Sanitary Sewer System Management Plan Year 5 Evaluation

Niagara Falls Water Board
Niagara Falls, New York

February 2013

SANITARY SEWER SYSTEM MANAGEMENT PLAN YEAR 5 EVALUATION

NIAGARA FALLS WATER BOARD
NIAGARA FALLS, NEW YORK

Prepared for

NIAGARA FALLS WATER BOARD

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CHAPTER 1
INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

The Niagara Falls Water Board (NFWB) owns and maintains the sewer system within the City of Niagara Falls, NY. Approximately two thirds of the collection system is a combined system, collecting both sanitary sewerage and stormwater from residential, commercial and industrial sources for conveyance to and treatment at the wastewater treatment plant (WWTP) on Buffalo Avenue. The remaining one third, the LaSalle area, is served by separate sanitary and storm sewers. The sanitary flows from LaSalle are directed to the WWTP through the combined system.

The combined sewer area encompasses the northern, western and central portions of the City while the LaSalle area encompasses the eastern portions of the City. The total area serviced by the collection system is approximately 7,030 acres. Of this, approximately 4,630 acres have combined sewers, and the LaSalle area consists of approximately 2,400 acres served by separate sanitary and storm sewers. Figure 1-1 illustrates the combined and sanitary sewer areas.

The LaSalle separate sewer system is subdivided into 8 mini-systems as shown schematically on Figure 1-2. These mini-systems collect sanitary flow, which is eventually conveyed to the combined system through mini-system LS-G or mini-system LS-3.

In the LaSalle system, there are a total of 1,324 sanitary manholes, 293,498 linear feet of sanitary sewers and 5 lift stations. Each station conveys flows from one mini-system into a downstream mini-system.

1.2 BACKGROUND AND PURPOSE

During periods of wet weather, extraneous water enters the sanitary sewer system in the LaSalle area through groundwater infiltration via cracked or shifted pipes and manholes, surface runoff through manhole cover vents and through illegally connected downspouts from buildings, sump pumps and storm drains. This excess water, generally termed infiltration and inflow (I/I), during wet weather periodically causes flows in the system to be greater than the capacity of the sewers and pump stations. This condition can result in a sanitary sewer overflow (SSO) discharge event in order to avoid service back-ups.

In 2007, Parsons Corporation finalized a report entitled “Niagara Falls Water Board Sanitary Sewer System Management Plan” (Plan). The Plan was subsequently submitted to and approved by the New

York State Department of Environmental Conservation (NYSDEC). In 2009, the NFWB entered into an Order on Consent (Order) with the NYSDEC to monitor SSOs in the LaSalle area sanitary sewer system and implement a plan to mitigate SSO events in this area. The order is provided in Appendix A. The Order referenced the Detailed Work Plan presented in the 2007 Plan. The Work Plan is an 18–year, phased approach to rehabilitating, maintaining, monitoring and evaluating the LaSalle Sanitary System with Year 1 of the Work Plan commencing in 2008. By Year 18 (2025), the estimated cost to the NFWB for implementing the Work Plan is over $6.3 million (over $350,000 average cost per year), reported in year 2007 dollars.

Pursuant to the Order, the NFWB is required to provide verification of the effectiveness of SSO mitigation activities as detailed in the 2007 Plan. This effort includes the implementation of flow metering and analysis of collected data to determine the relative success of the various activities. The NFWB is currently in Year 5 of the Plan. The purpose of this document is to evaluate the effectiveness of the I/I corrective activities and to update the assessment of the sanitary sewer system's response to wet weather events. The evaluation contained in this document is being submitted as the Year 5 flowmetering and analysis required in the approved Work Plan.

In Year 1 through Year 4 of the Work Plan, the NFWB generally focused on sewer cleaning and root removal activities, as well as spot repairs and cutting of laterals found to be protruding into sewer mains. Work performed in Year 1 through Year 4 is summarized on Table 1-1. The major activities planned in Year 6 through year 10 include upgrading the Luick Avenue sewer, identifying and removing cross-connections between the sanitary and storm sewers, rehabilitating manholes and investigating private properties for illicit discharges from roof leaders, sump pumps, year drains, etc. Year 6 through Year 10 also includes some spot excavations and repairs. This Year 5 evaluation will determine if there are sufficient reasons to modify the approved plan of activities.

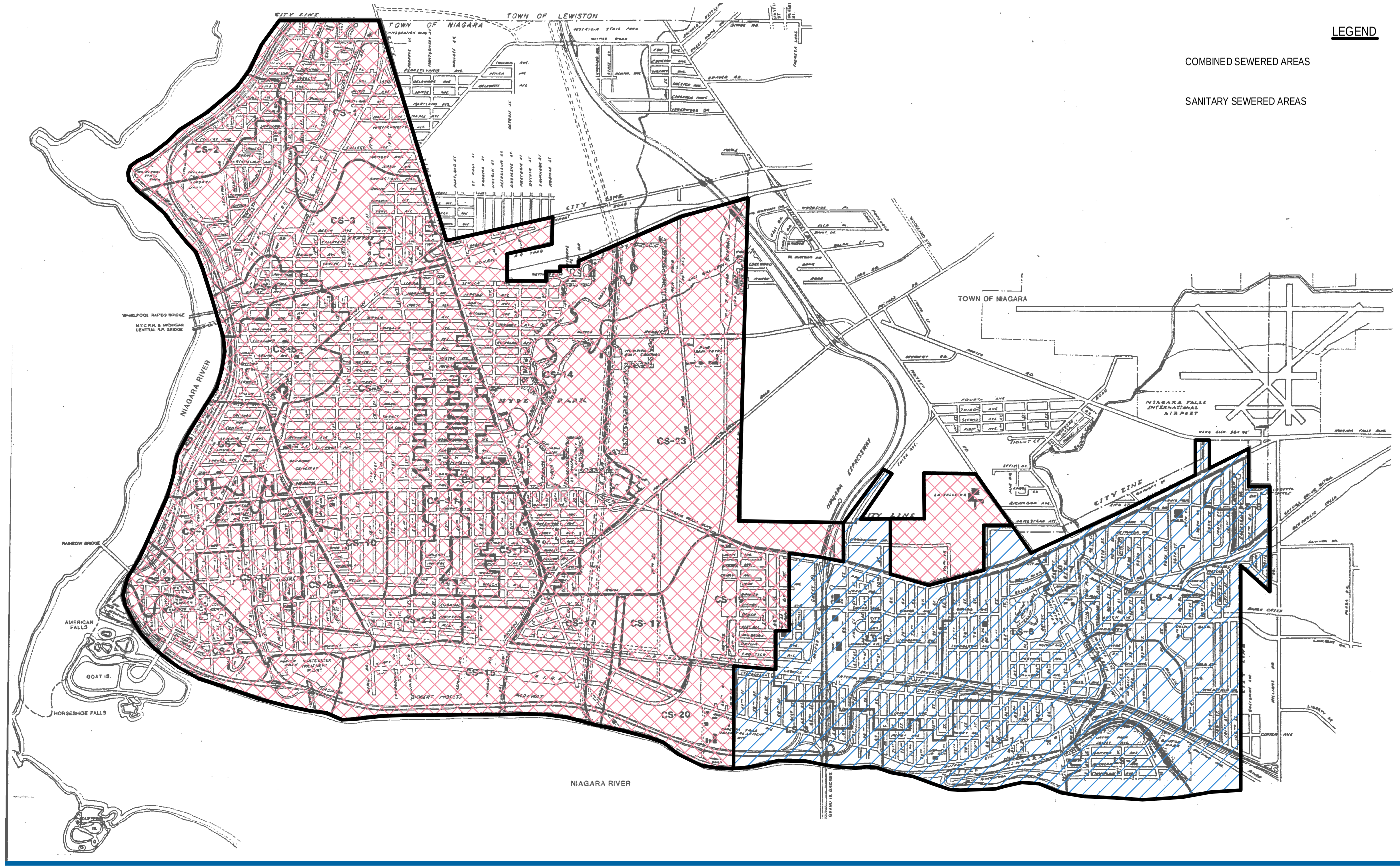
TABLE 1-1

NFWB LaSALLE YEAR 5 EVALUATION

YEAR 1 THROUGH YEAR 4 ACTIVITIES SUMMARY [1]

ACTIVITY	YEAR 1 (2008) AREAS	YEAR 2, 3, 4 (2009, 2010, 2011) AREAS
SEWER CLEANING	PASADENA, 101ST, 91ST	97TH, 99TH, 100TH, 101ST, 102ND, 103RD, 104TH
	76TH, 78TH, 79TH, 80TH	
	86TH, BOLLIER, MILITARY, 85TH, 78TH, 84TH, LAUGHLIN, PERSHING, 81ST	NIEMEL, BENJAMIN, CARAVELLE
	98TH, CAYUGA	
	75TH	
	82ND, 84TH, 87TH, MANG, MONSON, PERSHING, WITKOP	LORETTA, MARINE MEMORIAL
	92ND, CAYUGA, PERSHING	
	80TH, BUFFALO AVE, STEPHENSON, 85TH, TROY, 70TH, 71ST, 73RD 84TH, 86TH, 87TH	WEST RIVERSHORE
	61ST, 62ND, 65TH, 66TH, STEPHENSON, 67TH, 69TH, 70TH, 71ST, 72ND, 73RD	
ROOT TREATMENT	90TH, CREEKSIDE DR, OAK, 101ST, 96TH	97TH, 99TH, 100TH, 101ST, 102ND, 103RD, 104TH
	88TH, 93RD, 94TH, CAYUGA, 95TH, 98TH	
	78TH, 79TH, 80TH, STEPHENSON, 82ND, 70TH, 71ST, 72ND, 73RD, BUFFALO AVE, 77TH, 81ST, 83RD, 84TH, 85TH, 86TH	NIEMEL, BENJAMIN, CARAVELLE
	92ND, READ, PASADENA, 90TH, 91ST, 93RD, BUFFALO AVE, POINT	LORETTA, MARINE MEMORIAL
	68TH, 69TH, 70TH, 72ND, 73RD, 74TH, 75TH, 76TH	WEST RIVERSHORE
SPOT EXCAVATION AND REPAIR	90TH	100TH, DEURO, MUELLER, COLVIN
		94TH, 98TH, 99TH, CAYUGA
CUT PROTRUDING LATERALS	DEMUNDA, 94TH, CAYUGA, 97TH	N/A
	CREEKSIDE & LINDBERGH, 100TH, 102ND	
	70TH	
	79TH, 80TH, 85TH, BUFFALO AVE, 77TH, VALLE DR	
CROSS-CONNECTIONS	N/A	PASADENA, PEAR, 92ND, 91ST, 102ND, BROOKSIDE, 90TH, 93RD, DUERO DR, CREEKSIDE, MUELLER
		93RD, 89TH, 101ST, 97TH
SPOT CIPP	N/A	OAK, 100TH, COLVIN, GREENWALD, BLACK CREEK, DEURO
		CAYUGA, 93RD, 94TH, 100TH, 98TH
GROUT PIPE	N/A	93RD, 99TH, 100TH, 102ND
		97TH

(1) Per Table 4.2 in 2007 Management Plan



NIAGARA FALLS WATER BOARD
SANITARY SEWER SYSTEM
MANAGEMENT PROGRAM

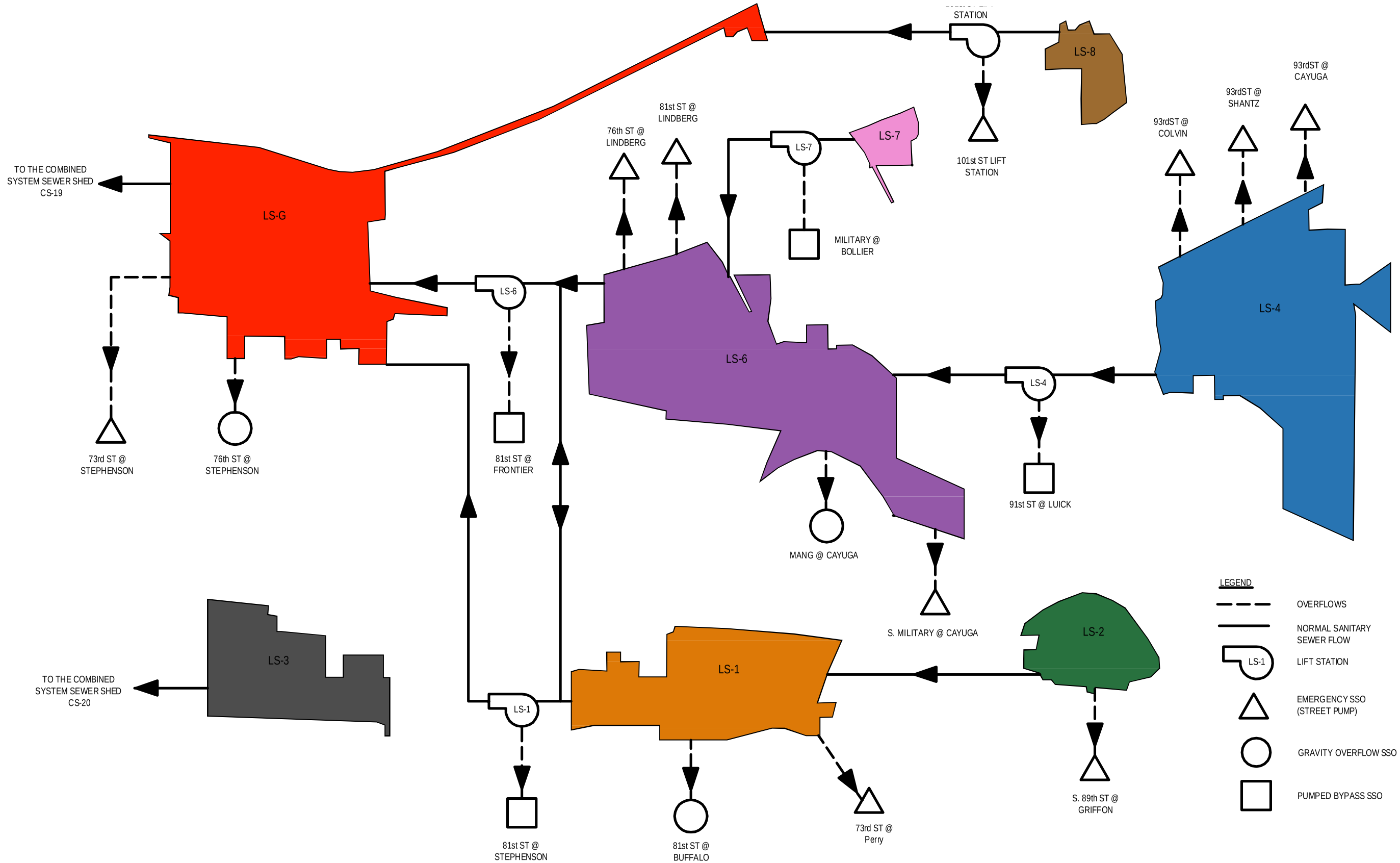
LASALLE YEAR 5 PROGRESS EVALUATION

Job Number	86-14883
Revision	A
Date	09 12

Figure 1-1

200 John James Audubon Parkway Suite 101, Amherst NY 14228 USA **T** 1 716 691 8503 **F** 1 716 691 8506 **E** amhmail@ghd.com **W** www.ghd.com

Plot Date: 25 September 2012 - 10:07 AM Cad File No: G:\86\14883\CADD\Drawings\YEAR 5 REPORT FIGURE 1-1.dwg



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NIAGARA FALLS WATER BOARD
SANITARY SEWER SYSTEM MANAGEMENT PROGRAM

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Figure 1-2

200 John James Audubon Parkway Suite 101, Amherst NY 14228 USA **T** 1 716 691 8503 **F** 1 716 691 8506 **E** amhmail@ghd.com **W** www.ghd.com

Plot Date: 25 September 2012 - 10:09 AM Cad File No: G:\86\14883\CADD\Drawings\YEAR 5 REPORT FIGURE 1-2.dwg

CHAPTER 2
COLLECTION SYSTEM MONITORING

2.1 FLOWMETER LOCATIONS

For the 2007 Plan, ten (10) in-system flowmeters were utilized to analyze the response of the sanitary sewers to various wet weather events. For this Year 5 evaluation, the same meter locations were utilized, with the intent of being able to directly compare two sets of data for similar locations. The goal was to compare the Year 5 data with the data obtained for the 2007 Plan to estimate the effectiveness of sewer system maintenance activities performed in Year 1 though Year 4.

To monitor flow and collect data to evaluate the sanitary sewer system, a total of ten (10) temporary, area-velocity type flowmeters were installed in manholes throughout the LaSalle area of the City. The flowmeters were in place from March 2012 through June 2012 and installed at the following locations:

- FM-01: 93rd Street, One Manhole South of Bergholtz Creek
- FM-02: 91st Street and Luick Avenue (immediately upstream of LS-4)
- FM-03: Frontier Avenue and 88th Street
- FM-04: 80th Street and Lindberg Avenue
- FM-05: 73rd Street and Girard Avenue
- FM-06: 66th Street and Frontier Avenue
- FM-07: 81st, flow from north of Frontier Avenue
- FM-70: Frontier Avenue, flow from east of 81st Street
- FM-08: 81st Street, flow from south of Stephenson Avenue
- FM-80: 81st Street, Crossover Pipe between mini-systems LS-1 and LS-6, beneath LaSalle Expressway.

Figure 2-1 provides a location map of all flowmeters.

2.2 RAIN GAUGE LOCATION

To collect rainfall volumes and intensities, one (1) temporary tipping bucket style rain gauge was installed during the flowmetering period. This data was used to help determine periods of dry weather and wet weather during the flow monitoring period of March 2012 through June 2012. The temporary rain gauge was located on the roof of Lift Sation LS-6, on Frontier Avenue at 81st Street. Rainfall data collected by the rain gauge was comparable to data collected at the Niagara Falls Airport over the same time period.

2.3 SUMMARY OF WET WEATHER EVENTS

A total of thirteen (13) wet weather events were experienced and recorded during the monitoring period of March 2012 through June 2012. The characteristics of the wet weather events, as recorded by the rain gauge, are presented in Table 2-1. Rainfall hyetographs for each event can be found in Appendix B.

TABLE 2-1

SUMMARY OF WET WEATHER EVENTS

Event Date	24-Hour Rainfall @ NF Airport (Inches)	24-Hour Rainfall @ LS-6 (Inches)	Peak Intensity (Inches/Hour)
March 3, 2012	0.09	0.10	0.12
March 8, 2012	0.37	0.35	0.12
March 24, 2012	0.54	0.58	0.16
April 1, 2012	0.40	0.34	0.24
April 11, 2012	0.02	0.04	0.12
April 15, 2012	0.12	0.14	0.12
April 23, 2012	1.73	1.52	0.16
April 30, 2012	0.53	0.52	0.28
May 8, 2012	1.52	1.86	0.72
June 1, 2012	0.63	0.66	0.36
June 3 - 4, 2012	0.29	0.30	0.36
June 9, 2102	0.09	0.14	0.12
June 12, 2012	0.31	0.32	0.36

2.4 FLOWMETER DATA

To measure flow, six (6) Hach 910 single sensor flowmeters and two (2) Hach 920 dual sensor flowmeters were installed in the manholes identified in Section 2.1. For each flowmeter, data were collected bi-weekly

over a four-month period from March 2012 through June 2012. Each area-velocity meter recorded depth of flow, velocity and flow rate. The data collected were used to determine the following:

- Dry Weather (Diurnal) Flow
- Wet Weather Flow
- Base Infiltration
- Wet Weather Infiltration/Inflow
- Wet Weather Peaking Factors

Appendix C provides a hydrograph of flow vs. time for all meter locations for each event identified in Table 2-1.

CHAPTER 3
DRY WEATHER FLOW ANALYSIS

3.1 DRY WEATHER FLOW AND BASE INFILTRATION

For the 2012 metering period a representative dry weather period occurred from May 22 through May 23. There were no wet weather events on or within several days of this representative period. The hydrographs of flow versus time for this representative dry weather period are provided in Appendix D.

Compared to the data used for the 2007 Plan, the Year 5 data showed generally lower dry weather flow. Total rainfall from 2012 was comparable to 2007, although rainfall intensity was lower. Although groundwater levels were not monitored for this project, it is likely that the groundwater table was depressed during the 2012 monitoring period, resulting in a lower base infiltration. In addition, the use of water saving plumbing fixtures (i.e. low flush toilets) has increased in recent years which may also contribute to decreased dry weather flows.

Base infiltration was defined as monitored dry weather flow, less the theoretical dry weather flow based on an assumed contribution of 80 gallons per day per capita (gpcd). The base infiltration represent non-sanitary flows in the system during dry weather which are attributable to extraneous infiltration through cracked pipes, shifted joints, etc. Table 3-1 summarizes the base infiltration for the two (2) monitoring periods.

TABLE 3-1

BASE INFILTRATION

Meter	Theoretical Dry Weather Flow (MGD) [1]	2007 Dry Weather Flow (MGD) [2]	2012 Dry Weather Flow (MGD) [3]	2007 Base Infiltration (MGD)	2012 Base Infiltration (MGD)
FM-01	0.132	0.221	0.106	0.089	-0.026
FM-02	0.273	0.365	0.475	0.092	0.202
FM-03	0.333	0.475	0.282	0.142	-0.051
FM-04	0.081	0.216	0.167	0.135	0.086
FM-05	0.691	1.372	0.701	0.681	0.01
FM-06	0.446	1.312	0.994	0.866	0.548
FM-07	0.224	0.459	0.236	0.235	0.012
FM-70	0.42	0.634	0.379	0.214	-0.041
FM-08	0.34	0.924	0.722	0.584	0.382

(1) As reported in 2007 Plan, based on 80 gpcd

(2) As metered for the 2007 Plan

(3) As metered during the representative dry weather period of May 22 through May 23, 2012

In three (3) instances (FM-01, FM-03 and FM-70), the 2012 base infiltration is less than the estimated dry weather sanitary flow at 80 gpcd.

CHAPTER 4
WET WEATHER FLOW ANALYSIS

4.1 PEAK FLOW ESTIMATION METHODOLOGY

A comprehensive flow monitoring study was conducted to separate and quantify the components within the various basins of the LaSalle area sanitary sewer system. Table 4-1 identifies the correlations between the subarea identification scheme used in this study and the scheme used in the 2007 Plan. Figure 4-1 shows the 2007 subareas and the Year 5 evaluation flowmeter locations.

TABLE 4-1

CORRELATION OF SUBAREAS

Metered Subarea	
YEAR 5 Evaluation (2012)	**Post Rehabilitation Flow Monitoring Assessment (2007)**
FM-01	A
FM-02	A + B
FM-03	A + B +C
FM-04	D
FM-05	A + B + C + D + E + F + G
FM-06	H + I
FM-07	D + E
FM-70	A + B + C + G
FM-08	I
FM-80	N/A

The relative amounts of I/I present in each designated subarea was quantified and compared to flow data obtained from the 2007 Plan. This task consisted of the following components:

- Installation of metering stations at the same locations as the 2007 Plan.
- Collection of flow and rainfall data over four-month period (March 2012 to June 2012)
- Analysis of the flow data to determine average flow, peak flow and to quantify I/I within the metered subareas.
- Comparison of Year 5 flow data to 2007 Plan.

- Analysis of I/I mitigation associated with Year 1 through Year 4 system improvements.
- Evaluation of additional flow reductions needed to achieve I/I abatement goals.

Flow data were collected and reviewed on a bi-weekly basis for a four-month period. The flow data were correlated with data obtained from the rain gauge. Utilizing the same analysis procedures that were accepted by NYSDEC on the NFWB's previous I/I studies, inflow for a one-year peak storm event (0.4 inches per hour) was determined. This was accomplished by plotting the peak wet weather flow as a function of rainfall intensity and developing a best-fit line to predict the relationship between rainfall intensity and peak flow by sewer subarea. Peak flow graphs for all flowmeters can be found in Appendix E.

The I/I data for each subarea was compared to 2007 peak flow data at a 0.4 inch per hour intensity storm. This comparison was used to estimate the amount of extraneous flow that has been abated through rehabilitation efforts. Table 4-2 shows the comparison between 2012 peak flows and 2007 peak flows and the estimated percent peak flow reduction.

TABLE 4-2

SUMMARY OF WET WEATHER I/I

2012 Meter	2012 Dry Weather Flow (MGD)	2012 I/I @ 0.4 in/hr (MGD)	2007 I/I @ 0.4 in/hr (MGD)	% Decrease (Increase) From 2007 - 2012
FM-01	0.106	1.34	0.60	(124%)
FM-02	0.475	2.41	1.98	(22%)
FM-03	0.282	1.96	2.11	7%
FM-04	0.167	0.86	0.48	(79%)
FM-05	0.701	3.60	4.49	20%
FM-06	0.994	2.62	1.98	(32%)
FM-07	0.236	1.76	1.46	(21%)
FM-70	0.379	2.34	2.57	9%
FM-08	0.722	2.28	1.78	(28%)

For numerous sites (FM-01, FM-02, FM-04, FM-06, FM-07 and FM-08), there was an increase in the predicted I/I at the design storm of 0.4 inches per hour based on the best-fit line analysis described previously. This may be attributed to lack of available rainfall data during the 2012 monitoring period. Only one (1) rainfall event had a peak intensity greater than the 0.4 inches per hour design event (May 8,

2012). Three (3) events had a peak intensity of 0.36 inches per hour, however the majority of events were significantly less intense than the design event. For the best-fit line analysis, the lack of events greater than the design event may have artificially skewed the best-fit line.

4.2 PEAKING FACTOR METHODOLOGY

Since the best-fit line methodology used to estimate peak I/I showed general locations with a higher wet weather flow in Year 5, it is difficult to estimate the effectiveness of I/I removal efforts in Year 1 through Year 4. Although the best-fit line methodology was the only approach utilized for the 2007 Plan, an alternate method of analyzing peaking factors was utilized for this Year 5 evaluation.

For each flowmeter, a dry weather diurnal hydrograph (flow vs. time) was generated. Data from May 22, 2012 through May 23, 2012 was utilized for developing the diurnal curves. During this time period no measurable rainfall events occurred. Also for each flowmeter, a hydrograph of each wet weather event was generated. The wet weather hydrographs were plotted on the same time scale as the dry weather diurnal curves, for a direct comparison of wet weather flow and dry weather flow. The rainfall hyetograph for each location was also plotted on the wet weather hydrographs. Hydrographs for all flowmeters can be found in Appendix F, including the wet weather and dry weather flows plotted on the same axis.

To quantify wet weather I/I, instantaneous peaking factors (ratio of wet weather flow to dry weather diurnal flow) were calculated for each wet weather event at each of the flowmeter locations. For each event, wet weather flow was compared to dry weather diurnal flow occuring. This comparison was used to characterize the LaSalle area's response to wet weather and to generally identify which subareas are most prone to I/I issues.

The criteria for determining the severity of I/I was based on the peaking factors. Table 4-3 presents the general criteria used for the most recent flowmetering. These criteria were used to evaluate the LaSalle area system.

TABLE 4-3
I/I SEVERITY LEVELS

Severity Level	Peaking Factor
Acceptable	Less than 2.5
Moderate	2.5 - 5.0
High	5.0 - 10.0
Extreme	Greater Than 10.0

Based on the instantaneous peaking factor severity levels presented in Table 4-3, the severity of I/I upstream of each flowmeter is presented in Table 4-4.

TABLE 4-4
INSTANTANEOUS PEAKING FACTOR SUMMARY

Flowmeter #		01	02	03	04	05	06	07	08	70
Instantaneous Peaking Factor	3/3/2012	3.19	1.57	3.85	2.11	2.44	1.58	2.78	1.67	2.61
	3/8/2012	4.23	3.19	6.02	2.69	4.62	2.27	7.74	2.43	5.17
	3/24/2012	7.72	3.52	3.98	3.37	4.23	2.05	5.19	2.60	3.81
	4/1/2012	7.16	6.16	6.02	3.13	4.95	2.65	7.90	2.77	6.35
	4/11/2012	3.55	2.44	2.32	1.17	1.88	7.21	1.71	1.16	2.44
	4/15/2012	3.74	2.56	3.69	1.32	2.86	1.48	3.41	1.78	3.27
	4/23/2012	41.57	10.65	10.28	19.57	6.39	4.57	11.31	5.38	22.97
	4/30/2012	8.16	2.21	4.79	5.67	5.17	3.17	7.49	3.16	4.99
	5/8/2012	5.33	16.34	10.56	7.97	11.70	5.71	12.15	8.52	11.29
	6/1/2012	8.67	2.62	3.73	3.69	4.31	2.87	5.13	3.05	3.50
	6/3/12 to 6/4/12	6.59	3.09	4.43	4.26	3.96	2.38	6.08	3.12	4.48
	6/9/2012	4.71	1.92	2.27	1.57	2.20	1.43	2.54	1.36	2.60
	6/12/2012	13.00	7.96	16.25	12.72	8.72	3.31	13.24	4.04	9.68
	Average	**9.05**	**4.94**	**6.01**	**5.33**	**4.88**	**3.13**	**6.67**	**3.16**	**6.40**

Following the calculation of the instantaneous peaking factors, a volumetric peaking factor was calculated for each meter during each event. The volumetric peaking factor was defined as the volume of flow recorded by the meter during a 48-hour period during wet weather compared to the volume of flow recorded by the meter during the representative dry weather period from May 22, 2012 through May 23, 2012. The volumetric peaking factors are summarized in Table 4-5.

TABLE 4-5

VOLUMETRIC PEAKING FACTOR SUMMARY

Flowmeter #		01	02	03	04	05	06	07	08	70
Volumeteric Peaking Factor	3/3/2012	1.69	1.11	1.95	1.74	1.86	1.28	2.00	1.24	1.91
	3/8/2012	1.65	1.49	2.66	2.37	2.39	1.35	2.81	1.35	2.50
	3/24/2012	2.28	1.34	2.35	1.61	2.20	1.36	2.50	1.28	2.32
	4/1/2012	2.18	1.35	2.27	1.51	2.05	1.59	2.17	1.22	2.24
	4/11/2012	1.00	0.69	1.18	1.07	1.10	1.56	1.05	0.92	1.17
	4/15/2012	1.25	0.82	1.34	1.35	1.23	1.22	1.21	0.96	1.29
	4/23/2012	11.43	3.27	7.55	4.13	4.85	2.87	6.57	3.07	7.38
	4/30/2012	2.38	0.50	2.60	1.79	2.24	1.56	2.39	1.40	2.64
	5/8/2012	9.00	4.93	6.61	3.63	4.69	3.11	2.33	3.07	6.39
	6/1/2012	1.79	1.43	1.79	1.38	1.60	1.21	1.27	1.10	1.85
	6/3/12 to 6/4/12	1.45	1.39	1.38	1.26	1.21	1.06	1.38	0.94	1.53
	6/9/2012	1.31	1.04	1.09	1.09	0.98	0.92	0.94	0.82	1.22
	6/12/2012	1.41	1.25	1.28	1.18	1.28	0.99	0.89	0.91	1.41
	Average	**2.99**	**1.59**	**2.62**	**1.85**	**2.13**	**1.54**	**2.12**	**1.41**	**2.60**

4.3 VOLUMETRIC COMPARISON METHODOLOGY

Since there were limitations with the best-fit line approach to estimating I/I at the design storm presented in Section 4.1, and since the peaking factor methodology presented in Section 4.2 was not utilized in the 2007 Plan, a third methodology was utilized as a means of comparing 2007 data with Year 5 data. This methodology, a volumetric comparison, is based on comparing metered data during similar wet weather events. Upon review of the wet weather events during the 2007 Plan monitoring period and the more recent Year 5 monitoring period, the two (2) most similar events appear to be July 21, 2003 and June 1, 2012. The characteristics of these events are presented in Table 4-6.

TABLE 4-6

SUMMARY OF RAIN EVENTS

Event Date	Total Rainfall (Inches)	Duration of Rain Event (Hours)	Peak Intensity (Inches/Hour)	Average Intensity (Inches/Hour)
July 21, 2003	0.70	13.3	0.41	0.05
June 1, 2012	0.66	15.3	0.36	0.04

As suggested by the data in Table 4-6, the July 21, 2003 and June 1, 2012 events were similar on a total rainfall, duration, and peak and average intensity basis. The volumetric comparison methodology compared the total volume recorded by each meter for each event. Since the two (2) events have similar characteristics, the volumes recorded by each meter are directly comparable as a means of evaluating the differences in system response between the 2007 plan period and the more recent Year 5 period.

The recorded volume at each meter during the 48-hours centered around the wet weather event was calculated for each of the two (2) events. These volumes are presented in Table 4-7.

TABLE 4-7

SUMMARY OF 48-HOUR FLOW VOLUMES

Meter	48-Hour Flow Volume on 7/21/03 (MG)	48-Hour Flow Volume on 6/1/2012 (MG)	% Decrease (Increase)
FM-01	N/A – Meter Error	0.38	N/A
FM-02	N/A	1.35	N/A
FM-03	1.14	1.01	12%
FM-04	0.34	0.46	(36%)
FM-05	1.50	2.24	(49%)
FM-06	2.10	2.41	(15%)
FM-07	0.82	0.60	27%
FM-70	1.56	1.40	10%
FM-08	1.98	1.59	19%
FM-80	N/A	N/A	N/A

As with other methods of analyzing wet weather flow conditions, the data in Table 4-7 suggest that it is difficult to compare the two monitoring periods for a similar rain event based on flow volume.

In addition to comparing the volume of flow for each meter for the two (2) wet weather events, the instantaneous peaking factor and volumetric peaking factor at each meter were also compared. A summary of the peaking factors for the two (2) similar wet weather events are presented in Table 4-8 and Table 4-9.

TABLE 4-8

SUMMARY OF WET WEATHER INSTANTANEOUS PEAKING FACTORS

Flowmeter #	Instantaneous Peaking Factor on 7/21/03	Instantaneous Peaking Factor on 6/1/12
FM-01	N/A	8.67
FM-02	4.24	2.62
FM-03	3.76	3.73
FM-04	5.31	3.69
FM-05	4.13	4.31
FM-06	3.24	2.87
FM-07	4.26	5.13
FM-08	3.30	3.05
FM-70	3.92	3.50
FM-80	N/A	N/A
Average	**4.02**	**4.17**

TABLE 4-9

SUMMARY OF WET WEATHER VOLUMETRIC PEAKING FACTORS

Flowmeter #	Volumetric Peaking Factor on 7/21/03	Volumetric Peaking Factor on 6/1/12
FM-01	N/A	1.79
FM-02	N/A	1.43
FM-03	1.36	1.79
FM-04	1.65	1.38
FM-05	0.81	1.60
FM-06	1.24	1.21
FM-07	1.34	1.27
FM-08	1.35	1.10
FM-70	1.37	1.85
FM-80	N/A	N/A
Average	**1.30**	**1.49**

The peaking factors summarized in Tables 4-8 and 4-9 suggest that for a similar wet weather event, the flow in the system generally has remained the same from the 2007 Plan to the Year 5 monitoring period. The average instantaneous and volumetric peaking factors across the system were similar for both monitoring periods.

CHAPTER 5
SANITARY SEWER SYSTEM MANAGEMENT WORKPLAN

5.1 PLANNED WORK FOR YEAR 6 THROUGH YEAR 10

The 2007 Plan prioritized several projects to occur in Year 6 through Year 10 of the Workplan. These projects generally included upgrading the sewer on Luick Avenue, identifying and removing cross connections, spot repairs, and manhole rehabilitation. In addition "Subarea D" (Tributary to Lindberg Avenue, west of 81st Street), was targeted for a pilot program for private property I/I investigations.

The general goal of this Year 5 evaluation is to review the 2007 Plan and determine if work originally scheduled for Year 6 through Year 10 should remain the highest priority. Based on a review of dry weather and wet weather flow data obtained for this evaluation (as described in Chapters 3 and 4) there is no quantitative or qualitative evidence to justify reprioritization of the original Plan. The 2012 data are generally inconclusive when it comes to comparing the 2007 wet weather flows with the 2012 wet weather flows.

The work originally scheduled for Years 6 through 10 should proceed as scheduled. In recent years, the NYSDEC has been advocating for identification and removal of I/I sources prior to proceeding with large capital projects. Regardless of the 2012 flowmetering results, it is likely that private property I/I investigations would have remained the highest priority from a regulatory point of view. The spot repairs, manhole rehabilitations, and cross connection removal efforts in Years 6 through 10 will decrease I/I in the system. The Luick Avenue sewer has known hydraulic issues during wet weather, and should remain a priority.

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

1. The NFWB has maintained a proactive schedule to mitigate SSOs in the LaSalle Area. Activities aimed at improving the collection system and lessening the sanitary sewers wet weather response have been undertaken and reported to the NYSDEC annually, as required.

2. This report has been prepared in accordance with the schedule for Year 5 of the Plan, and includes an analysis of flowmeter data to determine the potential need to reprioritize Years 6 through 10 of the Plan.

3. Temporary in-system flowmeters were installed in the spring of 2012 at the same locations utilized for the preparation of the 2007 Plan.

4. Several methods were used to compare flowmetering data obtained for this Year 5 report to flowmetering data obtained in the preparation of the 2007 Plan. These methods included:

    a. Comparison of dry weather flow in the system to theoretical dry weather sanitary flow to estimate base infiltration.

    b. A “best-fit” line analysis of peak flow versus rainfall intensity to estimate I/I at the design storm (0.4 inches per hour).

    c. Peaking factor analysis to compare:

        i. Instantaneous peaking factors

        ii. 48-hour volumetric peaking factors

    d. Analysis of similar rainfall events, to compare the volume of flow recorded by each meter for an event during the 2007 Plan preparation to a similar rainfall event during the 2012 Year 5 monitoring period.

5. For all methods of analysis, it was difficult to make general conclusions of wet weather flows between the two monitoring periods. The 2012 monitoring period was conducted during historically low dry weather conditions. Although groundwater monitoring was not included as part

of this project, it is likely that the groundwater table was depressed during the 2012 monitoring period resulting in lower than expected base infiltration.

6.2 RECOMMENDATIONS

1. Since the 2012 data does not suggest any significant changes to the system's response to wet weather events as a result of Year 1 through Year 4 activities, the Year 6 through 10 activities should proceed as originally scheduled.

APPENDIX A: Order on Consent (Schedule A)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Niagara Falls Water Board

SCHEDULE A

I. The above referenced Respondent shall, on or before the date indicated, perform the following items:

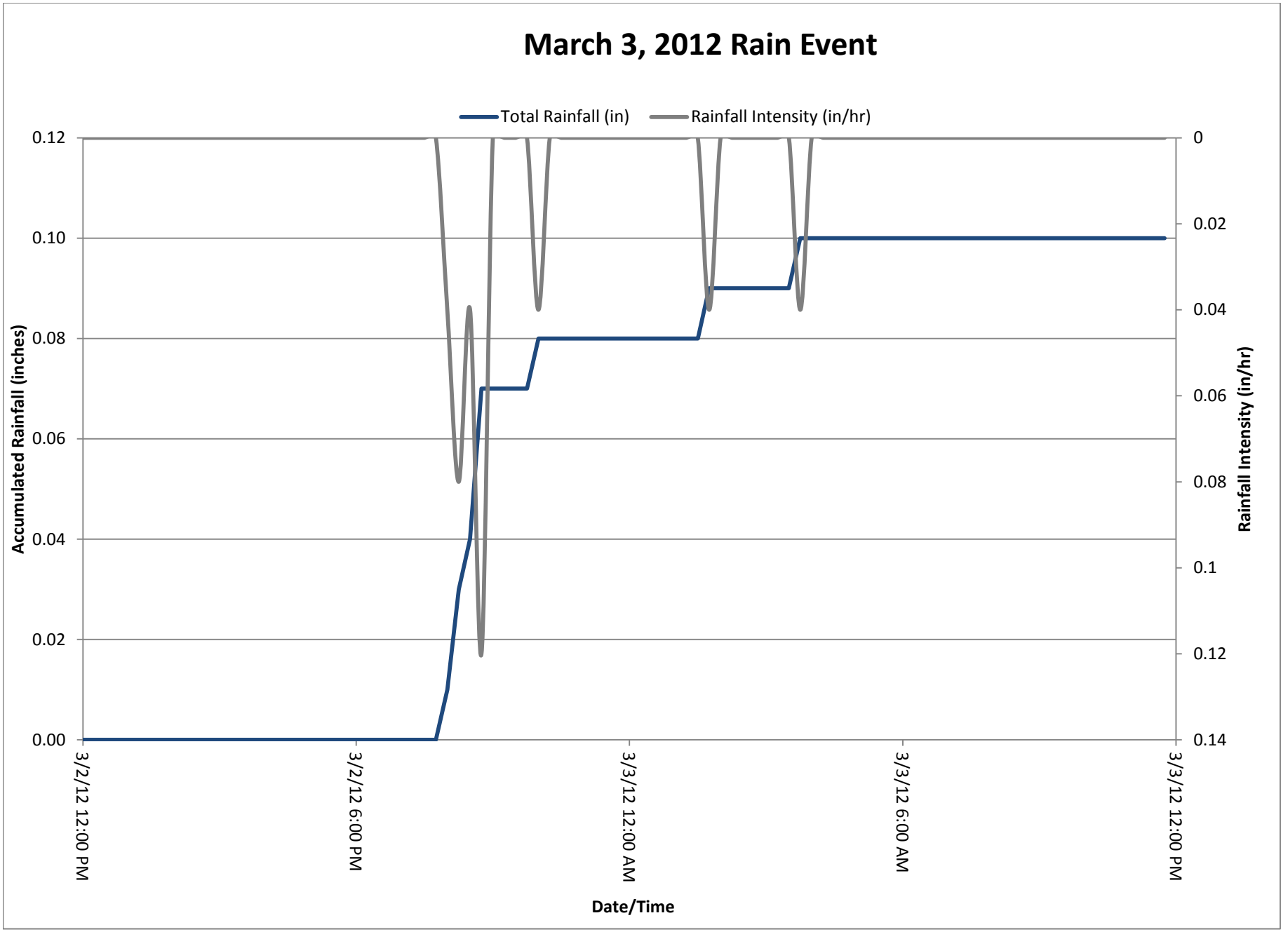
	ITEMS	**DATE**
1.	Sanitary Sewer Overflow ("SSO") Elimination	
a.	Implement the Schedule contained as Table 4.2 (Detailed Work Plan) of the approved August 2007 Sanitary Sewer System Management Plan. That Report and Schedule shall be incorporated into and become an enforceable part of this Order. The receipt by Respondent of any grant fund(s) or other financial assistance for any of the remedial work set forth in Schedule A shall expedite the time period for completion of such activities to a mutually agreeable date.	Upon DEC approval.
b.	Submit an annual report to the Department detailing the actions taken the preceding year in accordance with the Schedule. Detail proposed modifications (if any) to the Detailed Work Plan.	No later than April 1st of each year.
c.	Implement modifications to the Detailed Work Plan.	Upon DEC approval.
2.	Notification Requirements	
	Report the occurrence of all sanitary sewer overflows from outfall numbers 013 through 019 listed in Paragraph II below of this Schedule by submitting Monthly Reports as directed in Paragraph IV of this Order. Sanitary sewer overflows from any other location within the Niagara Falls Water Board's service area, including Portable Pump Stations A through I listed in Paragraph II below of this Schedule, must be reported by calling the Department's Regional Water Engineer at 851-7070 within 24 hours (or the next business day) of the event.	Immediately and ongoing.
3.	Capacity, Management, Operation and Maintenance ("CMOM") Program	
a.	Implement the Schedule contained as Table 4.1 (Schedule of Activities) of the approved August 2007 Sanitary Sewer System Management Plan. That Report and Schedule shall be incorporated by reference and enforceable under this Order.	Upon DEC approval.

b. Submit an annual report to the Department detailing the actions taken the preceding year in accordance with the Schedule. No later than April 1st of each year.

II. Respondent shall continue to conduct a maintenance and inspection program of the facilities identified in the chart set forth below. This program shall consist of minimum monthly inspections with required repair, cleaning and maintenance performed as needed. This is to ensure that no discharges occur during dry weather and that the maximum amount of wet weather flow is conveyed to the treatment plant. All maintenance and inspection program activities, including visual observations of the condition of the equipment and any repair work required, shall be summarized in an annual CMOM report.

Outfall Number/Portable Pump Station	Description	Location	Receiving Stream
013	Pump Station Bypass	Lift Station #4, 91st Street & Luick Avenue	Cayuga Creek
014	Pump Station Bypass	Lift Station #6, 81st Street & Frontier Avenue	Cayuga Creek
015	Pump Station Bypass	Lift Station #7, Military Road & Bollier Avenue	Cayuga Creek
016	Pump Station Bypass	Lift Station #1, 81st Street & Stephenson Avenue	Little Niagara River
017	Pumped Bypass	Mang Avenue & Cayuga Drive	Cayuga Creek
018	Pumped Bypass	Crossover between West Rivershore Drive & 81st Street at Buffalo Avenue	Little Niagara River
019	Gravity Overflow	76th Street & Stephenson Avenue	Little Niagara River
A	Portable Pump	73rd Street & Stephenson Avenue	Little Niagara River
B	Portable Pump	78th Street & Lindbergh	Little Niagara River
C	Portable Pump	81st Street & Lindbergh	Cayuga Creek
D	Portable Pump	82nd Street & Bollier Avenue	Cayuga Creek
E	Portable Pump	93rd Street & Colvin Avenue	Bergholtz Creek
F	Portable Pump	93rd Street & Cayuga Avenue	Bergholtz Creek
G	Portable Pump	93rd Street & Schantz	Bergholtz Creek
H	Portable Pump	101st Street (at lift station)	Bergholtz Creek
I	Portable Pump	South Military	Cayuga Creek

APPENDIX B: Rainfall Hyetographs



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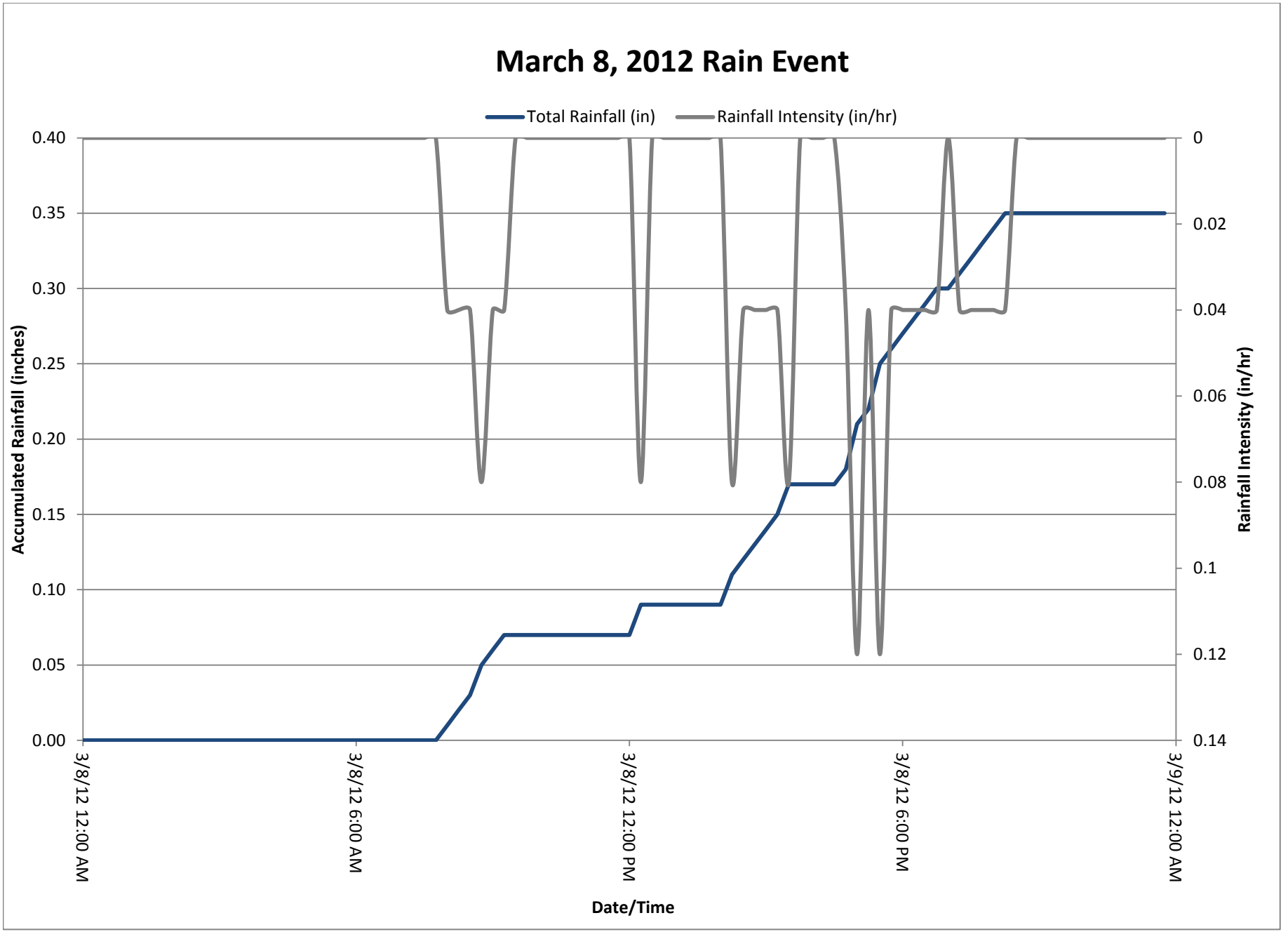

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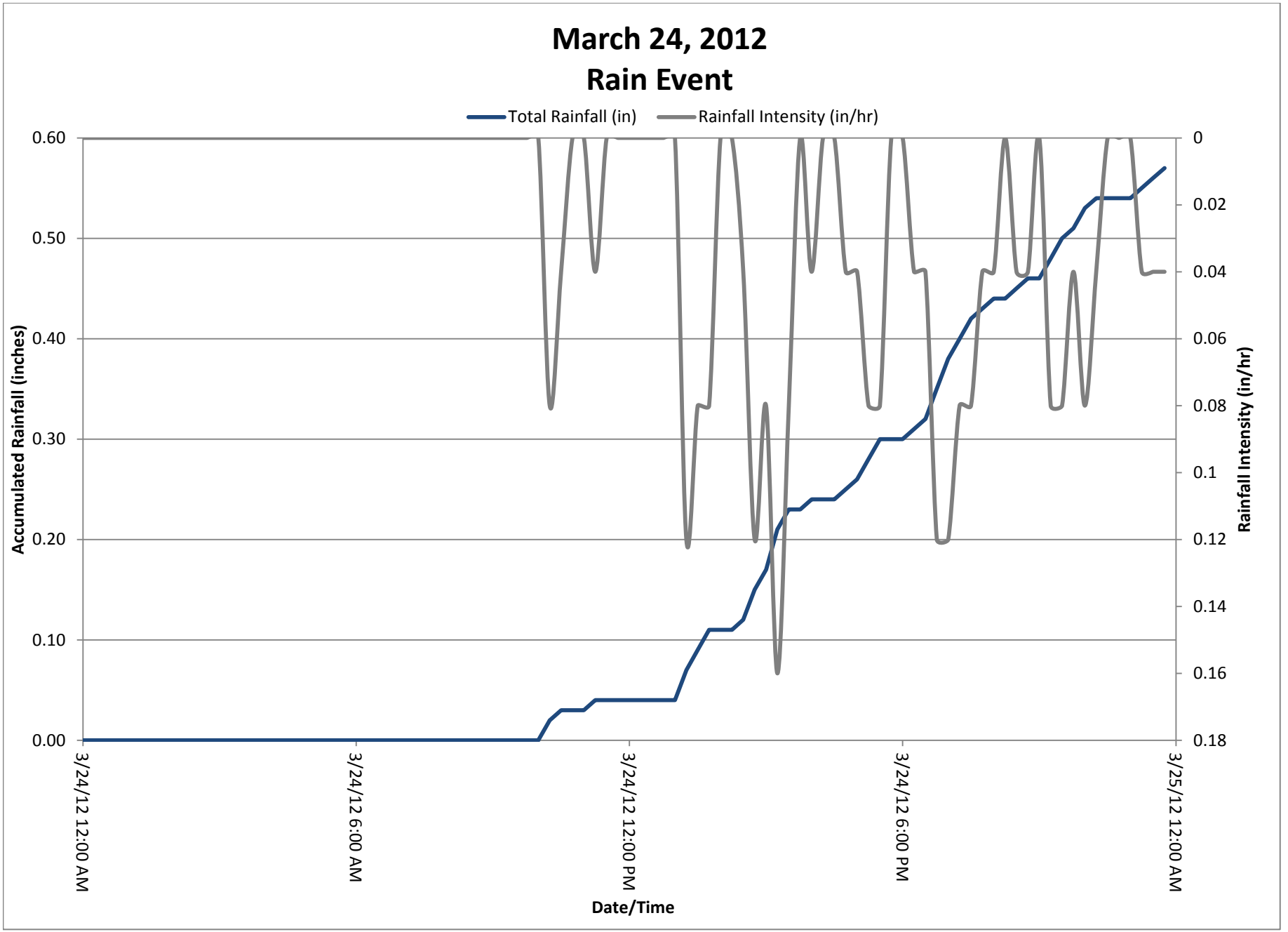

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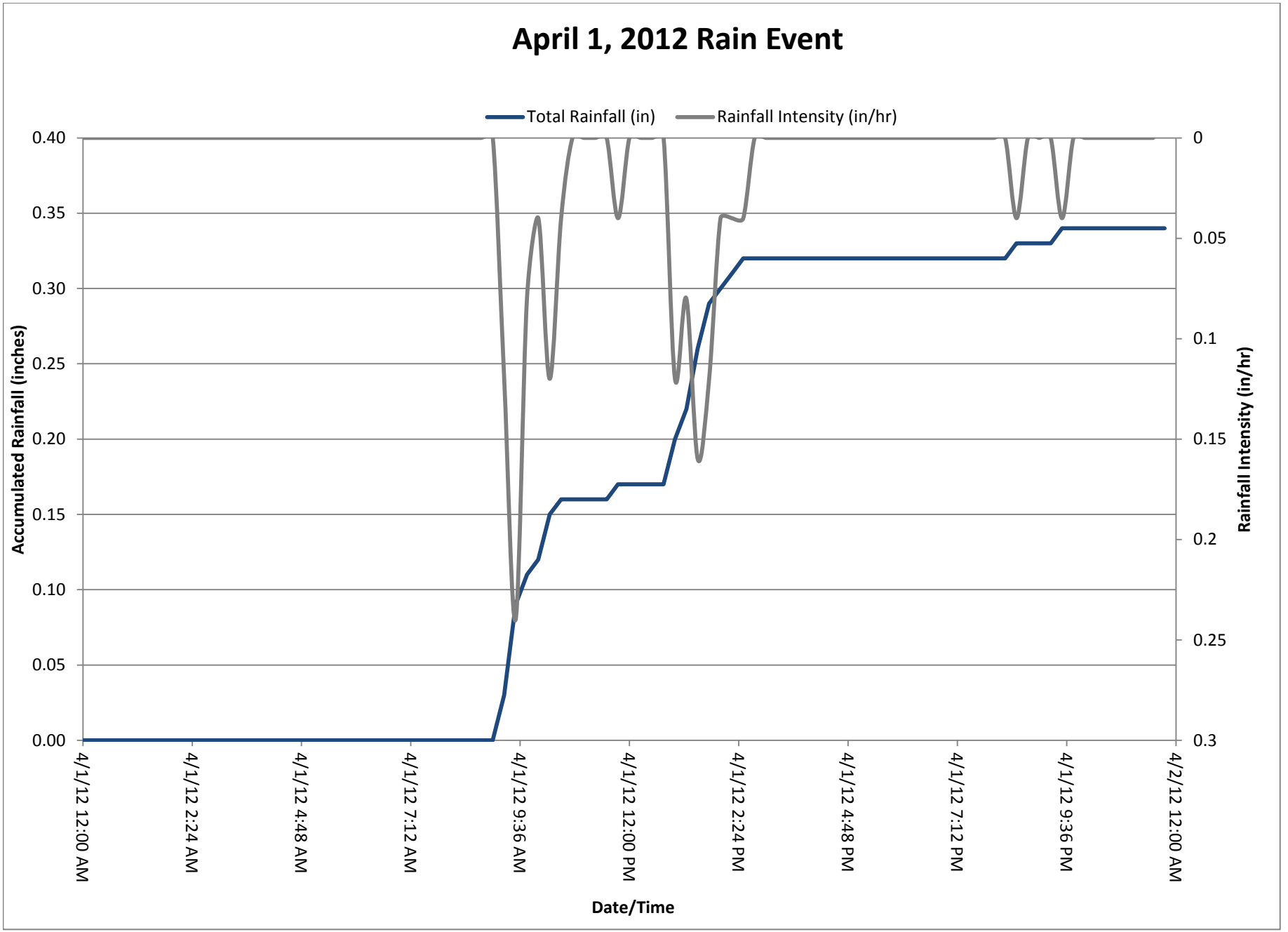

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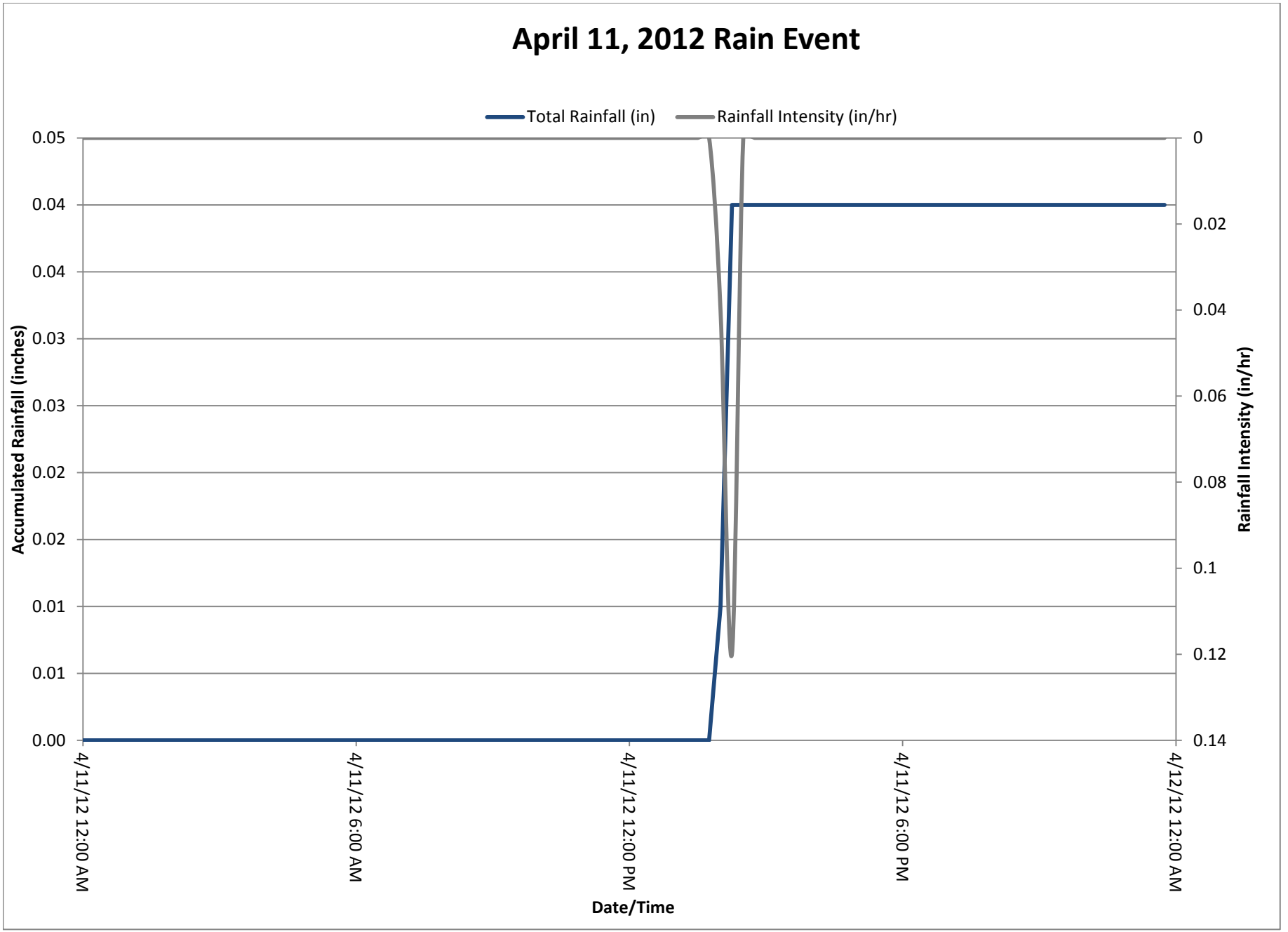

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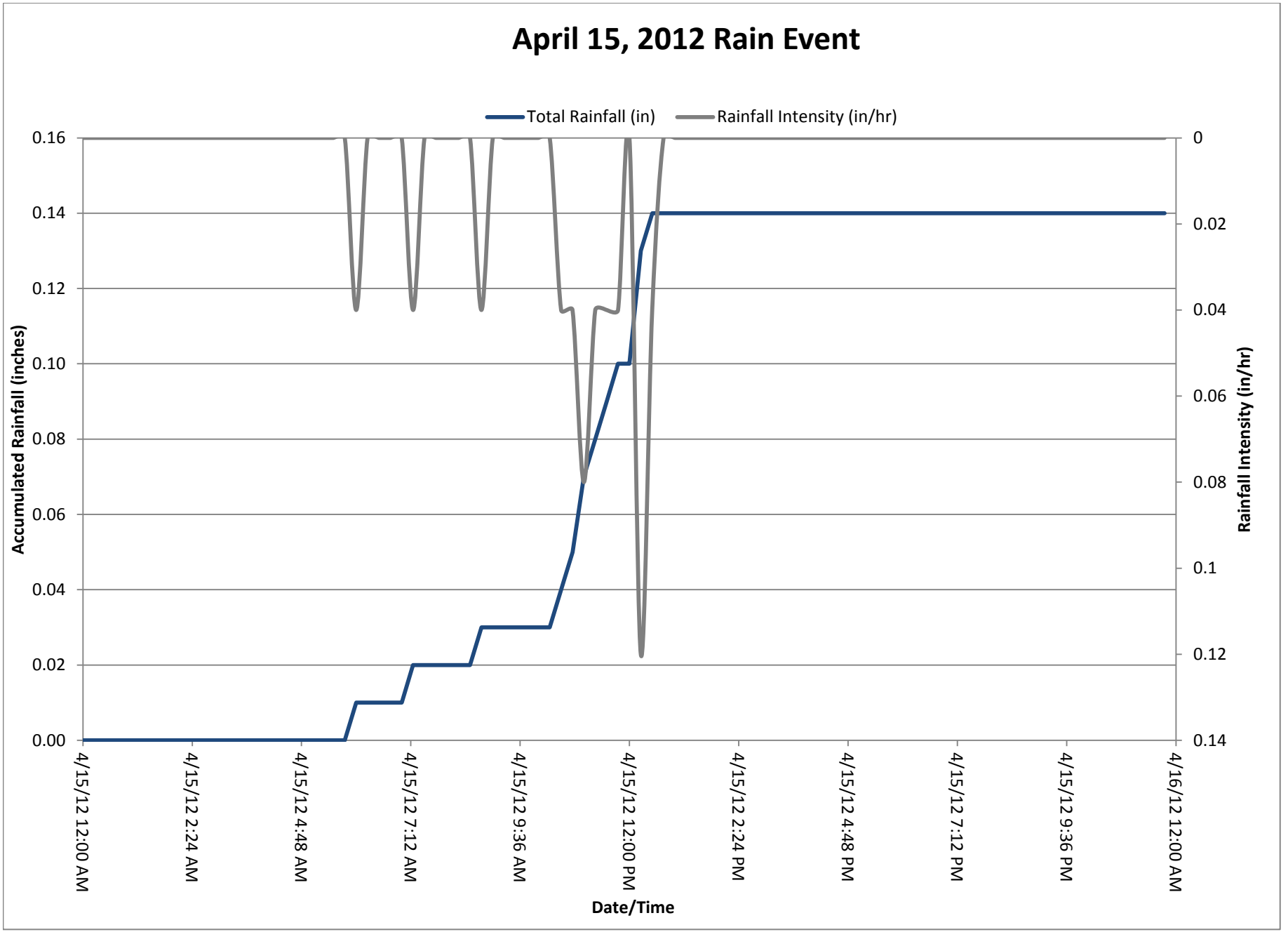

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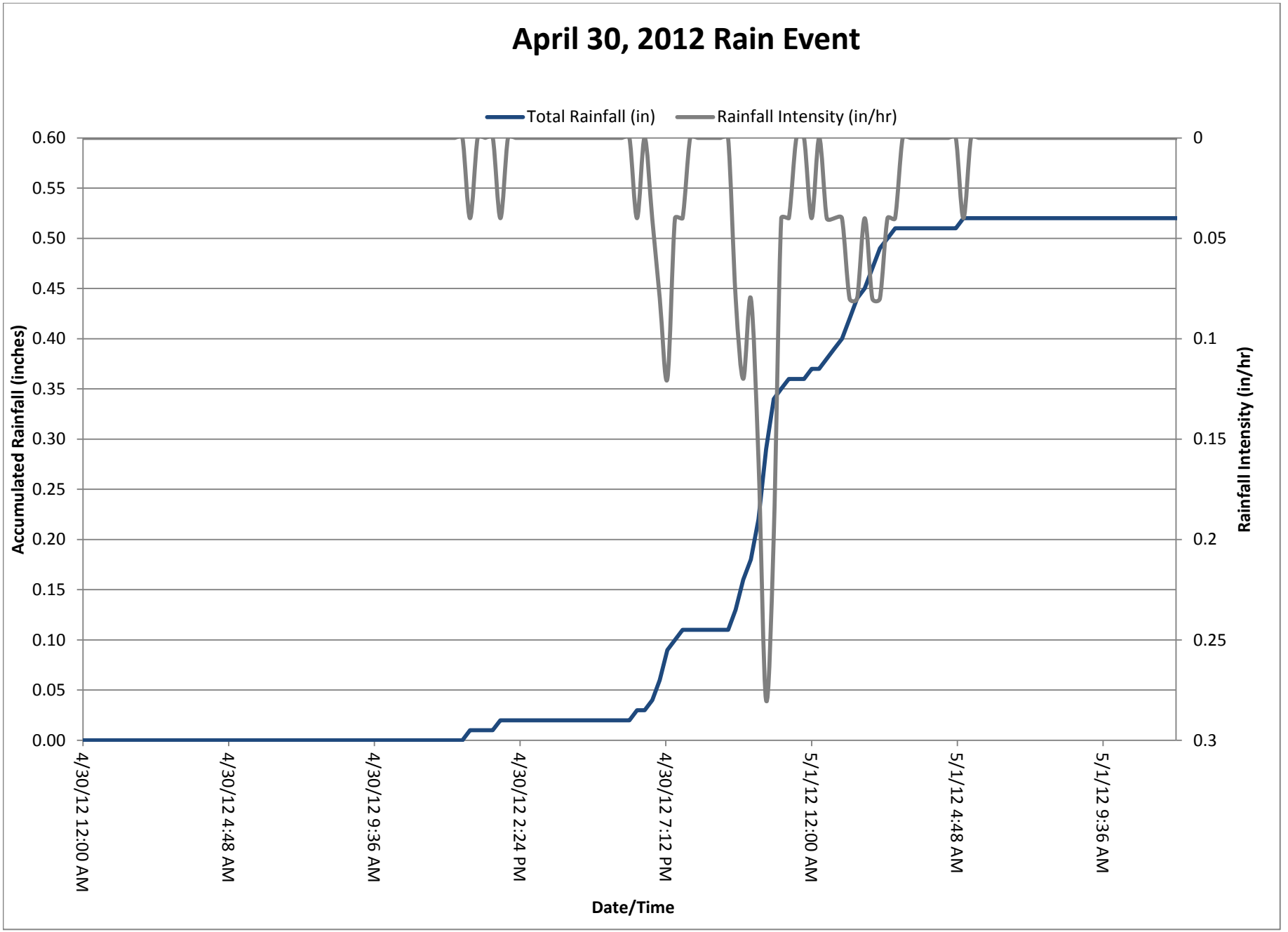

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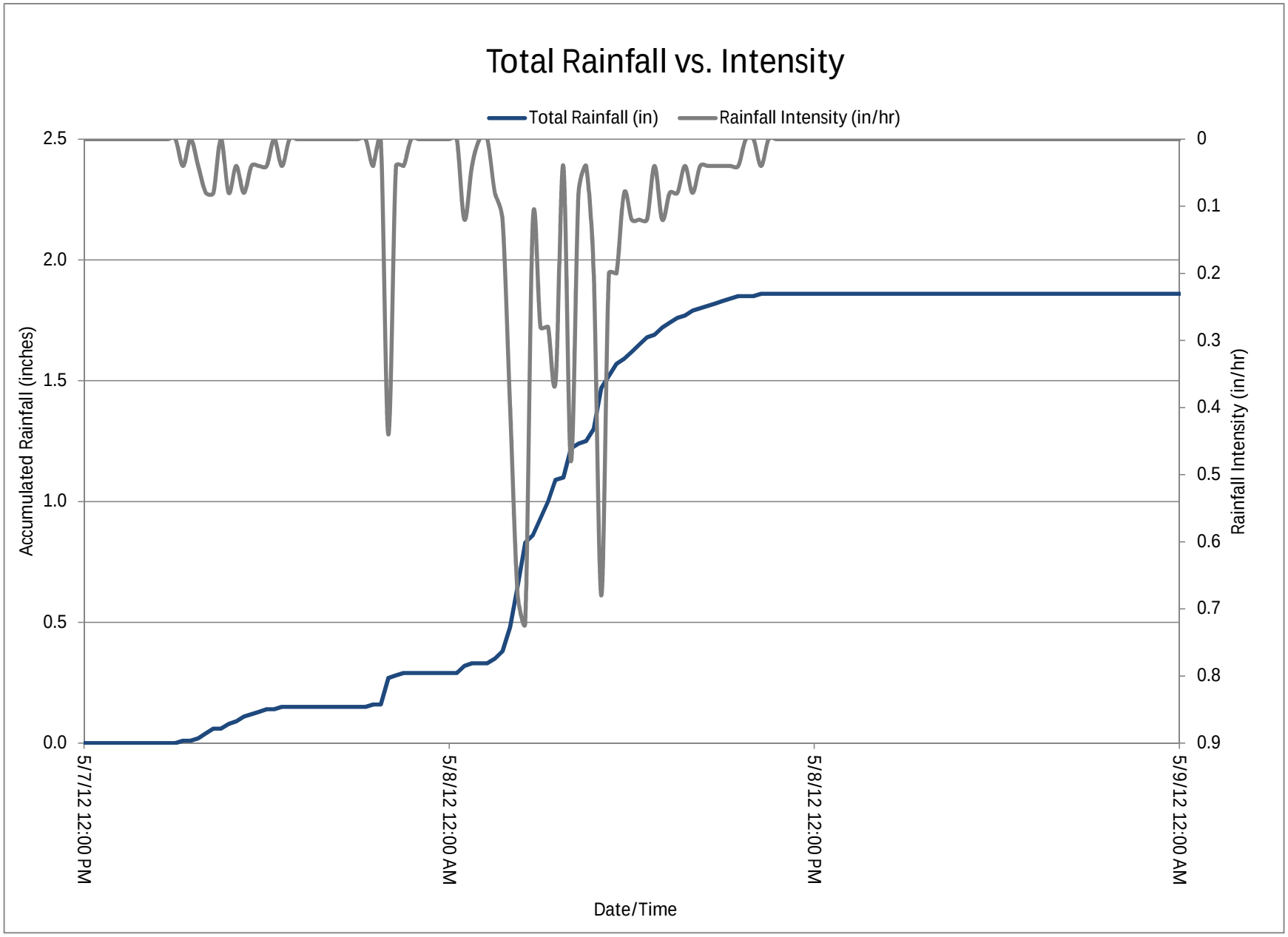

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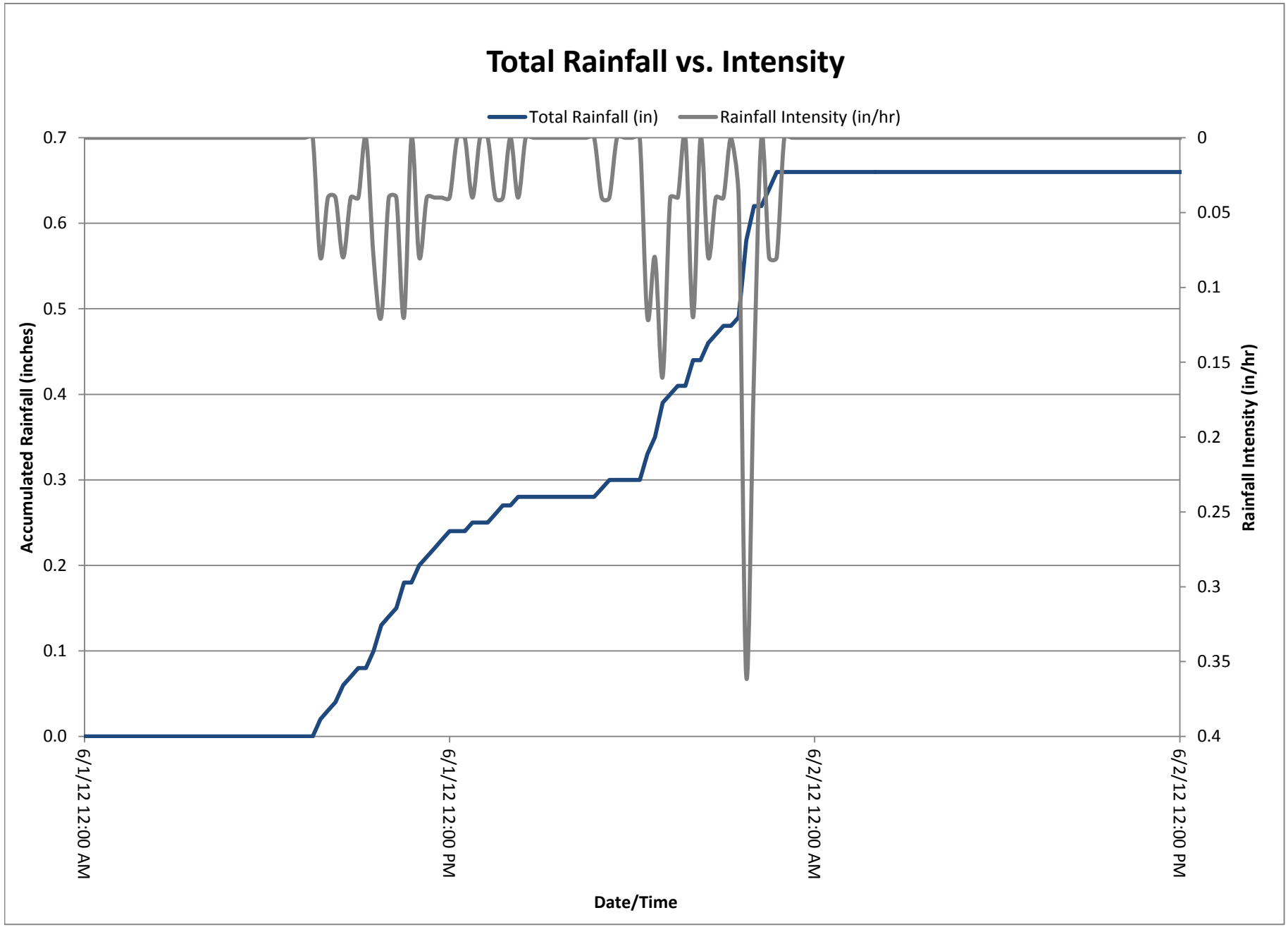

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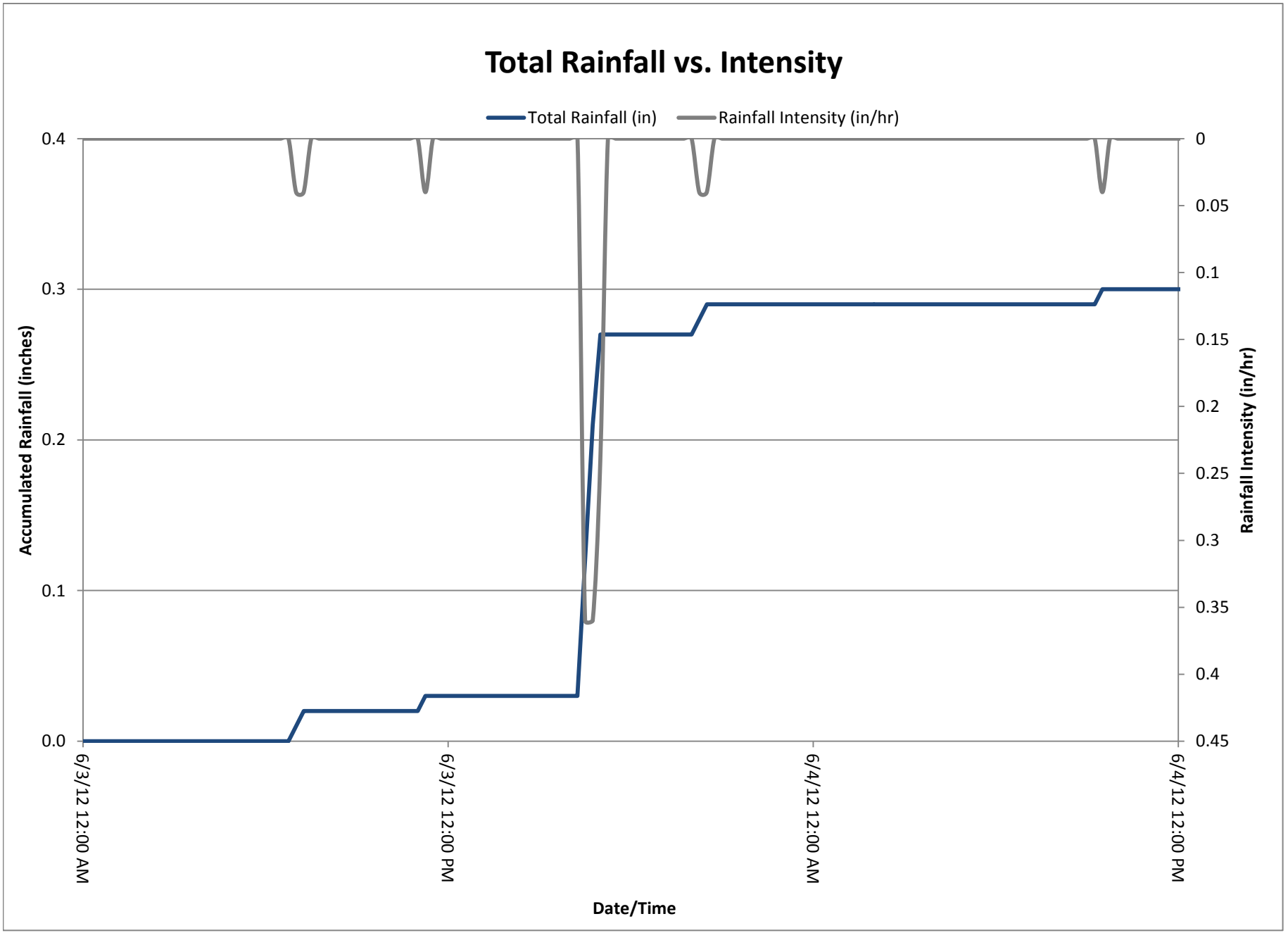

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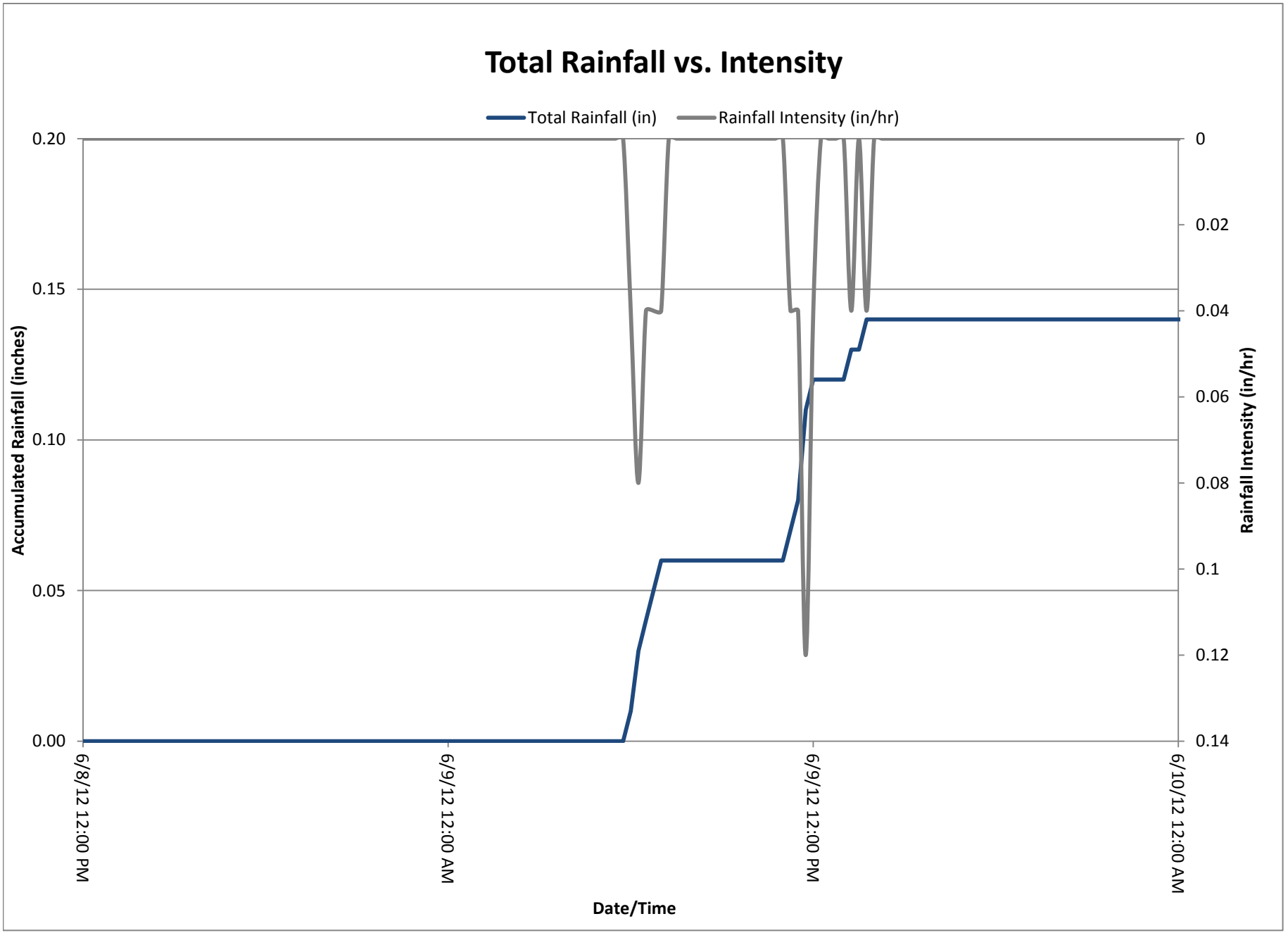

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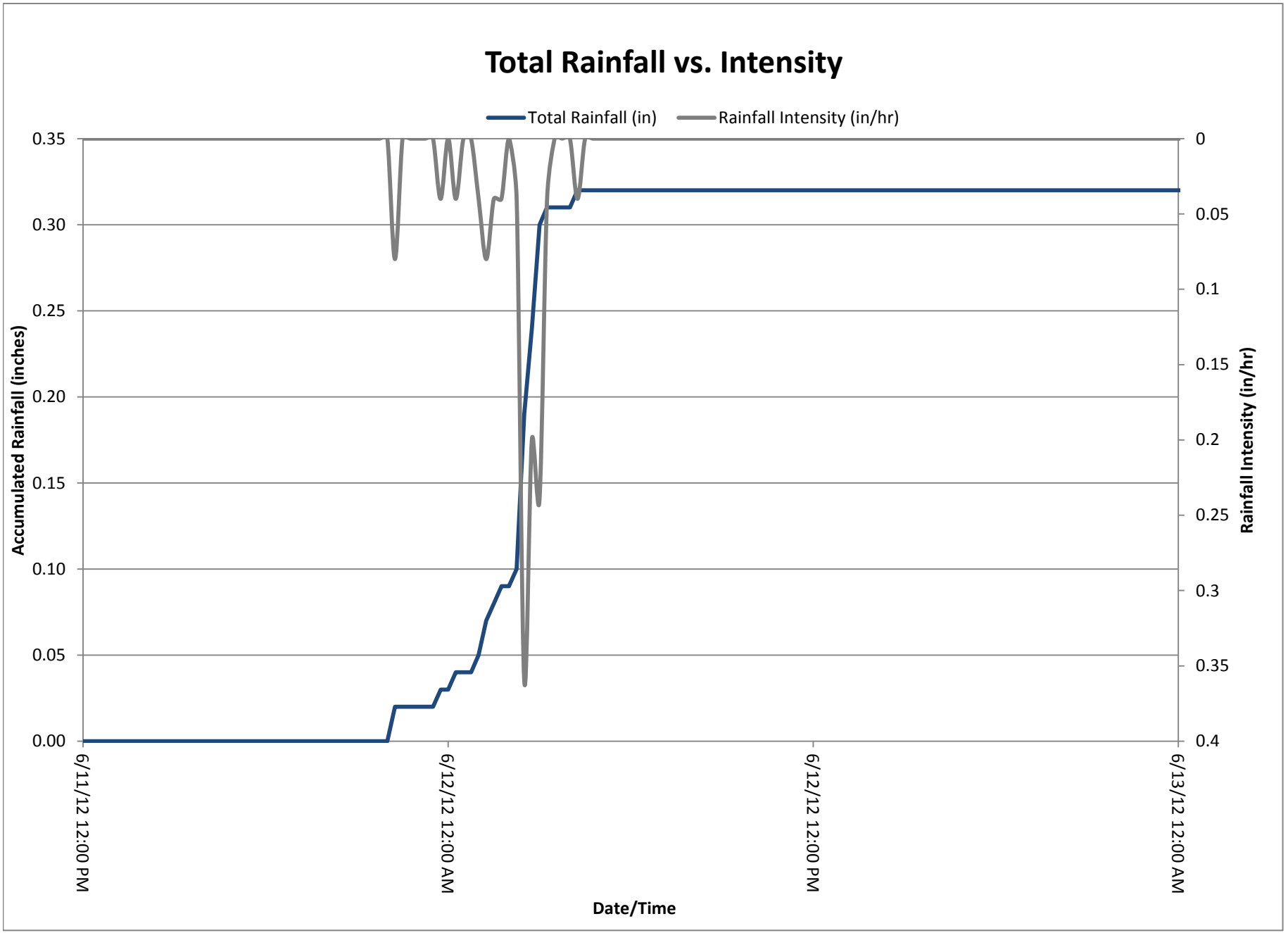

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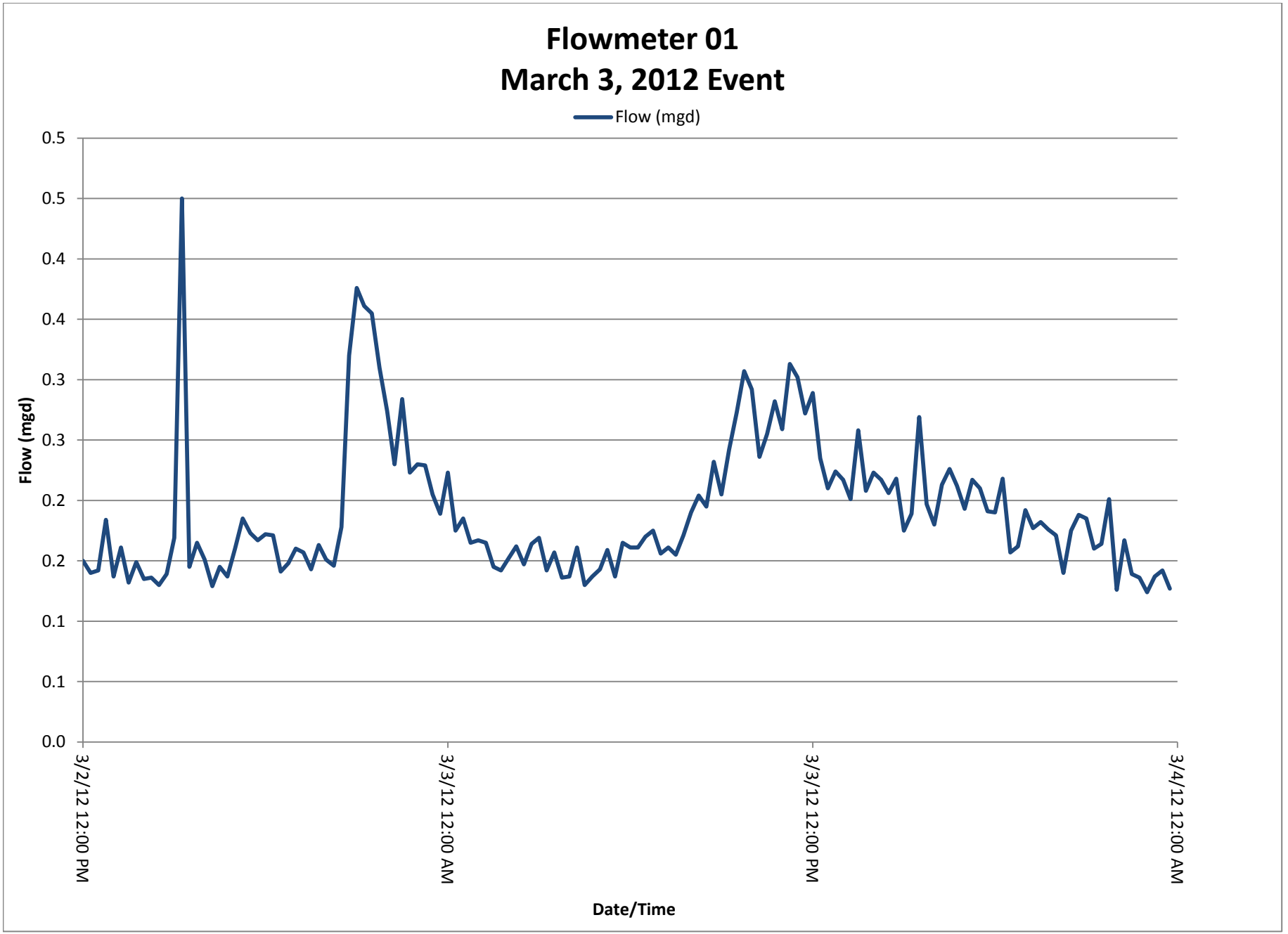
APPENDIX C: Wet Weather Hydrographs



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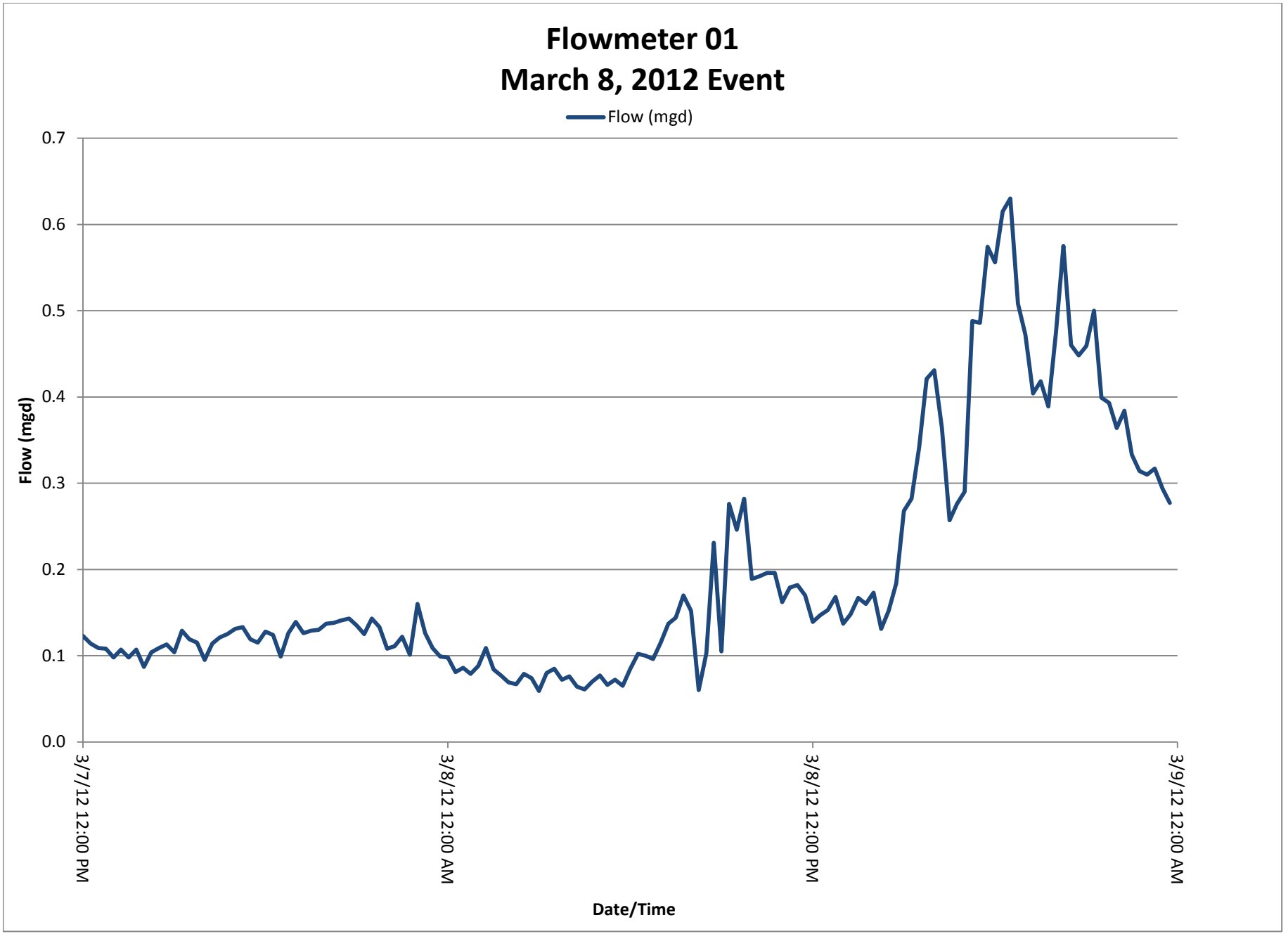

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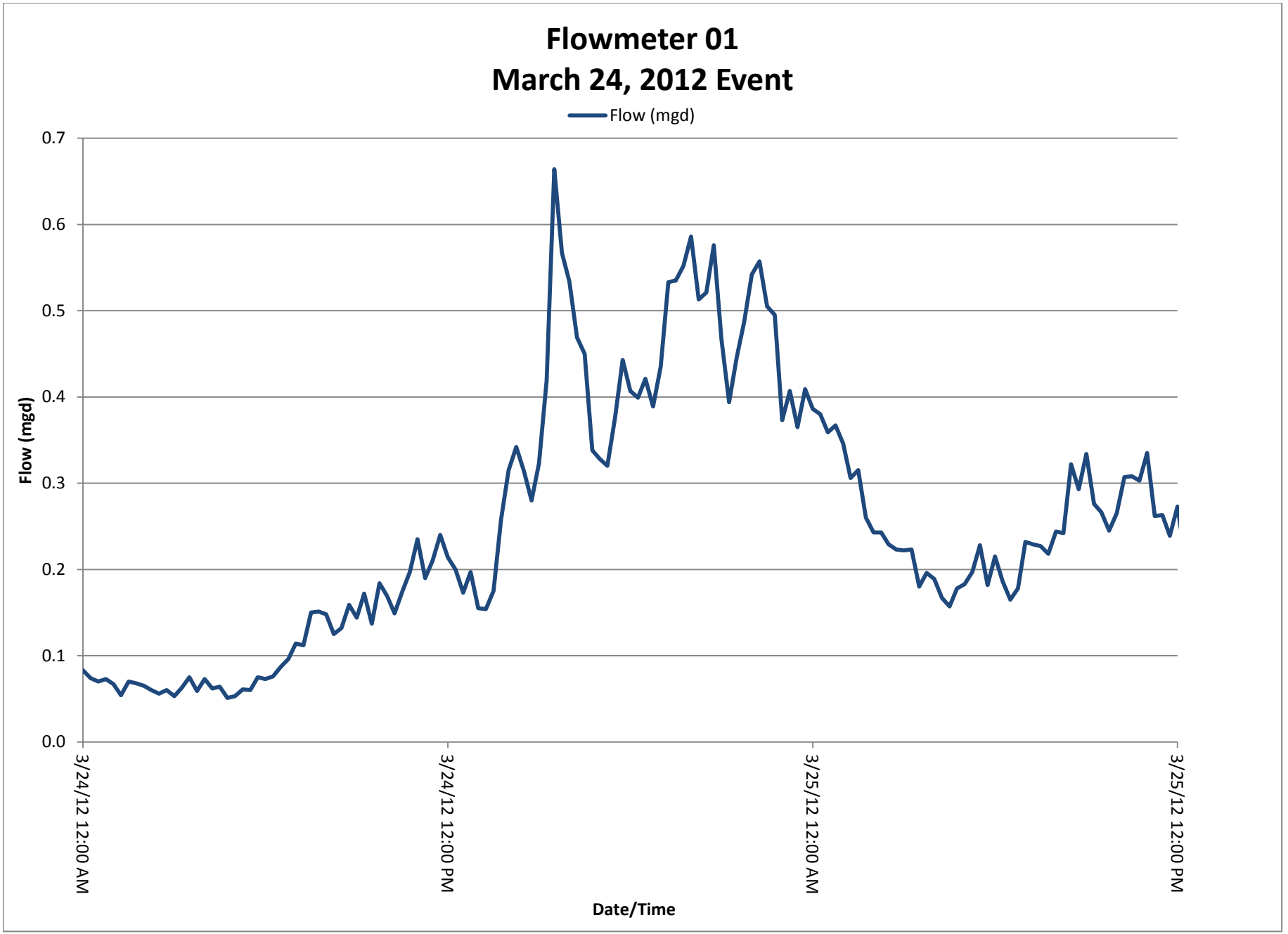

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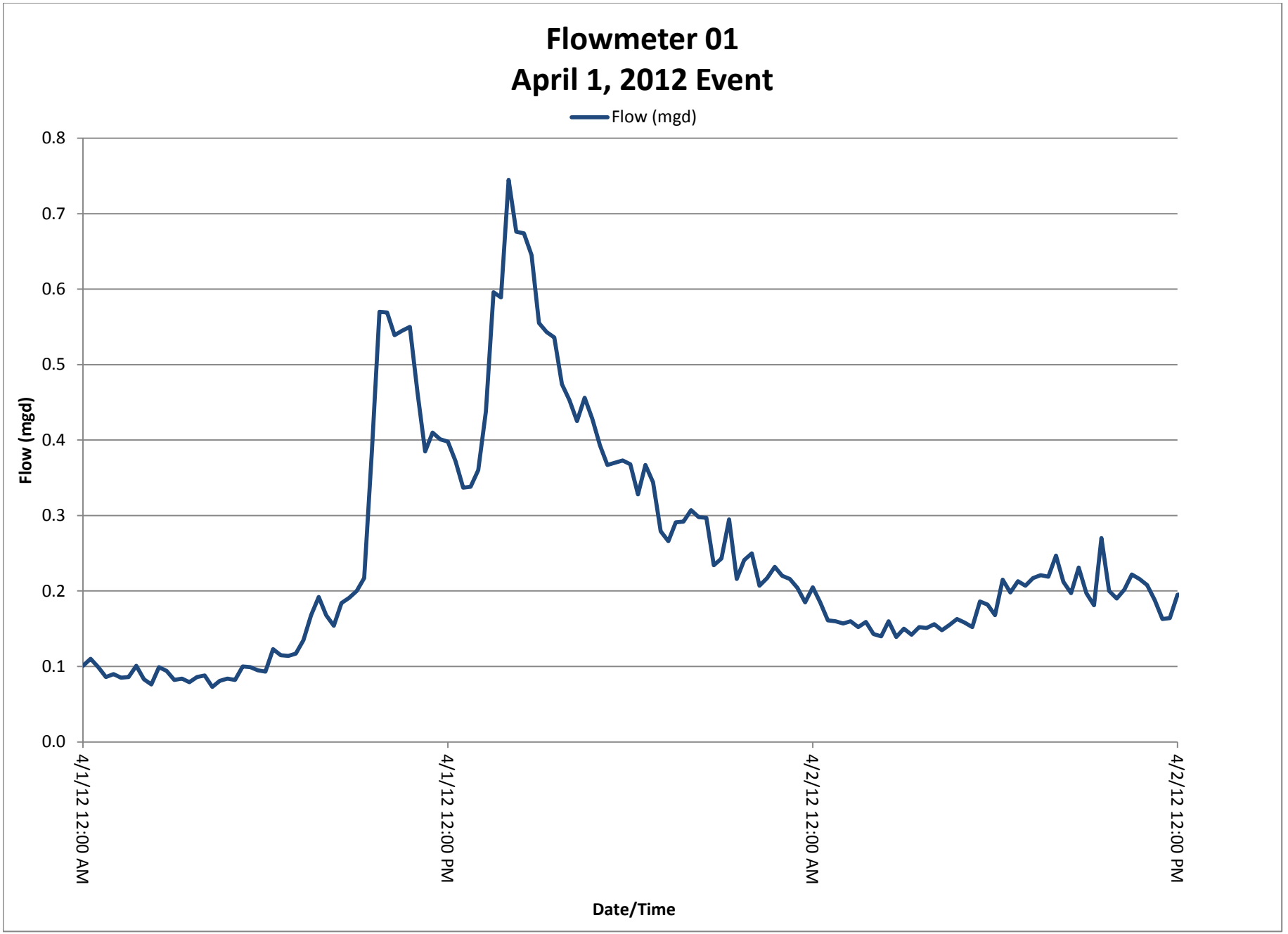

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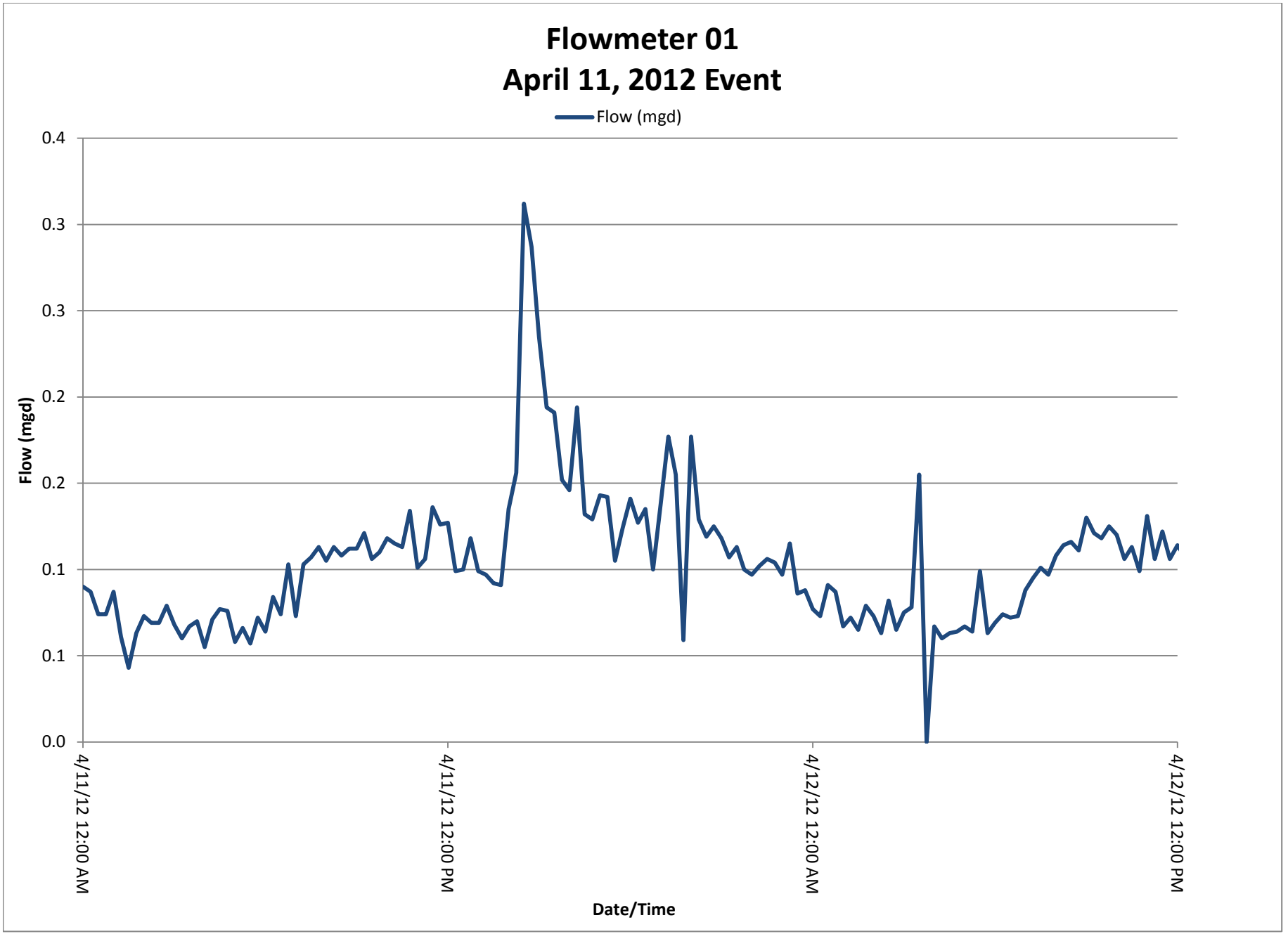

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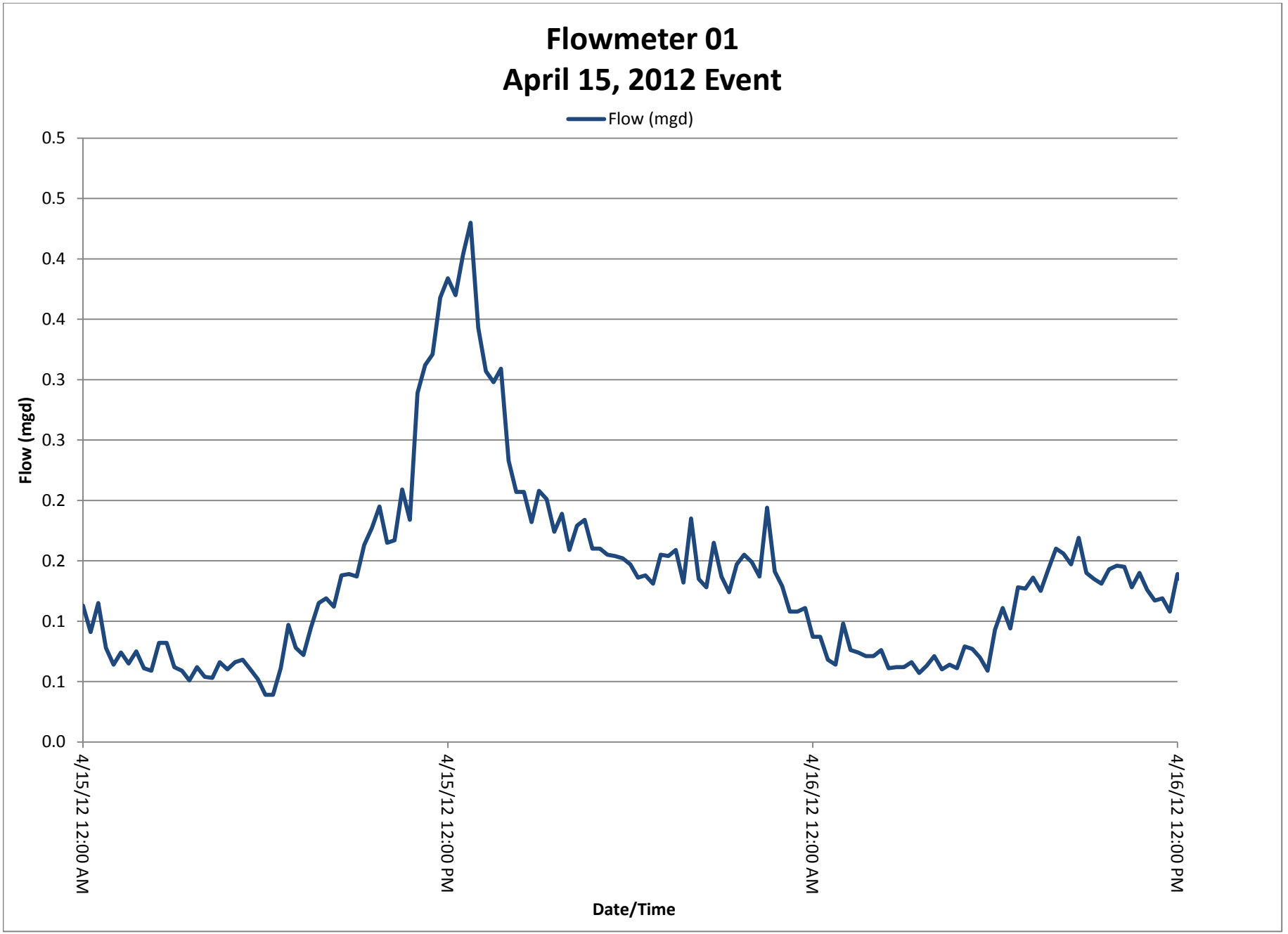

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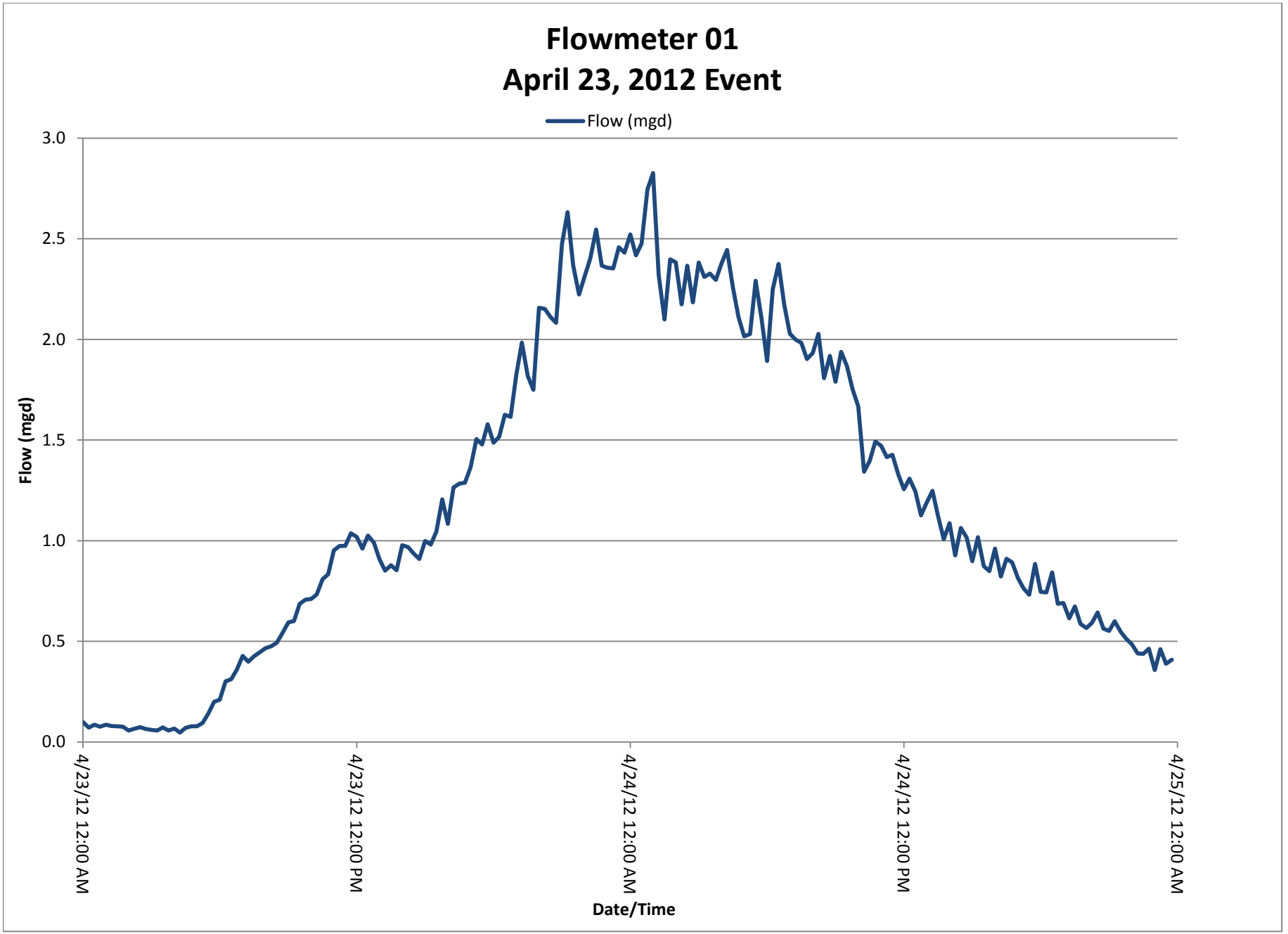

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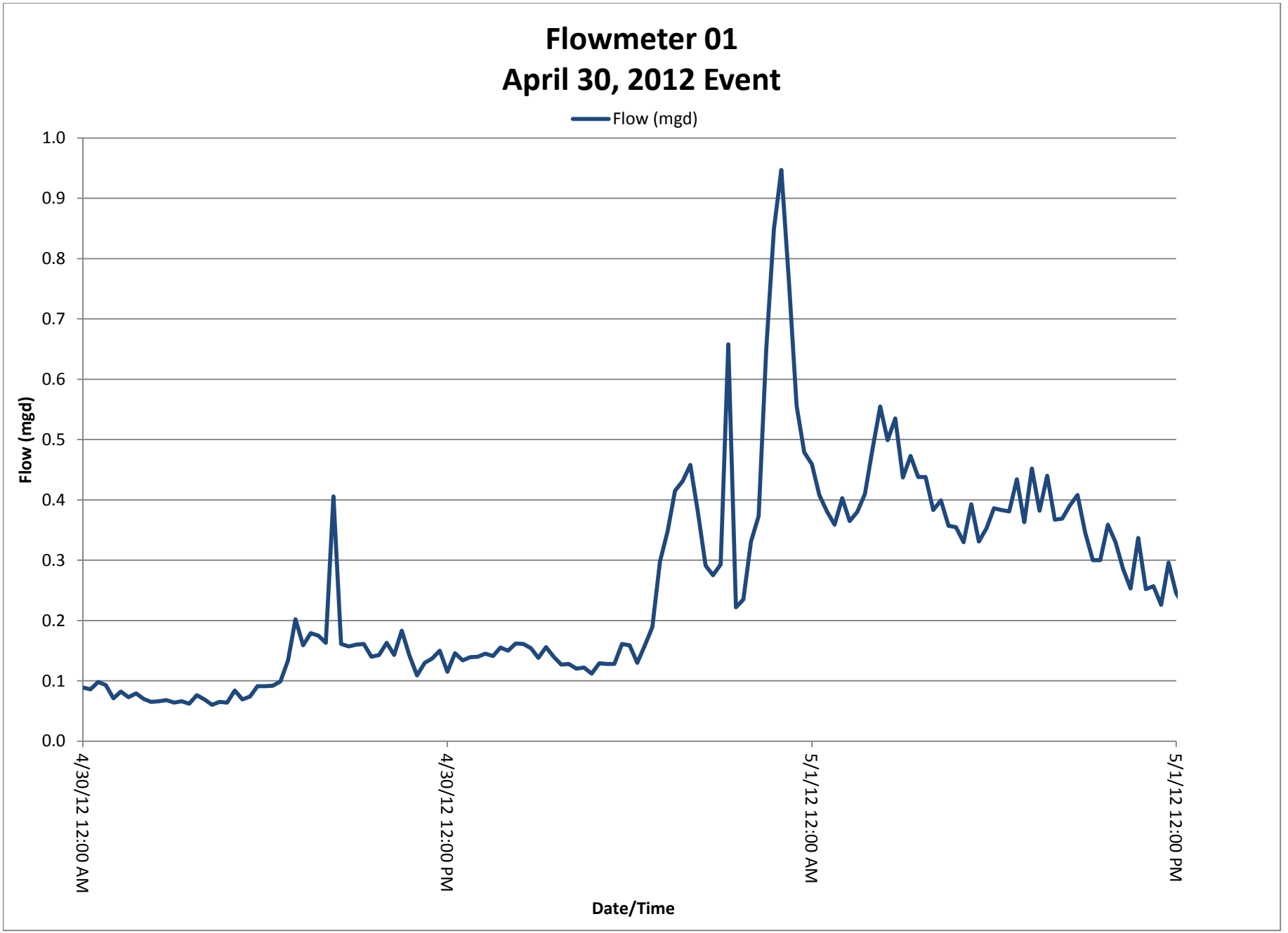

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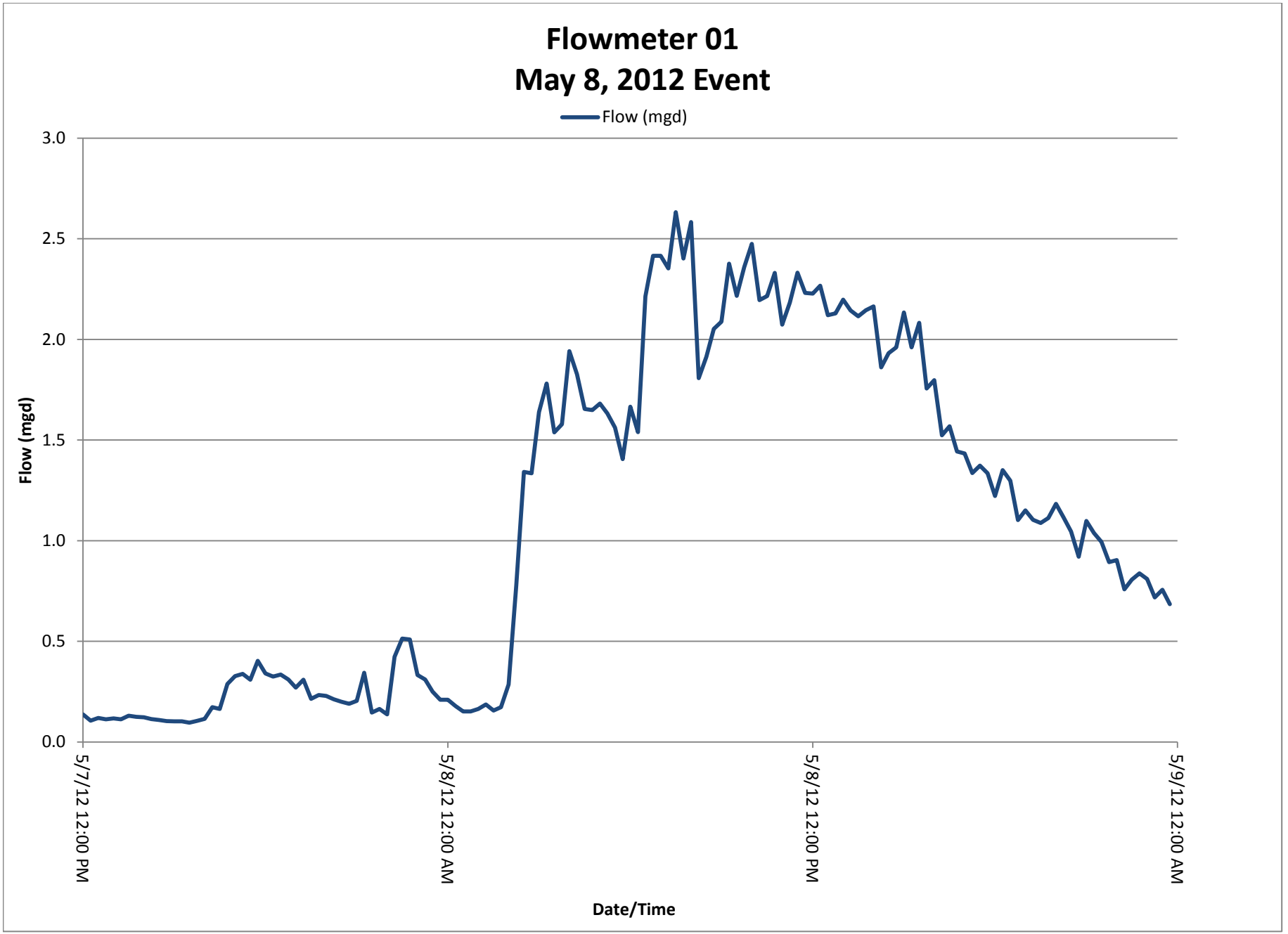

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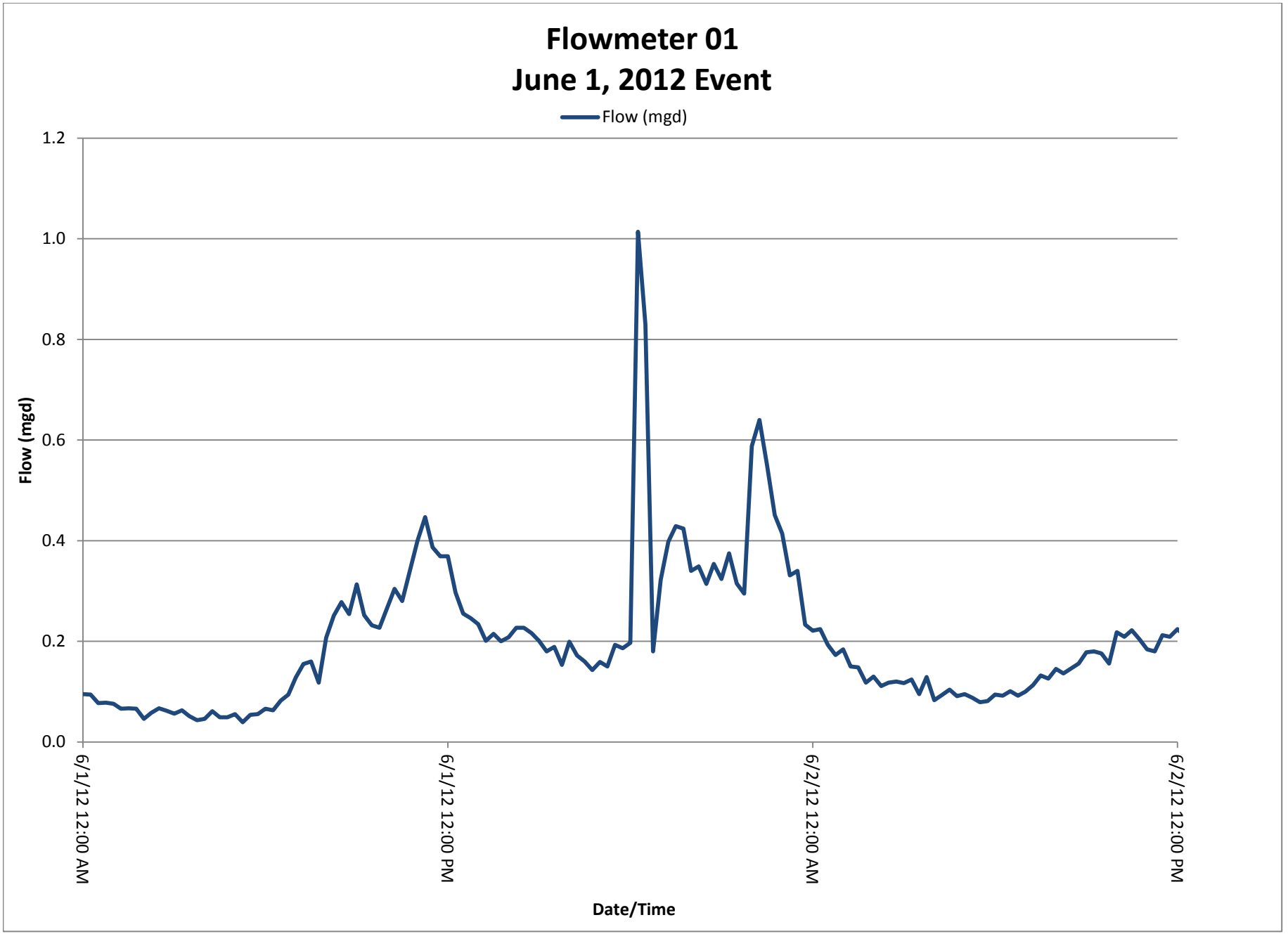

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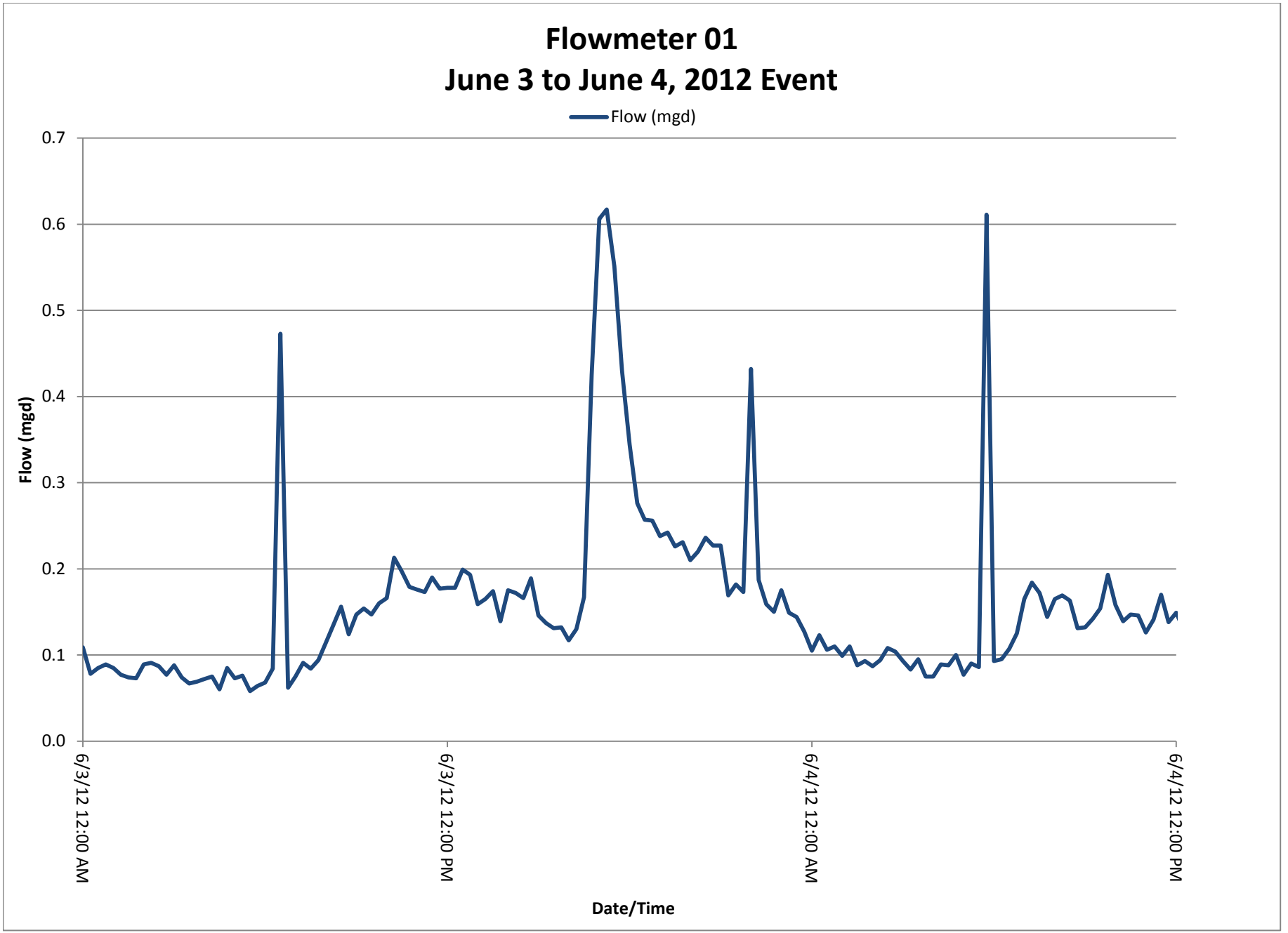

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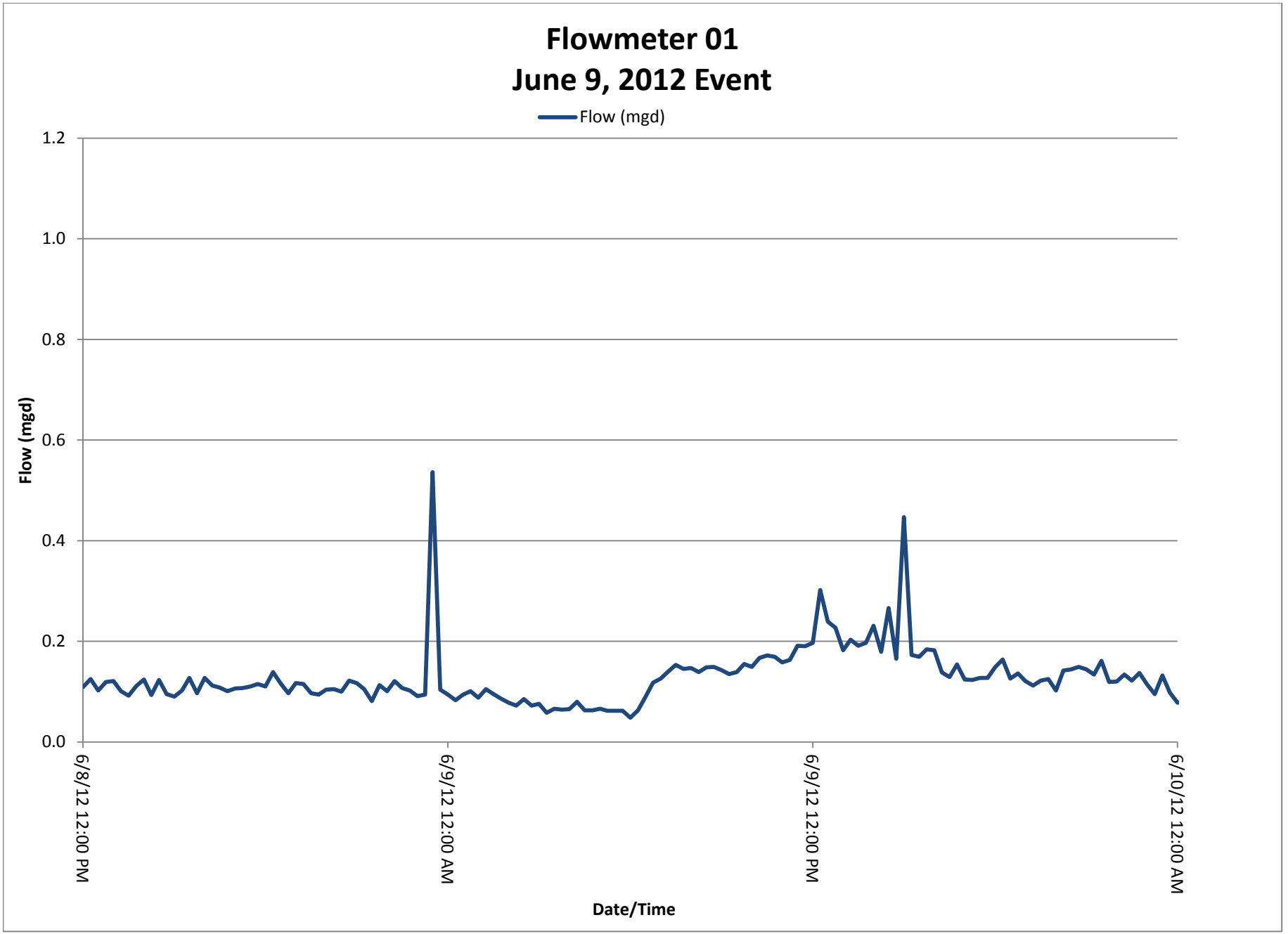

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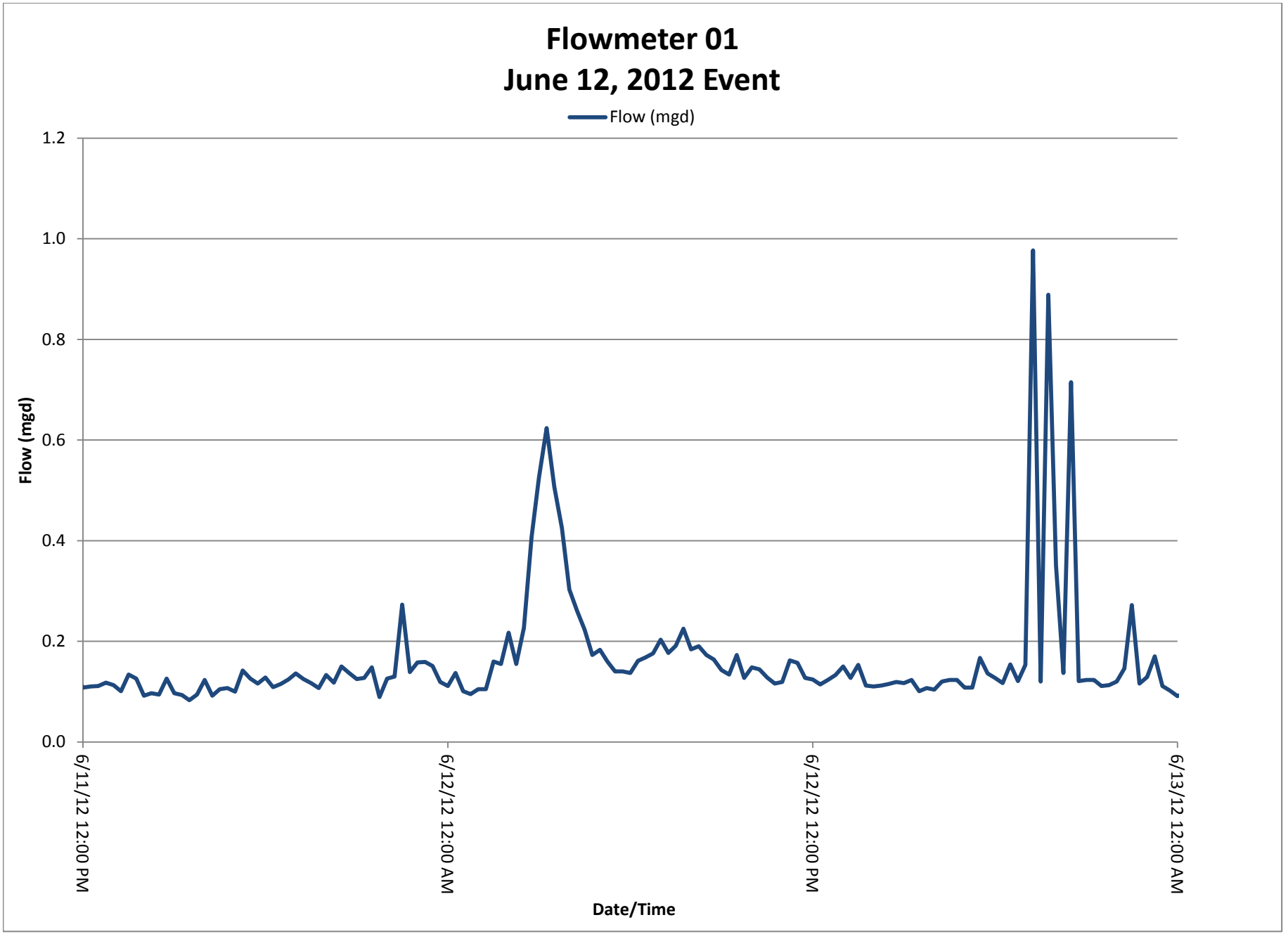

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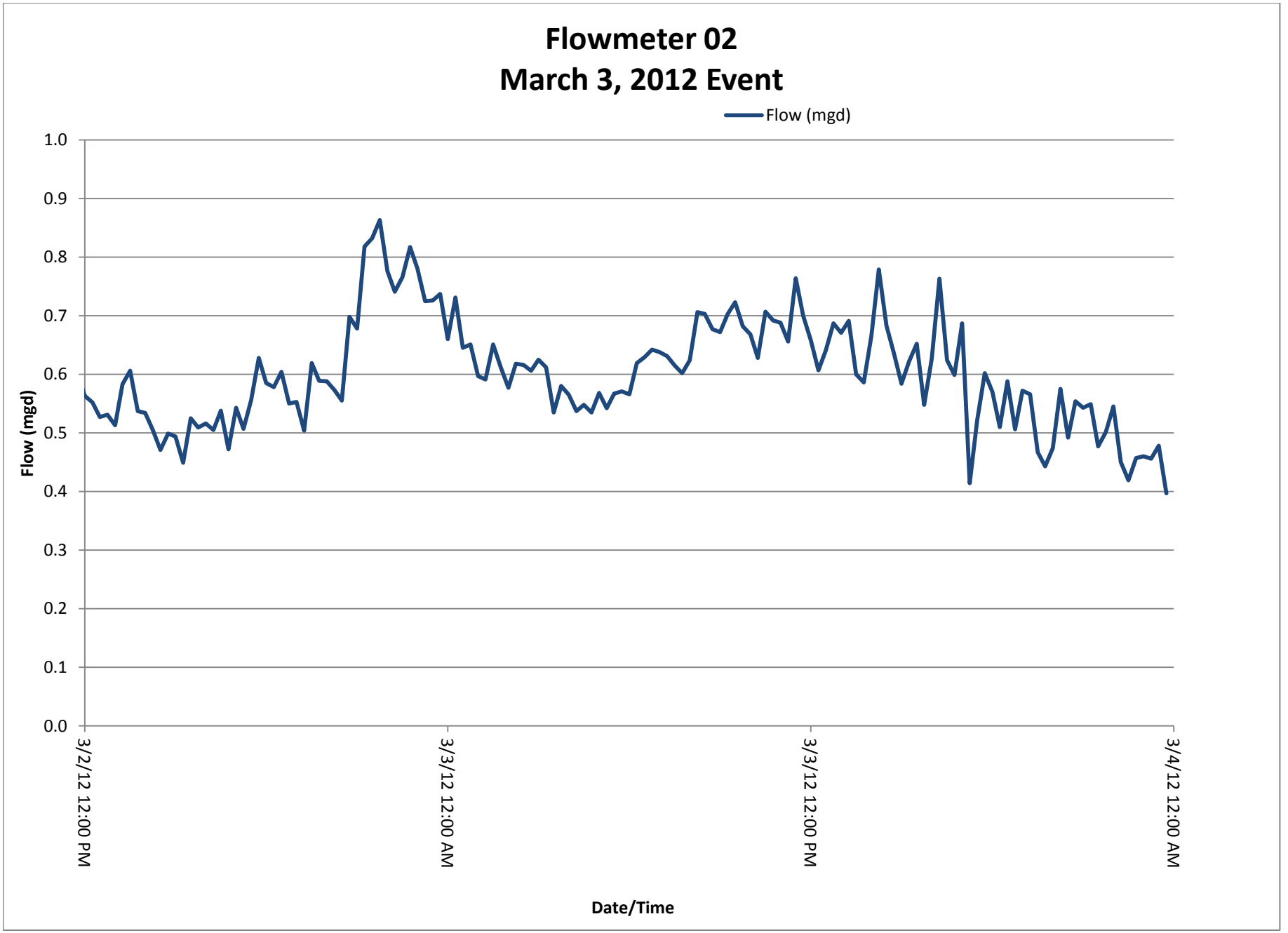

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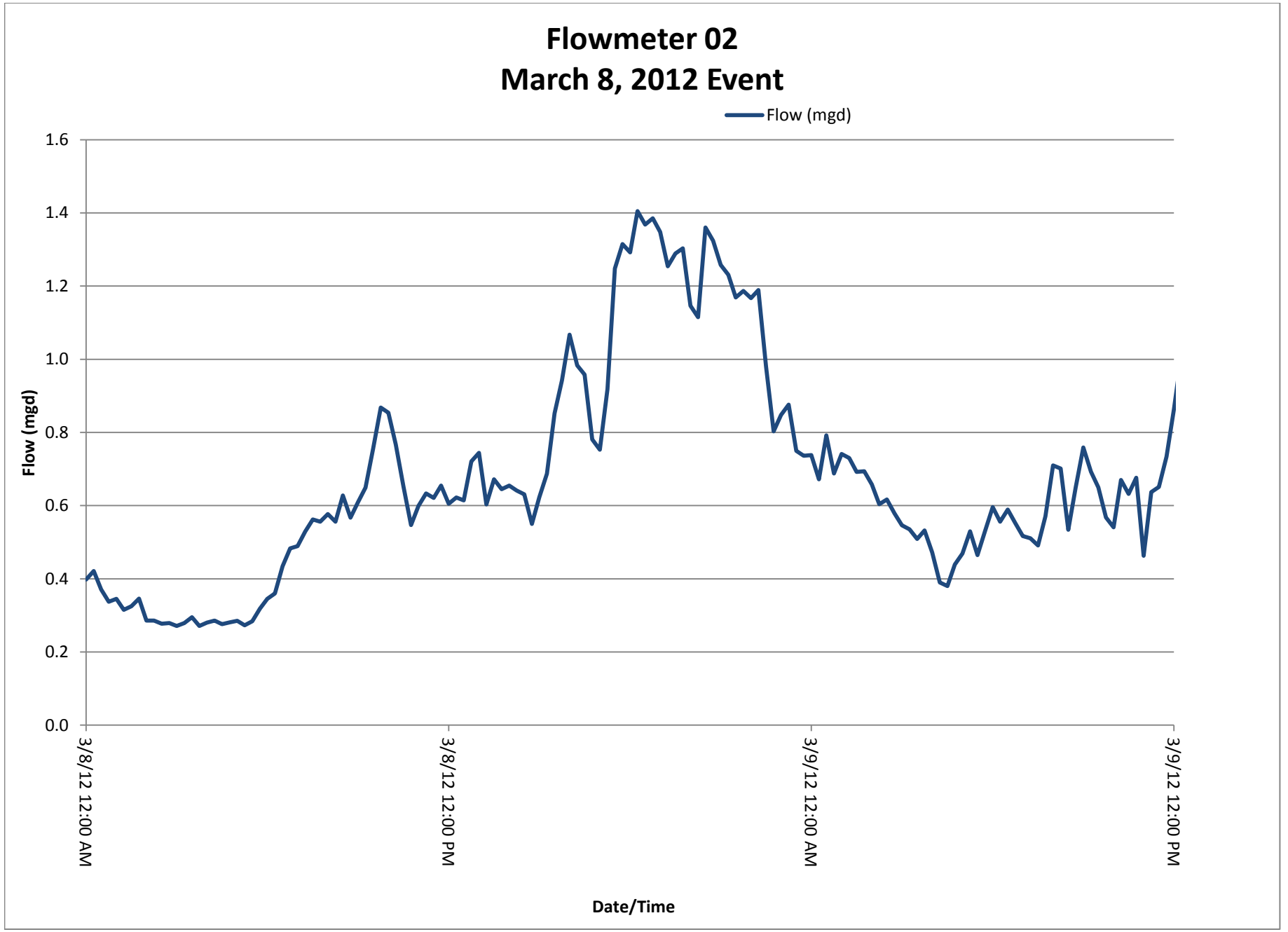

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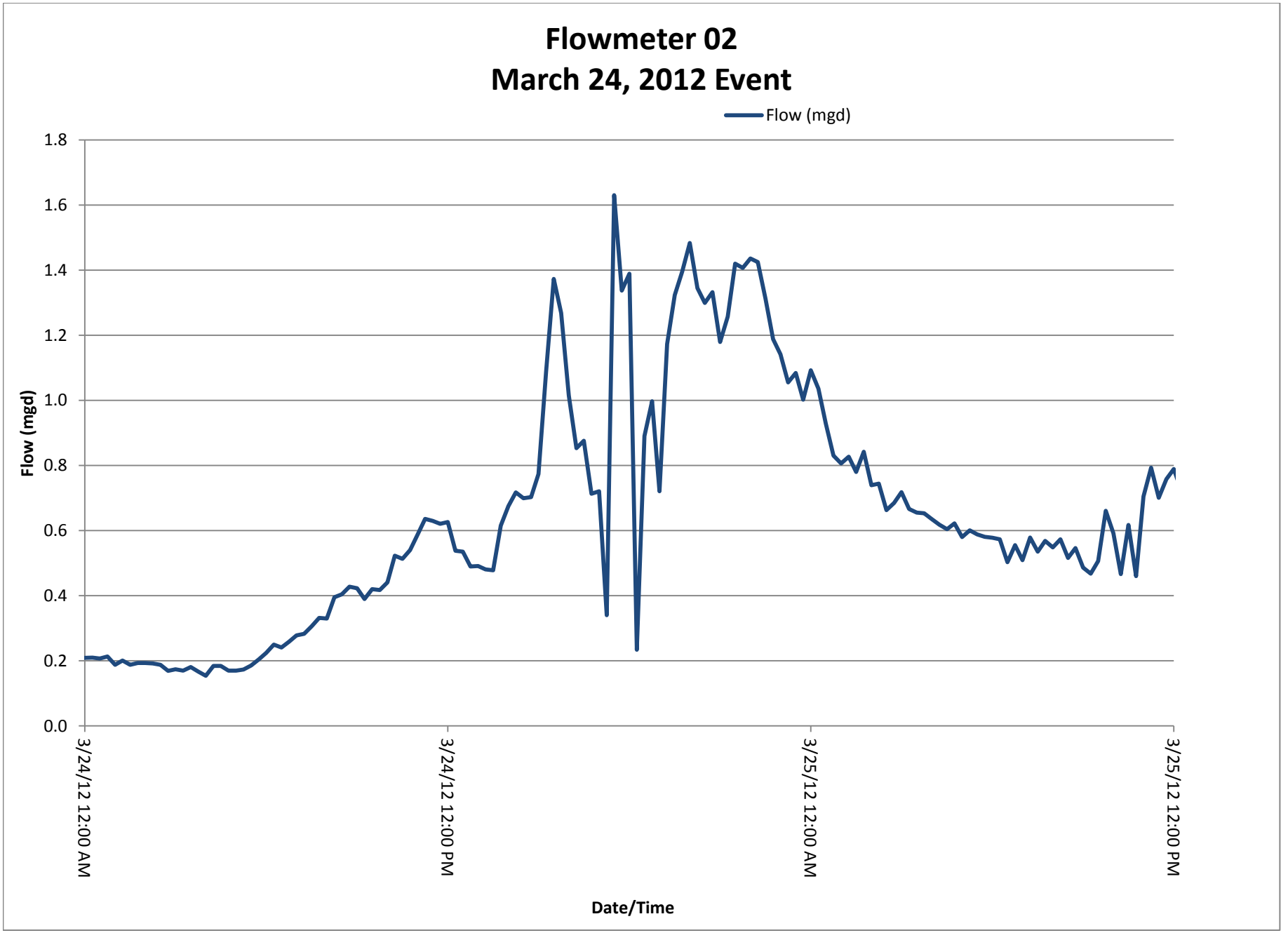

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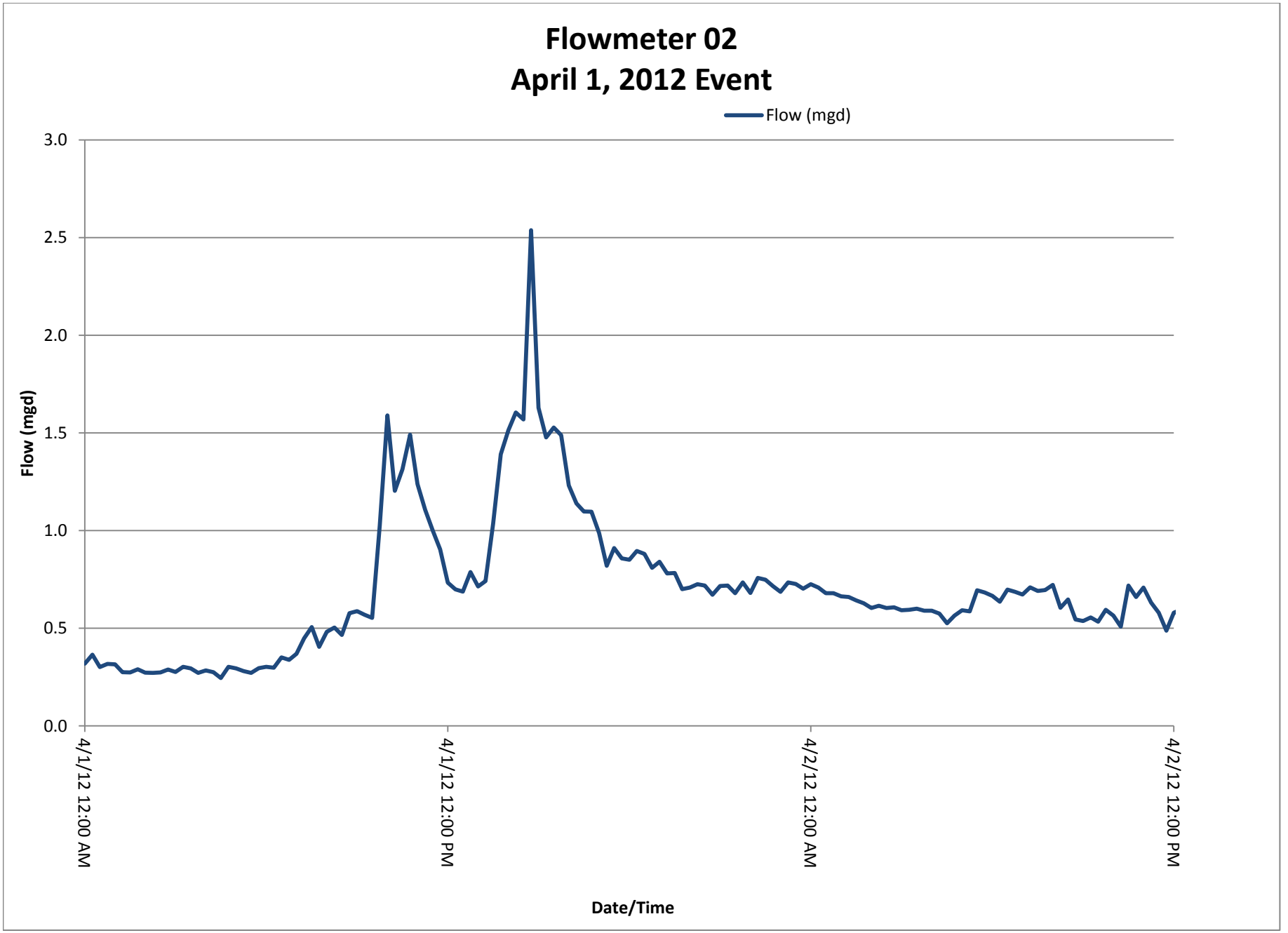

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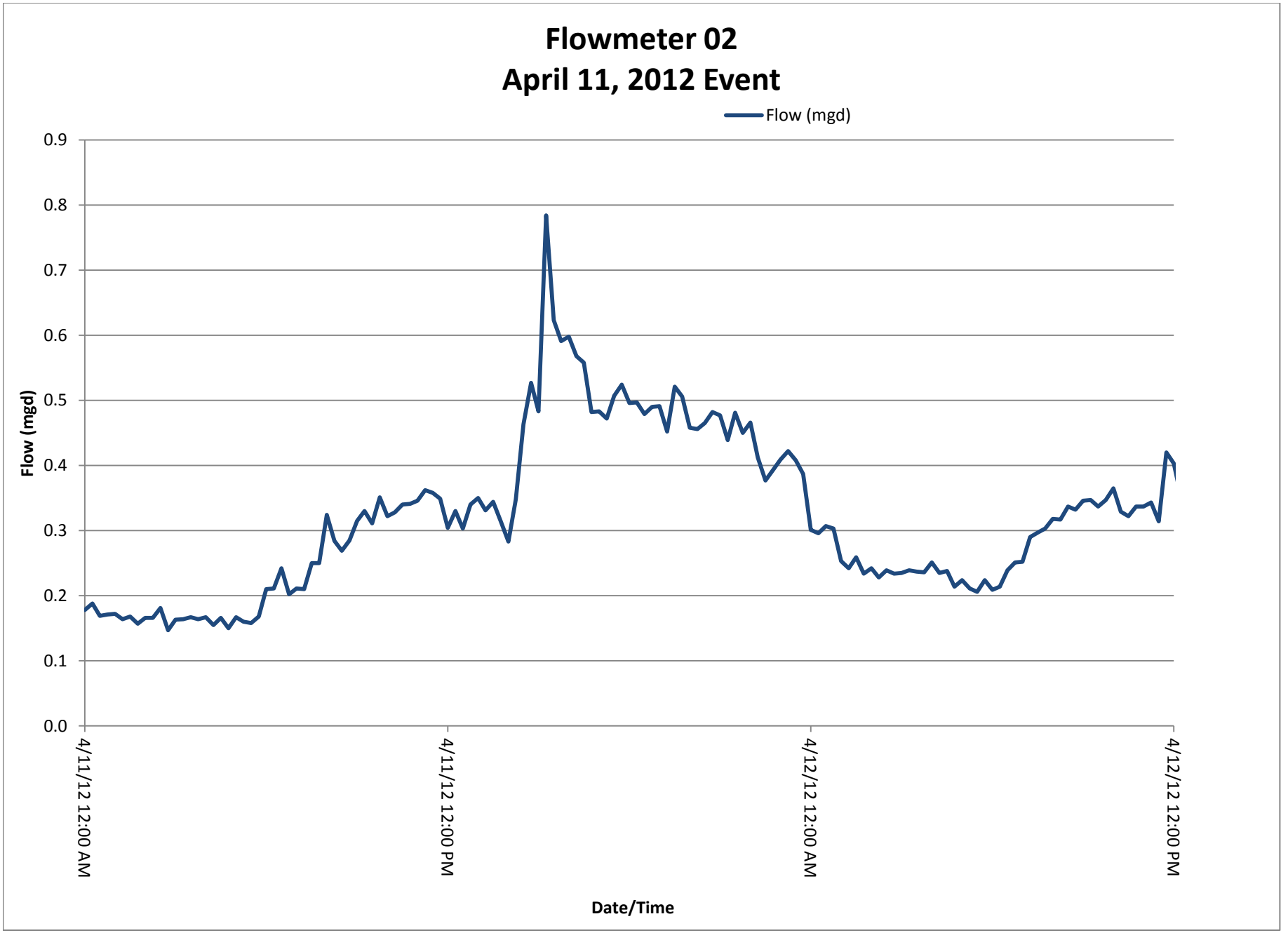

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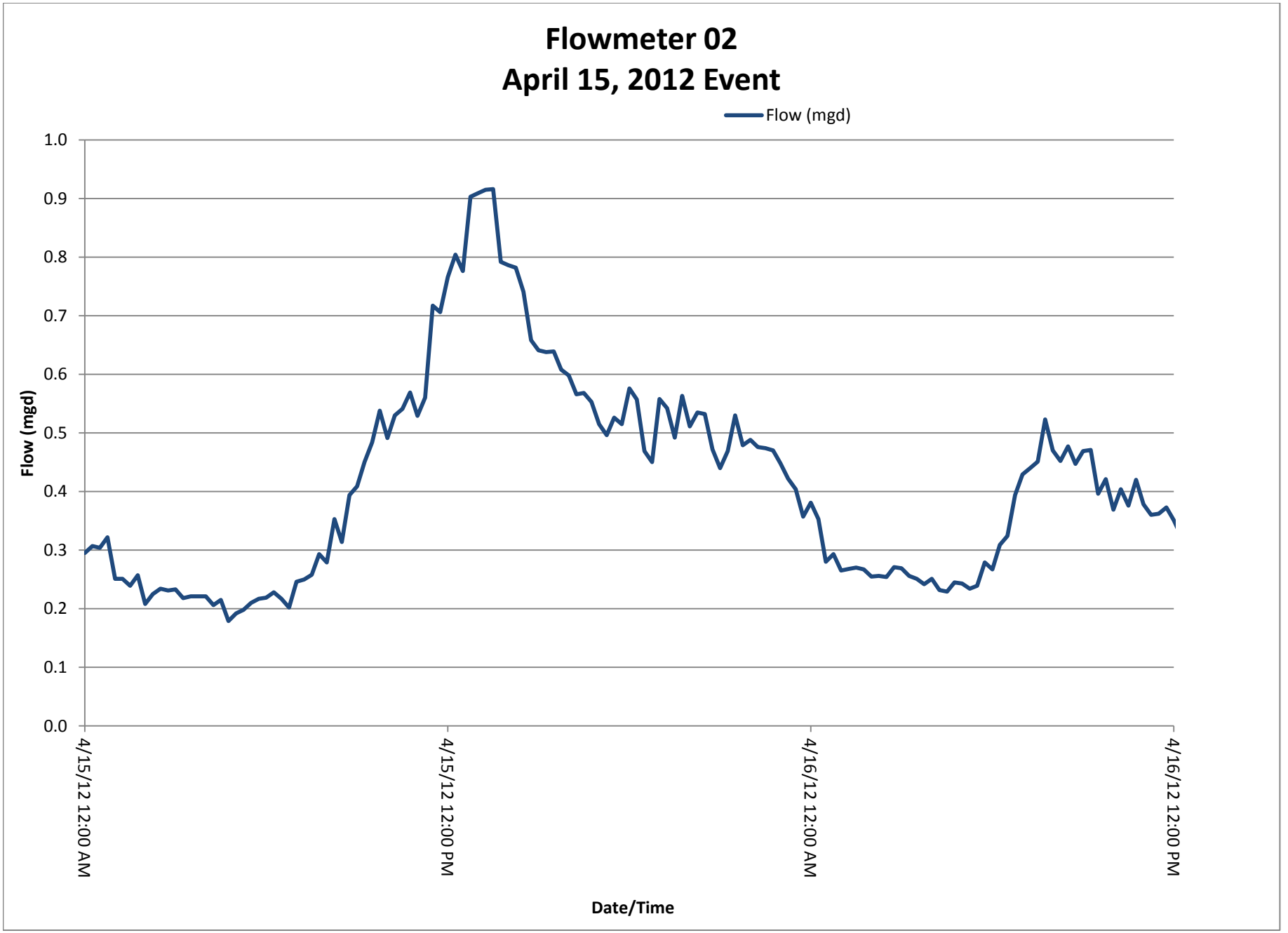

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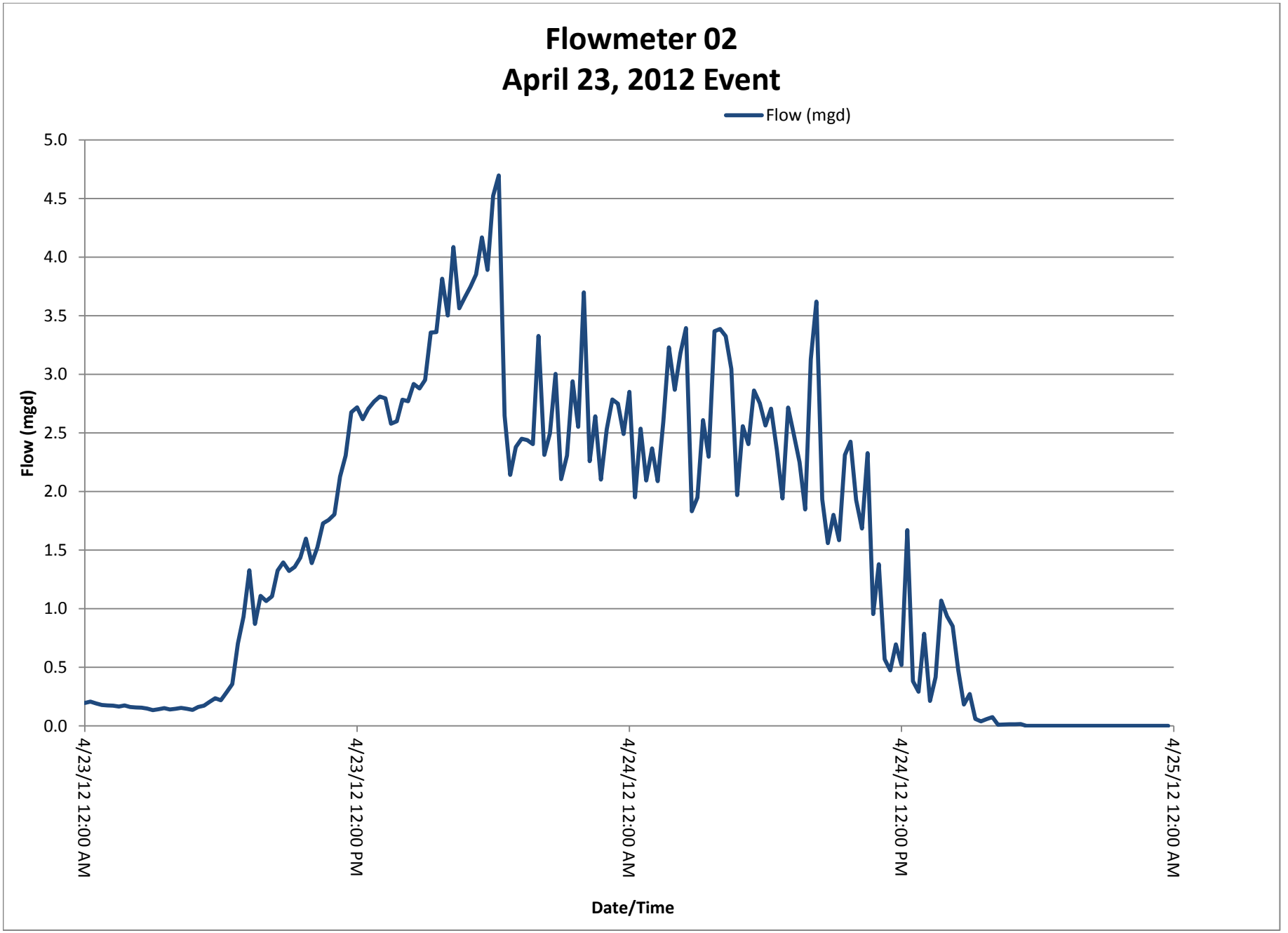

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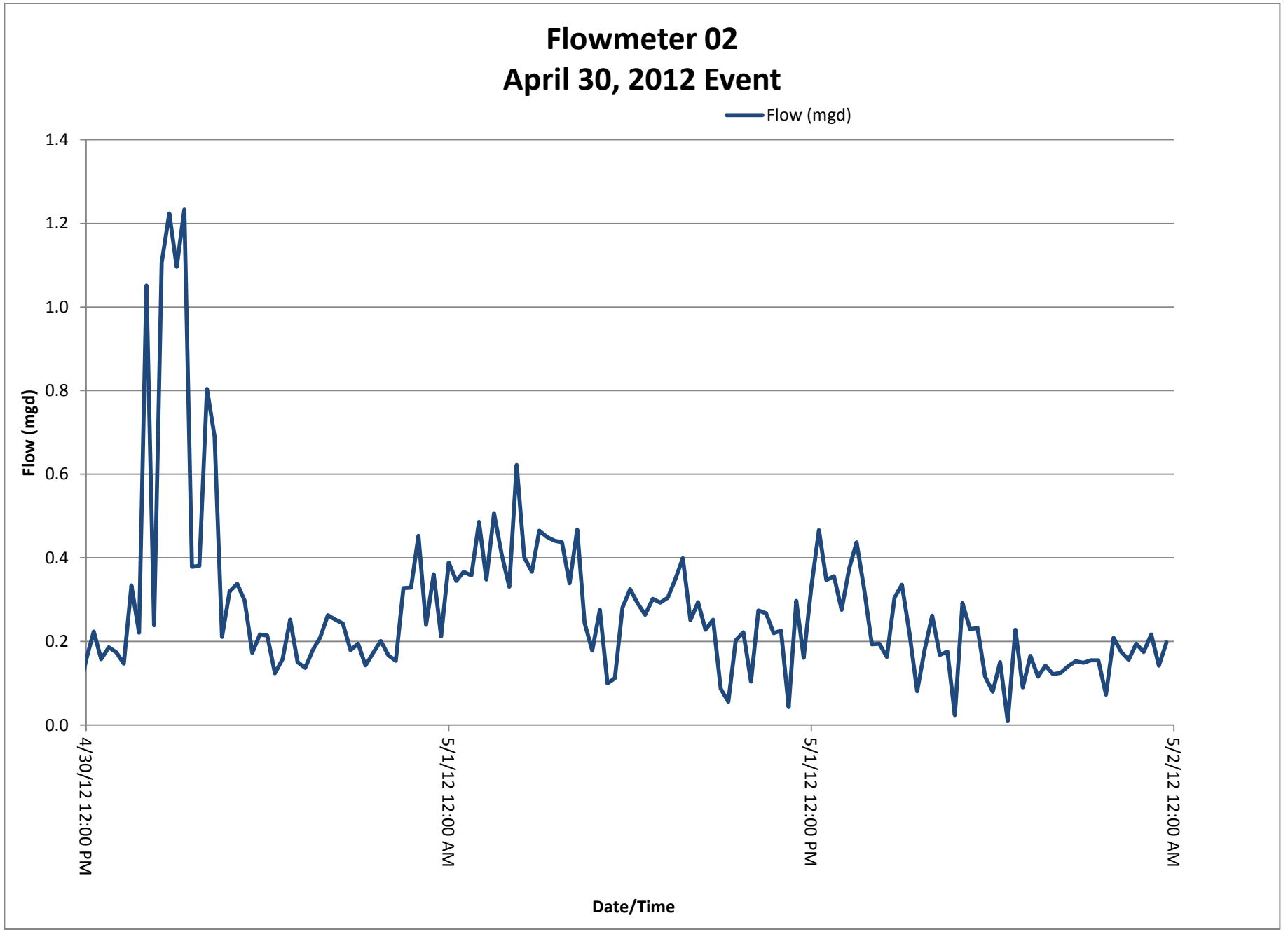

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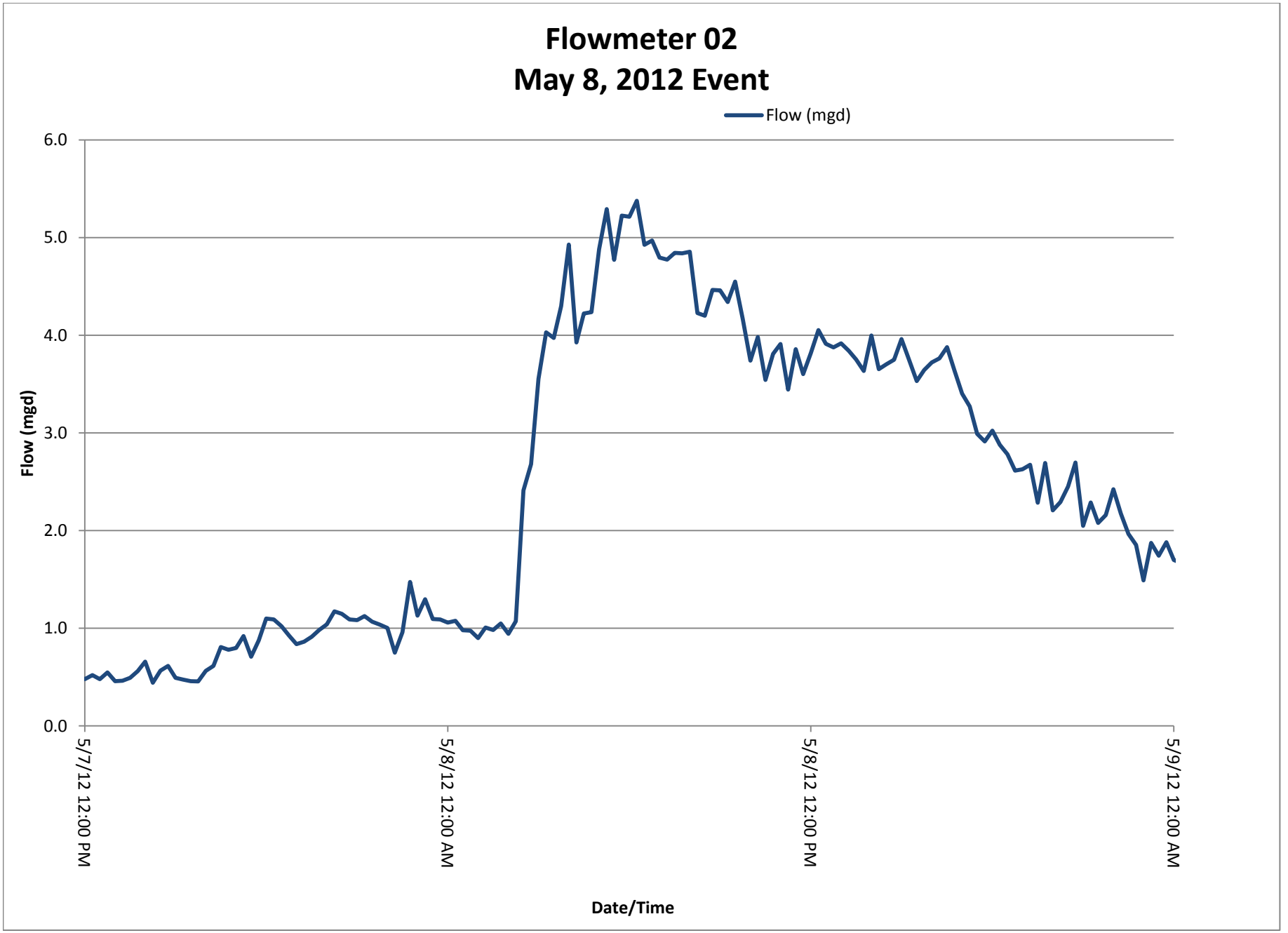

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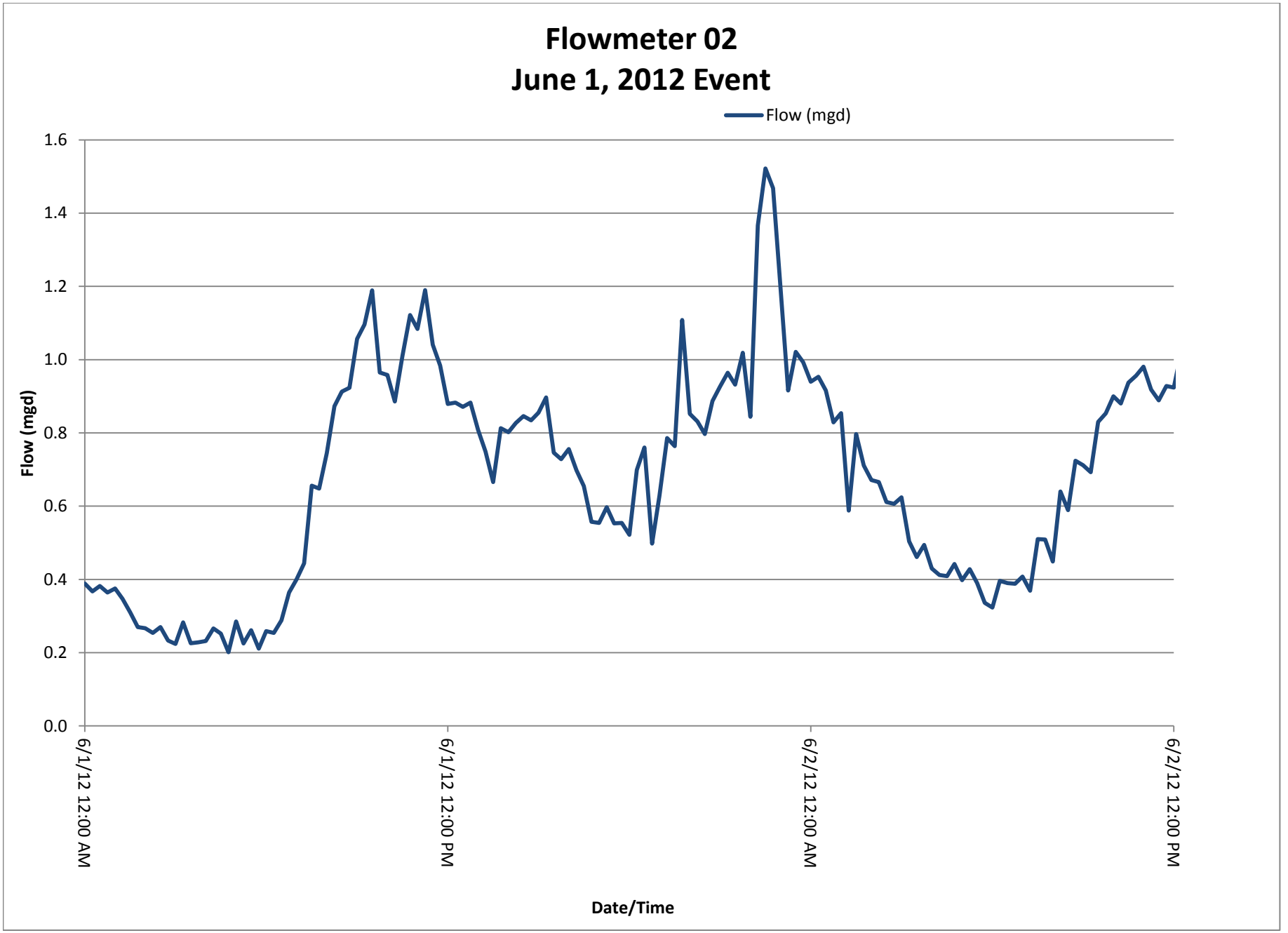

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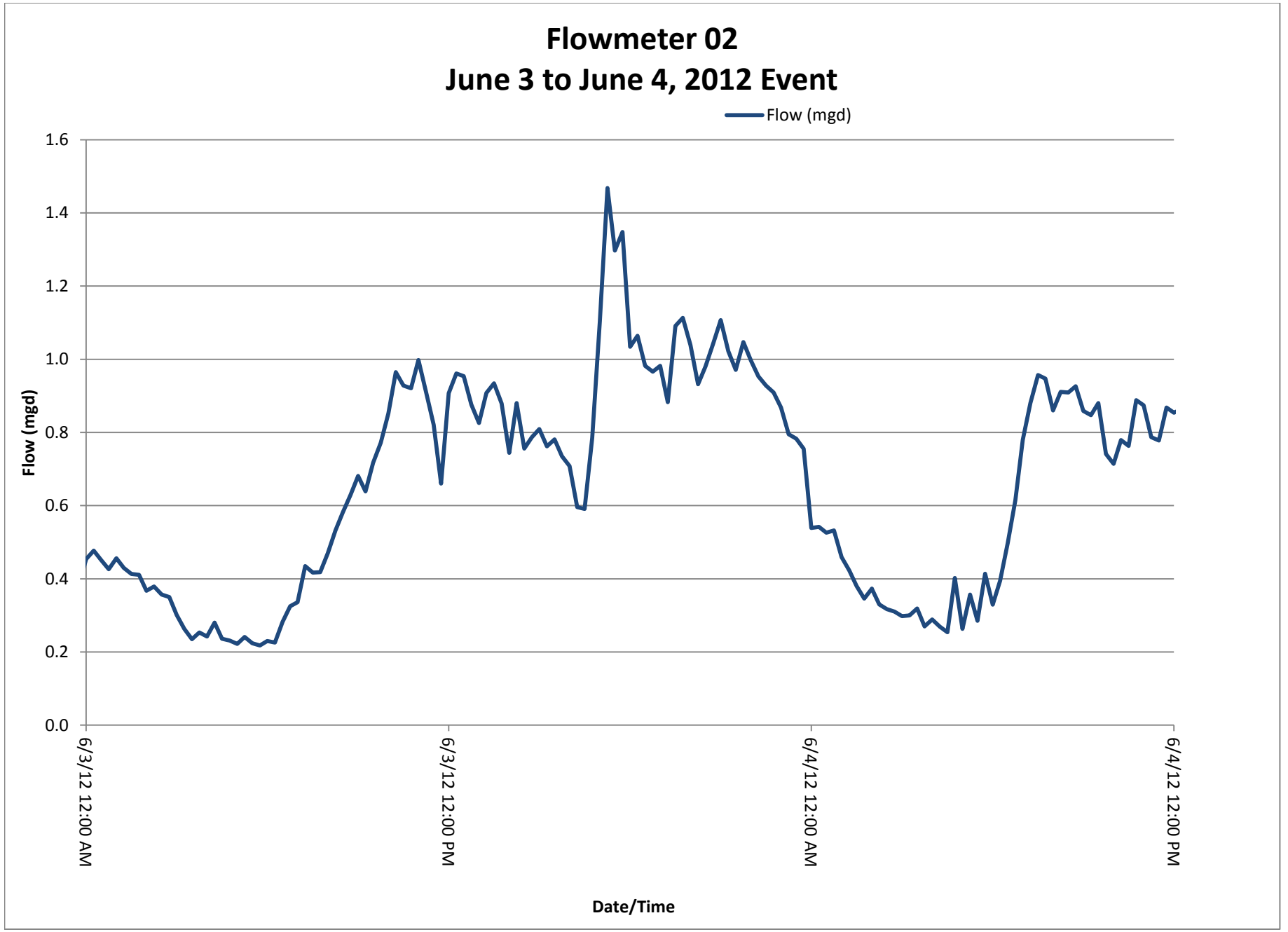

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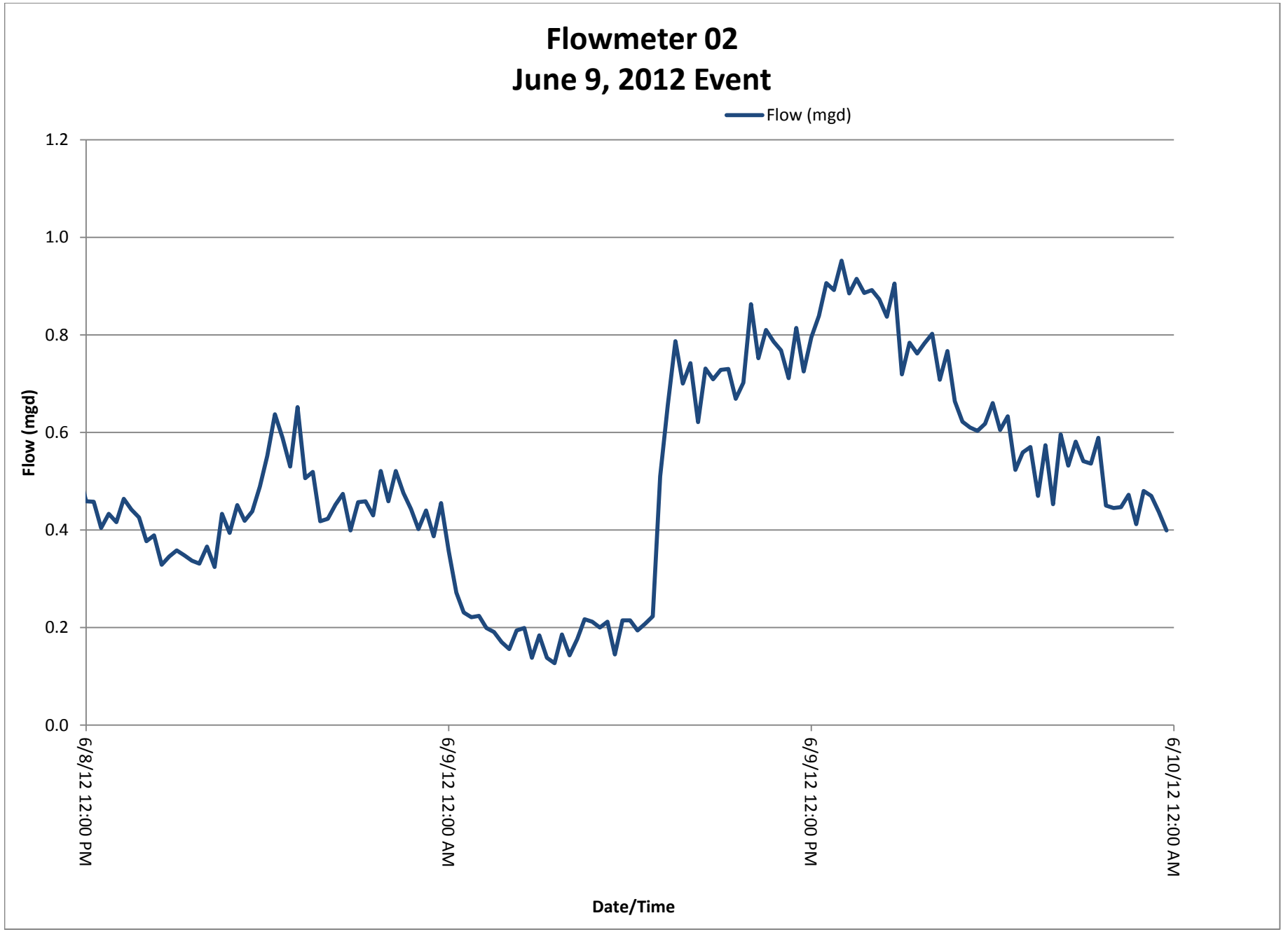

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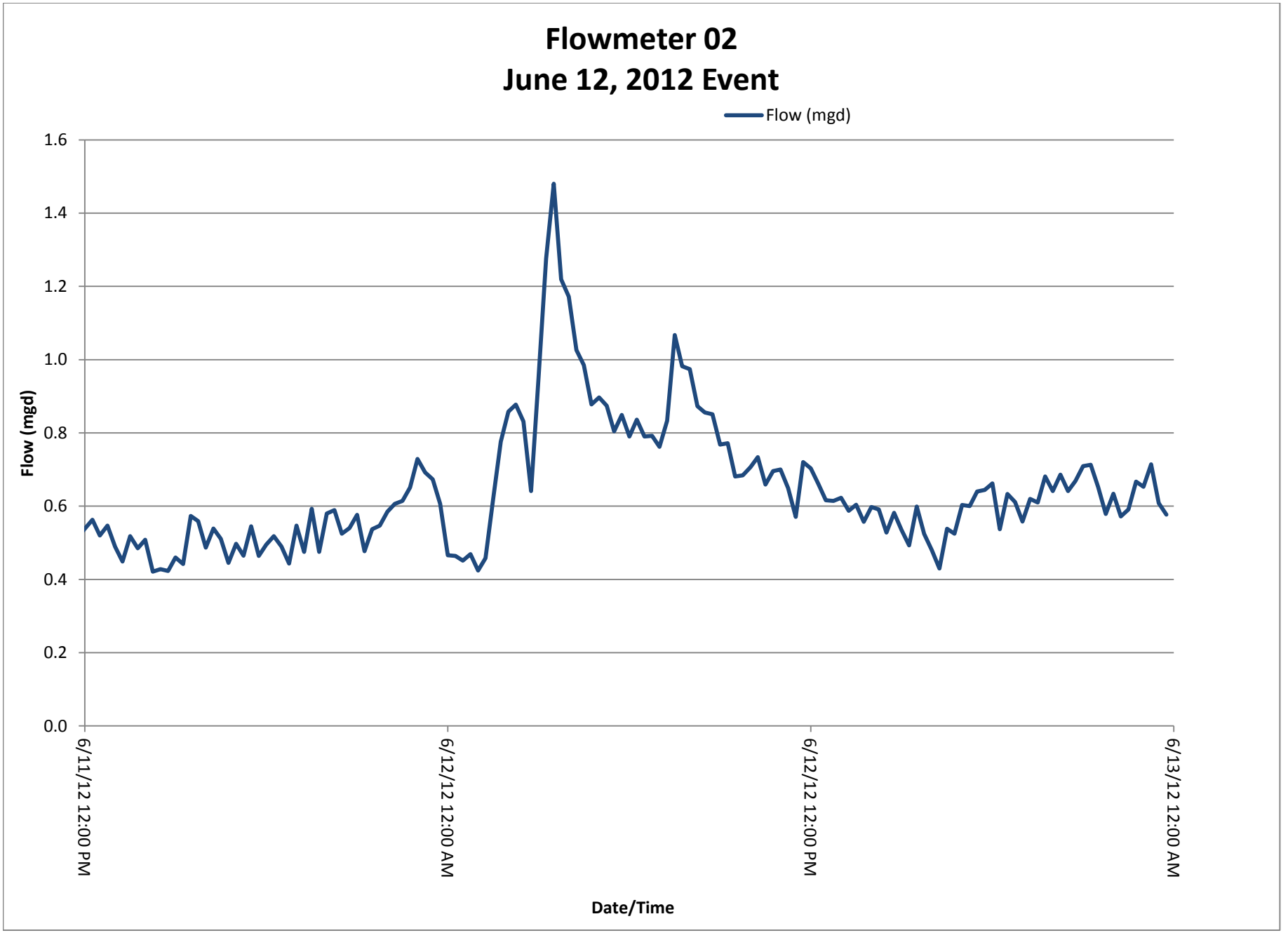

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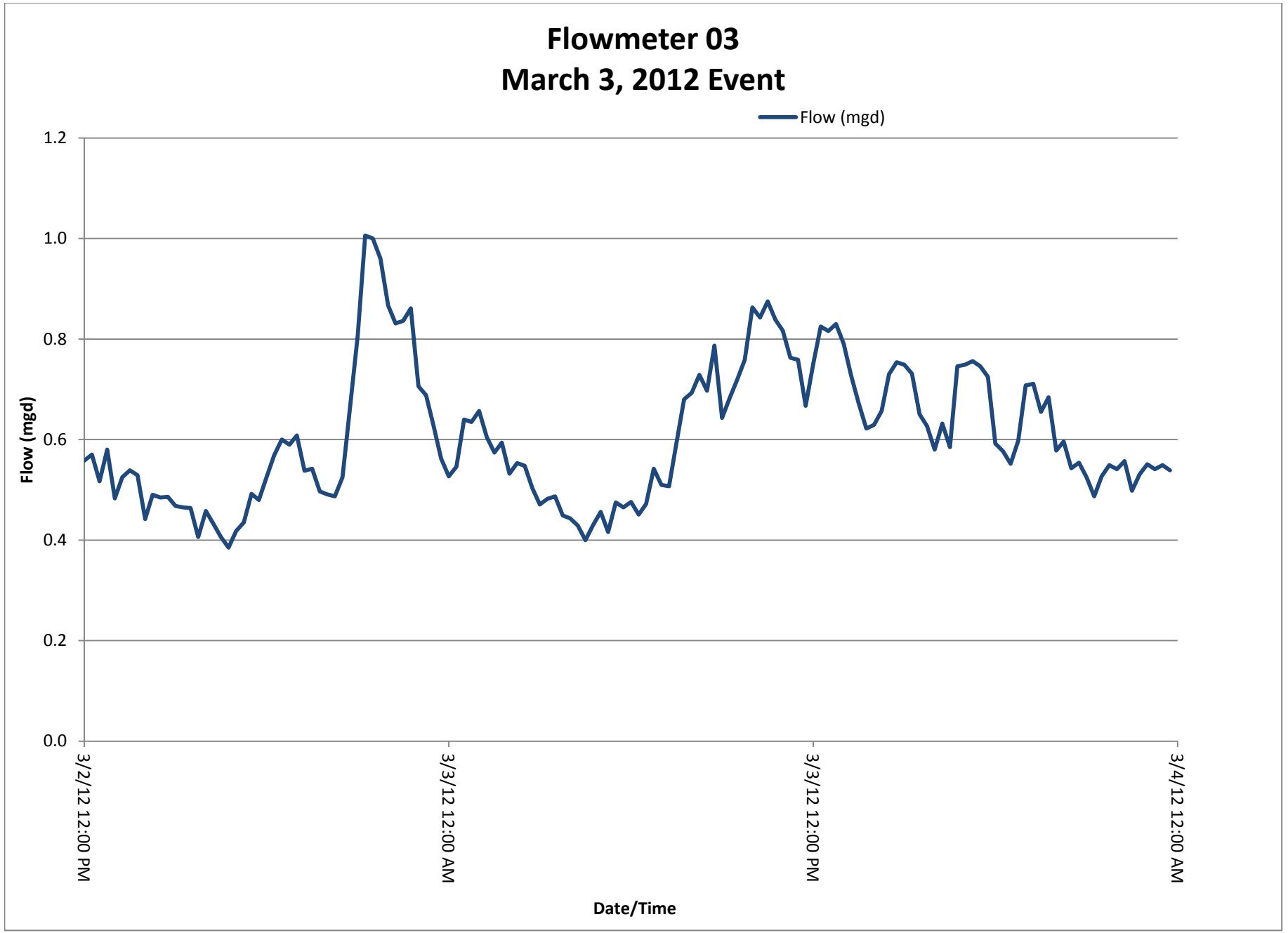
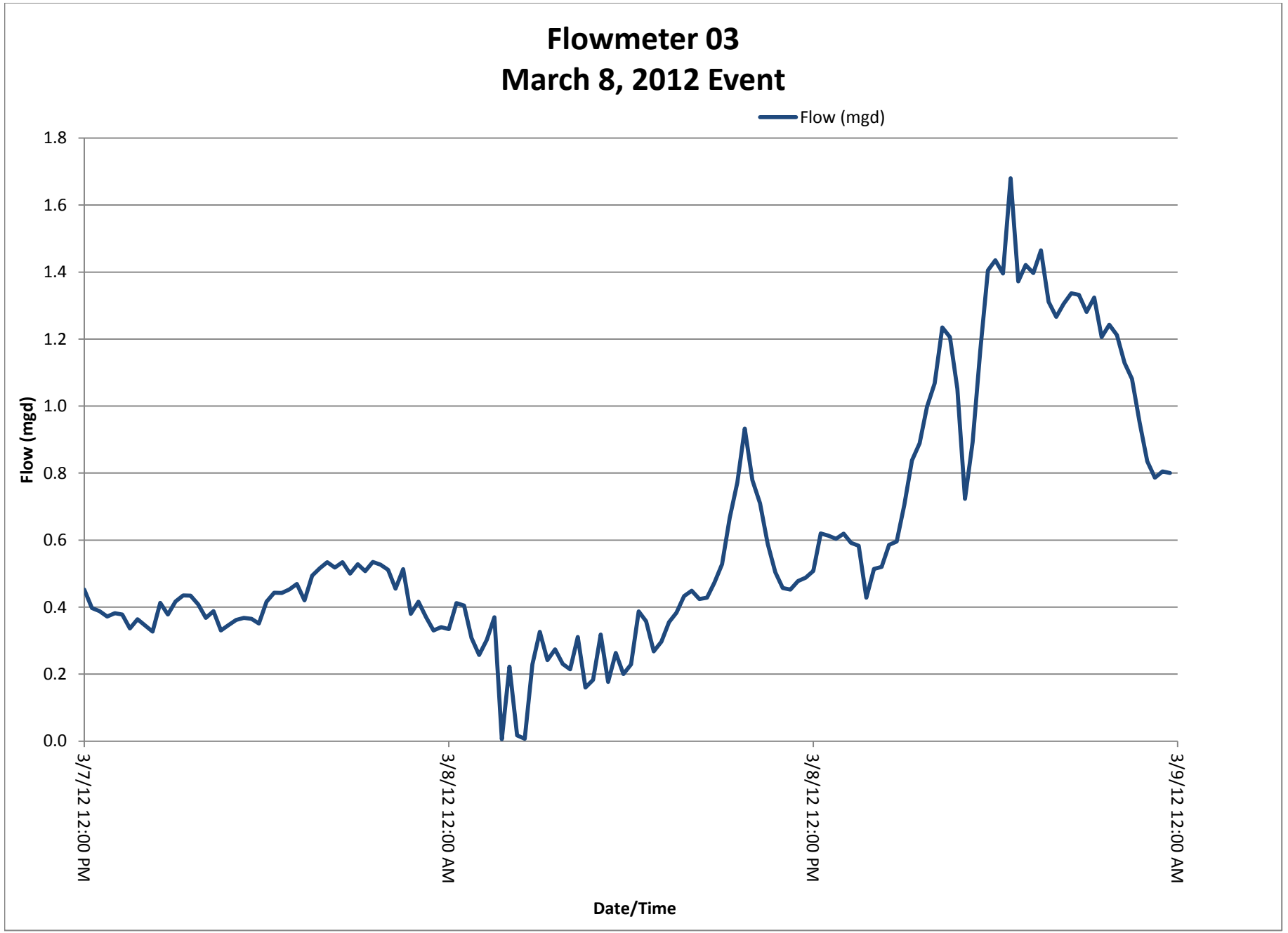
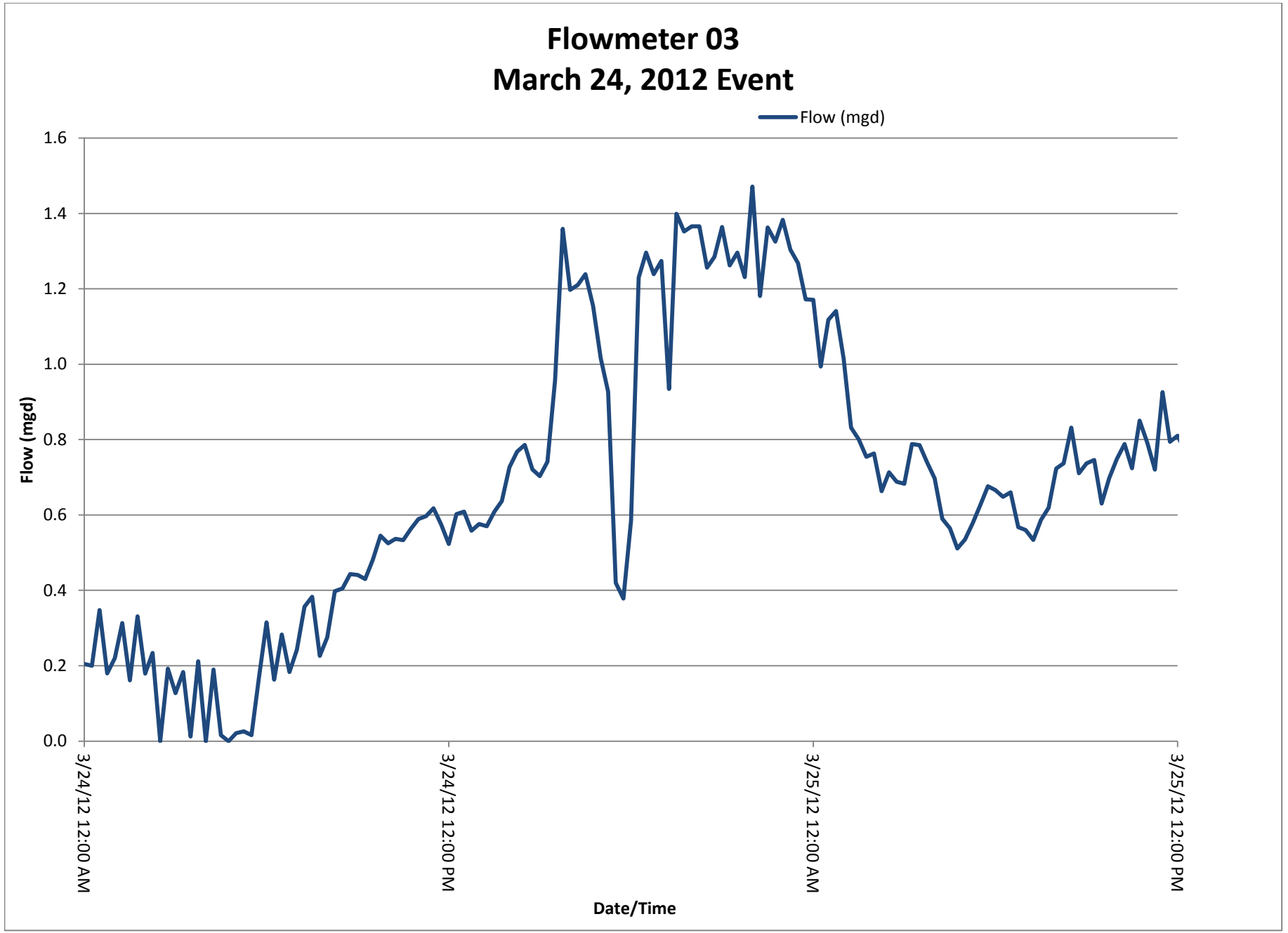
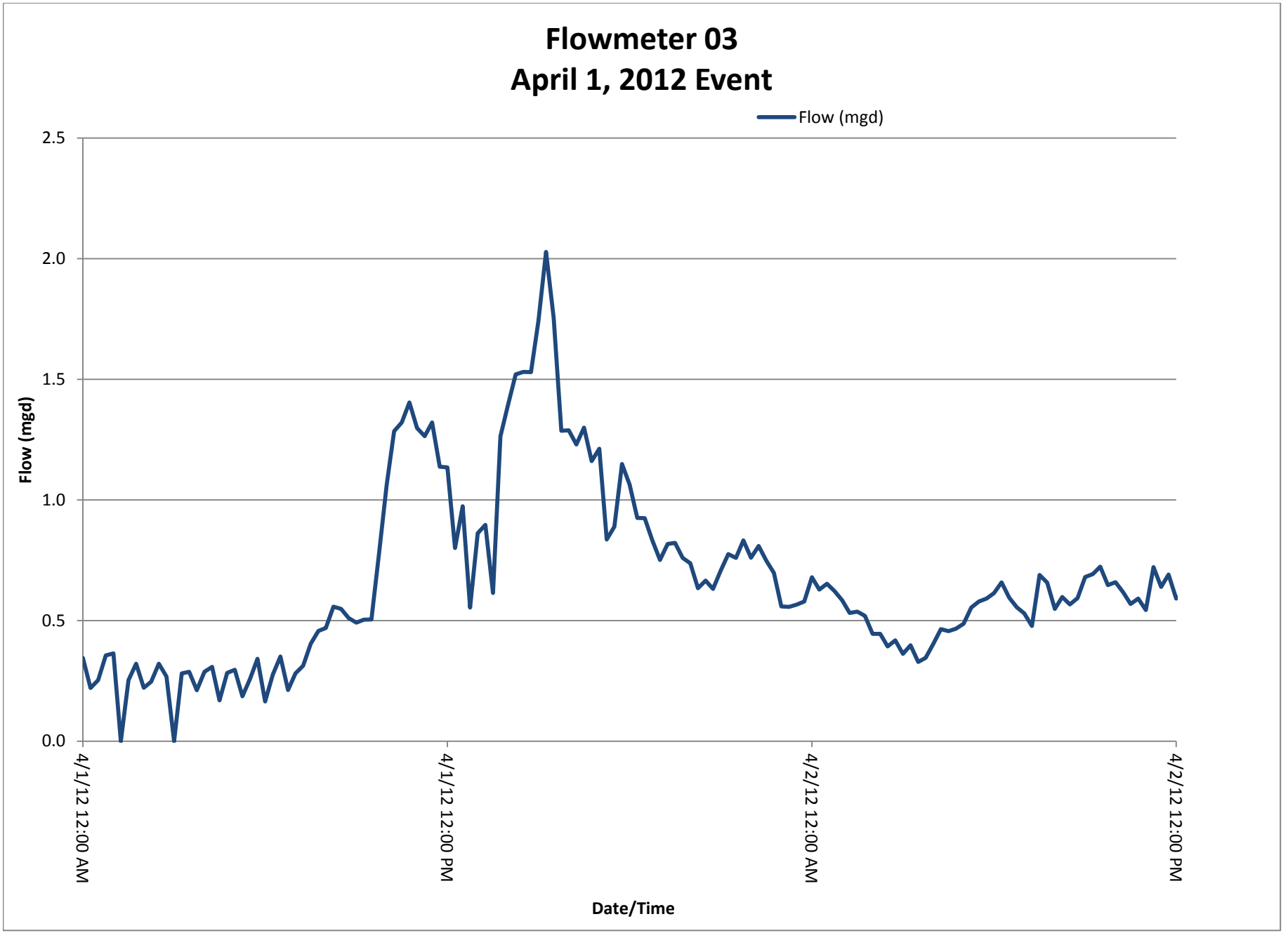
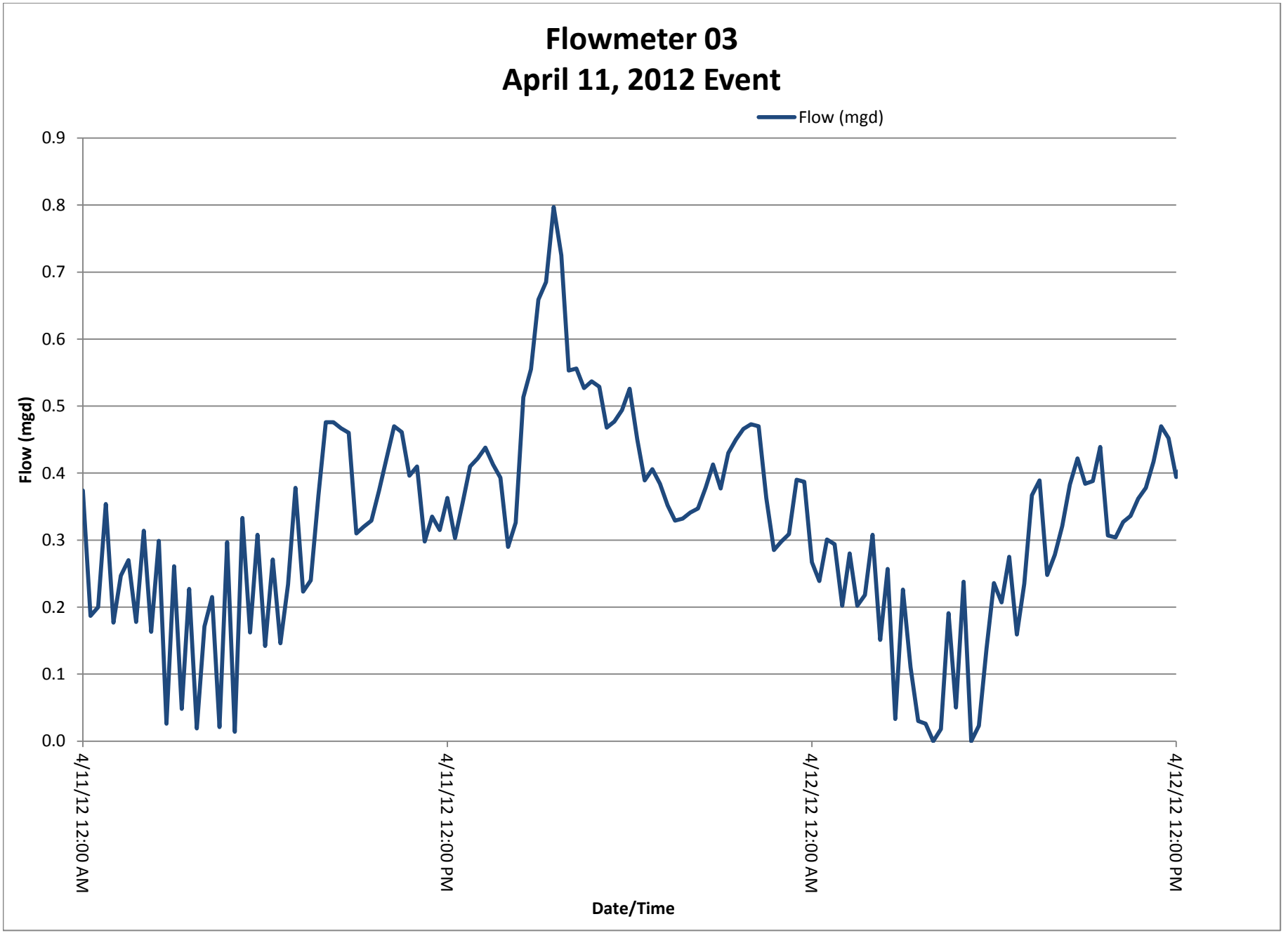
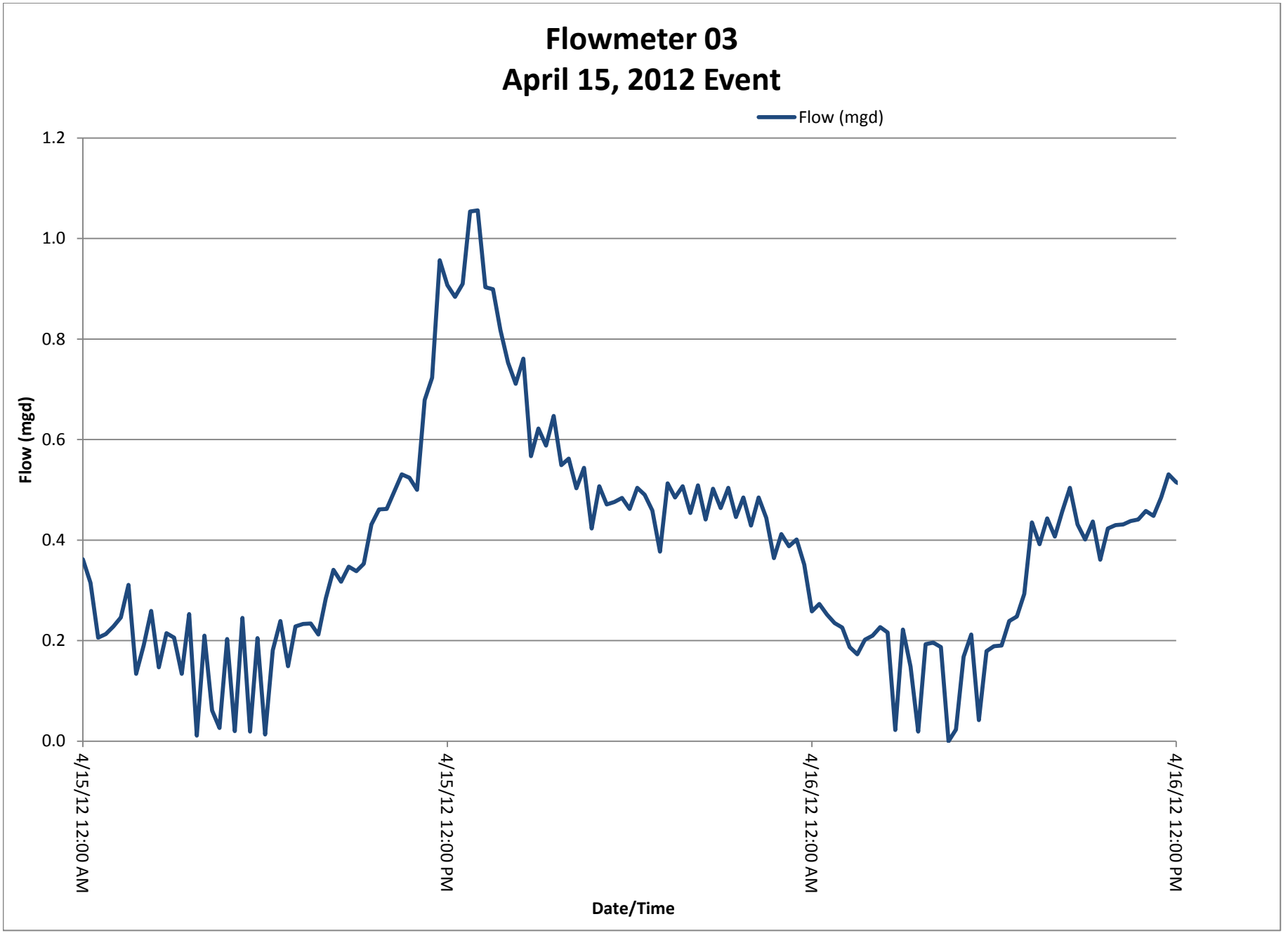

Flowmeter 03
March 3, 2012 Event
Flow (mgd)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (mgd)
3/2/12 12:00 PM
3/3/12 12:00 AM
3/3/12 12:00 PM
3/4/12 12:00 AM
Date/Time

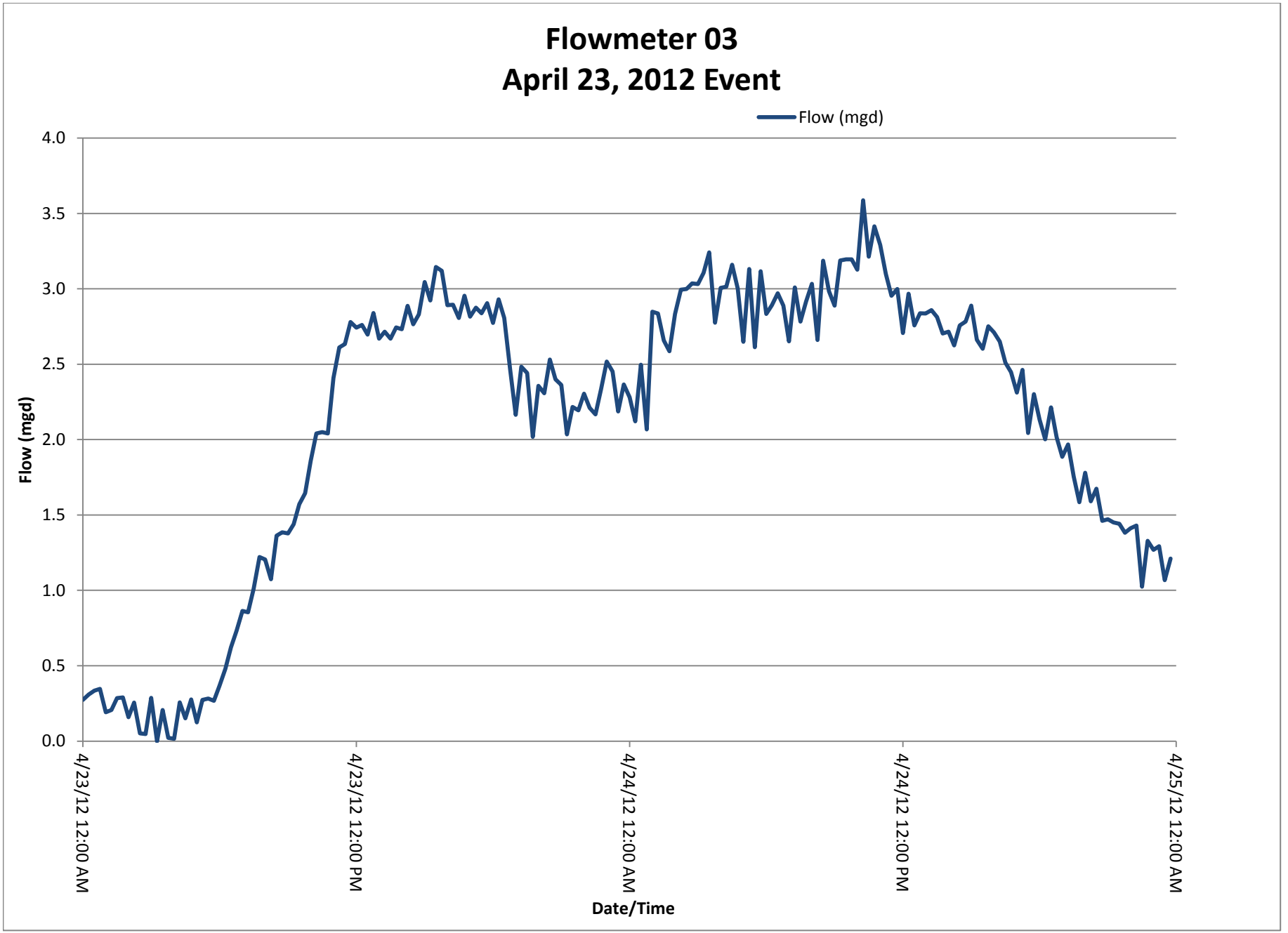

Flowmeter 03
March 8, 2012 Event
Flow (mgd)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (mgd)
3/7/12 12:00 PM
3/8/12 12:00 AM
3/8/12 12:00 PM
3/9/12 12:00 AM
Date/Time

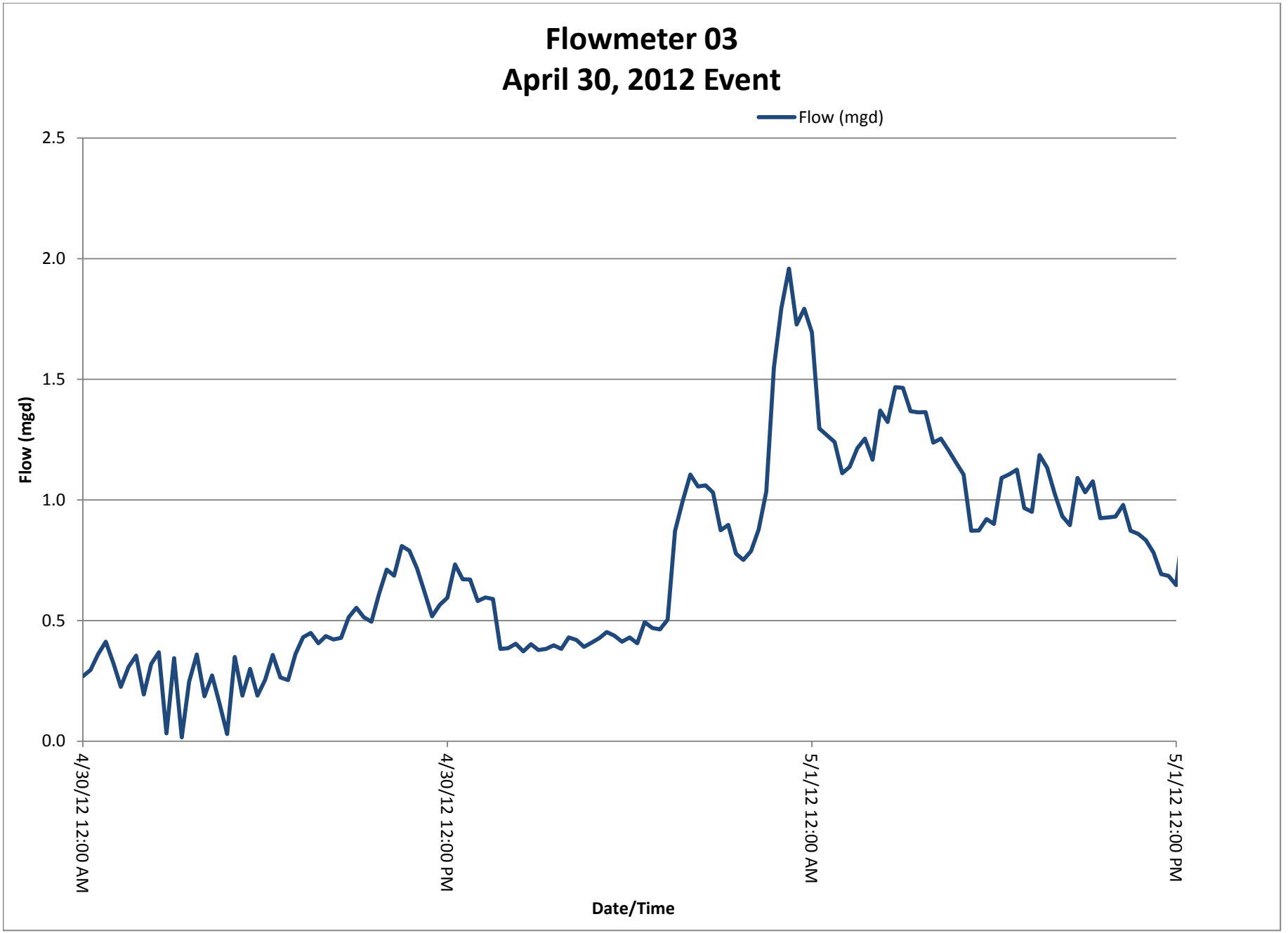

Flowmeter 03
March 24, 2012 Event
Flow (mgd)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (mgd)
3/24/12 12:00 AM
3/24/12 12:00 PM
3/25/12 12:00 AM
3/25/12 12:00 PM
Date/Time

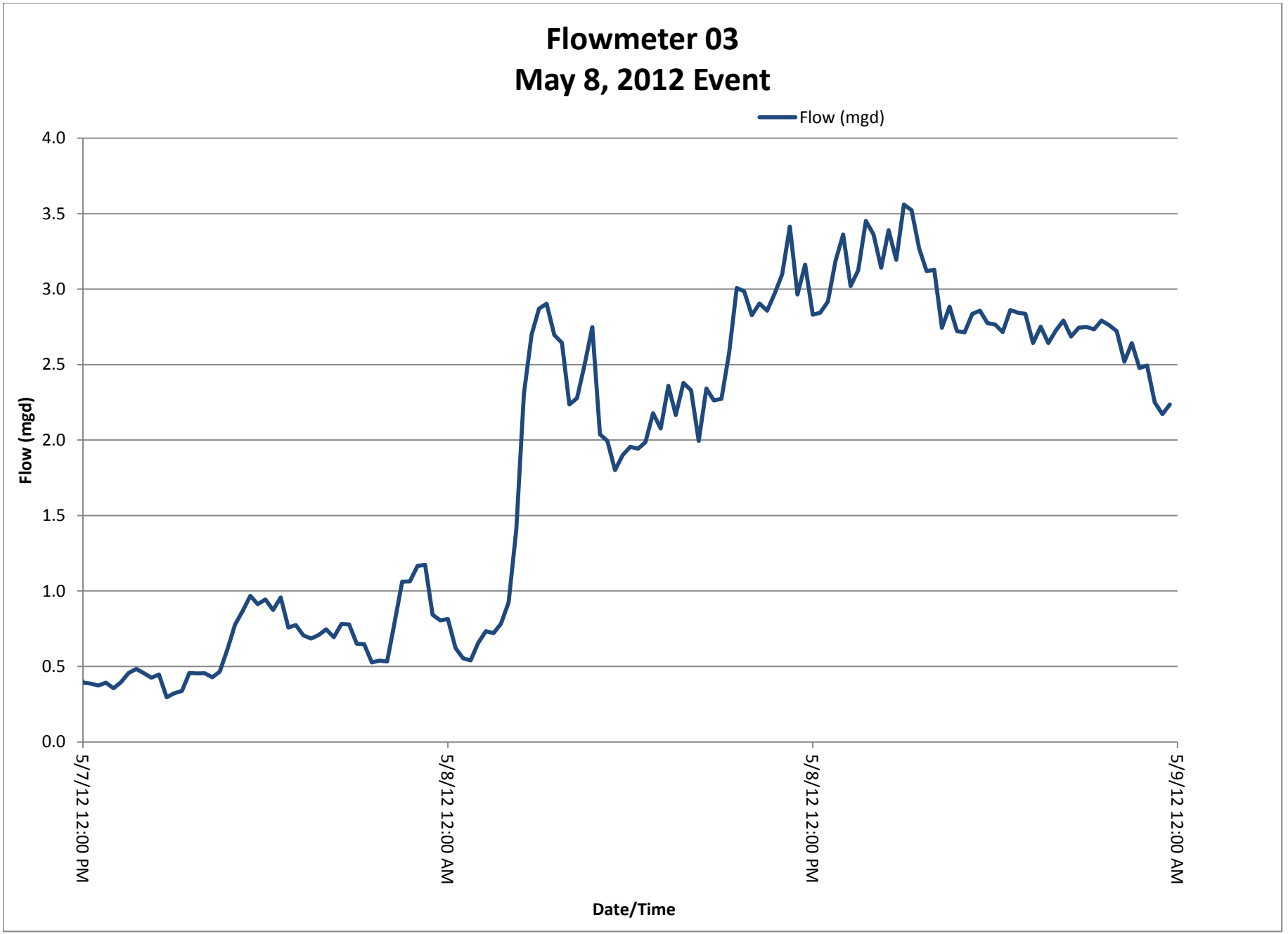

Flowmeter 03
April 1, 2012 Event
Flow (mgd)
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
4/1/12 12:00 AM
4/1/12 12:00 PM
4/2/12 12:00 AM
4/2/12 12:00 PM
Date/Time

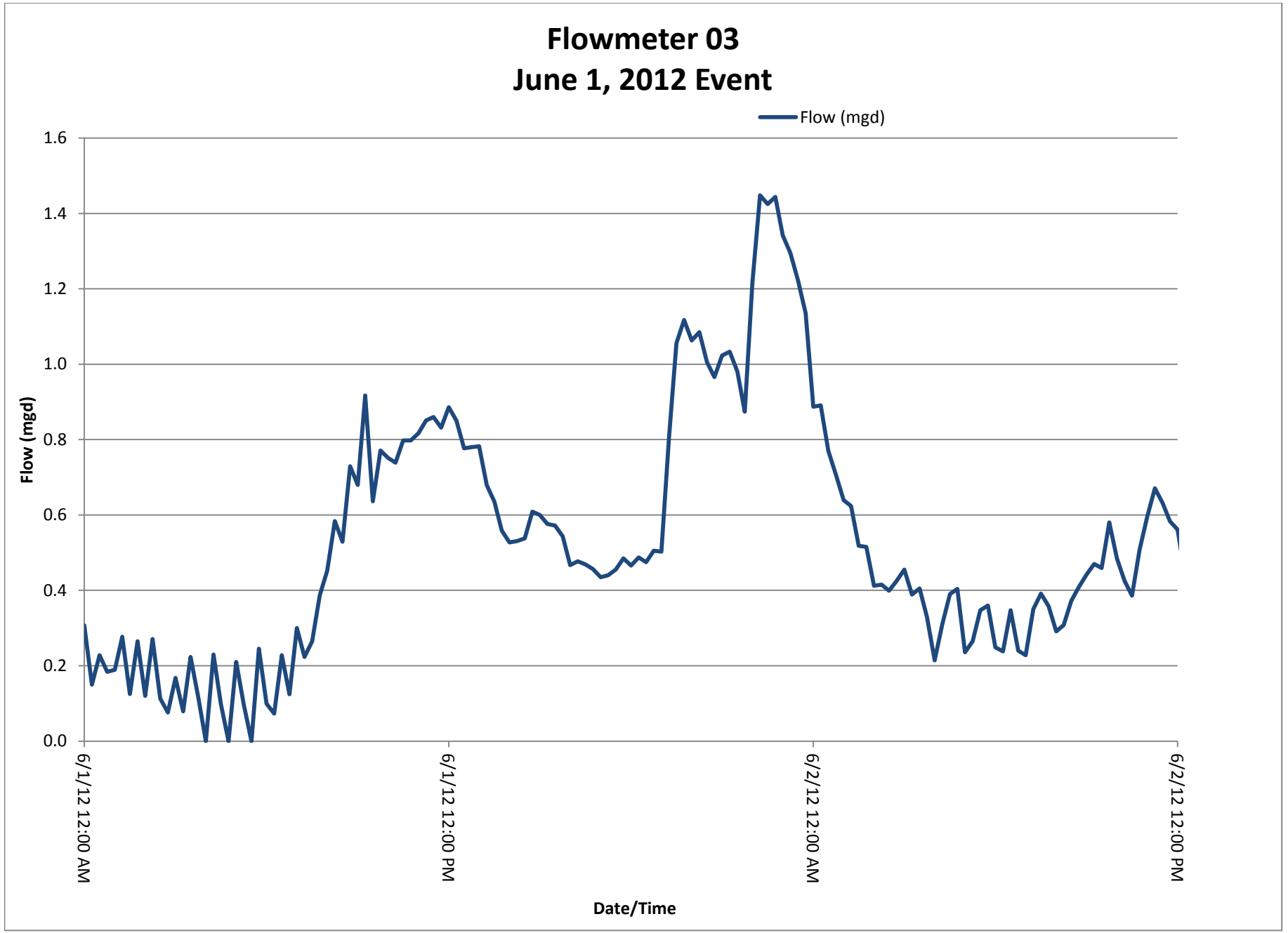

Flowmeter 03
April 11, 2012 Event
Flow (mgd)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Flow (mgd)
4/11/12 12:00 AM
4/11/12 12:00 PM
4/12/12 12:00 AM
4/12/12 12:00 PM
Date/Time

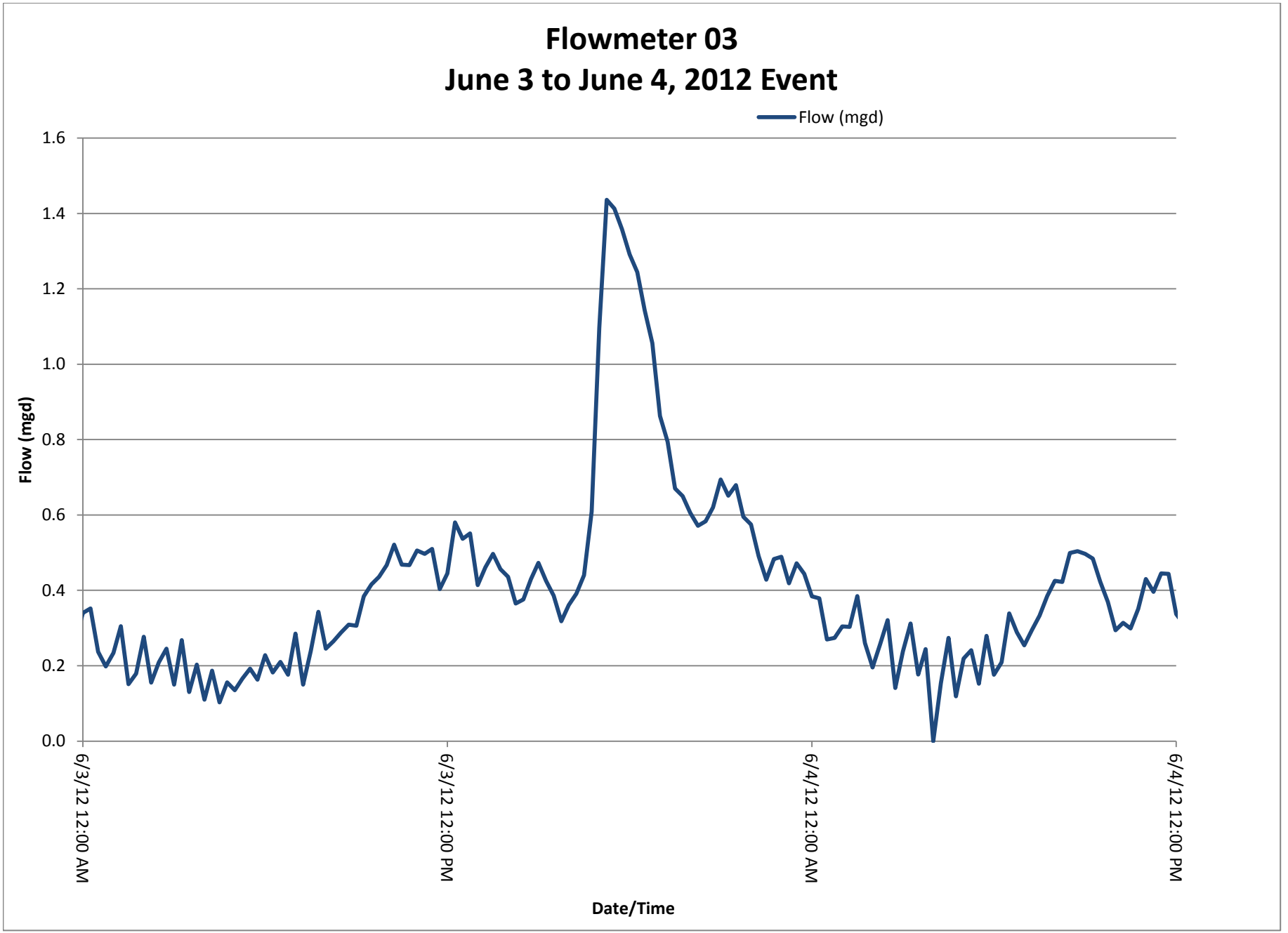

Flowmeter 03
April 15, 2012 Event
Flow (mgd)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (mgd)
4/15/12 12:00 AM
4/15/12 12:00 PM
4/16/12 12:00 AM
4/16/12 12:00 PM
Date/Time

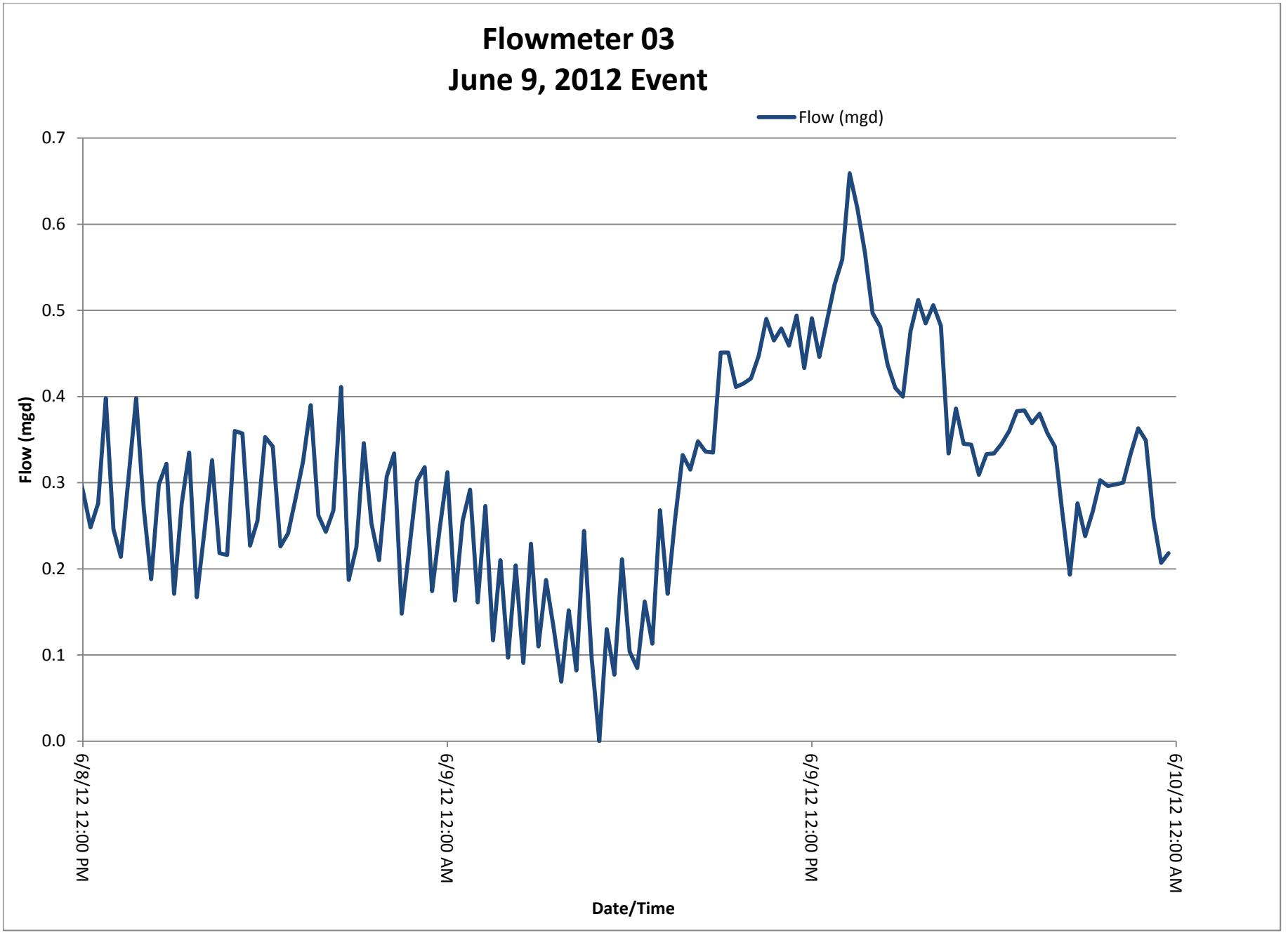

Flowmeter 03
April 23, 2012 Event
Flow (mgd)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
4/23/12 12:00 AM
4/23/12 12:00 PM
4/24/12 12:00 AM
4/24/12 12:00 PM
4/25/12 12:00 AM
Date/Time

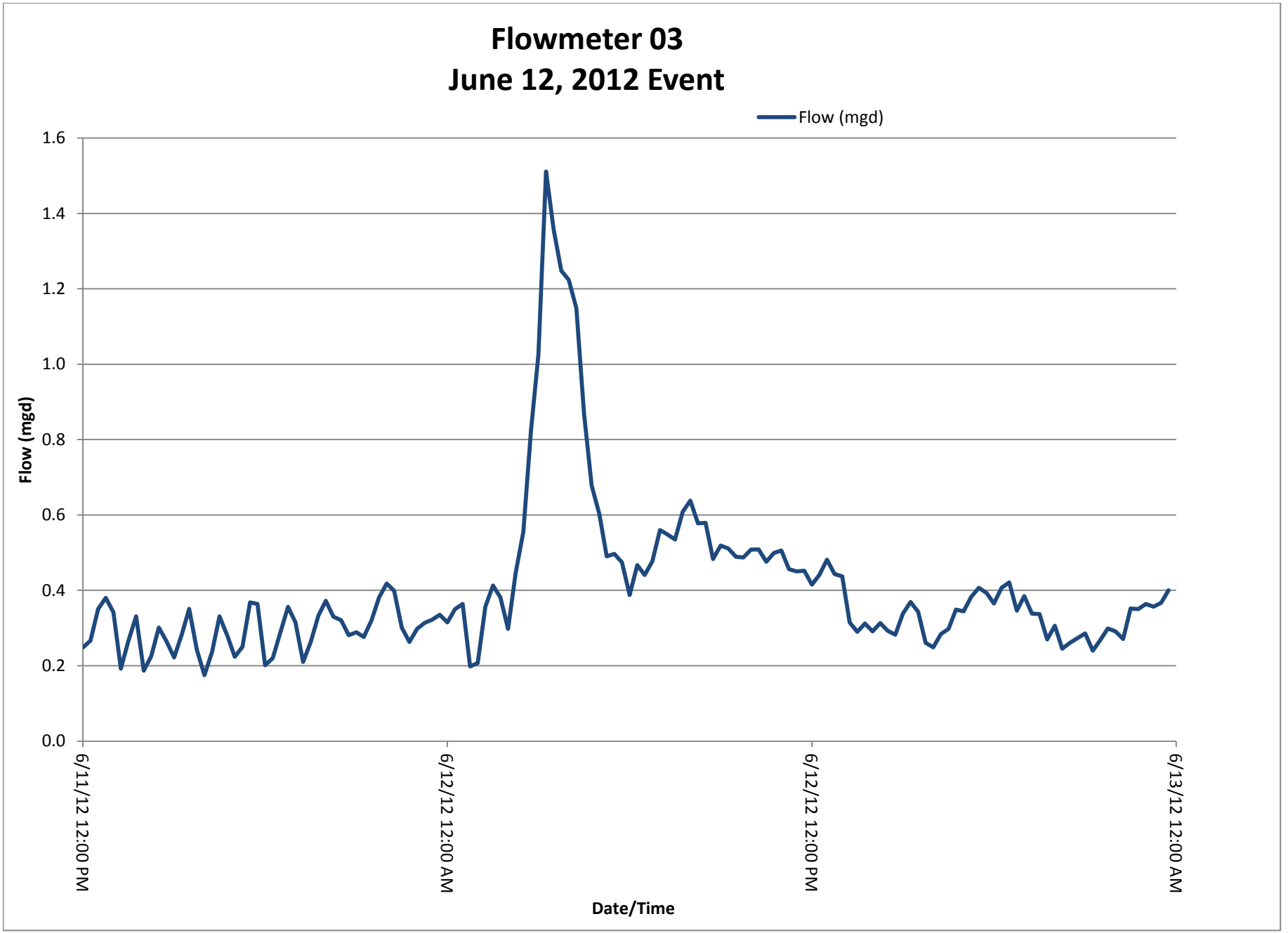

Flowmeter 03
April 30, 2012 Event
Flow (mgd)
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
4/30/12 12:00 AM
4/30/12 12:00 PM
5/1/12 12:00 AM
5/1/12 12:00 PM
Date/Time

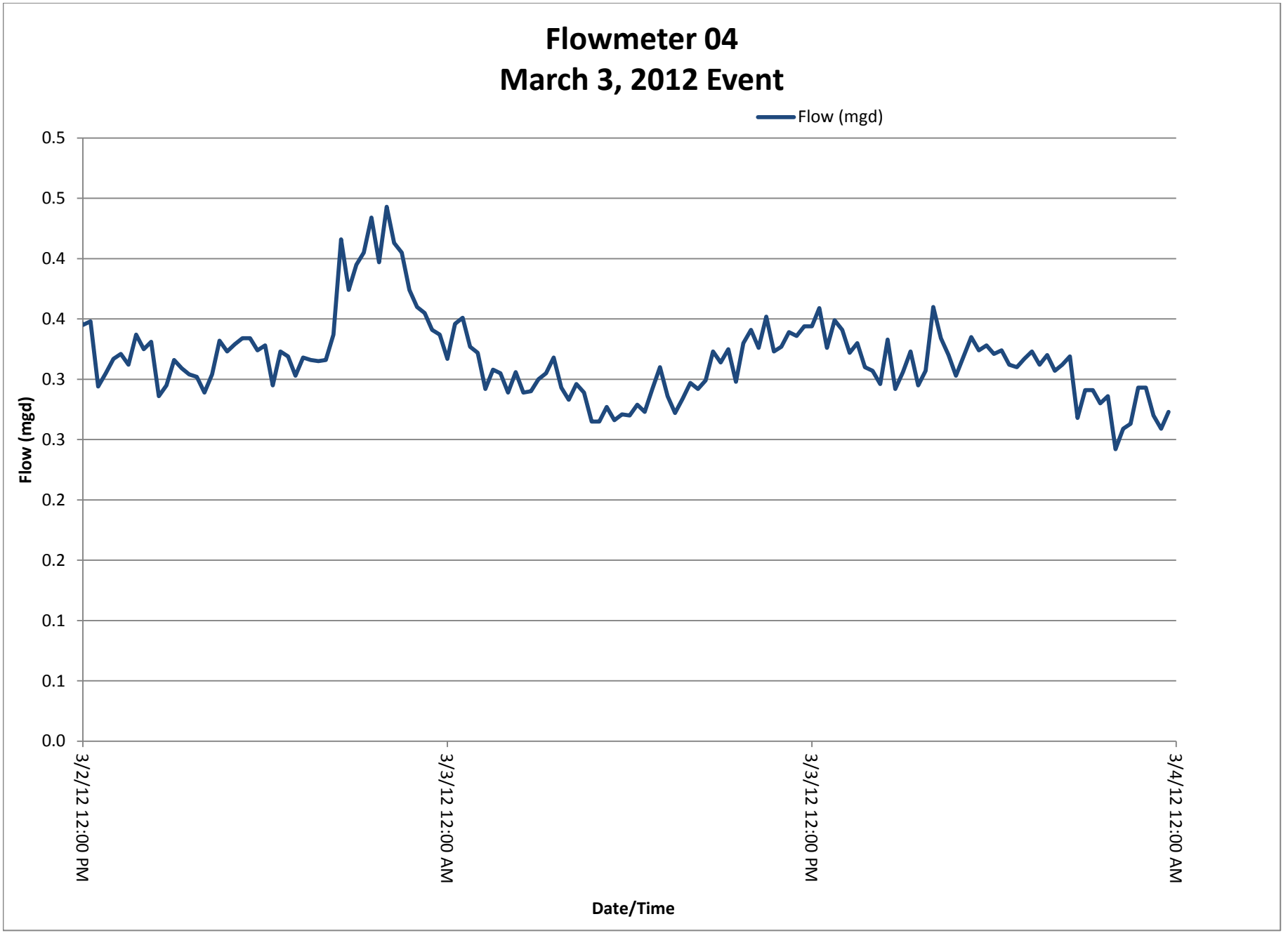

Flowmeter 03
May 8, 2012 Event
Flow (mgd)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
5/7/12 12:00 PM
5/8/12 12:00 AM
5/8/12 12:00 PM
5/9/12 12:00 AM
Date/Time


Flowmeter 03
June 1, 2012 Event
Flow (mgd)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (mgd)
6/1/12 12:00 AM
6/1/12 12:00 PM
6/2/12 12:00 AM
6/2/12 12:00 PM
Date/Time


Flowmeter 03
June 3 to June 4, 2012 Event
Flow (mgd)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (mgd)
6/3/12 12:00 AM
6/3/12 12:00 PM
6/4/12 12:00 AM
6/4/12 12:00 PM
Date/Time


Flowmeter 03
June 9, 2012 Event
Flow (mgd)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Flow (mgd)
6/8/12 12:00 PM
6/9/12 12:00 AM
6/9/12 12:00 PM
6/10/12 12:00 AM
Date/Time


Flowmeter 03
June 12, 2012 Event
Flow (mgd)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (mgd)
6/11/12 12:00 PM
6/12/12 12:00 AM
6/12/12 12:00 PM
6/13/12 12:00 AM
Date/Time



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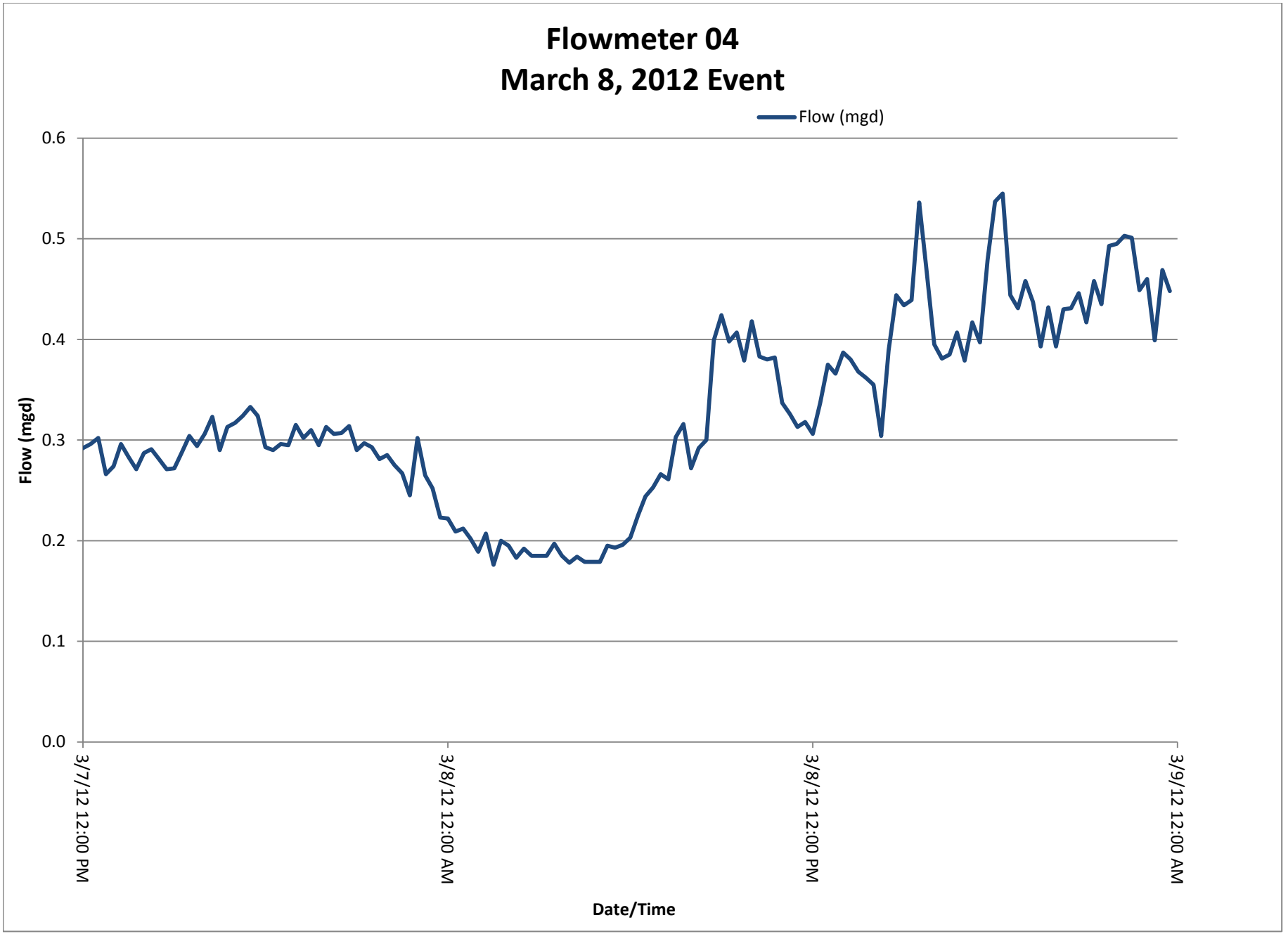

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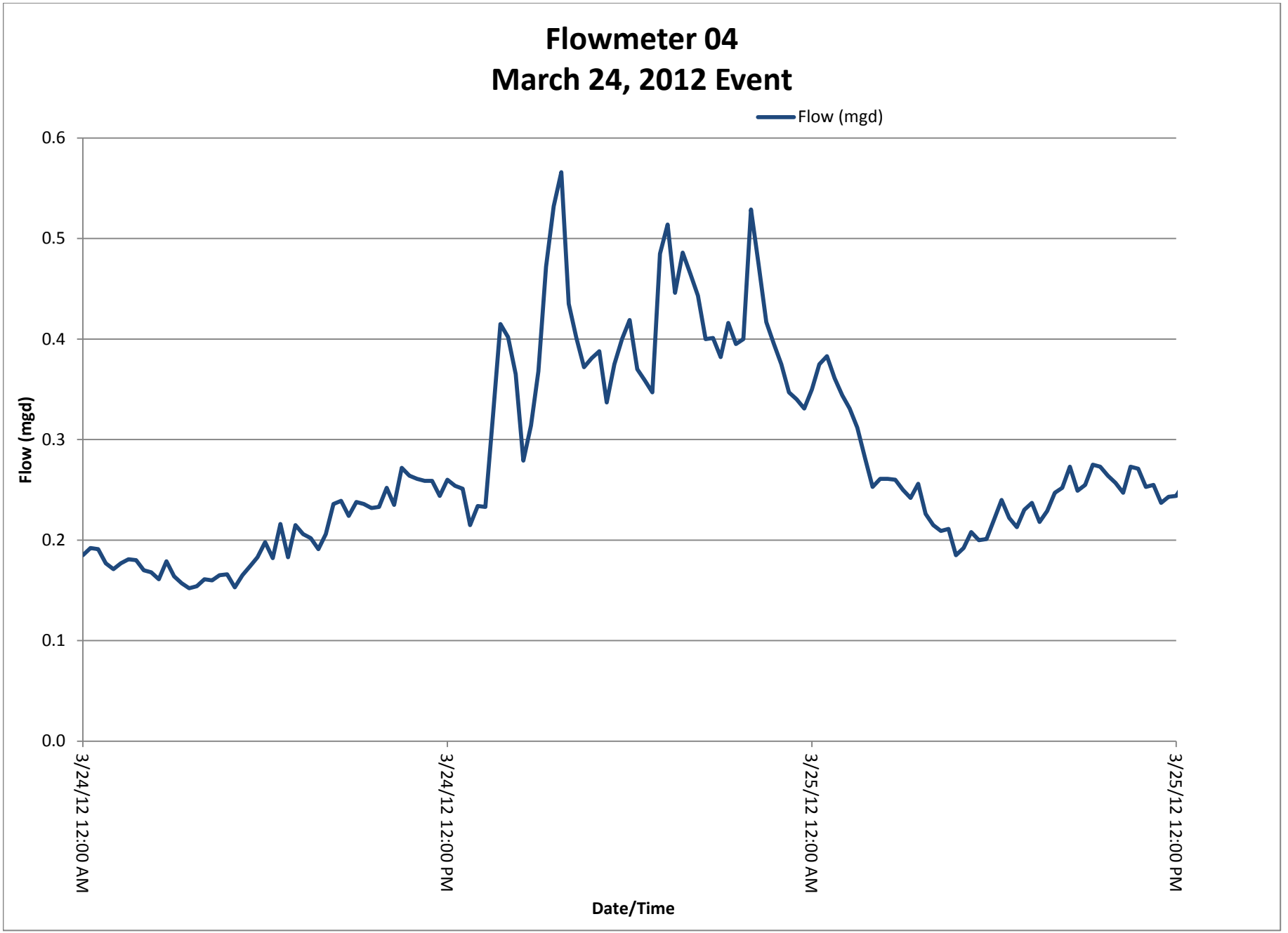

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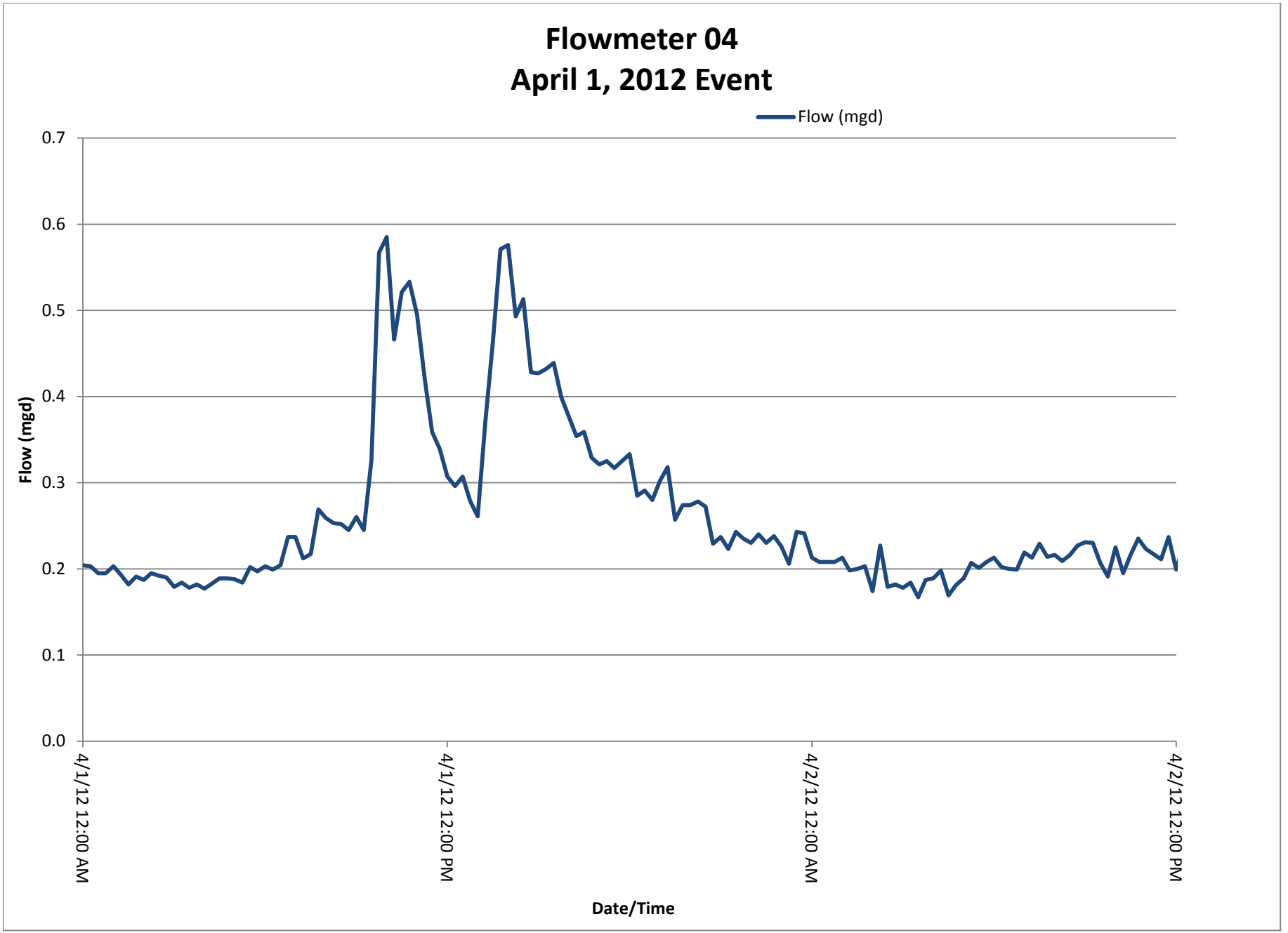

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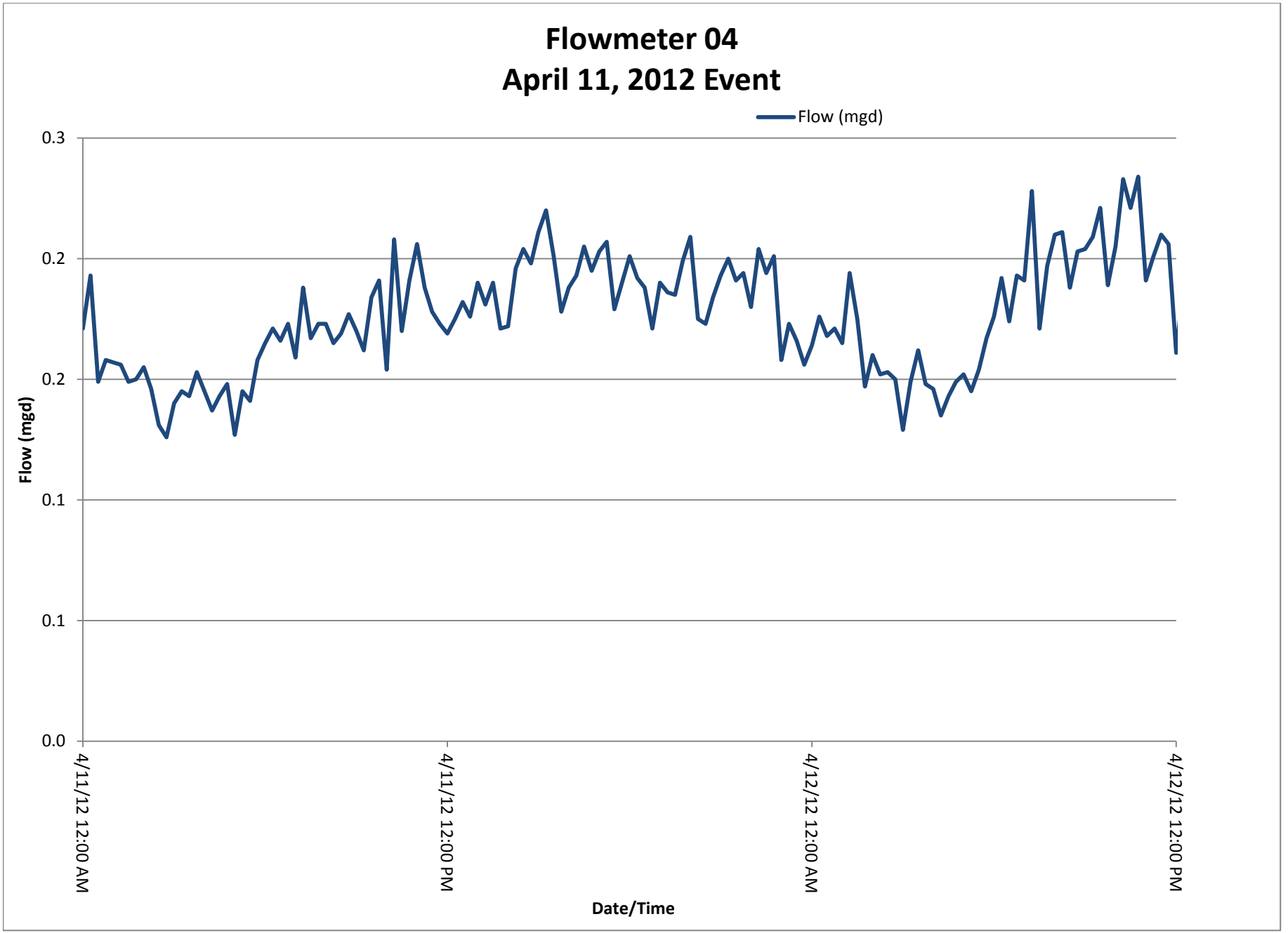

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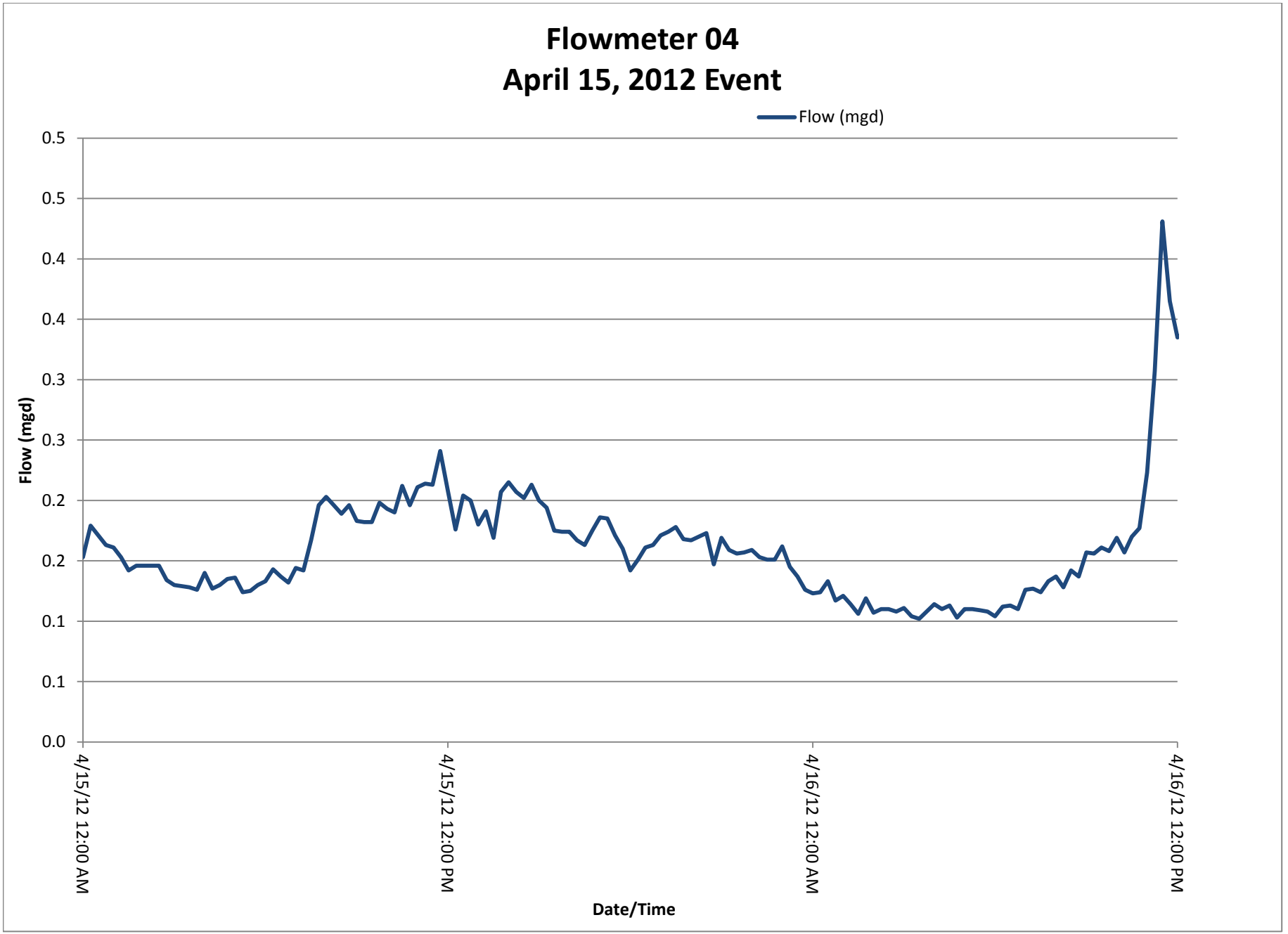

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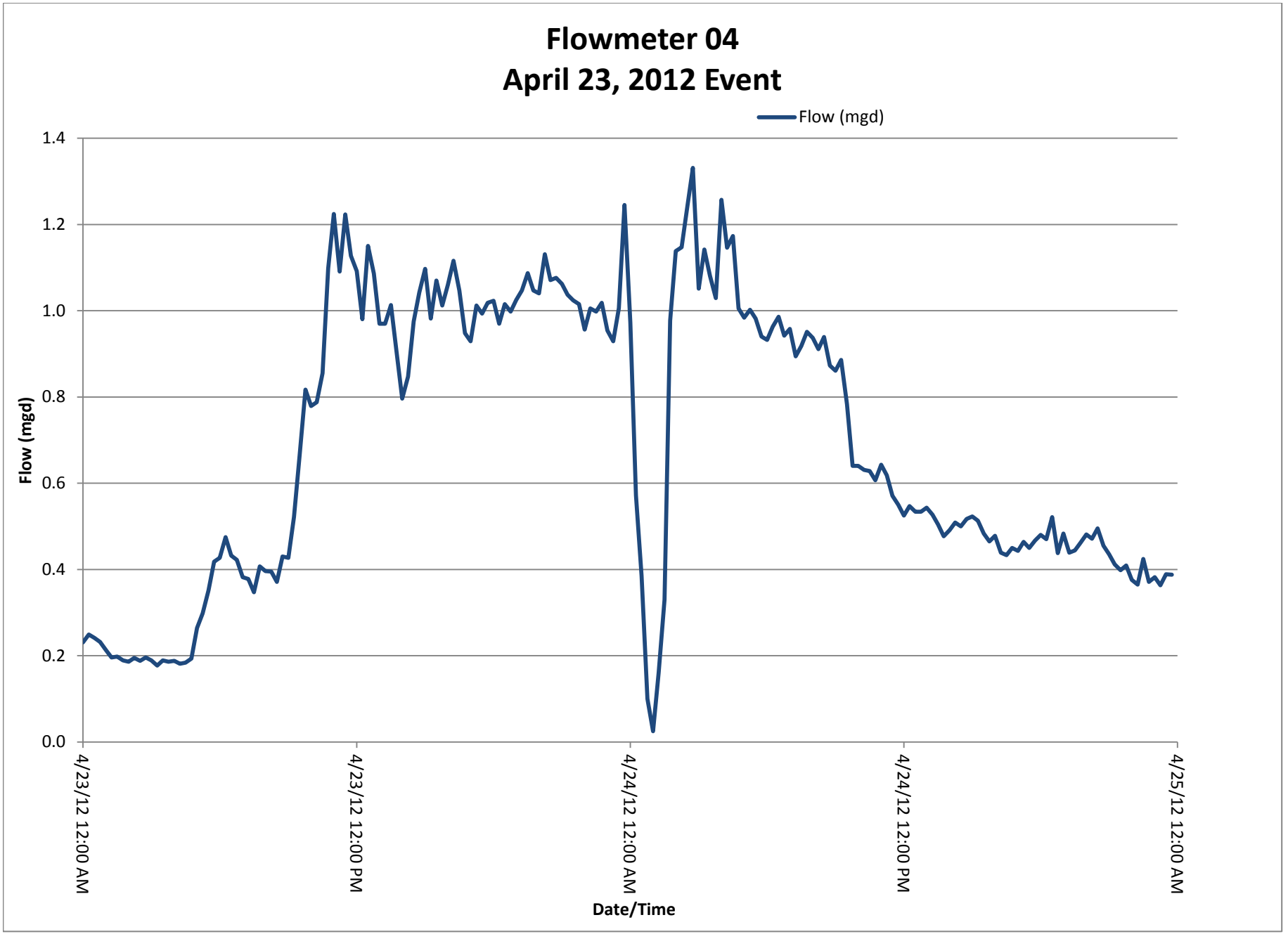

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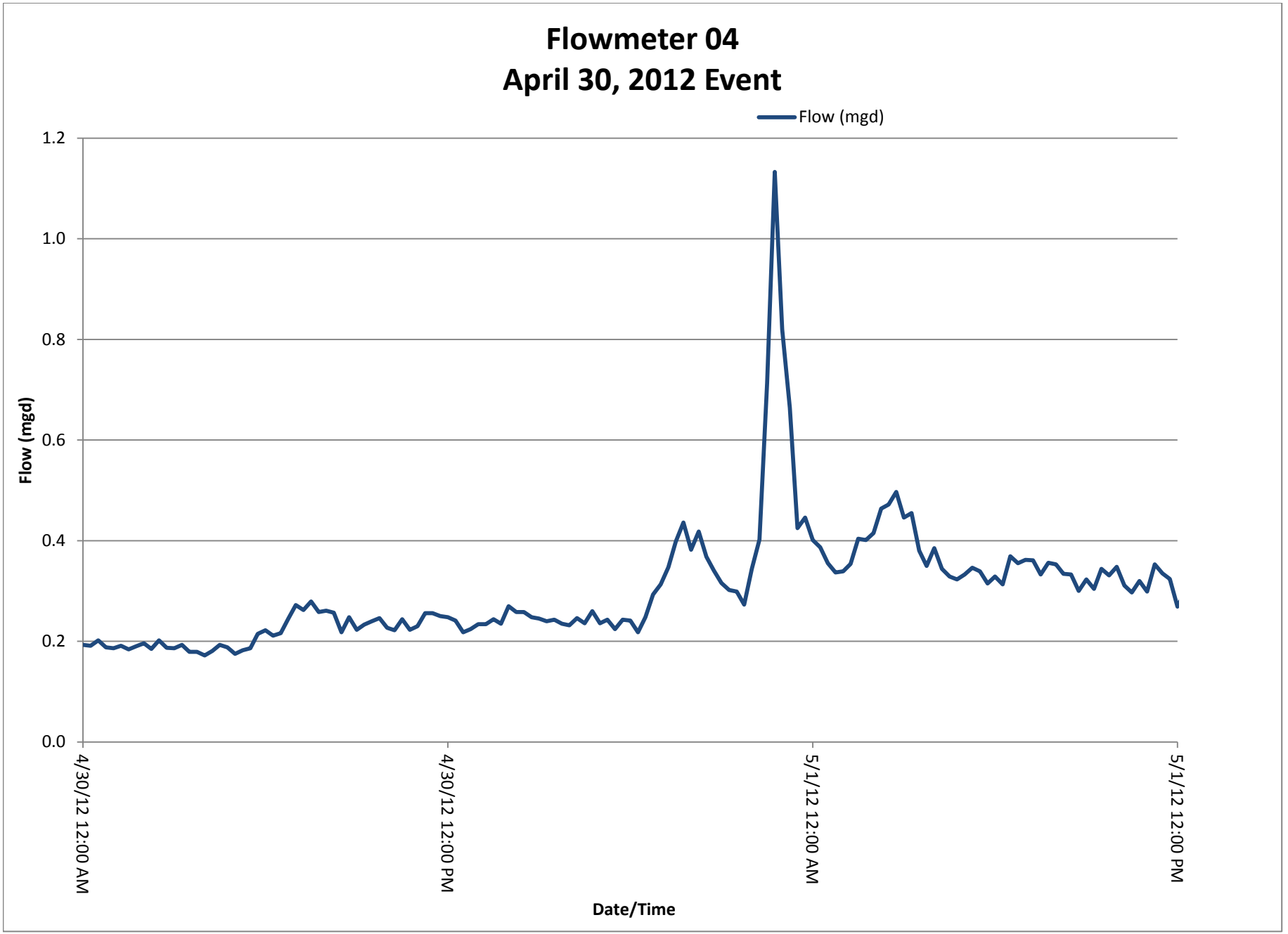

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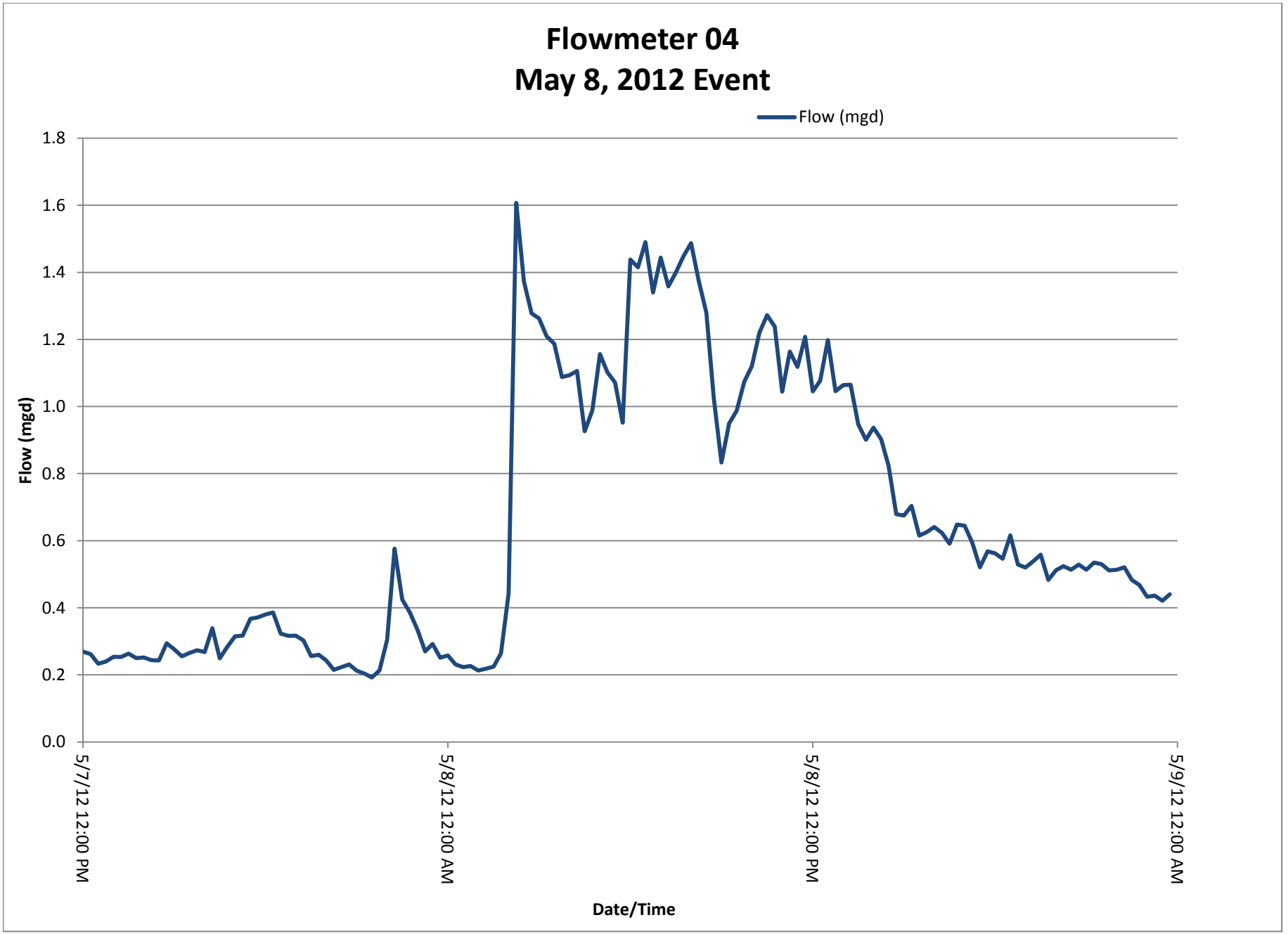

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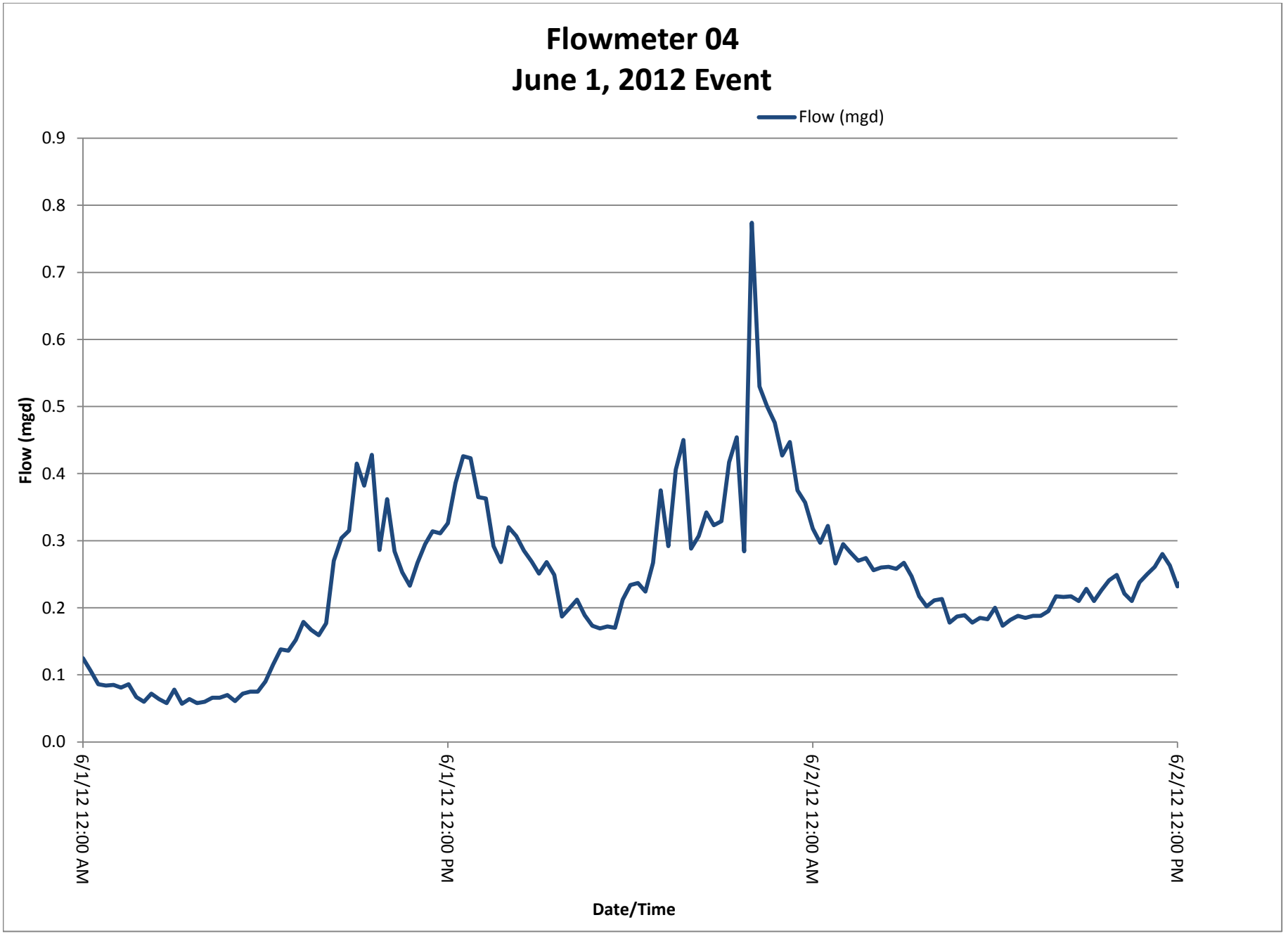

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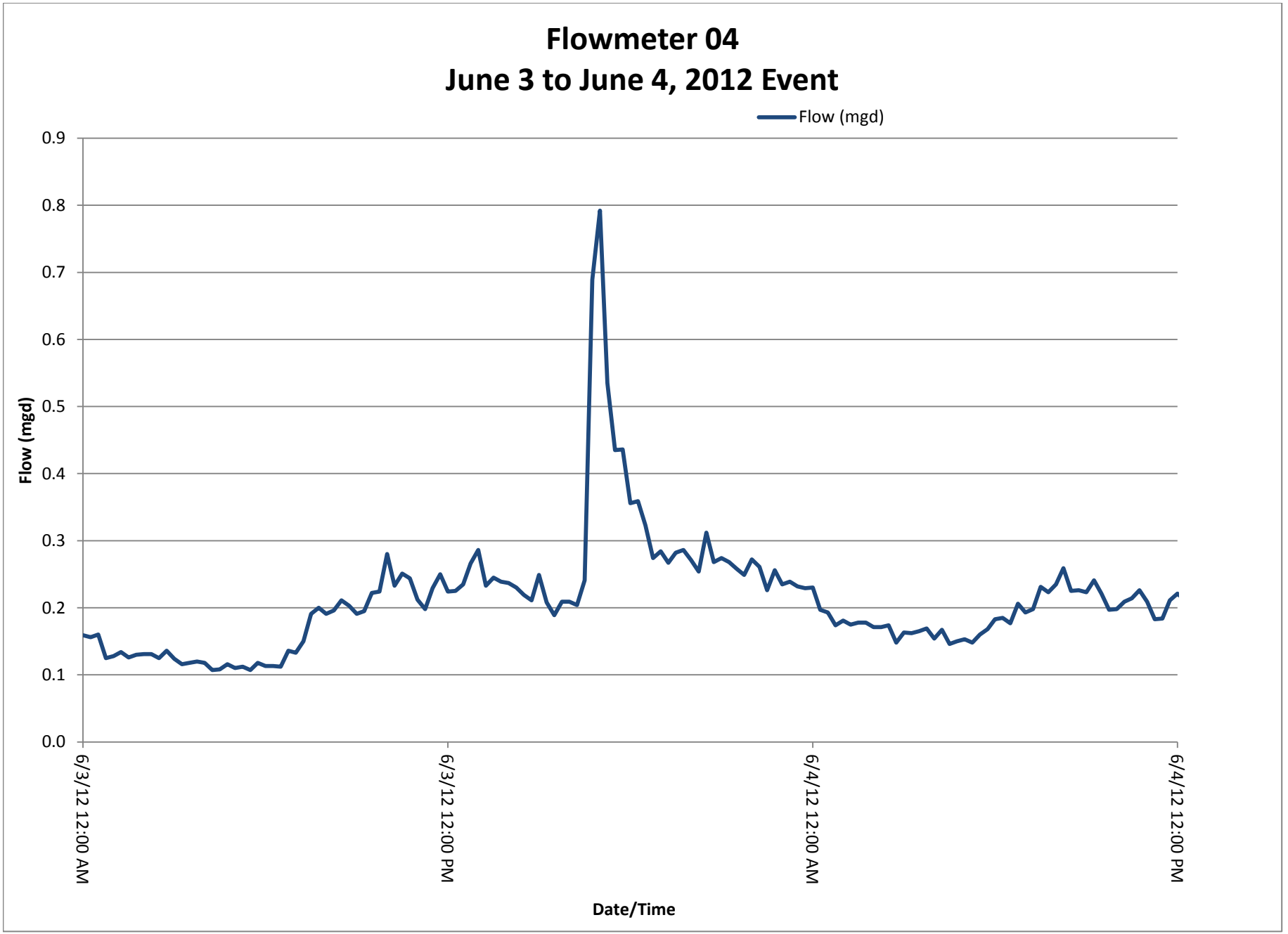

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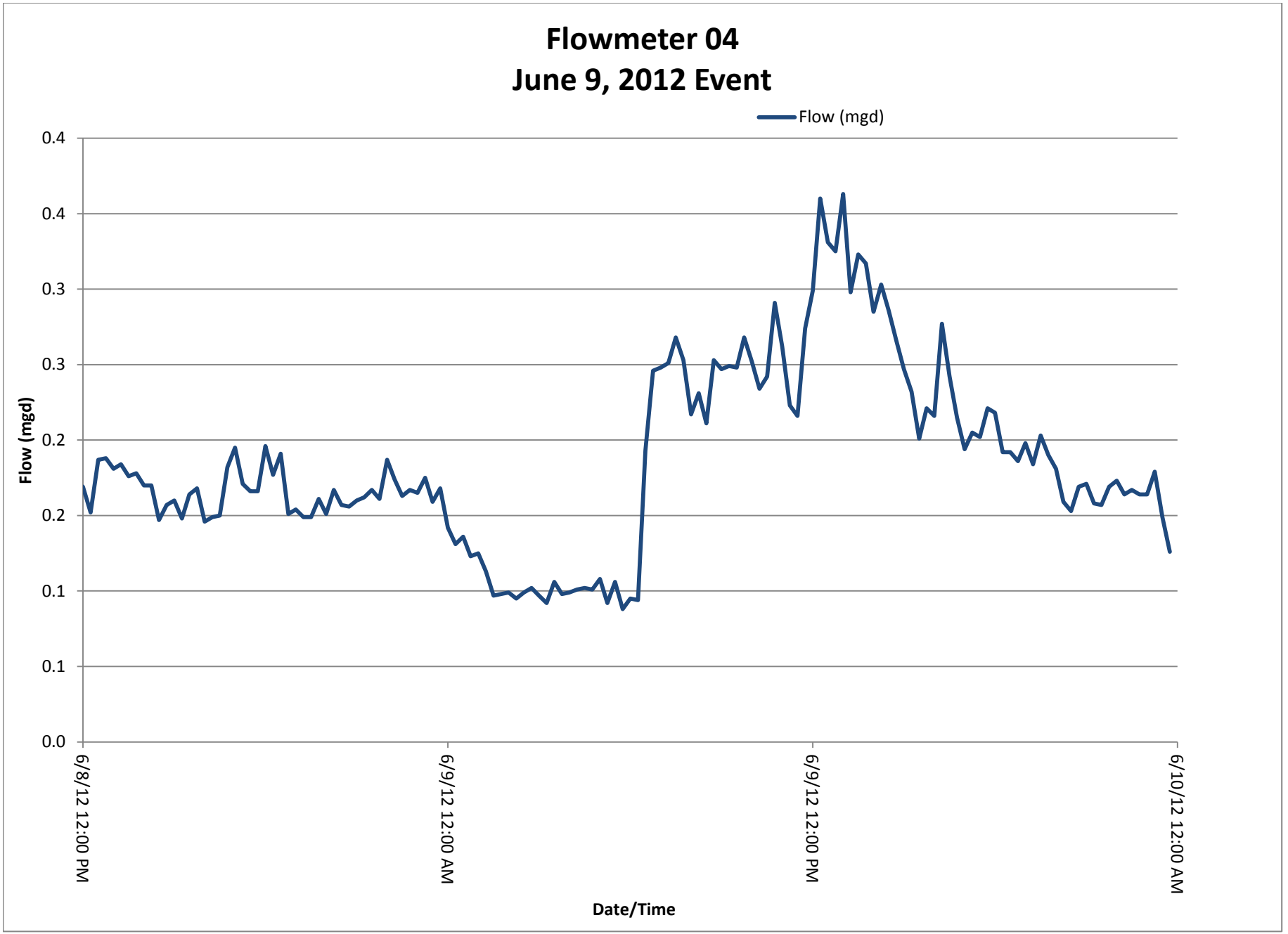

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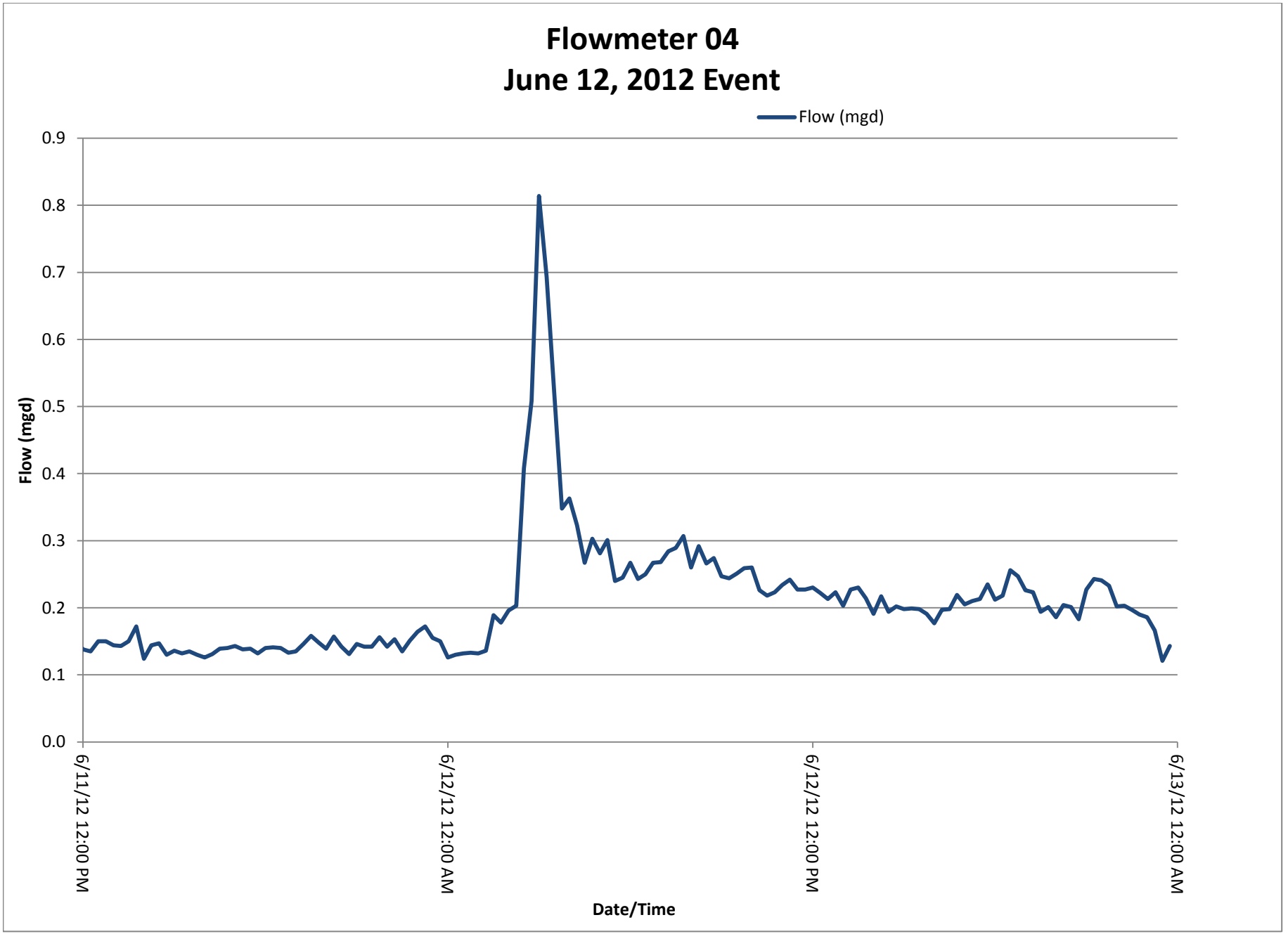

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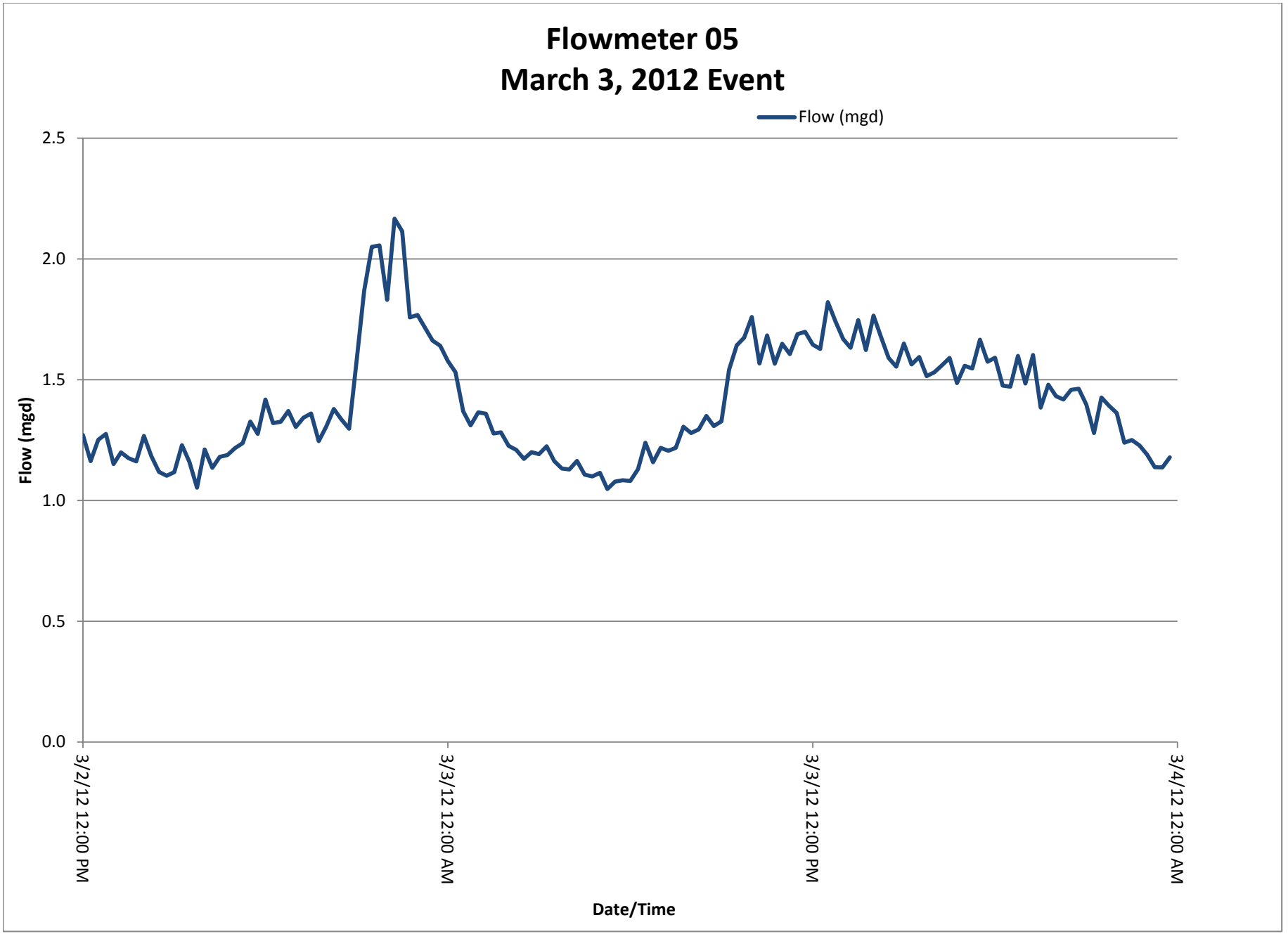

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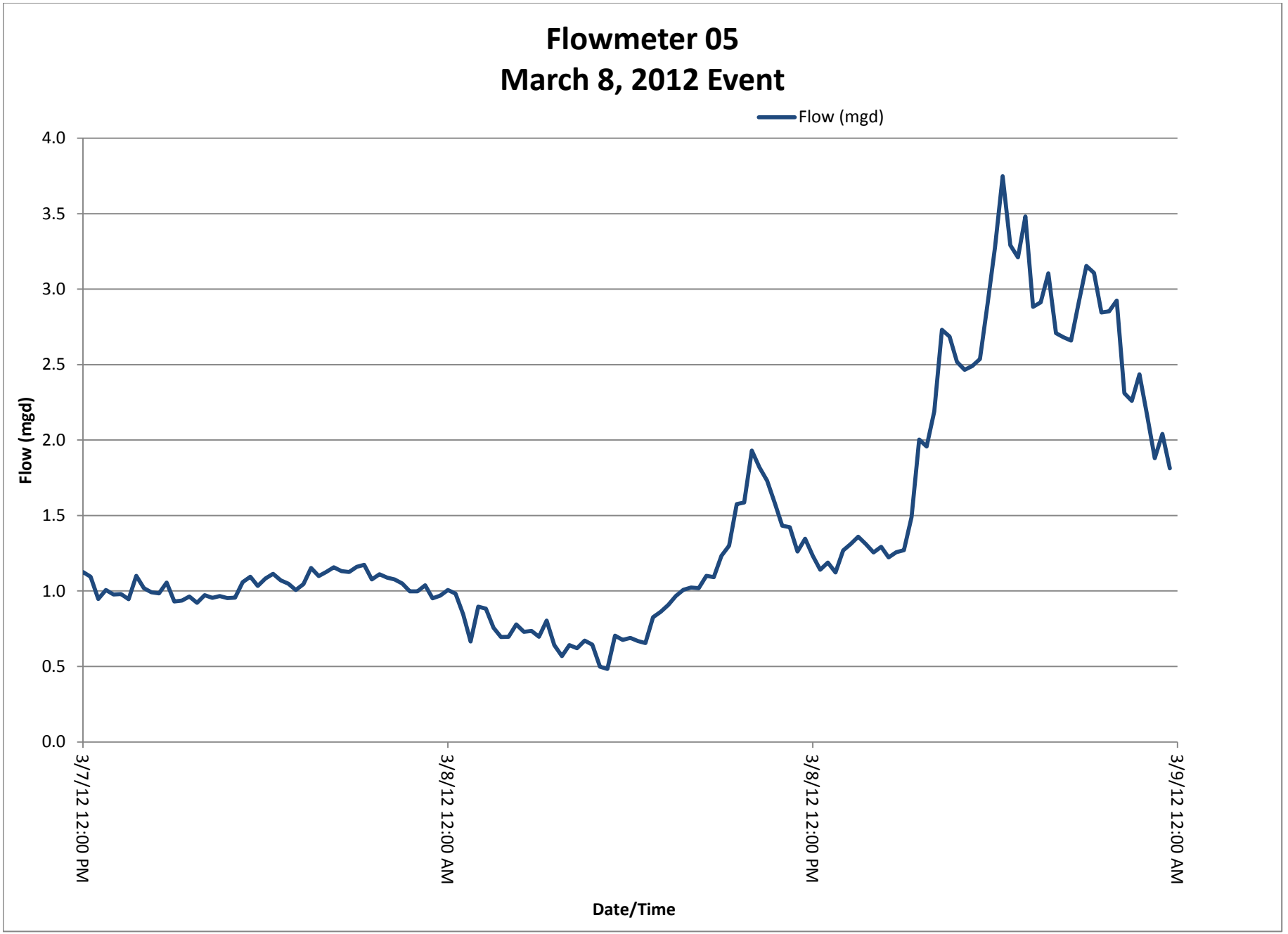

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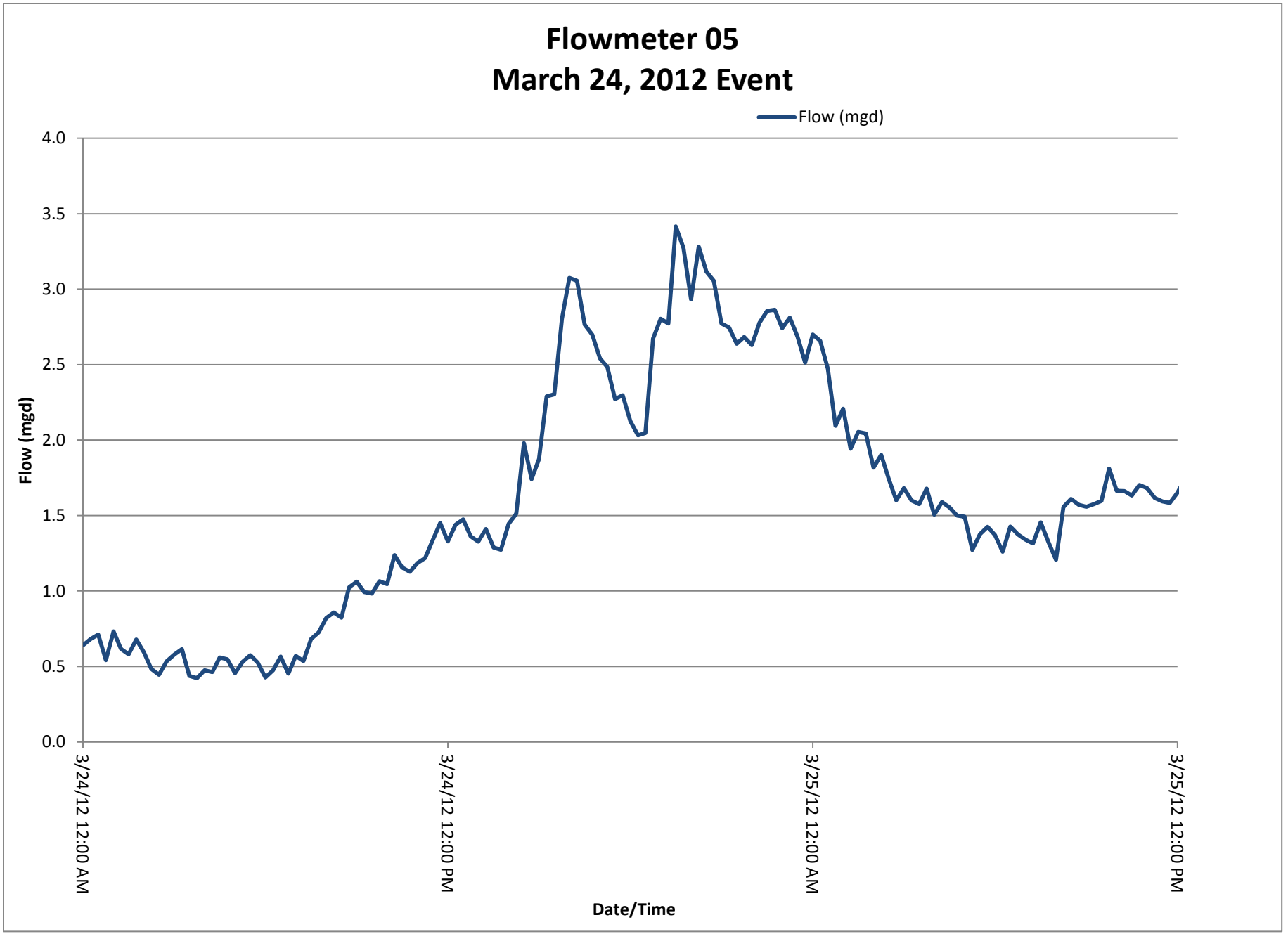

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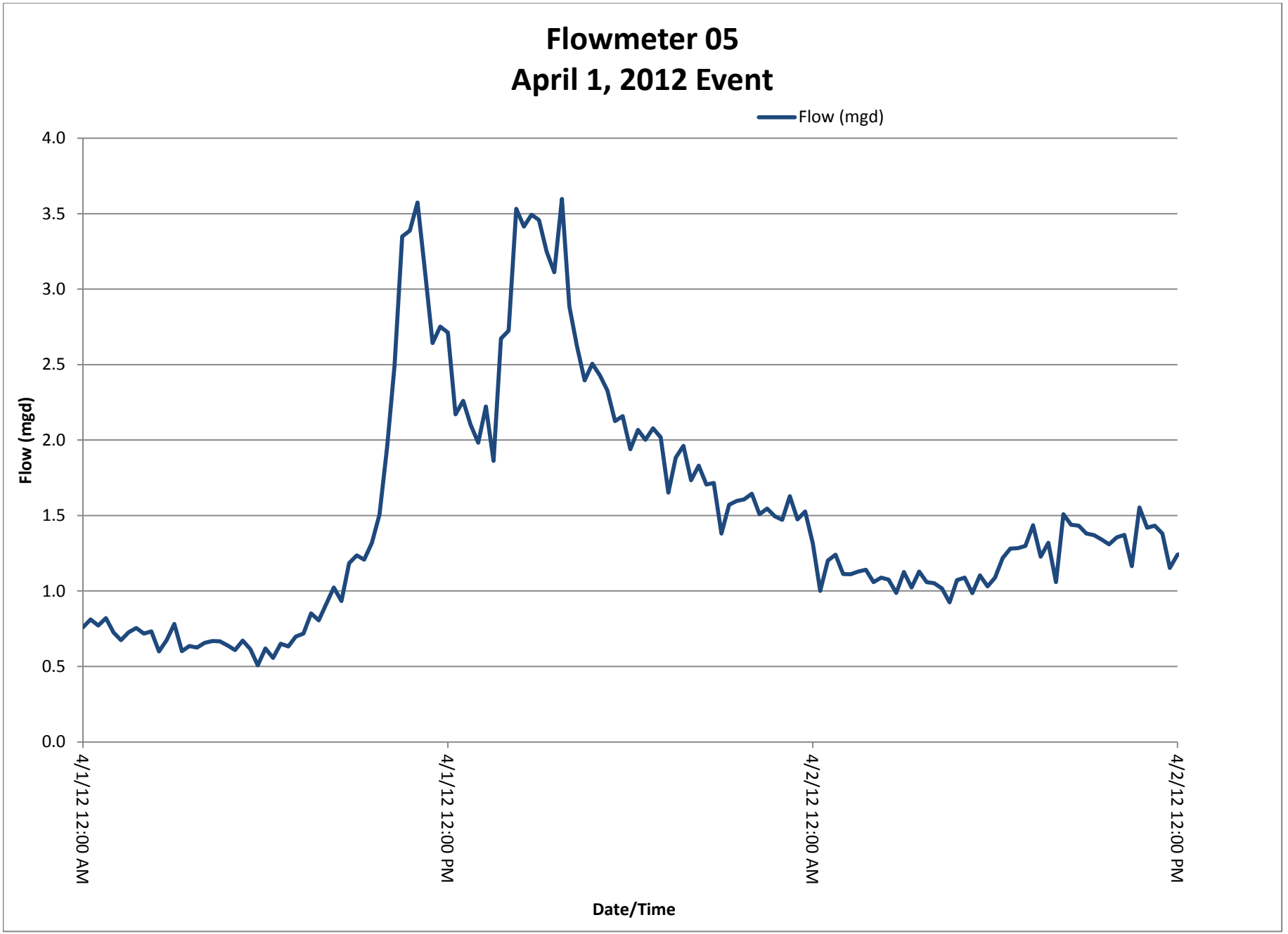

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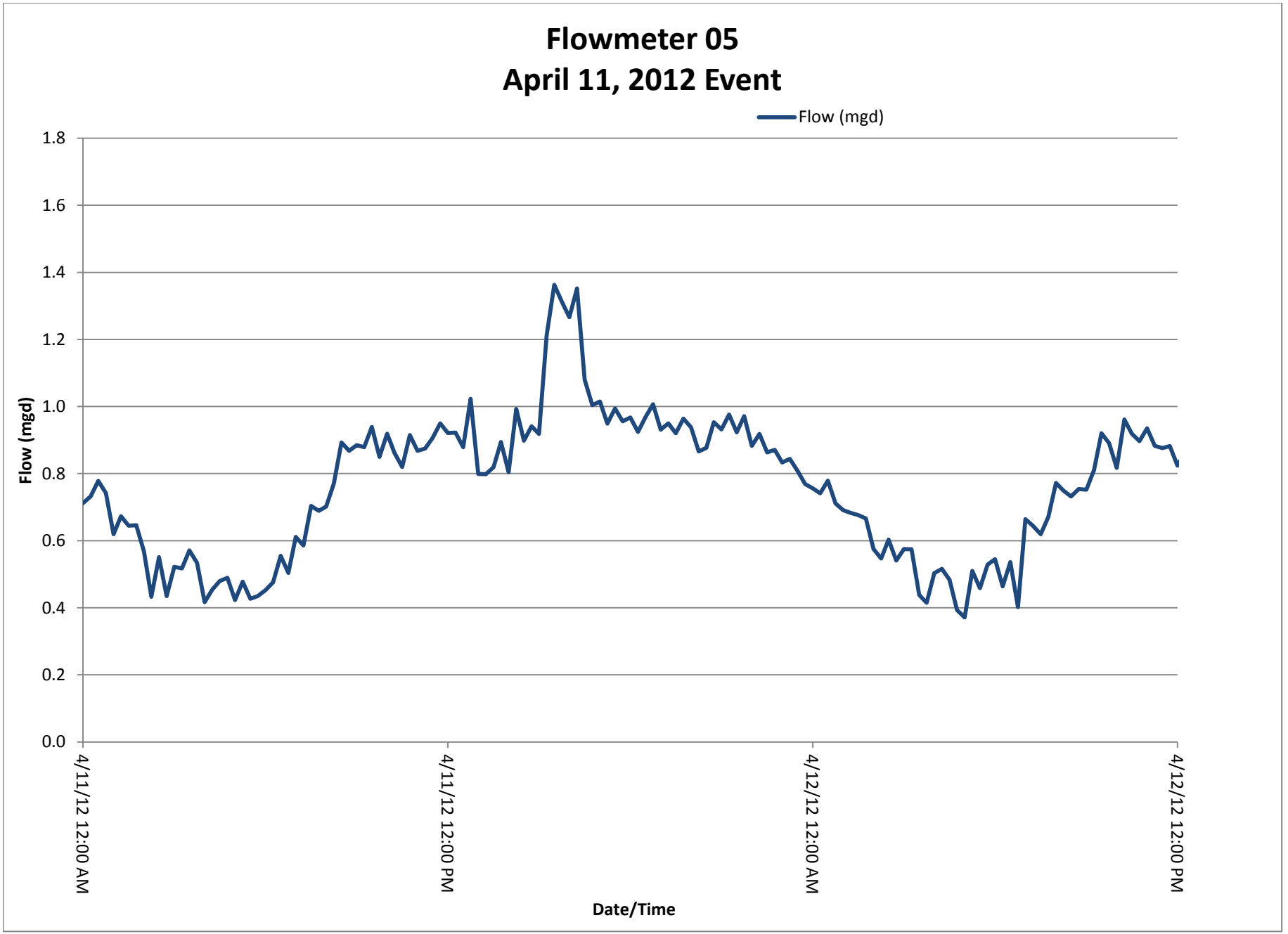

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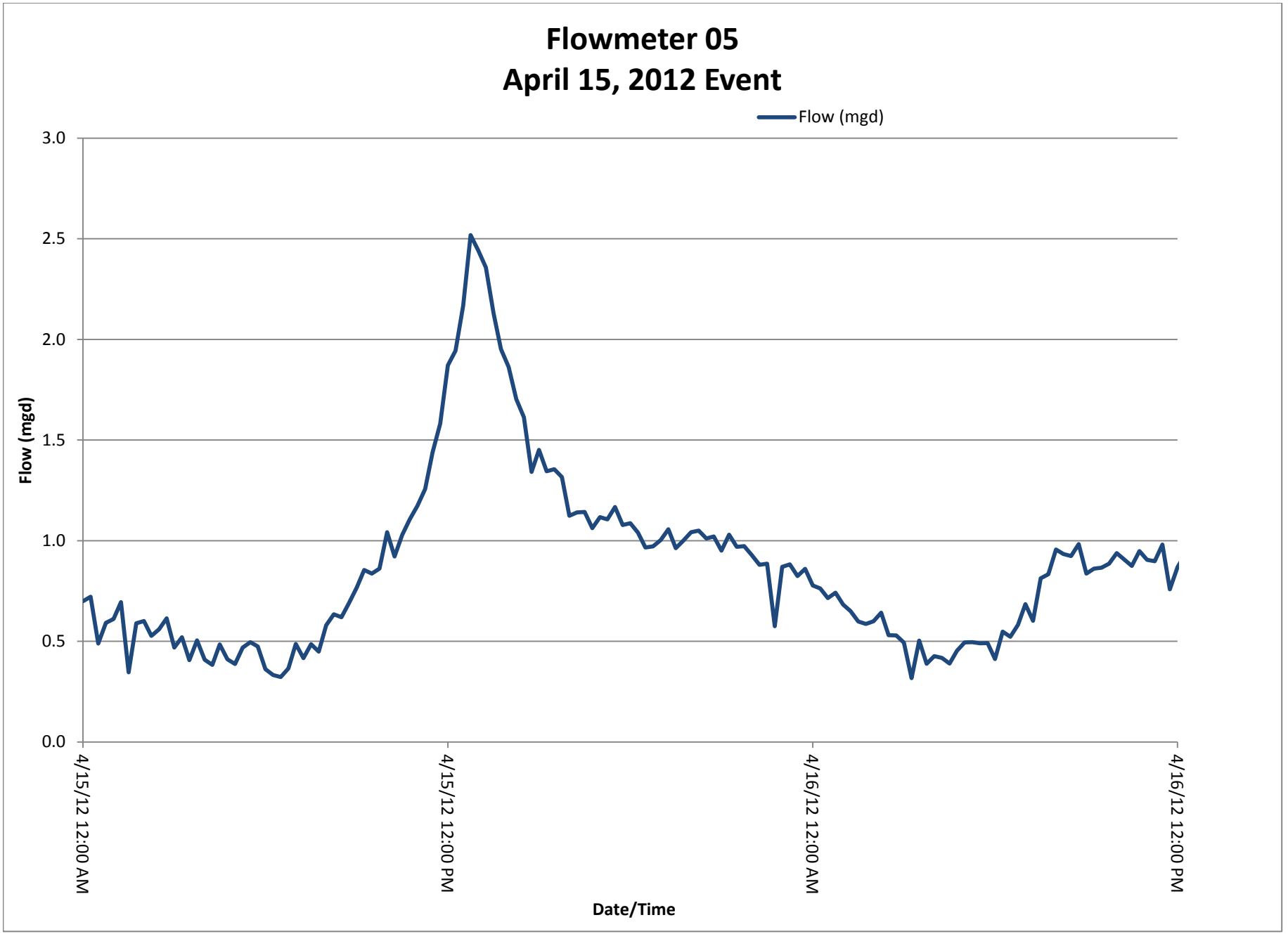

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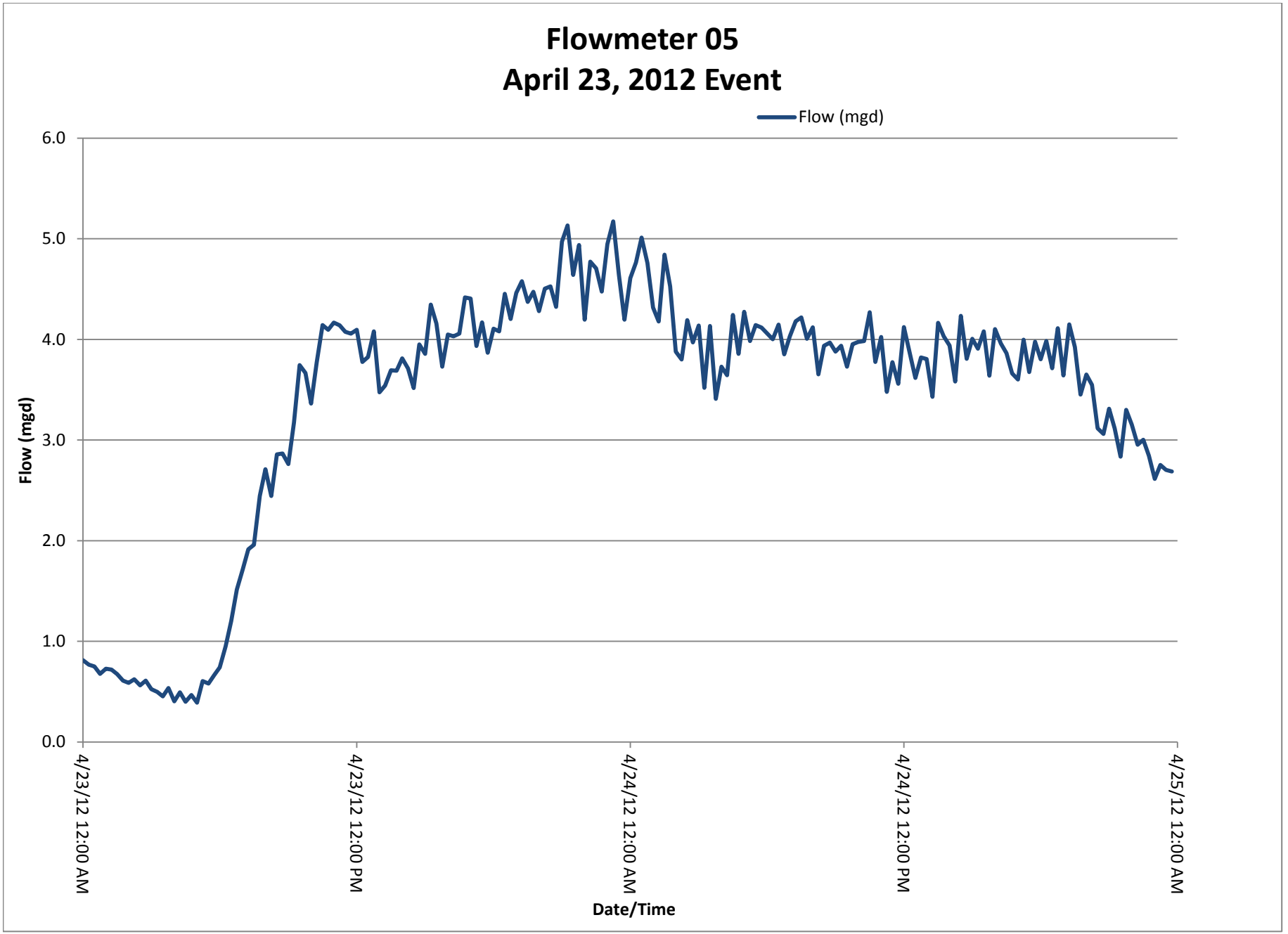

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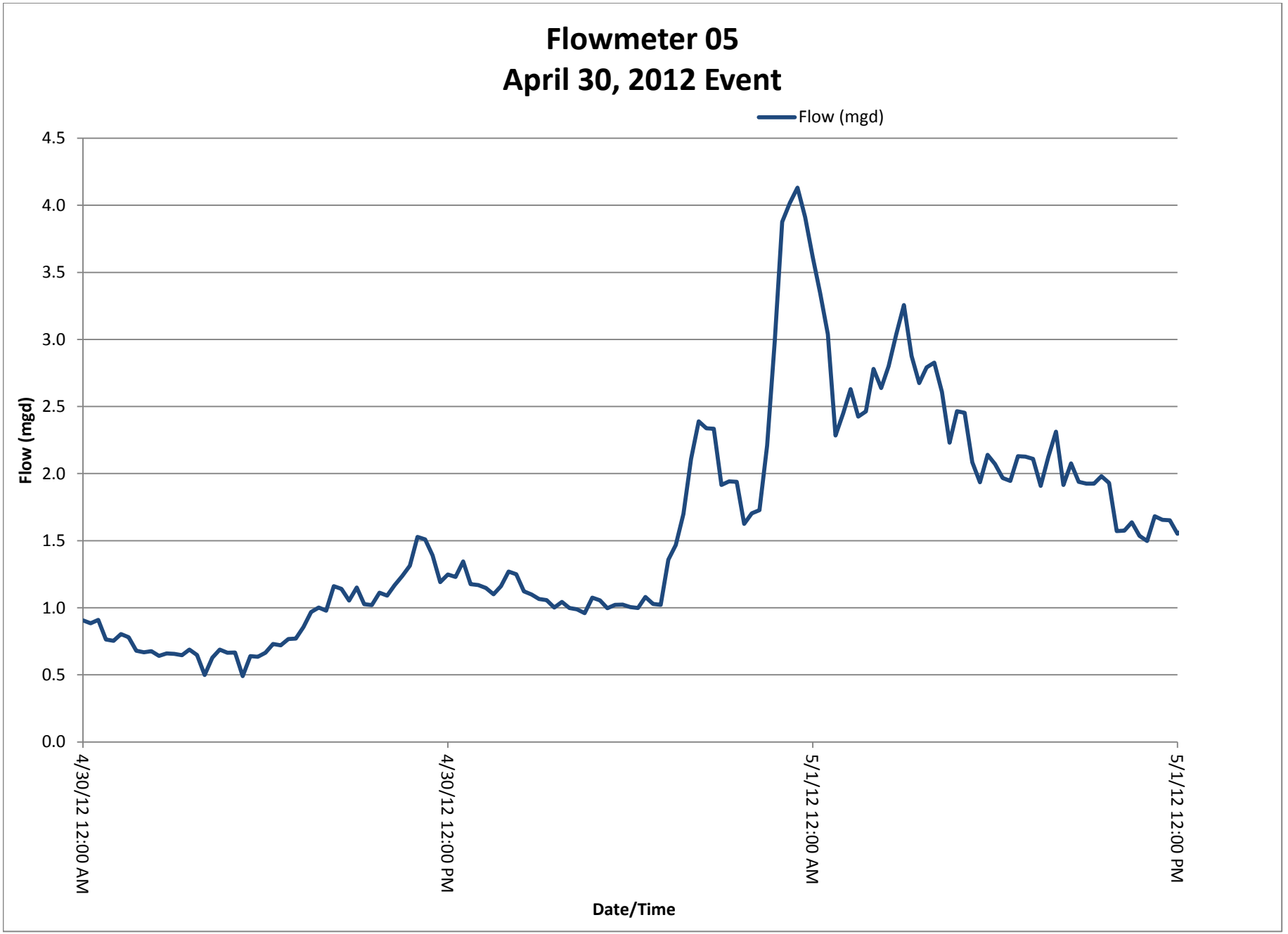

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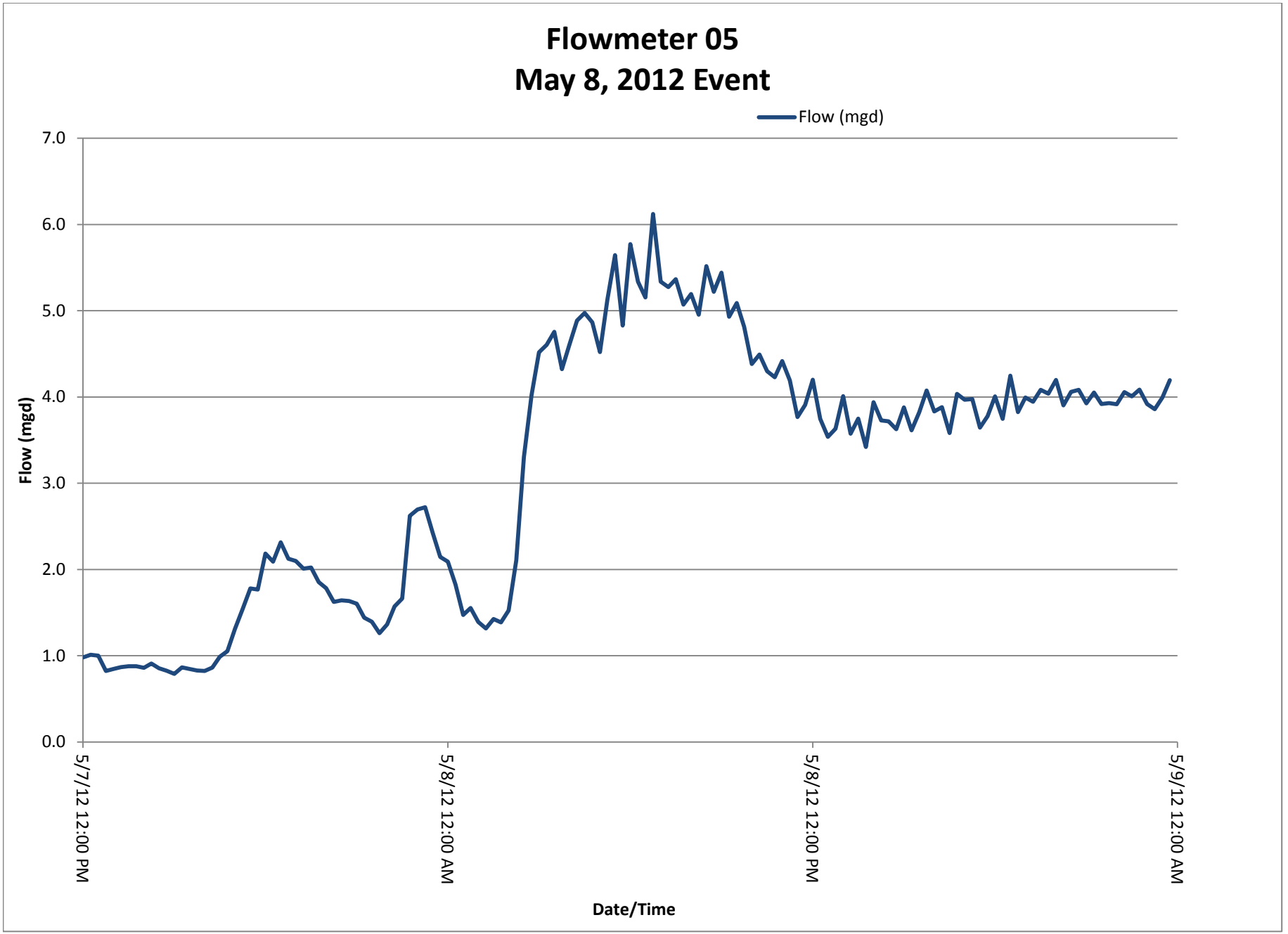

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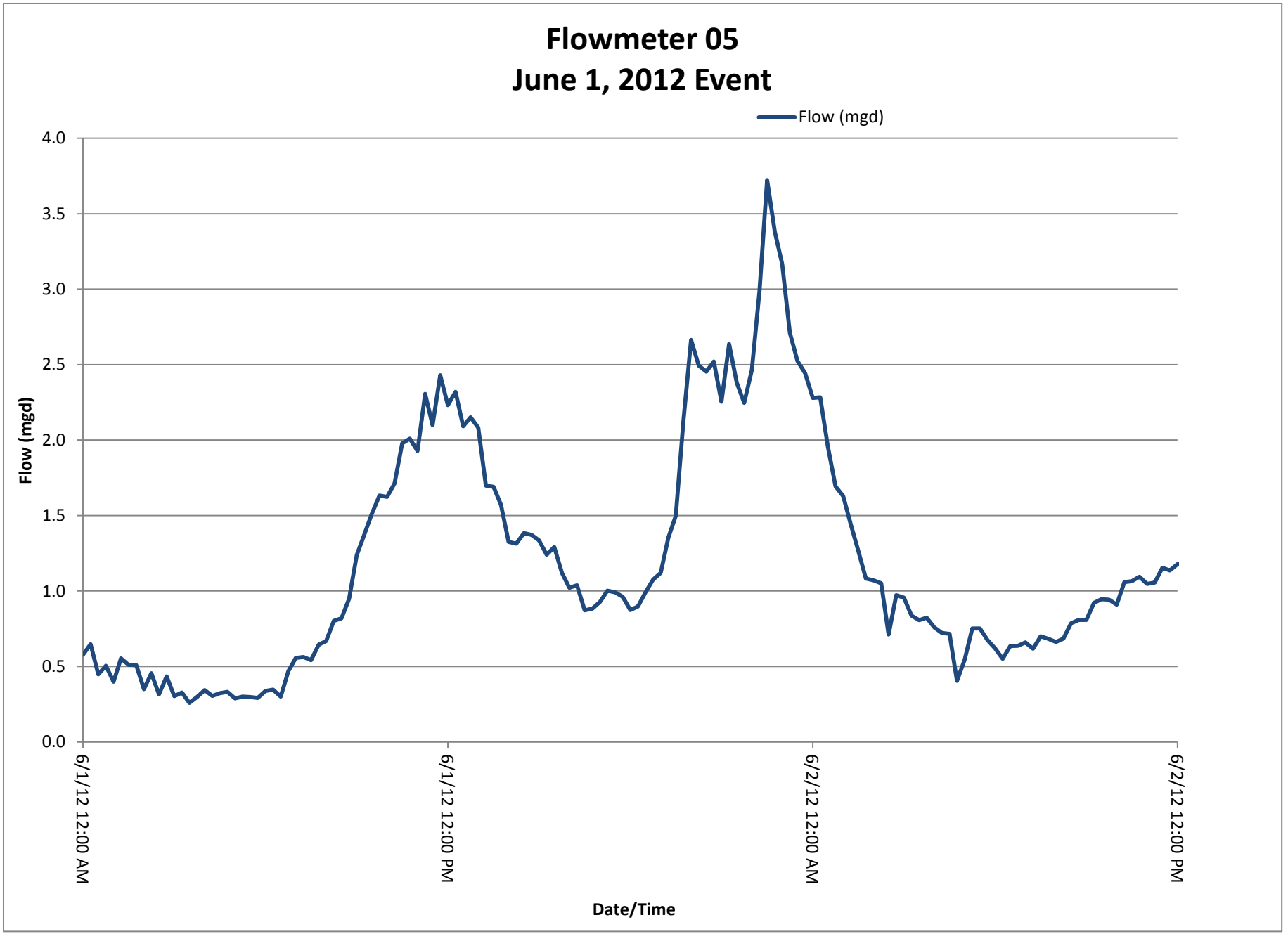

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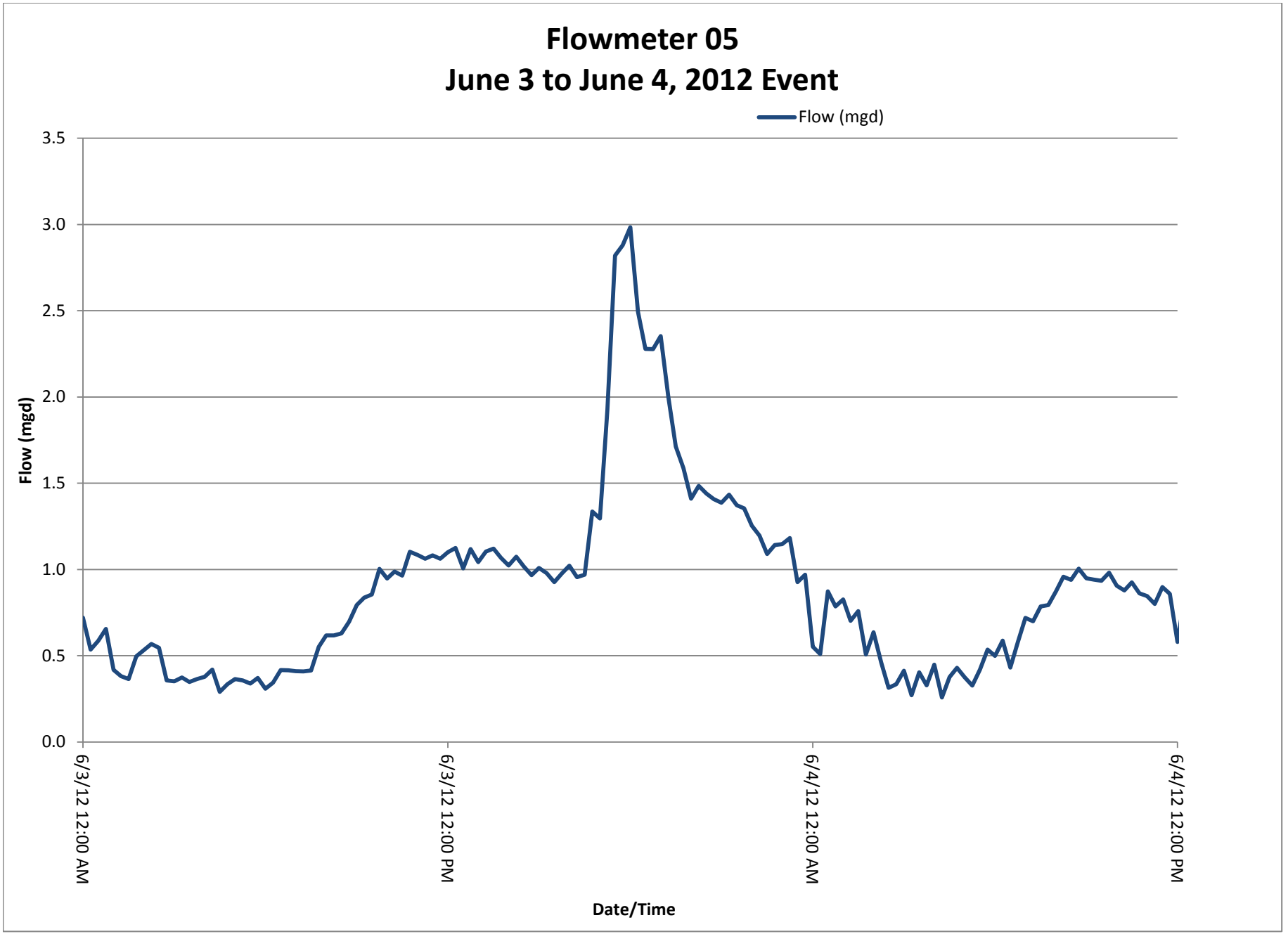

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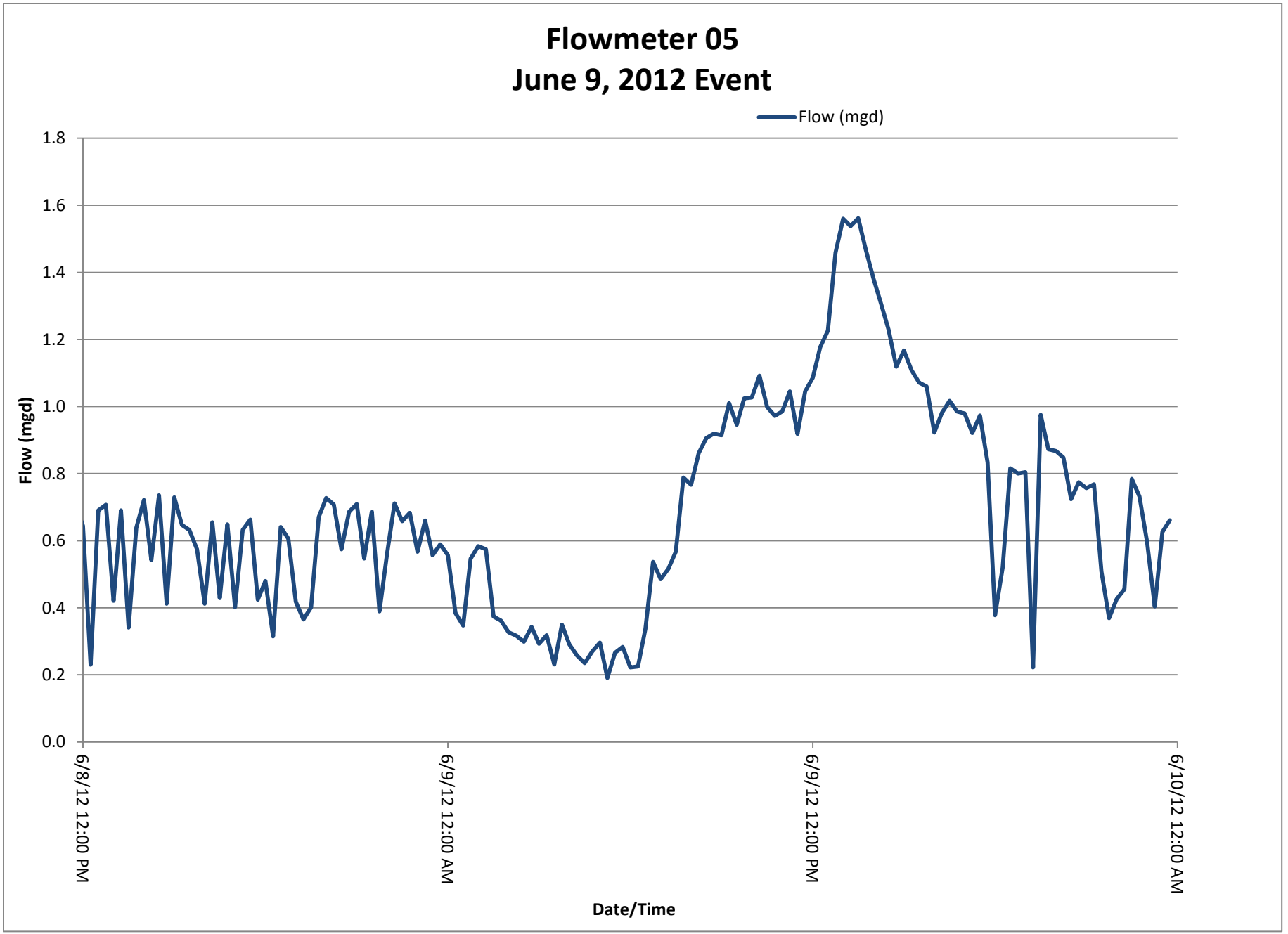

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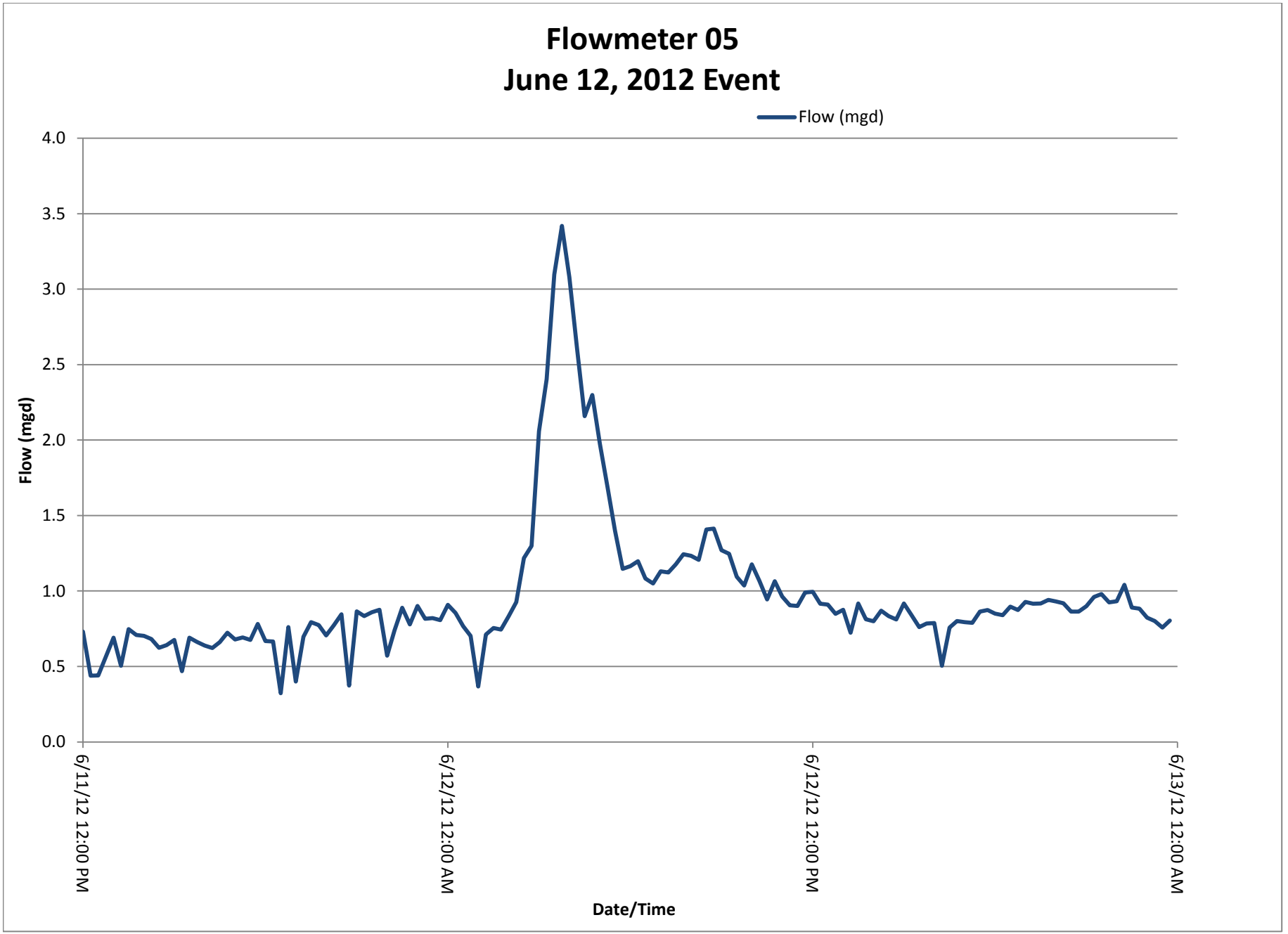

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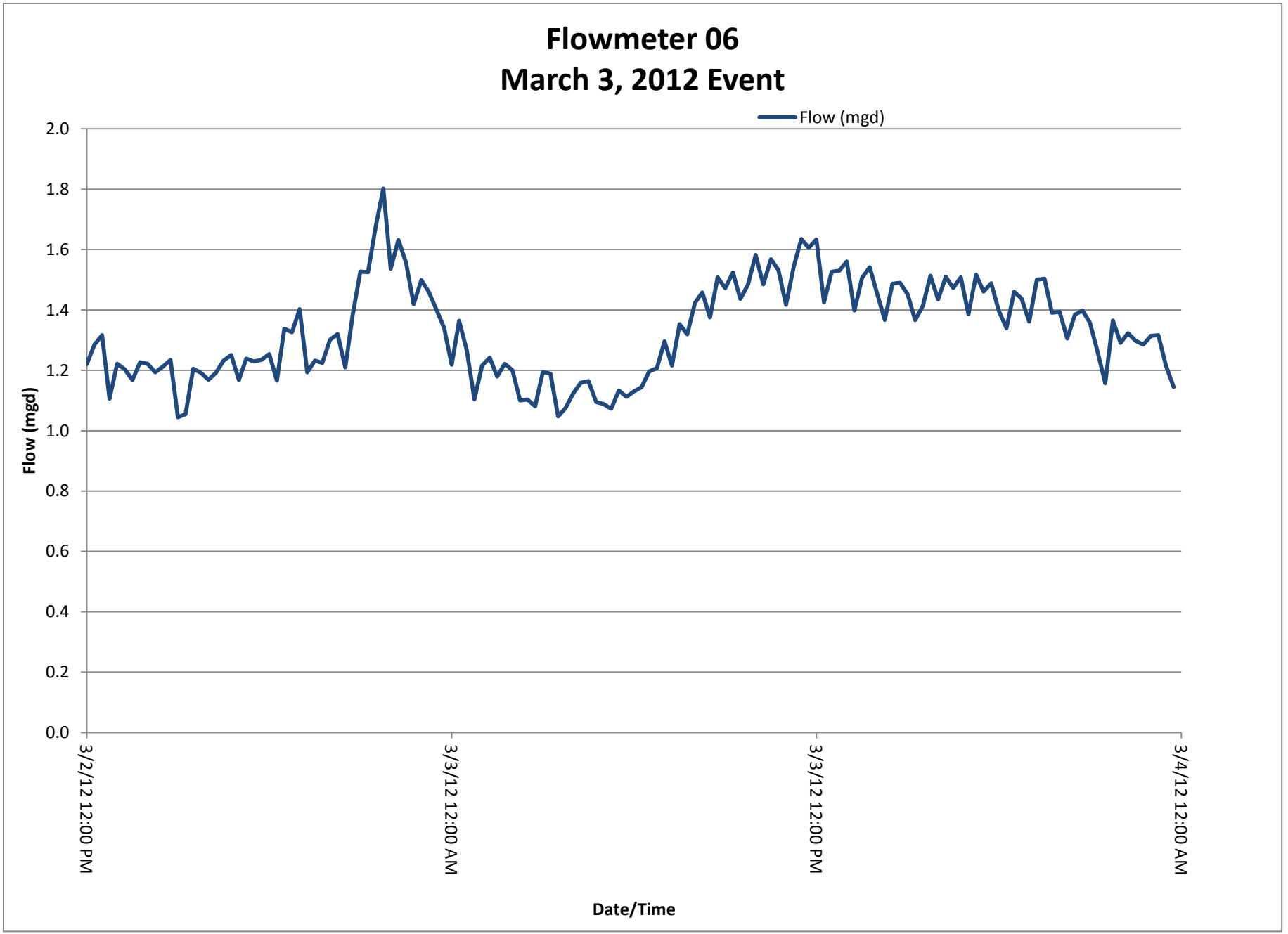

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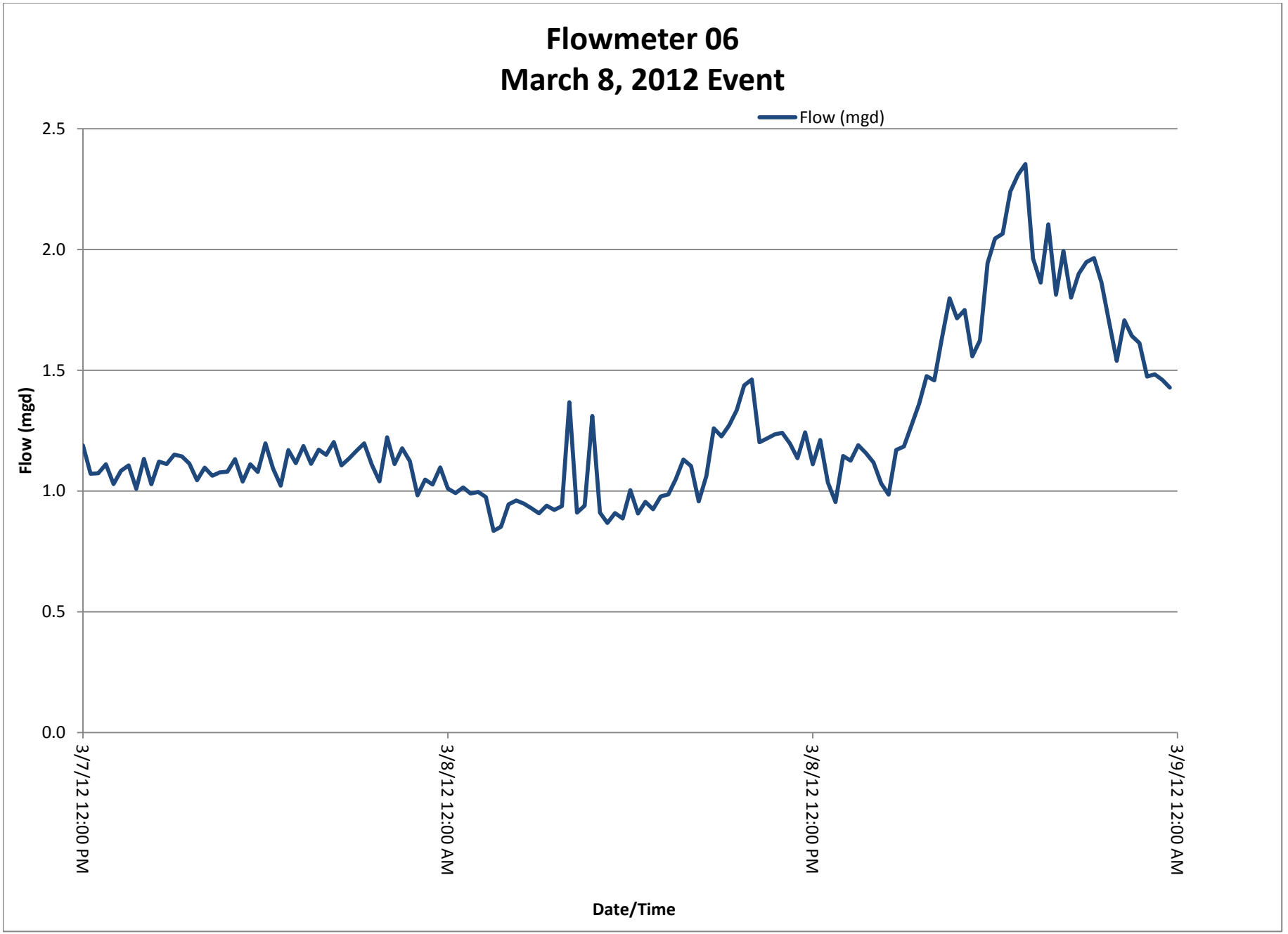

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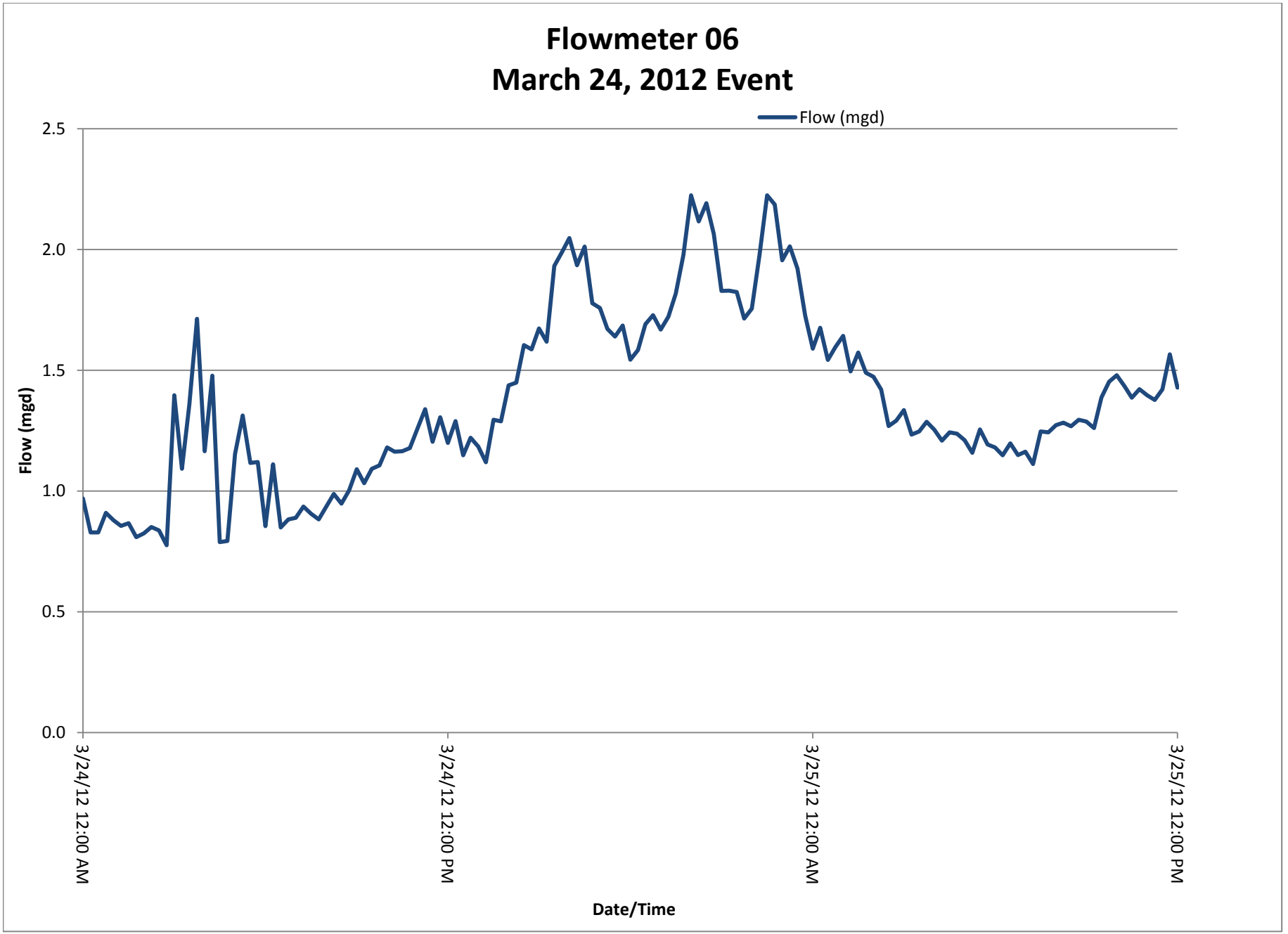

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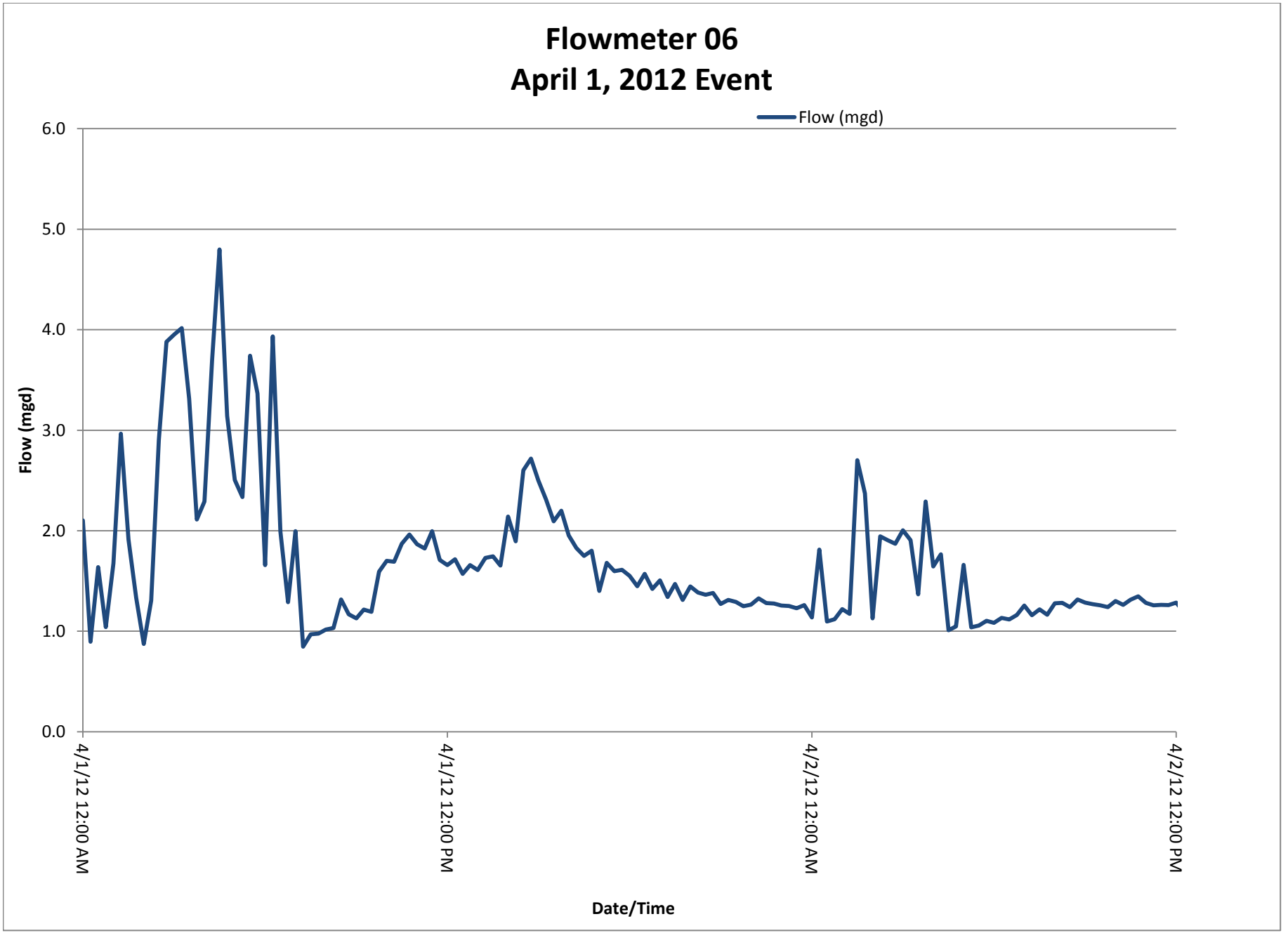

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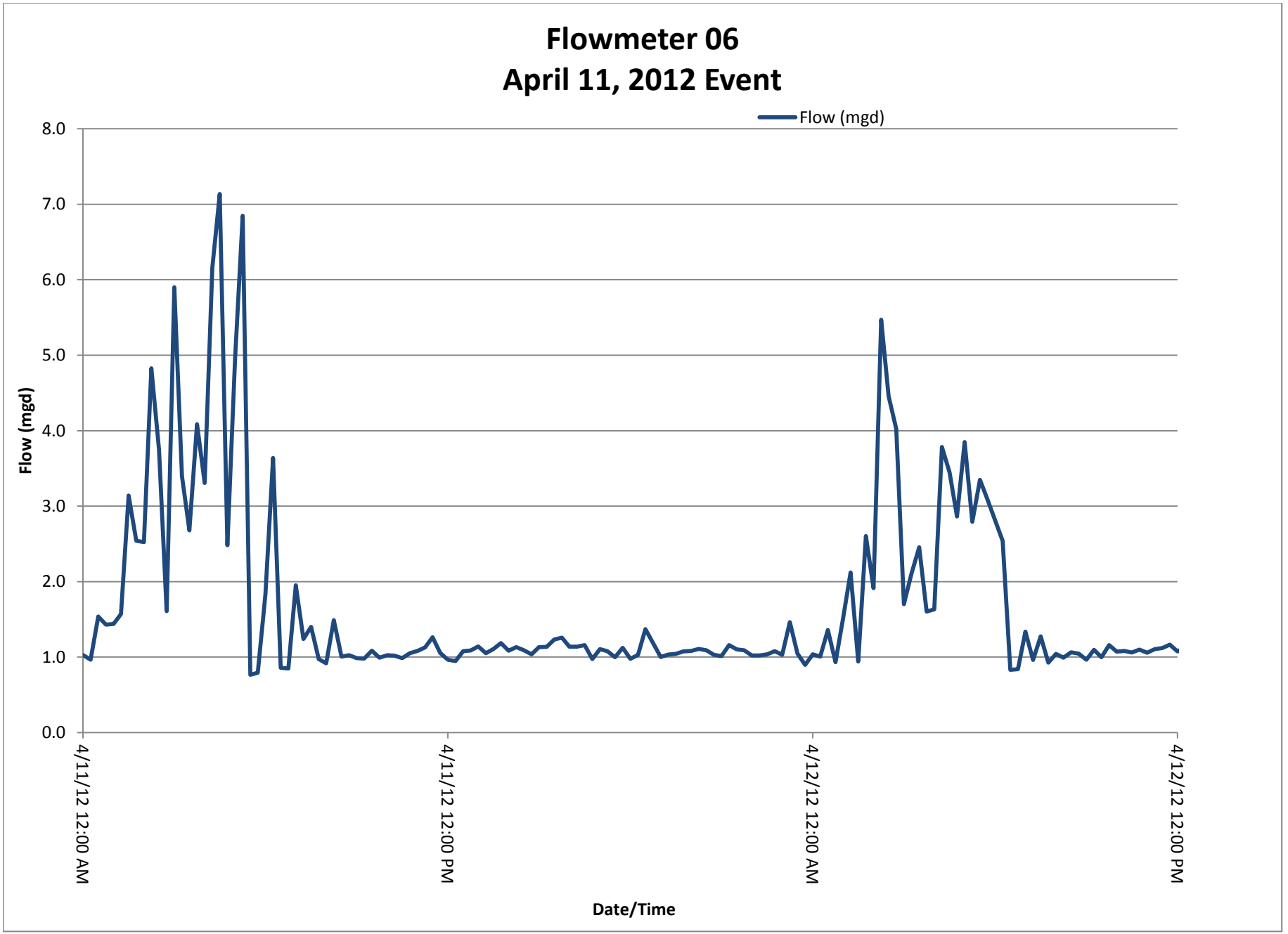

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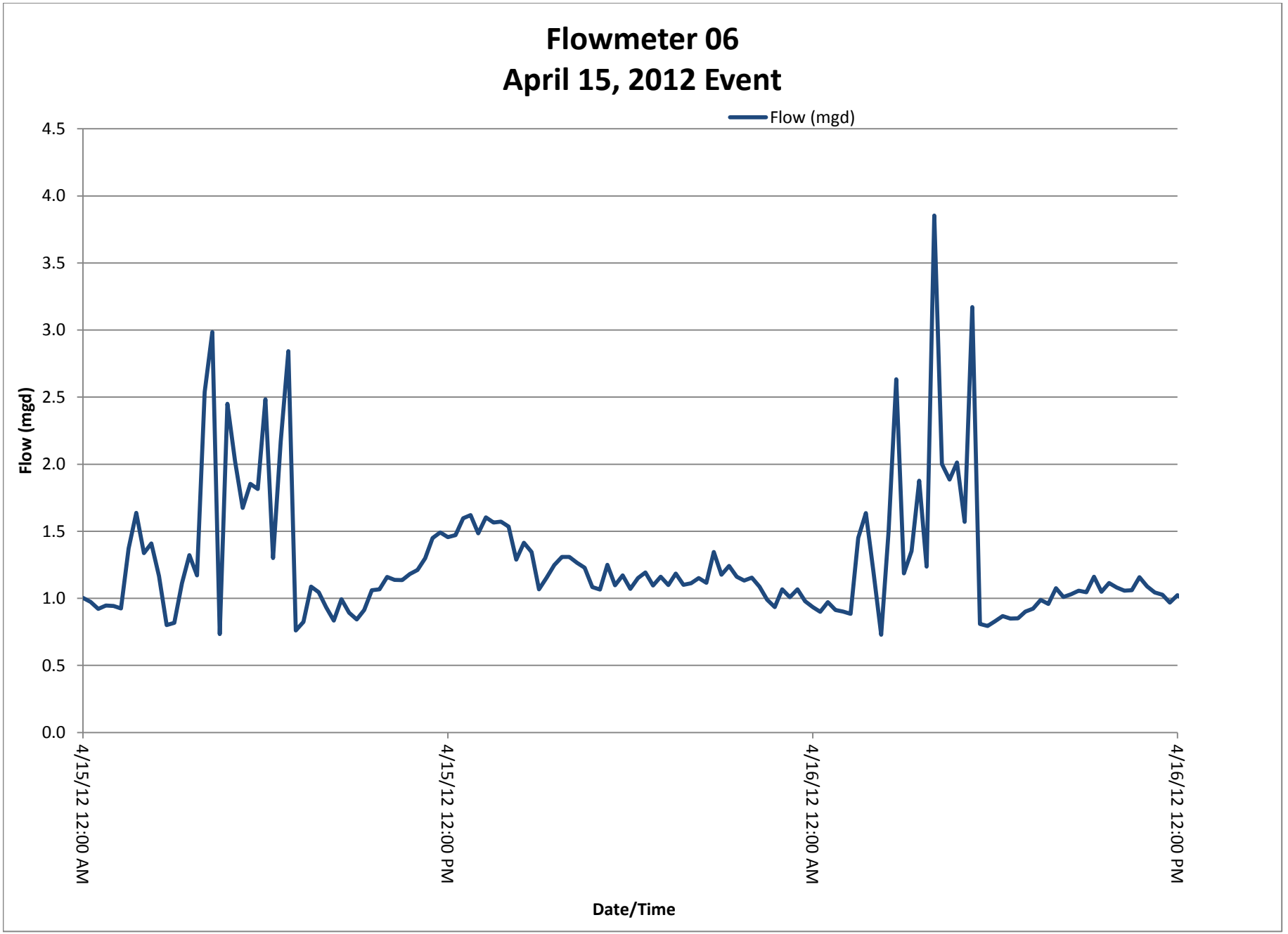

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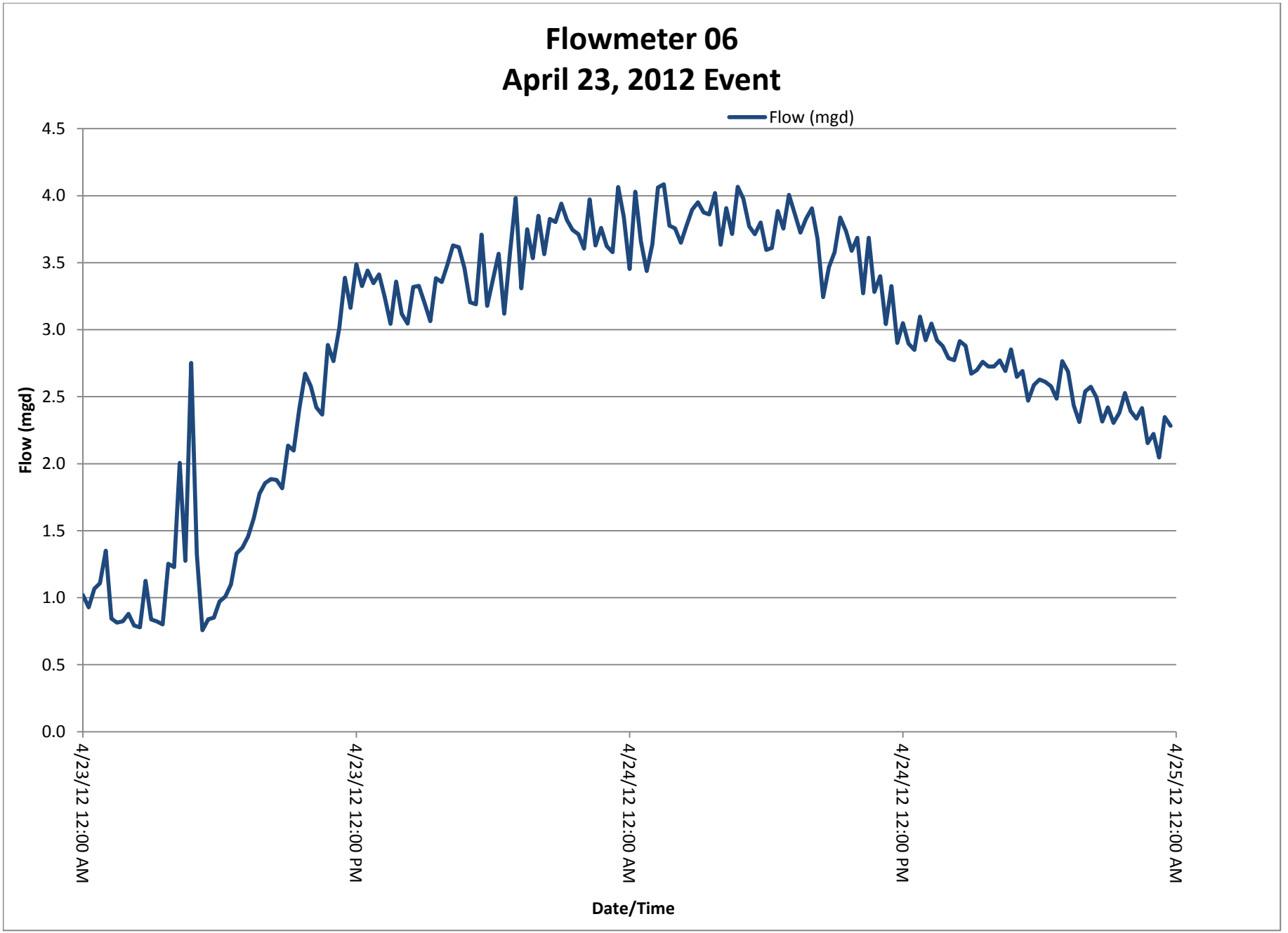

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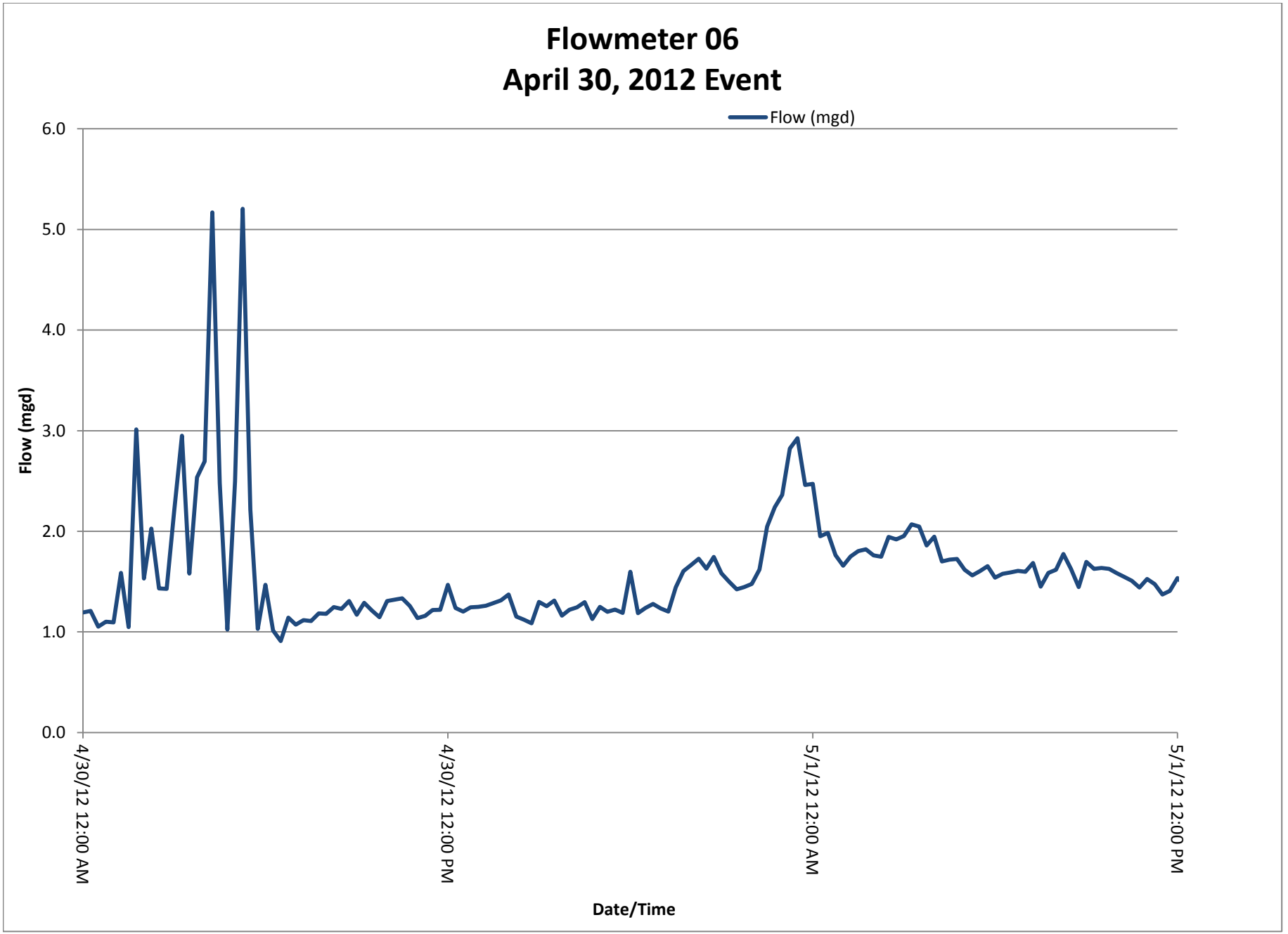

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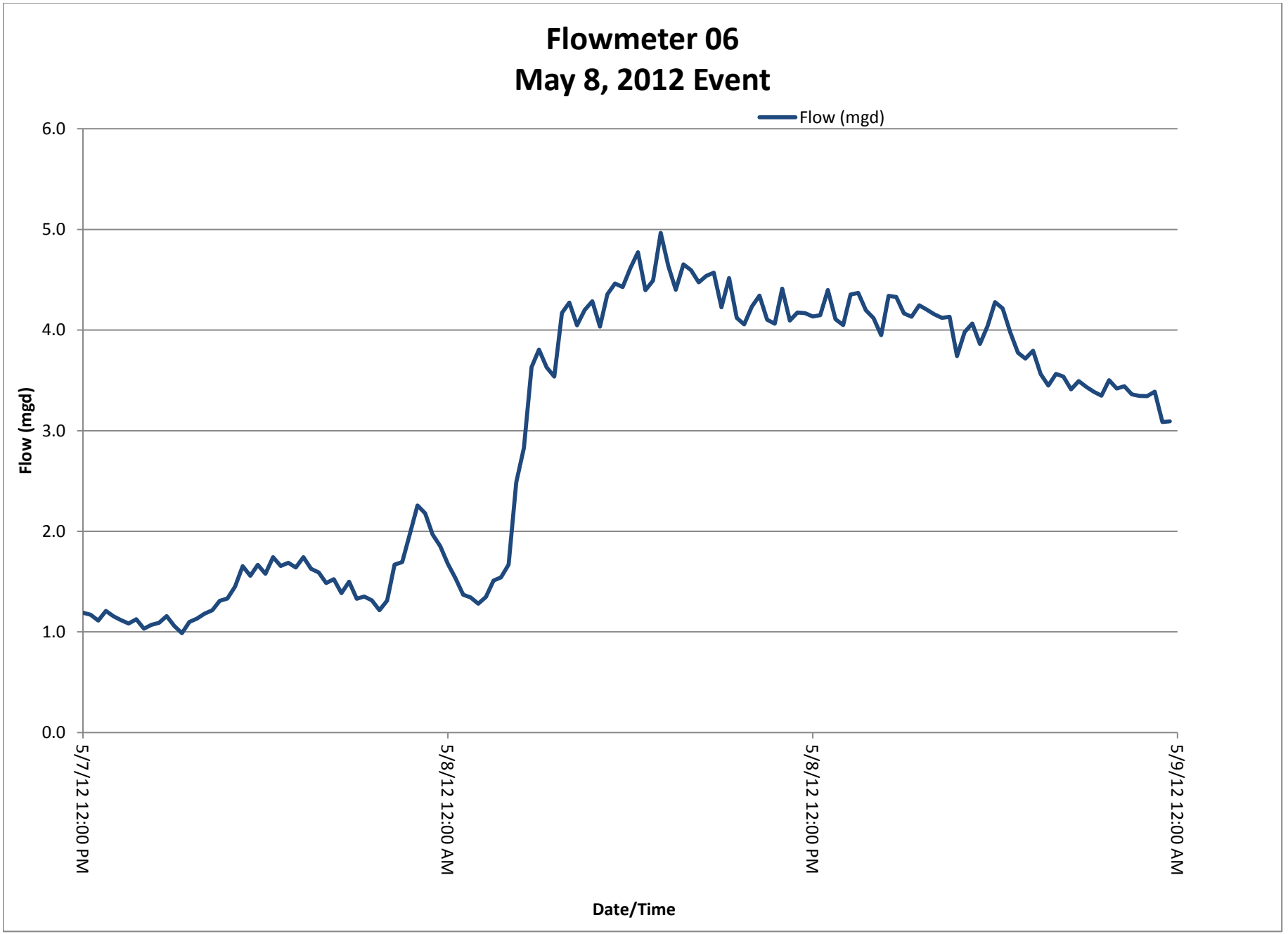

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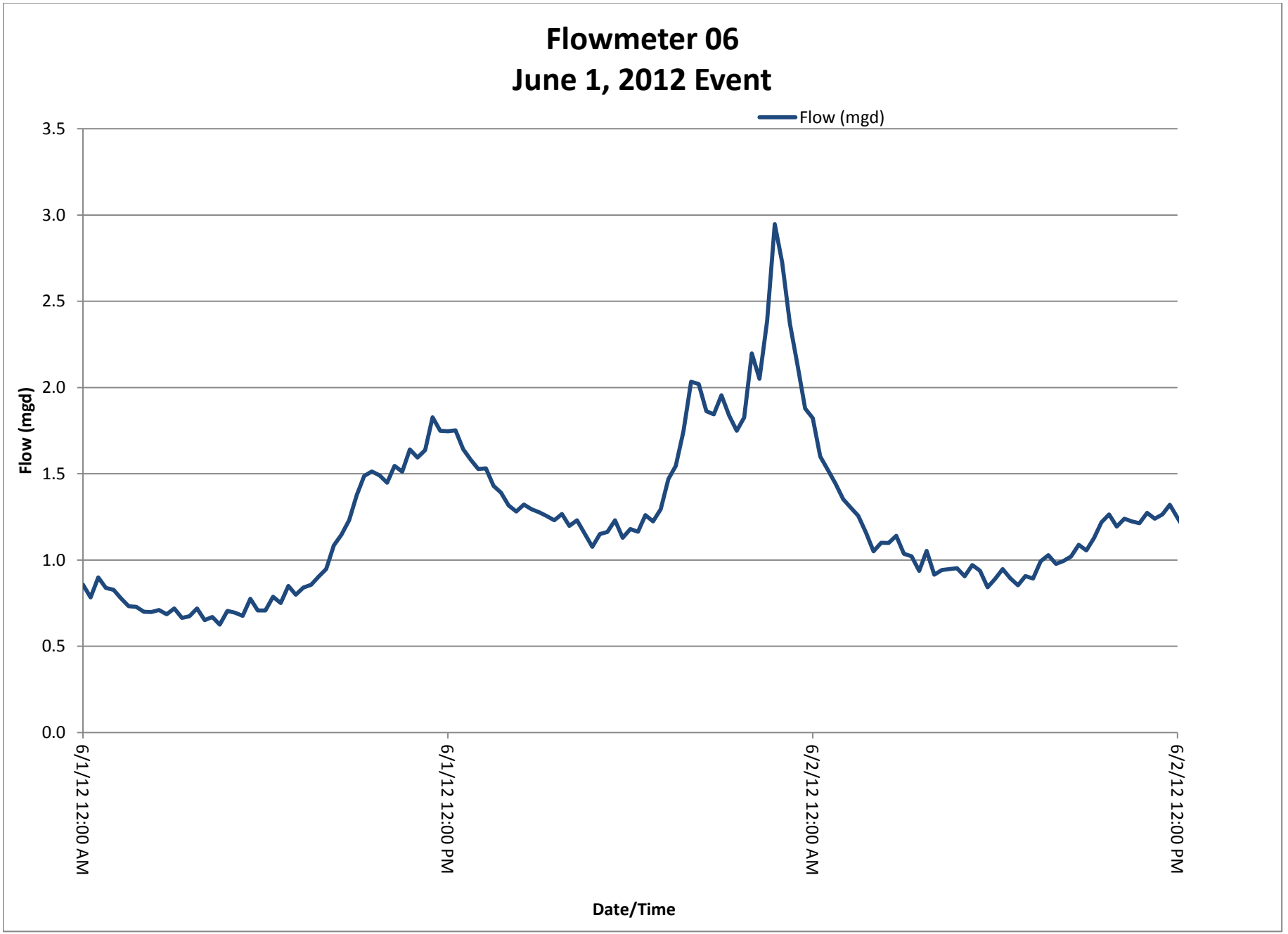

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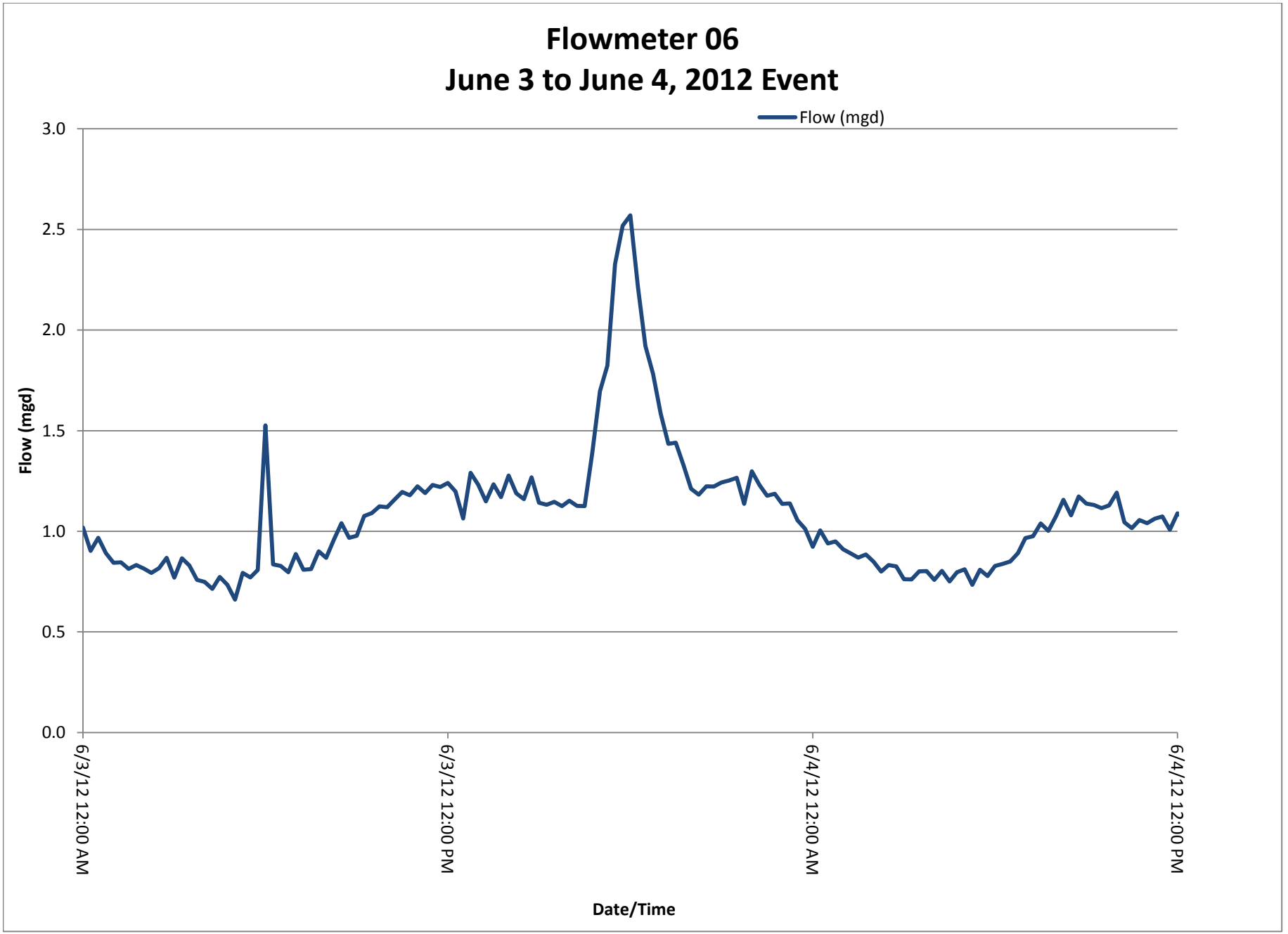

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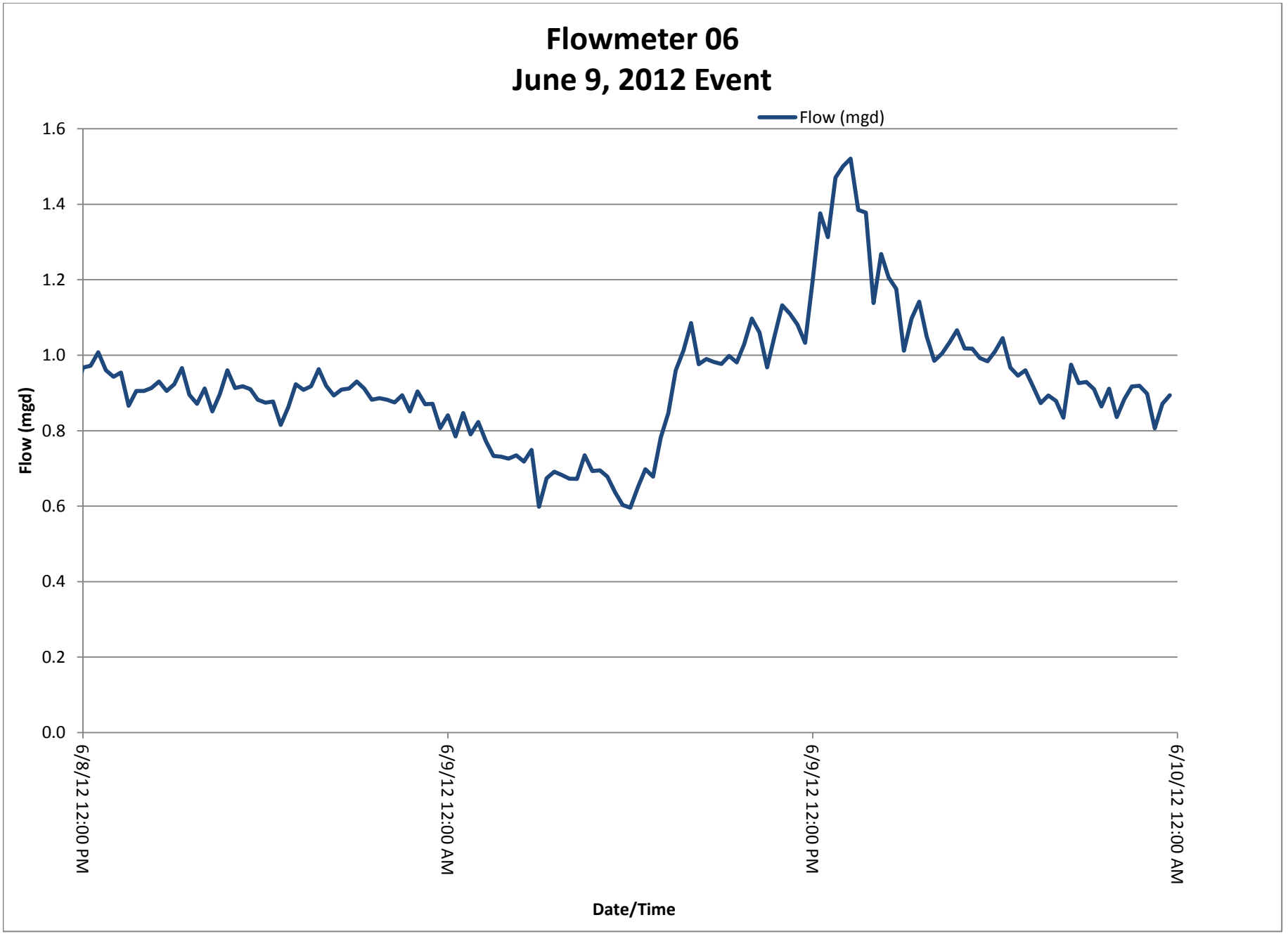

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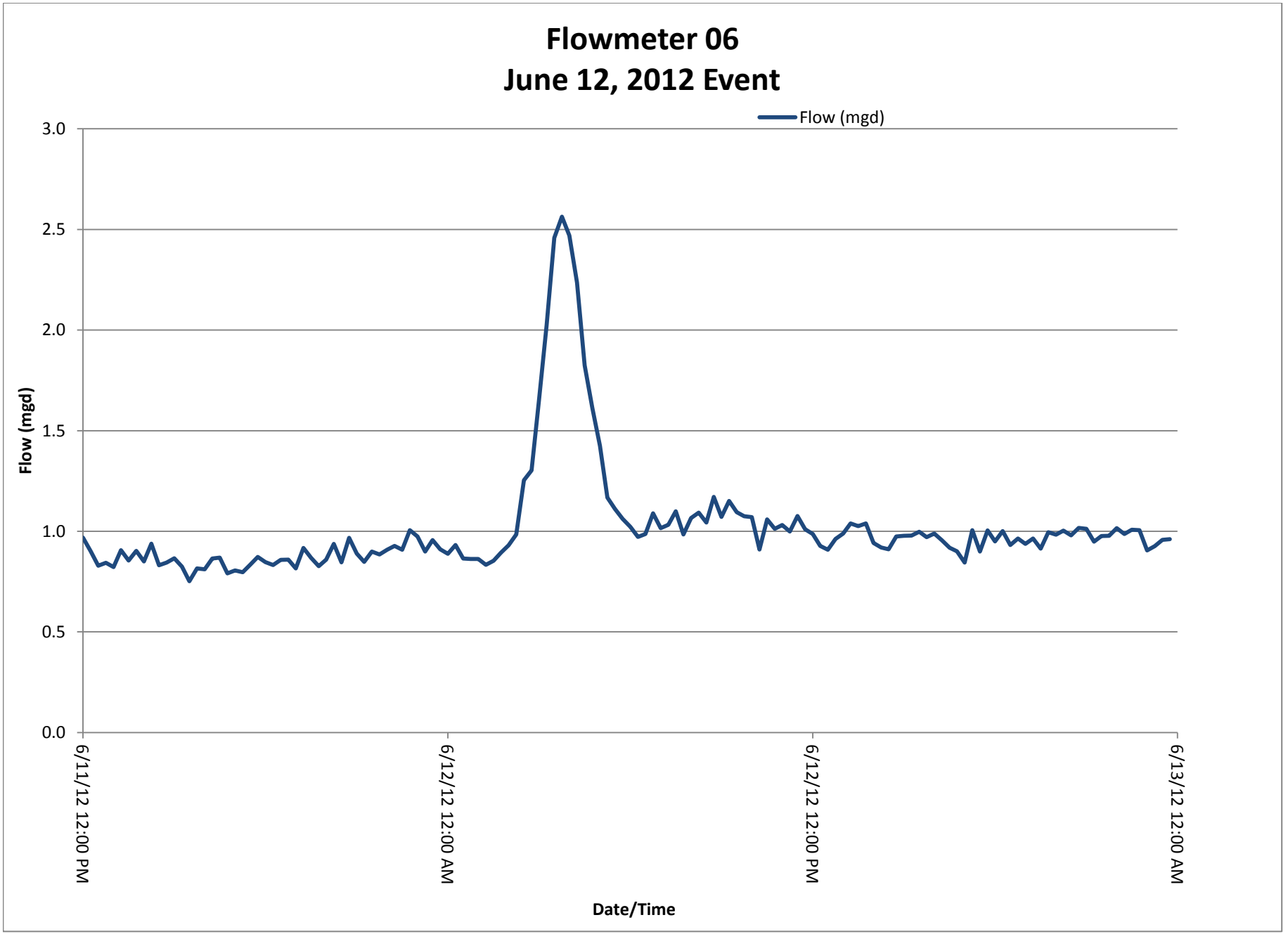

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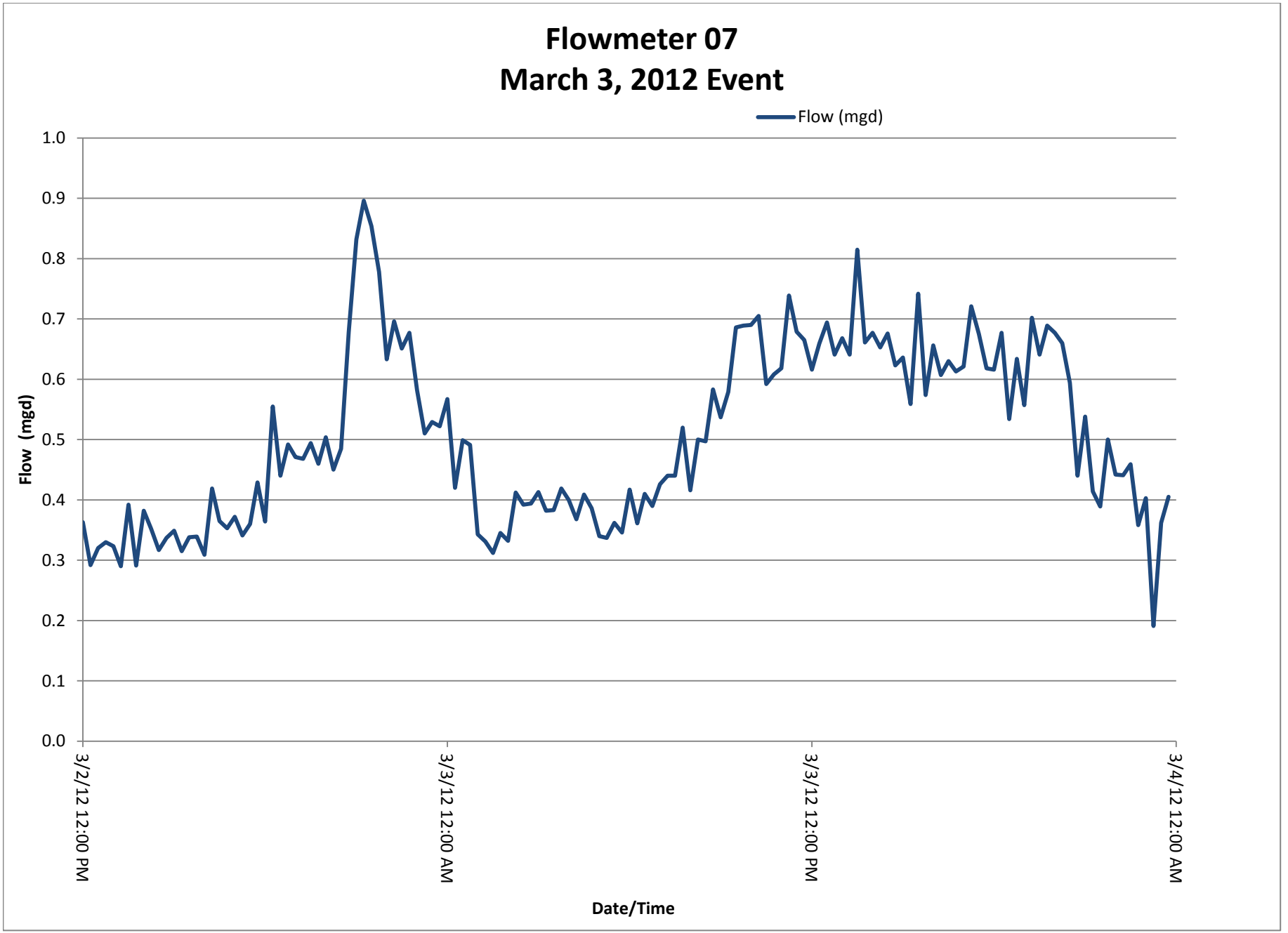

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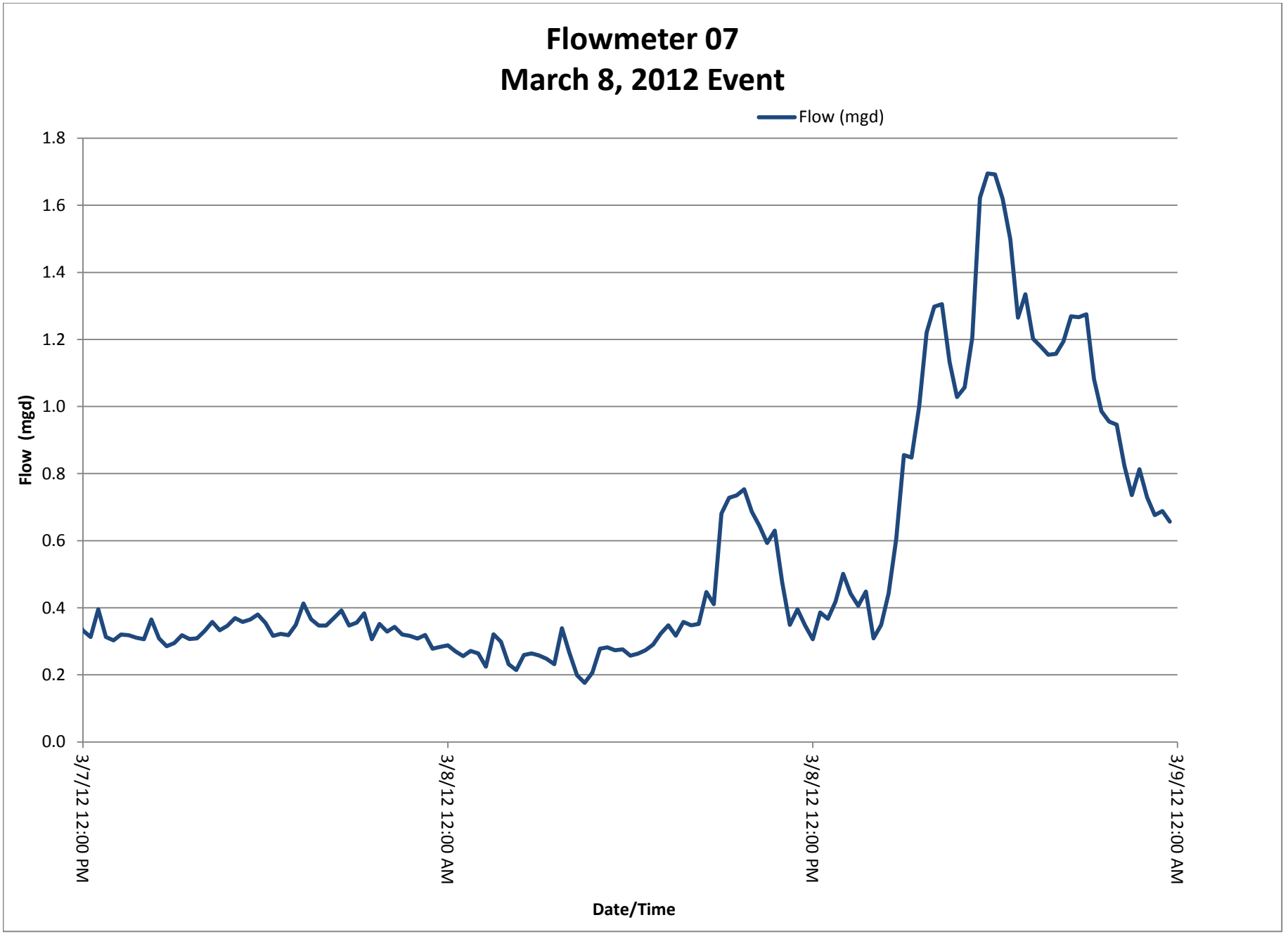

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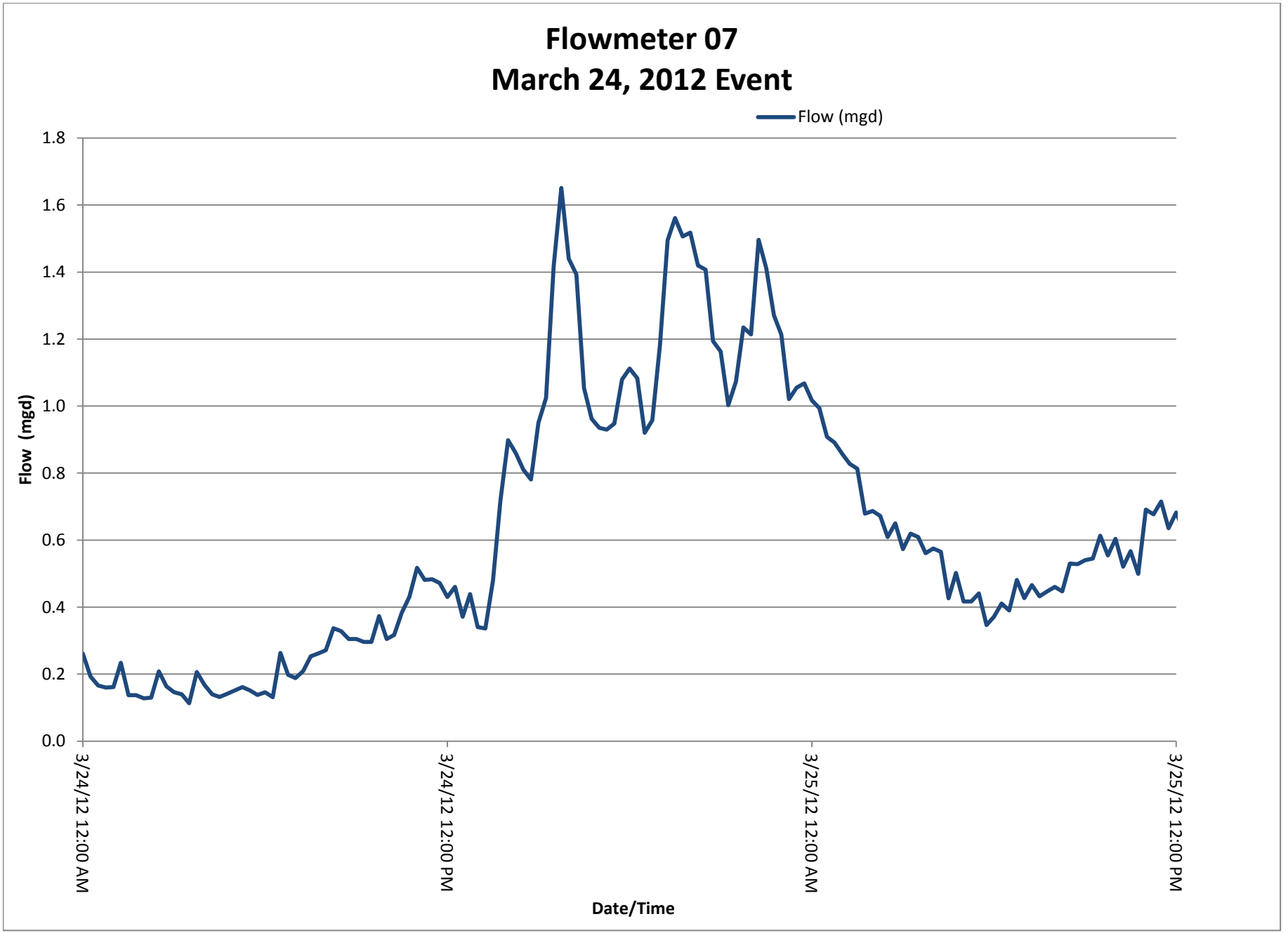

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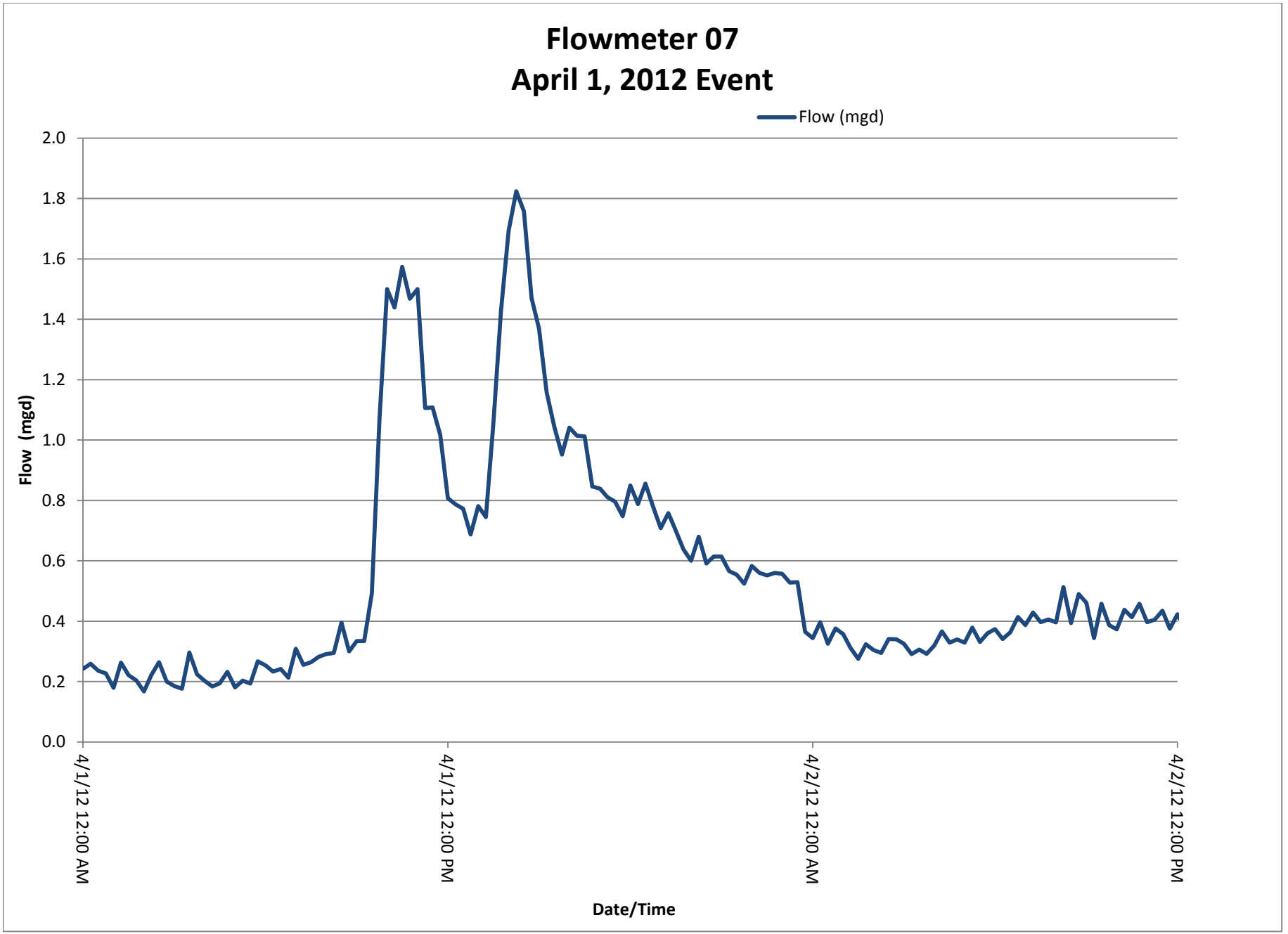

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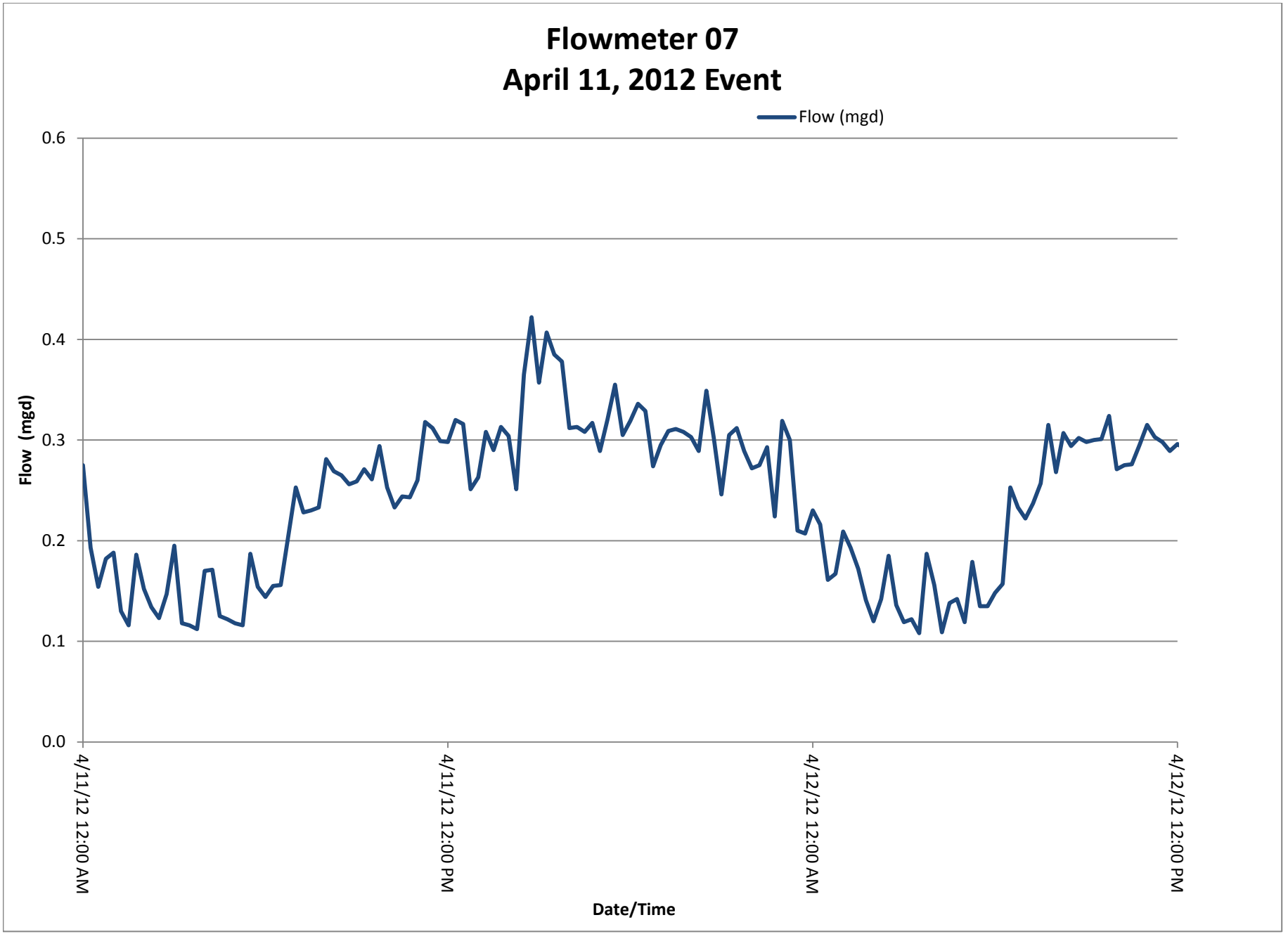

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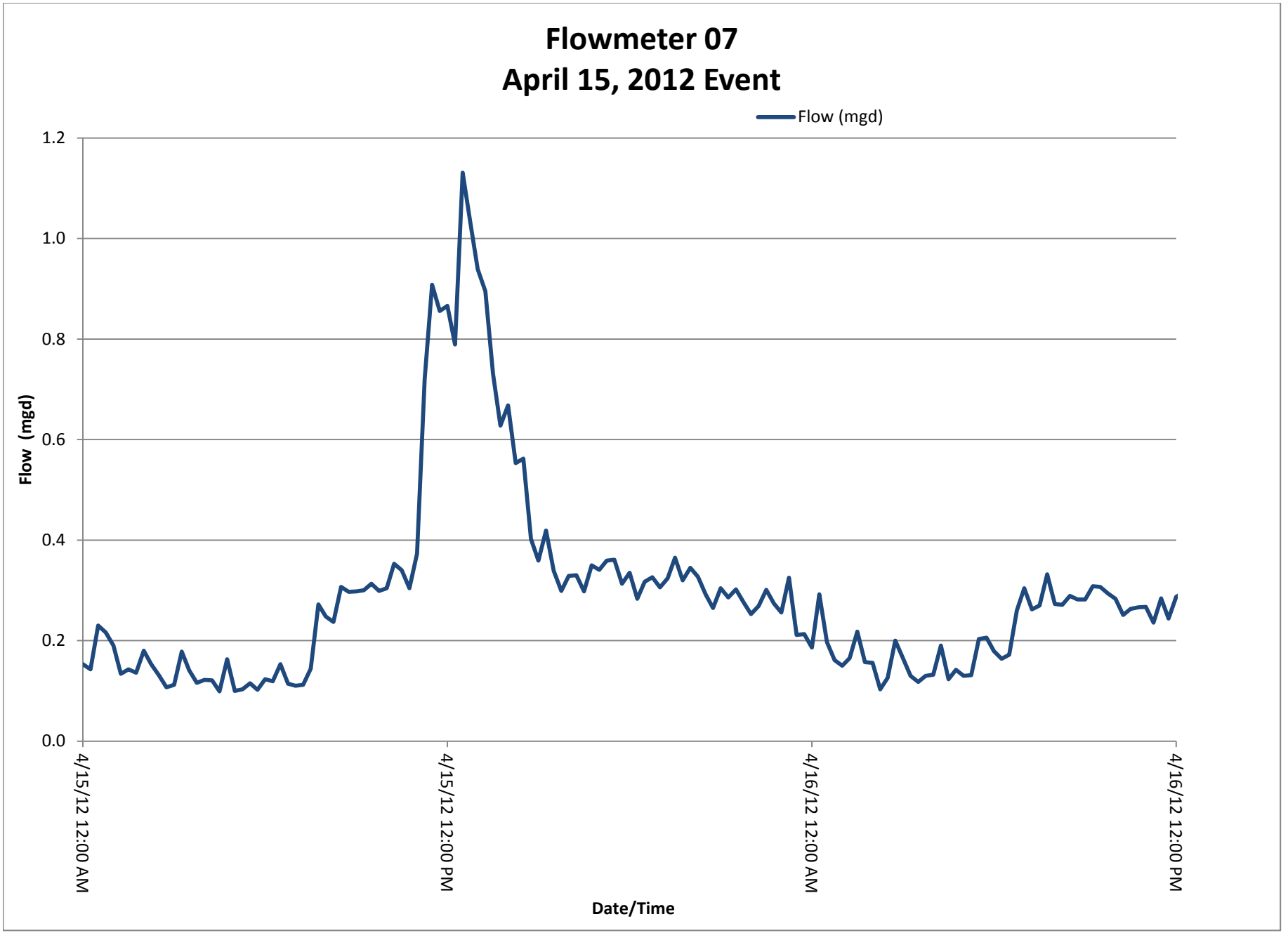

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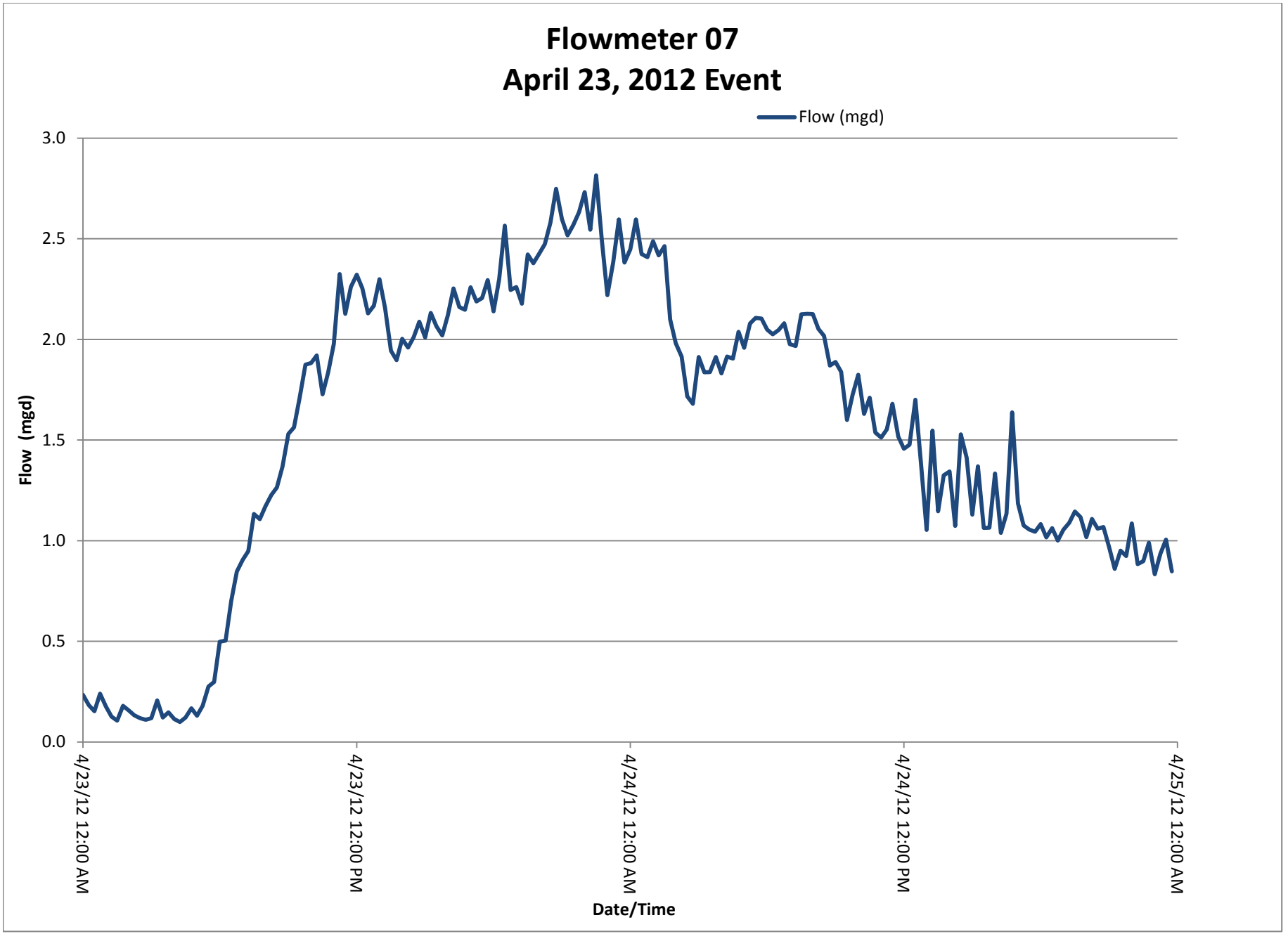

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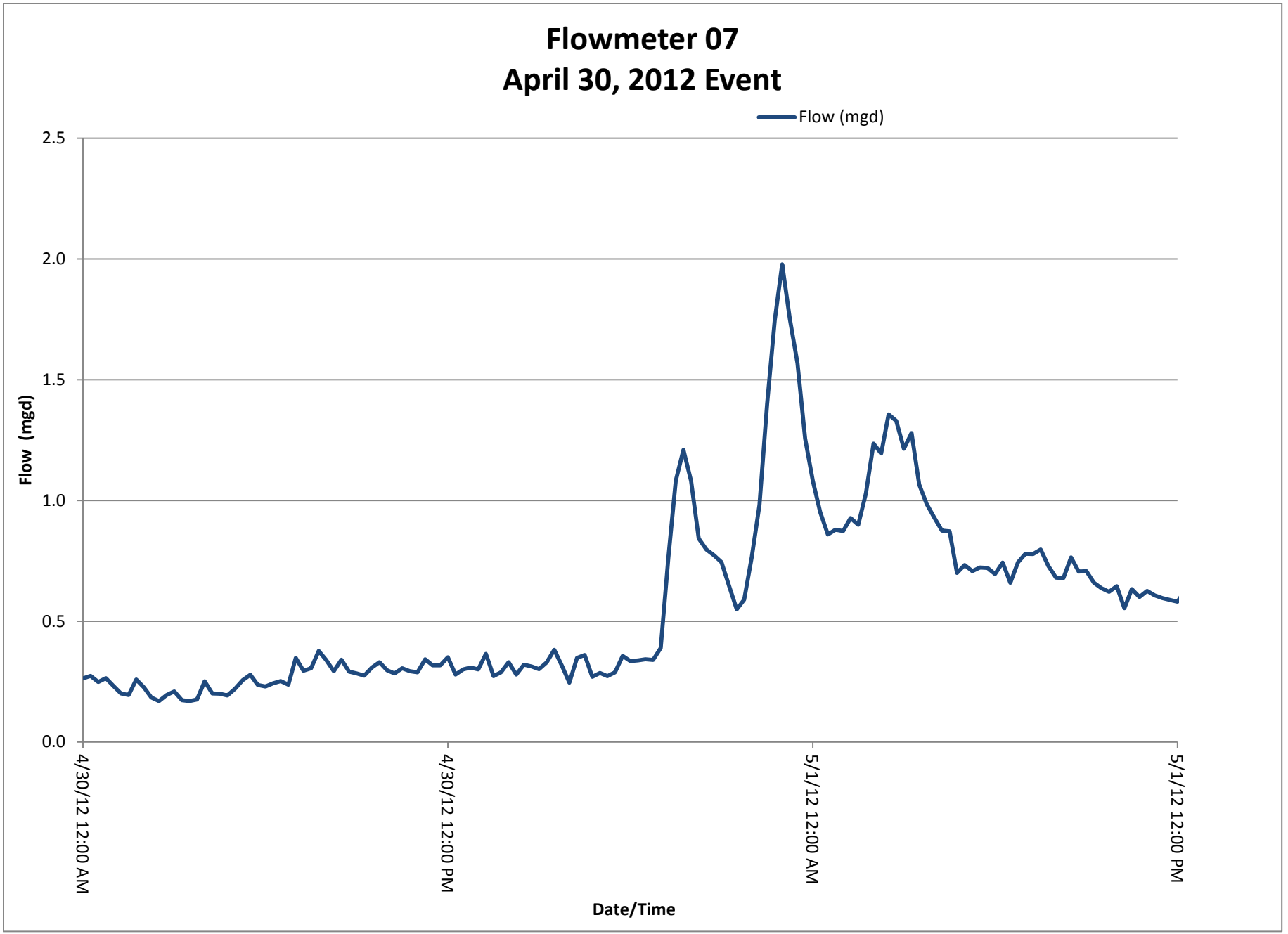

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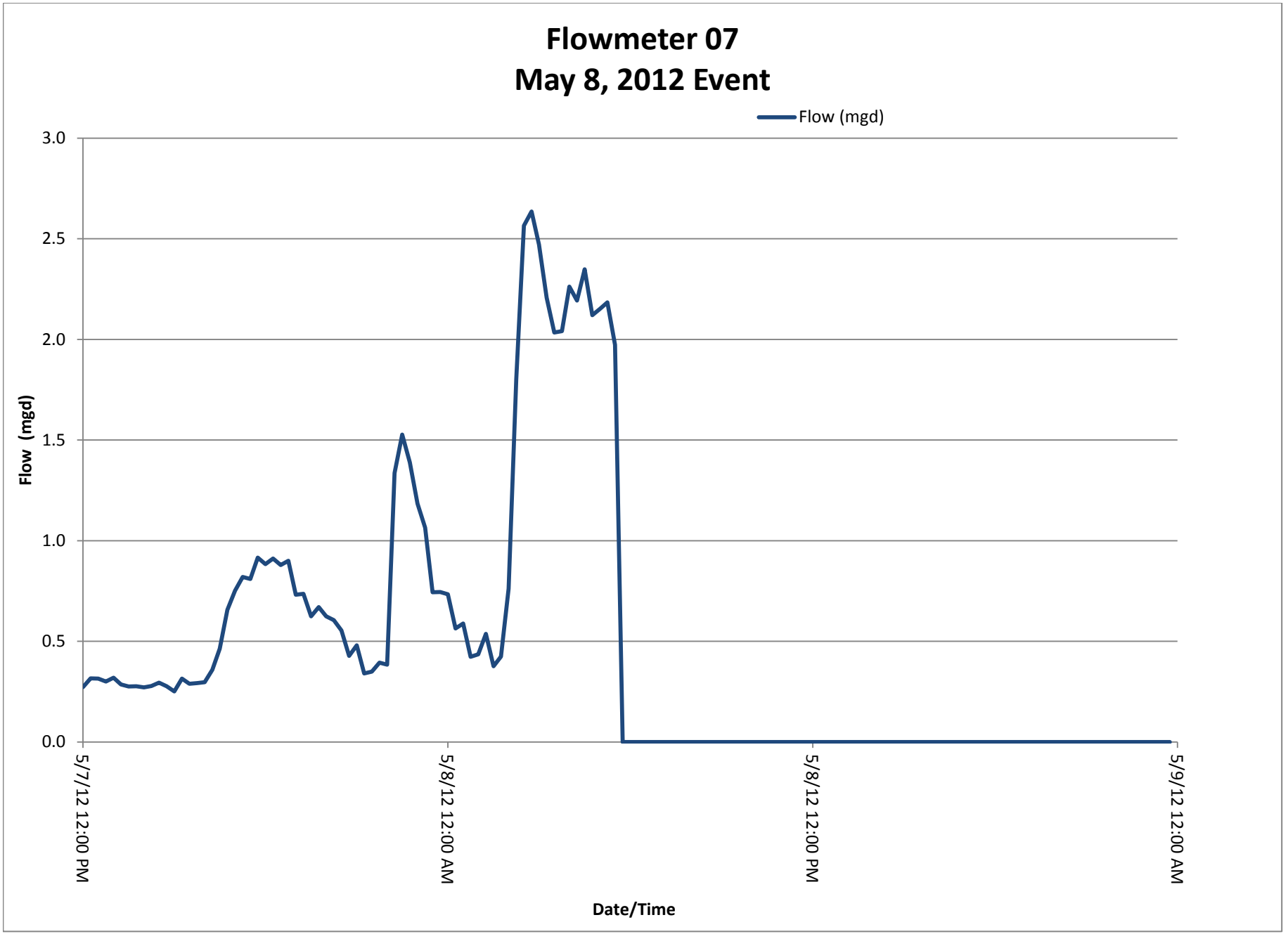

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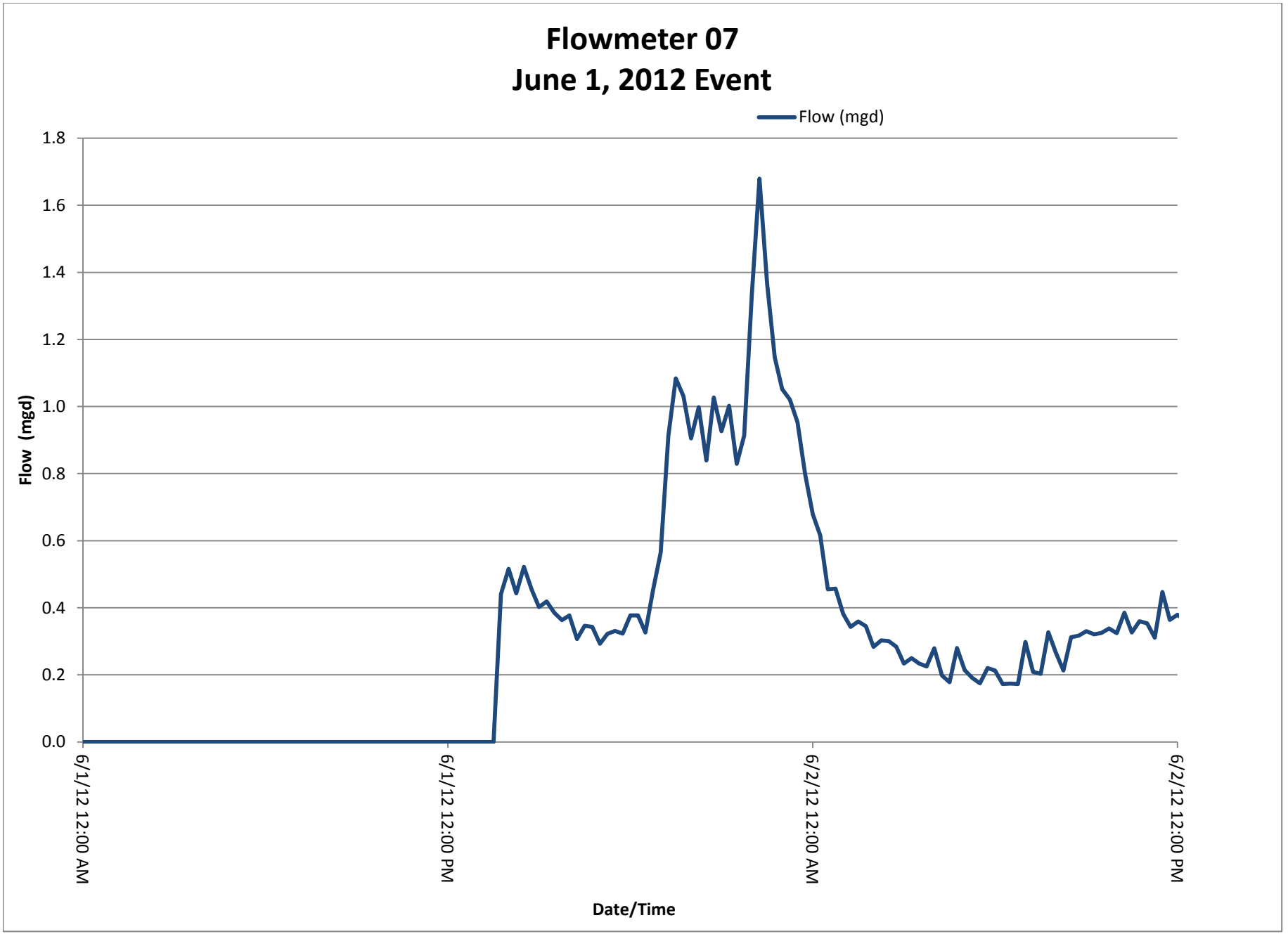

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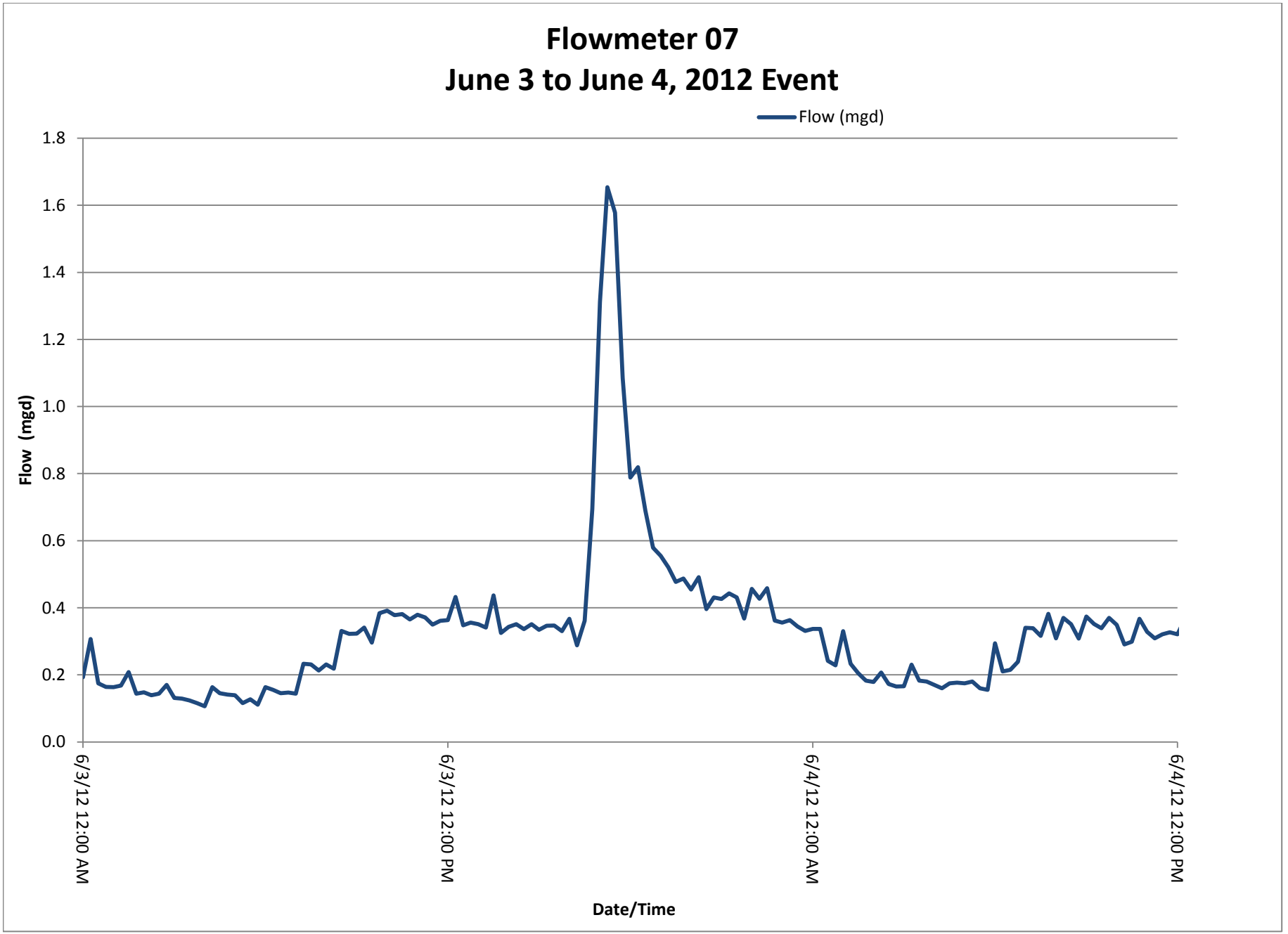

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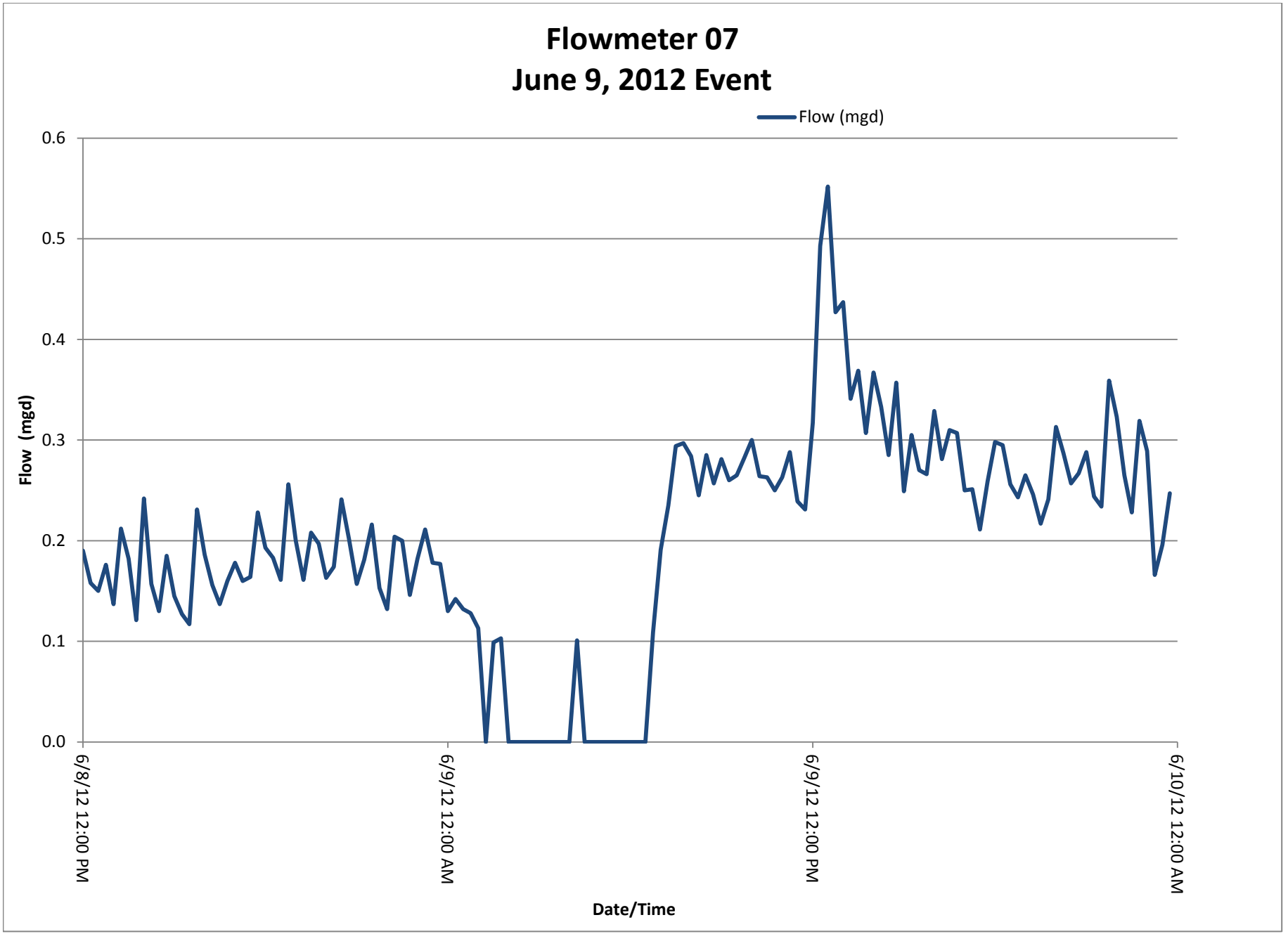

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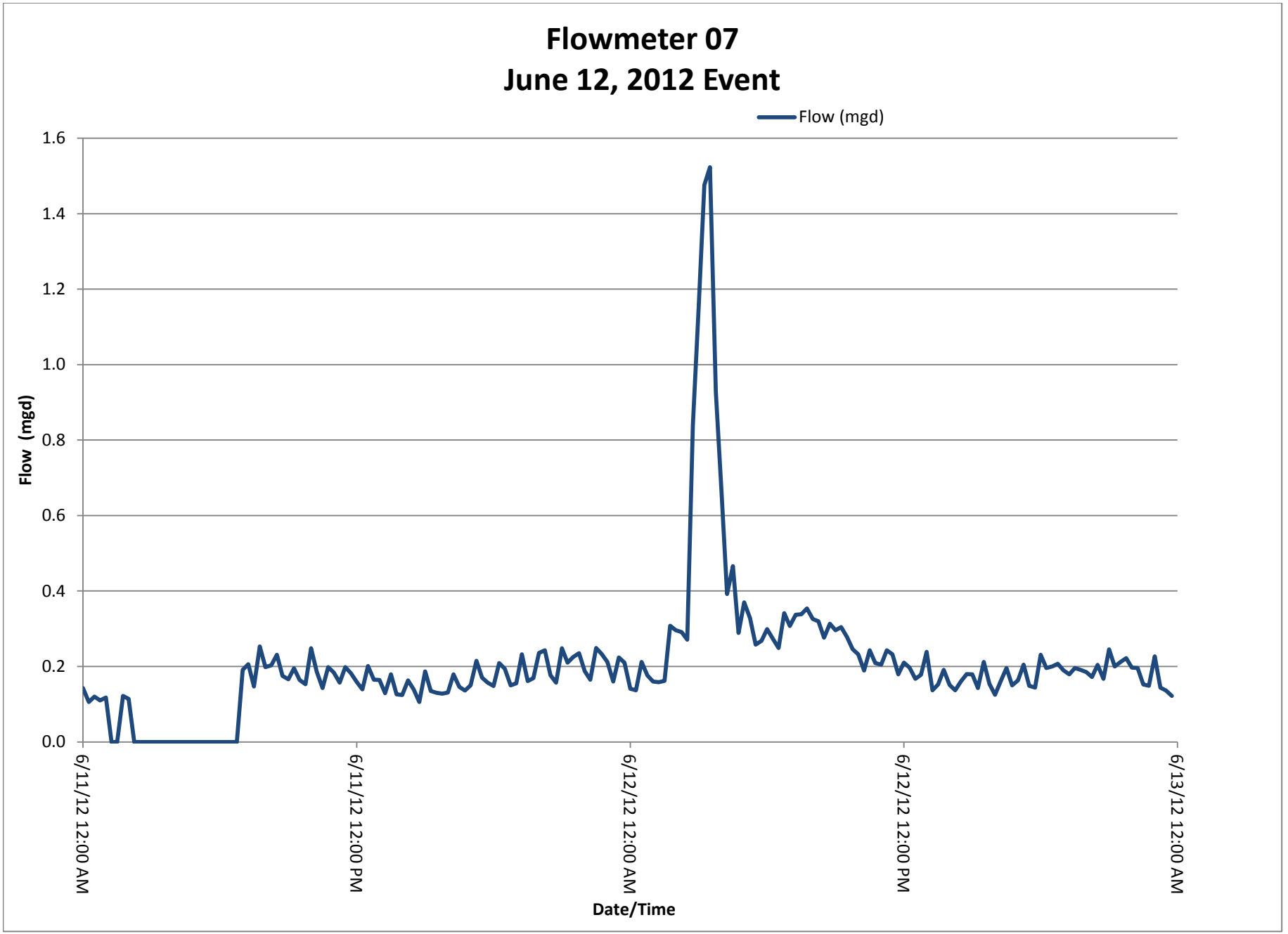

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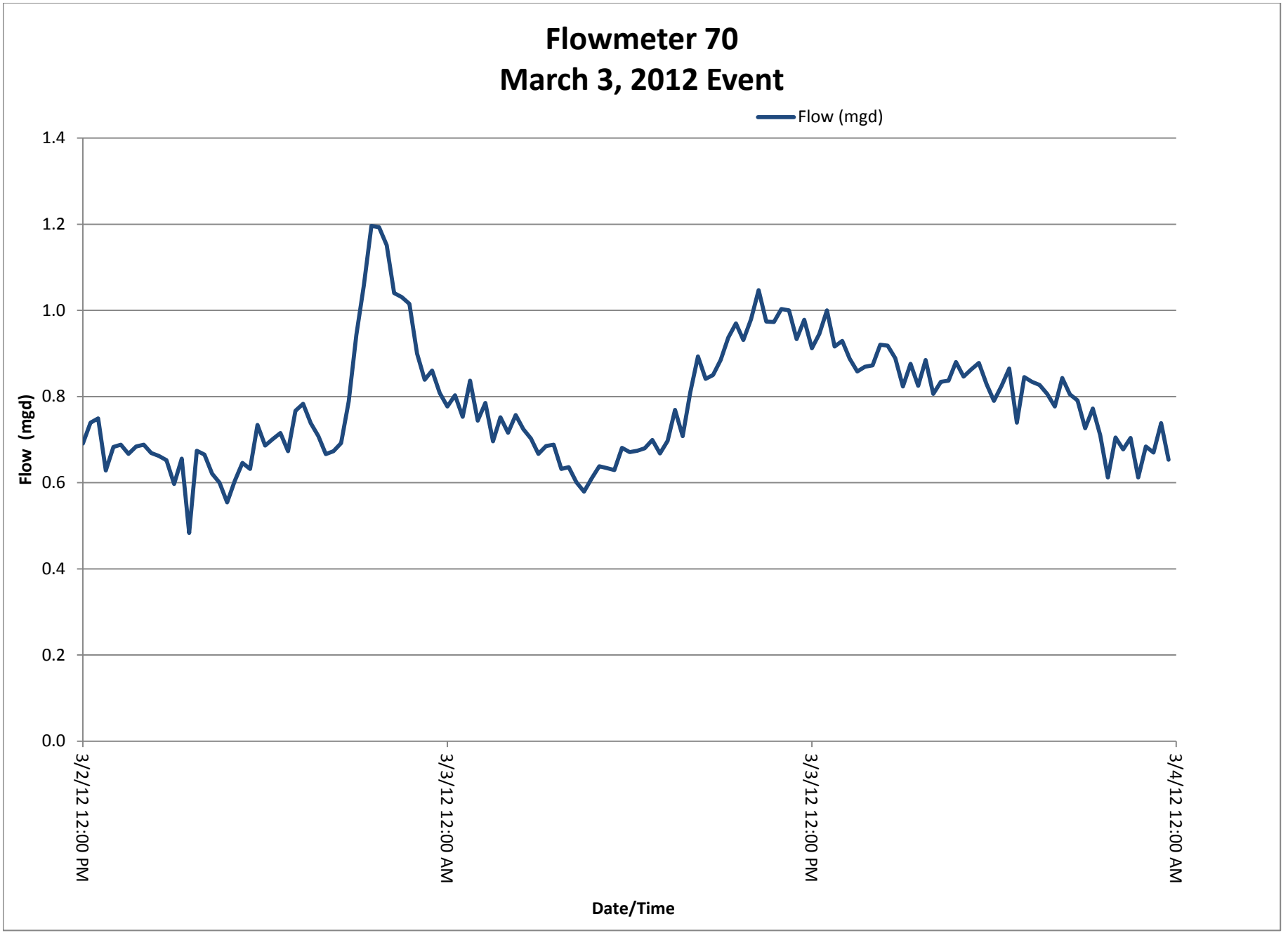
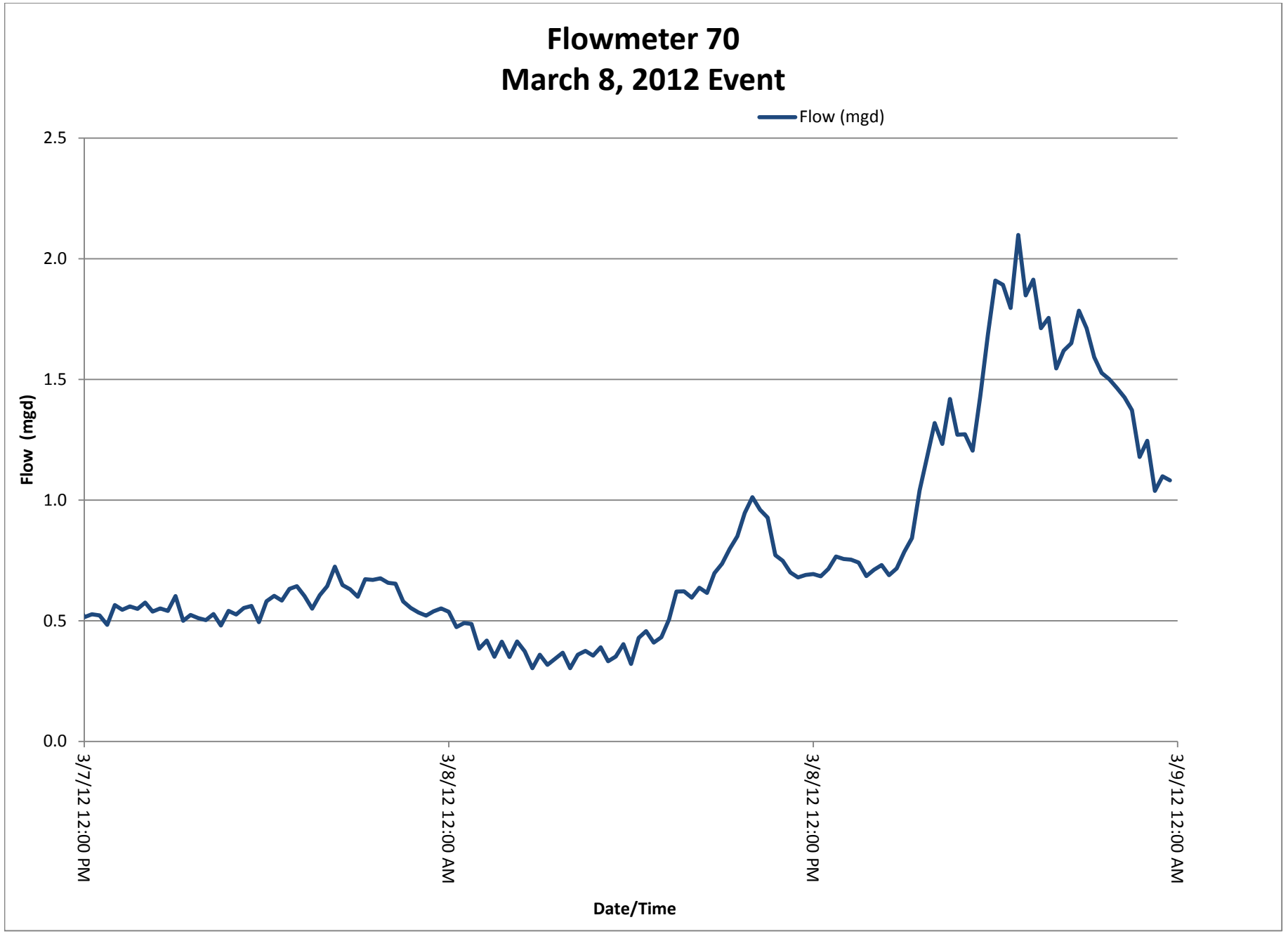
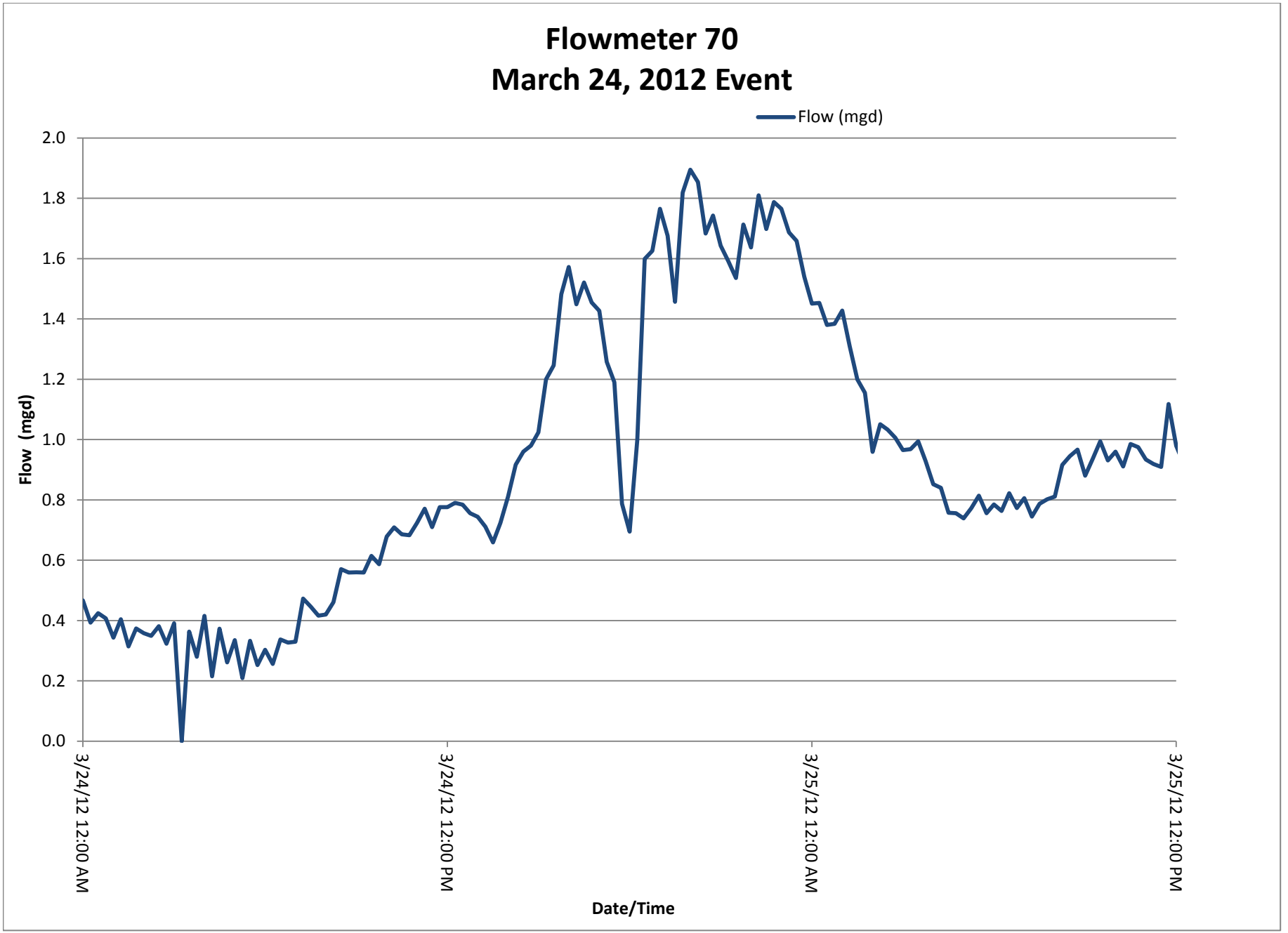
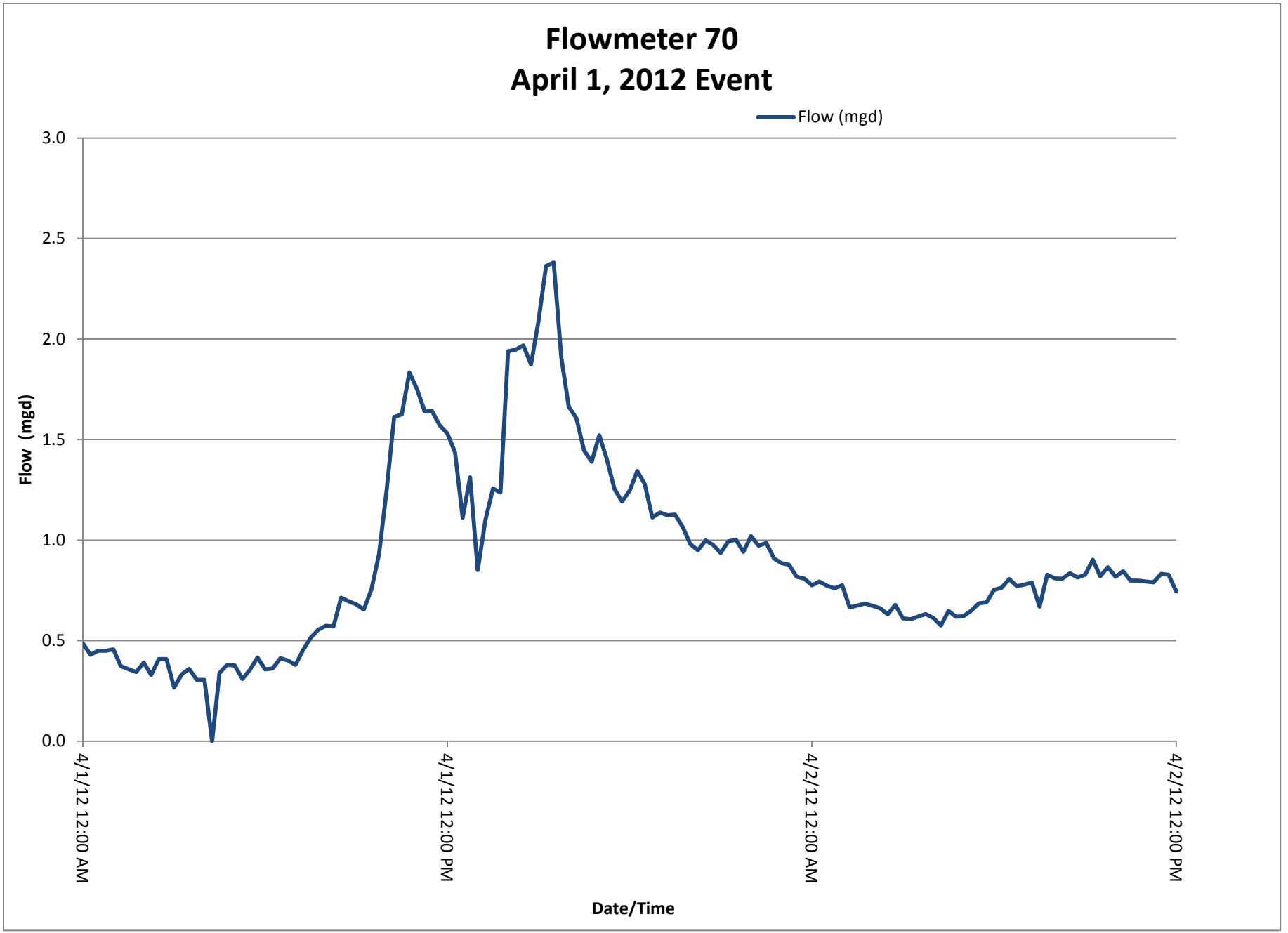
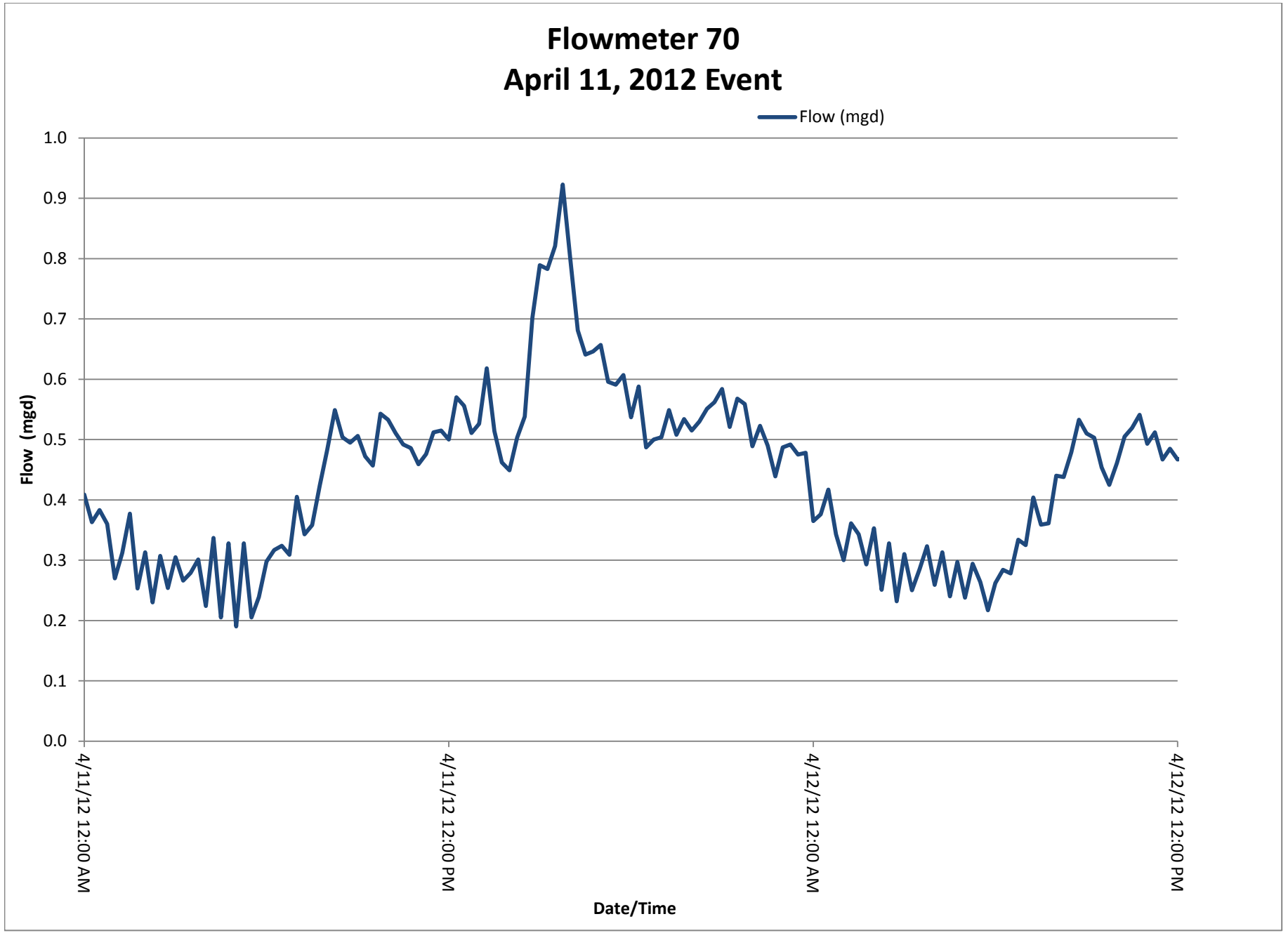
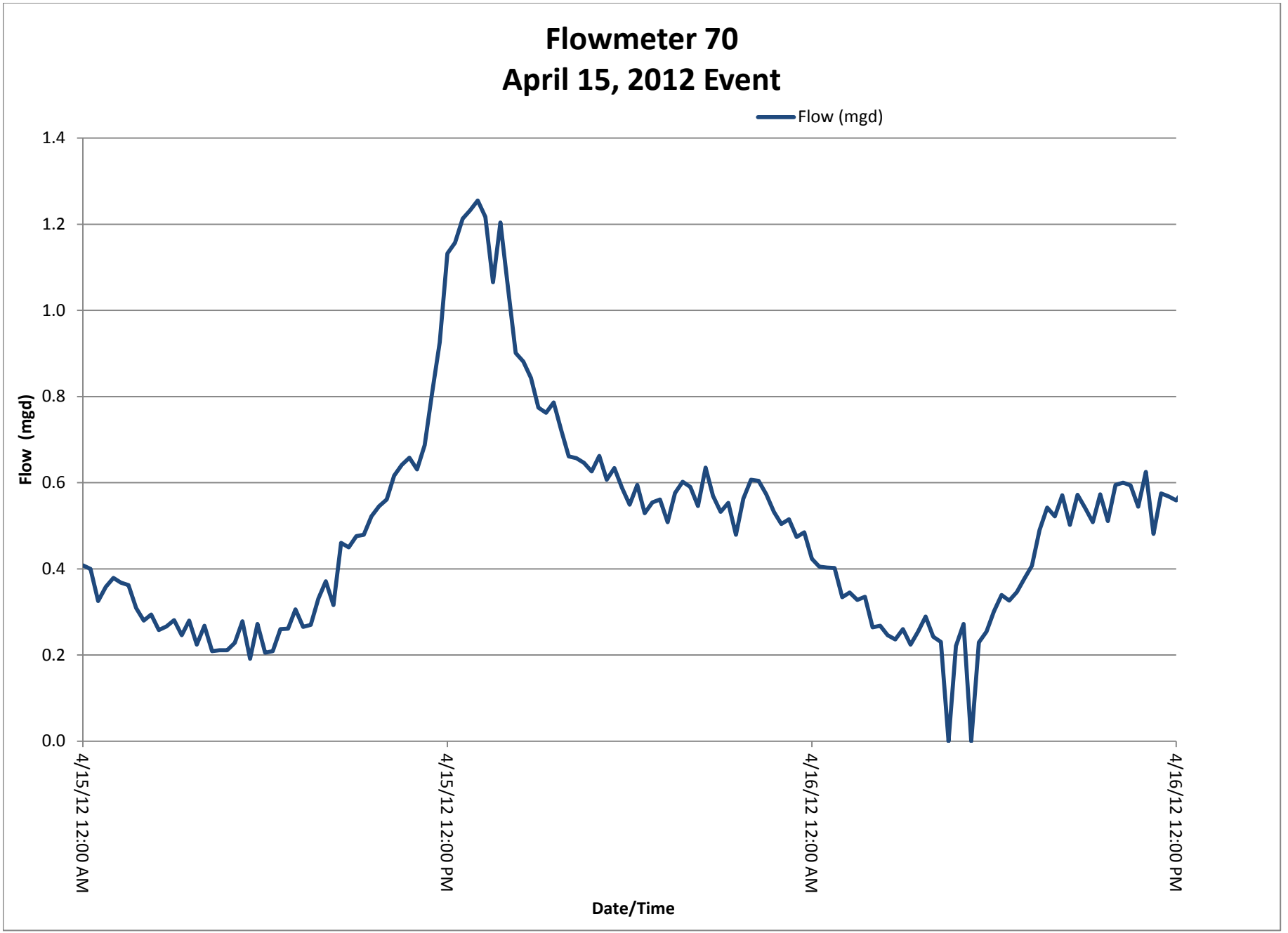

Flowmeter 70
March 3, 2012 Event
Flow (mgd)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (mgd)
3/2/12 12:00 PM
3/3/12 12:00 AM
3/3/12 12:00 PM
3/4/12 12:00 AM
Date/Time

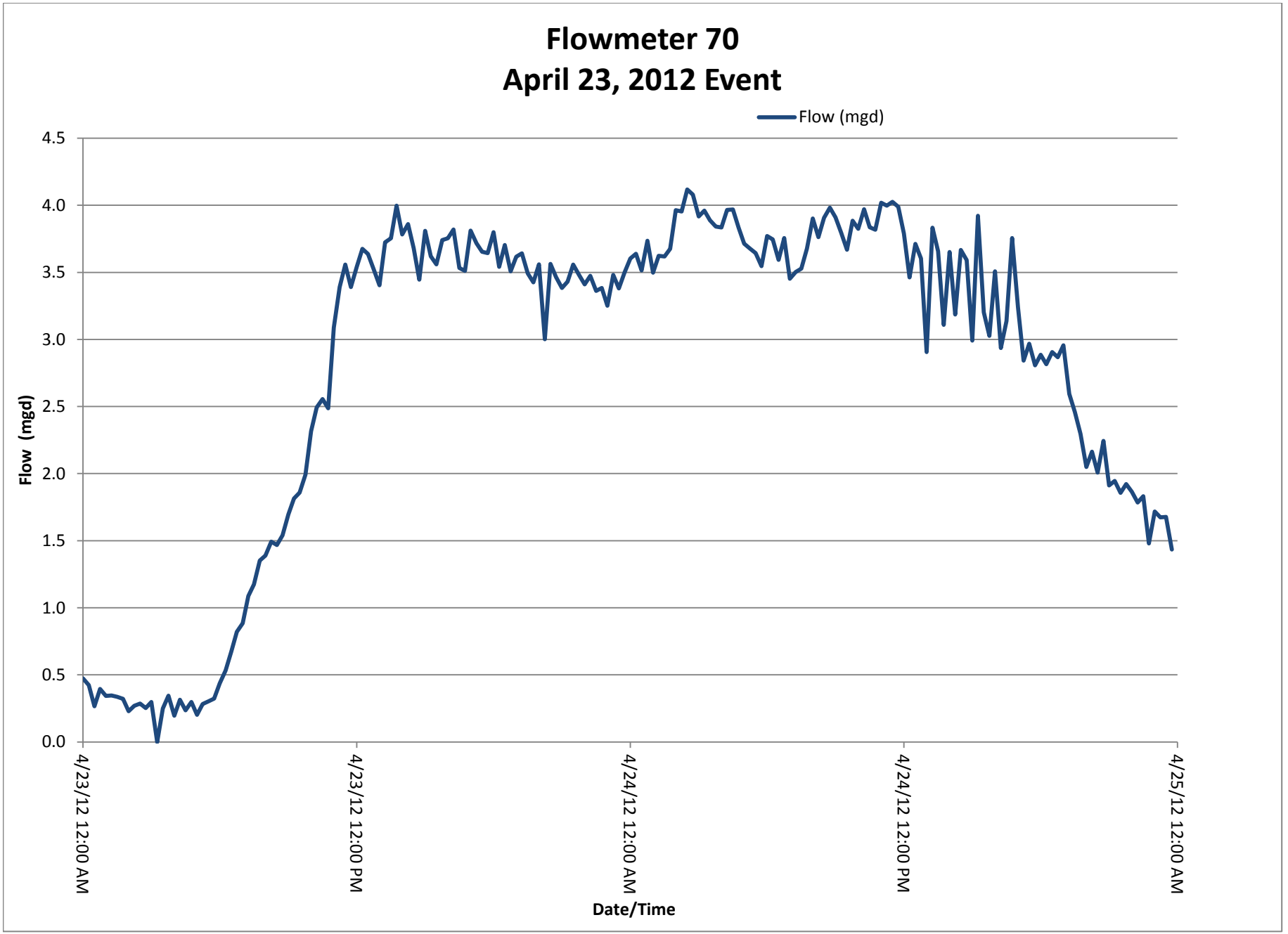

Flowmeter 70
March 8, 2012 Event
Flow (mgd)
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
3/7/12 12:00 PM
3/8/12 12:00 AM
3/8/12 12:00 PM
3/9/12 12:00 AM
Date/Time

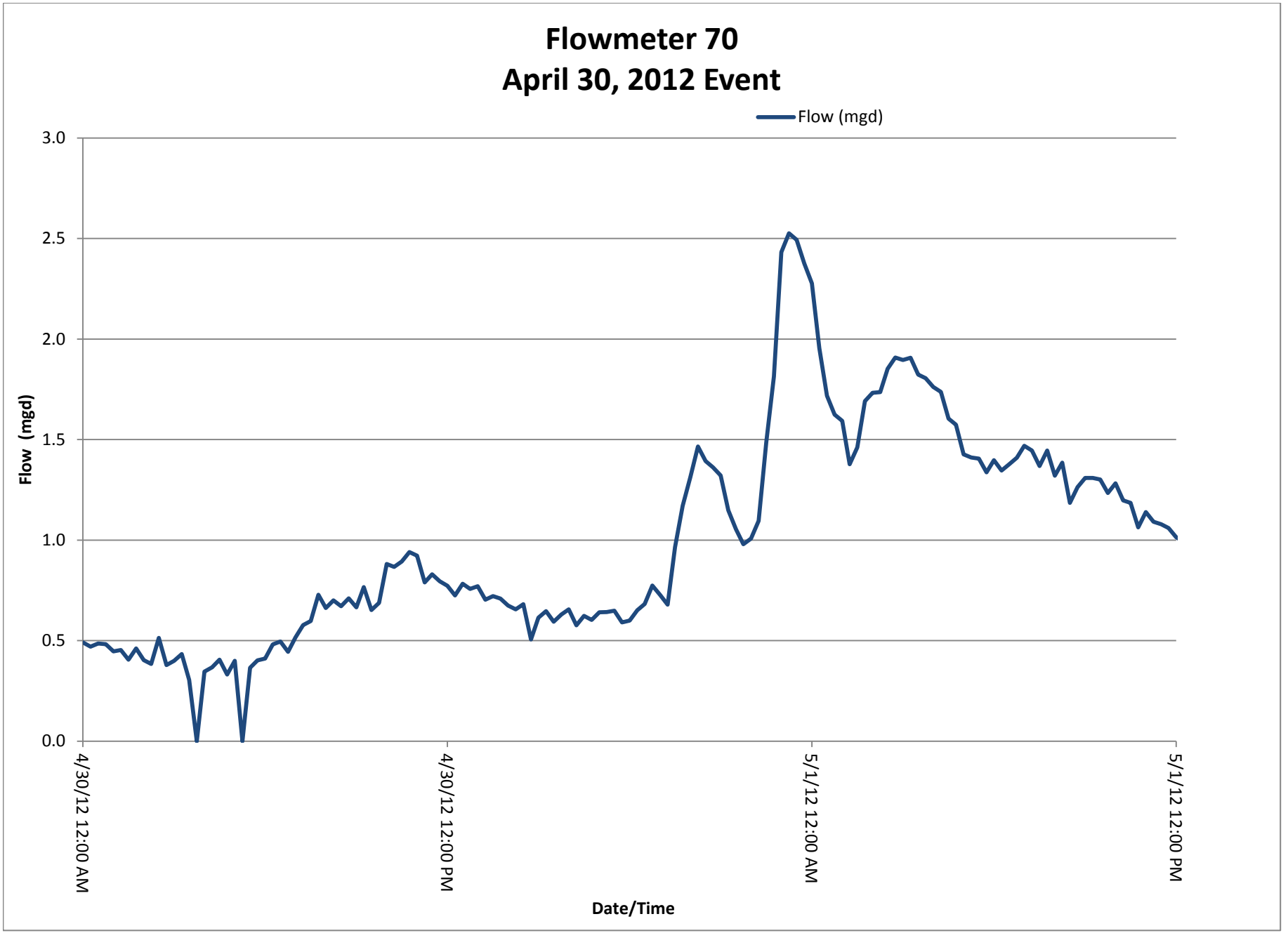

Flowmeter 70
March 24, 2012 Event
Flow (mgd)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (mgd)
3/24/12 12:00 AM
3/24/12 12:00 PM
3/25/12 12:00 AM
3/25/12 12:00 PM
Date/Time

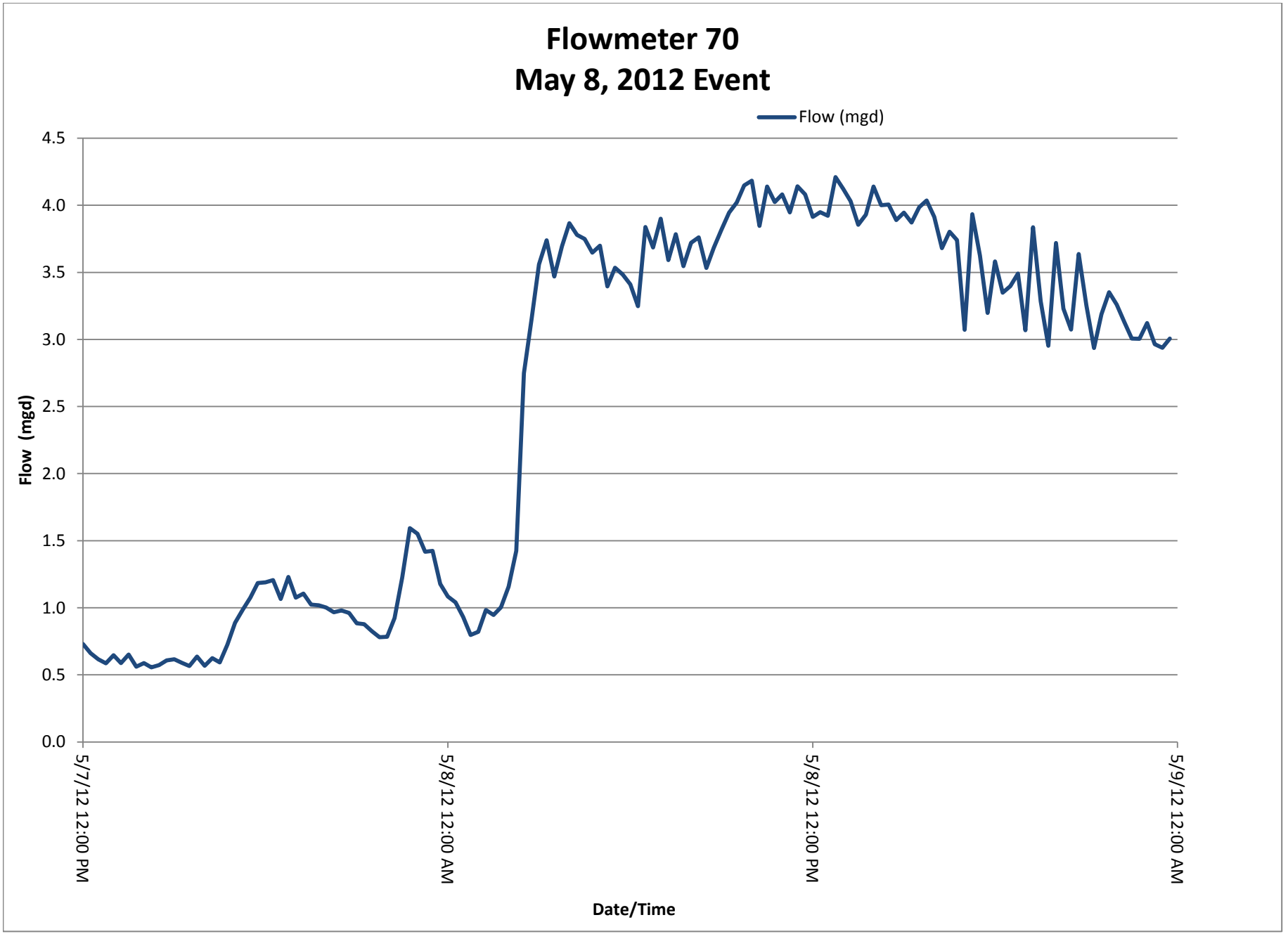

Flowmeter 70
April 1, 2012 Event
Flow (mgd)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
4/1/12 12:00 AM
4/1/12 12:00 PM
4/2/12 12:00 AM
4/2/12 12:00 PM
Date/Time

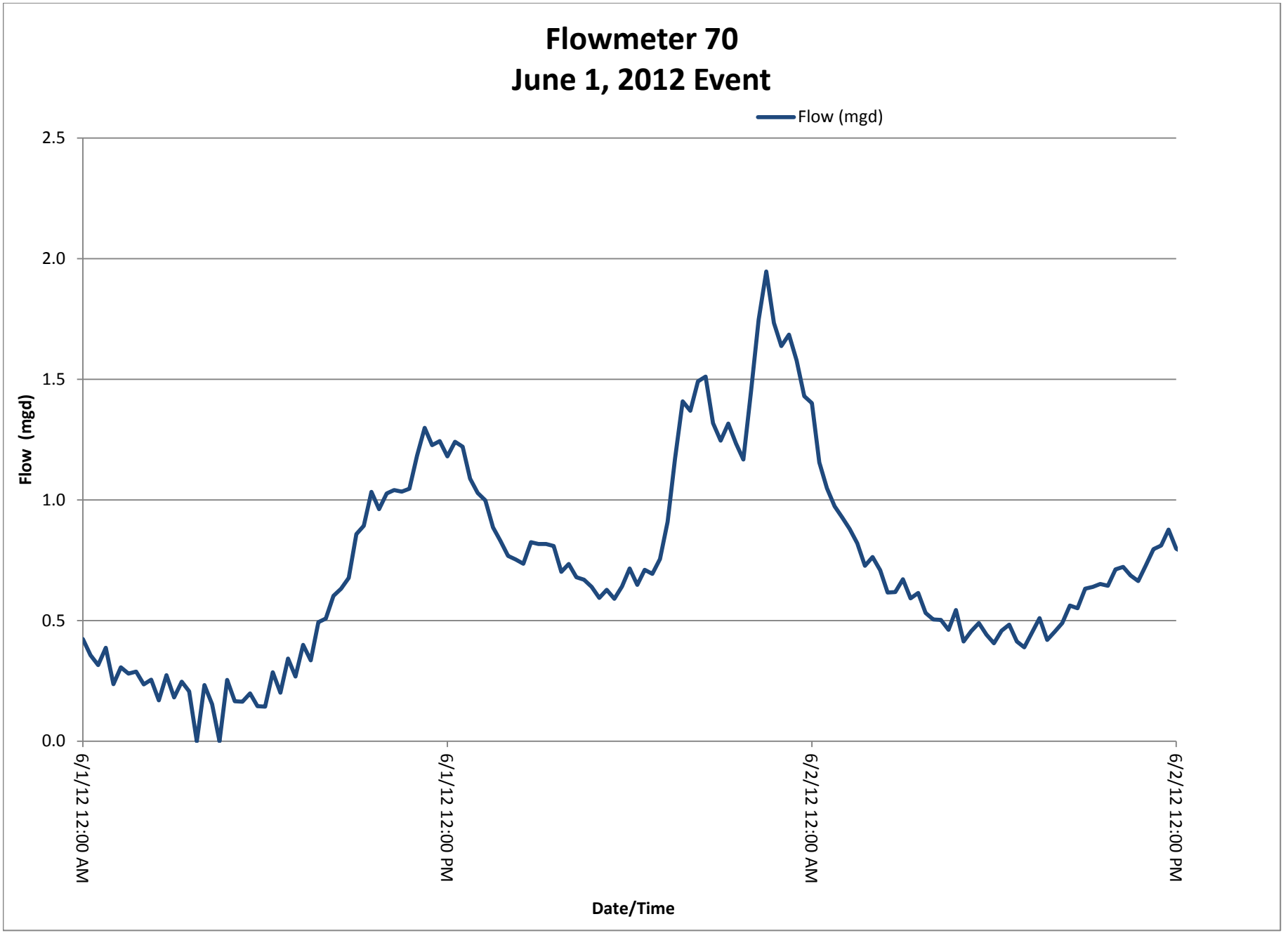

Flowmeter 70
April 11, 2012 Event
Flow (mgd)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Flow (mgd)
4/11/12 12:00 AM
4/11/12 12:00 PM
4/12/12 12:00 AM
4/12/12 12:00 PM
Date/Time

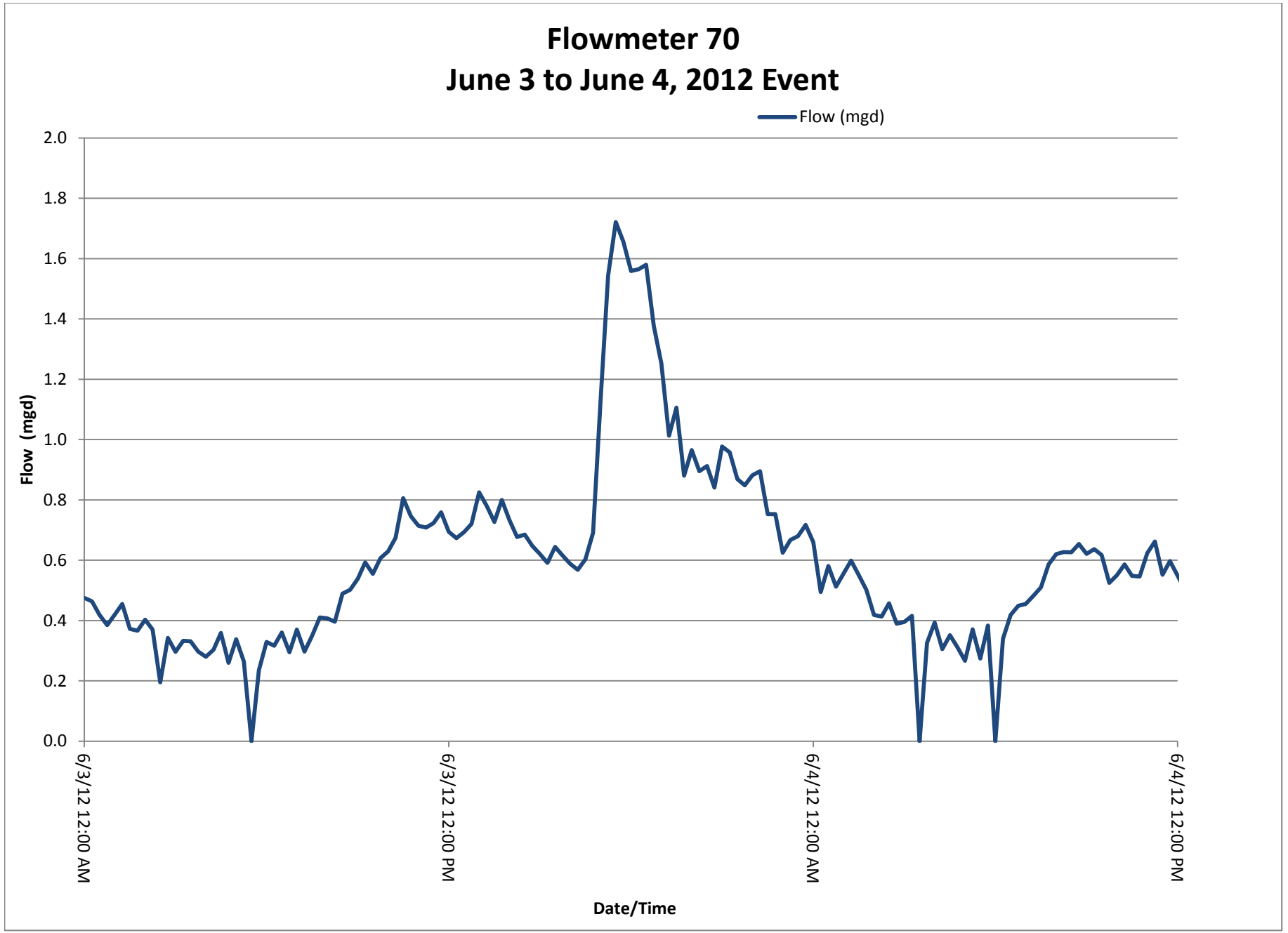

Flowmeter 70
April 15, 2012 Event
Flow (mgd)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (mgd)
4/15/12 12:00 AM
4/15/12 12:00 PM
4/16/12 12:00 AM
4/16/12 12:00 PM
Date/Time

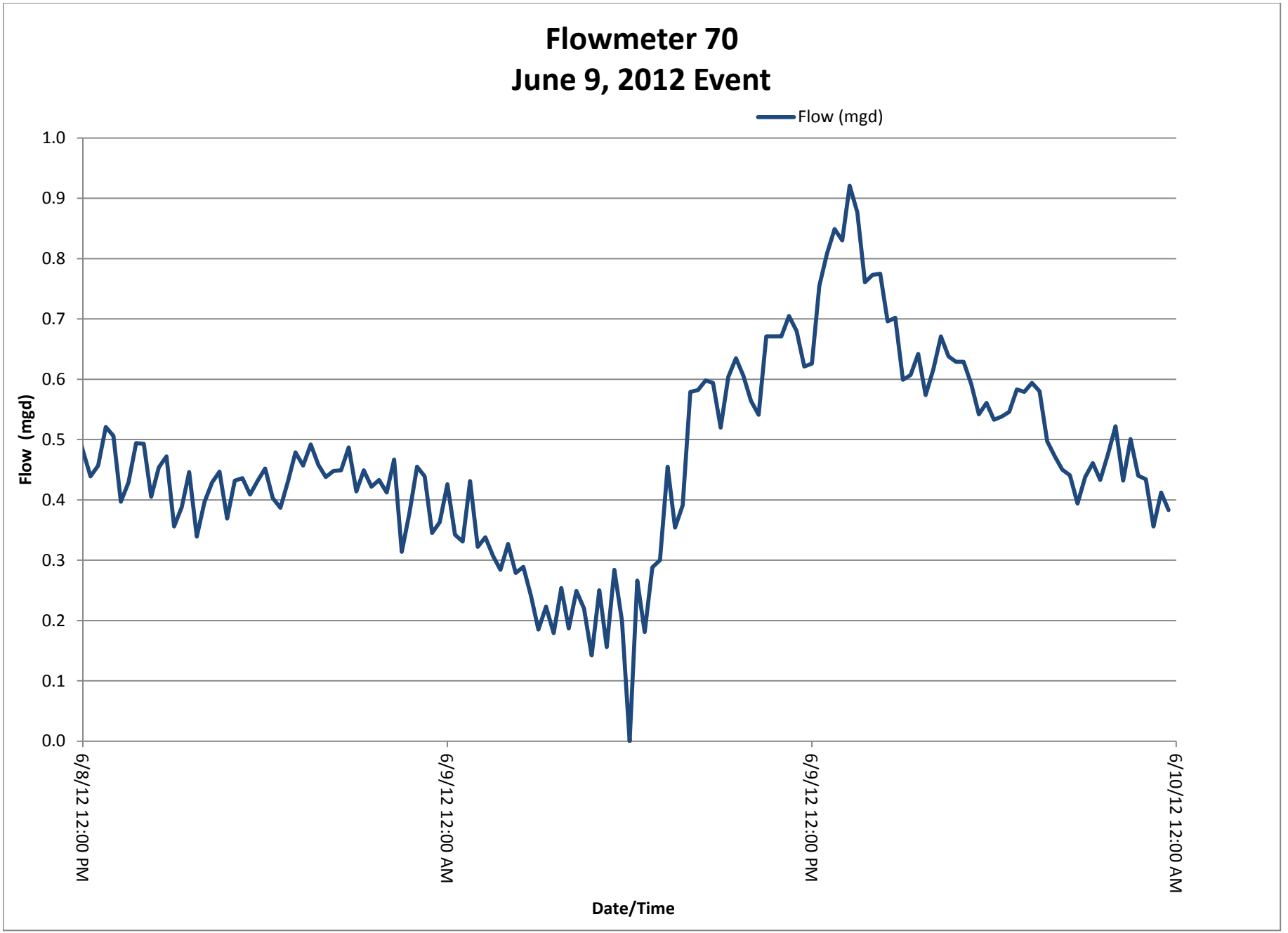

Flowmeter 70
April 23, 2012 Event
Flow (mgd)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
4/23/12 12:00 AM
4/23/12 12:00 PM
4/24/12 12:00 AM
4/24/12 12:00 PM
4/25/12 12:00 AM
Date/Time

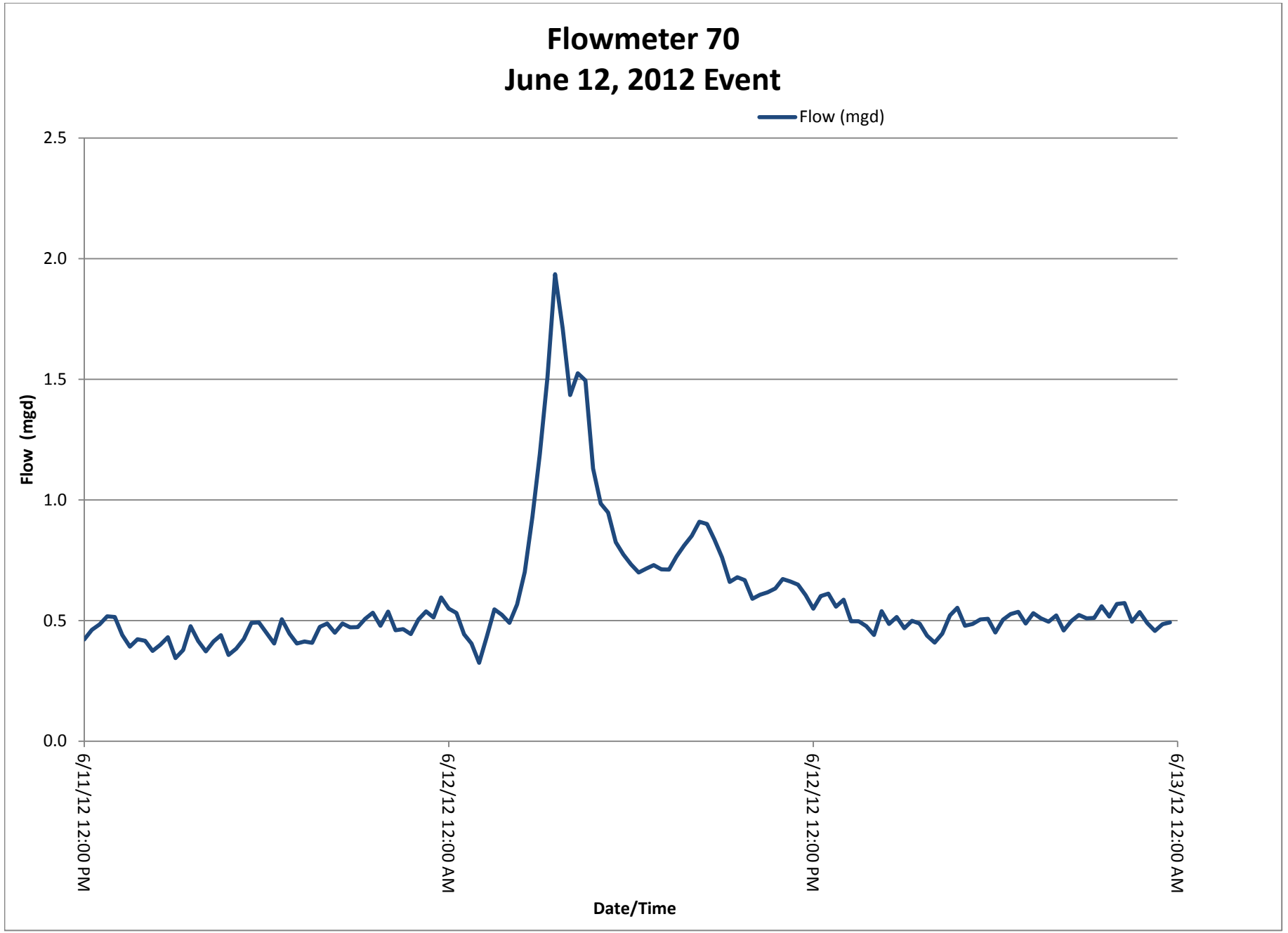

Flowmeter 70
April 30, 2012 Event
Flow (mgd)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
4/30/12 12:00 AM
4/30/12 12:00 PM
5/1/12 12:00 AM
5/1/12 12:00 PM
Date/Time

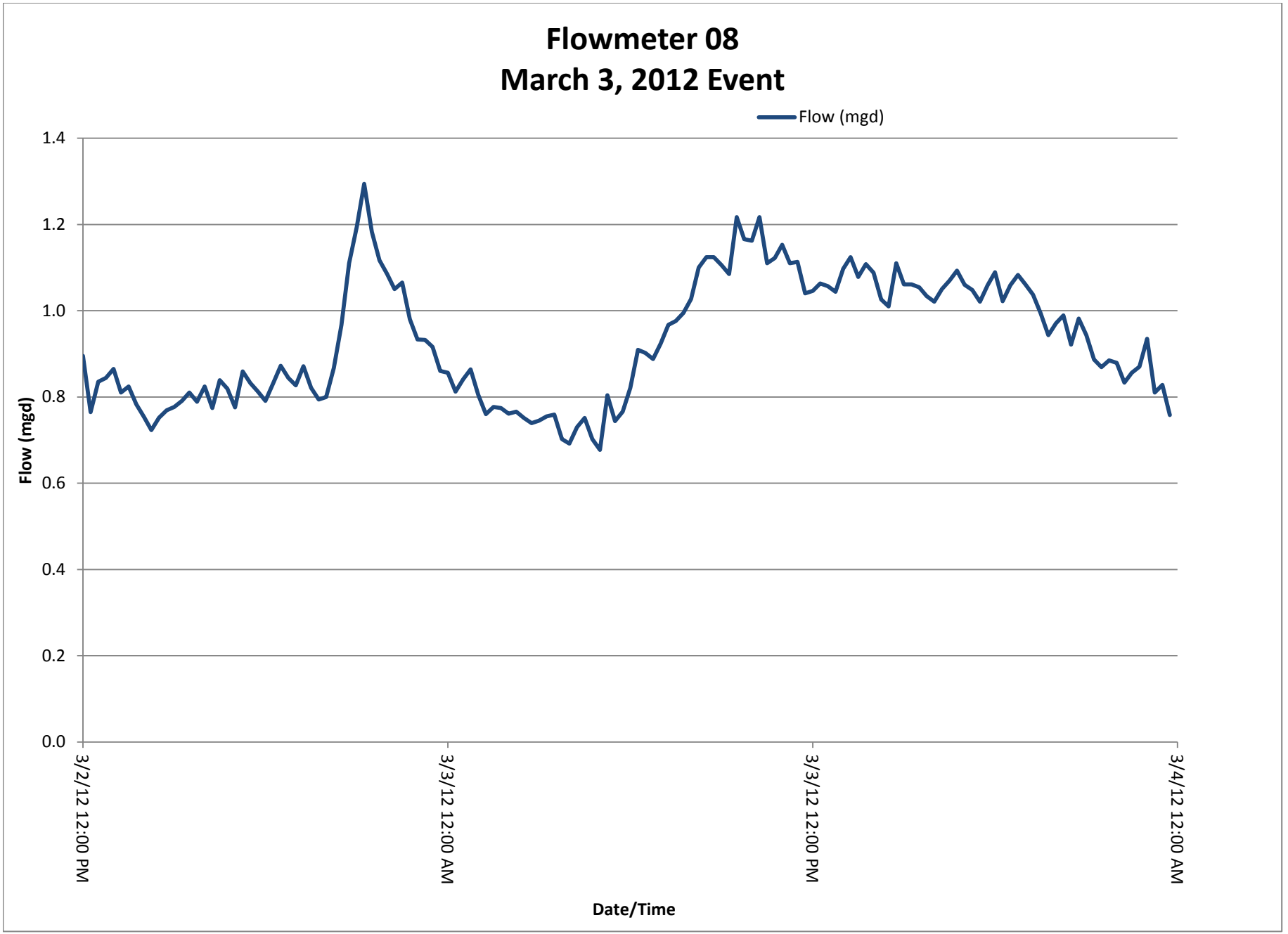

Flowmeter 70
May 8, 2012 Event
Flow (mgd)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
5/7/12 12:00 PM
5/8/12 12:00 AM
5/8/12 12:00 PM
5/9/12 12:00 AM
Date/Time


Flowmeter 70
June 1, 2012 Event
Flow (mgd)
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
6/1/12 12:00 AM
6/1/12 12:00 PM
6/2/12 12:00 AM
6/2/12 12:00 PM
Date/Time


Flowmeter 70
June 3 to June 4, 2012 Event
Flow (mgd)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (mgd)
6/3/12 12:00 AM
6/3/12 12:00 PM
6/4/12 12:00 AM
6/4/12 12:00 PM
Date/Time


Flowmeter 70
June 9, 2012 Event
Flow (mgd)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Flow (mgd)
6/8/12 12:00 PM
6/9/12 12:00 AM
6/9/12 12:00 PM
6/10/12 12:00 AM
Date/Time


Flowmeter 70
June 12, 2012 Event
Flow (mgd)
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
6/11/12 12:00 PM
6/12/12 12:00 AM
6/12/12 12:00 PM
6/13/12 12:00 AM
Date/Time



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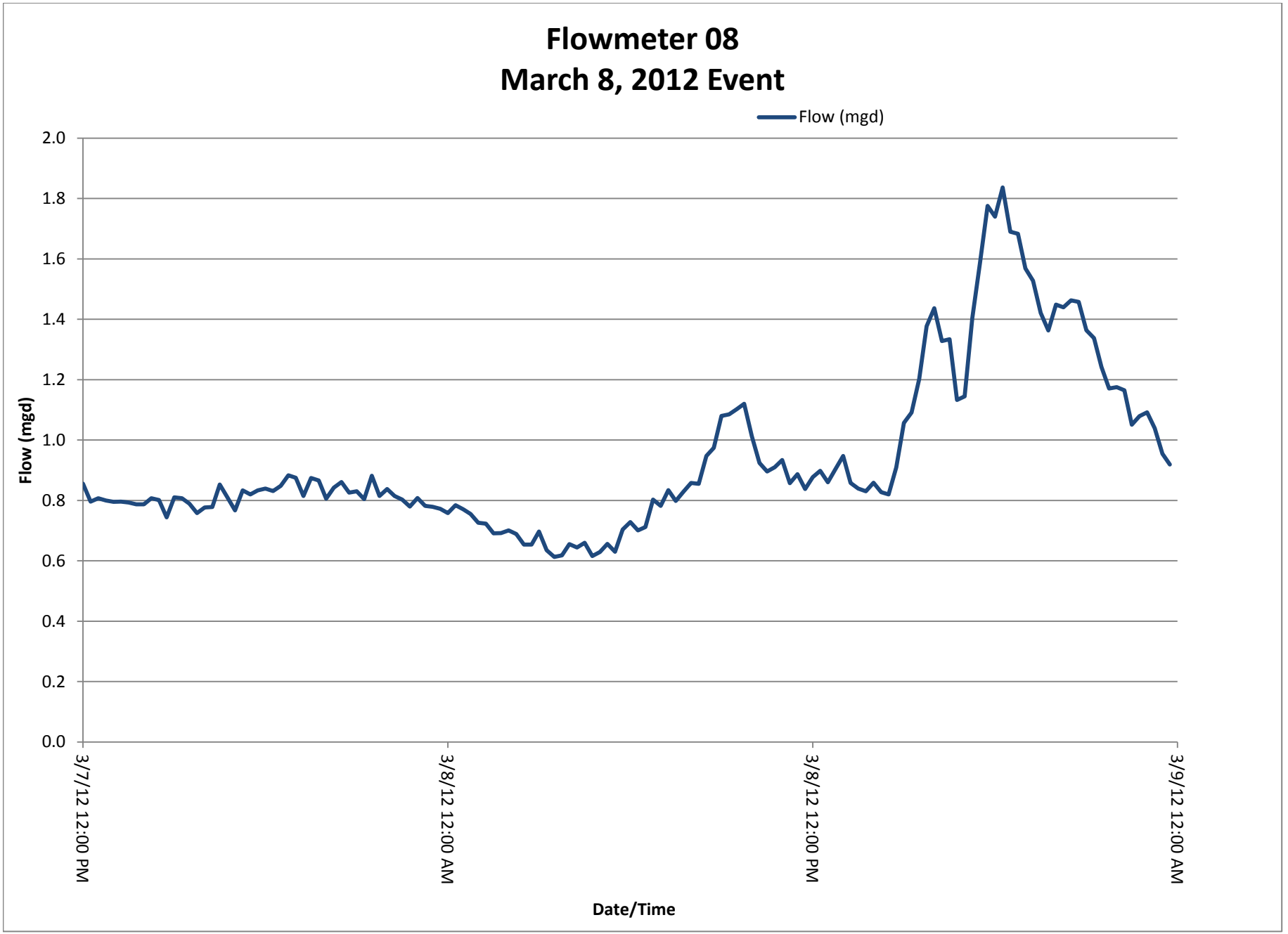

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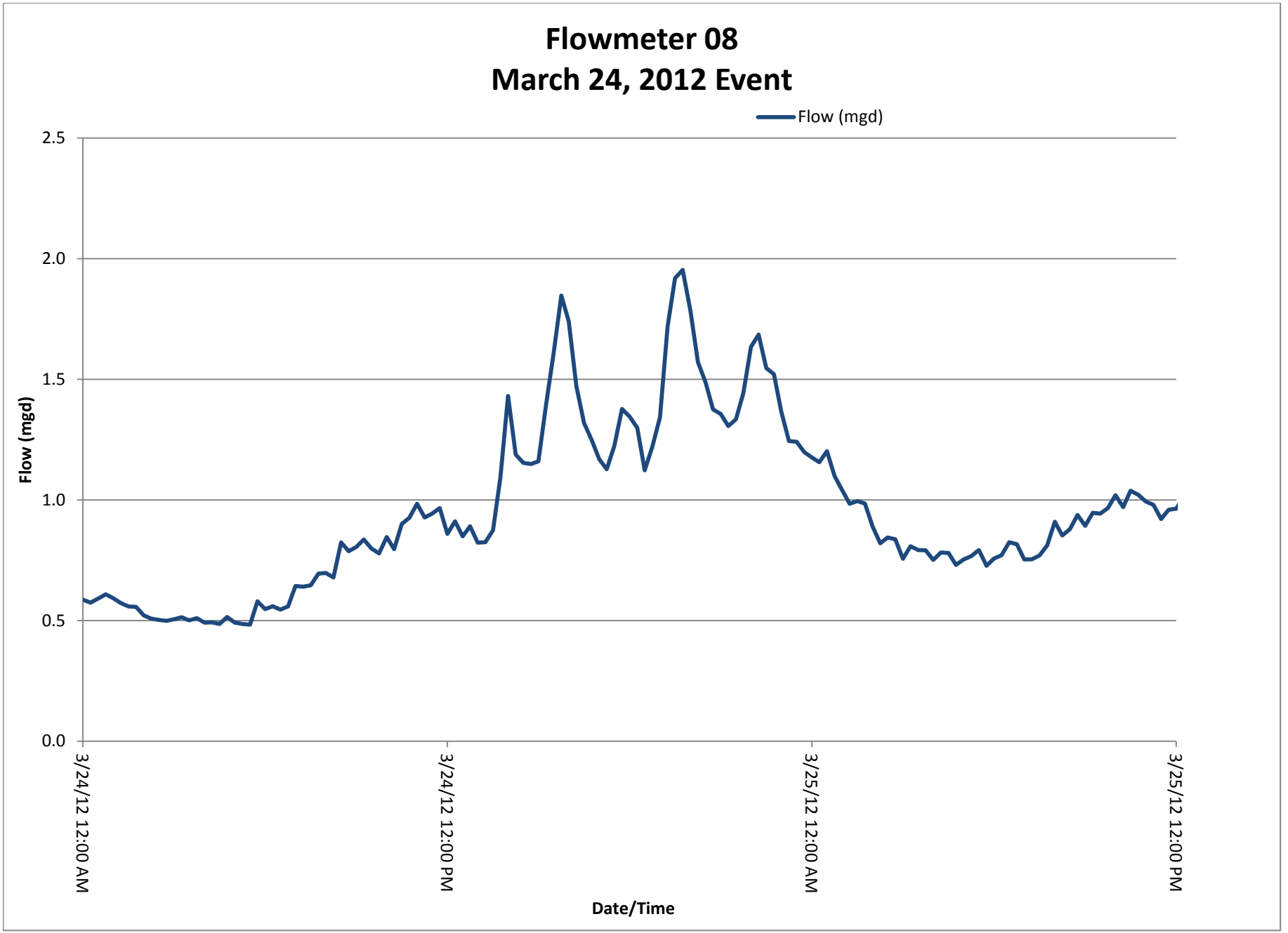

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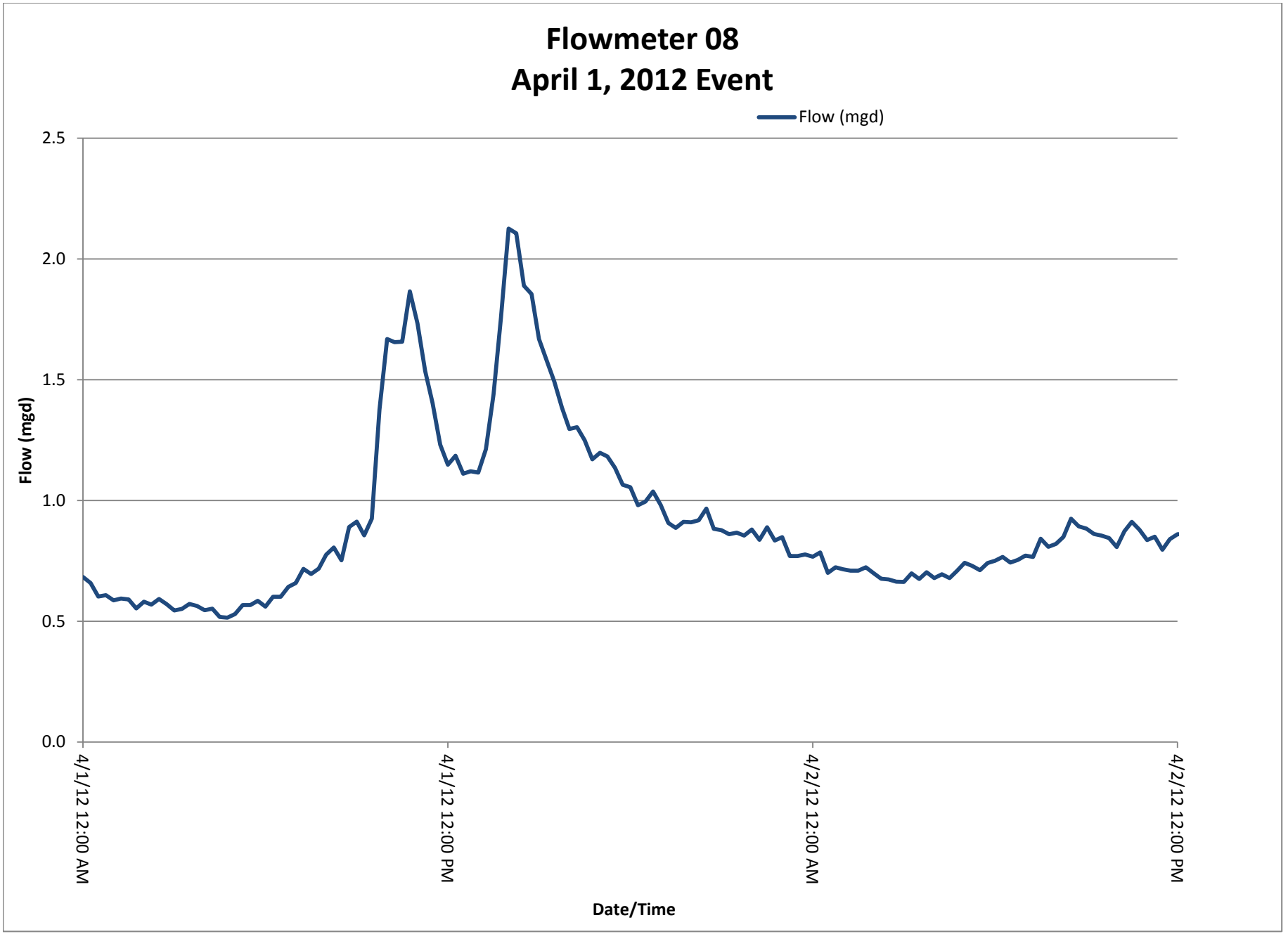

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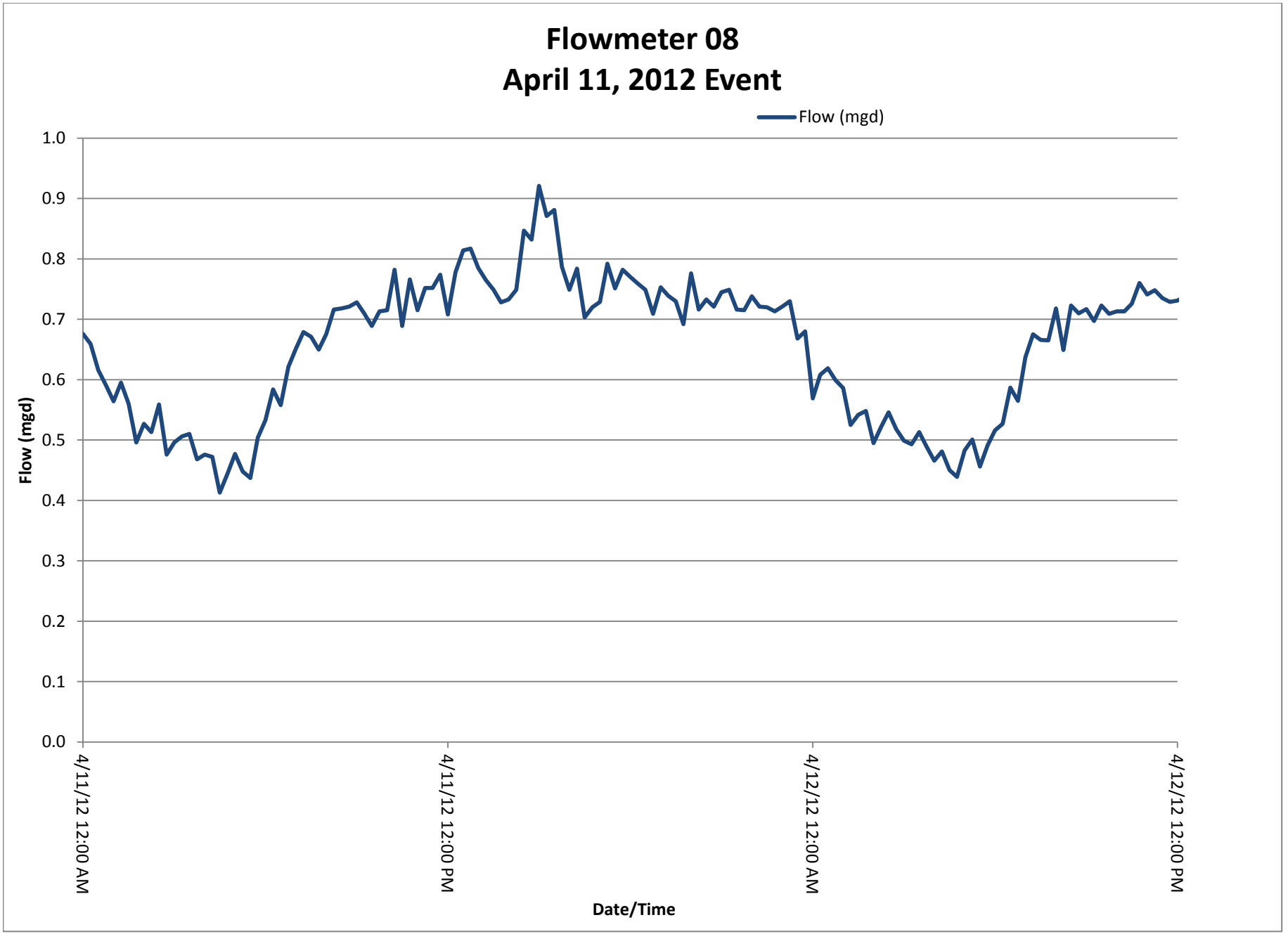

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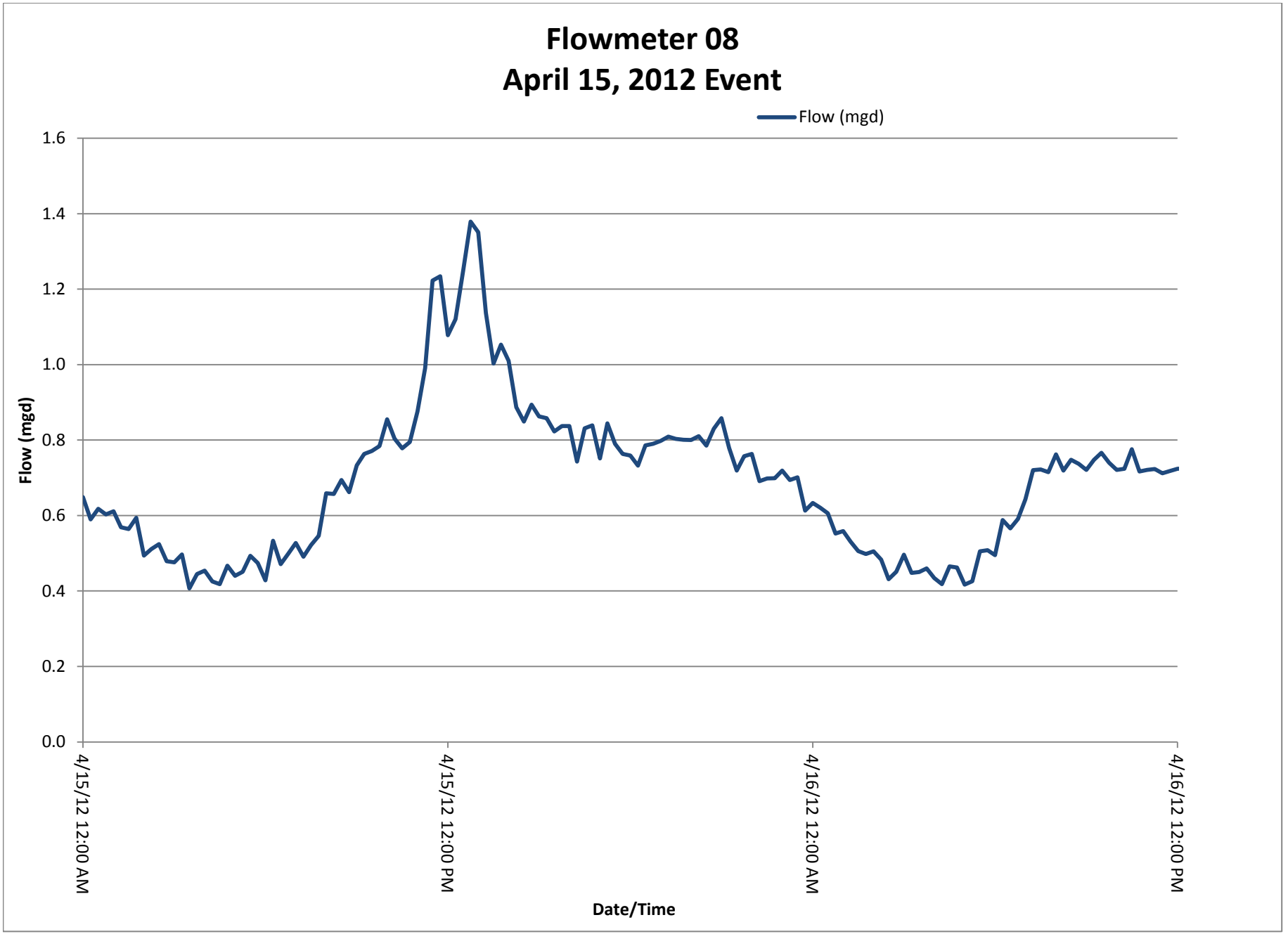

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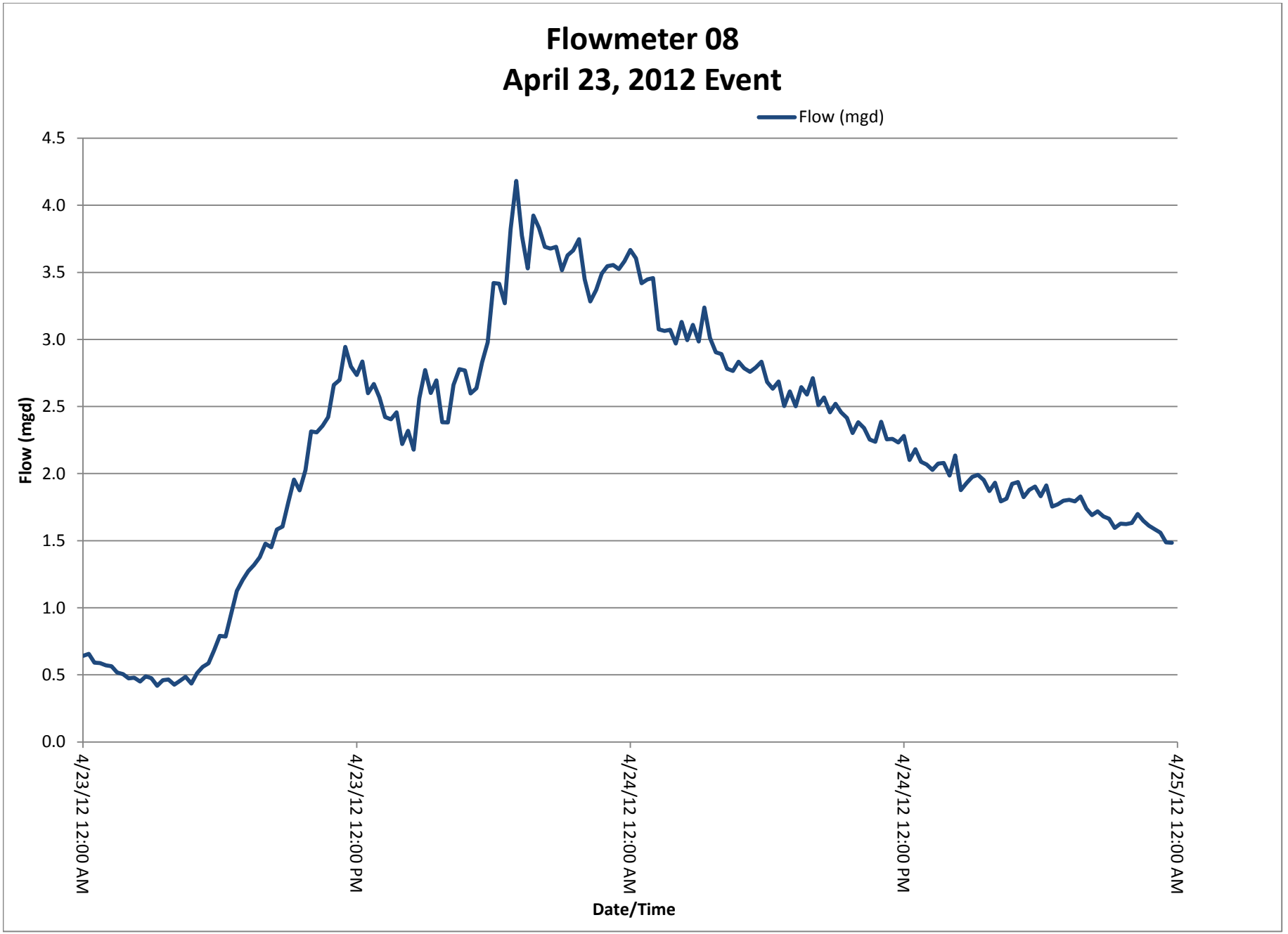

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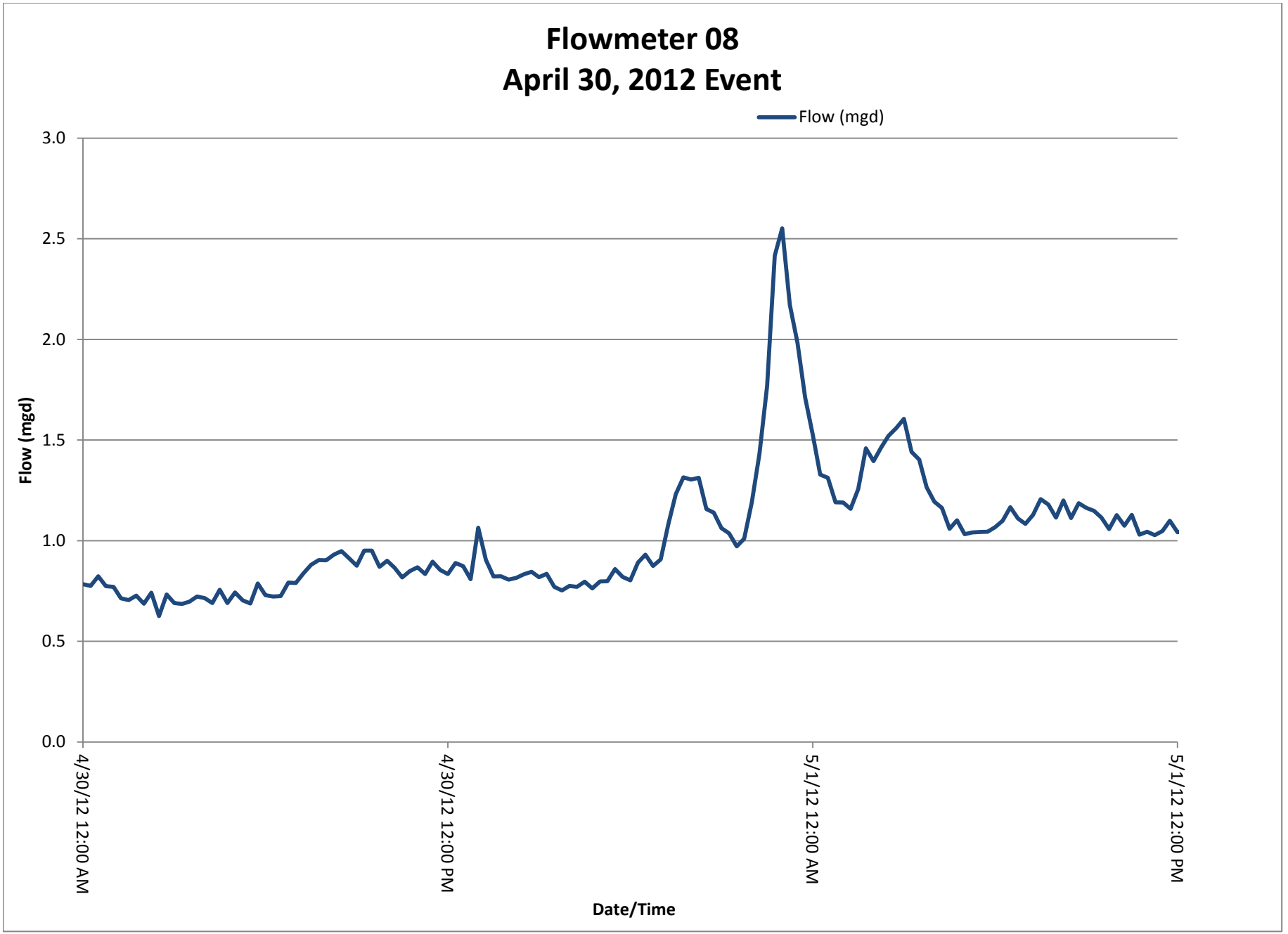

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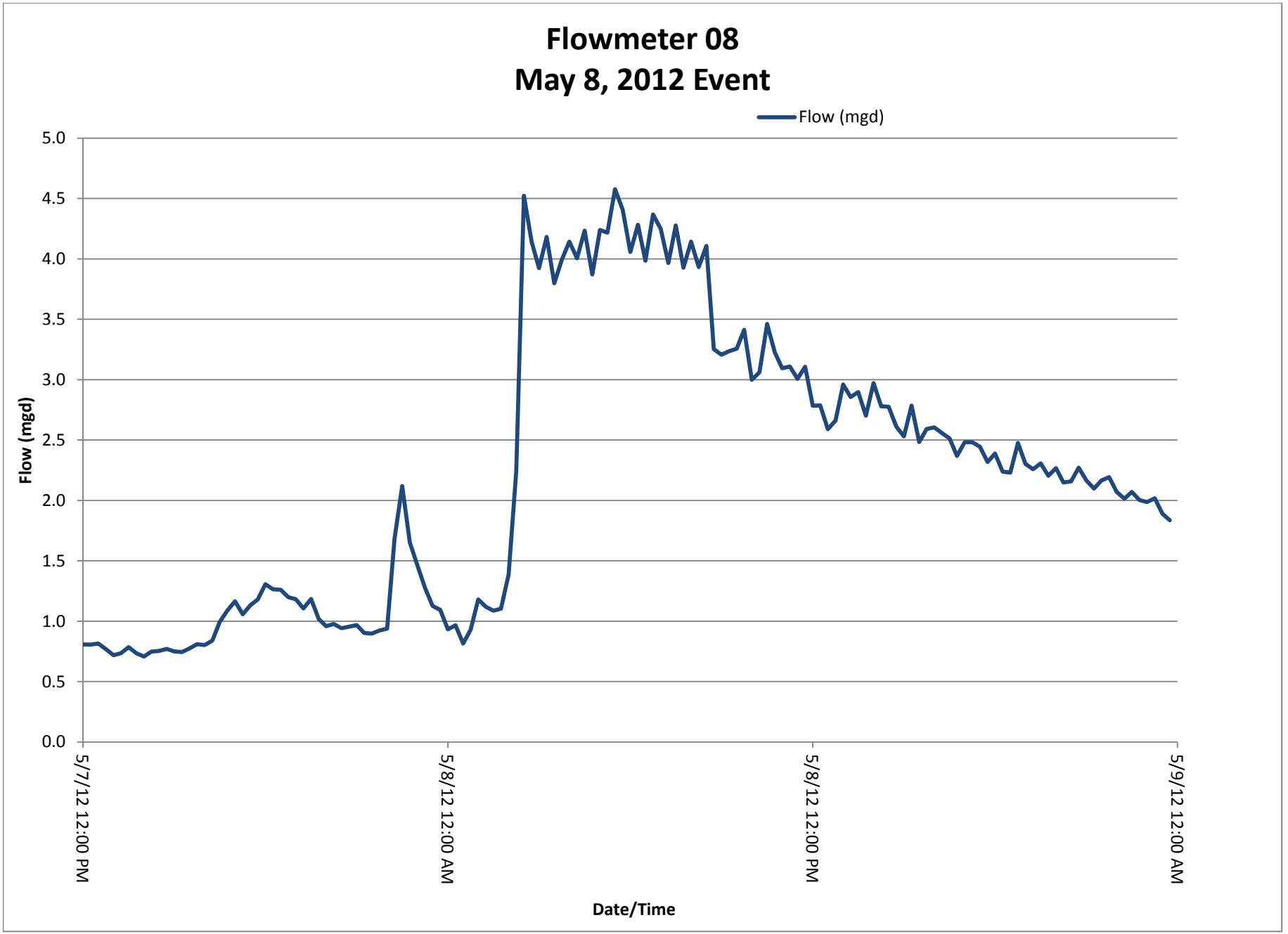

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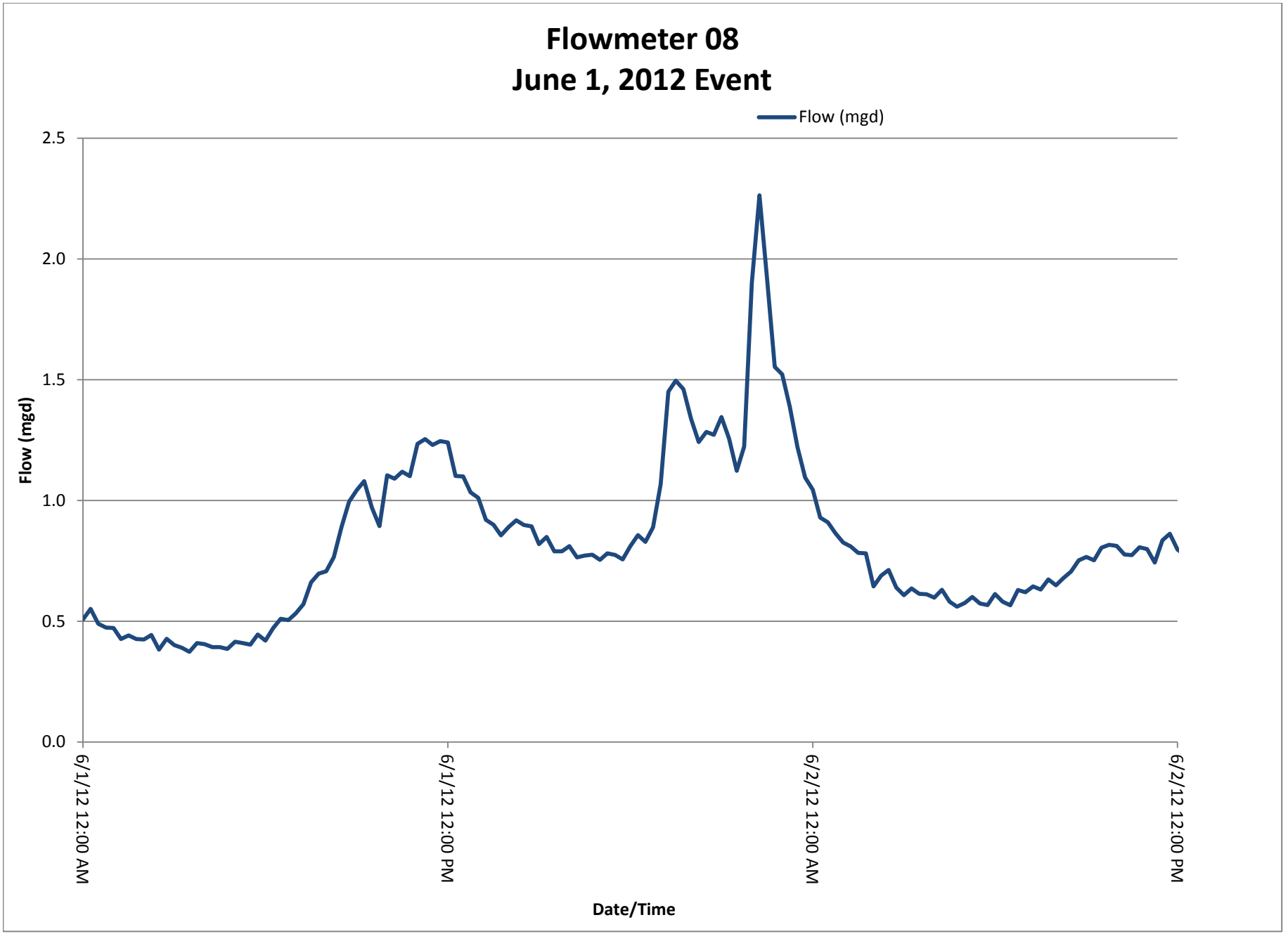

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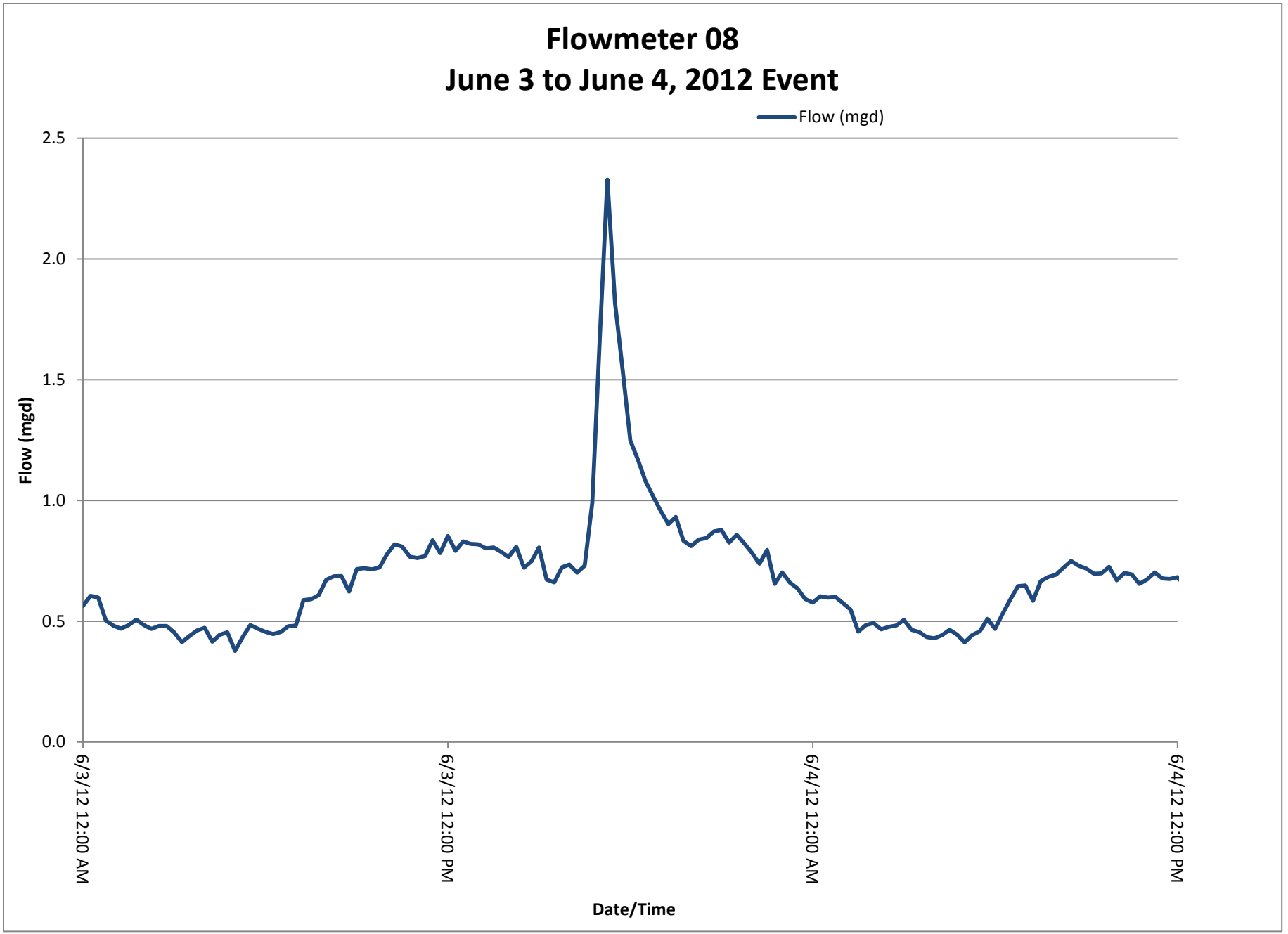

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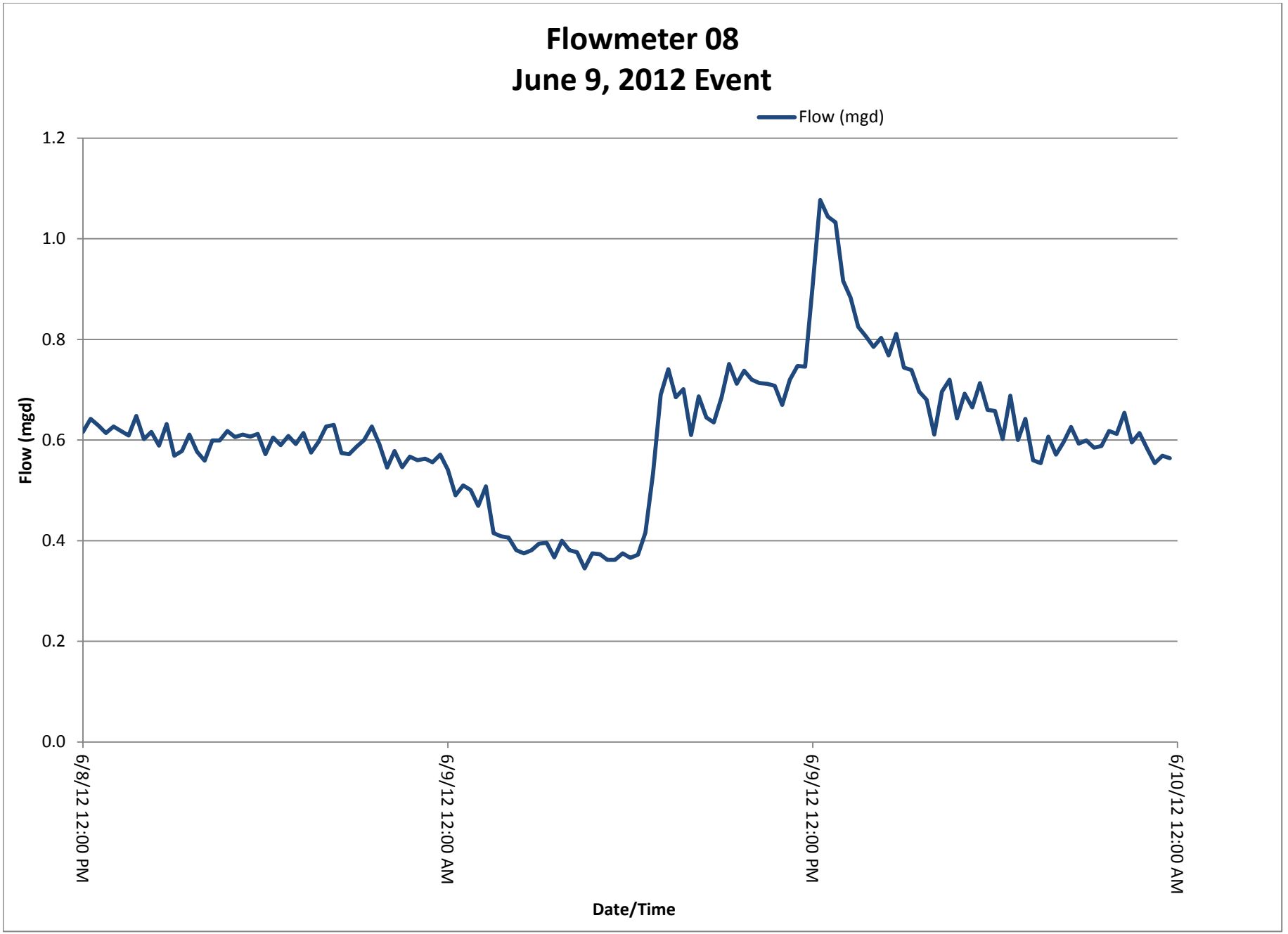

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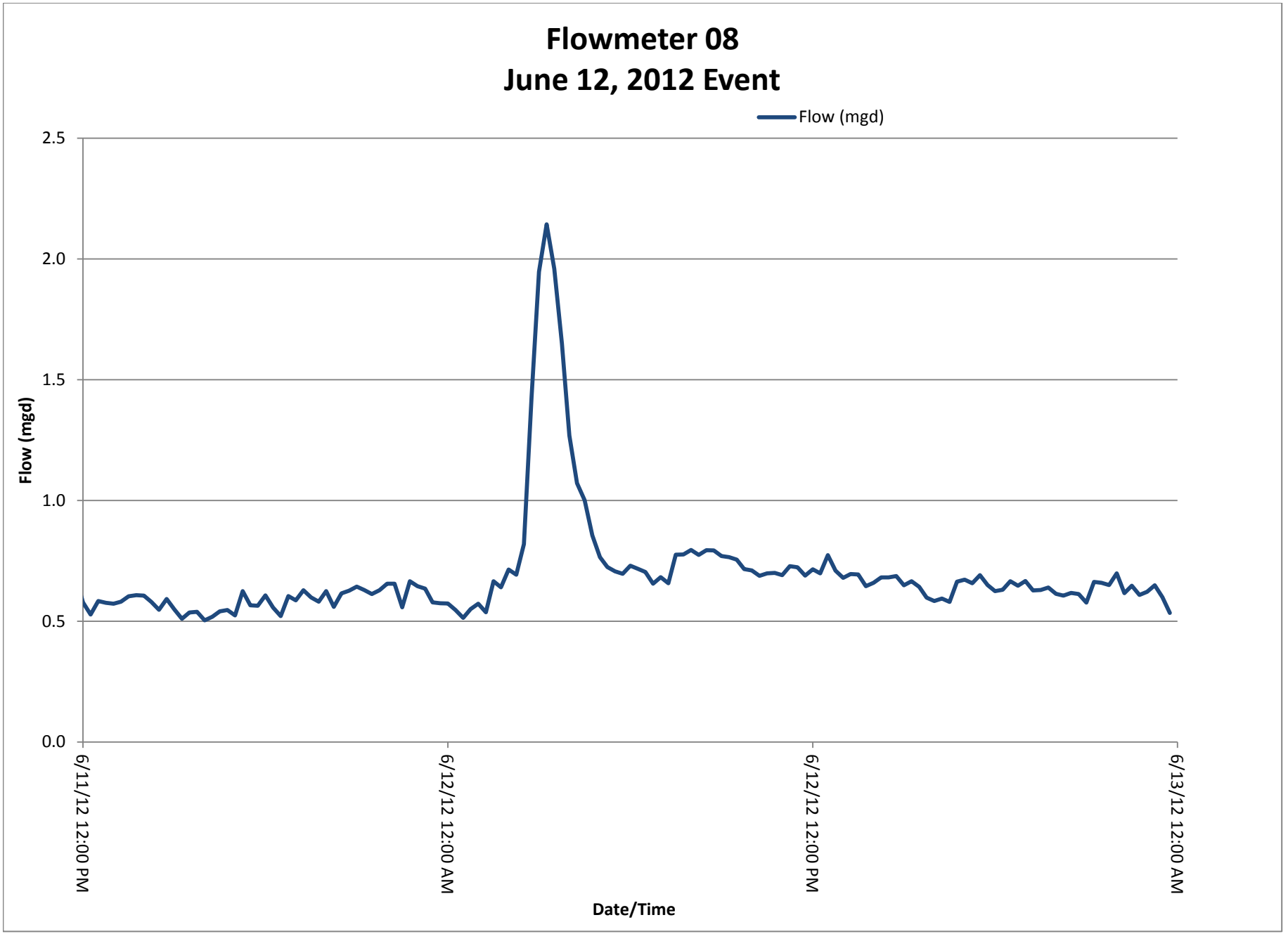

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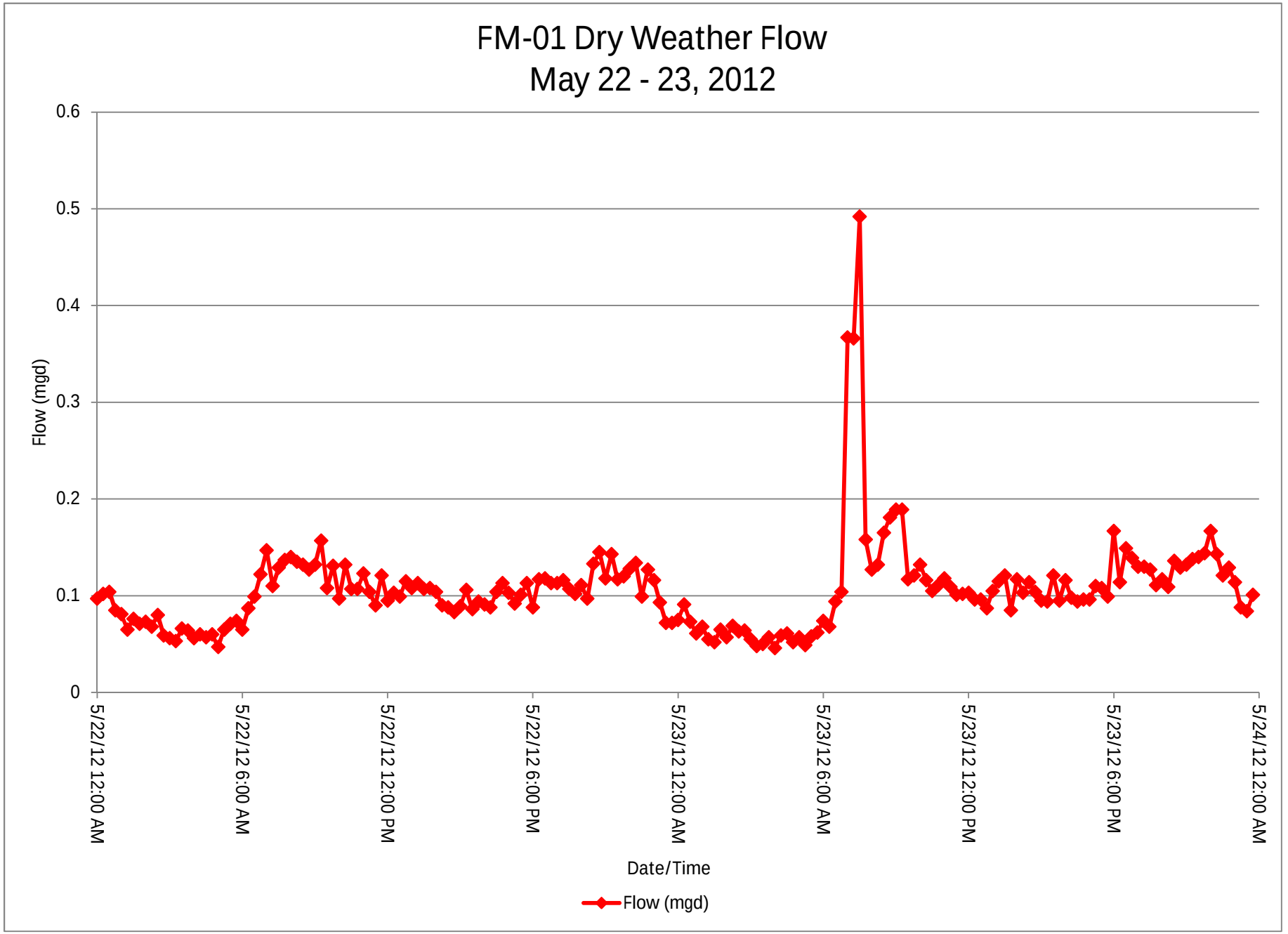
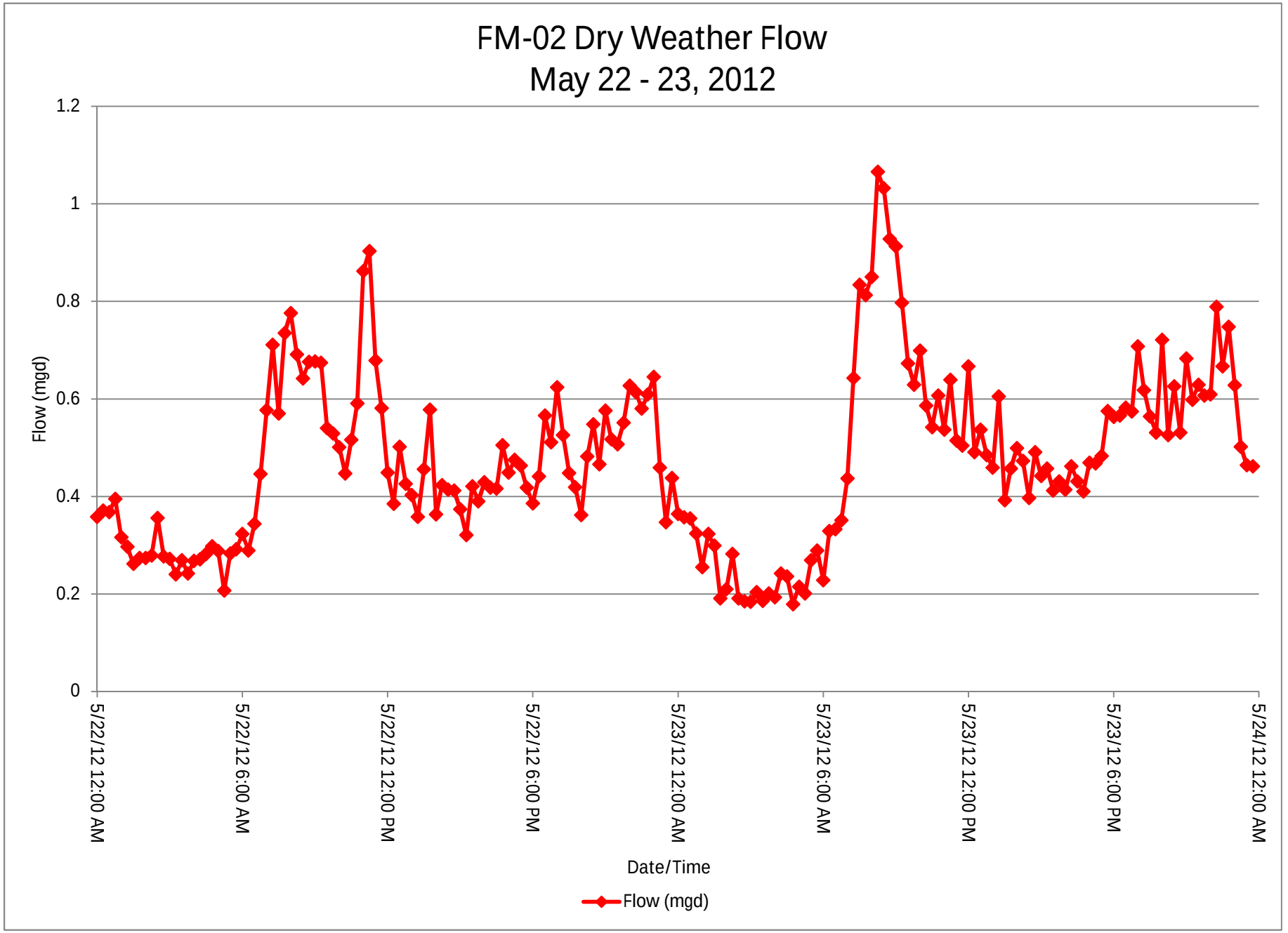
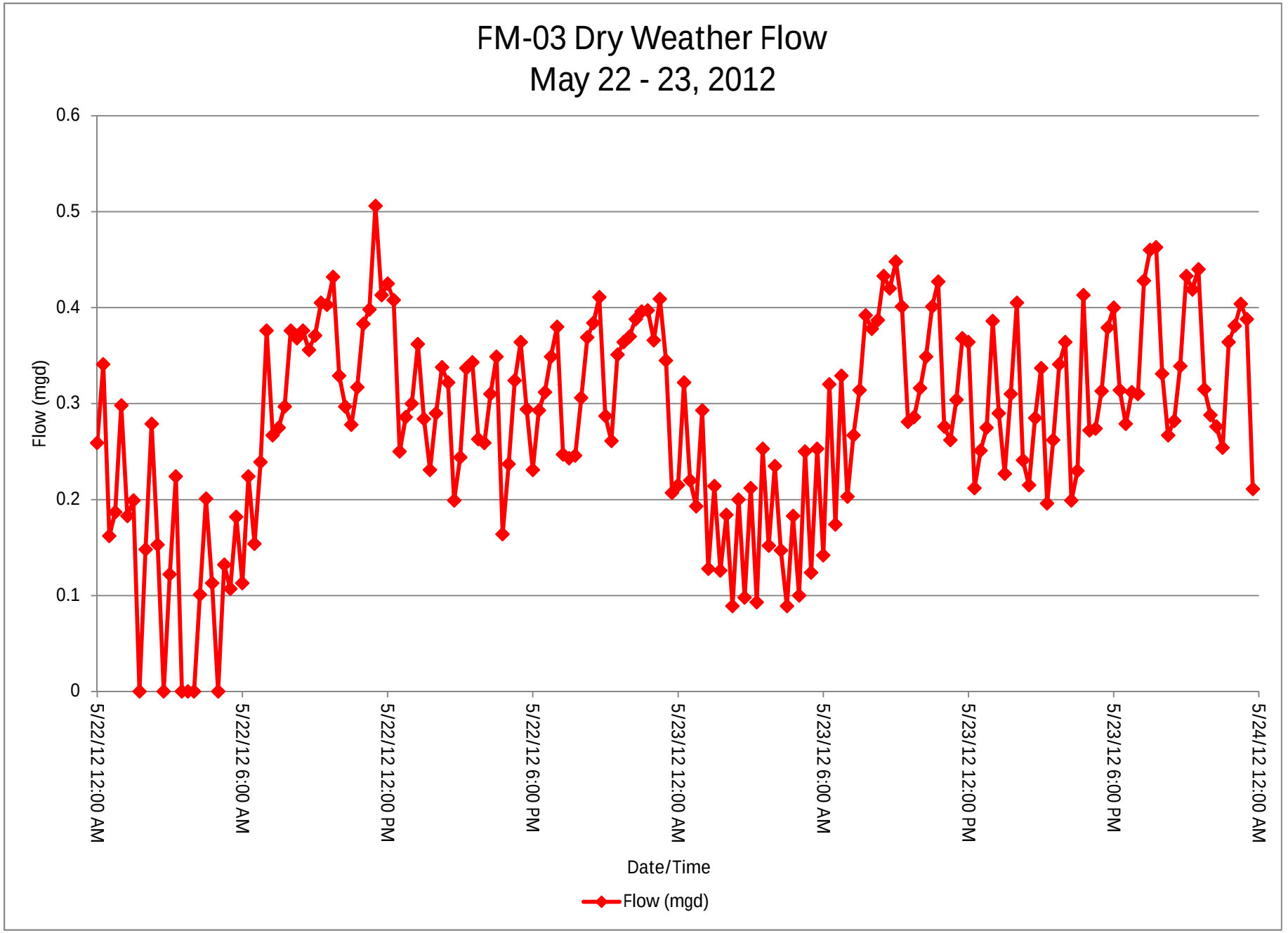
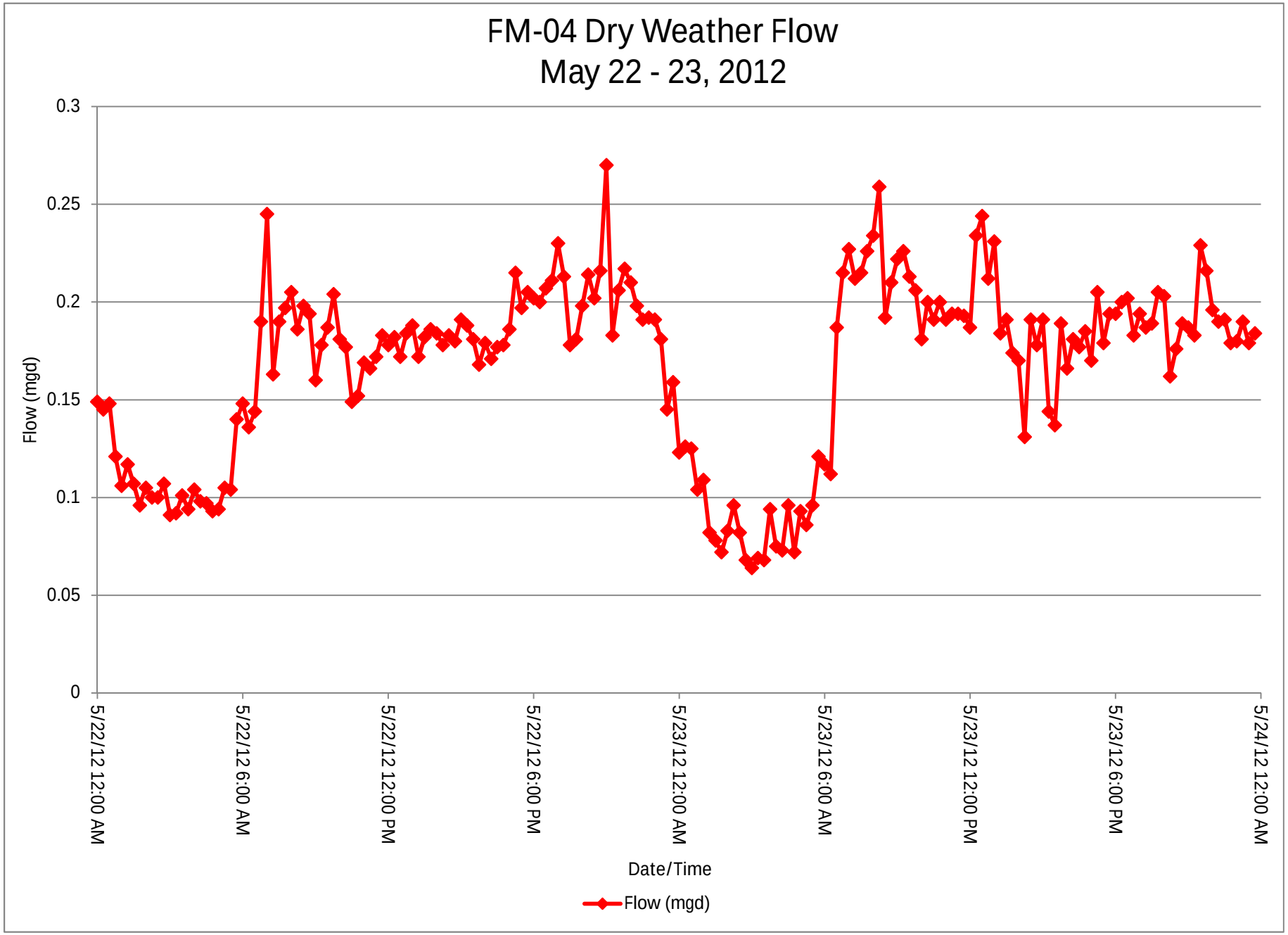
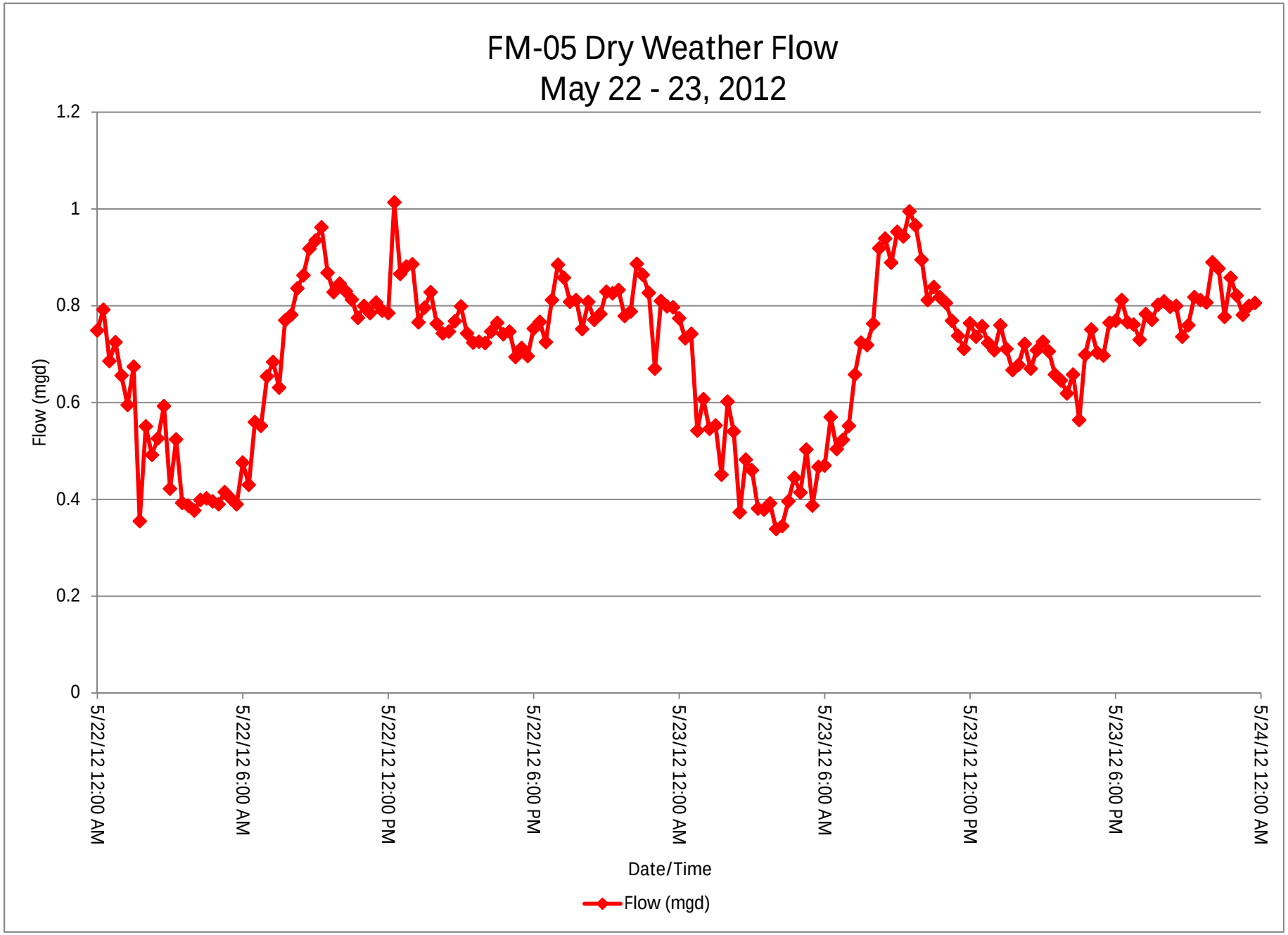
APPENDIX D: Dry Weather Hydrographs

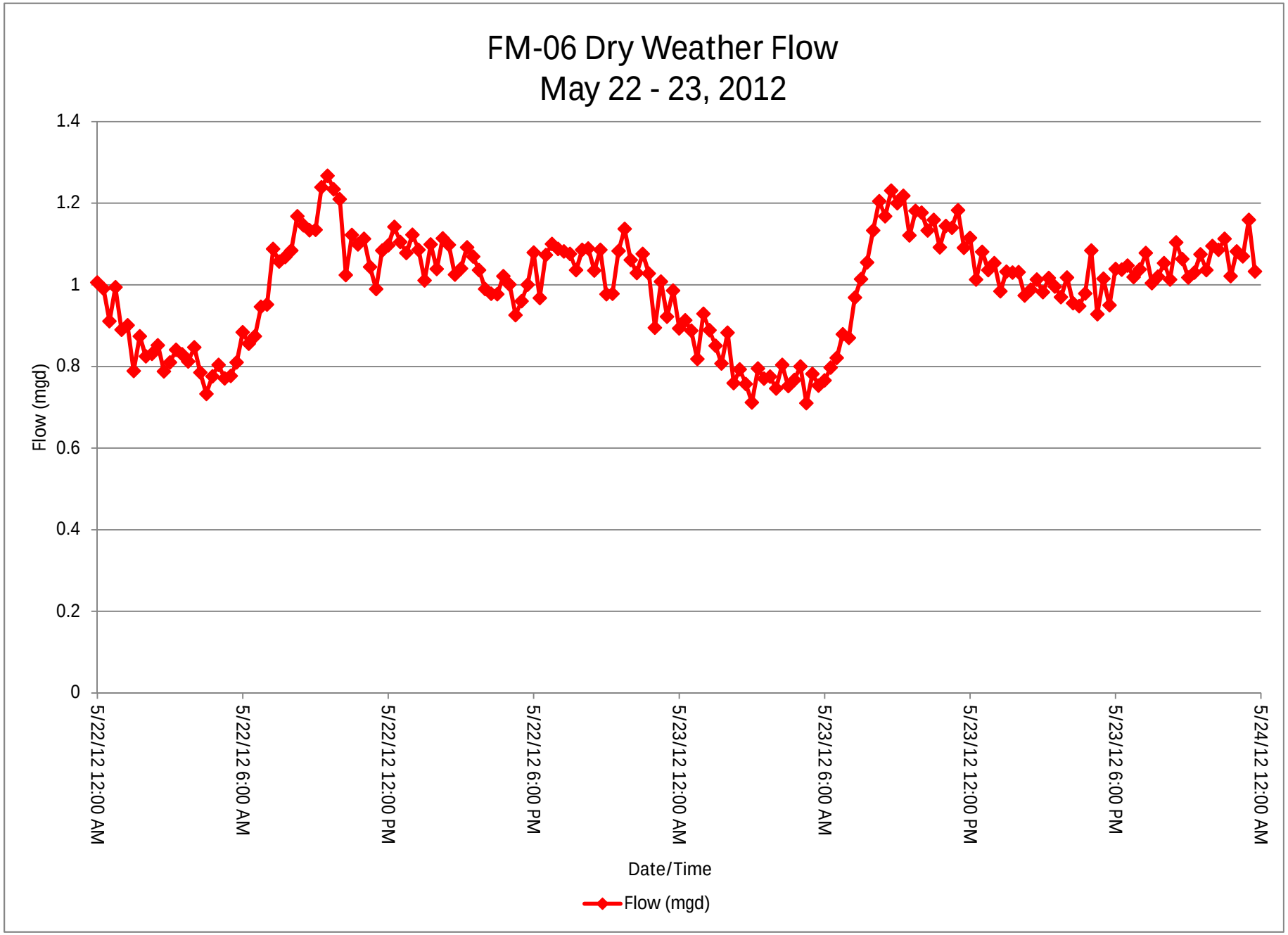

FM-01 Dry Weather Flow
May 22 - 23, 2012
0.6
0.5
0.4
0.3
0.2
0.1
0
Flow (mgd)
5/22/12 12:00 AM
5/22/12 6:00 AM
5/22/12 12:00 PM
5/22/12 6:00 PM
5/23/12 12:00 AM
5/23/12 6:00 AM
5/23/12 12:00 PM
5/23/12 6:00 PM
5/24/12 12:00 AM
Date/Time
Flow (mgd)

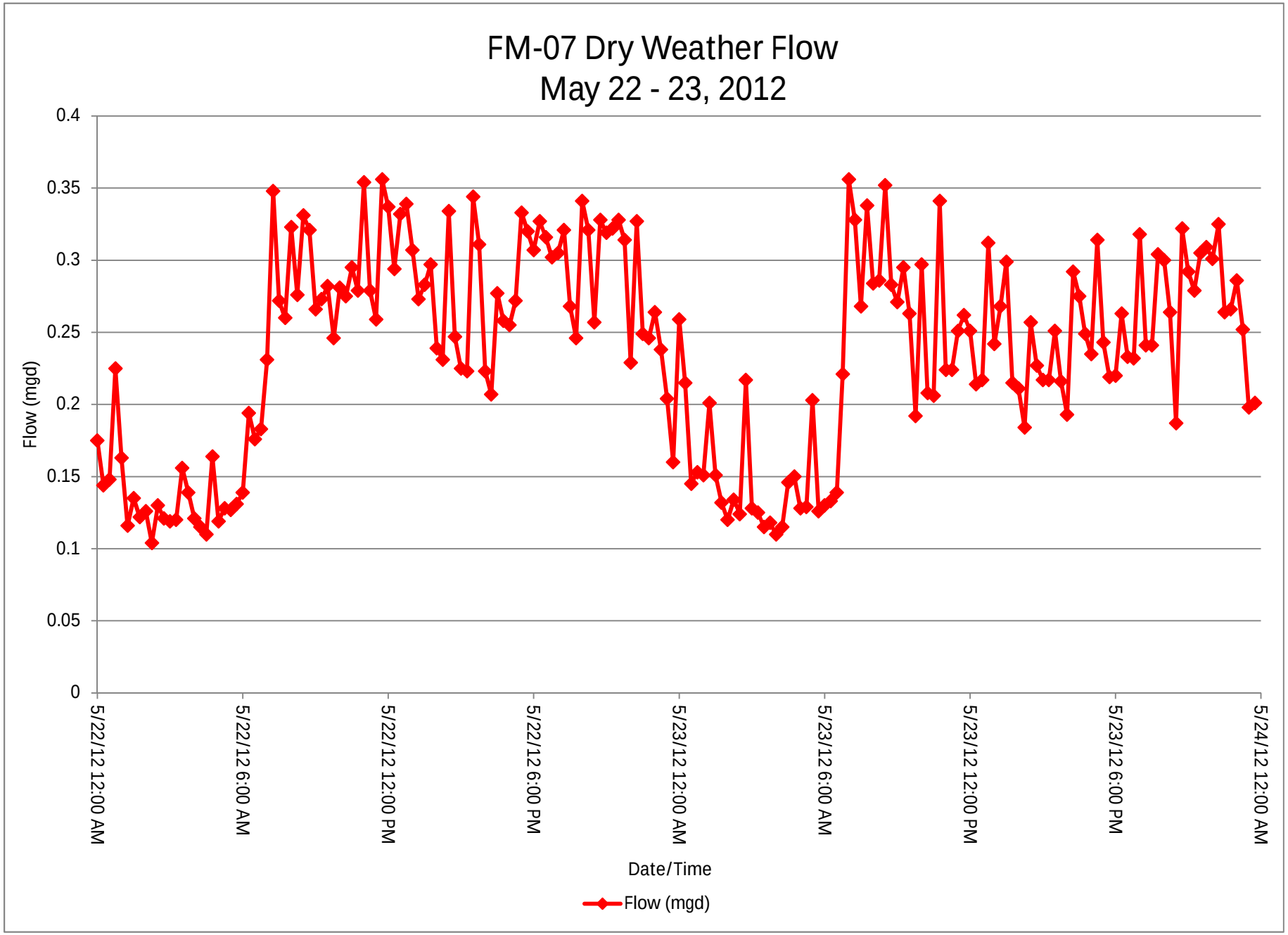

FM-02 Dry Weather Flow
May 22 - 23, 2012
Flow (mgd)
1.2
1
0.8
0.6
0.4
0.2
0
5/22/12 12:00 AM
5/22/12 6:00 AM
5/22/12 12:00 PM
5/22/12 6:00 PM
5/23/12 12:00 AM
5/23/12 6:00 AM
5/23/12 12:00 PM
5/23/12 6:00 PM
5/24/12 12:00 AM
Date/Time
Flow (mgd)

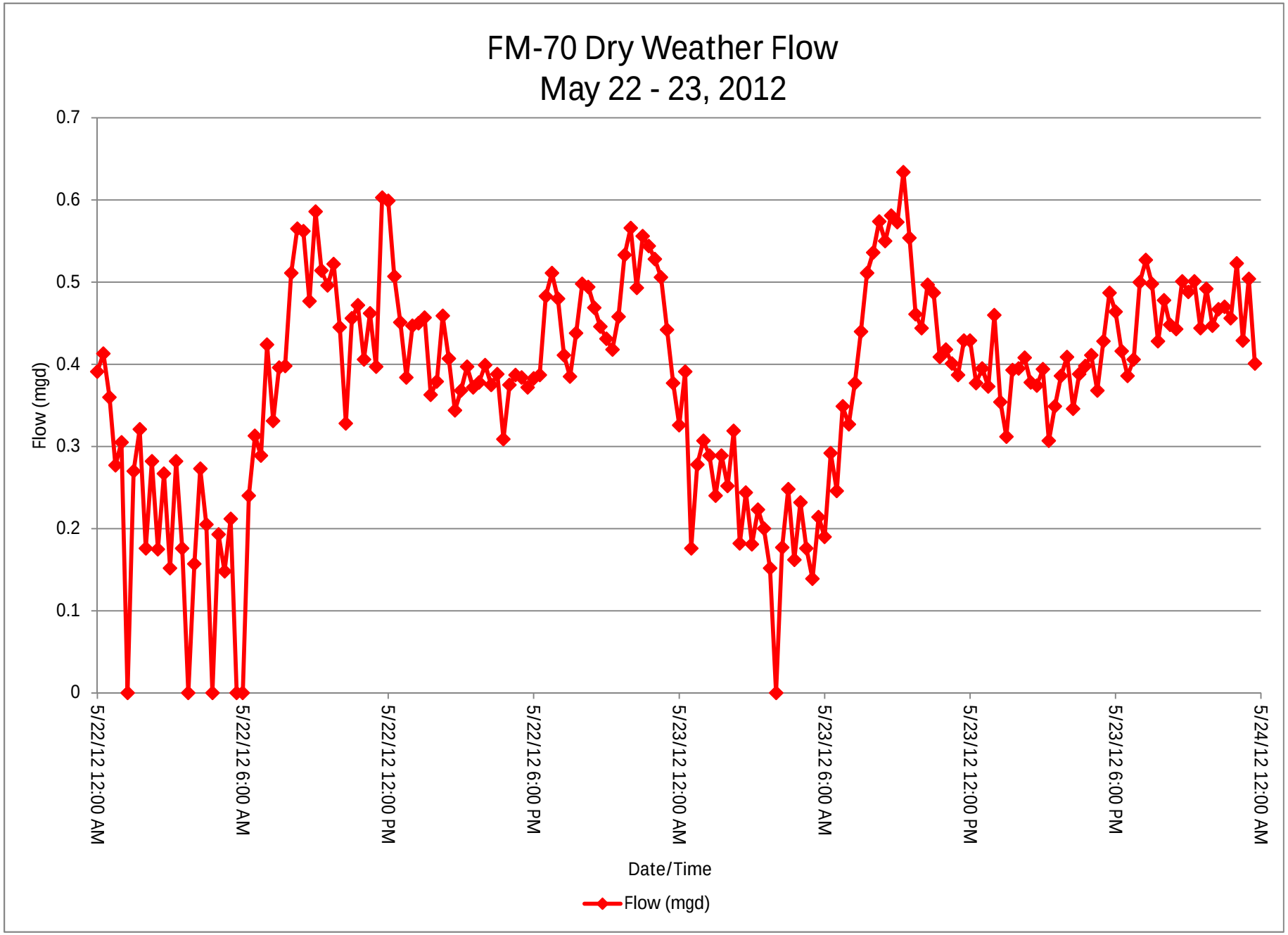

FM-03 Dry Weather Flow
May 22 - 23, 2012
Flow (mgd)
0.6
0.5
0.4
0.3
0.2
0.1
0
5/22/12 12:00 AM
5/22/12 6:00 AM
5/22/12 12:00 PM
5/22/12 6:00 PM
5/23/12 12:00 AM
5/23/12 6:00 AM
5/23/12 12:00 PM
5/23/12 6:00 PM
5/24/12 12:00 AM
Date/Time
Flow (mgd)

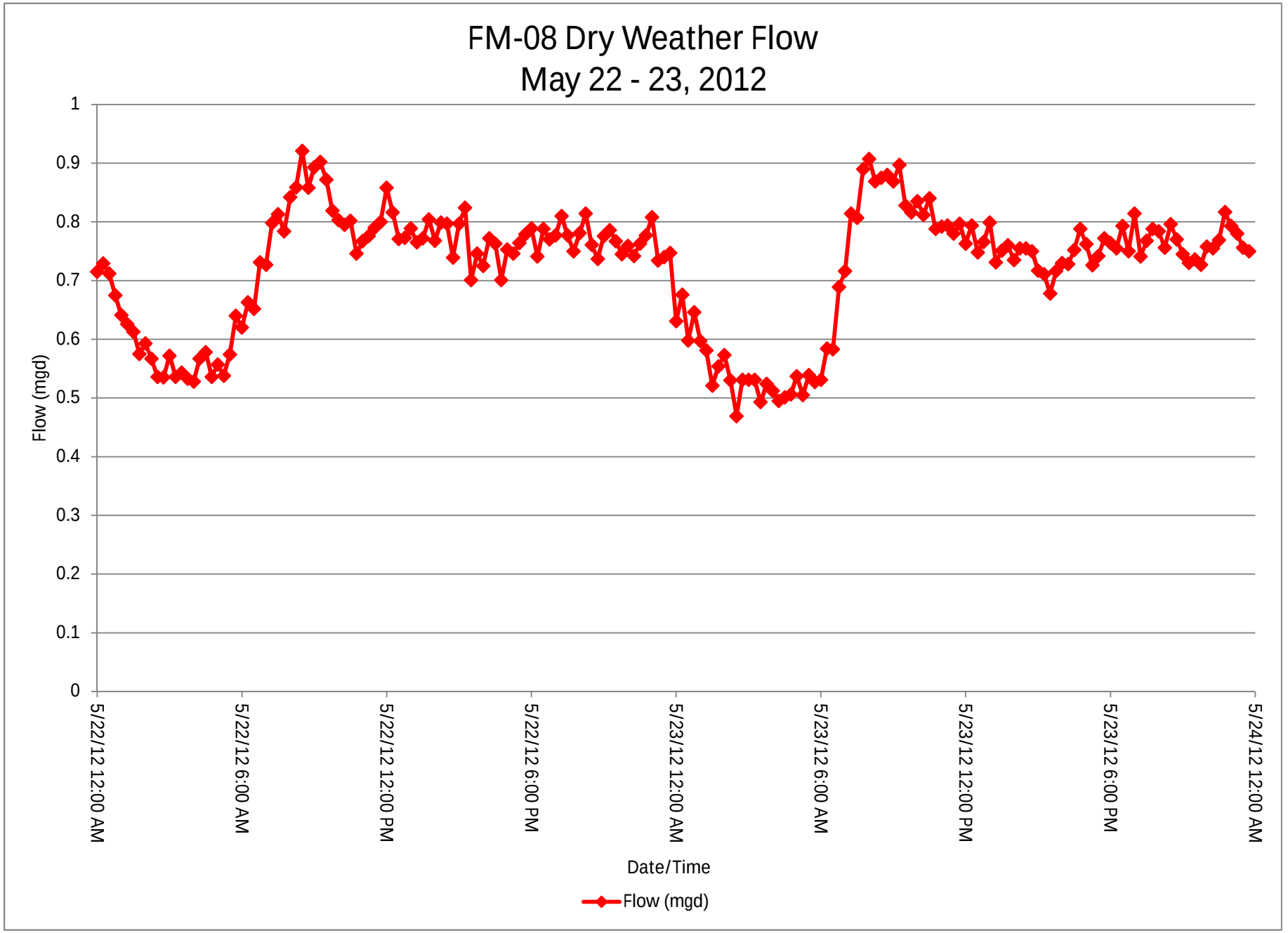

FM-04 Dry Weather Flow
May 22 - 23, 2012
0.3
0.25
0.2
0.15
0.1
0.05
0
Flow (mgd)
5/22/12 12:00 AM
5/22/12 6:00 AM
5/22/12 12:00 PM
5/22/12 6:00 PM
5/23/12 12:00 AM
5/23/12 6:00 AM
5/23/12 12:00 PM
5/23/12 6:00 PM
5/24/12 12:00 AM
Date/Time
Flow (mgd)


FM-05 Dry Weather Flow
May 22 - 23, 2012
1.2
1
0.8
0.6
0.4
0.2
0
Flow (mgd)
5/22/12 12:00 AM
5/22/12 6:00 AM
5/22/12 12:00 PM
5/22/12 6:00 PM
5/23/12 12:00 AM
5/23/12 6:00 AM
5/23/12 12:00 PM
5/23/12 6:00 PM
5/24/12 12:00 AM
Date/Time
Flow (mgd)

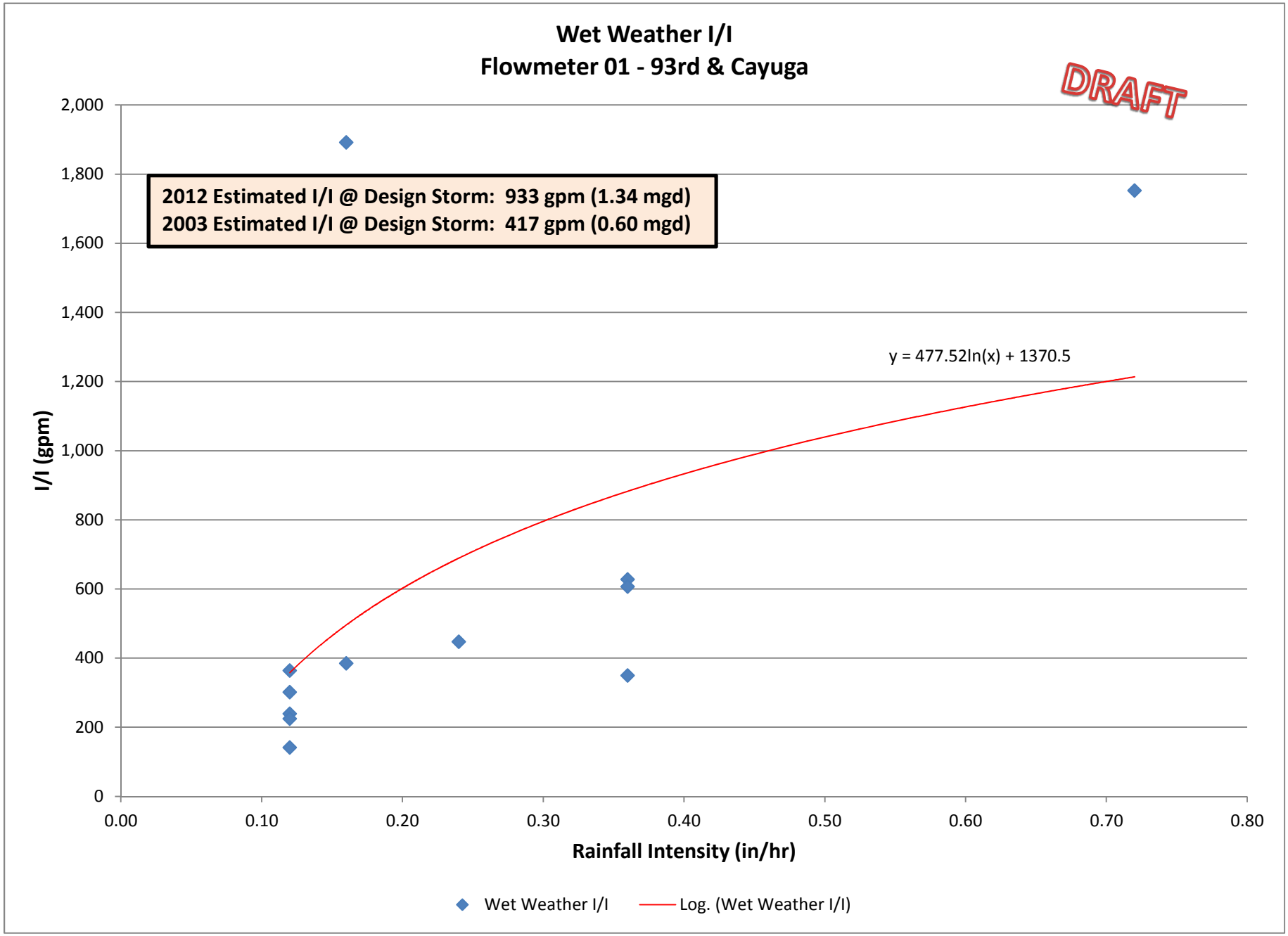

FM-06 Dry Weather Flow
May 22 - 23, 2012
Flow (mgd)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
5/22/12 12:00 AM
5/22/12 6:00 AM
5/22/12 12:00 PM
5/22/12 6:00 PM
5/23/12 12:00 AM
5/23/12 6:00 AM
5/23/12 12:00 PM
5/23/12 6:00 PM
5/24/12 12:00 AM
Date/Time
Flow (mgd)

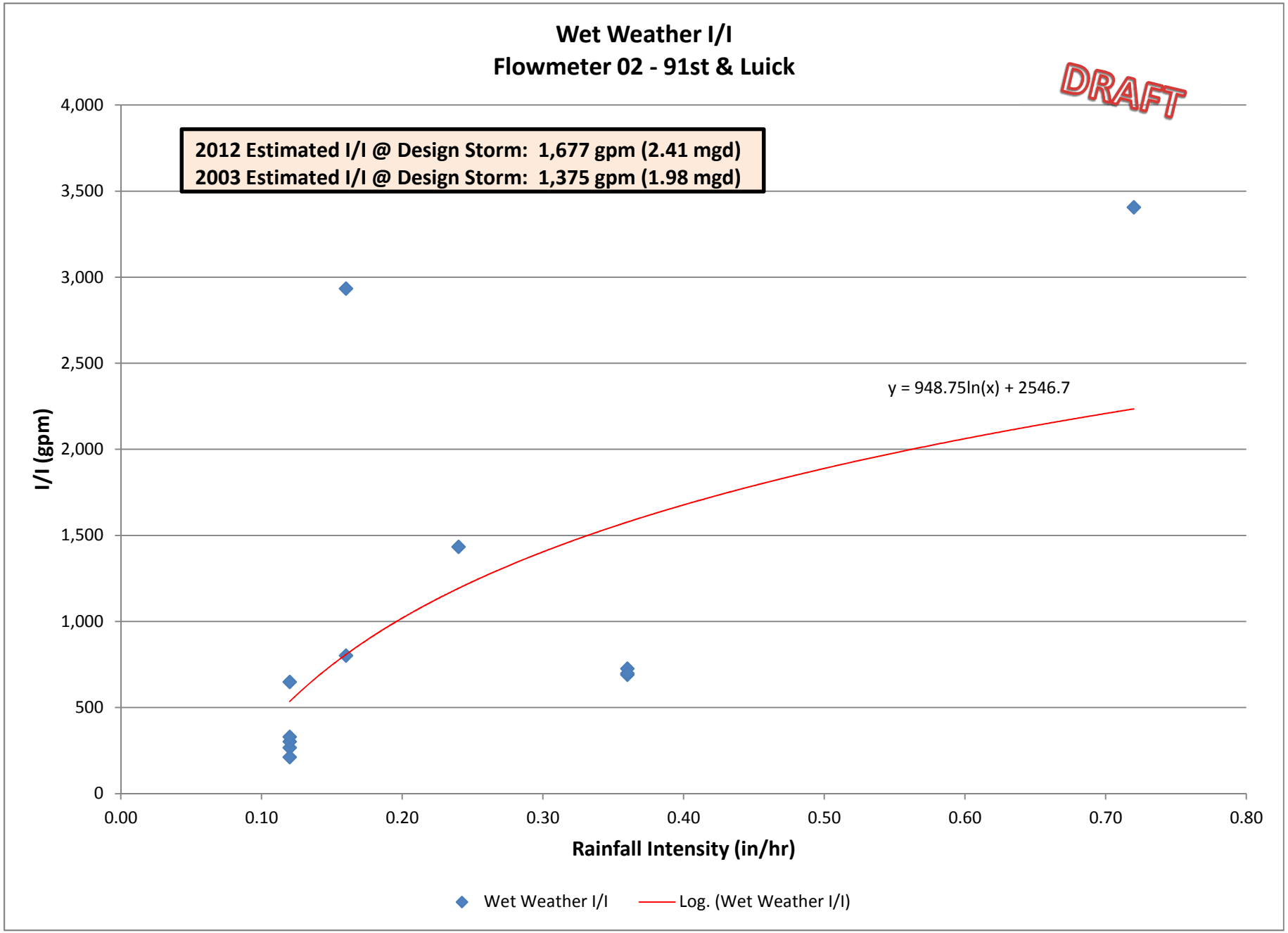

FM-07 Dry Weather Flow
May 22 - 23, 2012
Flow (mgd)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
5/22/12 12:00 AM
5/22/12 6:00 AM
5/22/12 12:00 PM
5/22/12 6:00 PM
5/23/12 12:00 AM
5/23/12 6:00 AM
5/23/12 12:00 PM
5/23/12 6:00 PM
5/24/12 12:00 AM
Date/Time
Flow (mgd)

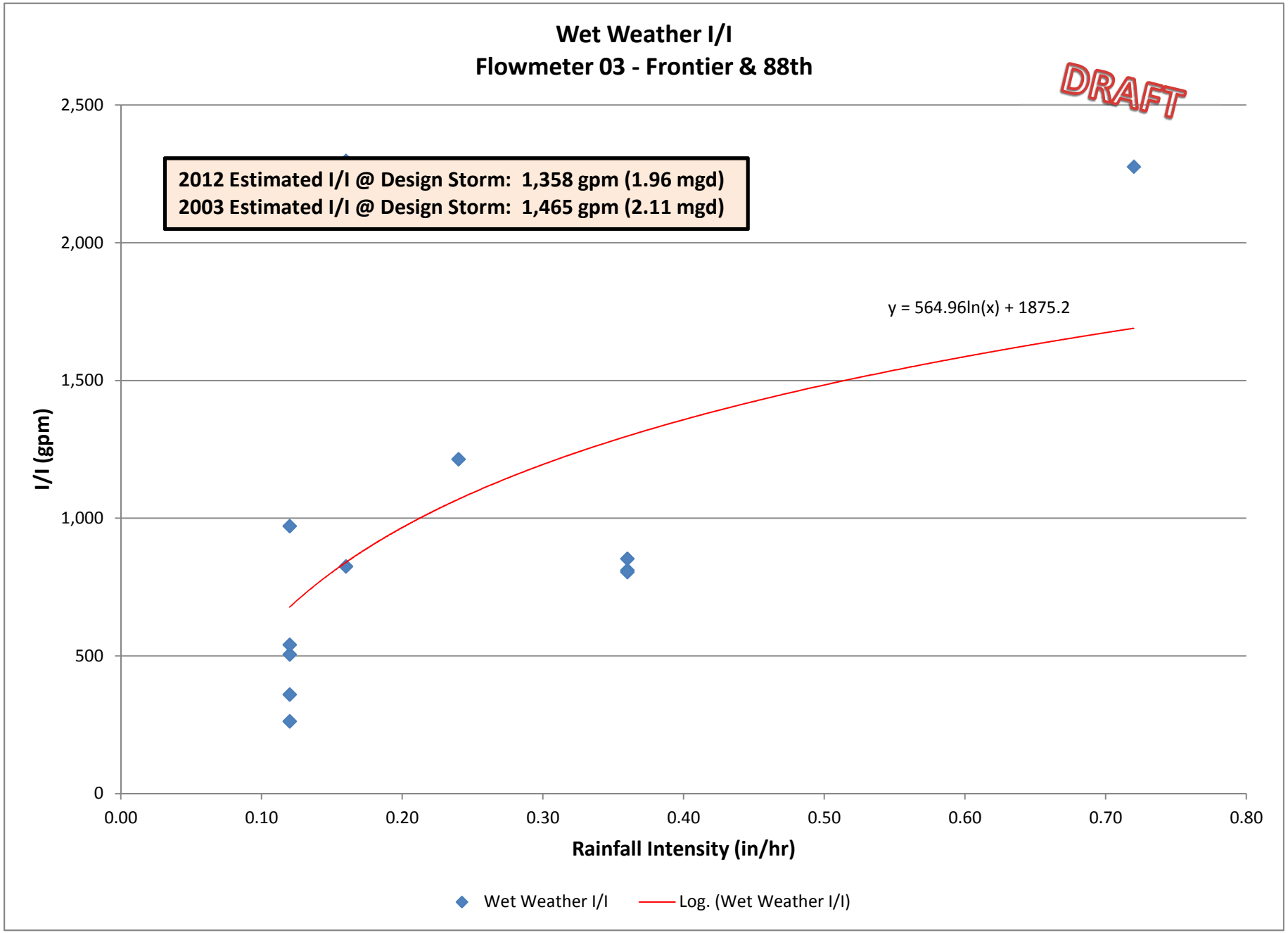

FM-70 Dry Weather Flow
May 22 - 23, 2012
Flow (mgd)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5/22/12 12:00 AM
5/22/12 6:00 AM
5/22/12 12:00 PM
5/22/12 6:00 PM
5/23/12 12:00 AM
5/23/12 6:00 AM
5/23/12 12:00 PM
5/23/12 6:00 PM
5/24/12 12:00 AM
Date/Time
Flow (mgd)

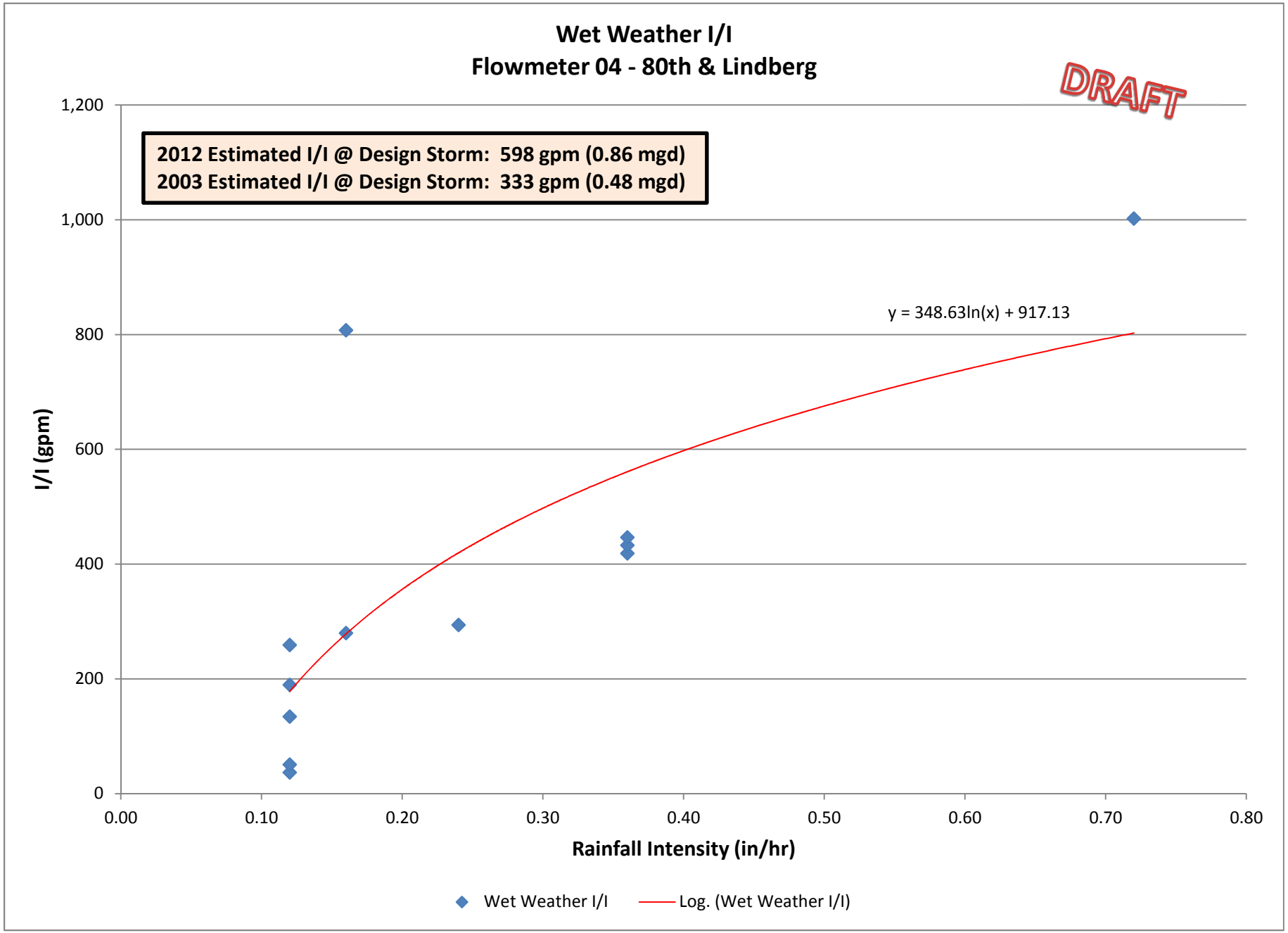

FM-08 Dry Weather Flow
May 22 - 23, 2012
Flow (mgd)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5/22/12 12:00 AM
5/22/12 6:00 AM
5/22/12 12:00 PM
5/22/12 6:00 PM
5/23/12 12:00 AM
5/23/12 6:00 AM
5/23/12 12:00 PM
5/23/12 6:00 PM
5/24/12 12:00 AM
Date/Time
Flow (mgd)

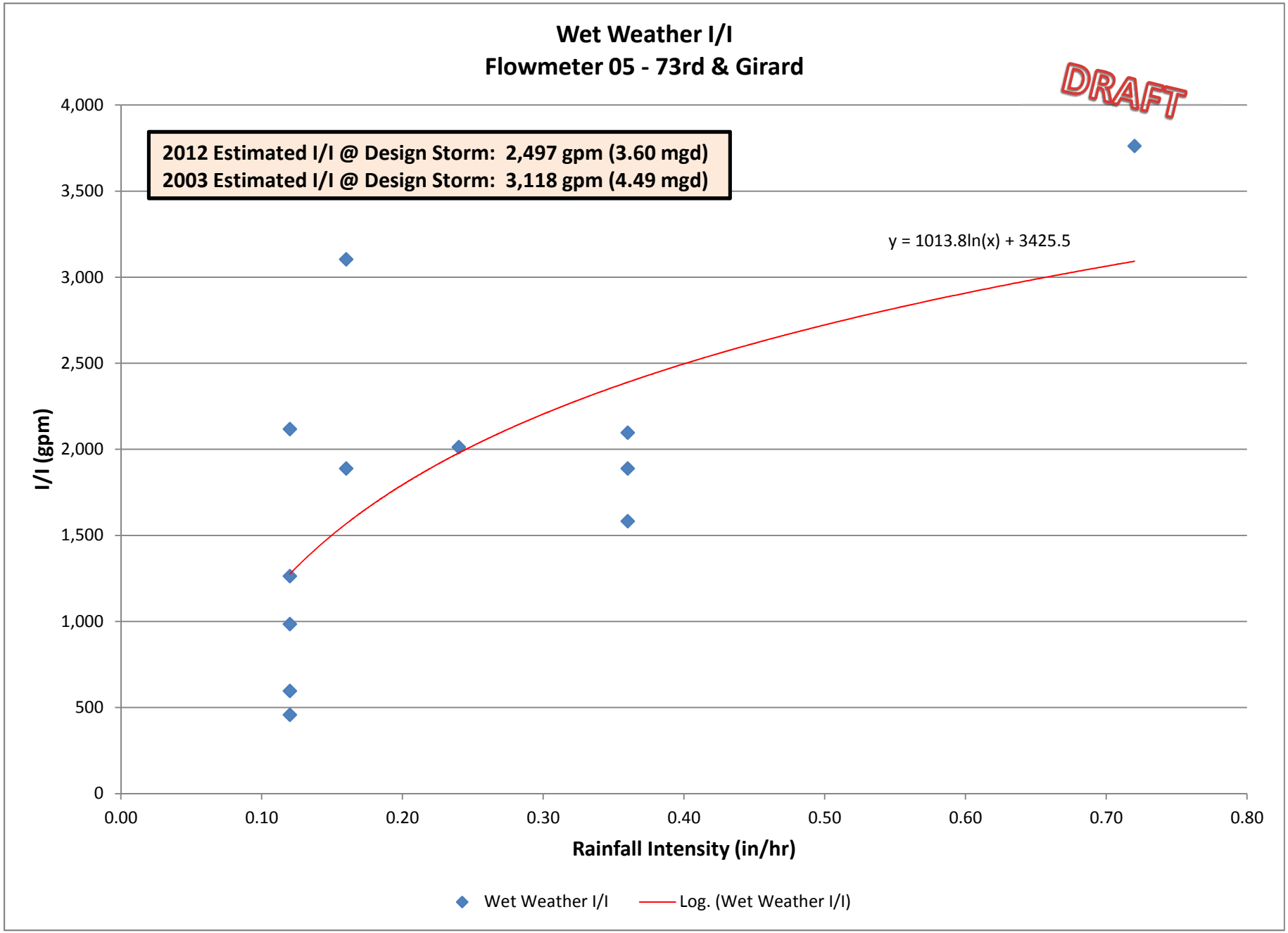
APPENDIX E: Peak Flow Graphs

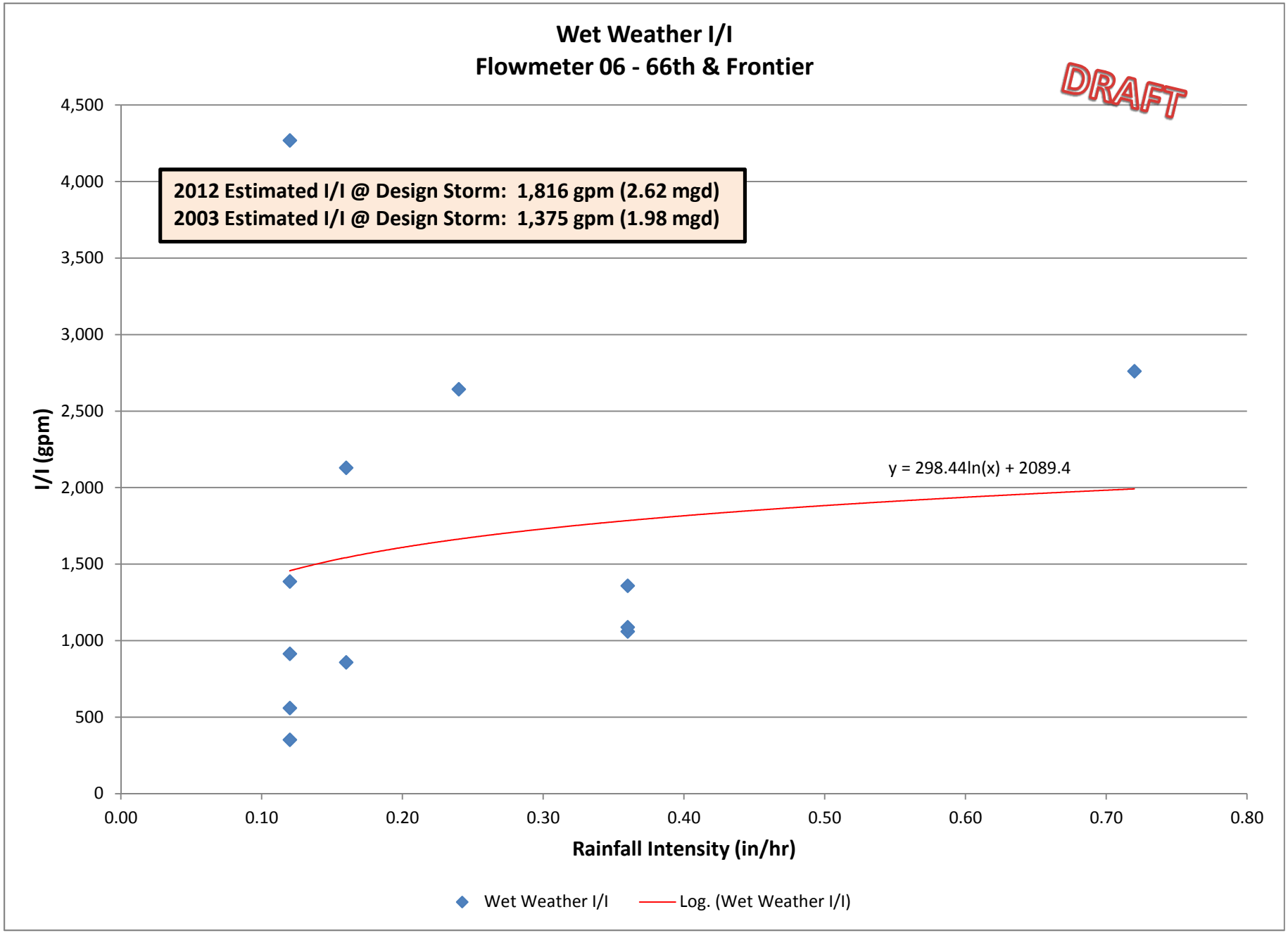

Wet Weather I/I
Flowmeter 01 - 93rd & Cayuga
DRAFT
2012 Estimated I/I @ Design Storm: 933 gpm (1.34 mgd)
2003 Estimated I/I @ Design Storm: 417 gpm (0.60 mgd)
y = 477.52ln(x) + 1370.5
I/I (gpm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Rainfall Intensity (in/hr)
Wet Weather I/I
Log. (Wet Weather I/I)

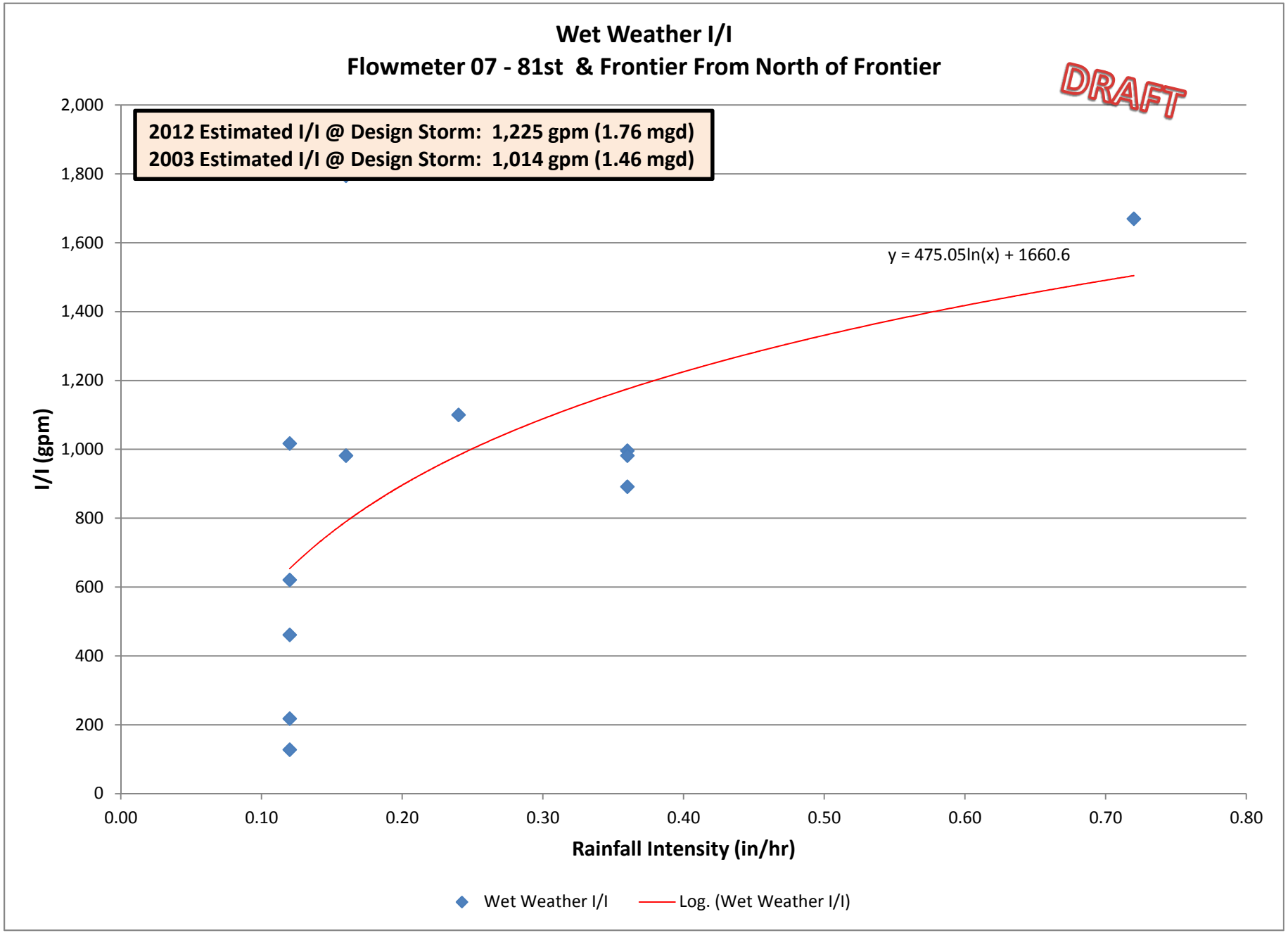

Wet Weather I/I
Flowmeter 02 - 91st & Luick
DRAFT
2012 Estimated I/I @ Design Storm: 1,677 gpm (2.41 mgd)
2003 Estimated I/I @ Design Storm: 1,375 gpm (1.98 mgd)
y = 948.75ln(x) + 2546.7
I/I (gpm)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Rainfall Intensity (in/hr)
Wet Weather I/I
Log. (Wet Weather I/I)

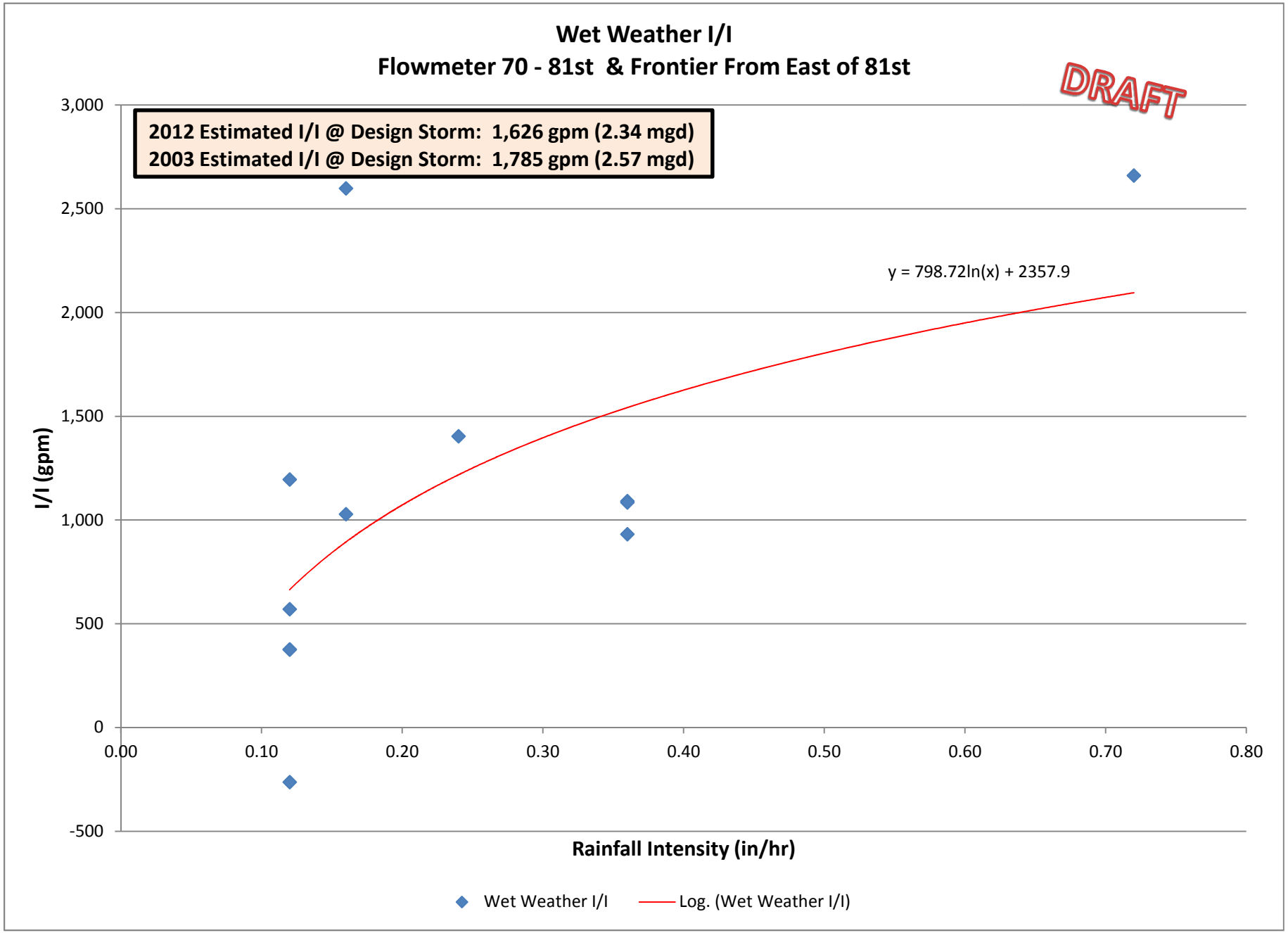

Wet Weather I/I
Flowmeter 03 - Frontier & 88th
DRAFT
2012 Estimated I/I @ Design Storm: 1,358 gpm (1.96 mgd)
2003 Estimated I/I @ Design Storm: 1,465 gpm (2.11 mgd)
y = 564.96ln(x) + 1875.2
I/I (gpm)
2,500
2,000
1,500
1,000
500
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Rainfall Intensity (in/hr)
Wet Weather I/I
Log. (Wet Weather I/I)

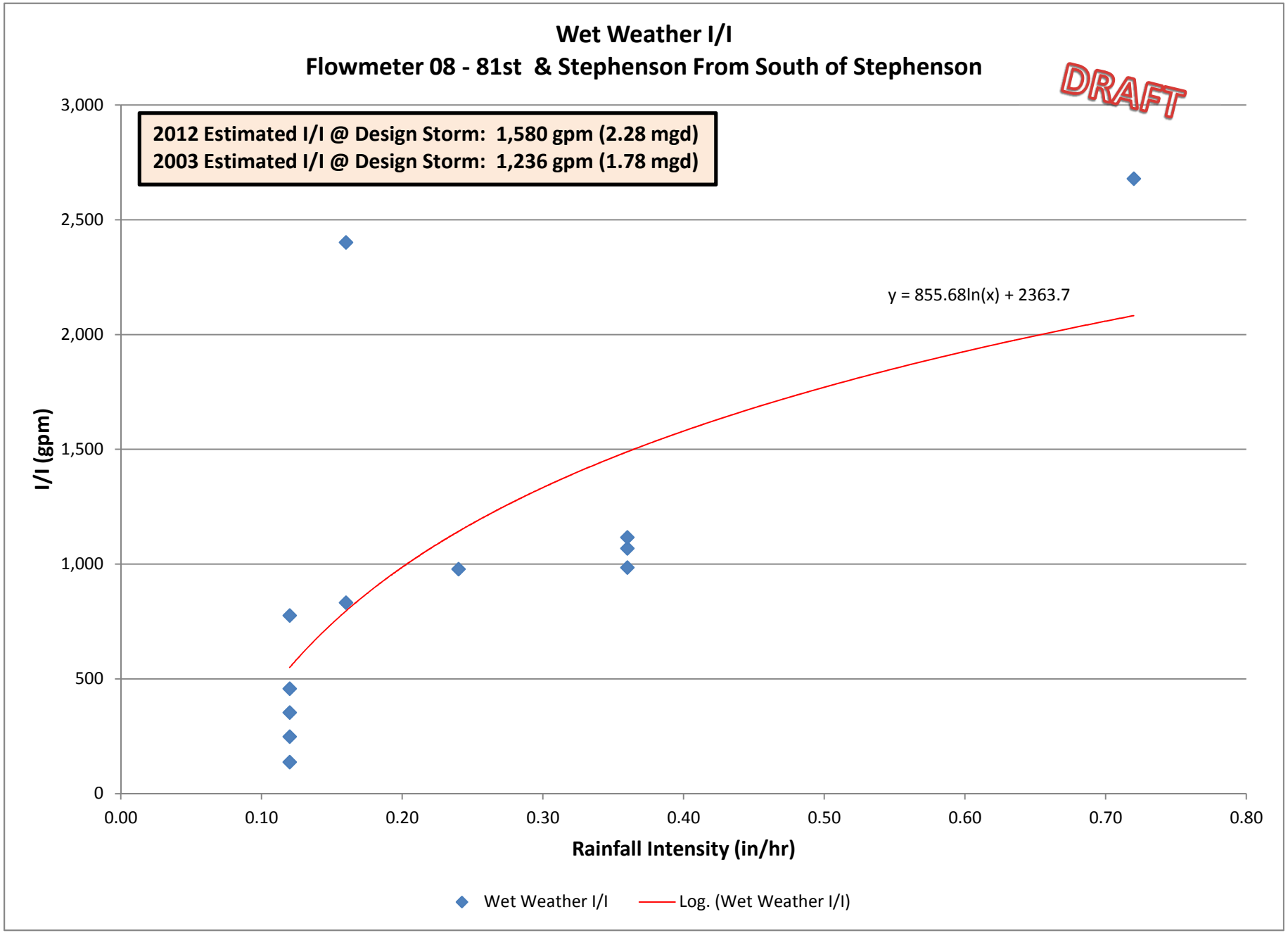

Wet Weather I/I
Flowmeter 04 - 80th & Lindberg
DRAFT
2012 Estimated I/I @ Design Storm: 598 gpm (0.86 mgd)
2003 Estimated I/I @ Design Storm: 333 gpm (0.48 mgd)
y = 348.63ln(x) + 917.13
I/I (gpm)
1,200
1,000
800
600
400
200
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Rainfall Intensity (in/hr)
Wet Weather I/I
Log. (Wet Weather I/I)


Wet Weather I/I
Flowmeter 05 - 73rd & Girard
DRAFT
2012 Estimated I/I @ Design Storm: 2,497 gpm (3.60 mgd)
2003 Estimated I/I @ Design Storm: 3,118 gpm (4.49 mgd)
y = 1013.8ln(x) + 3425.5
I/I (gpm)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Rainfall Intensity (in/hr)
Wet Weather I/I
Log. (Wet Weather I/I)

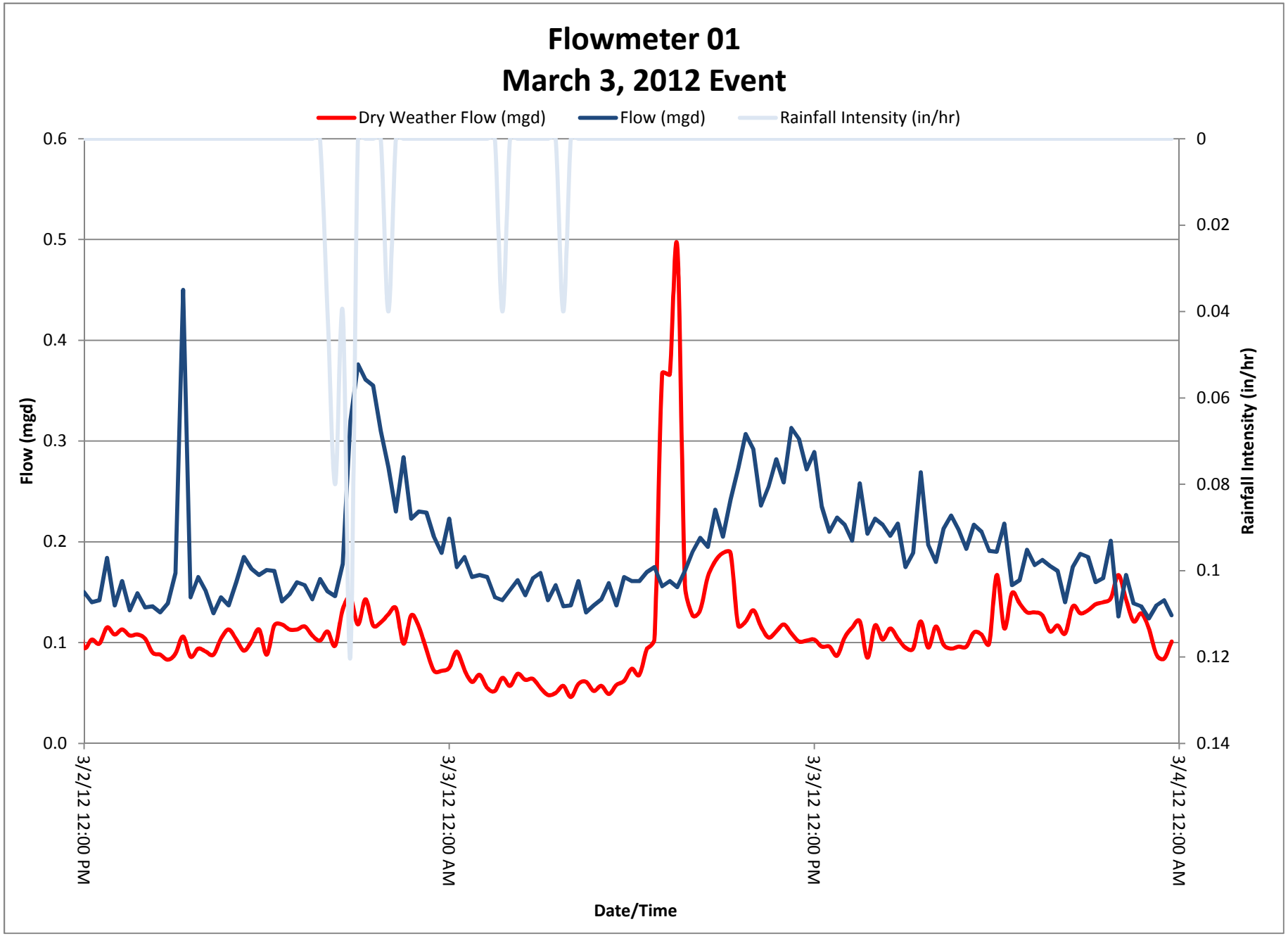

Wet Weather I/I
Flowmeter 06 - 66th & Frontier
DRAFT
2012 Estimated I/I @ Design Storm: 1,816 gpm (2.62 mgd)
2003 Estimated I/I @ Design Storm: 1,375 gpm (1.98 mgd)
y = 298.44ln(x) + 2089.4
I/I (gpm)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Rainfall Intensity (in/hr)
Wet Weather I/I
Log. (Wet Weather I/I)


Wet Weather I/I
Flowmeter 07 - 81st & Frontier From North of Frontier
DRAFT
2012 Estimated I/I @ Design Storm: 1,225 gpm (1.76 mgd)
2003 Estimated I/I @ Design Storm: 1,014 gpm (1.46 mgd)
y = 475.05ln(x) + 1660.6
I/I (gpm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Rainfall Intensity (in/hr)
Wet Weather I/I
Log. (Wet Weather I/I)


Wet Weather I/I
Flowmeter 70 - 81st & Frontier From East of 81st
DRAFT
2012 Estimated I/I @ Design Storm: 1,626 gpm (2.34 mgd)
2003 Estimated I/I @ Design Storm: 1,785 gpm (2.57 mgd)
y = 798.72ln(x) + 2357.9
3,000
2,500
2,000
1,500
1,000
500
0
-500
I/I (gpm)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Rainfall Intensity (in/hr)
Wet Weather I/I
Log. (Wet Weather I/I)


Wet Weather I/I
Flowmeter 08 - 81st & Stephenson From South of Stephenson
DRAFT
2012 Estimated I/I @ Design Storm: 1,580 gpm (2.28 mgd)
2003 Estimated I/I @ Design Storm: 1,236 gpm (1.78 mgd)
y = 855.68ln(x) + 2363.7
I/I (gpm)
3,000
2,500
2,000
1,500
1,000
500
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Rainfall Intensity (in/hr)
Wet Weather I/I
Log. (Wet Weather I/I)

APPENDIX F: Wet Weather/Dry Weather Comparison Hydrographs



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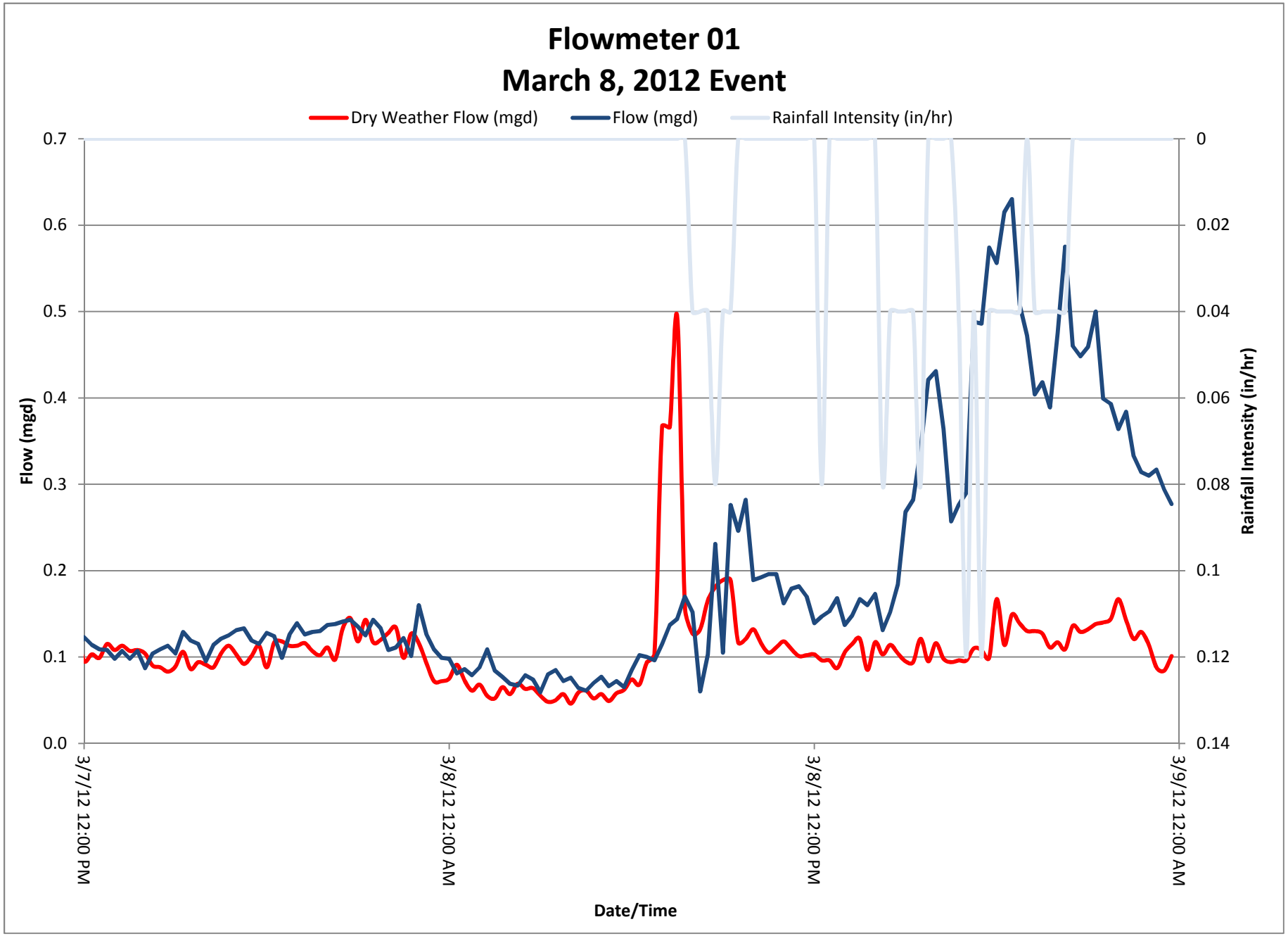
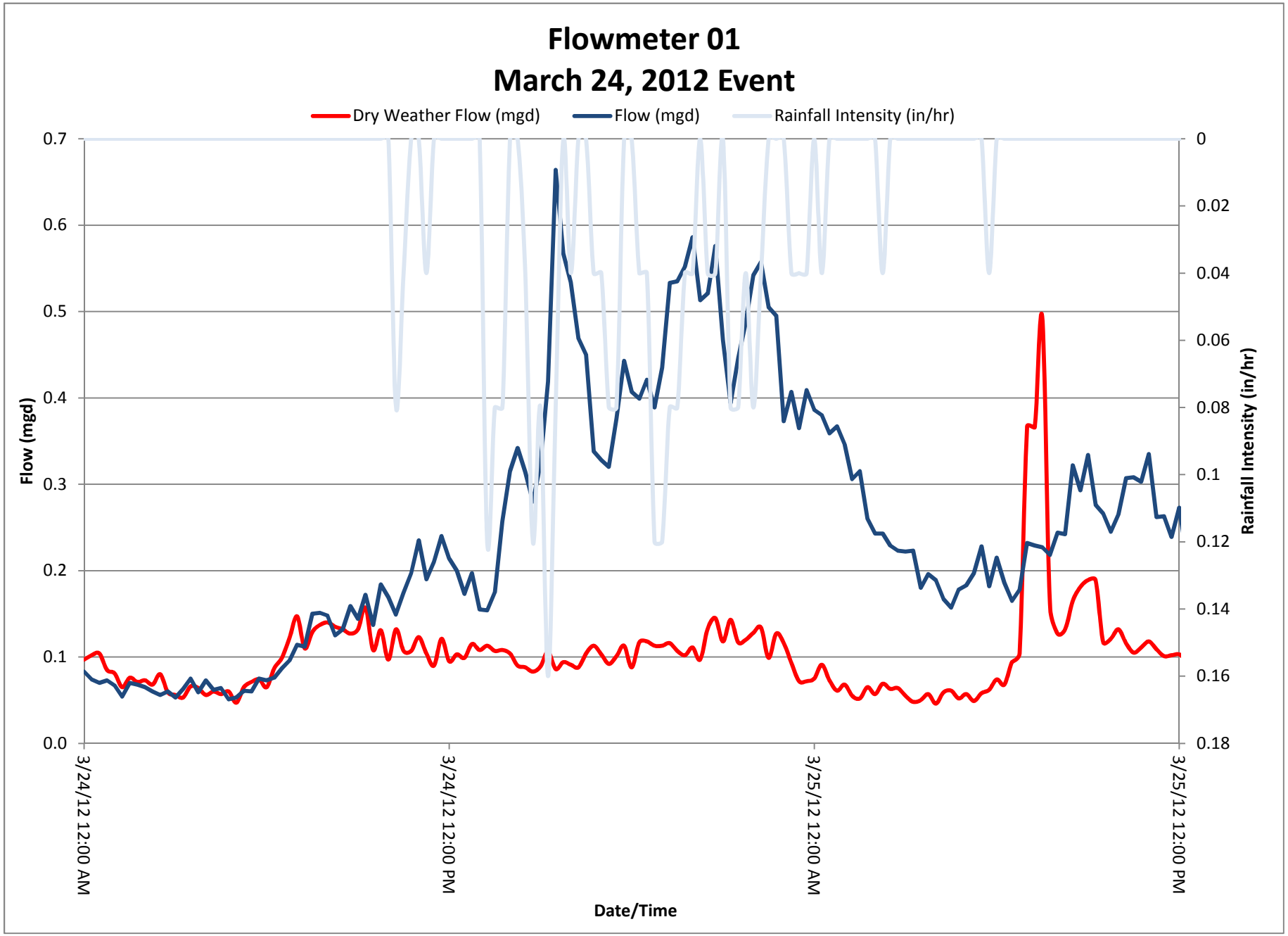


G:\86\14883\Tech\GHD Formatted Hydrographs\Site 01 (1130 93rd St)



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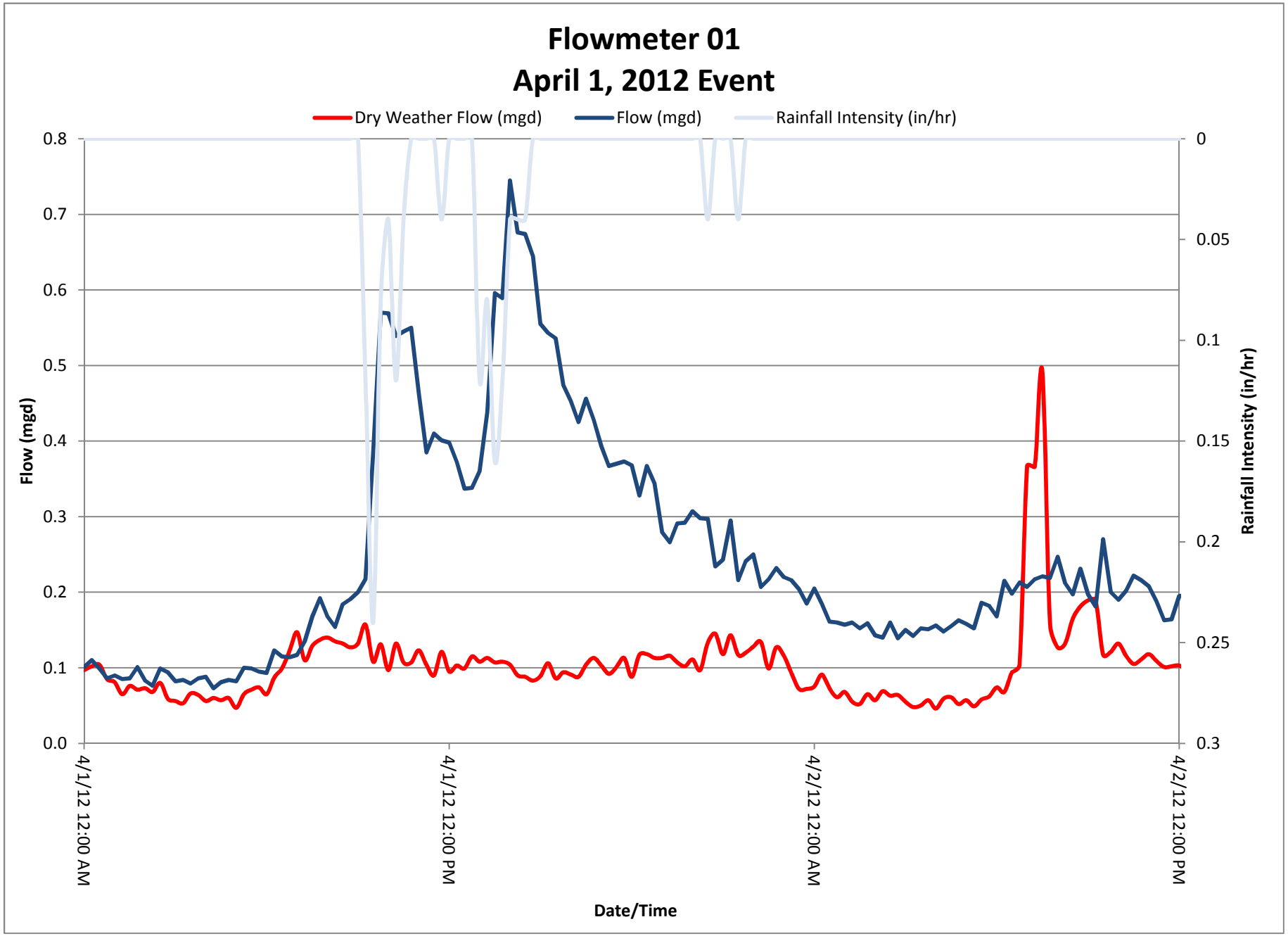

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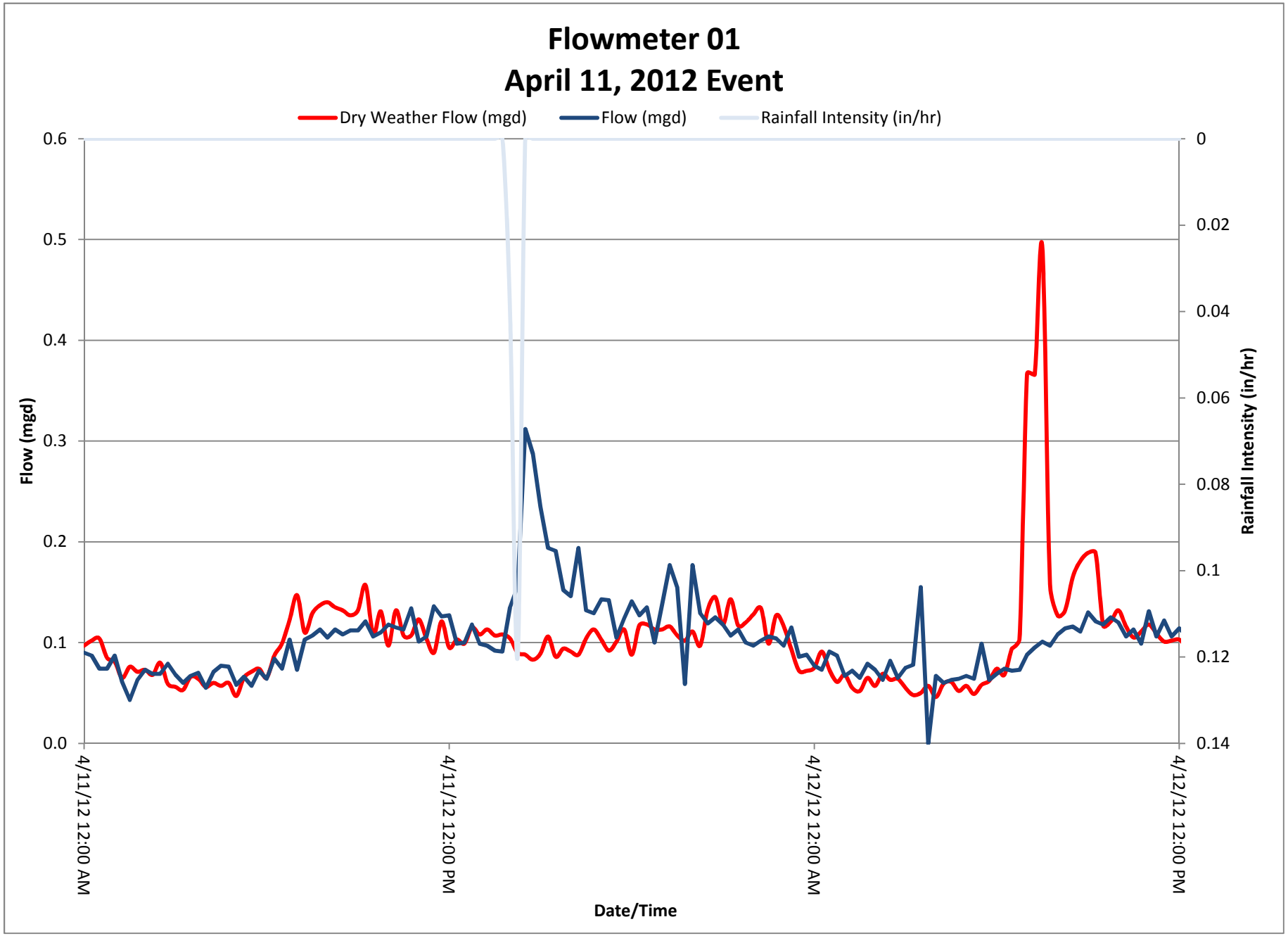

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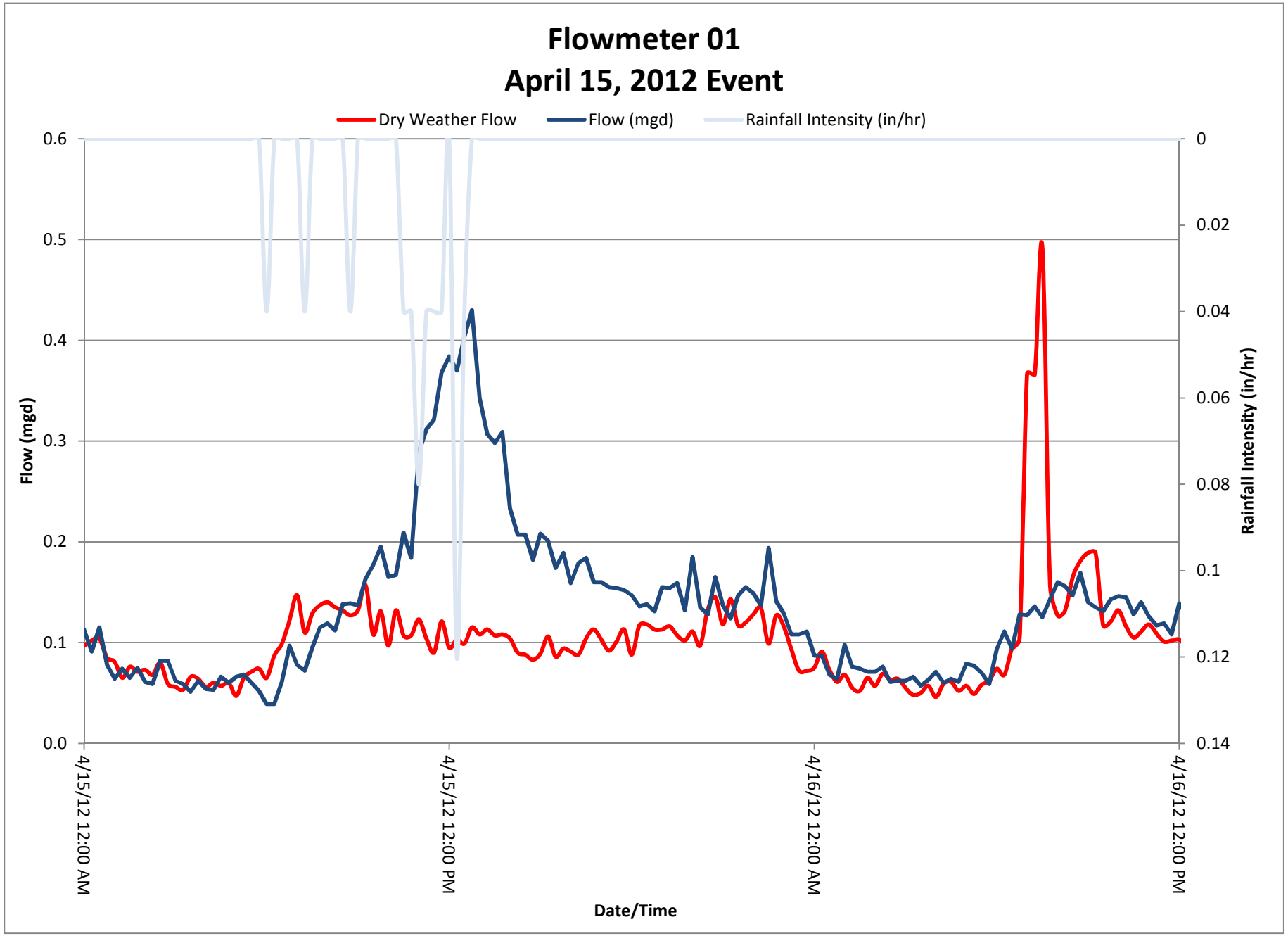

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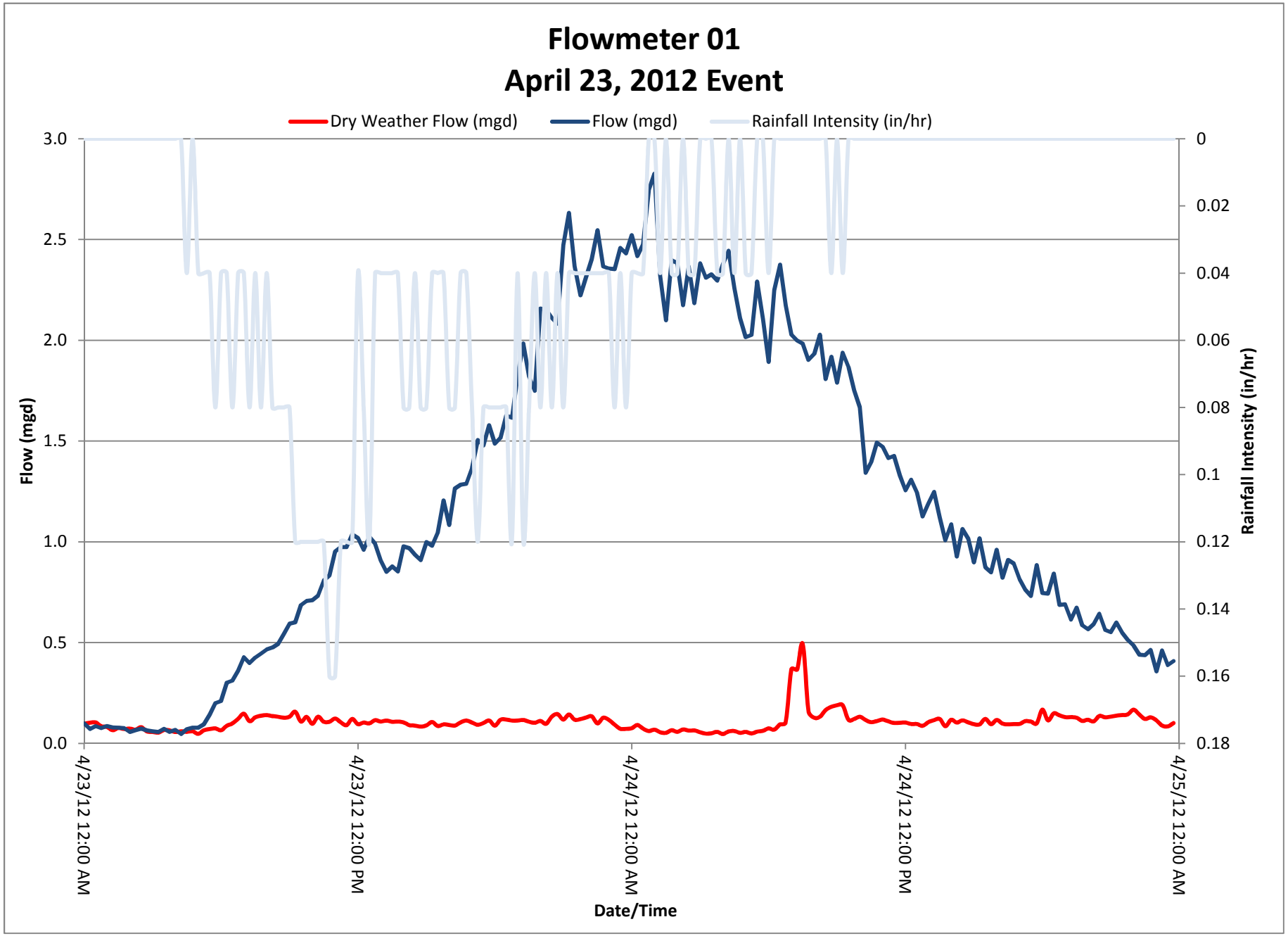

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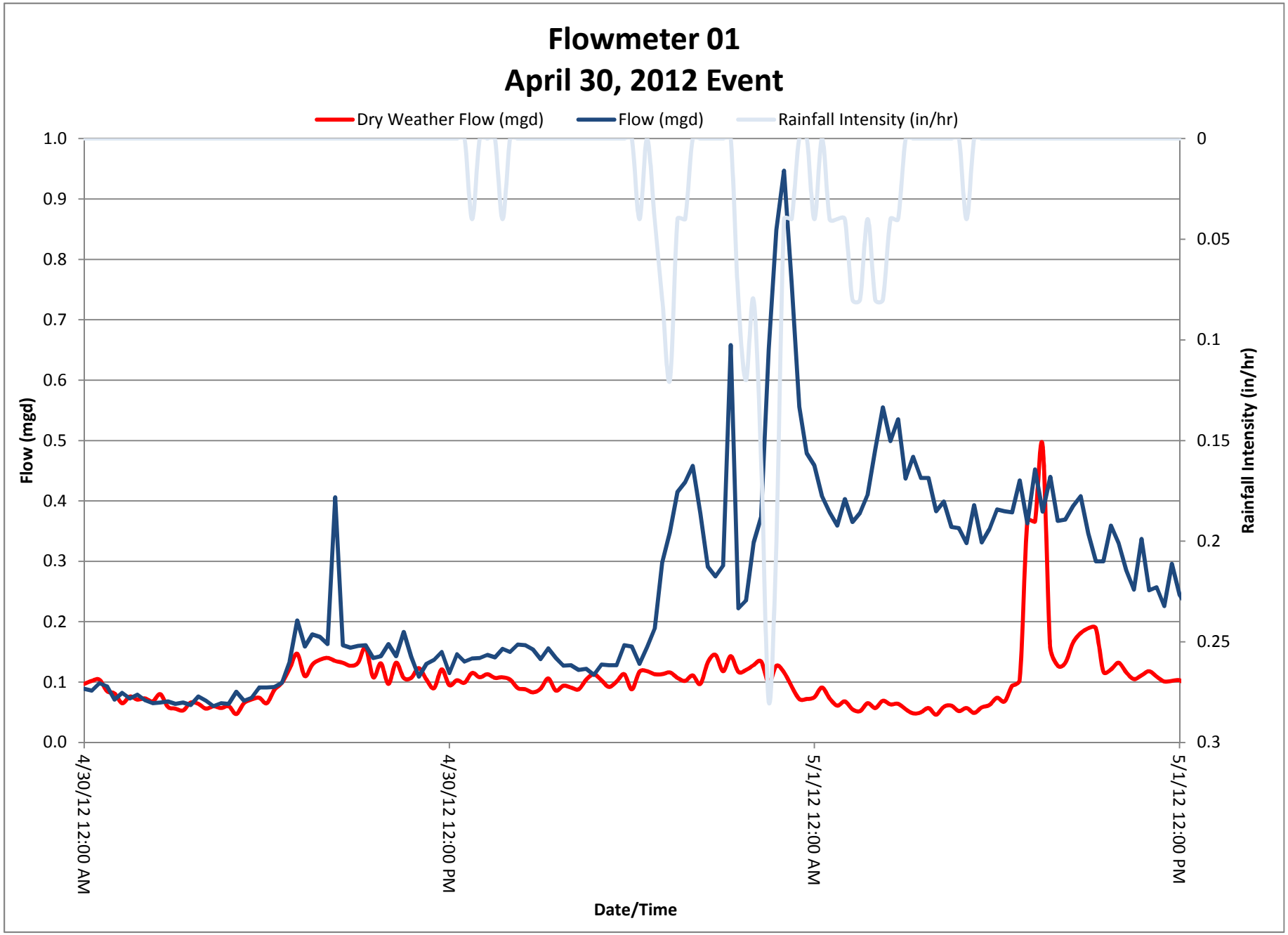
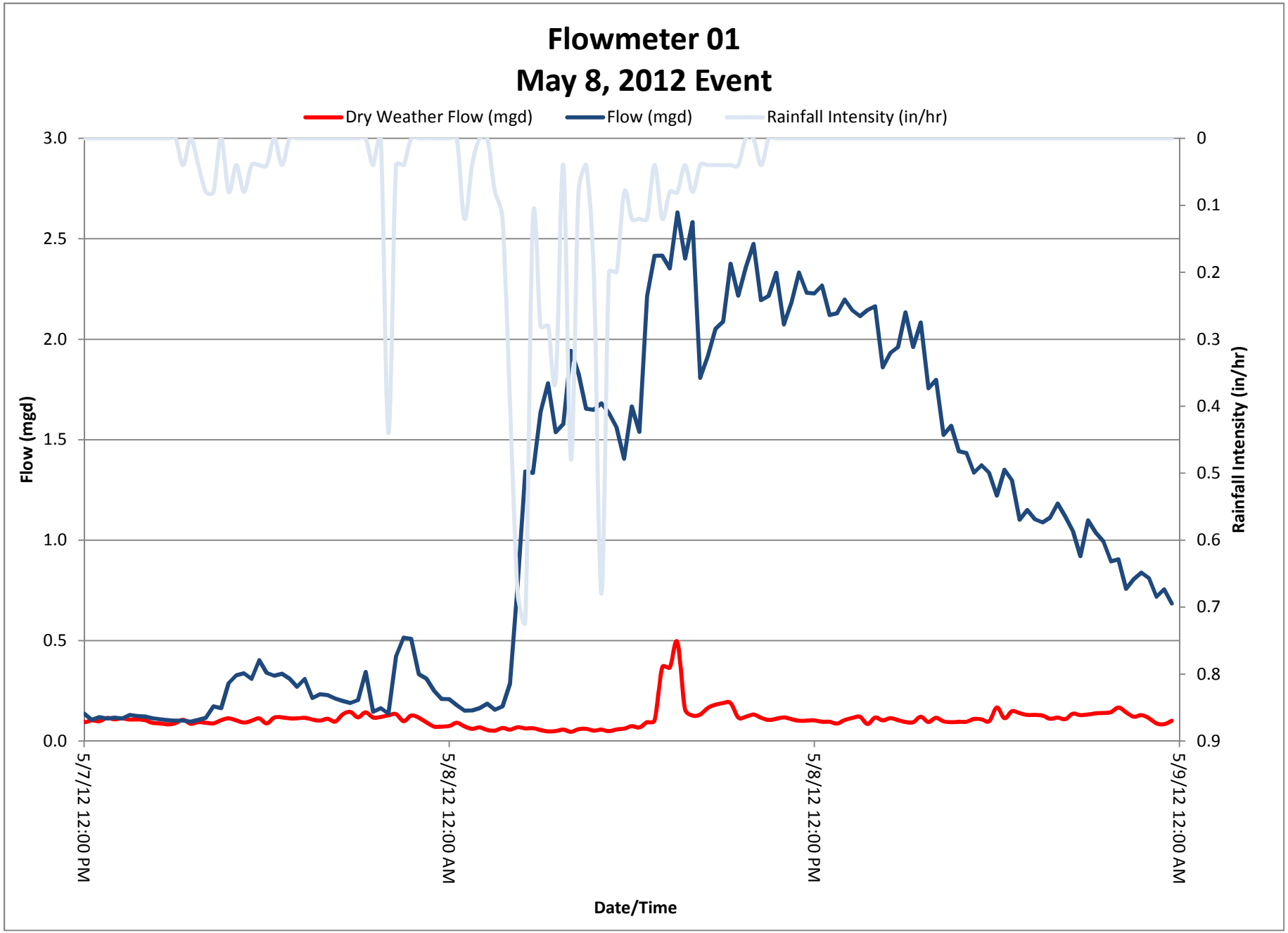
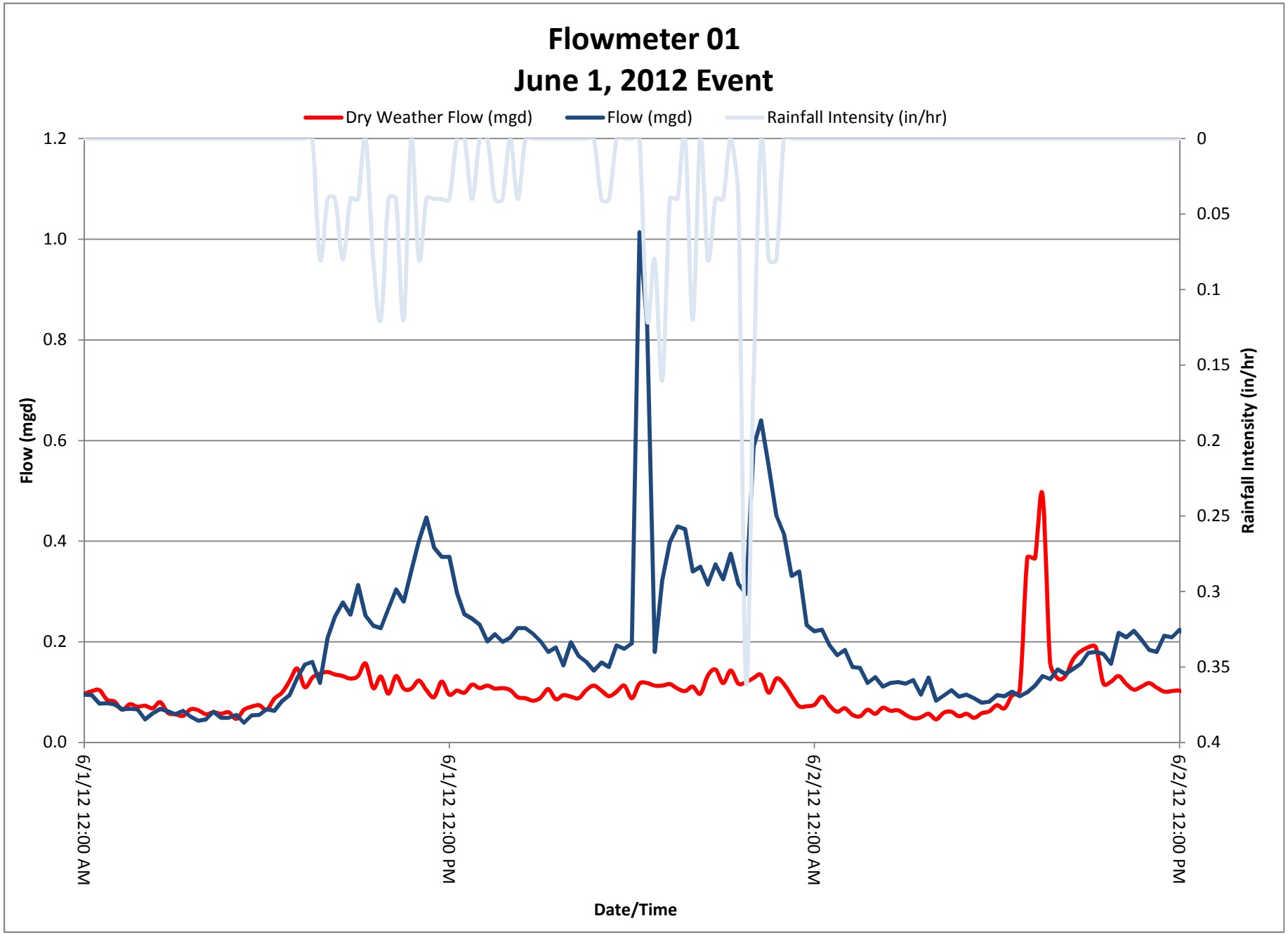


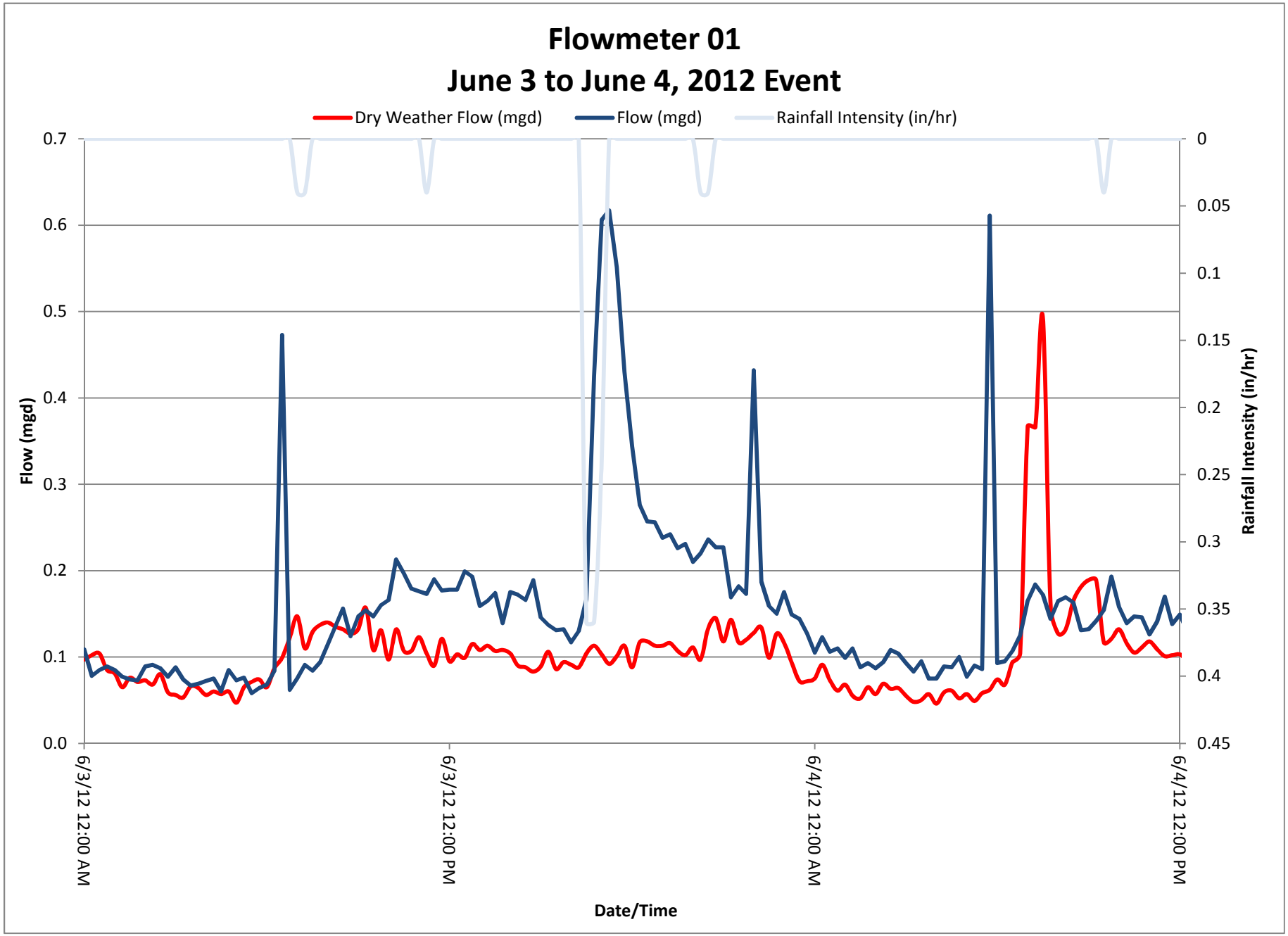
G:\86\14883\Tech\GHD Formatted Hydrographs\Site 01 (1130 93rd St)



G:\86\14883\Tech\GHD Formatted Hydrographs\Site 01 (1130 93rd St)



G:\86\14883\Tech\GHD Formatted Hydrographs\Site 01 (1130 93rd St)



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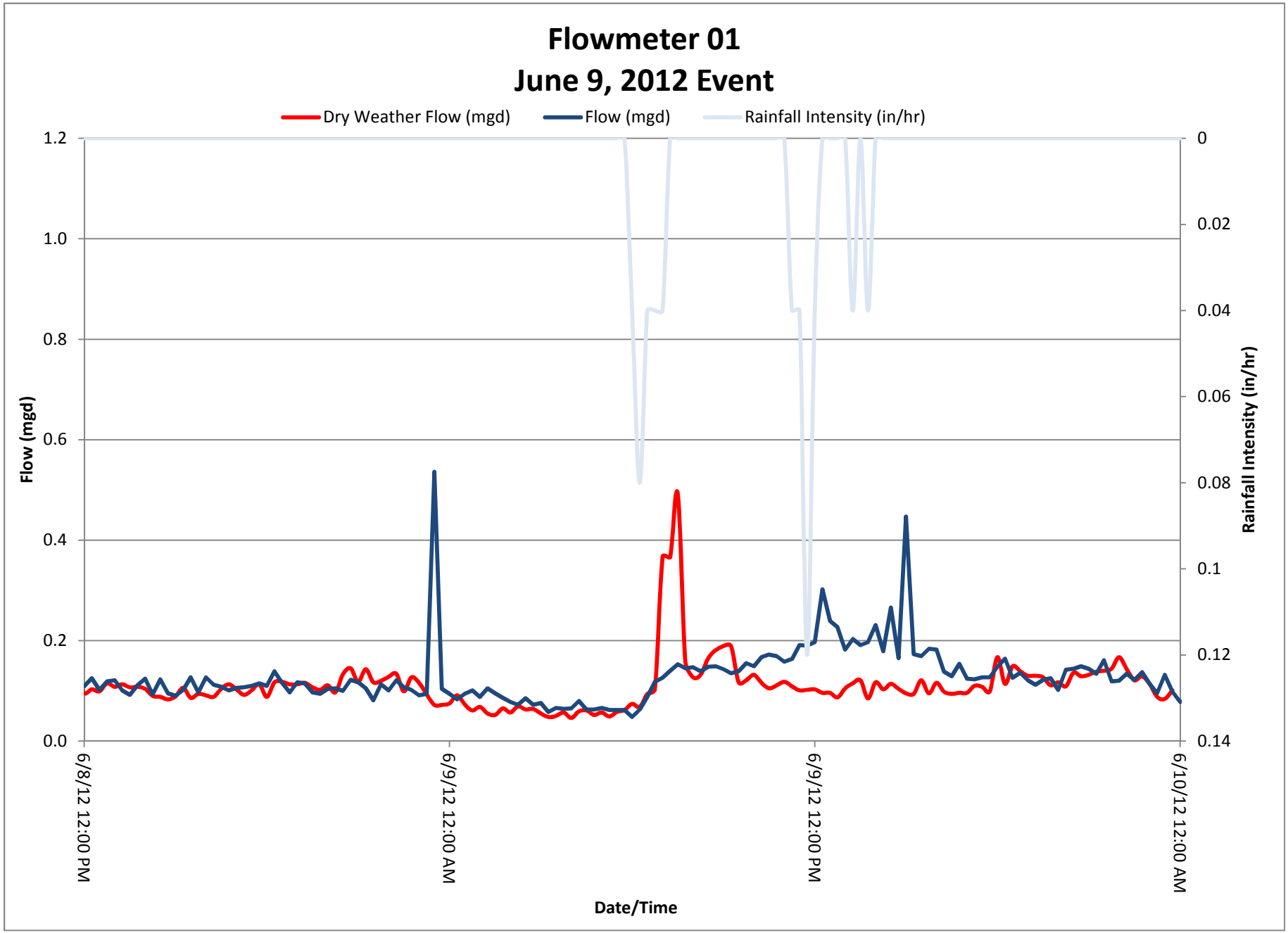

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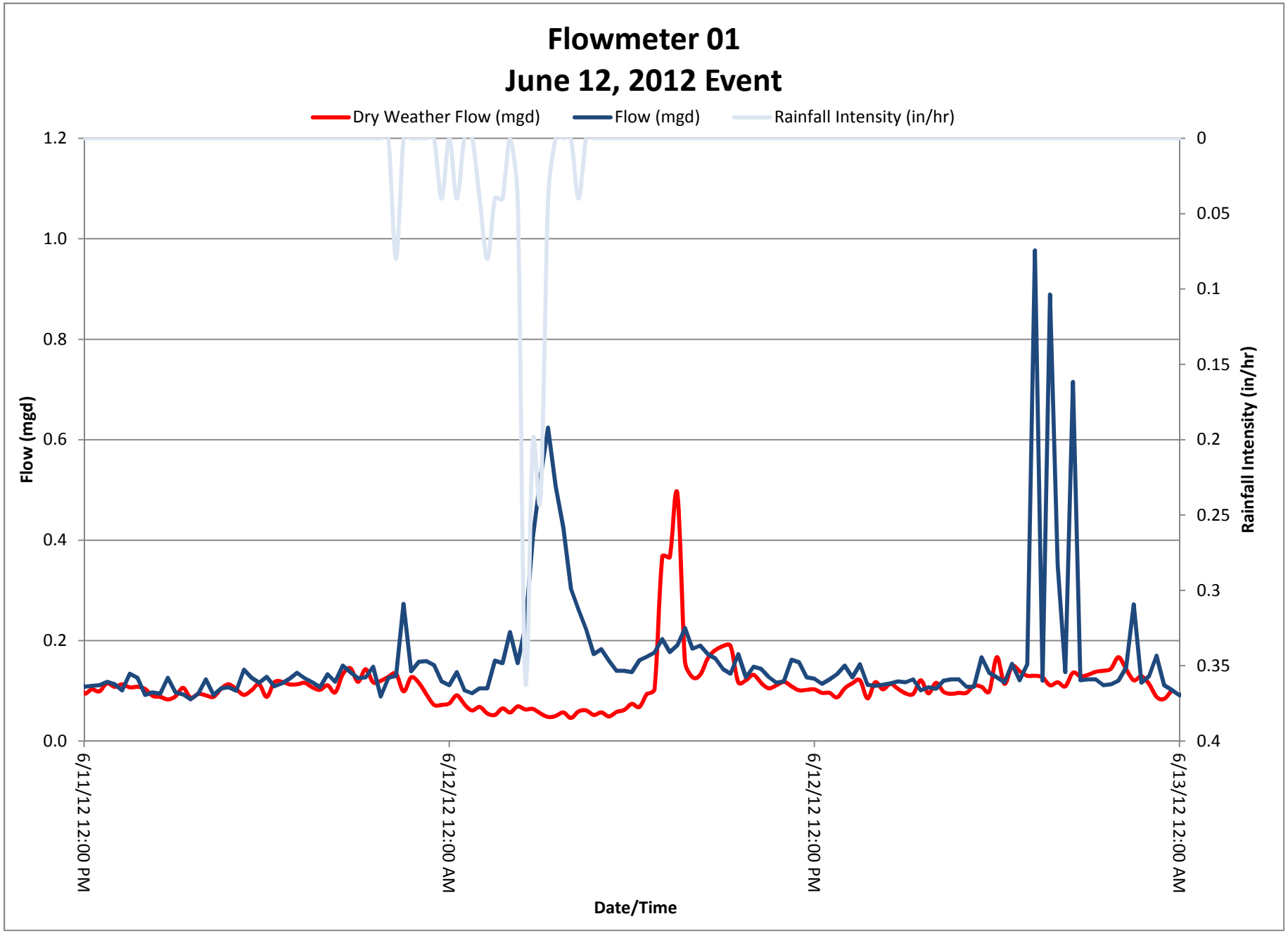

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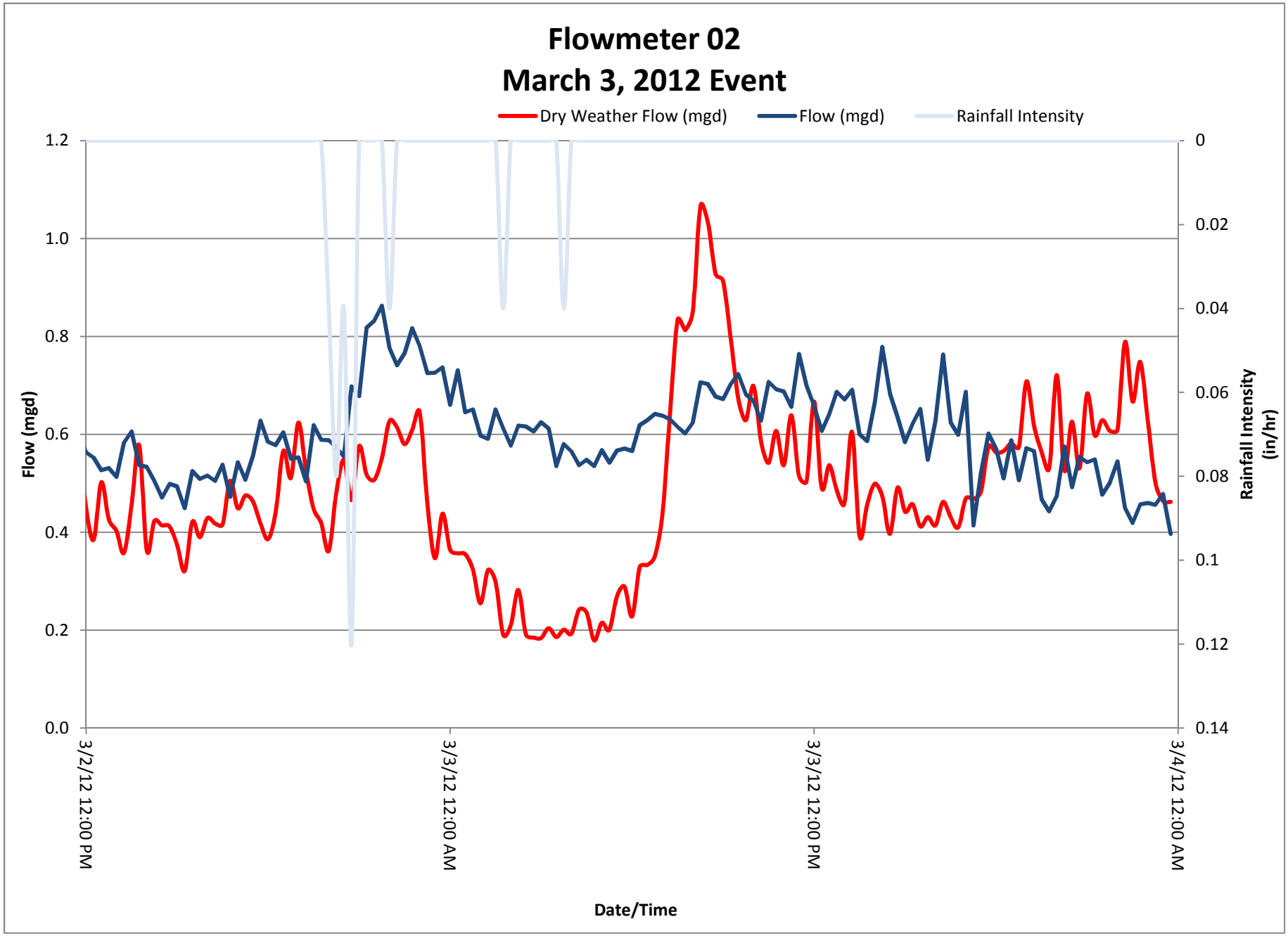

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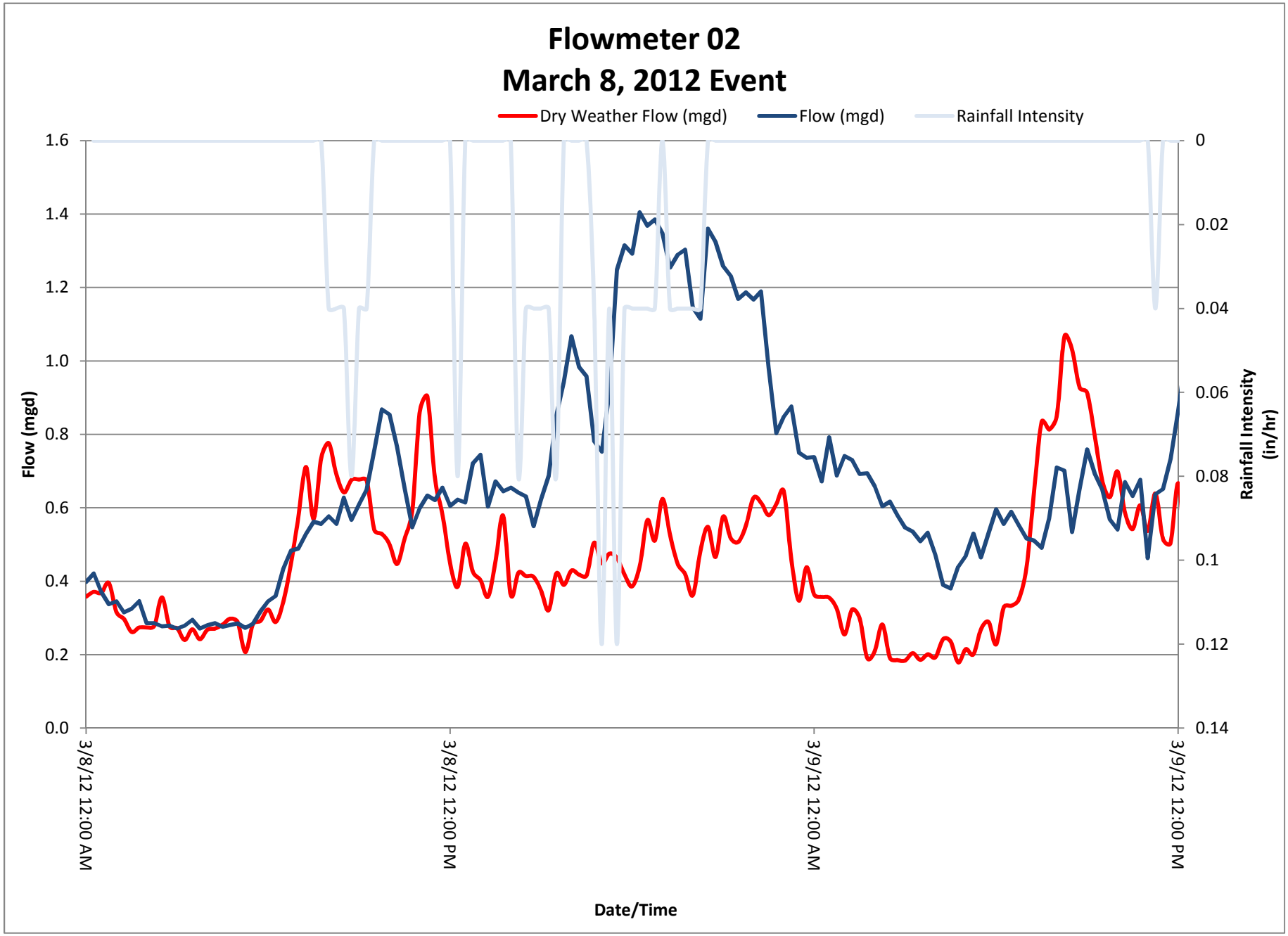

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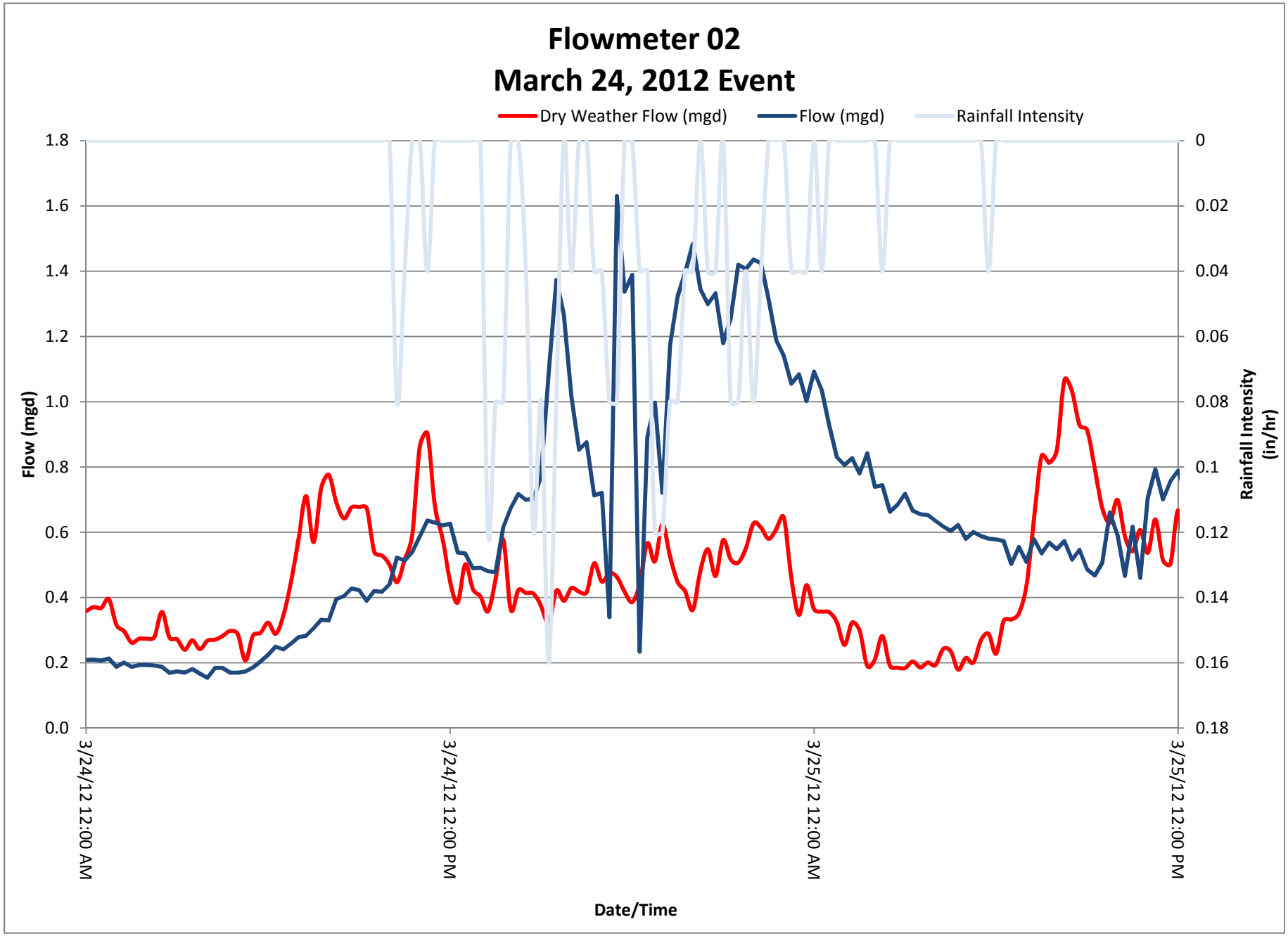

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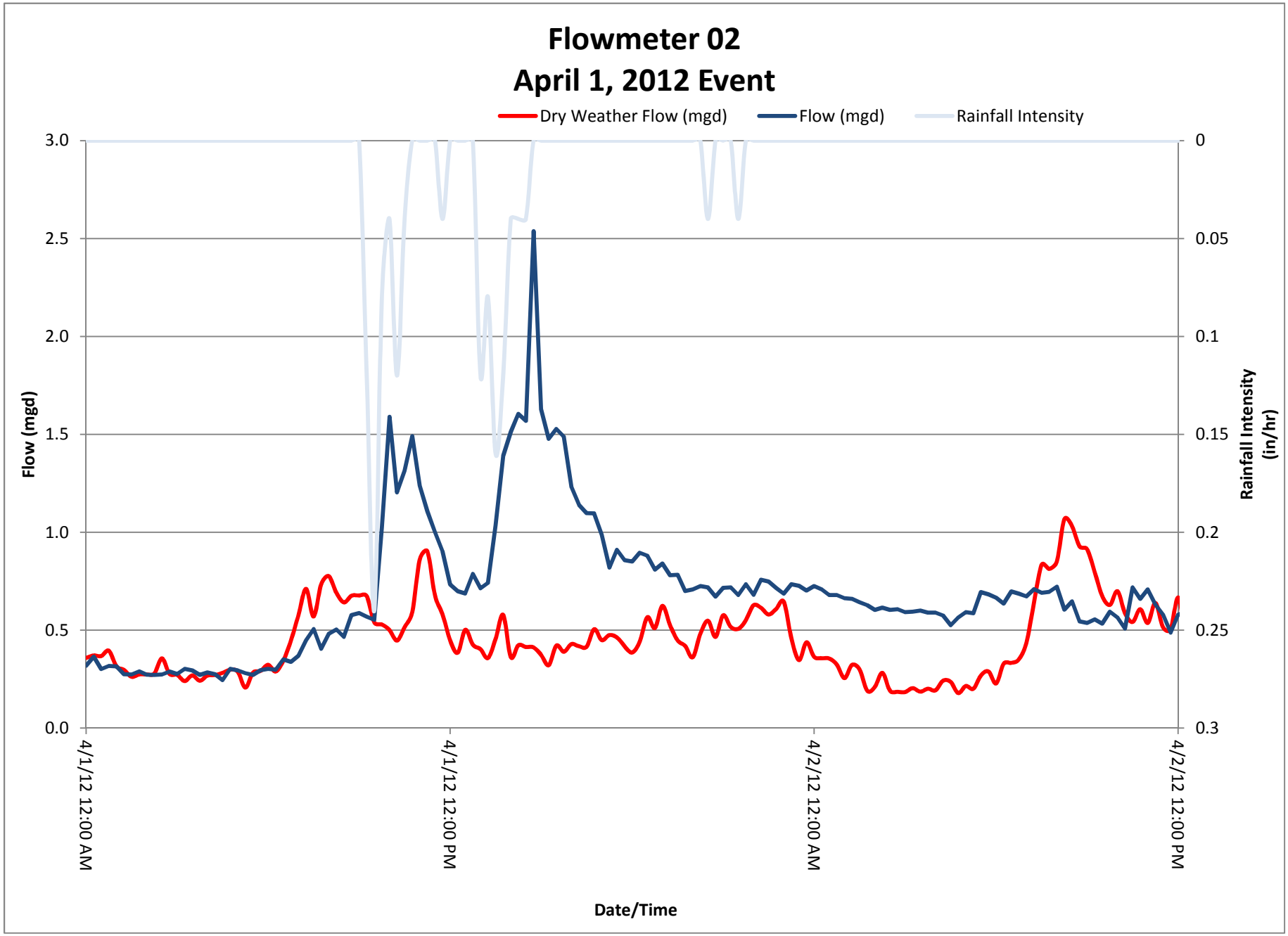

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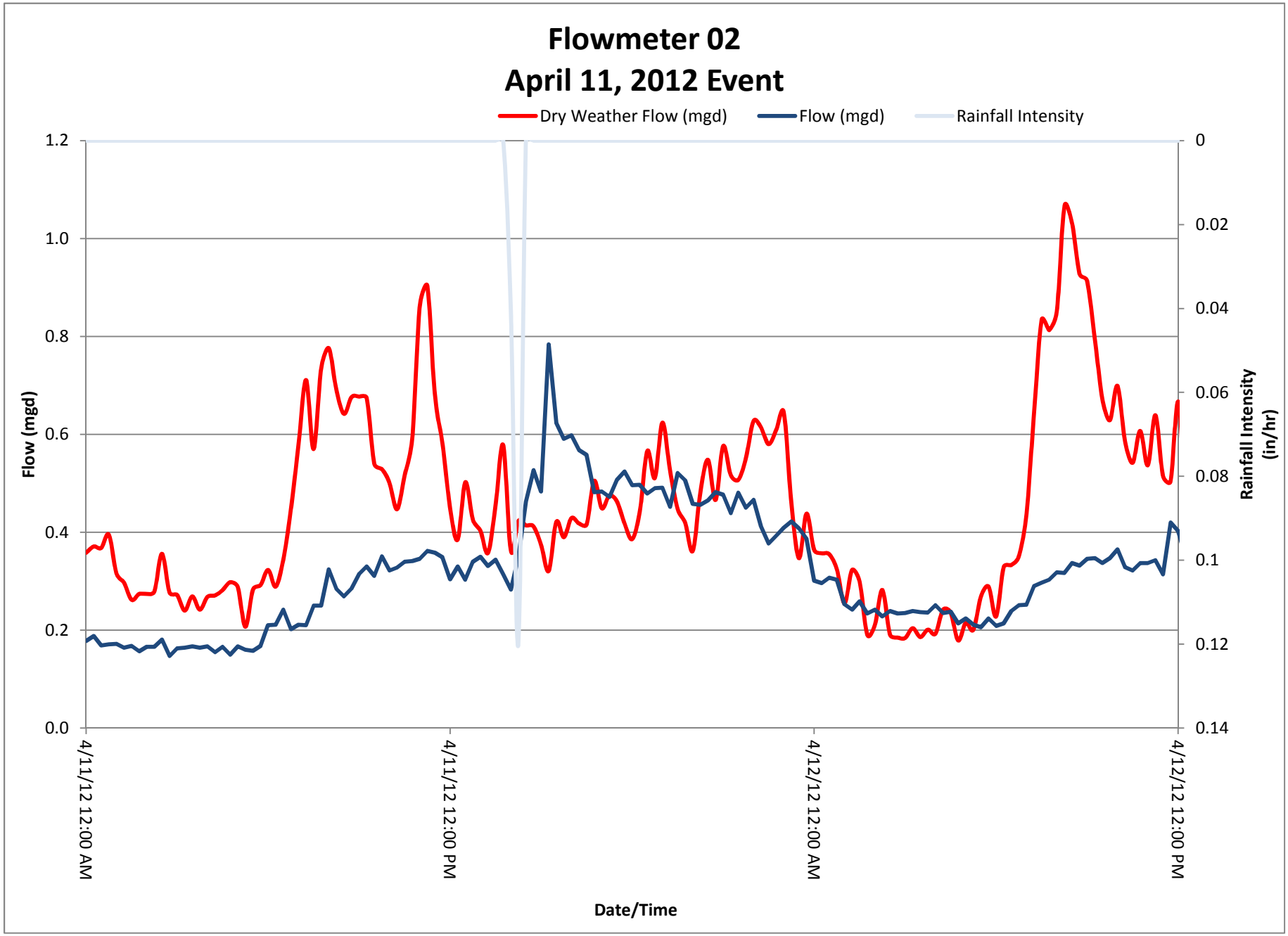

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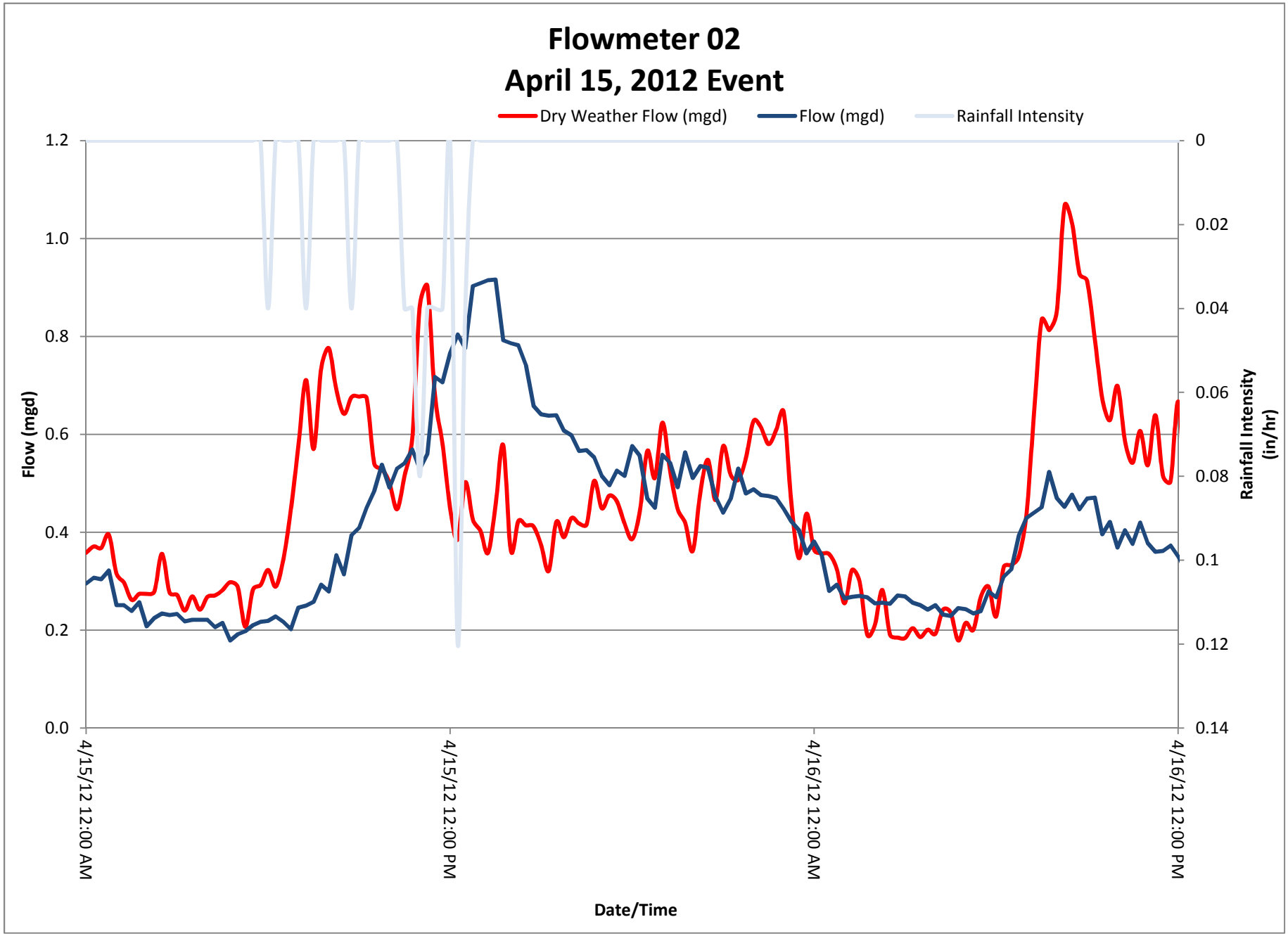

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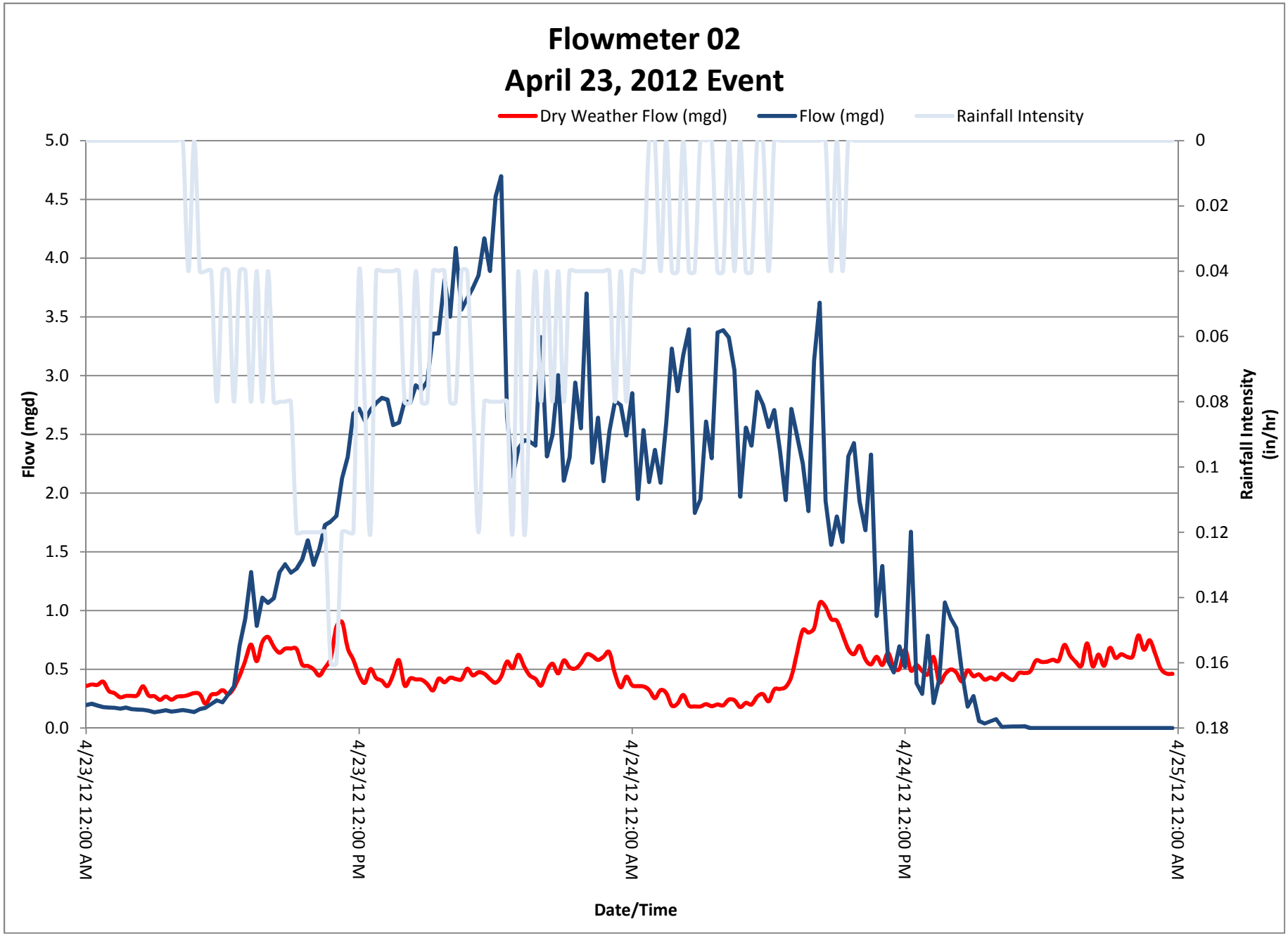

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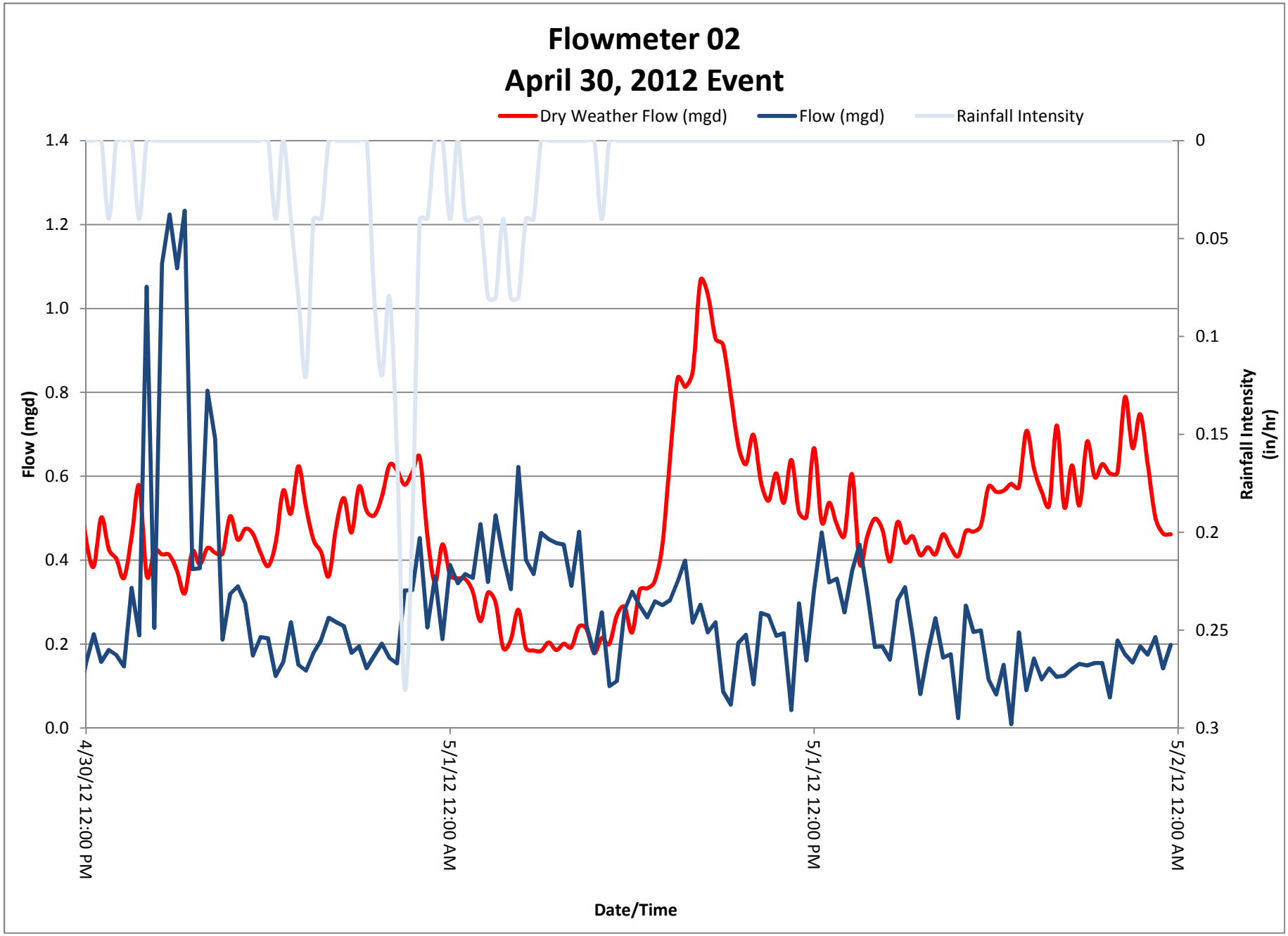

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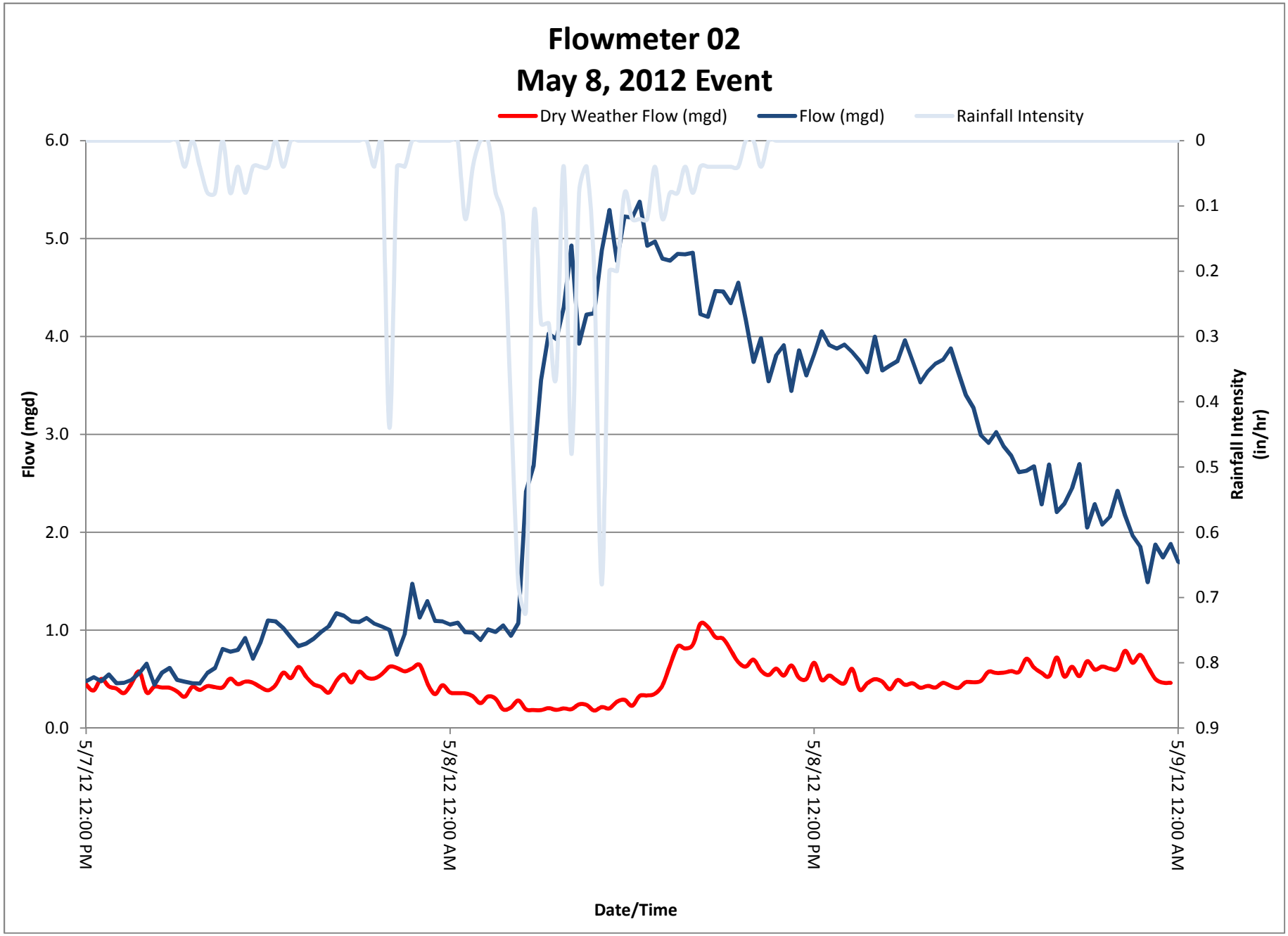

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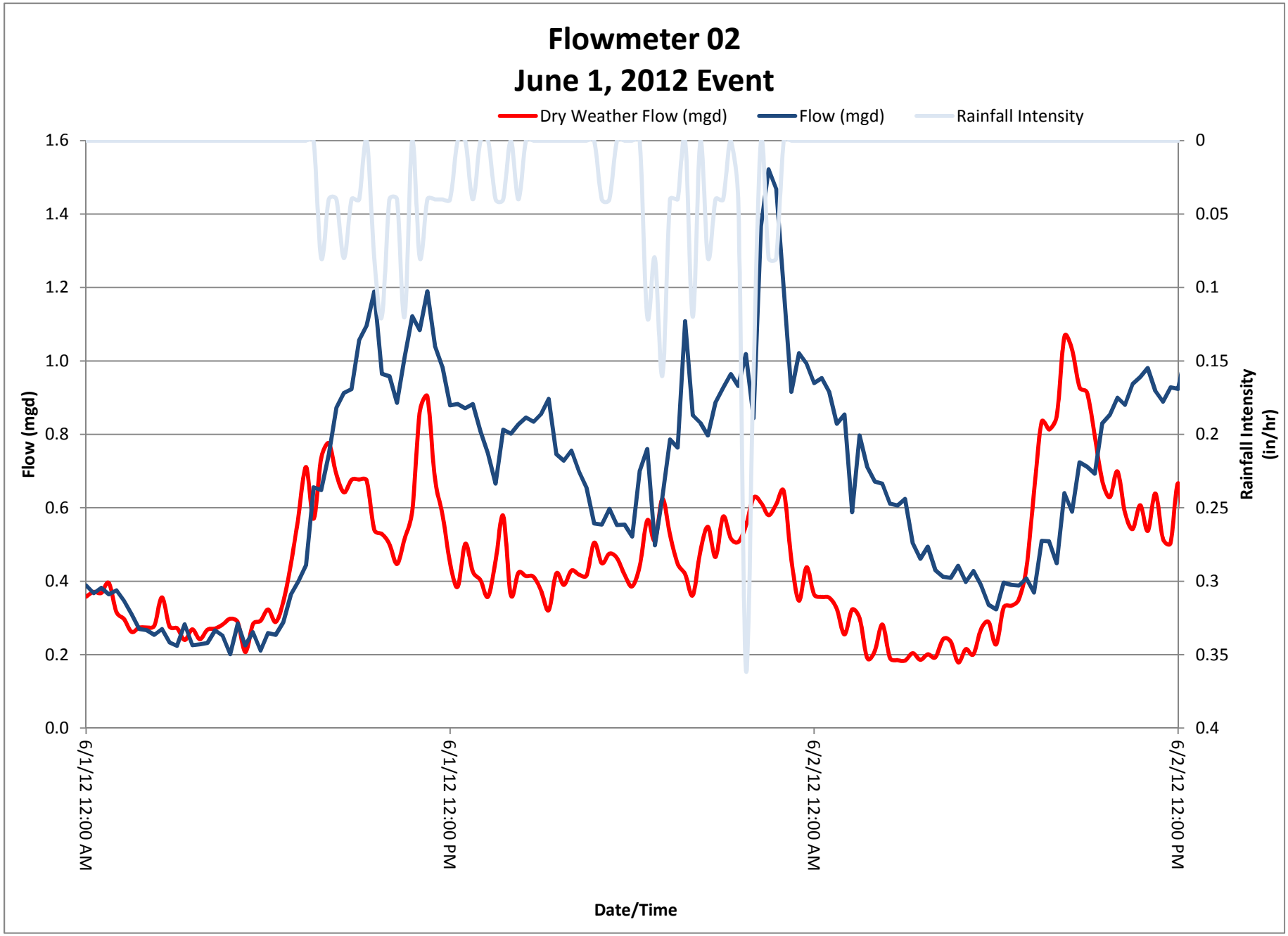

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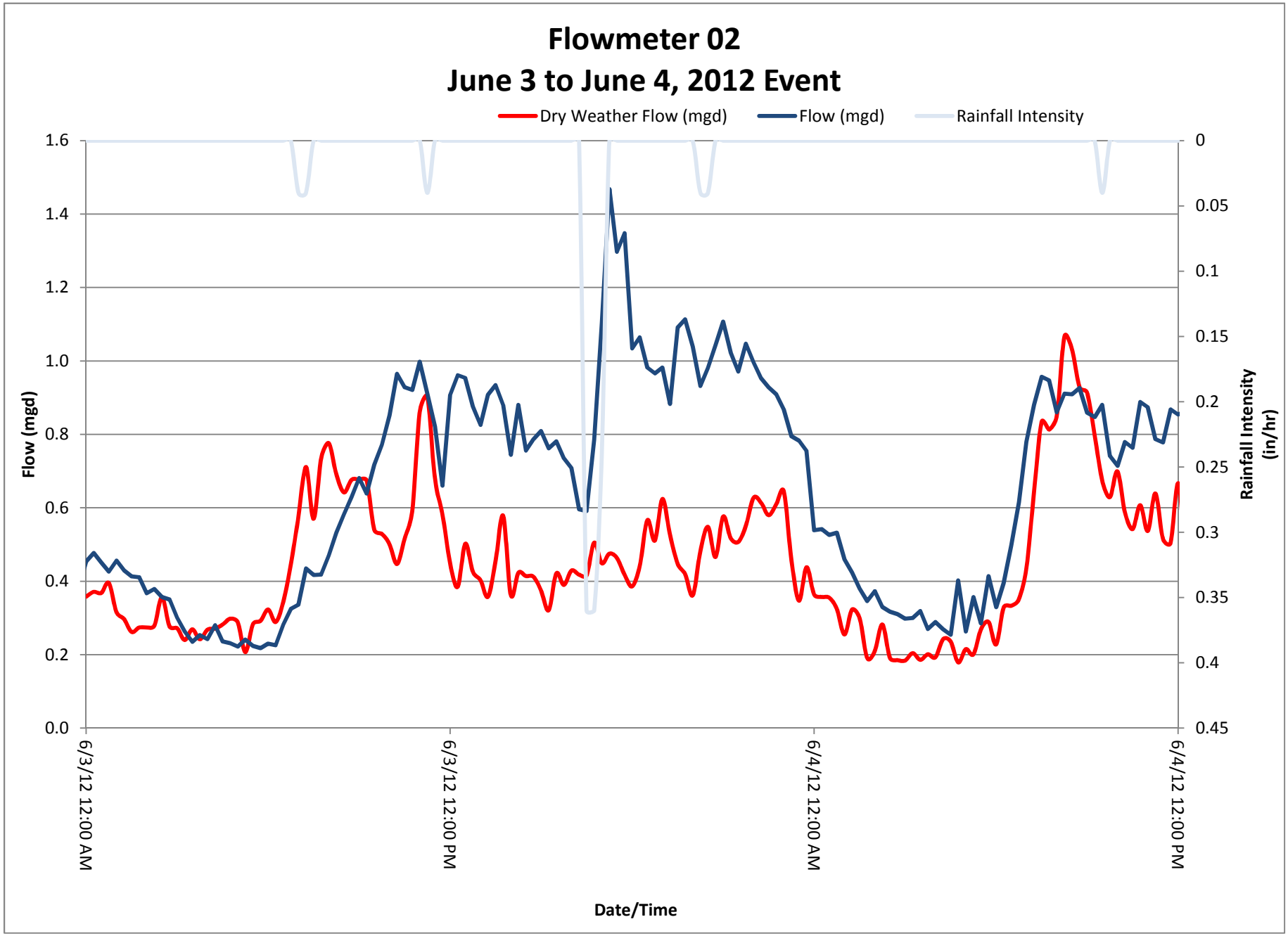

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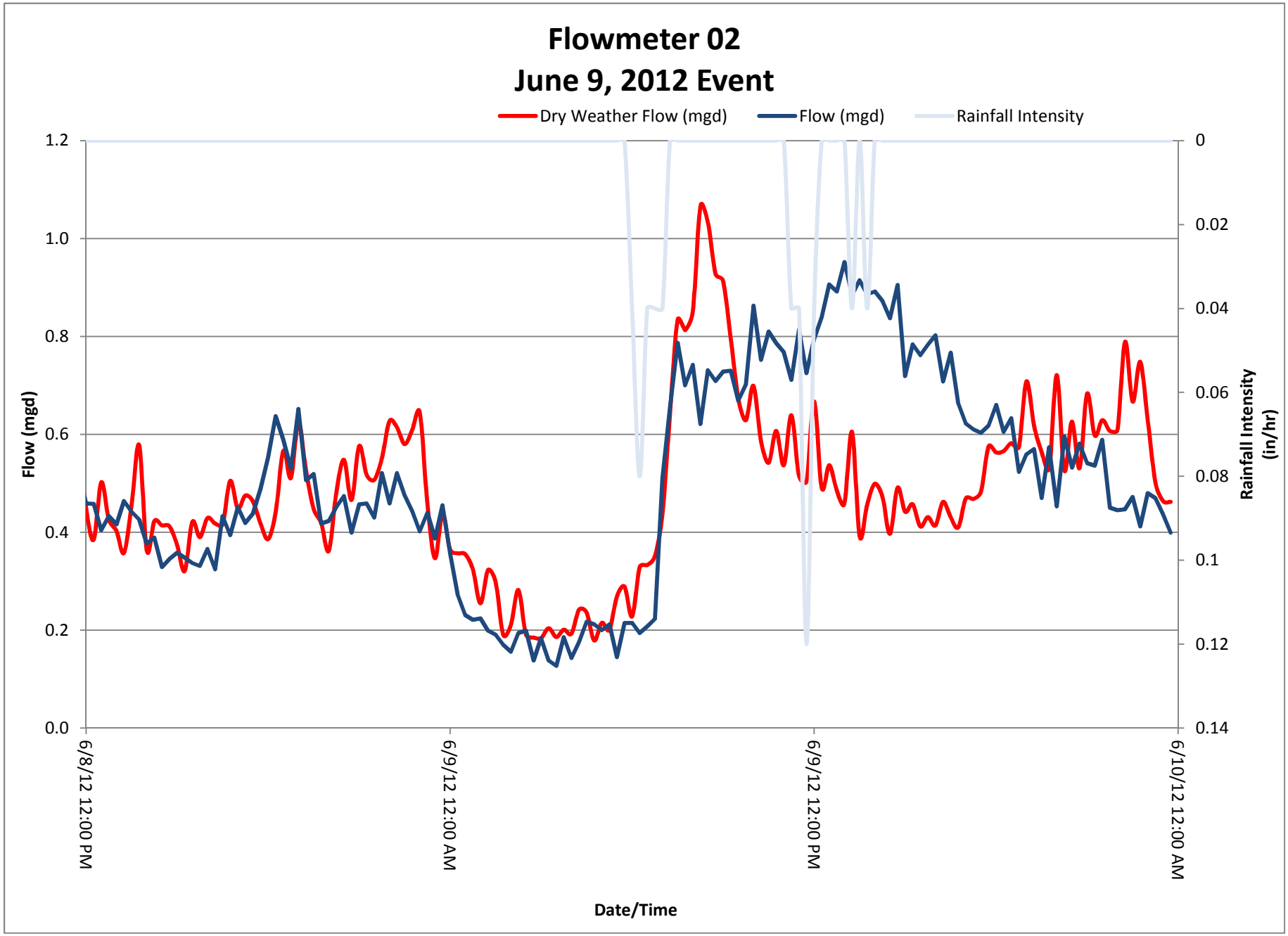

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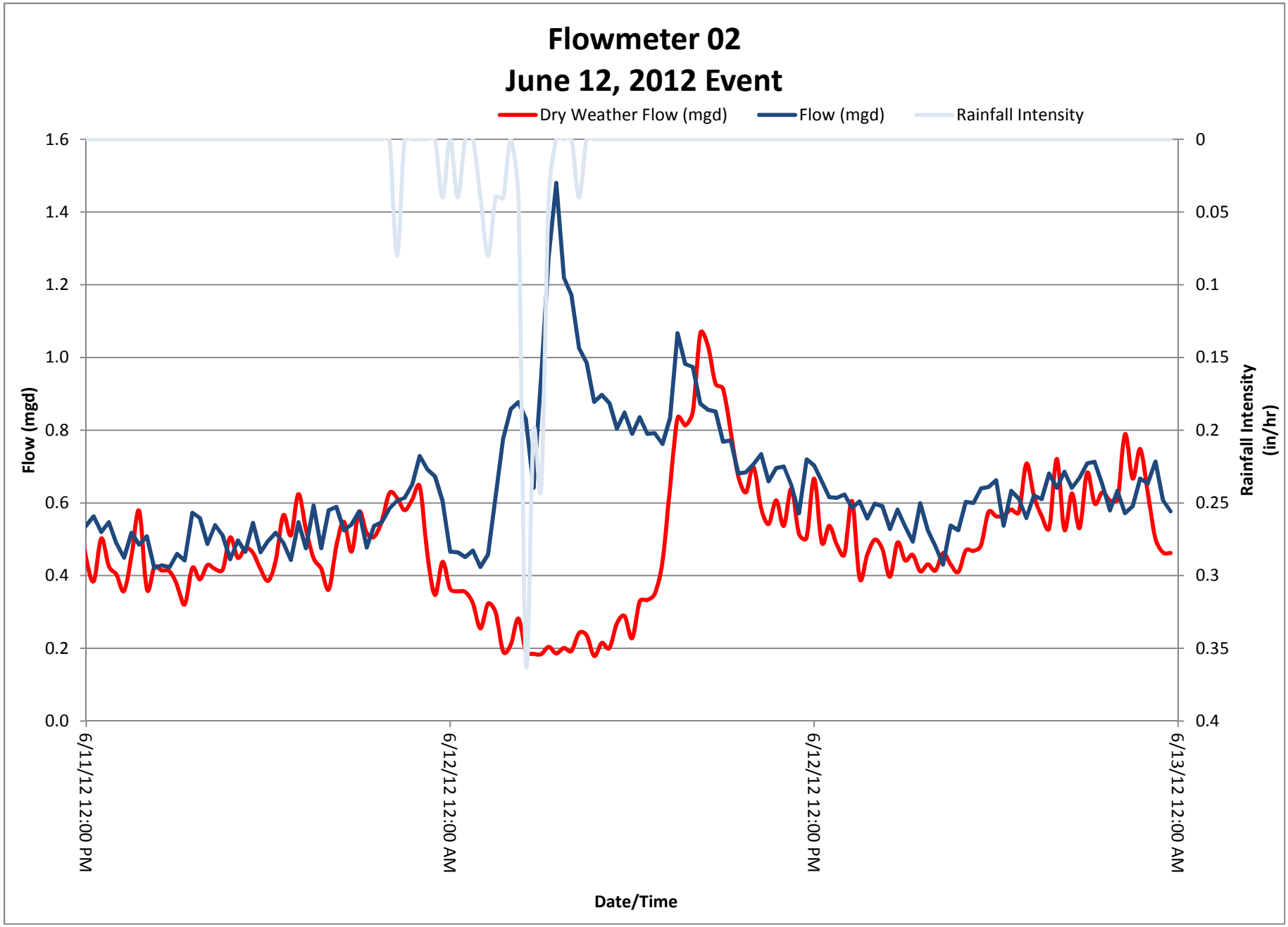

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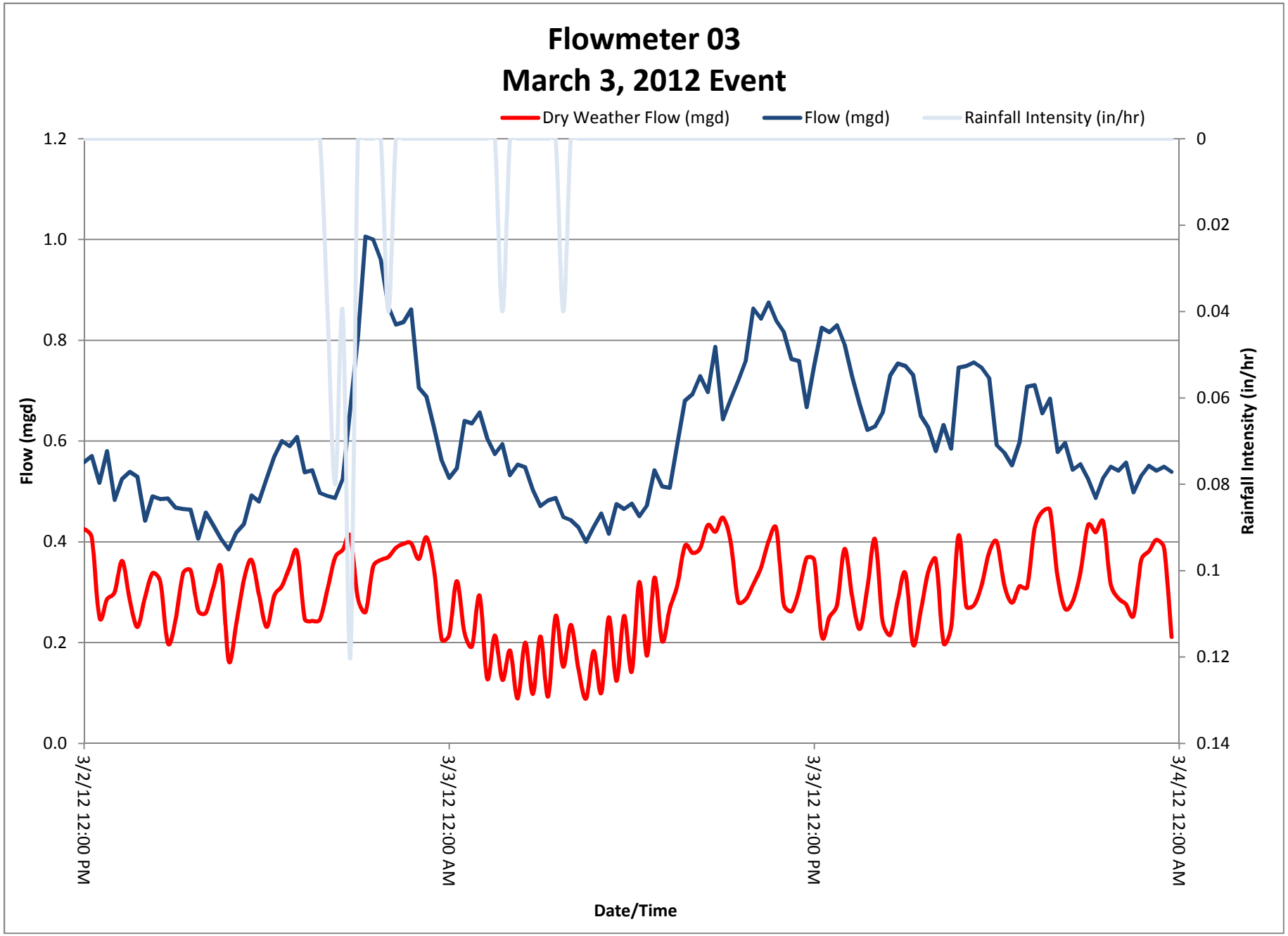

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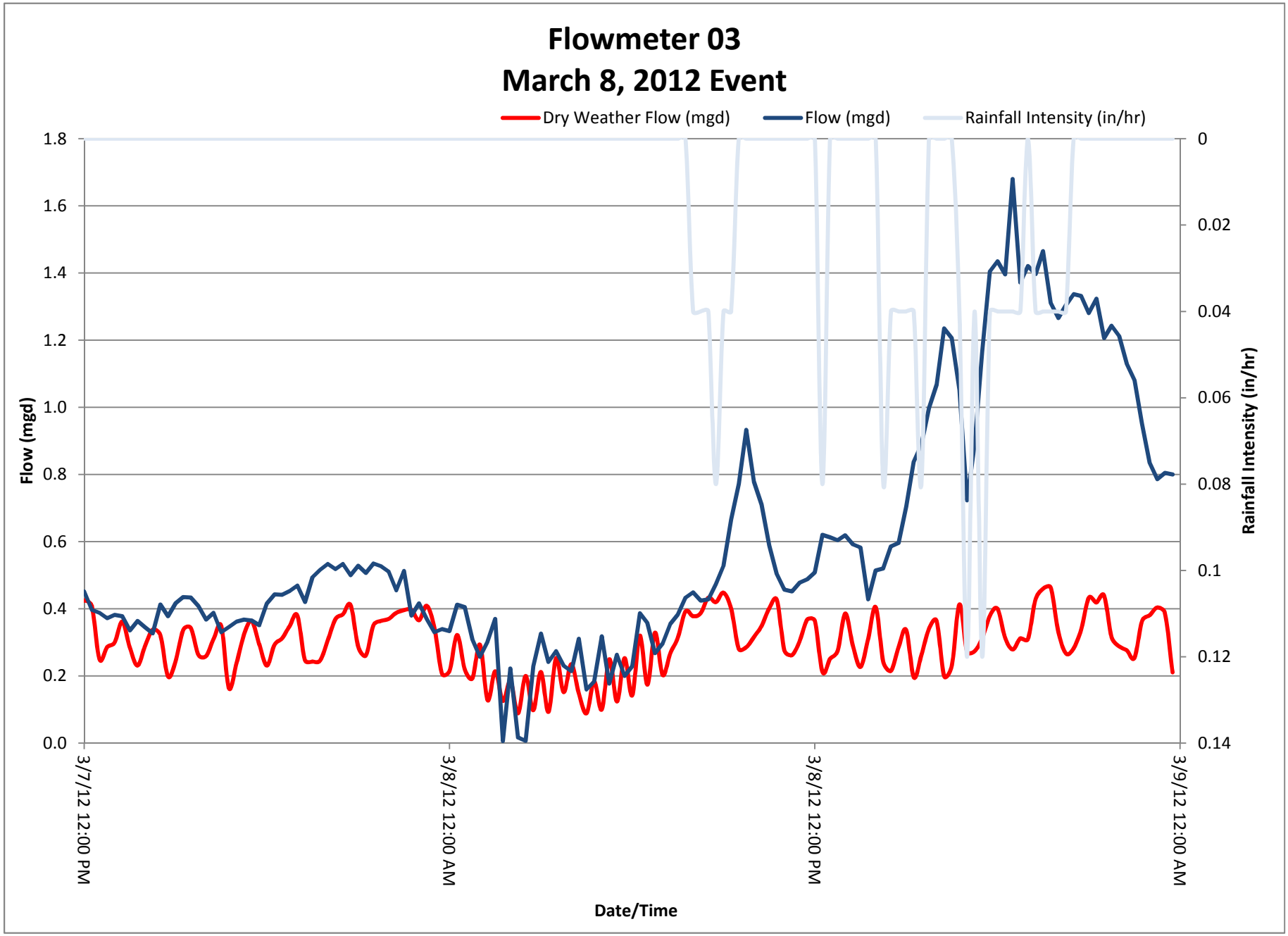

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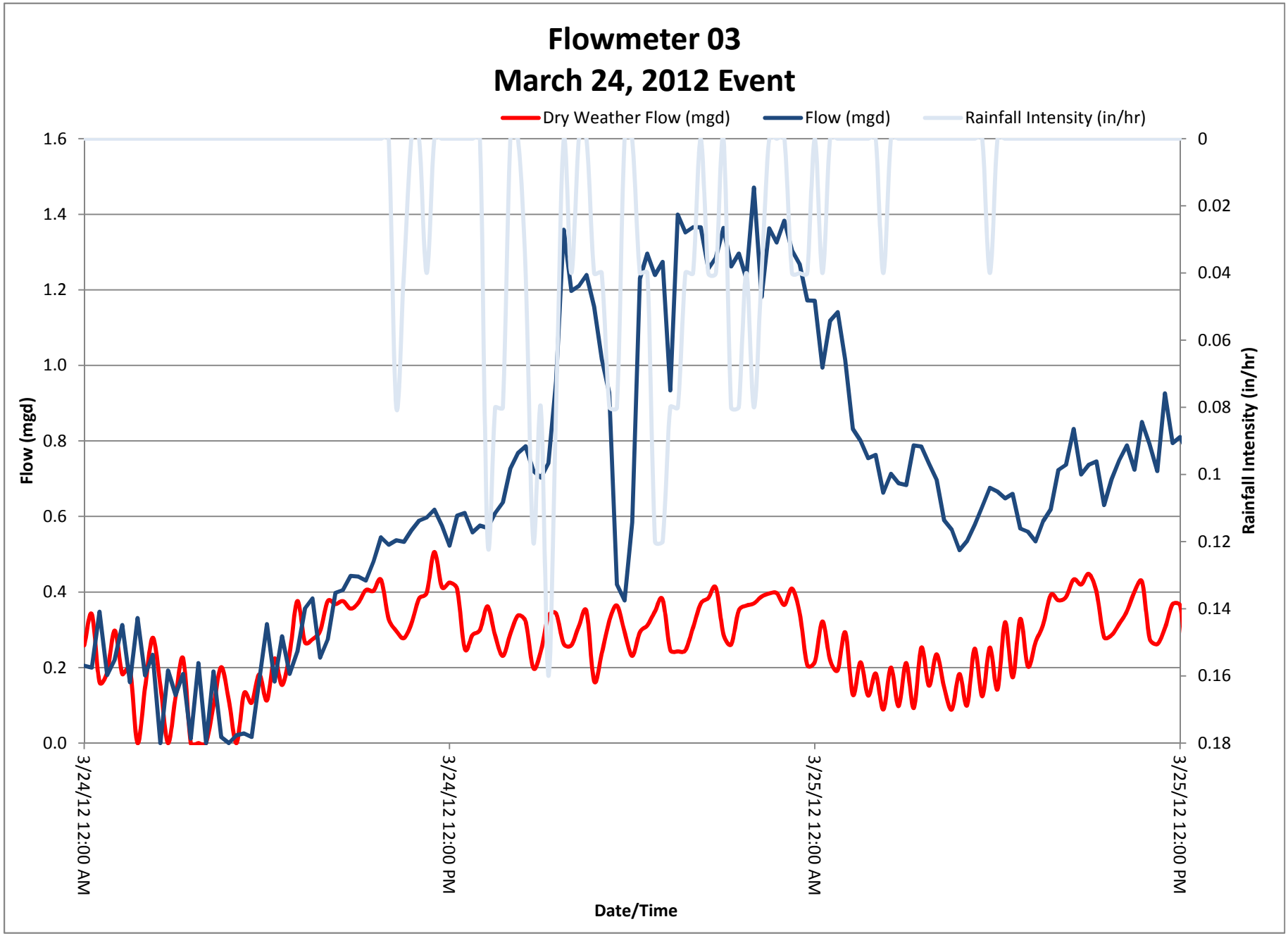

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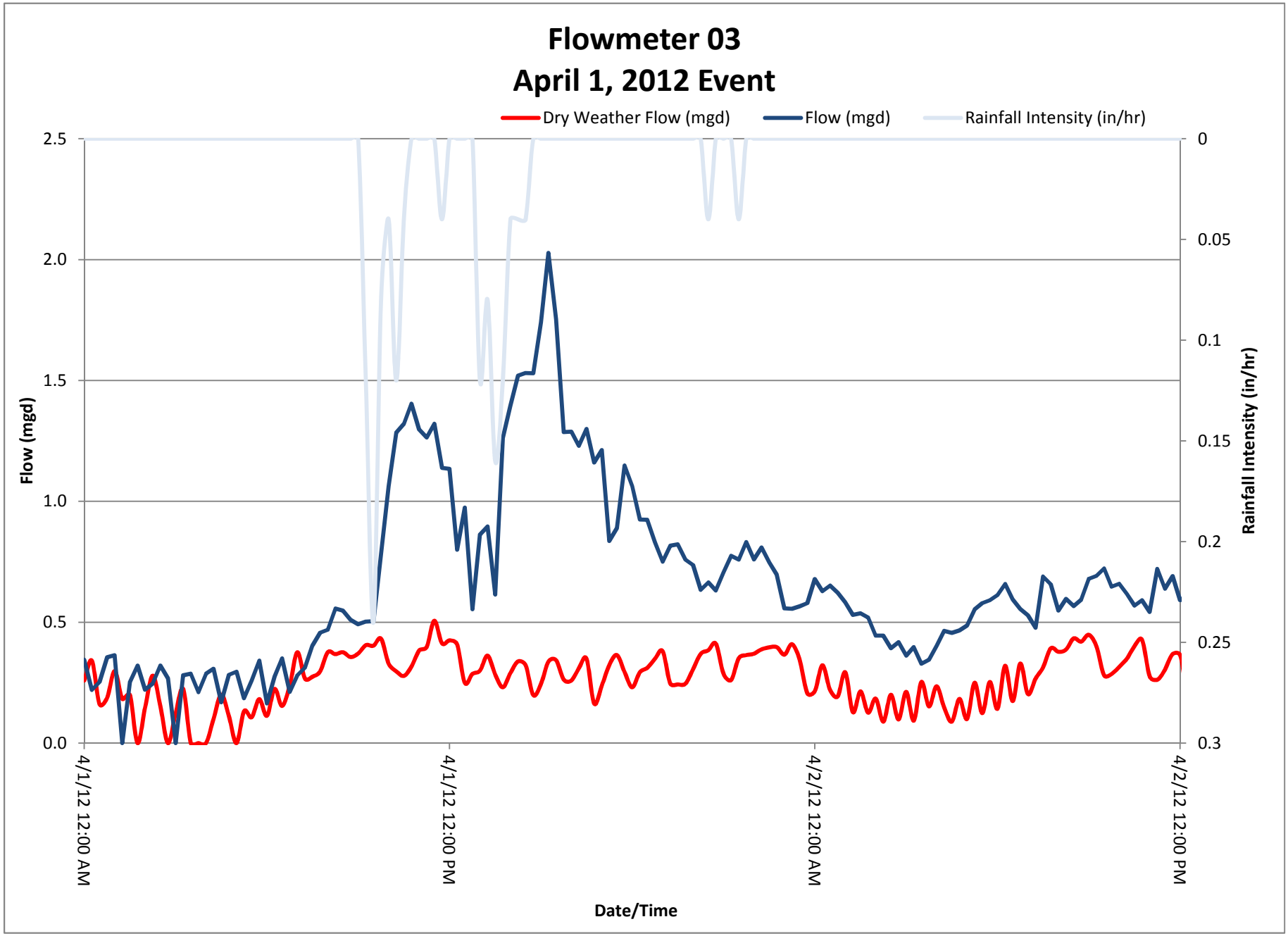

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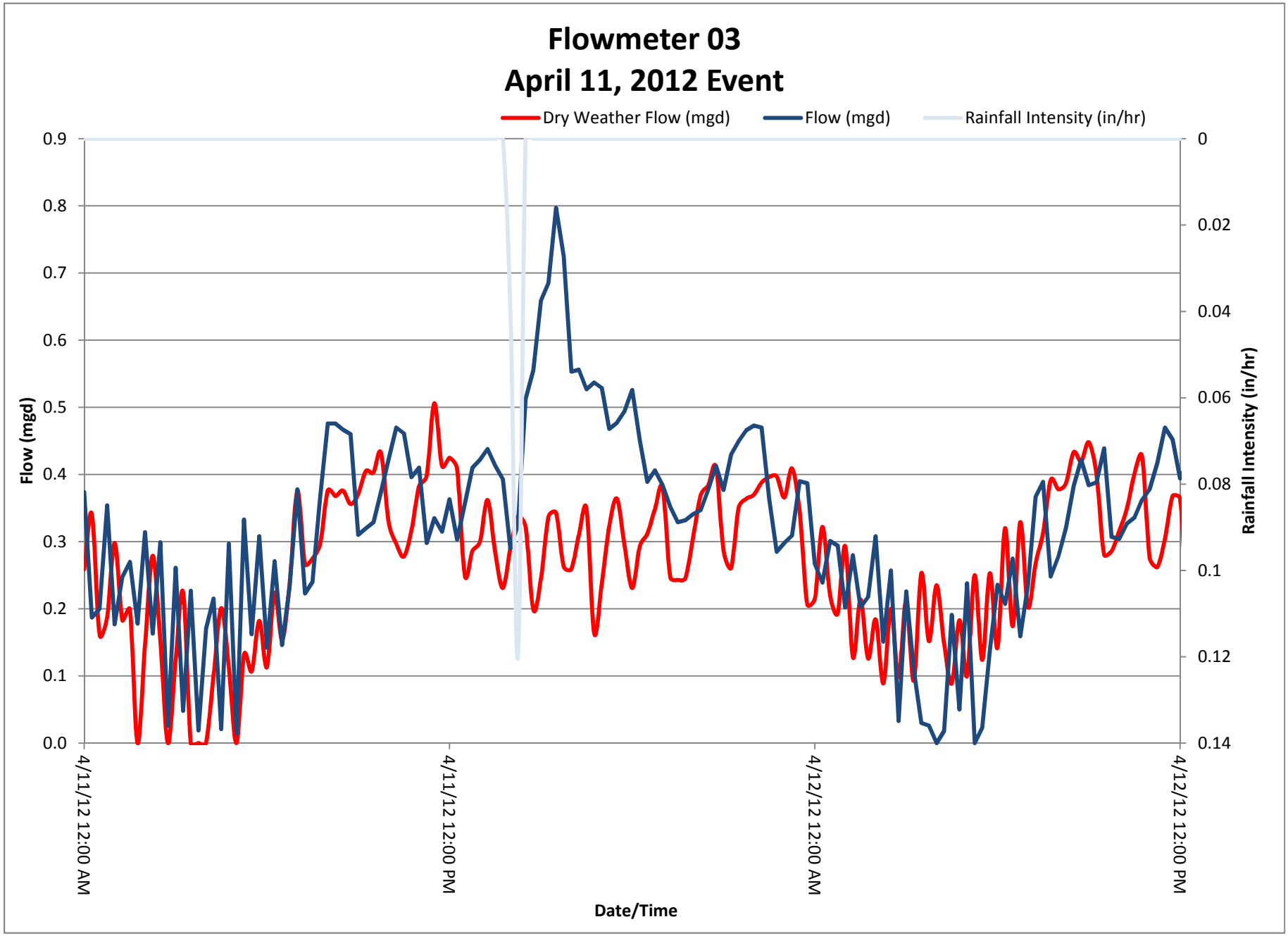

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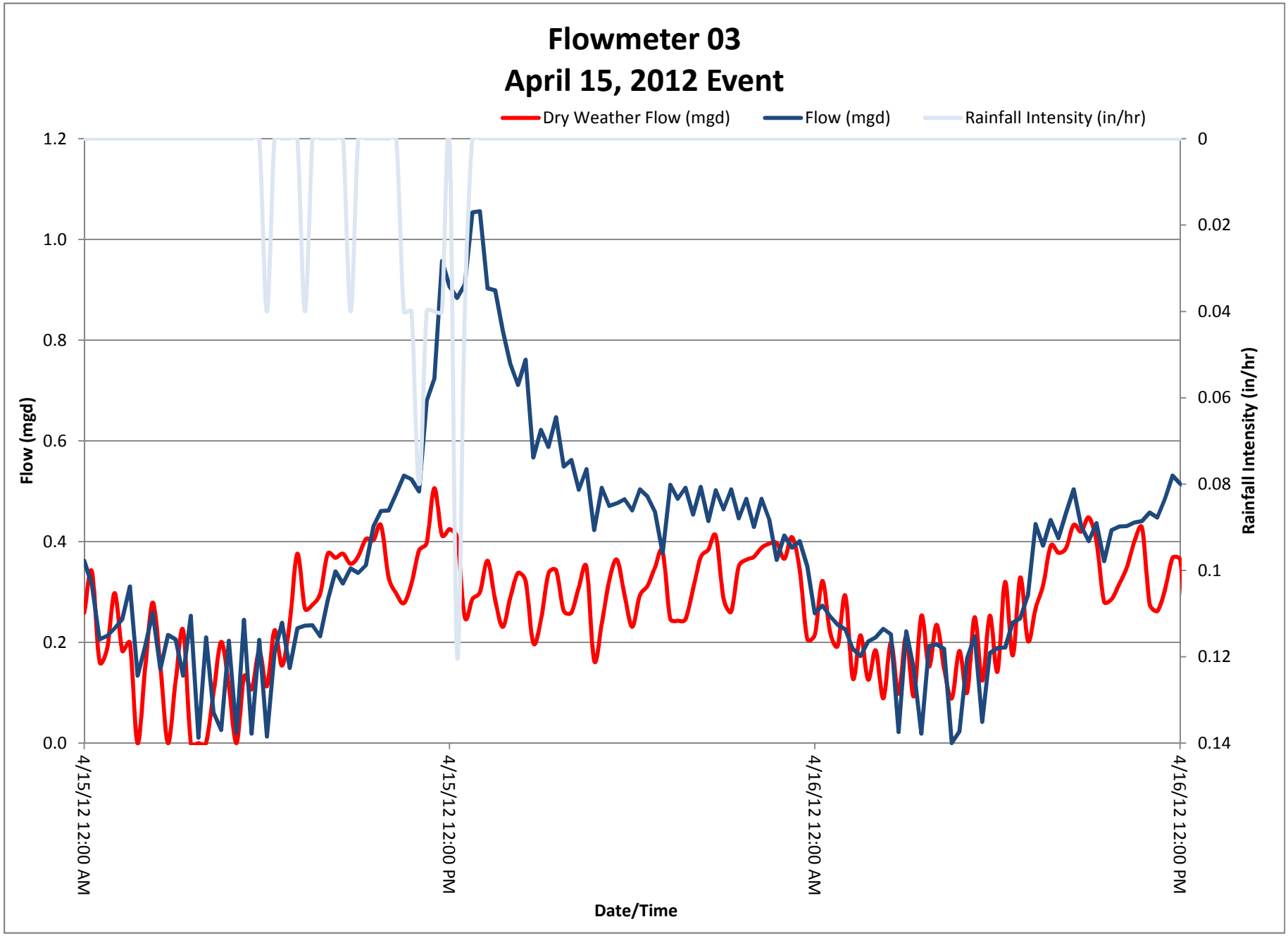

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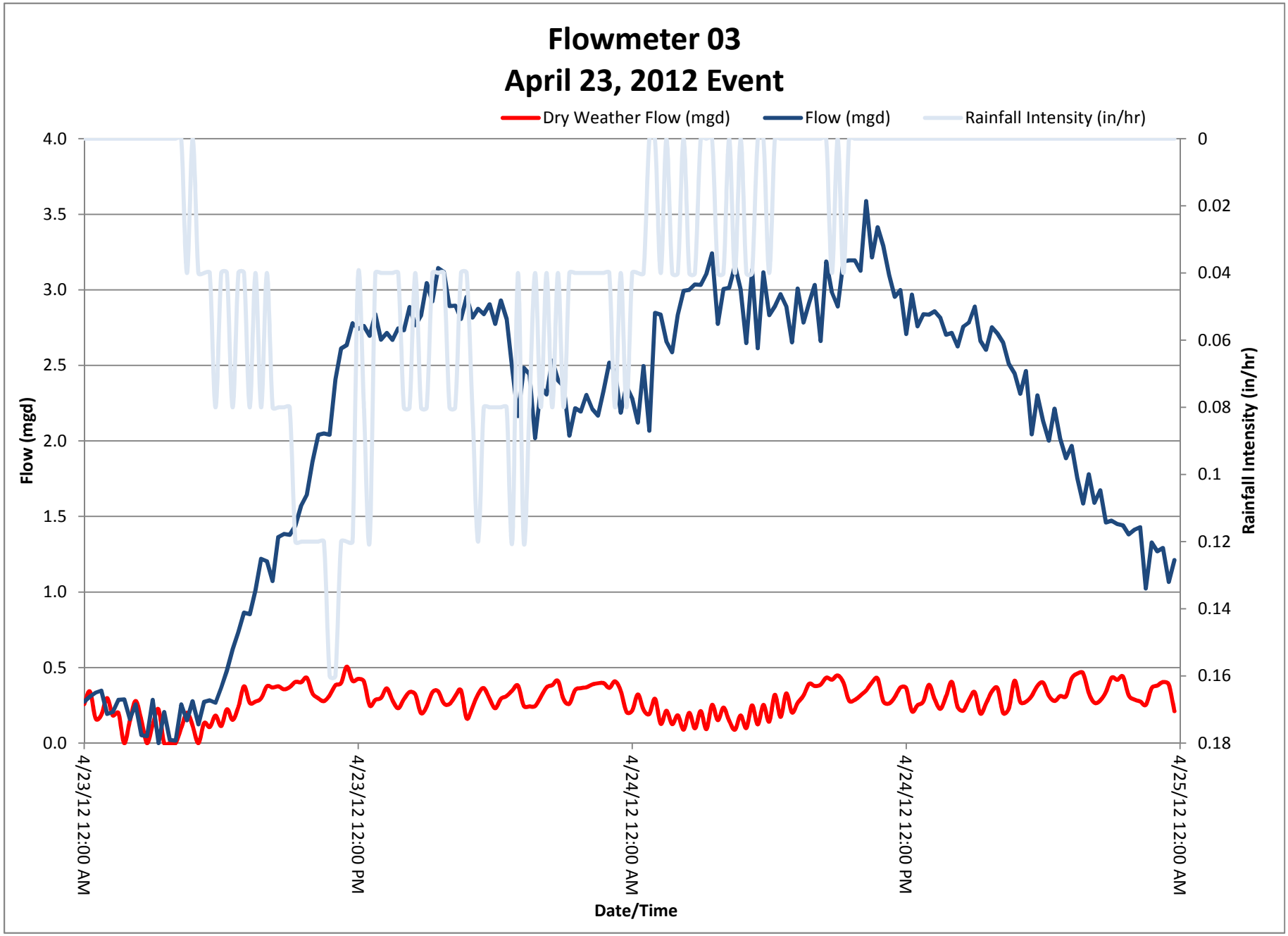

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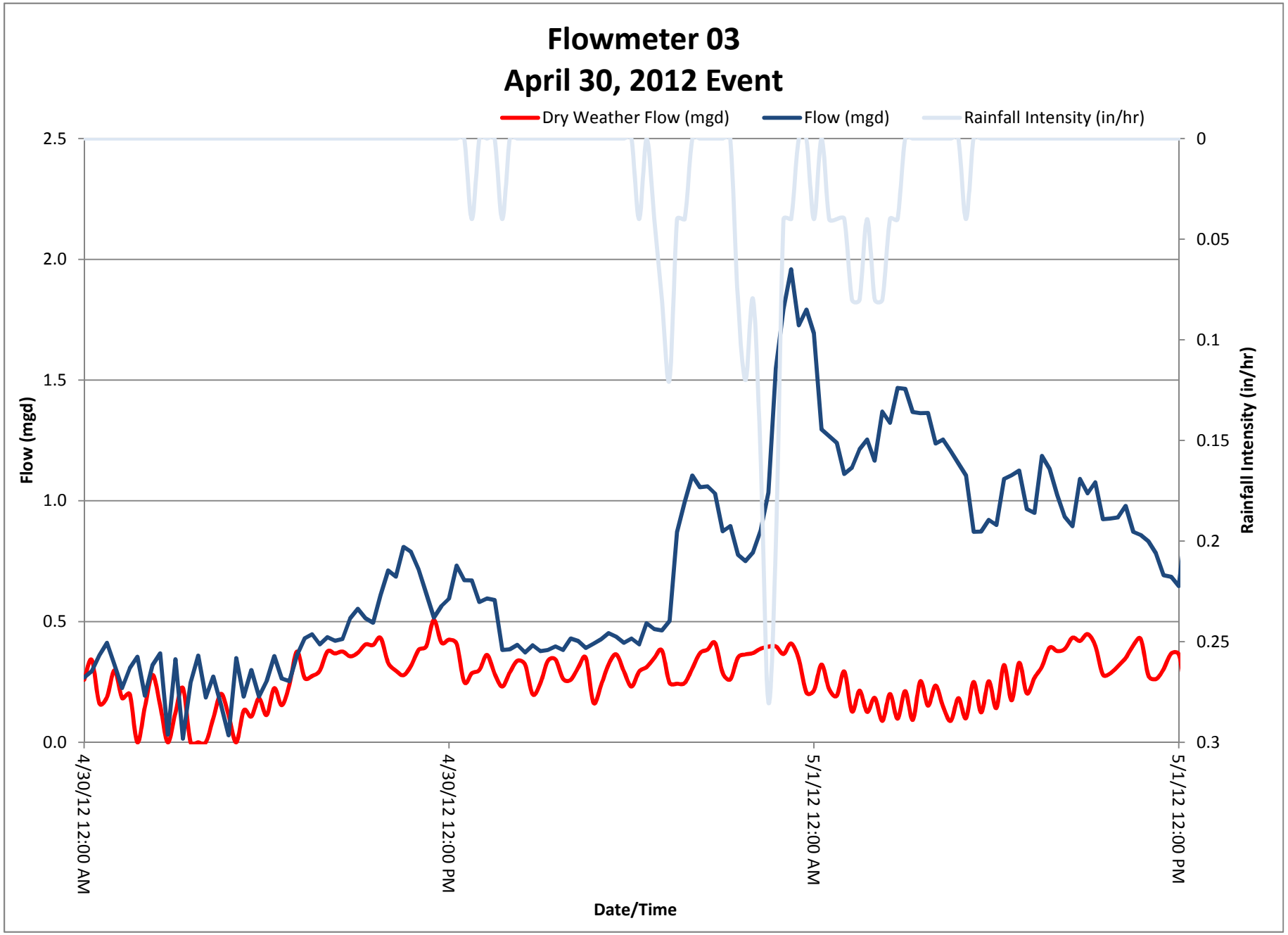

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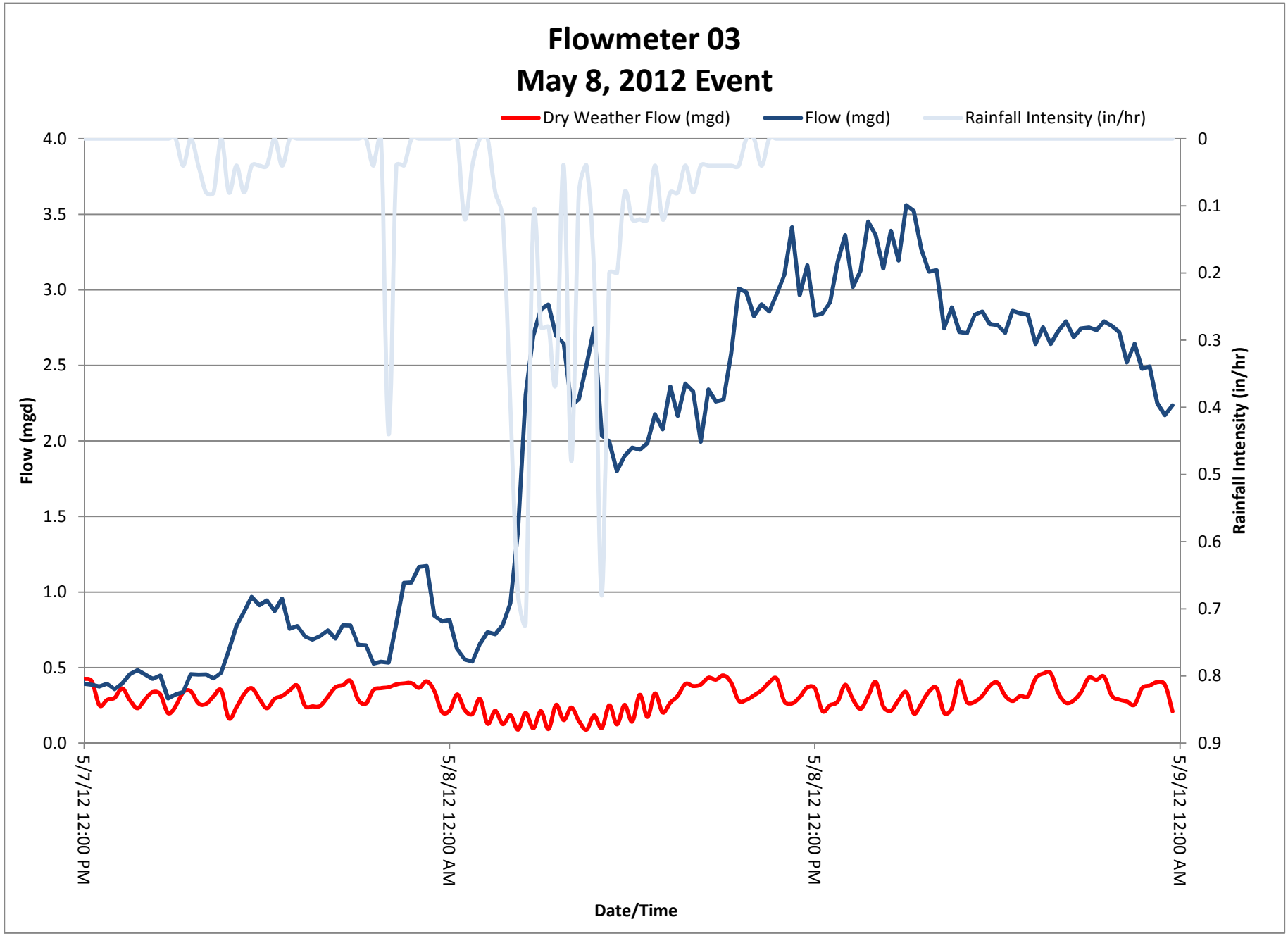

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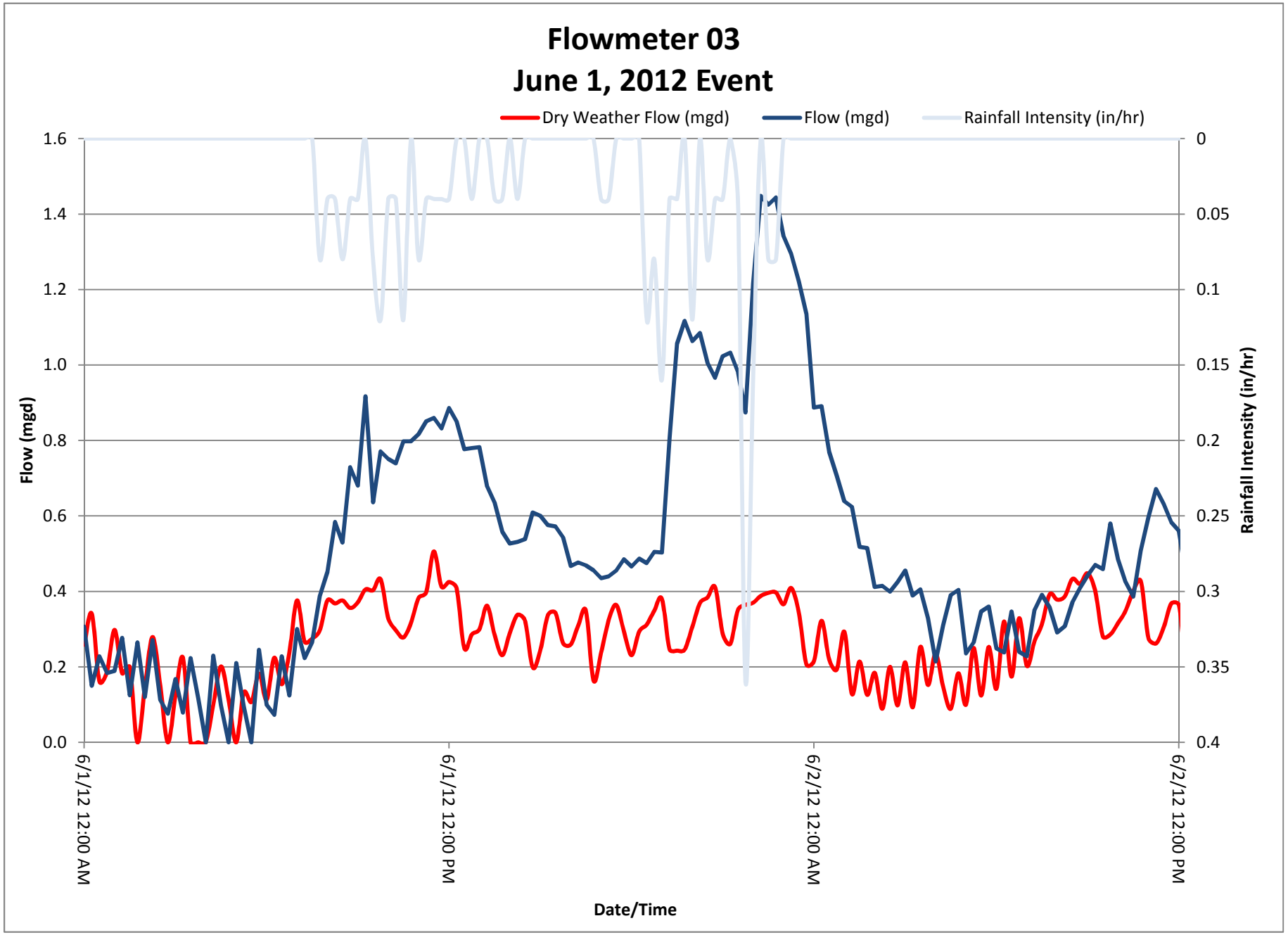

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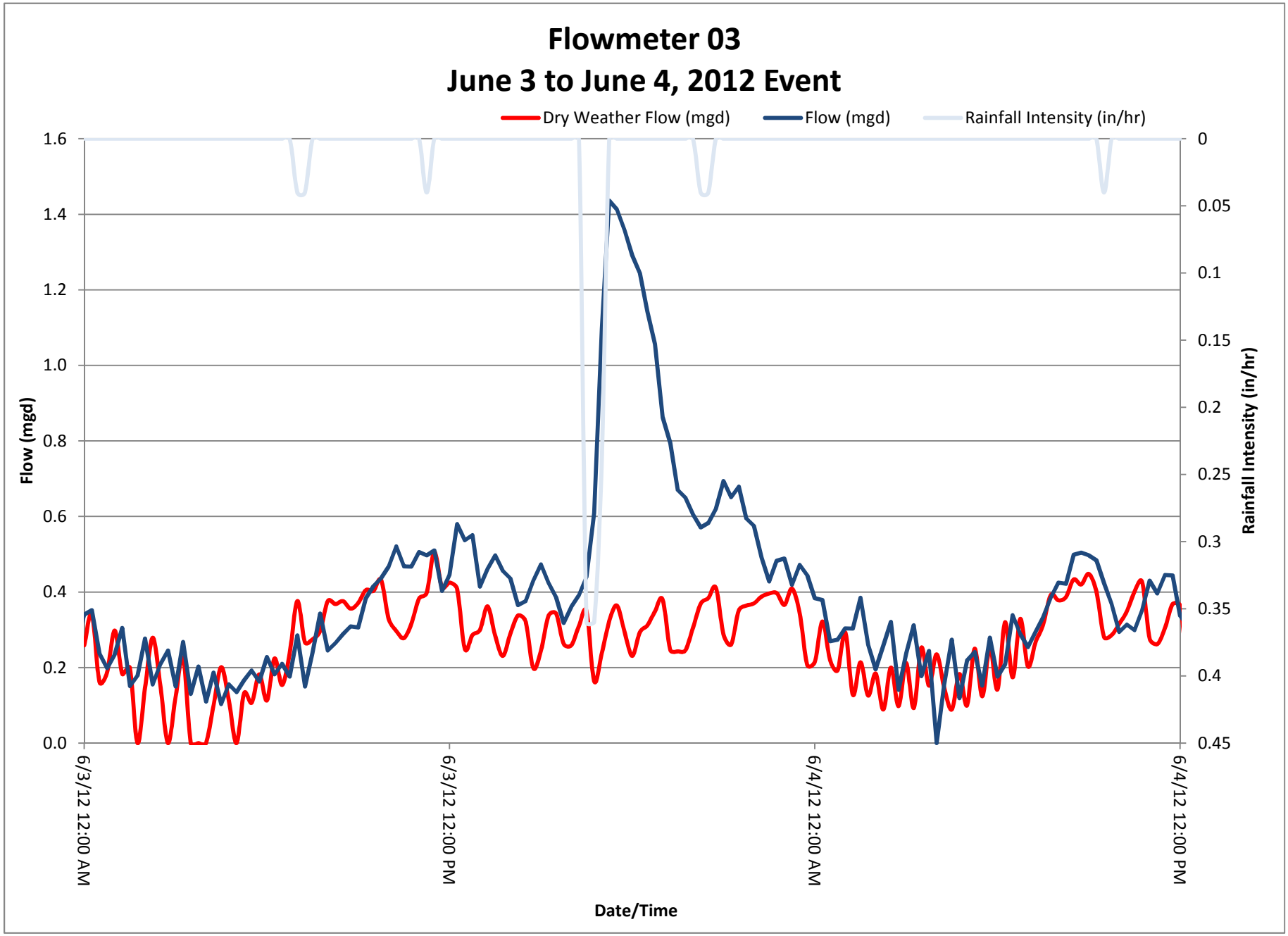

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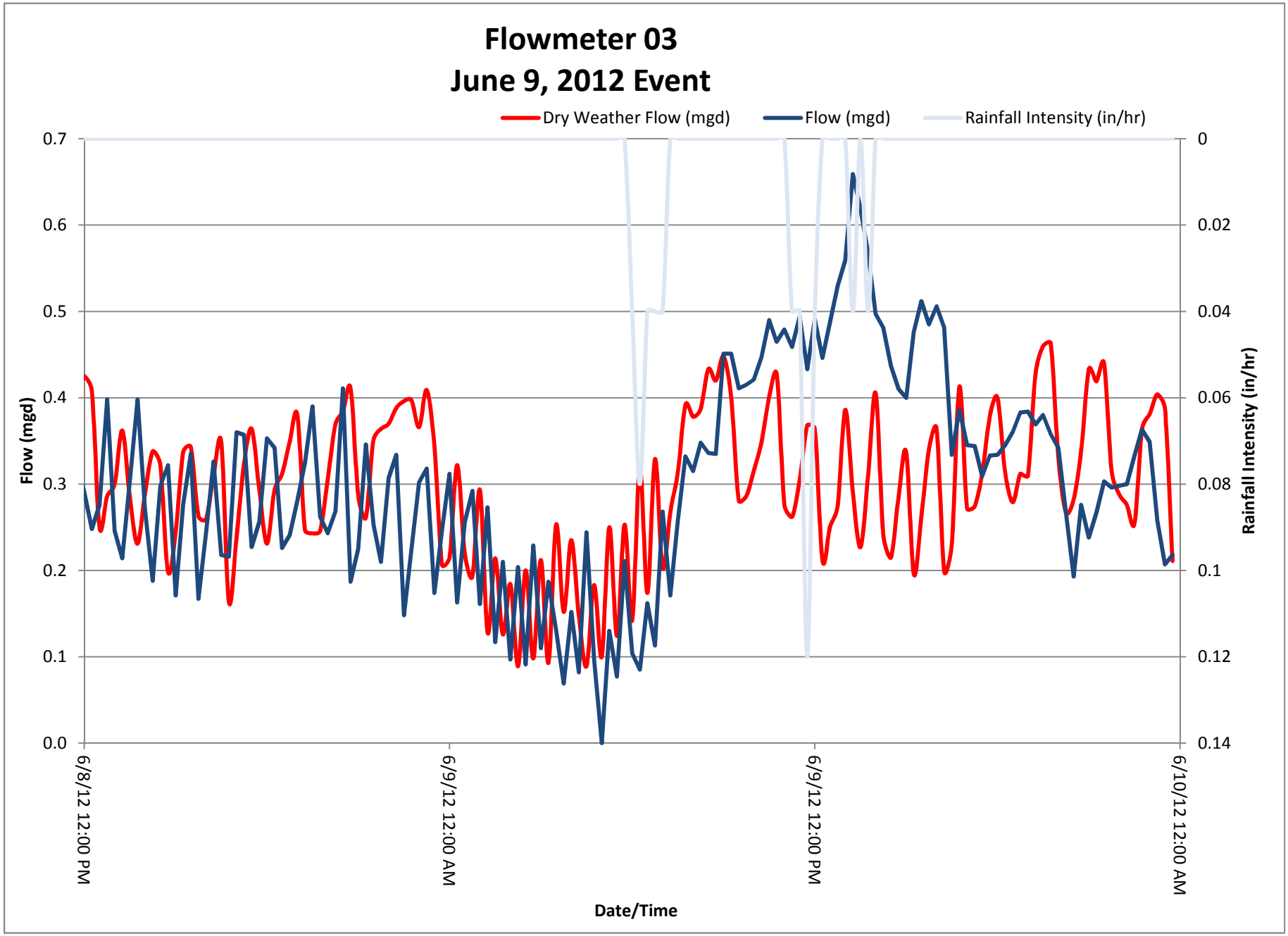

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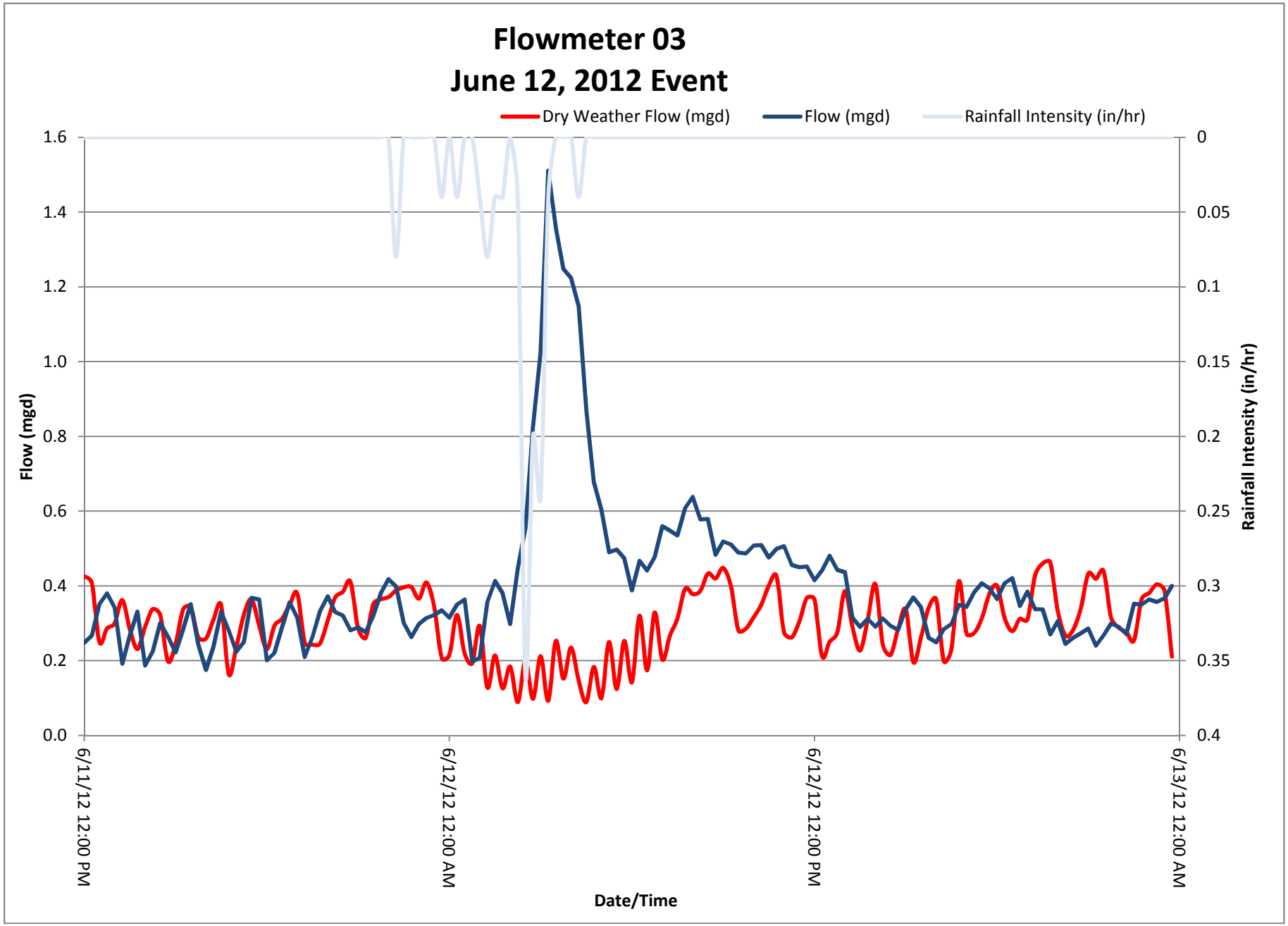

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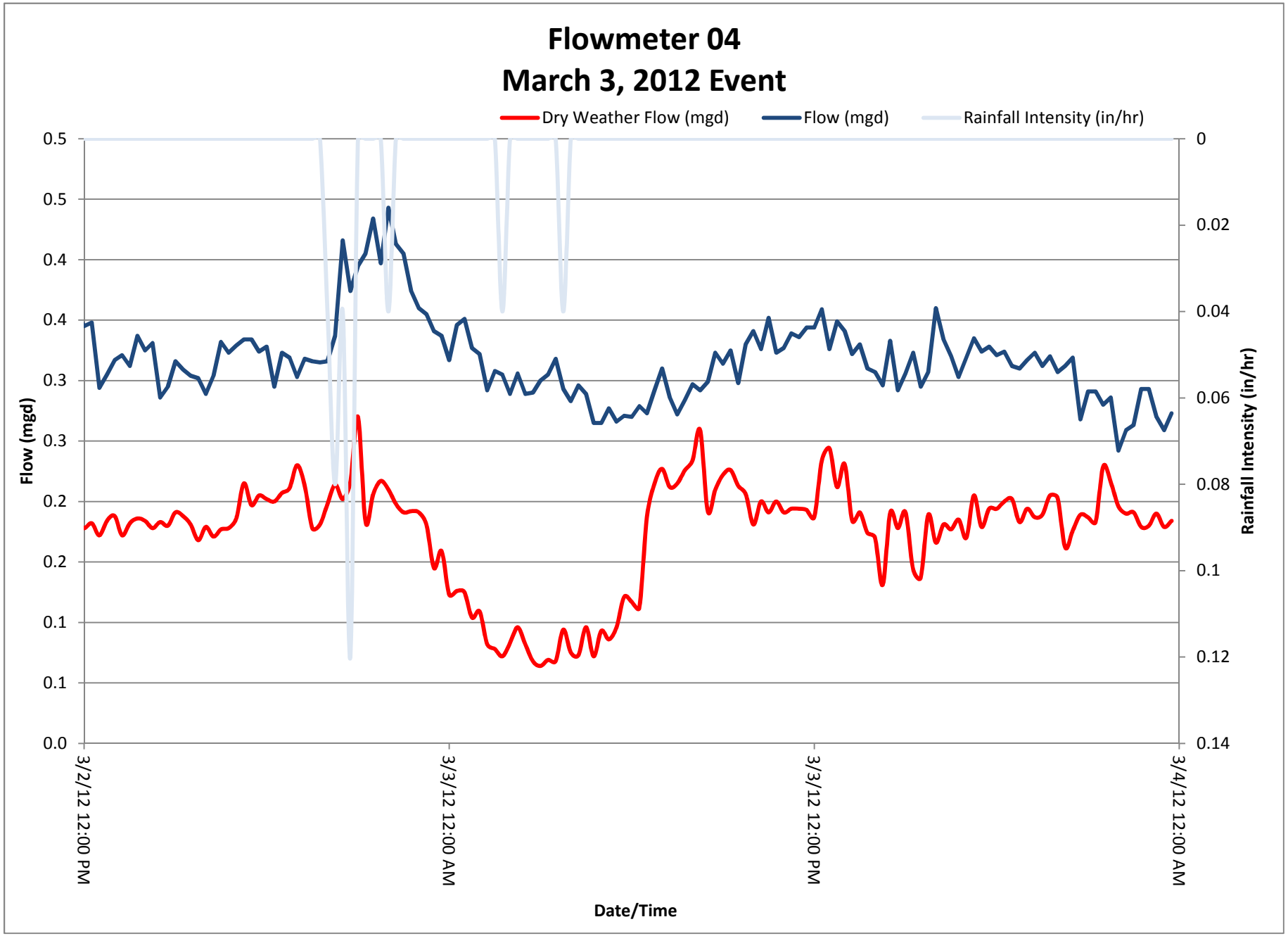

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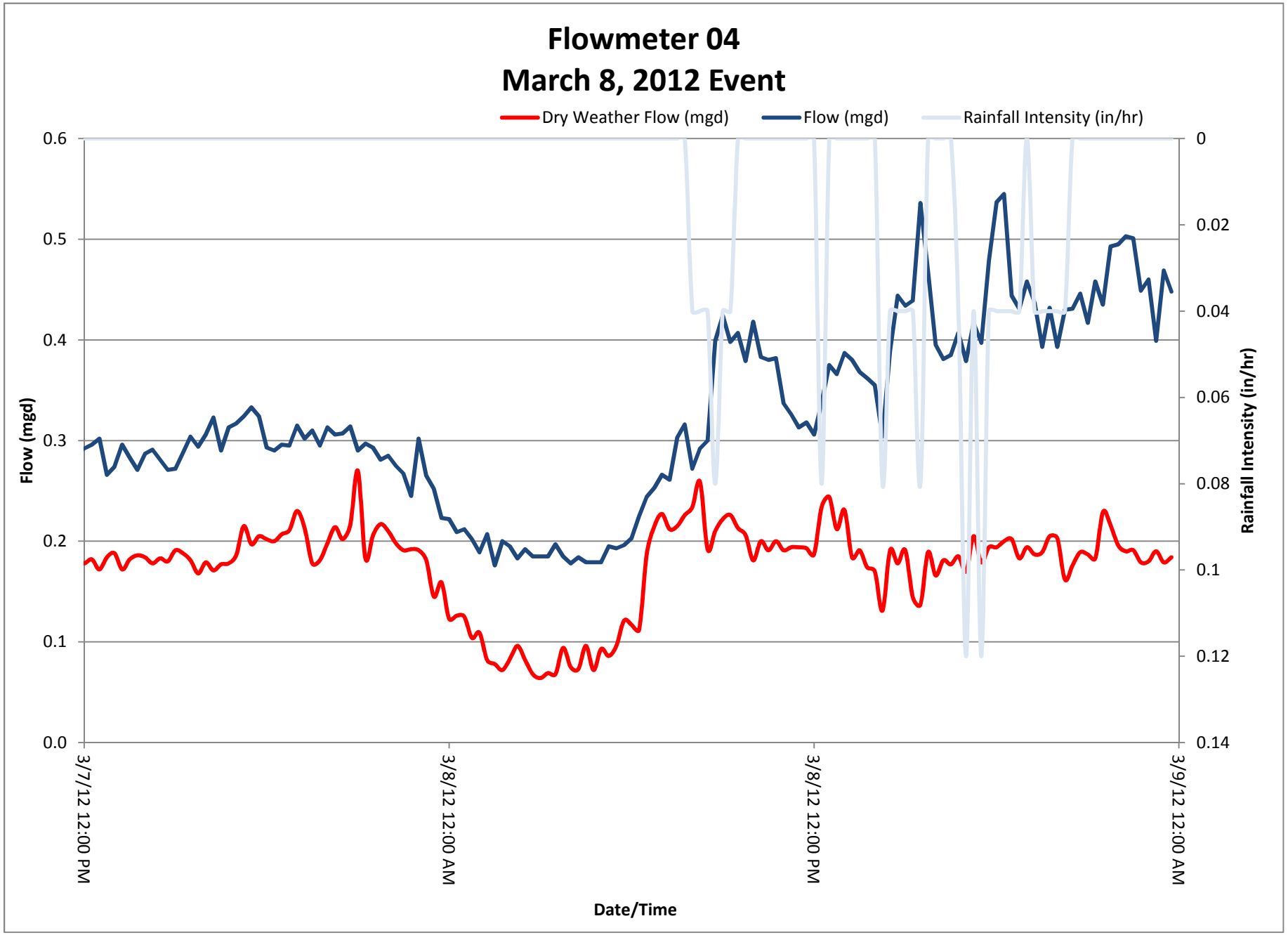

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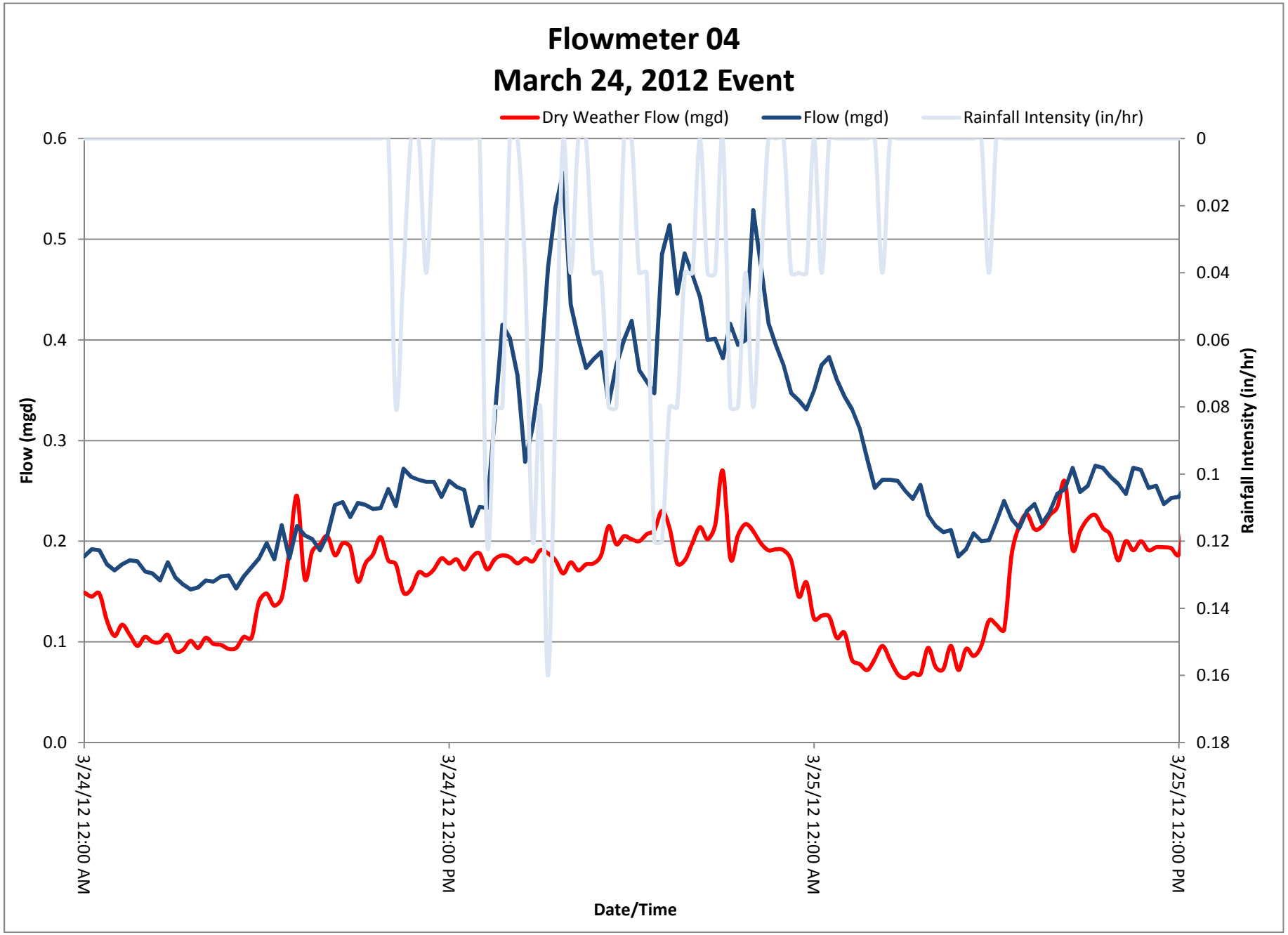

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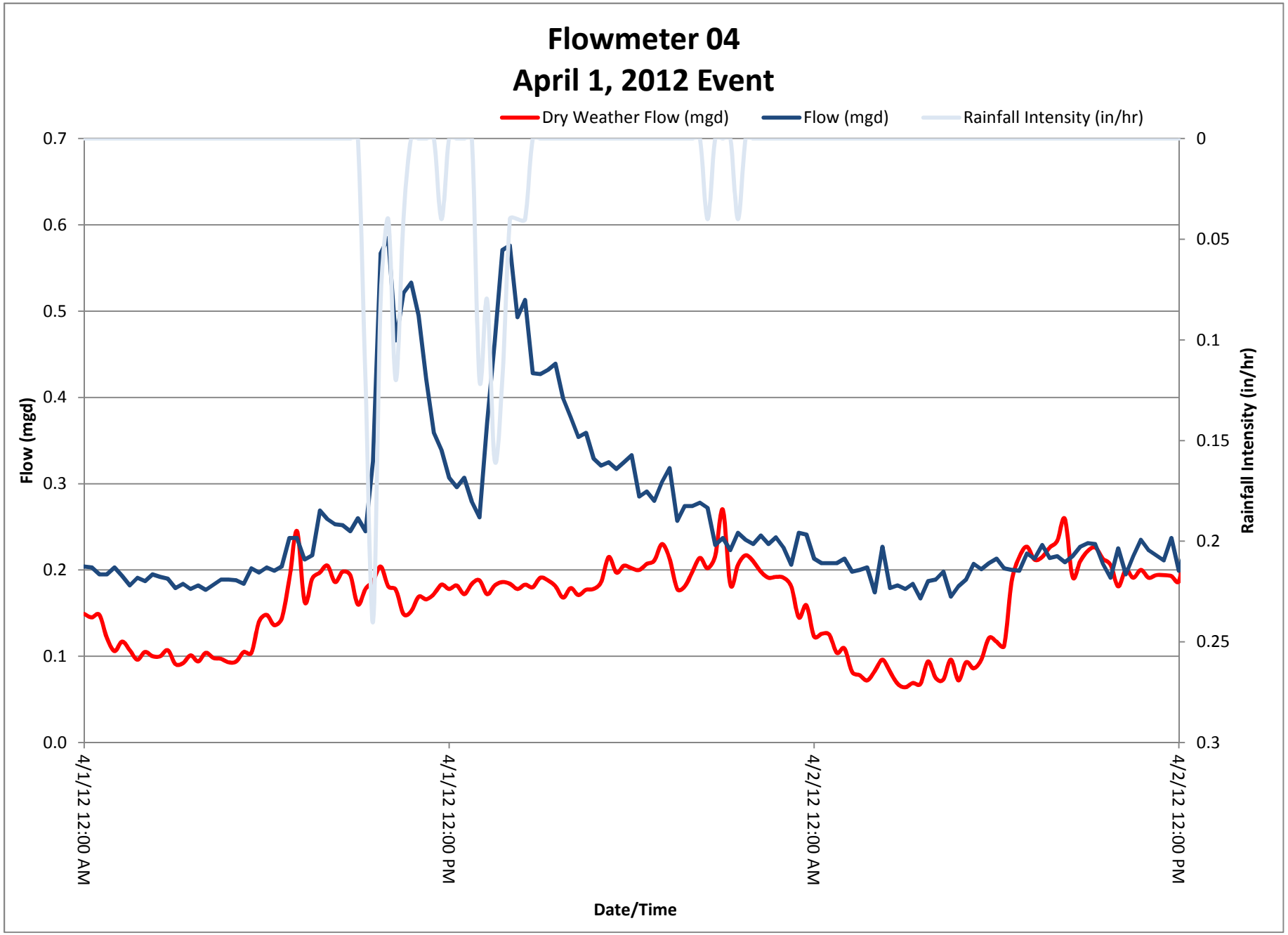

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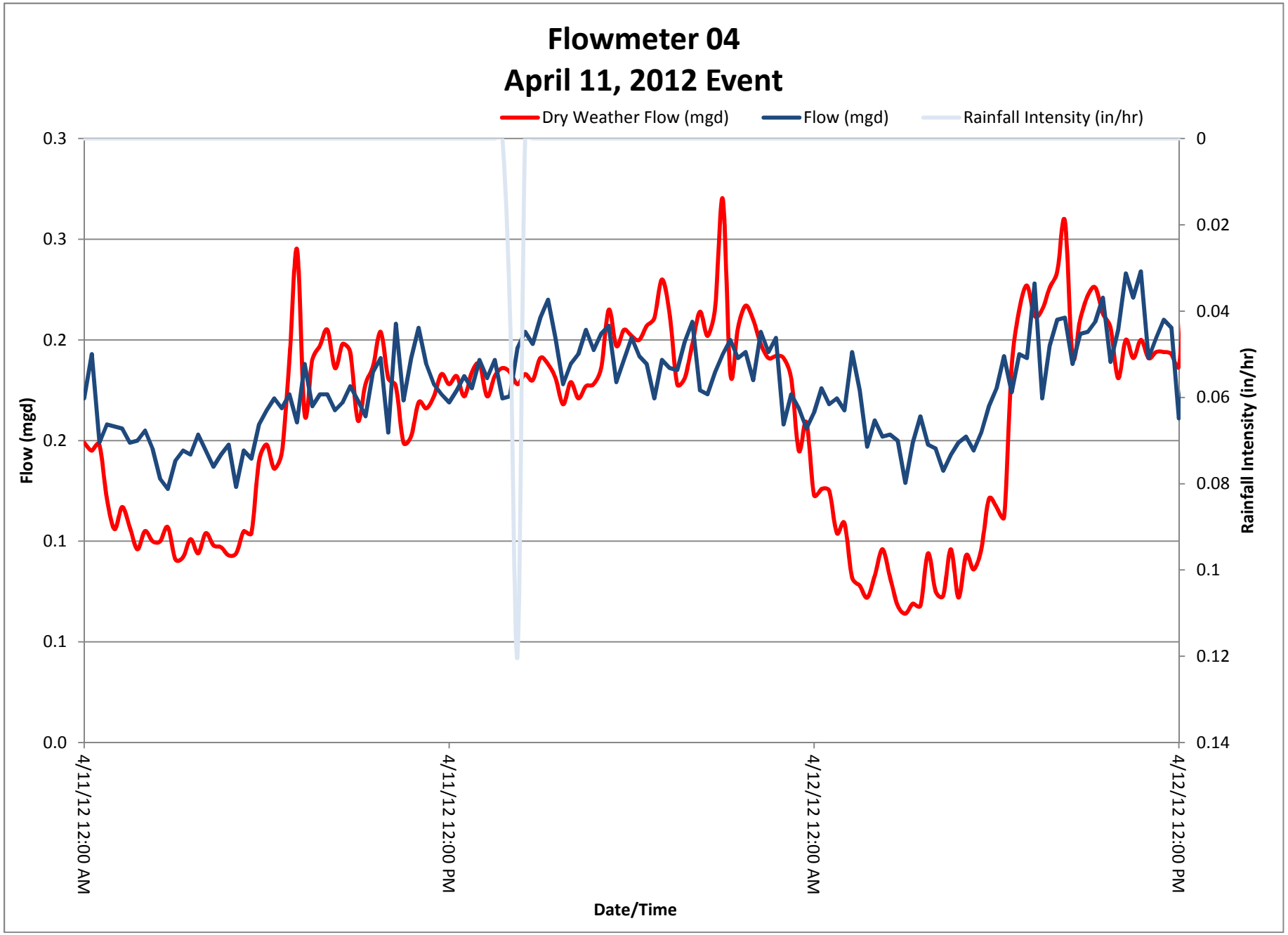

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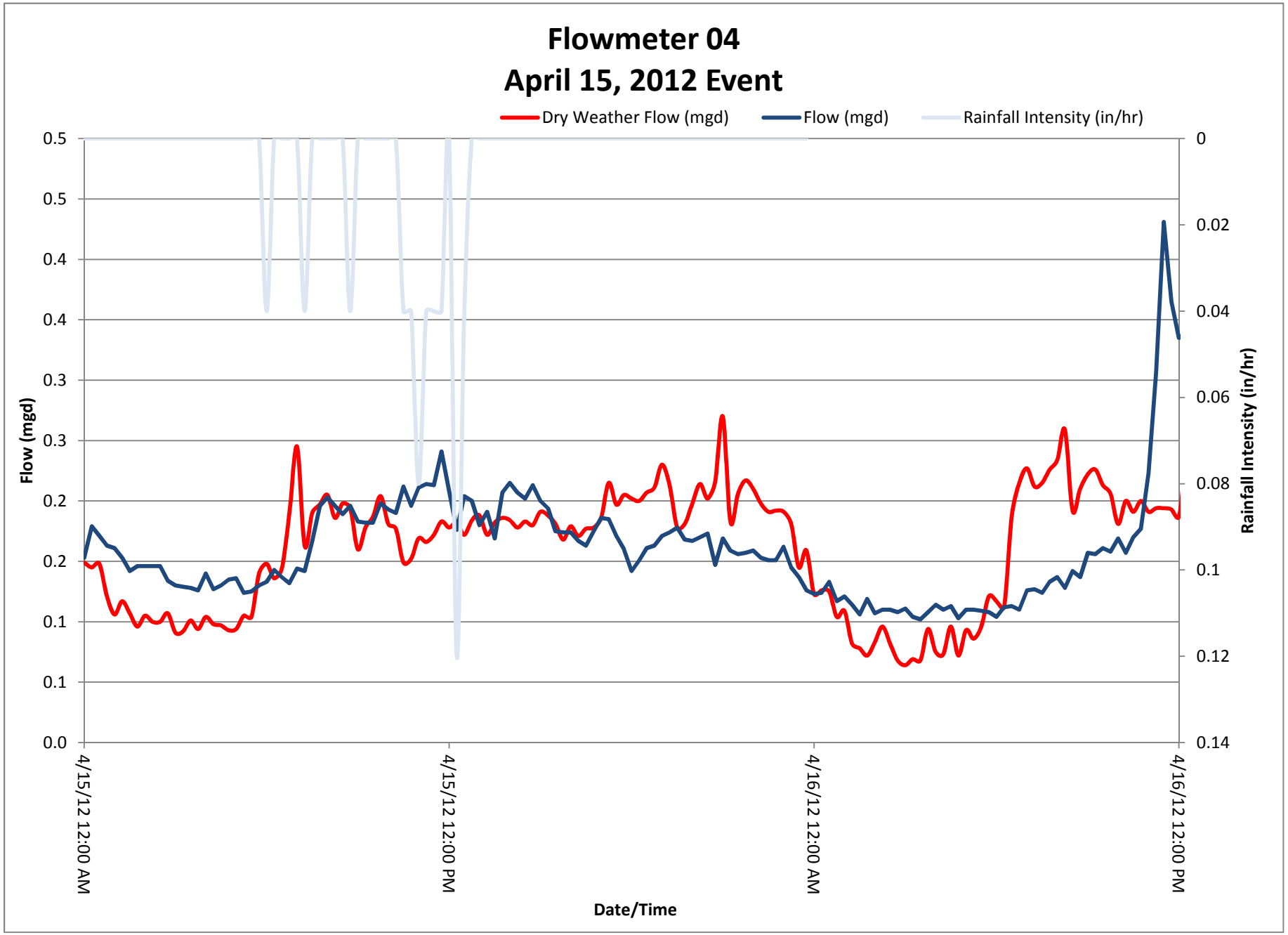

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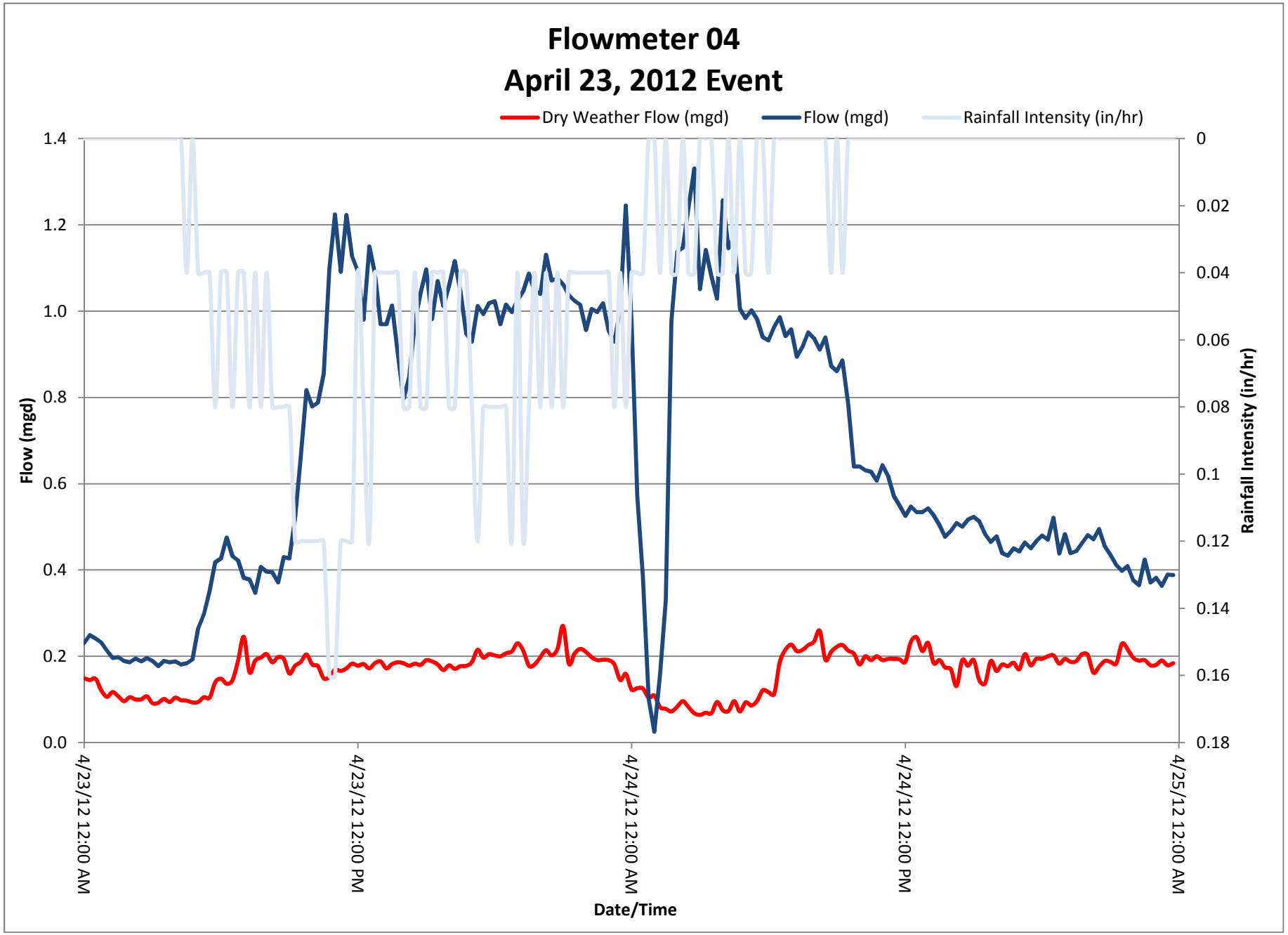

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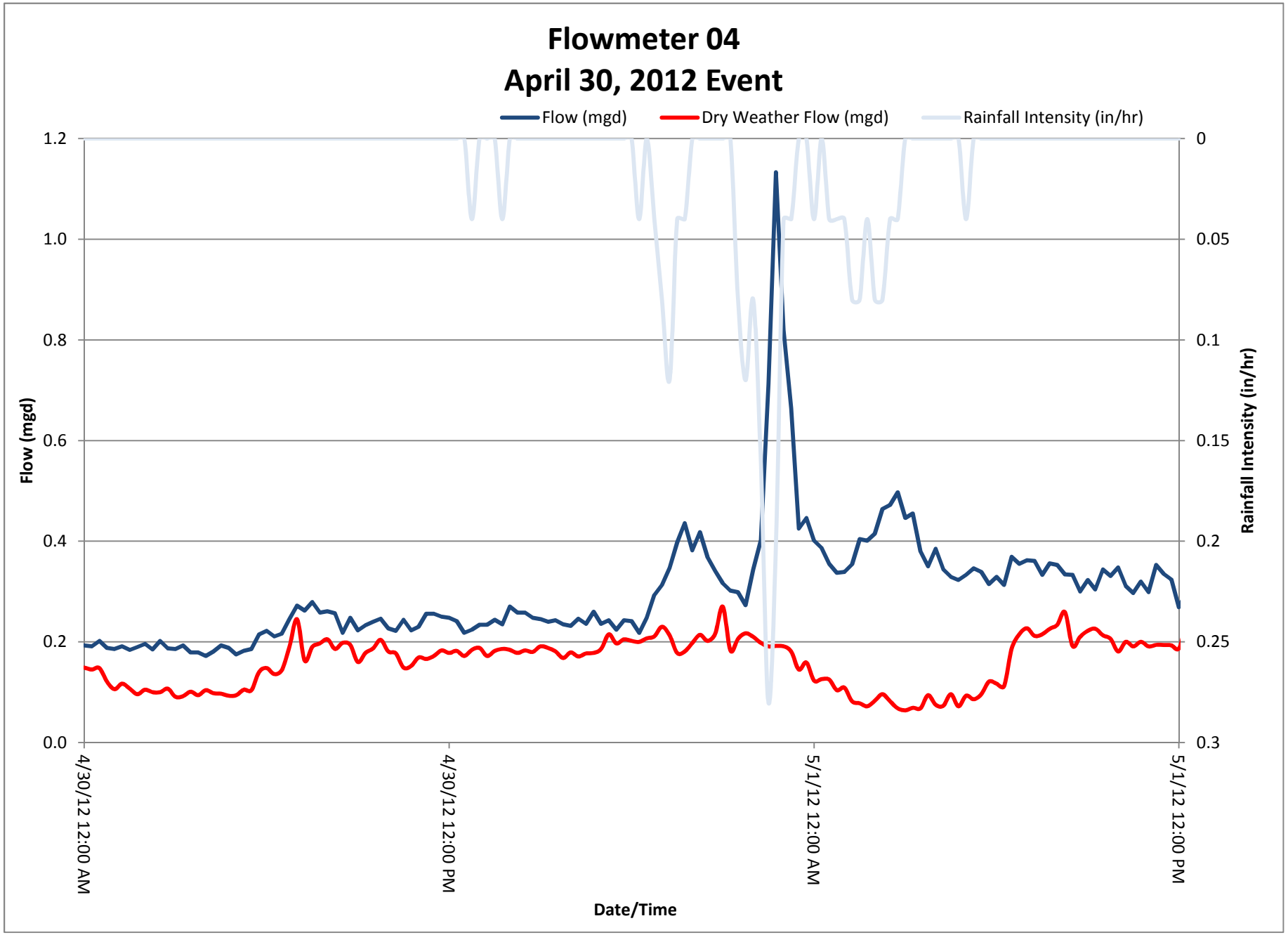

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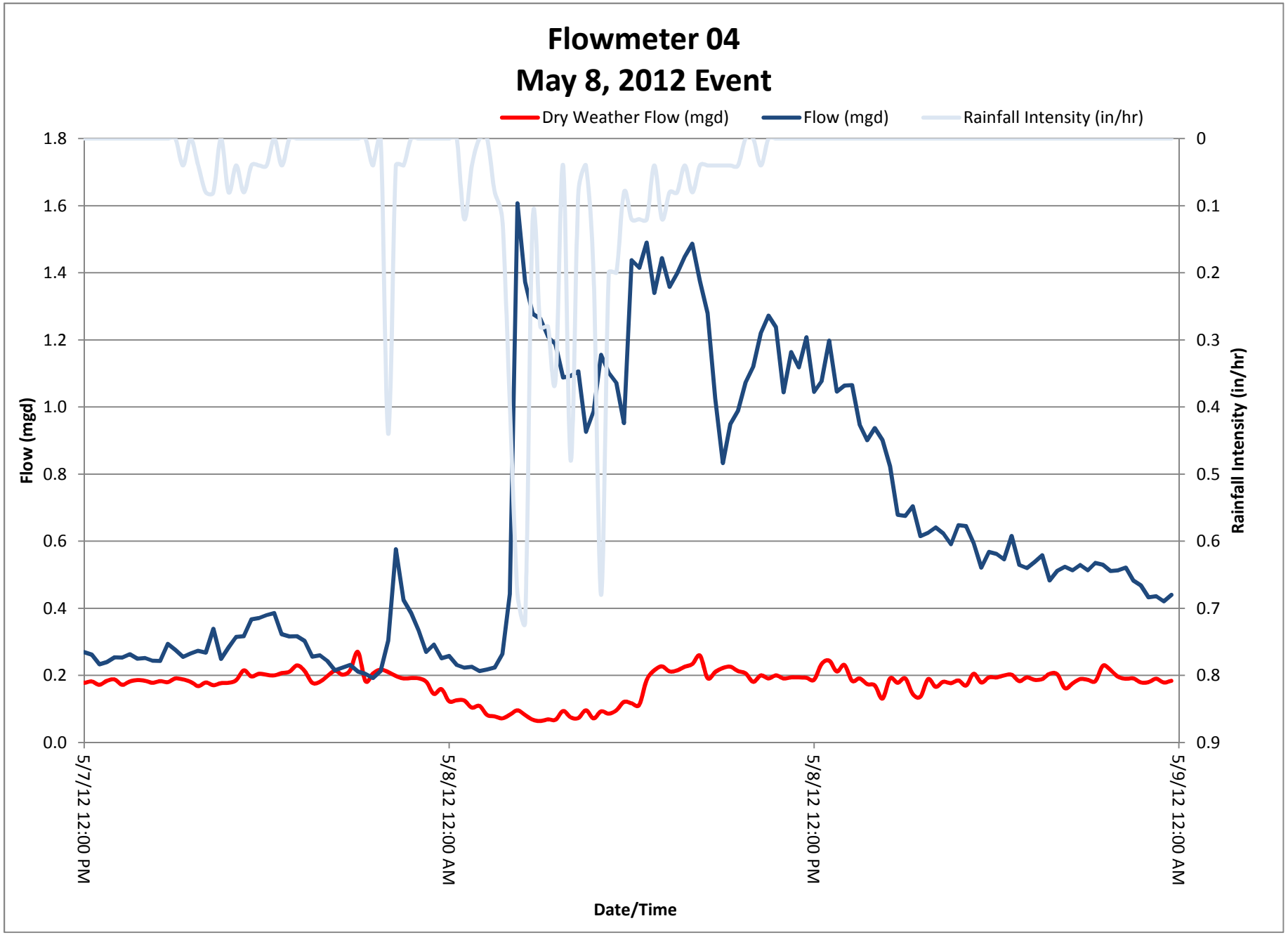

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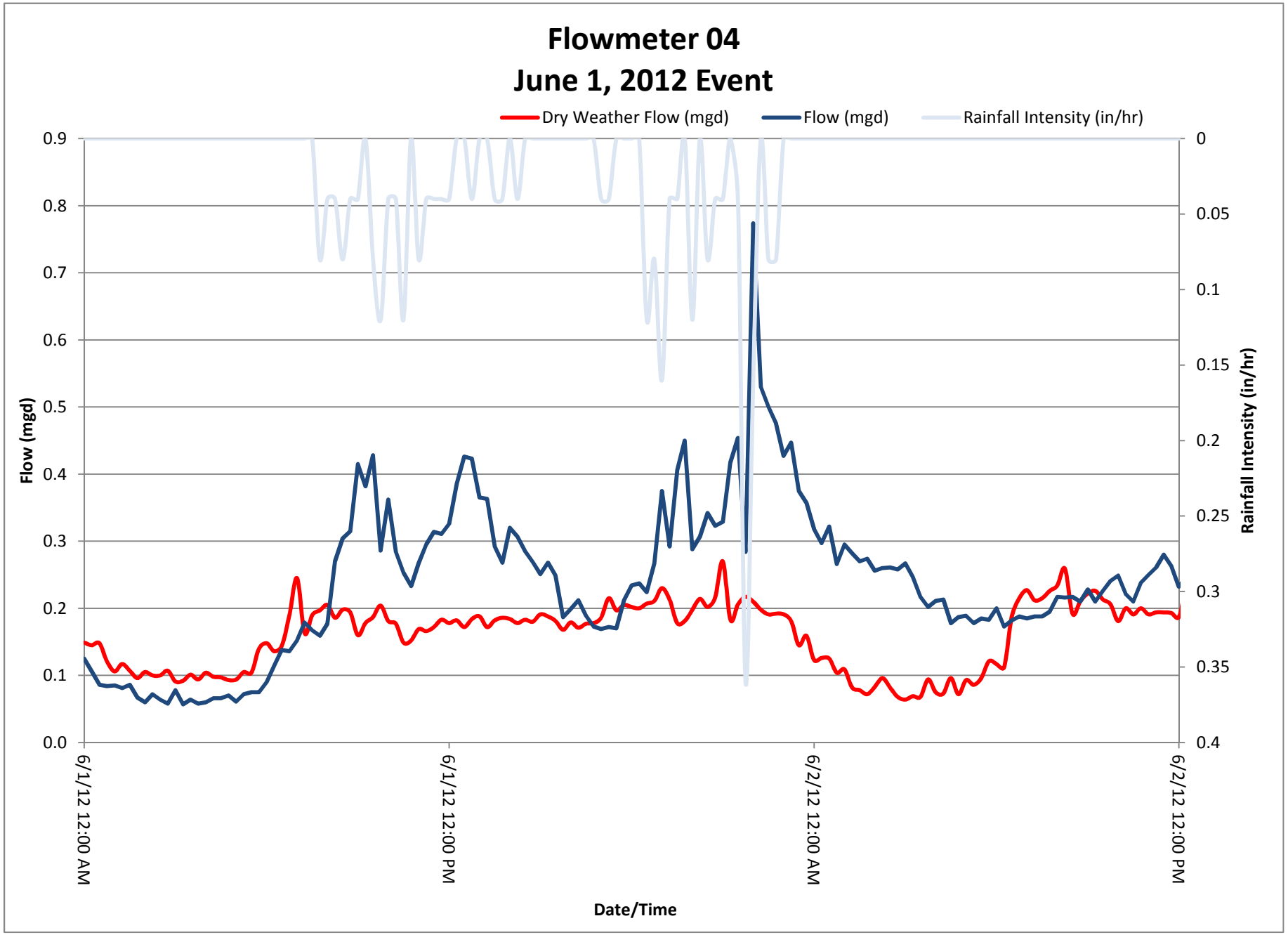

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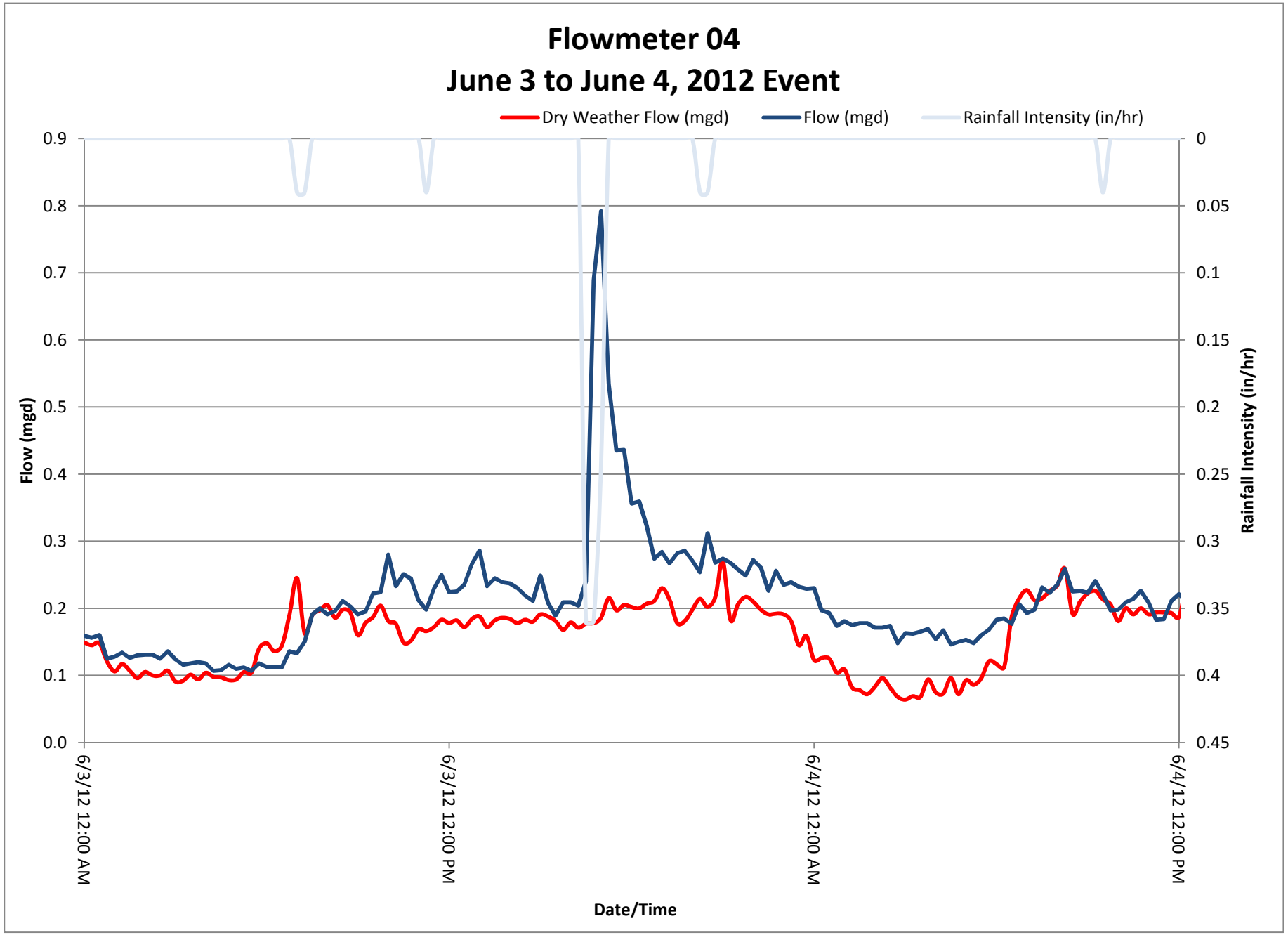

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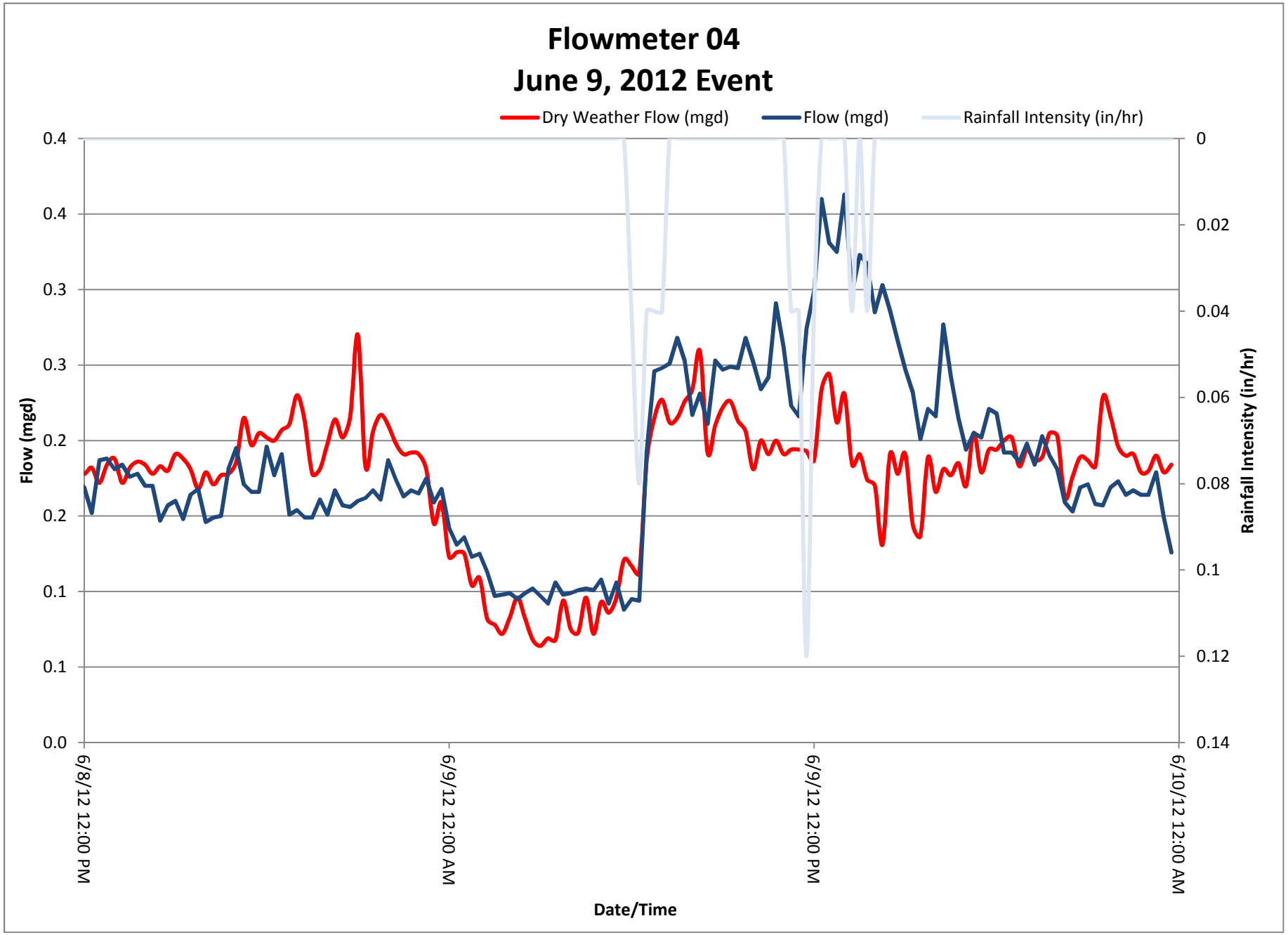

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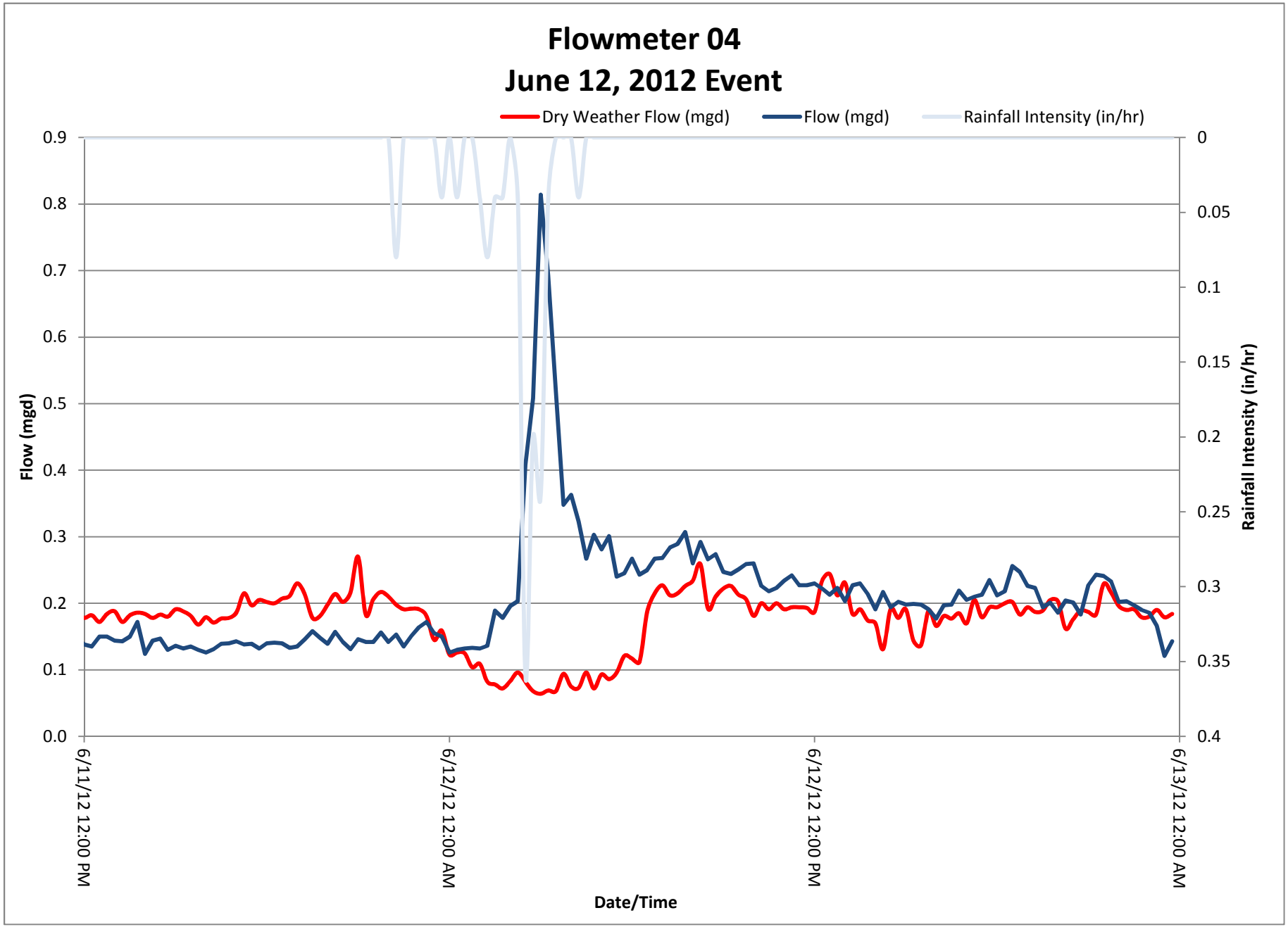

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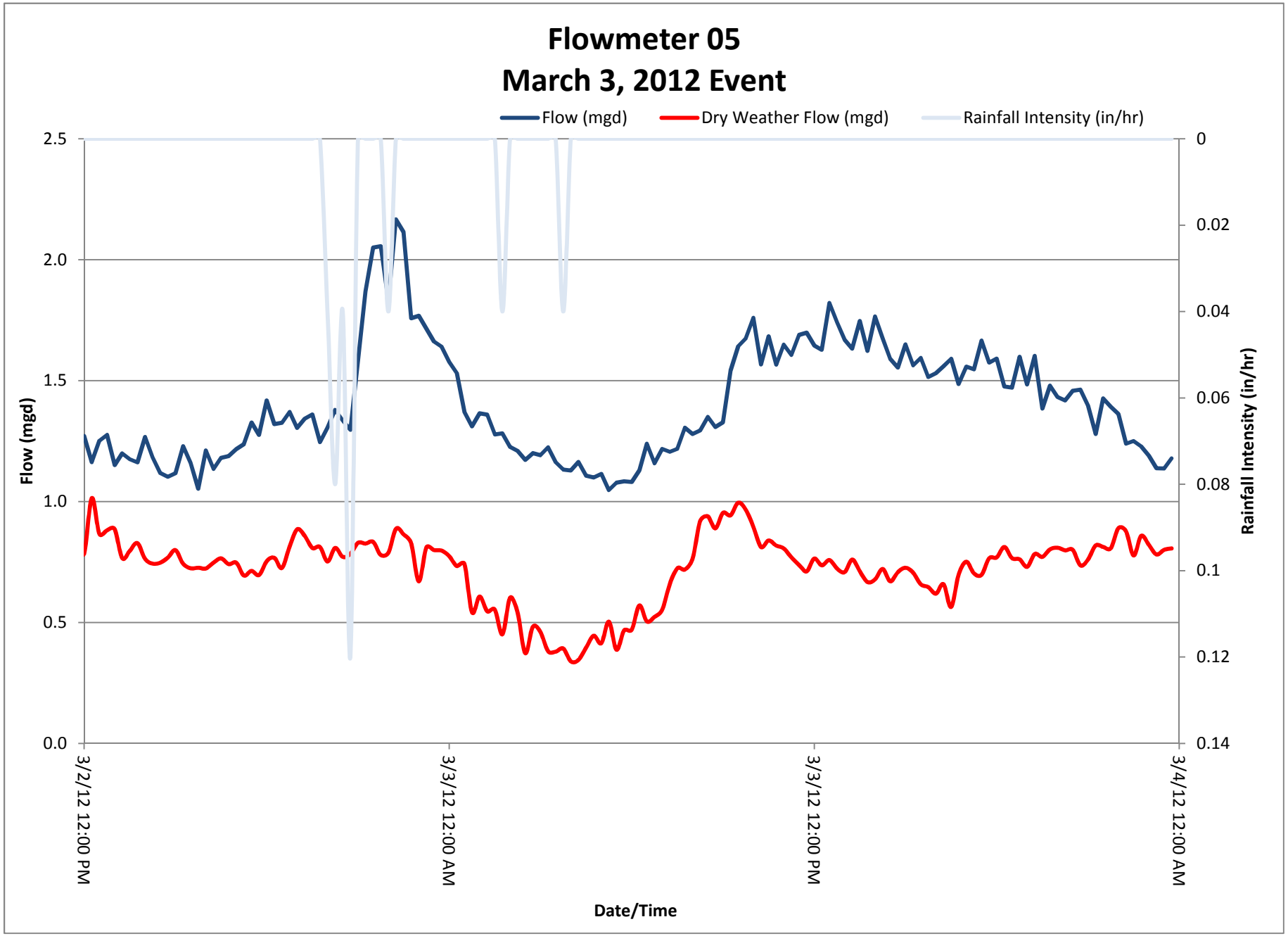

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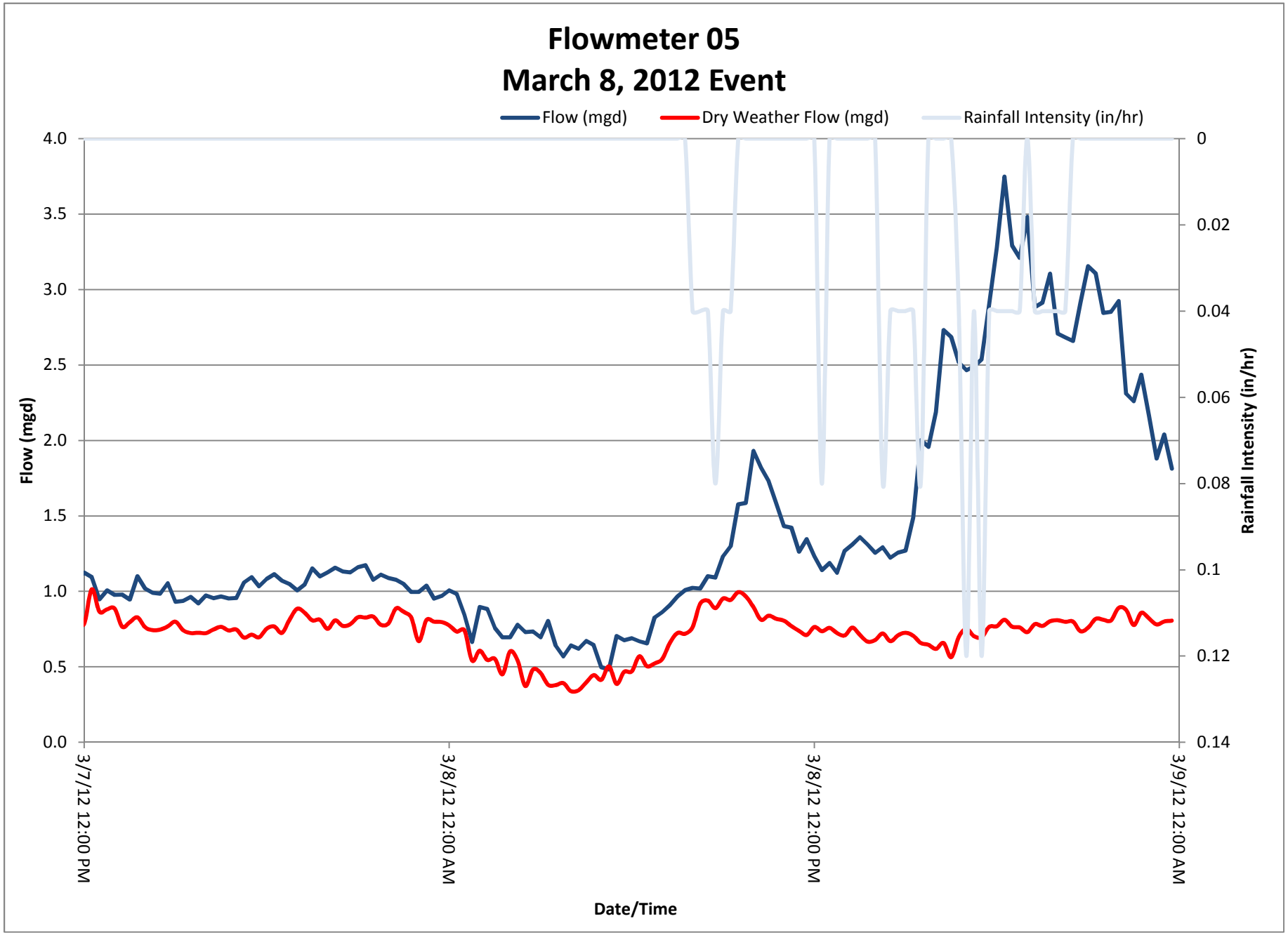

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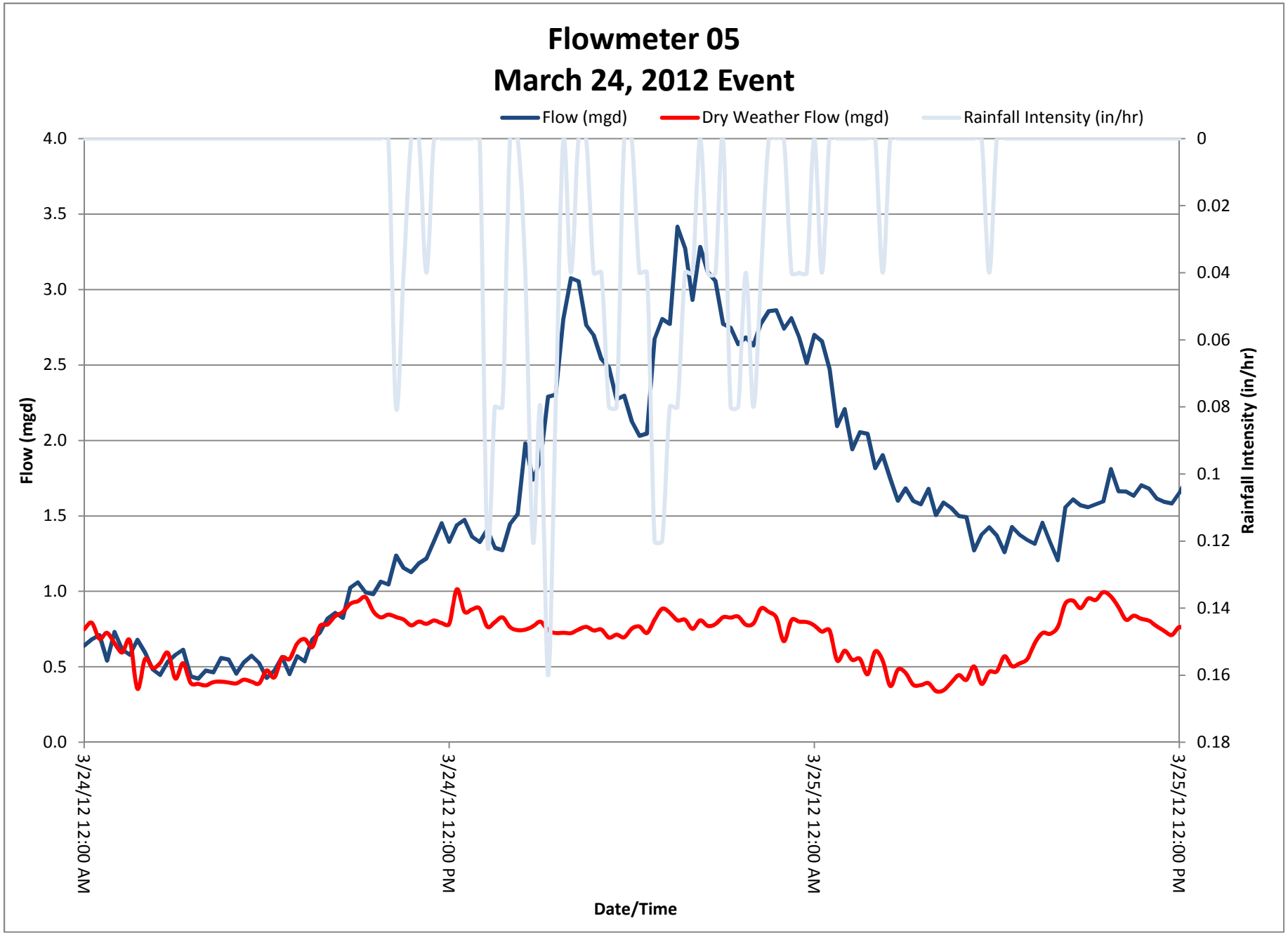

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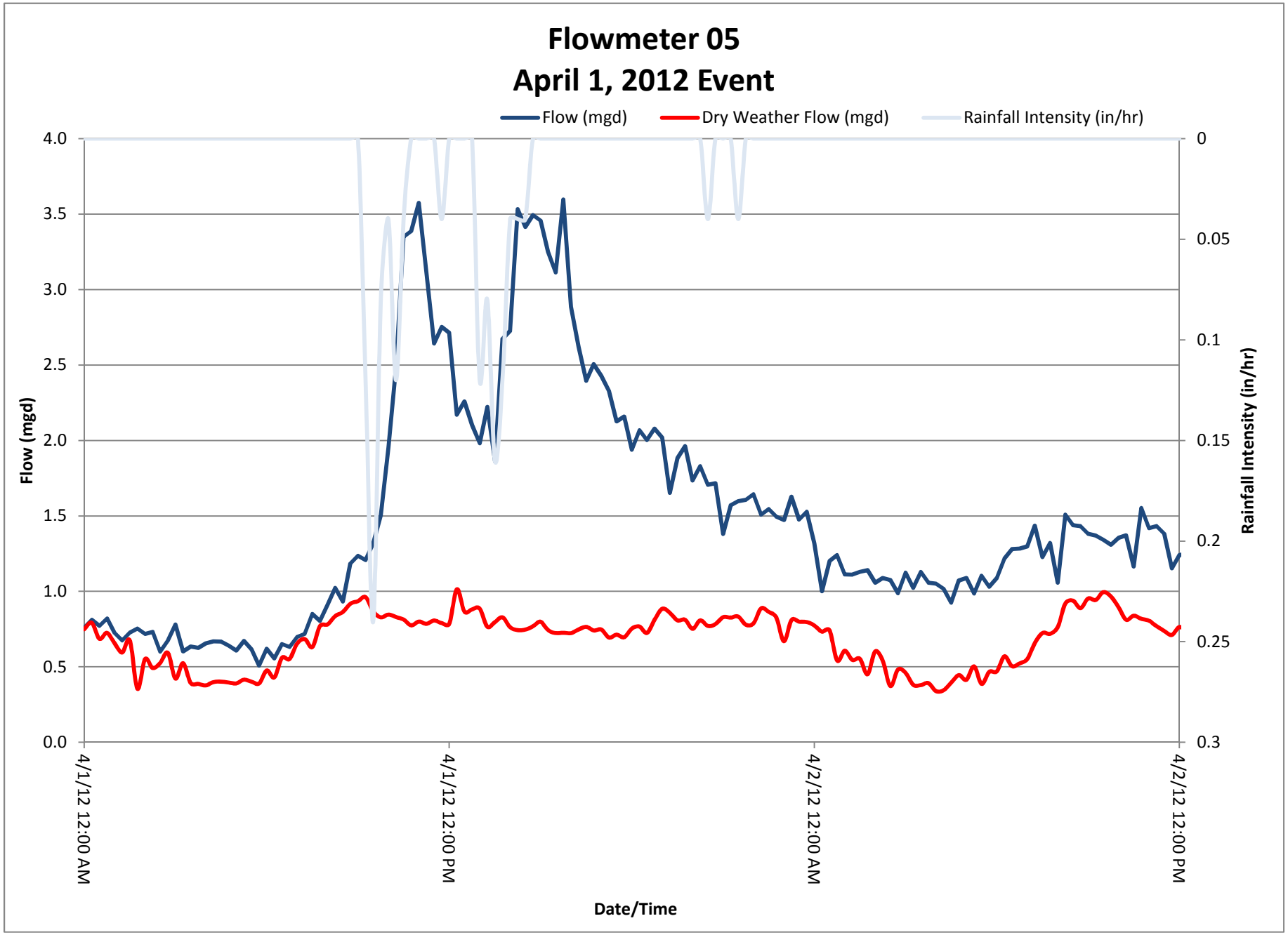

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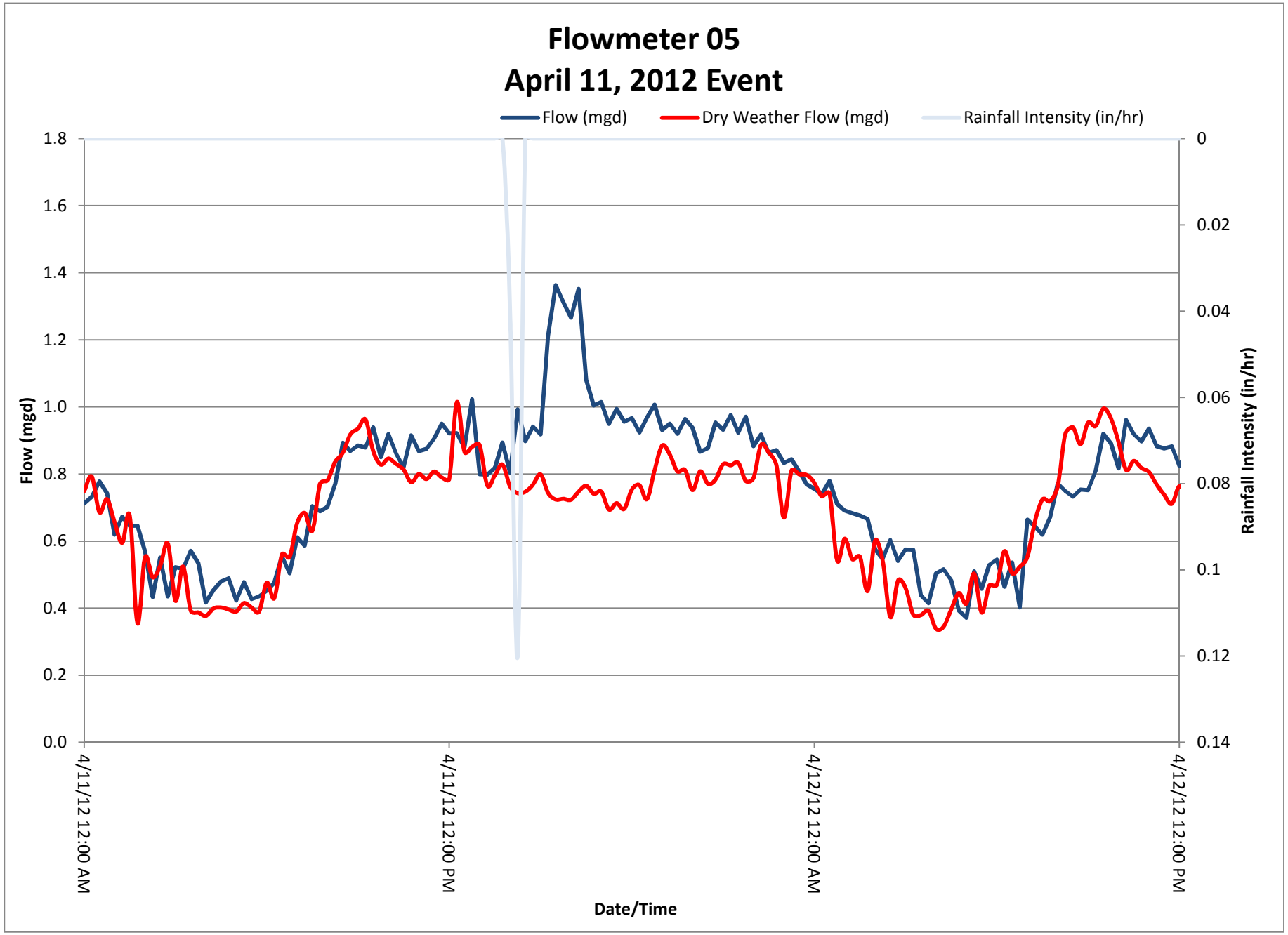

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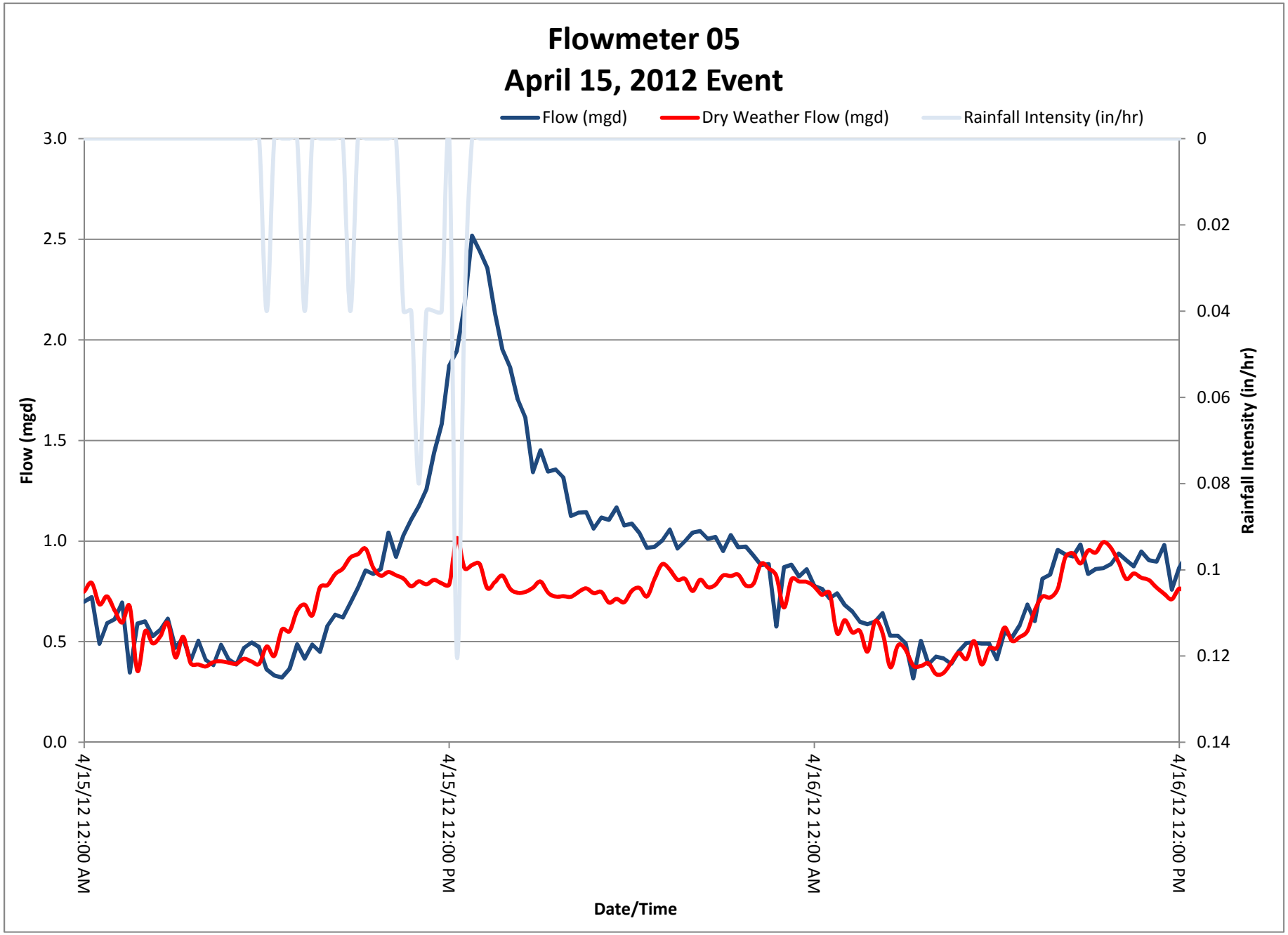

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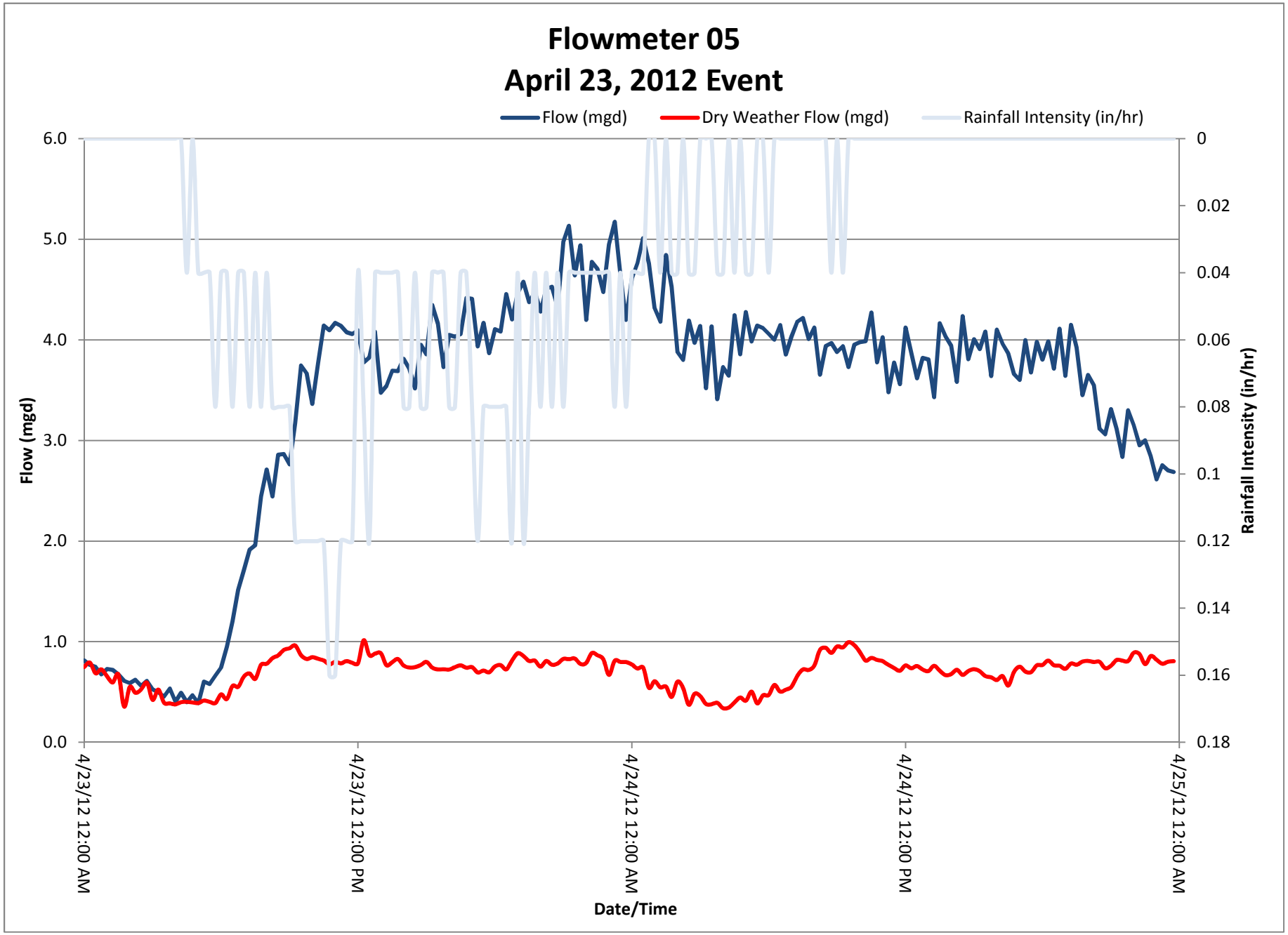

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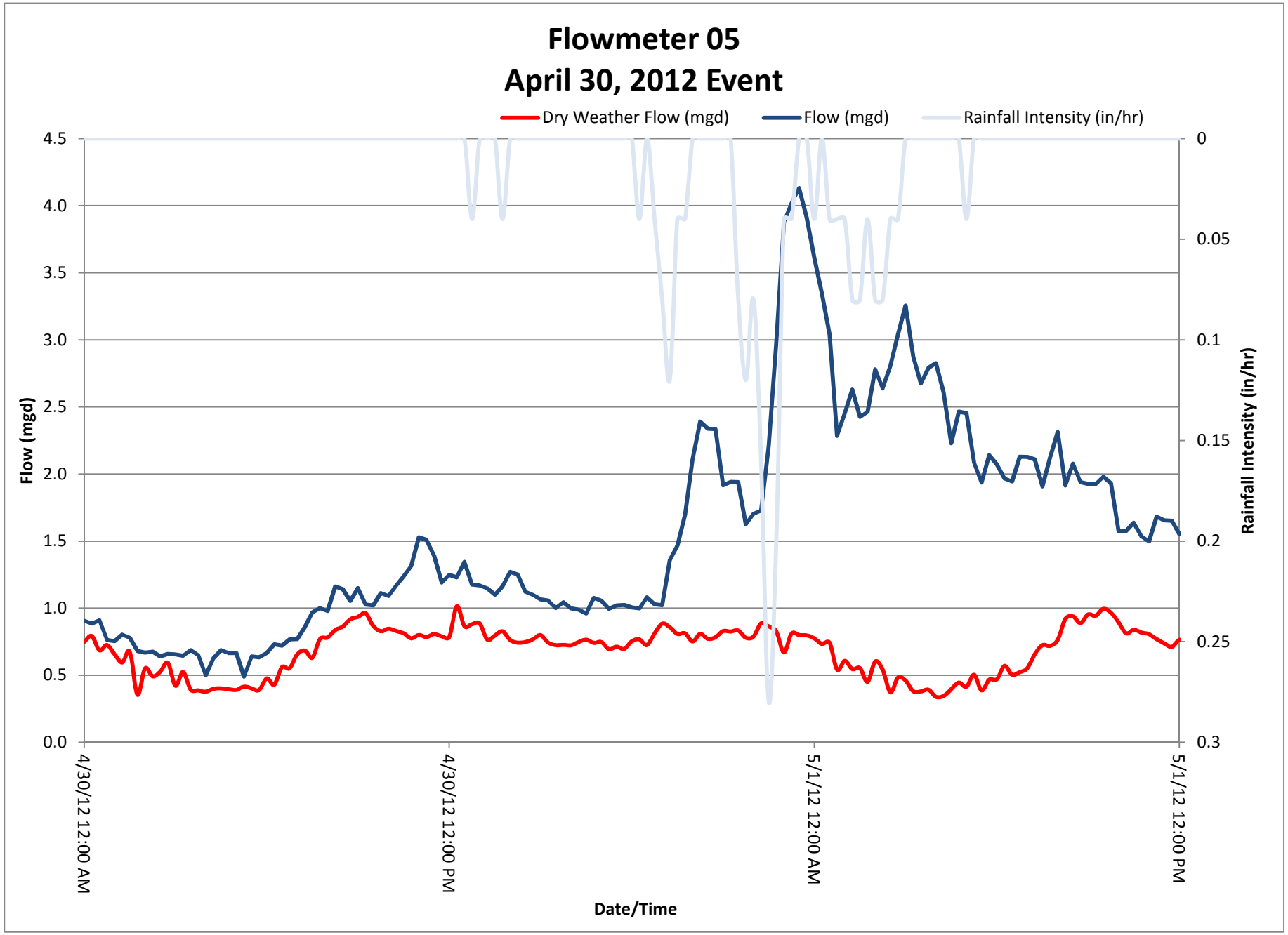

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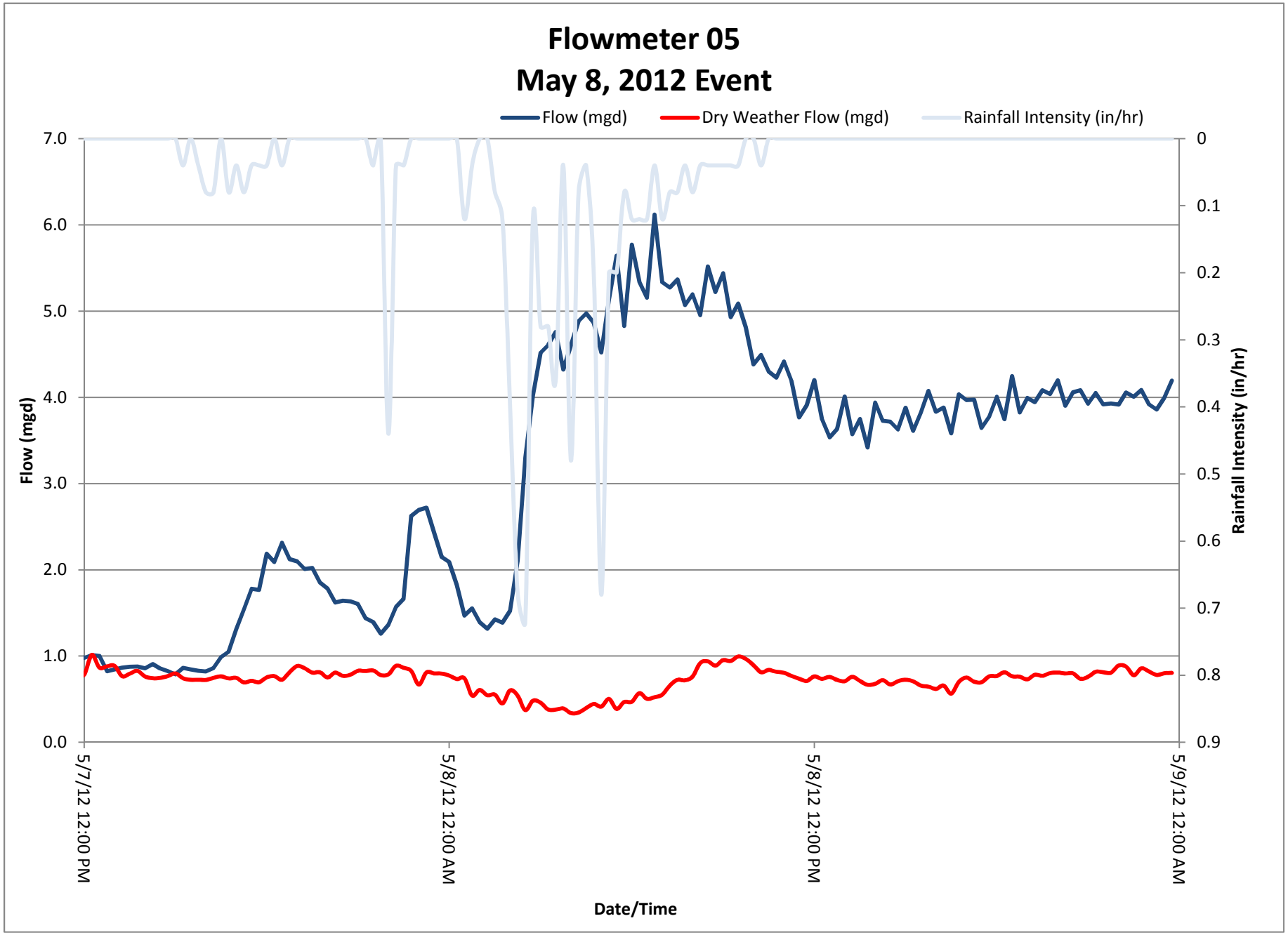

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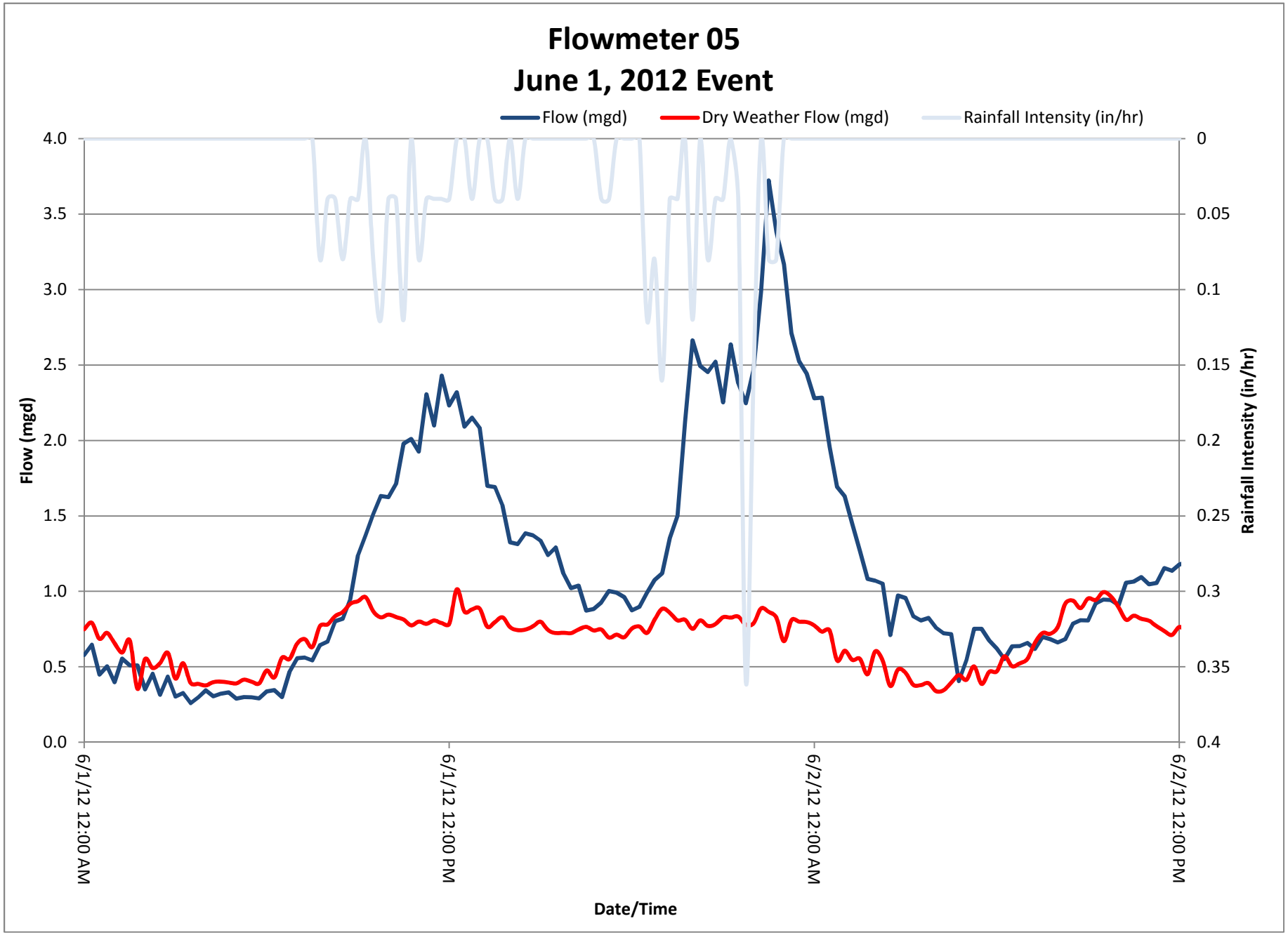

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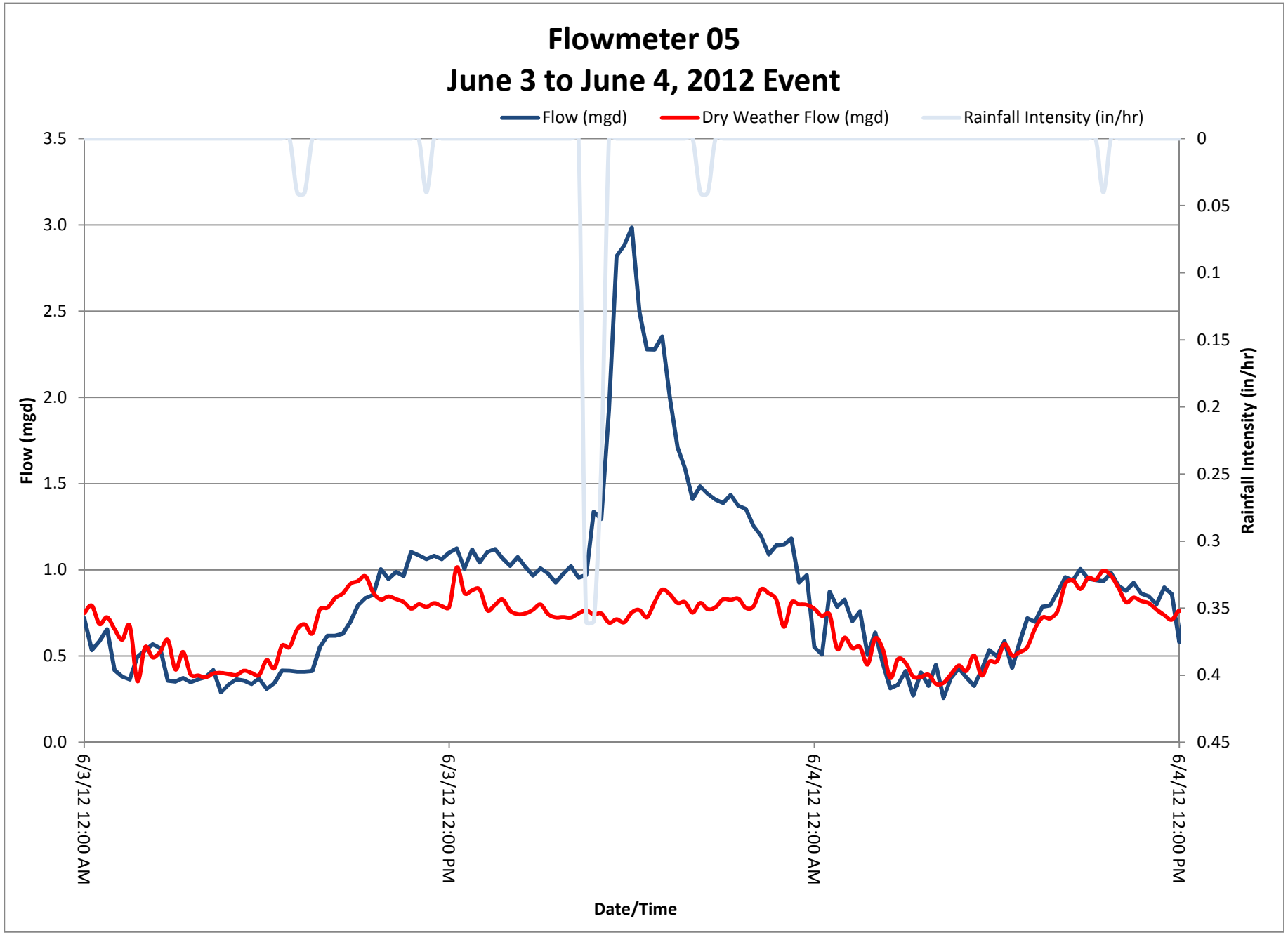

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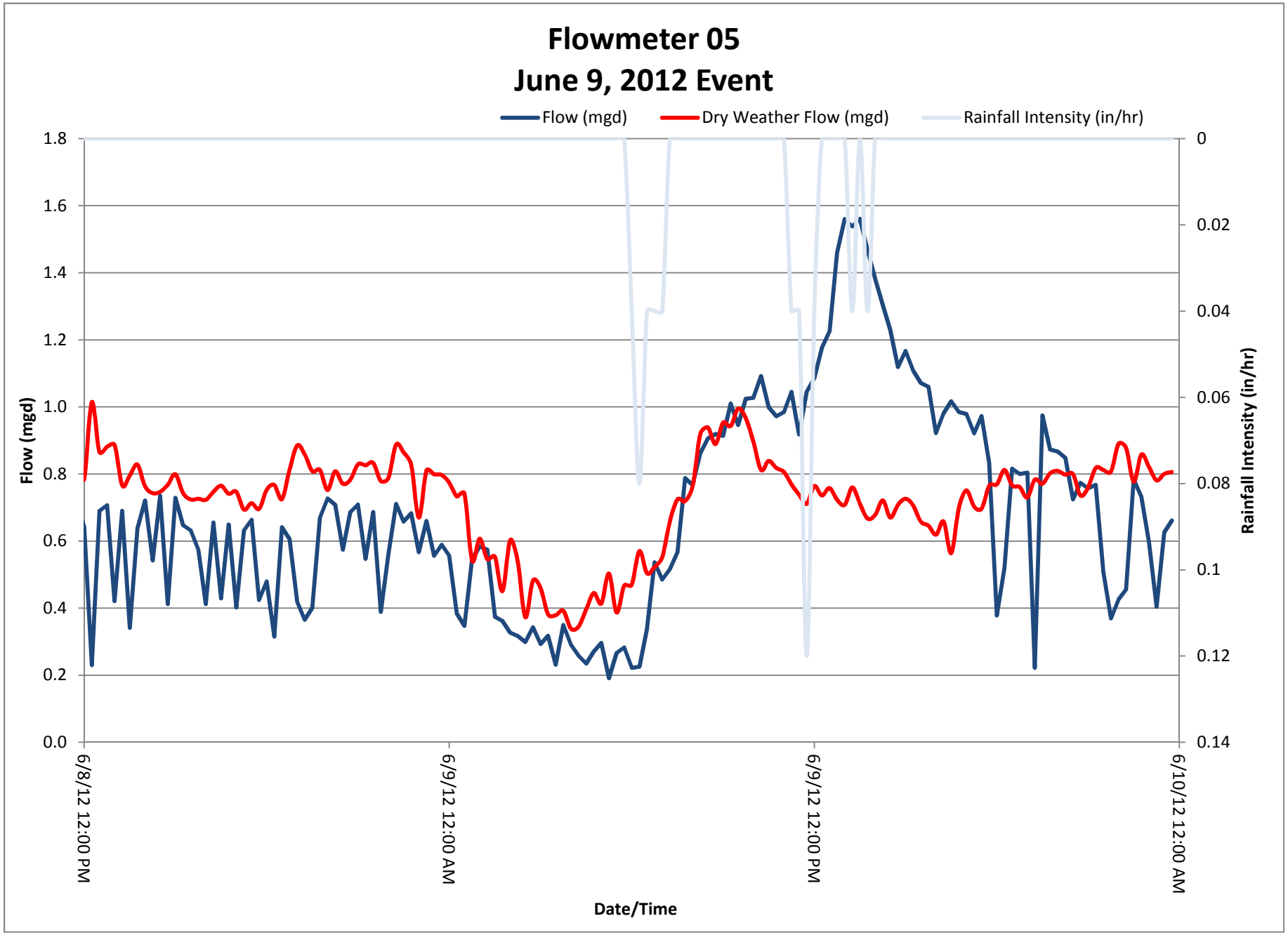

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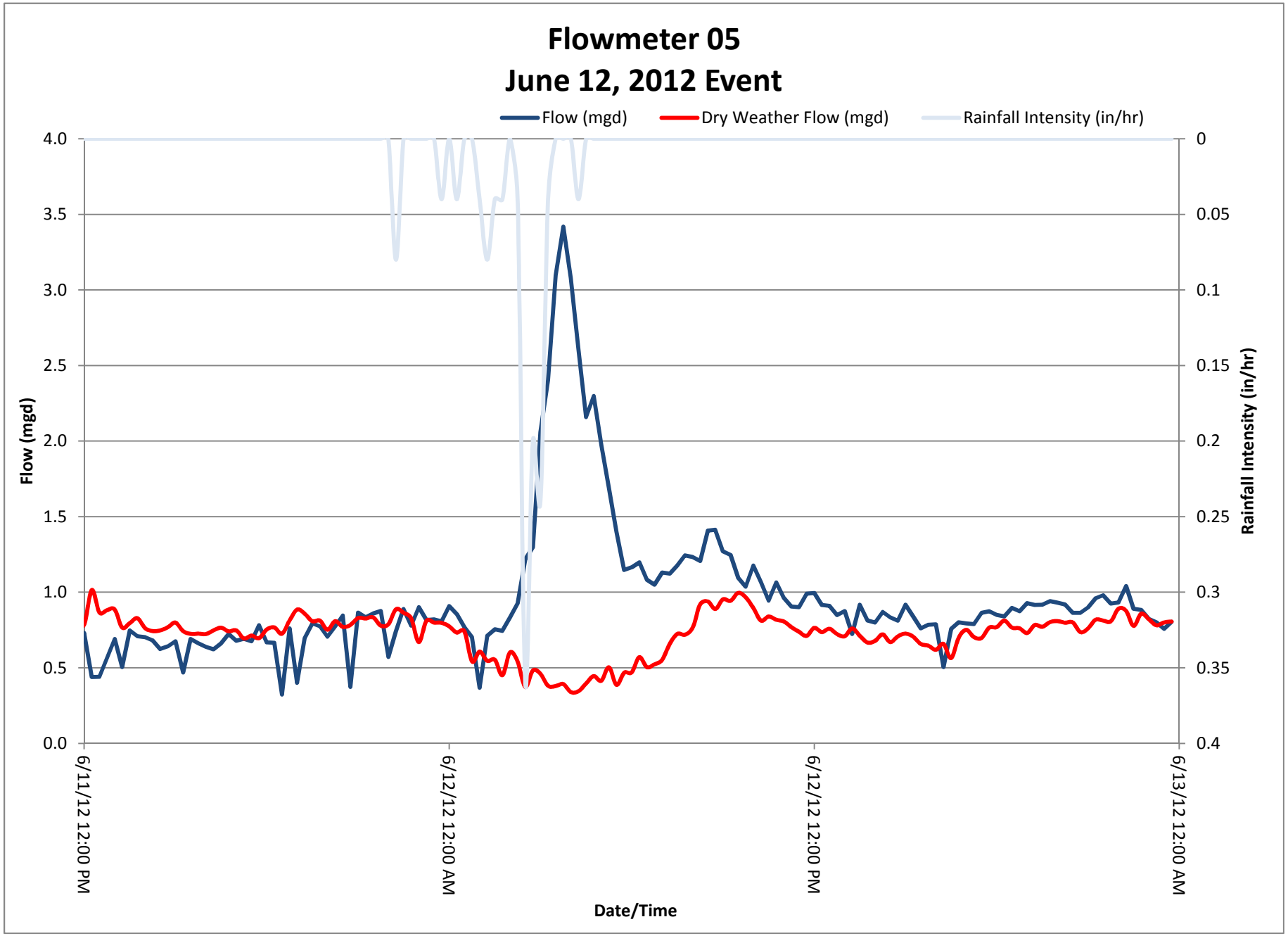

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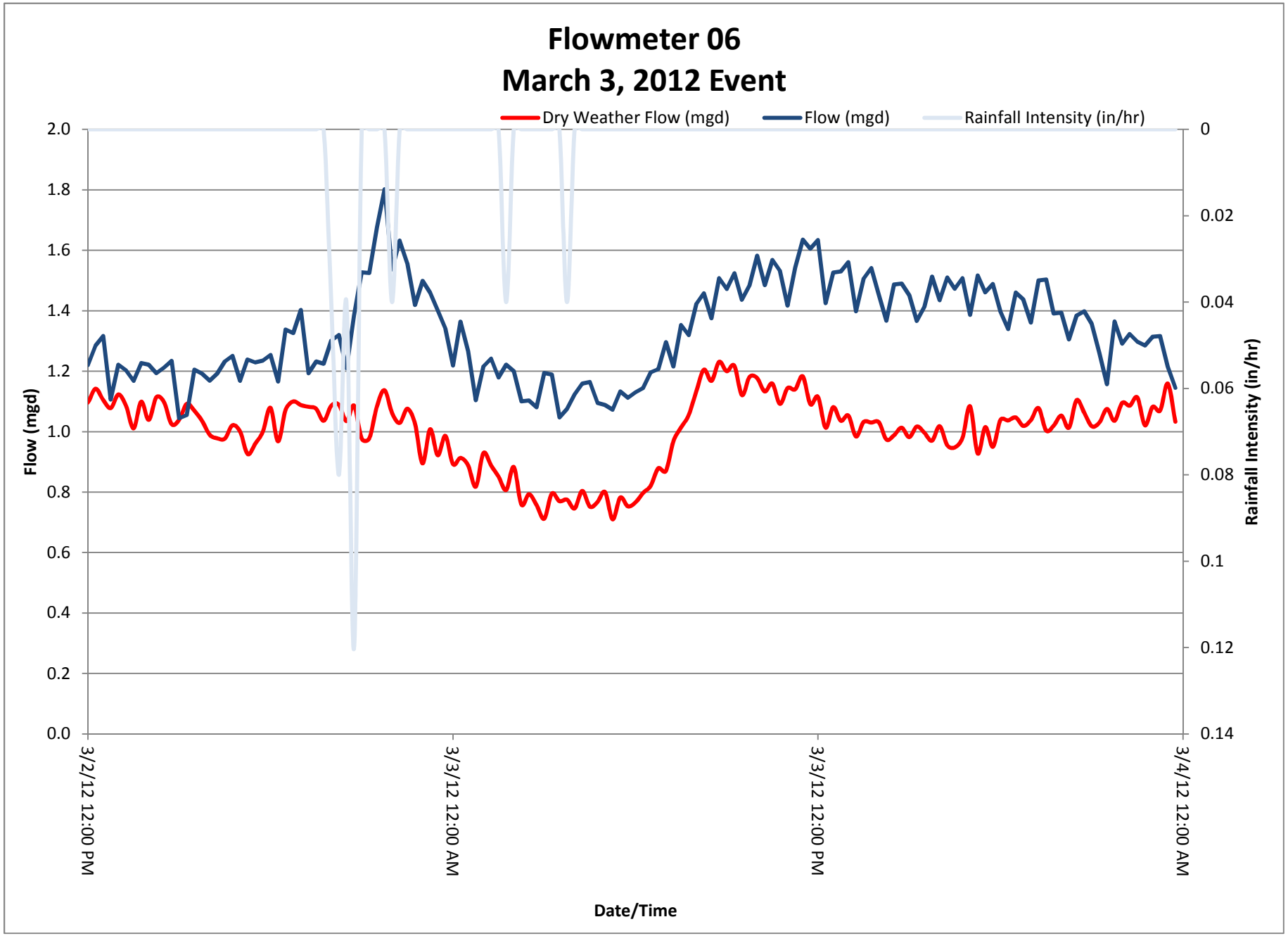

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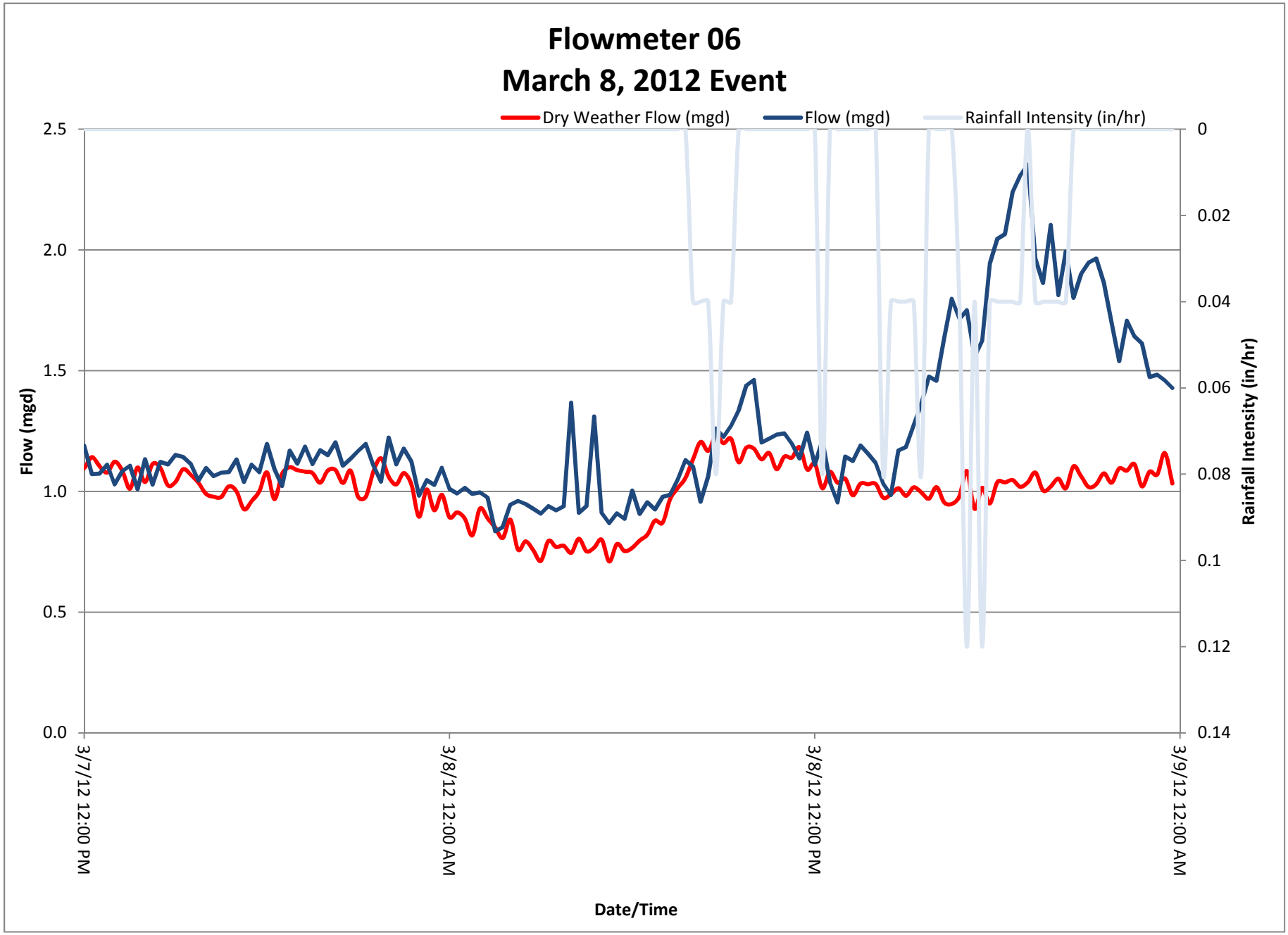

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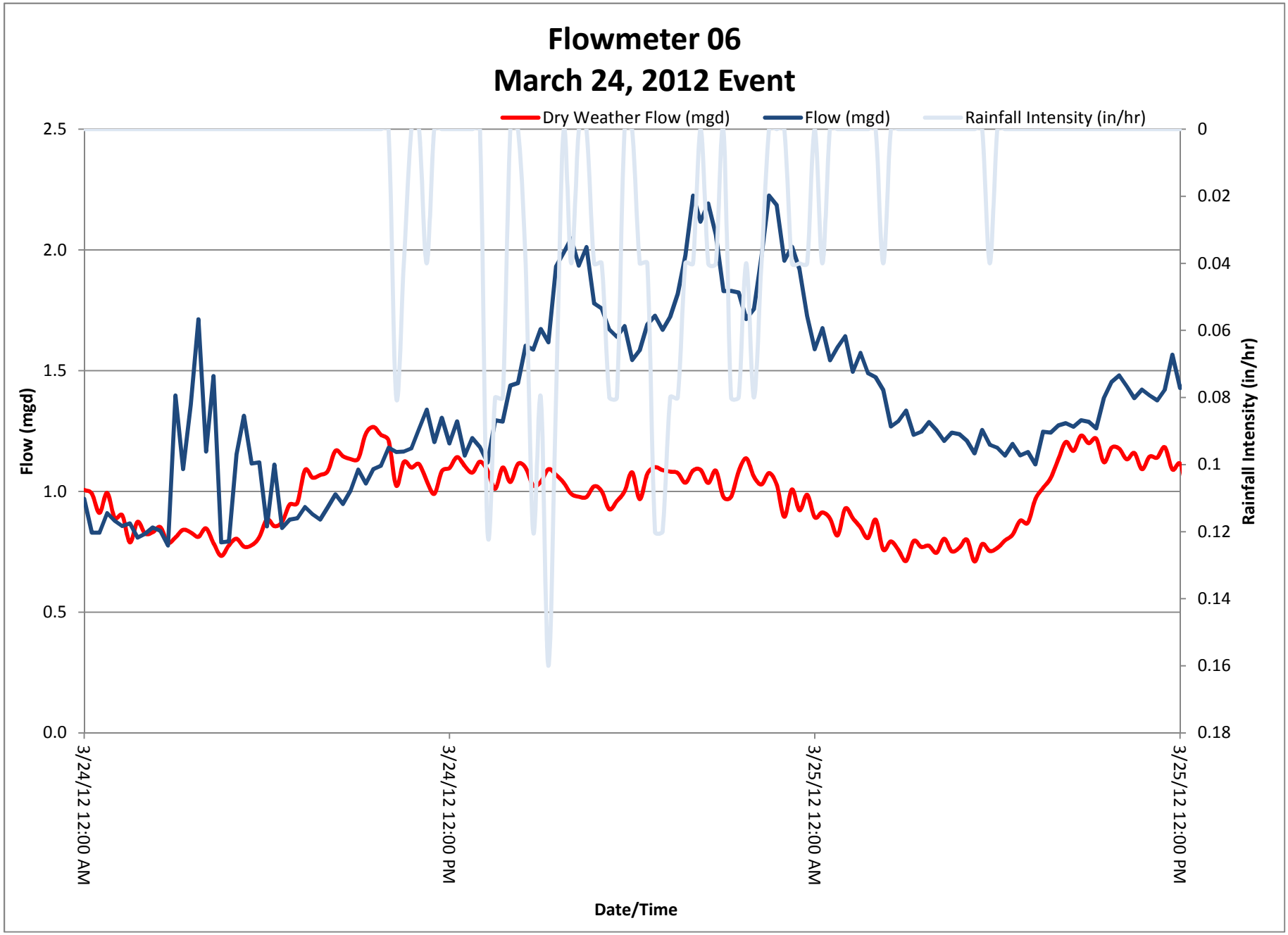

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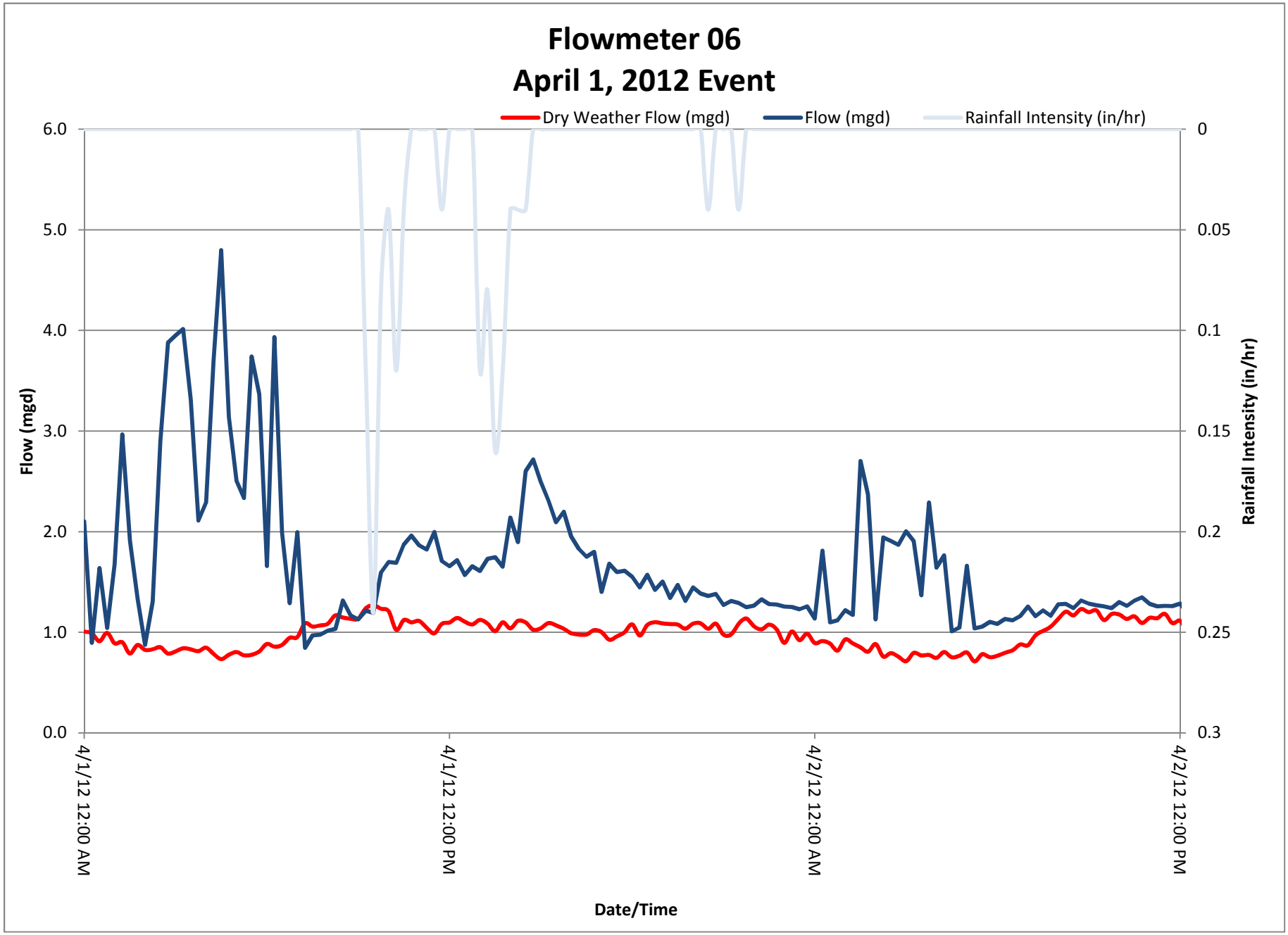

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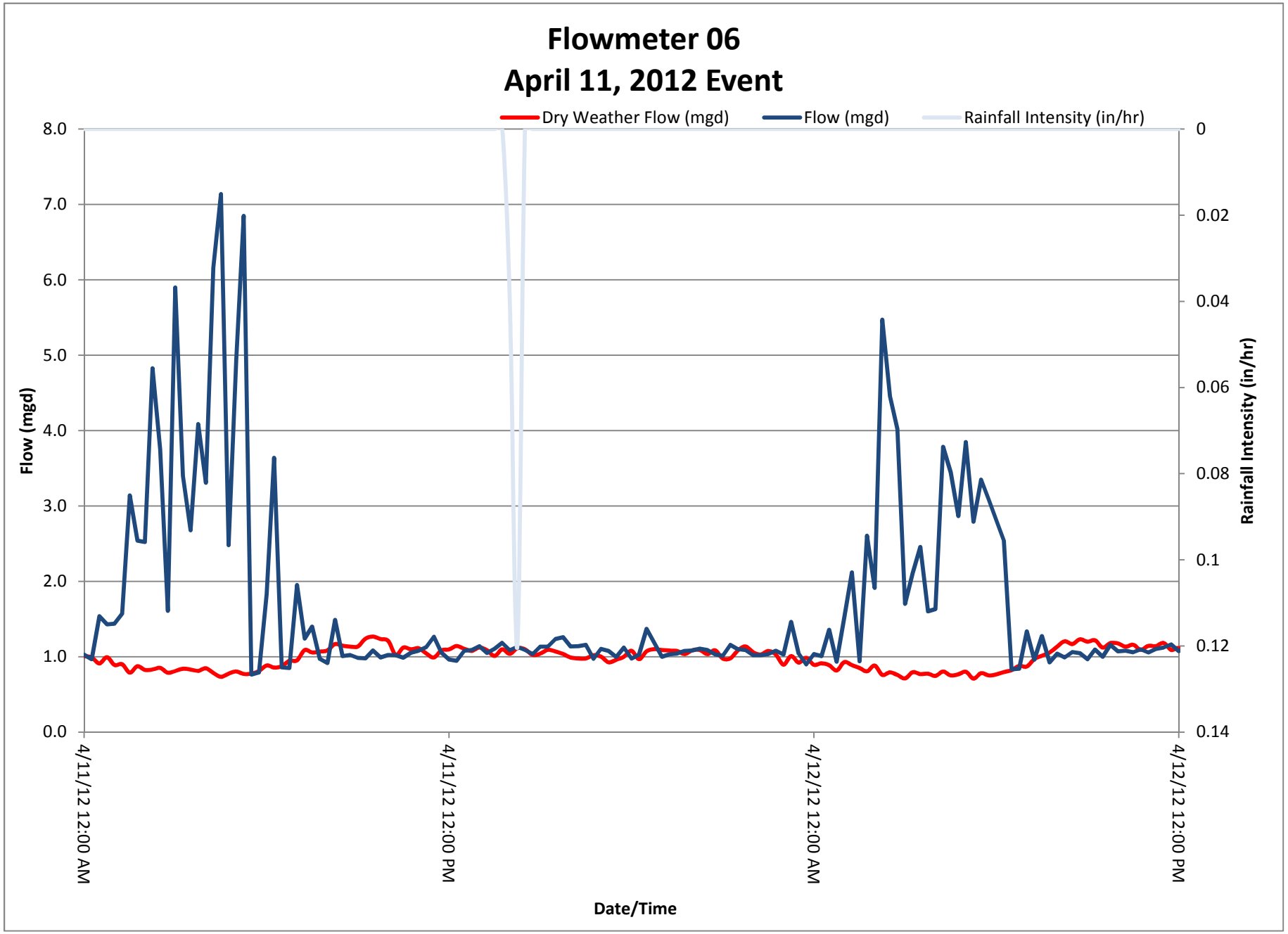

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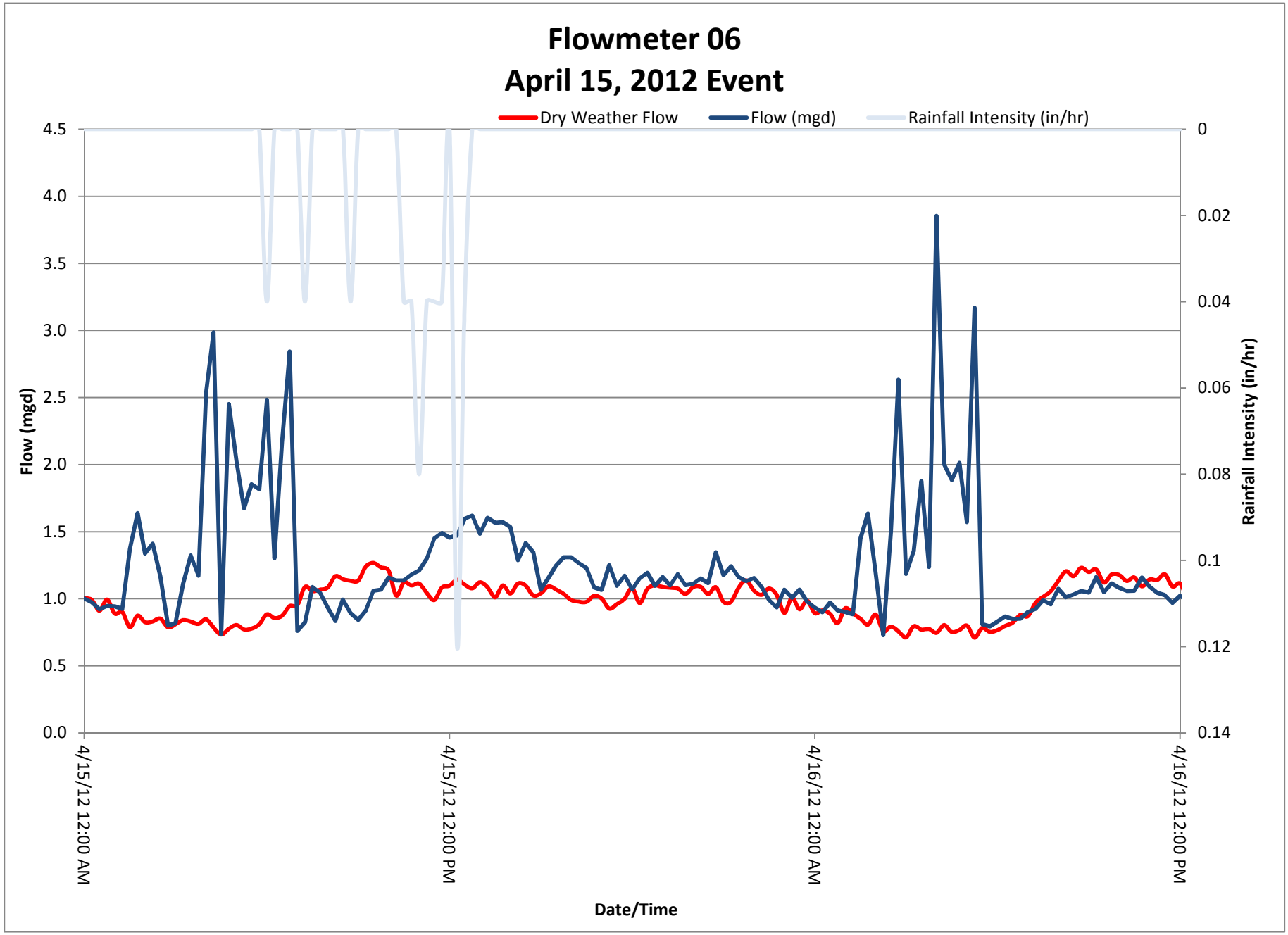

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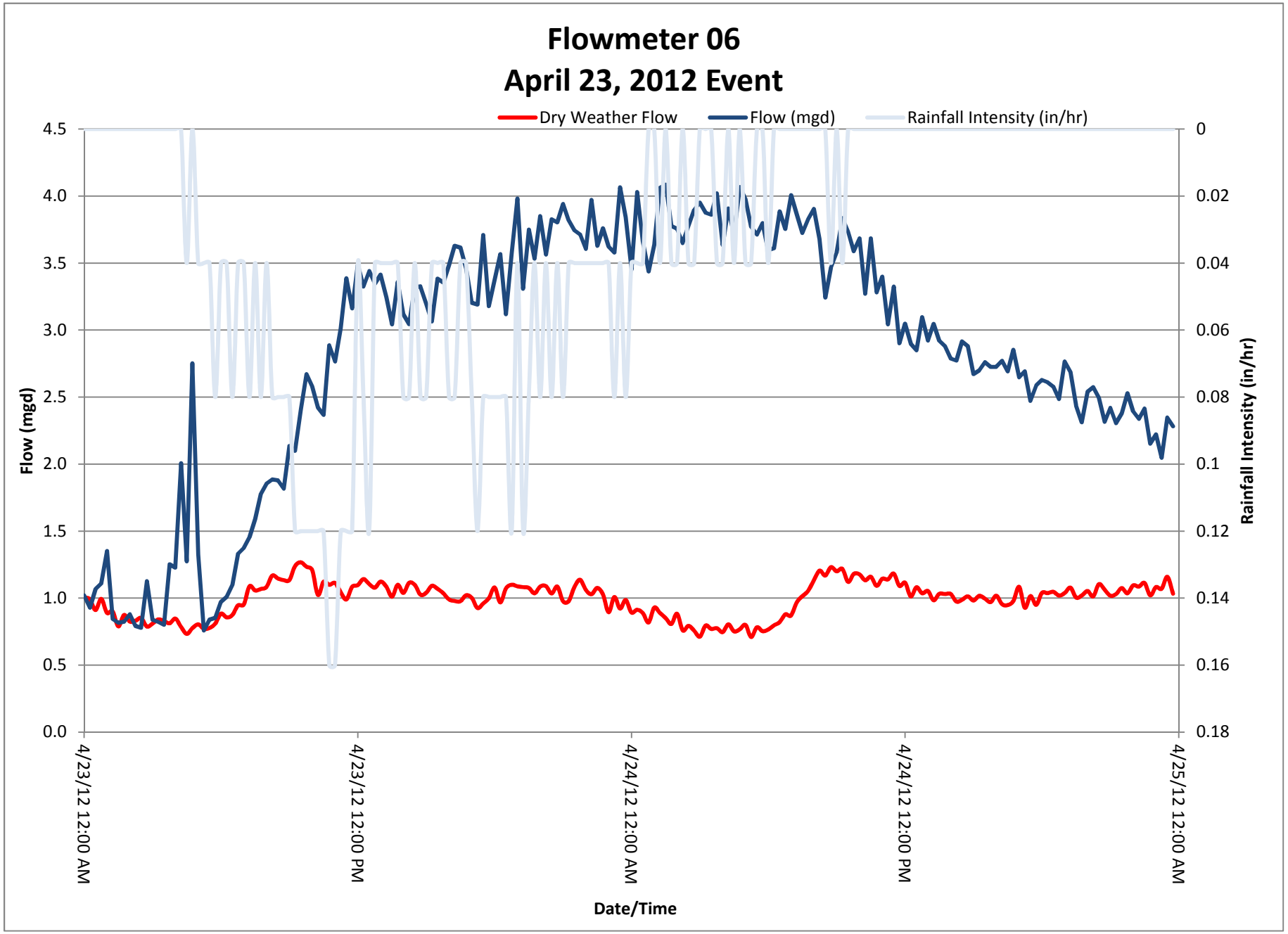

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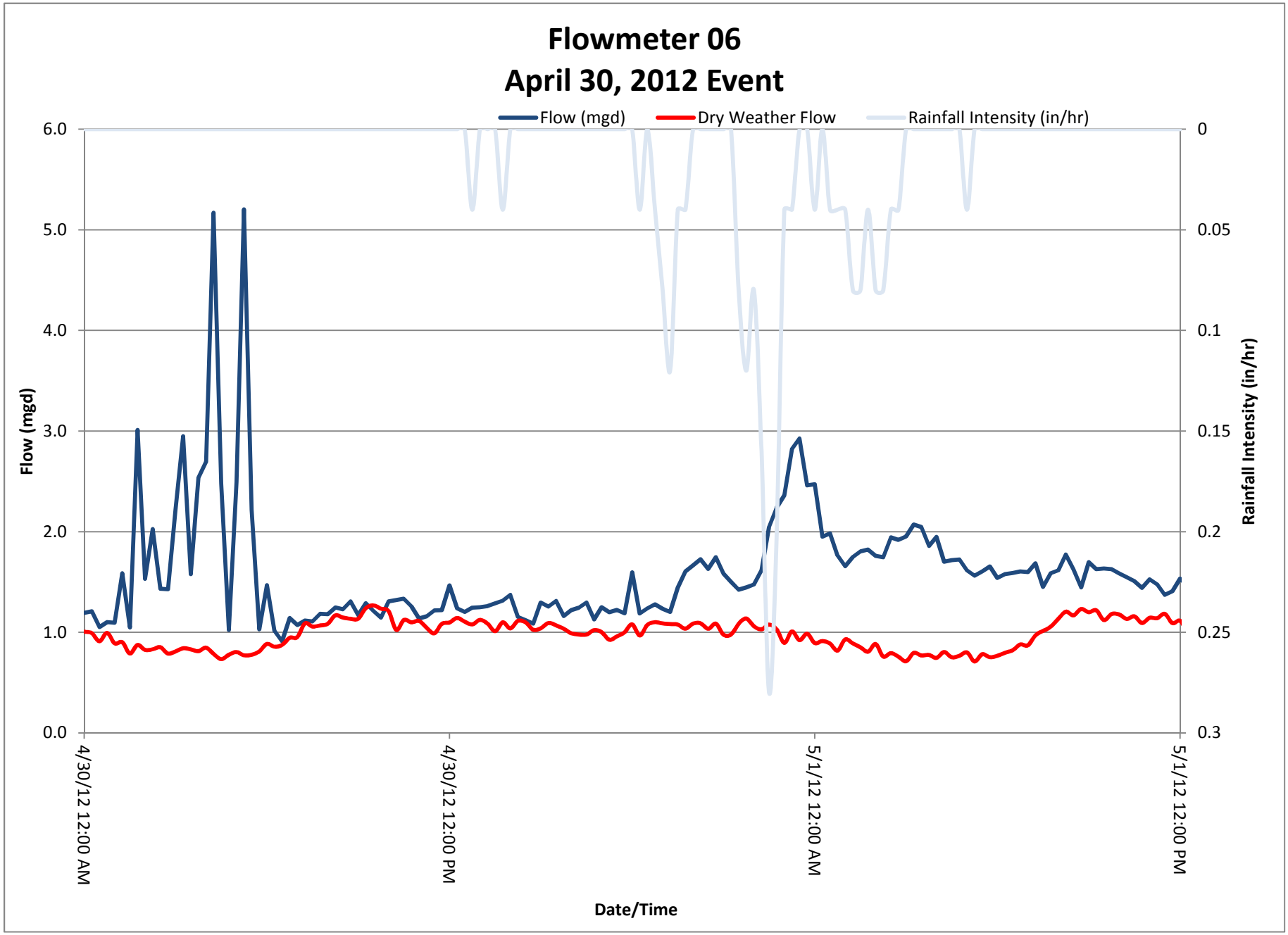

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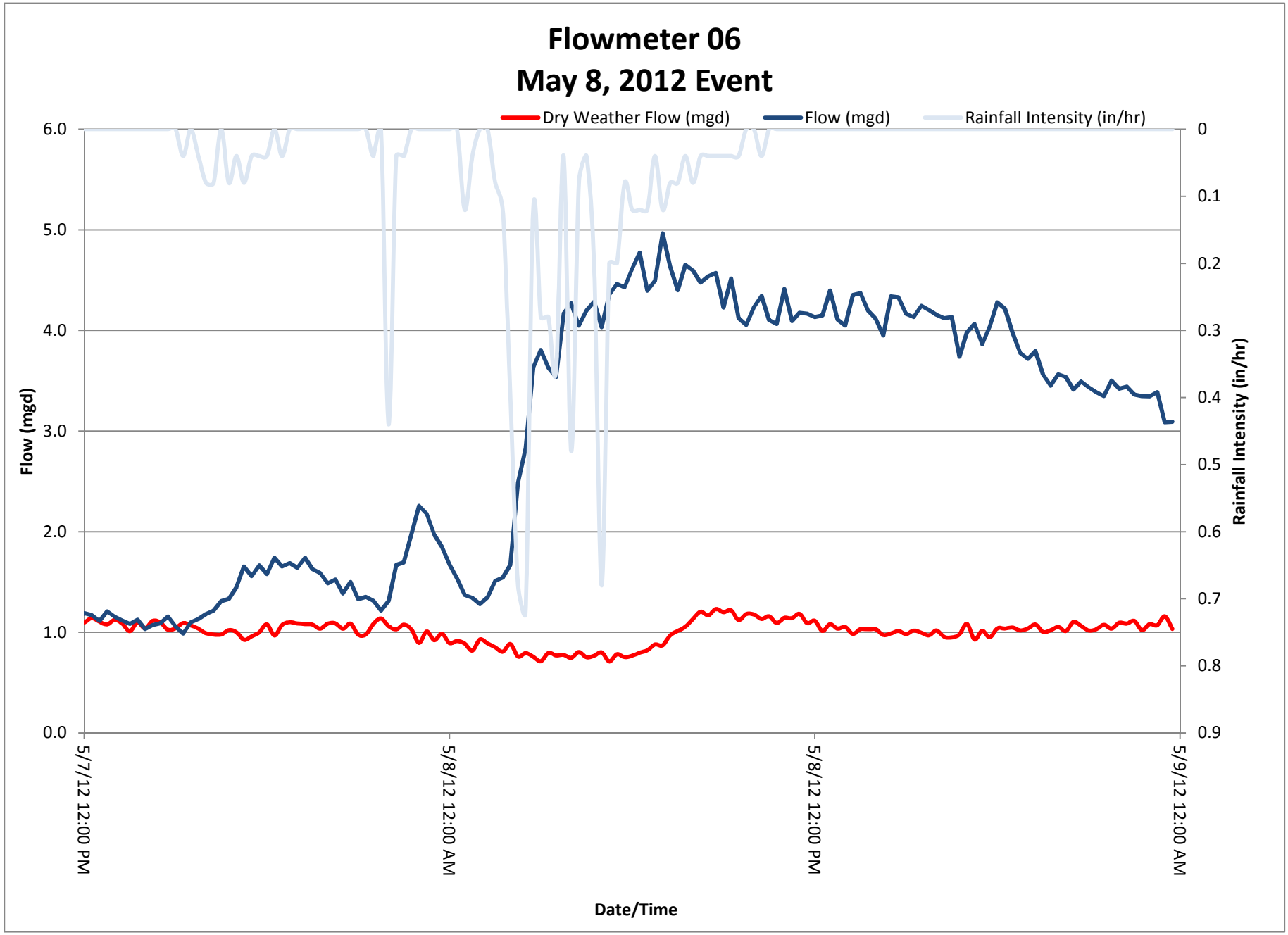

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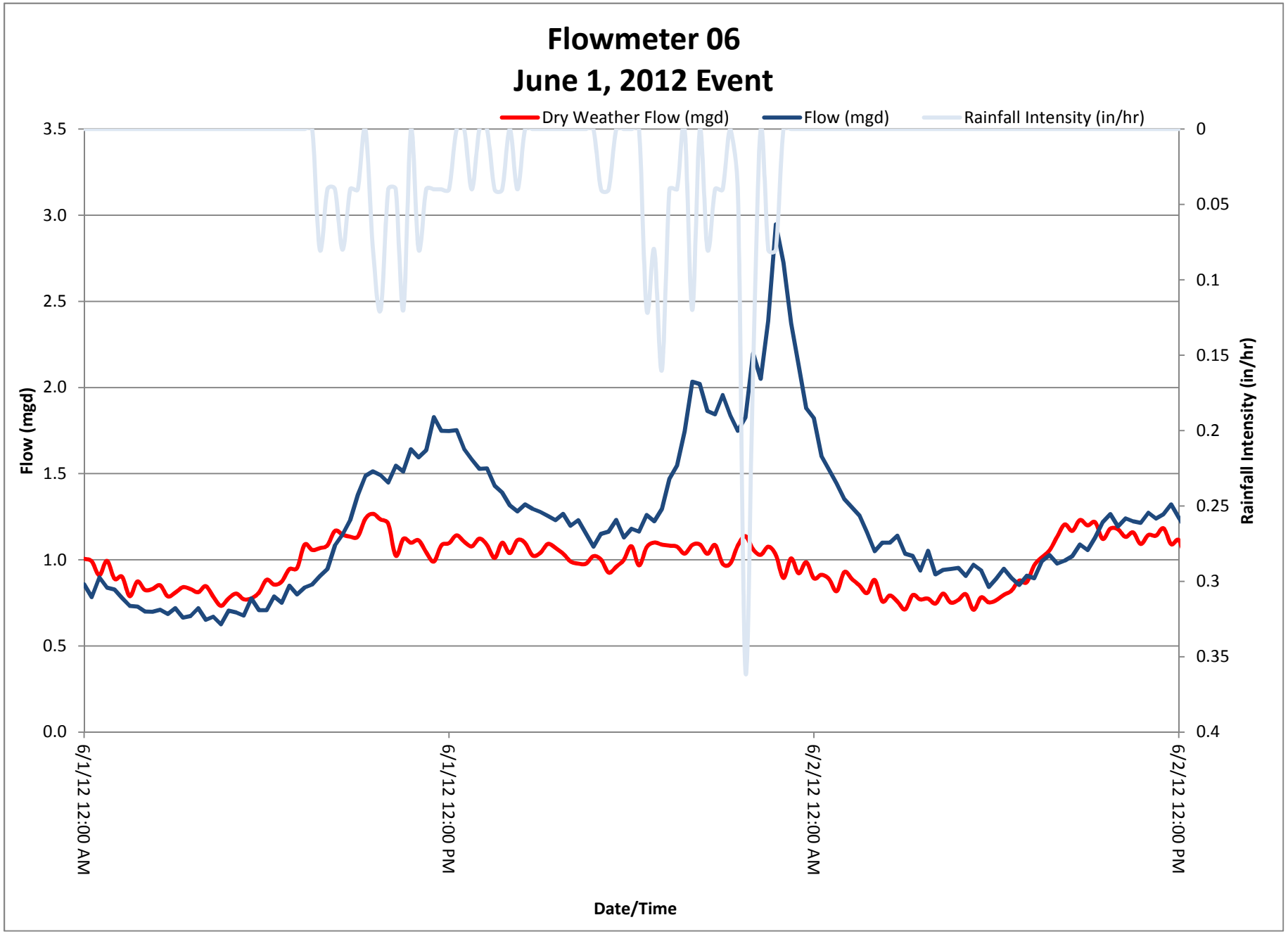

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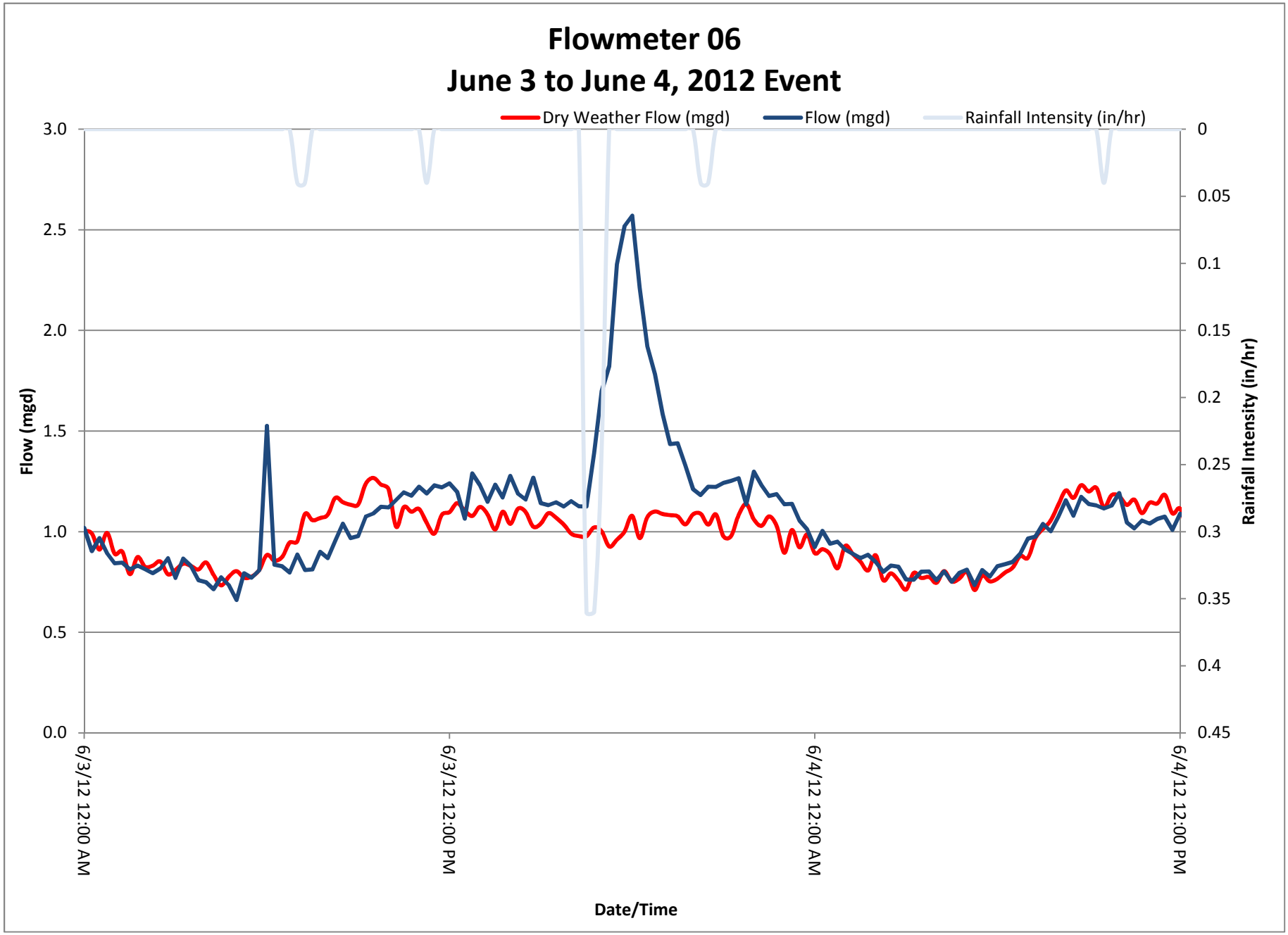

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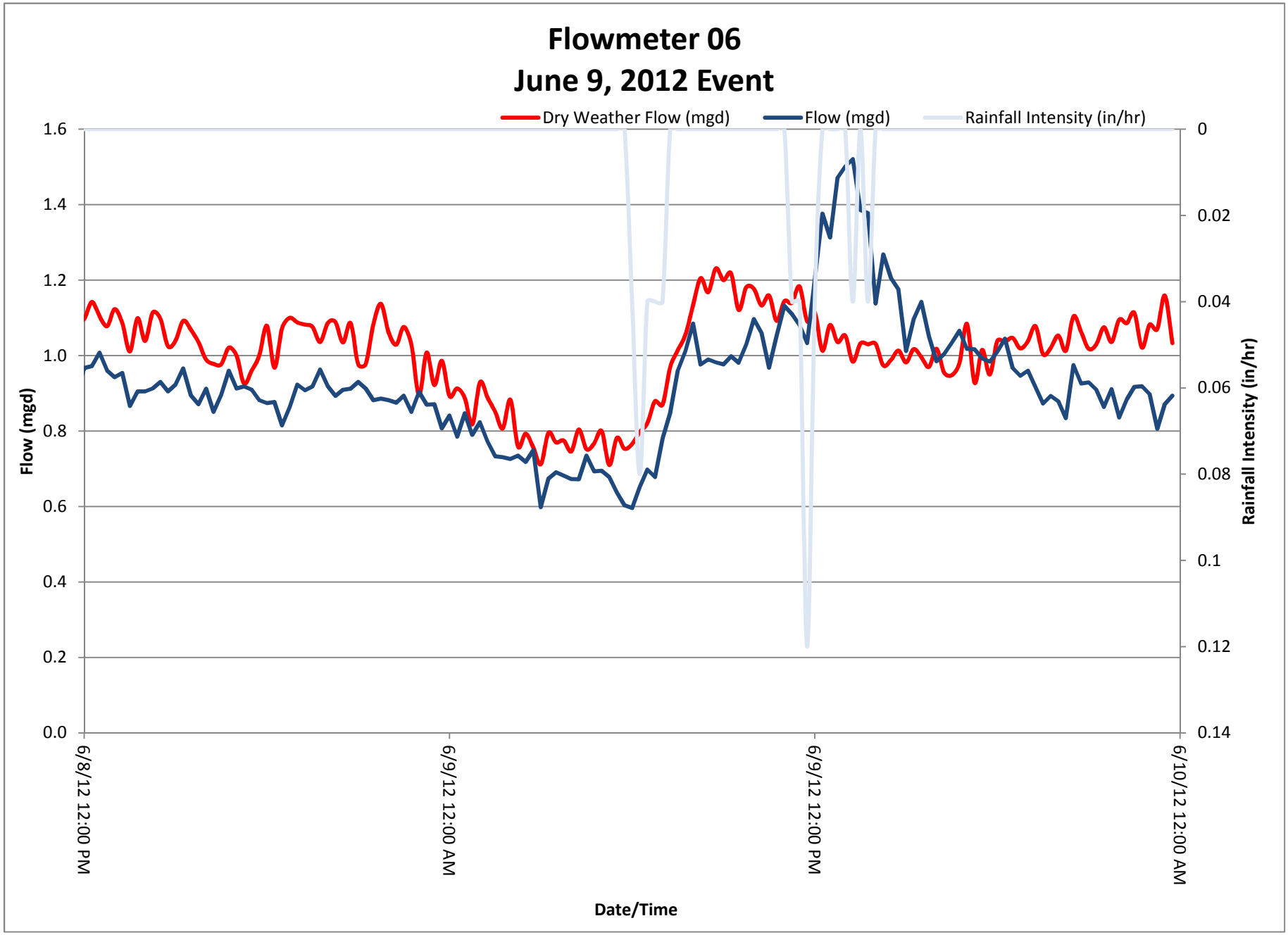

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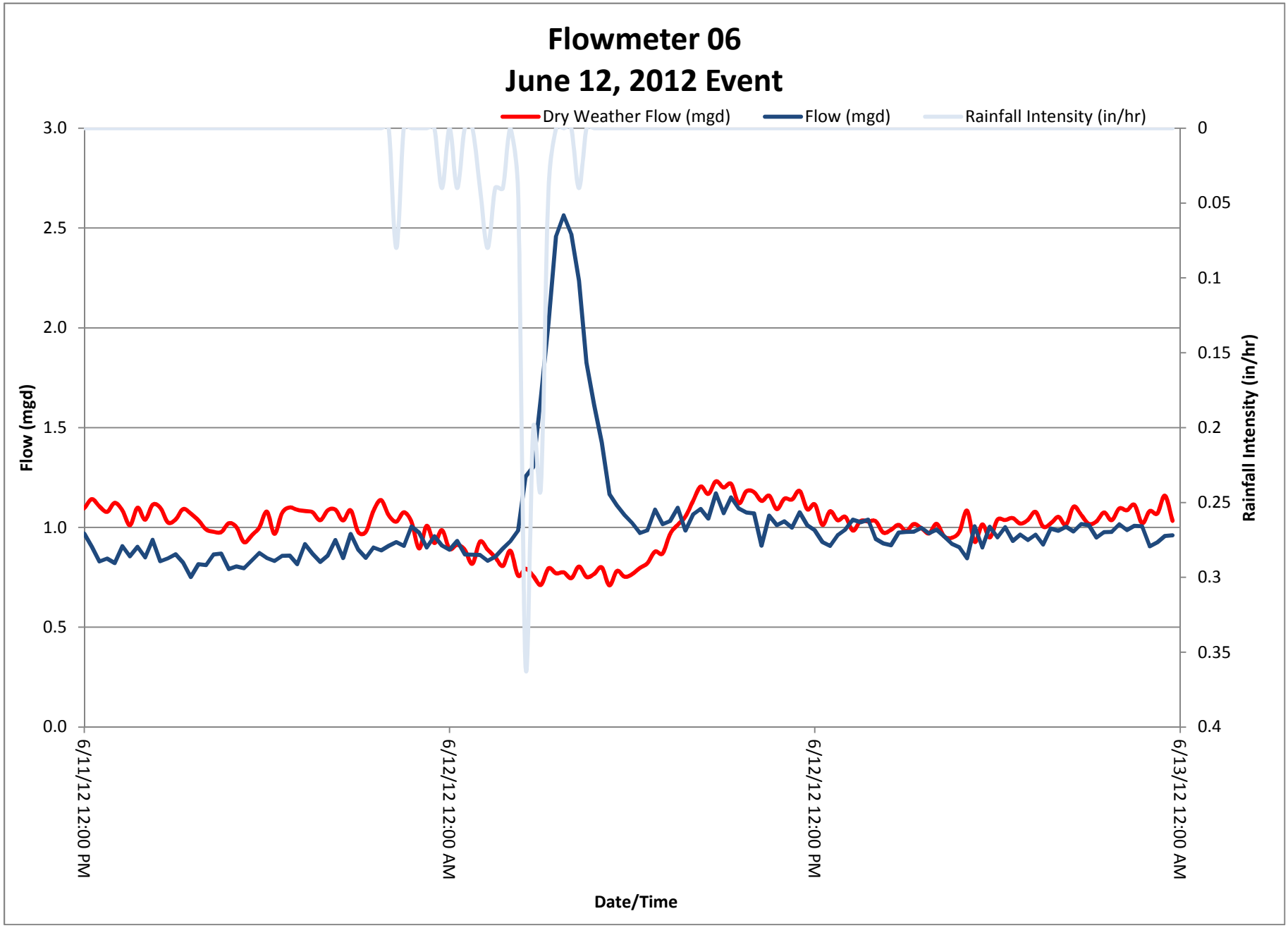

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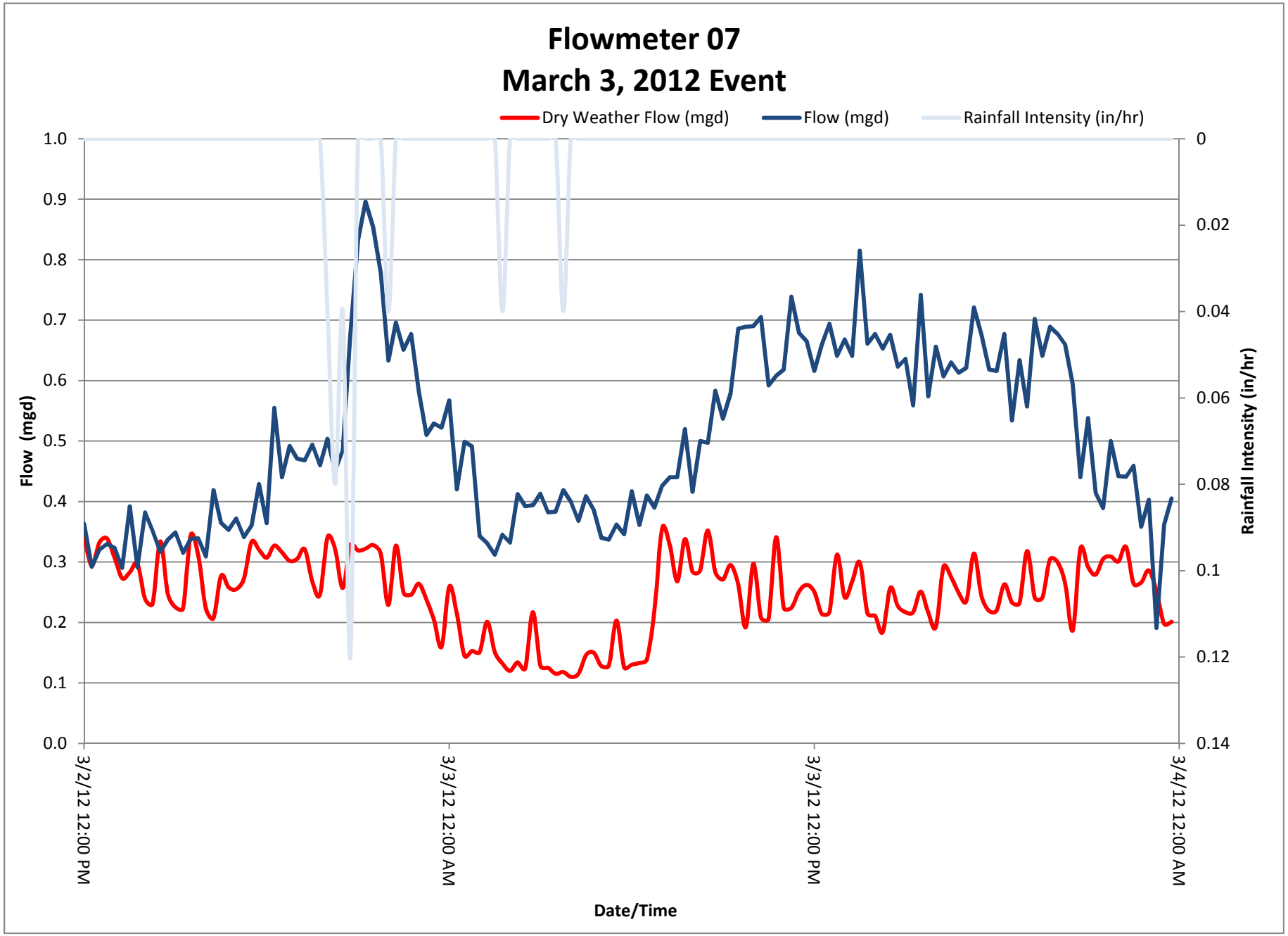

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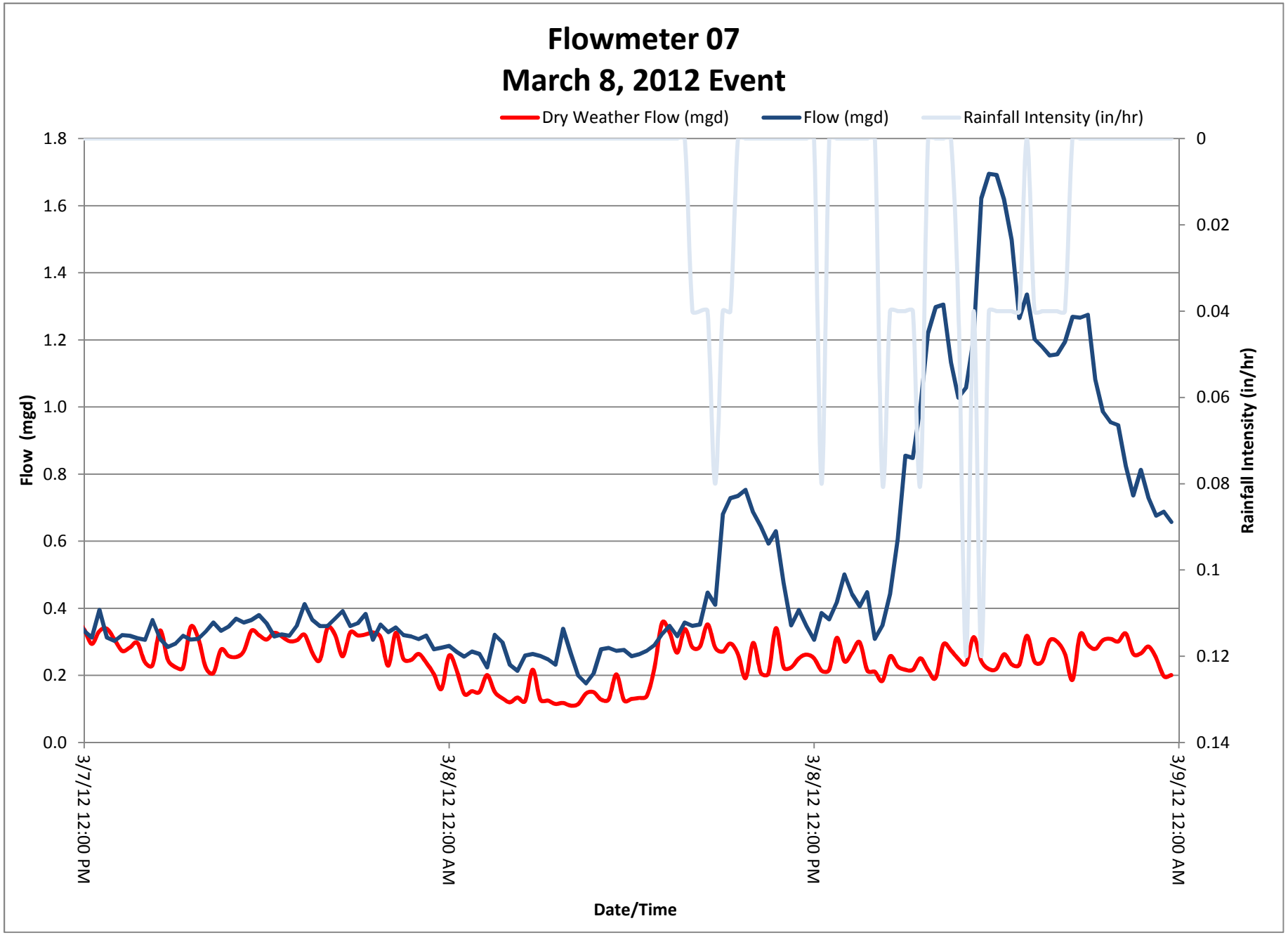

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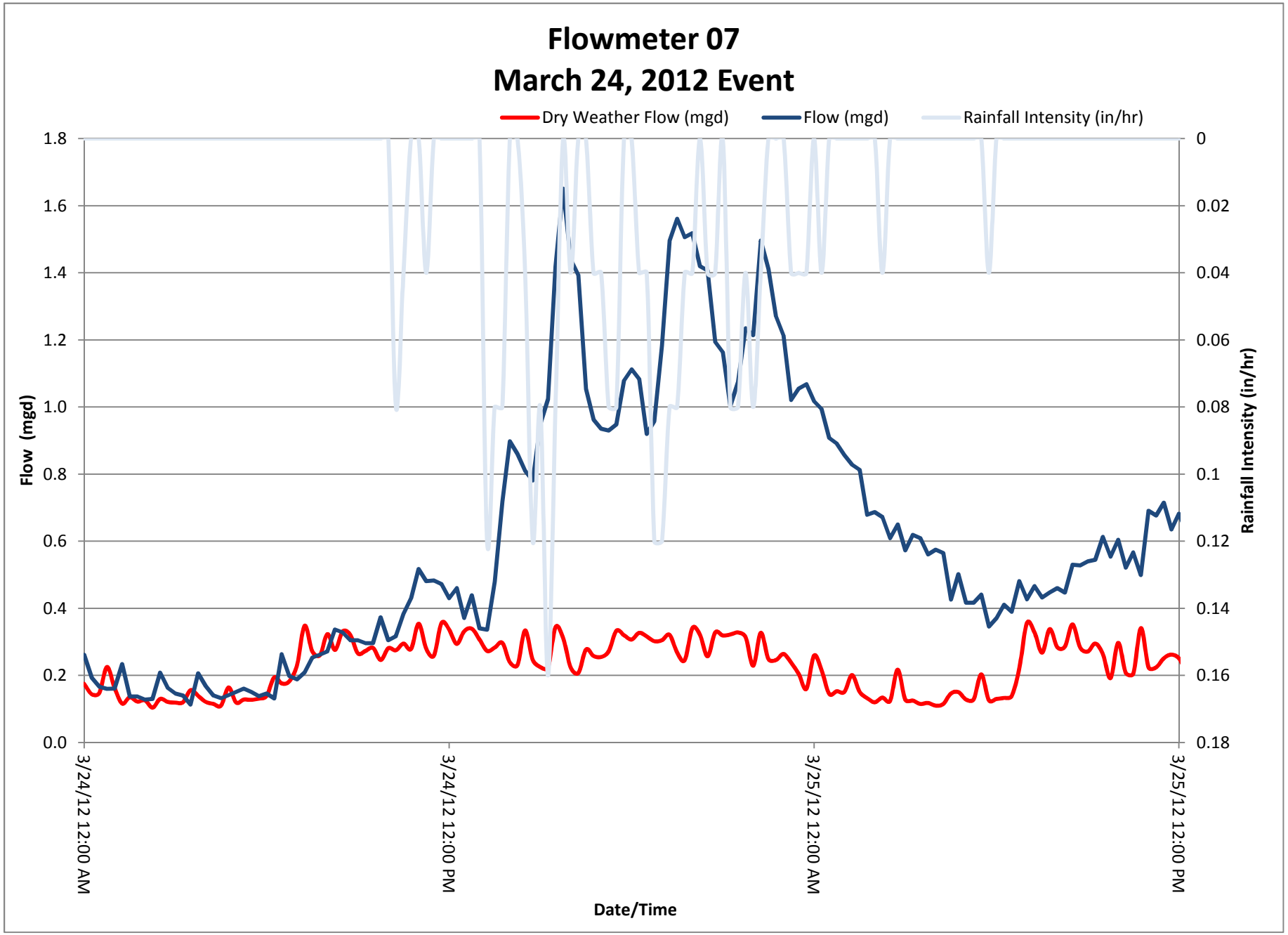

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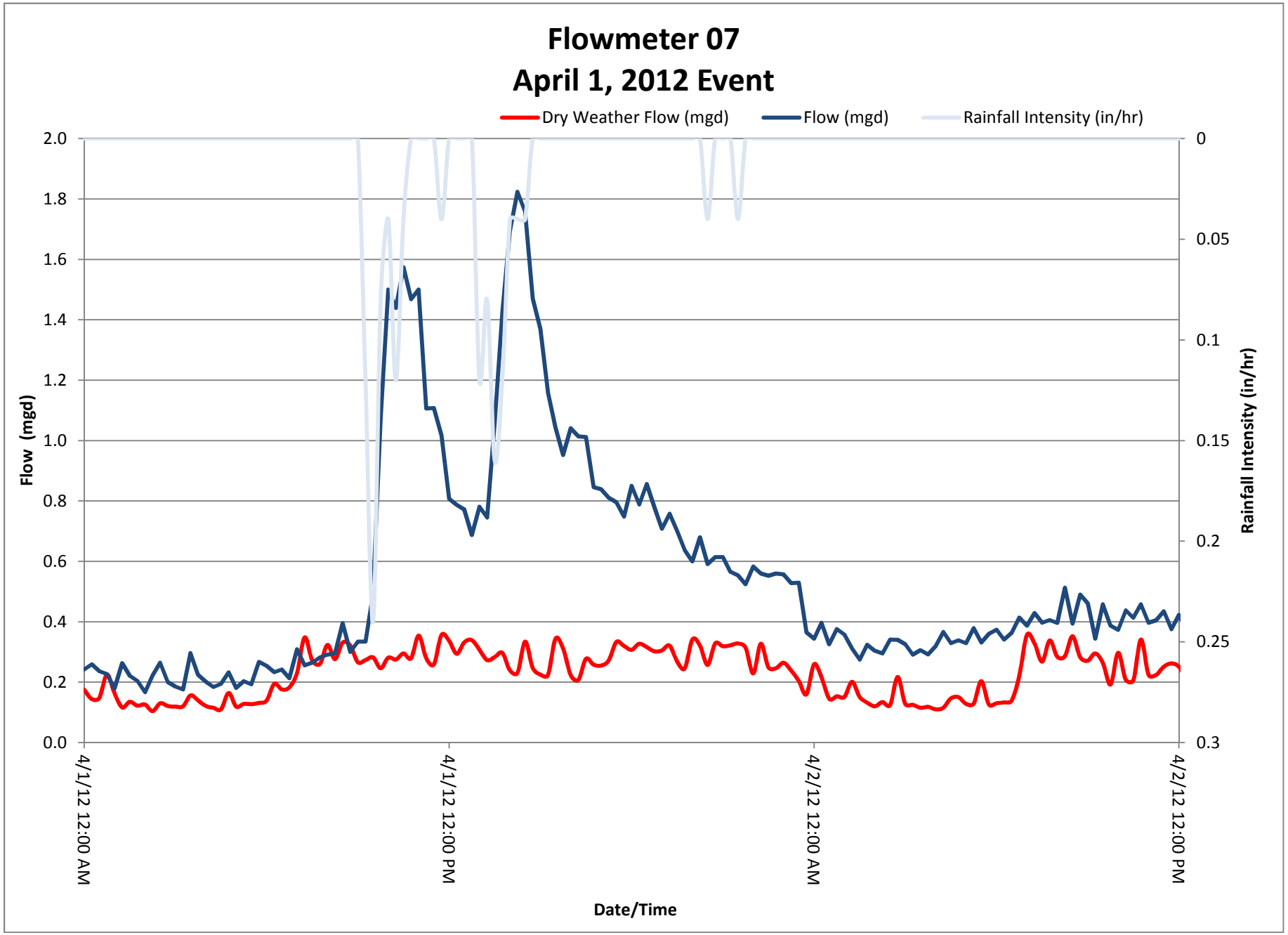

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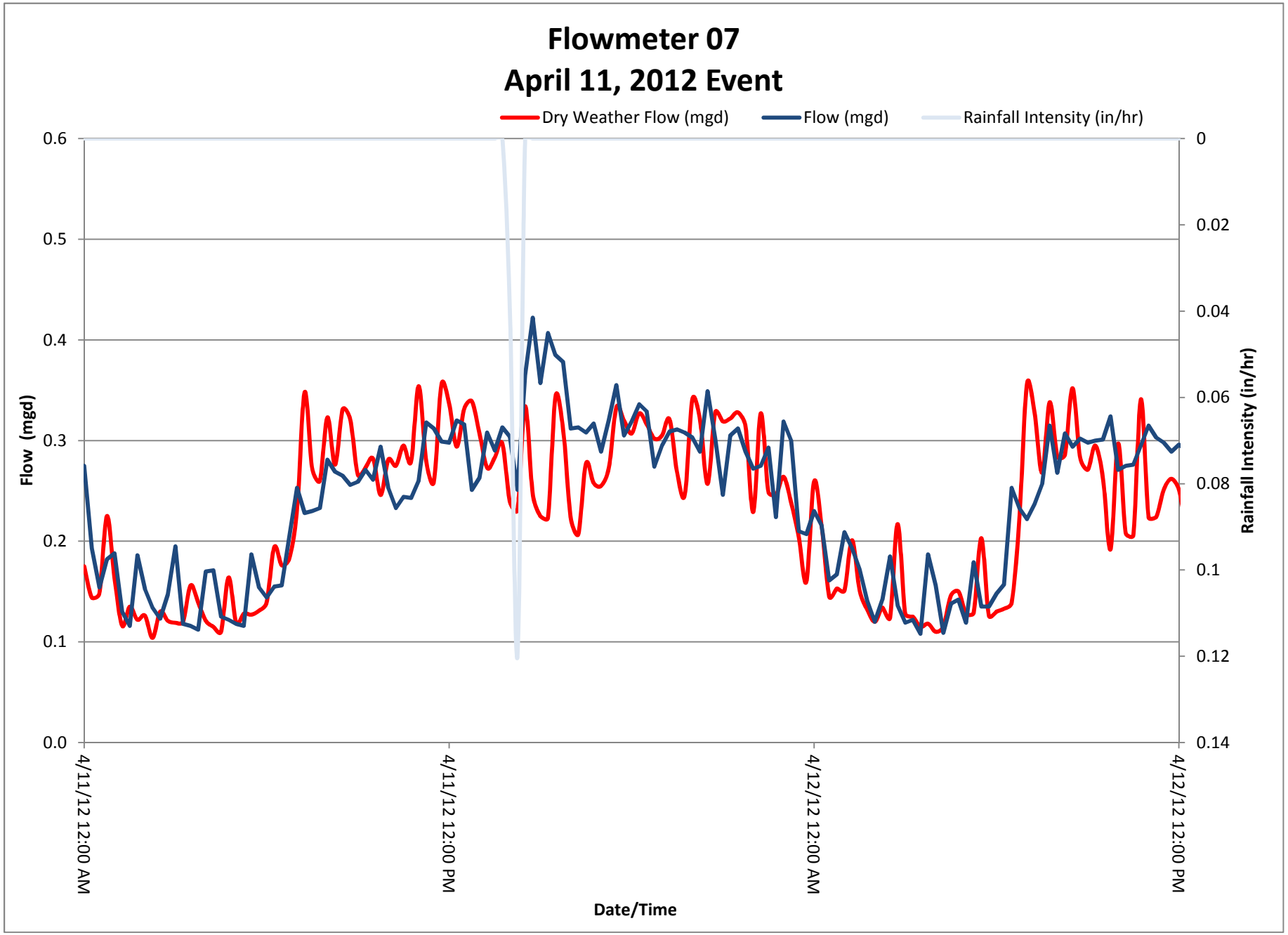

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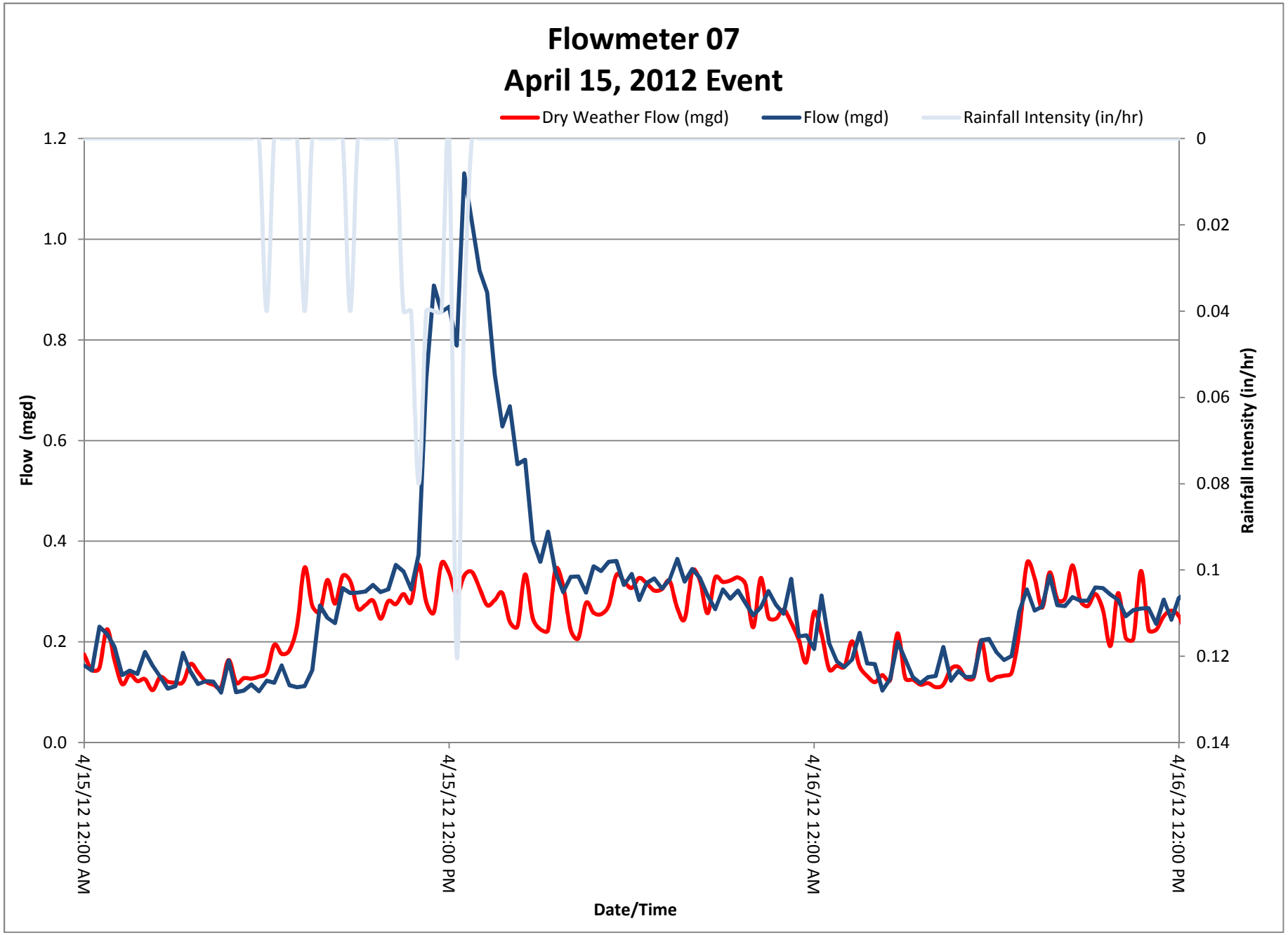

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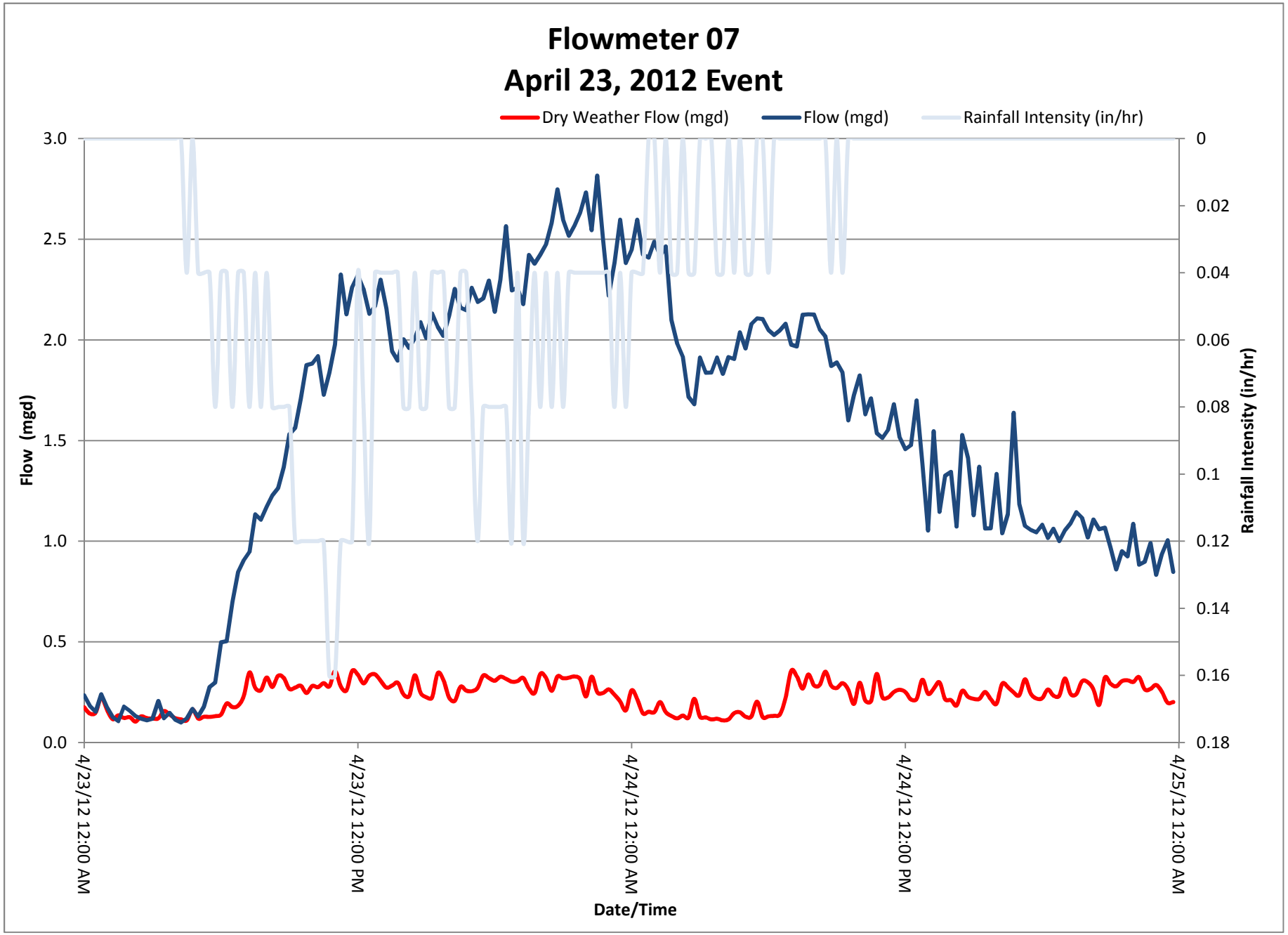

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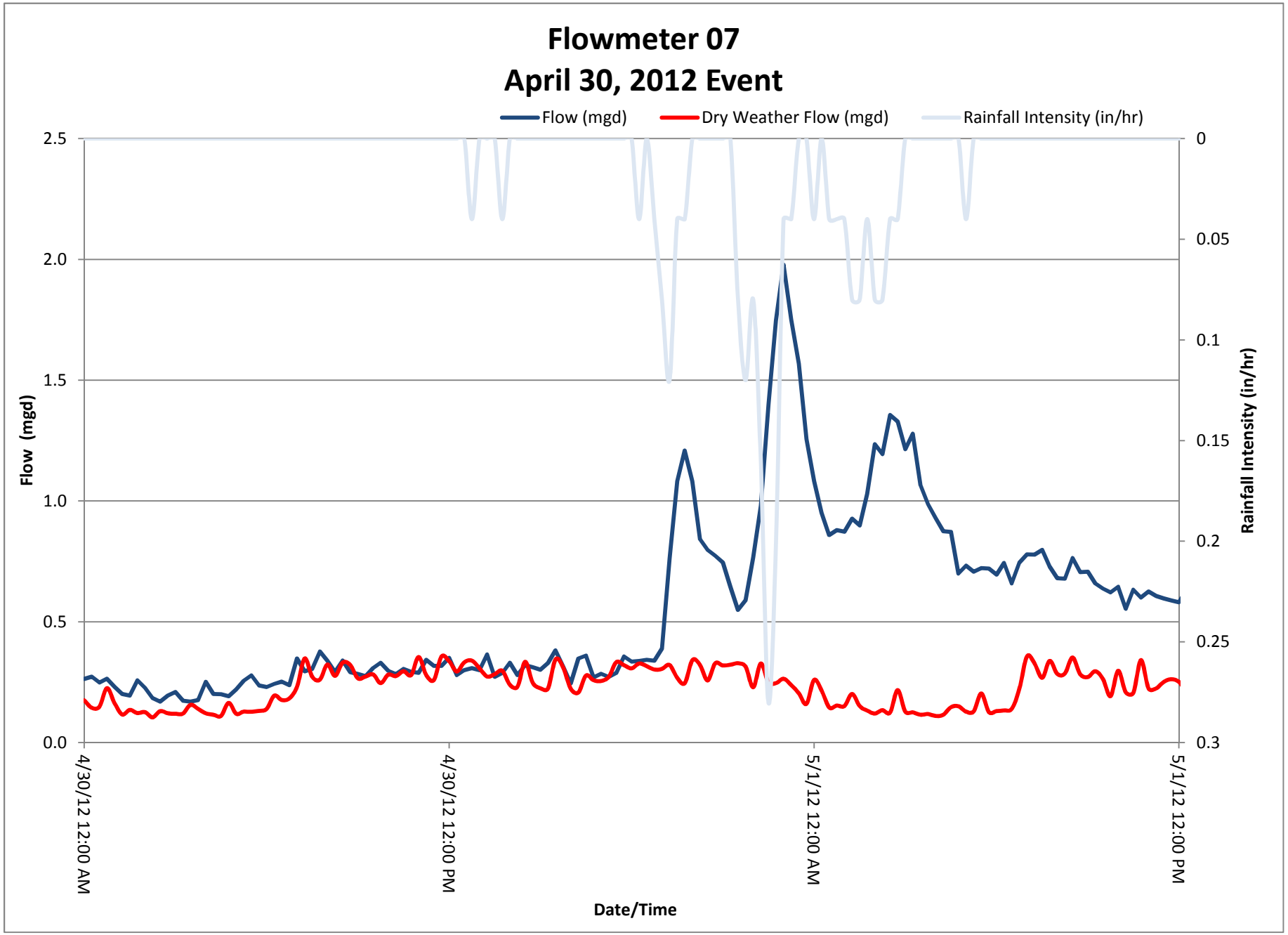

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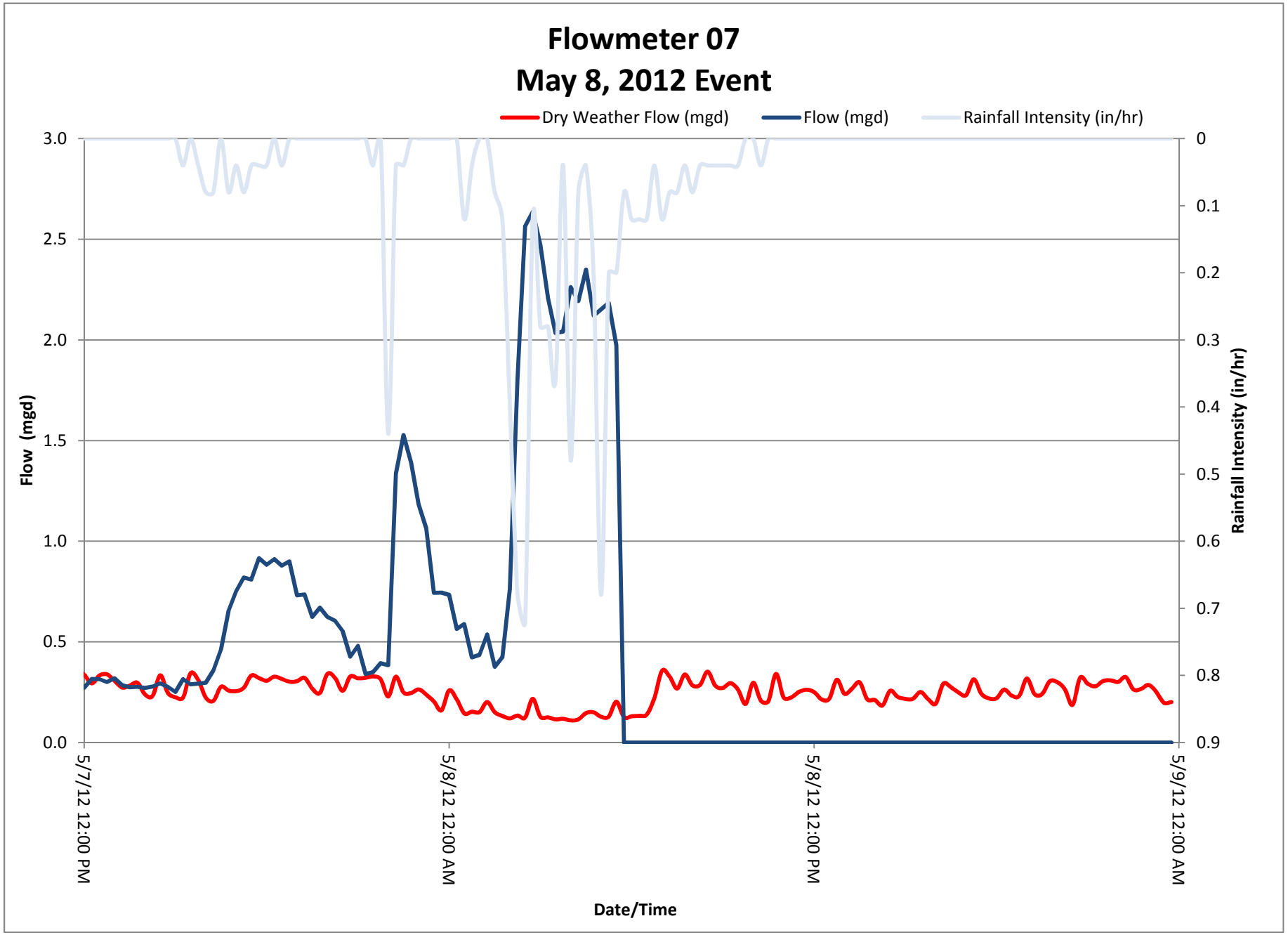

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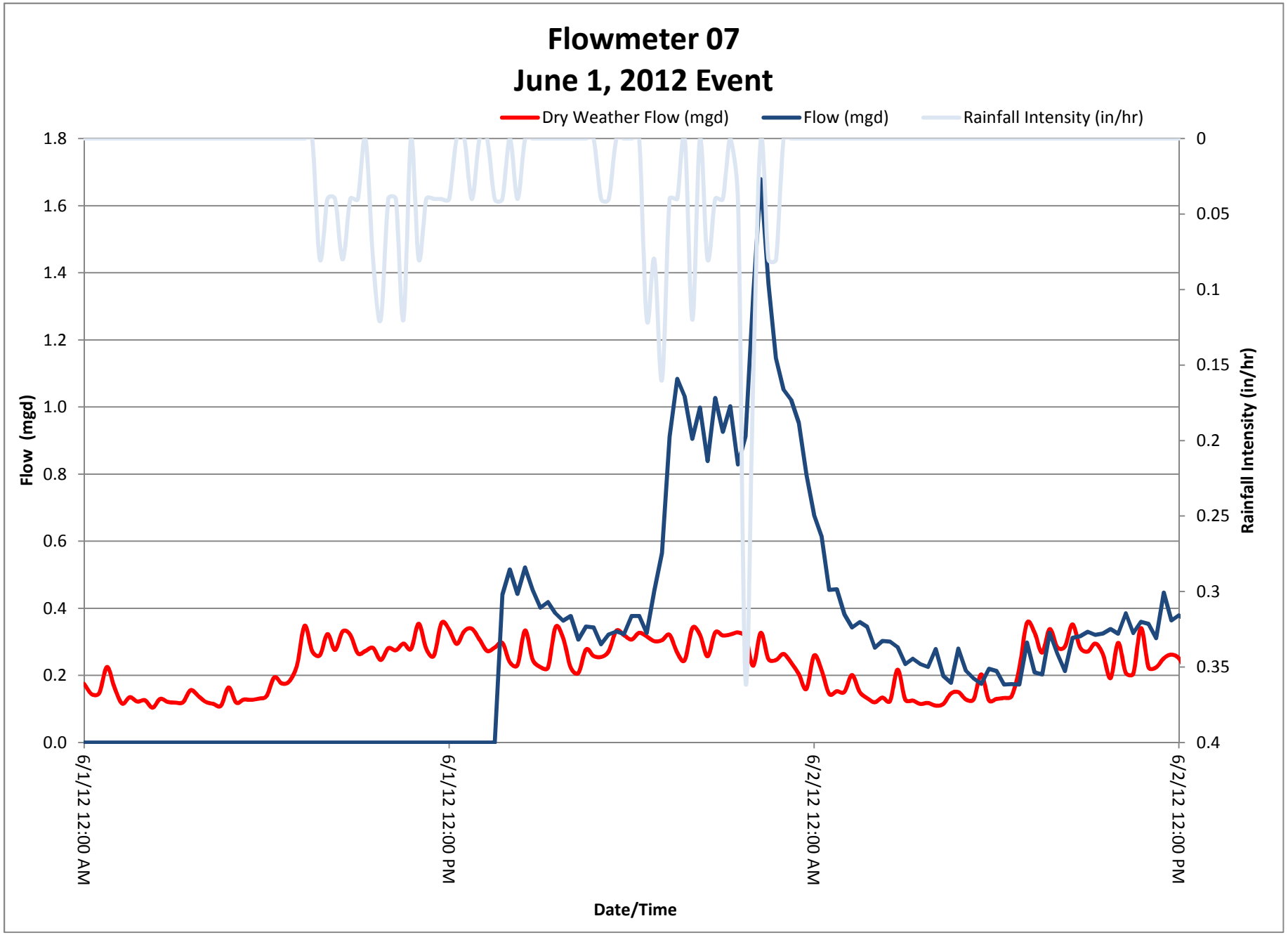

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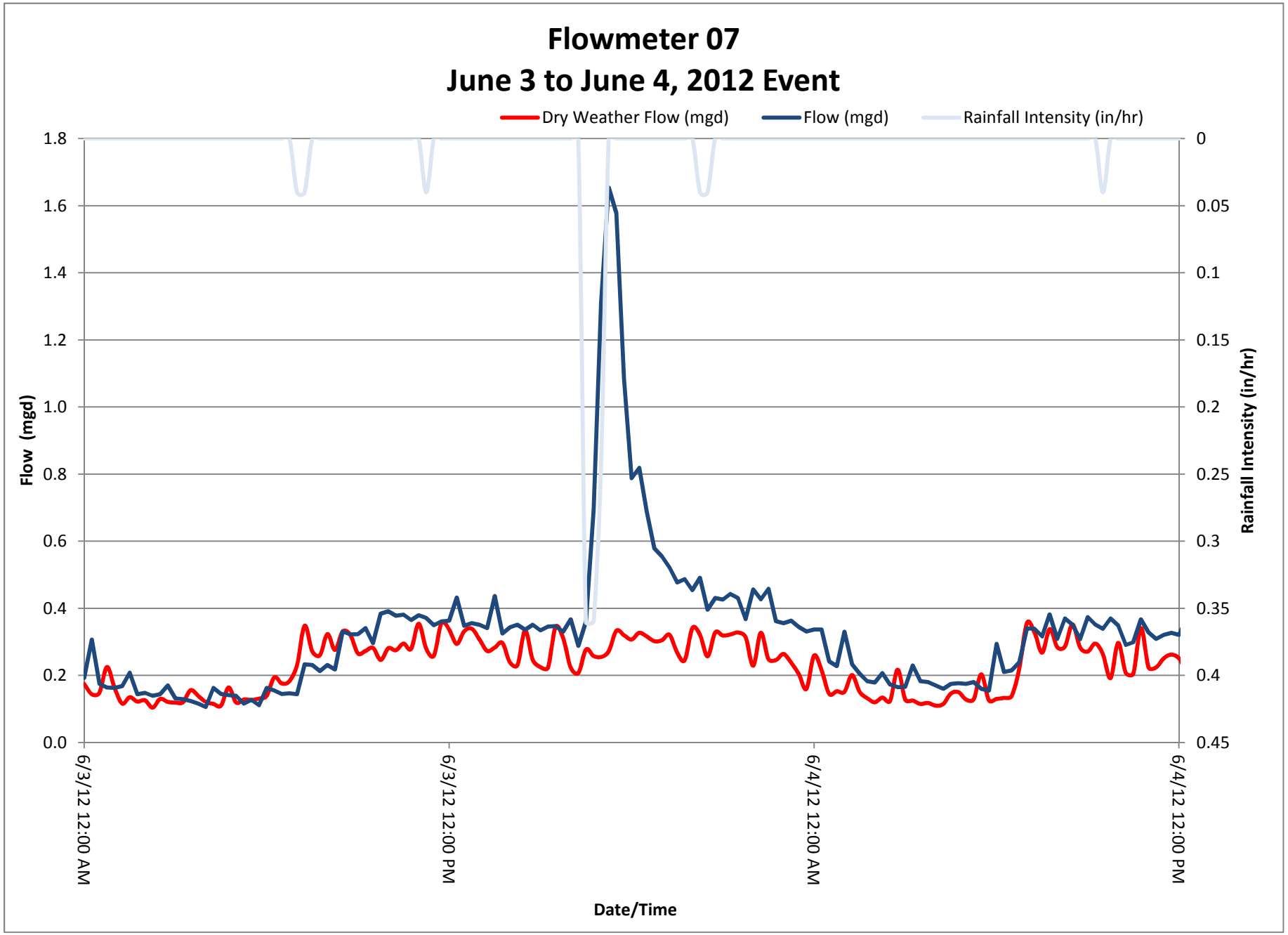

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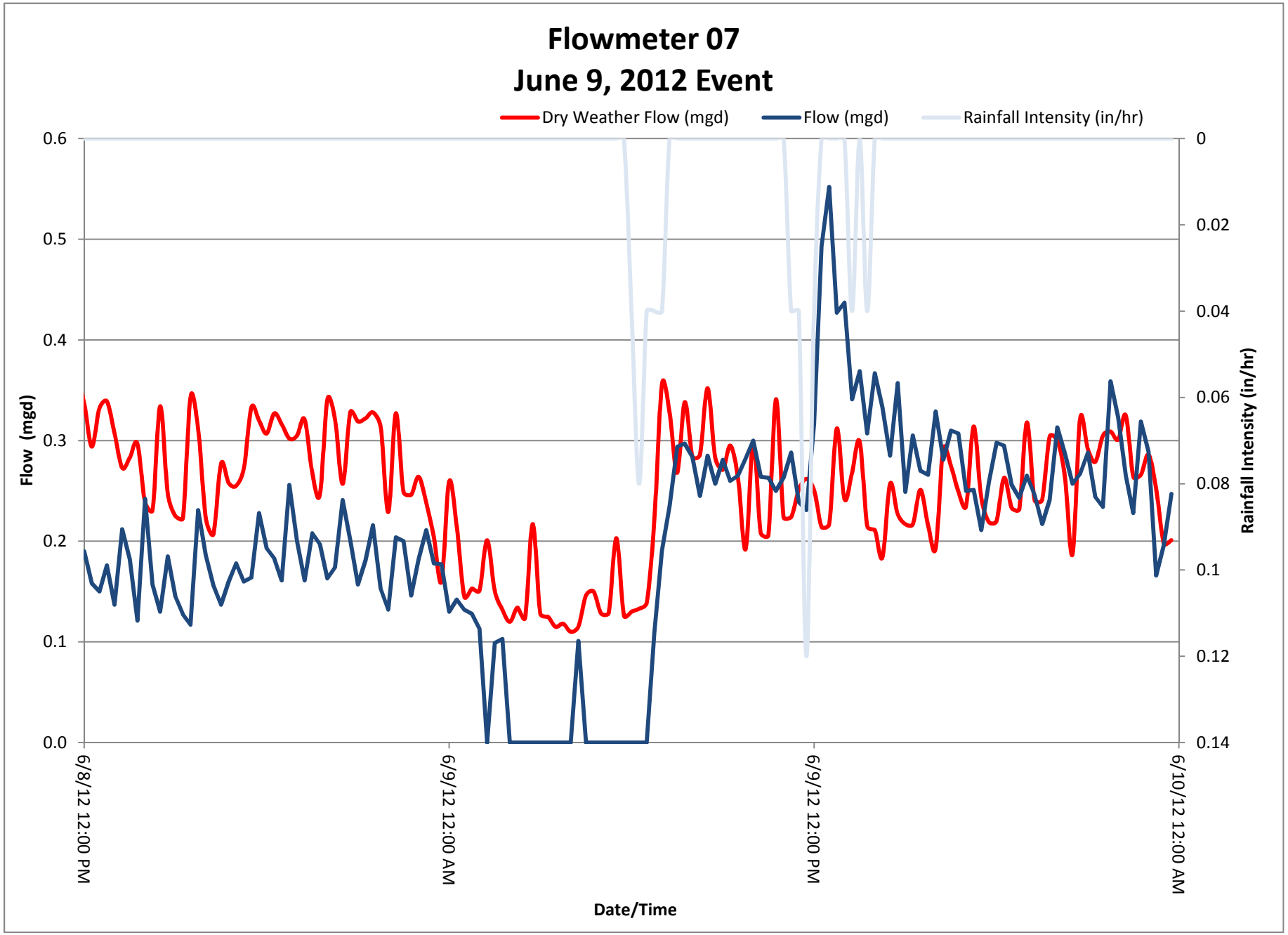

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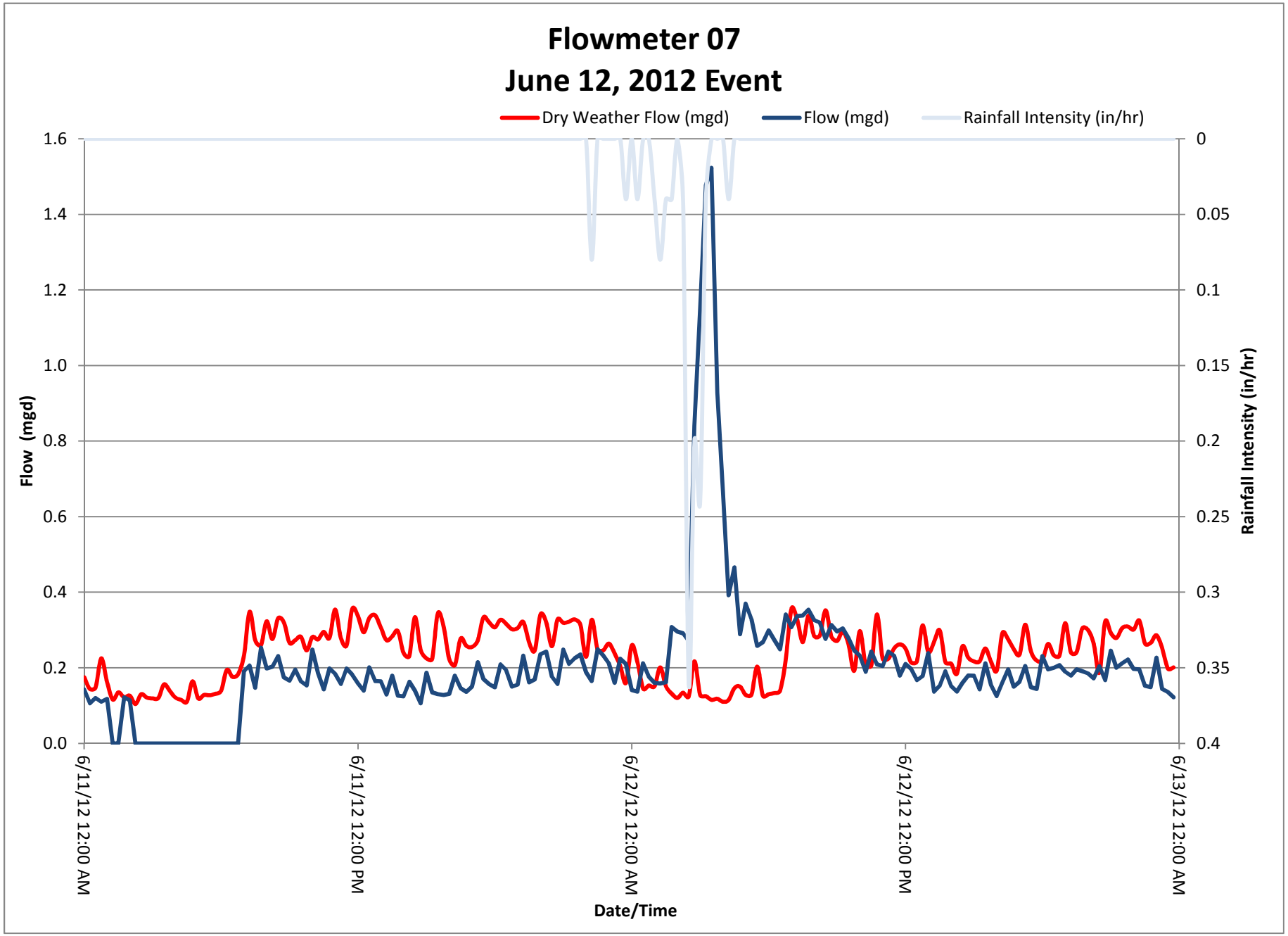

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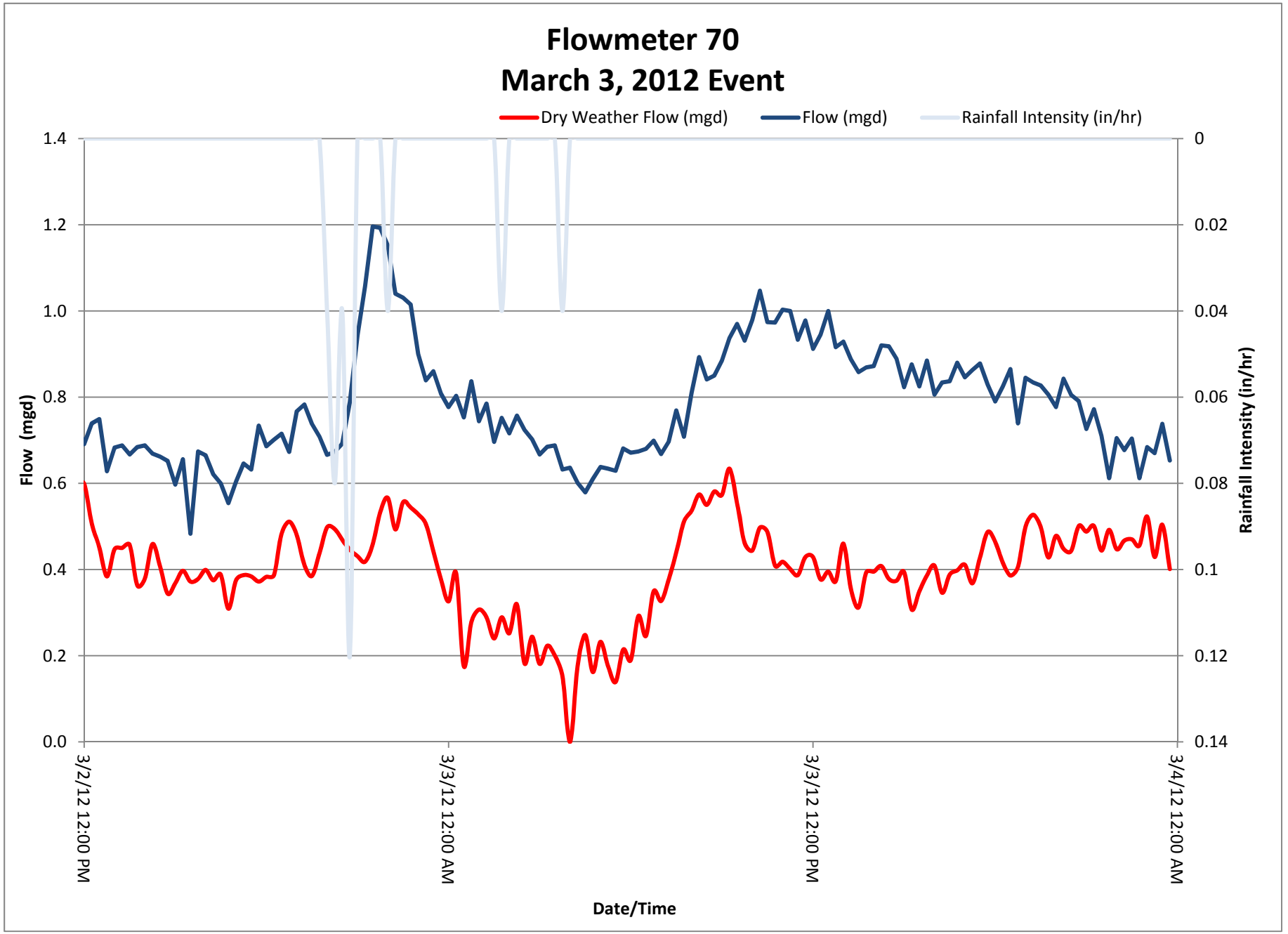

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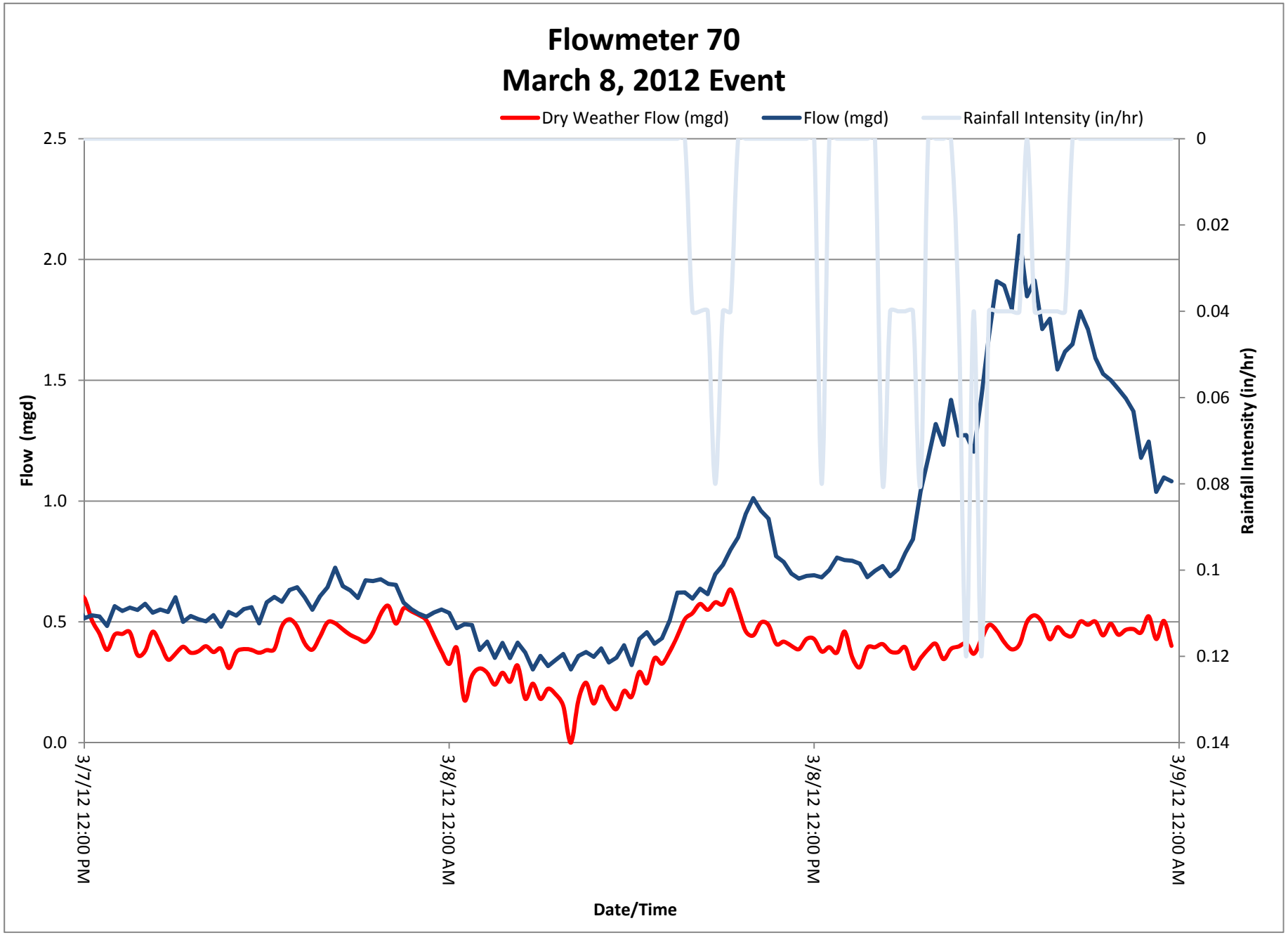

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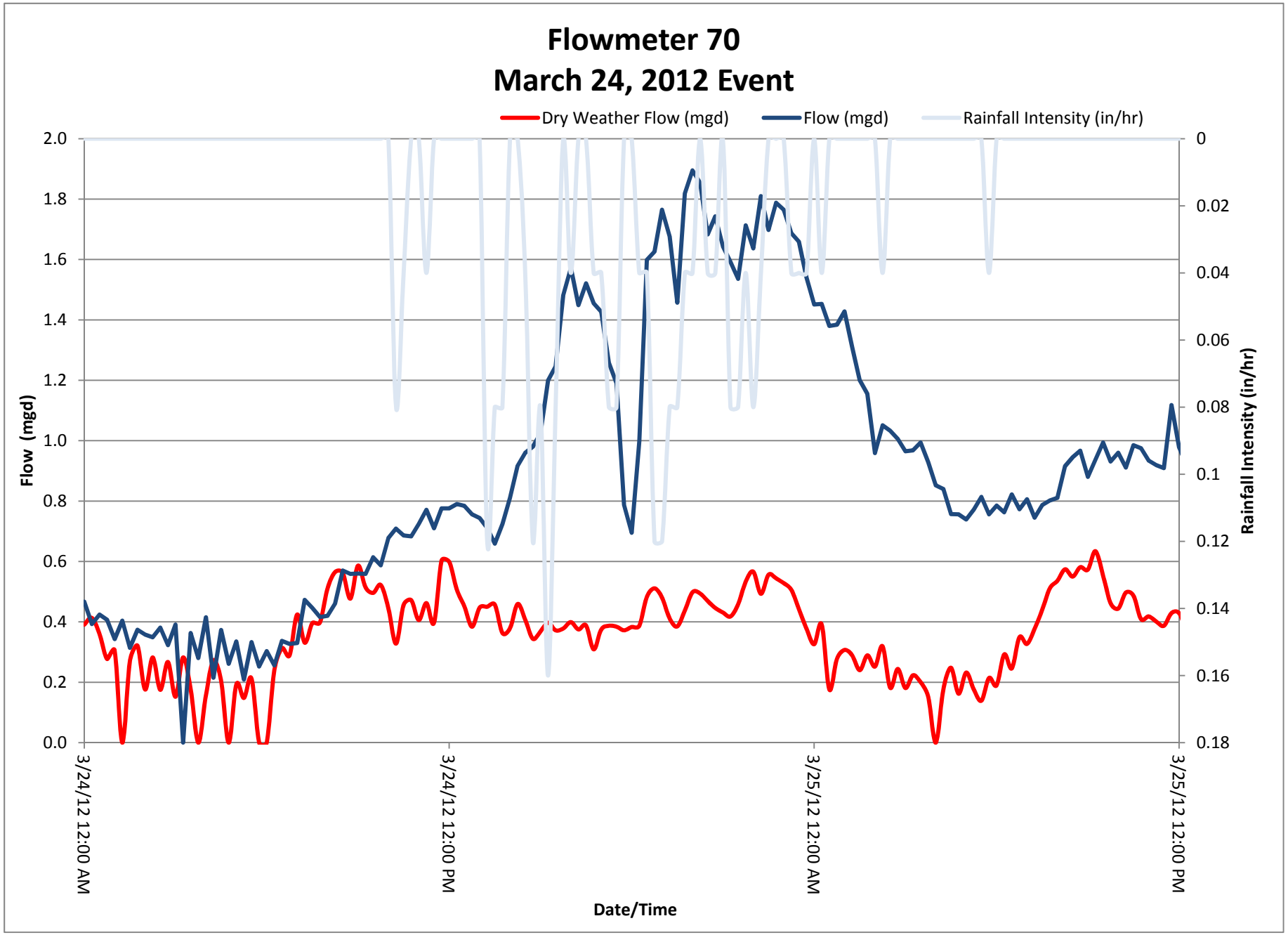

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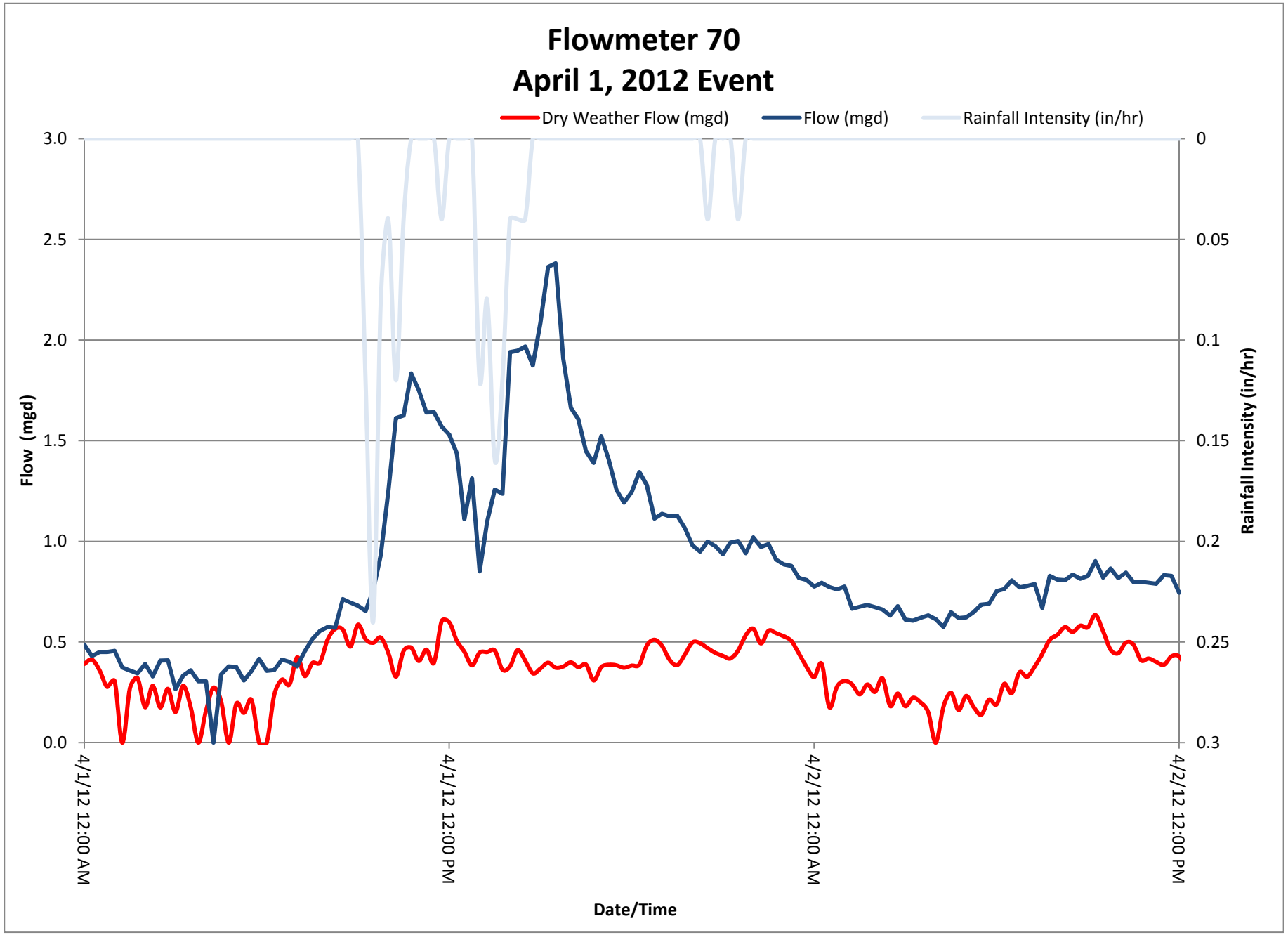

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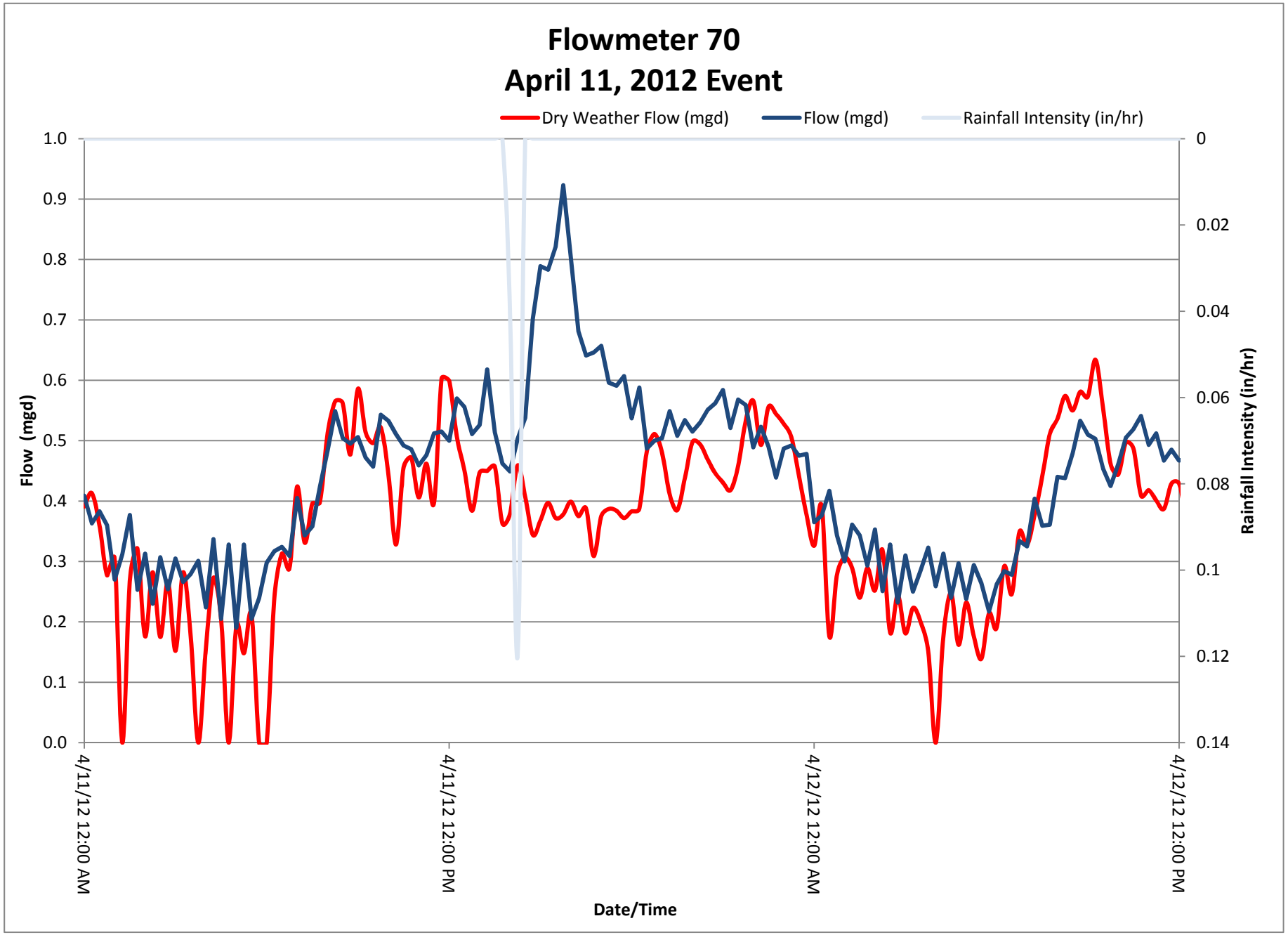

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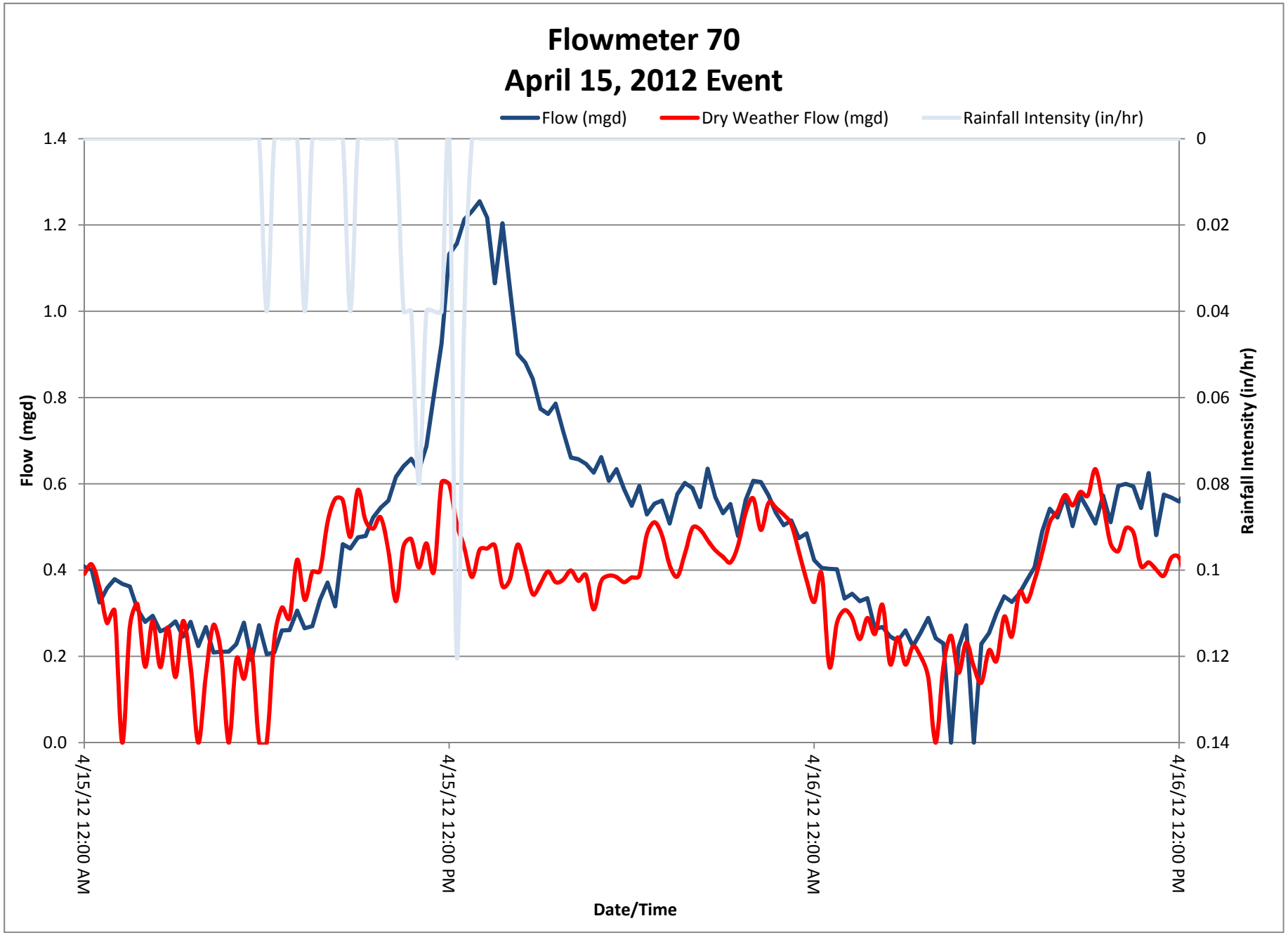

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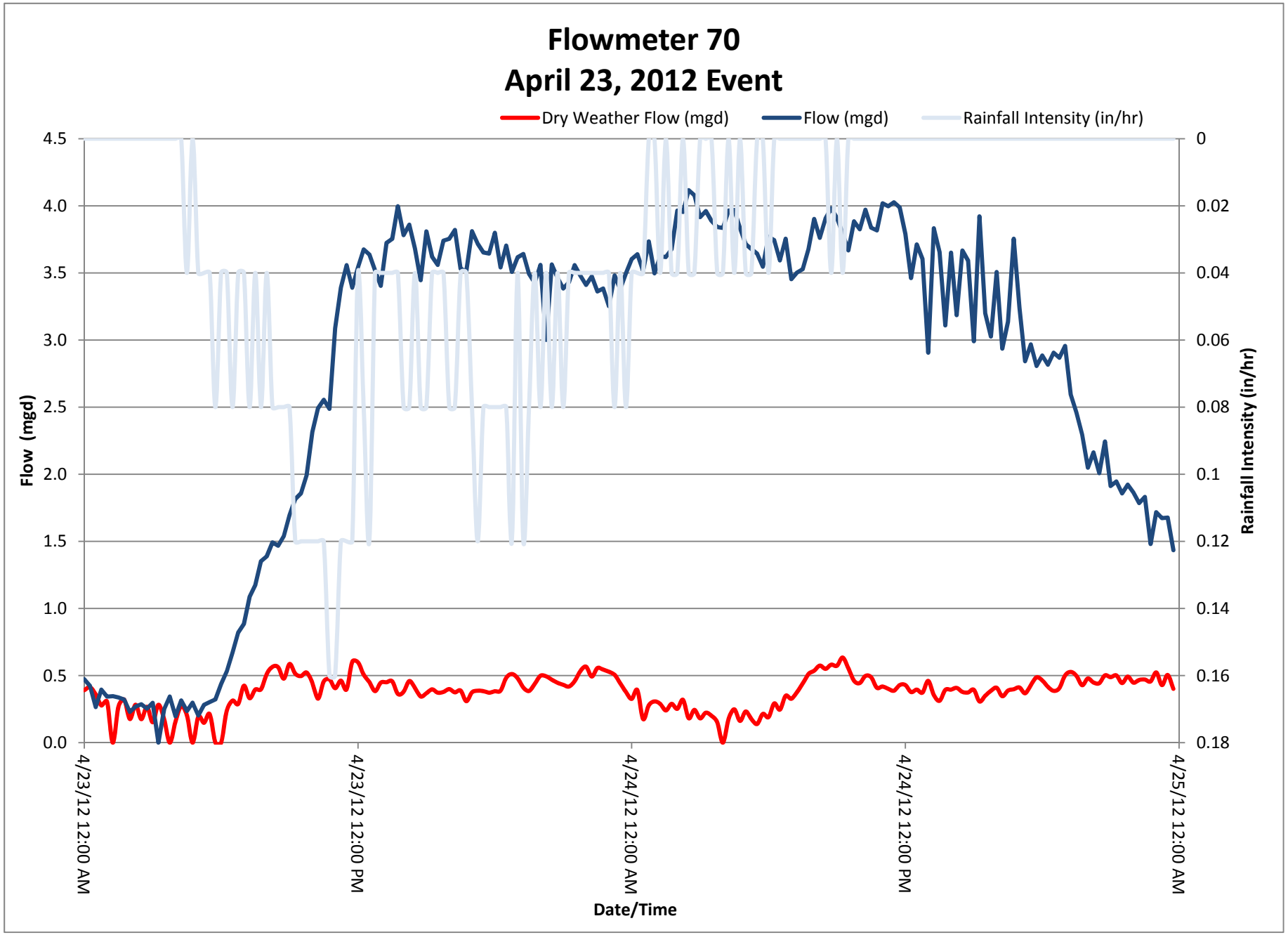

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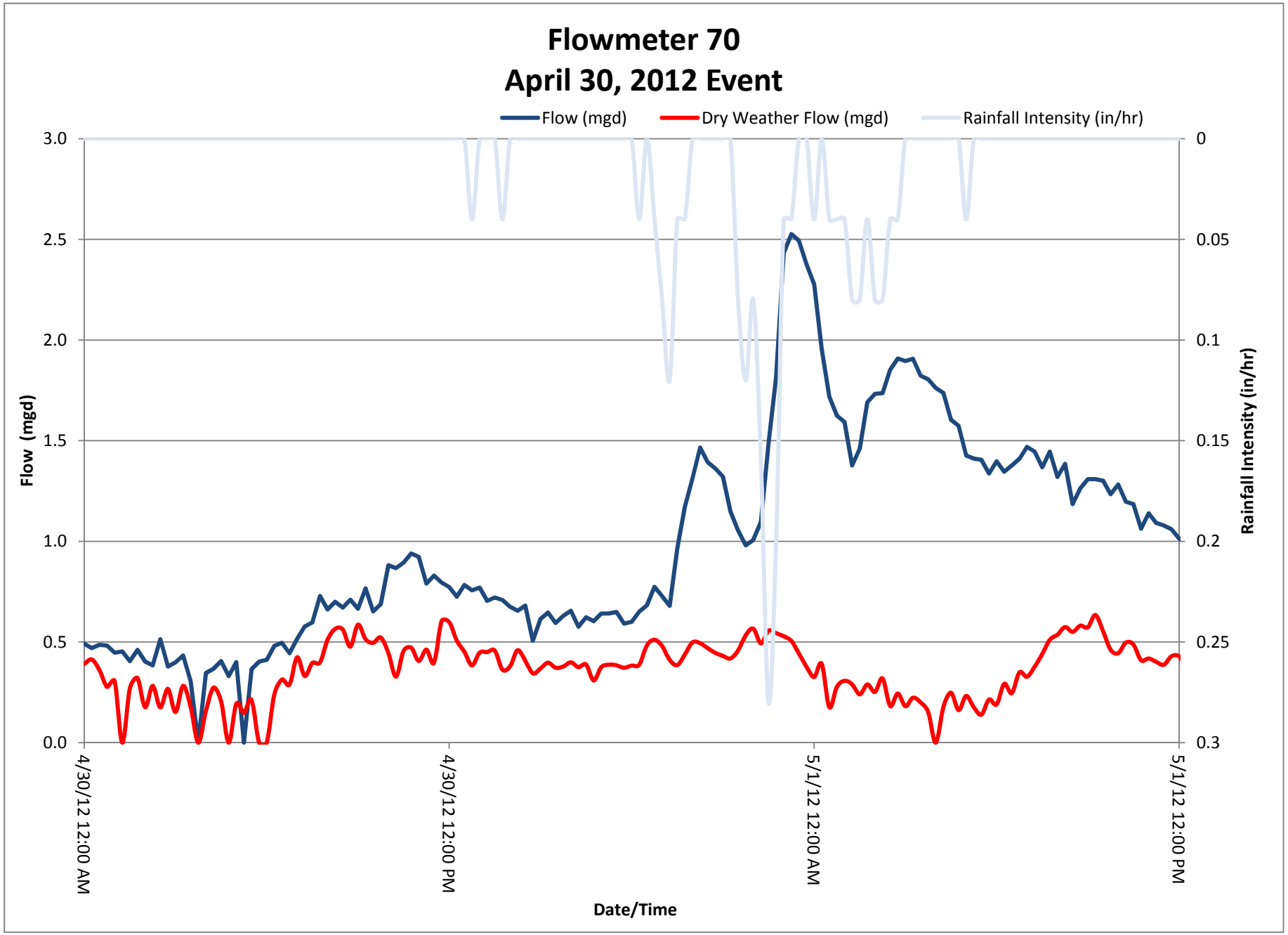

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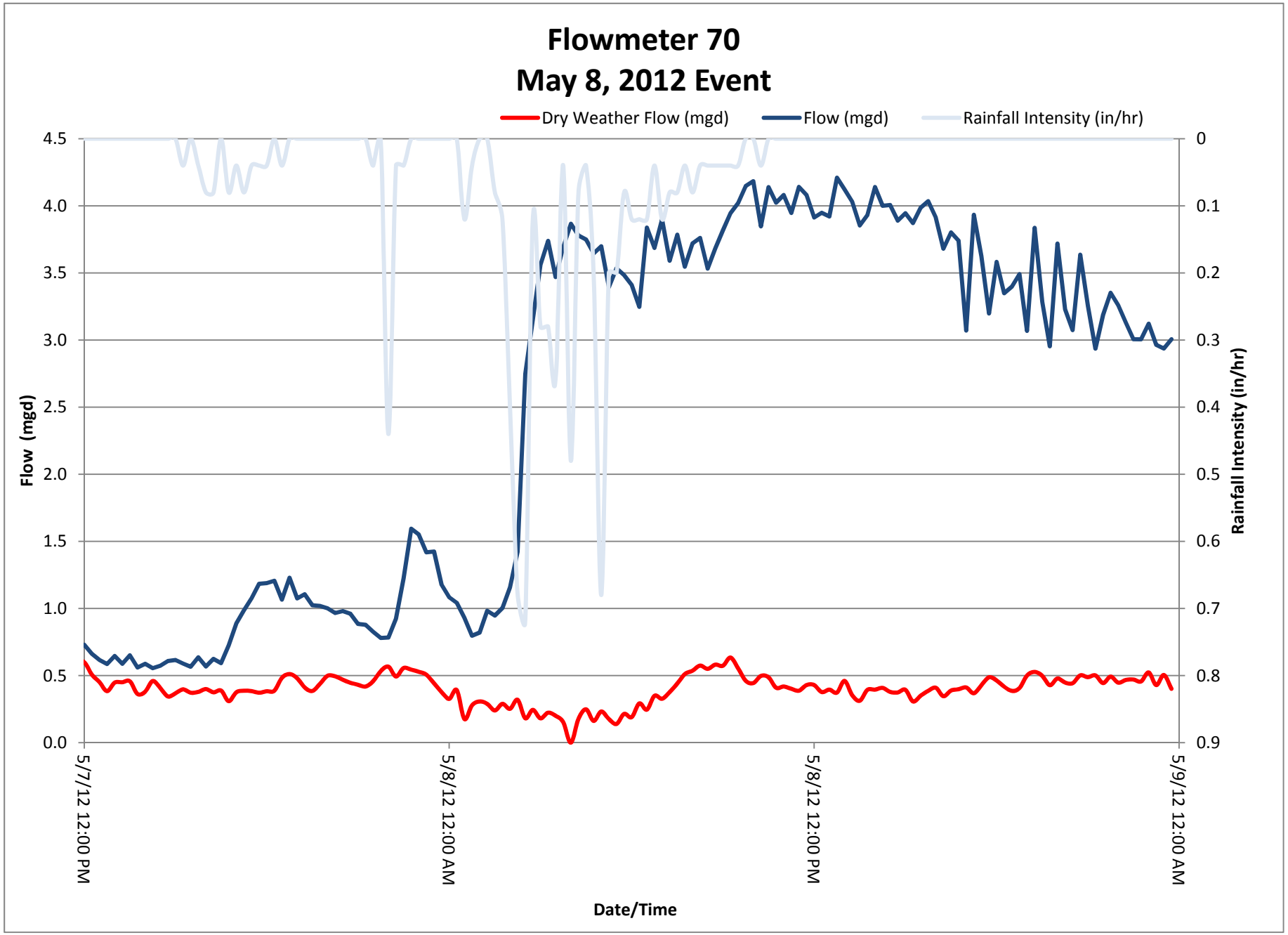

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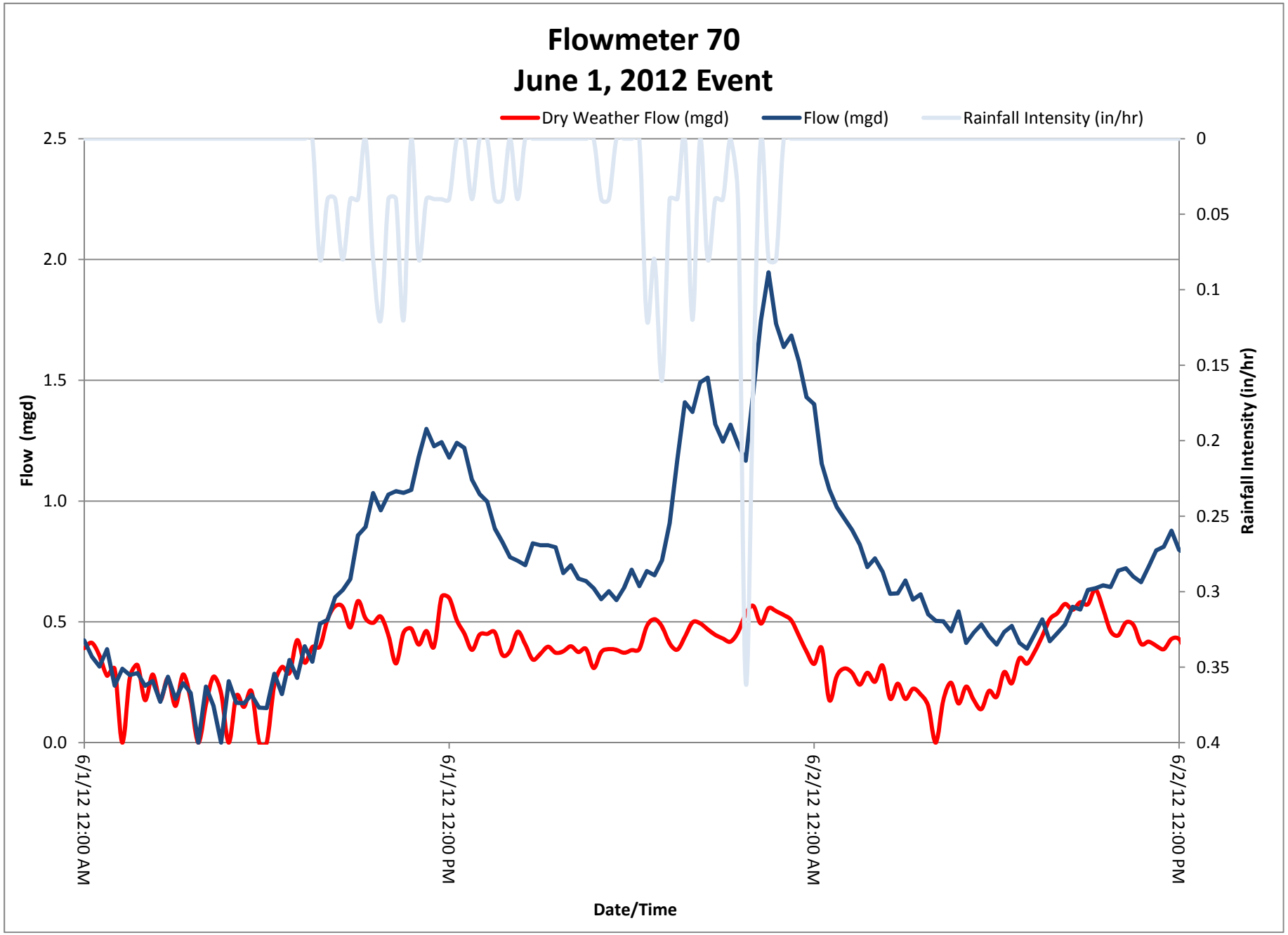

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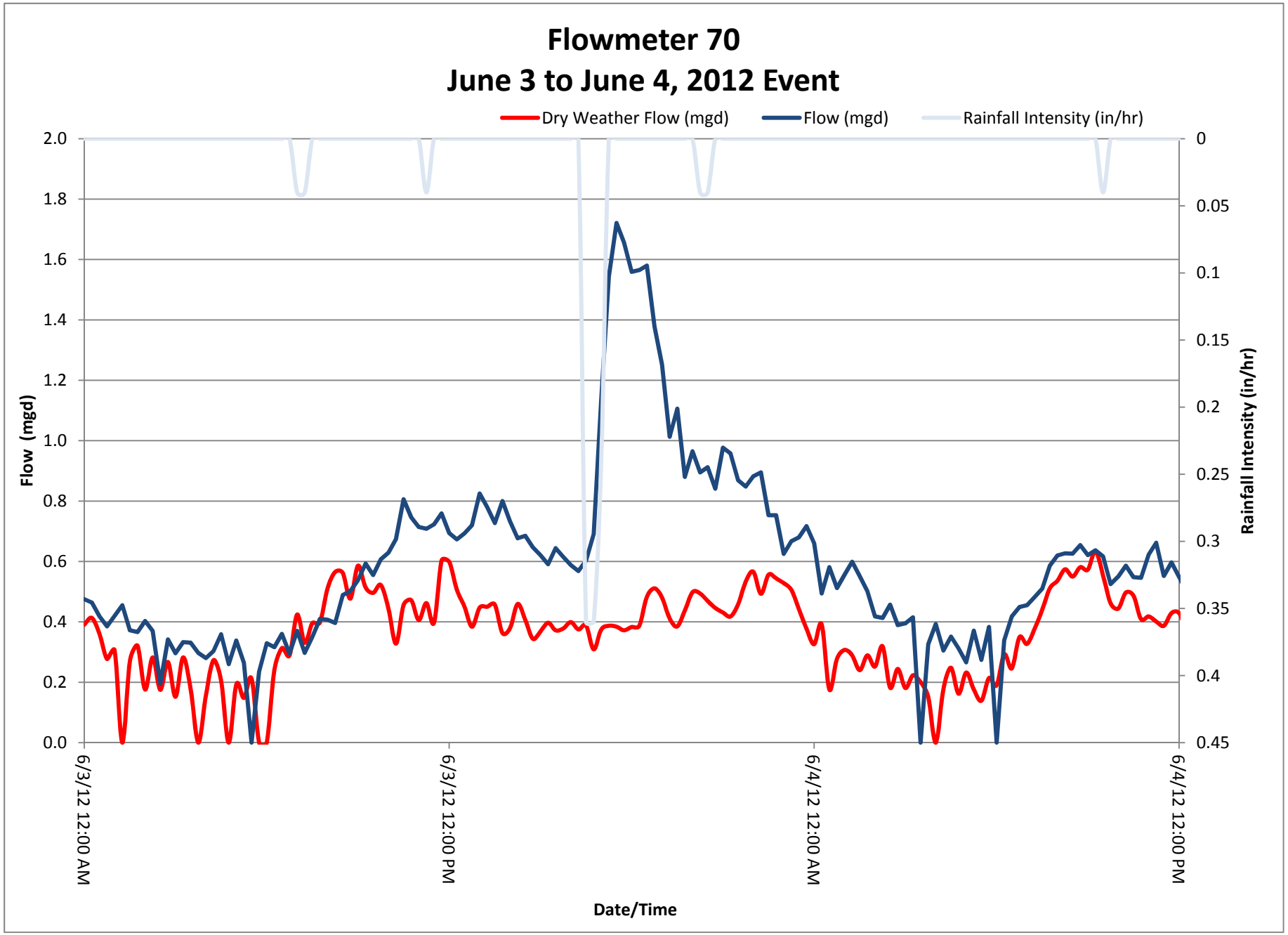

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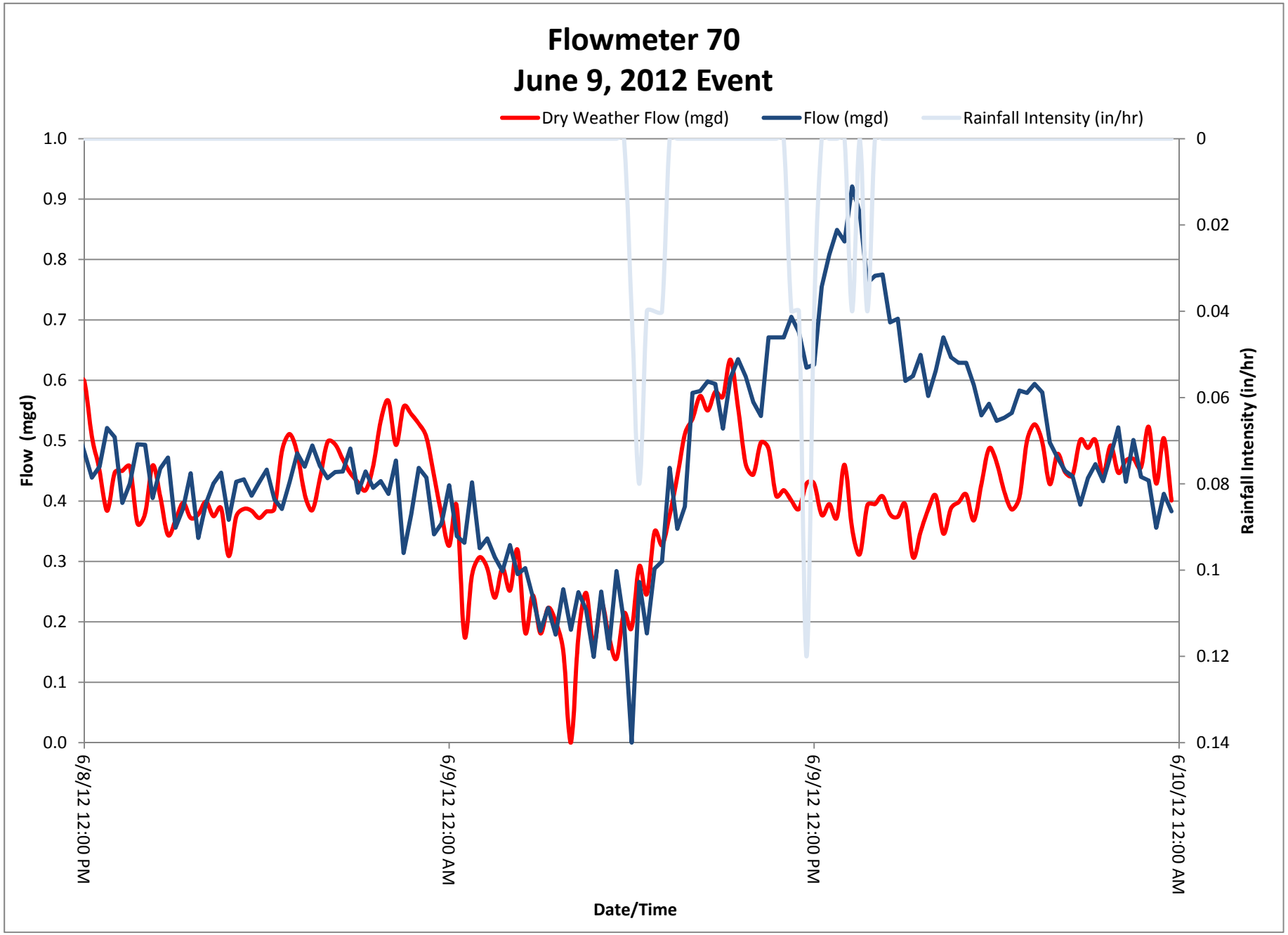

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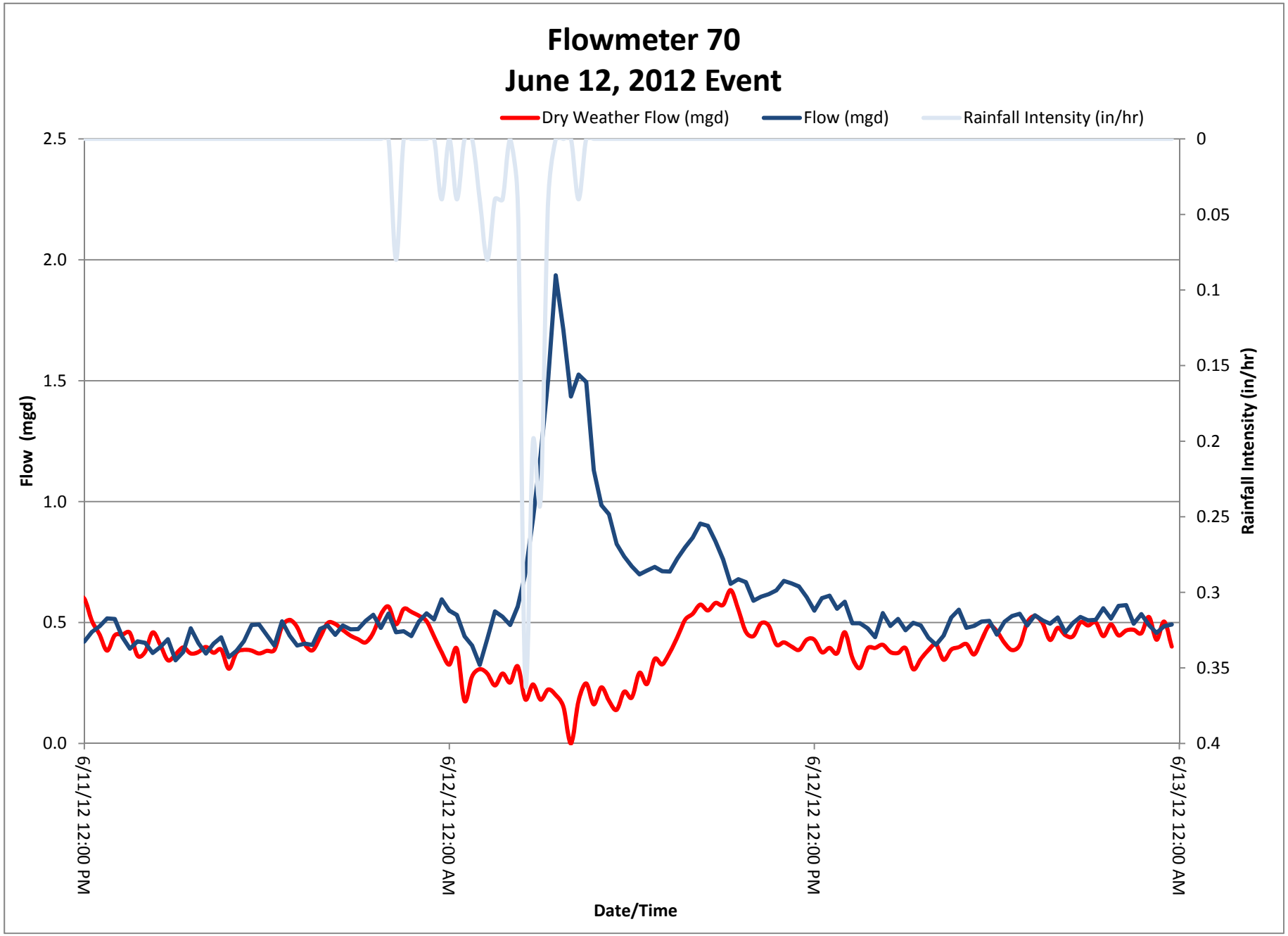

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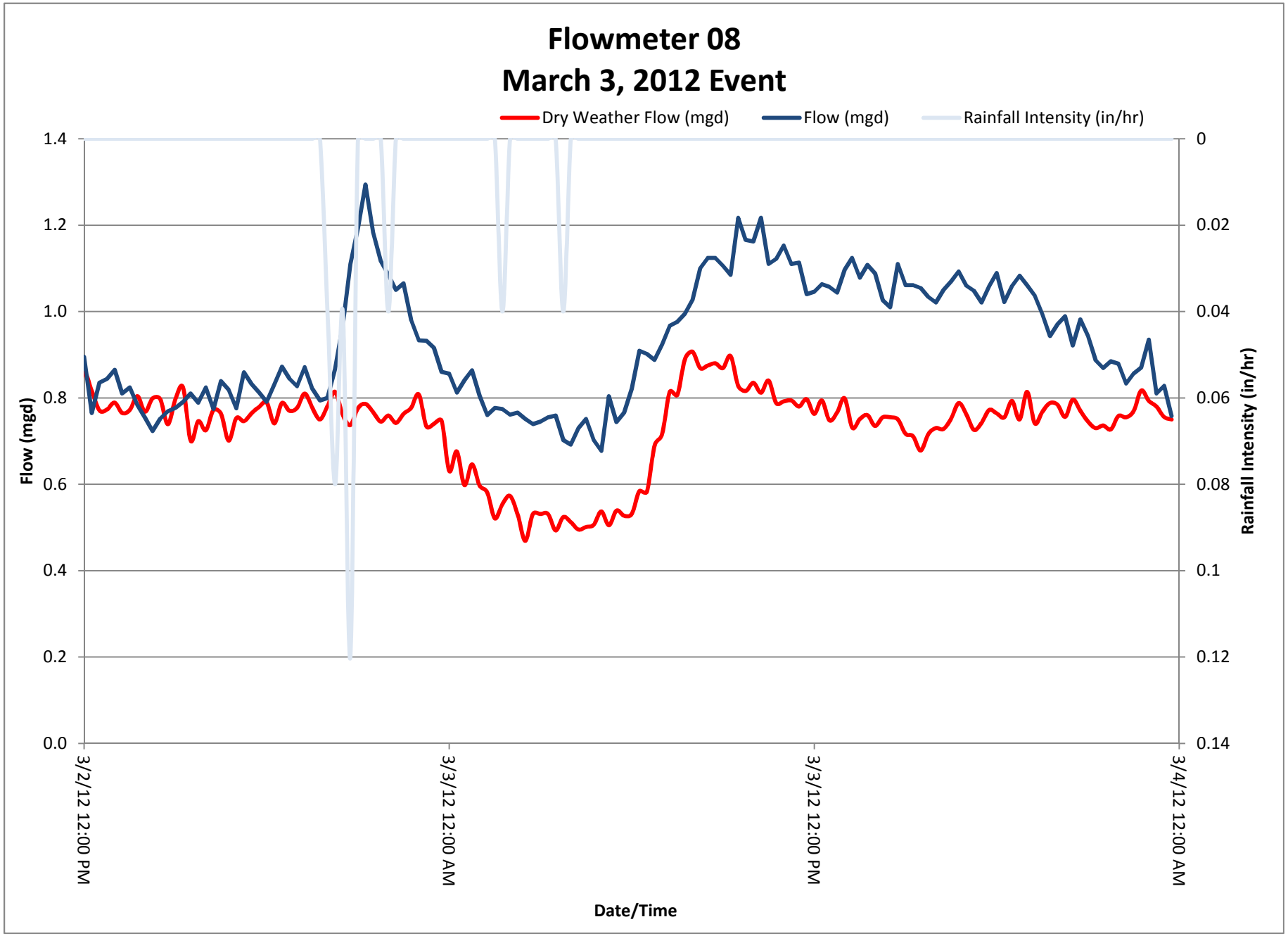

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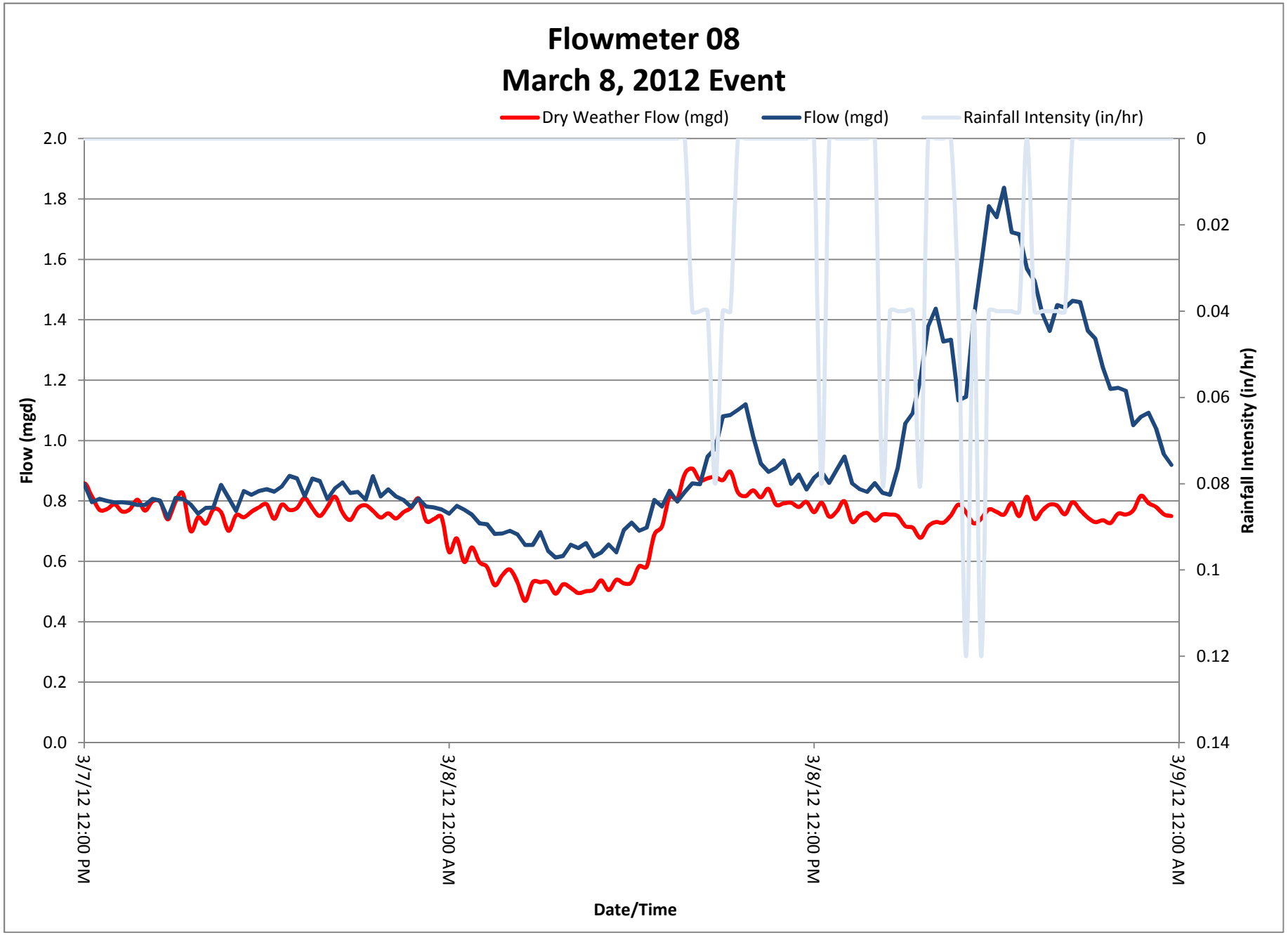

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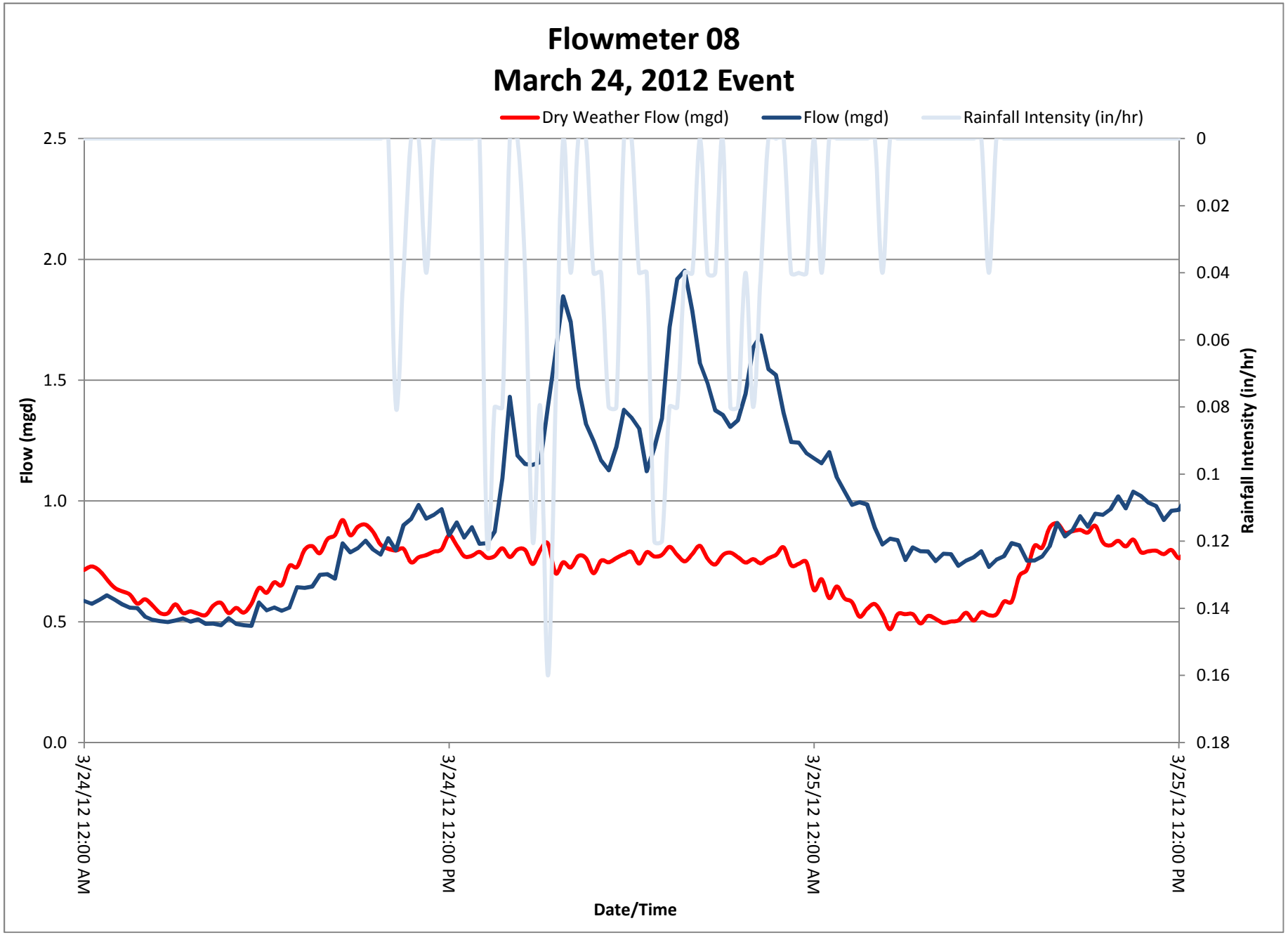

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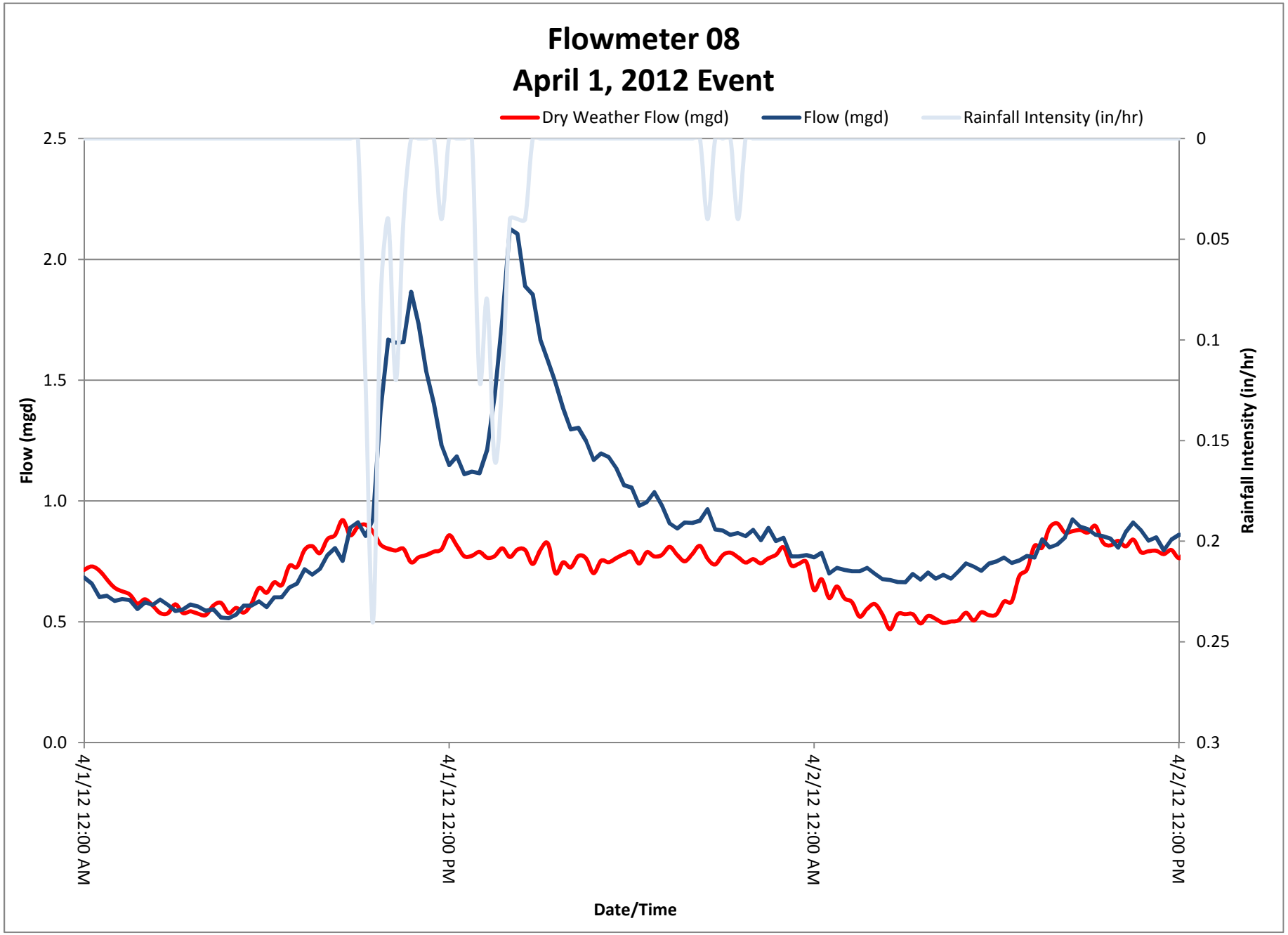

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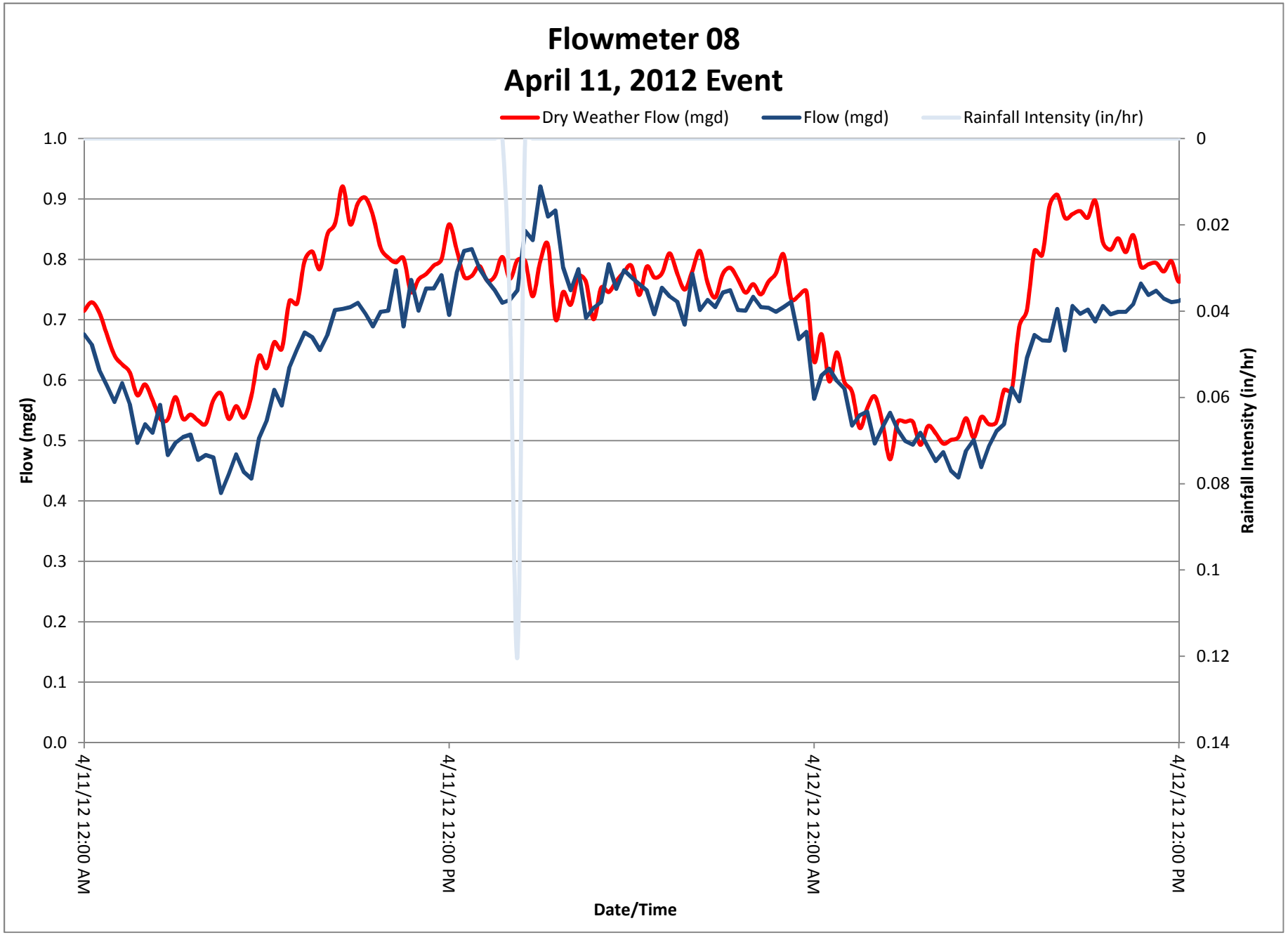

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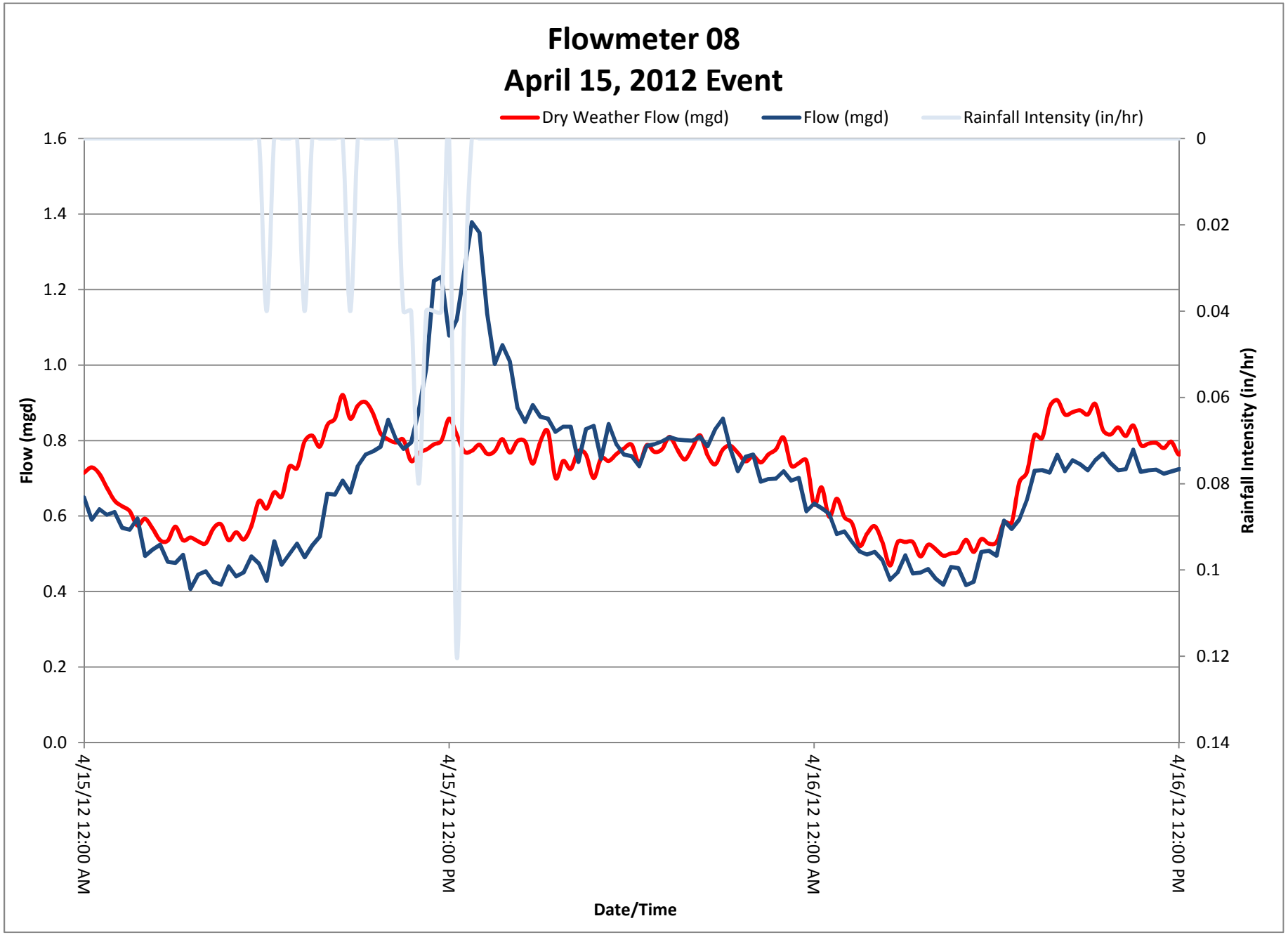

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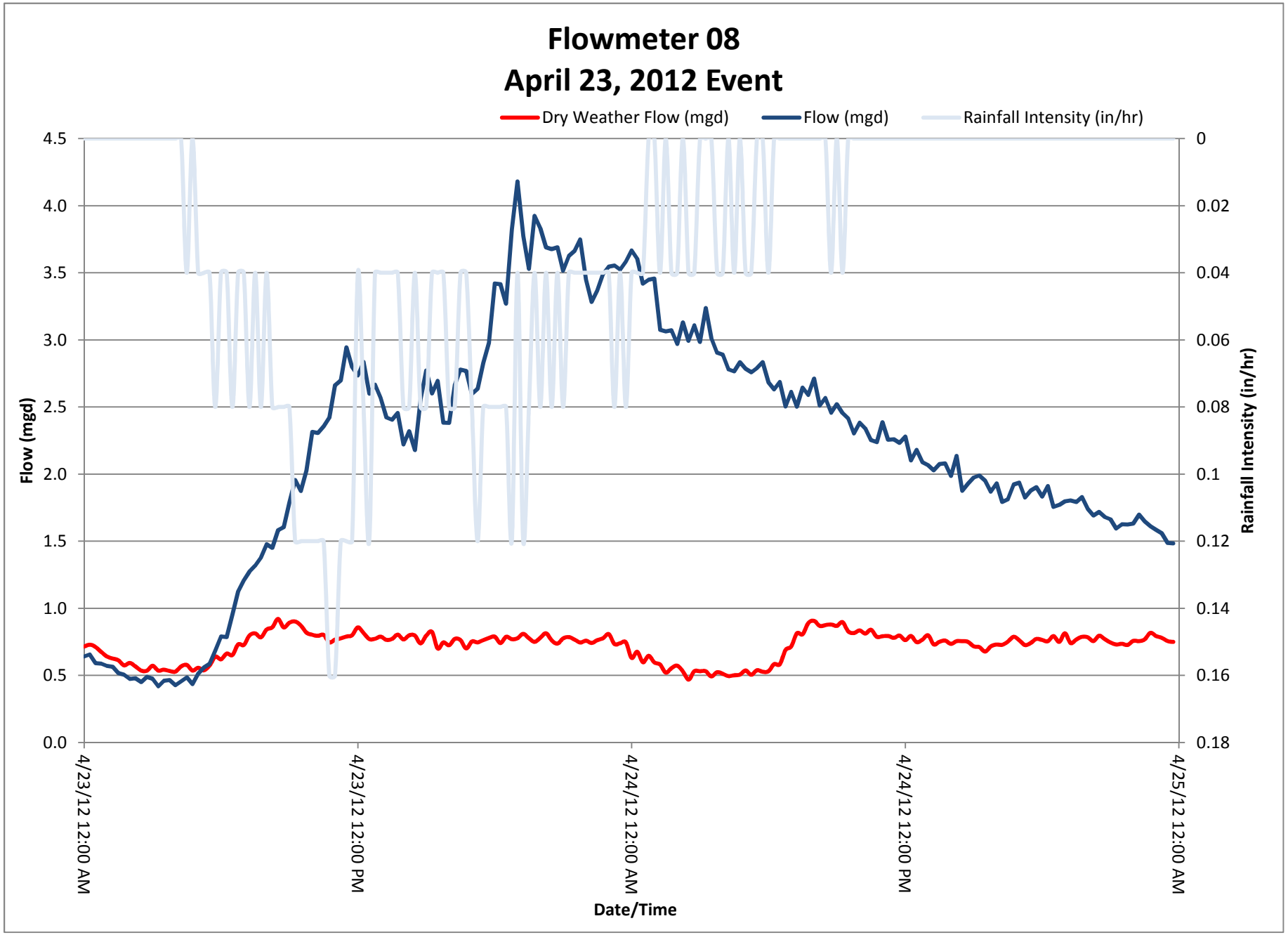

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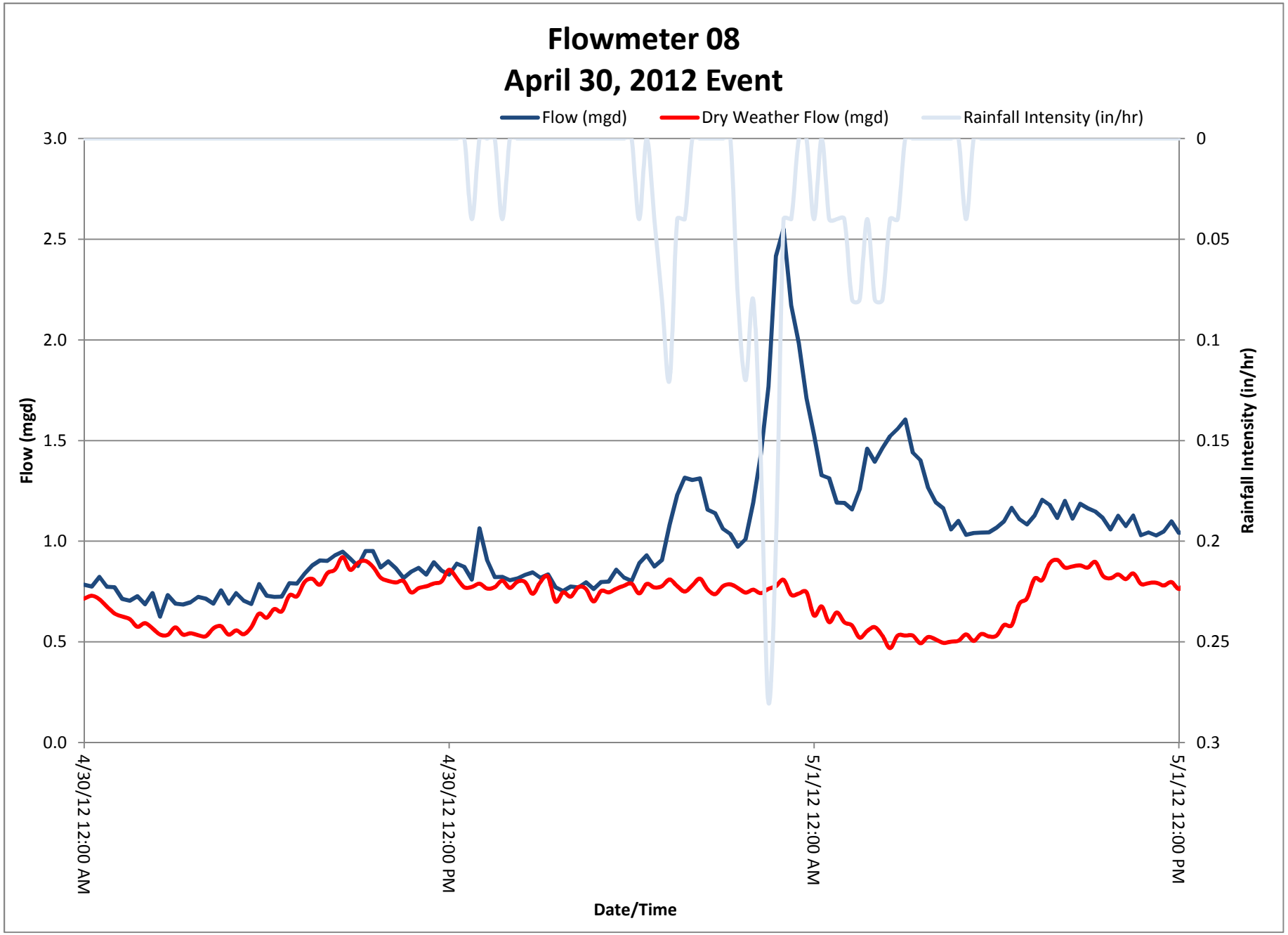

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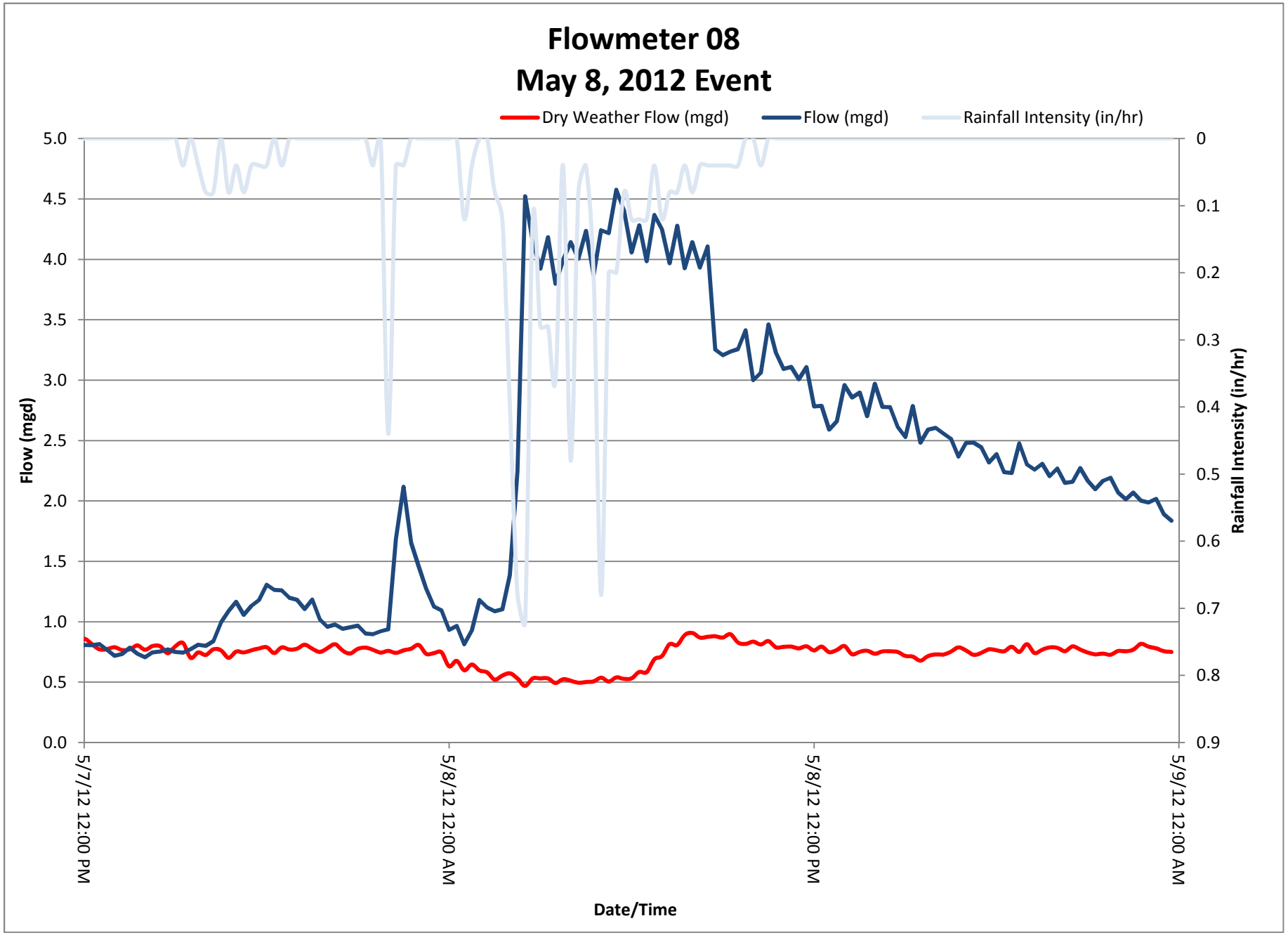

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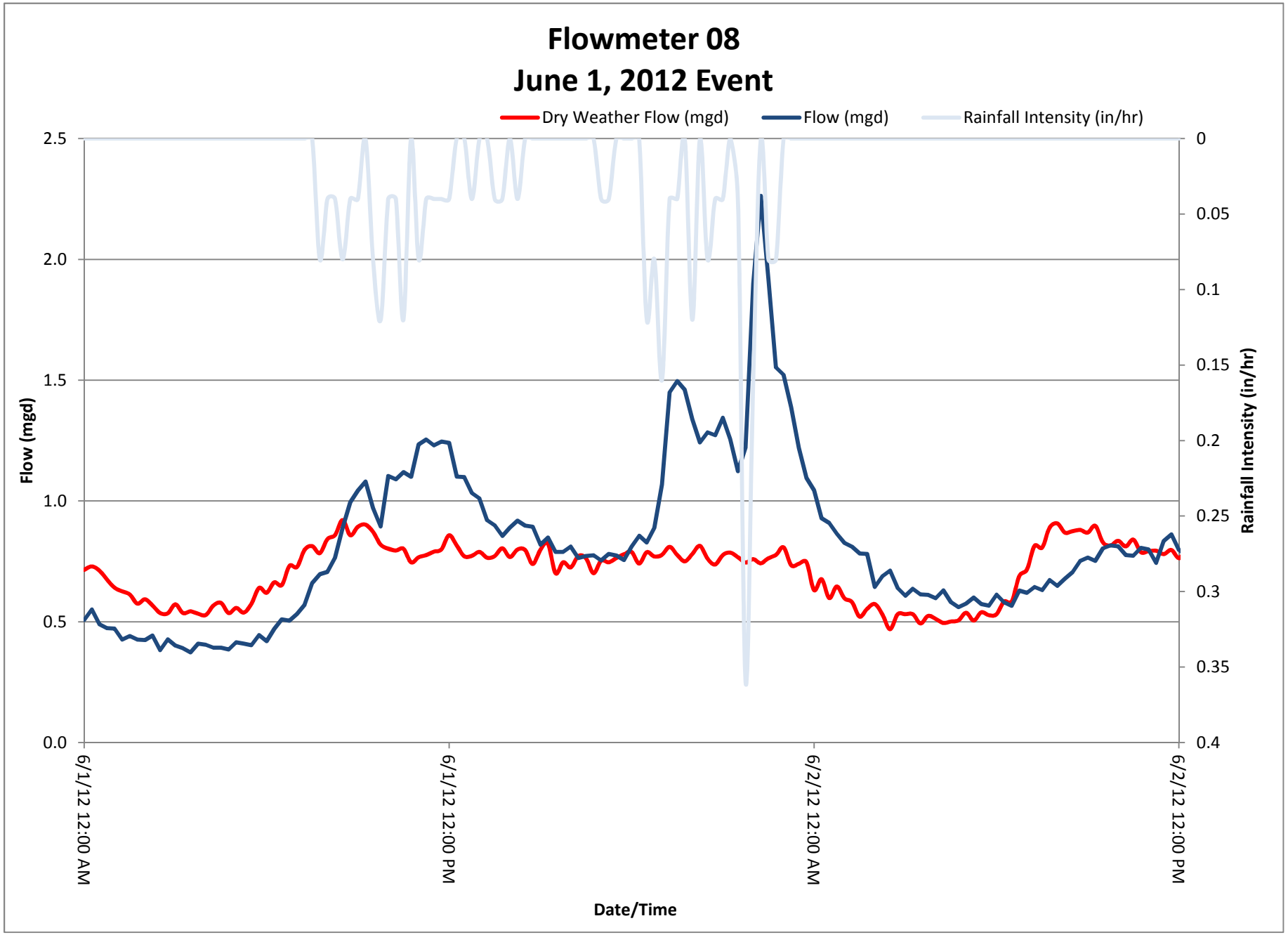

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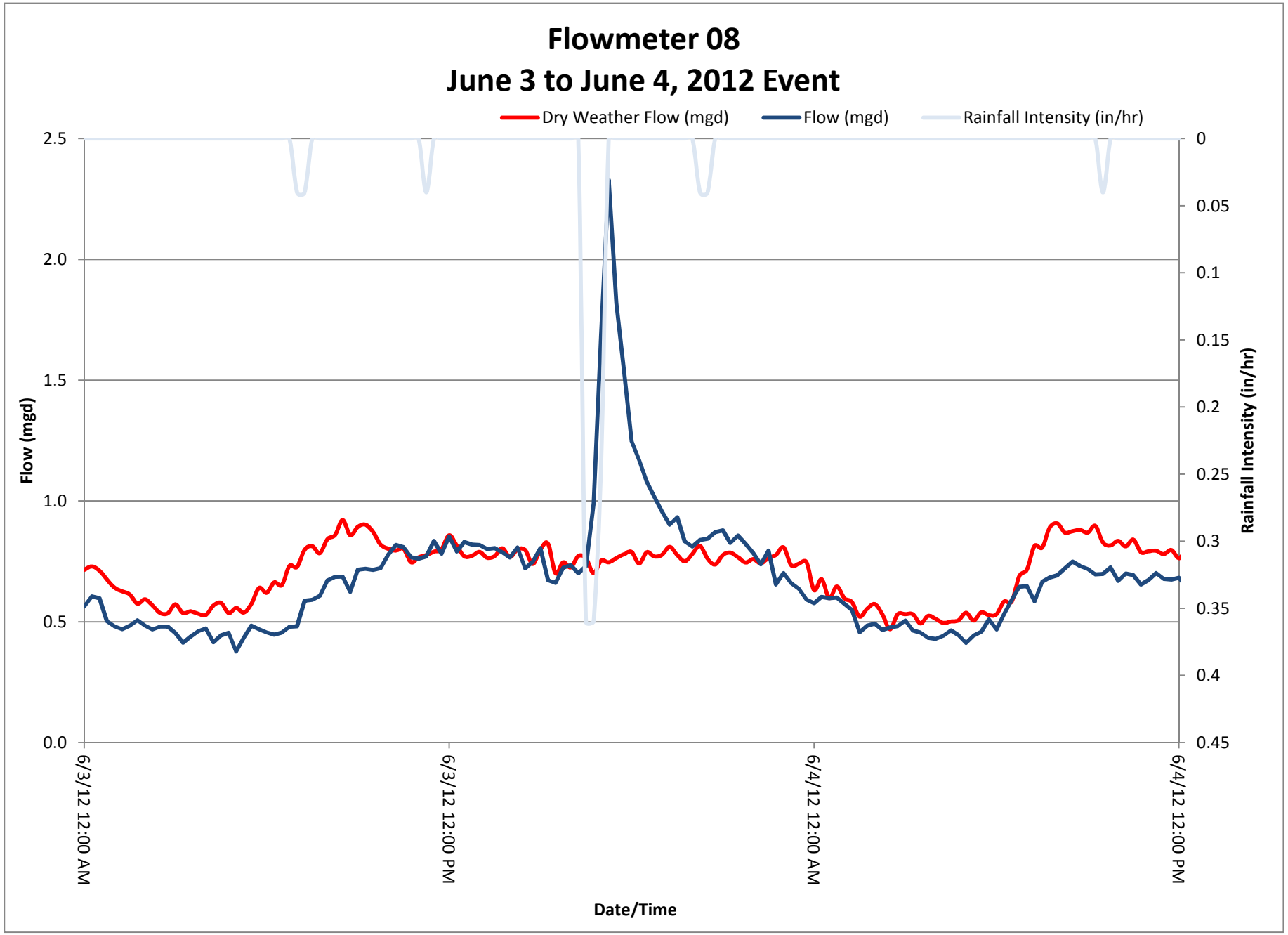

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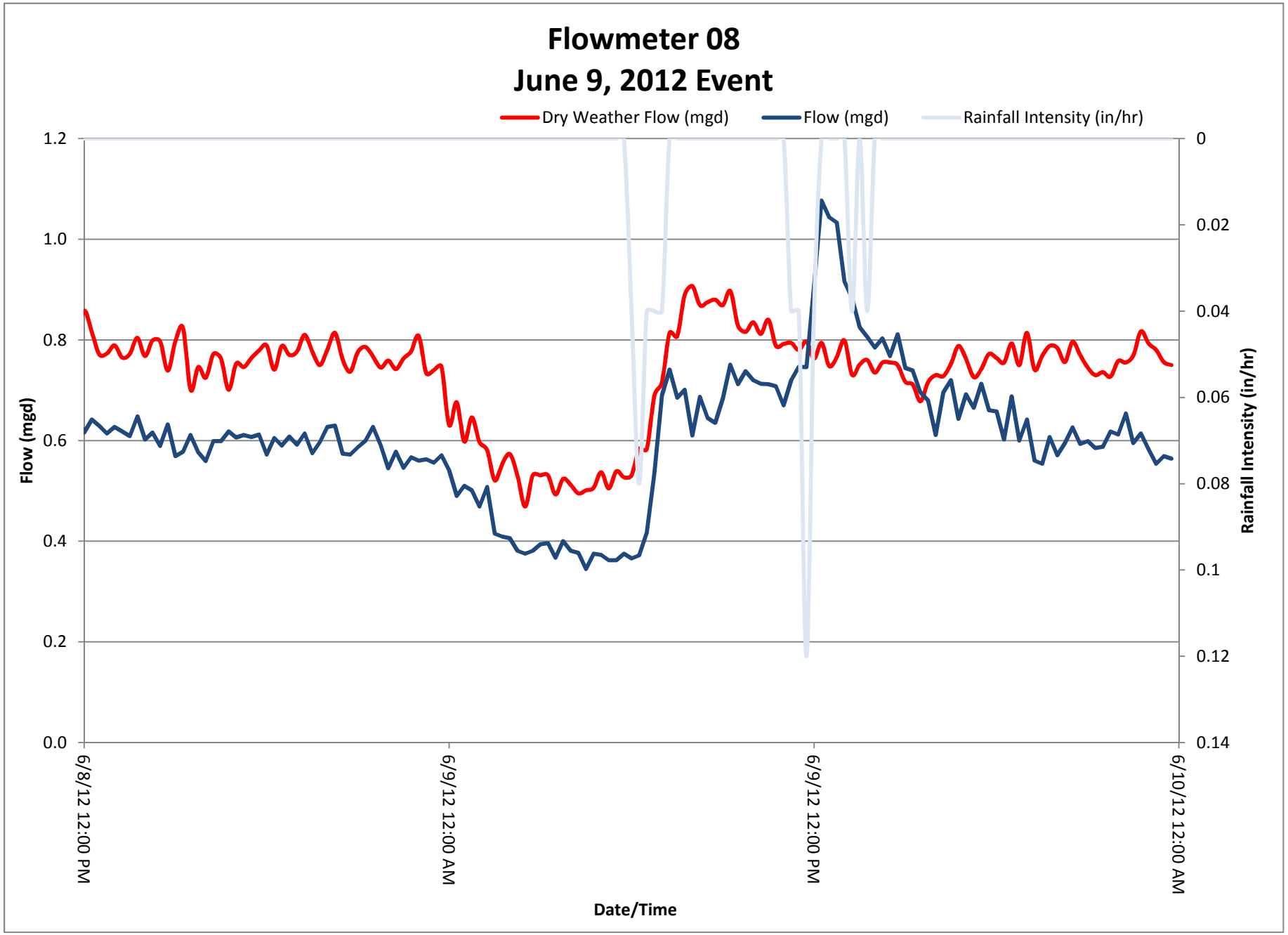

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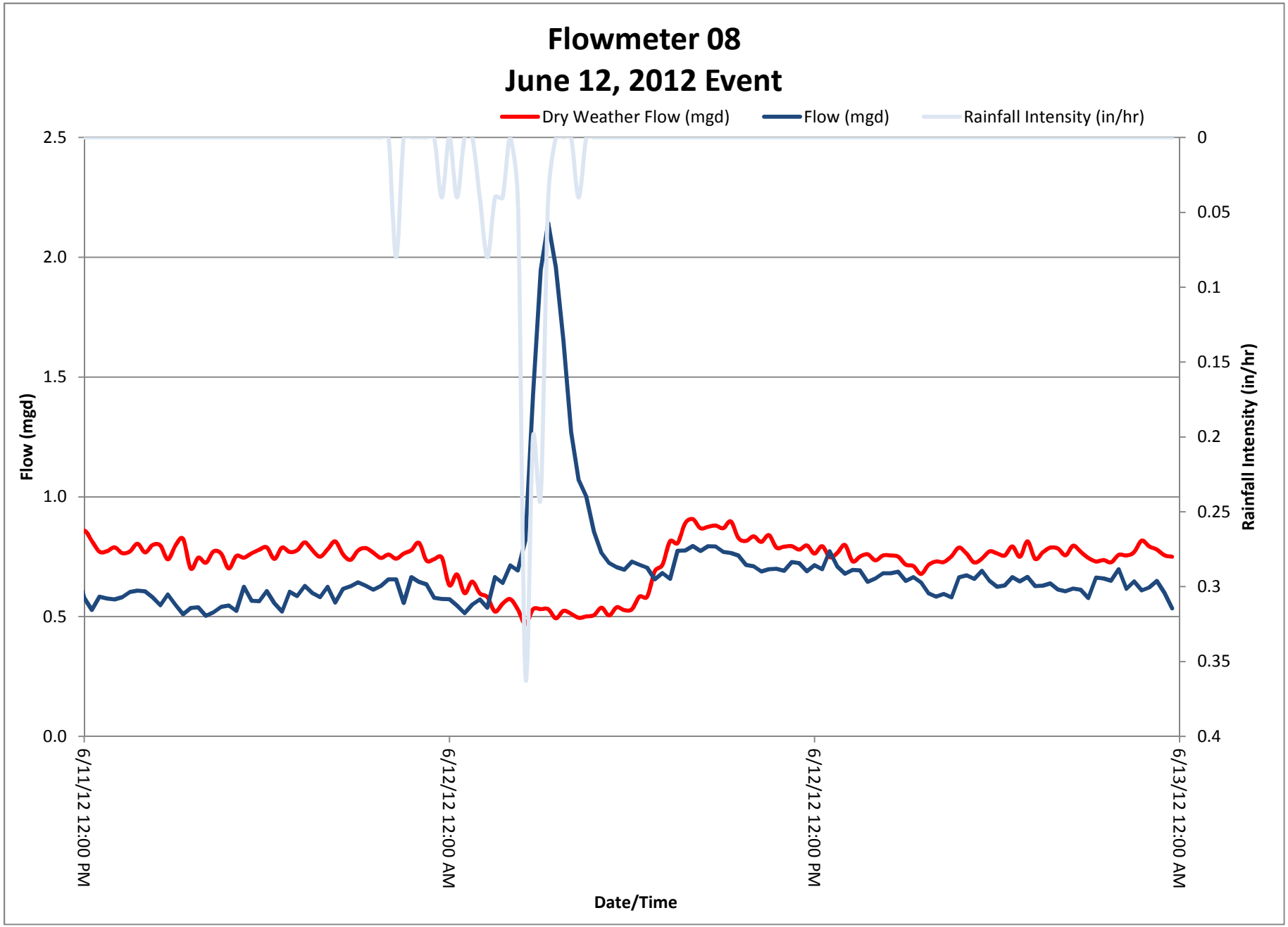

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