Fall 2021 Flow and Rainfall Monitoring Project

FINAL
Data Report

City of Manor

March 2022

GBA NO. 14925.00

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX

- Site Investigation Summaries and Observations
- Site Setup Descriptions, Hydrographs, and Scattergraphs
- Flow Parameter Calculations

Definitions and Abbreviations

ADDF	Average Daily Dry-Weather Flow
AOI	Area of Interest
CCTV	Closed Circuit Television
City	City of Manor
CSO	Combined Sewer Overflow
DIP	Ductile Iron Pipe
ft	Feet
fps	Feet Per Second
GBA	George Butler Associates, Inc.
GIS	Geographic Information System
in	Inch
I&I	Infiltration and Inflow
IDM	Inch Diameter Mile
LF	Linear Feet
MGD	Million Gallons Per Day
MH	Manhole
NA	Not Applicable
PVC	Polyvinyl Chloride
PVM	Portable Velocity Meter
RG	Rain Gauge
SS	Steven-Schutzbach method
SSES	Sanitary Sewer Evaluation Study
SSO	Sanitary Sewer Overflow

1 INTRODUCTION

1.1 Project Purpose

This report presents the results of the Fall 2021 Flow Monitoring program for the City of Manor, Texas. The 2021 Inflow and Infiltration (I&I) Monitoring project was completed by GBA with direction from the City of Manor Public Works Department. The project had two (2) primary objectives:

1. Perform I&I analysis on the separated sanitary sewers draining to City of Manor temporary flow meters.
2. Provide recommendations for future study and rehab projects based off I&I analysis conclusions.

The flow monitoring project included installation of flow meters at 14 sites. The temporary meter locations provided isolation of basins within the I&I Project area for 90 days.

1.2 Project Background

The City of Manor has encountered high wastewater collection and treatment system flows during storm events and rainy periods. These high flows jeopardize the City's ability to meet permitted flow requirements at treatment plant facilities (excursions) and present potential for system spills (bypasses). The City of Manor engaged GBA to conduct a limited-scope investigation with the purpose of identifying surface water inflow and ground water infiltration (I&I) into the city's existing wastewater system in an effort to mitigate high wastewater collection and treatment system flow conditions.

1.2.1 Project Area

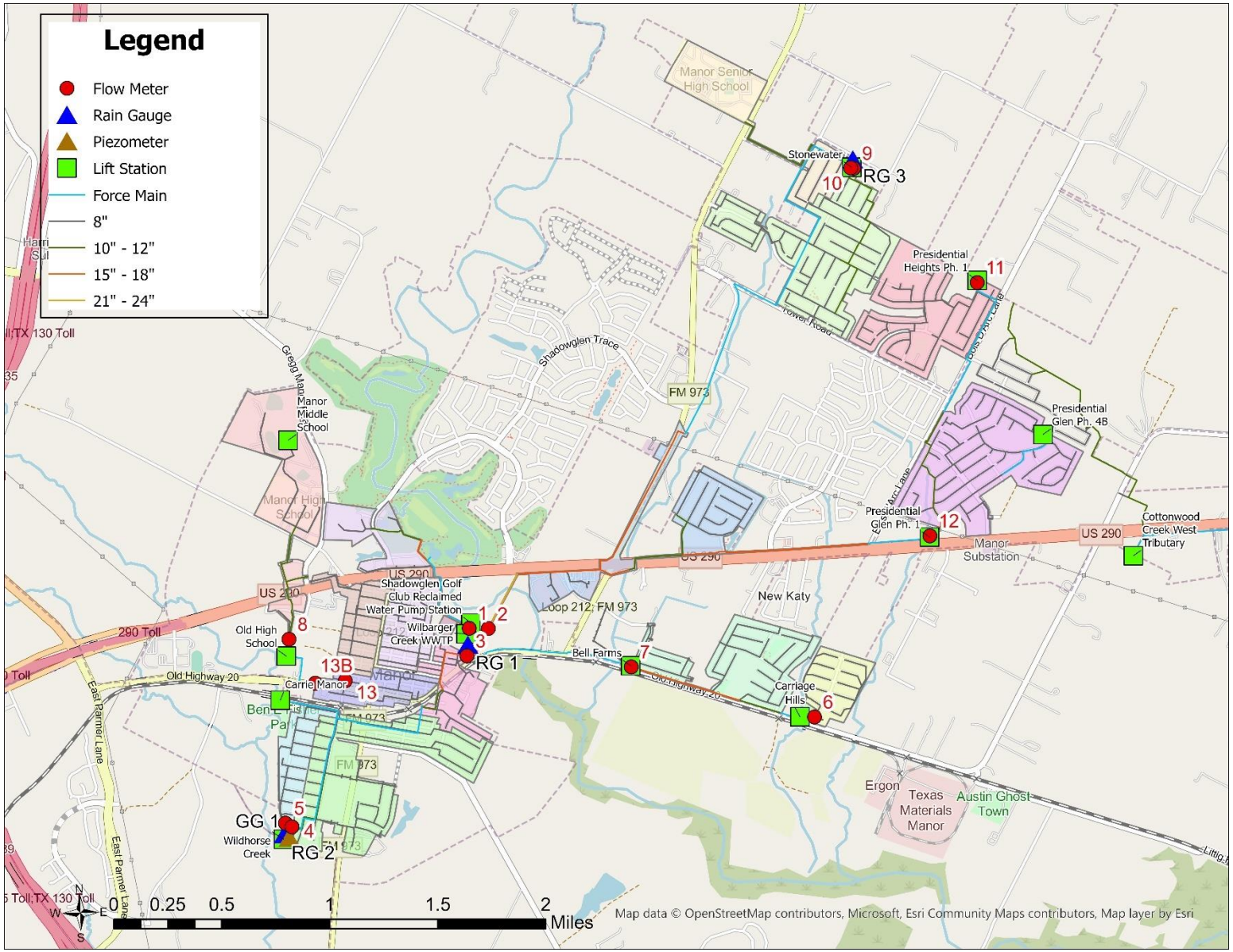
Flow monitoring locations were selected in order to meet project objectives. These locations encompass areas located within the City of Manor. The project area was divided into 13 basins. Basins were selected based upon optimal partitioning of the system to isolate I&I areas of suitable size for analysis of the entire system. The 13 basins are shown on Figure 1.

The study area included facilities within the Gilleland Creek, Wilbarger Creek, and Cottonwood watersheds. However, wastewater collected form the Cottonwood watershed is pumped into the Wilbarger Creek watershed. Therefore, analysis was conducted as only Gilleland Creek and Wilbarger Creek watersheds.

The City's Wilbarger Creek Wastewater Treatment Plant (WWTP) is located at 547 Llano Street. Reducing the amount of I&I in the project area will reduce the stress on this WWTP during wet weather events.

The pipe sizes throughout the project area range from six (6) inches to twenty-four (24) inches with a majority of the pipes being poly-vinyl chloride (PVC).

Figure 1 – Project Area Overview



2 METERING PLAN, INSTALLATION, AND SERVICING

2.1 Metering Plan

The metering plan for the City of Manor, TX flow monitoring included 13 flow meter sites, 1 groundwater depth gauge, and 3 rain gauges. The flow meter sites included 9 sites within the Wilbarger Creek watershed. The remaining 5 flow monitoring sites monitored flows within the Gilleland Creek watershed. The groundwater gauge was within the Gilleland Creek watershed.

Site investigations at monitoring sites were conducted prior to and during installation. All meter sites are listed in Table 1. The watershed and basins are shown in Figure 2. Figure 3 and Figure 4 show a more focused picture of the meter sites, rain gauges, and groundwater gauge locations.

2.2 Installation and Servicing of Meters

Installation of the 13 flow meters began on 8/30/2021 and was completed by 9/1/2021. Site 13's installation was delayed until 9/13/2021 due to construction rehabilitation of sanitary sewer at the intended site. Site 13 was originally installed in manhole O10-068 which is 3 manholes upstream of the intended manhole O09-007. Once construction was completed the meter at Site 13 was relocated to manhole O09-007 on 10/26/2021 and was renamed Site 13B.

The monitoring equipment was inspected and checked biweekly to download data and collect manual measurements for velocity and depth adjustments. The flow meters were synchronized to collect data on a 5-minute interval and on a concurrent basis. Flow monitoring was conducted for a 90-day period. Flow meters were removed beginning 11/29/2021 and completed by 12/1/2021.

Rainfall monitoring was done using three locations that were selected to accurately represent the rainfall received in each basin. Rain gauge locations are listed in Table 2.

2.3 System Characteristics

Flow monitoring sites were selected to isolate areas in the system and establish basin flow characteristics. A basin inventory for each meter site including acreages, sewer footages tributary to the meter sites, and inch-diameter mile totals is comprised in Table 3. A basin flow schematic diagram was created to represent the established basins. This schematic shows how meters and basins are inter-connected. The basin flow schematic is provided on Figure 5.

Table 1 – Flow Monitoring Site Summary

Meter Site ID	Watershed	Address	Manhole Number	Metered Segment	Pipe Diameter (in)	Installation Date	Data Start Date	Data End Date	Metered Days	Equipment
1	Wilbarger Creek	547 Llano St.	N10-002	N10-002_N10-001	24	8/31/21	9/1/21	12/1/21	91	ISCO 2150 - A/V Sensor
2	Wilbarger Creek	546 Llano St.	N11-003	N11-004_N11-003	24	8/30/21	9/1/21	12/1/21	91	ISCO 2150 - A/V Sensor
3	Wilbarger Creek	Gregg St.	O10-027	O10-027_011-004	15	8/30/21	9/1/21	11/30/21	90	ISCO 2150 - A/V Sensor
4	Wilbarger Creek	11806 Athens St.	P09-034	P09-035_P09-034	12	8/31/21	9/1/21	11/30/21	90	ISCO 2150 - A/V Sensor
5	Wilbarger Creek	11813 Athens St.	P09-002	P09-003_P09-002	8	8/31/21	9/1/21	11/30/21	90	ISCO 2150 - A/V Sensor
6	Wilbarger Creek	13300 Prairie Sage Cv.	O13-007	O13-007_O13-006	8	8/30/21	9/1/21	11/30/21	90	ISCO 2150 - A/V Sensor
7	Wilbarger Creek	FM Rd. 973	O12-001	O12-002_O12-001	15	8/31/21	9/1/21	11/30/21	90	ISCO 2150 - A/V Sensor
9	Wilbarger Creek	15009 Talus Rd.	I13-026	I13-027_I13-026	12	9/1/21	9/1/21	11/29/21	89	ISCO 2150 - A/V Sensor
10	Wilbarger Creek	15010 Talus Rd.	I13-002	I13-003_I13-002	12	9/1/21	9/1/21	11/29/21	89	ISCO 2150 - A/V Sensor
11	Wilbarger Creek	Jared Argo Cv.	J14-021	J14-022_J14-021	8	9/1/21	9/1/21	11/29/21	89	ISCO 2150 - A/V Sensor
12	Wilbarger Creek	13424 US HWY 290	M14-002	M14-003_M14-002	15	9/1/21	9/1/21	12/1/21	91	ISCO 2150 - A/V Sensor
8	Gilleland Creek	11616 US HWY 290	N09-001	N09-002_N09-001	12	9/1/21	9/1/21	11/30/21	90	ISCO 2150 - A/V Sensor
13	Gilleland Creek	209 Parsons St.	O10-068	O10-079_O10-068	12	9/13/21	9/13/21	10/26/21	43	ISCO 2150 - A/V Sensor
13B	Gilleland Creek	409 Parsons St.	O09-007	O09-008_O09-007	12	10/26/21	10/26/21	11/30/21	35	ISCO 2150 - A/V Sensor

Notes

Color indication of Wilbarger Creek watershed

Color indication of Gilleland Creek watershed

(1) Site 13 was installed at a later date due to rehabilitaiton at the intended metered site MH O09-007. Site 13 was located in MH O10-068 which was 3 manholes upstream of MH O09-007.

(2) Site 13B was installed in MH O09-007 on 10/26/21 after wastewater rehabilitation project was completed.

Table 2 – Rain Gauge Summary

Rain Gauge ID	General Location
RG 1	Wilbarger Creek Sludge Processing Plant
RG 2	Wildhorse Creek Lift Station Site
RG 3	Stonewater North Lift Station Site

Figure 2 – Wilbarger Creek & Gilleland Creek Watersheds

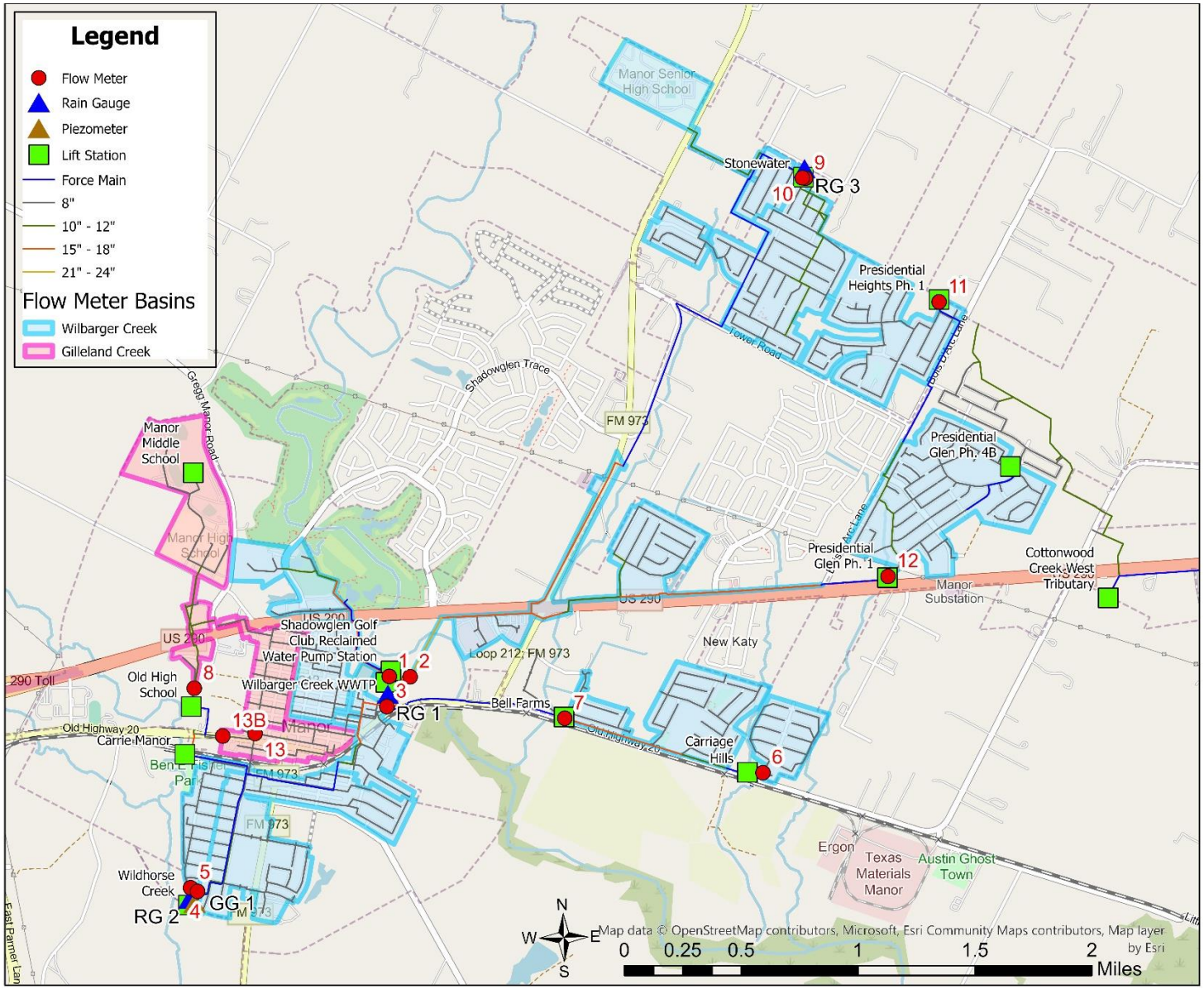


Figure 3 – Flow and Rainfall Monitoring Locations

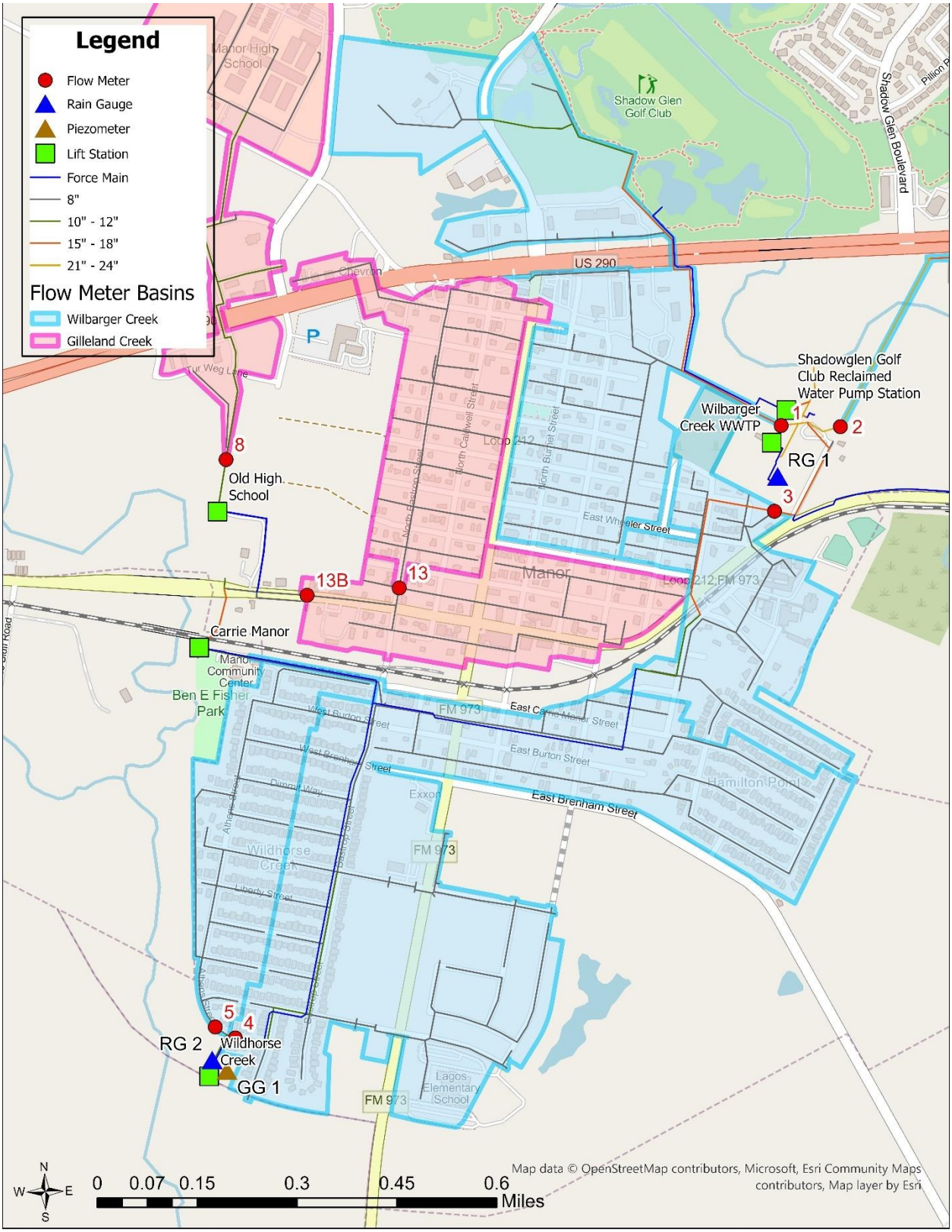


Figure 4 – Flow and Rainfall Monitoring Locations (Cont'd)

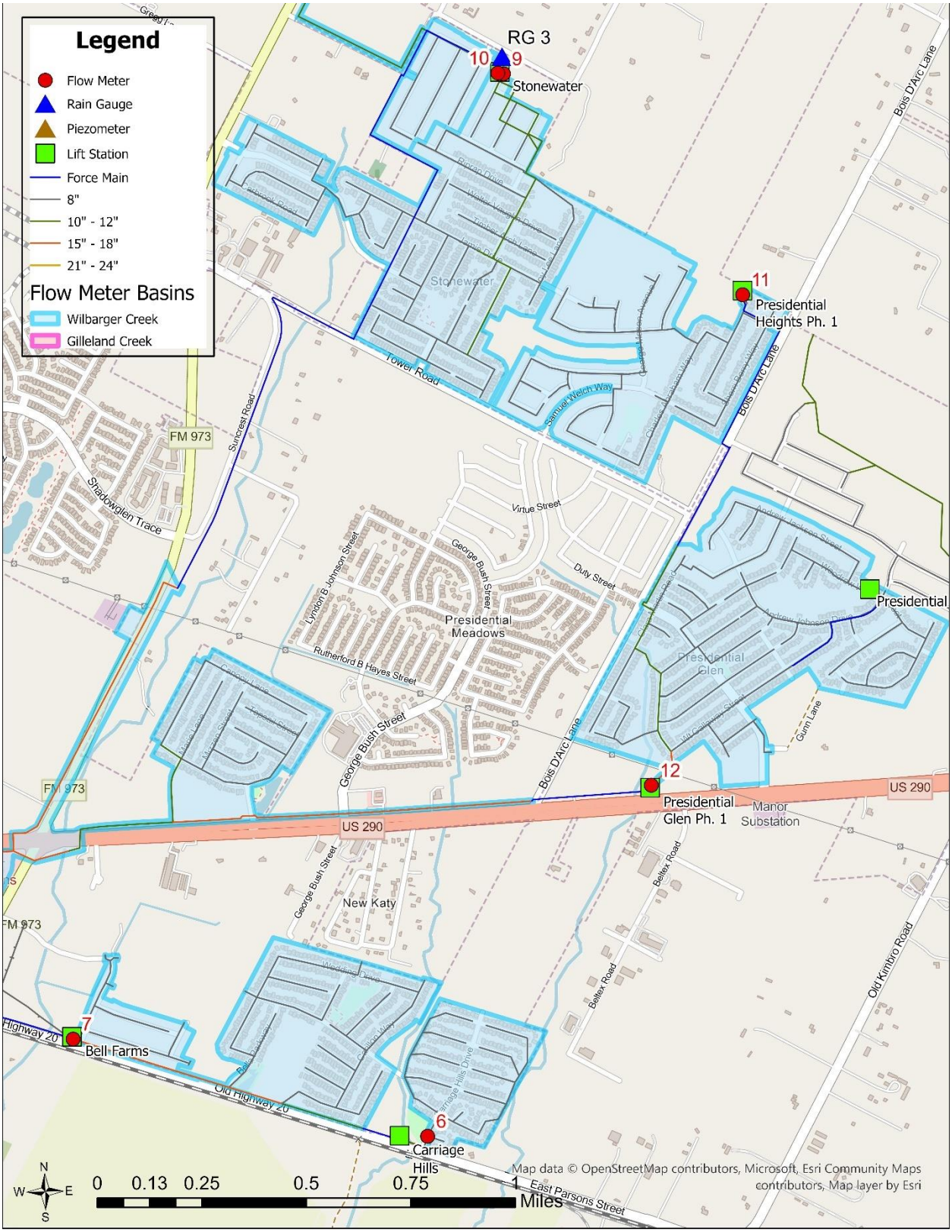


Figure 5 – City of Manor Subsystem Flow Diagram

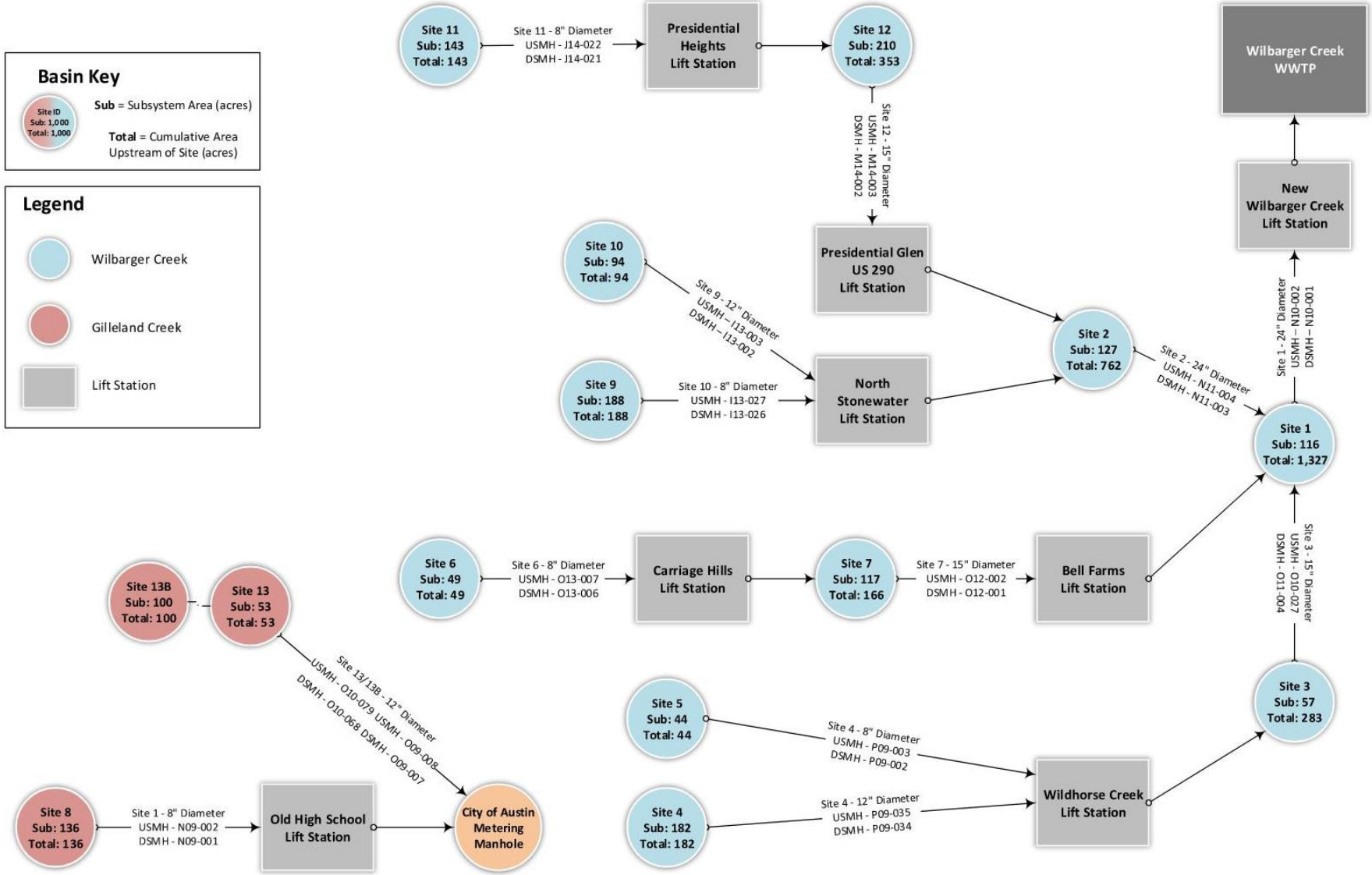


Table 3 – City of Manor Subsystem Characteristics

Basin ID	Subsystem Area (acres)	Cumulative Area (acres)	Subsystem Sewer (ft)	Cumulative Sewer (ft)	Subsystem IDM(1)	Cumulative IDM(1)
1	116	1,327	16,952	213,574	28	359
2	127	762	26,795	118,106	62	209
3	57	283	10,109	48,235	15	71
4	182	182	28,561	28,561	41	41
5	44	44	9,565	9,565	15	15
6	49	49	8,913	8,913	14	14
7	117	166	21,368	30,281	37	51
9	188	188	32,180	32,180	52	52
10	94	94	7,502	7,502	14	14
11	143	143	18,415	18,415	28	28
12	210	353	33,214	51,629	53	81
8	136	136	10,205	10,205	17	17
13	53	53	10,172	10,172	13	13
13B	100	100	17,588	17,588	22	22

Notes:

(1) IDM = inch-diameter miles, a benchmark used to quantify total amount of sanitary sewer pipe in each subsystem. It is found by taking the product of the diameter in inches and multiplying it by the length in miles.

3 EVALUATION OF COLLECTED DATA

3.1 Manual Field Measurements

Manual measurements for level and velocity were taken at the metering sites to compare to meter readings. The manual measurements were used to calibrate the flow monitoring data. Adjustments to level and/or velocity could be made in the field but were generally made in the office. Adjustments were made in the field only when excessive discrepancies were identified. The relative accuracy of the collected flow data can be evaluated by comparison of real-time flow meter readings and manually obtained flow-profiling data. These measurements have a generally accepted percentage error of 10 percent. This error is compounded under the following conditions: high velocity (3 feet per second (fps) and higher), low velocity (1 fps and lower), low level (less than 1 inch), or silting conditions in the pipe. Manual field measurements compared to meter readings are summarized for each flow monitoring site in the Appendix.

3.2 Mass Balance Checks

Mass balance checks were performed during flow monitoring as a quality assurance measure. These checks involved summing daily flows at each meter site throughout the monitoring period and comparing upstream to downstream base flows for connected meter sites. Daily volumes from flow meter data were calculated and summarized. The mass balance was conducted to provide assurance that recorded flows were reasonably accurate. A summary of the mass balance performed is provided in Table 4.

There were two places in the project area where the mass flow balance showed negative values, which is not expected. Negative values indicate potential issues in data quality or system connectivity.

- Site 1 Subsystem
  - Most daily flow volumes at Site 1 Subsystem are positive.
  - Some subsystem calculations for the last half of November resulted in negative volumes. Site 1 was an interior basin (other meters are monitoring flow upstream of this site's meter) and is one of the most downstream sites monitored as part of the project. This means it receives flow from many different sites upstream of it, which makes it difficult to identify where the imbalance originates. Due to the number of upstream meters, any small errors in upstream data are compounded and can result in an imbalance.

- Site 2 Subsystem
  - There are several days that the average flow recorded at Site 2 is less than the combined cumulative flow recorded at the meters directly upstream of it.
  - Site 2 is an interior basin (other meters are monitoring flow upstream of this site's meter) and is one of the most downstream sites monitored as part of the project. This means it receives flow from many different sites upstream of it, which makes it difficult to identify where the imbalance

originates. Due to the number of upstream meters, any small errors in upstream data are compounded and can result in an imbalance.

- Site 3 Subsystem
  - There are several days that the average flow recorded at Site 3 is less than the combined cumulative flow recorded at the meters directly upstream of it.
  - Site 3 is an interior basin and is downstream of Site 4 and Site 5 which were monitored as part of the project. The flow is pumped in via the Wildhorse Creek lift station. The data reflects the "on" and "off" cycling of pumps. This could lead to flow discrepancies due to the meter's average recordings.

- Site 13 and 13B Flows
  - The flows at site 13 were higher than flows at the downstream location Site 13B. The flows at Site 13 had much higher velocities and had multiple backups due to downstream bottleneck. The surcharging is attributed to a bottleneck and/or construction activities. Completion of Bastrop/Parsons CIP S-32 wastewater line upsizing eliminated system bottlenecks and allowed for relocation of meter from interim Site 13 to 13B.
  - Due to the bottleneck issues and construction activities, more confidence is placed in the downstream meter Site 13B flow data.

Table 4 – Mass Balance – All Meters (MG)

	Site 1 Cumulative	Site 1 Subsystem	Site 2 Cumulative	Site 2 Subsystem	Site 3 Cumulative	Site 3 Subsystem	Site 4 Cumulative	Site 5 Cumulative	Site 6 Cumulative	Site 7 Cumulative	Site 7 Subsystem	Site 9 Cumulative	Site 10 Cumulative	Site 11 Cumulative	Site 12 Cumulative	Site 12 Subsystem	Site 8 Cumulative	Site 13 Cumulative	Site 13B Cumulative	Avg. Rain (All 3 gauges)	RG1	RG2	RG3
	1	1-2-7-3	2	2-9-10-12	3	3-4-5	4	5	6	7	7-6	9	10	11	12	12-11	8	13	13B				
Date	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Flow Volume (MG)	Daily Total (in)	Daily Total (in)	Daily Total (in)	Daily Total (in)
30-Aug-21	0.00	-0.21	0.15	0.15	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31-Aug-21	0.54	0.05	0.27	0.27	0.14	-0.03	0.09	0.03	0.03	0.09	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-Sep-21	0.80	0.22	0.27	0.12	0.13	-0.03	0.13	0.04	0.04	0.18	0.14	0.04	0.02	0.06	0.09	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00
2-Sep-21	0.78	0.18	0.28	0.00	0.14	-0.01	0.13	0.03	0.04	0.18	0.14	0.05	0.04	0.12	0.19	0.07	0.03	0.00	0.00	0.00	0.00	0.00	0.00
3-Sep-21	0.76	0.19	0.28	0.01	0.13	-0.04	0.12	0.03	0.05	0.16	0.12	0.06	0.03	0.12	0.18	0.06	0.04	0.00	0.00	0.00	0.00	0.00	0.00
4-Sep-21	0.83	0.22	0.30	-0.02	0.13	-0.05	0.14	0.03	0.06	0.19	0.13	0.08	0.03	0.13	0.20	0.07	0.03	0.00	0.00	0.00	0.00	0.00	0.00
5-Sep-21	0.83	0.23	0.30	0.01	0.11	-0.08	0.14	0.03	0.05	0.19	0.14	0.07	0.03	0.13	0.19	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.00
6-Sep-21	0.90	0.24	0.33	-0.03	0.13	-0.05	0.15	0.04	0.06	0.19	0.14	0.10	0.07	0.15	0.19	0.05	0.03	0.00	0.00	0.15	0.02	0.00	0.43
7-Sep-21	0.83	0.17	0.31	0.05	0.14	-0.03	0.15	0.04	0.06	0.21	0.14	0.06	0.03	0.13	0.16	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00
8-Sep-21	0.80	0.17	0.31	0.06	0.14	-0.02	0.14	0.03	0.06	0.17	0.11	0.06	0.03	0.14	0.16	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00
9-Sep-21	0.78	0.15	0.31	0.06	0.14	-0.03	0.13	0.03	0.05	0.17	0.12	0.05	0.04	0.13	0.17	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00
10-Sep-21	0.79	0.16	0.33	0.06	0.14	-0.03	0.14	0.03	0.05	0.16	0.10	0.05	0.04	0.13	0.17	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00
11-Sep-21	0.84	0.16	0.35	0.07	0.14	-0.02	0.13	0.04	0.06	0.18	0.12	0.06	0.05	0.14	0.18	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00
12-Sep-21	0.93	0.23	0.36	0.02	0.14	-0.02	0.13	0.04	0.07	0.19	0.12	0.08	0.04	0.15	0.23	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.00
13-Sep-21	0.81	0.15	0.30	0.00	0.14	-0.04	0.13	0.03	0.06	0.22	0.16	0.07	0.04	0.14	0.19	0.05	0.04	0.04	0.00	0.00	0.00	0.00	0.00
14-Sep-21	0.83	0.16	0.29	-0.06	0.14	-0.04	0.15	0.03	0.06	0.24	0.18	0.08	0.08	0.13	0.19	0.06	0.05	0.12	0.00	0.00	0.00	0.00	0.00
15-Sep-21	0.78	0.12	0.28	-0.03	0.15	-0.02	0.15	0.03	0.06	0.22	0.15	0.07	0.07	0.13	0.17	0.04	0.04	0.07	0.00	0.00	0.00	0.00	0.00
16-Sep-21	0.78	0.12	0.29	0.00	0.16	0.00	0.14	0.03	0.06	0.21	0.15	0.07	0.08	0.12	0.14	0.02	0.04	0.09	0.00	0.00	0.00	0.00	0.00
17-Sep-21	0.78	0.13	0.29	0.00	0.16	-0.02	0.13	0.03	0.07	0.19	0.12	0.07	0.08	0.12	0.15	0.03	0.04	0.07	0.00	0.00	0.00	0.00	0.00
18-Sep-21	0.84	0.11	0.34	0.00	0.17	-0.03	0.15	0.04	0.06	0.22	0.15	0.08	0.05	0.14	0.21	0.07	0.03	0.06	0.00	0.00	0.00	0.00	0.00
19-Sep-21	0.91	0.16	0.36	-0.01	0.17	0.00	0.16	0.04	0.07	0.22	0.15	0.09	0.06	0.15	0.23	0.08	0.03	0.06	0.00	0.00	0.00	0.00	0.00
20-Sep-21	0.83	0.14	0.34	-0.01	0.15	-0.03	0.14	0.03	0.06	0.21	0.15	0.08	0.06	0.14	0.20	0.06	0.04	0.46	0.00	0.00	0.00	0.00	0.00
21-Sep-21	0.86	0.15	0.33	0.01	0.16	-0.01	0.14	0.04	0.06	0.22	0.15	0.08	0.09	0.14	0.16	0.02	0.04	0.55	0.00	0.00	0.00	0.00	0.00
22-Sep-21	0.86	0.13	0.34	0.04	0.16	-0.01	0.14	0.03	0.06	0.23	0.17	0.08	0.08	0.13	0.14	0.01	0.04	0.42	0.00	0.00	0.00	0.00	0.00
23-Sep-21	0.89	0.16	0.35	0.03	0.17	-0.01	0.14	0.03	0.06	0.21	0.15	0.08	0.07	0.14	0.17	0.03	0.04	0.13	0.00	0.00	0.00	0.00	0.00
24-Sep-21	0.86	0.12	0.37	0.03	0.15	-0.03	0.14	0.04	0.06	0.23	0.17	0.08	0.08	0.15	0.18	0.03	0.04	0.27	0.00	0.00	0.00	0.00	0.00
25-Sep-21	0.95	0.16	0.39	0.00	0.16	-0.06	0.14	0.05	0.06	0.24	0.18	0.10	0.09	0.15	0.20	0.05	0.03	0.07	0.00	0.00	0.00	0.00	0.00
26-Sep-21	1.01	0.18	0.41	-0.03	0.16	-0.03	0.16	0.06	0.07	0.25	0.18	0.11	0.08	0.17	0.25	0.08	0.03	0.06	0.00	0.00	0.00	0.00	0.00
27-Sep-21	0.92	0.15	0.36	-0.05	0.15	-0.04	0.15	0.04	0.06	0.26	0.20	0.10	0.09	0.15	0.22	0.07	0.01	0.07	0.00	0.00	0.01	0.00	0.00
28-Sep-21	0.93	0.15	0.36	-0.06	0.15	-0.07	0.16	0.04	0.06	0.26	0.20	0.12	0.07	0.16	0.23	0.07	0.01	0.09	0.00	1.20	1.40	0.92	1.27
29-Sep-21	1.26	0.18	0.48	-0.01	0.17	-0.03	0.18	0.05	0.09	0.43	0.34	0.16	0.07	0.17	0.25	0.08	0.03	0.80	0.00	0.46	0.57	0.41	0.41
30-Sep-21	1.10	0.14	0.43	-0.03	0.16	-0.02	0.15	0.05	0.09	0.37	0.28	0.15	0.08	0.17	0.23	0.06	0.02	1.02	0.00	0.00	0.00	0.00	0.00
1-Oct-21	1.25	0.09	0.48	0.01	0.18	-0.02	0.14	0.04	0.09	0.50	0.41	0.14	0.11	0.17	0.23	0.05	0.03	0.35	0.00	0.58	1.23	0.23	0.28
2-Oct-21	1.22	0.12	0.50	-0.05	0.16	-0.06	0.16	0.05	0.10	0.44	0.34	0.15	0.17	0.18	0.24	0.06	0.01	0.13	0.00	0.00	0.00	0.00	0.00
3-Oct-21	1.19	0.10	0.50	-0.06	0.18	-0.03	0.18	0.05	0.09	0.40	0.31	0.15	0.16	0.21	0.26	0.05	0.01	0.12	0.00	0.00	0.00	0.00	0.00
4-Oct-21	1.12	0.14	0.46	-0.04	0.17	-0.01	0.16	0.05	0.08	0.35	0.28	0.14	0.15	0.18	0.21	0.03	0.02	0.12	0.00	0.00	0.00	0.00	0.00
5-Oct-21	1.03	0.09	0.43	-0.05	0.16	-0.01	0.13	0.04	0.06	0.34	0.28	0.13	0.15	0.18	0.21	0.03	0.02	0.12	0.00	0.00	0.00	0.00	0.00
6-Oct-21	0.97	0.13	0.36	-0.12	0.16	0.00	0.13	0.04	0.06	0.33	0.27	0.12	0.15	0.18	0.20	0.03	0.02	0.10	0.00	0.00	0.00	0.00	0.00
7-Oct-21	0.94	0.10	0.36	-0.09	0.16	0.00	0.12	0.04	0.06	0.32	0.26	0.12	0.13	0.18	0.19	0.01	0.02	0.18	0.00	0.00	0.00	0.00	0.00
8-Oct-21	0.92	0.07	0.38	-0.01	0.14	-0.04	0.12	0.04	0.03	0.33	0.30	0.12	0.09	0.19	0.19	-0.01	0.02	0.11	0.00	0.00	0.00	0.00	0.00
9-Oct-21	0.97	0.02	0.44	0.01	0.16	-0.02	0.14	0.04	0.03	0.35	0.32	0.13	0.09	0.23	0.21	-0.02	0.01	0.12	0.00	0.00	0.00	0.00	0.00
10-Oct-21	1.02	0.06	0.43	-0.03	0.17	-0.02	0.14	0.04	0.02	0.37	0.35	0.13	0.09	0.25	0.24	-0.02	0.01	0.11	0.00	0.00	0.00	0.00	0.00
11-Oct-21	1.11	0.10	0.41	-0.04	0.16	-0.03	0.15	0.04	0.06	0.44	0.38	0.14	0.09	0.20	0.23	0.03	0.02	0.11	0.00	0.44	0.47	0.50	0.35
12-Oct-21	1.03	0.10	0.39	-0.04	0.16	0.02	0.14	0.05	0.07	0.38	0.31	0.12	0.08	0.21	0.22	0.01	0.02	0.07	0.00	0.10	0.11	0.12	0.07
13-Oct-21	1.02	0.04	0.39	-0.06	0.24	-0.13	0.13	0.02	0.08	0.35	0.27	0.14	0.08	0.19	0.23	0.04	0.04	0.10	0.00	2.07	2.14	1.99	2.07
14-Oct-21	2.36	0.14	0.91	0.22	0.38	0.23	0.35	0.03	0.18	0.92	0.75	0.20	0.10	0.22	0.40	0.18	0.10	0.33	0.00	1.10	1.23	0.93	1.13
15-Oct-21	1.44	0.28	0.53	0.02	0.17	0.01	0.13	0.03	0.11	0.46	0.36	0.16	0.09	0.18	0.26	0.07	0.05	0.07	0.00	0.00	0.00	0.00	0.00
16-Oct-21	1.24	0.23	0.46	-0.03	0.17	0.00	0.13	0.03	0.10	0.38	0.28	0.15	0.10	0.18	0.23	0.05	0.04	0.07	0.00	0.00	0.00	0.00	0.00
17-Oct-21	1.23	0.23	0.45	-0.06	0.17	0.01	0.14	0.03	0.09	0.38	0.29	0.16	0.09	0.19	0.26	0.06	0.03	0.06	0.00	0.00	0.00	0.00	0.00
18-Oct-21	1.11	0.20	0.39	-0.06	0.17	0.01	0.14	0.03	0.08	0.34	0.26	0.14	0.09	0.18	0.22	0.04	0.05	0.06	0.00	0.00	0.00	0.00	0.00

Table 4 - Mass Balance – All Meters (MG) (Cont'd)

Date	Site 1 Cumulative 1 Flow Volume (MG)	Site 1 Subsystem 1-2-7-3 Flow Volume (MG)	Site 2 Cumulative 2 Flow Volume (MG)	Site 2 Subsystem 2-9-10-12 Flow Volume (MG)	Site 3 Cumulative 3 Flow Volume (MG)	Site 3 Subsystem 3-4-5 Flow Volume (MG)	Site 4 Cumulative 4 Flow Volume (MG)	Site 5 Cumulative 5 Flow Volume (MG)	Site 6 Cumulative 6 Flow Volume (MG)	Site 7 Cumulative 7 Flow Volume (MG)	Site 7 Subsystem 7-6 Flow Volume (MG)	Site 9 Cumulative 9 Flow Volume (MG)	Site 10 Cumulative 10 Flow Volume (MG)	Site 11 Cumulative 11 Flow Volume (MG)	Site 12 Cumulative 12 Flow Volume (MG)	Site 12 Subsystem 12-11 Flow Volume (MG)	Site 8 Cumulative 8 Flow Volume (MG)	Site 13 Cumulative 13 Flow Volume (MG)	Site 13B Cumulative 13B Flow Volume (MG)	Avg. Rain (All 3 gauges) Daily Total (in)	RG1 Daily Total (in)	RG2 Daily Total (in)	RG3 Daily Total (in)
19-Oct-21	1.06	0.07	0.37	-0.07	0.17	0.00	0.12	0.03	0.07	0.45	0.39	0.14	0.09	0.16	0.21	0.05	0.05	0.06	0.00	0.00	0.00	0.00	0.00
20-Oct-21	1.06	0.19	0.39	-0.07	0.15	-0.02	0.13	0.03	0.06	0.33	0.26	0.14	0.09	0.17	0.22	0.05	0.04	0.07	0.00	0.00	0.00	0.00	0.00
21-Oct-21	1.03	0.17	0.37	-0.07	0.17	0.05	0.14	0.03	0.06	0.32	0.26	0.14	0.10	0.16	0.21	0.05	0.05	0.07	0.00	0.00	0.00	0.00	0.00
22-Oct-21	1.00	0.17	0.37	-0.06	0.15	-0.01	0.10	0.02	0.05	0.31	0.27	0.13	0.10	0.12	0.19	0.07	0.04	0.06	0.00	0.00	0.00	0.00	0.00
23-Oct-21	1.05	0.10	0.44	-0.02	0.17	-0.03	0.14	0.02	0.03	0.34	0.31	0.14	0.10	0.16	0.22	0.07	0.03	0.08	0.00	0.00	0.00	0.00	0.00
24-Oct-21	1.08	0.10	0.45	-0.07	0.18	-0.03	0.17	0.03	0.03	0.35	0.31	0.16	0.11	0.19	0.24	0.05	0.03	0.07	0.00	0.00	0.01	0.00	0.00
25-Oct-21	1.03	0.11	0.42	-0.07	0.17	-0.02	0.16	0.05	0.03	0.33	0.30	0.16	0.11	0.19	0.22	0.03	0.04	0.07	0.00	0.00	0.00	0.00	0.00
26-Oct-21	0.99	0.09	0.43	-0.05	0.17	-0.05	0.15	0.05	0.04	0.30	0.26	0.15	0.11	0.20	0.21	0.00	0.04	0.02	0.02	0.00	0.00	0.00	0.00
27-Oct-21	1.19	0.15	0.46	-0.06	0.18	-0.02	0.18	0.05	0.09	0.40	0.30	0.16	0.14	0.16	0.23	0.06	0.05	0.00	0.06	0.80	0.92	0.85	0.62
28-Oct-21	1.14	0.12	0.50	-0.02	0.17	-0.03	0.15	0.04	0.12	0.35	0.23	0.15	0.13	0.15	0.24	0.09	0.05	0.00	0.03	0.00	0.00	0.00	0.00
29-Oct-21	1.06	0.10	0.47	-0.01	0.17	-0.04	0.16	0.05	0.12	0.32	0.20	0.16	0.12	0.14	0.21	0.07	0.03	0.00	0.03	0.00	0.00	0.00	0.00
30-Oct-21	1.05	0.10	0.45	-0.05	0.19	-0.03	0.16	0.05	0.10	0.31	0.21	0.15	0.12	0.16	0.23	0.07	0.03	0.00	0.03	0.00	0.00	0.00	0.00
31-Oct-21	1.09	0.09	0.49	-0.05	0.18	-0.04	0.16	0.06	0.07	0.32	0.25	0.16	0.13	0.17	0.25	0.08	0.03	0.00	0.03	0.00	0.00	0.00	0.00
1-Nov-21	1.06	0.14	0.45	-0.03	0.17	-0.06	0.17	0.05	0.07	0.31	0.23	0.15	0.12	0.16	0.21	0.05	0.04	0.00	0.03	0.00	0.00	0.00	0.00
2-Nov-21	1.02	0.13	0.42	-0.05	0.16	-0.23	0.18	0.05	0.07	0.30	0.24	0.14	0.12	0.16	0.20	0.04	0.04	0.00	0.03	0.00	0.00	0.00	0.00
3-Nov-21	1.87	-0.52	1.01	0.38	0.78	0.58	0.34	0.06	0.17	0.61	0.44	0.17	0.15	0.19	0.31	0.12	0.10	0.00	0.15	1.85	2.06	1.71	1.79
4-Nov-21	1.65	0.25	0.61	-0.01	0.18	-0.01	0.15	0.05	0.19	0.60	0.41	0.18	0.14	0.15	0.30	0.15	0.09	0.00	0.06	0.00	0.00	0.00	0.00
5-Nov-21	1.49	0.25	0.63	0.10	0.16	-0.06	0.15	0.04	0.15	0.44	0.29	0.16	0.14	0.13	0.24	0.10	0.07	0.00	0.04	0.00	0.00	0.00	0.00
6-Nov-21	1.57	0.23	0.75	0.22	0.20	-0.02	0.17	0.05	0.13	0.40	0.27	0.16	0.14	0.11	0.23	0.12	0.05	0.00	0.04	0.00	0.00	0.00	0.00
7-Nov-21	1.56	0.21	0.78	0.27	0.19	-0.01	0.17	0.05	0.10	0.37	0.27	0.16	0.10	0.13	0.25	0.12	0.04	0.00	0.03	0.00	0.00	0.00	0.00
8-Nov-21	1.42	0.20	0.71	0.24	0.17	-0.04	0.16	0.04	0.07	0.34	0.27	0.15	0.10	0.11	0.22	0.11	0.04	0.00	0.03	0.00	0.00	0.00	0.00
9-Nov-21	1.35	0.07	0.79	0.35	0.17	-0.04	0.16	0.05	0.07	0.32	0.26	0.12	0.11	0.11	0.21	0.10	0.03	0.00	0.03	0.00	0.00	0.00	0.00
10-Nov-21	1.43	0.08	0.84	0.44	0.19	-0.03	0.16	0.04	0.07	0.32	0.25	0.10	0.10	0.13	0.20	0.08	0.03	0.00	0.02	0.00	0.00	0.00	0.00
11-Nov-21	1.49	0.15	0.79	0.35	0.21	0.01	0.16	0.05	0.07	0.35	0.28	0.11	0.11	0.18	0.23	0.05	0.02	0.00	0.03	0.00	0.00	0.00	0.00
12-Nov-21	1.37	0.17	0.69	0.28	0.17	-0.04	0.15	0.04	0.06	0.33	0.27	0.09	0.11	0.19	0.21	0.02	0.04	0.00	0.03	0.00	0.00	0.00	0.00
13-Nov-21	1.36	0.17	0.66	0.23	0.19	0.00	0.16	0.05	0.07	0.34	0.28	0.10	0.09	0.15	0.23	0.08	0.03	0.00	0.03	0.00	0.00	0.00	0.00
14-Nov-21	1.48	-0.02	0.91	0.42	0.23	0.05	0.14	0.06	0.07	0.36	0.29	0.13	0.11	0.13	0.26	0.13	0.03	0.00	0.03	0.00	0.00	0.00	0.00
15-Nov-21	1.31	-0.14	0.90	0.46	0.22	0.04	0.13	0.04	0.06	0.33	0.27	0.11	0.10	0.16	0.22	0.06	0.04	0.00	0.03	0.00	0.00	0.00	0.00
16-Nov-21	1.21	-0.09	0.78	0.36	0.19	0.00	0.14	0.05	0.06	0.32	0.26	0.10	0.11	0.16	0.21	0.06	0.04	0.00	0.03	0.00	0.00	0.00	0.00
17-Nov-21	1.26	-0.06	0.80	0.37	0.19	0.01	0.15	0.05	0.06	0.32	0.27	0.11	0.10	0.15	0.23	0.07	0.04	0.00	0.03	0.00	0.00	0.00	0.00
18-Nov-21	1.22	-0.08	0.78	0.37	0.19	0.02	0.14	0.04	0.06	0.33	0.27	0.11	0.09	0.15	0.21	0.06	0.04	0.00	0.03	0.00	0.00	0.00	0.00
19-Nov-21	1.16	-0.11	0.75	0.32	0.19	0.00	0.13	0.04	0.06	0.33	0.27	0.12	0.09	0.15	0.22	0.08	0.04	0.00	0.03	0.00	0.00	0.00	0.00
20-Nov-21	1.24	-0.05	0.76	-0.74	0.20	-0.01	0.14	0.05	0.06	0.34	0.28	0.12	0.10	0.16	1.28	1.12	0.03	0.00	0.03	0.00	0.00	0.00	0.00
21-Nov-21	1.34	-0.03	0.83	-0.34	0.20	0.01	0.15	0.05	0.06	0.34	0.28	0.13	0.10	0.15	0.95	0.79	0.03	0.00	0.03	0.00	0.00	0.00	0.00
22-Nov-21	1.33	0.01	0.81	0.27	0.18	-0.01	0.14	0.05	0.06	0.33	0.27	0.12	0.10	0.15	0.32	0.16	0.03	0.00	0.02	0.00	0.00	0.00	0.00
23-Nov-21	1.31	-0.02	0.80	0.40	0.20	0.00	0.14	0.05	0.06	0.33	0.26	0.12	0.10	0.16	0.19	0.04	0.03	0.00	0.02	0.00	0.00	0.00	0.00
24-Nov-21	1.37	0.00	0.84	0.42	0.19	-0.01	0.15	0.05	0.07	0.34	0.27	0.12	0.10	0.16	0.20	0.04	0.03	0.00	0.02	0.02	0.00	0.03	0.02
25-Nov-21	1.42	-0.05	0.89	0.29	0.20	0.02	0.15	0.06	0.07	0.38	0.31	0.13	0.10	0.15	0.36	0.21	0.03	0.00	0.02	0.11	0.00	0.20	0.12
26-Nov-21	1.30	0.01	0.79	0.39	0.16	-0.04	0.14	0.04	0.07	0.33	0.26	0.12	0.09	0.13	0.19	0.06	0.03	0.00	0.02	0.00	0.00	0.00	0.00
27-Nov-21	1.58	0.01	0.89	0.43	0.21	-0.01	0.16	0.04	0.09	0.47	0.39	0.13	0.09	0.11	0.24	0.13	0.04	0.00	0.05	0.23	0.00	0.00	0.70
28-Nov-21	1.72	-0.04	1.01	0.47	0.19	0.00	0.17	0.05	0.10	0.56	0.45	0.14	0.11	0.14	0.30	0.16	0.04	0.00	0.04	0.00	0.00	0.00	0.00
29-Nov-21	1.54	0.12	0.85	0.52	0.17	0.10	0.14	0.05	0.09	0.41	0.31	0.05	0.03	0.06	0.24	0.18	0.04	0.00	0.03	0.00	0.00	0.00	0.00
30-Nov-21	1.48	0.46	0.74	0.51	0.08	0.08	0.05	0.02	0.04	0.19	0.15	0.00	0.00	0.00	0.23	0.23	0.01	0.00	0.01	0.00	0.00	0.00	0.00
																				Total	Rainfall Totals		
Dry Weather Average[1]	1.09	0.12	0.51	0.08	0.17	-0.02	0.14	0.04	0.07	0.30	0.23	0.11	0.09	0.15	0.24	0.08	0.03	0.13	0.03	9.11	10.16	7.90	9.26
Dry Weather Minimum[1]	0.76	-0.14	0.27	-0.74	0.11	-0.23	0.10	0.02	0.02	0.16	0.10	0.05	0.03	0.11	0.14	0.01	0.01	0.06	0.02				
Dry Weather Maximum[1]	1.57	0.46	0.91	0.52	0.23	0.10	0.18	0.06	0.15	0.45	0.39	0.16	0.16	0.25	1.28	1.12	0.07	0.55	0.04				
Wet Weather Average	1.31	0.10	0.56	0.07	0.22	0.02	0.17	0.04	0.10	0.44	0.34	0.14	0.10	0.17	0.25	0.08	0.04	0.26	0.07				

Notes:
(1) Dry weather days exclude days with over 1/4" of rain and the day after.
Indicates Rain Event Occurred
Incomplete data
Indicates negative value

3.3 Surcharge Conditions

Surcharge is the depth of water in a sewer that exceeds the top of the pipe. Surcharge occurred in 8 of the 14 sites for the 2021 flow monitoring period.

Surcharge conditions are less desirable than gravity flow conditions to measure peak flows in sanitary sewer systems. However, many of the recorded surcharge events provided good hydrographs and provided data for I&I volume measurements. Maximum surcharge depth levels and duration of the surcharge was documented. For each surcharge event, a backup or pressure flow designation was assigned. The backup designation means that the surcharge elevation is impacted by downstream capacity limitations and is based on significant slowing of velocities as depths are increasing. Pressure flow is when velocities are increasing as levels are rising. This indicates that downstream conditions are not restricting flow. A summary of surcharge recordings for each site are provided in Table 5.

Most of the surcharging was due to backing up from downstream restrictions. Several sites are just upstream of lift stations. Backups at sites near lift stations was a common occurrence during wet weather and dry weather. The maximum surcharge caused by lift station backup was 164 inches at Site 12 during dry weather. The 11/21/2021 Dry Weather surcharge to 164" at Site 12 was attributed pump malfunction (only one pump was running) at the Presidential Glen Lift Station. Other sites that surcharged due to lift stations and wet weather were Sites 1, 2, 3, 7, 9, and 10. These lift stations should be reviewed to determine if residents are or could be impacted by possible backup of overflows. The pump stations should also be examined to see if pumps are functioning properly (debris buildup and or blockages), and that operational set points are correct so that the pipes do not surcharge during normal pump cycles.

Site 13 was not close to a pump station and experienced 4 dry weather surcharges. It is suspected to be related to the downstream construction. Construction crews could have been plugging the line downstream of site 13 or bypass pumping during the monitoring causing backups. The construction was upsizing an 8” line to 12” as well. It is possible the 8” downstream of 12” caused a bottleneck. The pipe upsizing project was conducted to alleviate known bottlenecks in the system along Parsons and Bastrop streets. The meter was relocated to Site 13B on 10/26/2021. There were no surcharges at relocated Site 13B.

Table 5 – Surcharge Summary

		Date of Storm	9/6/2021	9/10/2021	9/14/2021	9/20/2021	9/23/2021	9/28/2021	10/7/2021	10/13/2021	10/19/2021	11/3/2021	11/21/2021
		Total Storm Rainfall (in.)	0.43"	Dry Weather Surcharge	Dry Weather Surcharge	Dry Weather Surcharge	Dry Weather Surcharge	1.65"	Dry Weather Surcharge	3.15"	Dry Weather Surcharge	1.89"	Dry Weather Surcharge
Site	Diameter (in.)	Storm Duration (hrs.)	0.58					7.92		6.00		16.83	
1	24	Depth from Invert (in.)	-	-	-	-	-	-	-	37.43 (B)	-	66.63 (B)	-
2	24	Depth from Invert (in.)	-	-	-	-	-	-	-	-	-	45.12 (B)	-
3	15	Depth from Invert (in.)	-	-	-	-	-	-	-	17.47 (B)	-	24.74 (B)	-
7[(1)]	15	Depth from Invert (in.)	-	-	-	-	-	-	-	27.54 (B)	47.67 (B)	-	-
9	12	Depth from Invert (in.)	23.15 (P)	-	-	-	-	-	-	-	-	-	-
10	12	Depth from Invert (in.)	24.14 (B)	-	-	-	-	-	-	-	-	-	-
12[(2)]	15	Depth from Invert (in.)	-	32.56 (B)	-	-	-	-	-	-	-	-	164.49 (B)
13[(3)]	12	Depth from Invert (in.)	-	-	13.18 (B)	26.86 (B)	23.18 (B)	55.47 (B)	18.39 (B)	18.71 (B)	-	-	-

(1) The dry weather surcharge at Site 7 on 10/19/2021 is attributed to a singular pump control float malfunction event at the Bell Farms lift station.

(2) The dry weather surcharge at Site 12 on 11/21/2021 is attributed to a pump tripping out (only one pump was working at the time) at the Presidential Glen lift station.

(3) Surcharging is attributed to a bottleneck and/or construction activities. Completion of Bastrop/Parsons CIP S-32 wastewater line upsizing eliminated system bottlenecks and allowed for relocation of meter from interim Site 13 to 13B on 10/26/202

(P) Denotes pressurized flow caused by lack of capacity
(flow velocities generally increase as flow depths increase)

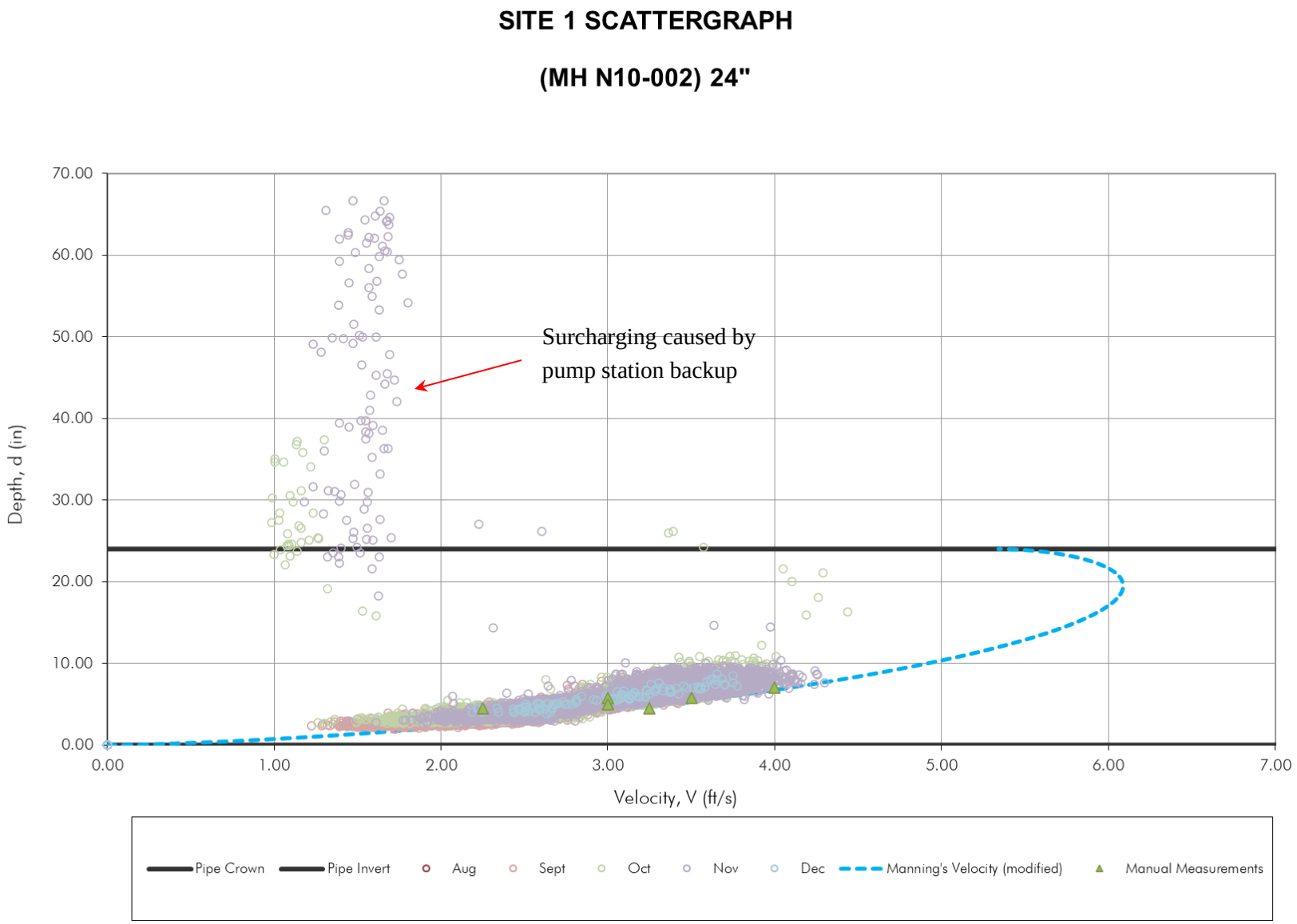
(B) Denotes flow backup caused by downstream restriction
(flow velocities generally decrease as flow depths increase)

3.4 Pump Station Considerations

Most flow monitoring sites were upstream of pump stations within the system. Many of the flow sites were impacted by the pump stations. The pump stations caused system backups during dry and wet weather. When the flow backs up into the system from pump stations, it can cause surcharging and flow depths that exceed top of pipe. Surcharging can lead to backups into residents or overflows out of the system through manhole lids or the pump station wet well itself. The example scattergraph for Site 1 shown in Figure 6 demonstrates the impact of the pump station on the flow site. The y-axis is the depth of flow, and the x-axis is the velocity. The depth and velocity points show how during peak wet weather flow the velocities greatly slow down and depths dramatically increase. This represents downstream capacity restrictions most likely caused by the Wilbarger Creek Lift Station.

Pump station backup during wet weather is common when base flows are greatly exceeded by peak flows. Also, some surcharging is OK if surcharging is kept to a minimum. Dry weather backup from pump stations is usually caused by pump station malfunctions caused by things like electric disturbance, grease, or part failures. The pump station backup issues need to be investigated to provide safety to the public and environment.

Figure 6 – Example Scattergrah (Site 1)



4 FLOW AND RAINFALL MONITORING DATA ANALYSIS

This fall 2021 flow monitoring collected data from 14 flow meter sites to isolate subsystems contributing sanitary sewer flow within the City of Manor, TX. The information gathered was used to:

- Analyze flow and rainfall monitoring data.
- Determine Average Daily Dry Weather Flow (ADDF).
- Determine high groundwater infiltration.
- Determine inflow.
- Conduct a volumetric analysis.

Detailed results for each flow monitoring site are provided in the Appendix.

4.1 Selection of Data for Analysis

The collected flow and rainfall data were reviewed for each monitoring site and representative days were selected for investigation of dry weather flow (ADDF) periods, high groundwater infiltration flow periods, and peak storm inflow periods. Storms chosen for detailed flow analysis were selected based on high rainfall depths throughout the sub-systems. A number of factors were considered when selecting storm events for detailed analysis. These factors included:

- Total measured rainfall (typically greater than 0.20 in. but preferably 0.5 in.).
- Peak rainfall intensity (typically greater 0.30 in/hr).
- Consistent base flow before and after storm events (typically a period of three days before and after a storm).
- Flow monitoring data showed a measurable reaction (typically a peak flow measuring at least twice where the base flow would be).
- Flow monitor did not measure surcharge conditions.
- Interval between storm events (typically at least three days or enough time to allow flows to return to base flow levels).

4.2 Analysis of Rainfall Data

Historical rainfall data provided by the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service was used as a point of comparison. The total annual average rainfall for the City of Manor is 36.33 inches. NOAA Atlas 14 Point Precipitation Frequency Estimates were referenced as well. A summary of the probability that a storm event with a particular recurrence interval will not be equaled or exceeded during a specified period is presented with historical data on average monthly rainfall amounts, total annual rainfall, and normal expected rainfall. Table 6 shows the historical rainfall depth-duration-frequency relationships.

Table 6 – Rainfall Depth-Duration-Frequency Relationship

Return Period (years)	Total Rainfall (in) for Duration Indicated					
	30 min	1 hr	2 hr	6 hr	12 hr	24 hr
1	1.3	1.6	2.0	2.5	2.8	3.2
2	1.5	2.0	2.4	3.2	3.6	4.1
5	1.9	2.5	3.1	4.1	4.7	5.4
10	2.2	2.9	3.7	5.1	5.8	6.7
25	2.6	3.5	4.6	6.5	7.5	8.6
50	3.0	4.0	5.4	7.7	8.9	10.2
100	3.4	4.6	6.2	9.1	10.6	12.1

Rainfall data for this project was collected from 3 rain gauge sites that were installed by GBA field crews. These gauges are considered representative of the project area and its basin tributary areas. The rain gauges were weighted based on proximity to each flow monitoring site. Table 7 shows the delineation of the percentages for each rain gauge per meter site.

Table 8 through Table 10 provide summaries of the recorded storm events during the monitoring period at the rain gauges. The average total depth of rainfall recorded at the rain gauge sites during the monitoring period was 9.57 inches which is approximately 6.5% less than the 10.24 inches expected for the monitored period in Manor based on the U.S. Climate Data and NOAA historical rainfall data. The average rainfall recorded during September was roughly 52% lower than expected. The month of October experienced about 30% more rainfall than expected. The rainfall recorded for the month of November was just slightly above the expected rainfall amount. Monthly rain gauge totals are compared with expected monthly averages on Figure 7.

The 10/13/21 storm had a 2-year return interval at all three rain gauges. Four of the monitoring sites had backup surcharging from the 3.16” storm. This storm accounts for 62% of the rainfall for the month of October.

Table 7 – Weighted Rain Gauge Delineation

RG ID / Meter Basin ID	RG 1	RG 2	RG 3
1	50%	50%	-
2	50%	50%	-
3	50%	50%	-
4	50%	50%	-
5	50%	50%	-
6	50%	50%	-
7	50%	50%	-
9	-	-	100%
10	-	-	100%
11	-	-	100%
12	-	-	100%
8	50%	50%	-
13	50%	50%	-
13B	50%	50%	-

Table 8 – Rain Gauge 1 – Rainfall Summary

Date	Total Storm Rainfall (in)	Time of Peak Rainfall	Peak 15 min. Intensity (in/hr)	Peak 60 min. Intensity (in/hr) [1]	Storm Duration (hr)	Storm Time Start	Storm Return Period (years)[2]
9/28/21	1.97	9/28/21 21:15	2.04	0.84	6.83	9/28/21 21:00	< 1
10/1/21	1.23	10/1/21 5:05	2.32	1.20	3.58	10/1/21 4:55	< 1
10/11/21	0.47	10/11/21 0:10	0.88	0.45	1.25	10/11/21 0:05	< 1
10/12/21	0.11	10/12/21 17:15	0.12	0.06	14.67	10/12/21 6:20	< 1
10/13/21	3.37	10/13/21 23:10	3.52	1.82	5.92	10/13/21 22:00	< 2
10/27/21	0.92	10/27/21 5:30	2.08	0.78	2.42	10/27/21 5:15	< 1
11/3/21	2.06	11/3/21 10:35	1.08	0.57	16.33	11/3/21 2:10	< 1
11/27/21	0.70	11/27/21 14:25	0.36	0.18	13.92	11/27/21 7:45	< 1
Total[3]	**10.86**						

Notes:

(1) The storm intensities are based on the maximum amount of rainfall for a 60-min. period for each storm event

(2) Storm return period based on 60-min. intensities. Source NOAA Atlas 14, Volume 11, Version 2, Precipitation-Frequency Atlas of United States, Manor, TX

(3) Total inches of rainfall recorded; includes trace rain events less than 0.10 inches that are not shown in the table.

(4) The 11/27/21 Storm is from RG3, due to RG1&RG2 being removed 11/26/21

Table 9 – Rain Gauge 2 – Rainfall Summary

Date	Total Storm Rainfall (in)	Time of Peak Rainfall	Peak 15 min. Intensity (in/hr)	Peak 60 min. Intensity (in/hr) [1]	Storm Duration (hr)	Storm Time Start	Storm Return Period (years)[2]
9/28/21	1.33	9/28/21 21:20	0.84	0.57	7.75	9/28/21 21:10	< 1
10/1/21	0.23	10/1/21 5:10	0.48	0.19	3.67	10/1/21 4:55	< 1
10/11/21	0.50	10/11/21 0:50	0.84	0.48	1.17	10/11/21 0:05	< 1
10/12/21	0.12	10/12/21 17:10	0.16	0.06	10.92	10/12/21 6:15	< 1
10/13/21	2.92	10/13/21 23:10	3.44	1.70	6.00	10/13/21 21:55	< 2
10/27/21	0.85	10/27/21 5:25	1.72	0.73	2.25	10/27/21 5:15	< 1
11/3/21	1.71	11/3/21 10:35	0.72	0.39	16.83	11/3/21 2:10	< 1
11/24/21	0.23	11/25/21 1:00	0.64	0.18	4.92	11/24/21 22:10	< 1
11/27/21	0.70	11/27/21 14:25	0.36	0.18	13.92	11/27/21 7:45	< 1
Total[3]	**8.60**						

Notes:

(1) The storm intensities are based on the maximum amount of rainfall for a 60-min. period for each storm event

(2) Storm return period based on 60-min. intensities. Source NOAA Atlas 14, Volume 11, Version 2, Precipitation-Frequency Atlas of United States, Manor, TX

(3) Total inches of rainfall recorded; includes trace rain events less than 0.10 inches that are not shown in the table.

(4) The 11/27/21 Storm is from RG3, due to RG1&RG2 being removed 11/26/21

Table 10 – Rain Gauge 3 – Rainfall Summary

Date	Total Storm Rainfall (in)	Time of Peak Rainfall	Peak 15 min. Intensity (in/hr)	Peak 60 min. Intensity (in/hr) [1]	Storm Duration (hr)	Storm Time Start	Storm Return Period (years)[2]
9/6/21	0.43	9/6/21 15:00	1.40	0.43	0.58	9/6/21 14:50	< 1
9/28/21	1.68	9/28/21 21:25	1.84	0.77	6.92	9/28/21 20:50	< 1
10/1/21	0.28	10/1/21 5:20	0.36	0.21	3.50	10/1/21 5:10	< 1
10/11/21	0.35	10/11/21 0:50	0.76	0.33	1.25	10/11/21 0:05	< 1
10/13/21	3.20	10/13/21 23:10	3.24	1.64	15.00	10/13/21 22:00	< 2
10/27/21	0.62	10/27/21 5:35	1.32	0.49	2.33	10/27/21 5:20	< 1
11/3/21	1.79	11/3/21 9:25	0.92	0.50	10.67	11/3/21 8:05	< 1
11/24/21	0.14	11/25/21 1:10	0.24	0.10	4.33	11/24/21 22:45	< 1
11/27/21	0.70	11/27/21 14:25	0.36	0.18	13.92	11/27/21 7:45	< 1
Total[3]	**9.26**						

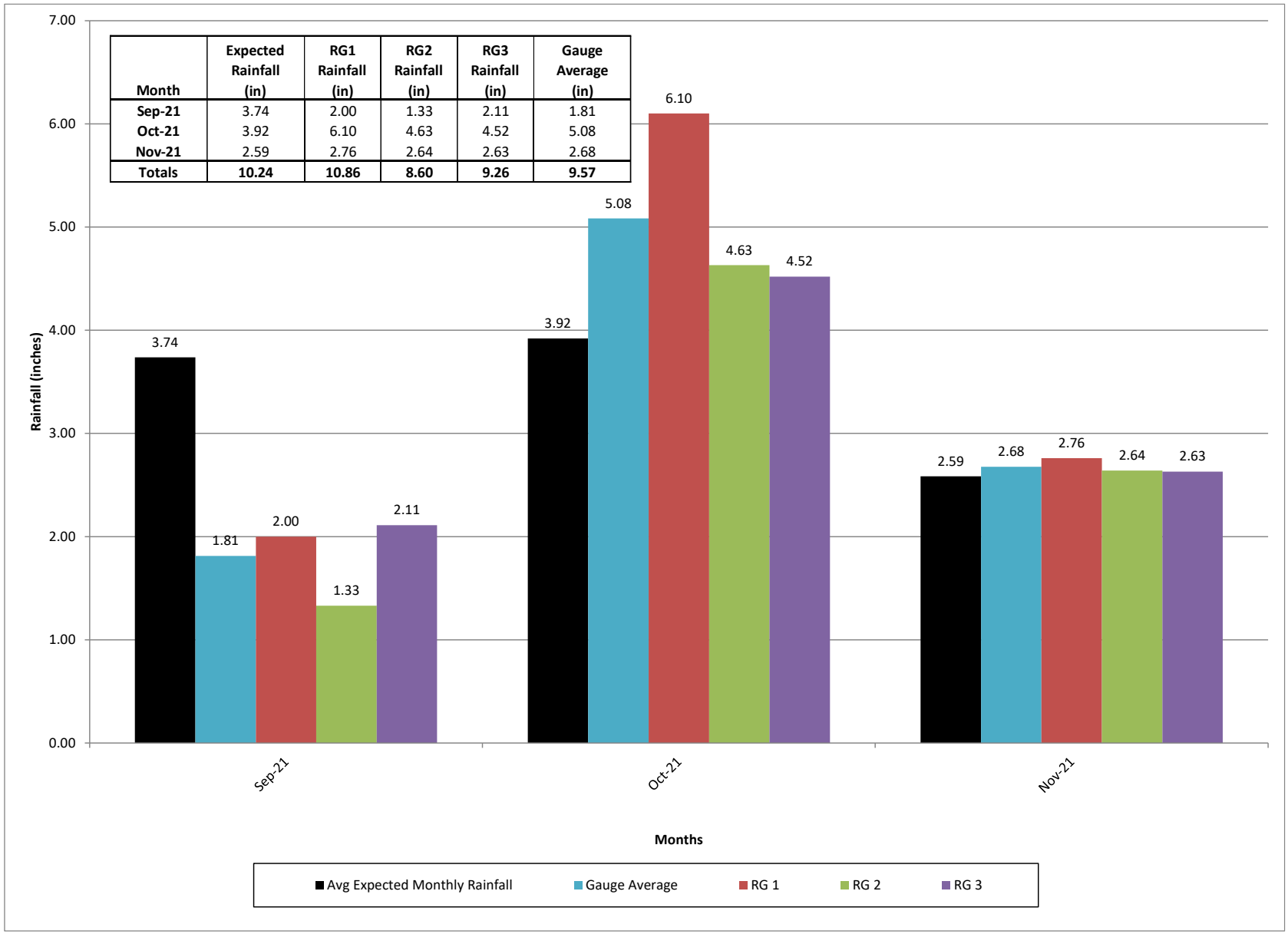
Notes:

(1) The storm intensities are based on the maximum amount of rainfall for a 60-min. period for each storm event

(2) Storm return period based on 60-min. intensities. Source NOAA Atlas 14, Volume 11, Version 2, Precipitation-Frequency Atlas of United States, Manor, TX

(3) Total inches of rainfall recorded; includes trace rain events less than 0.10 inches that are not shown in the table.

Figure 7 – Measured Versus Expected Monthly Average Rainfall



4.3 Average Daily Dry Weather Flow (ADDF)

Average Daily Dry Weather Flow (ADDF) is defined as the normal wastewater flow generated in the sanitary sewer system during dry weather conditions. This flow includes wastewater production and permanent infiltration naturally present during dry conditions with low groundwater levels. This flow does not include rainfall-induced infiltration and inflow. The ADDF rate can be measured directly during dry weather/low groundwater conditions. The instantaneous ADDF rate varies throughout each day with the highest rates normally observed near 8:00 a.m. and 6:00 p.m.

The ratio of peak instantaneous flow to ADDF is the ADDF peaking factor and is typically determined from representative flow data days. The best way to measure ADDF is in gallons per day per inch-diameter-mile (IDM) which creates an even comparison between basins, regardless of the length or diameters of sewers within them. A summary of ADDF for each subsystem is shown in Table 11.

Table 11 – ADDF Summary

Basin ID	Subsystem Area (acres)	Cumulative Area (acres)	Subsystem ADDF (mgd)	Cumulative ADDF (mgd)	Peaking Factor	Cumulative Peak ADDF (mgd)[(1)]	Subsystem ADDF per Acre (gpd/acre)	Cumulative ADDF per Acre (gpd/acre)	Subsystem ADDF per IDM (gpd/IDM)	Cumulative ADDF per IDM (gpd/IDM)
1	116	1,327	0.176	0.821	1.650	1.355	1,519	619	6,294	2,288
2	127	762	-0.016	0.310	1.717	0.532	-123	407	-252	1,483
3	57	283	-0.021	0.152	2.096	0.319	-374	537	-1,421	2,141
4	182	182	0.138	0.138	1.641	0.227	760	760	3,372	3,372
5	44	44	0.035	0.035	1.882	0.066	797	797	2,339	2,339
6	49	49	0.063	0.063	1.624	0.103	1,293	1,293	4,526	4,526
7	117	166	0.120	0.183	1.429	0.262	1,023	1,103	3,235	3,590
9	188	188	0.074	0.074	1.945	0.143	392	392	1,417	1,417
10	94	94	0.068	0.068	1.607	0.110	728	728	4,891	4,891
11	143	143	0.133	0.133	1.578	0.210	932	932	4,758	4,758
12	210	353	0.050	0.183	1.971	0.362	239	520	948	2,265
8	136	136	0.052	0.052	1.388	0.071	379	379	3,031	3,031
13	53	53	0.068	0.068	1.551	0.106	1,289	1,289	5,256	5,256
13B	100	100	0.028	0.028	1.736	0.048	276	276	1,256	1,256

Notes:

(1) Cumulative Peak ADDF is the product of the Cumulative ADDF and the ADDF Peaking Factor.

(2) Subsystem calculations for Site 2 and Site 3 resulted in negative values. Both sites are interior basins which can result in negative flows due to limitations of meter accuracy and site conditions.

4.4 Infiltration

Infiltration is defined as flows entering the wastewater collection system through defects below ground such as defective pipes, pipe joints, and manholes as well as the quantity and severity of these defects. The rate of infiltration depends on the depth of groundwater above the defects, as well as the percentage of the collection system below the groundwater table. The variation in groundwater levels and subsequent infiltration is seasonal and weather dependent. Since the groundwater levels are normally a relative constant over periods of several days, the peak infiltration can be considered as the maximum infiltration, which occurs during the maximum groundwater period of the year. To determine high groundwater infiltration, flow data from the day following significant storm events were analyzed. The hydrographs were examined to verify inflow had subsided. If inflow had not subsided, the flow from the next day was used to determine infiltration. The total flow measured during these infiltration periods included ADDF plus infiltration flow. Infiltration flow was determined by subtracting the ADDF from the total flow measured during the infiltration periods. Night flow readings were used for the analysis since the least temporal variation in base flow occurred during this period. Infiltration is calculated by subtracting the minimum three-hour flow during ADDF week from the minimum three-hour flow during an infiltration day.

Some common inflow and infiltration source examples are shown on Figure 8. The difference between ADDF, inflow, and infiltration is further demonstrated graphically on Figure 9.

The infiltration parameters are shown for each subsystem for the flow monitoring period in Table 12 and Figure 10. Subsystems with excessive infiltration were based on an infiltration rate above 2,500 gpd/IDM. The 2,500 gpd/IDM threshold is based on GBA's historical flow monitoring observations and experience. Four subsystems indicated having excessive infiltration based on an infiltration rate above the 2,500 gpd/IDM for the monitoring period. One of those four is Basin 13 which has poor data quality confidence due to bottleneck and construction activities. Basins 6 & 7 have the highest subsystem infiltration rates.

Figure 8 – Inflow and Infiltration Sources

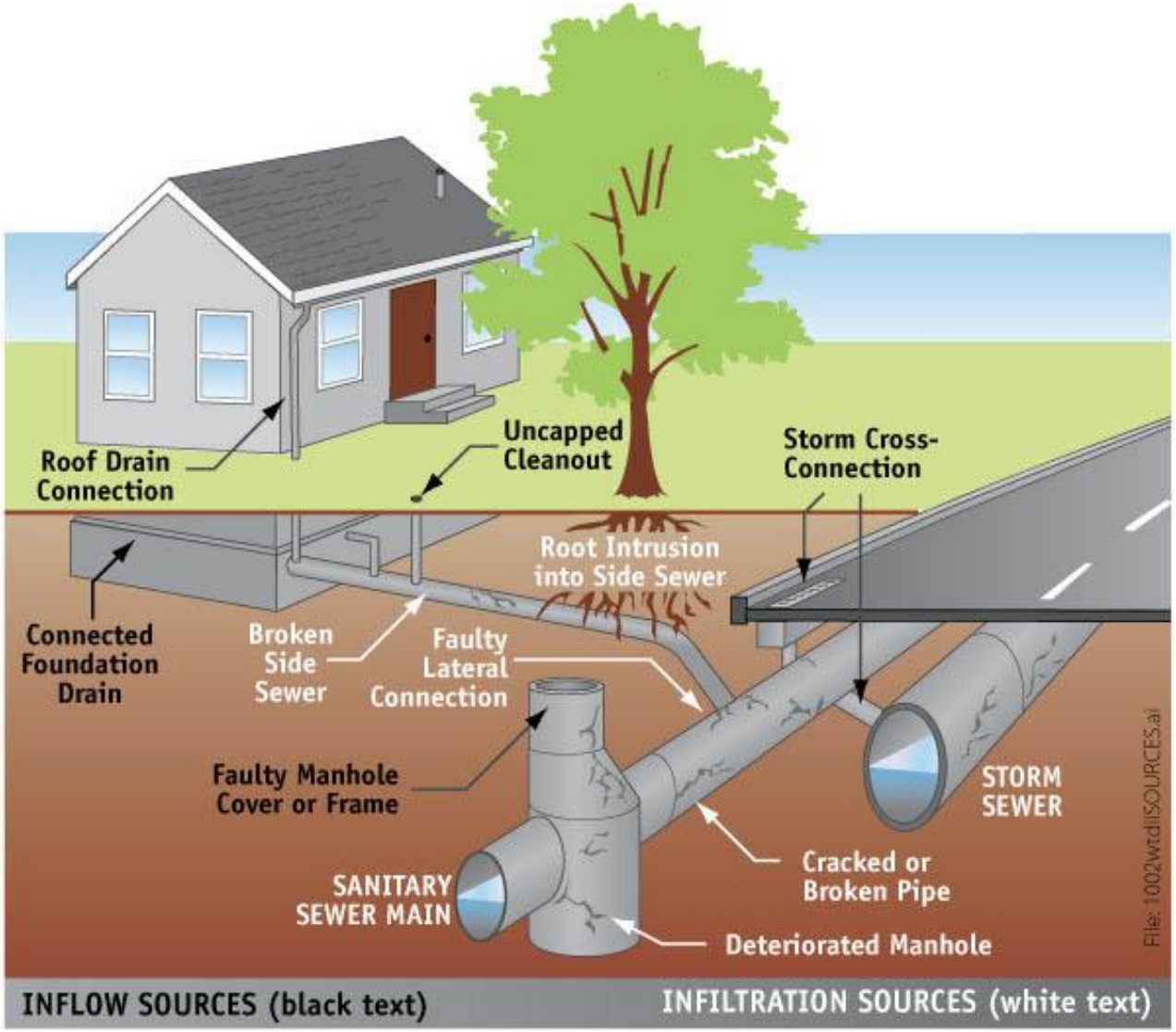


Figure 9 – Graphical Illustration of I&I Components

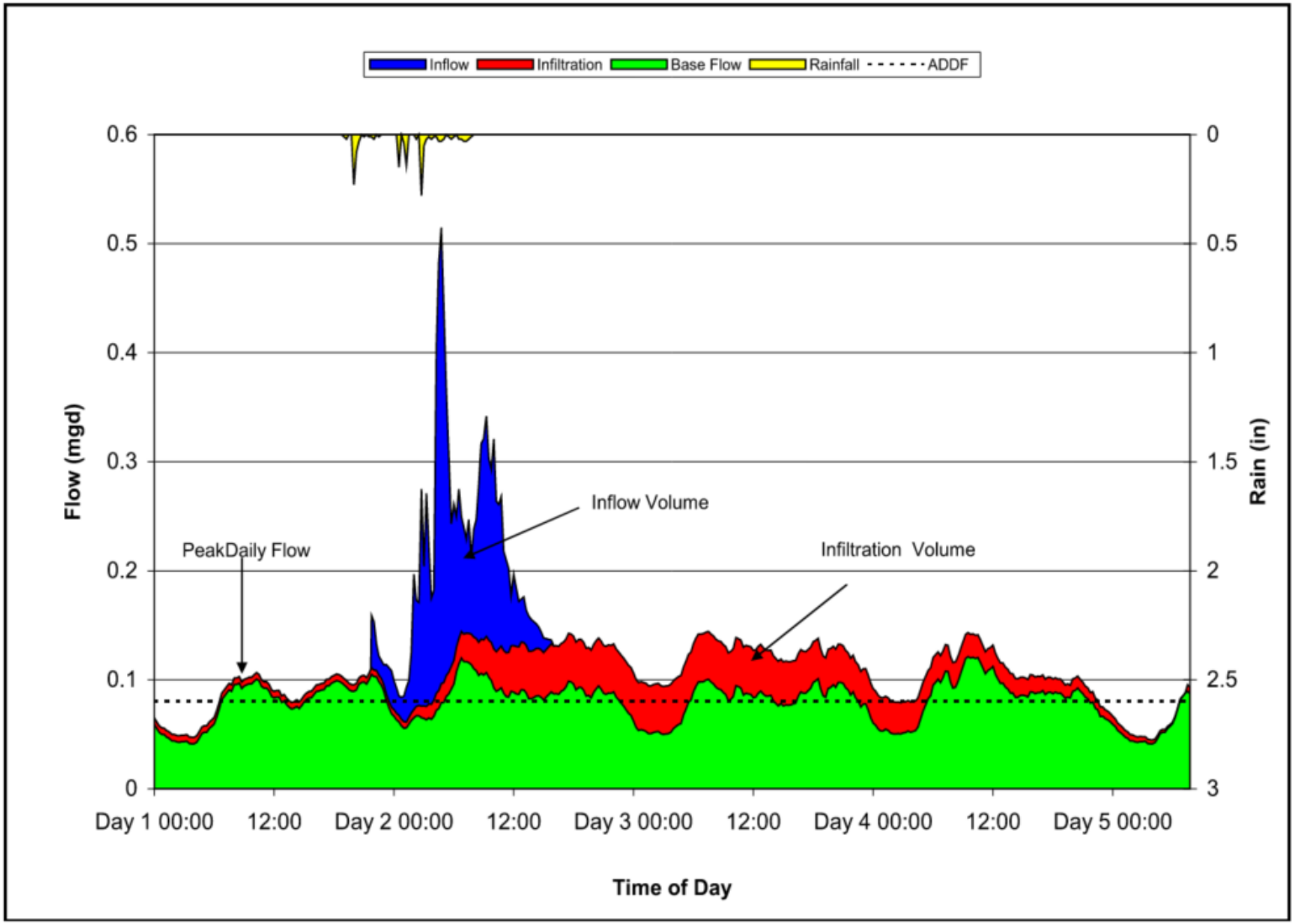


Table 12 – Infiltration Summary

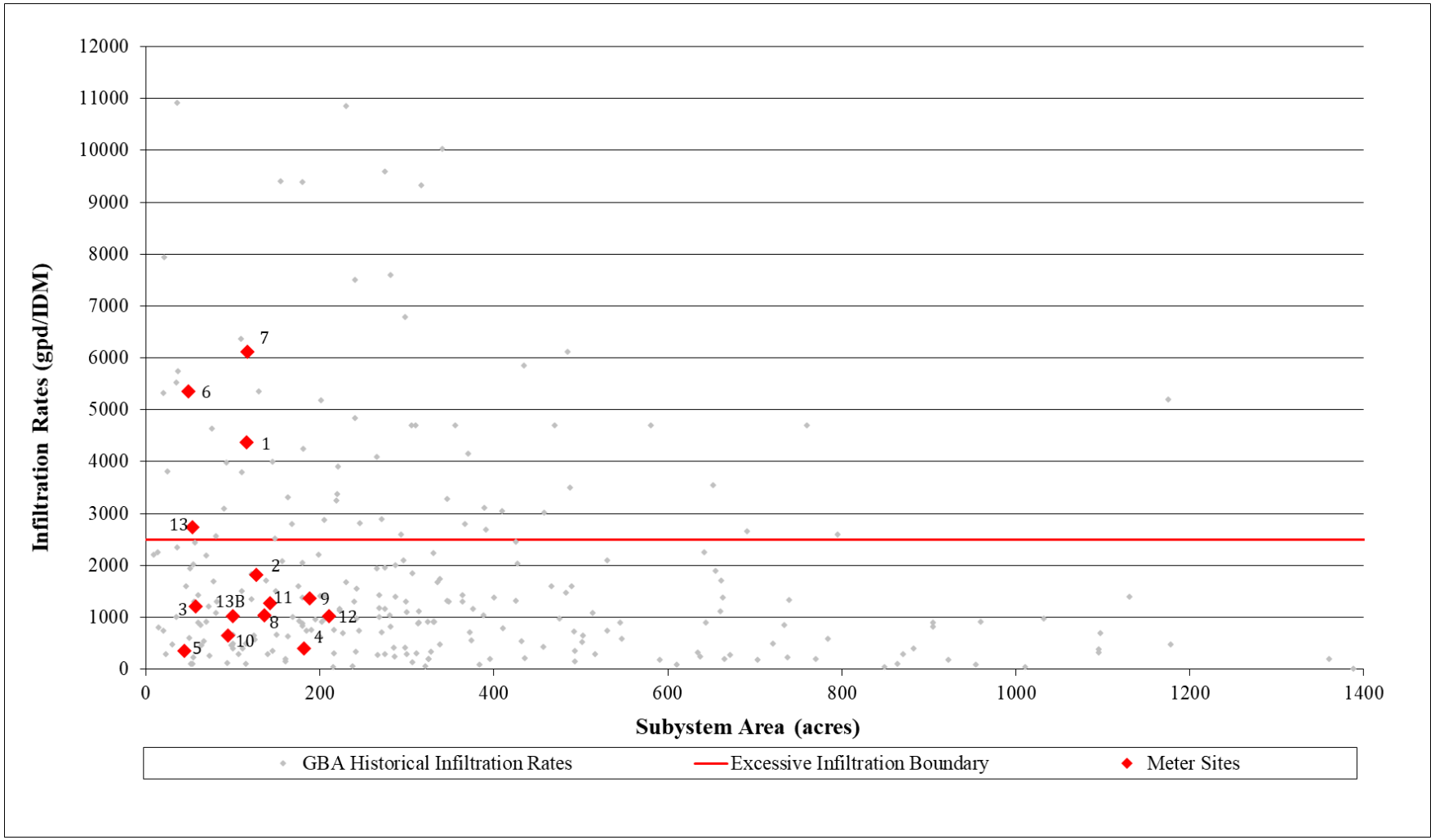
Basin ID	Subsystem Area (acres)	Cumulative Area (acres)	Subsystem IDM	Cumulative IDM	Subsystem Infiltration (mgd)	Cumulative Infiltration (mgd)	Subsystem Infiltration Rate (gpd/IDM)[1]	Cumulative Infiltration Rate (gpd/IDM)	Cumulative Infiltration per Acre (gpd/acre)	Infiltration Ranking[2]
1	116	1,327	28	359	0.122	0.747	4,366	2,080	563	3
2	127	762	62	209	0.113	0.283	1,817	1,353	371	5
3	57	283	15	71	0.018	0.040	1,203	564	142	8
4	182	182	41	41	0.017	0.017	407	407	92	13
5	44	44	15	15	0.005	0.005	356	356	121	14
6	49	49	14	14	0.075	0.075	5,362	5,362	1,532	2
7	117	166	37	51	0.226	0.302	6,121	5,912	1,816	1
9	188	188	52	52	0.071	0.071	1,368	1,368	378	6
10	94	94	14	14	0.009	0.009	655	655	98	12
11	143	143	28	28	0.036	0.036	1,270	1,270	249	7
12	210	353	53	81	0.054	0.090	1,023	1,108	254	11
8	136	136	17	17	0.018	0.018	1,040	1,040	130	9
13	53	53	13	13	0.036	0.036	2,742	2,742	673	4
13B	100	100	22	22	0.023	0.023	1,029	1,029	226	10

Notes:

(1) Excessive Infiltration (over 2,500 gpd/IDM) highlighted.

(2) Ranking based on Subsystem Infiltration Rate (gpd/IDM).

Figure 10 – Excessive Infiltration



4.5 Inflow

Inflow is defined as rainfall-related water entering the collection system from sources such as private sewer laterals, downspouts, foundation drains, yard and area drains, storm sump pumps, manhole covers, and cross connections from storm drains. Inflow is directly influenced by the intensity and duration of a storm event and therefore is not a fixed quantity.

A value for the design inflow is not directly calculated. Instead, a constant is calculated based on the storm duration, intensity, and the monitored flow. This constant, "K," is then used to predict inflow values for different rainfall return intervals. The "K" coefficient accounts for rainfall that enters the sewer system as inflow.

For each selected storm, the peak rainfall, peak flow, and time from peak rainfall to peak flow were used to calculate the "K" value at the flow monitoring point. Values for ADDF and infiltration were subtracted from the peak flow to determine the peak inflow. Once the peak inflow was determined and rainfall intensity was calculated from the rainfall monitoring data, a "K" value was determined. Several "K" values were averaged to arrive at a "K" value for the basin being monitored.

The inflow coefficient "K" for each storm event at each monitoring point was determined by the following formula:

$$K = \frac{Q}{iA}$$

Where:

Q = peak inflow (cfs)
K = inflow coefficient
i = rainfall intensity for selected recurrence interval and time of concentration (in/hr)
A = sewered area (acres)

Interior basins are basins with at least one upstream tributary area. Basin inflow coefficients for interior basins were calculated using measured cumulative flow, tributary basin inflow coefficients and tributary areas. The flow generated within an interior basin must be calculated because measured flow includes the dynamic cumulative effect from all tributary basins. System dynamics considers the time of travel through the sewer system. Each interior basin inflow coefficient was determined using the following weighted coefficient formula.

$$K_t = (K_1A_1 + K_2A_2 + ... + K_iA_i) / A_t$$

Where:

K_t = cumulative inflow coefficient
K_i = tributary basin inflow coefficient
A_i = tributary sewered basin area (acres)
A_t = total sewered tributary area (acres)
i = Number of basins

Exterior basins are basins in which there is no upstream tributary area coming into the basin. The relative accuracy of the "K" coefficient determined for a basin is typically higher for exterior basins that have only one sewer line outlet from the basin monitored. A decrease in the relative accuracy of the "K" coefficient is typical for interior flow basins due to cumulative flow effects. Inflow coefficients may also be skewed in basins that are largely undeveloped or contain pockets of undeveloped area.

A table showing the calculation of inflow for each storm event and calculation of an inflow coefficient at each monitoring location is included in the individual site analysis located in Appendix. The inflow calculations required determining the sewered acreage tributary to the site and a time of concentration, which in turn was determined after review of storm event time of concentrations. Many storm data dates were available that showed measurable inflow responses, which included a minimum of four events to provide an average value at each site.

A summary of inflow parameters for each subsystem is shown in Table 13. The 1-year subsystem inflow rates for each basin were calculated by ratio of 1-year subsystem storm inflow (gpd) to the subsystem's sewer footage length per 1,000 feet. Based on GBA's historical data from past flow monitoring projects an excessive subsystem inflow rate boundary line was established from the upper third of data. As subsystem area and sewer footage increases, the excessive inflow rate boundary decreases to represent the larger subsystems more accurately.

The excessive inflow rate boundary line is generally greater than or equal to 26,000 gpd/1000 ft for basins less than 300 acres in area, greater than or equal to 20,000 gpd/1000 ft for basins less than 500 acres in area, and greater than or equal to 17,000 gpd/1000 ft for basins greater than 500 acres in area, as shown in Table 13 and Figure 11, nine of the fourteen basins exceeded this high inflow rate. Site 2 had the largest subsystem "K" value and highest 1-year inflow rate.

Table 13 – Inflow Summary

Basin ID	Subsystem Area (acres)	Cumulative Area (acres)	Subsystem Sewer (ft)	Cumulative Sewer (ft)	Cumulative Time of Concentration (min)[1]	Subsystem Inflow Coefficient K	Cumulative Inflow Coefficient K	1-Year Storm Inflow (mgd)[2]		Subsystem 1-Year Inflow Rate (gpd/1000ft)[3]	10-Year Storm Inflow (mgd)[2]		Ranking[4]
								Subsystem (mgd)	Cumulative (mgd)		Subsystem (mgd)	Cumulative (mgd)	
1	116	1,327	16,952	213,574	120	0.0052	0.0052	0.31	3.60	18,549	0.58	6.62	12
2	127	762	26,795	118,106	105	0.0628	0.0151	4.59	6.62	171,197	8.45	12.19	1
3	57	283	10,109	48,235	75	0.0301	0.0103	1.25	2.13	124,070	2.31	3.92	3
4	182	182	28,561	28,561	60	0.0058	0.0058	0.90	0.90	31,477	1.65	1.65	7
5	44	44	9,565	9,565	60	0.0033	0.0033	0.12	0.12	12,953	0.23	0.23	13
6	49	49	8,913	8,913	75	0.0073	0.0073	0.26	0.26	29,454	0.48	0.48	8
7	117	166	21,368	30,281	105	0.0142	0.0122	0.95	1.16	44,654	1.76	2.14	5
9	188	188	32,180	32,180	75	0.0060	0.0060	0.82	0.82	25,523	1.51	1.51	10
10	94	94	7,502	7,502	60	0.0118	0.0118	0.95	0.95	126,497	1.74	1.74	2
11	143	143	18,415	18,415	75	0.0023	0.0023	0.24	0.24	12,906	0.44	0.44	14
12	210	353	33,214	51,629	90	0.0046	0.0037	0.62	0.83	18,741	1.14	1.52	11
8	136	136	10,205	10,205	105	0.0038	0.0038	0.30	0.30	29,188	0.55	0.55	9
13	53	53	10,172	10,172	45	0.0143	0.0143	0.78	0.78	76,441	1.43	1.43	4
13B	100	100	17,588	17,588	105	0.0112	0.0112	0.65	0.65	36,714	1.19	1.19	6

Notes:

(1) Time of concentration is calculated by averaging the time from peak rainfall to peak inflow for selected storms.

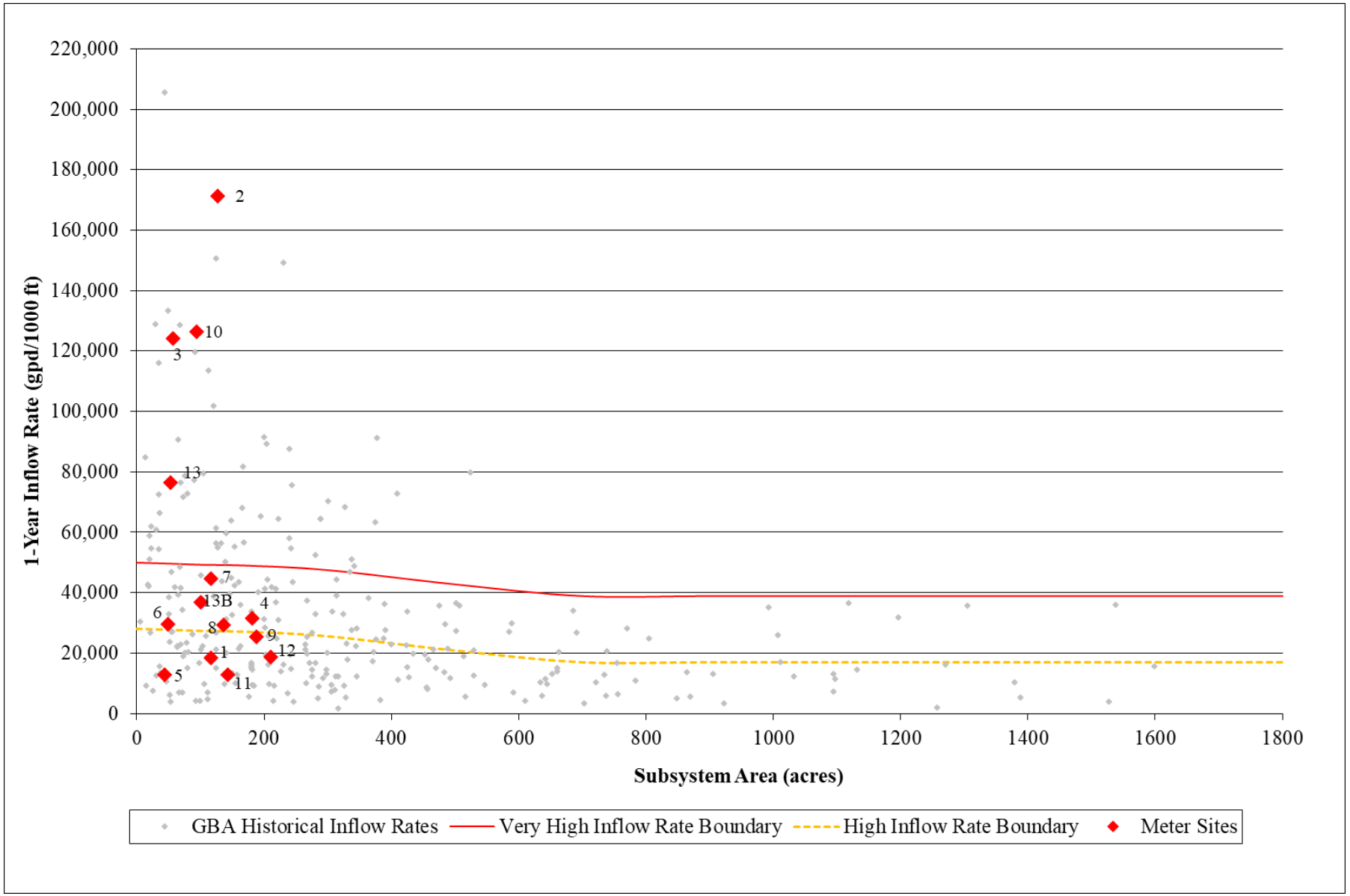
(2) 1-year storm and 10-year storm inflow are based on the following formula: Q= KiA*0.6463 (conversion factor from CFS to MGD)

(3) High subsystem infiltration rates (generally >26,000 gpd/1000 ft for basins <300 acres, >20,000 gpd/1000 ft for basins <500 acres, and >17,000 gpd/1000 ft for basins >500 acres) highlighted.

(4) Ranking based on 1-Year Inflow Rate (gpd/1000 ft).

(5) Site 1 Subsystem Inflow Coefficient K is set equivalent to Cumulative Inflow Coefficient K because the subsystem calculation results in a negative value.

Figure 11 – Excessive Inflow



4.6 Peak System Flow Rates

The sewer system capacity at the flow monitoring sites was compared to peak flows with various recurrence intervals. The sewer capacities were calculated using measured pipe diameters and the calibrated energy gradient determined from Manning's equation and flow meter data. These capacities may not represent the capacity of sewers upstream or downstream of the monitoring locations. The approximate level of protection at each of these points was estimated by comparing the cumulative peak flows for various return periods with the existing capacity. A summary of peak subsystem flow rates and known capacities is shown in Table 14.

The lowest level of protection was estimated as flows from greater than a 1-year storm but less than a 2-year storm at Sites 2. The next lowest protection was estimated as flows from greater than a 2-year storm but less than a 5-year storm at Site 9 and Site 13B.

Table 14 – Calculated Capacity vs Peak Flows

Basin ID	Pipe Dia. (in.)	Existing Capacity[1] (mgd)	Maximum Recorded Flow Rate (mgd)	Cumulative Peak Flows (mgd)							Approximate Level of Protection[2]
				1 Year	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	
1	24	10.87	8.11	5.70	6.59	7.79	8.72	10.05	11.07	12.14	Between 25 and 50 Year
2	24	8.67	9.10	7.43	9.07	11.30	13.00	15.38	17.32	19.25	Between 1 and 2 Year
3	15	6.21	8.11	2.49	3.00	3.71	4.28	5.05	5.66	6.28	Between 50 and 100 Year
4	12	3.65	1.09	1.14	1.35	1.65	1.89	2.21	2.47	2.74	Greater than 100 Year
5	8	0.58	0.15	0.20	0.22	0.27	0.30	0.34	0.38	0.41	Greater than 100 Year
6	8	1.11	0.47	0.44	0.50	0.59	0.66	0.76	0.83	0.91	Greater than 100 Year
7	15	3.10	3.31	1.72	2.01	2.40	2.70	3.12	3.46	3.80	Between 10 and 25 Year
9	12	1.24	1.12	1.04	1.23	1.51	1.73	2.02	2.26	2.50	Between 2 and 5 Year
10	12	1.71	1.74	1.07	1.29	1.61	1.86	2.20	2.47	2.75	Between 5 and 10 Year
11	8	0.97	0.45	0.48	0.54	0.62	0.68	0.77	0.84	0.91	Greater than 100 Year
12	15	1.87	2.00	1.28	1.48	1.76	1.98	2.28	2.52	2.76	Between 5 and 10 Year
8	12	0.57	0.53	0.39	0.46	0.56	0.64	0.75	0.83	0.92	Between 5 and 10 Year
13	12	2.13	2.28	0.92	1.11	1.36	1.57	1.85	2.07	2.30	Between 50 and 100 Year
13B	12	0.89	0.46	0.72	0.88	1.09	1.26	1.49	1.68	1.87	Between 2 and 5 Year

Notes:

(1) Existing Capacity is calculated using the pipe diameter and calibrated energy gradient determined from Manning's equation.

(2) Level of protection is the approximate storm recurrence interval which will overload the system.

4.7 Volumetric Analysis

Utilizing significant storm events, the amount of rainfall (I&I volume, or percent rain to sewer) entering the sanitary sewer system was calculated. Using the meter data for each storm, the I&I volume was determined by creating an I&I hydrograph, which is the difference between an adjusted dry weather flow period and the storm's wet weather hydrograph. The adjusted dry weather flow period represents what the predicted dry weather flow would be if the rain event had not occurred. Typically, flows from the day or week before the storm event are used as the adjusted dry weather flow. The total I&I volumes were plotted on a graph against the corresponding 24-hour rainfall total for each event. A linear regression analysis was then used to determine the total I&I volumes for any given amount of rain.

Table 15 indicates which subsystems have excessive I&I volumes. A subsystem is considered to have excessive I&I if it averaged 2% or greater total rain volume entering the sanitary sewer. Each subsystem was ranked for excessiveness of I&I volume. Four of the basins were above the excessive level. Basins 6 & 7 had the highest percent of rain to sewer. Individual site percent rain to sewer analyses are detailed in the Appendix.

Table 15 – Statistical Analysis of Rain to Sewer Volume

Basin ID	Cumulative Average Percent Rain to Sewer (%)	Number of Storm Events Analyzed	Cumulative 2-inch Storm Event Volume (MG)	10-Year I/I Volume (MG)	Ranking[(2)]
1	1.66%	7	1.19	3.97	7
2	1.58%	7	0.65	2.17	9
3	1.37%	6	0.21	0.70	10
4	1.03%	7	0.10	0.34	12
5	0.95%	7	0.02	0.08	13
6	6.37%	7	0.17	0.47	2
7	6.75%	7	0.61	1.68	1
9	1.59%	8	0.16	0.54	8
10	1.90%	7	0.10	0.32	6
11	1.99%	8	0.15	0.52	5
12	1.16%	8	0.22	0.74	11
8	0.79%	7	0.06	0.19	14
13	2.98%	4	0.09	0.58	3
13B	2.40%	3	0.13	0.36	4

Notes:

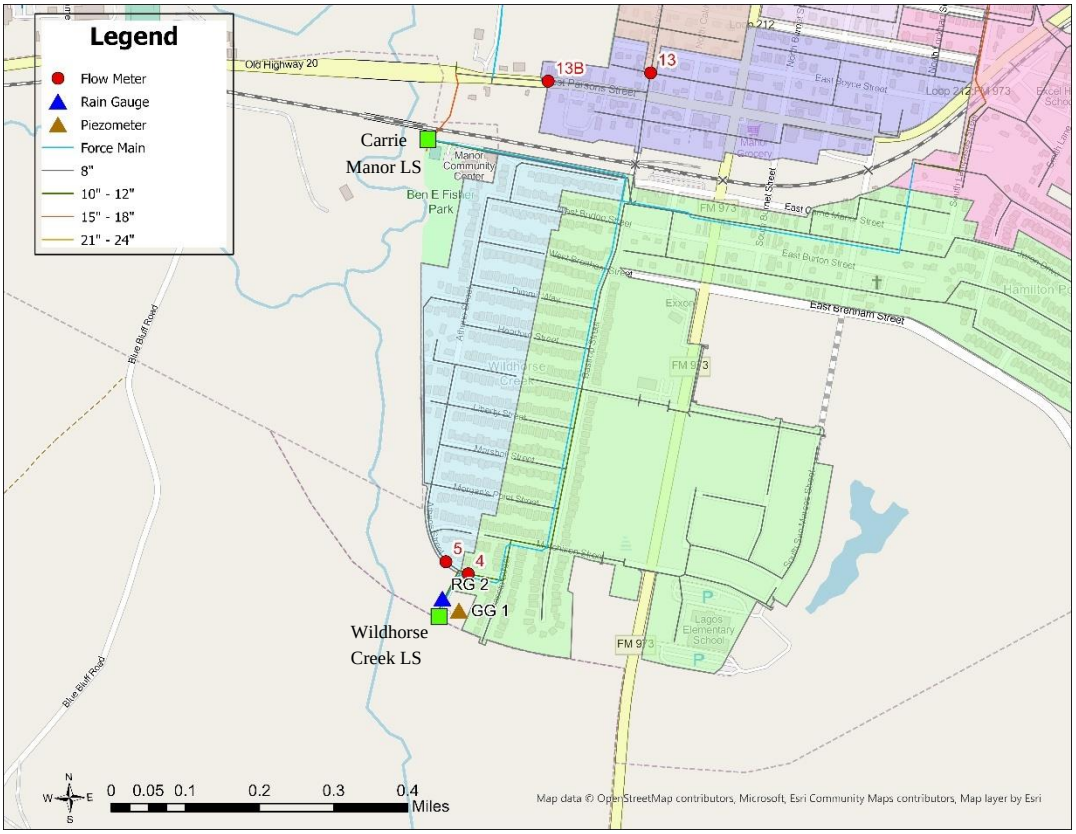
(1) Excessive I/I volumes (greater than 2% of rain volumes) are highlighted.

(2) Ranking based on Cumulative Average Percent Rain to Sewer.

4.8 Groundwater Monitoring

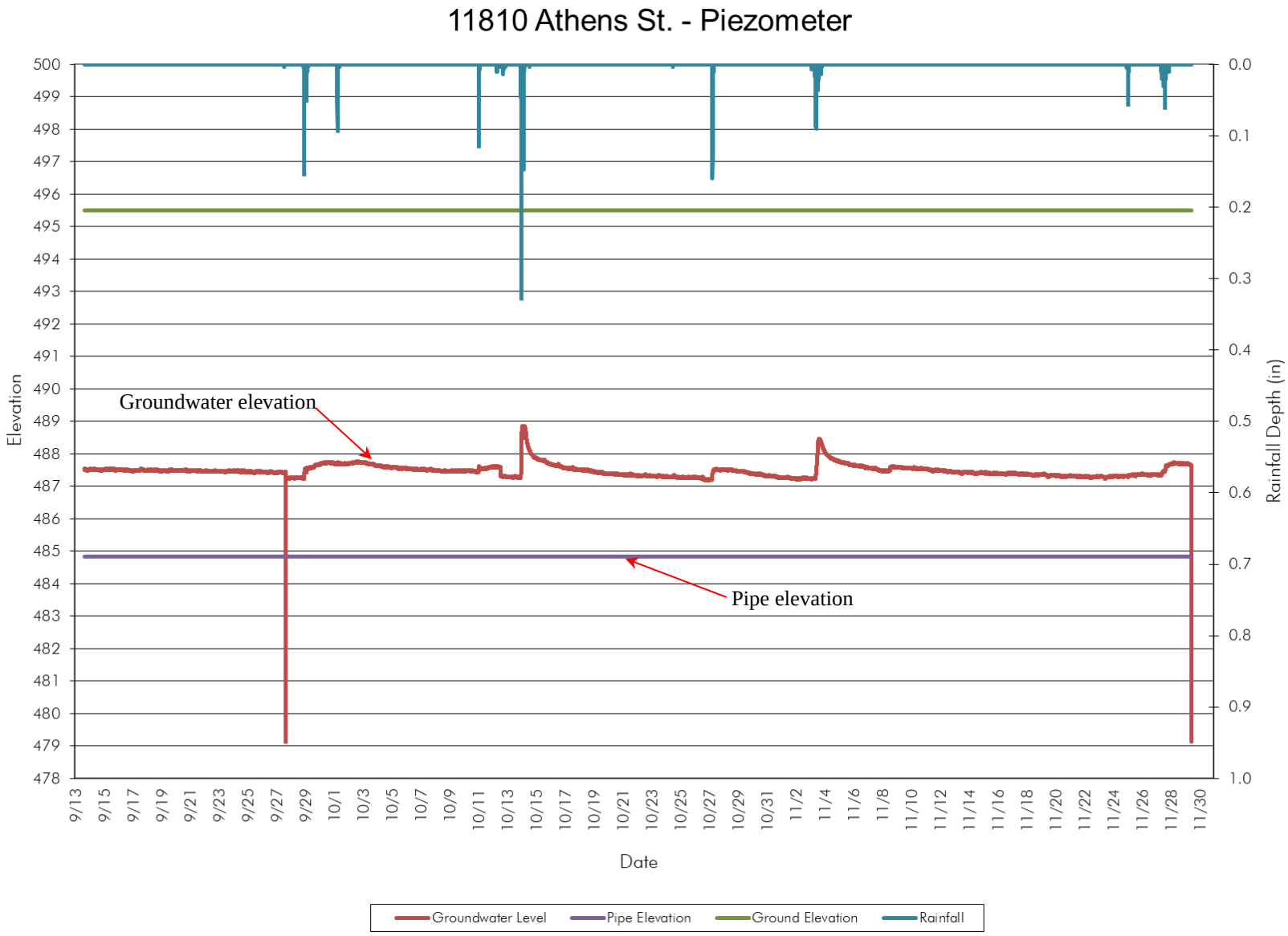
Groundwater monitoring was completed as part of the fall 2021 flow monitoring project. The level of groundwater plays a key role in water entering a sewer system. If the groundwater is above the sanitary sewer pipes it affects the static pressure that permits more I&I to enter the system. One groundwater piezometer well was installed at the Wildhorse Creek Lift Station located at 11810 Athens St as shown on Figure 12. The groundwater gauge was installed 9/13/2021 and removed 11/29/2021.

Figure 12 – Piezometer GG1 Location



The groundwater piezometer recorded an average water elevation of 487.78 feet. Figure 13 shows the graph of the water levels recorded in the groundwater well at the Wildhorse Creek Lift Station. The sanitary sewers in the area of the well have an average pipe elevation of 484.84 feet, which would put them just below the average water elevation in the well. The well showed an increase in groundwater level after rain events, with the highest increase occurring after the 10/13/2021 rain event which produced 3.15" of rain. The water level rose by 1.6 feet during this event. The 11/3/2021 rain event recorded a rise of 1.2 feet after the 1.89" rain event.

Figure 13 – Piezometer GG1 Water Level Graph



5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Conclusions for the fall 2021 flow monitoring are provided below:

1. **Rainfall** – The fall 2021 flow monitoring provided 6 storms over 0.5" including three storms that were over 1". The overall rainfall for the three-month monitoring period was about expected when compared to historical rainfall data. Though more rainfall events are desired, the data provided direction for identifying and removing I&I sources

2. **I&I Evaluation** – The flow meter flow reactions were mixed for the rainfall storm events. Though all meters reacted to some of the rain events with increased flows indicating I&I. There was a significant number of storms for each site that did not cause noticeable reactions. This would indicate more saturated ground condition sources or defects affected by high creek levels are present in the system.

    a. Excessive Infiltration Areas – During the fall 2021 flow monitoring period, four subsystems were considered to have excessive infiltration. The sites found to have excessive infiltration were Sites 1, 6, 7, and 13.

    b. Excessive Inflow Areas – Nine of the subsystems were considered to have excessive inflow (Sites 2, 3, 4, 6, 7, 8, 10, 13 & 13B). The excessive inflow indicators are based on historical flow monitoring data collected by GBA over the last 30 years. Please note that the larger storms on 10/13 and 11/3 provided much higher inflow reactions than other storms and these types of storms should be considered for capacity protection.

    c. I&I Volume - Additionally, four subsystems had an average percentage rain to sewer I&I volume greater than 2% of rainfall volumes. The sites with excessive percent rain to sewer were Sites 6, 7, 13, and 13B.

3. **Capacity** – The flow monitoring sites provided insight to the capacity limitations of the system. Many of the sites were located just upstream of the pump stations. Conclusions for capacity issues for both the gravity sewers and the impacts of the pump stations are below.

    a. Gravity Sewer at the Site – Previously, Table 14 provided capacity of the gravity sewer at the monitoring sites. Site 2 was determined to have between a 1 to 2-year storm protection. Of the 14 sites it was determined that two sites (9 and 13b) had between 2 and 5-year storm protection. In addition, three sites (8, 10, and 12) had between a 5 to 10-year protection. The storm protection is lower at these sites than desired and may cause issues

as the City grows. The other sites seemed to have plenty of storm protection and room for growth.

b. Pump Stations – The pump stations had a significant effect on the flow capacity at the monitoring sites. Many of the site's backup up due to the limiting capacity of the downstream pump station. The surcharge table (Table 5) identified four pump stations that surcharged above the top of pipe during the 10/13 and 11/3 storm events. Pump stations are usually the limiting capacity factor for systems especially systems that have a significant reaction to rainfall. An evaluation should be conducted to determine if capacity can be improved at the pump stations.

5.2 Recommendations

Recommendations for 2021 flow monitoring are provided below:

1. **I&I Investigation** – Recommend inspecting basins 2, 6, and 7. Field activities to include.

   a. Basin 2 had very large peak flows during the 10/13 and 11/3 storms of 7 mgd and 9 mgd respectively. Those peaks were not as dramatic in upstream basins so the source of the peaks should be in Basin 2. These large peaks could impact the functionality of facilities downstream including pump stations and the treatment plant. It is recommended to conduct flow monitoring isolation of the peak flow source. It is also recommended to include groundwater gages inside of manholes (piezometers) to establish groundwater levels along the interceptors and/or deeper depth sewers to confirm the source type.

   b. Basins 6 and 7 are the highest I&I volumes. Also, with limited data from fall flow monitoring, these two basins provided the best correlations and hydrographs of the monitoring sites. These basins would be good candidates for initial testing to determine the type of sources in the Manor system. This work would include smoke testing, dye testing, manhole inspections and CCTV of selected sewers.

   c. It is recommended to continue monitoring during the Fall season to collect additional flow data and firm up peak flow to rainfall correlations. The larger storms produced backups at several sites due to proximity to lift stations. Flow monitoring upstream a manhole or two, if possible, could provide more data representative of the subsystem's inflow characteristics.

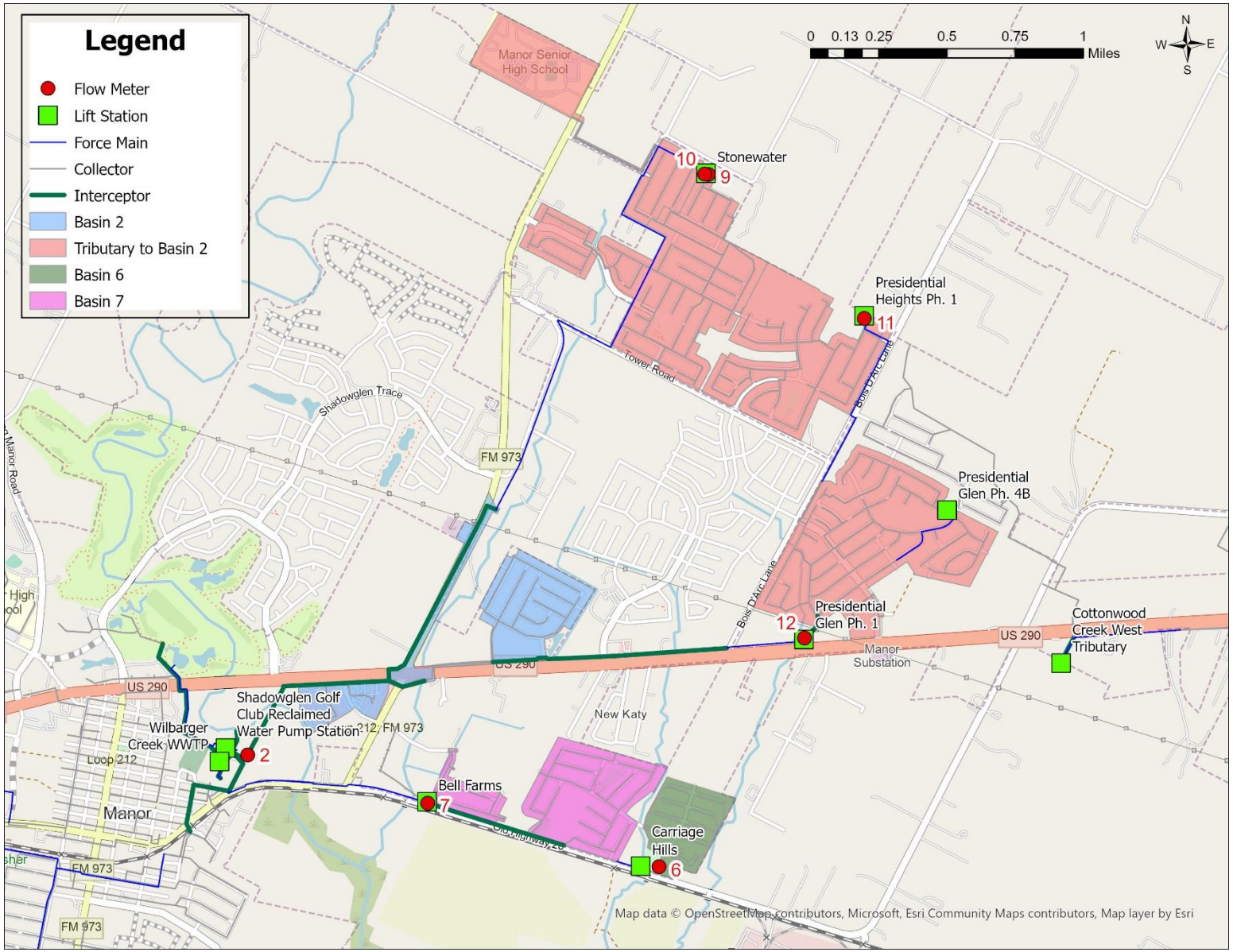
2. **Capacity Planning** – The City's living equivalent unit (LUE) system for establishing design flows is recommended to be compared to peak flows established for the basins. Improvement recommendations to the City's design flow standards should be made based on the findings.

3. **Pump Station Capacity, Maintenance, and Operation Review** – Pump Station rated capacity will be compared to flow monitoring data to establish if the pump stations are performing as intended. Also, each pump station will be reviewed for equipment malfunctions, maintenance activities and operational improvements. For pump stations not performing as intended or those not adequate for peak flows now and/or in the future, recommended improvements will be made.

Table 16 – Recommended Study Estimated Costs

Description	Estimated Cost
Basin 2 Flow Monitoring Isolation	
Flow Monitoring Isolation (4 sites x 60 days)	$40,000
Piezometers (4 site x 60 days)	$1,500
Sub Total	**$41,500**
Basin 6 & 7 I&I Source Investigations	
Smoke Testing (30,281 LF)	$30,000
Manhole Inspections (105 Manholes)	$10,000
CCTV of sanitary sewer pipes (30,281 LF)	$115,000
Dye Testing (20 sources)	$4,500
Sub Total	**$159,500**
2022 Fall Flow Monitoring	
Flow Monitoring (Excessive I&I Basins) (9 sites x 90 days)	$60,000
Sub Total	**$60,000**
Capacity Planning	
Capacity Planning	$15,000
Sub Total	**$15,000**
Pump Station Review	
Pump Station Capacity, Maintenance, and Operation Review	$15,000
Sub Total	**$15,000**
Grand Total	**$291,000**

Figure 14 – Recommended Study Area Map



APPENDIX

TABLE OF CONTENTS

A.1 Site 1

Description

Site 1 was located in the outflowing pipe at manhole N10-002. This meter site is located within the Wilbarger Wastewater Treatment Plant site in the first manhole upstream of the new lift station. It is near the public works building. The flow meter installed at this site was placed in the effluent 24" diameter pipe. The pipe material is Polyvinyl chloride (PVC).

Observations

The average flow depth was 5.69 inches and flow velocity averaged 1.13 feet per second. This site experienced light to medium grease as reported during the site services. Level and velocity readings were consistent with manual measurements during site visits. There were no level or velocity adjustments made to the raw data. The site is considered good quality dry and wet weather data.

This site surcharged during two rainfall events in fall 2021 due to backups.

Table 1 – Surcharge Summary (Site 1)

		Date of Storm	10/13/2021	11/3/2021
		Total Storm Rainfall (in.)	3.15"	1.89"
Site	Diameter (in.)	Storm Duration (hrs.)	6.00	16.83
1	24	Depth from Invert (in.)	37.43 (B)	66.63 (B)

(P) Denotes pressurized flow caused by lack of capacity
(flow velocities generally increase as flow depths increase)
(B) Denotes flow backup caused by downstream restriction
(flow velocities generally decrease as flow depths increase)

Table 2 – Service Interrogations Summary (Site 1)

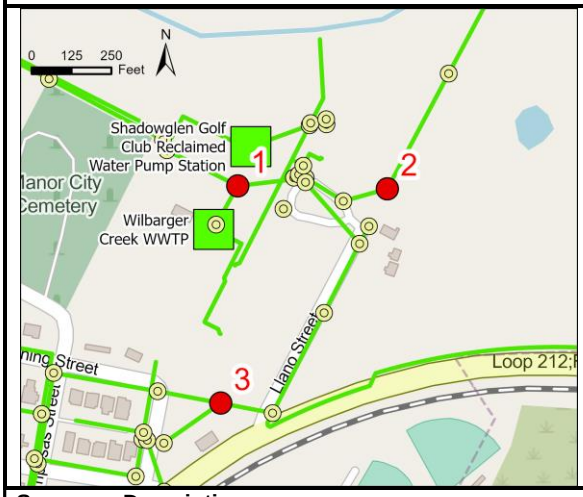
Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 1	8/31/2021	10:25	24	4.50	4.37	-0.13	4.50	4.10	-0.40	3.25	3.14	-0.11	3.25	2.64	-0.61	Install	Meter installed at out pipe
	9/13/2021	9:50		4.50	4.35	-0.15	4.50	4.30	-0.20	1.50	2.58	1.08	2.25	2.10	-0.15	Service/Upload	
	9/27/2021	10:27		5.00	5.70	0.70	5.00	5.40	0.40	3.25	3.00	-0.25	3.00	2.90	-0.10	Service/Upload	
	10/12/2021	15:22		6.00	5.90	-0.10	5.75	5.30	-0.45	3.00	3.10	0.10	3.00	2.80	-0.20	Service/Upload	
	10/26/2021	15:08		6.00	5.92	-0.08	5.00	5.16	0.16	3.25	3.25	0.00	3.00	2.99	-0.01	Service/Upload	
	11/8/2021	13:19		6.50	6.30	-0.20	5.75	5.93	0.18	3.50	3.58	0.08	3.50	3.35	-0.15	Service/Upload	Medium grease and light debris.
	12/1/2021	9:42		6.75	6.96	0.21	7.00	7.16	0.16	3.50	3.56	0.06	4.00	3.88	-0.12	Removal	Light grease.

Figure 1 – Flow Meter Site Investigation (Site 1)

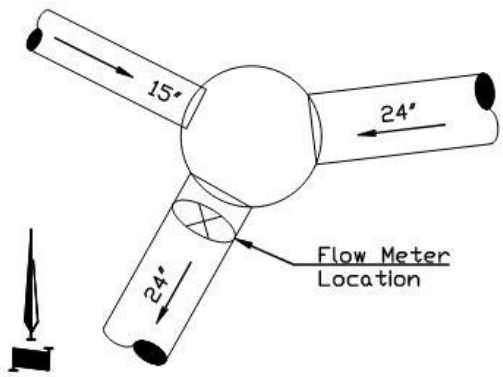
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 12-01-2021 / 09:42	**Crew:** JA-VI
MH#: N10-002	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 24
Site ID: 1	**Address:** 547 Llano St.	**Site Quality:** Good	**Monitoring Purpose:** Short-term FM

Location Map



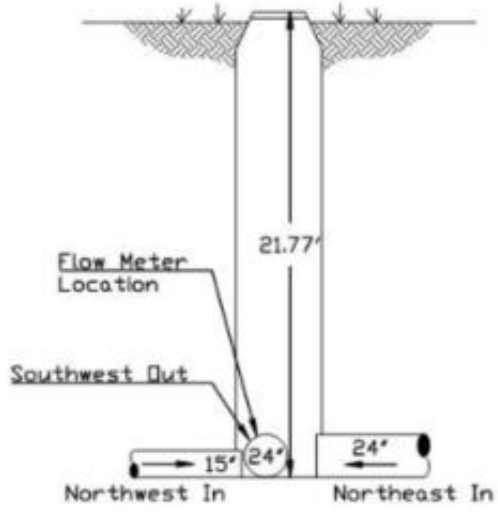
Planar Description



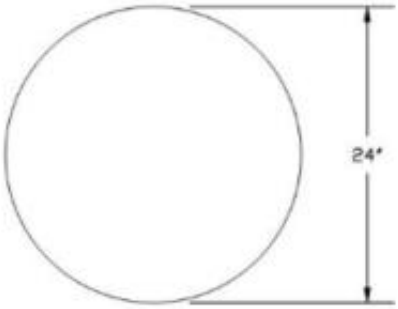
Summary Description:
Located within the Wilbarger Wastewater Treatment Plant site in the 1st manhole upstream of the new lift station. It is near the old public works building.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? None		**Manhole Depth (ft):** 21.77	**Surcharge Evidence?** No
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 0.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 32.00	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Bolt Down	**Usable MH Steps?** No
Describe potential hazards:		**Measured Flow Depth (in):** 7.00	**Meter:** ISCO 2150
		Velocity (fps): 4.00	**Cellular Signal Strength:** N/A
		Mounting Band Description: Scissor Jack Band	**Antennae Install Considerations:** None
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes

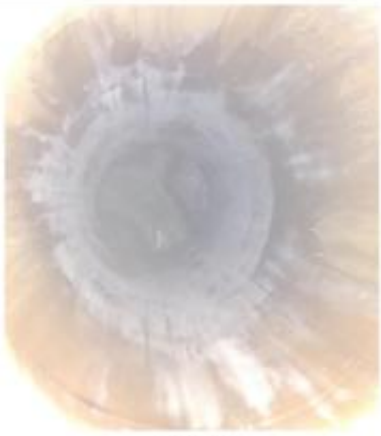


Pipe Cross Section



Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE



DOWN

INFLOW

OUTFLOW

Figure 2 – Site Information (Site 1)

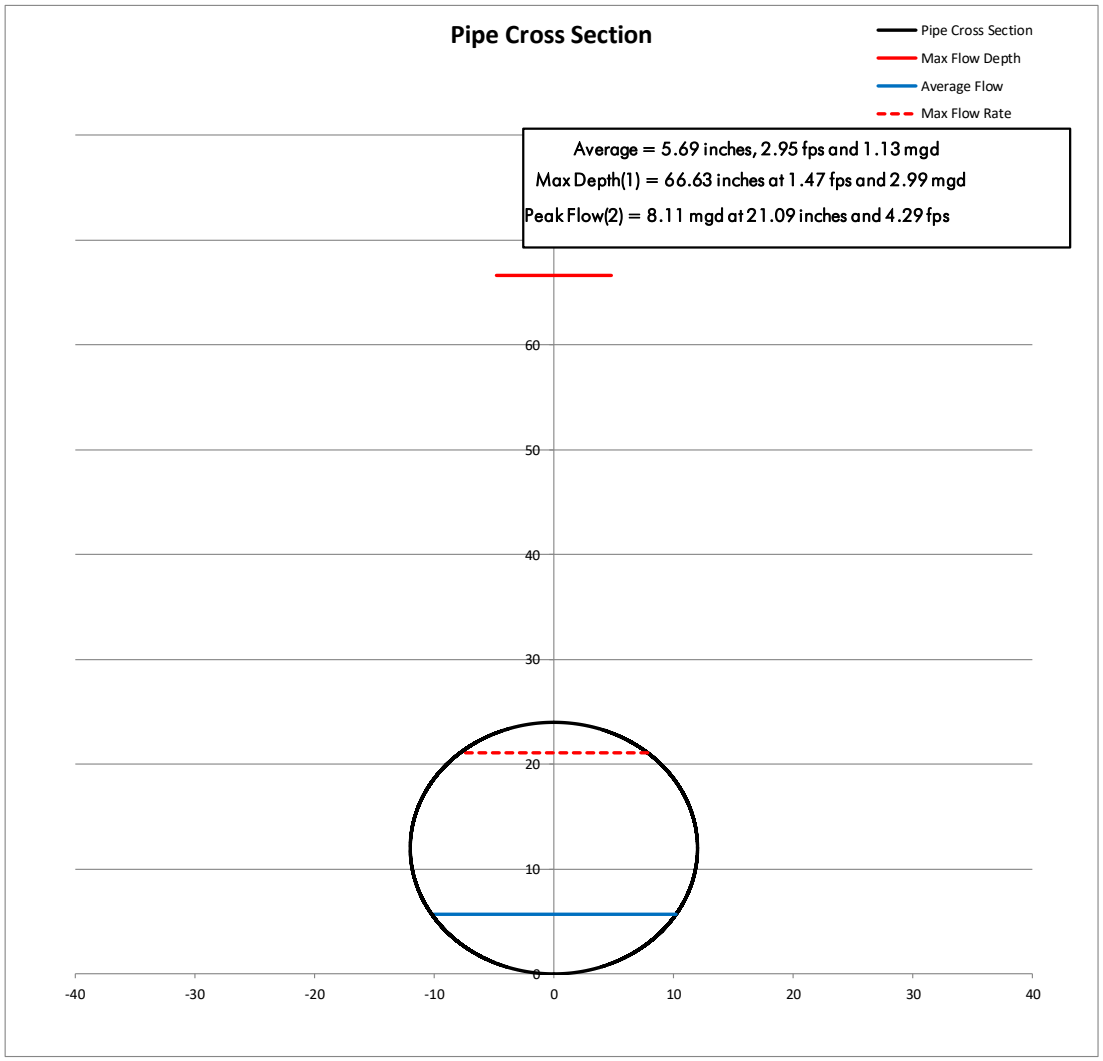
SITE INFORMATION RECORD

Site Information

Meter ID #:	1
Monitoring Program:	Short-Term FM
Manhole #:	N10-002

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	24	
Pipe Width, W (in):	24	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0055	ASSUMED!



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 1	8/31/2021	24	10:25	4.50	4.10	-0.40	3.25	2.64	-0.61
	9/13/2021		9:50	4.50	4.30	-0.20	2.25	2.10	-0.15
	9/27/2021		10:27	5.00	5.40	0.40	3.00	2.90	-0.10
	10/12/2021		15:22	5.75	5.30	-0.45	3.00	2.80	-0.20
	10/26/2021		15:08	5.00	5.16	0.16	3.00	2.99	-0.01
	11/8/2021		13:19	5.75	5.93	0.18	3.50	3.35	-0.15
	12/1/2021		9:42	7.00	7.16	0.16	4.00	3.88	-0.12

Figure 3 – August- September Monthly Flow Hydrograph (Site 1)

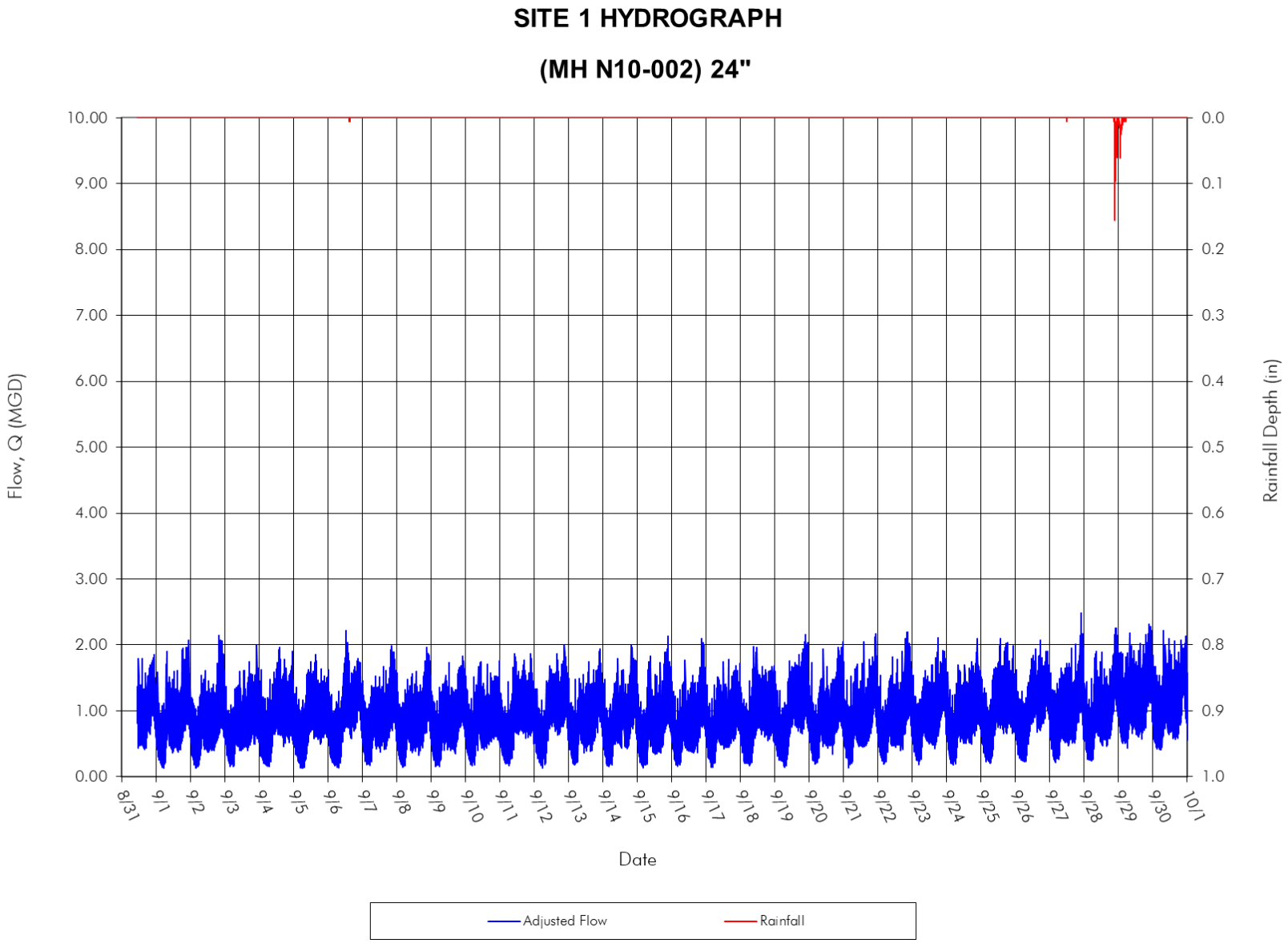


Figure 4 – August-September Monthly Level and Velocity Hydrograph (Site 1)

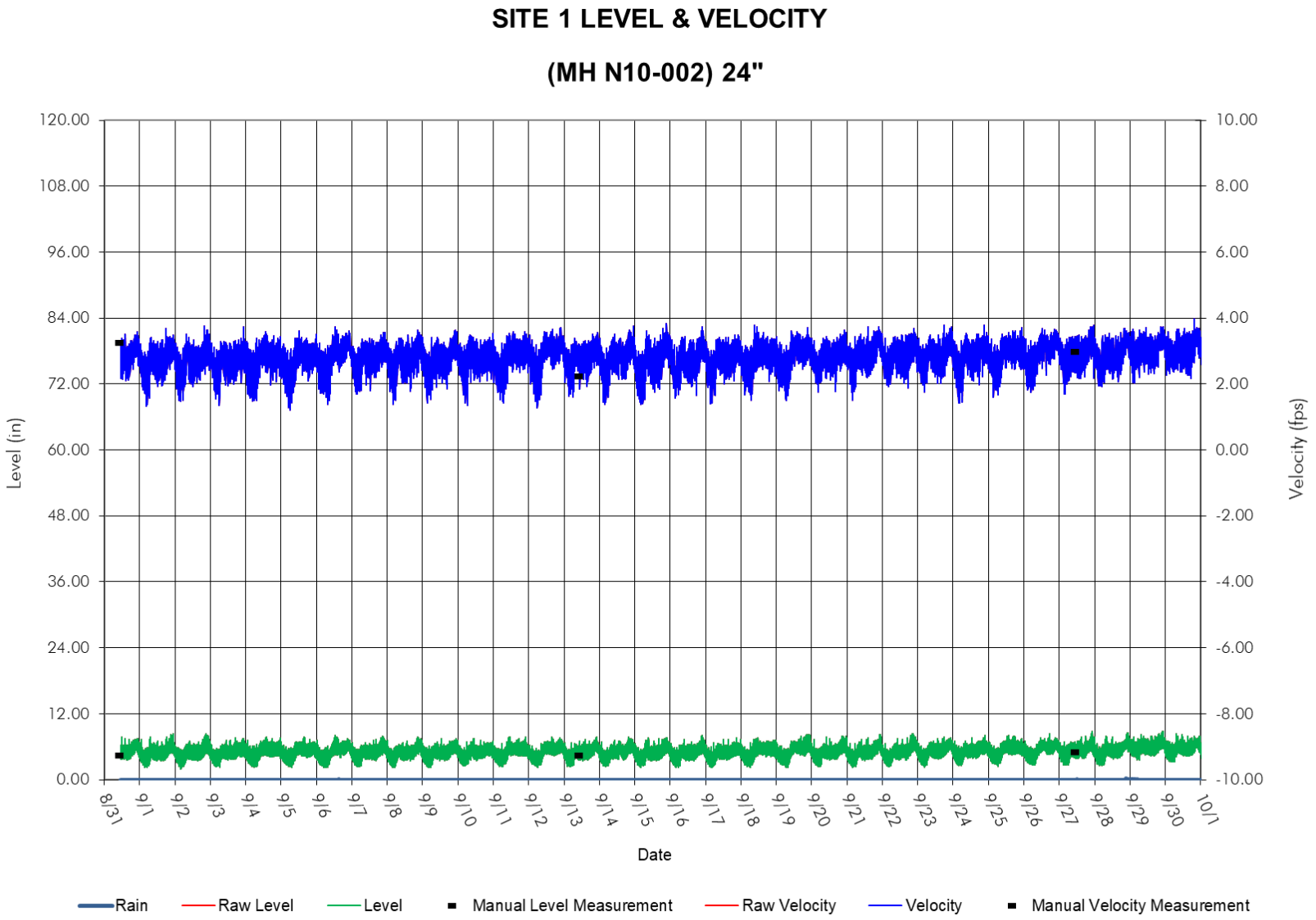


Figure 5 – October Monthly Flow Hydrograph (Site 1)

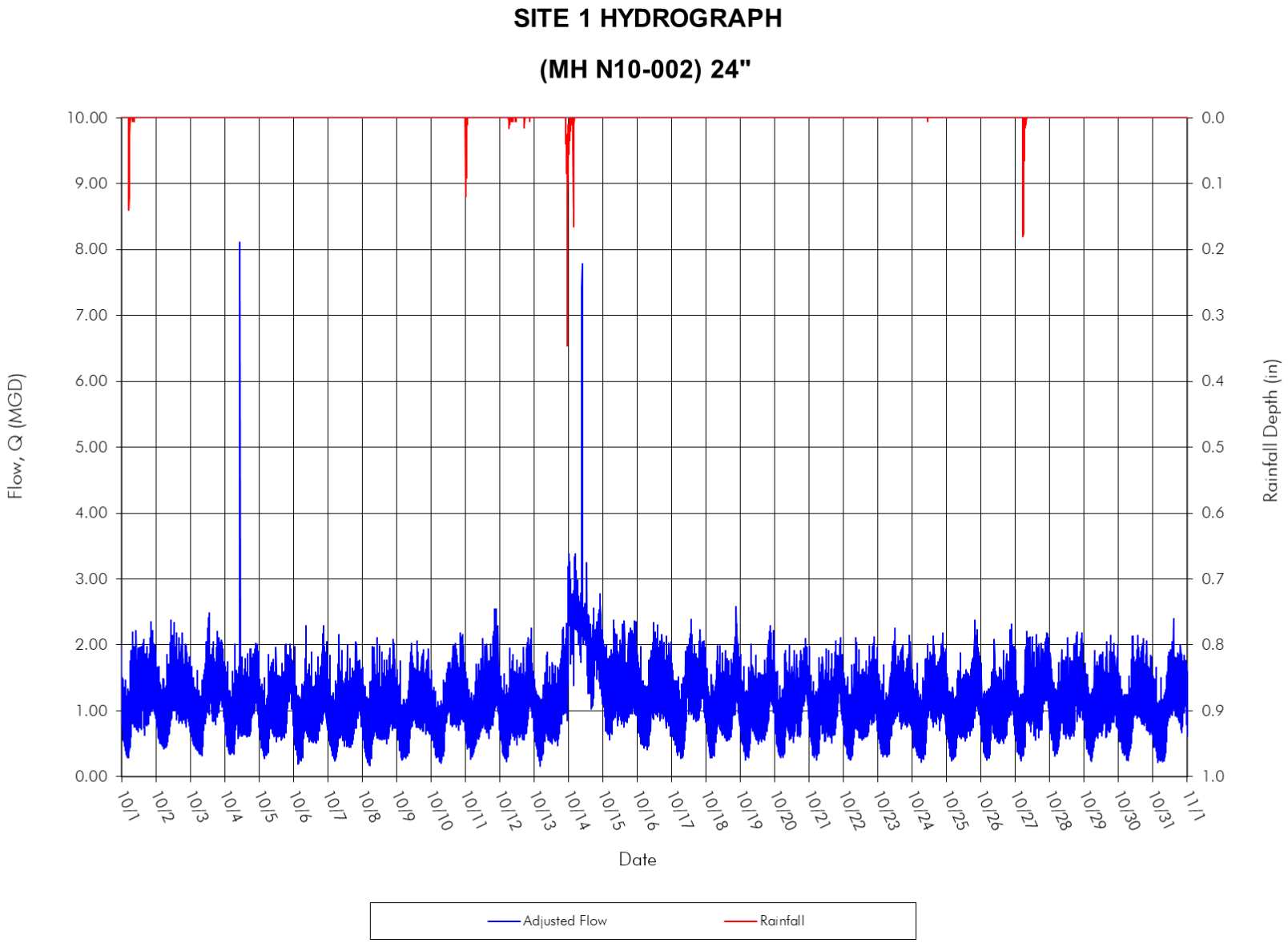


Figure 6 – October Monthly Level and Velocity Hydrograph (Site 1)

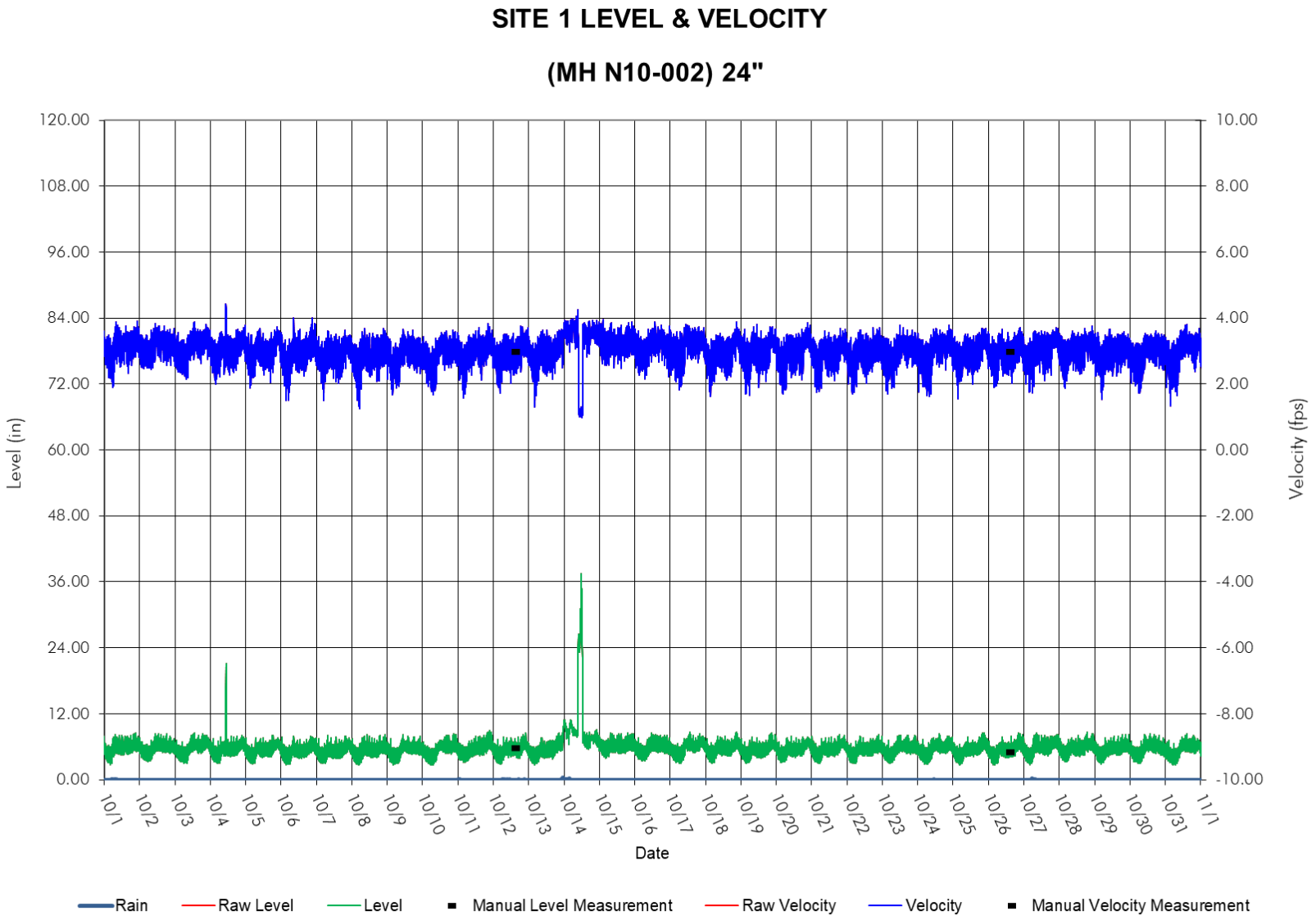


Figure 7 – November-December Monthly Flow Hydrograph (Site 1)

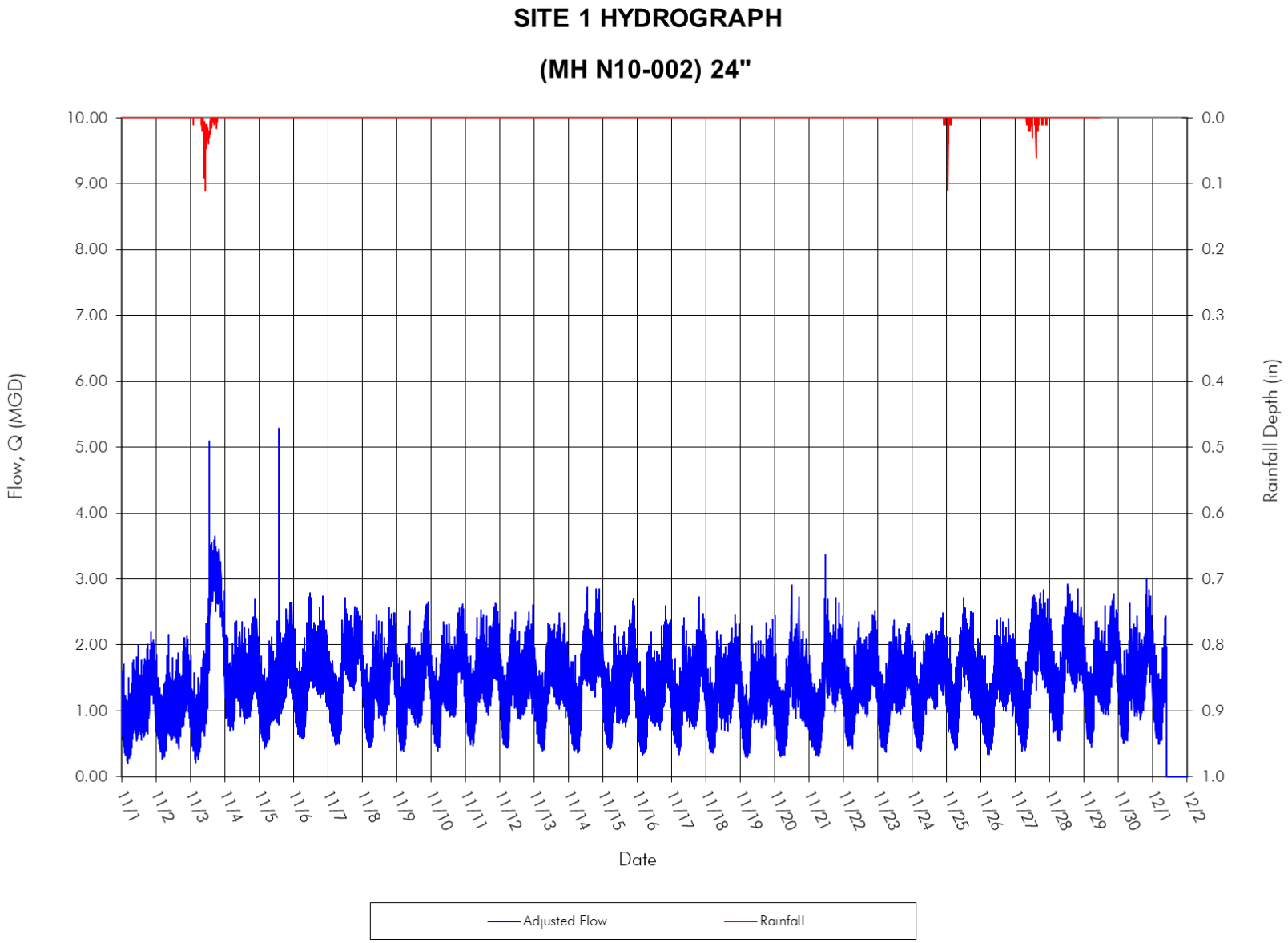


Figure 8 – November-December Monthly Level and Velocity Hydrograph (Site 1)

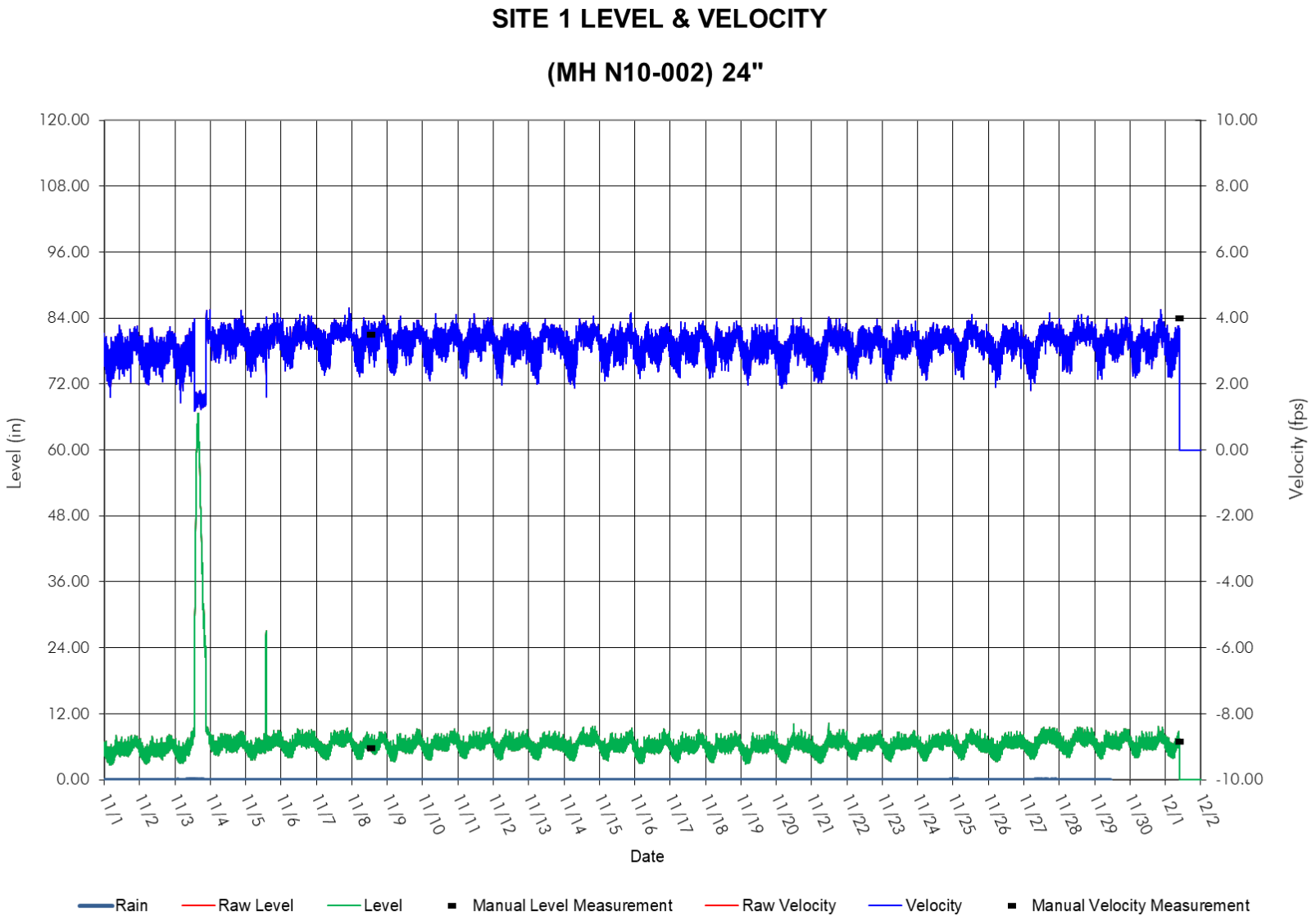


Figure 9 – Overall Flow Hydrograph (Site 1)

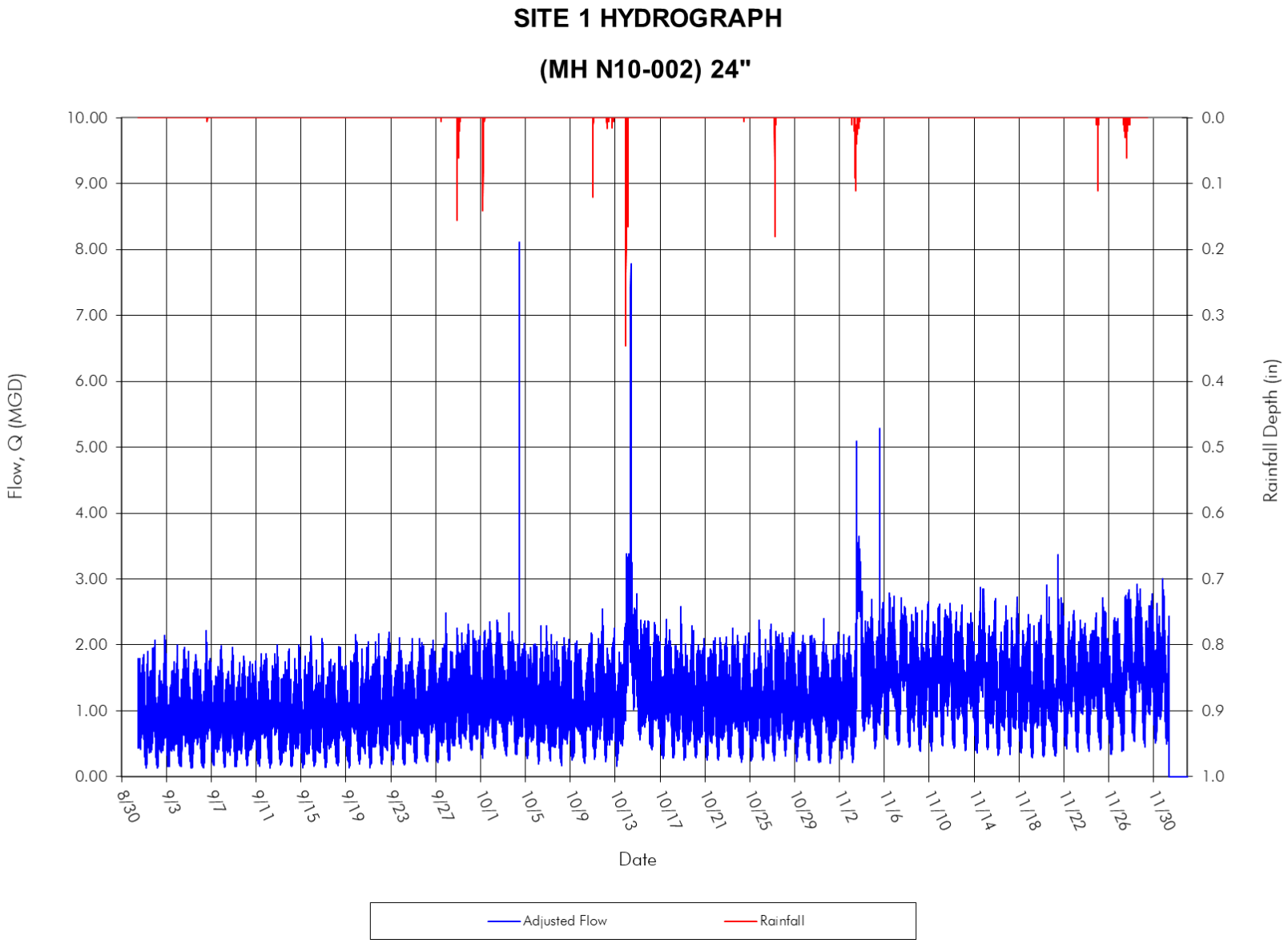


Figure 10 – Overall Level and Velocity Hydrograph (Site 1)

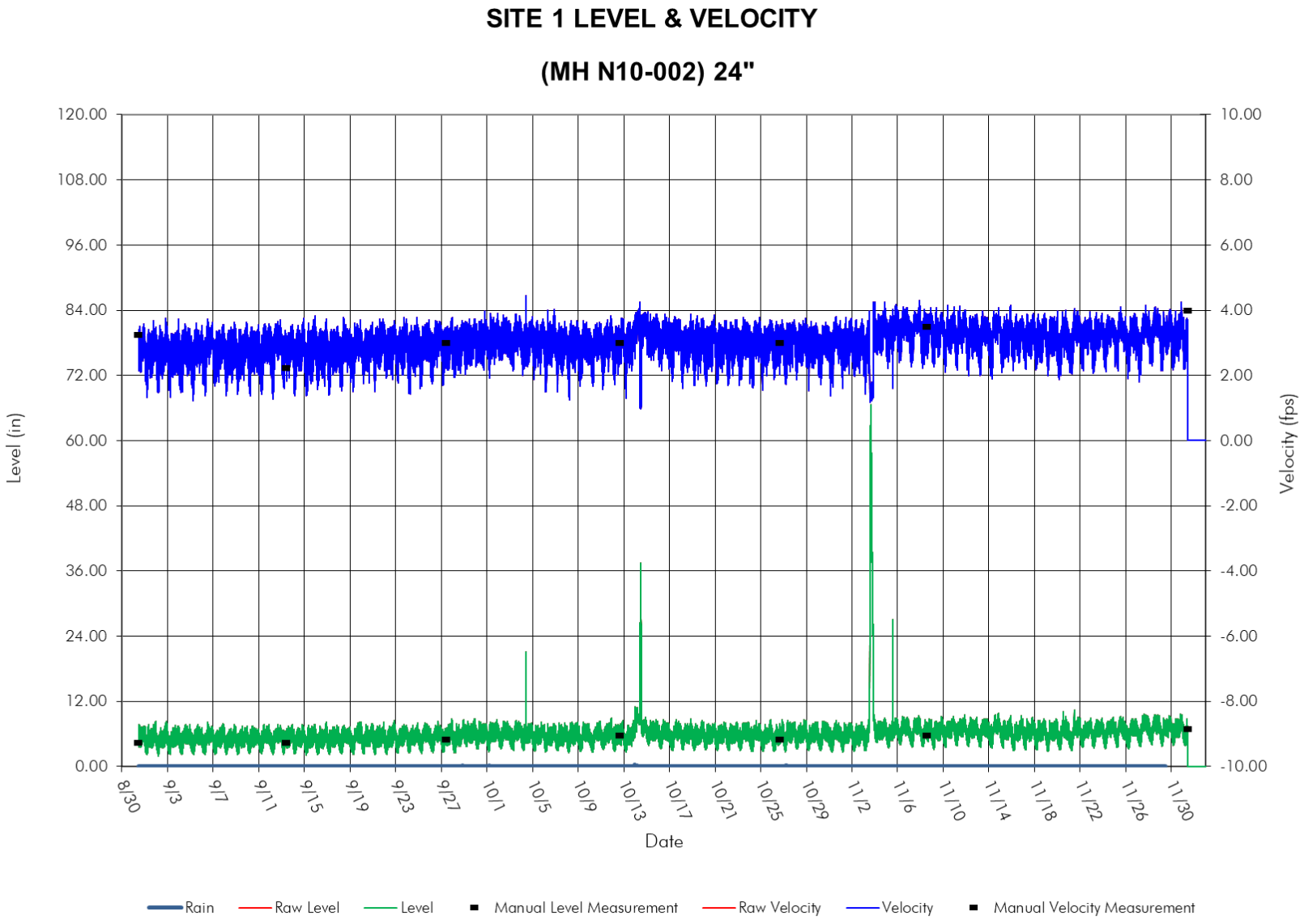


Figure 11 – Standard Flow Scattergraph (Site 1)

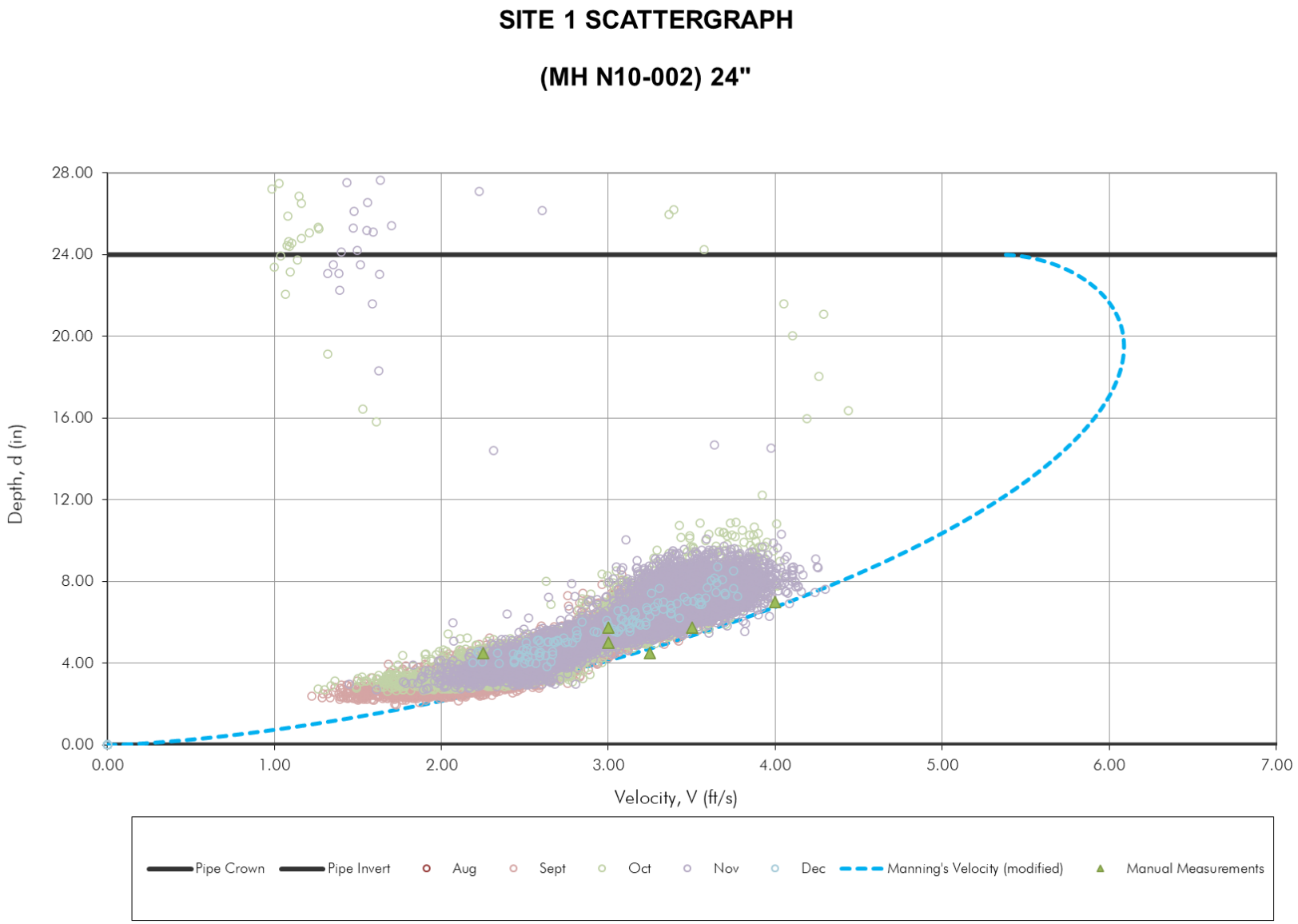


Figure 12 – Surcharge Flow Scattergraph (Site 1)

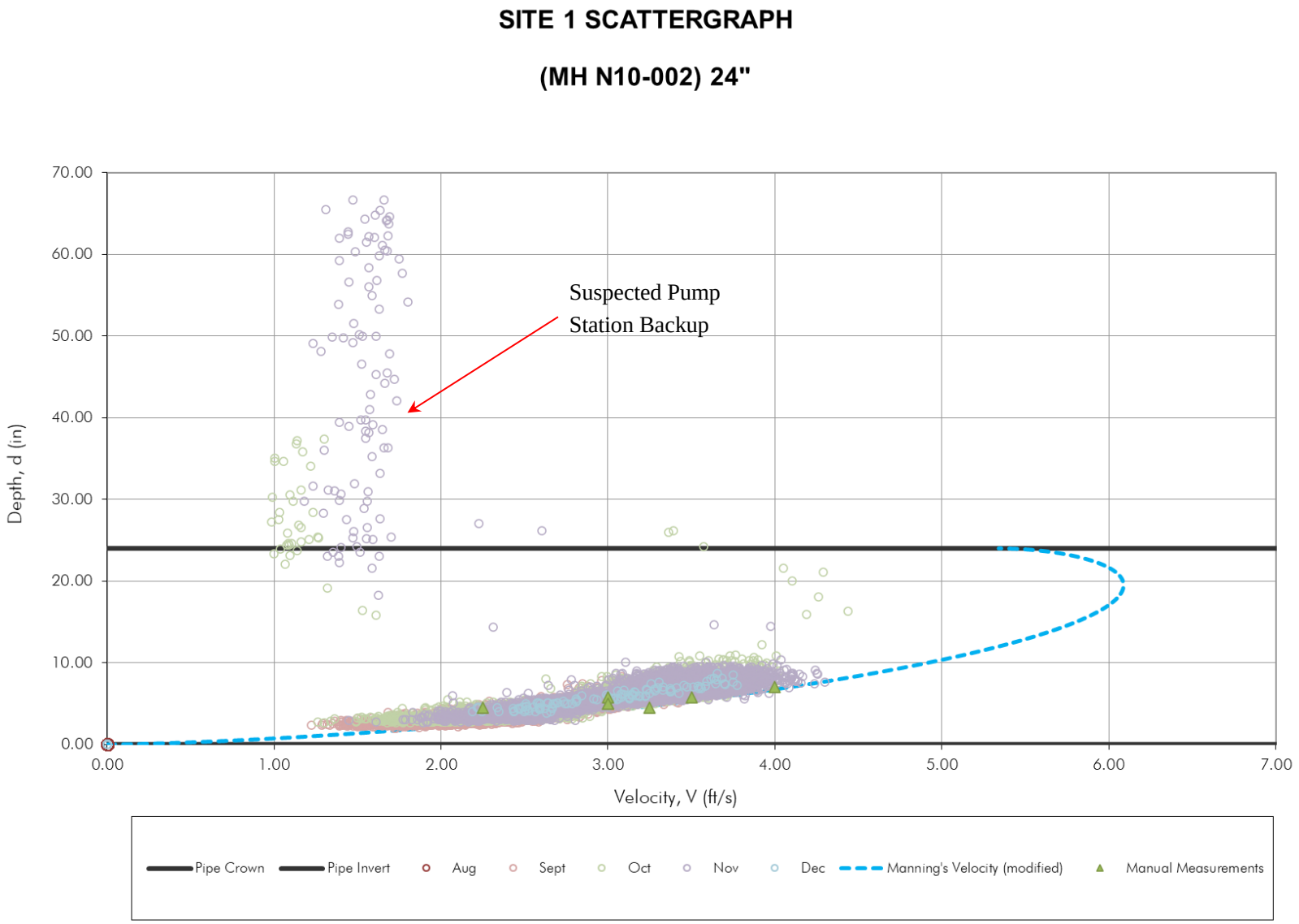


Table 3 – ADDF and Infiltration Summary (Site 1)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 1
Meter: 1
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.927	1.499	1.618	0.386	28-Nov-21	1.090
13-Sep-21	Mon	0.814	1.436	1.763	0.389		
14-Sep-21	Tue	0.831	1.377	1.658	0.373		
15-Sep-21	Wed	0.781	1.417	1.815	0.350		
16-Sep-21	Thu	0.775	1.387	1.789	0.350	04-Nov-21	1.387
17-Sep-21	Fri	0.777	1.158	1.491	0.359	15-Oct-21	1.176
18-Sep-21	Sat	0.844	1.194	1.414	0.397	16-Oct-21	0.821
7 Count		0.821 Average	1.353 Average	1.650 Average	0.372 Average	4 Count	1.119 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.821	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.821	
	Diurnal Peaking Factor (DPF):	1.650	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.747	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.747	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.821	

Figure 13 – Dry Weather Diurnal (Site 1)

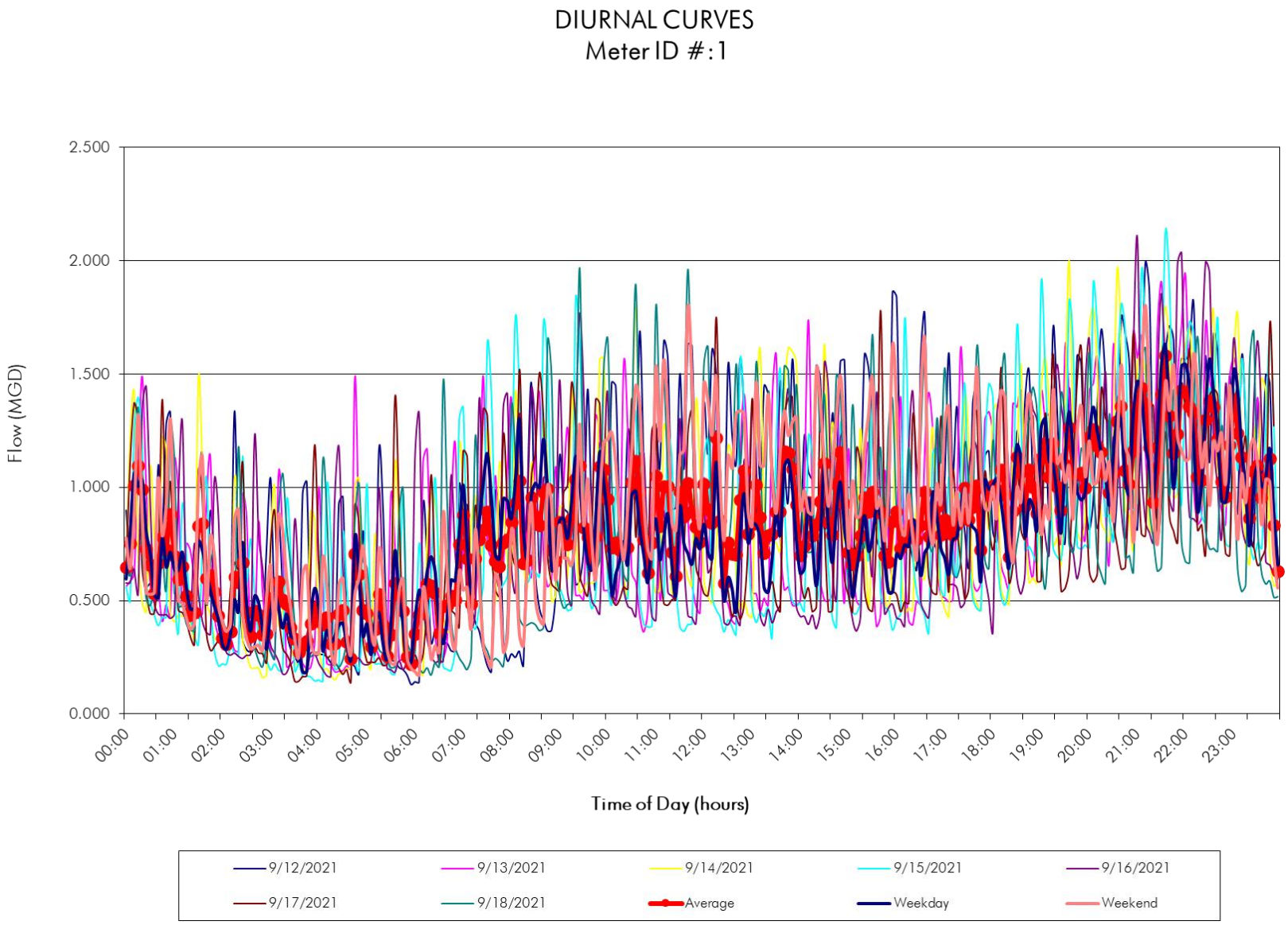


Figure 14 – High/Low Groundwater Diurnal (Site 1)

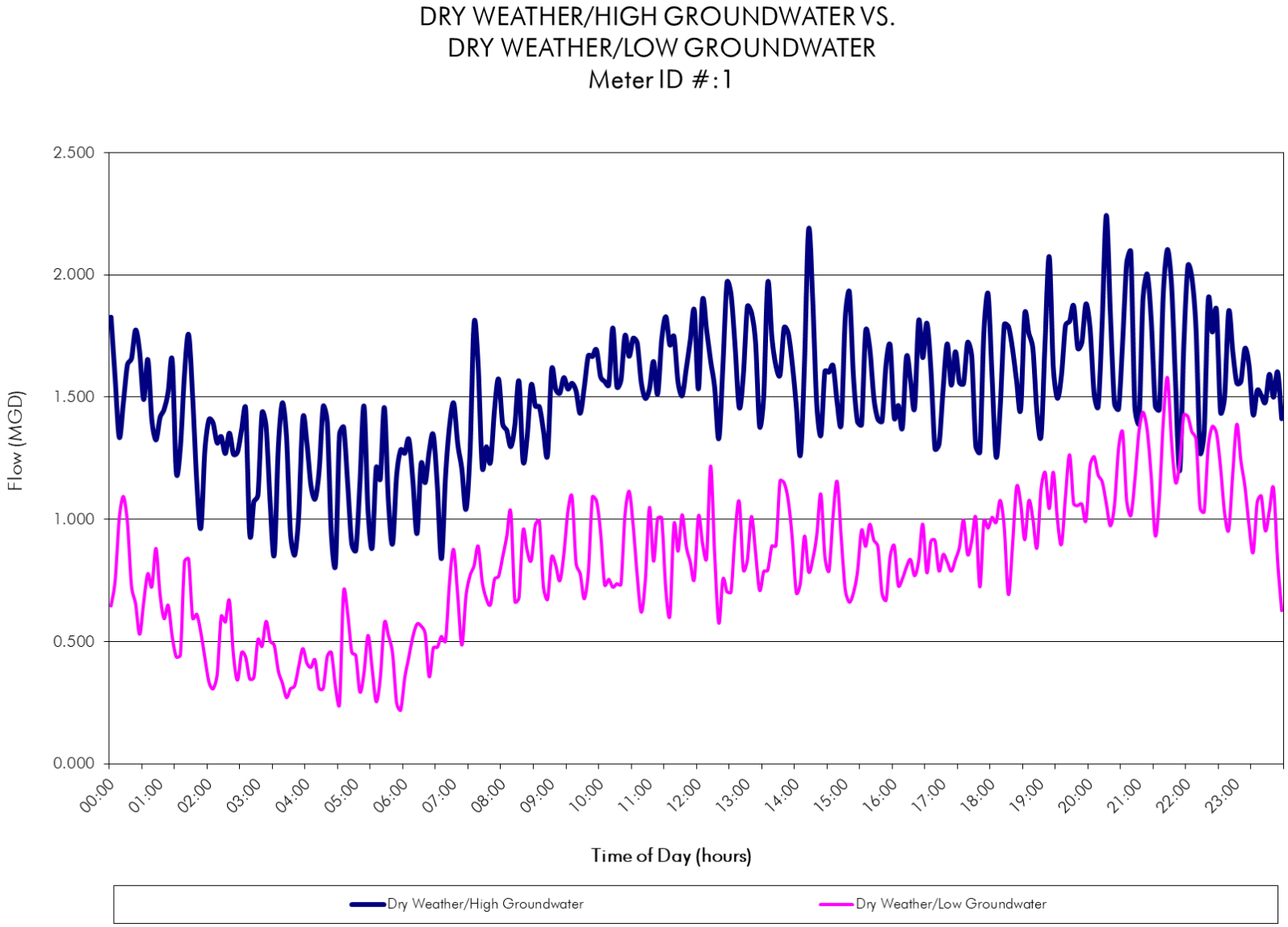


Table 4 – Inflow Calculations and Projections (Site 1)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	1
Meter:	1
Units of Flow:	MGD

Storm Count:	7	Cum. Trib. Area:	1,327 acres	Pipe Shape:	Circular
Avg Delta Time	152	Cum. Time of Conc.:	120 minutes	Pipe Diameter:	24 in
Avg Kp:	0.00658			Pipe Slope:	0.006 ft/ft
Avg Selected Kp:	0.00518			Pipe Capacity:	10.87 mgd
				ADDF Cum.:	0.821 mgd
				ADDF Peak. Factor:	1.65
				Peak ADDF Flow:	1.355 mgd
				Infiltration:	0.747 mgd
				Cum. Peak Flow:	2.102 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	2.102
1	0.810	3.597	5.566	5.699
2	1.010	4.485	6.940	6.587
5	1.280	5.684	8.795	7.786
10	1.490	6.617	10.238	8.718
25	1.790	7.949	12.299	10.051
50	2.020	8.970	13.880	11.072
100	2.260	10.036	15.529	12.138

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/28/21 21:00	1.65	7.92	9/28/21 21:55	9/28/21 21:20	35	2.260	09/27/21	1.057	1.203	0.570	0.00246	y	0.00246					
10/1/21 4:55	0.73	3.67	10/1/21 7:35	10/1/21 5:05	150	2.189	09/24/21	1.374	0.815	0.350	0.00272	y	0.00272					
10/11/21 0:05	0.49	1.25	10/11/21 0:20	10/11/21 0:05	15	1.591	10/10/21	0.557	1.034	0.240	0.00502	y	0.00502					
10/13/21 21:55	3.15	6.00	10/14/21 9:35	10/14/21 3:30	365	7.789	10/13/21	0.638	7.151	1.040	0.00802	n						Surcharged
10/27/21 5:15	0.89	2.42	10/27/21 8:05	10/27/21 5:25	160	2.210	10/26/21	1.110	1.100	0.420	0.00305	y	0.00305					
11/3/21 2:10	1.89	16.83	11/3/21 13:15	11/3/21 10:35	160	5.097	11/02/21	0.609	4.488	0.430	0.01217	n						Surcharged
11/27/21 7:45	0.70	13.92	11/27/21 17:25	11/27/21 14:25	180	2.784	11/20/21	1.158	1.626	0.150	0.01264	y	0.01264					

Figure 15 – Inflow Projections (Site 1)

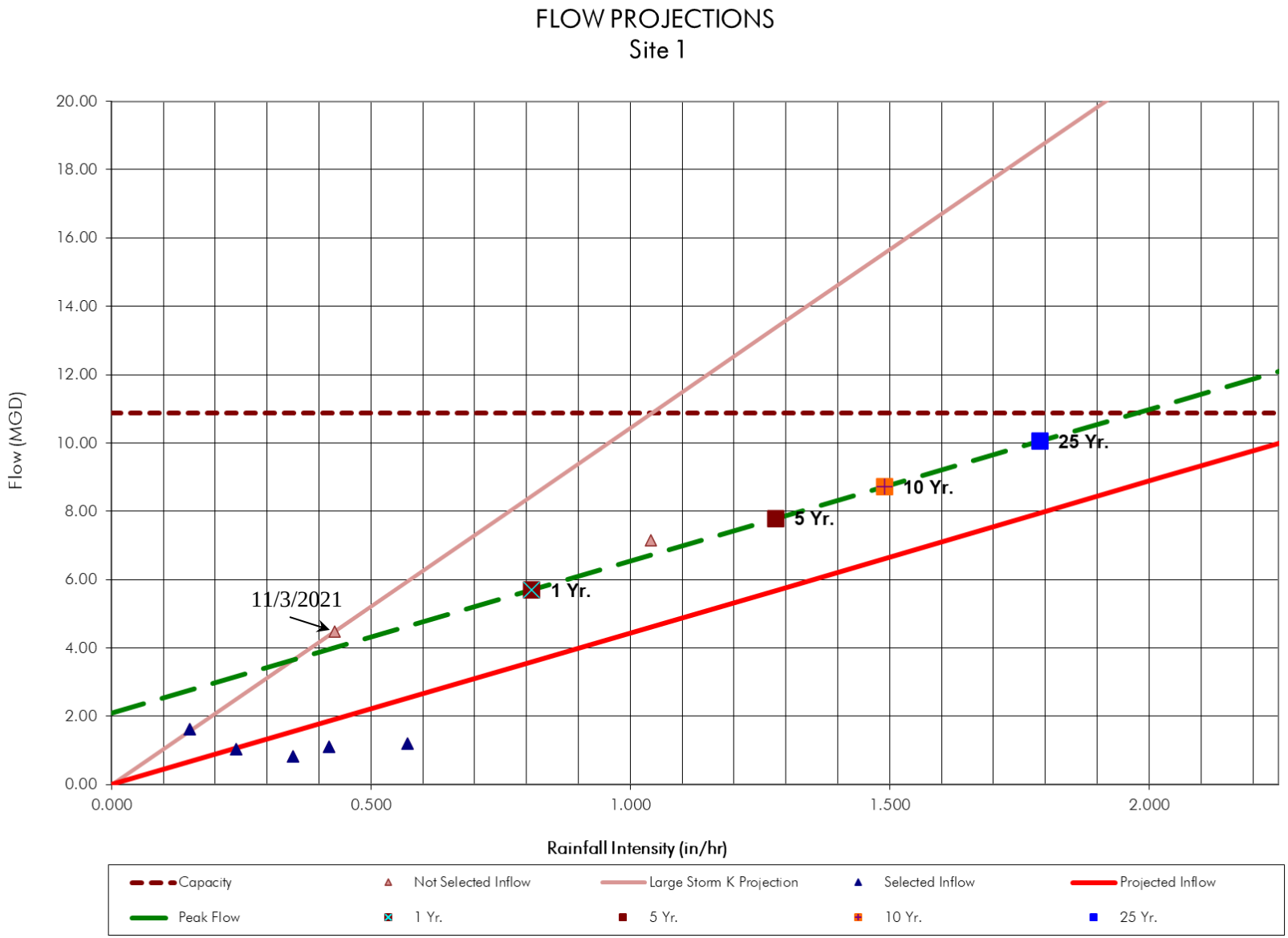
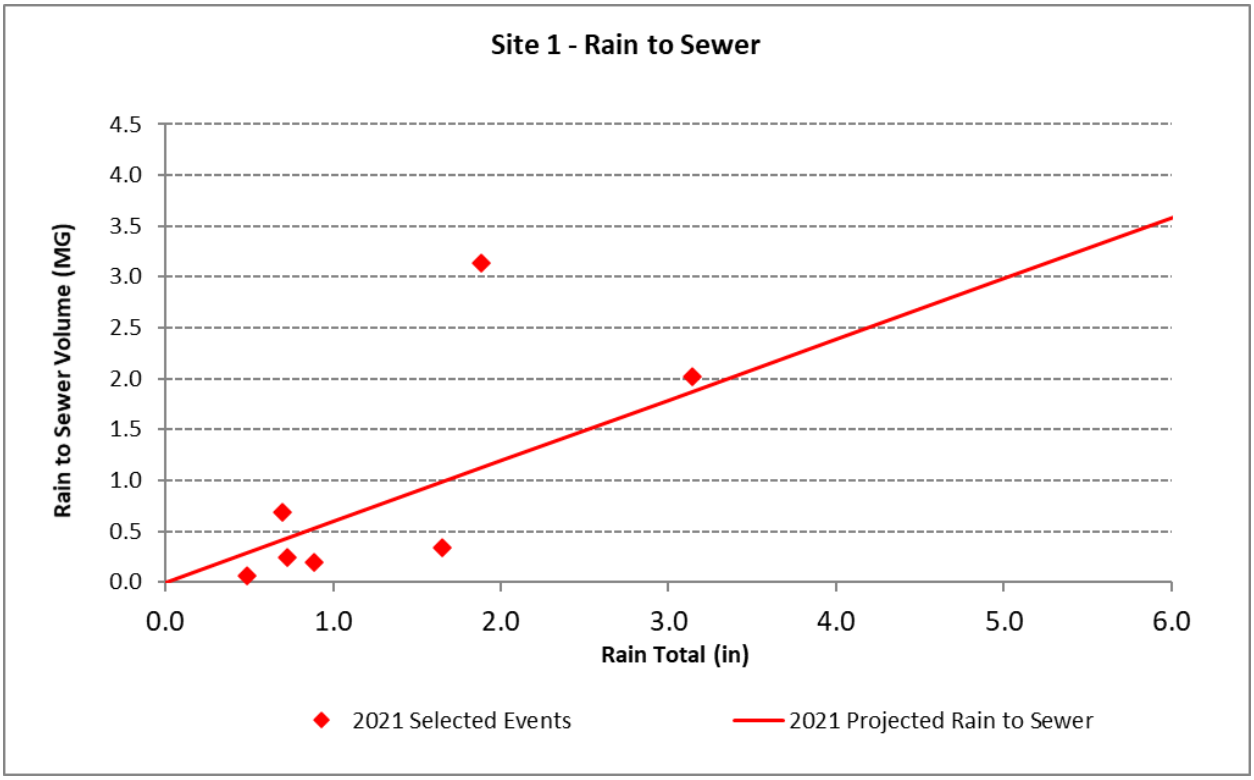


Table 5 –Rain to Sewer Summary (Site 1)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 1 (24")	9/28/2021	1.65	59.452	0.334	0.56%
	10/1/2021	0.73	26.303	0.236	0.90%
	10/11/2021	0.49	17.475	0.065	0.37%
	10/13/2021	3.15	113.318	2.015	1.78%
	10/27/2021	0.89	31.888	0.199	0.62%
	11/3/2021	1.89	67.919	3.138	4.62%
	11/27/2021	0.70	25.222	0.690	2.74%
				Average	**1.66%**

Figure 16 – Rain to Sewer Volumetric Analysis (Site 1)



A.2 Site 2

Description

Site 2 was at manhole N11-003. The meter site is located outside of Wilbarger Wastewater Treatment Plant Site on the northeast side of fenced area. It measured flows in the influent 24" diameter PVC pipe. This meter measures flow that contributes to the Wilbarger Wastewater Treatment Plant.

Observations

The average flow depth was 3.95 inches and flow velocity averaged 2.24 feet per second. This site experienced light to medium grease as reported during the site services. There were a few low-level velocity dropouts that were autocorrected using valid readings. The level remained consistent with manual measurements during site visits.

This site surcharged during one rainfall event in fall 2021.

Table 6 – Surcharge Summary (Site 2)

		Date of Storm	10/13/2021	11/3/2021
		Total Storm Rainfall (in.)	3.15"	1.89"
Site	Diameter (in.)	Storm Duration (hrs.)	6.00	16.83
2	24	Depth from Invert (in.)	-	45.12 (B)

(P) Denotes pressurized flow caused by lack of capacity
(flow velocities generally increase as flow depths increase)
(B) Denotes flow backup caused by downstream restriction
(flow velocities generally decrease as flow depths increase)

Table 7 – Service Interrogations Summary (Site 2)

Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 2	8/30/2021	13:49	24	3.25	3.01	-0.24	3.25	3.24	-0.01	2.25	2.19	-0.06	2.25	2.11	-0.14	Install	Meter installed at in pipe
	9/13/2021	11:07		3.00	2.90	-0.10	3.00	3.00	0.00	1.90	1.90	0.00	2.00	2.25	0.25	Service/Upload	
	9/27/2021	10:58		3.50	3.00	-0.50	4.00	4.00	0.00	2.00	2.10	0.10	2.00	2.00	0.00	Service/Upload	
	10/12/2021	15:48		3.25	3.10	-0.15	4.00	3.90	-0.10	2.00	2.10	0.10	2.00	1.80	-0.20	Service/Upload	
	10/26/2021	15:33		3.00	2.99	-0.01	3.75	3.72	-0.03	2.00	2.05	0.05	2.00	2.02	0.02	Service/Upload	
	11/8/2021	13:40		4.25	4.17	-0.08	4.50	4.50	0.00	2.25	2.36	0.11	2.50	2.49	-0.01	Service/Upload	Medium grease.
	12/1/2021	10:36		5.00	4.86	-0.14	5.00	4.94	-0.06	2.50	2.40	-0.10	2.50	2.39	-0.11	Removal	Light grease.

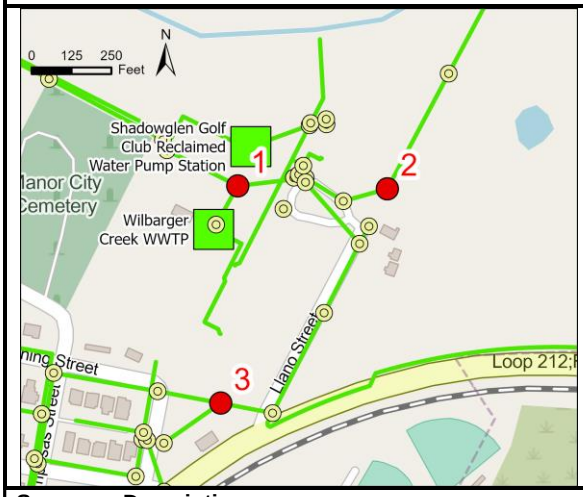
Figure 17 – Flow Meter Site Investigation (Site 2)

Flow Meter Site Investigation

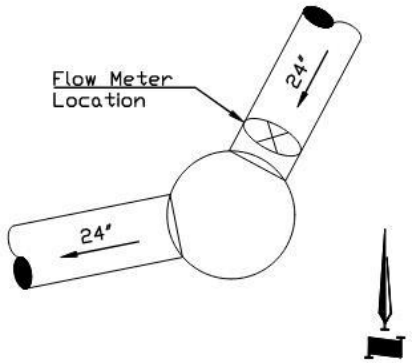
Project: Manor Flow Monitoring	**Location:** City of Manor, TX	**Date/Time:** 12-01-2021 / 9:42	**Crew:** JA-VI
MH#: N11-003	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 24

Site ID:	**Address:**	**Site Quality:**	**Monitoring Purpose:**
2	546 Llano St.	Poor	Short-term FM

Location Map



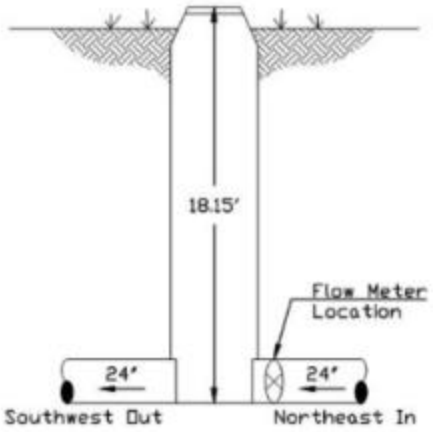
Planar Description



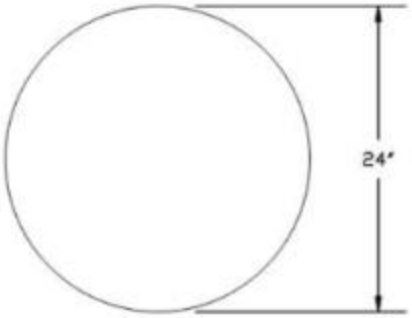
Summary Description:
Located outside of Wilbarger Wastewater Treatment Plant Site on the Northeast side of the fenced area. 100 feet north of last house on Llano Street.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? None		**Manhole Depth (ft):** 18.15	**Surcharge Evidence?** No
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 0.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 24.00	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Standard	**Usable MH Steps?** No
Describe potential hazards:		**Measured Flow Depth (in):** 5.00	**Meter:** ISCO 2150
		Velocity (fps): 2.50	**Cellular Signal Strength:** N/A
		Mounting Band Description: Scissor Jack Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes



Pipe Cross Section

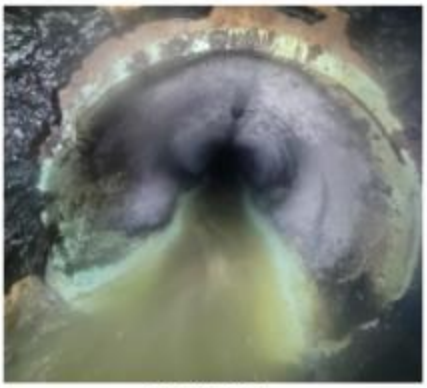


Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE

DOWN

INFLOW



OUTFLOW

Figure 18 – Site Information (Site 2)

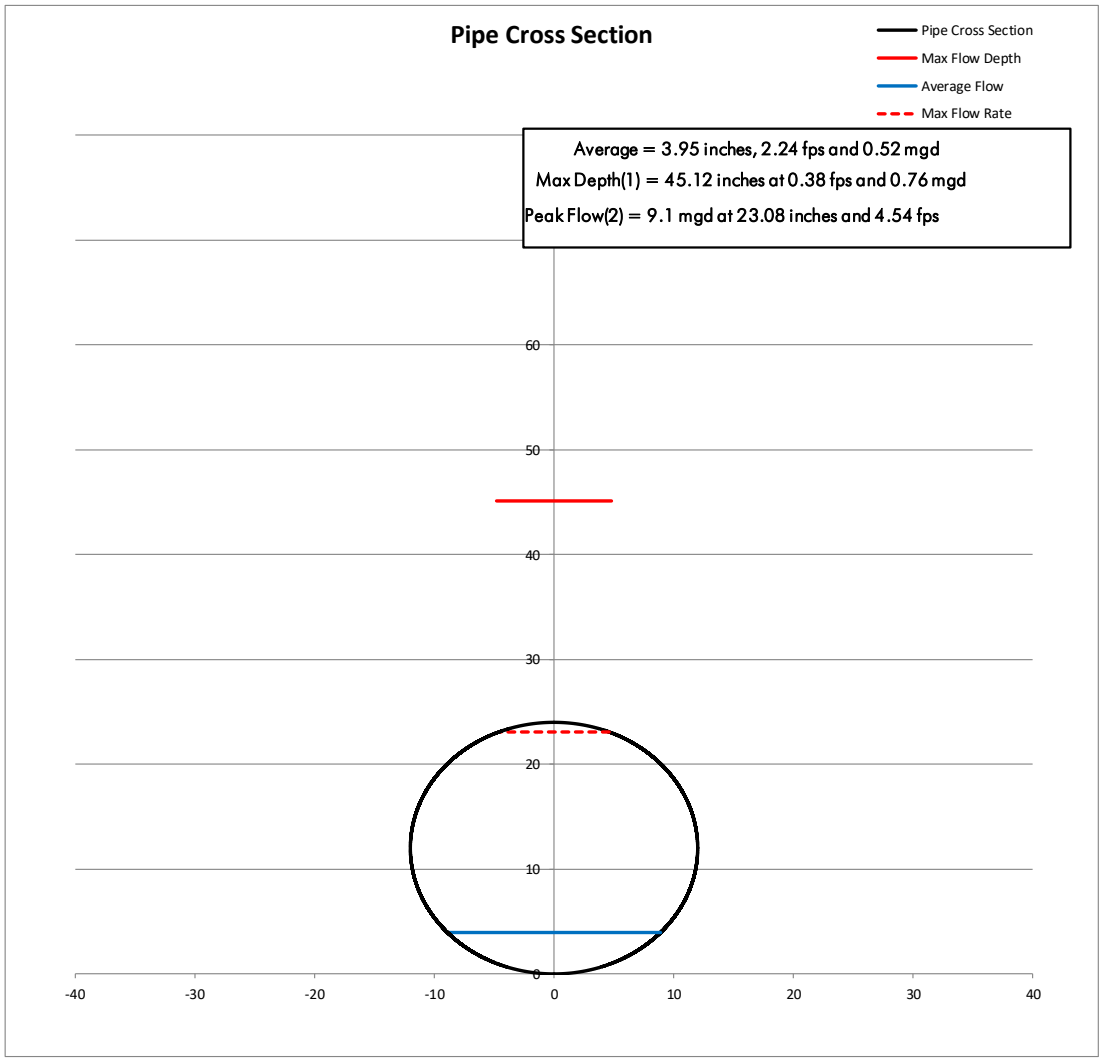
SITE INFORMATION RECORD

Site Information

Meter ID #:	2
Monitoring Program:	Short-Term FM
Manhole #:	N11-003

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	24	
Pipe Width, W (in):	24	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0035	ASSUMEDI



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 2	8/30/2021	24	13:49	3.25	3.24	-0.01	2.25	2.11	-0.14
	9/13/2021		11:07	3.00	3.00	0.00	2.00	2.25	0.25
	9/27/2021		10:58	4.00	4.00	0.00	2.00	2.00	0.00
	10/12/2021		15:48	4.00	3.90	-0.10	2.00	1.80	-0.20
	10/26/2021		15:33	3.75	3.72	-0.03	2.00	2.02	0.02
	11/8/2021		13:40	4.50	4.50	0.00	2.50	2.49	-0.01
	12/1/2021		10:36	5.00	4.94	-0.06	2.50	2.39	-0.11

Figure 19 – August-September Monthly Flow Hydrograph (Site 2)

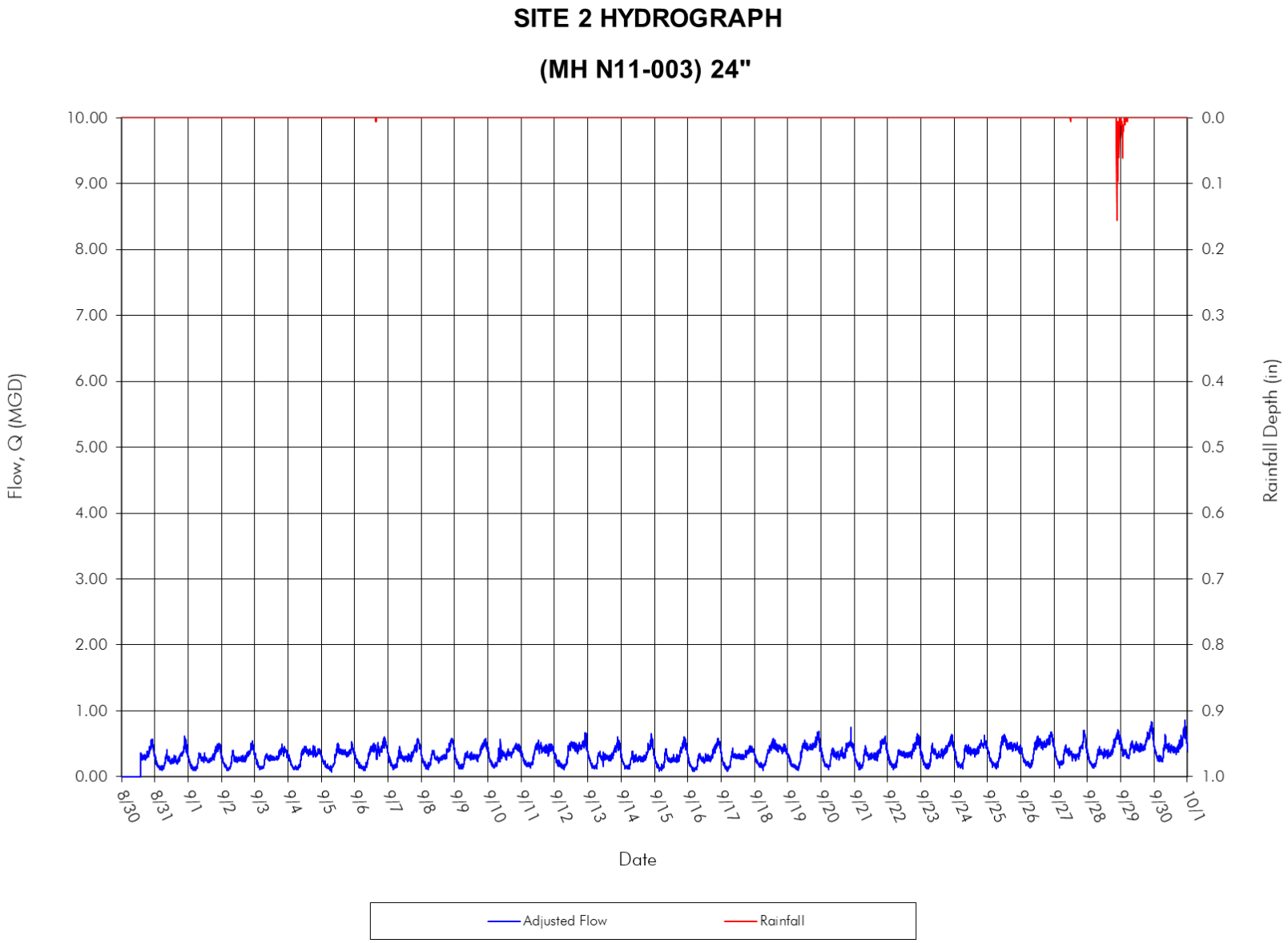


Figure 20 – August-September Monthly Level and Velocity Hydrograph (Site 2)

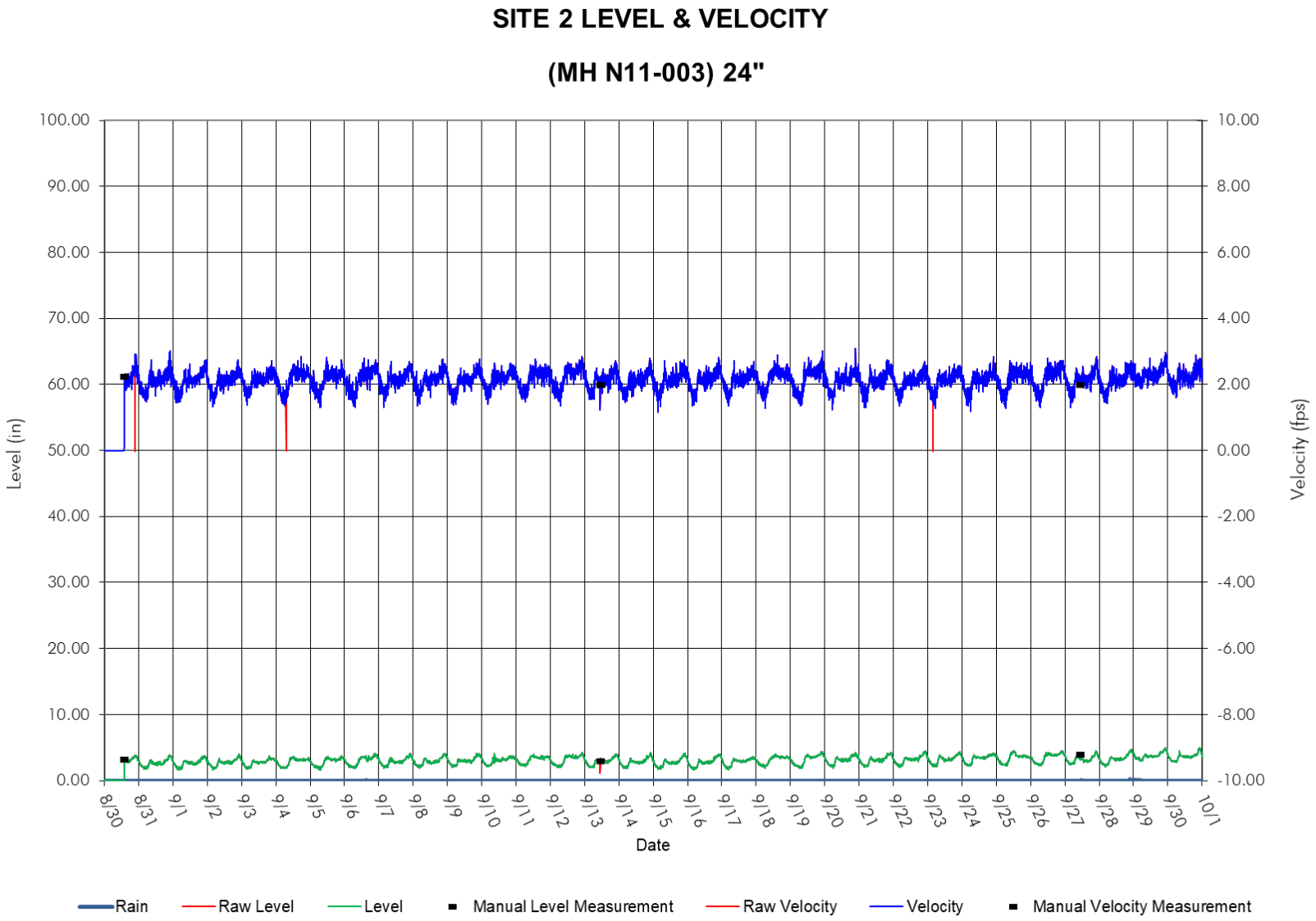


Figure 21 – October Flow Hydrograph (Site 2)

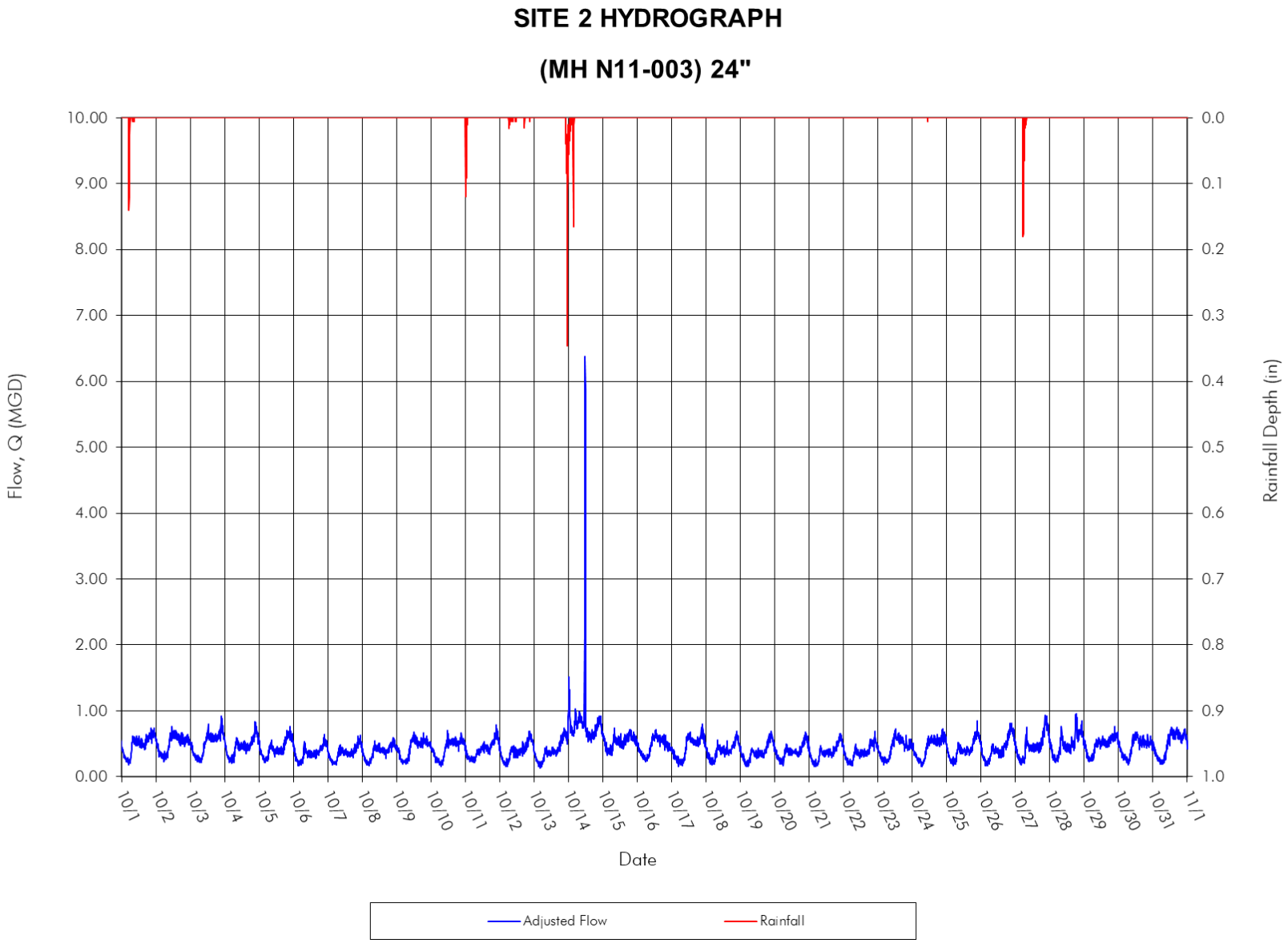


Figure 22 – October Monthly Level and Velocity Hydrograph (Site 2)

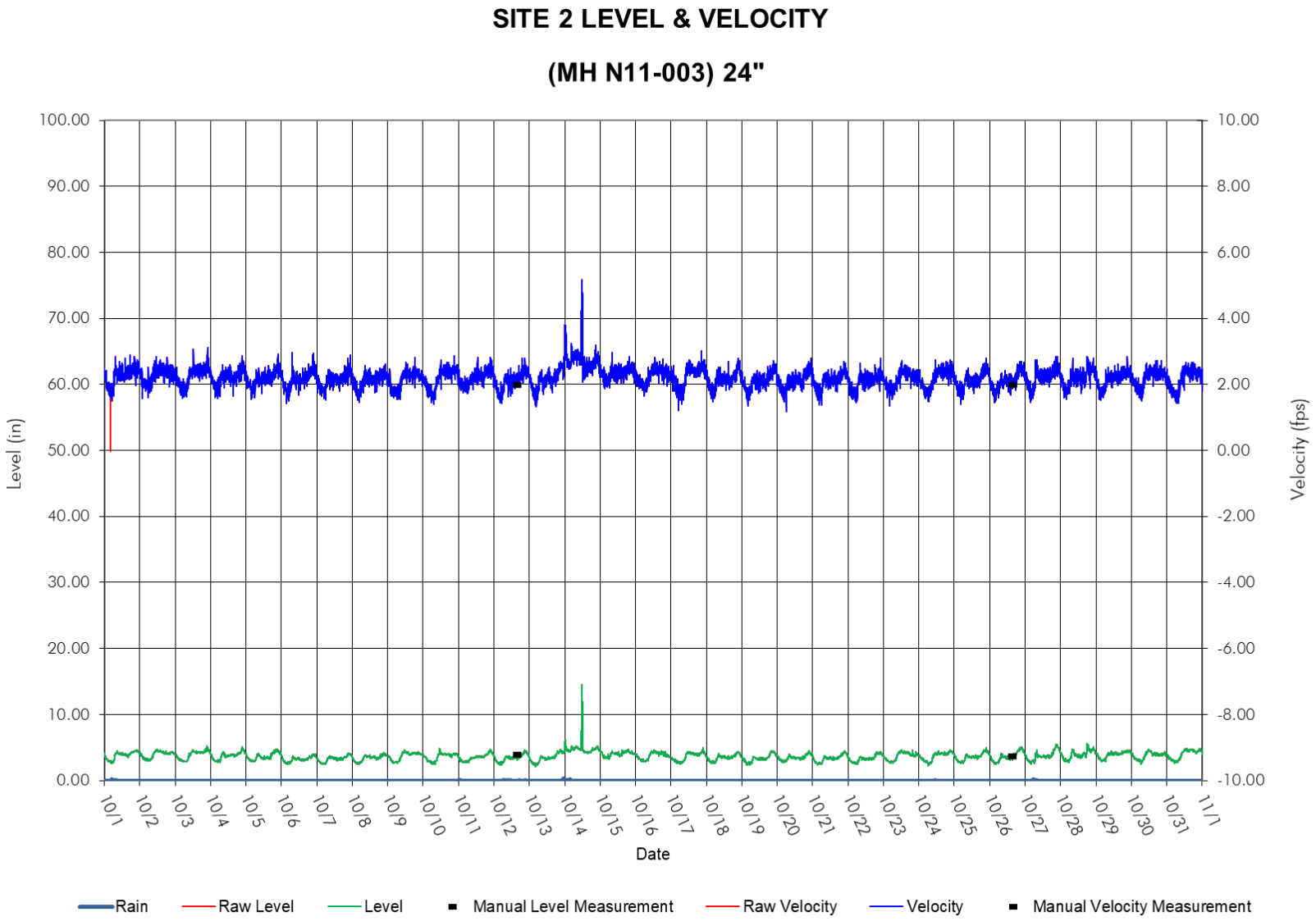


Figure 23 – November-December Monthly Flow Hydrograph (Site 2)

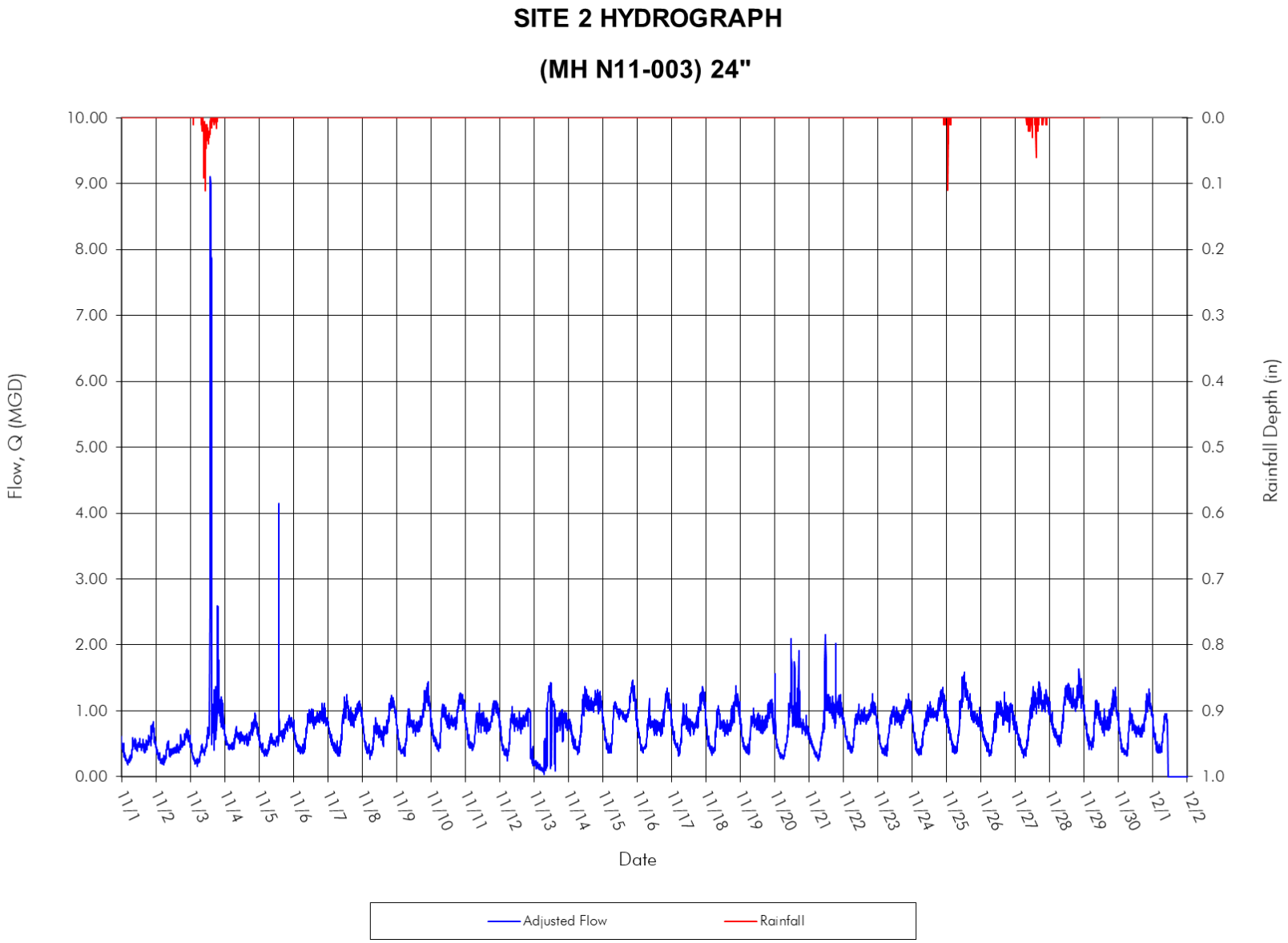


Figure 24 – November-December Level and Velocity Hydrograph (Site 2)

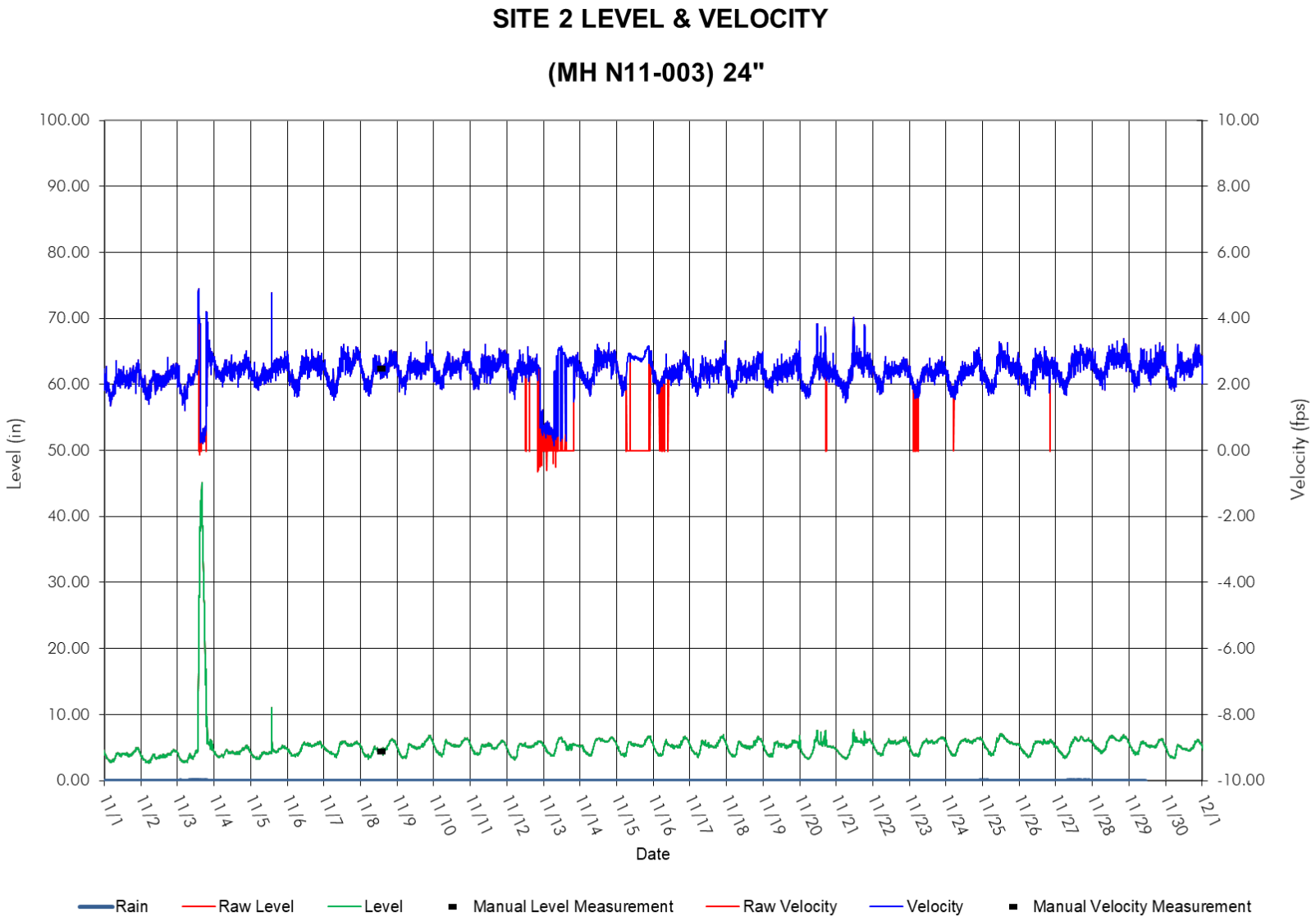


Figure 25 – Overall Flow Hydrograph (Site 2)

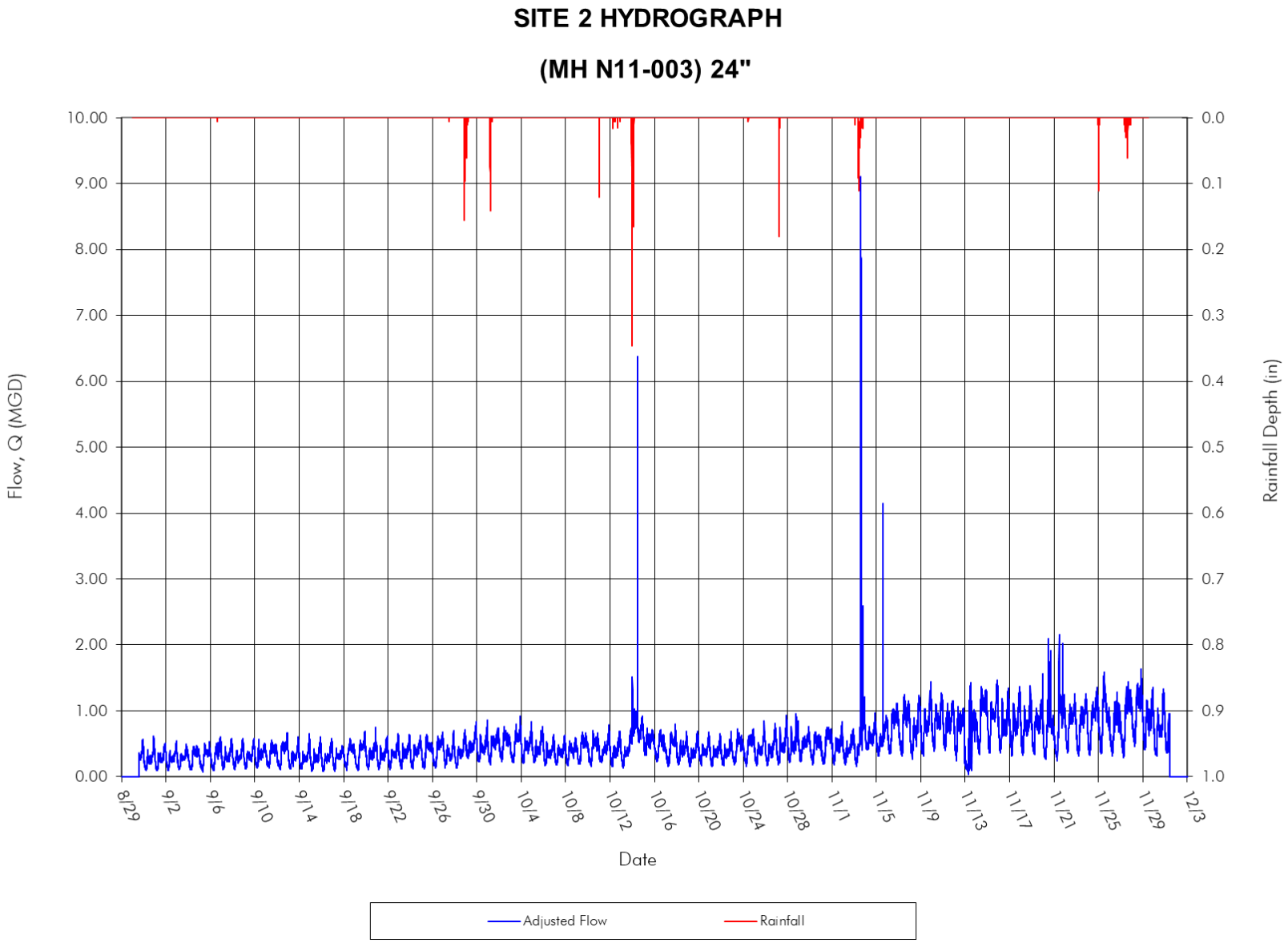


Figure 26 – Overall Level and Velocity Hydrograph (Site 2)

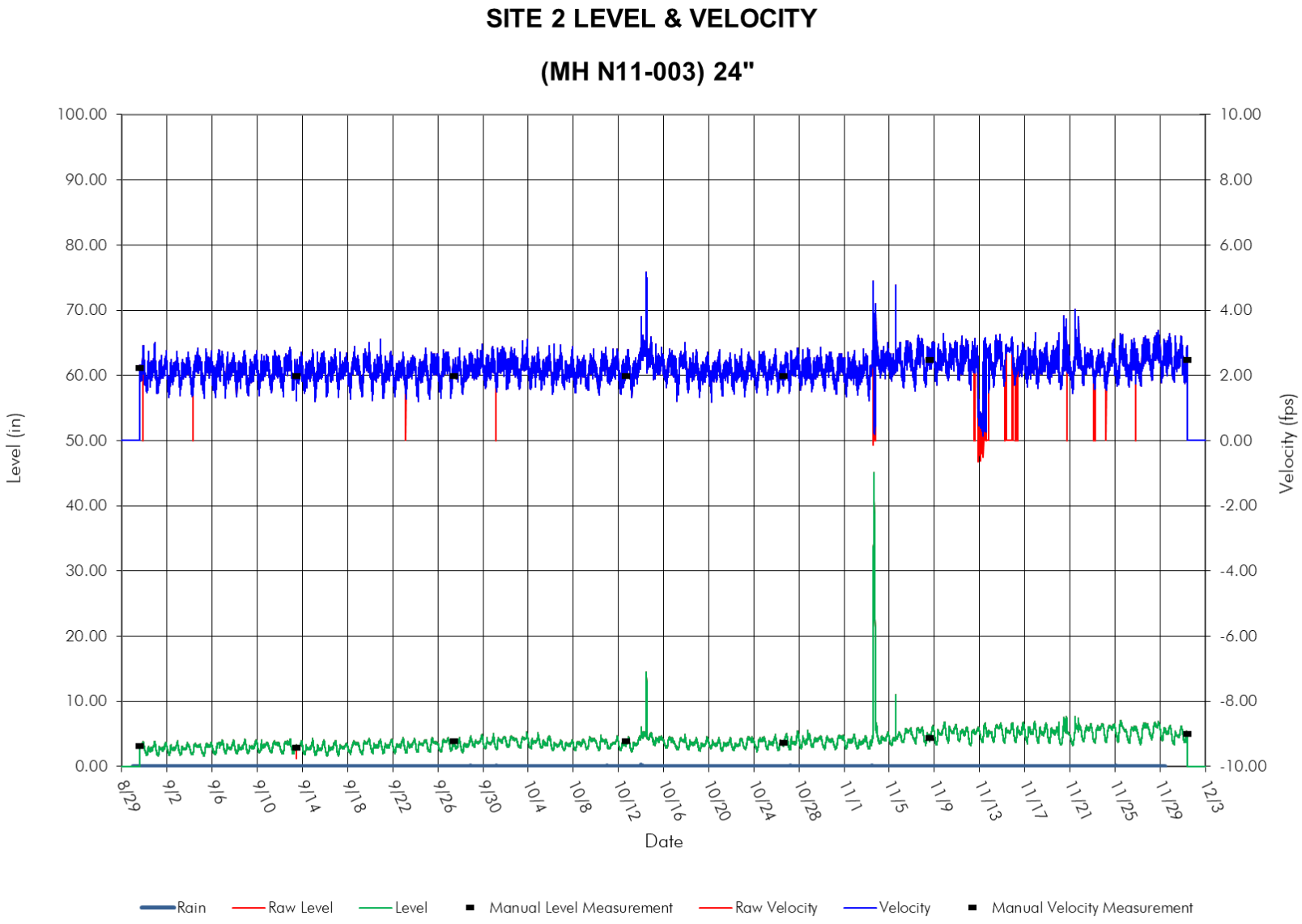


Figure 27 – Standard Flow Scattergraph (Site 2)

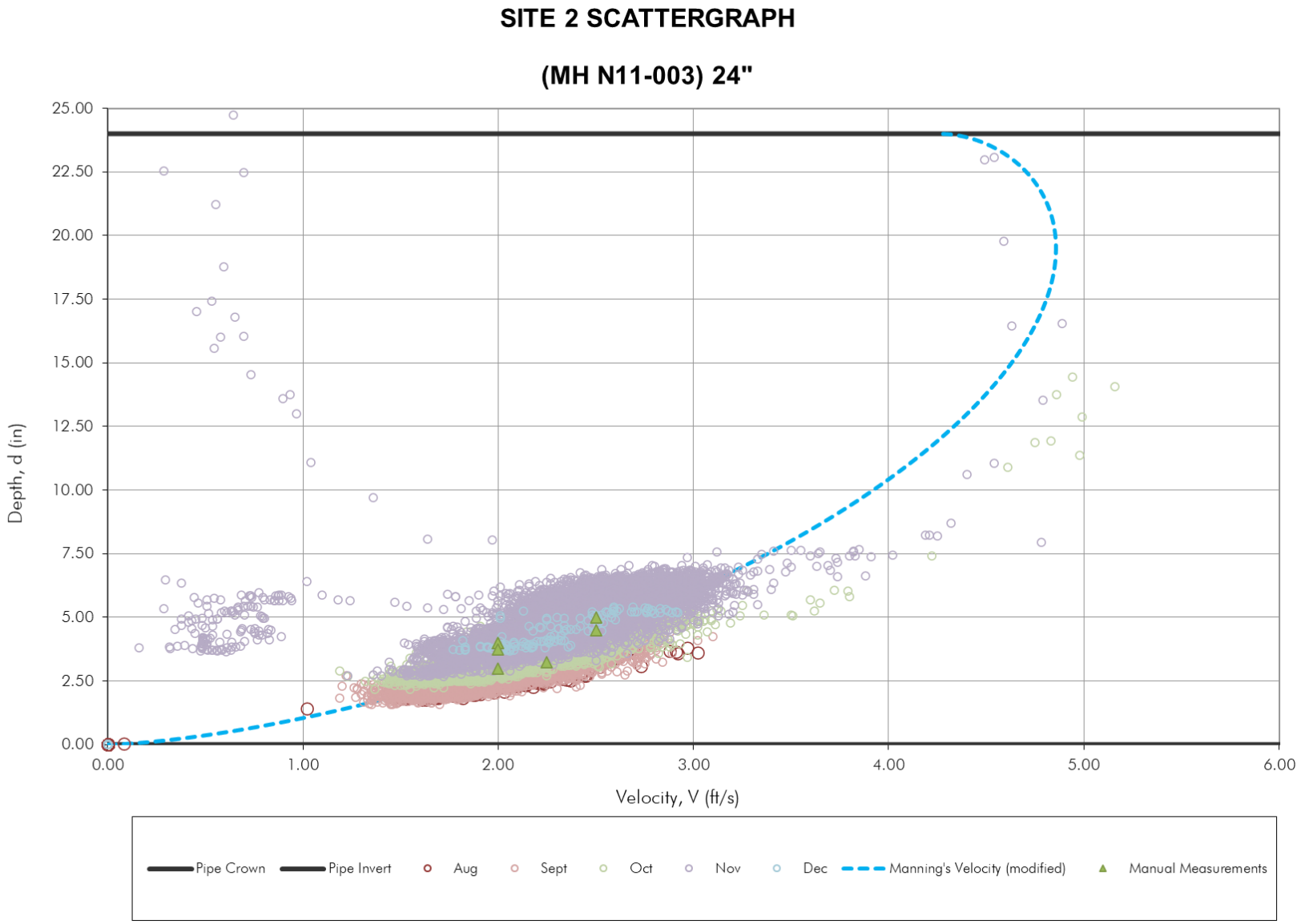


Figure 28 – Surcharged Flow Scattergraph (Site 2)

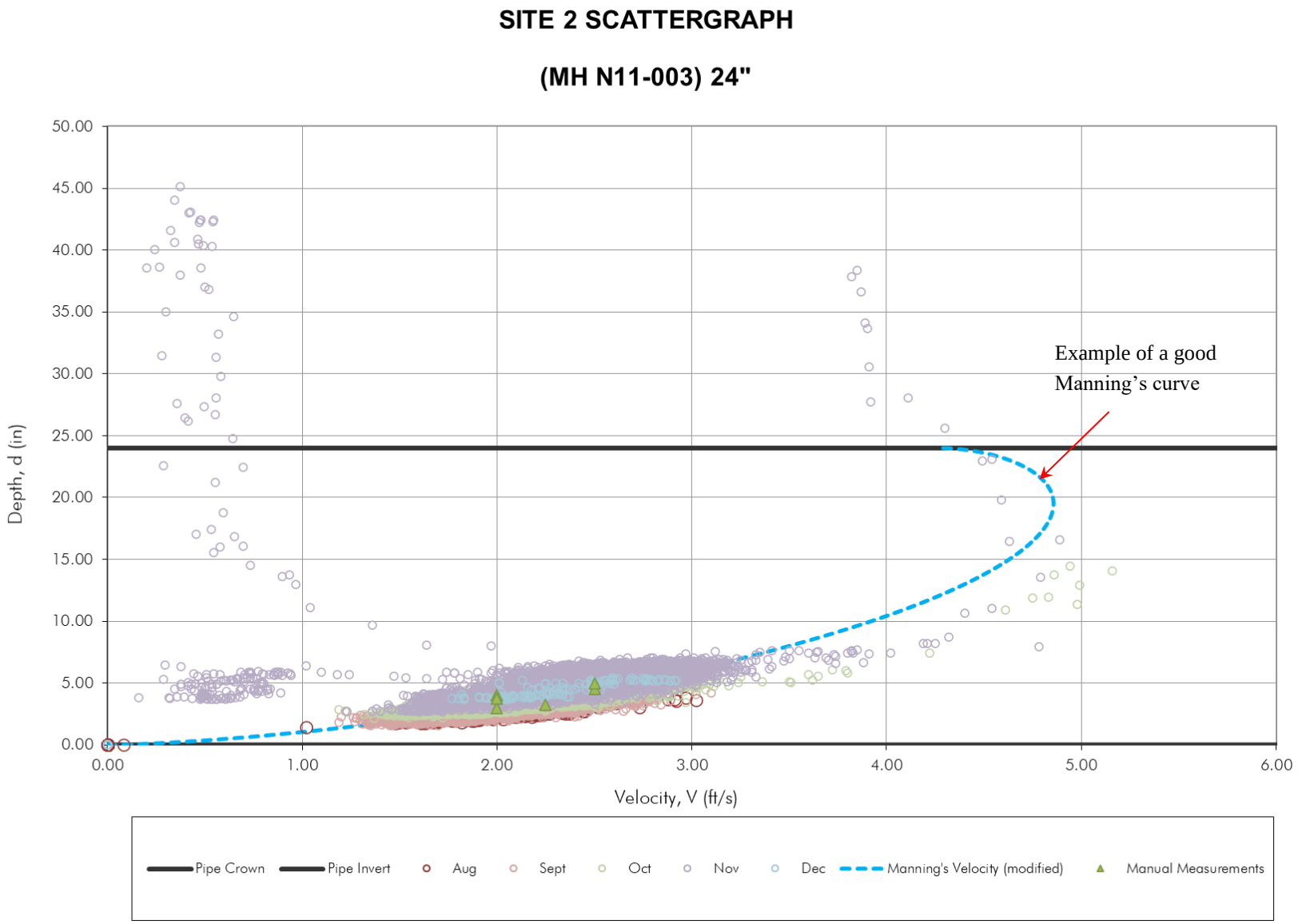


Table 8 – ADDF and Infiltration Summary (Site 2)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name	City of Manor Flow Monitoring Fall 2021
Project No:	14925
Subsystem:	2
Meter:	2
Units of Flow:	MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.364	0.618	1.695	0.150	28-Nov-21	0.569
13-Sep-21	Mon	0.305	0.516	1.695	0.146		
14-Sep-21	Tue	0.292	0.562	1.928	0.142		
15-Sep-21	Wed	0.284	0.538	1.893	0.127		
16-Sep-21	Thu	0.287	0.534	1.857	0.116	04-Nov-21	0.449
17-Sep-21	Fri	0.293	0.426	1.455	0.126	15-Oct-21	0.386
18-Sep-21	Sat	0.345	0.517	1.499	0.161	16-Oct-21	0.280
7 Count		0.310 Average	0.530 Average	1.717 Average	0.138 Average	4 Count	0.421 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.310	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.310	
	Diurnal Peaking Factor (DPF):	1.717	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.283	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.283	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.310	

Figure 29 – Dry Weather Diurnal (Site 2)

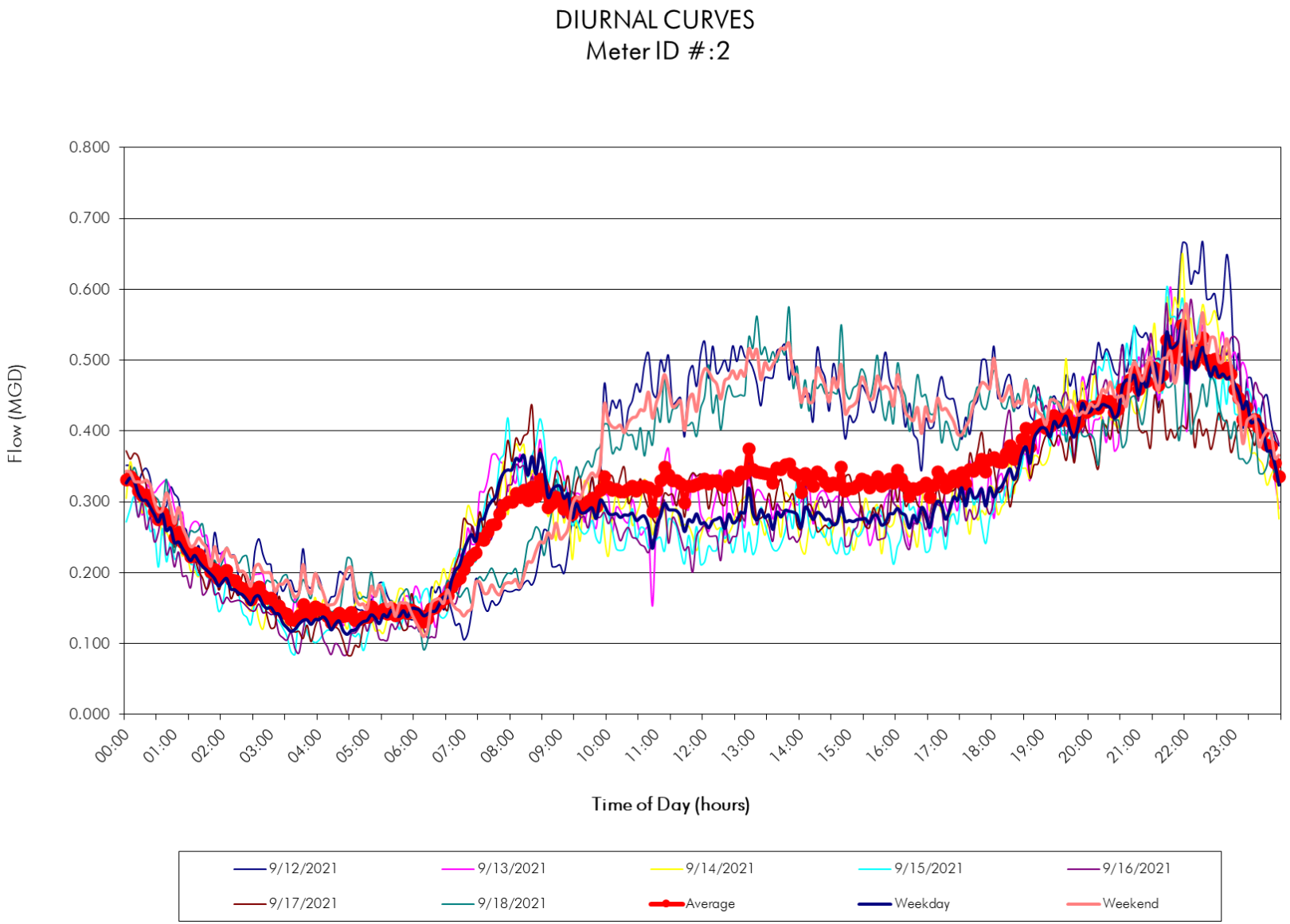


Figure 30 – High/Low Groundwater Diurnal (Site 2)

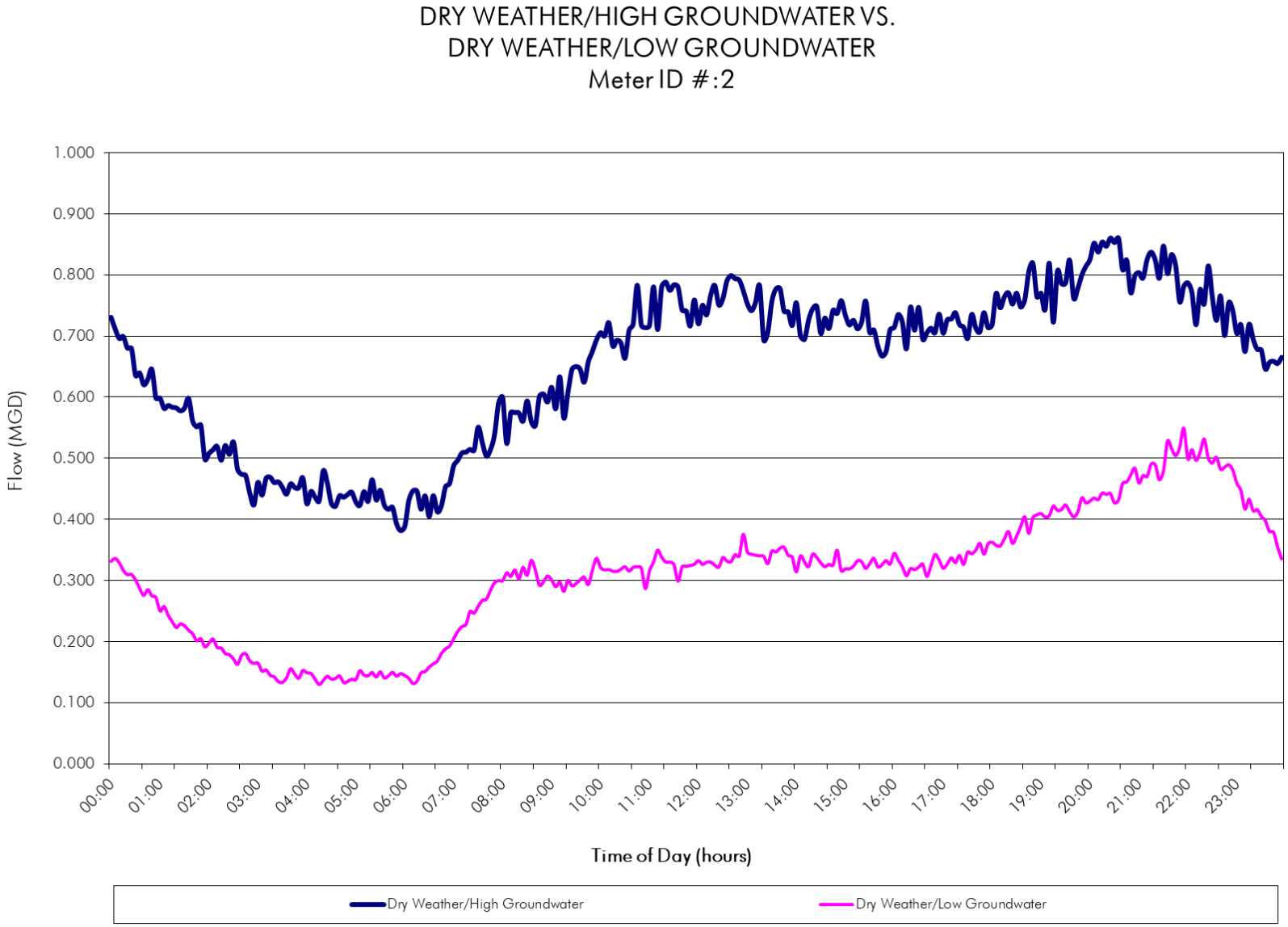


Table 9 – Inflow Calculations and Projections (Site 2)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	2
Meter:	2
Units of Flow:	MGD

Storm Count:	7	Cum. Trib. Area:	762 acres	Pipe Shape:	Circular
Avg Delta Time	169	Cum. Time of Conc.:	105 minutes	Pipe Diameter:	24 in
Avg Kp:	0.00881			Pipe Slope:	0.004 ft/ft
Avg Selected Kp:	0.01509			Pipe Capacity:	8.67 mgd
				ADDF Cum.:	0.310 mgd
				ADDF Peak. Factor:	1.72
				Peak ADDF Flow:	0.532 mgd
				Infiltration:	0.283 mgd
				Cum. Peak Flow:	0.815 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.815
1	0.890	6.615	10.235	7.430
2	1.110	8.250	12.765	9.065
5	1.410	10.480	16.216	11.295
10	1.640	12.190	18.861	13.005
25	1.960	14.568	22.541	15.383
50	2.220	16.501	25.531	17.316
100	2.480	18.433	28.521	19.248

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/28/21 21:00	1.65	7.92	9/28/21 21:55	9/28/21 21:20	35	0.630	09/21/21	0.588	0.042	0.610	0.00014	n						No reaction
10/1/21 4:55	0.73	3.67	10/1/21 7:40	10/1/21 5:05	155	0.614	09/30/21	0.395	0.219	0.400	0.00111	n						No reaction
10/11/21 0:05	0.49	1.25	10/11/21 0:20	10/11/21 0:05	15	0.429	10/10/21	0.423	0.006	0.280	0.00005	n						No reaction
10/13/21 21:55	3.15	6.00	10/14/21 11:35	10/14/21 3:30	485	6.377	10/13/21	0.336	6.041	1.150	0.01067	y	0.01067					
10/27/21 5:15	0.89	2.42	10/27/21 8:05	10/27/21 5:25	160	0.747	10/26/21	0.446	0.302	0.470	0.00130	y	0.00130					
11/3/21 2:10	1.89	16.83	11/3/21 14:00	11/3/21 10:35	205	9.102	11/02/21	0.389	8.713	0.440	0.04021	y	0.04021					Surcharged just after peak
11/27/21 7:45	0.70	13.92	11/27/21 16:35	11/27/21 14:25	130	1.440	11/20/21	0.754	0.686	0.170	0.00819	y	0.00819					

Figure 31 – Inflow Projections (Site 2)

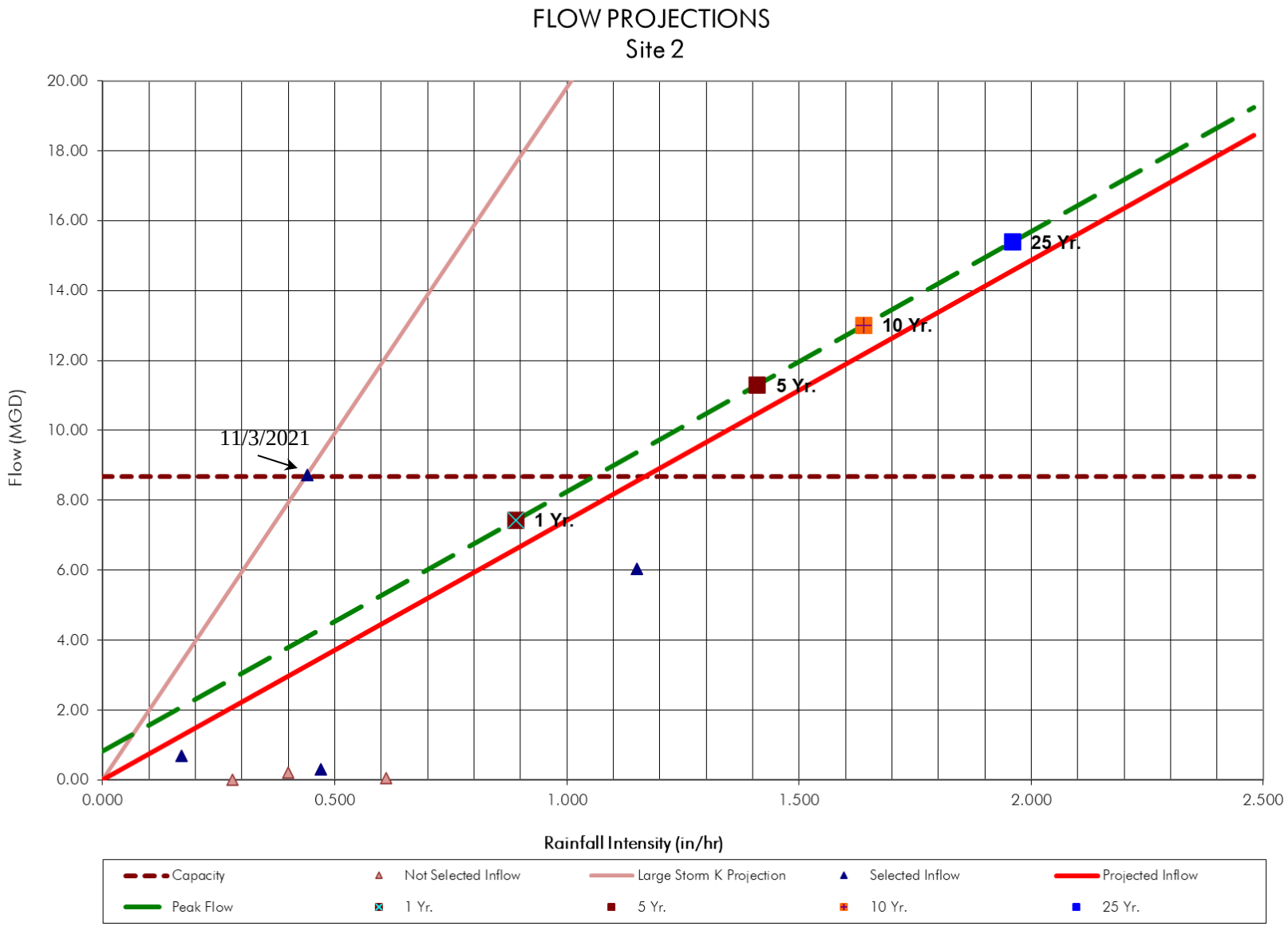
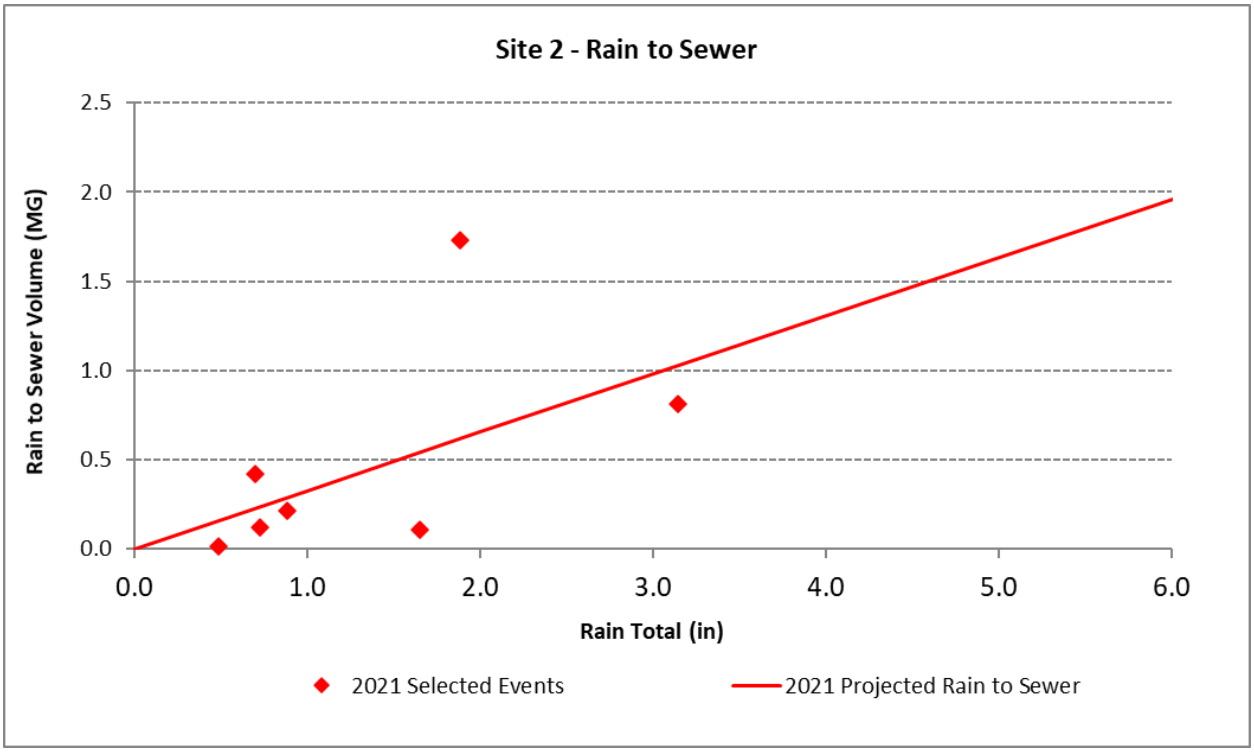


Table 10 –Rain to Sewer Summary (Site 2)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 2 (24")	9/28/2021	1.65	34.139	0.109	0.32%
	10/1/2021	0.73	15.104	0.124	0.82%
	10/11/2021	0.49	10.035	0.015	0.15%
	10/13/2021	3.15	65.070	0.815	1.25%
	10/27/2021	0.89	18.311	0.216	1.18%
	11/3/2021	1.89	39.001	1.727	4.43%
	11/27/2021	0.70	14.483	0.418	2.89%
				Average	**1.58%**

Figure 32 – Rain to Sewer Volumetric Analysis (Site 2)



A.3 Site 3

Description

Site 3 (manhole O10-027) is located in greenbelt between Gregg Street and Llano Street. The flow meter measures flow in the 15" diameter PVC outflow pipe. Flows from Site 4 and Site 5 are pumped into the metered-out pipe. This meter site contributes to the Wilbarger Wastewater Treatment Plant and is an exterior basin to Site 1. Flows from Basin 4 and Basin 5 are pumped in via the Wildhorse Lift Station.

Observations

The average flow depth for this site was 1.49 inches and 2.9 feet per second for the 2021 monitoring period. This site was considered a good metering site but did experience some light to medium grease at site visits. There were a few velocity dropouts that were corrected using valid readings. Level readings remained consistent with manual measurements at site visits. The flow data reflects the "on" and "off" cycling as it is located downstream of the Wildhorse Creek lift station.

There wasn't much reaction to most storm events. However, this site surcharged due to backups during the two larger storms that took place during the fall 2021 flow monitoring.

Table 11 – Surcharge Summary (Site 3)

		Date of Storm	10/13/2021	11/3/2021
		Total Storm Rainfall (in.)	3.15"	1.89"
Site	Diameter (in.)	Storm Duration (hrs.)	6.00	16.83
3	15	Depth from Invert (in.)	17.47 (B)	24.74 (B)

(P) Denotes pressurized flow caused by lack of capacity
(flow velocities generally increase as flow depths increase)
(B) Denotes flow backup caused by downstream restriction
(flow velocities generally decrease as flow depths increase)

Table 12 – Service Interrogations Summary (Site 3)

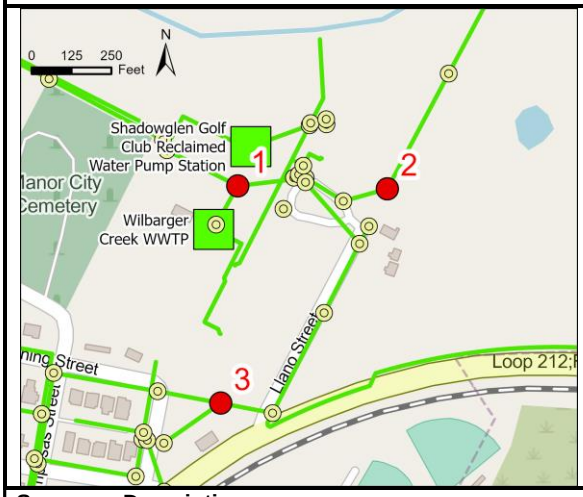
Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 3	8/30/2021	14:58	15	1.00	0.88	-0.12	1.00	0.97	-0.03	0.85	0.69	-0.16	0.85	0.75	-0.10	Install	Meter installed at out pipe
	9/13/2021	11:33		1.00	0.90	-0.10	1.25	0.80	-0.45	2.25	2.70	0.45	2.25	2.40	0.15	Service/Upload	
	9/27/2021	11:20		1.50	1.40	-0.10	1.00	1.20	0.20	1.75	1.75	0.00	2.30	2.30	0.00	Service/Upload	
	10/12/2021	15:00		1.76	1.00	-0.76	1.00	0.90	-0.10	1.00	1.50	0.50	1.00	1.30	0.30	Service/Upload	
	10/26/2021	15:52		1.50	1.12	-0.38	1.50	1.20	-0.30	1.75	1.77	0.02	2.00	1.94	-0.06	Service/Upload	
	11/8/2021	14:03		1.50	1.59	0.09	1.50	1.64	0.14	3.00	3.07	0.07	2.75	2.74	-0.01	Service/Upload	Medium to heavy grease on the sides.
	11/30/2021	14:36		1.50	1.06	-0.44	1.50	1.07	-0.43	1.50	1.46	-0.04	1.50	1.52	0.02	Removal	Light grease.

Figure 33 – Flow Meter Site Investigation (Site 3)

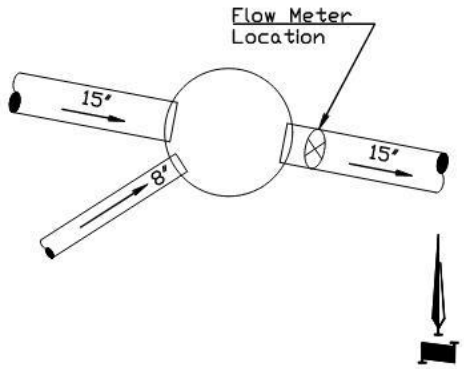
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 11-30-2021 / 14:36	**Crew:** JA-VI
MH#: O10-027	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 15
Site ID: 3	**Address:** Gregg St.	**Site Quality:** Fair	**Monitoring Purpose:** Short-term FM

Location Map



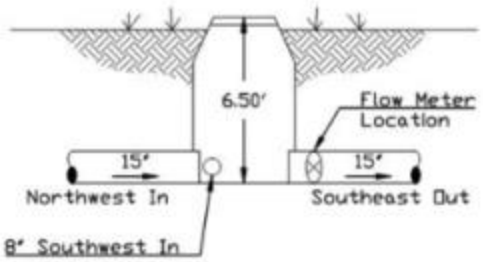
Planar Description



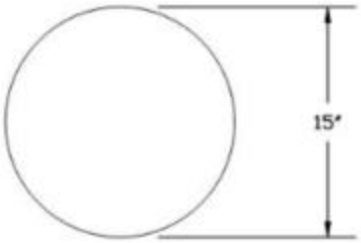
Summary Description:
Located in greenbelt between Gregg Street and Llano Street. Accessible through both roads and manhole has a wastewater green post marker.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? None		**Manhole Depth (ft):** 6.50	**Surcharge Evidence?** No
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 0.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 32.00	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Standard	**Usable MH Steps?** No
Describe potential hazards:		**Measured Flow Depth (in):** 1.50	**Meter:** ISCO 2150
		Velocity (fps): 1.50	**Cellular Signal Strength:** N/A
		Mounting Band Description: Scissor Jack Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes



Pipe Cross Section



Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE

DOWN

INFLOW

OUTFLOW

GBA

Figure 34 – Site Information (Site 3)

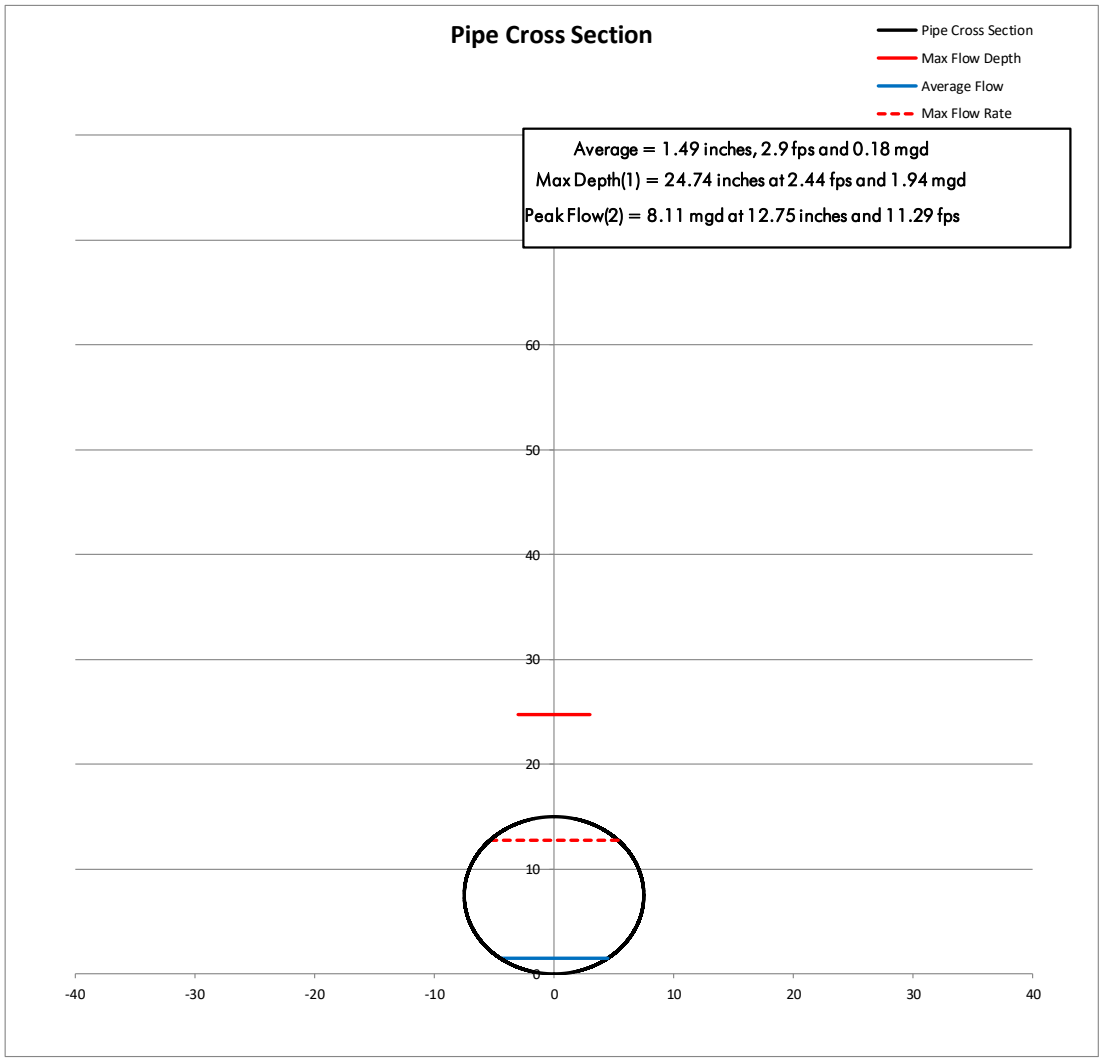
SITE INFORMATION RECORD

Site Information

Meter ID #:	3
Monitoring Program:	Short-Term FM
Manhole #:	O10-027

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	15	
Pipe Width, W (in):	15	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0220	ASSUMEDI



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 3	8/30/2021	15	14:58	1.00	0.97	-0.03	0.85	0.75	-0.10
	9/13/2021		11:33	1.25	0.80	-0.45	2.25	2.40	0.15
	9/27/2021		11:20	1.00	1.20	0.20	2.30	2.30	0.00
	10/12/2021		15:00	1.00	0.90	-0.10	1.00	1.30	0.30
	10/26/2021		15:52	1.50	1.20	-0.30	2.00	1.94	-0.06
	11/8/2021		14:03	1.50	1.64	0.14	2.75	2.74	-0.01
	11/30/2021		14:36	1.50	1.07	-0.43	1.50	1.52	0.02

Figure 35 – August-September Monthly Flow Hydrograph (Site 3)

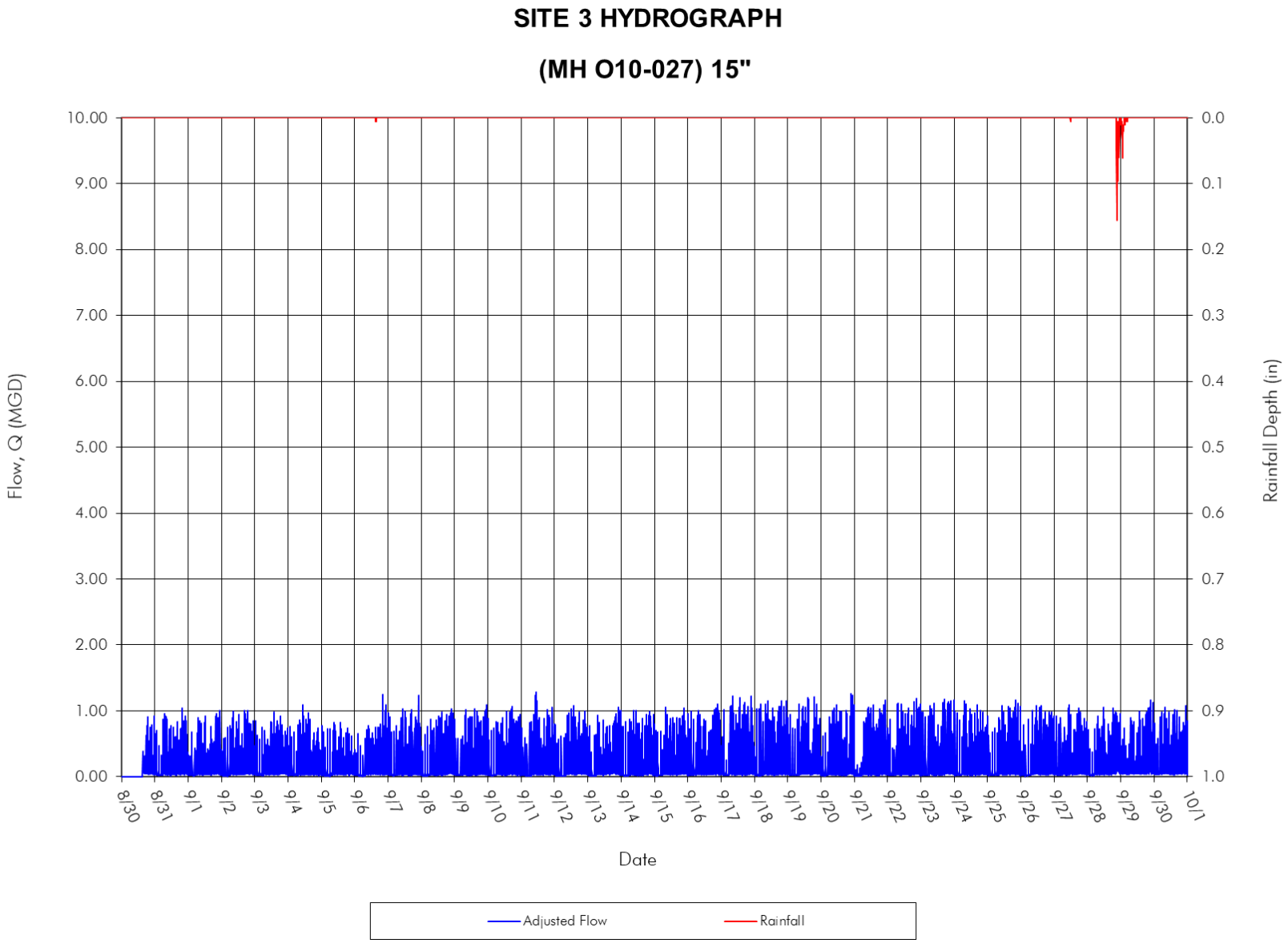


Figure 36 – August-September Monthly Level and Velocity Hydrograph (Site 3)

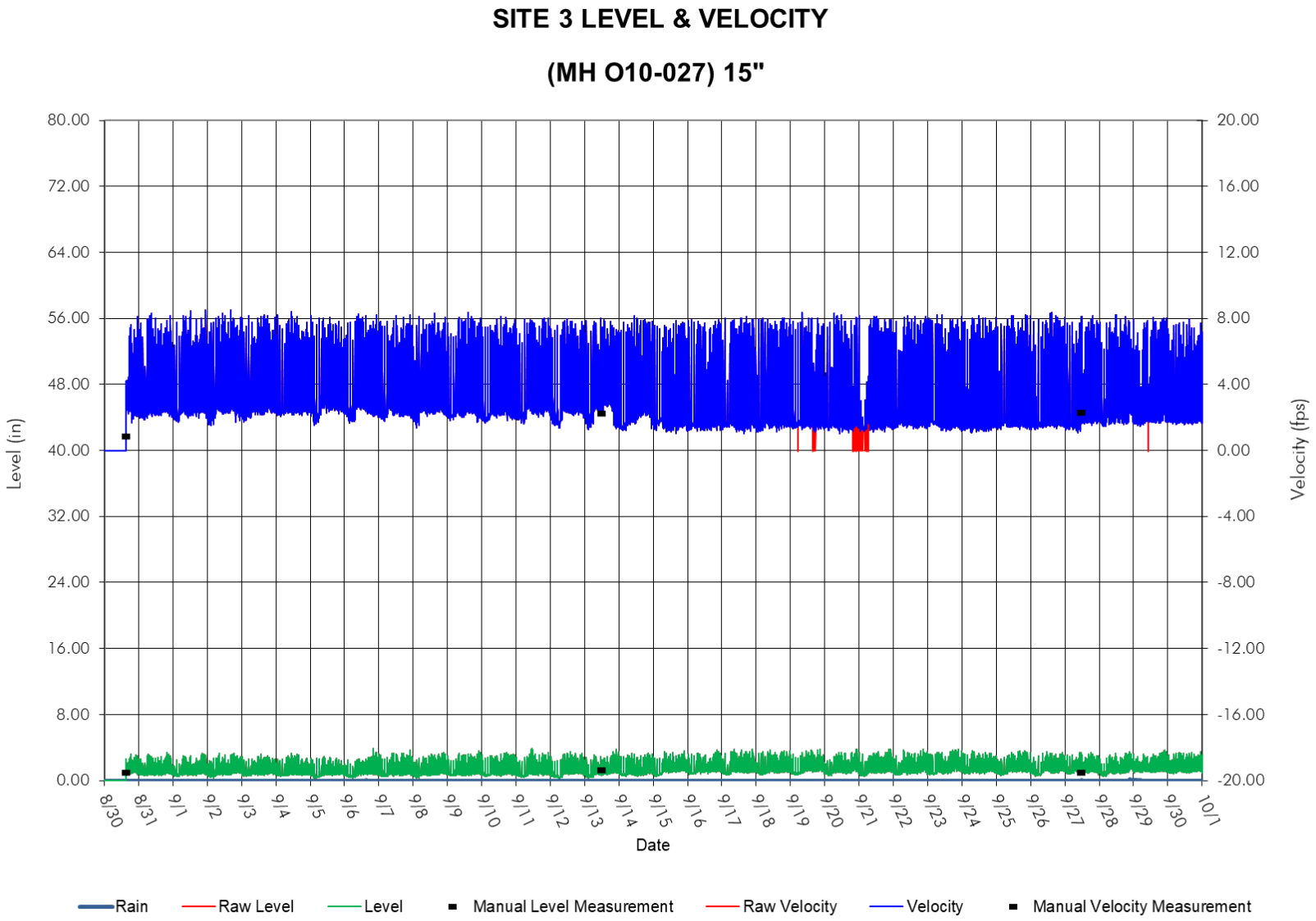


Figure 37 – October Flow Hydrograph (Site 3)

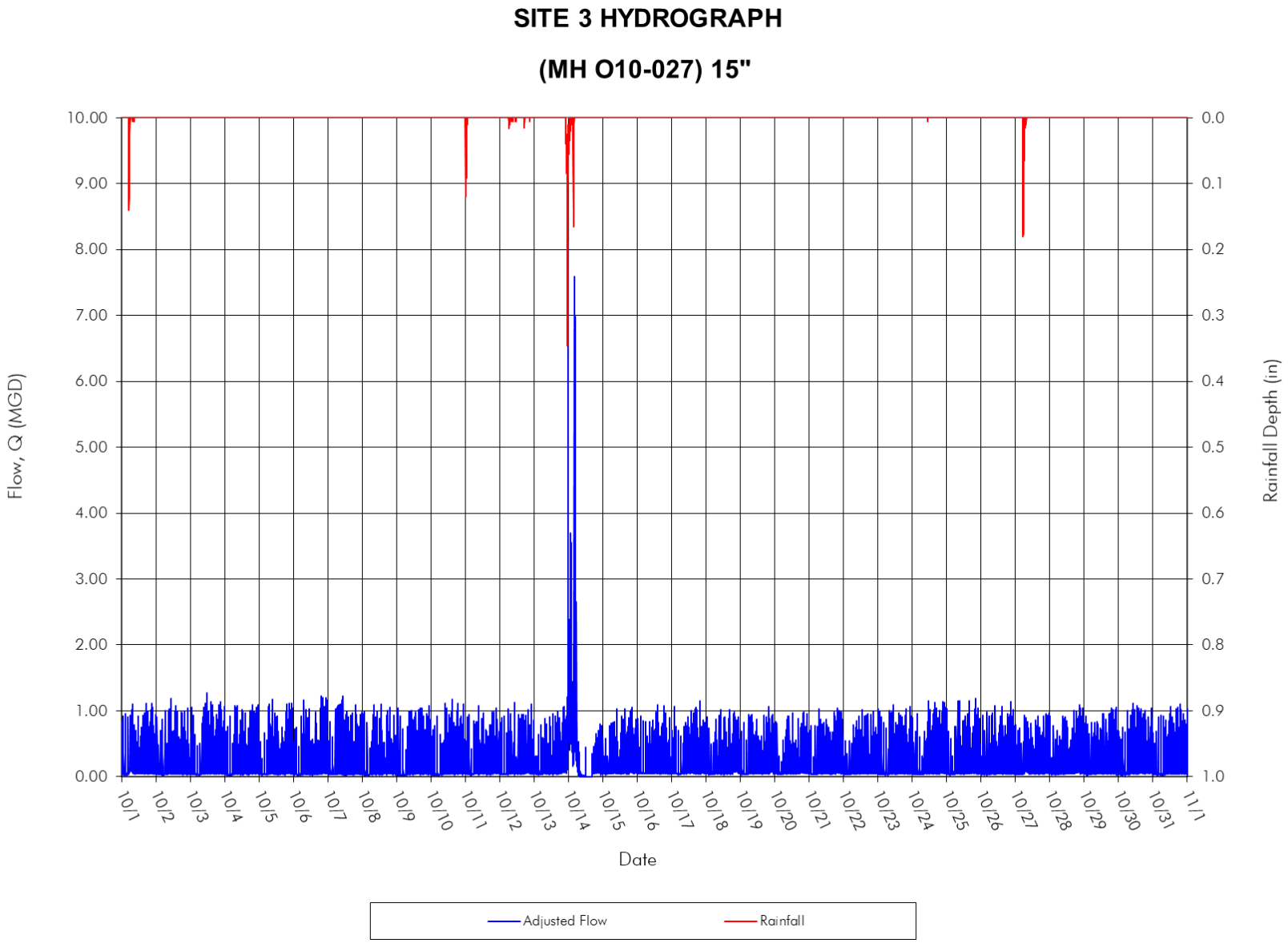


Figure 38 – October Monthly Level and Velocity Hydrograph (Site 3)

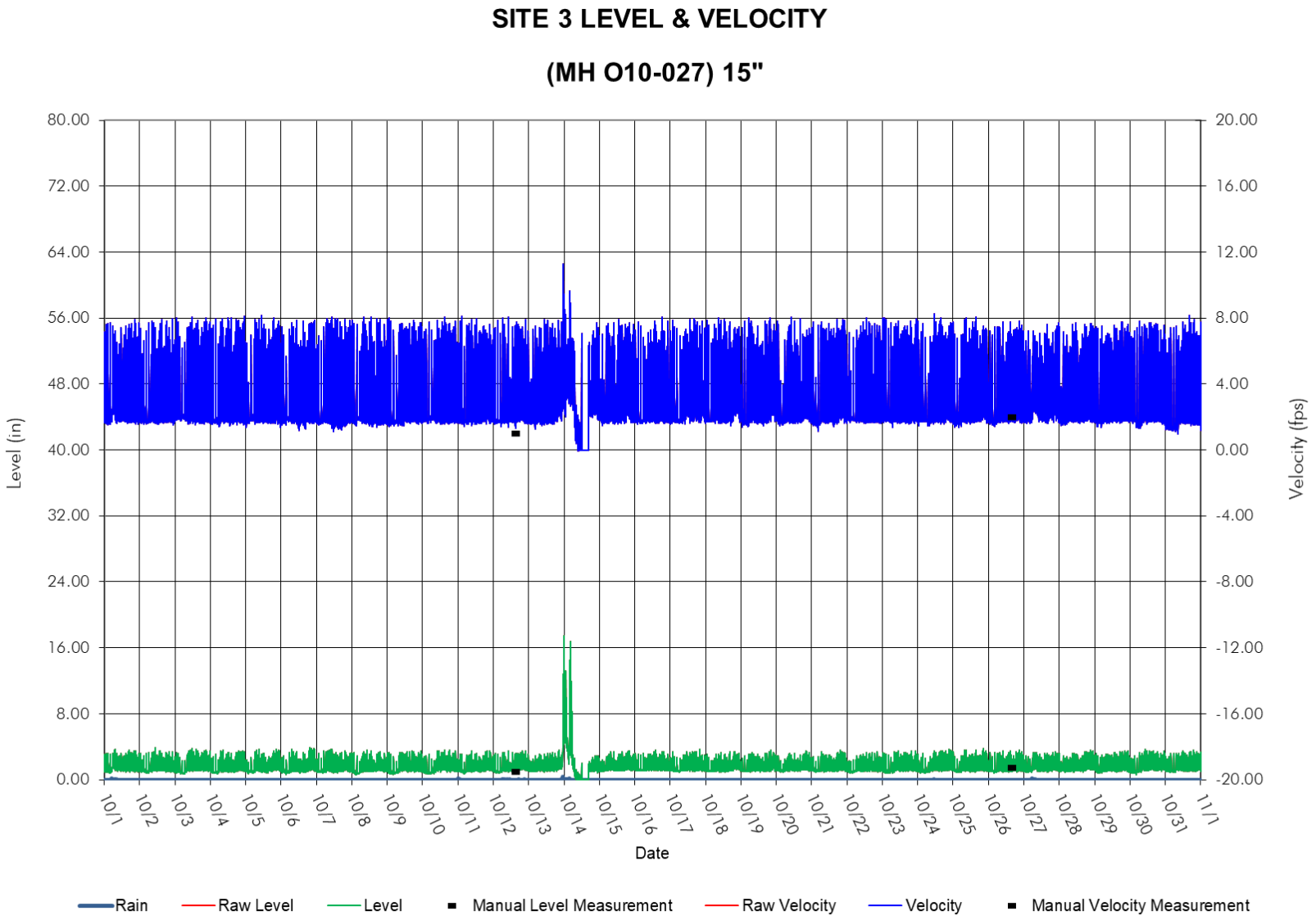


Figure 39 – November-December Monthly Flow Hydrograph (Site 3)

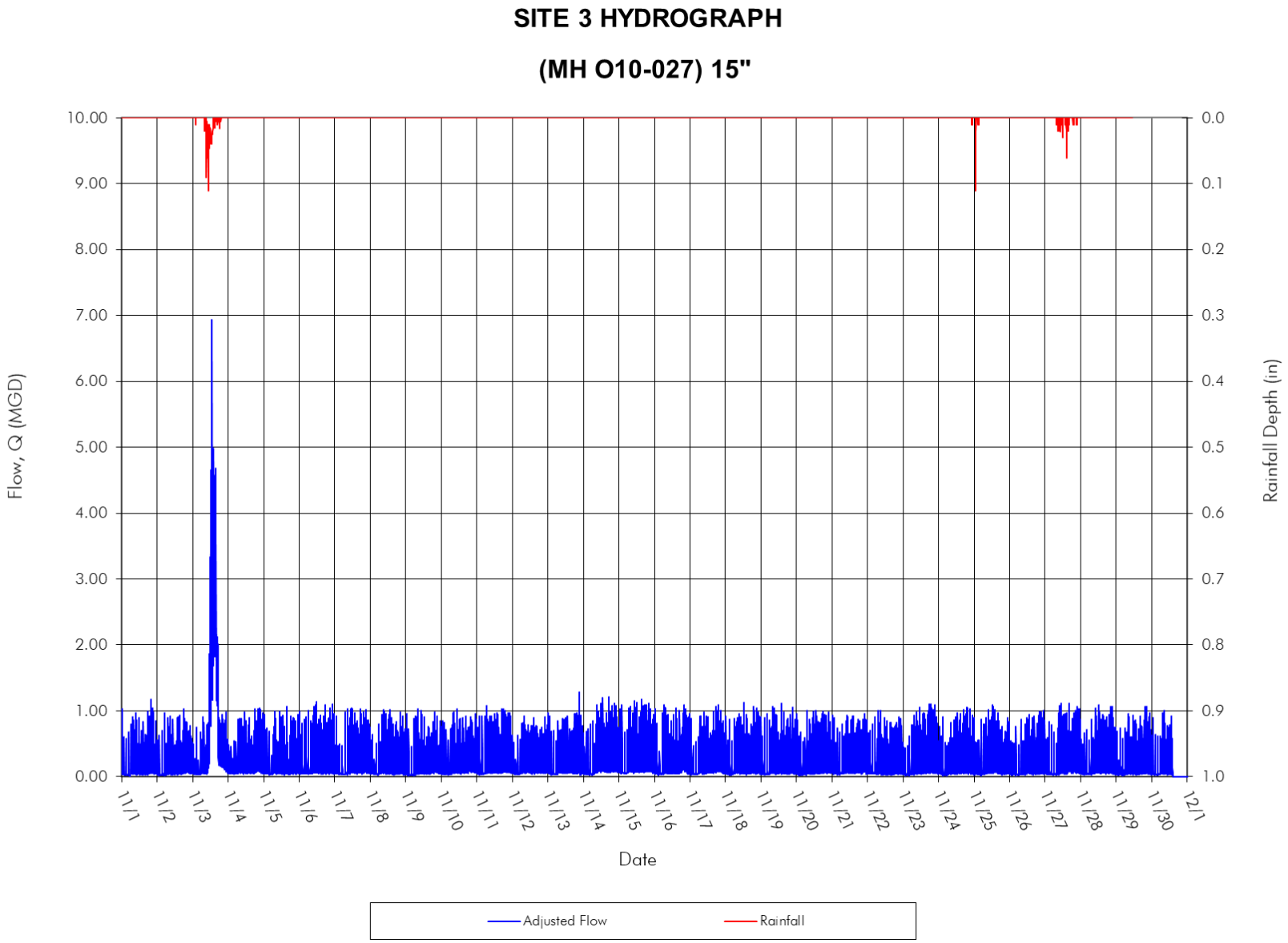


Figure 40 – November-December Level and Velocity Hydrograph (Site 3)

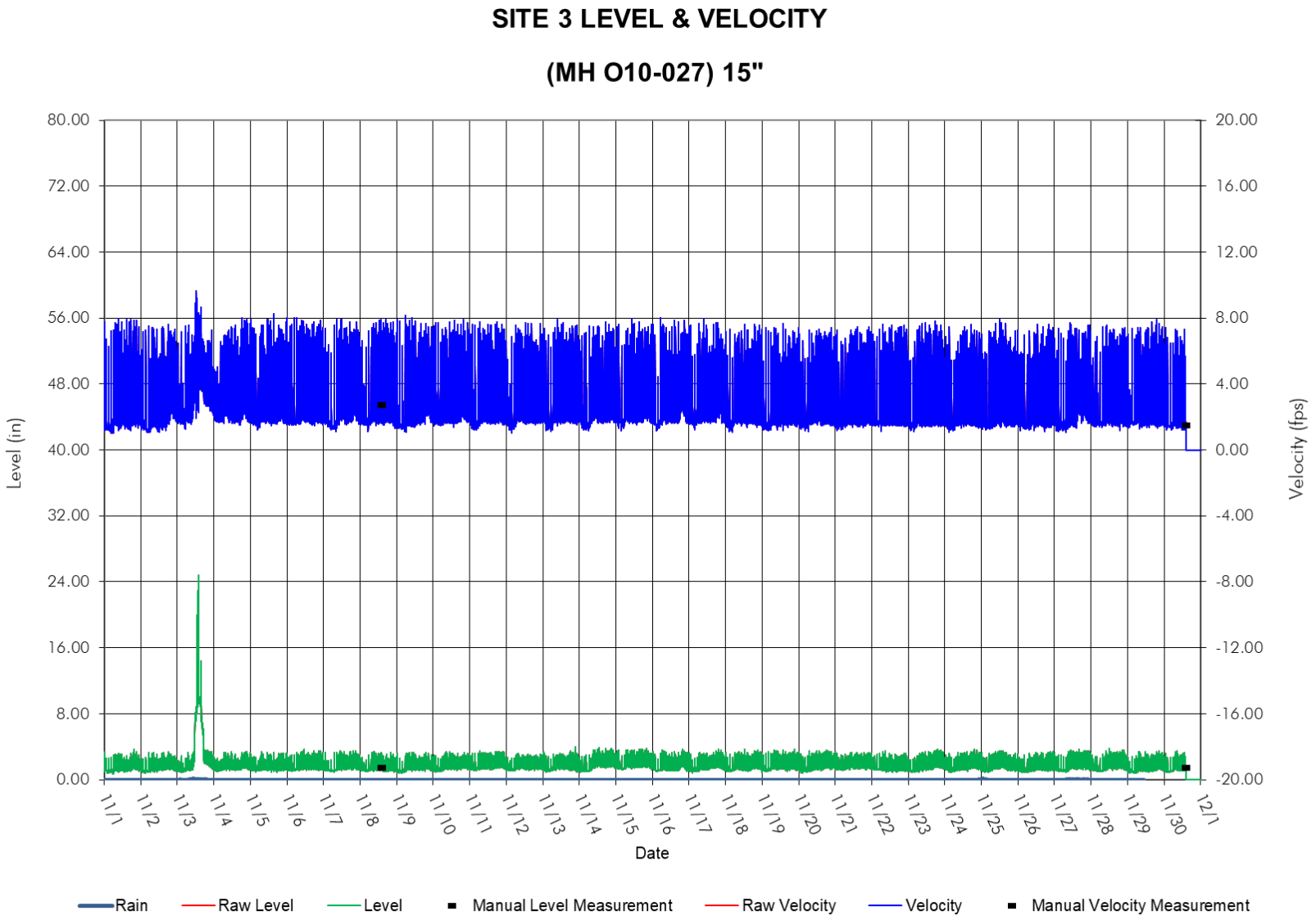


Figure 41 – Overall Flow Hydrograph (Site 3)

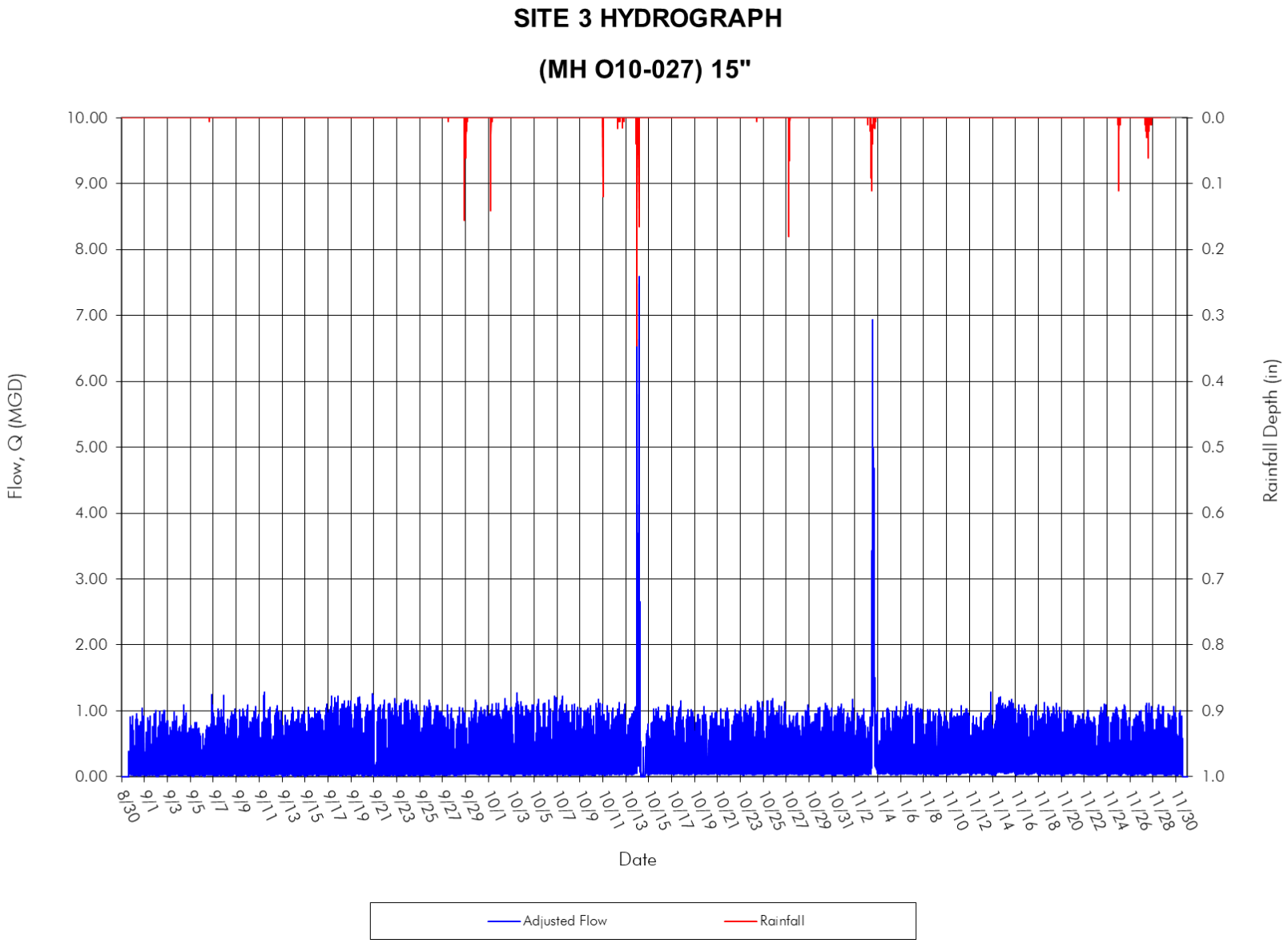


Figure 42 – Overall Level and Velocity Hydrograph (Site 3)

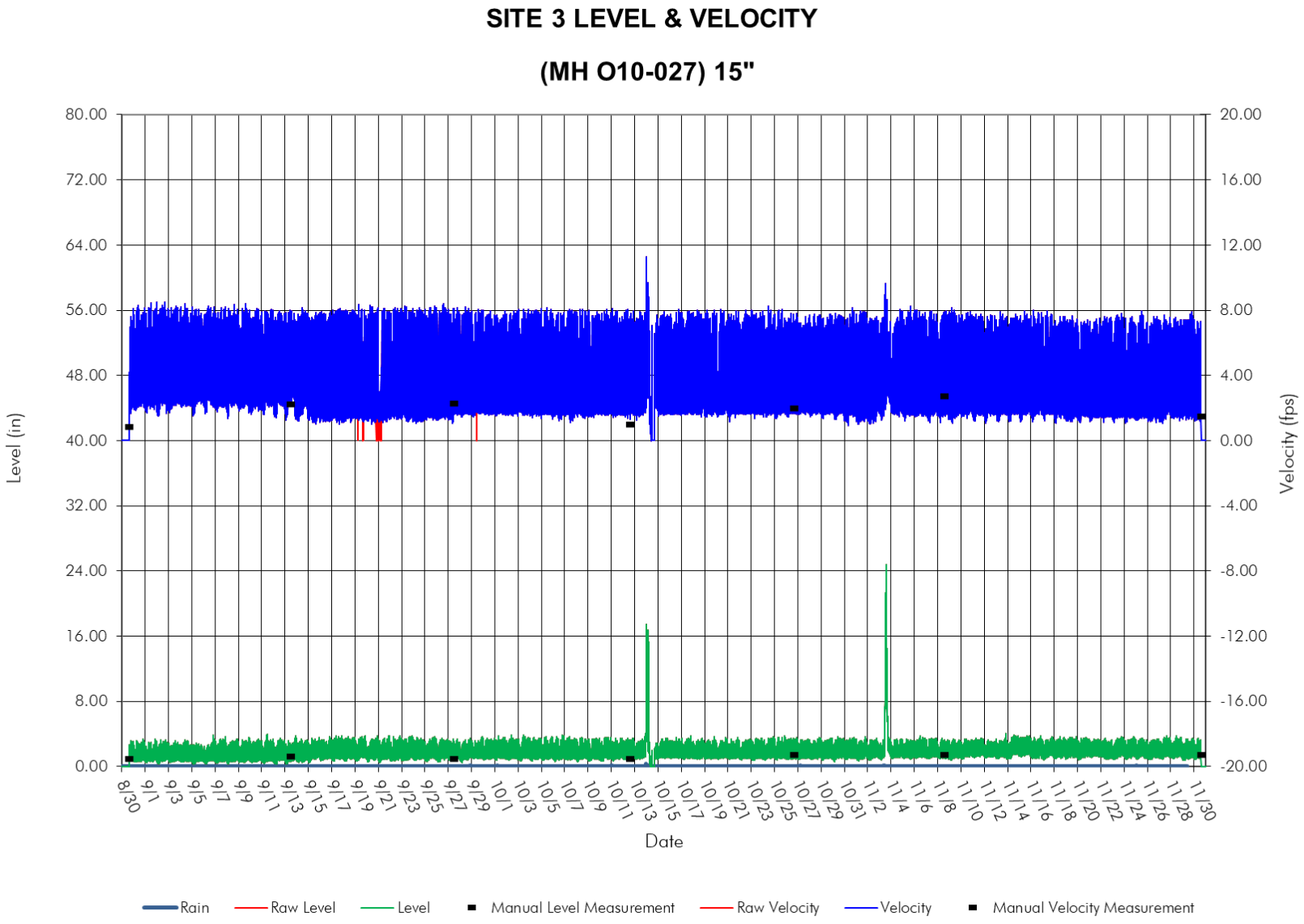


Figure 43 – Standard Flow Scattergraph (Site 3)

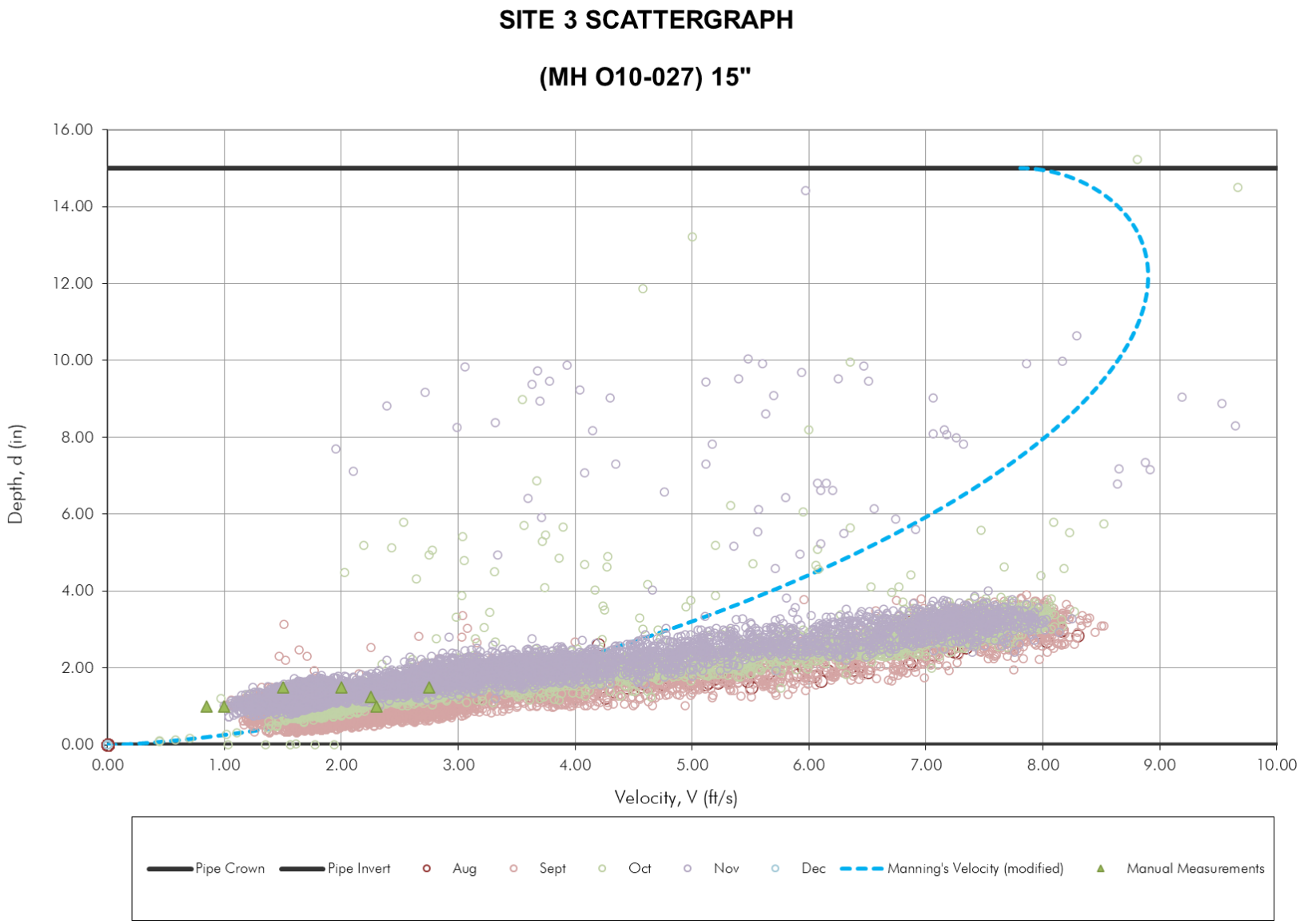


Figure 44 – Surcharged Flow Scattergraph (Site 3)

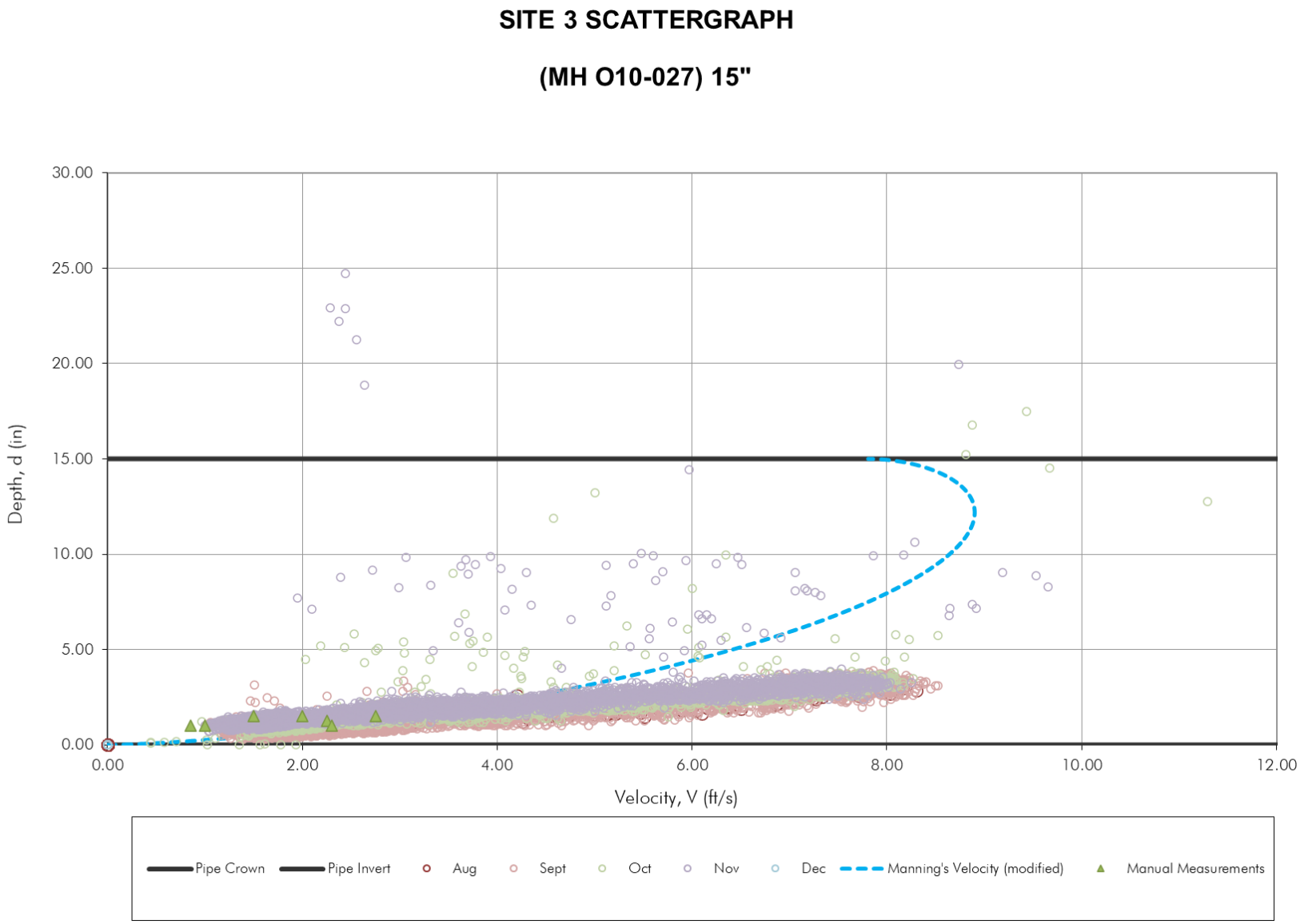


Table 13 – ADDF and Infiltration Summary (Site 3)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 3
Meter: 3
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.143	0.321	2.249	0.034		
13-Sep-21	Mon	0.142	0.312	2.199	0.026		
14-Sep-21	Tue	0.136	0.280	2.062	0.049		
15-Sep-21	Wed	0.152	0.311	2.043	0.047		
16-Sep-21	Thu	0.158	0.384	2.433	0.069	04-Nov-21	0.089
17-Sep-21	Fri	0.163	0.314	1.927	0.034	15-Oct-21	0.084
18-Sep-21	Sat	0.170	0.300	1.760	0.065	16-Oct-21	0.087
7 Count		0.152 Average	0.318 Average	2.096 Average	0.046 Average	3 Count	0.086 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.152	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.152	
	Diurnal Peaking Factor (DPF):	2.096	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.040	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.040	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.152	

Figure 45 – Dry Weather Diurnal (Site 3)

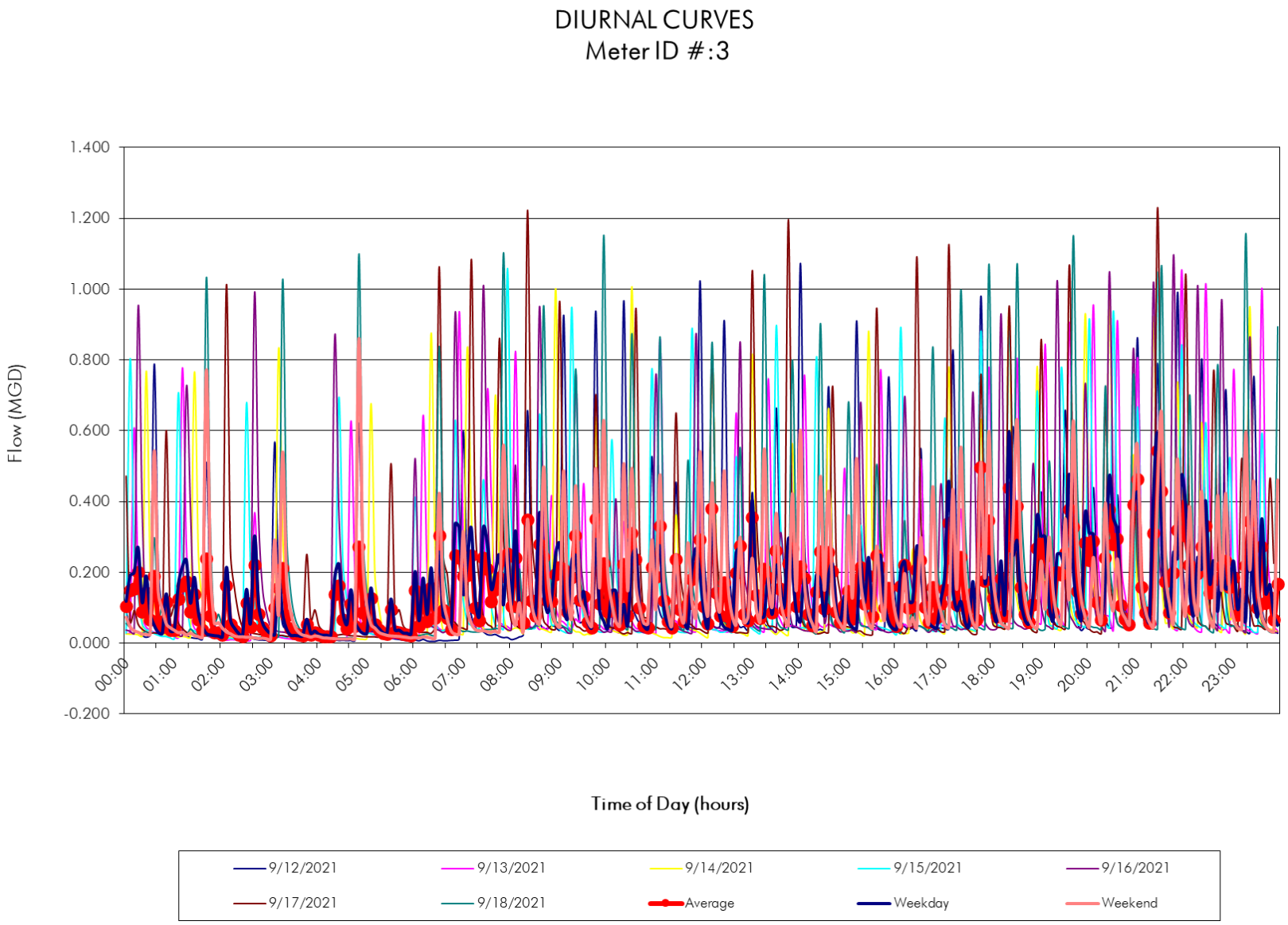


Figure 46 – High/Low Groundwater Diurnal (Site 3)

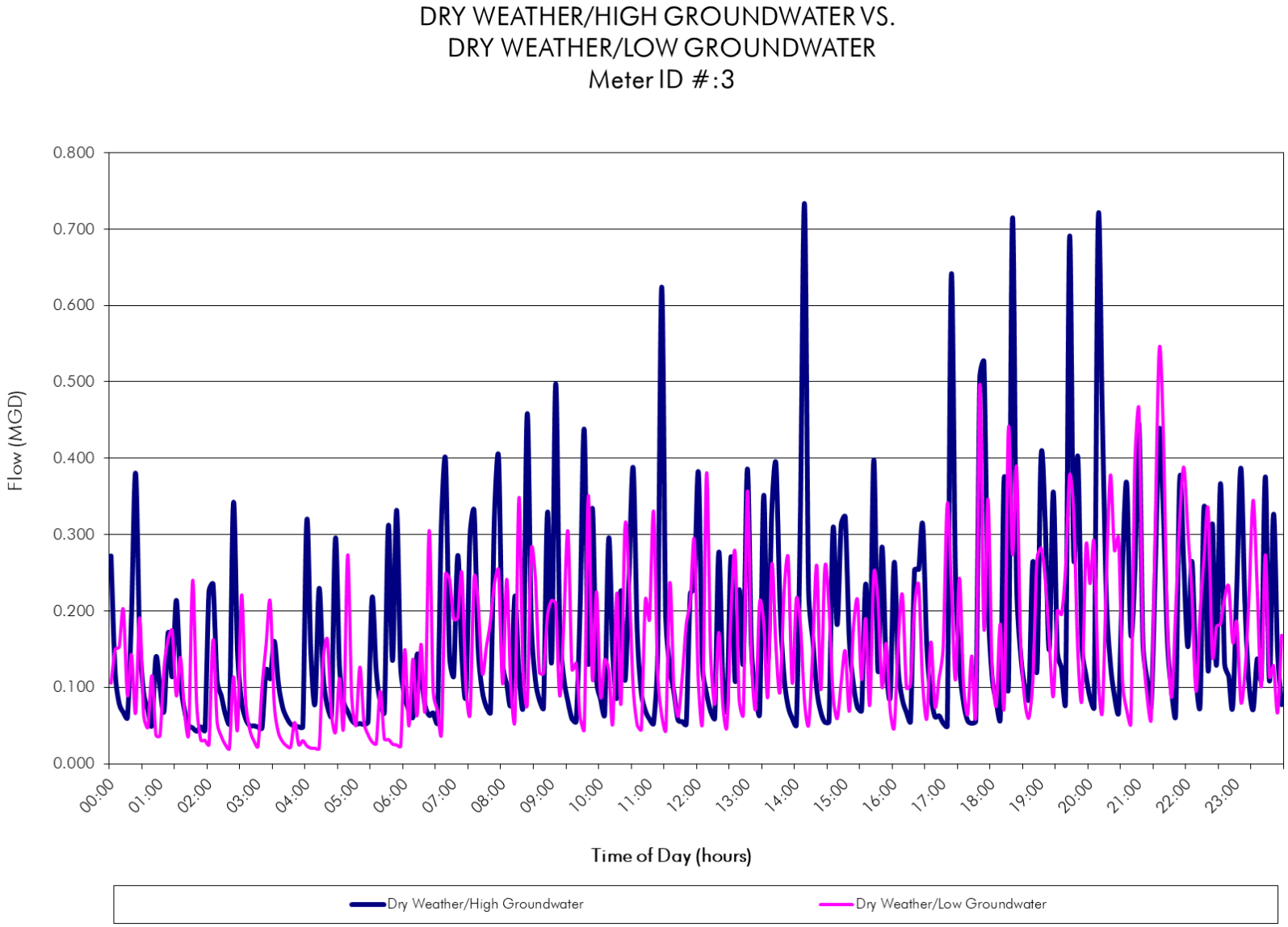


Table 14 – Inflow Calculations and Projections (Site 3)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	3
Meter:	3
Units of Flow:	MGD

Storm Count:	7	Cum. Trib. Area:	283 acres	Pipe Shape:	Circular
Avg Delta Time	81	Cum. Time of Conc.:	75 minutes	Pipe Diameter:	15 in
Avg Kp:	0.02302			Pipe Slope:	0.022 ft/ft
Avg Selected Kp:	0.01031			Pipe Capacity:	6.21 mgd
				ADDF Cum.:	0.152 mgd
				ADDF Peak. Factor:	2.10
				Peak ADDF Flow:	0.319 mgd
				Infiltration:	0.040 mgd
				Cum. Peak Flow:	0.359 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.359
1	1.130	2.130	3.296	2.489
2	1.400	2.639	4.083	2.998
5	1.780	3.355	5.191	3.714
10	2.080	3.921	6.066	4.279
25	2.490	4.693	7.262	5.052
50	2.810	5.296	8.195	5.655
100	3.140	5.918	9.157	6.277

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain I in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/28/21 21:00	1.65	7.92	9/28/21 21:25	9/28/21 21:20	5	0.917	09/27/21	0.085	0.831	0.630	0.00722	n						No reaction
10/1/21 4:55	0.73	3.67	10/1/21 7:30	10/1/21 5:05	145	1.099	09/24/21	0.198	0.902	0.560	0.00880	y	0.00880					
10/11/21 0:05	0.49	1.25	10/11/21 1:30	10/11/21 0:05	85	0.908	10/04/21	0.026	0.882	0.380	0.01269	y	0.01269					
10/13/21 21:55	3.15	6.00	10/13/21 23:40	10/13/21 23:10	30	8.112	10/06/21	0.045	8.067	1.490	0.02960	n						Surcharge
10/27/21 5:15	0.89	2.42	10/27/21 6:10	10/27/21 5:25	45	0.926	10/26/21	0.039	0.887	0.620	0.00782	n						No reaction
11/3/21 2:10	1.89	16.83	11/3/21 13:05	11/3/21 10:35	150	6.932	10/27/21	0.202	6.730	0.430	0.08557	n						Surcharge
11/27/21 7:45	0.70	13.92	11/27/21 16:15	11/27/21 14:25	110	1.109	11/26/21	0.799	0.310	0.180	0.00942	y	0.00942					

Figure 47 – Inflow Projections (Site 3)

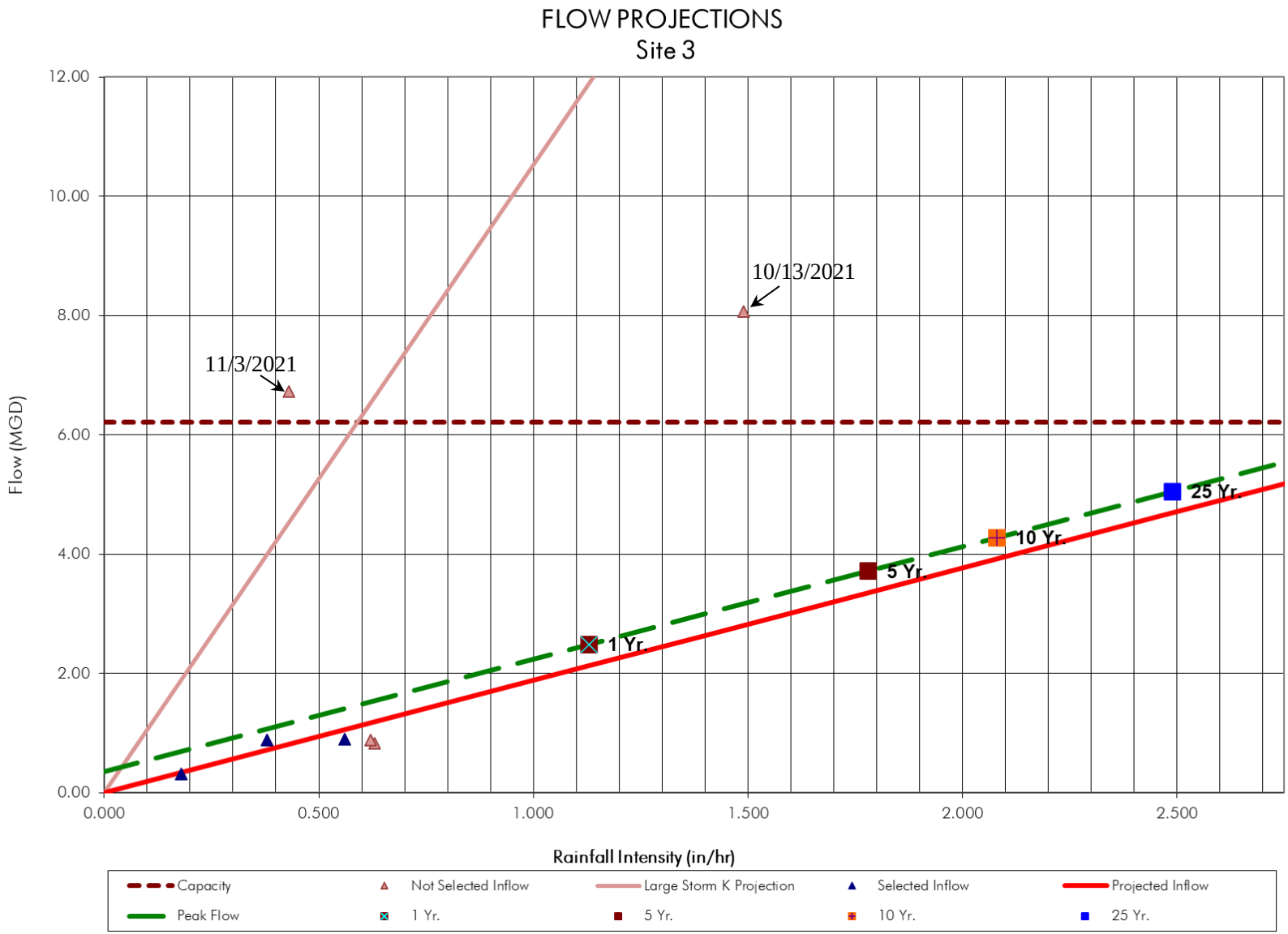
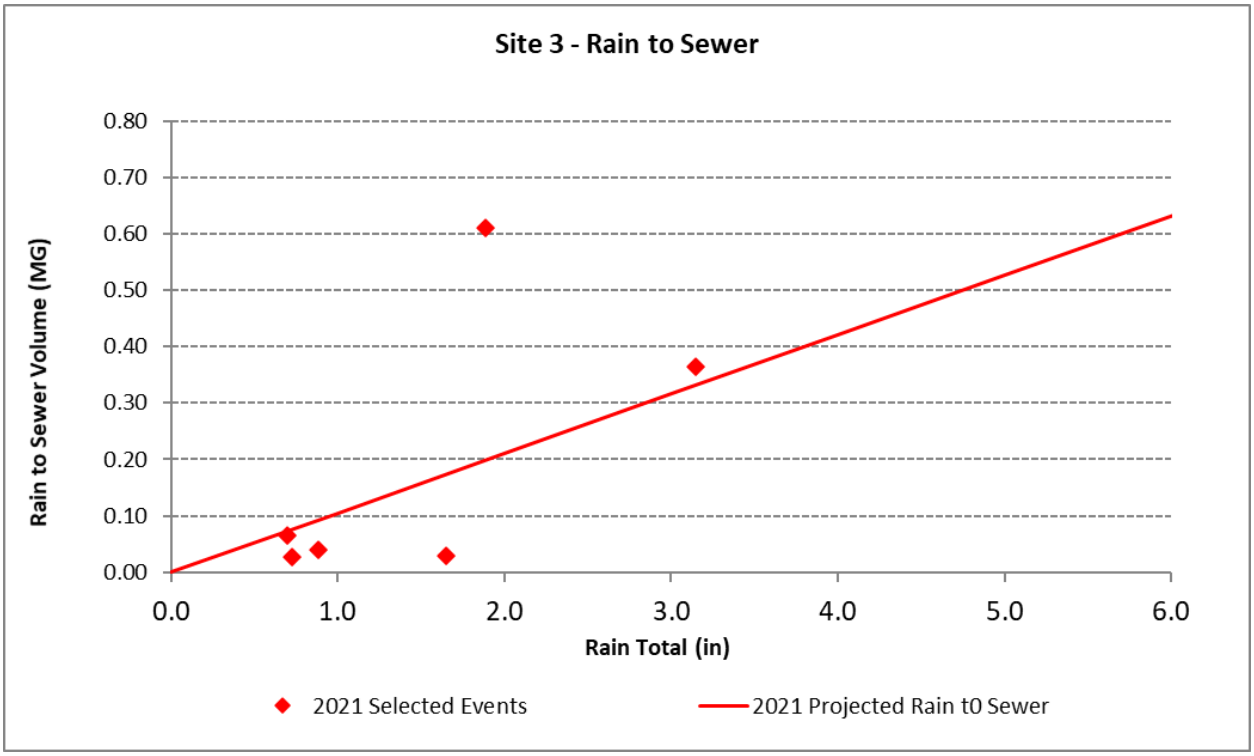


Table 15 – Rain to Sewer Summary (Site 3)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 3 (15")	9/28/2021	1.65	12.679	0.029	0.23%
	10/1/2021	0.73	5.609	0.026	0.46%
	10/13/2021	3.15	24.167	0.364	1.51%
	10/27/2021	0.89	6.800	0.040	0.59%
	11/3/2021	1.89	14.485	0.611	4.22%
	11/27/2021	0.70	5.379	0.066	1.23%
				Average	**1.37%**

Figure 48 – Rain to Sewer Volumetric Analysis (Site 3)



A.4 Site 4

Description

Site 4 was located at manhole P09-034. The manhole near intersection of Athens Street and Wildhorse Creek Lift Station Access Road. In the middle of an asphalt street. The area velocity sensor was placed in the influent 12" diameter PVC pipe of the manhole. This meter measures flow upstream of the Wildhorse Creek Lift Station which pumps flow to Site 3. The basin is upstream of Site 1 and contributes to the Wilbarger Creek Wastewater Treatment Plant.

Observations

The average flow depth in 2021 for this site was 2.21 inches with an average velocity of 2.25 feet per second. The site experience light grease and light to medium debris during site visits. The collected data from this monitoring site was considered good. The data required minimal edits to level and velocity.

There was no surcharging recorded at Site 4 during the 2021 flow monitoring.

Table 16 – Service Interrogations Summary (Site 4)

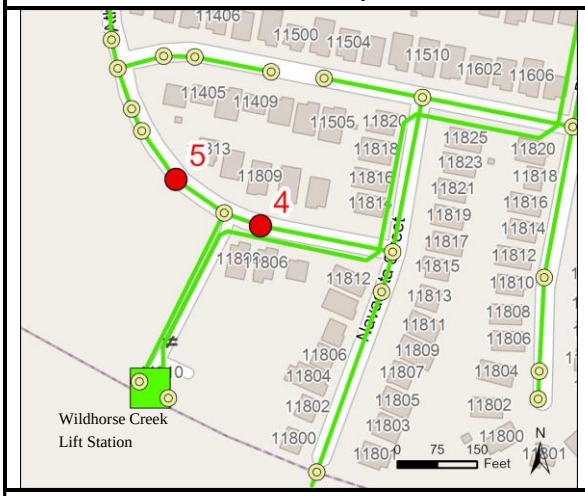
Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 4	8/31/2021	11:27	12	2.25	2.25	0.00	2.25	2.32	0.07	2.50	2.45	-0.05	2.50	2.32	-0.18	Install	Meter installed at in pipe
	9/13/2021	15:06		2.00	2.00	0.00	2.00	2.30	0.30	2.00	2.40	0.40	2.75	2.75	0.00	Service/Upload	
	9/27/2021	15:18		2.25	2.30	0.05	2.25	2.30	0.05	2.50	2.40	-0.10	2.50	2.25	-0.25	Service/Upload	
	10/12/2021	12:10		2.25	2.10	-0.15	2.00	2.00	0.00	2.00	2.25	0.25	2.00	2.00	0.00	Service/Upload	
	10/26/2021	13:52		2.25	2.14	-0.11	2.25	2.09	-0.16	2.50	2.50	0.00	2.50	2.52	0.02	Service/Upload	
	11/8/2021	12:34		2.25	2.35	0.10	2.25	2.11	-0.14	3.00	3.03	0.03	2.50	2.58	0.08	Service/Upload	Light grease.
	11/30/2021	12:02		3.00	2.98	-0.02	2.50	2.30	-0.20	2.00	1.88	-0.12	2.00	1.98	-0.02	Removal	Light grease and medium debris.

Figure 49 – Flow Meter Site Investigation (Site 4)

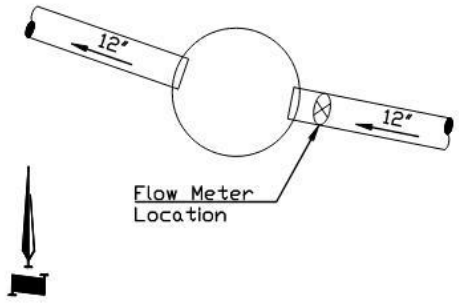
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 11-30-2021 / 12:02	**Crew:** JA-VI
MH#: P09-034	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 12
Site ID: 4	**Address:** 11806 Athens St.	**Site Quality:** Good	**Monitoring Purpose:** Short-term FM

Location Map



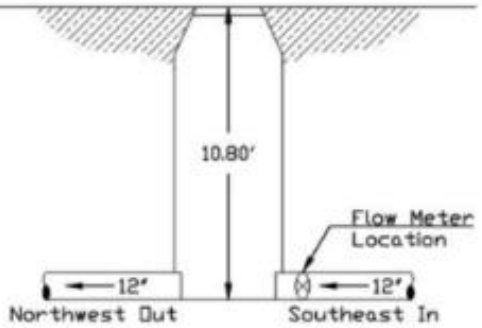
Planar Description



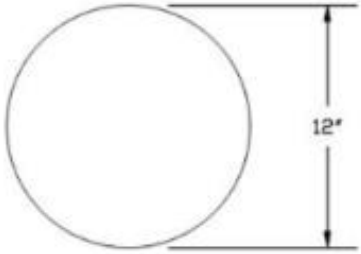
Summary Description:
Located near intersection of Athens Street and Wildhorse Creek Lift Station Access Road. In the middle of an asphalt street.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? Light		**Manhole Depth (ft):** 10.80	**Surcharge Evidence?** No
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 0.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 24.00	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Standard	**Usable MH Steps?** No
Describe potential hazards: Cones are needed and service truck light needs to be on throughout the whole service due to being on a local street.		**Measured Flow Depth (in):** 2.50	**Meter:** ISCO 2150
		Velocity (fps): 2.00	**Cellular Signal Strength:** N/A
		Mounting Band Description: Spring Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes

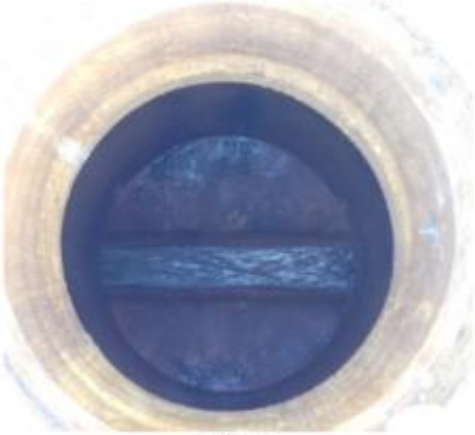


Pipe Cross Section



Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE



DOWN

INFLOW

OUTFLOW

Figure 50 – Site Information (Site 4)

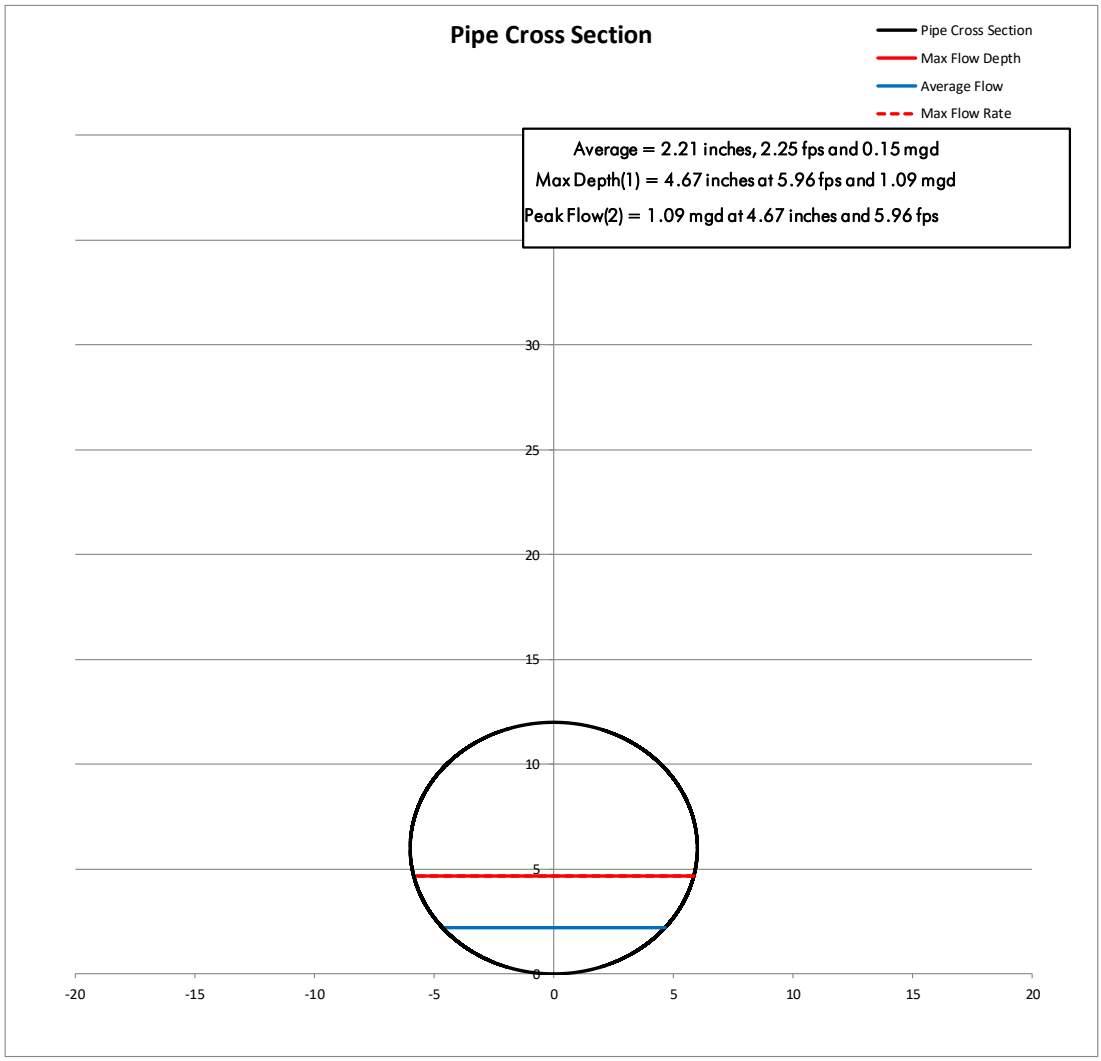
SITE INFORMATION RECORD

Site Information

Meter ID #:	4
Monitoring Program:	Short-Term FM
Manhole #:	P09-034

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	12	
Pipe Width, W (in):	12	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0250	ASSUMEDI



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 4	8/31/2021	12	11:27	2.25	2.32	0.07	2.50	2.32	-0.18
	9/13/2021		15:06	2.00	2.30	0.30	2.75	2.75	0.00
	9/27/2021		15:18	2.25	2.30	0.05	2.50	2.25	-0.25
	10/12/2021		12:10	2.00	2.00	0.00	2.00	2.00	0.00
	10/26/2021		13:52	2.25	2.09	-0.16	2.50	2.52	0.02
	11/8/2021		12:34	2.25	2.11	-0.14	2.50	2.58	0.08
	11/30/2021		12:02	2.50	2.30	-0.20	2.00	1.98	-0.02

Figure 51 – August-September Monthly Flow Hydrograph (Site 4)

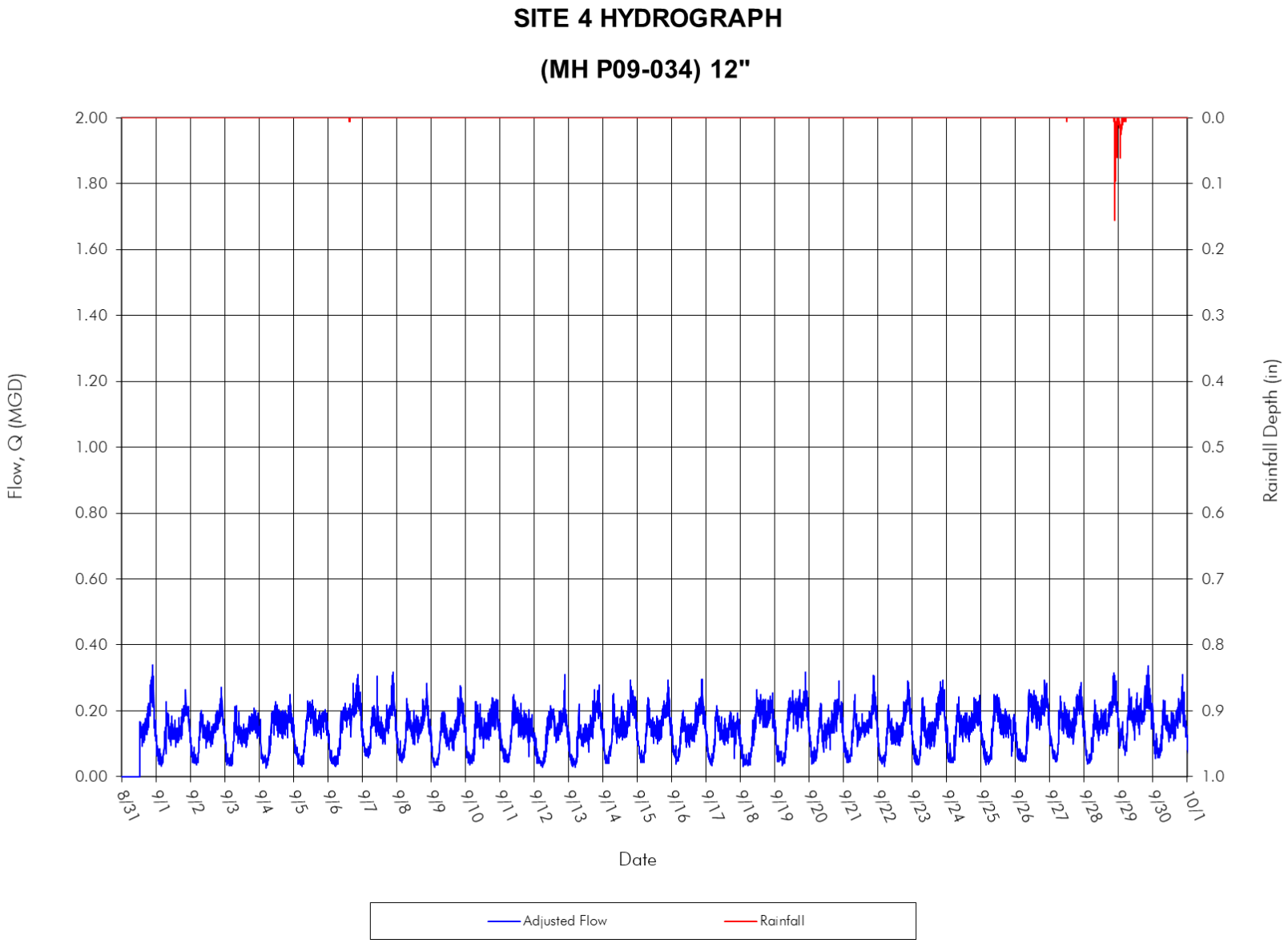


Figure 52 – August-September Monthly Level and Velocity Hydrograph (Site 4)

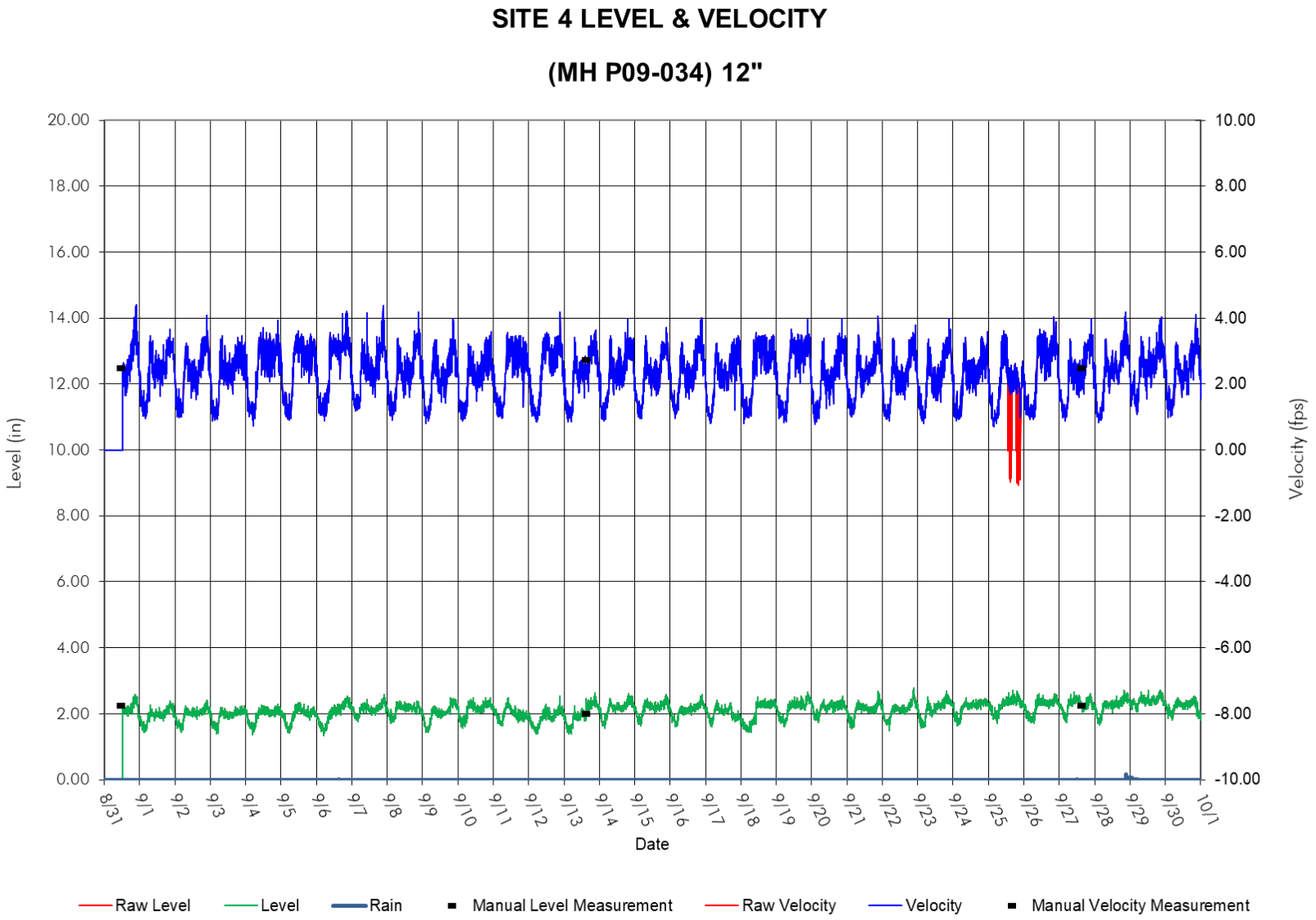


Figure 53 – October Flow Hydrograph (Site 4)

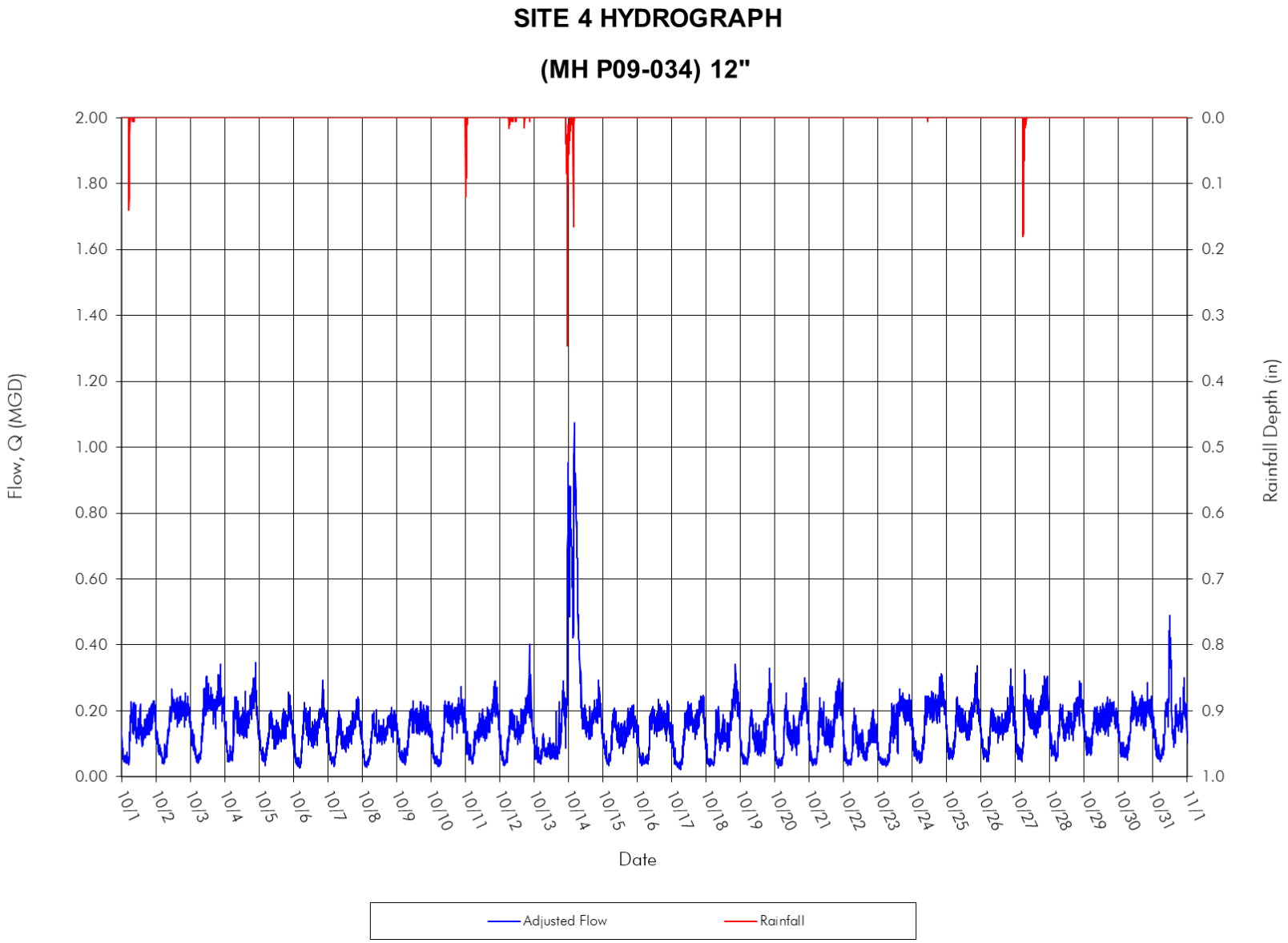


Figure 54 – October Monthly Level and Velocity Hydrograph (Site 4)

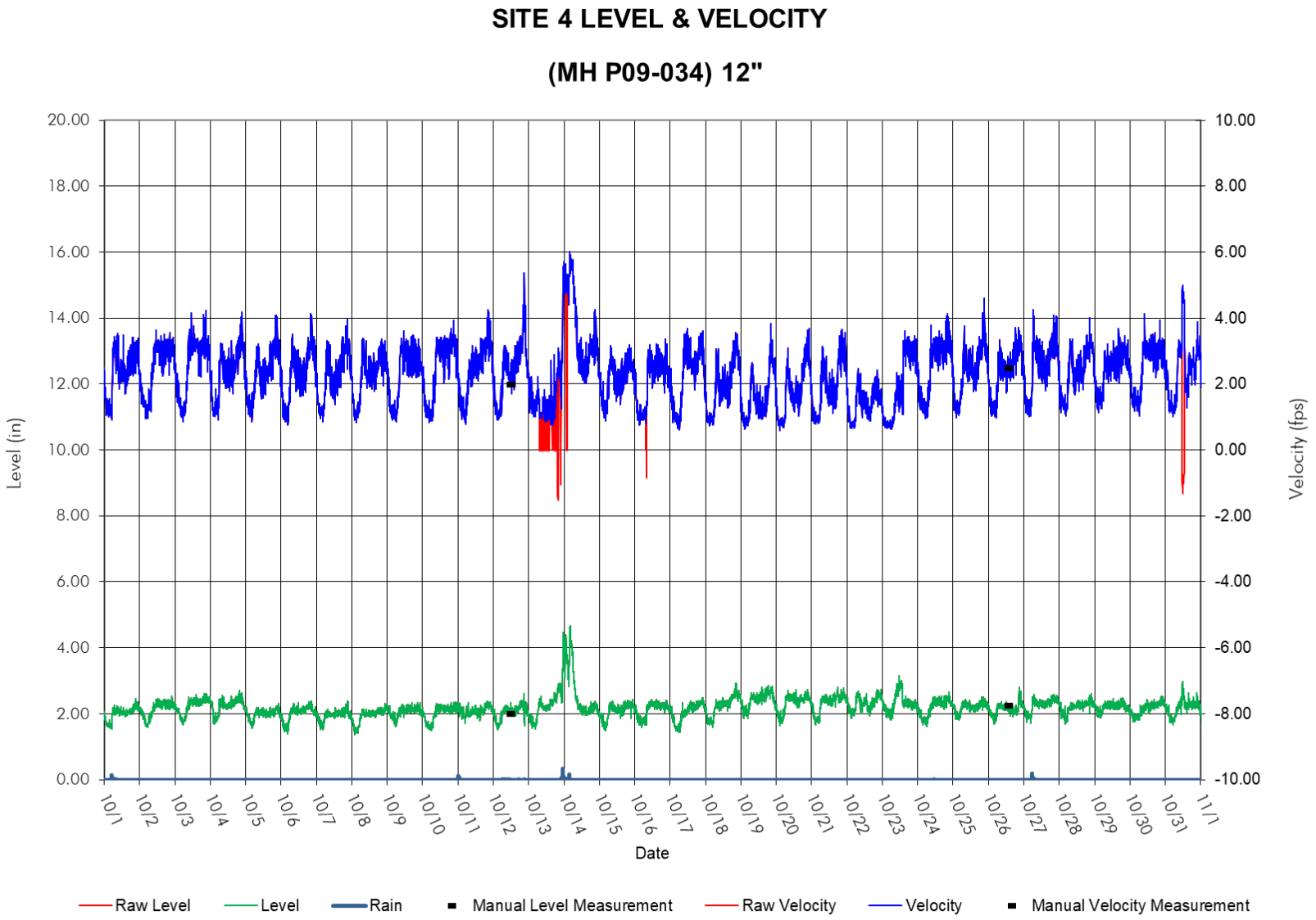


Figure 55 – November Monthly Flow Hydrograph (Site 4)

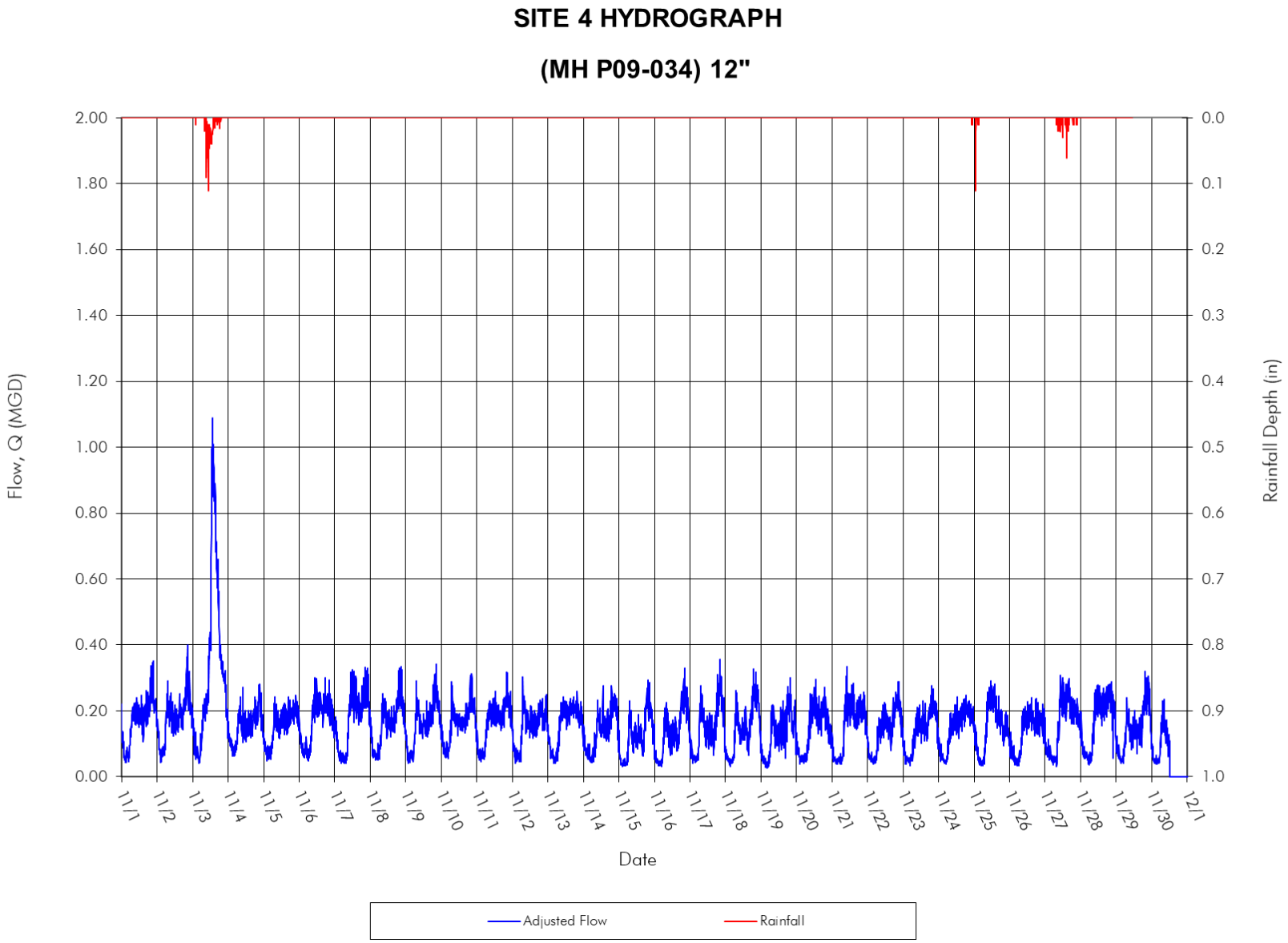


Figure 56 – November Level and Velocity Hydrograph (Site 4)

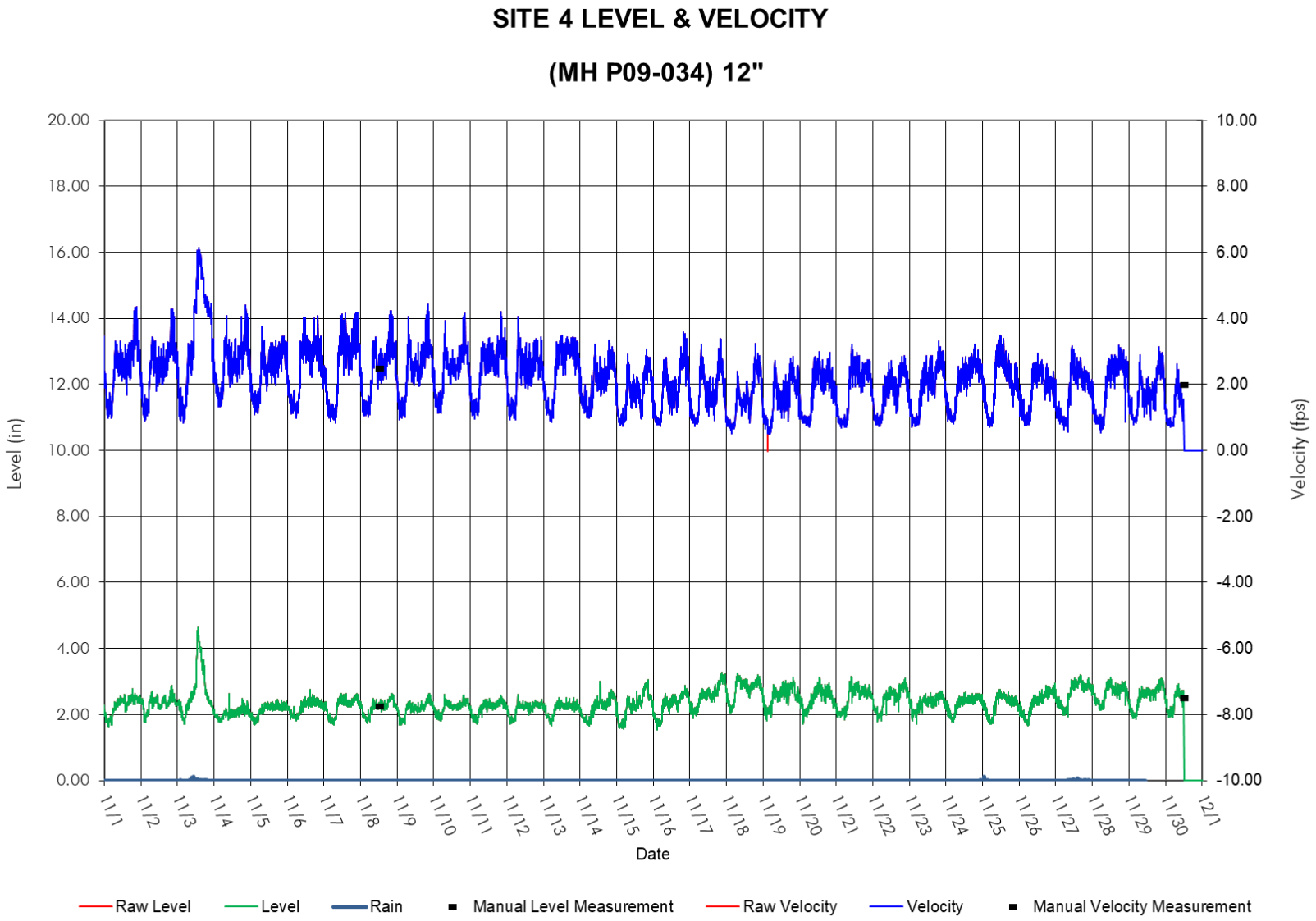


Figure 57 – Overall Flow Hydrograph (Site 4)

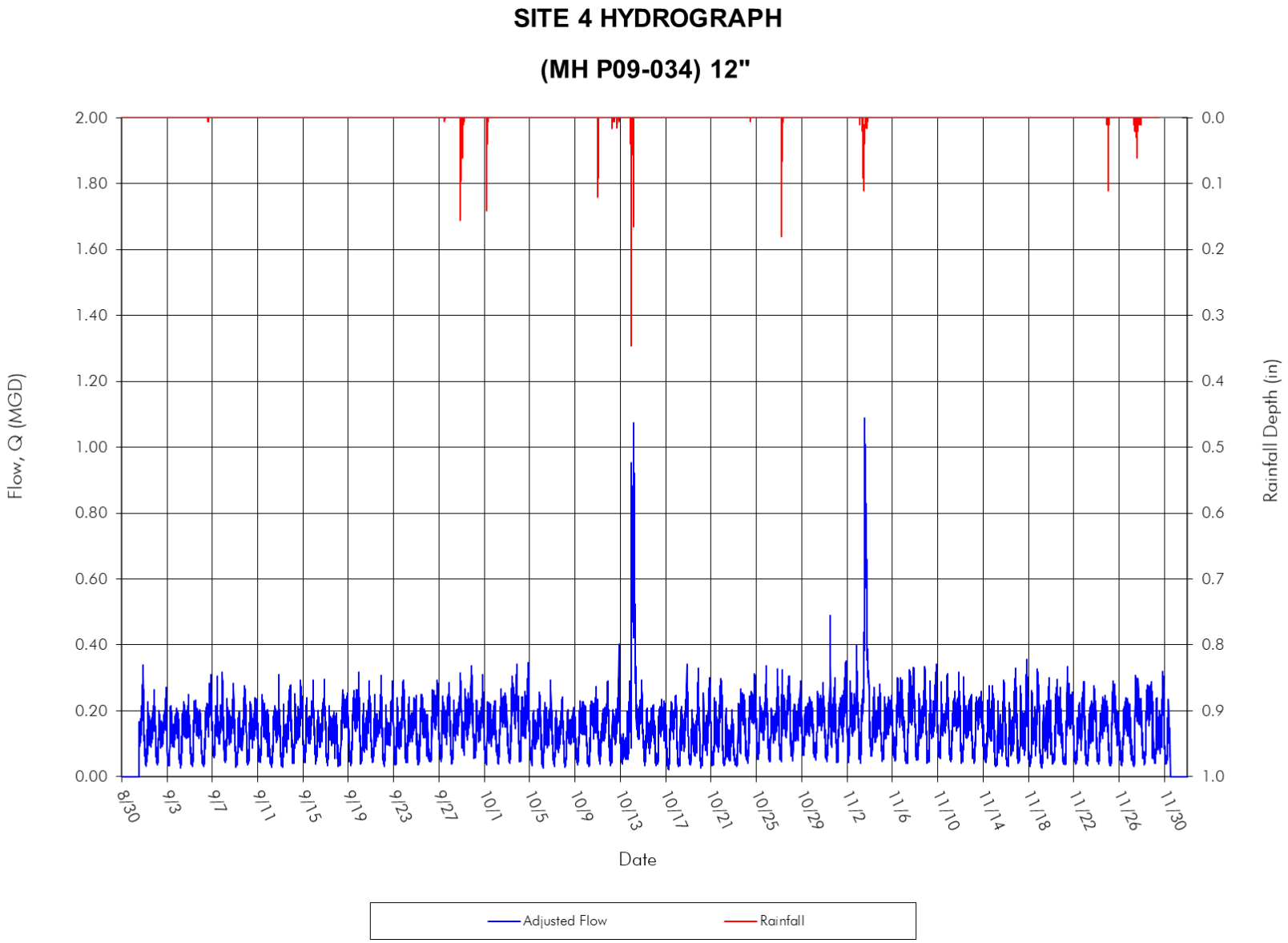


Figure 58 – Overall Level and Velocity Hydrograph (Site 4)

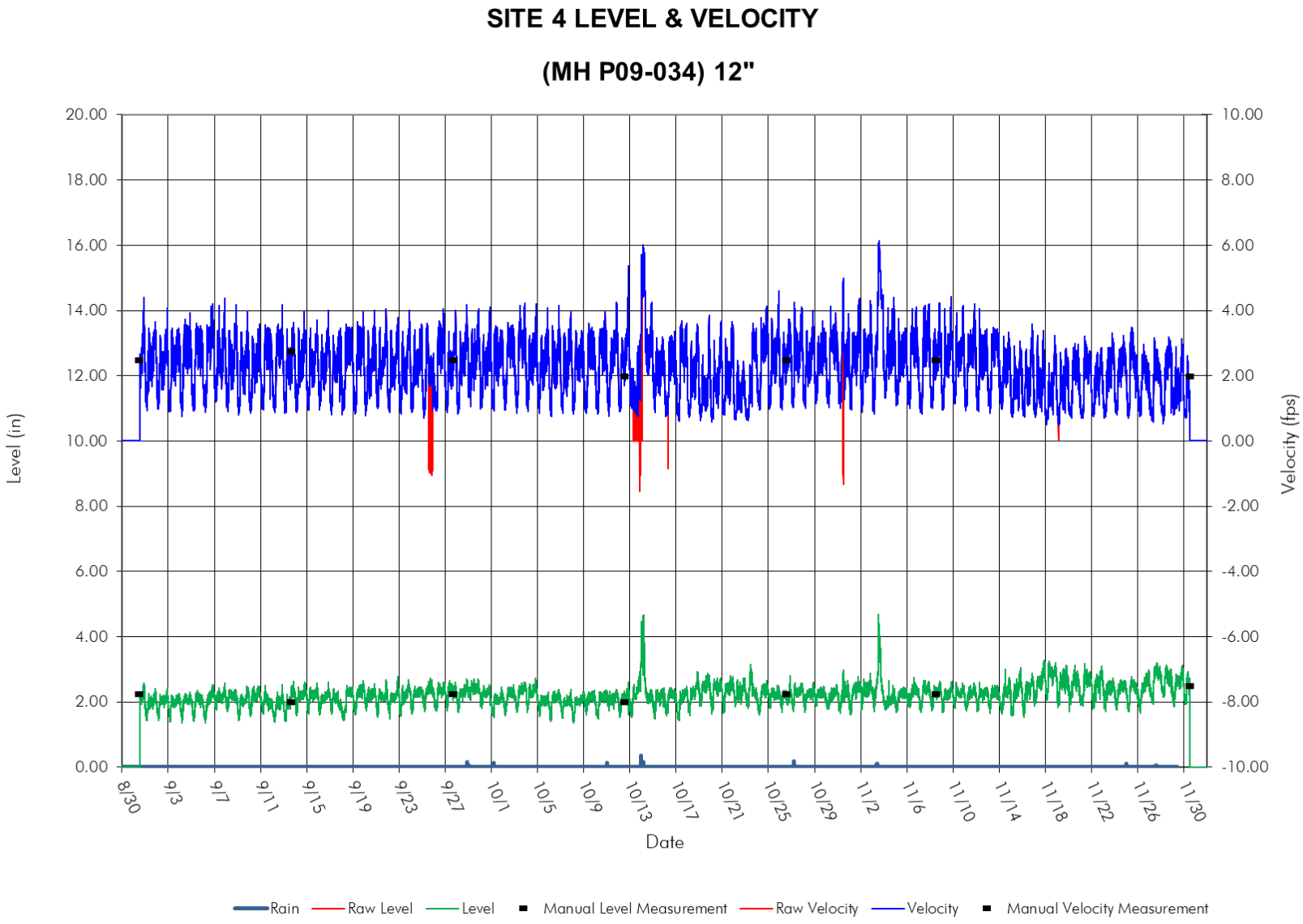


Figure 59 – Standard Flow Scattergragh (Site 4)

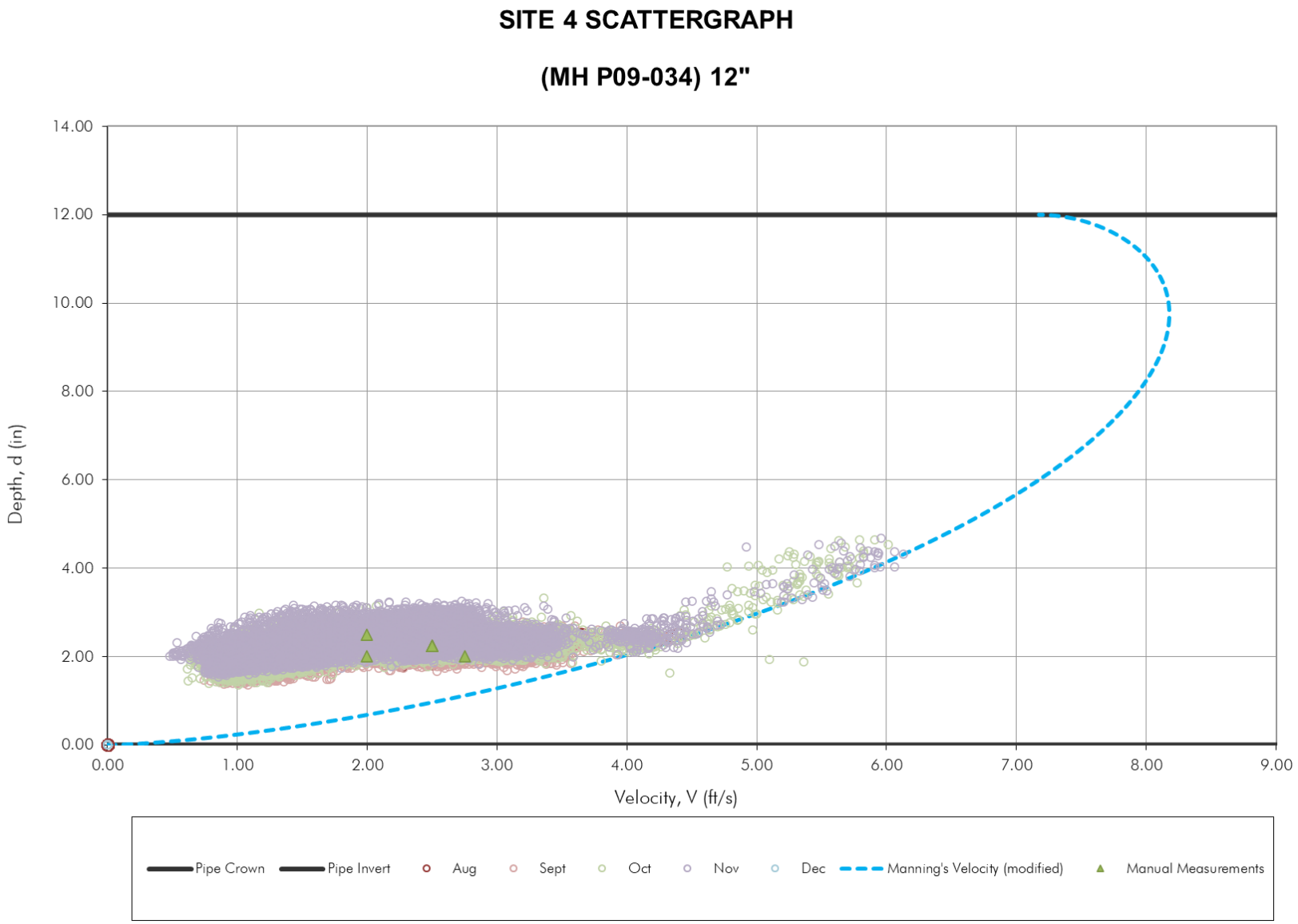


Table 17 – ADDF and Infiltration Summary (Site 4)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 4
Meter: 4
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.127	0.212	1.674	0.040		
13-Sep-21	Mon	0.132	0.230	1.744	0.041		
14-Sep-21	Tue	0.148	0.240	1.621	0.051		
15-Sep-21	Wed	0.145	0.233	1.605	0.056	30-Sep-21	0.076
16-Sep-21	Thu	0.143	0.255	1.785	0.061	04-Nov-21	0.081
17-Sep-21	Fri	0.127	0.193	1.516	0.050	15-Oct-21	0.052
18-Sep-21	Sat	0.146	0.224	1.539	0.044	02-Oct-21	0.055
7 Count		0.138 Average	0.227 Average	1.641 Average	0.049 Average	4 Count	0.066 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.138	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.138	
	Diurnal Peaking Factor (DPF):	1.641	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.017	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.017	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.138	

Figure 60 – Dry Weather Diurnal (Site 4)

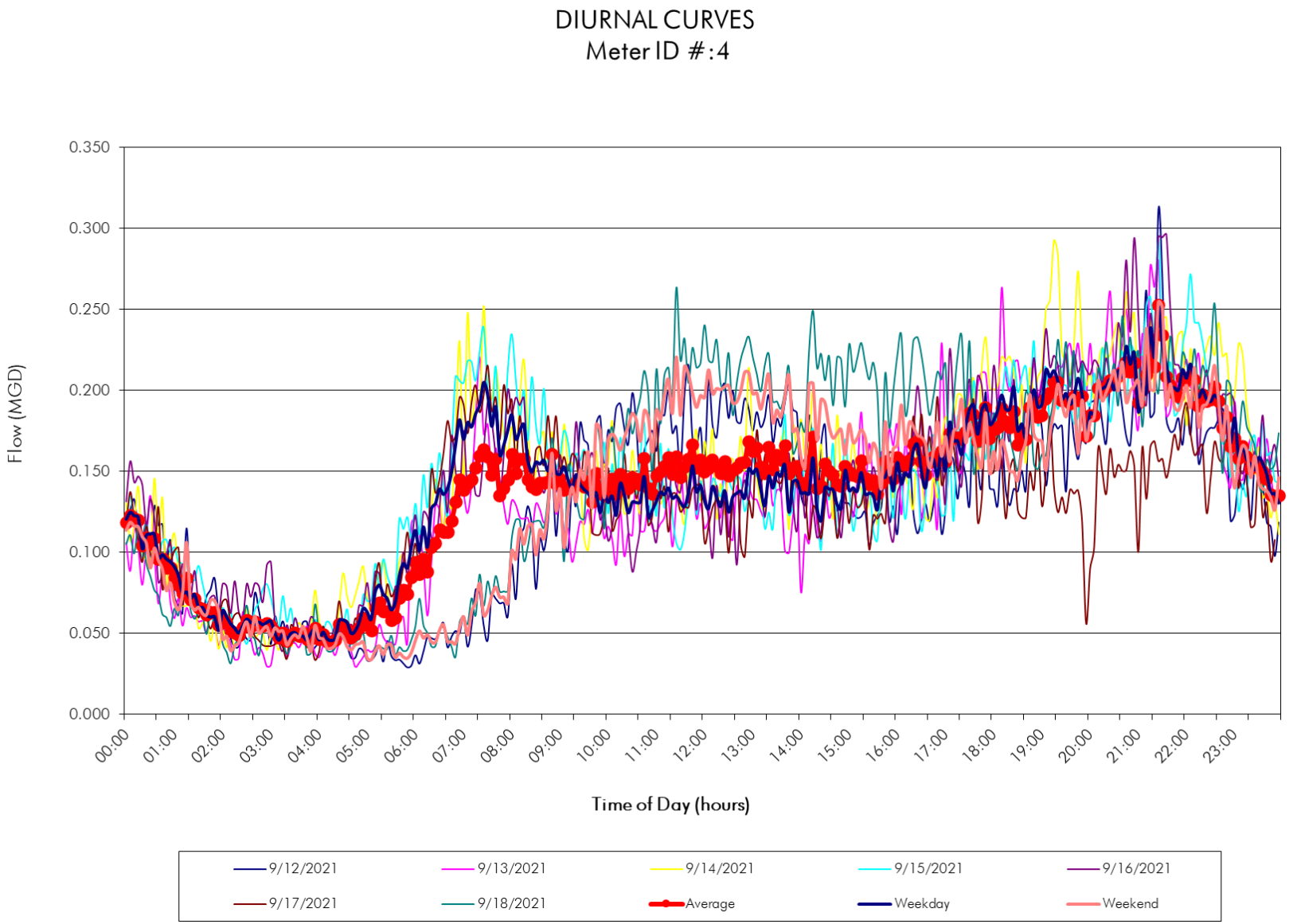


Figure 61 – High/Low Groundwater Diurnal (Site 4)

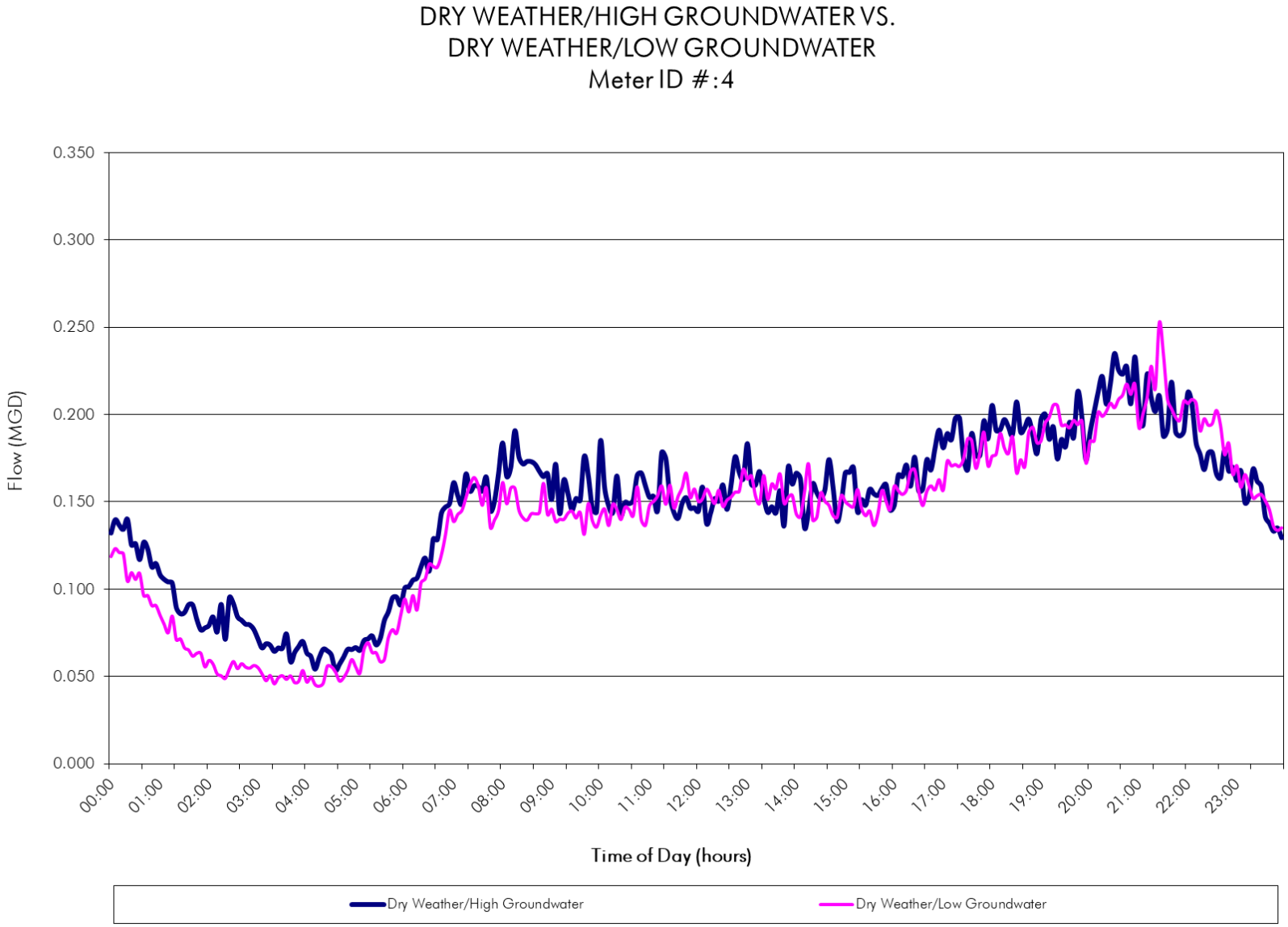


Table 18 – Inflow Calculations and Projections (Site 4)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	4
Meter:	4
Units of Flow:	MGD

Storm Count:	7	Cum. Trib. Area:	182 acres	Pipe Shape:	Circular
Avg Delta Time	66	Cum. Time of Conc.:	60 minutes	Pipe Diameter:	12 in
Avg Kp:	0.00439			Pipe Slope:	0.025 ft/ft
Avg Selected Kp:	0.00579			Pipe Capacity:	3.65 mgd
				ADDF Cum.:	0.138 mgd
				ADDF Peak. Factor:	1.64
				Peak ADDF Flow:	0.227 mgd
				Infiltration:	0.017 mgd
				Cum. Peak Flow:	0.244 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.244
1	1.320	0.899	1.391	1.143
2	1.630	1.110	1.718	1.354
5	2.070	1.410	2.181	1.653
10	2.420	1.648	2.550	1.892
25	2.890	1.968	3.045	2.212
50	3.270	2.227	3.446	2.471
100	3.660	2.493	3.857	2.736

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/28/21 21:00	1.65	7.92	9/28/21 21:30	9/28/21 21:20	10	0.308	09/27/21	0.227	0.081	0.710	0.00097	y	0.00097					
10/1/21 4:55	0.73	3.67	10/1/21 6:45	10/1/21 5:05	100	0.227	09/24/21	0.160	0.068	0.700	0.00082	n						No reaction
10/11/21 0:05	0.49	1.25	10/11/21 0:05	10/11/21 0:05	0	0.177	10/10/21	0.124	0.053	0.470	0.00096	n						No reaction
10/13/21 21:55	3.15	6.00	10/13/21 23:40	10/13/21 23:10	30	0.954	10/06/21	0.138	0.816	1.760	0.00394	y	0.00394					
10/27/21 5:15	0.89	2.42	10/27/21 6:25	10/27/21 5:25	60	0.324	10/20/21	0.108	0.215	0.750	0.00244	y	0.00244					
11/3/21 2:10	1.89	16.83	11/3/21 13:20	11/3/21 10:35	165	1.089	10/27/21	0.144	0.945	0.480	0.01674	y	0.01674					
11/27/21 7:45	0.70	13.92	11/27/21 16:00	11/27/21 14:25	95	0.299	11/20/21	0.196	0.103	0.180	0.00486	y	0.00486					

Figure 62 – Inflow Projections (Site 4)

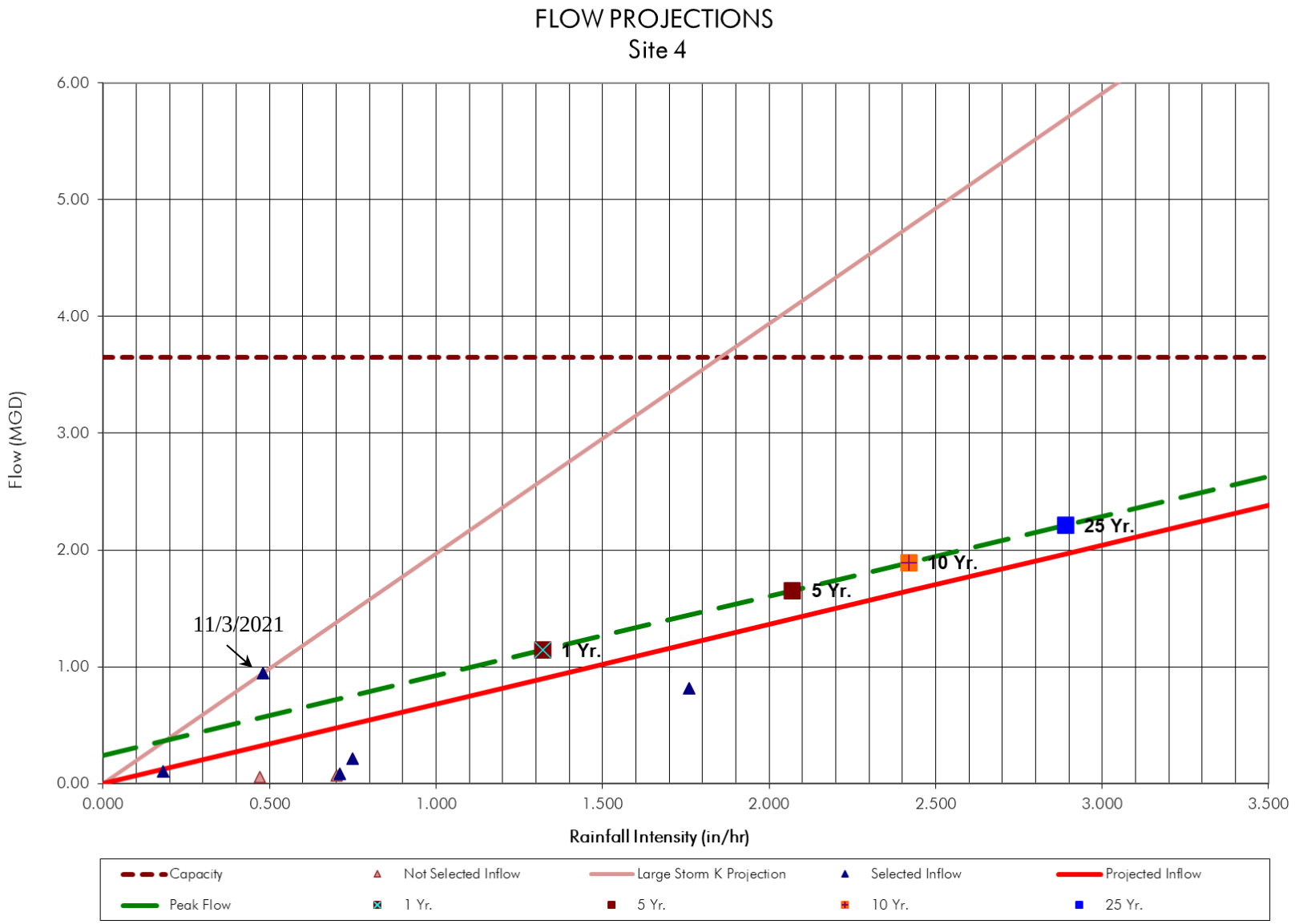
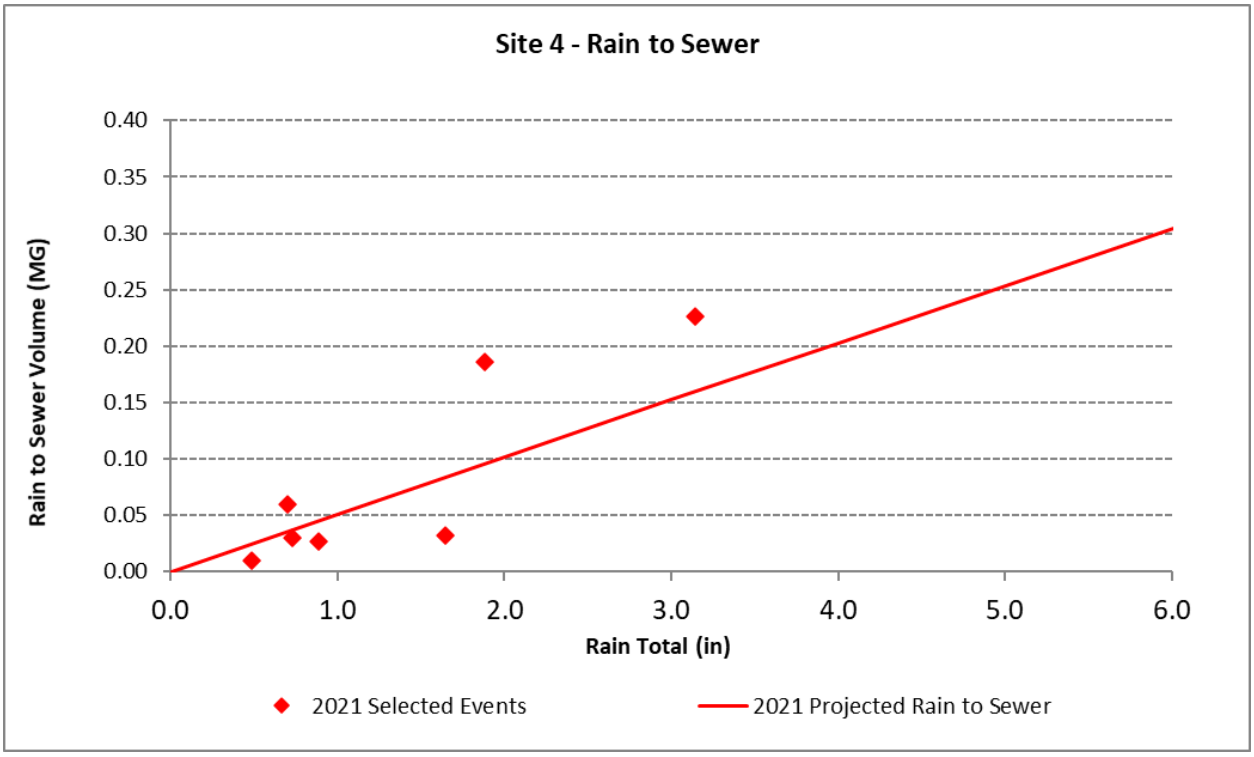


Table 19 – Rain to Sewer Summary (Site 4)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 4 (12")	9/28/2021	1.65	8.154	0.032	0.40%
	10/1/2021	0.73	3.607	0.030	0.84%
	10/11/2021	0.49	2.397	0.009	0.39%
	10/13/2021	3.15	15.542	0.226	1.46%
	10/27/2021	0.89	4.373	0.027	0.61%
	11/3/2021	1.89	9.315	0.186	1.99%
	11/27/2021	0.70	3.459	0.060	1.74%
				Average	**1.03%**

Figure 63 – Rain to Sewer Volumetric Analysis (Site 4)



A.5 Site 5

Description

Site 5 measures flow in manhole P09-002. This manhole is located near intersection of Athens Street and Wildhorse Creek Lift Station Access Road. The area velocity sensor was placed in the influent 8" diameter PVC pipe of the manhole. This meter measures flow upstream of the Wildhorse Creek Lift Station then is pumped into the Wilbarger Creek Watershed.

Observations

The average flow depth for this site was 1.83 inches with an average velocity of 1.0 feet per second. The collected data from this monitoring site was considered good. Light debris and grease were reported during one site visit during the monitoring period. Velocity dropouts were common at low levels, however there were enough valid recordings to adjust the dropouts accordingly.

There were no surcharging events recorded at this site during the 2021 monitoring period.

Table 20 – Service Interrogations Summary (Site 5)

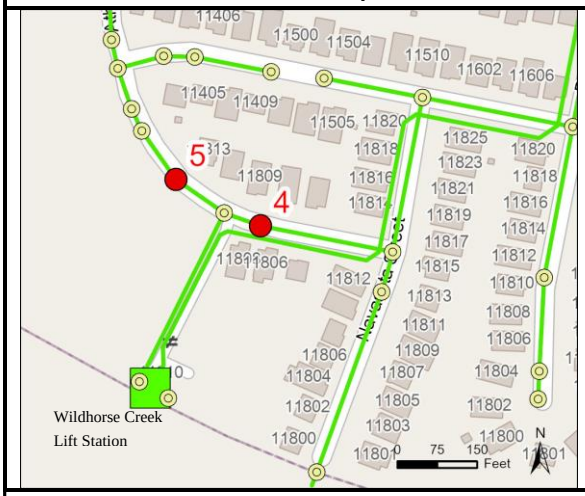
Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 5	8/31/2021	12:02	8	2.00	2.20	0.20	2.00	1.69	-0.31	1.75	1.68	-0.07	1.75	1.56	-0.19	Install	Meter installed at in pipe
	9/13/2021	14:45		1.50	1.75	0.25	1.25	1.70	0.45	1.50	1.40	-0.10	1.50	1.60	0.10	Service/Upload	
	9/27/2021	14:55		1.00	2.00	1.00	1.50	1.60	0.10	1.25	1.00	-0.25	1.50	1.40	-0.10	Service/Upload	
	10/12/2021	11:52		1.75	2.20	0.45	1.50	1.60	0.10	2.50	0.00	-2.50	1.50	1.40	-0.10	Service/Upload	
	10/26/2021	13:33		1.75	1.79	0.04	2.00	2.03	0.03	1.00	0.99	-0.01	1.50	1.52	0.02	Service/Upload	
	11/8/2021	12:17		1.50	1.50	0.00	1.50	1.50	0.00	1.00	0.94	-0.06	1.50	1.57	0.07	Service/Upload	Light debris and grease.
	11/30/2021	11:33		1.50	1.80	0.30	1.25	1.29	0.04	1.00	0.95	-0.05	1.25	1.17	-0.08	Removal	

Figure 64 – Flow Meter Site Investigation (Site 5)

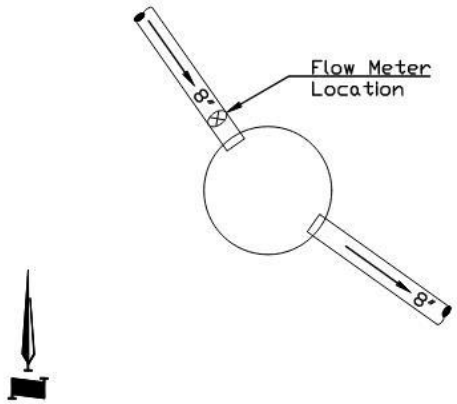
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 11-30-2021 / 11:33	**Crew:** JA-VI
MH#: P09-002	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 8
Site ID: 5	**Address:** 11813 Athens St.	**Site Quality:** Good	**Monitoring Purpose:** Short-term FM

Location Map

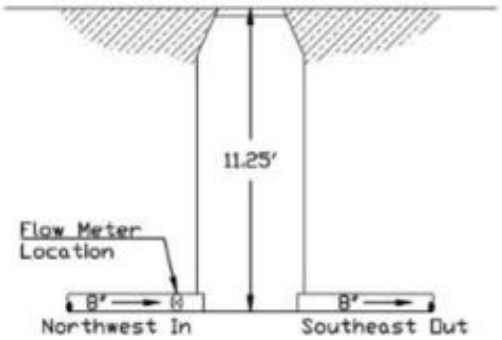
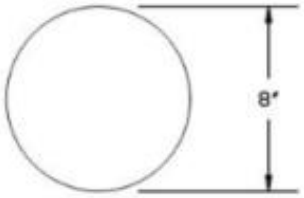


Planar Description



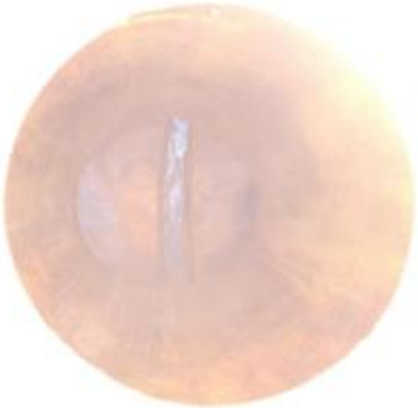
Summary Description:
Located near intersection of Athens Street and Wildhorse Creek Lift Station Access Road. In the middle of an asphalt street.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? Light		**Manhole Depth (ft):** 11.25	**Surcharge Evidence?** No
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 0.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 24.00	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Standard	**Usable MH Steps?** No
Describe potential hazards: Cones are needed and service truck light needs to be on throughout the whole service due to being on a local street.		**Measured Flow Depth (in):** 1.25	**Meter:** ISCO 2150
		Velocity (fps): 1.25	**Cellular Signal Strength:** N/A
		Mounting Band Description: Spring Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes	Pipe Cross Section
	

Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE



DOWN

INFLOW

OUTFLOW

GBA

Figure 65 – Site Information (Site 5)

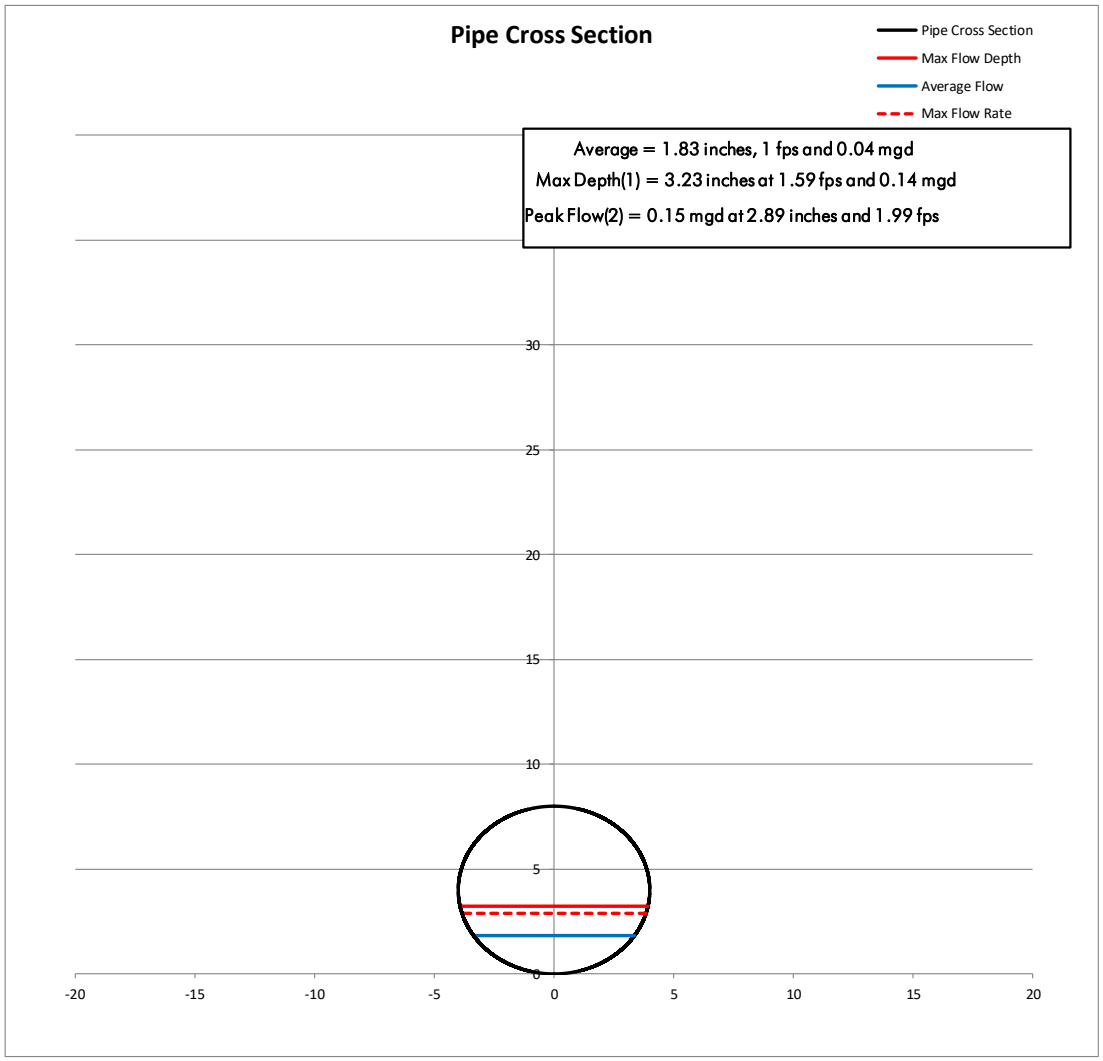
SITE INFORMATION RECORD

Site Information

Meter ID #:	5
Monitoring Program:	Short-Term FM
Manhole #:	P09-002

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	8	
Pipe Width, W (in):	8	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0055	ASSUMED!



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 5	8/31/2021	8	12:02	2.00	1.69	-0.31	1.75	1.56	-0.19
	9/13/2021		14:45	1.25	1.70	0.45	1.50	1.60	0.10
	9/27/2021		14:55	1.50	1.60	0.10	1.50	1.40	-0.10
	10/12/2021		11:52	1.50	1.60	0.10	1.50	1.40	-0.10
	10/26/2021		13:33	2.00	2.03	0.03	1.50	1.52	0.02
	11/8/2021		12:17	1.50	1.50	0.00	1.50	1.57	0.07
	11/30/2021		11:33	1.25	1.29	0.04	1.25	1.17	-0.08

Figure 66 – August-September Monthly Flow Hydrograph (Site 5)

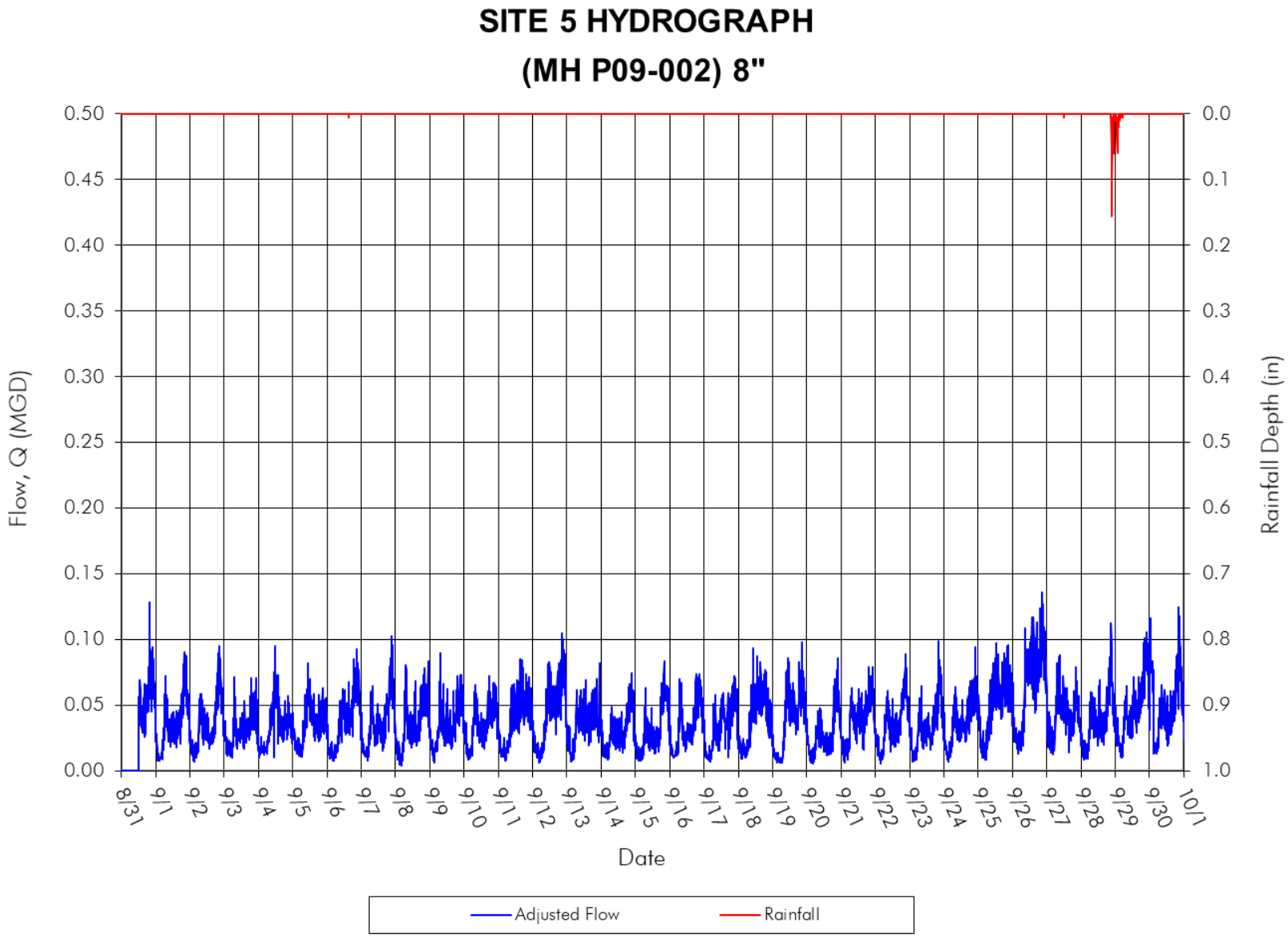


Figure 67 – August-September Monthly Level and Velocity Hydrograph (Site 5)

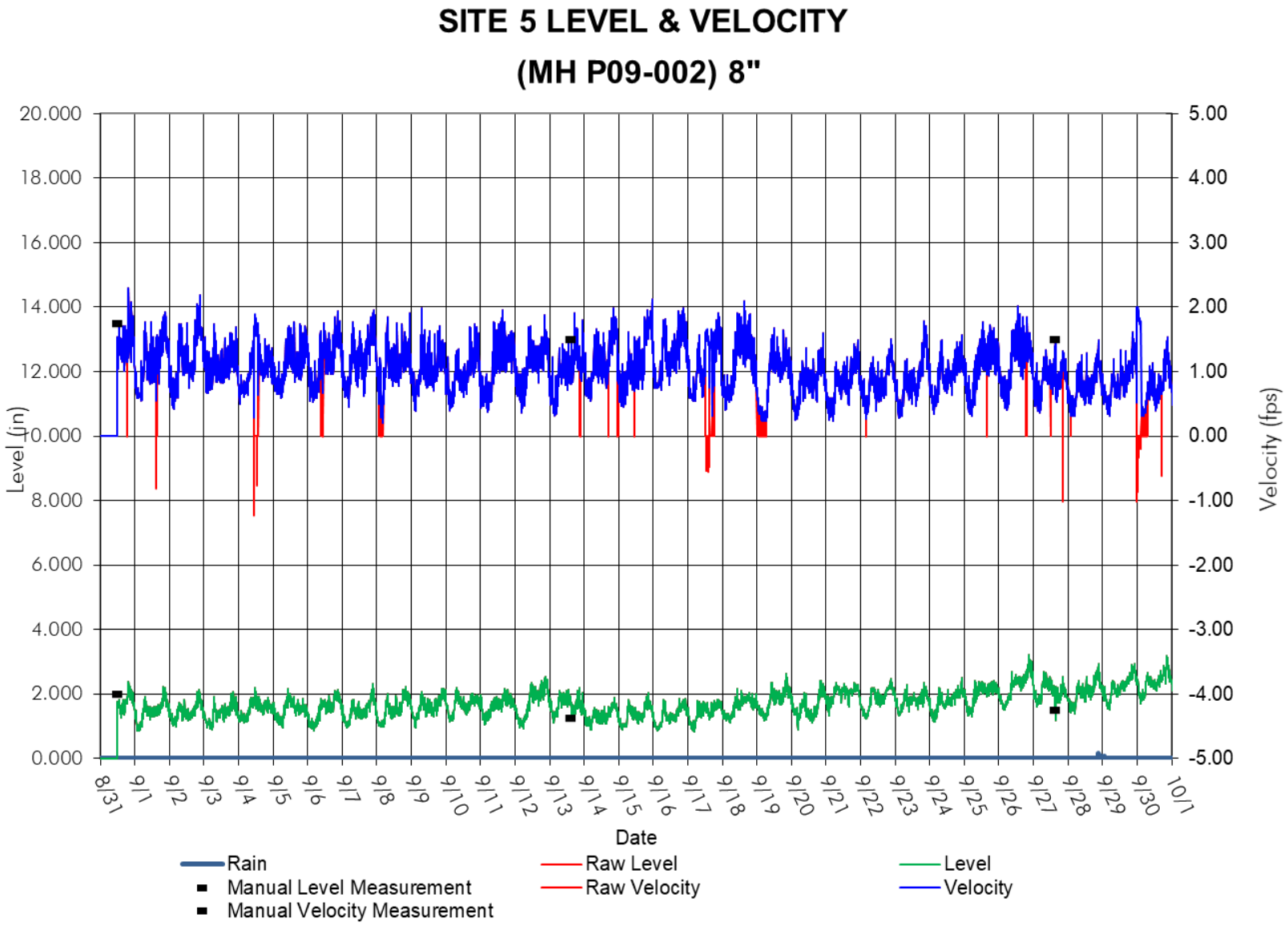


Figure 68 – October Flow Hydrograph (Site 5)

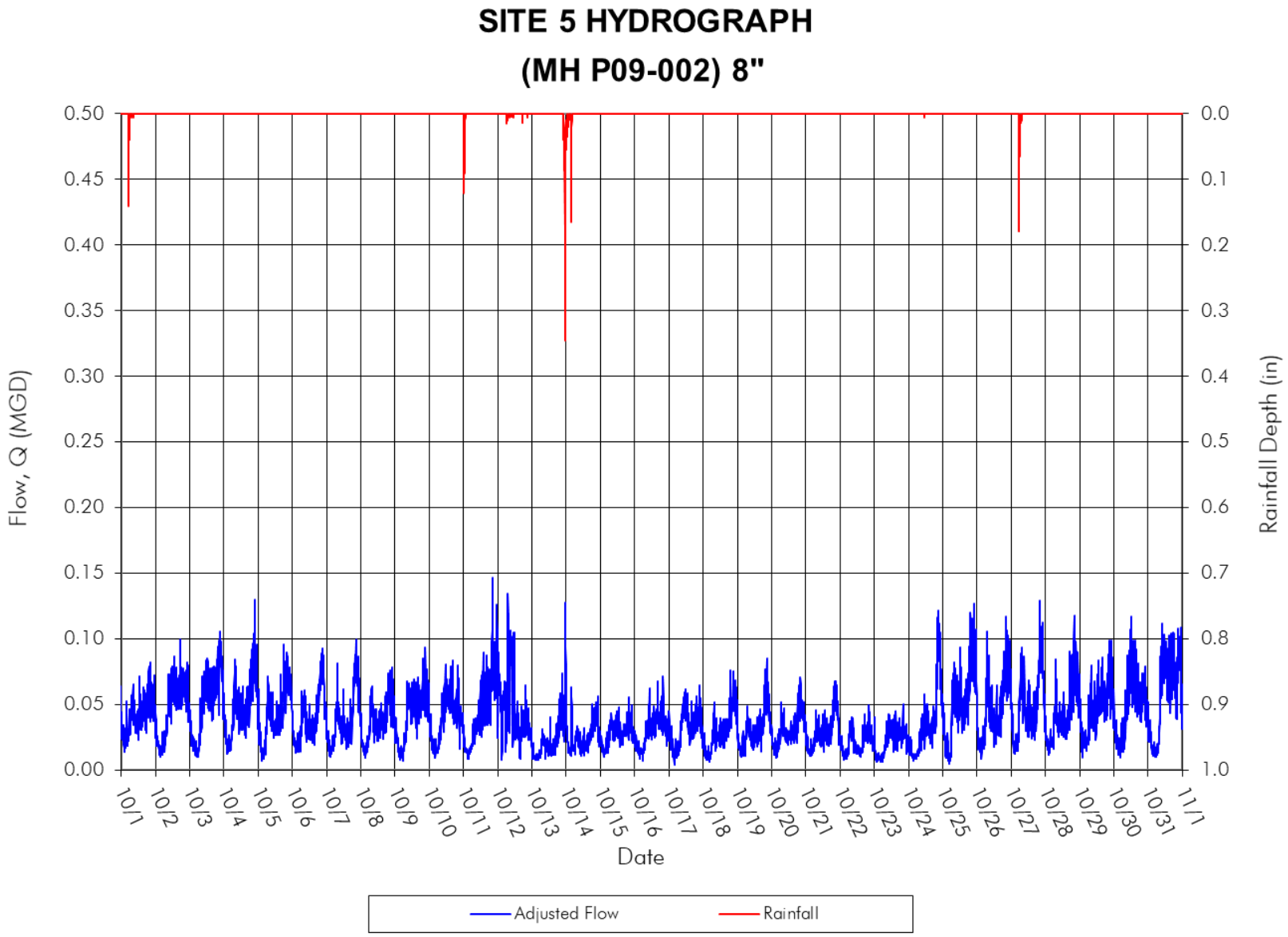


Figure 69 – October Monthly Level and Velocity Hydrograph (Site 5)

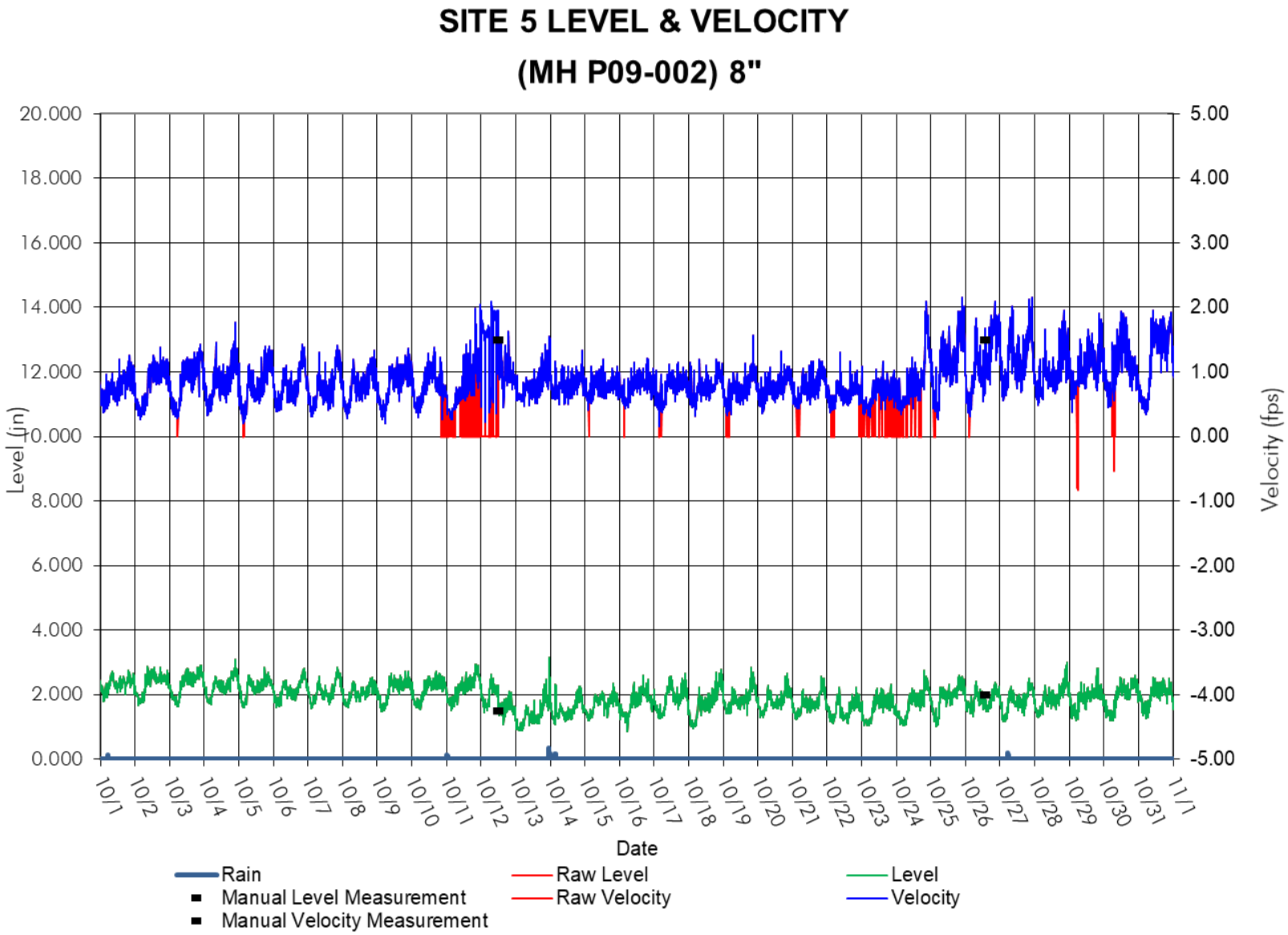


Figure 70 – November Monthly Flow Hydrograph (Site 5)

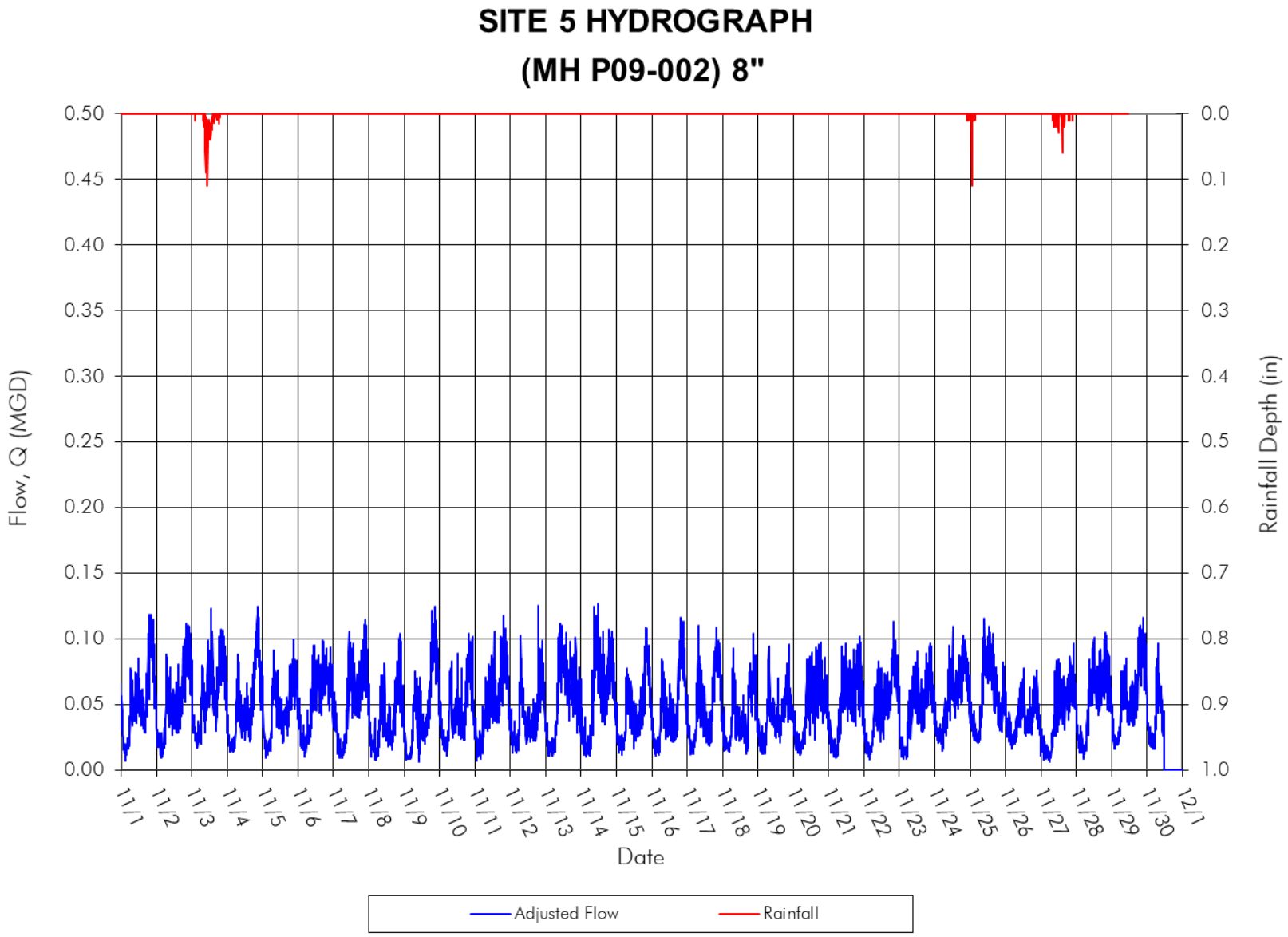


Figure 71 – November Level and Velocity Hydrograph (Site 5)

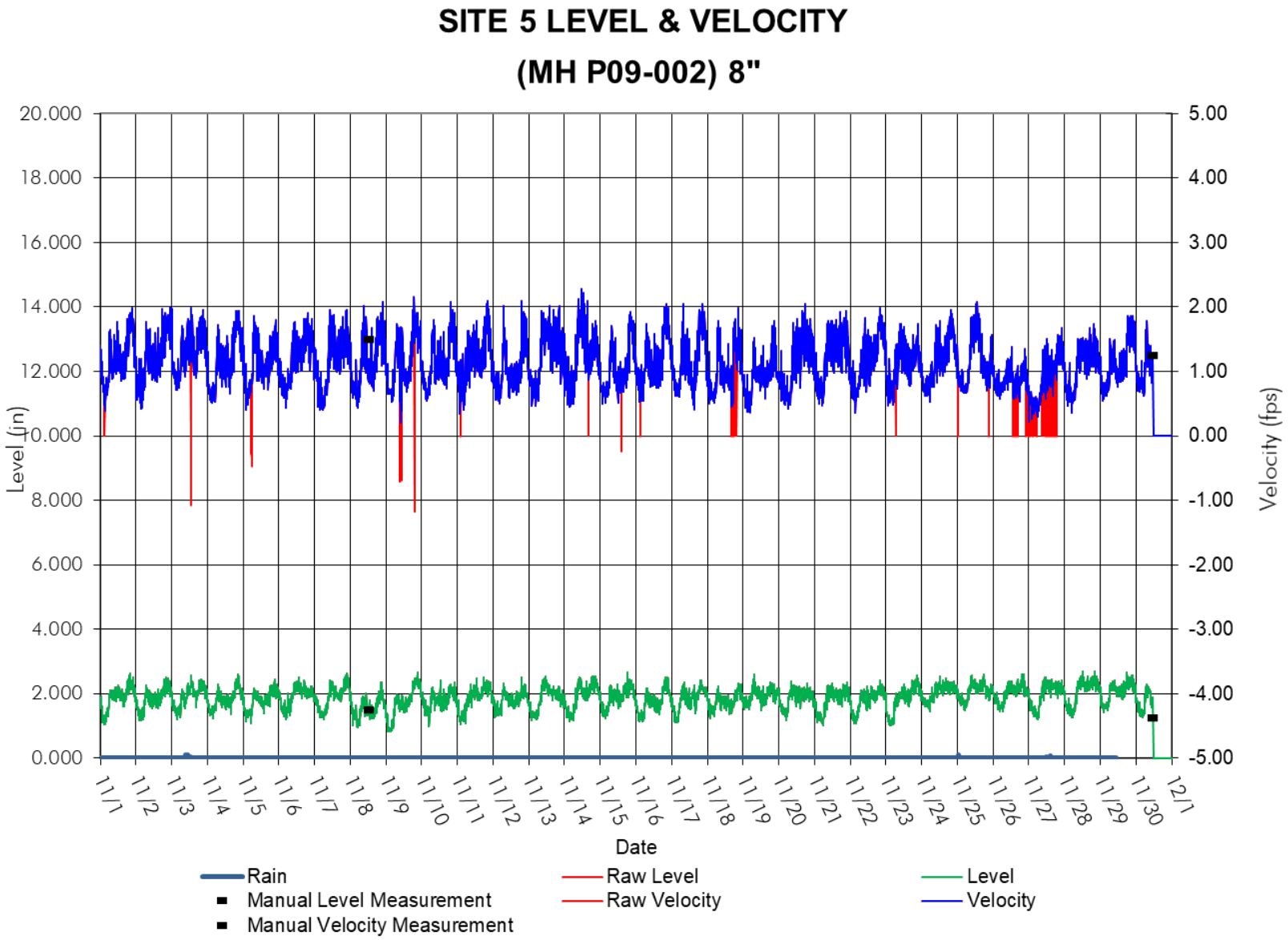


Figure 72 – Overall Flow Hydrograph (Site 5)

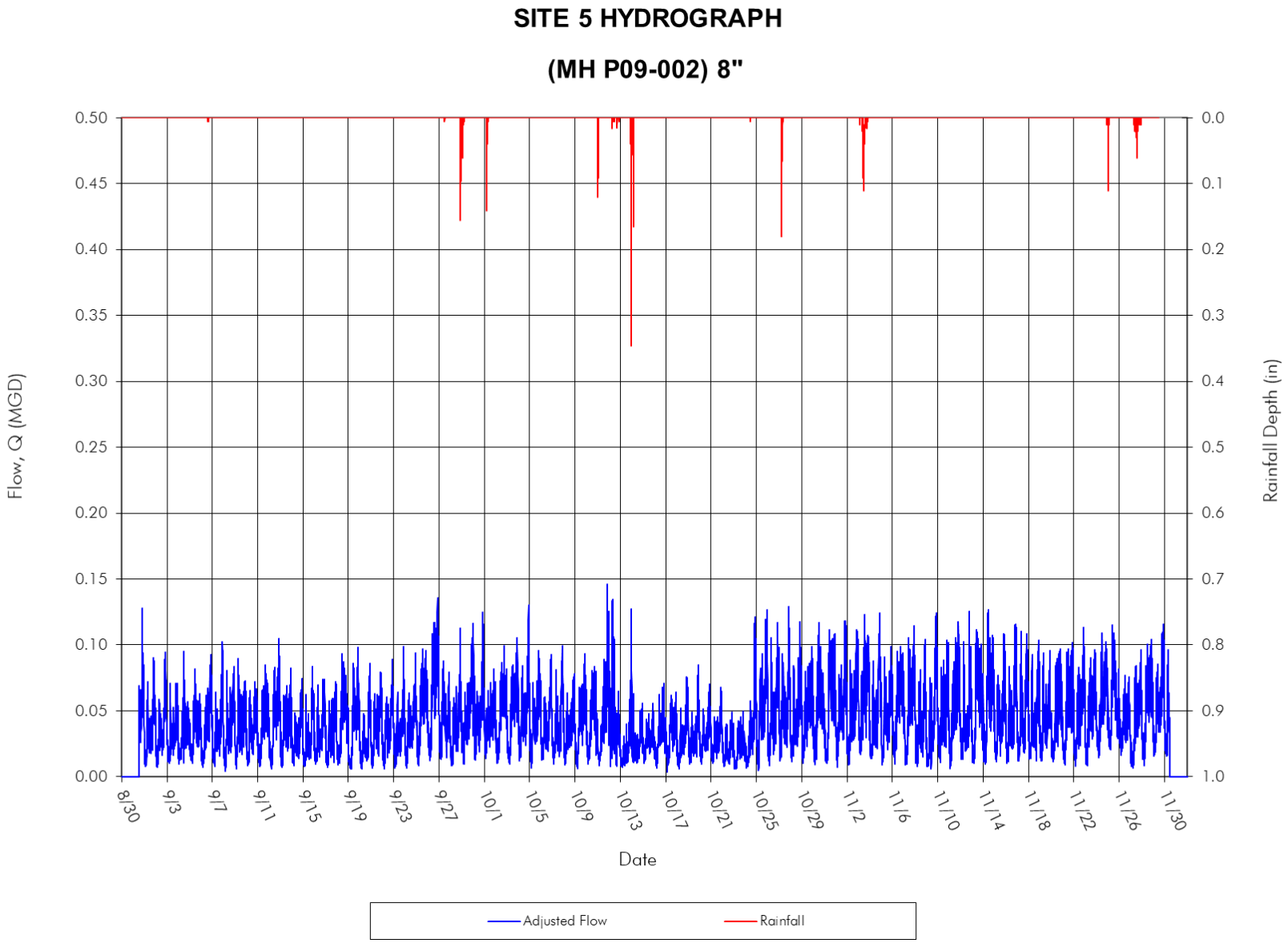


Figure 73 – Overall Level and Velocity Hydrograph (Site 5)

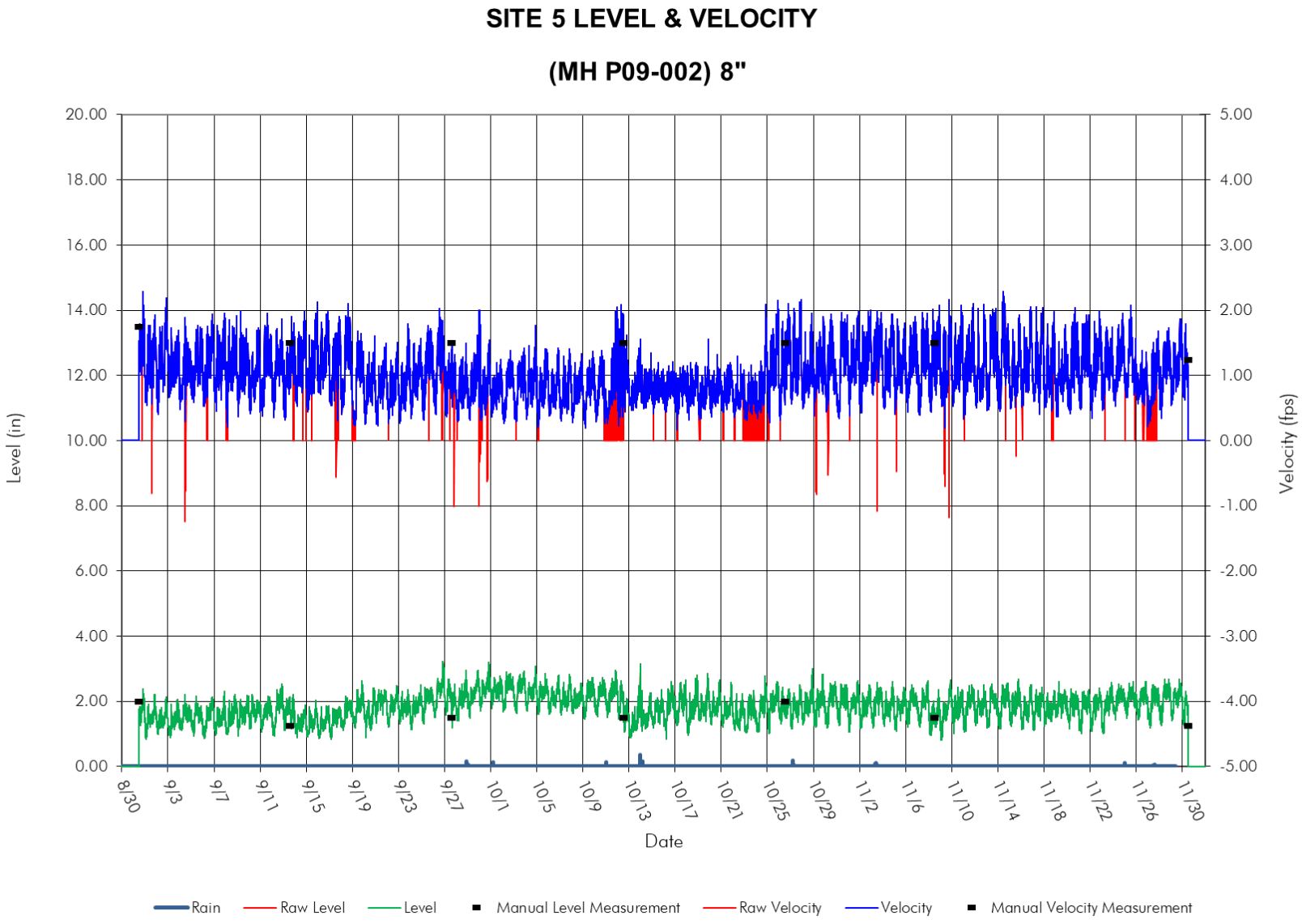


Figure 74 – Standard Flow Scattergraph (Site 5)

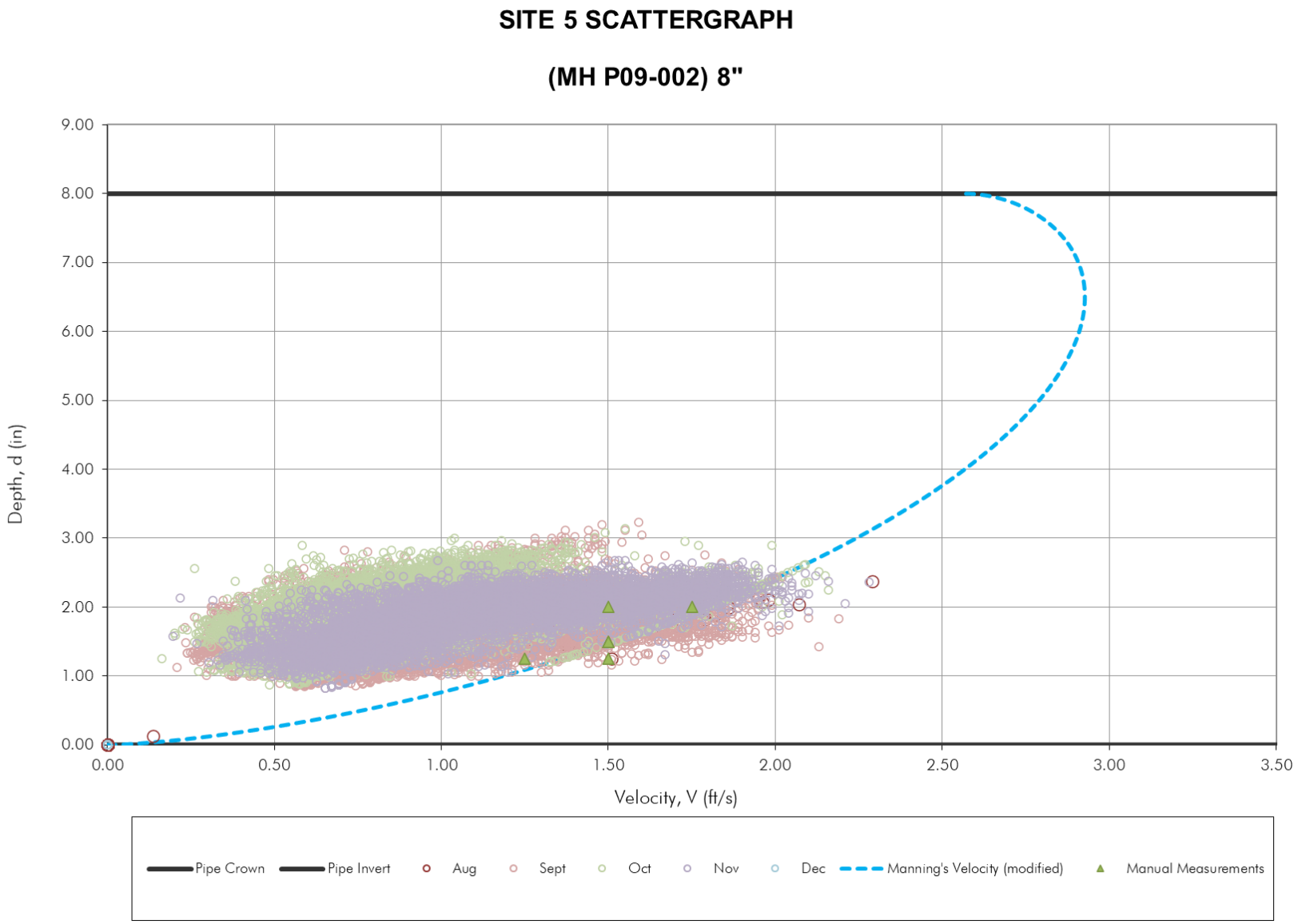


Table 21 – ADDF and Infiltration Summary (Site 5)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 5
Meter: 5
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.043	0.087	2.034	0.012	28-Nov-21	0.016
13-Sep-21	Mon	0.035	0.057	1.625	0.012		
14-Sep-21	Tue	0.030	0.059	1.956	0.013		
15-Sep-21	Wed	0.031	0.067	2.149	0.011		
16-Sep-21	Thu	0.033	0.065	1.954	0.012	04-Nov-21	0.018
17-Sep-21	Fri	0.034	0.059	1.772	0.010	29-Oct-21	0.022
18-Sep-21	Sat	0.040	0.068	1.685	0.015	16-Oct-21	0.013
7 Count		0.035 Average	0.066 Average	1.882 Average	0.012 Average	4 Count	0.018 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.035	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.035	
	Diurnal Peaking Factor (DPF):	1.882	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.005	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.005	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.035	

Figure 75 – Dry Weather Diurnal (Site 5)

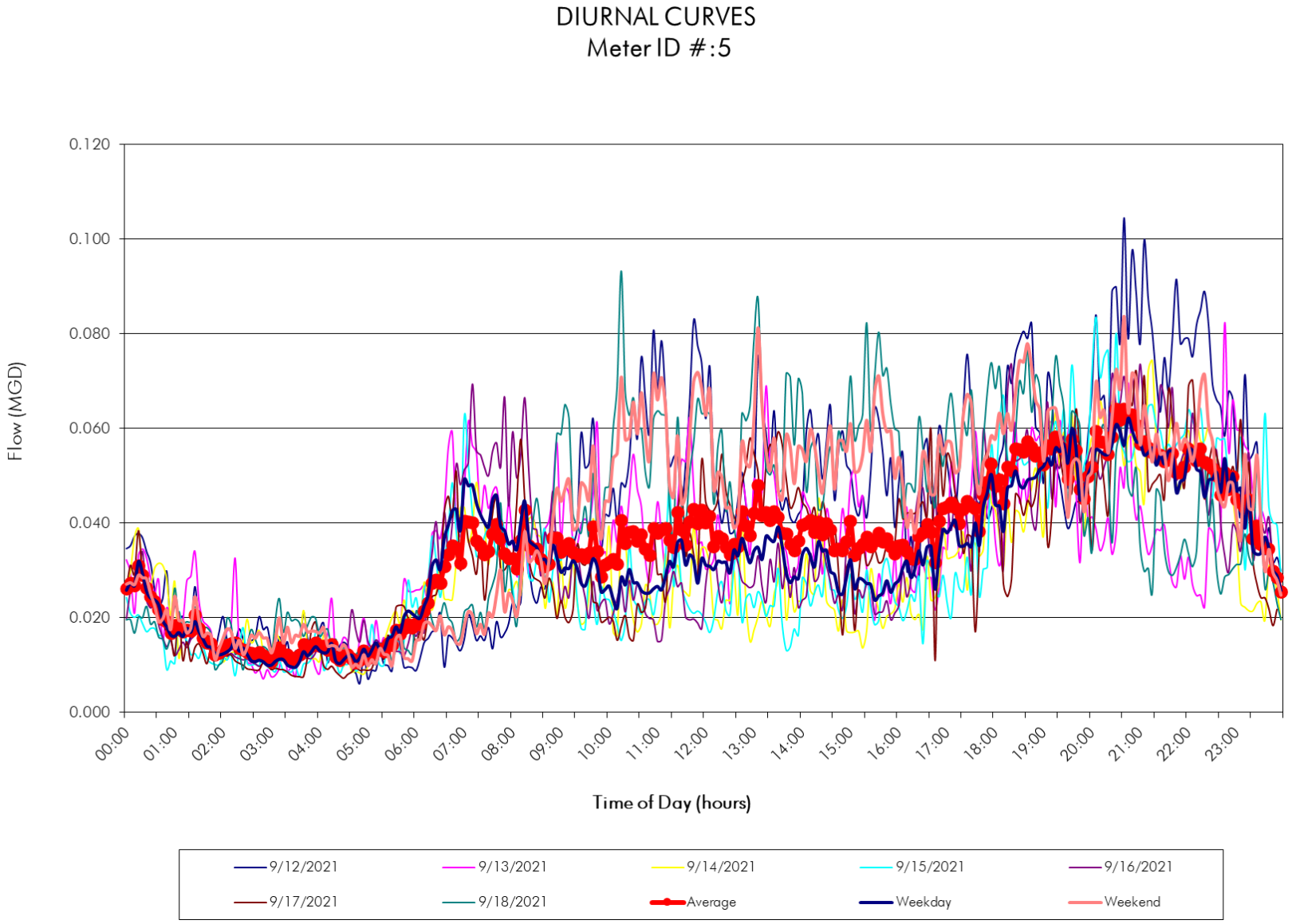


Figure 76 – High/Low Groundwater Diurnal (Site 5)

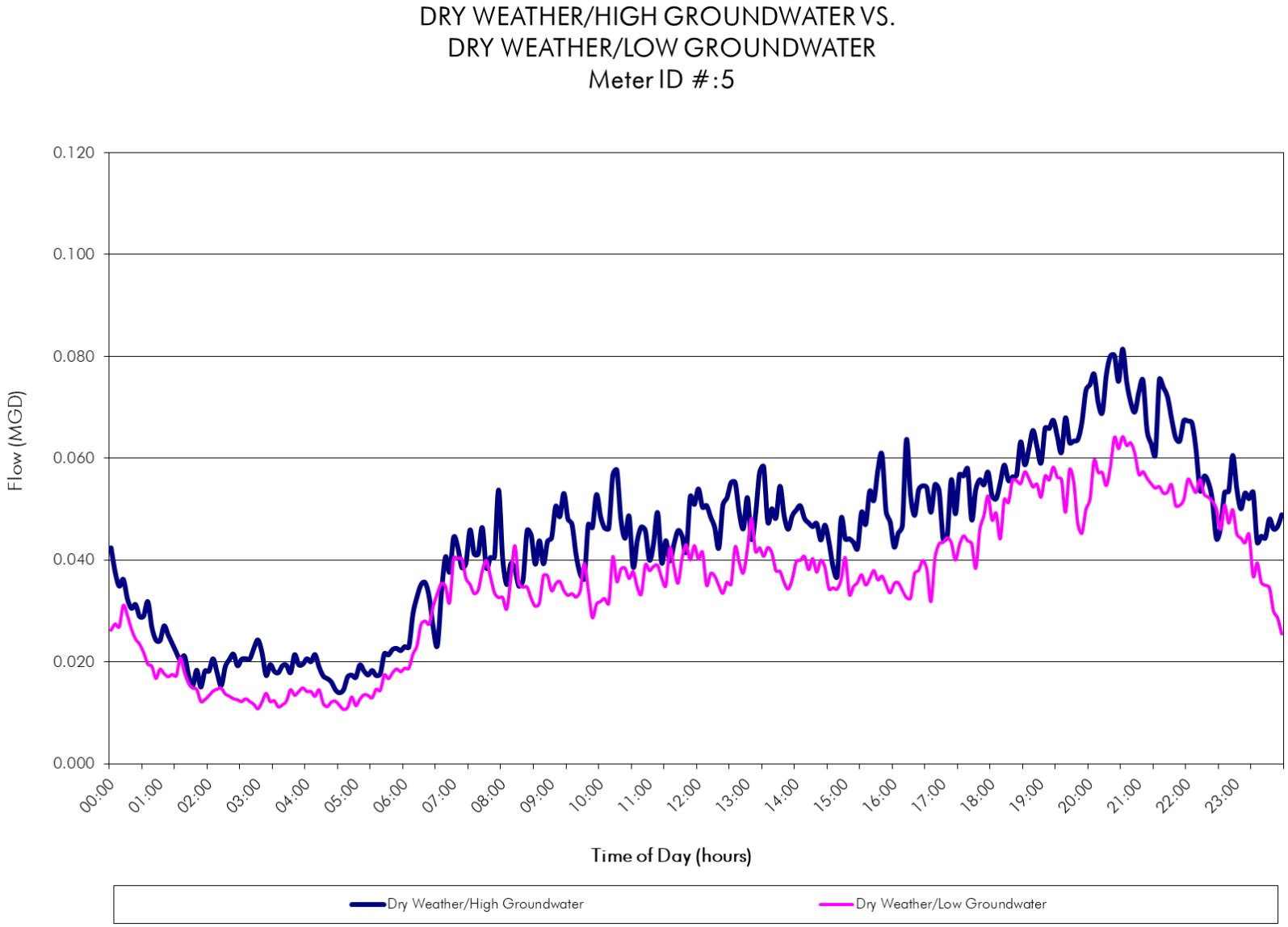


Table 22 – Inflow Calculations and Projections (Site 5)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	5
Meter:	5
Units of Flow:	MGD

Storm Count:	7	Cum. Trib. Area:	44 acres	Pipe Shape:	Circular
Avg Delta Time	76	Cum. Time of Conc.:	60 minutes	Pipe Diameter:	8 in
Avg Kp:	0.00273			Pipe Slope:	0.006 ft/ft
Avg Selected Kp:	0.00330			Pipe Capacity:	0.58 mgd
				ADDF Cum.:	0.035 mgd
				ADDF Peak. Factor:	1.88
				Peak ADDF Flow:	0.066 mgd
				Infiltration:	0.005 mgd
				Cum. Peak Flow:	0.071 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.071
1	1.320	0.124	0.192	0.195
2	1.630	0.153	0.237	0.224
5	2.070	0.194	0.301	0.266
10	2.420	0.227	0.351	0.299
25	2.890	0.271	0.420	0.343
50	3.270	0.307	0.475	0.378
100	3.660	0.344	0.532	0.415

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/28/21 21:00	1.65	7.92	9/28/21 21:45	9/28/21 21:20	25	0.072	09/27/21	0.045	0.027	0.710	0.00135	y	0.00135					
10/1/21 4:55	0.73	3.67	10/1/21 8:20	10/1/21 5:05	195	0.065	09/30/21	0.033	0.032	0.700	0.00163	y	0.00163					
10/11/21 0:05	0.49	1.25	10/11/21 0:05	10/11/21 0:05	0	0.034	10/10/21	0.043	-0.009	0.470	-0.00066	n						No reaction
10/13/21 21:55	3.15	6.00	10/13/21 23:15	10/13/21 23:10	5	0.127	10/12/21	0.030	0.097	1.760	0.00194	y	0.00194					
10/27/21 5:15	0.89	2.42	10/27/21 7:20	10/27/21 5:25	115	0.093	10/20/21	0.040	0.053	0.750	0.00247	y	0.00247					
11/3/21 2:10	1.89	16.83	11/3/21 13:00	11/3/21 10:35	145	0.123	10/27/21	0.056	0.067	0.480	0.00492	y	0.00492					
11/27/21 7:45	0.70	13.92	11/27/21 15:10	11/27/21 14:25	45	0.071	11/26/21	0.033	0.038	0.180	0.00750	y	0.00750					

Figure 77 – Inflow Projections (Site 5)

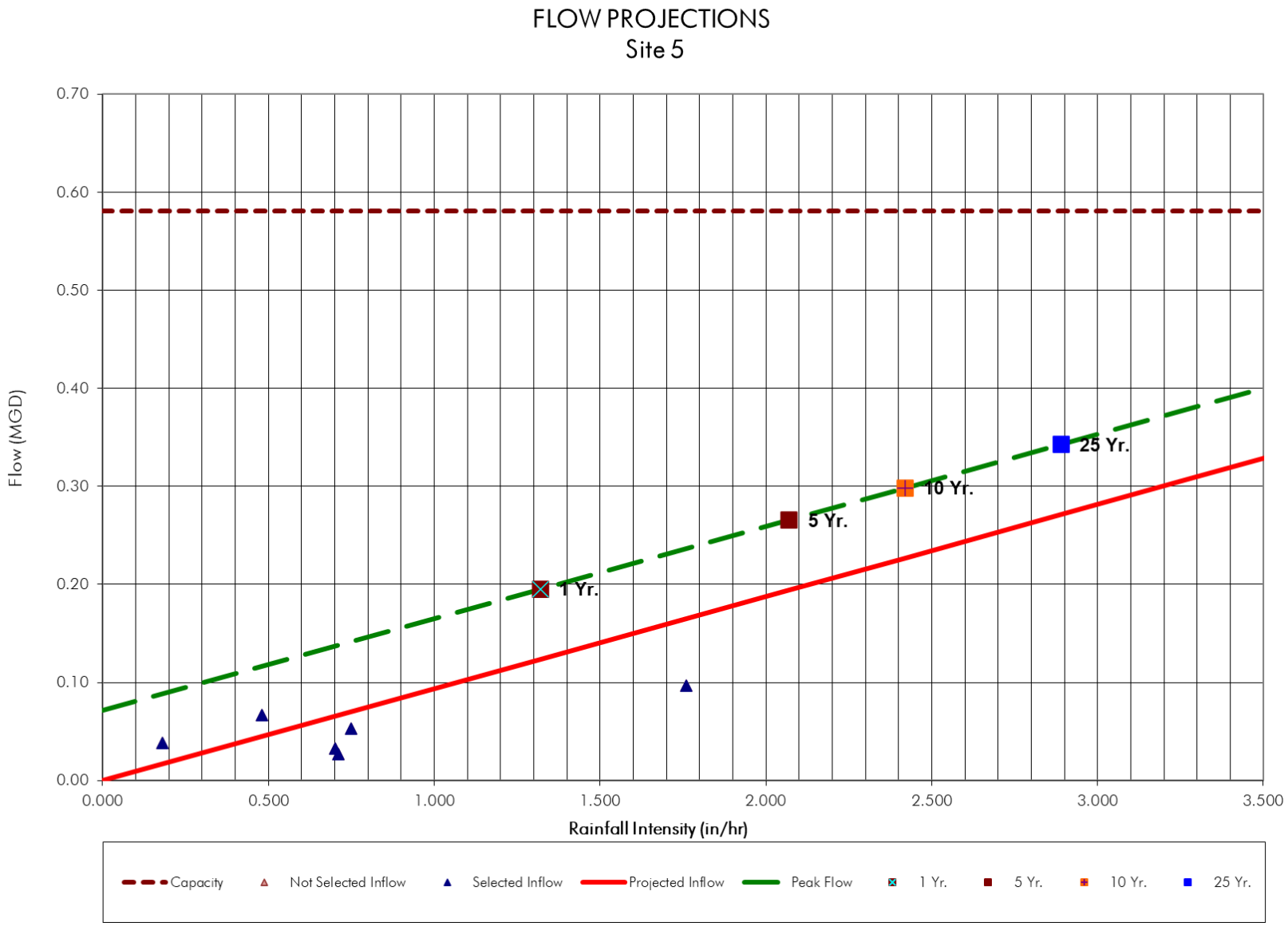
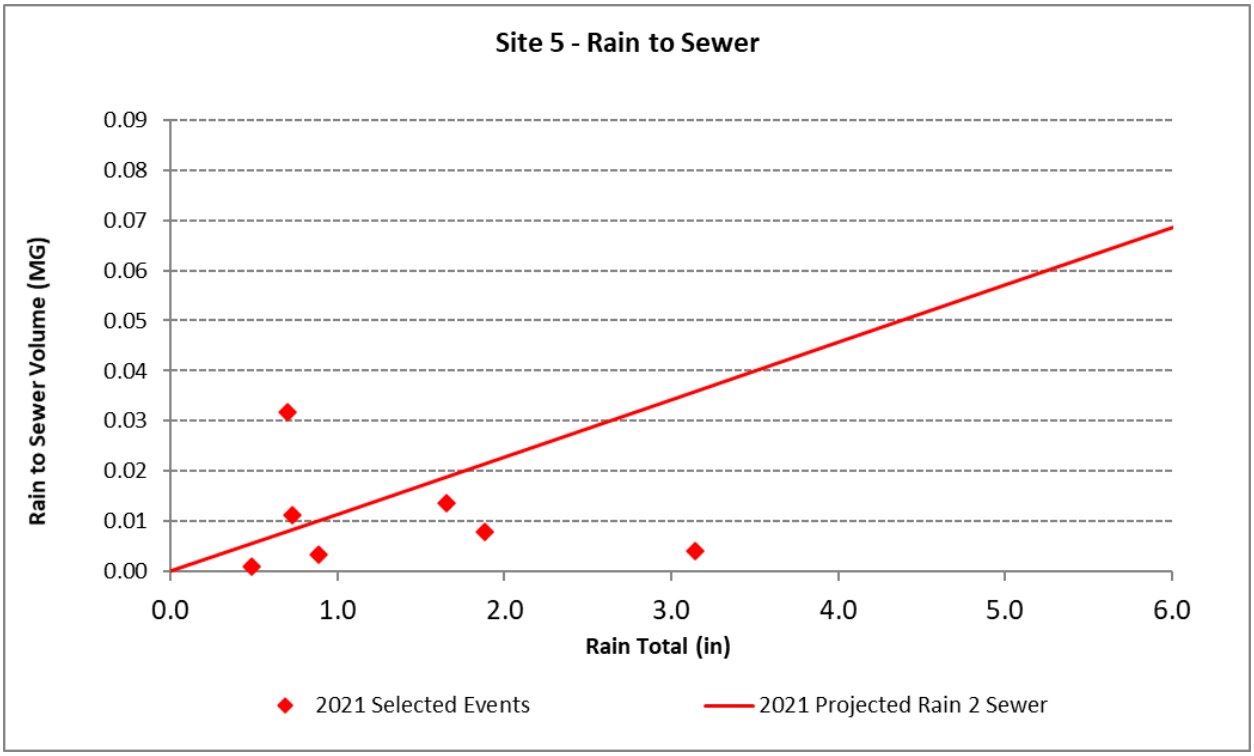


Table 23 – Rain to Sewer Summary (Site 5)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 5 (8")	9/28/2021	1.65	1.971	0.013	0.68%
	10/1/2021	0.73	0.872	0.011	1.29%
	10/11/2021	0.49	0.579	0.001	0.14%
	10/13/2021	3.15	3.757	0.004	0.11%
	10/27/2021	0.89	1.057	0.003	0.31%
	11/3/2021	1.89	2.252	0.008	0.34%
	11/27/2021	0.70	0.836	0.032	3.80%
				Average	**0.95%**

Figure 78 – Rain to Sewer Volumetric Analysis (Site 5)



A.6 Site 6

Description

Site 6 was located in manhole O13-007 at intersection of Carriage Hills Drive and Prairie Sage Cove. This meter was installed in the 8" diameter PVC out flow pipe and measures flow contributing to the Wilbarger Wastewater Treatment Plant. The flow collects at the Carriage Hills Lift Station and pumped into Basin 7.

Observations

The flow observed at this site had an average depth of 1.37 inches of flow moving at 2.66 feet per second for the 2021 flow monitoring period. The site had some light grease on probe at site visits. The level and velocity readings were consistent with manuals taken at site visits. The site does have consistent low level velocity dropouts these were easily autocorrected using valid readings. The site is considered a good quality dry and wet weather monitoring site.

This site did not experience any surcharging during the 2021 flow monitoring period.

Table 24 –Service Interrogations Summary (Site 6)

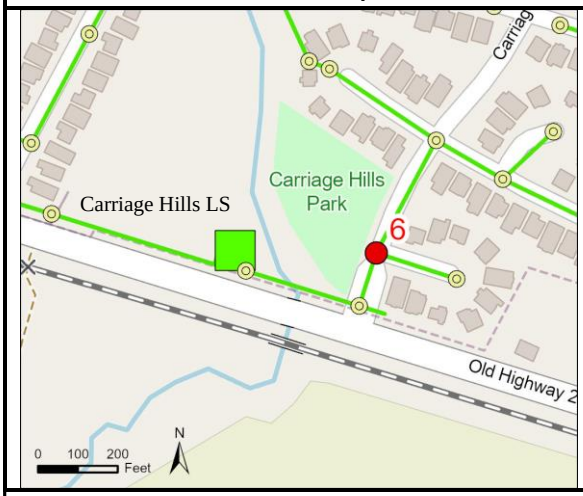
Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 6	8/31/2021	14:22	8	1.25	1.30	0.05	1.25	1.05	-0.20	2.75	2.75	0.00	2.75	2.79	0.04	Install	Meter installed at out pipe
	9/13/2021	13:38		1.00	0.90	-0.10	1.00	1.00	0.00	2.50	2.60	0.10	3.00	3.20	0.20	Service/Upload	
	9/27/2021	13:07		1.25	1.20	-0.05	1.00	1.00	0.00	3.00	3.00	0.00	3.00	2.80	-0.20	Service/Upload	
	10/12/2021	13:50		1.25	1.15	-0.10	1.50	1.30	-0.20	3.00	3.10	0.10	3.00	2.87	-0.13	Service/Upload	
	10/26/2021	10:25		2.00	1.12	-0.88	1.00	1.12	0.12	1.00	0.96	-0.04	1.00	0.96	-0.04	Service/Upload	
	11/8/2021	9:58		1.25	1.31	0.06	1.50	1.46	-0.04	3.25	3.31	0.06	3.25	3.16	-0.09	Service/Upload	Light grease.
	11/30/2021	13:20		1.25	1.35	0.10	1.25	1.38	0.13	3.00	2.90	-0.10	3.00	3.06	0.06	Removal	Light grease.

Figure 79 – Flow Meter Site Investigation (Site 6)

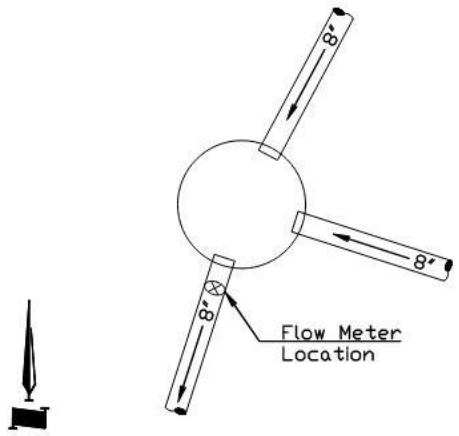
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 11-30-2021 / 13:20	**Crew:** JA-VI
MH#: O13-007	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 8
Site ID: 6	**Address:** 13300 Prairie Sage Cv.	**Site Quality:** Fair	**Monitoring Purpose:** Short-term FM

Location Map



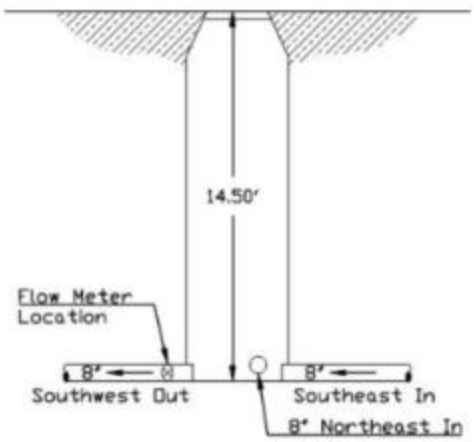
Planar Description



Summary Description:
Located at intersection of Carriage Hills Drive and Prairie Sage Cove. Original flow meter was to be installed at the 1st manhole upstream of the Carriage Hills Lift Station but was unable to install a meter in it due to manhole constantly surcharging and heave grease build up. Surcharge and grease build up continued all the way to the next manhole upstream.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? Medium		**Manhole Depth (ft):** 8.39	**Surcharge Evidence?** No
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 0.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 24.00	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Standard	**Usable MH Steps?** No
Describe potential hazards: Street is a collector which requires cones to be installed throughout the whole service as well as the service truck lights to be on. Top man is to be aware of incoming traffic.		**Measured Flow Depth (in):** 1.25	**Meter:** ISCO 2150
		Velocity (fps): 3.00	**Cellular Signal Strength:** N/A
		Mounting Band Description: Spring Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes



Pipe Cross Section

Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE

DOWN

INFLOW

OUTFLOW

Figure 80 – Site Information (Site 6)

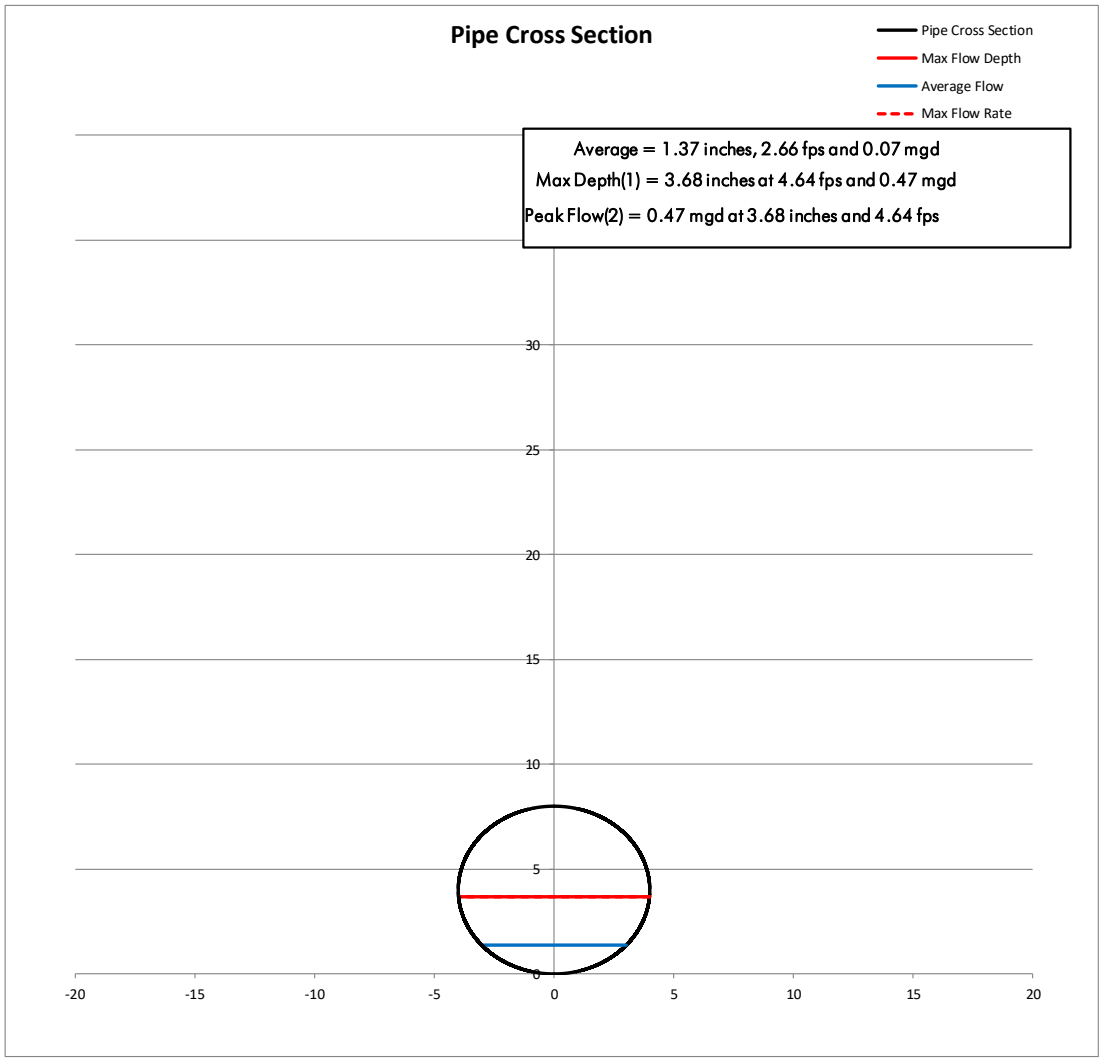
SITE INFORMATION RECORD

Site Information

Meter ID #:	6
Monitoring Program:	Short-Term FM
Manhole #:	O13-007

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	8	
Pipe Width, W (in):	8	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0200	ASSUMEDI



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 6	8/31/2021	8	14:22	1.25	1.05	-0.20	2.75	2.79	0.04
	9/13/2021		13:38	1.00	1.00	0.00	3.00	3.20	0.20
	9/27/2021		13:07	1.00	1.00	0.00	3.00	2.80	-0.20
	10/12/2021		13:50	1.50	1.30	-0.20	3.00	2.87	-0.13
	10/26/2021		10:25	1.00	1.12	0.12	1.00	0.96	-0.04
	11/8/2021		9:58	1.50	1.46	-0.04	3.25	3.16	-0.09
	11/30/2021		13:20	1.25	1.38	0.13	3.00	3.06	0.06

Figure 81 – August-September Monthly Flow Hydrograph (Site 6)

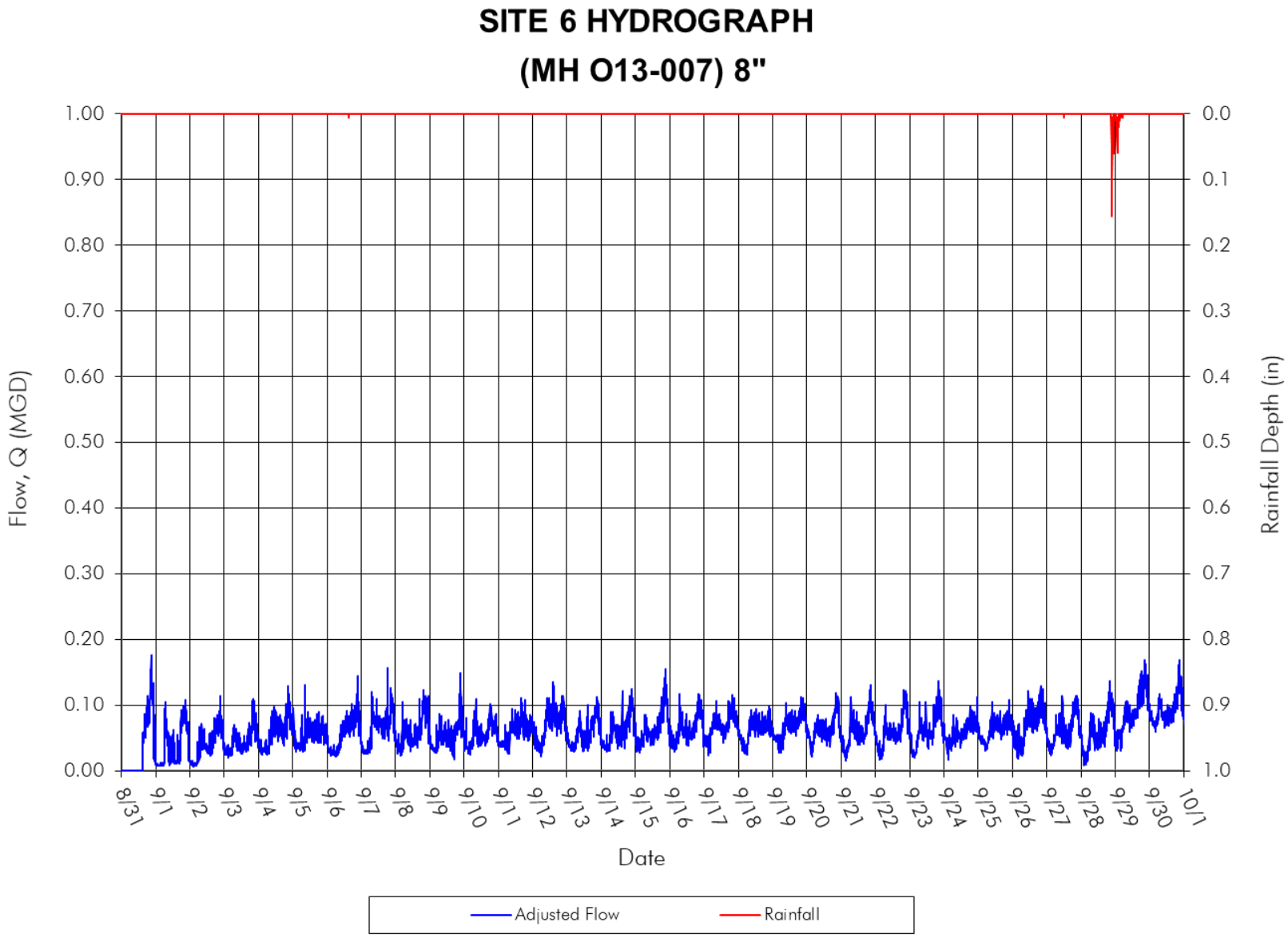


Figure 82 – August-September Monthly Level and Velocity Hydrograph (Site 6)

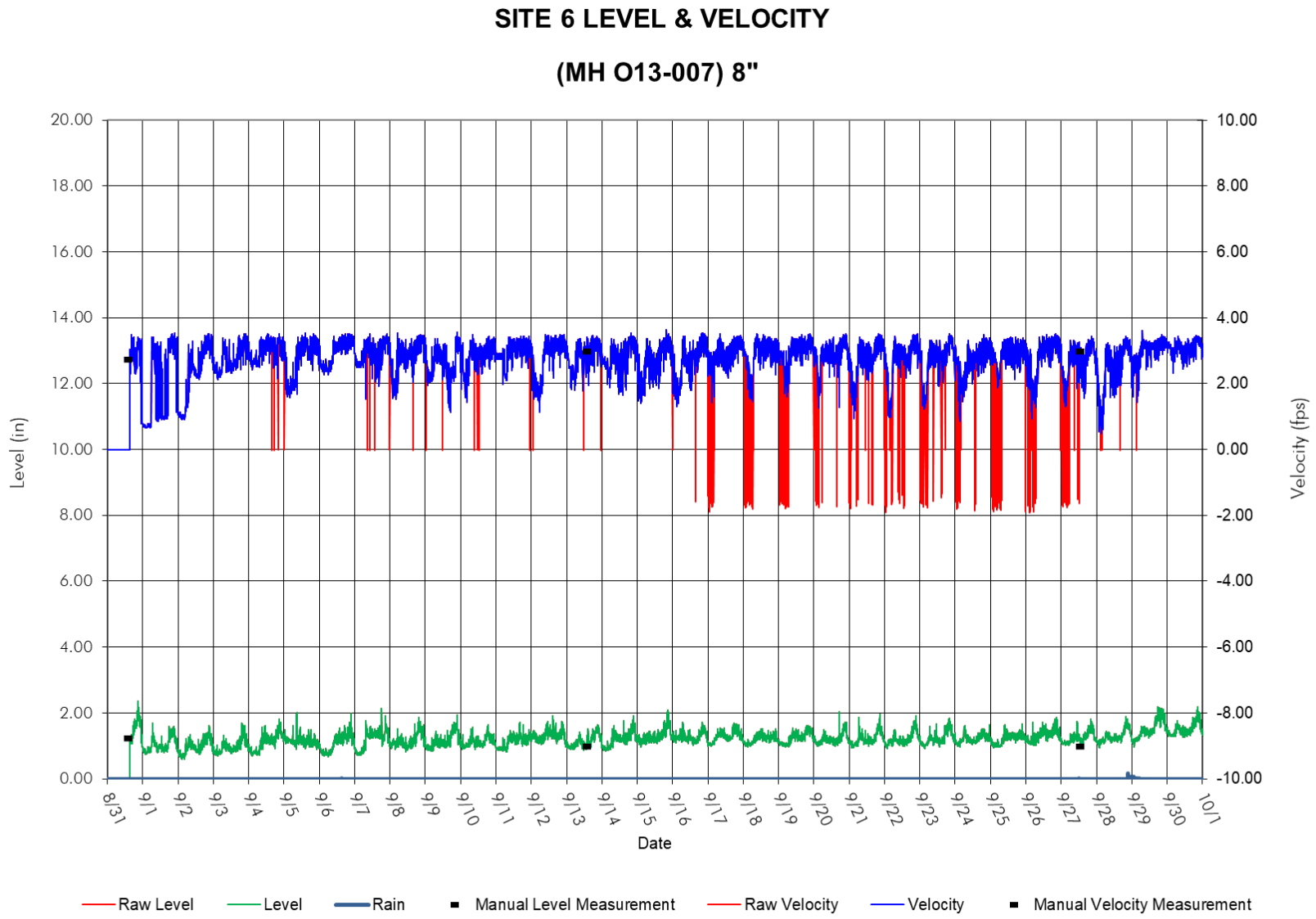


Figure 83 – October Flow Hydrograph (Site 6)

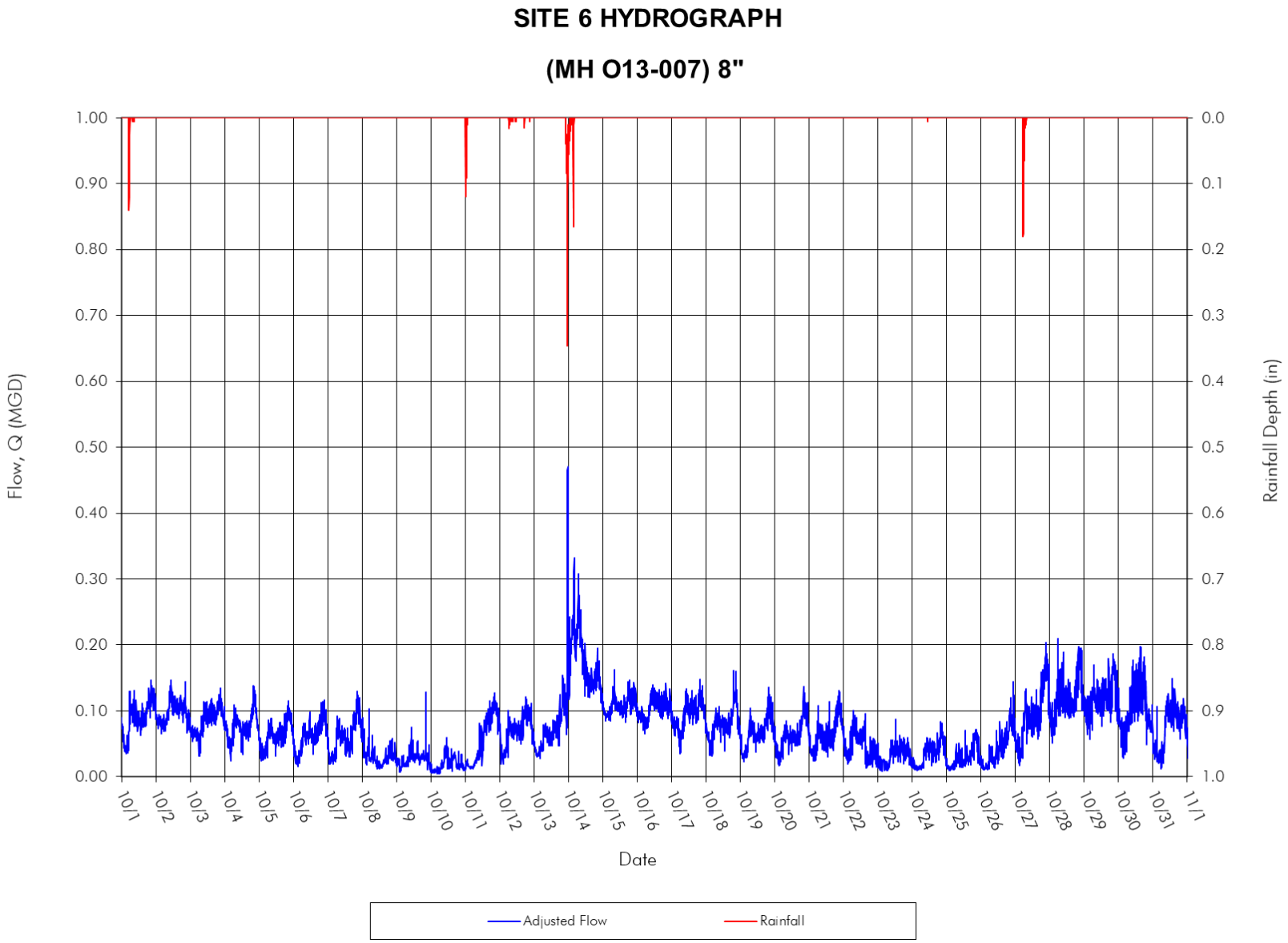


Figure 84 – October Monthly Level and Velocity Hydrograph (Site 6)

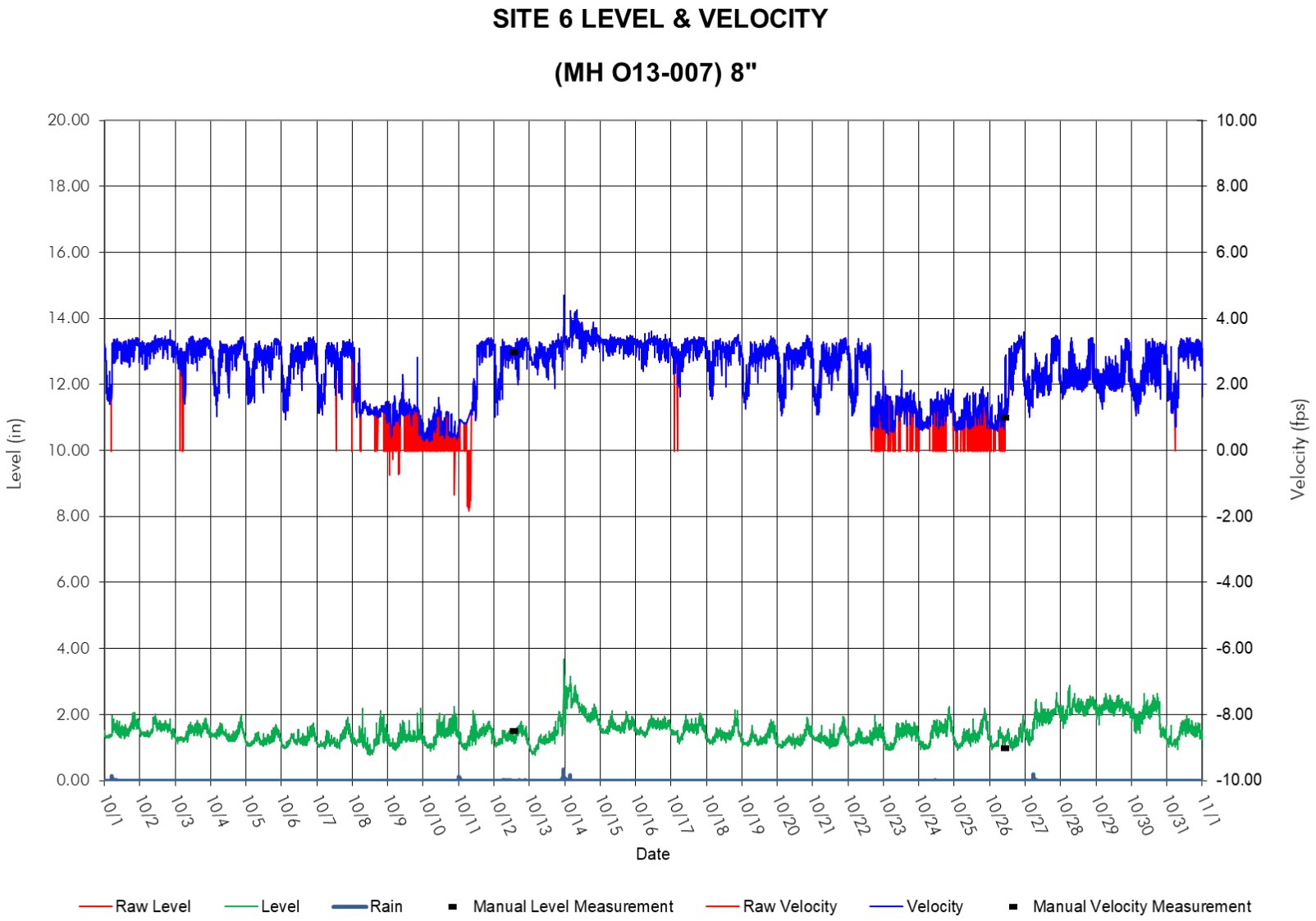


Figure 85 – November Monthly Flow Hydrograph (Site 6)

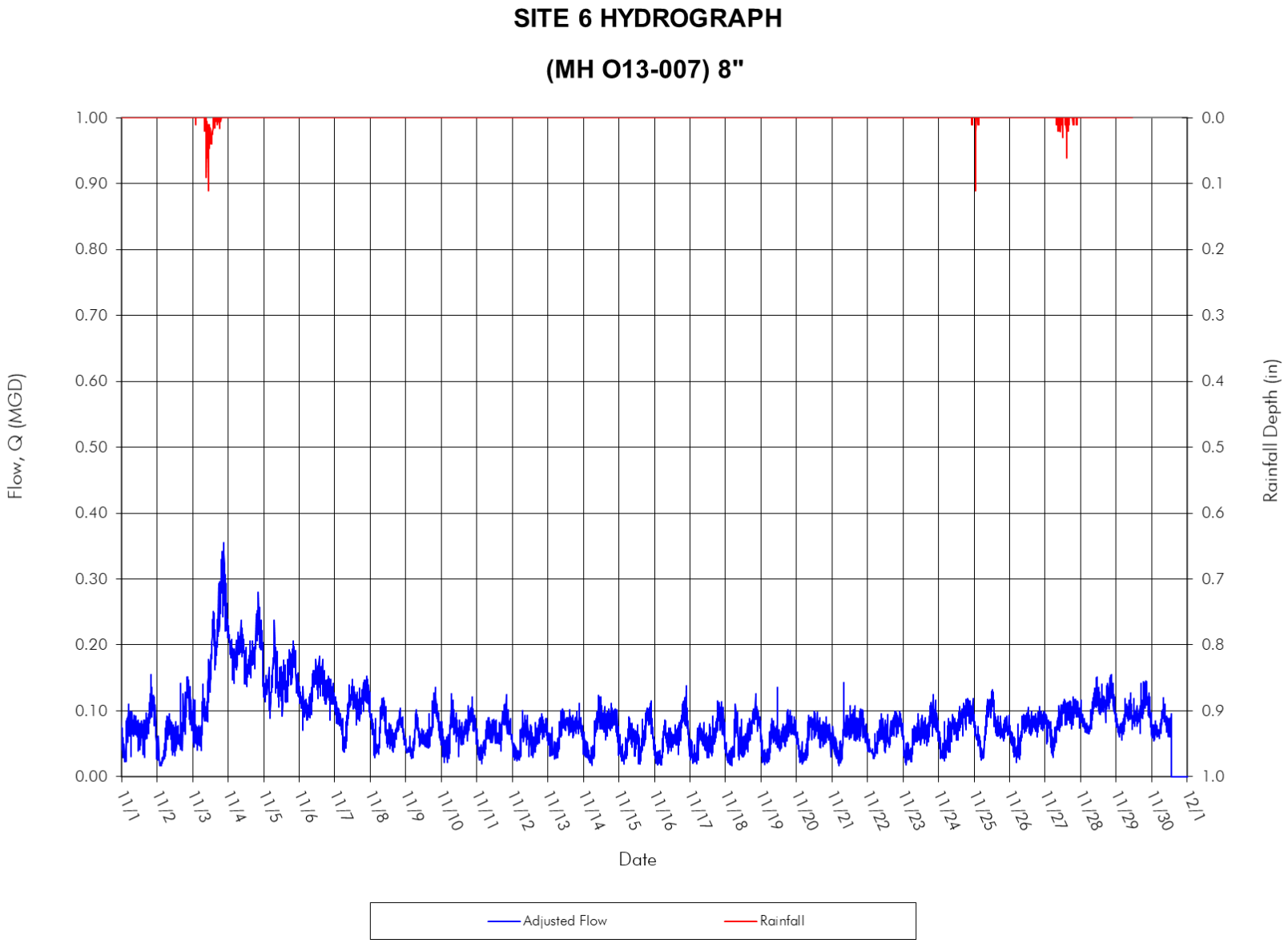


Figure 86 – November Level and Velocity Hydrograph (Site 6)

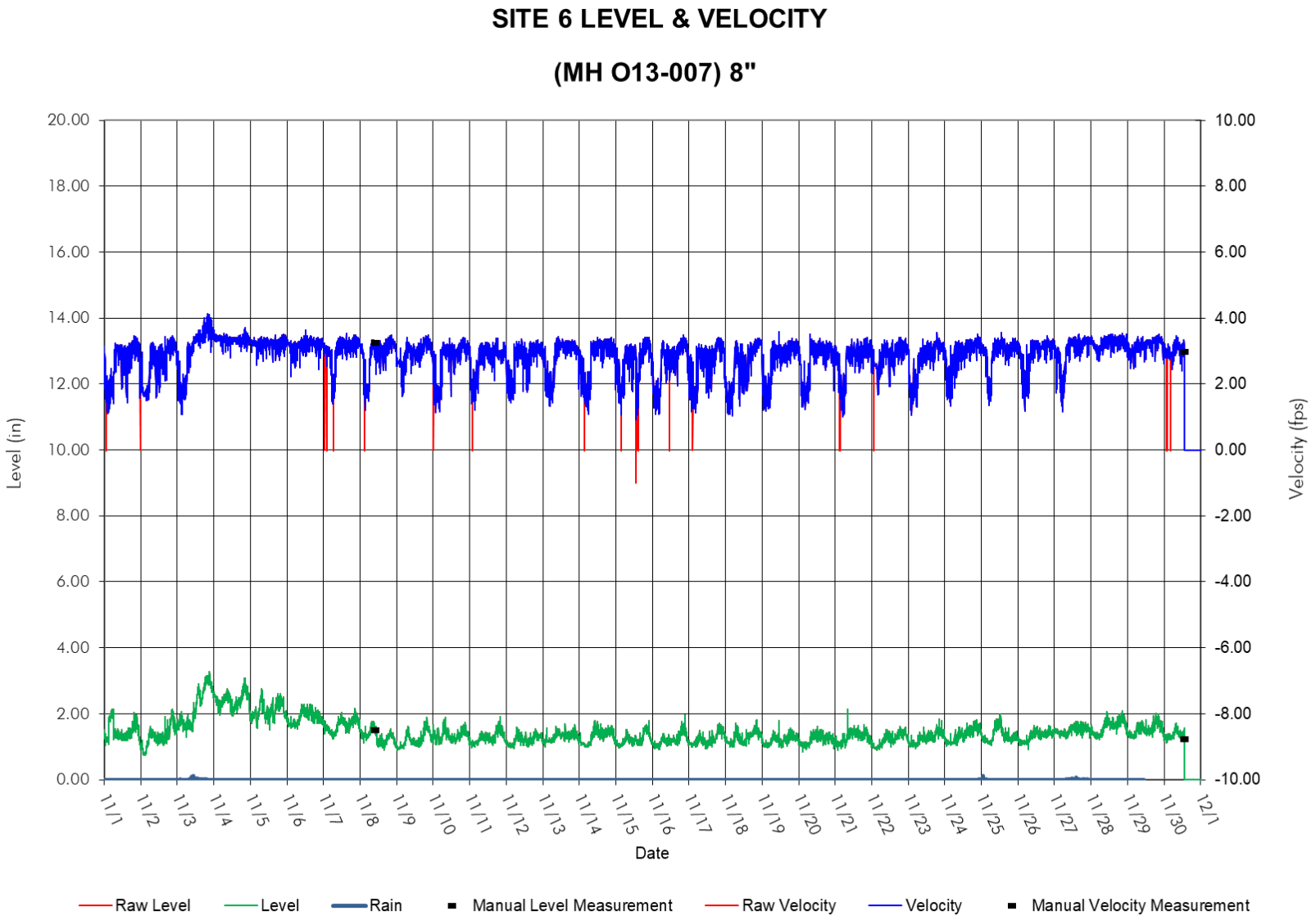


Figure 87 – Overall Flow Hydrograph (Site 6)

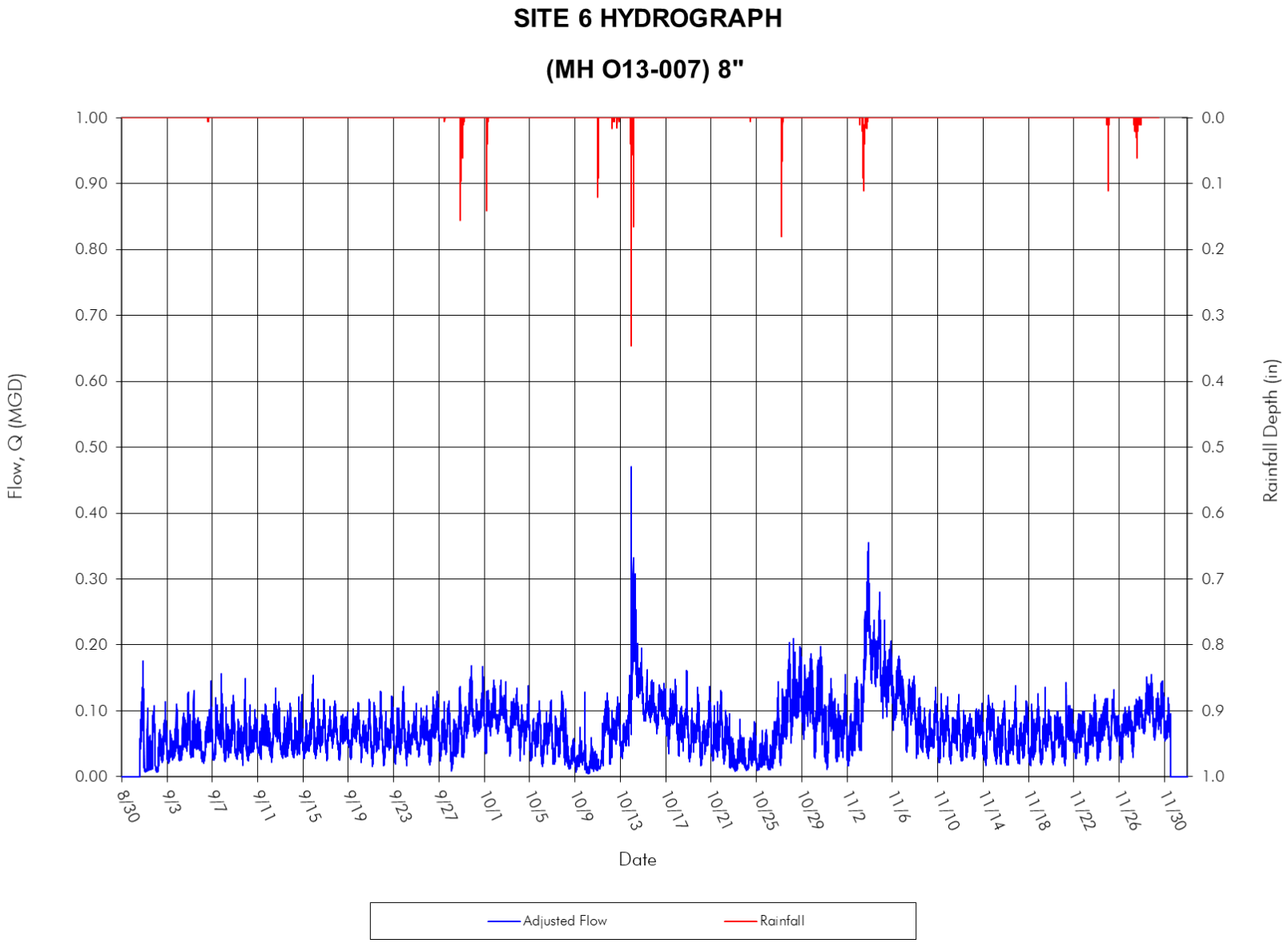


Figure 88 – Overall Level and Velocity Hydrograph (Site 6)

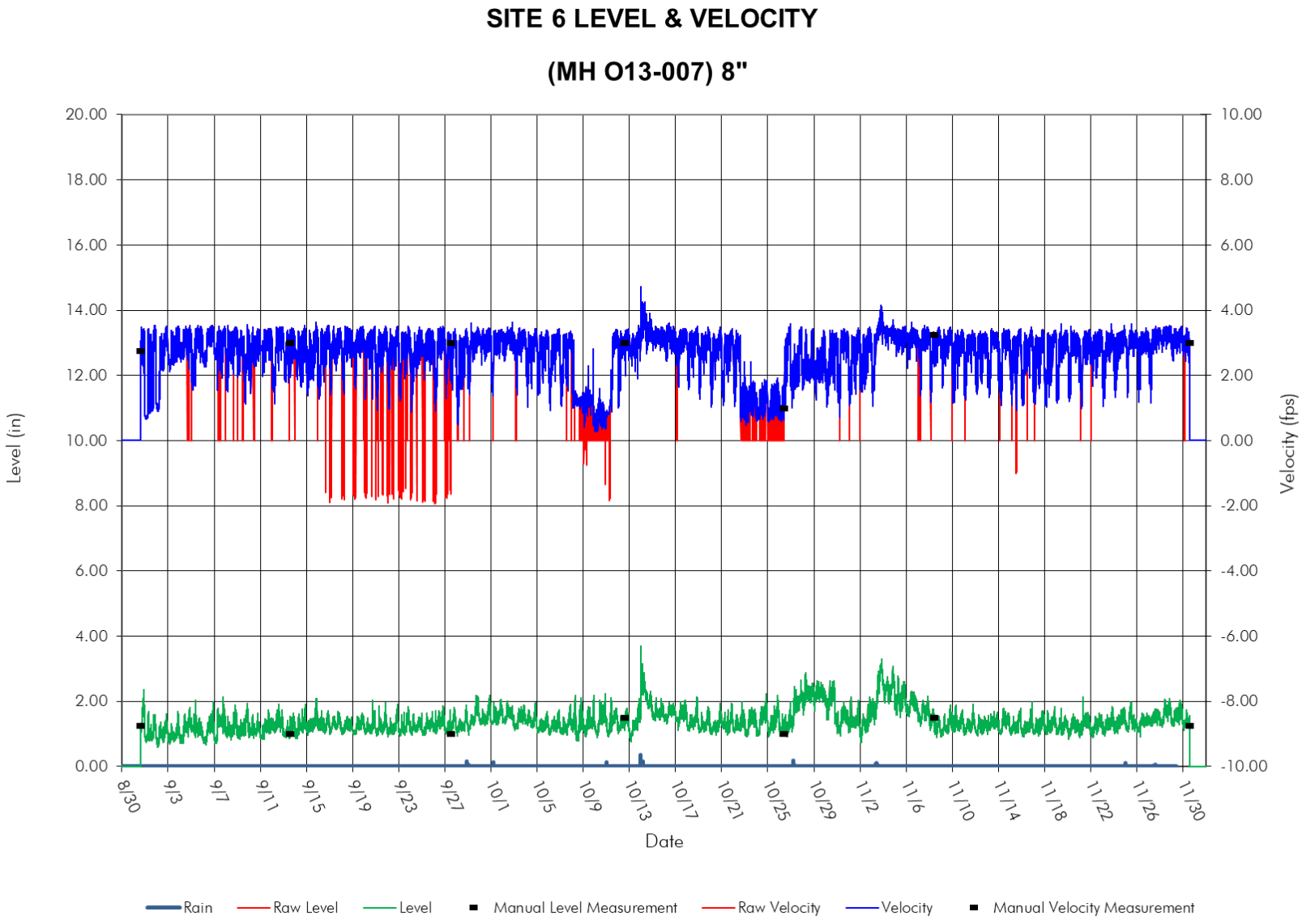


Figure 89 – Standard Flow Scattergraph (Site 6)

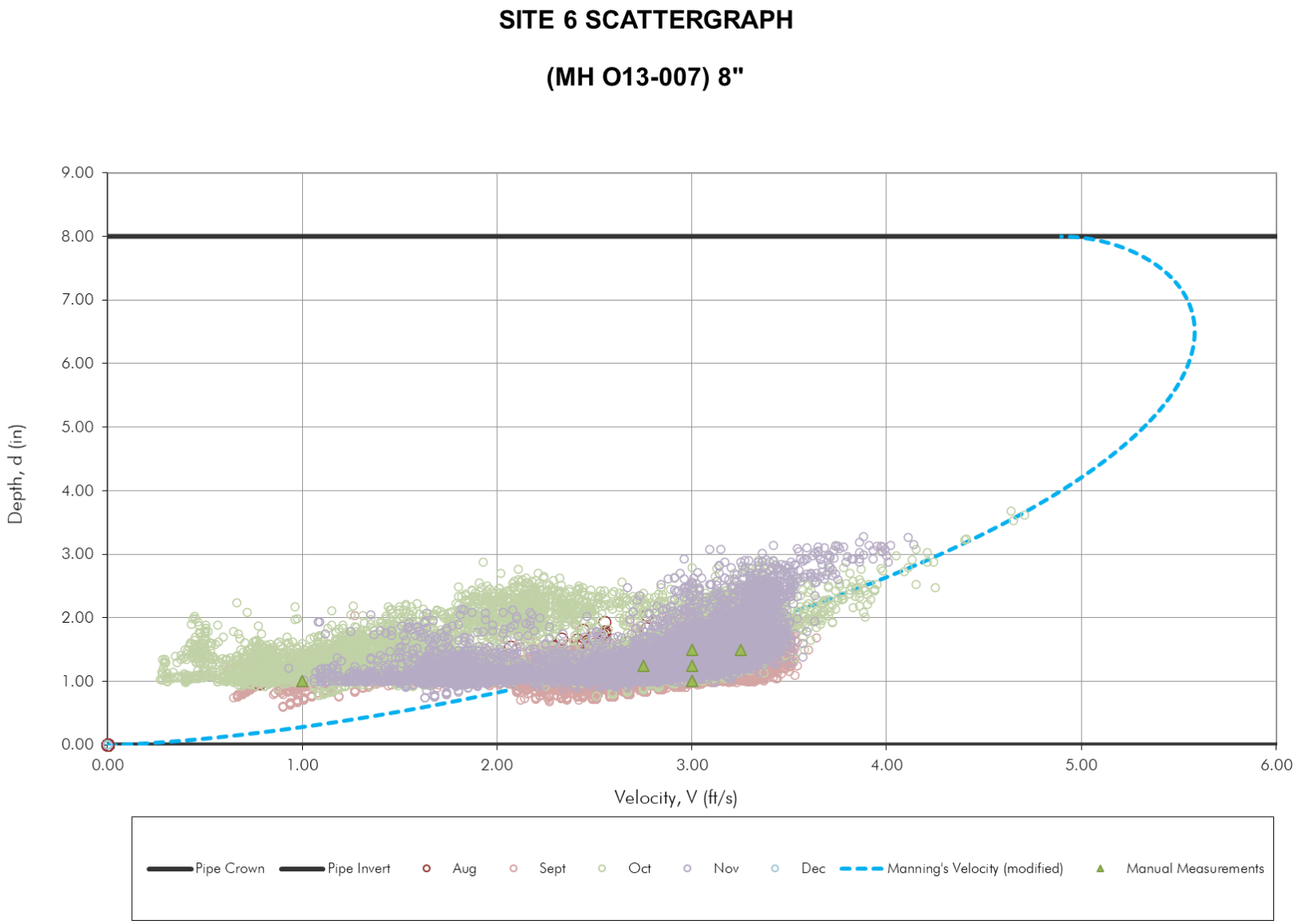


Table 25 – ADDF and Infiltration Summary (Site 6)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 6
Meter: 6
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.070	0.106	1.526	0.038	28-Nov-21	0.073
13-Sep-21	Mon	0.056	0.096	1.712	0.034	29-Nov-21	0.071
14-Sep-21	Tue	0.060	0.108	1.797	0.035		
15-Sep-21	Wed	0.065	0.127	1.954	0.039		
16-Sep-21	Thu	0.063	0.101	1.617	0.039	04-Nov-21	0.157
17-Sep-21	Fri	0.068	0.099	1.447	0.042	05-Nov-21	0.131
18-Sep-21	Sat	0.062	0.081	1.312	0.035	06-Nov-21	0.131
7 Count		0.063 Average	0.103 Average	1.624 Average	0.037 Average	5 Count	0.112 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.063	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.063	
	Diurnal Peaking Factor (DPF):	1.624	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.075	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.075	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.063	

Figure 90 – Dry Weather Diurnal (Site 6)

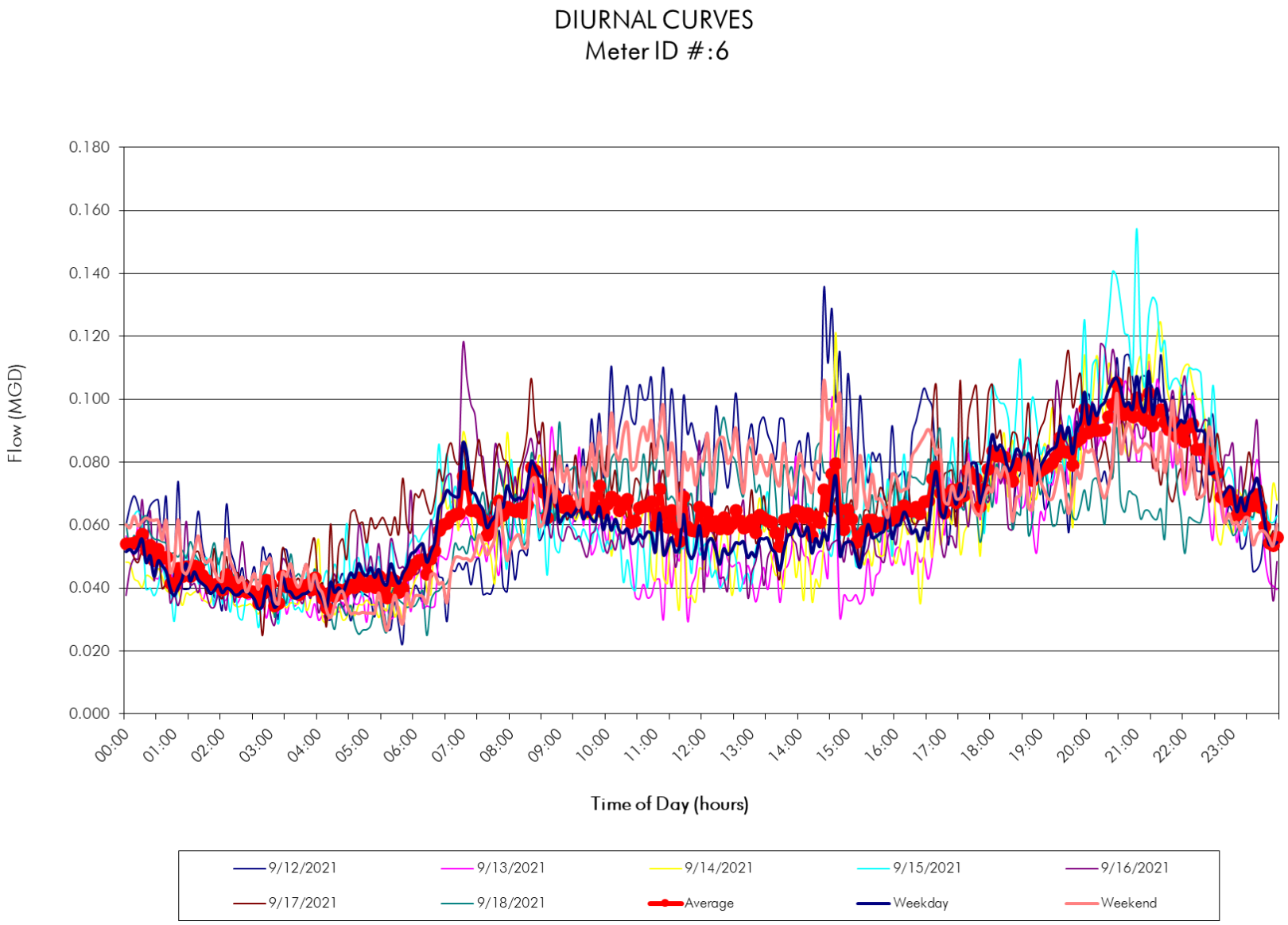


Figure 91 - High/Low Groundwater Diurnal (Site 6)

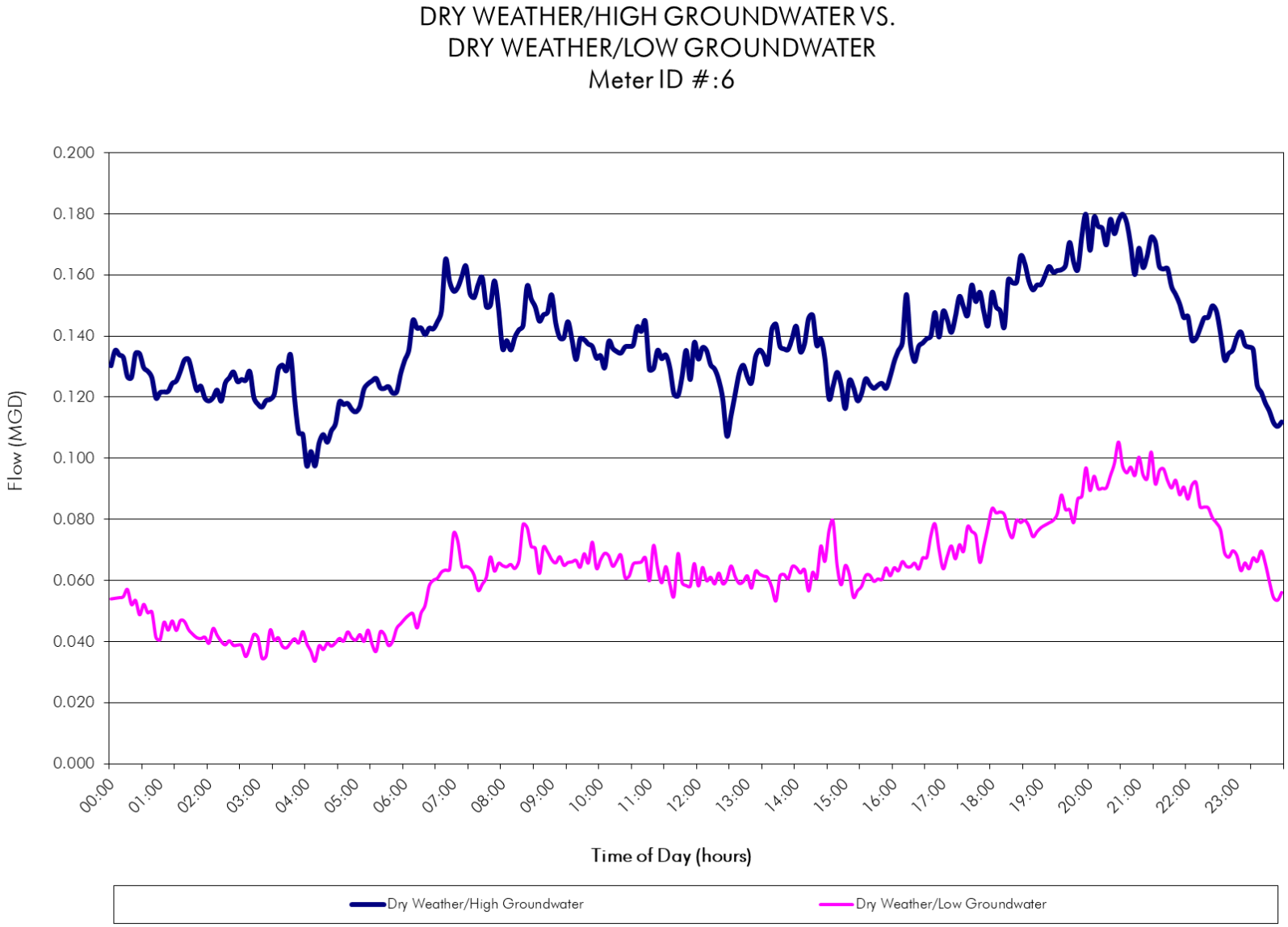


Table 26 – Inflow Calculations and Projections (Site 6)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	6
Meter:	6
Units of Flow:	MGD

Storm Count:	7	Cum. Trib. Area:	49 acres	Pipe Shape:	Circular
Avg Delta Time	84	Cum. Time of Conc.:	75 minutes	Pipe Diameter:	8 in
Avg Kp:	0.00648			Pipe Slope:	0.020 ft/ft
Avg Selected Kp:	0.00734			Pipe Capacity:	1.11 mgd
				ADDF Cum.:	0.063 mgd
				ADDF Peak. Factor:	1.62
				Peak ADDF Flow:	0.103 mgd
				Infiltration:	0.075 mgd
				Cum. Peak Flow:	0.178 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.178
1	1.130	0.263	0.406	0.440
2	1.400	0.325	0.503	0.503
5	1.780	0.414	0.640	0.591
10	2.080	0.483	0.748	0.661
25	2.490	0.578	0.895	0.756
50	2.810	0.653	1.010	0.831
100	3.140	0.729	1.129	0.907

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/28/21 21:00	1.65	7.92	9/28/21 21:40	9/28/21 21:20	20	0.115	09/21/21	0.081	0.034	0.630	0.00168	y	0.00168					
10/1/21 4:55	0.73	3.67	10/1/21 5:25	10/1/21 5:05	20	0.129	09/24/21	0.045	0.084	0.560	0.00475	y	0.00475					
10/11/21 0:05	0.49	1.25	10/11/21 1:15	10/11/21 0:05	70	0.026	10/10/21	0.010	0.016	0.380	0.00133	n						Poor Data quality
10/13/21 21:55	3.15	6.00	10/13/21 23:30	10/13/21 23:10	20	0.470	10/12/21	0.067	0.403	1.490	0.00854	y	0.00854					
10/27/21 5:15	0.89	2.42	10/27/21 7:30	10/27/21 5:25	125	0.133	10/26/21	0.030	0.103	0.620	0.00526	y	0.00526					
11/3/21 2:10	1.89	16.83	11/3/21 13:50	11/3/21 10:35	195	0.251	11/02/21	0.058	0.193	0.430	0.01418	y	0.01418					
11/27/21 7:45	0.70	13.92	11/27/21 16:40	11/27/21 14:25	135	0.115	11/20/21	0.061	0.055	0.180	0.00960	y	0.00960					

Figure 92 – Inflow Projections (Site 6)

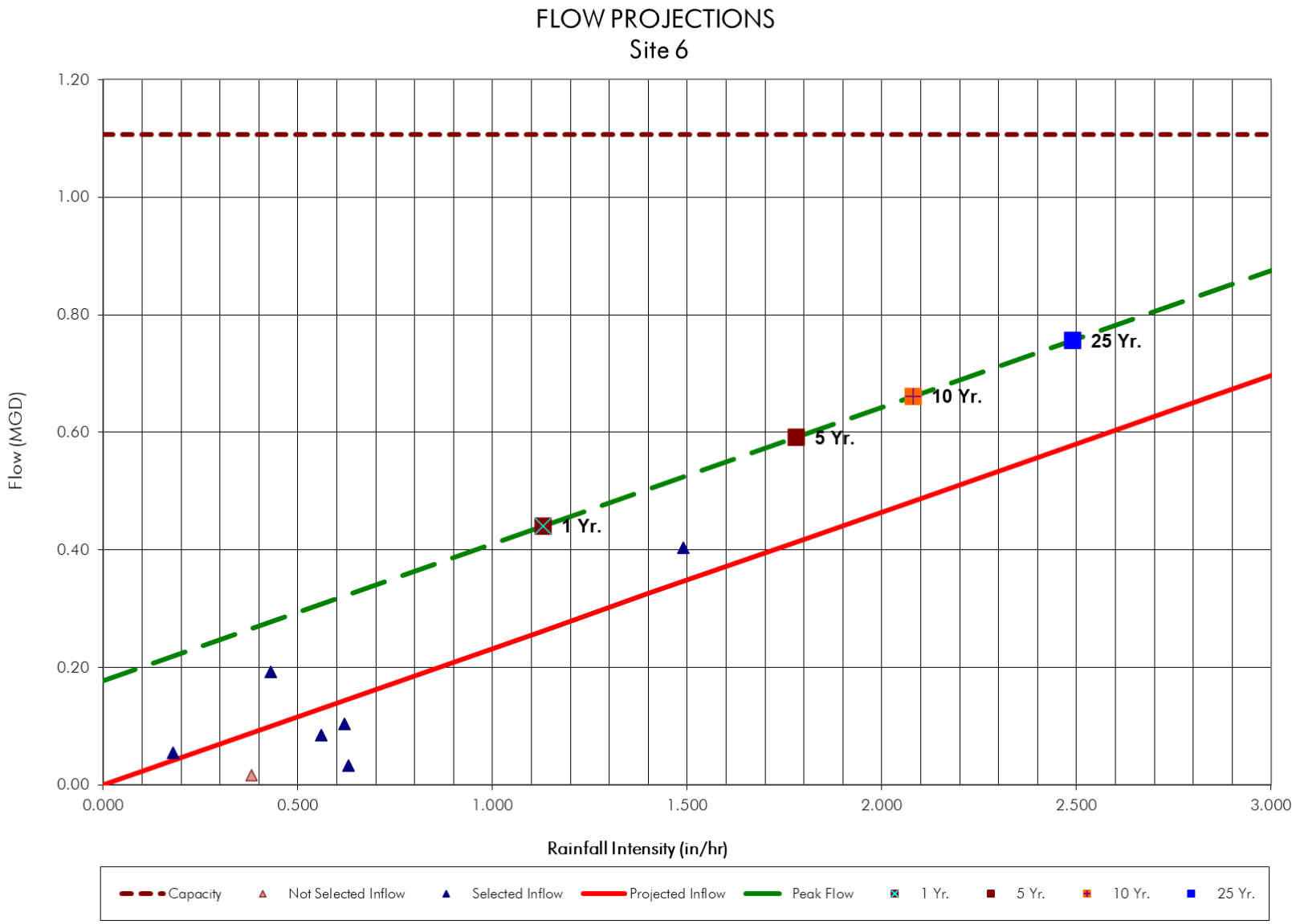
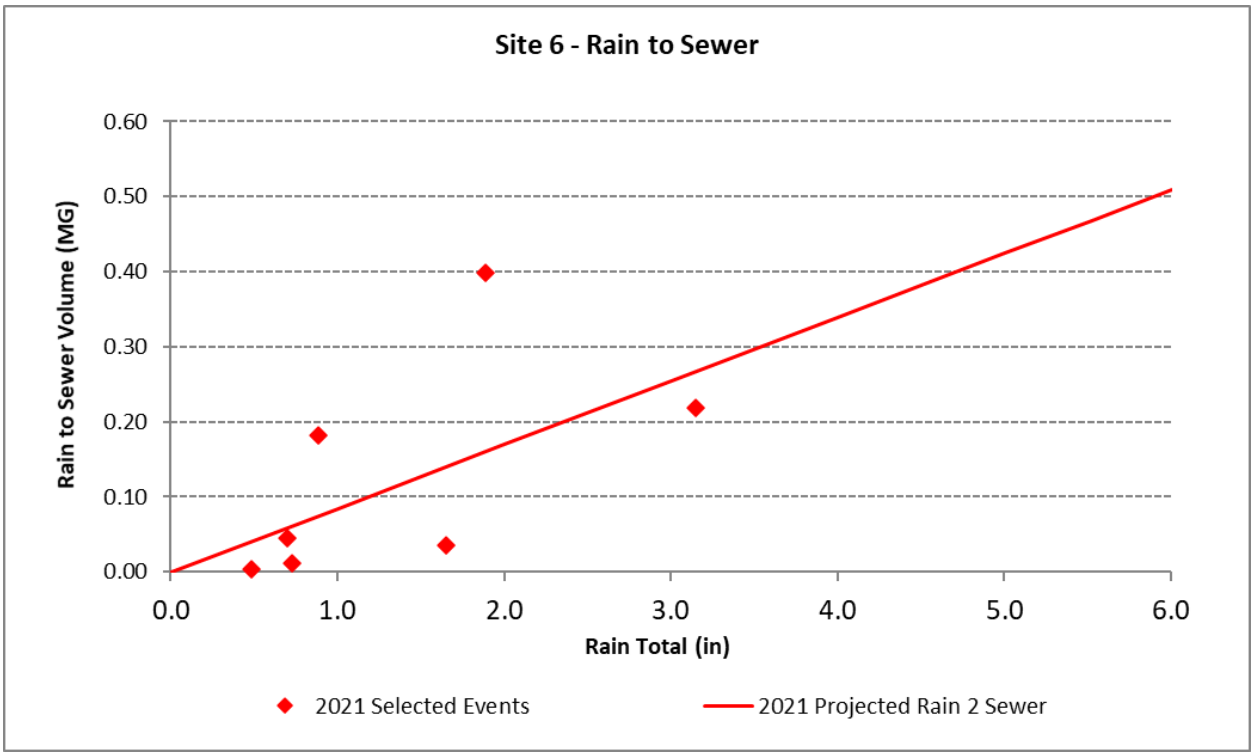


Table 27 – Rain to Sewer Summary (Site 6)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 6 (8")	9/28/2021	1.65	2.195	0.036	1.62%
	10/1/2021	0.73	0.971	0.011	1.14%
	10/11/2021	0.49	0.645	0.003	0.46%
	10/13/2021	3.15	4.184	0.218	5.21%
	10/27/2021	0.89	1.177	0.182	15.44%
	11/3/2021	1.89	2.508	0.398	15.86%
	11/27/2021	0.70	0.931	0.046	4.90%
				Average	**6.37%**

Figure 93 – Rain to Sewer Volumetric Analysis (Site 6)



A.7 Site 7

Description

Site 7 was located in manhole O12-001 inside Bell Farms Lift Station. The flow meter measured flows in the influent 15" diameter PVC pipe. The subsystem flow collects at Bell Farms Lift Station which is upstream of Site 1 and contributes flow to the Wilbarger Wastewater Treatment Plant.

Observations

The flow observed at this site had an average depth of 3.7 inches of flow moving at 2.07 feet per second for the 2021 flow monitoring period. The site had some medium grease on probe at site visits. The level and velocity readings were consistent with manuals taken at site visits. The site does have consistent low level velocity dropouts these were easily autocorrected using valid readings. The site is considered a good quality dry and wet weather monitoring site.

Site 7 did experience two surcharging events during 2021. One dry weather surcharge event occurred.

Table 28 – Surcharge Summary (Site 7)

		Date of Storm	10/13/2021	10/19/2021
		Total Storm Rainfall (in.)	3.15"	Dry Weather Surcharge
Site	Diameter (in.)	Storm Duration (hrs.)	6.00	
7	15	Depth from Invert (in.)	27.54 (B)	47.67 (B)

(P) Denotes pressurized flow caused by lack of capacity
(flow velocities generally increase as flow depths increase)
(B) Denotes flow backup caused by downstream restriction
(flow velocities generally decrease as flow depths increase)

Table 29 – Service Interrogations Summary (Site 7)

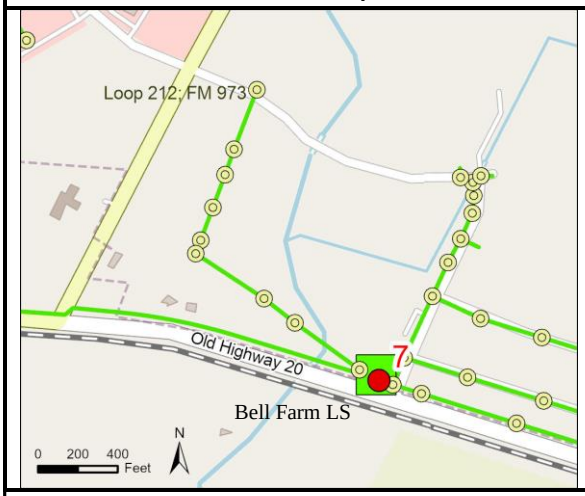
Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 7	8/31/2021	15:05	15	3.25	2.50	-0.75	3.25	3.10	-0.15	2.00	1.98	-0.02	2.00	1.95	-0.05	Install	Meter installed at out pipe
	9/13/2021	14:10		2.25	2.40	0.15	2.75	3.10	0.35	2.00	1.90	-0.10	2.00	2.00	0.00	Service/Upload	
	9/27/2021	13:58		2.75	3.00	0.25	3.00	3.00	0.00	2.00	1.90	-0.10	2.00	2.20	0.20	Service/Upload	
	10/12/2021	14:14		3.00	4.00	1.00	3.75	4.10	0.35	2.50	2.00	-0.50	2.00	1.90	-0.10	Service/Upload	
	10/26/2021	10:50		3.50	3.60	0.10	3.25	3.69	0.44	1.75	1.76	0.01	1.80	1.84	0.04	Service/Upload	
	11/8/2021	10:33		3.50	3.80	0.30	3.50	3.60	0.10	2.00	1.96	-0.04	2.00	2.04	0.04	Service/Upload	Medium to heavy grease.
	11/30/2021	13:55		3.50	3.74	0.24	3.75	4.01	0.26	2.00	2.03	0.03	2.50	2.44	-0.06	Removal	Medium grease.

Figure 94 – Flow Meter Site Investigation (Site 7)

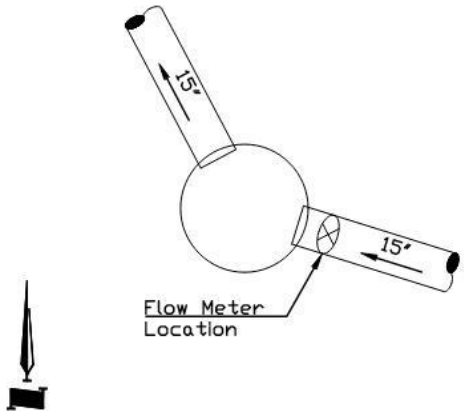
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 11-30-2021 / 13:55	**Crew:** JA-VI
MH#: O12-001	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 15
Site ID: 7	**Address:** 12217 Old Hwy. 20	**Site Quality:** Good	**Monitoring Purpose:** Short-term FM

Location Map



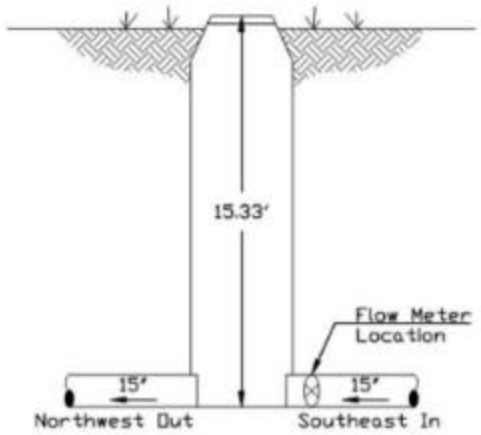
Planar Description



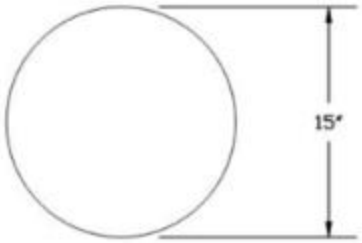
Summary Description:
Inside Bell Farms Lift Station site; 1st manhole upstream of wet well. Site has a gate with a combination lock.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? None		**Manhole Depth (ft):** 15.33	**Surcharge Evidence?** No
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 0.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 32	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Bolt Down	**Usable MH Steps?** No
Describe potential hazards:		**Measured Flow Depth (in):** 3.75	**Meter:** ISCO 2150
		Velocity (fps): 2.50	**Cellular Signal Strength:** N/A
		Mounting Band Description: Scissor Jack Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes

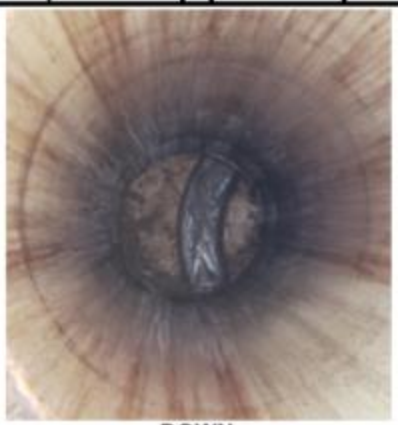


Pipe Cross Section



Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE



DOWN

INFLOW

OUTFLOW

GBA

Figure 95 – Site Information (Site 7)

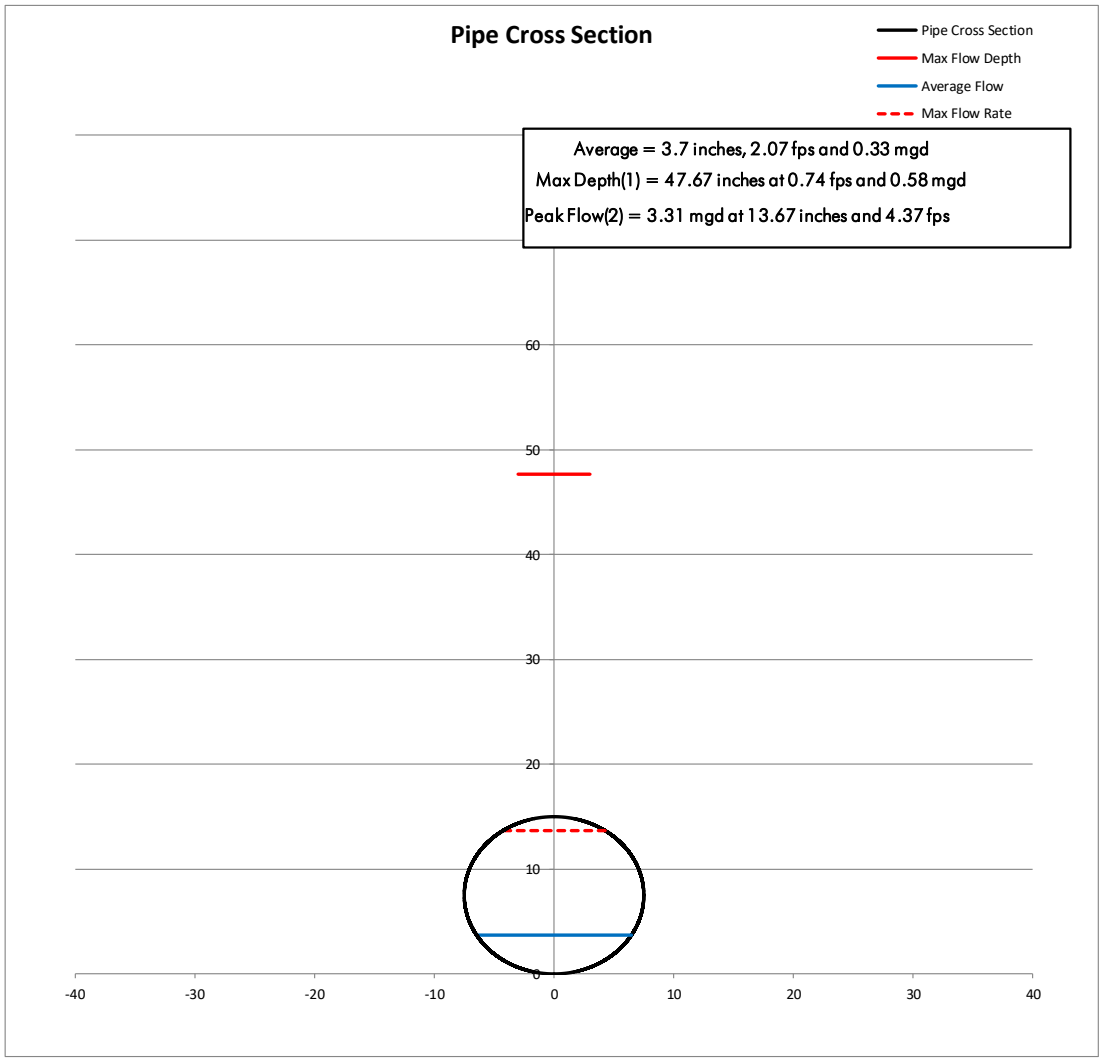
SITE INFORMATION RECORD

Site Information

Meter ID #:	7
Monitoring Program:	Short-Term FM
Manhole #:	O12-001

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	15	
Pipe Width, W (in):	15	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0055	ASSUMED!



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 7	8/31/2021	15	15:05	3.25	3.10	-0.15	2.00	1.95	-0.05
	9/13/2021		14:10	2.75	3.10	0.35	2.00	2.00	0.00
	9/27/2021		13:58	3.00	3.00	0.00	2.00	2.20	0.20
	10/12/2021		14:14	3.75	4.10	0.35	2.00	1.90	-0.10
	10/26/2021		10:50	3.25	3.69	0.44	1.80	1.84	0.04
	11/8/2021		10:33	3.50	3.60	0.10	2.00	2.04	0.04
	11/30/2021		13:55	3.75	4.01	0.26	2.50	2.44	-0.06

Figure 96 – August-September Monthly Flow Hydrograph (Site 7)

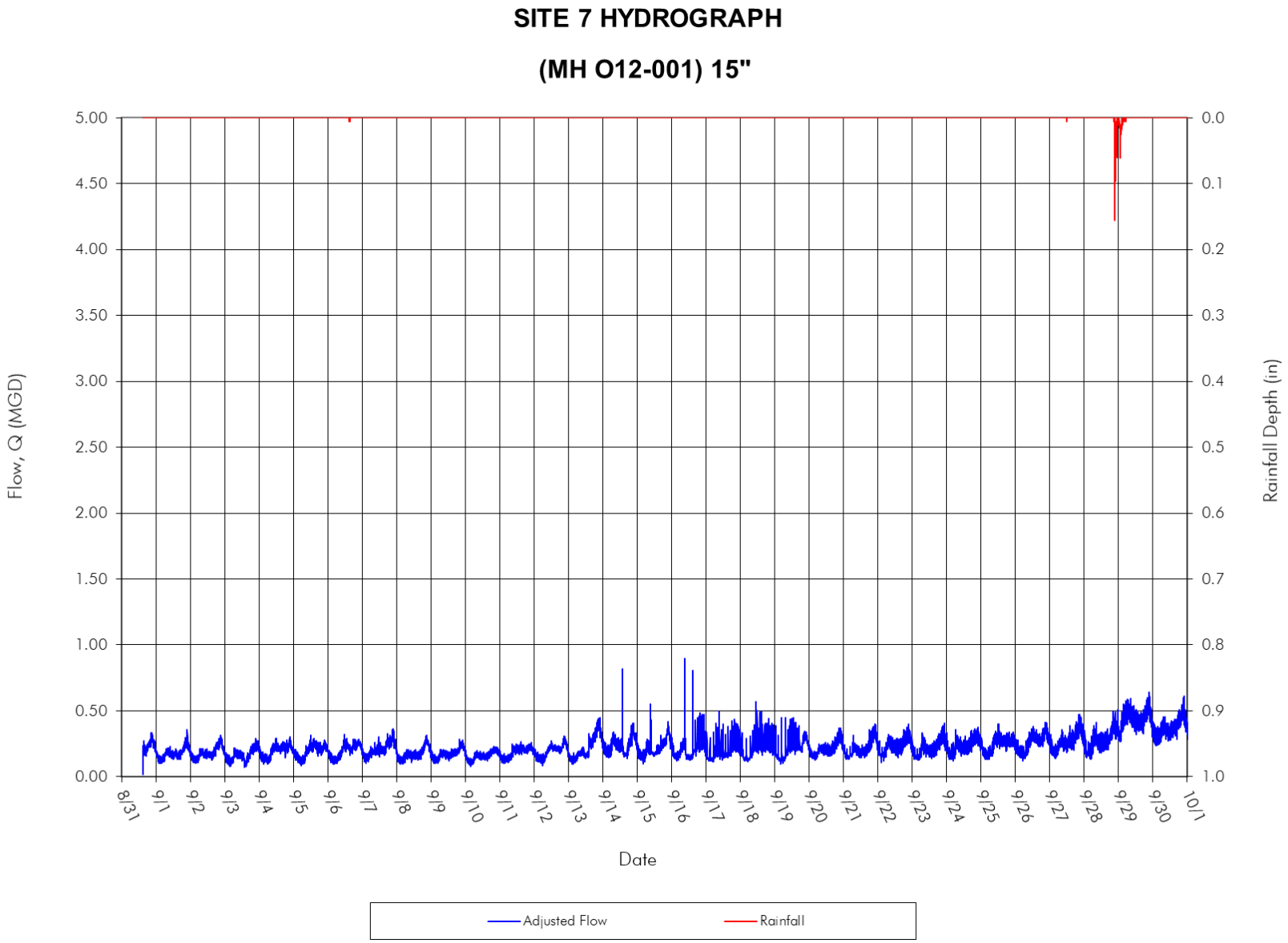


Figure 97 – August-September Monthly Level and Velocity Hydrograph (Site 7)

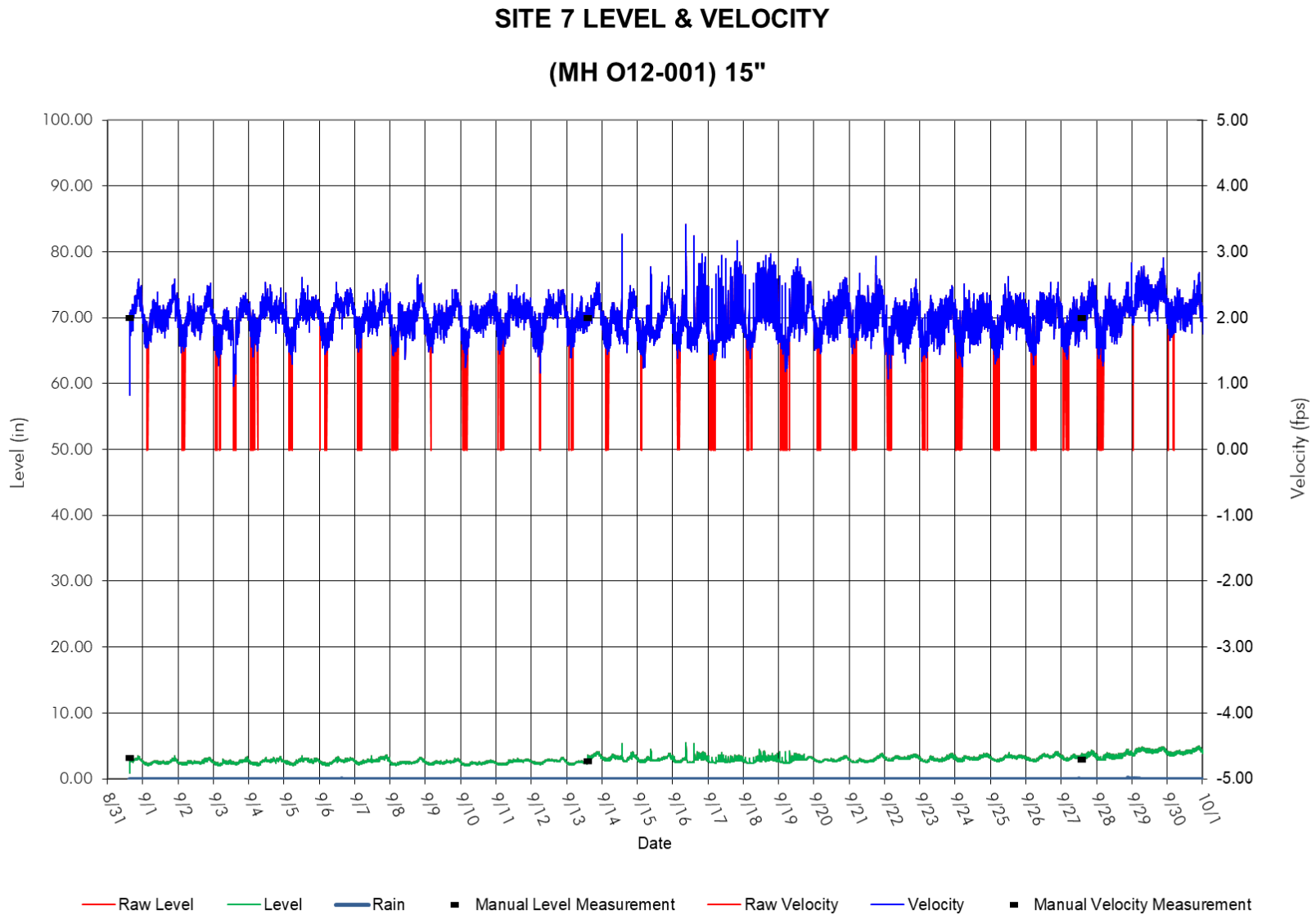


Figure 98 – October Flow Hydrograph (Site 7)

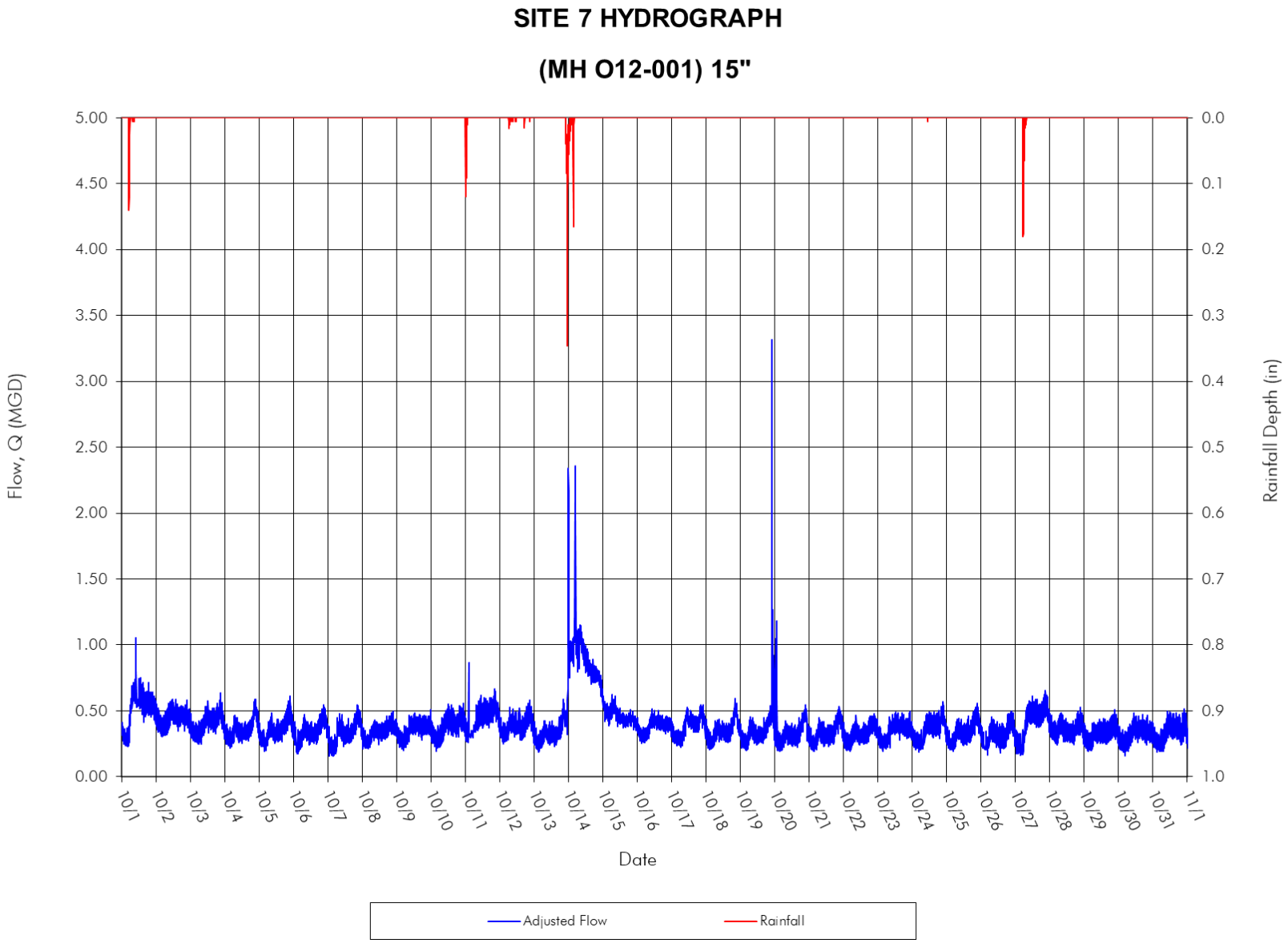


Figure 99 – October Monthly Level and Velocity Hydrograph (Site 7)

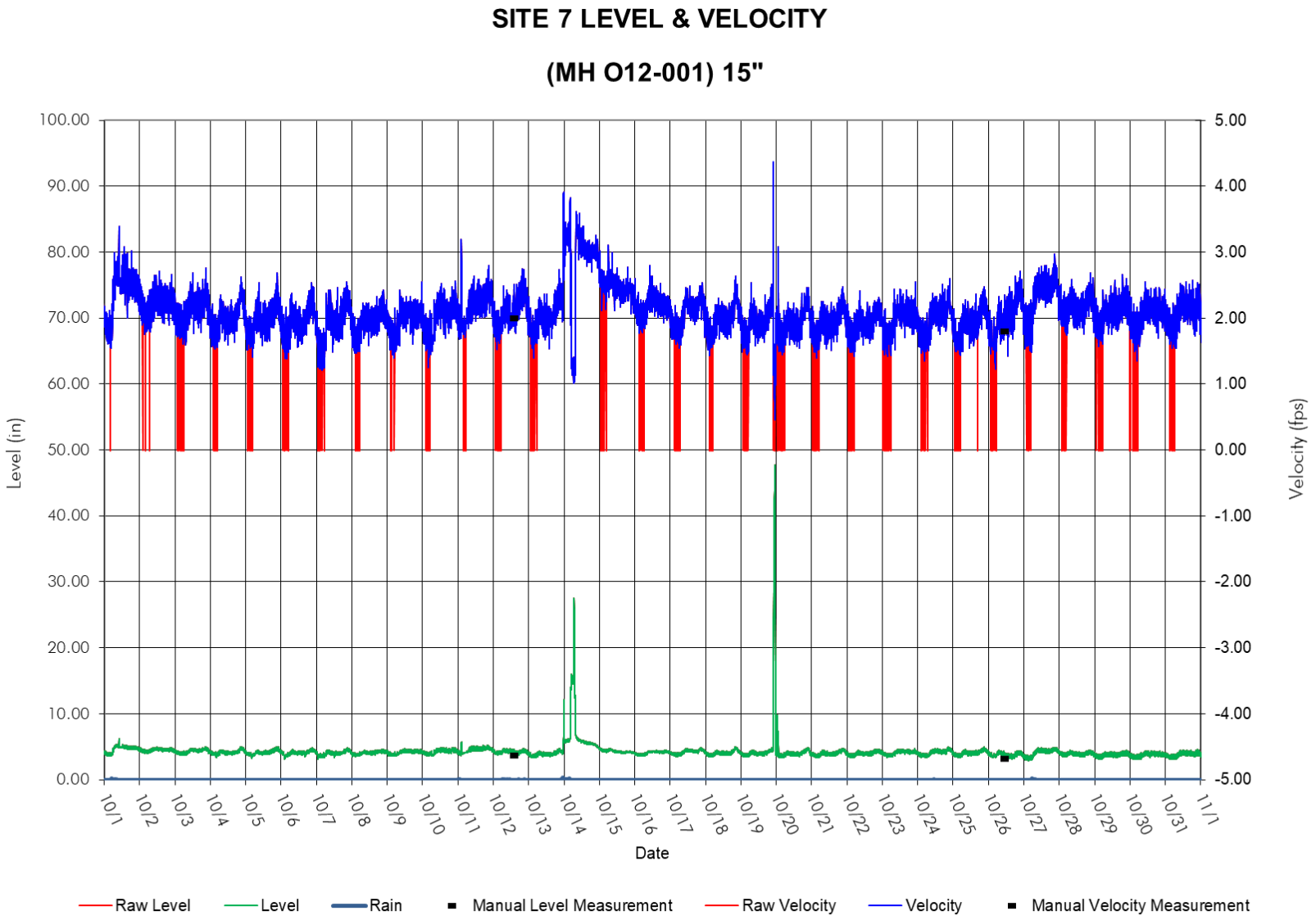


Figure 100 – November Monthly Flow Hydrograph (Site 7)

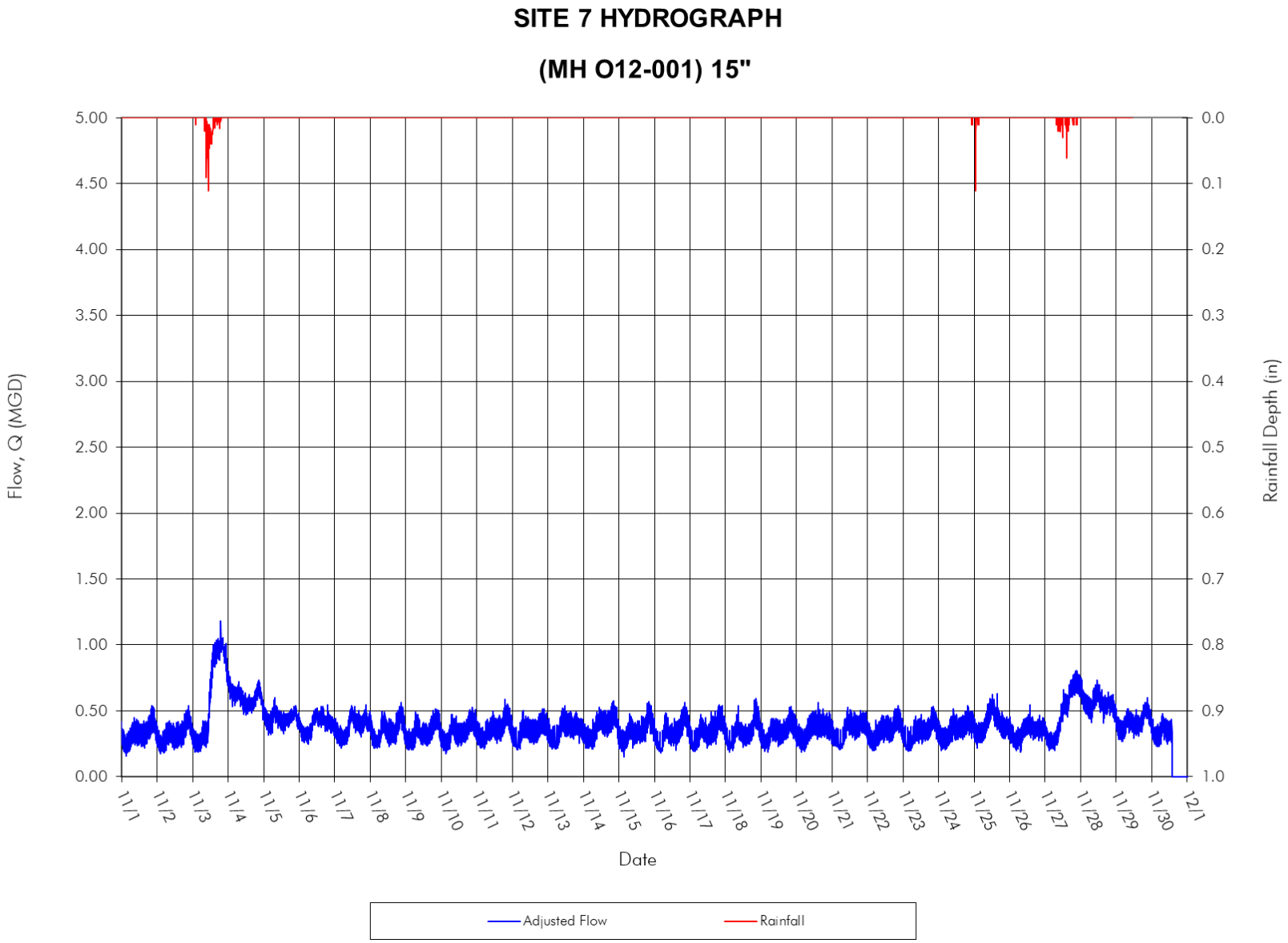


Figure 101 – November Level and Velocity Hydrograph (Site 7)

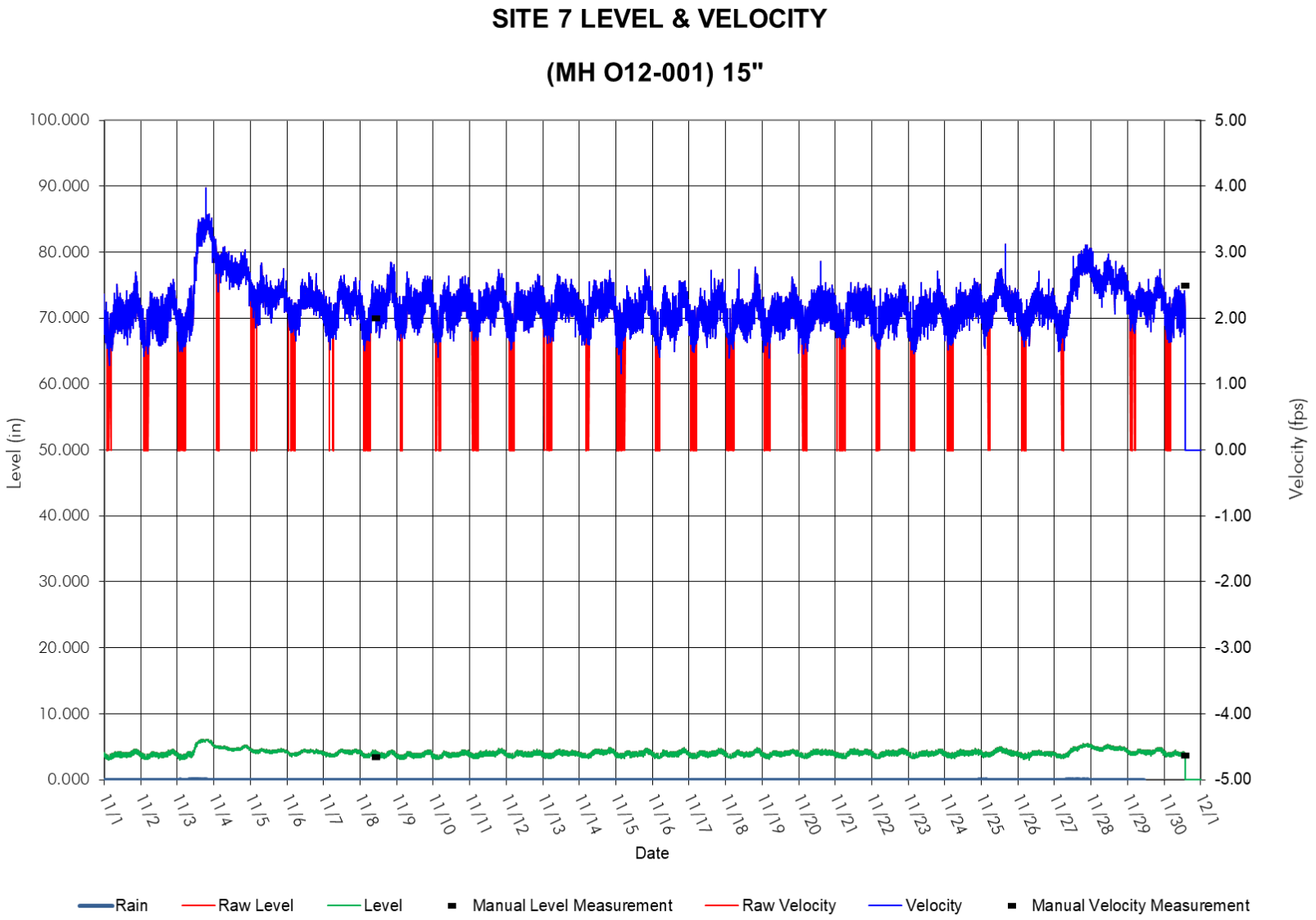


Figure 102 – Overall Flow Hydrograph (Site 7)

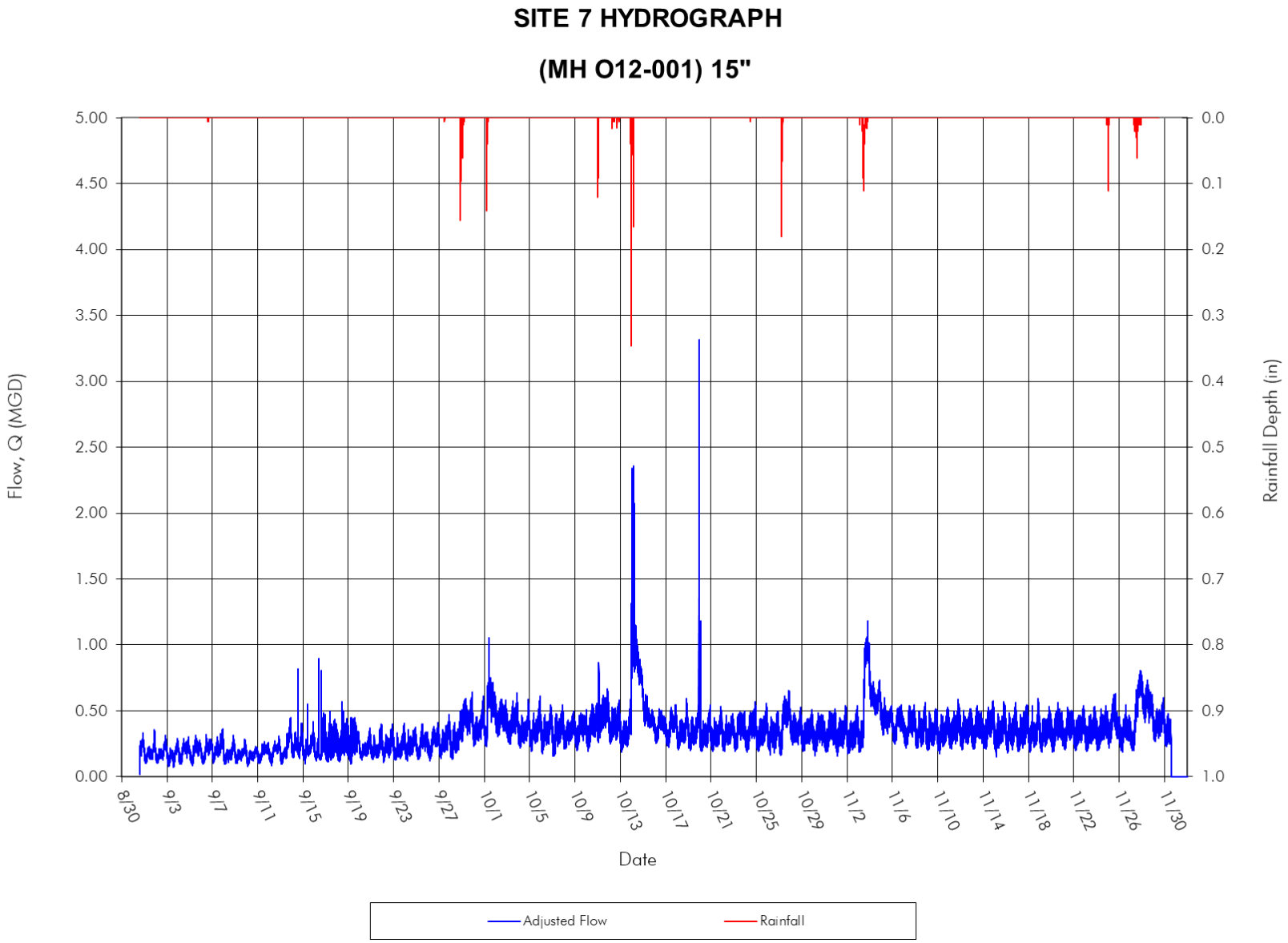


Figure 103 – Overall Level and Velocity Hydrograph (Site 7)

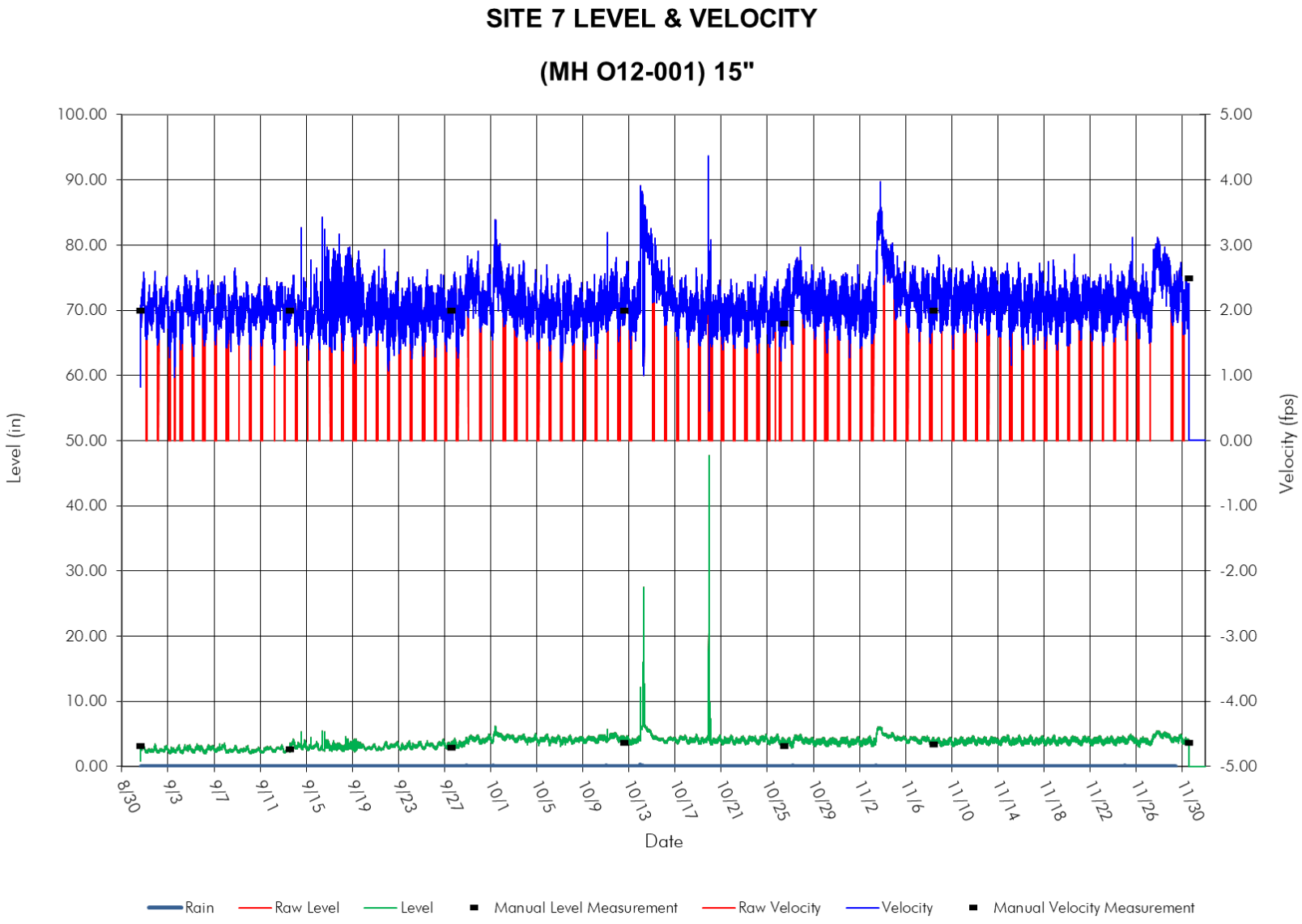


Figure 104 – Standard Flow Scattergraph (Site 7)

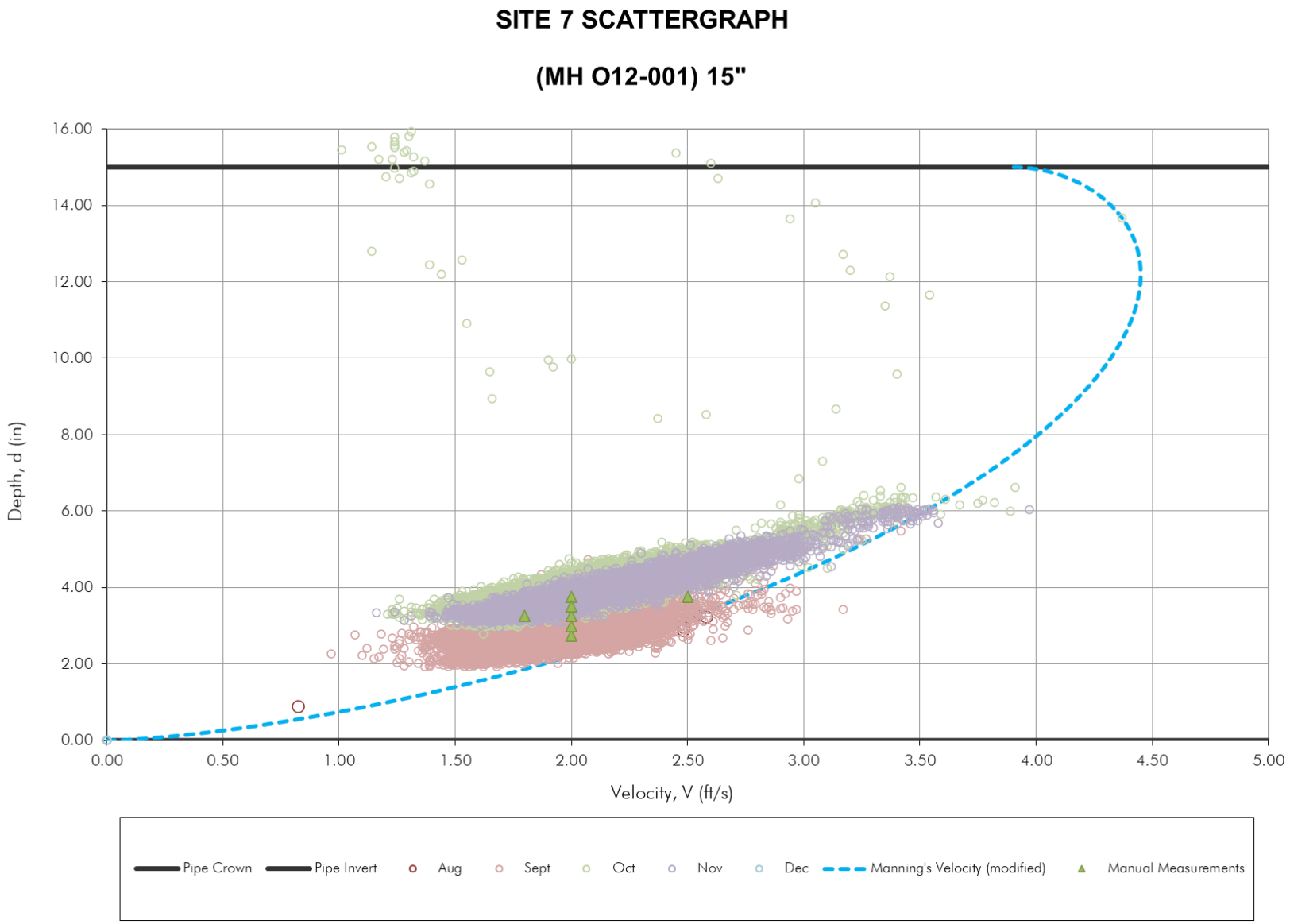


Figure 105 – Surcharged Flow Scattergraph (Site 7)

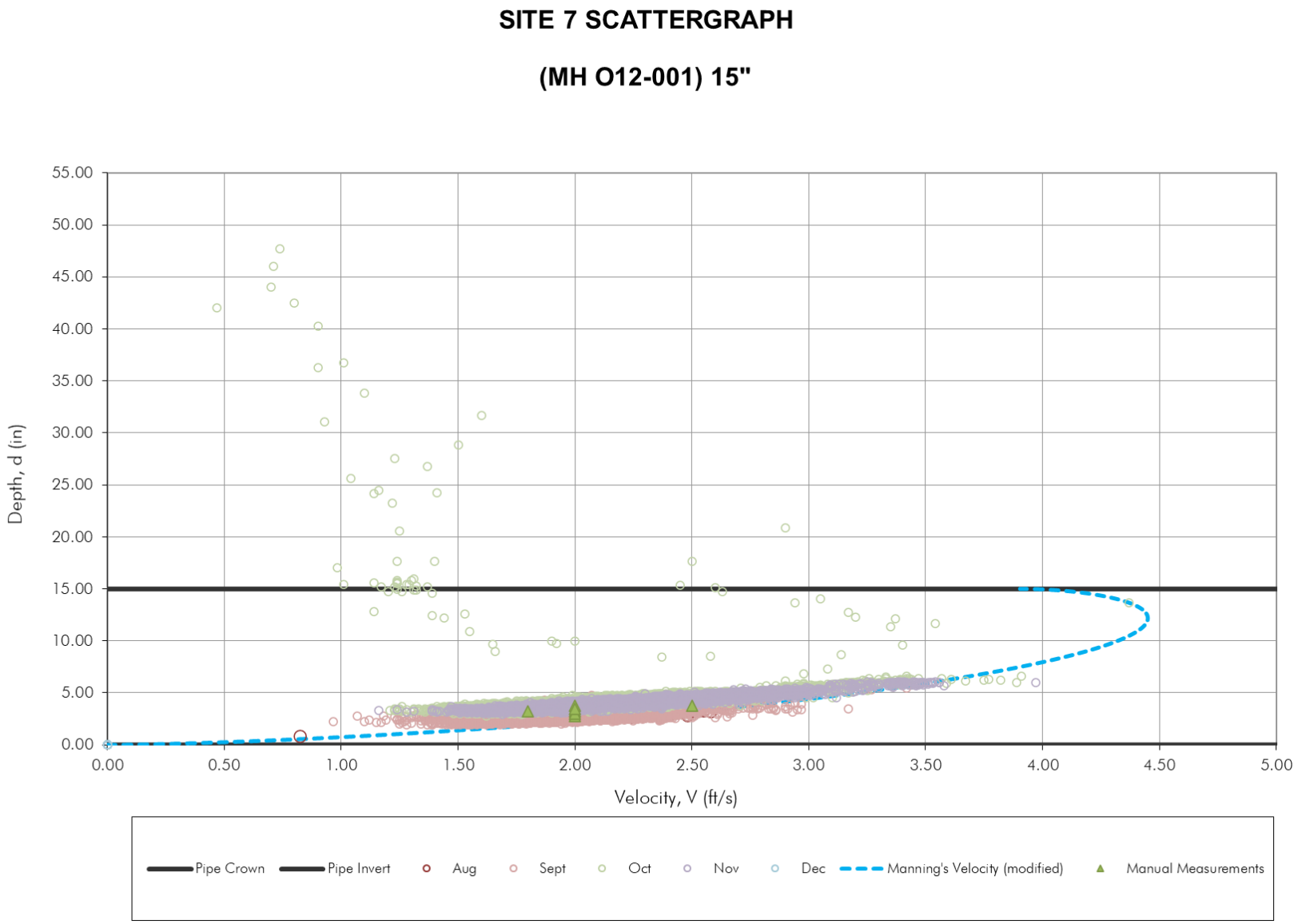


Table 30 – ADDF and Infiltration Summary (Site 7)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 7
Meter: 7
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.193	0.277	1.437	0.121	28-Nov-21	0.504
06-Sep-21	Mon	0.195	0.264	1.354	0.117	29-Nov-21	0.334
07-Sep-21	Tue	0.208	0.331	1.596	0.140		
08-Sep-21	Wed	0.172	0.284	1.648	0.117		
09-Sep-21	Thu	0.173	0.246	1.417	0.119	04-Nov-21	0.547
10-Sep-21	Fri	0.158	0.205	1.293	0.105	05-Nov-21	0.413
11-Sep-21	Sat	0.183	0.230	1.258	0.126	06-Nov-21	0.312
7 Count		0.183 Average	0.262 Average	1.429 Average	0.120 Average	5 Count	0.422 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.183	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.183	
	Diurnal Peaking Factor (DPF):	1.429	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.302	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.302	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.183	

Figure 106 – Dry Weather Diurnal (Site 7)

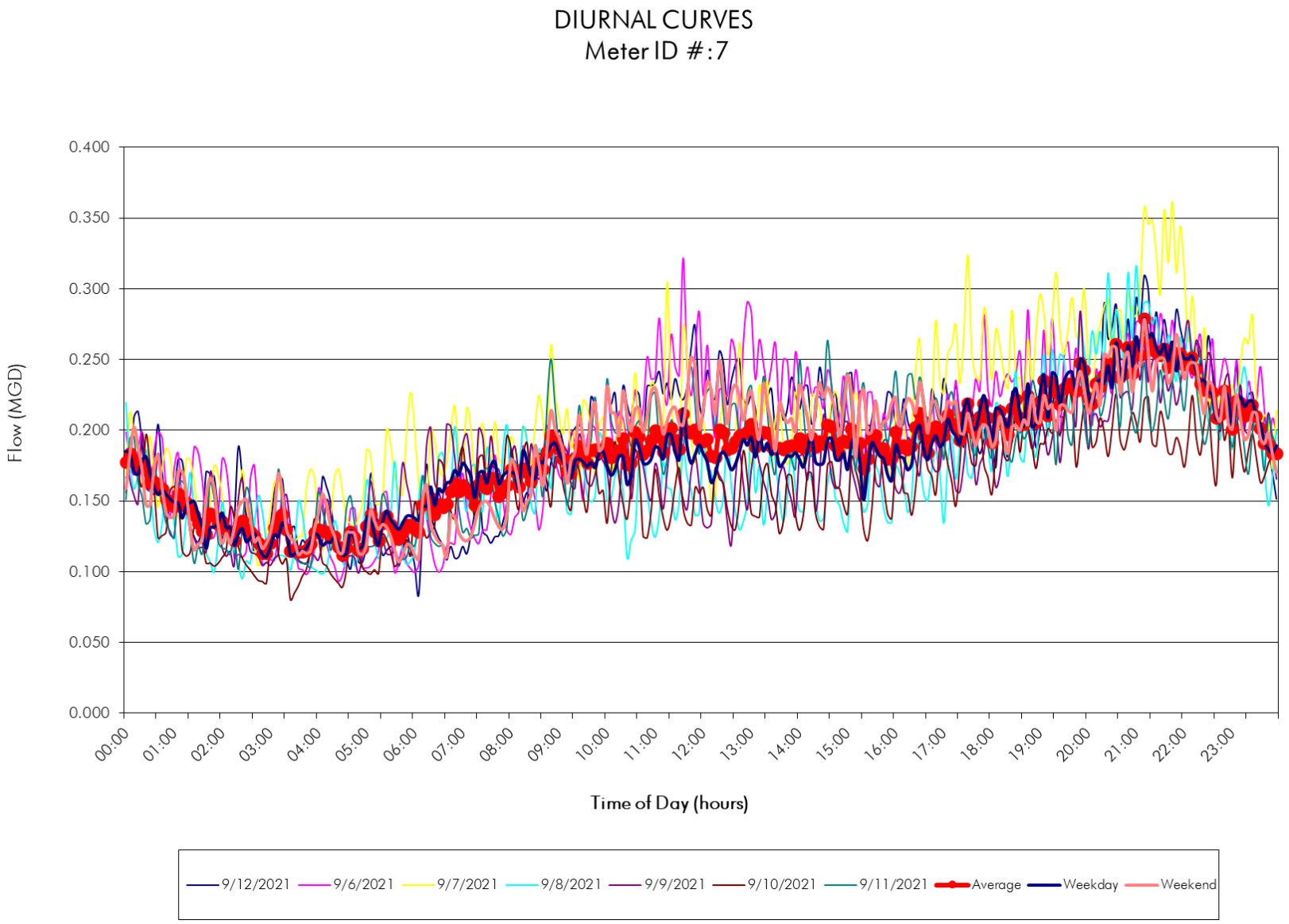


Figure 107 – High/Low Groundwater Diurnal (Site 7)

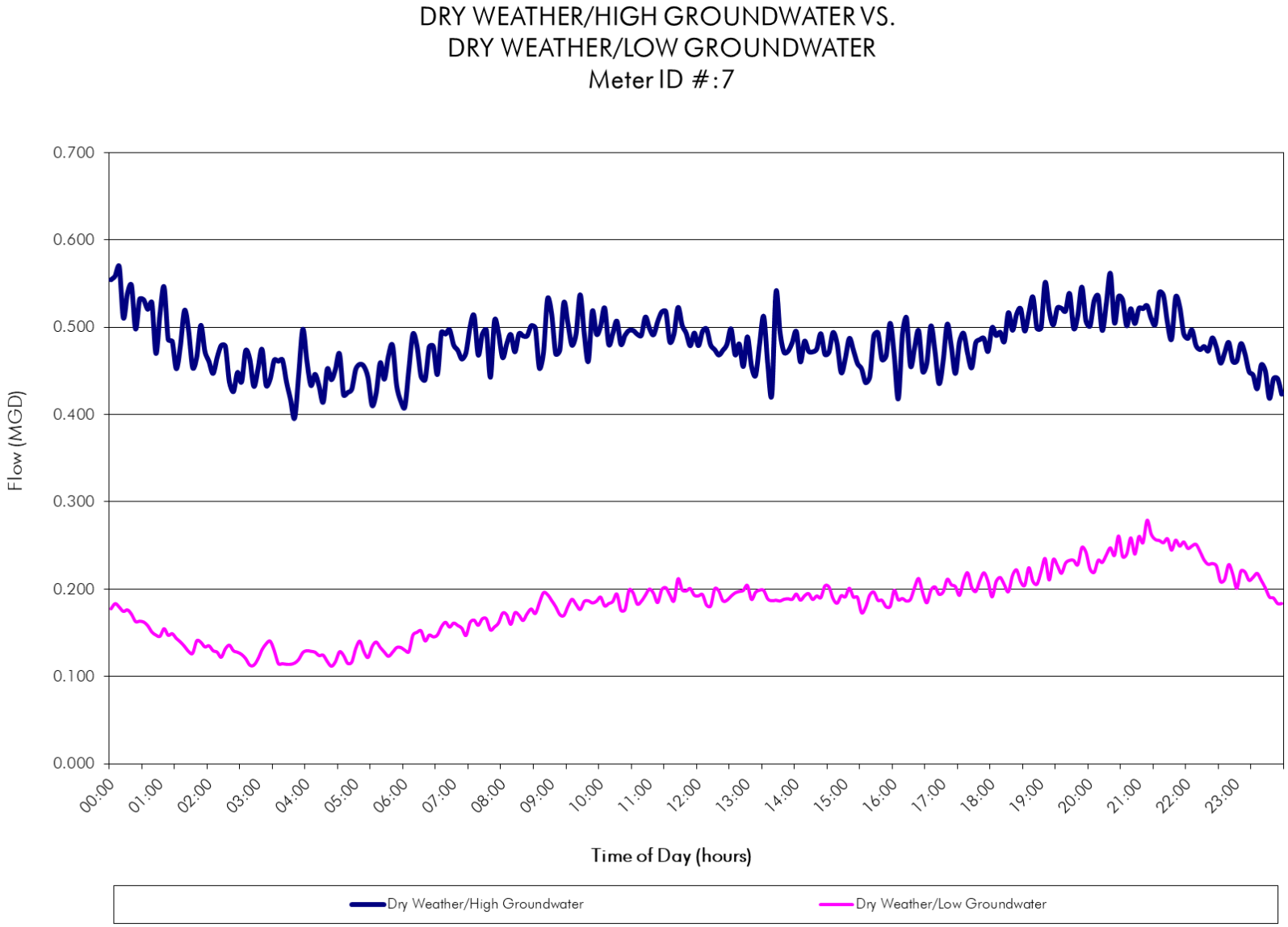


Table 31 – Inflow Calculations and Projections (Site 7)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name: City of Manor Flow Monitoring Fall 2021
Project No.: 14925
Subsystem: 7
Meter: 7
Units of Flow: MGD

Storm Count: 7
Avg Delta Time 117
Avg Kp: 0.01274
Avg Selected Kp: 0.01216

Cum. Trib. Area: 166 acres
Cum. Time of Conc.: 105 minutes

Pipe Shape: Circular
Pipe Diameter: 15 in
Pipe Slope: 0.006 ft/ft
Pipe Capacity: 3.10 mgd
ADDF Cum.: 0.183 mgd
ADDF Peak. Factor: 1.43
Peak ADDF Flow: 0.262 mgd
Infiltration: 0.302 mgd
Cum. Peak Flow: 0.563 mgd
Manning's Coefficient, n: 0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.563
1	0.890	1.161	1.796	1.724
2	1.110	1.448	2.240	2.011
5	1.410	1.839	2.846	2.402
10	1.640	2.139	3.310	2.702
25	1.960	2.557	3.956	3.120
50	2.220	2.896	4.481	3.459
100	2.480	3.235	5.005	3.798

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/28/21 21:00	1.65	7.92	9/28/21 21:45	9/28/21 21:20	25	0.492	09/21/21	0.390	0.102	0.610	0.00156	y	0.00156					
10/1/21 4:55	0.73	3.67	10/1/21 6:55	10/1/21 5:05	110	0.690	09/24/21	0.292	0.399	0.400	0.00929	y	0.00929					
10/11/21 0:05	0.49	1.25	10/11/21 2:20	10/11/21 0:05	135	0.865	10/10/21	0.252	0.613	0.280	0.02042	y	0.02042					
10/13/21 21:55	3.15	6.00	10/13/21 23:55	10/13/21 23:10	45	2.342	10/06/21	0.338	2.004	1.150	0.01624	n						Surcharge
10/27/21 5:15	0.89	2.42	10/27/21 8:00	10/27/21 5:25	155	0.523	10/26/21	0.298	0.226	0.470	0.00448	y	0.00448					
11/3/21 2:10	1.89	16.83	11/3/21 14:10	11/3/21 10:35	215	0.997	11/02/21	0.229	0.768	0.440	0.01627	y	0.01627					
11/27/21 7:45	0.70	13.92	11/27/21 16:40	11/27/21 14:25	135	0.696	11/26/21	0.314	0.382	0.170	0.02094	y	0.02094					

Figure 108 – Inflow Projections (Site 7)

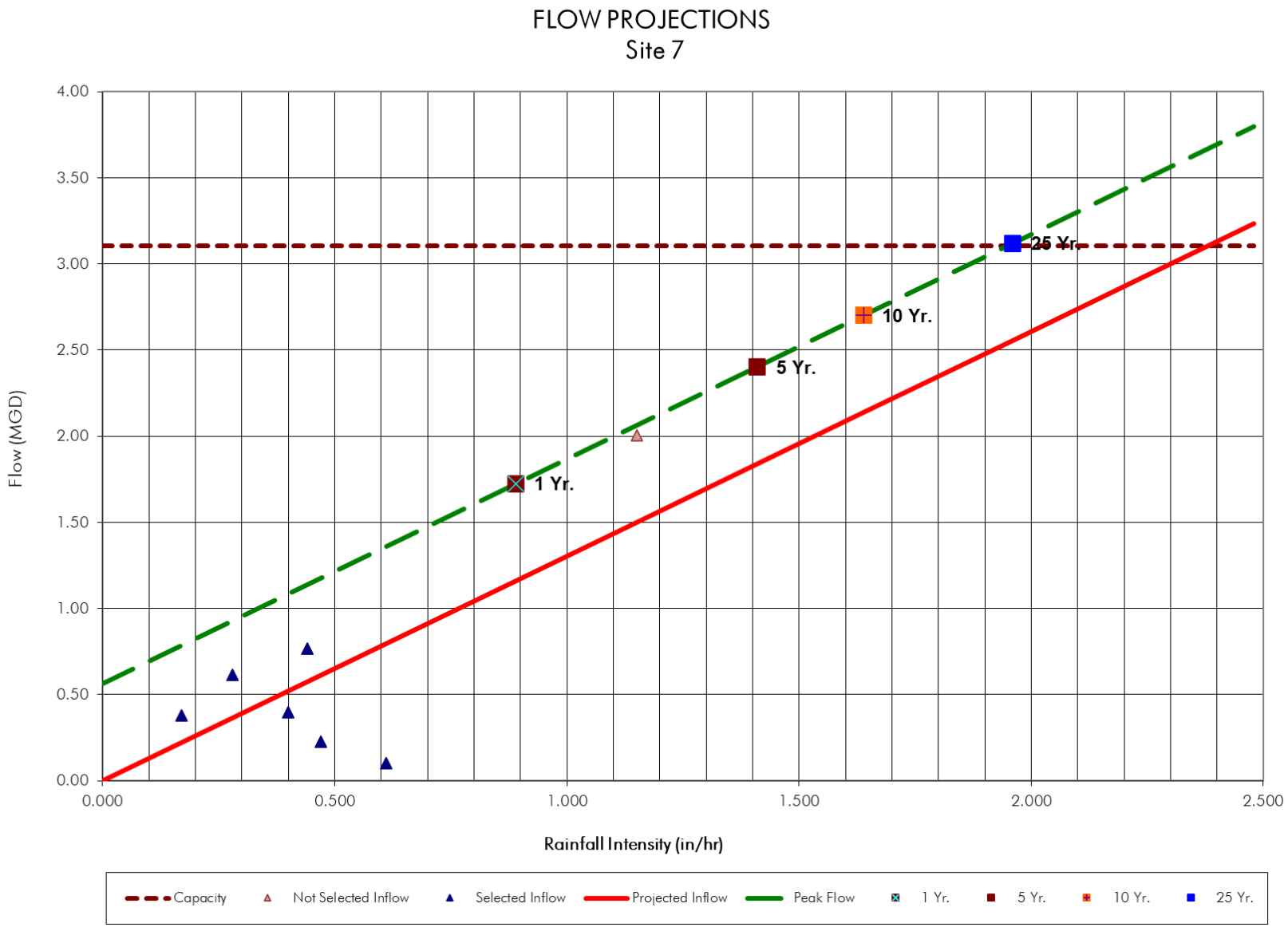
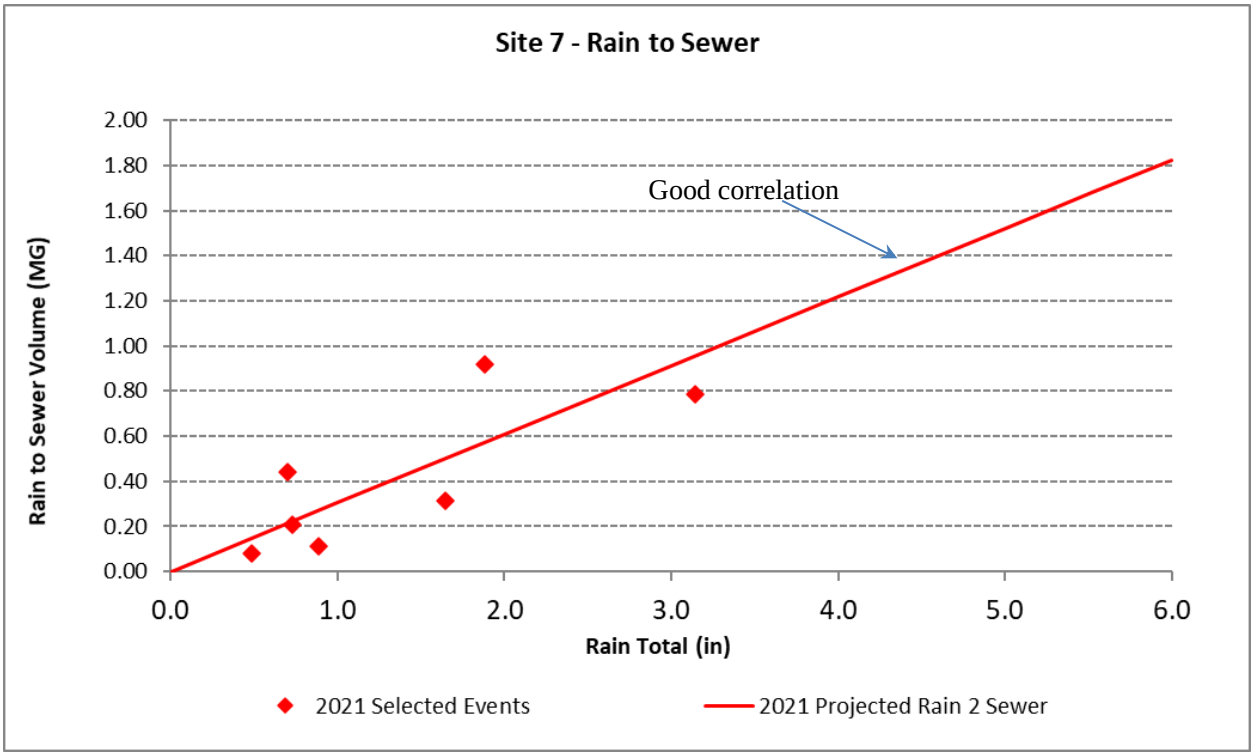


Table 32 – Rain to Sewer Summary (Site 7)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 7 (15")	9/28/2021	1.65	7.437	0.315	4.24%
	10/1/2021	0.73	3.290	0.205	6.23%
	10/11/2021	0.49	2.186	0.079	3.63%
	10/13/2021	3.15	14.175	0.783	5.52%
	10/27/2021	0.89	3.989	0.113	2.83%
	11/3/2021	1.89	8.496	0.920	10.83%
	11/27/2021	0.70	3.155	0.440	13.96%
				Average	**6.75%**

Figure 109 – Rain to Sewer Volumetric Analysis (Site 7)



A.8 Site 8

Description

Site 8 measures flow in manhole N09-001. north of Old Manor Lift Station and south of Tur Weg Lane. The area velocity sensor was placed in the influent 12" diameter PVC pipe of the manhole. This meter measures flow upstream of the Old High School Lift Station that is within the Gilleland Creek Watershed.

Observations

The average flow depth for this site was 2.83 inches with an average velocity of 0.45 feet per second. The collected data from this monitoring site was considered good. Light to heavy debris was reported during site visits. Light to heavy silt was reported at site visits as well. The meter was removed 9/27/2021 and reinstalled the next day for line to be cleaned. This allowed for more consistent velocity readings. However, velocity dropouts were common at low levels. There were enough valid recordings to adjust the dropouts accordingly.

There were no surcharging events recorded at this site during the 2021 monitoring period.

Table 33 – Service Interrogations Summary (Site 8)

Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 8	9/1/2021	10:00	12	2.75	2.50	-0.25	2.75	2.80	0.05	0.50	0.41	-0.09	0.50	0.43	-0.07	Install	Meter installed at in pipe
	9/14/2021	9:22		3.00	3.30	0.30	3.00	3.30	0.30	0.50	0.00	-0.50	0.50	0.40	-0.10	Service/Upload	Heavy Debris on probe
	9/27/2021	9:30		3.00	3.40	0.40	3.00	3.00	0.00	0.50	0.00	-0.50	0.50	0.50	0.00	Service/Upload	Meter removed 9/27 to 9/28 for jetting of line.
	10/13/2021	12:44		2.75	2.75	0.00	2.75	2.83	0.08	0.50	0.40	-0.10	0.50	0.34	-0.16	Service/Upload	
	10/26/2021	9:47		3.25	3.26	0.01	3.00	3.20	0.20	0.00	0.00	0.00	0.50	0.47	-0.03	Service/Upload	No velocity reading on dirty reading
	11/8/2021	9:24		3.00	3.56	0.56	3.00	3.25	0.25	0.70	0.72	0.02	0.50	0.51	0.01	Service/Upload	Light debris and very light silt.
	11/30/2021	9:56		2.50	0.00	-2.50	2.50	0.00	-2.50	1.00	0.00	-1.00	1.00	0.00	-1.00	Removal	Heavy silt and light debris. No readings.

Figure 110 – Flow Meter Site Investigation (Site 8)

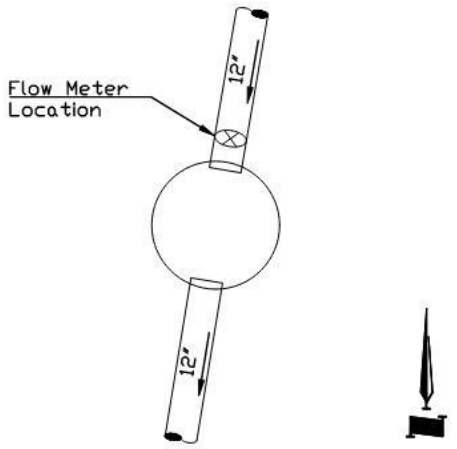
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 11-30-2021 / 9:56	**Crew:** JA-VI
MH#: N09-001	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 12

Site ID: 8	**Address:** 11616 US Hwy. 290	**Site Quality:** Poor	**Monitoring Purpose:** Short-term FM

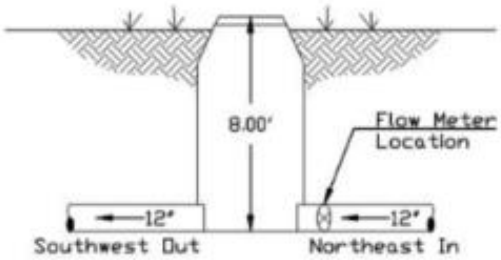
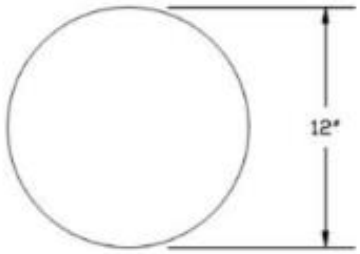
Location Map

Planar Description



Summary Description:
Location is north of Old Manor Lift Station and south of Tur Weg Lane. Future road from US 290 to Parsons was being built during analysis period.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? None		**Manhole Depth (ft):** 8.39	**Surcharge Evidence?** No
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 0.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 32	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Bolt Down	**Usable MH Steps?** No
Describe potential hazards: Steep slope and snakes.		**Measured Flow Depth (in):** 2.50	**Meter:** ISCO 2150
		Velocity (fps): 1.00	**Cellular Signal Strength:** N/A
		Mounting Band Description: Spring Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes	Pipe Cross Section
	

Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE

DOWN

INFLOW

OUTFLOW

Figure 111 – Site Information (Site 8)

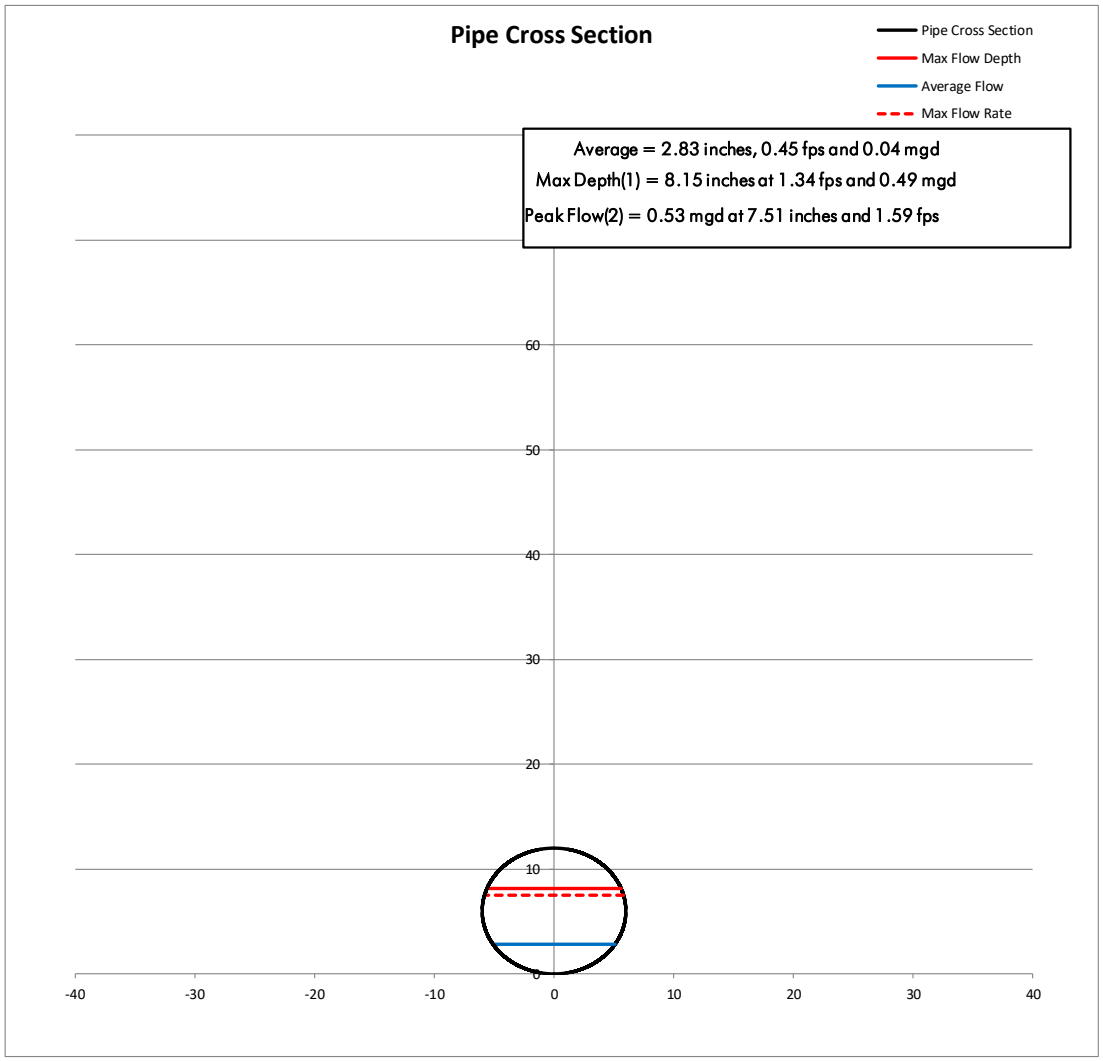
SITE INFORMATION RECORD

Site Information

Meter ID #:	8
Monitoring Program:	Short-Term FM
Manhole #:	N09-001

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	12	
Pipe Width, W (in):	12	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0004	ASSUMED!



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 8	9/1/2021	12	10:00	2.75	2.80	0.05	0.50	0.43	-0.07
	9/14/2021		9:22	3.00	3.30	0.30	0.50	0.40	-0.10
	9/27/2021		9:30	3.00	3.00	0.00	0.50	0.50	0.00
	10/13/2021		12:44	2.75	2.83	0.08	0.50	0.34	-0.16
	10/26/2021		9:47	3.00	3.20	0.20	0.50	0.47	-0.03
	11/8/2021		9:24	3.00	3.25	0.25	0.50	0.51	0.01
	11/30/2021		9:56	2.50	0.00	-2.50	1.00	0.00	-1.00

Figure 112 – September Monthly Flow Hydrograph (Site 8)

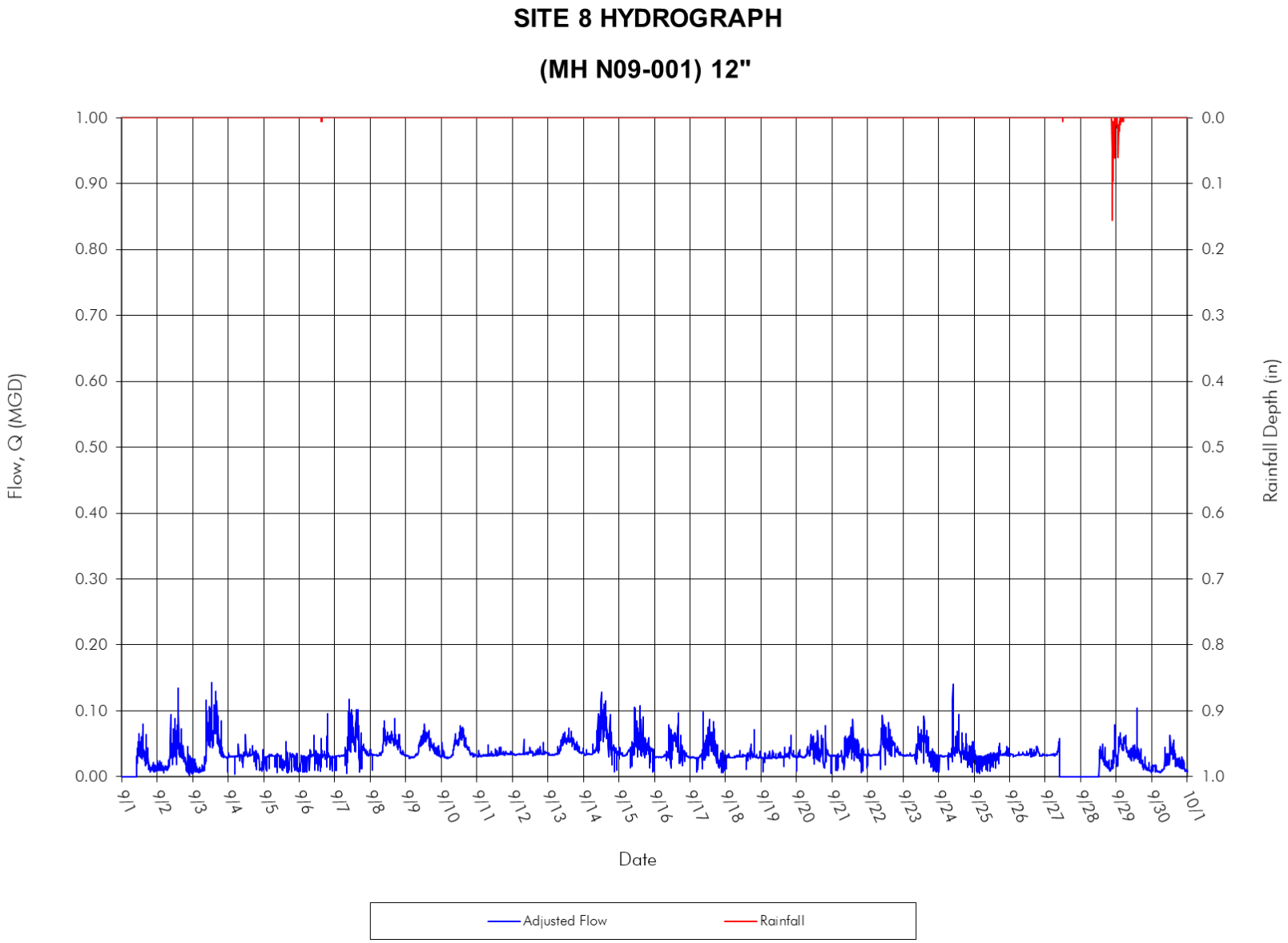


Figure 113 – September Monthly Level and Velocity Hydrograph (Site 8)

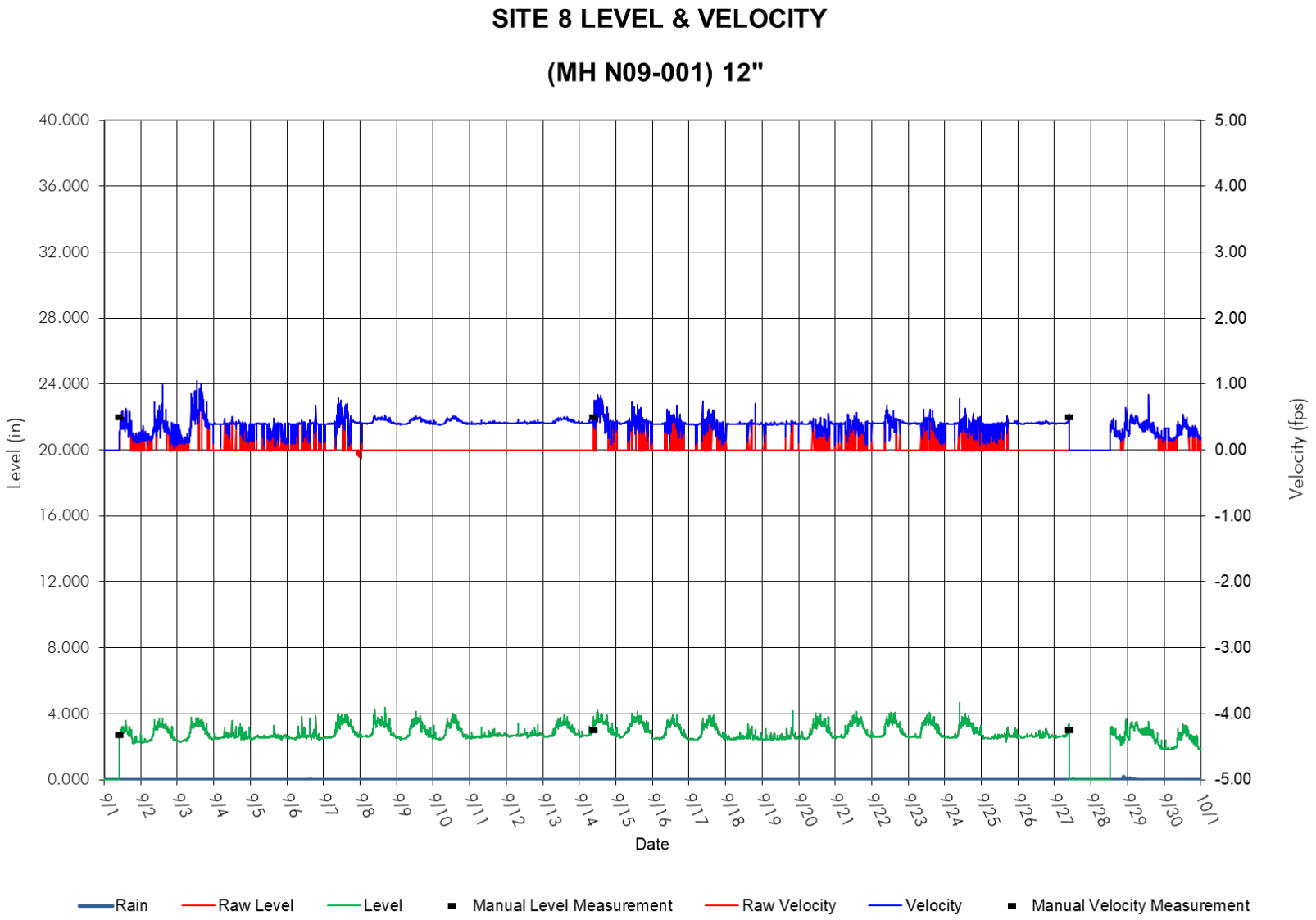


Figure 114 – October Flow Hydrograph (Site 8)

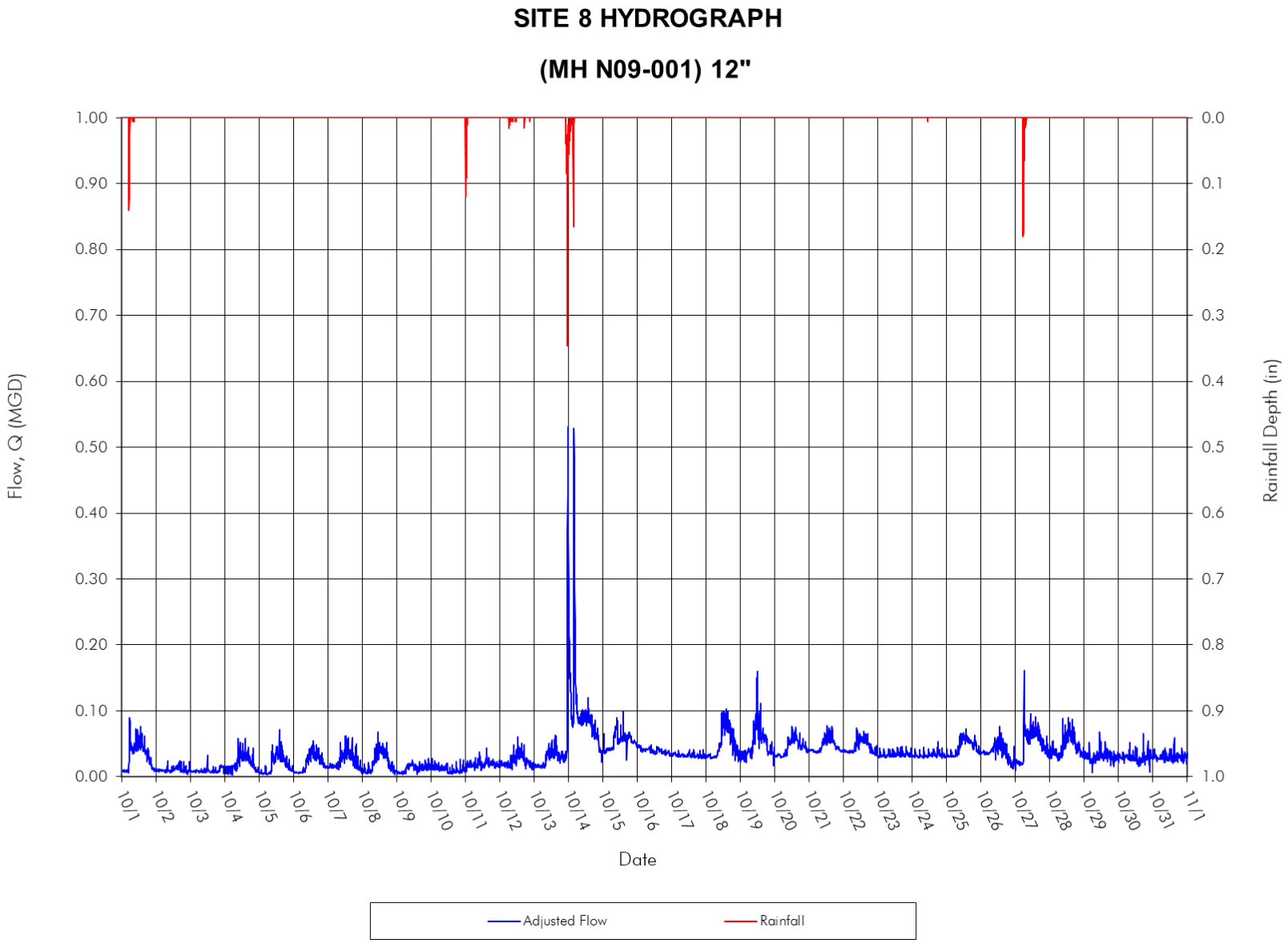


Figure 115 – October Monthly Level and Velocity Hydrograph (Site 8)

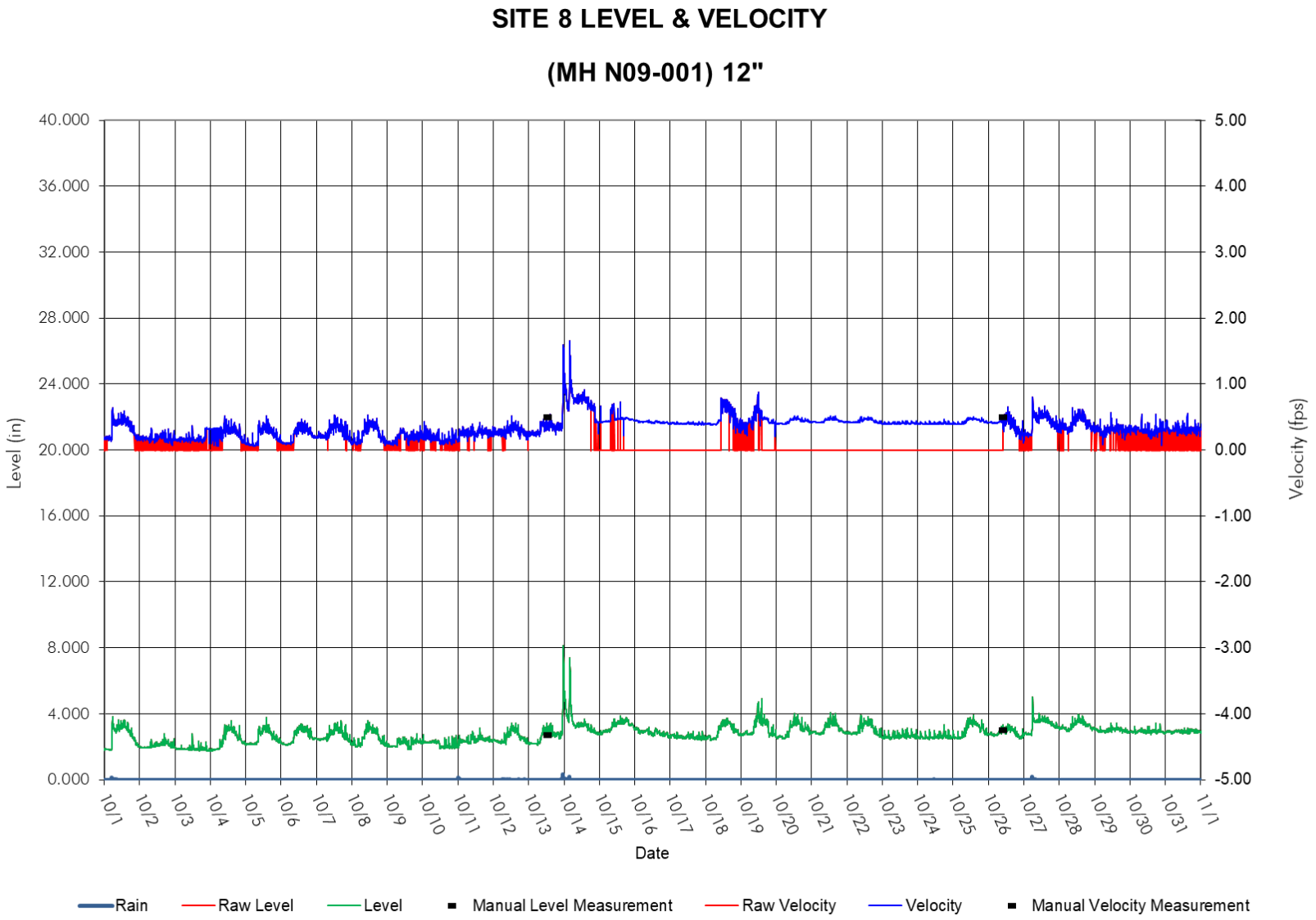


Figure 116 – November Monthly Flow Hydrograph (Site 8)

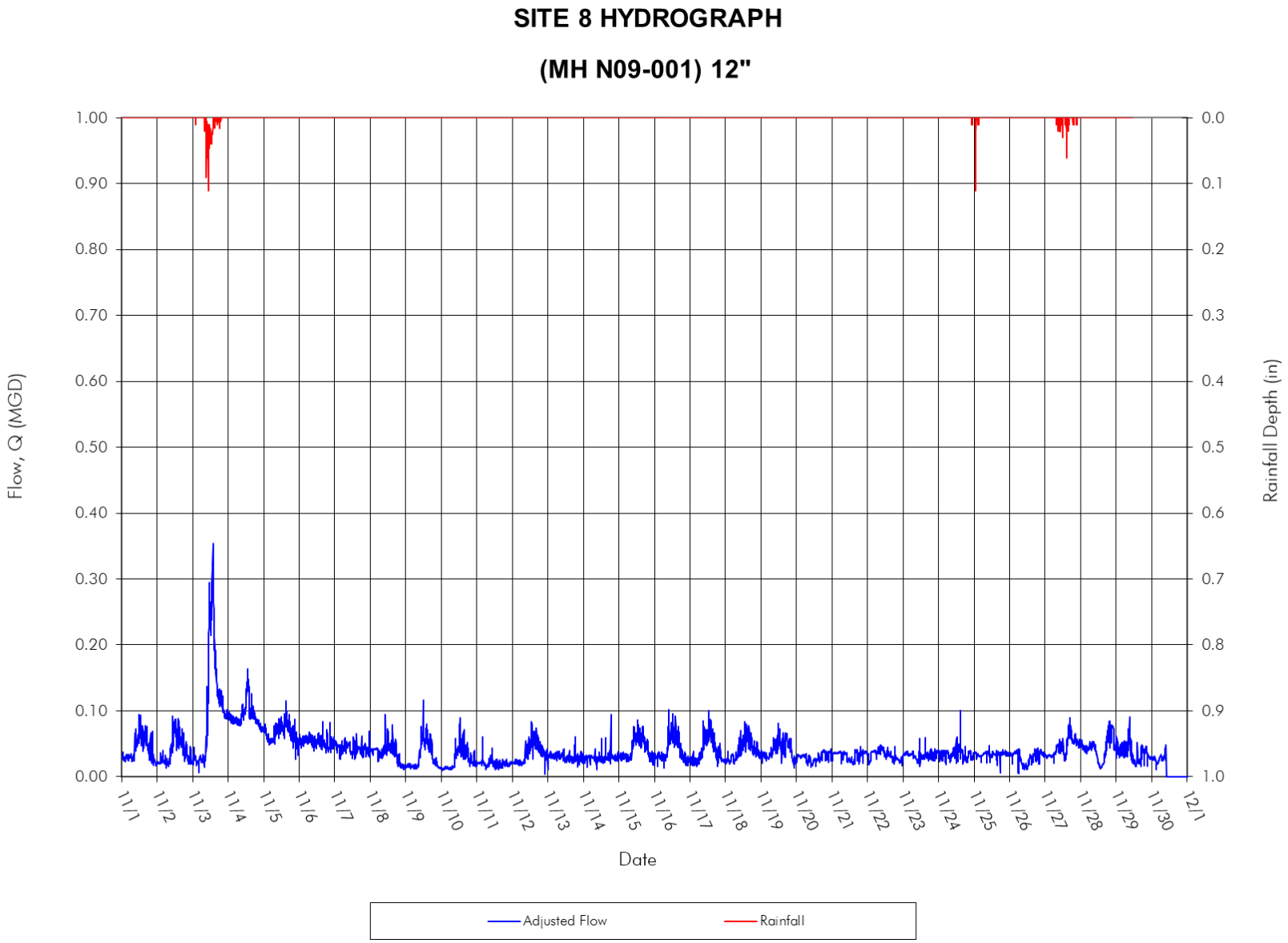


Figure 117 – November Level and Velocity Hydrograph (Site 8)

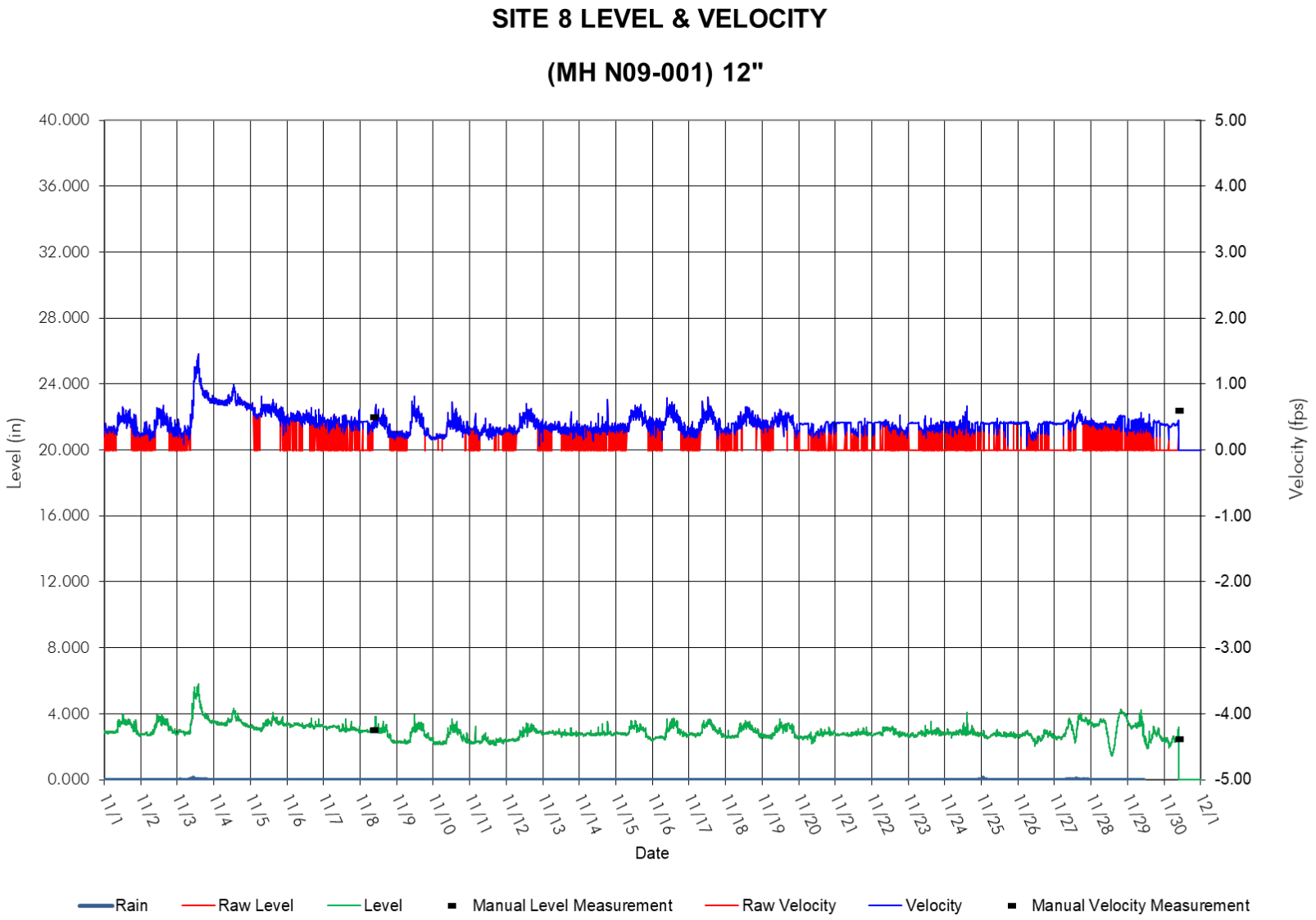


Figure 118 – Overall Flow Hydrograph (Site 8)

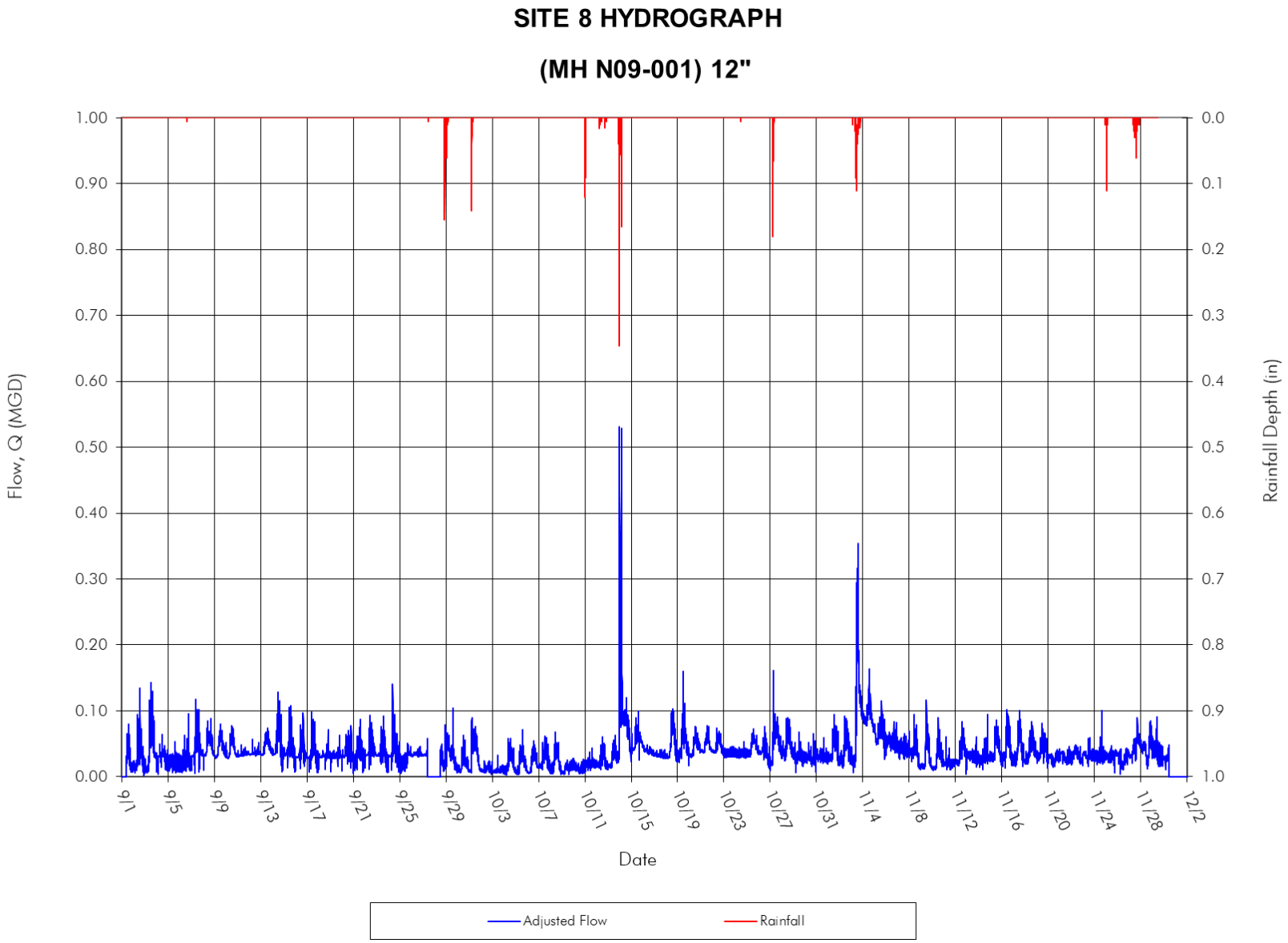


Figure 119 – Overall Level and Velocity Hydrograph (Site 8)

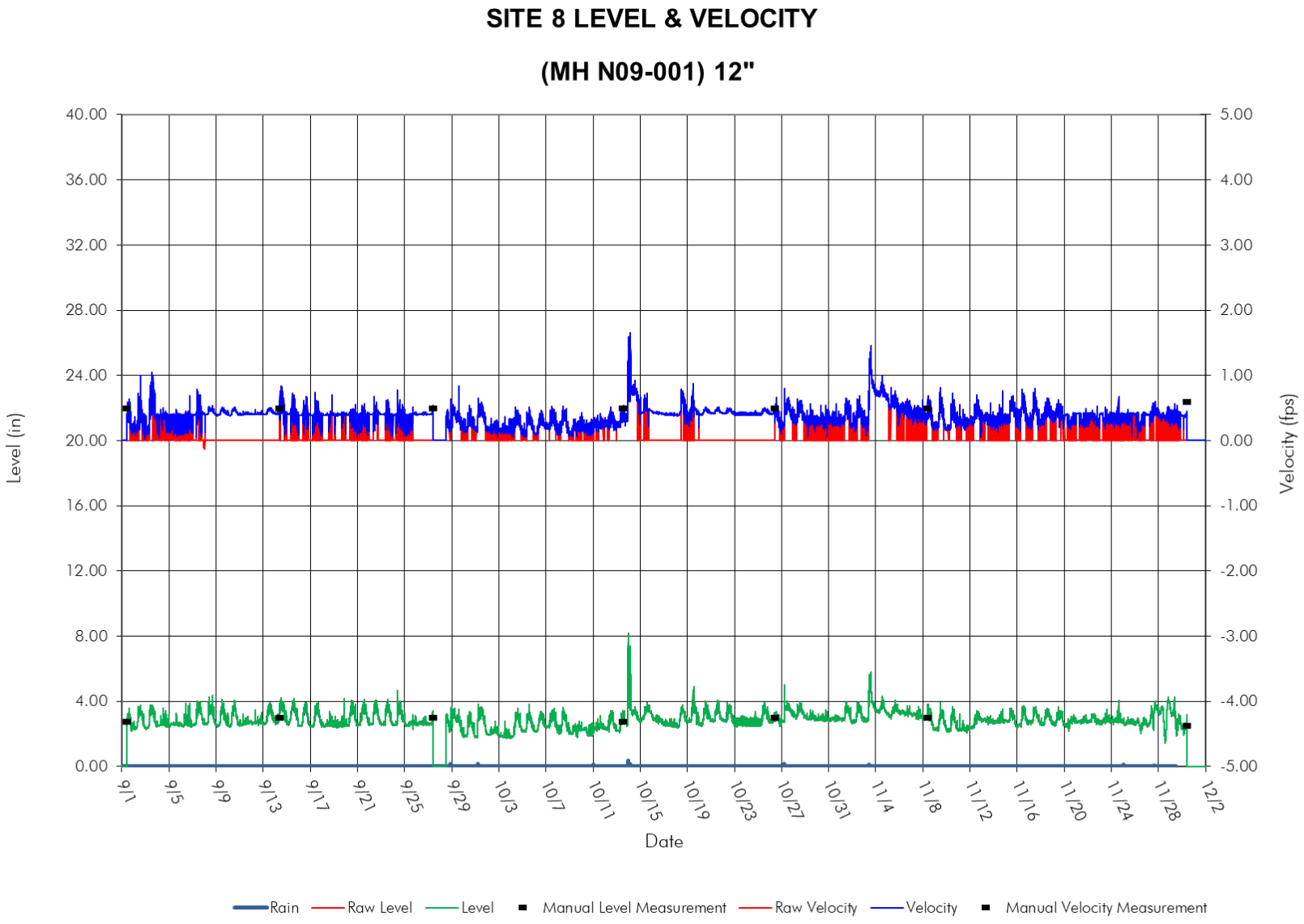


Figure 120 – Standard Flow Scattergraph (Site 8)

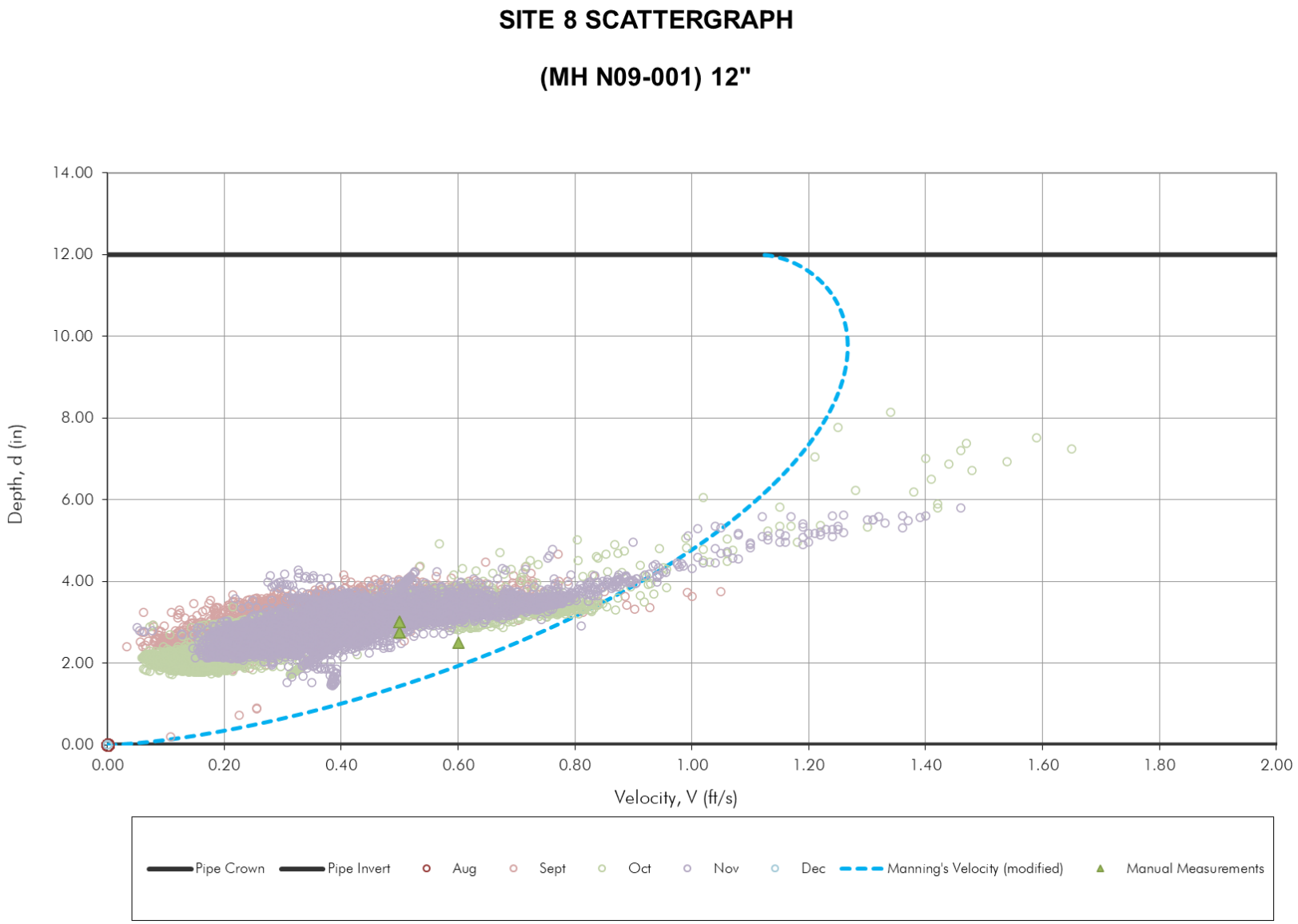


Figure 121 – ADDF and Infiltration Summary (Site 8)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 8
Meter: 8
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.052	0.059	1.151	0.049		
13-Sep-21	Mon	0.064	0.090	1.391	0.048		
14-Sep-21	Tue	0.059	0.090	1.520	0.049		
15-Sep-21	Wed	0.053	0.077	1.448	0.044		
16-Sep-21	Thu	0.047	0.062	1.329	0.041	04-Nov-21	0.073
17-Sep-21	Fri	0.041	0.065	1.579	0.027	15-Oct-21	0.056
18-Sep-21	Sat	0.044	0.057	1.294	0.039	16-Oct-21	0.051
7 Count		0.052 Average	0.072 Average	1.388 Average	0.042 Average	3 Count	0.060 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.052	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.052	
	Diurnal Peaking Factor (DPF):	1.388	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.018	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.018	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.052	

Figure 122 – Dry Weather Diurnal (Site 8)

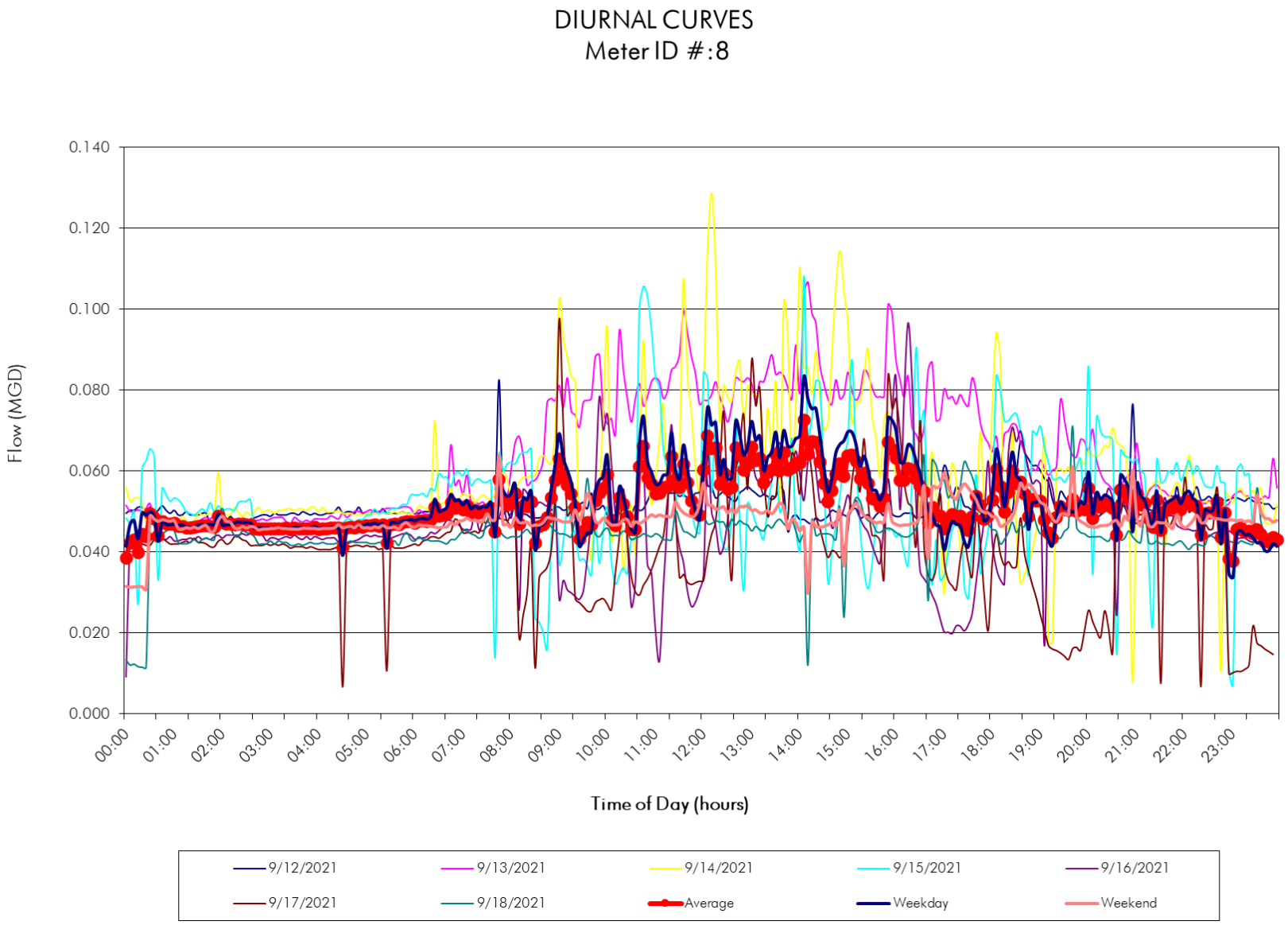


Figure 123 – High/Low Groundwater Diurnal (Site 8)

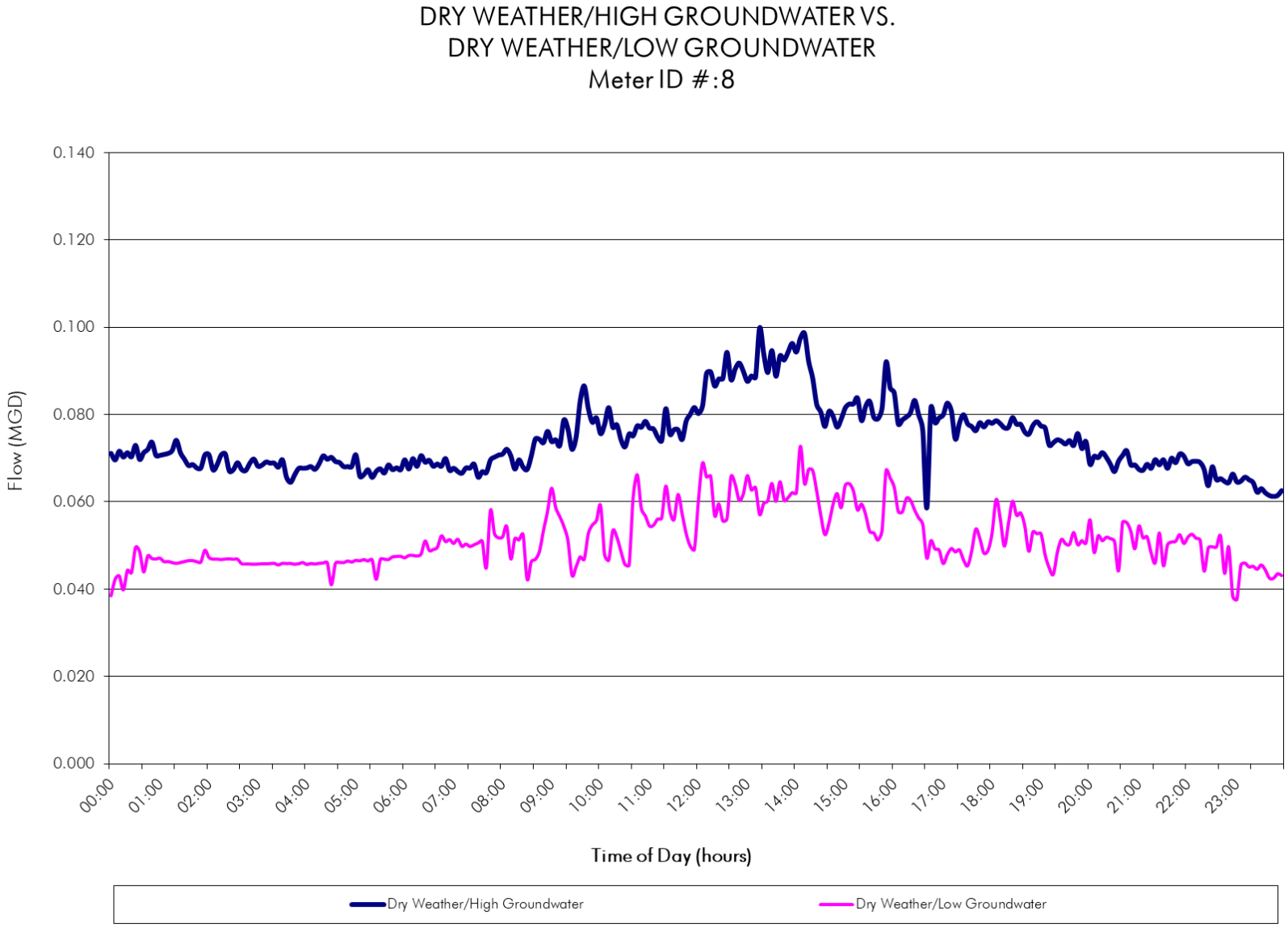


Table 34 – Inflow Calculations and Projections (Site 8)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	8
Meter:	8
Units of Flow:	MGD

Storm Count:	7	Cum. Trib. Area:	136 acres	Pipe Shape:	Circular
Avg Delta Time	105	Cum. Time of Conc.:	105 minutes	Pipe Diameter:	12 in
Avg Kp:	0.00333			Pipe Slope:	0.001 ft/ft
Avg Selected Kp:	0.00381			Pipe Capacity:	0.57 mgd
				ADDF Cum.:	0.052 mgd
				ADDF Peak. Factor:	1.39
				Peak ADDF Flow:	0.071 mgd
				Infiltration:	0.018 mgd
				Cum. Peak Flow:	0.089 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.089
1	0.890	0.298	0.461	0.387
2	1.110	0.371	0.575	0.461
5	1.410	0.472	0.730	0.561
10	1.640	0.549	0.849	0.638
25	1.960	0.656	1.015	0.745
50	2.220	0.743	1.150	0.832
100	2.480	0.830	1.284	0.919

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/28/21 21:00	1.65	7.92	9/28/21 22:55	9/28/21 21:20	95	0.079	09/27/21	0.047	0.032	0.610	0.00060	y	0.00060					
10/1/21 4:55	0.73	3.67	10/1/21 5:40	10/1/21 5:05	35	0.089	09/30/21	0.007	0.082	0.400	0.00234	y	0.00234					
10/11/21 0:05	0.49	1.25	10/11/21 3:25	10/11/21 0:05	200	0.025	10/10/21	0.014	0.011	0.280	0.00046	n						No reaction
10/13/21 21:55	3.15	6.00	10/13/21 23:40	10/13/21 23:10	30	0.531	10/12/21	0.014	0.518	1.150	0.00512	y	0.00512					
10/27/21 5:15	0.89	2.42	10/27/21 6:05	10/27/21 5:25	40	0.161	10/20/21	0.045	0.117	0.470	0.00283	y	0.00283					
11/3/21 2:10	1.89	16.83	11/3/21 13:45	11/3/21 10:35	190	0.354	11/02/21	0.044	0.310	0.440	0.00802	y	0.00802					
11/27/21 7:45	0.70	13.92	11/27/21 16:50	11/27/21 14:25	145	0.089	11/20/21	0.030	0.059	0.170	0.00394	y	0.00394					

Figure 124 – Inflow Projections (Site 8)

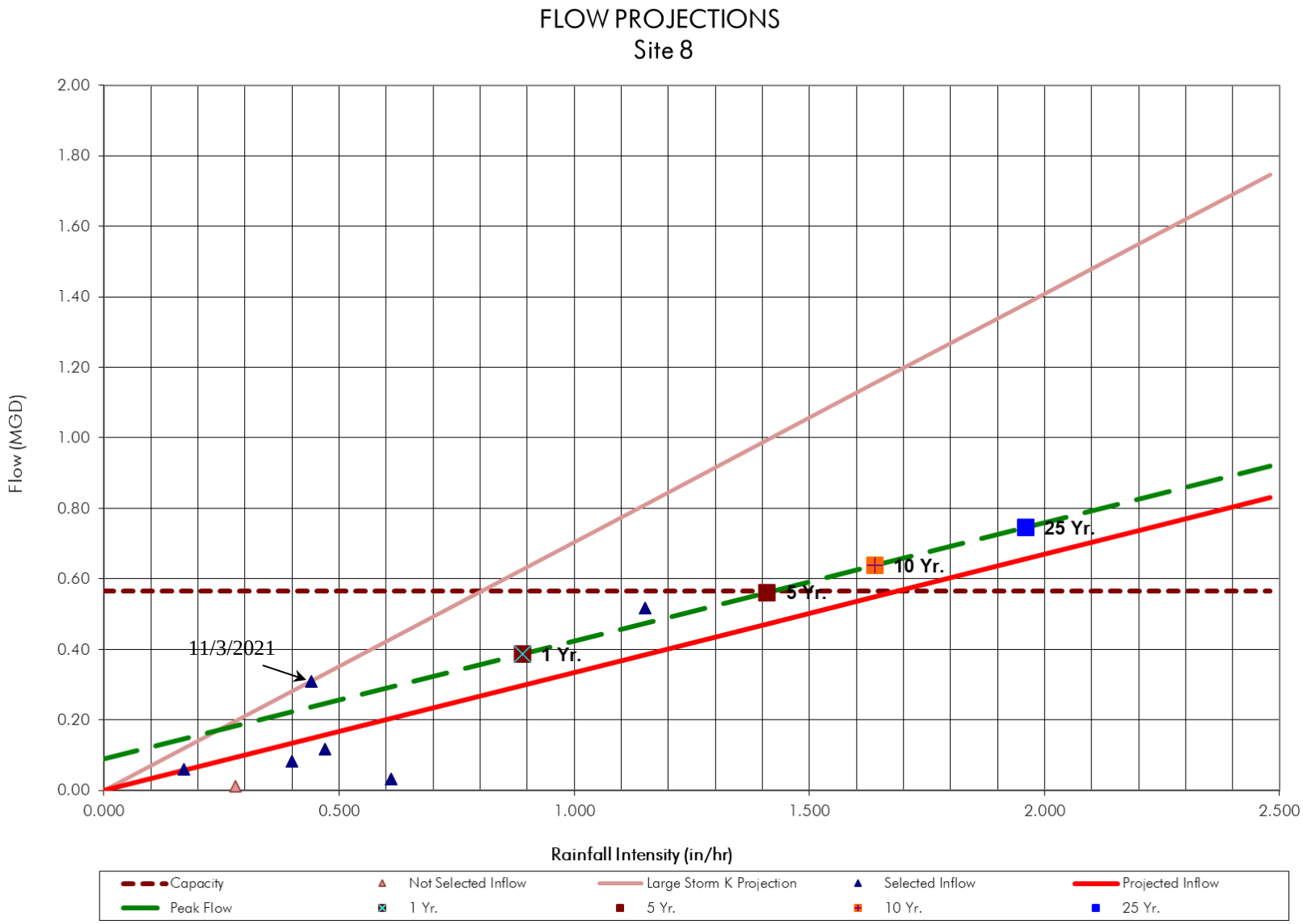
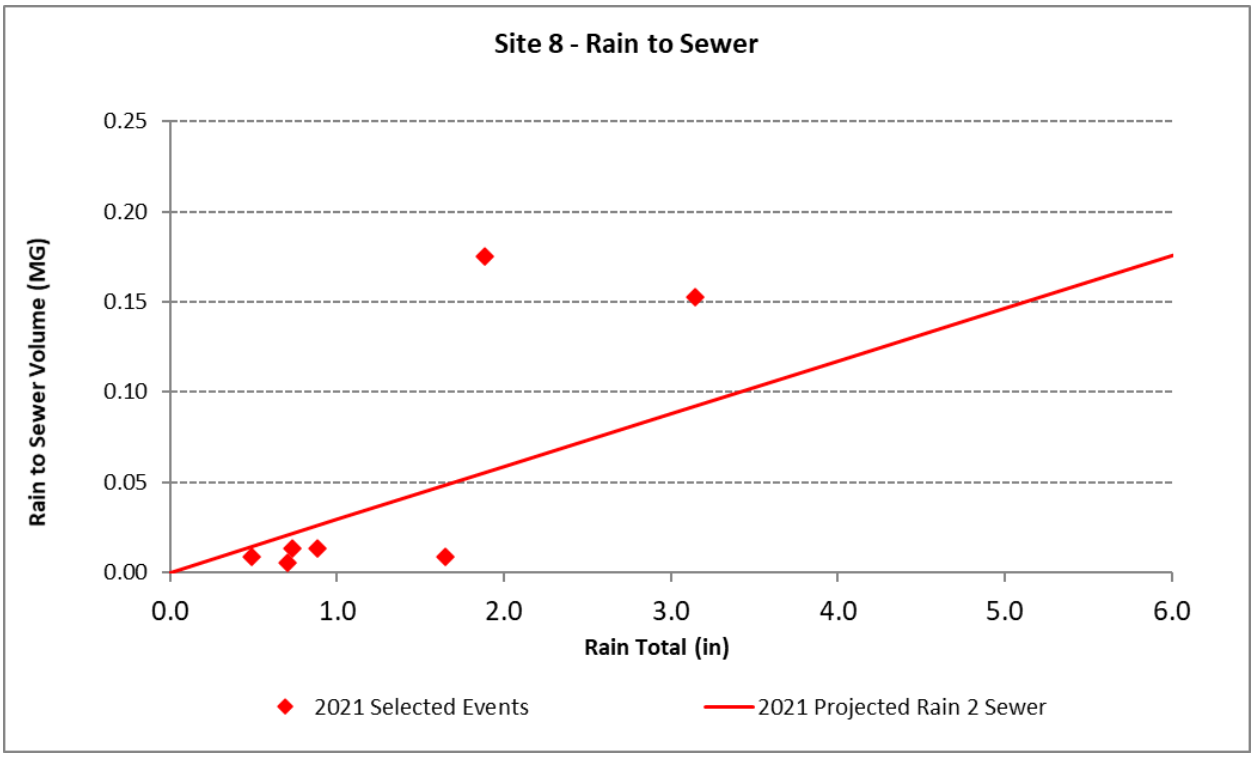


Table 35 – Rain to Sewer Summary (Site 8)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 8 (12")	9/28/2021	1.65	6.093	0.009	0.14%
	10/1/2021	0.73	2.696	0.013	0.48%
	10/11/2021	0.49	1.791	0.009	0.48%
	10/13/2021	3.15	11.614	0.153	1.32%
	10/27/2021	0.89	3.268	0.013	0.40%
	11/3/2021	1.89	6.961	0.175	2.51%
	11/27/2021	0.70	2.585	0.005	0.21%
				Average	**0.79%**

Figure 125 – Rain to Sewer Volumetric Analysis (Site 8)



A.9 Site 9

Description

Site 9, at manhole I13-026 in the middle of asphalt street near the North Stonewater lift station. The area velocity sensor was installed in the 12" diameter PVC influent pipe. This monitoring site measured flows that collect at the North Stonewater Lift Station that are pumped to Basin 2 which further flows to Basin 1 which contributes to the Wilbarger Wastewater Treatment Plant.

Observations

The average flow depth was found to be approximately 3.01 inches and average velocity of 1.12 feet per second. This site experienced light debris and light silting. The site had very minimal velocity dropouts that were autocorrected with valid meter recordings. The level and velocity readings were consistent with manual measurements during site visits. The site is considered a good monitoring site.

Site 9 experienced one wet weather surcharge event in 2021.

Table 36 – Surcharge Summary (Site 9)

		Date of Storm	9/6/2021
		Total Storm Rainfall (in.)	0.43"
Site	Diameter (in.)	Storm Duration (hrs.)	0.58
9	12	Depth from Invert (in.)	23.15 (P)

(P) Denotes pressurized flow caused by lack of capacity
(flow velocities generally increase as flow depths increase)
(B) Denotes flow backup caused by downstream restriction
(flow velocities generally decrease as flow depths increase)

Table 37 – Service Interrogation Summary (Site 9)

Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 9	9/1/2021	11:15	12	2.50	2.30	-0.20	2.50	2.25	-0.25	1.25	1.15	-0.10	1.25	1.15	-0.10	Install	Meter installed at in pipe
	9/14/2021	11:16		2.50	2.38	-0.12	2.50	2.38	-0.12	1.00	1.03	0.03	1.00	1.08	0.08	Service/Upload	
	9/28/2021	10:14		2.75	2.80	0.05	3.00	3.12	0.12	1.00	0.86	-0.14	1.25	1.03	-0.22	Service/Upload	
	10/13/2021	10:57		3.50	3.40	-0.10	3.50	3.63	0.13	2.00	0.00	-2.00	1.00	1.18	0.18	Service/Upload	
	10/27/2021	10:50		3.75	3.68	-0.07	3.75	3.74	-0.01	1.00	1.02	0.02	1.00	1.09	0.09	Service/Upload	
	11/9/2021	10:58		3.25	3.71	0.46	3.00	3.60	0.60	1.25	1.17	-0.08	1.25	1.15	-0.10	Service/Upload	Light debris and silt.
	11/29/2021	12:11		2.75	3.23	0.48	3.00	2.95	-0.05	1.25	1.12	-0.13	1.25	1.16	-0.09	Removal	Light silt.

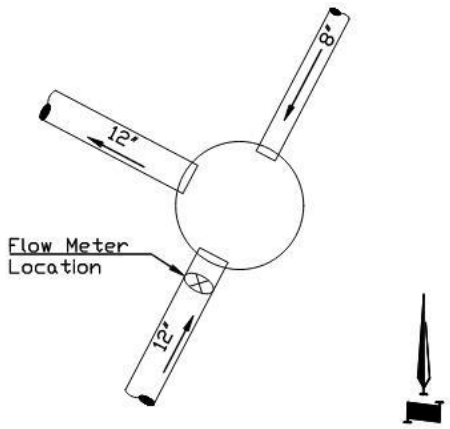
Figure 126 – Flow Meter Site Investigation (Site 9)

Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 11-29-2021 / 12:11	**Crew:** JA-VI
MH#: I13-026	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 12
Site ID: 9	**Address:** 15009 Talus Rd.	**Site Quality:** Fair	**Monitoring Purpose:** Short-term FM

Location Map

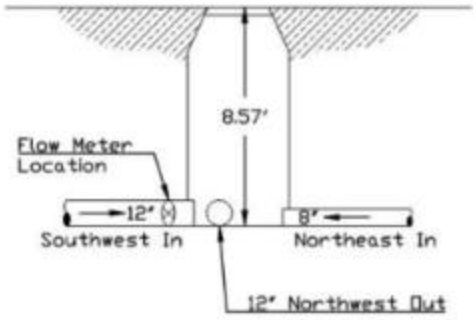
Planar Description



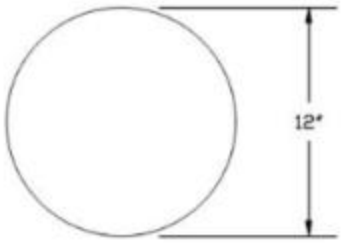
Summary Description:
Located in middle of asphalt street near the North Stonewater Lift Station.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? Light		**Manhole Depth (ft):** 8.57	**Surcharge Evidence?** No
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 0.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 24.00	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Standard	**Usable MH Steps?** No
Describe potential hazards: Light traffic in residential subdivision. Cones and service truck lights need to be on during service.		**Measured Flow Depth (in):** 3.00	**Meter:** ISCO 2150
		Velocity (fps): 1.25	**Cellular Signal Strength:** N/A
		Mounting Band Description: Spring Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes



Pipe Cross Section



Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE

DOWN

INFLOW

OUTFLOW

GBA

Figure 127 – Site Information (Site 9)

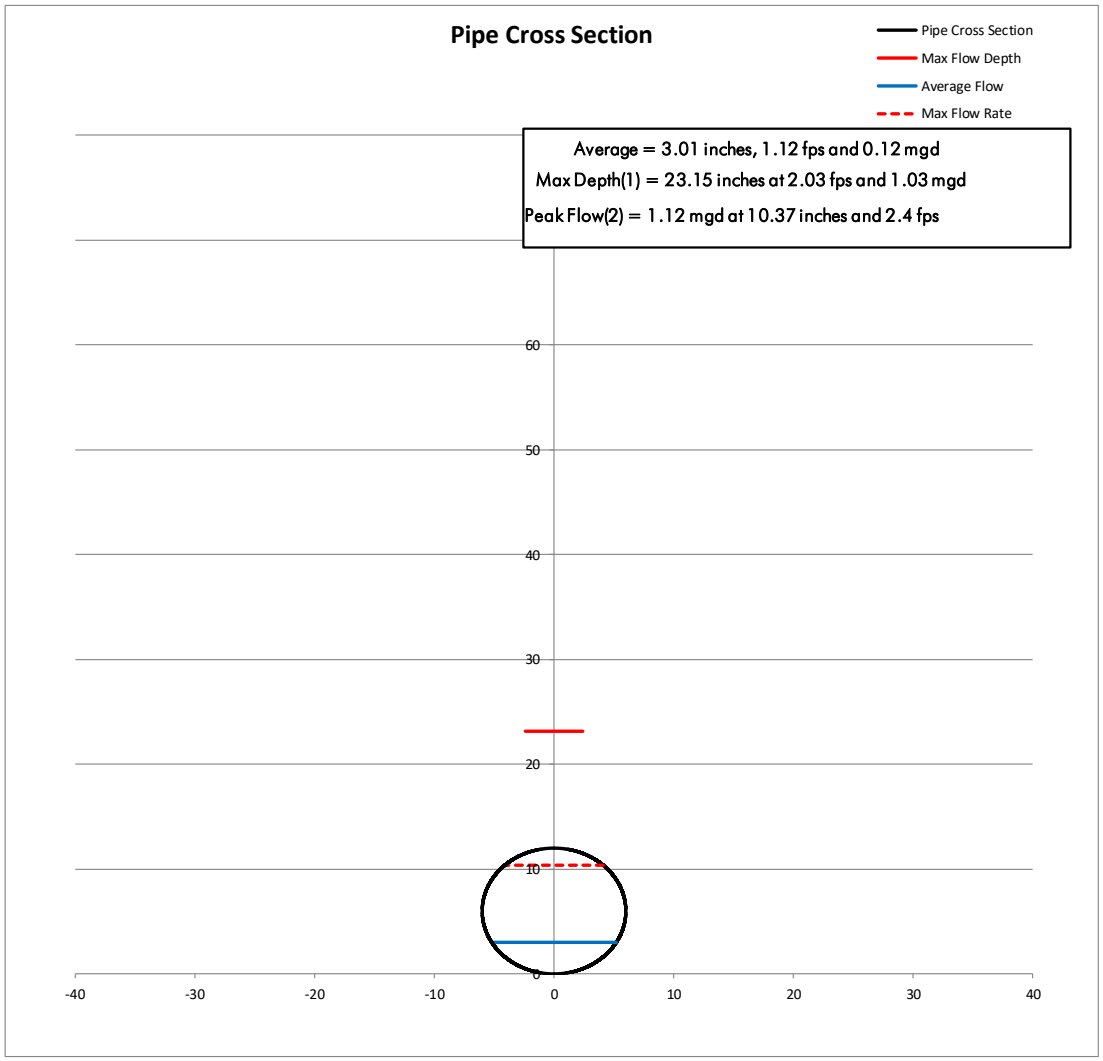
SITE INFORMATION RECORD

Site Information

Meter ID #:	9
Monitoring Program:	Short-Term FM
Manhole #:	I13-026

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	12	
Pipe Width, W (in):	12	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0030	ASSUMEDI



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 9	9/1/2021	12	11:15	2.50	2.25	-0.25	1.25	1.15	-0.10
	9/14/2021		11:16	2.50	2.38	-0.12	1.00	1.08	0.08
	9/28/2021		10:14	3.00	3.12	0.12	1.25	1.03	-0.22
	10/13/2021		10:57	3.50	3.63	0.13	1.00	1.18	0.18
	10/27/2021		10:50	3.75	3.74	-0.01	1.00	1.09	0.09
	11/9/2021		10:58	3.00	3.60	0.60	1.25	1.15	-0.10
	11/29/2021		12:11	3.00	2.95	-0.05	1.25	1.16	-0.09

Figure 128 –September Monthly Flow Hydrograph (Site 9)

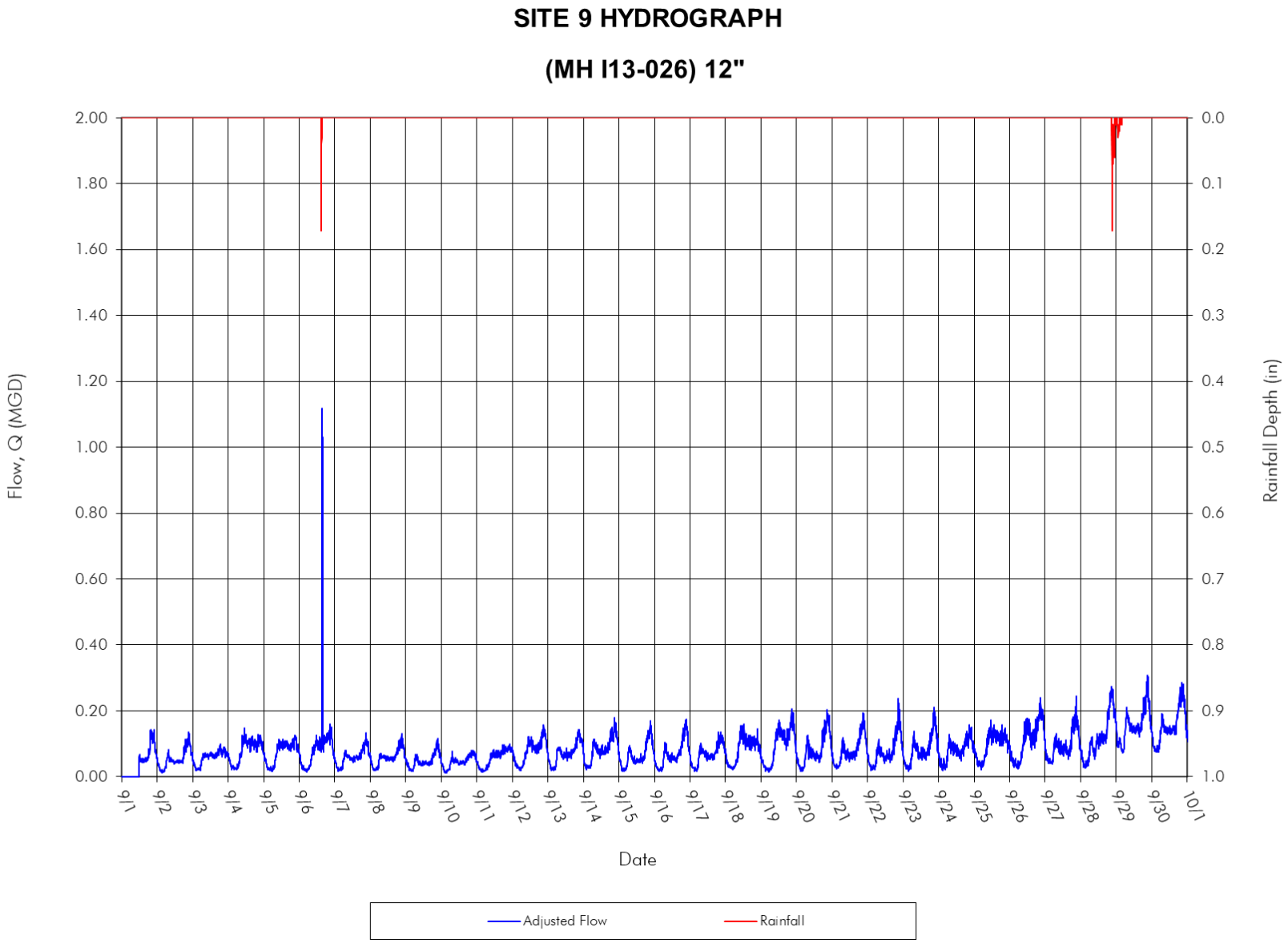


Figure 129 –September Monthly Level and Velocity Hydrograph (Site 9)

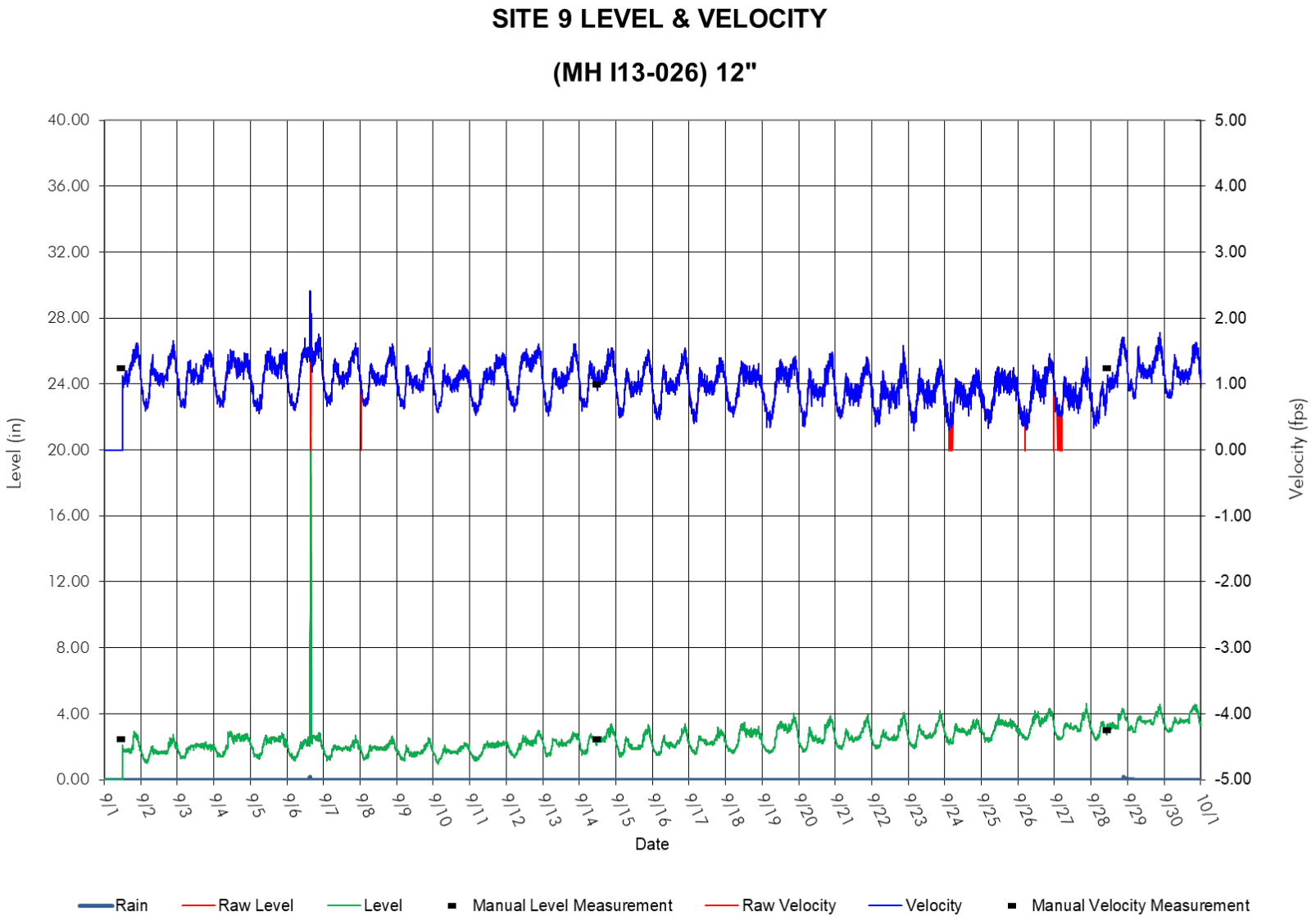


Figure 130 – October Flow Hydrograph (Site 9)

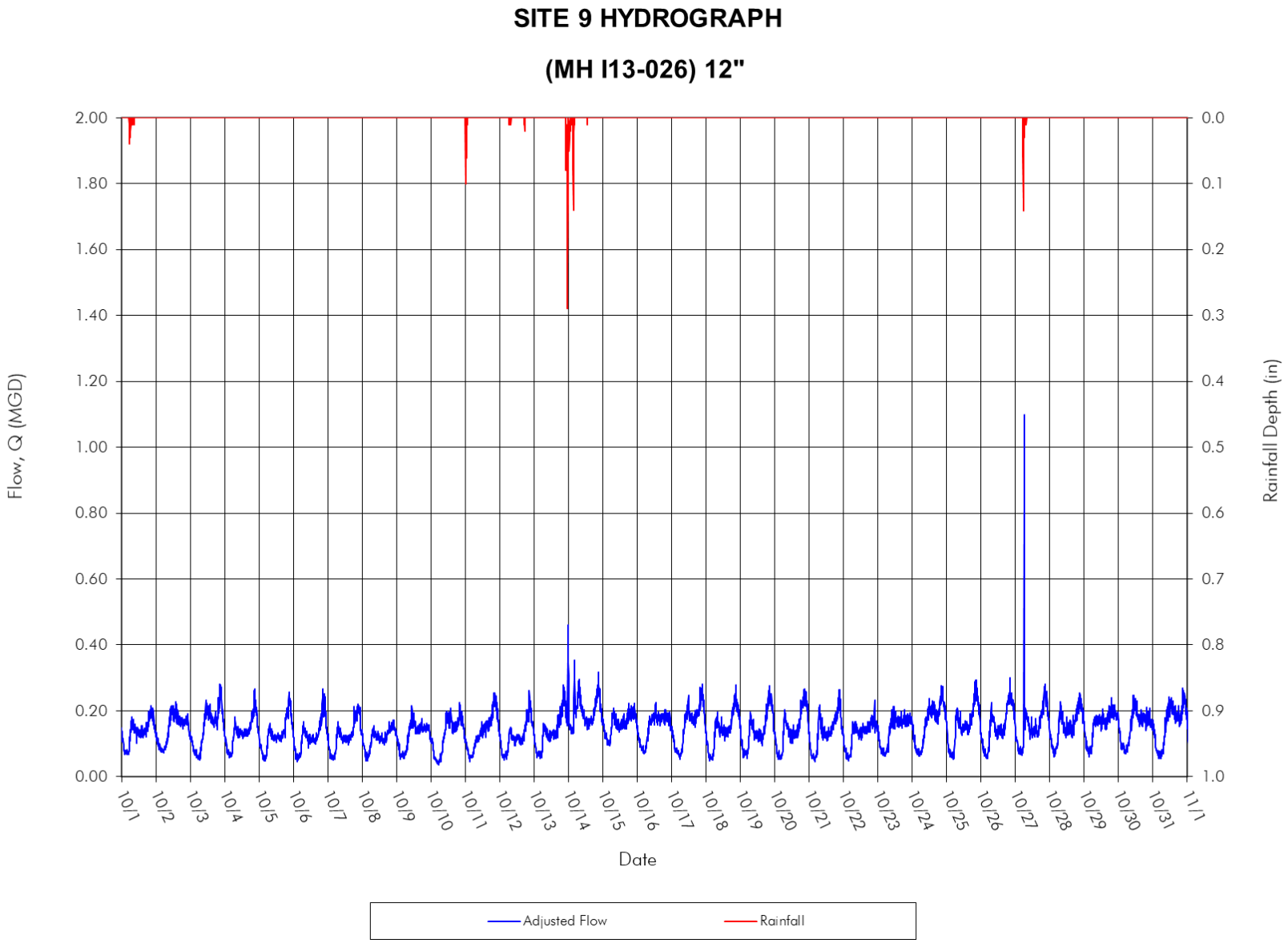


Figure 131 – October Monthly Level and Velocity Hydrograph (Site 9)

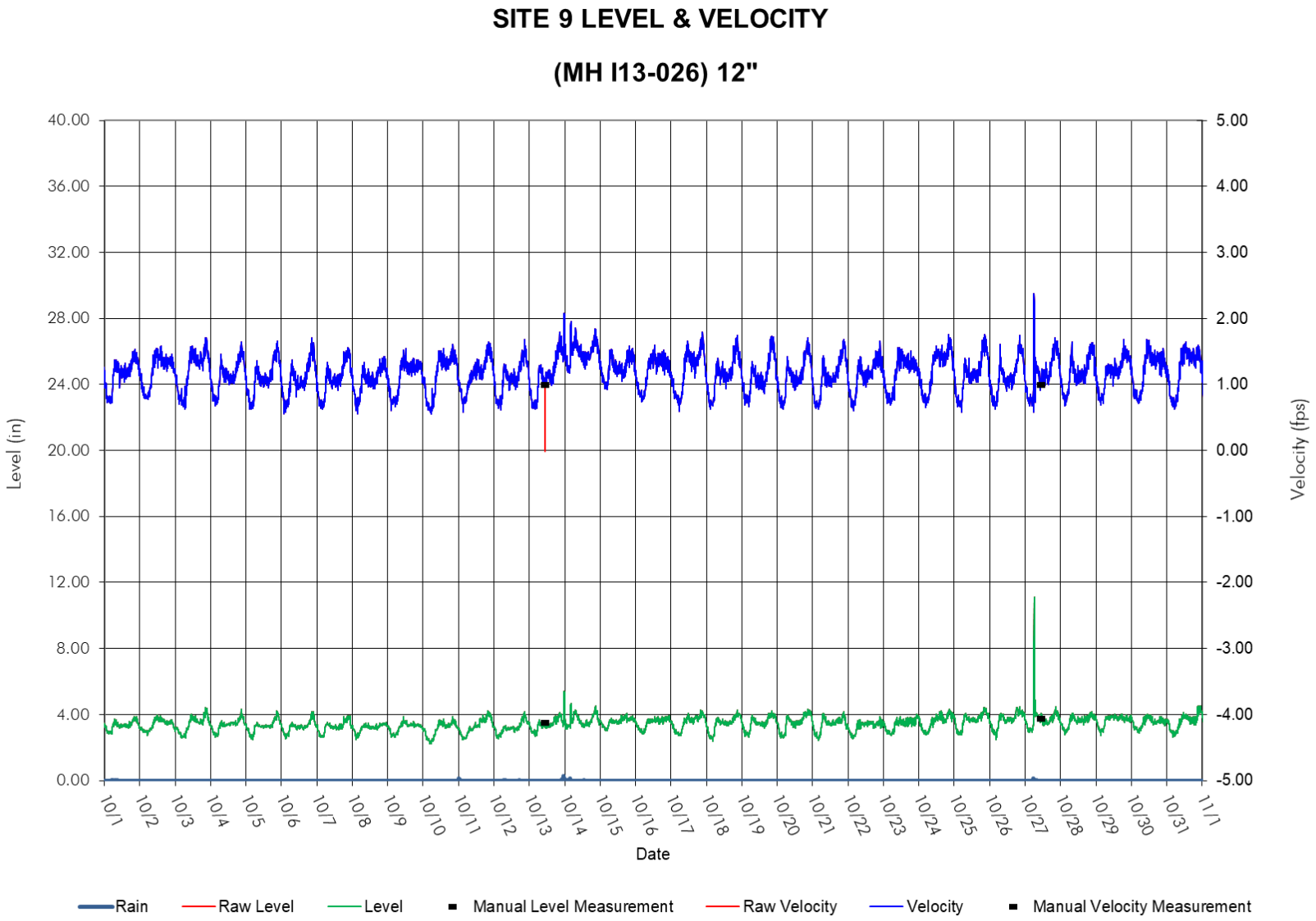


Figure 132 – November Monthly Flow Hydrograph (Site 9)

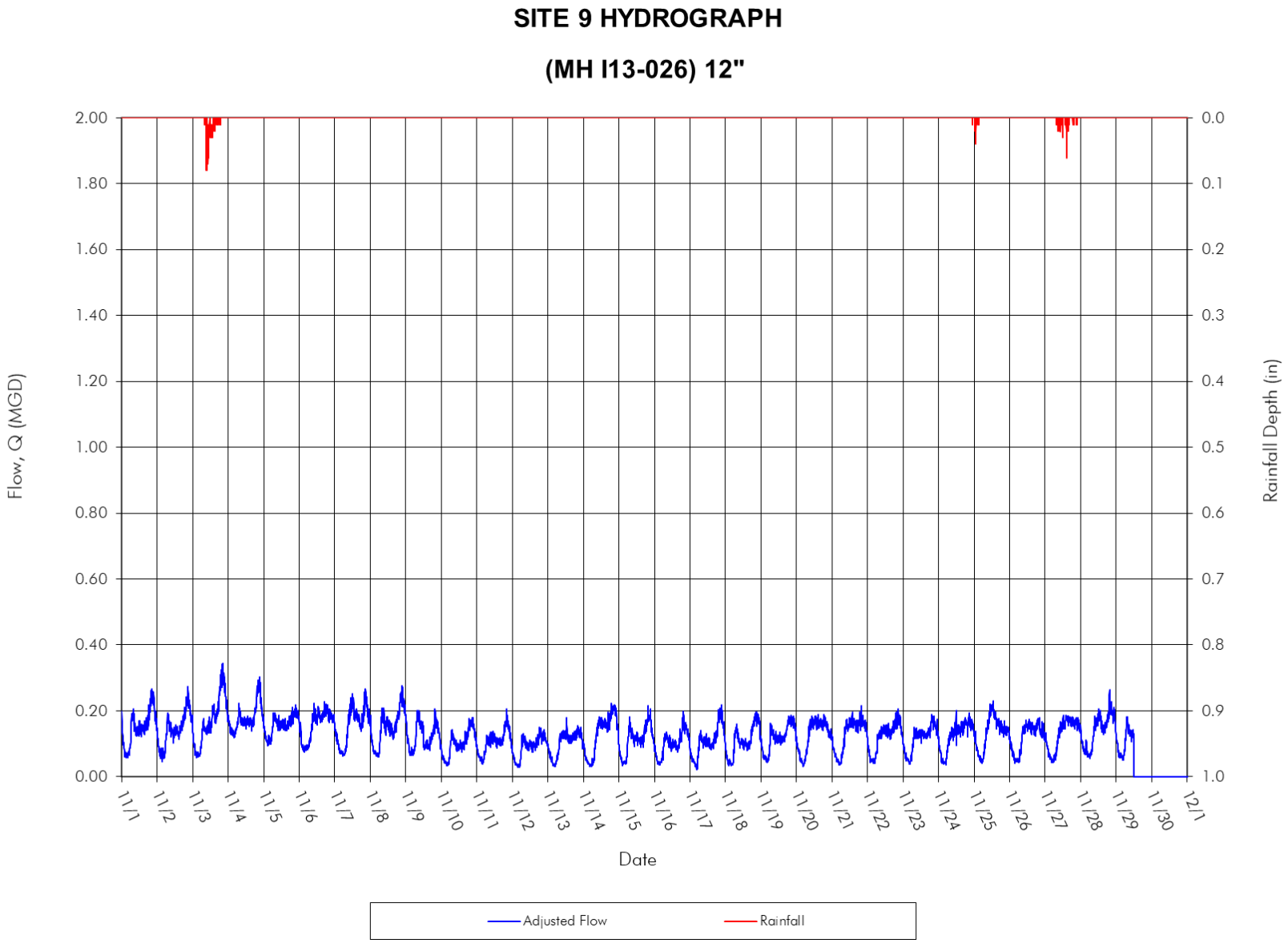


Figure 133 – November Level and Velocity Hydrograph (Site 9)

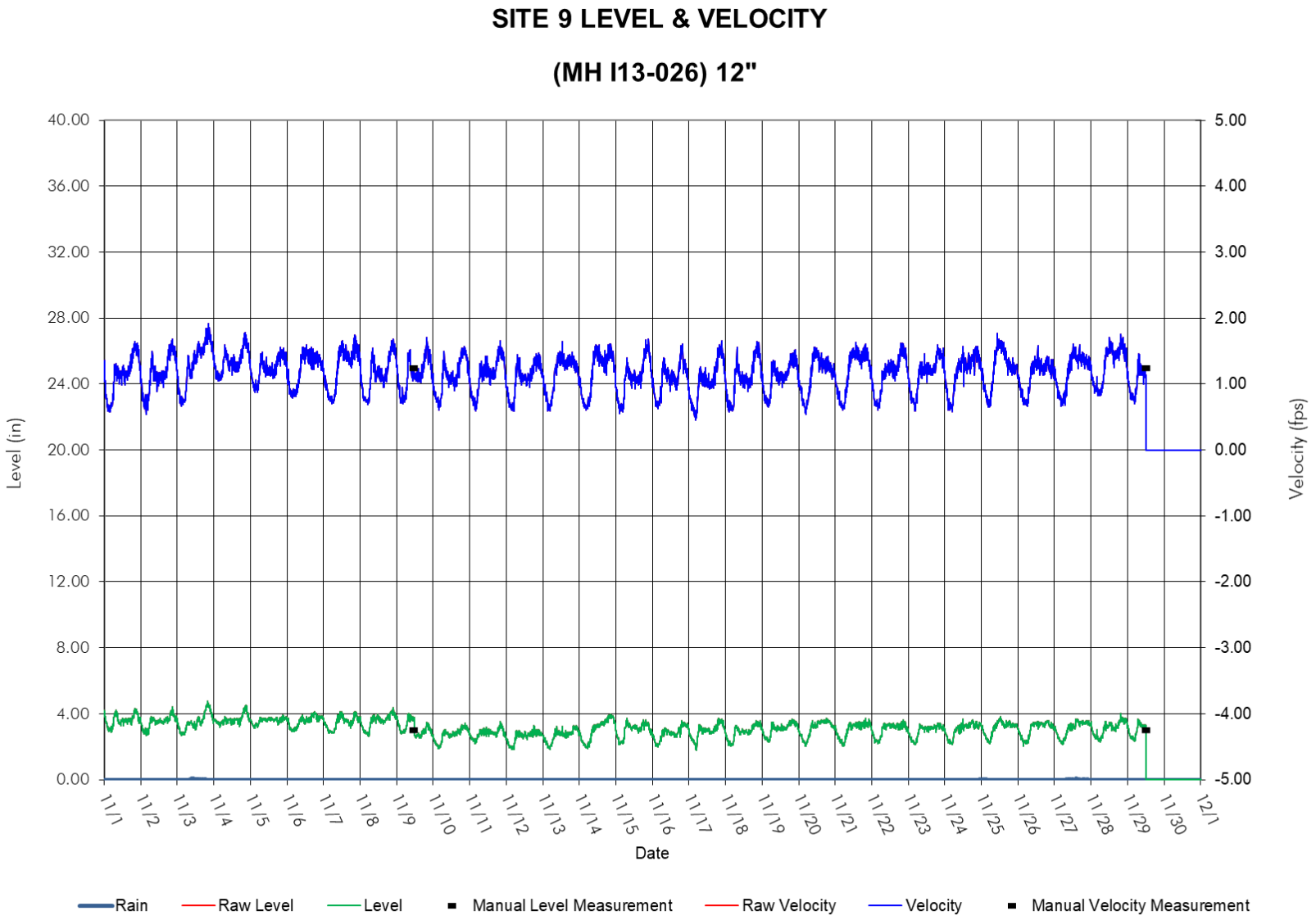


Figure 134 – Overall Flow Hydrograph (Site 9)

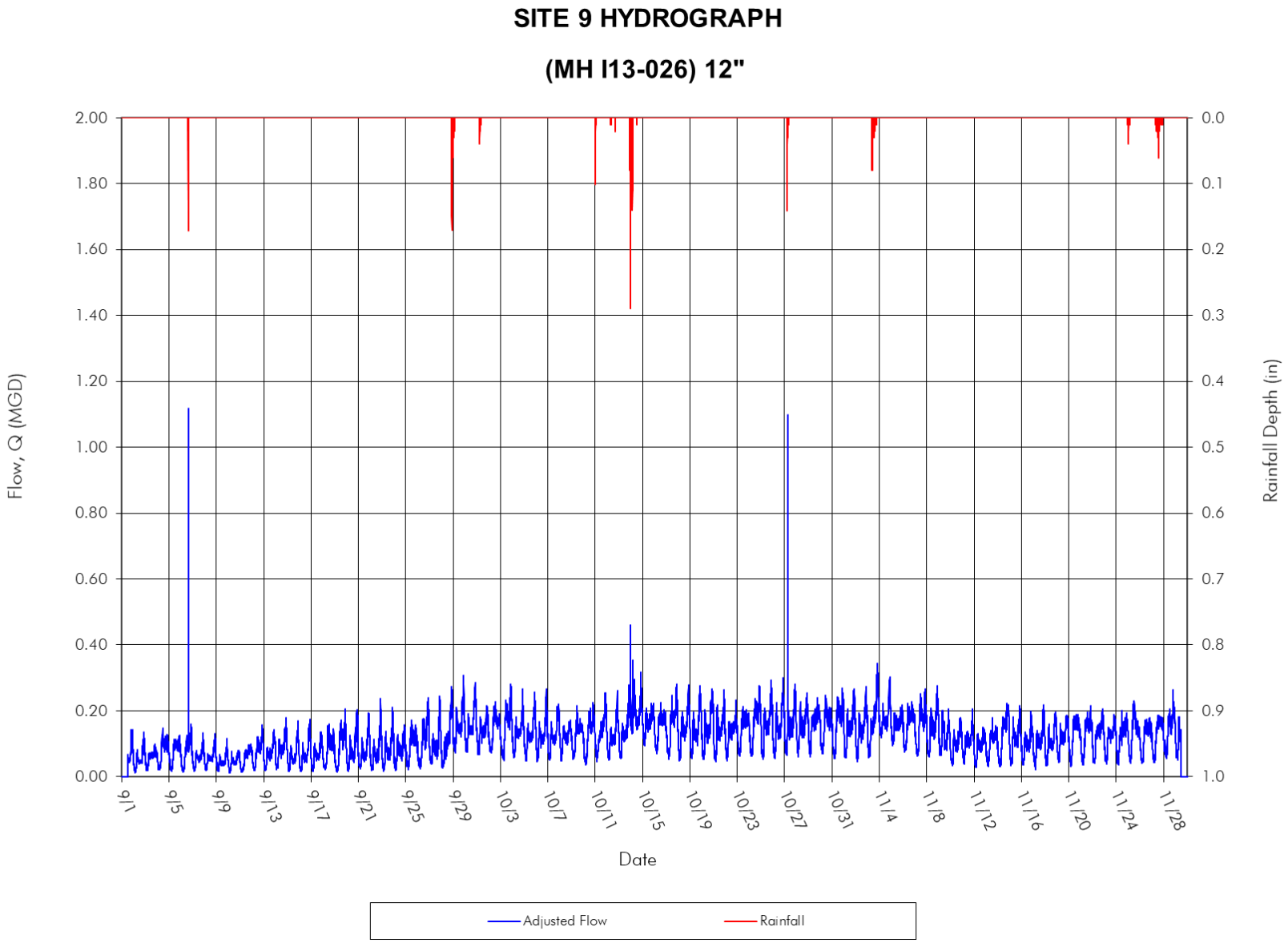


Figure 135 – Overall Level and Velocity Hydrograph (Site 9)

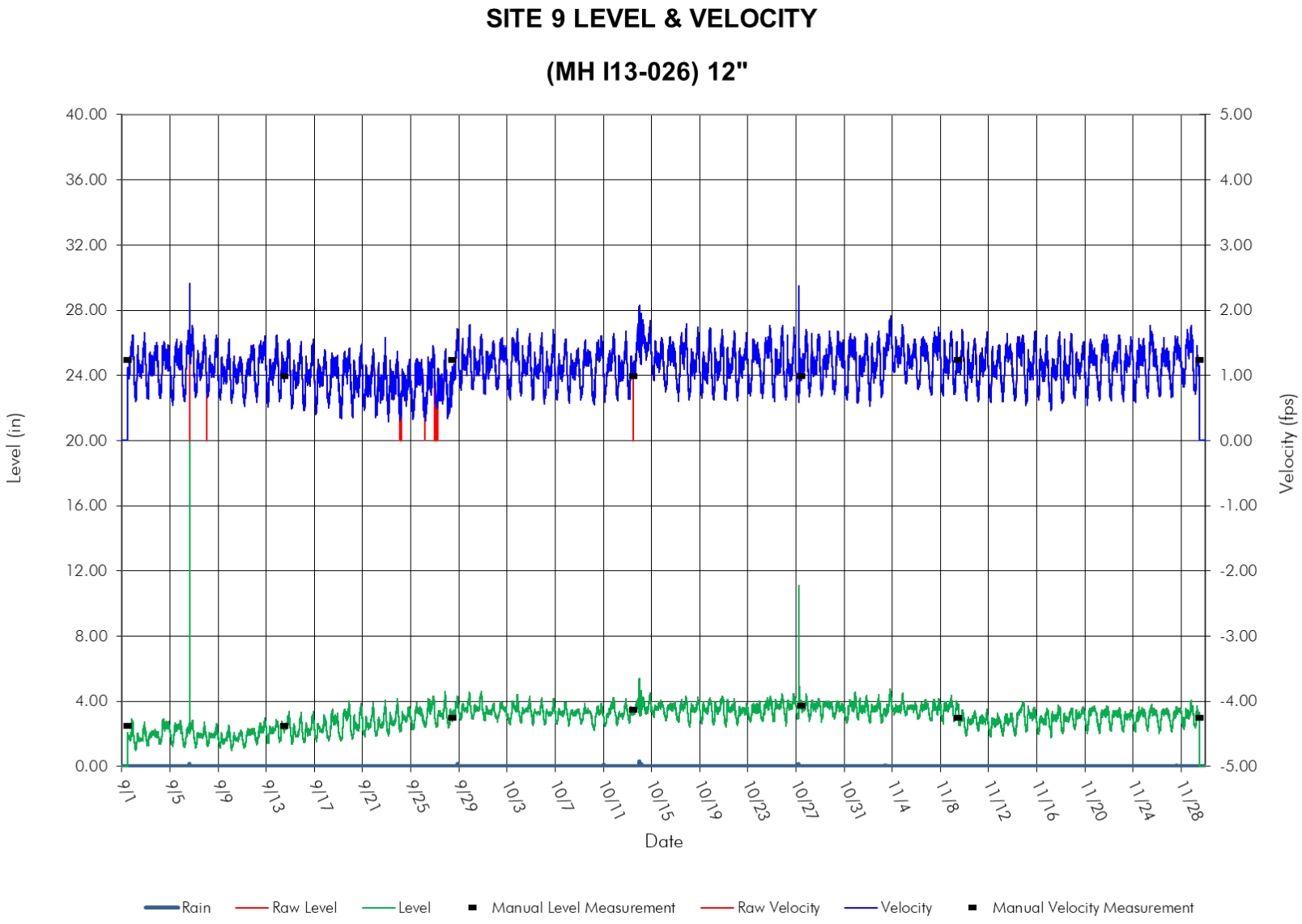


Figure 136 – Standard Flow Scattergraph (Site 9)

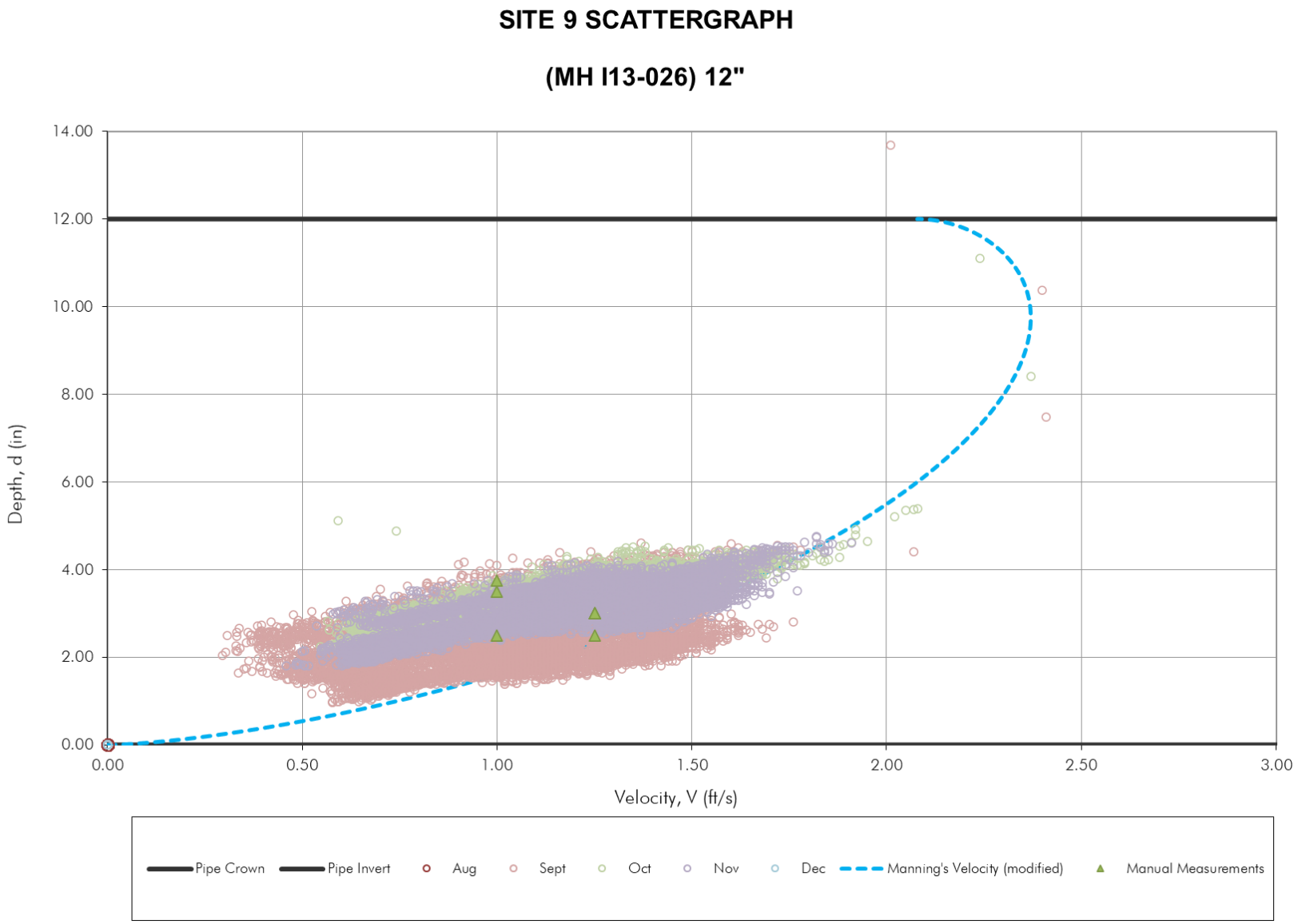


Figure 137 – Surcharged Flow Scattergraph (Site 9)

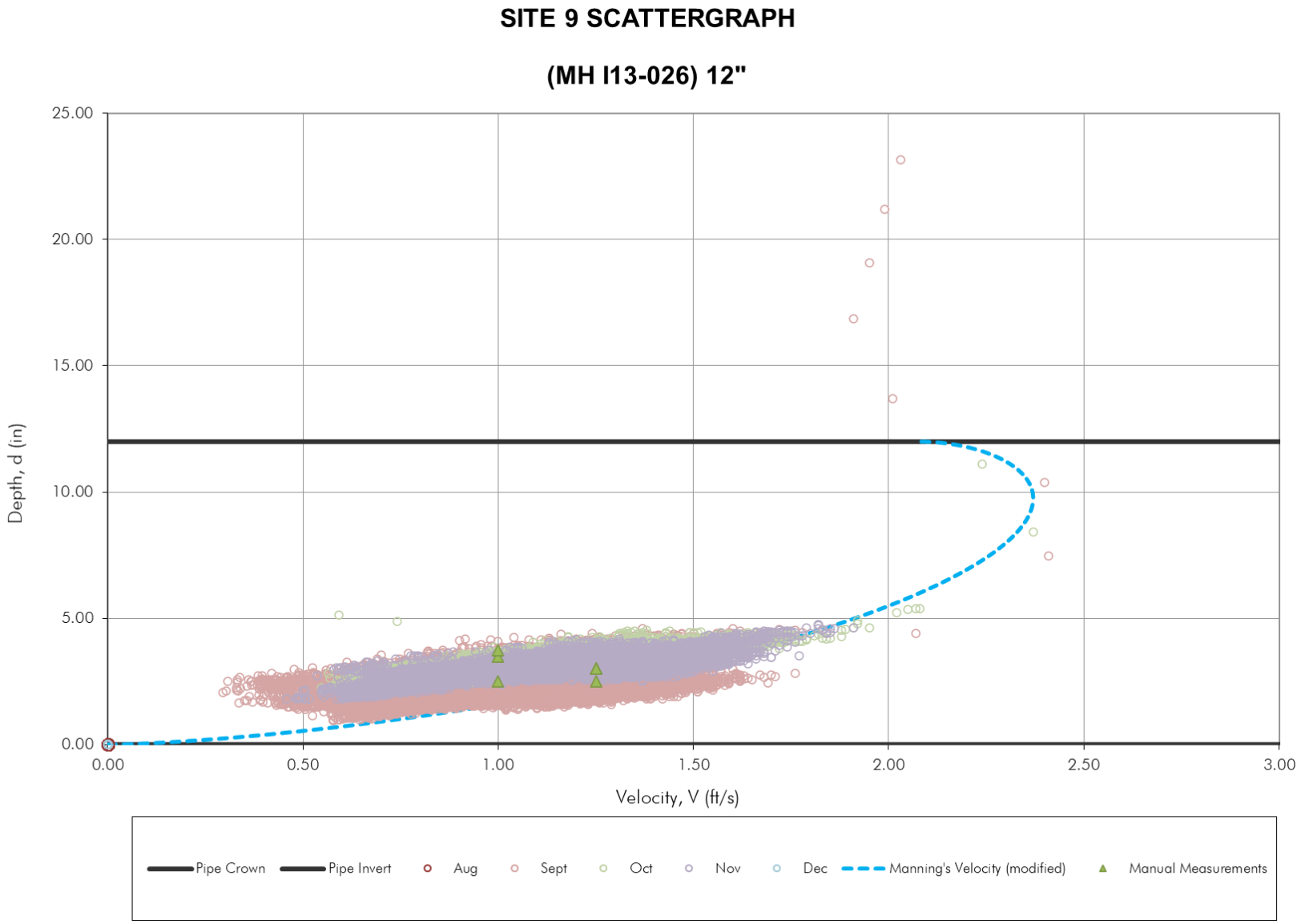


Table 38 – ADDF and Infiltration Summary (Site 9)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 9
Meter: 9
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.077	0.143	1.861	0.025	28-Nov-21	0.066
13-Sep-21	Mon	0.071	0.135	1.892	0.023		
14-Sep-21	Tue	0.082	0.154	1.869	0.029		
15-Sep-21	Wed	0.066	0.151	2.284	0.022		
16-Sep-21	Thu	0.069	0.158	2.288	0.022	04-Nov-21	0.131
17-Sep-21	Fri	0.067	0.117	1.733	0.023	15-Oct-21	0.105
18-Sep-21	Sat	0.083	0.140	1.688	0.027	16-Oct-21	0.080
7 Count		0.074 Average	0.142 Average	1.945 Average	0.024 Average	4 Count	0.096 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.074	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.074	
	Diurnal Peaking Factor (DPF):	1.945	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.071	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.071	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.074	

Figure 138 – Dry Weather Diurnal (Site 9)

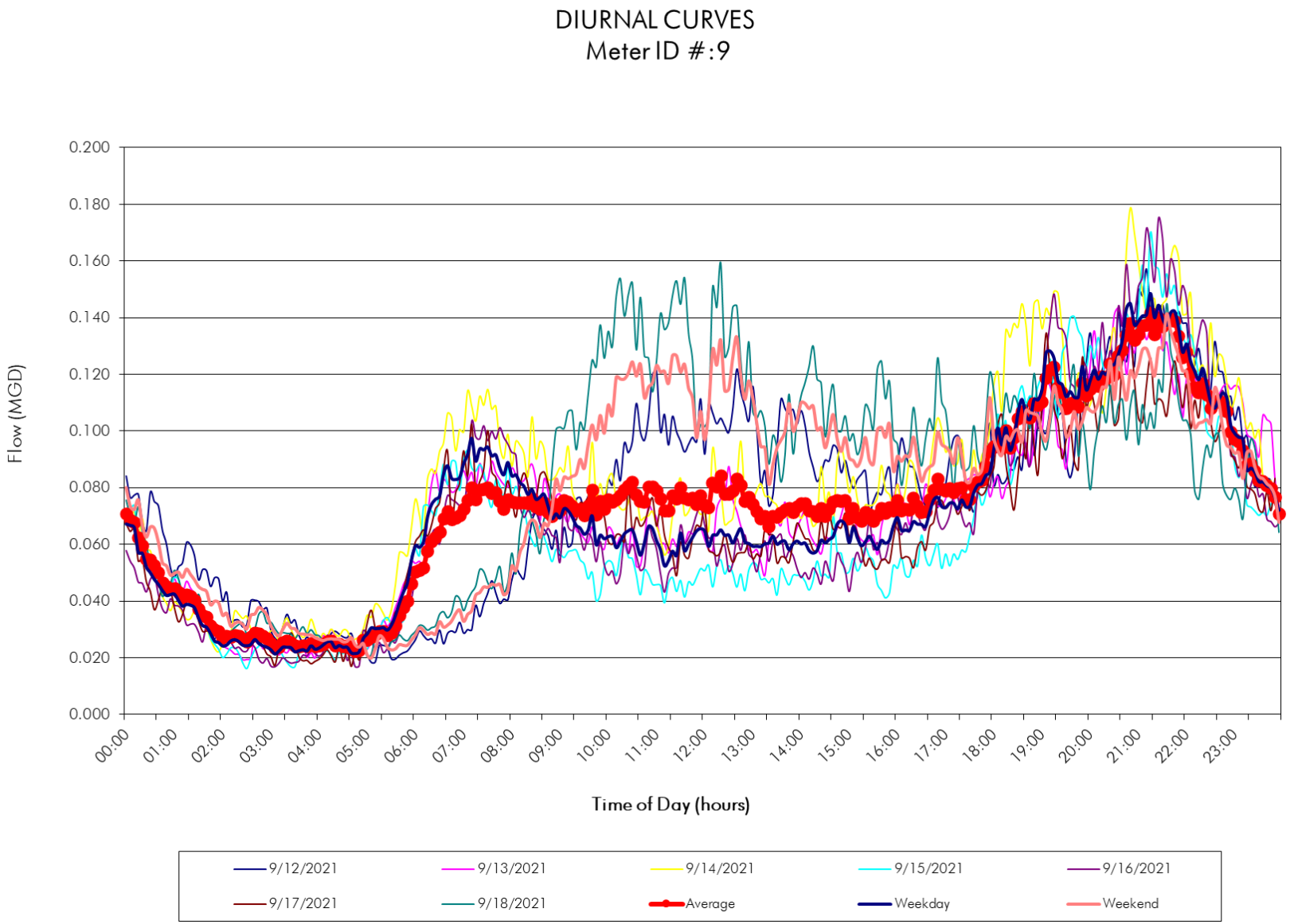


Figure 139 – High/Low Groundwater Diurnal (Site 9)

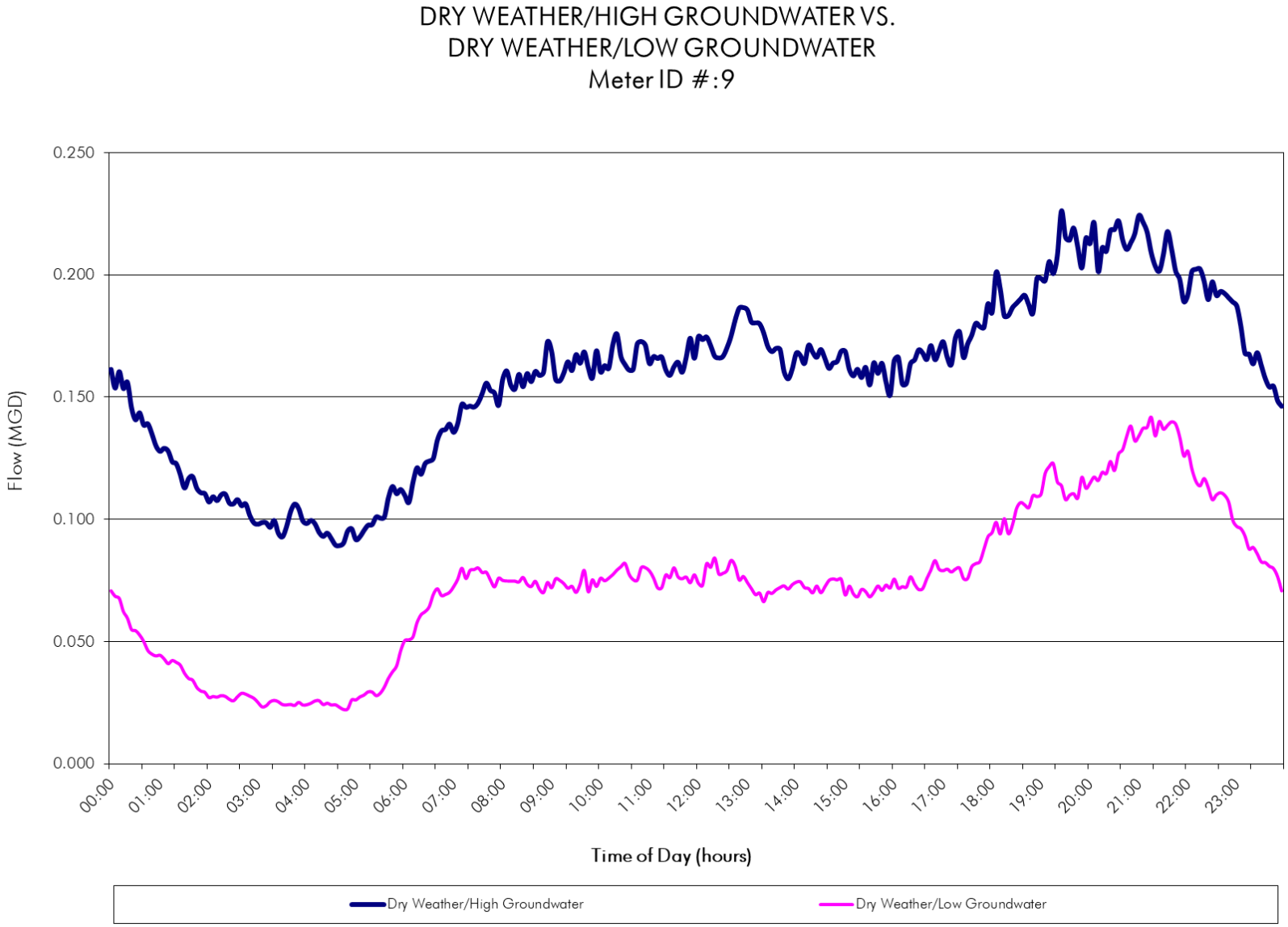


Table 39 – Inflow Calculations and Projections (Site 9)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	9
Meter:	9
Units of Flow:	MGD

Storm Count:	8	Cum. Trib. Area:	188 acres	Pipe Shape:	Circular
Avg Delta Time	56	Cum. Time of Conc.:	75 minutes	Pipe Diameter:	12 in
Avg Kp:	0.00660			Pipe Slope:	0.003 ft/ft
Avg Selected Kp:	0.00598			Pipe Capacity:	1.24 mgd
				ADDF Cum.:	0.074 mgd
				ADDF Peak. Factor:	1.94
				Peak ADDF Flow:	0.143 mgd
				Infiltration:	0.071 mgd
				Cum. Peak Flow:	0.214 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.214
1	1.130	0.821	1.271	1.036
2	1.400	1.018	1.574	1.232
5	1.780	1.294	2.002	1.508
10	2.080	1.512	2.339	1.726
25	2.490	1.810	2.800	2.024
50	2.810	2.042	3.160	2.257
100	3.140	2.282	3.531	2.497

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/6/21 14:50	0.43	0.58	9/6/21 15:20	9/6/21 15:00	20	1.119	09/05/21	0.103	1.016	0.344	0.02431	n						Surcharge
9/28/21 20:50	1.68	6.92	9/28/21 21:45	9/28/21 21:25	20	0.264	09/21/21	0.151	0.112	0.688	0.00135	y	0.00135					
10/1/21 5:10	0.28	3.50	10/1/21 7:05	10/1/21 5:15	110	0.182	09/24/21	0.113	0.069	0.200	0.00284	n						No reaction
10/11/21 0:05	0.35	1.25	10/11/21 0:20	10/11/21 0:05	15	0.114	10/04/21	0.107	0.007	0.272	0.00021	n						No reaction
10/13/21 22:00	3.20	15.00	10/13/21 23:40	10/13/21 23:10	30	0.460	10/06/21	0.121	0.339	1.432	0.00195	y	0.00195					
10/27/21 5:20	0.62	2.33	10/27/21 6:10	10/27/21 5:35	35	1.099	10/26/21	0.123	0.976	0.416	0.01931	y	0.01931					
11/3/21 8:05	1.79	10.67	11/3/21 13:15	11/3/21 10:35	160	0.214	10/27/21	0.141	0.073	0.456	0.00132	y	0.00132					
11/27/21 7:45	0.70	13.92	11/27/21 15:25	11/27/21 14:25	60	0.185	11/26/21	0.151	0.034	0.184	0.00150	n						No reaction

Figure 140 – Inflow Projections (Site 9)

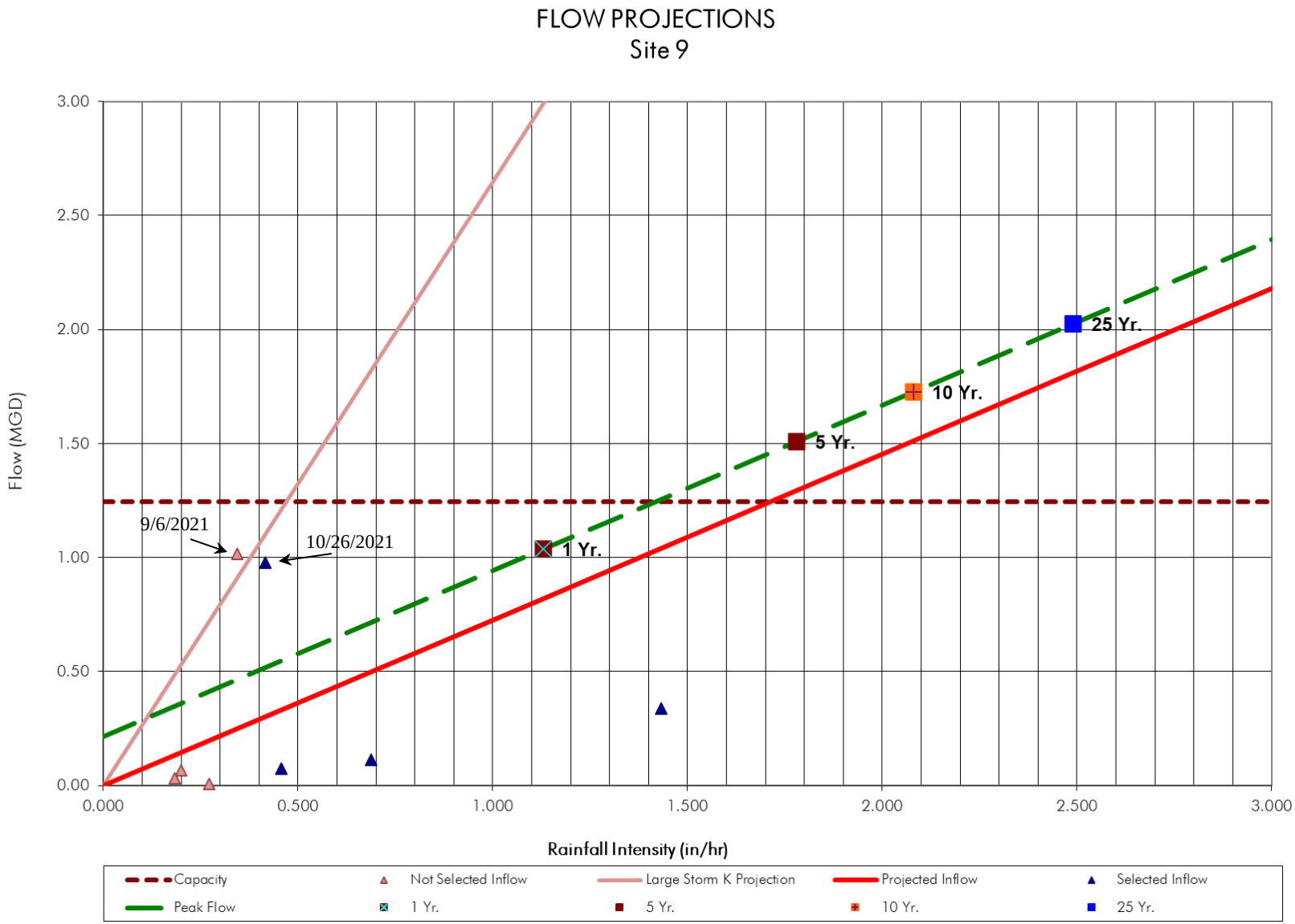
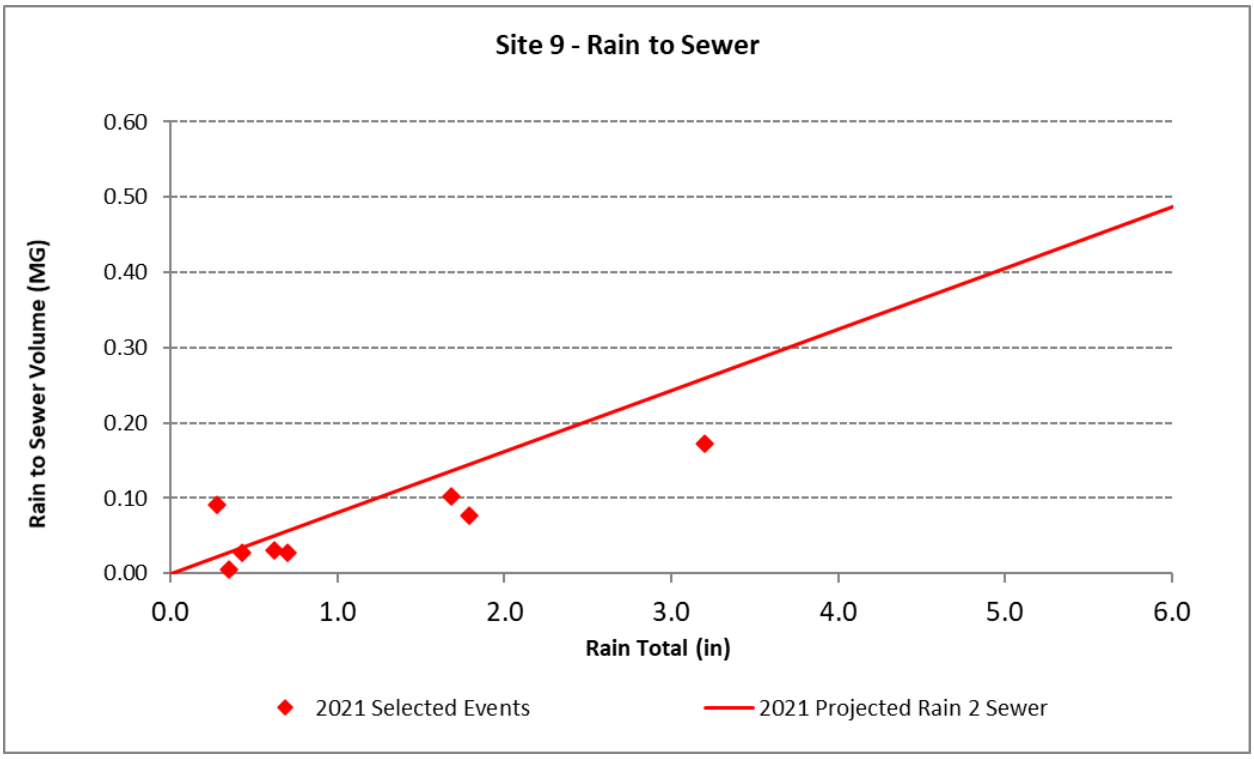


Table 40 – Rain to Sewer Summary (Site 9)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 9 (12")	9/6/2021	0.43	2.195	0.027	1.22%
	9/28/2021	1.68	8.576	0.102	1.19%
	10/1/2021	0.28	1.429	0.091	6.40%
	10/11/2021	0.35	1.787	0.006	0.31%
	10/13/2021	3.20	16.335	0.172	1.05%
	10/27/2021	0.62	3.165	0.030	0.95%
	11/3/2021	1.79	9.137	0.078	0.85%
	11/27/2021	0.70	3.573	0.027	0.75%
				Average	**1.59%**

Figure 141 – Rain to Sewer Volumetric Analysis (Site 9)



A.10 Site 10

Description

Site 10 was installed in manhole I13-002. Site 10 located inside the North Stonewater Lift Station. The sensor monitored the influent flow of the 12" diameter pipe that collects at the North Stonewater Lift Station that are pumped the basin of Site 2 which further flows to Site 1 that contributes to the Wilbarger Wastewater Treatment Plant.

Observations

This flow meter site averaged 1.68 inches of flow depth and a flow velocity of 2.05 feet per second during the 2021 flow monitoring period. The site experienced light grease during site services. The site had consistent low level velocity dropouts that were autocorrected using valid recordings before and after dropout. The level and velocity readings were consistent with manual measurements. The site is considered a good monitoring site.

Site 10 experienced one surcharge during the 2021 flow monitoring period. The surcharge was due to backing up from lift station.

Table 41 – Surcharge Summary (Site 10)

		Date of Storm	9/6/2021
		Total Storm Rainfall (in.)	0.43"
Site	Diameter (in.)	Storm Duration (hrs.)	0.58
10	12	Depth from Invert (in.)	24.14 (B)

(P) Denotes pressurized flow caused by lack of capacity
(flow velocities generally increase as flow depths increase)
(B) Denotes flow backup caused by downstream restriction
(flow velocities generally decrease as flow depths increase)

Table 42 – Service Interrogations Summary (Site 10)

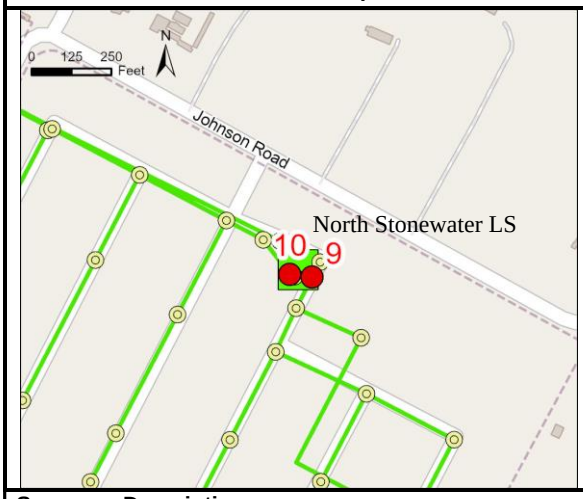
Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 10	9/1/2021	11:55	12	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.25	0.25	Install	Meter installed at in pipe
	9/14/2021	11:42		1.00	1.01	0.01	2.00	1.50	-0.50	2.50	2.40	-0.10	3.50	3.70	0.20	Service/Upload	
	9/28/2021	9:36		1.25	1.82	0.57	1.50	1.65	0.15	1.00	0.89	-0.11	1.00	0.95	-0.05	Service/Upload	
	10/13/2021	11:29		1.25	1.34	0.09	1.50	1.50	0.00	1.50	2.05	0.55	1.75	1.13	-0.62	Service/Upload	
	10/27/2021	11:09		1.75	1.90	0.15	2.00	1.83	-0.17	0.00	0.00	0.00	1.75	1.79	0.04	Service/Upload	No velocity reading on dirty reading
	11/9/2021	11:22		2.25	2.22	-0.03	2.00	1.92	-0.08	3.75	3.80	0.05	3.75	3.84	0.09	Service/Upload	Very light grease.
	11/29/2021	11:25		1.25	1.90	0.65	1.25	1.80	0.55	2.25	2.38	0.13	1.00	1.04	0.04	Removal	Light grease.

Figure 142 – Flow Meter Site Investigation (Site 10)

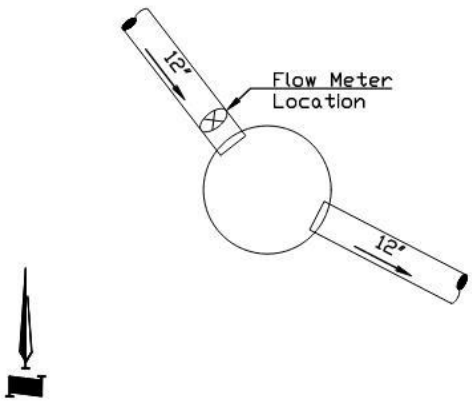
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 11-29-2021 / 11:25	**Crew:** JA-VI
MH#: I13-002	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 12
Site ID: 10	**Address:** 15010 Talus Rd.	**Site Quality:** Fair	**Monitoring Purpose:** Short-term FM

Location Map

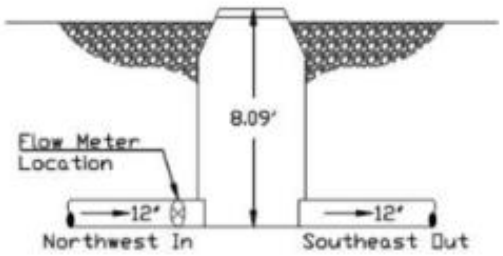
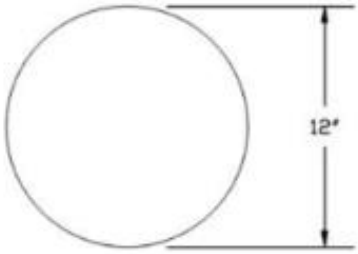


Planar Description



Summary Description:
Located inside North Stonewater Lift Station Site; it is the 2nd manhole upstream of wet well. Site has a gate with a combination lock.

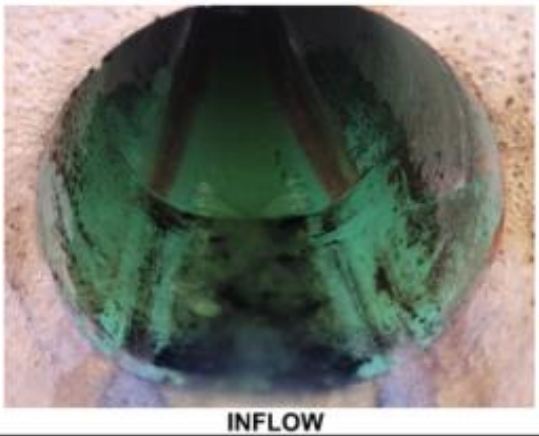
Site Hazards		Measurements	Site Conditions
Heavy Traffic? None		**Manhole Depth (ft):** 8.09	**Surcharge Evidence?** No
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 0.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 32	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Bolt Down	**Usable MH Steps?** No
Describe potential hazards:		**Measured Flow Depth (in):** 1.25	**Meter:** ISCO 2150
		Velocity (fps): 1.00	**Cellular Signal Strength:** N/A
		Mounting Band Description: Spring Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes	Pipe Cross Section
	

Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE

DOWN



INFLOW

OUTFLOW

Figure 143 – Site Information (Site 10)

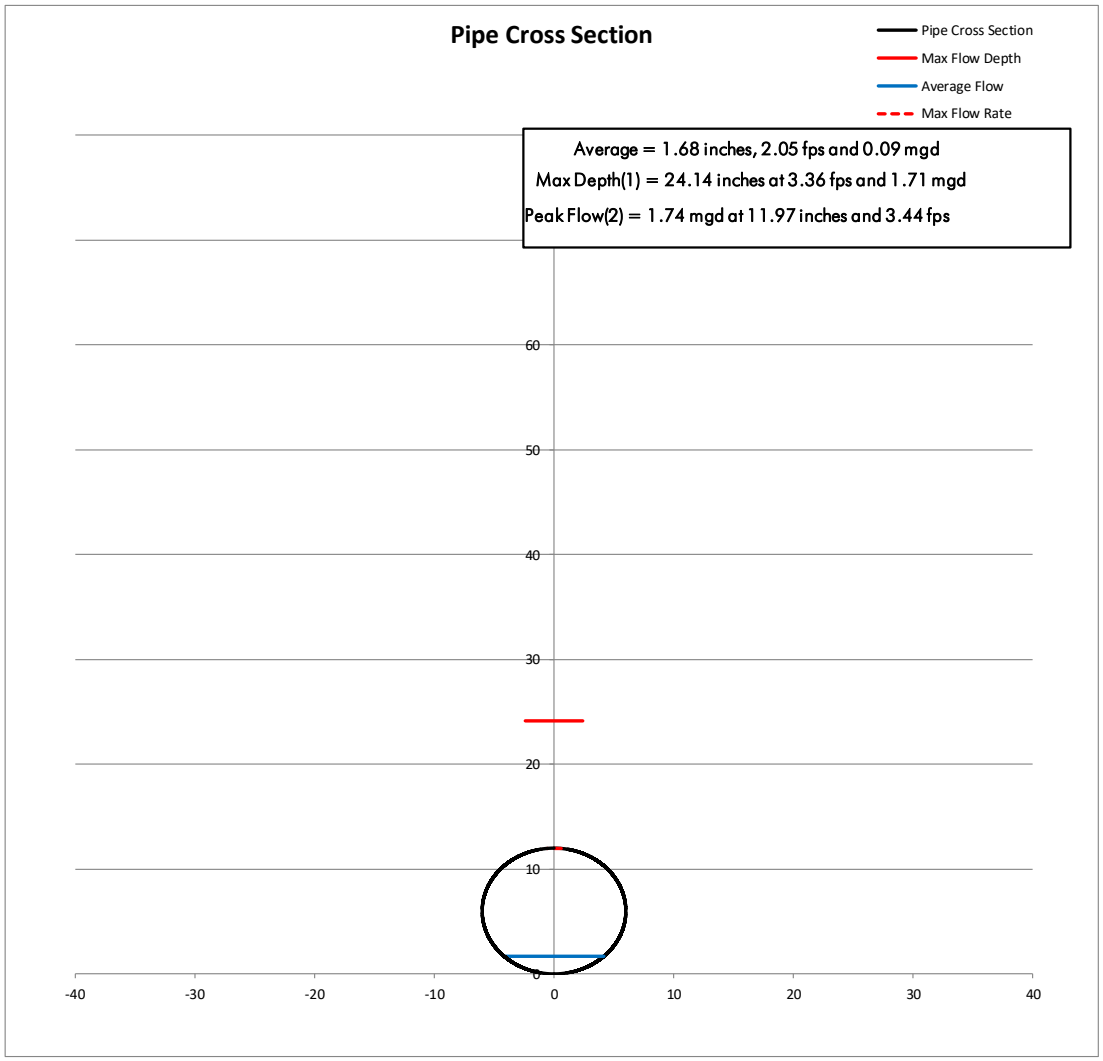
SITE INFORMATION RECORD

Site Information

Meter ID #:	10
Monitoring Program:	Short-Term FM
Manhole #:	I13-002

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	12	
Pipe Width, W (in):	12	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0055	ASSUMEDI



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 10	9/1/2021	12	11:55	1.00	1.00	0.00	1.00	1.25	0.25
	9/14/2021		11:42	2.00	1.50	-0.50	3.50	3.70	0.20
	9/28/2021		9:36	1.50	1.65	0.15	1.00	0.95	-0.05
	10/13/2021		11:29	1.50	1.50	0.00	1.75	1.13	-0.62
	10/27/2021		11:09	2.00	1.83	-0.17	1.75	1.79	0.04
	11/9/2021		11:22	2.00	1.92	-0.08	3.75	3.84	0.09
	11/29/2021		11:25	1.25	1.80	0.55	1.00	1.04	0.04

Figure 144 – September Monthly Flow Hydrograph (Site 10)

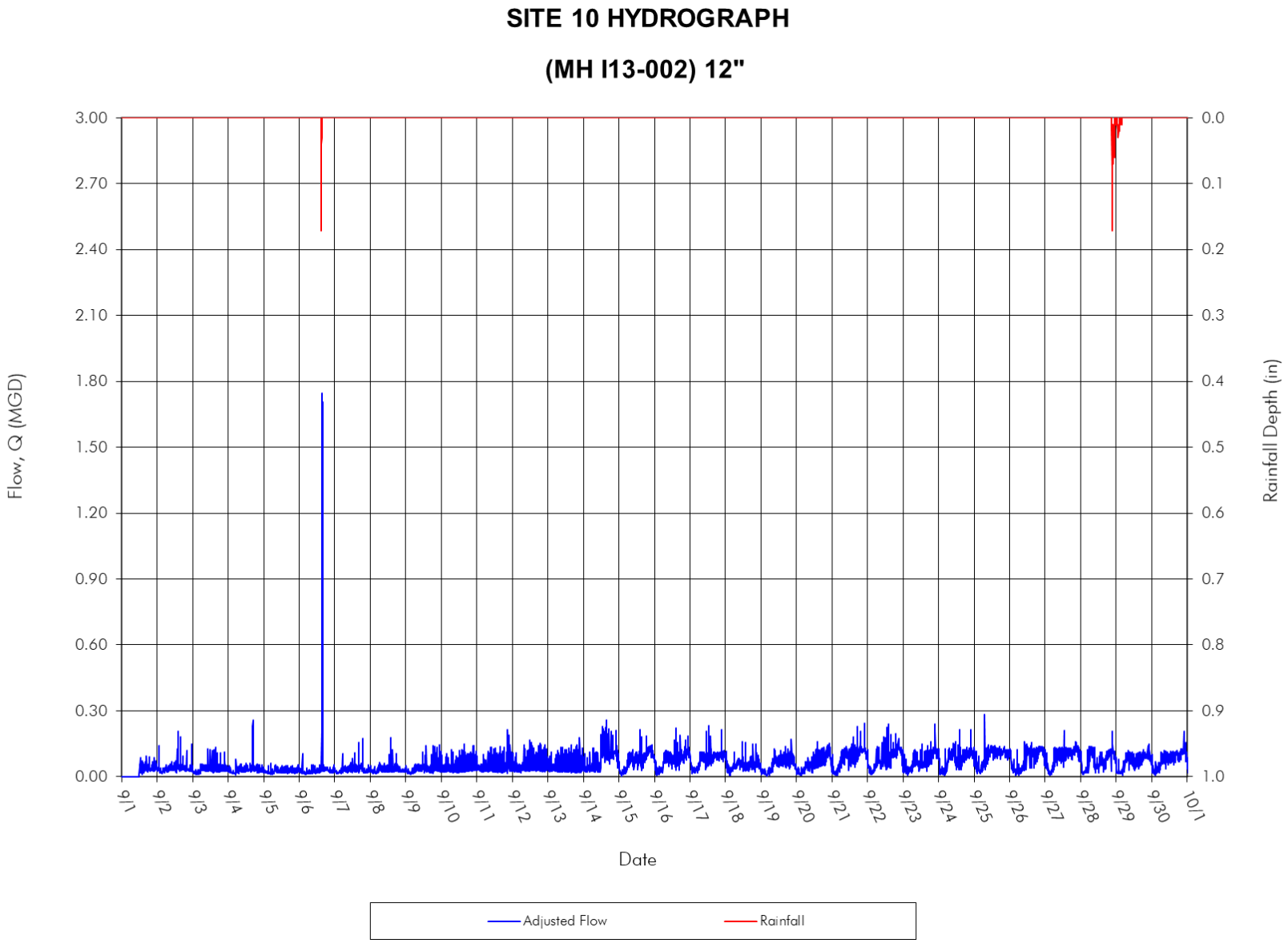


Figure 145 – September Monthly Level and Velocity Hydrograph (Site 10)

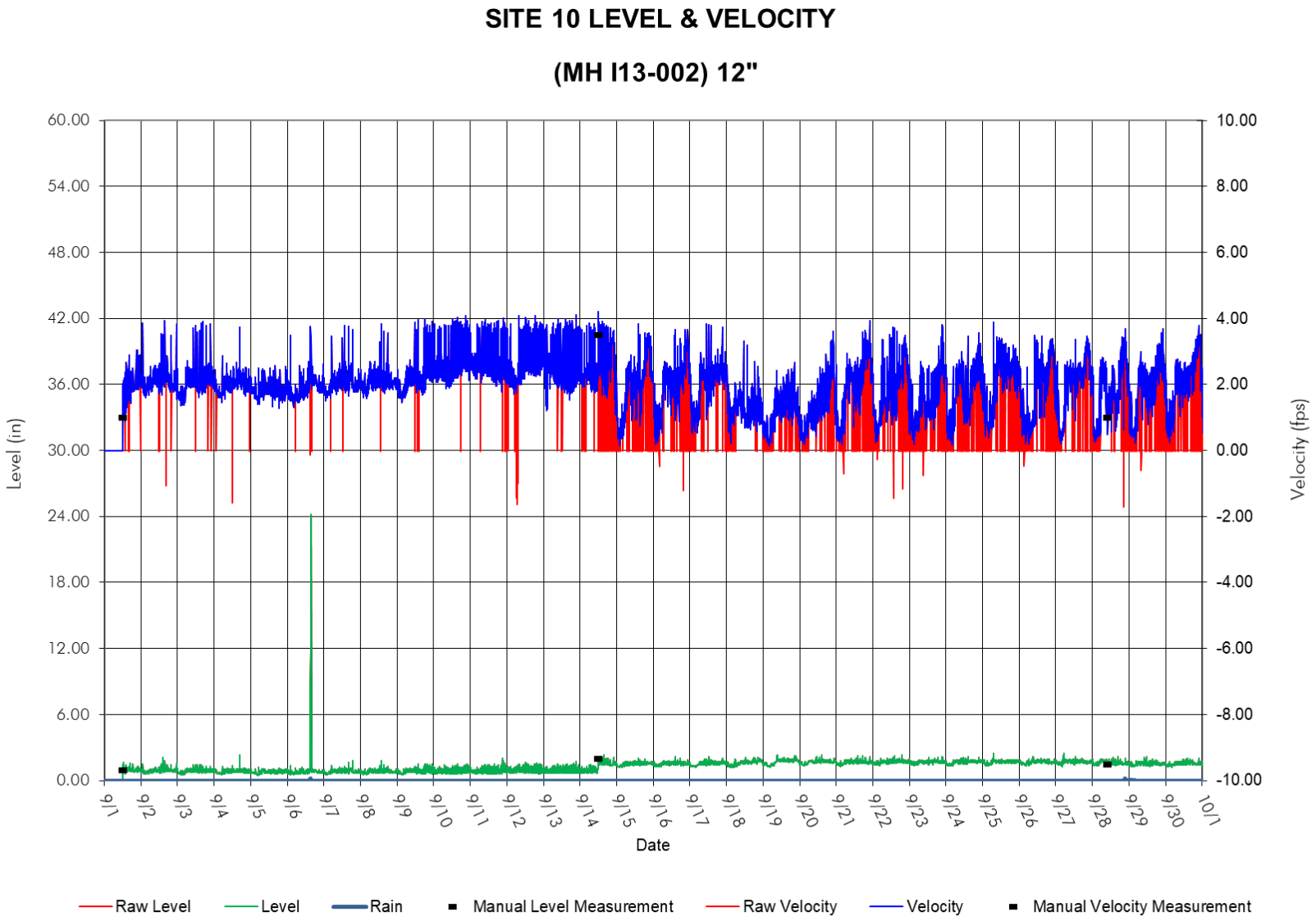


Figure 146 – October Flow Hydrograph (Site 10)

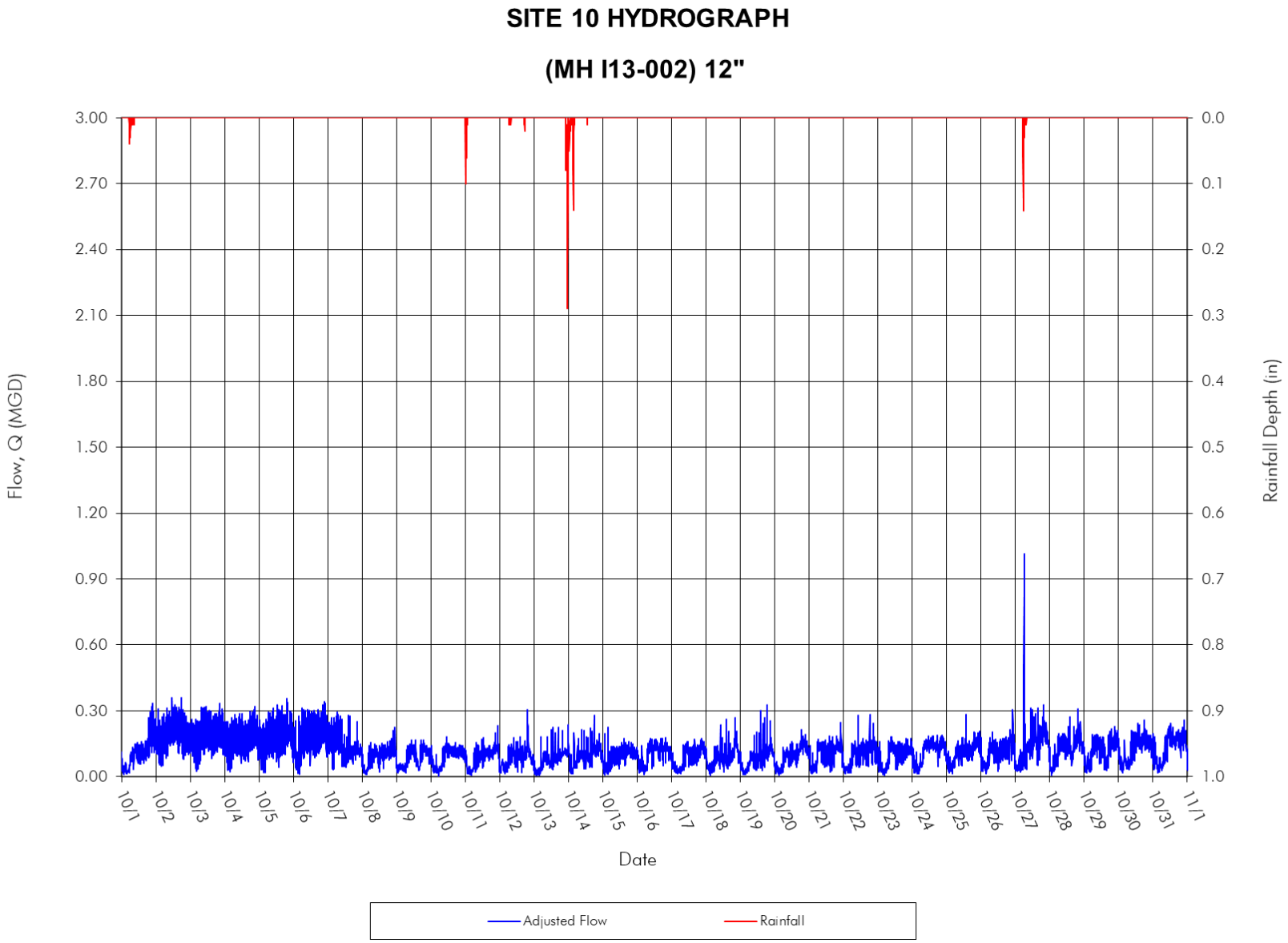


Figure 147 – October Monthly Level and Velocity Hydrograph (Site 10)

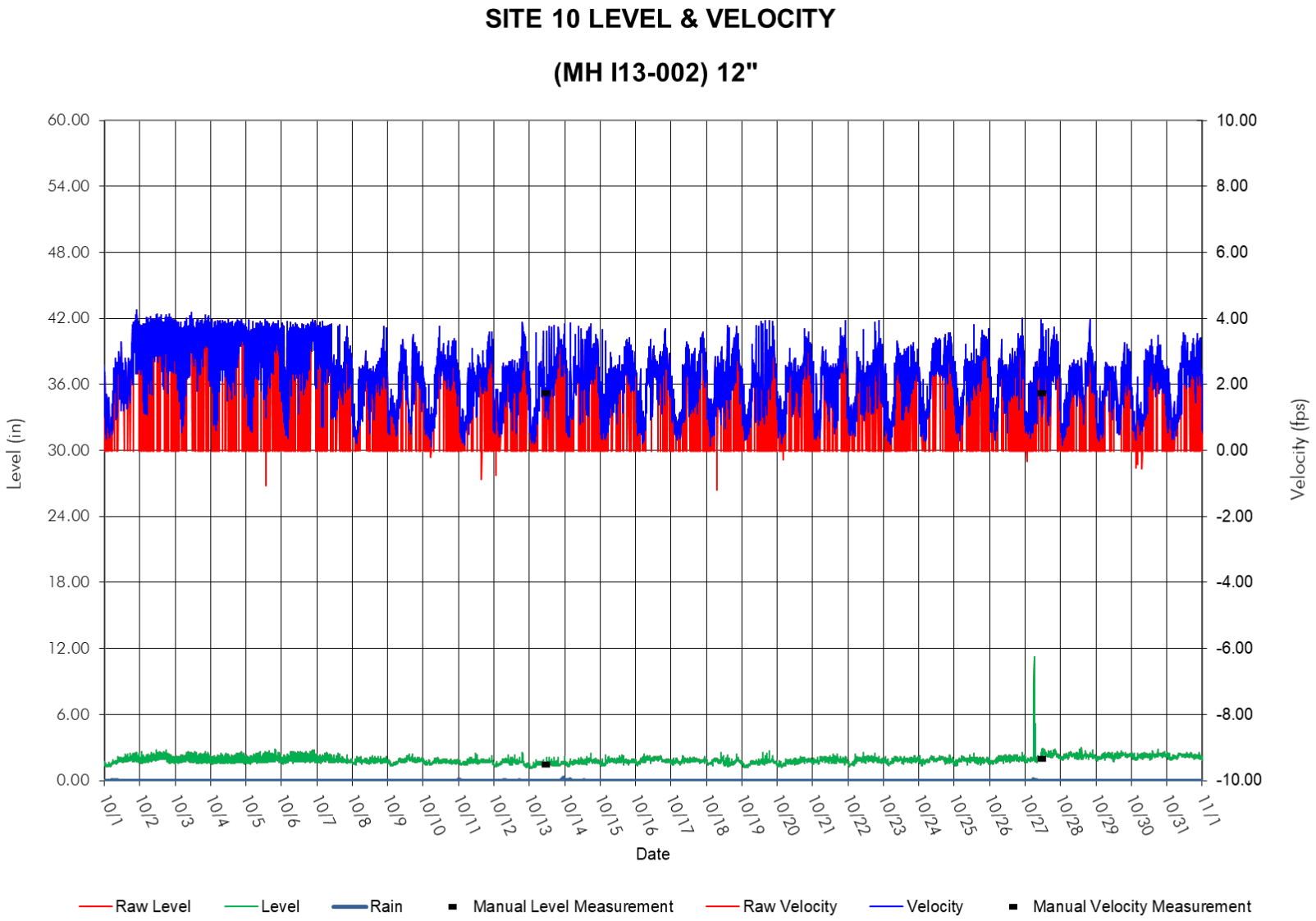


Figure 148 – November Monthly Flow Hydrograph (Site 10)

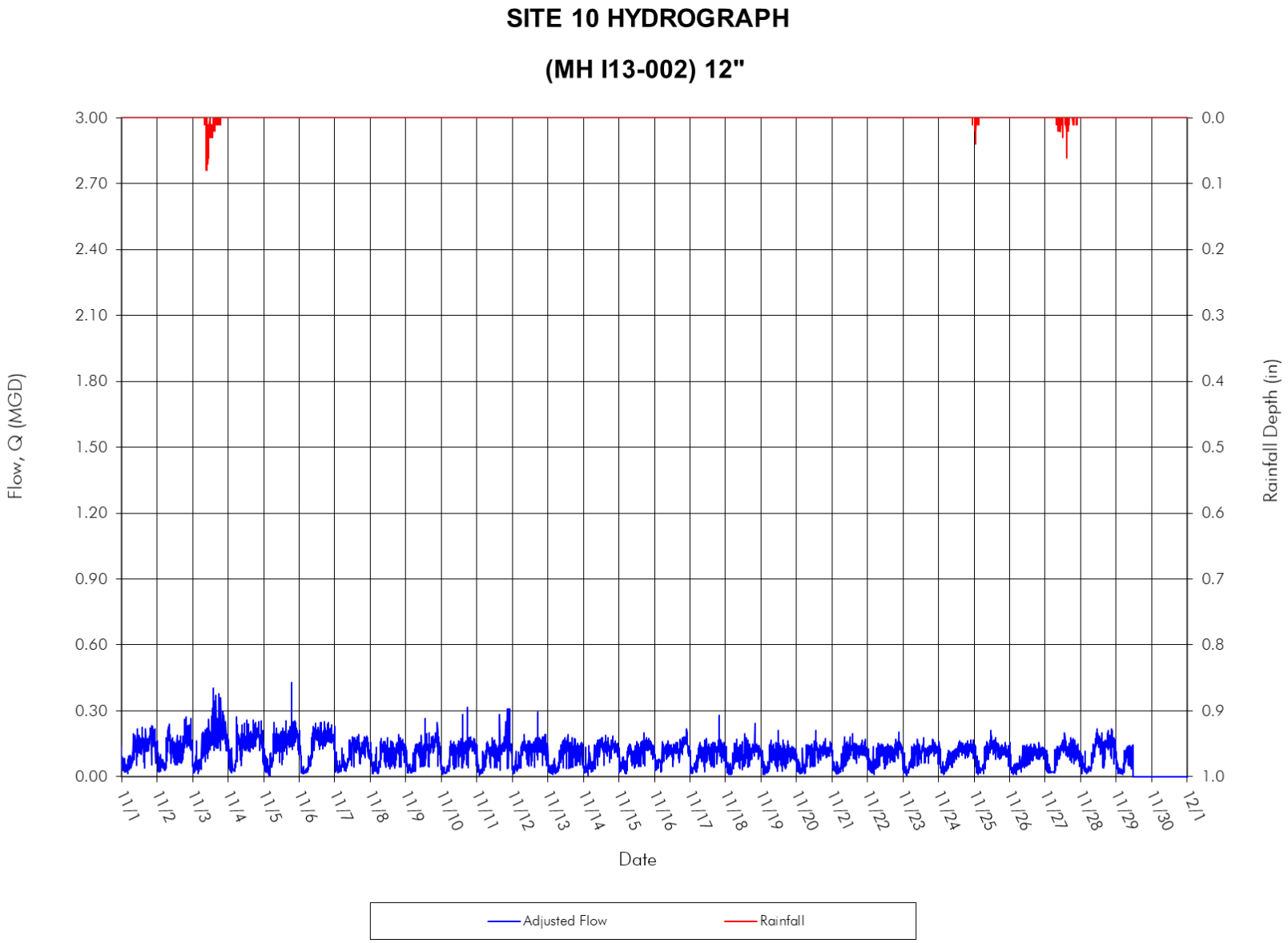


Figure 149 – November Level and Velocity Hydrograph (Site 10)

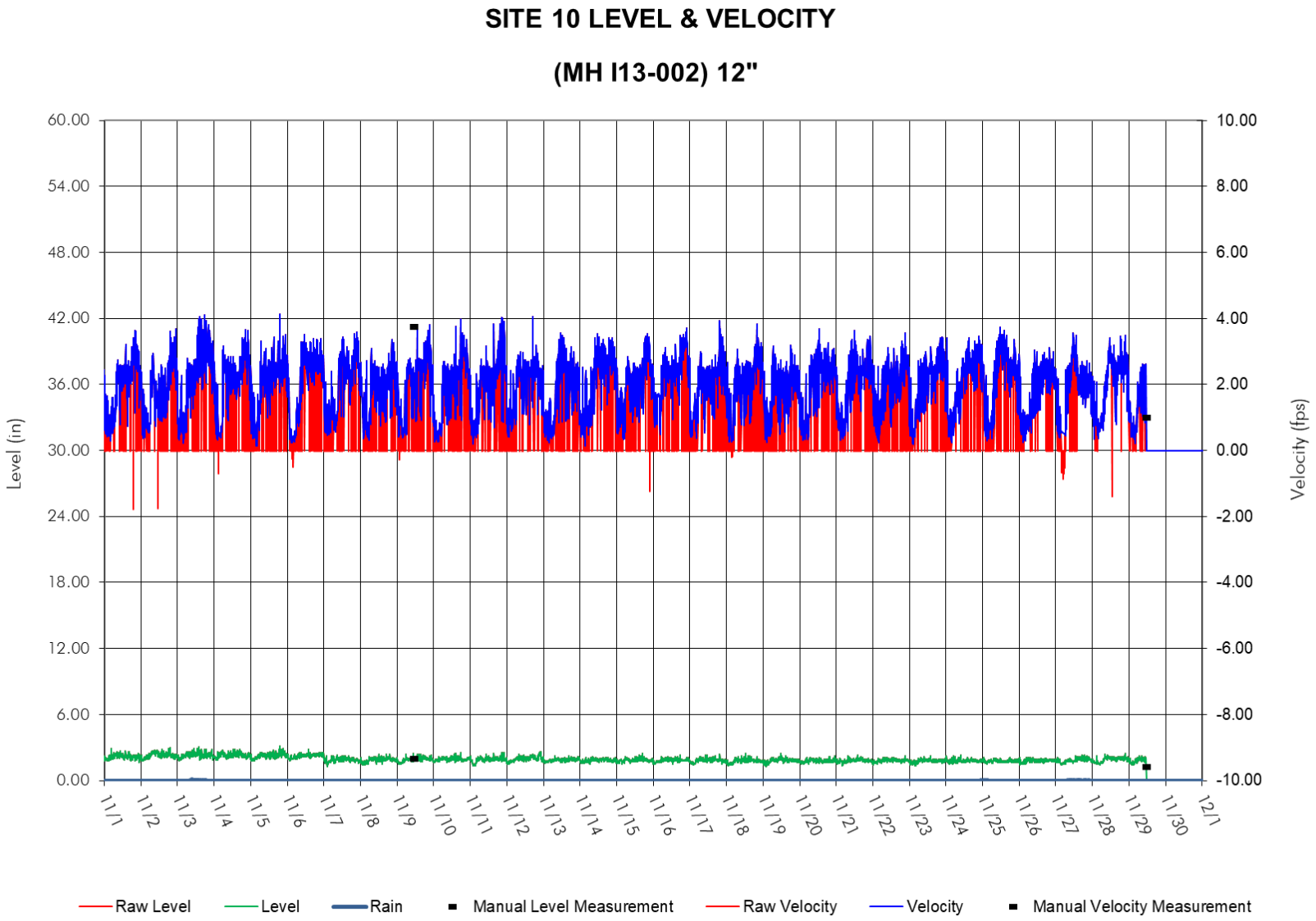


Figure 150 – Overall Flow Hydrograph (Site 10)

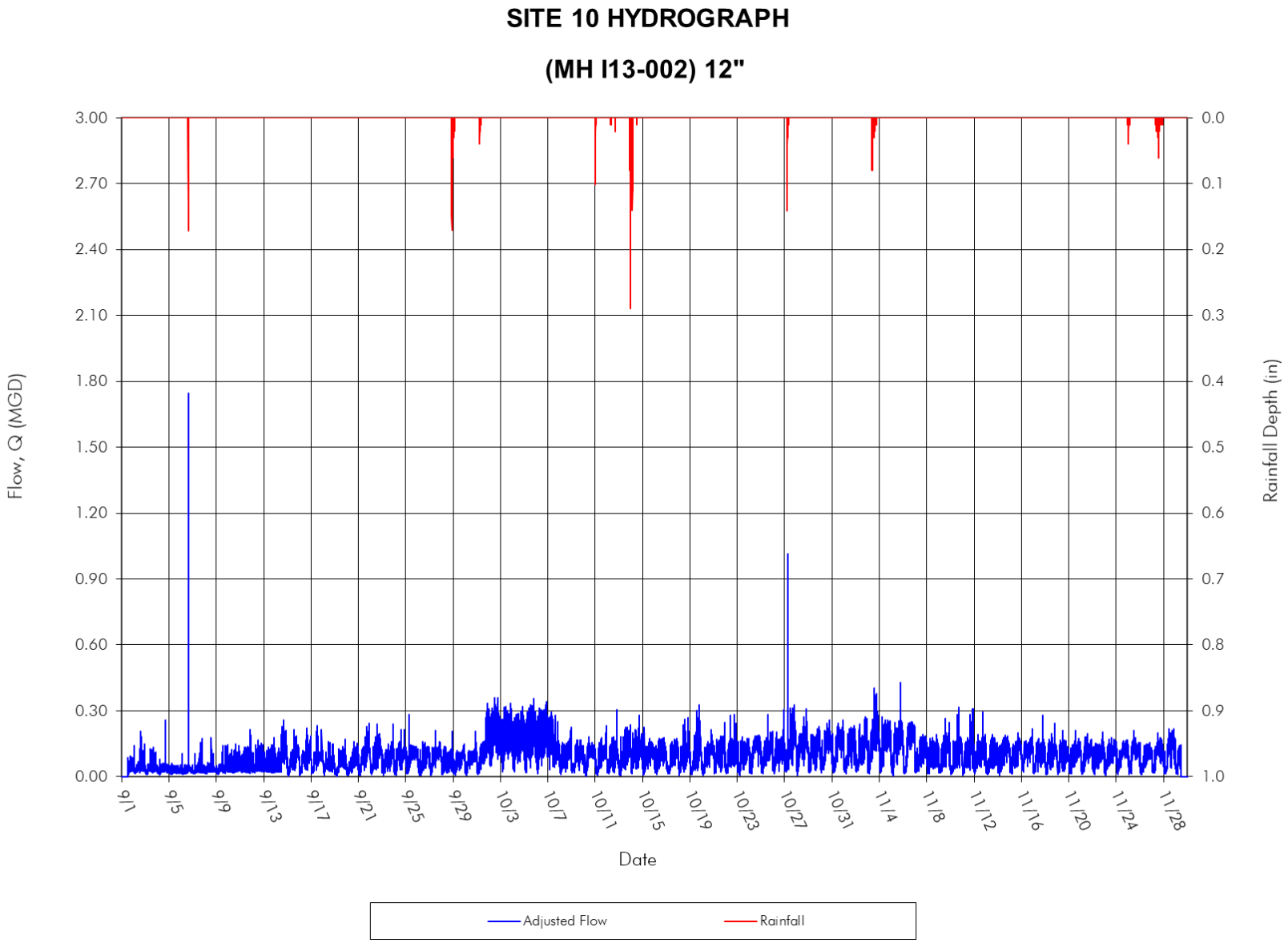


Figure 151 – Overall Level and Velocity Hydrograph (Site 10)

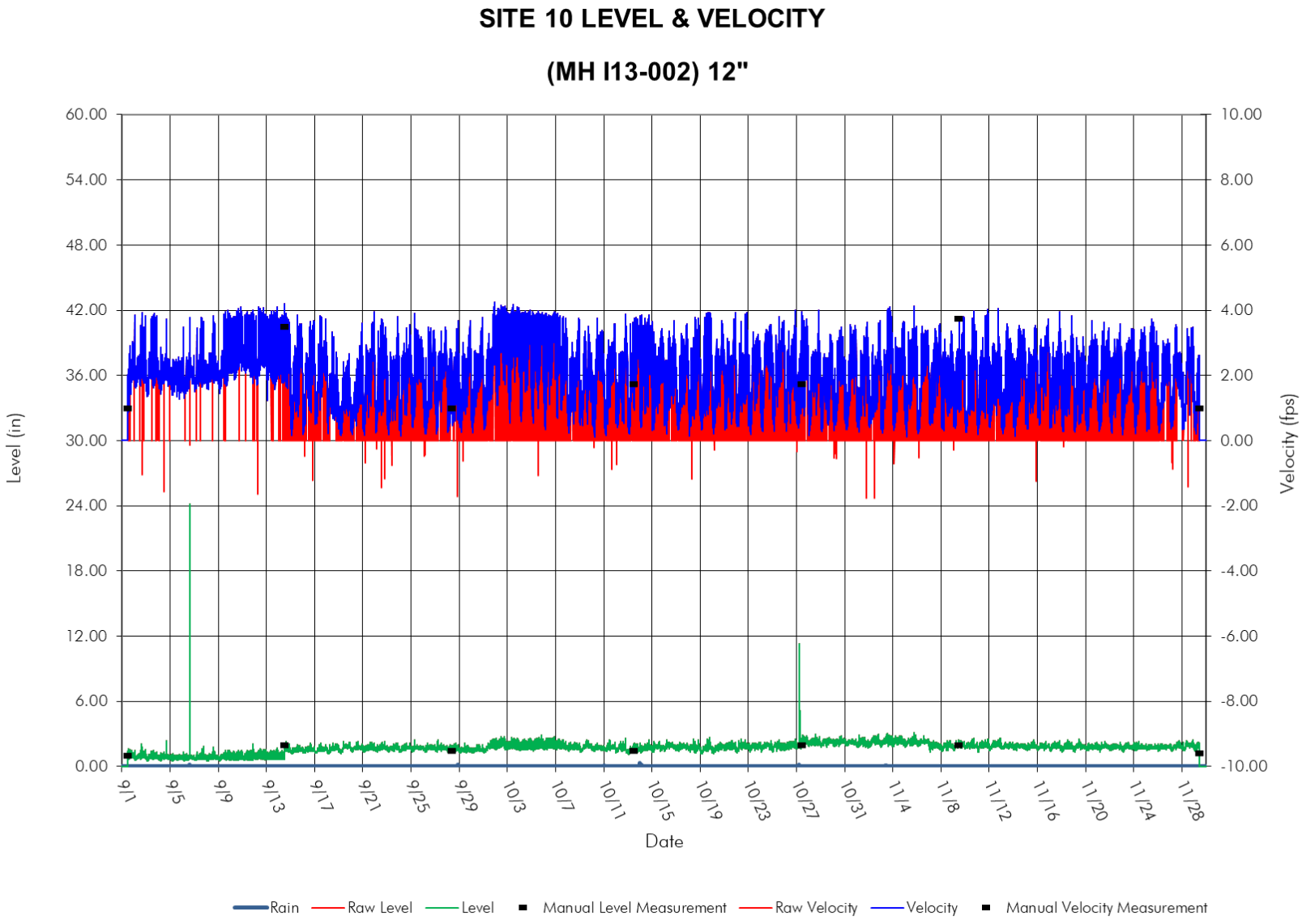


Figure 152 – Standard Flow Scattergraph (Site 10)

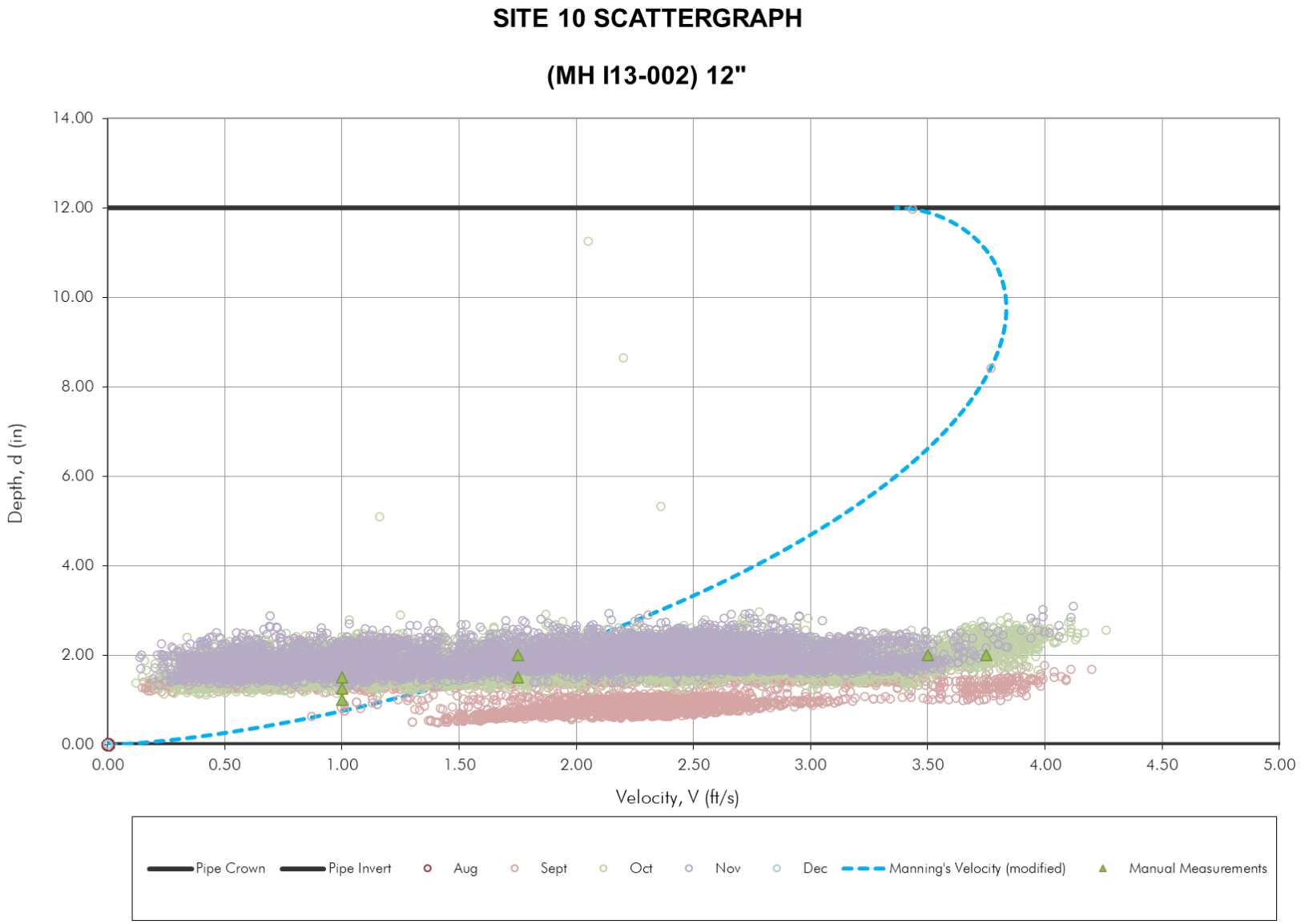


Figure 153 – Surcharged Flow Scattergraph (Site 10)

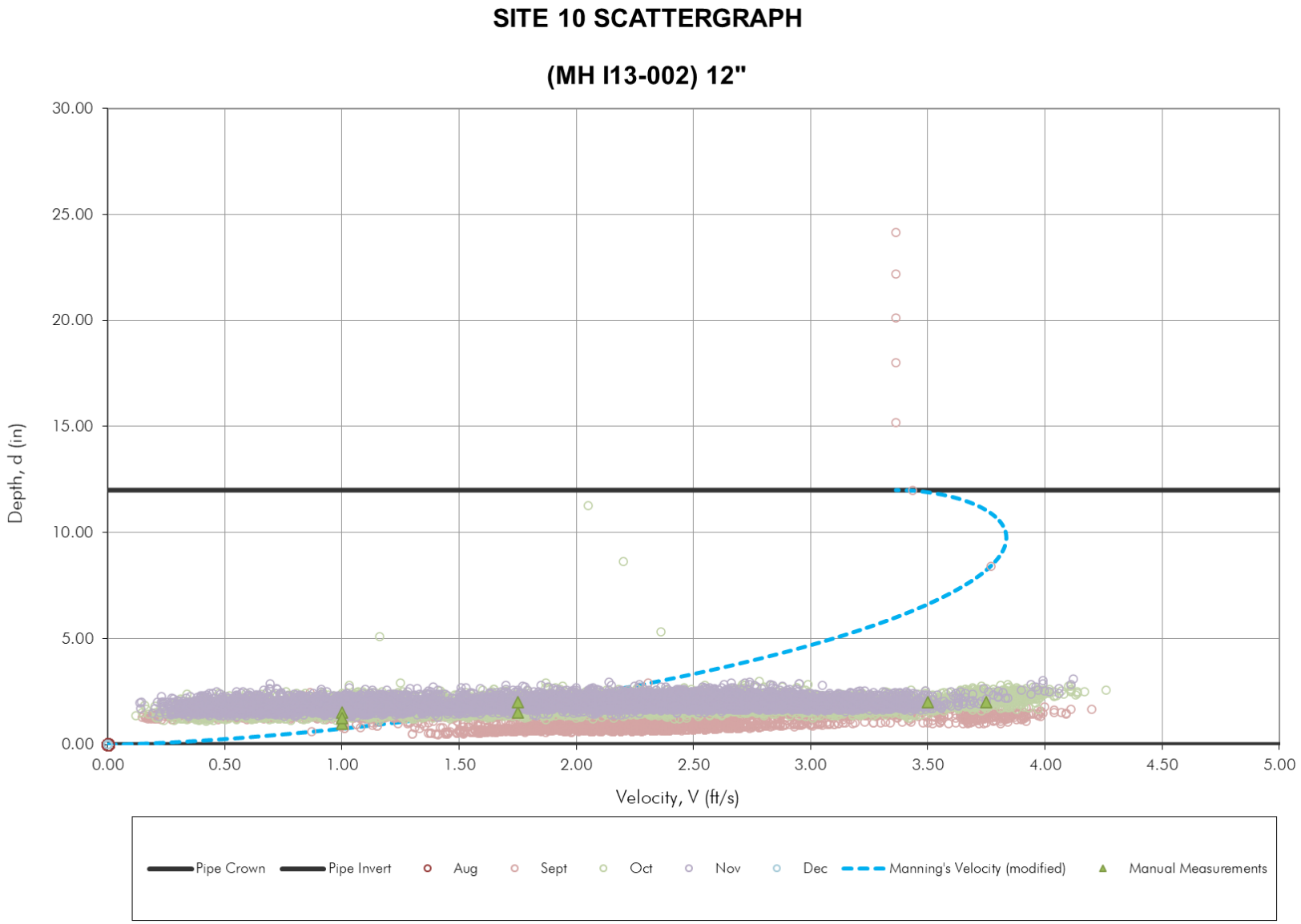


Table 43 – ADDF and Infiltration Summary (Site 10)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 10
Meter: 10
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.044	0.067	1.509	0.033		
13-Sep-21	Mon	0.044	0.063	1.424	0.036		
14-Sep-21	Tue	0.079	0.147	1.862	0.034		
15-Sep-21	Wed	0.074	0.126	1.699	0.018		
16-Sep-21	Thu	0.077	0.123	1.606	0.026	04-Nov-21	0.038
17-Sep-21	Fri	0.078	0.114	1.458	0.028	15-Oct-21	0.039
18-Sep-21	Sat	0.083	0.140	1.686	0.027	16-Oct-21	0.037
7 Count		0.068 Average	0.111 Average	1.607 Average	0.029 Average	3 Count	0.038 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.068	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.068	
	Diurnal Peaking Factor (DPF):	1.607	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.009	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.009	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.068	

Figure 154 – Dry Weather Diurnal (Site 10)

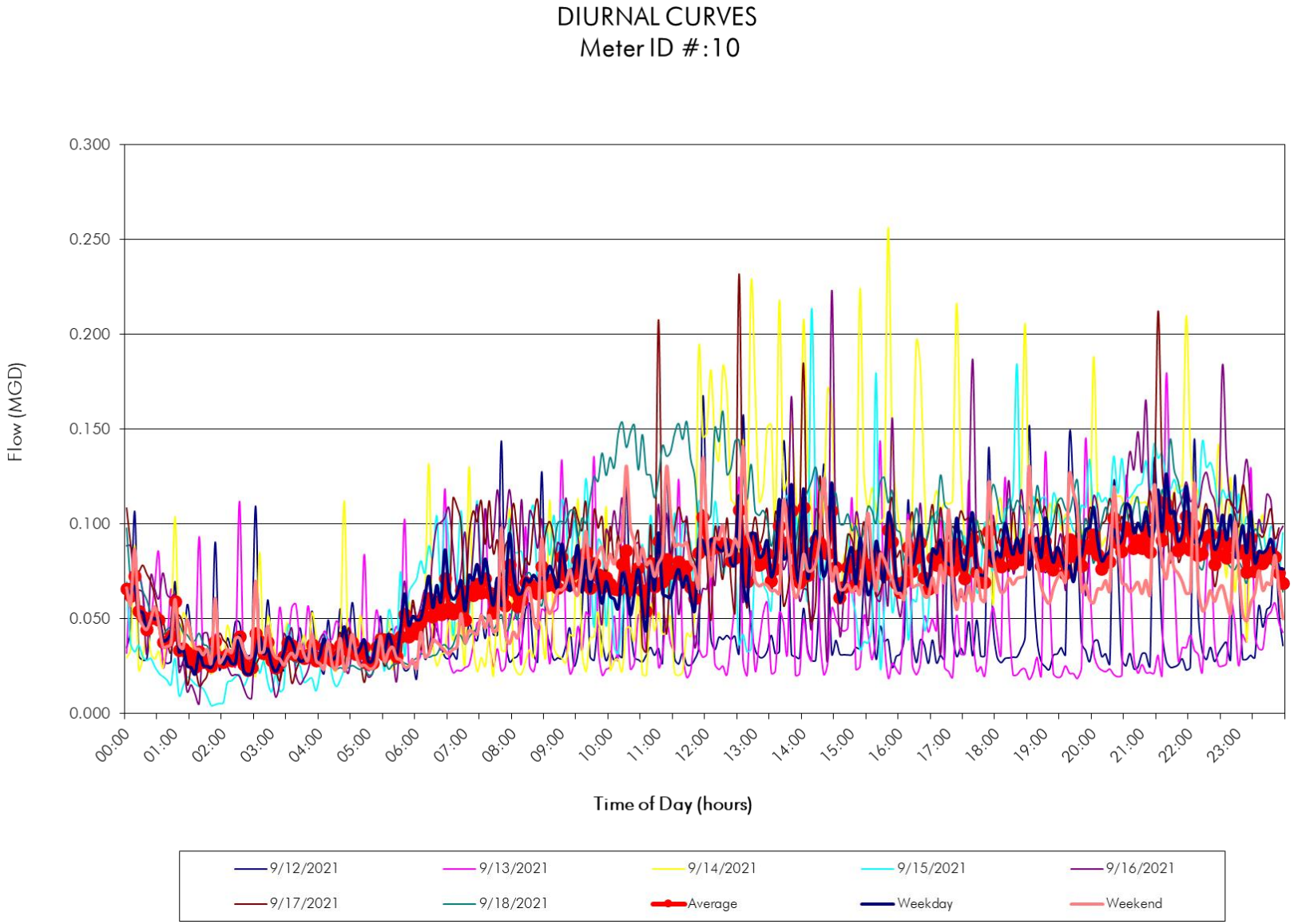


Figure 155 – High/Low Groundwater Diurnal (Site 10)

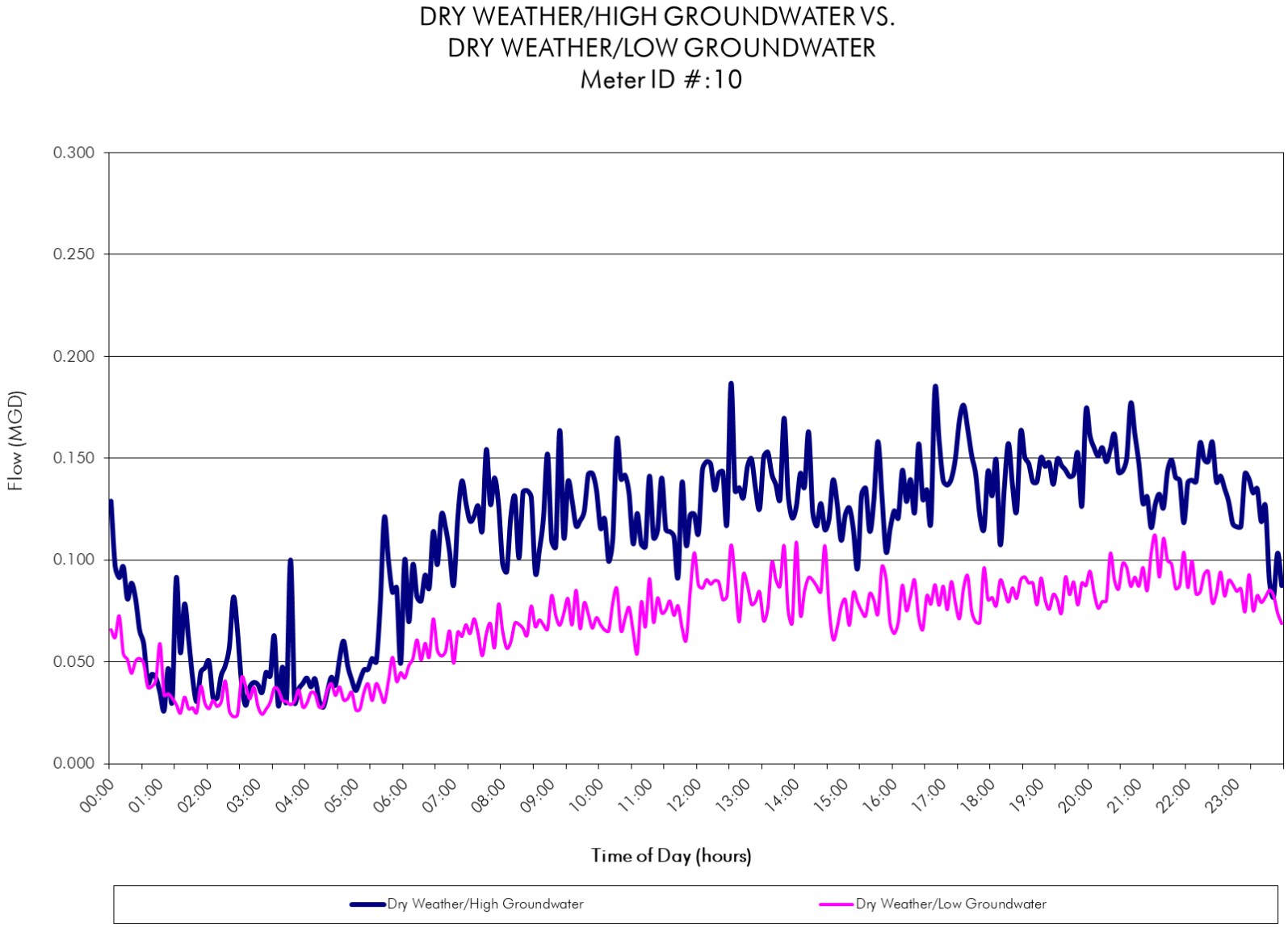


Table 44 – Inflow Calculations and Projections (Site 10)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	10
Meter:	10
Units of Flow:	MGD

Storm Count:	8	Cum. Trib. Area:	94 acres	Pipe Shape:	Circular
Avg Delta Time	60	Cum. Time of Conc.:	60 minutes	Pipe Diameter:	12 in
Avg Kp:	0.01501			Pipe Slope:	0.006 ft/ft
Avg Selected Kp:	0.01183			Pipe Capacity:	1.71 mgd
				ADDF Cum.:	0.068 mgd
				ADDF Peak. Factor:	1.61
				Peak ADDF Flow:	0.110 mgd
				Infiltration:	0.009 mgd
				Cum. Peak Flow:	0.119 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.119
1	1.320	0.949	1.468	1.068
2	1.630	1.172	1.813	1.291
5	2.070	1.488	2.303	1.607
10	2.420	1.740	2.692	1.859
25	2.890	2.078	3.215	2.197
50	3.270	2.351	3.637	2.470
100	3.660	2.631	4.071	2.750

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/6/21 14:50	0.43	0.58	9/6/21 15:20	9/6/21 15:00	20	1.744	09/05/21	0.023	1.722	0.430	0.06590	n						Surcharge
9/28/21 20:50	1.68	6.92	9/28/21 21:30	9/28/21 21:25	5	0.207	09/21/21	0.116	0.090	0.770	0.00193	y	0.00193					
10/1/21 5:10	0.28	3.50	10/1/21 6:20	10/1/21 5:15	65	0.107	09/24/21	0.064	0.043	0.210	0.00340	n						No reaction
10/11/21 0:05	0.35	1.25	10/11/21 0:10	10/11/21 0:05	5	0.121	10/10/21	0.140	-0.019	0.330	-0.00095	n						No reaction
10/13/21 22:00	3.20	15.00	10/13/21 23:55	10/13/21 23:10	45	0.236	10/12/21	0.074	0.161	1.640	0.00162	y	0.00162					
10/27/21 5:20	0.62	2.33	10/27/21 6:10	10/27/21 5:35	35	1.014	10/20/21	0.044	0.970	0.490	0.03258	y	0.03258					
11/3/21 8:05	1.79	10.67	11/3/21 13:50	11/3/21 10:35	195	0.402	11/02/21	0.061	0.340	0.500	0.01121	y	0.01121					
11/27/21 7:45	0.70	13.92	11/27/21 16:15	11/27/21 14:25	110	0.154	11/26/21	0.105	0.048	0.180	0.00441	n						No reaction

Figure 156 – Inflow Projections (Site 10)

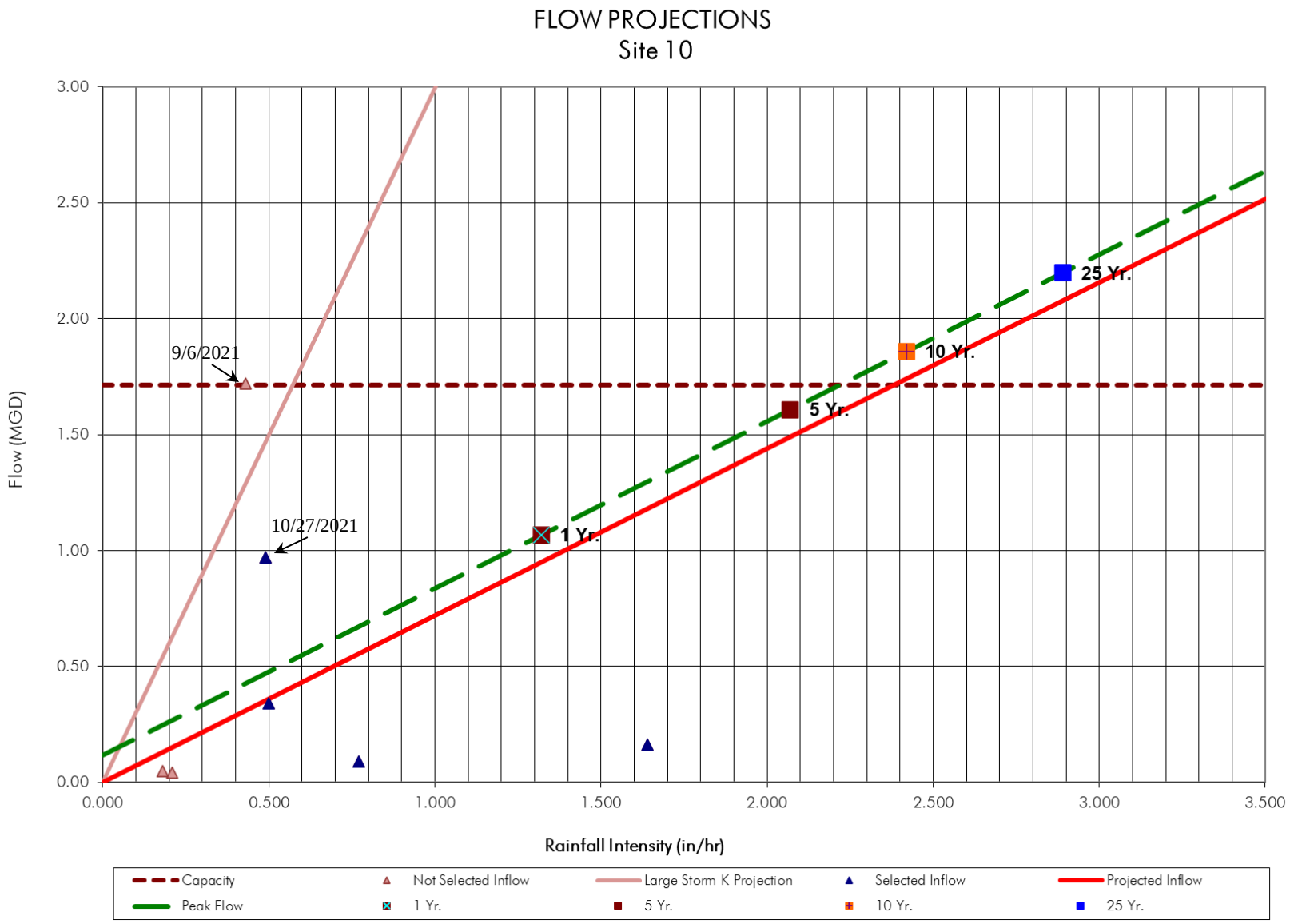
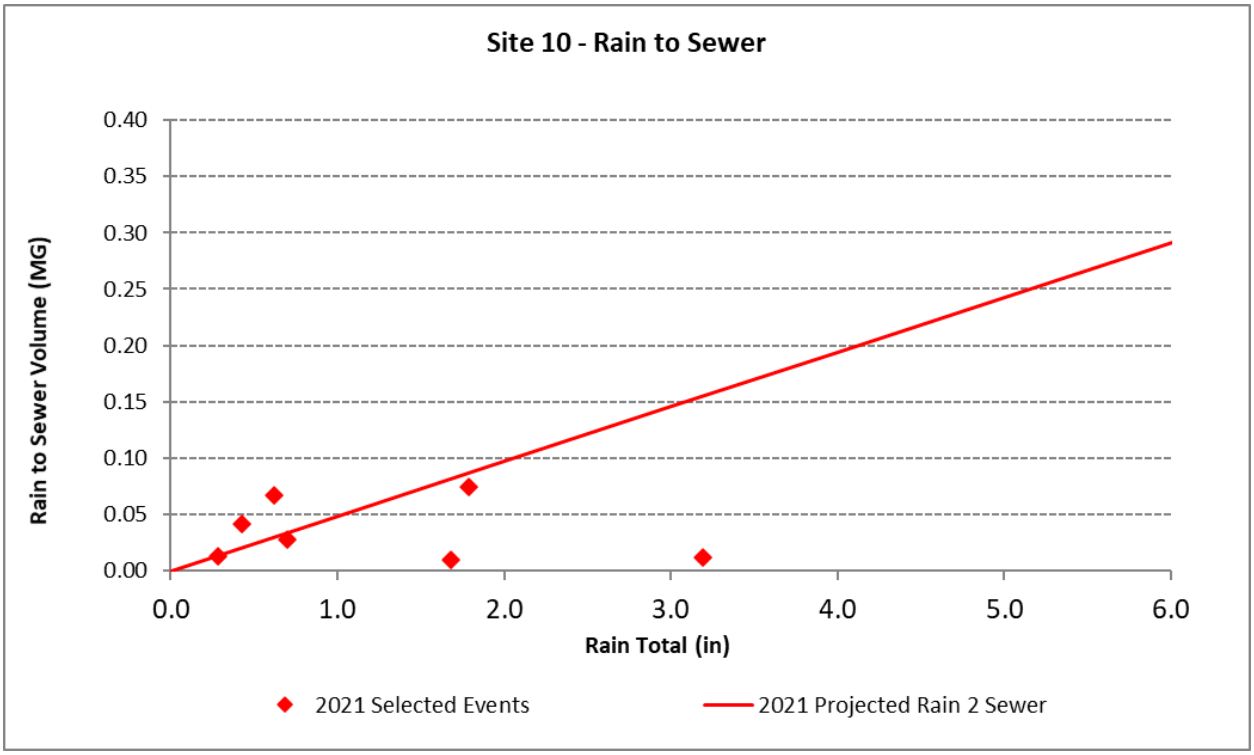


Table 45 – Rain to Sewer Summary (Site 10)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 10 (12")	9/6/2021	0.43	1.098	0.042	3.81%
	9/28/2021	1.68	4.288	0.009	0.22%
	10/1/2021	0.28	0.715	0.013	1.75%
	10/13/2021	3.19	8.142	0.011	0.14%
	10/27/2021	0.62	1.582	0.067	4.21%
	11/3/2021	1.79	4.569	0.074	1.62%
	11/27/2021	0.70	1.787	0.028	1.56%
				Average	**1.90%**

Figure 157 – Rain to Sewer Volumetric Analysis (Site 10)



A.11 Site 11

Description

Site 11, at manhole J14-021, was located just outside the Presidential Heights Lift Station. The sensor is in the influent 8" diameter PVC pipe. The meter measured flow to an exterior basin to Site 12 and contributes to the Wilbarger Wastewater Treatment Plant.

Observations

The average flow depth was 2.69 inches and the average velocity observed was 2.38 feet per second. The collected data from this monitoring site was considered good even with constant medium to heavy debris reported during a few site services. The velocity had several low-level velocity dropouts that were autocorrected with valid recordings before and after dropout. The level and velocity was consistent with manual measurements during site visits.

Site 11 experienced no surcharging during 2021 flow monitoring.

Table 46 – Service Interrogations Summary (Site 11)

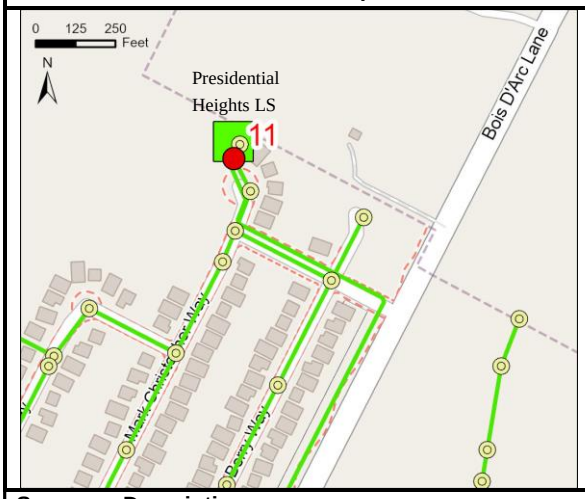
Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 11	9/1/2021	13:52	8	1.75	1.80	0.05	1.75	1.80	0.05	1.25	1.00	-0.25	1.75	1.89	0.14	Install	Meter installed at in pipe
	9/14/2021	10:40		2.50	2.60	0.10	2.00	2.20	0.20	2.50	2.50	0.00	2.50	2.80	0.30	Service/Upload	
	9/28/2021	10:52		2.00	2.00	0.00	2.25	2.00	-0.25	3.00	2.86	-0.14	3.00	2.80	-0.20	Service/Upload	
	10/13/2021	10:20		3.50	3.60	0.10	3.00	3.12	0.12	1.75	2.05	0.30	1.75	2.05	0.30	Service/Upload	
	10/27/2021	10:20		3.00	3.37	0.37	2.50	3.00	0.50	2.25	2.33	0.08	2.50	2.25	-0.25	Service/Upload	
	11/9/2021	10:22		1.75	2.79	1.04	2.50	2.49	-0.01	0.50	0.69	0.19	1.75	1.76	0.01	Service/Upload	Medium to heavy debris.
	11/29/2021	13:54		2.50	2.61	0.11	2.00	1.75	-0.25	2.25	2.25	0.00	3.00	3.04	0.04	Removal	Medium debris.

Figure 158 – Flow Meter Site Investigation (Site 11)

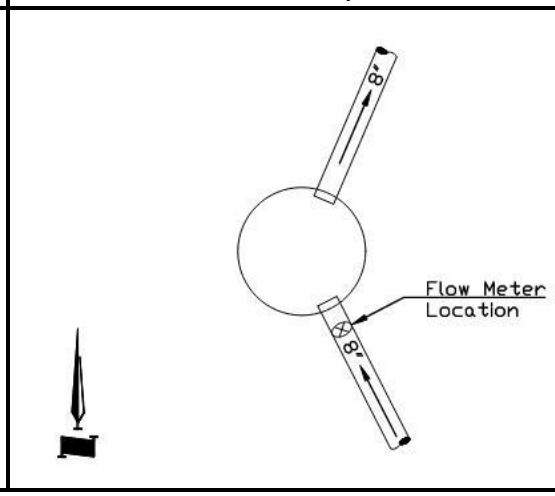
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 11-29-2021 / 13:54	**Crew:** JA-VI
MH#: J14-021	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 8
Site ID: 11	**Address:** Jared Argo Cv.	**Site Quality:** Good	**Monitoring Purpose:** Short-term FM

Location Map

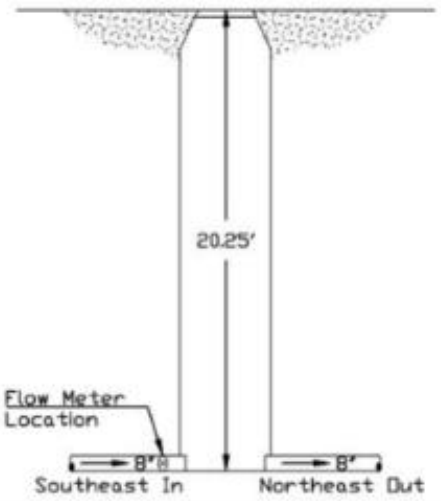


Planar Description



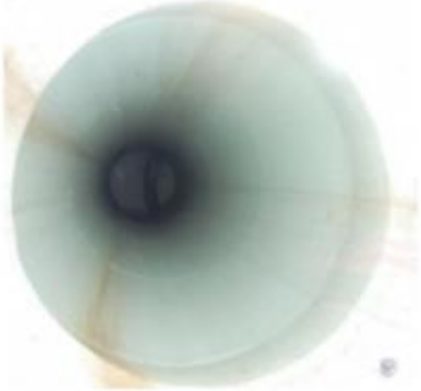
Summary Description:
Located right outside of Lift Station site. Manhole is in the middle of the driveway at the cul-de-sac of Jared Argo Cove.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? None		**Manhole Depth (ft):** 20.25	**Surcharge Evidence?** No
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 0.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 32.00	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Bolt Down	**Usable MH Steps?** No
Describe potential hazards:		**Measured Flow Depth (in):** 2.00	**Meter:** ISCO 2150
		Velocity (fps): 3.00	**Cellular Signal Strength:** N/A
		Mounting Band Description: Spring Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

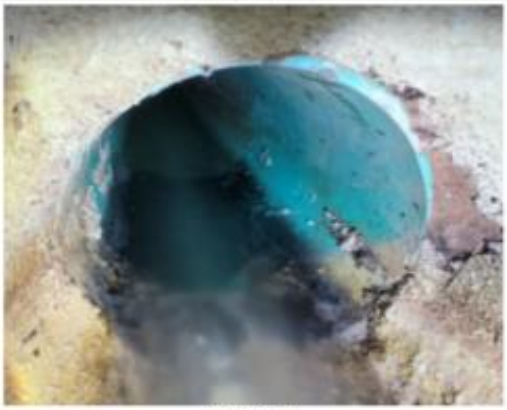
Installation Sketch & Notes	Pipe Cross Section
	

Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE



DOWN



INFLOW

OUTFLOW

Figure 159 – Site Information (Site 11)

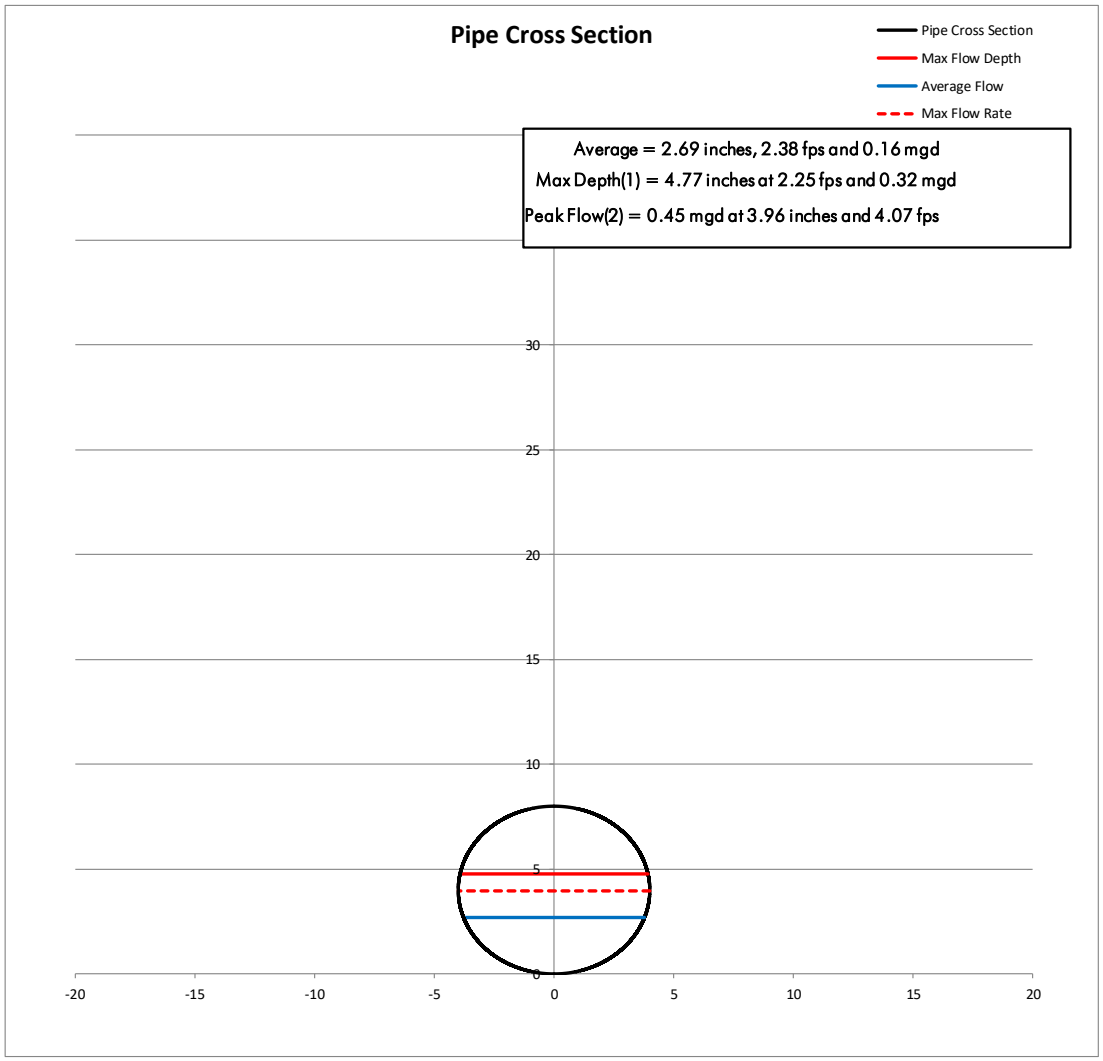
SITE INFORMATION RECORD

Site Information

Meter ID #:	11
Monitoring Program:	Short-Term FM
Manhole #:	J14-021

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	8	
Pipe Width, W (in):	8	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0155	ASSUMED!



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 11	9/1/2021	8	13:52	1.75	1.80	0.05	1.75	1.89	0.14
	9/14/2021		10:40	2.00	2.20	0.20	2.50	2.80	0.30
	9/28/2021		10:52	2.25	2.00	-0.25	3.00	2.80	-0.20
	10/13/2021		10:20	3.00	3.12	0.12	1.75	2.05	0.30
	10/27/2021		10:20	2.50	3.00	0.50	2.50	2.25	-0.25
	11/9/2021		10:22	2.50	2.49	-0.01	1.75	1.76	0.01
	11/29/2021		13:54	2.00	1.75	-0.25	3.00	3.04	0.04

Figure 160 – September Monthly Flow Hydrograph (Site 11)

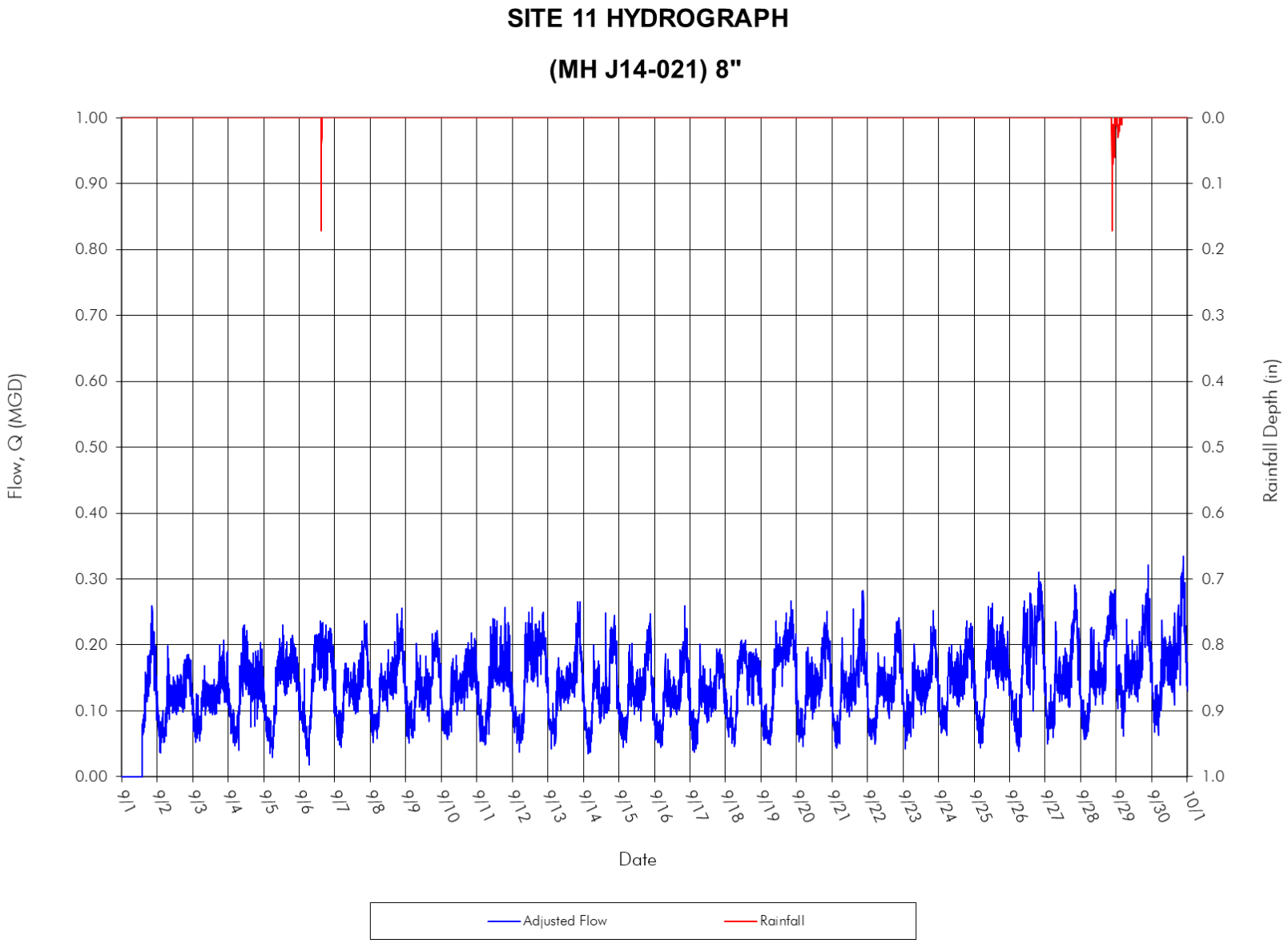


Figure 161 – September Monthly Level and Velocity Hydrograph (Site 11)

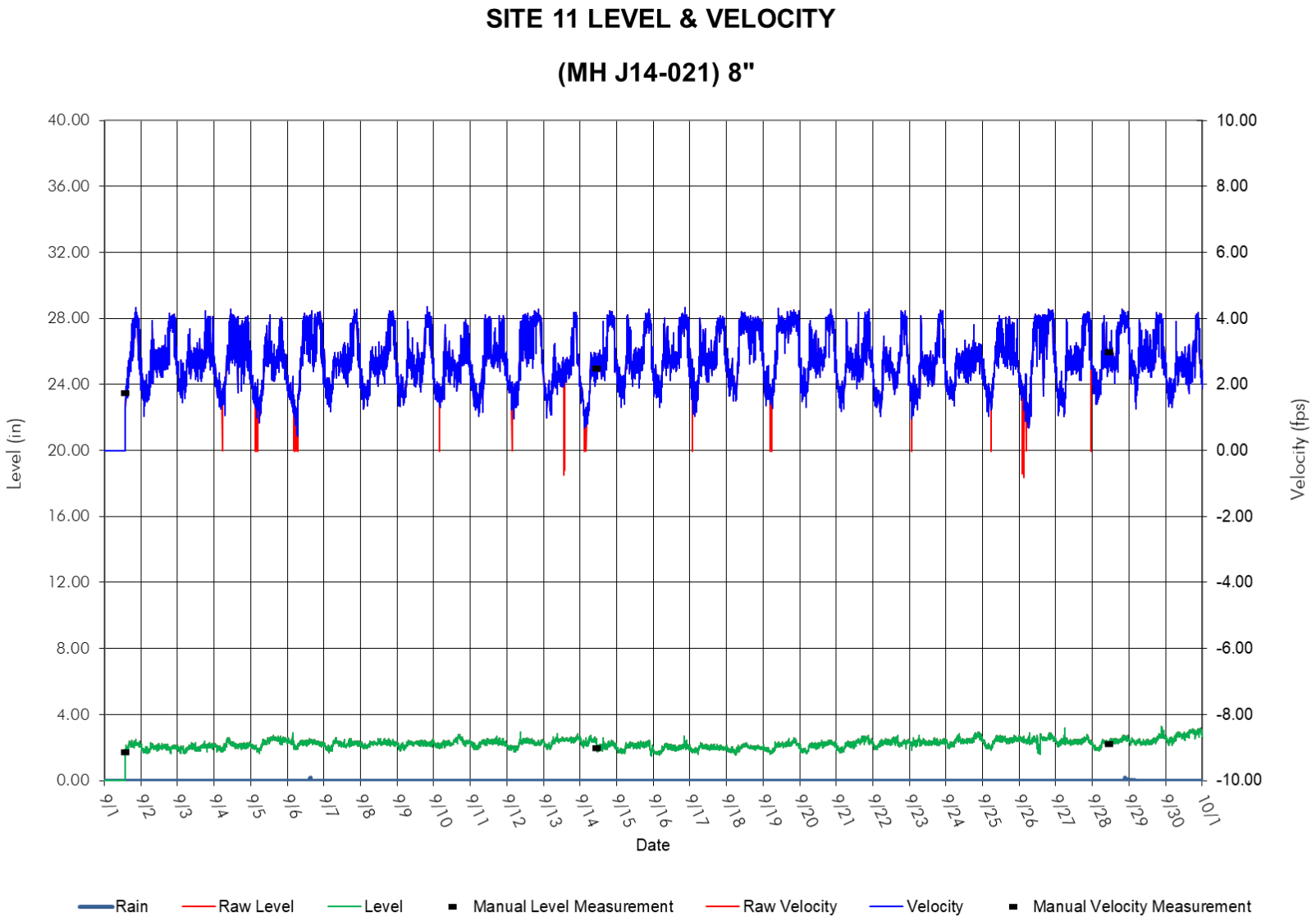


Figure 162 – October Flow Hydrograph (Site 11)

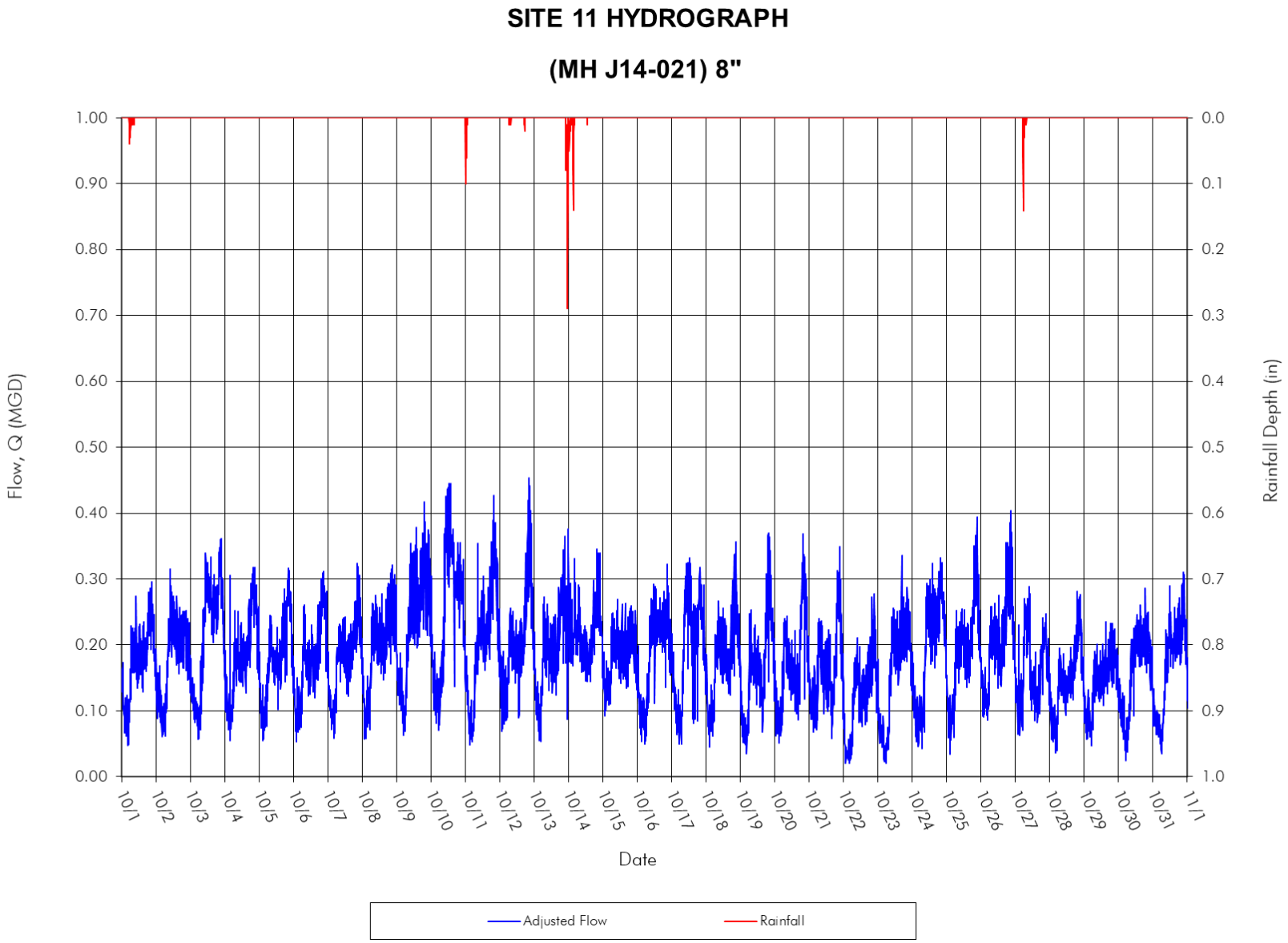


Figure 163 – October Monthly Level and Velocity Hydrograph (Site 11)

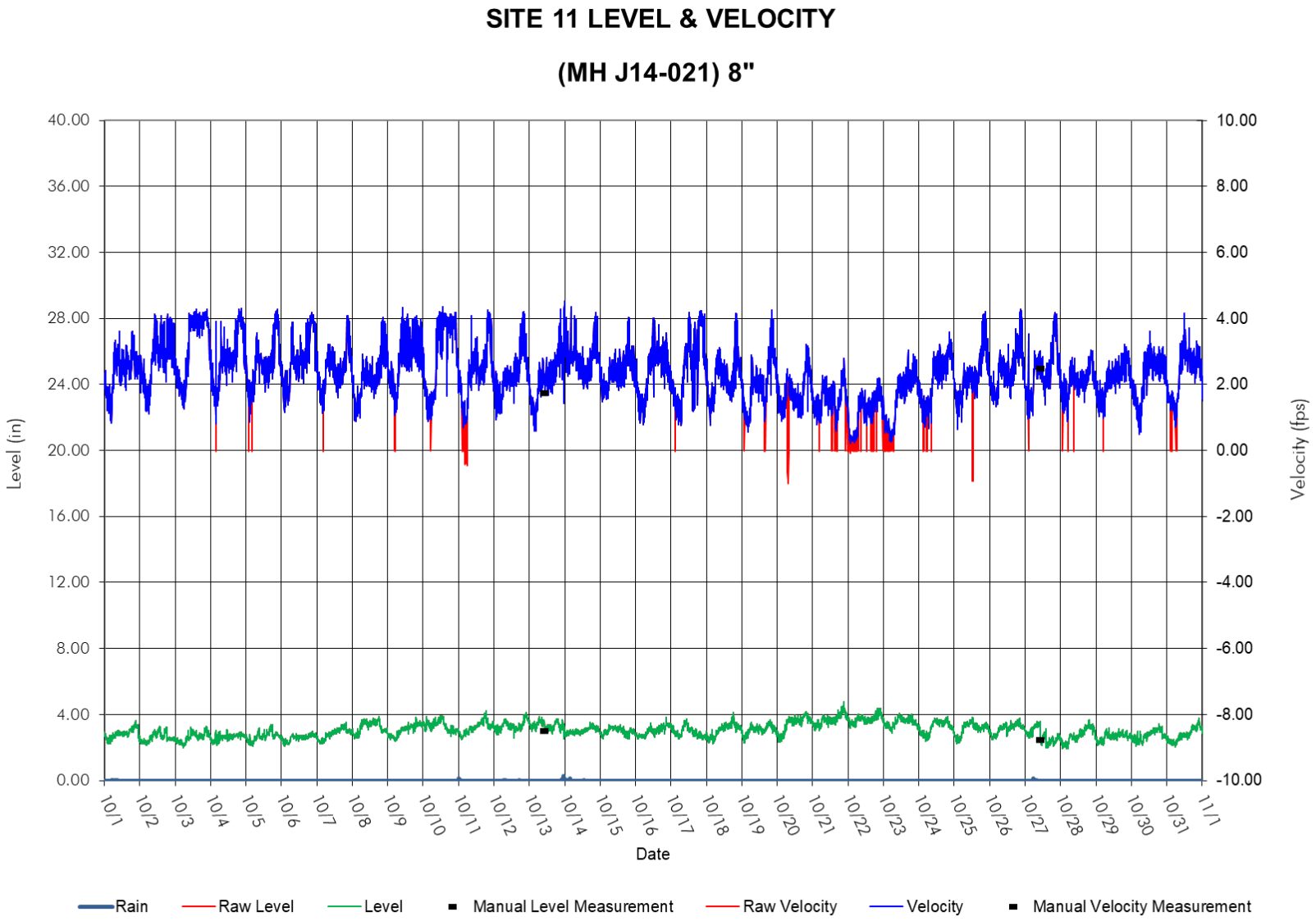


Figure 164 – November Monthly Flow Hydrograph (Site 11)

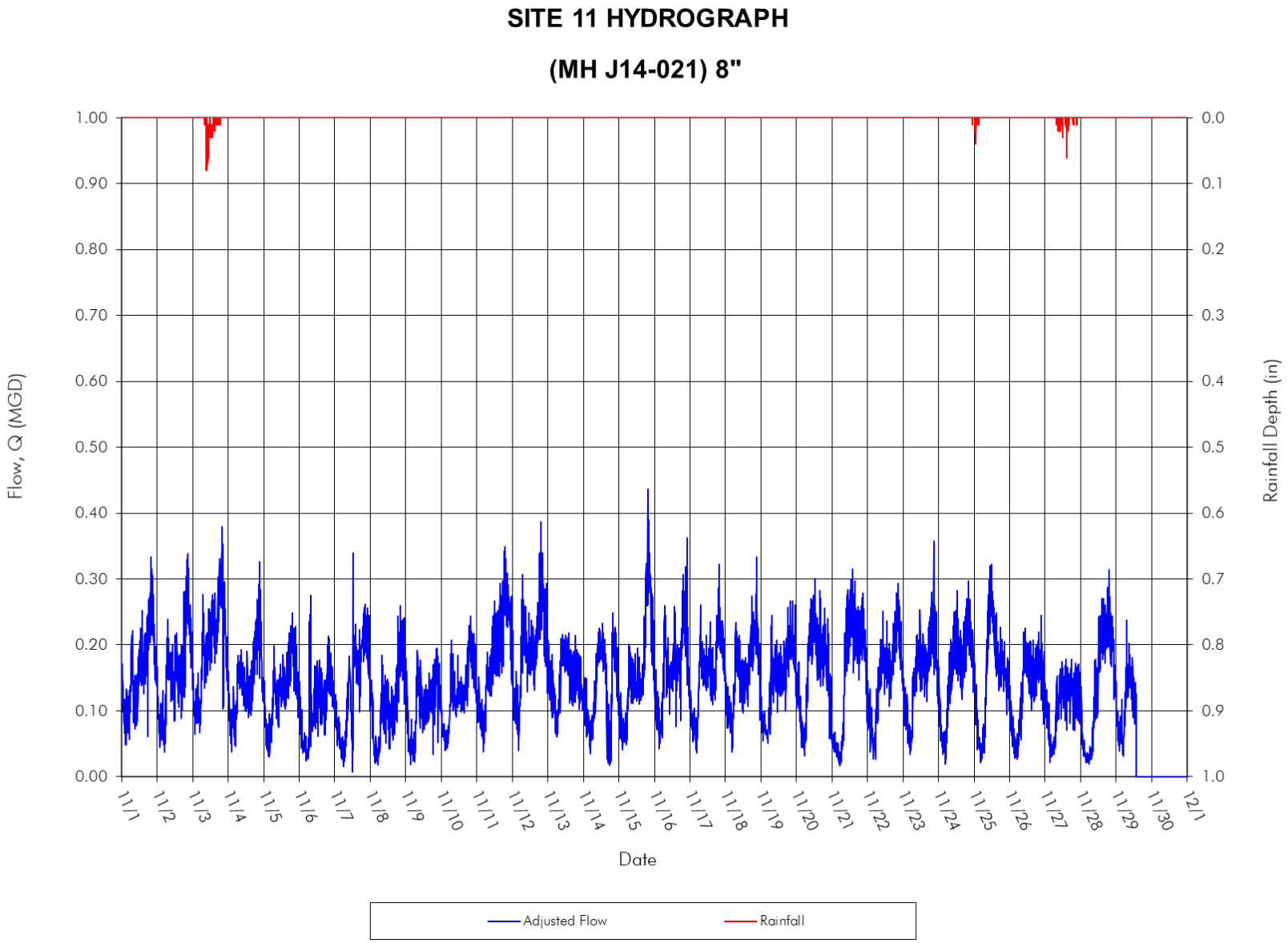


Figure 165 – November Level and Velocity Hydrograph (Site 11)

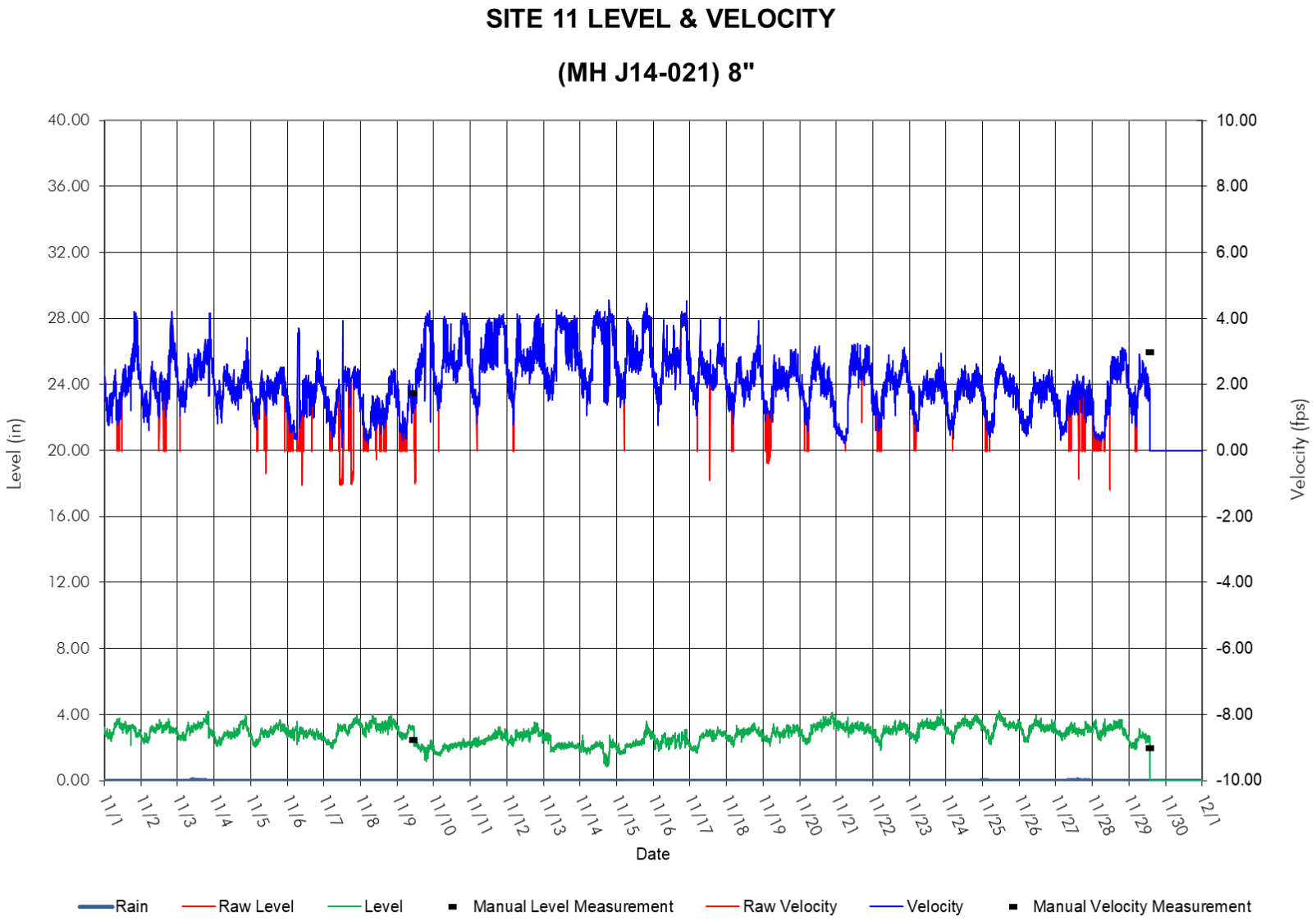


Figure 166 – Overall Flow Hydrograph (Site 11)

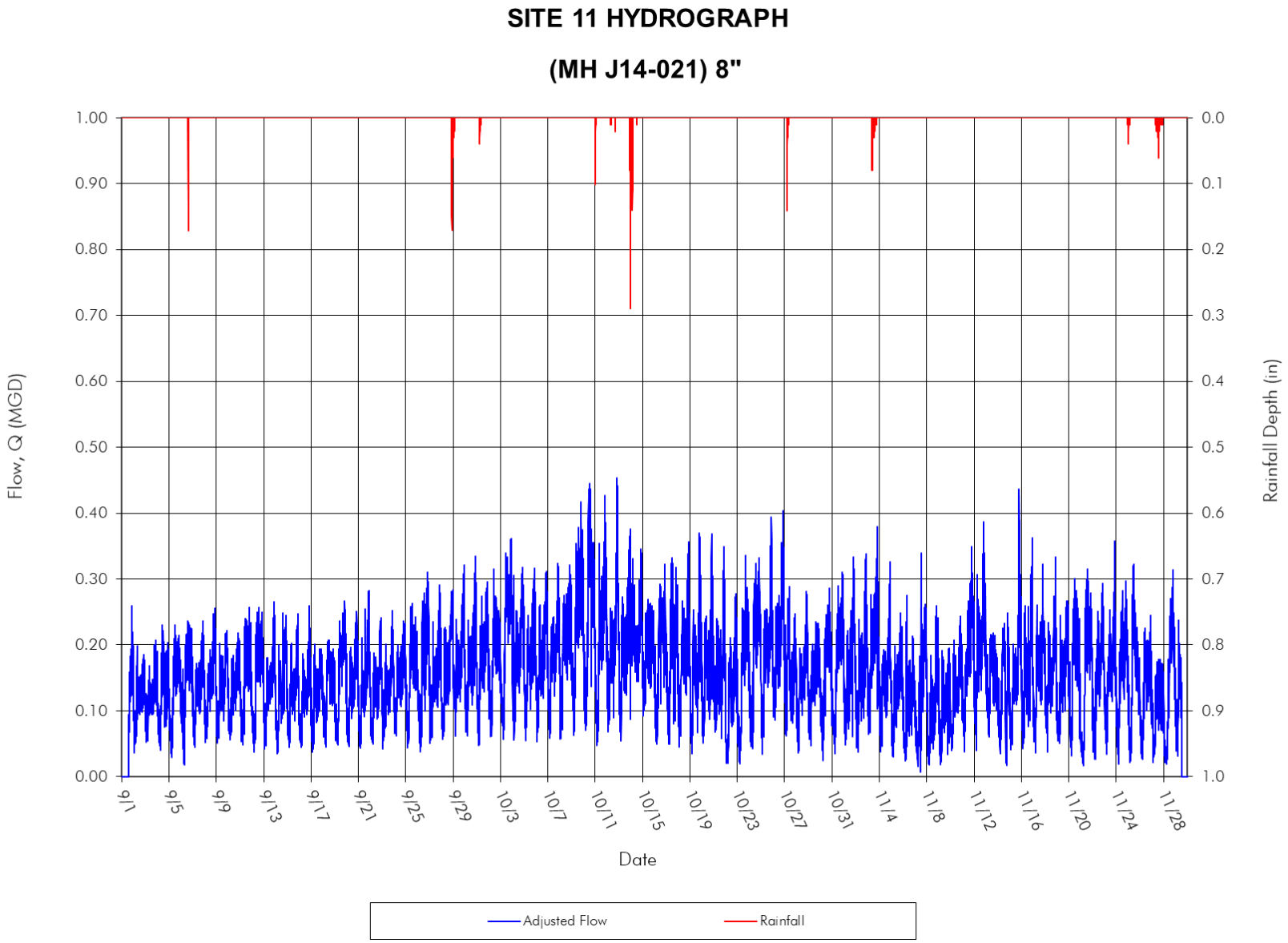


Figure 167 – Overall Level and Velocity Hydrograph (Site 11)

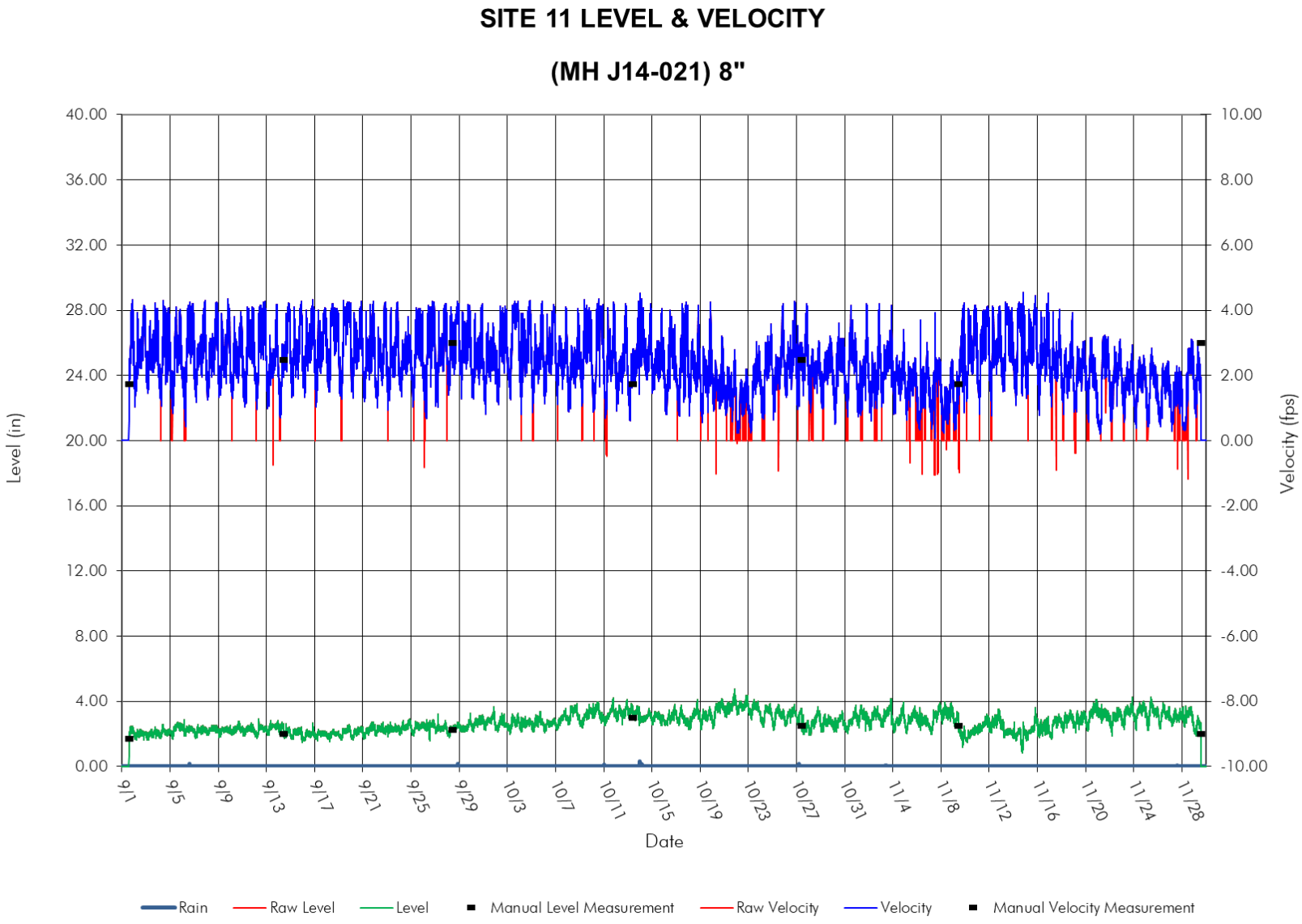


Figure 168 – Standard Flow Scattergraph (Site 11)

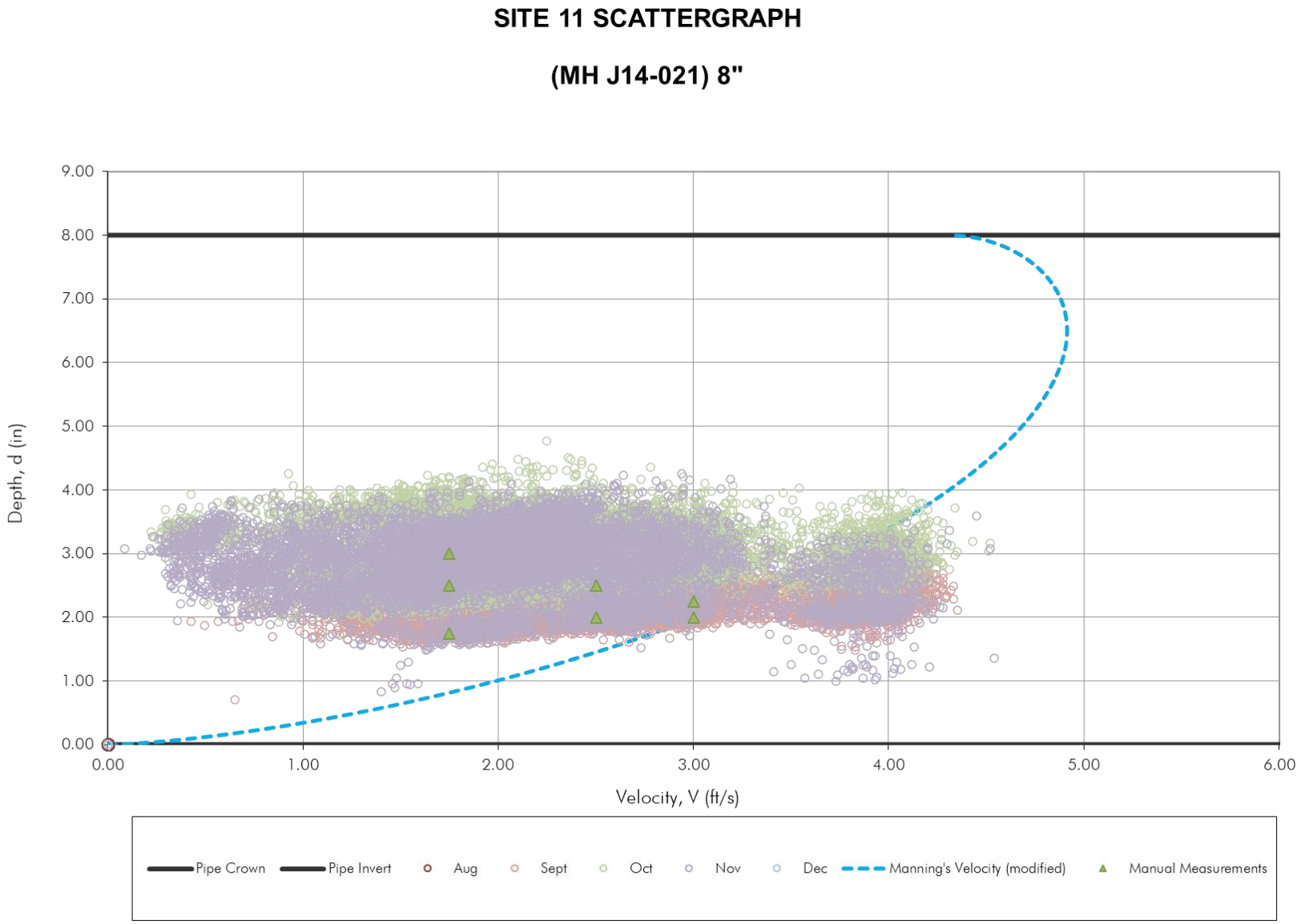


Table 47 – ADDF and Infiltration Summary (Site 11)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name	City of Manor Flow Monitoring Fall 2021
Project No:	14925
Subsystem:	11
Meter:	11
Units of Flow:	MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.153	0.226	1.476	0.062		
13-Sep-21	Mon	0.139	0.238	1.712	0.072		
14-Sep-21	Tue	0.128	0.212	1.656	0.052		
15-Sep-21	Wed	0.129	0.216	1.680	0.069		
16-Sep-21	Thu	0.124	0.211	1.701	0.064	04-Nov-21	0.082
17-Sep-21	Fri	0.121	0.174	1.441	0.068	15-Oct-21	0.134
18-Sep-21	Sat	0.139	0.192	1.379	0.067	16-Oct-21	0.085
7 Count		0.133 Average	0.210 Average	1.578 Average	0.065 Average	3 Count	0.100 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.133	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.133	
	Diurnal Peaking Factor (DPF):	1.578	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.036	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.036	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.133	

Figure 169 – Dry Weather Diurnal (Site 11)

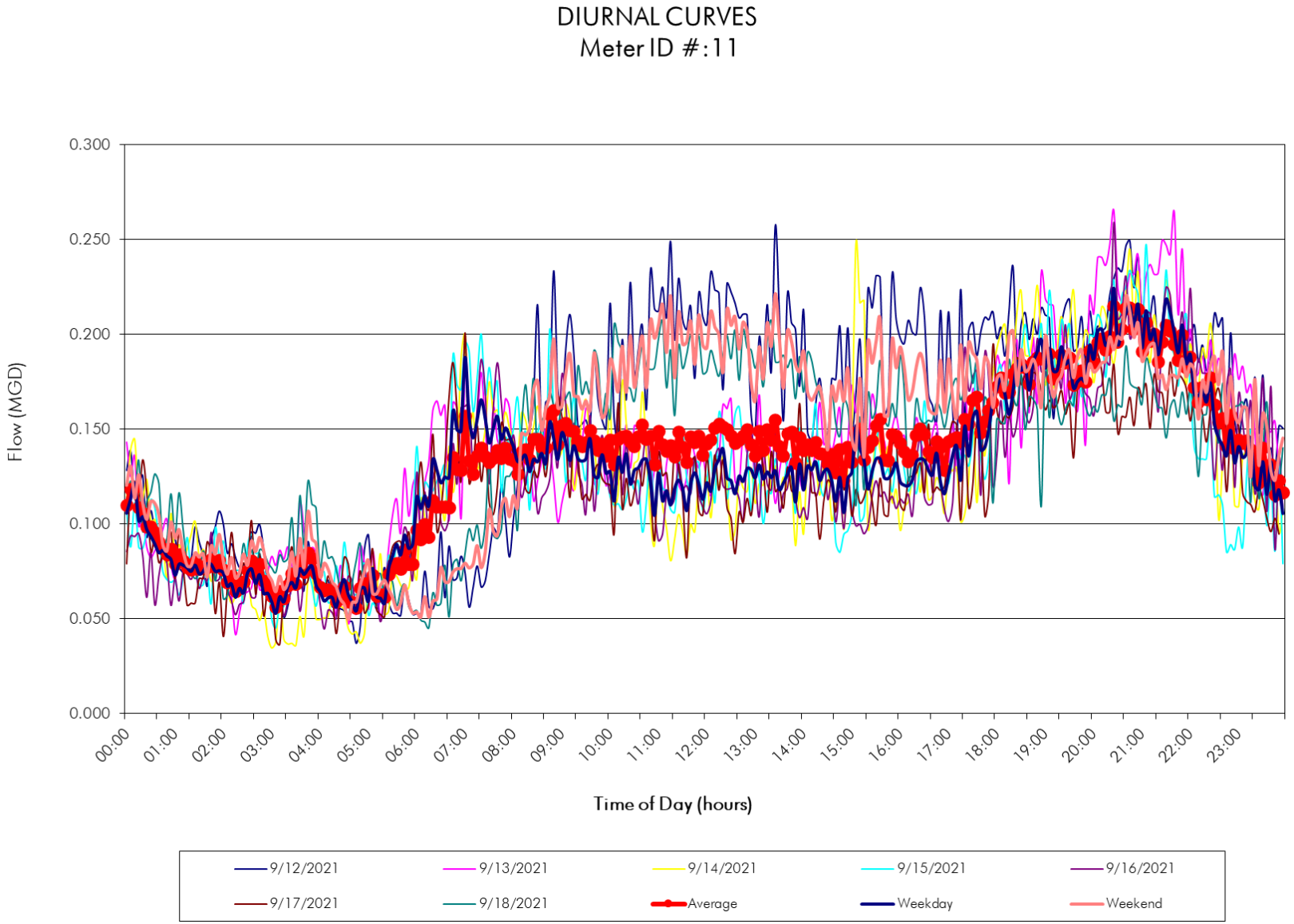


Figure 170 – High/Low Groundwater Diurnal (Site 11)

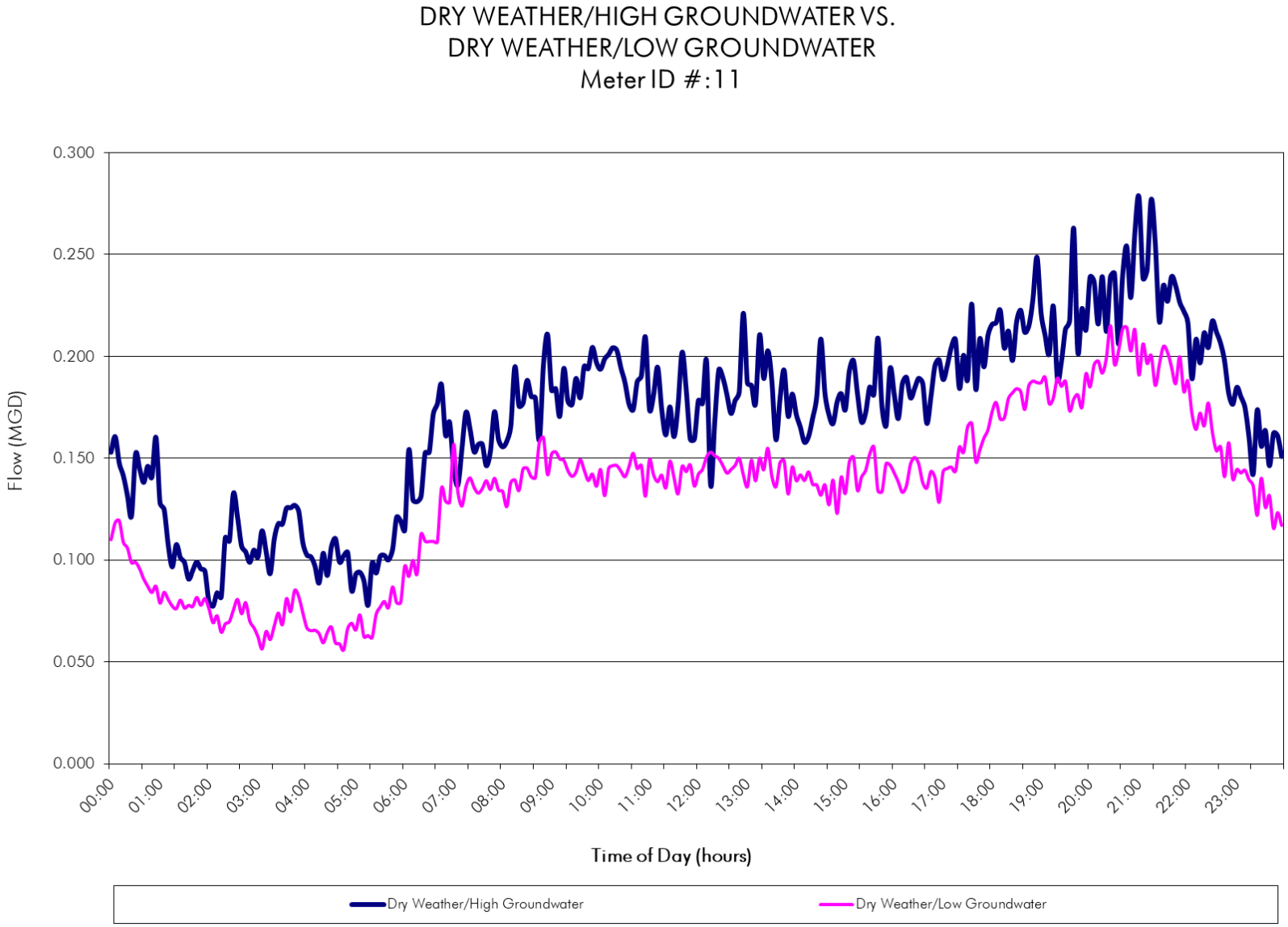


Table 48 – Inflow Calculations and Projections (Site 11)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	11
Meter:	11
Units of Flow:	MGD

Storm Count:	8	Cum. Trib. Area:	143 acres	Pipe Shape:	Circular
Avg Delta Time	76	Cum. Time of Conc.:	75 minutes	Pipe Diameter:	8 in
Avg Kp:	0.00240			Pipe Slope:	0.016 ft/ft
Avg Selected Kp:	0.00228			Pipe Capacity:	0.97 mgd
				ADDF Cum.:	0.133 mgd
				ADDF Peak. Factor:	1.58
				Peak ADDF Flow:	0.210 mgd
				Infiltration:	0.036 mgd
				Cum. Peak Flow:	0.246 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.246
1	1.130	0.238	0.368	0.483
2	1.400	0.294	0.456	0.540
5	1.780	0.374	0.579	0.620
10	2.080	0.437	0.677	0.683
25	2.490	0.524	0.810	0.769
50	2.810	0.591	0.914	0.837
100	3.140	0.660	1.022	0.906

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/6/21 14:50	0.43	0.58	9/6/21 15:20	9/6/21 15:00	20	0.232	09/05/21	0.143	0.089	0.344	0.00281	n						No reaction
9/28/21 20:50	1.68	6.92	9/28/21 21:40	9/28/21 21:25	15	0.278	09/21/21	0.157	0.121	0.688	0.00190	y	0.00190					
10/1/21 5:10	0.28	3.50	10/1/21 6:45	10/1/21 5:15	90	0.229	09/24/21	0.154	0.075	0.200	0.00408	n						No reaction
10/11/21 0:05	0.35	1.25	10/11/21 0:50	10/11/21 0:05	45	0.183	10/04/21	0.128	0.055	0.272	0.00219	n						No reaction
10/13/21 22:00	3.20	15.00	10/13/21 23:40	10/13/21 23:10	30	0.376	10/06/21	0.150	0.226	1.432	0.00171	y	0.00171					
10/27/21 5:20	0.62	2.33	10/27/21 6:30	10/27/21 5:35	55	0.271	10/26/21	0.202	0.068	0.416	0.00178	y	0.00178					
11/3/21 8:05	1.79	10.67	11/3/21 12:55	11/3/21 10:35	140	0.266	10/27/21	0.110	0.156	0.456	0.00371	y	0.00371					
11/27/21 7:45	0.70	13.92	11/27/21 18:00	11/27/21 14:25	215	0.178	11/20/21	0.161	0.017	0.184	0.00100	n						No reaction

Figure 171 – Inflow Projections (Site 11)

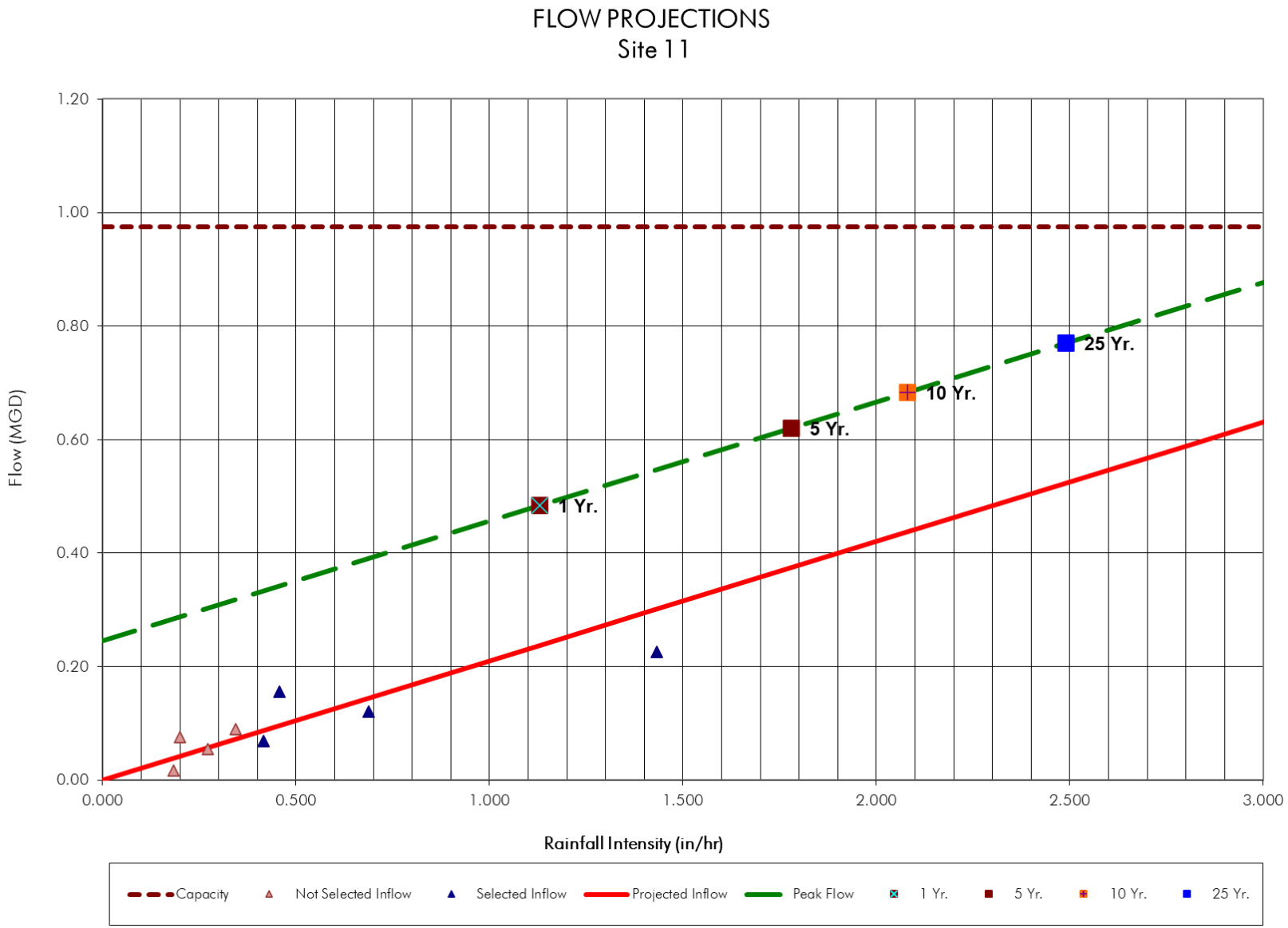
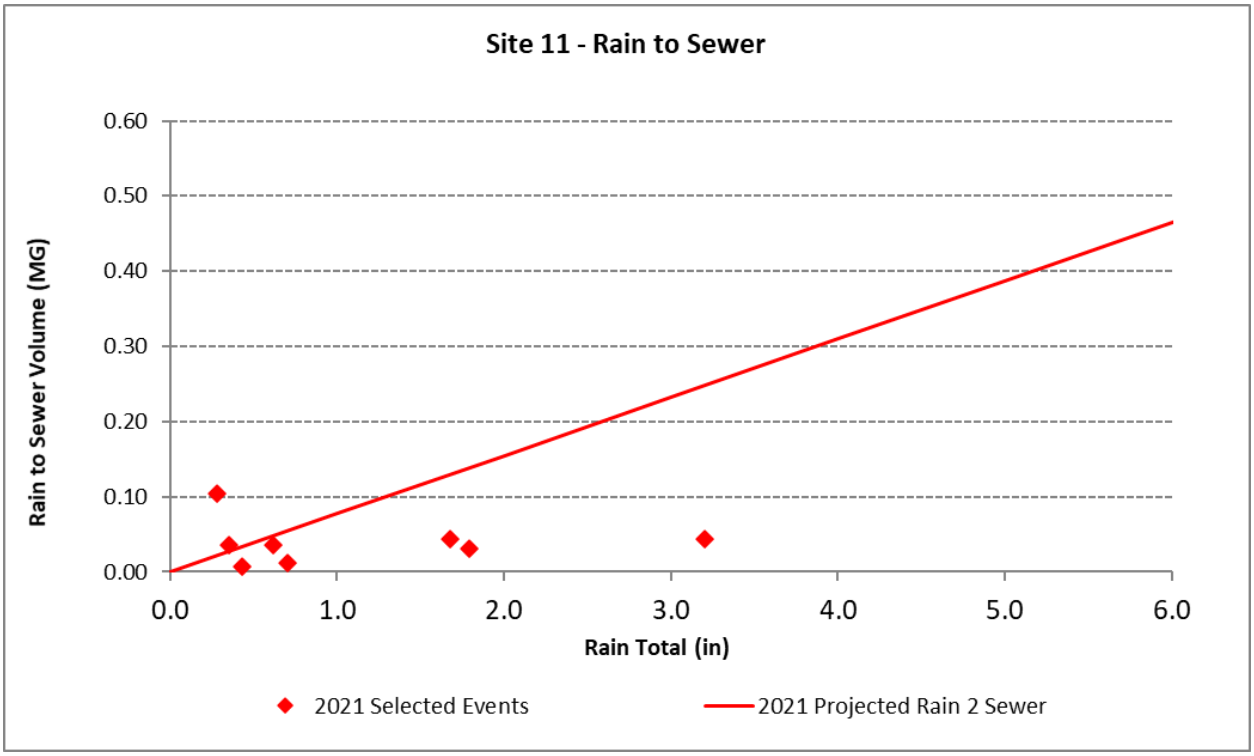


Table 49 – Rain to Sewer Summary (Site 11)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 11 (8")	9/6/2021	0.43	1.670	0.007	0.41%
	9/28/2021	1.68	6.523	0.043	0.67%
	10/1/2021	0.28	1.087	0.104	9.55%
	10/11/2021	0.35	1.359	0.036	2.61%
	10/13/2021	3.20	12.425	0.044	0.35%
	10/27/2021	0.62	2.407	0.035	1.46%
	11/3/2021	1.79	6.950	0.031	0.44%
	11/27/2021	0.70	2.718	0.012	0.45%
				Average	**1.99%**

Figure 172 – Rain to Sewer Volumetric Analysis (Site 11)



A.12 Site 12

Description

Site 12, at manhole M14-002, is on the north side of Presidential Glen US 290 Lift Station. The area velocity sensor was placed in the influent 15" diameter PVC pipe of the manhole. The meter measured flows as part of Wilbarger Wastewater Treatment Plant. The basin is interior to Site 11 and exterior to Site 2.

Observations

The average flow depth recorded at this site was 5.5 inches with an average velocity of 1.39 feet per second. The site experienced medium grease and debris as reported during site services. There were several velocity dropouts that were corrected with valid recordings. The level and velocity were consistent with manual measurements during site services. The collected data from the flow monitoring site was considered good with minor adjustments needed.

Site 12 experienced two dry weather surcharges due to backing up during the 2021 flow monitoring. The surcharging on 11/21/2021 was attributed to malfunction at the Presidential Glen Lift Station due to debris binding the float controls.

Table 50 – Surcharge Summary (Site 12)

		Date of Storm	9/10/2021	11/21/2021
		Total Storm Rainfall (in.)	Dry Weather Surcharge	Dry Weather Surcharge
Site	Diameter (in.)	Storm Duration (hrs.)		
12[(1)]	15	Depth from Invert (in.)	32.56 (B)	164.49 (B)

(1) The 11/21/2021 Dry Weather surcharge to 164" at Site 12 was attributed to the Presidentia Glen Lift Station malfunction resulting from float controls being bound by debris and was corrected by the City operations staff.

(P) Denotes pressurized flow caused by lack of capacity
(flow velocities generally increase as flow depths increase)

(B) Denotes flow backup caused by downstream restriction
(flow velocities generally decrease as flow depths increase)

Table 51 – Service Interrogations Summary (Site 12)

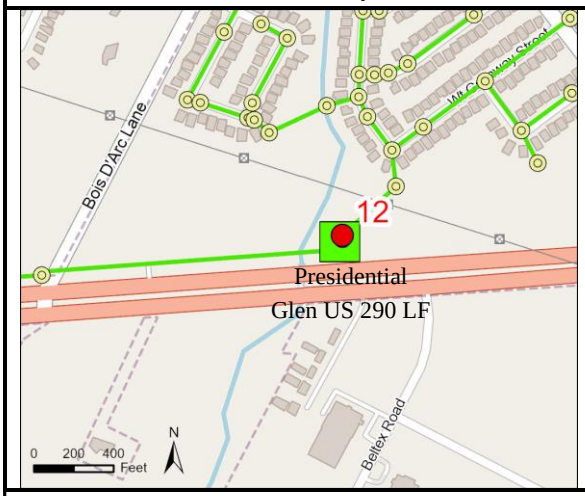
Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 12	9/1/2021	15:18	15	2.75	2.75	0.00	2.75	2.43	-0.32	1.00	1.06	0.06	1.00	1.03	0.03	Install	Meter installed at in pipe
	9/14/2021	10:08		2.50	2.60	0.10	3.75	3.80	0.05	1.00	1.00	0.00	1.50	1.50	0.00	Service/Upload	
	9/28/2021	11:45		3.75	3.78	0.03	3.25	3.24	-0.01	1.25	1.46	0.21	1.25	1.25	0.00	Service/Upload	
	10/13/2021	9:36		4.00	3.89	-0.11	3.75	3.80	0.05	1.50	1.40	-0.10	1.50	1.44	-0.06	Service/Upload	
	10/27/2021	12:02		3.00	3.09	0.09	3.00	2.98	-0.02	1.25	1.25	0.00	1.25	1.20	-0.05	Service/Upload	
	11/9/2021	9:40		2.75	2.76	0.01	4.50	4.45	-0.05	1.00	1.02	0.02	2.00	2.03	0.03	Service/Upload	Medium grease and debris.
	12/1/2021	11:20		3.00	0.00	-3.00	2.00	0.00	-2.00	1.00	0.00	-1.00	1.00	0.00	-1.00	Removal	Medium silt. No readings.

Figure 173 – Flow Meter Site Investigation (Site 12)

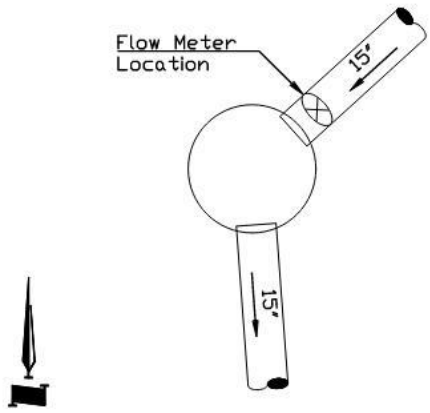
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 12-1-2021 / 11:20	**Crew:** JA-VI
MH#: M14-002	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 15
Site ID: 12	**Address:** 13424 US Hwy. 290	**Site Quality:** Poor	**Monitoring Purpose:** Short-term FM

Location Map



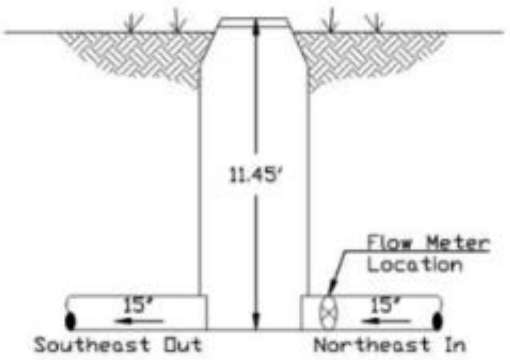
Planar Description



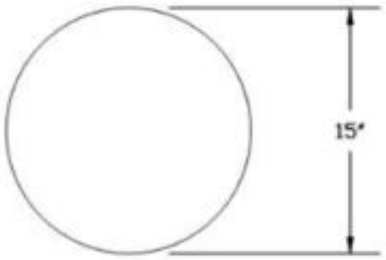
Summary Description:
Manhole metered is on the North side of the Lift Station Site on the outside grassy area of the enclosed site.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? None		**Manhole Depth (ft):** 11.45	**Surcharge Evidence?** Yes
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 10.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 32.00	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Bolt Down	**Usable MH Steps?** No
Describe potential hazards:		**Measured Flow Depth (in):** 2.00	**Meter:** ISCO 2150
		Velocity (fps): 1.00	**Cellular Signal Strength:** N/A
		Mounting Band Description: Spring Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes

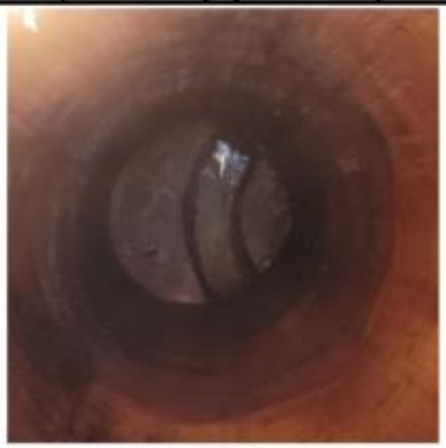


Pipe Cross Section



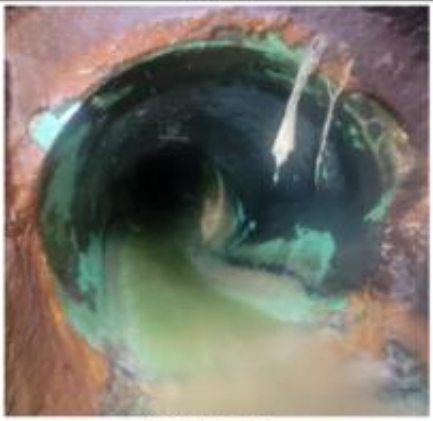
Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE



DOWN

INFLOW



OUTFLOW

Figure 174 – Site Information (Site 12)

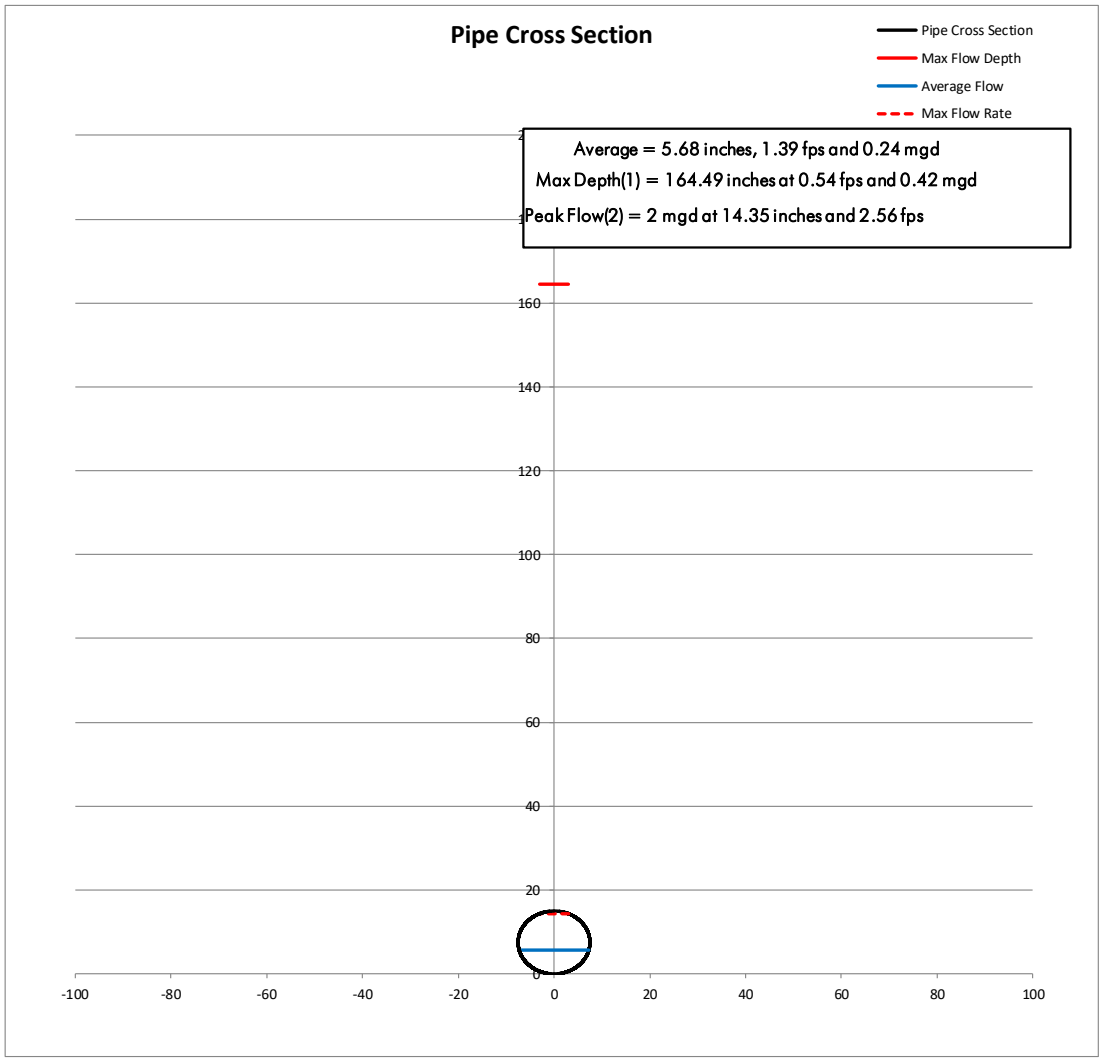
SITE INFORMATION RECORD

Site Information

Meter ID #:	12
Monitoring Program:	Short-Term FM
Manhole #:	M14-002

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	15	
Pipe Width, W (in):	15	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0020	ASSUMED!



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 12	9/1/2021	15	15:18	2.75	2.43	-0.32	1.00	1.03	0.03
	9/14/2021		10:08	3.75	3.80	0.05	1.50	1.50	0.00
	9/28/2021		11:45	3.25	3.24	-0.01	1.25	1.25	0.00
	10/13/2021		9:36	3.75	3.80	0.05	1.50	1.44	-0.06
	10/27/2021		12:02	3.00	2.98	-0.02	1.25	1.20	-0.05
	11/9/2021		9:40	4.50	4.45	-0.05	2.00	2.03	0.03
	12/1/2021		11:20	2.00	0.00	-2.00	1.00	0.00	-1.00

Figure 175 – September Monthly Flow Hydrograph (Site 12)

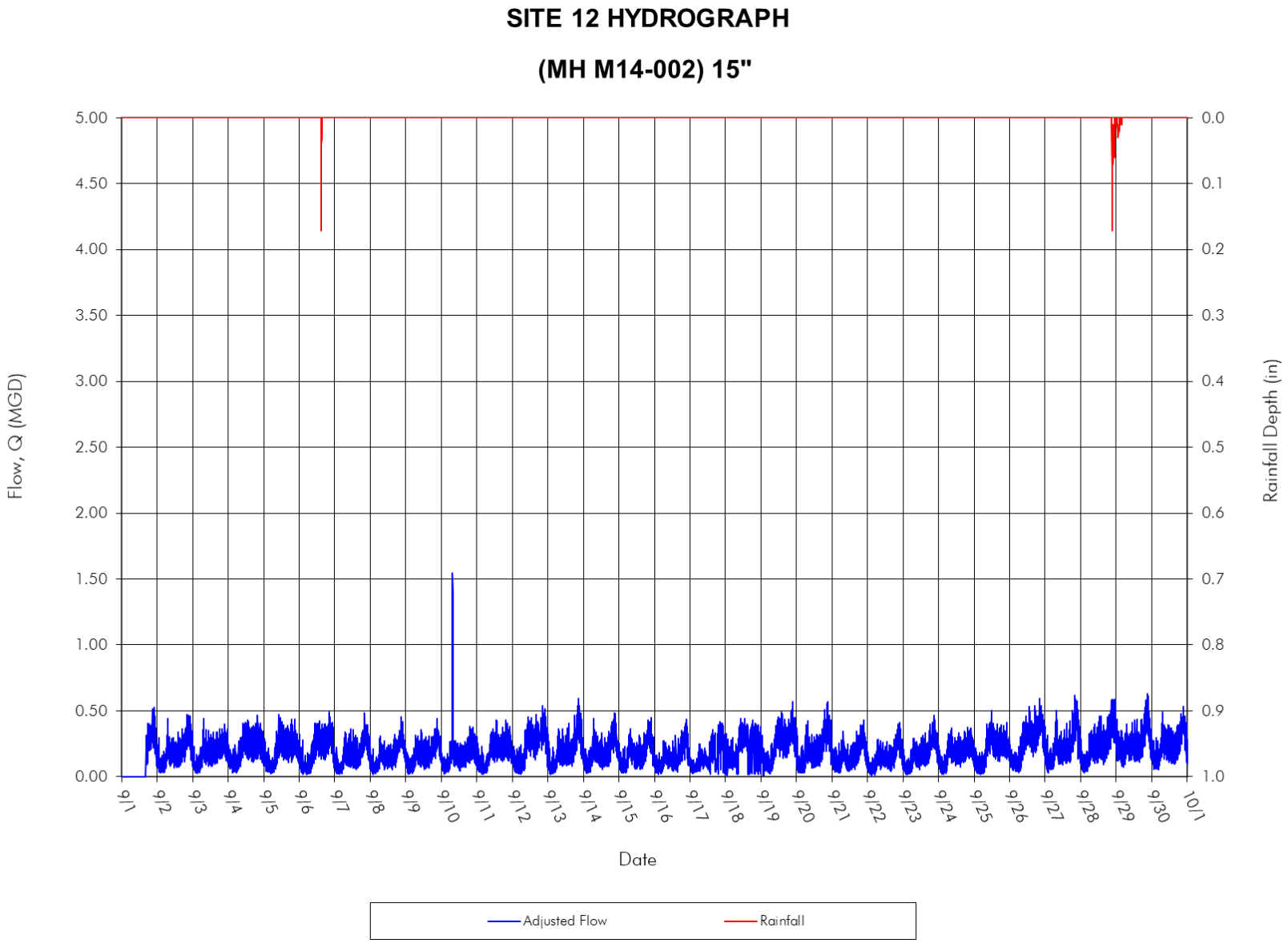


Figure 176 – September Monthly Level and Velocity Hydrograph (Site 12)

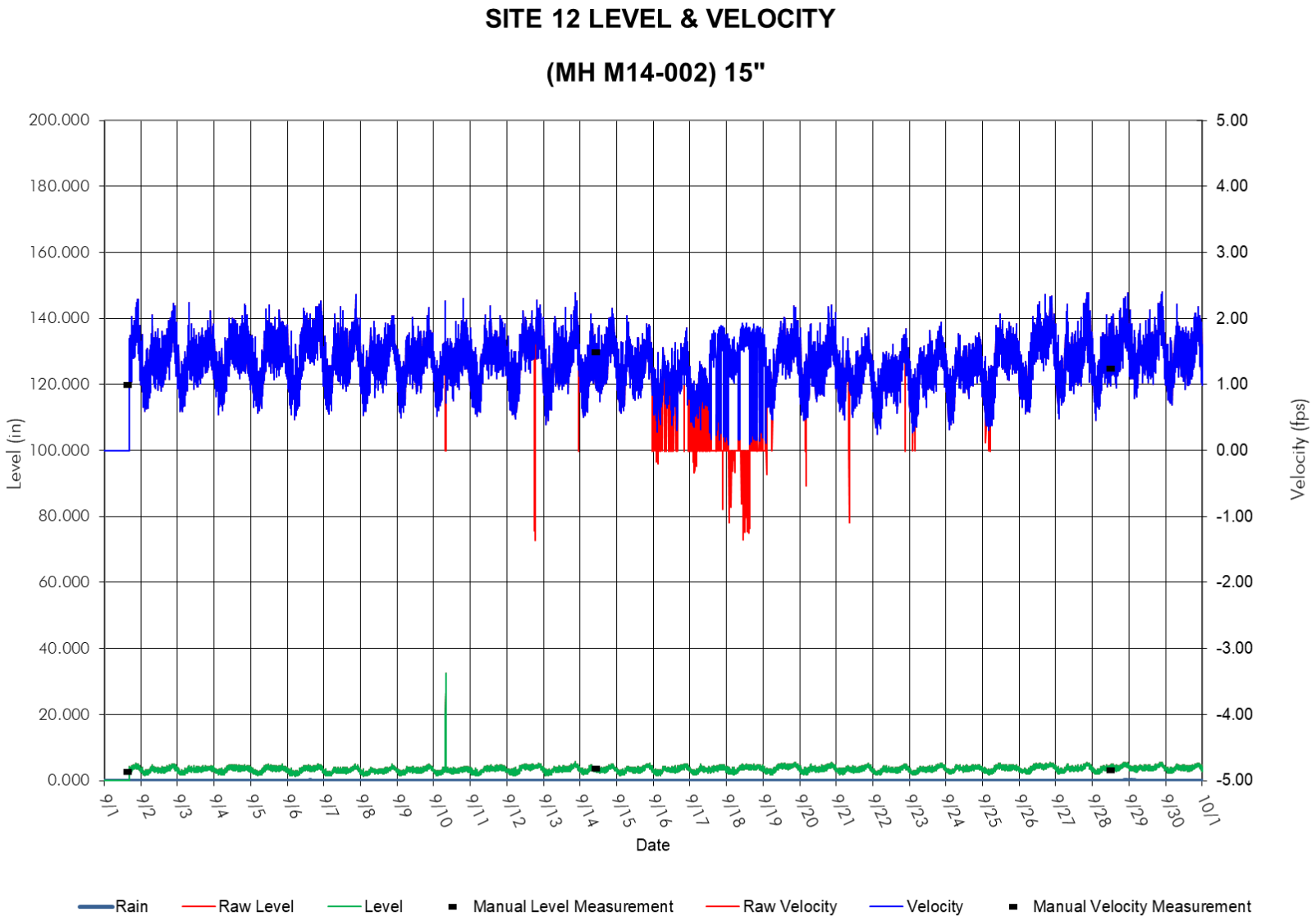


Figure 177 – October Flow Hydrograph (Site 12)

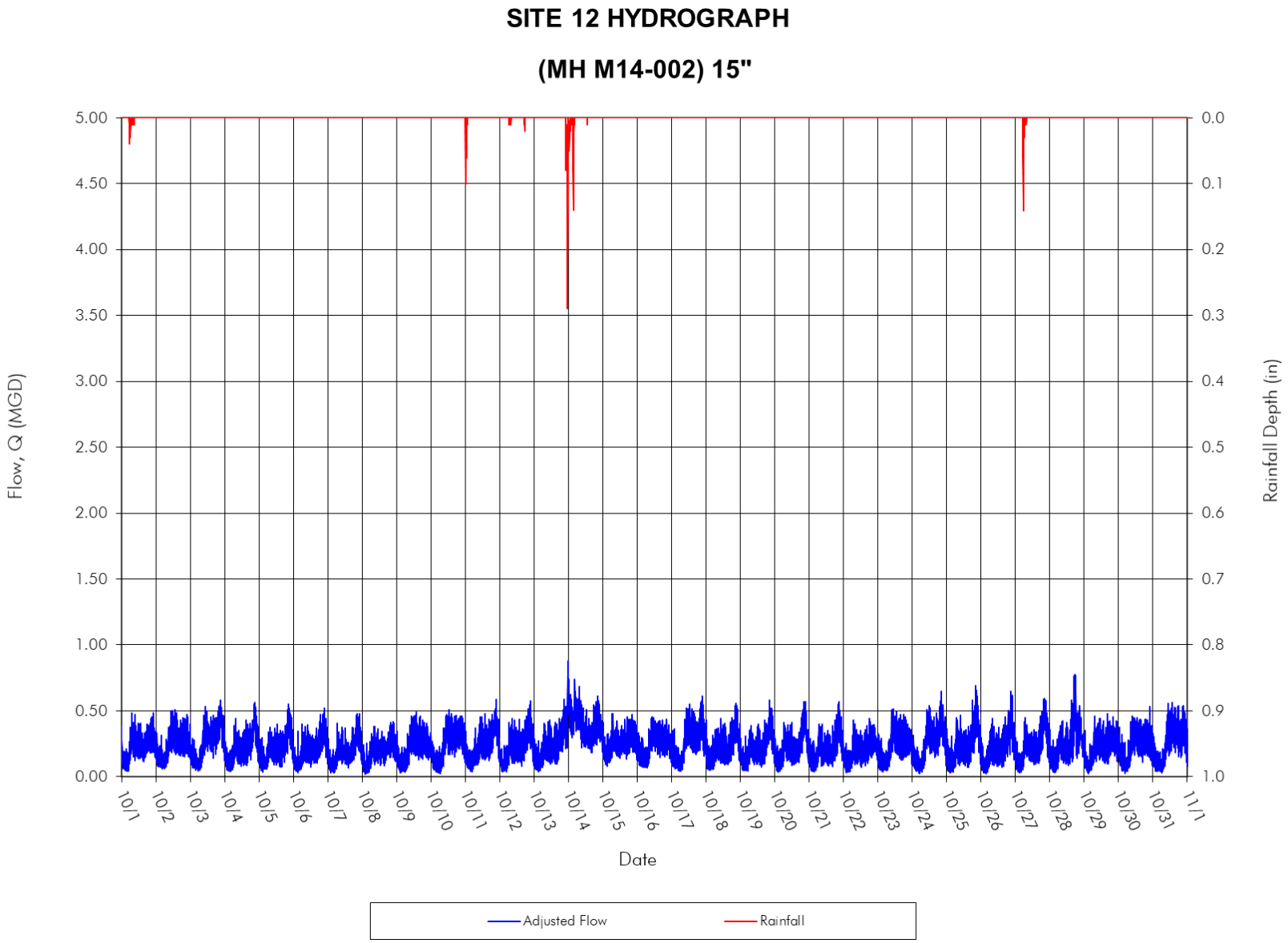


Figure 178 – October Monthly Level and Velocity Hydrograph (Site 12)

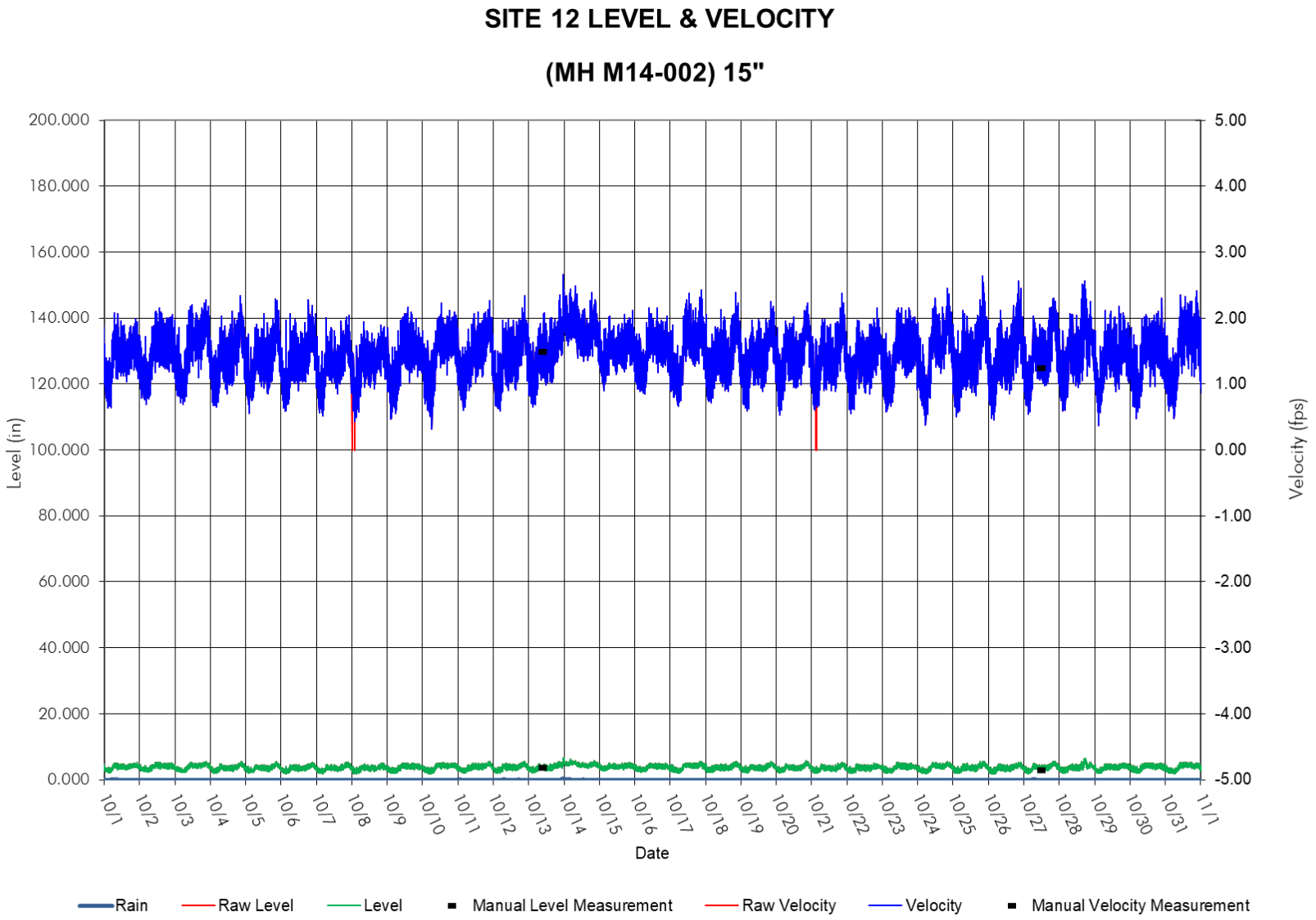


Figure 179 – November-December Monthly Flow Hydrograph (Site 12)

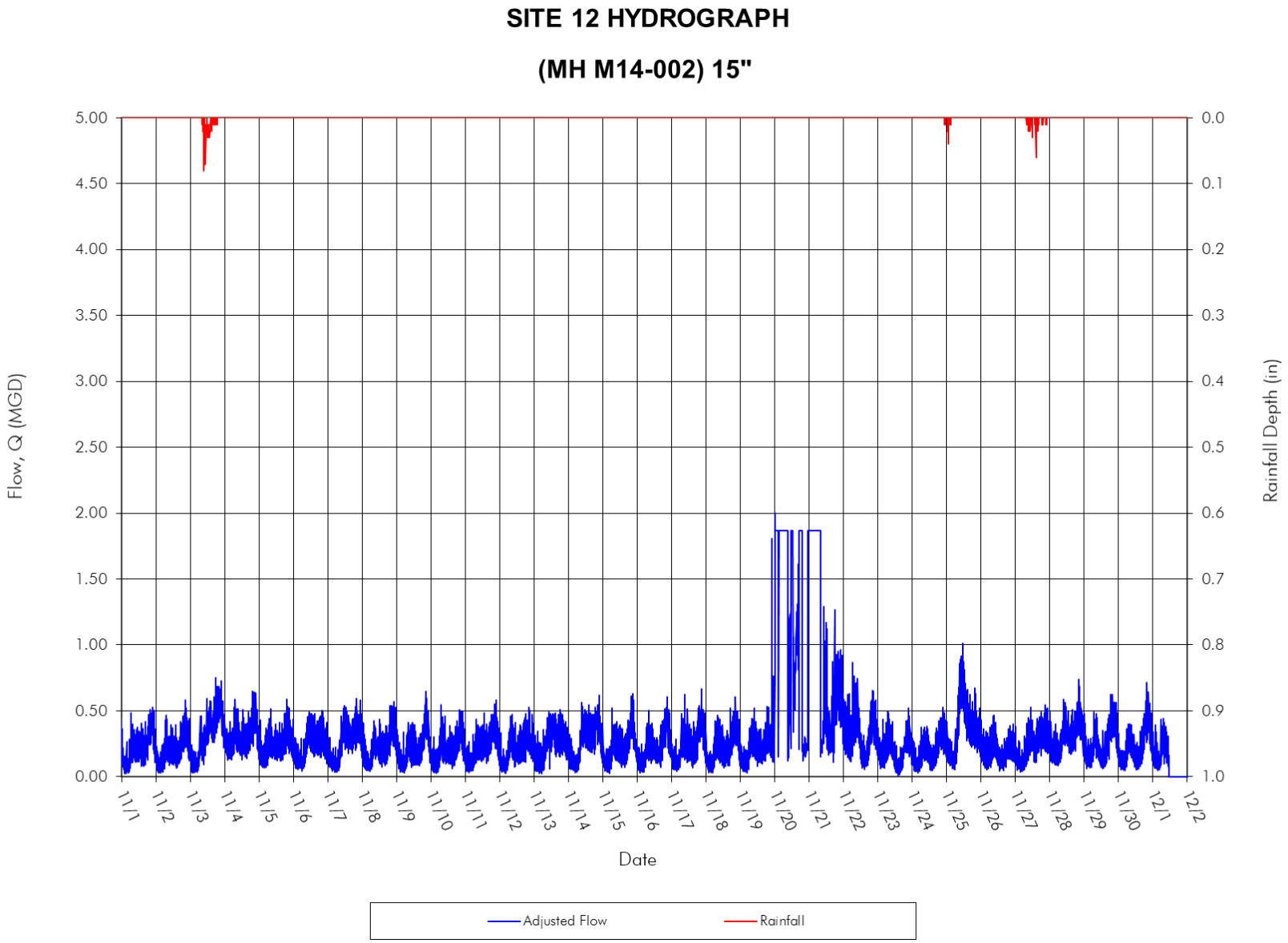


Figure 180 – November-December Level and Velocity Hydrograph (Site 12)

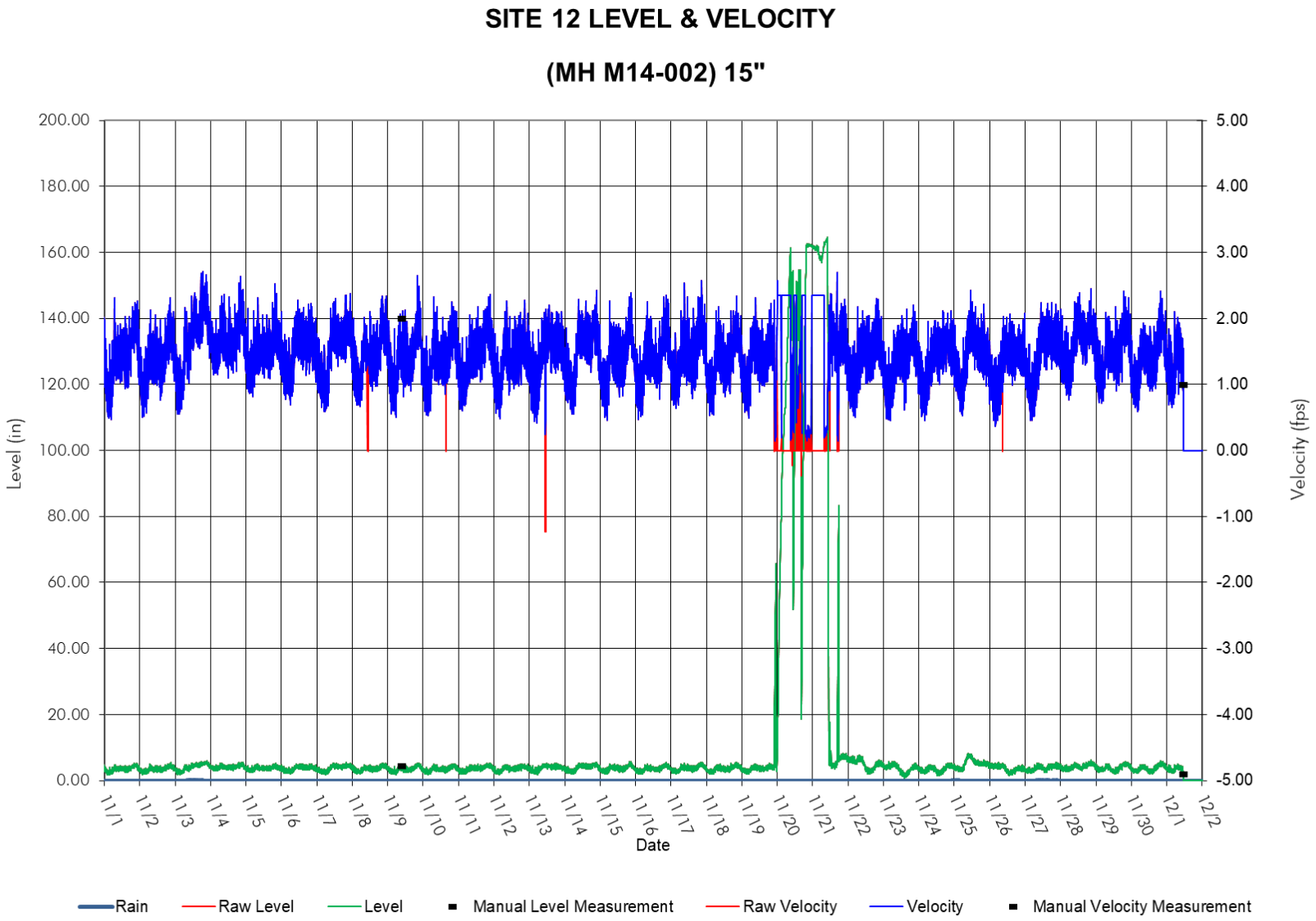


Figure 181 – Overall Flow Hydrograph (Site 12)

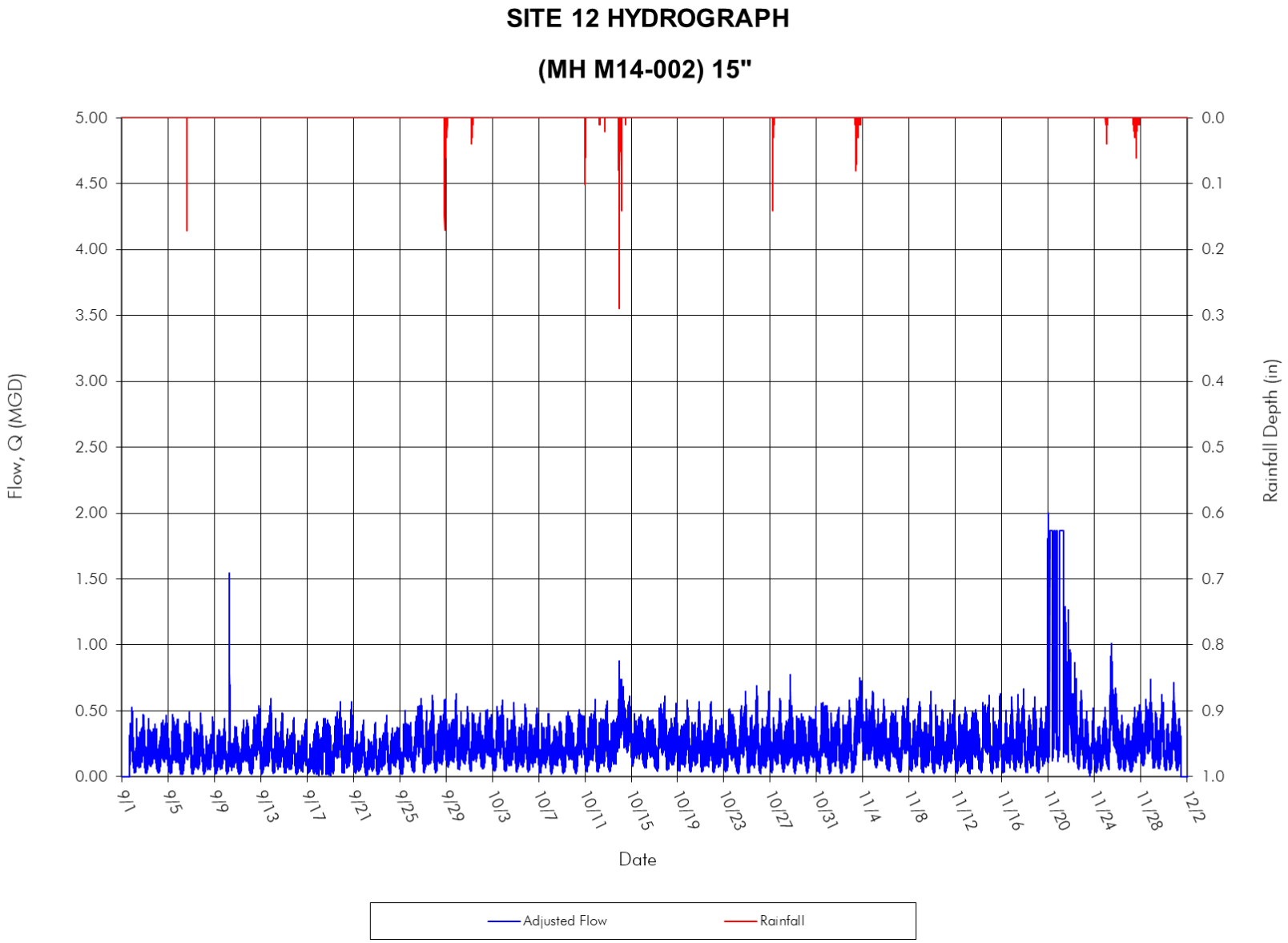


Figure 182 – Overall Level and Velocity Hydrograph (Site 12)

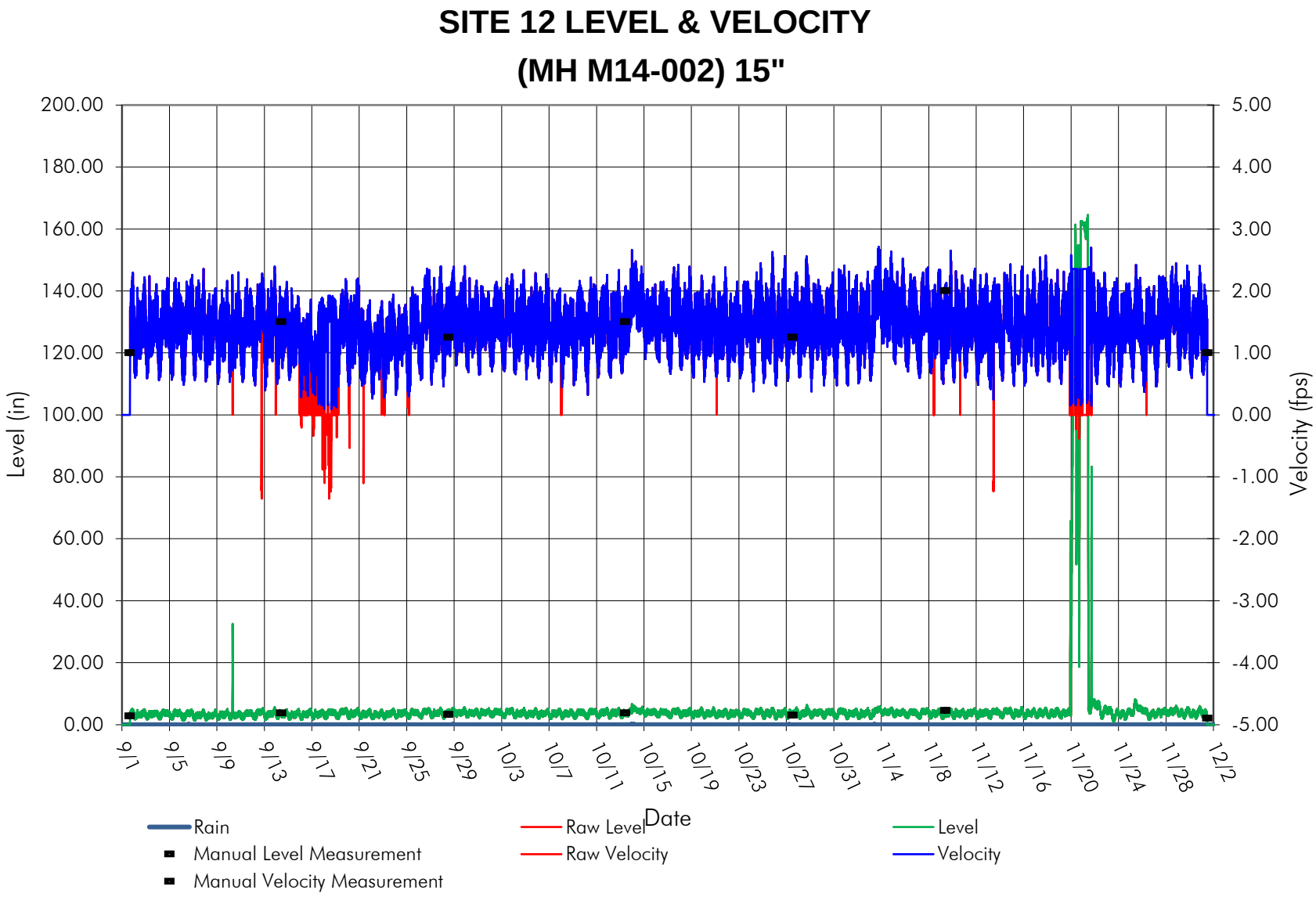


Figure 183 – Standard Flow Scattergraph (Site 12)

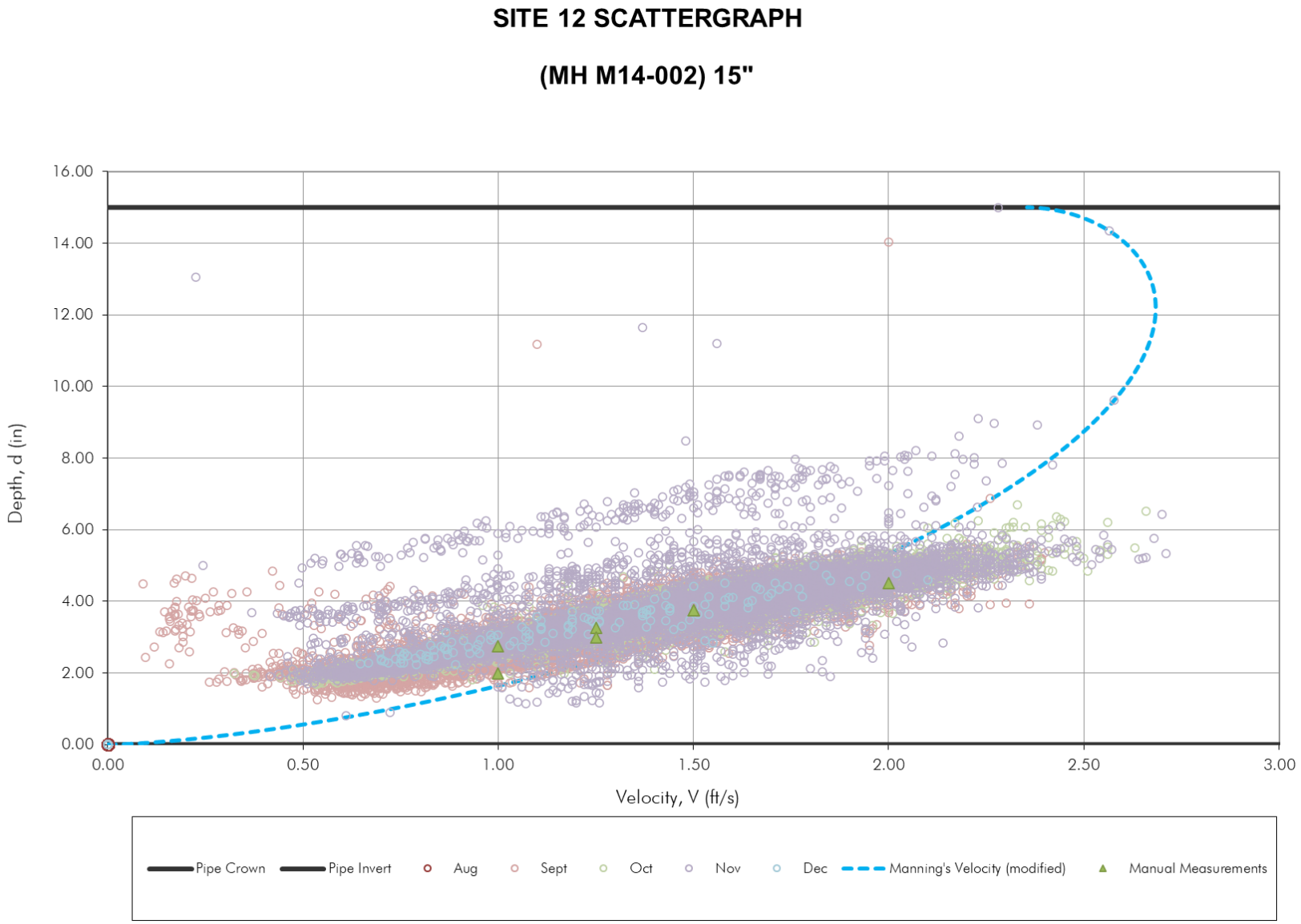


Figure 184 – Surcharged Flow Scattergraph (Site 12)

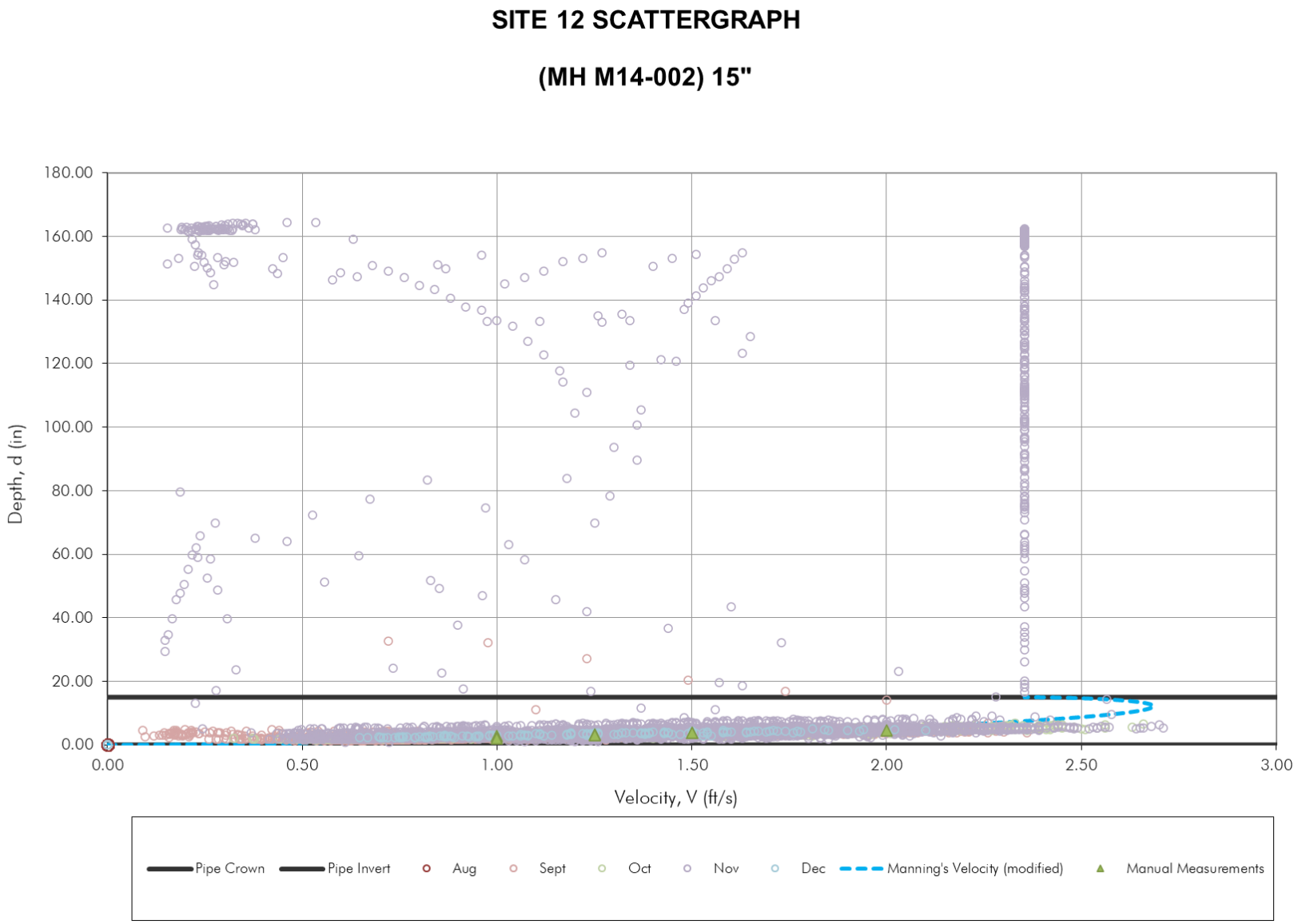


Table 52 – ADDF and Infiltration Summary (Site 12)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 12
Meter: 12
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
12-Sep-21	Sun	0.226	0.411	1.818	0.062	28-Nov-21	0.146
13-Sep-21	Mon	0.193	0.433	2.244	0.065		
14-Sep-21	Tue	0.187	0.374	1.998	0.079		
15-Sep-21	Wed	0.172	0.324	1.887	0.068		
16-Sep-21	Thu	0.143	0.317	2.209	0.055	04-Nov-21	0.202
17-Sep-21	Fri	0.149	0.313	2.098	0.055	15-Oct-21	0.173
18-Sep-21	Sat	0.214	0.330	1.544	0.091	16-Oct-21	0.111
7 Count		0.183 Average	0.357 Average	1.971 Average	0.068 Average	4 Count	0.158 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.183	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.183	
	Diurnal Peaking Factor (DPF):	1.971	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.090	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.090	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.183	

Figure 185 – Dry Weather Diurnal (Site 12)

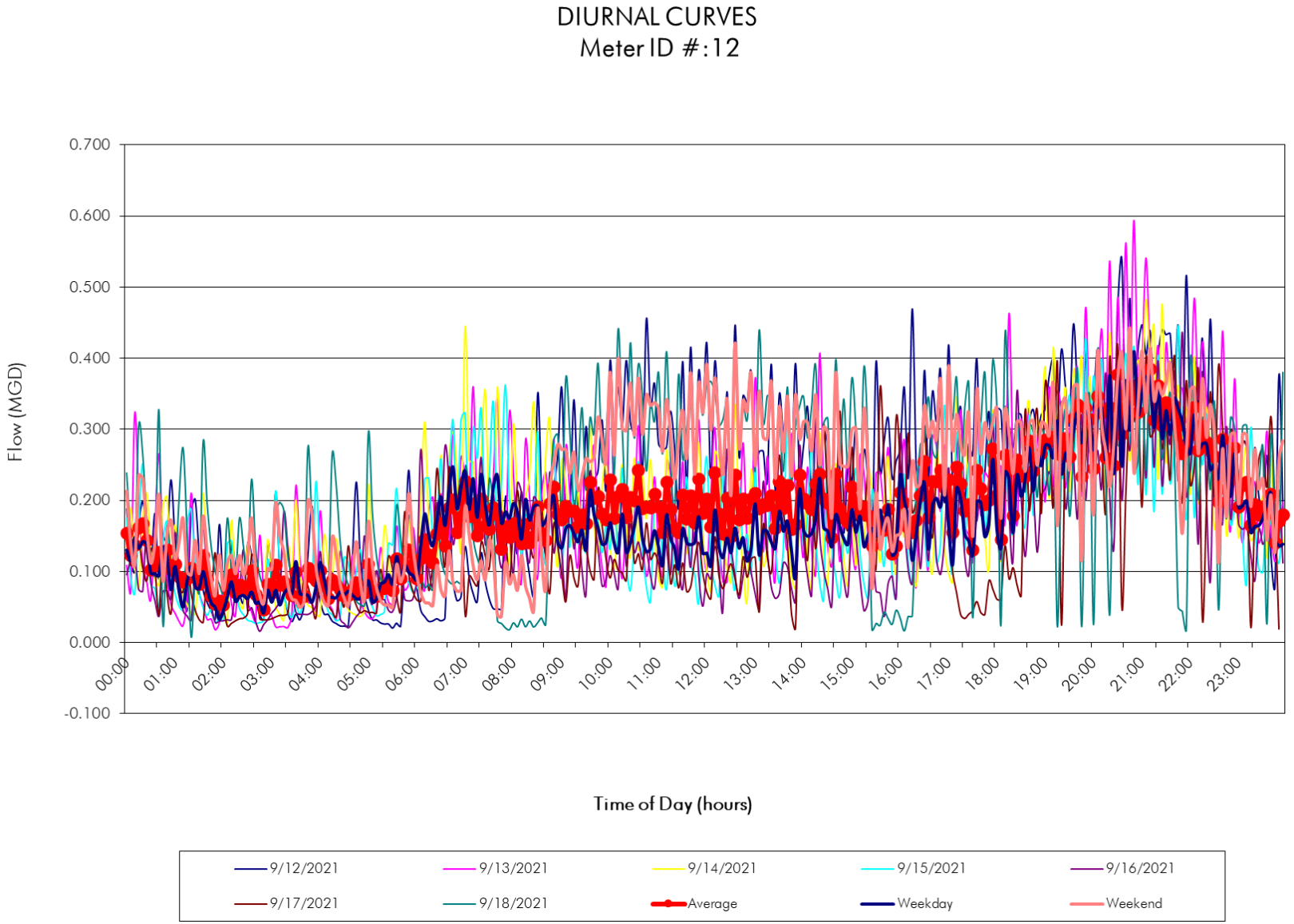


Figure 186 – High/Low Groundwater Diurnal (Site 12)

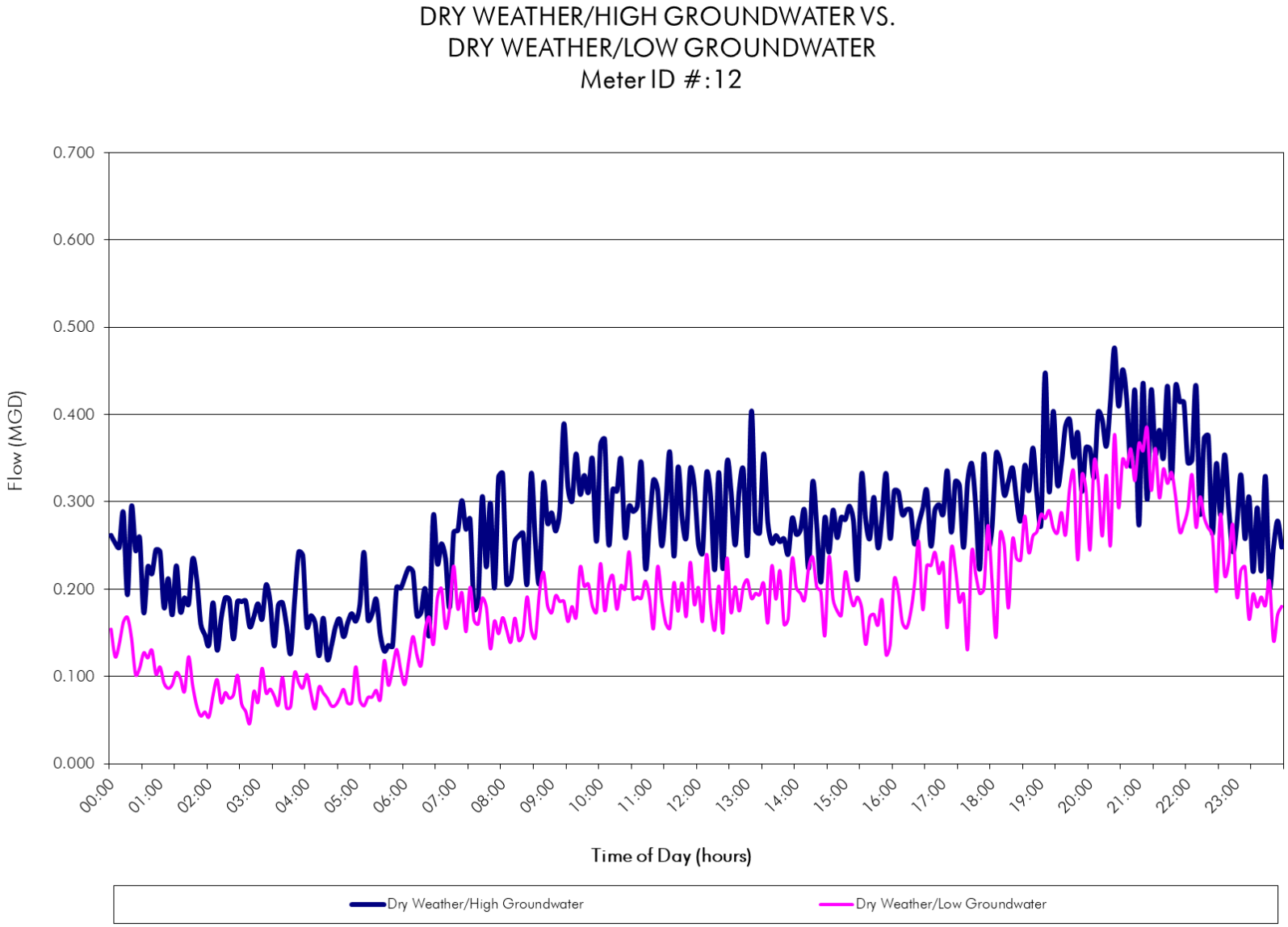


Table 53 – Inflow Calculations and Projections (Site 12)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	12
Meter:	12
Units of Flow:	MGD

Storm Count:	8	Cum. Trib. Area:	353 acres	Pipe Shape:	Circular
Avg Delta Time	72	Cum. Time of Conc.:	90 minutes	Pipe Diameter:	15 in
Avg Kp:	0.00359			Pipe Slope:	0.002 ft/ft
Avg Selected Kp:	0.00365			Pipe Capacity:	1.87 mgd
				ADDF Cum.:	0.183 mgd
				ADDF Peak. Factor:	1.97
				Peak ADDF Flow:	0.362 mgd
				Infiltration:	0.090 mgd
				Cum. Peak Flow:	0.451 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.451
1	1.000	0.833	1.289	1.284
2	1.240	1.033	1.598	1.484
5	1.570	1.307	2.023	1.759
10	1.830	1.524	2.358	1.975
25	2.190	1.824	2.822	2.275
50	2.480	2.065	3.196	2.517
100	2.770	2.307	3.569	2.758

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/6/21 14:50	0.43	0.58	9/6/21 16:55	9/6/21 15:00	115	0.399	09/05/21	0.310	0.089	0.287	0.00136	n						No reaction
9/28/21 20:50	1.68	6.92	9/28/21 21:30	9/28/21 21:25	5	0.585	09/21/21	0.314	0.271	0.640	0.00186	y	0.00186					
10/1/21 5:10	0.28	3.50	10/1/21 6:55	10/1/21 5:15	100	0.487	09/24/21	0.186	0.301	0.167	0.00791	y	0.00791					
10/11/21 0:05	0.35	1.25	10/11/21 0:10	10/11/21 0:05	5	0.344	10/04/21	0.115	0.229	0.233	0.00429	n						No reaction
10/13/21 22:00	3.20	15.00	10/13/21 23:35	10/13/21 23:10	25	0.878	10/12/21	0.201	0.677	1.293	0.00229	y	0.00229					
10/27/21 5:20	0.62	2.33	10/27/21 6:50	10/27/21 5:35	75	0.449	10/26/21	0.238	0.211	0.360	0.00257	y	0.00257					
11/3/21 8:05	1.79	10.67	11/3/21 11:20	11/3/21 10:35	45	0.591	10/27/21	0.194	0.396	0.480	0.00362	y	0.00362					
11/27/21 7:45	0.70	13.92	11/27/21 17:55	11/27/21 14:25	210	0.493	11/26/21	0.290	0.203	0.187	0.00477	n						No reaction

Figure 187 – Inflow Projections (Site 12)

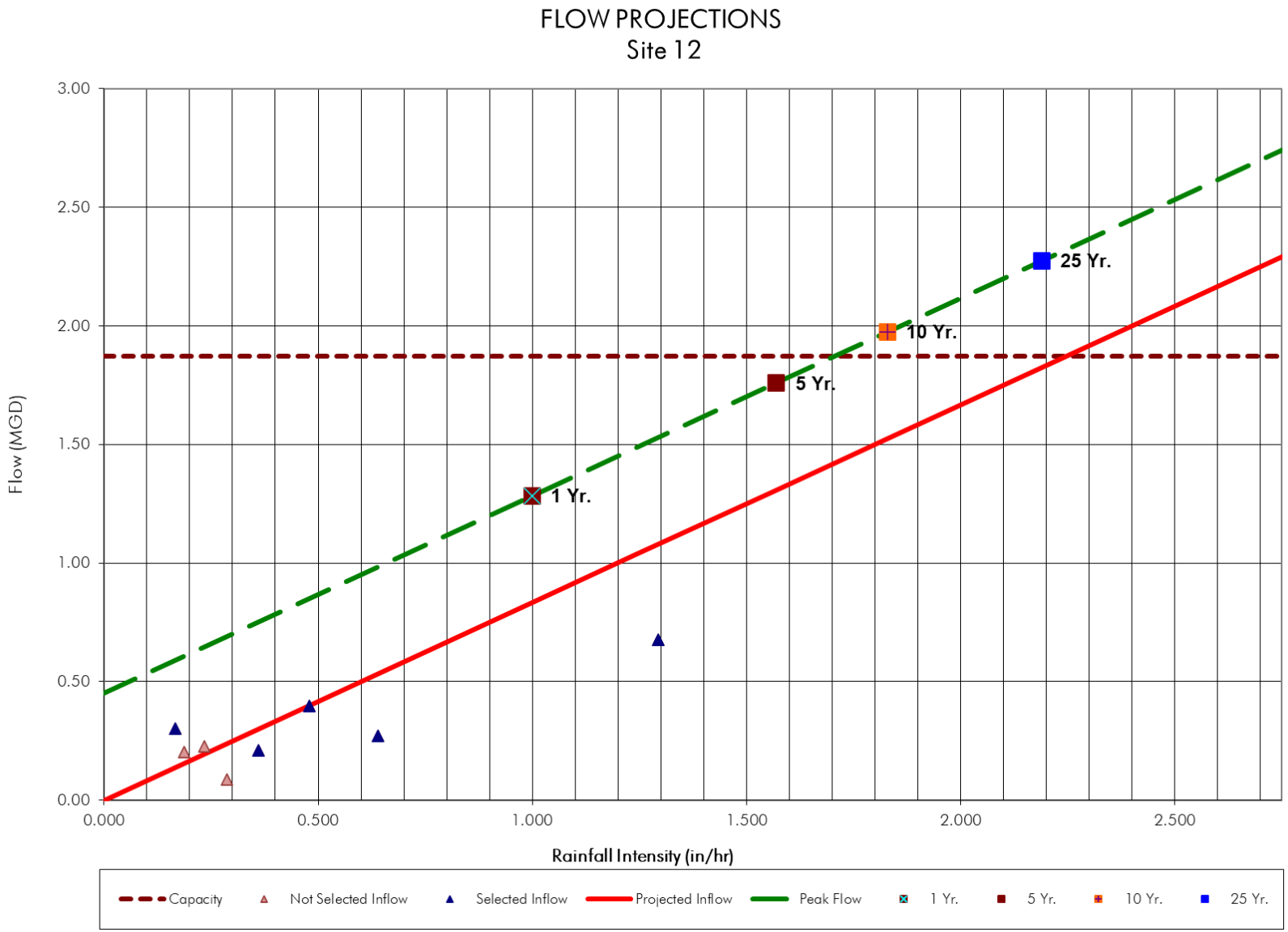
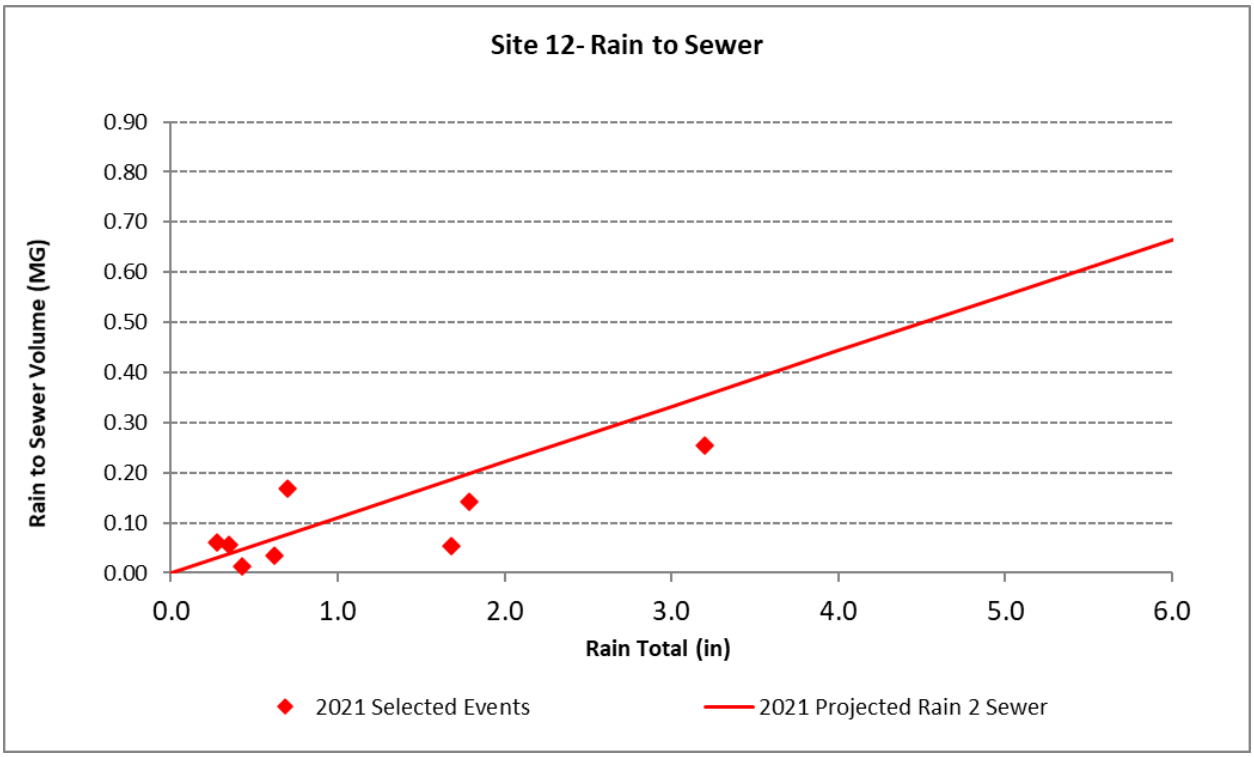


Table 54 – Rain to Sewer Summary (Site 12)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 12 (15")	9/6/2021	0.43	4.121	0.012	0.29%
	9/28/2021	1.68	16.102	0.053	0.33%
	10/1/2021	0.28	2.684	0.060	2.25%
	10/11/2021	0.35	3.355	0.055	1.64%
	10/13/2021	3.20	30.671	0.253	0.83%
	10/27/2021	0.62	5.943	0.035	0.59%
	11/3/2021	1.79	17.157	0.142	0.83%
	11/27/2021	0.70	6.709	0.168	2.50%
				Average	**1.16%**

Figure 188 – Rain to Sewer Volumetric Analysis (Site 12)



A.13 Site 13

Description

Site 13 measures flow in manhole O10-068. This manhole is located North Bishop St. The area velocity sensor was placed the north in flow 12" diameter PVC pipe of the manhole. This meter measures flow within the Gilleland Creek Watershed. The intended site was planned for manhole O09-007 however construction was in progress to upsize the segment at that manhole.

Observations

The average flow depth for this site was 2.67 inches with an average velocity of 2.08 feet per second. The meter was relocated to manhole O09-007 on 10/26/2021. The collected data from this monitoring site was considered poor. There were several backups and flow were higher at this location than what was monitored downstream after 10/26/2021. This could be attributed to construction and possible bypass pumping. Velocity dropouts were common at low levels, however there were enough valid recordings to adjust the dropouts accordingly.

There were several dry weather surcharging events recorded at this site during the 2021 monitoring period. The surcharging backups is suspected to be due to smaller diameter pipe downstream prior to construction downstream of the meter location. The construction to upsize the pipe downstream may have also contributed to backups.

Table 55 – Surcharge Summary (Site 13)

		Date of Storm	9/14/2021	9/20/2021	9/23/2021	9/28/2021	10/7/2021	10/13/2021
		Total Storm Rainfall (in.)	Dry Weather Surcharge	Dry Weather Surcharge	Dry Weather Surcharge	1.65"	Dry Weather Surcharge	3.15"
Site	Diameter (in.)	Storm Duration (hrs.)				7.92		6.00
13[(1)]	12	Depth from Invert (in.)	13.18 (B)	26.86 (B)	23.18 (B)	55.47 (B)	18.39 (B)	18.71 (B)

(1) Surcharging is attributed to a bottleneck and/or construction activities. Completion of Bastrop/Parsons CIP S-32 wastewater line upsizing eliminated system bottlenecks and allowed for relocation of meter from interim Site 13 to 13B on 10/26/2021.
(P) Denotes pressurized flow caused by lack of capacity
(flow velocities generally increase as flow depths increase)
(B) Denotes flow backup caused by downstream restriction
(flow velocities generally decrease as flow depths increase)

Table 56 – Service Interrogations Summary (Site 13)

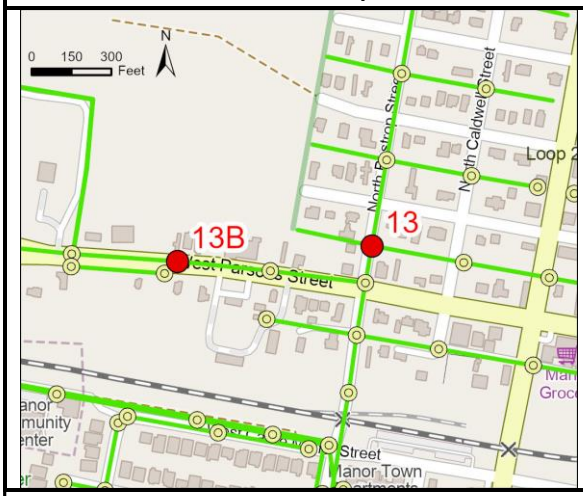
Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 13	9/13/2021	13:03	12	1.25	1.00	-0.25	1.25	1.37	0.12	2.00	2.60	0.60	2.00	2.40	0.40	Install	Meter installed at temporary location
	9/27/2021	14:25		1.25	1.20	-0.05	1.50	1.50	0.00	2.50	2.40	-0.10	2.50	2.40	-0.10	Service/Upload	
	10/12/2021	11:15		1.50	1.90	0.40	1.50	2.00	0.50	2.00	2.30	0.30	2.00	2.20	0.20	Service/Upload	
	10/26/2021	11:20		1.25	1.36	0.11	1.50	1.36	-0.14	1.50	1.38	-0.12	1.50	1.38	-0.12	Removal	Removed meter from temporary location

Figure 189 – Flow Meter Site Investigation (Site 13)

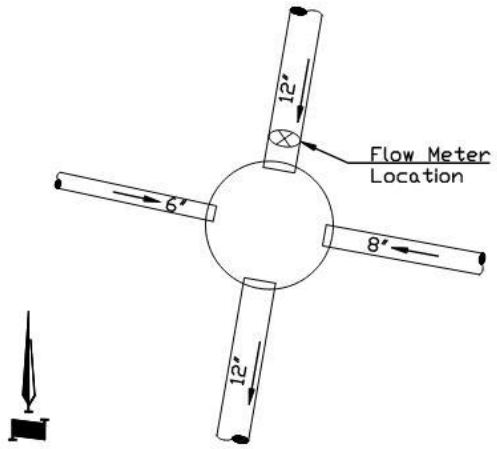
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 10-26-2021 / 11:20	**Crew:** JA-VI
MH#: 010-068	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 12
Site ID: 13	**Address:** 209 Parsons St.	**Site Quality:** Poor	**Monitoring Purpose:** Short-term FM

Location Map



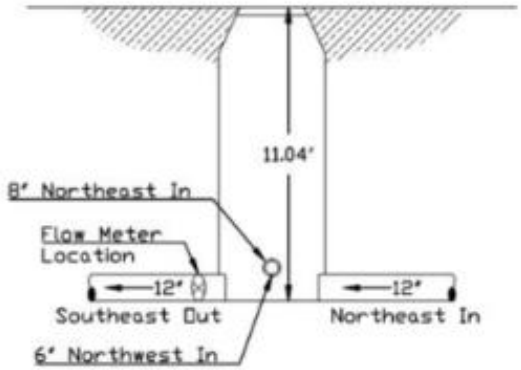
Planar Description



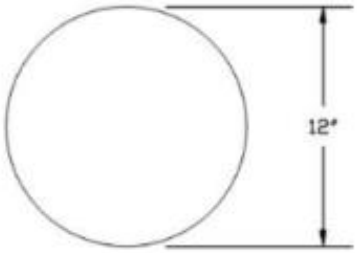
Summary Description:
Preliminary metered manhole was to be where Site 13B is but due to ongoing wastewater rehabilitation project on Parson Street the manhole was unavailable. Meter on Site 13 was moved to original location (Site 13B) after construction was finished. Site 13 manhole is in the middle of the street in front of a Hair Salon.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? Medium		**Manhole Depth (ft):** 8.39	**Surcharge Evidence?** Yes
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 6.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 24.00	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Standard	**Usable MH Steps?** No
Describe potential hazards: Traffic can be busy during certain periods of the day such as mornings, and during lunch hour. Cones need to be placed immediately and service vehicle lights need to be always on. During service the truck blocks one side of traffic. Top man needs to be very attentive and may need to direct traffic.		**Measured Flow Depth (in):** 1.50	**Meter:** ISCO 2150
		Velocity (fps): 1.50	**Cellular Signal Strength:** N/A
		Mounting Band Description: Spring Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes



Pipe Cross Section



Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE

DOWN

INFLOW

OUTFLOW

Figure 190 – Site Information (Site 13)

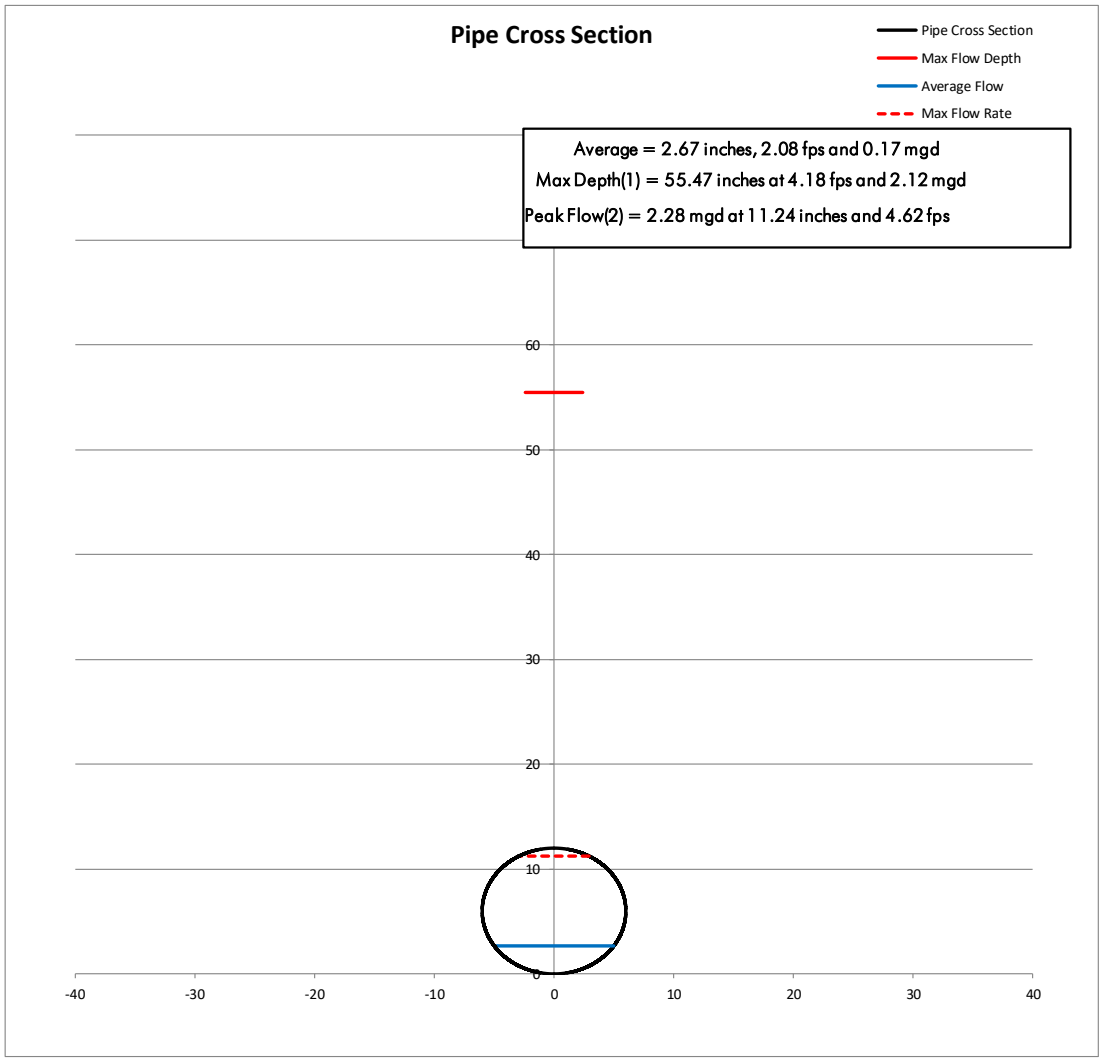
SITE INFORMATION RECORD

Site Information

Meter ID #:	13
Monitoring Program:	Short-Term FM
Manhole #:	O10-068

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	12	
Pipe Width, W (in):	12	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0085	ASSUMEDI



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 13	9/13/2021	12	13:03	1.25	1.37	0.12	2.00	2.40	0.40
	9/27/2021		14:25	1.50	1.50	0.00	2.50	2.40	-0.10
	10/12/2021		11:15	1.50	2.00	0.50	2.00	2.20	0.20
	10/26/2021		11:20	1.50	1.36	-0.14	1.50	1.38	-0.12

Figure 191 – September Monthly Flow Hydrograph (Site 13)

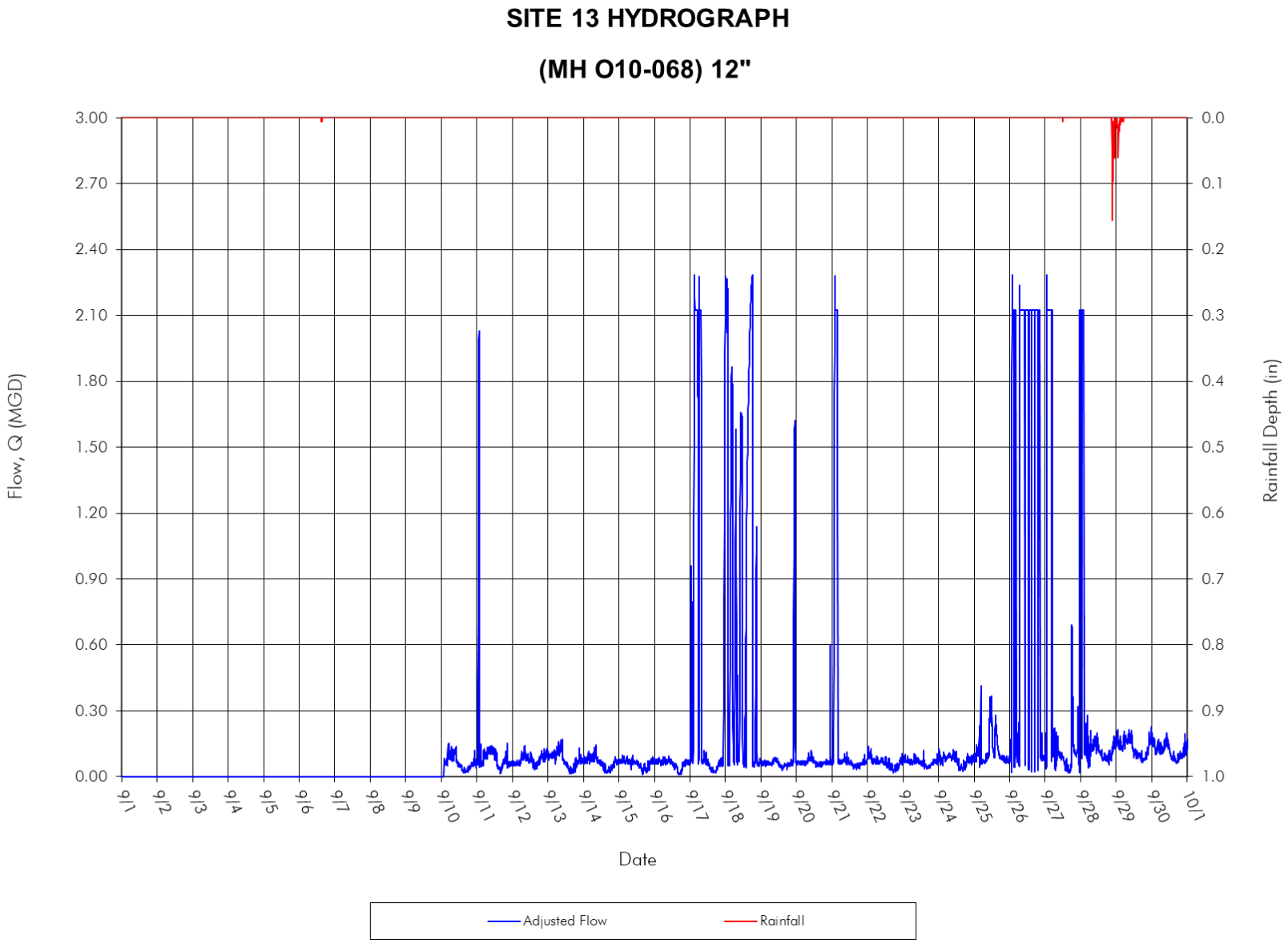


Figure 192 – September Monthly Level and Velocity Hydrograph (Site 13)

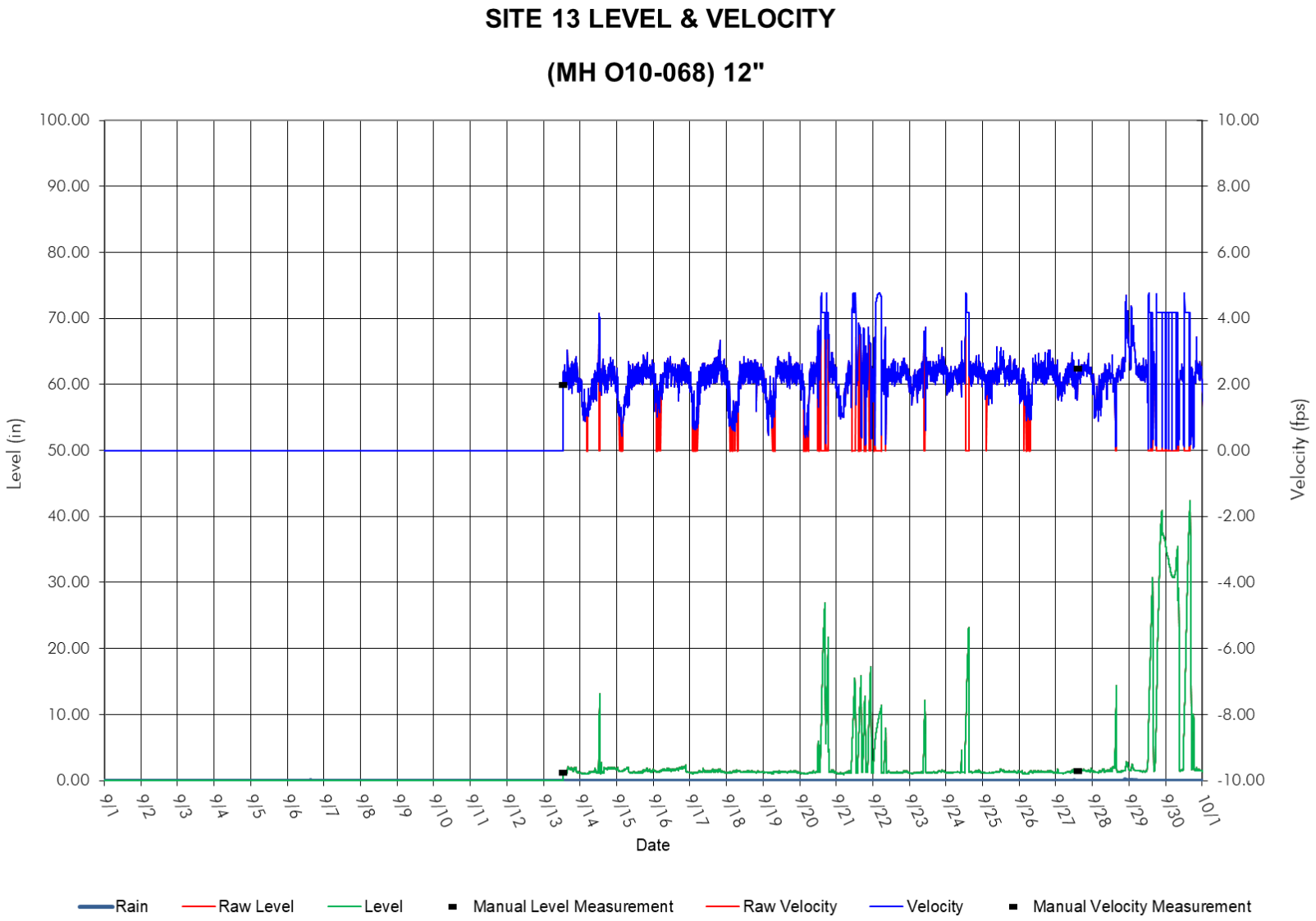


Figure 193 – October Flow Hydrograph (Site 13)

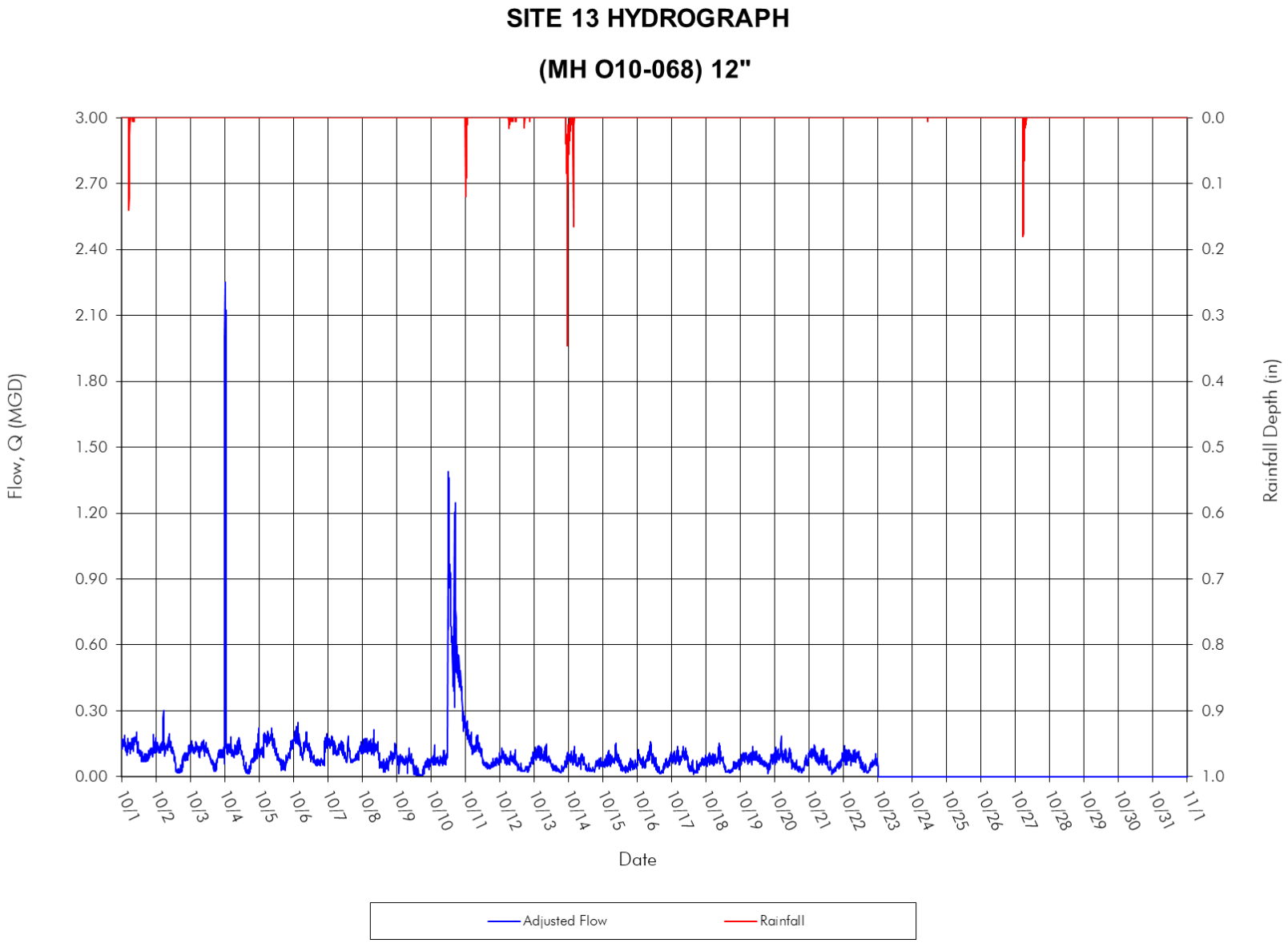


Figure 194 – October Monthly Level and Velocity Hydrograph (Site 13)

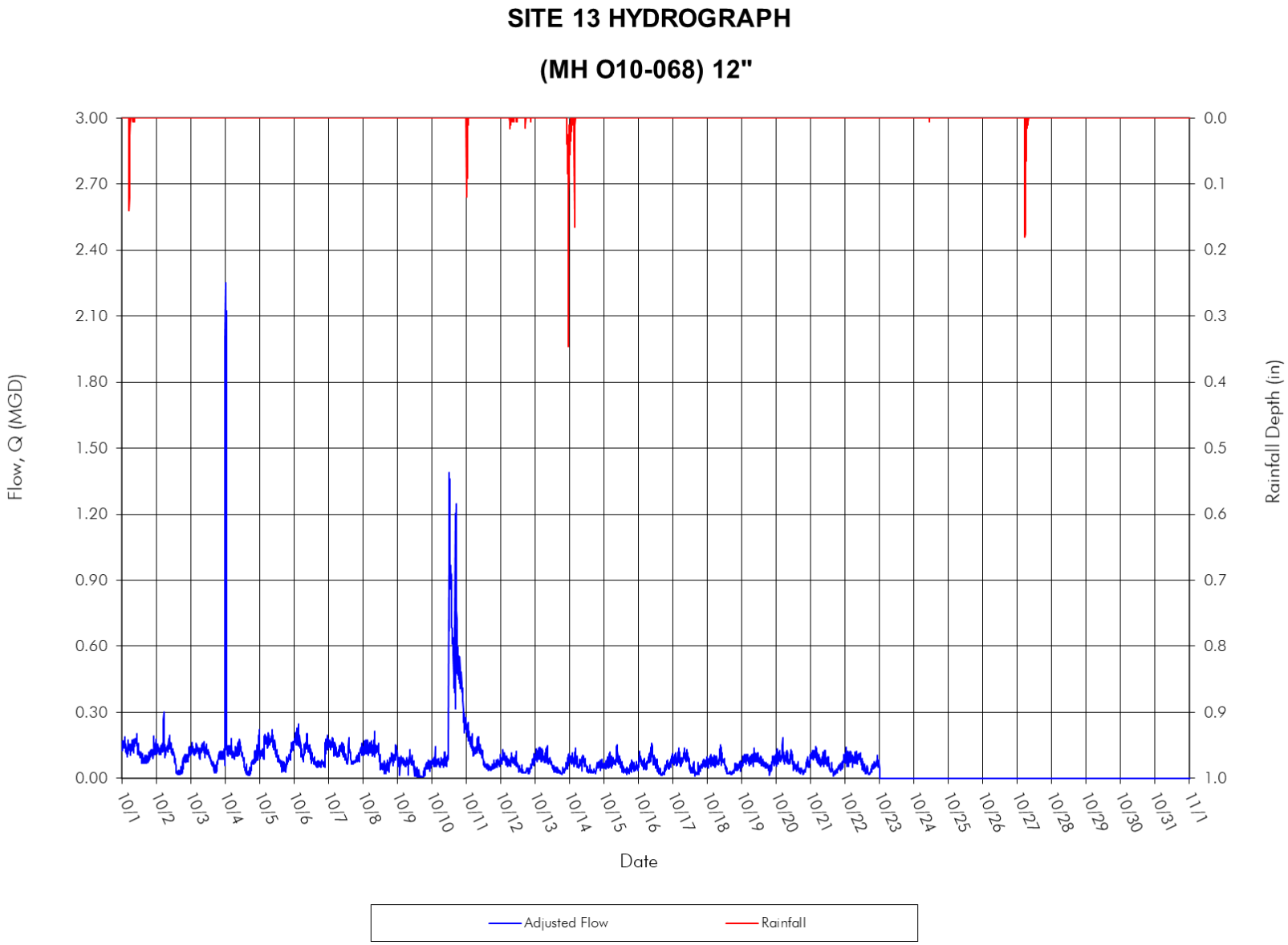


Figure 195 – Overall Flow Hydrograph (Site 13)

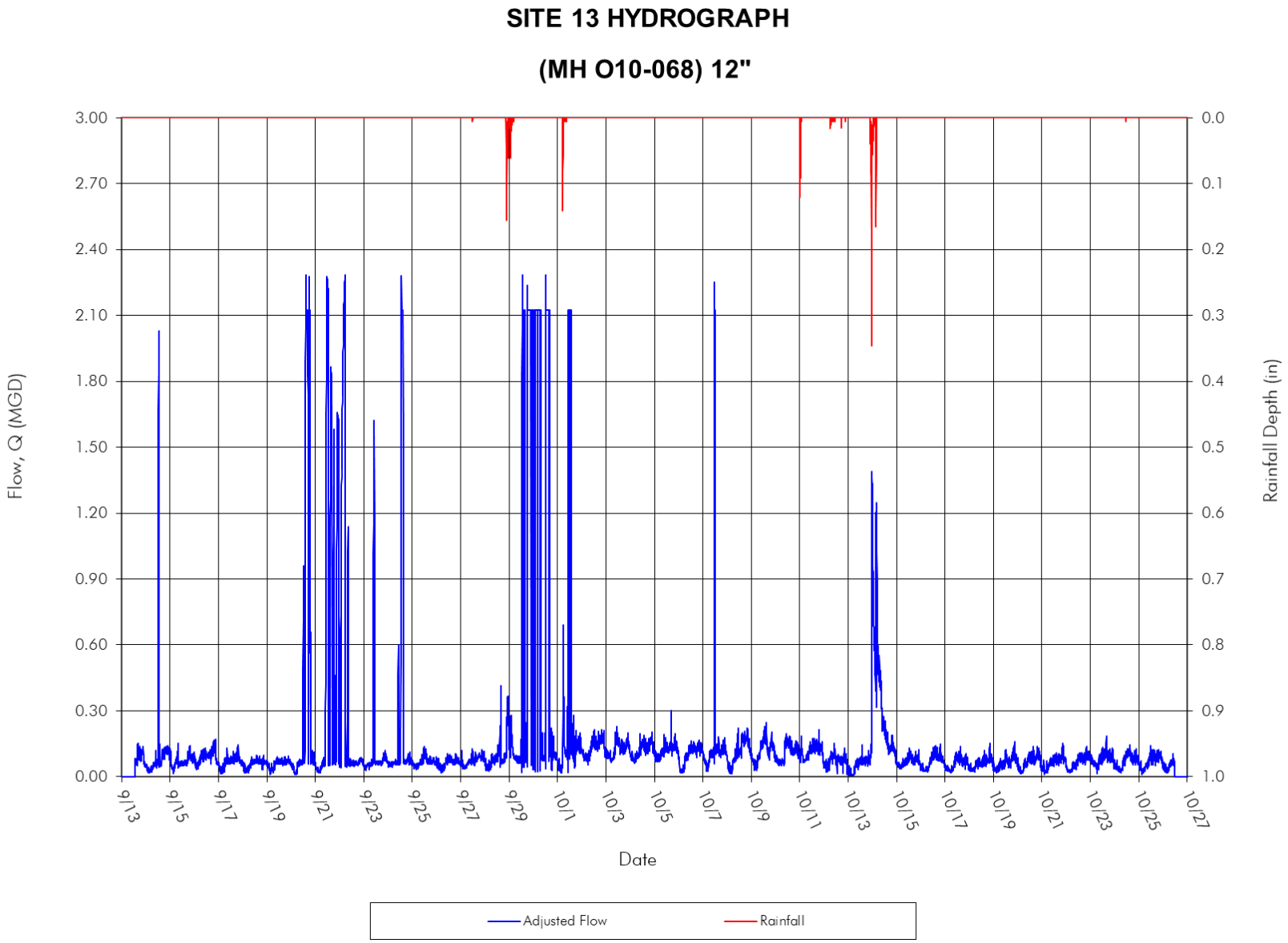


Figure 196 – Overall Level and Velocity Hydrograph (Site 13)

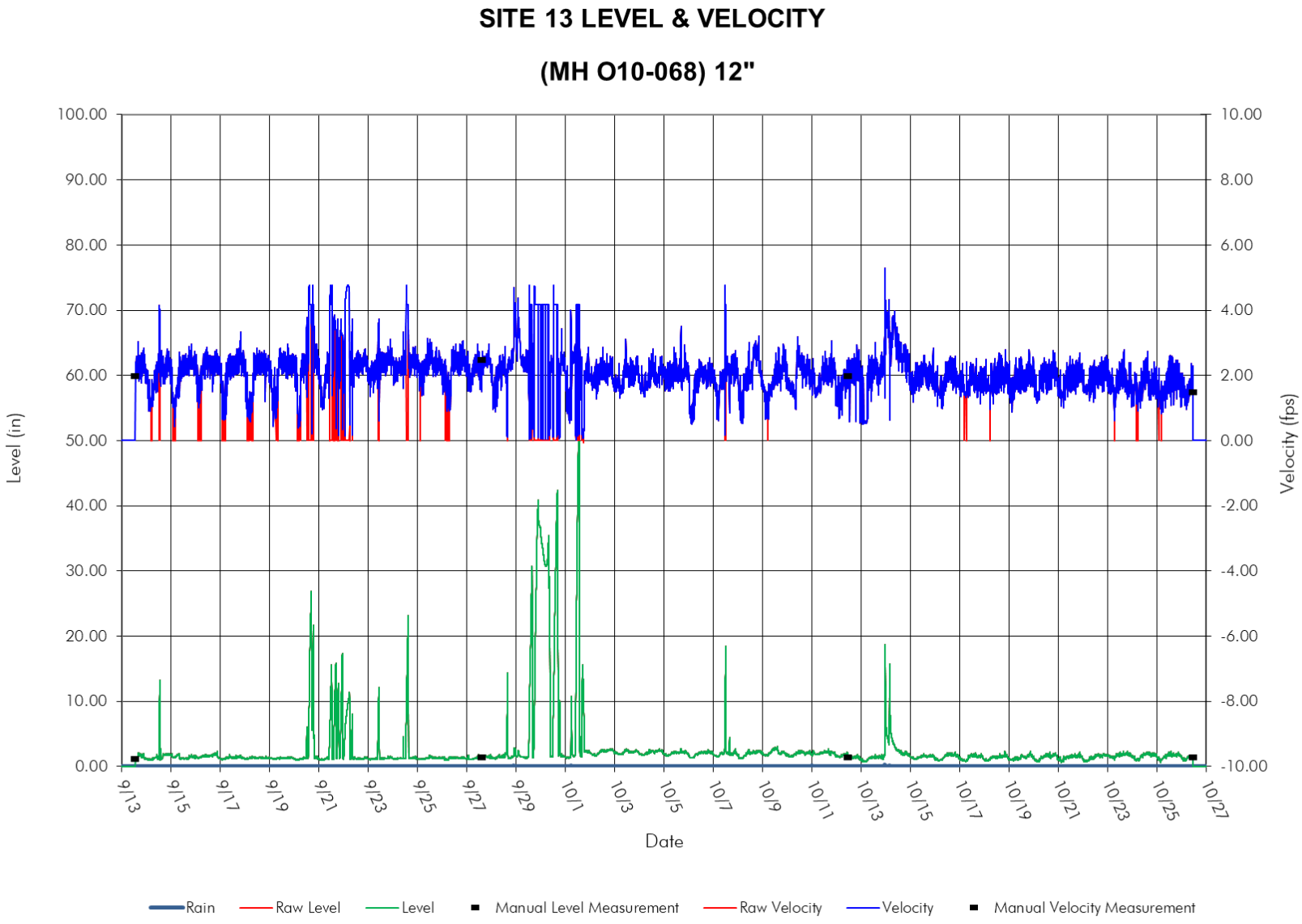


Figure 197 – Standard Flow Scattergraph (Site 13)

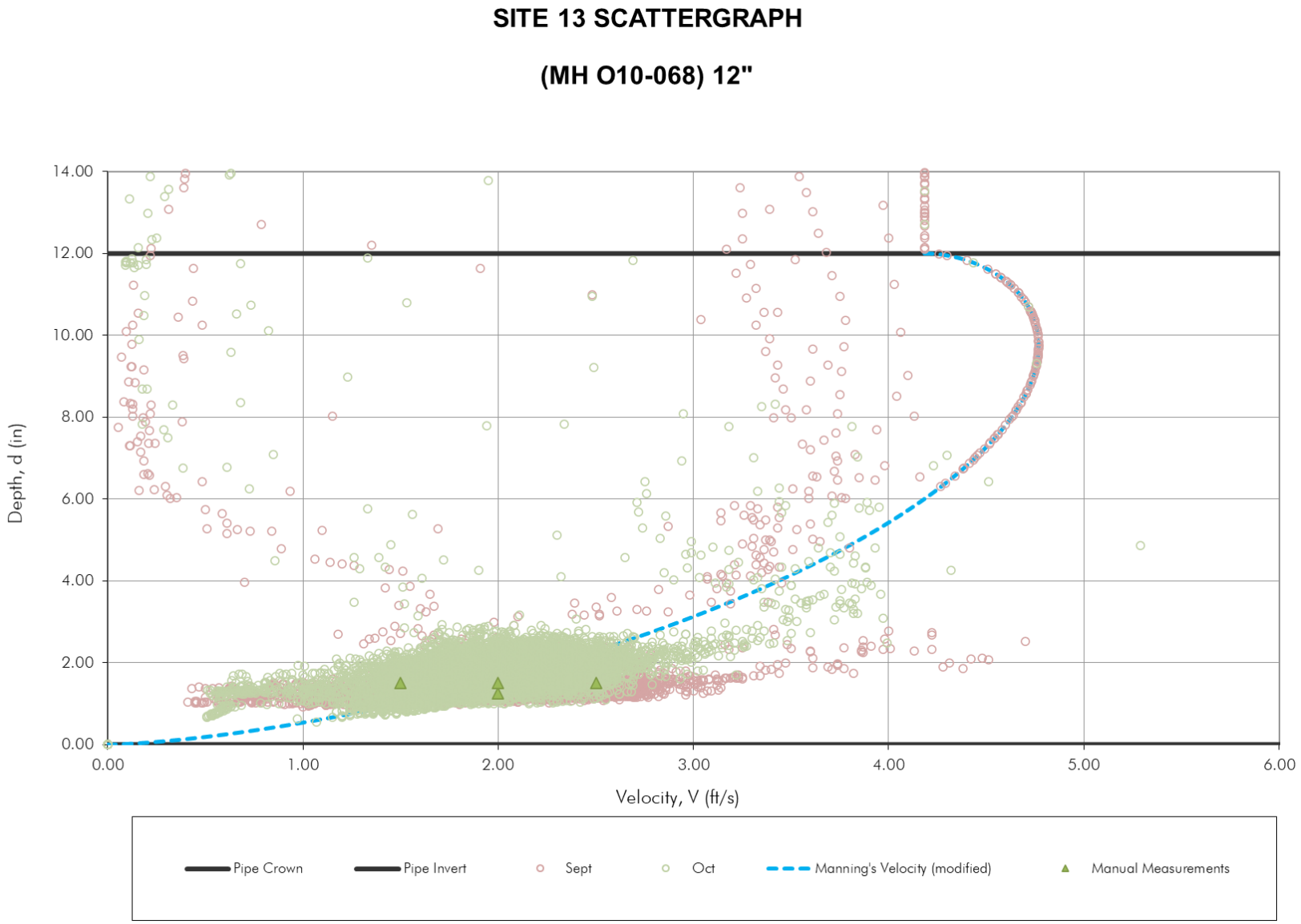


Figure 198 – Surcharged Flow Scattergraph (Site 13)

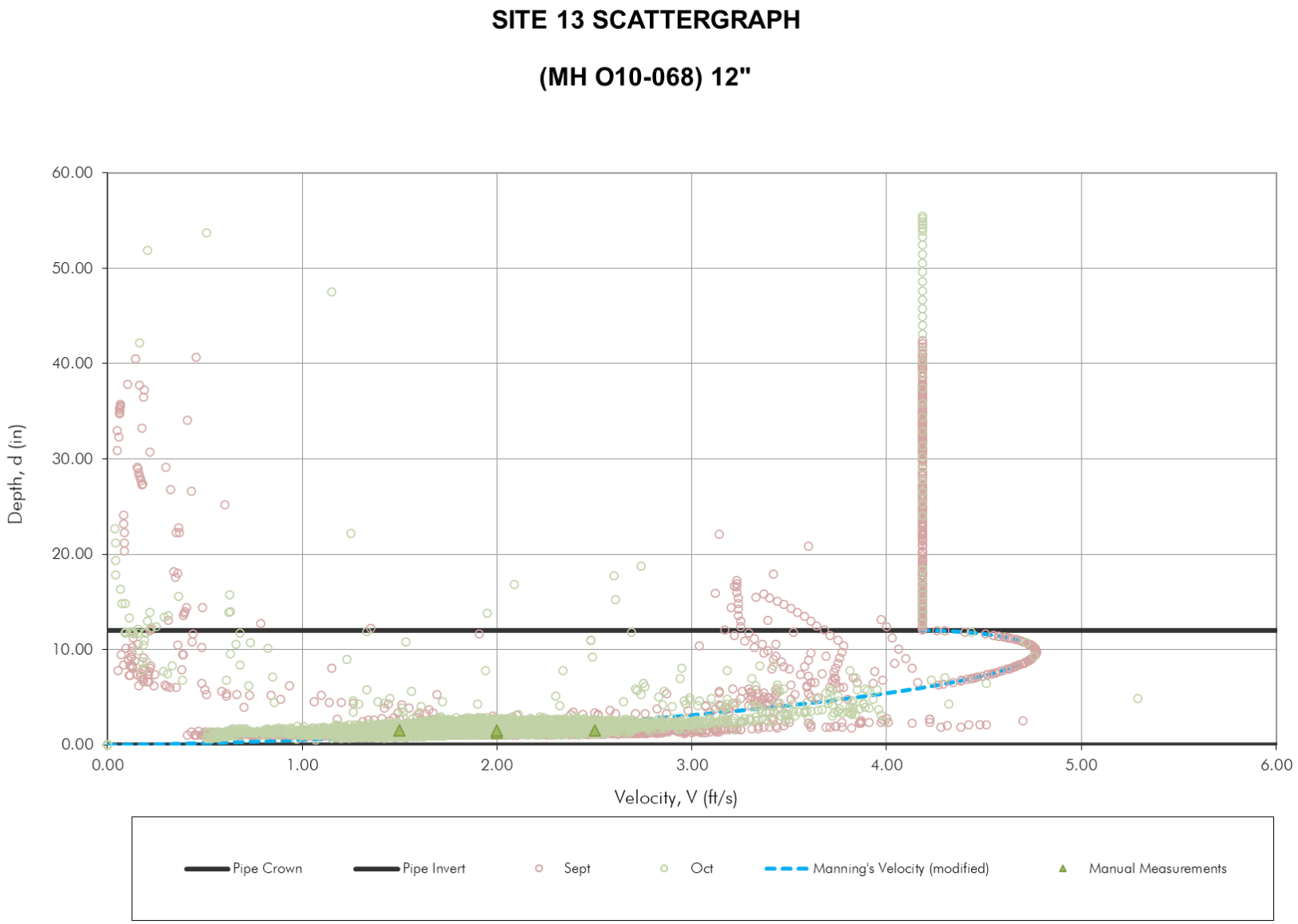


Figure 199 – ADDF and Infiltration Summary (Site 13)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 13
Meter: 13
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
19-Sep-21	Sun	0.059	0.078	1.324	0.032	03-Oct-21	0.080
27-Sep-21	Mon	0.073	0.098	1.338	0.044		
14-Sep-21	Tue	0.066	0.119	1.792	0.023		
15-Sep-21	Wed	0.068	0.111	1.634	0.032		
16-Sep-21	Thu	0.088	0.139	1.581	0.052		
17-Sep-21	Fri	0.066	0.119	1.792	0.023	15-Oct-21	0.047
18-Sep-21	Sat	0.058	0.080	1.396	0.026	02-Oct-21	0.080
7 Count		0.068 Average	0.106 Average	1.551 Average	0.033 Average	3 Count	0.069 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.068	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.068	
	Diurnal Peaking Factor (DPF):	1.551	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.036	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.036	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.068	

Figure 200 – Dry Weather Diurnal (Site 13)

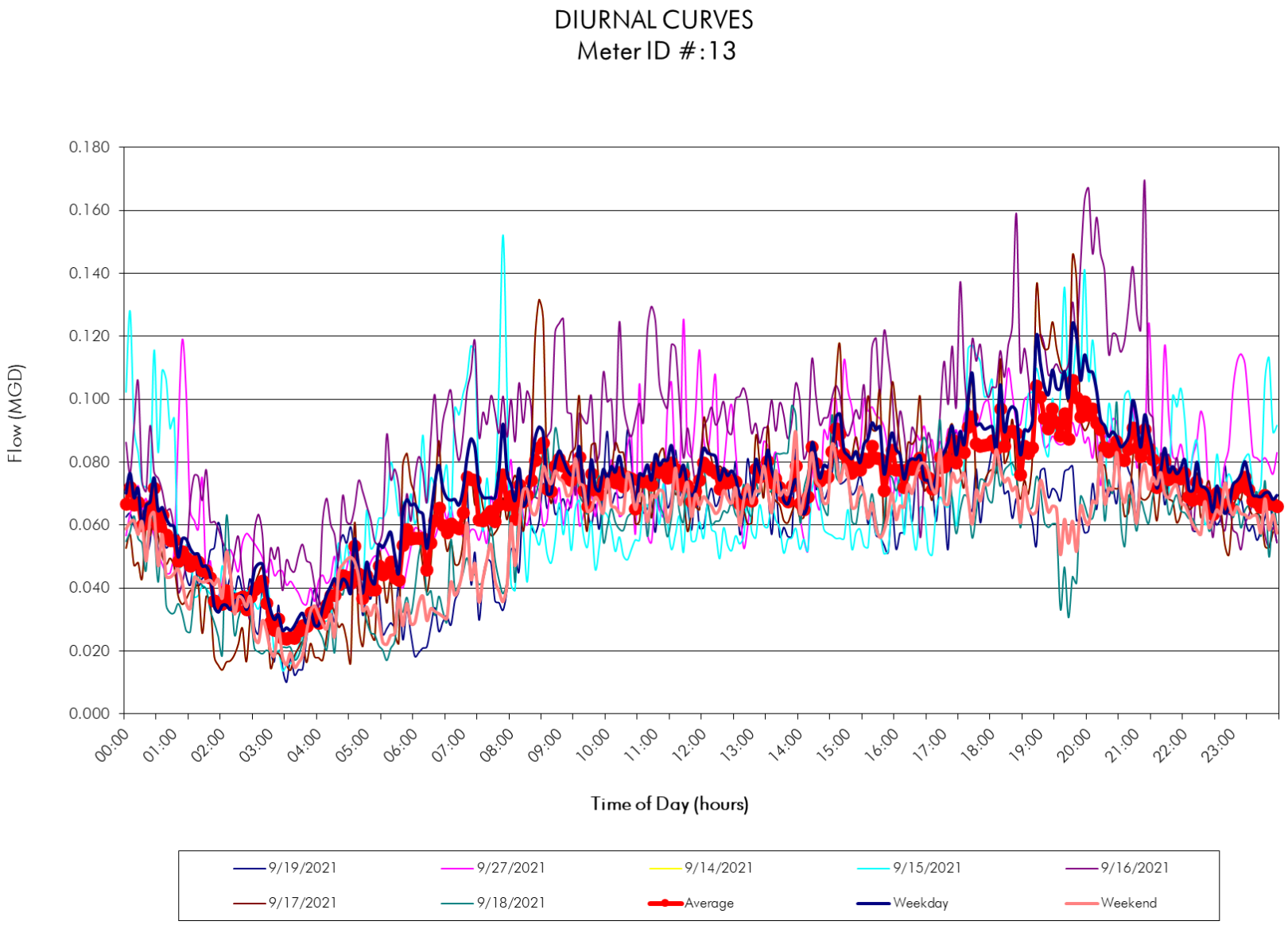


Figure 201 – High/Low Groundwater Diurnal (Site 13)

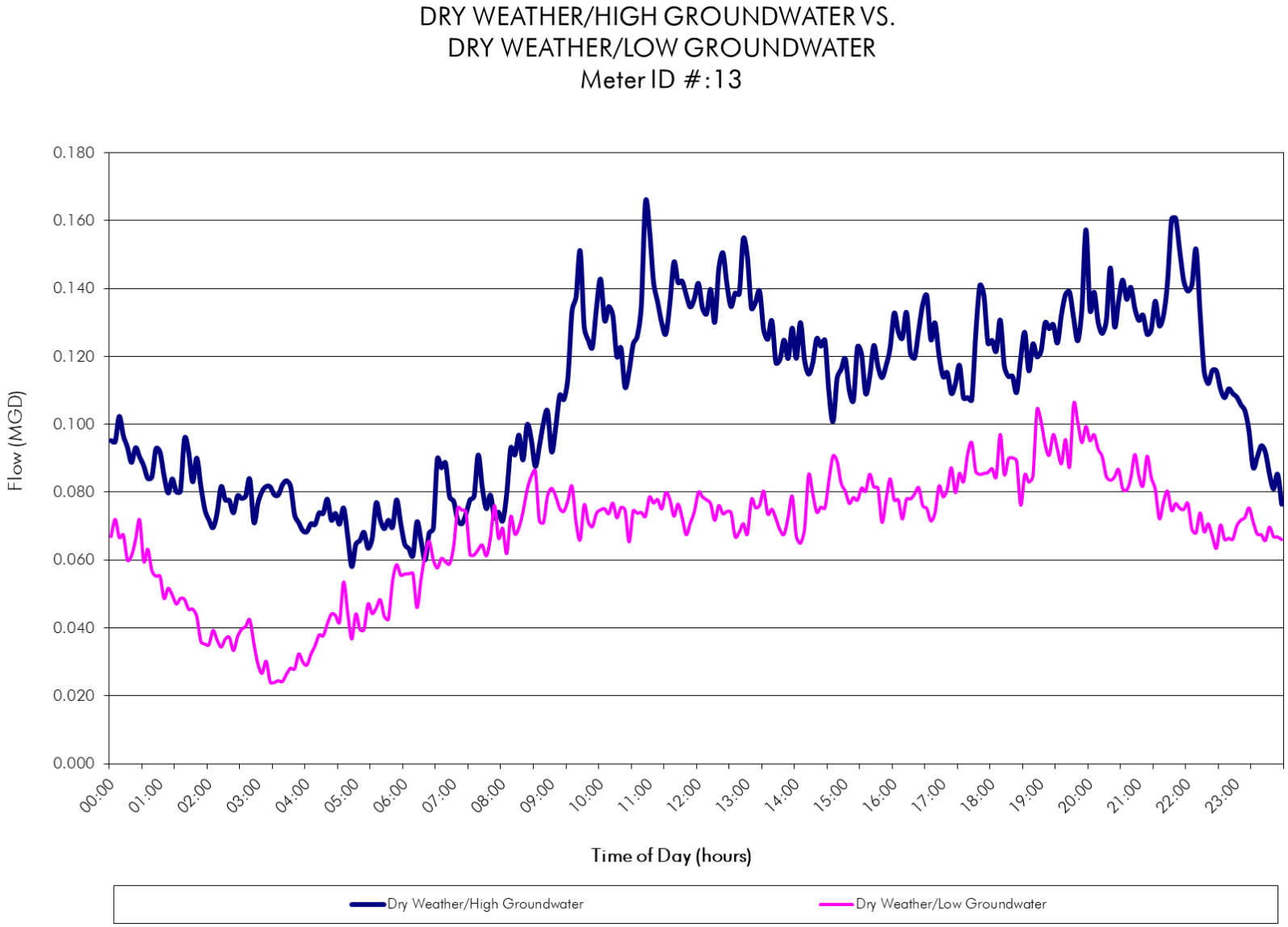


Table 57 – Inflow Calculations and Projections (Site 13)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	13
Meter:	13
Units of Flow:	MGD

Storm Count:	7	Cum. Trib. Area:	53	acres	Pipe Shape:	Circular	
Avg Delta Time	43	Cum. Time of Conc.:	45	minutes	Pipe Diameter:	12	in
Avg Kp:	0.01428				Pipe Slope:	0.009	ft/ft
Avg Selected Kp:	0.01428				Pipe Capacity:	2.13	mgd
					ADDF Cum.:	0.068	mgd
					ADDF Peak. Factor:	1.55	
					Peak ADDF Flow:	0.106	mgd
					Infiltration:	0.036	mgd
					Cum. Peak Flow:	0.142	mgd
					Manning's Coefficient, n:	0.013	

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.142
1	1.590	0.778	1.203	0.919
2	1.970	0.963	1.491	1.105
5	2.500	1.223	1.892	1.364
10	2.920	1.428	2.209	1.570
25	3.490	1.707	2.641	1.848
50	3.950	1.932	2.989	2.073
100	4.410	2.157	3.337	2.298

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/28/21 21:00	1.65	7.92	9/28/21 22:10	9/28/21 21:20	50	0.364	09/27/21	0.082	0.282	0.870	0.00947	y	0.00947					
10/1/21 4:55	0.73	3.67	10/1/21 5:25	10/1/21 5:05	20	0.692	09/24/21	0.063	0.629	0.890	0.02064	y	0.02064					
10/11/21 0:05	0.49	1.25	10/11/21 1:25	10/11/21 0:05	80	0.186	10/04/21	0.078	0.108	0.370	0.00848	y	0.00848					
10/13/21 21:55	3.15	6.00	10/13/21 23:30	10/13/21 23:10	20	1.391	10/12/21	0.053	1.338	2.110	0.01851	y	0.01851					Brief Surcharge
10/27/21 5:15	0.89	2.42																Meter relocated to 13B
11/3/21 2:10	1.89	16.83																Meter relocated to 13B
11/27/21 7:45	0.70	13.92																Meter relocated to 13B

Figure 202 – Inflow Projections (Site 13)

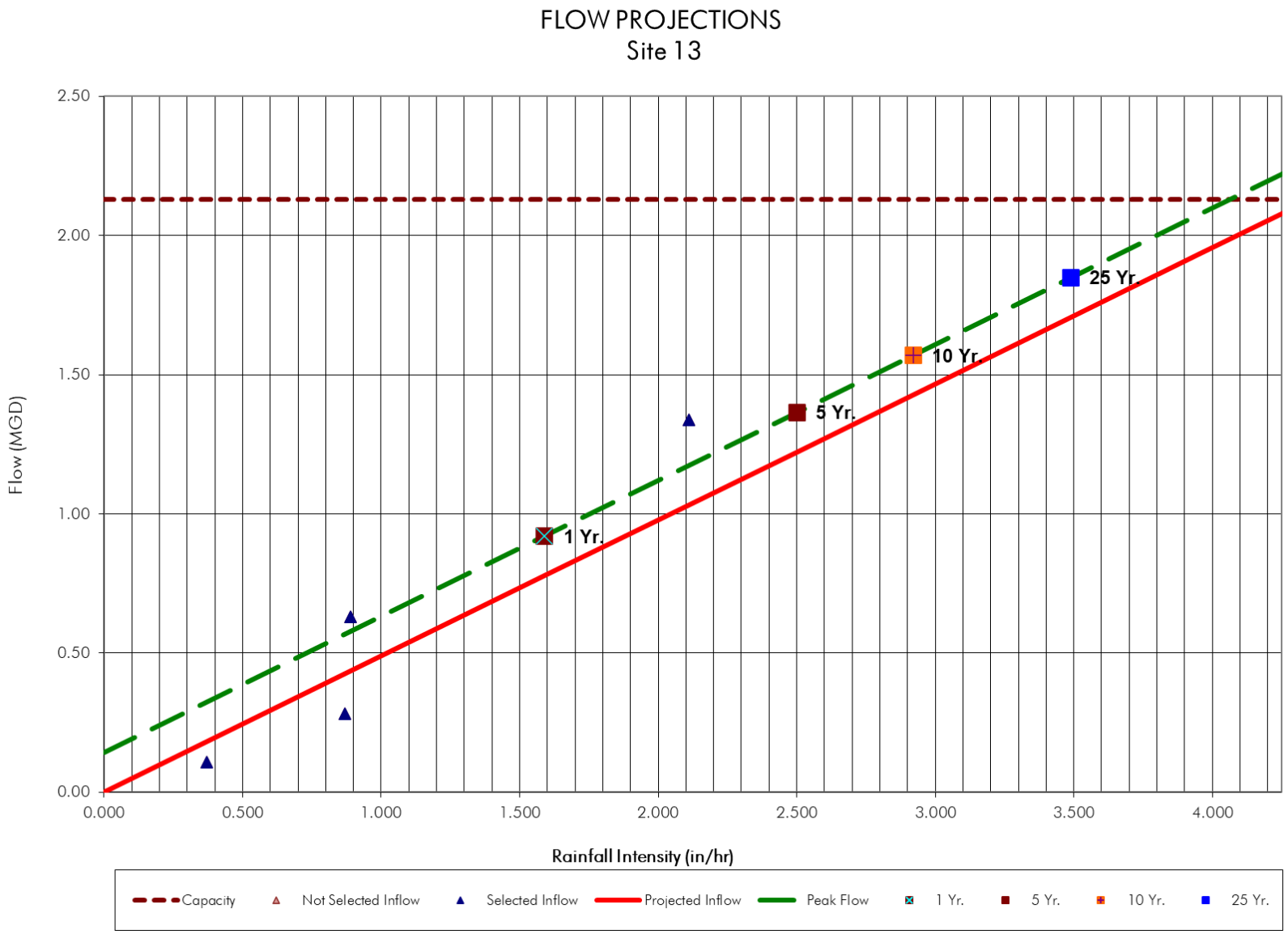
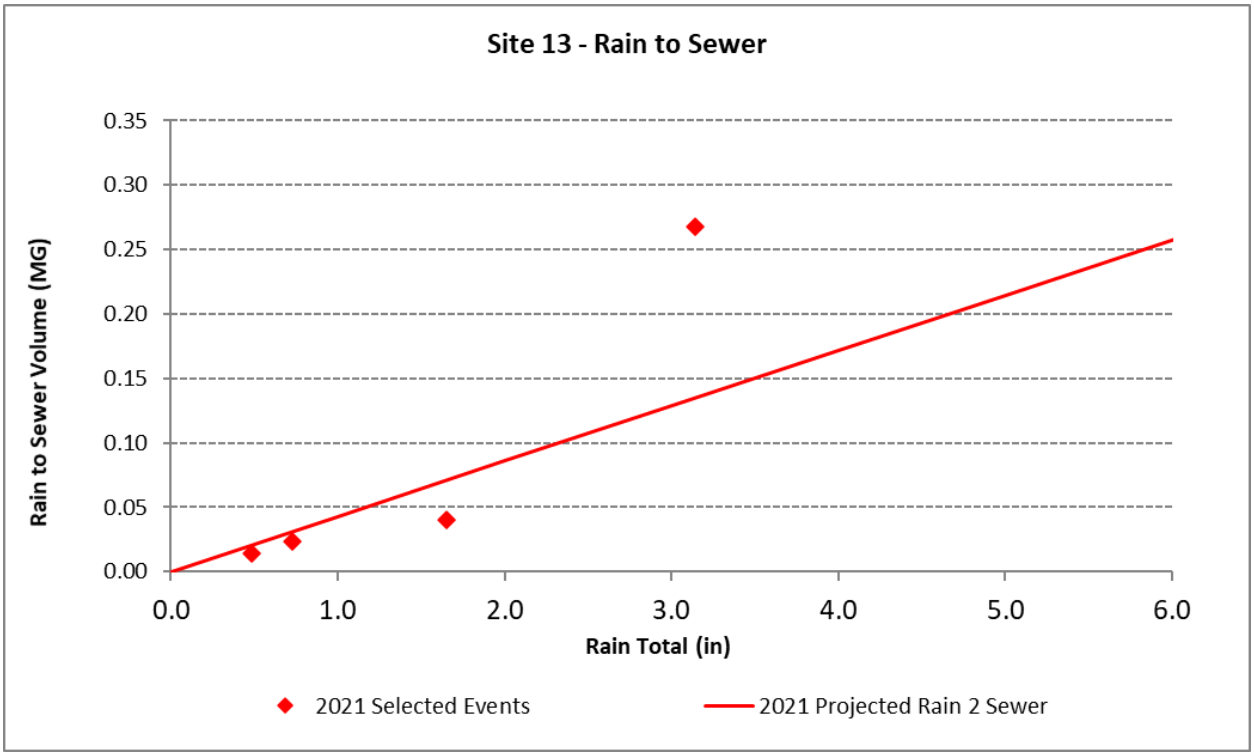


Table 58 – Rain to Sewer Summary (Site 13)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 13 (12")	9/28/2021	1.65	2.374	0.040	1.70%
	10/1/2021	0.73	1.051	0.024	2.25%
	10/11/2021	0.49	0.698	0.014	2.05%
	10/13/2021	3.15	4.526	0.268	5.91%
				Average	**2.98%**

Figure 203 – Rain to Sewer Volumetric Analysis (Site 13)



A.14 Site 13B

Description

Site 13 measures flow in manhole O09-007. This manhole is located on West Parsons St. The area velocity sensor was placed the east in flow 12" diameter PVC pipe of the manhole. This meter measures flow within the Gilleland Creek Watershed. The meter was relocated from Site 13 at manhole O10-068.

Observations

The average flow depth for this site was 2.2 inches with an average velocity of 0.48 feet per second. The meter was relocated to manhole O09-007 on 10/26/2021. Medium debris and light grease were reported during site services. The collected data from this monitoring site was considered good. Velocity dropouts were common at low levels, however there were enough valid recordings to adjust the dropouts accordingly.

There were no surcharging events recorded at this site during the 2021 monitoring period.

Table 59 – Service Interrogations Summary (Site 13B)

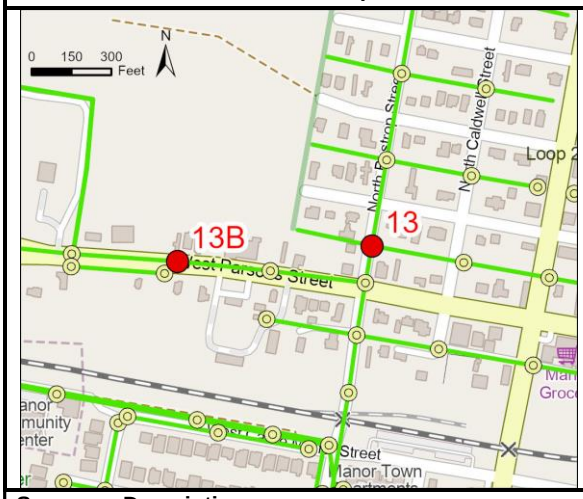
Site ID	Date	Time	Size	Level (in)			Level (in) After Cleaning			Velocity (fps)			Velocity After Cleaning (fps)				
Number	Install / Download		(in)	Manual	Meter	Diff.	Manual	Meter	Diff.	Manual	Meter	Diff	Manual	Meter	Diff.	Purpose:	Comment:
Site 13B	10/26/2021	12:15	12	2.00	2.10	0.10	2.00	2.10	0.10	0.50	0.43	-0.07	0.50	0.43	-0.07	Install	Meter installed at original location
	11/8/2021	11:08		2.50	2.37	-0.13	2.00	2.20	0.20	0.75	0.57	-0.18	0.50	0.53	0.03	Service/Upload	Medium debris and light grease.
	11/30/2021	10:58		2.50	2.41	-0.09	2.00	2.05	0.05	0.50	0.51	0.01	0.50	0.56	0.06	Removal	Medium debris.

Figure 204 – Flow Meter Site Investigation (Site 13B)

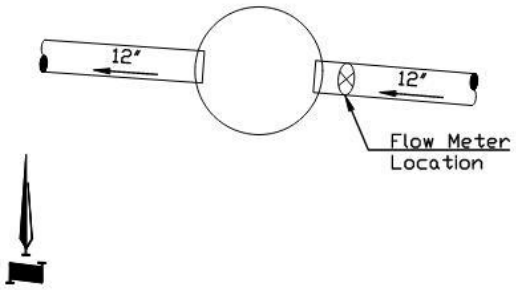
Flow Meter Site Investigation

Project: Manor I&I Program	**Location:** City of Manor, TX	**Date/Time:** 11-30-2021 / 10:58	**Crew:** JA-VI
MH#: 009-007	**Pipe Shape:** Circular	**Pipe Material:** PVC	**Pipe Size (in):** 12
Site ID: 13B	**Address:** 409 Parsons St.	**Site Quality:** Poor	**Monitoring Purpose:** Short-term FM

Location Map



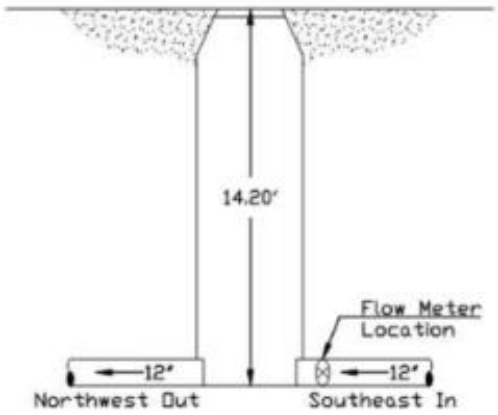
Planar Description



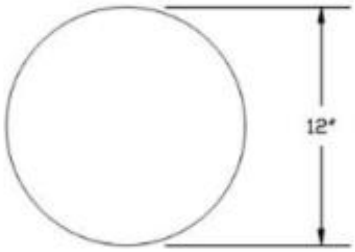
Summary Description:
Preliminary metered manhole was to be where Site 13B is but due to ongoing wastewater rehabilitation project on Parson Street the manhole was unavailable. Meter on Site 13 was moved to original location (Site 13B) after construction was finished. Site 13B manhole is in the middle of a sidewalk.

Site Hazards		Measurements	Site Conditions
Heavy Traffic? Light		**Manhole Depth (ft):** 14.20	**Surcharge Evidence?** Yes
Needed Traffic Attendants: 0		**Manhole Dia. (in):** 48.00	**Depth of Surcharge (ft):** 6.00
H_2S: 0	**O_2:** 20.8	**MH Cover Size (in):** 24.00	**Depth of Debris (in):** 0.00
LEL: 0	**CO:** 0	**MH Cover Type:** Standard	**Usable MH Steps?** No
Describe potential hazards: Sidewalk and edge of road lane are close to each other. Service team is to be aware and attentive of selves and each other during servicing.		**Measured Flow Depth (in):** 2.00	**Meter:** ISCO 2150
		Velocity (fps): 0.50	**Cellular Signal Strength:** N/A
		Mounting Band Description: Spring Band	**Antennae Install Considerations:** N/A
		Other Comments:	**Permanent Power Available?** No

Installation Sketch & Notes



Pipe Cross Section



Depth (in)	Width (in)		Depth (in)	Width (in)

SURFACE

DOWN

INFLOW

OUTFLOW

Figure 205 – Site Information (Site 13B)

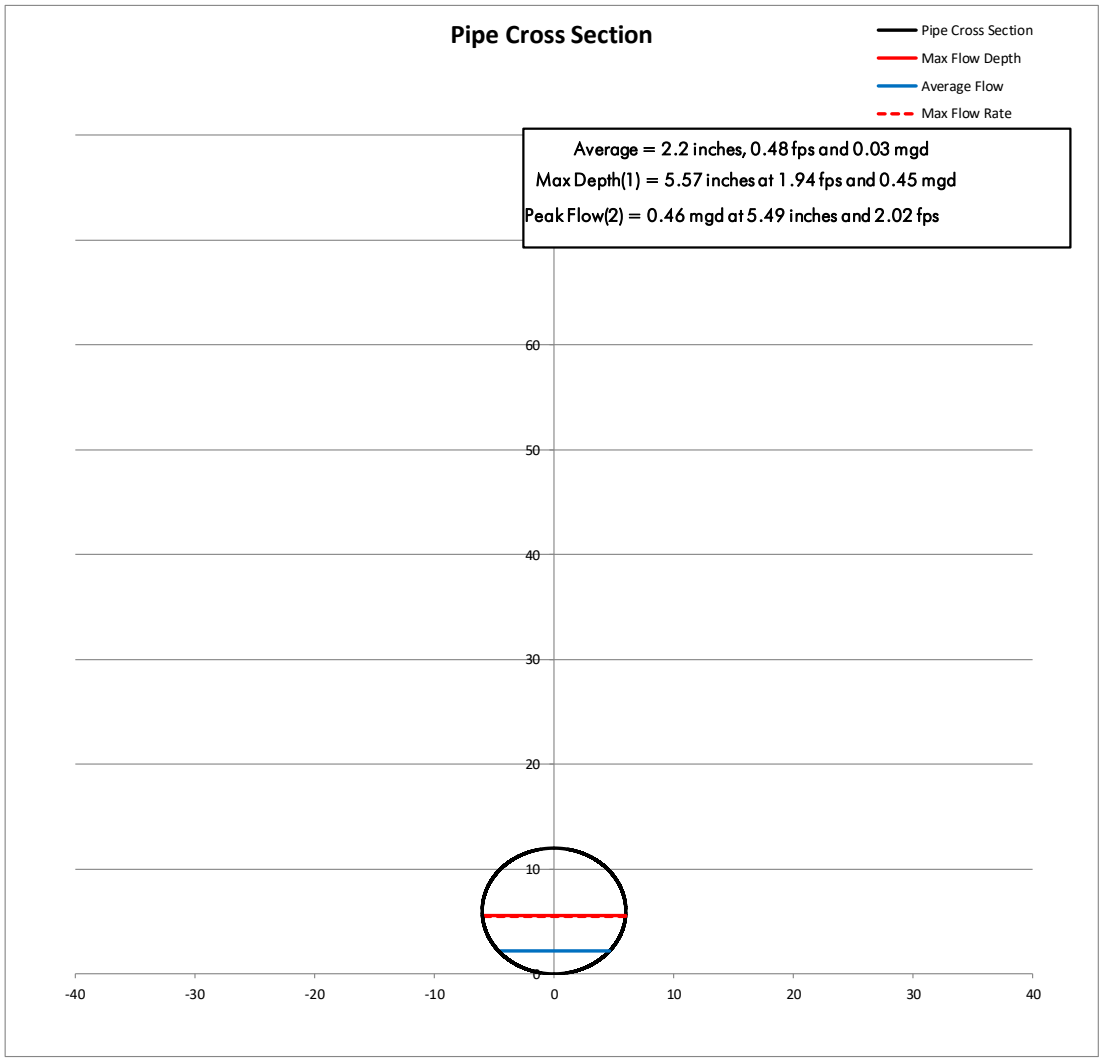
SITE INFORMATION RECORD

Site Information

Meter ID #:	13B
Monitoring Program:	Short-Term FM
Manhole #:	O09-007

Sewer Information

Pipe Shape	Circle	
Pipe Height, H (in):	12	
Pipe Width, W (in):	12	
Manning Roughness Coefficient, n:	0.013	
As-Built Pipe Slope, S (ft/ft):	0.0015	ASSUMED!



Site ID Number	Date Install/Download	Diameter (in.)	Time	Level (in.) After Cleaning Manual	Meter	Diff	Velocity (fps) After Cleaning Manual	Meter	Diff.
Site 13B	10/26/2021	12	12:15	2.00	2.10	0.10	0.50	0.43	-0.07
	11/8/2021		11:08	2.00	2.20	0.20	0.50	0.53	0.03
	11/30/2021		10:58	2.00	2.05	0.05	0.50	0.56	0.06

Figure 206 – October Flow Hydrograph (Site 13B)

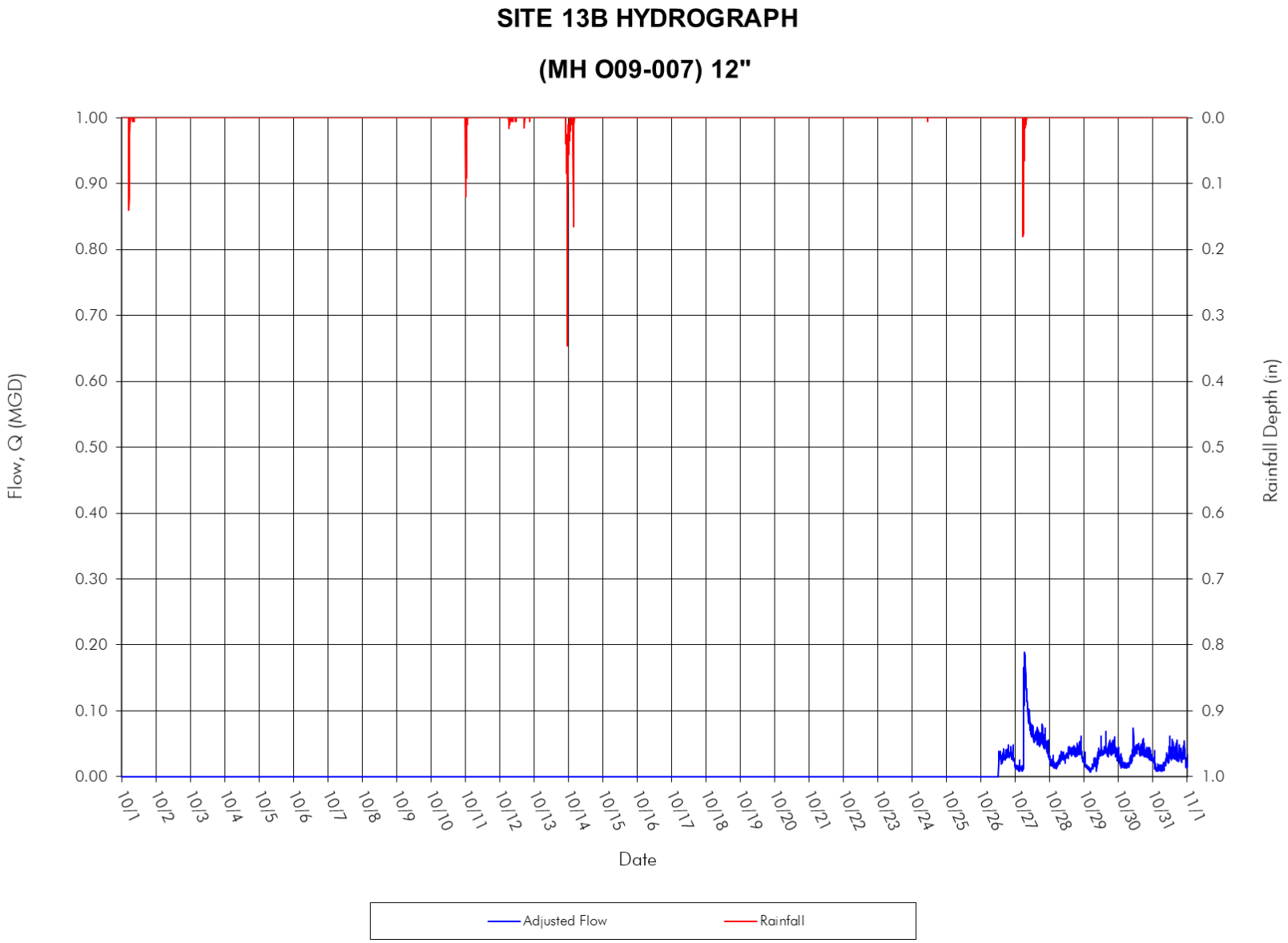


Figure 207 – October Monthly Level and Velocity Hydrograph (Site 13B)

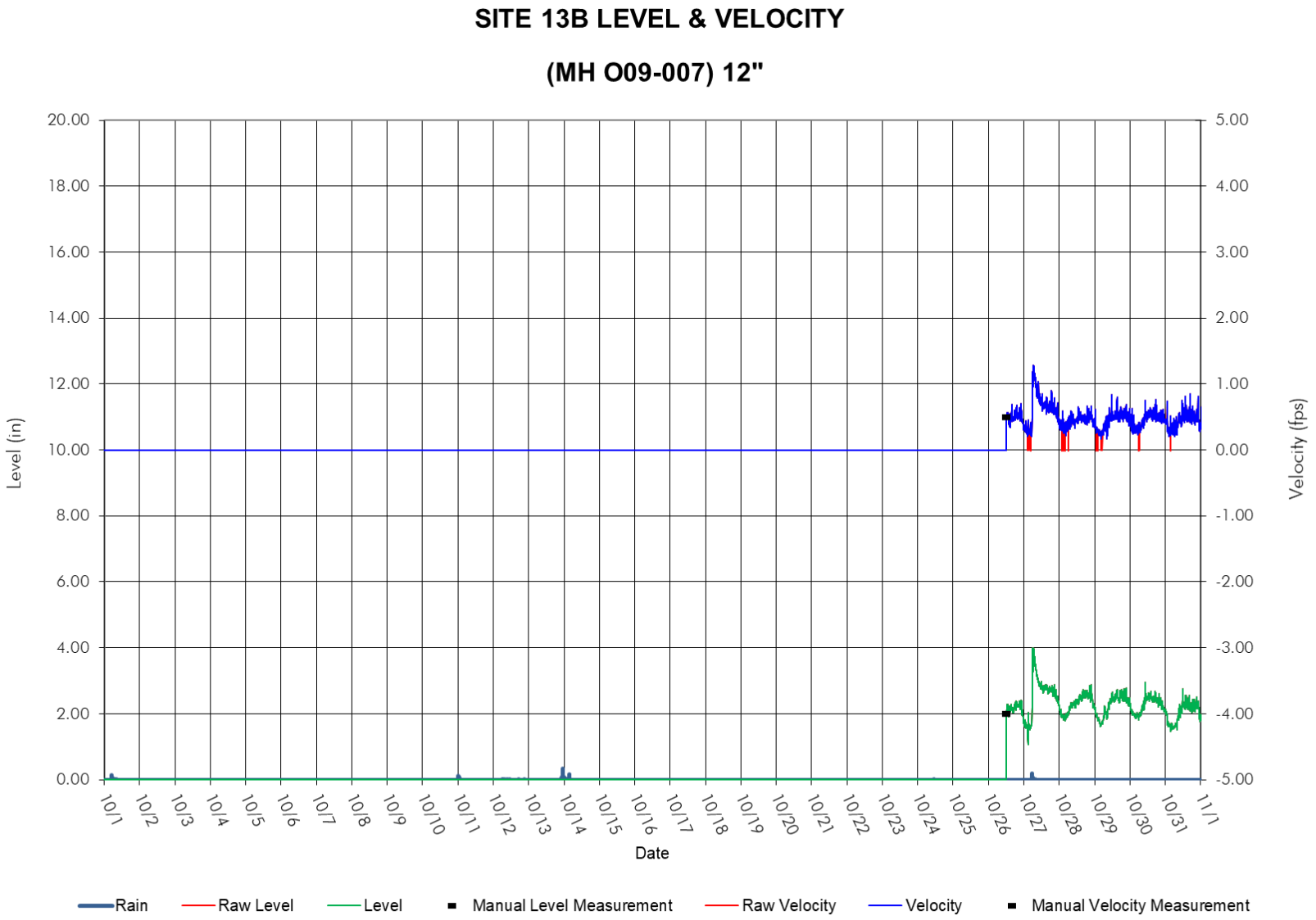


Figure 208 – November Monthly Flow Hydrograph (Site 13B)

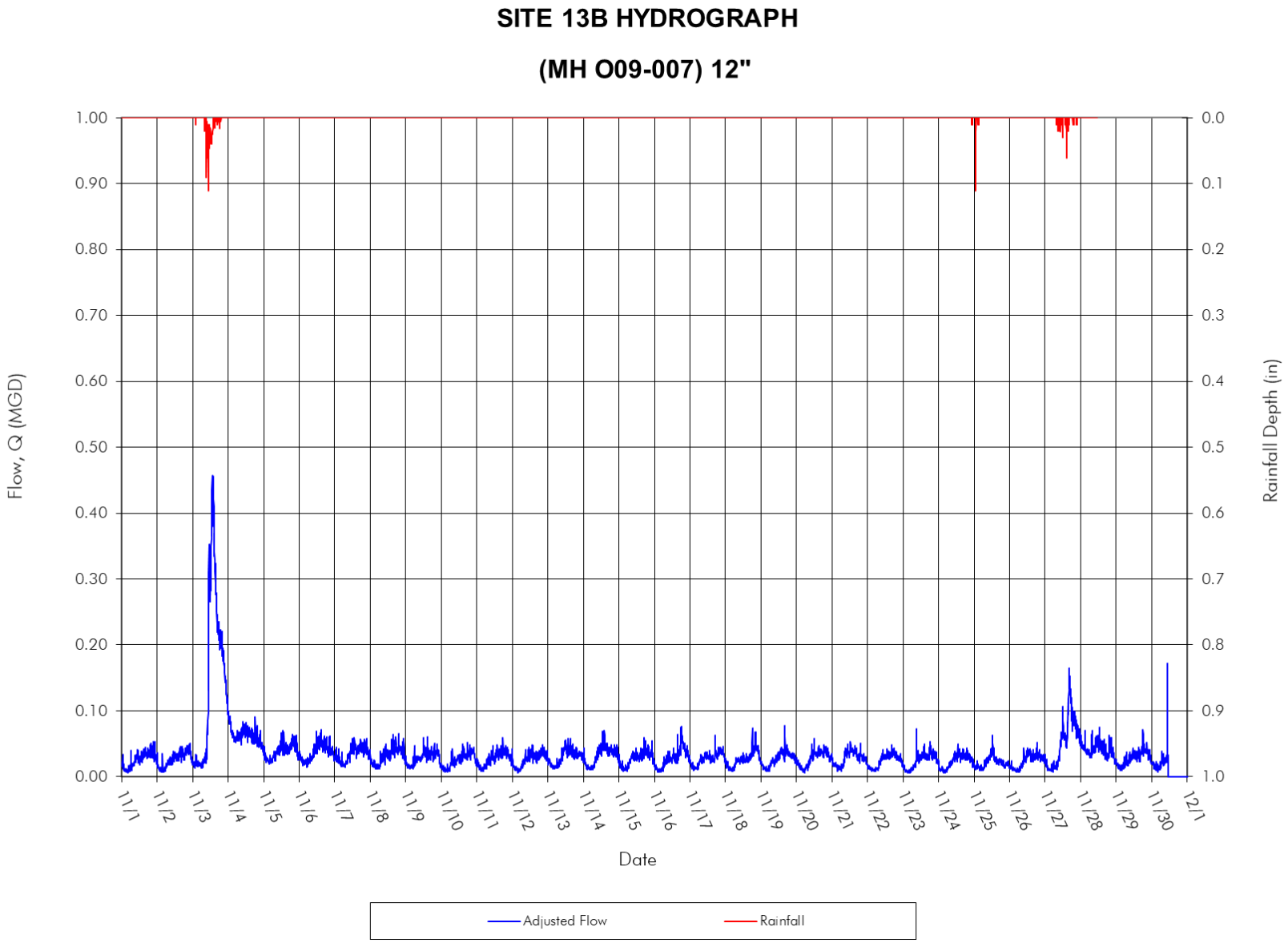


Figure 209 – November Level and Velocity Hydrograph (Site 13B)

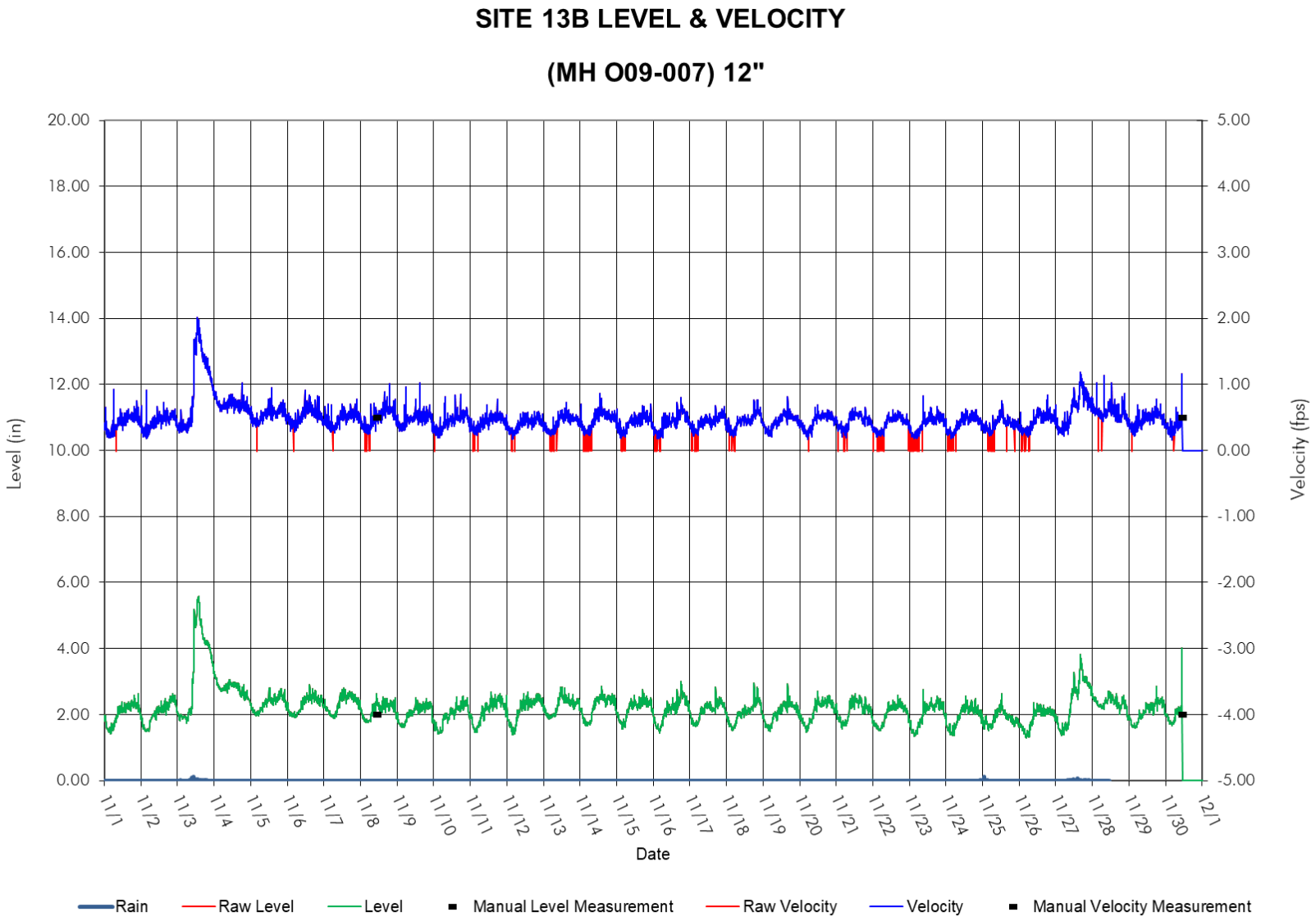


Figure 210 – Overall Flow Hydrograph (Site 13B)

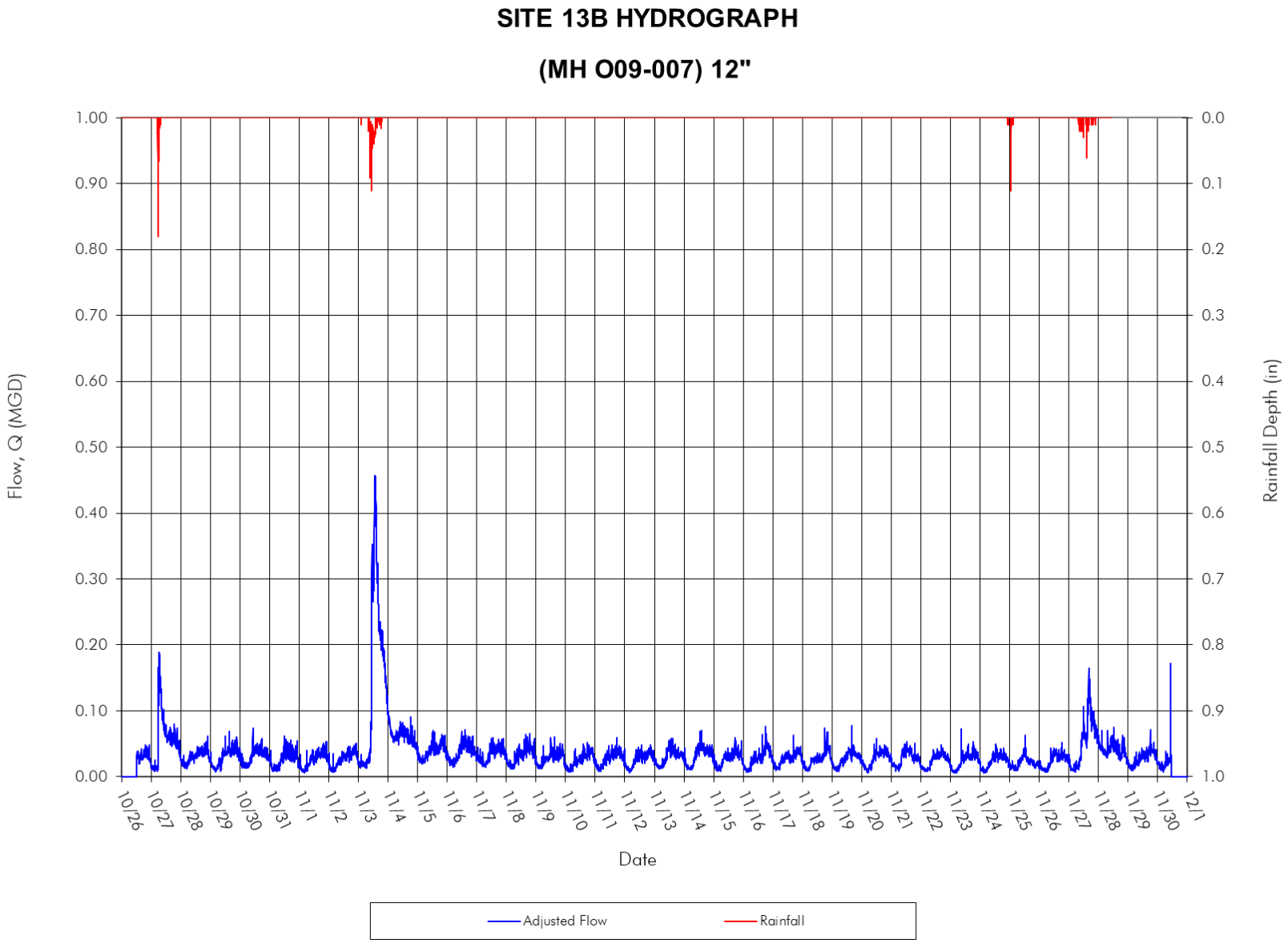


Figure 211 – Overall Level and Velocity Hydrograph (Site 13B)

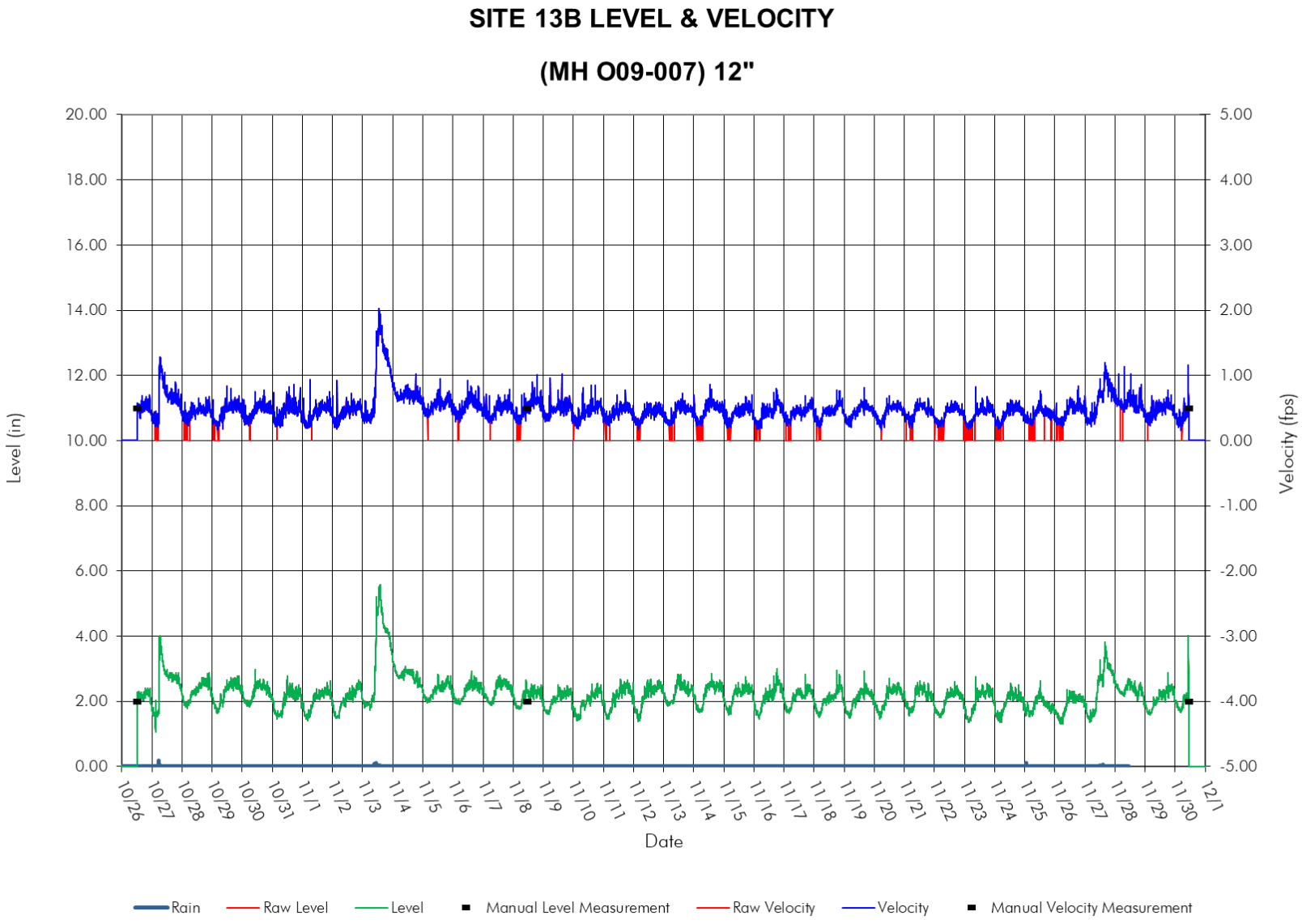


Figure 212 – Standard Flow Scattergraph (Site 13B)

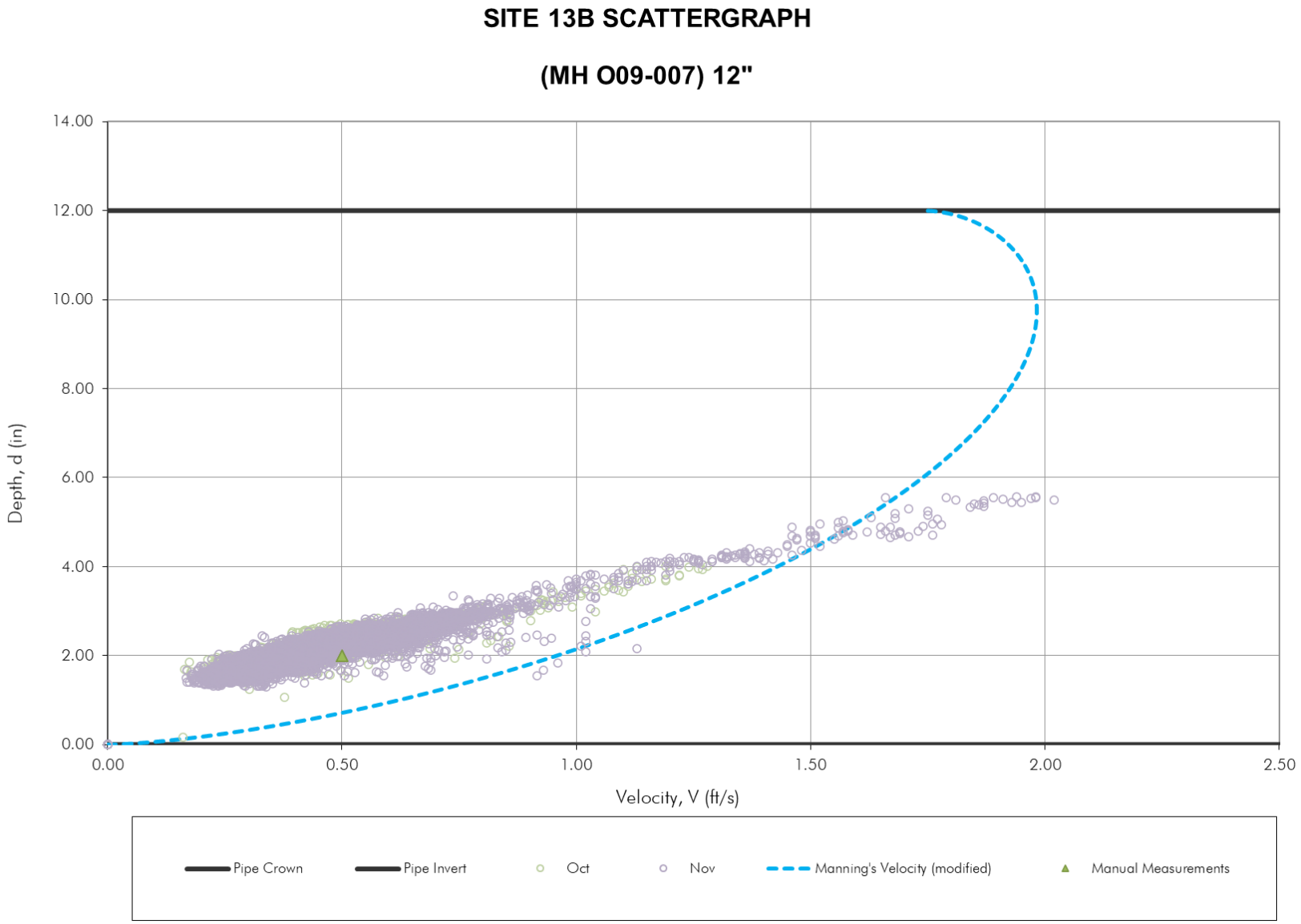


Figure 213 – ADDF and Infiltration Summary (Site 13B)

AVERAGE DAILY DRY WEATHER FLOW, WASTEWATER PRODUCTION, AND INFILTRATION

Project Name City of Manor Flow Monitoring Fall 2021
Project No: 14925
Subsystem: 13B
Meter: 13B
Units of Flow: MGD

(1) DW/LG Date	(2) Day	(3) Avg. Dry Weather (ADDF) Flow	(4) Peak Hourly Dry Weather Flow	(5) Diurnal Peaking Factor	(6) DW/LG Lowest 3-Hour Flow	(7) DW/HG Date	(8) DW/HG Lowest 3-Hour Flow
14-Nov-21	Sun	0.031	0.052	1.660	0.013	28-Nov-21	0.030
15-Nov-21	Mon	0.027	0.040	1.480	0.012		
16-Nov-21	Tue	0.027	0.062	2.274	0.010		
17-Nov-21	Wed	0.027	0.040	1.473	0.013		
18-Nov-21	Thu	0.027	0.056	2.074	0.011	04-Nov-21	0.048
19-Nov-21	Fri	0.026	0.043	1.618	0.011	05-Nov-21	0.024
20-Nov-21	Sat	0.027	0.043	1.576	0.010		
7 Count		0.028 Average	0.048 Average	1.736 Average	0.011 Average	3 Count	0.034 Average

Notes:
DW/LG = Dry Weather/Low Groundwater
DW/HG = Dry Weather/High Groundwater

Summary:			
	Wastewater Production (WWP):	0.028	(Assume = ADDF or enter value)
	Avg. Dry Weather Flow (ADDF):	0.028	
	Diurnal Peaking Factor (DPF):	1.736	
	Dry Weather Infiltration (DWI):	0.000	(ADDF - WWP)
	Wet Weather Infiltration Increase (WWI):	0.023	(DW/HG - DW/LG)
	Total Infiltration (TI):	0.023	(WWI + DWI, DWI > 0)
	Large User Flow	0.000	
	Distributed Flow (ADDF - Large User)	0.028	

Figure 214 – Dry Weather Diurnal (Site 13B)

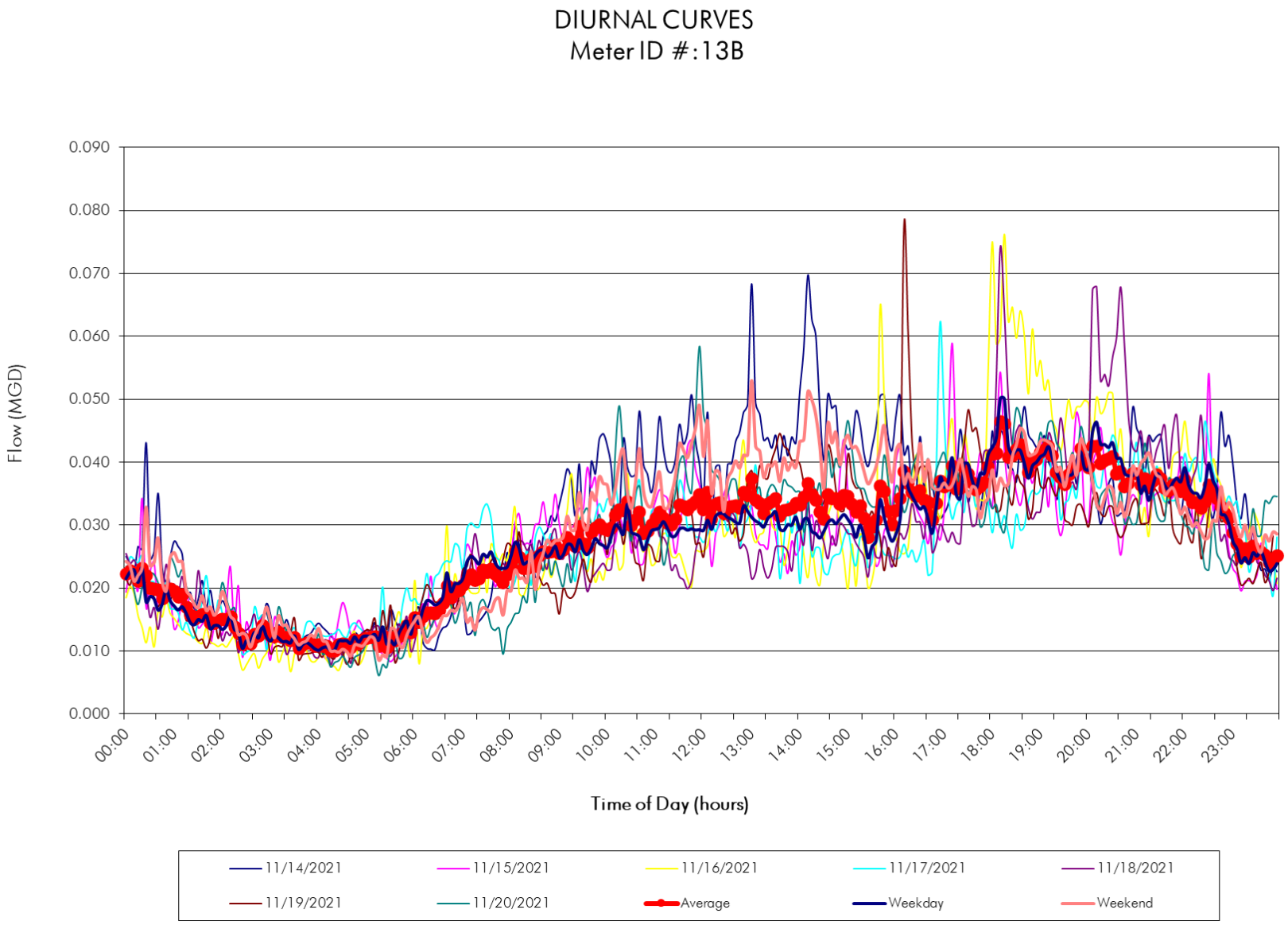


Figure 215 – High/Low Groundwater Diurnal (Site 13B)

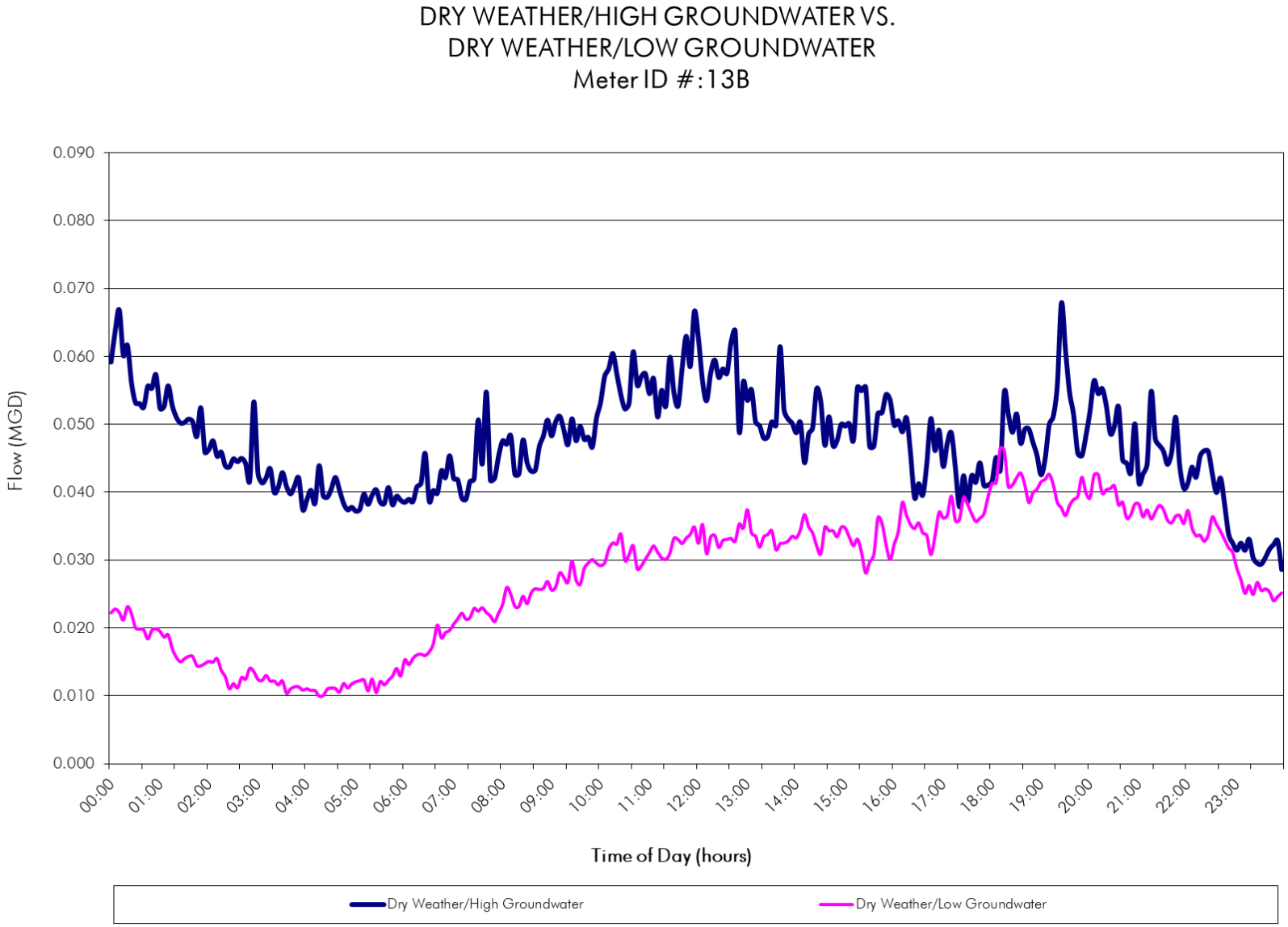


Table 60 – Inflow Calculations and Projections (Site 13B)

INFLOW CALCULATIONS AND PROJECTIONS

Project Name:	City of Manor Flow Monitoring Fall 2021
Project No.:	14925
Subsystem:	13B
Meter:	13B
Units of Flow:	MGD

Storm Count:	7	Cum. Trib. Area:	100 acres	Pipe Shape:	Circular
Avg Delta Time	110	Cum. Time of Conc.:	105 minutes	Pipe Diameter:	12 in
Avg Kp:	0.01123			Pipe Slope:	0.001 ft/ft
Avg Selected Kp:	0.01123			Pipe Capacity:	0.89 mgd
				ADDF Cum.:	0.028 mgd
				ADDF Peak. Factor:	1.74
				Peak ADDF Flow:	0.048 mgd
				Infiltration:	0.023 mgd
				Cum. Peak Flow:	0.071 mgd
				Manning's Coefficient, n:	0.013

Projected Inflow

YEAR STORM (R)	Peak Rainfall Rate (in/hr)	Peak Inflow Rate (mgd)	Peak Inflow Rate (cfs)	Peak Flow (mgd)
0	0	0	0	0.071
1	0.890	0.646	0.999	0.716
2	1.110	0.805	1.246	0.876
5	1.410	1.023	1.583	1.094
10	1.640	1.190	1.841	1.260
25	1.960	1.422	2.200	1.493
50	2.220	1.611	2.492	1.681
100	2.480	1.799	2.784	1.870

(1) Storm Name	(2) Total Rainfall (in.)	(3) Length of Storm (hrs)	(4) Time Qp	(5) Time ip	(6) Delta Time (min)	(7) Peak Flow Rate (mgd)	(8) WWP+Infilt. Date	(9) WWP+Infilt (mgd)	(10) Peak Inflow Rate (mgd)	(11) Rain i in/hr	(12) Kp	(13) Use? Y/N	(14) Selected "Kp"	(15) Time from Qp to 1/2 Inflow (hrs)	(16) "Kv"	(17) Selected "Kv"	(18) Calc. Inflow Vol. mg	(19) Note
9/28/21 21:00	1.65	7.92																Meter was located at Site 13
10/1/21 4:55	0.73	3.67																Meter was located at Site 13
10/11/21 0:05	0.49	1.25																Meter was located at Site 13
10/13/21 21:55	3.15	6.00																Meter was located at Site 13
10/27/21 5:15	0.89	2.42	10/27/21 6:35	10/27/21 5:25	70	0.190	10/26/21	0.018	0.172	0.470	0.00565	y	0.00565					
11/3/21 2:10	1.89	16.83	11/3/21 13:10	11/3/21 10:35	155	0.457	11/02/21	0.024	0.433	0.440	0.01523	y	0.01523					
11/27/21 7:45	0.70	13.92	11/27/21 16:10	11/27/21 14:25	105	0.165	11/26/21	0.024	0.141	0.170	0.01280	y	0.01280					

Figure 216 – Inflow Projections (Site 13B)

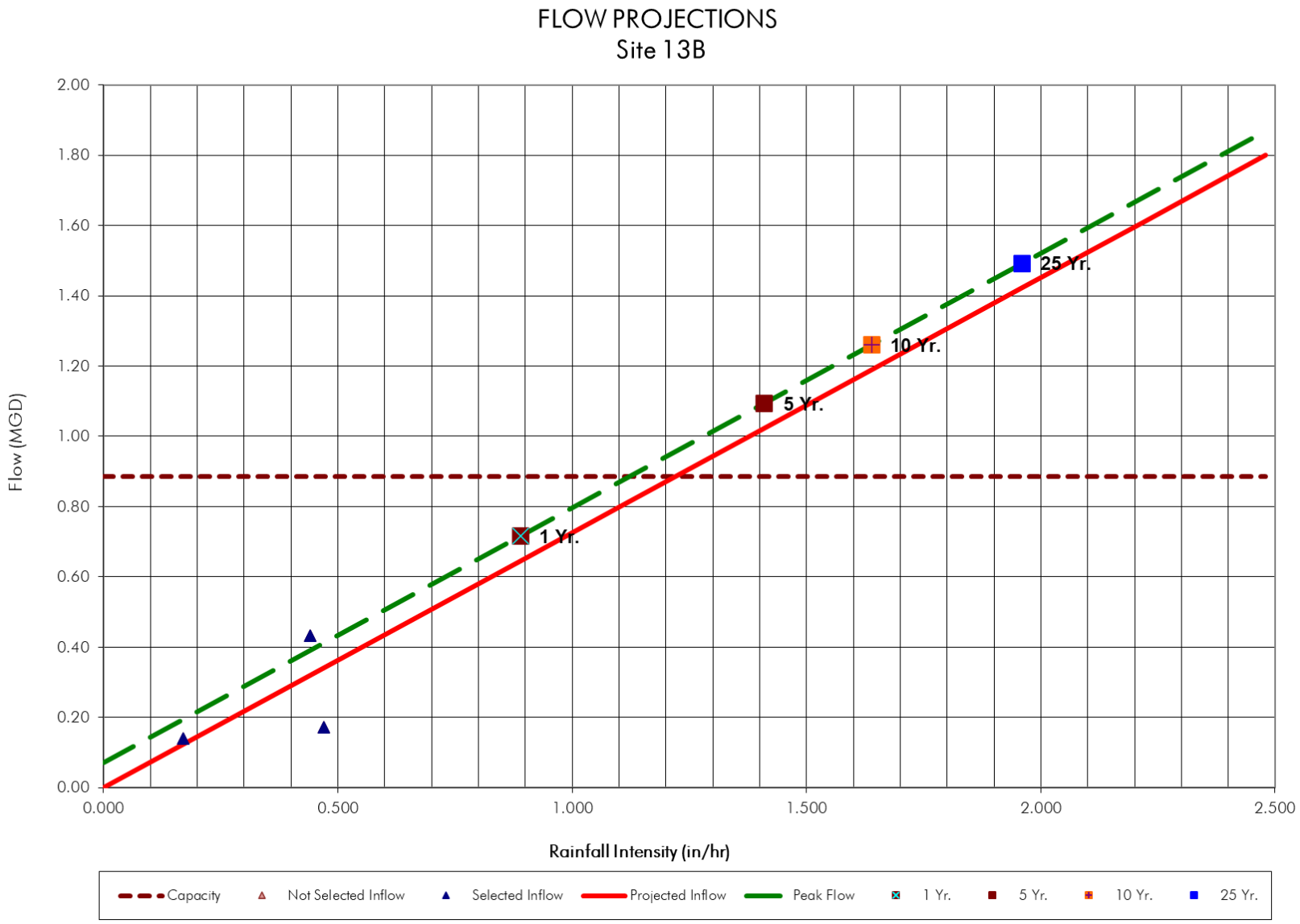


Table 61 – Rain to Sewer Summary (Site 13B)

Meter Site	Storm Date	Storm Rain Depth (in)	Rain Volume (MG)	Storm I&I Volume (MG)	Rain to Sewer (%)
Site 13B (12")	10/27/2021	0.89	2.403	0.033	1.39%
	11/3/2021	1.88	5.091	0.172	3.39%
	11/27/2021	0.70	1.901	0.046	2.42%
				Average	**2.40%**

Figure 217 – Rain to Sewer Volumetric Analysis (Site 13B)