



Streets and Utilities Committee

MEETING AGENDA

Berryville-Clarke County Government Center

101 Chalmers Court, Second Floor

Main Meeting Room

Regular Session

March 15, 2023

3:00 PM

Item

Page

1. **Call to Order**
2. **Approval of Agenda**
3. **Unfinished Business**
Results of SSES Study
4. **New Business**
5. **Other**
6. **Closed Session**
7. **Adjourn**



PROJECT FINDINGS

Duke's Microdetection I&I Study

Study Period: September 1, 2022 to December 7, 2022

Prepared For:

Berryville, VA

800.447.6687 | dukes.com



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- iTracker Study
 - Results Pipe Map
 - Rain Data
 - iTracker Study Area– Aerial
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ZONE ONE

- Results Detail

ZONE TWO

- Results Detail

ZONE THREE

- Results Detail

ZONE FOUR

- Results Detail

ZONE FIVE

Results Detail

ZONE SIX

Results Detail

Executive Summary Report

Berryville VA — Microdetection I&I Study



Purpose of Study:

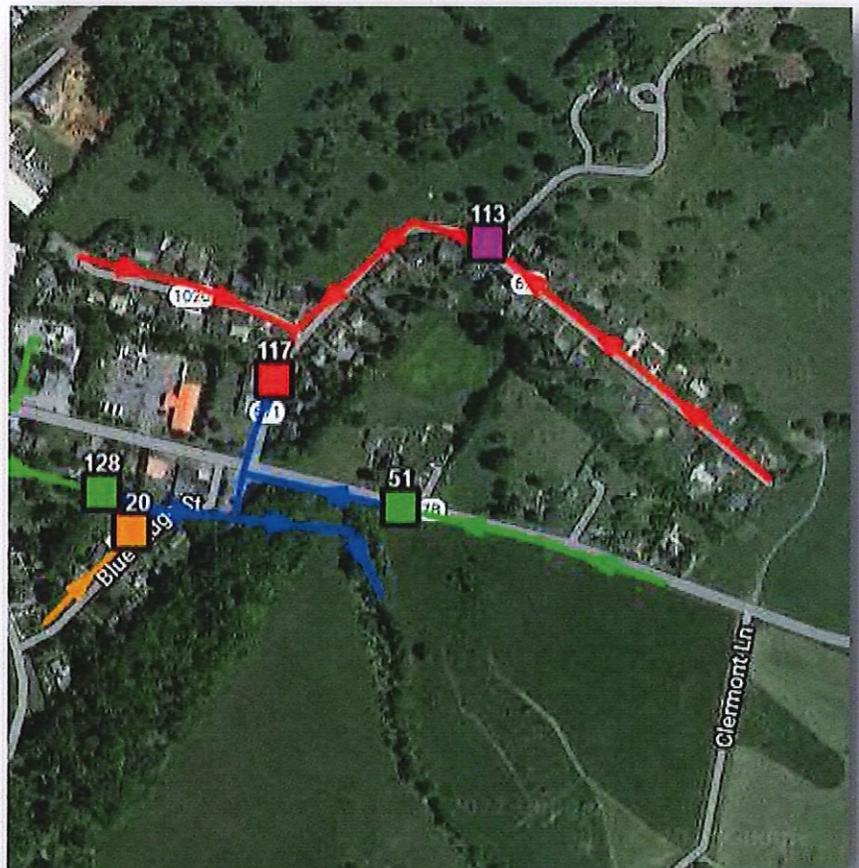
Dukes Microdetection seeks to identify and prioritize areas of most concern, while also eliminating certain areas that are less likely to need additional resources. Specific follow up actions are identified and can be applied strategically to a much more concentrated area, resulting in cost effective and efficient next steps.

Methods:

This study seeks to identify sources of Inflow and Infiltration due to rain events as well as potential O&M defects causing reduced capacity. Three technologies were deployed for this study. Ultrasonic level microdetection meters, known as iTrackers, which continuously measure level changes in 15 minute increments were deployed throughout the study area. This level data is compared during times of dry weather versus selected wet weather periods in order to determine which areas show the greatest impact. Volumetric flow estimates are calculated in order to provide context in the overall evaluation.

In addition to the iTracker Microdetection, (3) area velocity meters were installed in strategic locations in order to measure volumetric flow.

Study Quick Glance Statistics	
iTrackers Installed	88
Linear Feet (LF)	17,086
Study Length (days)	98
Number Rain Days	28
Total Rainfall (inches)	8.92
Average Rainfall (inches)	0.32
Average Wet Period	29%
Heaviest Rainfall (24 hours)	1.21
Good/Fair Rating	73
Moderate/Severe Rating	15
Surcharged or Not Measured	0



Manhole 177 and upstream noted as SEVERE, along Batteletown Drive

iTracker Study Findings:

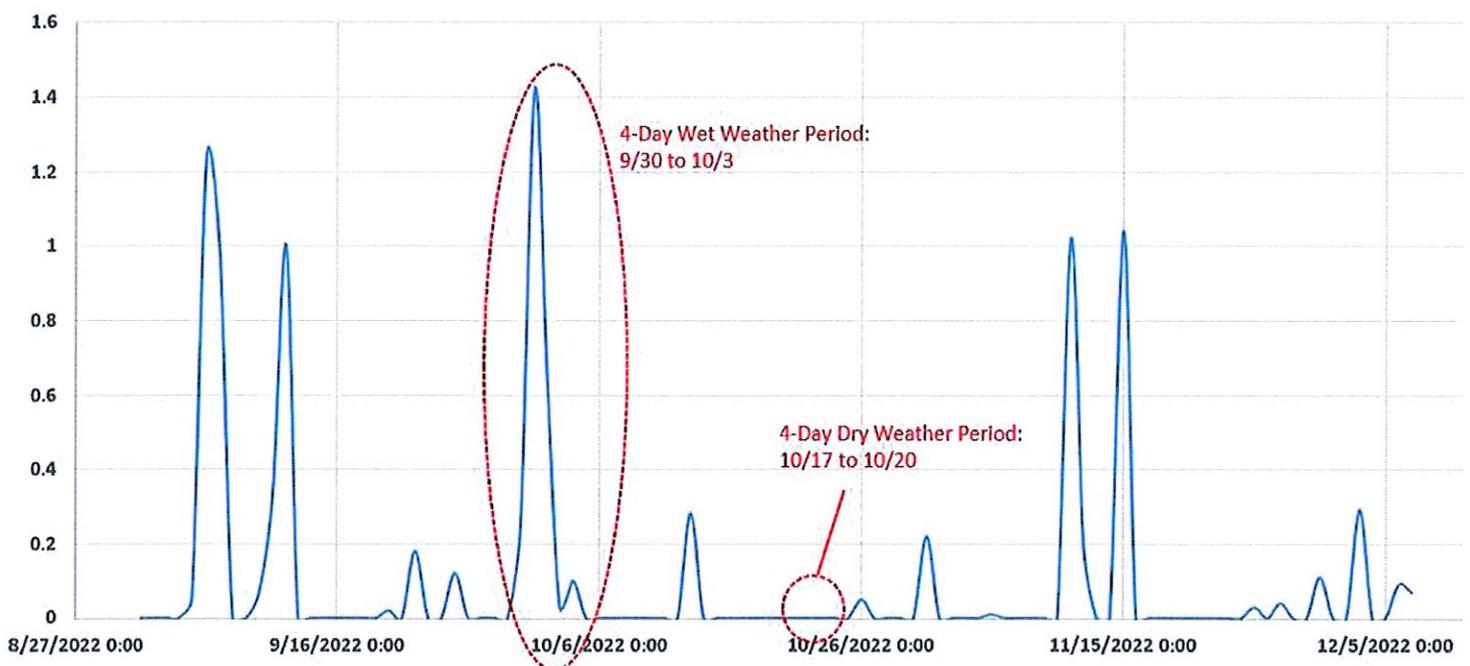
The purpose of a microdetection metering study is to pinpoint and isolate key contributor lines within a collection system that are prone to respond to rain events with increases in level, and corresponding flow. Those additional wet weather flows increase WWTP costs, reduce system capacity and have the potential to cause surcharging, overflows and backups in the system. Dukes deployed microdetection meters, called ITrackers, throughout the system.

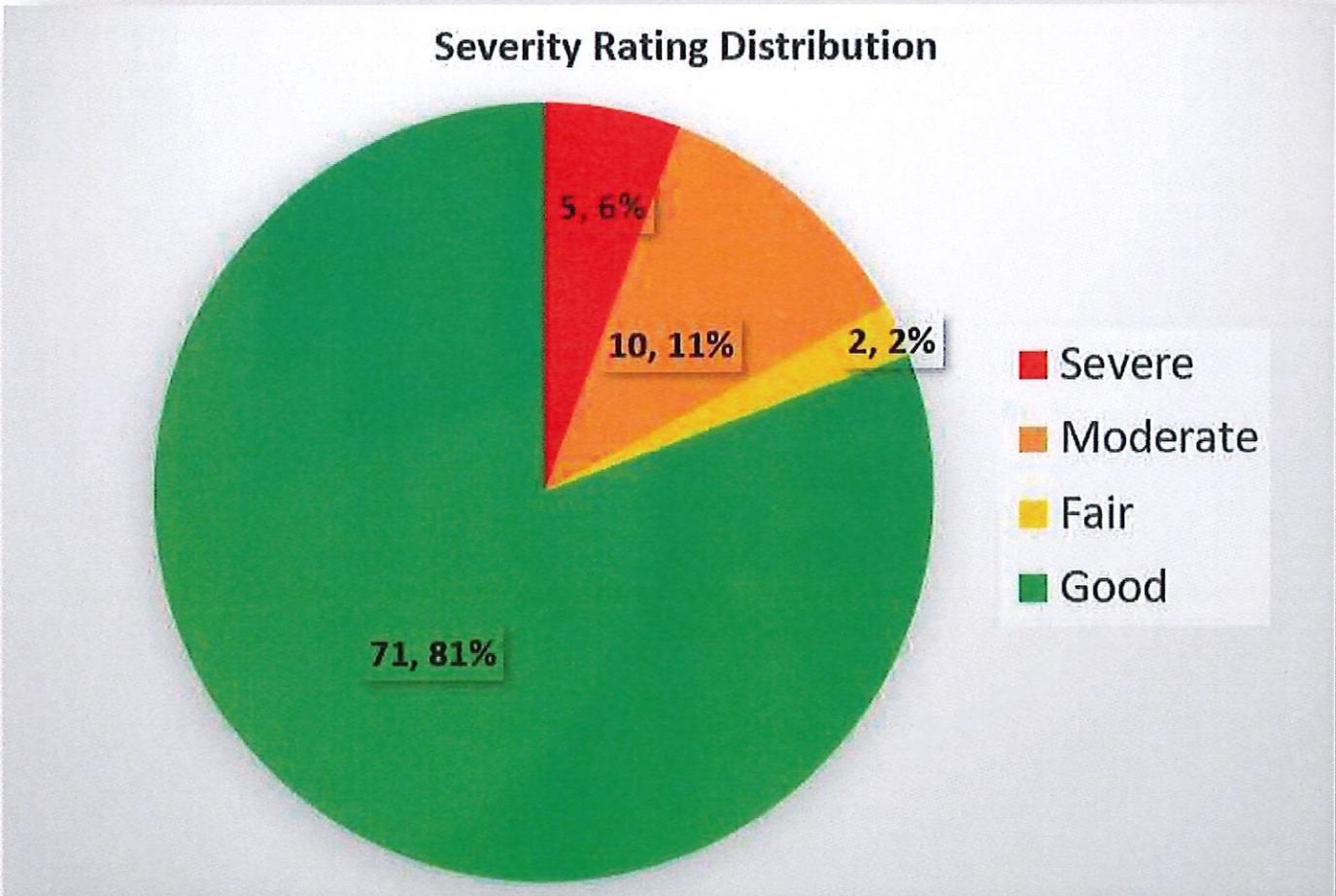
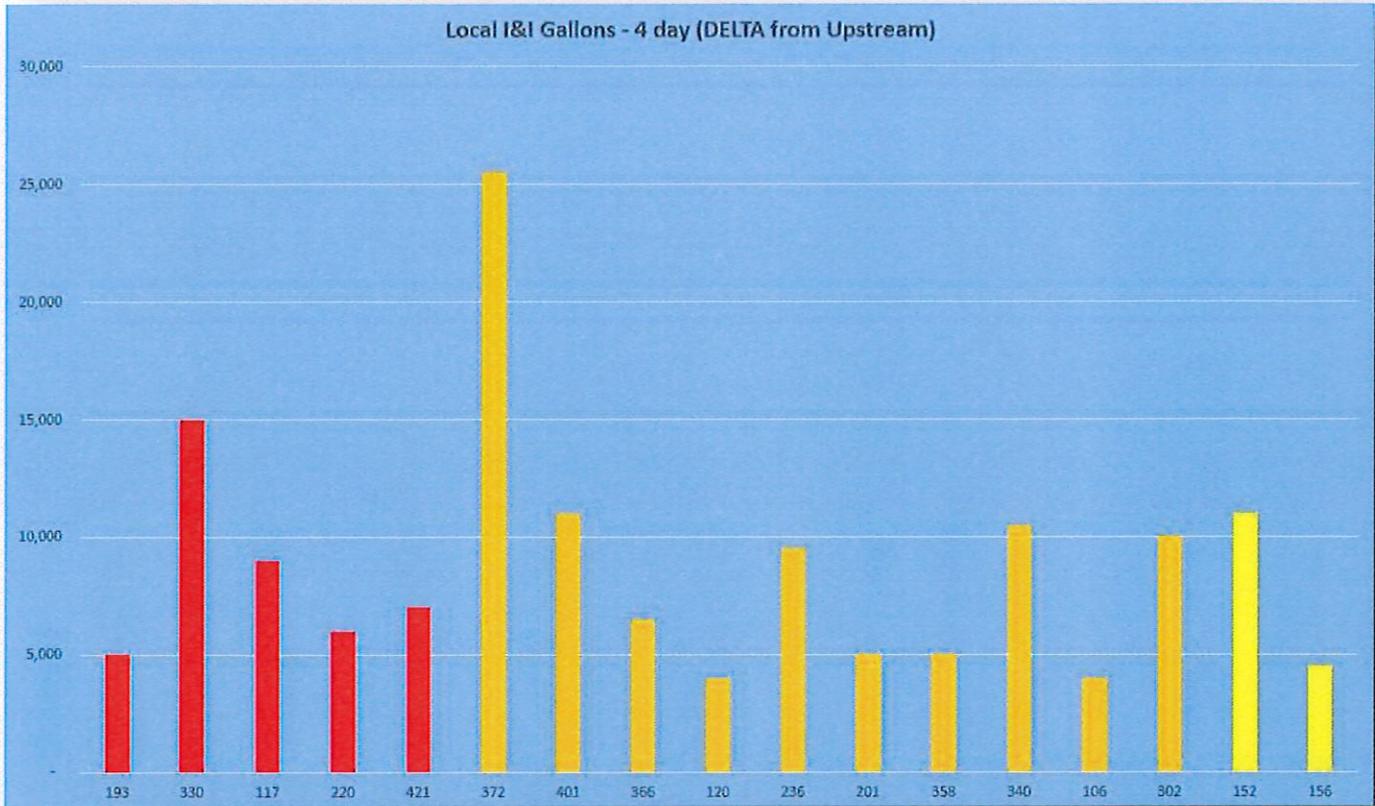
It was observed that this area experiences relatively small amounts of inflow. Surge conditions did not exist throughout the study period. Each area just upstream of each iTracker receives a final priority rating of; good, fair, moderate, or severe. All data is available and provided in a .csv file.

Method of Analysis: Flow levels during wet weather are compared with flow levels during dry weather in order to compare the collection system's reaction, and determine potential areas of I&I sources. The dry weather period used for this study is a 4-day period beginning June 20 through June 23. The 4-day wet weather period is defined during the dates between May 23 and May 26. A four day wet weather flow estimate will capture both inflow (1 day of heaviest rain) and infiltration (plus 3 days).

The 4 day wet weather volume is compared with the 4-day dry weather volume. Consideration is given towards upstream values in order to differentiate and not include upstream contributions. Results are scored based on the relative severity of estimated inflow and infiltration volumes as compared with the estimated average dry weather flows (ADWF). For example, a pipe segment with relatively small ADWF showing large amounts of I&I would generate a high score of severity. The intent of the score is to help determine pipe segments that would be better candidates for further investigative or rehabilitation efforts. Recommended follow up action steps would include smoke testing of areas with a SEVERE or MODERATE score. Often, smoke tests can generate relatively quick and cost effective repairs that can significantly reduce sources of inflow, such as cross connections and illegal roof/gutter connections.

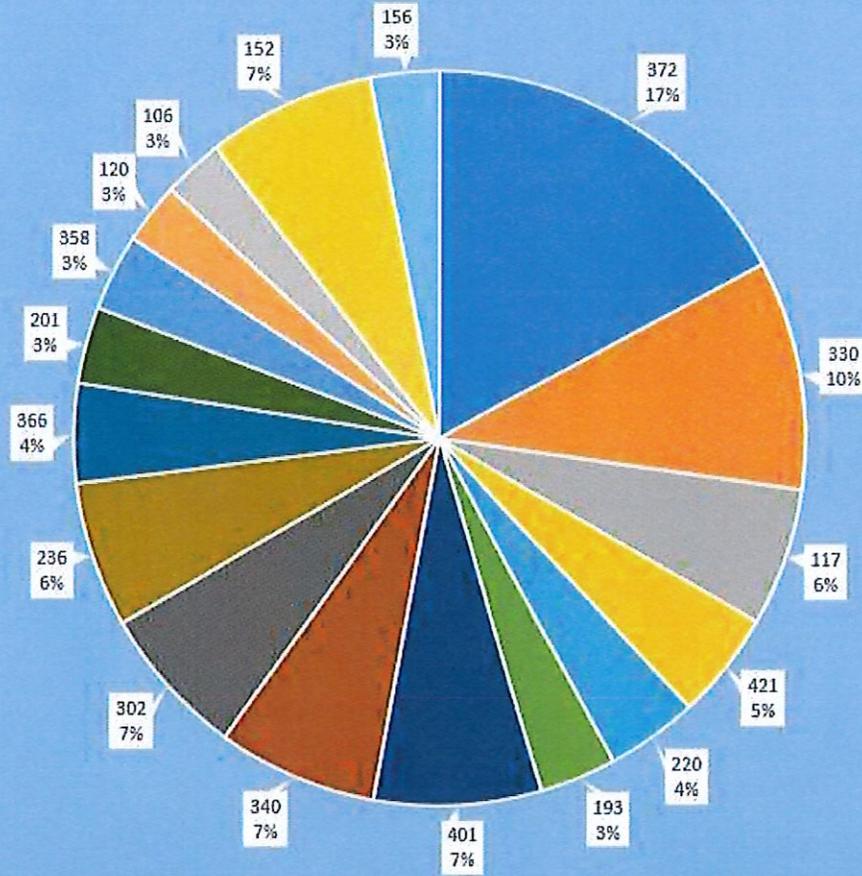
24-Hour Rainfall Totals – Berryville VA (inches)





iTracker Results:

Estimated I&I Distribution - 4 day (DELTA from Upstream)



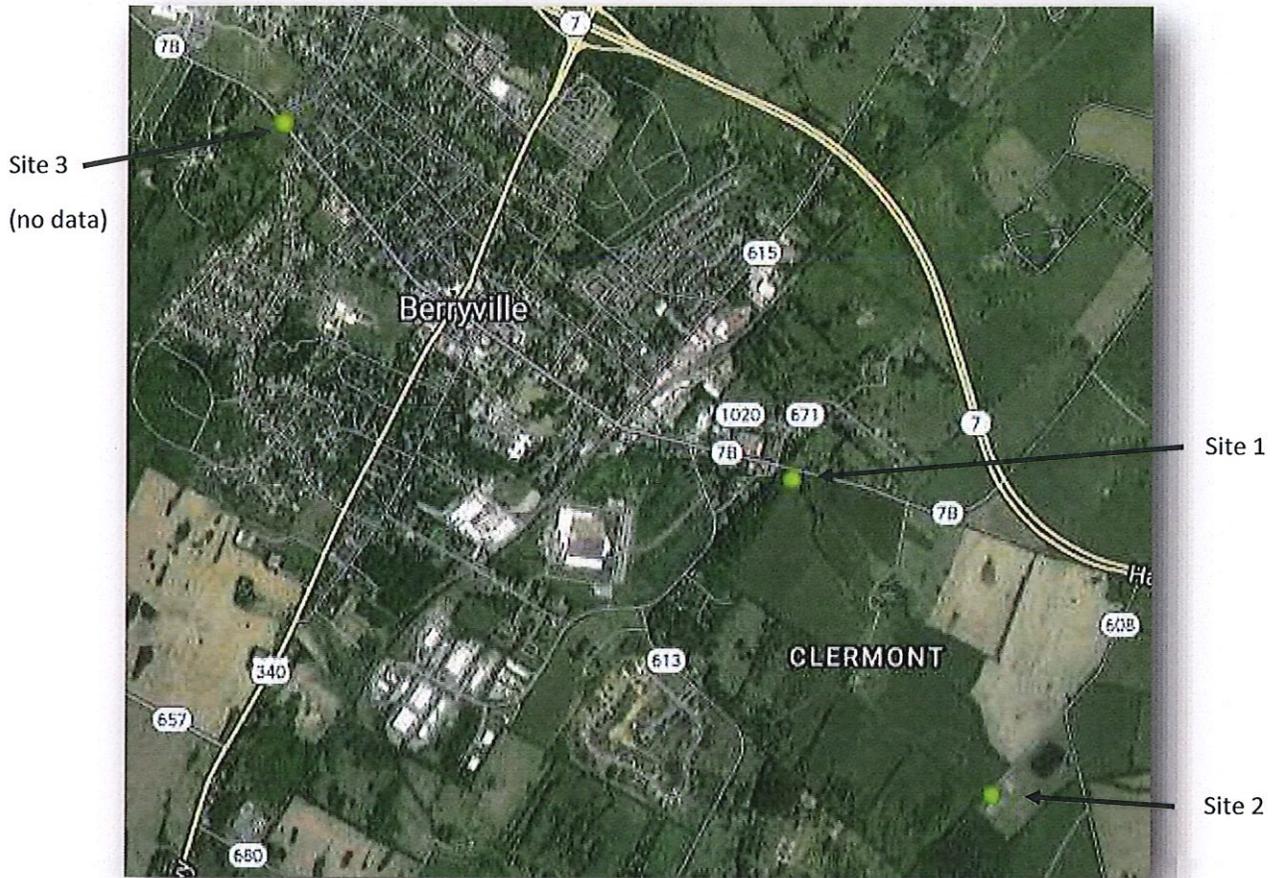
Flow Meter Summary:

A detailed appendix of flow data is provided as an electronic .csv file. The equipment utilized were Hach FL900 series, with a submerged area velocity sensor that measures level and velocity in 5 minute intervals. Data is sent via cellular modem to a server in 2 hour increments. All raw data is available via the Claros web platform. The data appendix contains data that is lightly edited to account for "pops" and "drops" within the data. All installation and maintenance logs are provided separately within the flow meter portion of the report. An overall summary of findings is included within this section of the report.



It should be noted that Site 3 had site conditions that were such that intended results were not possible to obtain. This was noted during the time of equipment installation. However, it was decided to make an attempt in order to get the best results possible, with the possibility that pump cycles could be determined and analyzed. Level and velocity characteristics were outside of the manufacturer's recommendations. Post study, this data was analyzed further in order to assess whether or not it would be possible to draw a conclusion based on recognizing individual pump cycles, in order to determine a higher pumping frequency during rain events. While it is possible to determine some pump cycles, the data quality is not sufficient to determine a final conclusion regarding increased pumping during rain event time periods. Therefore the data for Site 3 was removed.

Flow Meter Summary:



Locations of Flow Meter Installations

TABLE 1: 1st RAIN EVENT - 1.55 in of RAINFALL

DRY WEATHER FLOW (11/5/2022 - 11/8/2022) , WET WEATHER FLOW (11/11/2022 - 11/14/2022)

METER	PIPE DIAMETER (in)	AVERAGE LEVEL (in)	AVERAGE VELOCITY (in)	AVERAGE FLOW (gpm)	TOTAL FLOW FOR ENTIRE PERIOD (gal)	DRY WEATHER FLOW (gal)	WET WEATHER FLOW (gal)	RDII (gal)	PEAK WET WEATHER FLOW (gpm)	PEAKING FACTOR (PEAK WET WEATHER FLOW/AVERAGE FLOW)	TOTAL RAINFALL DURING WET WEATHER EVENT (in)
Berryville VA 1	18	4.02	1.77	246.35	14,544,385	1,205,019	1,571,353	366,334	543.14	2.20	1.55
Berryville VA 2	24	3.50	1.94	255.47	15,082,860	1,308,766	1,623,411	314,645	679.45	2.66	1.55

TABLE 2: 2nd RAIN EVENT - 0.94 in of RAINFALL

DRY WEATHER FLOW (11/5/2022 - 11/8/2022) , WET WEATHER FLOW (11/16/2022 - 11/19/2022)

METER	PIPE DIAMETER (in)	AVERAGE LEVEL (in)	AVERAGE VELOCITY (in)	AVERAGE FLOW (gpm)	TOTAL FLOW FOR ENTIRE PERIOD (gal)	DRY WEATHER FLOW (gal)	WET WEATHER FLOW (gal)	RDII (gal)	PEAK WET WEATHER FLOW (gpm)	PEAKING FACTOR (PEAK WET WEATHER FLOW/AVERAGE FLOW)	TOTAL RAINFALL DURING WET WEATHER EVENT (in)
Berryville VA 1	18	4.02	1.77	246.35	14,544,385	1,205,019	1,494,425	289,405	397.32	1.61	0.94
Berryville VA 2	24	3.50	1.94	255.47	15,082,860	1,308,766	1,567,291	258,525	453.90	1.78	0.94

PRECISION I&I MICRODETECTION

Precision I&I Microdetection seeks to identify sources of Inflow and Infiltration due to rain events, which is classified of RDII – Rain Derived Inflow and Infiltration. Other anomalies such as reduced flow capacity due to pipe structural or O&M conditions can also be identified. Ultrasonic level detectors, known as iTrackers, continuously measure sewer levels in 15-minute increments are deployed throughout the study area. Our algorithms prioritize areas of most concern by looking at dry weather levels, wet weather levels, pipe sizes, and pipe connectivity. All data is reviewed to eliminate occurrences of erroneous data that can impact the final priority score.



FIELD DATA COLLECTION

Basin isolation studies utilize iTrackers in key outfalls within a study area to determine which basin(s) may be contributing I&I within a system.

Microdetection studies utilize the installation of iTrackers in manholes canvassing the study area in an effort to pinpoint which pipe segments may be contributing I&I within a basin or system.

Study durations are dependent on major (>1 inch) rain events. Minimum study length is typically 30 days.



This section contains definitions and abbreviations commonly used throughout this report.

Base Flow– sustained or dry weather flows not directly generated by rainfall. It commonly constitutes flows generated by domestic and industrial discharge and also infiltration.

CCTV– Closed Circuit Television

Direct Cross Connection– a connection of a collector of storm water, e.g. area drain or inlet, to the sanitary sewer main line or building lateral.

Drop Pipe Connection– A vertical connection to or near the invert level of a manhole from a sewer or drain at a higher level.

GIS– Geographical Information System

GPD– Gallons per day

GPM– Gallons per minute

GPS– Global Positioning System

Gravity System (or Gravity Sewer)- a drain or sewerage system whereby flow is created by the action of gravity and where the pipeline is designed to operate partially full.

Hydrograph– a graph showing, for a given point on a stream or conduit, the discharge, stage, velocity, available power or other property of water with respect to time.

Indirect Cross Connection– the storm sewer is not directly connected to the sanitary sewer main line or building lateral, but there are leaks in both storm sewer and the sanitary sewer allowing storm water to migrate to the sanitary sewer.

Infiltration (as defined by USEPA) - the water entering a sewer system and service connections from the ground through such means as, but not limited to, defective pipe, pipe joints, service connections, service laterals, or manhole walls.

Inflow (as defined by USEPA) - the water discharge into a sewer system, including service connections, from such sources as downspouts; sump pumps; cellar, yard, and area drains; foundation drains; cooling water discharges; drains from springs and swampy areas; manhole covers; cross connections from storm sewers, combined sewers, or catch basins; storm waters; surface runoff; or drainage.

Inflow and Infiltration I&I– the extraneous clean water from rainfall that enters the sanitary sewer system that can be eliminated on a cost-effective basis.

Invert– The lowest point of the internal surface of a drain, sewer or channel at any cross section.

Lagoon– a pond in which algae, sunlight, and oxygen interact to restore wastewater to a quality often equal to that of the effluent from the secondary treatment stage.

MACP– Manhole Assessment Certification Program

Manhole– A working chamber with cover constructed on a drain or sewer within which a person may inspect, test or clear and remove obstructions.

MGD-Million gallons per day

Outfall– the point, location or structure where wastewater or drainage discharges from a pipe, channel, weir, drain or other conduit.

Overflow– the intentional or unintentional discharge of sewage to the environment before it has been treated.

NASSCO– National Association of Sewer Service Companies

PACP– Pipeline Assessment Certification Program

Pump Station– a structure containing pumps and appurtenant piping, valves and other mechanical and electrical equipment for pumping water, wastewater and other liquids.

PVC– Polyvinyl Chloride

Sanitary Sewer Evaluation Survey (SSES) - the study of a sanitary system through various investigation techniques, to identify sources of extraneous rainwater that are entering the sewers. These investigations may include flow monitoring, precision I&I microdetection, dye testing, smoke testing, television inspection, man-hole inspection and flood prevention inspection.

Sewage– wastewater and/or surface water conveyed by a drain or sewer

Sewer System– the network of pipelines and ancillary works, which conveys wastewater and/or surface water from drains to a treatment works or other place of disposal.

Silt– sediment (often soil) consisting of particles which is carried in the waterflow and may settle to the bottom of a pipe.

Standard Deviation 2- Two standard deviations represent 95% of all observations within the data population.

Storm Sewer– a sewer that carries only runoff from storm events

Surcharge– overloading of the sewer beyond its design capacity. The channel entrance and exit are submerged and the pipe is flowing full.

VCP– Vitrified Clay Pipe

Wastewater- water changed by use and discharged to a drain or sewer system

WWTP-Wastewater Treatment Plant

OVERALL RESULTS SUMMARY & DEFINITIONS



Site ID	Pipe Diam	Depth-Max (in)	Depth-Min (in)	Average Dry Level (in)	% of full pipe DRY (Capacity or O&M)	Time In Surge (hours)	ADWF (GPM)	GWI (GPM)	4 day Rain Event (1 Gallons - Estimated)	Local (1 Gallons - 4 day Delta from Upstream)	Peak Factor	Relative Severity	Priority
193	8	1.22	0.17	0.40	0.05	0	0.29	0.23	5,000	5,000	17.60	1.25	Severe
330	8	1.35	0.44	0.65	0.08	0	2.72	1.35	15,000	15,000	5.40	1.13	Severe
117	8	1.12	0.25	0.52	0.06	0	1.31	1.02	9,000	9,000	5.84	0.81	Severe
220	8	0.78	0.25	0.41	0.05	0	0.73	0.43	6,000	6,000	4.44	0.72	Severe
421	8	1.02	0.25	0.45	0.06	0	1.22	0.82	8,000	7,000	6.31	0.61	Severe
372	8	2.81	0.6	2.20	0.28	0	22.37	11.93	52,000	25,500	2.39	0.59	Moderate
401	8	1.04	0.5	0.50	0.06	0	4.46	4.46	11,000	11,000	5.76	0.48	Moderate
366	8	1.45	0.46	0.69	0.09	0	1.63	0.90	7,000	6,500	5.32	0.42	Moderate
120	8	0.84	0.14	0.31	0.04	0	0.79	0.53	5,000	4,000	9.79	0.32	Moderate
236	8	2.42	1.01	1.48	0.19	0	4.98	3.39	10,000	9,500	2.63	0.30	Moderate
201	8	1.15	0.52	0.69	0.09	0	1.69	1.26	6,000	5,000	3.20	0.25	Moderate
358	8	1.21	0.68	0.87	0.11	0	2.15	2.38	5,000	5,000	2.12	0.25	Moderate
240	8	0.95	0.25	0.54	0.07	0	7.75	4.65	21,000	10,500	3.35	0.22	Moderate
106	8	0.83	0.34	0.54	0.07	0	1.40	1.20	4,000	4,000	3.70	0.20	Moderate
302	8	2.48	0.17	0.95	0.12	0	11.19	3.77	10,000	10,000	3.70	0.20	Moderate
152	6	2.55	0.93	1.36	0.23	0	14.53	9.79	30,000	11,000	3.49	0.14	Fair
156	8	1.49	0.75	0.94	0.12	0	3.06	2.96	10,000	4,500	4.80	0.10	Fair
324	15	4.24	1.49	2.38	0.16	0	73.72	49.84	197,000	20,000	3.41	0.09	Good
59	8	1.67	1.04	1.24	0.16	0	7.54	6.44	10,000	6,000	1.94	0.09	Good
285	8	2.63	1.25	0.25	0.03	0	4.66	4.18	3,000	3,000	2.87	0.09	Good
261	12	2.14	1.2	1.78	0.15	0	26.10	17.17	50,000	10,000	1.48	0.08	Good
326	8	1.62	0.41	0.90	0.11	0	6.07	1.31	20,000	5,000	3.25	0.08	Good
379	8	1.62	0.86	1.13	0.14	0	21.55	14.27	52,000	10,000	2.25	0.08	Good
294	15	5.19	3.1	3.73	0.25	0	112.37	81.34	230,000	20,000	2.07	0.08	Good
424	18	0.52	0.24	0.30	0.02	0	0.72	1.00	2,000	2,000	5.32	0.08	Good
141	8	1.43	1.25	1.25	0.16	0	21.80	22.08	60,000	10,000	1.35	0.08	Good
288	18	4.74	1.9	2.75	0.15	0	97.80	48.77	254,000	20,000	3.27	0.08	Good
8	8	0.61	0.25	0.29	0.04	0	0.51	0.37	1,500	1,500	5.70	0.08	Good
249	8	2.06	0.85	1.47	0.18	0	29.70	28.44	70,000	10,000	2.03	0.07	Good
383	8	0.91	0.35	0.62	0.08	0	15.56	6.13	35,000	8,000	1.90	0.07	Good
315	8	1.11	0.5	0.83	0.10	0	19.18	10.25	45,000	10,000	1.83	0.07	Good
63	8	1.85	1.04	1.34	0.17	0	4.50	4.15	4,000	4,000	2.04	0.06	Good
384	8	0.88	0.25	0.50	0.06	0	3.90	1.33	6,000	4,000	3.33	0.06	Good
299	18	1.22	0.72	5.60	0.31	0	4.55	3.69	8,000	5,000	1.70	0.06	Good
277	8	0.99	0.5	0.52	0.07	0	4.16	3.94	4,000	3,500	4.59	0.06	Good
293	18	4.51	1.55	3.14	0.17	0	128.31	61.83	375,000	21,000	3.64	0.06	Good
144	15	1.08	0.4	0.73	0.05	0	2.43	1.27	3,000	3,000	2.43	0.06	Good
142	8	2.04	0.85	1.29	0.16	0	30.22	17.54	84,000	10,000	2.64	0.06	Good
411	8	0.63	0.25	0.30	0.04	0	0.59	0.41	3,000	1,500	5.53	0.06	Good
374	8	1.6	0.5	1.05	0.13	0	25.56	11.79	60,000	8,000	2.43	0.05	Good
232	12	1.57	0.63	1.15	0.10	0	10.31	4.44	15,000	5,000	1.94	0.05	Good
295	8	1.24	0.59	0.73	0.09	0	7.82	6.65	13,000	5,000	3.46	0.05	Good
321	8	0.41	0.72	5.60	0.70	0	0.21	0.20	1,000	1,000	3.32	0.05	Good
128	18	5.78	1.08	2.36	0.13	0	150.69	34.64	432,000	20,000	4.08	0.05	Good
291	18	4.77	1.96	2.83	0.16	0	100.42	75.60	270,000	16,000	3.11	0.05	Good
225	15	1.73	0.25	0.85	0.06	0	10.59	1.14	20,000	5,000	4.31	0.04	Good
56	8	1.41	1.01	1.14	0.14	0	11.39	15.21	15,000	5,000	1.60	0.04	Good
204	8	0.6	0.25	0.28	0.04	0	0.48	0.36	1,000	1,000	6.04	0.03	Good
470	8	0.27	0.25	0.25	0.03	0	0.38	0.38	1,000	1,000	1.19	0.03	Good
16	8	1.01	0.84	0.88	0.11	0	2.19	2.27	2,000	2,000	1.37	0.03	Good
172	8	1.93	1.06	1.49	0.19	0	13.13	10.44	25,000	4,500	1.74	0.03	Good
130	8	0.25	0.25	0.25	0.03	0	0.15	0.15	1,000	1,000	1.00	0.02	Good
419	8	0.53	0.25	0.25	0.03	0	0.82	0.82	1,000	1,000	6.26	0.02	Good
182	8	0.7	0.25	0.44	0.05	0	3.44	1.85	12,000	2,000	2.92	0.02	Good
442	8	1.11	0.35	0.71	0.09	0	9.51	4.87	10,000	3,000	2.39	0.02	Good
102	8	0.46	0.25	0.25	0.03	0	0.34	0.34	500	500	4.41	0.01	Good
70	10	1.05	0.42	0.54	0.05	0	1.35	1.24	1,000	1,000	4.66	0.01	Good
88	8	1.02	0.26	0.76	0.10	0	1.65	2.62	1,000	1,000	1.87	0.01	Good
191	8	2.12	1.07	1.57	0.20	0	2.18	1.75	8,000	1,000	1.72	0.01	Good
390	6	0.64	0.43	0.54	0.09	0	1.19	0.84	1,000	1,000	1.43	0.01	Good
436	8	1.01	0.33	0.65	0.08	0	1.67	0.90	1,000	1,000	2.56	0.01	Good
473	8	0.39	0.28	0.34	0.04	0	0.61	0.72	500	500	1.43	0.01	Good
413	18	6.47	6	6.00	0.33	0	694.25	694.25	1,000	500	1.11	0.01	Good
43	8	0.82	0.39	0.72	0.09	0	1.89	1.31	2,000	1,000	1.29	0.01	Good
176	8	1.07	0.67	0.87	0.11	0	2.71	2.46	7,000	1,000	1.58	0.01	Good
189	8	0.25	0.25	0.25	0.03	0	0.41	0.41	9,000	1,000	1.00	0.01	Good
385	8	0.76	0.25	0.44	0.06	0	1.90	1.09	2,000	1,000	3.22	0.01	Good
465	15	0.9	0.47	0.73	0.05	0	1.85	2.13	3,000	1,000	1.63	0.01	Good
6	8	0.59	0.25	0.35	0.04	0	0.95	0.50	2,000	500	3.51	0.01	Good
79	8	0.45	0.25	0.29	0.04	0	1.12	0.73	500	500	2.76	0.01	Good
170	8	0.44	0.25	0.25	0.03	0	0.84	0.82	500	500	3.89	0.01	Good
186	8	1.17	0.58	0.82	0.10	0	4.76	3.40	10,000	1,000	2.22	0.01	Good
242	8	0.92	0.27	0.56	0.07	0	1.42	0.65	500	500	2.83	0.01	Good
337	8	6	0.25	1.30	0.16	0	16.04	36.05	500	500	5.45	0.01	Good
410	18	0.74	0.34	0.51	0.03	0	1.86	1.43	3,500	500	2.45	0.01	Good
460	8	0.77	0.35	0.49	0.06	0	2.14	1.61	4,000	1,000	2.95	0.01	Good
20	6	1.39	1.28	1.31	0.22	0	4.45	1.00	3,000	1,000	1.14	0.00	Good
212	8	4.3	1.79	2.47	0.31	0	123.81	85.98	386,000	5,000	2.08	0.00	Good
255	18	3.44	2.22	2.65	0.15	0	134.52	106.14	391,000	5,000	1.80	0.00	Good
178	8	1.26	0.73	1.01	0.13	0	6.23	4.72	13,000	1,000	1.61	0.00	Good
361	8	0.76	0.32	0.58	0.07	0	4.09	1.34	5,500	1,000	1.79	0.00	Good
455	8	1.55	0.5	0.69	0.09	0	5.95	2.23	5,000	1,000	5.41	0.00	Good
275	8	1.03	0.79	0.89	0.11	0	2.52	2.20	500	500	1.39	0.00	Good
449	8	0.5	0.5	0.50	0.06	0	3.19	3.19	6,000	1,000	1.60	0.00	Good
445	8	1.95	1.22	1.59	0.20	0	10.77	9.20	7,000	1,000	1.55	0.00	Good
51	10	0.89	0.7	0.76	0.08	0	2.36	2.05	500	500	1.44	0.00	Good
349	8	1.56	0.93	1.13	0.14	0	3.63	2.82	4,500	500	2.05	0.00	Good
426	8	0.72	0.51	0.63	0.08	0	6.68	5.53	5,500	500	1.34	0.00	Good

Manhole ID – The unique identifier of the manhole where the iTracker was installed.

Pipe Diameter – Diameter of Pipe

Depth Max – The maximum water level across the data set

Depth Min – The minimum water level across the data set

Average Dry Level – The average dry level associated during a two-day period with no rain events

Surcharge – The condition in which the water has exceeded the pipe diameter, or anything more than full pipe

Time in surcharge – The total amount of time that the site experienced a surcharge condition

% of full pipe DRY – This value represents the level as compared with diameter during dry weather conditions

Dry Weather Average Flow – The estimated flow value in a defined dry weather period. Flow is calculated with Eastech algorithm

Priority Level – Indicates the level of priority in terms of the reaction to wet weather based on all data collected

Manhole ID – The unique identifier of the manhole where the iTracker was installed.

Pipe Diameter – Diameter of Pipe

Depth Max – The maximum water level across the data set

Depth Min – The minimum water level across the data set

Average Dry Level – The average dry level associated during a two-day period with no rain event

Surcharge – The condition in which the water has exceeded the pipe diameter, or anything more than full pipe

Time in surcharge – The total amount of time that the site experienced a surcharge condition

Surcharge Max – The maximum amount of surcharge observed over full pipe (note that levels above the measuring device cannot be measured)

Estimated 4 Day Dry Weather - the volume during dry weather pattern that is representative of flow without impacts of inflow and infiltration

4 Day Rain Event I&I - The estimated value of total inflow and infiltration measured. This total would include both I&I that is determined to be adjacent/local AND "carrier" I&I from sources determined to be further upstream

Delta Q - A calculated value utilizing local I&I values, ADWF, and total I&I. This score determined the relative severity

