November 2017

Village of Bradley 2017 Comprehensive Flow Monitoring

Final Report

Village of Bradley

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November 10, 2017

Mr. Terry J. Memenga
Director of Public Works
Village of Bradley, IL
147 S. Michigan Avenue
Bradley, Illinois 60915

SUBJECT: BRADLEY COMPREHENSIVE FLOW MONITORING – FINAL REPORT

Dear Mr. Memenga,

RJN Group, Inc. (RJN) is pleased to submit this summary of the 2017 short term flow monitoring program. The results of this study will assist the Village in determining the basins that are most troubled by inflow and infiltration. This study will also help quantify the effects of any future rehabilitation projects by establishing baseline flows, with pre-rehabilitation dry weather and wet weather data.

PROJECT BACKGROUND

Flow monitoring is a valuable tool that can be used to study a variety of problem areas and to gather data for a number of reasons. Because of this, the Village has decided that it is in their best interest to conduct a system wide flow monitoring study to evaluate and prioritize areas in need of investigation and rehabilitation as part of a comprehensive sewer program. In 2016, RJN submitted a Statement of Qualifications (SOQ) to the Village of Bradley for Professional Consulting Services for Sanitary Sewer Investigations & Rehabilitation. Following the submittal and interview process, RJN was selected by the Village for this work. This flow monitoring project represents the initial step in Year-1 of the program. Flow monitoring in the Village is important for three reasons. The primary purpose for the flow monitoring project is to provide the Village with a comprehensive and comparative assessment of the vast majority of the sewers within the Village. This data will help drive future long term operations and maintenance programs for the Village by comparing each basin against the other and identifying areas with the highest inflow and infiltration (I/I) as well as understanding their effects upon each other and the effects of downstream sewers.

This project provided flow monitoring of the entire Village's sanitary sewer system at (13) approved monitoring locations for a duration of 60 days. Work included the installation of (13) flow monitors and (3) rain gauges, maintenance and calibrations throughout the flow monitoring period.

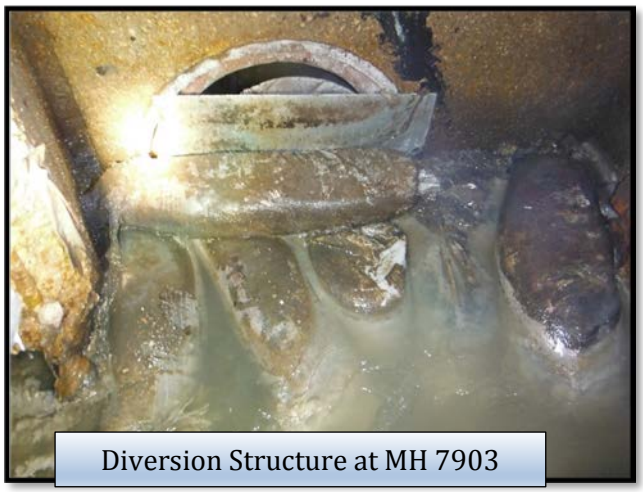
PROJECT APPROACH

Flow monitoring is important for obtaining empirical data of sewer flows at locations throughout a sewer system. The data is used in determining base flow, causes of sewer surcharging, and the extent of Rainfall Derived Infiltration and Inflow (RDII) into a sanitary sewer system. Flow monitoring is typically performed during spring and fall seasons when groundwater levels are highest, and rainfall is most likely to occur. When selecting the flow meter basins for an I/I analysis, it is important to select similarly sized basins that discretely break up the area for analysis.

The following approach was adopted for the flow monitoring study:

- Inspect permanent flow monitoring sites and determine if they were adequate for the flow monitoring study.
- Determine monitoring locations that segregate the area into distinct discrete basins.
- Inspect the locations for data collection suitability and, if necessary, evaluate alternate locations.
- Install flow meters.
- Maintain the flow meters and rain gauges for a minimum of 60 days and collect the data at least weekly via wireless telemetry.
- Perform dry-weather and wet-weather data analysis
- Prepare results and conclusions for future recommendations.

RJN conducted preliminary site investigations for key monitoring locations ahead of meter site selection and installations. One such site is pictured below at manhole 7903 where the diversion structure use to allow dry weather flow through town via a 21" VCP sewer, but now has been blocked off to follow the old overflow route toward the river down a 48" brick sewer as it makes its way to the KRMA Wastewater Treatment Plant (WWTP). This structure was inspected to determine if flow was getting past the plugged pipe down the 21" line as some sinkholes have formed over the years near the Meadowview Shopping Plaza.



Diversion Structure at MH 7903

During preliminary investigations, RJN also inspected all three permanent flow meter billing sites at Blatt, Brookmont & YMCA permanent flume site locations for potential use during the flow monitoring period. The first two of these sites utilized Palmer Bowlus flumes and the third had a Montana Flume.

Site 1, Blatt had evidence of surcharging and downstream control, most likely caused by the KRMA WWTP and Bourbonnais interceptor. Flumes are sized to have an acceptable flow range for each size

and type of flume, once the maximum flow is reached, ultrasonic level flow monitors will flat line at the maximum capacity. Since a flume measures flow by the hydraulic depth, if the site surcharges or is operating in submerged conditions the flows measured during those events is inaccurate and should not be trusted.

Site 2, Brookmont did not have any observed issues with the operation of the flume or ultrasonic sensor and the location appeared to be a good site for flow monitoring. Site 3, YMCA however, has very turbulent hydraulic conditions through the Montana flume and the site is not ideal for accurate flow measurements. Significant turbulence can reduce the accuracy of the flow measurements by not allowing consistent level measurements. These hydraulic conditions will be difficult to correct at this site due to the size of the interceptor, the volume of flow and the high velocities at which flow is moving through the site.

Each of the three permanent flume sites were measuring depth using ISCO 3010 ultrasonic sensors. These meters have been obsolete for about 15 years and have been replaced with ISCO 4210's which are also now outdated metering equipment that ISCO no longer makes replacement parts for. In addition, the ISCO 3010's do not record data unless a telemetry unit is connected to the 4-20 mA output and there is only (1) 4-20 mA output which KRMA is using to transmit the totalizer flows to KRMA. Recording totalized flow values ensures no accuracy of the data collected and cannot indicate to the Village if there has been an issue with the meter or if they are in surcharged or backup conditions. Due to these issues with the flume sites and the outdated metering technology is was deemed necessary to install temporary flow monitors near each permanent site for this metering study. Each site also is recommended for upgrades to the metering technology so the Village can better utilize these sites for valuable billing and flow tracking information.

In addition to inspecting the three permanent billing sites, RJN visited the four Village lift stations including Upper Soldier Creek, Lower Soldier Creek, K-Mart & Camelot. K-Mart & Camelot had daily run times recorded but no flow meters and therefore could not be used effectively as part of this flow study. While Upper & Lower Soldier Creek lift stations both had flow meters, their settings were limited by Omni-Site to two hour intervals and therefore it was opted to use temporary flow meters nearby to record data in the 5-minute intervals needed for this flow study. The rain gauge at Upper Soldiers Creek lift station was also not used due to the programming limitations with Omni-Site and data only being available in 2-hour increments.

During final site inspections for temporary flow monitoring locations, RJN crews check multiple sites for each meter to ensure that the chosen locations will provide ample conditions to flow monitor. Collected data during the site inspections includes typical flow velocity and depth, other pipes in the manhole, flow path, manhole characteristics, pipe sizes and material, atmospheric conditions, and a GPS point with photos for reference.

Meter Installation at BRD-05

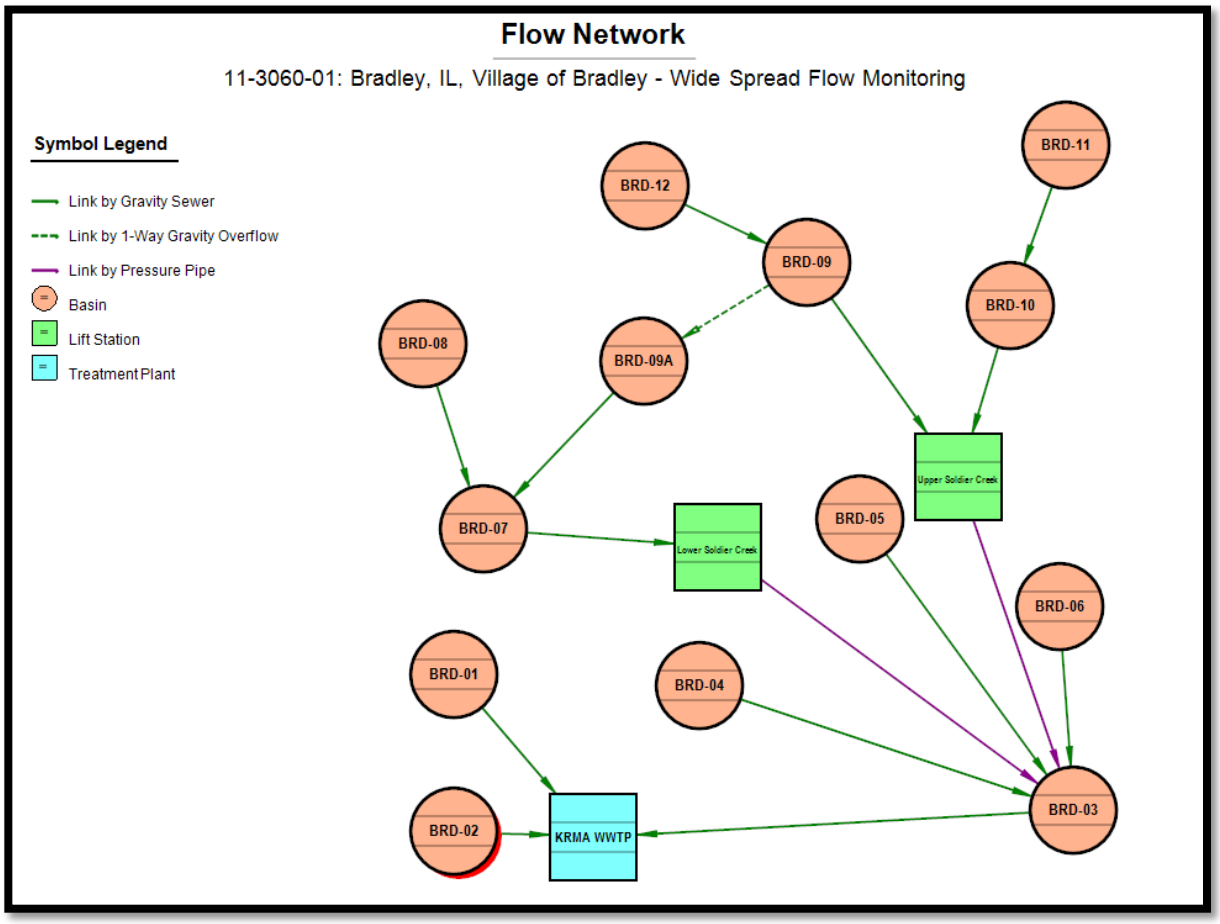
A site with good hydraulic conditions is critical in achieving optimal results from flow meters. Good hydraulic conditions include a pipe with sufficient grade, velocities between 1 and 3 fps, and smooth laminar flow as shown in the adjacent photograph. While it is usually impossible to obtain all sites with such ideal conditions, field investigations were performed to locate the best possible option for each site.

The interrelations between the meter basins and interceptors are represented schematically in Figure 1. In the schematic, solid arrows indicate the primary flow path between meter basins, as inferred from the interceptor flow directions and invert elevations. The locations of each meter and rain gauge are shown in Exhibit A.

TABLE 1
FLOW MONITORING SITES

Meter Site	Manhole	Pipe	Height (Inches)	Width (Inches)	Pipe Shape	Pipe Material	Location Description
BRD-01	7928	NE-In	9.81	9.81	Circular	PVC	499 Valley Ave
BRD-02	1639A	E-IN	21.18	21.18	Circular	VCP	1423 W. Brookmont Blvd
BRD-03	7914	NE-In	49.37	49.06	Circular	Brick	525 W. Brookmont Blvd
BRD-04	1002	W-In	23.12	22.25	Circular	VCP	495 S. Wabash Ave
BRD-05	674	N-In	24.18	24.24	Circular	VCP	Congress St., E. of Washington
BRD-06	659	N-In	27.00	30.06	Circular	Brick	304 S Schuyler Ave
BRD-07	400	E-In	14.56	17.75	Circular	Concrete	701-799 Liberty St
BRD-08	386	N-In	9.75	9.43	Circular	VCP	183 N. Madison Ave
BRD-09	3185	N-In	15.18	15.25	Circular	VCP	420 N. 2000E Rd
BRD-09A	3200	N-In	15.06	15.18	Circular	VCP	29 Old Farm South Ct
BRD-10	3328	N-In	35.37	35.75	Circular	VCP	400 Edgebrook Dr
BRD-11	7382	N-In	20.62	209.30	Circular	Concrete	2751-3019 Co Hwy 44
BRD-12	7088	N-In	14.25	14.50	Circular	PVC	1661-1699 N 2000E Rd

FIGURE 1
BASIN FLOW NETWORK



DATA MANAGEMENT

Data was logged every 5 minutes and uploaded nightly to the Telog server hosted by RJN. To ensure the proper functioning of the flow meters and rain gauges, the RJN Data Group reviewed all the site data weekly (at a minimum), issuing work orders when the data indicated a problem at the site. Field crews were dispatched to the troubled sites on an as-needed basis.

Where necessary, the field crews entered the manhole to clear debris from the probe or to reposition the probe for optimal data collection. Malfunctioning meters and probes or meters recording suspect data were replaced during these visits. All field actions at the sites were recorded on electronic maintenance logs.

The data finalization performed by the RJN Data Group utilized field calibrations collected by RJN to validate the flow and rainfall data recorded by the monitoring equipment. The "raw" data was edited to eliminate temporary meter malfunctions, or "pops" and "drops" that can distort data analysis, and to adjust the instrument readings as necessary to align with manual calibrations.

Following the QC and finalization processes, the finalized data was campared to the meter basin configurations to ensure proper balancing of flows prior to analysis. The flow data was analyzed in conjunction with rainfall data to establish an Average Dry-Weather Flow (ADWF) baseline and to quantify the response to wet-weather events. Accuracy of the metered level and velocity readings was verified throughout the metering period through onsite calibrations that occurred at least on a monthly basis.

Data Calibration

In order to verify that the flow monitors and rain gauges were collecting accurate data, RJN collected multiple manual field measurements throughout the monitoring period. Calibration measurements were conducted at least five times at every site.

The field confirmations are used to adjust and edit data based on the manual measurements at the time of the calibration. These adjustments are made by the RJN Data Group after the flow monitoring period is completed. All the calibrations are taken into account and adjustments are made when the meter measurements are not in agreement with the manual measurements. Data calibrations and corresponding data editing are essential to obtaining accuracy throughout the metering period.

Dry-Weather Analysis

Flow data collected during dry-weather/low-groundwater periods was analyzed to determine the average daily dry-weather flow (ADWF) for each meter basin. The dry-weather periods used for the ADWF analysis are summarized in Table 3.

Table 3
Dry-Weather Periods

Meter	Dry-Weather Period		Total Days
	Start	End	
BRD-01	06/05/17	06/12/17	7
BRD-02	06/05/17	06/12/17	7
BRD-03	06/05/17	06/12/17	7
BRD-04	06/05/17	06/12/17	7
BRD-05	06/05/17	06/12/17	7
BRD-06	06/05/17	06/12/17	7
BRD-07	06/05/17	06/12/17	7
BRD-08	06/05/17	06/12/17	7
BRD-09	06/05/17	06/12/17	7
BRD-09A	06/05/17	06/12/17	7
BRD-10	06/05/17	06/12/17	7
BRD-11	06/05/17	06/12/17	7
BRD-12	06/05/17	06/12/17	7

Diurnal Variations and Peaking Factors

Diurnal curves, or plots of typical flow variation throughout a day, were created by averaging data points hourly, separating out weekday and weekend diurnal flow patterns. The diurnal curve for BRD-10 is shown in Figure 2 as an example, while diurnal curves for all meters are in Appendix B.

Wastewater flows during dry-weather periods will vary during the day in response to water consumption. Typically cresting in the morning and evening hours and dropping during the overnight and mid-afternoon hours in residential areas. The ADWF and diurnal variation characteristics are summarized in Table 4.

FIGURE 2
TYPICAL DIURNAL FLOW – BRD-10

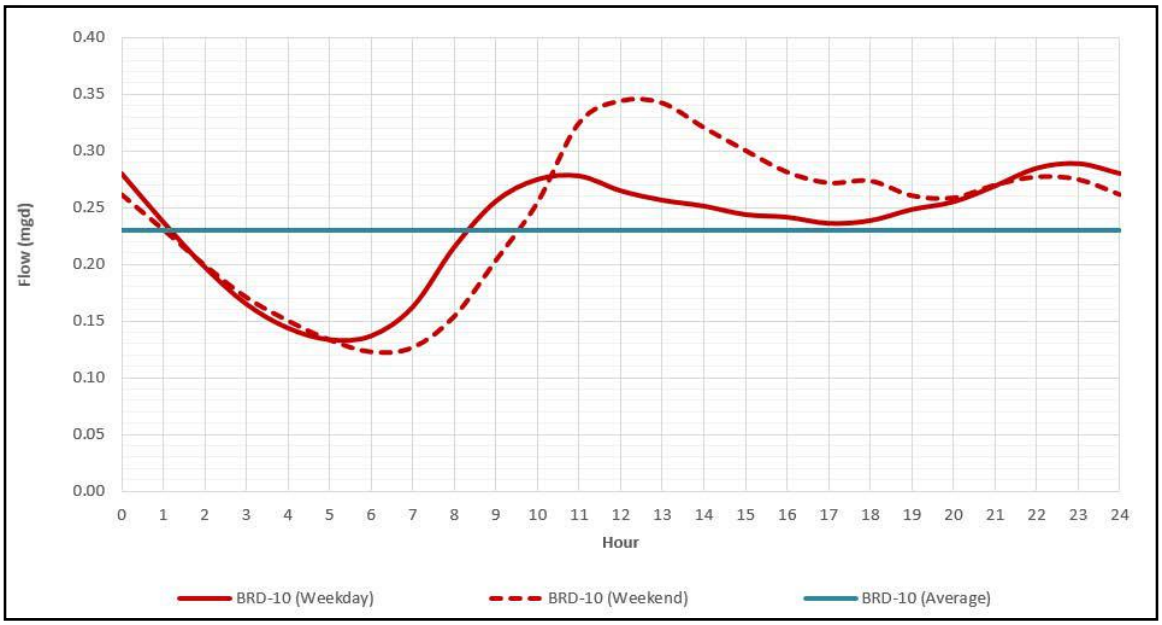


TABLE 4
DRY-WEATHER FLOW CHARACTERISTICS

Meter	Cumulative Weekday ADWF (mgd)	Discrete Weekday ADWF (mgd)	Peak Hourly Flow (mgd)	Diurnal Peaking Factor (TYP. 1.5-1.8)	Diurnal Trough (mgd)	Percent Of Trough to ADWF (TYP. 25%-30%)	Discrete ADWF per Parcel (gpdpp)
BRD-01	0.04	0.04	0.05	1.27	0.02	60%	106
BRD-02	0.07	0.07	0.09	1.30	0.03	41%	71
BRD-03	2.31	0.74	2.59	1.12	1.77	77%	390
BRD-04	0.05	0.05	0.06	1.24	0.03	62%	42
BRD-05	0.31	0.31	0.33	1.09	0.26	85%	115
BRD-06	0.14	0.14	0.16	1.12	0.12	83%	245
BRD-07	0.34	0.20	0.43	1.27	0.26	76%	91
BRD-08	0.20	0.20	0.26	1.31	0.14	73%	852
BRD-09	0.51	0.36	0.60	1.17	0.35	68%	124
BRD-09A	0.00	0.00	0.00	-	0.00	-	-
BRD-10	0.23	0.13	0.29	1.25	0.13	58%	92
BRD-11	0.10	0.10	0.12	1.24	0.06	65%	84
BRD-12	0.15	0.15	0.20	1.28	0.09	61%	454

By examining the ADWF diurnal variations in the data, a diurnal peak flow and diurnal trough flow was calculated for each meter basin. The diurnal peak flow is the peak hourly flow rate during a typical dry day, and the diurnal trough is the lowest average hourly flow rate during a typical dry day.

Diurnal variations in ADWF are useful in assessing the prevalence of base infiltration—that is, groundwater that infiltrates the system even during dry periods—within a meter basin. The Diurnal Peaking Factor is the ratio of the peak hourly flow rate to the average daily flow. Low Diurnal Peaking Factors can be indicators of a large base infiltration component. Similarly, the Trough-to-ADWF Percentage is a measure of how overnight low flows compare to average flows, and therefore, higher percentages indicate a greater base infiltration component. In a residential meter basin, the Diurnal Peaking Factor is often in the range of 1.5 to 1.8 with smaller basins tending toward the higher end, and the overnight (diurnal trough) flow is expected to be 15% to 30% of the ADWF (with smaller basins tending toward the lower end) when there is little or no base infiltration.

On these measures, the ADWF of every meter basin in Bradley (with the exception of the overflow site, BRD-09A) appears to have above-average base infiltration flow components. The diurnal peaking factors are all below the typical range. Higher base infiltration during the night will increase the ADWF, which will in turn lower the diurnal peaking factor. The same effects can be seen when comparing the daily minimum (trough) flows to the ADWF. Throughout the night, sewer flow should decrease significantly in residential areas, as water usage decreases significantly. Strong base infiltration will reduce the difference, and dampen the percent of trough to ADWF.

RAIN EVENTS

The three RJN mounted rain gauges recorded rainfall every five minutes. Rain events that occurred during the flow metering period are listed in Tables 5A and 5B and are graphically represented in Figure 3 and Figure 4. These values are averages of all three rain gauges, and do not represent the values used in the regression analysis. The regression analysis uses a formula to weigh each rain gauge with respect to their distance to each basin.

The rain events used in the flow data analysis ranged from a less than a 1-month recurrence interval to as large as a 1-year recurrence interval. The range of data provides a spread of rain event sizes, with most events that occurred being on the small side. The flow monitors did capture one storm event that was a 1-year 1-hour event for two of the rain gauges which assisted in a more confident projected storm events. The storm event shown in Table 5A averages as a 6-month event, but two rain gauges recorded it as a 1-year event.

TABLE 5A
1-HOUR RAIN EVENTS

Date	1-Hr Recurrence Interval	1-Hr Rainfall (in)
06/13/17	6-month	0.96

TABLE 5B
24-HOUR RAIN EVENTS

Date	24-Hr Recurrence Interval	24-Hr Rainfall (in)
	None	

Rain events less than a 2-month recurrence were omitted from the summary tables.

FIGURE 3
24-HR RAINFALL

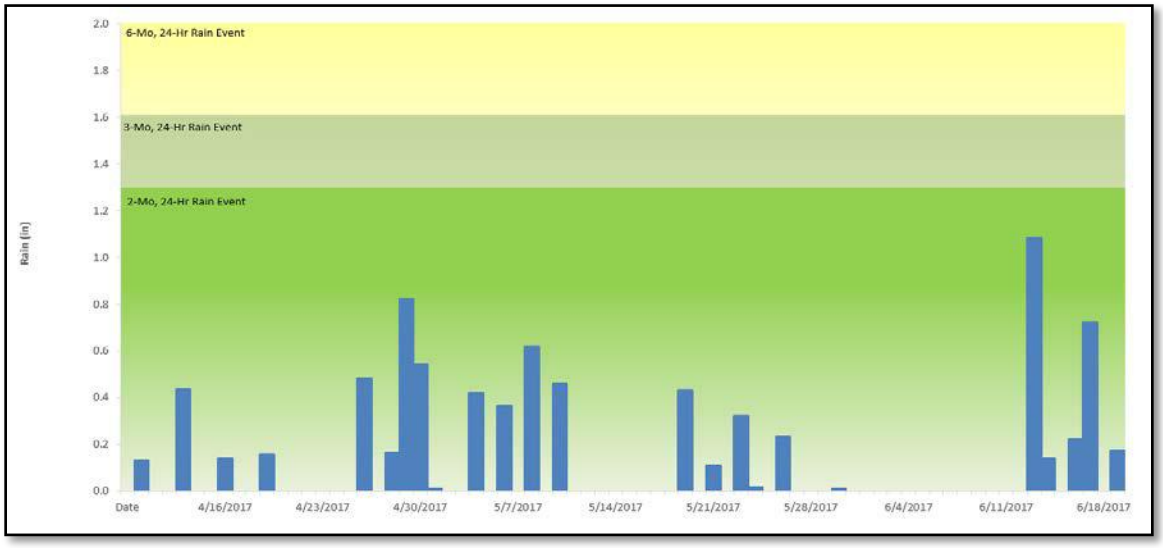
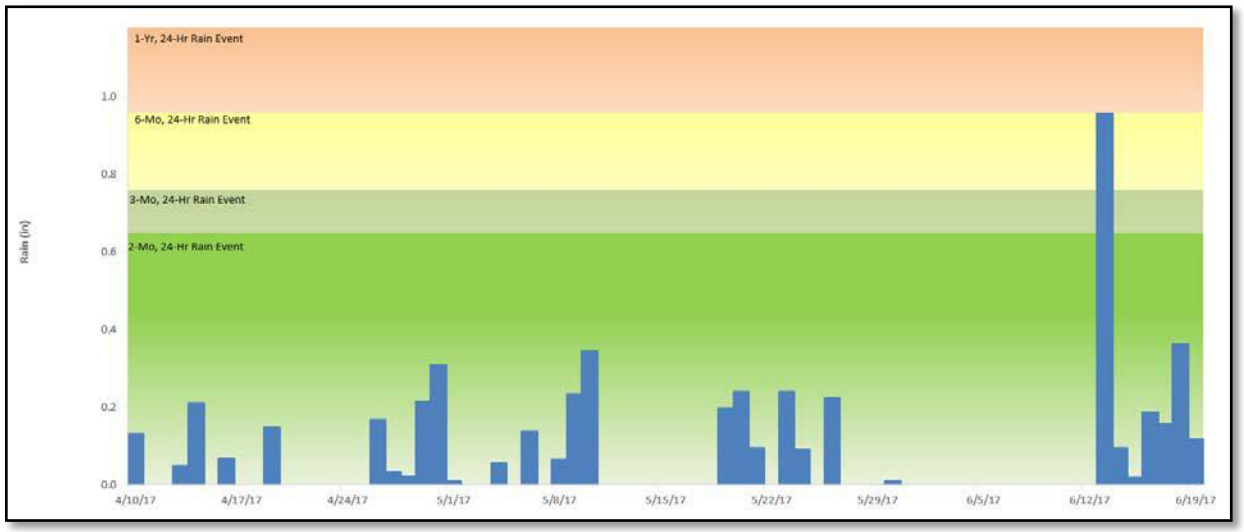


FIGURE 4
1-HR RAINFALL



With the distance between rain gauges being as great as five miles, a given storm can register differently at each rain gauge site. Figure 5 & Figure 6 both show the differences that were shown throughout the monitoring period. Figure 5 shows a range of 0.77 inches for the 24 hour storm on June 13th, and Figure 6 shows a difference of 0.23 inches for the storm on May 23rd. These figures show the importance of using multiple rain gauges in order to more accurately correlate the rainfall data with the excess flow in the regression analysis. The variance in rainfall can be seen in a 1 hour event, as well as a 24 hour event.

FIGURE 5
JULY 28 RAIN EVENT

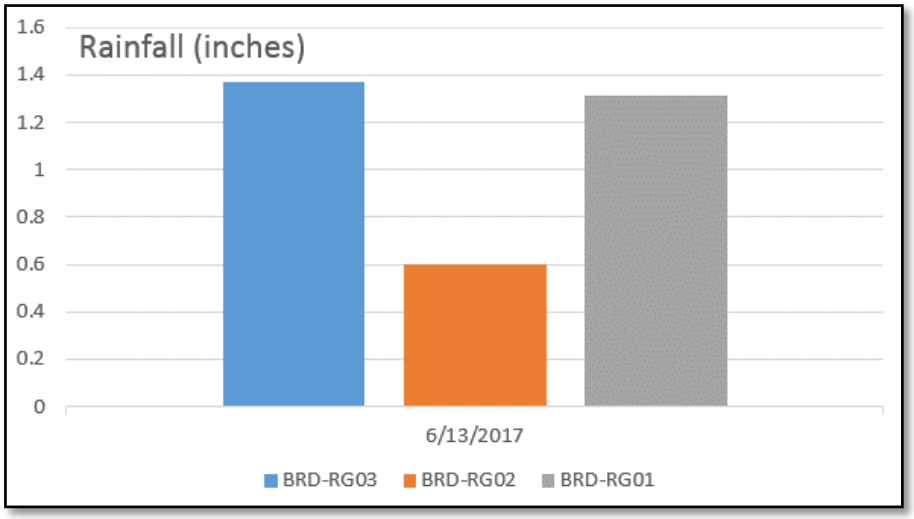
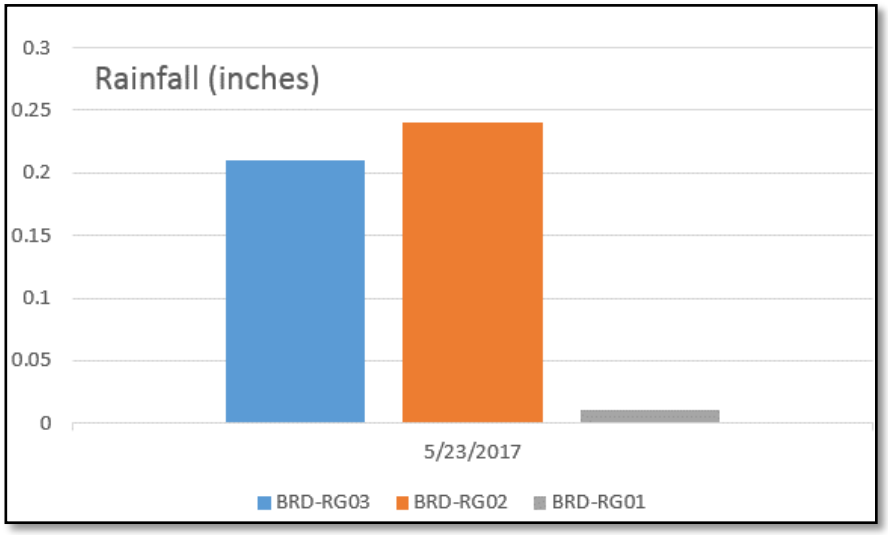


FIGURE 6
1-HR MAXIMUM RAINFALL



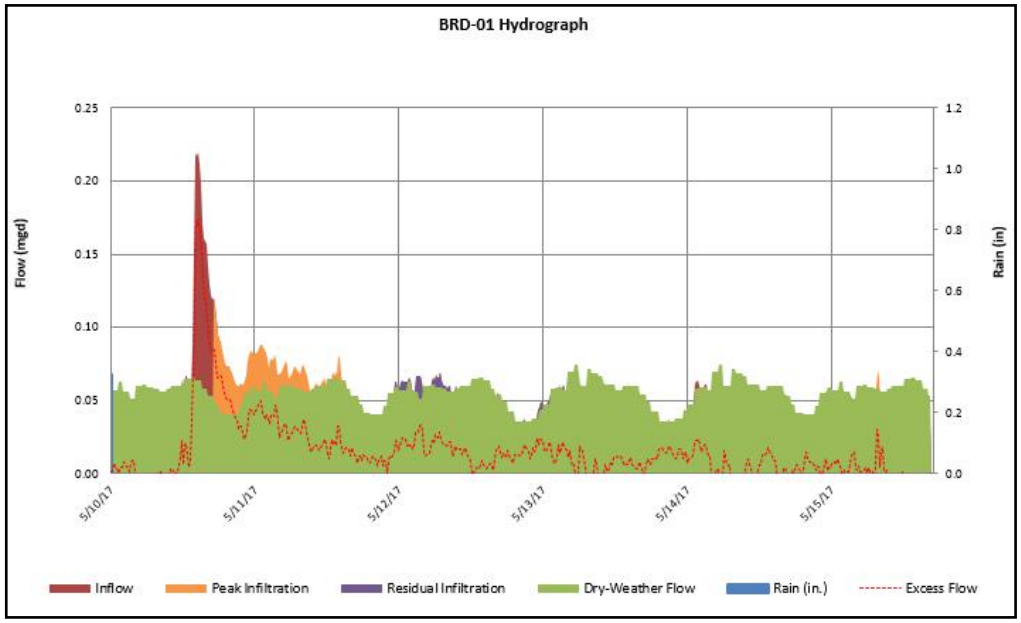
WET-WEATHER FLOW ANALYSIS

Stormwater that enters the sanitary sewer system is characterized as rainfall-derived inflow and infiltration (RDII). Inflow is extraneous flow that is a direct result of stormwater runoff. Inflow enters the sanitary system quickly through improper connections, such as directly connected downspouts, area drains, pickhole covers, and cleanouts. Inflow may also enter the system through direct or indirect stormwater connections to the sanitary sewer, as well as through sewer mainline, service laterals, and manhole defects. The large volume and rapid input of inflow to the system can result in system surcharge and in extreme cases, overflows and basement backups. The primary concern in most sewer systems is inflow.

Infiltration is the water entering a sewer system through the ground, from sources such as cracks in mainline sewers and service laterals, pipe joints, and manhole walls. Infiltration occurs during both wet and dry conditions and enters the sewer system more slowly than inflow. Infiltration that occurs during dry-weather periods is called base infiltration and is caused by groundwater entering the sewer system. This flow is included within the dry-weather flow. Rainfall induced infiltration can occur both during and following wet-weather periods, mainly from defective manhole walls, sewer mains, and service laterals. Infiltration that occurs within 24 hours of a rain event is commonly referred to as peak infiltration whereas residual infiltration, a primary indicator of how tightly sealed a system is, can linger for days after a storm event. A sample wet-weather hydrograph differentiating

the components of RDII is presented in Figure 7. This figure shows the 5-10-2017 storm event for BRD-01. As the figure shows, rain-derived infiltration remains in the system for a couple of days following significant rain events. The total flow is separated into its dry-weather flow, residual infiltration, and excess flow components.

FIGURE 7
RDII HYDROGRAPH



Wet-Weather Peaking Factors

Rain and flow data were analyzed in conjunction with one another to determine the peak 1-hour excess flow rate resulting from the peak 1-hour rainfall. In order to isolate the effects of the peak rainfall on peak flows, the dry-weather flow and any lingering infiltration from antecedent rains was subtracted from the total flow to calculate a peak excess flow for that rain event.

Peak excess flow (Q) versus peak rainfall intensity (I) data points were plotted and used to calculate a regression line. The regression line was then extrapolated to predict the amount of excess flow that would result from 1-hour events at larger recurrence intervals. An example of the regression analysis is shown in Figure 8 while the results of all regression analyses are presented in Appendix C.

A new sanitary sewer system is typically designed to convey 3 to 4 times the calculated ADWF. Therefore, a peaking factor less than four is generally not considered to be an issue, as the sewer should be able to convey this flow without surcharging or overflows. Older areas in the Village have shown peaking factors between 9 and 45 for 1-yr, 1-hr storm events, and issues are likely to arise in locations where sewers are not sized to accommodate these higher flows. About half of the meter sites in this study exhibited peaking factors above 4 for 1-year, 1-hour storm events and are therefore considered to have high RDII.

FIGURE 8
REGRESSION ANALYSIS

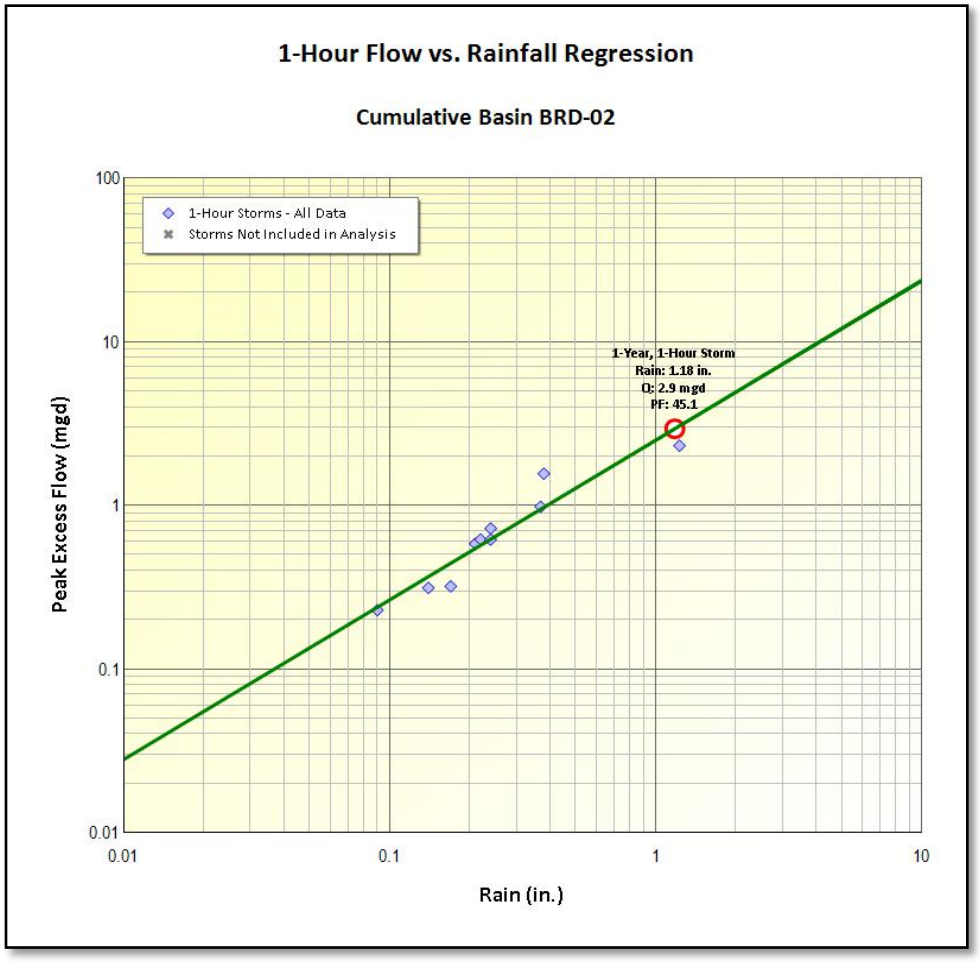


Table 6 summarizes the results of the peak flow analysis. The peaking factors (PF) are the ratio of the total flow (ADWF plus excess flow) to the ADWF. The table also lists the maximum surcharge depth observed at each meter site, as well as the extent of downstream control. Downstream control, discussed further in the following section, is important to note because it can dampen flow peaks. This should be taken into account when considering peaking factors and potential improvements such as capacity increases or flow reduction.

TABLE 6
BASIN CONDITION SUMMARY

Meter	DWF (mgd)	1-Yr, 1-Hr PF	5-Yr, 1-Hr PF	10-Yr, 1-Hr PF	1-Yr, 1-Hr Excess Flow	5-Yr, 1-Hr Excess Flow	10-Yr, 1-Hr Excess Flow
Bradley 1	0.04	11.0	16.1	18.6	0.4	0.6	0.7
Bradley 2	0.07	45.1	67.2	78.4	2.9	4.4	5.1
Bradley 3	2.30	3.0	3.8	4.2	4.5	6.4	7.4
Bradley 4	0.05	20.2	37.6	48.0	0.9	1.6	2.1
Bradley 5	0.31	9.5	14.9	17.8	2.6	4.3	5.1
Bradley 6	0.14	4.0	5.7	6.6	0.4	0.7	0.8
Bradley 7	0.35	2.5	3.0	3.2	0.5	0.7	0.8
Bradley 8	0.20	1.9	2.0	2.1	0.2	0.2	0.2
Bradley 9	0.51	2.3	2.5	2.7	0.6	0.8	0.9
Bradley 10	0.2	2.6	3.1	3.3	0.4	0.5	0.5
Bradley 11	0.1	1.5	1.5	1.5	0.5	0.5	0.5
Bradley 12	0.2	2.3	2.7	2.9	0.2	0.3	0.3

*Note: BRD-09A has been ommitted as no dry weather data is available.

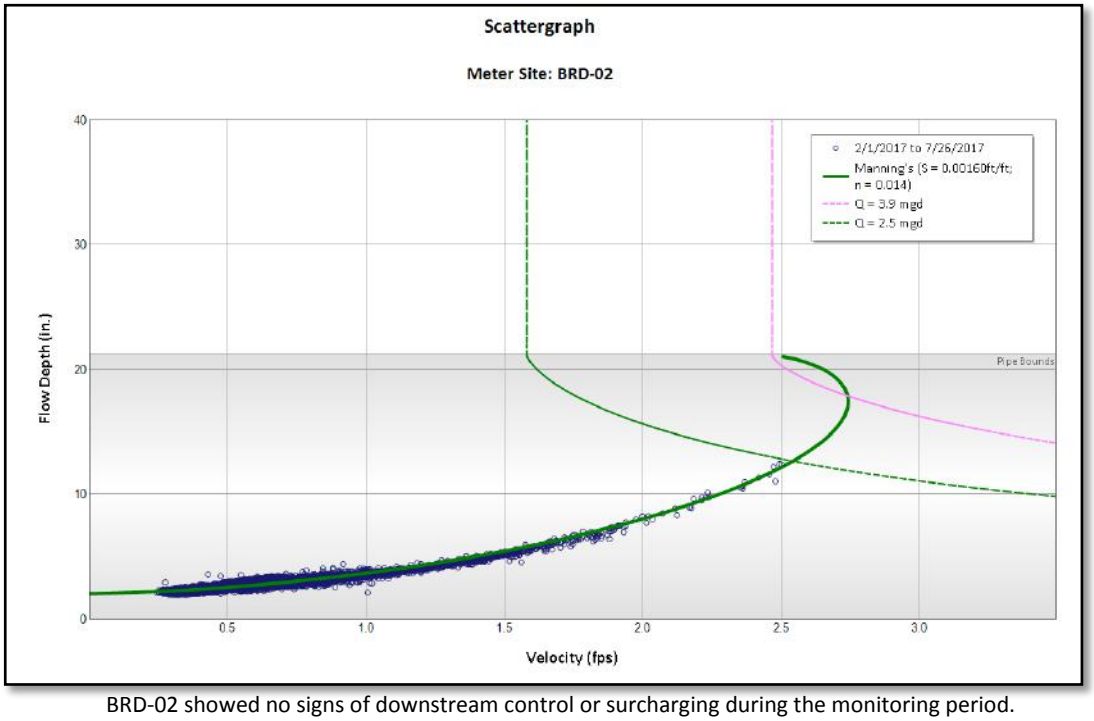
HYDRAULIC ANALYSIS

Scattergraphs are a useful tool for understanding the hydraulics of each flow meter site, particularly the effects of debris and downstream control. On a scattergraph, the flow velocity is plotted versus the flow depth for each collected data point, creating a visualization of how the depth and velocity relate with one another.

Scattergraphs can be helpful for understanding when flow is limited by the capacity of the pipe at the meter location and when it is limited by downstream control. Downstream control is any condition downstream of the metering point that restricts flow from reaching the potential capacity of the pipe. Downstream control is typically caused by a blockage or a bottleneck in the system, such as a downstream pump station or undersized and surcharged sewer.

In the example scattergraphs, Figures 9 and 10, the green curve indicates the depth-velocity relationship predicted by Manning's formula in ideal hydraulic conditions based on a best estimate of the pipe roughness and slope at the monitoring location. Points that significantly deviate from this curve indicate hydraulic anomalies such as downstream control or supercritical flow. In addition, if the Manning's curve crosses the depth axis above zero, it indicates a fixed hydraulic head downstream (often referred to as a "dead dog"), which can be caused by an obstruction (such as sediment, debris or an offset pipe joint) or the water level in a downstream sewer.

FIGURE 9
BRD-02 SCATTERGRAPH

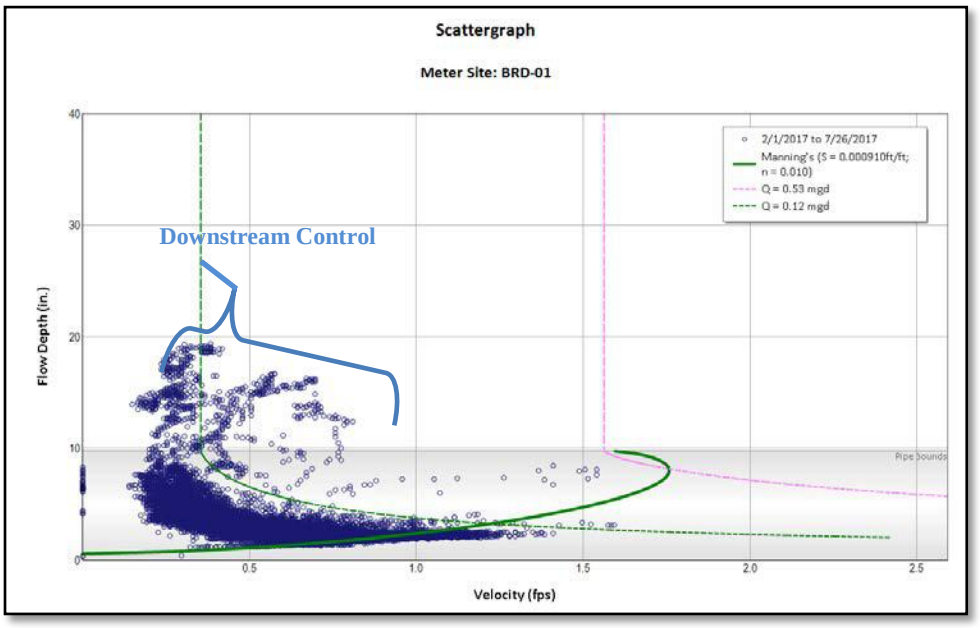


BRD-02 showed no signs of downstream control or surcharging during the monitoring period.

The dotted lines are Iso-Q lines, so called because any corresponding depth/velocity along an Iso-Q line will represent one flow value through the pipe. A clustering of points along these lines is indicative of a system characteristic or recurring condition that tends to restrict flows to that specific flow limit over the course of multiple events. The green line indicates the maximum flow event observed during the monitoring period. The pink line represents an estimate of the capacity of the pipe, assuming no downstream control.

Scattergraphs for all meters are located in Appendix D.

FIGURE 10
BRD-01 SCATTERGRAPH



BRD-01 displayed flow restrictions in the form of downstream control. With the full pipe capacity estimated to be 0.53 MGD, the current flow conditions allow for 23% of this flow at full pipe conditions.

BRD-01 experienced the largest amount of downstream control throughout the monitoring period. The 1-year, 1-hour storm recorded on 6-13-2017 had no downstream control, however. The downstream control occurred during the smaller storms in April and May.

During dry weather conditions, BRD-07 consistently recorded high depths with low velocities. This is an indication of downstream control. In these conditions, debris can settle out and create more head loss, potentially causing surcharging.

VOLUMETRIC ANALYSIS

Volumetric analysis is another useful tool in determining which basins are most troubled by inflow and infiltration. Volumetric analysis is a useful way of separation the flow data from the constraints of a meter site. When flow metering, the size and layout of the basin have an impact on the peaking factor. With volumetric analysis, these parameters will not have an impression on the calculations.

Dry weather flows are subtracted out, providing the excess flows for the analysis. Table 7 shows the results of the analysis. The data represents flows from 4-12-2017 to 6-18-2017.

TABLE 7
VOLUMETRIC ANALYSIS

Meter	DWF (MGD)	Rainfall (inches)	Volume of Excess flow (MGD)	Normalized Volume of Excess Flow (MGD/inch)	Percent Captured (%)	Percent Excess Flow (%)
Bradley 1	0.04	8.0	0.5	0.1	3.2	21.3
Bradley 2	0.07	8.0	1.2	0.1	4.3	26.5
Bradley 3	0.71	8.2	18.1	2.2	27.6	38.3
Bradley 4	0.05	8.1	0.4	0.0	1.5	13.1
Bradley 5	0.31	8.0	9.5	1.2	11.6	46.5
Bradley 6	0.14	8.1	2.2	0.3	8.8	23.4
Bradley 7	0.15	7.9	1.3	0.2	1.7	12.3
Bradley 8	0.20	7.5	2.1	0.3	4.1	15.6
Bradley 9	0.35	7.1	7.0	1.0	9.4	29.3
Bradley 10	0.14	7.1	3.3	0.5	4.38	36.6
Bradley 11	0.10	6.9	0.2	0.0	0.17	3.5
Bradley 12	0.15	6.8	2.4	0.4	2.67	23.4

The normalized volume of excess flow is calculated by dividing the volume of excess flow by rainfall. This information can be useful when trying to predict flows at a treatment plant or lift station based on rain data.

Percent captured refers to the excess flow divided by the rainfall volume for each basin. When calculating rainfall volume, the area for each basin is taken into factor. Therefore, basin size does not have to be taken into account when comparing with other meter locations.

Percent excess flow compares the total volume of excess flow to the total volume of dry weather flow. By dividing the excess volume by the dry weather volume, each basin becomes independent of their size. Similar to percent captured, this statistic is useful for comparing basins of different sizes and shapes.

BRD-02, BRD-03, BRD-05, BRD-09, and BRD-10 all reported Excess Flow Percentages greater than 25%. These basins are the main contributors of excess flow to the treatment plant during rain events.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The dry weather flow analysis showed a noteworthy amount of infiltration in the system. Each meter site showed diurnal peaking factors much lower than the typical values. Higher base infiltration during the night will increase the ADWF, which will in turn lower the diurnal peaking factor. This is due to the average daily flow being raised by infiltration. These values will decrease over time, as the Village develops a comprehensive O&M plan and begins rehabilitation on manholes, main line sewer, service laterals and service connections.

The data obtained from the flow monitoring period is also beneficial for observing the response to wet-weather events in the system. Surcharging levels and high peaking factors provide the information needed to formulate a plan of attack for a rehabilitation program. The three basins with the highest estimated peaking factors are BRD-02, BRD-04 & BRD-01. BRD-02 showed the highest peaking factor, with an estimated peaking factor of 45.1 for the 1 year – 1 hour storm event.

For BRD-01, the estimated peaking factors are dampened due to the downstream control. The downstream control restricts flow upstream and releases it at a slower rate, which obscures the actual peaking factor. Without downstream control, the peaking factor for BRD-01 would be greater.

The frequency of smaller storms created tight regression fits for many of the metering sites, which allows for an accurate regression analysis to be produced. However, with only 1 storm event averaging near the 6-month recurrence interval across all rain gauges, this monitoring period lacked the large storms that often confirm what the regression analysis predicts. For example, BRD-02 projected to a peaking factor of 101.8 without the June 13th storm event. This shows the importance of filling out a regression, and not extrapolating too far away from the data points.

With few exceptions, the hydraulics analysis of these sites showed available capacity, and standard flow conditions. Many of the pipes did not reach capacity during the monitoring period due to the low-intensity rainfalls recorded. However for these sites, the capacity to handle 2-4 month storm events is evident and can be seen on the scattergraphs.

Two sites experienced downstream during the monitoring period, BRD-01 & BRD 07. BRD-01 experienced surcharging during rain events, likely due to higher flows downstream coming from the junction with flows from Bourbonnais just outside the KRMA treatment plant. Another possiblity is that flows are restricted at BRD-01 due to KRMA throttling the flow or closing gates to limit wet weather flows into the plant. BRD-07 showed signs of downstream control during dry weather periods, with high depths and low velocities. It is recommended to investigate this issue. Potential causes can be large amounts of debris downstream that needs to be cleaned out, or a flow restriction due to the downstream Lower Soldier Creek lift station.

Recommendations

The following recommendations are being made to improve the overall performance of the sanitary sewer system and to provide the basis for an on-going sewer program intended to upkeep and improve the condition of the sanitary sewer system.

1. Permanent Meter Site Upgrades

RJN recommends upgrading all three permanent flow meter billing sites at Blatt, Brookmont & YMCA permanent flume site locations. Upgrades of permanent meter sites will provide the Village with the following benefits:

- Allow the Village to remotely monitor each billing site and collect this flow data. Currently flows at these sites are only totalized and only available to KRMA. This will increase the possibility of catching a maintenance issue or failure at each site before problems occur, and

thus flow data then becomes available at the office. Additionally, these upgrades allow the Village to check billings coming from KRMA and dispute false readings during times of surcharge.

- Since the Village has just embarked on a multi-year investigation and rehabilitation program, the meter data will assist in tracking long term progress of an I/I reduction and sewer rehabilitation program. Historical data can over time show the cost benefit of performing I/I reduction and upkeep of Village sewer infrastructure.
- Future development and planning can use the data to determine if added flow will create capacity issues. Sites at or near their capacity can be identified an investigated.

The costs for the meter upgrades at each site the equipment cost will be roughly $5,000 - $7,000 for Signature series flow monitors with ultrasonic sensors and submerged AV sensors with dual 4-20 mA outputs for sending data to both the Village & KRMA.

During earlier conversations with the Village it had been mentioned that approximately $95,000 budgeted for SCADA work could be diverted to Omni-Site and lift station monitoring upgrades. It is recommended that in addition to upgrades at the permanent billing sites and bringing those sites into Omni-Site, the Village also consider upgrades to Omni-Site to allow Upper & Lower Soldier Creek flow meters as well as the rain gauge at Upper Soldier Creek to store and view data in 5-minute intervals.

2. SSES for High Priority Inflow Basins

Basins with the highest peaking factors are all centrally located around the oldest parts of the Village. Due to the age of the infrastructure and the clear indications of deterioration, basins 1 through 6 are recommended for smoke testing, manhole inspections and closed circuit televising (CCTV) as well as defect analysis to prioritize repairs. Follow up dyed water flooding is expected for basins 2 & 4 due to the extremely high peaking factors and the likelihood of finding storm sewer cross connections during smoke testing procedures. Priority basins listed from worst to best based on peaking factor are 2, 4, 1, 5, 6, and 3. Basins 7-12 did not show significant peaking factors during a 1-Yr, 1-Hr storm event and therefore are not recommended for smoke testing at this time.

3. SSES for High Priority Infiltration Basins

Basins with the largest volumes of infiltration & inflow are scattered throughout the Village and will need to be dealt with as part of a long term program because they are contributing most of the I/I that the Village ultimately is paying for at the KRMA billing sites. In these basins it is recommended that manhole inspections and closed circuit televising (CCTV) be conducted as well as defect analysis to prioritize repairs. Priority basins listed from worst to best based on total volume of I/I contributed are 3, 5, 9, 10, 6, 12, 2, 1. No investigations are recommended for Basins 7, 8 & 11 at this time as they didn't show a significant response to either inflow or infiltration.

4. Establish Annual Rehabilitation Program

Following SSES investigations for both High Priority Inflow & Infiltration basins, an annual program to complete prioritized repairs including Point Repairs, Manhole Rehabilitation, Cured-in-Place Pipelining, Grouting, T-Lining and Private Sector repairs is recommended.

If Village staff concurs with these recommendations, RJN has provided in Table 8 below, a multi-year plan with estimated annual costs to complete the recommended tasks.

TABLE 8
RECOMMENDED SEWER BUDGET (5-YEAR PROGRAM)

	FY - 2017 Basins		FY - 2018 Basins		FY - 2019 Basins		FY - 2020 Basins		FY - 2021 Basins	
Engineering/Investigations										
Program Management		$15,000		$15,000		$15,000		$15,000		$15,000
Flow Monitoring	**All**	$60,000	**Perm.**	$7,500	**Perm**	$2,500	**Perm.**	$2,500	**Perm.**	$2,500
Manhole Inspections	**2**	$7,000	**3,5**	$27,000	**9,10**	$30,000	**1,4,6,12**	$24,000		$0
Smoke Testing	**2**	$18,000	**5**	$40,000	**1,4**	$25,000	**6**	$10,000	**3**	$36,000
Dyed Water Flooding		$0	**2**	$4,000		$0	**4**	$3,500		$0
TV (Review & Analysis)		$0	**5**	$17,000	**9,10**	$32,000	**3,4,6**	$24,000	**1,2,12**	$23,000
Building Inspections		$0		$0		$0		$0		$0
Subtotal		$100,000		$110,500		$104,500		$79,000		$76,500
Rehabilitation/Construction										
**Clean & TV Program		$0		$0		$0		$0		$0
Point Repairs		$0		$0		$50,000		$50,000		$0
Grout/Lining/Spot Liners		$0		$0		$175,000		$175,000		$175,000
Manhole Rehabilitation		$0		$250,000		$250,000		$250,000		$125,000
T-Liners/Lateral Grouts		$0		$0		$0		$0		$200,000
Private Sector Disconnects		0		$10,000		$5,000		$5,000		$5,000
Subtotal		$0		$250,000		$480,000		$480,000		$505,000
Total		**$100,000**		**$360,500**		**$584,500**		**$559,000**		**$581,500**

** Clean & TV costs are listed at $0 annually, because it is anticipated the Village will complete this work in house

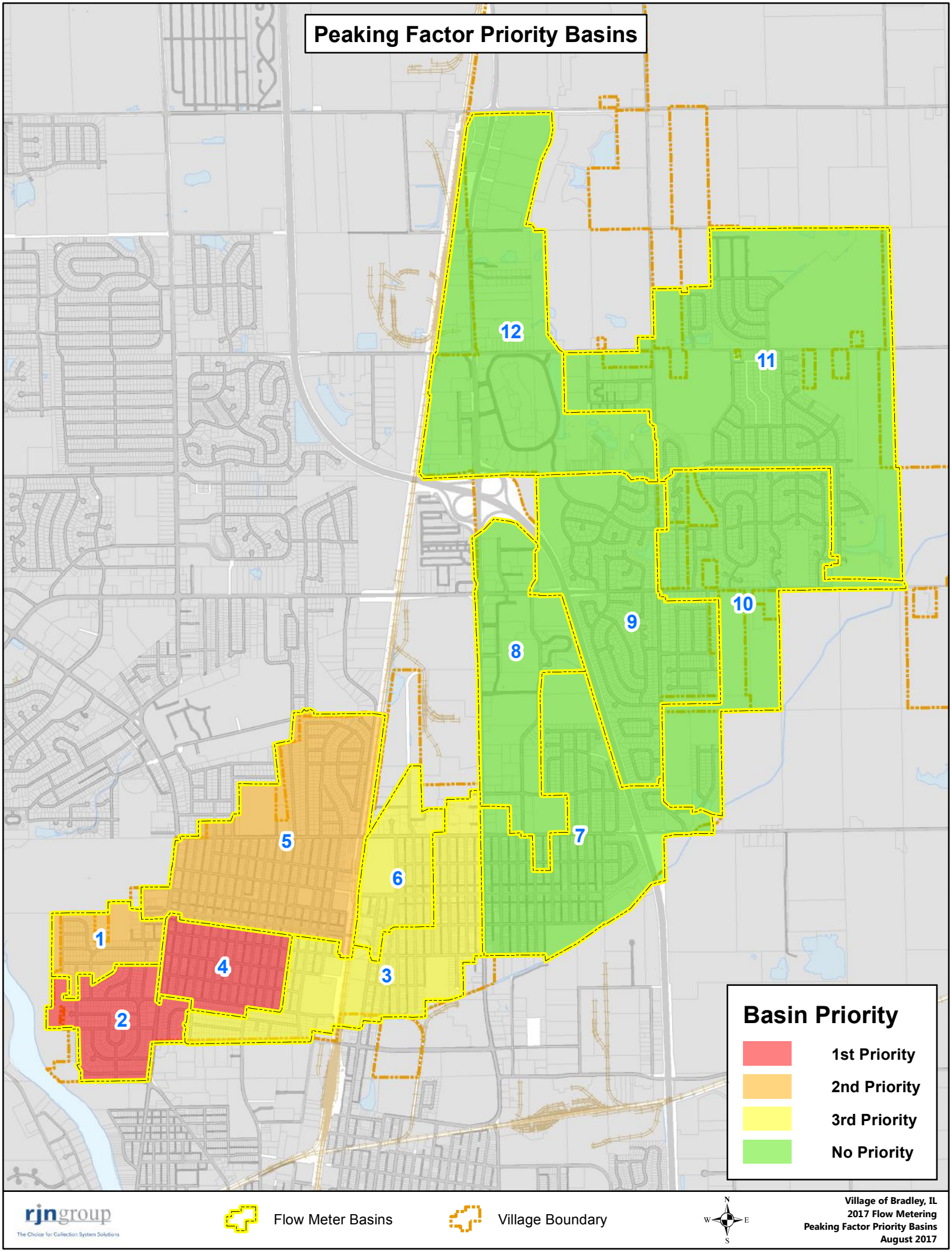
It has been our pleasure serving the Village of Bradley on this important project, and it is our hope that the findings and recommendations of this study will help to guide a program which ultimately benefits the Village and its sewer system users. We appreciate any feedback that the Village might have and look forward to continuing to provide sanitary sewer collection system services to the Village of Bradley.

Sincerely,

RJN Group, Inc.

Bobby Peters
Staff Engineer

Joe Sullivan
Project Manager


Peaking Factor Priority Basins
12
11
10
9
8
7
6
5
4
3
2
1
Basin Priority
1st Priority
2nd Priority
3rd Priority
No Priority
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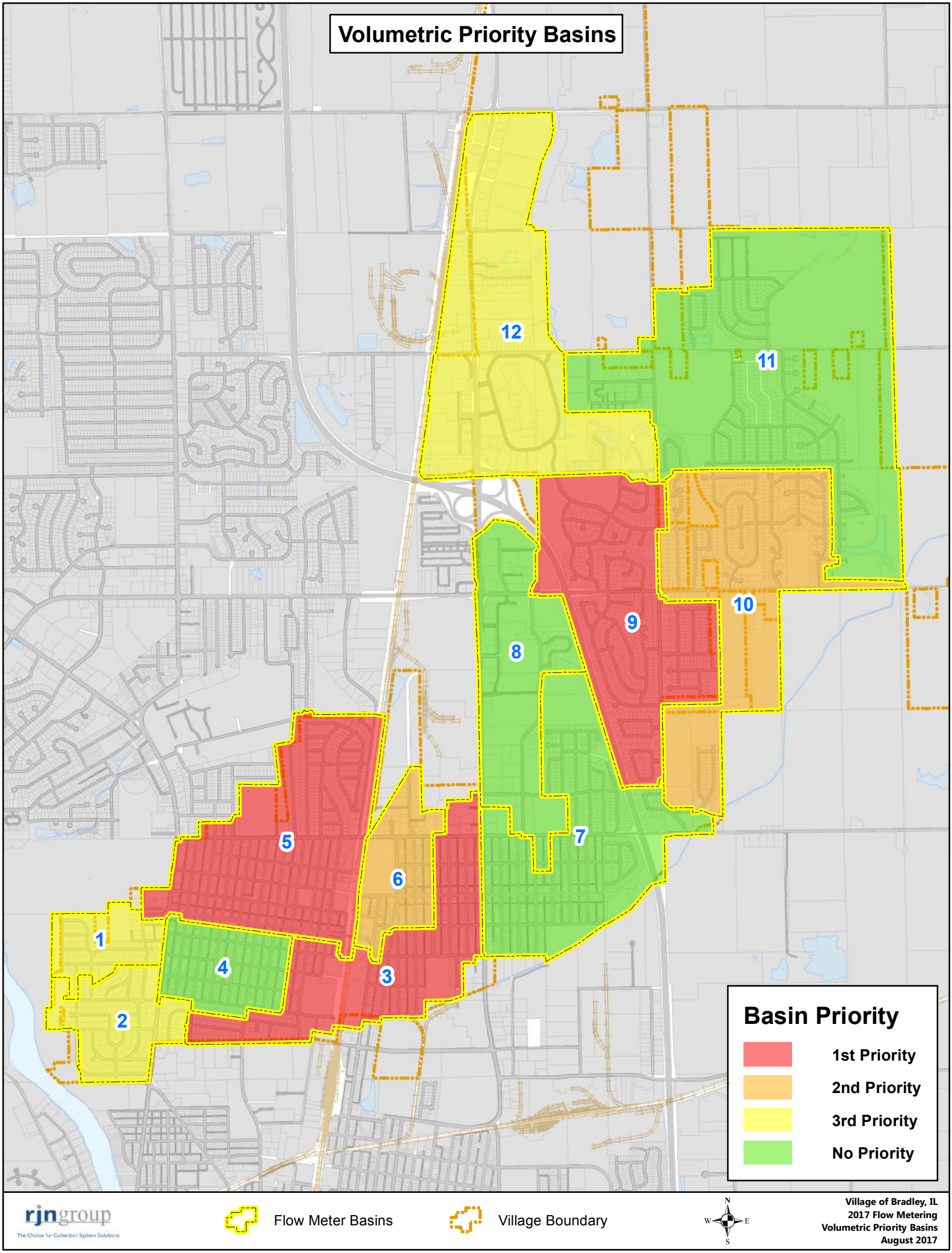
Flow Meter Basins
Village Boundary
N
W
E
S
Village of Bradley, IL
2017 Flow Metering
Peaking Factor Priority Basins
August 2017


Volumetric Priority Basins
12
11
10
9
8
7
6
5
4
3
2
1
Basin Priority
1st Priority
2nd Priority
3rd Priority
No Priority
rjngroup
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Flow Meter Basins
Village Boundary
N
W
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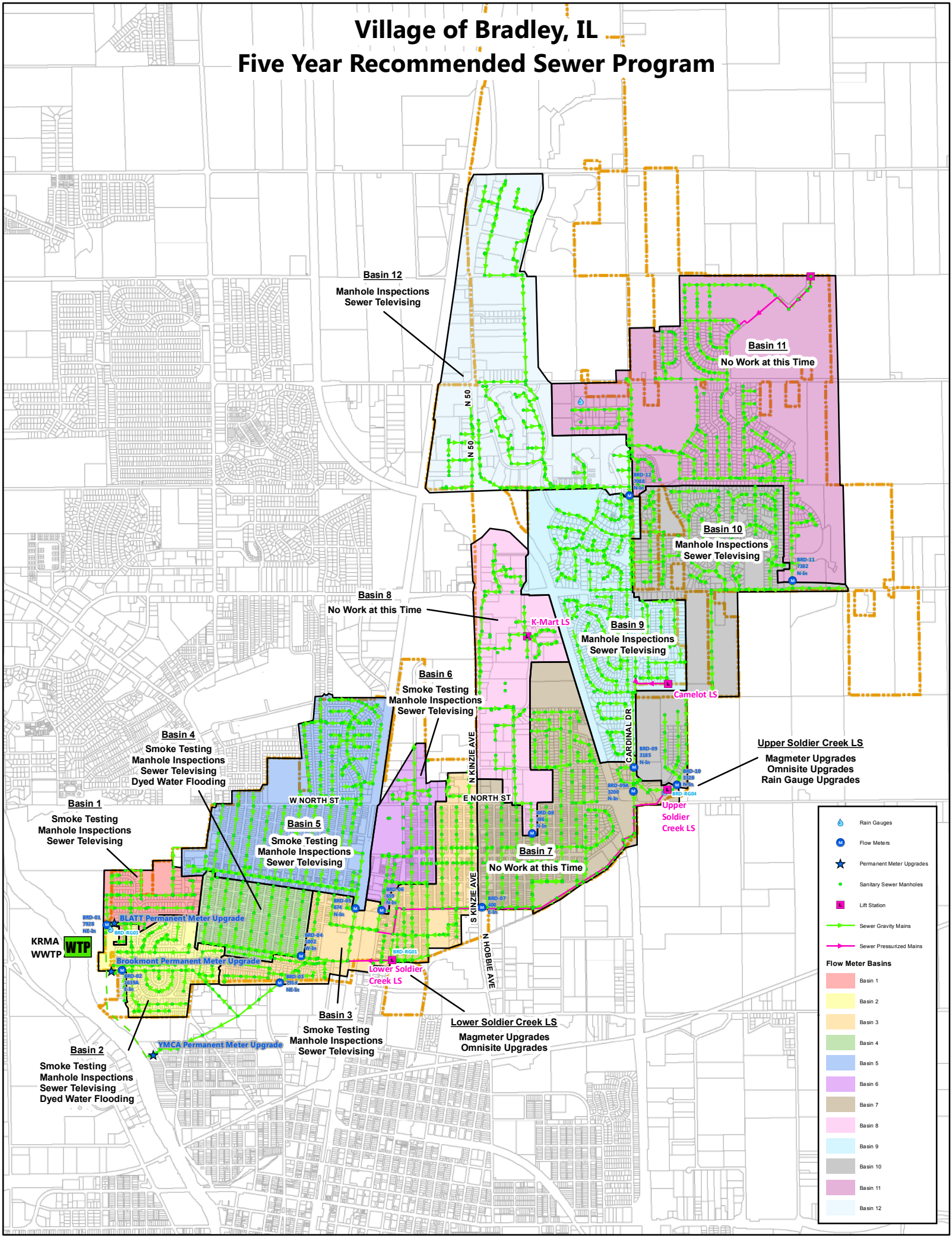
S
Village of Bradley, IL
2017 Flow Metering
Volumetric Priority Basins
August 2017

Village of Bradley, IL
Five Year Recommended Sewer Program



APPENDIX A - Site Sheets

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The Choice for Collection System Solutions

Bradley, IL

Village of Bradley - Site Investigations

Site Name
BRD-01

Inspected By	aspivey	Project No.	Site Code
Inspected Date/Time	3/7/2017 10:17 AM	11-3060-01	T

System Information

Target Pipe Dia. (in)	12.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	7928
U/S Connecting MH I.D	7927
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	499 Valley Ave
Site Access	Fenced In
Longitude	-87.88527200
Latitude	41.13969900
MH Type	Precast Concrete
Manhole Depth (ft)	9.53
Manhole Width (ft)	3.0
Elevated MH	Yes
Height Elevated (ft)	0.6
Structural Integrity	Safe

Site Information

Pipe Height (in)	9.81		
Pipe Width (in)	9.81		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	3.00
Instant Velocity (fps)	0.55
Surcharge Evidence (ft)	6.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	Yes
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

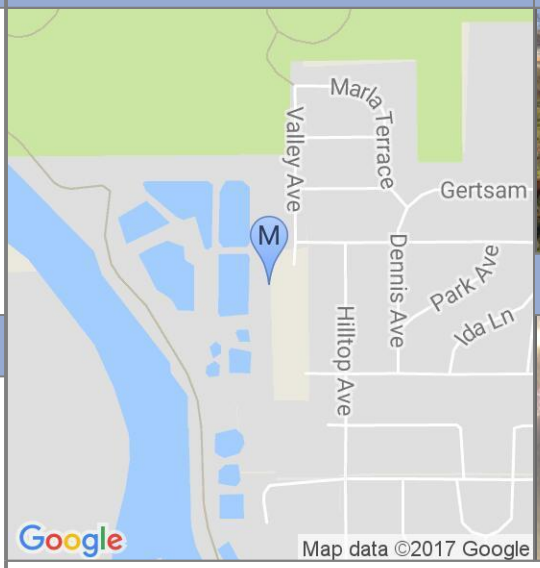
Installation Notes

Location in Pipe (ft)	0.7
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/4/2017	

Area Location Map



Area View Picture

Top View Picture

Access Notes Next to flume

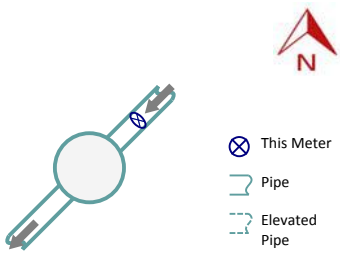
Investigation Photo

Hydraulic Characteristics

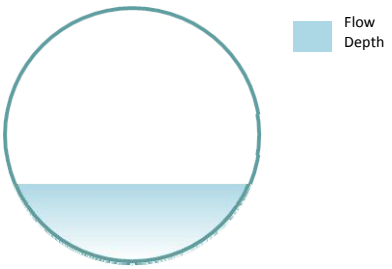
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Approvals

Recommended by FSP	Client Approval
	No

rjngroup The Choice for Collection System Solutions	Bradley, IL Village of Bradley - Site Investigations	Site Name BRD-02

Inspected By	aspivey	Project No.	Site Code
Inspected Date/Time	3/7/2017 11:35 AM	11-3060-01	T

System Information

Target Pipe Dia. (in)	0.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	1639A
U/S Connecting MH I.D	1691
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	1423 W Brookmont Blvd
Site Access	Parkway
Longitude	-87.88385000
Latitude	41.13653500
MH Type	Concrete Block
Manhole Depth (ft)	15.10
Manhole Width (ft)	3.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	21.18		
Pipe Width (in)	21.18		
Pipe Type	Vitrified Clay		
Pipe Shape	Circular		
O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	3.00
Instant Velocity (fps)	0.72
Surcharge Evidence (ft)	7.00
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

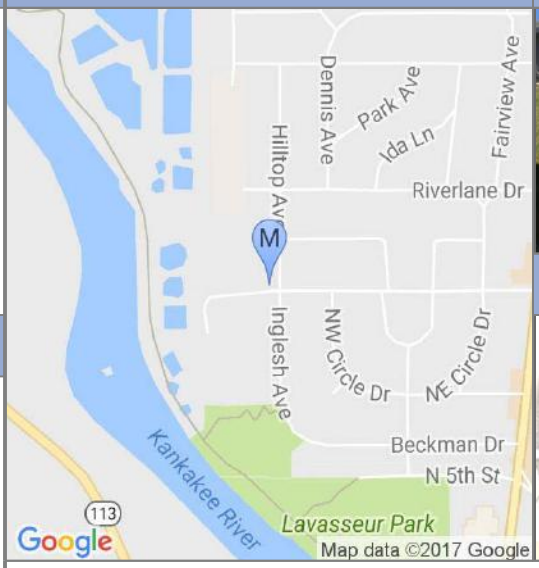
Installation Notes

Location in Pipe (ft)	8.0
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/4/2017	

Area Location Map



Area View Picture

Top View Picture

Access Notes

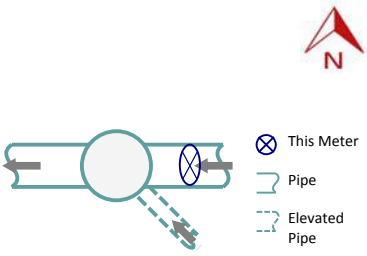
Investigation Photo

Hydraulic Characteristics

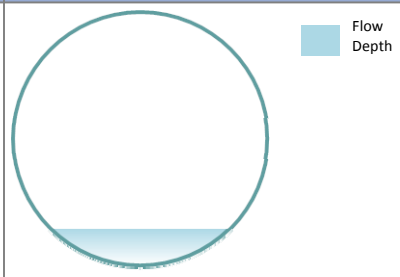
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Approvals

Recommended by FSP	Client Approval
	No

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Bradley, IL

Village of Bradley - Site Investigations

Site Name
BRD-03

Inspected By	aspivey	Project No.	Site Code
Inspected Date/Time	3/7/2017 12:30 PM	11-3060-01	

System Information

Target Pipe Dia. (in)	48.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	7914
U/S Connecting MH I.D	1393
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	525 W Brookmont Blvd
Site Access	Roadway, Low Traffic
Longitude	-87.86931700
Latitude	41.13567300
MH Type	Brick
Manhole Depth (ft)	12.55
Manhole Width (ft)	3.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	49.37		
Pipe Width (in)	49.06		
Pipe Type	Brick		
Pipe Shape	Circular		
O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	13.75
Instant Velocity (fps)	1.70
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

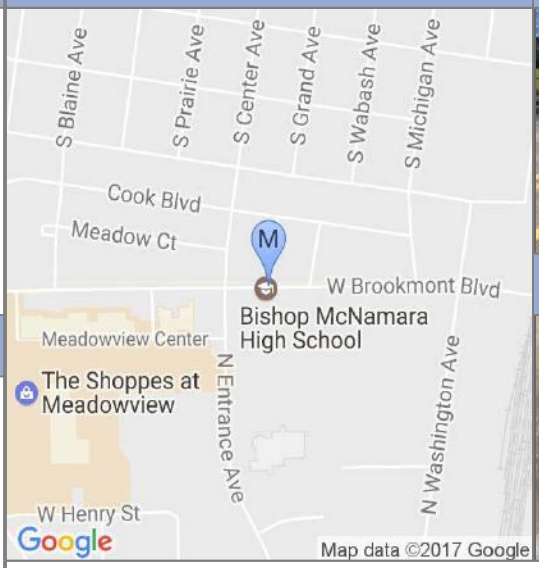
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/4/2017	

Area Location Map



Area View Picture

Top View Picture

Access Notes In the left turning lane westbound

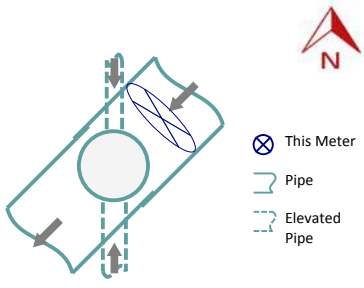
Investigation Photo

Hydraulic Characteristics

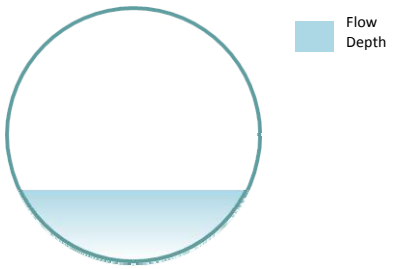
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Approvals

Recommended by FSP	Client Approval
	No

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The Choice for Collection System Solutions

Bradley, IL

Village of Bradley - Site Investigations

Site Name	Project No.	Site Code
BRD-04	11-3060-01	T

Inspected By	aspivey
Inspected Date/Time	3/7/2017 1:13 PM

System Information

Target Pipe Dia. (in)	24.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	1002
U/S Connecting MH I.D	1048
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	495 S Wabash Ave
Site Access	Roadway, Low Traffic
Longitude	-87.86735600
Latitude	41.13755300
MH Type	Brick
Manhole Depth (ft)	8.90
Manhole Width (ft)	3.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	23.12
Pipe Width (in)	22.25
Pipe Type	Vitrified Clay
Pipe Shape	Circular

O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	1.00
Instant Velocity (fps)	2.40
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

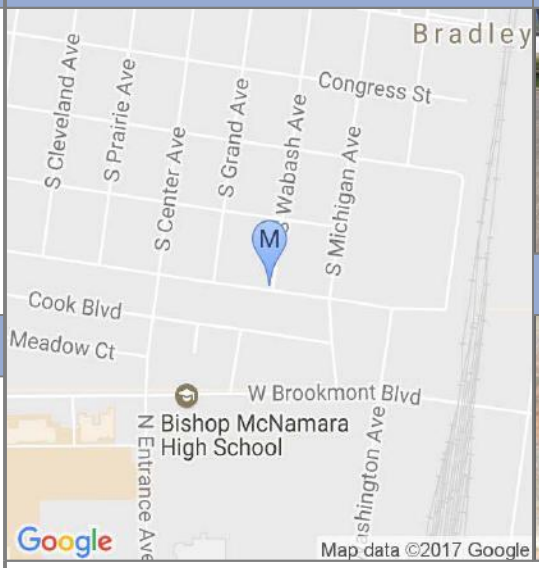
Installation Notes

Location in Pipe (ft)	0.8
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/5/2017	

Area Location Map



Area View Picture

Top View Picture

Access Notes

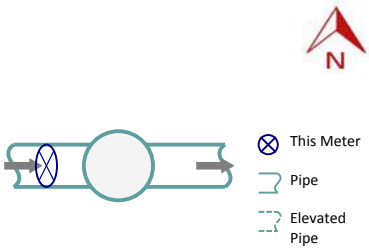
Investigation Photo

Hydraulic Characteristics

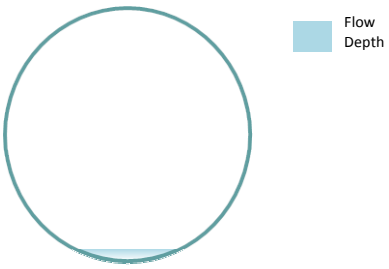
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Approvals

Recommended by FSP	Client Approval
	No

rjngroup
The Choice for Collection System Solutions

Bradley, IL

Village of Bradley - Site Investigations

Site Name
BRD-05

Inspected By	aspivey	Project No.	Site Code
Inspected Date/Time	3/7/2017 1:47 PM	11-3060-01	T

System Information

Target Pipe Dia. (in)	18.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	674
U/S Connecting MH I.D	6666
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	Congress St Bradley
Site Access	Roadway, Low Traffic
Longitude	-87.86236900
Latitude	41.14084700
MH Type	Brick
Manhole Depth (ft)	8.00
Manhole Width (ft)	3.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	24.18		
Pipe Width (in)	24.24		
Pipe Type	Vitrified Clay		
Pipe Shape	Circular		
O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	3.00
Instant Velocity (fps)	3.37
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

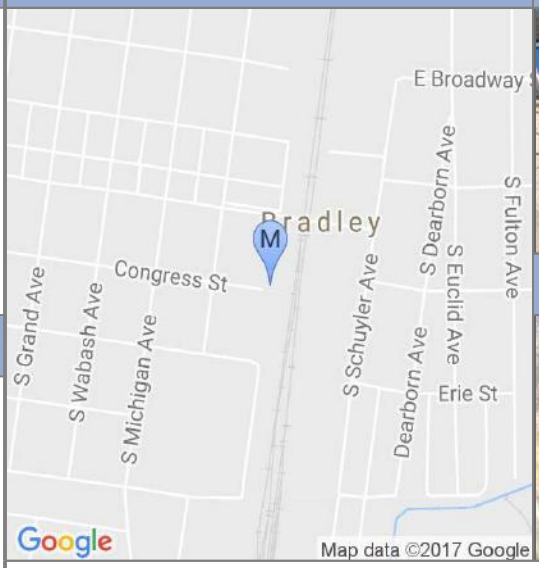
Installation Notes

Location in Pipe (ft)	0.8
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/5/2017	

Area Location Map



Area View Picture

Top View Picture

Access Notes

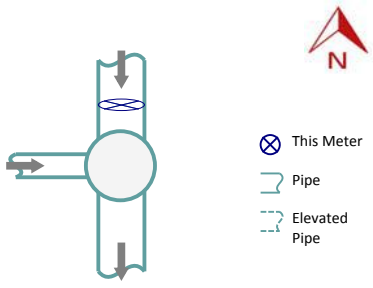
Investigation Photo

Hydraulic Characteristics

Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch

Approvals

Recommended by FSP	Client Approval
	No

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Bradley, IL

Village of Bradley - Site Investigations

Site Name
BRD-06

Inspected By	aspivey	Project No.	Site Code
Inspected Date/Time	3/7/2017 2:38 PM	11-3060-01	T

System Information

Target Pipe Dia. (in)	24.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	659
U/S Connecting MH I.D	653
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	304 S Schuyler Ave
Site Access	Roadway, Low Traffic
Longitude	-87.85993800
Latitude	41.14070800
MH Type	Brick
Manhole Depth (ft)	5.70
Manhole Width (ft)	3.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	27.00		
Pipe Width (in)	30.06		
Pipe Type	Brick		
Pipe Shape	Circular		
O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	6.00
Instant Velocity (fps)	1.21
Surcharge Evidence (ft)	
Silt Type	Coarse
Silt Depth (in)	5.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

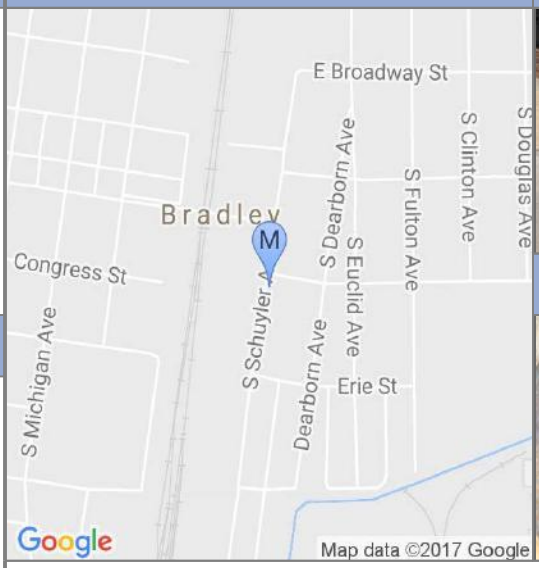
Installation Notes

Location in Pipe (ft)	
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/10/2017	

Area Location Map



Area View Picture

Top View Picture

Access Notes

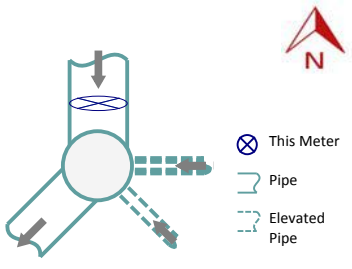
Investigation Photo

Hydraulic Characteristics

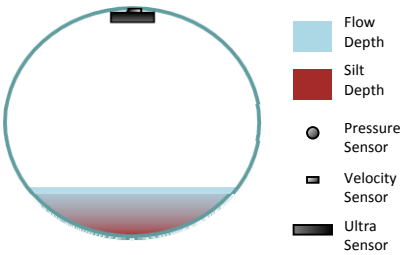
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 0:00

Velocity Clock Position: 0:00

Approvals

Recommended by FSP	Client Approval
	No

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Bradley, IL

Village of Bradley - Site Investigations

Site Name
BRD-07

Inspected By	aspivey	Project No.	Site Code
Inspected Date/Time	3/7/2017 3:11 PM	11-3060-01	T

System Information

Target Pipe Dia. (in)	18.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	400
U/S Connecting MH I.D	6610
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	701-799 Liberty St
Site Access	Roadway, Low Traffic
Longitude	-87.85072000
Latitude	41.14092500
MH Type	Precast Concrete
Manhole Depth (ft)	14.80
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	14.56		
Pipe Width (in)	17.75		
Pipe Type	Other		
Pipe Shape	Elliptical		
O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	9.00
Instant Velocity (fps)	0.75
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/5/2017	

Area Location Map

Area View Picture

Top View Picture

Access Notes In the curb of Liberty St and S Kinzie Ave

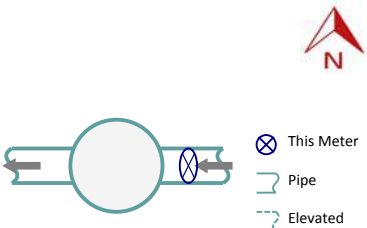
Investigation Photo

Hydraulic Characteristics

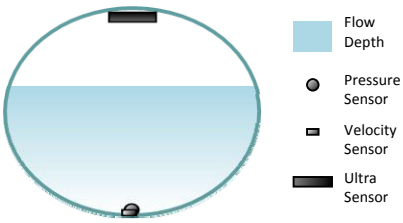
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 6:00

Velocity Clock Position: 6:00

Approvals

Recommended by FSP	Client Approval
	No

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Bradley, IL

Village of Bradley - Site Investigations

Site Name
BRD-08

Inspected By	aspivey	Project No.	Site Code
Inspected Date/Time	3/8/2017 9:26 AM	11-3060-01	T

System Information

Target Pipe Dia. (in)	12.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	386
U/S Connecting MH I.D	388
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	183 N Madison Ave
Site Access	Other
Longitude	-87.84609000
Latitude	41.14604000
MH Type	Precast Concrete
Manhole Depth (ft)	7.49
Manhole Width (ft)	3.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	9.75		
Pipe Width (in)	9.43		
Pipe Type	Vitrified Clay		
Pipe Shape	Circular		
O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	4.25
Instant Velocity (fps)	1.30
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

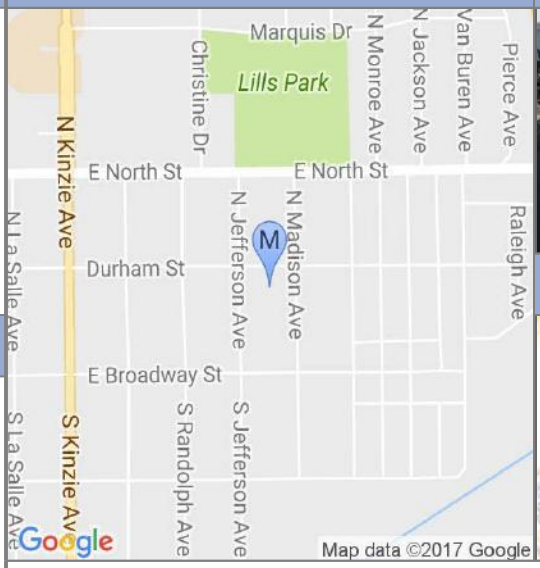
Installation Notes

Location in Pipe (ft)	0.4
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/5/2017	

Area Location Map



Area View Picture

Top View Picture

Access Notes Alley

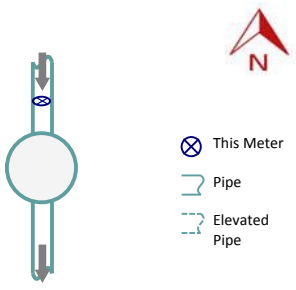
Investigation Photo

Hydraulic Characteristics

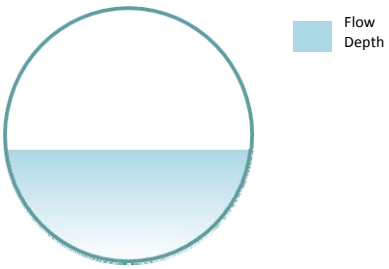
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Approvals

Recommended by FSP	Client Approval
	No

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Bradley, IL

Village of Bradley - Site Investigations

Site Name
BRD-09

Inspected By	aspivey	Project No.	Site Code
Inspected Date/Time	3/8/2017 11:20 AM	11-3060-01	

System Information

Target Pipe Dia. (in)	15.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	3185
U/S Connecting MH I.D	7263
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	420 N 2000E Rd
Site Access	Roadway, Low Traffic
Longitude	-87.83669800
Latitude	41.15063300
MH Type	Precast Concrete
Manhole Depth (ft)	8.00
Manhole Width (ft)	3.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	15.18		
Pipe Width (in)	15.25		
Pipe Type	Vitrified Clay		
Pipe Shape	Circular		
O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	5.00
Instant Velocity (fps)	2.80
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

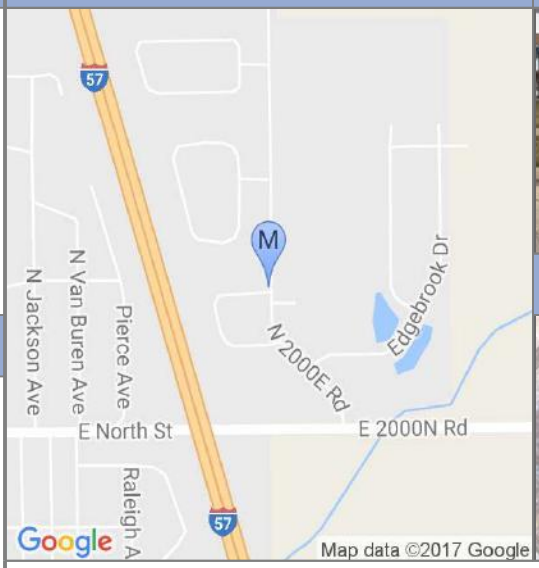
Installation Notes

Location in Pipe (ft)	0.9
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/6/2017	

Area Location Map



Area View Picture

Top View Picture

Access Notes In the curb of Old Farm S and Cardinal

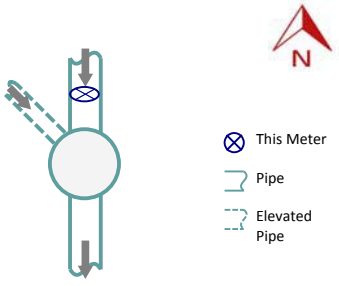
Investigation Photo

Hydraulic Characteristics

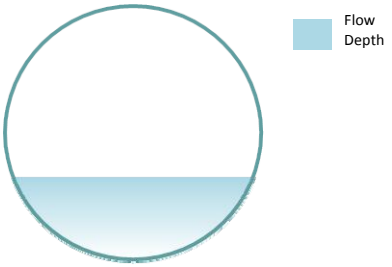
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Approvals

Recommended by FSP	Client Approval
	No

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Bradley, IL

Village of Bradley - Site Investigations

Site Name
BRD-09A

Inspected By	aspivey	Project No.	Site Code
Inspected Date/Time	3/8/2017 11:58 AM	11-3060-01	T

System Information

Target Pipe Dia. (in)	15.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	3200
U/S Connecting MH I.D	3198
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	29 Old Farm S Ct
Site Access	Off-Road
Longitude	-87.83676500
Latitude	41.14896600
MH Type	Precast Concrete
Manhole Depth (ft)	7.18
Manhole Width (ft)	3.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	15.06		
Pipe Width (in)	15.18		
Pipe Type	Vitrified Clay		
Pipe Shape	Circular		
O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	1.00
Instant Velocity (fps)	0.00
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	No Flow

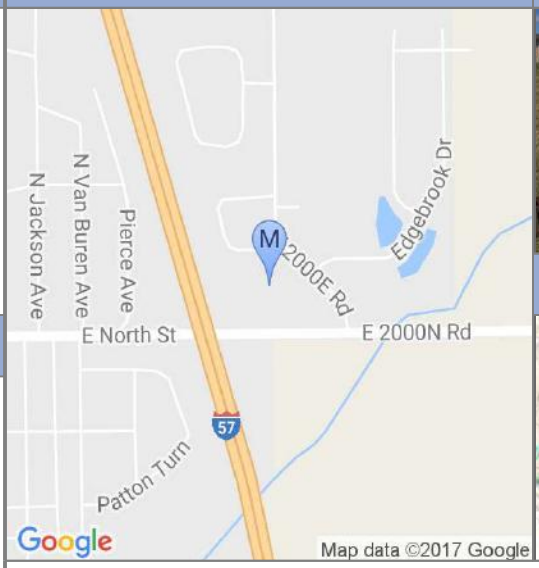
Installation Notes

Location in Pipe (ft)	1.1
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/6/2017	

Area Location Map



Area View Picture

Top View Picture

Access Notes Behind white fence in the field

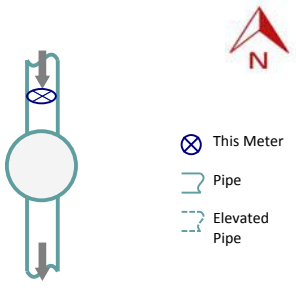
Investigation Photo

Installation Photo

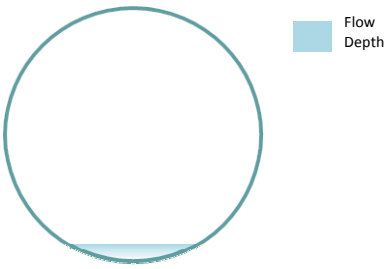
Hydraulic Characteristics

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Approvals

Recommended by FSP	Client Approval
	No

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Bradley, IL

Village of Bradley - Site Investigations

Site Name
BRD-10

Inspected By	aspivey	Project No.	Site Code
Inspected Date/Time	3/8/2017 1:05 PM	11-3060-01	T

System Information

Target Pipe Dia. (in)	0.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	3328
U/S Connecting MH I.D	3326
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	400 Edgebrook Dr
Site Access	Off-Road
Longitude	-87.83275600
Latitude	41.14940500
MH Type	Precast Concrete
Manhole Depth (ft)	11.65
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	35.37		
Pipe Width (in)	35.75		
Pipe Type			
Pipe Shape	Circular		
O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	3.00
Instant Velocity (fps)	1.50
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

Installation Notes

Location in Pipe (ft)	2.2
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/6/2017	

Area Location Map

Area View Picture

Top View Picture

Access Notes In the field next to pond

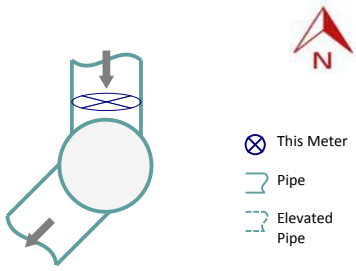
Investigation Photo

Hydraulic Characteristics

Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch

Approvals

Recommended by FSP	Client Approval
	No

rjngroup
The Choice for Collection System Solutions

Bradley, IL

Village of Bradley - Site Investigations

Site Name
BRD-11

Inspected By	aspivey	Project No.	Site Code
Inspected Date/Time	3/8/2017 1:34 PM	11-3060-01	T

System Information

Target Pipe Dia. (in)	0.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	7382
U/S Connecting MH I.D	5555
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	2751-3019 Co Hwy 44
Site Access	Off-Road
Longitude	-87.82210000
Latitude	41.16356500
MH Type	Precast Concrete
Manhole Depth (ft)	12.30
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	0.5
Structural Integrity	Safe

Site Information

Pipe Height (in)	20.62		
Pipe Width (in)	20.93		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	LEL %	0.0
H2S	0.0	CO	0.0

Hydraulic Information

Flow Depth (in)	1.50
Instant Velocity (fps)	1.34
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

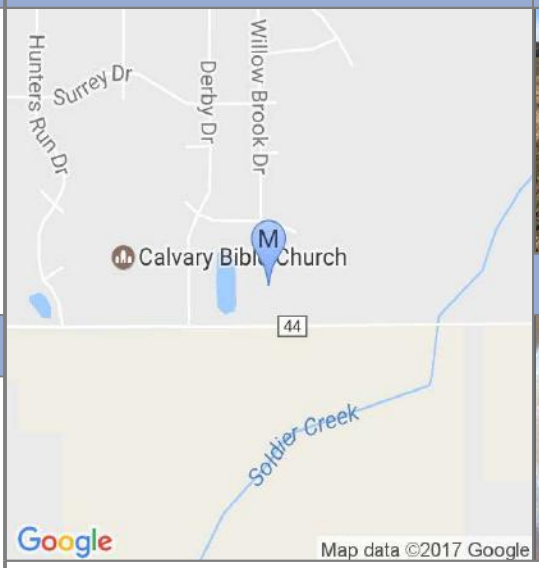
Installation Notes

Location in Pipe (ft)	1.4
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/6/2017	

Area Location Map



Area View Picture

Top View Picture

Access Notes

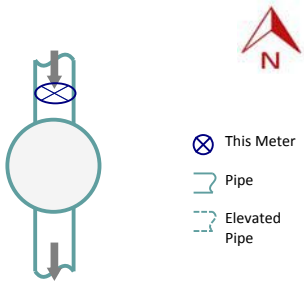
Investigation Photo

Hydraulic Characteristics

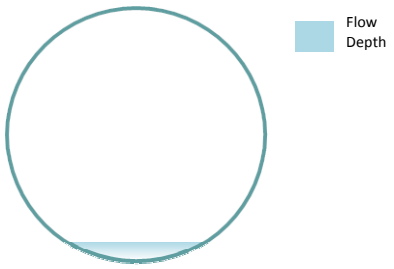
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Approvals

Recommended by FSP	Client Approval
	No

rjngroup The Choice for Collection System Solutions	**Bradley, IL** Village of Bradley - Site Investigations	**Site Name** BRD-12

Inspected By	aspivey	**Project No.**	**Site Code**
Inspected Date/Time	3/8/2017 2:22 PM	11-3060-01	T

System Information

Target Pipe Dia. (in)	15.0
Municipality	
District	Bradley
Assigned Rain Gauge	
Client Manhole #	7088
U/S Connecting MH I.D	7086
System Characteristics:	
Residential - ☐ Commercial - ☐ Industrial - ☐	
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	1661-1699 N 2000E Rd
Site Access	Parkway
Longitude	-87.83712200
Latitude	41.16945500
MH Type	Precast Concrete
Manhole Depth (ft)	11.25
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	14.25		
Pipe Width (in)	14.50		
Pipe Type	Polyvinyl Chloride		
Pipe Shape	Circular		
O2	20.9	**LEL %**	0.0
H2S	0.0	**CO**	0.0

Hydraulic Information

Flow Depth (in)	4.50
Instant Velocity (fps)	1.60
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Good

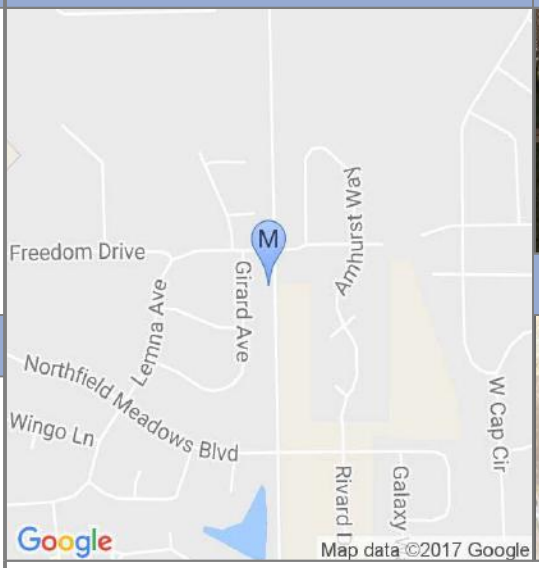
Installation Notes

Location in Pipe (ft)	1.4
Location from Manhole	Upstream
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	100

Post Installation Notes

Meter Type	ADS	Triton+
Telemetry Type		
Installation Date	4/7/2017	

Area Location Map



Area View Picture

Top View Picture

Access Notes Next to storm drain

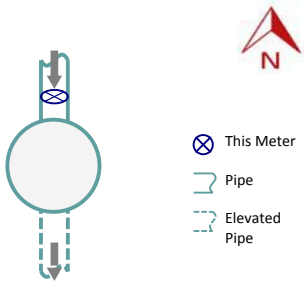
Investigation Photo

Hydraulic Characteristics

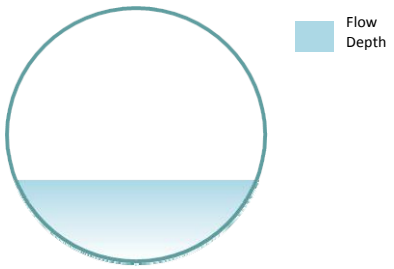
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch

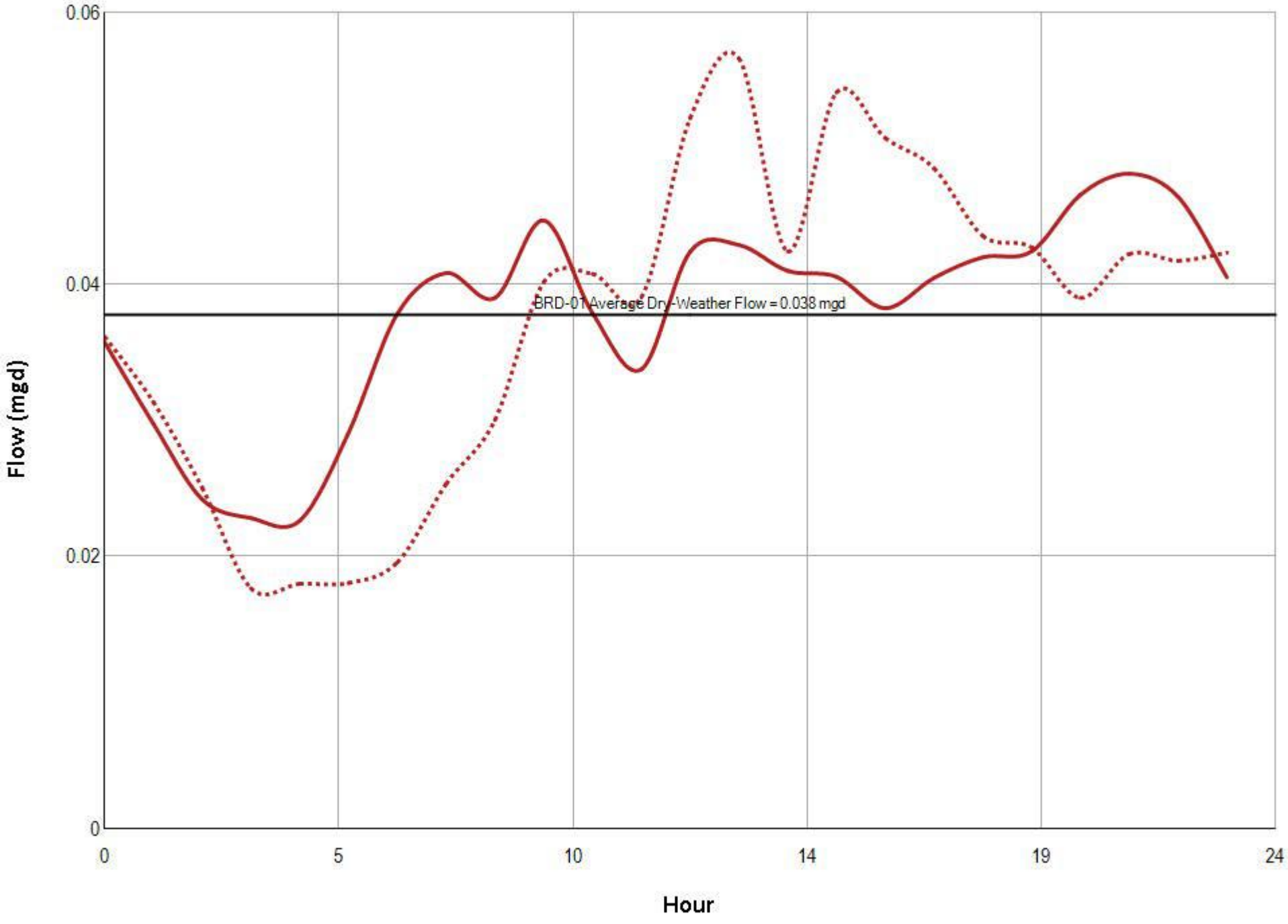


Approvals

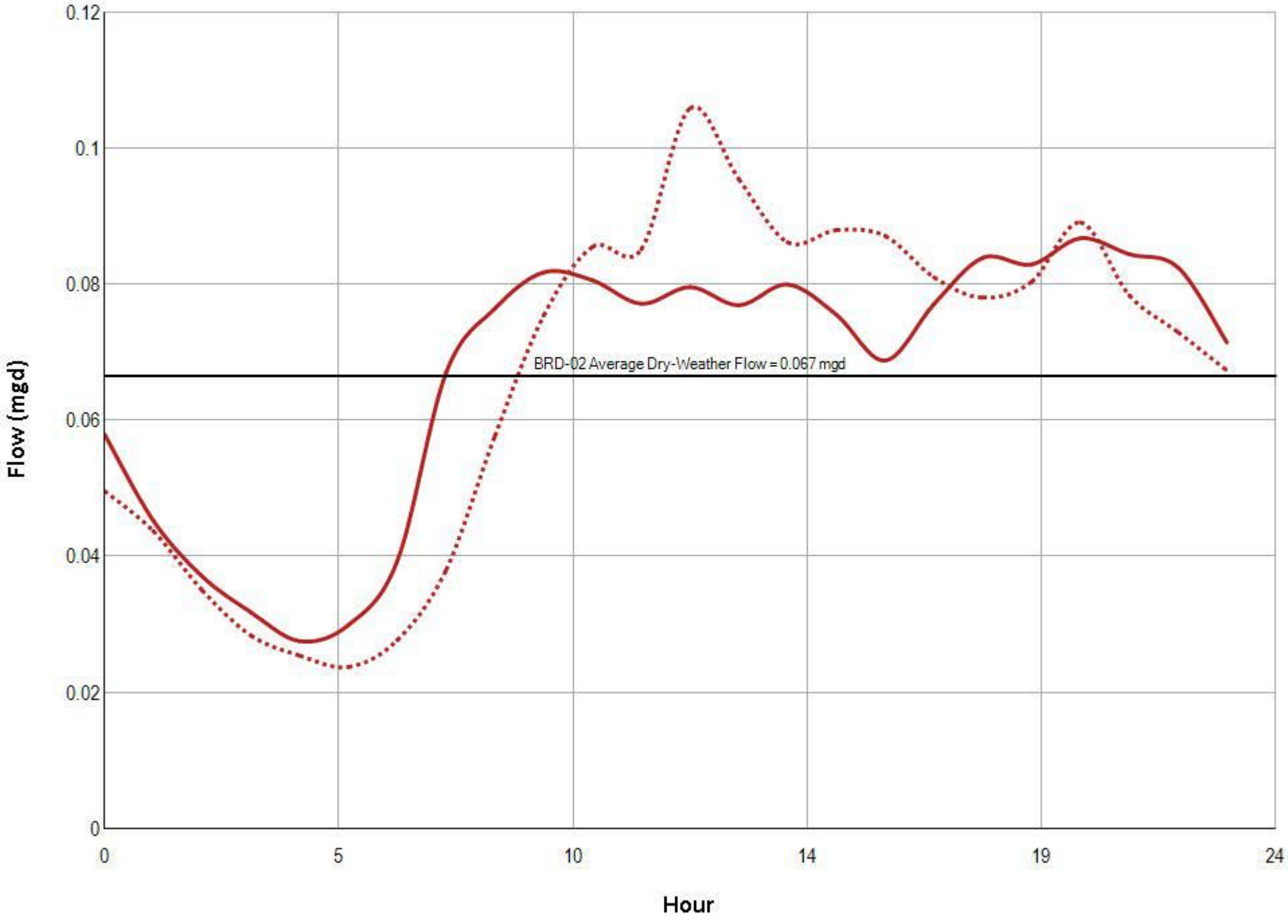
Recommended by FSP	**Client Approval**
	No

APPENDIX B – Diurnal Curves

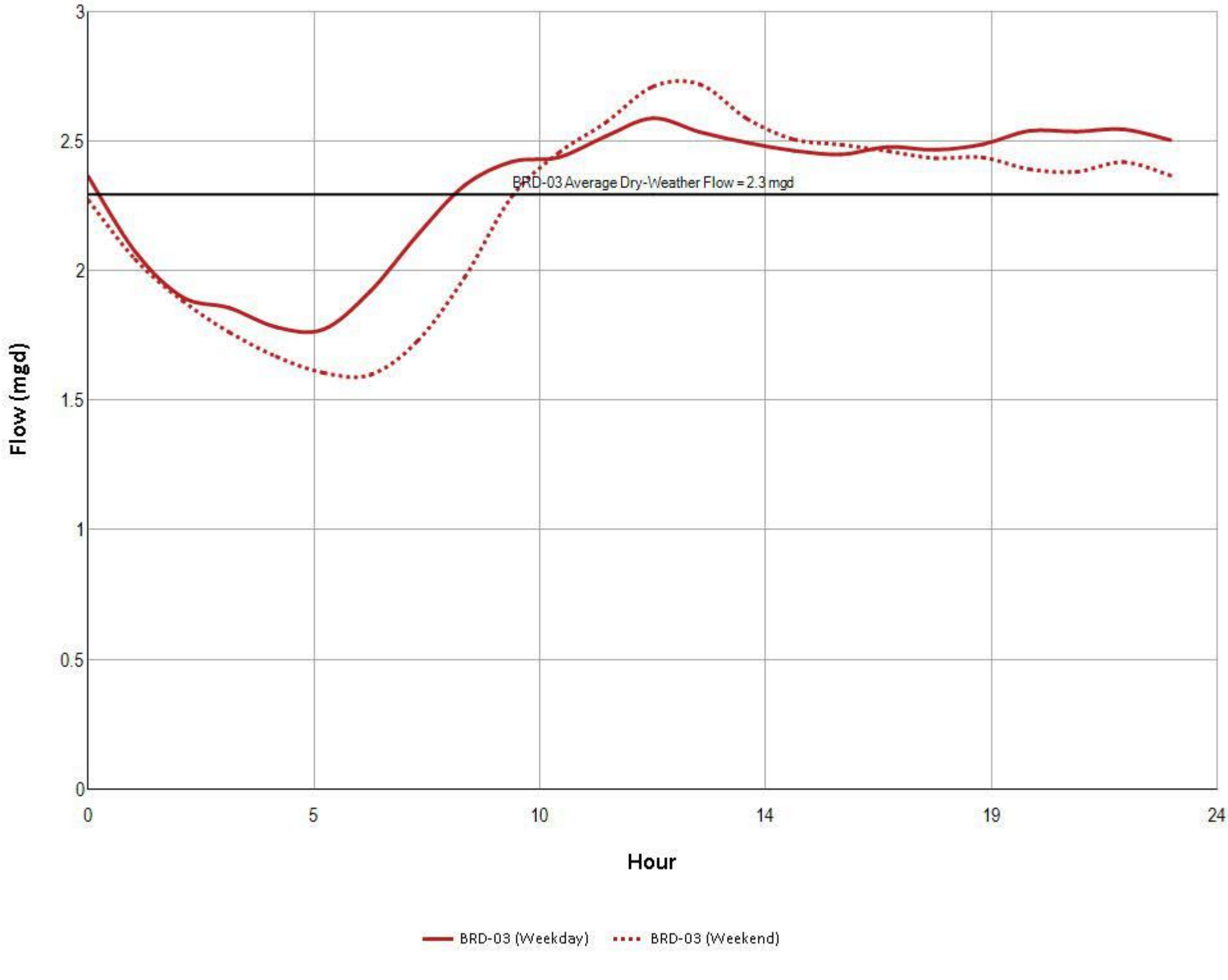
Site: BRD-01 - Average Dry-Weather Flow



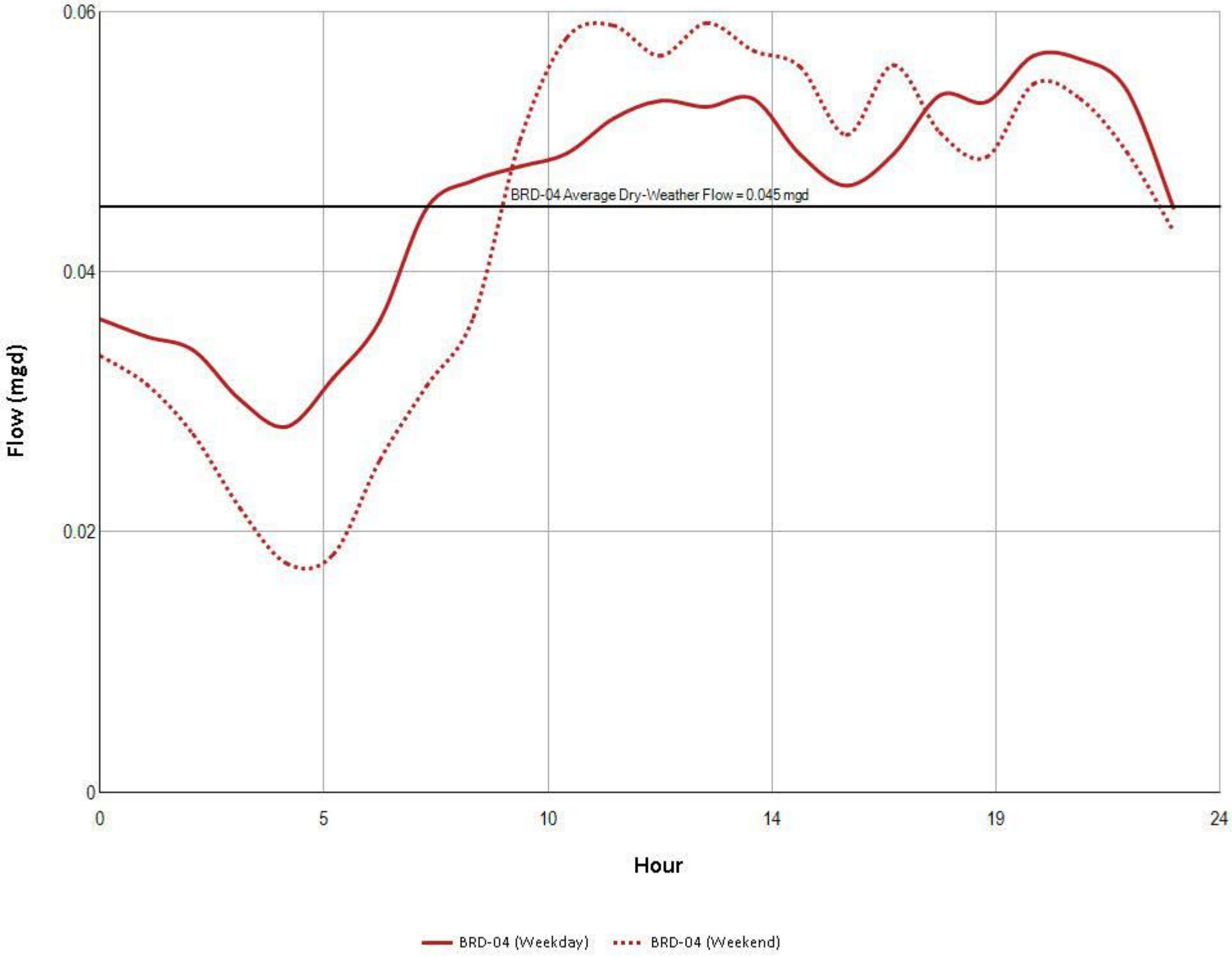
Site: BRD-02 - Average Dry-Weather Flow

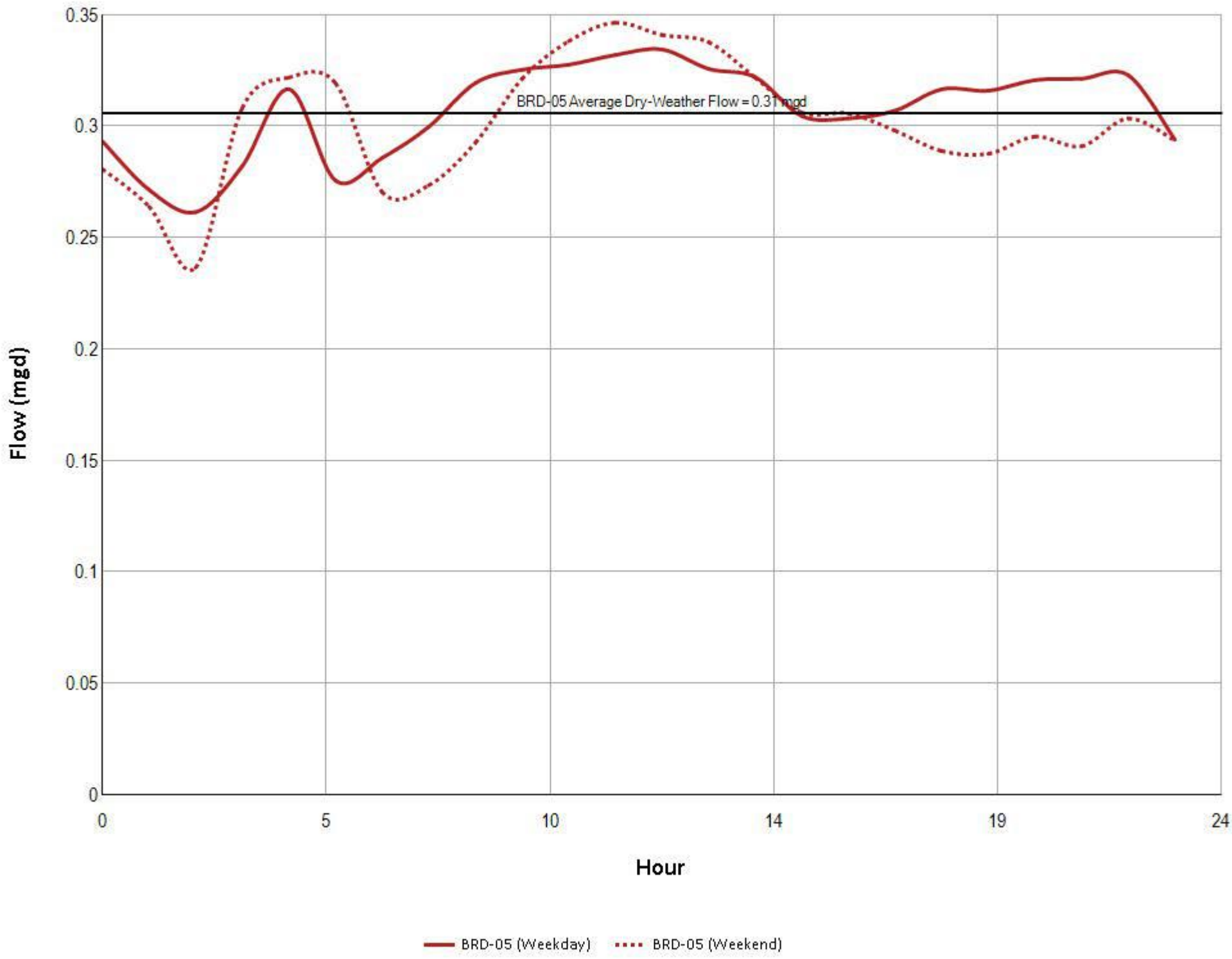


Site: BRD-03 - Average Dry-Weather Flow

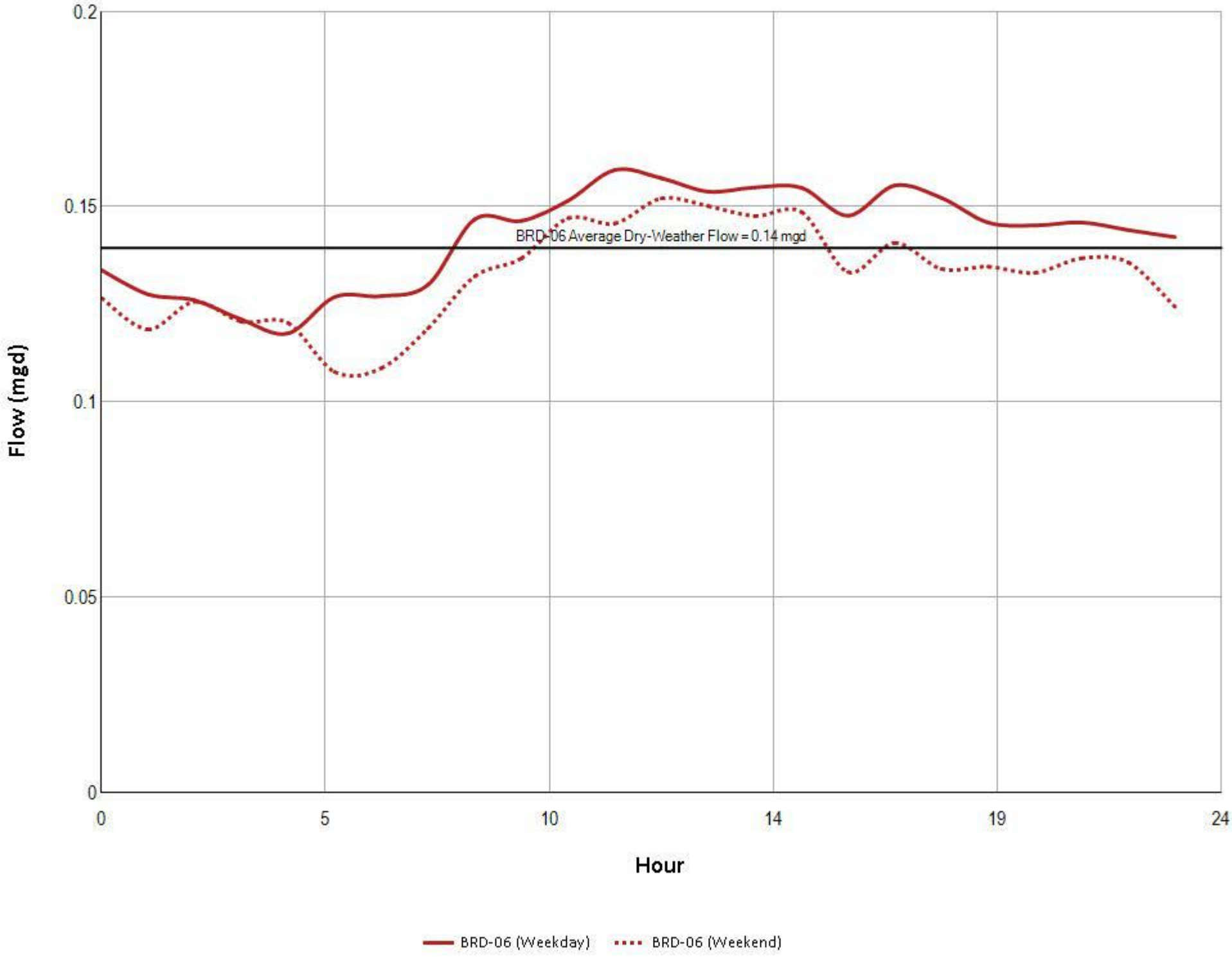


Site: BRD-04 - Average Dry-Weather Flow

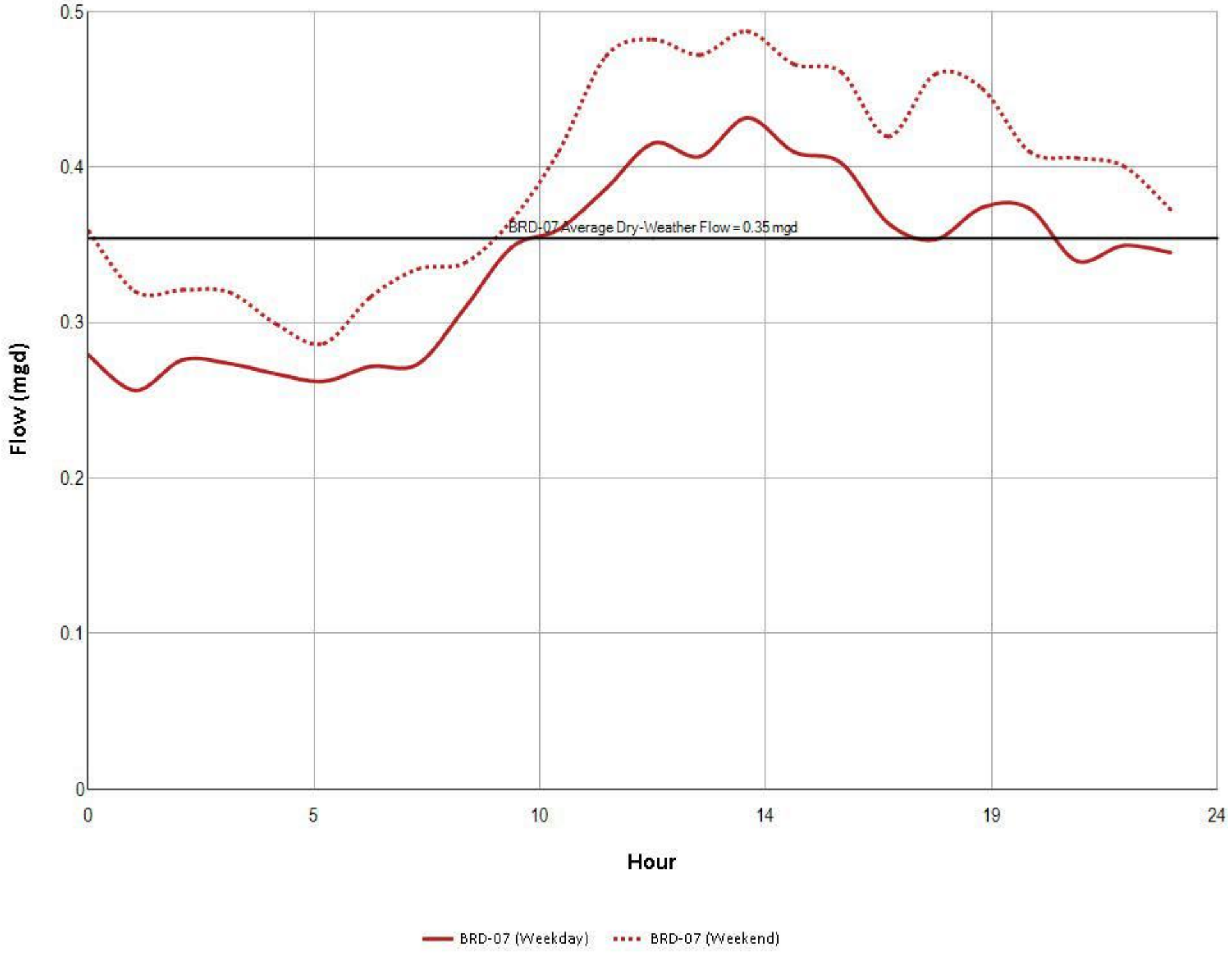



Site: BRD-05 - Average Dry-Weather Flow
BRD-05 Average Dry-Weather Flow = 0.31 mgd
Flow (mgd)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
14
19
24
Hour
BRD-05 (Weekday)
BRD-05 (Weekend)

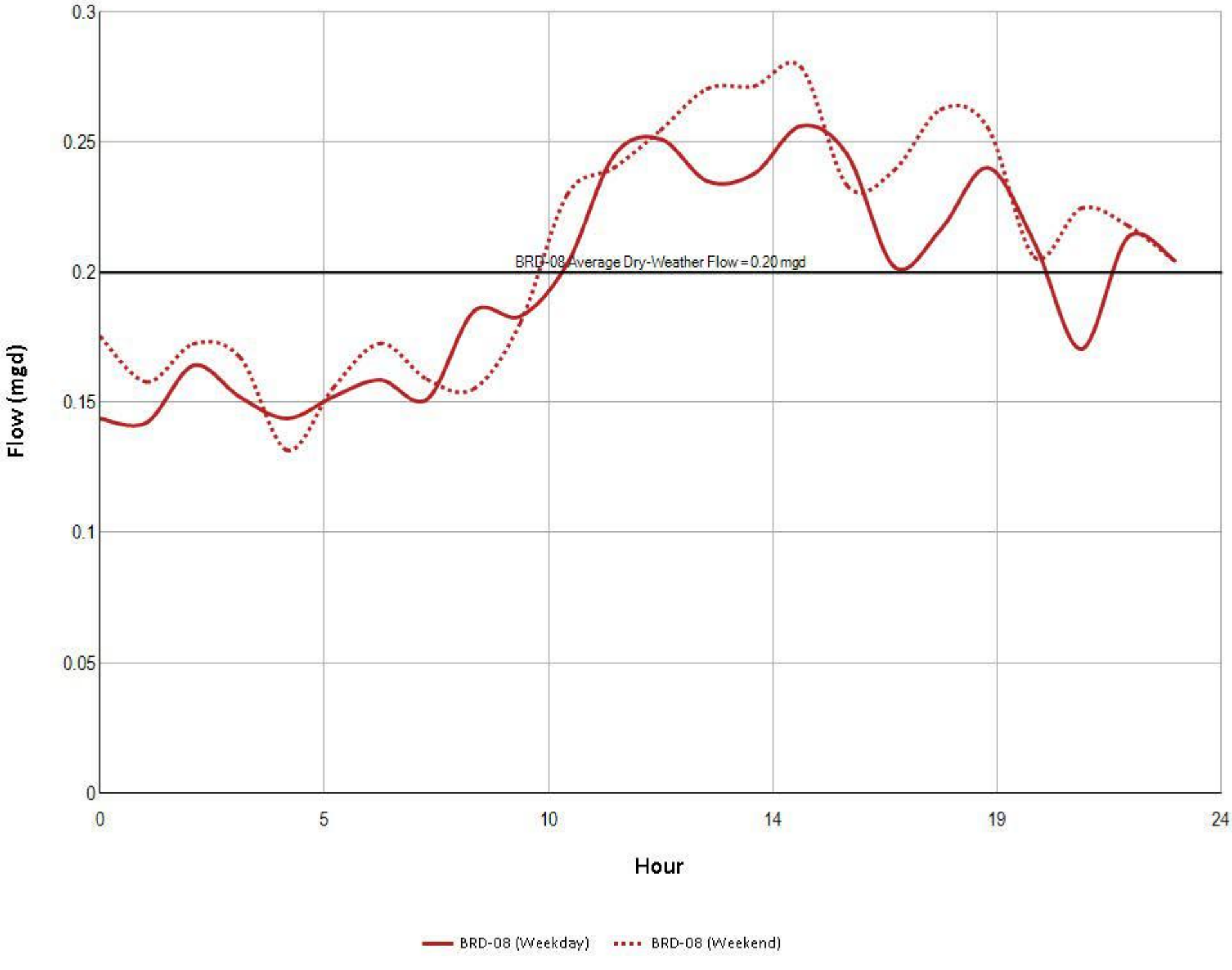
Site: BRD-06 - Average Dry-Weather Flow



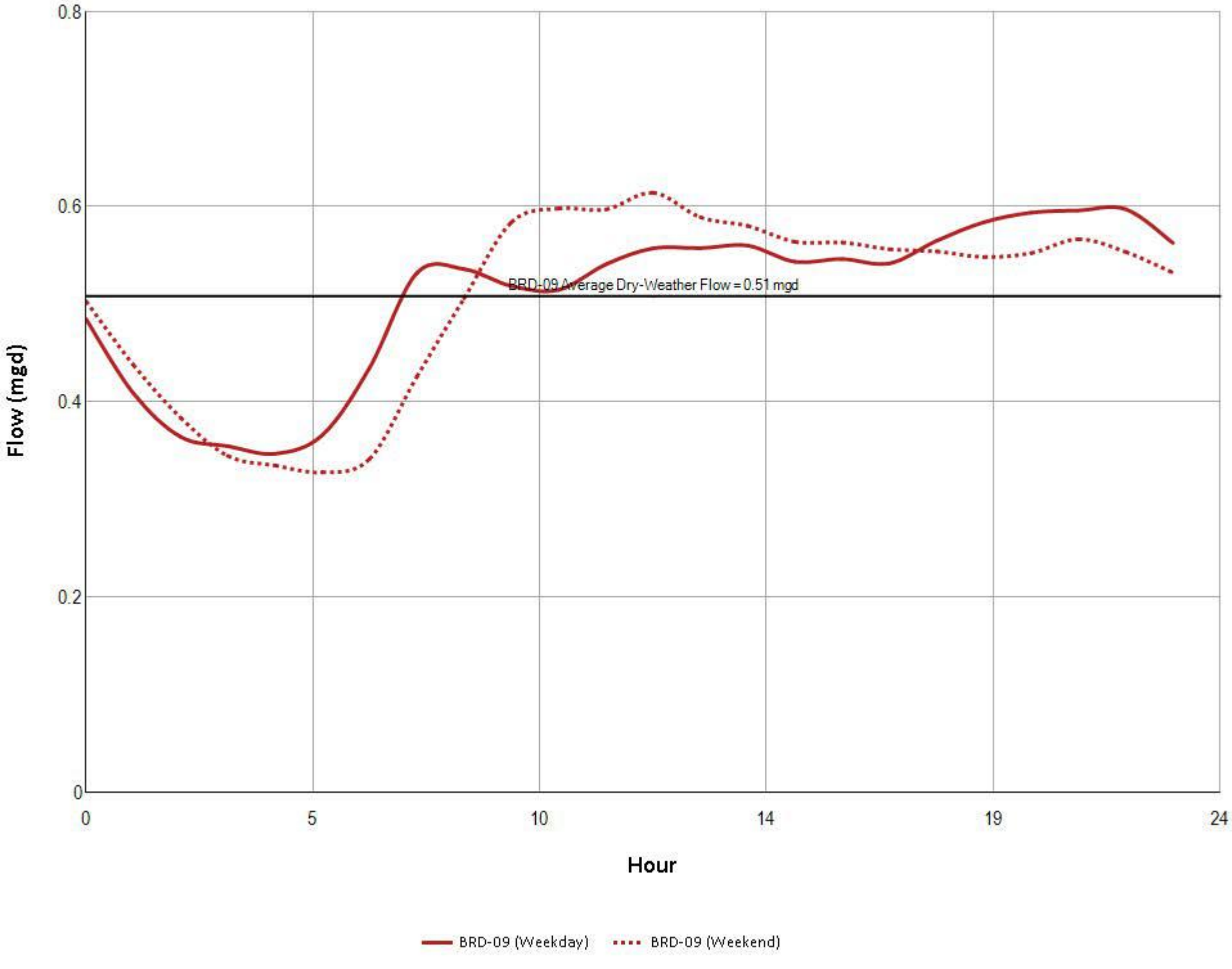
Site: BRD-07 - Average Dry-Weather Flow



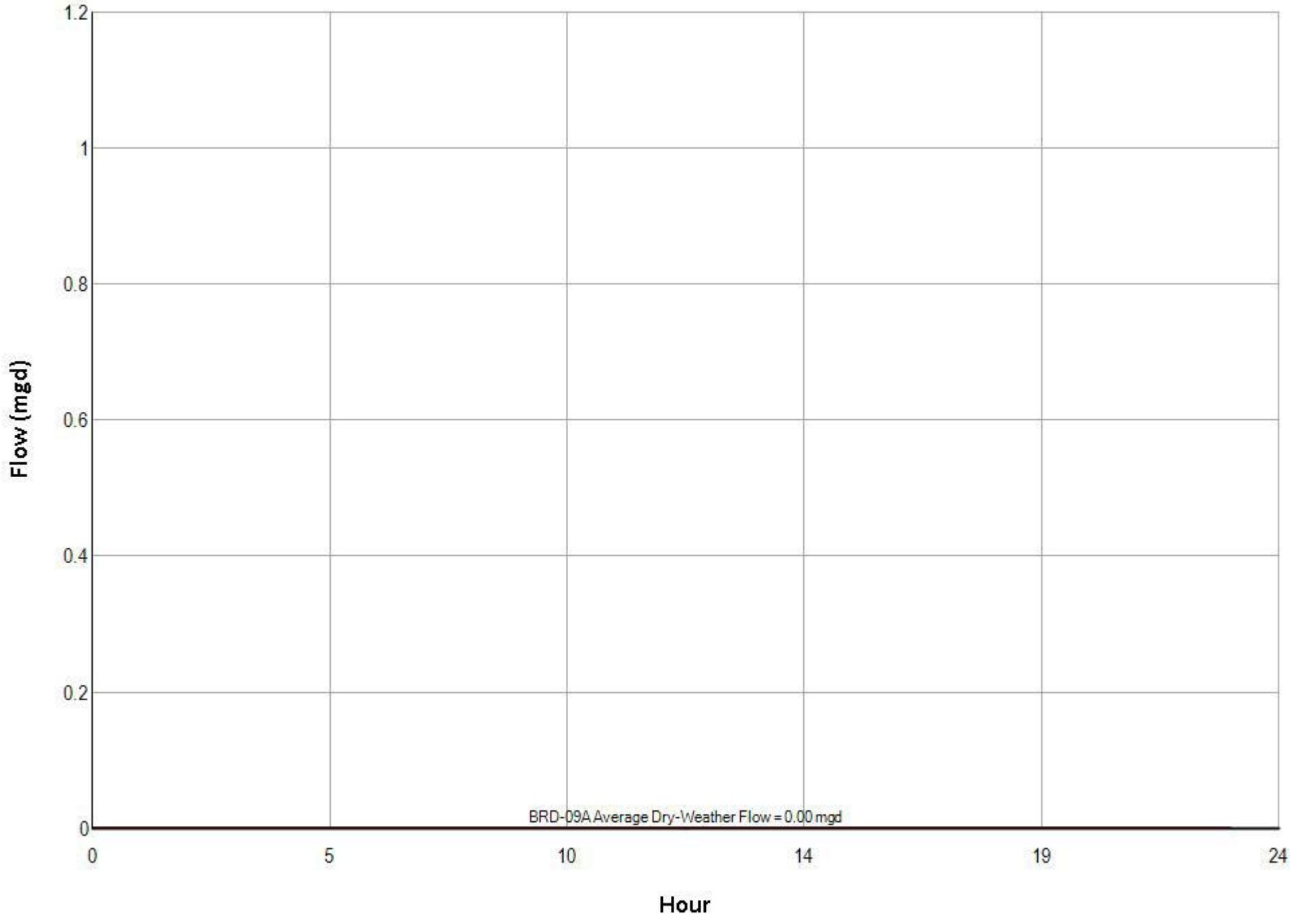
Site: BRD-08 - Average Dry-Weather Flow



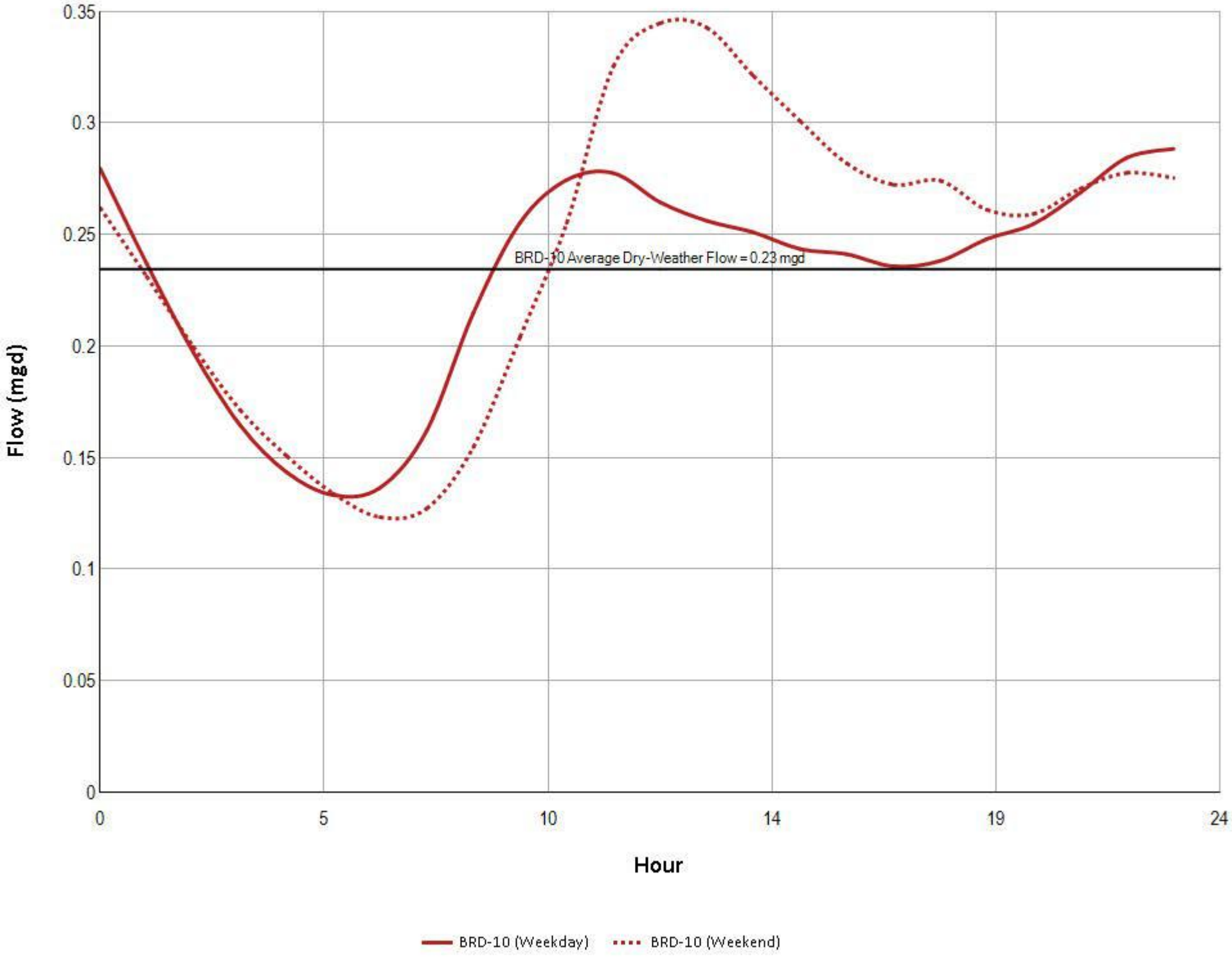
Site: BRD-09 - Average Dry-Weather Flow

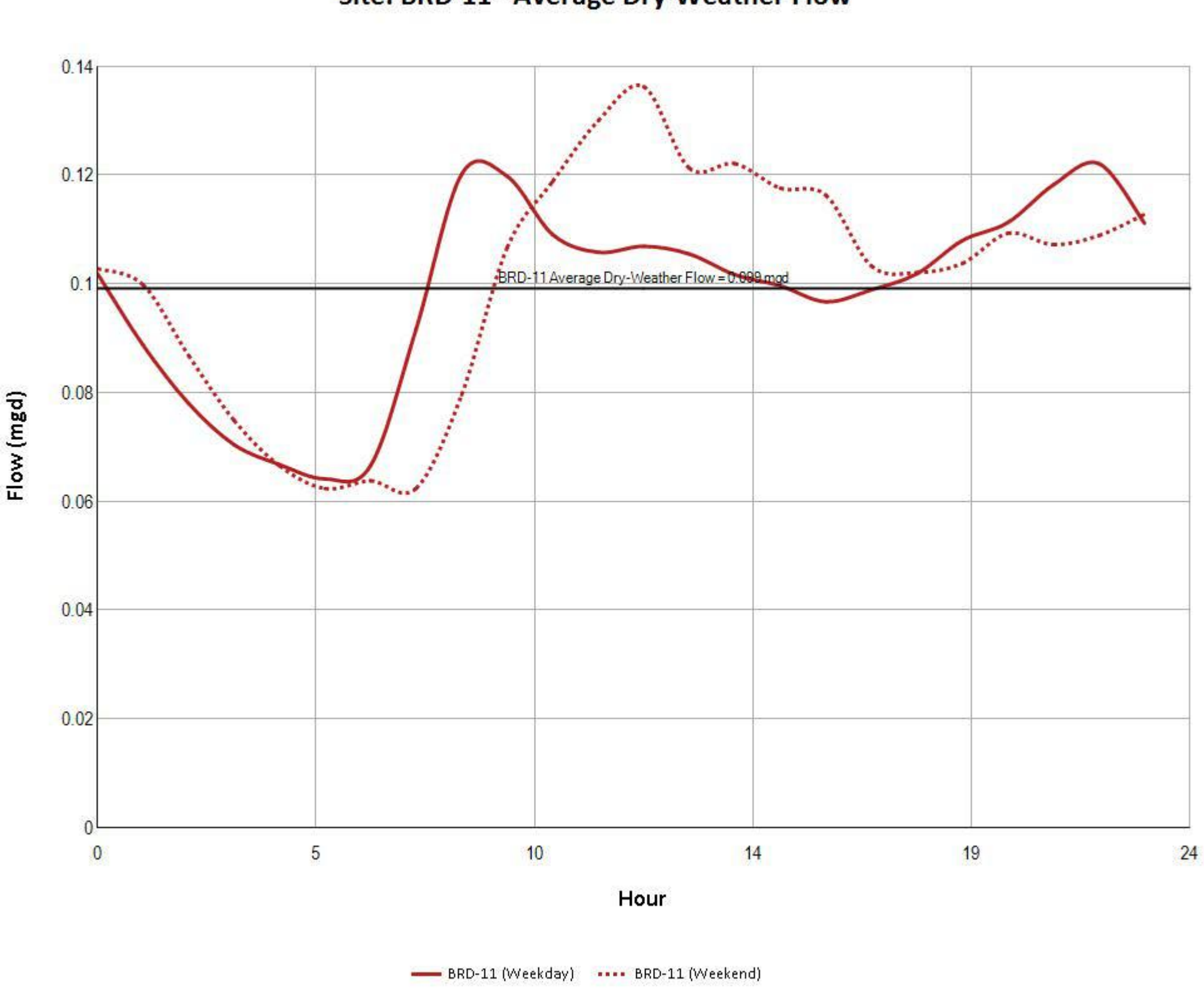


Site: BRD-09A - Average Dry-Weather Flow

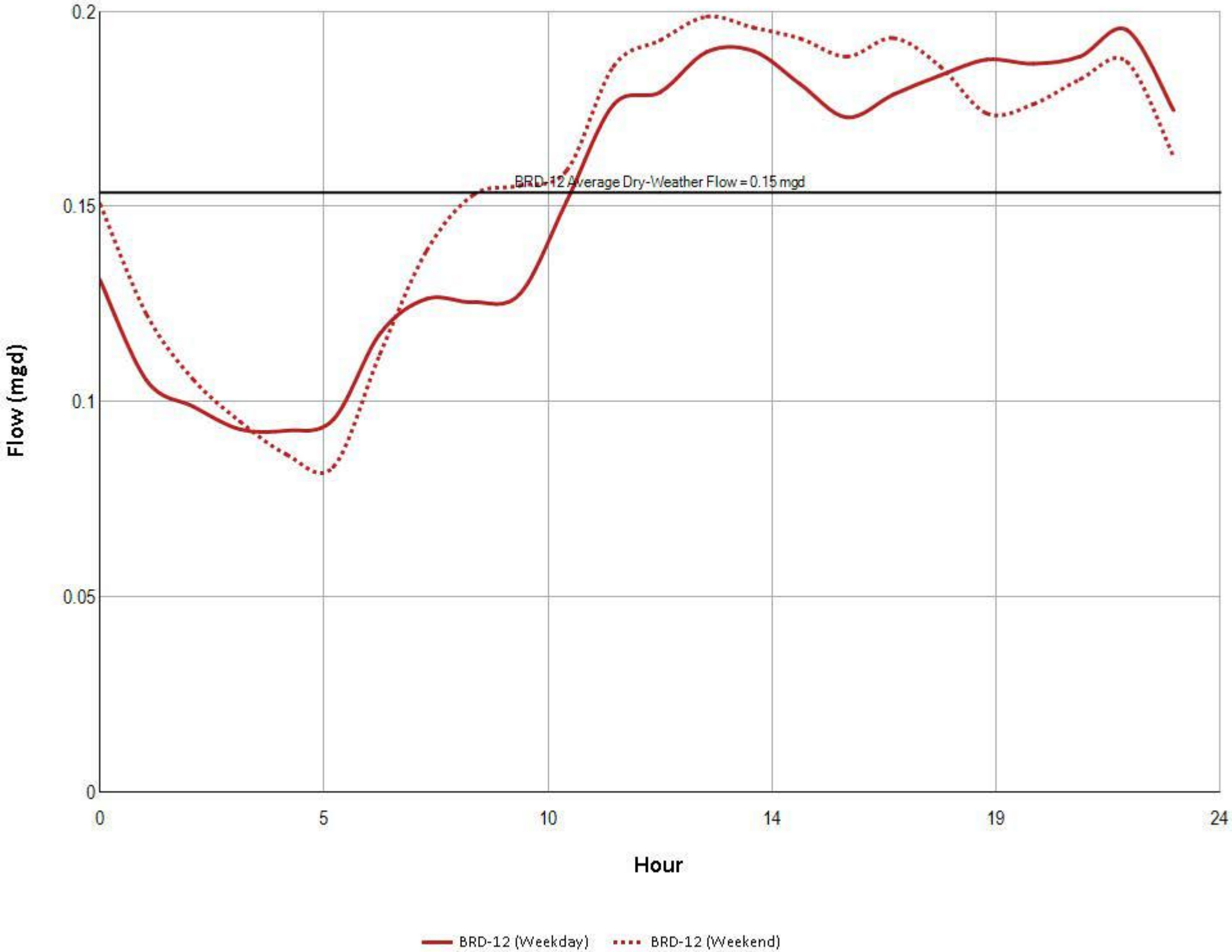


Site: BRD-10 - Average Dry-Weather Flow




Site: BRD-11 - Average Dry-Weather Flow
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Flow (mgd)
BRD-11 Average Dry-Weather Flow = 0.089 mgd
0
5
10
14
19
24
Hour
BRD-11 (Weekday)
BRD-11 (Weekend)

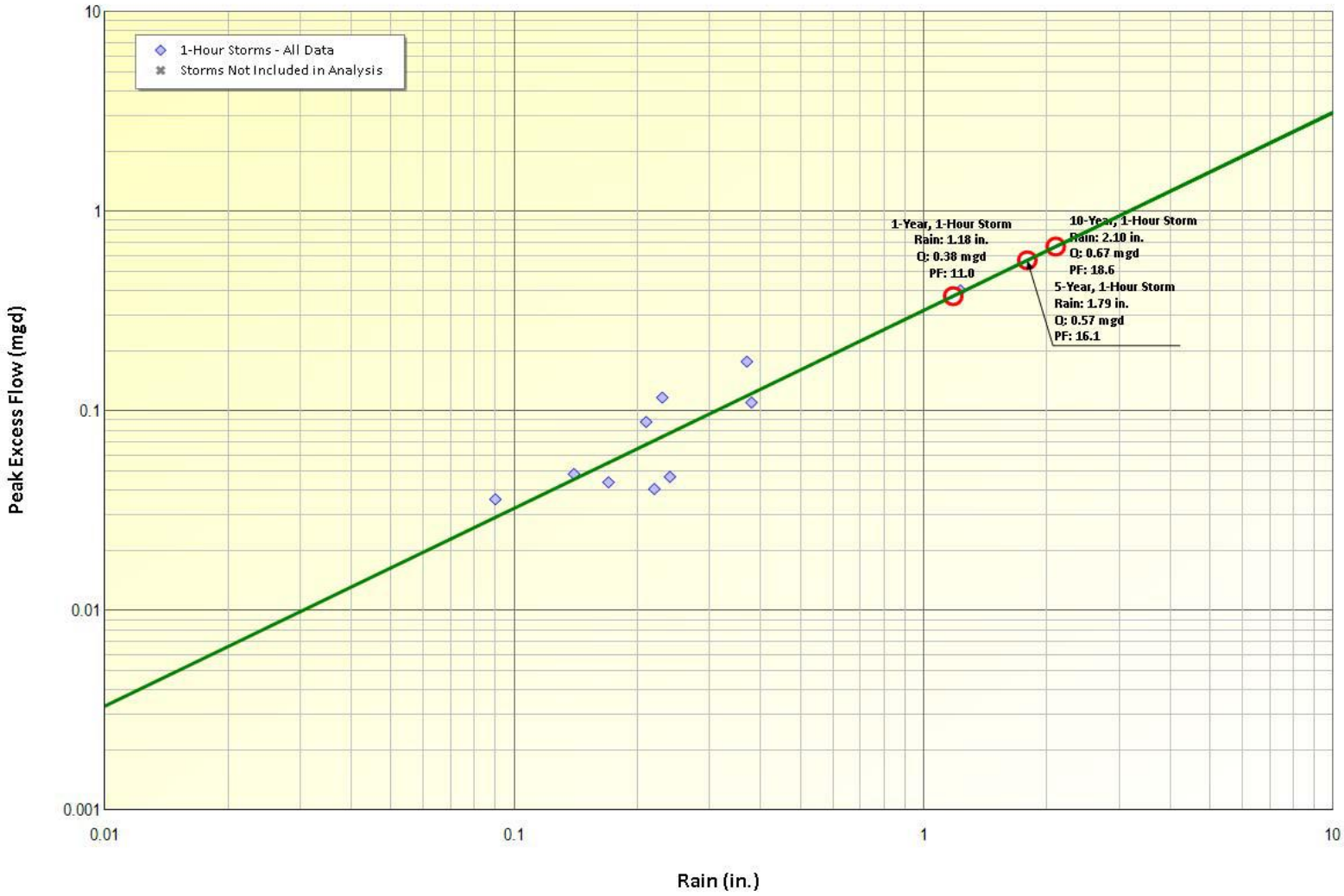
Site: BRD-12 - Average Dry-Weather Flow



APPENDIX C – Regression Curves

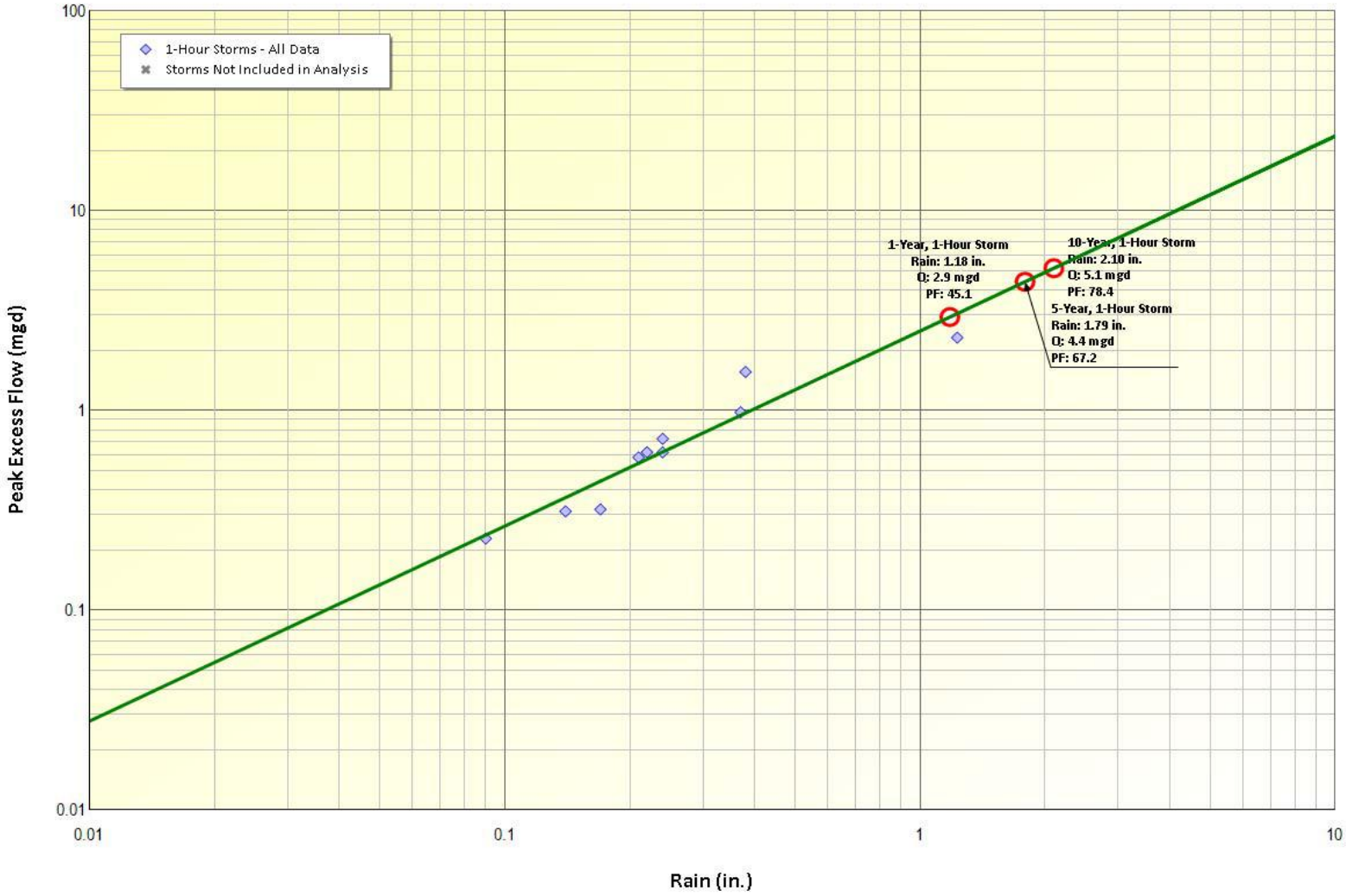
1-Hour Flow vs. Rainfall Regression

Cumulative Basin BRD-01



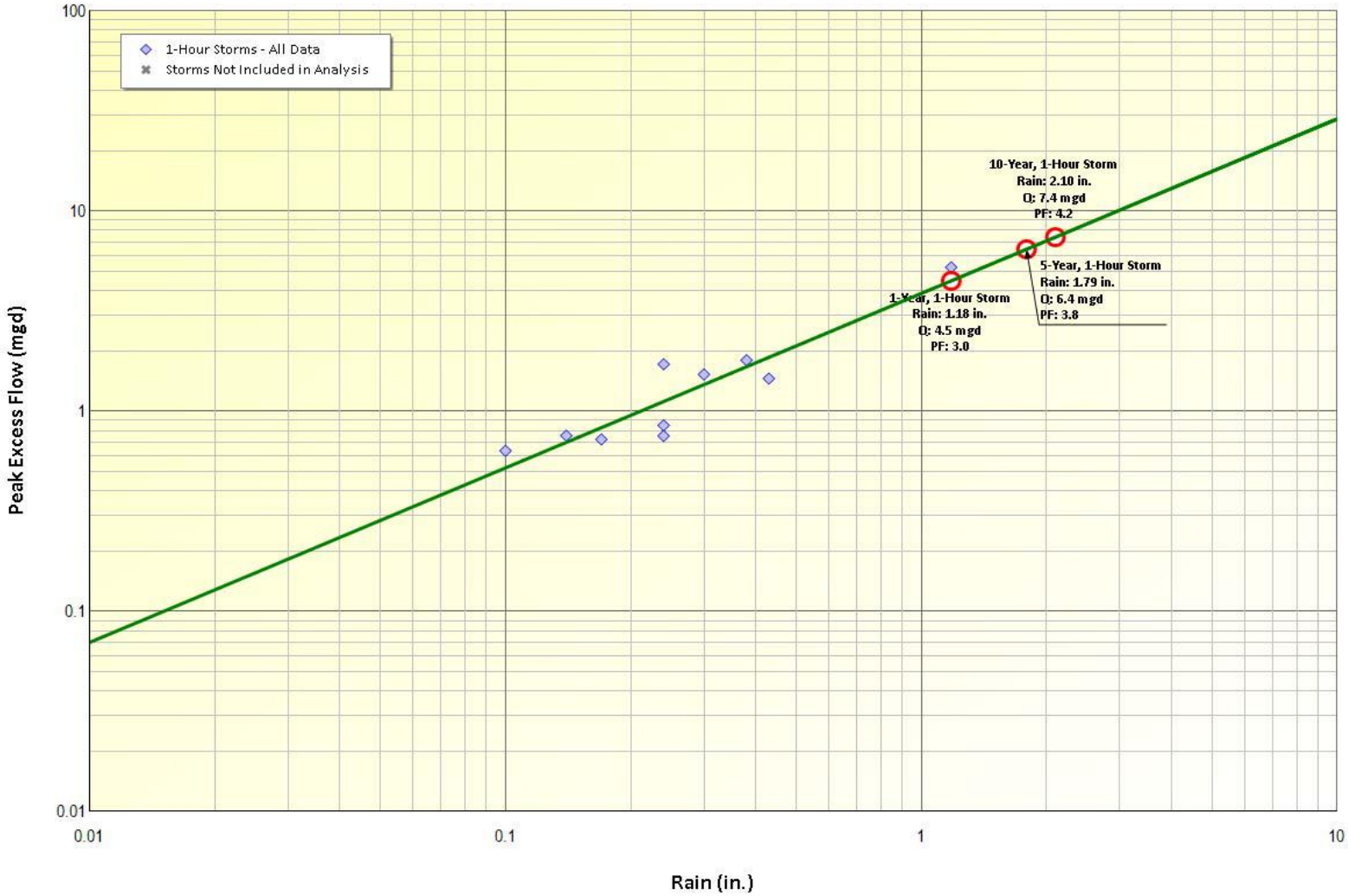
1-Hour Flow vs. Rainfall Regression

Cumulative Basin BRD-02



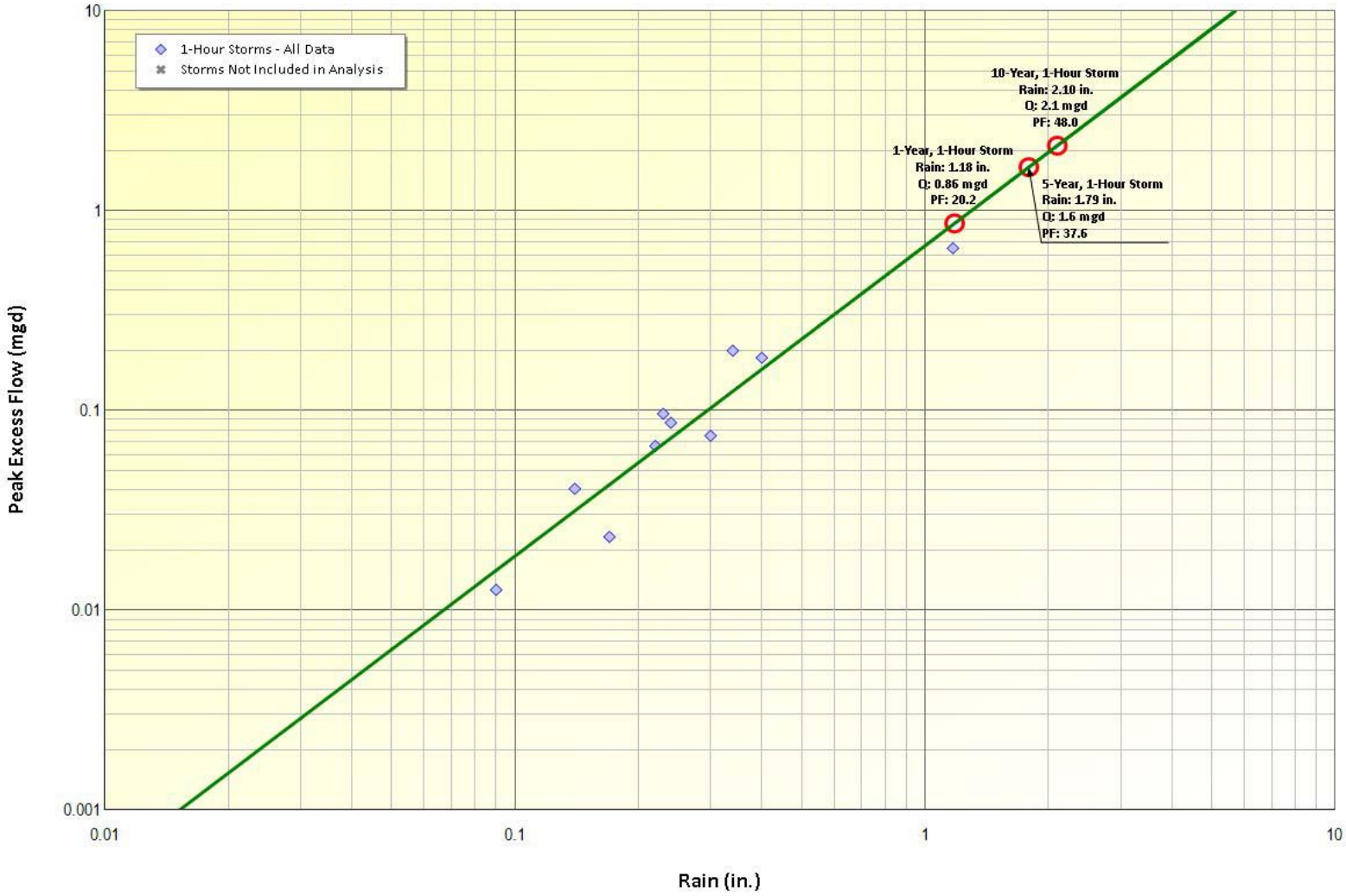
1-Hour Flow vs. Rainfall Regression

Cumulative Basin BRD-03



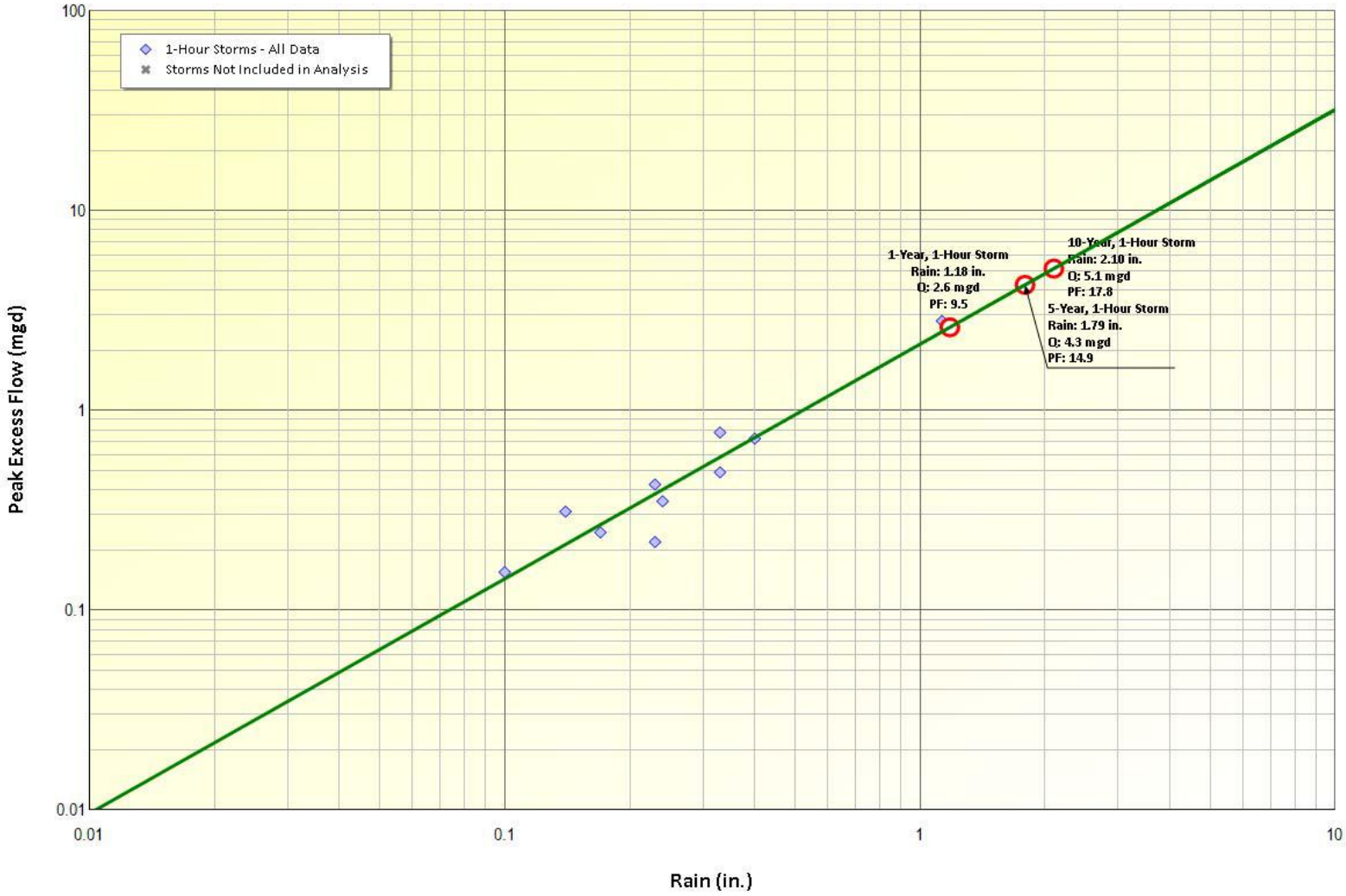
1-Hour Flow vs. Rainfall Regression

Cumulative Basin BRD-04



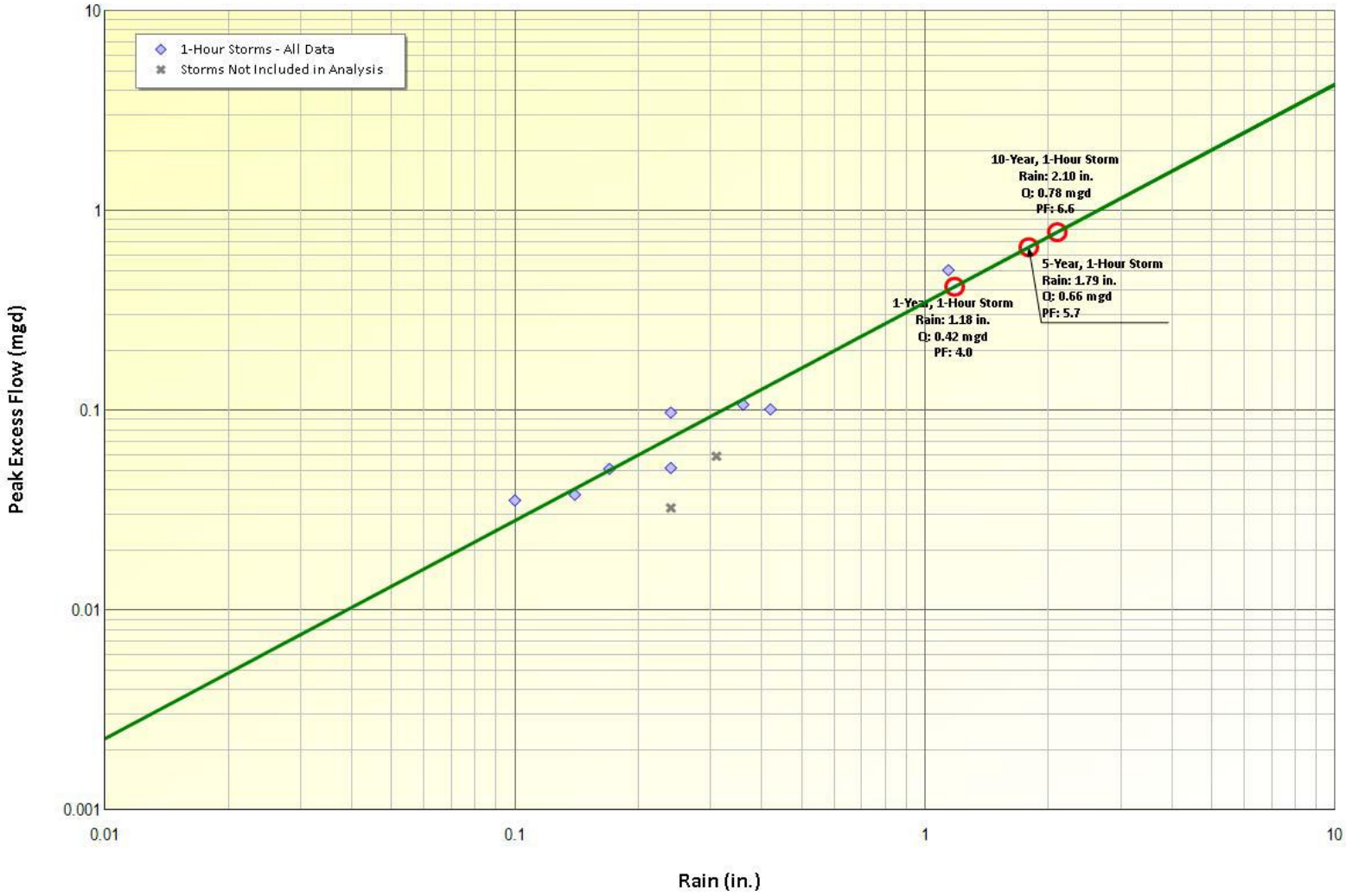
1-Hour Flow vs. Rainfall Regression

Cumulative Basin BRD-05



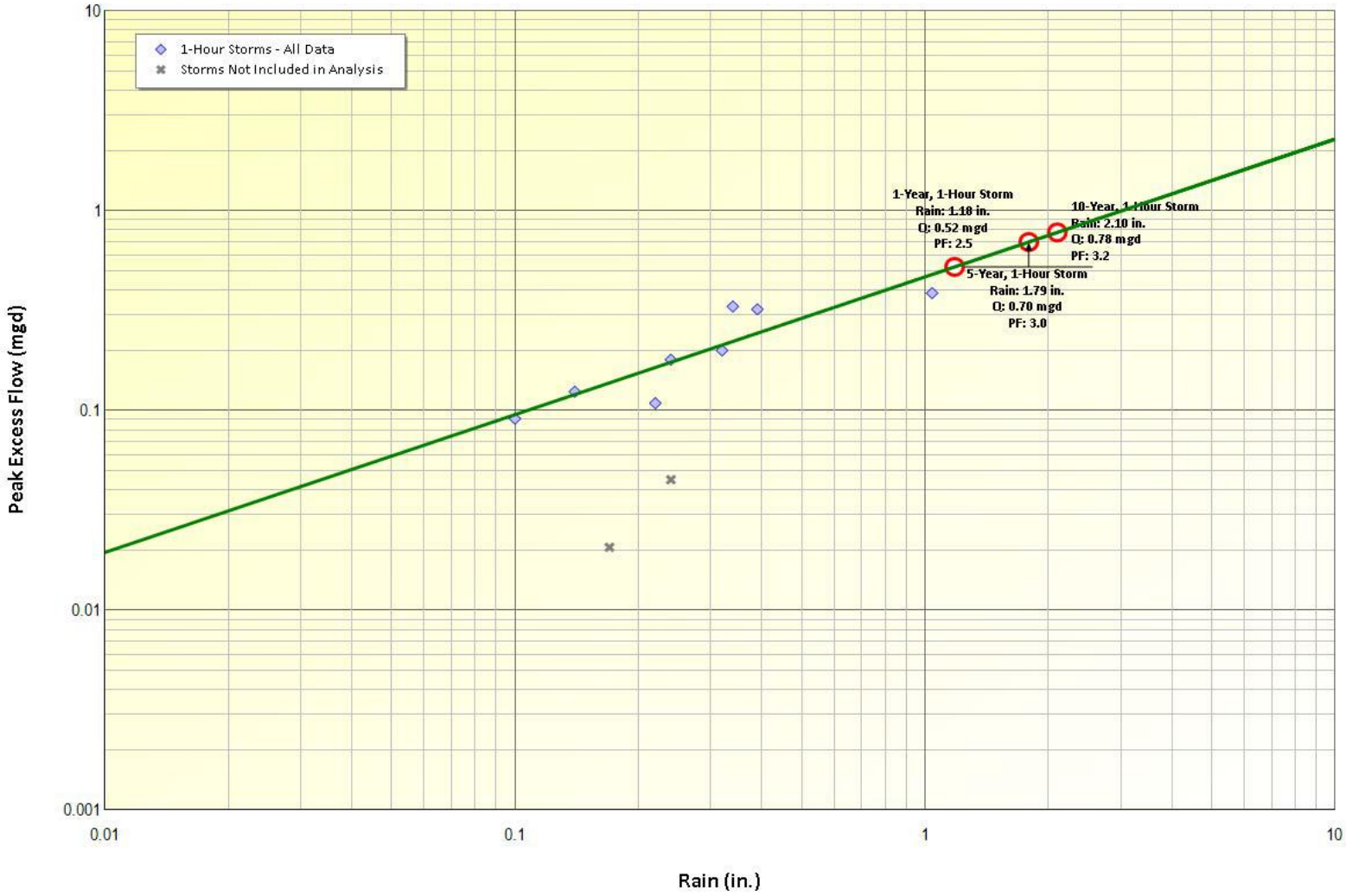
1-Hour Flow vs. Rainfall Regression

Cumulative Basin BRD-06



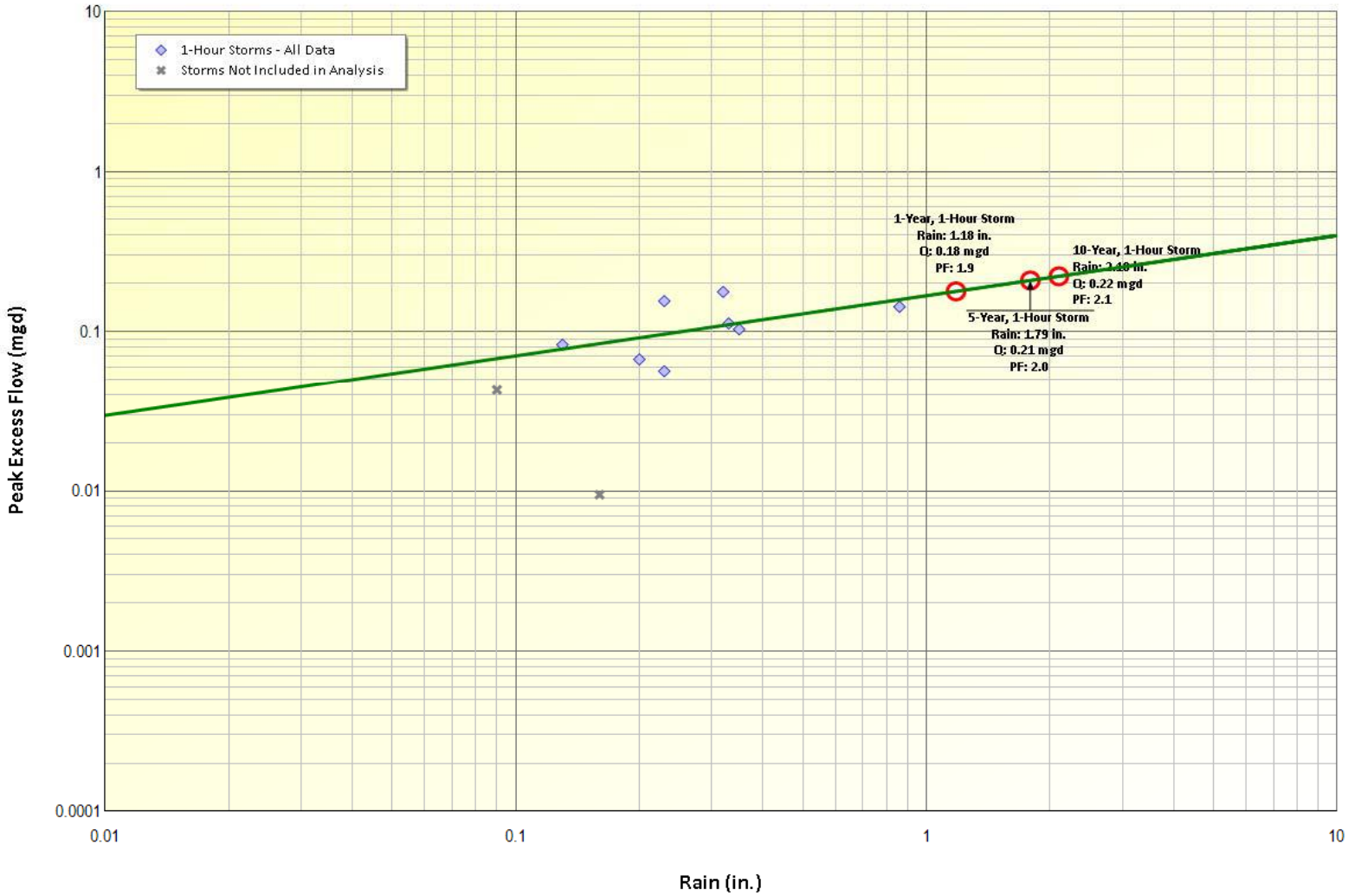
1-Hour Flow vs. Rainfall Regression

Cumulative Basin BRD-07



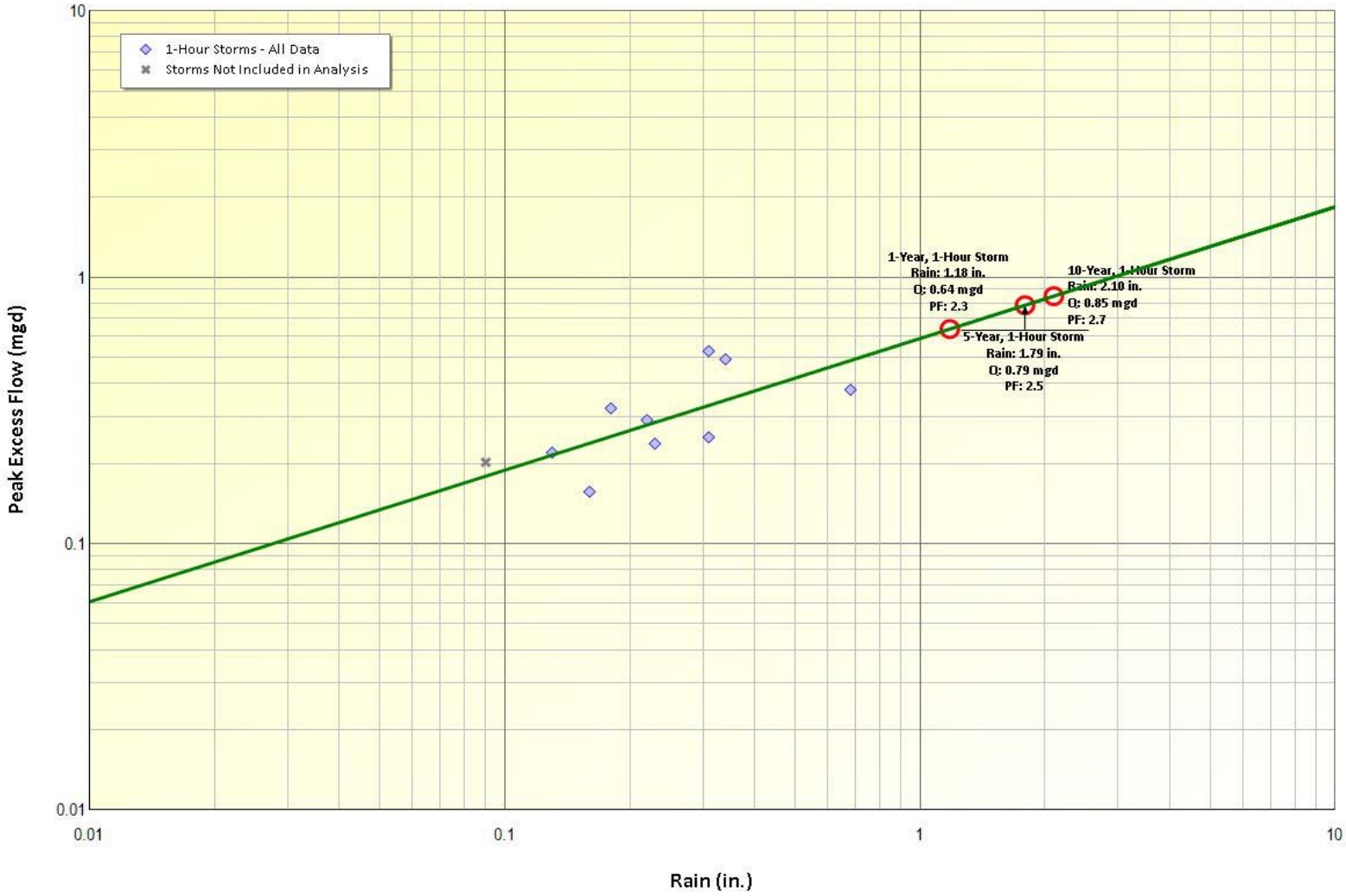
1-Hour Flow vs. Rainfall Regression

Cumulative Basin BRD-08



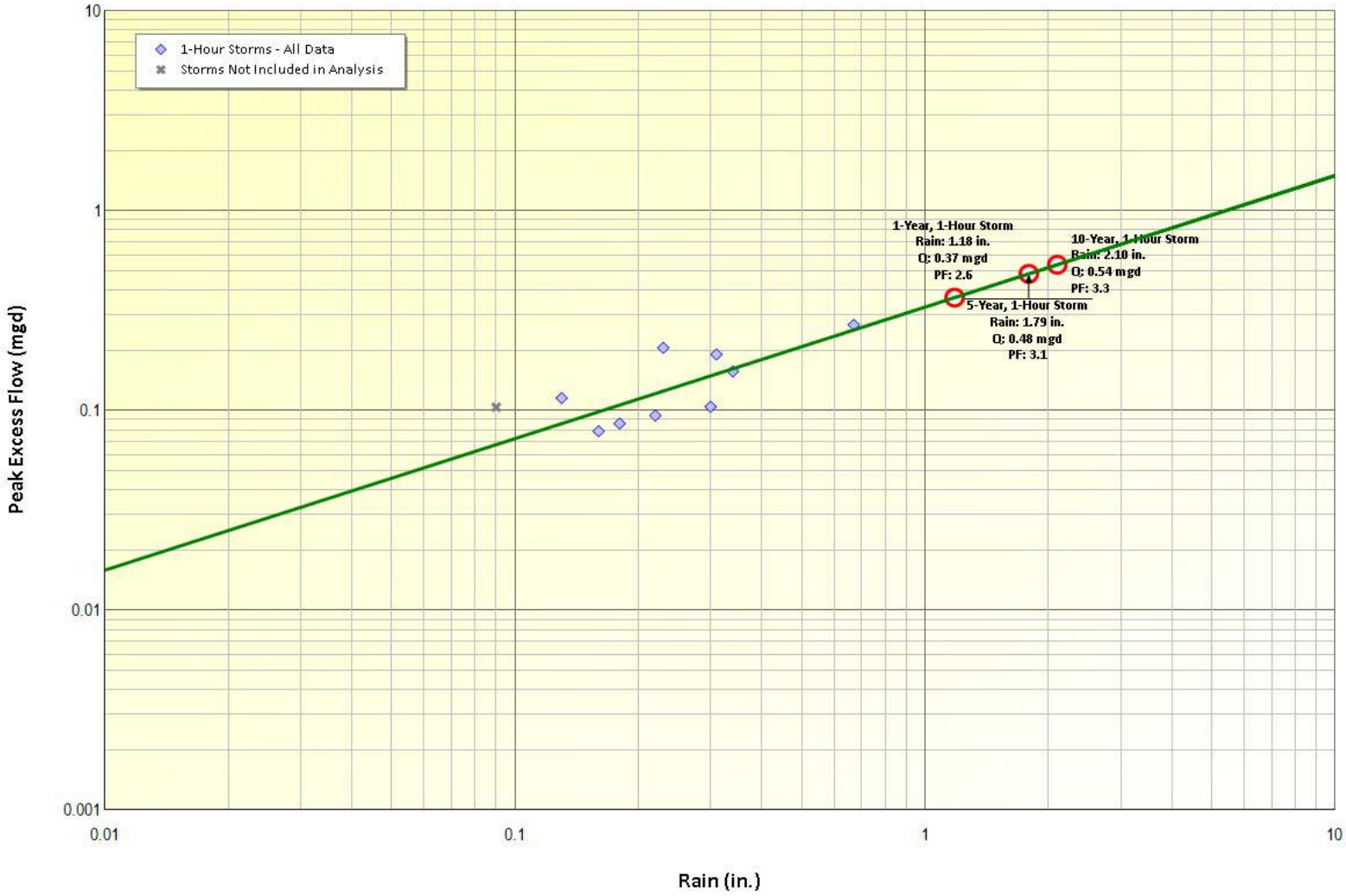
1-Hour Flow vs. Rainfall Regression

Cumulative Basin BRD-09



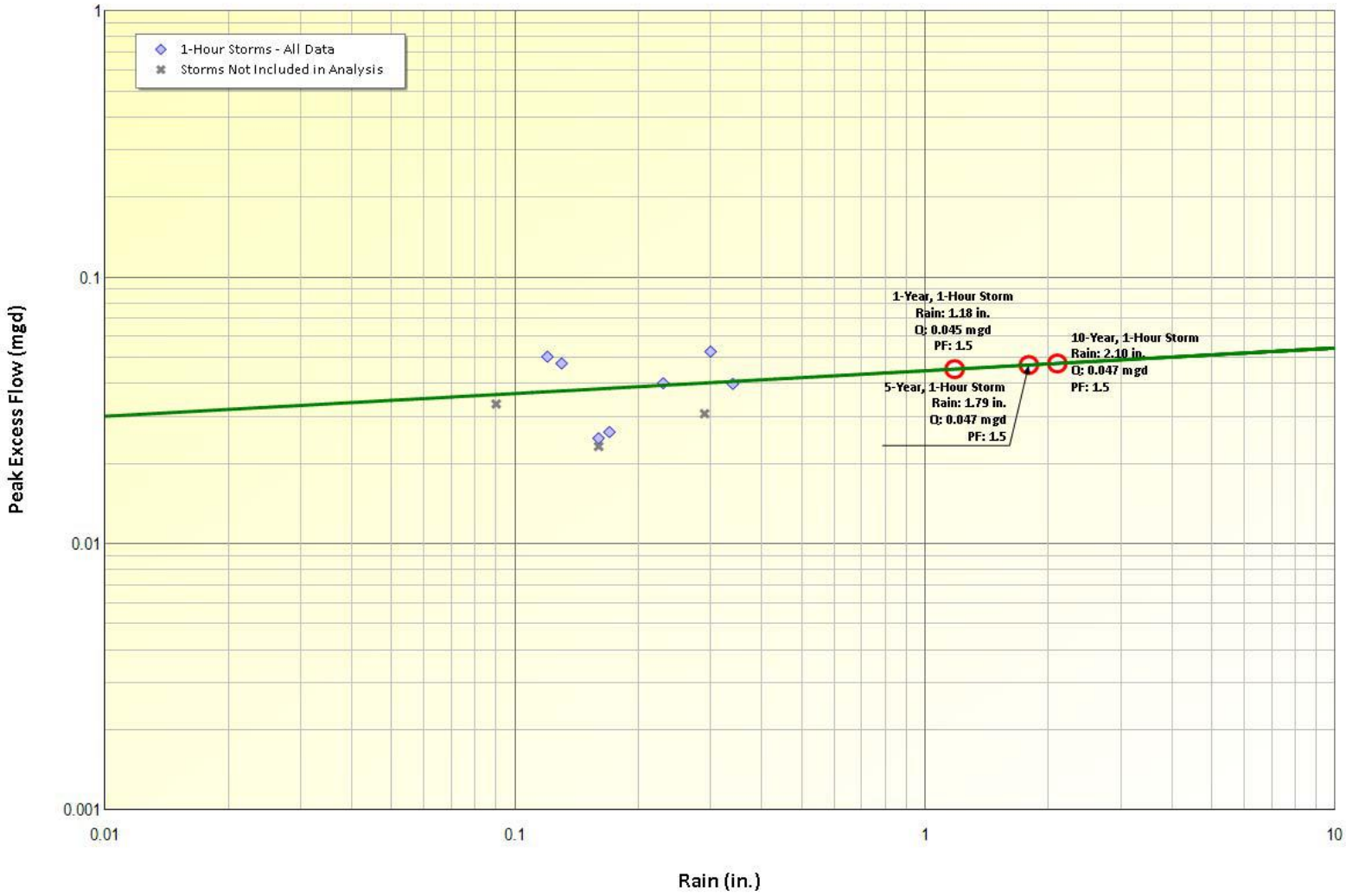
1-Hour Flow vs. Rainfall Regression

Cumulative Basin BRD-10



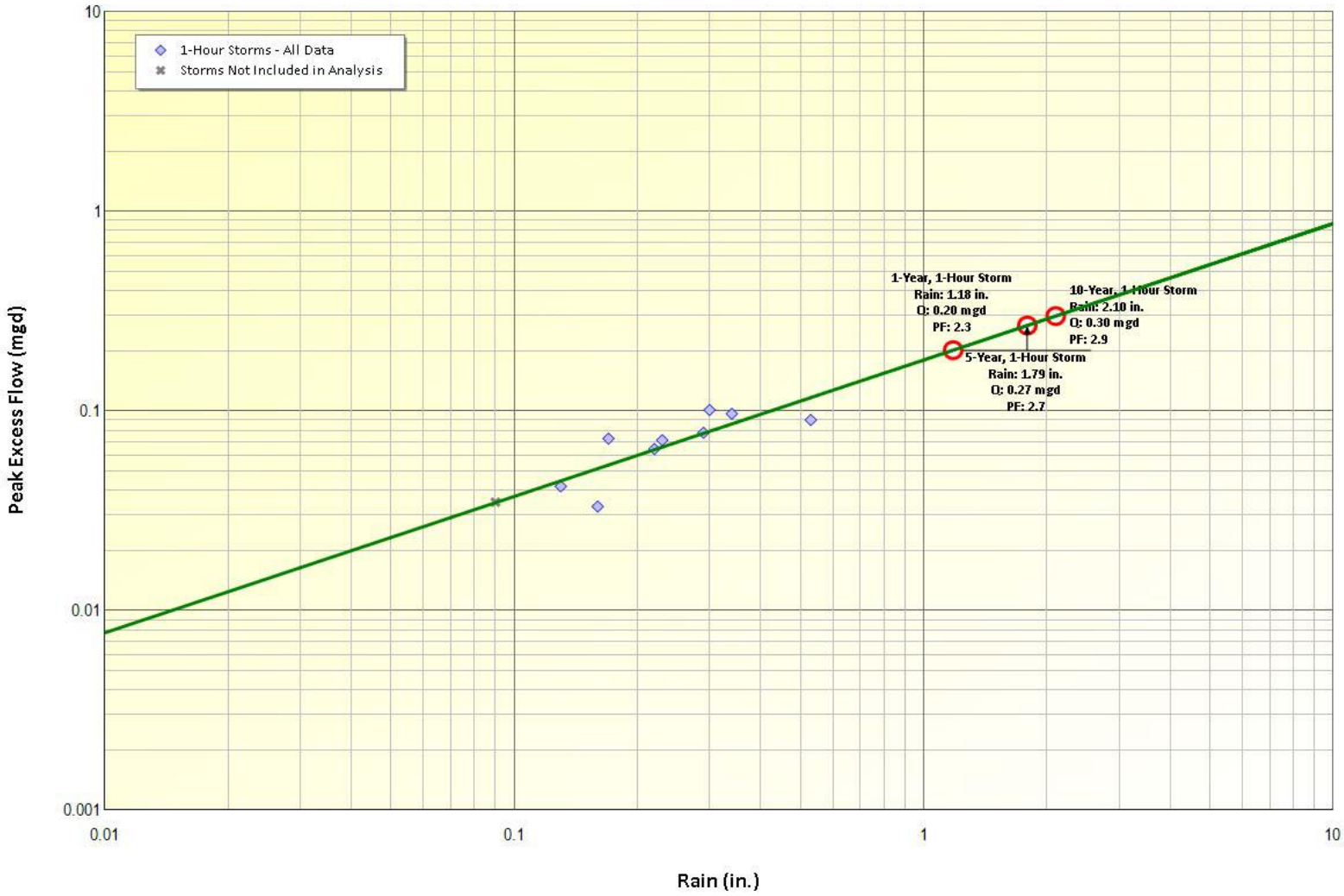
1-Hour Flow vs. Rainfall Regression

Cumulative Basin BRD-11



1-Hour Flow vs. Rainfall Regression

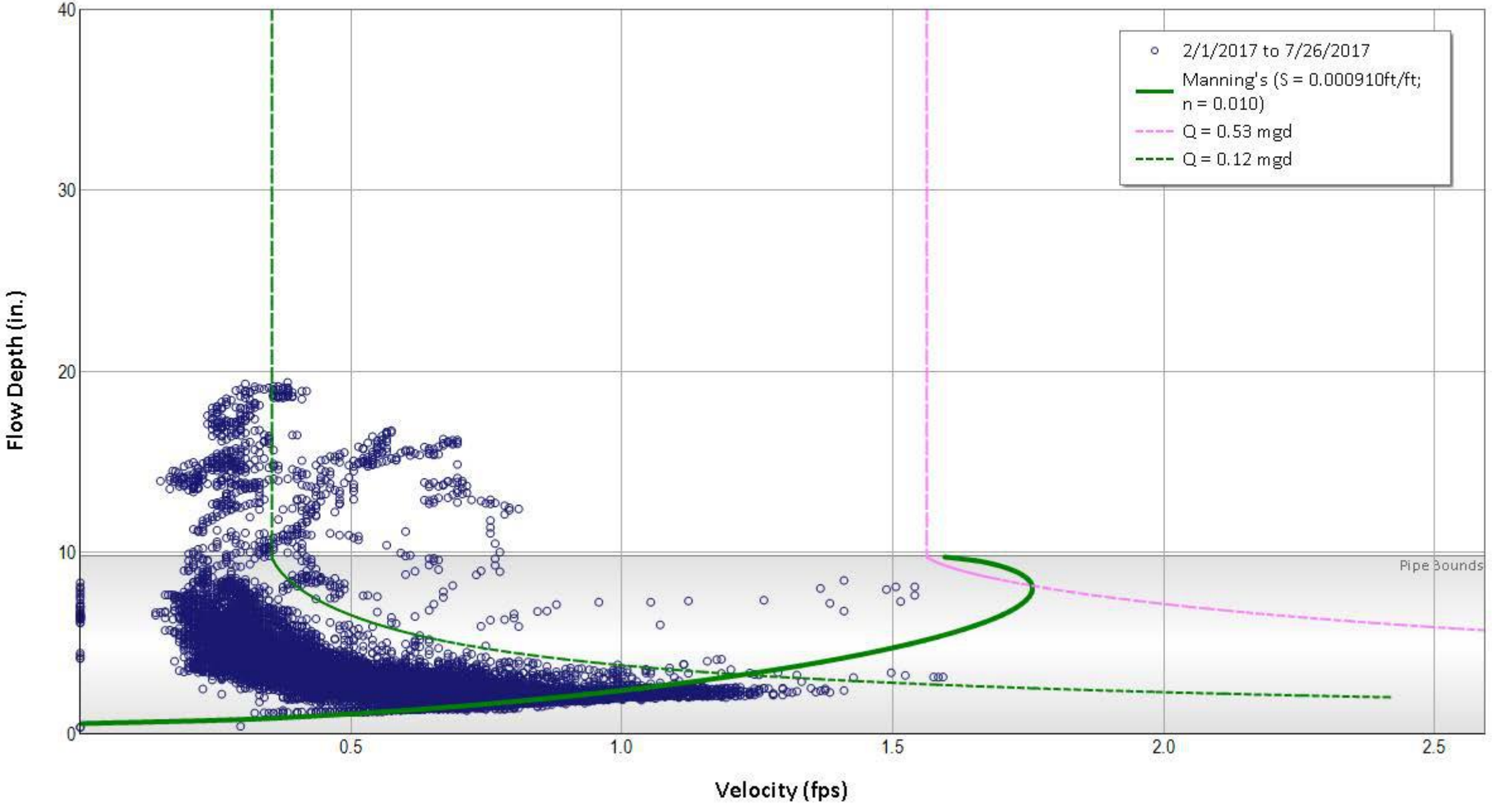
Cumulative Basin BRD-12



APPENDIX D – Scattergraphs

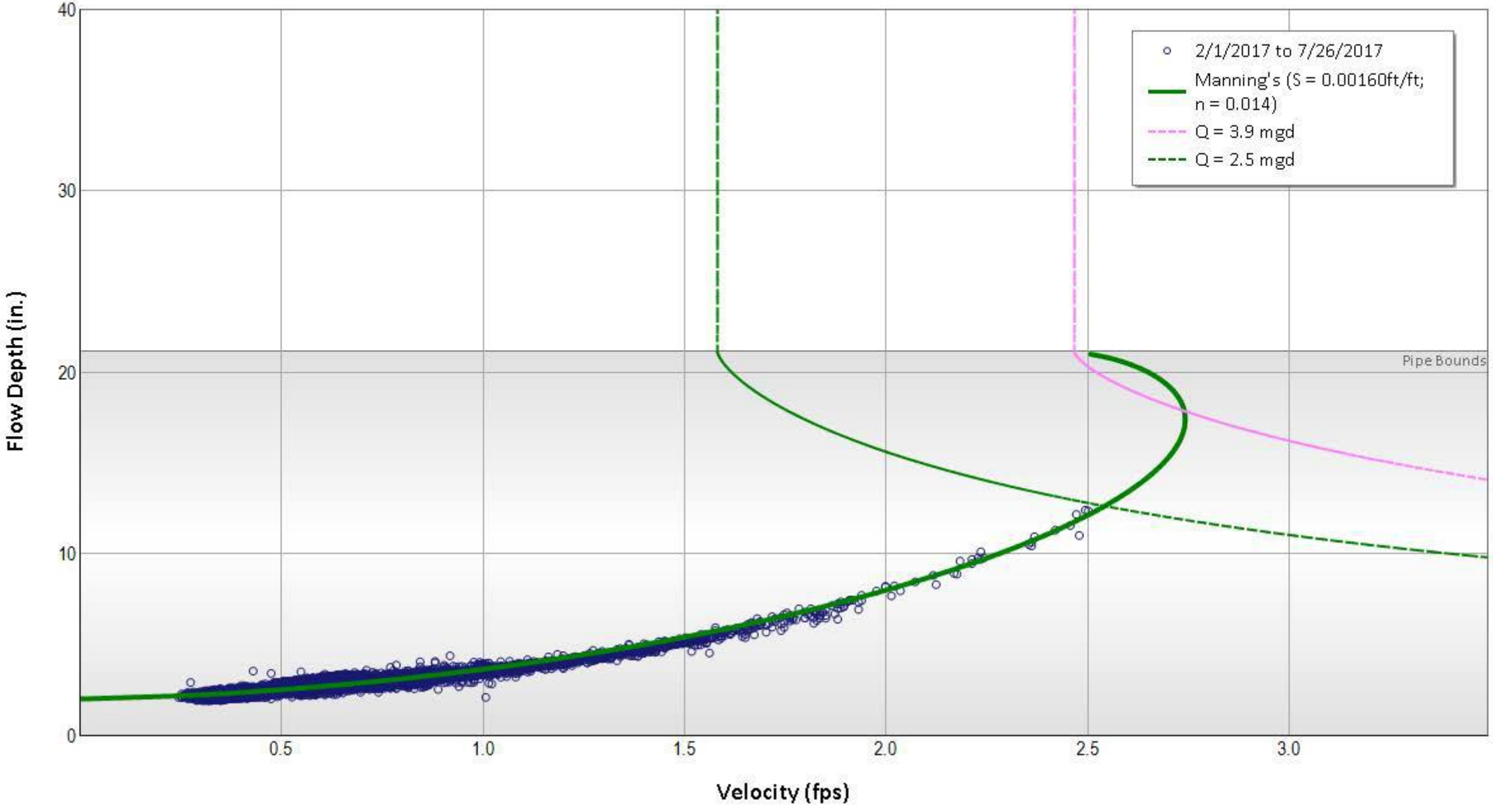
Scattergraph

Meter Site: BRD-01



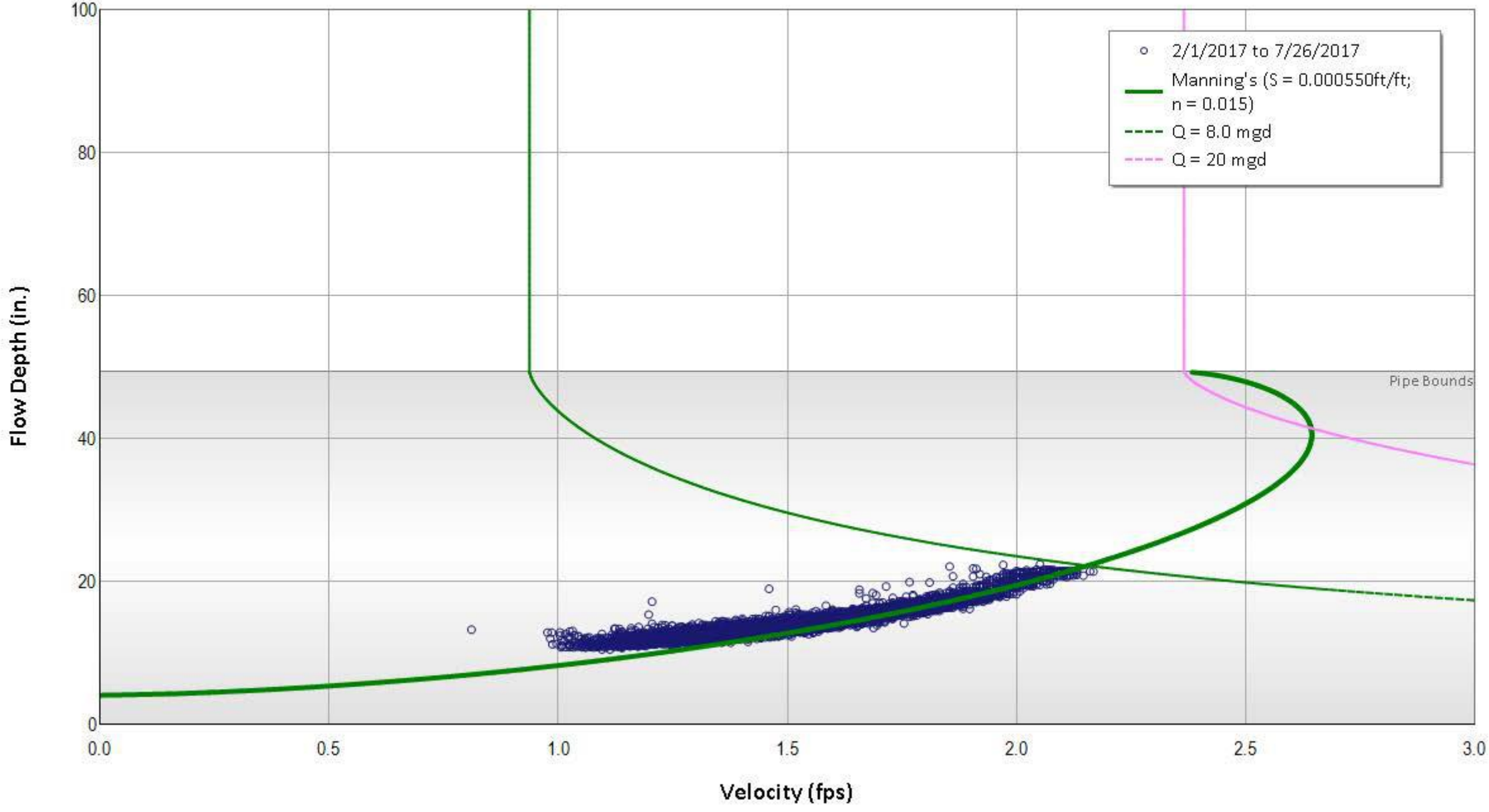
Scattergraph

Meter Site: BRD-02



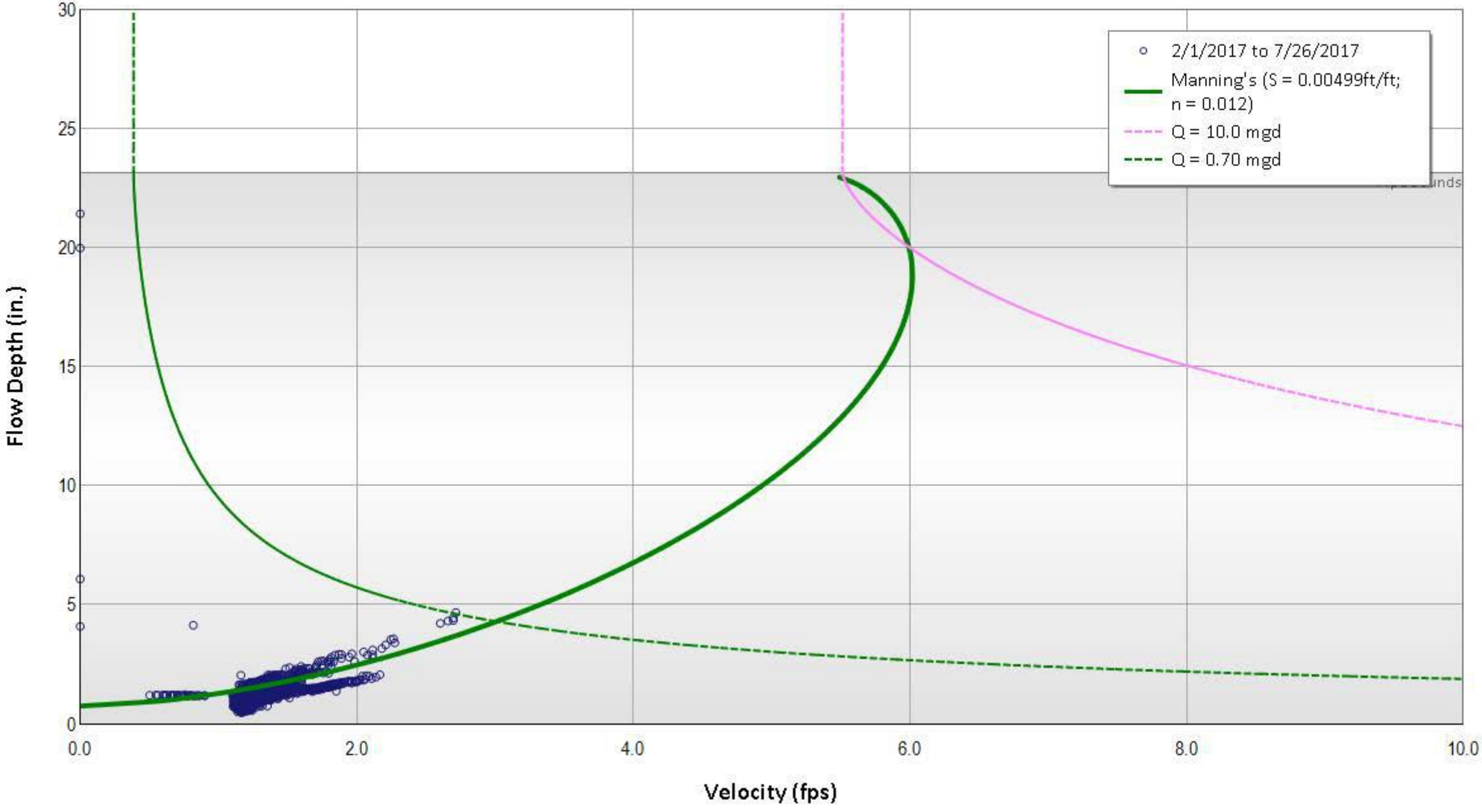
Scattergraph

Meter Site: BRD-03



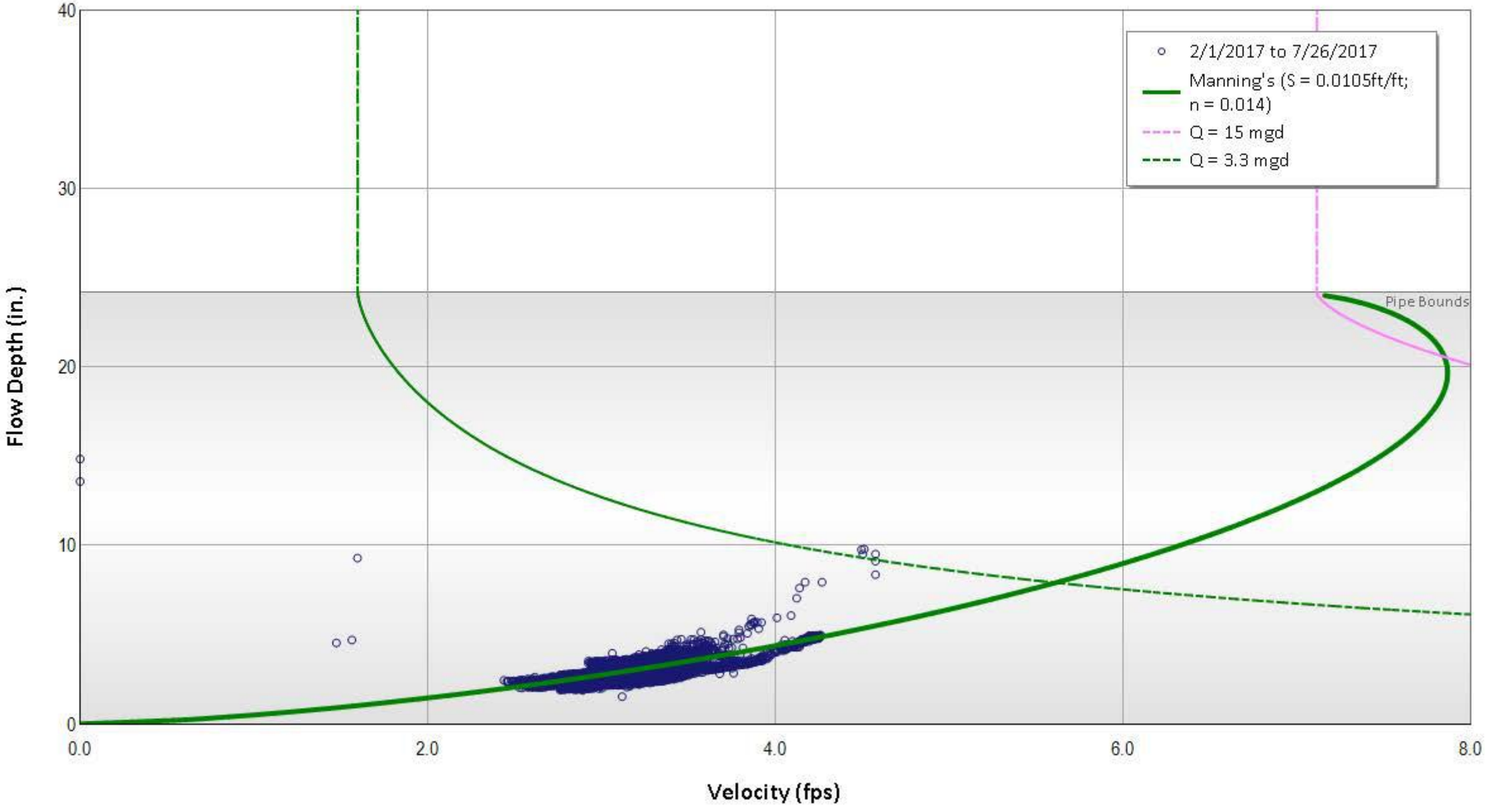
Scattergraph

Meter Site: BRD-04



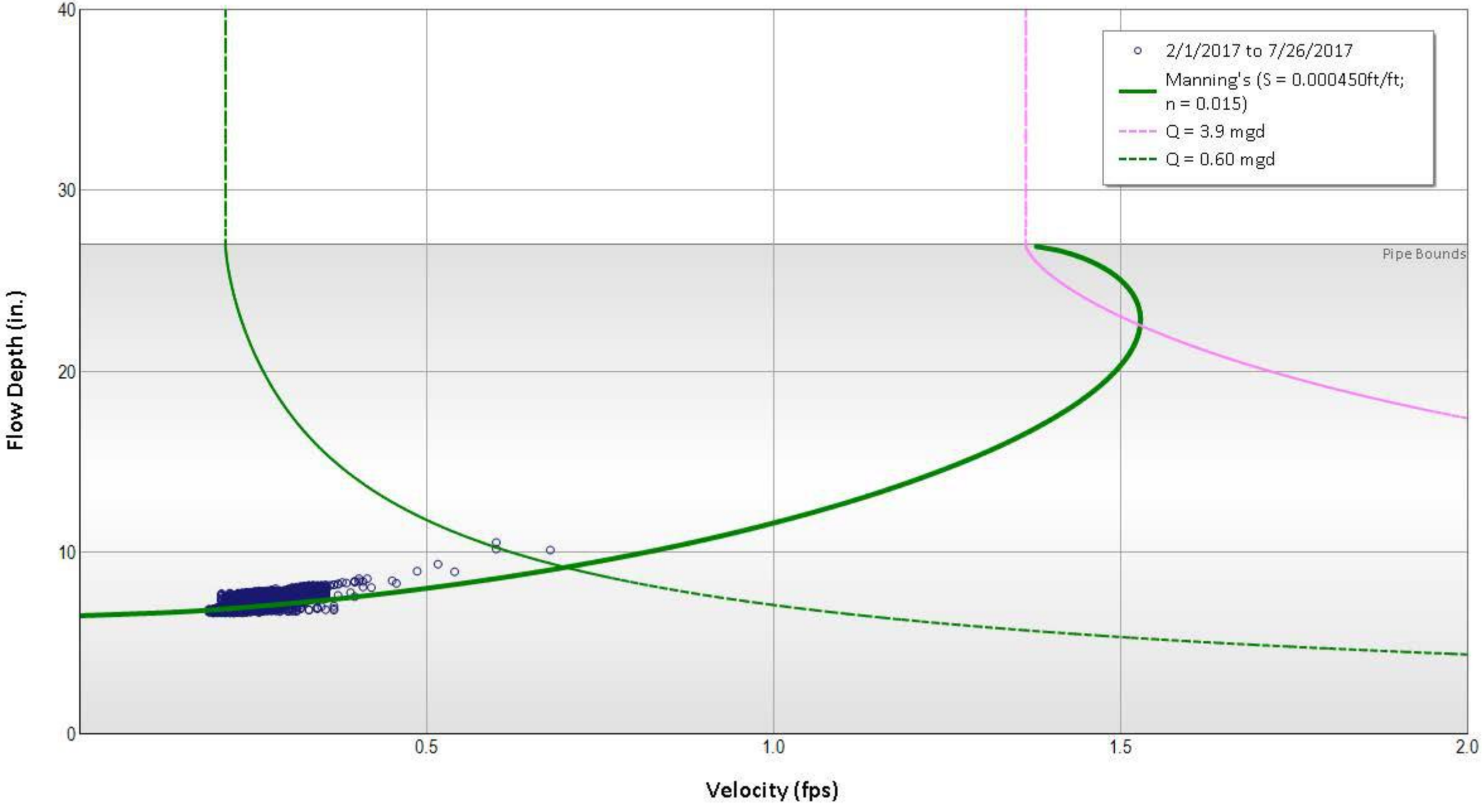
Scattergraph

Meter Site: BRD-05



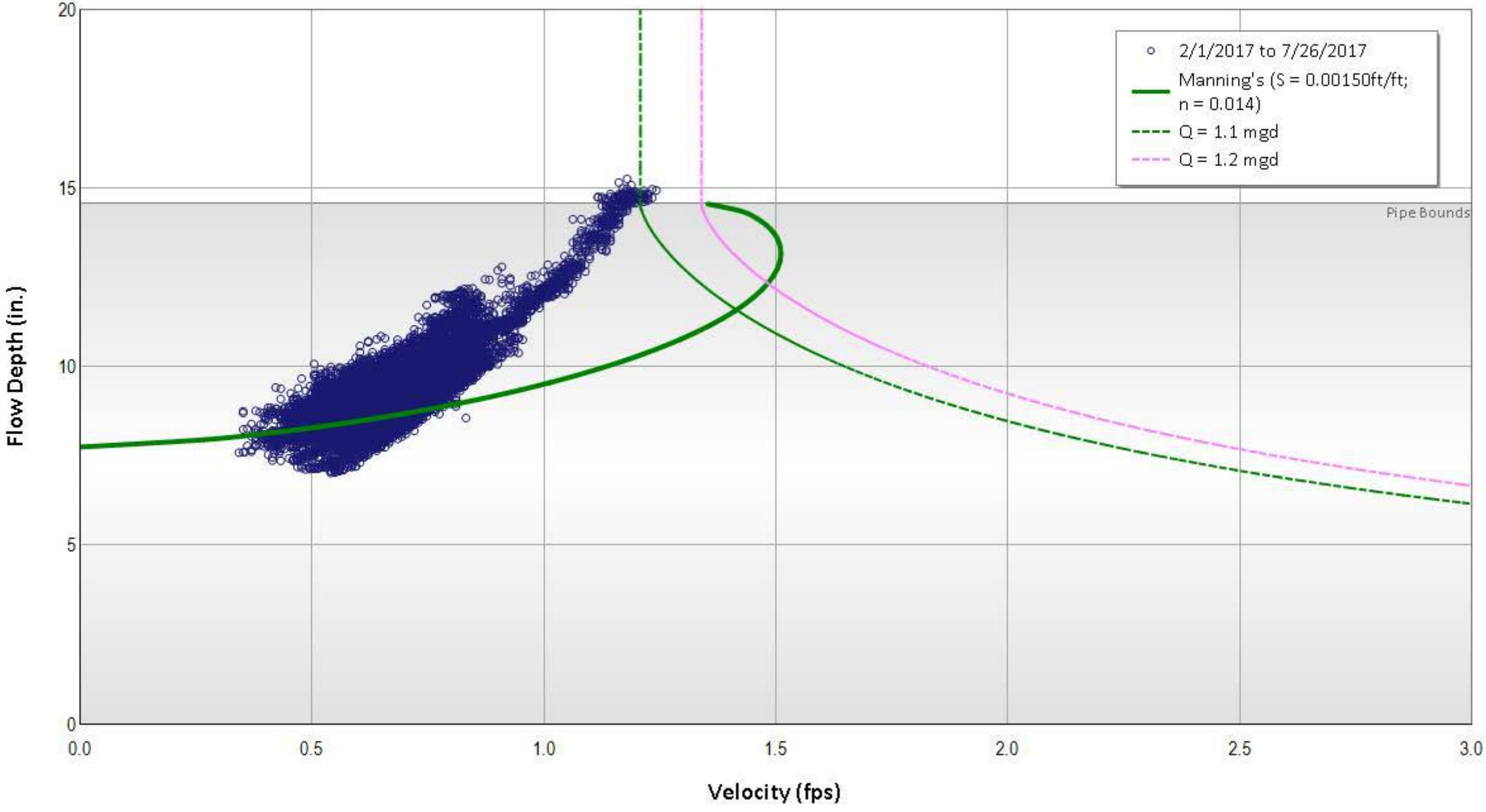
Scattergraph

Meter Site: BRD-06



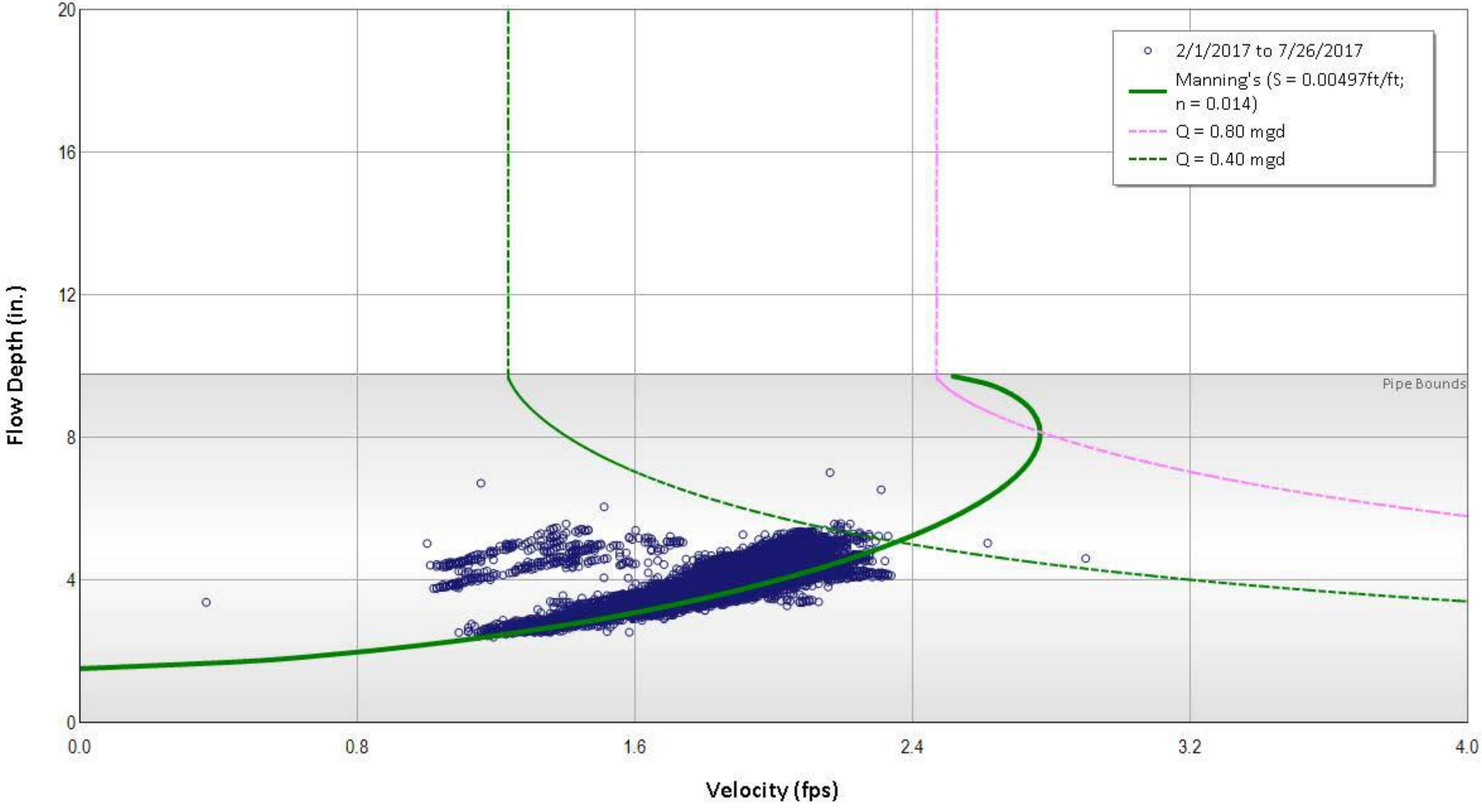
Scattergraph

Meter Site: BRD-07



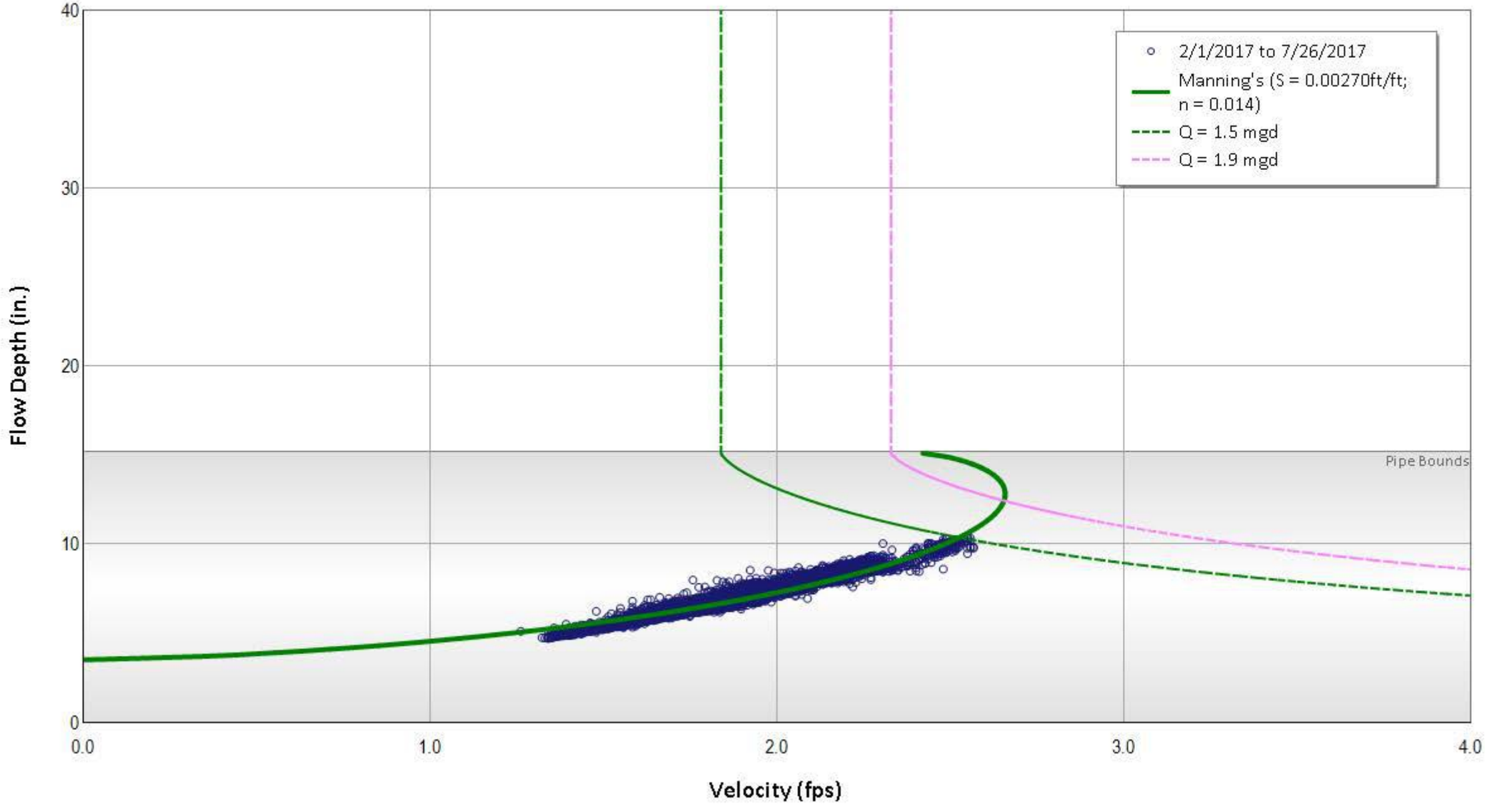
Scattergraph

Meter Site: BRD-08



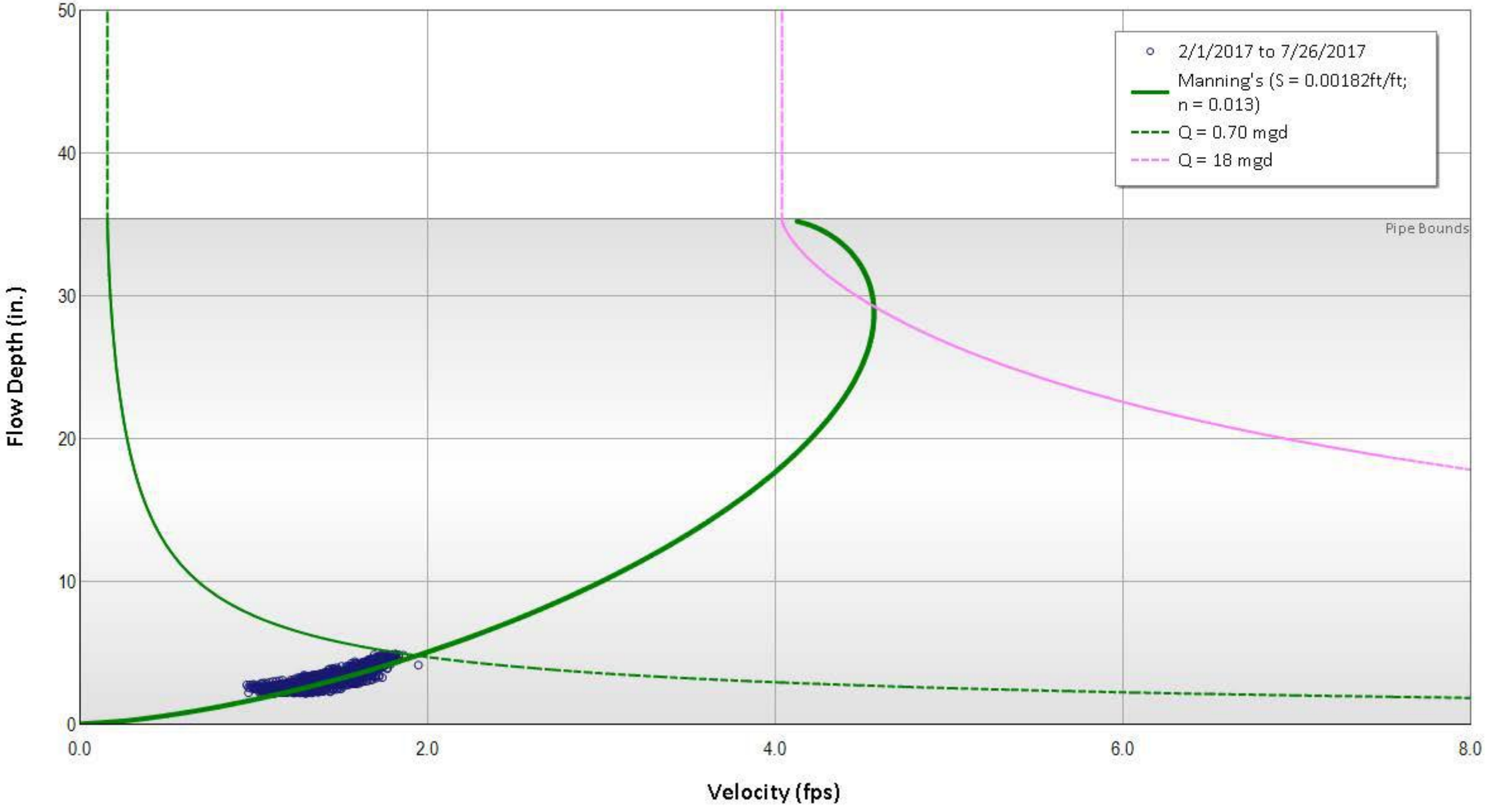
Scattergraph

Meter Site: BRD-09



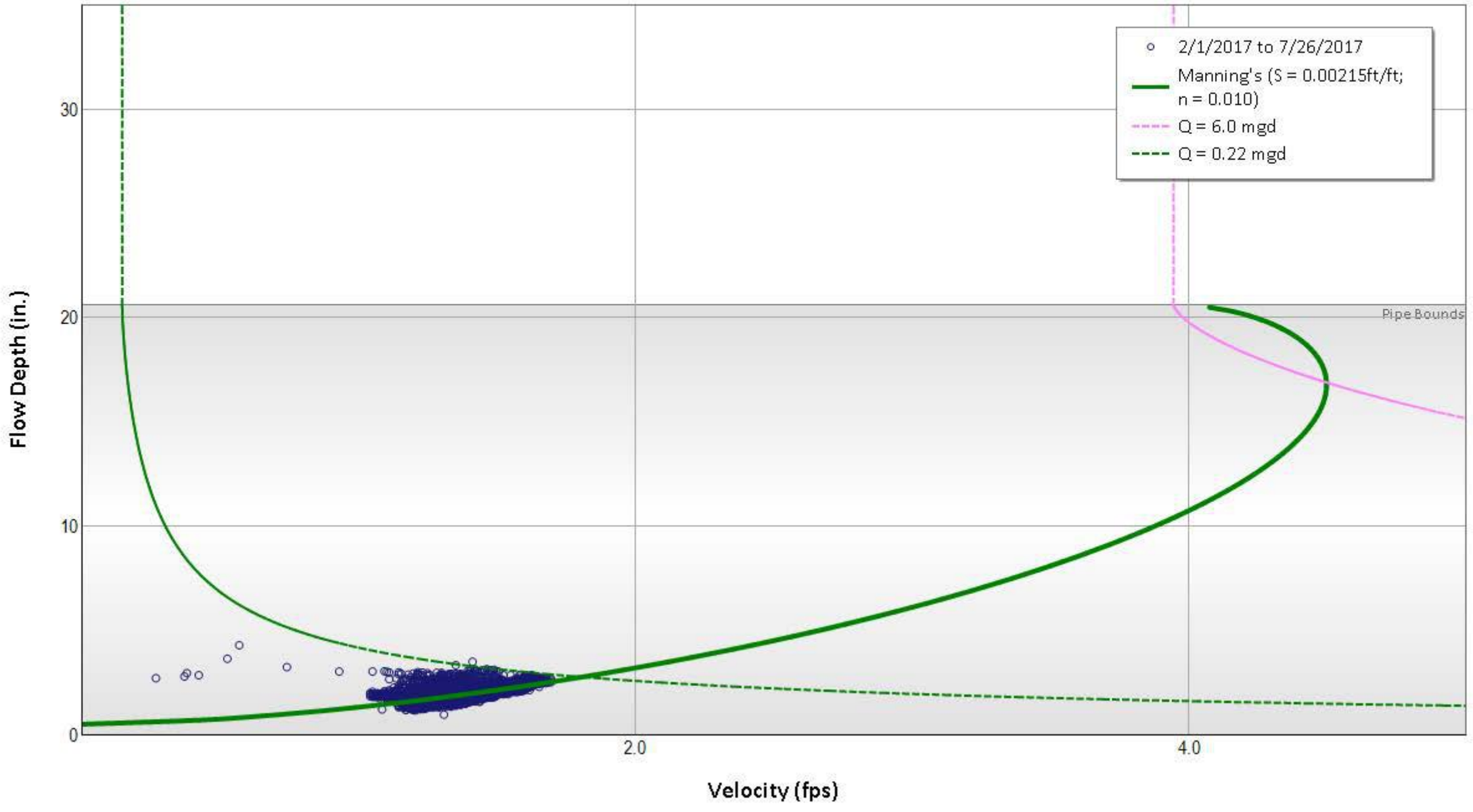
Scattergraph

Meter Site: BRD-10



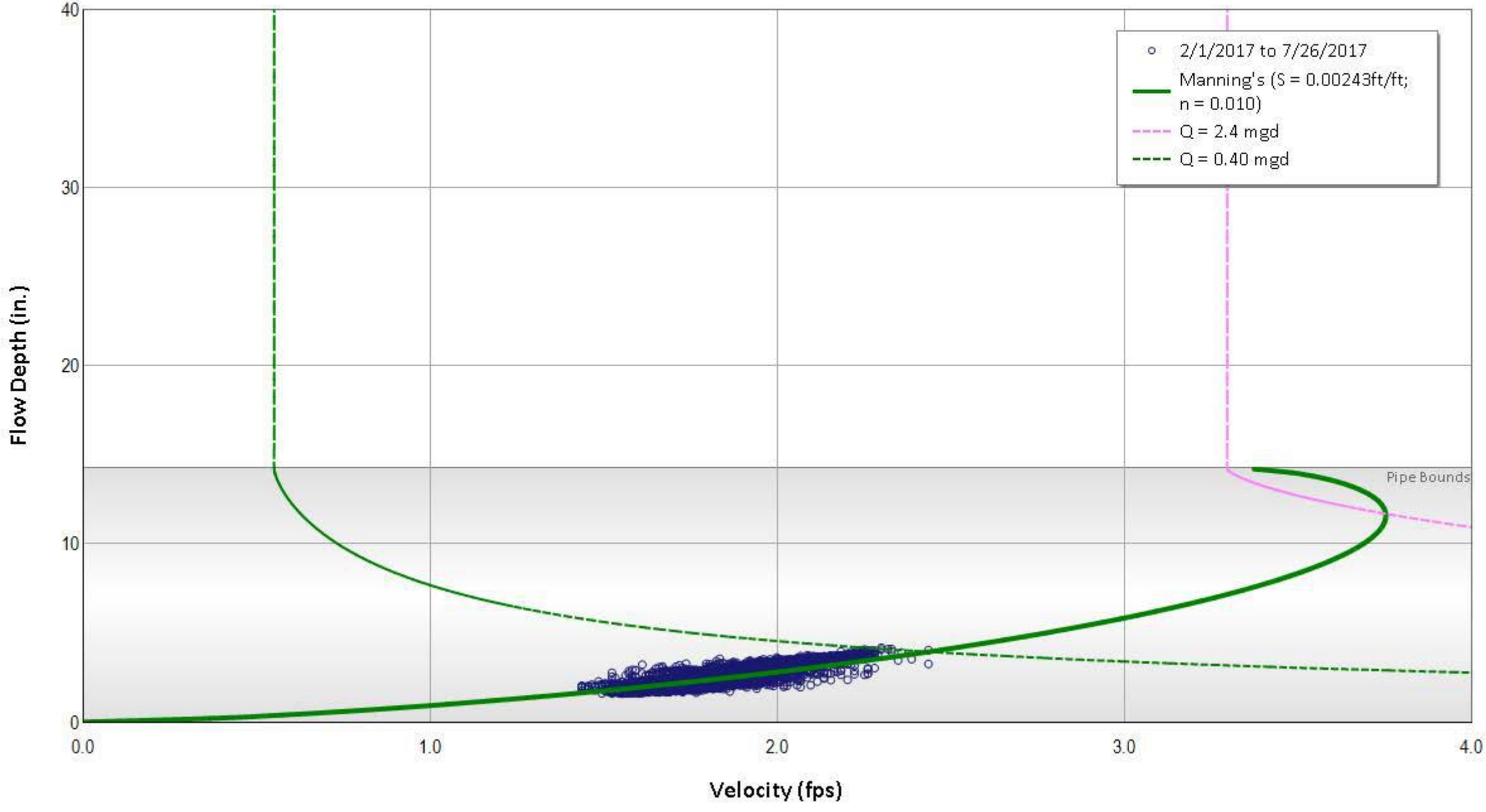
Scattergraph

Meter Site: BRD-11



Scattergraph

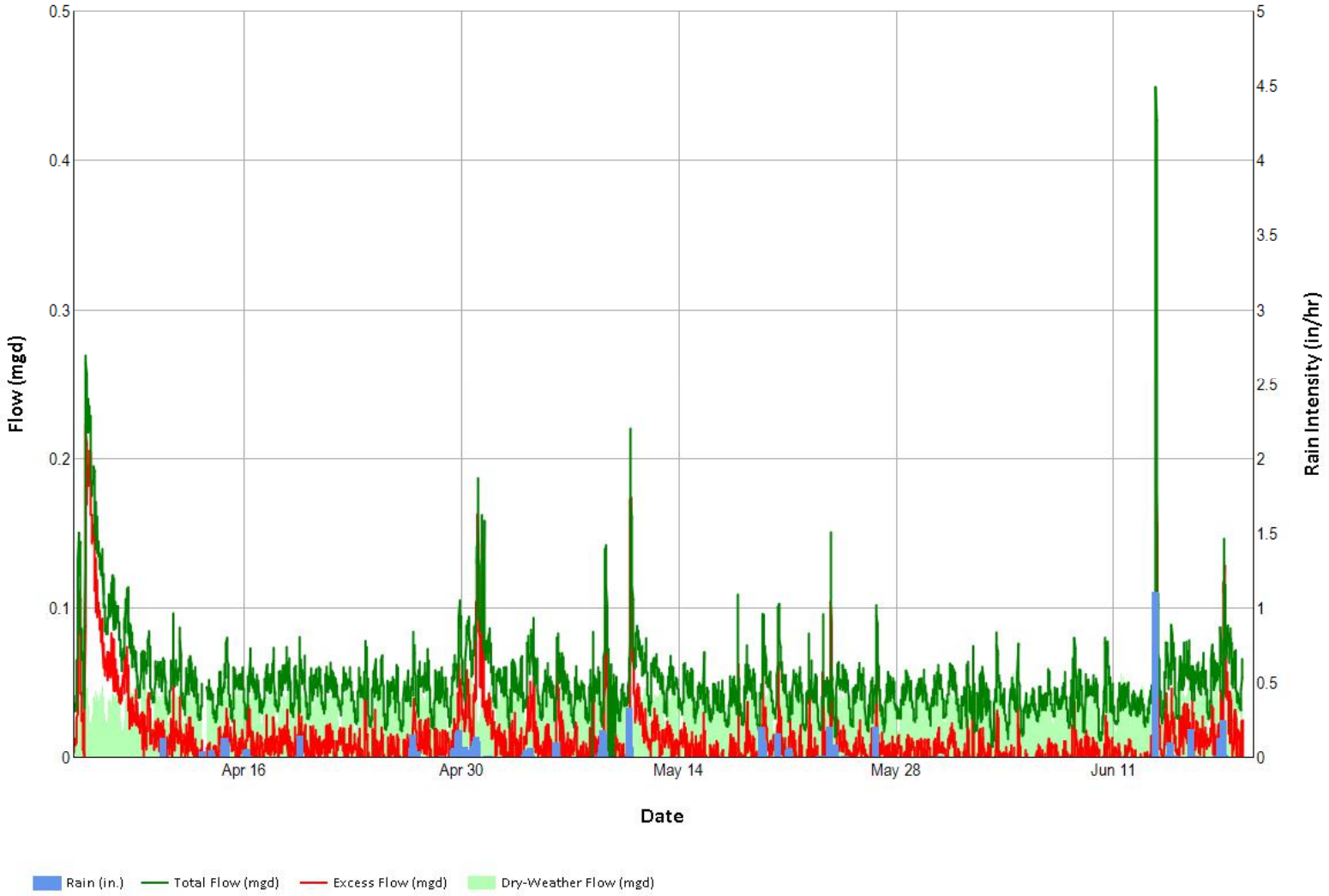
Meter Site: BRD-12



APPENDIX E – Hydrographs

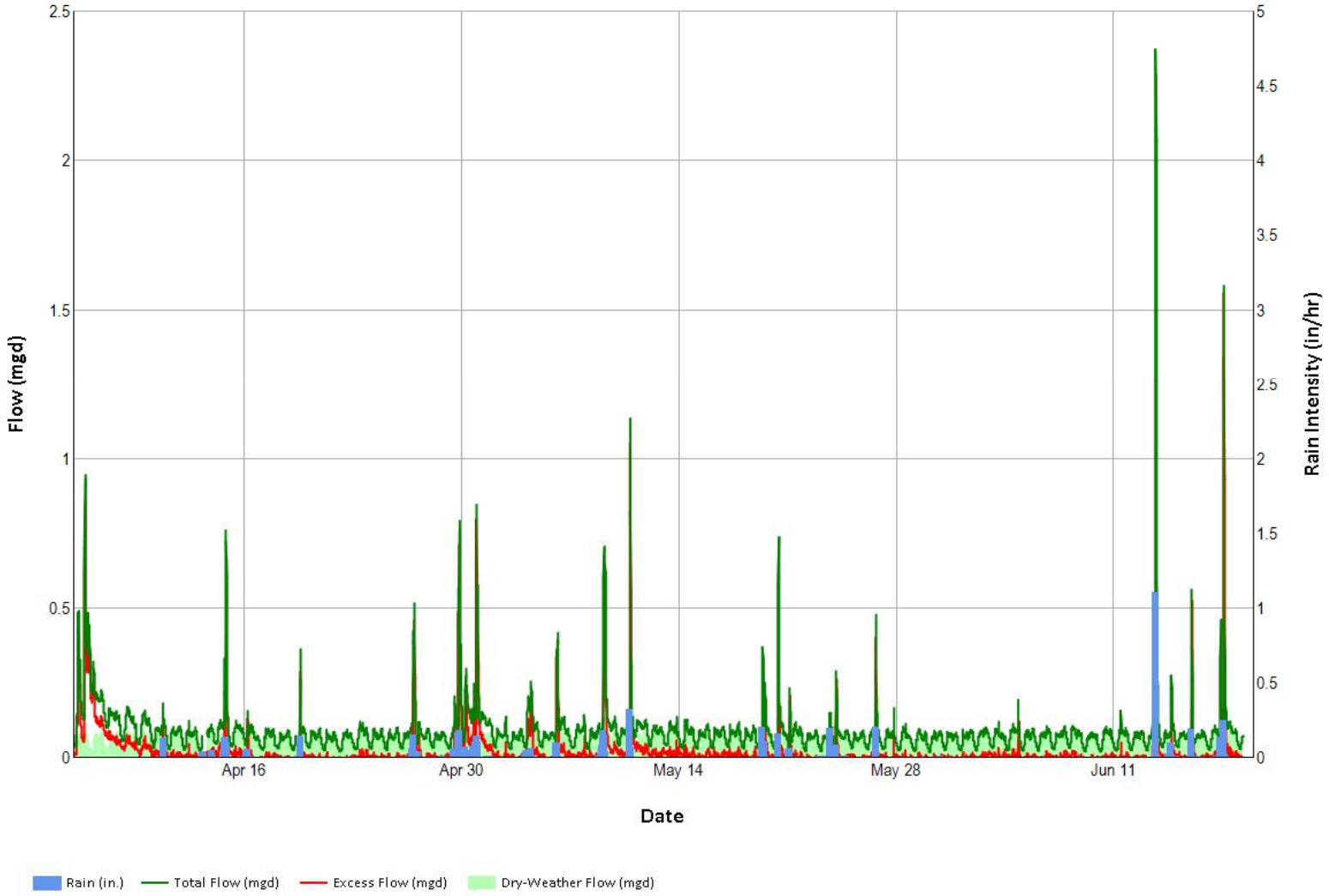
Metered Flow Hydrograph

Basin BRD-01



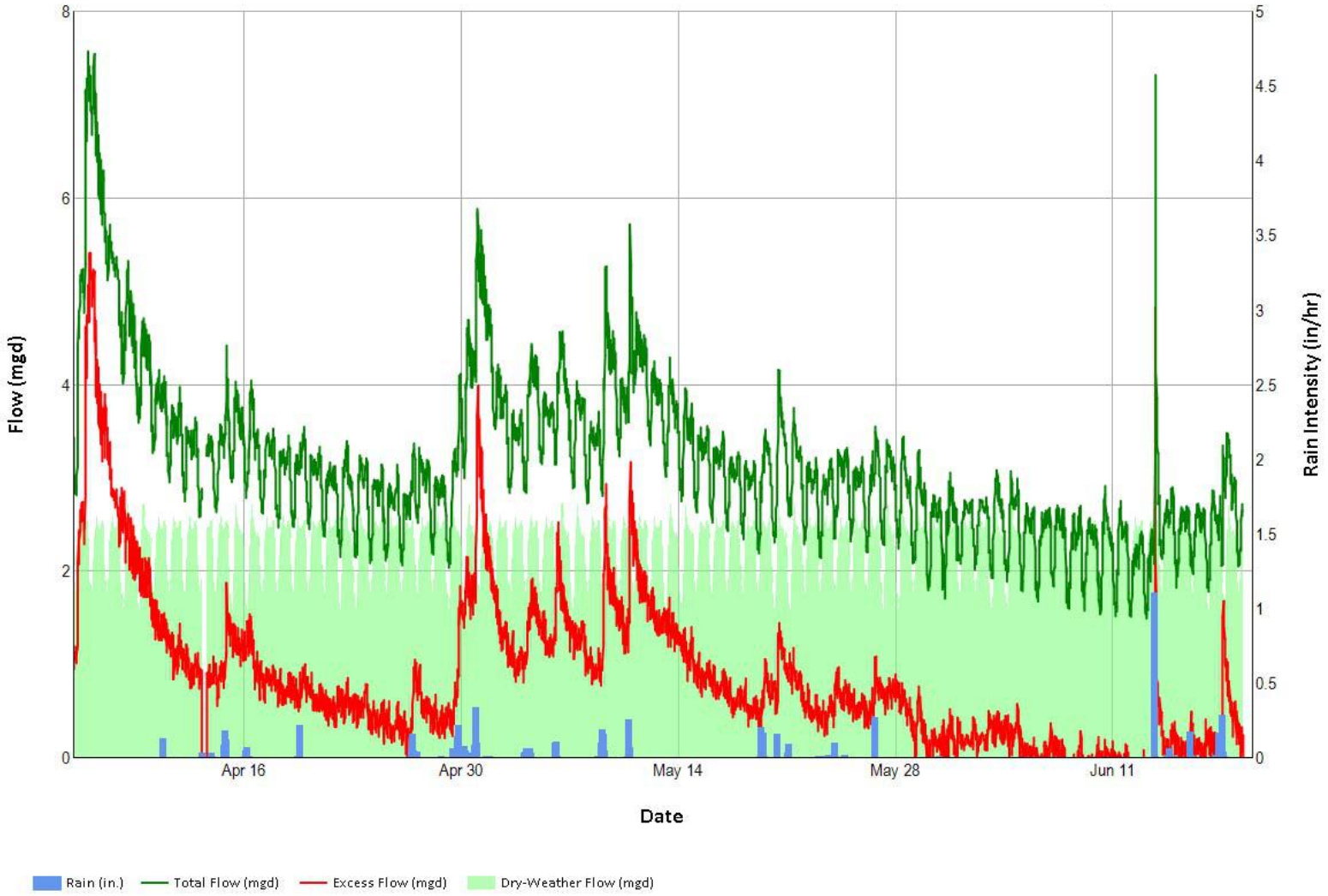
Metered Flow Hydrograph

Basin BRD-02



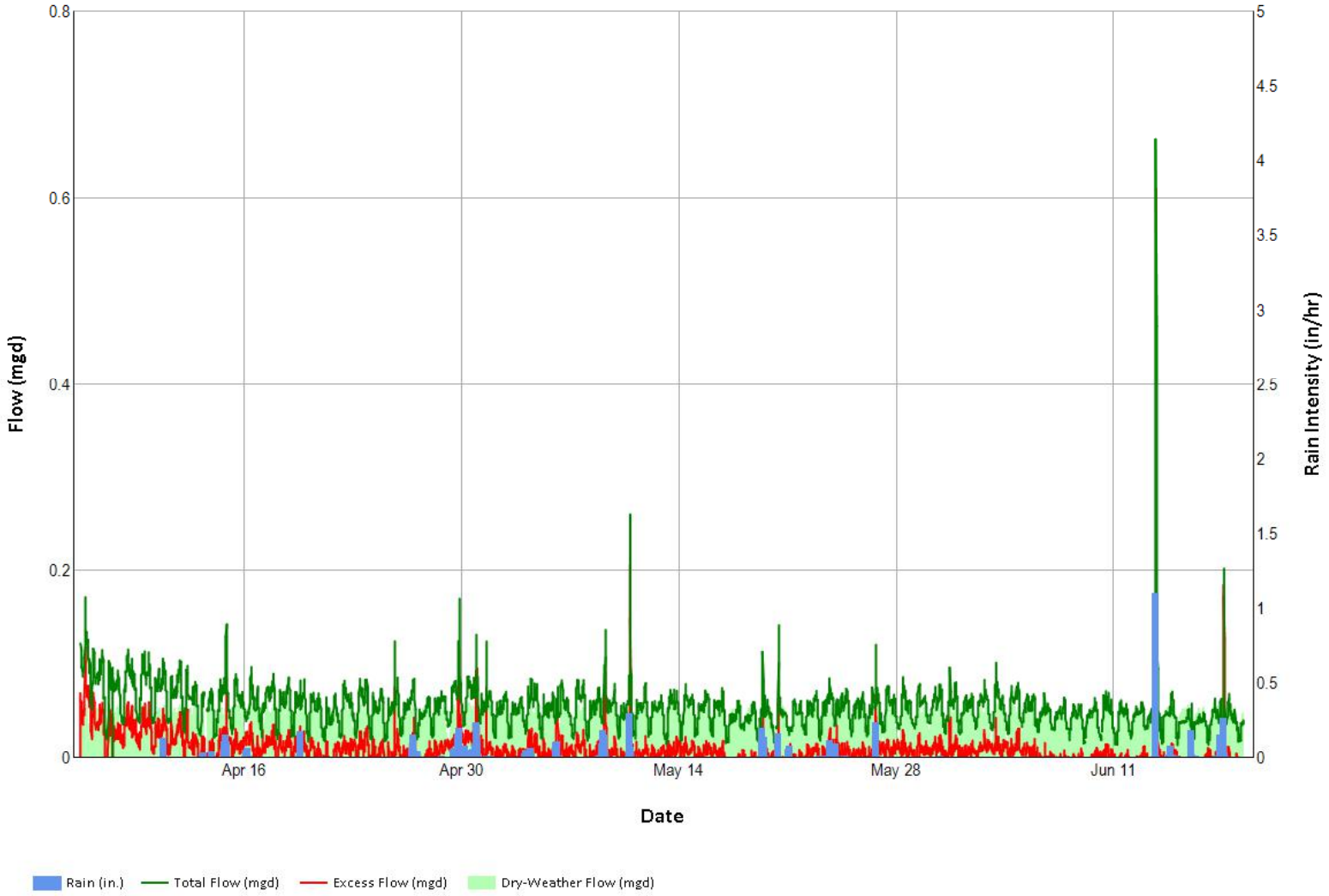
Metered Flow Hydrograph

Basin BRD-03



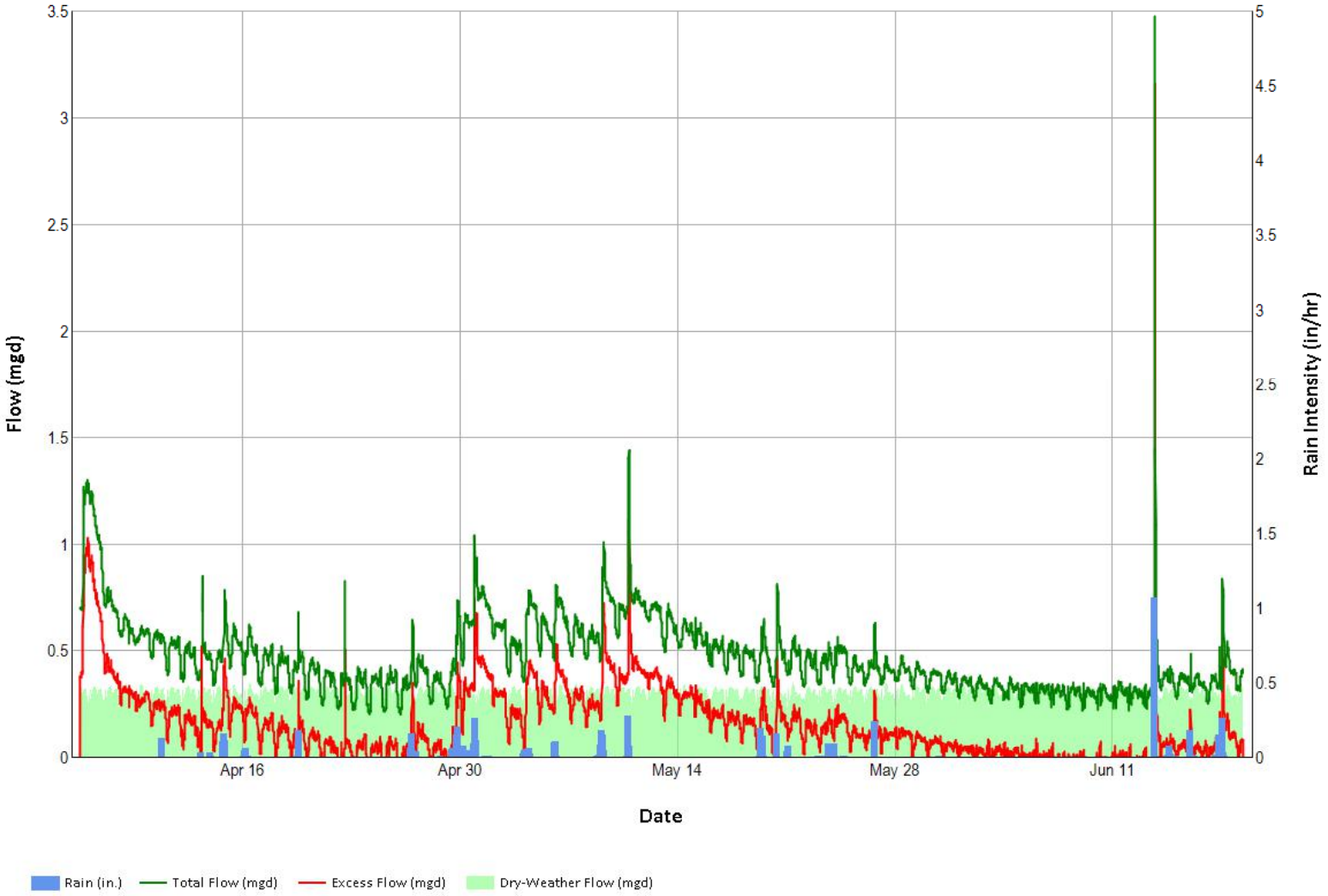
Metered Flow Hydrograph

Basin BRD-04



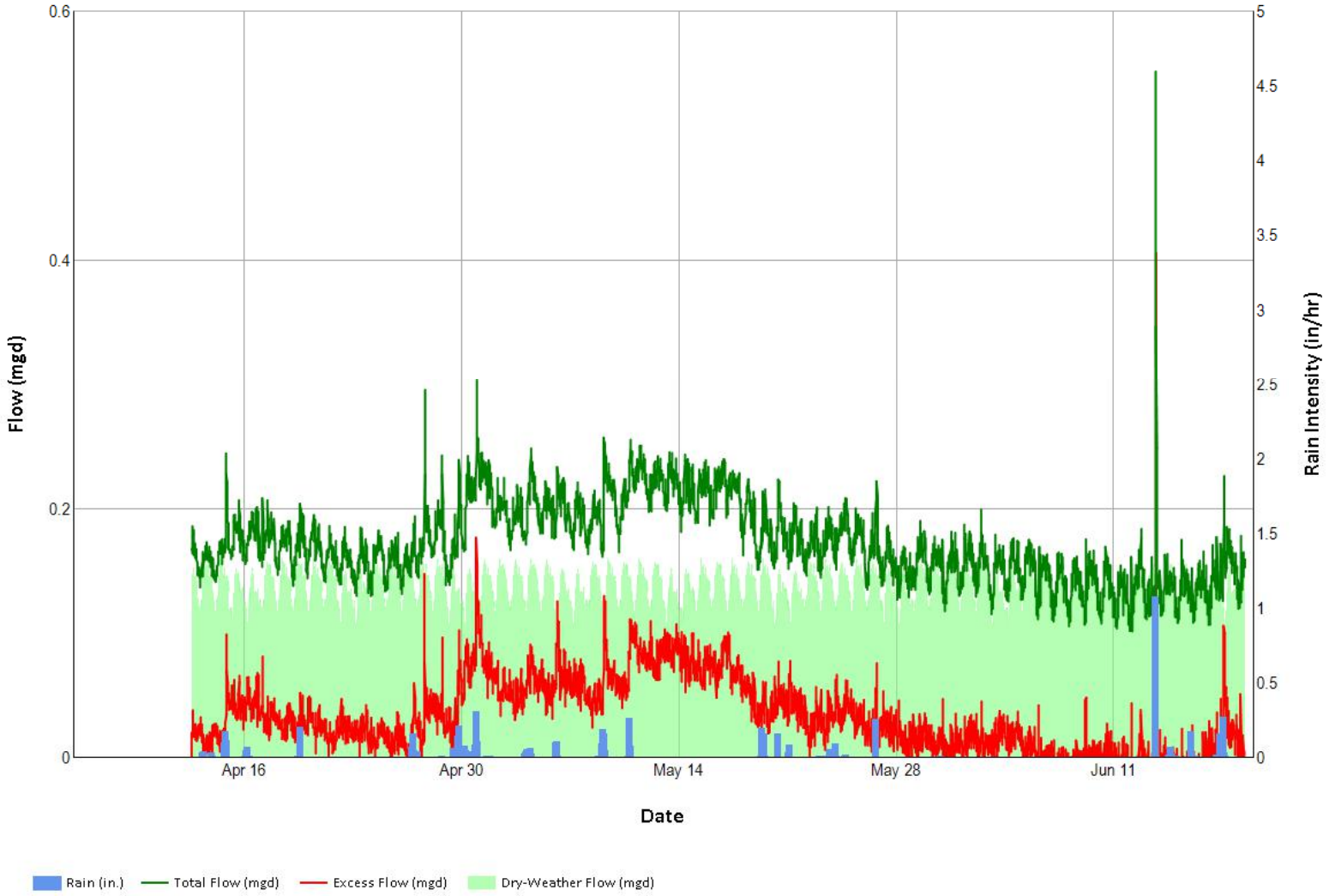
Metered Flow Hydrograph

Basin BRD-05



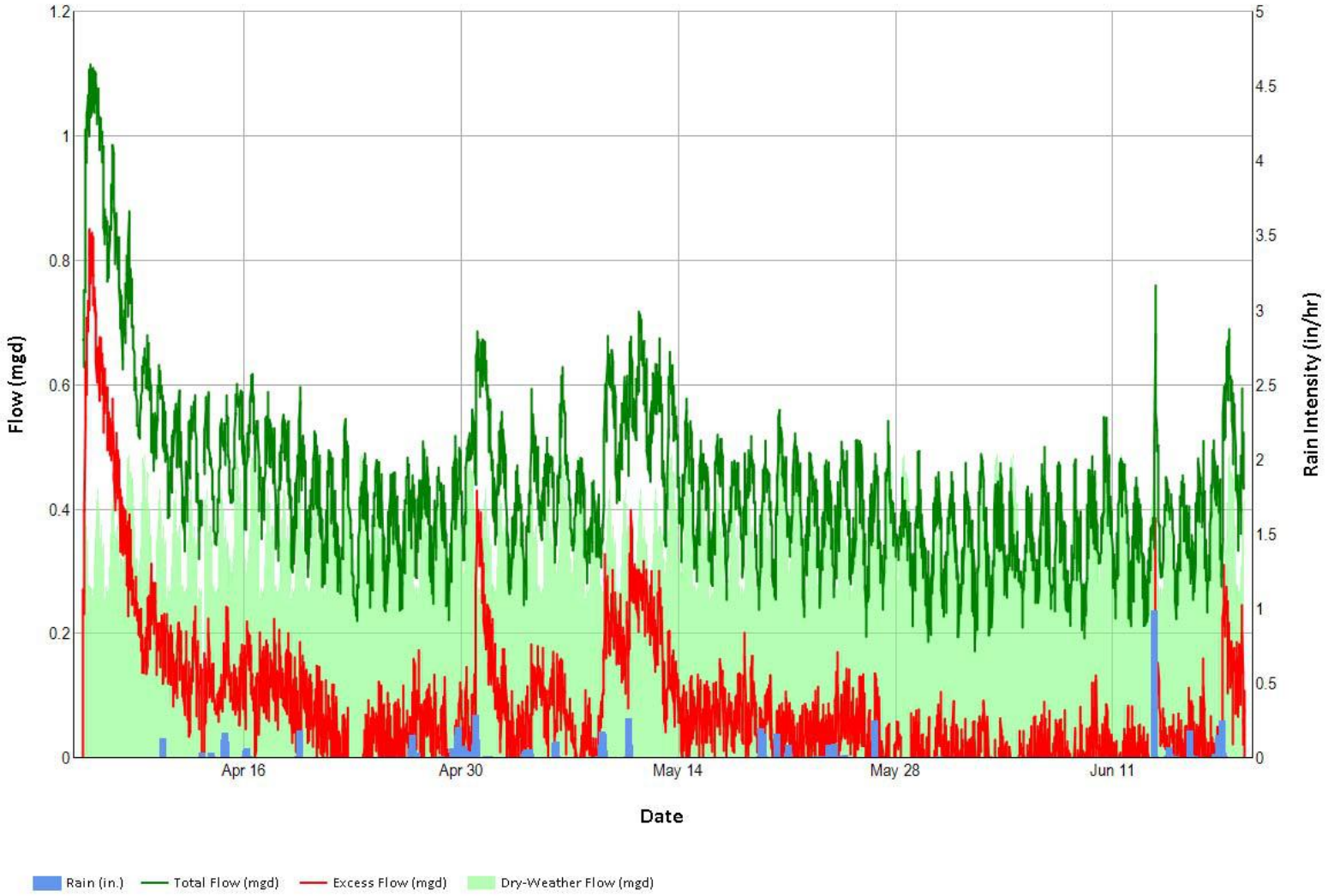
Metered Flow Hydrograph

Basin BRD-06



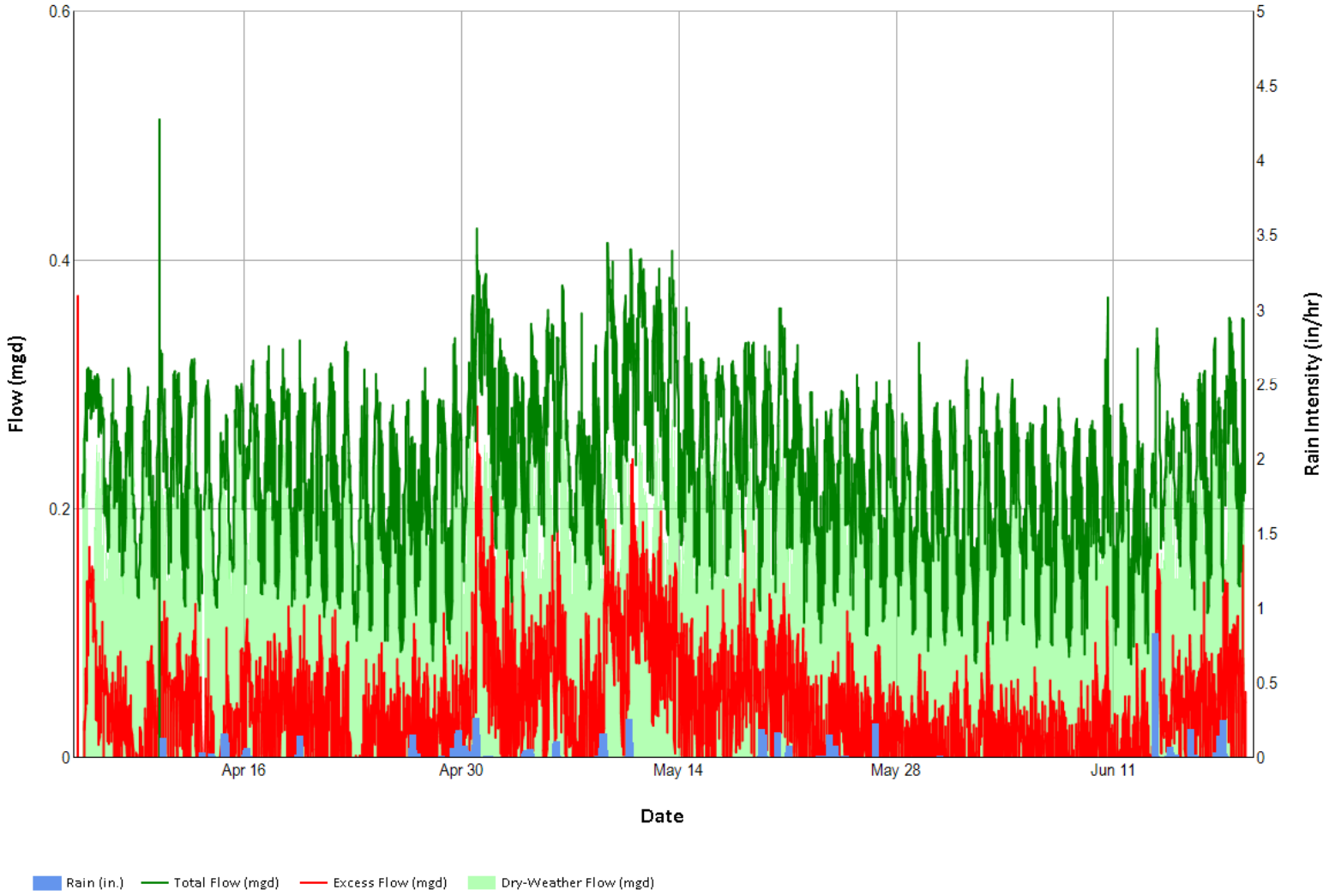
Metered Flow Hydrograph

Basin BRD-07



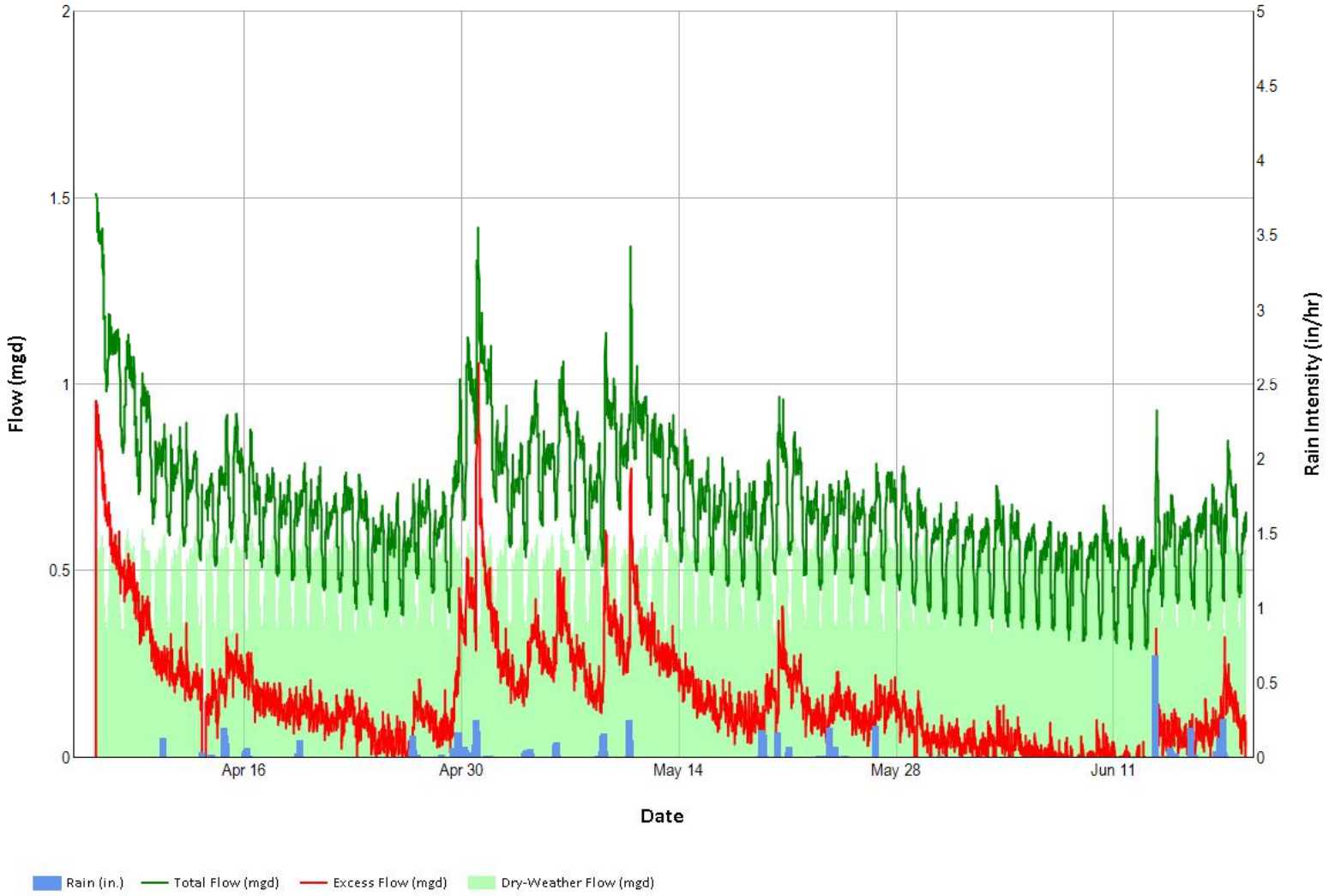
Metered Flow Hydrograph

Basin BRD-08



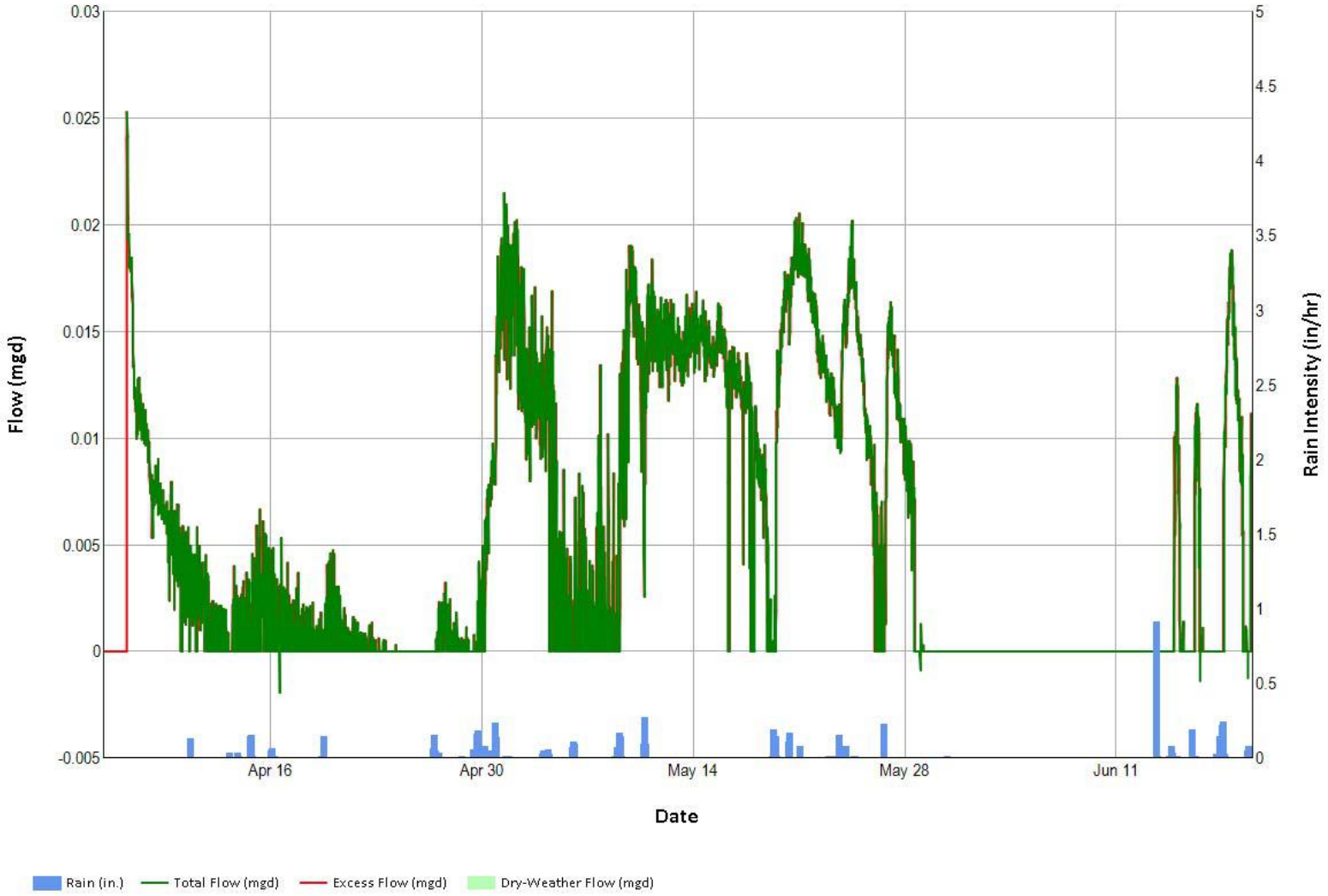
Metered Flow Hydrograph

Basin BRD-09



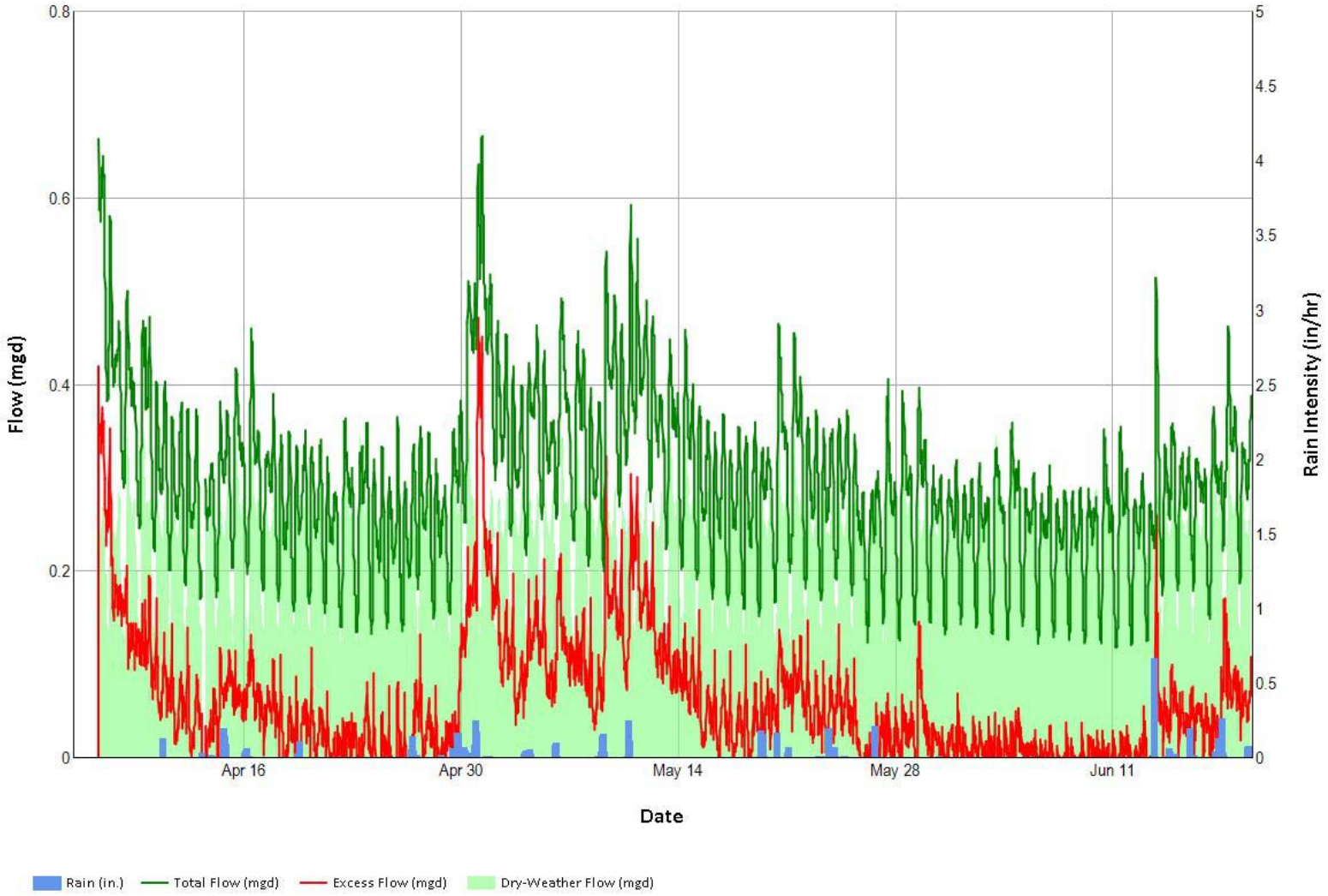
Metered Flow Hydrograph

Basin BRD-09A



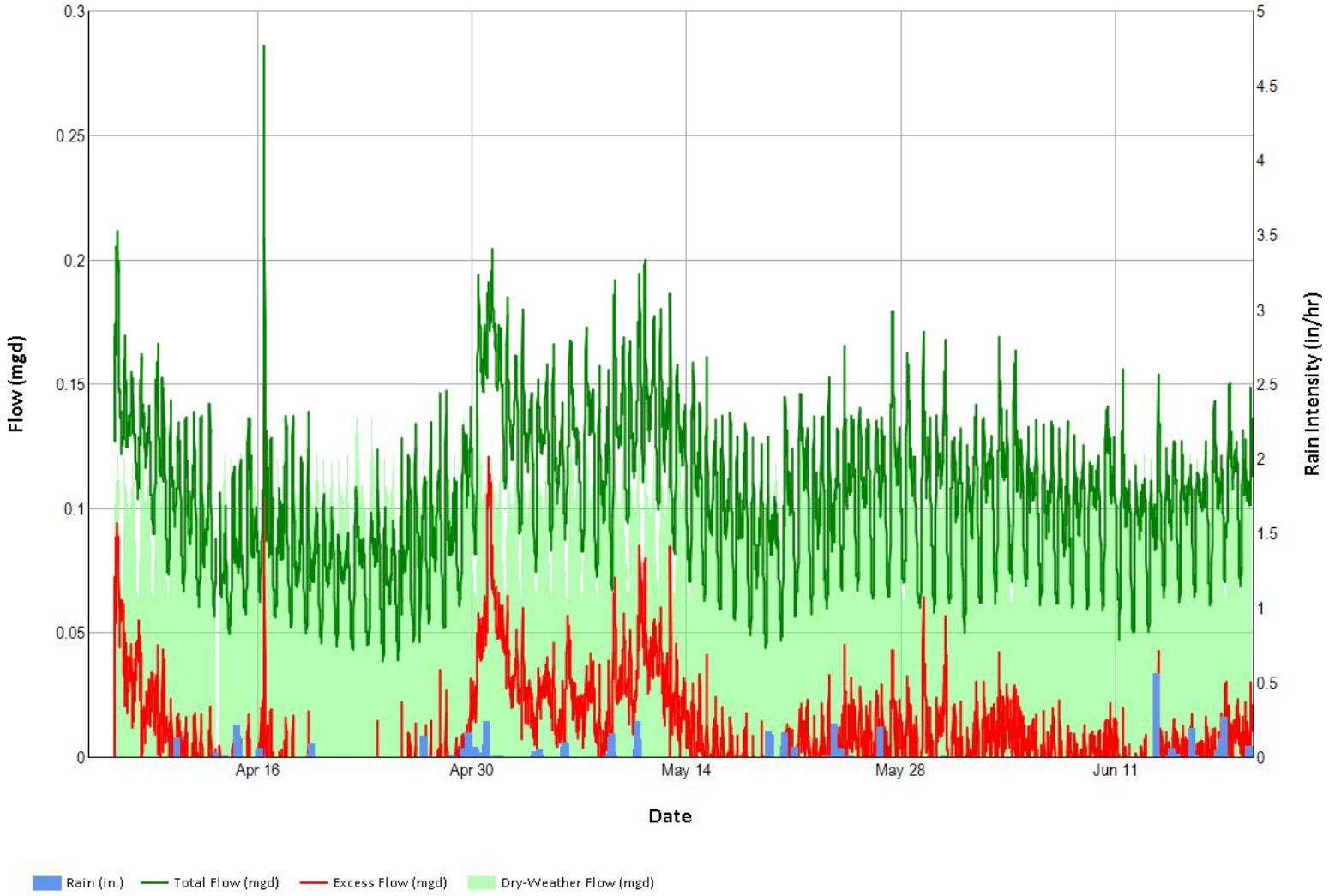
Metered Flow Hydrograph

Basin BRD-10



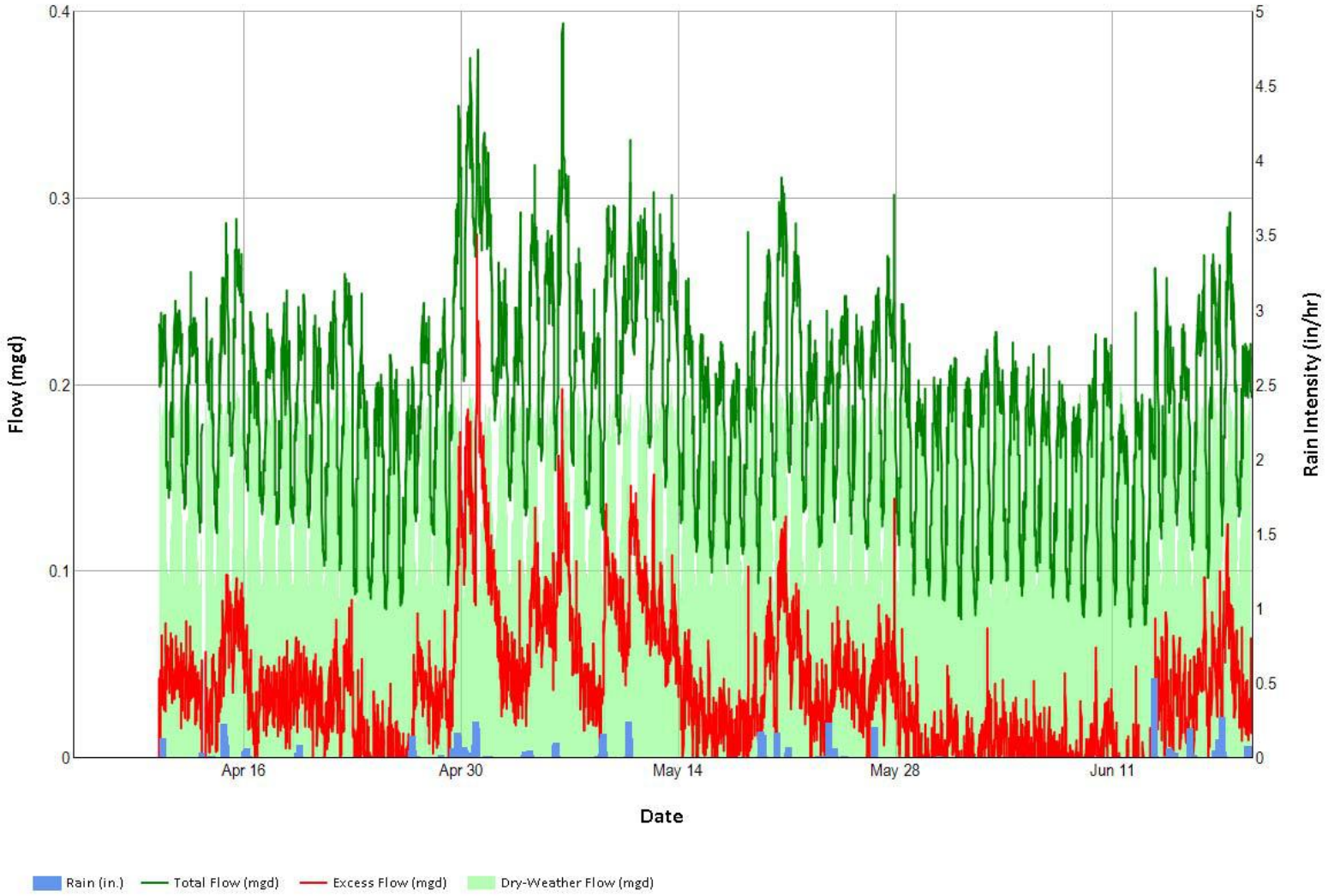
Metered Flow Hydrograph

Basin BRD-11



Metered Flow Hydrograph

Basin BRD-12



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