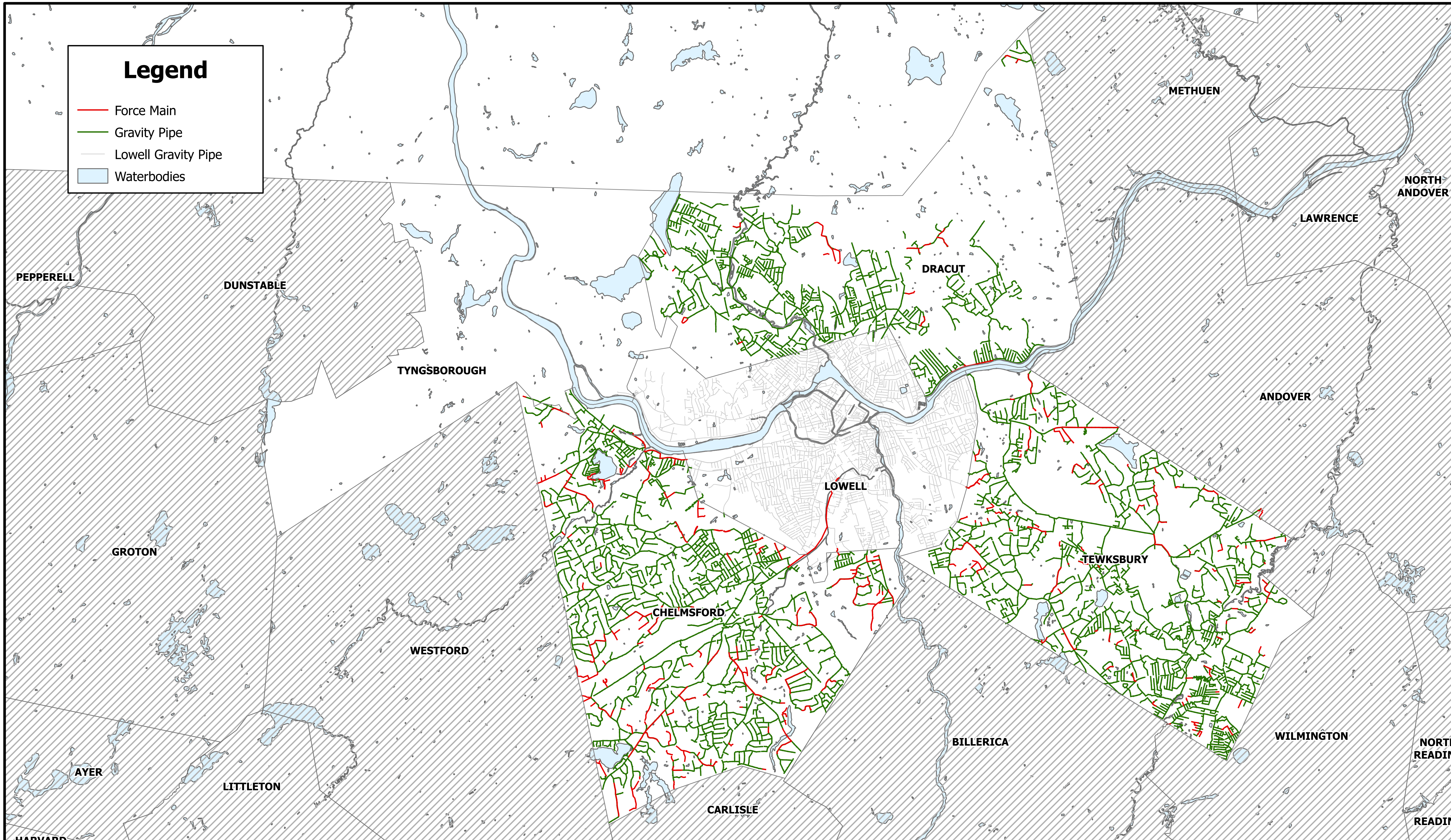

0 12,500 25,000
Feet

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2023 I/I Analysis
Member Communities
Sewer Systems

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

FIGURE

2

2.3 PAST STUDIES

Kleinfelder reviewed various past reports and available data provided by the Utility to better understand the history of sewer system evaluations and investigations under previous sewer system studies, and the sewer system improvements completed with I/I reduction benefits. A review of the following reports was performed:

1. Phase 1 I/I Report (CDM Smith, 1990),
2. 2004 Warren Street CSO Separation PDR,
3. CSO Phase 2 Long Term Control Plan (LTCP) (CDM Smith, 2014),
4. I/I Control Plans, Capacity, Management, Operation, and Maintenance (CMOM) Reports, and NPDES Reports, and
5. Conductance Surveys.

2.3.1 1990 Phase 1 I/I Report

The 1990 Phase 1 I/I program included a comprehensive City-wide flow metering program, dividing the City into 48 sewer catchments to identify those areas with excessive amounts of I/I. Sewer catchments ranged in size from 4,560 feet to 44,740 feet of sewer pipe. The 1990 Phase 1 I/I Report followed the 1989 Sanitary Sewer Evaluation Survey (SSES) guidelines where MassDEP classifies “high” infiltration rates as equal to, or higher than, 5,000 gallons per day per inch-diameter-mile (gpd/idm). Thirty out of the 48-meter areas were identified as high-infiltration contributors and recommended for further investigations including flow isolation, closed-circuit television (CCTV) inspections, and manhole inspections.

2.3.2 2004 Warren Street CSO Separation PDR

The 2004 Warren Street CSO Separation PDR focused on the Warren Street CSO area and identified 11 out of 12 metered areas as high infiltration contributors (greater than 5,000 gpd/idm). This PDR included the design of 12 key sewer separation projects to reduce CSO volumes and sewer surcharging and to mitigate I/I contributions including: Industrial-Wellman, Weed Street, Plain Street, Bolt Street, Newhall Street South, Lincoln Street West, Middlesex Street East, Crosby Avenue, Newhall Street North, Sanders Avenue, Gorham Street South, and Boston Road.

2.3.3 2014 CSO Long-Term Control Plan (LTCP)

The 2014 CSO LTCP summarized six (6) completed sewer separation projects in the Warren CSO area totaling approximately 950 acres, over 46,000 feet of new/rehabilitated sewer, and approximately 81,000 feet of new storm drain. Through these sewer separation efforts, the LRWWU carried out an aggressive sump pump identification and removal program, disconnecting approximately 331 sump pumps to further reduce inflow into the sanitary sewer system.

In addition to these projects in the Warren CSO area, the Utility completed the University Crossing Sewer Separation Project in the Tilden CSO Area.

2.3.4 I/I Control Plans, CMOM Reports, and NPDES Reports

Kleinfelder reviewed LRWWU's available I/I Control Plans, CMOM Reports, and NPDES Reports to better understand the LRWWU's operation and maintenance activities, reported sanitary sewer overflows (SSOs), and additional system investigations efforts. In addition to the sewer separation work noted in Section 2.3.3, the Utility has completed CCTV inspections, manhole inspections, lining projects, and sewer repairs and replacements in recent years. The LRWWU purchased a CCTV truck in 2012 with an equipment upgrade in 2022 allowing for sewer pipeline inspections to be conducted in-house. The LRWWU, and its subcontractors, has inspected roughly 49% of their pipelines from 2007 through 2022. Lowell rehabilitated approximately 46,000 feet of sewer pipe with Cured-in-Place Pipe (CIPP) lining and installed 53,300 feet of new sewer pipe since 2000.

2.3.5 Conductance Surveys

In an effort to identify potential inflow sources, the City performs conductance surveys through a field program. Conductance is a measure of electrical conductivity (or dissolved ions) in water. Typically, sewage has a high specific conductivity in the range of 1,000 micro-Siemens per centimeter (µS/cm). Sections of the collection system with high I/I tend to dilute the sewage and lower the conductance, offering a low-effort screening tool to identify areas of the system in need of further inspection and repair. **Figure 3** illustrates the results of the conductance surveys performed from 2021 to 2023. Areas identified as high priority yielded the lowest conductivity values, suggesting a significant source of I/I contributing to the wastewater flow and are flagged for further investigation.

TYNGSBOROUGH

DRACUT

CHELMSFORD

WESTFORD

TEWKSBURY

BILLERICA

Legend

Gravity Pipe

Siphon Pipe

Conductivity Survey Result

High Priority
(0 - 399 µS/cm)

Normal Priority
(>399 – 799 µS/cm)

Low Priority
(>799 µS/cm)

0 4,000 8,000

Feet

N

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2023 I/I Analysis
Conductance Results

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

FIGURE
3

3 FLOW MONITORING PROGRAM

In March 2023, Kleinfelder subcontracted with ADS Environmental Services (ADS) to conduct a City-wide flow monitoring program through temporary wastewater flow metering, groundwater depth monitoring, and precipitation monitoring to quantify the magnitude to of I/I entering the sewer system.

3.1 FLOW METERING PROGRAM

ADS installed sixty-three (63) temporary gravity sewer flow meters for a period of ten (10) weeks from March 24, 2023 to June 2, 2023. 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. 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 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. **Table 2** summarizes the meter installation locations and total sewer length in each meter area. Meter installation reports are included **in Appendix D**. The locations of the flow meters are indicated in **Figure 4** with stars and their respective relationships are depicted in the schematic displayed in **Figure 5**. Meter Area 63 (Tanner Street) exhibited explosive levels of gas during meter installations and is recommend for further investigation to assess pipe condition given the potential impacts of high gas levels on the structural integrity of the concrete portions of pipe.

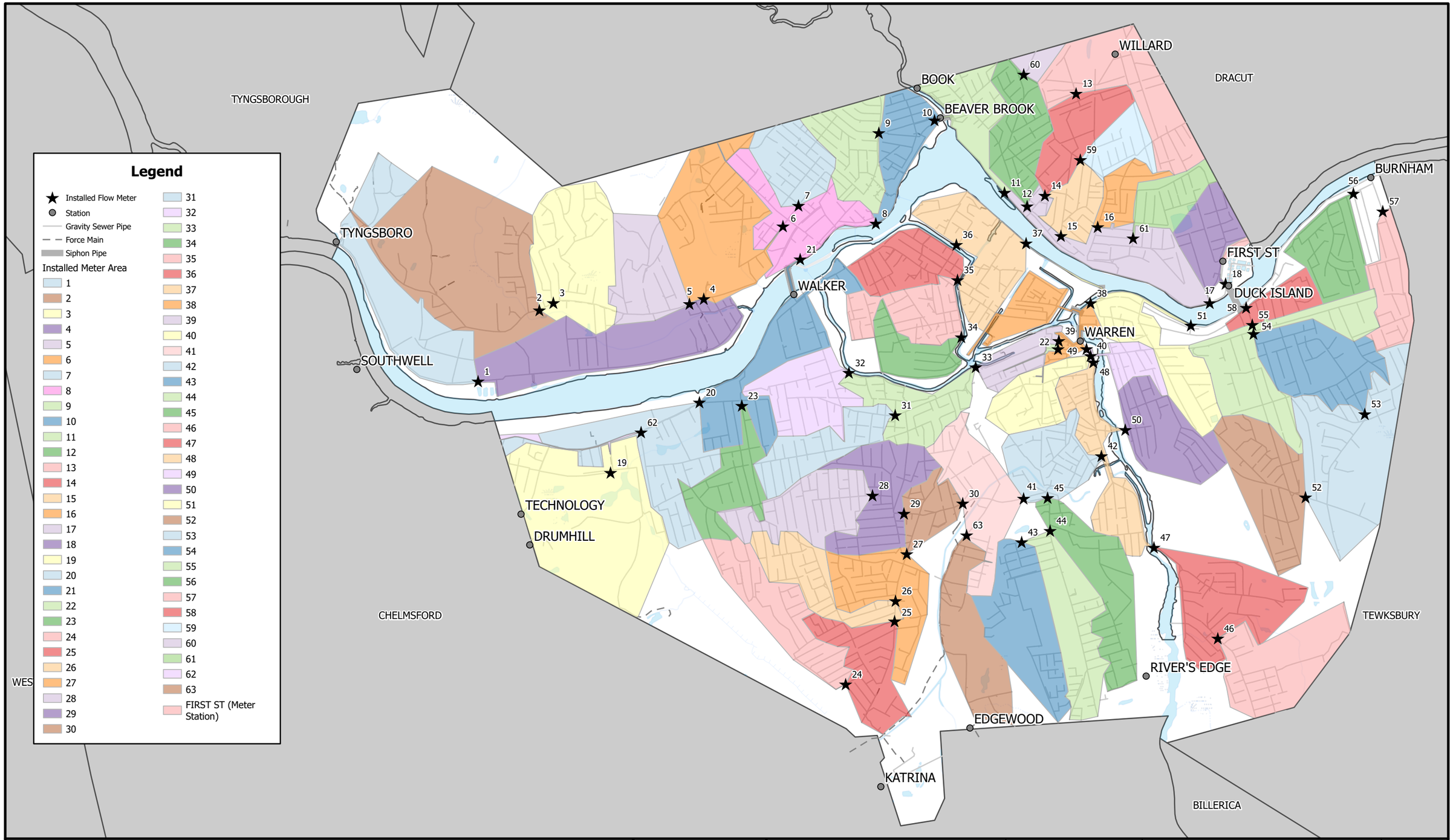
Upon review of the final metering data for all sites, Kleinfelder excluded data from eleven (11) meter areas from the I/I analysis due to poor quality of data and flow balancing issues between sites. These meters, which accounted for 17% of the total system metered, were located upstream of the Utility's Barasford and Warren CSO Stations and are noted in gray in **Figure 5**. Ten of these meter areas will be re-metered by ADS in Spring 2024 to determine infiltration and inflow volumes. The remaining meter area (22) is small in size and inspections of the area sewers will be included within the future field investigation program to identify sources of I/I. **Figure 5** depicts the fifty-two meters (52) analyzed for I/I contributions through the City-wide flow monitoring program.

Table 2: Meter Locations

Meter No.	SMH ID	LF (Lowell Pipe Only)	Location	ADS Measured Pipe Size (IN.)	Sensor Location
1	SMH-006372	20,625	Clyde St and Pawtucket Blvd	18	DS
2	SMH-006907	22,790	821 Varnum Ave	14	DS
3	SMH-006982	23,234	Varnum Ave and Laurie Ln	15	DS
4	SMH-000435	21,863	360 Varnum Ave (Varnum Ave & Delaware Ave)	17.5	DS
5	SMH-000432	13,693	391 Varnum Ave	17.5	DS
6	SMH-000559	24,370	15 Woodward Ave	50x34.5	DS
7	SMH-000799	17,076	Mt Grove St and 4th Ave	48	DS
8	SMH-007882	24,940	Off of VFW Highway	84	DS
9	SMH-004482	20,943	Riverside St and Sparks St	49.5x45.75	DS
10	STA-000025	17,707	911 Martin St	96	US
11	SMH-002522	17,039	Merrimack Walking Path	95.5x96	DS
12	SMH-008640	21,915	427 Lakeview Ave	55x47	DS
13	SMH-003089	24,138	Barker Ave and Sutherland St	48	DS
14	SMH-002536	13,905	54 West St	60	DS
15	SMH-002494	11,190	Coburn St and Lakeview Ave	41x27.5	DS
16	SMH-007791	8,915	Bridge St and W 5th St	32.5x29.25	US
17	SMH-005078	27,180	Merrimack Walking Path (near 333 First St Blvd)	95.75x96.25	DS
18	SMH-007913	12,216	Duck Island	18	US
19	SMH-001593	20,372	115 Hadley St	18	DS
20	SMH-000229	26,326	915 Pawtucket St	47.5	DS
21	SMH-007874	25,373	Varnum Ave Southwest of Mammoth Rd	36	US
22*	SMH-002436	1,757	Williams St	30x21	DS
23	SMH-000998	16,116	34-24 Foster St	18	DS
24	SMH-007328	21,933	W Albert St and Baltimore Ave	9.1	US
25	SMH-001766	20,172	Chelmsford St and Jenness St	36	DS
26	SMH-001769	20,550	Chelmsford St and Maitland St	36	US
27*	SMH-001714	24,076	480 Chelmsford St	56x52	DS
28	SMH-004651	25,490	144 Shaw St	51.5x36.8	DS
29*	SMH-001720	22,654	38 Nottingham St	50x49	DS
30*	SMH-002212	11,159	Lowell Connector (near Leverett St)	72x73	DS
31	SMH-004763	17,549	Branch St and Queen St	34x24.25	DS
32	SMH-007465	18,028	101 Pevey St	42.5x28.5	DS
33	SMH-003554	19,708	355 Jackson St	48	DS
34	SMH-002346	11,989	116 Suffolk St	40x30.5	DS
35	SMH-002371	23,003	432 Suffolk St	52x37.5	US
36	SMH-003850	21,532	Cabot St (grass near turf fields)	40.5	DS
37	SMH-002480	23,360	1 River Pl Building C	36	US
38	SMH-004149	22,148	50 Stackpole St	96	US
39	SMH-002442	10,163	34 Hurd St	54x37	DS
40	SMH-004178	14,472	219 Church St	54.6x36.6	US

Meter No.	SMH ID	LF (Lowell Pipe Only)	Location	ADS Measured Pipe Size (IN.)	Sensor Location
41*	SMH-002839	16,986	549 Lawrence St	86	DS
42	SMH-007216	20,148	Olive St	92	DS
43	SMH-002906	20,902	76 Maple St	47.6x34	DS
44	SMH-002884	18,806	Gorham St and Olive St	55x46.5	US
45	SMH-002868	20,367	978 Gorham St	74x50	US
46	SMH-005717	17,165	Woburn St and Carmine St	12	DS
47	SMH-005252	25,320	Lawrence St	36	DS
48	SMH-004183	26,090	174 Warren Ct	84	DS
49	SMH-004159	9,632	132 Warren St	90	DS
50	SMH-006378	20,654	68 Rogers St	46	US
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
56	SMH-006171	18,203	188 River Rd	36	US
57	SMH-006667	13,685	230 Burnham Rd	30	DS
58*	SMH-007928	8,041	678 E Merrimack St	82	DS
59	SMH-003141	9,507	85 Hildreth St	38x26	DS
60	SMH-007770	754	George Ave	24	DS
61	SMH-006585	11,084	38 Myrtle St	37.5x25.25	DS
62	SMH-000222	4,594	Middlesex St and Baldwin St	48	DS
63	SMH-002193	13,605	Tanner St and Canada St	41x28.5	US

*Meter Area excluded from I/I analysis



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PROJECT NO.	20220166.003A
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CREATED BY:	JRossini
CHECKED BY:	KGoyette
FILE NAME:	Lowell 2023_Flow_Meter.mxd

2023 I/I Analysis
Flow Meter Locations
Keyplan

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

FIGURE
4

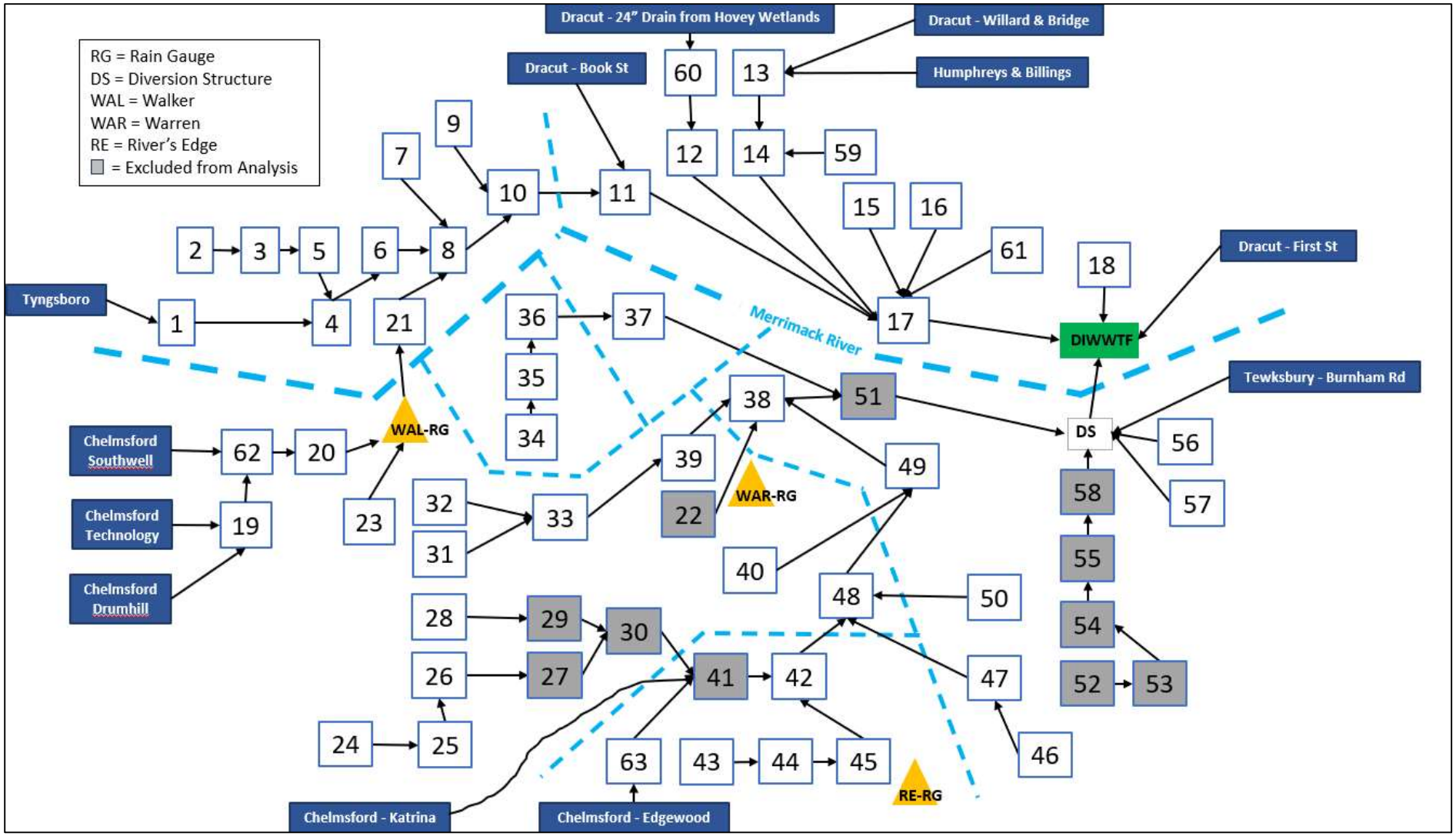


Figure 5: Flow Meter and Rain Gauge Schematic

3.2 GROUNDWATER MONITORING

As part of this flow monitoring program, ADS installed a total of one hundred and ten (110) groundwater gauges. Of which, sixty-one (61) automatic groundwater monitoring devices and forty-nine (49) manual groundwater monitoring devices (piezometers) were installed inside sewer manholes. This yielded approximately two (2) groundwater gauges per meter area, with the exception for locations in close proximity, eliminating the need for multiple groundwater gauges. Although this minor reduction in ground water gauges is a deviation from the guidelines, the Utility did not need the redundancy given the large groundwater gauge program which accurately would capture trends in each meter area as intended. The automatic gauge shared a manhole with the temporary flow meter, while the manual gauge was chosen for its proximity to surface water and ability to capture areas with measurable groundwater, considering the area's topography. The automatic gauges used were CS-4 flow sensors with pressure turned to measure the groundwater and are connected to the Triton+ flow meters. In general, groundwater gauges were installed twelve to fifteen inches above the manhole shelf. Inspection and maintenance occurred as needed when crews would perform site visits to corresponding flow meters or otherwise directed by ADS's data analyst.

Figure 6 depicts some of the groundwater gauges with the highest average groundwater depths, measured in inches above the gauge install location, that also display peak responses to the wettest portion of the program or remain consistently at a high level throughout the duration of the program. A summary of average depths for all groundwater gauges is included in **Appendix A**. **Figure 7** includes the automatic groundwater gauge locations and displays the average value throughout the metering period associated with its meter area to show relative saturation. These groundwater gauge readings confirm the metering program was conducted during a high groundwater period which, in turn, accurately represents infiltration results from the analysis. This also validates the higher groundwater portions of the City are near waterbodies and validates inspection of pipe adjacent waterbodies or cross-country easement pipe as part of future inspections. During the metering period, the highest groundwater was observed from April 23, 2023 to May 10, 2023. **Figure 8** shows the United States Geological Survey's (USGS) "Merrimack River B: Concord River at Lowell, MA – 01100000" river gauge levels from September 2021 to December 2023, with some of the highest river levels recorded in a similar period of late April/early May 2023. Historically higher levels of the Merrimack River have corresponded to higher treatment flows recorded at Duck Island. **Figure 8** also includes the comparison of Merrimack River levels with Duck Island effluent flow and illustrates the trends in WWTF flows with river levels.

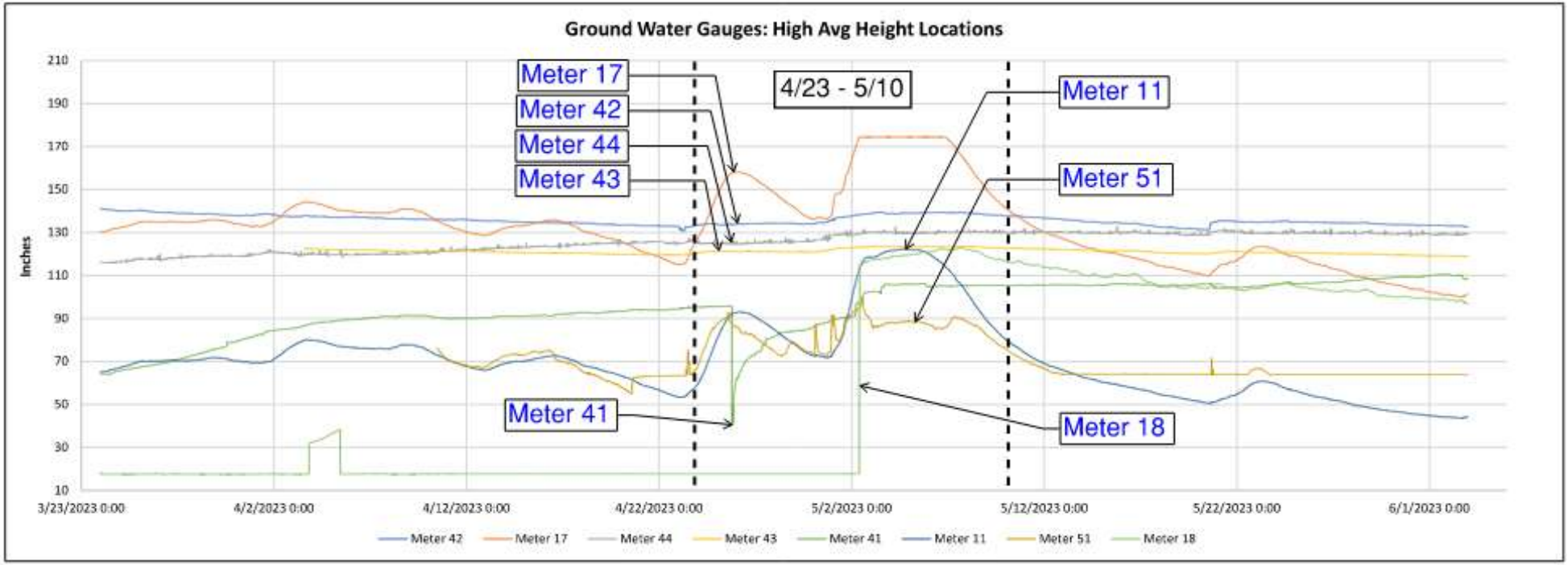
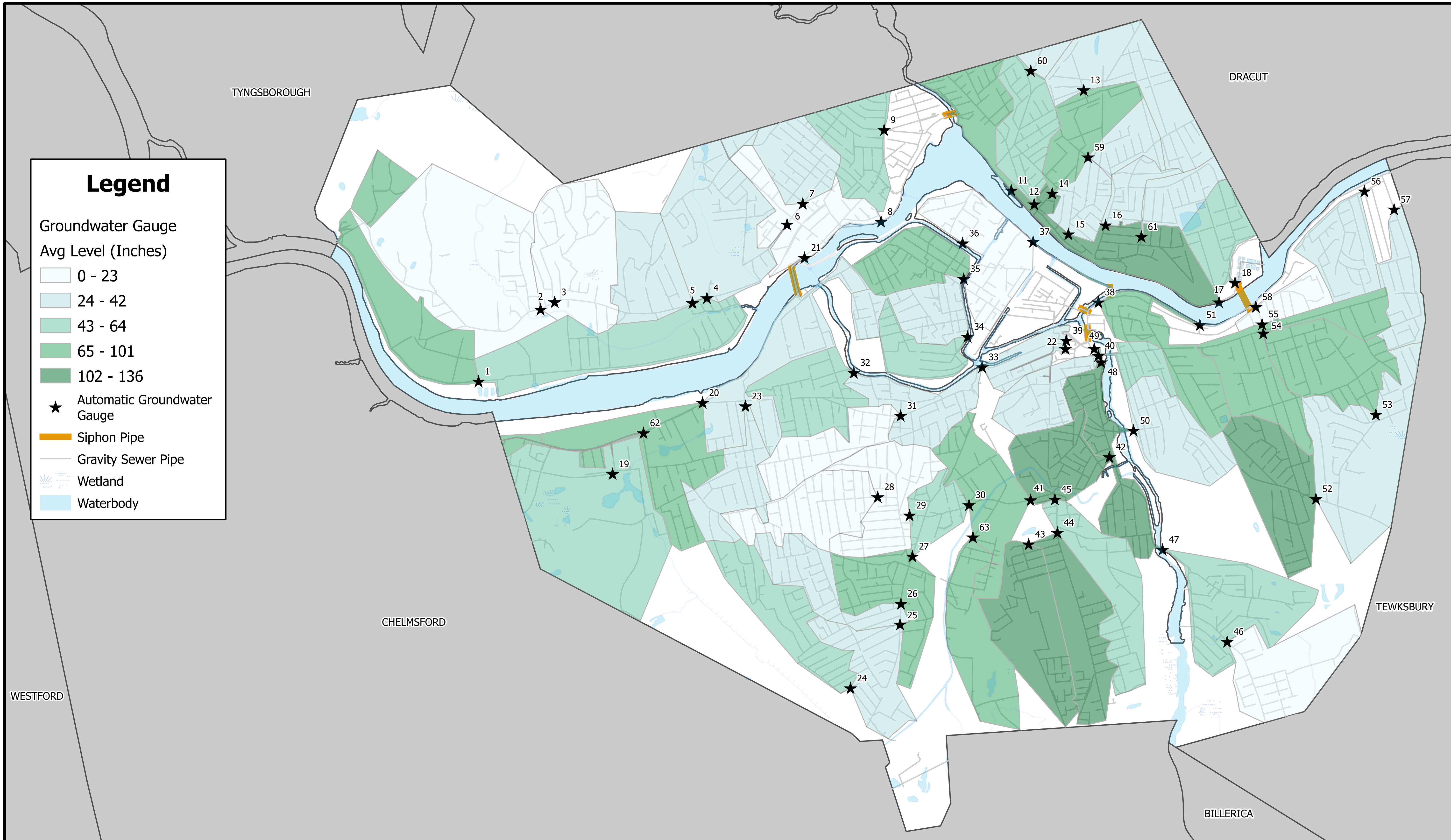


Figure 6: Highest Average Groundwater Gauge Readings (inches above gauge location)



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FILE NAME:	Lowell 2023_Flow_Meter.mxd

2023 I/I Analysis
Groundwater Gauges

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FIGURE
7

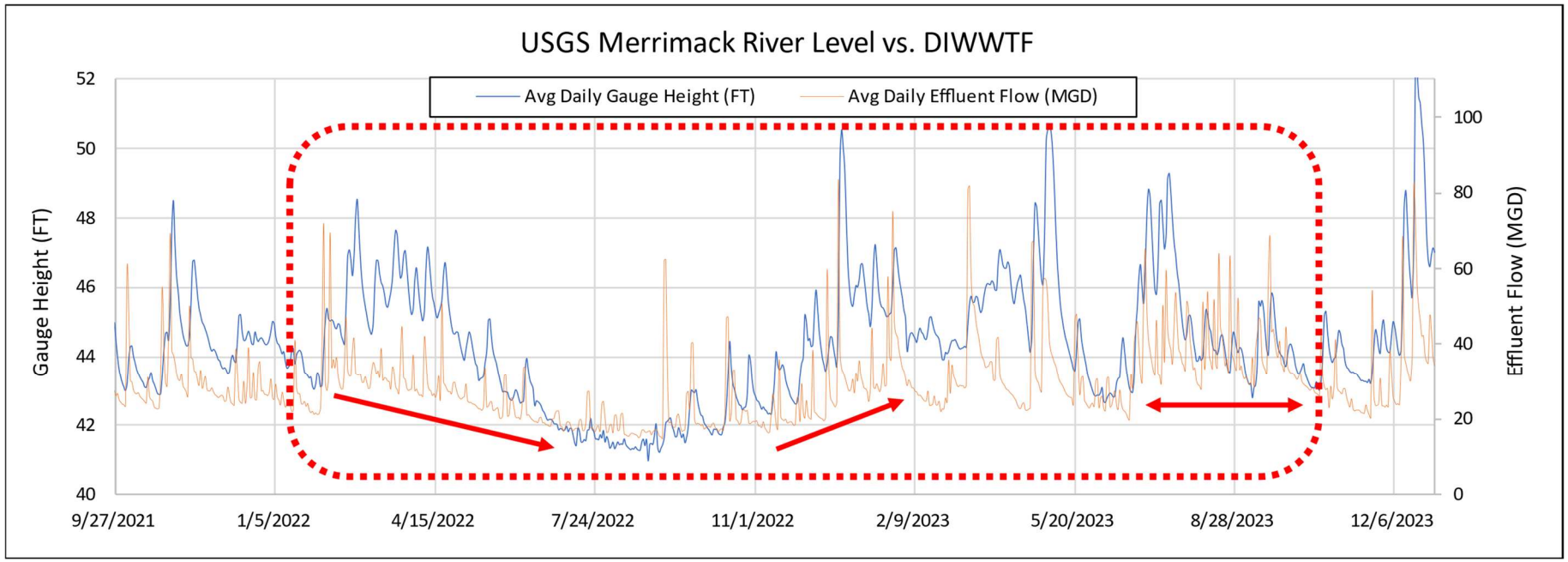


Figure 8: USGS Merrimack River Levels vs. DIWWTF Trends

3.3 RAINFALL MONITORING

The flow meter program included the installation of three (3) rain gauges evenly distributed throughout the City. The MassDEP Guidelines call for a minimum of 2 rain gauges within the study area as well as preferably one gauge located every 3 to 4 square miles. The City consists of 14.5 square miles and the flow monitoring program was designed to utilize 3 temporary rain gauges and the City's Duck Island permanent rain gauge. The gauges were installed on March 29, 2023, at the Warren Diversion Structure, Walker Diversion Structure, and River's Edge Pump Station, shown in **Figure 4** in Section 3.1. The gauges were Rain Alert III with TB-6 tipping bucket and were placed on flat surfaces clear of encroaching trees or building structures. Precipitation readings were recorded in 5-minute intervals. The Utility's rain gauge at Duck Island had minor maintenance issues during a portion of the metering period and therefore was not used for the analysis due to loss of data. Since then, the gauge has had maintenance performed to restore its typical functionality. 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 9** presents the cumulative precipitation recorded during the flow metering period for all three (3) rain gauges. During this time, frequent short duration storms were recorded digitally in 5-minute intervals and monitored weekly. Three (3) rain events that exceeded one inch of precipitation were identified during the monitoring period. Of the three storm events that exceeded one inch of precipitation, April 23rd and May 20th were selected for inflow analysis. The remaining storm selected is the May 24th storm event. Dry weather and wet weather distinctions from the average of all three rain gauges are displayed in **Table 3**.

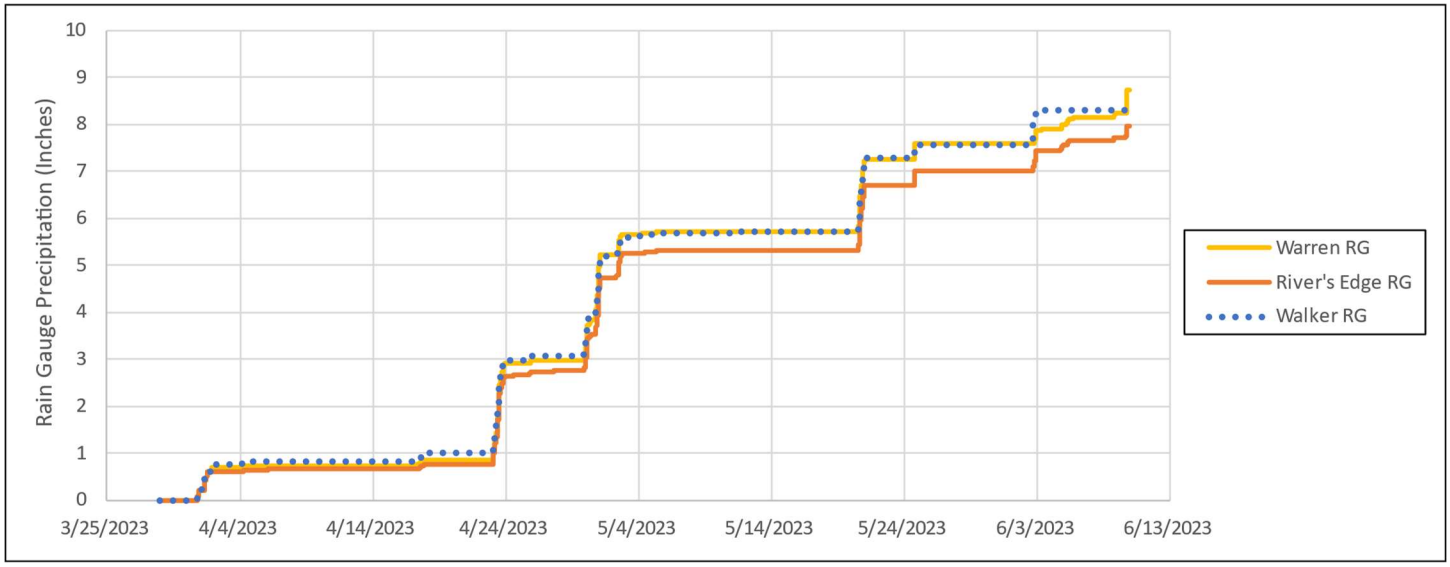


Figure 9: Rain Gauge Precipitation

Table 3: Dry and Wet Weather Periods

No.	Duration	Rain Event	Average Intensity (in/hr)	Peak Intensity (in/hr)	Sum (in)
	~2.8 days	3/30 @ 10:30 - 3/31 @ 17:00	DRY		
1	32 hr	3/31 @ 18:00 - 4/01 @ 21:00	0.02	0.13	0.69
	~2.1 days	4/0 @ 22:00 - 4/04 @ 04:00	DRY		
2	3 hr	4/04 @ 05:00 - 4/04 @ 07:00	0.01	0.02	0.04
	~12.8 days	4/04 @ 08:00 - 4/17 @ 02:00	DRY		
3	18 hr	4/17 @ 03:00 - 4/17 @ 20:00	0.01	0.06	0.13
	~5.1 days	4/17 @ 21:00 - 4/22 @ 23:00	DRY		
4	24 hr	4/23 @ 00:00 - 4/23 @ 23:00	0.08	0.32	1.98
	~1.8 days	4/24 @ 00:00 - 4/25 @ 17:00	DRY		
5	3 hr	4/25 @ 18:00 - 4/25 @ 20:00	0.02	0.05	0.06
	~3.9 days	4/25 @ 21:00 - 4/29 @ 17:00	DRY		
6	34 hr (1.4 days)	4/29 @ 18:00 - 5/01 @ 03:00	0.06	0.27	2.11
	~1.1 days	5/01 @ 04:00 - 5/02 @ 06:00	DRY		
7	12 hr	5/02 @ 07:00 - 5/02 @ 18:00	0.04	0.26	0.47
	~0.9 days	5/02 @ 19:00 - 5/03 @ 16:00	DRY		
8	44 hr (1.8 days)	5/03 @ 17:00 - 5/05 @ 09:00	0.00	0.03	0.06
	~15.0 days	5/05 @ 10:00 - 5/20 @ 11:00	DRY		
9	17 hr	5/20 @ 12:00 - 5/21 @ 04:00	0.09	0.37	1.50
	~3.5 days	5/21 @ 05:00 - 5/24 @ 16:00	DRY		
10	3 hr	5/24 @ 17:00 - 5/24 @ 19:00	0.10	0.20	0.30
	~8.8 days	5/24 @ 20:00 - 6/02 @ 15:00	DRY		
11	7 hr	6/02 @ 16:00 - 6/02 @ 22:00	0.07	0.50	0.50

4 INFILTRATION AND INFLOW ANALYSIS

This section details Kleinfelder's analysis completed to estimate I/I within the wastewater collection system, conducted in accordance with MassDEP's Guidelines.

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 10**) 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 7 antecedent dry weather. The dry weather period primarily utilized for this analysis was April 10, 2023 through April 12, 2023. In instances where the dry weather synthetic day misrepresented the overall sanitary baseflow relative to the metering period or there was poor quality data, a dry weather period of May 10, 2023, through May 12, 2023 was utilized as noted in **Table 4**. 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 10** illustrates the diurnal sanitary flow curve and the baseflow attributed to infiltration, during dry weather conditions, taken from Meter 1. The corresponding dry weather hydrograph for each metered area is included in **Appendix B**.

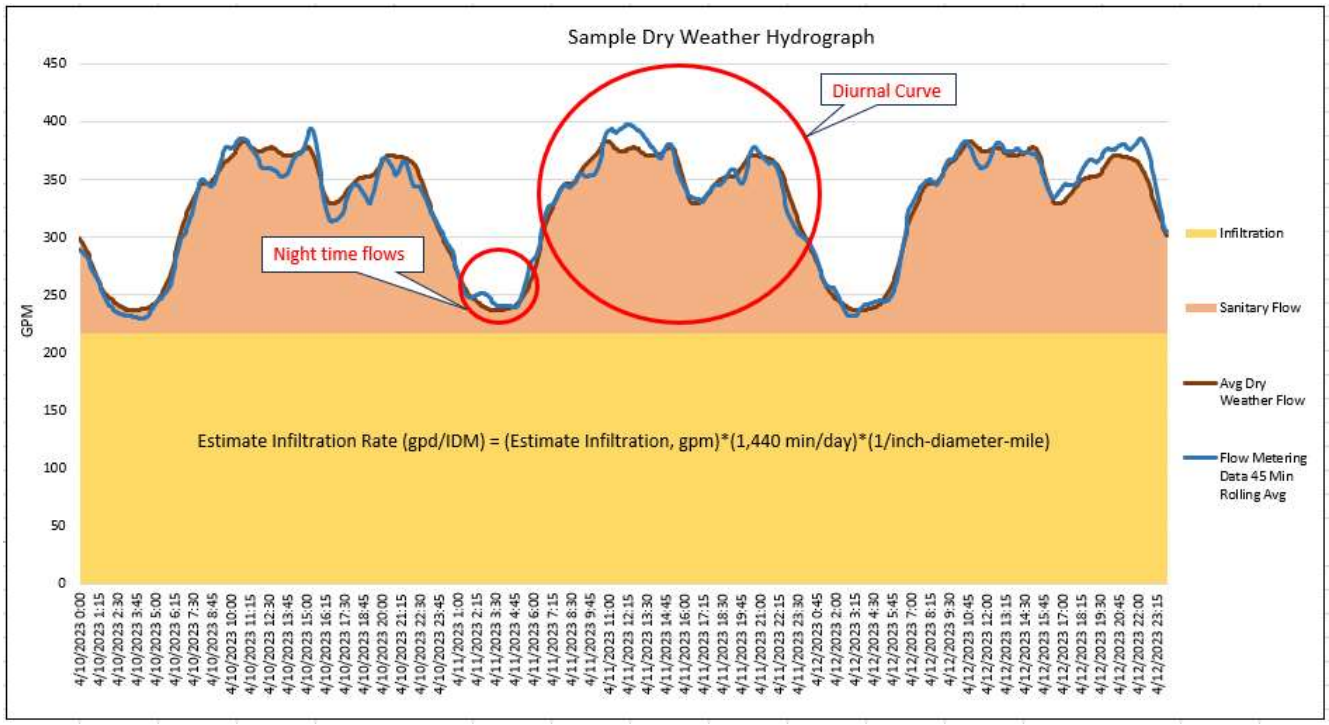


Figure 10: Sample Dry Weather Hydrograph

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.

An infiltration rate of 4,000 gpd/idm is the threshold, defined by MassDEP, for which further field investigations such as manhole inspections, flow isolation, and CCTV should be prioritized to identify infiltration sources. Per **Table 4** and **Figure 11**, twenty-four (24) of 52 metered areas analyzed exceeded the 4,000 gpd/idm threshold and require further investigation to identify infiltration sources per the MassDEP designation.

Note that Meter 42 likely displays a somewhat artificially higher infiltration than what is experienced. This is due to poor upstream data from Meter 41, however when analyzed including Meter 41 it likely underrepresents the infiltration rate given the additional pipe footage from Chelmsford's Katrina Pump Station. Meter 42 will be revisited upon further re-metering of meter area 41 in Spring 2024. Additionally, for Meter 13 where the Humphrey's and Billing's Brook contribute, the flow meter data (from LRWWU's Hach Meter Website) of the brook at Humphrey Street observed flows of 0.8 MGD during the dry weather period analyzed. This contribution would reduce the calculated infiltration rate if accounted for and likely remove Meter 13 from the above 4,000 gpd/idm threshold. Similarly, Meter 60 receives flow from the Hovey Field wetlands. I/I contributions in meter areas 13 and 60 will be addressed via the Utility's Centralville Sewer Separation Project.

Due to flow balance issues, three (3) meter areas were analyzed compositely and require the inclusion of immediate upstream tributary meter areas due to their interrelationships of flows. As noted in Section 3.1, eleven (11) meter areas were not included in the I/I analysis due to poor quality of data and are shaded in gray in **Table 4** and **Figure 11**.

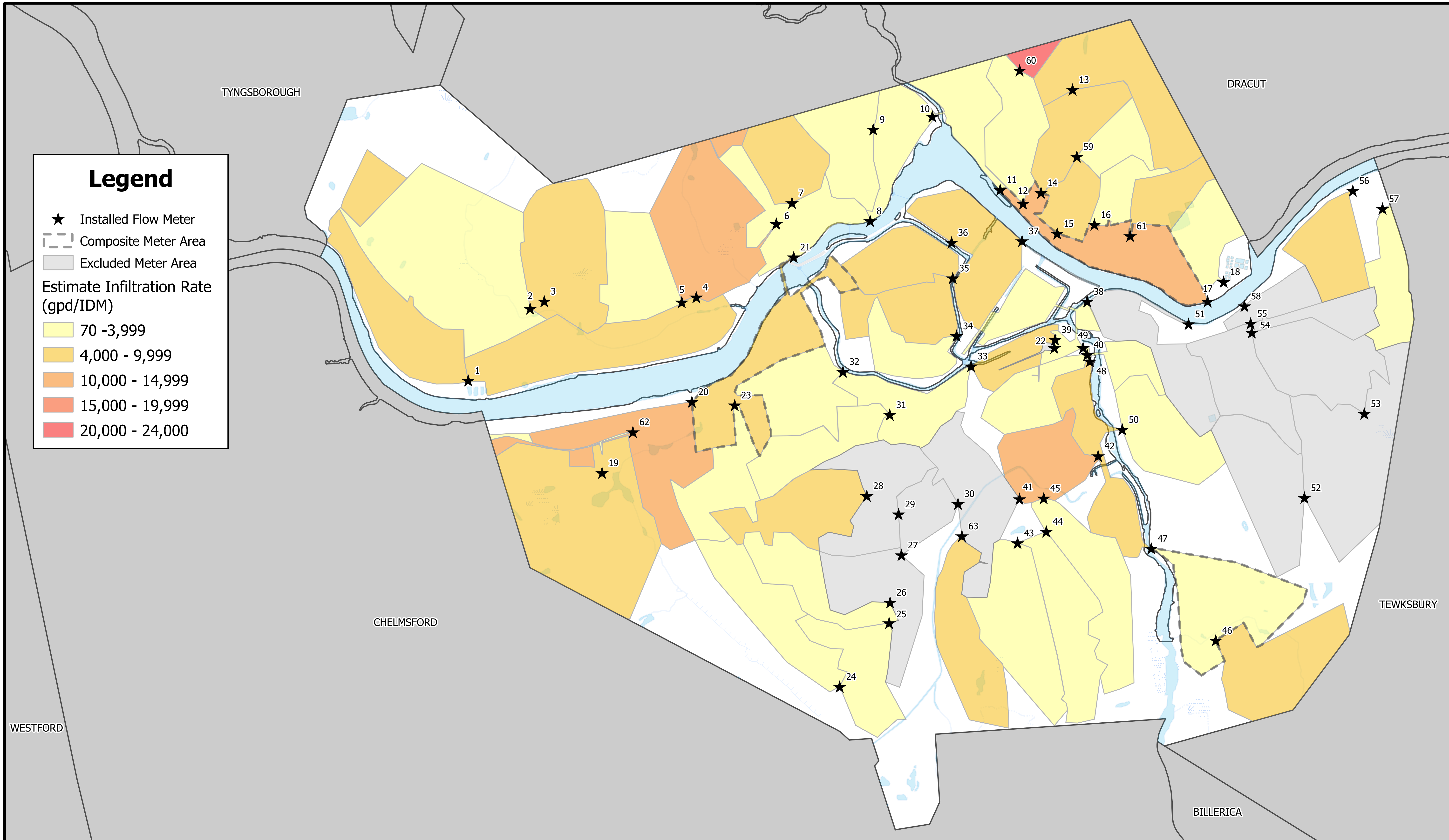
Table 4: Estimated Infiltration Rates

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
17*	Mostly Combined	111,229	483.58	4,871	14,504	Warren	4/10 to 4/12
6	Mostly Combined	24,370	65.87	603	13,192	Walker	4/10 to 4/12
42	Mostly Combined	20,148	98.26	876	12,832	Warren	4/10 to 4/12 + 5/10 to 5/12
20	Both	26,326	70.77	518	10,539	Walker	4/11 to 4/13
35	Mostly Combined	23,003	68.64	366	7,678	Warren	4/10 to 4/12
63	Fully Separated	53,607	100.76	518	7,405	Warren	4/10 to 4/12
61	Fully Combined	11,084	23.73	116	7,052	Warren	4/10 to 4/12
13	Fully Combined	28,672	84.73	411	6,986	Warren	4/10 to 4/12
1	Fully Separated	20,625	44.88	217	6,970	Walker	4/10 to 4/12
3	Mostly Separated	23,234	38.15	176	6,662	Walker	4/10 to 4/12
48	Mostly Combined	26,090	119.99	552	6,631	Warren	4/10 to 4/12
15	Fully Combined	11,190	28.37	128	6,520	Warren	4/10 to 4/12
39	Mostly Combined	10,163	37.80	163	6,223	Warren	5/10 to 5/12
21*	Both	67,815	201.95	858	6,116	Walker	4/11 to 4/13
4	Fully Separated	21,863	47.22	195	5,944	Walker	4/10 to 4/12
19	Mostly Separated	34,194	60.29	220	5,251	Walker	4/10 to 4/12
56	Mostly Combined	18,203	39.76	135	4,899	Warren	4/10 to 4/12
36	Fully Combined	21,532	65.29	219	4,821	Warren	4/10 to 4/12
46	Fully Separated	17,165	31.12	104	4,793	River's Edge	4/10 to 4/12
7	Mostly Combined	17,076	49.26	151	4,424	Walker	4/10 to 4/12
14	Fully Combined	13,905	55.35	167	4,352	Warren	4/10 to 4/12
37	Both	23,360	100.40	297	4,259	Warren	5/10 to 5/12
28	Both	25,490	71.42	202	4,071	Walker	4/10 to 4/12
59	Fully Combined	9,507	24.58	60	3,514	Warren	4/10 to 4/12
23	Mostly Combined	16,116	36.51	86	3,378	Walker	4/10 to 4/12
45	Both	20,367	76.23	177	3,338	Warren	4/10 to 4/12
24	Fully Separated	21,933	36.02	83	3,321	Walker	4/10 to 4/12
44	Mostly Separated	18,806	51.04	113	3,190	River's Edge	5/10 to 5/12
12	Fully Combined	21,915	63.08	135	3,093	Warren	4/10 to 4/12
18	Fully Combined	12,216	29.51	63	3,088	Warren	5/10 to 5/12
9	Mostly Separated	20,943	49.47	102	2,967	Walker	5/10 to 5/12
8	Mostly Combined	24,940	93.45	186	2,865	Walker	4/10 to 4/12
50	Mostly Combined	20,654	54.95	107	2,811	Warren	4/10 to 4/12
11	Mostly Combined	17,039	90.13	144	2,306	Warren	4/10 to 4/12
57	Fully Combined	13,685	34.30	49	2,061	Warren	4/10 to 4/12

Meter	Type	Pipe Length (LF)	IDM	Estimate Infiltration (gpm)	Estimate Infiltration Rate (gpd/IDM)	Rain Gauge	DW Day Used
32	Mostly Combined	18,028	59.86	80	1,922	Walker	5/10 to 5/12
34	Fully Combined	11,989	39.97	51	1,841	Warren	4/10 to 4/12
25	Mostly Separated	20,172	47.37	54	1,648	Warren	4/13 14:00 to 4/15 13:55
43	Fully Separated	20,902	57.04	62	1,571	River's Edge	5/10 to 5/12
47*	Both	42,485	87.91	88	1,434	River's Edge	4/10 to 4/12
2	Mostly Separated	22,790	38.93	38	1,412	Walker	5/10 to 5/12
First St	–	111,107	208.87	169	1,165	Warren	4/14 to 4/16
40	Mostly Combined	14,472	51.48	41	1,147	Warren	4/10 to 4/12
33	Mostly Combined	19,708	63.38	47	1,077	Warren	4/10 to 4/12
5	Fully Separated	13,693	26.80	20	1,059	Walker	4/10 to 4/12
16	Fully Combined	8,915	22.02	16	1,039	Warren	4/10 to 4/12
Burnham Rd	–	824,213	1600.01	796	716	Warren	4/10 to 4/12
38	Mostly Combined	22,148	87.67	41	672	Warren	4/10 to 4/12
26	Both	20,550	52.60	22	594	Warren	4/13 14:00 to 4/15 13:55
49	Mostly Combined	9,632	35.02	10	411	Warren	5/10 to 5/12
31	Mostly Combined	17,549	49.22	10	302	Walker	4/10 to 4/12
10	Fully Separated	17,707	92.73	13	207	Walker	4/10 to 4/12
62	Both	240,601	411.05	20	70	Walker	4/10 to 4/12
52	Mostly Combined	24,794	51.33			River's Edge	
55	Fully Combined	21,531	62.71			Warren	
30*	Both	57,888	183.43			Warren/Walker	
27	Mostly Separated	24,076	64.53			Warren	
54	Fully Combined	22,349	69.59			Warren	
53	Both	24,932	68.04			Warren	
41	Fully Separated	643,810	1101.29			Warren	
51	Mostly Combined	24,514	138.59			Warren	
22	Fully Combined	1,757	5.51			Warren	
29	Mostly Combined	22,654	69.86			Walker	
58	Fully Combined	8,041	22.64			Warren	

*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 were not analyzed



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CREATED:	1/31/2024
CREATED BY:	JRossini
CHECKED BY:	KGoyette
FILE NAME:	Lowell 2023_Flow_Meter.mxd

2023 I/I Analysis
Infiltration Rates

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

FIGURE
11

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 ten (10) week flow metering analysis, there were a variety of storms and dry weather periods that occurred, as shown in **Table 3** 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 summarized in **Table 5** 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 5: Selected Storm Events

Storm No.	Duration (hrs)	Rain Event (Start – Finish)	Avg Intensity (in/hr)	Peak Intensity (in/hr)	Sum (inches)
1	24	4/23 @ 00:00 – 4/23 @ 23:00	0.08	0.32	1.98
2	17	5/20 @ 12:00 – 5/21 @ 04:00	0.09	0.37	1.50
3	3	5/24 @ 17:00 – 5/24 @ 19:00	0.10	0.20	0.30

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. Where dry weather conditions had increased baseflows in May, a dry weather period of May 10, 2023 to May 12, 2023 was utilized rather than April data to remain proportional to the timeframe as not to exaggerate the wet weather volumes experienced during the storm.

The hydrograph depicted in **Figure 12** was taken from Meter 6 and was selected to illustrate the sanitary curve and the system's response to the storm event. The wet weather hydrographs for each metered area are included in **Appendix C**. Design Storm inflows are estimated from a "best fit" curve 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 6** reports the inflow volume for each of the three storm events analyzed and the corresponding inflow volume for the Design Storm. **Table 6** also breaks down the Design storm inflow volume by direct and delayed (or indirect) contributions.

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 11, has a D/I ration less than 1.0, indicating a higher delayed inflow volume versus the direct inflow volume. Given the proximity of Meter area 11 to the Merrimack River and Beaver Brook, it is possible that there are defects in the pipes and manholes that contribute significant RII with the increase in both groundwater and river/brook levels. Following the MassDEP Guidelines, metered areas that account for 80% of the total inflow of the system should be further investigated. Nineteen meter areas (17, 13, 21, 37, 49, 11, 38, 36, 12, 45, 60, 34, 42, 40, 10, 33,

15, 48, and 57) account for 80% total of the inflow identified within the 52 metered areas analyzed, depicted in **Table 6** and **Figure 13**. Meter areas ranked by volume of direct inflow can be found in **Table 7.** Meter areas ranked by volume of delayed inflow are included in **Table 8**. As noted in Section 3.1, eleven (11) meter areas were not included in the I/I analysis due to poor quality of data and are shaded in gray in **Tables 6, 7, and 8** and **Figure 13**.

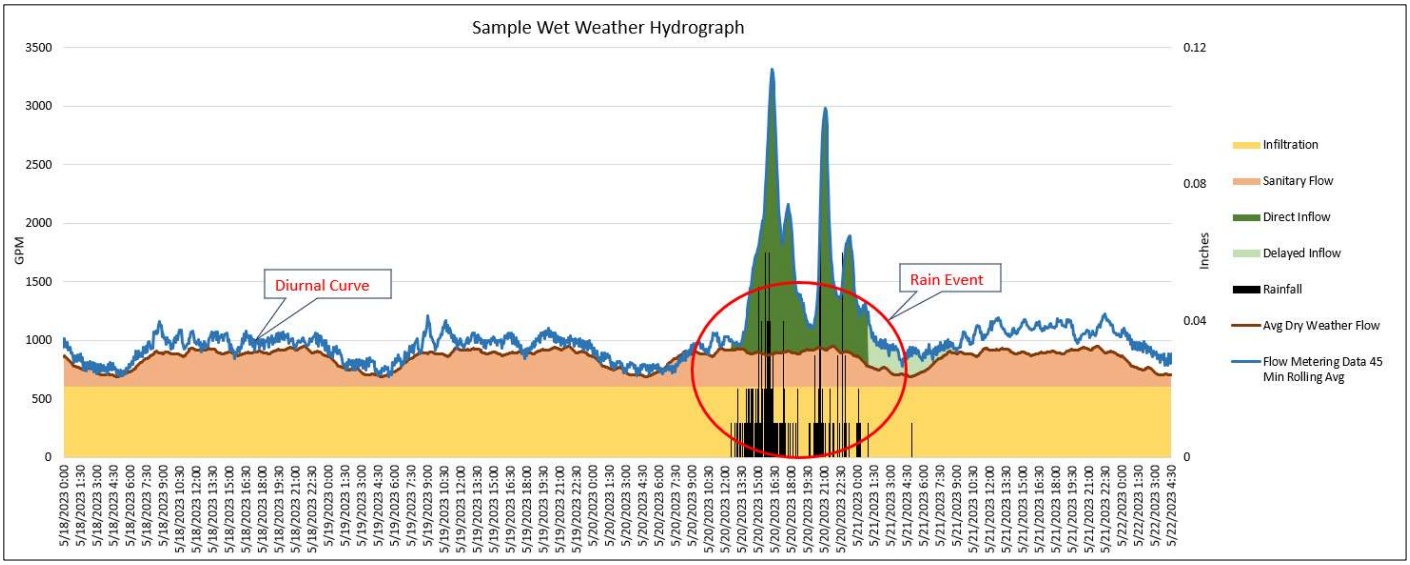

Figure 12: Sample Wet Weather Hydrograph

Table 6: Inflow Summary

		Storm Event Volume (MG)				Design Storm				
Meter	Type	23-Apr	20-May	24-May	[1]Design Storm Inflow (gal)	D/I Ratio (avg)	Delayed Inflow (gal)	Direct Inflow (gal)	Percent Inflow	Percent Cumulative Inflow
17*	Mostly Combined	19.161	12.375	2.057	15,202,908	2.88	3,918,275	11,284,633	26.76%	26.76%
13	Fully Combined	7.284	3.604	0.484	5,325,120	1.53	2,100,984	3,224,136	9.37%	36.14%
21*	Mostly Combined	3.386	2.514	0.429	2,852,620	9.77	264,828	2,587,792	5.02%	41.16%
37	Both	4.101	0.444	0.121	2,368,440	9.02	236,337	2,132,103	4.17%	45.33%
49	Mostly Combined	4.125	0.069	0.003	2,225,680	5.51	341,886	1,883,794	3.92%	49.25%
11	Mostly Combined	2.900	1.322	0.334	2,088,596	0.65	1,266,499	822,097	3.68%	52.92%
38	Mostly Combined	1.605	2.401	0.393	1,823,200	167.90	10,795	1,812,405	3.21%	56.13%
36	Fully Combined	[2]N/A	1.509	0.253	1,697,640	16.04	99,645	1,597,995	2.99%	59.12%
12	Fully Combined	1.956	1.553	0.282	1,670,808	144.14	11,512	1,659,296	2.94%	62.06%
45	Both	1.572	1.071	0.170	1,269,360	4.33	237,941	1,031,419	2.23%	64.30%
60	Mostly Combined	1.608	0.827	0.094	1,186,800	1.34	506,975	679,825	2.09%	66.39%
34	Fully Combined	1.390	1.004	0.193	1,147,240	16.14	66,919	1,080,321	2.02%	68.41%
42	Mostly Combined	1.696	0.537	0.126	1,123,160	8.54	117,793	1,005,367	1.98%	70.38%
40	Mostly Combined	1.317	1.019	0.166	1,112,324	19.75	53,606	1,058,718	1.96%	72.34%
10	Fully Separated	1.110	1.047	0.030	1,020,476	3.50	226,888	793,588	1.80%	74.14%
33	Mostly Combined	1.198	0.943	0.176	1,019,960	95.49	10,571	1,009,389	1.80%	75.93%
15	Fully Combined	1.031	0.720	0.118	839,876	30.47	26,687	813,189	1.48%	77.41%
48	Mostly Combined	0.602	1.051	0.253	751,640	10.38	66,039	685,601	1.32%	78.74%
57	Fully Combined	1.298	0.144	0.008	748,200	259.95	2,867	745,333	1.32%	80.05%
14	Fully Combined	0.716	0.886	0.185	742,352	2.40	218,034	524,318	1.31%	81.36%
7	Mostly Combined	0.916	0.591	0.097	733,580	382.94	1,911	731,669	1.29%	82.65%
6	Mostly Combined	0.816	0.676	0.114	717,584	7.28	86,677	630,907	1.26%	83.91%
8	Mostly Combined	0.710	0.789	0.136	710,876	23.34	29,210	681,666	1.25%	85.17%
35	Mostly Combined	0.839	0.605	0.088	689,720	26.41	25,164	664,556	1.21%	86.38%
50	Mostly Combined	0.850	0.548	0.095	674,240	13.77	45,657	628,583	1.19%	87.57%
28	Both	0.780	0.513	0.103	629,864	113.71	5,491	624,373	1.11%	88.68%
56	Mostly Combined	0.791	0.506	0.089	626,080	294.90	2,116	623,964	1.10%	89.78%
32	Mostly Combined	0.626	0.536	0.100	560,720	304.71	1,834	558,886	0.99%	90.76%
39	Mostly Combined	0.482	0.672	0.091	526,320	1.83	186,018	340,302	0.93%	91.69%
59	Fully Combined	0.550	0.385	0.096	450,640	40.57	10,839	439,801	0.79%	92.48%
9	Mostly Separated	0.635	0.205	0.040	422,776	130.88	3,206	419,570	0.74%	93.23%
62	Both	0.487	0.361	0.068	411,080	16.78	23,125	387,955	0.72%	93.95%
23	Mostly Combined	0.454	0.336	0.059	381,840	246.81	1,541	380,299	0.67%	94.62%
47*	Both	0.381	0.248	0.025	330,240	3.31	76,642	253,598	0.58%	95.21%
16	Fully Combined	0.370	0.279	0.067	311,320	39,234.87	8	311,312	0.55%	95.75%
19	Mostly Separated	0.349	0.163	0.030	252,840	5.06	41,689	211,151	0.45%	96.20%
44	Mostly Separated	0.278	0.203	0.034	251,120	18,577.27	14	251,106	0.44%	96.64%

Meter	Type	23-Apr	20-May	24-May	[1]Design Storm Inflow (gal)	D/I Ratio (avg)	Delayed Inflow (gal)	Direct Inflow (gal)	Percent Inflow	Percent Cumulative Inflow
61	Fully Combined	0.311	0.197	0.000	245,960	2.43	71,807	174,153	0.43%	97.07%
20	Both	0.335	0.156	0.028	242,348	2.26	74,338	168,010	0.43%	97.50%
18	Fully Combined	[2]N/A	0.203	0.038	229,276	15.76	13,677	215,599	0.40%	97.90%
26	Both	0.256	0.229	0.034	228,416	17,097.67	13	228,403	0.40%	98.31%
31	Mostly Combined	0.288	0.161	0.025	220,848	70.05	3,109	217,739	0.39%	98.70%
63	Fully Separated	0.206	0.085	0.031	146,200	9.02	14,590	131,610	0.26%	98.95%
2	Mostly Separated	0.162	0.128	0.040	141,556	4.97	23,699	117,857	0.25%	99.20%
46	Fully Separated	0.122	0.084	0.014	108,360	8,161.33	13	108,347	0.19%	99.39%
3	Mostly Separated	0.157	0.014	0.003	88,752	0.63	54,542	34,210	0.16%	99.55%
25	Mostly Separated	0.093	0.086	0.013	84,280	6,225.43	14	84,266	0.15%	99.70%
5	Fully Separated	0.074	0.048	0.006	59,168	8,531.60	7	59,161	0.10%	99.80%
24	Fully Separated	0.051	0.066	0.002	54,180	0.72	31,591	22,589	0.10%	99.90%
4	Fully Separated	0.058	0.013	0.047	38,872	0.43	27,140	11,732	0.07%	99.97%
1	Fully Separated	0.015	0.008	0.004	11,180	8.46	1,182	9,998	0.02%	99.98%
43	Fully Separated	0.009	0.006	0.002	8,600	38.92	215	8,385	0.02%	100.00%
First St		0.096	0.042	0.008	68,800	1.89	23,806	44,994		
Burnham Rd		0.454	1.111	0.143	686,280	0.87	366,995	319,285		
22	Fully Combined									
27	Mostly Separated									
29	Mostly Combined									
30*	Fully Separated									
41	Fully Separated									
51	Mostly Combined									
52	Mostly Combined									
53	Both									
54	Fully Combined									
55	Fully Combined									
58	Fully Combined									

[1]Using Assumed Design Storm of 1.72

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

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

Grayed out meters are values not analyzed or are not within the City's jurisdiction (First St, Burnahm Rd)

Table 7: Direct Inflow Ranking

		Storm Event Volume (MG)				Design Storm		
Meter	Type	23-Apr	20-May	24-May	[1]Design Storm Inflow (gal)	D/I Ratio (avg)	Delayed Inflow (gal)	Direct Inflow (gal)
17*	Mostly Combined	19.161	12.375	2.057	15,202,908	2.88	3,918,275	11,284,633
13	Fully Combined	7.284	3.604	0.484	5,325,120	1.53	2,100,984	3,224,136
21*	Mostly Combined	3.386	2.514	0.429	2,852,620	9.77	264,828	2,587,792
37	Both	4.101	0.444	0.121	2,368,440	9.02	236,337	2,132,103
49	Mostly Combined	4.125	0.069	0.003	2,225,680	5.51	341,886	1,883,794
38	Mostly Combined	1.605	2.401	0.393	1,823,200	167.90	10,795	1,812,405
12	Fully Combined	1.956	1.553	0.282	1,670,808	144.14	11,512	1,659,296
36	Fully Combined	[2]N/A	1.509	0.253	1,697,640	16.04	99,645	1,597,995
34	Fully Combined	1.390	1.004	0.193	1,147,240	16.14	66,919	1,080,321
40	Mostly Combined	1.317	1.019	0.166	1,112,324	19.75	53,606	1,058,718
45	Both	1.572	1.071	0.170	1,269,360	4.33	237,941	1,031,419
33	Mostly Combined	1.198	0.943	0.176	1,019,960	95.49	10,571	1,009,389
42	Mostly Combined	1.696	0.537	0.126	1,123,160	8.54	117,793	1,005,367
11	Mostly Combined	2.900	1.322	0.334	2,088,596	0.65	1,266,499	822,097
15	Fully Combined	1.031	0.720	0.118	839,876	30.47	26,687	813,189
10	Fully Separated	1.110	1.047	0.030	1,020,476	3.50	226,888	793,588
57	Fully Combined	1.298	0.144	0.008	748,200	259.95	2,867	745,333
7	Mostly Combined	0.916	0.591	0.097	733,580	382.94	1,911	731,669
48	Mostly Combined	0.602	1.051	0.253	751,640	10.38	66,039	685,601
8	Mostly Combined	0.710	0.789	0.136	710,876	23.34	29,210	681,666
60	Mostly Combined	1.608	0.827	0.094	1,186,800	1.34	506,975	679,825
35	Mostly Combined	0.839	0.605	0.088	689,720	26.41	25,164	664,556
6	Mostly Combined	0.816	0.676	0.114	717,584	7.28	86,677	630,907
50	Mostly Combined	0.850	0.548	0.095	674,240	13.77	45,657	628,583
28	Both	0.780	0.513	0.103	629,864	113.71	5,491	624,373
56	Mostly Combined	0.791	0.506	0.089	626,080	294.90	2,116	623,964
32	Mostly Combined	0.626	0.536	0.100	560,720	304.71	1,834	558,886
14	Fully Combined	0.716	0.886	0.185	742,352	2.40	218,034	524,318
59	Fully Combined	0.550	0.385	0.096	450,640	40.57	10,839	439,801
9	Mostly Separated	0.635	0.205	0.040	422,776	130.88	3,206	419,570
62	Both	0.487	0.361	0.068	411,080	16.78	23,125	387,955
23	Mostly Combined	0.454	0.336	0.059	381,840	246.81	1,541	380,299
39	Mostly Combined	0.482	0.672	0.091	526,320	1.83	186,018	340,302
16	Fully Combined	0.370	0.279	0.067	311,320	39,234.87	8	311,312
47*	Both	0.381	0.248	0.025	330,240	3.31	76,642	253,598
44	Mostly Separated	0.278	0.203	0.034	251,120	18,577.27	14	251,106

Meter	Type	23-Apr	20-May	24-May	[1]Design Storm Inflow (gal)	D/I Ratio (avg)	Delayed Inflow (gal)	Direct Inflow (gal)
26	Both	0.256	0.229	0.034	228,416	17,097.67	13	228,403
31	Mostly Combined	0.288	0.161	0.025	220,848	70.05	3,109	217,739
18	Fully Combined	[2]N/A	0.203	0.038	229,276	15.76	13,677	215,599
19	Mostly Separated	0.349	0.163	0.030	252,840	5.06	41,689	211,151
61	Fully Combined	0.311	0.197	0.000	245,960	2.43	71,807	174,153
20	Both	0.335	0.156	0.028	242,348	2.26	74,338	168,010
63	Fully Separated	0.206	0.085	0.031	146,200	9.02	14,590	131,610
2	Mostly Separated	0.162	0.128	0.040	141,556	4.97	23,699	117,857
46	Fully Separated	0.122	0.084	0.014	108,360	8,161.33	13	108,347
25	Mostly Separated	0.093	0.086	0.013	84,280	6,225.43	14	84,266
5	Fully Separated	0.074	0.048	0.006	59,168	8,531.60	7	59,161
3	Mostly Separated	0.157	0.014	0.003	88,752	0.63	54,542	34,210
24	Fully Separated	0.051	0.066	0.002	54,180	0.72	31,591	22,589
4	Fully Separated	0.058	0.013	0.047	38,872	0.43	27,140	11,732
1	Fully Separated	0.015	0.008	0.004	11,180	8.46	1,182	9,998
43	Fully Separated	0.009	0.006	0.002	8,600	38.92	215	8,385
First St		0.096	0.042	0.008	68,800	1.89	23,806	44,994
Burnham Rd		0.454	1.111	0.143	686,280	0.87	366,995	319,285
22	Fully Combined							
27	Mostly Separated							
29	Mostly Combined							
30*	Fully Separated							
41	Fully Separated							
51	Mostly Combined							
52	Mostly Combined							
53	Both							
54	Fully Combined							
55	Fully Combined							
58	Fully Combined							

[1]Using Assumed Design Storm of 1.72

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

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

Grayed out meters are values not analyzed or are not within the City's jurisdiction (First St, Burnahm Rd)

Table 8: Delayed Inflow Ranking

		Storm Event Volume (MG)				Design Storm		
Meter	Type	23-Apr	20-May	24-May	[1]Design Storm Inflow (gal)	D/I Ratio (avg)	Delayed Inflow (gal)	Direct Inflow (gal)
17*	Mostly Combined	19.161	12.375	2.057	15,202,908	2.88	3,918,275	11,284,633
13	Fully Combined	7.284	3.604	0.484	5,325,120	1.53	2,100,984	3,224,136
11	Mostly Combined	2.900	1.322	0.334	2,088,596	0.65	1,266,499	822,097
60	Mostly Combined	1.608	0.827	0.094	1,186,800	1.34	506,975	679,825
49	Mostly Combined	4.125	0.069	0.003	2,225,680	5.51	341,886	1,883,794
21*	Mostly Combined	3.386	2.514	0.429	2,852,620	9.77	264,828	2,587,792
45	Both	1.572	1.071	0.170	1,269,360	4.33	237,941	1,031,419
37	Both	4.101	0.444	0.121	2,368,440	9.02	236,337	2,132,103
10	Fully Separated	1.110	1.047	0.030	1,020,476	3.50	226,888	793,588
14	Fully Combined	0.716	0.886	0.185	742,352	2.40	218,034	524,318
39	Mostly Combined	0.482	0.672	0.091	526,320	1.83	186,018	340,302
42	Mostly Combined	1.696	0.537	0.126	1,123,160	8.54	117,793	1,005,367
36	Fully Combined	[2]N/A	1.509	0.253	1,697,640	16.04	99,645	1,597,995
6	Mostly Combined	0.816	0.676	0.114	717,584	7.28	86,677	630,907
47*	Both	0.381	0.248	0.025	330,240	3.31	76,642	253,598
20	Both	0.335	0.156	0.028	242,348	2.26	74,338	168,010
61	Fully Combined	0.311	0.197	0.000	245,960	2.43	71,807	174,153
34	Fully Combined	1.390	1.004	0.193	1,147,240	16.14	66,919	1,080,321
48	Mostly Combined	0.602	1.051	0.253	751,640	10.38	66,039	685,601
3	Mostly Separated	0.157	0.014	0.003	88,752	0.63	54,542	34,210
40	Mostly Combined	1.317	1.019	0.166	1,112,324	19.75	53,606	1,058,718
50	Mostly Combined	0.850	0.548	0.095	674,240	13.77	45,657	628,583
19	Mostly Separated	0.349	0.163	0.030	252,840	5.06	41,689	211,151
24	Fully Separated	0.051	0.066	0.002	54,180	0.72	31,591	22,589
8	Mostly Combined	0.710	0.789	0.136	710,876	23.34	29,210	681,666
4	Fully Separated	0.058	0.013	0.047	38,872	0.43	27,140	11,732
15	Fully Combined	1.031	0.720	0.118	839,876	30.47	26,687	813,189
35	Mostly Combined	0.839	0.605	0.088	689,720	26.41	25,164	664,556
2	Mostly Separated	0.162	0.128	0.040	141,556	4.97	23,699	117,857
62	Both	0.487	0.361	0.068	411,080	16.78	23,125	387,955
63	Fully Separated	0.206	0.085	0.031	146,200	9.02	14,590	131,610
18	Fully Combined	[2]N/A	0.203	0.038	229,276	15.76	13,677	215,599
12	Fully Combined	1.956	1.553	0.282	1,670,808	144.14	11,512	1,659,296
59	Fully Combined	0.550	0.385	0.096	450,640	40.57	10,839	439,801
38	Mostly Combined	1.605	2.401	0.393	1,823,200	167.90	10,795	1,812,405
33	Mostly Combined	1.198	0.943	0.176	1,019,960	95.49	10,571	1,009,389

Meter	Type	23-Apr	20-May	24-May	[1]Design Storm Inflow (gal)	D/I Ratio (avg)	Delayed Inflow (gal)	Direct Inflow (gal)
28	Both	0.780	0.513	0.103	629,864	113.71	5,491	624,373
9	Mostly Separated	0.635	0.205	0.040	422,776	130.88	3,206	419,570
31	Mostly Combined	0.288	0.161	0.025	220,848	70.05	3,109	217,739
57	Fully Combined	1.298	0.144	0.008	748,200	259.95	2,867	745,333
56	Mostly Combined	0.791	0.506	0.089	626,080	294.90	2,116	623,964
7	Mostly Combined	0.916	0.591	0.097	733,580	382.94	1,911	731,669
32	Mostly Combined	0.626	0.536	0.100	560,720	304.71	1,834	558,886
23	Mostly Combined	0.454	0.336	0.059	381,840	246.81	1,541	380,299
1	Fully Separated	0.015	0.008	0.004	11,180	8.46	1,182	9,998
43	Fully Separated	0.009	0.006	0.002	8,600	38.92	215	8,385
25	Mostly Separated	0.093	0.086	0.013	84,280	6,225.43	14	84,266
44	Mostly Separated	0.278	0.203	0.034	251,120	18,577.27	14	251,106
26	Both	0.256	0.229	0.034	228,416	17,097.67	13	228,403
46	Fully Separated	0.122	0.084	0.014	108,360	8,161.33	13	108,347
16	Fully Combined	0.370	0.279	0.067	311,320	39,234.87	8	311,312
5	Fully Separated	0.074	0.048	0.006	59,168	8,531.60	7	59,161
First St		0.096	0.042	0.008	68,800	1.89	23,806	44,994
Burnham Rd		0.454	1.111	0.143	686,280	0.87	366,995	319,285
22	Fully Combined							
27	Mostly Separated							
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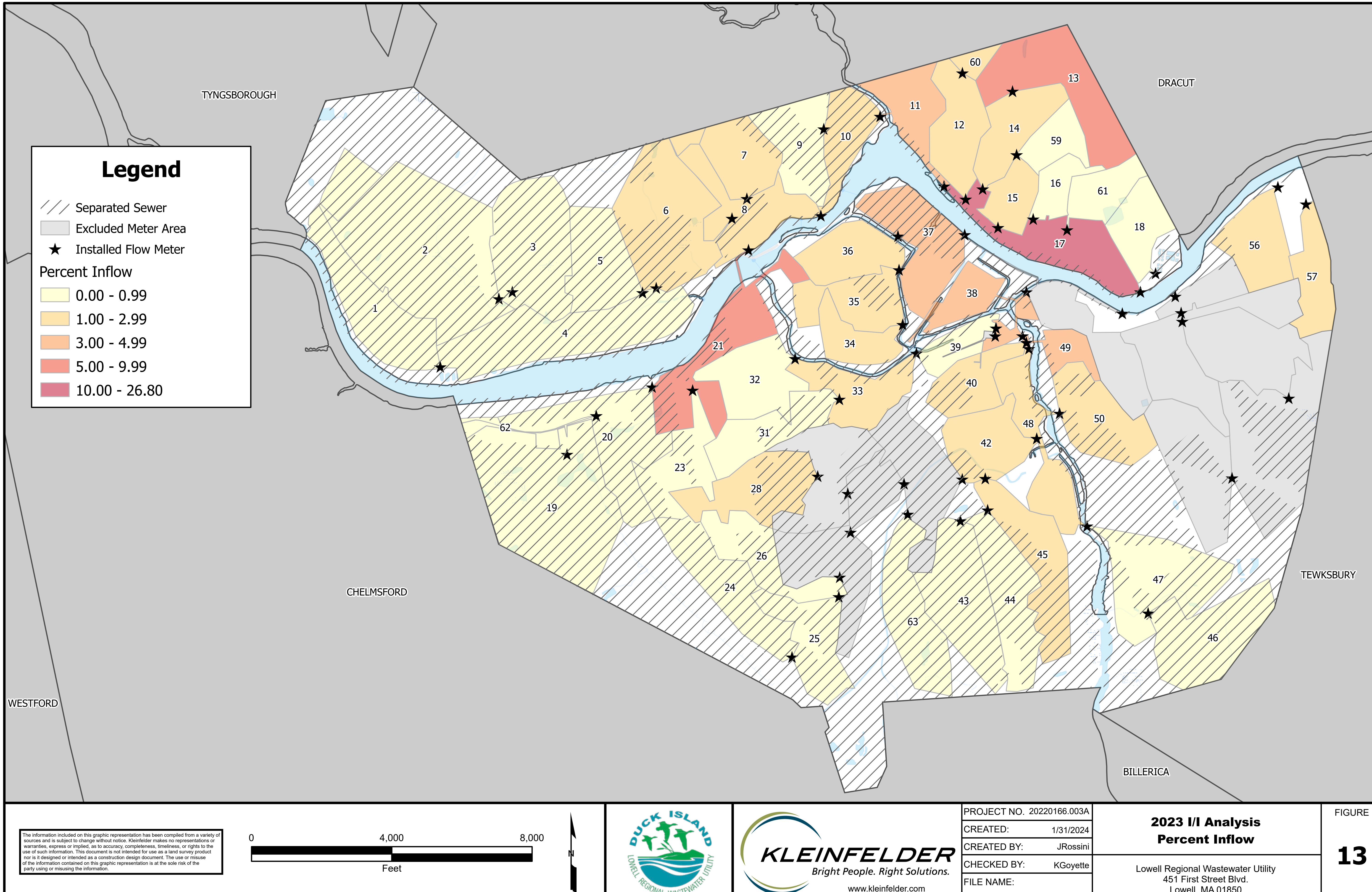
30*	Fully Separated							
41	Fully Separated							
51	Mostly Combined							
52	Mostly Combined							
53	Both							
54	Fully Combined							
55	Fully Combined							
58	Fully Combined							

[1]Using Assumed Design Storm of 1.72

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

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

Grayed out meters are values not analyzed or are not within the City's jurisdiction (First St, Burnahm Rd)



Date: 1/31/2024 User: JRossini Path: \\azrgisstorp01\GIS_Projects\Client\MA_Lowell\20220166.003_Consent_Decree_Compliance\MXD\Lowell 2023_Flow_Meter\Lowell 2023_Flow_Meter.aprx

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2023 I/I Analysis
Percent Inflow

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

FIGURE
13

4.3 ASSESSMENT OF SSO RISK

314 CMR12.04 requires all sewer system authorities to assess the risk of sanitary sewer overflows (SSOs) from a five-year, 24-hour storm event, defined with a total depth of 4.61 inches, a peak intensity of 0.73 inch/hour, and an average intensity of 0.19 inches/hour. The 2022 I/I Abatement Plan identified 17 SSOs at 6 locations between 2016 to 2021. The Kleinfelder 2023 Illicit Discharge Detection and Elimination (IDDE) Program outlines 2020 to 2023 SSOs and inventories 50 SSOs in 2023, shown in **Appendix F**.

CDM provided a GIS shape file of 27 unique SSO locations that occurred in 2023, as displayed and categorized by root cause in **Figure 14**. These 25 locations that were caused by rain events are majority located in areas that are incorporated into the SSES Plan, Interceptor Inspections, ADS Re-Meter Areas, or addressed through Centralville or Tilden Sewer Separation Areas.

CDM Smith is currently working with the City to update and calibrate the City's existing sewer system model based on the 2023 metering data in support of CSO planning efforts. Once the model calibration is finalized, it will be used to predict areas at risk of SSOs events under the five-year storm event. These results will be reported as a supplemental memorandum to the I/I Analysis Report.

Legend

- Gravity Pipe
- Siphon Pipe
- Installed Meter Area

SSO Cause

- Grease blockage (2 Locations)
- Rain Event (25 Locations)

TYNGSBOROUGH
DRACUT
CHELMSFORD
WESTFORD
TEWKSBURY
BILLERICA
FIRST ST

0 4,000 8,000
Feet

N

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PROJECT NO.	20220166.003A
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CREATED BY:	JRossini
CHECKED BY:	KGoyette
FILE NAME:	Lowell 2023_Flow_Meter.mxd

2023 I/I Analysis
SSOs

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

FIGURE
14

5 CONCLUSIONS AND RECOMMENDATIONS

The following sections summarize the conclusions and recommendations from the 2023 City-wide flow monitoring program.

5.1 SANITARY SEWER EVALUATION SURVEYS (SSES)

As detailed in the MassDEP Guidelines, upon conclusion of the flow monitoring program a Sanitary System Evaluation Survey (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.

Meter areas where infiltration or inflow was found to be excessive during the I/I analysis are to be included in the SSES implementation plan. 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. Twenty-four (24) of 52 metered areas analyzed exceeded the 4,000 gpd/idm threshold and require further investigation to identify infiltration sources per the MassDEP designation as detailed in **Table 4** and **Figure 11** in Section 4.1.2.

Four of the 24 meter areas identified for further infiltration investigations (13, 14, 15, and 60) are included in the scope of the Utility's *December 2023 Centralville Sewer Separation Preliminary Design Report (Humphrey's Brook PDR),* which will reduce infiltration sources for these areas. Two additional high-infiltration meter areas (35 and 36) are within the Tilden CSO area included in the Utility's Phase 3 CSO Preliminary Design Report and Sewer Separation Implementation Schedule, to be completed by December 31, 2024 in accordance with the 2023 Draft Consent Decree. I/I sources in the Centralville and Tilden areas will be investigated through these CSO planning efforts and are excluded from the SSES Implementation Plan. The SSES Implementation Plan will include field investigations to identify sources of infiltration for the remaining eighteen meter areas.

Inflow investigations such as smoke testing, building inspections, and dye testing should be prioritized for the meter areas which account for not less than 80% of the total system inflow volume. Nineteen (19) metered areas account for 80% of the total inflow identified within the 52 metered areas analyzed as depicted in **Table 6** and **Figure 13** in Section 4.2.1. Volumes of direct and delayed inflow should be

examined for each meter. Smoke testing, building inspections, and dye tests are successful tools for investigating direct public and private direct inflow sources in separated sewer areas. Building inspections may also identify sump pumps discharging to the sanitary sewer, a significant source of delayed inflow along with RII. Potential sources of RII are best identified through manhole and CCTV inspections as they are typically structural in nature.

The majority of the nineteen (19) meter areas that contribute 80% of the inflow are combined sewer catchments, with exception of meter area 10 which is assumed to be fully separated and meter areas 37 and 45 which are partially separated. Of the 19 high-inflow meter areas, three areas (13, 15, 60) are located within the scope of the Utility's December 2023 Centralville Sewer Separation Preliminary Design Report (Humphrey's Brook PDR), which will reduce inflow sources for these areas. It is anticipated that several of the high-inflow areas may be included within the Phase 3 CSO report and inflow sources will be addressed through those efforts. To that end, inflow investigations for only the 3 separated/partially-separated meter areas will be included in the SSES Implementation Plan at this time. Infiltration investigations are included for 8 of the 19 high-inflow meter areas under the SSES Implementation Plan. Manhole inspections will identify potential inflow sources from manhole covers and frames and both manhole and CCTV inspections will identify structural defects that may also contribute to RII during high groundwater and rainfall periods. It is recommended that the Kleinfelder and CDM Smith consultant teams continue to collaborate on the City's sewer system improvement efforts to address the various CSO, I/I, and CMOM goals.

Meter areas that experience wet-weather SSO events should also be investigated for inflow sources to determine if peak inflow rates are contributing to the SSO events in the system by reducing the capacity of the local sewers. The majority of 2023 SSOs caused by rain events, shown in **Figure 14**, are located in areas slated for future inspection of sewer separation, as noted in Section 4.3. Similarly, the conductance survey results mentioned in Section 2.3.5 will continue to be used as a tool throughout the SSES phases to refine our approach of field investigations.

In review of the areas identified with excessive infiltration and inflow, Kleinfelder recommends an eight-phase SSES Implementation Plan, detailed below in **Table 9**. **Table 9** 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. The associated costs for the SSES implementation plan are detailed in **Table 10**. **Figure 15** shows the meter areas identified for each SSES phase. The Centralville and Tilden future sewer separation areas referenced above are also identified in **Figure 15**.

In accordance with the 2023 Draft Consent Decree, the Utility shall complete an Updated Long-Term CSO Control Plan (Updated LTCP) by September 2034. The 8-phase SSES Implementation Plan proposes SSES investigations through 2032 and construction through 2034. At that time, an overall system assessment is anticipated to begin in support of the Updated LTCP and future I/I identification and removal efforts will be developed in coordination with the Updated LTCP.

Phase 1 of the SSES Implementation Plan focuses on completion 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). In Spring 2023, the Utility completed CCTV of 31,500 feet of 8-inch to 36-inch diameter sewer and 220 manhole inspections in meter areas 51, 38, and 37, along with cleaning and inspection of the East Merrimack siphon. **Appendix E** includes a summary of the sewer, manhole, and siphon inspections, documents structural condition and operation and maintenance issues, and provides recommendations for rehabilitation. SSES Phase 1 incudes CCTV inspection of approximately 24,000 feet of sewer and fifty manhole inspections within these 3 subareas.

In addition to CCTV and manhole inspections within the downtown area, SSES Phase 1 also includes multi-sensor inspection (Digital CCTV and Sonar) of the Utility's river-front interceptor pipe, approximately 47,000 LF of sewer ranging in size from 36 to 120-inch in diameter as shown in **Figure 15**. These critical assets are located within ten of the meter areas identified with either high infiltration, high inflow, or both. This includes meter areas 17 and 11, which as noted in Section 4 and shown in **Figure 13**, exhibited some of the highest delayed inflow volumes, possibly indicating the presence of system defects that allow for RII to enter the system with elevated groundwater and river levels. Historically the Utility has also observed the increase in flows at the WWTF with the increase in the Merrimack River level.

The Utility will also prioritize inspections of the remaining 5 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 infiltration and inflow through this I/I analysis.

Table 9: Proposed 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	M38, M51, M37	24,000	50	-	-	-	-	-
2024	1	Interceptor	47,000	150	-	-	-	-	-
2026	2	M6, M39, M22, M37[1]	36,300	150	-	36,300	23,400	40	20
2027	3	M42, M48, M10[1]	46,300	280	-	46,300	17,800	220	40
2028	4	M45	20,400	130	Walker	20,400	20,400	300	50
2029	5	M20, M21	51,700	250	Beaver Brook	51,700	-	-	-
2030	6	M63, M19	34,000	170	Merrimack River	34,000	-	-	-
2031	7	M1, M3	43,900	250	Warren	43,900	-	-	-
2032	8	M4, M7, M61	50,100	270	Concord River	50,100	-	-	-
	TOTAL		**385,200**	**1,920**	**6**	**282,700**	**61,600**	**560**	**110**

**Phase 0 field inspections completed in 2023*

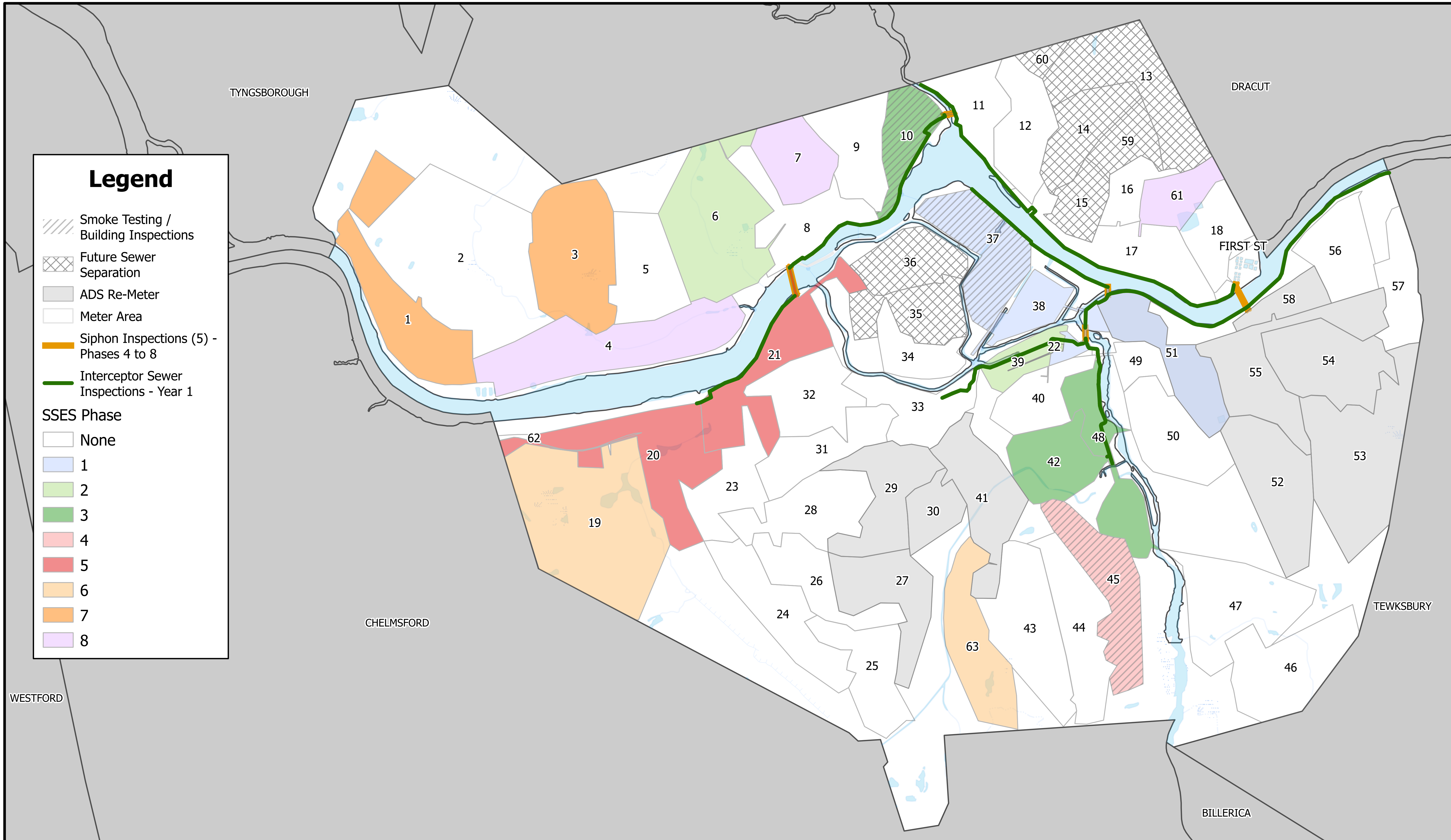
[1] Inflow investigations only (smoke testing, building inspections, dye testing)

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

Table 10: Cost Estimate for Proposed 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	M38, M51, M37	M6, M39, M22, M37[1]	M42, M48, M10[1]	M45	M20, M21	M63, M19	M1, M3	M4, M7, M61
CCTV Inspections	$62,000	$200,000	$250,000	$110,000	$280,000	$180,000	$240,000	$270,000
MH Inspections	$6,000	$13,000	$23,000	$12,000	$21,000	$15,000	$21,000	$22,000
Interceptor Inspections	$383,000	$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	$17,000	$21,000	$10,000	$23,000	$16,000	$20,000	$22,000
Smoke testing	$0	$12,000	$9,000	$10,000	$0	$0	$0	$0
Building Inspections	$0	$14,000	$55,000	$75,000	$0	$0	$0	$0
Dye Testing	$0	$6,000	$11,000	$14,000	$0	$0	$0	$0
Engineering	$150,000	$100,000	$150,000	$100,000	$150,000	$100,000	$150,000	$150,000
Subtotal	***$601,000***	***$362,000***	***$519,000***	***$435,000***	***$515,000***	***$424,000***	***$499,000***	***$505,000***
Contingency 10%	*$61,000*	*$37,000*	*$52,000*	*$44,000*	*$52,000*	*$43,000*	*$50,000*	*$51,000*
Escalation 4%	*$0*	*$33,000*	*$72,000*	*$82,000*	*$123,000*	*$124,000*	*$174,000*	*$205,000*
TOTAL	**$662,000**	**$432,000**	**$643,000**	**$561,000**	**$690,000**	**$591,000**	**$723,000**	**$761,000**

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



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2023 I/I Analysis
SSES Plan
Keyplan

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

FIGURE
15

The SSES report for each phase will include a summary of field investigations completed and recommendations for sewer system rehabilitation and repair. Design and construction costs and associated schedule for implementation of SSES recommendations will be provided. Per MassDEP Guidelines, recommendations shall also include a post-construction flow monitoring program to document the effectiveness of the I/I removal work. The implementation schedule shown in **Figure 16** 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. It is anticipated that multiple design and construction contracts will be required to address system deficiencies identified through SSES Phase 1 investigations in meter areas 51, 38, and 37 and the inspections of the river-front interceptors. Therefore, field investigations in support of SSES Phase 2 are currently scheduled to begin in FY26.

As noted in Section 3, a supplemental memorandum to this I/I Analysis Report will be prepared to summarize the I/I analysis of 10 meter areas where meters will be re-installed in Spring 2024. Eleven (11) meter areas were not included in the I/I analysis due to poor quality of data. Meter Areas 27, 29, 30, 41, 51, 52, 53, 54, 55, and 58 shown in **Figure 15** will be re-metered in Spring 2024 by ADS to determine infiltration and inflow volumes within these meter areas. Meter Area 22, containing 1,800 LF of sewer will be included within Phase 2 of the SSES Implementation Plan shown in **Table 9** and **Figure 15.** It is important to note that meter areas 27, 29, 30, 41, 52 and 53 are also partially or fully separated. Excessive inflow volumes in these areas will warrant additional inflow investigations to identify and remove inflow sources in these fully/partially separated areas.

As discussed in Section 4.3, the assessment of SSO risk in the sewer system will be evaluated using the City's hydraulic model once the model calibration efforts have been completed. These results will also be included in the supplemental memorandum noted above.

Based on the findings of the additional I/I and SSO analyses, along with the results of the Phase 1 SSES river-front interceptor inspections, the future I/I Analysis Supplemental Memorandum will reassess the proposed I/I Implementation Plan provided in **Figure 16.** These additional system evaluations and field investigations may shift the priority areas for future SSES phases as currently planned for the Utility to identify and remove excessive volumes of I/I within the collection system.

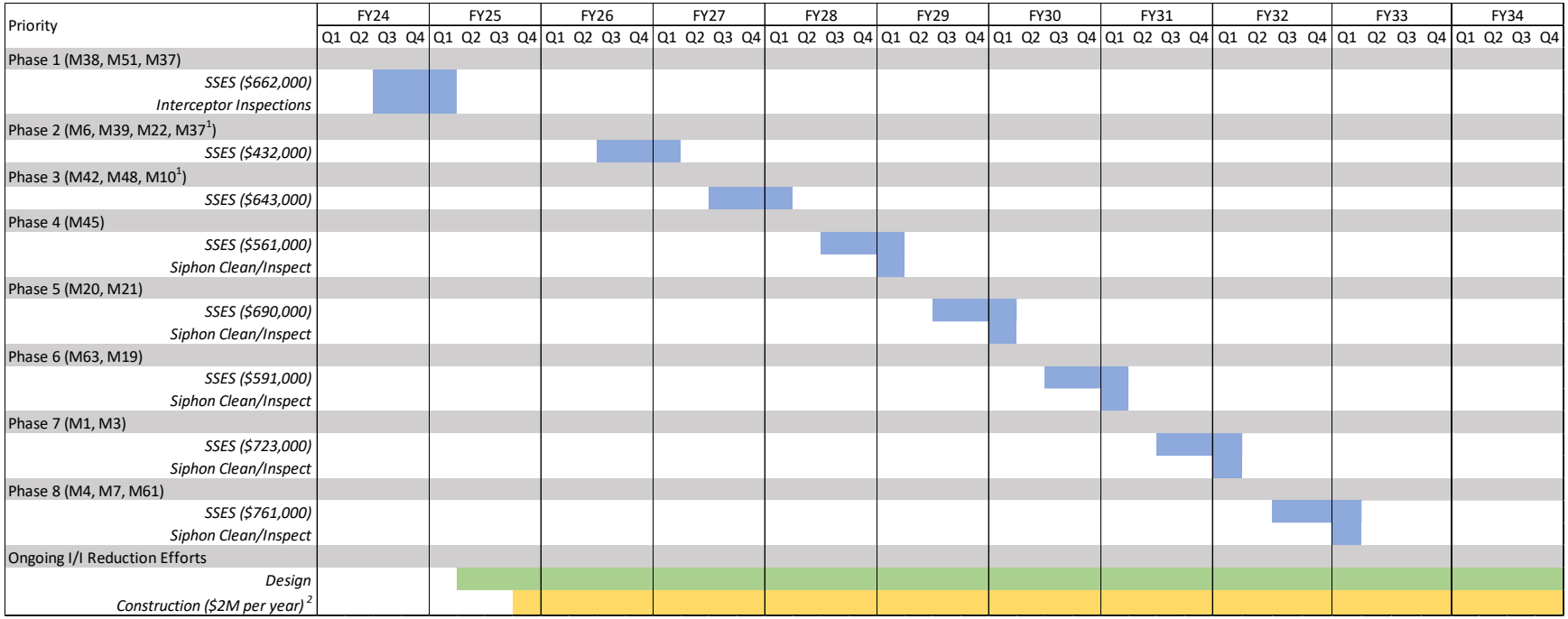


Figure 16: Infiltration/Inflow Implementation Schedule

Fiscal years begin on July 1st and end on June 30th the following year.

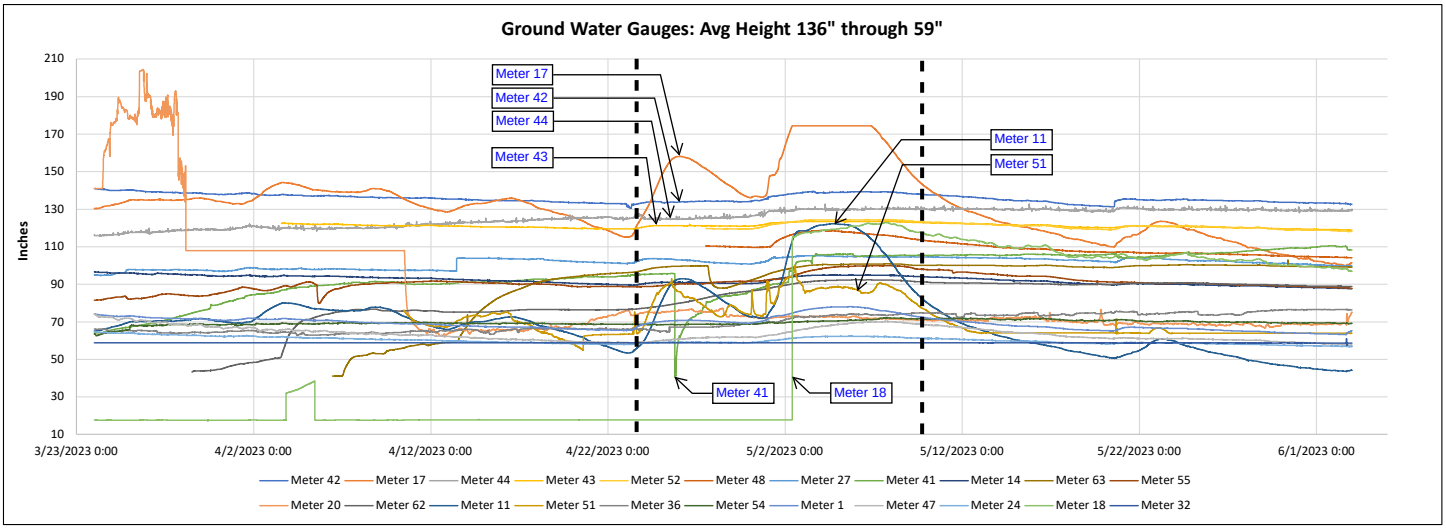
Priority meter areas included in SSES Phases 2 through 8 to be re-evaluated with results of Spring 2024 metering, SSO risk analysis, and results of interceptor inspections.

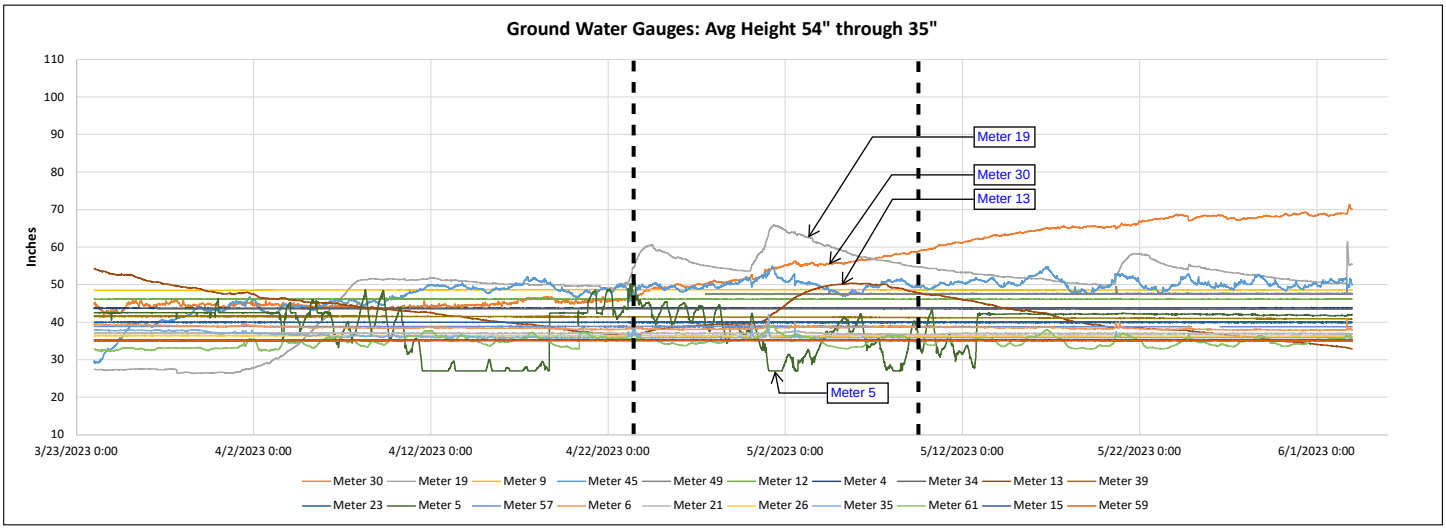
[1] Inflow investigations only (smoke testing, building inspections, dye testing).

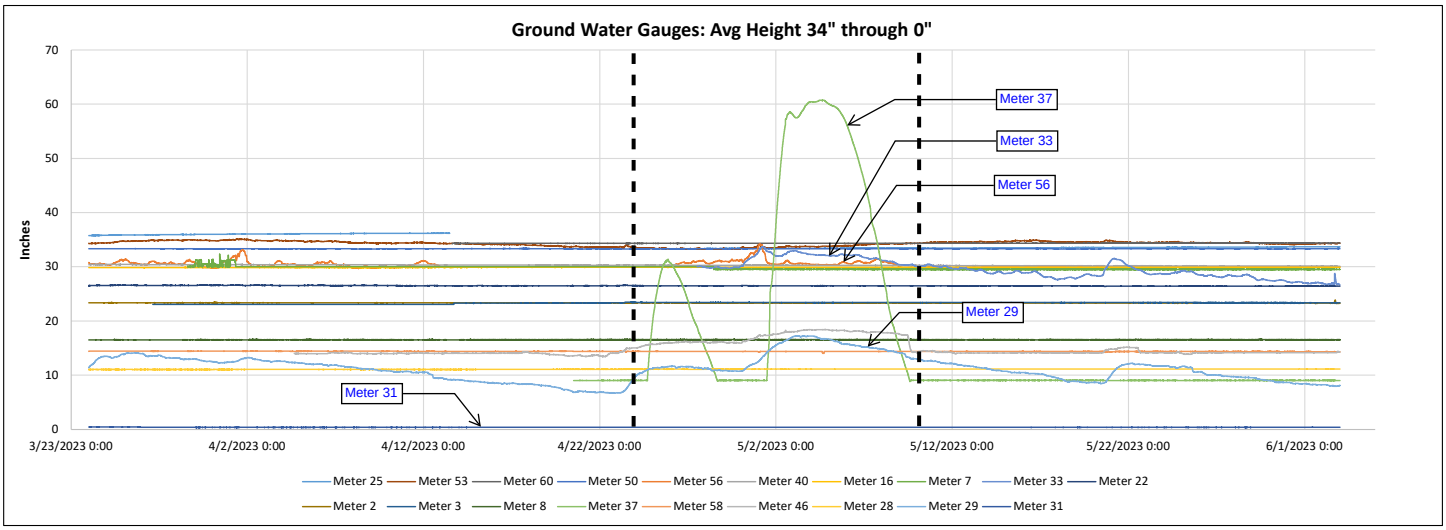
[2] Includes post-construction flow monitoring.

APPENDIX A - GROUNDWATER GAUGE HYDROGRAPHS

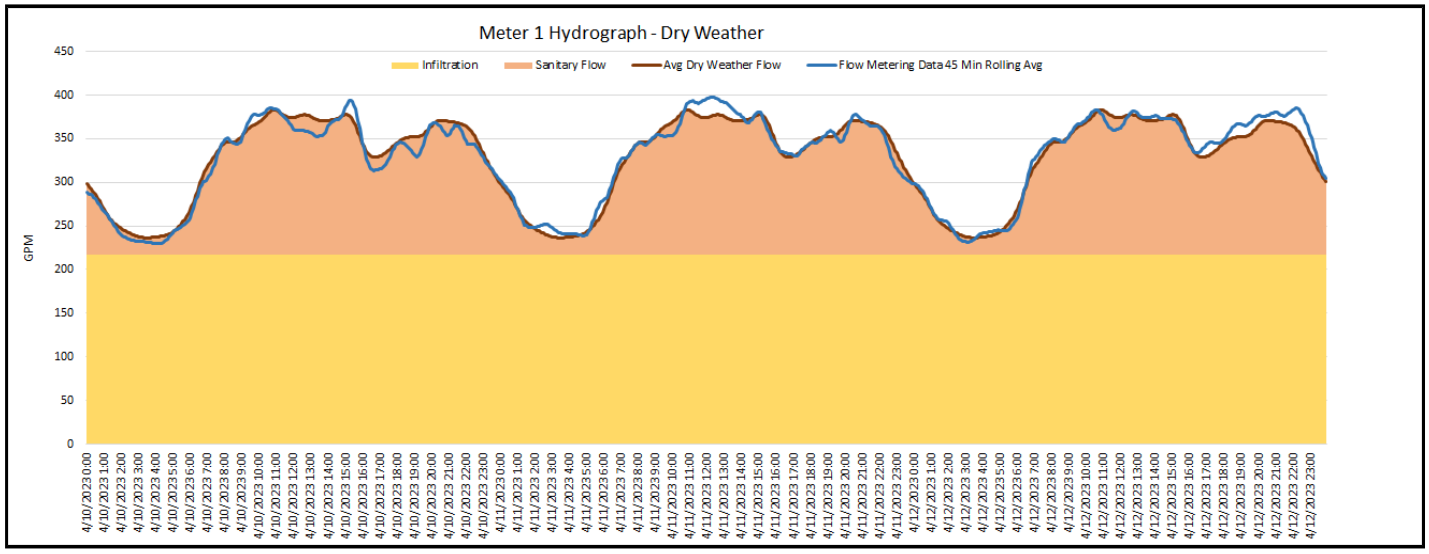
2023 I/I Study: Groundwater Gauges







APPENDIX B - DRY WEATHER HYDROGRAPHS


Meter 1 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
0
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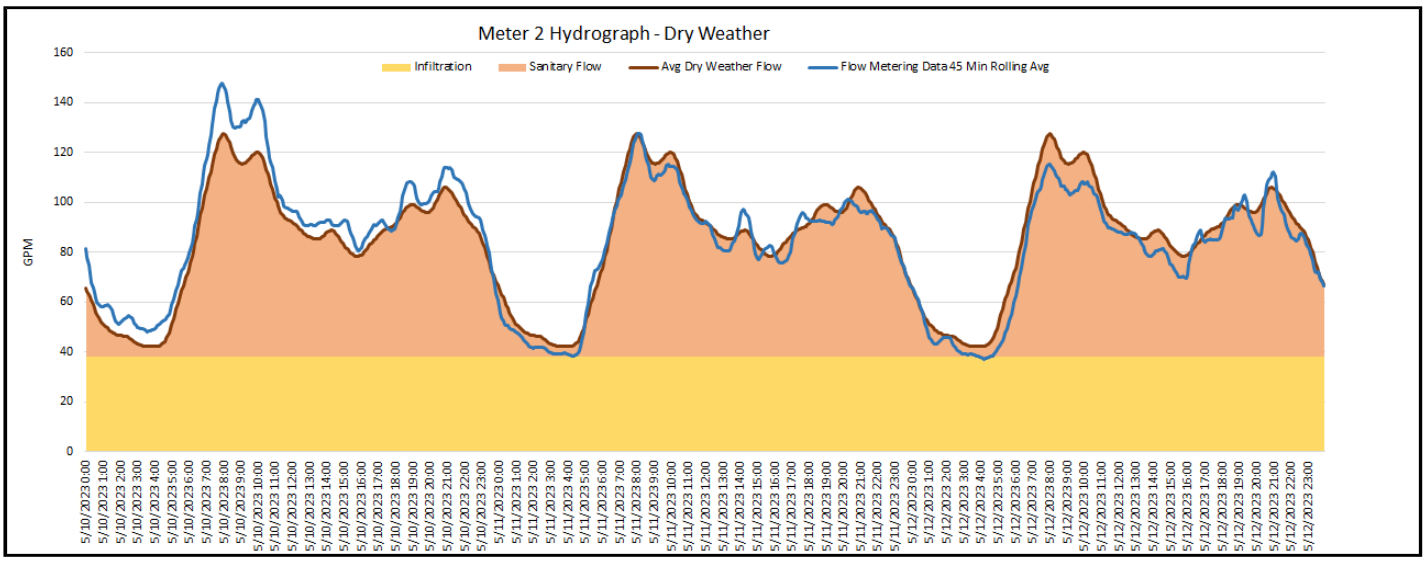
Meter 2 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
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80
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120
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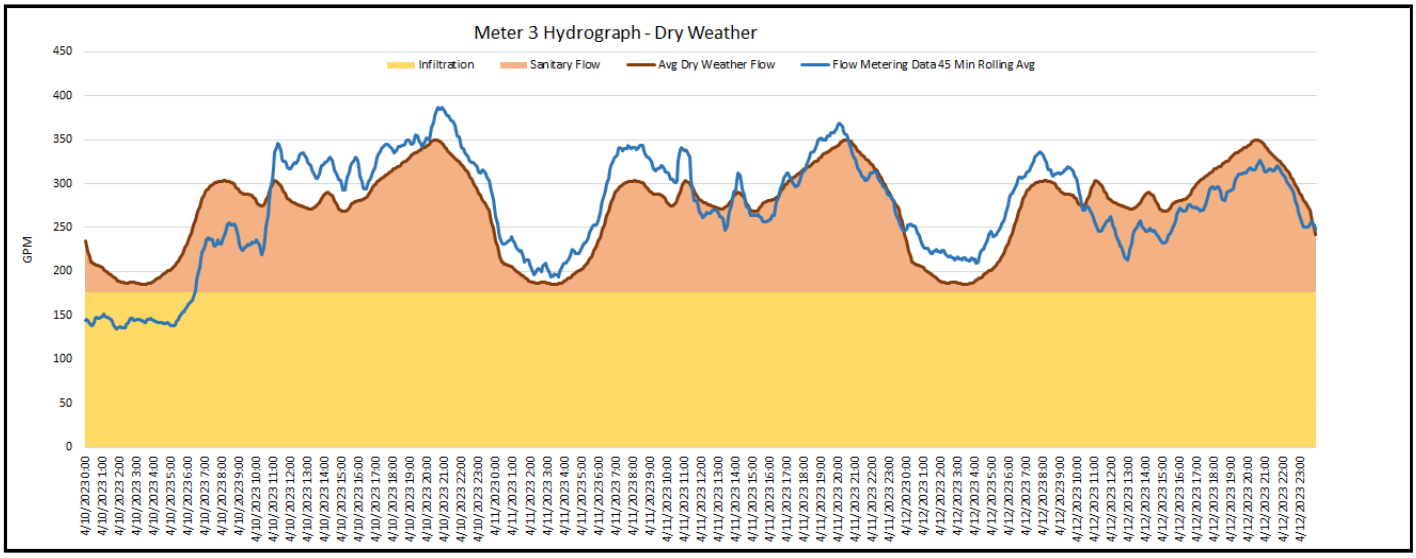
160


Meter 3 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
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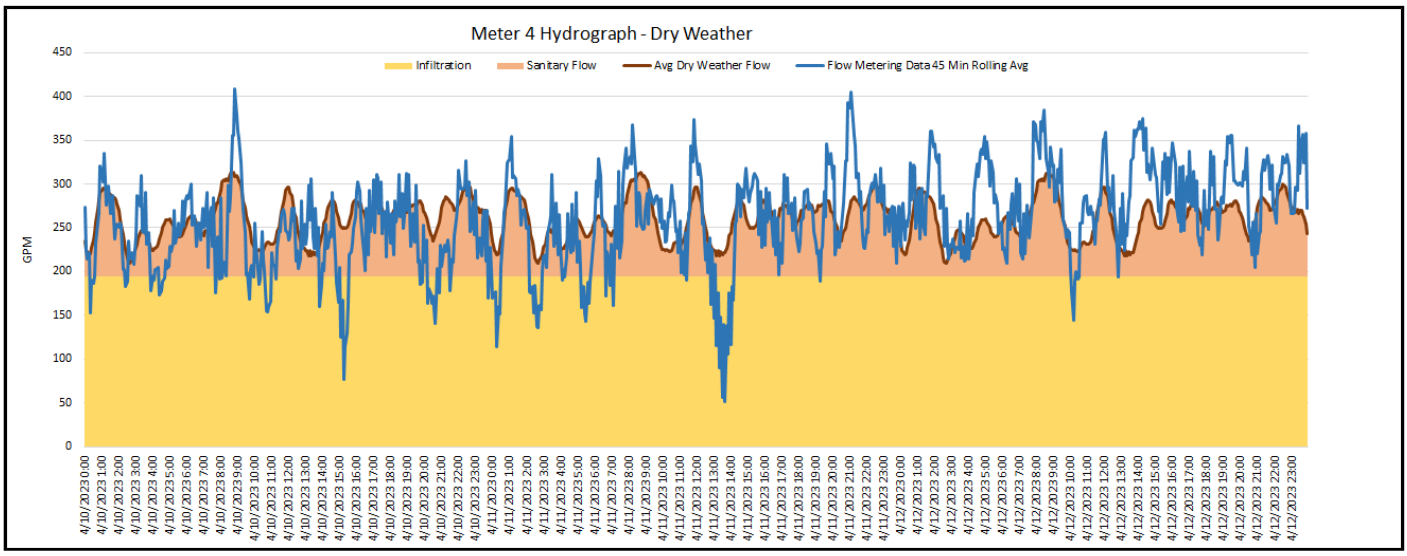
Meter 4 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
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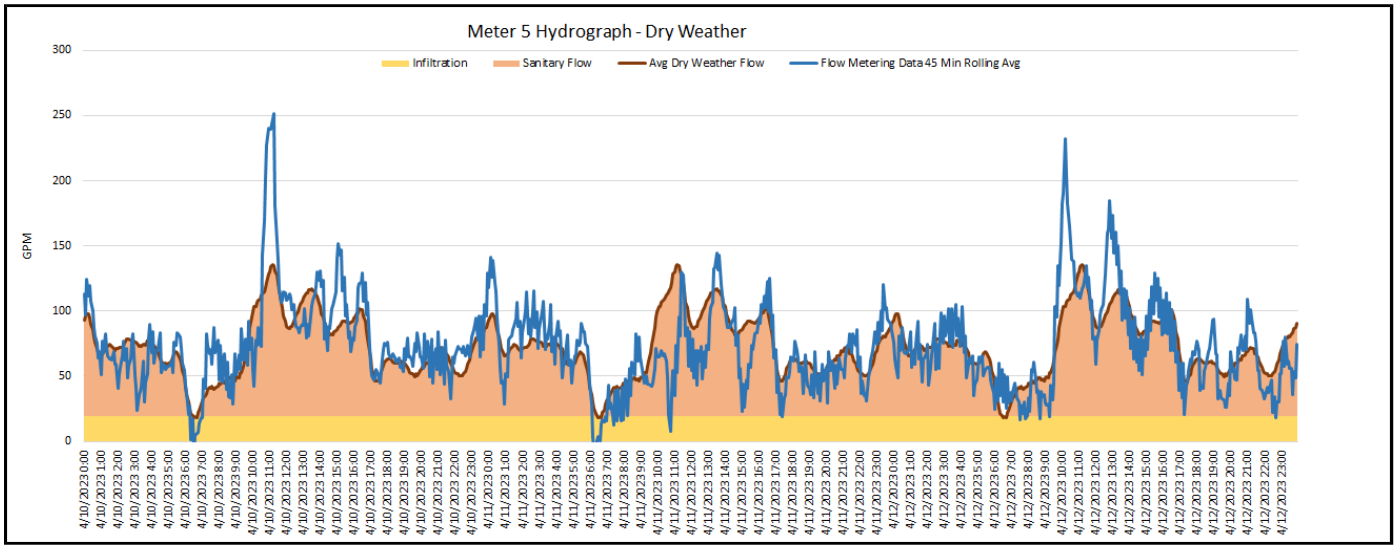
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Sanitary Flow
Avg Dry Weather Flow
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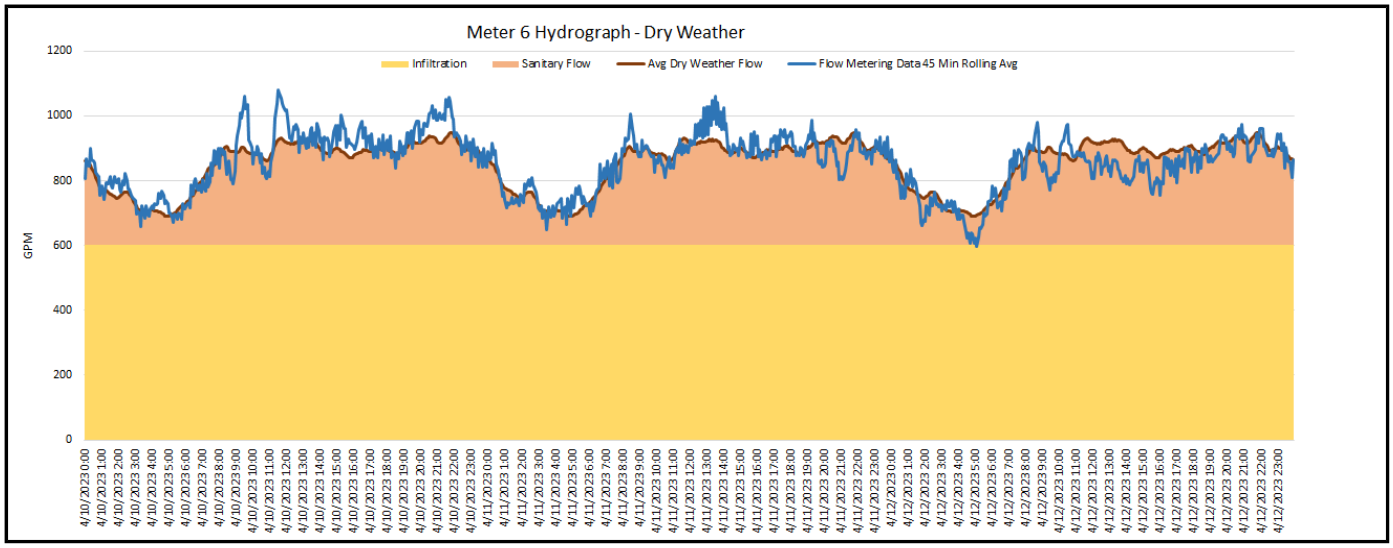
Meter 6 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
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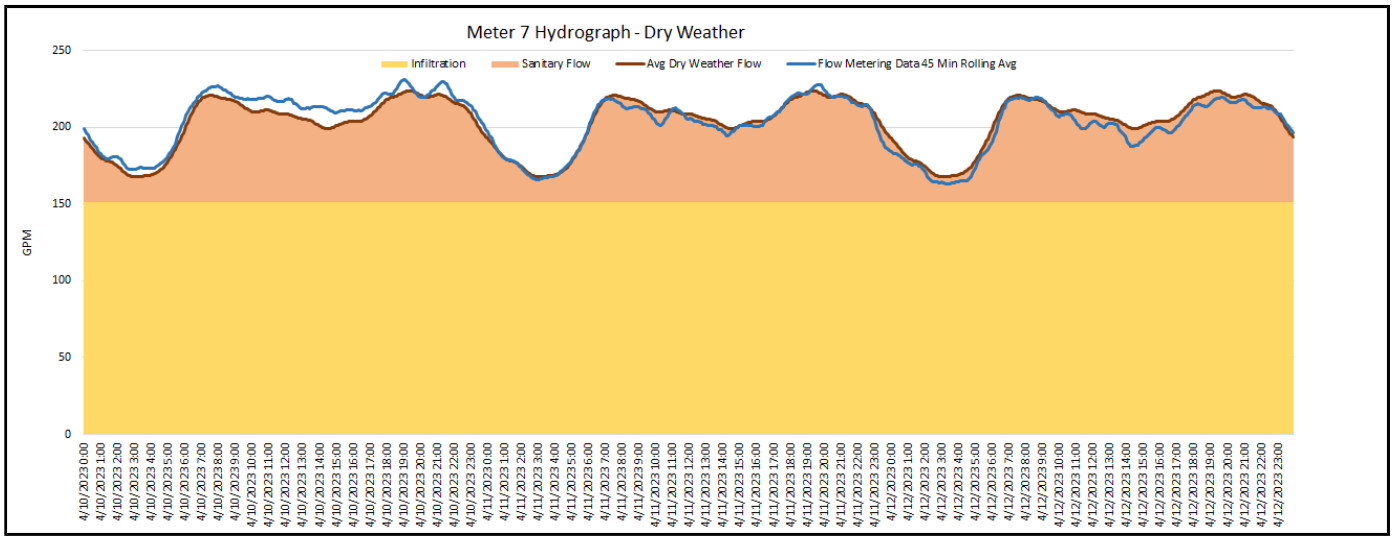
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Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
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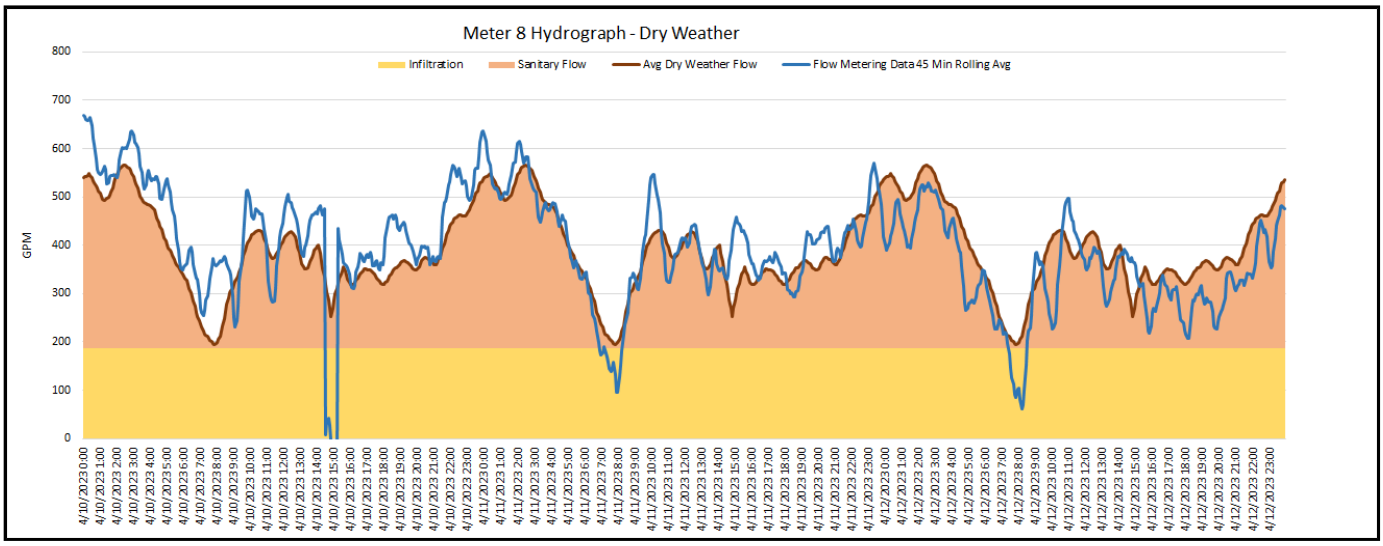
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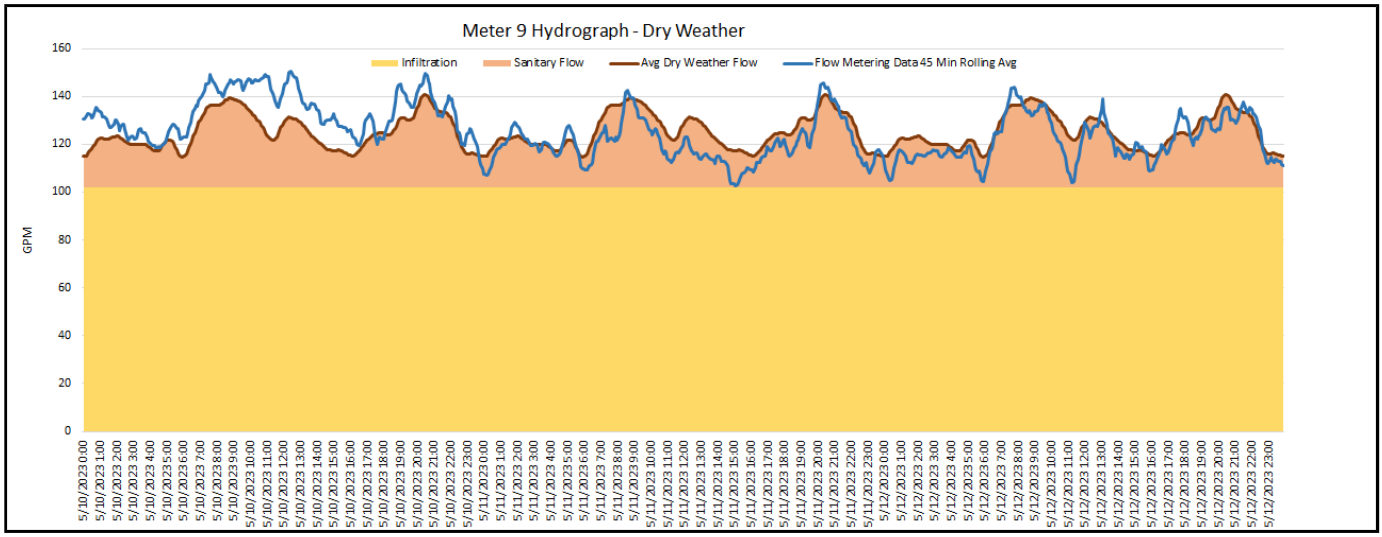
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Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
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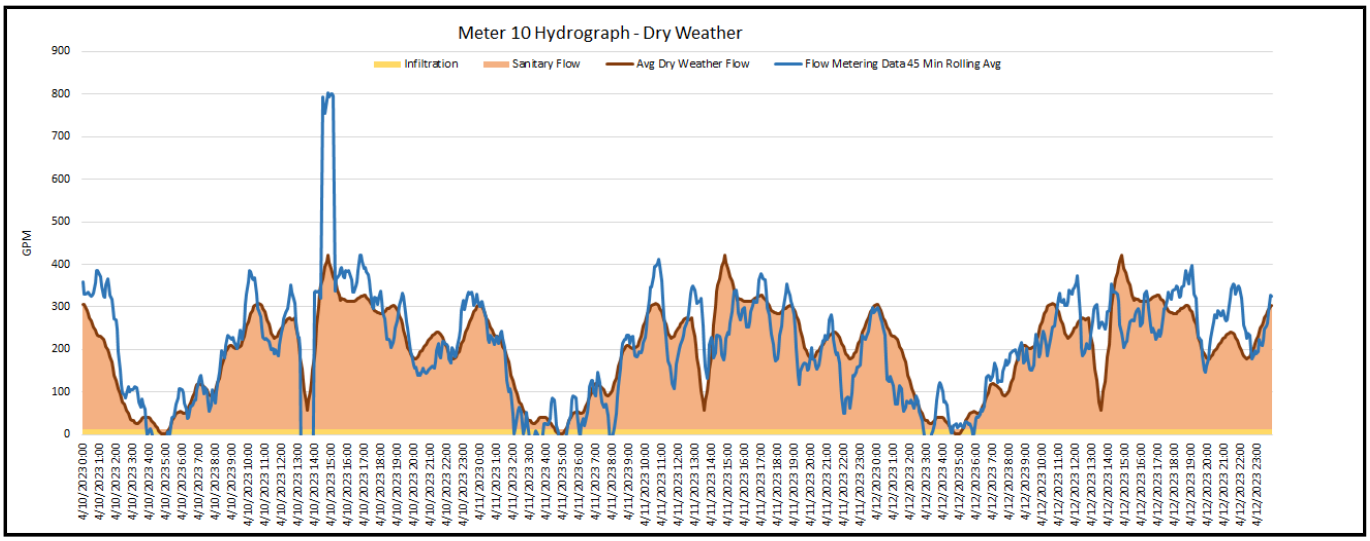
Meter 10 Hydrograph - Dry Weather
Infiltration
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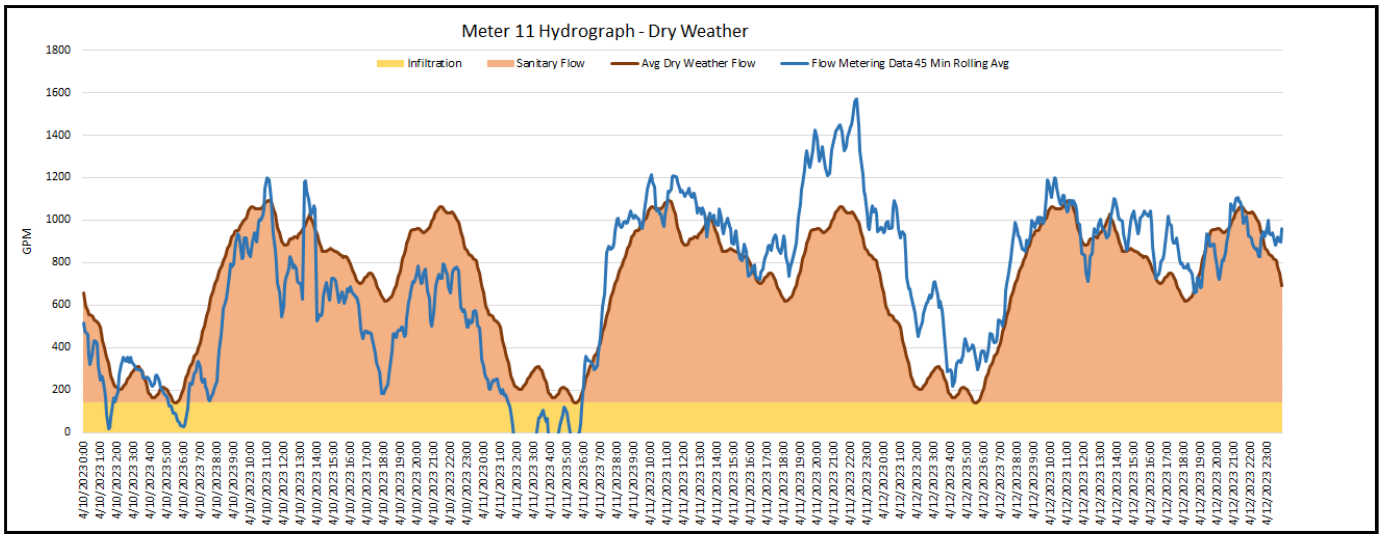
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Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
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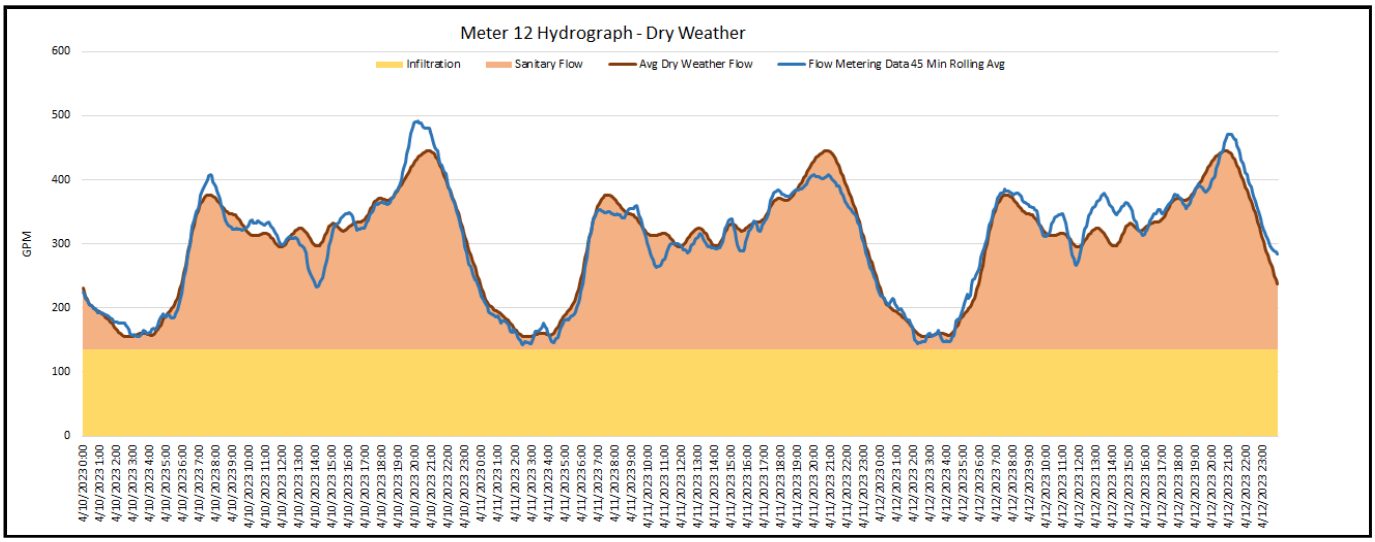
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Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
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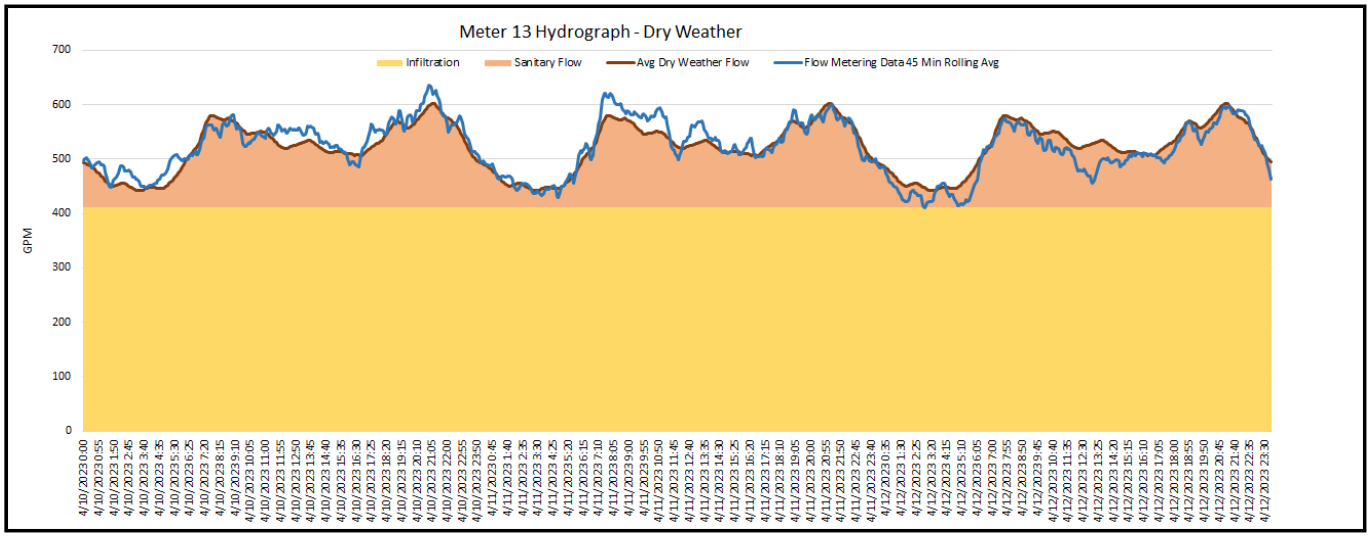
Meter 13 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
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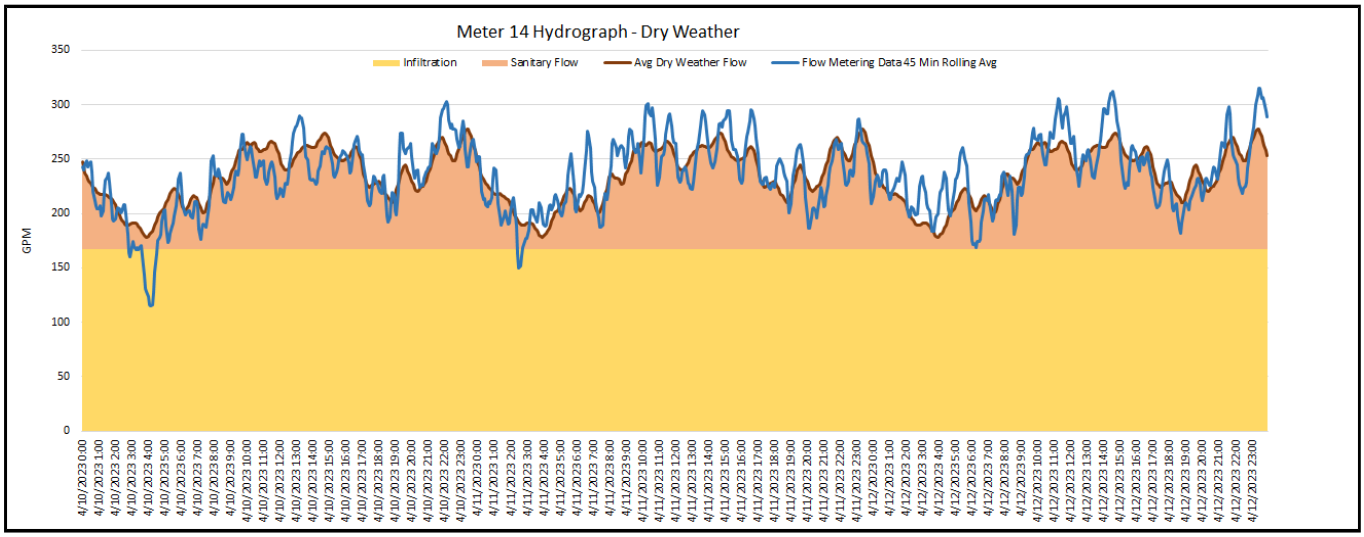
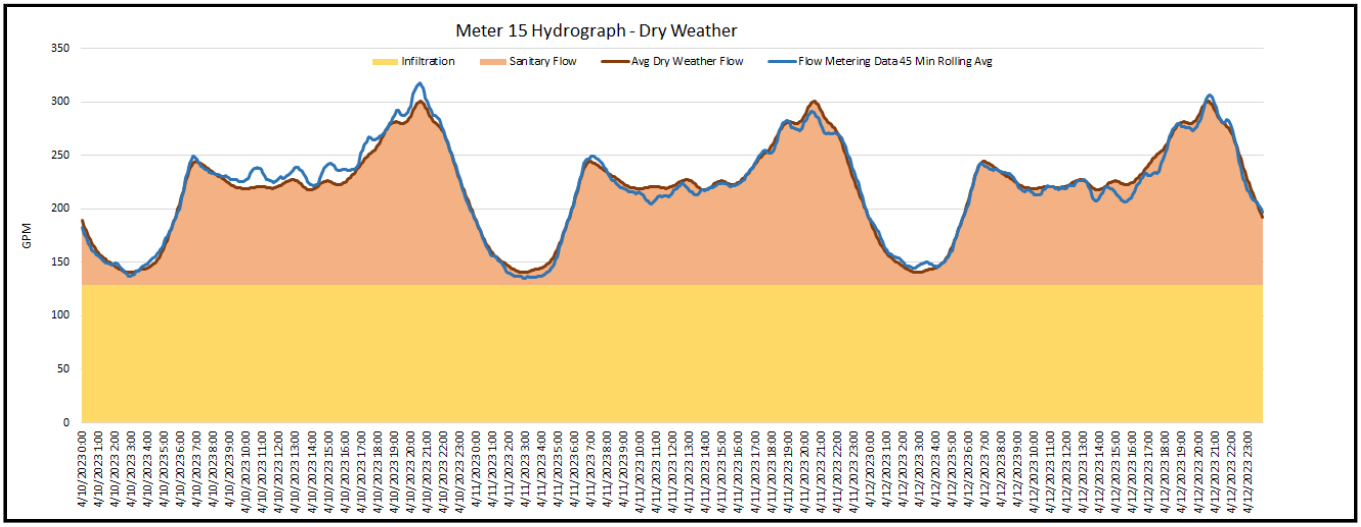
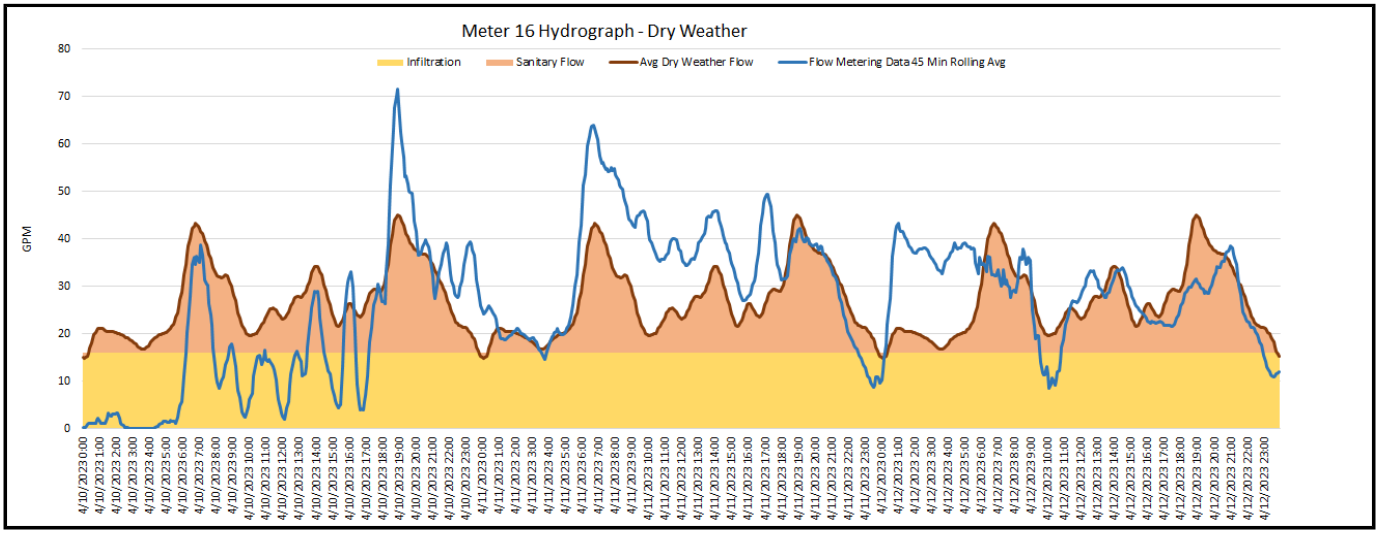
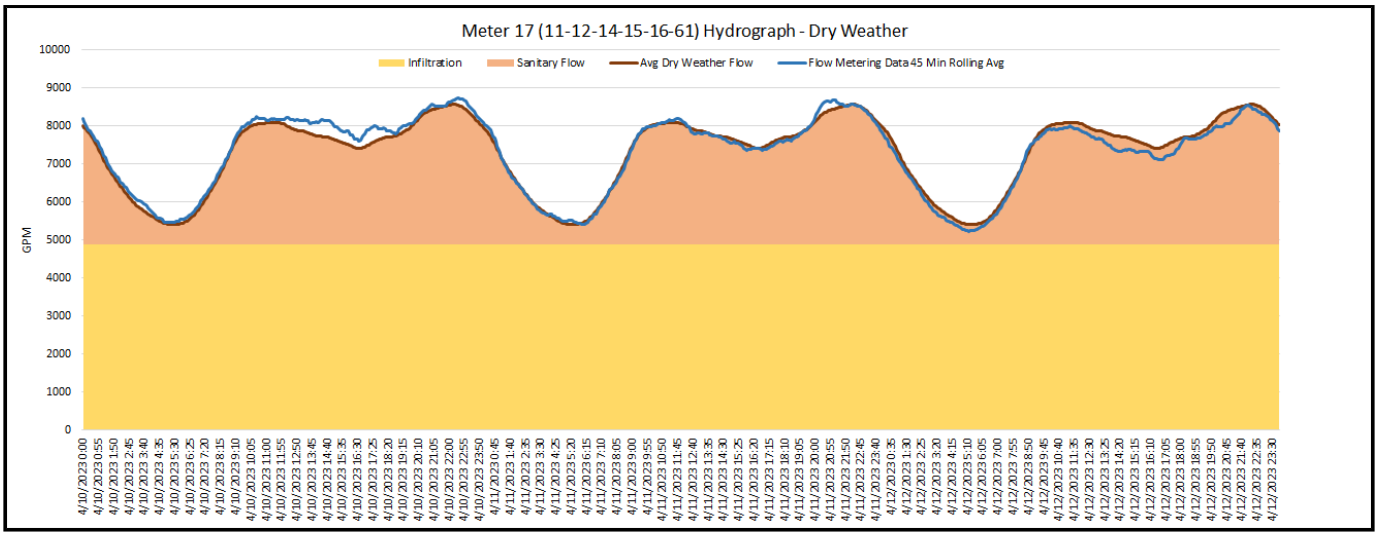
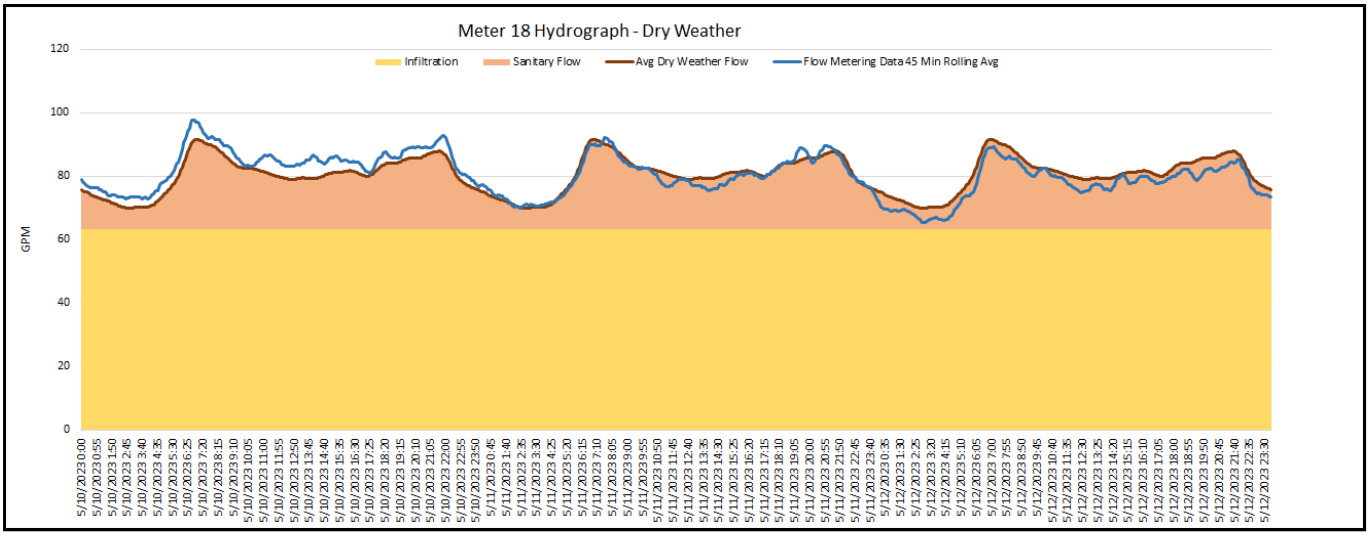
600
700

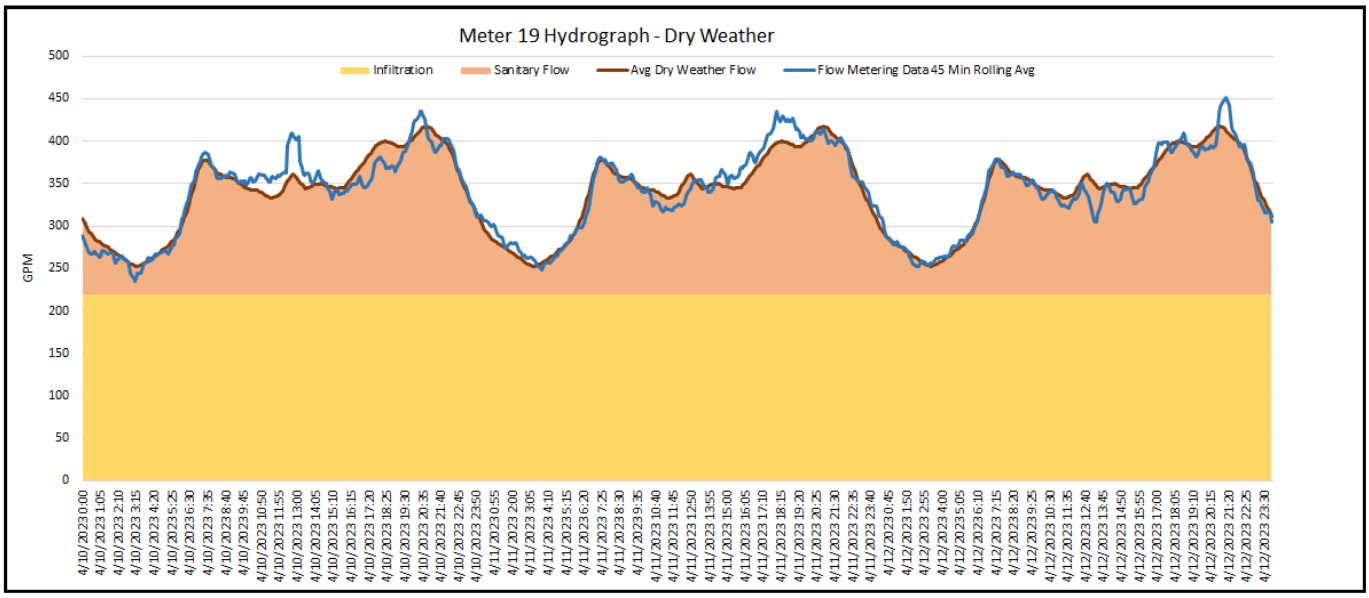

Meter 14 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
0
50
100
150
200
250
300
350

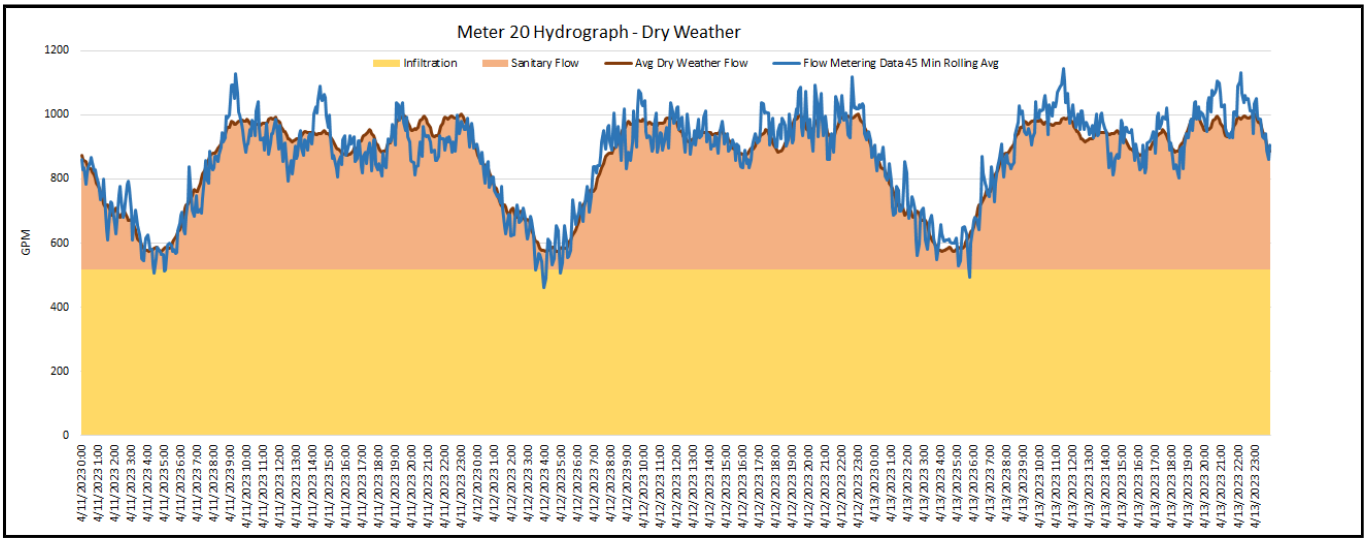

Meter 15 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
0
50
100
150
200
250
300
350

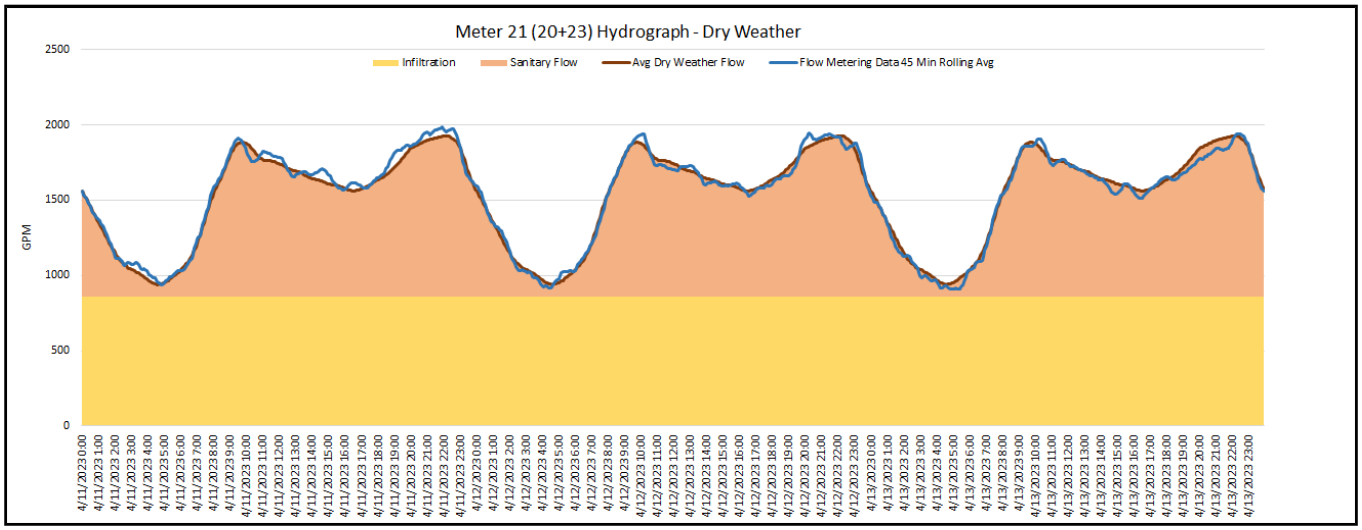

Meter 16 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

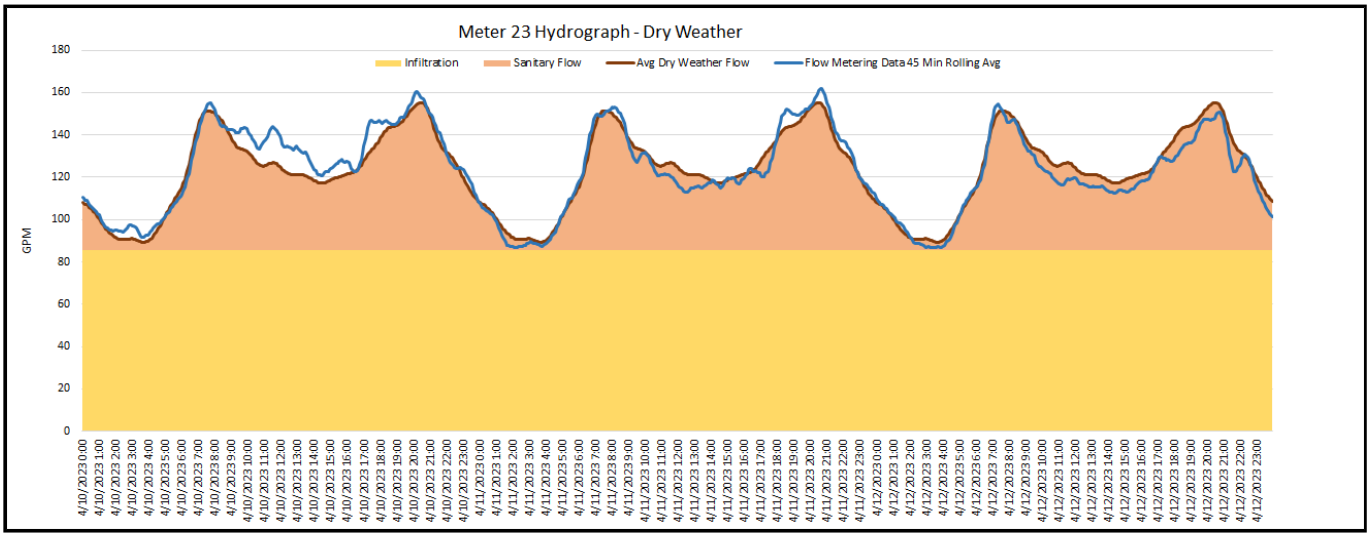

Meter 17 (11-12-14-15-16-61) Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

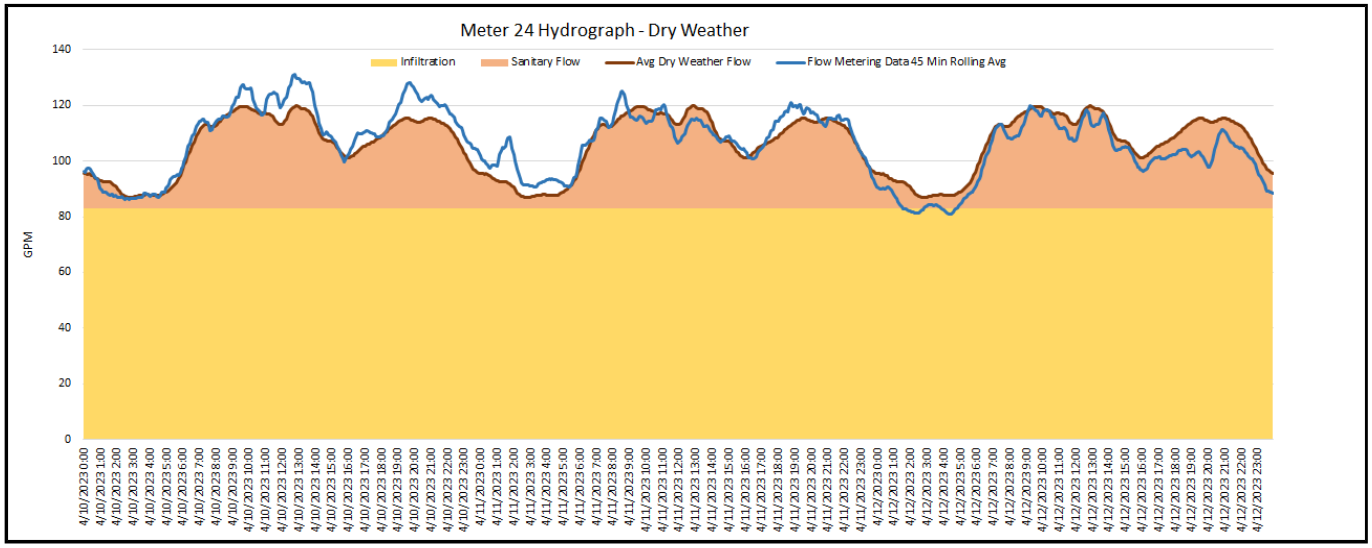

Meter 18 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

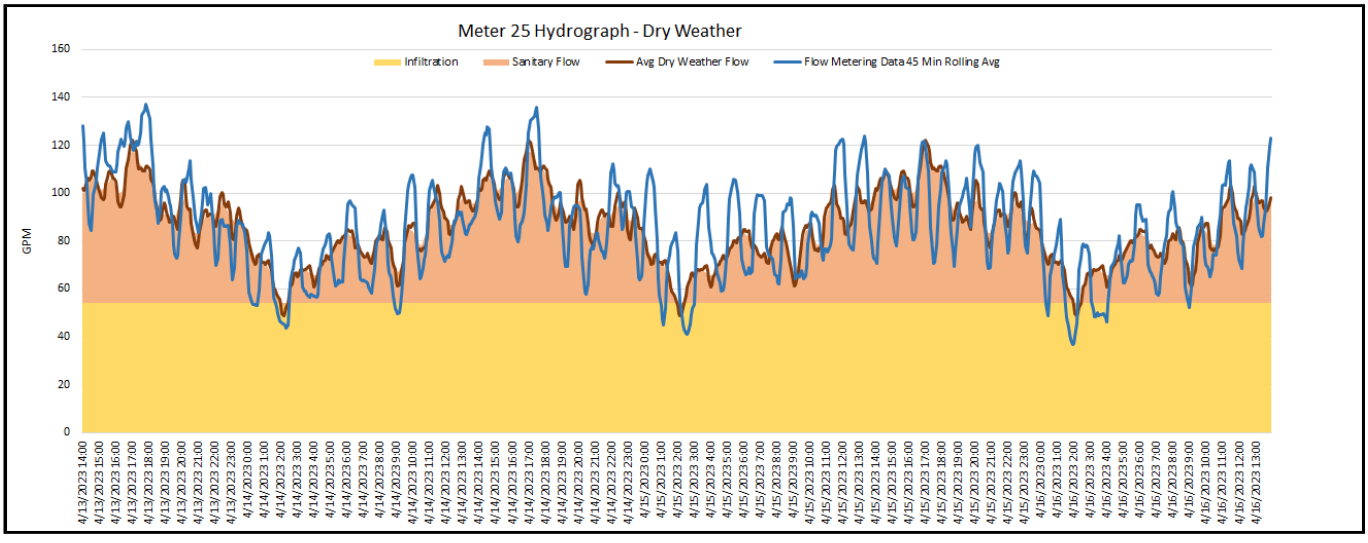

Meter 19 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
500
450
400
350
300
250
200
150
100
50
0

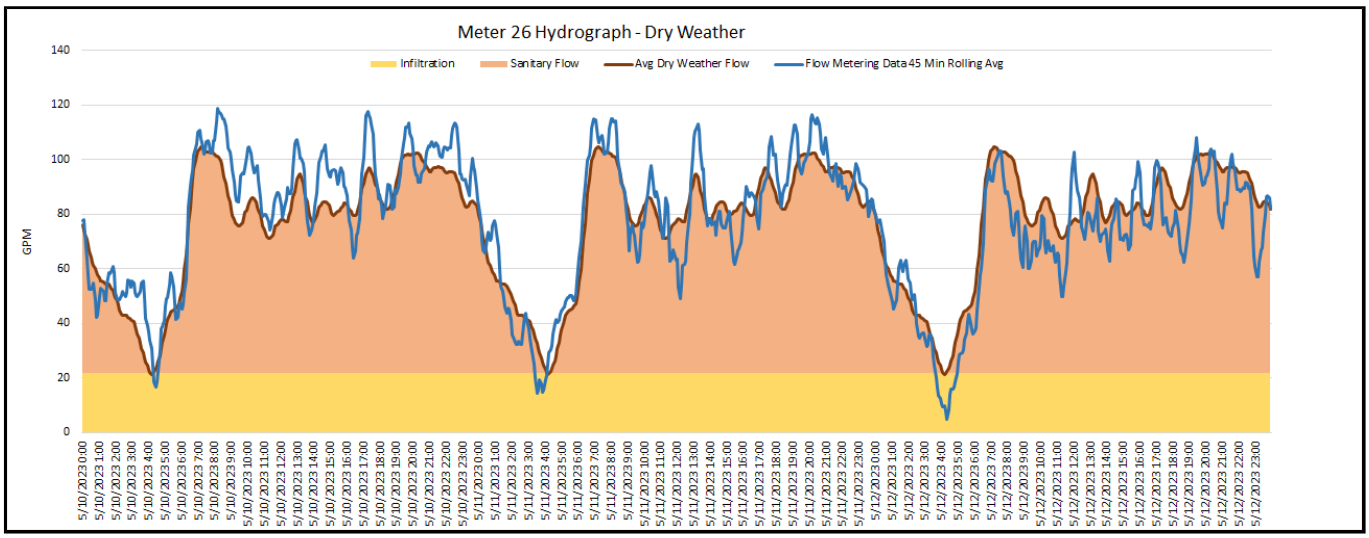

Meter 20 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
1200
1000
800
600
400
200
0

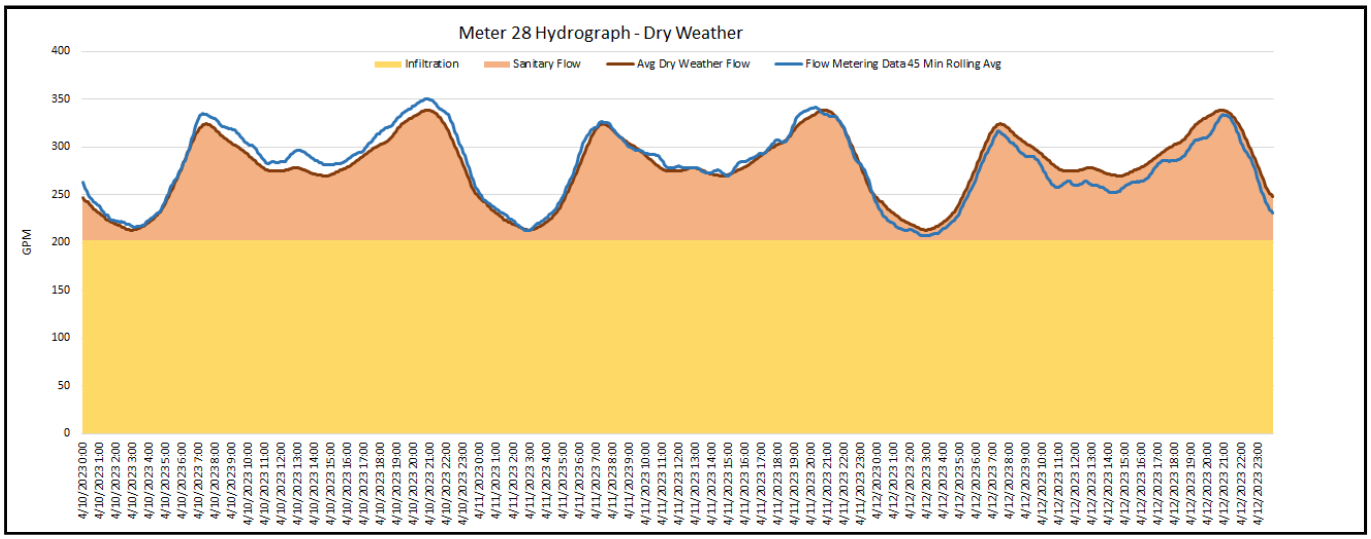

Meter 21 (20+23) Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
2500
2000
1500
1000
500
0

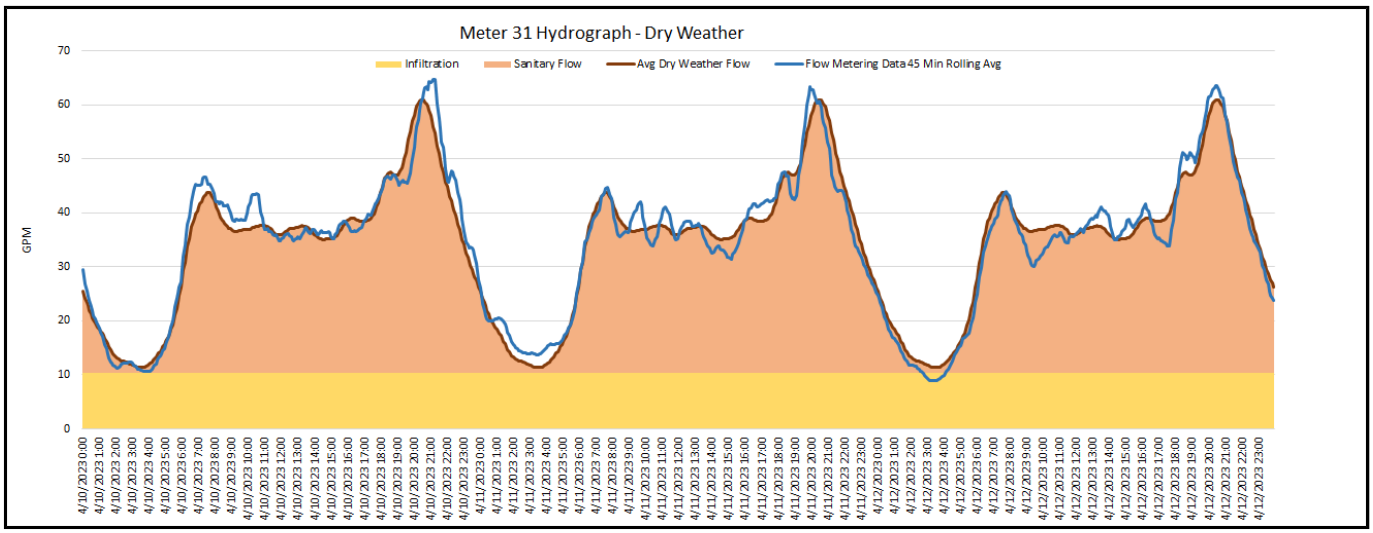

Meter 23 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

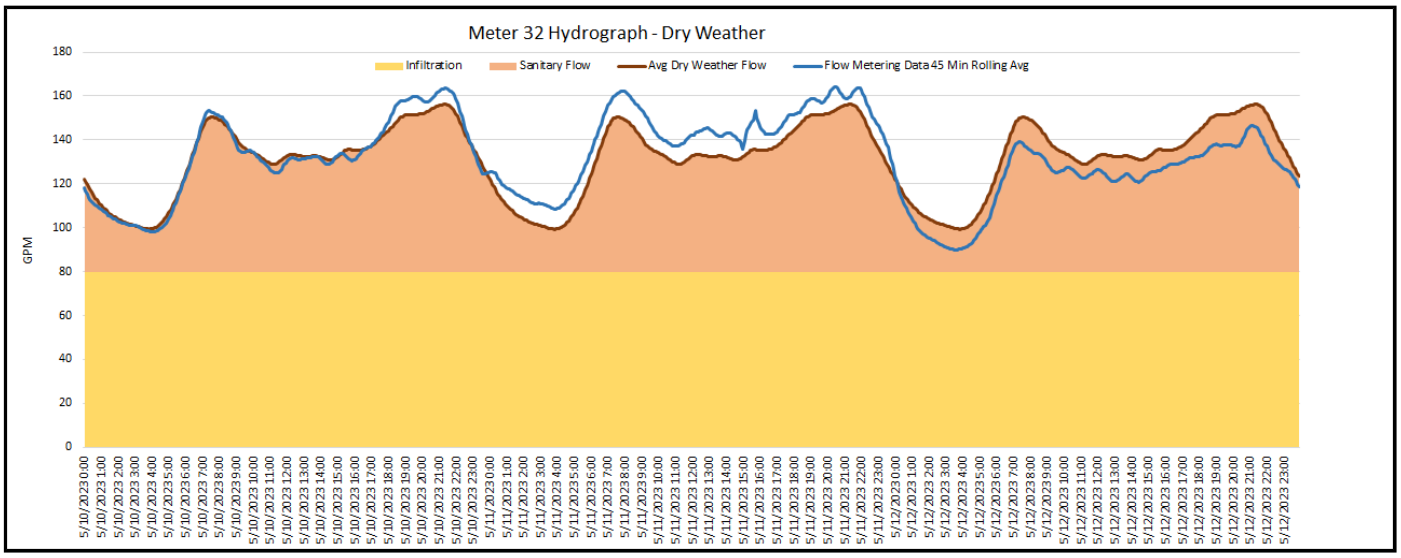

Meter 24 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

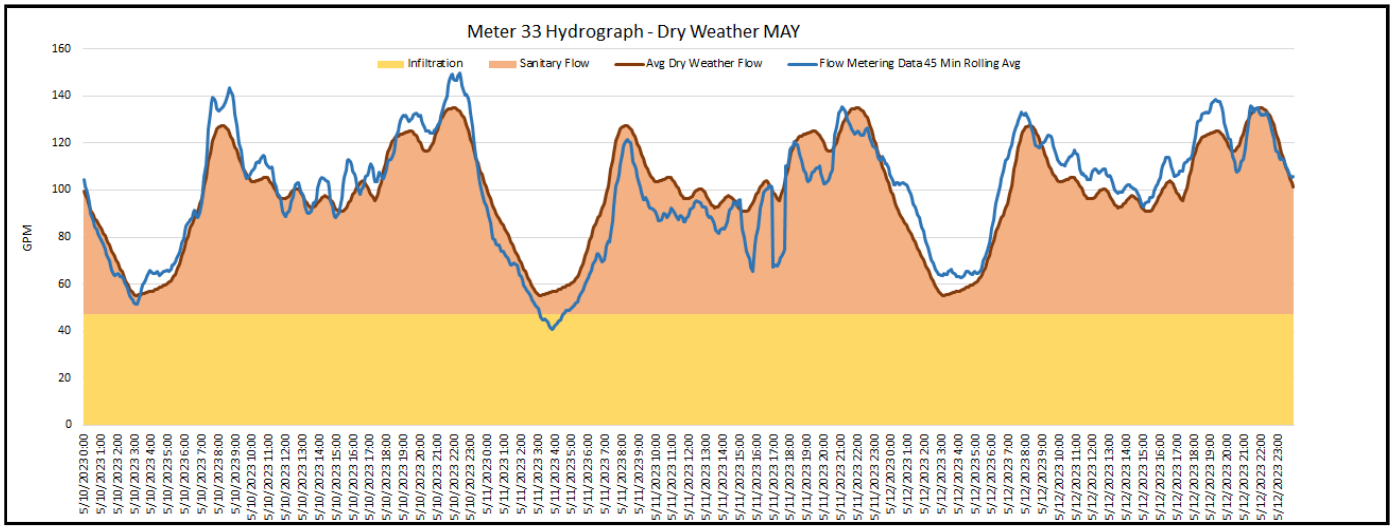

Meter 25 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

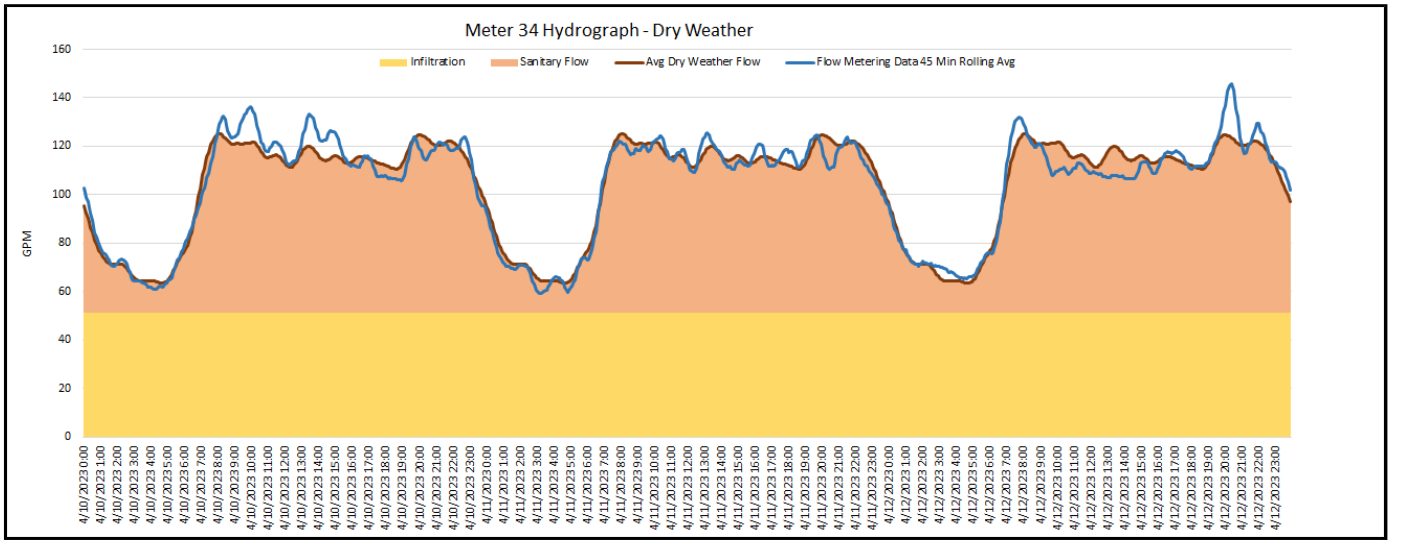

Meter 26 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

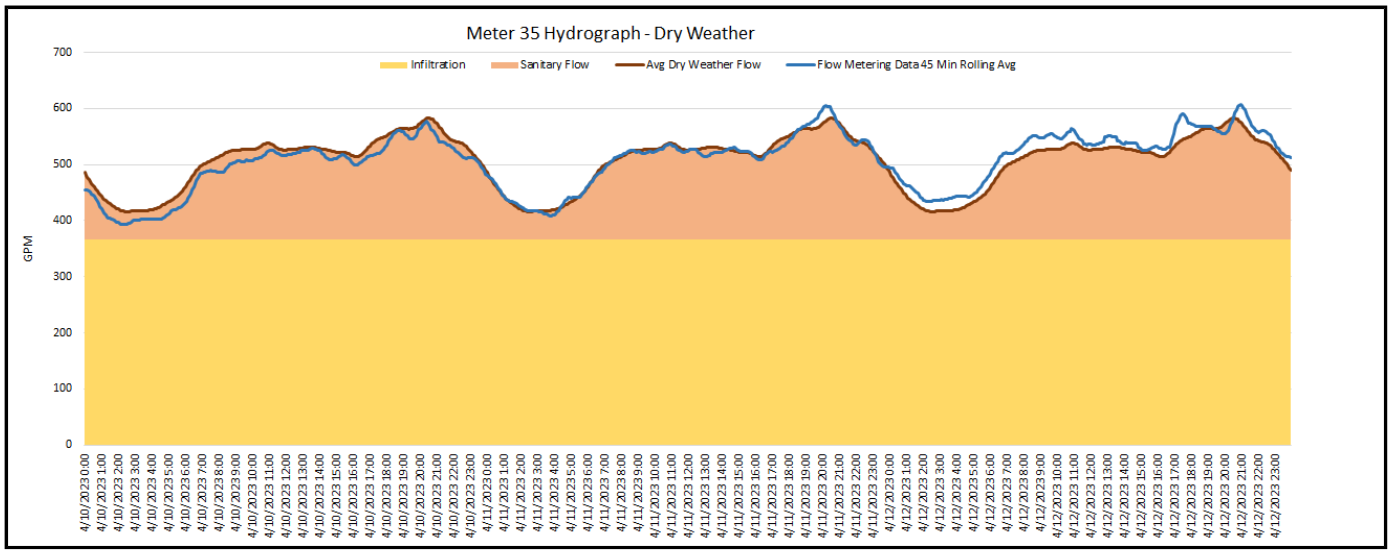

Meter 28 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

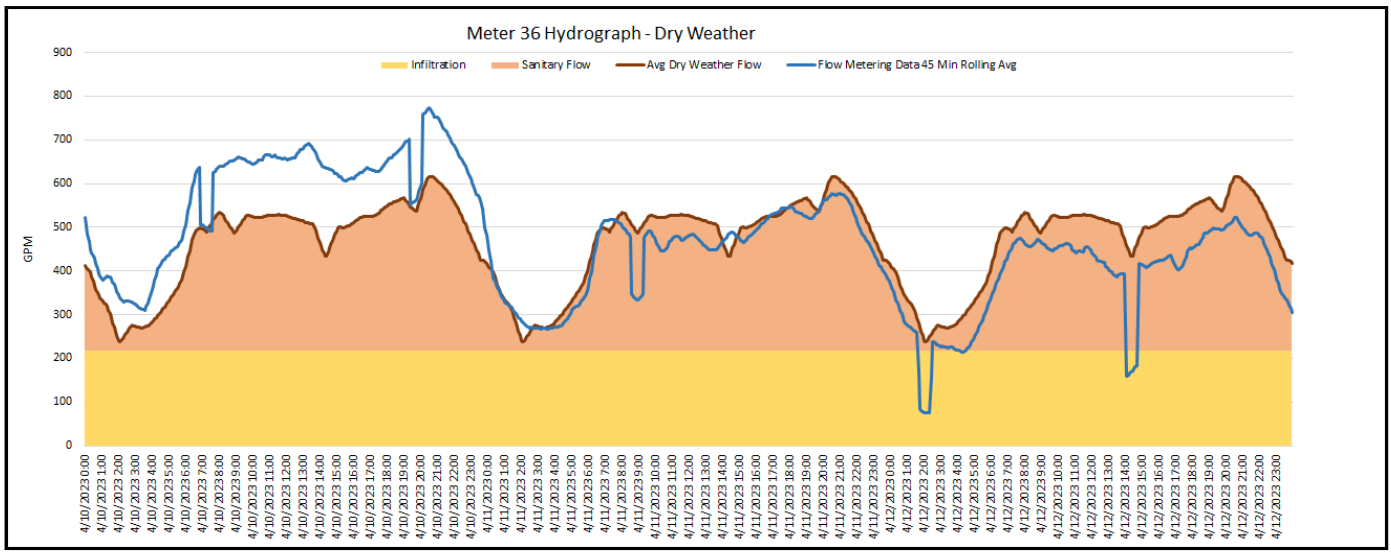

Meter 31 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

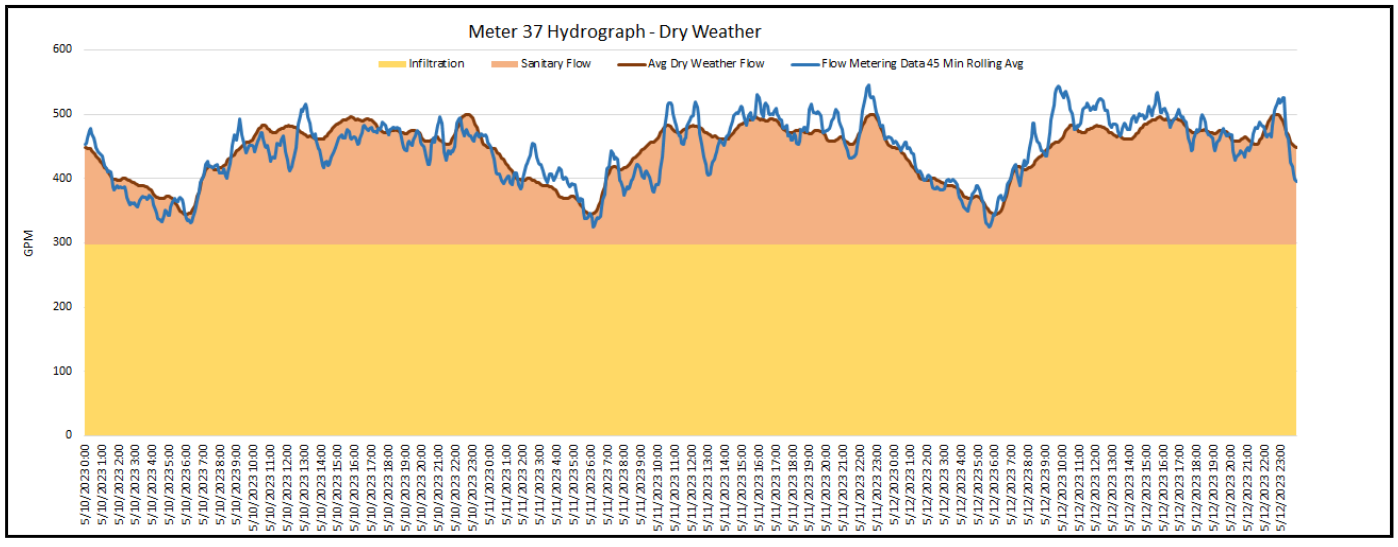

Meter 32 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

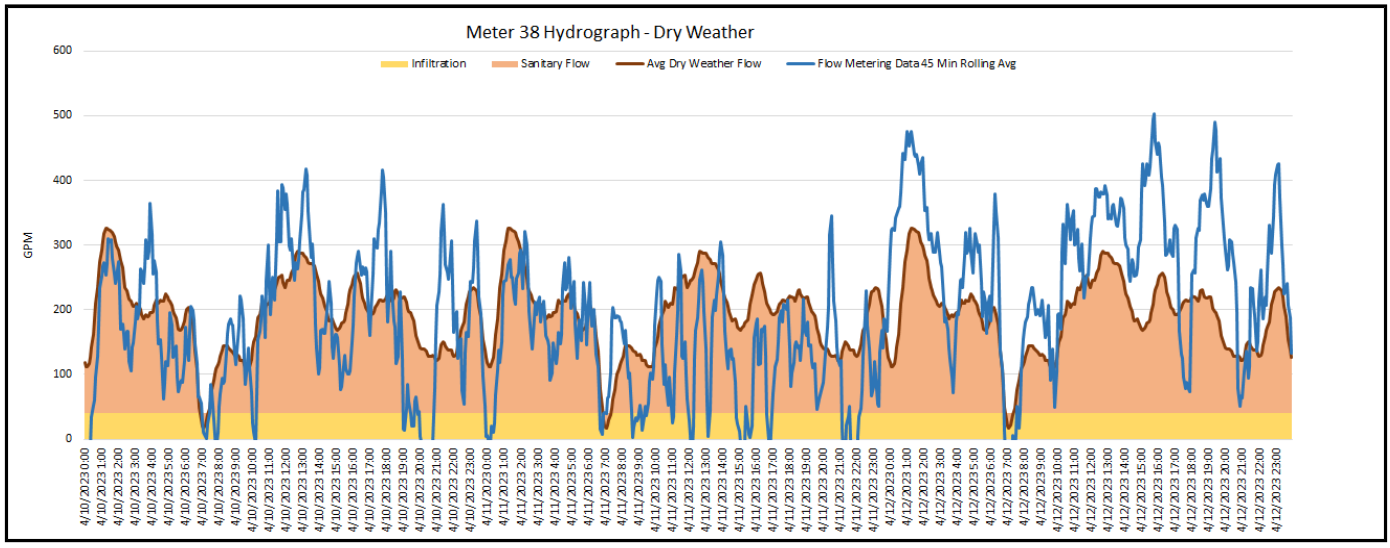

Meter 33 Hydrograph - Dry Weather MAY
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

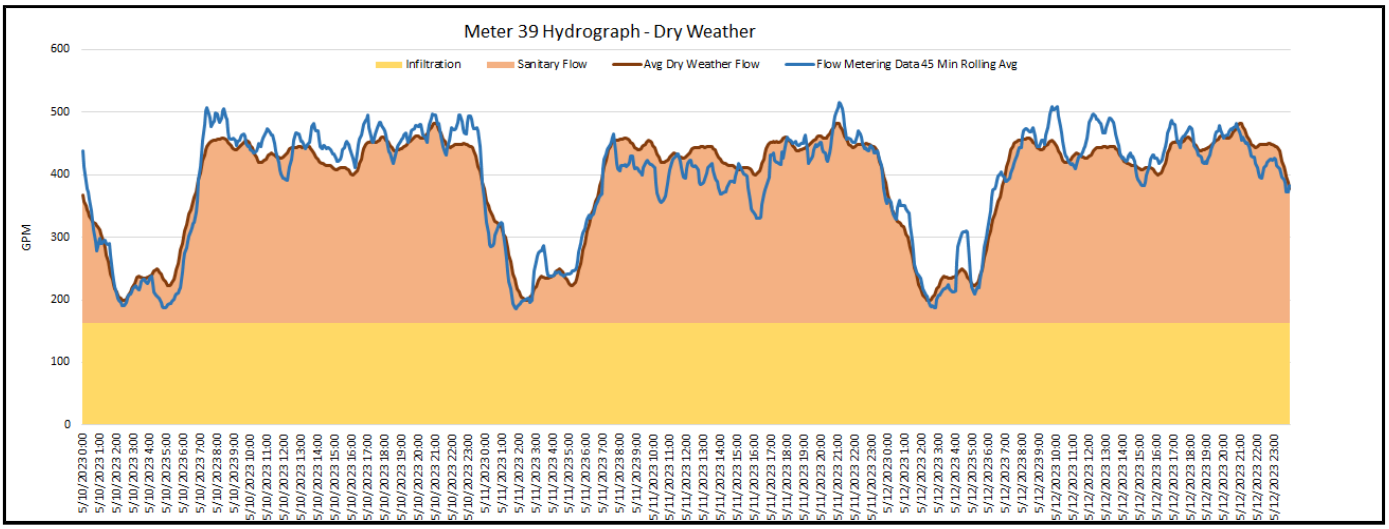

Meter 34 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

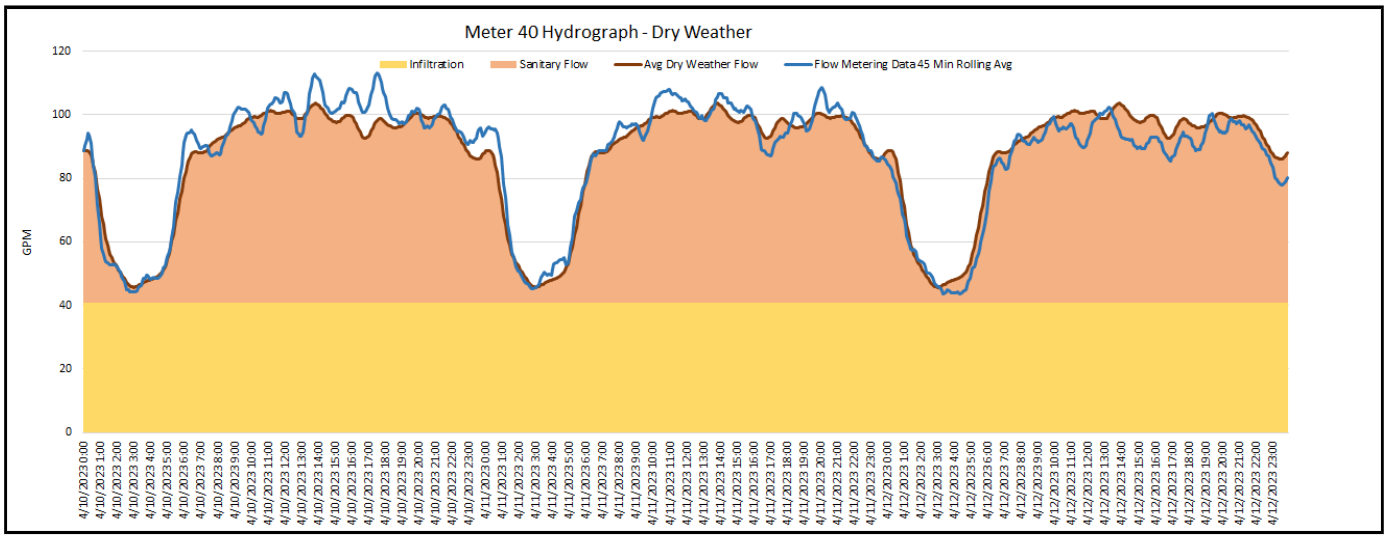

Meter 35 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
0
100
200
300
400
500
600
700

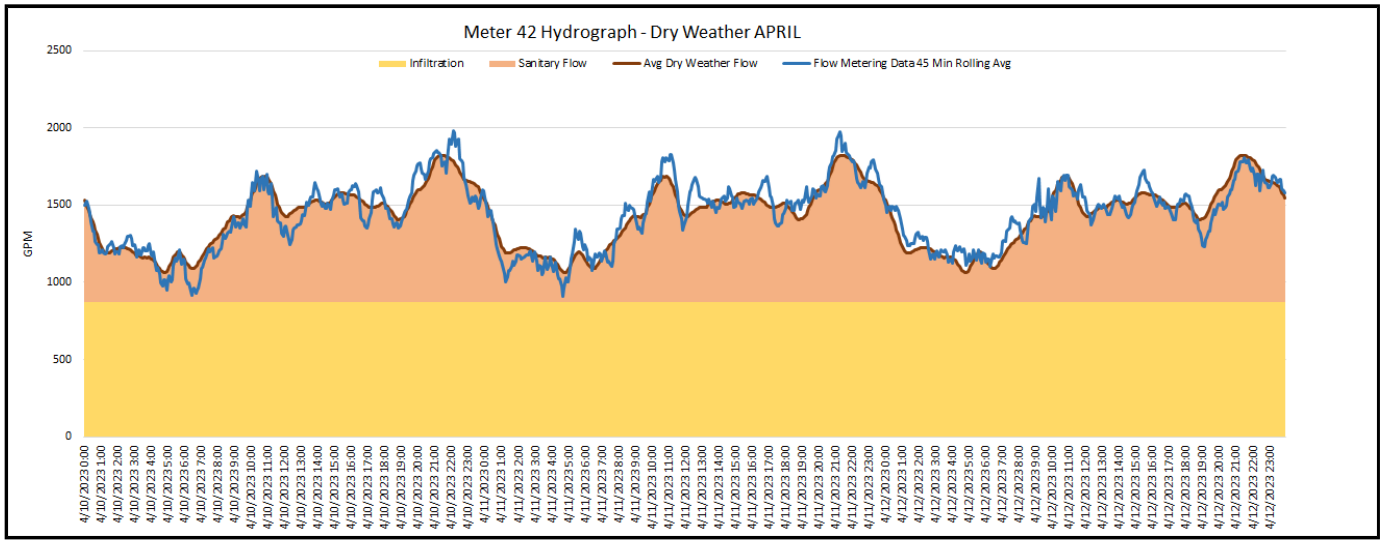

Meter 36 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
0
100
200
300
400
500
600
700
800
900

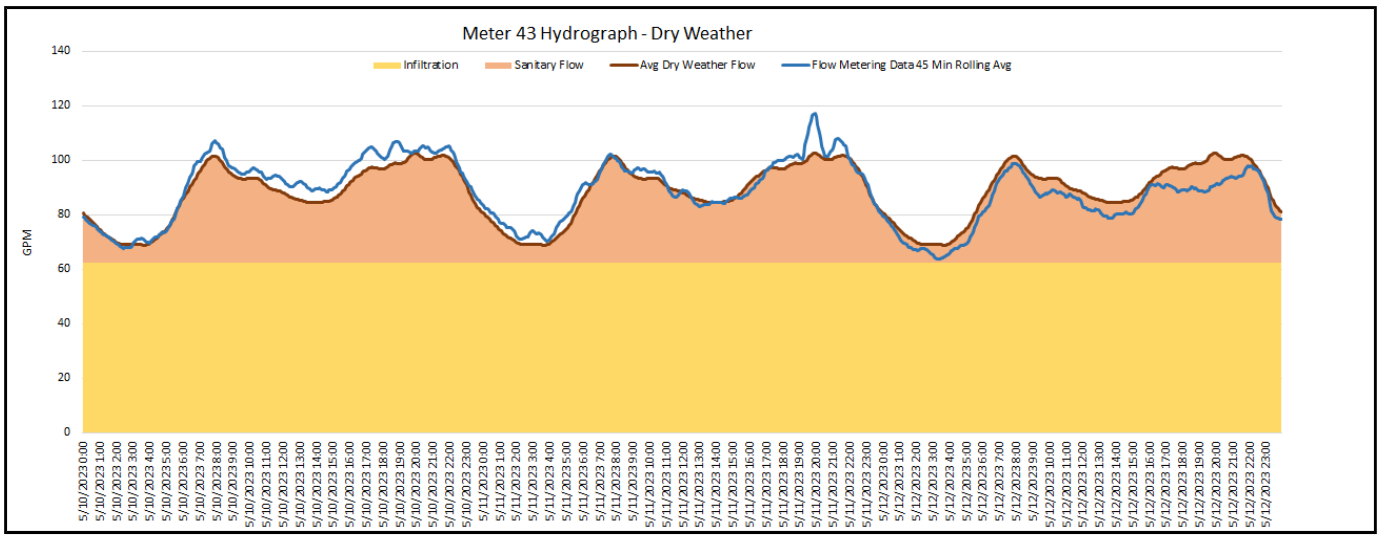

Meter 37 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
0
100
200
300
400
500
600

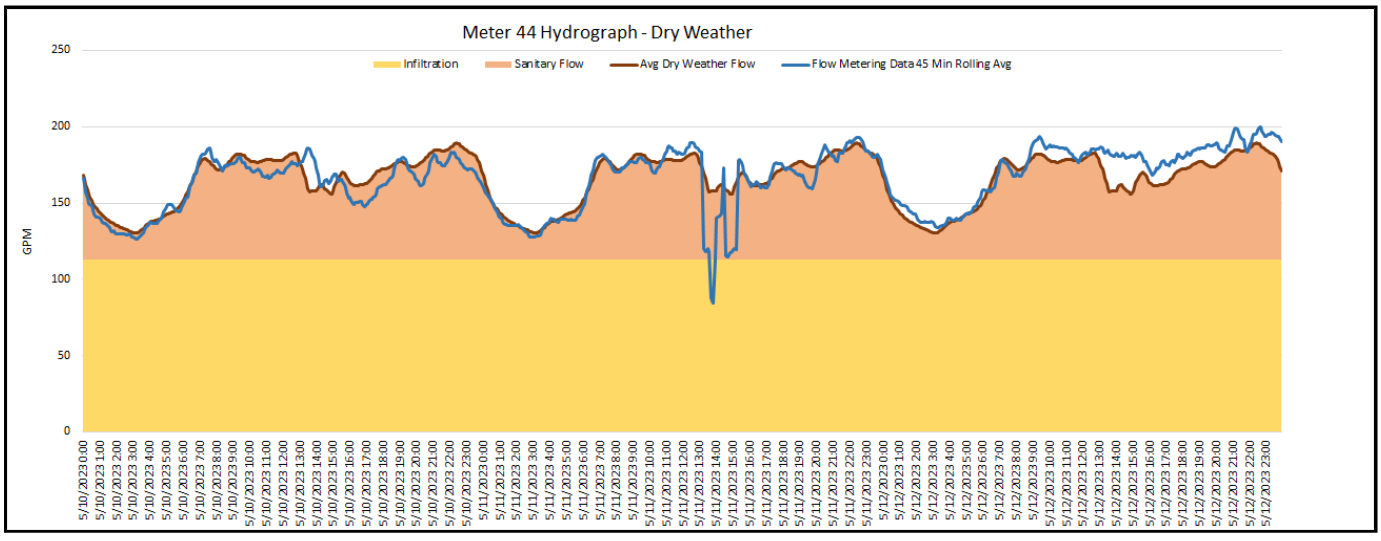

Meter 38 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
600
500
400
300
200
100
0

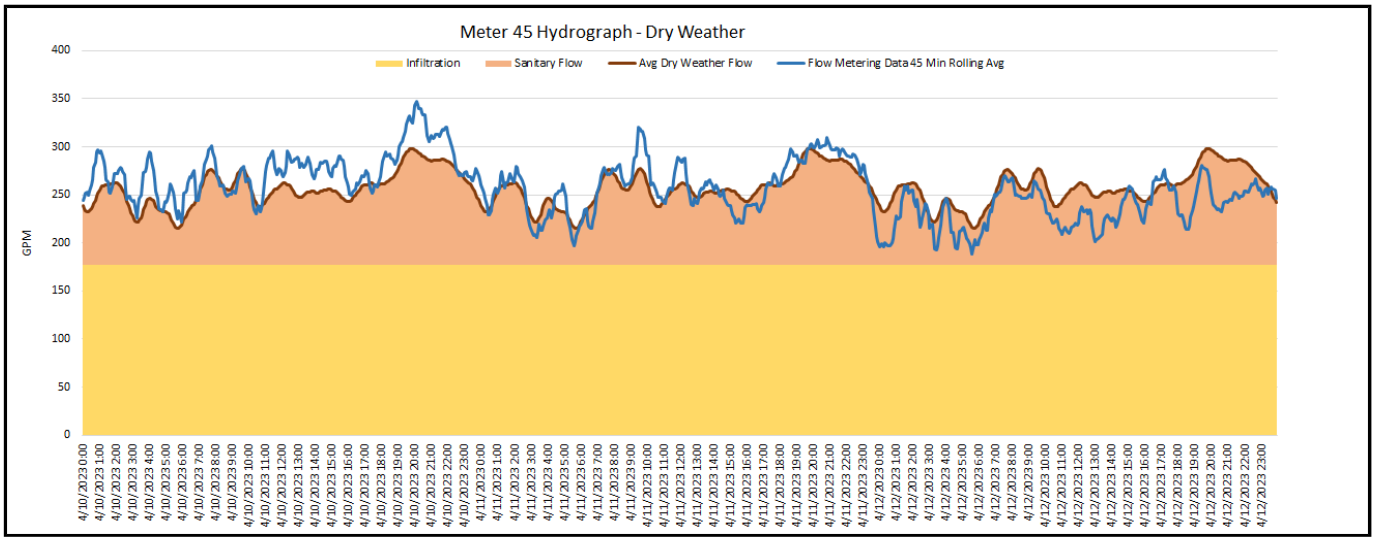

Meter 39 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
600
500
400
300
200
100
0

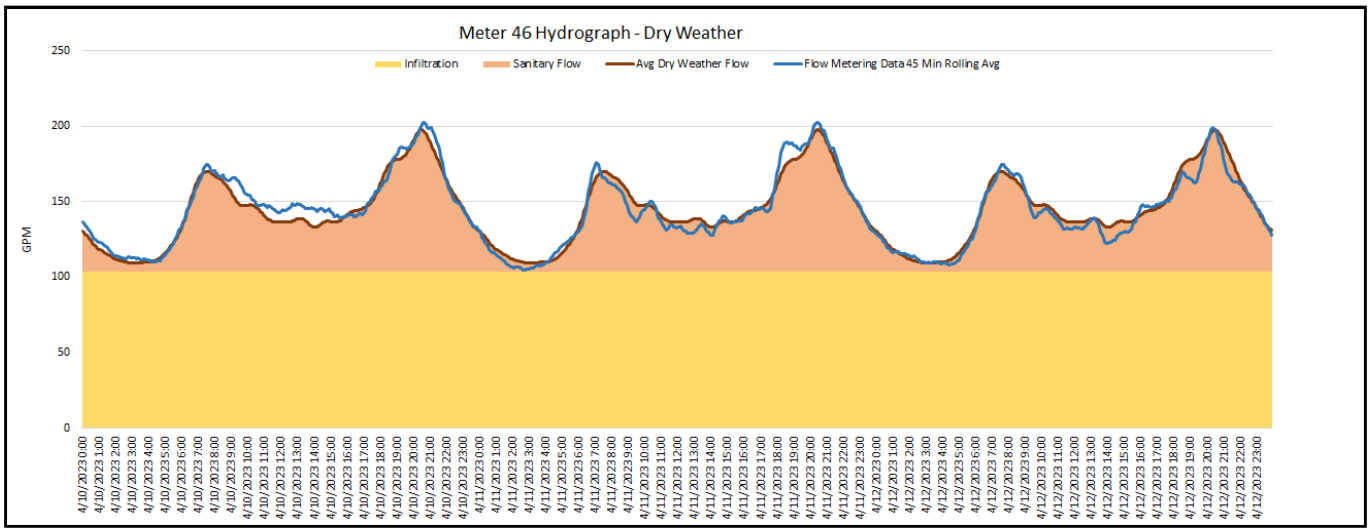

Meter 40 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
120
100
80
60
40
20
0

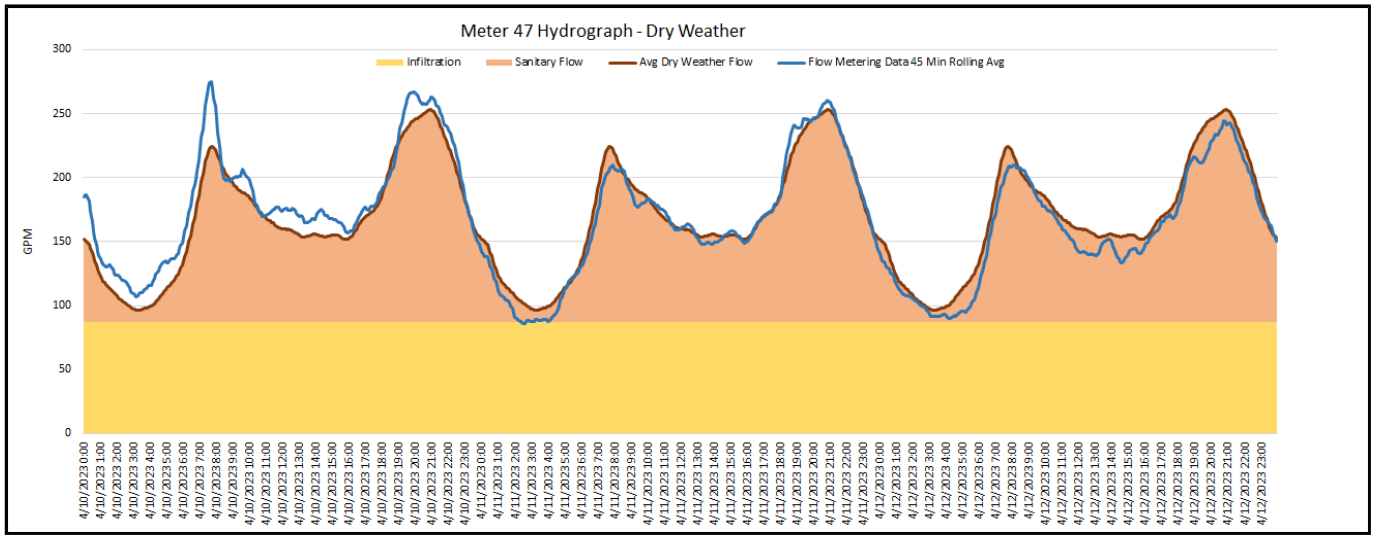

Meter 42 Hydrograph - Dry Weather APRIL
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
2500
2000
1500
1000
500
0

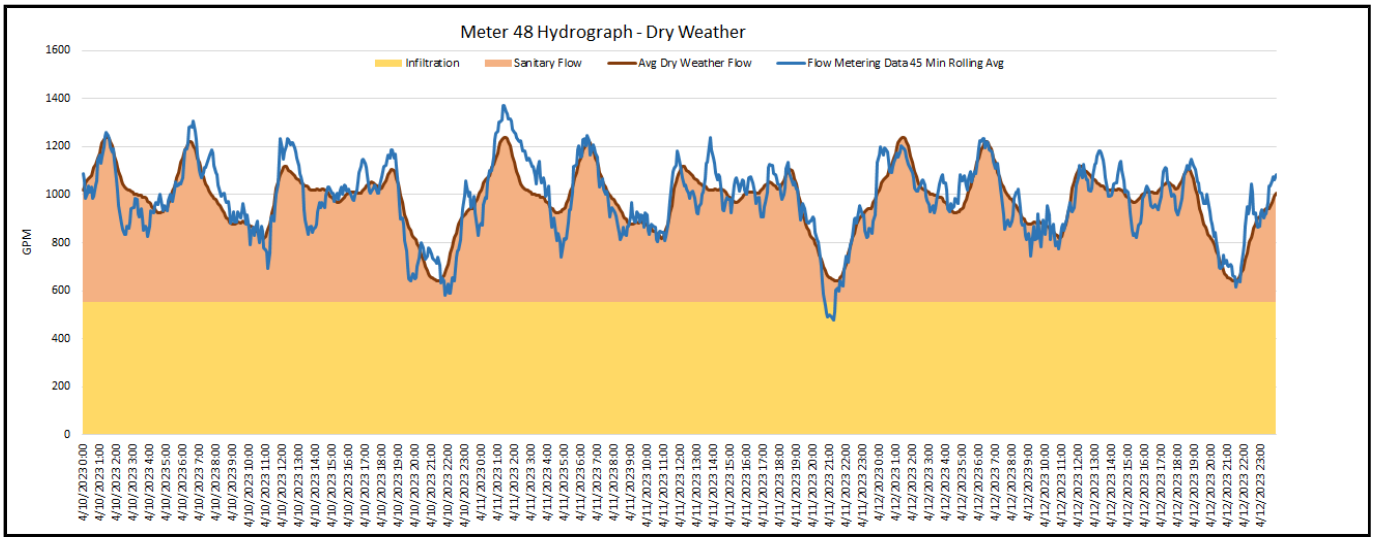

Meter 43 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
140
120
100
80
60
40
20
0

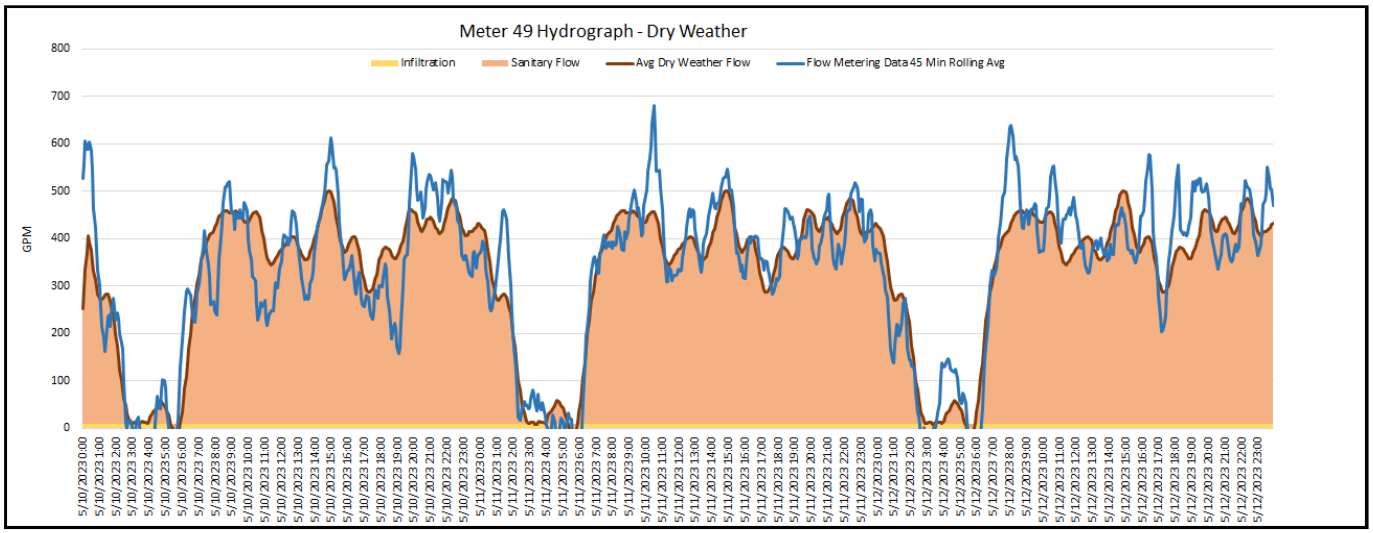

Meter 44 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
250
200
150
100
50
0

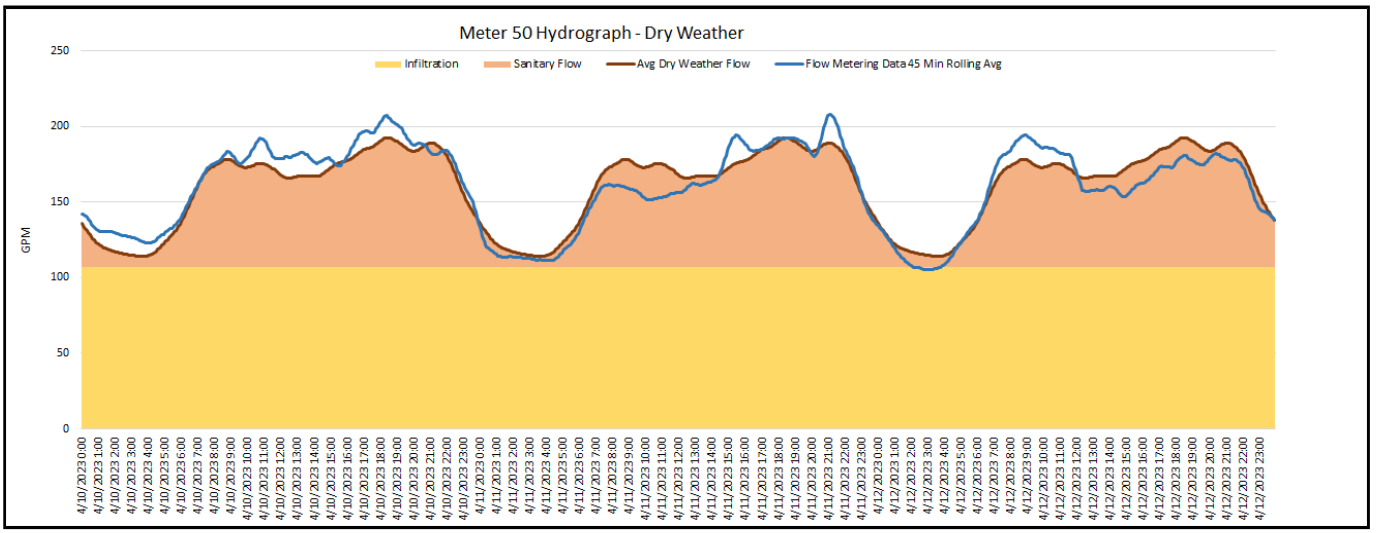

Meter 45 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
400
350
300
250
200
150
100
50
0

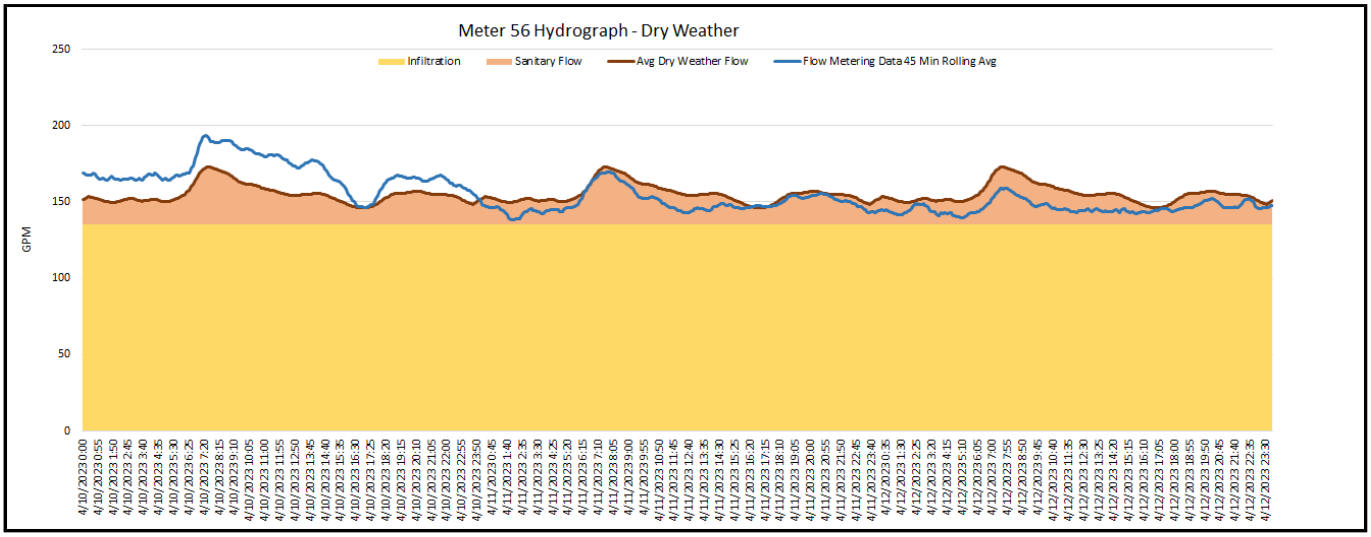

Meter 46 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
250
200
150
100
50
0

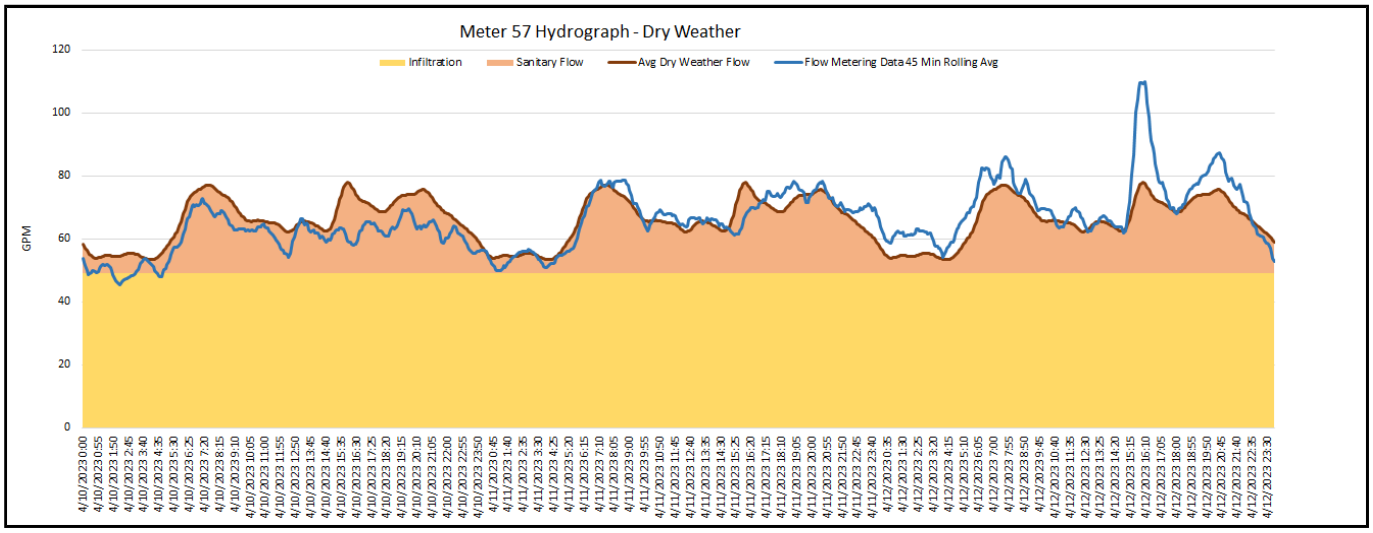

Meter 47 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
300
250
200
150
100
50
0

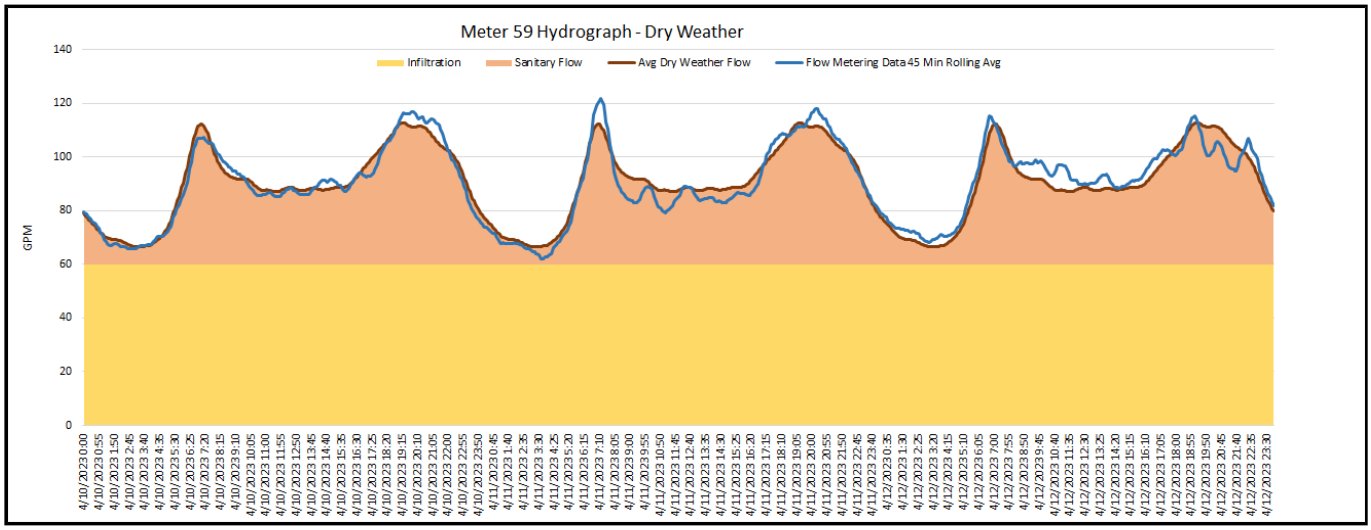

Meter 48 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
0
200
400
600
800
1000
1200
1400
1600

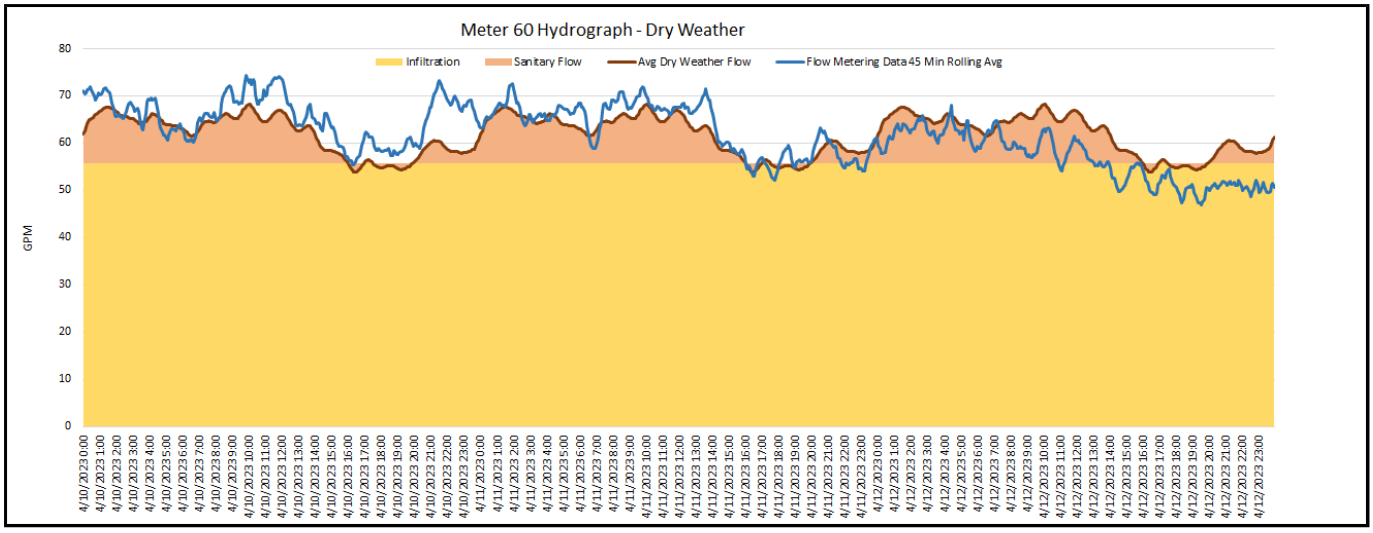

Meter 49 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
0
100
200
300
400
500
600
700
800

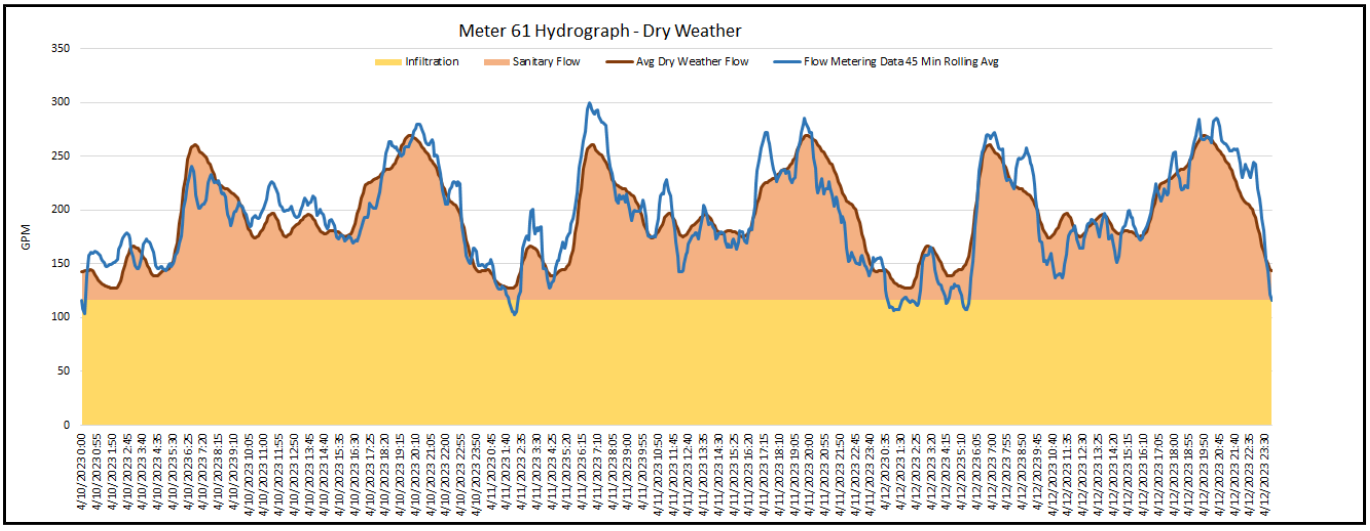

Meter 50 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
0
50
100
150
200
250

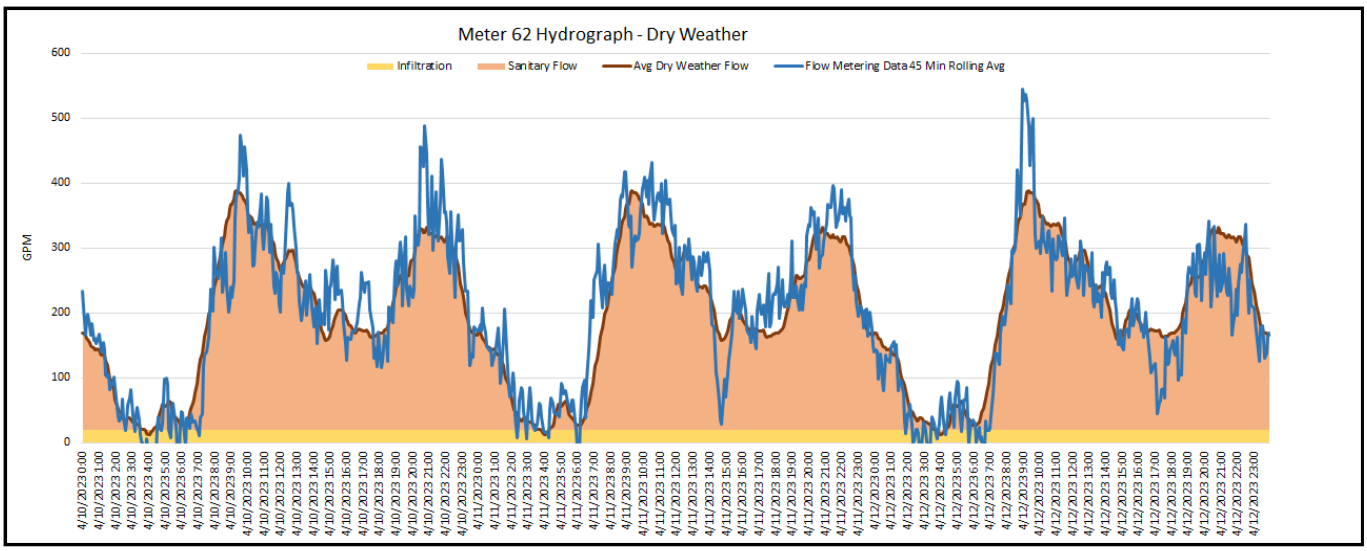

Meter 56 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
250
200
150
100
50
0

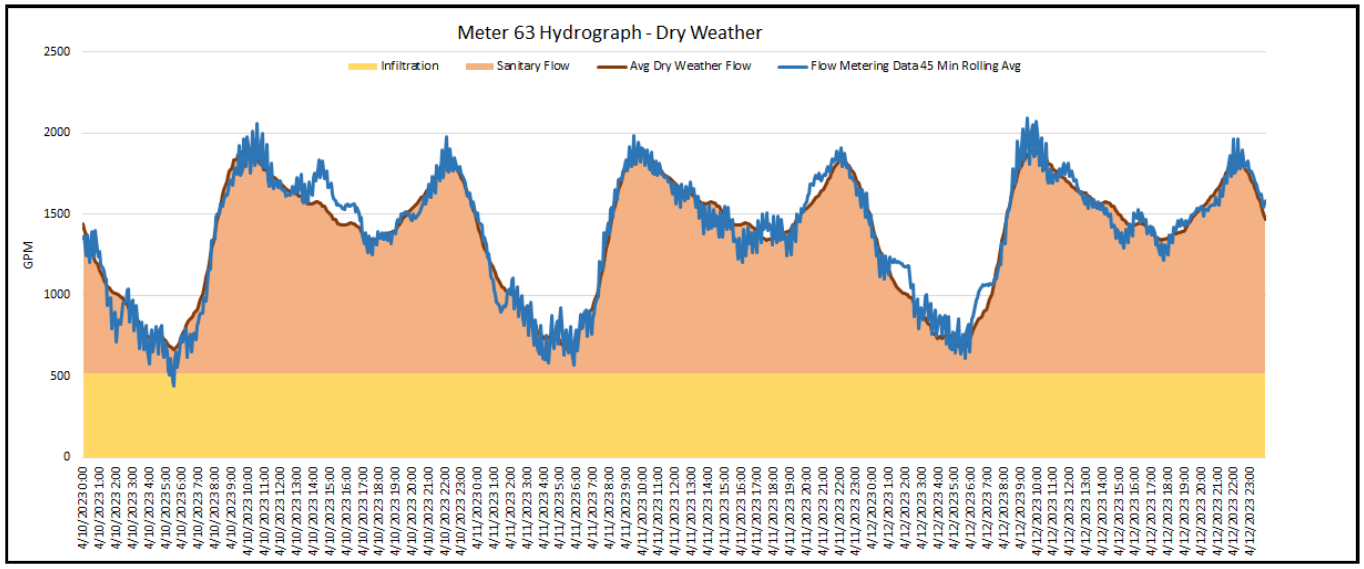

Meter 57 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
120
100
80
60
40
20
0

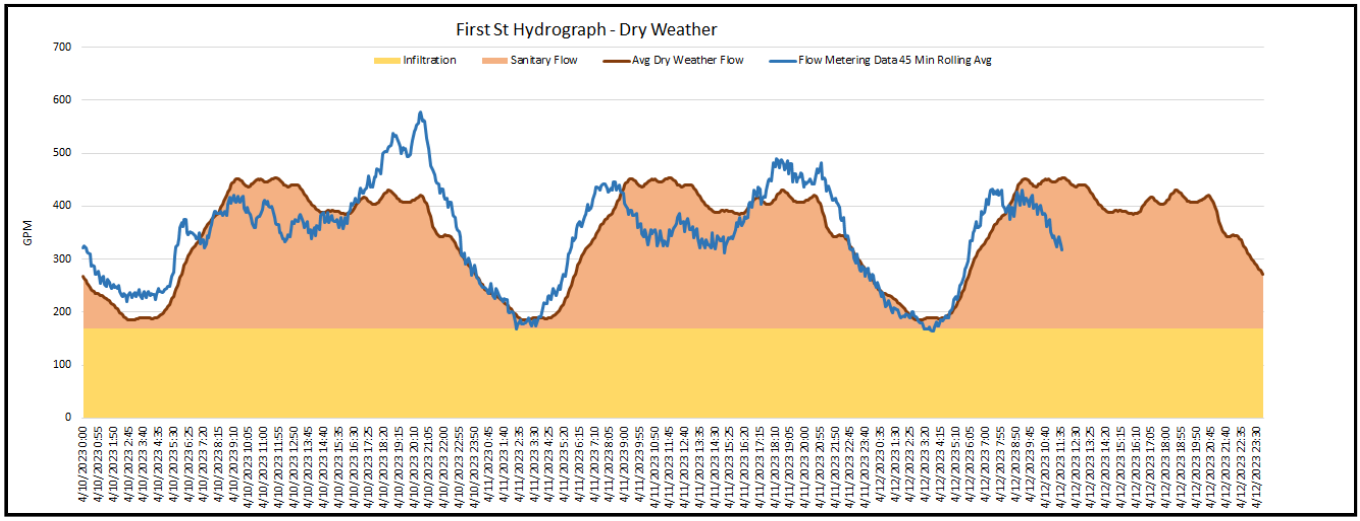

Meter 59 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
140
120
100
80
60
40
20
0

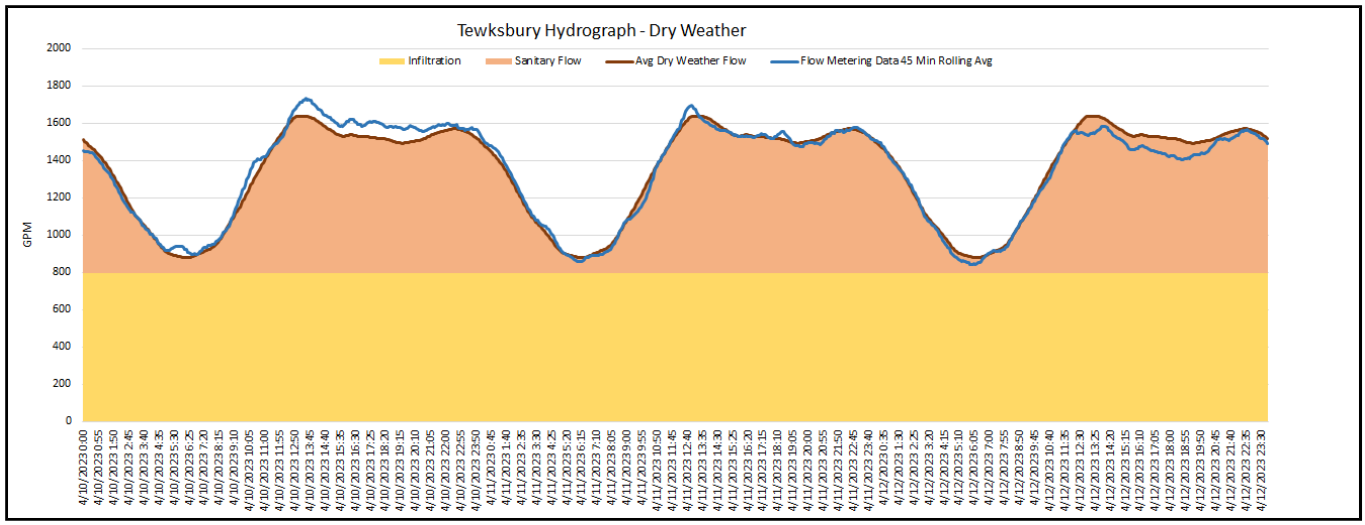

Meter 60 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM


Meter 61 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

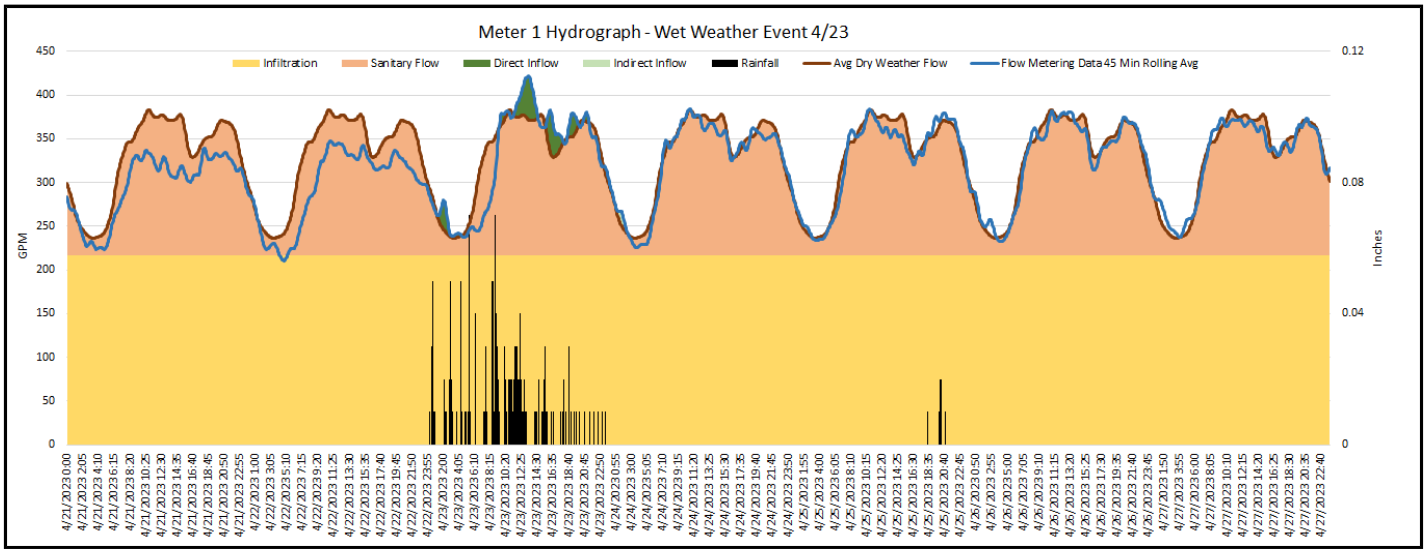

Meter 62 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM

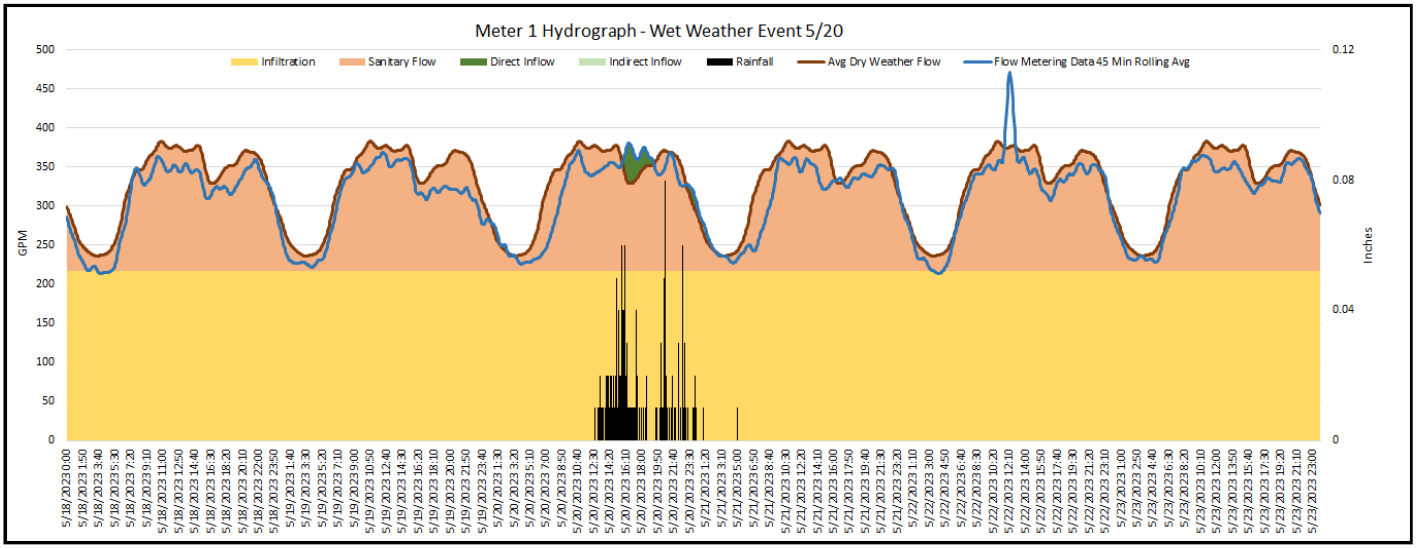

Meter 63 Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
2500
2000
1500
1000
500
0

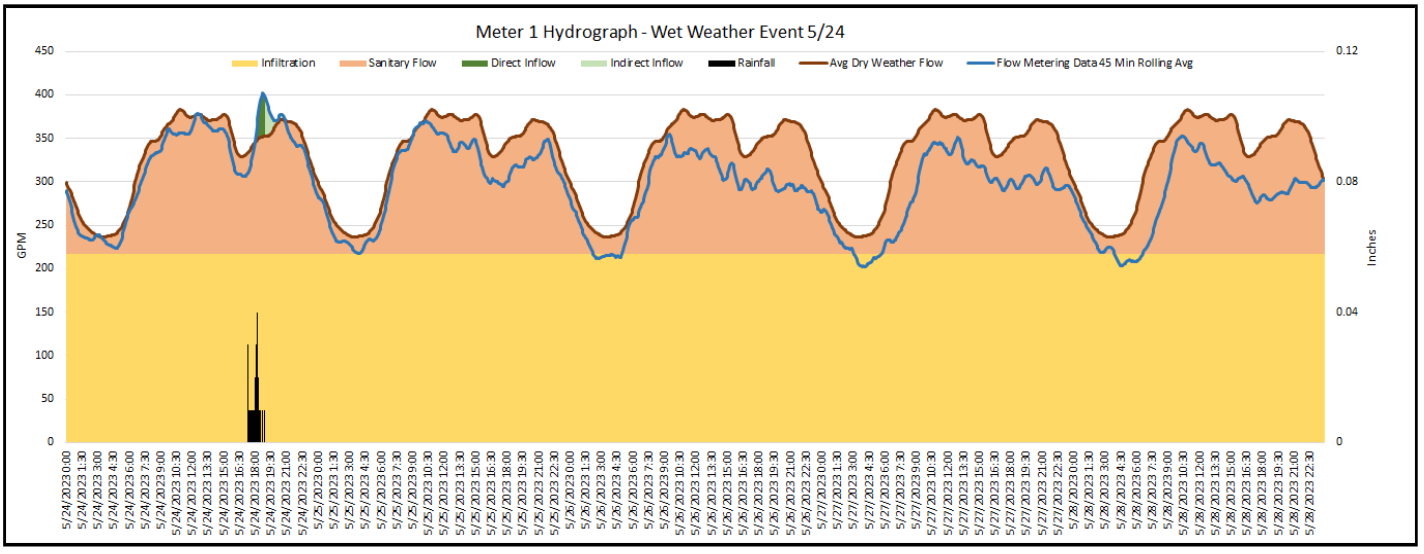

First St Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
700
600
500
400
300
200
100
0

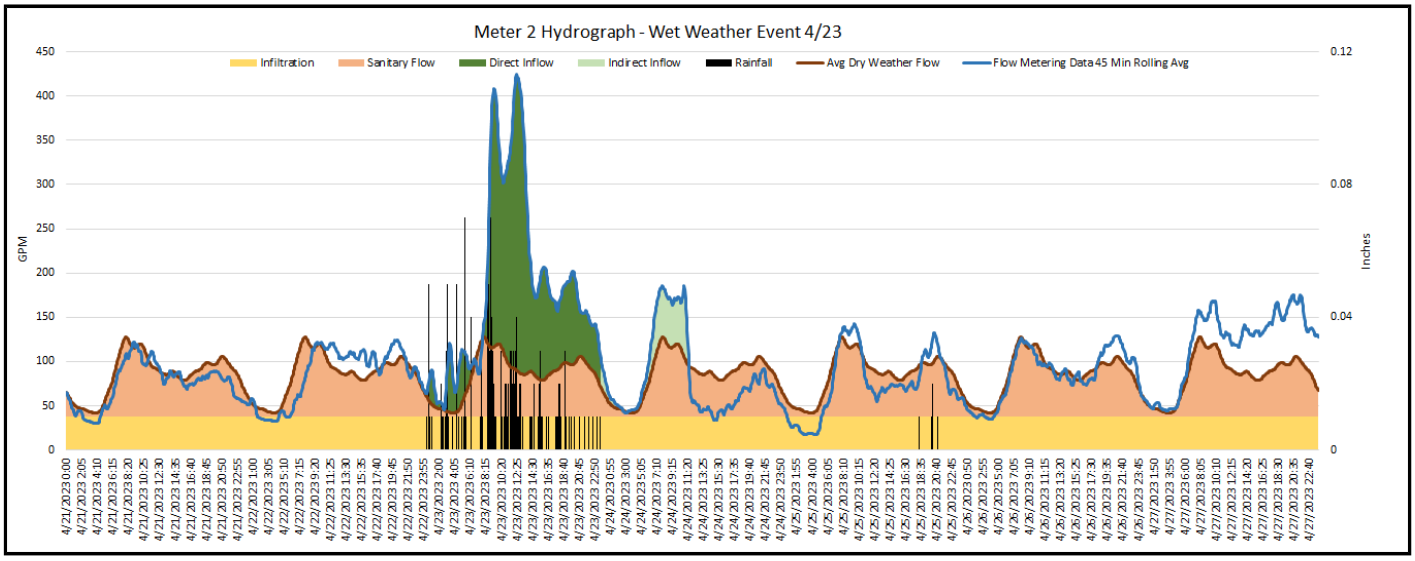

Tewksbury Hydrograph - Dry Weather
Infiltration
Sanitary Flow
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
2000
1800
1600
1400
1200
1000
800
600
400
200
0

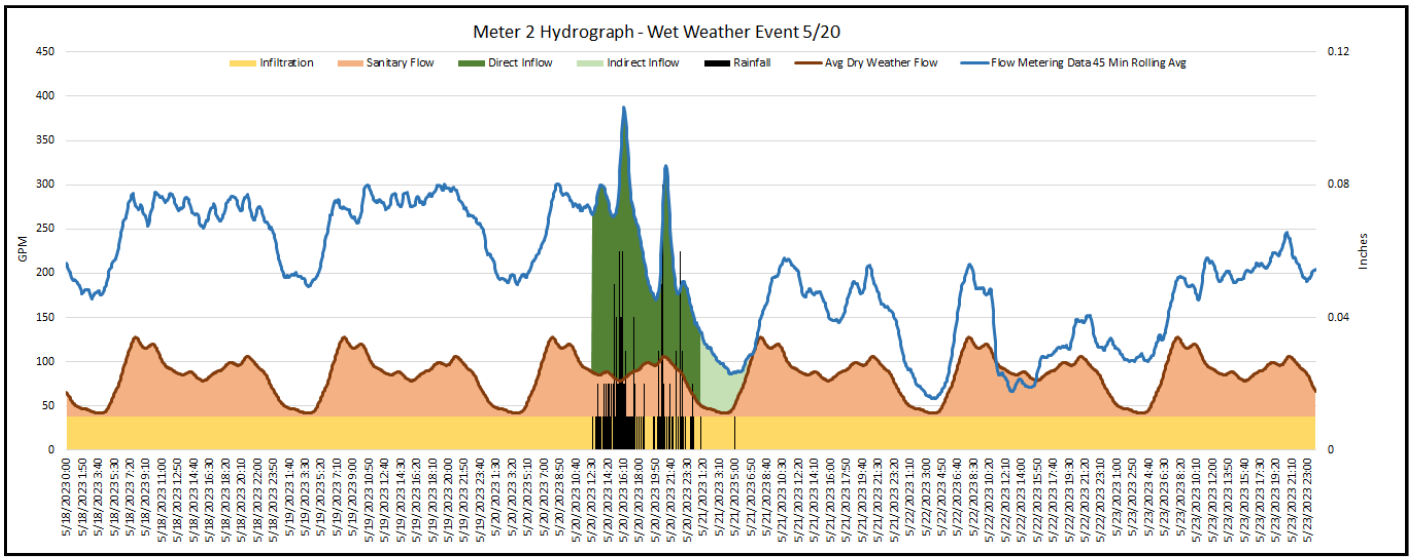
APPENDIX C - WET WEATHER HYDROGRAPHS

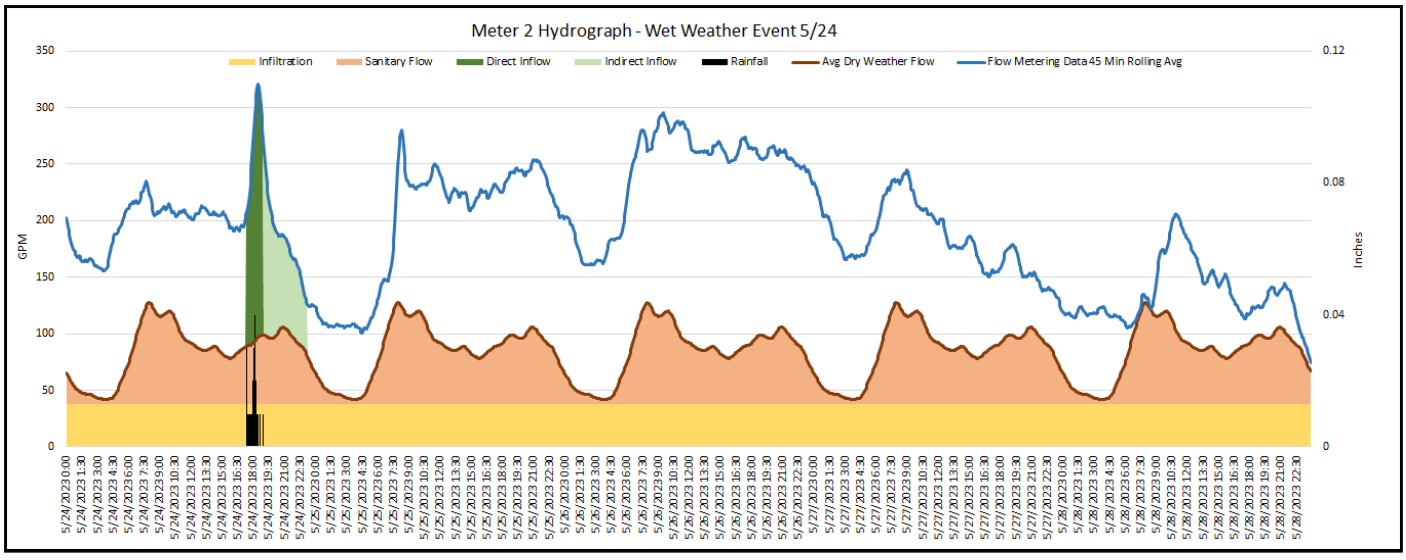

Meter 1 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

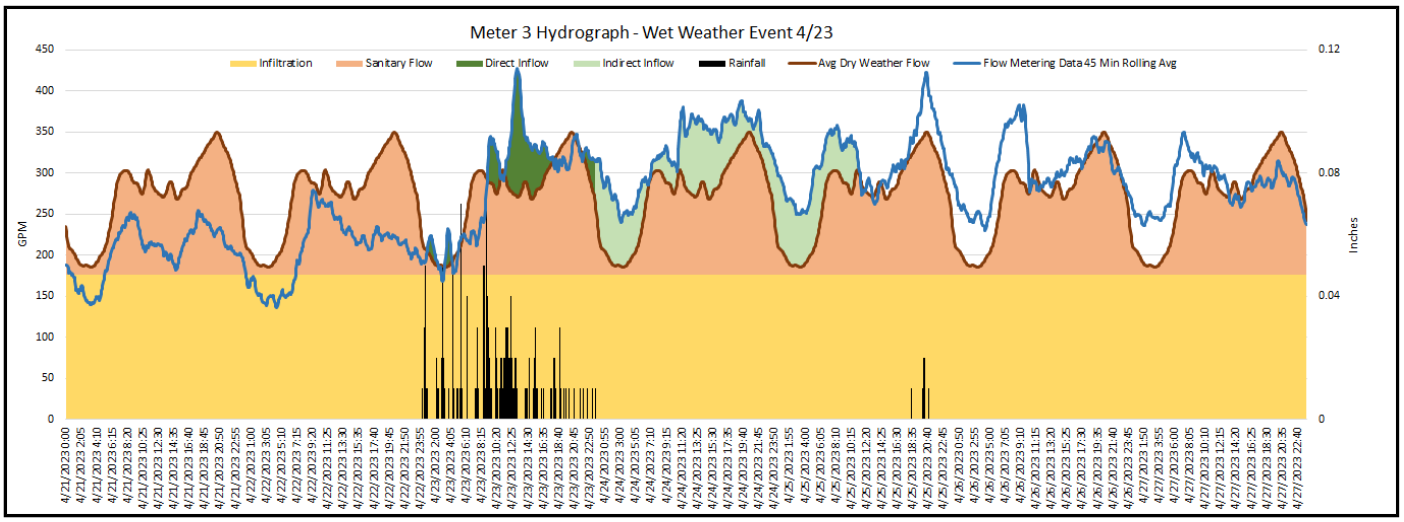

Meter 1 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

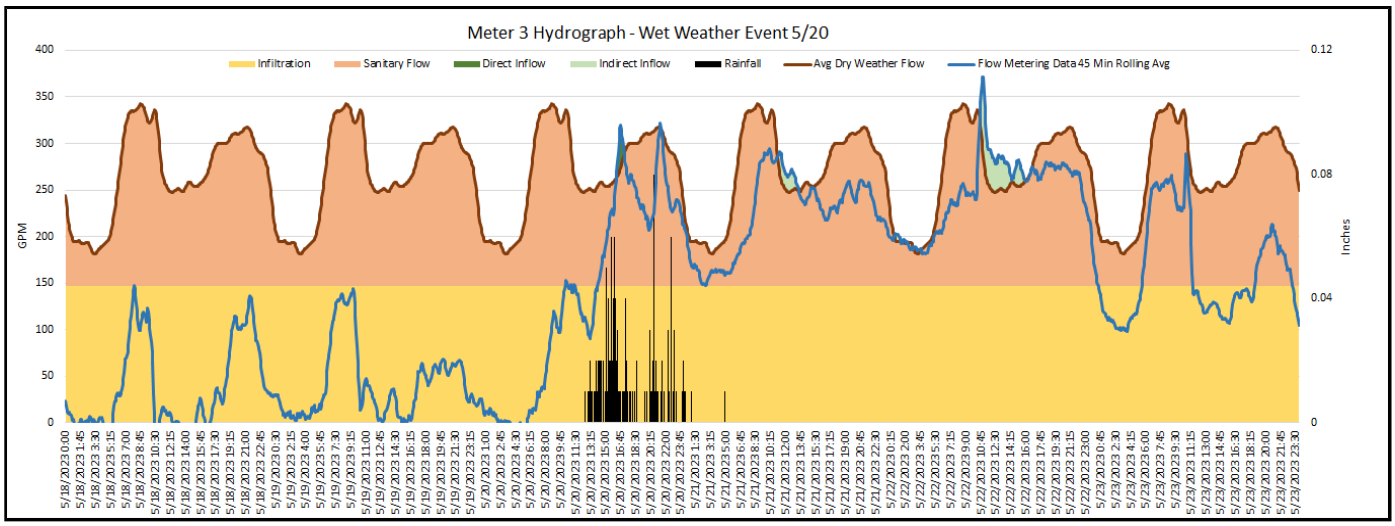

Meter 1 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

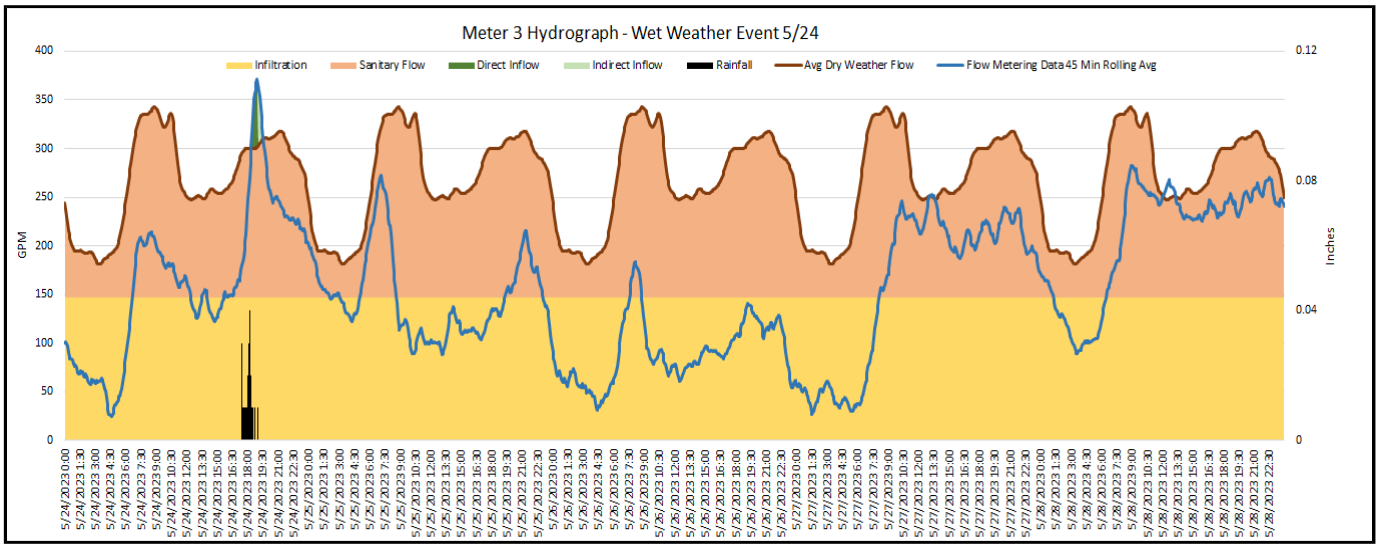

Meter 2 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

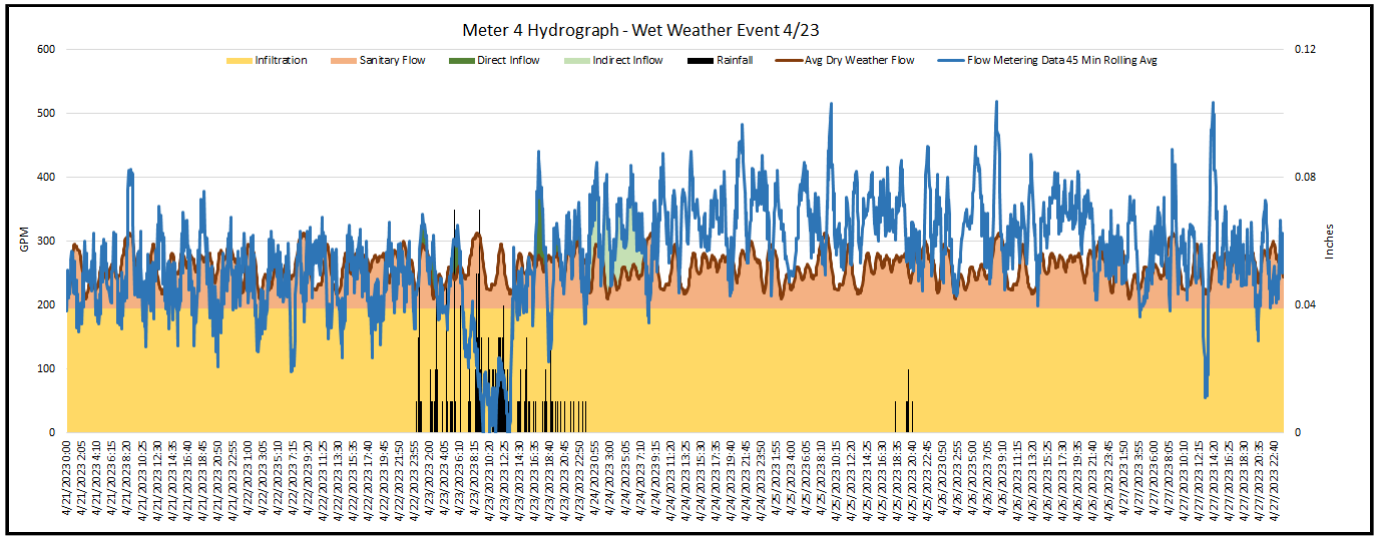

Meter 2 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

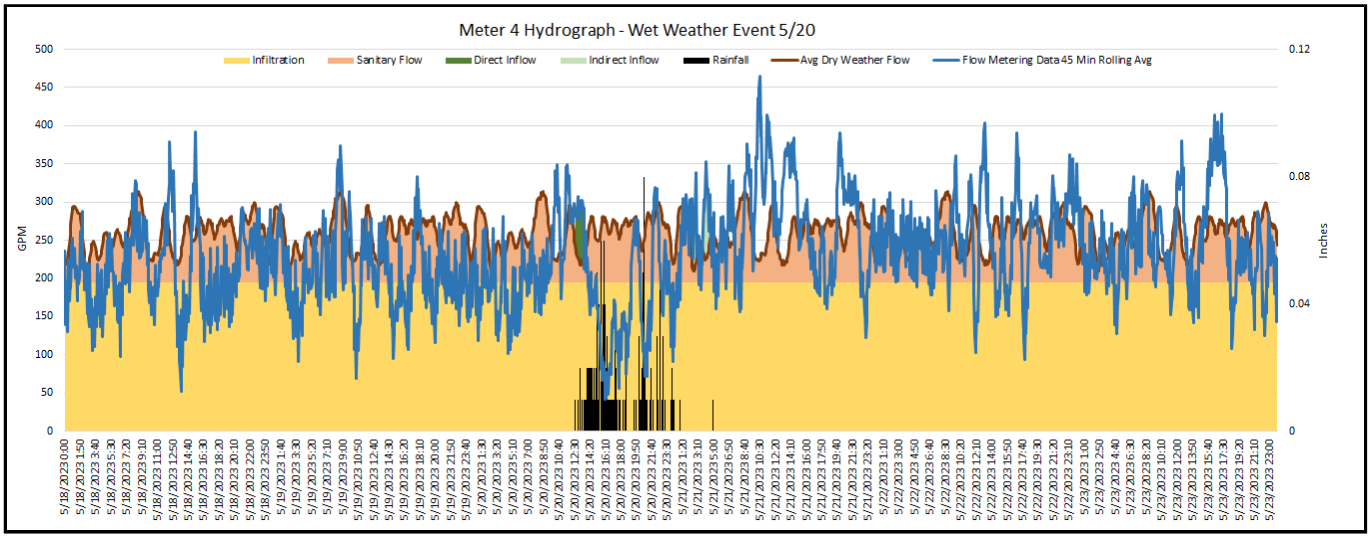

Meter 2 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

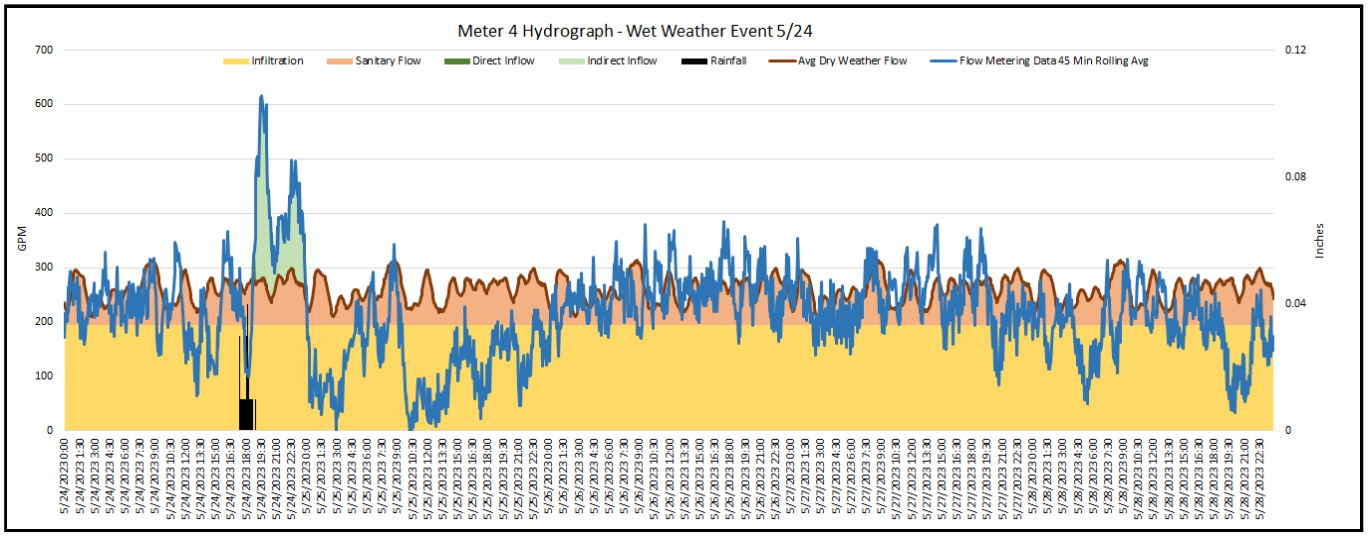

Meter 3 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

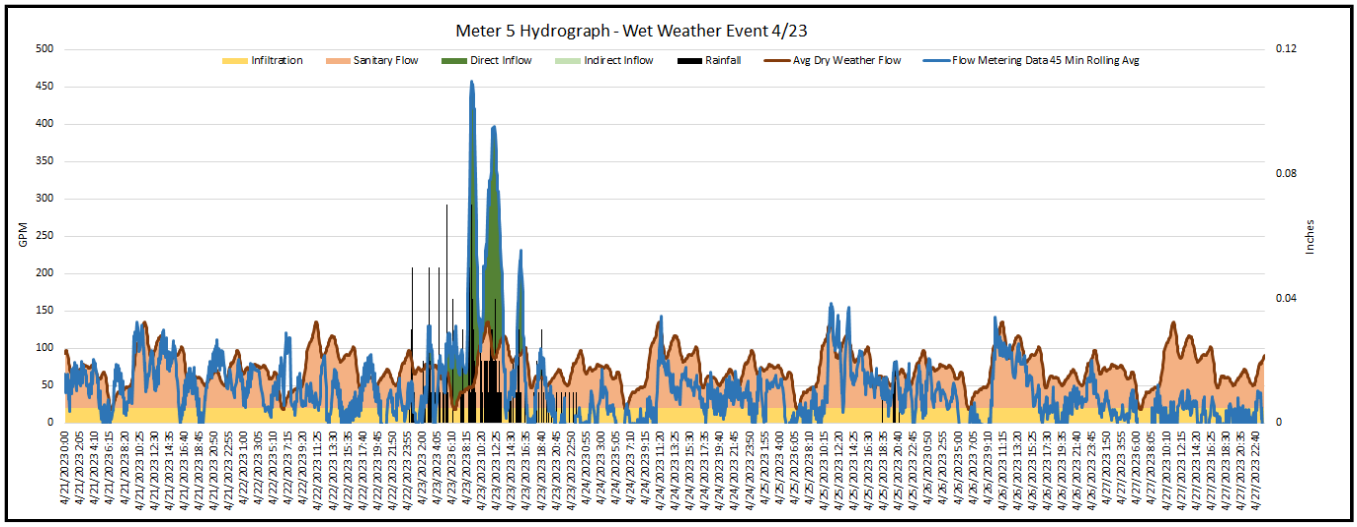

Meter 3 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

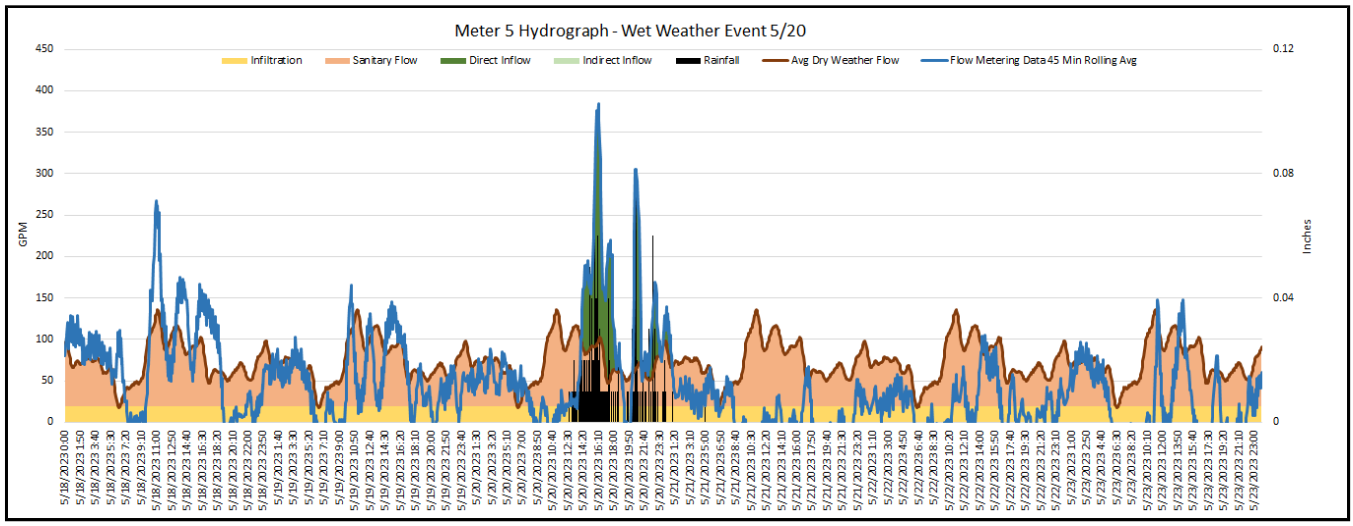

Meter 3 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

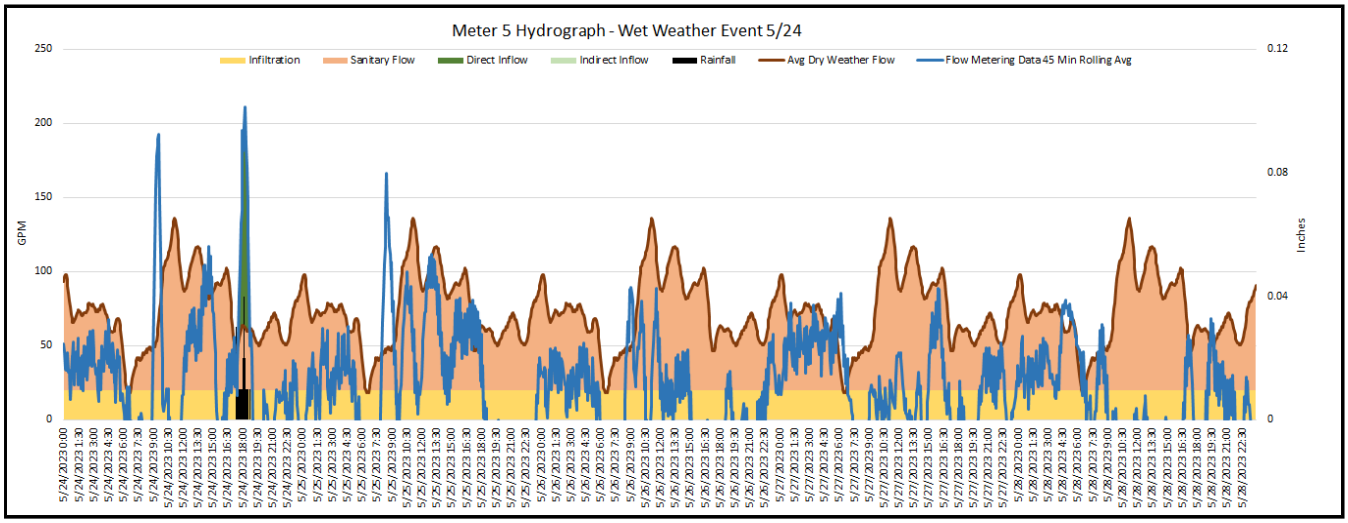

Meter 4 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

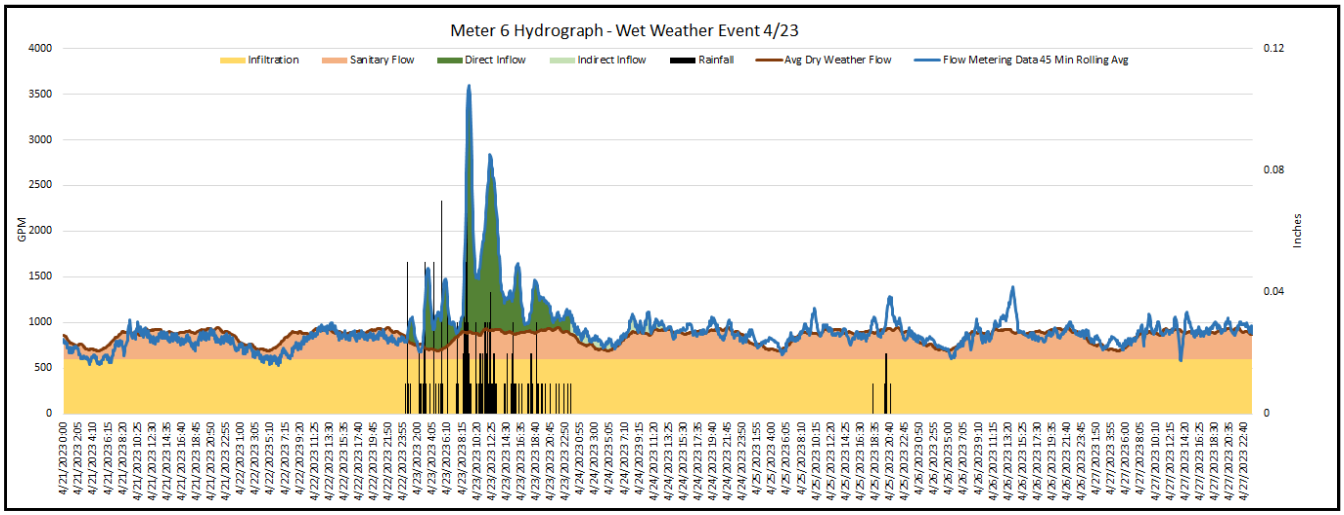

Meter 4 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

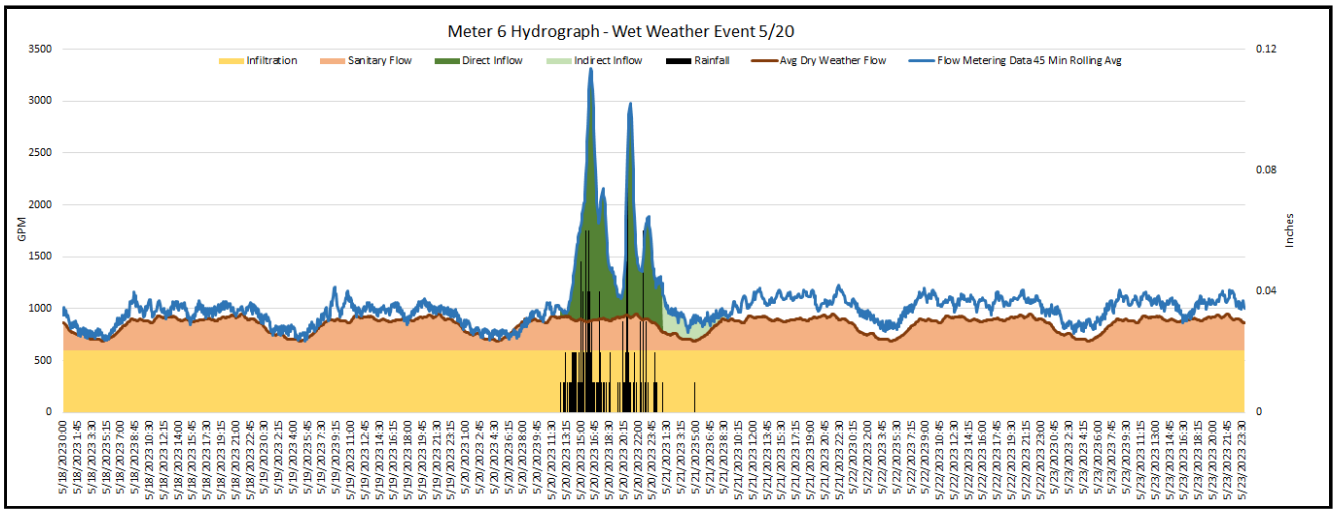

Meter 4 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

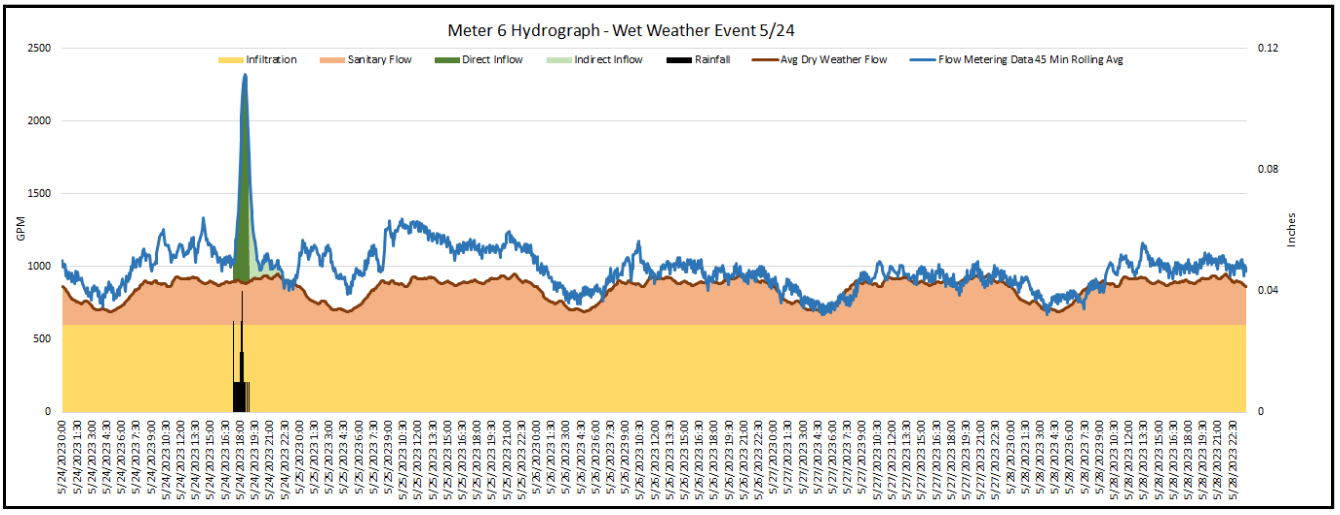

Meter 5 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

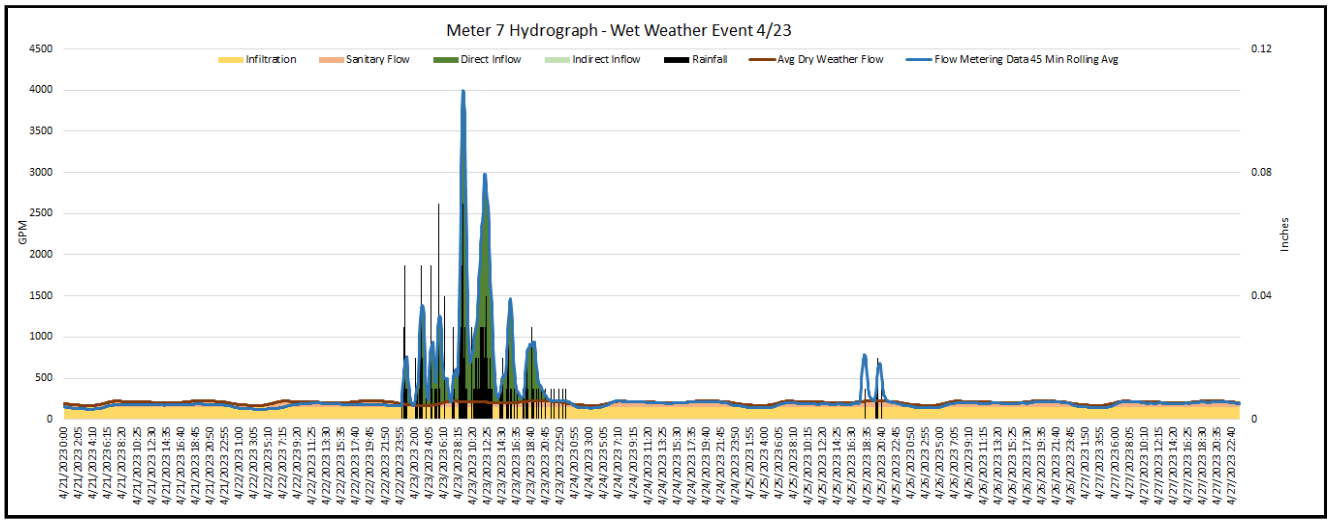

Meter 5 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

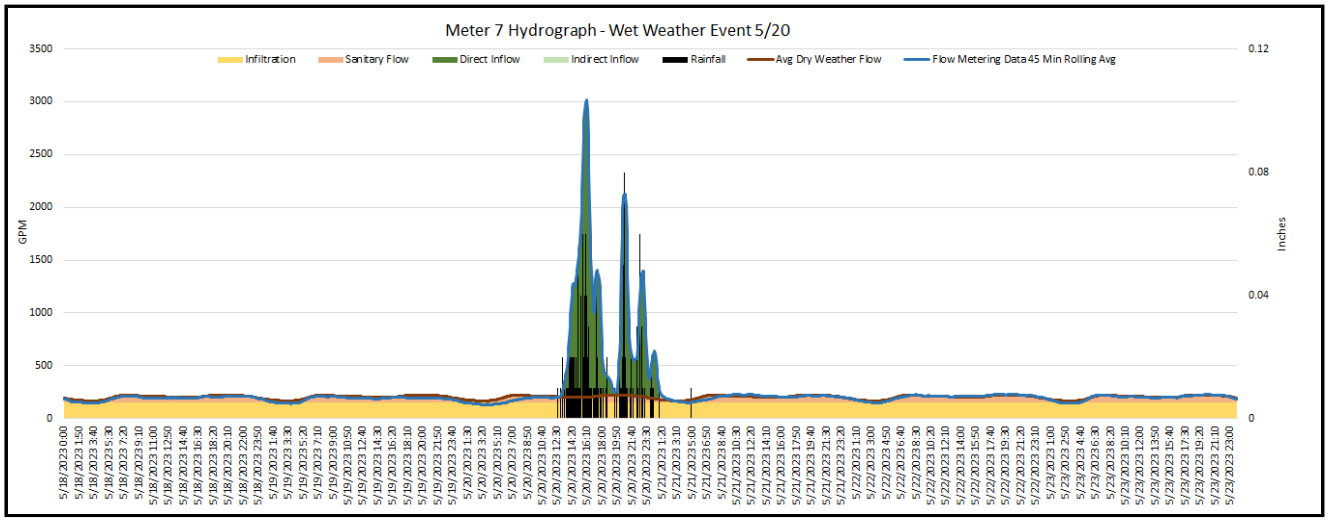

Meter 5 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

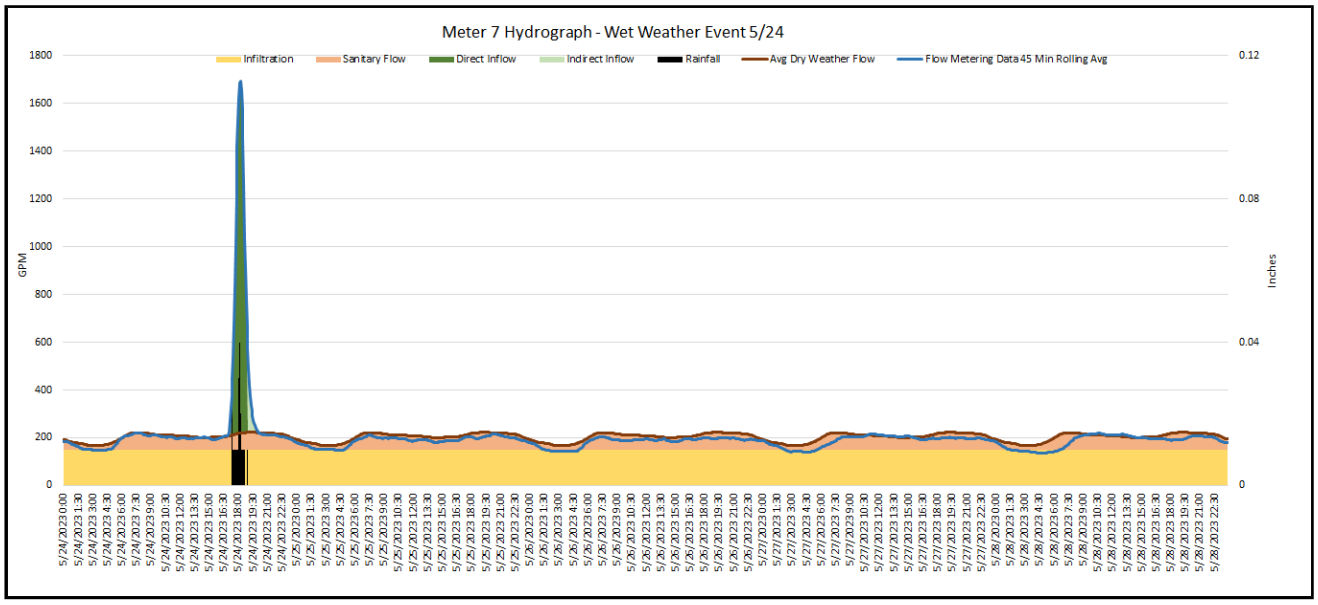

Meter 6 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

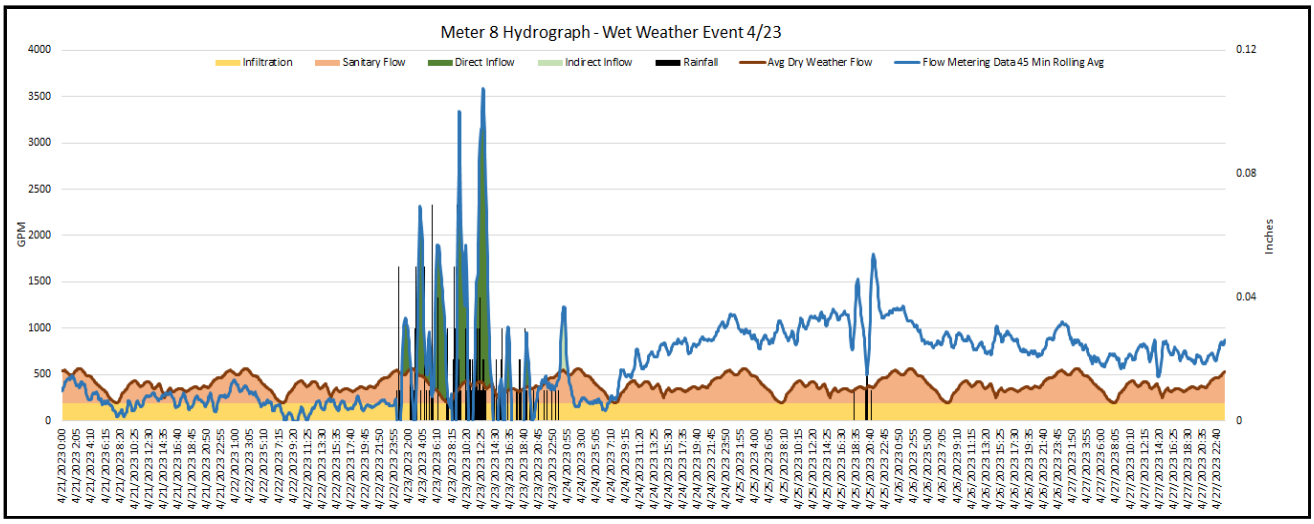

Meter 6 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

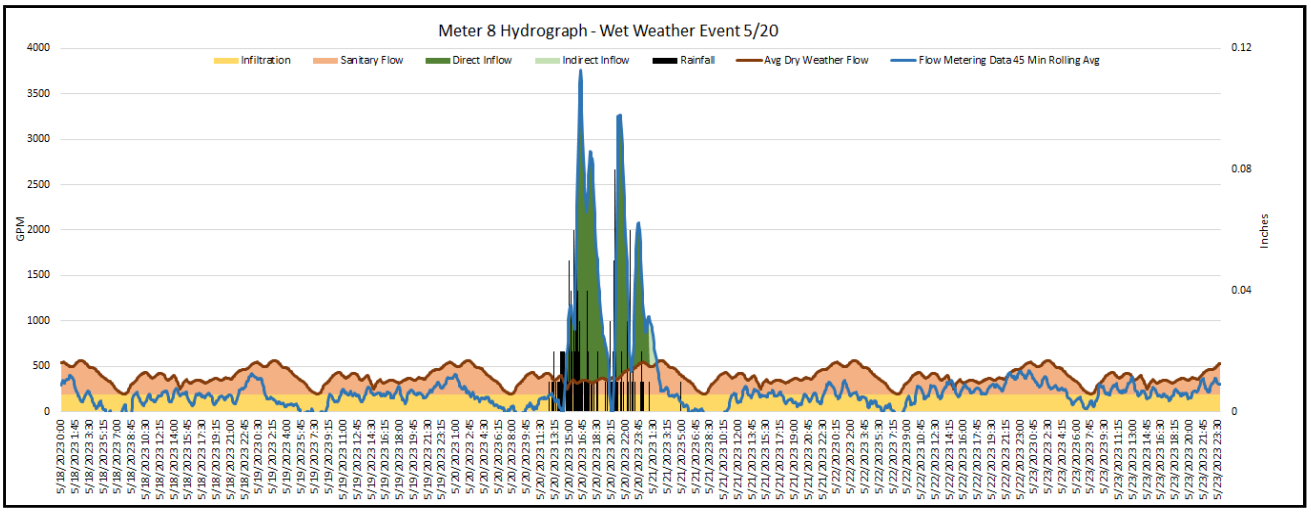

Meter 6 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

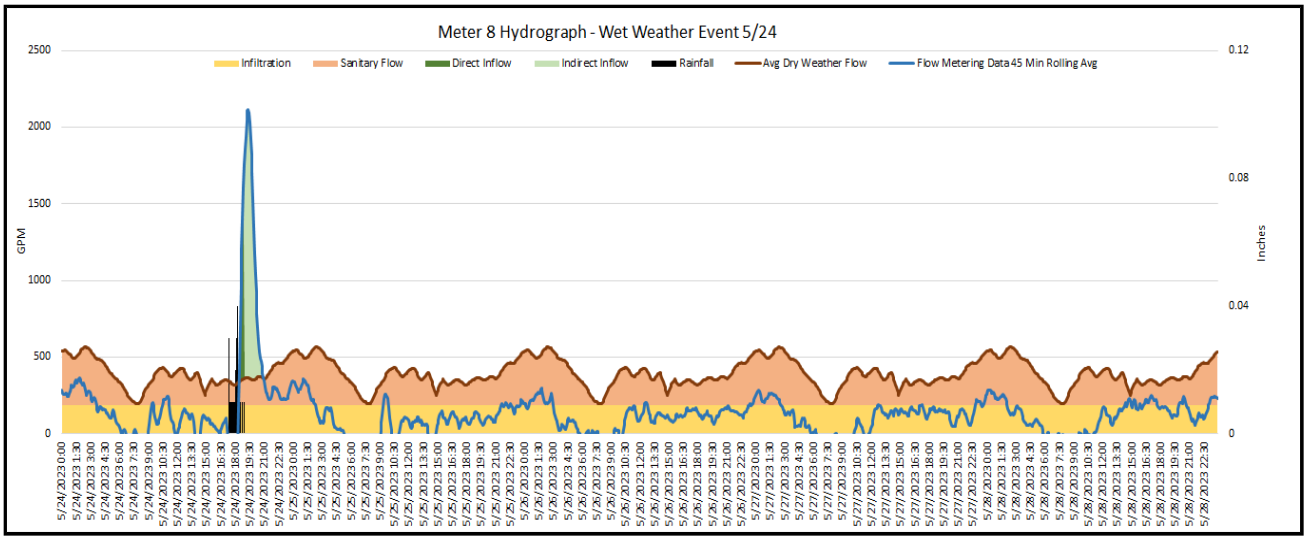

Meter 7 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

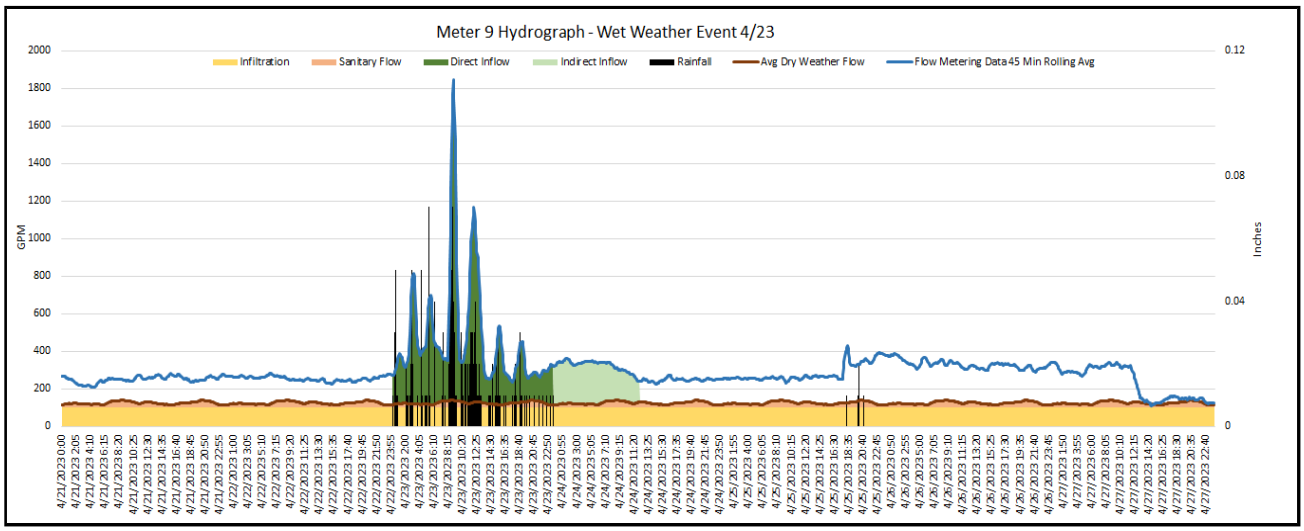

Meter 7 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

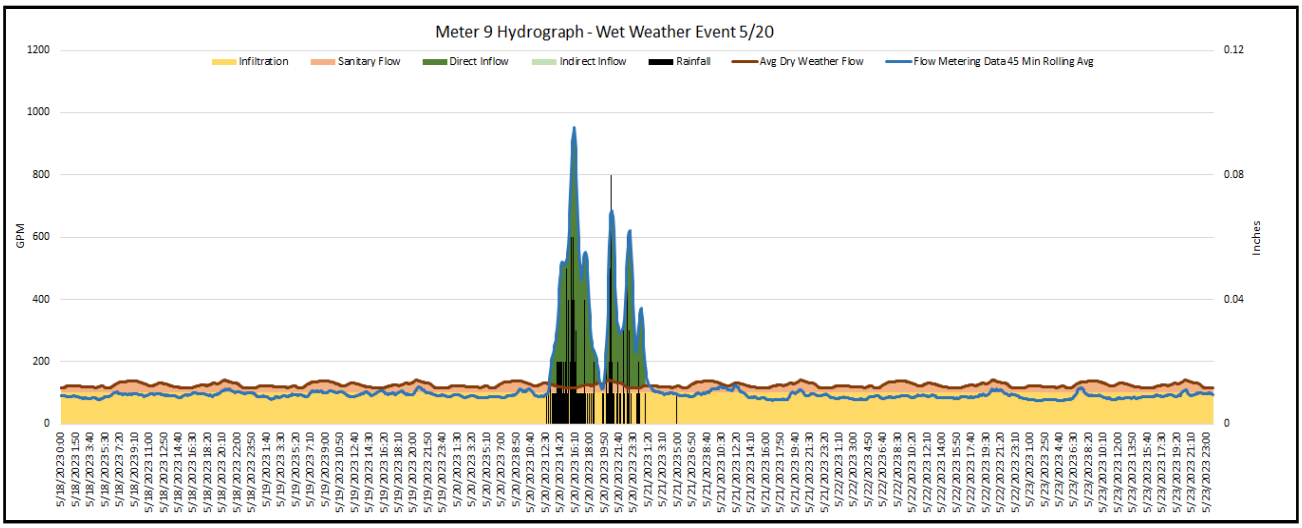

Meter 7 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

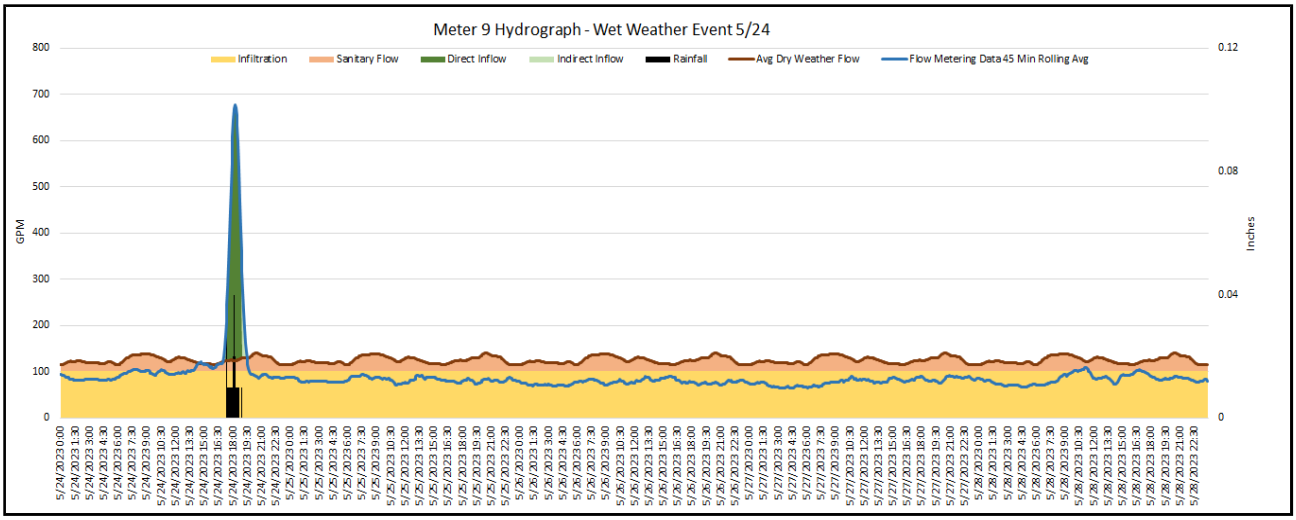

Meter 8 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

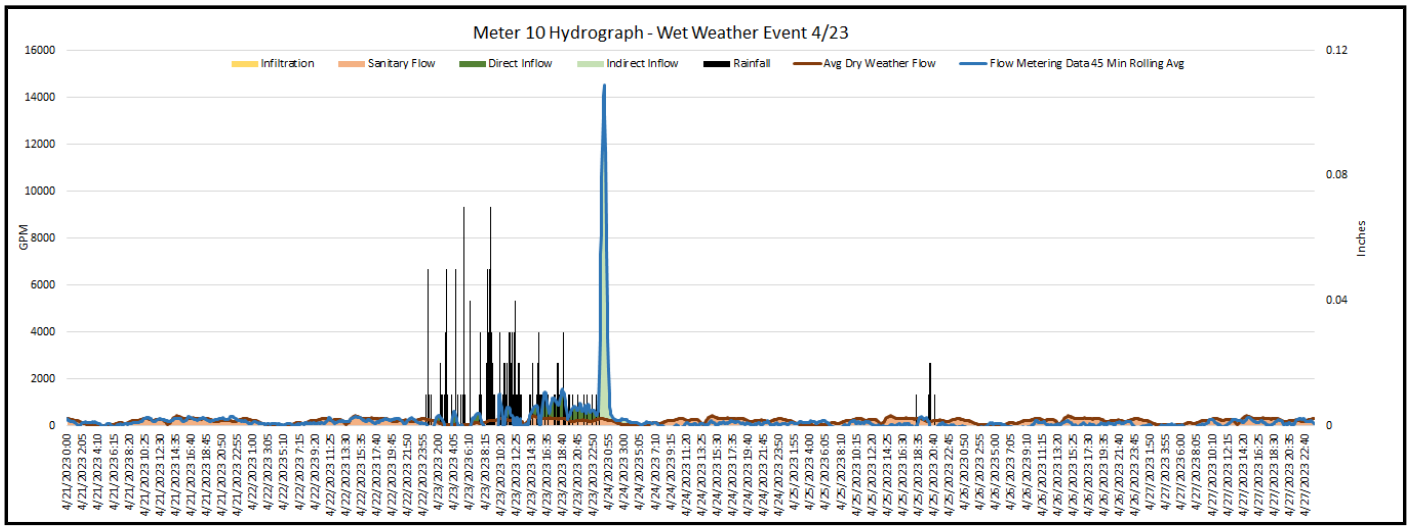

Meter 8 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

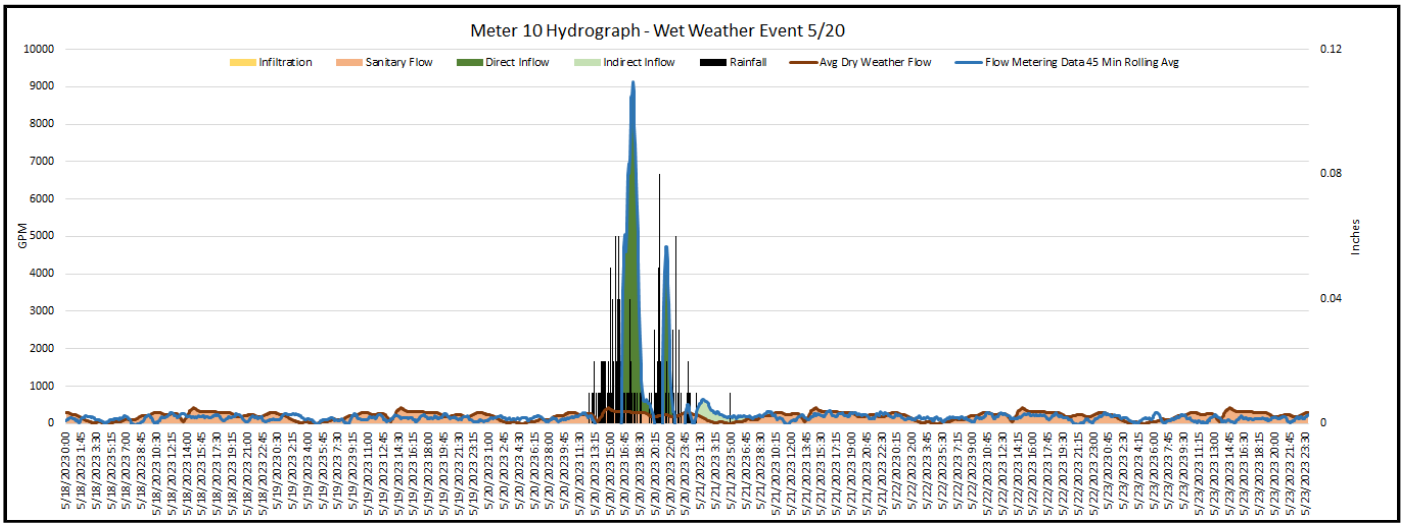

Meter 8 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

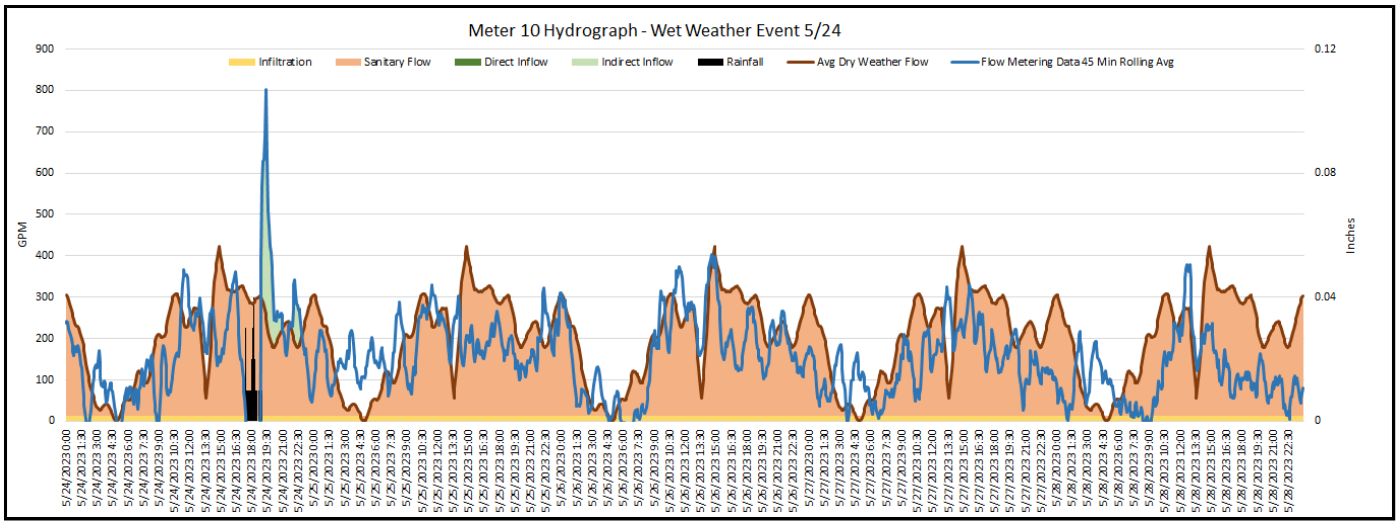

Meter 9 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

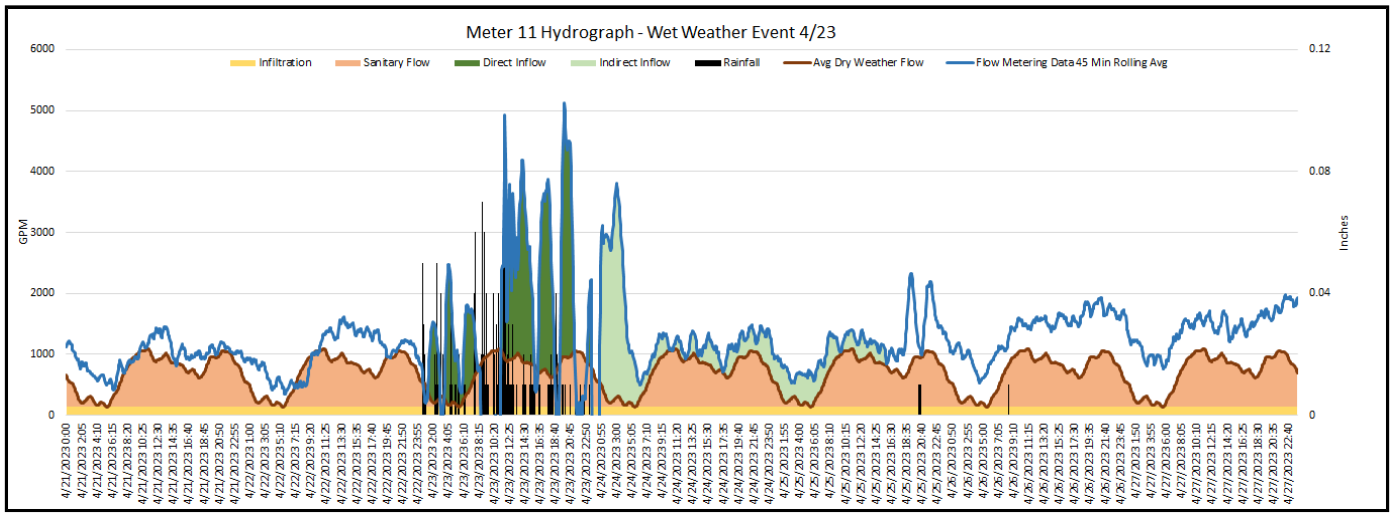

Meter 9 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

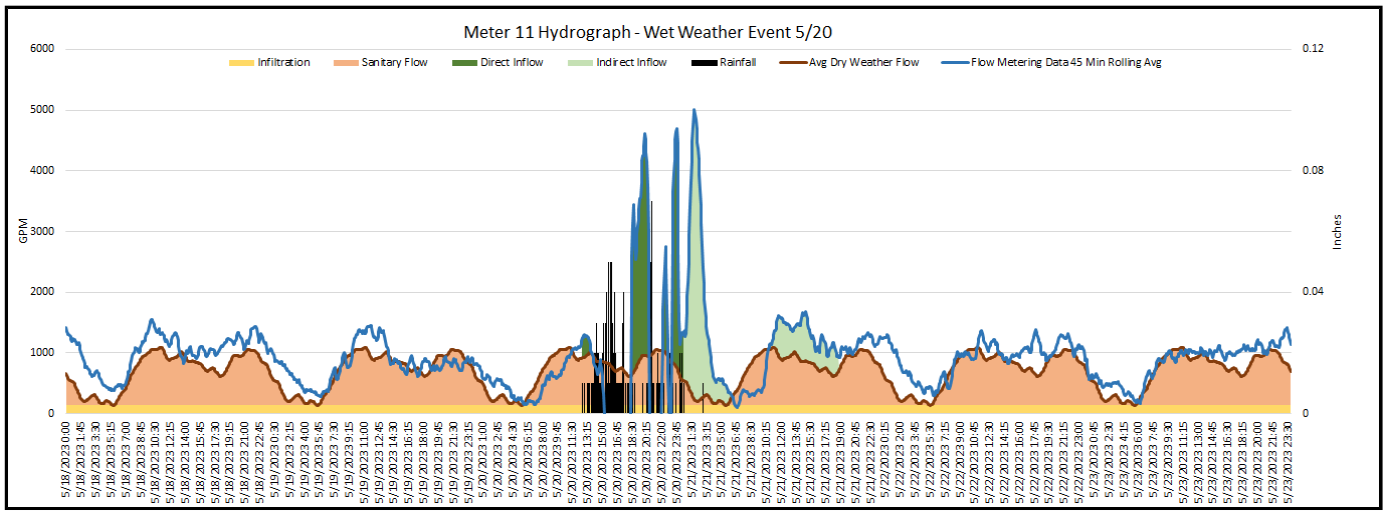

Meter 9 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

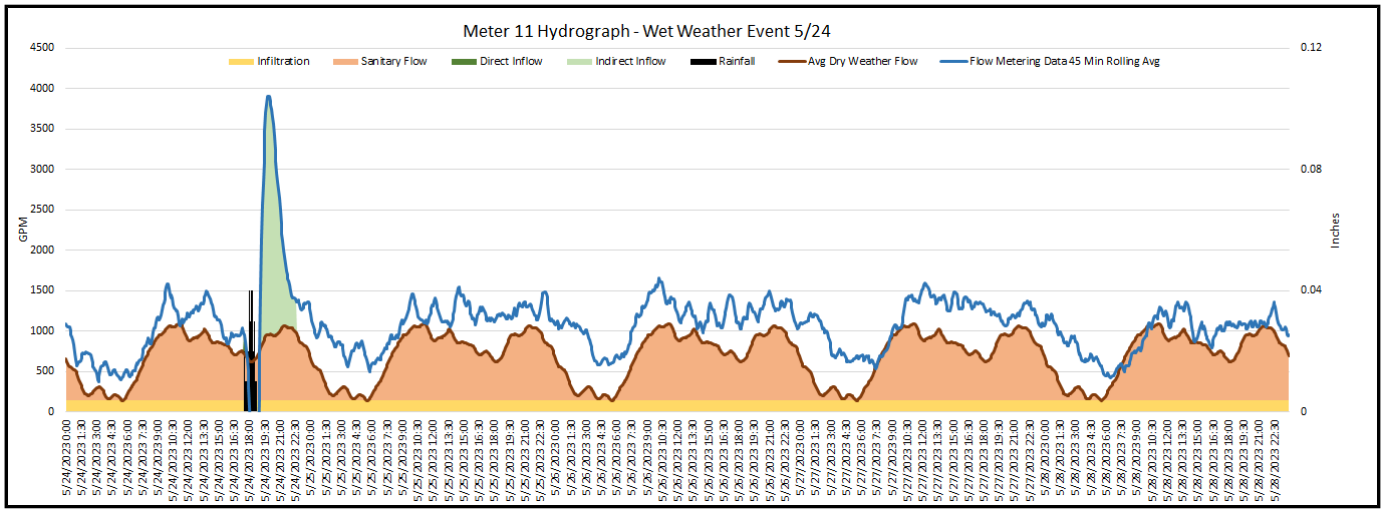

Meter 10 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

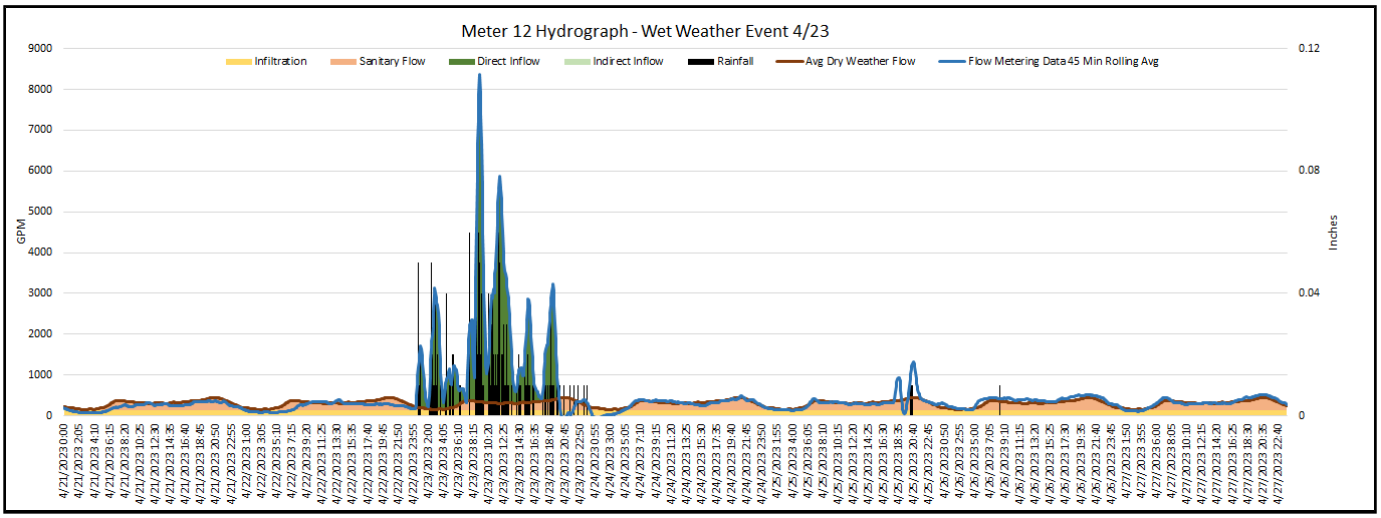

Meter 10 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

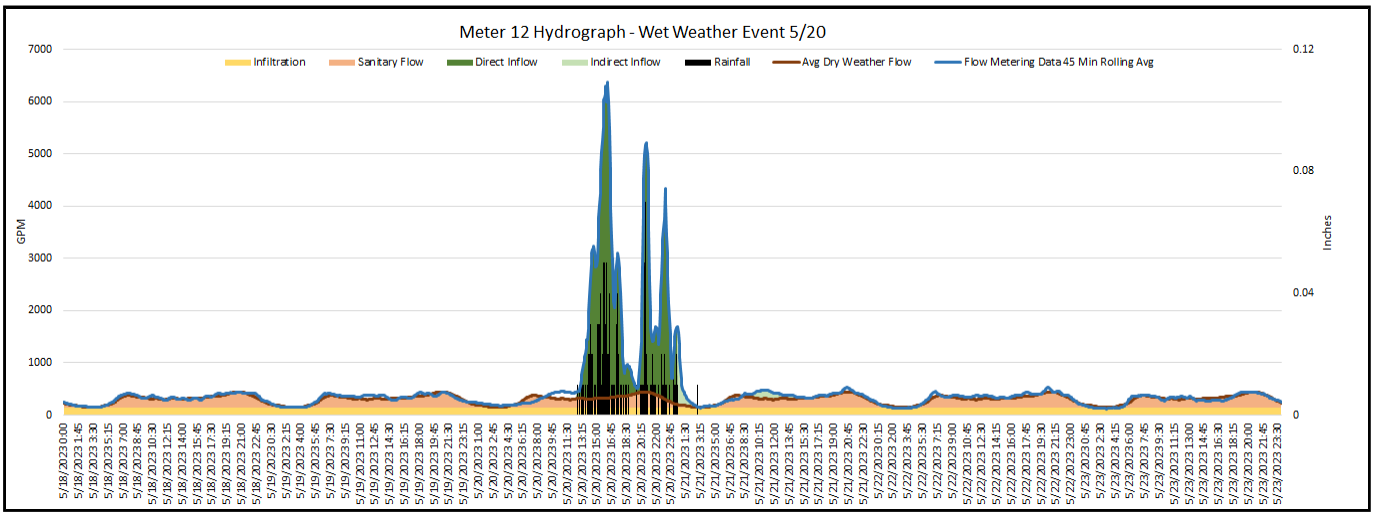

Meter 10 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

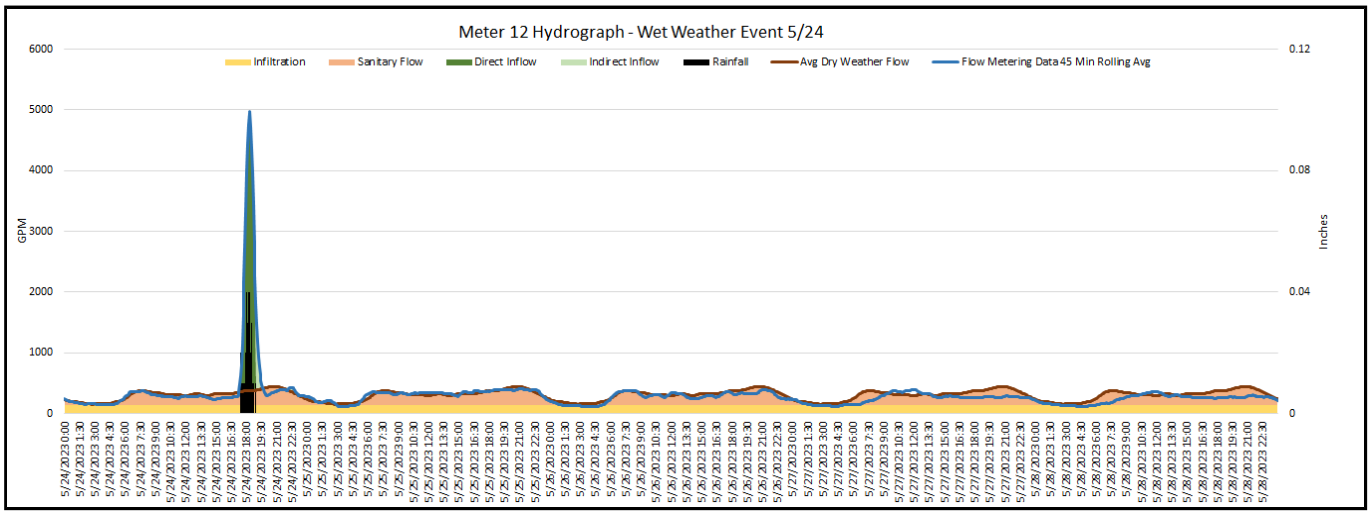

Meter 11 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

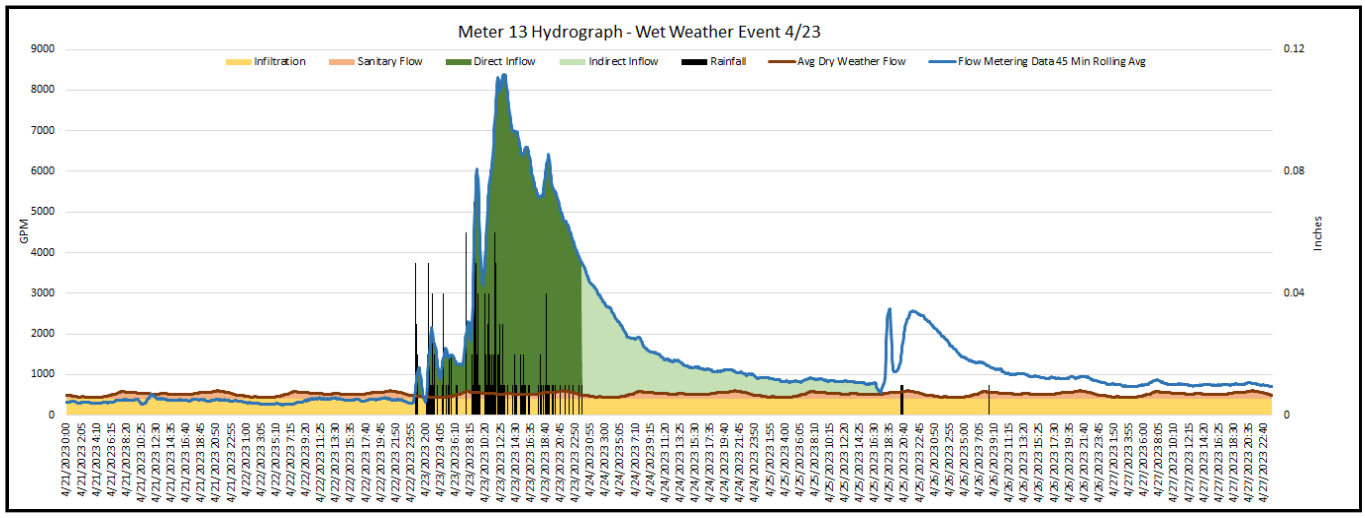

Meter 11 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

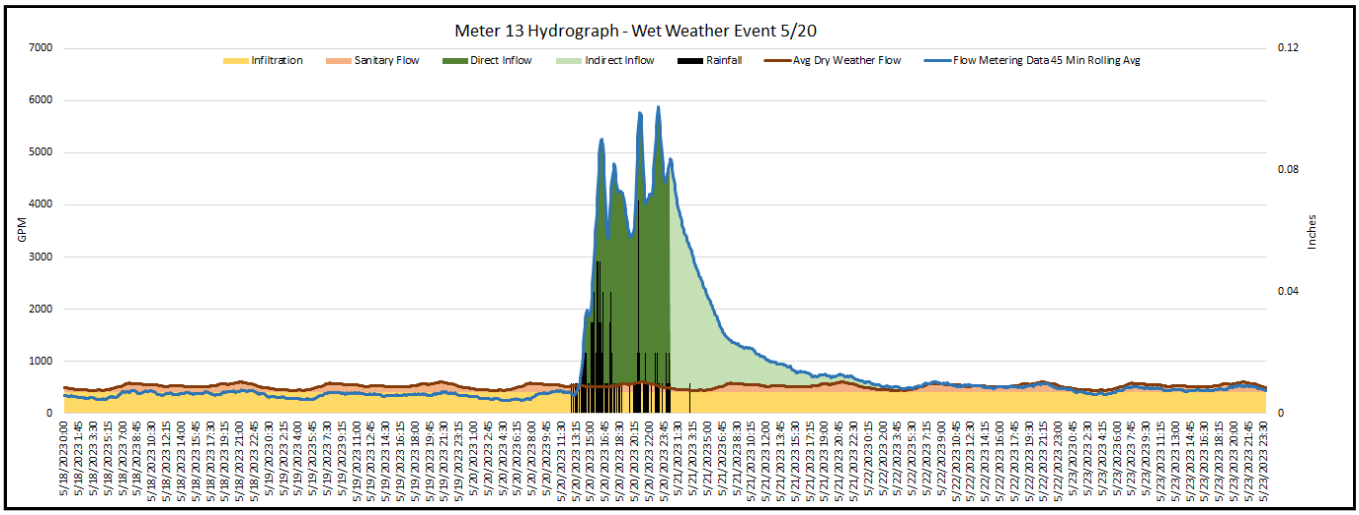

Meter 11 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

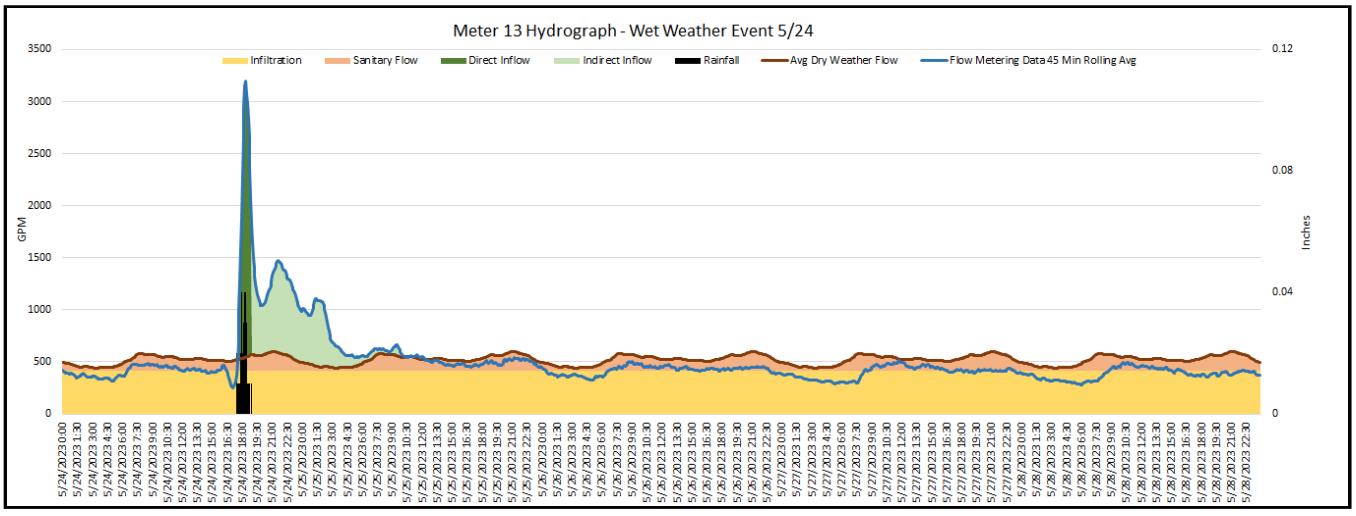

Meter 12 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

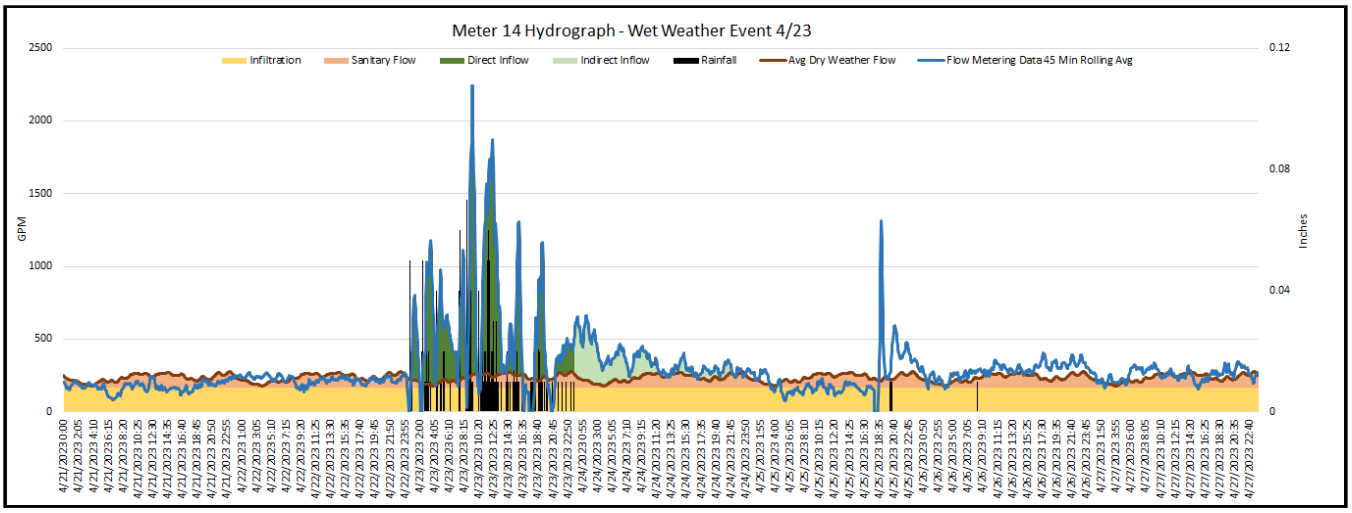

Meter 12 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

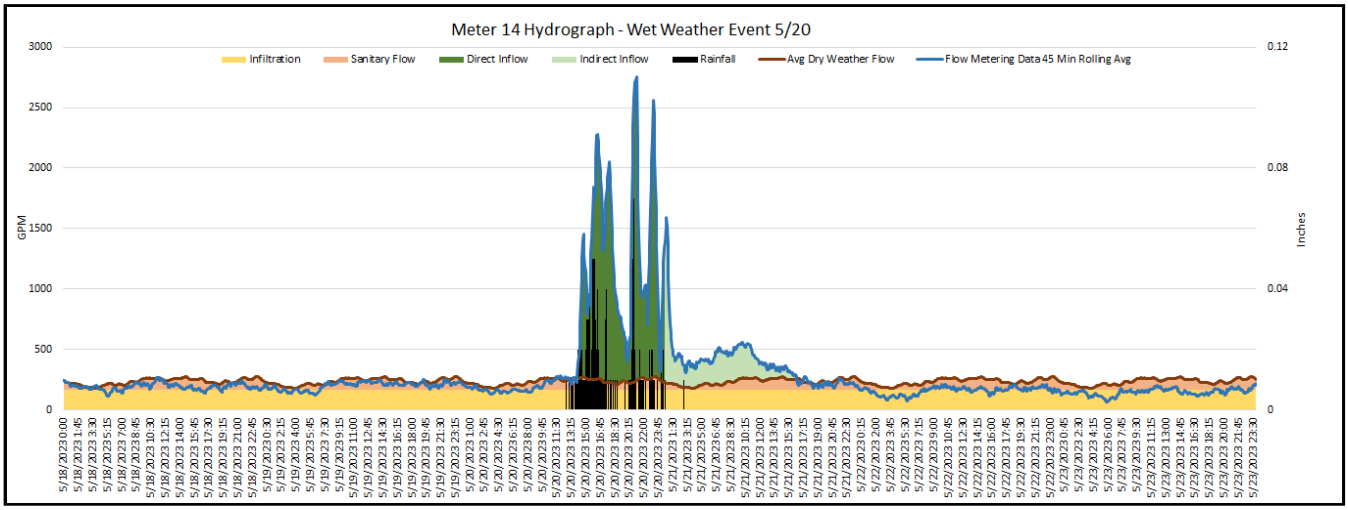

Meter 12 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

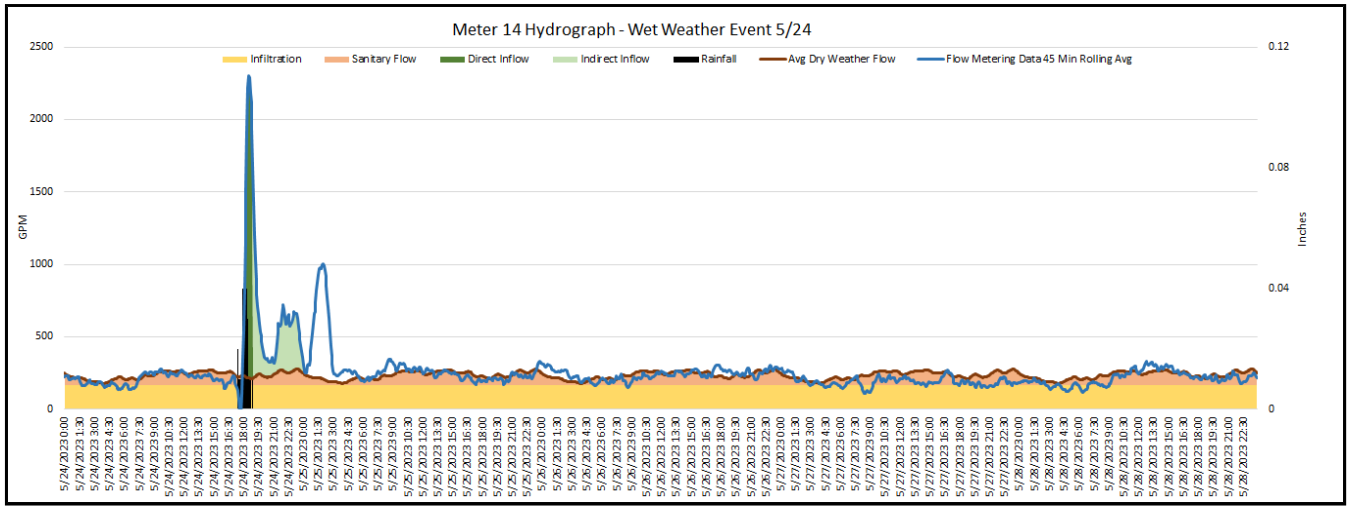

Meter 13 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

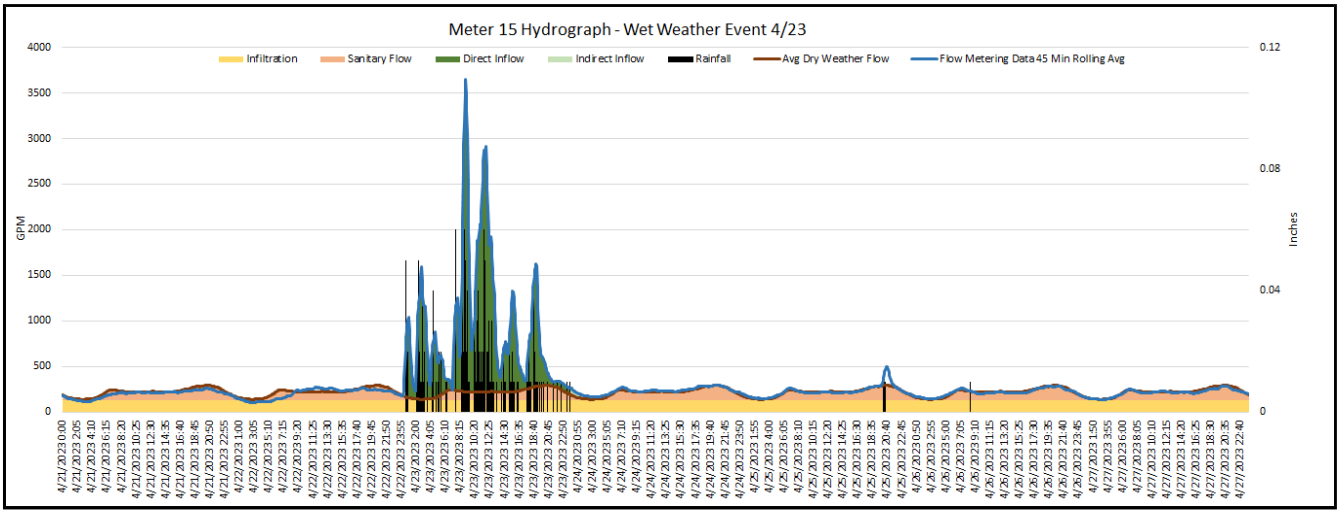

Meter 13 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

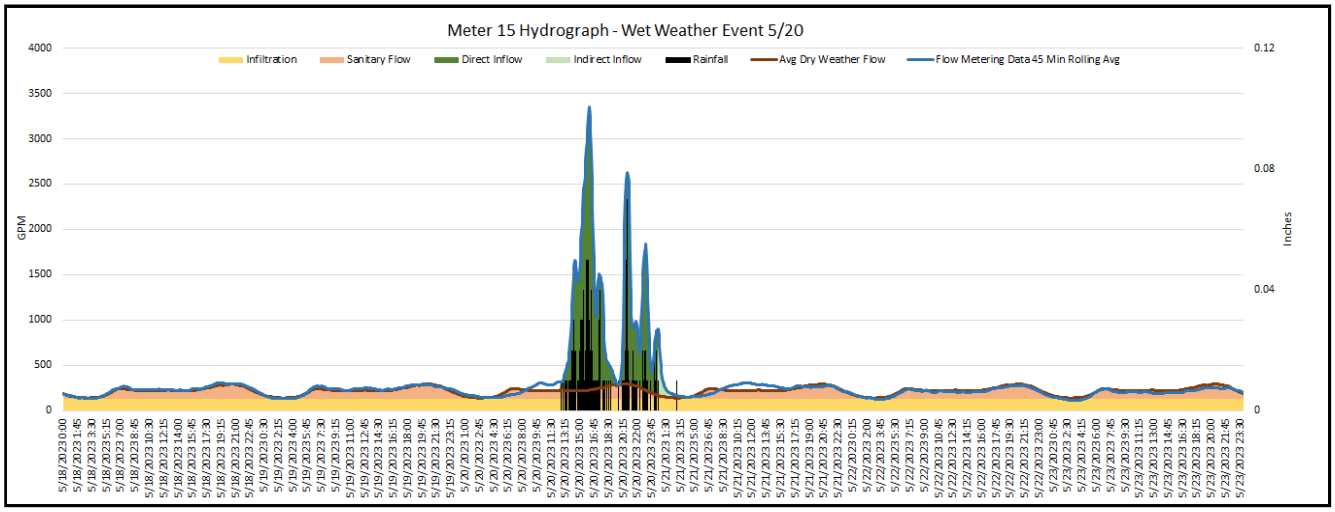

Meter 13 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

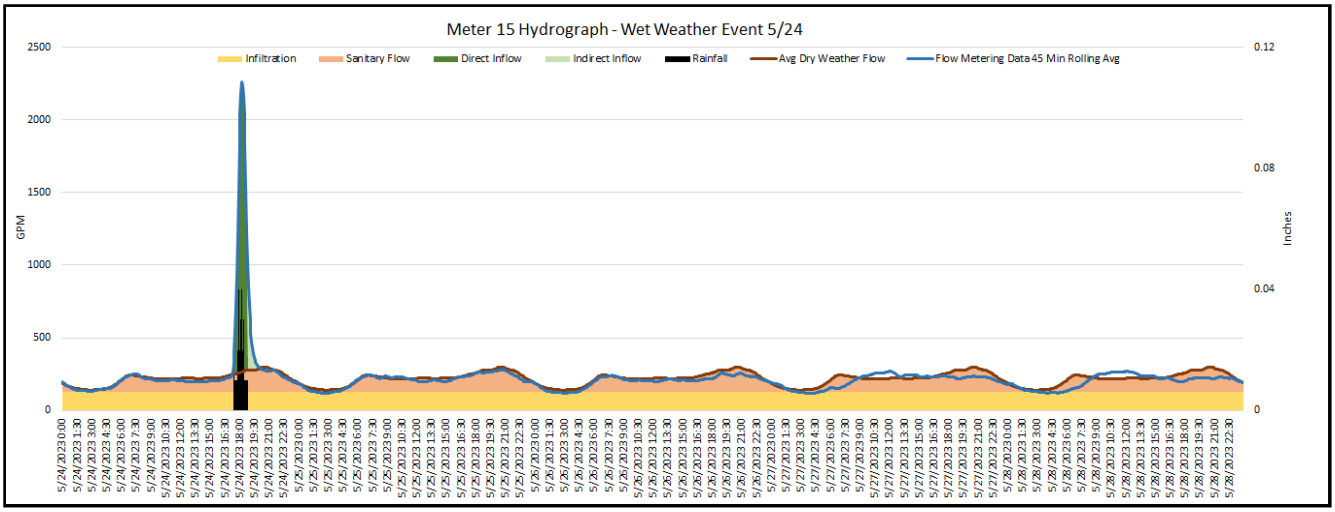

Meter 14 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

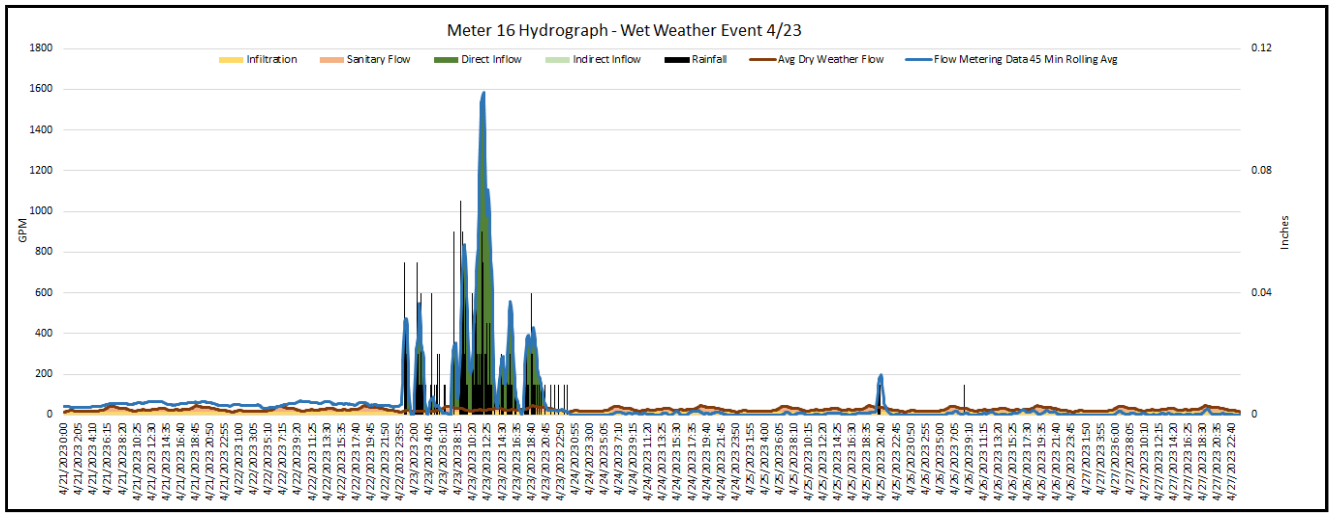

Meter 14 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

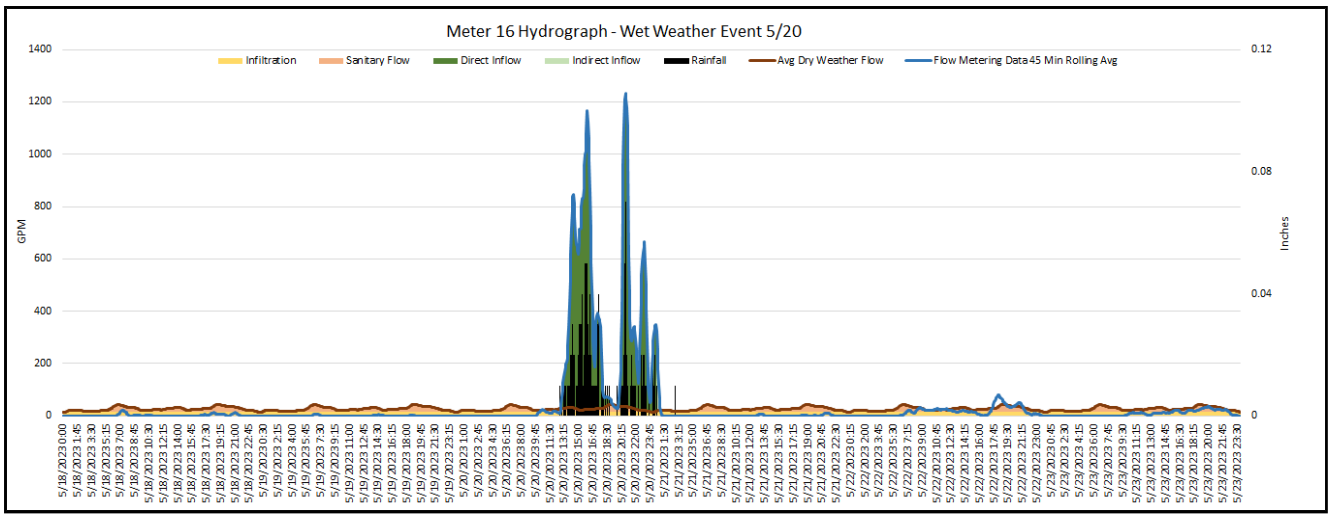

Meter 14 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

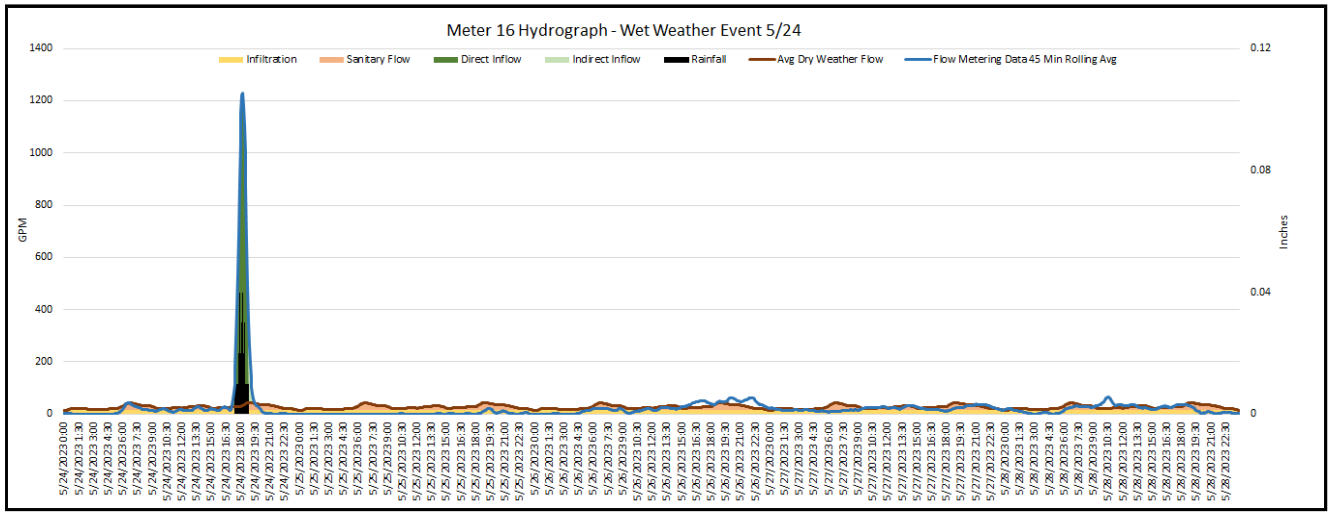

Meter 15 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

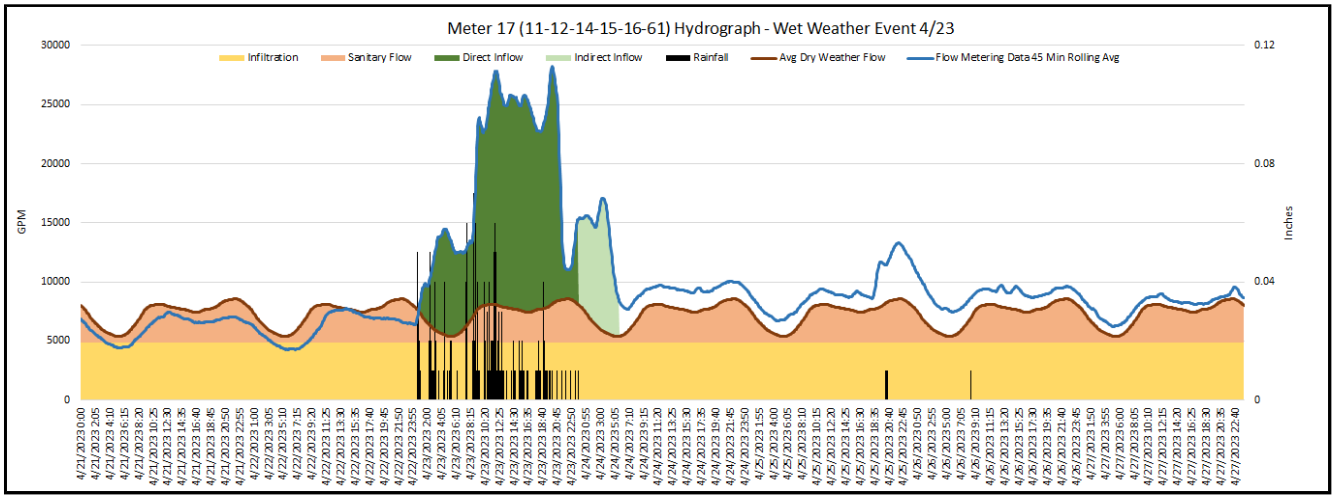

Meter 15 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

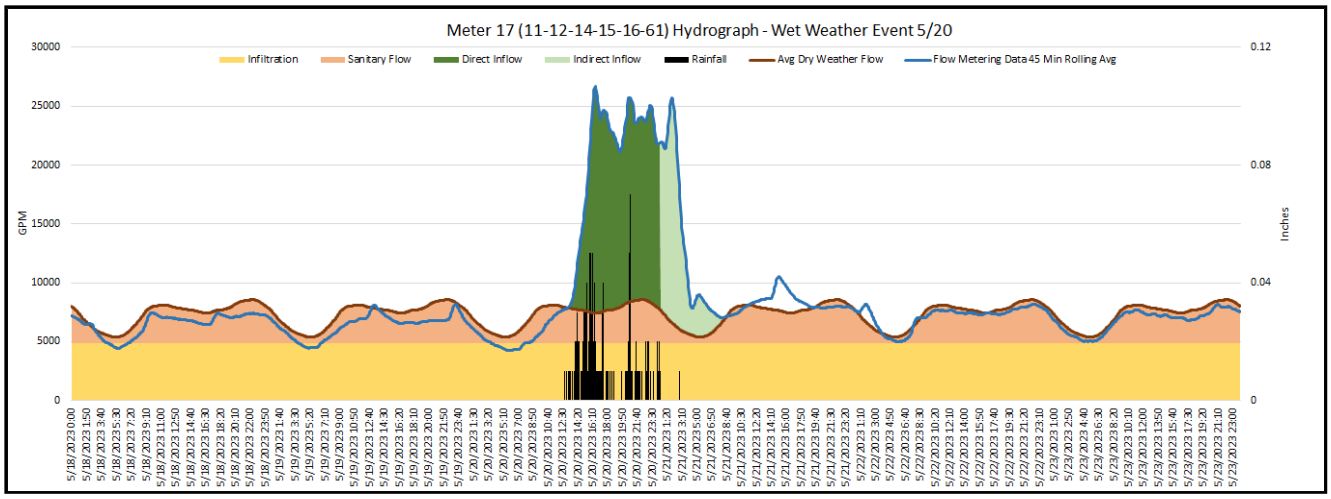

Meter 15 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

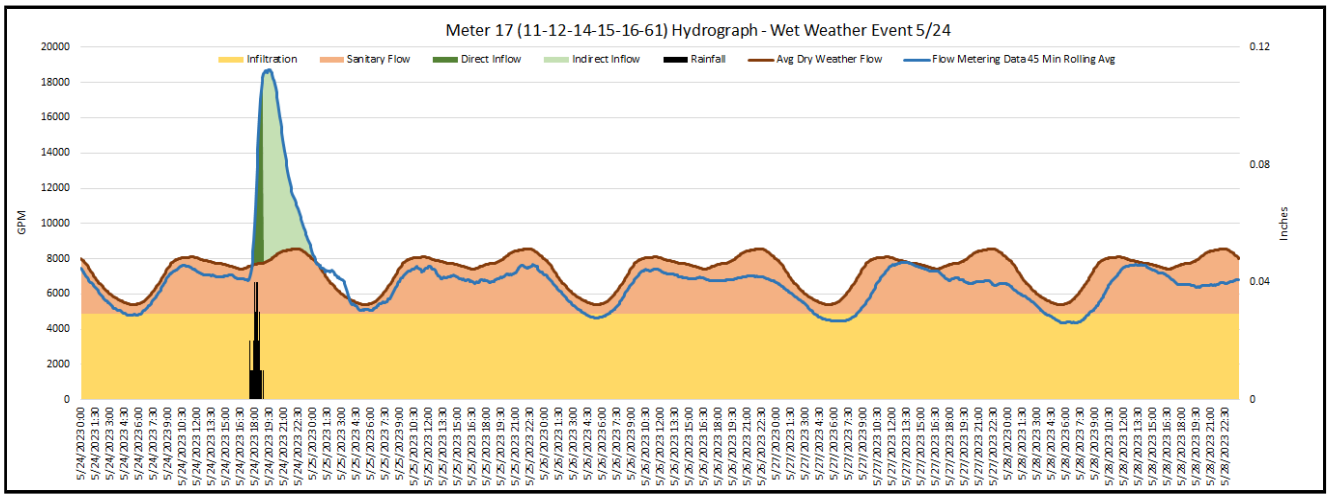

Meter 16 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

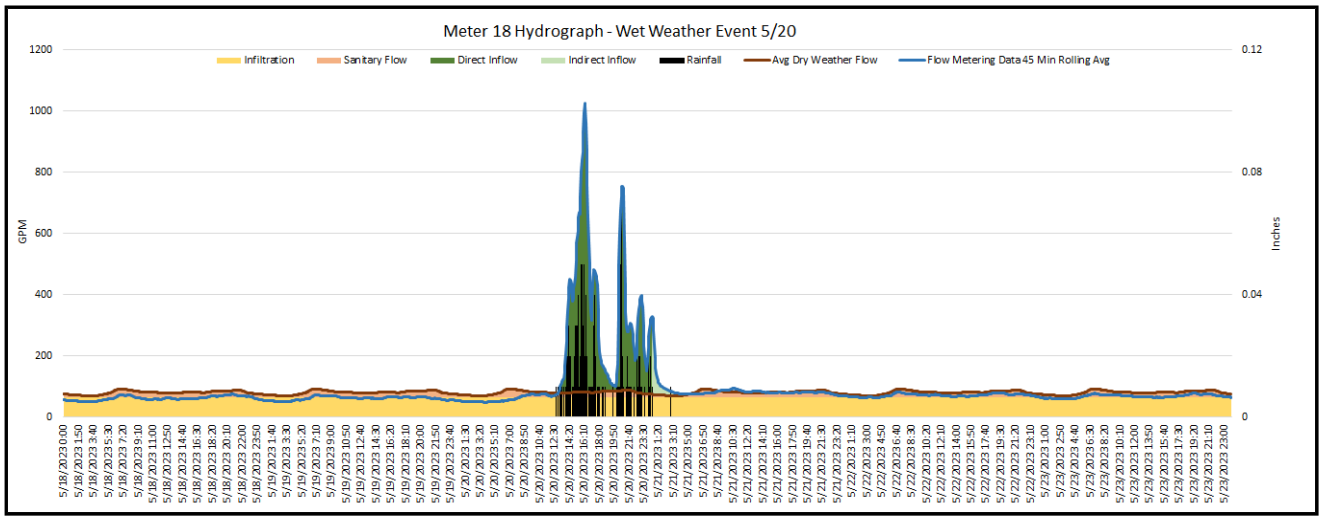

Meter 16 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

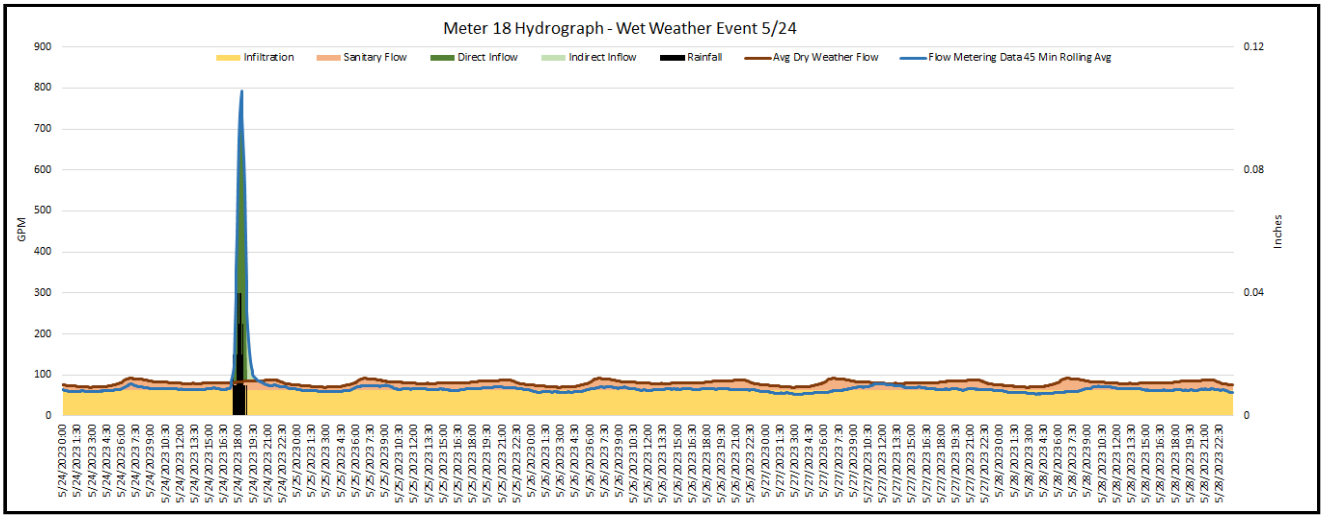

Meter 16 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

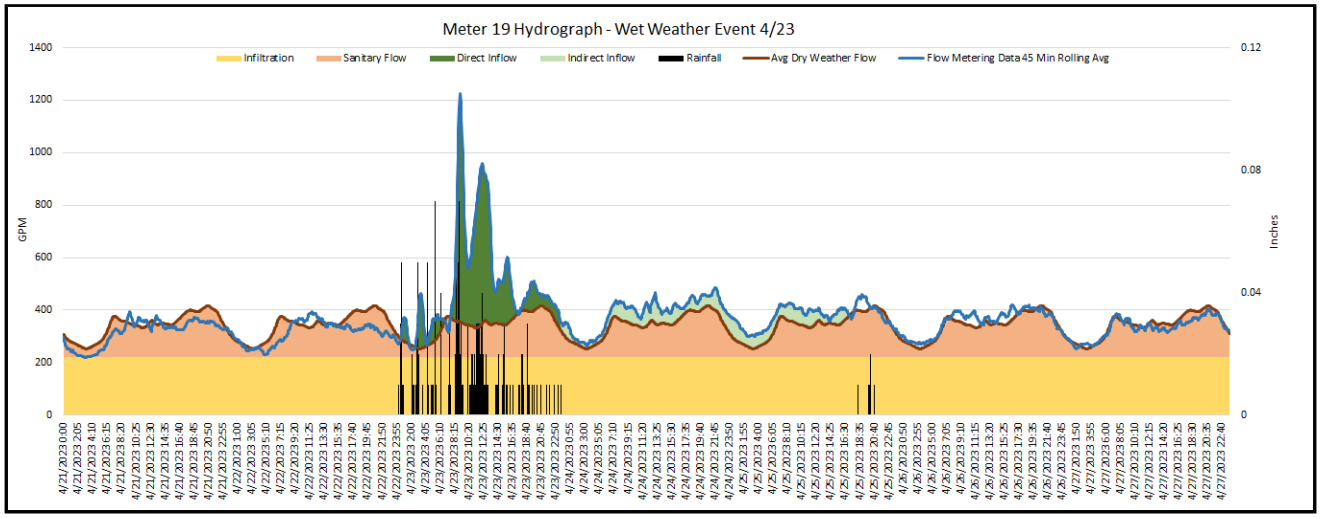

Meter 17 (11-12-14-15-16-61) Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

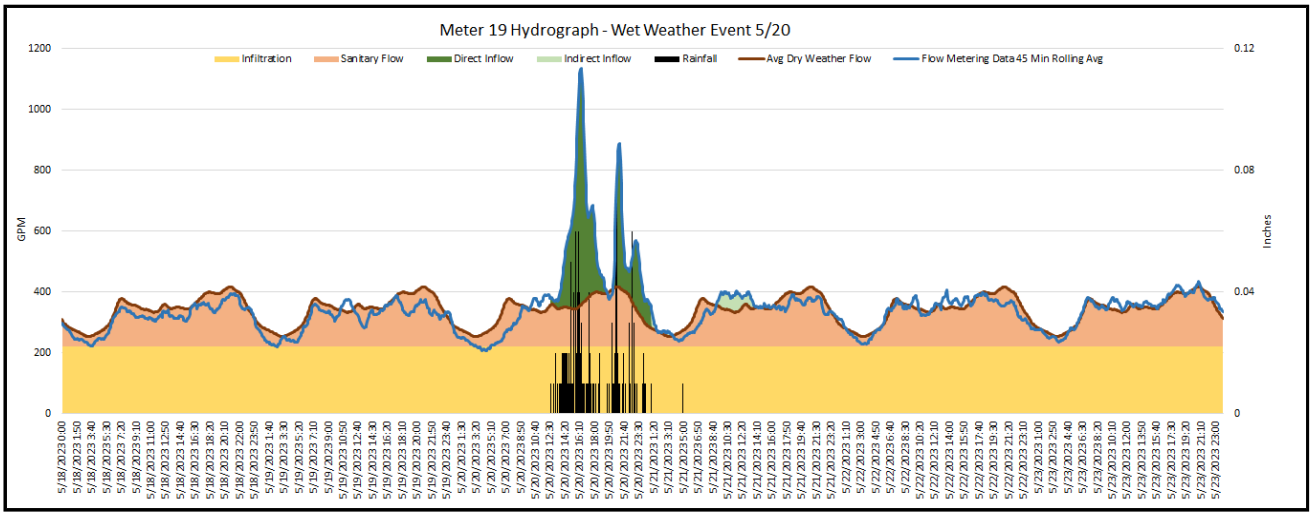

Meter 17 (11-12-14-15-16-61) Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

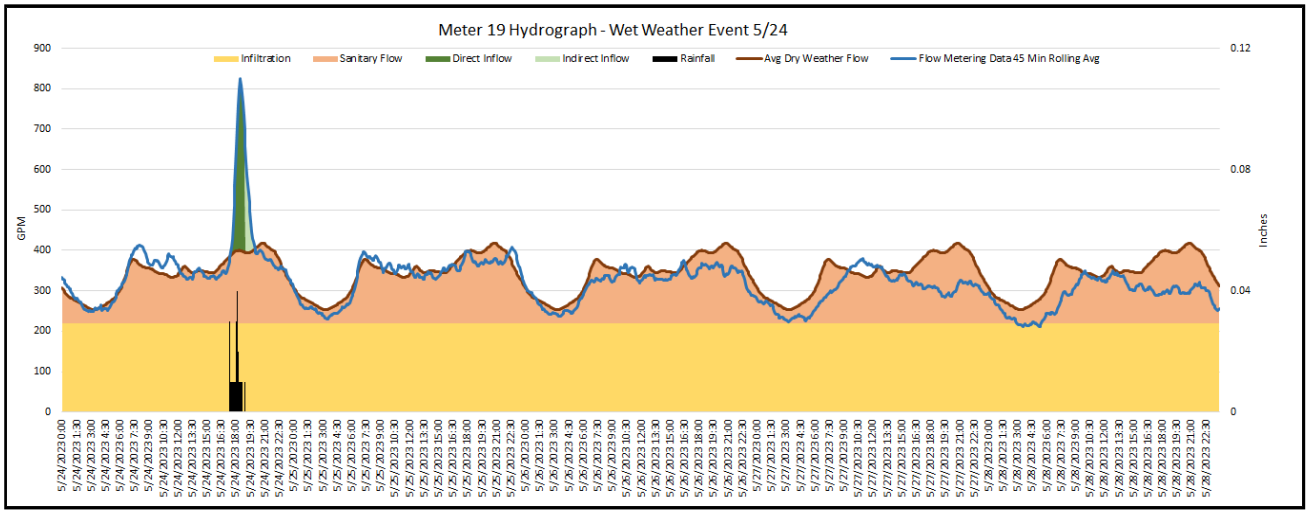

Meter 17 (11-12-14-15-16-61) Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

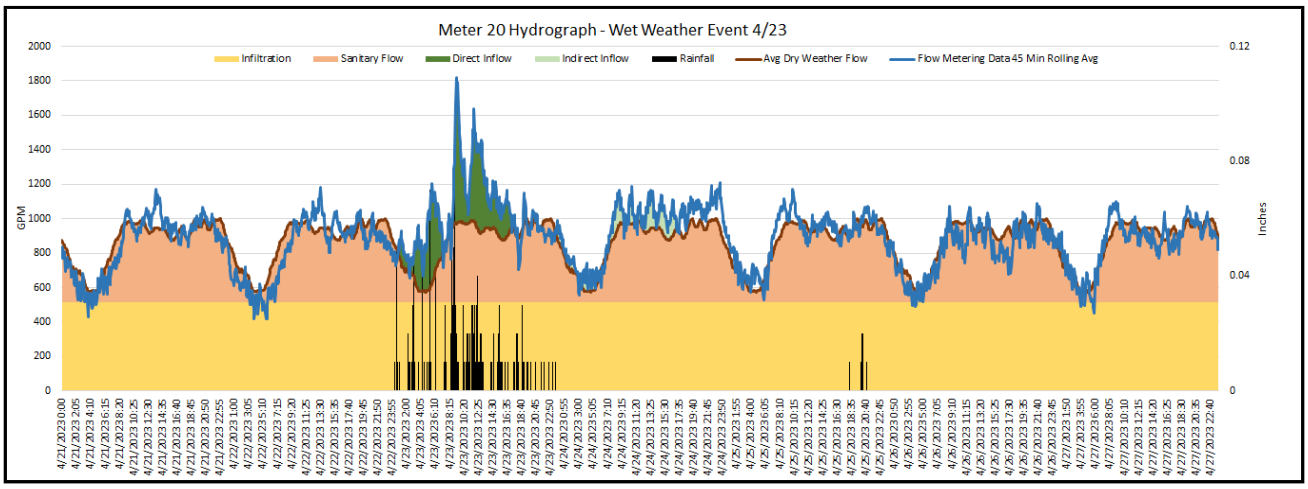

Meter 18 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches
0
200
400
600
800
1000
1200
0
0.04
0.08
0.12

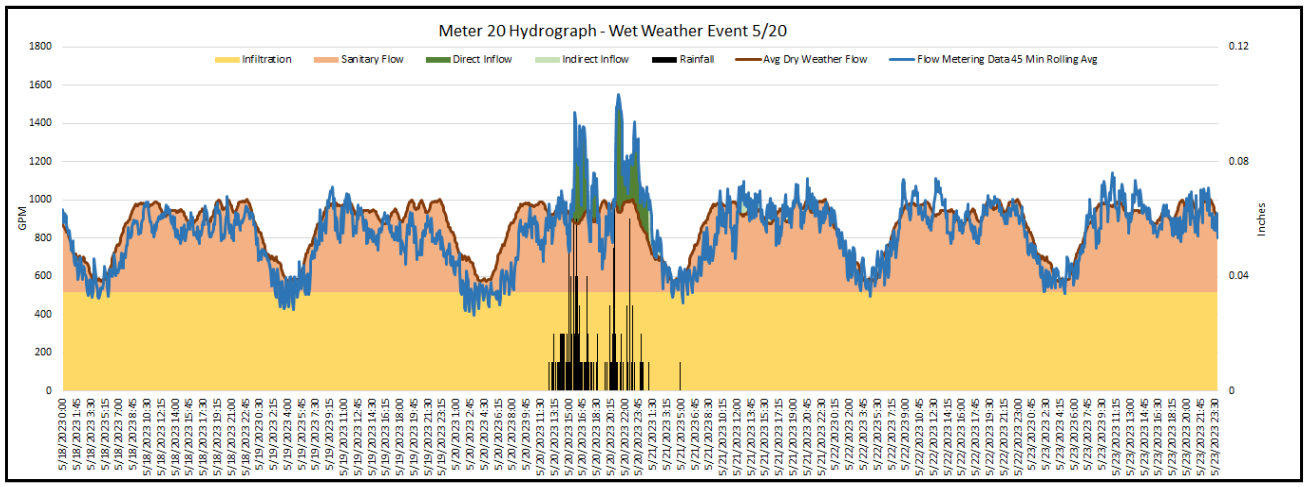

Meter 18 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches
0
100
200
300
400
500
600
700
800
900
0
0.04
0.08
0.12

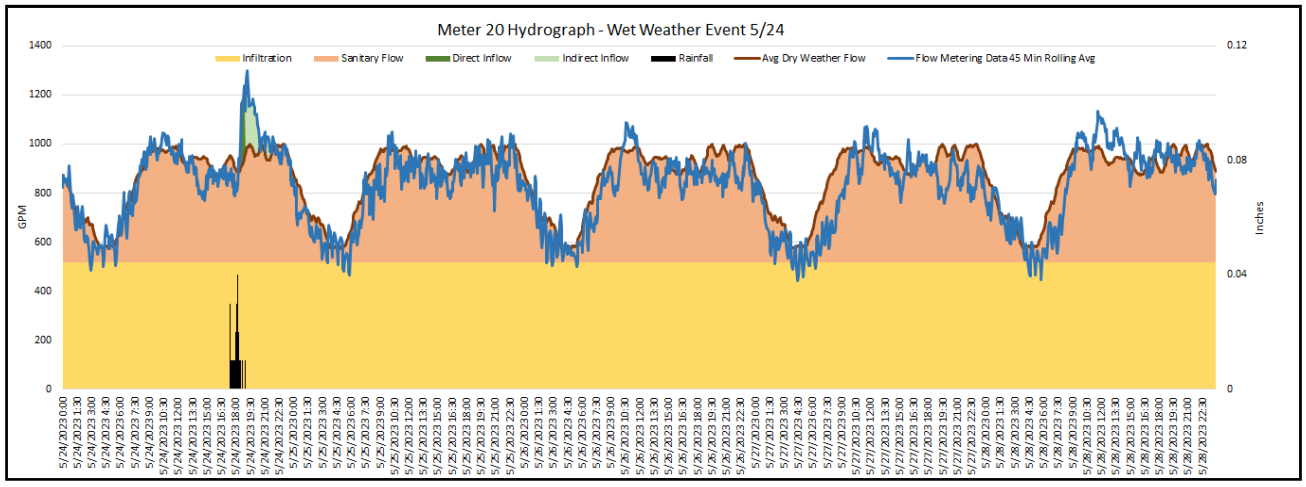

Meter 19 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

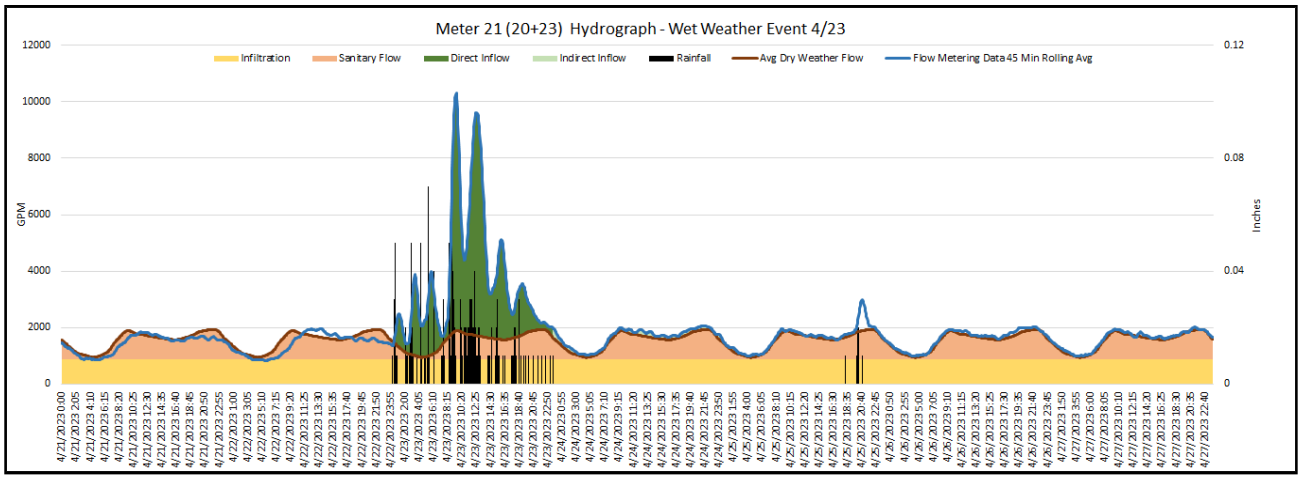

Meter 19 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

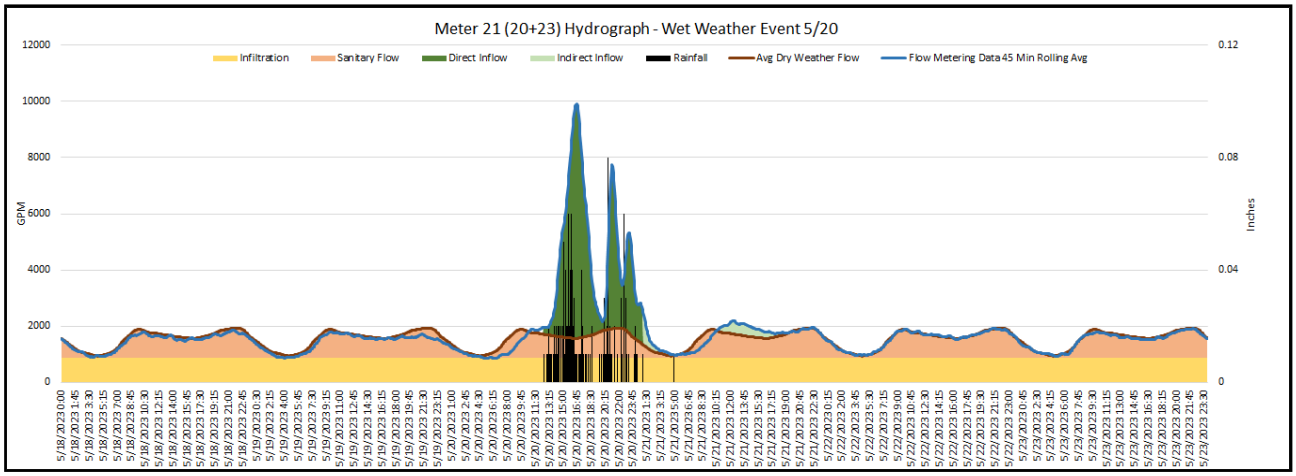

Meter 19 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

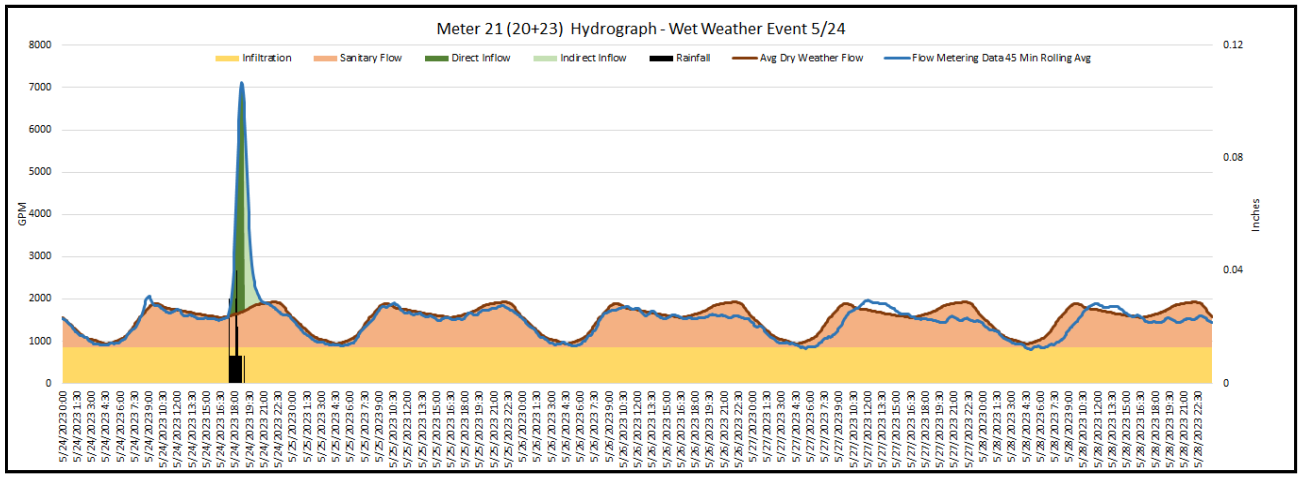

Meter 20 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

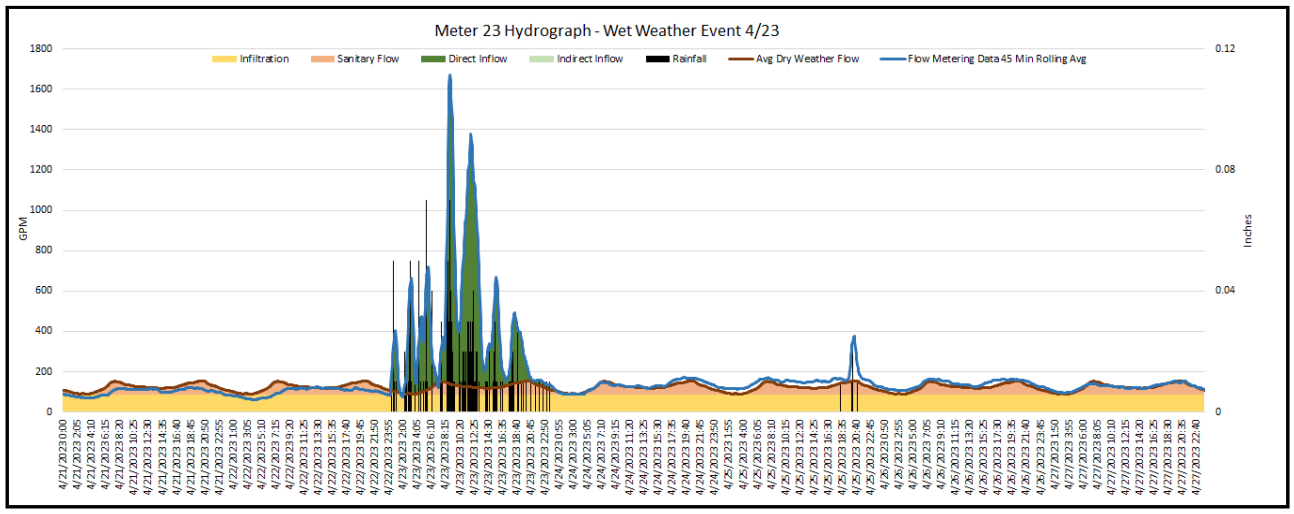

Meter 20 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

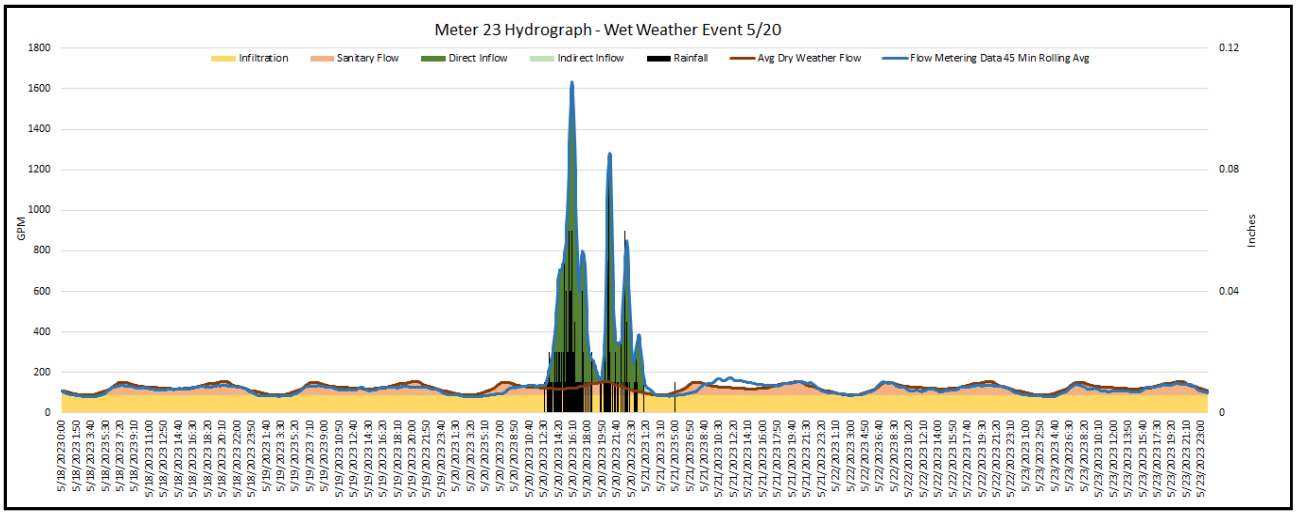

Meter 20 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

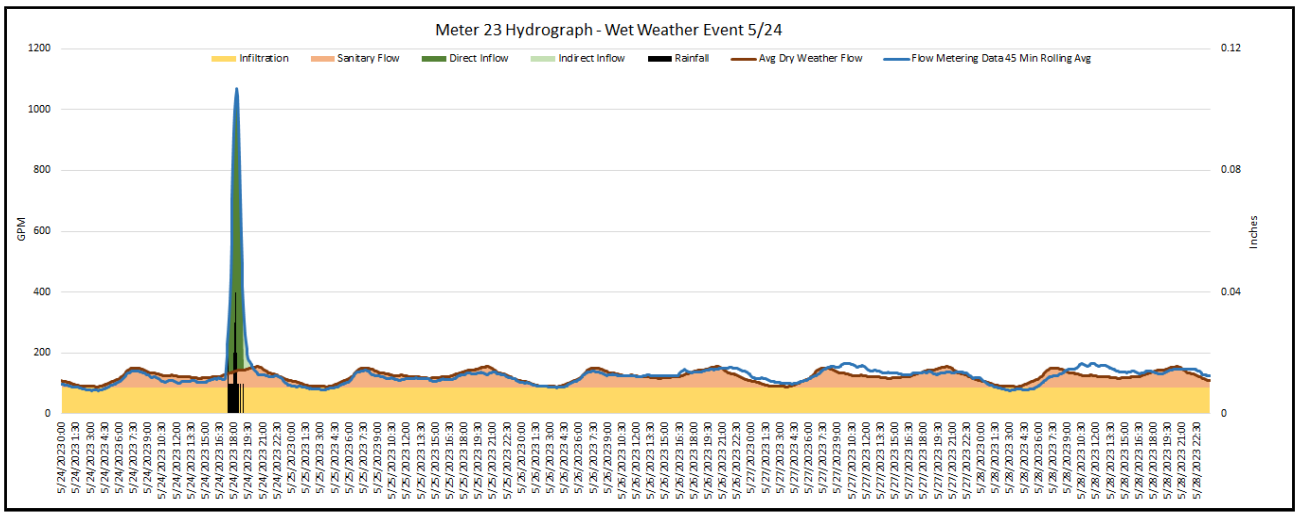

Meter 21 (20+23) Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

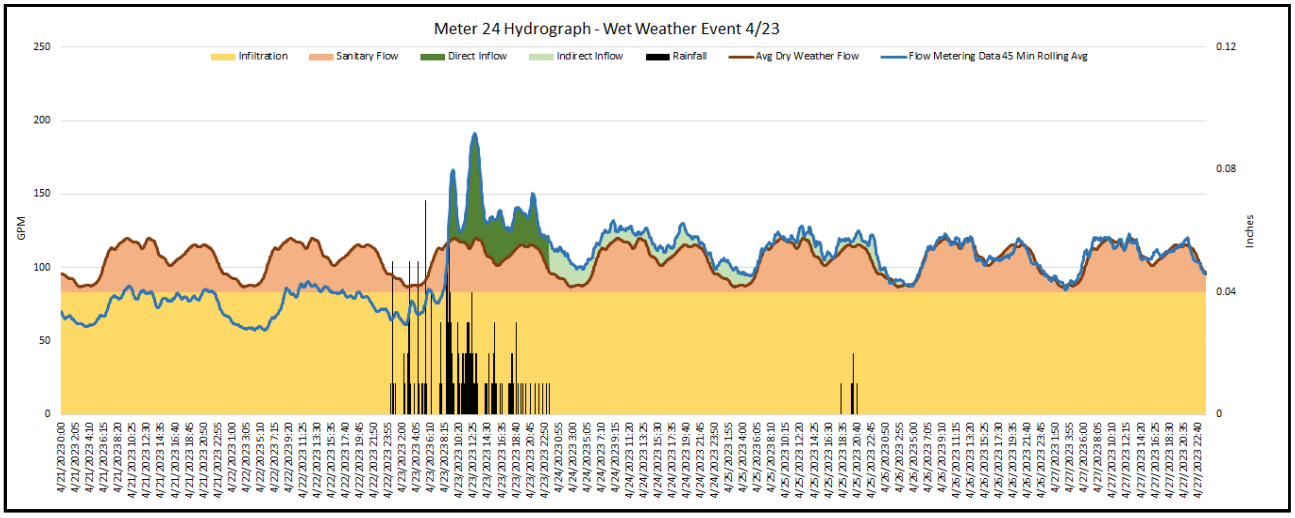

Meter 21 (20+23) Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

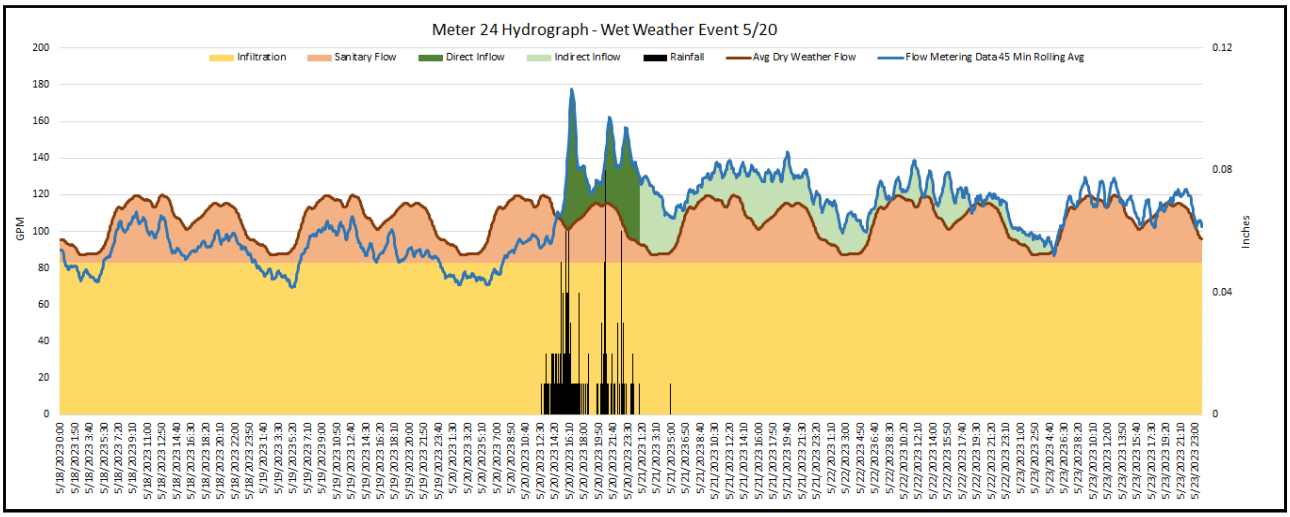

Meter 21 (20+23) Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

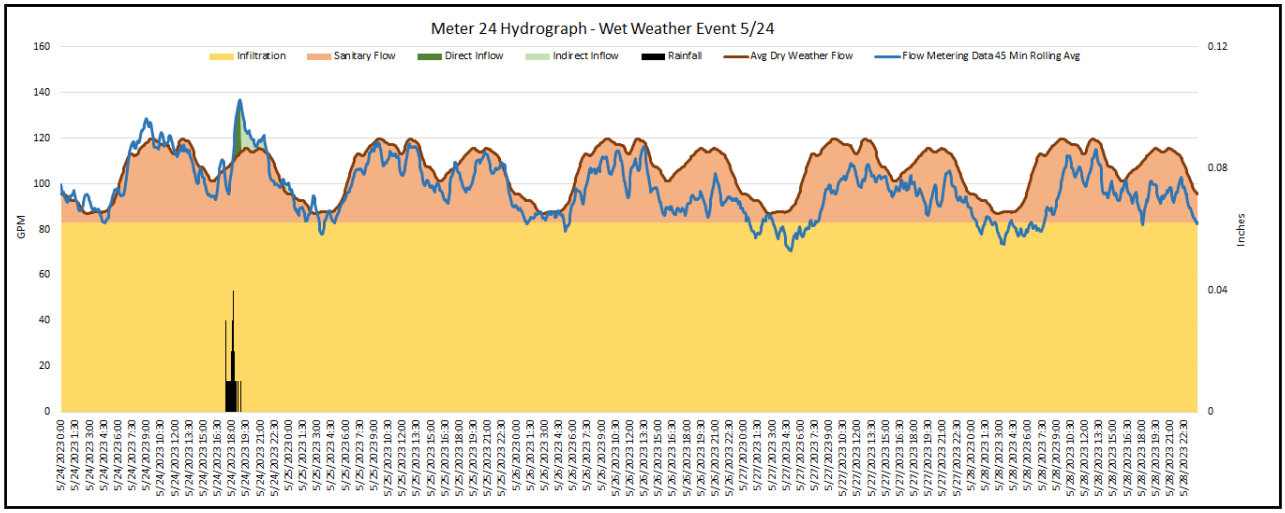

Meter 23 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

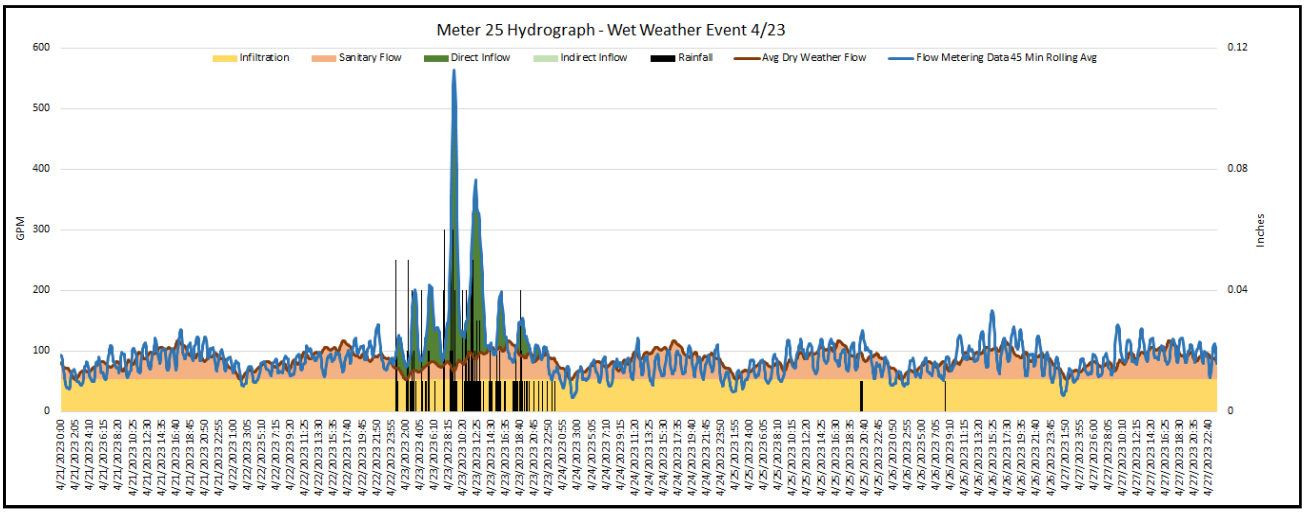

Meter 23 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

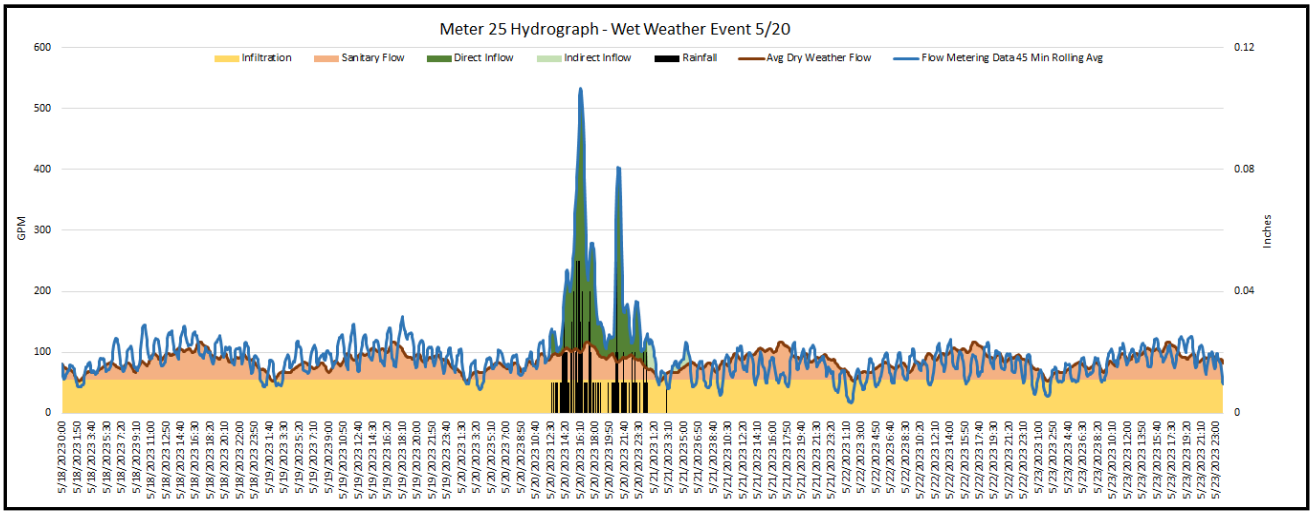

Meter 23 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

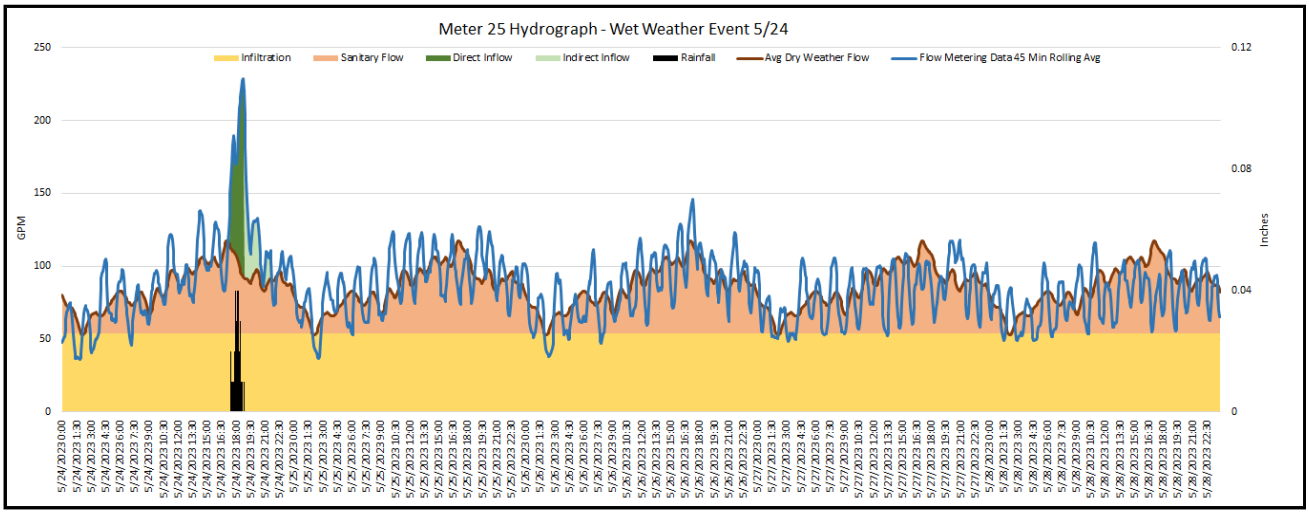

Meter 24 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

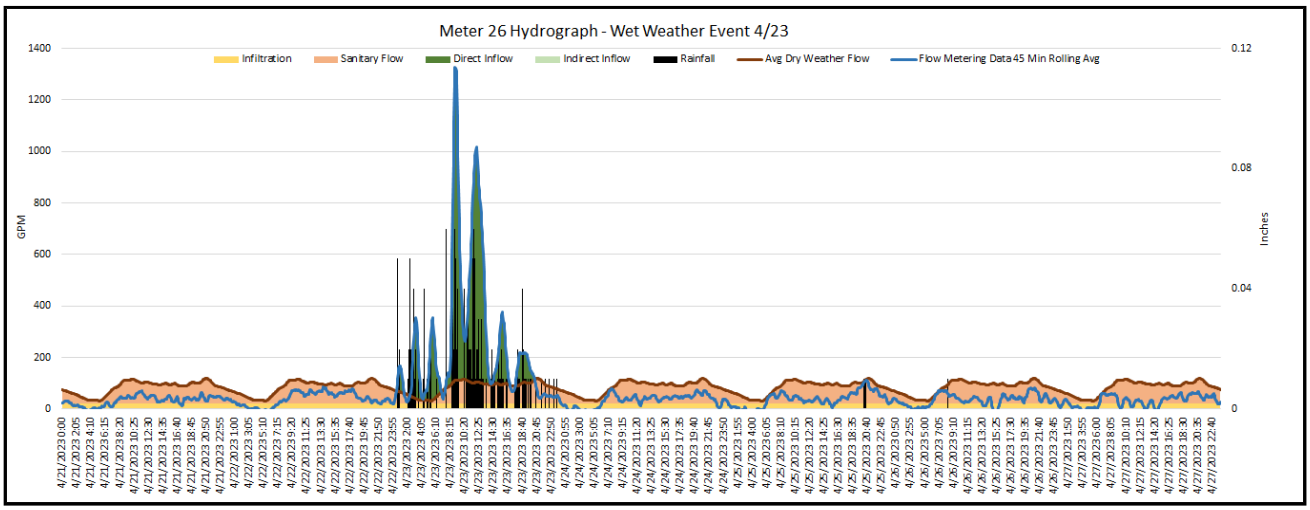

Meter 24 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

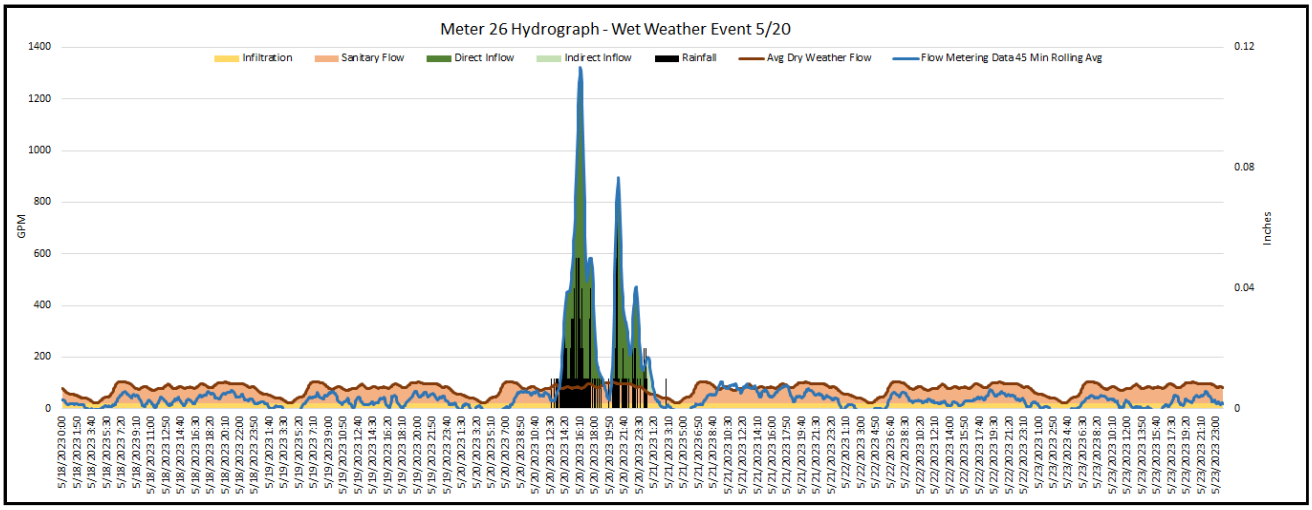

Meter 24 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

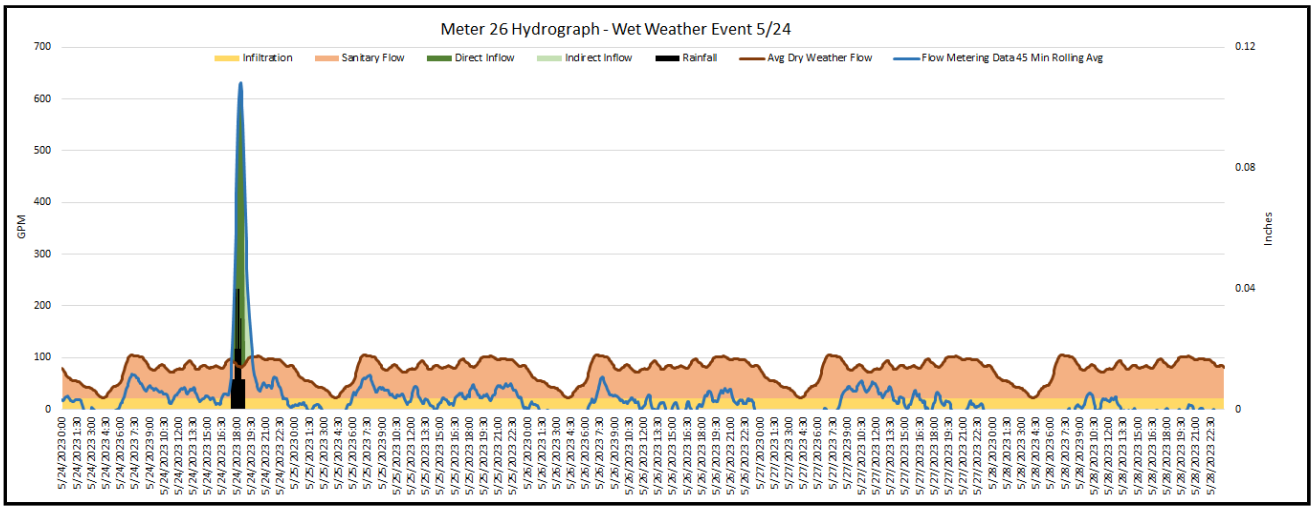

Meter 25 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

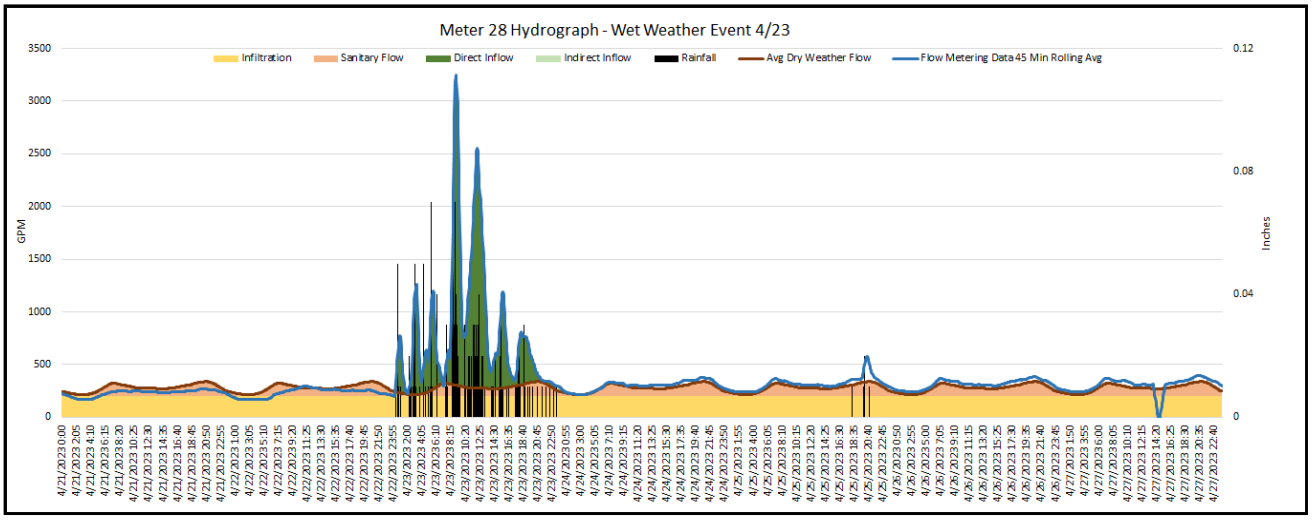

Meter 25 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

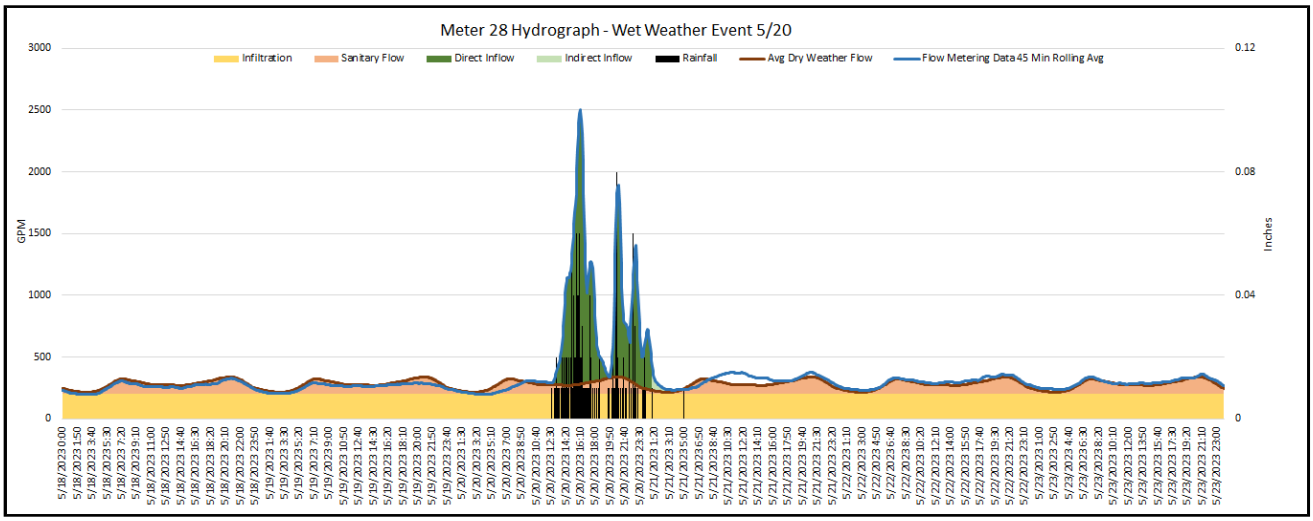

Meter 25 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

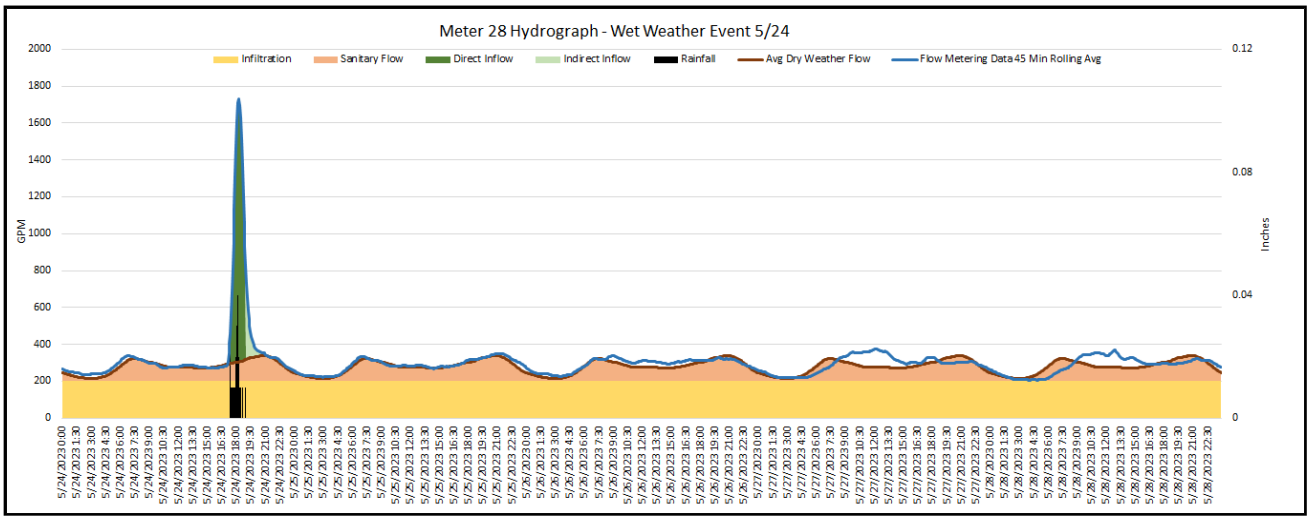

Meter 26 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

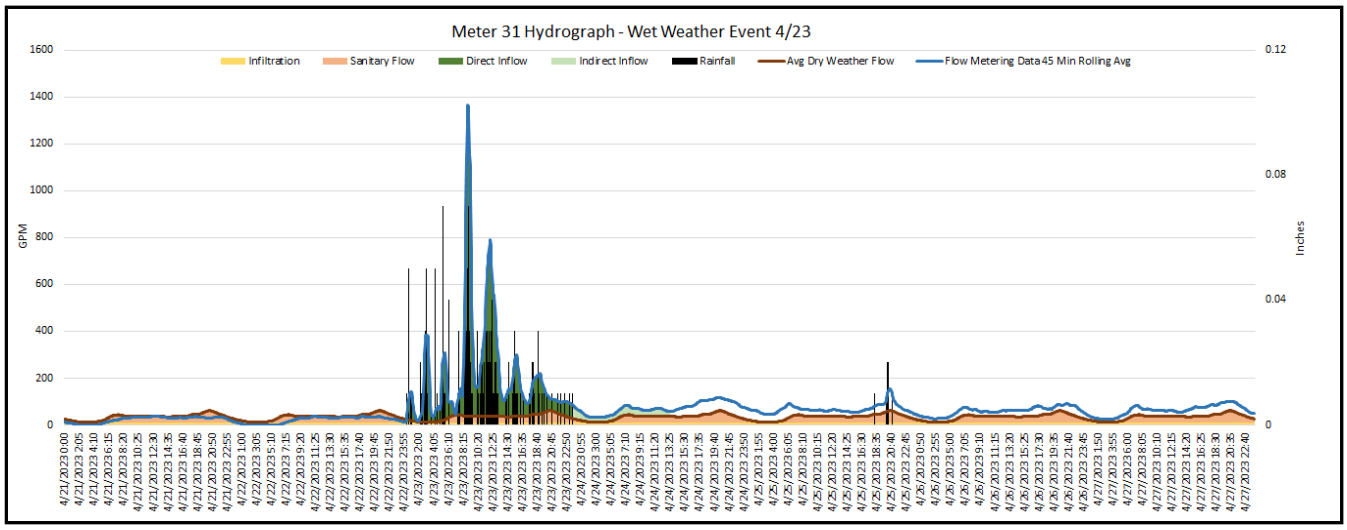

Meter 26 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

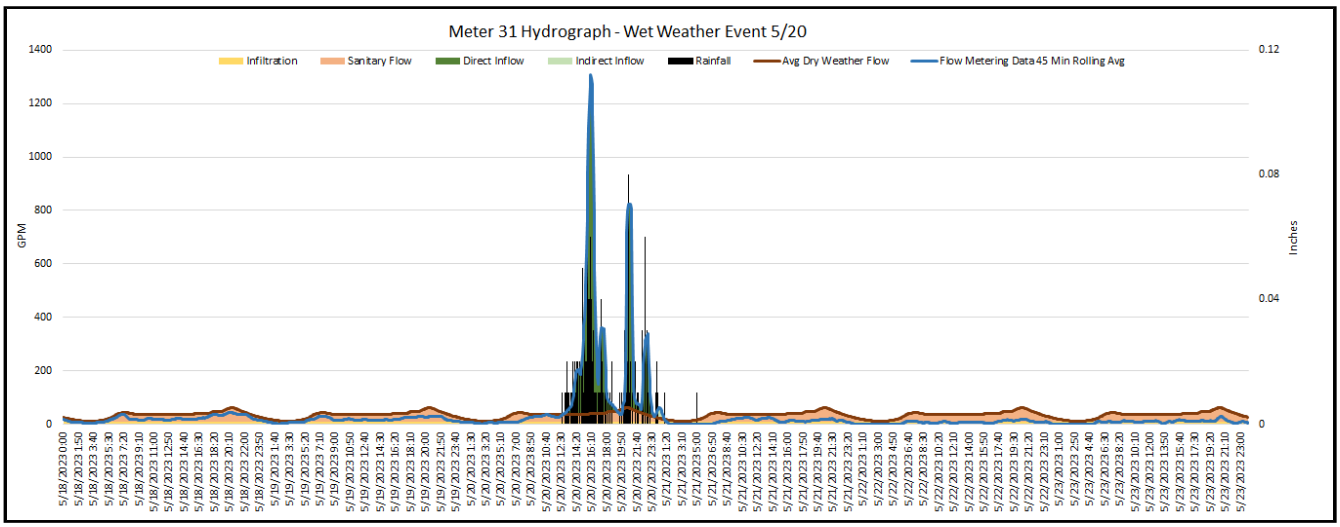

Meter 26 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

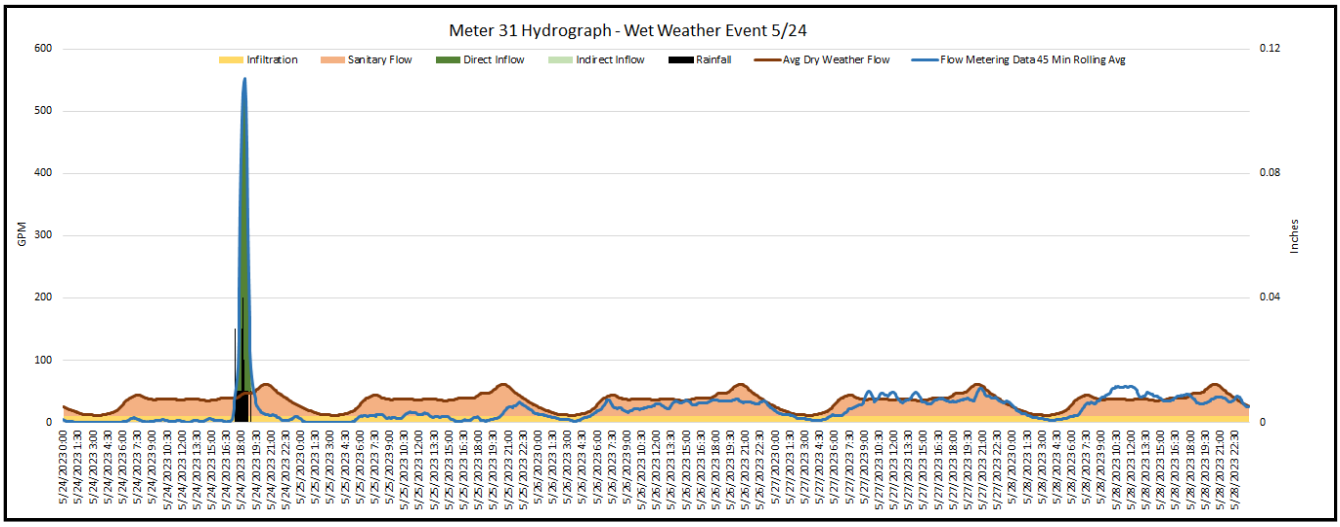

Meter 28 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

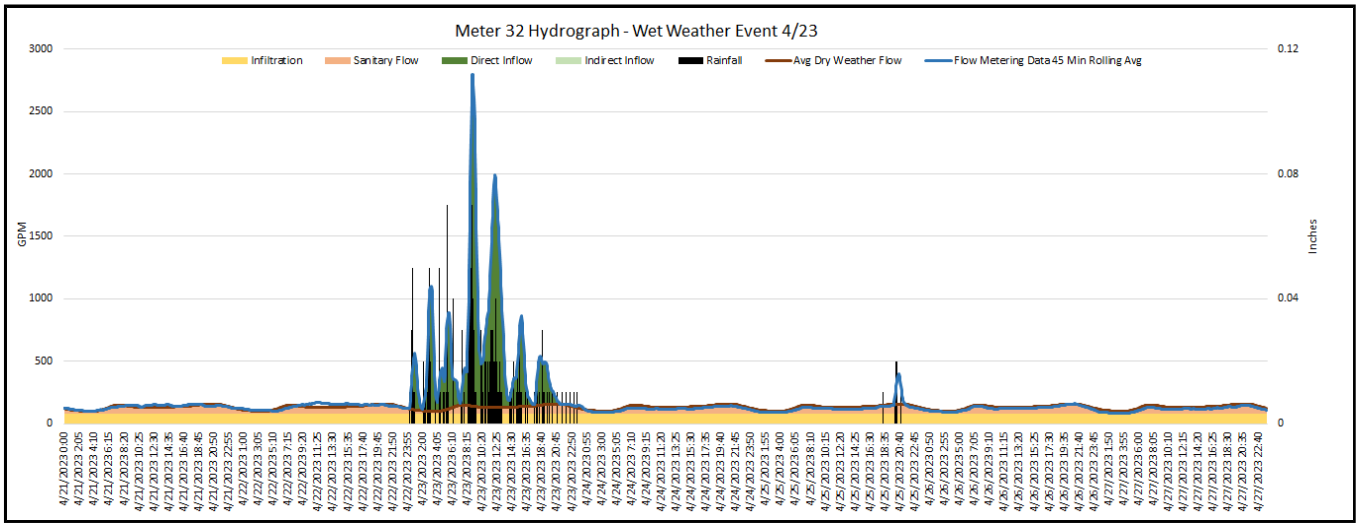

Meter 28 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

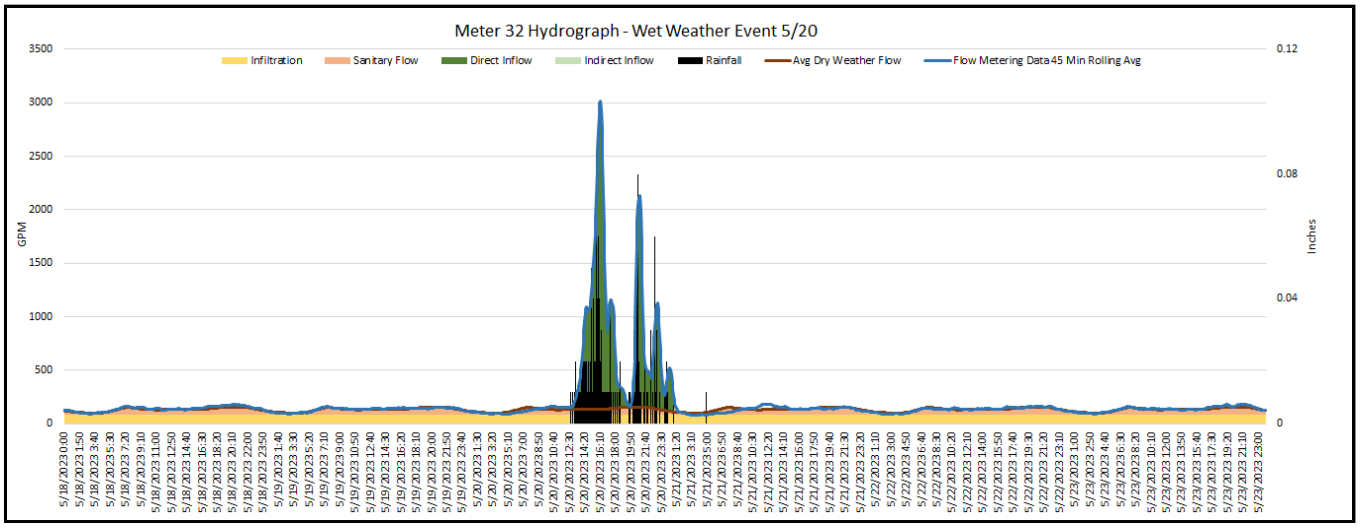

Meter 28 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

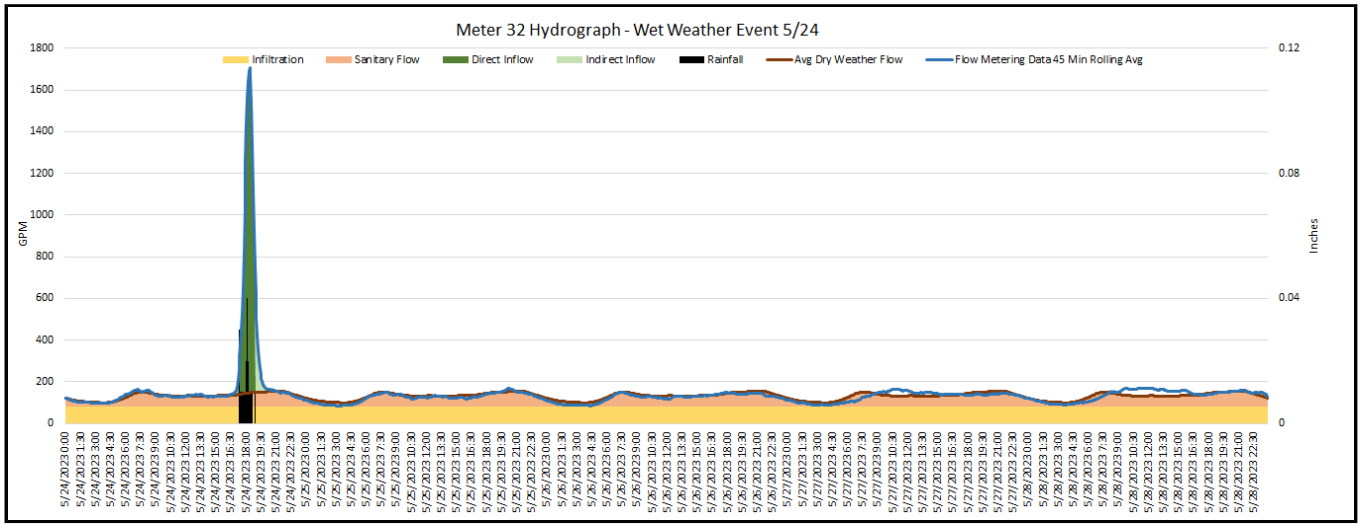

Meter 31 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

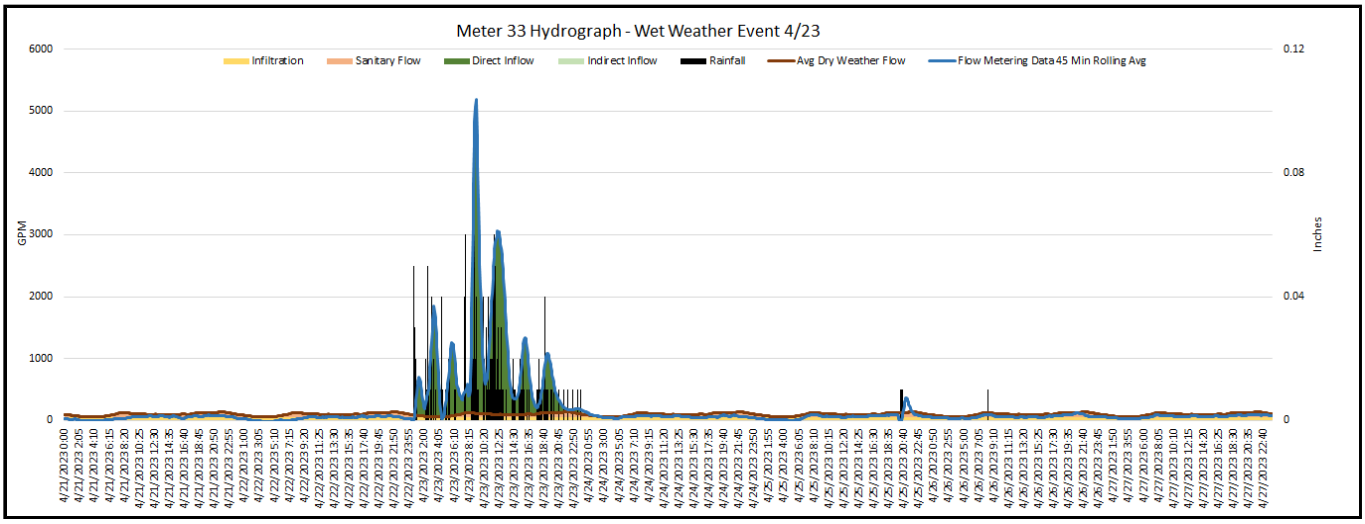

Meter 31 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

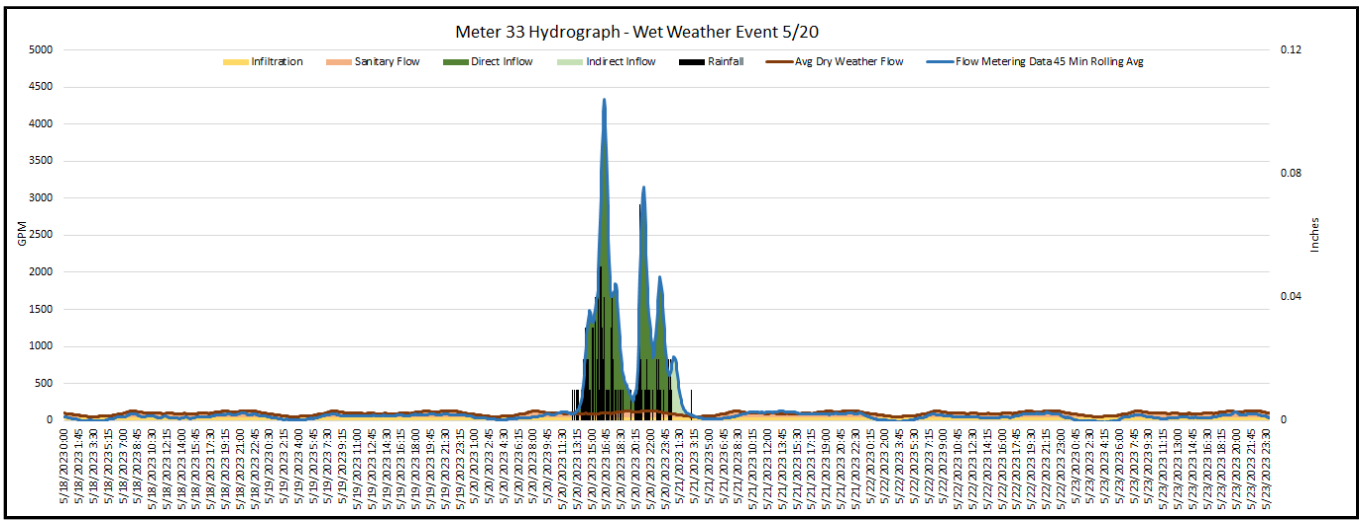

Meter 31 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

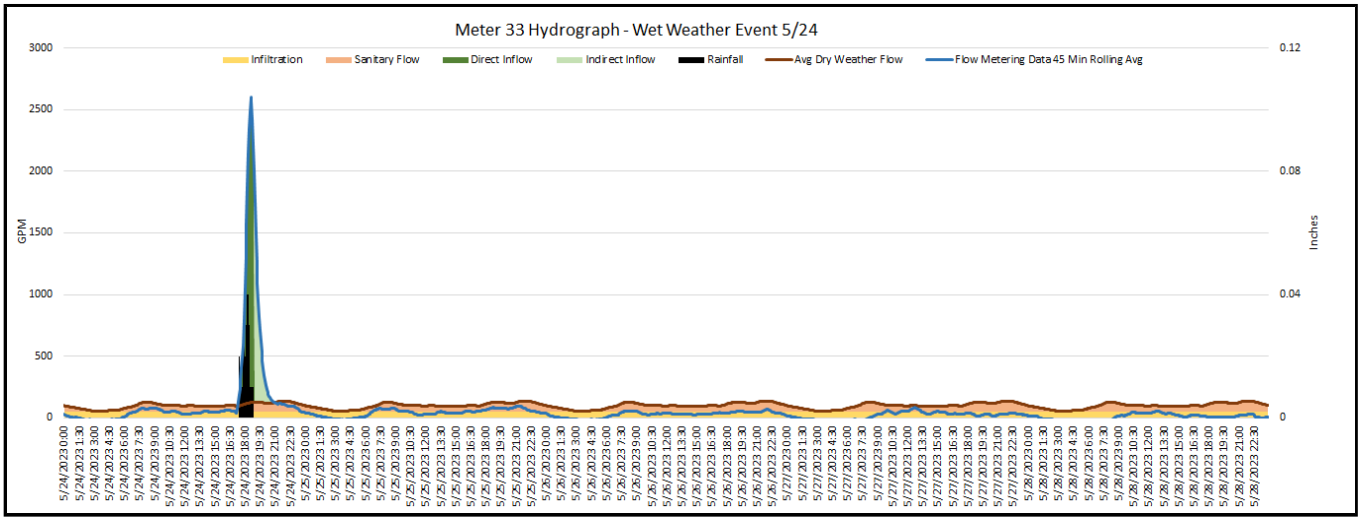

Meter 32 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

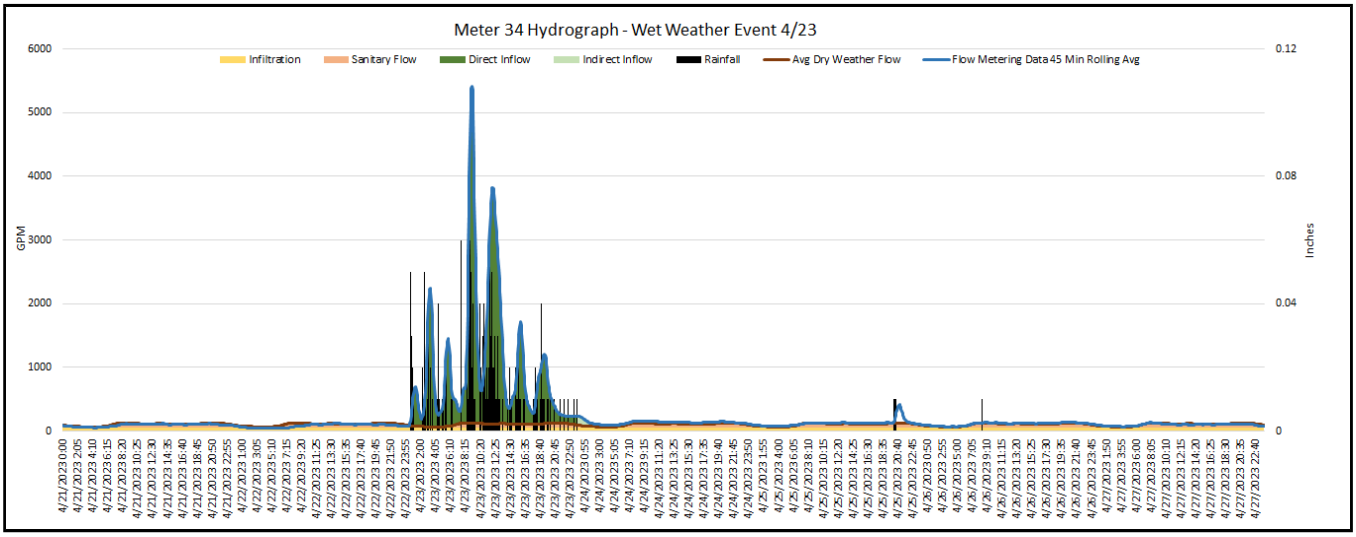

Meter 32 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

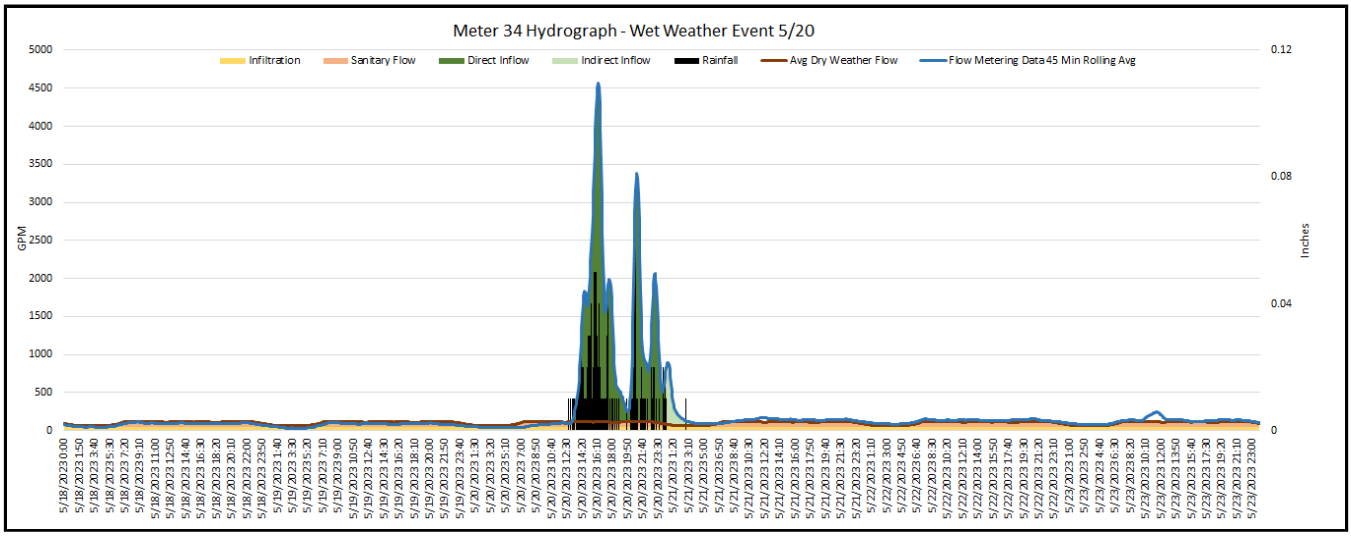

Meter 32 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

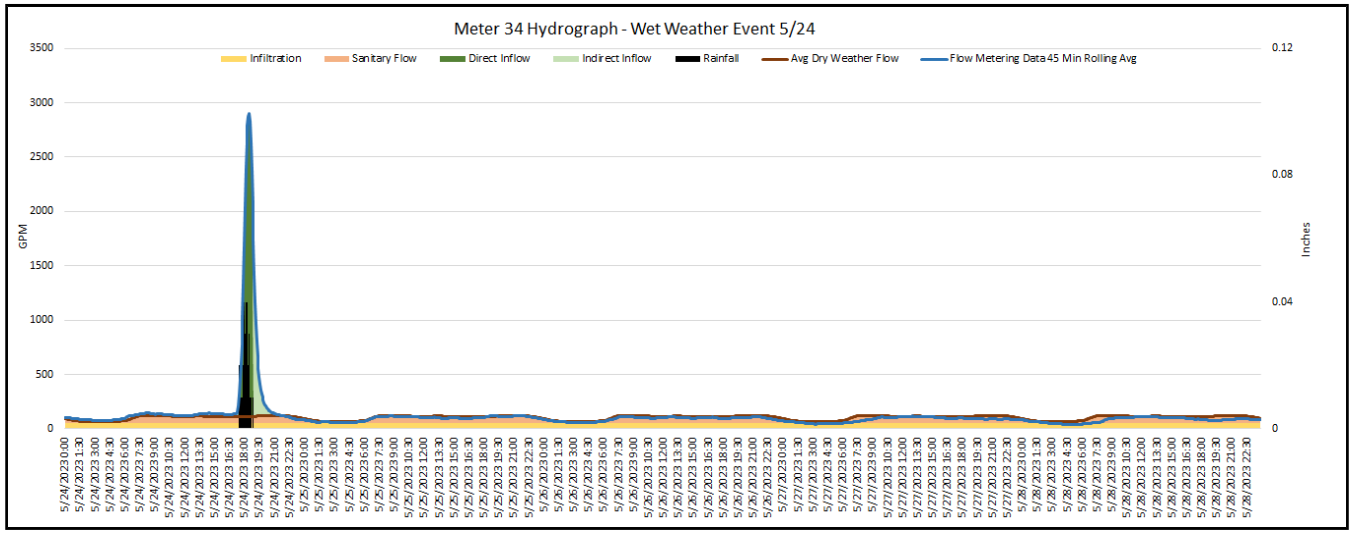

Meter 33 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

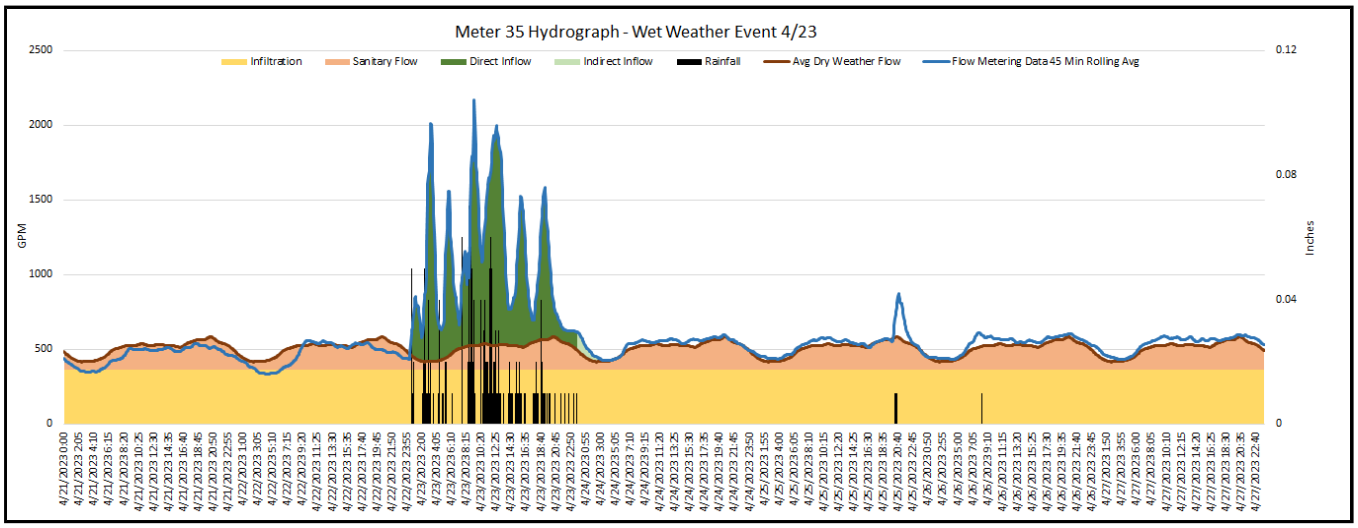

Meter 33 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

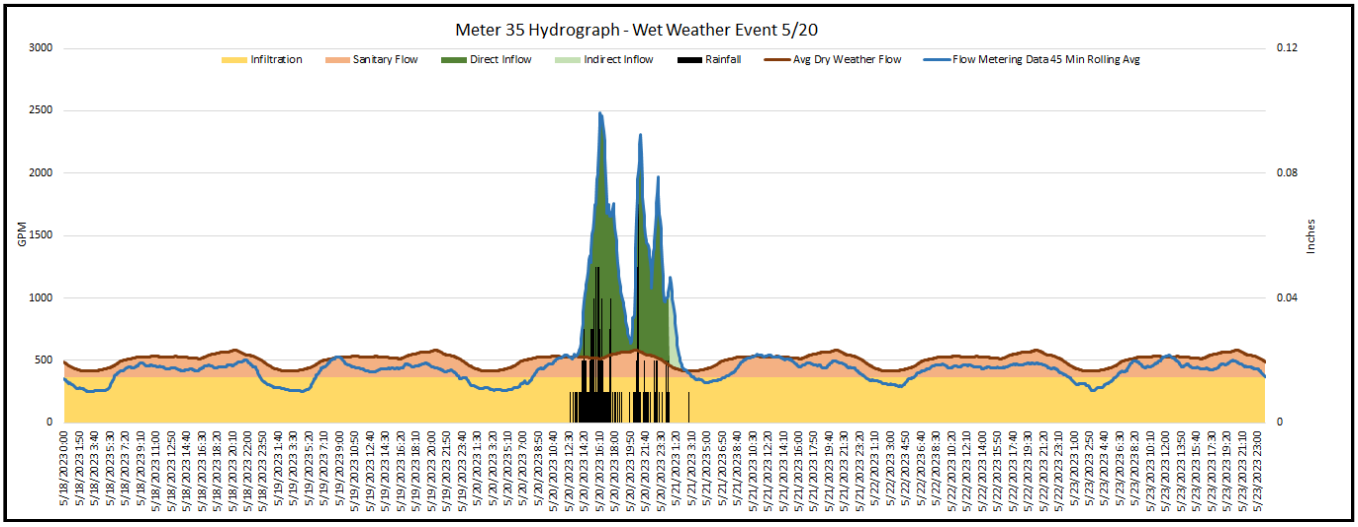

Meter 33 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

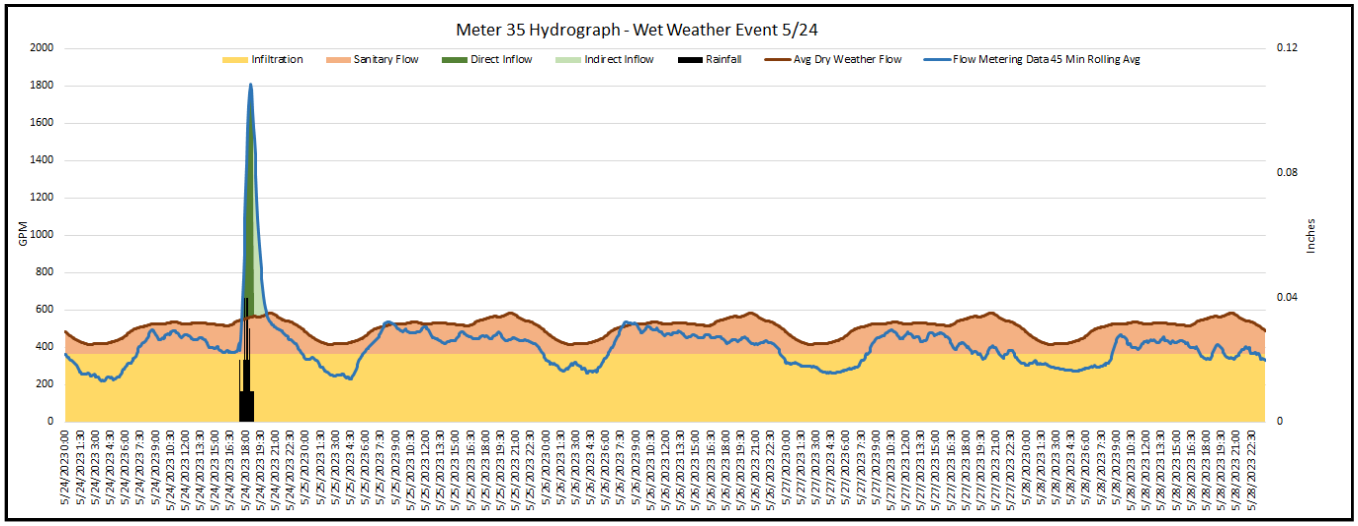

Meter 34 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

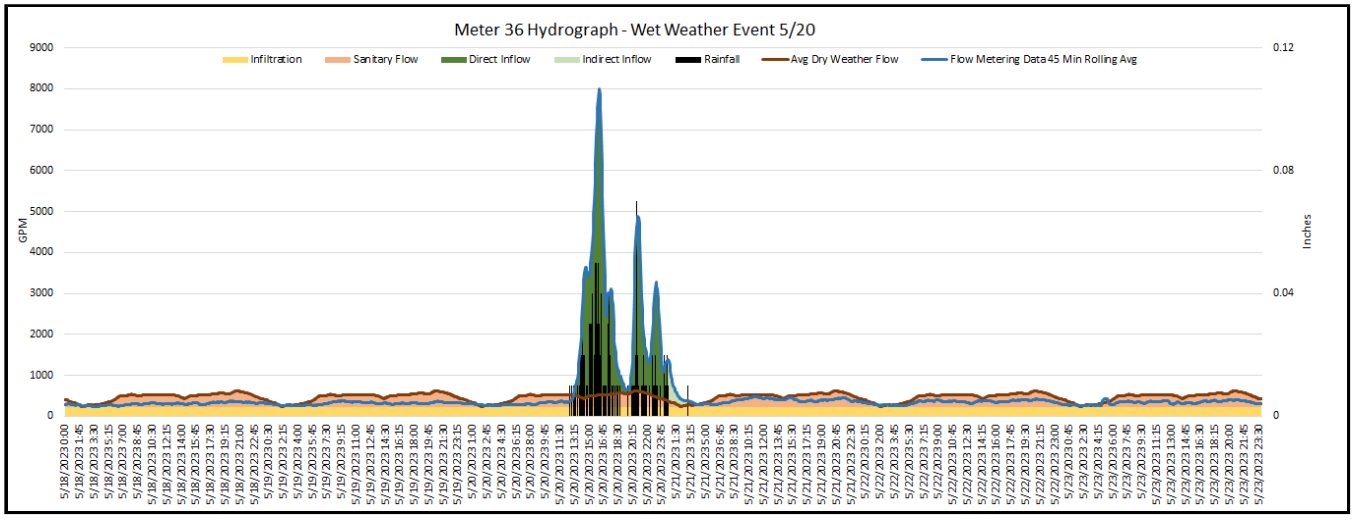

Meter 34 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

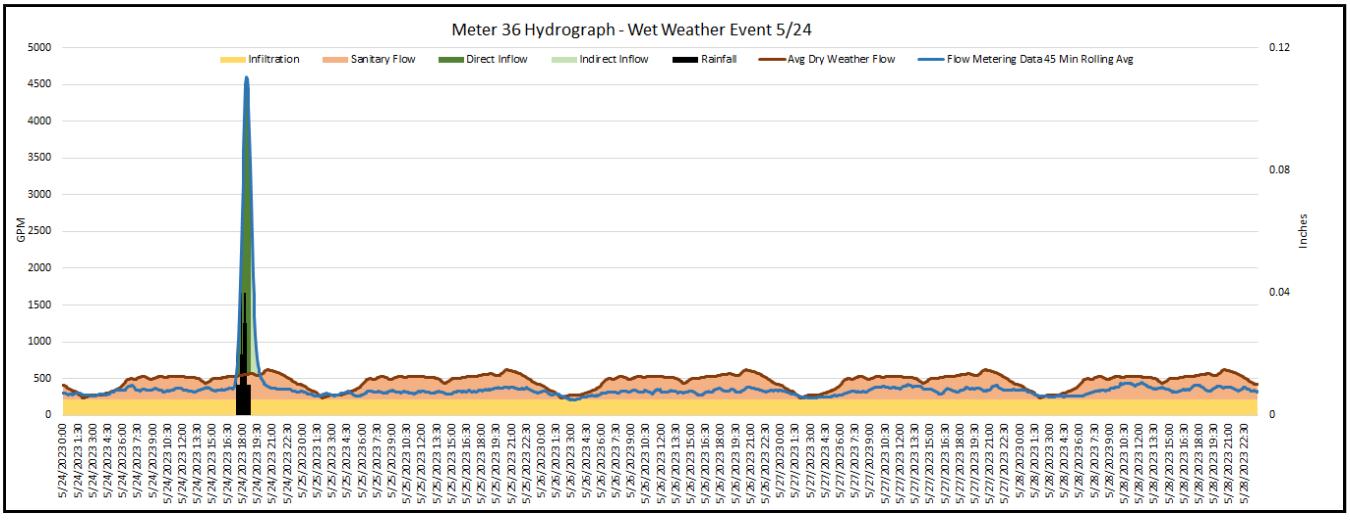

Meter 34 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

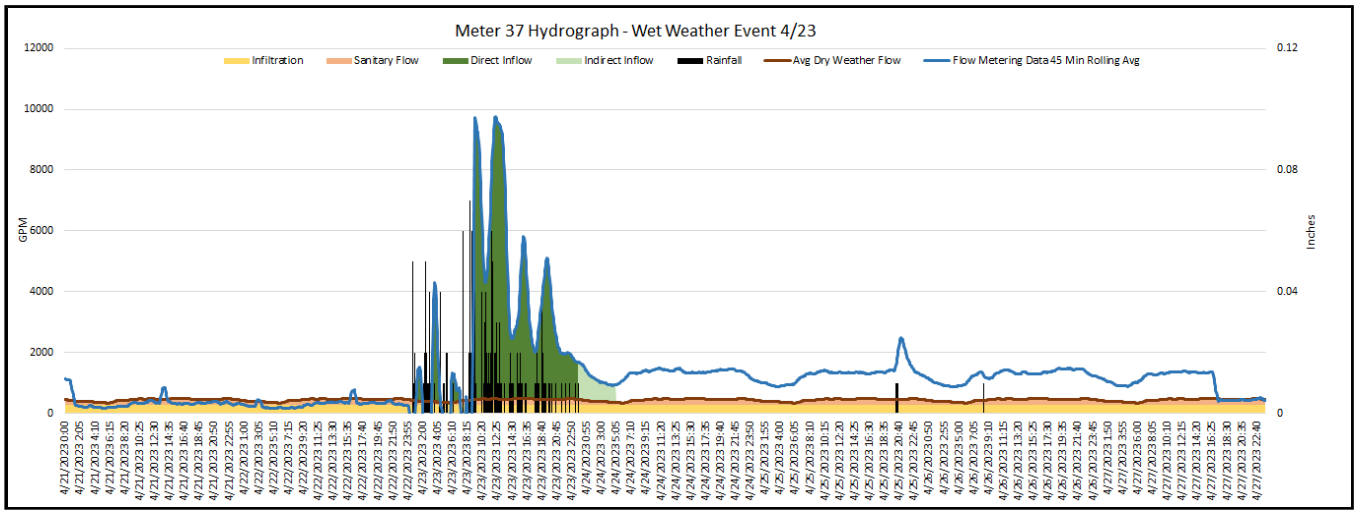

Meter 35 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

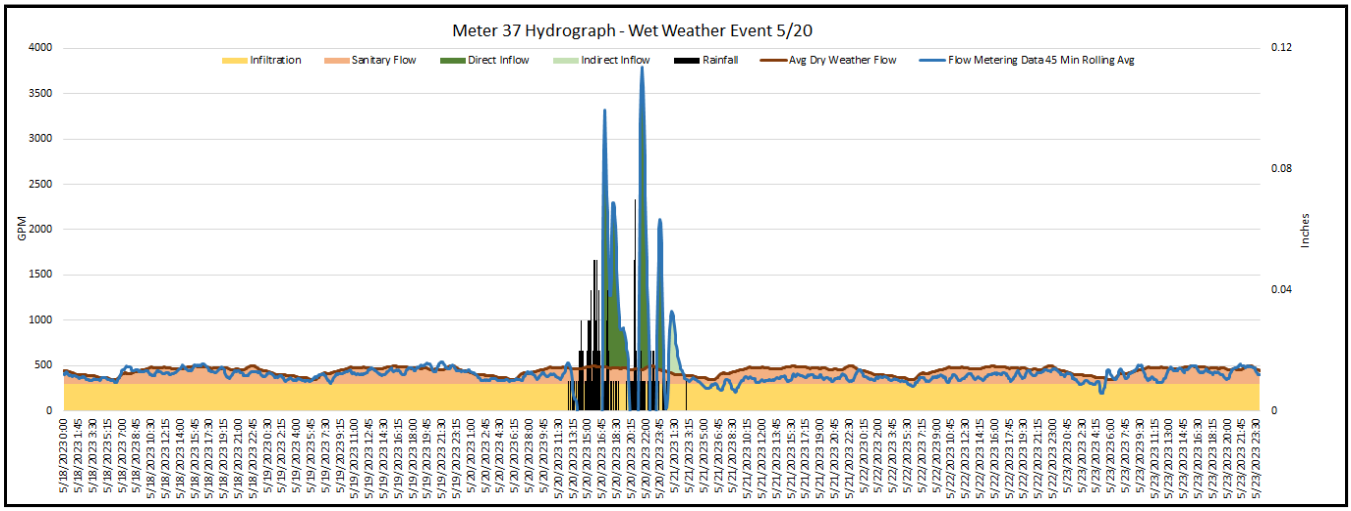

Meter 35 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

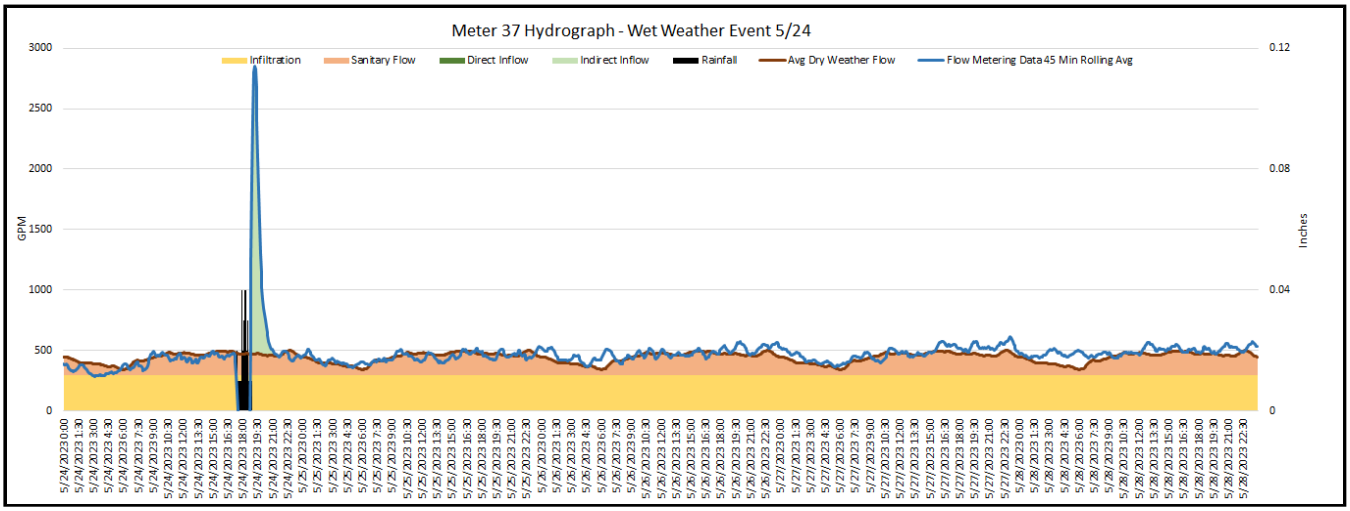

Meter 35 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

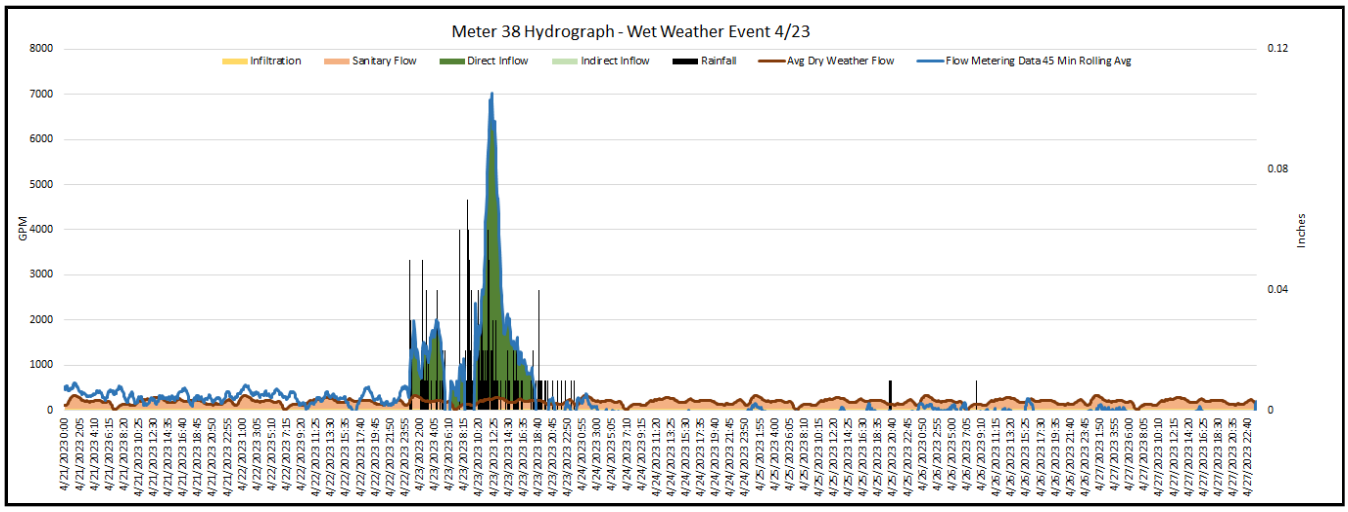

Meter 36 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

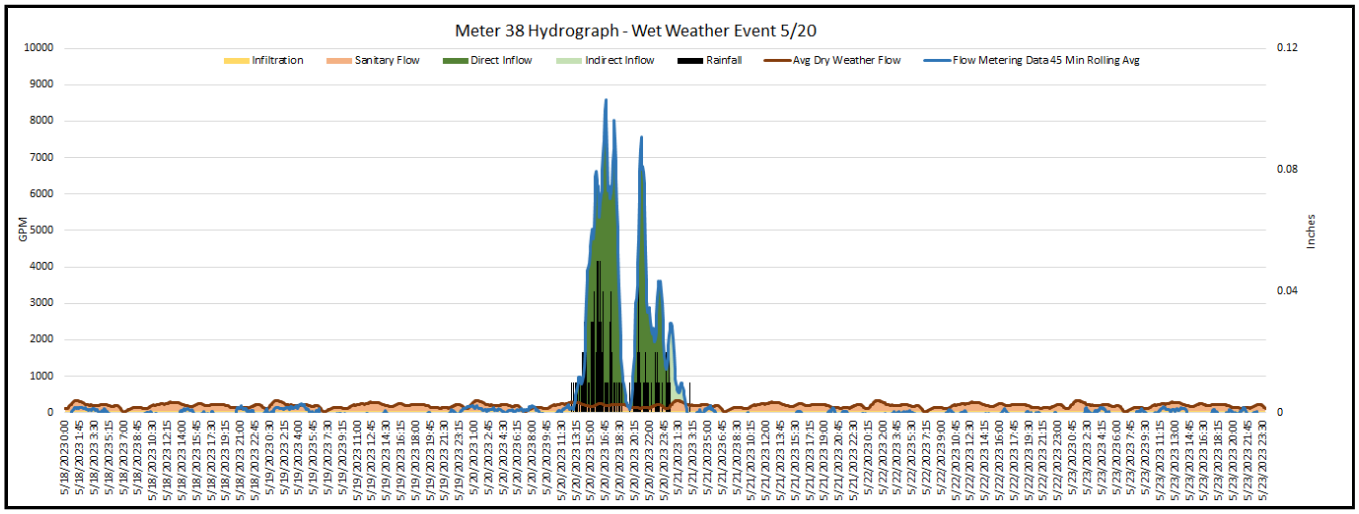

Meter 36 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

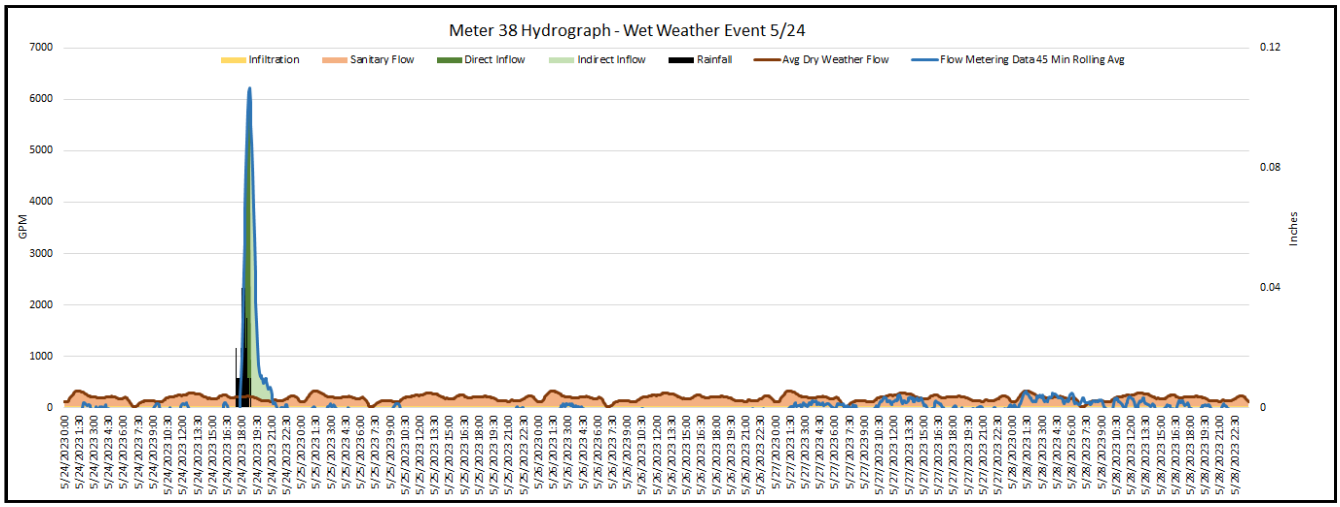

Meter 37 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

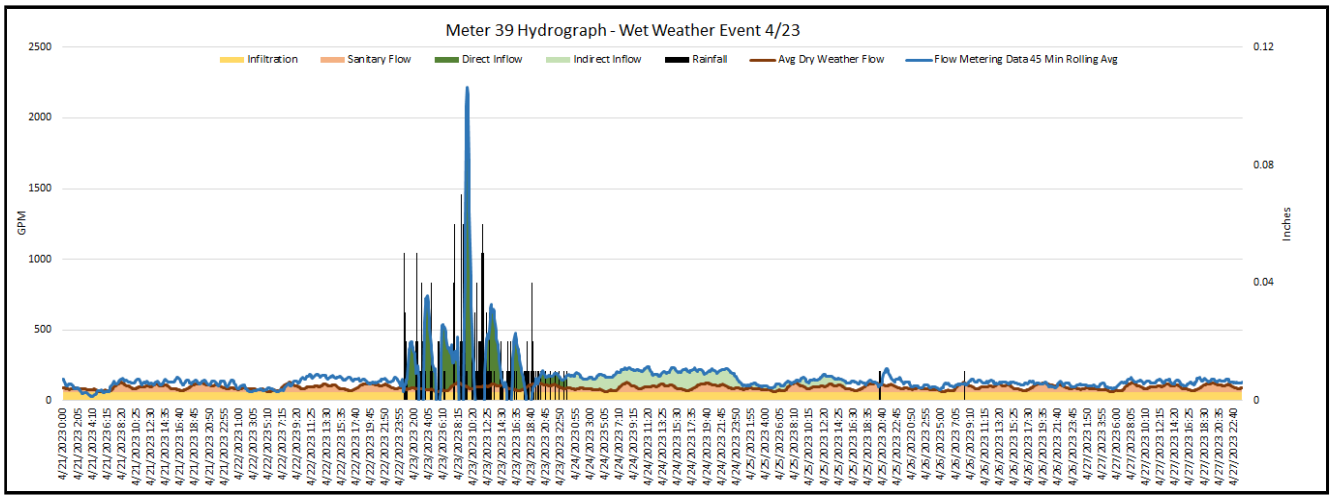

Meter 37 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

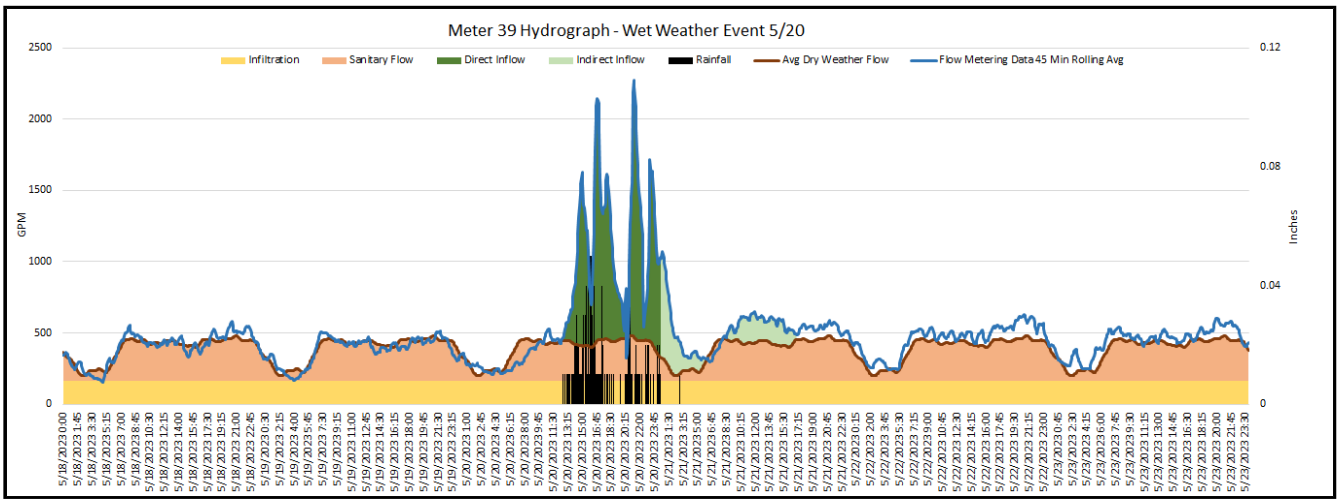

Meter 37 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

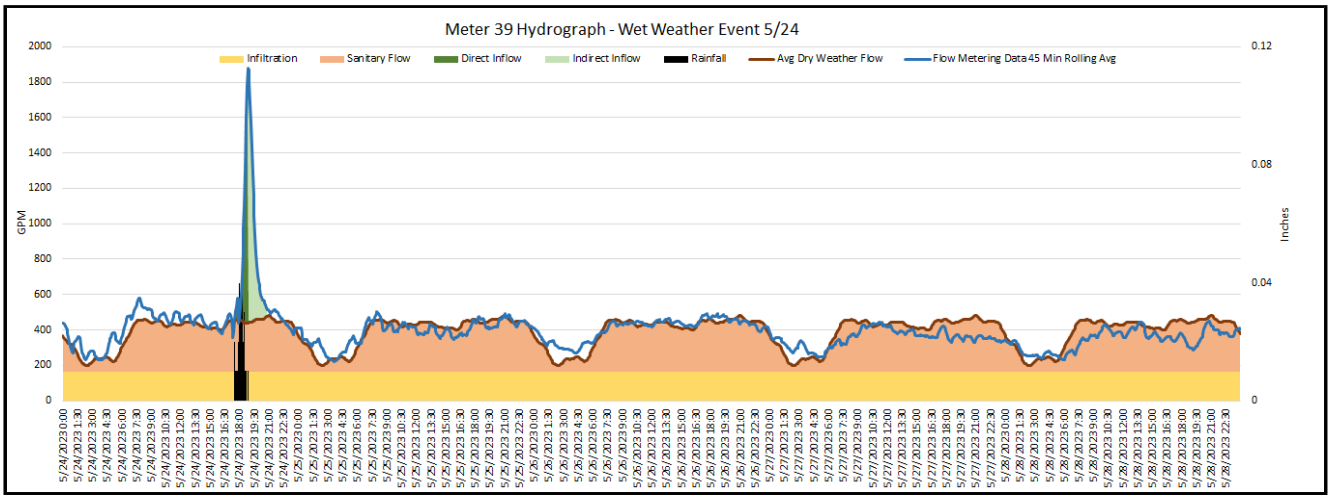

Meter 38 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

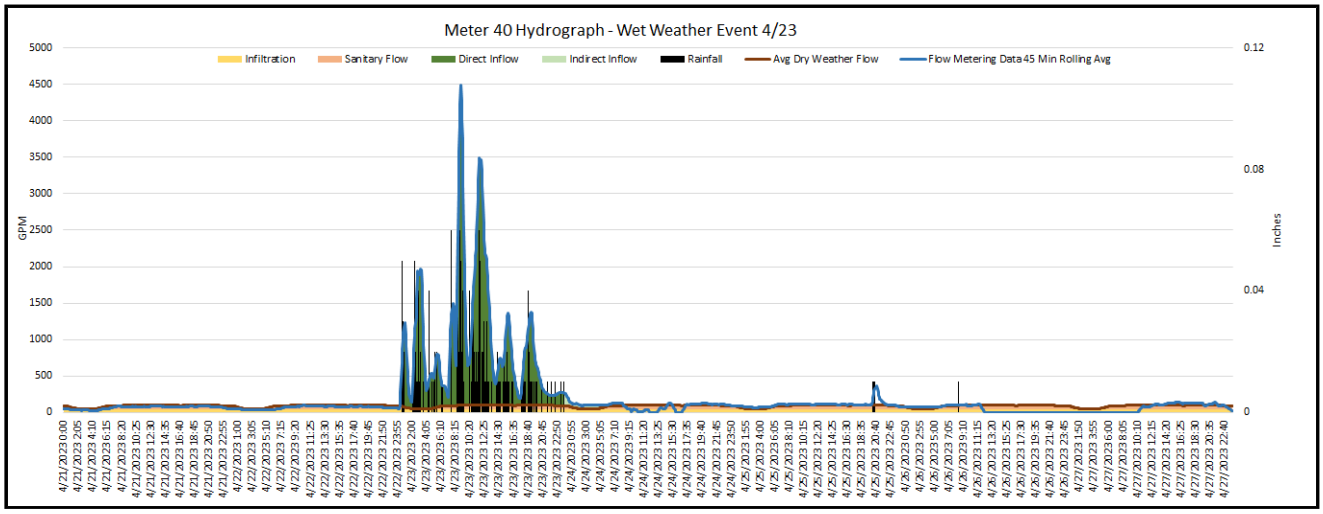

Meter 38 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

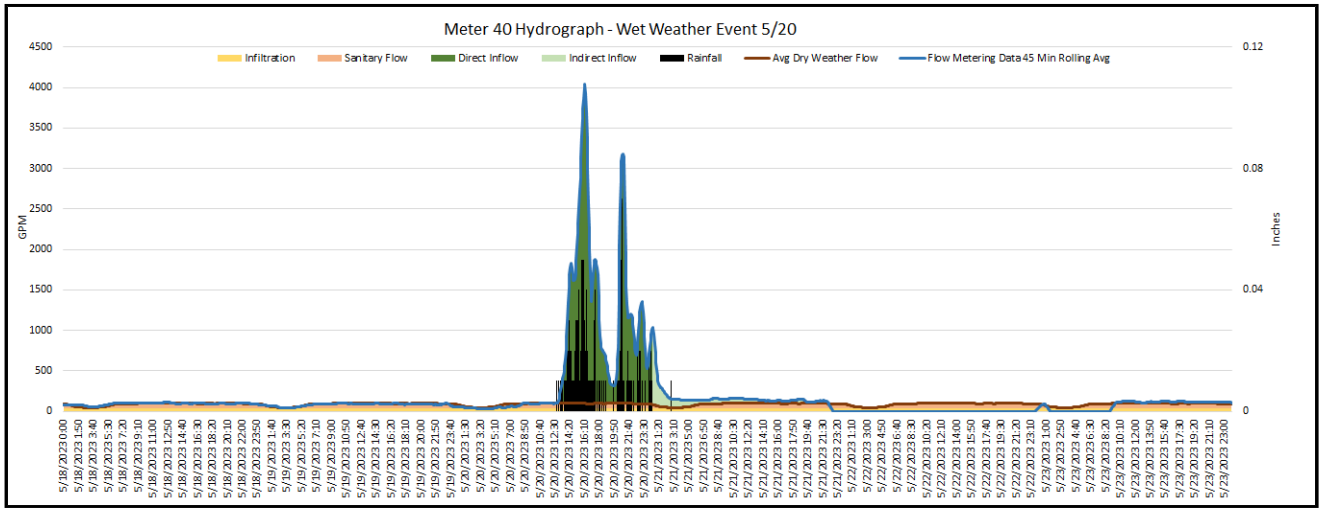

Meter 38 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

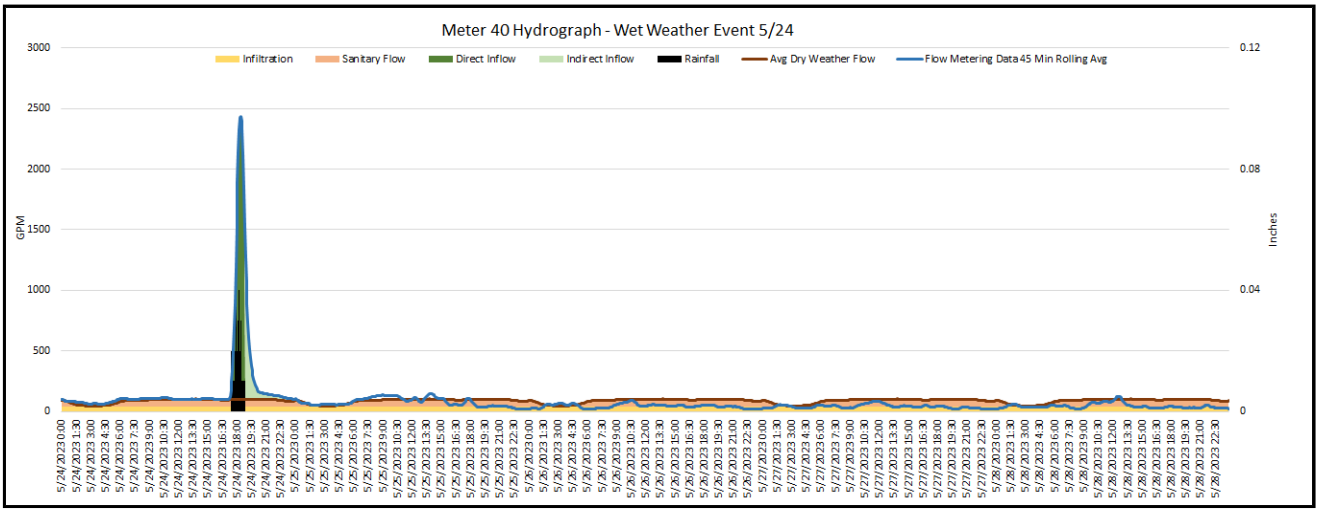

Meter 39 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

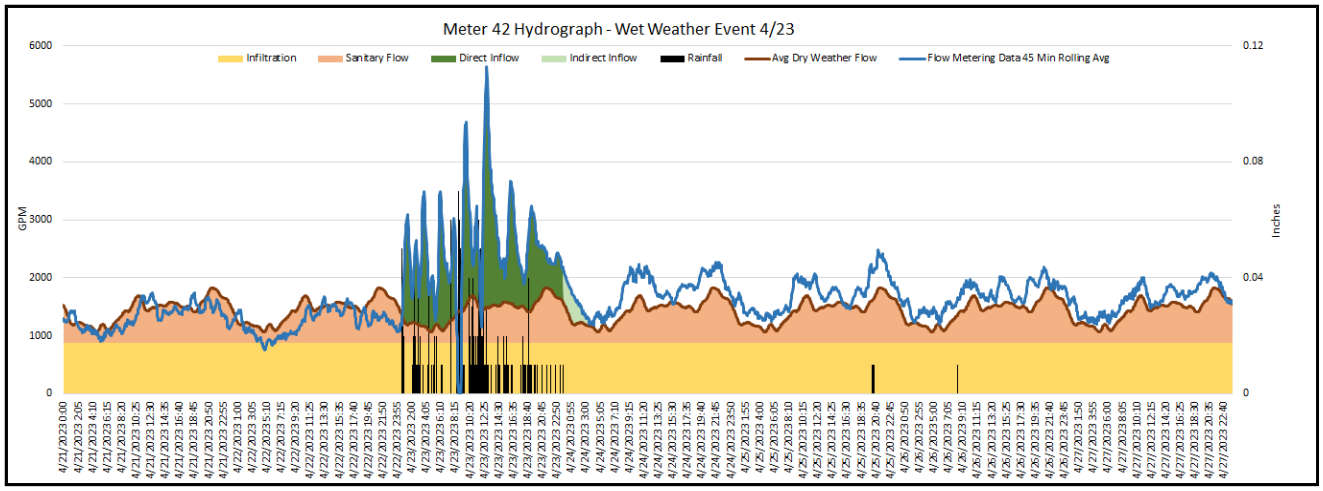

Meter 39 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

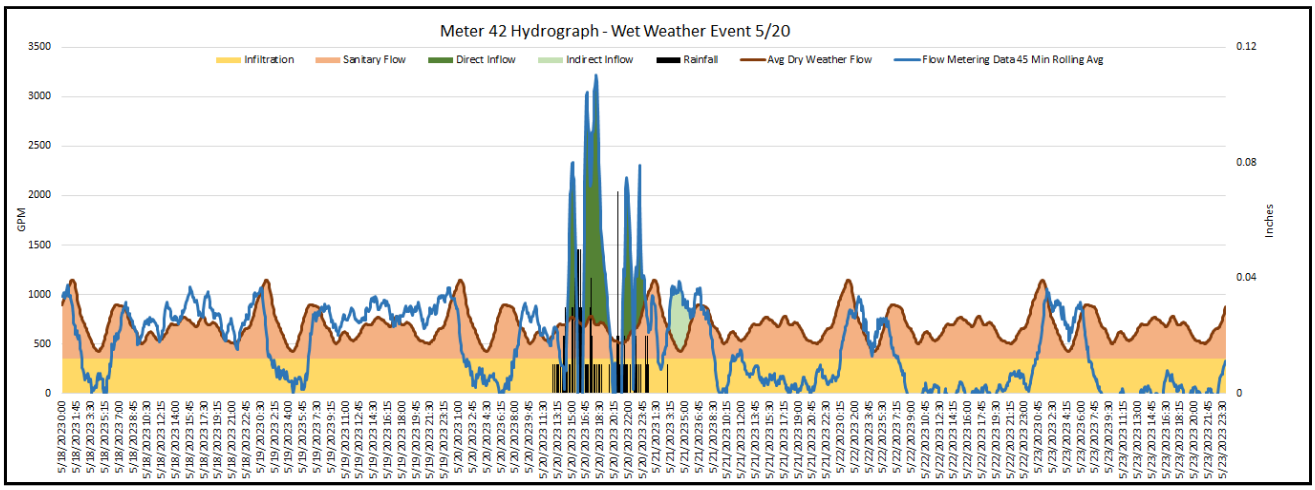

Meter 39 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

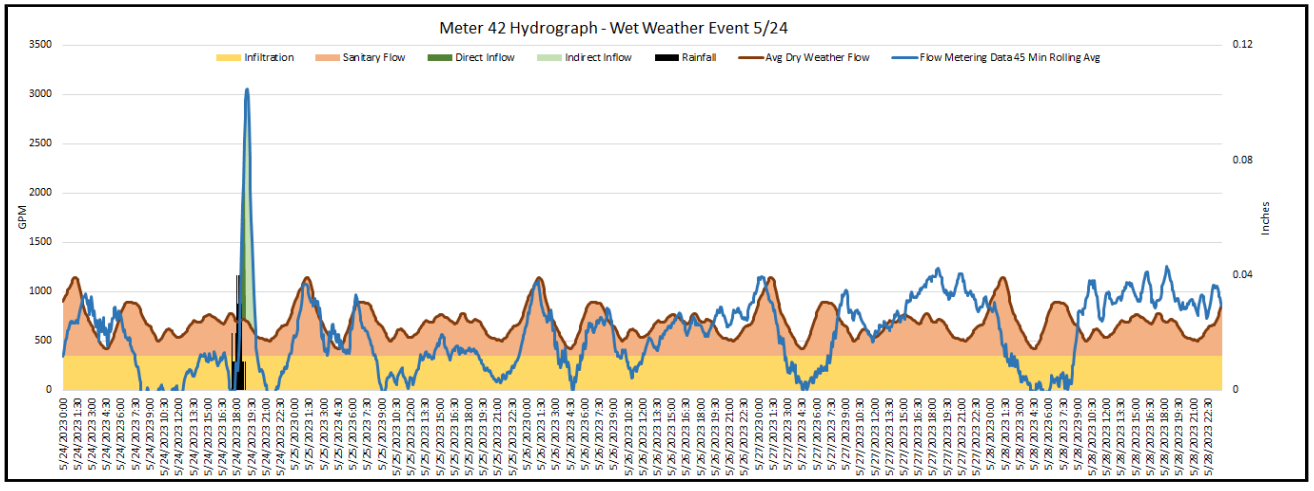

Meter 40 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

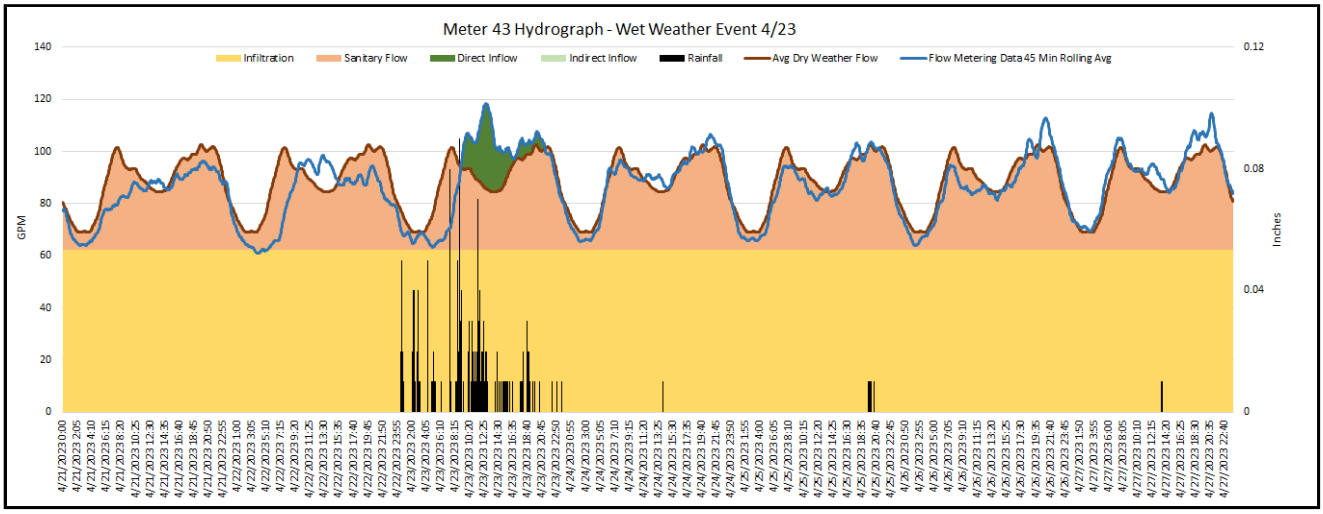

Meter 40 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

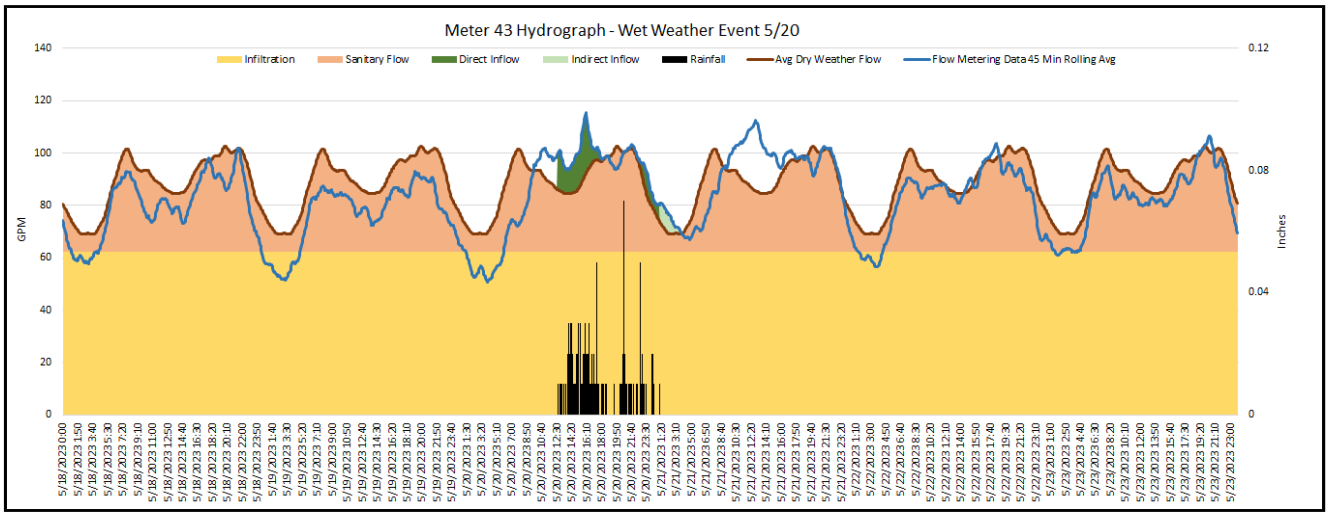

Meter 40 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

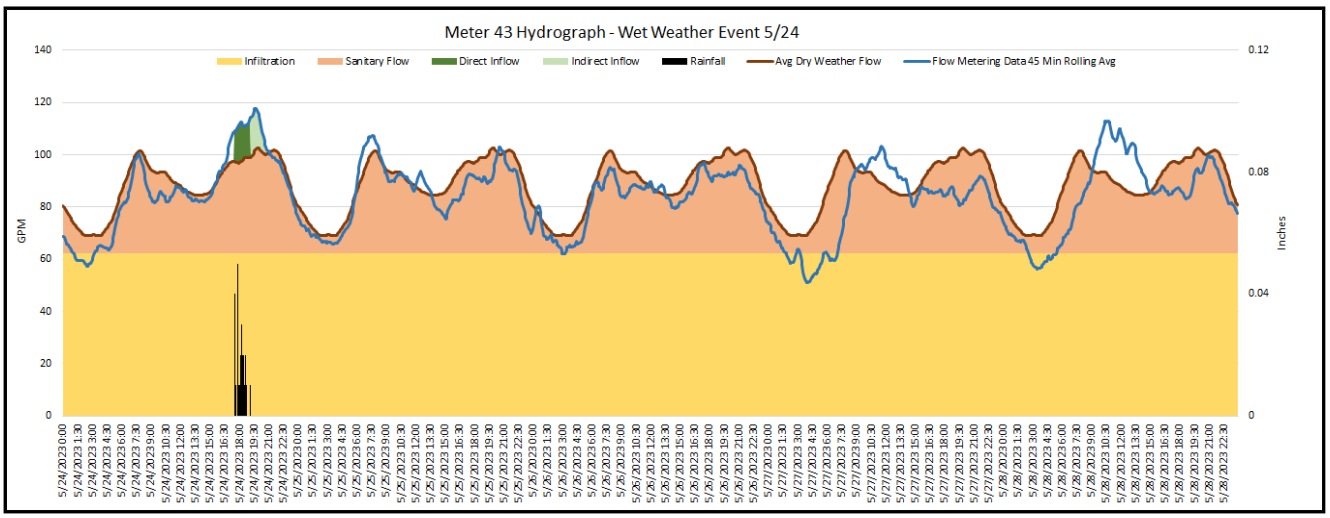

Meter 42 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

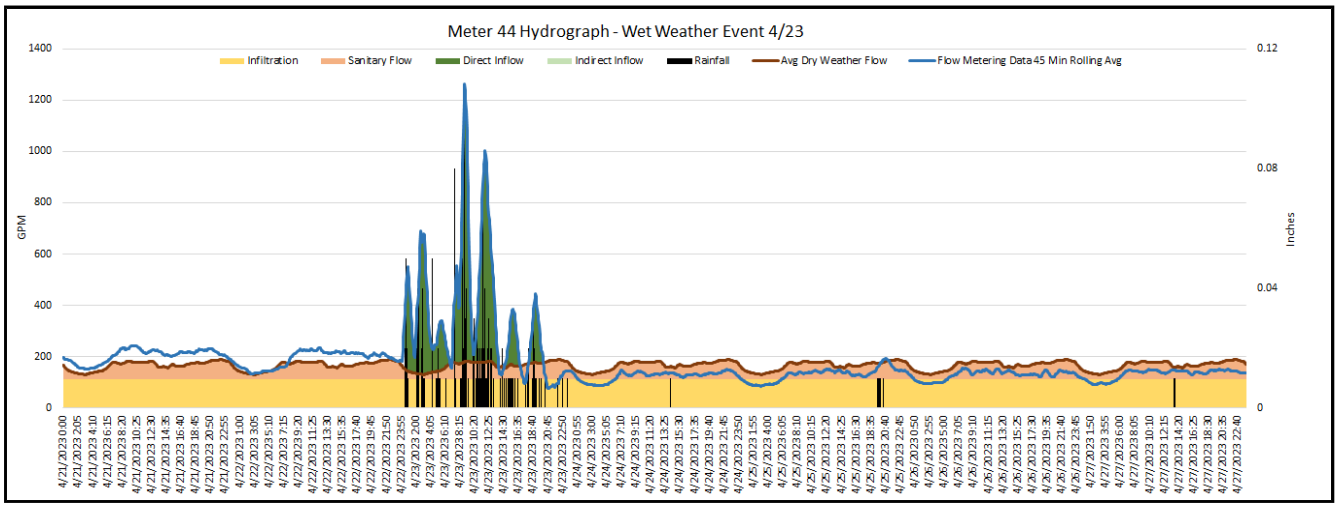

Meter 42 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

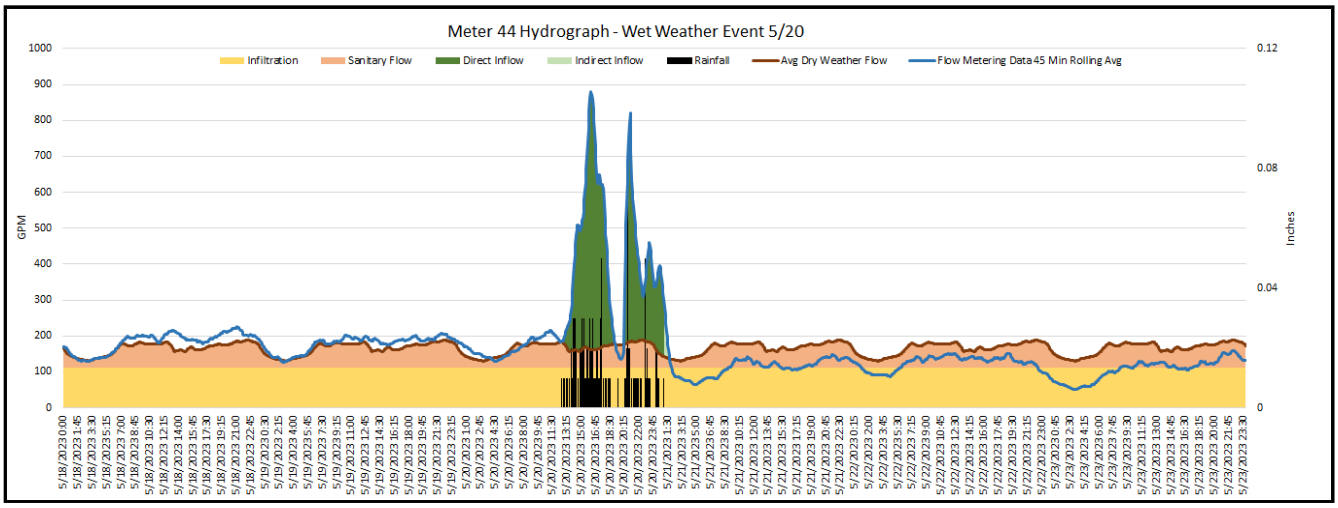

Meter 42 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

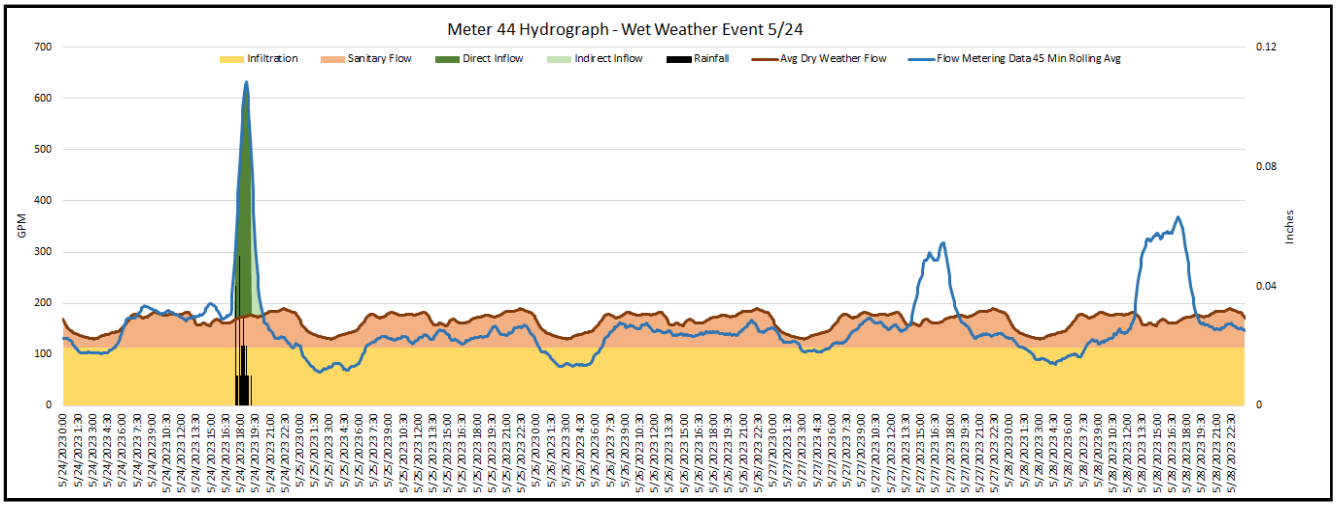

Meter 43 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

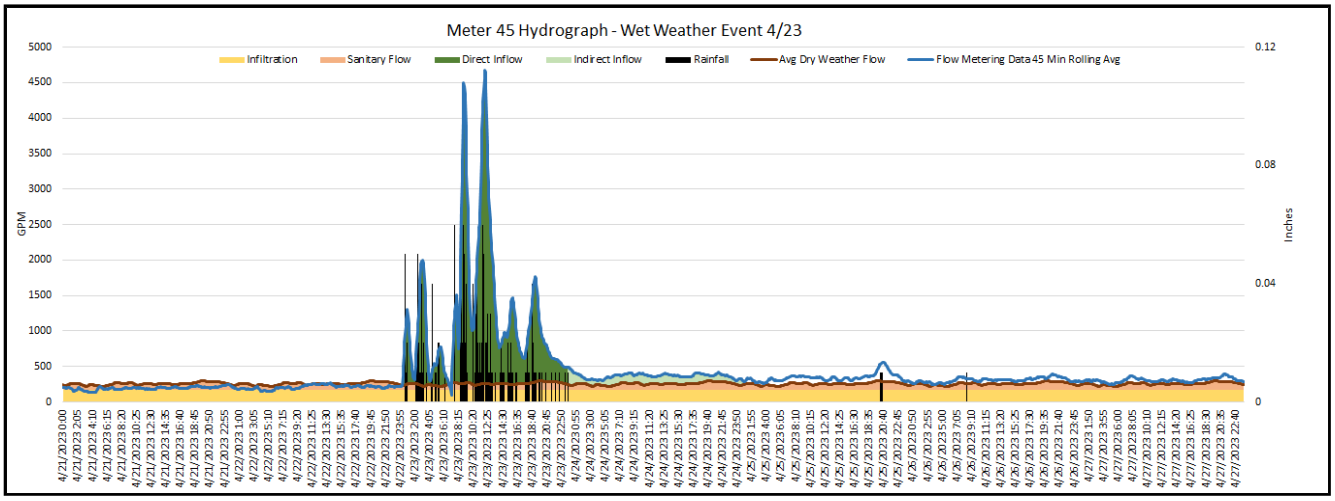

Meter 43 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

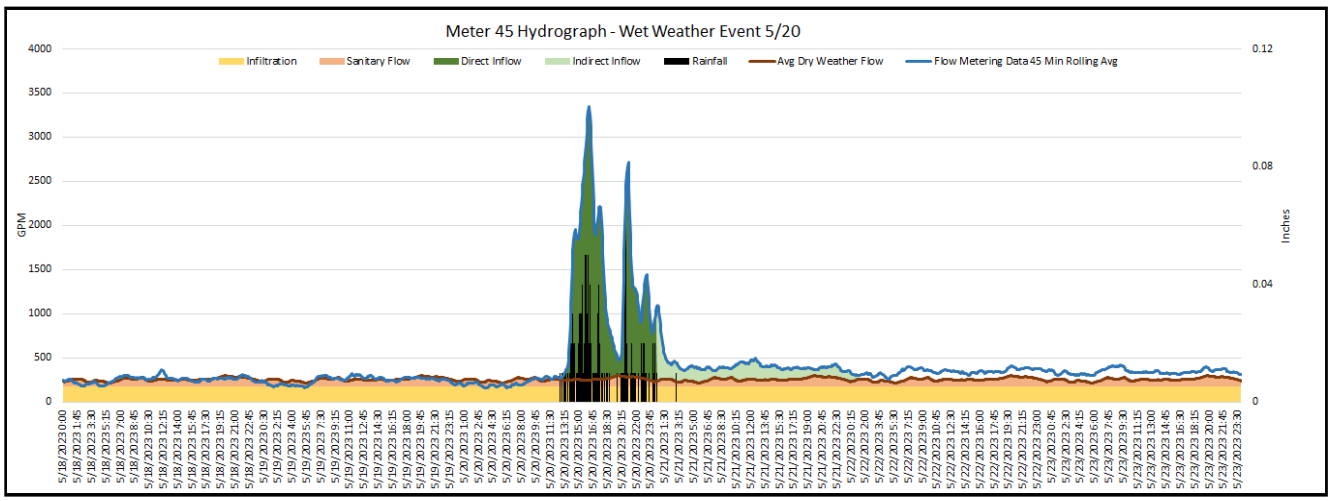

Meter 43 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

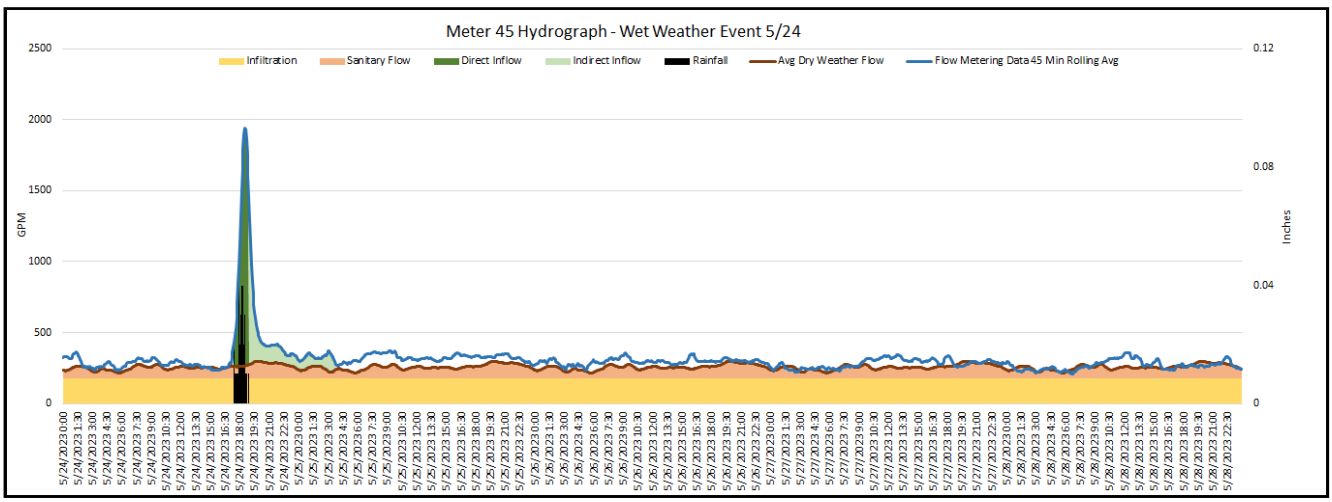

Meter 44 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

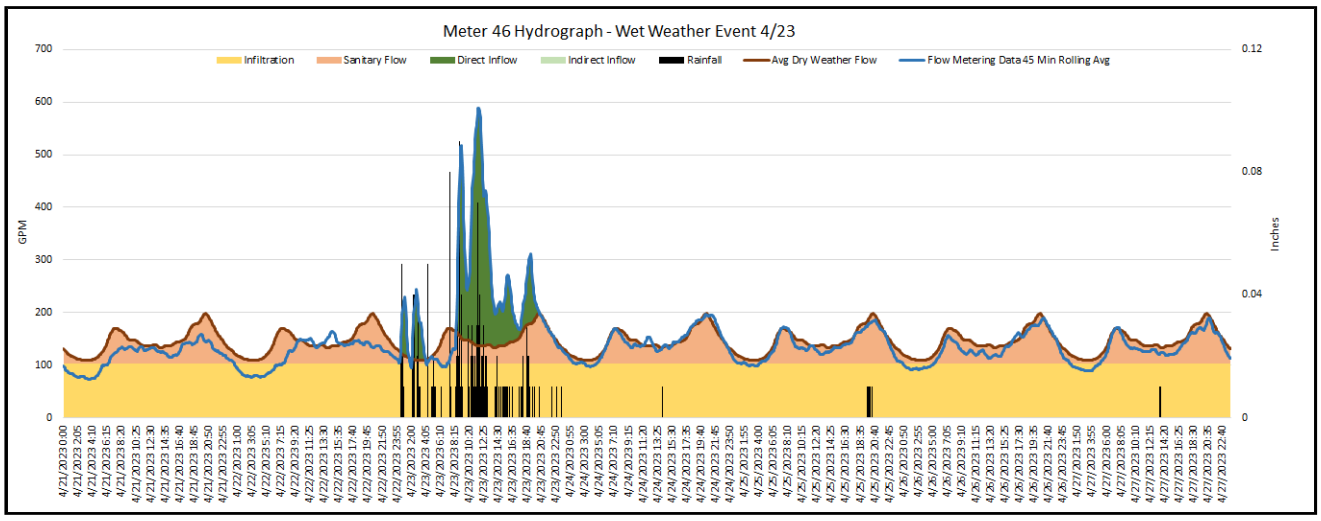

Meter 44 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

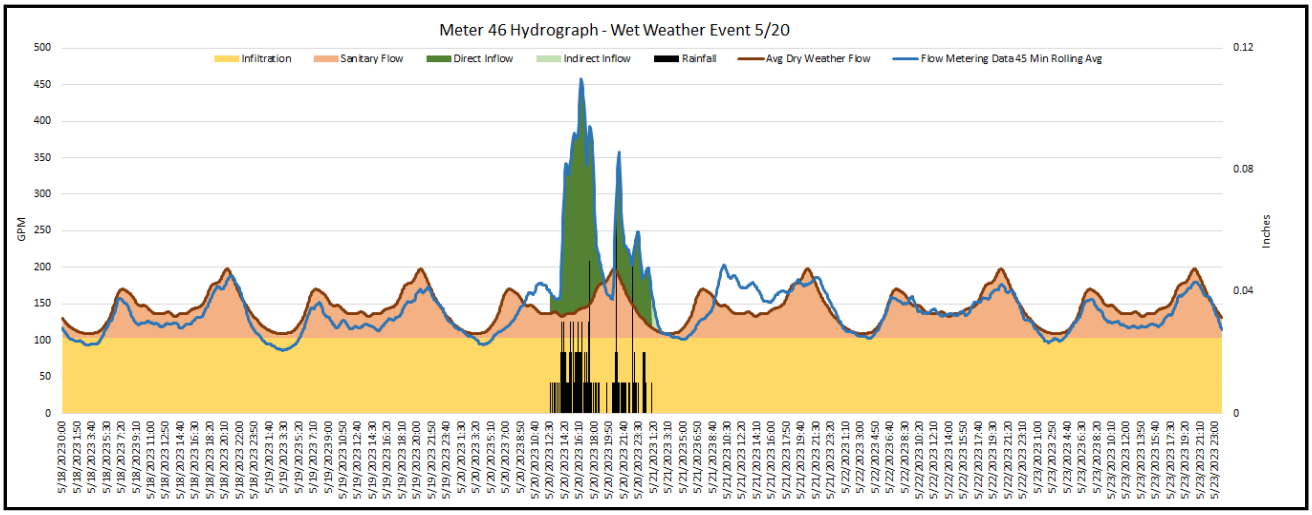

Meter 44 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

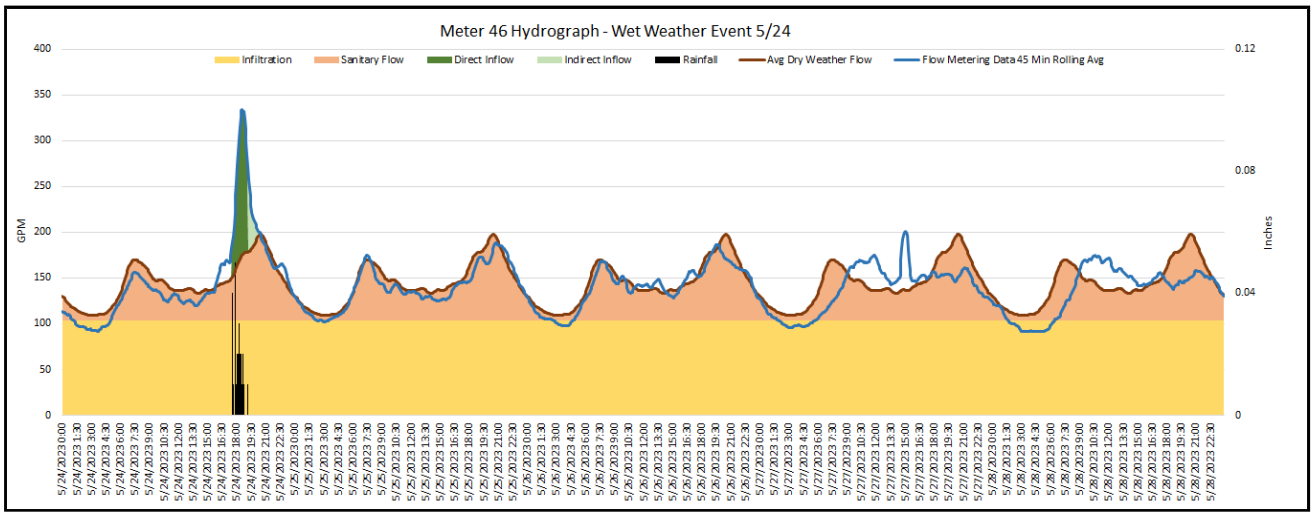

Meter 45 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

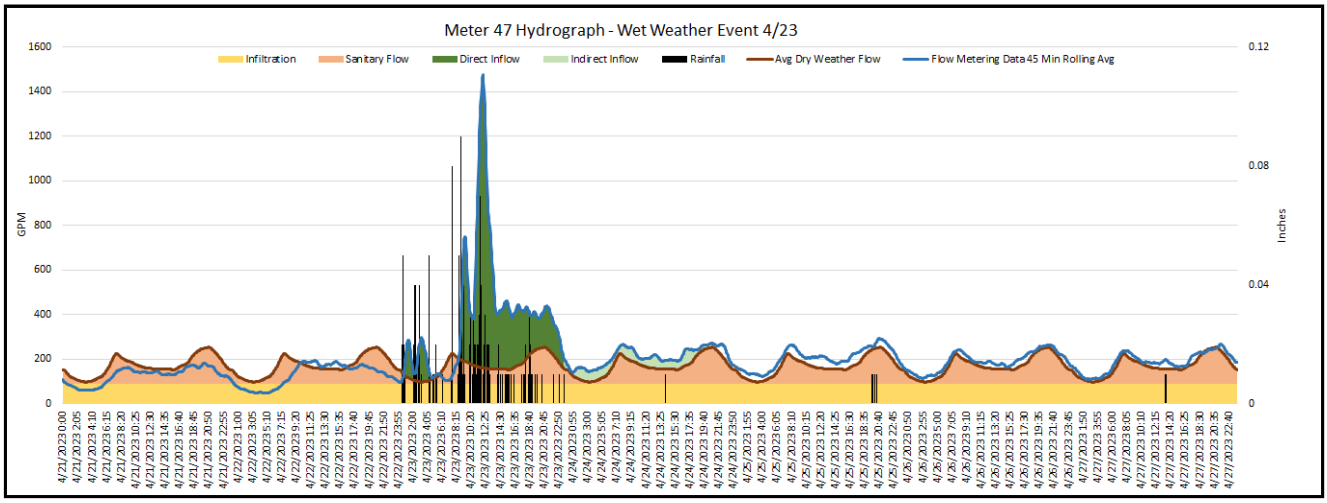

Meter 45 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

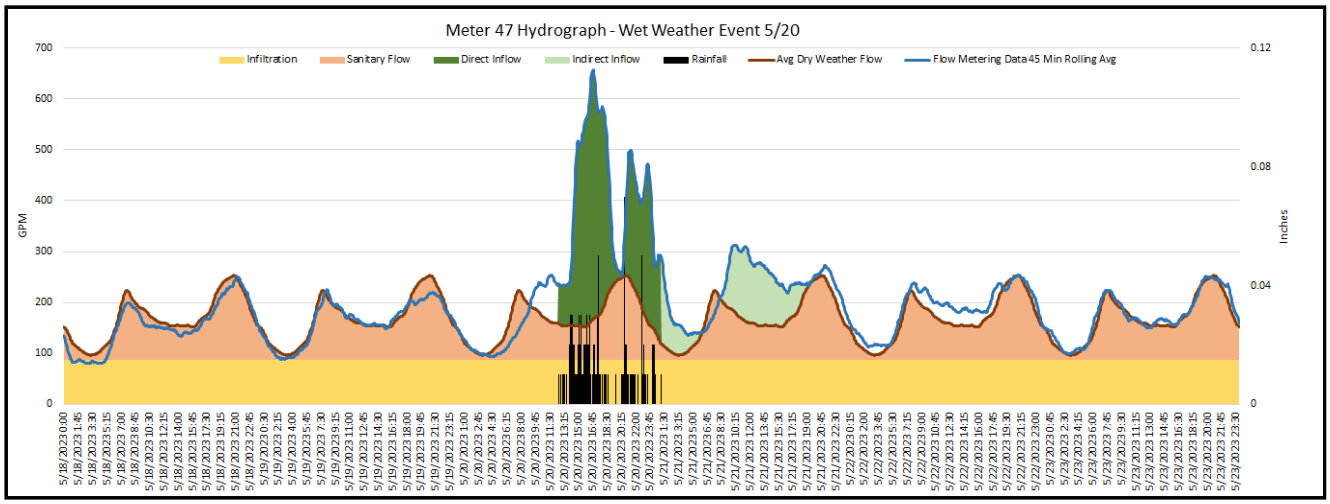

Meter 45 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

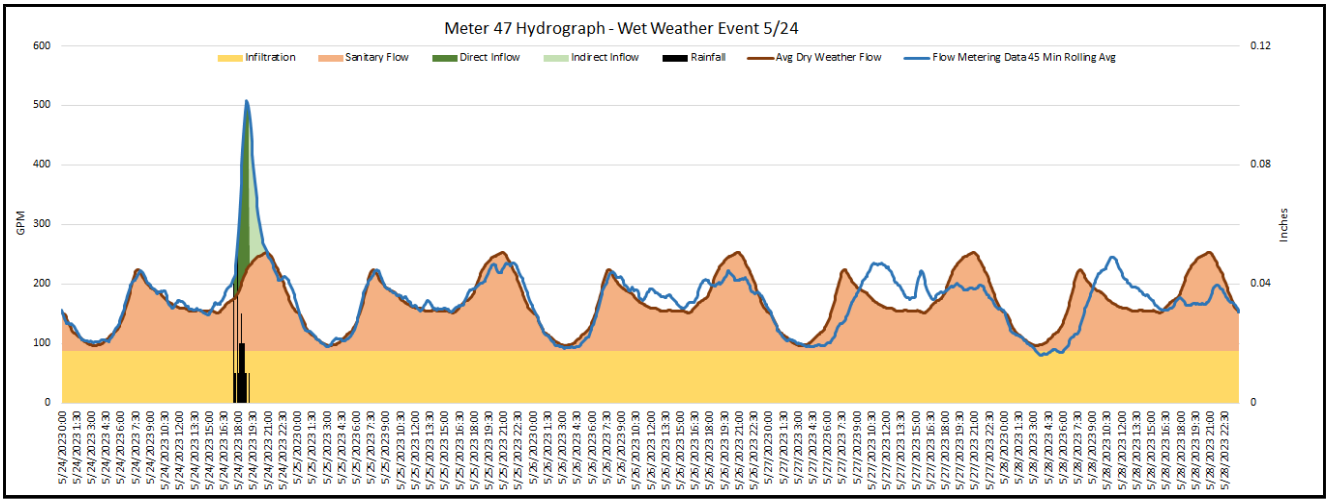

Meter 46 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

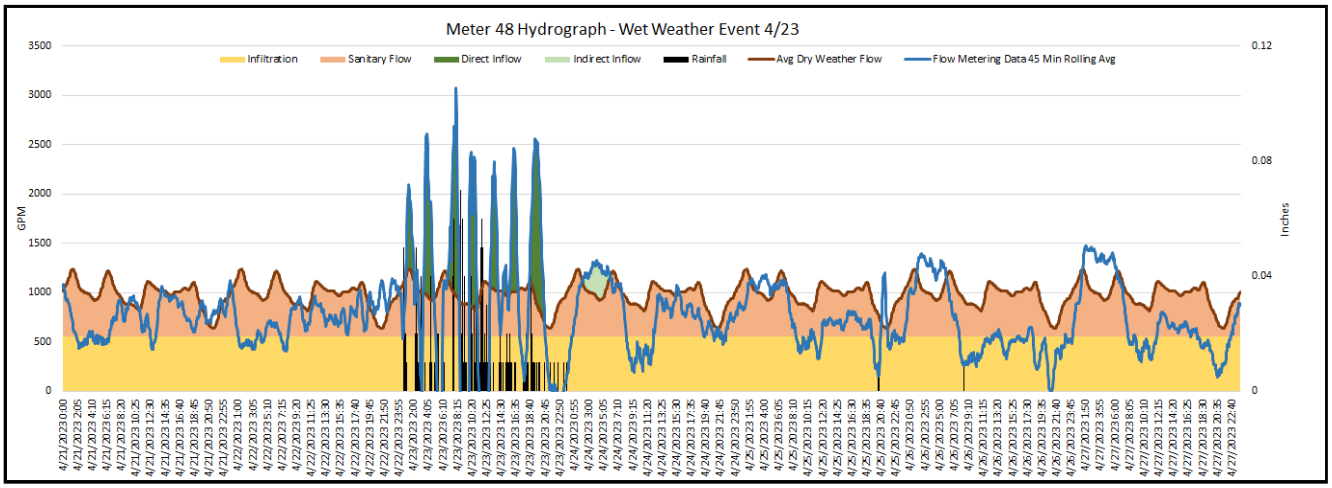

Meter 46 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

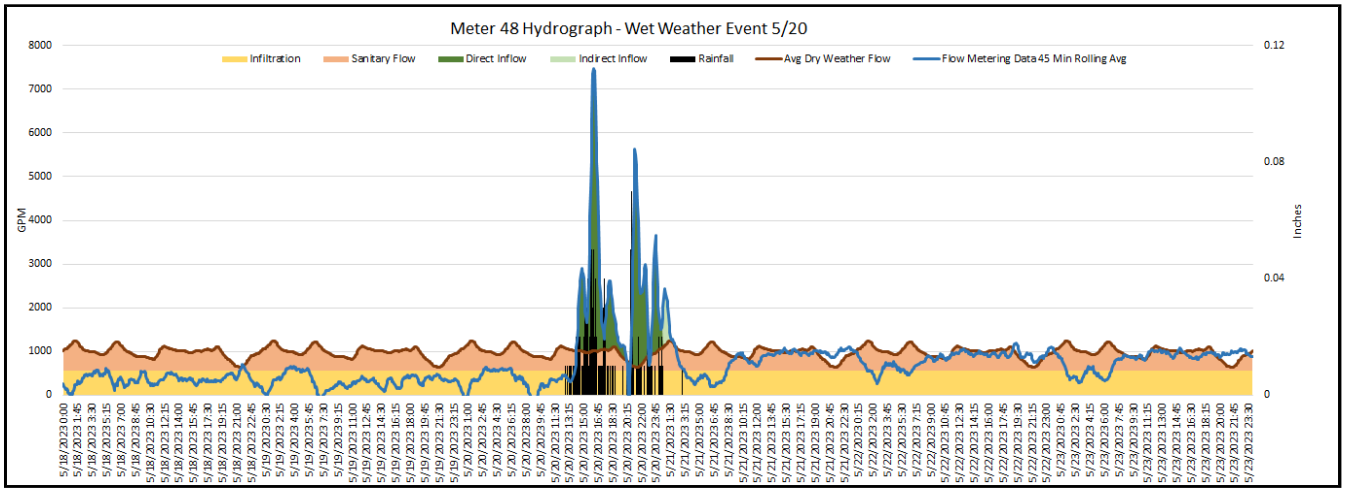

Meter 46 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

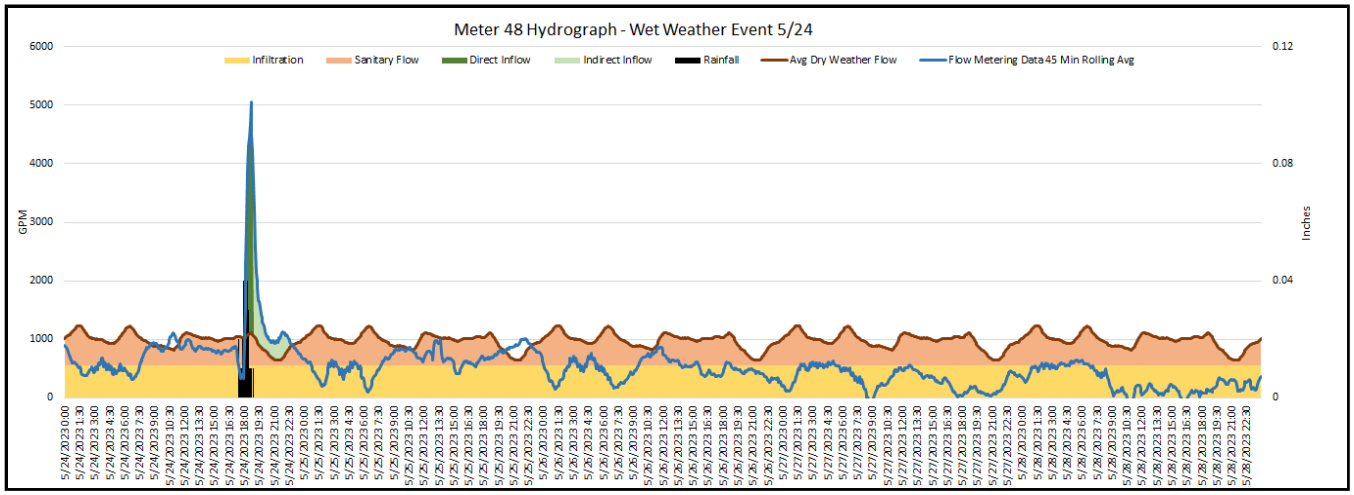

Meter 47 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

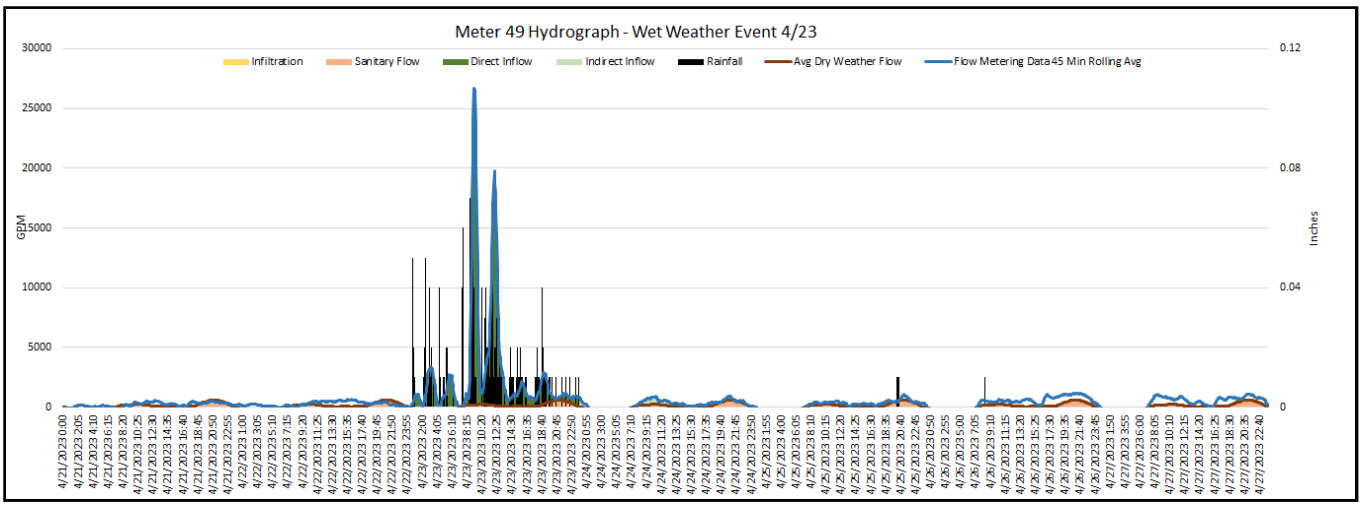

Meter 47 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

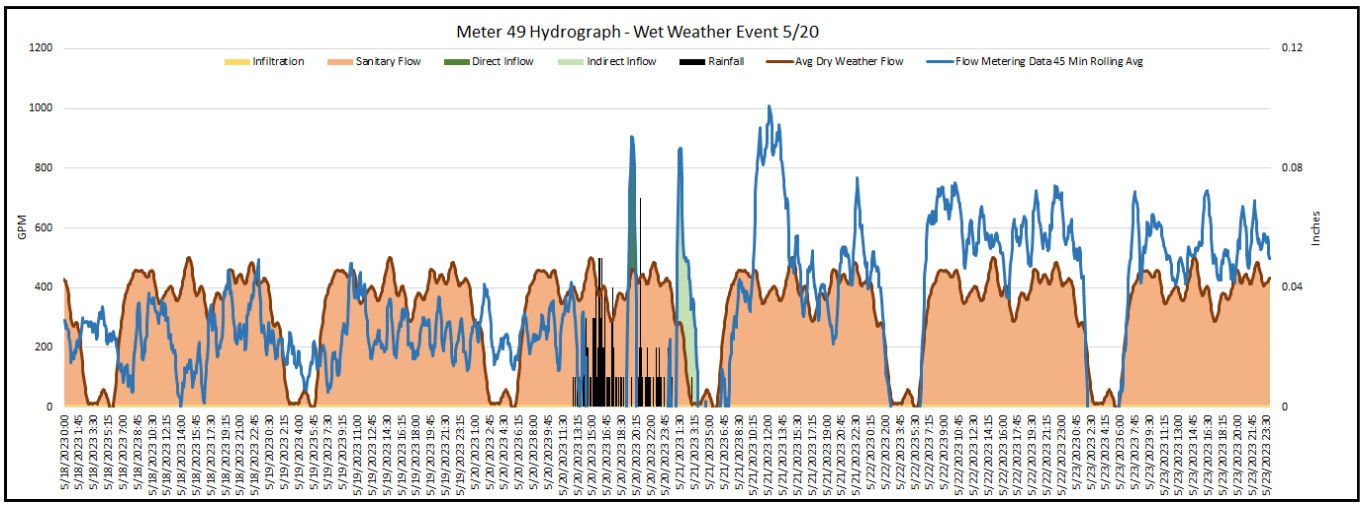

Meter 47 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

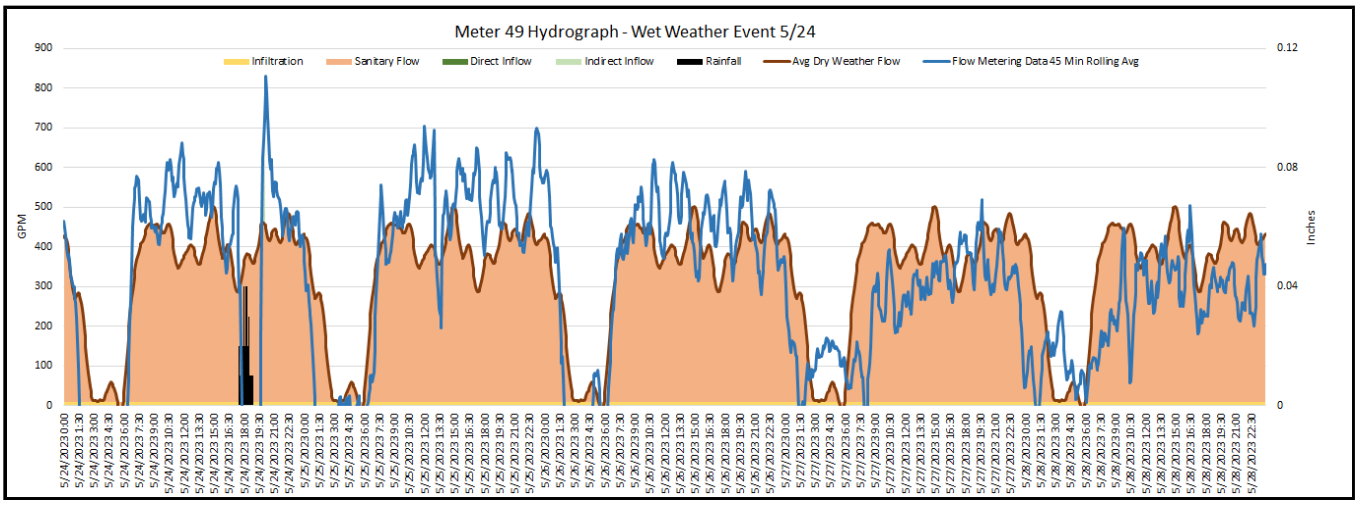

Meter 48 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

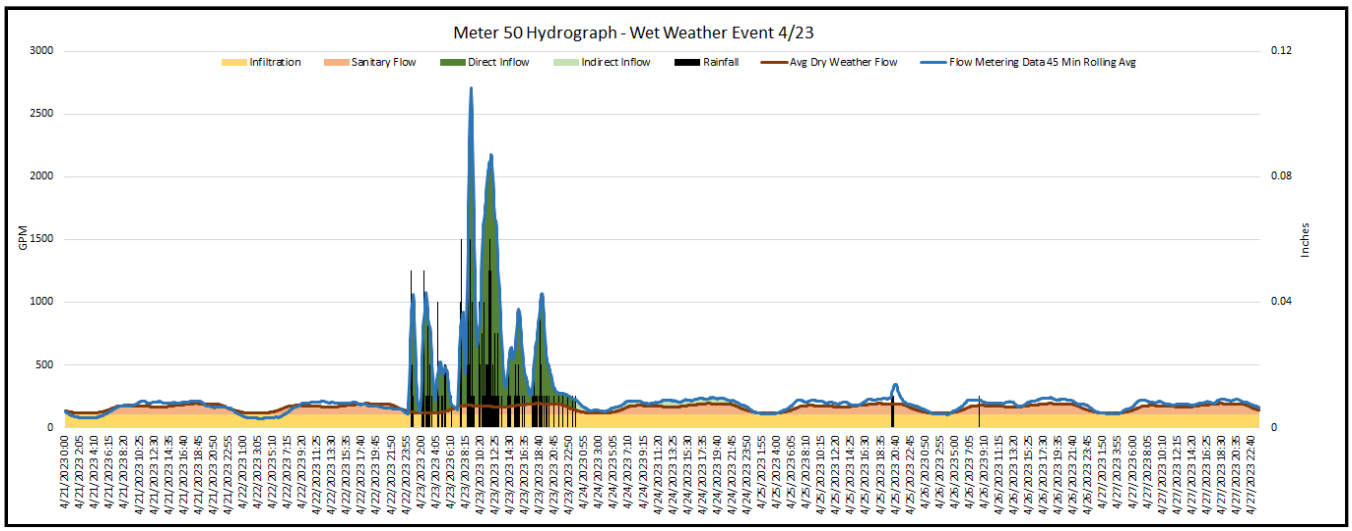

Meter 48 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

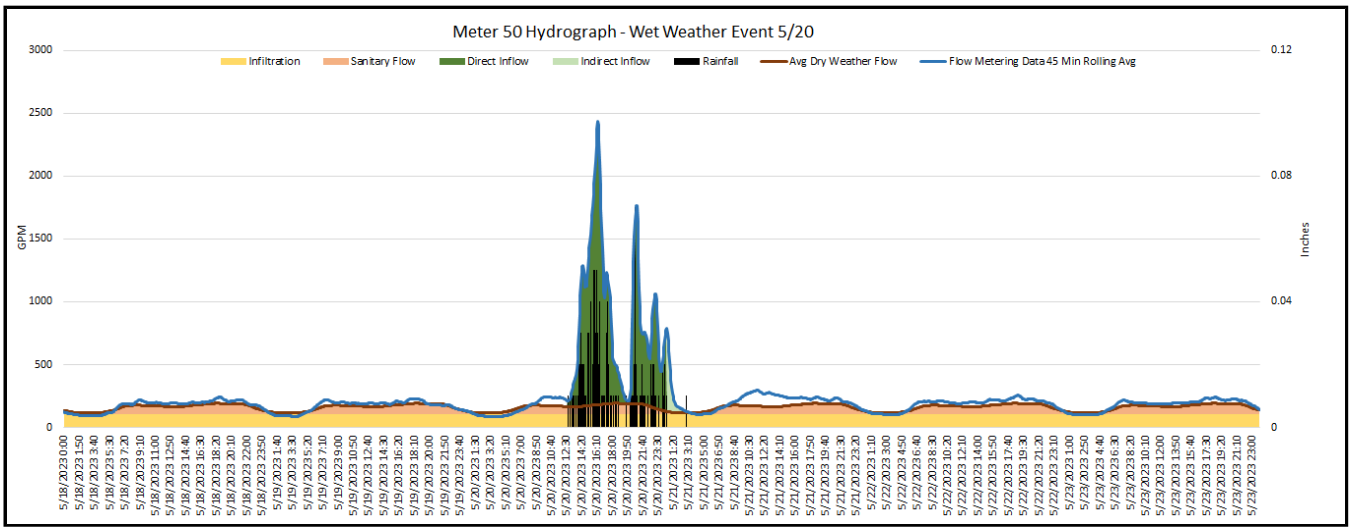

Meter 48 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

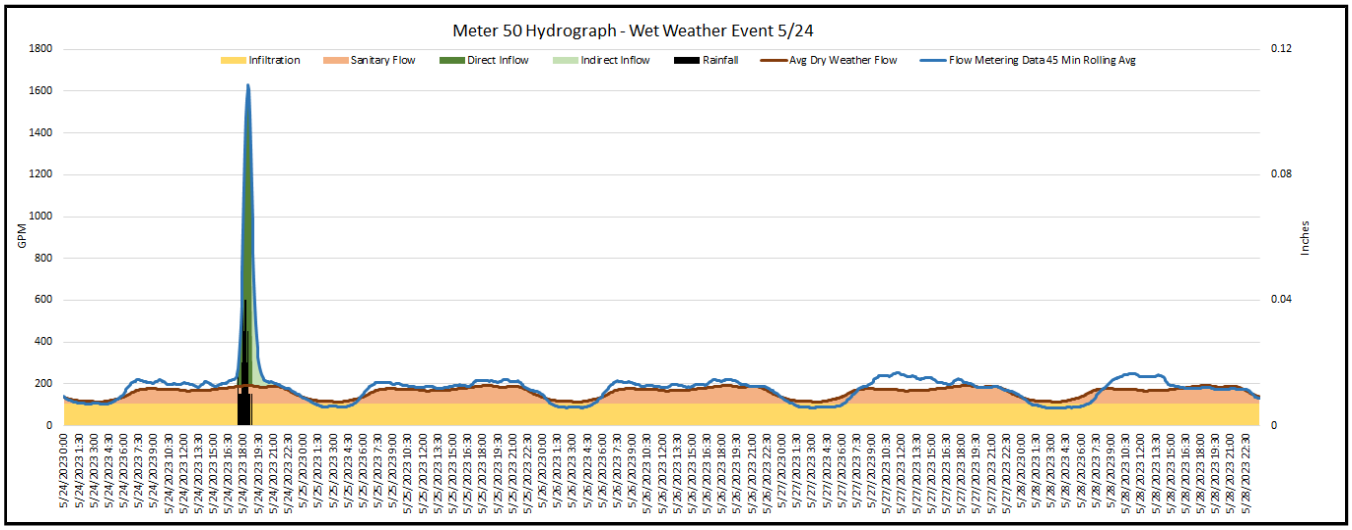

Meter 49 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

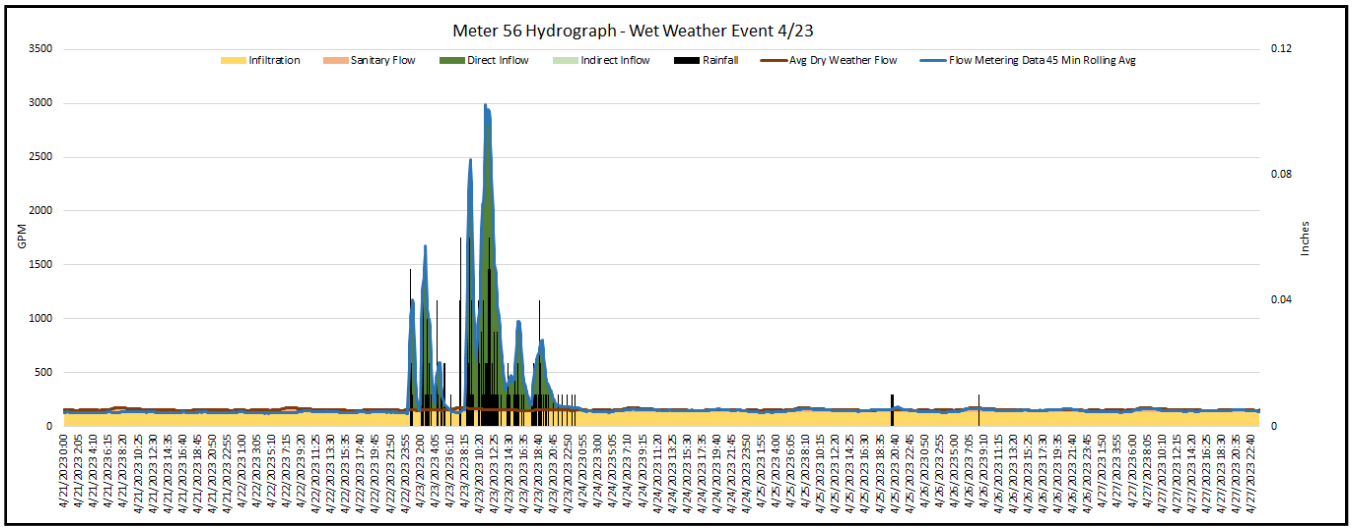

Meter 49 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

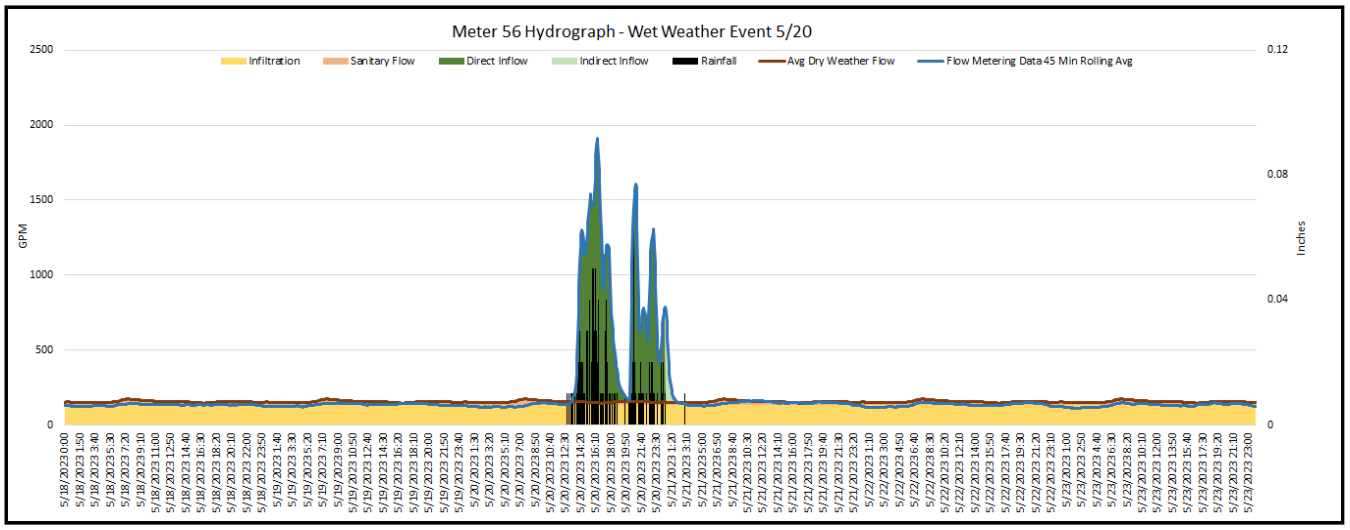

Meter 49 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

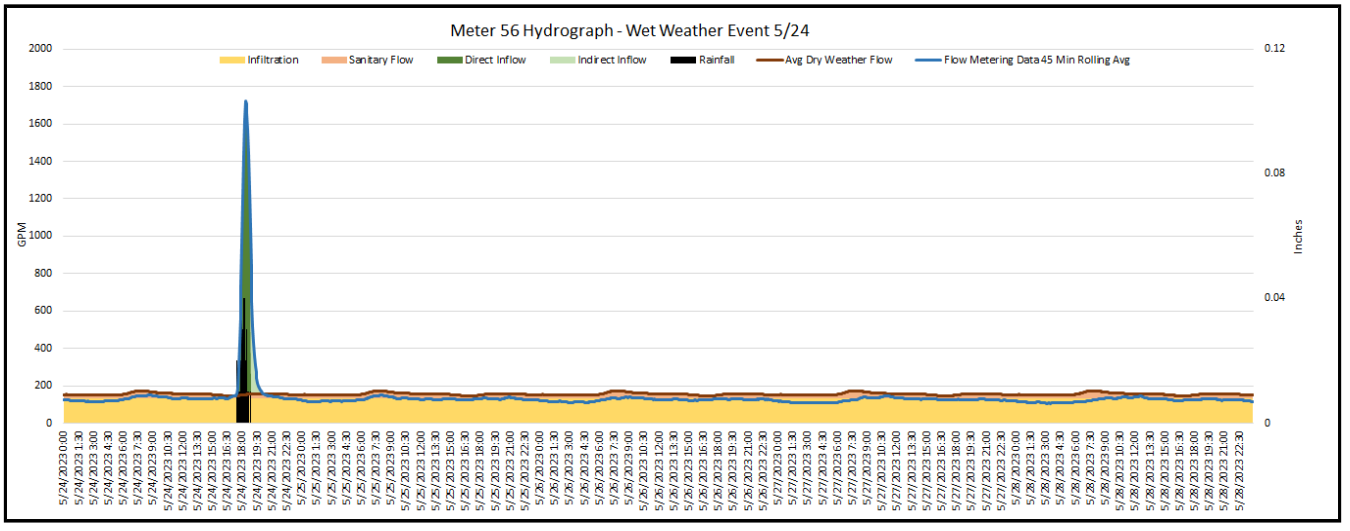

Meter 50 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

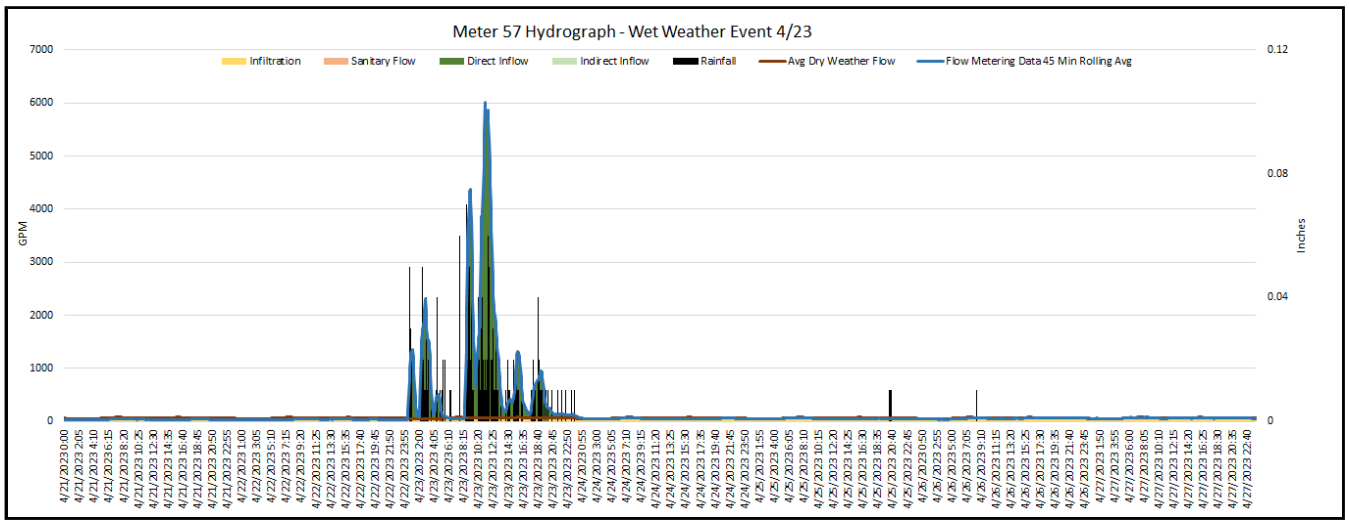

Meter 50 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

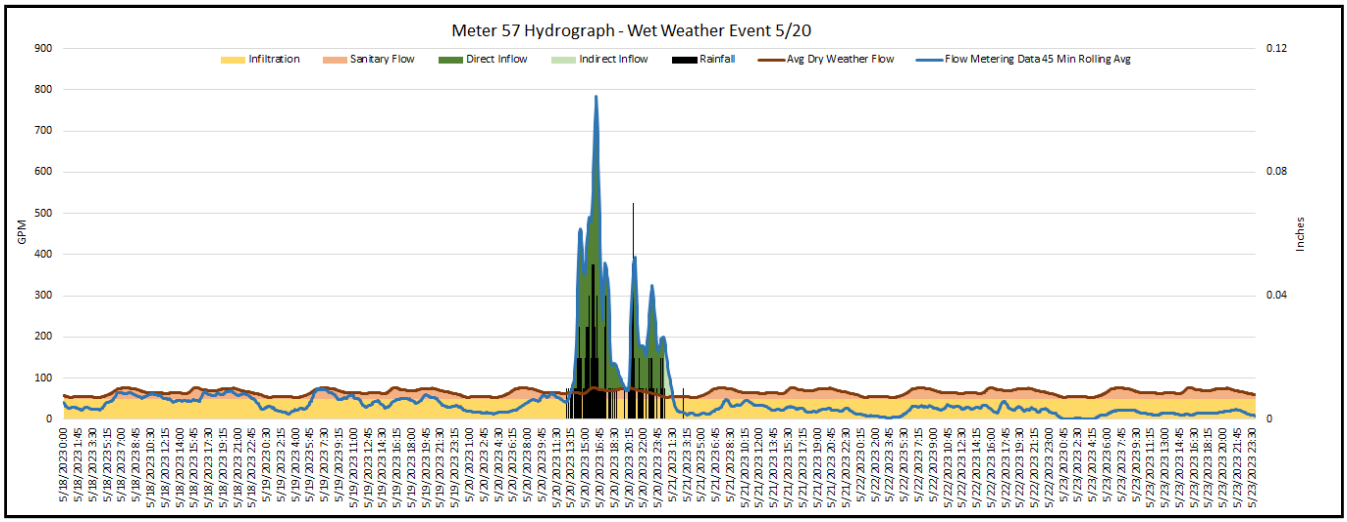

Meter 50 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

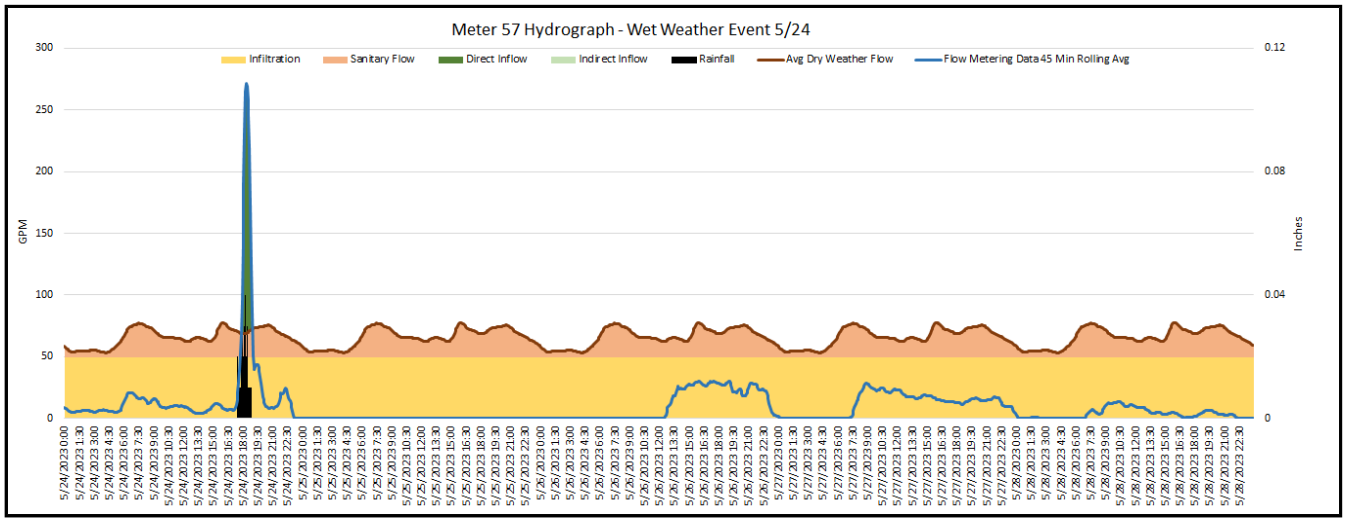

Meter 56 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

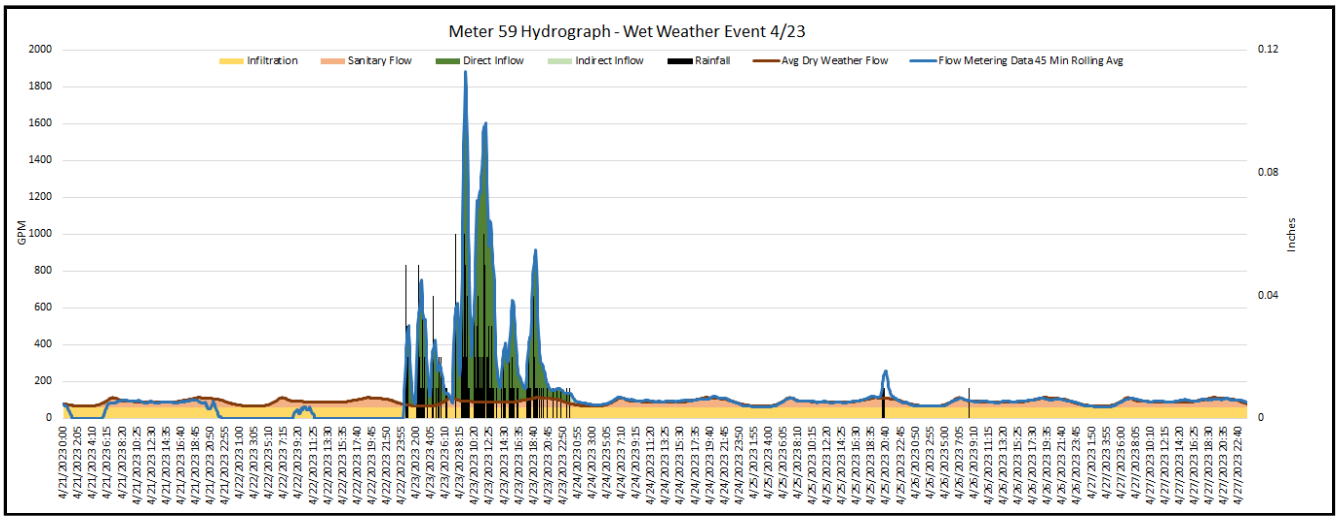

Meter 56 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

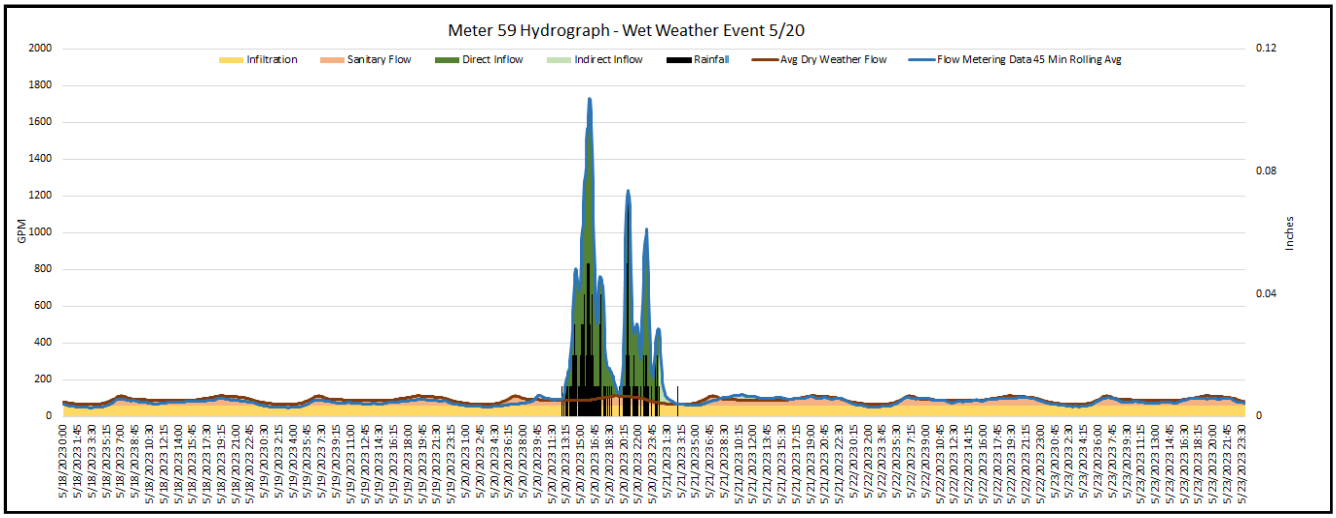

Meter 56 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

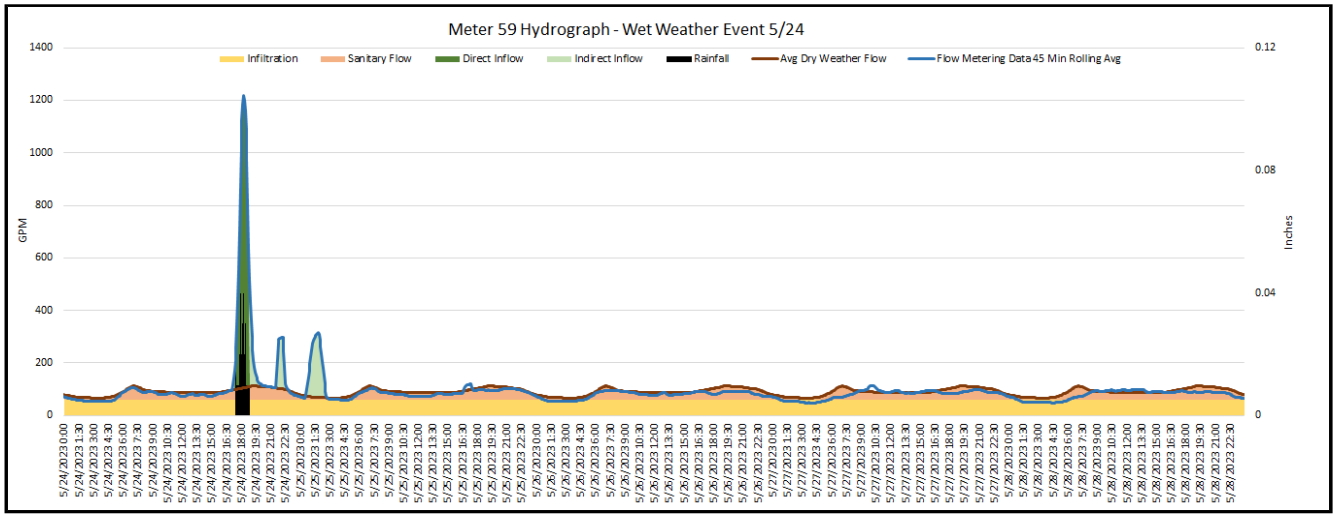

Meter 57 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

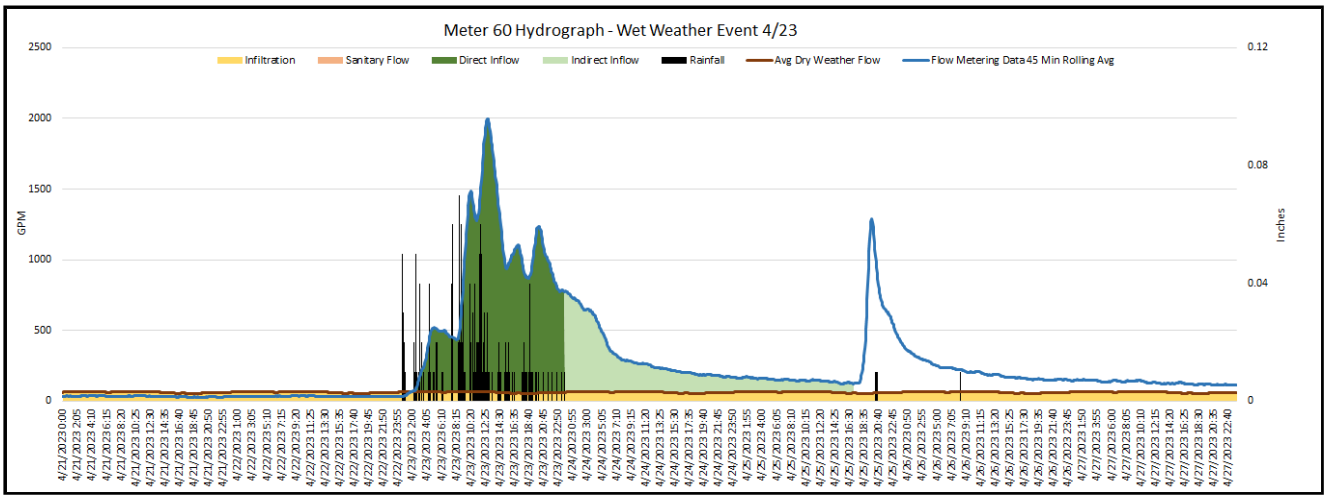

Meter 57 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

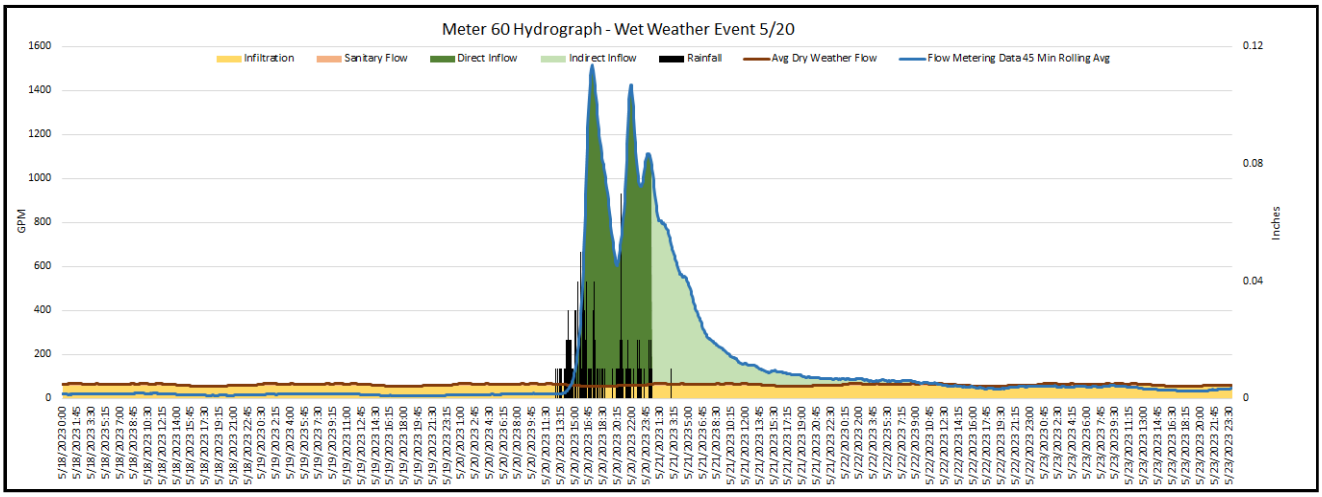

Meter 57 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

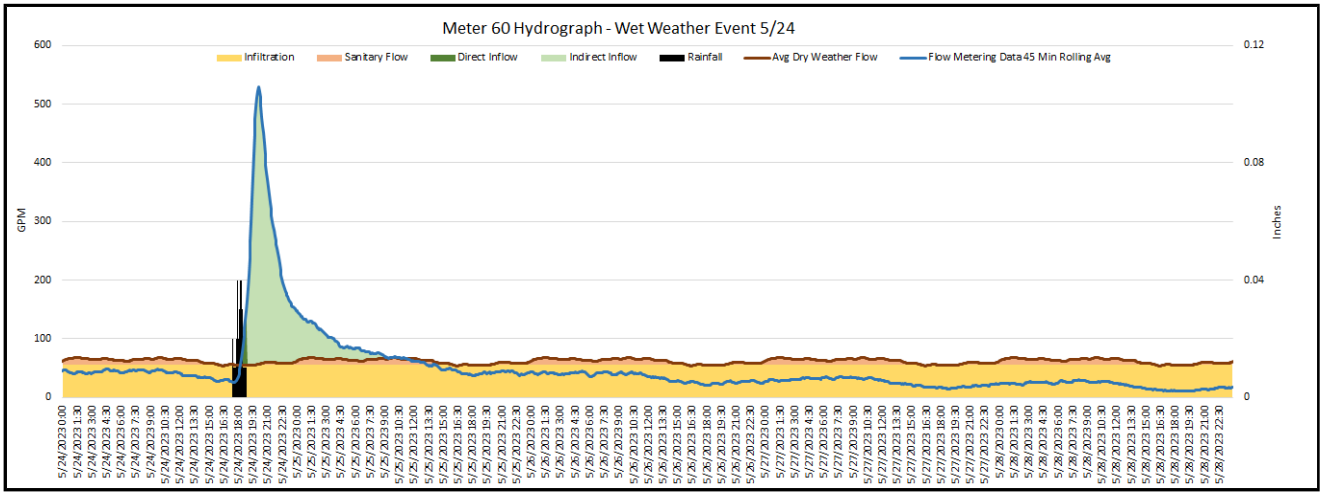

Meter 59 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

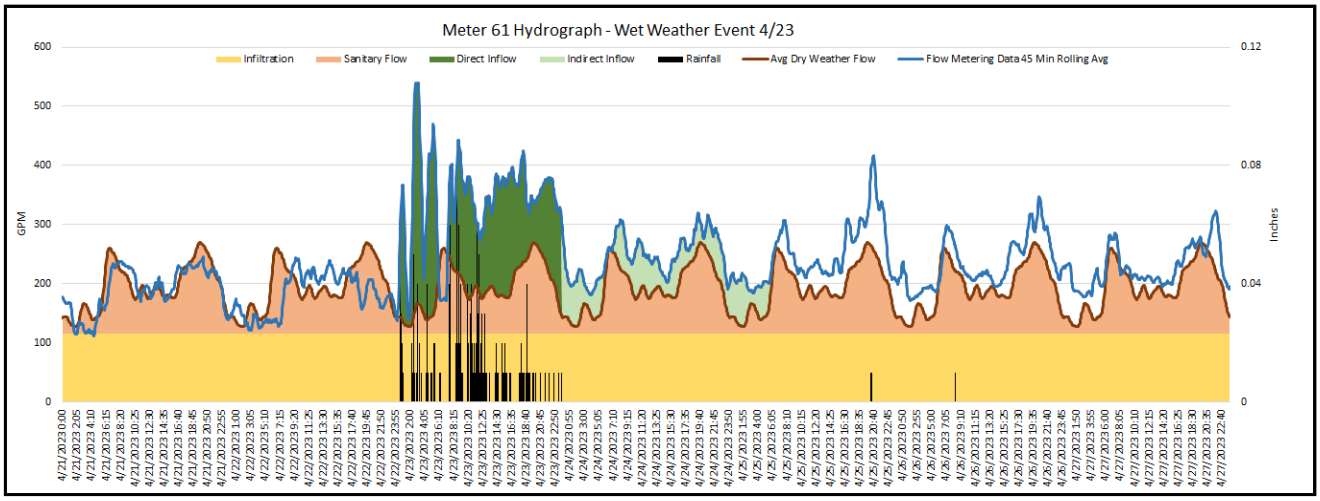

Meter 59 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

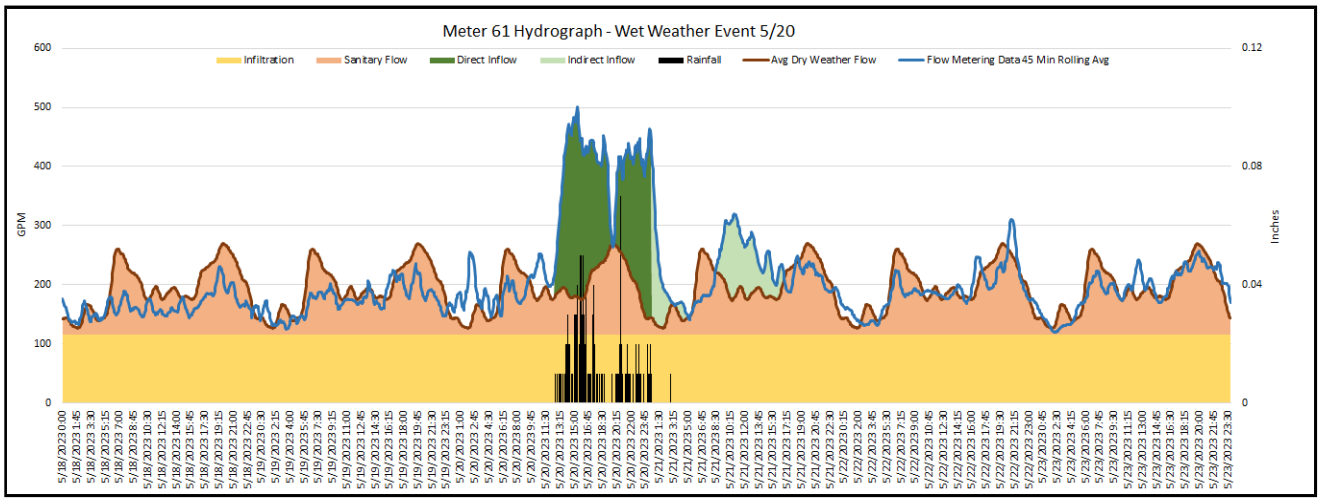

Meter 59 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

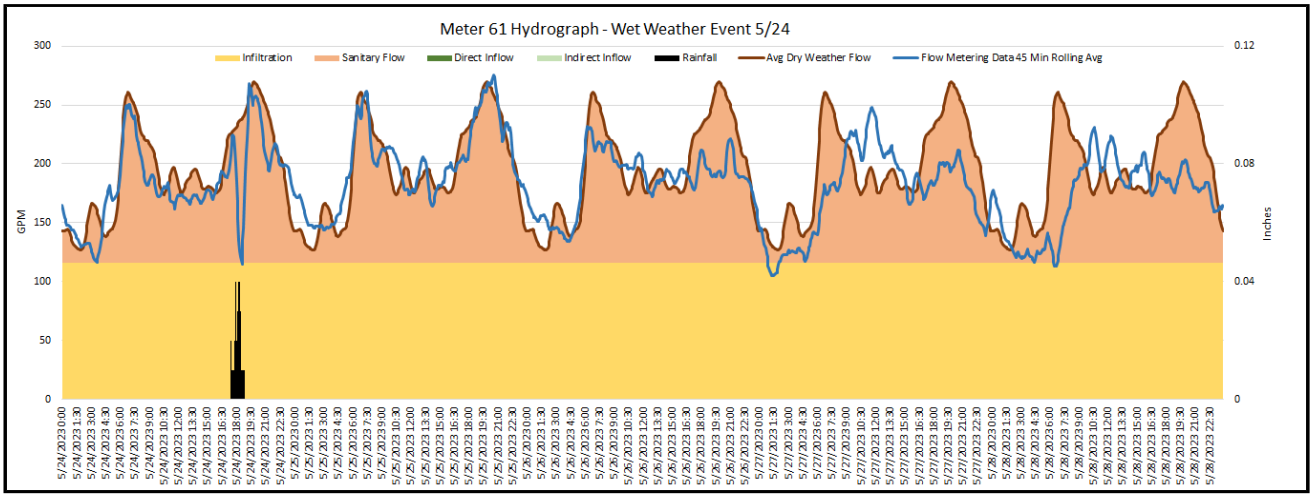

Meter 60 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

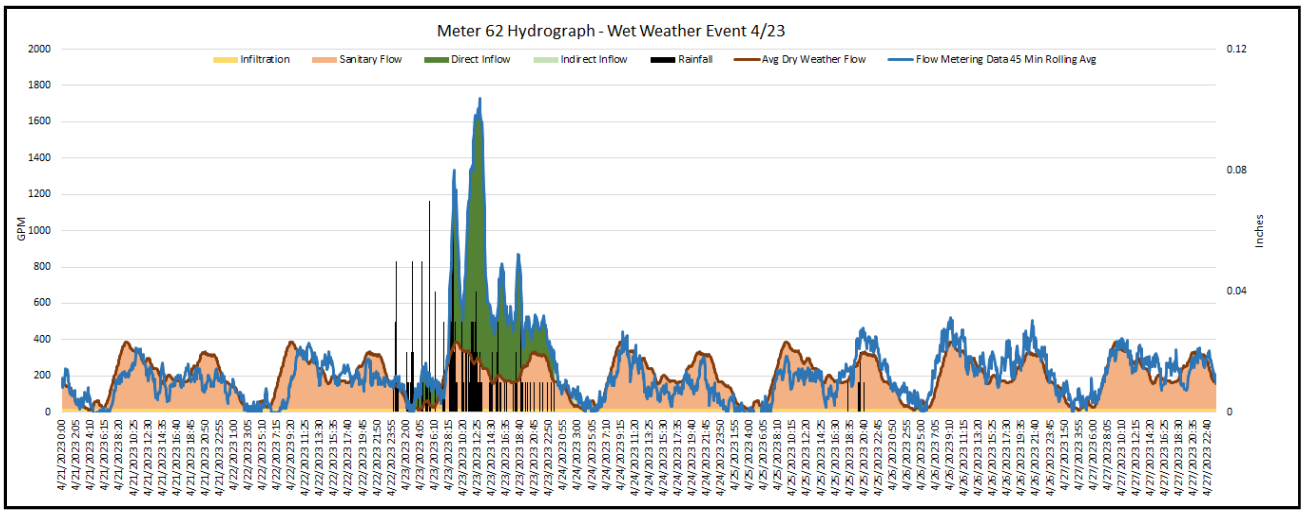

Meter 60 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

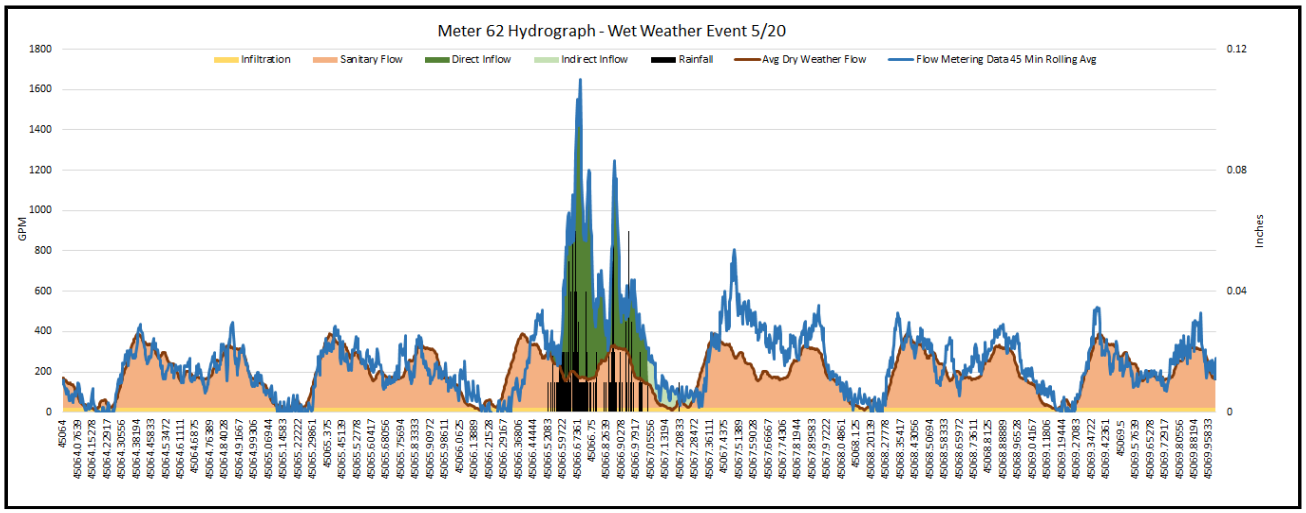

Meter 60 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

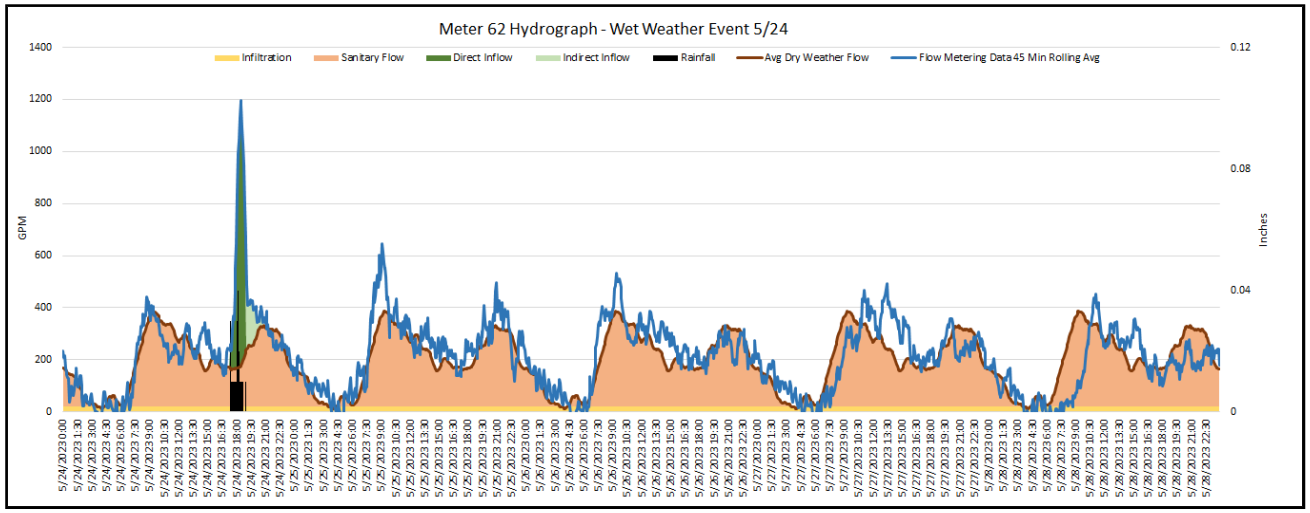

Meter 61 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

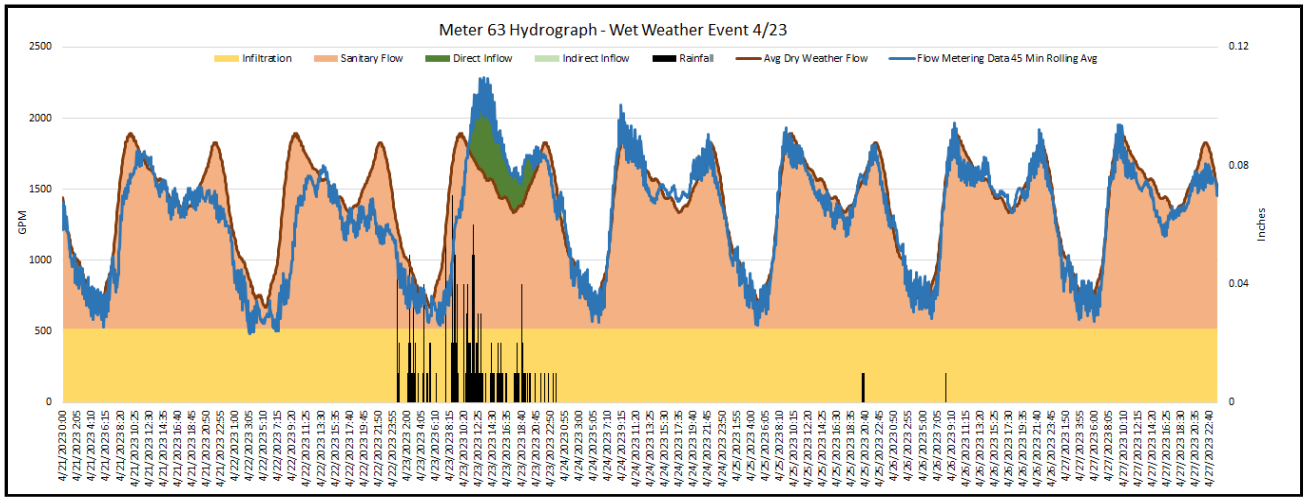

Meter 61 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

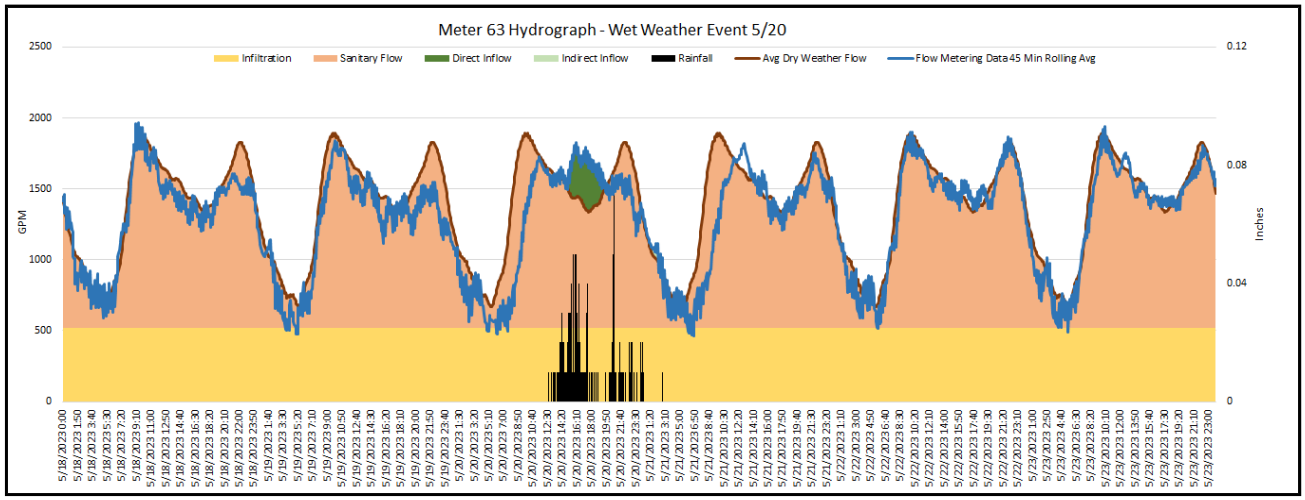

Meter 61 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

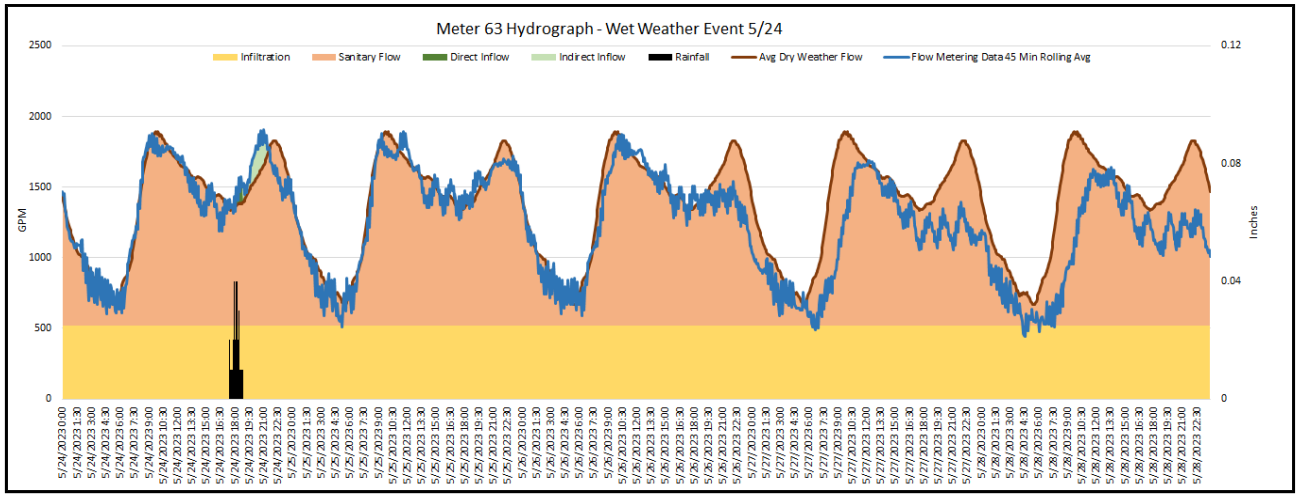

Meter 62 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

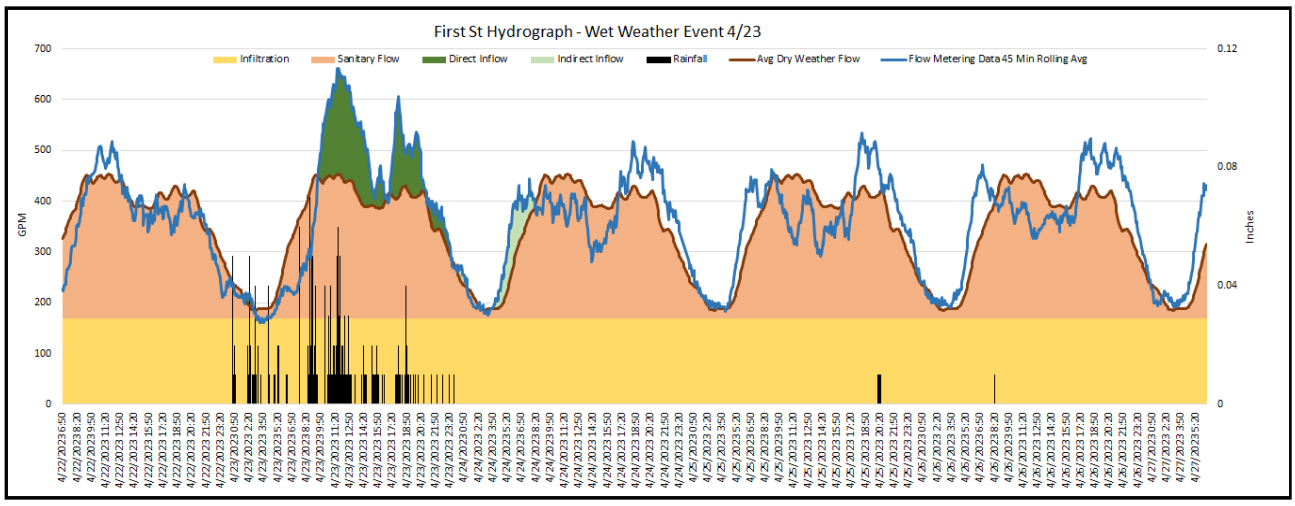

Meter 62 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

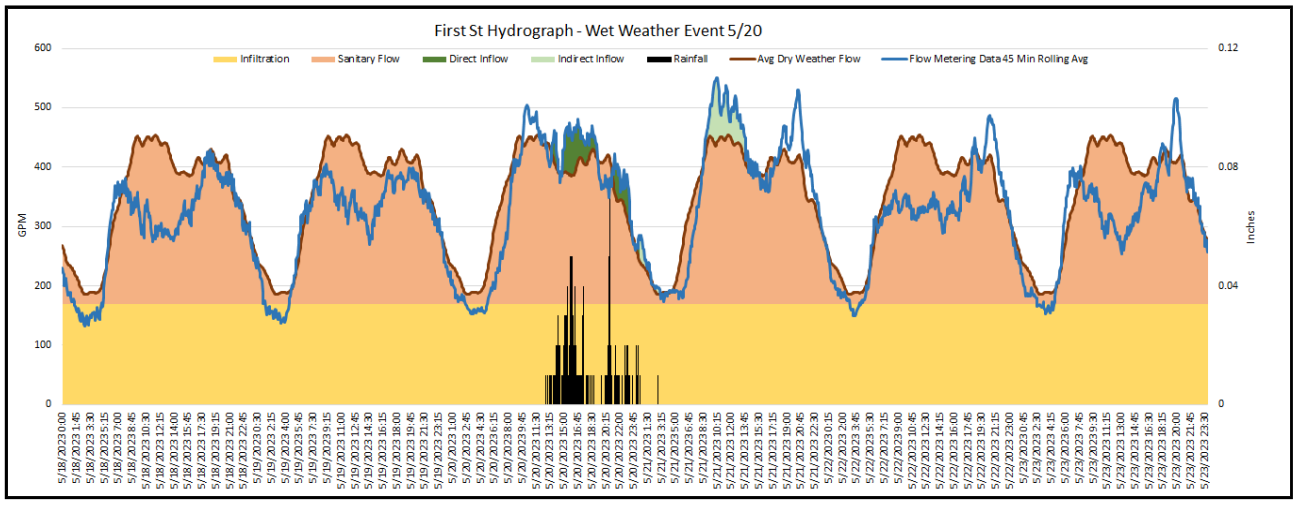

Meter 62 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

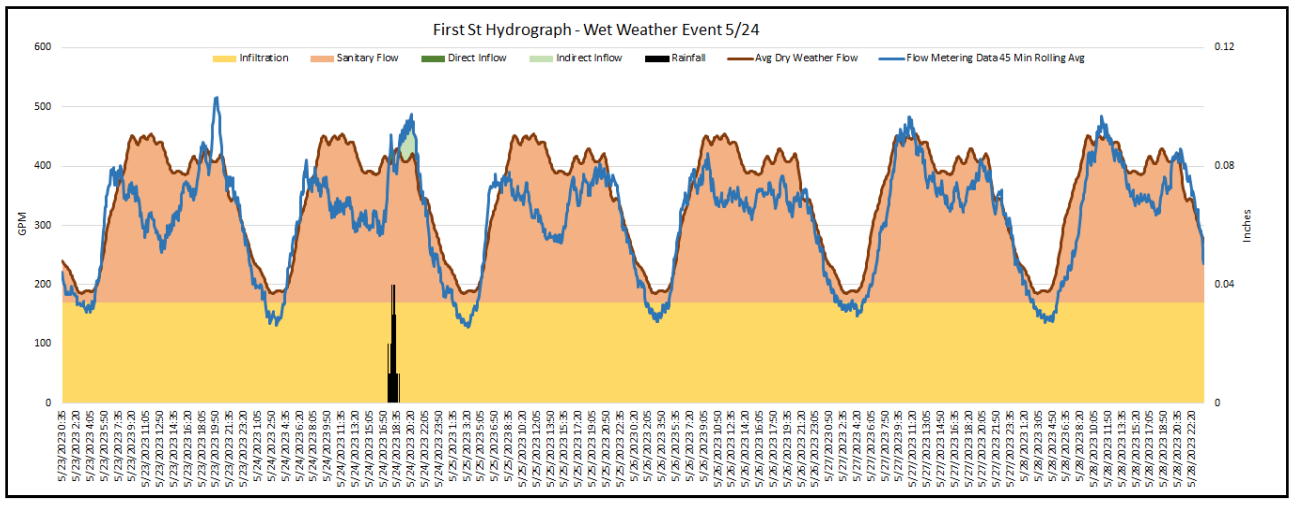

Meter 63 Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches
2500
2000
1500
1000
500
0
0.12
0.08
0.04
0

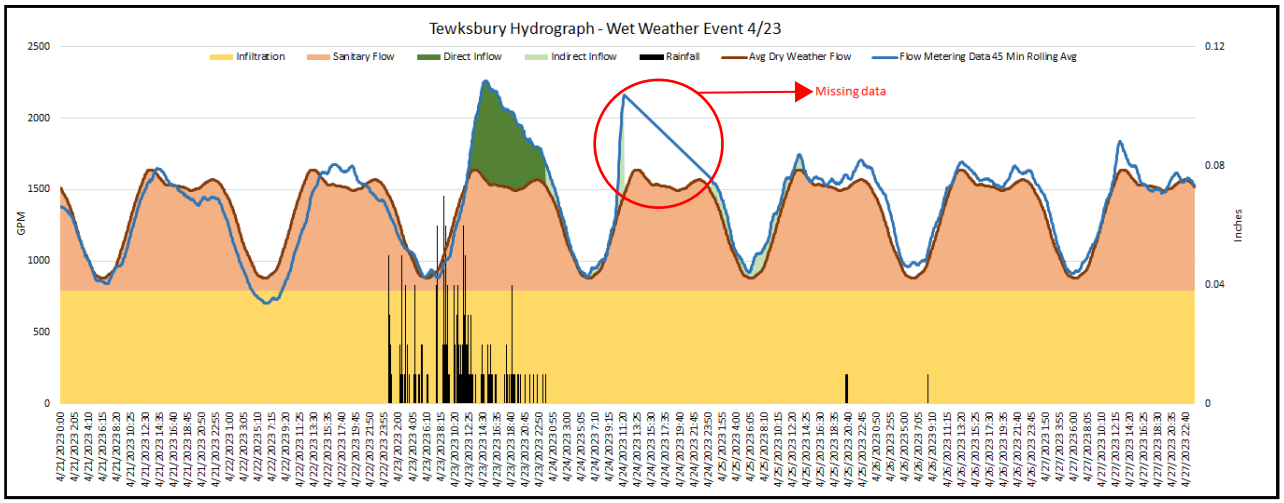

Meter 63 Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches
2500
2000
1500
1000
500
0
0.12
0.08
0.04
0

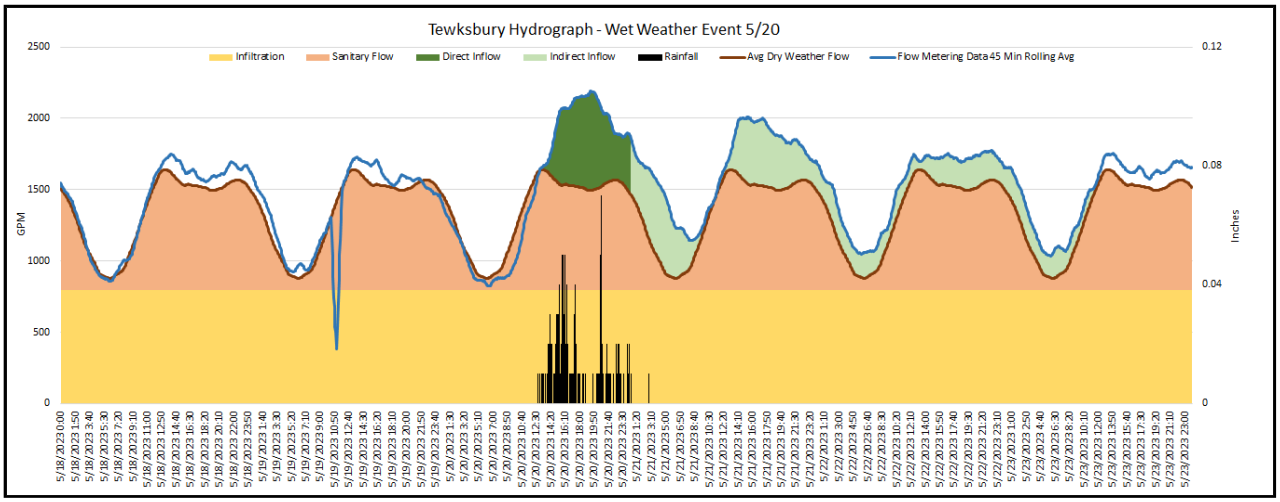

Meter 63 Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches
2500
2000
1500
1000
500
0
0.12
0.08
0.04
0

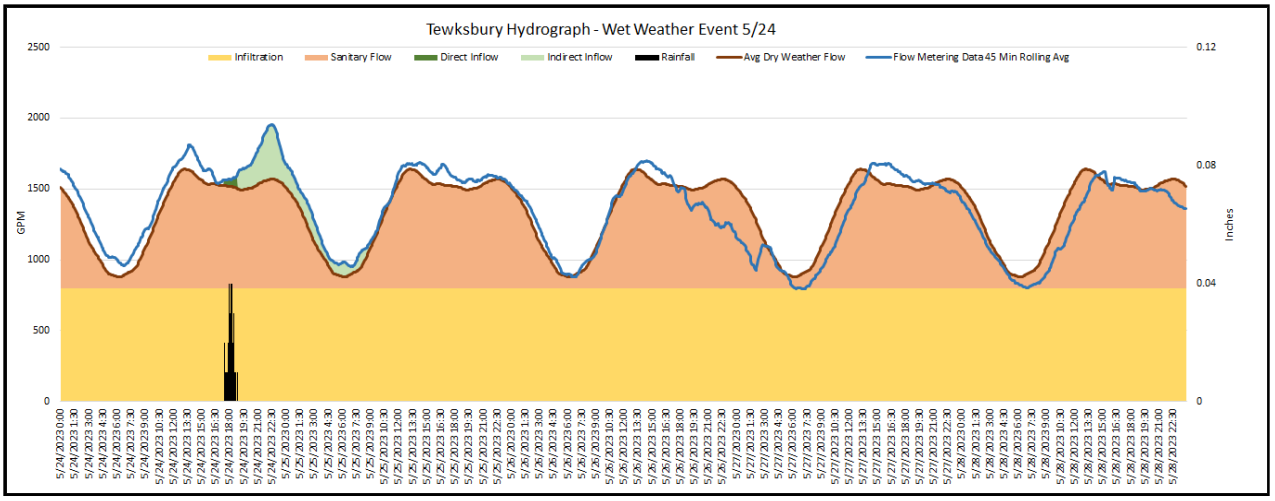

First St Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches


First St Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches


First St Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches


Tewksbury Hydrograph - Wet Weather Event 4/23
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
Missing data
GPM
Inches


Tewksbury Hydrograph - Wet Weather Event 5/20
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches


Tewksbury Hydrograph - Wet Weather Event 5/24
Infiltration
Sanitary Flow
Direct Inflow
Indirect Inflow
Rainfall
Avg Dry Weather Flow
Flow Metering Data 45 Min Rolling Avg
GPM
Inches

APPENDIX D - ADS FLOW METER INSTALL LOGS

Lowell, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

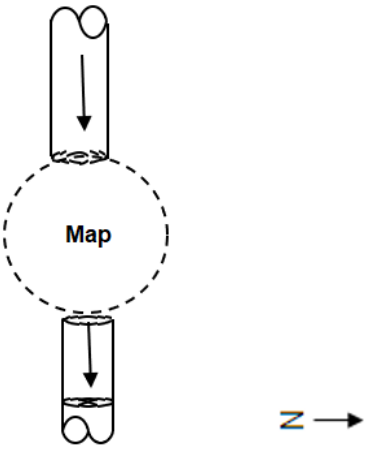
Site I.D.

Meter-1

Site Address / Location:	Coburn St and Lakeview Ave. 42.639879, -71.366122
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
18.00x18.00	Circular

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



ADS Project Name:	
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Thursday, March 9, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
10:24:00 AM	18.00x18.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
5.77	12.3
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
1.97	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
164	Common Trench
Manhole Material:	**Manhole Condition:**
Brick	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
18	18
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

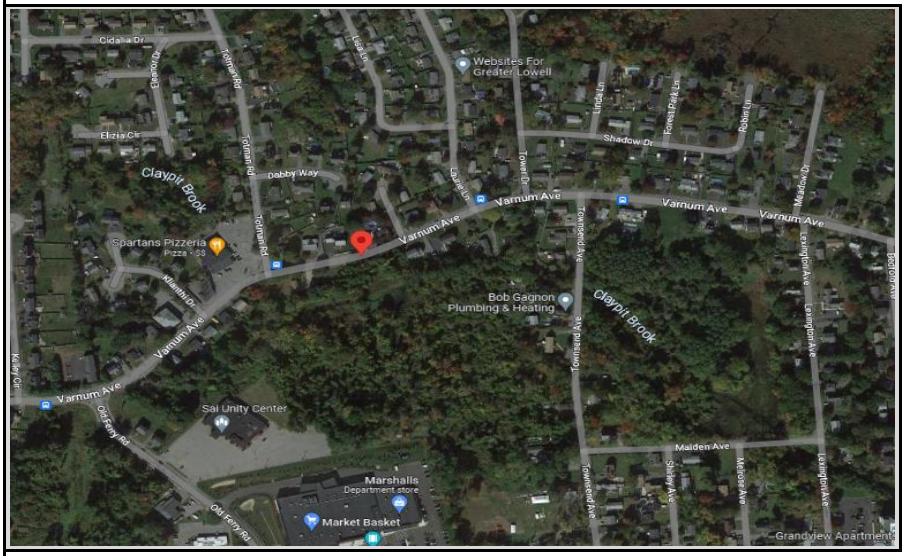
ADS ENVIRONMENTAL SERVICES®

Site I.D.

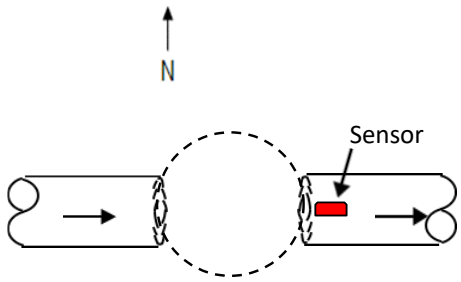
Meter-2

Site Address / Location:	821 Varnum Ave
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
14.00x14.00	Circular



Manhole #	System Characteristics
2	Residential
Access	**Traffic**
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Thursday, March 9, 2023	Doppler Standard Ring and Crank
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)
10:39:00 AM	14.00x14.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
7.33	4.67
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
1	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
163.5	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:**
	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®

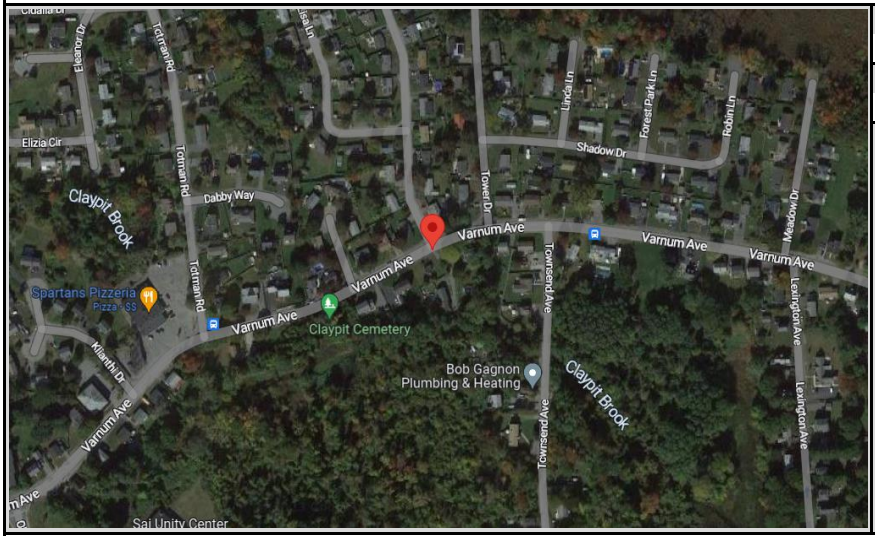
Site I.D.

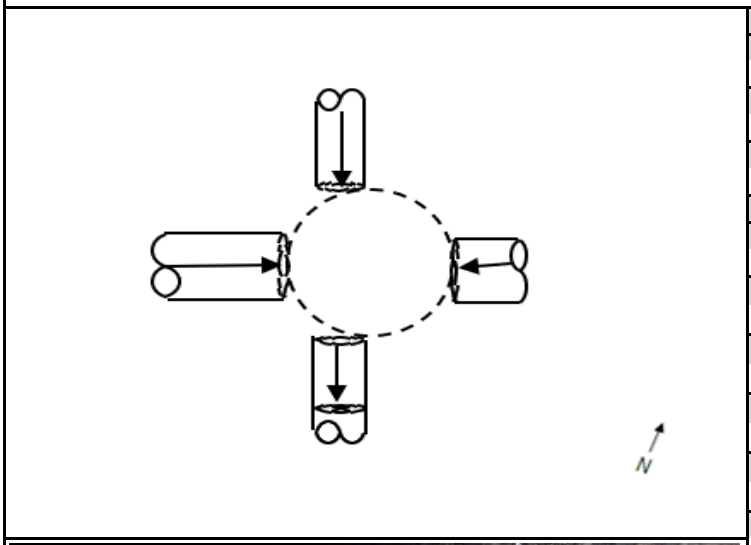
Meter-3

Site Address / Location:	Varnum Ave & Laurie Ln, Lowell, MA
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
15.00x15.00	Circular

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





ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Monday, March 27, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
3:30:00 PM	15.00x15.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
13.52	1.48
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
0.82	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
168.13	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:**
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®

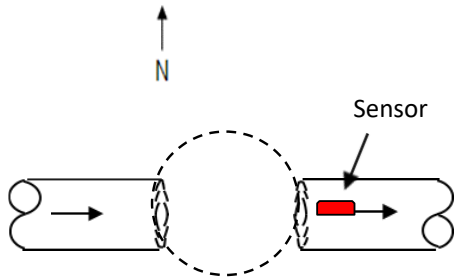
Site I.D.

Meter-4

Site Address / Location:	360 Varnum Ave
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
17.50x17.510	Circular

Manhole #	System Characteristics
4	Residential
Access	**Traffic**
Drive	Medium



Installation Information

Installation Date:	Installation Type:
Thursday, March 9, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
10:10:00 AM	17.50x17.50
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
9.1	8.4
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
4.26	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
180.5	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:**
PVC	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®

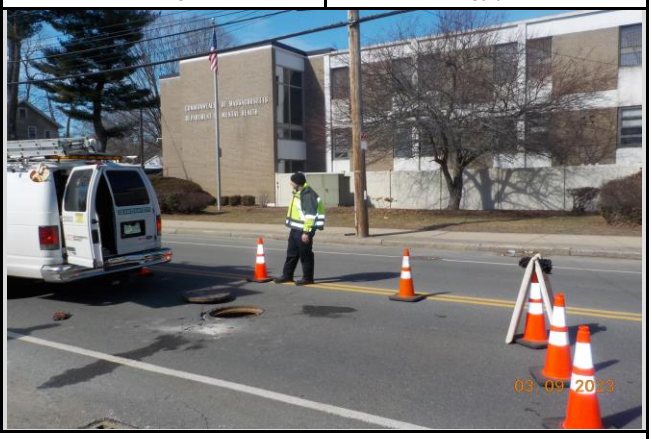
Site I.D.

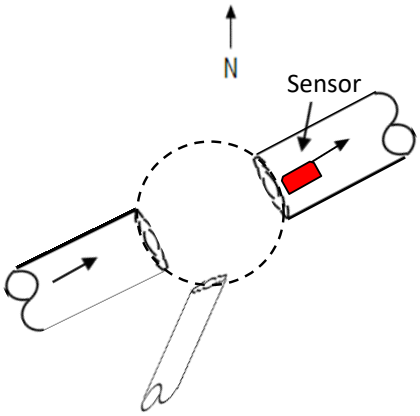
Meter-5

Site Address / Location:	391 Varnum Ave
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
17.50x17.50	Circular

Manhole #	System Characteristics
5	Residential
Access	**Traffic**
Drive	Medium





ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Thursday, March 9, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
11:42:00 AM	17.50x17.50
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
5.85	11.65
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
3	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
86.5	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:**
Yes, Inside	Good
Pipe Material	**Pipe Condition:**
Vitrified Clay Pipe	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®

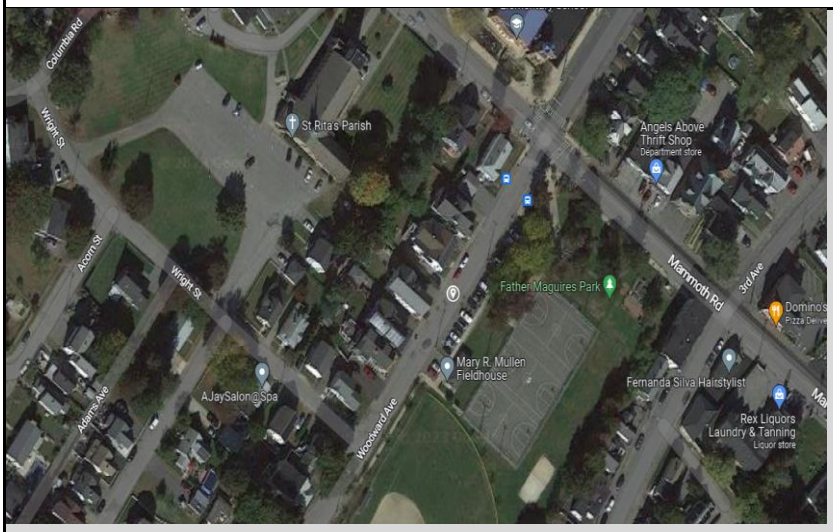
Site I.D.

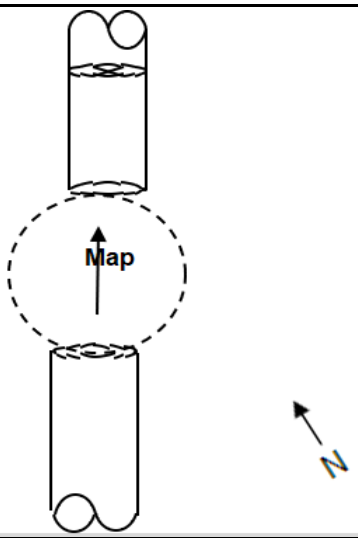
Meter-6

Site Address / Location:	15 Woodward Ave, Lowell, MA/ 42.651474, -71.335103
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
50.00x34.50	Elliptical

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





ADS Project Name:	Lowell, MA
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 8, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
V|Max/Peak Combo (CS9)/LRD (Long Range Dept	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
12:42:00 PM	50.00x34.50
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
9.92	40.08
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
154	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
4.07	3.38
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
210.5	Common Trench
Manhole Material:	**Manhole Condition:**
Brick	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
18	18
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

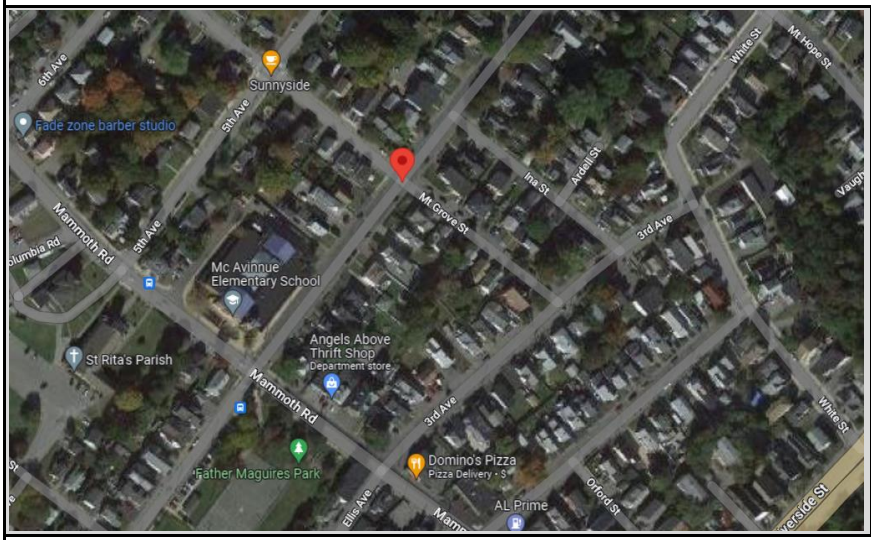
ADS ENVIRONMENTAL SERVICES®

Site I.D.

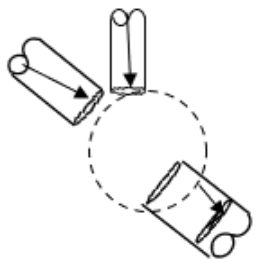
Meter 7

Site Address / Location:	Mt Grove St and 4th Street, 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
7	Residential
Access	Traffic
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 29, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
2:19:00 PM	48.00x48.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
2.25	45.75
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.52	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
171.83	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

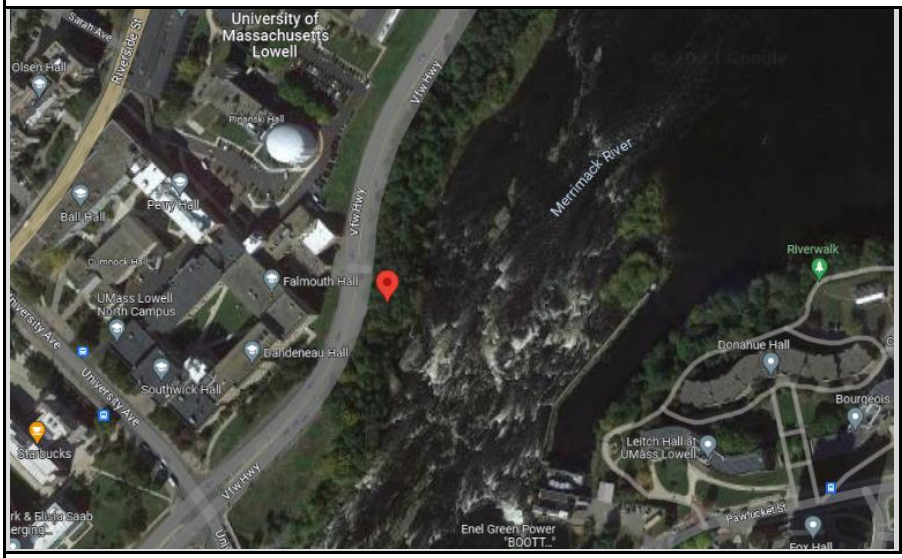
ADS ENVIRONMENTAL SERVICES®

Site I.D.

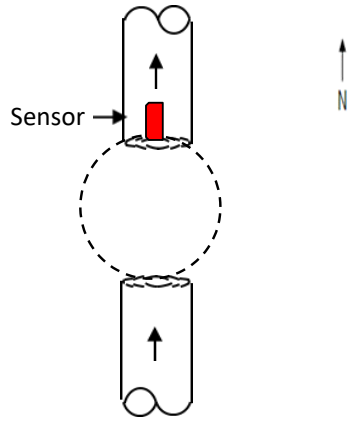
Meter-8

Site Address / Location:	Off of VFW highway (42.653674,-71.323815)
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
84.00x84.00	Circular



Manhole #	System Characteristics
8	Residential
Access	Traffic
Drive	None



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, March 21, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
2:22:00 PM	84.00x84.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
13.11	70.89
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.5	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
144	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

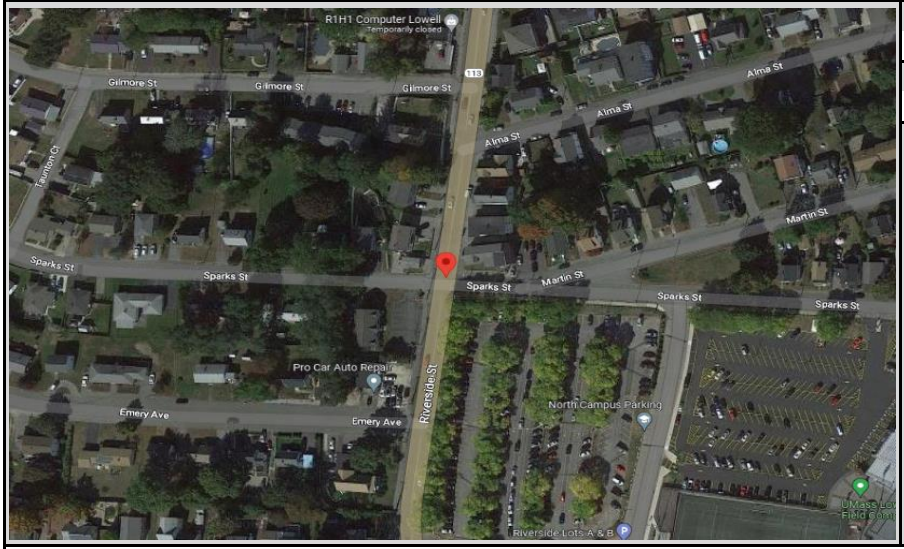
ADS ENVIRONMENTAL SERVICES®

Site I.D.

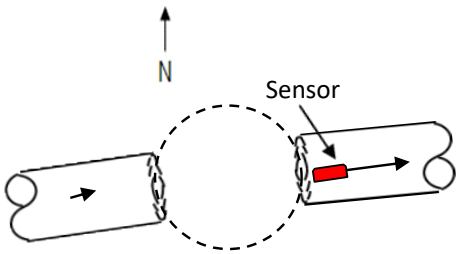
Meter-9

Site Address / Location:	Riverside St at Sparks St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
49.50x45.75	Elliptical



Manhole #	System Characteristics
9	Residential
Access	Traffic
Drive	Medium



Installation Information

Installation Date:	Installation Type:
Friday, March 10, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
10:04:00 AM	49.50x45.75
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
1.2	48.3
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.73	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
120.25	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:

ADS Project Name:	Lowell, Ma
ADS Project Number:	

Lowell, MA

Flow Monitoring
Site Installation Report

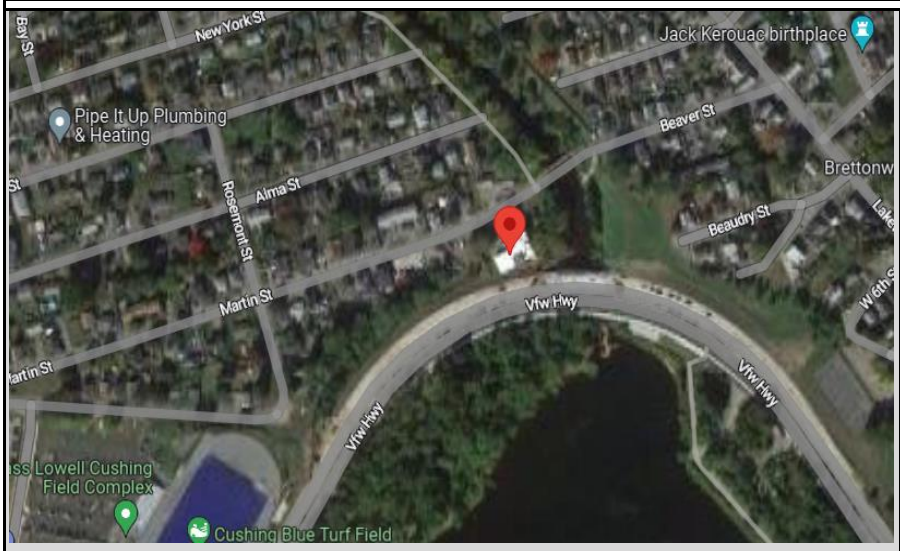
ADS ENVIRONMENTAL SERVICES®

Site I.D.

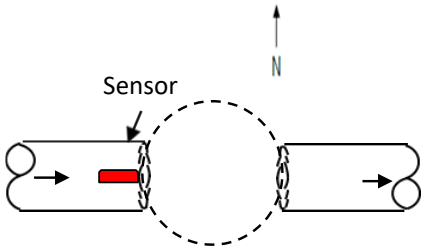
Meter-10

Site Address / Location:	911 Martin St, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
96.00x96.00	Circular



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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, March 21, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
6:20:00 PM	96.00x96.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
17.98	78.02
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.21	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

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

Communication Information:

Communication Type	Antenna Location
Wireless	

Additional Site Info. / Comments:

Meter is located in PS- No ground water gauge installed

Lowell, MA

Flow Monitoring
Site Installation Report

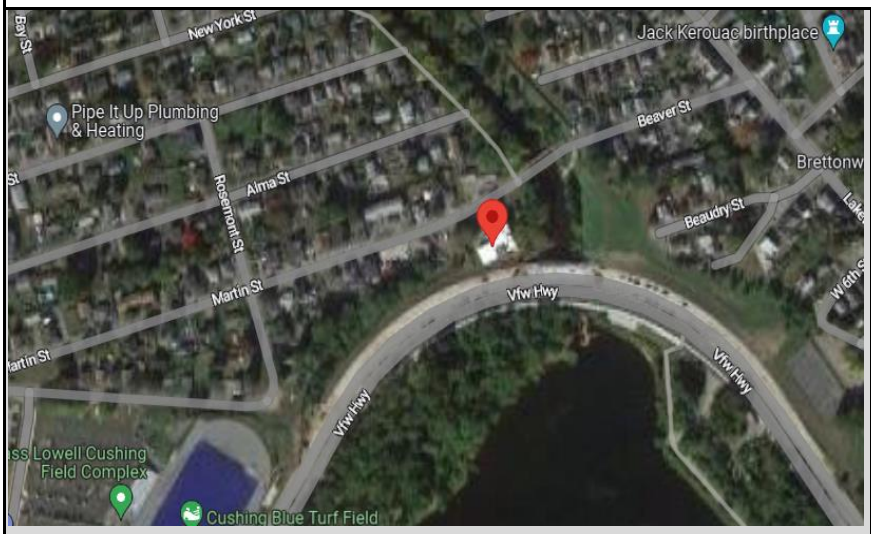
ADS ENVIRONMENTAL SERVICES®

Site I.D.

Meter-10

Site Address / Location:	911 Martin St, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
96.00x96.00	Circular



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

ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, March 21, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
6:20:00 PM	96.00x96.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
17.98	78.02
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.21	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

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

Communication Information:

Communication Type	Antenna Location
Wireless	

Additional Site Info. / Comments:

Meter is located in PS- No ground water gauge installed

Lowell, MA

Flow Monitoring
Site Installation Report

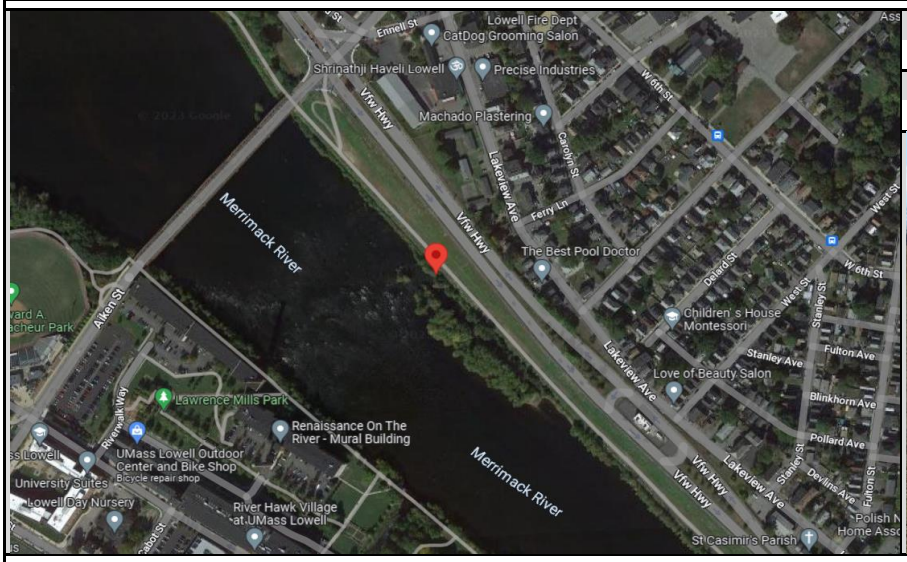
ADS ENVIRONMENTAL SERVICES®

Site I.D.

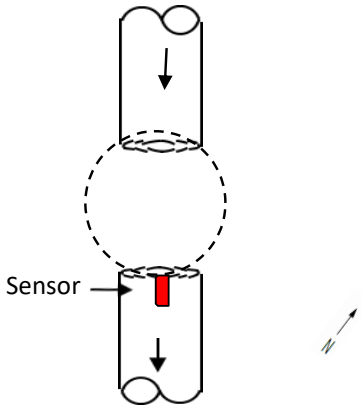
Meter-11

Site Address / Location:	Located on the Merrimack Walking Path (Use coordinates 42.653916,-71.312797)
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
95.50x96.00	Elliptical



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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, March 21, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV|Max/Peak Combo (CS9)-Smart Depth (CS5)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
3:55:00 PM	95.50x96.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
26.66	68.34
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
1.5	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
1.77	0
Silt (in)	**Silt Type**
9	

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
162	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®

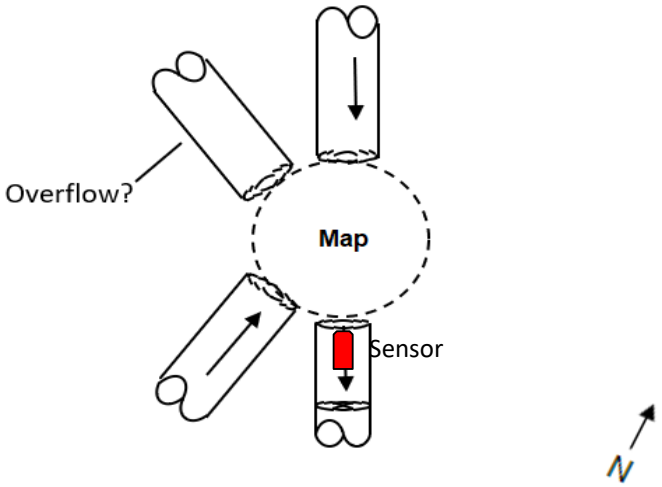
Site I.D.

Meter-12

Site Address / Location:	427 Lakeview Ave, Lowell, MA/ 42.653022, -71.310484
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
54.75x47.00	Elliptical

Manhole #	System Characteristics
	Residential
Access	Traffic
Drive	Light



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 8, 2023	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)
3:02:00 PM	54.75x47.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
4.07	50.43
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.46	0.13
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
203.5	Common Trench
Manhole Material:	Manhole Condition:
Brick	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
18	18
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

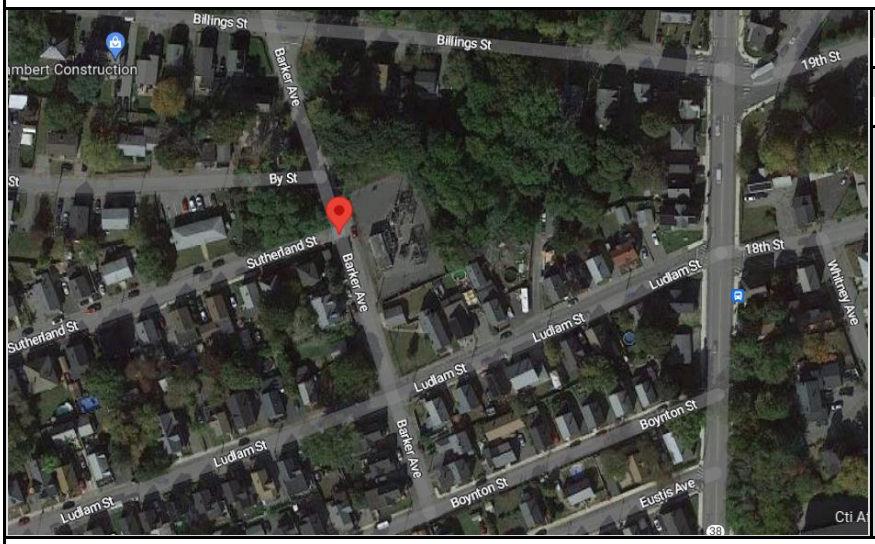
ADS ENVIRONMENTAL SERVICES®

Site I.D.

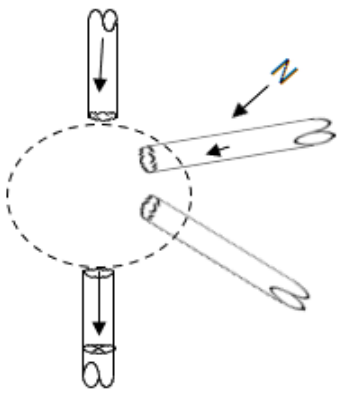
Meter-13

Site Address / Location:	Barker Ave at Sutherland St
Site Access:	Drive

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



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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 15, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
3:07:00 PM	48.00x48.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
15.59	32.41
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
3.7	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
242	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:**
Yes, Inside	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

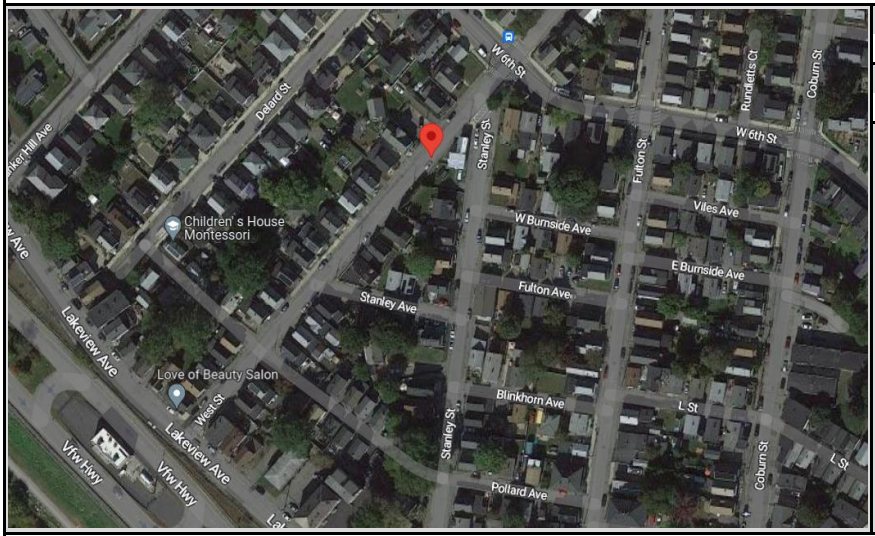
ADS ENVIRONMENTAL SERVICES®

Site I.D.

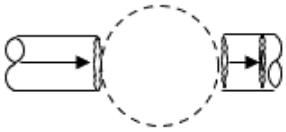
Meter-14

Site Address / Location:	54 West Street, Lowell, MA
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
60.00x60.00	Circular



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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Monday, March 20, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
3:04:00 PM	60.00x60.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
12.36	47.64
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.18	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
247	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®

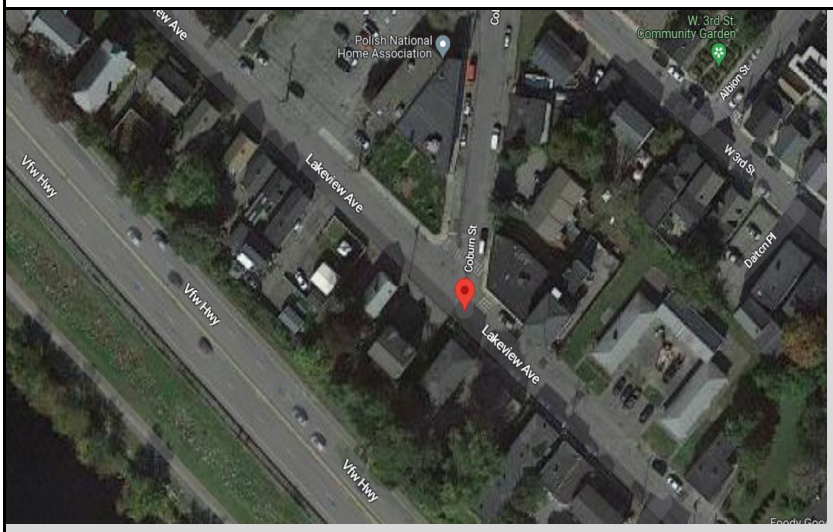
Site I.D.

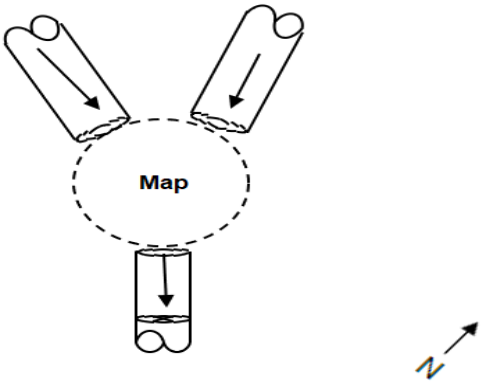
Meter-15

Site Address / Location:	Coburn St and Lakeview Ave. 42.650665, -71.306919
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
41.00x27.50	Standard Egg

Manhole #	System Characteristics
	Residential
Access	**Traffic**
Drive	Medium





ADS Project Name:	
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 8, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
4:44:00 PM	41.00x27.50
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
3.2	37.8
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.99	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
	Common Trench
Manhole Material:	**Manhole Condition:**
Brick	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
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

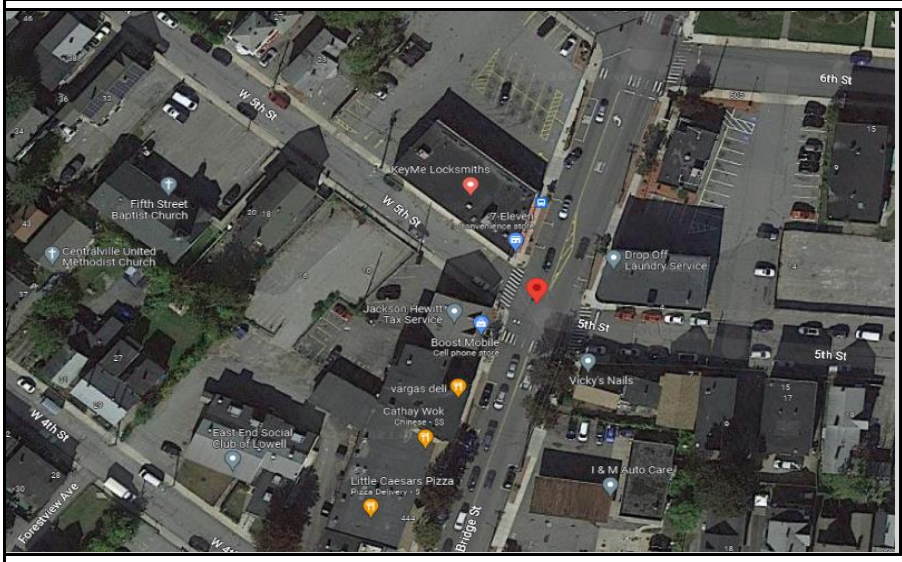
ADS ENVIRONMENTAL SERVICES®

Site I.D.

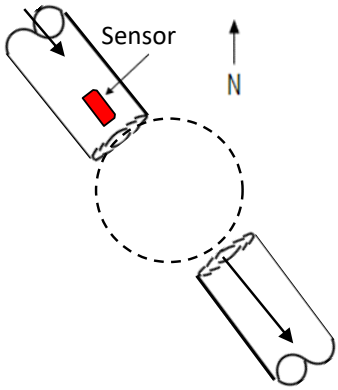
Meter-16

Site Address / Location:	Bridge St at W 5th St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
32.50x29.25	Elliptical



Manhole #	System Characteristics
16	Residential
Access	Traffic
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Friday, March 10, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
12:21:00 PM	32.50x29.25
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
2.16	30.34
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.37	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
115.25	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

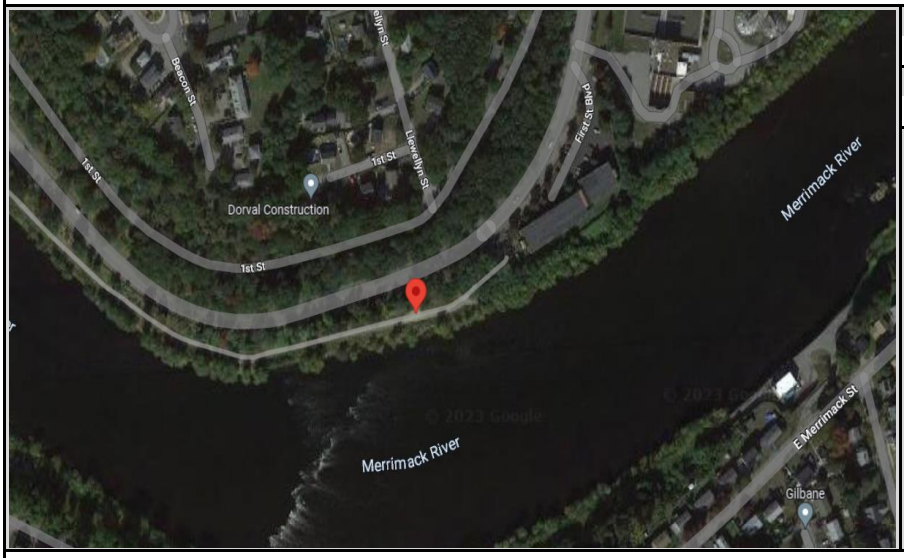
ADS ENVIRONMENTAL SERVICES®

Site I.D.

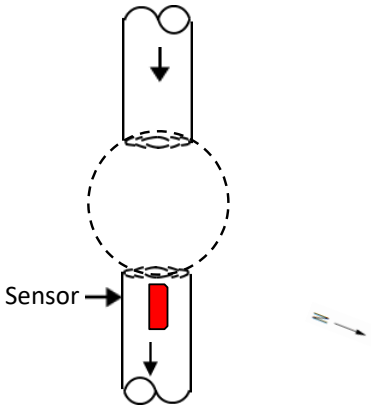
Meter-17

Site Address / Location:	Located on the Merrimack Walking Path- Can access the path from apartment building at 333 first St Blvd- 42.645561, -71.292618
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
95.75x96.25	Elliptical



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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, March 21, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
9:40:00 AM	95.75x96.25
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
22.74	73.01
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.68	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
204	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®

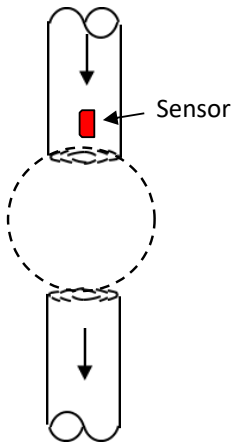
Site I.D.

Meter-18

Site Address / Location:	Lowell City Waste Water Department
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
18.00x18.00	Circular

Manhole #	System Characteristics
18	Residential
Access	Traffic
Drive	None



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, May 2, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
12:08:00 PM	18.00x18.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
2.5	15.5
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.28	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
339	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:
Yes, Inside	Good
Pipe Material	Pipe Condition:
PVC	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

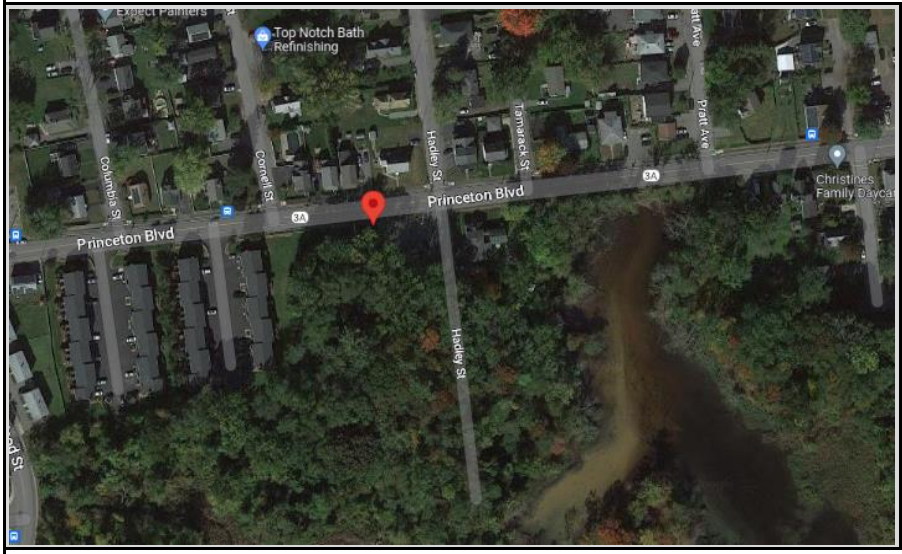
ADS ENVIRONMENTAL SERVICES®

Site I.D.

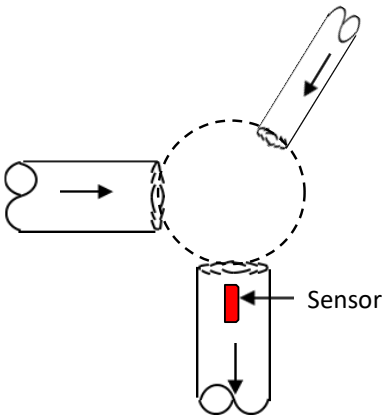
Meter-19

Site Address / Location:	115 Hadley St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
18.00x18.00	Circular



Manhole #	System Characteristics
19	Residential
Access	Traffic
Drive	None



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Friday, March 17, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
2:29:00 PM	18.00x18.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
7	11
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.46	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
	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:
Cast Iron Pipe	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®

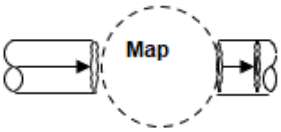
Site I.D.

Meter-20

Site Address / Location:	915 Pawtucket Street, Lowell, MA
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
47.50x47.50	Circular

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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, March 21, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
12:37:00 PM	47.50x47.50
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
10.52	36.98
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.75	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inhes):	Manhole Configuration
206.75	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

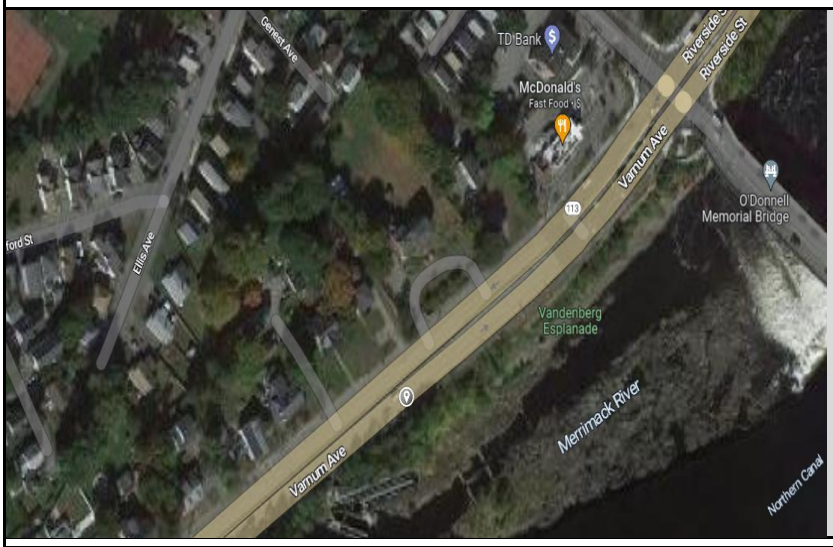
ADS ENVIRONMENTAL SERVICES®

Site I.D.

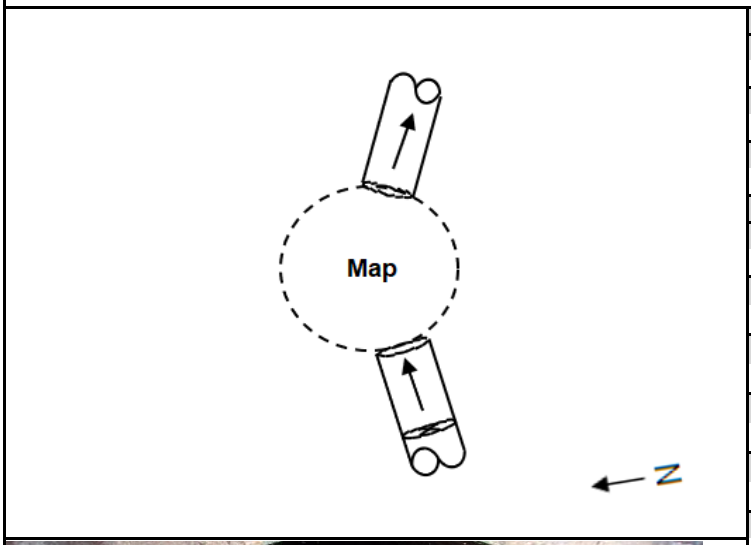
Meter-21

Site Address / Location:	42.648948, -71.333508
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
36.006x36.00	Circular



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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Thursday, March 9, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
11:59:00 AM	36.00x36.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
11.15	24.85
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.27	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
411.5	Common Trench
Manhole Material:	**Manhole Condition:**
Concrete	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
24	24
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

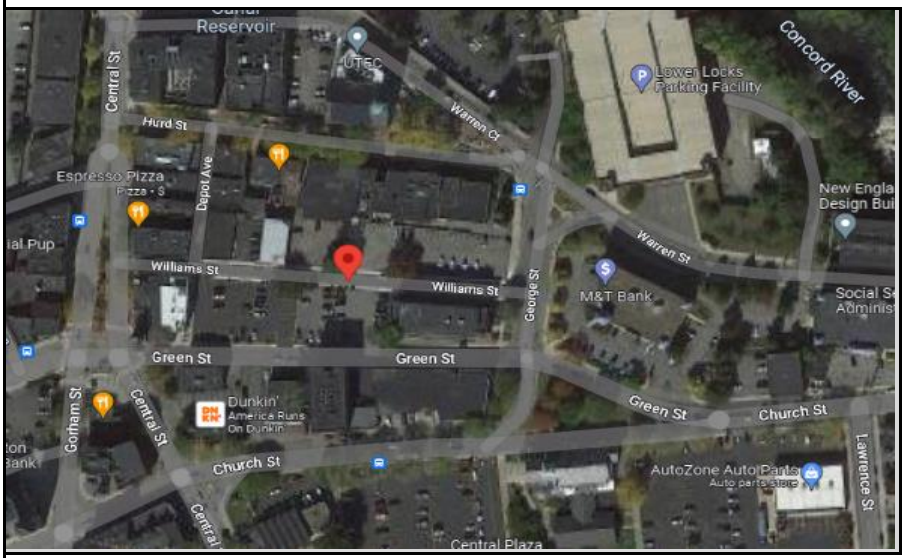
ADS ENVIRONMENTAL SERVICES®

Site I.D.

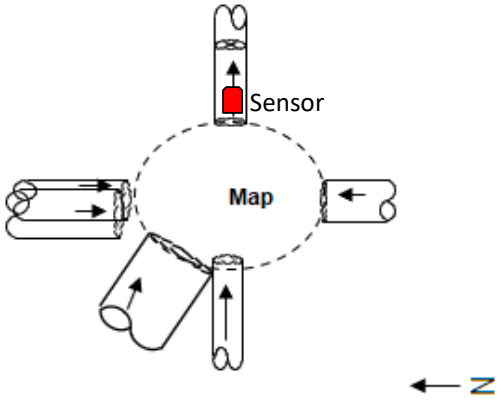
Meter-22

Site Address / Location:	Williams St. (Use coordinates 42.642193, -71.307234)
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
30.00x21.00	Standard Egg



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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Friday, March 10, 2023	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)
10:01:00 AM	30.00x21.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
4.19	24.81
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
0.79	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
164.25	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®

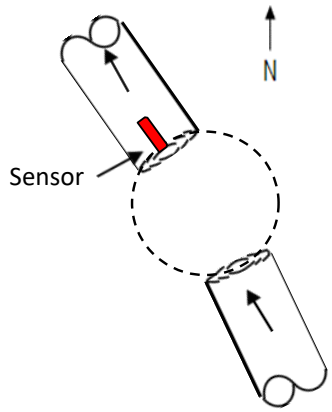
Site I.D.

Meter-23

Site Address / Location:	34-24 Foster St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
18.00x18.00	Circular

Manhole #	System Characteristics
23	Residential
Access	Traffic
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Thursday, March 16, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
3:48:00 PM	18.00x18.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
4.95	13.05
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.87	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
115	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

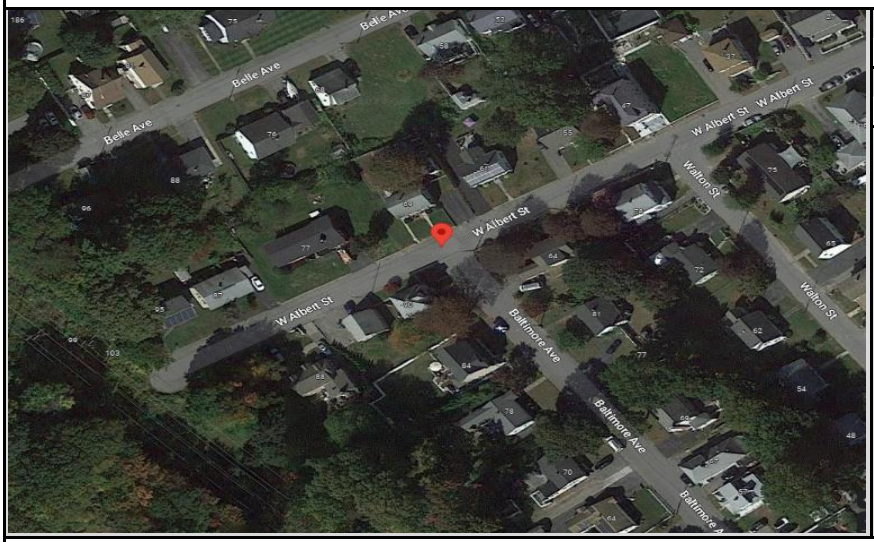
ADS ENVIRONMENTAL SERVICES®

Site I.D.

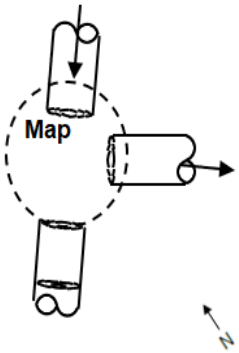
Meter-24

Site Address / Location:	W Albert St and Balimore Ave, Lowell, MA
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
9.13x9.13	Circular



Manhole #	System Characteristics
24	Residential
Access	**Traffic**
Drive	Medium



ADS Project Name:	Lowell, MA
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 8, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
9:48:00 AM	9.13x9.13
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
4.92	4.21
Downlooker Physical Offset (in)	**Confidence**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.14	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
208	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:**
Cast Iron Pipe	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

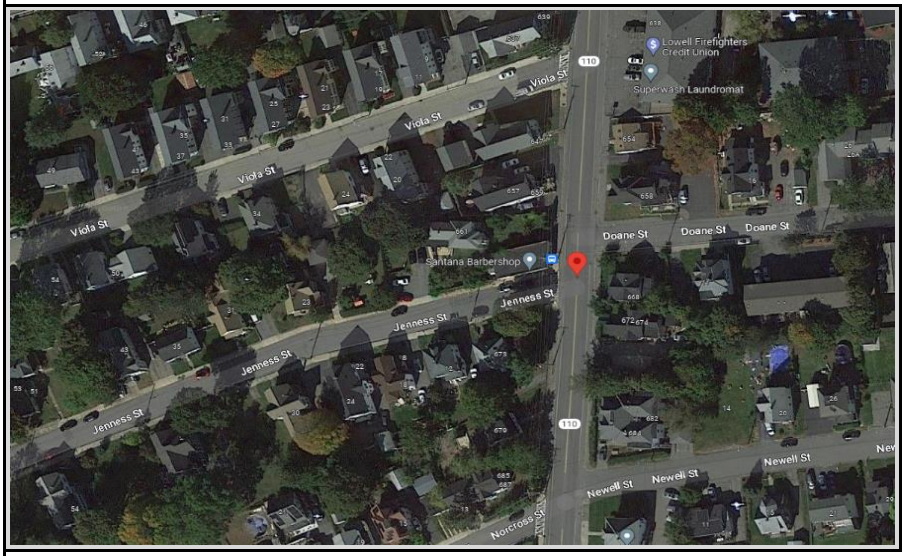
ADS ENVIRONMENTAL SERVICES®

Site I.D.

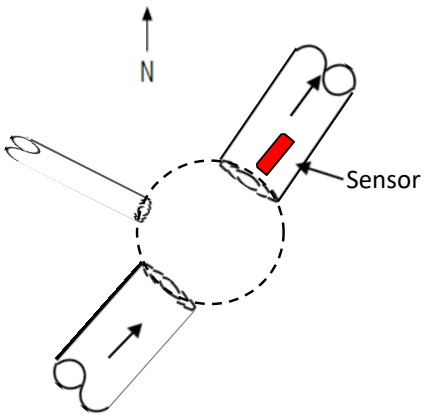
Meter-25

Site Address / Location:	Chelmsford St at Jenness St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
36.00x36.00	Circular



Manhole #	System Characteristics
25	Residential
Access	**Traffic**
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 8, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
11:41:00 AM	36.00x36.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
8.42	27.58
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
0.78	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
186.75	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

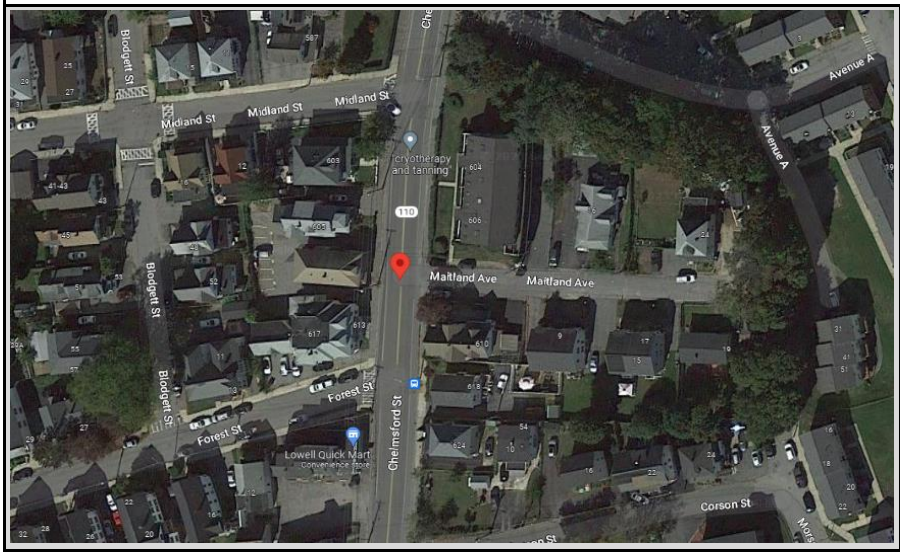
ADS ENVIRONMENTAL SERVICES®

Site I.D.

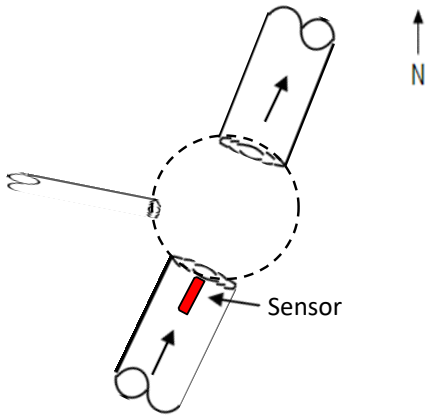
Meter-26

Site Address / Location:	63 Chelmsford St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
36.00x36.00	Circular



Manhole #	System Characteristics
26	Residential
Access	Traffic
Drive	Medium



Installation Information

Installation Date:	Installation Type:
Wednesday, March 8, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
2:03:00 PM	36.00x36.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
5.89	30.11
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.46	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
231	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:
Yes, Inside	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®

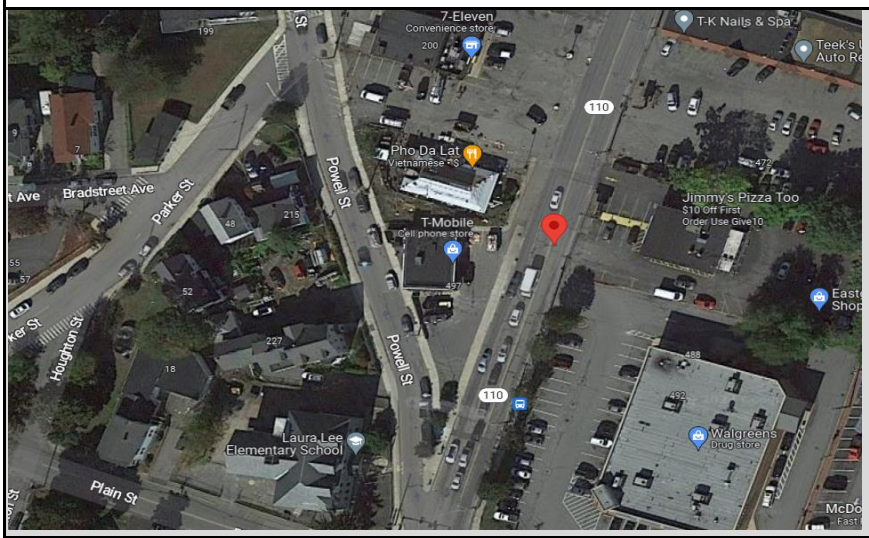
Site I.D.

Meter-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**
56.00x52.00	Elliptical

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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 22, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
11:08:00 AM	56.00X52.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
12.95	43.05
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
0.48	0
Silt (in)	**Silt Type**
0	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:

Lowell, MA

Flow Monitoring
Site Installation Report

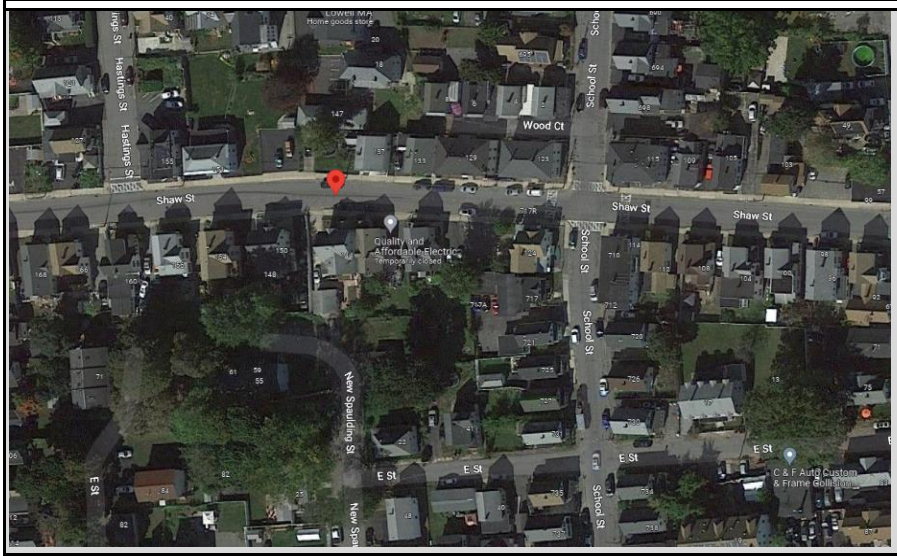
ADS ENVIRONMENTAL SERVICES®

Site I.D.

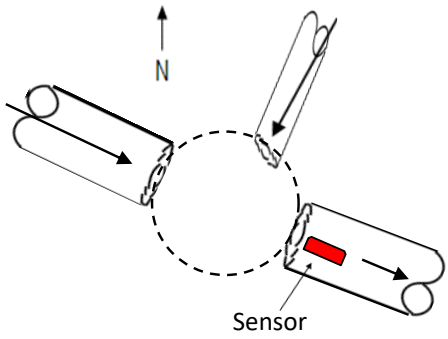
Meter-28

Site Address / Location:	144 Shaw St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
51.50x36.83	Standard Egg



Manhole #	System Characteristics
28	Residential
Access	Traffic
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Friday, March 17, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
2:09:00 PM	51.50x36.83
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
5.25	46.25
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
4.58	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
165	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®

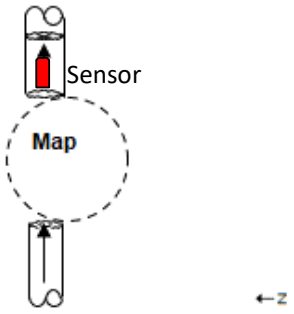
Site I.D.

Meter-29

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

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



Installation Information

Installation Date:	Installation Type:
Thursday, March 23, 2023	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)
10:36:00 AM	50.00x49.13
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
4.76	45.24
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
4.63	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:

ADS Project Name:	Lowell, Ma
ADS Project Number:	

Lowell, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

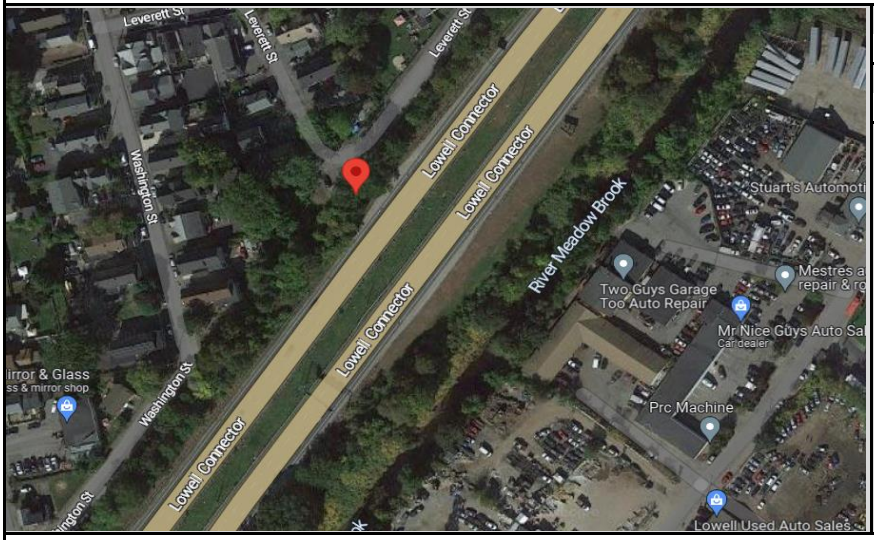
Site I.D.

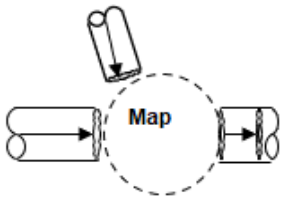
Meter-30

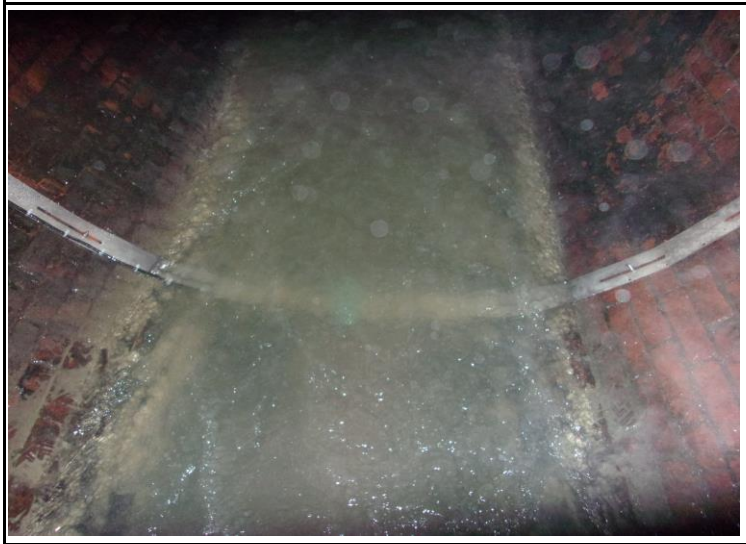
Site Address / Location:	42.630695, -71.316934
Site Access:	

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
72.00x73.00	Elliptical

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







ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, March 21, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
2:26:00 PM	72.00x73.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
6.18	65.82
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
5	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
402.63	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:**
Yes, Inside	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®

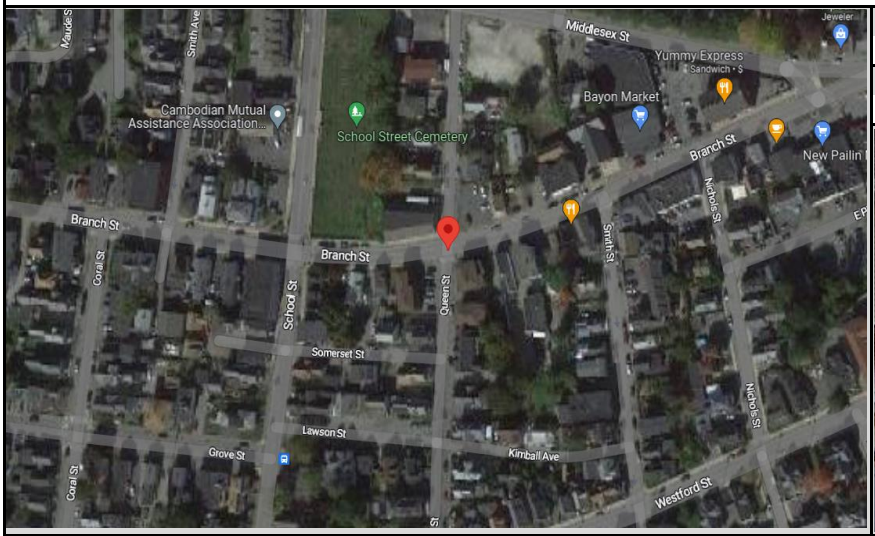
Site I.D.

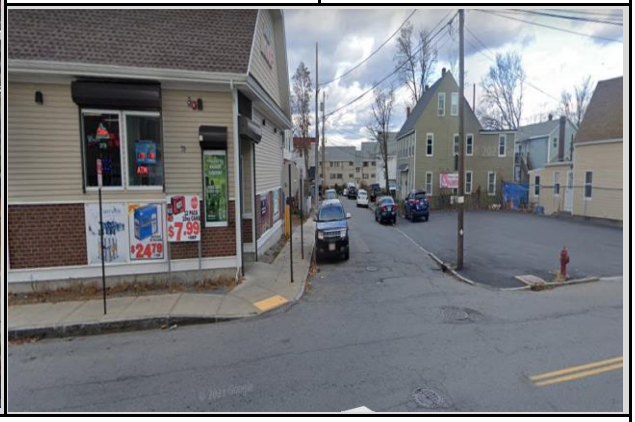
Meter-31

Site Address / Location:	Branch Street and Queen Street, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
34.00x24.25	Standard Egg

Manhole #	System Characteristics
31	Residential
Access	**Traffic**
Drive	Medium





ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 22, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
1:16:00 PM	34.00x24.25
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
4.2	29.8
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.38"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
1.16	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
139	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

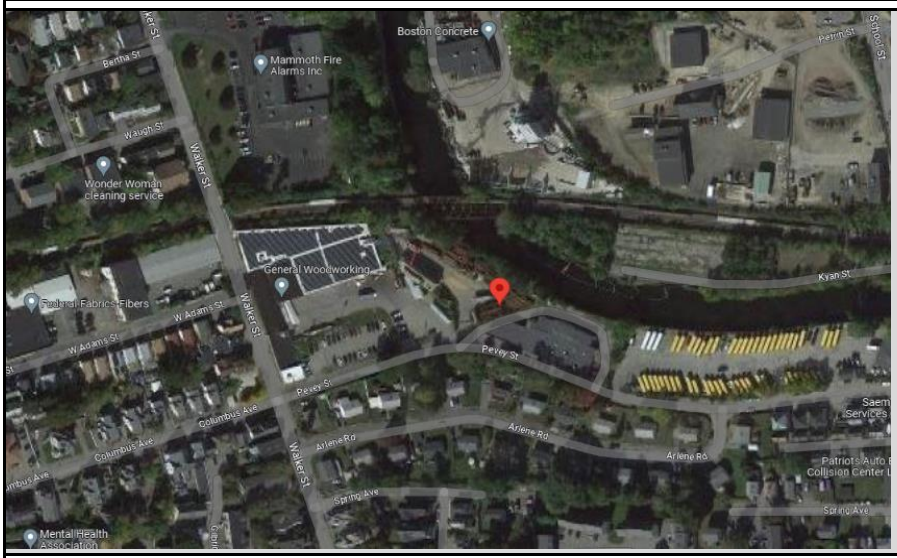
ADS ENVIRONMENTAL SERVICES®

Site I.D.

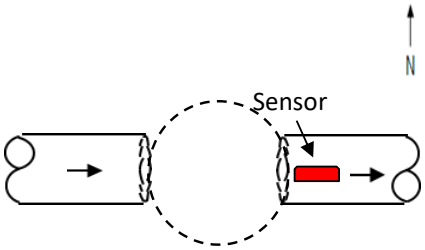
Meter-32

Site Address / Location:	101 Pevey St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
42.50x28.50	Standard Egg



Manhole #	System Characteristics
32	Residential
Access	Traffic
Drive	None



Installation Information

Installation Date:	Installation Type:
Wednesday, March 22, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV|Max/Peak Combo (CS9)-Smart Depth (CS5)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
2:50:00 PM	42.50x28.50
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
7.23	35.27
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.77	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
168	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	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

ADS Project Name:	Lowell, Ma
ADS Project Number:	

Lowell, MA

Flow Monitoring
Site Installation Report

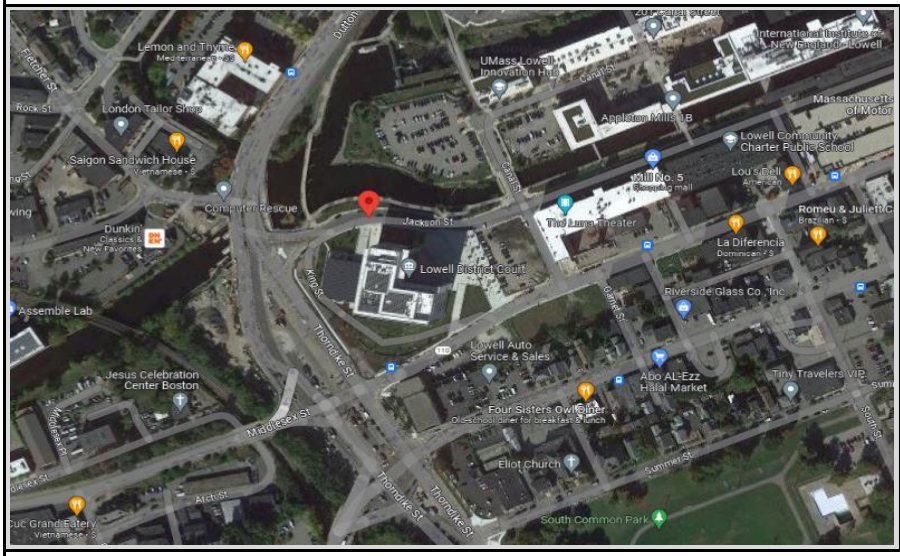
ADS ENVIRONMENTAL SERVICES®

Site I.D.

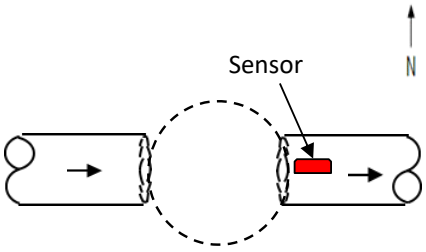
Meter-33

Site Address / Location:	355 Jackson St
Site Access:	Drive

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



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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 22, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV|Max/Peak Combo (CS9)-Smart Depth (CS5)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:20:00 AM	48.00x48.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
4.76	43.24
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.69	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
180	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	Manhole Pick / Vent Hole

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

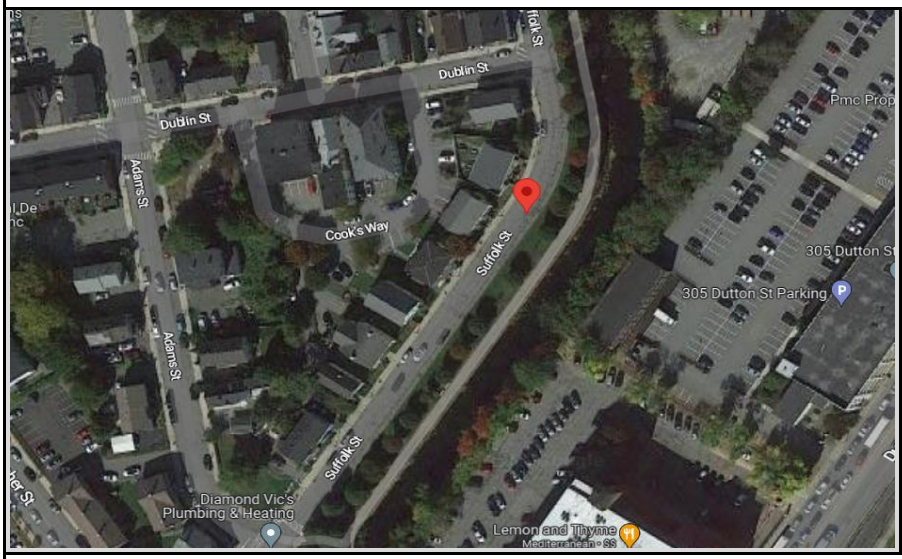
ADS ENVIRONMENTAL SERVICES®

Site I.D.

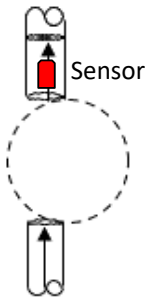
Meter-34

Site Address / Location:	116 Suffolk Street, Lowell, MA
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
40x30.5	Elliptical



Manhole #	System Characteristics
34	Residential
Access	Traffic
Drive	Light



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Monday, March 27, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Downstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV|MAX/Peak Combo (CS9), Smart Depth (CS5)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
12:10:00 PM	40x30.5
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
11.26	26.99
Downlooker Physical Offset (in)	Measurement Confidence (in)
1.5	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.75	3
Silt (in)	Silt Type
0	Sandy

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
194.75	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®

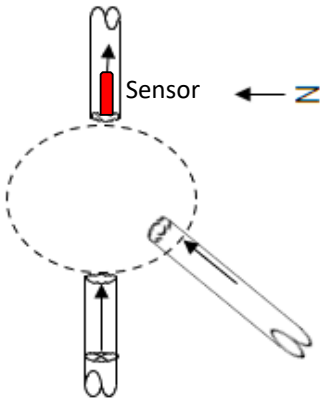
Site I.D.

Meter-35

Site Address / Location:	432 Suffolk St Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
52.00x37.5	Standard Egg

Manhole #	System Characteristics
35	Residential
Access	Traffic
Drive	Light



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 15, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Downstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV|MAX/Peak Combo (CS9), Smart Depth (CS5)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
12:33:00 PM	52.00x37.5
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
14.3	38.7
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.04	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
198	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®

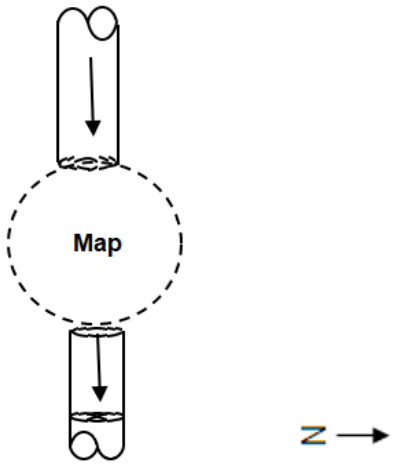
Site I.D.

Meter-36

Site Address / Location:	Cabot St in grass, use coordinates 42.649998, -71.317590
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
40.50x40.50	Circular

Manhole #	System Characteristics
36	Residential
Access	Traffic
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 15, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
12:53:00 PM	40.50x40.50
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
16.16	24.34
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.57	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
281	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:
Cast Iron Pipe	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

Lowell, MA

Flow Monitoring
Site Installation Report

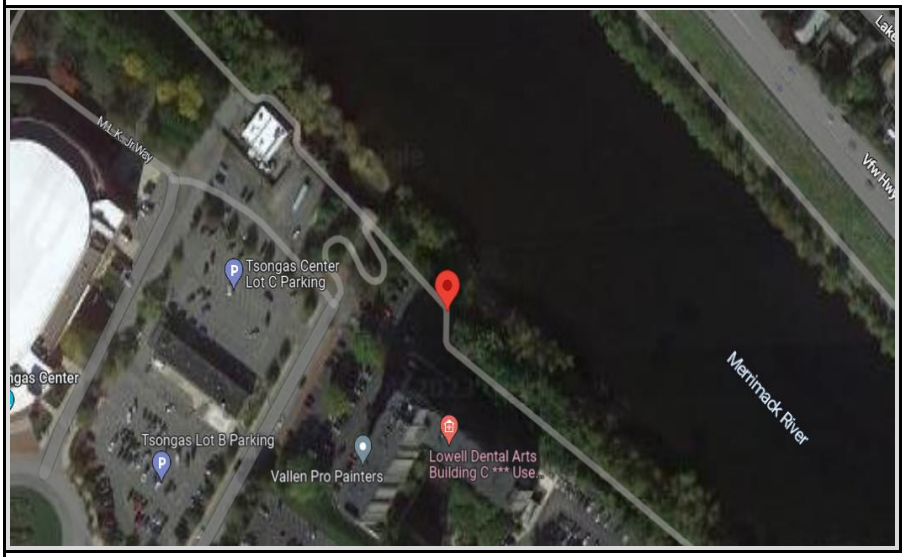
ADS ENVIRONMENTAL SERVICES®

Site I.D.

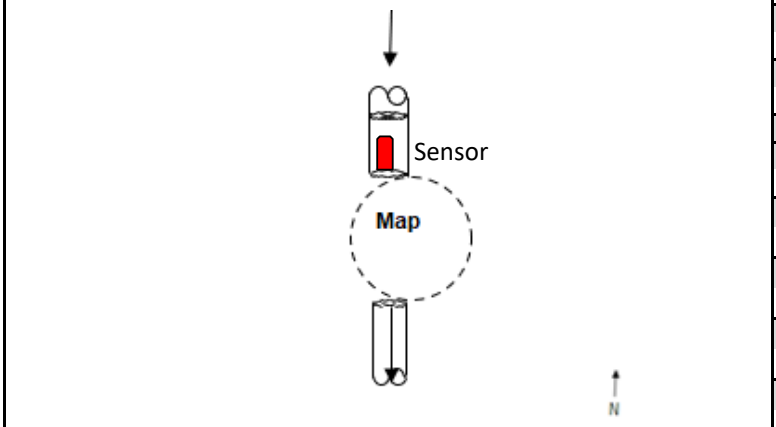
Meter-37

Site Address / Location:	1 River Pl Building C, Lowell, Ma (42.650112, -71.310496)
Site Access:	Walk

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
36.00x36.00	Circular



Manhole #	System Characteristics
37	Residential
Access	**Traffic**
Walk (Commercial)	Light



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 22, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
12:00:00 PM	36.00x36.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
11.25	36.75
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.59	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
60	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

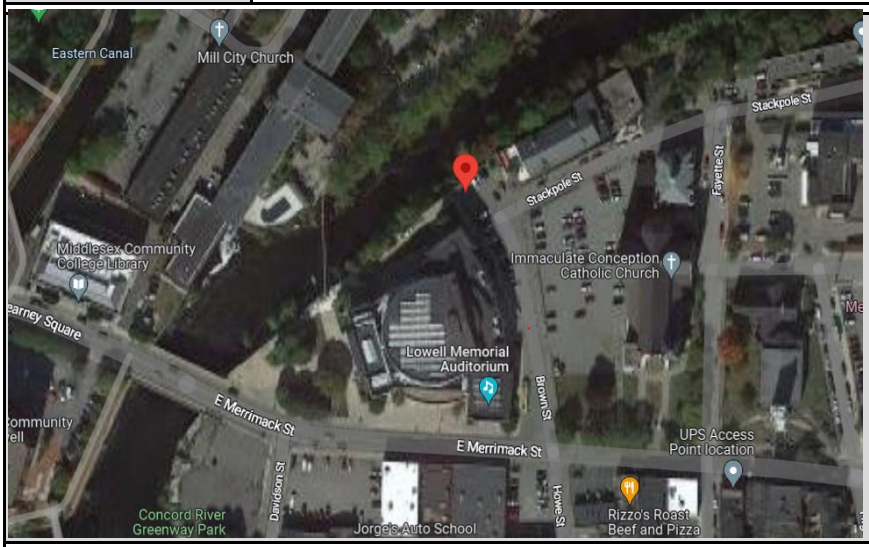
ADS ENVIRONMENTAL SERVICES®

Site I.D.

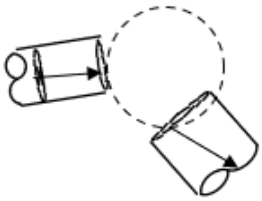
Meter-38

Site Address / Location:	50 Stackpole St, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
96.00x96.00	Circular



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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Tuesday, March 21, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV|MAX/Peak Combo (CS9), Smart Depth (CS5)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
10:34:00 AM	96.00x96.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
21.86	74.14
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
1.5	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.81	14.5
Silt (in)	**Silt Type**
0	Gravel

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. *Inches*):	Manhole Configuration
269.25	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®

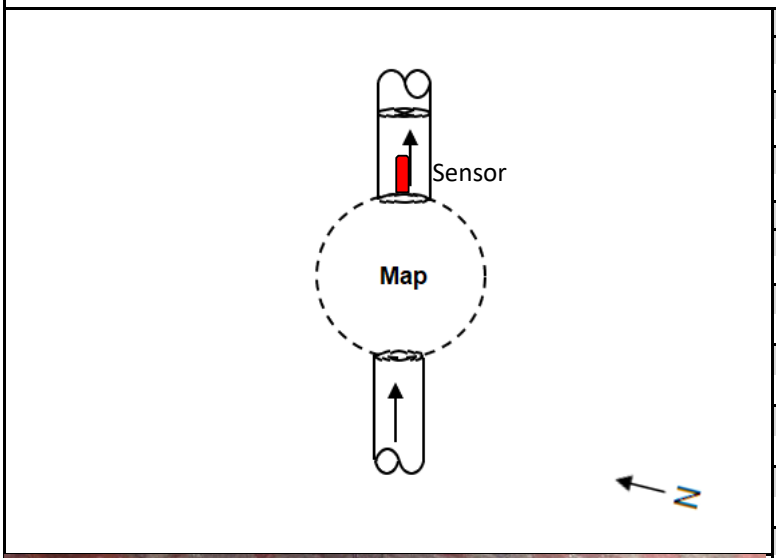
Site I.D.

Meter-39

Site Address / Location:	34 Hurd St, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
54.00x37.00	Standard Egg

Manhole #	System Characteristics
	Residential
Access	Traffic
Drive	Light



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Thursday, March 9, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Downstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV|Max/Peak Combo (CS9)/Smart Depth (CS5)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
2:45:00 PM	54.00x37.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
4.04	48.46
Downlooker Physical Offset (in)	Measurement Confidence (in)
1.5	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
5.12	0.5
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
178.75	Common Trench
Manhole Material:	Manhole Condition:
Brick	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
18	18
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

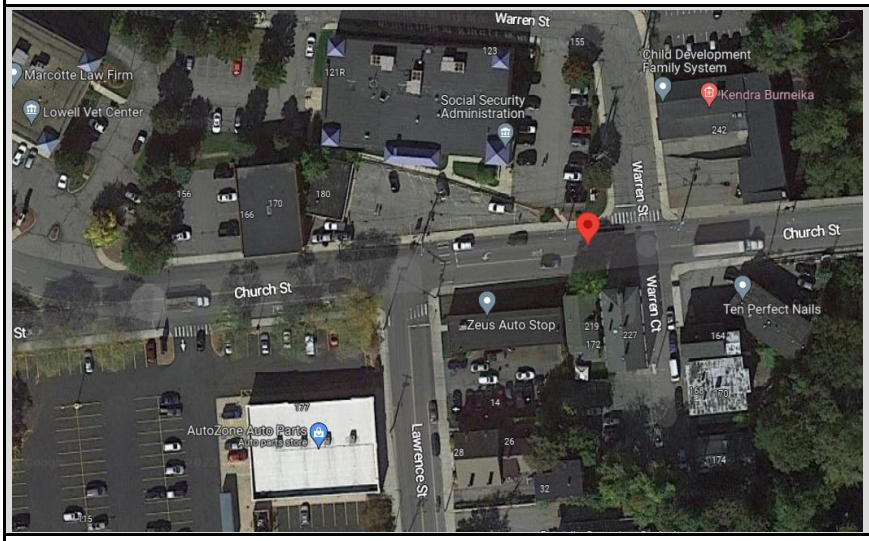
ADS ENVIRONMENTAL SERVICES®

Site I.D.

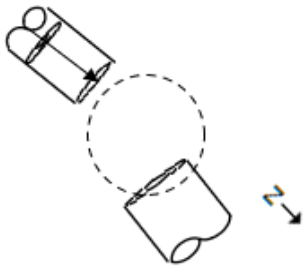
Meter-40

Site Address / Location:	219 Church St, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
54.63x36.63	Standard Egg



Manhole #	System Characteristics
40	Residential
Access	**Traffic**
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Thursday, March 16, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
3:29:00 PM	54.63x36.63
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
3.74	50.85
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
5.3	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches)	Manhole Configuration
160	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

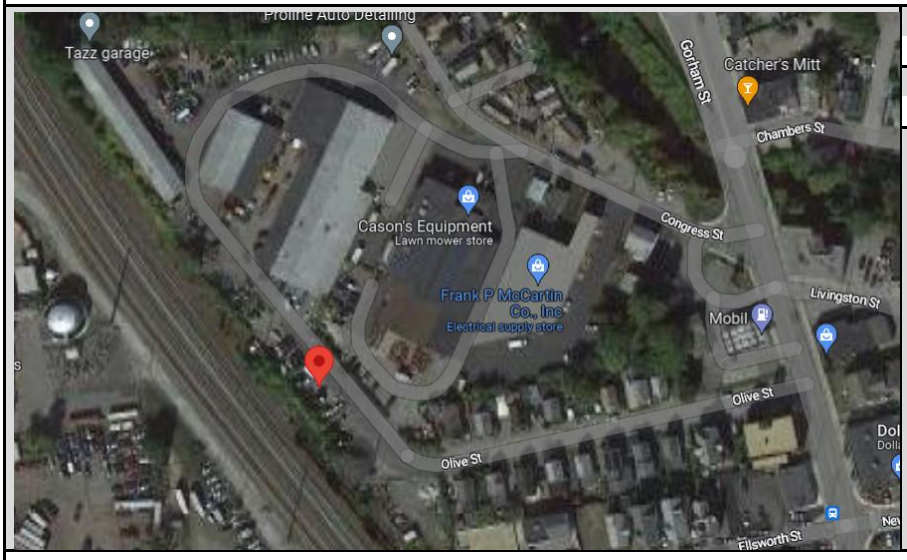
ADS ENVIRONMENTAL SERVICES®

Site I.D.

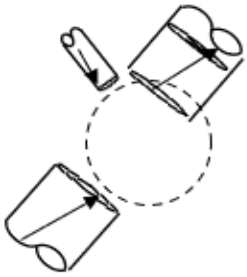
Meter-41

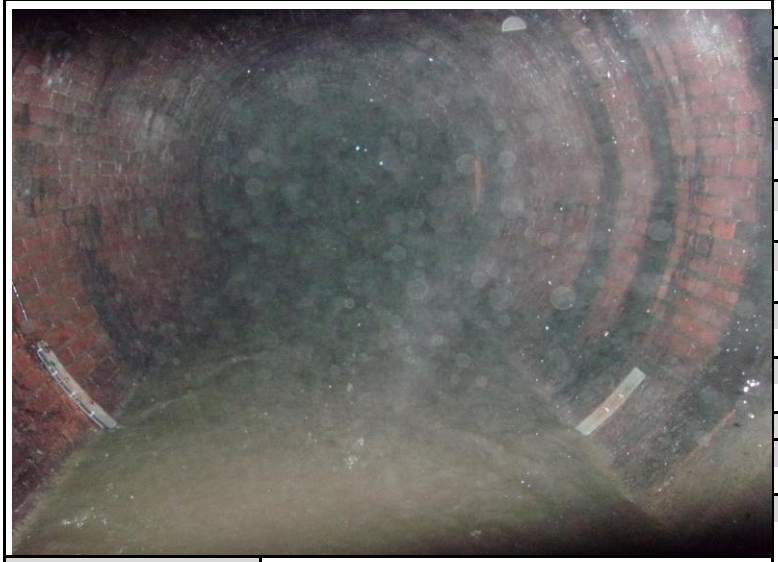
Site Address / Location:	Olive St (42631143,-71.310788)
Site Access:	Drive

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



Manhole #	System Characteristics
42	Residential
Access	Traffic
Drive	None





ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Friday, March 24, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
10:27:00 AM	86.00x86.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
12.81	73.19
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.39	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

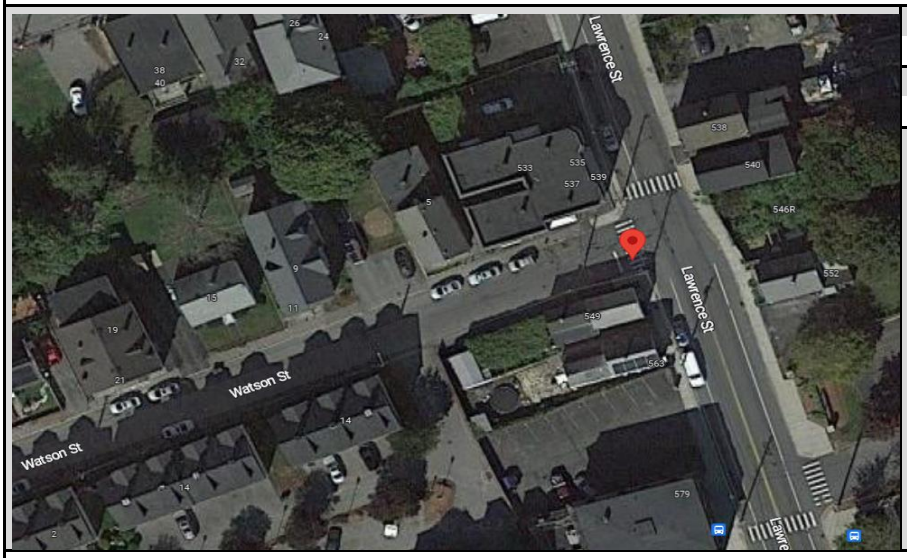
ADS ENVIRONMENTAL SERVICES®

Site I.D.

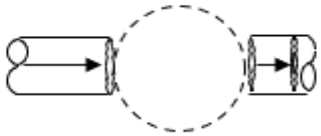
Meter-42

Site Address / Location:	549 Lawrence Street, Lowell, MA
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
92.00x92.00	Circular



Manhole #	System Characteristics
41	Residential
Access	Traffic
Drive	Light



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ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Monday, March 20, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
1:15:00 PM	92.00x92.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
12.03	79.97
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
5.13	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
253	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®

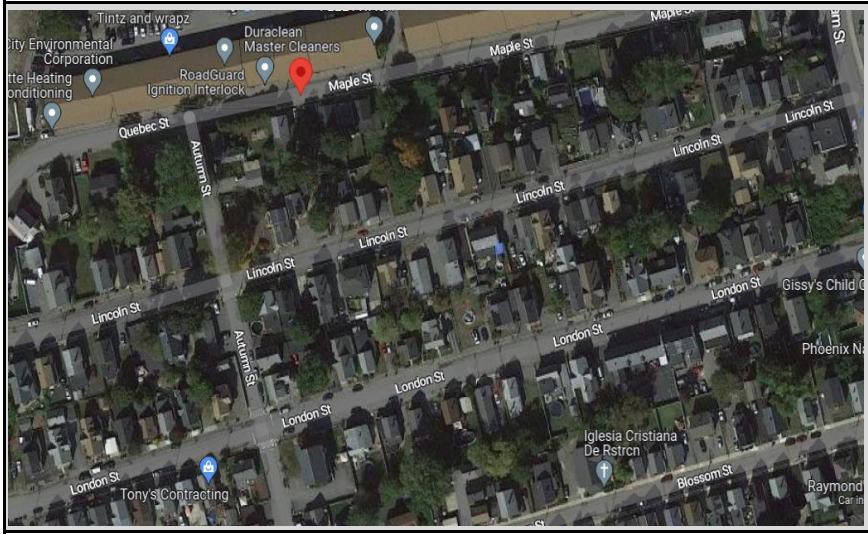
Site I.D.

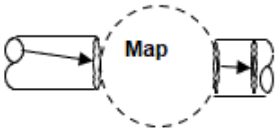
Meter-43

Site Address / Location:	76 Maple Steet, Lowell, MA
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
47.63x34.00	Standard Egg

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





ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Monday, March 20, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV|MAX/Peak Combo (CS9), Smart Depth (CS5)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
10:39:00 AM	47.63x34.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
7.69	39.94
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
2.75	0.38"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
0.75	4
Silt (in)	**Silt Type**
4	

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
212	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

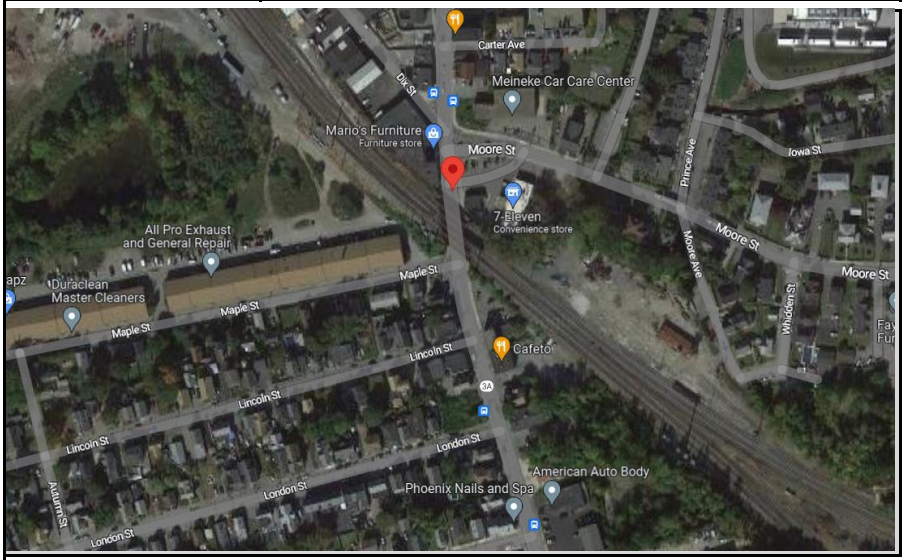
ADS ENVIRONMENTAL SERVICES®

Site I.D.

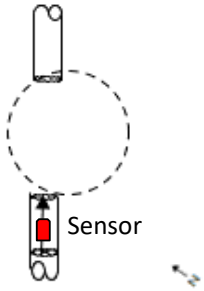
Meter-44

Site Address / Location:	978 Gorham St, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
55.00x46.5	Elliptical



Manhole #	System Characteristics
44	Residential
Access	Traffic
Drive	Heavy



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Thursday, March 16, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
AV|MAX/Peak Combo (CS9), Smart Depth (CS5)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
1:01:00 PM	55.00x46.5
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
13.68	42.82
Downlooker Physical Offset (in)	Measurement Confidence (in)
1.5	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.12	11
Silt (in)	Silt Type
11.5	Hard Packed

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
218	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:
Yes, Inside	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

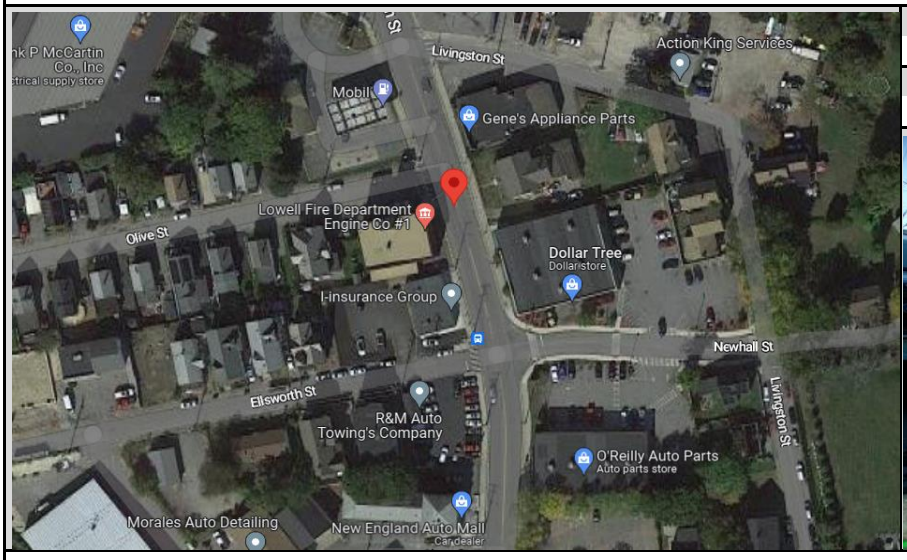
ADS ENVIRONMENTAL SERVICES®

Site I.D.

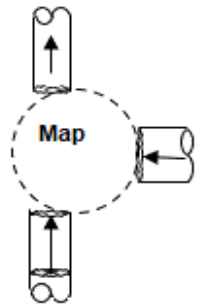
Meter-45

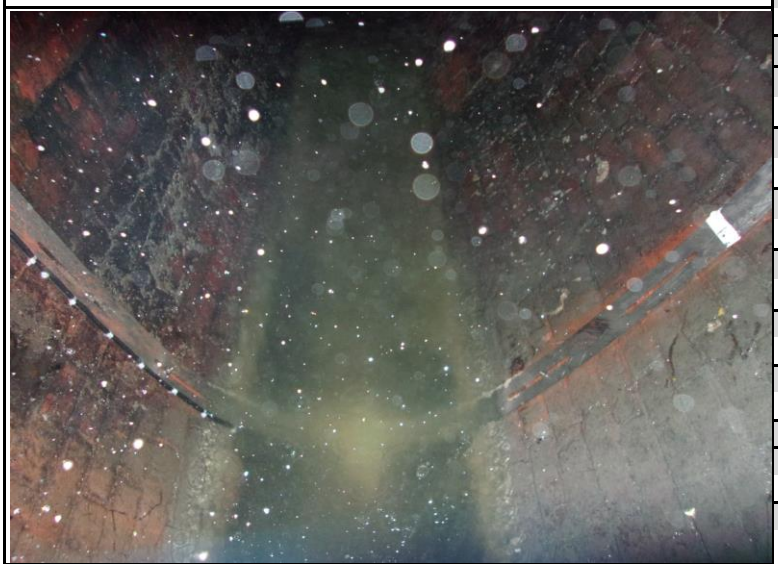
Site Address / Location:	Gorham & Olive Street, Lowell, MA
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
74.00x50.00	Standard Egg



Manhole #	System Characteristics
44	Residential
Access	Traffic
Drive	Heavy





ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 22, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 0-5 FT	Manhole
Sensors / Devices:	Pressure Sensor Range (psi)
Peak Combo (CS4)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
3:39:00 PM	74.00x50.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
7.89	66.1
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.5	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
360	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:
Yes, Inside	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

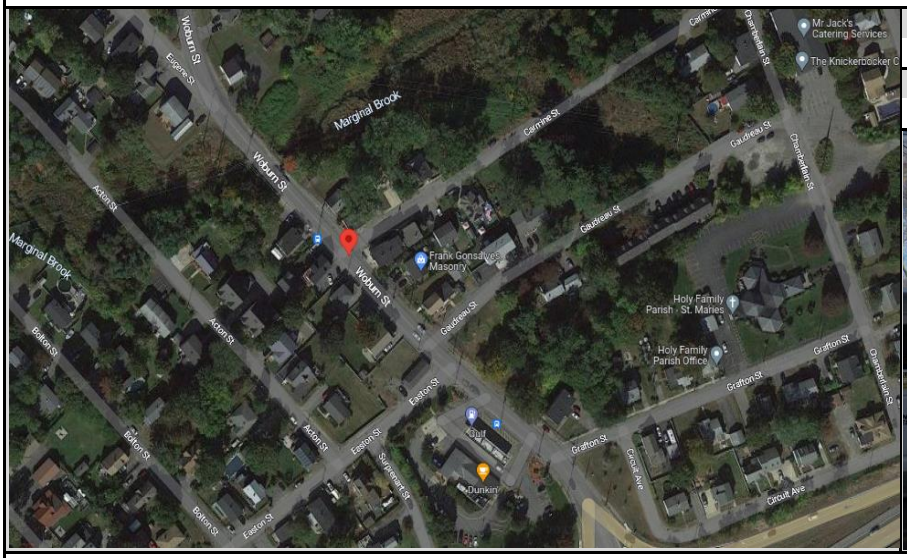
ADS ENVIRONMENTAL SERVICES®

Site I.D.

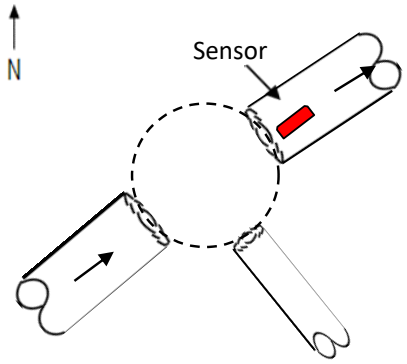
Meter-46

Site Address / Location:	Woburn St at Carmine St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
12.00x12.00	Circular



Manhole #	System Characteristics
46	Residential
Access	Traffic
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Monday, March 13, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
10:39:00 AM	12.00x12.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
5.55	6.45
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
0.75	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
86	Common Trench
Manhole Material:	Manhole Condition:
Brick	Good
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):
18	18
Manhole Cover	Manhole Frame
Concealed	Normal
Active Drop Connections	Air Quality:
No	Good
Pipe Material	Pipe Condition:
Cast Iron Pipe	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®

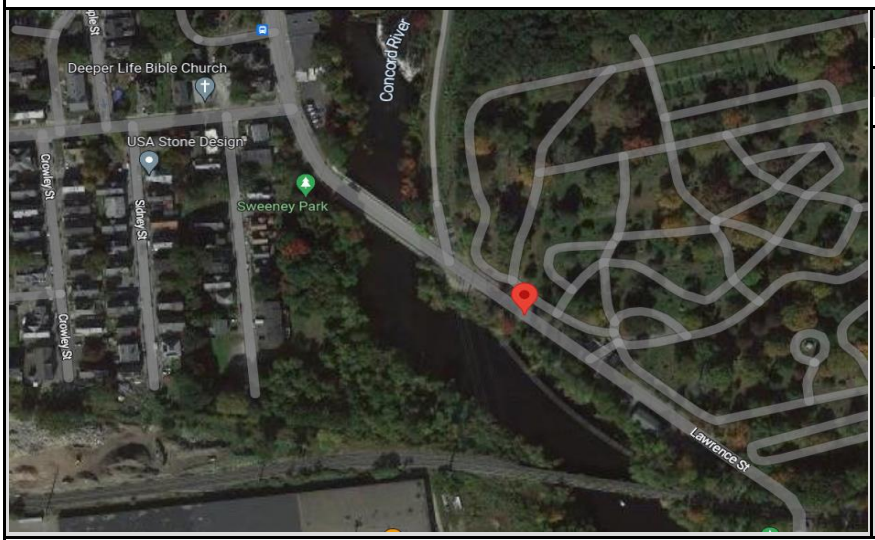
Site I.D.

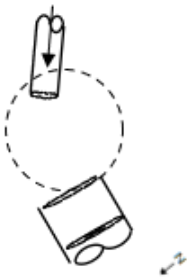
Meter-47

Site Address / Location:	42.627471,-71.297308- Near Lowell Cemetery
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
36.00x36.00	Circular

Manhole #	System Characteristics
47	Residential
Access	**Traffic**
Drive	Medium





ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Thursday, March 16, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
10:12:00 AM	36.00x36.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
6.32	29.68
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.7	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
193	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

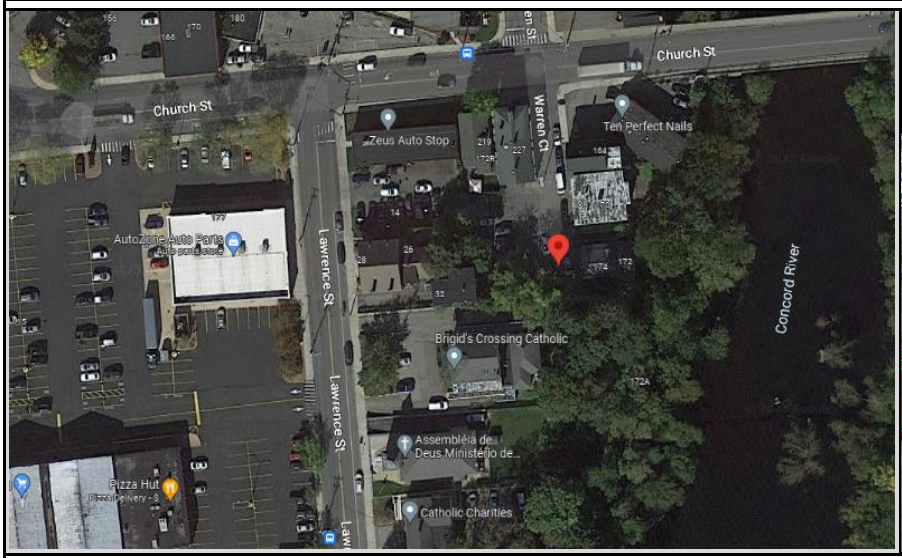
ADS ENVIRONMENTAL SERVICES®

Site I.D.

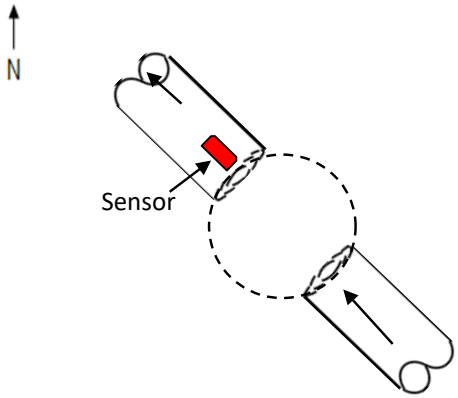
Meter-48

Site Address / Location:	174 Warren Ct
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
84.00x84.00	Circular



Manhole #	System Characteristics
48	Residential
Access	Traffic
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Monday, March 13, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
2:49:00 PM	84.00x84.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
7.16	76.84
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
6.1	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
366	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

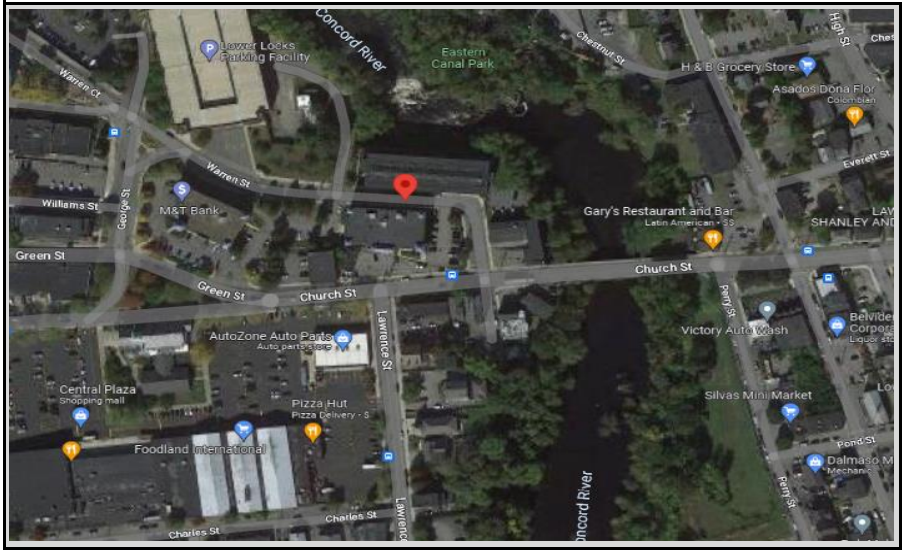
ADS ENVIRONMENTAL SERVICES®

Site I.D.

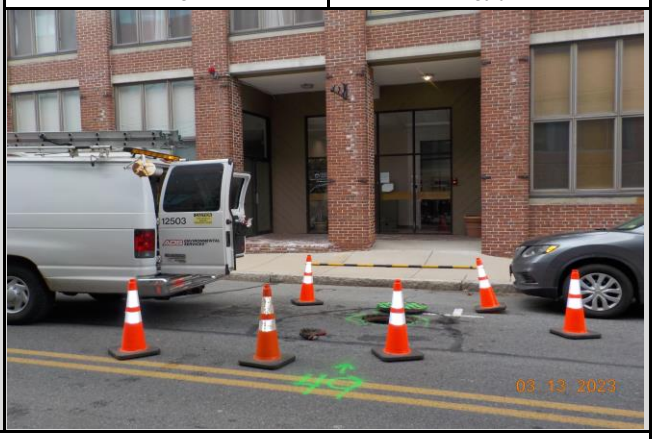
Meter-49

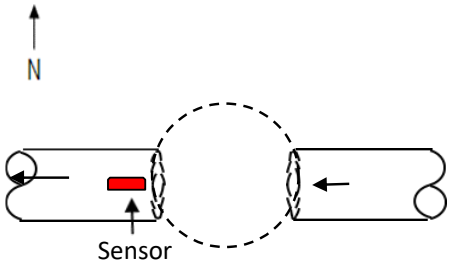
Site Address / Location:	132 Warren St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
90.00x90.00	Circular



Manhole #	System Characteristics
49	Residential
Access	Traffic
Drive	Medium





Installation Information

Installation Date:	Installation Type:
Monday, March 13, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
1:04:00 PM	90.00x90.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
12.9	77.1
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	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
335	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®

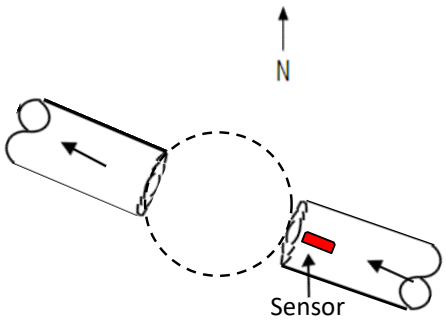
Site I.D.

Meter-50

Site Address / Location:	68 Rogers St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
46.00x46.00	Circular

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



Installation Information

Installation Date:	Installation Type:
Thursday, March 16, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
3:48:00 PM	46.00x46.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
4.95	43.05
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.93	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
181	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®

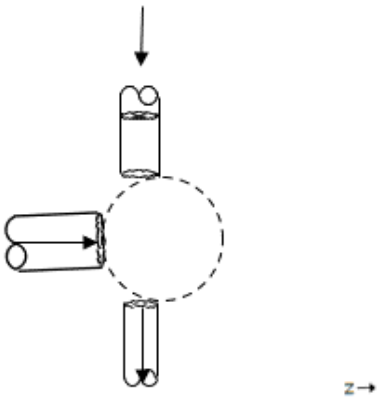
Site I.D.

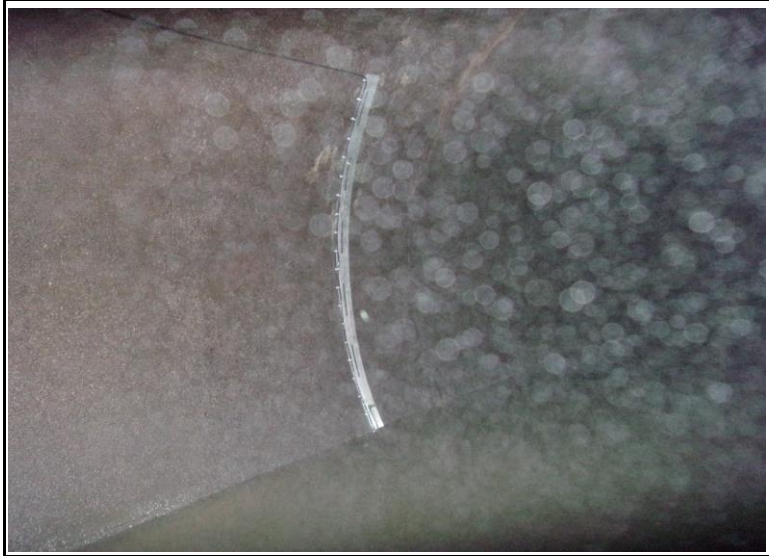
Meter 51

Site Address / Location:	Stackpole St at Corrigan Ave- Use cordintes 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:
Thursday, March 23, 2023	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)
2:52:00 PM	120.00x120.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
27.95	92.05
Downlooker Physical Offset (in)	Measurement Confidence (in)
70	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
2.24	10
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:

Lowell, MA

Flow Monitoring
Site Installation Report

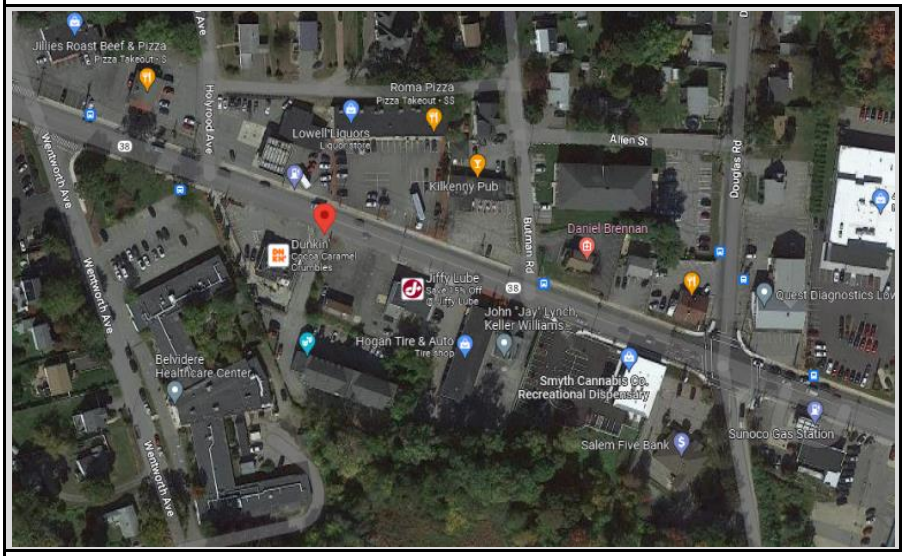
ADS ENVIRONMENTAL SERVICES®

Site I.D.

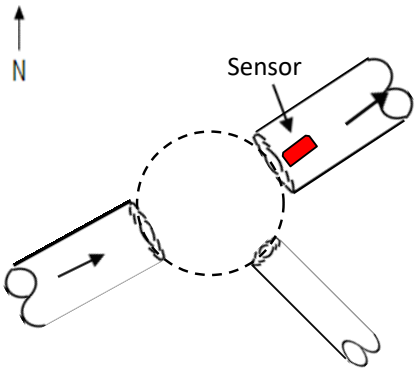
Meter-52

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:
Friday, March 10, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
4:11:00 PM	30.75x30.75
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
3.07	27.68
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.33	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

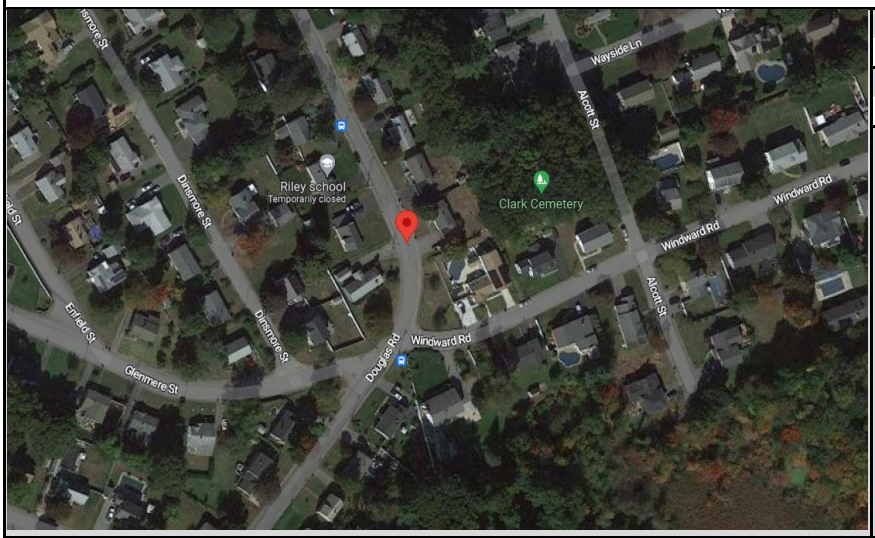
ADS ENVIRONMENTAL SERVICES®

Site I.D.

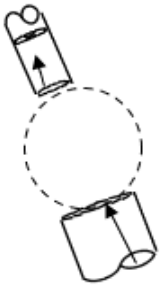
Meter-53

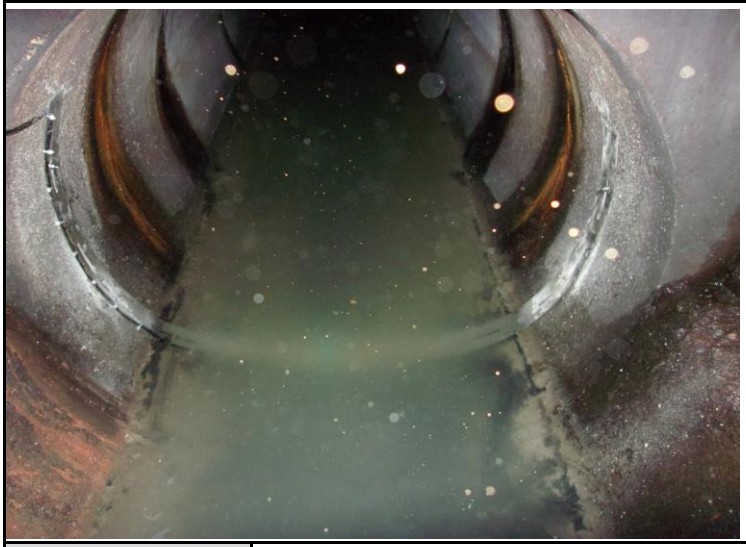
Site Address / Location:	306 Douglas Rd, Lowell, Ma
Site Access:	Drive

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, March 21, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
4:03:00 PM	48.00x48.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
9.29	38.71
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.38"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1.38	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
263	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®

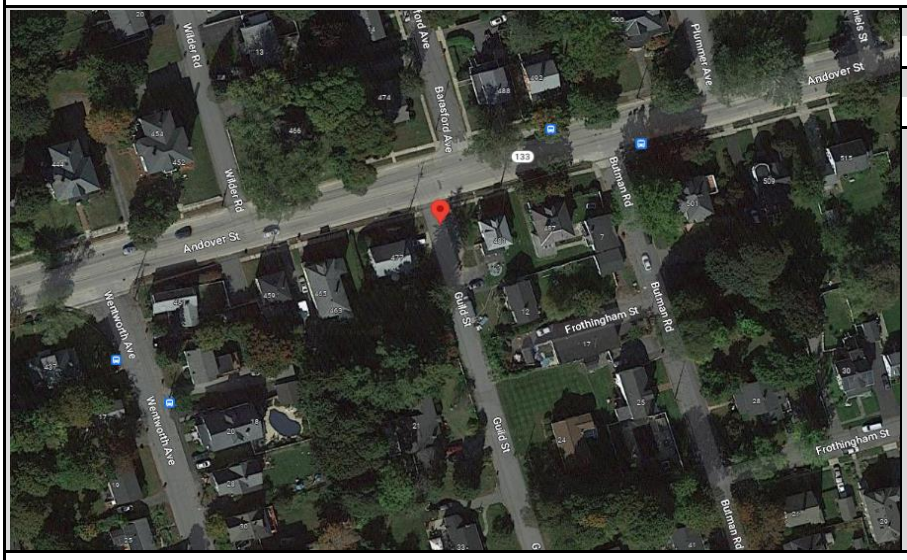
Site I.D.

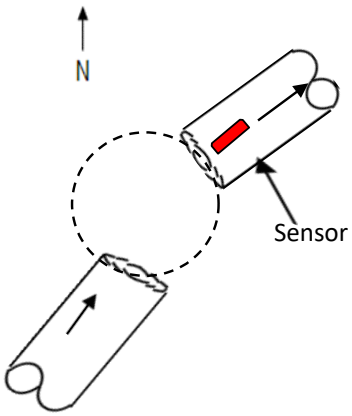
Meter-54

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:
Thursday, March 16, 2023	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)
1:51:00 PM	48.00x49.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
10.16	38.16
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
2.94	0
Silt (in)	**Silt Type**
0	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

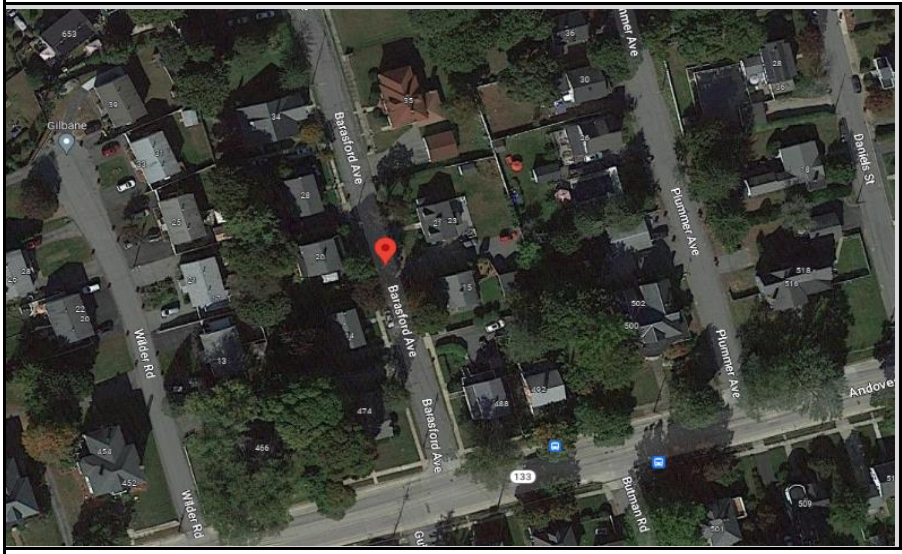
ADS ENVIRONMENTAL SERVICES®

Site I.D.

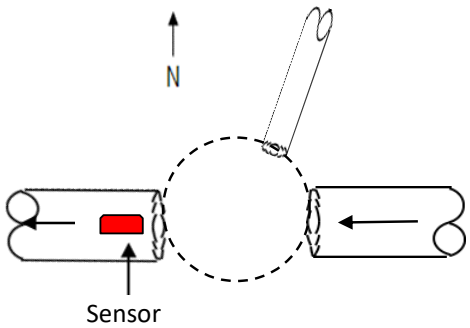
Meter-55

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

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
60.00x60.00	Circular



Manhole #	System Characteristics
55	Residential
Access	Traffic
Drive	Light



Installation Information

Installation Date:	Installation Type:
Thursday, March 16, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
11:59:00 AM	60.00x60.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
4.74	55.26
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
6.1	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:

ADS Project Name:	Lowell, Ma
ADS Project Number:	

Lowell, MA

Flow Monitoring
Site Installation Report

ADS ENVIRONMENTAL SERVICES®

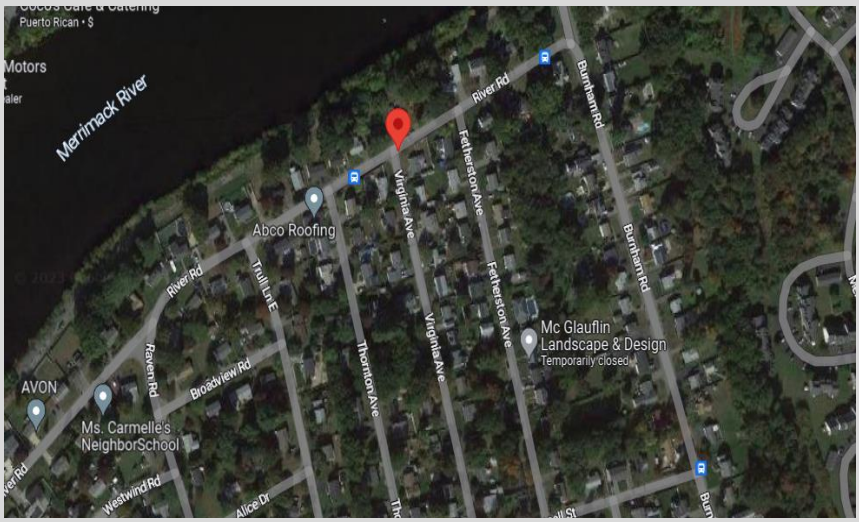
Site I.D.

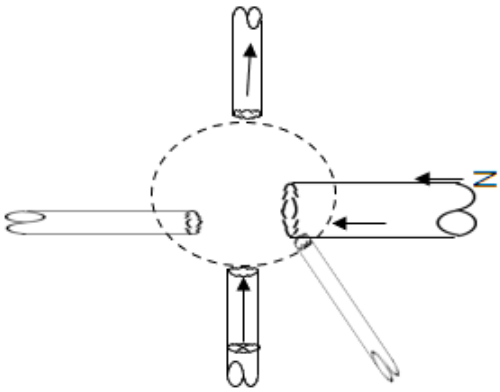
Meter-56

Site Address / Location:	188 River Rd, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
36.00x36.00	Circular

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





ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 15, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
10:03:00 AM	36.00x36.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
5.1	31
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
7.94	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
192	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

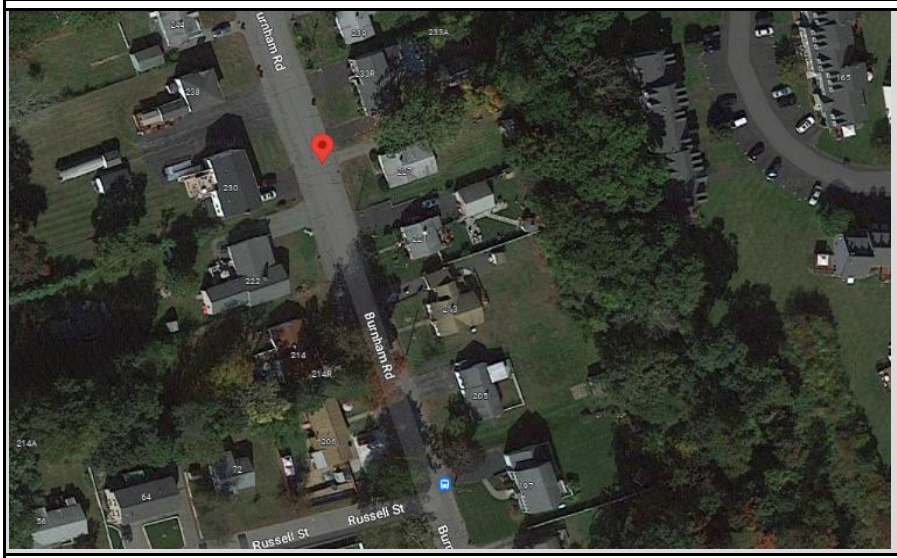
ADS ENVIRONMENTAL SERVICES®

Site I.D.

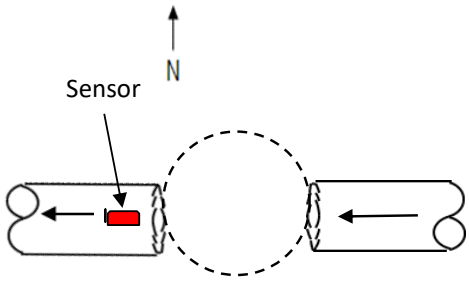
Meter-57

Site Address / Location:	230 Burnham Rd
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
30.00x30.00	Circular



Manhole #	System Characteristics
57	Residential
Access	Traffic
Drive	Light



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 15, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
10:20:00 AM	30.00x30.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
2.36	27.64
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
5.64	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

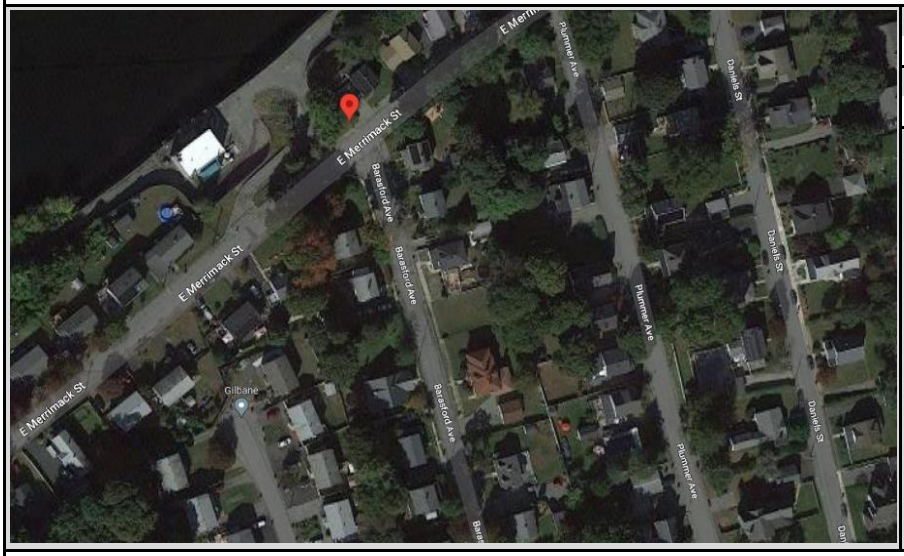
ADS ENVIRONMENTAL SERVICES®

Site I.D.

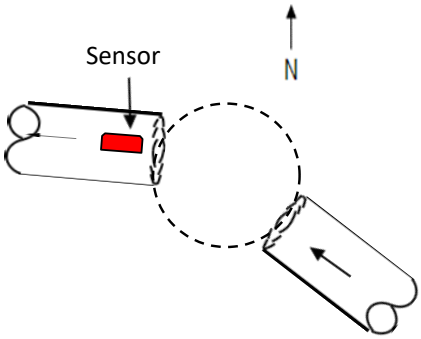
Meter-58

Site Address / Location:	678 E Merrimack St
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
82.00x82.00	Circular



Manhole #	System Characteristics
58	Residential
Access	Traffic
Drive	Medium



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Thursday, March 16, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
10:39:00 AM	82.00x82.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
14.13	67.87
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
6.86	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
206.25	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®

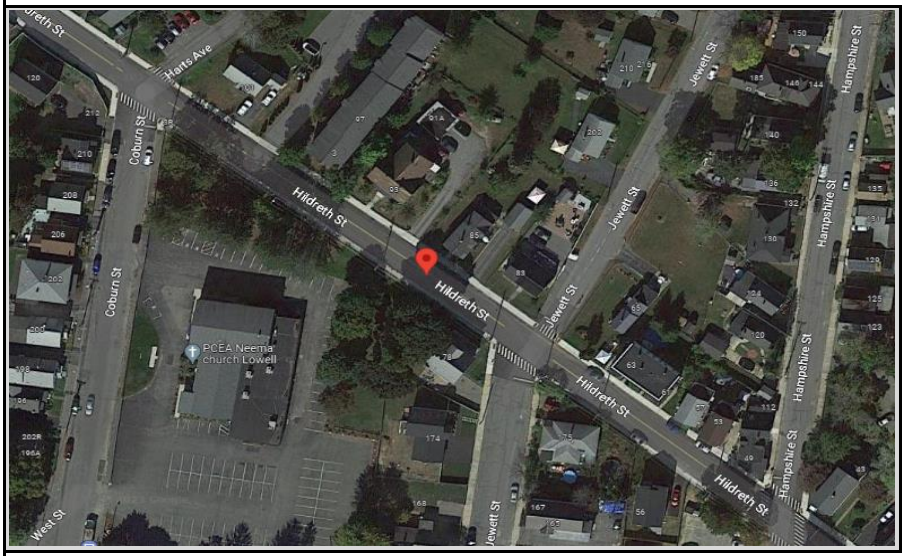
Site I.D.

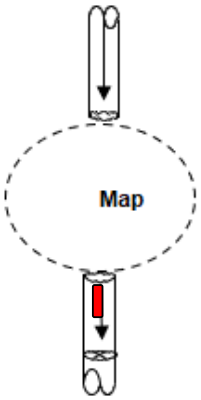
Meter-59

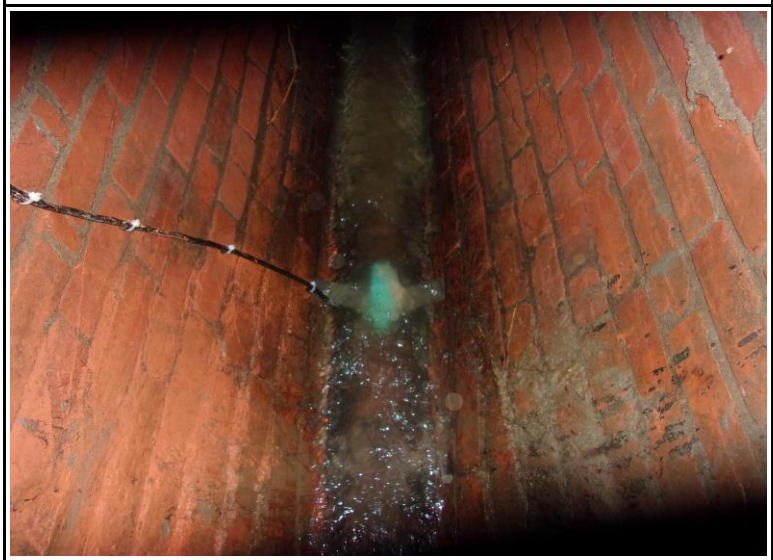
Site Address / Location:	85 Hildreth St, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
38.00x26.00	Standard Egg

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







ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Friday, March 10, 2023	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)
12:51:00 PM	38.00x26.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
2.38	35.62
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
3.27	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
183.13	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

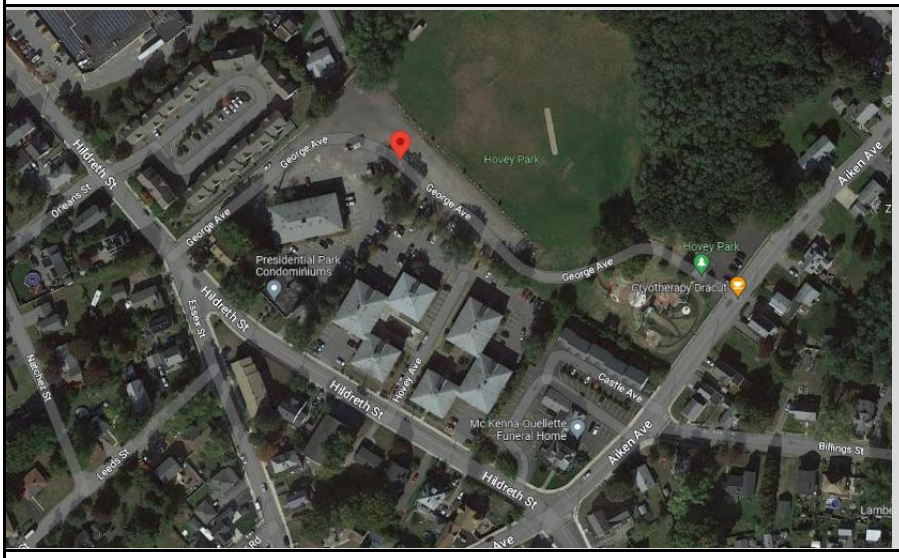
ADS ENVIRONMENTAL SERVICES®

Site I.D.

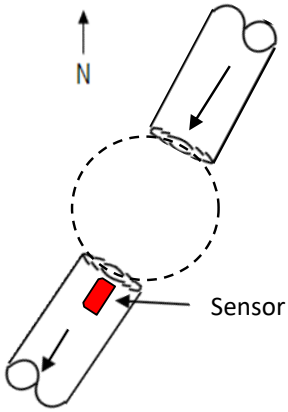
Meter-60

Site Address / Location:	George Ave (use coordinates 42.6636087,-71.3100202)
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
24.00x24.00	Circular



Manhole #	System Characteristics
60	Residential
Access	Traffic
Drive	Light



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Monday, March 13, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
9:25:00 AM	24.00x24.00
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
3.82	20.18
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
1	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. inches):	Manhole Configuration
104.85	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®

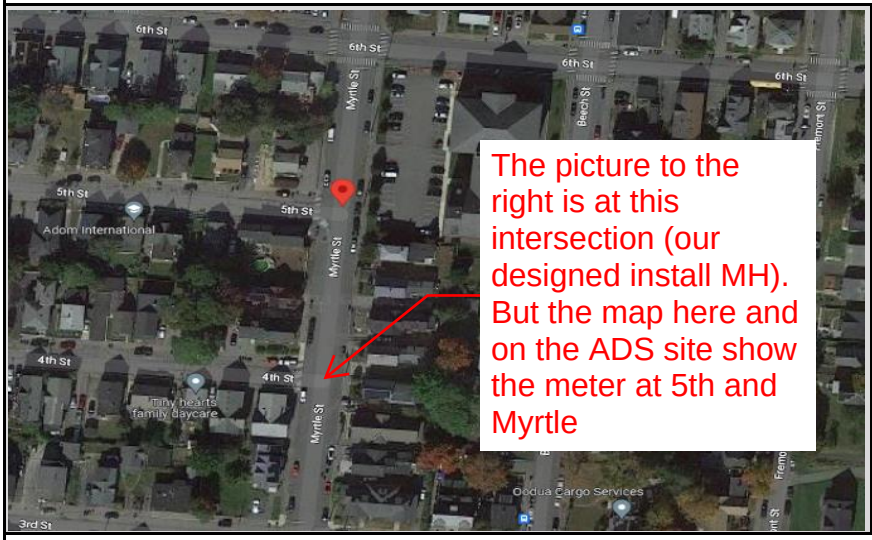
Site I.D.

Meter-61

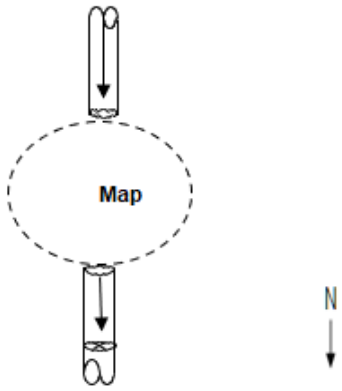
Site Address / Location:	38 Myrtle St, Lowell, Ma
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	**Pipe Shape**
37.50x25.25	Circular

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



The picture to the right is at this intersection (our designed install MH). But the map here and on the ADS site show the meter at 5th and Myrtle



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Friday, March 10, 2023	Doppler Special Installation
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 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)
2:17:00 PM	37.50x25.25
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
1.39	36.11
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
0	0.25"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
5.14	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
169.75	Common Trench
Manhole Material:	**Manhole Condition:**
Brick	Good
Manhole Opening Diameter (in)	**Manhole Diameter (Approx.):**
18	18
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

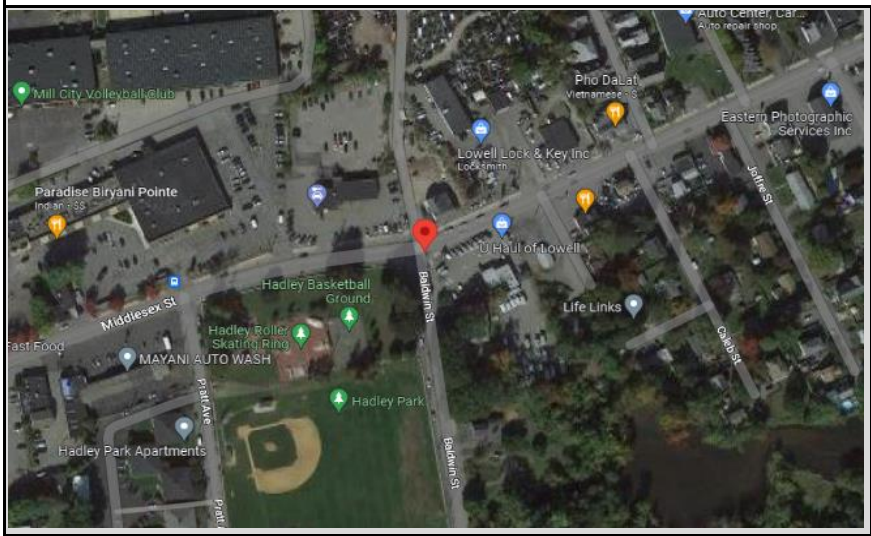
Flow Monitoring
Site Installation Report

Site I.D.

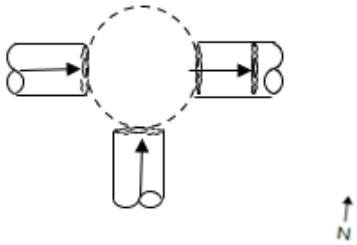
Meter-62

Site Address / Location:	Middlesex St at Baldwin St
Site Access:	Drive

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



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



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Wednesday, March 29, 2023	Doppler Standard Ring and Crank
Monitoring Location (Sensors):	**Monitor Location:**
Upstream 0-5 FT	Manhole
Sensors / Devices:	**Pressure Sensor Range (psi)**
AV|MAX/Peak Combo (CS9), Smart Depth (CS5)	0 -5 psi

Installation Confirmation:

Confirmation Time:	Pipe Size (HxW)
11:26:00 AM	48.00x48.00
Depth of Flow (Wet DOF) (in)	**Range (Air DOF) (in)**
15.34	32.66
Downlooker Physical Offset (in)	**Measurement Confidence (in)**
1.5	0.38"
Peak Velocity (fps)	**Velocity Sensor Offset (in)**
1.89	0
Silt (in)	**Silt Type**
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. Inches):	Manhole Configuration
203.25	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:

Site location is extremely busy. Better to visit in early mornings.

Lowell, MA

Flow Monitoring
Site Installation Report

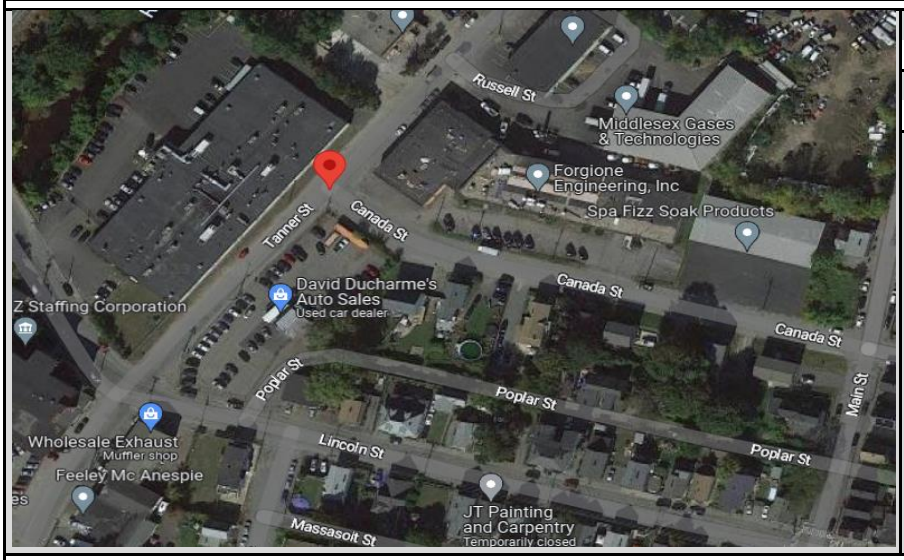
ADS ENVIRONMENTAL SERVICES®

Site I.D.

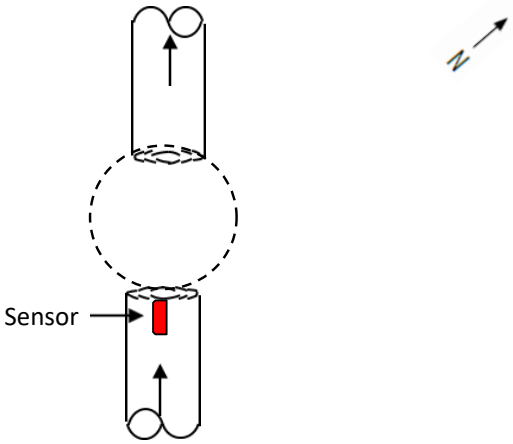
Meter-63

Site Address / Location:	Canada Street and Tanner Street, Lowell, MA
Site Access:	Drive

Monitor Series	Location Type
TRITON+	Temporary
Pipe Size (H x W)	Pipe Shape
41.00x28.50	Standard Egg



Manhole #	System Characteristics
63	Residential
Access	Traffic
Drive	Light



ADS Project Name:	Lowell, Ma
ADS Project Number:	

Installation Information

Installation Date:	Installation Type:
Friday, March 24, 2023	Doppler Special Installation
Monitoring Location (Sensors):	Monitor Location:
Upstream 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)
2:45:00 PM	41.00x28.50
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)
16.1	24.9
Downlooker Physical Offset (in)	Measurement Confidence (in)
0	0.25"
Peak Velocity (fps)	Velocity Sensor Offset (in)
3.42	0
Silt (in)	Silt Type
0	0

Hydraulic Comments:

Manhole / Pipe Information:

Manhole Depth (Approx. FT):	Manhole Configuration
120	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:
Lined	Good

Communication Information:

Communication Type	Antenna Location
Wireless	Drilled Pavement / Concrete

Additional Site Info. / Comments:

This manhole has an issue with the atmosphere, LEL can hit 10 randomly. Use a blower when at this site.

APPENDIX E - 2023 I/I FIELD INVESTIGATION PROGRAM FINDINGS TECHNICAL MEMORANDUM

MEMORANDUM

TO: Aaron Fox | Lowell Regional Wastewater Utility

FROM: Jill Rossini, Kate Goyette | Kleinfelder

DATE: January 19, 2024

SUBJECT: 2023 Inflow/Infiltration Field Investigation Program Findings

CC: Evan Walsh | Lowell Regional Wastewater Utility

This technical memorandum summarizes the findings of the field investigation program conducted throughout 2023 as part of the Lowell Regional Wastewater Utility's (Utility) I/I Removal Program as detailed in the City's *Infiltration and Inflow (I/I) Abatement Plan* (December 2022).

The 2022 I/I Abatement Plan included the following recommendations:

1. Conduct a City-wide Flow Metering Program and summarize findings and recommendations in an I/I Analysis Report in accordance with MassDEP Guidelines.
2. Conduct closed-circuit television (CCTV) and manhole inspections during high groundwater periods in subareas 7, 9, 19, 20 (as defined in the City's 1990 Phase 1 Infiltration/Inflow Study). Includes approximately 60,100 feet (5% of system) of sewer inspections and 330 manhole inspections (5% of system).
3. CCTV inspections of River-front interceptors (up to 10,000 feet) and siphon (up to 1 location).
4. Repair of Kearney Square sewer.

Figure 1 illustrates the recommended I/I Investigations and sewer repair presented in the I/I Abatement Plan from the review and assessment of the City's existing information.

In Spring 2023, CCTV and manhole inspections were conducted in subareas 7, 9, and 20, along with cleaning and inspection of the East Merrimack siphon. This memorandum includes a summary of the sewer, manhole, and siphon inspections, documents structural condition and operation and maintenance issues, and provides recommendations for rehabilitation.

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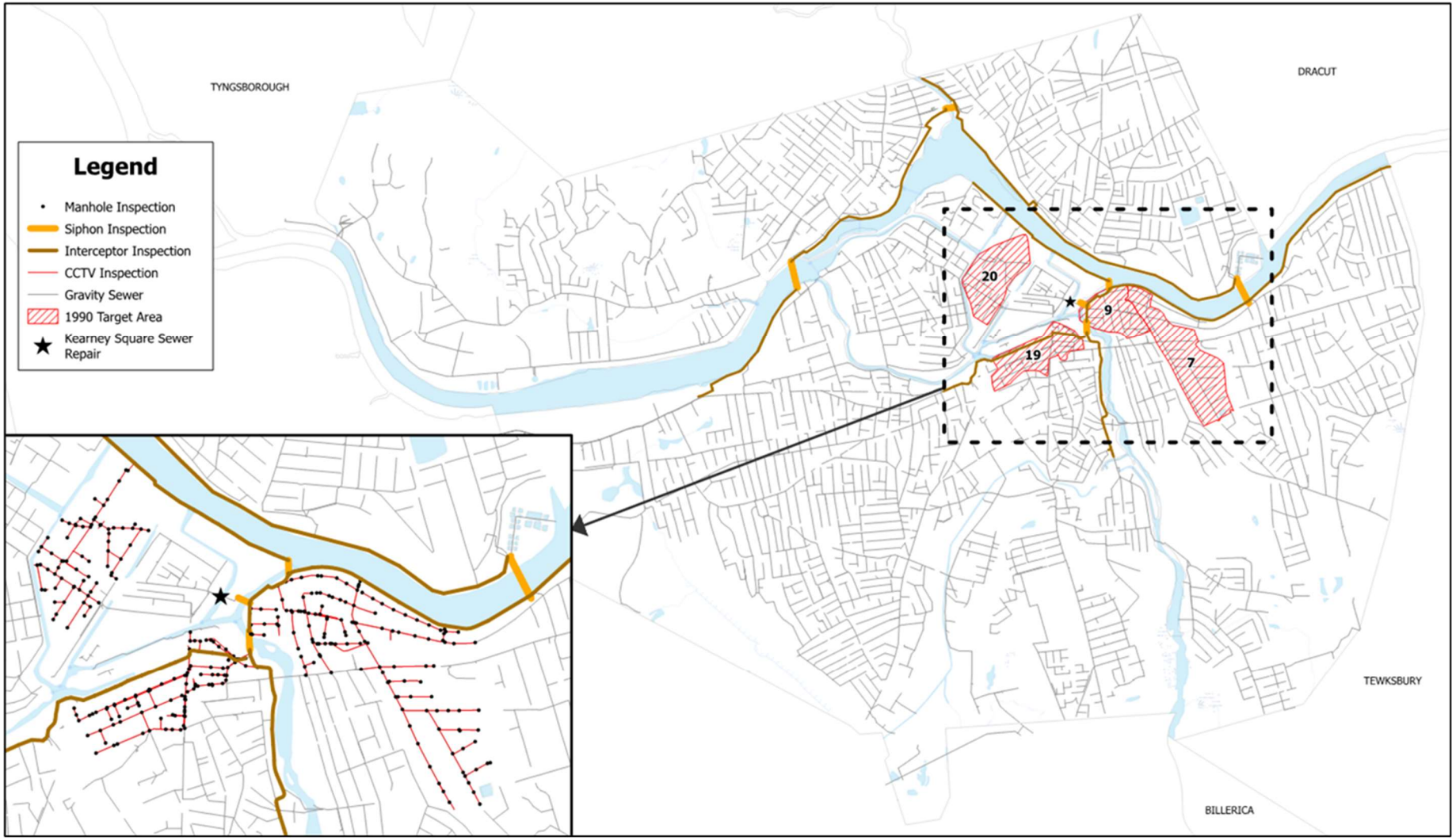

Figure 1: I/I Abatement Plan Recommendations

Section 1: Manhole Inspections

EST Inc, a subcontractor to Kleinfelder, conducted sewer manhole inspections within Sewer Subareas 7, 9, 20 (as defined in the 1990 Phase 1 Infiltration/Inflow Report). Subareas 7, 9, and 20 loosely correspond to 2023 City-wide flow meter areas 51, 38, 37. A total of two hundred and twenty (220) sewer manholes were selected for Type I (visual ground level) manhole inspections completed EST Associates, Inc. (EST) from May to July 2023. The 1990 Phase 1 Report identified Subareas 7, 9, and 20 with some of the highest infiltration rates of the 48 subareas studied. In addition to their historically high infiltration, these areas compromise some of the City's oldest infrastructure, are located downtown and in close proximity to the Merrimack and Concord Rivers and canals.

Sixty (60) manholes, or 27%, were in good condition with no visible defects or signs of deterioration. The remaining one hundred and sixty (160) manholes, or 73%, displayed at least one form of defect (of the cover, frame, chimney, cone, wall, bench, or channel). Noteworthy defects (190 total) include missing mortar, holes with soil visible, infiltration runners/weepers, and displayed or missing bricks, quantified in **Table 1**. The majority of covers and frames were in acceptable conditions with minimal requiring replacement. Defective chimneys were common but were typical of showing signs of deterioration more so than a cause for action or concern. Most of the manholes with defective walls also exhibited defective chimneys and contribute the majority of the observed infiltration, shown in **Table 2**. Each manhole component in **Table 2** displays the sum of that component from the contributing identified manholes with infiltration rates assigned through defects (for example, the 33 wall defects collectively contribute a sum of 8.9 gpm of infiltration).

Of the total 220 inspections conducted, thirty-five (35) manholes, or 16%, are recommended for further investigation (9) or repair/rehabilitation (26), shown geographically in **Figure 2.** Nine manholes noted for further action include observed construction debris and evidence of surcharging, potentially identifying associated pipelines with capacity issues. Nineteen (19) of the 26 manholes recommended for rehabilitation yield approximately 11.3 GPM of total infiltration observed through these inspections. The remaining 7 manholes exhibit significant structural issues in need of mitigation. Although these structurally compromised manholes did not exhibit obvious signs of infiltration at the time of inspection, they may still be potential sources of infiltration. **Appendix A** is EST's MH inspection report documenting all field collected findings. Additionally, NWMCC identified the manholes within Dummer Street to be in poor structural condition and are in need of rehabilitation or replacement.

Table 1 Quantity of Defects per Manhole Component

	Cover	Frame	Chimney	Cone	Wall	Bench	Channel	Total Defects
Quantity	2	8	117	12	33	12	6	**190**
Percent of Total Defects	1%	4%	62%	6%	17%	6%	3%	

Table 2 Exhibited Infiltration per Manhole Component

Wall (GPM)	Bench (GPM)	Channel (GPM)	Total (GPM)	Total (GPD)
8.9	0.7	1.7	11.3	**~16,300**

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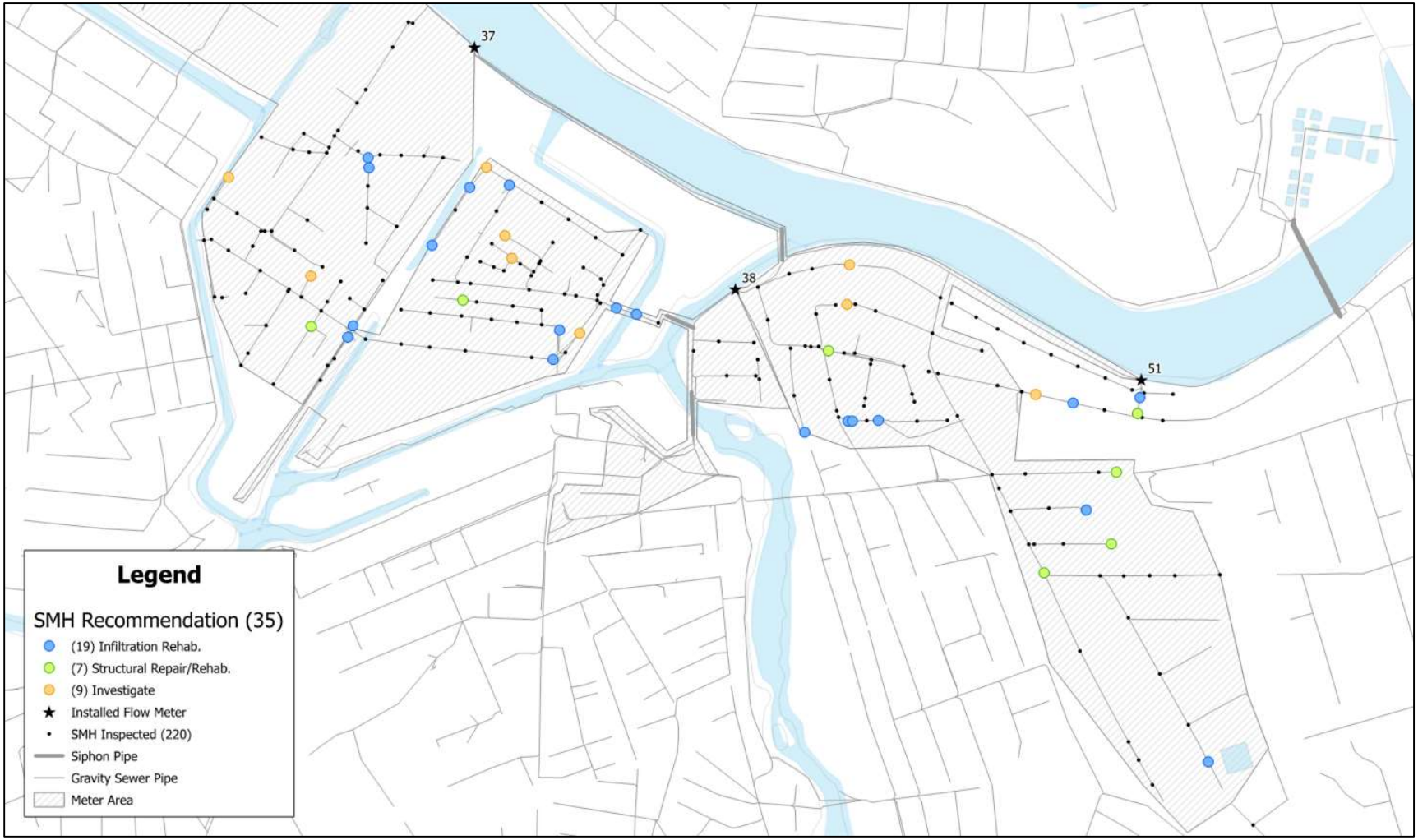

Figure 2: Manhole Recommendations

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Section 2: Subarea Cleaning and Inspections

Through the 2022 I/I Abatement Plan efforts, Kleinfelder identified approximately 40,000 feet of sewer pipes within Subareas 7, 9, and 20 for cleaning and CCTV inspection. Subareas 7, 9, and 20 loosely correspond to 2023 meter areas 51, 38, 37. National Water Main Cleaning Company (NWMCC) conducted cleaning and inspection of approximately 31,500 feet of 8-inch to 36-inch diameter sewer from April to August 2023. The remaining scope was not completed due to abandoned pipe, pipe that did not exist, or inaccessibility. Paired with the manhole inspections, the sewer cleaning and inspection offers imperative insight to sources of infiltration, observed structural defects, and operation and maintenance (O&M) considerations for a comprehensive approach to fully inspect this downtown area of the City.

The degree of cleaning experienced during this effort**,** shown in **Figure 3**, will help inform the City's CMOM program and the frequency of sewer cleaning needed in this area to provide necessary capacity. The quick structural ratings (QSR), as shown in **Figure 4**, identify approximately 15,000 LF of pipe to be considered for rehabilitation or replacement in the near future. **Figure 5** displays the quick maintenance ratings (QMR) as it pertains to I/I and compliments identified pipes within **Figure 4** that can be candidates for rehabilitation or replacement. **Appendix B** contains all NWMCC's CCTV inspection logs from this effort.

Overall, the field program findings included the following:

- System configuration updates to revise the City's GIS
- Abandoned and new assets identified
- Several pipes with more minor offset joints and infiltration defects
- Several pipes with more significant issues (shown in **Table 3**)
    - Paige Street flow-filled pipe
        - Heavy cleaning was attempted and proved the material is adhered to the pipe wall and has permanently reduced the pipe's capacity leaving the pipe to require replacement.
    - 144 E Merrimack Street stone pipeline with voids
        - Due to the type of stone construction, there are voids that may allow infiltration and exfiltration from the pipeline. This pipe may be best rehabilitated through spray lining or slip lining.
    - Moody Street Canal cross-connection into the combined sewer

        - It became apparent that the plate or control mechanism that kept the Moody Street Canal (a secondary connection between primary canal ways) blocked off from the sewer became dislodged at some point in time. The Utility worked with private owners to fabricate a new plate to be installed in place to prevent this cross connection of canal water entering the sewer.
    - John Street hinge fractures
        - Given the pipe depth relative to the roadway, pipe material, pipe age, and high traffic area, these hinge fractures could cause pipe collapsed if not addressed in the near future.
    - Nesmith Street, Lee Street, Bartlett Street missing bricks
        - Likely due to high traffic, these old brick pipelines have lost bricks over time which reduces their structural integrity, making them contenders for rehabilitation.
- Areas that required medium and heavy cleaning

Table 3: Field Identified Significant Pipe Defects

Paige St – Flow filled Pipe

Moody Street – Canal Inflow

John Street – Hinge Fractures

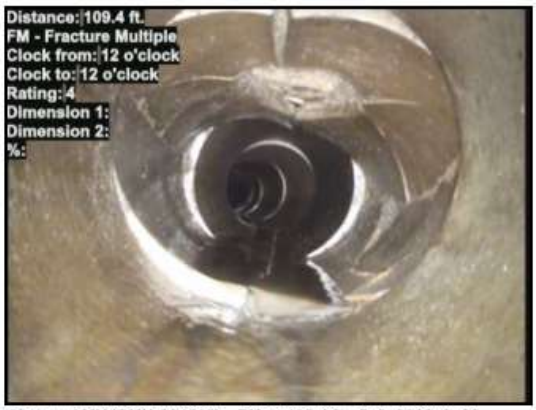
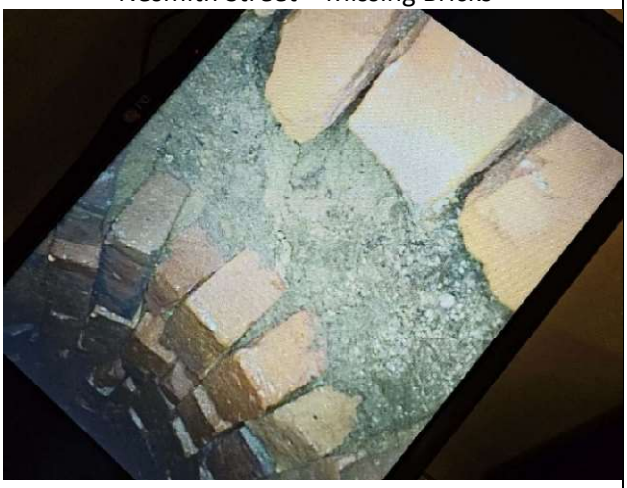


Photo: AMH 'SMH-004116'__FM at 109.4 ft._5_2_2023_9_03 AM.JPG

At: 109.4 ft. FM - Fracture Multiple 12/12

Nesmith Street – Missing Bricks



Lee Street – Holes

Photo: AMH 'SMH-004107'__H at 138.9 ft._4_20_2023_9_53 AM.JPG

At: 138.9 ft. 12/. H - Hole

Bartlett – Roots, Holes, Displaced Bricks

Photo: AMH 'SMH-006656'__HSV at 14.2 ft._6_22_2023_12_06 PM.JPG

At: 14.2 ft. 1/3 HSV - Hole Soil Visible

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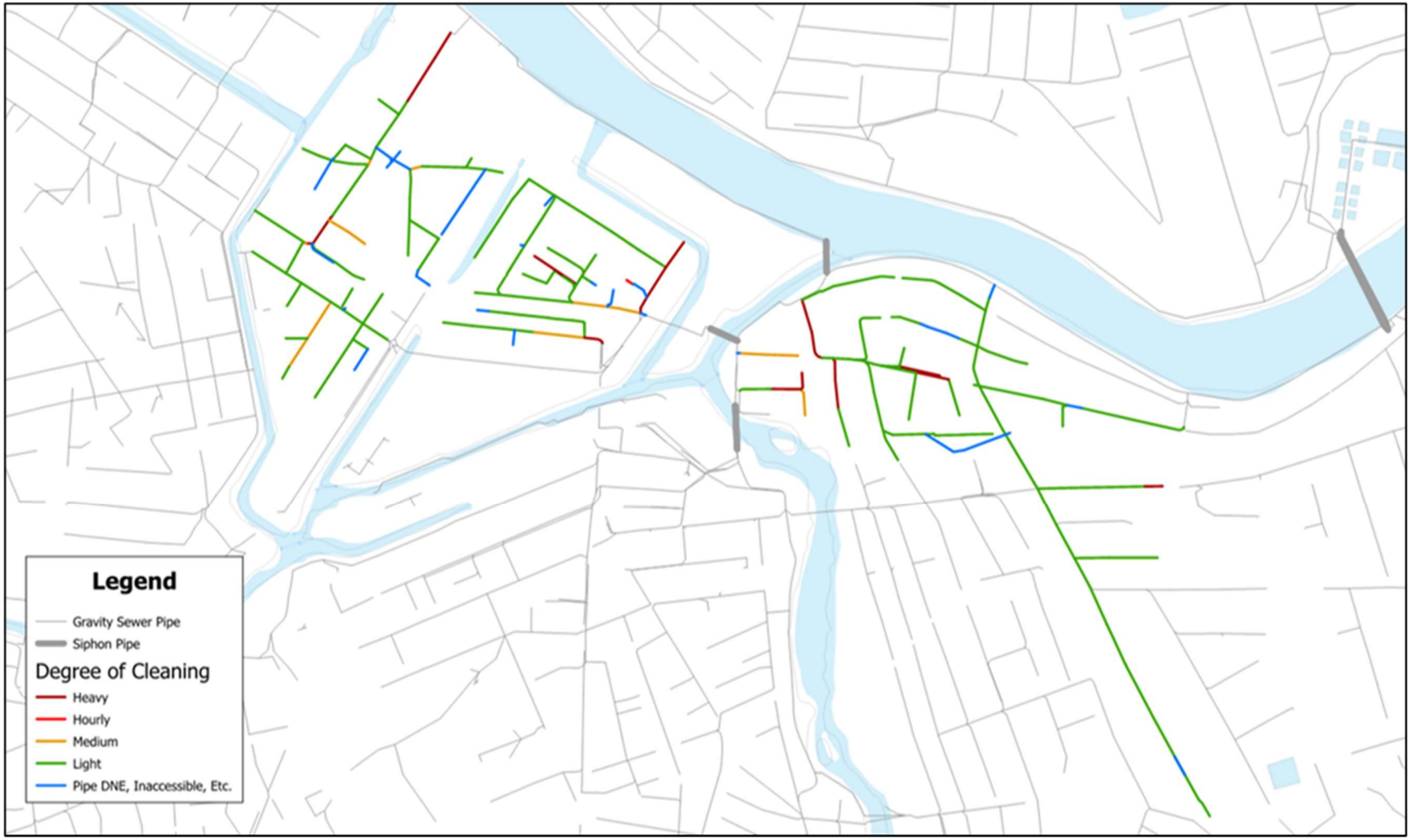


Figure 3: Decree of Cleaning Summary

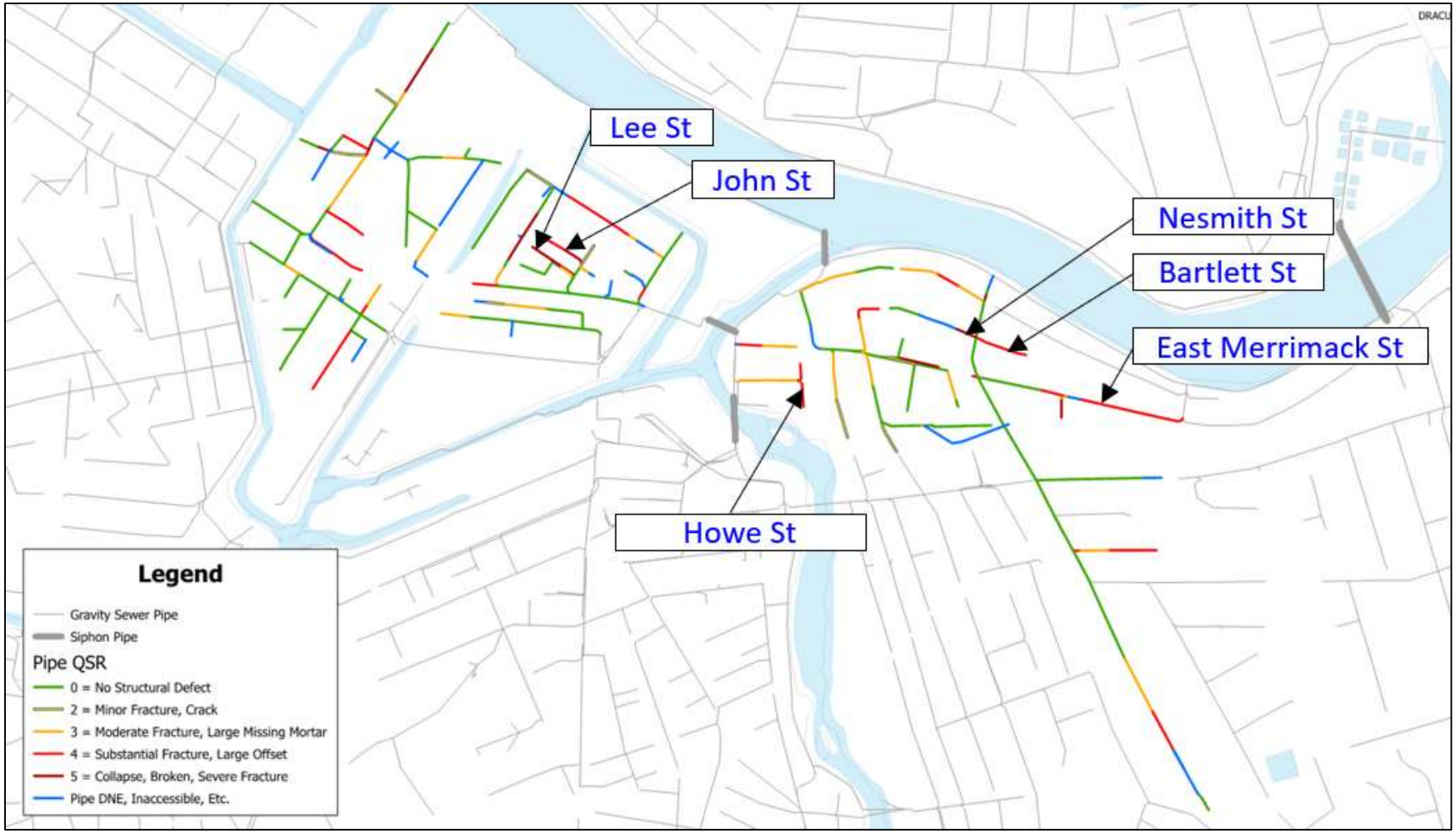


Figure 4: Quick Structural Rating Summary

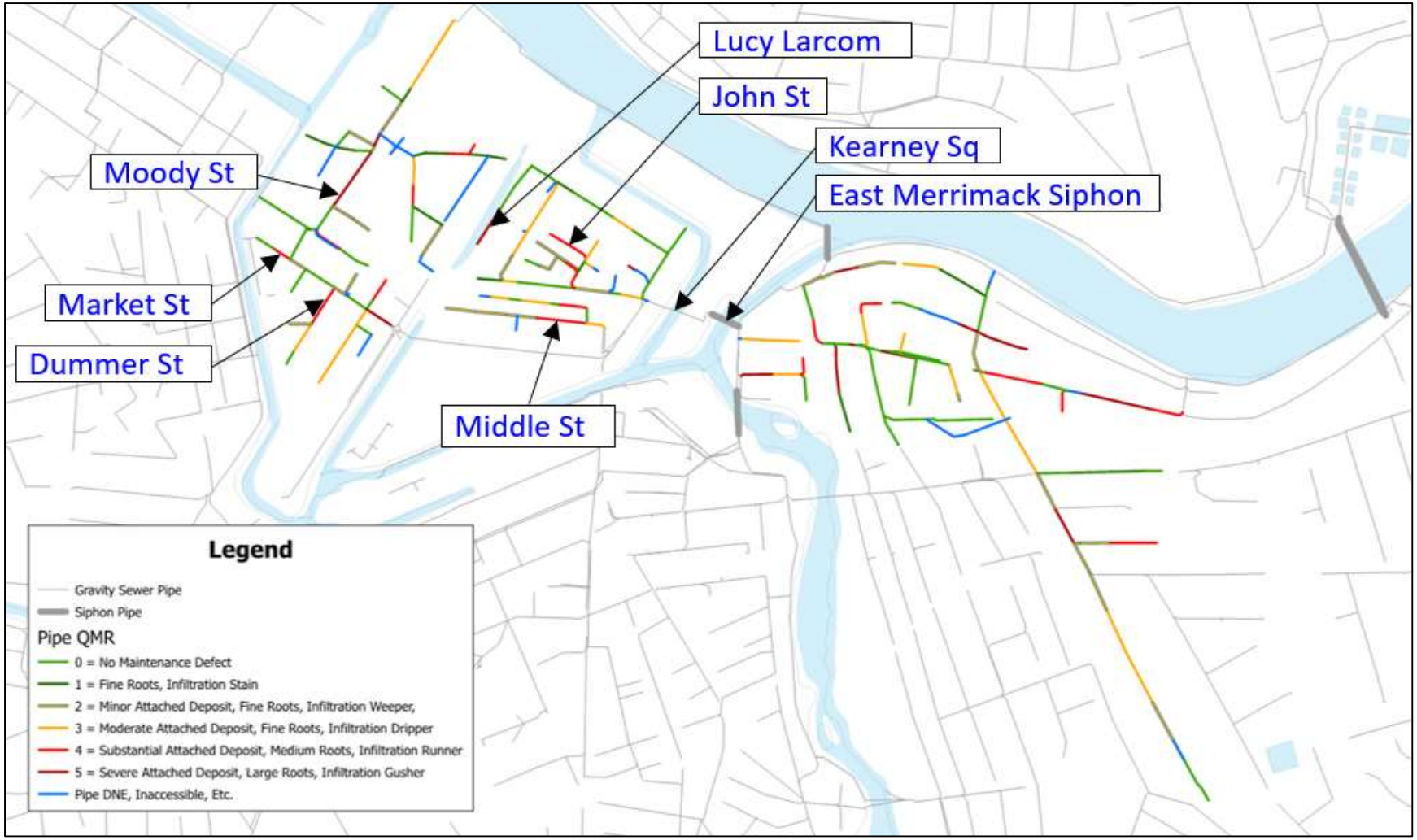


Figure 5: Quick Maintenance Rating Summary

Section 3: Siphon Cleaning and Inspections

Kleinfelder subcontracted with NWMCC to perform cleaning and CCTV inspection of the East Merrimack siphon located in downtown Lowell and shown in **Figure 6.** The siphon is a triple-barrel siphon consisting of 6-inch, 12-inch, and 30-inch ductile iron pipes. The corresponding siphon structure is not operational and has not been cleaned in years. Upon inspection, the 6-inch pipe was fully clogged with debris.

NWM fully cleaned all three barrels from June 13 to June 19, 2023, and confirmed the structural integrity of all three barrels with minimal defects observed. Representative photos are included in **Table 4**. Kleinfelder recommends monitoring the debris accumulation of the three barrels through routine annual cleaning from the downstream access hatch to maintain sanitary level of service in the 12-inch and 30-inch barrels.

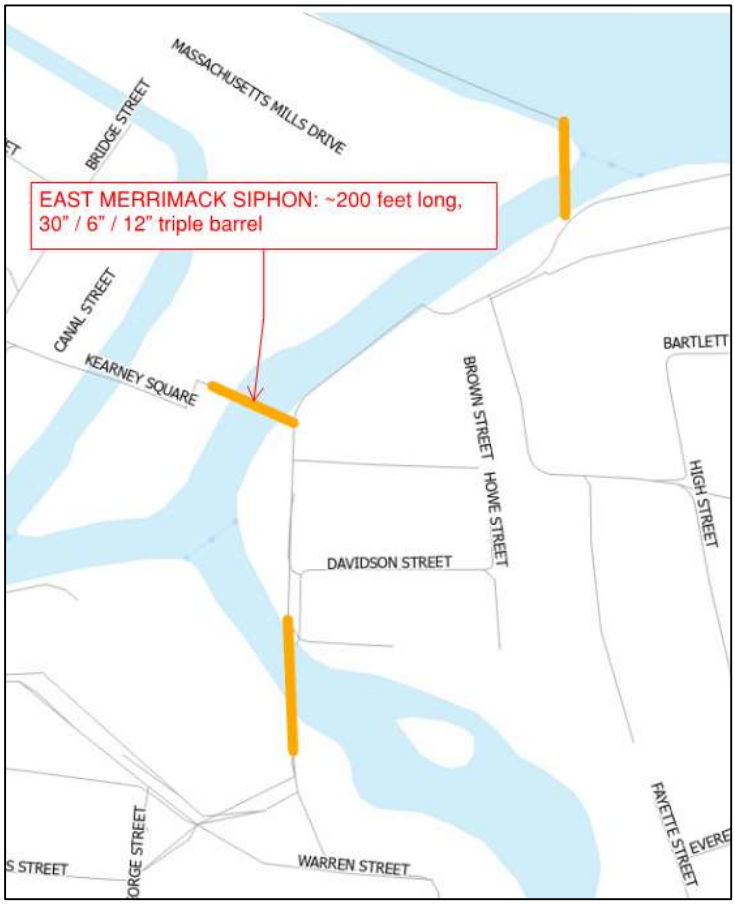
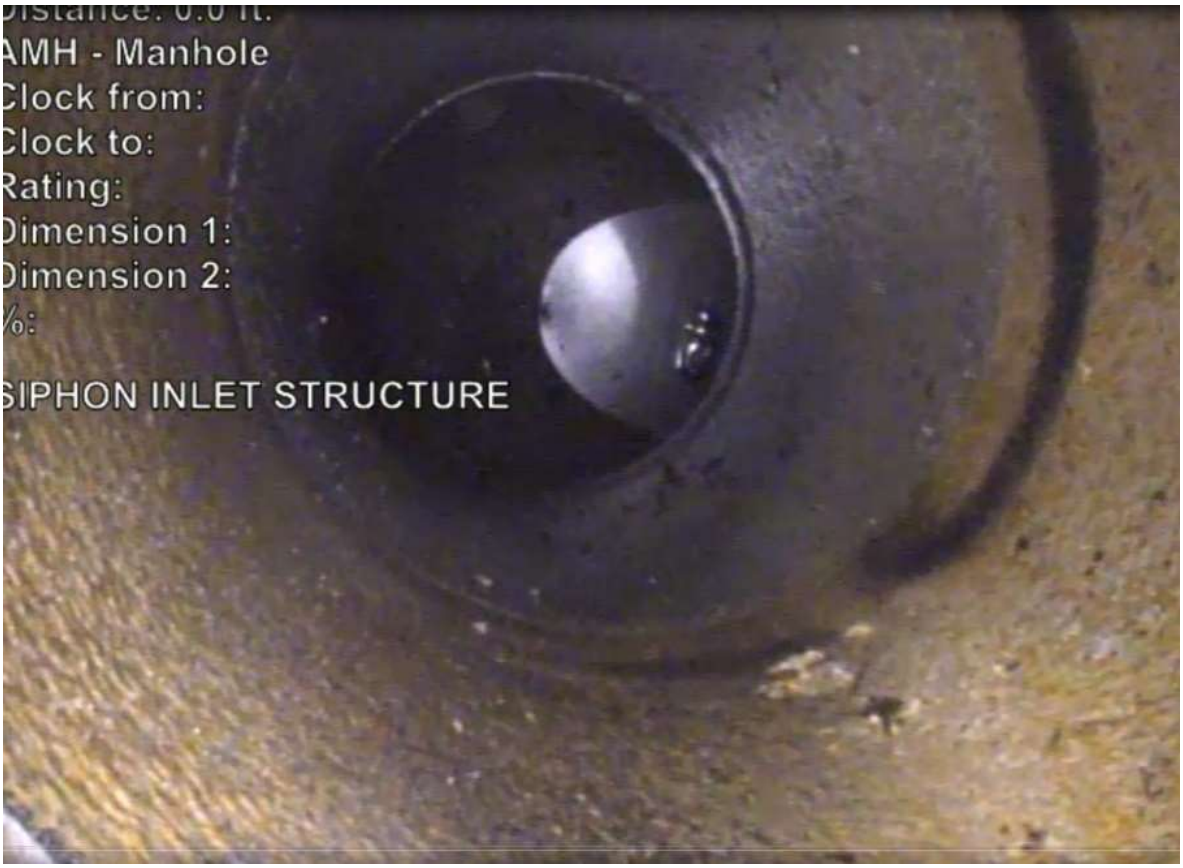


Figure 6: East Merrimack Siphon Location

Table 4: Siphon Condition Summary

6-inch Barrel

12-inch Barrel



30-inch Barrel

Section 4: Recommended Sewer System Improvements

Sections 1 and 2 detail the results of the pipe and manhole inspections conducted in Sewer Subareas 7, 9, 20 (as defined in the 1990 Phase 1 I/I Report). Of the total 220 manhole inspections conducted, thirty-five (35) manholes, or 16%, are recommended for further investigation (9) or repair/rehabilitation (26), shown geographically in **Figure 2** in Section 1.

Of the approximately 31,500 feet of 8-inch to 36-inch diameter sewer inspected, approximately 15,000 feet is recommended for rehabilitation or replacement as shown in **Figure 4** in Section 2. **Table 4** below details the conceptual engineering design and construction costs for the infrastructure recommended for repair within Subareas 7, 9, and 20. Costs include a 25% contingency and 25% for engineering services during design and construction.

Table 4: Conceptual Costs for Rehabilitation/Replacement of Sewer Infrastructure
Sewer Subareas 7, 9, 20 (1990 Phase 1 I/I Report)

Description	Qty	Unit	Unit Cost	Total
Mob/Demobilization	1	LS	$ 30,000	$ 30,000
8-10" CIPP	2200	LF	$ 40	$ 88,000
12-15" CIPP	4400	LF	$ 80	$ 352,000
16-18" CIPP	2750	LF	$ 90	$ 247,500
20-24" CIPP	1100	LF	$ 175	$ 192,500
30-36" CIPP	550	LF	$ 250	$ 137,500
MH Cement Line	240	VF	$ 320	$ 76,800
MH Chimney Seal	30	EA	$ 500	$ 15,000
Spot Repairs	5	EA	$ 10,000	$ 50,000
18" PVC	3000	LF	$ 500	$ 1,500,000
Traffic Management	1	LS	$ 20,000	$ 20,000
Subtotal				***$2,709,300***
Contingency (25%)				$ 677,300
Engineering (25%)				$ 846,700
TOTAL				**4,233,300**

With completion of these collection system investigations, there are approximately 24,000 linear feet of CCTV and 50 manhole inspections remaining to be inspected within the 2023 City-wide metering areas 51, 38, and 37. The Utility intends to complete CCTV and manhole inspections in these 3 areas in Spring 2024. The scope of the sewer rehabilitation/replacement work and sequencing of subsequent construction contracts to address system defects will be revisited upon completion of the 2024 condition assessments.

The manhole, CCTV, and East Merrimack Street Siphon inspections described in Sections 1, 2, and 3 respectively were performed based on recommendations in the City's 2022 I/I Abatement Plan. Other recommendations from the 2022 I/I Abatement Plan include:

- **Conduct a City-wide Flow Metering Program and summarize findings and recommendations in an I/I Analysis Report in accordance with MassDEP Guidelines.** The City-wide Flow Metering Program as recommended in the I/I Abatement Plan was conducted in Spring 2023 and is summarized in the Utility's *Infiltration/Inflow Analysis Report (January 2024)*.
- **Conduct CCTV and manhole inspections during high groundwater periods in Subarea 19 (as defined in the City's 1990 Phase 1 Infiltration/Inflow Study)**. Subarea 19 consists of approximately 20,400 feet of 8 to 48-inch sewer inspections and 118 manholes. The inspections in this Subarea are planned to be conducted under the Utility's phased SSES Implementation Plan, detailed in the Utility's *Infiltration/Inflow Analysis Report (January 2024)*.
- **Conduct CCTV inspections of River-front interceptors (up to 10,000 feet).** This work was contracted to be completed in the Spring 2023. Due to equipment failure by the subconsultant in Spring 2023 and a significant drop in the Merrimack River levels following the spring-time months, the river-front interceptor inspections were postponed until Spring 2024.
- **Repair of Kearney Square sewer.** A hole in the sewer that crosses the canal in Kearney Square is allowing a significant volume of I/I to enter the collection system in Meter Area 38. Kleinfelder designed a repair to the defect including a pipe sleeve with subsequent CIPP lining to comprehensive restore the structural integrity of the pipeline. The Utility bid the project in June 2023 and received no bids. This defect is anticipated to be repaired in 2024.

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APPENDIX F - SSO LOCATIONS

SSO Location	Discharge Statement	Date	Duration	Estimated Volume	Description	Mitigation Steps	Mitigation Planned
Marshall Avenue	Discharge from Sanitary Sewer Manhole to ground	5/24/2021	Unknown	500 gallons	Pipe blockage due to root intrusion	Sewer line cleaned by jetting and affected area was cleaned and disinfected. Roots have since been removed.	
Varnum Avenue	Discharge from backup into property to basement	10/28/2022	Unknown	Unknown	Pipe blockage due to root intrusion	Sewer line cleared by jetting and affected area was cleaned and disinfected. Roots have since been removed.	
35 Eagle Court	Discharge from Sanitary Sewer Manhole to receiving water	6/26/2023	14 minutes	Unknown	Rain event	Impacted area was cleaned.	Planned to inspect the gravity sewer mains and assess the catch basins.
35 Eagle Court	Discharge from Sanitary Sewer Manhole to receiving water	6/27/2023	3 minutes	Unknown	Rain event	Impacted area was cleaned.	Planned to inspect the gravity sewer mains and assess the catch basins.
35 Windward Road	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	6/27/2023	6 minutes	Unknown	Rain event	Impacted area was cleaned.	Planned to inspect the gravity sewer mains and assess the catch basins.
401 Lakeview Avenue	Discharge from Sanitary Sewer Manhole to ground surface	6/26/2023	14 minutes	Unknown	Rain event		Planned to inspect the gravity sewer mains and assess the catch basins.
67 Payne Street	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	6/26/2023	16 minutes	Unknown	Rain event		Planned to inspect the gravity sewer mains and assess the catch basins.
67 Payne Street	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	6/27/2023	6 minutes	Unknown	Rain event		Planned to inspect the gravity sewer mains and assess the catch basins.
35 Windward Road	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	6/28/2023	62 minutes	Unknown	Rain event	Impacted area was cleaned.	Planned to inspect the gravity sewer mains and assess the catch basins.
35 Windward Road	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	7/3/2023	10 minutes	1600 gallons	Rain event	Impacted area was cleaned.	Planned to inspect the gravity sewer mains and assess the catch basins.

SSO Location	Discharge Statement	Date	Duration	Estimated Volume	Description	Mitigation Steps	Mitigation Planned
657 Middlesex Street	Discharge from Sanitary Sewer Manhole to receiving water	7/14/2023	13 minutes	450 gallons	Rain event		Planned to inspect the gravity sewer mains and assess the catch basins.
67 Payne Street	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	7/14/2023	15 minutes	410 gallons	Rain event		Planned to inspect the gravity sewer mains and assess the catch basins.
67 Payne Street	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	7/16/2023	4 minutes	10 gallons	Rain event	Impacted area was cleaned.	Planned to inspect the gravity sewer mains and assess the catch basins.
17 Lura Street	Combined sewer line Backup into Property	7/21/2023	Unknown	Unknown	Rain event	Impacted area was cleaned.	
47 Birch Street	Combined sewer line Backup into Property Basement	7/21/2023	Unknown	Unknown	Rain event	Impacted area was cleaned.	
88 Elliot Street	Combined sewer line Backup into Property	7/21/2023	Unknown	Unknown	Rain event	Impacted area was cleaned.	
112 Corbett Street	Combined sewer line Backup into Property Basement	7/21/2023	Unknown	Unknown	Rain event & Downstream Pipe blockage due to root intrusion	Sewer line cleaned by jetting and affected area was cleaned and disinfected. Roots have since been removed.	This section of the sewer main has been added as a candidate to the Utility's CIPP lining list.
138 Rea Street	Combined sewer line Backup into Property Basement	7/21/2023	Unknown	Unknown	Rain event & Downstream Pipe blockage due to root intrusion	Sewer line cleaned by jetting and affected area was cleaned and disinfected. Roots have since been removed.	This section of the sewer main has been added as a candidate to the Utility's CIPP lining list.
150 Rea Street	Combined sewer line Backup into Property Basement	7/21/2023	Unknown	Unknown	Rain event & Downstream Pipe blockage due to root intrusion	Sewer line cleaned by jetting and affected area was cleaned and disinfected. Roots have since been removed.	This section of the sewer main has been added as a candidate to the Utility's CIPP lining list.
190 Lawrence Street	Discharge from Sanitary Sewer Manhole to receiving water	7/21/2023	Unknown	Unknown	Rain event	Impacted area was cleaned.	
199 Crawford Street	Combined sewer line Backup into Property	7/21/2023	Unknown	Unknown	Rain event	Impacted area was cleaned.	
657 Middlesex Street	Discharge from Sanitary Sewer Manhole to receiving water	7/21/2023	36 minutes	1440.9 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
67 Payne Street	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	7/21/2023	1 minute	30.51 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
Raven Road & Broadview Road intersection, by 246 Raven Road	Discharge from Sanitary Sewer Manhole to ground surface	7/21/2023	2 minutes	46.72 gallons	Rain event & Pipe blockage due to root intrusion	Impacted area was cleaned.	

SSO Location	Discharge Statement	Date	Duration	Estimated Volume	Description	Mitigation Steps	Mitigation Planned
Windward/Douglas Road	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	7/21/2023	64 minutes	13416.15 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
59 Charles Street	Combined sewer line Backup into Property	7/29/2023	Unknown	Unknown	Rain event	Impacted area was cleaned.	
239 Princeton Boulevard	Combined sewer line Backup into Property	7/29/2023	Unknown	Unknown	Rain event	Impacted area was cleaned.	
330 Douglas Road	Combined sewer line Backup into Property	7/29/2023	Unknown	Unknown	Rain event	Impacted area was cleaned.	
340 Douglas Road	Combined sewer line Backup into Property	7/29/2023	Unknown	Unknown	Rain event	Impacted area was cleaned.	
657 Middlesex Street	Discharge from Sanitary Sewer Manhole to receiving water	7/29/2023	30 minutes	1366.6 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
67 Payne Street	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	7/29/2023	28 minutes	1806.9 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
Windward/Douglas Road	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	7/29/2023	30 minutes	5548.7 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
47 Birch Street	Combined sewer line Backup into Property	8/8/2023	6 minutes	Unknown	Rain event	Impacted area was cleaned.	
64 Foster Street	Combined sewer line Backup into Property	8/8/2023	6 minutes	Unknown	Rain event	Impacted area was cleaned.	
67 Payne Street	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	8/8/2023	5 minutes	400 gallons	Rain event	Impacted area was cleaned.	
88 Elliot Street	Combined sewer line Backup into Property	8/8/2023	9 minutes	Unknown	Rain event	Impacted area was cleaned.	
239 Industrial Avenue	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	8/8/2023	6 minutes	Unknown	Rain event	Impacted area was cleaned.	
657 Middlesex Street	Discharge from Sanitary Sewer Manhole to receiving water	8/8/2023	5 minutes	130 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
Windward/Douglas Road	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	8/8/2023	6 minutes	1560 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
67 Payne Street	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	8/10/2023	2 minutes	320 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
657 Middlesex Street	Discharge from Sanitary Sewer Manhole to receiving water	8/10/2023	3 minutes	170 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.

SSO Location	Discharge Statement	Date	Duration	Estimated Volume	Description	Mitigation Steps	Mitigation Planned
Windward/Douglas Road	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	8/10/2023	61 minutes	1230 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
12 Concord Road	Discharge from Sanitary Sewer Manhole to ground surface	8/18/2023	11 minutes	Unknown	Rain event	Impacted area was cleaned.	Planned to inspect the gravity sewer mains and assess the catch basins.
Windward/Douglas Road	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	8/18/2023	50 minutes	1480 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
657 Middlesex Street	Discharge from Sanitary Sewer Manhole to receiving water	8/18/2023	12 minutes	883 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
67 Payne Street	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	8/18/2023	6 minutes	826 gallons	Rain event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
15 Donald Terrace	Discharge from Sanitary Sewer Manhole to ground surface	8/23/2023	25 minutes	Unknown	Sewer System blockage by Grease	Sewer line cleaned by jetting and affected area was cleaned and disinfected.	
67 Payne Street	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	9/11/2023	14 minutes	828 gallons	Rain Event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
657 Middlesex Street	Discharge from Sanitary Sewer Manhole to receiving water	9/11/2023	11 minutes	330 gallons	Rain Event	Impacted area was cleaned.	The area and alternative solutions are being evaluated as part of the Phase 3 PDR.
Barasford CSO Station	Discharge from Sanitary Sewer Manhole to Catch Basin to receiving water	11/22/2023	131 minutes	1.82 MG	Rain event and operational error	Impacted area was cleaned.	Updates to the SCADA logic and head operator training
131 Bellevue Street	Discharge from Sanitary Sewer Manhole to ground	11/27/2023	52 minutes	Unknown	Pipe blockage due to grease	Sewer line cleaned by jetting and affected area was cleaned and disinfected. Grease blockages has since been removed.	
350 Adams Street	Discharge from Sanitary Sewer Manhole to ground	12/15/2023	30 minutes	Unknown	Pipe blockage due to grease	Sewer line cleaned by jetting and affected area was cleaned and disinfected. Grease blockages has since been removed.	