FINAL

Town of Colma
Wastewater Collection System
Master Plan

PREPARED BY:

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GLOSSARY

ADWF	Average Dry Weather Flow; not influenced by rainfall; does not include RDII or GWI, averaged across single day
Basin	smallest unit of sewer system isolated by an individual flow meter
CIP	Capital Improvement Project
design storm	Standard precipitation event to calibrate hydraulic model; specified depth, duration, and probabilistic return period
DIA	nominal diameter
Diurnal Flow	Daily Hydrograph
DWF	Sewer Dry Weather Flow; not influenced by rainfall; does not include RDII or GWI
EX / EXST	Existing
FAR	Floor to Area Ratio; building floor space to at-grade parcel area ratio
Force main	Pressurized sewer pipeline that is pumped from lift station
GIS	ESRI ArcGIS (Geographical Information System) software or data
gpd	gallons per day
gpm	gallons per minute (694.44 gpm per 1.00 mgd)
GWDR	SWRCB Order No. 2006-0003 Statewide General Waste Discharge Requirements
GWI	Groundwater Infiltration; seasonal; constant underlying baseflow
hydrograph	Graph of sewer flow vs time
I/I	Inflow and Infiltration; includes RDII and GWI
Invert	Lowest flow line of sewer pipe
K	Ratio of Time Recession; RTK method
Land Use	Supersedes zoning; applied to wastewater generation rates
Lateral	Lateral service gravity line (typically 4")
Main	City owned gravity sewer main (typically 6" to 24" DIA)
MGD	million gallons per day
MH	Manhole
NOAA	U.S. Department of Commerce: National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PDWF	Peak Dry Weather Flow; peak instantaneous dry weather flow; ADWF after multiplied by peaking factor
LS	Sewer Lift Station
R	Fraction of rainfall volume entering sewer system as RDII; see RTK method
RDII	Rain Derived Inflow and Infiltration; sewer flow from surface (inflow) or below-grade groundwater (infiltration)
RTK	Triangular synthetic unit hydrograph to characterize RDII response to rainfall event
SCS	Soil Conservation Service

SSCO	Sanitary Sewer Cleanout; private or public; provides delineation between private and public pipe; location to service lateral service line
SSMH	Sanitary Sewer Manhole; manhole
SSMP	Sanitary Sewer Master Plan; official municipal document mandated by SWRCB
SSO	Sanitary Sewer Overflow
SSOAP	U.S. Environmental Protection Agency (EPA) Sanitary Sewer Overflow and Analysis Program Software
SWRCB	State Water Resources Control Board
Synthetic Unit Hydrograph	Summation of unit hydrographs resulting in common hydrograph from specified precipitation
T	Time to Peak; equivalent to Time of Concentration; see RTK method
The Town	The Town of Colma
UBO	Ultimate Build-out
Unit Hydrograph	Theoretical hydrograph resulting from a unit of precipitation
Wet Weather Flow	Wet Weather Flow; influenced by rainfall; may include GWI, RDII
WW Generation Rate	Average sewer flow applied to parcels with specific land use to produce ADWF
WWE	Water Works Engineers
Zoning	Planning department zone delineation for individual City parcel

EXECUTIVE SUMMARY

The purpose of this Wastewater Collection System Master Plan is to assess the Town of Colma's (Town) wastewater collection system and its capacity to convey flow during a design storm without sanitary sewer overflows (SSOs) for the near-term and long-term (ultimate build-out conditions) in compliance with the State Water Resources Control Board Order No. 2006-0003 Statewide General Waste Discharge Requirements for Sanitary Sewer Systems (GWDRs). This Executive Summary summarizes the development of the GIS-based (Geographical Information System) sewer network and hydraulic model and the findings and recommendations based on the results of the hydraulic modeling effort.

ES.1 Wastewater Flows

Flow monitoring conducted in January and February of 2017, by Total Flow Monitoring Inc. (Total Flow), informed the dry weather and wet weather wastewater flowrates. Total Flow, in coordination with City engineering staff input, analyzed the physical layout of the sewer network and delineated the collection system into 10 sewer basins. Total Flow installed flow monitoring equipment at 10 locations throughout the system which generally mirrored the delineated sewer basins. Flow data from each of these sites was logged and analyzed to produce dry weather (no rain event) and wet weather (during rain event) flow averages and peaks. From this data dry and wet weather peaking factors for each basin were evaluated.

In parallel with this work, Water Works Engineers (Water Works or WWE) developed the physical geometry and applied wastewater flow generation loadings to a hydraulic model (Innovyze InfoSewer) based on land use types (e.g., residential, commercial, cemetery, other) from the Town of Colma Zoning Map. Two hydraulic model scenarios were developed, the Existing Conditions (short-term) and Ultimate Buildout (UBO, long-term) Conditions, which are reflective of the Town's wastewater flow rates under current conditions and with additional planned (future) developments.

For existing conditions, unique wastewater generation rates by land use type were developed and calibrated against the observed dry weather flow (DWF) from the flow monitoring analysis. Water Works further refined the dry weather generation rates for existing conditions by developing, applying and refining diurnal curves, which define loading patterns over the course of a day, to calibrate the hydraulic model peak dry weather flow (PDWF) to observed flow monitoring results.

For UBO conditions, the 2014 Land Use and Urban Design Strategy document was used to refine the dry weather wastewater flowrates of future development. Parcels identified as Opportunity Sites, which are areas likely to undergo construction of new development, were assigned a wastewater generation rate based on the land use type described in the Town's general planning documentation. The addition of these opportunity sites as well as an increase in commercial wastewater generation rates expected for master planning efforts, comprises the UBO conditions scenario during DWF conditions.

For wet weather flow, rain derived inflow and infiltration (RDII) response of the system was applied to the hydraulic model and calibrated to the largest storm event during the flow monitoring period, which occurred on January 21st, 2017. Calibration of the modeled system response to the observed (via flow monitoring) storm event was completed using the U.S. Environmental Protection Agency (EPA) Sanitary

Sewer Overflow and Analysis Program (SSOAP) Software. The peak Rain Derived Inflow and Infiltration (RDII) was based on a 10-year return, 24-hour duration, and 3.95-inch total precipitation “design storm” listed in NOAA Atlas 14, Volume 6, Version 2 for the region consistent with the Town of Colma geographic location. The peak RDII for each basin was applied in addition to the DWF loads in the hydraulic model to simulate wet weather flow. In accordance with industry standard, Water Works employed a “peak on peak” to complete the wet weather capacity analysis of the Town’s wastewater collection system (i.e. the time of the maximum storm response flow resultant from the “design storm” RDII was adjusted to coincide with the maximum PDWF to quantify peak wet weather flow (PWWF). Water Works modeled PWWF for both existing conditions and UBO. The Town of Colma wastewater collection system average and peak dry and wet weather flows (ADWF, PDWF, AWWF, and PWWF) produced by the hydraulic model under existing and UBO conditions are shown in **Figure ES- 1** and **Figure ES- 2.**

ES.2 Sewer Network and Hydraulic Model Capacity Assessment

The Town of Colma discharges wastewater flows to Daly City and City of South San Francisco (SSF), with the collection of basins discharging to each neighboring agency operating independently of one another. As the Town did not have a pre-existing physical model, WWE developed a sewer network based on the Town’s GIS data representative of the independent systems discharging to the two points. A third discharge location from a small basin with limited connections was not modeled as part of this study. The geometry of the network inclusive of pipes and manholes was developed using as-builts, CAD drawings, Town staff knowledge, and other available information. The collection system map was used to assign pipe diameter, pipe slope, invert elevations, manhole rim elevation, and pipe and manhole IDs. The collection system map rounded the invert elevations to the nearest whole number. To create the physical model with more accuracy the following assumptions were made:

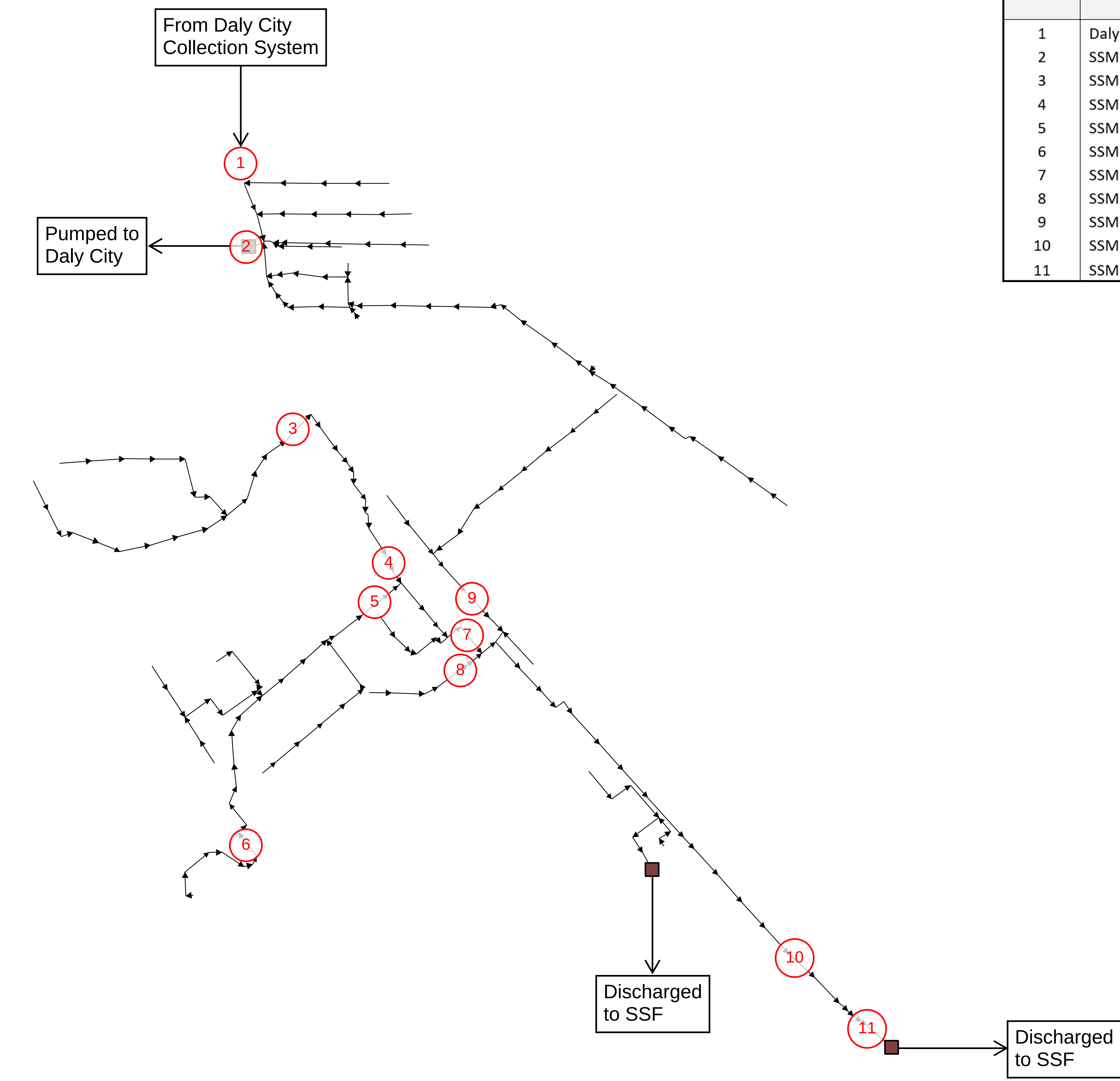
- Pipe slope percentages in the collection system map were used in coordination with the pipe length in the GIS network to estimate the elevation drop across the pipe
- Industry accepted minimum slopes for given pipe diameters were assigned to pipes missing slopes
- The resultant physical model geometry (with above assumptions) was evaluated against the collection system map for major deviations and unreasonable invert elevations to ensure that these errors did not propagate to the downstream network

The GIS-based network was used to create a hydraulic model, which simulated PDWF and PWWF for the Existing and Ultimate Build-out Conditions scenarios. The hydraulic model simulation(s) for all scenarios were analyzed against capacity deficiency criteria, the results of which are illustrated by the following figures:

Figure ES- 3 Capacity Assessment Results under Existing Conditions Peak Dry Weather Flow
Figure ES- 4 Capacity Assessment Results under Existing Conditions Peak Wet Weather Flow
Figure ES- 5 Capacity Assessment Results under UBO Conditions Peak Dry Weather Flow
Figure ES- 6 Capacity Assessment Results under UBO Conditions Peak Wet Weather Flow

The 10 identifiable basins are also delineated on these figures.

For the Existing Conditions and UBO Conditions PDWF scenarios, simulation results did not show potential SSOs nor surcharging pipes. For the Existing Conditions PWWF scenario, no potential SSOs were modeled. However, model results did include manholes that surcharged to within 3 feet of the rim elevation, as well as a number of surcharging pipes. For the UBO Conditions PWWF scenario, simulation results showed one potential SSO along El Camino Real. Analysis also indicated a number of surcharging pipes and several manholes that surcharged to within 3 feet of the rim elevation throughout the system.



Label ID	Pipe ID	Existing Conditions			
		ADWF (MGD)	PDWF (MGD)	AWWF (MGD)	PWWF (MGD)
1	Daly City Point Load	0.508	0.508	0.508	0.508
2	SSMH7E38_OUTFALL	0.546	0.570	1.099	2.110
3	SSMH8E13_SSMH8E14	0.024	0.063	0.058	0.156
4	SSMH8E22_SSMH8E23	0.040	0.100	0.092	0.240
5	SSMH8E24_SSMH8E23	0.076	0.102	0.194	0.458
6	SSMH9E62_SSMH9E61	0.032	0.049	0.051	0.115
7	SSMH9E70_SSMH9E75	0.130	0.217	0.319	0.781
8	SSMH9E15_SSMH9E75	0.006	0.008	0.008	0.016
9	SSMH8E30_SSMH9E4	0.032	0.046	0.035	0.053
10	SSMH10F24_SSMH10F25	0.183	0.295	0.436	1.038
11	SSMH10F27_SSMH11G1	0.195	0.314	0.465	1.080

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Manhole
- Outlet
- Pipe

Basins

- DCMB
- SSFMB1A
- SSFMB1B
- SSFMB2
- SSFMB3
- SSFMB4A
- SSFMB4B
- SSFMB5
- SSFMB6
- SSFMB7
- Does not flow to Colma

N

900 450 0 900 Feet

Figure ES-1.
Existing Conditions Average and Peak Dry and Wet Weather Flows

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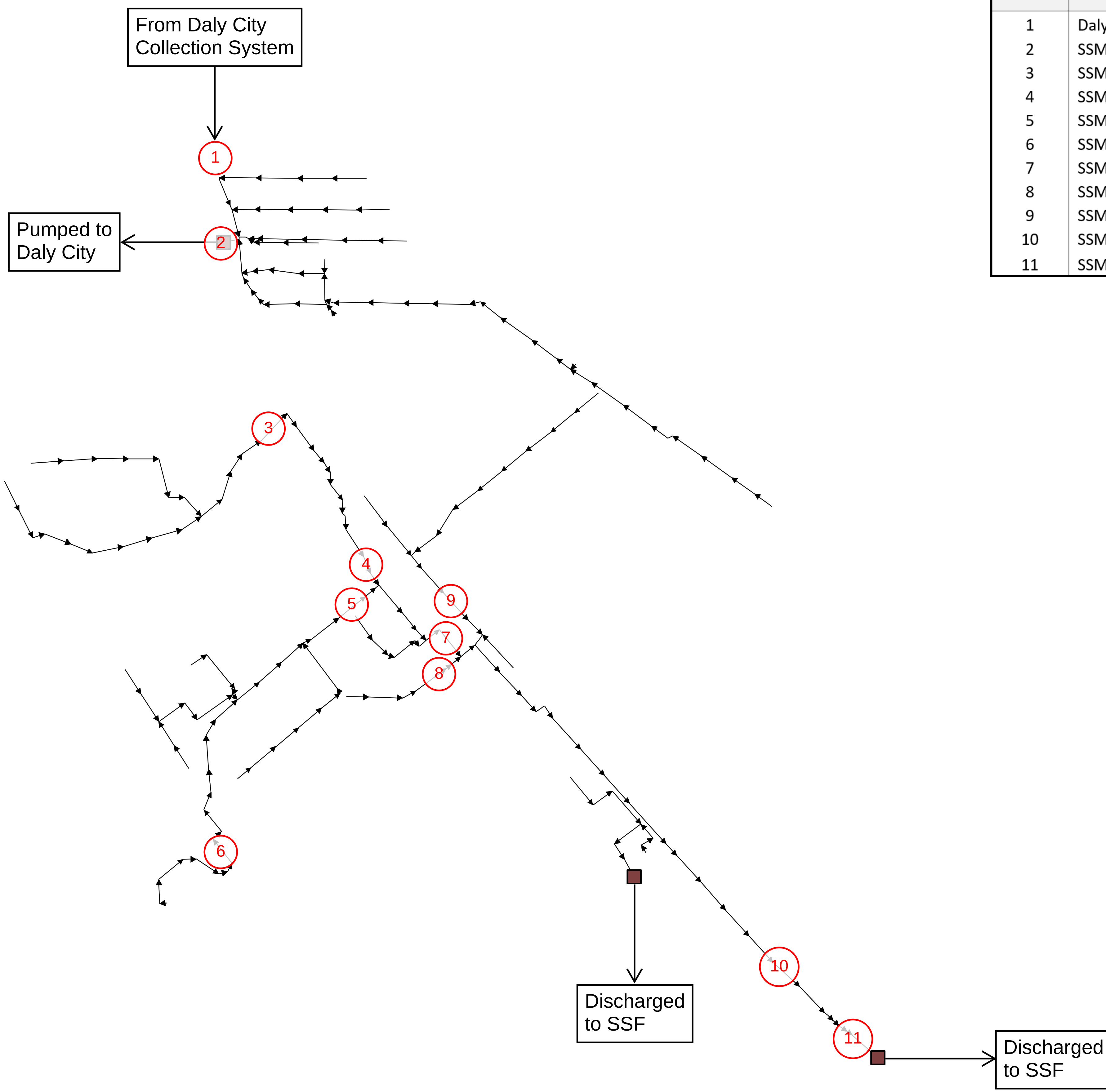

Label ID	Pipe ID	Ultimate Build-out Conditions			
		ADWF (MGD)	PDWF (MGD)	AWWF (MGD)	PWWF (MGD)
1	Daly City Point Load	0.508	0.508	0.508	0.508
2	SSMH7E38_OUTFALL	0.567	0.601	1.121	2.136
3	SSMH8E13_SSMH8E14	0.031	0.084	0.066	0.168
4	SSMH8E22_SSMH8E23	0.046	0.117	0.098	0.249
5	SSMH8E24_SSMH8E23	0.094	0.125	0.212	0.482
6	SSMH9E62_SSMH9E61	0.032	0.049	0.051	0.115
7	SSMH9E70_SSMH9E75	0.178	0.293	0.366	0.845
8	SSMH9E15_SSMH9E75	0.014	0.021	0.016	0.028
9	SSMH8E30_SSMH9E4	0.030	0.043	0.033	0.050
10	SSMH10F24_SSMH10F25	0.236	0.380	0.488	1.110
11	SSMH10F27_SSMH11G1	0.248	0.397	0.516	1.152

Legend

- Manhole
- Outlet
- Pipe

Basins

- DCMB
- SSFMB1A
- SSFMB1B
- SSFMB2
- SSFMB3
- SSFMB4A
- SSFMB4B
- SSFMB5
- SSFMB6
- SSFMB7
- Does not flow to Colma

N

900 450 0 900 Feet

Figure ES-2.
Ultimate Build-out Average and Peak Dry and Wet Weather Flows

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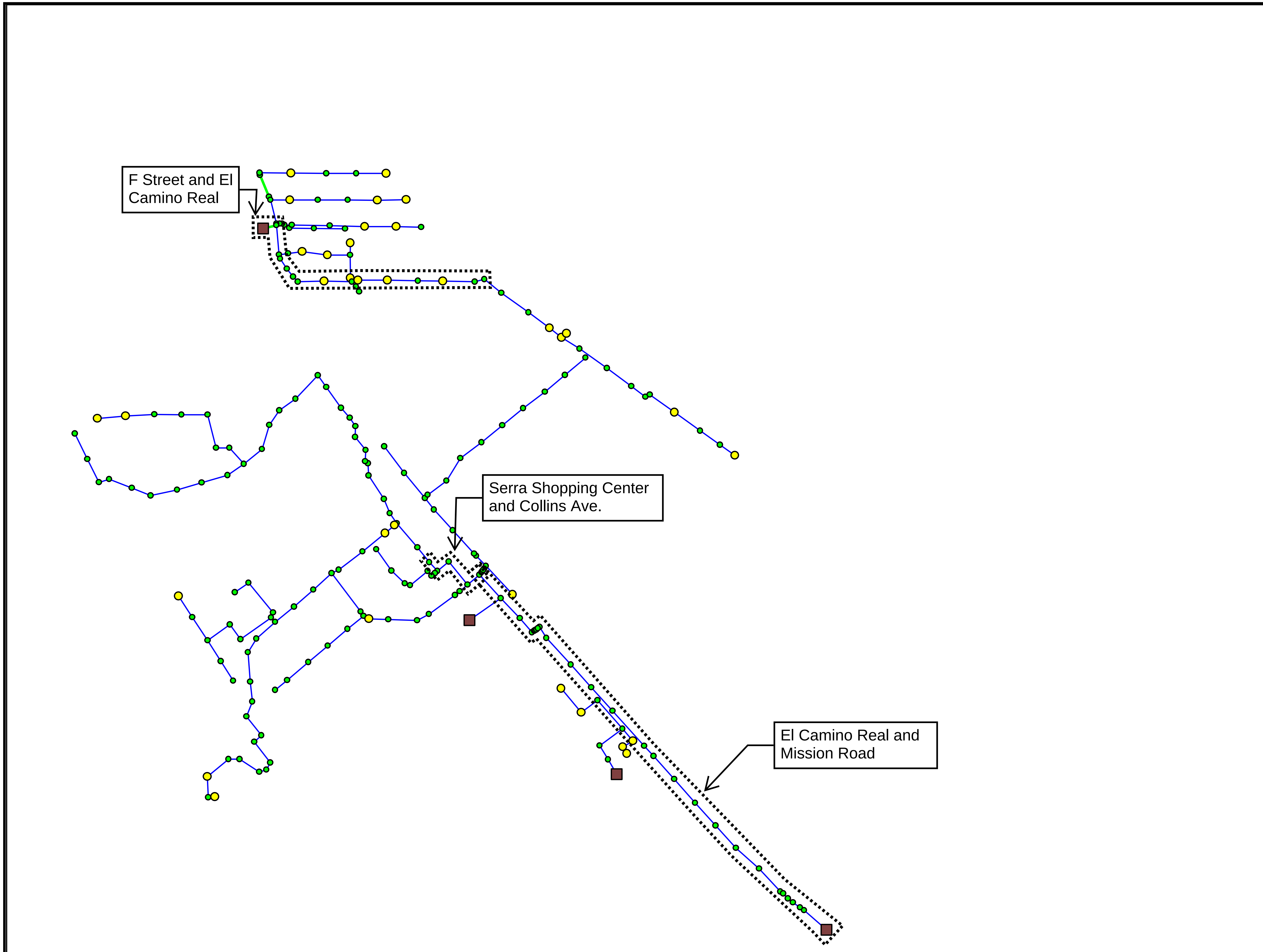
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

Manhole Unfilled Depth

- Potential SSO
- 0 - 3 Feet
- 3 - 5 Feet
- > 5 Feet

Outlet

- Active

Pipe Max "d/D" Ratio

- Less than 0.5
- 0.5~0.75
- 0.75~0.99
- Greater than 0.99

Basins

- DCMB
- SSFMB1A
- SSFMB1B
- SSFMB2
- SSFMB3
- SSFMB4A
- SSFMB4B
- SSFMB5
- SSFMB6
- SSFMB7
- Does not flow to Colma

N

800 400 0 800 Feet

Figure ES-3:
Capacity Assessment Results Under Existing Conditions Peak Dry Weather Flow

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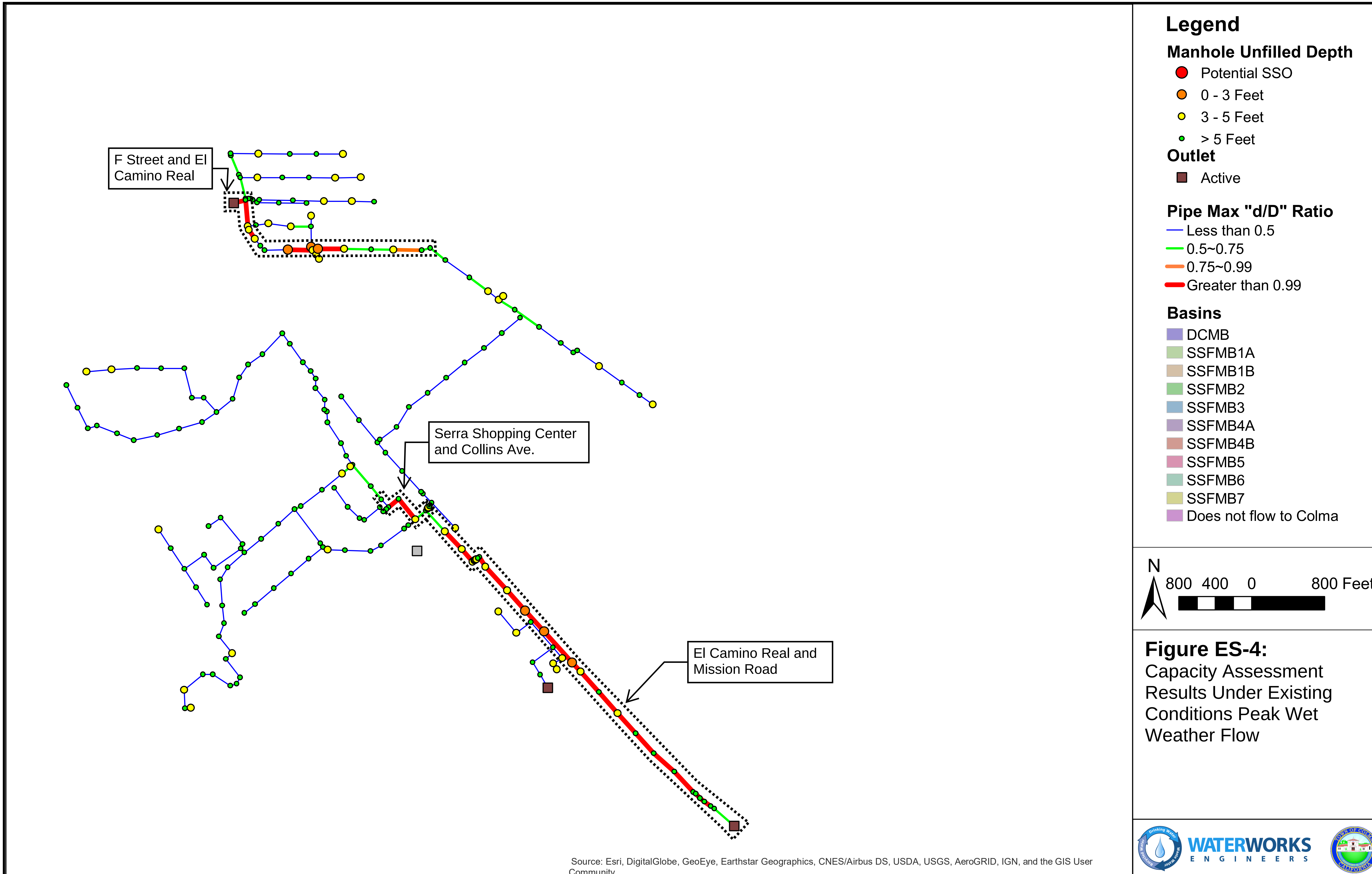

Figure ES-4: Capacity Assessment Results Under Existing Conditions Peak Wet Weather Flow

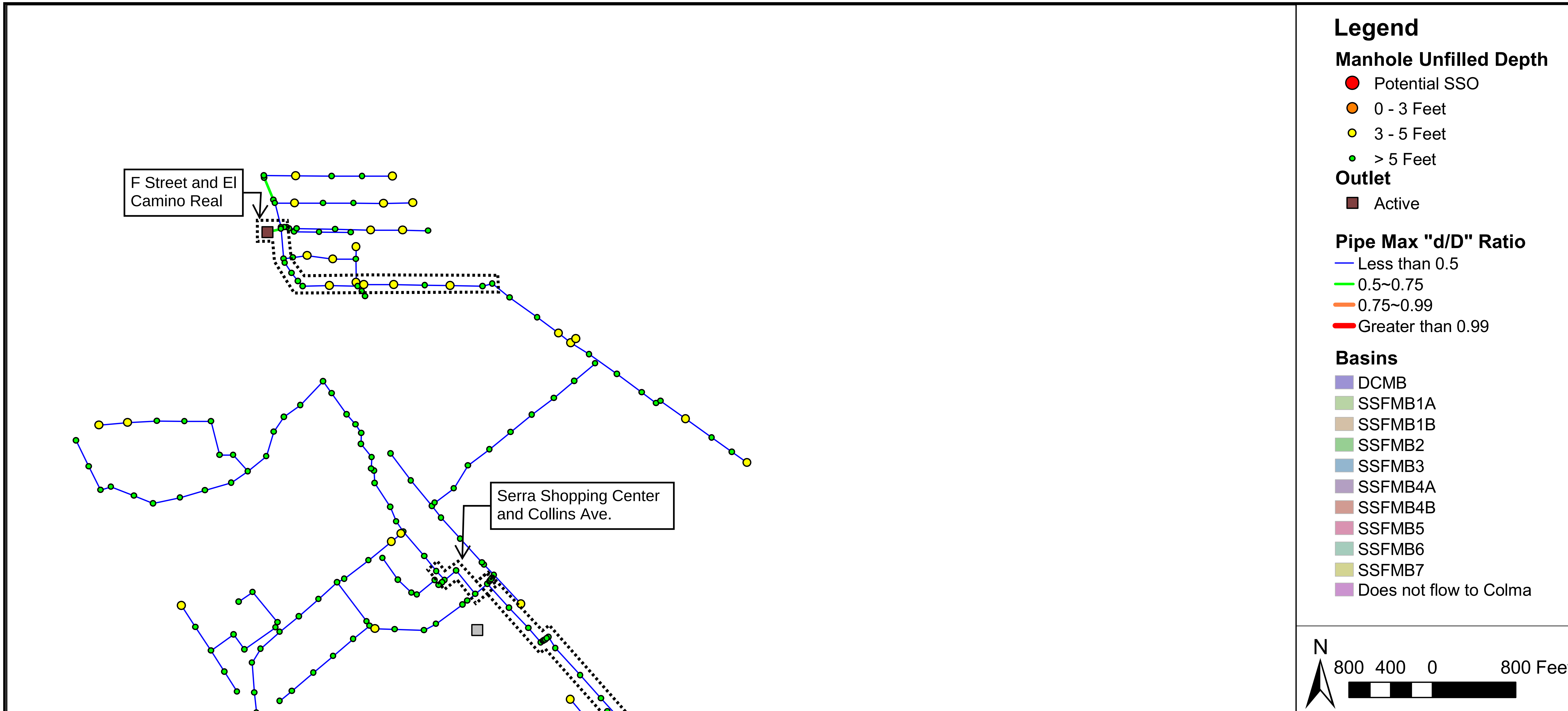

Figure ES-5:
Capacity Assessment Results Under UBO Conditions Peak Dry Weather Flow

WATERWORKS ENGINEERS

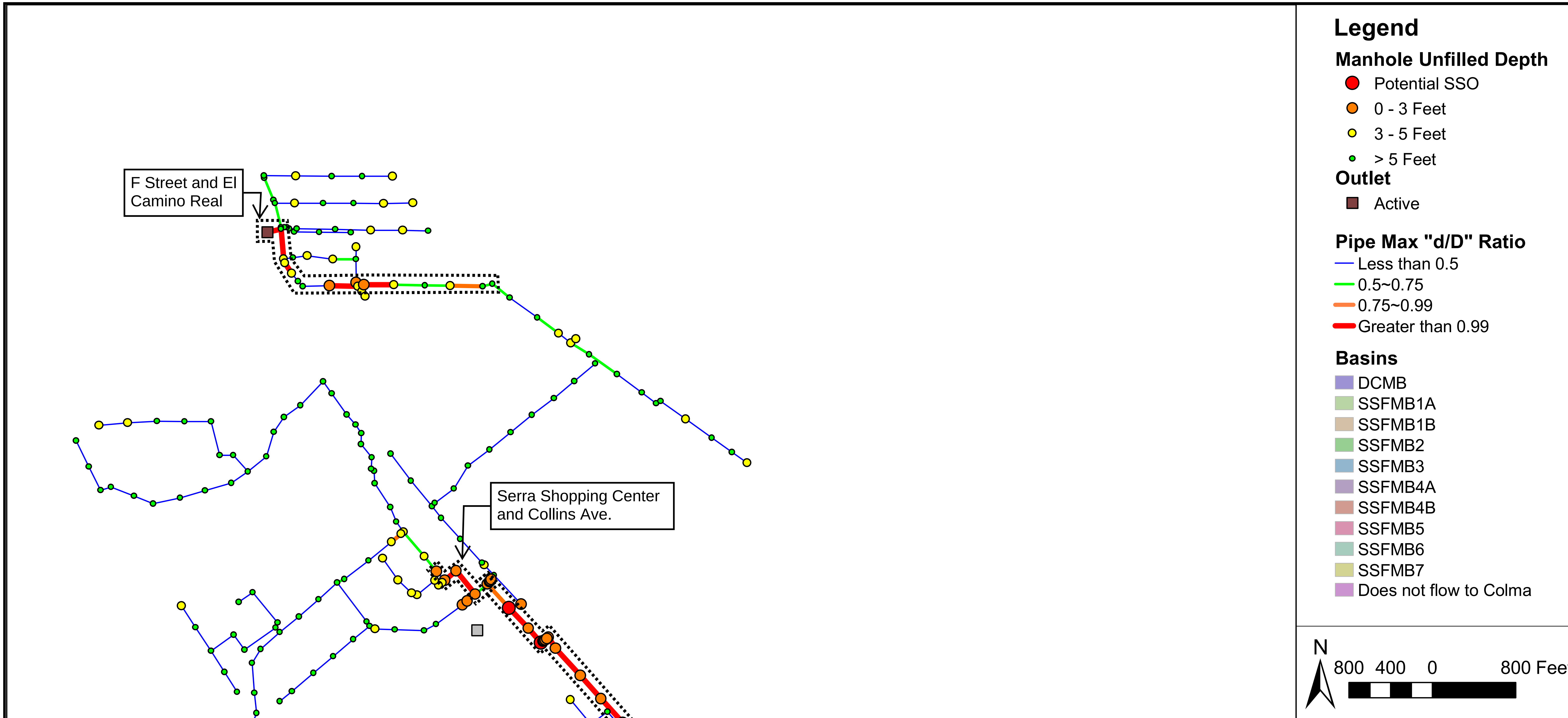

Figure ES-6: Capacity Assessment Results Under UBO Conditions Peak Wet Weather Flow

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ES.3 Recommendations and Capital Improvement Projects

To meet regulatory requirements to provide adequate capacity to convey existing and future wastewater flows while mitigating potential SSOs, it is recommended that the Town implement a Capital Improvement Project (CIP) to increase capacity in the sanitary sewer system where deficiencies are modeled, in particular upstream of the SSF connection. The existing 10" pipe along El Camino Real/Mission Road, which eventually discharges to SSF's system at the intersection of Mission Road and Lawndale Blvd, experiences numerous surcharging pipes and two potential SSOs under the UBO Conditions PWWF model scenario (refer to **Figure ES- 6** above). However, this same section of piping experiences surcharging under the Existing Conditions PWWF model scenario as well. While there were no potential SSOs modeled under the Existing Conditions PWWF model scenario, certain manholes did experience surcharging to within 3 feet of the ground surface. Therefore, modeling results indicate that in order to sufficiently convey projected growth in wastewater contributions into the future, as well as mitigate surcharging during a design storm under existing conditions, the Town should move forward with the implementation of a CIP to address the capacity deficiency found in the 10" pipeline along El Camino Real/Mission Road. Modeling results indicate an additional 0.3 MGD of capacity will mitigate modeled SSOs and excessive surcharging. The following CIP alternatives provide the required 0.3 MGD of capacity:

- **Alternative 1**: An 8/10" parallel gravity main on Mission Road approximately 4,300 linear feet and would be installed at a depth of 4-12 feet from the surface and discharge into the SSF outlet. A 10" siphon overflow pipe segment would also be installed above the existing Caltrans box culvert from SSMH9F13_S to SSMH9F14_S in order to provide conveyance redundancy to mitigate conveyance issues should a blockage/constriction develop in the existing siphon.
- **Alternative 2**: A 10" gravity main that would be located on El Camino Real, in Cal Trans right of way, that would be approximately 3,300 linear feet installed at a depth ranging from 7-35 feet below the surface and would discharge into an SSF manhole located on El Camino Real
- **Alternative 3A**: A pre-fabricated lift station and 4" force main located on Mission Road and installed at a depth of 4-5 feet that would discharge into the SSF outlet
- **Alternative 3B**: A pre-fabricated lift station and 4" force main installed on El Camino Real at a depth of 4-5 feet that would discharge to a manhole located on El Camino Real
- **Alternative 4**: Upsize approximately 4,100 linear feet of the existing gravity main directly upstream of the SSF outlet by Replace-in-Place method

In addition to designing and constructing a CIP to provide sufficient capacity for projected wastewater flows, another strategy that is recommended for implementation by the Town is a Rain Derived Inflow and Infiltration (RDII) Reduction Program. RDII can be described as rainfall runoff that enters a closed sewer collection system through pipe and/or manhole defects, manhole lids, and cleanouts. There are various strategies that are commonly utilized to identify areas within the wastewater collection system that exhibit relatively significant RDII response. These strategies can include: Closed Circuit Television (CCTV) inspections, smoke testing, dye tracing, and micromonitoring. After these system assessment strategies have been implemented, rehabilitation projects can be developed for the specific areas found to exhibit high RDII response. Typical rehabilitation projects include the following:

- Lining of mains, side sewers, and laterals can reduce the volume of infiltration that enters through cracks in the pipes

- Lining and structural grouts in manholes reduce the volume of infiltration by covering and sealing the cracks
- Improving the seal between the frame and cover of the manhole can reduce the volume of inflow that enters the system during a storm event
- Eliminating illegal/ illicit cross-connections can greatly reduce the volume of inflow to the sanitary sewer system

An RDII reduction analysis was performed for the Town's system and various basins. In order to compare the basins, the volume of RDII per inch-diameter mile of pipe within the particular basin was determined. The comparison allows the Town to effectively rank each basin relative to each other, thereby focusing initial RDII reduction efforts on the basins representing the largest response to a storm event. Table ES - 1 below lists the results of the RDII analysis for each basin, along with their relative rankings.

Table ES - 1. RDII by Basin

Basin	RDII Area (Acres)	Peak RDII (MGD)	Peak RDII/idm (gpd/idm)	Ranking
SSFMB1A	72	0.125	16,184	6
SSFMB1B	22	0.055	23,309	4
SSFMB2	72	0.014	2,649	9
SSFMB3	71	0.294	34,927	3
SSFMB4A	21	0.049	14,399	7
SSFMB4B	12	0.010	3,453	8
SSFMB5	190	0.224	18,595	5
SSFMB6	9	0.094	60,200	2
DCMB	200	1.578	107,488	1

Figure ES- 7 displays the RDII analysis results for each basin within the Town.

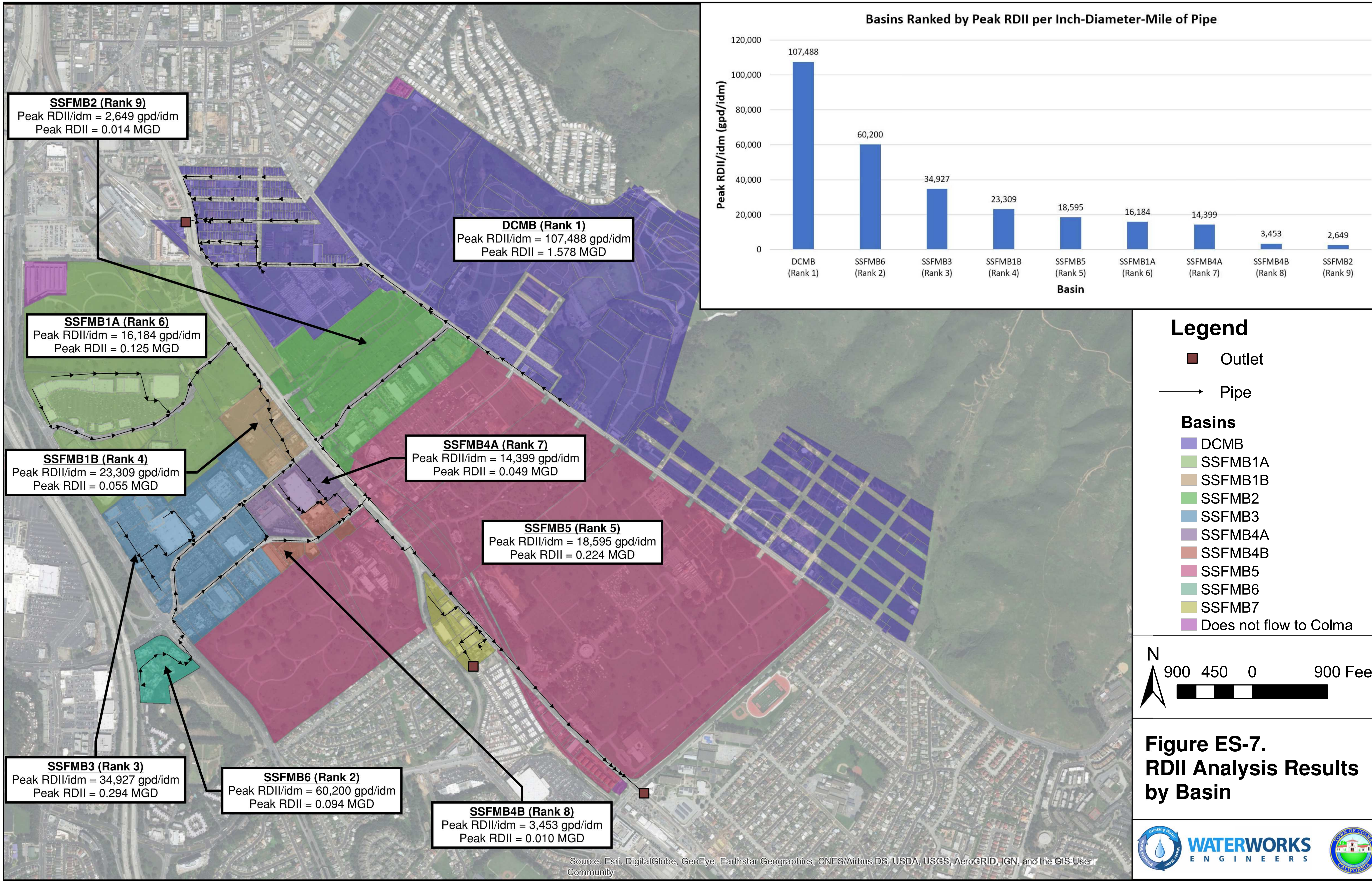


Figure ES-7. RDII Analysis Results by Basin

Given modeled (and flow meter data corroborated) variation between PWWF and PDWF, it is recommended that an RDII reduction program be implemented on basins SSFMB6 and SSFMB3 in conjunction with one of the presented CIP alternatives. While the RDII reduction analysis shows that enough wastewater flow could potentially be reduced from basins SSFMB6 and SSFMB3 to mitigate surcharging and potential SSOs along the Mission Road pipeline, it is not the recommendation of WWE that the RDII Reduction Program be implemented in place of a CIP. However, it is good practice for the Town to continually aim for RDII reduction throughout the collection system to mitigate capacity concerns for downstream systems and treatment plants.

Planning level cost estimates and potential effectiveness (likelihood of success in mitigating capacity deficiency within regulatorily defensible timeframe) of each alternative and the recommended I&I program are listed in Table ES - 2.

Table ES - 2. Cost Estimates and Effectiveness of the CIP Alternatives and the RDII Reduction Program

Project	Labor, Materials, & Equipment ($)	Design/ Construction Contingencies (%)	Total Construction Cost ($)	Administrative/ Construction Management (%)	Total Project Cost Estimate ($)	Short-Term/ Long-term Effectiveness
Alternative 1: Parallel Gravity Main Mission Road	1.15 Million	30/10	1.61 Million	5/10	**1.9 Million**	High/High
Alternative 2: Gravity Main El Camino Real	1.80 Million	30/10	2.47 Million	5/10	**3.0 Million**	High/High
Alternative 3A: Lift Station and Force Main Mission Road*	1.18 Million	30/10	1.65 Million	5/10	**1.9 Million**	High/Medium
Alternative 3B: Lift Station and Force Main El Camino Real*	1.18 Million	30/10	1.65 Million	5/10	**2.0 Million**	High/Medium
Alternative 4: Replace-in-Place Existing Main on Mission Road	1.83 Million	30/10	2.56 Million	5/10	**2.9 Million**	High/High
RDII Reduction Program	1.20 Million	30/10	1.67 Million	5/10	**1.9 Million**	Low/Medium
*Cost estimates for these alternatives do not include potential land acquisition costs for the lift station						

1 INTRODUCTION

1.1 Project Background

Water Works Engineers, LLC (Water Works or WWE) is under contract with the Town of Colma (Town) to develop the Town of Colma Wastewater Collection System Master Plan (Master Plan). The intent of the Master Plan is to prevent sanitary sewer overflows (SSOs) by identifying system hydraulic capacity deficiencies under existing and future conditions and to develop Capital Improvement Plans (CIP) to mitigate those deficiencies. To identify the deficiencies in the system, WWE created a GIS-based wastewater collection system hydraulic model. The Master Plan and hydraulic model are necessary efforts with the objective of meeting State Water Resources Control Board Order No. 2006-0003 Statewide General Waste Discharge Requirements for Sanitary Sewer Systems (GWDRs).

1.2 Project Objective

The general objective of this project is to evaluate the collection system's capacity and to develop potential CIPs to address capacity deficiencies. A summary of the steps involved in this project can be found below:

- Reviewed available as-builts, CAD data, County parcel data, and satellite imagery to develop GIS-based sewer network for the hydraulic model.
- Produced parcel-by-parcel sewer loads calibrated to existing dry weather flow monitoring data, which were then subsequently scaled up to represent Ultimate Build-out (UBO) development scenarios.
- Built new Innovyze InfoSewer hydraulic model and calibrated it with dry/wet weather flow monitoring and rainfall data.
- Simulated peak dry weather flow (PDWF) peak wet weather flow (PWWF) model scenarios based on a chosen design storm.
- Conducted capacity assessment and sensitivity analysis (by loading model with increasing design storms) and stressing the collection system model to identify modeled capacity deficiencies.
- Developed CIPs into discrete groups with planning level cost estimates for the different stages of development.

1.3 Description of Service Area

The Town of Colma, located in San Mateo County, borders Daly City to the north and west and City of South San Francisco to the south. The Town owns and operates a sewer collection system, which is comprised of close to 8 miles of gravity sewer pipe ranging in diameter from 4" to 12". The sewer collection system encompasses a service area of approximately 1,145 acres. Unique among municipalities, most land usage in Colma is used for local cemeteries and mortuaries which contribute little to no major sewer flows. The Town does not own or operate any wastewater treatment facilities. The Town discharges wastewater flows generated in the northeast region of town to Daly City and wastewater flow generated in the southwest region of town to City of South San Francisco (SSF).

2 GROWTH SCENARIO DEVELOPMENT

2.1 Existing and Ultimate Build-out Conditions Scenario

WWE took the approach of developing and simulating two land use scenarios as part of this study, the Existing Conditions scenario and the UBO Conditions scenario. To produce these two scenarios, planning documents were studied to understand and represent the Town of Colma at different stages of development. The applicable information gathered from these documents is presented in the following section. Previously the UBO Conditions scenario was based on more outdated sources of planning information but has been updated to reflect the most recent planning analysis. The previous UBO conditions can be found in Appendix A.

2.2 Sources of Land Use Information

WWE incorporated existing land use data and development projections for this study. Future land use planning assumptions were agreed upon by WWE and the Town of Colma Public Works & Engineering Department during several meetings and a presentation at the Town Hall (November 19, 2018).

2.2.1 Town of Colma Zoning Map

The Town zoning map shown in **Figure 2-1** was used as the basis for delineating the land use of each parcel under existing conditions which was inclusive of Residential, Commercial, Cemetery, and Other (e.g., open space) land use types. The total acres by land use type are presented in **Table 2-1** below.

Table 2-1: Existing Land Usage in Colma

Acres by Land Use Type				
Residential	Other	Cemetery	Commercial	Total
37	36	930	142	1145

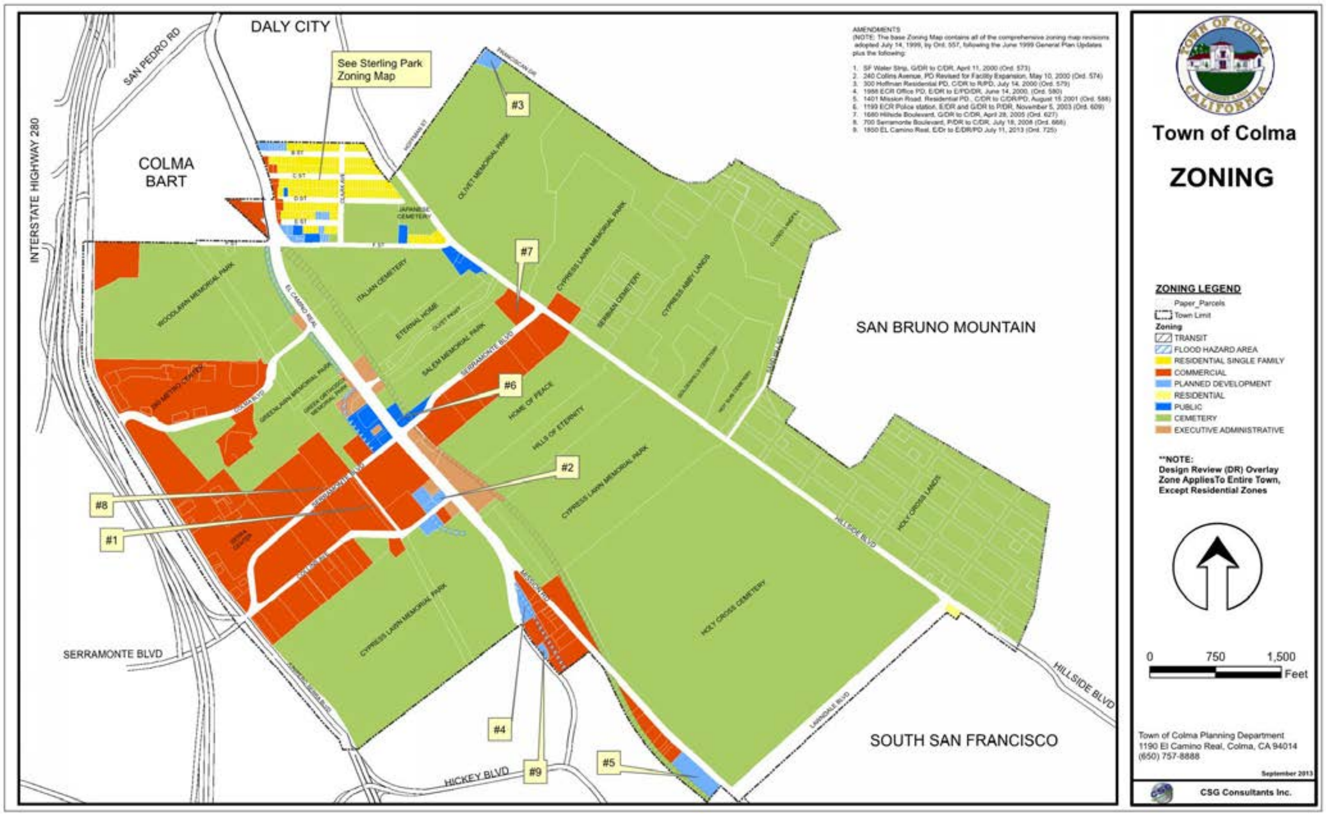


Figure 2-1: Town of Colma Zoning Map (Accessed 2018)

2.2.2 2014 Town of Colma Land Use and Urban Design Strategy

The Town's Land Use and Urban Design Strategy document, completed in October 2014, was the primary resource used to develop the UBO scenario. This document was completed in advance of the General Plan update, which is currently being prepared, and will inform and be integrated into the General Plan update. The land use designations for the UBO scenario were assigned according to a map in the Land Use and Urban Design Strategy which presents the future land use framework (**Figure 2-2**).

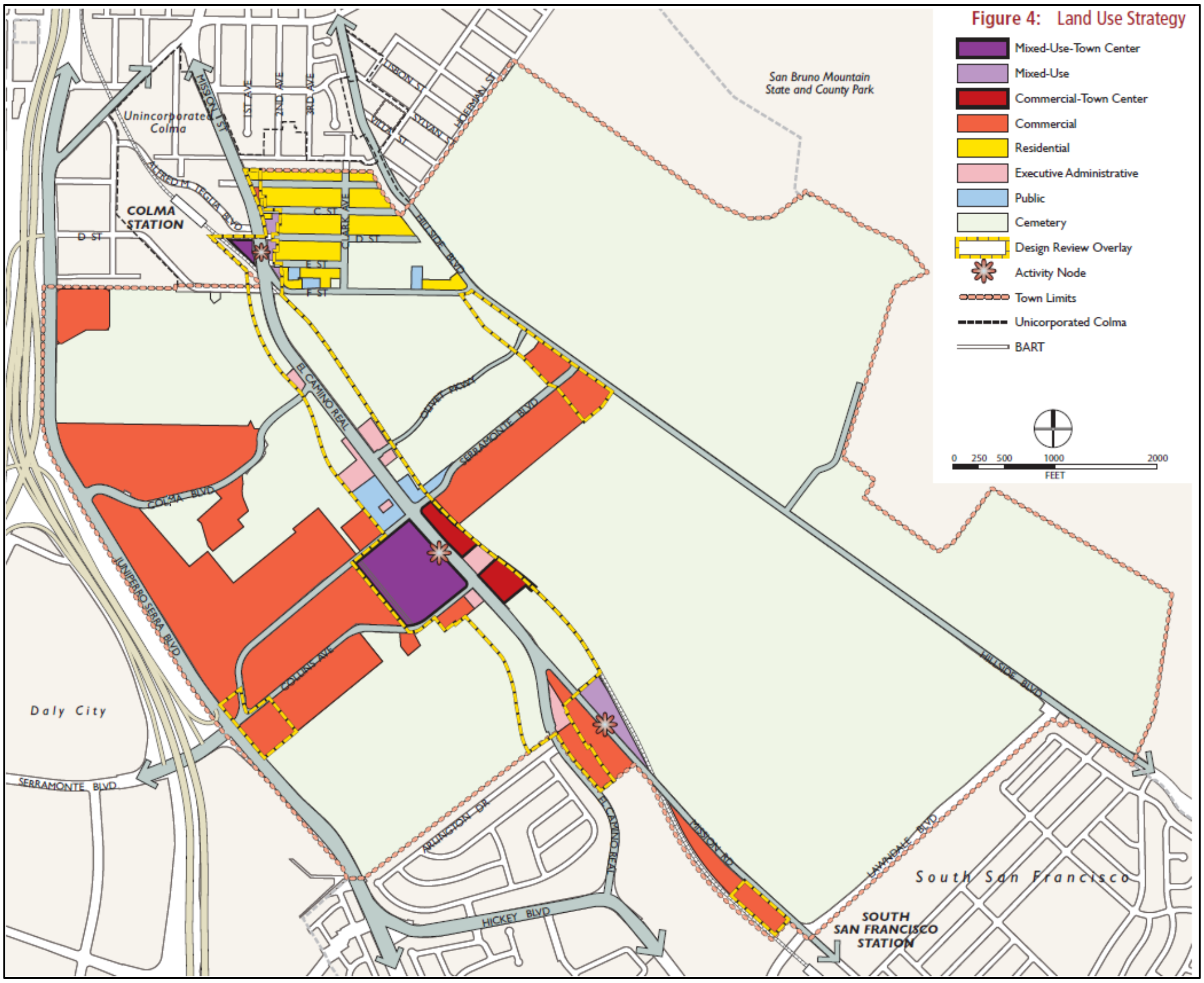


Figure 2-2: Land Use Strategy Map (Excerpt from Town of Colma Land Use and Urban Design Strategy)

For the purposes of this study, some of the land use types were combined when conducting the analysis. The resultant land use types for the UBO scenario are shown in **Table 2-2**.

Table 2-2: Ultimate Build-out Conditions Scenario Land Use Categories

<table>
<tr><th>Original Land Use Type</th><th>Resultant Land Use Type</th></tr>
<tr><td>Residential</td><td>Residential</td></tr>
<tr><td>Cemetery</td><td>Cemetery</td></tr>
<tr><td>Mixed-Use-Town Center</td><td rowspan="2">Mixed-Use</td></tr>
<tr><td>Mixed-Use</td></tr>
<tr><td>Commercial-Town Center</td><td rowspan="4">Commercial/ Office</td></tr>
<tr><td>Commercial</td></tr>
<tr><td>Public</td></tr>
<tr><td rowspan="2">Executive Administrative</td></tr>
<tr><td>Executive Administrative*</td></tr>
<tr><td colspan="2">*Only select parcels designated executive administrative land use type by Figure 2-2 retained that land use type. Further explanation provided herein.</td></tr>
</table>

Additionally, the Land Use and Urban Design Strategy identified 18 opportunity sites, which are parcels likely to undergo a land use or intensity change. Inclusion of the opportunity sites is the primary difference between the Existing Conditions and UBO Conditions scenarios. All opportunity sites identified in the Land Use and Urban Design Strategy are described in **Table 2-3**. Note that additional land use types beyond those presented in **Table 2-2** were utilized to provide a more comprehensive analysis of the opportunity sites.

Table 2-3: Opportunity Sites Identified by 2014 Land Use and Urban Design Strategy

Opportunity Sites				
Site	Location	Description/ Tenant(s)	Planned Land Use	Size (ac.)
1	3601 Junipero Serra	Extra Space Storage site	Commercial	5.3
2	Colma BART station area	Bocci site, Sandblaster site, and Prime Auto Detail site	Commercial/ Mixed-Use*	1.3
3	1160 El Camino Real	Vacant site adjacent to Art in Stone Memorials, portion east of Colma Creek only	Executive Administrative	0.2
4	Corner of Olivet Pkwy. and El Camino Real	Parcels in the north side and south side of Olivet Pkwy.	Medical Office	1.6
5	600 Serramonte, portion along Serramonte Blvd.	Serramonte Certified Used car sales	Commercial	1.6
6	Northwest corner of El Camino Real and Serramonte	Town Hall	Executive Administrative	1.8
7	1500 Collins Avenue at Junipero Serra	Hyundai Serramonte Site	Commercial	3.7

8	600, 650, and 900 Collins Ave.	Parking lots and Uniake Construction	Commercial	2.8
9	735 Serramonte Blvd.	Dollar Tree site	Commercial	2
10	248 Collins Ave.	Standard Plumbing Site	Commercial	0.7
11	South West Corner of El Camino Real and Serramonte Blvd.	Kohl's site and adjacent parcels	Mixed-Use	13.1
12	Southeast corner of El Camino Real and Serramonte Blvd.	Vacant office building and surface parking	Commercial	2.4
13	401 Serramonte Blvd.	CarMax Store	Commercial	8.8
14	1299 El Camino Real, southern portion	Vacant parts of Hills of Eternity along El Camino Real	Commercial	2.3
15	Northern portion of Mission Road corridor	The Y intersection between Mission Road and El Camino Real	Commercial	4.9
16	1670-1692 Mission Rd.	The triangle-shaped parcel across Mission Road and El Camino Real	Mixed-Use	3.2
17	1545/1595 Mission Rd.	Site with historic structure in southern portion of Mission Rd. corridor	Commercial	0.4
18	27 Colma Blvd.	West half of 280 Metro Center	Commercial	Approx. 11
***** Only the Bocci Site is designated mixed use, Sandblaster and Prime Auto Detail sites are designated commercial land use type.				

Five of the eighteen opportunity sites were further identified as focus areas, for which overall build-out data and conceptual site plans were provided either by the Land Use and Urban Design Strategy or by Public Works & Engineering Department staff. The additional data for the focus areas were used to further develop wastewater generation planning assumptions under the UBO Conditions scenario, explained in detail in **Chapter 5**. **Table 2-4** summarizes available focus area data and **Figure 2-3** visually displays the focus areas as well as all other opportunity sites.

Table 2-4: Opportunity Sites Designated as Focus Areas

Focus Areas			
Opp. Site	Land Use Type	Dwelling Units/ Patient Beds	Commercial/ Office Area (SQFT)
2	Mixed-Use	42	8,500
4*	Medical Office	30	-
11	Mixed-Use	240	160,000
16	Mixed-Use	66	18,000
18	Commercial	-	110,000
*The northern portion of opportunity site 4 is to be a dialysis center per communications with Public Works & Engineering Department staff.			

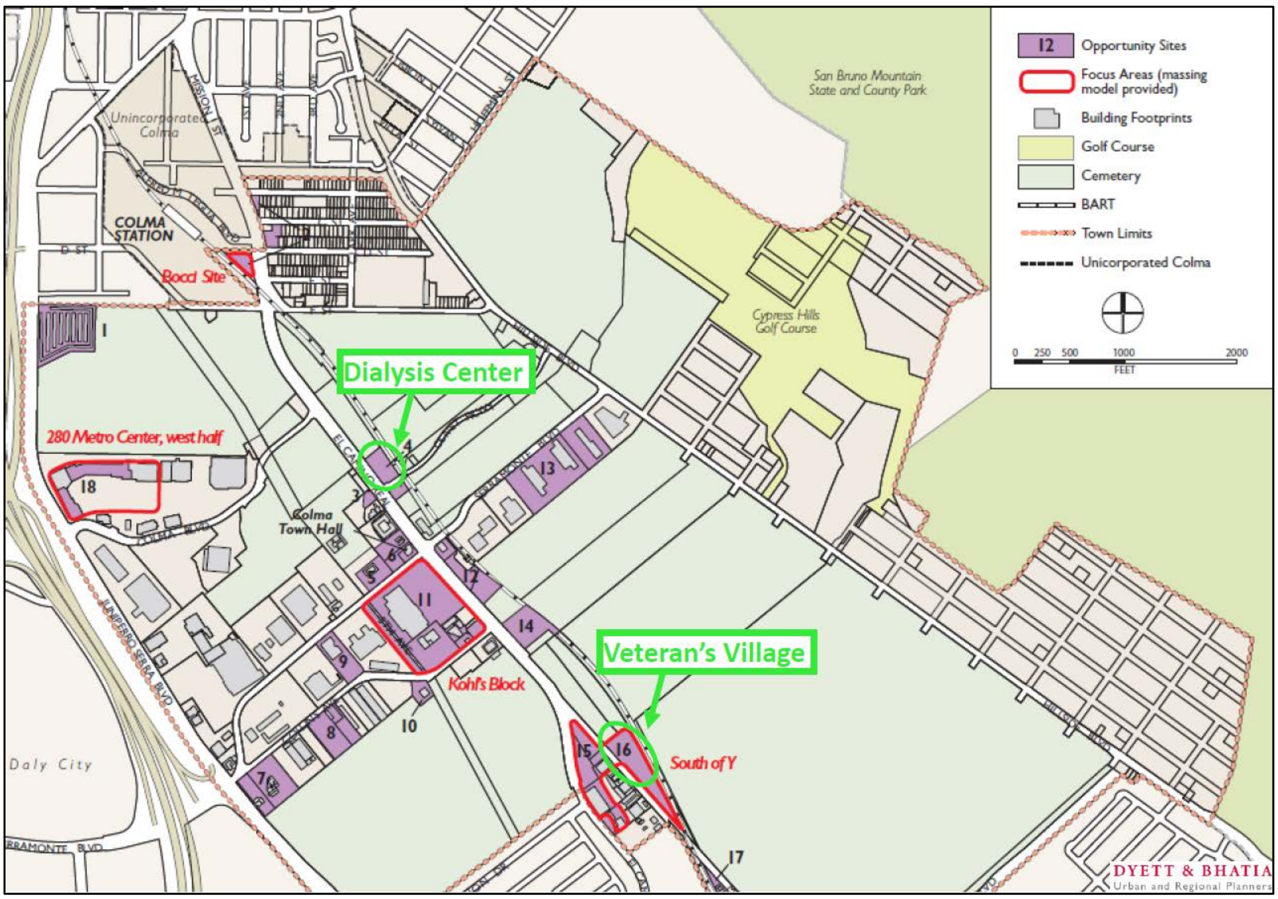


Figure 2-3. Opportunity Sites (Modified from Town of Colma Land Use and Urban Design Strategy)

2.3 Existing and Ultimate Build-out Scenarios Development

2.3.1 Existing Conditions Scenario

The purpose of the Existing Conditions scenario was to simulate operation of the sewer collection system calibrated to the available flow monitoring data to ensure an accurate representation of the collection system. The approach for the Existing Conditions scenario included the following parameters:

Existing Conditions Scenario:

- Land use types are consistent with the Town of Colma Zoning Map
- Average household size consistent with Town of Colma 2015 Housing Element at 3.05 persons
- Accounted for existing vacancies

2.3.2 Ultimate Build-Out Scenario

The purpose of the UBO scenario was to simulate the sewer collection system with increased densification of existing development and maximize infill development. This UBO scenario is intended to identify capacity deficiencies to inform future discussions and facilitate densification within existing city limits. The approach for the UBO Scenario included the following parameters:

Ultimate Buildout Scenario:

- Land use types are consistent with the Land Use Strategy map, opportunity sites and focus area data
- A floor to area ratio (FAR) of 1:1 was assumed for all opportunity sites, with the exception of the 5 focus areas
- The 5 focus areas identified among the opportunity sites were further developed to take into consideration the available data regarding building square footage and number of dwelling units
- Average household size was kept consistent with the Town of Colma 2015 Housing Element
- The density of all commercial parcels not identified as opportunity sites was increased by 5% from the Existing Conditions Scenario to represent typically conservative growth patterns utilized in hydraulic modeling/ master planning

3 PHYSICAL MODEL DEVELOPMENT

3.1 Sources of Physical Model

The Town did not have a pre-existing physical model; therefore, WWE developed a new GIS-based sewer network using available resources. The Town provided WWE with as-builts/CAD drawings/etc. of the Town's wastewater collection system and WWE formed the physical model geometry consisting of all pipes and manholes in the collection system. The methodology for how these resources were used is summarized below.

The collection system map was reviewed for all applicable information regarding collection system attributes (i.e. pipe and manhole IDs, pipe diameters, pipe slopes, pipe inverts, manhole rim elevations). These pieces of data were used as a starting point for the process of determining the final pipe inverts elevations and manhole rim elevations. One important point to note about the provided system maps is that the elevations provided are all seemingly rounded to the nearest whole number. Therefore, the following approach to pipe inverts was taken in order to create a physical model that most accurately represents a typical gravity sewer collection system.

- Where possible, the pipe slope percentages provided on the collection system maps are used in conjunction with the GIS-measured pipe lengths to determine the approximate elevation drop across that pipe segment.
- In most instances where pipe slopes are not provided, that particular pipe segment's slope was assumed to be the typical industry-wide minimum design slope for the pipe's diameter. This assumption was employed to ensure the Town's hydraulic model did not overstate a pipe segment's available conveyance capacity, thereby keeping the model "conservative" in its simulation of collection system performance.

An overarching objective of this process was to take a global view of the surrounding sewer system's invert elevations and make educated decisions for individual pipe segment attribute calculations such that localized discrepancies did not propagate through to the rest of the collection system. The various instances where deviations from the aforementioned pipe-slope approach were applied are explained below:

- Where two pipe segments have a common downstream manhole, and only one of the pipe segments is provided with a slope, the downstream invert elevations of both pipes are assumed to be the same (i.e. the downstream invert elevation of the pipe segment that was provided a slope value).
- In certain instances when utilizing the given pipe slope to calculate invert elevations resulted in an abnormally high or low invert elevation, an invert elevation closer to the map invert was used. This was done to prevent pipe segments located further downstream from also being abnormally high or low.

4 HYDRAULIC MODEL DEVELOPMENT

The hydraulic model is based on the newly formed GIS sewer network and was simulated using Innovyze's InfoSewer modeling software. The InfoSewer software was used to simulate dry-weather and wet-weather flow quasi-dynamically in 15-minute increments. The development of the model depended on flow meter data and rainfall data, calibrated dry and wet weather flows, and a chosen design storm. This methodology is explained in the subsequent sections and **Chapter 5**.

4.1 Flow Meter Data

The Town obtained the services of Total Flow Inc. for the rental, installation, procurement, and analysis of temporary flow meter data across January and February 2017. The results and monitoring methodology are presented in Appendix B**,** the Town of Colma Flow Monitoring Services Report completed by Total Flow Inc. in collaboration with WWE. The flow monitoring data was used to calibrate dry and wet weather flow by sewer basin.

4.2 System Configuration

The Town's sanitary sewer system can be characterized as including ten identifiable sewer basins, which generally correspond with the flow meter locations utilized by Total Flow Inc. during monitoring in early 2017. The approximate acreage of each basin is displayed in **Table 4-1**.

Table 4-1: Basin Acreages

Basin	Total Acres
DCMB	408
SSFMB1A	138
SSFMB1B	14
SSFMB2	60
SSFMB3	59
SSFMB4A	15
SSFMB4B	8
SSFMB5	424
SSFMB6	9
SSFMB7	10
Total	1145

4.3 Hydraulic Loading

The hydraulic model wastewater loading was accomplished via a point load to a manhole node from individual parcels. The wastewater flow from each parcel was assigned to the closest downstream manhole. Each parcel was assigned an average dry weather flow and wet weather flow with corresponding peaking factors.

5 DRY WEATHER MODEL DEVELOPMENT

5.1 Average Dry Weather Flow

Average dry-weather flow (ADWF) is an essential component of a hydraulic model and can be characterized as the diurnal or daily wastewater flow from a parcel that is not influenced by groundwater level changes or rainfall effects. The theoretical ADWF was calculated for each parcel based on land use and typical wastewater generation rates and was then calibrated to the observed flow meter data produced by Total Flow Inc.

5.1.1 January 2017 DWF Analysis

The methodology of estimating wastewater generation rates was an iterative approach that was calibrated to observed flow meter ADWF. The observed average weekday and weekend flows are shown on **Table 5-1**.

Table 5-1: Daily Average Flows by Flow Meter

Flow Meter	Average Weekday (MGD)	Average Weekend (MGD)
1	0.190	0.166
2	0.033	0.037
3N	0.139	0.132
3W	0.007	0.006
4	0.031	0.033
5	0.516	0.544
6	0.635	0.658
7	0.032	0.028
8N	0.044	0.043
8W	0.041	0.040

5.1.2 Average Dry Weather Flow Calibration

Average dry weather flow for the Existing Conditions scenario was calculated to closely match the flow of each basin presented in Table 5-1. This was done by assigning different wastewater generation rates for each of the land use types, residential, commercial, cemetery and other. The iterative approach began by assigning a typical per capita sewage flow to residential parcels and multiplying this by the house hold size. The remaining flow for each basin was apportioned predominately to commercial, while a small amount of wastewater flow was assigned to cemetery land use parcels that contained buildings. The values for residential and commercial wastewater generation rates were adjusted for each basin until the calculated ADWF approximated the flows in **Table 5-1**. The land use type "Other" was predominately open space. As open space land use parcels typically are not significant contributors of wastewater flow, they were consequently excluded from the calibration process. The resultant wastewater generation rates by basin are summarized in **Table 5-2.**

Table 5-2: Existing Wastewater Generation Rates Calculated to Flow Meter Data

Existing Wastewater Generation Rates			
Basin	Residential (gpd/person)	Commercial (gpd/acre)	Cemetery (gpd/bldg.)
DCMB	65	1500	480
SSFMB1A	55	1050	
SSFMB1B	55	3300	
SSFMB2	55	1450	
SSFMB3	55	675	
SSFMB4A	60	3600	
SSFMB4B	55	1250	
SSFMB5	60	1500	
SSFMB6	60	1500	
SSFMB7	55	1500	

5.2 Wastewater Generation Rates

To model the UBO scenario the wastewater flow was increased to reflect the potential increase in both residential and commercial development. This was accomplished by increasing wastewater generation rates as well as incorporating opportunity sites.

For the UBO scenario the commercial wastewater generation rate increased by 5% reflecting an assumed increase in densification (**Table 5-3**).

Table 5-3: Commercial Wastewater Generation Rates for Each Basin

Commercial		
Basin	Existing Flow (gpd/acre)	Ultimate Build-out Flow (gpd/acre)
DCMB	1500	1575
SSFMB1A	1050	1102.5
SSFMB1B	3300	3465
SSFMB2	1450	1522.5
SSFMB3	675	708.75
SSFMB4A	3600	3780
SSFMB4B	1250	1312.5
SSFMB5	1500	1575
SSFMB6*	1500	0
SSFMB7	1500	1575

*Basin SSFMB6 is entirely composed of residential parcels and so was assigned a wastewater generation rate of 0 gpd/acre.

5.2.1 Opportunity Site Wastewater Generation Rates

To develop ADWF for the UBO Conditions Scenario wastewater generation rates for the 18 opportunity sites were integrated into the Existing Conditions scenario. The 5 focus areas and the remaining 13 opportunity sites were calculated differently from one another because of the varying degree of data available.

The land use types for the 13 opportunity sites not identified as focus areas were determined to be either commercial or executive administrative based on the most current parcel GIS shapefile that is publicly available through San Mateo County. The wastewater generation rates of 1,000 gpd/acre and 1,200 gpd/acre were assigned to commercial and executive administrative land use types respectively.

The available data for the focus areas in **Table 2-4** were used to calculate the wastewater flow rates for the focus areas. The different land use types mixed-use, medical office and commercial each had unique methods for wastewater flow calculation summarized below.

Commercial:

- Wastewater generation rate of 1,000 gpd/acre
- Only total building area and not total parcel area was used to calculate acreage

Mixed-use:

- Sum of residential and commercial flow rates
- Each dwelling unit had a house hold size of 3.05 persons
- The residential wastewater generation rate for each dwelling unit was assigned according to the UBO Flow in **Table 5-1** for the corresponding basin
- The commercial flow for each site was calculated using a wastewater generation rate of 1,000 gpd/acre, only building acreage was taken into consideration for calculation

Medical Office:

- Wastewater flow calculation was driven by the number of patient beds
- Assumed 60 gpd of wastewater would be produced for each patient bed

5.3 Peaking Factors

The observed hourly peaking factors (diurnal curves) measured at each flow meter are applied to ADWF in the hydraulic model by basin to allow for real-time dynamic hydraulic modeling. The peaking factors for each flow meter are displayed graphically in **Figure 5-1**, and the peaking factors are listed for each basin in **Table 5-4.** The minimum and maximum flows occur approximately at 4AM and 3PM respectively. The PDWF is determined by multiplying the average dry weather flow by the corresponding hourly peaking factor (PF).

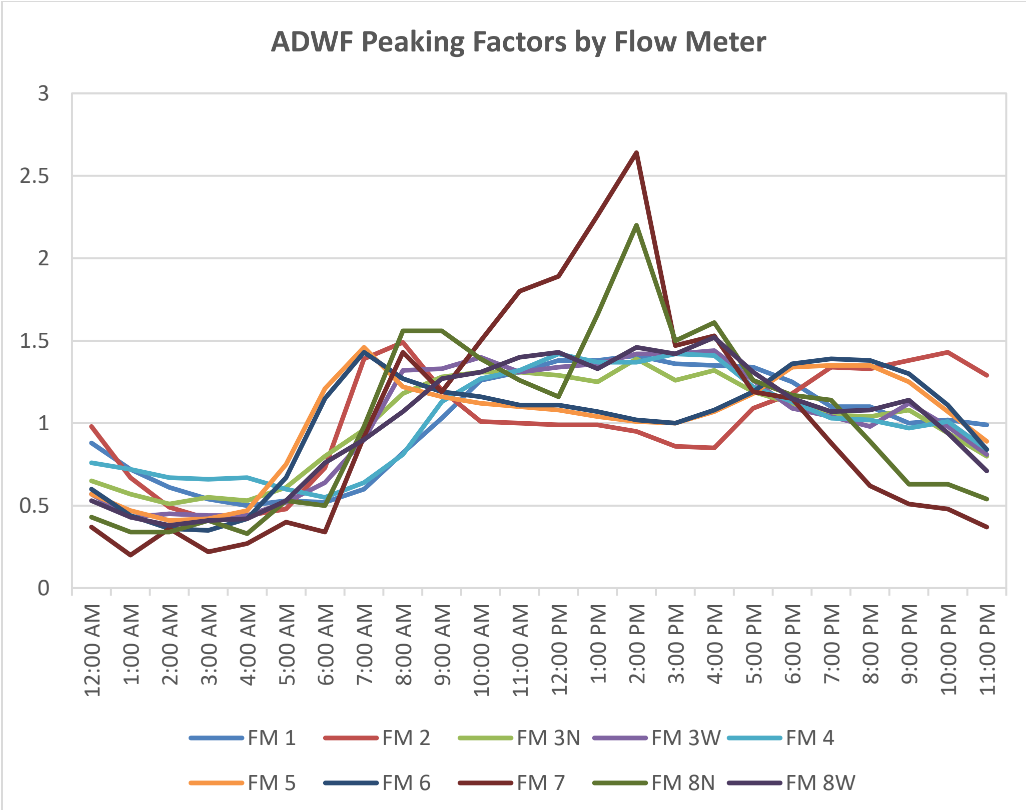


Figure 5-1. Dry Weather Flow Hourly Peaking Factors by Flow Meter

Table 5-4: Dry Weather Flow Hourly Peaking Factors by Basin

Basin	Peaking Factor (ADWF to PDWF)
SSFMB1A	2.64
SSFMB1B	2.2
SSFMB2	1.42
SSFMB3	1.52
SSFMB4A	1.39
SSFMB4B	1.44
SSFMB5	1.41
SSFMB6	1.49
DCMB	1.43

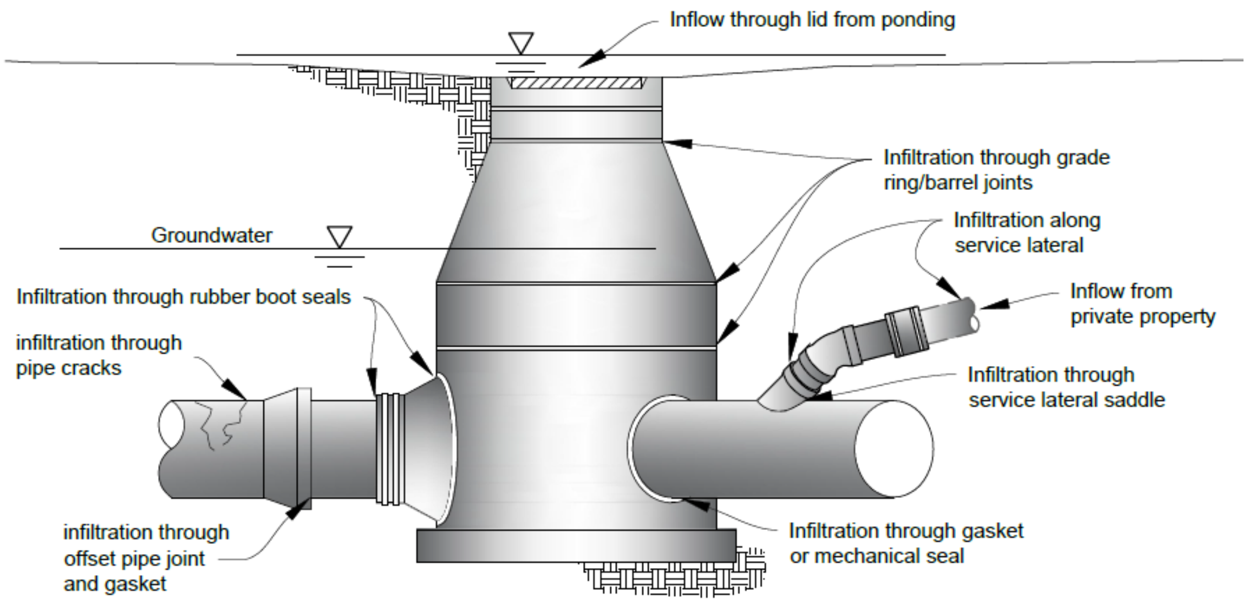
6 WET WEATHER MODEL DEVELOPMENT

6.1 Wastewater Flow Characterization

The hydraulic model simulates PWWF given a design storm hyetograph (rainfall over time) and a calibrated theoretical system response to that rainfall. PWWF is collectively made up of PDWF and Rainfall-Derived Inflow and Infiltration.

6.1.1 Rainfall-Derived Inflow and Infiltration

Rainfall-Derived Inflow and Infiltration (RDII) is rainfall runoff that enters a closed sewer collection system through manhole and pipe defects, manhole lids and clean-outs, and is visually represented in **Figure 6-1**. The relative magnitude of the RDII is often correlated with the age of the collection system. High intensity inflows typically dissipate soon after rainfall stops as opposed to low intensity groundwater infiltration (GWI) that can stay at elevated levels for many days after a storm, as evident in a sample hydrograph displayed in **Figure 6-2.**



Common Sources of Inflow and Infiltration

Figure 6-1: Common Sources of RDII

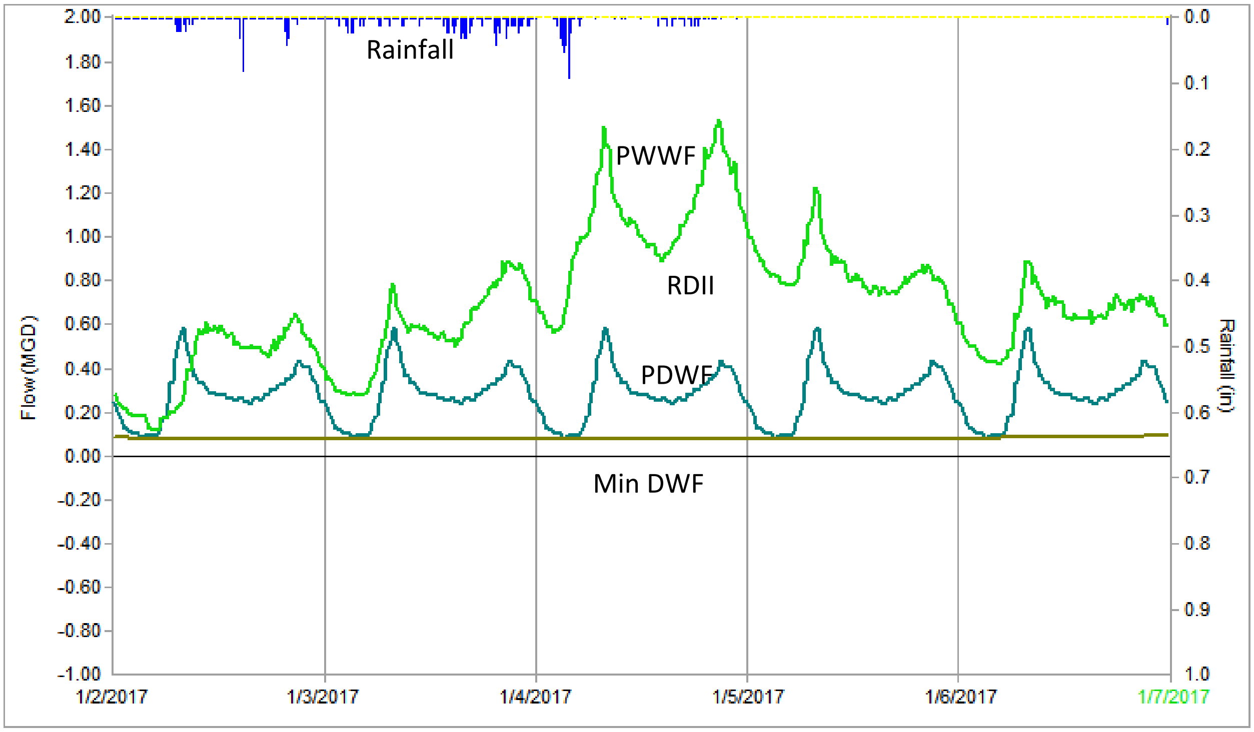


Figure 6-2: PWWF, PDWF, RDII

The flow meter data used to generate the design storm for the hydraulic model PWWF analysis occurred in late February 2017. The rainfall data was in the middle of the 2017 Water Year (October 1, 2016 to September 30, 2017), which was a record wet year for California and in many areas ended drought conditions that had persisted for 5 years prior. As such it was assumed that antecedent moisture conditions were relatively high before and after the February 2017 storm, which conservatively affects the hydraulic model by maximizing RDII responsiveness and measured peak flows. Comparatively, a storm earlier in the Water Year might have had low antecedent moisture conditions and a higher soil capacity that could attenuate any RDII responses.

RDII was applied in the hydraulic model by calculating the total for each basin, and then applying it equally across each basin manhole.

6.2 Calculation of Peak Wet Weather Design Flows

6.2.1 Rainfall Data Source and Calibration

The rainfall data used to develop the model RDII response to storm events was derived from the temporary 5-minute increment wet weather flow station located at the Town Hall. The single high-resolution rain gauge was applied equally across the City Basins for calibration purposes. The largest storm during the monitoring period was on February 20th, totaling 1.61" and was used as the design storm benchmark to calibrate the wet weather flow model.

The three main components of a design storm are the total depth, duration, and probabilistic return period or frequency of that storm. This study incorporated a 10-year return, 24-hour duration, and 3.95-inch total precipitation storm listed in NOAA Atlas 14, Volume 6, Version 2 for the Colma Region. The temporal distribution of the storm was developed via the Natural Resources Conservation Service (NRCS) Soil Conservation Service (SCS) Type 1A rainfall distribution method, which is the typical rainfall distribution method used in the Bay Area region surrounding Colma. The specific rainfall distribution methods typically employed in various parts of the country are displayed in **Figure 6-3.** The resultant rainfall hyetograph is displayed in **Figure 6-4**.

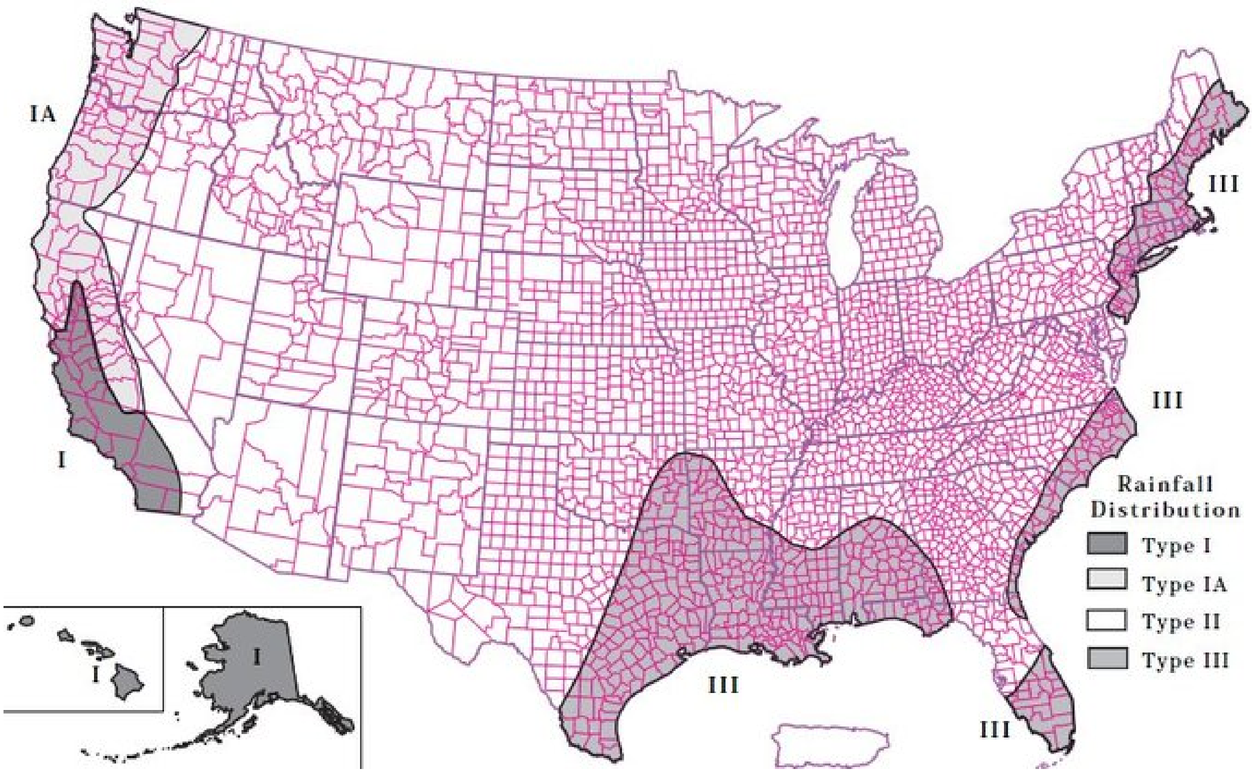


Figure 6-3: NRCS SCS Rainfall Patterns

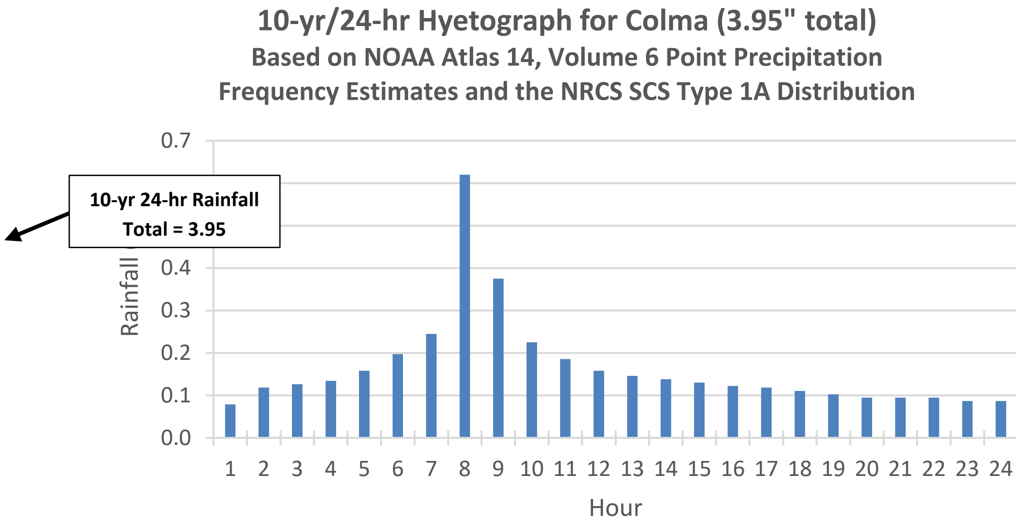


Figure 6-4: NRCS SCS 10-yr/ 24-hr Type 1A Hyetograph

6.2.2 RDII Synthetic Unit Hydrograph Development

The rainfall and flow meter data, along with the chosen 10-yr/24-hr design storm hyetograph, were inputted into the EPA's Sanitary Sewer Overflow Analysis and Planning (SSOAP) Toolbox Software. Within the software, basin-specific 10-yr/24-hr theoretical unit RDII hydrographs were produced (i.e., theoretical RDII response curves). The process is based on modifying specific triangular unit hydrograph parameters (R, T, and K values) to best fit the observed storm response during the storm event. Where R is the fraction of RDII rainfall volume entering the system, T is the time to peak, and K is the ratio of time of recession to T. As many as three triangular unit hydrographs can be fit to an observed RDII hydrograph corresponding to a single rain event.

The R value depends on the actual area that contributes RDII (i.e., an area that conceivably drains towards manholes). To that end, the RDII contributing areas of the large cemetery parcels were significantly reduced given the existing site conditions to local sewer. The resultant SSOAP hourly RDII by basin is shown in **Figure 6-5**.

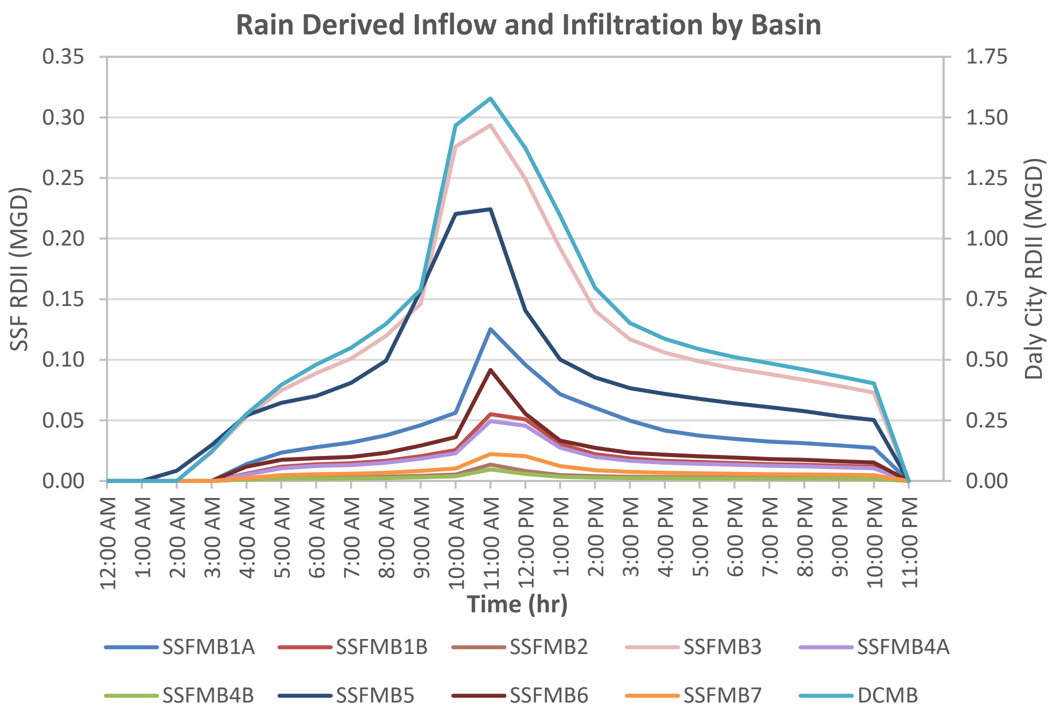


Figure 6-5: Theoretical RDII Hydrographs by Basin for 10-yr/24-hr Type 1A Storm

6.2.3 InfoSewer Hydraulic Model

The average dry weather flow, peaking factors, and RDII were all incorporated into the hydraulic model as separate variables. The Existing Conditions Scenario and UBO Conditions Scenario were simulated using the Innovyze InfoSewer software. The results of the model simulations for the two scenarios are summarized in the following section.

7 MODEL RESULTS

7.1 Capacity Criteria

The objective of the model was to assess the capacity of the system under Existing and UBO Conditions and identify capacity deficiencies. This report defines a capacity deficiency as any location where surcharging of a manhole occurs due to a downstream restriction in flow and where surcharging of a pipe occurs. To assess the potential for surcharging of manholes and pipes the maximum unfilled manhole depths and maximum pipe depth to diameter ratios (d/D) were grouped into discrete categories, summarized in **Table 7-1** and **Table 7-2**.

Table 7-1: Manhole Capacity Criteria

Manhole Capacity Categories		
Maximum Unfilled Depth (ft)	**Color Code**	**Description**
Potential SSO	Red	Above capacity, likely spilling at ground level
0 - 3 Feet	Orange	Nearing capacity, within 3 feet of ground level
3 - 5 Feet	Yellow	Sufficient freeboard capacity
> 5 Feet	Green	Sufficient freeboard capacity

Table 7-2: Pipe Capacity Criteria

Pipe Capacity Categories		
Maximum d/D	**Color Code**	**Description**
> 0.99	Red	At capacity, surcharged by depth and flow
0.75 - 0.99	Orange	Nearing capacity, may be acceptable for short periods during design storm
0.50 - 0.75	Green	Sufficient capacity
0.00 - 0.49	Blue	Extra capacity available

7.2 Existing System Results

7.2.1 PDWF Existing Results

For the Existing Conditions scenario, model simulations were performed for PDWF and PWWF conditions. The PDWF model simulations provide an approximation of how the collection system responds to the wastewater that enters the system for a typical day. The PDWF results are shown in **Appendix C.1**. No SSOs resulted from the PDWF simulation and the maximum unfilled manhole depth was within 3-5 feet of the rim elevation. There were two instances of pipe surcharging, one on Collins Street and a section of pipe intersecting El Camino Real. However, surcharging in these locations was a result of the siphons located there and not because the pipe diameters are undersized. Under Existing Conditions, the collection system is adequately sized to convey the PDWF to the Daly City and South San Francisco collection systems.

7.2.2 PWWF Existing Results

The PWWF model simulation results are shown in **Appendix C.2**. In contrast to the PDWF results the PWWF scenario had many areas of pipe that were surcharging as well as manhole unfilled depths that were less than 3 feet below the rim elevation. Three areas of concern were identified; along F Street and El Camino Real, Serra Shopping Center and Collins Avenue, and El Camino Real and Mission Road. The capacity assessment for the three areas of concern are summarized below.

F Street and El Camino Real

- The HGL profiles for this area are shown in **Appendix C.3**
- Unfilled manhole depths for SSMH7E72, SSMH7E49, and SSMH7E83 were less than 3 feet from the rim elevation. This is partially due to the shallowness of the manholes which are only 3-5 feet deep.
- The following pipe segments had a d/D greater than 1: SSMH7E73-SSMH7E49, SSMH7E82-SSMH7E83, SSMH7E86-SSMH7E87, and SSMH7E43 to the Daly City outlet.
- Some pipes also showed a d/D between 0.75-0.99

Serra Shopping Center and Collins Avenue

- The HGL profiles for this area are shown in **Appendix C.4**.
- For this area, the model did not show any potential SSOs. All manholes were at least 3 feet below the rim elevation or deeper.
- All pipes in this area had a d/D greater than 1.

El Camino Real and Mission Road

- The HGL profiles are shown in **Appendix C.5**.
- There were no potential SSOs modeled in this area, however manholes SSMH9F17, SSMH9F18, and SSMH10F19 were less than 3 feet below the rim elevation.
- The siphon structure located in between manholes SSMH9F13_S and SSMH9F14_S is utilized to provide sufficient vertical clearance from an overhead storm drain. The siphon inherently flows full and effectively creates a submerged/pressure condition in the siphon piping, thereby increasing the total dynamic head which subsequently raises the upstream HGL.
- From manhole SSMH9E2 to SSMH10F26 the d/D is greater than 1, which encompasses nearly the entire pipe length for this area.

While no SSOs were shown for the Existing Conditions scenario for either PDWF or PWWF the model assumes no obstructions in pipes or manholes, which is unlikely to be the case in the actual collection system. As such manholes that are not overflowing but are within 3 feet of the rim elevation are also of concern.

The Existing Conditions PWWF hydrographs for the Daly City and South San Francisco outlets are shown in **Figure 7-1**. The maximum flow modeled at the Daly City and SSF outlets were 2.11 MGD and 1.086 MGD respectively.

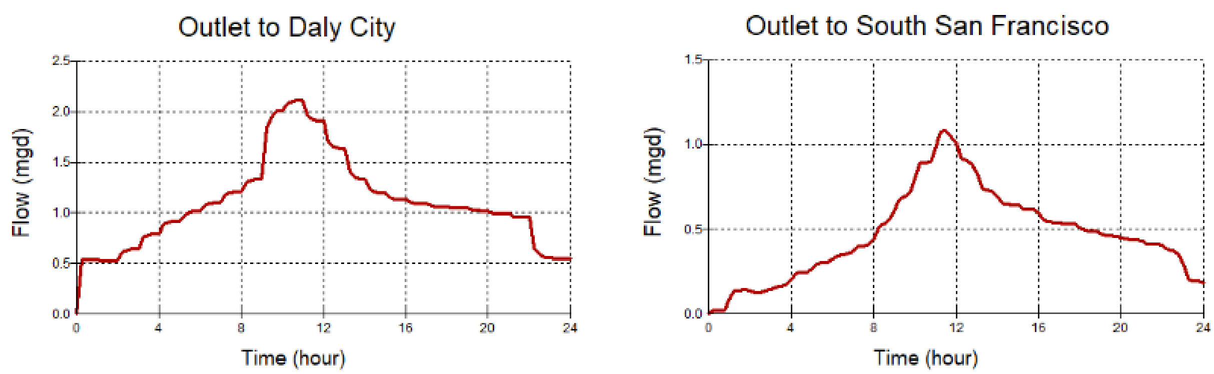


Figure 7-1. Existing Conditions 10-yr/ 24-hr PWWF hydrographs

7.3 Ultimate Build-out System Results

7.3.1 UBO PDWF Results

The model results for PDWF for the UBO Conditions scenario are shown in **Appendix D.1**. The UBO PDWF results were very similar to the Existing Conditions PDWF results. All unfilled manhole depths were at least 3 feet from the rim elevation. The only surcharging pipes were again on Collins Street and intersecting El Camino Real where the siphons are located. Additionally, from manholes SSMH10F25-SSMH10F27 the d/D was between 0.5 to 0.75. Under UBO conditions the collection system is adequately sized for PDWF.

7.3.2 UBO PWWF Results

The model results for UBO Conditions during PWWF are shown in **Appendix D.2**. The PWWF model results for the UBO Conditions scenario resulted in a few SSOs and various instances of pipe surcharging. The three areas of concern previously detailed for the Existing Conditions PWWF scenario remain the predominant areas of concern for the UBO Conditions PWWF scenario. A summary of the capacity assessment for all three areas of concern follows below.

F Street and El Camino Real

- The HGL profiles for this area are shown in **Appendix D.3**.
- Unfilled manhole depths for SSMH7E72, SSMH7E49, and SSMH7E83 were within 3 feet of the rim elevation. As noted in **Section 7.2** above this is in part due to the inherit shallowness of the manholes.
- All other manholes were 3 feet or more from the rim elevation.
- The pipes from manhole SSMH7E73 to SSMH7E49, manhole SSMH7E82 to SSMH7E83, manhole SSMH7E86 to SSMH7E87, SSMH7E43 the outlet, and SSMH7E97 to SSMH7E38 had d/D values greater than 1.

Serra Shopping Center and Collins Avenue

- The HGL profiles are shown in **Appendix D.4**.

- All manholes in this area from manhole SSMH9E6 to manhole SSMH9E12 were within 3 feet of the rim elevation.
  All pipes from manhole SSMH9E6 to manhole SSMH9E12 were surcharged.

El Camino Real and Mission Road

- The HGL profiles are shown in **Appendix D.5**.
- Manholes SSMH9F20 and SSMH9F13 were potential SSOs.
- Manholes SSMH9F21, SSMH9F13_S, SSMH9F14, SSMH9F15, SSMH9F16, SSMH9F17, SSMH9F18, SSMH10F19, SSMH10F20, and SSMH10F21 were all within 3 feet of the rim elevation.
- Flow performance is again negatively impacted by the siphon structure located between SSMH9F13_S and SSMH9F14_S, which flows full creating a submerged pressure condition and raises the upstream HGL.
- All pipes from manhole SSMH9E2 through SSMH10F26 had a d/D greater than 1.

The many manholes that are within 3 feet of the rim elevation, numerous surcharging pipes, and two potential SSOs demonstrate that the system is currently undersized to meet future demand during wet weather conditions. In order to accommodate the planned development of the UBO condition under PWWF an additional 0.3 MGD of capacity is required in the system to convey the flow to South San Francisco while maintaining a d/D less than 1.

The UBO Conditions PWWF hydrographs for Daly City and South San Francisco are shown in **Figure 7-2**. The maximum flows modeled at the Daly City and SSF outlets were 2.136 and 1.158 respectively. The UBO Conditions scenario maximum flows are only slightly higher than those of the Existing Conditions scenario from Section **7.2**. This is because the difference in dry weather flow is minimal relative to the volume of RDII that enters the collection system for the 10-yr/24-hr Type 1A design storm.

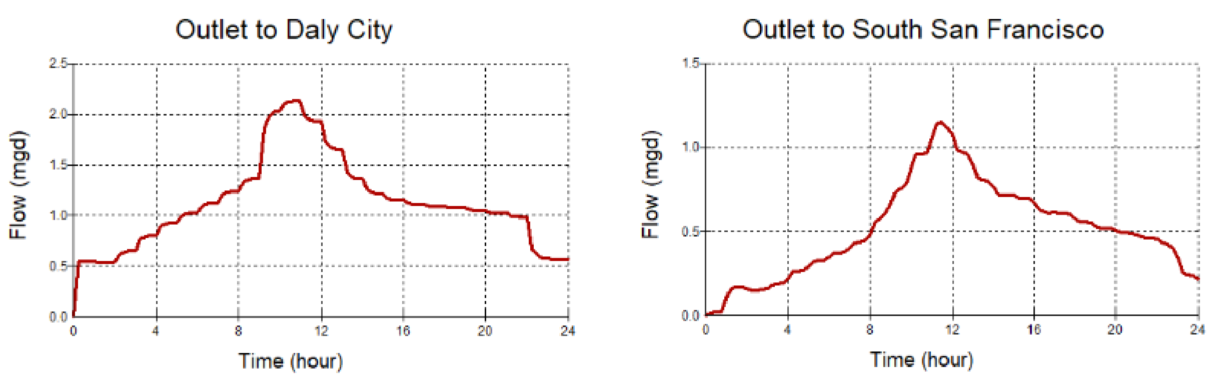


Figure 7-2. UBO Conditions 10-yr/24-hr PWWF hydrographs

8 RDII REDUCTION

Many social, environmental, and economic benefits are attributed to reducing RDII. Excessive RDII in urban areas can hinder the potential for growth by reducing the available capacity of the sanitary sewer system facilities. A system that is inadequate to convey and treat the RDII puts the health of the public at risk through sewer backups and basements flooding. Additionally, the health of tributary streams may be impacted if the RDII is significant enough to reduce groundwater levels. Considerable increases in ratepayer cost for conveying and treating wastewater as well as heightened maintenance and operation of supporting facilities can result from excessive RDII [U.S. Environmental Protection Agency, 2014 and Federation of Canadian Municipalities and National Research Council, 2003]

The goal of an RDII reduction program for the Town would be to reduce the PWWF to aid in eliminating all potential SSOs and surcharging pipes. Major elements of an RDII reduction program include:

- Flow monitoring
- Sanitary sewer assessment and analysis
- System improvement plan development
- System improvement plan implementation

General flow monitoring is necessary for determining basins in which the RDII response was pronounced. Thereafter, several strategies including closed circuit television inspection, smoke and dye testing, micro monitoring, and point-of-sale ordinances can be utilized to further identify smaller sub-basins or segments of pipe that exhibit a significant RDII response. Description of these methods can be found below:

- Closed Circuit Television (CCTV) Inspection has been widely used in assessing sewer pipes. CCTV inspection produces a video and field log documenting problems on the interior of the pipes and manholes. CCTV can be used to identify structural issues, locate leaking joints, blockages, root intrusion, and dropped joints. Point repairs for identified high severity structural pipe defects have been found to effectively reduce RDII contributions.
- Smoke testing can be used to locate the sources of RDII in the sewer main and service laterals. Smoke testing involves blowing smoke into a manhole and through an isolated segment of pipe. If the sewer pipe is in good condition the smoke will emerge at the downstream manhole or vents on the roof of a house. Smoke emerging from cracks in sidewalks or through resident's yards is an indication that a sewer pipe is in poor condition.
- Dye tracing is often used as a compliment to smoke testing if the results of smoke testing are inconclusive. Dye testing can be used to confirm whether or not a connection is a source of RDII.
- Micromonitoring can be used to monitor the flow of upstream pipes with small diameters with relatively low flow. Micromonitors are placed upstream of a conventional flow monitor and are used to pinpoint the areas which are primary RDII contributors .
- Point-of-sale ordinances have been implemented to require the rehabilitation/replacement of the sewer upper lateral upon the sale of a residential house, commercial property, etc. It is typical for a public agency to only own/maintain the lower lateral serving a building (i.e. the portion of the sewer lateral from the cleanout to the connection point at the main sewer pipeline), thus

rendering it relatively difficult to properly assess/maintain the upper lateral. Upper laterals could contain illegal cross-connections and/or significant structural defects, thus having an ordinance within the pertinent municipal code in place that provides an opportunity for upper lateral rehabilitation activities could be a beneficial strategy within an agency's RDII reduction program.

Following a system assessment, rehabilitation projects can be formed and implemented in the areas where defects and false plumbing connections are found. Typical rehabilitation projects are described below:

- Lining of mains, side sewers, and laterals can reduce the volume of infiltration that enters through cracks in the pipes
- Lining and structural grouts in manholes reduce the volume of infiltration by covering and sealing the cracks
- Improving the seal between the frame and cover of the manhole can reduce the volume of inflow that enters the system during a storm event
- Eliminating illegal/ illicit cross-connections can greatly reduce the volume of inflow to the sanitary sewer system

8.1 RDII Reduction Program (SSFMB6 and SSFMB3)

Industry experience has shown that the outcome of RDII reduction programs tends to be much less than what is expected. This is because it is difficult to find and address the many areas where RDII is entering the system. Additionally, private building laterals typically are major contributors to RDII and assessing and rehabbing private property can be a very difficult and costly process, especially without cooperation of the community [Federation of Canadian Municipalities and National Research Council, 2003]. Due to the variability of the outcome of RDII reduction programs they are not intended to be a sole solution to addressing capacity deficiencies, rather they should be ongoing and used as a preventative measure.

8.1.1 Major RDII Contributing Basins

The costs associated with RDII reduction efforts can be greatly reduced by developing a targeted RDII reduction program; additionally, this generally improves the efficiency of the RDII reduction efforts. This can be done by first identifying the basins that have the greatest negative impacts to the sanitary sewer system in regard to RDII. In order to compare the basins, the amount of RDII with considerations to total pipe length and diameter for each basin were calculated, the relative magnitude of RDII per inch of diameter per mile (idm) of sewer piping for each basin are displayed in **Table 8-1**. Also presented in **Table 8-1** are the basins ranked relative to each other, with the basin ranked #1 representing the largest response to the storm event (I.e., the "leakiest basin").

Table 8-1. RDII by Basin

Basin	RDII Area (Acres)	Peak RDII (MGD)	Peak RDII/idm (gpd/idm)	Ranking
SSFMB1A	72	0.125	16,184	6
SSFMB1B	22	0.055	23,309	4
SSFMB2	72	0.014	2,649	9
SSFMB3	71	0.294	34,927	3
SSFMB4A	21	0.049	14,399	7
SSFMB4B	12	0.010	3,453	8
SSFMB5	190	0.224	18,595	5
SSFMB6	9	0.094	60,200	2
DCMB	200	1.578	107,488	1

While **Table 8-1** ranks the basins in order of which have the greatest RDII response, the locations of the basins relative to the capacity deficiencies identified in **Chapter 7** must also be considered. The basins that are ranked higher for greatest RDII response and are located upstream of the major capacity deficiencies should be prioritized when developing a plan for system improvements. **Table 8-2** presents the basins ranked by priority, with #1 representing the basin that should undergo system improvements first. Basins that did not receive a ranking exhibit a minimal RDII reduction response; consequently, under the current state of the system it is not recommended that these basins undergo improvements to reduce RDII.

Table 8-2. Sanitary System Improvement Plan

Basin	Recommended Prioritization	Comments
SSFMB1A		Minimal RDII response
SSFMB1B	4	Addresses El Camino Real and Mission Rd
SSFMB2		Minimal RDII response
SSFMB3	2	Addresses El Camino Real and Mission Rd
SSFMB4A		Minimal RDII response
SSFMB4B		Minimal RDII response
SSFMB5	5	Addresses El Camino Real and Mission Rd
SSFMB6	1	Addresses El Camino Real and Mission Rd
DCMB	3	Addresses F Street and El Camino Real

In **Table 8-1** Basin DCMB is ranked as #1 but addressing the substantial RDII response in DCMB would have no effect on the major capacity deficiencies modeled on El Camino Real and Mission Road. Additionally, no potential SSOs are modeled in DCMB, the most significant response are manholes that surcharge to within 3 feet of the rim elevation, but this is largely due to the inherent shallowness of the manholes. Consequently, DCMB is not the recommended basin with which to begin implementation of system improvements. Instead it is recommended that basin SSFMB6 and SSFMB3 be the first and second basins respectively on which efforts for system improvements are focused. SSFMB6 and SSFMB3 exhibited the highest Peak RDII/idm and are located upstream of the capacity deficiencies on El Camino Real and Mission Road (see **Figure 8-1** below). After efforts are made to reduce the RDII responses which impact El

Camino Real and Mission Road, DCMB can then be targeted if reduced PWWF to be discharged to Daly City is desired.

Figure 8-1. RDII Reduction Program Basins (SSFMB3 & SSFMB6)

8.1.2 Potential Volume of RDII Reduction

While the exact volume of RDII reduction cannot be determined, assumptions based on industry experience and professional opinion were made to estimate the potential volume of RDII that could be reduced for the proposed RDII reduction program.

The characteristics of the basins must be considered when estimating how effective selected RDII rehabilitation methods will be. Both SSFMB6 and SSFMB3 are predominantly impervious as they consist of a large apartment complex and mostly parking lots for the accompanying shopping centers and businesses. For impervious land types, where the effects of surface runoff are more significantly felt by the collection system, the proportion of RDII stemming from inflow is increased. To determine the individual infiltration and inflow percentages of the RDII response, the approximate base GWI first needs to be known. However, because the flow monitoring conducted by Total Flow Monitoring Inc. was only conducted across the wet months of January and February 2017, the base GWI would have been difficult to determine without making significant assumptions regarding the Town’s wet and dry seasons. The determination of base GWI requires flow monitoring data of dry weather flows across both the wet and dry seasons in order to assess the seasonal variance of groundwater infiltration's effects on the Town's collection system. Therefore, the range of infiltration/inflow proportions shown in **Table 8-3** were used to reflect basins with differing sources of RDII. The infiltration and inflow percentages of the GWI Basin type are representative of a typical system. The percentages of the Inflow Basin represent a basin with increased inflow, which can in part be a result of more impervious area, ponding at manholes, or illegal/illicit cross-connections. The Inflow Heavy Basin represents a basin that exhibits a very pronounced inflow response, likely where a significant cross-connection is known.

Table 8-3. Infiltration to Inflow Proportions

Basin Type	Infiltration	Inflow
GWI Basin	80%	20%
Inflow Basin	70%	30%
Inflow Heavy Basin	50%	50%

As previously mentioned RDII reduction efforts are often variable and cannot remove 100% of the RDII. Some rehabilitation methods used for reducing RDII are more effective than others. The proposed rehabilitation methods for this RDII reduction program and their anticipated effectiveness at reducing infiltration and inflow follow in **Table 8-4**.

Table 8-4. Percent Reduction of Infiltration and Inflow for the Different Rehabilitation Methods

RDII Rehabilitation Method Percent Reduction		
Rehabilitation Method	Infiltration	Inflow
Pipe & Lateral Lining	75%	0%
SSMH Lid Seal	0%	20%
Structural Grout & Liner	15%	20%
Illegal/Illicit Cross-Connection	0%	40%

The resulting volume of RDII removed using the values of **Table 8-3** and **Table 8-4** for basins SSFMB6 and SSFMB3 individually and combined are shown in **Table 8-5**. The values shown in **Table 8-5** do not include the elimination of illegal/illicit cross-connections as this rehab method is difficult to accomplish and the success of this rehab method is highly dependent on the degree of community involvement. If the Town desires to further reduce the volume of RDII through the elimination of illegal/ illicit cross-connections, then a program which engages the community and can procure the cooperation of private property owners is necessary.

The total RDII percent reduction for the GWI Basin, Inflow Basin, and Inflow Heavy Basin are 80%, 75%, and 65% respectively. The percent reduction decreases as the proportion of RDII consisting of inflow increases because reduction of inflow is less effective than the reduction of infiltration. Basins SSFMB6 and SSFMB3 likely reflect either the GWI basin or Inflow Basin and not the Inflow Heavy Basin as no significant illegal/illicit cross-connection that skews the proportion of RDII towards inflow is known. As such it is estimated that a potential RDII reduction volume ranging from 0.291-0.310 MGD could be achieved for basins SSFMB6 and SSFMB3, as shown in **Table 8-5**.

Table 8-5. RDII Reduction for basins SSFMB6 and SSFMB3 at Varying Proportions of Infiltration/Inflow

SSFMB6 and SSFMB3 RDII Volume Reduced (MGD)			
Basin	GWI Basin	Inflow Basin	Inflow Heavy Basin
SSFMB6	0.075	0.071	0.061
SSFMB3	0.235	0.221	0.191
Total	**0.310**	**0.291**	**0.252**

The **UBO PWWF Results** section states that the Mission Road line upstream of the SSF discharge point is undersized by 0.3 MGD and while 0.31 MGD of RDII flow could potentially be reduced from SSFMB6 and SSFMB3 collectively, it is not the recommendation of WWE that the RDII reduction program be implemented in place of a CIP. There is substantial statistical variation associated with the RDII reduction program and it does not guarantee that the necessary volume of reduction would be achieved. However, because of the many benefits associated with reducing RDII it is recommended that the proposed RDII reduction program be implemented in coordination with one of the CIP alternatives presented **below**. Cost estimates for the RDII reduction program are provided in **Table 8-6**.

Table 8-6. RDII Reduction Program Cost Estimate

Pipe Lining					
Basin	Pipe Length for 6" Dia. (LF)	Unit Cost 6" ($/LF)	Pipe Length for 8" Diameter (LF)	Unit Cost 8" ($/LF)	Cost
SSFMB6	1,374	$90	0	$120	$123,660
SSFMB3	5,366		1,531		$666,660
Subtotal (rounded to the nearest $1,000)					$790,000
Lateral Connection Rehab					
Basin	Number of Connections*		Unit	Unit Cost	Cost
SSFMB6	26		Connection	$5,000	$130,000
SSFMB3	32		Connection	$5,000	$160,000
Subtotal (rounded to the nearest $1,000)					$290,000
SSMH Lid Seal					
Basin	Number of Manholes		Unit	Unit Cost	Cost
SSFMB6	10		Manhole	$250	$2,500
SSFMB3	32		Manhole	$250	$8,000
Subtotal (rounded to the nearest $1000)					$11,000
SSMH Structural Grout & Liner					
Basin	Number of Manholes		Unit	Unit Cost	Cost
SSFMB6	10		Manhole	$2,500	$25,000
SSFMB3	32		Manhole	$2,500	$80,000
Subtotal (rounded to the nearest $1,000)					$105,000
Total Labor Materials and Equipment					$1,196,000
30% Design and 10% Construction Contingency					$478,400
5% Administrative and 10% Construction Management					$179,400
Total Project Cost (rounded to the nearest $1,000)					**$1,854,000**
*Total number of connections for each basin were estimated based on number of buildings with considerations made to the size of each building					

9 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

As noted in **Section 7.3.2** to mitigate all surcharging of pipes and potential sanitary sewer overflows an additional 0.3 MGD of capacity is needed to convey the PWWF of the UBO scenario to the City of South San Francisco's system. The downstream capacity in the City of South San Francisco was considered when developing CIPs to address the deficiencies. The following sections cover an analysis of the available capacity in the City of South San Francisco and several CIP alternatives.

9.1 Downstream Capacity, City of South San Francisco

On behalf of the City of South San Francisco, Akel Engineering Group, Inc. (Akel Engineering) provided an analysis of SSF's system downstream of the Town's system, the complete analysis package is provided in Appendix E. The analysis package documented two potential points of discharge, as identified by WWE, shown on **Figure 9-1** and **Figure 9-2**. The potential discharge point identified as Hickey Blvd and El Camino Real on **Figure 9-1** connects to an existing 15" diameter sanitary sewer pipe. The potential discharge point identified as Mission Road and Lawndale Blvd on **Figure 9-2** connects to an existing 18" diameter sanitary sewer pipe.

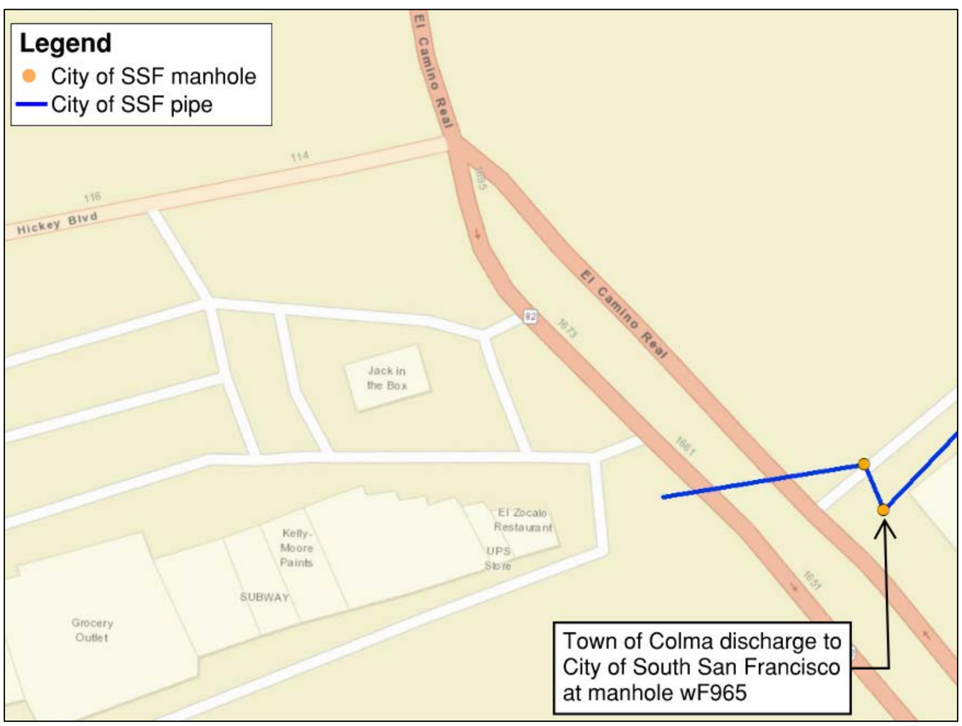


Figure 9-1. Town of Colma Potential Discharge Point to City of SSF at Hickey Blvd. and El Camino Real

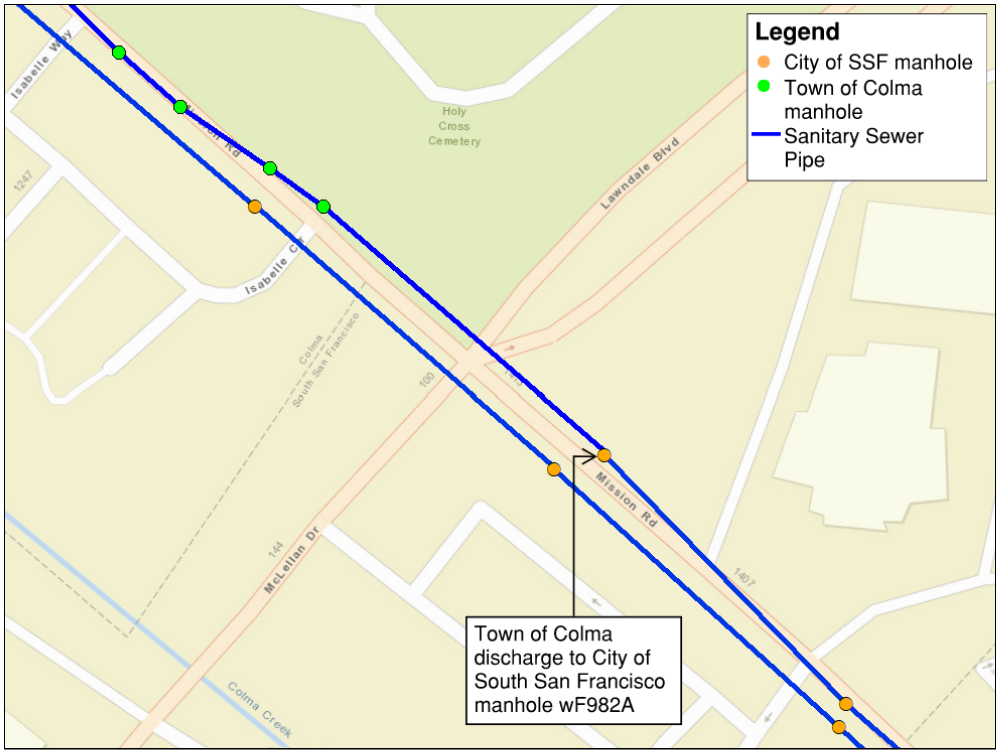


Figure 9-2. Town of Colma Potential Discharge Point to City of SSF at Mission Road and Lawndale Blvd.

Akel Engineering modeled SSF's existing PDWF and existing PWWF just downstream of both of the potential discharge points. The model results were only reflective of flows from SSF and did not include any wastewater flows from Colma or Daly City. Scenarios including potential future SSF flow projections stemming from planning developments were not modeled. The theoretical maximum allowable discharge for PDWF and PWWF was determined for the downstream pipe segments of both of the discharge points.

For PDWF, the theoretical maximum allowable discharge is the point at which the d/D in the trunk reaches 0.9, per the SSF Sanitary Sewer Master Plan (SSMP). The maximum allowable discharge for PWWF is met when the HGL is within one foot of the rim elevation, a criterion indicated by Akel Engineering. The PWWF scenario was based on a 10-yr/ 24-hr storm event (3.85 in) obtained from NOAA Atlas 14. **Table 9-1** summarizes the resultant model flows for both discharge points. Note that the remaining capacity is the difference between the theoretical maximum capacity and the discharge for the existing system. The theoretical remaining capacity is the capacity available to accept waste water flows from potential future development of SSF, flows form Daly city and flows from Colma. However, no information was provided as to how much of the capacity is designated to be used by the Town.

Table 9-1. South San Francisco model results for the potential discharge points

South San Francisco Model Results				
Modeling Scenario	Hickey & El Camino Real		Mission & Lawndale	
	Max PDWF (MGD)	Max PWWF (MGD)	Max PDWF (MGD)	Max PWWF (MGD)
Existing System*	0.432	2.736	1.044	5.652
Theoretical Maximum Capacity	0.540	3.744	3.564	8.100
Remaining Capacity	0.108	1.008	2.520	2.448
*Flows included only reflect SSF and not Colma or Daly City				

As shown in Appendix C.1 and Appendix D.1 during PDWF for the Town's Existing and UBO scenarios respectively there are no capacity deficiencies and all pipes, with the exception of the siphons, meet the SSF SSMP maximum d/D criteria. As shown in **Figure 7-2** the PWWF discharged to SSF is 1.158 MGD which is less than the remaining 2.448 MGD of capacity at the Mission and Lawndale discharge point. As discussed in the following sections the potential maximum discharge to Hickey and El Camino Real discharge point during PWWF would be 0.3 MGD which is less than the remaining 1.08 MGD of capacity. This analysis informed the CIP alternatives and was utilized to ensure that all CIP alternatives were viable options.

9.2 CIP Alternatives

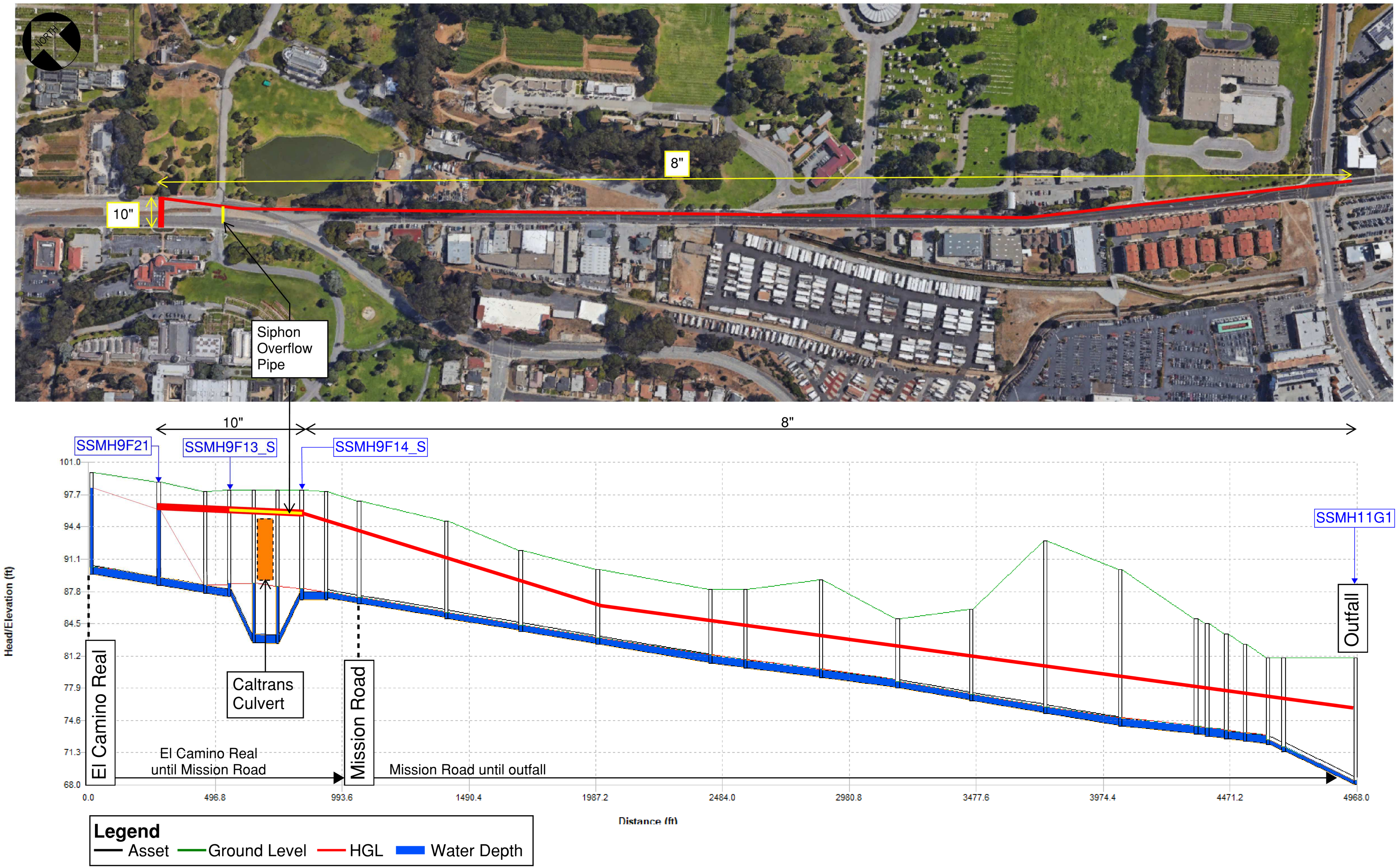
As stated **above** to eliminate all instances of surcharging on El Camino Real and Mission Road an additional 0.3 MGD of capacity is required. Several CIP alternatives were developed that would provide the additional required capacity and are described in the following subsections.

9.2.1 Alternative 1: Parallel Gravity Main Mission Road

One method to gain additional capacity and reduce the total PWWF discharge in the surcharging El Camino and Mission Road line would be to divert 0.3 MGD onto a parallel gravity main on Mission road as shown in plan and profile view in **Figure 9-3**. A high flow relief line would divert the surcharging flow during times of wet weather flow to the proposed gravity main. The gravity main would begin at manhole SSMH9F21 just upstream of a Caltrans box culvert. Spanning the box culvert the gravity main would need to be installed at a shallow depth with a flatter slope resulting in the need for a 10" diameter pipe. After the box culvert, beginning at manhole SSMH9F14_S, the gravity main could be installed at a shallower depth with a steeper slope and only an 8" diameter pipe would be required throughout the line up to the discharge point to the SSF system at manhole SSMH11G1. Additionally, a 10" overflow pipe for the Town's existing siphon shown in Figure 9-3 is recommended for inclusion in this CIP alternative. The siphon overflow pipe would be installed above the existing Caltrans box culvert (i.e. from SSMH9F13_S to SSMH9F14_S), and would provide conveyance redundancy in the event that a blockage/constriction occurs in the existing siphon piping section.

A benefit to this alternative is that construction would take place in Mission Road which is the Town's right of way. However, due to existing parallel utilities the construction corridor would be tight. Additionally, Mission Road is a heavily trafficked street and efforts to minimize traffic impacts could limit construction to night work.

Figure 9-3. Alternative 1: Parallel Gravity Main on Mission Road Plan and Profile Views

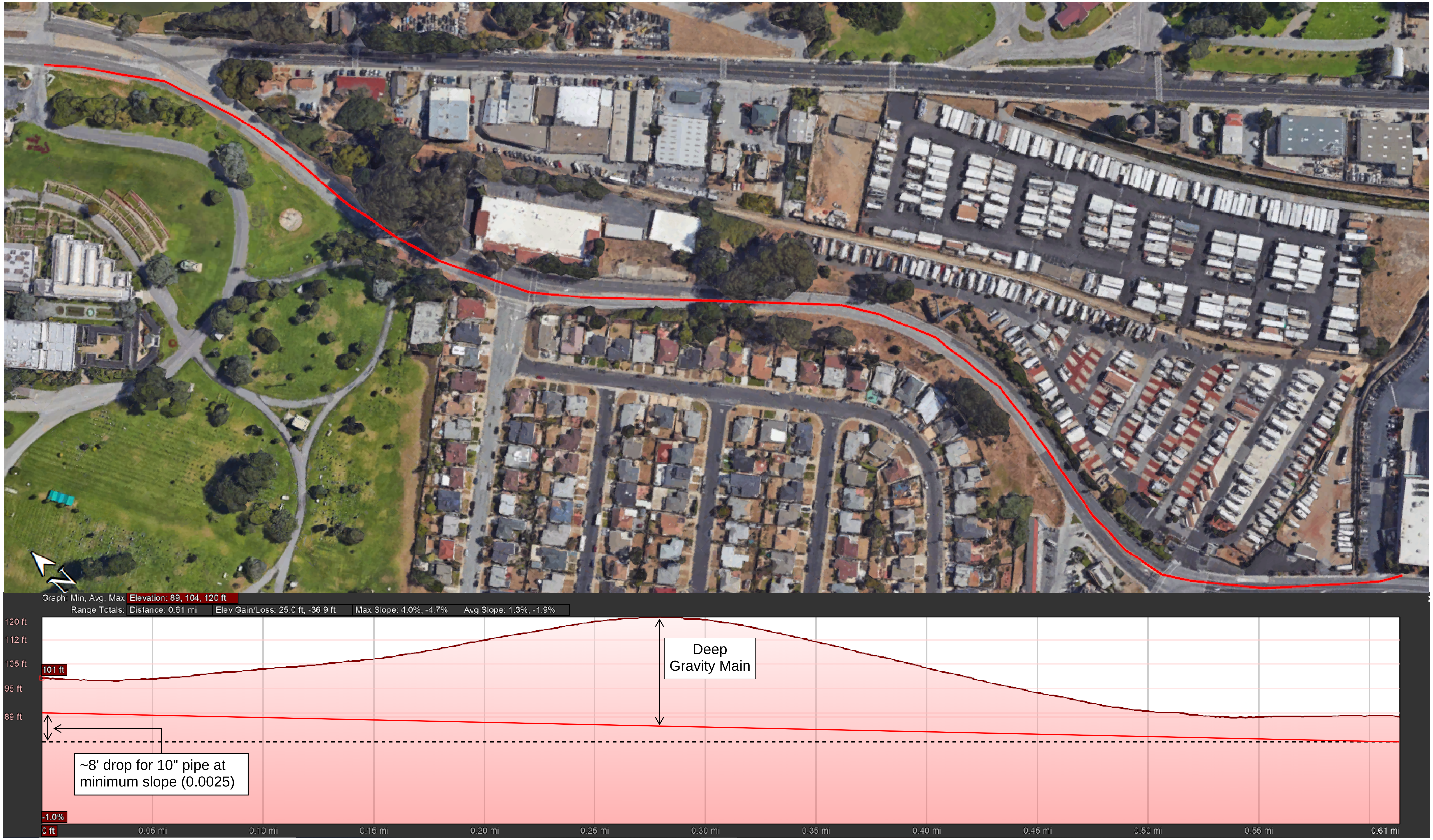


9.2.2 Alternative 2: Gravity Main El Camino Real

Similar to Alternative 1, Alternative 2 is a high flow relief line that would divert 0.3 MGD during wet weather flow but would instead be located on El Camino Real. The proposed gravity main is shown on **Figure 9-4**. The gravity main would start on Mission road at manhole SSMH9F13 located at the intersection of El Camino Real and Cypress Avenue and end at the SSF discharge point in manhole wF965 on El Camino Real near Hickey Blvd. The gravity main would need to be 10” in diameter and have an approximate 8’ drop to satisfy minimum slope requirements. Because of the surface elevation at some points, the gravity main would need to be installed at a depth as great as 30’, in contrast to the approximate maximum depth of 12’ for Alternative 1.

The construction corridor for this alternative would be located in Caltrans right of way, making construction more difficult as it would require permitting and likely would be restricted to night-time work. Additionally, this alternative would have higher excavation costs than Alternative 1 because portions of the gravity main would need to be installed at a much greater depth.

Figure 9-4. Alternative 2: Gravity Main on El Camino Real Plan and Profile Views



9.2.3 Alternative 3A and 3B

Alternative 3A and 3B both consist of diverting the requisite 0.3 MGD of flow off of the existing 10" main on Mission Road through a lift station and 4" force main, which would be located on Mission Road and El Camino Real respectively. A list of recommended preliminary parameters for a pre-fabricated lift station follows:

- Sized for a flow rate of 0.504 MGD
- Precast wet well to have an approximate internal diameter of 6'
- Hatch and top slab of wet well to be H-20 traffic rated with a cast-in vent
- Two 5 HP submersible pumps (1 duty 1 standby), which should be explosion proof for wastewater application
- Precast valve vault assembly, which should include top slab with hatch and be H-20 traffic rated
- Level control system
- Lift station control panel

Alternative 3A: Lift Station and Force Main Mission Road

Alternative 3A, shown on **Figure 9-5**, is to be located on Mission Road and would begin near manhole SSMH9F14_S with the prefabricated lift station. A 4" force main after the lift station would be installed at a depth of 4-5 feet until manhole SSMH10F25 thereafter it would break to an 8" gravity main until the SSF discharge point at manhole SSMH11G1.

Alternative 3B: Lift Station and Force Main El Camino Real

Alternative 3B, shown on **Figure 9-6**, is to be located on El Camino Real and the lift station would begin on the intersection of El Camino Real and Cypress Avenue near manhole SSMH9F13. The 4" force main would be installed at a depth of 4-5 feet up until the high point along the alignment is reached, at which point the force main would break to a gravity main. As this alternative would be located in Caltrans right of way, recent experience with Caltrans has resulted in their requirement that all pressurized pipelines installed in Caltrans right of way need to be installed within a steel casing pipe.

The benefits and drawbacks of working on either Mission Road and El Camino Real previously stated for Alternatives 1 and 2 are also applicable to Alternatives 3A and 3B respectively. Additionally, a benefit of a force main is that the cost of construction is greatly reduced when compared to a gravity main as excavation is less costly and complex at shallower depths. A drawback however, would be the added operation and maintenance of the lift station, which would include electrical costs and any necessary cleaning or replacement of parts.

Figure 9-5. Alternative 3A: Lift Station and Force Main on Mission Road Plan and Profile Views

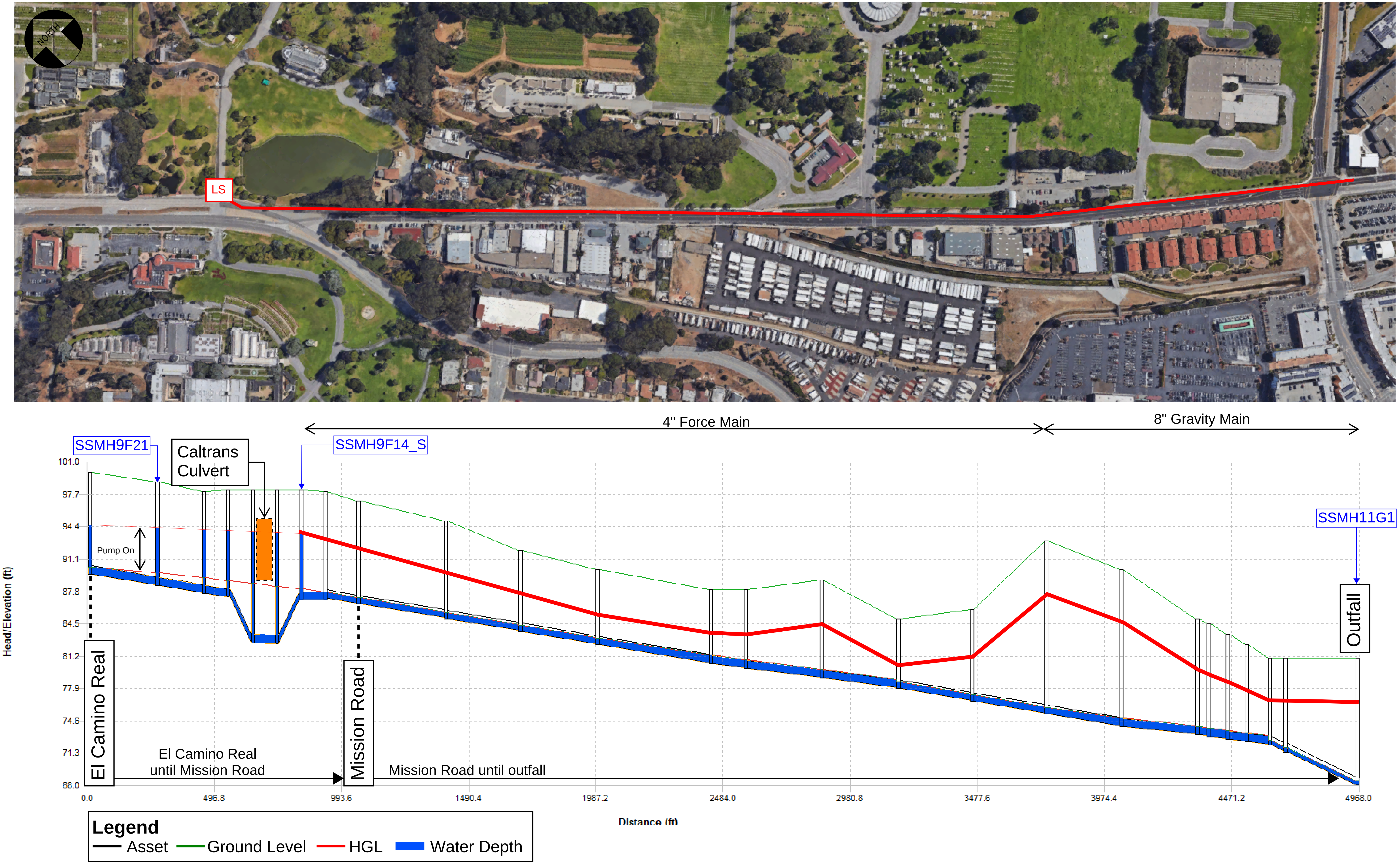


Figure 9-6. Alternative 3B: Lift Station and Force Main on El Camino Real Plan and Profile Views

9.2.4 Alternative 4: Replace-in-Place Existing Main on Mission Road

Upsizing of the existing 10" main on Mission Road to a 15" diameter pipe by the replace-in-place method would provide the needed 0.3 MGD of additional capacity. As stated for Alternatives 1 and 3A construction on Mission Road is desirable as it is in the Town's right of way. Because the pipe would be replaced in place the tight construction corridor on Mission Road would pose less of an issue during construction when compared with Alternative 1 and 3A.

9.3 Cost Estimates for Alternatives

Cost estimates of each alternative as well as the proposed RDII reduction program, which is recommended to be implemented as a compliment to one of the CIP alternatives, are shown in **Table 9-2**.

Table 9-2. Cost estimates for CIP alternatives

Alternative	Labor, Materials, & Equipment ($)	Design/ Construction Contingencies (%)	Total Construction Cost ($)	Administrative/ Construction Management (%)	Total Project Cost Estimate ($)	Alignment Length (LF) / Min-Max Depth (VF)
1: Parallel Gravity Main Mission Road	1.15 Million	30/10	1.61 Million	5/10	**1.9 Million**	4300 / 4-12
2: Gravity Main El Camino Real	1.80 Million	30/10	2.47 Million	5/10	**3.0 Million**	3300 / 7-35
3A: Lift Station and Force Main Mission Road *	1.18 Million	30/10	1.65 Million	5/10	**1.9 Million**	4100 / 4-5
3B: Lift Station and Force Main El Camino Real *	1.18 Million	30/10	1.65 Million	5/10	**2.0 Million**	3300 / 4-5
4: Replace-in-Place Existing Main on Mission Road	1.83 Million	30/10	2.56 Million	5/10	**2.9 Million**	4100 /8-16
*Cost estimates for these alternatives do not include potential land acquisition costs for the lift station						

All CIP alternatives would eliminate instances of surcharging during the Existing and UBO PWWF scenario. It is recommended that the Town choose one of the CIP alternatives and move forward with the implementation of the CIP as soon as possible as the Existing PWWF scenario shows extensive surcharging of the pipes and manholes within 3 feet of the rim elevation. To facilitate the Town's selection of a CIP alternative the different alternatives are ranked by estimated cost and the short-term and long-term effectiveness are shown in **Table 9-3**. The short-term effectiveness is the ability of a project alternative to address current capacity deficiencies within two years; given that the project would need to be designed, bid, and built within this time frame. Whereas the long-term effectiveness is the ability of a project alternative to address capacity deficiencies of the UBO PWWF conditions, in addition to mitigation of potential SSOs beyond the 10-yr/24-hr Type 1A storm modeled. The short-term and long-term effectiveness categories were assigned either a Low, Medium, or High ranking, which represent 25%, 50%, and 99% confidence intervals for the likelihood of a project alternative meeting the criterion stated for the two categories.

Note that the RDII reduction program is also presented in **Table 9-3** but is not included as a ranked alternative as it is not recommended that the RDII reduction program take the place of a CIP as discussed in **Section 8.1.2**.

Table 9-3. Short- and Long-Term Effectiveness of CIPs and RDII Reduction Program

Alternative	Cost ($)	Short-Term Effectiveness	Long Term Effectiveness
1: Parallel Gravity Main Mission Road	1.9 Million	High	High
3A: Lift Station and Force Main Mission Road	1.9 Million	High	Medium
3B: Lift Station and Force Main El Camino Real	2.0 Million	High	Medium
4: Replace-in-Place Existing Main Mission Road	2.9 Million	High	High
2: Gravity Main El Camino Real	3.0 Million	High	High
RDII Reduction Program	1.9 Million	Low	Medium

10 REFERENCES

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Federation of Canadian Municipalities and National Research Council (2003) *Infiltration/Inflow Control/Reduction for Wastewater Collection Systems.* Retrieved from https://www.grandriver.ca/en/our-watershed/resources/Documents/Water_Wastewater_Optimization_InfraguideInflow.pdf

11 APPENDICES

Appendix A. Town of Colma Wastewater Collection System Hydraulic Model Report (Water Works, June 2018)

Town of Colma

WASTEWATER COLLECTION SYSTEM HYDRAULIC MODEL REPORT

FINAL PROJECT REPORT

REGISTERED PROFESSIONAL ENGINEERS
MICHAEL J. FISHER
No. C67194
Exp: 09/30/2018
CIVIL
STATE OF CALIFORNIA

Date: June 2018

Prepared by: Mike Fisher, P.E.
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0 EXECUTIVE SUMMARY

The Town of Colma contracted Water Works Engineers to develop a new hydraulic model of the existing sanitary sewer system utilizing available GIS, land use, zoning, and flow monitoring data. The hydraulic model's wastewater flow loading is calibrated to the available flow monitoring data to ensure an accurate representation of the collection system to allow for a capacity analysis to identify potential capital improvement projects that shall alleviate any capacity deficiencies found.

The following scenarios are simulated within the hydraulic model:

- Existing Conditions: Average Dry Weather Flow (ADWF)
- Existing Conditions: Peak Wet Weather Flow (PWWF)
- Ultimate Buildout: ADWF
- Ultimate Buildout: PWWF

The Existing Conditions ADWF scenario contains the results of the aforementioned calibration effort, with Table 0-1 below listing the average modeled flow rates against the actual monitored flow rates at each flow meter site.

Table 0-1: Average Flow Rate Comparison by Flow Meter Site

FM Site	Manhole ID	Actual Average Flow Rate Monitored (MGD)*	Modeled Average Flow Rate (MGD)
1	10F25	0.190	0.184
2	9F61	0.033	0.032
3N	9E75	0.139	0.131
3W	9E75	0.007	0.006
4	9E04	0.031	0.032
5	7E19	0.516	0.508
6	E07-39	0.635	0.546
7	8E14	0.032	0.024
8N	8E23	0.044	0.040
8W	8E23	0.041	0.076

*These flow rate values are taken from the Town of Colma Flow Monitoring Service Report completed by Total Flow Inc. in cooperation with Water Works Engineers.

The Ultimate Buildout scenario is a theoretical development scenario based on a combination of General Plan population projections and planned improvements.

Each of the PWWF scenarios (Existing Conditions and Ultimate Buildout) include the simulation of a standard 5-year return, 24-hour duration, and 3.25-inch total precipitation storm listed in NOAA Atlas 14, Volume 6, Version 2 for the Colma region. The modeling results for both simulations are discussed below.

The Existing Conditions PWWF simulation shows no sanitary sewer overflows (SSOs), however surcharging of pipelines is modeled in multiple locations. The 10" pipeline that runs southeast along Mission Road is under capacity according to the model, with flow performance negatively impacted by a siphon structure. Also, this scenario shows that there is significant local sewer capacity in the Daly City MiniBasin, however the confluence of flows from Daly City at El Camino Real and Albert Tegla Blvd effectively block the local upstream capacity from being utilized without surcharging into the low-lying Colma manholes SSMH7E43 and SSMH7E87.

The Ultimate Buildout PWWF simulation shows no SSOs, however a number of manholes are modeled to be within 5 feet of overflowing. Surcharging of pipelines is also modeled in multiple locations. The 10" pipeline that runs southeast along Mission Road is again negatively impacted by a siphon structure, however the simulated surcharging conditions are worse when compared to the Existing Conditions PWWF scenario. Also, the same conditions are simulated for the Daly City MiniBasin as previously described for the Existing Conditions PWWF scenario.

The peak flow rates modeled at each of the flow meter sites for the Existing Conditions and Ultimate Buildout PWWF scenarios are summarized in Table 0-2 below.

Table 0-2: Peak Modeled Flow Rates by Flow Meter Site

FM Site	Manhole ID	Existing Conditions Scenarios Peak Flow Rates (MGD)		Ultimate Buildout Scenarios Peak Flow Rates (MGD)	
		No RDII	RDII	No RDII	RDII
1	10F25	0.297	0.865	0.372	0.928
2	9F61	0.048	0.158	0.053	0.162
3N	9E75	0.217	0.733	0.278	0.782
3W	9E75	0.008	0.021	0.009	0.022
4	9E04	0.045	0.059	0.054	0.067
5*	7E19	0.508	2.05	0.508	2.05
6	E07-39	0.57	2.265	0.626	2.336
7	8E14	0.063	0.08	0.068	0.086
8N	8E23	0.1	0.231	0.109	0.233
8W	8E23	0.104	0.469	0.129	0.493

*Flow Meter Site 5 was installed to measure flows from Daly City. Because Daly City's sewer collection system is not included in the hydraulic model, no assumptions about future growth were made. This results in the same peak flow rates between the Existing Conditions and Ultimate Buildout scenarios.

The peaking factors by sewer basin are presented in Table 0-3 below. The sewer basins are listed in descending order according to the ADWF to PWWF peaking factor. This ranked list of highest to lowest "peaking conditions" could be utilized to represent those basins that are candidates for additional analysis, identification of defects, and potential capital improvements to mitigate the defects.

Table 0-3: Sewer Basins Ranked by Peaking Factor (ADWF to PWWF)

Basin	Existing Conditions Scenario Peaking Factors		Ultimate Buildout Scenario Peaking Factors	
	ADWF to PDWF	ADWF to PWWF	ADWF to PDWF	ADWF to PWWF
SSFMB3	1.55	7.00	1.77	6.75
SSFMB1B	2.50	5.78	2.48	5.30
SSFMB6	1.45	4.79	1.47	4.50
SSFMB4A	1.36	4.58	1.57	4.42
SSFMB5	1.27	3.70	1.37	3.42
DCMB	1.02	3.52	1.64	3.97
SSFMB4B	1.33	3.50	1.29	3.14
SSFMB1A	2.74	3.48	2.72	3.44
SSFMB2	1.41	1.84	1.13	1.40

The Existing PWWF Scaled 1.3x scenario is a model simulation where the 5yr/24hr design storm is uniformly scaled up to increase modeled rain-derived infiltration and inflow (RDII). A sensitivity analysis was performed, which found that the first SSO was encountered when the storm RDII response was scaled up to an approximate 10yr/24hr storm event (i.e. 3.25” increased to 3.85” total rainfall). The Mission Road 10” pipeline again sees worse surcharging conditions when compared to both of the aforementioned model scenarios, with manhole 9F20 coming within 1 foot of an SSO. Also, the same conditions are simulated for the Daly City MiniBasin as previously described for the Existing Conditions and Ultimate Buildout PWWF scenarios.

It is recommended that the Town of Colma move forward with the development of a Capital Improvement Project (CIP) Plan and an overall System Evaluation and Capacity Assurance Plan (SECAP). The CIP Plan aims to alleviate each identified hydraulic deficiency found in the modelling results, and would be included as a part of the overall SECAP. Another goal of the SECAP is to provide the Town of Colma with proper guidance on how to prepare and plan for future developments that impact the Town’s ability to ensure system capacity for customers.

1 INTRODUCTION

1.1 Project Background

Water Works Engineers, LLC (WWE) is under contract with the Town of Colma (Town) to prepare a new hydraulic model of the existing sanitary sewer system to determine the capacity of the system under various development scenarios and identify potential improvements.

1.2 Description of Service Area

The Town is a small municipality located between Daly City and City of South San Francisco (Cities) that owns and operates a sanitary sewer collection system encompassing a service area of 1152 acres. Unique among municipalities, most of land usage in Colma is for local cemeteries and mortuaries, which contribute relatively little to no major sewer flows.

1.3 Physical Model Development

A new GIS-based sewer network was developed for the hydraulic model based off available as-builts, CAD data, and satellite imagery. In some instances, missing or inaccurate data attributes such as manhole rim elevations, pipe inverts, and pipe diameters were interpolated and modified to ensure accurate system representation within the hydraulic model. For instance, some manhole rim elevations were verified against San Mateo County elevation data and satellite imagery. Another example of a common modification was interpolating the slope of a pipe segment based on upstream and downstream pipe segments or listing it under a minimum slope given the line size.

Multiple figures that show the layout of the system with manhole identification numbers can be found in Appendix A.

1.4 Development Scenarios

Land Use Information

The Town zoning map in Figure 1 below was used as the basis for delineating the land use (LU) of each parcel which was inclusive of Residential, Commercial, Cemetery, and Other (i.e., open space) land use types. The total acres by LU type are presented in Table 1-1 below.

Table 1-1: Land Usage in Colma

Acres by LU type				
RESIDENTIAL	OTHER	CEMETERY	COMMERCIAL	TOTAL
37	36	930	142	1145

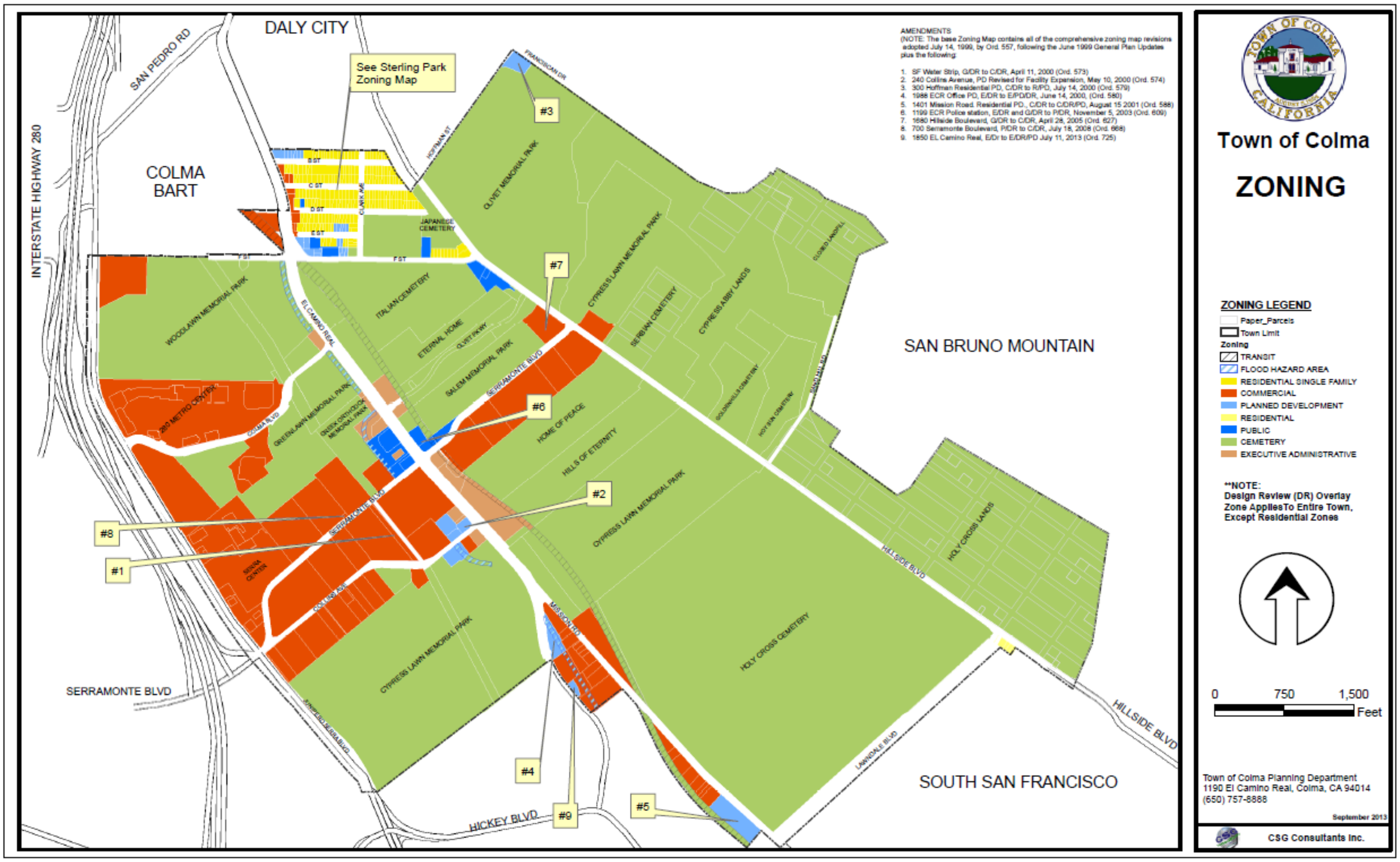


Figure 1: Town of Colma Zoning Map (Accessed June 2017)

Existing Scenario

The existing development scenario is based on current date zoning and land use data, and is intended to closely match existing conditions.

Ultimate Buildout Scenario

The ultimate buildout scenario is a theoretical development scenario based on a combination of General Plan (GP) population projections (roughly 10% after accounting for residential developments) and planned improvements.

Household Size: Increased from 3.05 to 3.355 for 10% population increase.

Commercial Utilization: The wastewater generation rates (flow per acre) were increased by 10% from calibrated existing values to represent increased commercial utilization. This is presented in more detail below.

Planned Developments: Planned developments listed in updated planning documents were modeled in the UBO scenario, and are listed below:

- Potential Housing Developments *(adapted from General Plan)*

Table H-44: Sterling Park Single Family Detached Development Potential

APN	Location	Designation & Zone	Acres	Dev. Pot.	Density Allowed	Constraints
008-126-100	C Street (southside)	Residential (R)	0.1	2	13 units/ acre	None, infra-structure capacity exists
008-126-040	B Street (southside)	Residential (R)	0.7	9		
008-125-180	B Street (northside)	Residential (R)	0.11	1		
Total			***0.91***	***12 units***		

Table H-45: El Camino Real Parcels Multi-Family Development Potential

APN	Location	Designation & Zone	Acres	Dev. Pot.	Density Allowed	Constraints
008-127-020 (Sandblaster)	El Camino Real	Residential/ Commercial (Mixed Use) - (R/C)	0.53	13	30 units/acre	Topography, possible ground surface contamination
008-141-080 (Bocci)	El Camino Real	Commercial (Mixed-Use) - (C)	0.6	24	30 units/acre	Utility Easement, Triangular Shape
Total			***1.13 ac***	***37 units***		

- Other listed Planned Developments (note, some of these projects have been built, and were included in the existing scenario, while others are assumed to develop in the UBO scenario) *(Adapted from zoning map)*

AMENDMENTS
(NOTE: The base Zoning Map contains all of the comprehensive zoning map revisions adopted July 14, 1999, by Ord. 557, following the June 1999 General Plan Updates plus the following:

1. SF Water Strip, G/DR to C/DR, April 11, 2000 (Ord. 573)
2. 240 Collins Avenue, PD Revised for Facility Expansion, May 10, 2000 (Ord. 574)
3. 300 Hoffman Residential PD, C/DR to R/PD, July 14, 2000 (Ord. 579)
4. 1988 ECR Office PD, E/DR to E/PD/DR, June 14, 2000, (Ord. 580)
5. 1401 Mission Road. Residential PD., C/DR to C/DR/PD, August 15 2001 (Ord. 588)
6. 1199 ECR Police station, E/DR and G/DR to P/DR, November 5, 2003 (Ord. 609)
7. 1680 Hillside Boulevard, G/DR to C/DR, April 28, 2005 (Ord. 627)
8. 700 Serramonte Boulevard, P/DR to C/DR, July 18, 2008 (Ord. 668)
9. 1850 EL Camino Real, E/Dr to E/DR/PD July 11, 2013 (Ord. 725)

<u>Ultimate Buildout Changes to Wastewater Generation Rates (WWGR)</u>

#1) SF Water Strip (no change made)
#2) 240 Collins Ave (police station WWGR increased from 3960gpd to 7920gpd)
#3) 300 Hoffman Residential (already included in model for Existing Scenario; this parcel does not contribute to Colma sewer system)
#4) 1988 ECR Office PD (WWGR increased from 1500gpd to 3960gpd)
#5) 1401 Mission Rd Residential (already included in model for Existing Scenario)
#6) 119 ECR Police Station (WWGR increased from 1450gpd to 3960gpd)
#7) 1680 Hillside Blvd (WWGR increased from 1450gpd to 3960gpd)
#8) 700 Serramonte Blvd (WWGR increased from 675gpd to 3960gpd)
#9) 1850 El Camino Real (WWGR increased from 1500gpd to 3960gpd)
#10) APN 008127020 changed from 1 home to 13 homes per Town GP
#11) APN 008141080 changed from commercial to residential with 24 homes per Town GP
#12) APN 008126100 changed from 1 home to 2 homes per Town GP
#13) APN 008126040 changed from 1 home to 9 homes per Town GP

2 HYDRAULIC MODEL DEVELOPMENT

The hydraulic model is based off the newly formed GIS sewer network and was simulated via the Innovyze InfoSewer software plugin which is a quasi-dynamic modeling package that simulates peak wet weather flow in 15-minute increments. The development of the model depends on flow meter and rainfall data, calibrated dry and wet weather flows, and a chosen design storm. This methodology is explained below.

2.1 Flow Meter Data

The Town obtained the services of Total Flow Inc. for the rental, installation, procurement, and analysis of temporary flow meter data across January and February 2017. The results and monitoring methodology are presented in the Town of Colma Flow Monitoring Services Report completed by Total Flow Inc. in collaboration with WWE. The flow monitoring data was used to calibrate dry and wet weather flow by sewer basin and is explained in depth in proceeding sections.

2.2 System Configuration

The Town sanitary sewer system can be characterized as including ten identifiable sewer basins, which correspond with the flow meter locations utilized by Total Flow Inc. during monitoring in early 2017. The approximate acreage of each basin in acres is displayed in **Table 2-1** below.

Table 2-1: Basin Acreages

Basin	Total Acres
DCMB	408
SSFMB1A	138
SSFMB1B	14
SSFMB2	60

SSFMB3	59
SSFMB4A	15
SSFMB4B	8
SSFMB5	424
SSFMB6	9
SSFMB7	10
Total	1145

2.3 Dry Weather Flow Development

Average Dry Weather Flow

Average dry weather flow (ADWF) is the primary component of a hydraulic model and can be characterized as the diurnal or daily wastewater flow from a parcel that is not influenced by groundwater level changes or rainfall effects. Typical Colma minimum flows occur approximately at 4AM, with peak flows approximately occurring at 3PM. This corresponds with Peak Dry Weather Flow (PDWF), which is determined by multiplying the ADWF by an hourly peaking factor (PF). Theoretical ADWF is calculated from each parcel based on land use/population/density and wastewater generation rates, and is then calibrated to observed flow meter data.

Wastewater Generation Rates & Calibration

The methodology of estimating wastewater generations rates (the basis for theoretical ADWF) was an iterative approach that was calibrated to observed flow meter data ADWF.

Table 2-2: Wastewater Gen Rate (residential)

Residential			
Basin	EXST Flow (gpd/unit)	UBO Flow (gpd/unit)	Unit
DCMB	65	Same as Existing	Person
SSFMB1A	55		
SSFMB1B	55		
SSFMB2	55		
SSFMB3	55		
SSFMB4A	60		
SSFMB4B	55		
SSFMB5	60		
SSFMB6	60		
SSFMB7	55		

Table 2-3: Wastewater Generation Rates (non-residential)

Non-Residential				
Land Use Type	Basin	EXST Flow (gpd/unit)	UBO* Flow (gpd/unit)	Unit
CEMETERY/MORTUARY	All Basins	480	480	Building
COMMERCIAL	DCMB	1500	1650	Acre
	SSFMB1A	1050	1155	
	SSFMB1B	3300	3630	
	SSFMB2	1450	1595	
	SSFMB3	675	743	
	SSFMB4A	3600	3960	
	SSFMB4B	1250	1375	
	SSFMB5	1500	1650	
	SSFMB6	1500	1650	
	SSFMB7	1500	1650	

*UBO commercial wastewater generation rates were increased by 10%

Diurnal Patterns

The diurnal patterns applied to ADWF to calculate PDWF were obtained for each flow meter site and are displayed graphically in Figure 2.

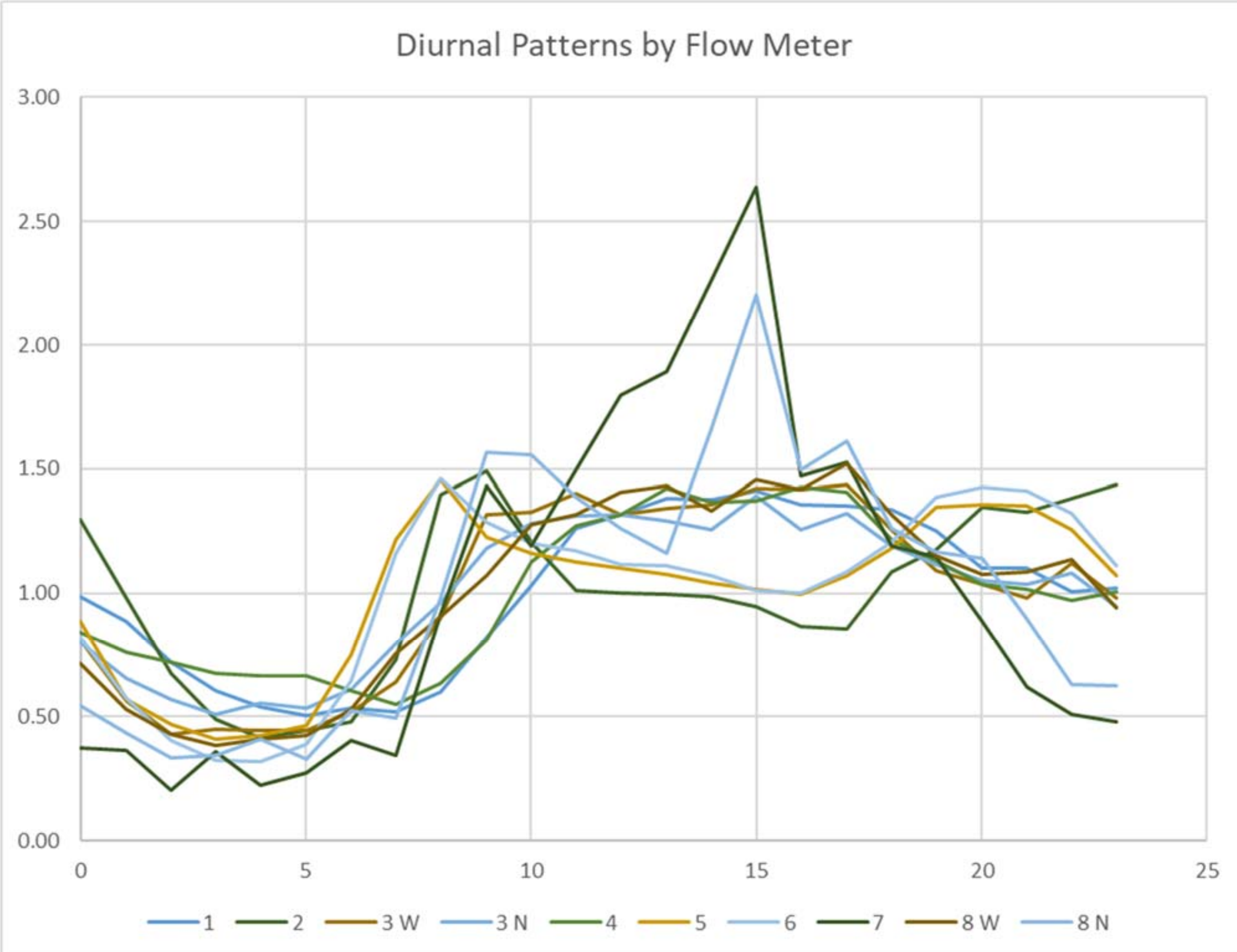


Figure 2: Diurnal Patterns by Flow Meter

2.4 Wet Weather Flow Development

The hydraulic model simulates Peak Wet Weather Flow (PWWF) given a particular design storm hyetograph (rainfall over time) and a calibrated theoretical system response to that rainfall. PWWF is made up of PDWF and Rain Derived Inflow and Infiltration (RDII). This is graphically displayed in Figure 3 below.

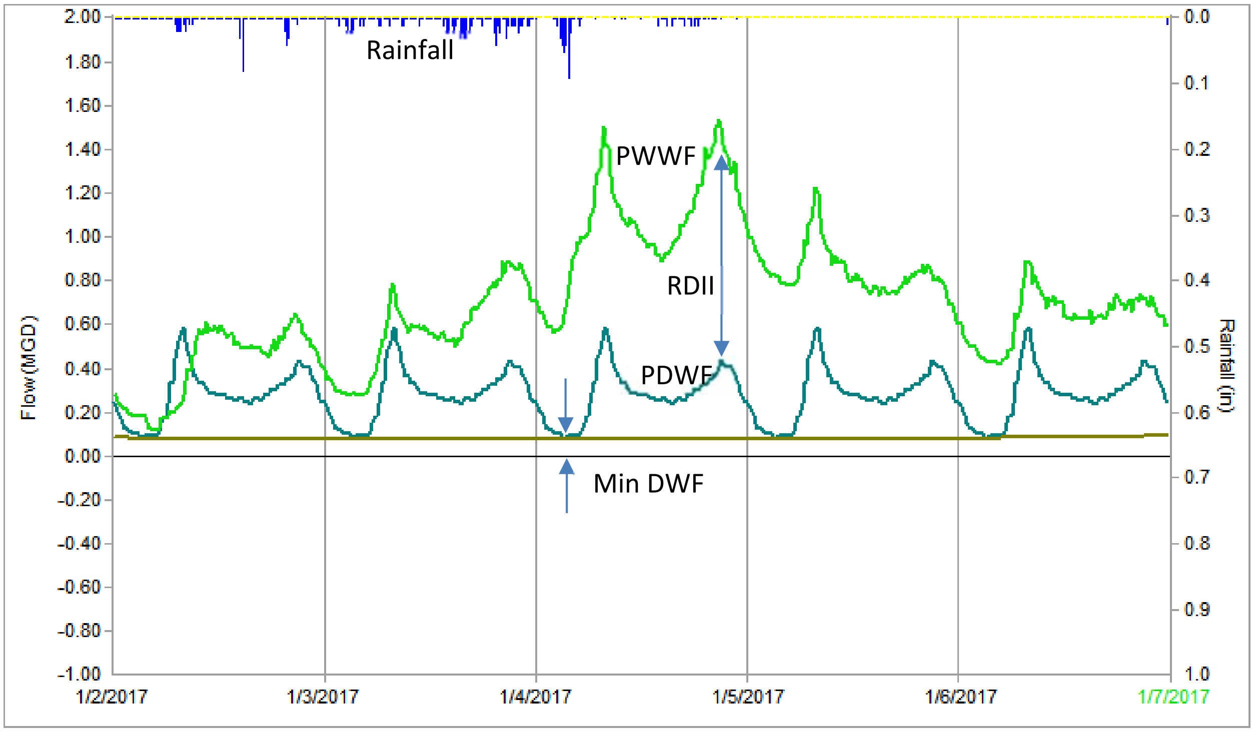


Figure 3: PWWF, PDWF, and RDII

2.5 Rain Derived Inflow and Infiltration

Rainfall Dependent Infiltration and Inflow (RDII) is rainfall runoff that enters a closed sewer collection system through manhole/pipe defects, manhole lids and clean-outs and is visually represented in Figure 4. The relative magnitude of the RDII is often correlated with the age of the collection system. High intensity inflows typically dissipate soon after rainfall stops as opposed to low intensity groundwater infiltration that can stay at elevated levels for many days after a storm, as evident in a sample hydrograph displayed in Figure 3.

The design storm used for the PWWF analysis occurred in late February 2017, in the middle of a notable wet winter for California. As such, it was assumed that antecedent moisture conditions were very high before and after the storm, which conservatively affects the hydraulic model by maximizing RDII responsiveness and peak flow. In comparison, a storm earlier in the winter season might have had low antecedent moisture conditions and a higher soil capacity that could attenuate any RDII response.

RDII was applied in the hydraulic model by calculating the average for each basin and then applying it equally across each basin manhole.

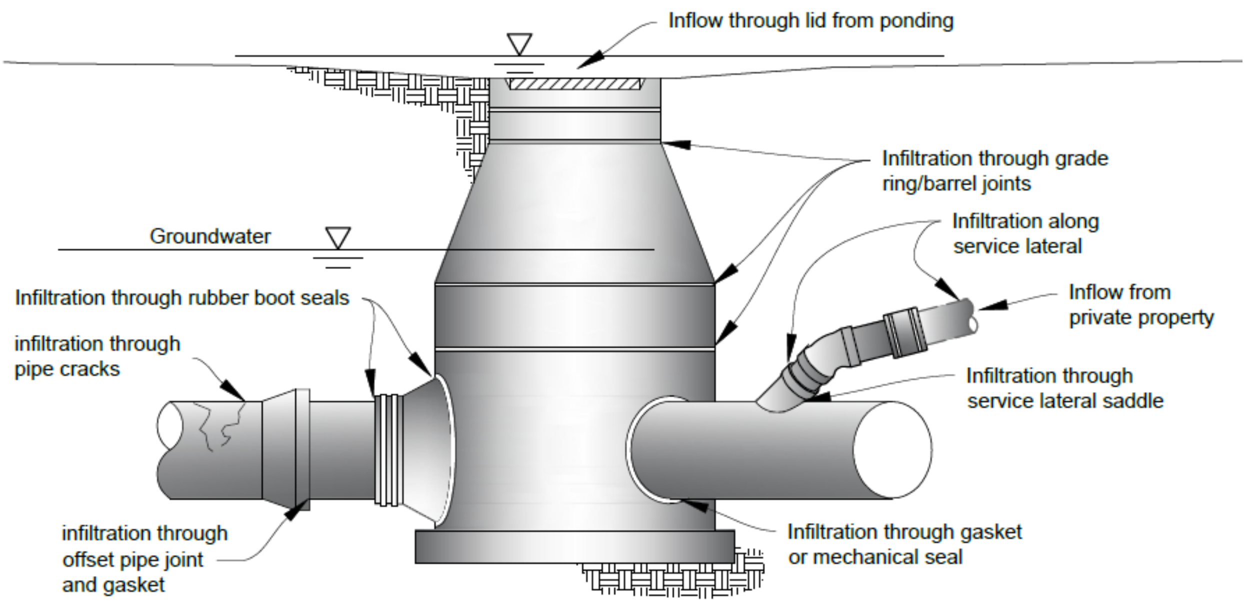


Figure 4: Common Sources of I&I

2.6 Rainfall & Design Storm Hyetograph

The rainfall data used to develop the hydraulic model RDII response was in 5-minute increments from a temporary weather station located at the Town Hall. The single high-resolution rain gauge was applied equally across the City basins for calibration purposes. The largest storm during the monitoring period was on February 20th, totaling 1.61", and was used as the sole design storm benchmark for calibrating the wet weather flow model.

The three main components of a design storm are the total depth, duration, and probabilistic return period or frequency of that storm. This study incorporated a standard 5-year return, 24-hr duration, and 3.25-in total precipitation storm listed in NOAA Atlas 14, Volume 6, Version 2 for the Colma region. The temporal distribution of the storm was developed via the NRCS SCS Type 1 rainfall distribution method in which the Colma region falls. This is displayed in Figure 5 below and the resultant hyetograph is displayed in Figure 6.

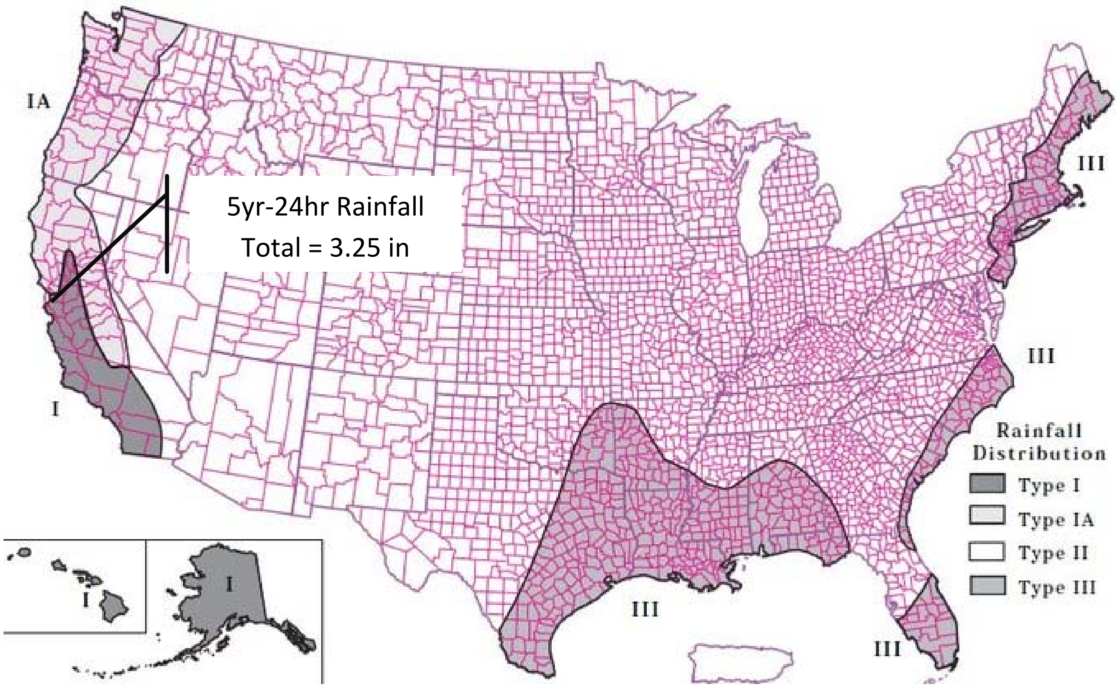


Figure 5: NRCS SCS Rainfall Patterns

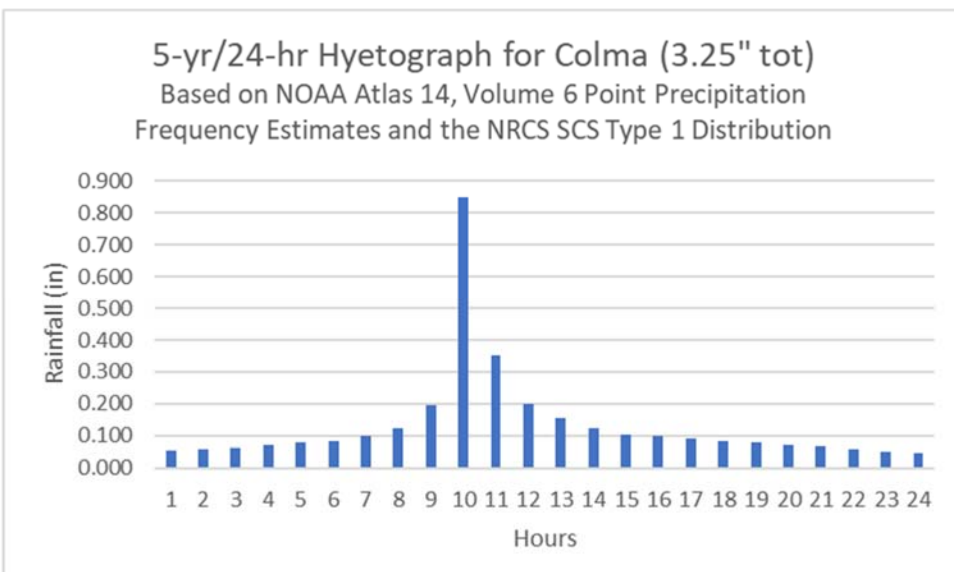


Figure 6: Colma 5-yr/24-hr Hyetograph

2.7 RDII Synthetic Unit Hydrograph Development

The rainfall, flowmeter, and system data along with the chosen 5-yr/24-hr design storm hyetograph was inputted into the EPA's Sanitary Sewer Overflow Analysis and Planning (SSOAP) Toolbox software. Within the software, FM basin specific 5-yr/24-hr theoretical unit RDII hydrographs were produced (i.e., theoretical RDII response curves). The process is based on modifying specific triangular unit hydrographs parameters (R, T, and K values) to best fit the observed storm response during. The R value, or fraction of rainfall volume that is estimated to enter the sewer system as RDII depends on the actual area that contributes RDII (i.e., an area that conceivably drains towards manholes). To that end, the RDII contributing areas of the large cemetery parcels were reduced significantly given the existing site conditions and distance to local sewer. The results of the SSOAP analysis are shown below in Table 2-4.

Table 2-4: SSOAP Existing 5yr-24hr RDII results

Basin	RDII Acres	In*dia*mi	Pk RDII (MGD)	Pk RDII / In*dia*mi (gpd/in*dia*mi)
SSFMB6	8.9	1.56	0.1256	80,513
SSFMB1B	22	2.35	0.1492	63,489
SSFMB3	75	8.37	0.2589	30,932
DCMB	200	14.68	0.165	11,240
SSFMB4B	12.35	1.41	0.0131	9,291
SSFMB1A	72.4	7.72	0.0353	4,573
SSFMB4A	17.1	2.94	0.0136	4,626
SSFMB2	71.7	5.24	0.0185	3,531
SSFMB5	189	10.93	0.0297	2,717

A sample theoretical RDII hydrograph for Flowmeter #5 given a 5yr/24hr storm is displayed in Figure 7 below.

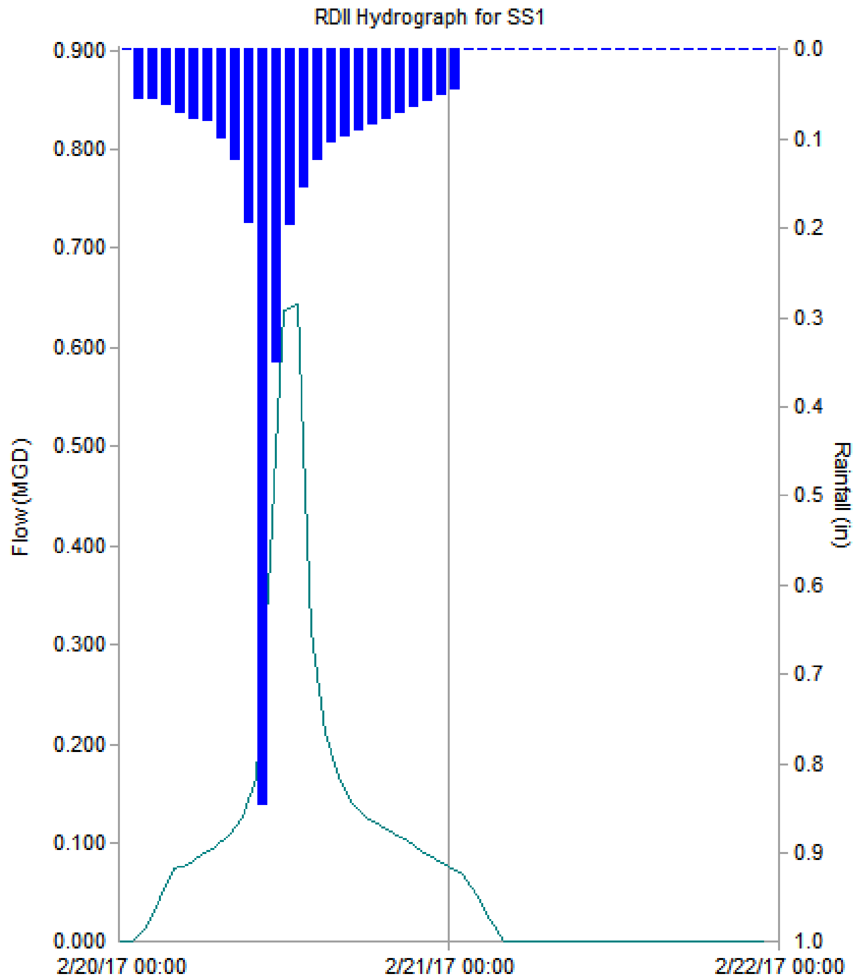


Figure 7: Sample RDII Hydrograph

3 HYDRAULIC MODEL RESULTS

The InfoSewer ADWF and PWWF hydraulic model results are presented below for the existing scenario and UBO scenario. In addition, a sensitivity analysis or "stress" test was conducted where the 5-yr/24-hr RDII response was uniformly scaled up until a sanitary sewer overflow (SSO) was observed in the system.

The peak flow rates modeled at each of the flow meter sites for the Existing Conditions and Ultimate Buildout scenarios are summarized in **Table 3-1** below.

Table 3-1: Peak Flow Rates by Flow Meter Site

FM Site	Manhole ID	Existing Conditions Scenarios Peak Flow Rates (MGD)		Ultimate Buildout Scenarios Peak Flow Rates (MGD)	
		No RDII	RDII	No RDII	RDII
1	10F25	0.297	0.865	0.372	0.928
2	9F61	0.048	0.158	0.053	0.162
3N	9E75	0.217	0.733	0.278	0.782
3W	9E75	0.008	0.021	0.009	0.022
4	9E04	0.045	0.059	0.054	0.067
5*	7E19	0.508	2.05	0.508	2.05
6	E07-39	0.57	2.265	0.626	2.336
7	8E14	0.063	0.08	0.068	0.086
8N	8E23	0.1	0.231	0.109	0.233
8W	8E23	0.104	0.469	0.129	0.493

*Flow Meter Site 5 was installed to measure flows from Daly City. Because Daly City's sewer collection system is not included in the hydraulic model, no assumptions about future growth were made. This results in the same peak flow rates between the Existing Conditions and Ultimate Buildout scenarios.

3.1 Existing System Results

The results of the 5yr/24hr PWWF Existing Conditions simulation did not produce any SSOs. Surcharging was modeled, however, in several locations. The main result to highlight is that the 10" mainline that runs southeast along Mission Road is under capacity. See Appendix B for a figure that contains the "Existing PWWF Scenario" results for depth to diameter (d/D) pipe ratios and manhole unfilled depth (i.e. how close a particular manhole is to producing an SSO) for the entire collection system.

<u>Mission Road</u>

Surcharging (d/D > 1)

Approx. Capacity = 0.8 – 1.0 mgd

Approx. Max Modeled Flow = 0.85 mgd

Discussion: flow performance is negatively impacted by a siphon structure which is utilized to provide sufficient vertical clearance from an overhead storm drain. The siphon flows full and effectively creates a submerged/pressure condition and increases total dynamic head which subsequently raises the upstream hydraulic grade line (HGL). See Appendix C for a figure that contains the Mission Road pipe profile at the time of peak "stress" on the line resulting from the Existing PWWF scenario.

<u>DCMB</u>

There is significant local sewer capacity in DCMB (e.g., main line along F St and Hillside Blvd) but the confluence of flows from Daly City at El Camino Real and Albert Tegla Blvd, effectively block the local upstream capacity from being utilized without surcharging into the low-lying Colma manhole on F street.

3.2 Ultimate Buildout Results

The results of the 5yr/24hr PWWF UBO simulation did not produce any SSOs, but a portion of the system manholes are within 5 feet of the overflowing. Surcharging was modeled in several locations. This simulation is a theoretical, "what-if" scenario, and is a useful way to highlight areas with long-term, systemic issues. See Appendix D for a figure that contains the "Ultimate Buildout PWWF Scenario" results for d/D pipe ratios and manhole unfilled depth (i.e. how close a particular manhole is to producing an SSO) for the entire collection system.

<u>Mission Road</u>

Surcharging (d/D > 1)

Approx. Capacity = 0.8 – 1.0 mgd

Approx. Max Modeled Flow = 0.92 mgd

Discussion: flow performance is once again negatively impacted by a siphon structure which is utilized to provide sufficient vertical clearance from an overhead storm drain. The siphon flows full and effectively creates a submerged/pressure condition and increases total dynamic head which subsequently raises the upstream hydraulic grade line (HGL). However, the Mission Road line is observed to have worse surcharging conditions when compared to the Existing PWWF Scenario. See Appendix E for a figure that contains the Mission Road pipe profile at the time of peak "stress" on the line resulting from the Ultimate Buildout PWWF scenario.

<u>DCMB</u>

There is significant local sewer capacity in DCMB (e.g., main line along F St and Hillside Blvd) but the confluence of flows from Daly City at El Camino Real and Albert Tegla Blvd, effectively block the local upstream capacity from being utilized without surcharging into the low-lying Colma manhole on F street.

3.3 Sensitivity Analysis Results

The sensitivity analysis conducted on the 5yr/24hr Existing Conditions hydraulic model is a method to uniformly scale up the 5yr/24hr storm and subsequently increase modeled RDII. Based on the sensitivity analysis, the first SSO was encountered when the storm RDII response was scaled up to an approximate 10yr-24hr storm event (3.25” increased to 3.85” total rainfall). This can be seen in Appendix F, a figure that contains the “Existing PWWF Scaled 1.3x Scenario” results for d/D pipe ratios and manhole unfilled depth (i.e. how close a particular manhole is to producing an SSO) for the entire collection system.

Mission Road

The Mission Road line once again sees worse surcharging conditions when compared to both of the aforementioned model scenarios. In particular, the Mission Road line comes within 1 foot of an SSO at MH 9F20. See Appendix G for a figure that contains the Mission Road pipe profile at the time of peak “stress” on the line resulting from the Existing PWWF Scaled 1.3x scenario.

DCMB

There is significant local sewer capacity in DCMB (e.g., main line along F St and Hillside Blvd) but the confluence of flows from Daly City at El Camino Real and Albert Tegla Blvd, effectively block the local upstream capacity from being utilized without surcharging into the low-lying Colma manhole on F street.

3.4 Resultant Peaking Factors

The peaking factors observed from the various model scenario results can be seen in **Table 3-2** below. Peaking factors are presented for each sewer basin in the following fashion:

- Peaking Factor for ADWF to PDWF (both Existing and UBO)
- Peaking Factor for ADWF to PWWF (both Existing and UBO)

Table 3-2: Peaking Factors by Sewer Basin

Basin	Existing Conditions Scenario Peaking Factors		Ultimate Buildout Scenario Peaking Factors	
	ADWF to PDWF	ADWF to PWWF	ADWF to PDWF	ADWF to PWWF
SSFMB5	1.27	3.70	1.37	3.42
SSFMB6	1.45	4.79	1.47	4.50
SSFMB4A	1.36	4.58	1.57	4.42
SSFMB4B	1.33	3.50	1.29	3.14
SSFMB2	1.41	1.84	1.13	1.40
DCMB	1.02	3.52	1.64	3.97
SSFMB1A	2.74	3.48	2.72	3.44
SSFMB1B	2.50	5.78	2.48	5.30
SSFMB3	1.55	7.00	1.77	6.75

3.5 Siphon Analysis

Table 3-3 below presents the modeled velocities for the two existing siphons in Colma's collection system.

Table 3-3: Siphon Velocities

			Siphon @ El Camino Real & Collins	Siphon @ Mission & Cypress
Down Pipe	ADWF	Min Velocity (fps)	2.15	3.89
		Max Velocity (fps)	2.86	5.76
	PWWF	Max velocity (fps)	3.12	7.85
Flat Pipe	ADWF	Min Velocity (fps)	0.58	0.89
		Max Velocity (fps)	0.77	1.25
	PWWF	Max velocity (fps)	0.83	2.39
Up Pipe	ADWF	Min Velocity (fps)	0.06	0.22
		Max Velocity (fps)	0.16	0.82
	PWWF	Max velocity (fps)	0.21	2.40

4 NEXT STEPS

4.1 Capital Improvement Projects (CIPs)

It is recommended that the Town move forward with the development of Capital Improvement Projects (CIPs) aimed at alleviating each of the identified hydraulic capacity deficiencies found in the modelling results. The development of each CIP is assumed to include the completion of the following tasks:

- Identify the hydraulic capacity deficiency that the CIP will address.
- Develop and describe the mitigation improvement. Examples include:
    - New pipeline alignment
    - Upsizing of existing pipeline(s)
    - Pump Station
    - Basin flow transfer(s)
- Utilize the newly developed hydraulic model to simulate the new CIP's effect on the collection system for each pertinent scenario. Confirm the new CIP resolves the identified deficiency.
- Determine "trigger points" for the CIP based on flow and/or growth parameters.
- Develop recommendations for approximate construction timeframes for the CIP.
- Develop appropriate figures and conceptual level cost estimates that depict the recommended CIP and the "trigger points" associated with growth parameters.
- Prioritize the developed CIPs to address the existing collection system deficiencies.

The CIP Plan would then be included in an overall System Evaluation and Capacity Assurance Plan (SECAP or Master Plan), which is described in more detail in the next section of this report.

4.2 System Evaluation and Capacity Assurance Plan (SECAP or Master Plan)

It is recommended that the Town also move forward with the development of a SECAP that is aimed at preventing sanitary sewer overflows by identifying collection system hydraulic deficiencies and developing and implementing CIPs to mitigate those deficiencies. Another goal of the SECAP is to provide the Town with proper guidance on how to prepare and plan for future developments that impact the Town's ability to ensure system capacity for customers.

The SECAP is assumed to include the following items:

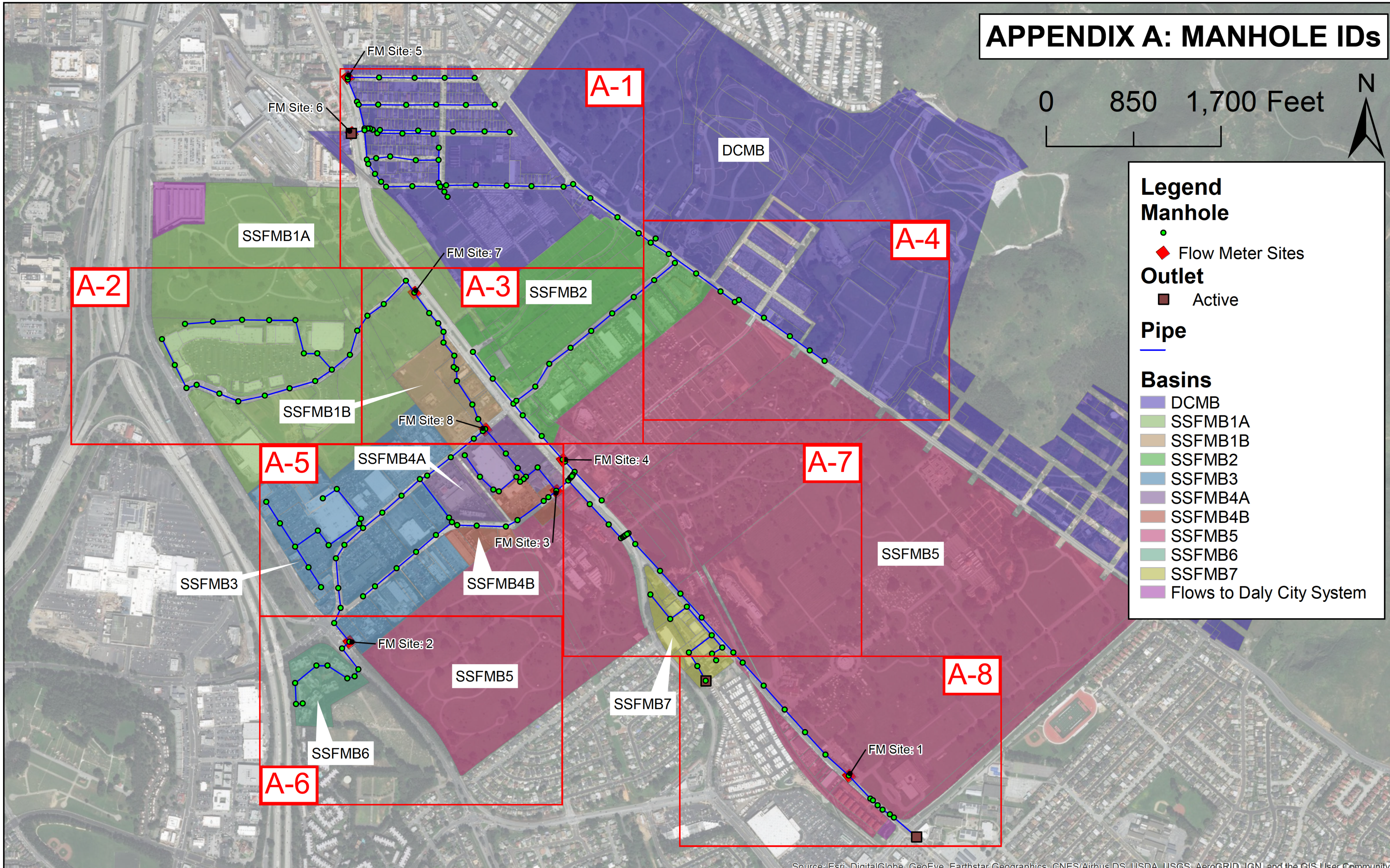
- Introduction and project overview.
- Summary of Town's compliance with provision D.13.viii of the Sanitary Sewer System General Waste Discharge Requirement Sewer System Management Plan requirements.
- Town General Plan summary and Town growth scenario(s).
- Summary of hydraulic model development and calibration efforts.
- Summary of capacity analysis and the evaluation criteria utilized.
- Summary of developed CIPs that address capacity deficiencies found from capacity analysis.
    - Project descriptions

    - Cost estimates
    - Priority of CIP implementation with “trigger point(s)” description
- Appendices of supporting documentation/data

The SECAP can be updated periodically by the Town (every five years at a minimum) to incorporate any conditions that could impact the collection system capacity. As an example, any changes to the physical collection system, such as pipe replacements, repairs, rehabilitation, and/or new infrastructure, can be implemented in the hydraulic model to provide a more accurate representation of the system. In addition, the Town can periodically calibrate the hydraulic model with any new flow monitoring data collected to maintain modelling accuracy.

Appendices

Appendix A: Manhole IDs



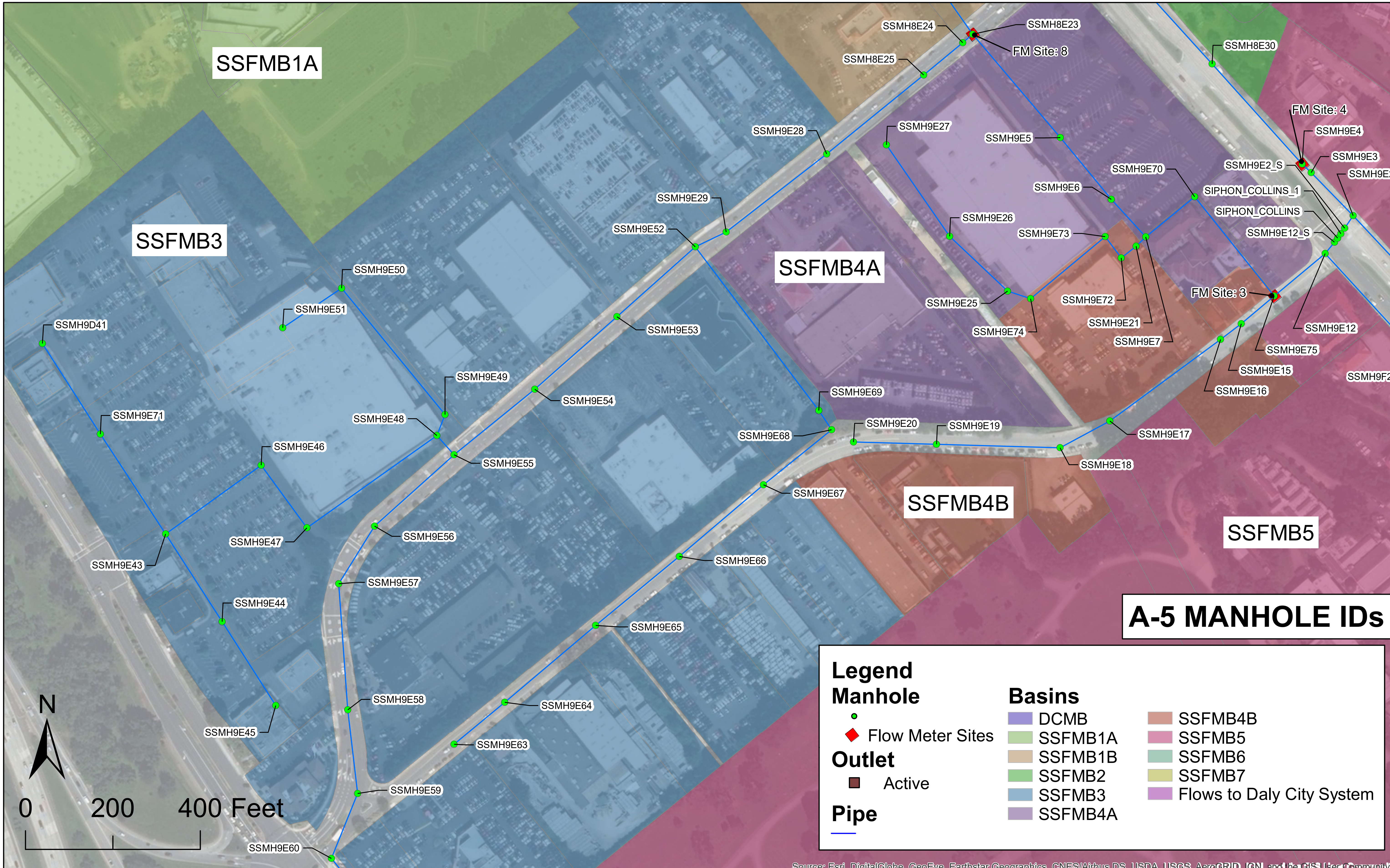
APPENDIX A: MANHOLE IDs
0 850 1,700 Feet
N
Legend
Manhole
Flow Meter Sites
Outlet
Active
Pipe
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
A-1
A-2
A-3
A-4
A-5
A-6
A-7
A-8
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB5
SSFMB6
SSFMB7
FM Site: 1
FM Site: 2
FM Site: 3
FM Site: 4
FM Site: 5
FM Site: 6
FM Site: 7
FM Site: 8
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


A-1 MANHOLE IDs
Legend
Manhole
Flow Meter Sites
Outlet
Active
Pipe
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
FM Site: 5
FM Site: 6
SSMH7E19
SSMH7E18
SSMH7E17
SSMH7E16
SSMH7E15
SSMH7E95
SSMH7E96
SSMH7E24
SSMH7E25
SSMH7E26
SSMH7E27
SSMH7E28
SSMH7E23
SSMH7E98
SSMH7E99
SSMH7E37
SSMH7E97
SSMH7E35
SSMH7E34
SSMH7E33
SSMH7E31
SSMH7E30
SSMH7E29
SSMH7E36
SSMH7E32
SSMH7E38
SSMH7E47
SSMH7E44
SSMH7E45
SSMH7E46
SSMH7E43
SSMH7E48
SSMH7E87
SSMH7E86
SSMH7E49
SSMH7E85
SSMH7E72
SSMH7E73
SSMH7E74
SSMH7E75
SSMH7E76
SSMH7E77
SSMH7E84
SSMH7E83
SSMH7E82
SSMH7E81
SSMH7E80
SSMH7F3
SSMH7F2
SSMH8F11
SSMH7F1
SSMH8F1
DCMB
SSFMB1A
SSFMB2
N
0
200
400 Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

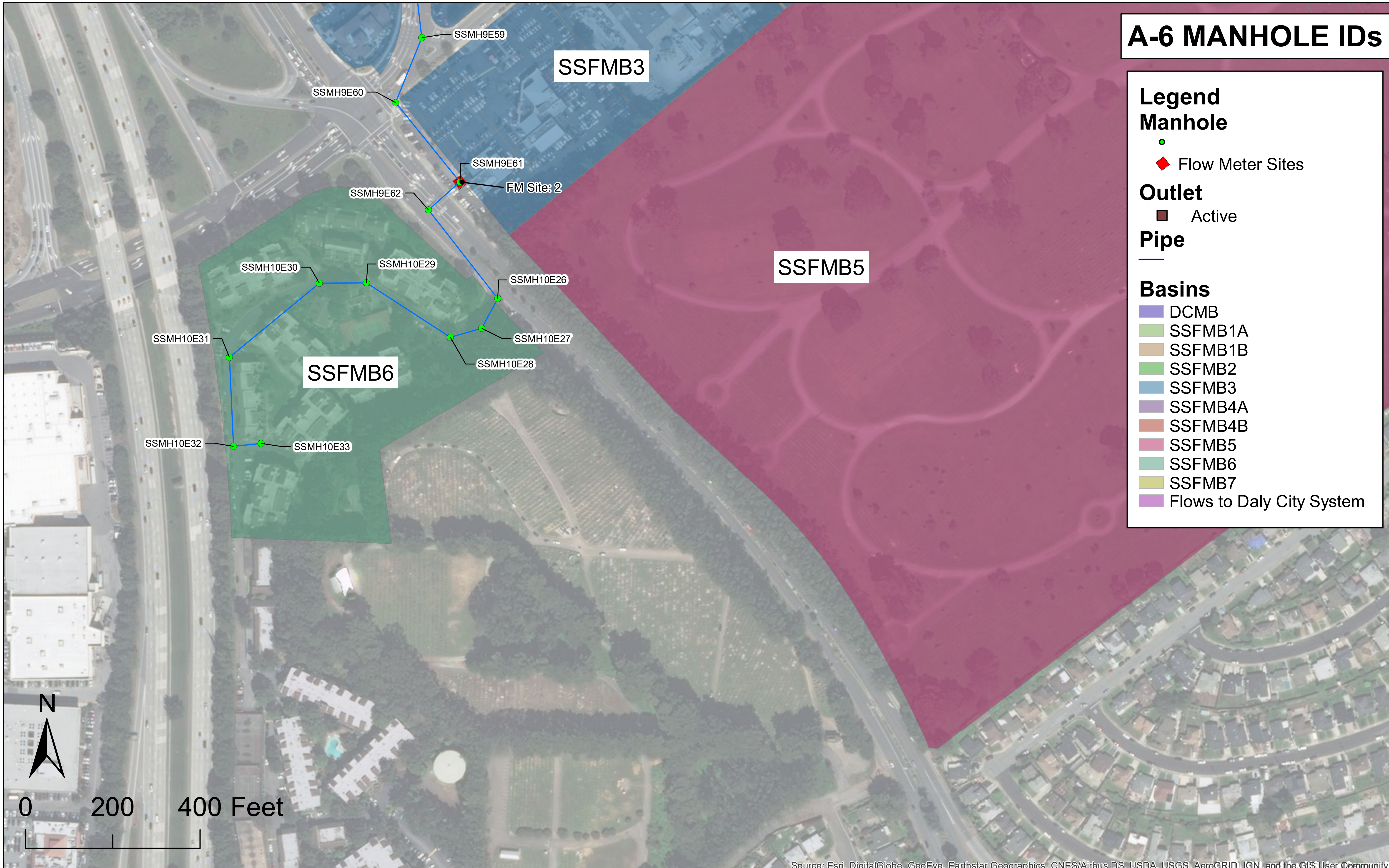

A-2 MANHOLE IDs
Legend
Manhole
Outlet
Active
Pipe
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
SSFMB1A
SSMH8E1
SSMH8E2
SSMH8E3
SSMH8E4
SSMH8E5
SSMH8E6
SSMH8E7
SSMH8E9
SSMH8E10
SSMH8E11
SSMH8D35
SSMH8D36
SSMH8D37
SSMH8D38
SSMH8D29
SSMH8D28
SSMH8D30
SSMH8D31
SSMH8D32
SSMH8D33
SSMH8D34
N
0 200 400 Feet
SSFMB3
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


A-3 MANHOLE IDs
Legend
Manhole
Flow Meter Sites
Outlet
Active
Pipe
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
DCMB
SSFMB2
SSFMB1A
SSFMB1B
SSFMB3
SSFMB4A
SSFMB5
FM Site: 7
FM Site: 8
FM Site: 4
SSMH8E13
SSMH8E14
SSMH8E1
SSMH8E15
SSMH8E2
SSMH8E38
SSMH8E16
SSMH8E3
SSMH8E17
SSMH8E26
SSMH8E4
SSMH8E18
SSMH8E19
SSMH8E37
SSMH8E20
SSMH8E27
SSMH8E21
SSMH8E22
SSMH8E24
SSMH8E23
SSMH8E25
SSMH8E28
SSMH8E29
SSMH8E30
SSMH8E31
SSMH8E32
SSMH8E33
SSMH8E34
SSMH8F13
SSMH8F14
SSMH8F15
SSMH8F16
SSMH9E28
SSMH9E27
SSMH9E5
SSMH9E4
SSMH9E3
SSMH9E2
SSMH9E2_S
SSMH9E70
SSMH9E6
N
0
200
400 Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

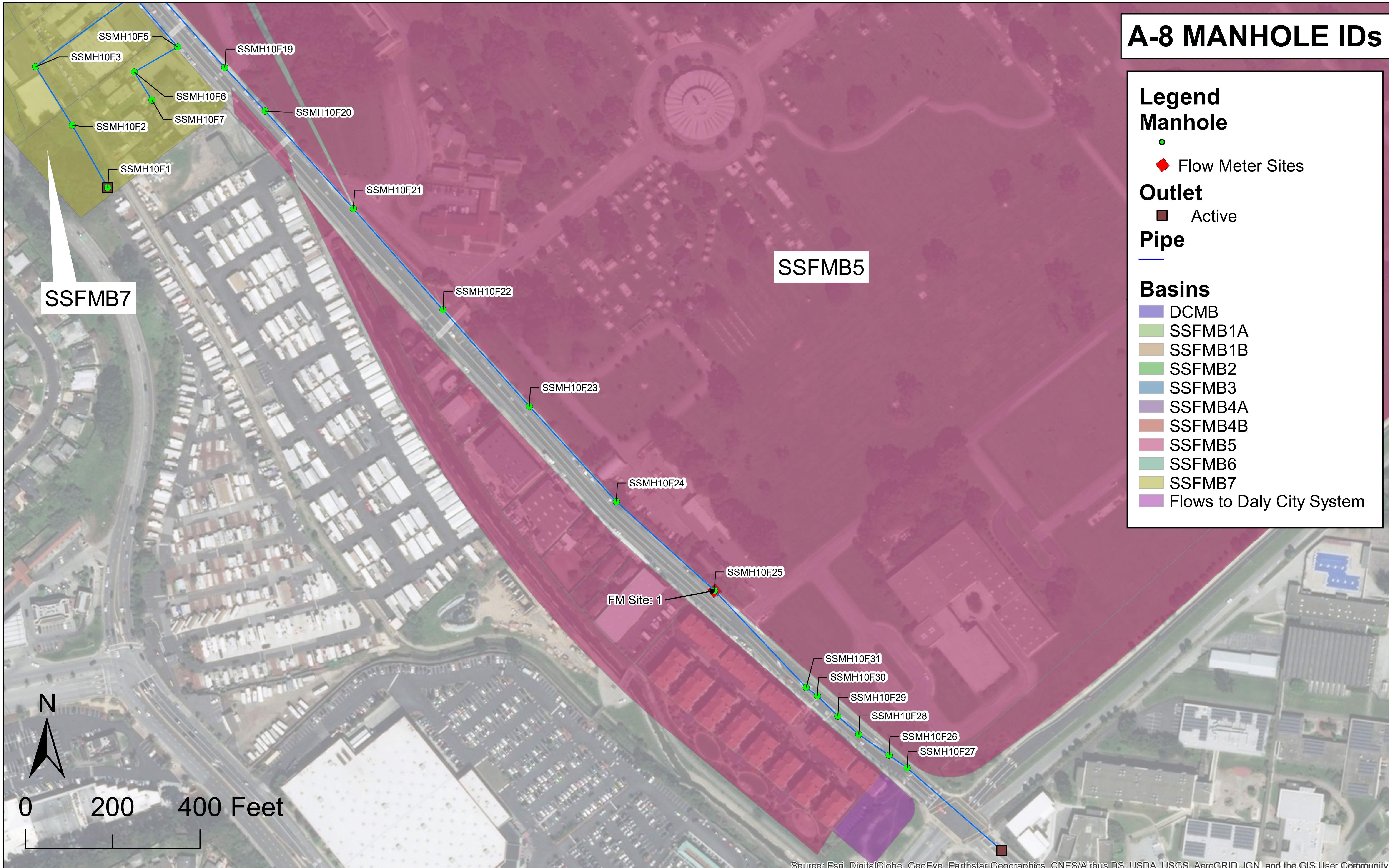

A-4 MANHOLE IDs
Legend
Manhole
Outlet
Active
Pipe
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
DCMB
SSFMB2
SSFMB5
SSMH7F1
SSMH8F1
SSMH8F2
SSMH8F3
SSMH8F4
SSMH8F5
SSMH8F6
SSMH8F7
SSMH8F8
SSMH8F9
SSMH8F10
SSMH8F11
SSMH8F12
SSMH8F13
SSMH8F14
N
0
200
400 Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



A-5 MANHOLE IDs
SSFMB1A
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSMH8E24
SSMH8E23
FM Site: 8
SSMH8E25
SSMH8E30
FM Site: 4
SSMH9E4
SSMH9E3
SSMH9E2_S
SSMH9E2
SSMH9E28
SSMH9E27
SSMH9E5
SSMH9E70
SIPHON_COLLINS_1
SIPHON_COLLINS
SSMH9E12_S
SSMH9E6
SSMH9E29
SSMH9E26
SSMH9E73
SSMH9E52
FM Site: 3
SSMH9E50
SSMH9E25
SSMH9E72
SSMH9E51
SSMH9E21
SSMH9E12
SSMH9D41
SSMH9E53
SSMH9E74
SSMH9E7
SSMH9E75
SSMH9E15
SSMH9F20
SSMH9E49
SSMH9E16
SSMH9E69
SSMH9E54
SSMH9E71
SSMH9E48
SSMH9E20
SSMH9E19
SSMH9E68
SSMH9E17
SSMH9E46
SSMH9E55
SSMH9E18
SSMH9E67
SSMH9E56
SSMH9E47
SSMH9E43
SSMH9E66
SSMH9E57
SSMH9E44
SSMH9E65
SSMH9E58
SSMH9E64
SSMH9E45
SSMH9E63
SSMH9E59
SSMH9E60
N
0
200
400 Feet
Legend
Manhole
Flow Meter Sites
Outlet
Active
Pipe
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


A-6 MANHOLE IDs
SSFMB3
SSFMB5
SSFMB6
SSMH9E59
SSMH9E60
SSMH9E61
FM Site: 2
SSMH9E62
SSMH10E30
SSMH10E29
SSMH10E26
SSMH10E31
SSMH10E27
SSMH10E28
SSMH10E32
SSMH10E33
Legend
Manhole
Flow Meter Sites
Outlet
Active
Pipe
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
N
0
200
400 Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

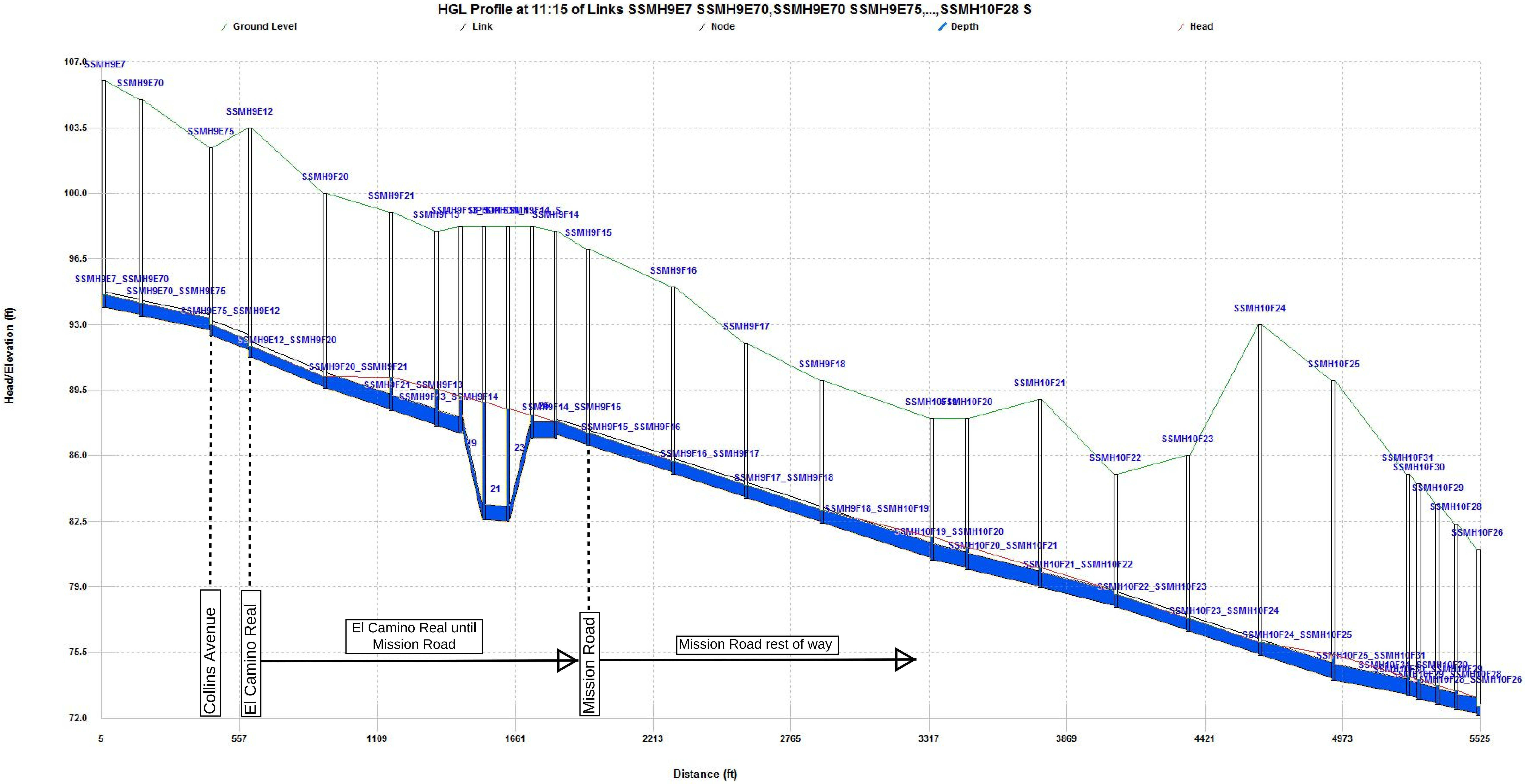

A-7 MANHOLE IDs
Legend
Manhole
Flow Meter Sites
Outlet
Active
Pipe
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
SSFMB5
SSFMB7
SSMH9E3
SSMH9E2_S
SSMH9E2
SIPHON_COLLINS_1
SIPHON_COLLINS
SSMH9E12_S
FM Site: 3
SSMH9E12
SSMH9E75
SSMH9E15
SSMH9E16
SSMH9F19
SSMH9F20
SSMH9F21
SSMH9F14_S
SSMH9F14
SSMH9F13
SSMH9F13_S
SIPHON
SIPHON_1
SSMH9F15
SSMH9F16
SSMH9F17
SSMH9F10
SSMH9F8
SSMH9F18
SSMH9F9
SSMH9F4
SSMH10F5
SSMH10F3
SSMH10F19
N
0
200
400 Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


A-8 MANHOLE IDs
Legend
Manhole
Flow Meter Sites
Outlet
Active
Pipe
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
SSFMB5
SSFMB7
SSMH10F1
SSMH10F2
SSMH10F3
SSMH10F5
SSMH10F6
SSMH10F7
SSMH10F19
SSMH10F20
SSMH10F21
SSMH10F22
SSMH10F23
SSMH10F24
SSMH10F25
FM Site: 1
SSMH10F31
SSMH10F30
SSMH10F29
SSMH10F28
SSMH10F26
SSMH10F27
N
0 200 400 Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix B: Existing PWWF Scenario Results Figure

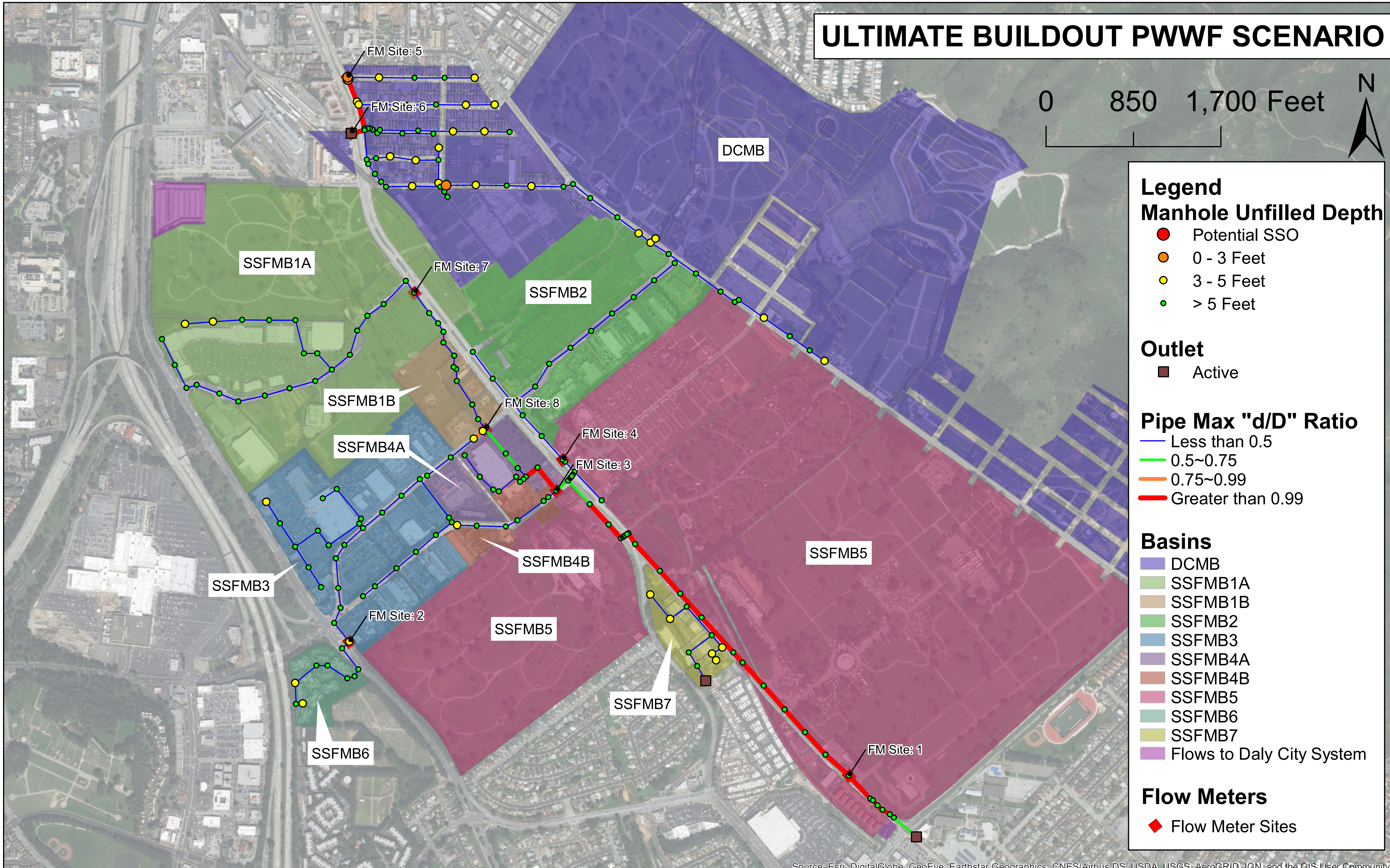

EXISTING PWWF SCENARIO
0 850 1,700 Feet
N
Legend
Manhole Unfilled Depth
Potential SSO
0 - 3 Feet
3 - 5 Feet
> 5 Feet
Outlet
Active
Pipe Max "d/D" Ratio
Less than 0.5
0.5~0.75
0.75~0.99
Greater than 0.99
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
Flow Meters
Flow Meter Sites
FM Site: 5
FM Site: 6
FM Site: 7
FM Site: 8
FM Site: 4
FM Site: 3
FM Site: 2
FM Site: 1
DCMB
SSFMB1A
SSFMB2
SSFMB1B
SSFMB4A
SSFMB4B
SSFMB3
SSFMB5
SSFMB5
SSFMB7
SSFMB6
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix C: Mission Road Pipe Profile for Existing PWWF Scenario



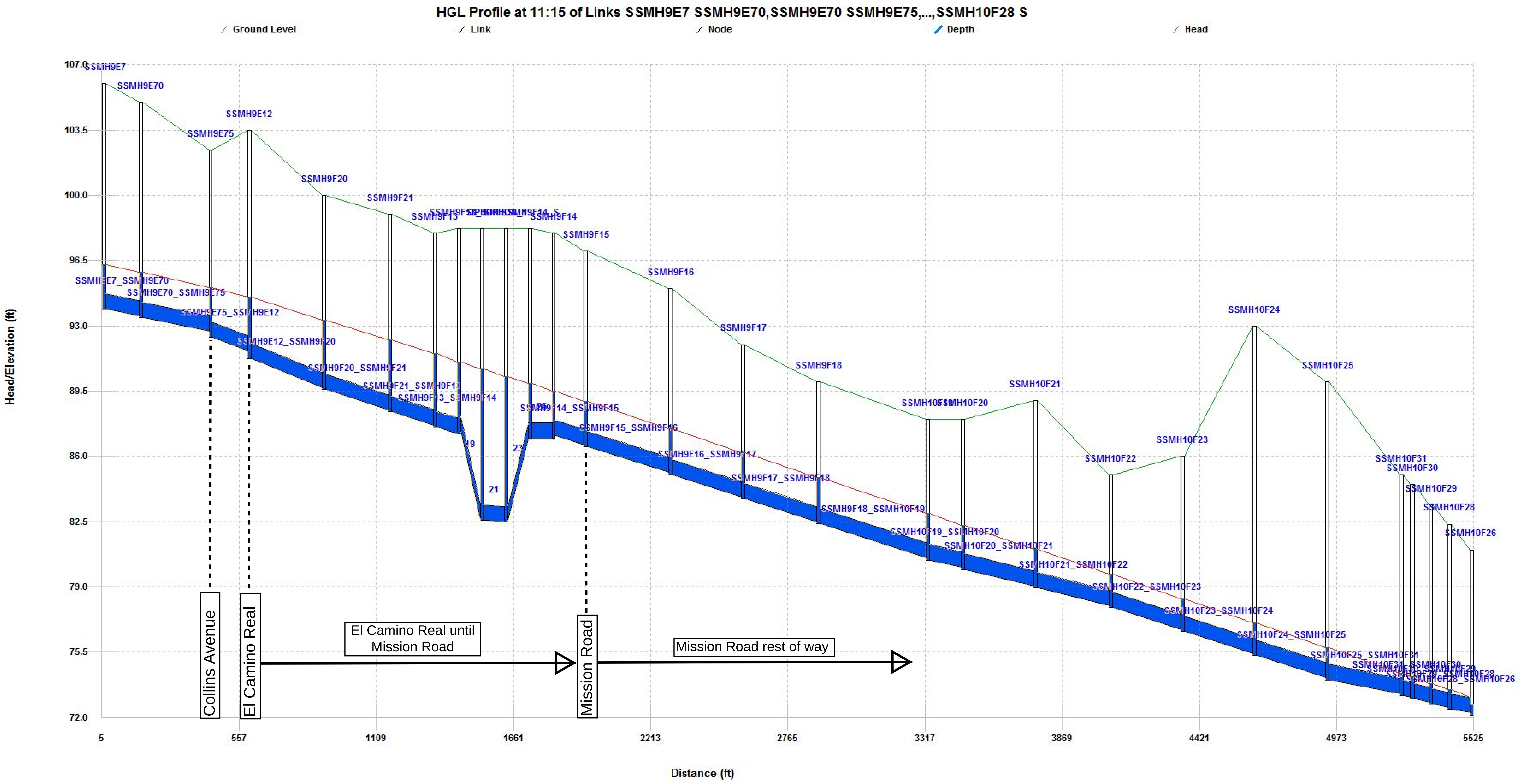
HGL Profile at 11:15 of Links SSMH9E7 SSMH9E70,SSMH9E70 SSMH9E75,...,SSMH10F28 S
Ground Level
Link
Node
Depth
Head
Head/Elevation (ft)
Distance (ft)
Collins Avenue
El Camino Real
El Camino Real until Mission Road
Mission Road
Mission Road rest of way

Appendix D: Ultimate Buildout PWWF Scenario Results Figure



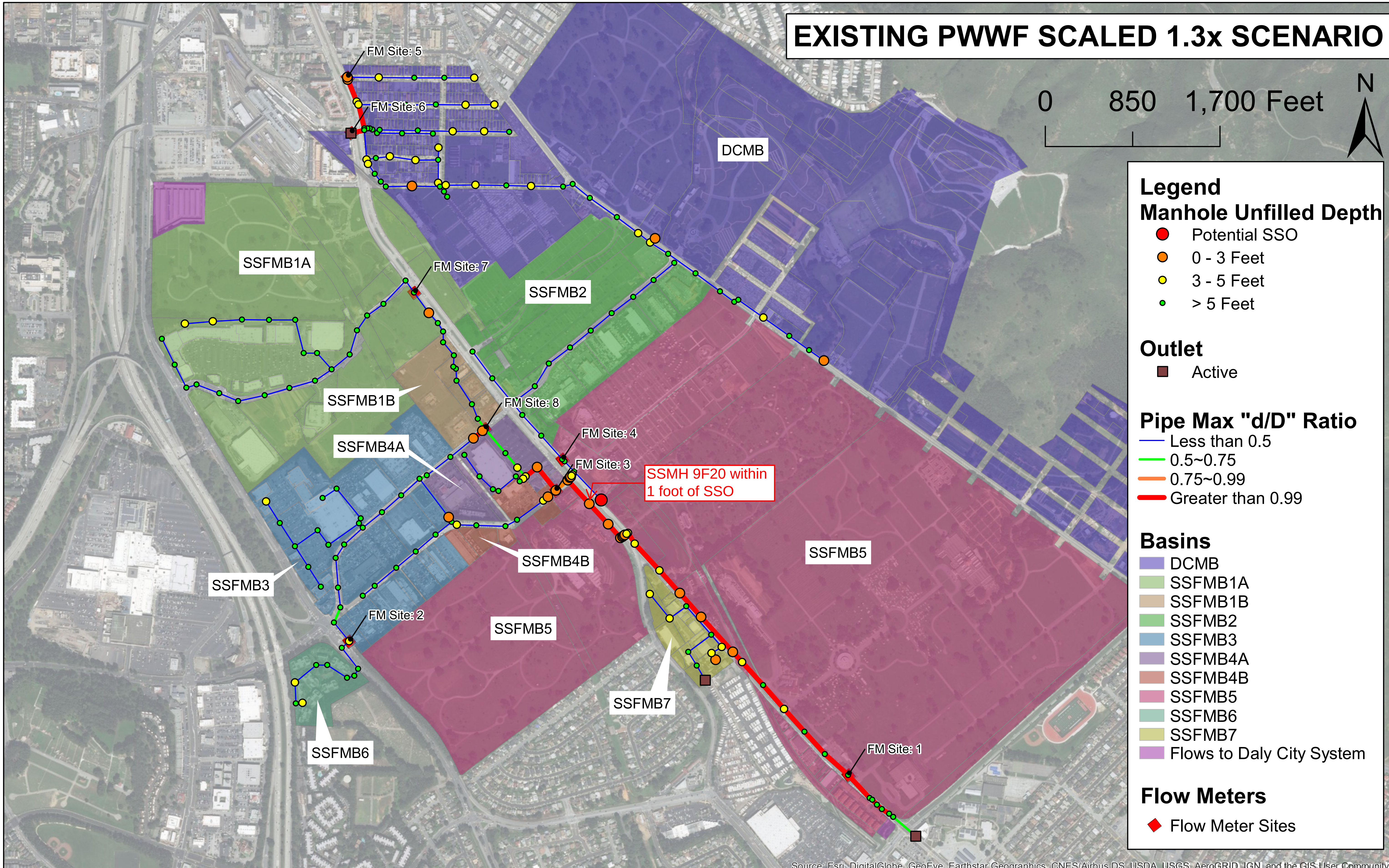
ULTIMATE BUILDOUT PWWF SCENARIO
0 850 1,700 Feet
N
Legend
Manhole Unfilled Depth
Potential SSO
0 - 3 Feet
3 - 5 Feet
> 5 Feet
Outlet
Active
Pipe Max "d/D" Ratio
Less than 0.5
0.5~0.75
0.75~0.99
Greater than 0.99
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
Flow Meters
Flow Meter Sites
FM Site: 5
FM Site: 6
FM Site: 7
FM Site: 8
FM Site: 4
FM Site: 3
FM Site: 2
FM Site: 1
DCMB
SSFMB1A
SSFMB2
SSFMB1B
SSFMB4A
SSFMB4B
SSFMB3
SSFMB5
SSFMB5
SSFMB7
SSFMB6
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix E: Mission Road Pipe Profile for Ultimate Buildout PWWF Scenario

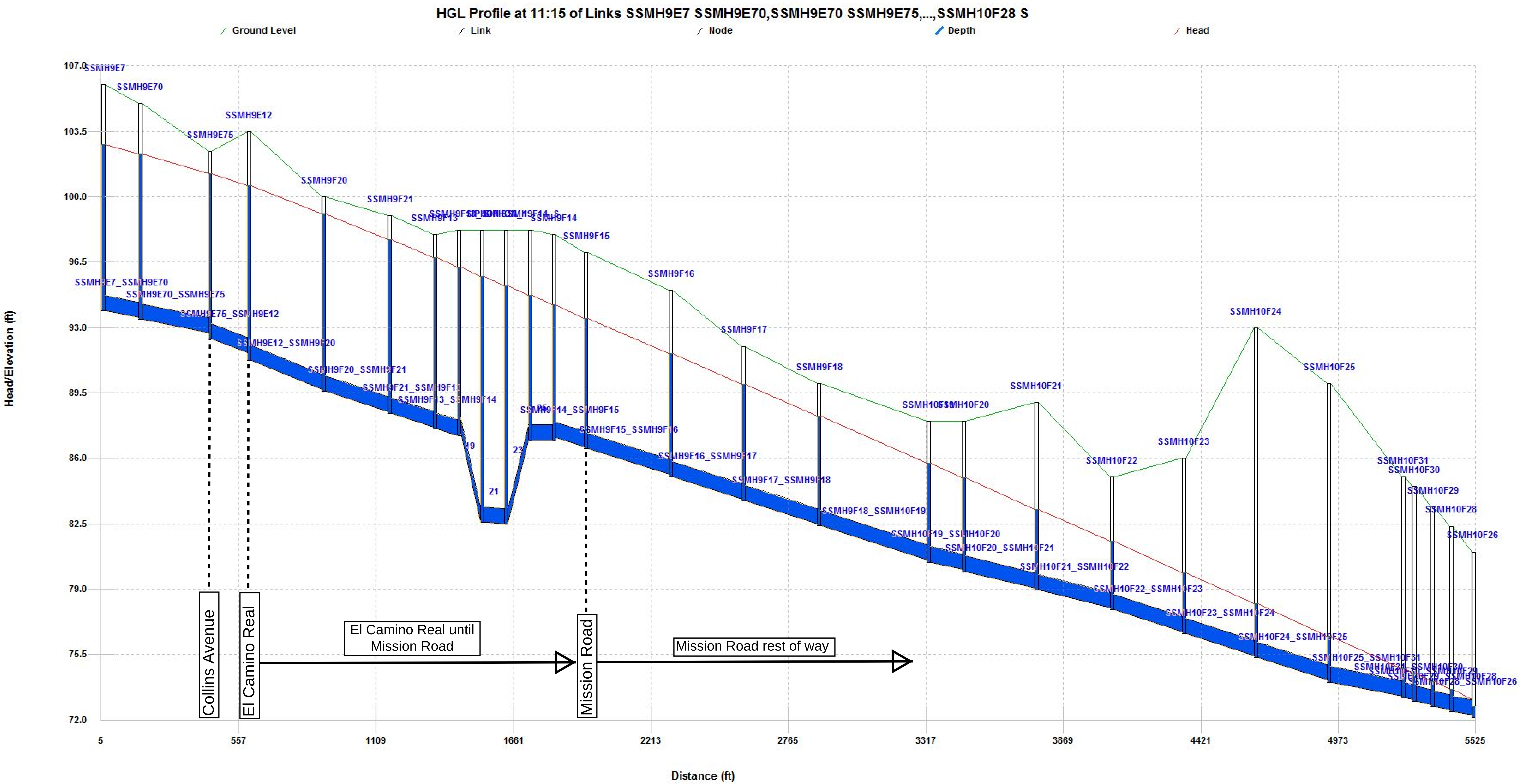


HGL Profile at 11:15 of Links SSMH9E7 SSMH9E70,SSMH9E70 SSMH9E75,...,SSMH10F28 S
Ground Level
Link
Node
Depth
Head
Head/Elevation (ft)
Distance (ft)
Collins Avenue
El Camino Real
El Camino Real until Mission Road
Mission Road
Mission Road rest of way

Appendix F: Existing PWWF Scaled 1.3x Scenario Results Figure


EXISTING PWWF SCALED 1.3x SCENARIO
0
850
1,700 Feet
N
DCMB
SSFMB1A
SSFMB2
SSFMB1B
SSFMB4A
SSFMB4B
SSFMB3
SSFMB5
SSFMB5
SSFMB7
SSFMB6
FM Site: 5
FM Site: 6
FM Site: 7
FM Site: 8
FM Site: 4
FM Site: 3
FM Site: 2
FM Site: 1
SSMH 9F20 within
1 foot of SSO
Legend
Manhole Unfilled Depth
Potential SSO
0 - 3 Feet
3 - 5 Feet
> 5 Feet
Outlet
Active
Pipe Max "d/D" Ratio
Less than 0.5
0.5~0.75
0.75~0.99
Greater than 0.99
Basins
DCMB
SSFMB1A
SSFMB1B
SSFMB2
SSFMB3
SSFMB4A
SSFMB4B
SSFMB5
SSFMB6
SSFMB7
Flows to Daly City System
Flow Meters
Flow Meter Sites
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix G: Mission Road Pipe Profile for Existing PWWF Scaled 1.3x Scenario



HGL Profile at 11:15 of Links SSMH9E7 SSMH9E70,SSMH9E70 SSMH9E75,...,SSMH10F28 S
Ground Level
Link
Node
Depth
Head
Head/Elevation (ft)
Distance (ft)
Collins Avenue
El Camino Real
El Camino Real until Mission Road
Mission Road
Mission Road rest of way
SSMH9E7
SSMH9E70
SSMH9E75
SSMH9E12
SSMH9F20
SSMH9F21
SSMH9F15
SSMH9F16
SSMH9F17
SSMH9F18
SSMH10F21
SSMH10F22
SSMH10F23
SSMH10F24
SSMH10F25
SSMH10F26

Appendix B. Town of Colma Flow Monitoring Services Performed (Total Flow Inc., April 2018)

Total Flow Inc.

23520 Foley St.
Unit B
Hayward Ca 94545
Tel: (510) 774-9223
Jeff.Blum@totalflowinc.com

April 6, 2018

Abdulkader Hashem Associate Engineer
Town of Colma Public Works
1188 El Camino Real
Colma CA, CA 94104

Re: Town of Colma Flow Monitoring Services

Dear Mr. Hashem

On behalf of Total Flow, Inc. (TFI), I am pleased to submit two copies of the Revised Town of Colma Flow Monitoring Services report. This report covers the work performed during the between January 2017 to February 2017 It also includes a follow up investigation October-December 2017.

I would like to thank you for giving us the opportunity to serve you. Please feel free to call me at (510) 774-9223 or e-mail me at jeff.blum@TotalFlowInc.com with any comments or questions, at your convenience

Sincerely,

Jeff Blum
Project Manager

cc: File

EXECUTIVE SUMMARY

Total Flow Inc. conducted temporary flow monitoring at eight manholes in the Town of Colma's sanitary sewer collection system. The flow monitoring program covered about 1 month from the end of January to the end of February 2017. The program's objective was to measure the magnitude of wastewater flows that are contributed by Colma residents, businesses, and the multitude of cemeteries.

A Marsh-McBirney Model 2000 portable electromagnetic velocity meter was utilized to record velocity measurements, while depth measurements were conducted by hand during weekly site visits to the flow meters. One tipping bucket rain gauge was placed at the City Hall Portable roof to continuously record rainfall data for the program. These weekly site visits served the purpose of comparing the depth and velocity measured values to the monitored values collected by the Hach brand flow meters that collection the same two types of data.

The results section of this report details the daily average flows and RDII volumes for each flow meter for the storm event occurring from February 19 to February 22. This section also discusses the resultant peaking factors seen from the hydraulic model analysis performed by Water Works Engineers (WWE).

A concern arose regarding flow meter site #1 at the southern end of Colma's collection system on Mission Road. While the flow values observed as a part of this flow monitoring program closely matched flow values from previous Colma flow monitoring projects (roughly around 0.1 MGD), WWE's subsequent hydraulic model development found that the cumulative flows at this flow meter site should theoretically be larger than the monitored values. This observation leads WWE to believe that there might be an unknown diversion upstream of this site that is reducing the monitored values at site #1. Investigation into this area of the collection system might be worthwhile for the Town of Colma to perform to determine exactly how flows are routed throughout.

Total Flow (TFI) was also concerned about this discrepancy in flow and performed a follow up investigation. TFI completed localized dye testing at the manholes for Sites 3 and 4. TFI then followed up by checking parallel and adjacent storm lines for evidence of a cross connection, however none were found. While checking for dye, TFI took spot flow points in the downstream sewer manholes going toward Site 1. Flows were found to be consistent among the observed manholes. TFI did not feel the discrepancy had yet been resolved, so TFI installed flow meters back in Site 1 and in MH 10F20 in December 2017. Flows at MH 10F20 were consistent with the combined flows of Sites 3 and 4, with data available in the Appendix. There seems to be no cross connection(s) in the reaches between manholes 10F20 and 10F25. TFI then took a real close look at the flow development at MH 10F25 (Site 1). TFI discovered that there was a sharp reduction in velocity at the opening of the inlet pipe at MH 10F25 (Site 1). When comparing velocity just up in the inlet pipe against velocity in the manhole pipe channel / outlet pipe, the velocity was nearly double in the inlet pipe. TFI believes there is a hydraulic jump that caused the depth to go up slightly with this reduction of recorded velocity. TFI took this new calibration information and applied it to the data to get a new flow which does line up with the flows at Sites 3 and 4. Revised data can be found in the Appendix.

Total Flow Inc. observed surcharge conditions at flow meter sites #5 and #6 during storm events. The crew that performed the weekly site visit during a storm event near these sites believe that there could be a restriction in flow between SSMH7E23 and SSMH7E97. Another possibility is the downstream “F Street Lift Station” operational conditions affecting the pipelines near flow meter sites #5 and #6.

INTRODUCTION

This report presents the results of the flow monitoring program conducted during the period of January 22, 2017 to February 27, 2017. The report is prepared in accordance with the agreement to provide flow monitoring services for Town of Colma. A total of 8 flow monitors for 10 pipes and one rain gauge installed for this project.

This report contains the following sections:

- Project Description -- Discussion of flow components, monitoring and rain gauge equipment and locations
- Equipment and Site Calibration -- Discussion of field calibration routine, manhole inspection, and flow isolation field procedures
- Flow Analysis -- Discussion of flow monitor calibration and data analysis techniques
- Results -- Discussion of the flow and rainfall monitoring results and data problems
- Appendix FLOW -- Flow monitor site descriptions, site photographs, manhole inspection forms, site calibration data, plots of hourly flow and rainfall data, and a flow summary table.

PROJECT DESCRIPTION

Flow monitoring was conducted to measure the magnitude and components of flow that enter the wastewater collection system. Wastewater flow is comprised of the following components:

- Sanitary Flow (SF) -- Normal sewage flow from residential, commercial, and industrial sources.

Dry weather flow (DWF) periods contain only the SF and GWI components. Wet weather flow (WWF) periods include the RDI/I component in addition to DWF. The relative percentage contributed by each component of DWF and WWF will vary from one area to another as social, environmental, and physical conditions change over time.

FLOW MONITORS

Flow monitors were deployed from January 17, 2017 to February 23, 2017. Monitoring sites were selected by Dave Bishop and were based on reconnaissance by

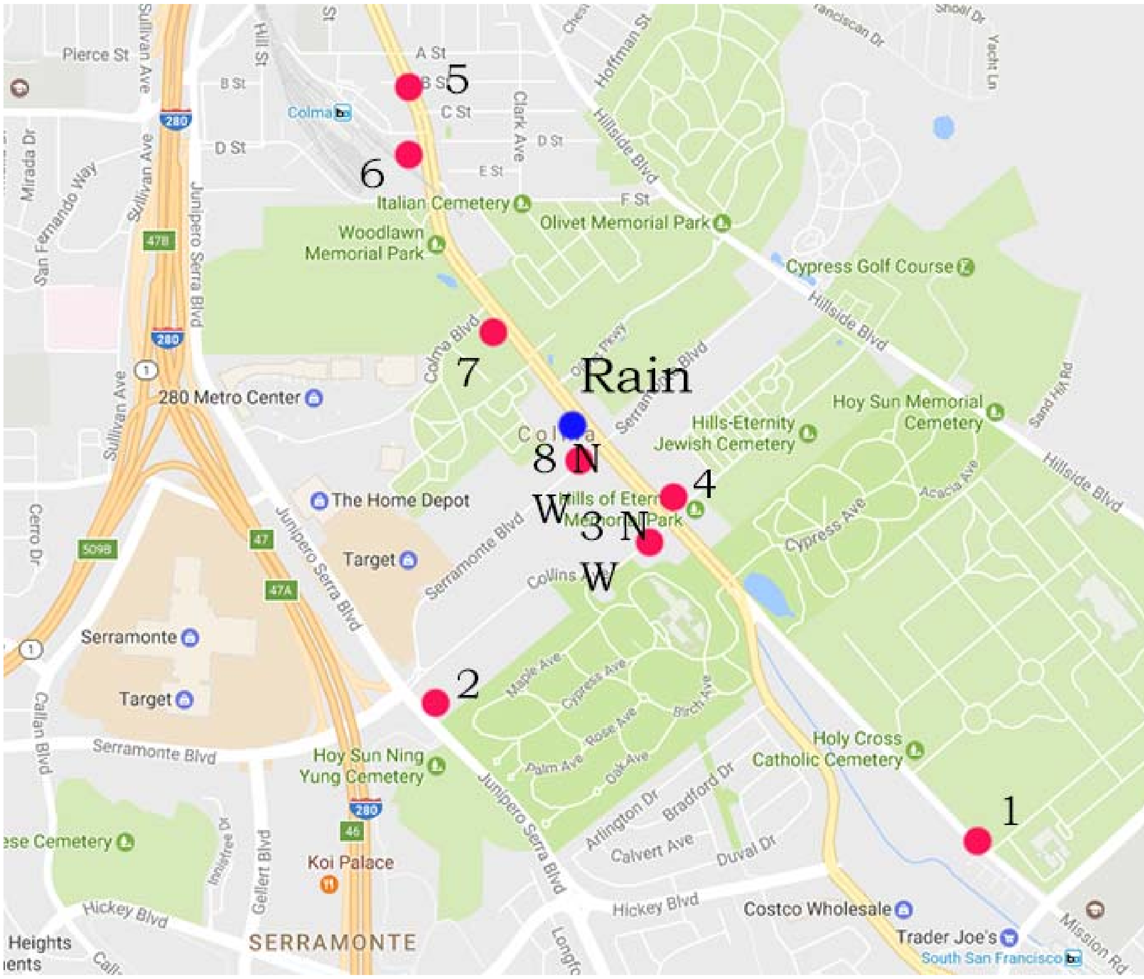
Total Flow, Inc. (TFI). A flow monitoring plan was prepared to determine proper locations for equipment installation. The table below shows the site locations.

Table 1

Town of Colma Flow Meter Site

	Site SSMH#	**Location**	**Pipe Size** (inches)	**Meter Type**	**Monitor Acres**	**Basin Acres**
1	10F25	1427 Mission St	10”	FL904Submerged	469.2	189.6
2	9F61	Junipero Serra Blvd	6”	FL904 FloDar	9	9
3	9E76	205 Collins	N 10” W 10”	FL904Submerged	N 195.5 W 12.4	N 17.1 W 12.4
4	9E4	El Camino Real North of Collins	8”	FL904Submerged	71.7	71.7
5	7E19	El Camino Real at B St.	10”	FL904Submerged	500~	
6	E07-39	El Camino Real at Albert M Teglia Blvd	12”	FL904Submerged	702.2	200.2
7	8E14	El Camino Real South of Colma Blvd on side Rd.	8”	Fl900 FloDar	72.5	72.5
8	8E23	Serramonte Blvd West of El Camino Real	N 8” W 8”	FL904Submerged	N 94.4 W 84	N 21.9 W 75
Rain Gauge		City Hall				

Figure 1 Map of flow meters and rain gauge locations



Hach FL900 Flow Meters were used at all the flow monitoring sites. The Hach depth and velocity meters automate the data collection requirements associated with flow monitoring. Data was collect and stored on the loggers in 5 minute intervals. Flow information is stored in solid-state memory units that are quickly and easily retrieved through a notebook computer during routine data collection.

The Fl900 AV meter uses a FloDar sensor. FloDar has an ultrasonic depth senor and a microwave velocity sensor

The Fl900 AV meter also use a submerged pressure transducer to measure depth if the pipe becomes surcharged. The probe is mounted in the FloDar meter and the pressure at the probe varies proportionately with the level of the flow once the sensor is submerged. The submerged pressure transducer is ideal for surcharging conditions.

EQUIPMENT AND SITE CALIBRATION

FLOW MONITORING

Maintenance of the pipeline flow monitors involved weekly site visits to check on the operating status, collect recorded data, and obtain calibration information. During visits to the monitor sites, depth and velocity of sewage flow were measured by hand with a carpenter's ruler and recorded along with corresponding observed instantaneous monitor values. Depth was measured by hand, and velocity was measured with a Marsh-McBirney Model 2000 portable electromagnetic velocity meter.

Due to the normal diurnal variation of sewage flow, the sites were visited at various hours of the day to obtain measured and metered values corresponding throughout each site's flow range.

The measured and monitor values were compared in the field to verify monitor accuracy. Equipment showing significant deviation from measured values was recalibrated. The measured and metered values were later analyzed in the office to determine offsets for flow processing and analysis.

RAIN GAUGES

Onset one-channel HOBO event recorder and tipping bucket rain gauges were used to continuously record rainfall data for the flow-monitoring program. Tipping bucket rain gauges are designed to close a mercury switch with each 0.01-inch of rainfall, allowing the data pod to record the time of the event. The rain gauge was located at City Hall Portable roof

- Accessibility for installation, data retrieval, maintenance, and removal
- Adequate distance from objects such as high structures and trees that could distort rainfall measurements
- Security

FLOW ANALYSIS

A brief description of the flow analysis performed on the field data is presented in this section.

PIPELINE MONITOR SITES

The Hach monitors collected both flow depth and velocity information. The first step in processing the flow monitor data is to calculate flow by entering the data into a computer for processing. From this point, two methods were used to calculate flow, the depth-versus-flow curve, and area and velocity calculation.

The depth-versus-flow method utilizes the calibration depth and velocity data to develop a best-fit relationship between depth and velocity. This method allows the user to determine flow from depth data alone. In developing the curve, the method does not rely on estimates or guesses at site-specific factors affecting flow. These factors include debris, pipe roughness, localized pipe slope, and any other condition which can affect the depth-versus-flow relationship.

Typically, a curve is obtained that matches the field calibration measurements with a correlation coefficient of 95 percent or better. The curve was used to accurately generate a continuous flow hydrograph for each site. Hourly flows were calculated from hourly flow depth data using the specific depth-versus-flow equation.

The area and velocity calculation was used to process hourly flow based on the continuity equation:

$Q = A \times V$

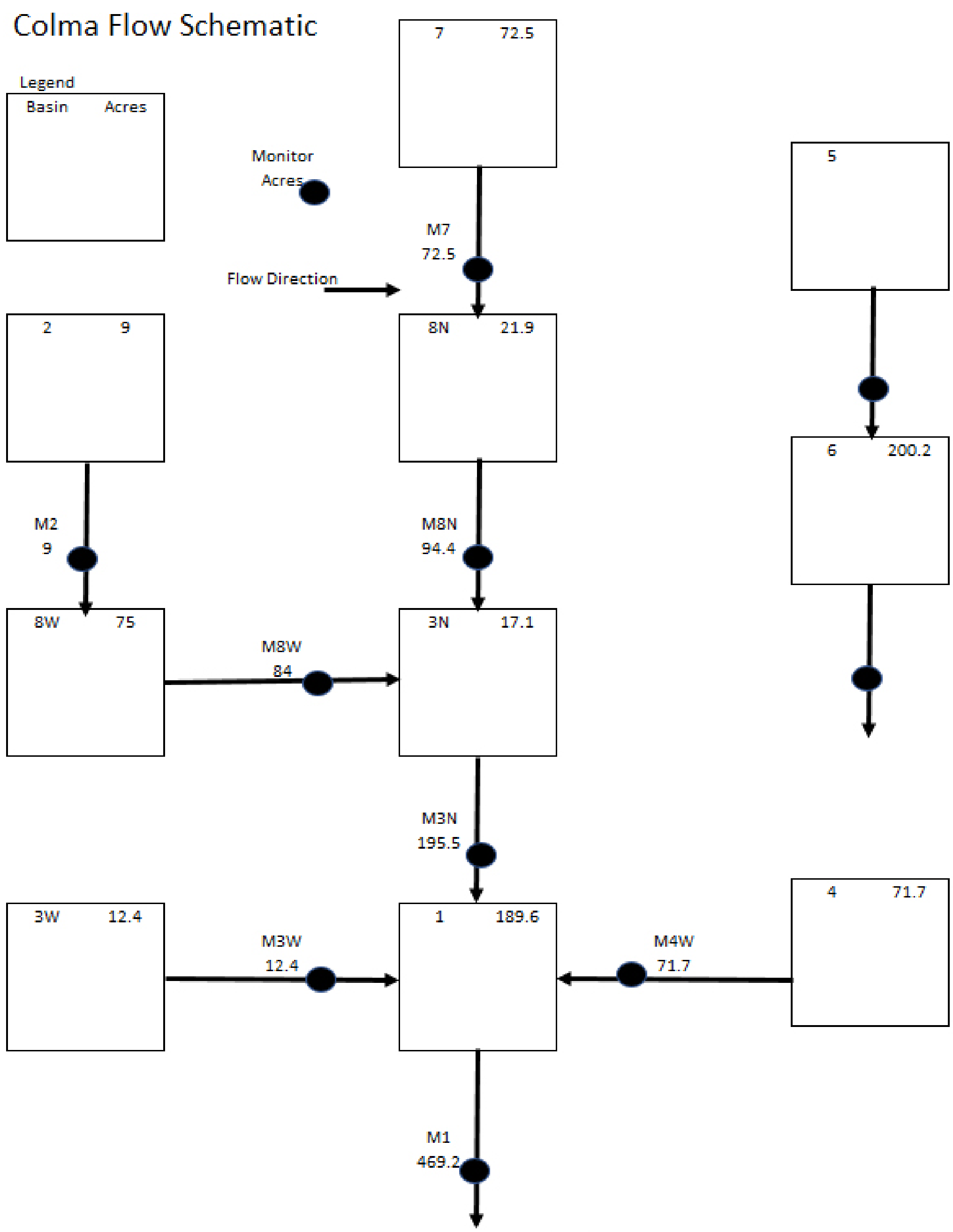
where:

- Q = Flow
- A = Cross-sectional area of flow based upon pipe diameter and recorded depth, including any offset adjustments for sediment that may be required.
- V = Average velocity calculated from recorded velocity.

Velocity values were correlated with depth values within the computer program in order to establish a site-specific, measured depth-versus-velocity relationship over a wide range of depth values. This relationship accounts for site-specific debris, local slope, and roughness conditions.

Figure 2 is a basin flow schematic to help visual how the flow from each meter effects the downstream meters

Figure 2



RDI/I SEPARATION

As discussed earlier, measured flows consist of SF, GWI, and RDI/I. The amount of RDI/I entering the District's sanitary sewer system was determined for the Districts flow monitoring sites. The RDI/I separation performed for this project consists of identifying base flow, calculating the difference between the base flow and total flow, and then calculating the RDI/I return ratio. The steps of the analysis process are discussed in the following sections.

BASEFLOW

The average base flow (ABF) at each monitor was developed by analyzing monitored flow data from a dry period during the monitoring period. An ABF hydrograph, composed of SF and GWI, was determined from reviewing the flow patterns before and after storm events. Base flow hydrographs for weekdays and weekends were developed for each site.

RDI/I SUBTRACTION

The storm events captured during the monitoring period were analyzed to determine the RDI/I response in the monitoring area. Wet weather flow data are analyzed from the beginning of the rain event to an end point where it appears that the hydrograph consists of only base flow, indicating the RDI/I have receded from the collection system. The volume of RDI/I for each discrete storm event is calculated by subtracting the ABF hydrograph from the monitored flow hydrograph.

RDI/I QUANTITY

The result of the RDI/I subtraction is an RDI/I hydrograph. The quantity of RDI/I determined from the subtraction can be thought of as the amount of rainfall that entered the sanitary sewer system. This value is expressed as a return ratio, R, expressed as a percentage. The value of R can be used to measure how the sewer basin responds to a rainfall event.

The amount of rainfall falling in each monitor area was determined from the gathered rainfall data and the monitor service area. For the monitoring period covered in this report, the project area experienced a moderately wet season. Nine distinct storm events occurred within the monitor period. These events were generally separated by dry days that allowed the flows to return to normal winter levels. The R-values for the monitor are summarized in the appendix. The plots of each RDI/I separation summary listings of the R- values are also included in the appendix.

RESULTS

FLOW MONITORING DATA

The flow meters were installed in January 2017 and removed in February 2017. The initial period was over 38 days with 19 days of rain. During the installed period, there were 9 days of rain over .5 of an inch with a season average total of 10.77 inches.

The detailed results of flow monitoring sites are presented in the Appendix. The site reports are separated by dividers. The data include monitor site sheets, site photographs, plots of flow and depth data, and a table listing the average daily flow and daily minimum and peak flows. The hydrographs cover a 24-hour period beginning at 0000 hours and ending at 2300 hours. Hourly flow averages and rainfall sums are included as a separate sheet within the site MS Excel© workbook. In addition, base flow and RDI/I were performed at all sites. Five separate storms were analyzed. Base flow plots, R% tables and RDI/I separation plots are in the appendix with each site.

Table 2 presents the Daily average flows RDI/I Volume for storm 2/19/17through 2/22/17, rain for that storm and the average of the highest 3 peak R%.

Table 2 Town of Colma Monitor RDI and Base Flow Summary

Site	MH#	Pipe Size (inches)	Monitor Acres	Average Weekday MGD	Average Weekend MGD	RDI/I Volume 2/19-22/17 MG	Ave. Rain for RDI Volume Inches	Ave Top 3 R%
1	10F25	10	469.2	0.190	0.166	0.236	1.88	0.8%
2	9F61	6	9	0.033	0.037	0.011	1.81	2.90%
3N	9E76	10	195.5	0.139	0.132	0.097	1.81	1.01%
3W	9E76	10	12.4	0.007	0.006	0.005	1.81	1.18%
4	9E04	8	71.7	0.031	0.033	0.017	1.81	1.22%
5	7E19	10	500	0.516	0.544	0.548	1.81	2.24%
6	E07-39	12	702.2	0.635	0.658	0.39	1.81	1.38%
7	8E14	8	72.5	0.032	0.028	0.032	1.81	1.80%
8N	8E23	8	94.4	0.044	0.043	0.047	1.81	1.13%
8W	8E23	8	84	0.041	0.04	0.04	1.81	1.10%

Table 3 presents peaking factors for each flow meter site and sewer basin for the following modeling scenarios completed by WWE:

- Existing Conditions Scenario

- o Peaking Factor: Average Dry Weather Flow (ADWF) to Peak Dry Weather Flow (PDWF)
- o Peaking Factor: ADWF to Peak Wet Weather Flow (PWWF)

- Ultimate Buildout Scenario
  - o Peaking Factor: ADWF to PDWF
  - o Peaking Factor: ADWF to PWWF

Table 3 Peaking Factors by Flow Meter Site

Site	Associated Basin	Existing Conditions Scenario Peaking Factors		Ultimate Buildout Scenario Peaking Factors	
		ADWF to PDWF	ADWF to PWWF	ADWF to PDWF	ADWF to PWWF
1	SSFMB5	1.27	3.70	1.37	3.42
2	SSFMB6	1.45	4.79	1.47	4.50
3N	SSFMB4A	1.36	4.58	1.57	4.42
3W	SSFMB4B	1.33	3.50	1.29	3.14
4	SSFMB2	1.41	1.84	1.13	1.40
5*	N/A	N/A	N/A	N/A	N/A
6	DCMB	1.02	3.52	1.64	3.97
7	SSFMB1A	2.74	3.48	2.72	3.44
8N	SSFMB1B	2.50	5.78	2.48	5.30
8W	SSFMB3	1.55	7.00	1.77	6.75

*Flow Meter Site 5 was installed to measure flows from Daly City, and because Daly City's sewer system is not included in the hydraulic model by WWE, peaking factors for this site are not provided.

WWE had questions about flow during rain events at locations that were not monitored. The flows coming from the Trailer Park off Mission and the flows from the top of F St. including a lot of cemetery area. The crew went during the Storm on 2/20/17. The flows on F street looked very similar to dry days about ¼ of an inch flowing about .5 ft./sec. The flows coming from the Trailer Park should a significant increase. It is a 6" pipe with about 1 inch of flow at over 9 ft. per sec., about .13 mgd. On a dry day, it was about half this amount.

Site 7 shows spikes during rain events which maybe from a sump pump on an upstream property.

Site 5 and 6 both had surcharge occurrences during storm events. Site 5 had more sever capacity issues. The crew check manhole between sites 5 and 6 during the storm on February 20, to try to determine the location of a restriction in flow. The manhole at the intersection of El Camino and C St was partially surcharge and the crew believes there is a restriction in flow somewhere between C St. and D St. MH-E07-023 and MH E07-097.

APPENDIX
A

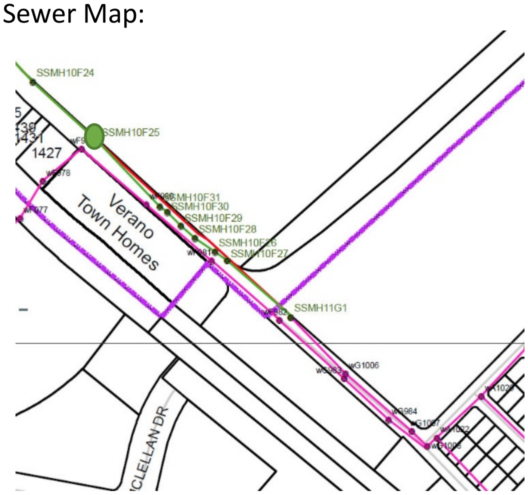
Site Information Report

Flow Monitor Site: 1 MH 10F25

Manhole Number SSMH Location: 1427 Mission St.
MH Depth ~16’
Diameter: 10”
Safety: Ok
Traffic: Medium
Gas: Ok
Rungs: Yes
Meter Type: Hach FL900
Depth: Pressure 3”
Velocity: Doppler 1.5 ft./sec
Meter Type Submerged

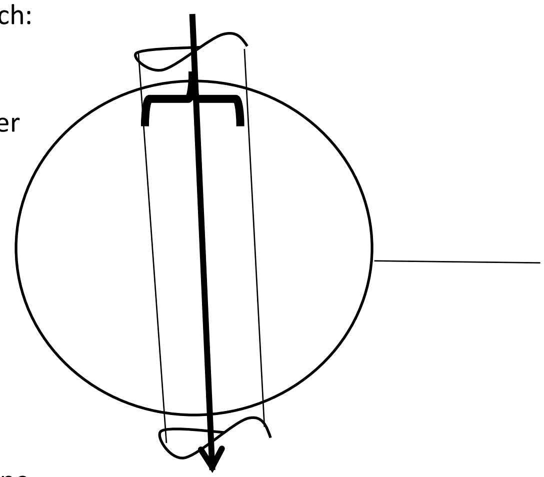
Ariel View:

City Sewer Map:



Flow Sketch:

Flow Meter



10-inch Pipe

Surface View:

Invert View:

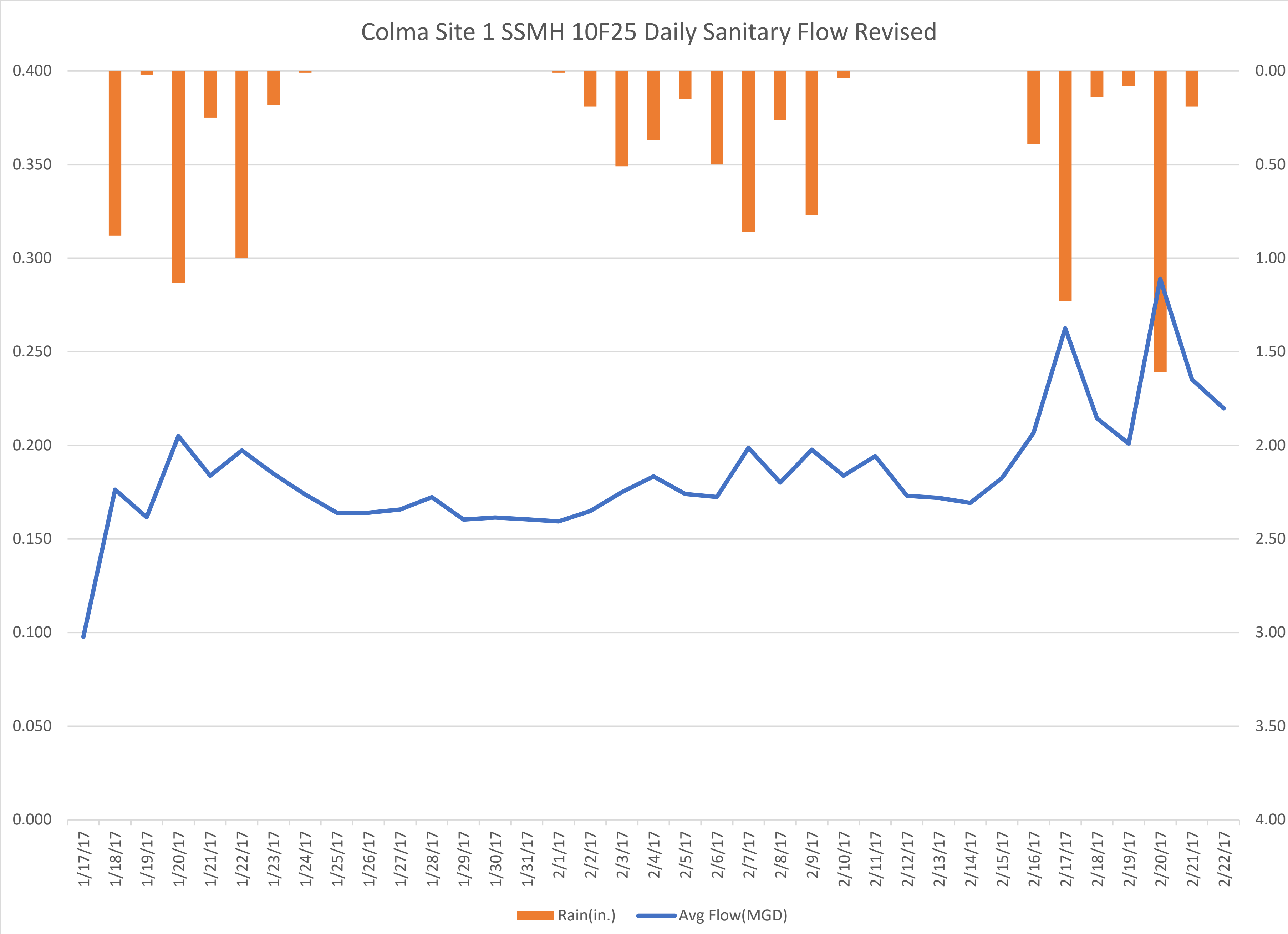
Outlet Pipe:	Inlet Pipe:
	

Colma Site 1 SSMH 10F25 Sanitary Flow Revised

Daily Summary

Date	Day	Avg Flow(MGD)	Min Flow(MGD)	Max Flow(MGD)	Max Depth(in.)	Rain(in.)
1/17/17	Tuesday	0.098	0.000	0.296	3.575	0.00
1/18/17	Wednesday	0.176	0.053	0.543	4.389	0.88
1/19/17	Thursday	0.162	0.055	0.288	3.452	0.02
1/20/17	Friday	0.205	0.090	0.909	5.864	1.13
1/21/17	Saturday	0.184	0.074	0.375	3.910	0.25
1/22/17	Sunday	0.197	0.102	0.526	4.402	1.00
1/23/17	Monday	0.185	0.077	0.463	4.117	0.18
1/24/17	Tuesday	0.174	0.061	0.515	4.447	0.01
1/25/17	Wednesday	0.164	0.064	0.508	4.369	0.00
1/26/17	Thursday	0.164	0.062	0.412	3.983	0.00
1/27/17	Friday	0.166	0.058	0.394	3.863	0.00
1/28/17	Saturday	0.172	0.070	0.352	3.655	0.00
1/29/17	Sunday	0.160	0.050	0.342	3.611	0.00
1/30/17	Monday	0.161	0.065	0.422	4.102	0.00
1/31/17	Tuesday	0.161	0.058	0.475	4.244	0.00
2/1/17	Wednesday	0.159	0.062	0.373	3.891	0.01
2/2/17	Thursday	0.165	0.070	0.353	3.781	0.19
2/3/17	Friday	0.175	0.062	0.432	4.227	0.51
2/4/17	Saturday	0.183	0.076	0.411	4.077	0.37
2/5/17	Sunday	0.174	0.071	0.330	3.636	0.15
2/6/17	Monday	0.172	0.065	0.349	3.749	0.50
2/7/17	Tuesday	0.199	0.096	0.452	4.192	0.86
2/8/17	Wednesday	0.180	0.080	0.385	4.027	0.26
2/9/17	Thursday	0.198	0.076	0.442	4.200	0.77
2/10/17	Friday	0.184	0.076	0.381	4.177	0.04
2/11/17	Saturday	0.194	0.086	0.417	4.271	0.00
2/12/17	Sunday	0.173	0.092	0.291	3.712	0.00
2/13/17	Monday	0.172	0.073	0.333	3.766	0.00
2/14/17	Tuesday	0.169	0.066	0.304	3.772	0.00
2/15/17	Wednesday	0.183	0.072	0.339	3.871	0.00
2/16/17	Thursday	0.207	0.077	0.405	4.006	0.39
2/17/17	Friday	0.263	0.093	0.525	4.748	1.23
2/18/17	Saturday	0.214	0.098	0.388	4.282	0.14
2/19/17	Sunday	0.201	0.103	0.371	4.240	0.08
2/20/17	Monday	0.289	0.138	0.644	5.058	1.61
2/21/17	Tuesday	0.235	0.133	0.413	4.361	0.19
2/22/17	Wednesday	0.220	0.103	0.362	4.331	0.00

Average Flow	0.186	MGD
Max Depth	5.86	Inches
Total Rain	10.77	Inches


Colma Site 1 SSMH 10F25 Daily Sanitary Flow Revised
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
1/17/17
1/18/17
1/19/17
1/20/17
1/21/17
1/22/17
1/23/17
1/24/17
1/25/17
1/26/17
1/27/17
1/28/17
1/29/17
1/30/17
1/31/17
2/1/17
2/2/17
2/3/17
2/4/17
2/5/17
2/6/17
2/7/17
2/8/17
2/9/17
2/10/17
2/11/17
2/12/17
2/13/17
2/14/17
2/15/17
2/16/17
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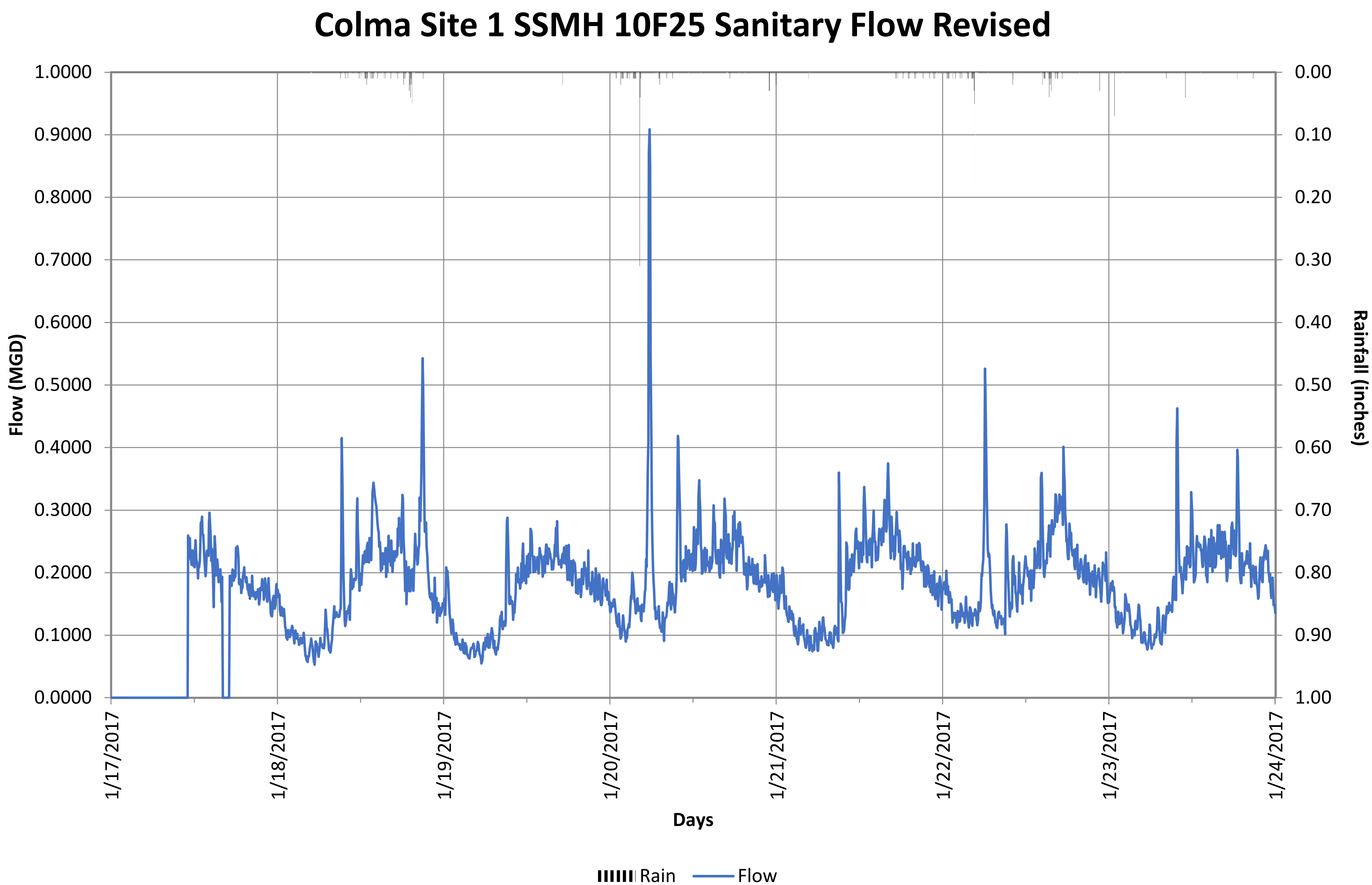
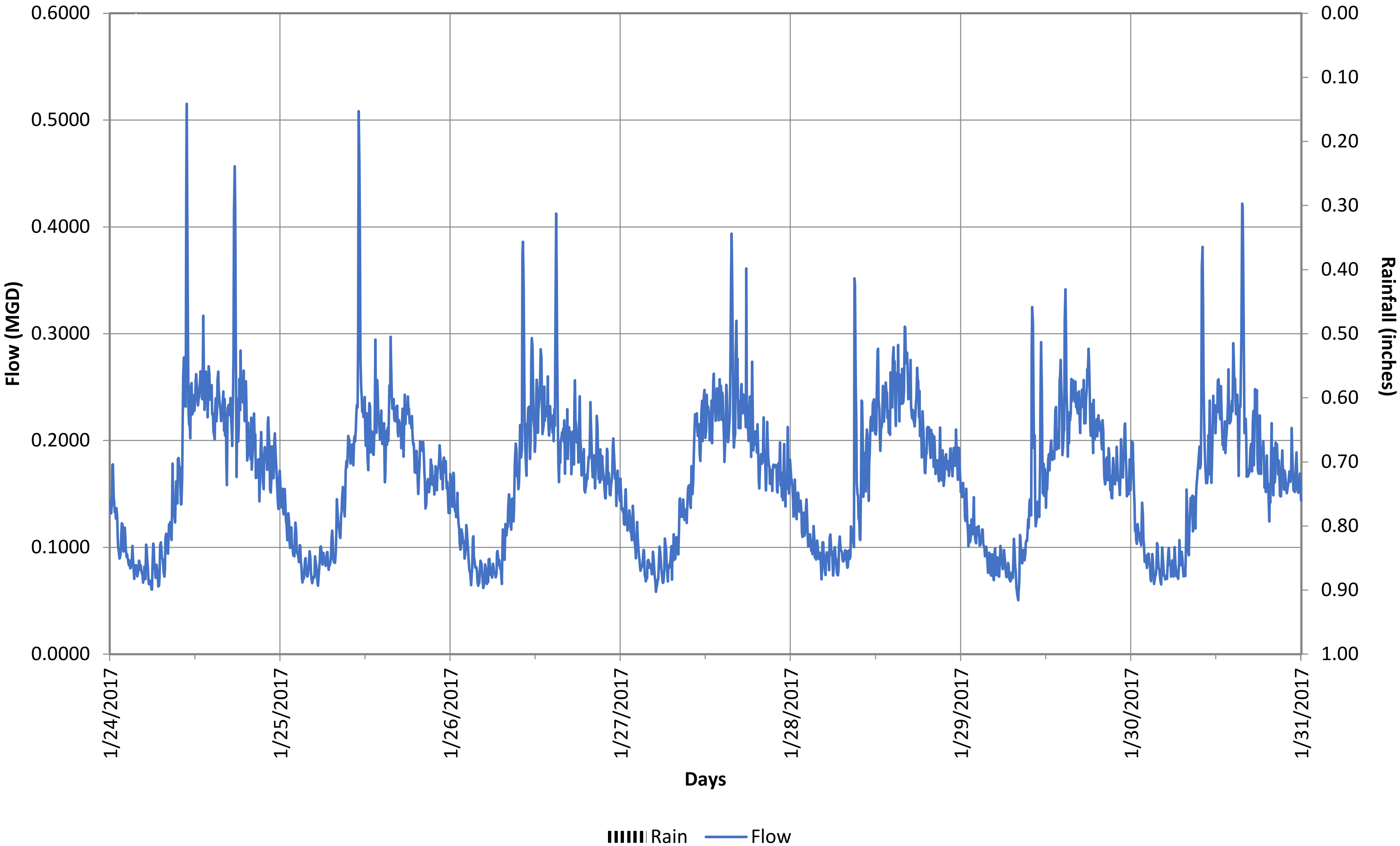
2/19/17
2/20/17
2/21/17
2/22/17
Rain(in.)
Avg Flow(MGD)



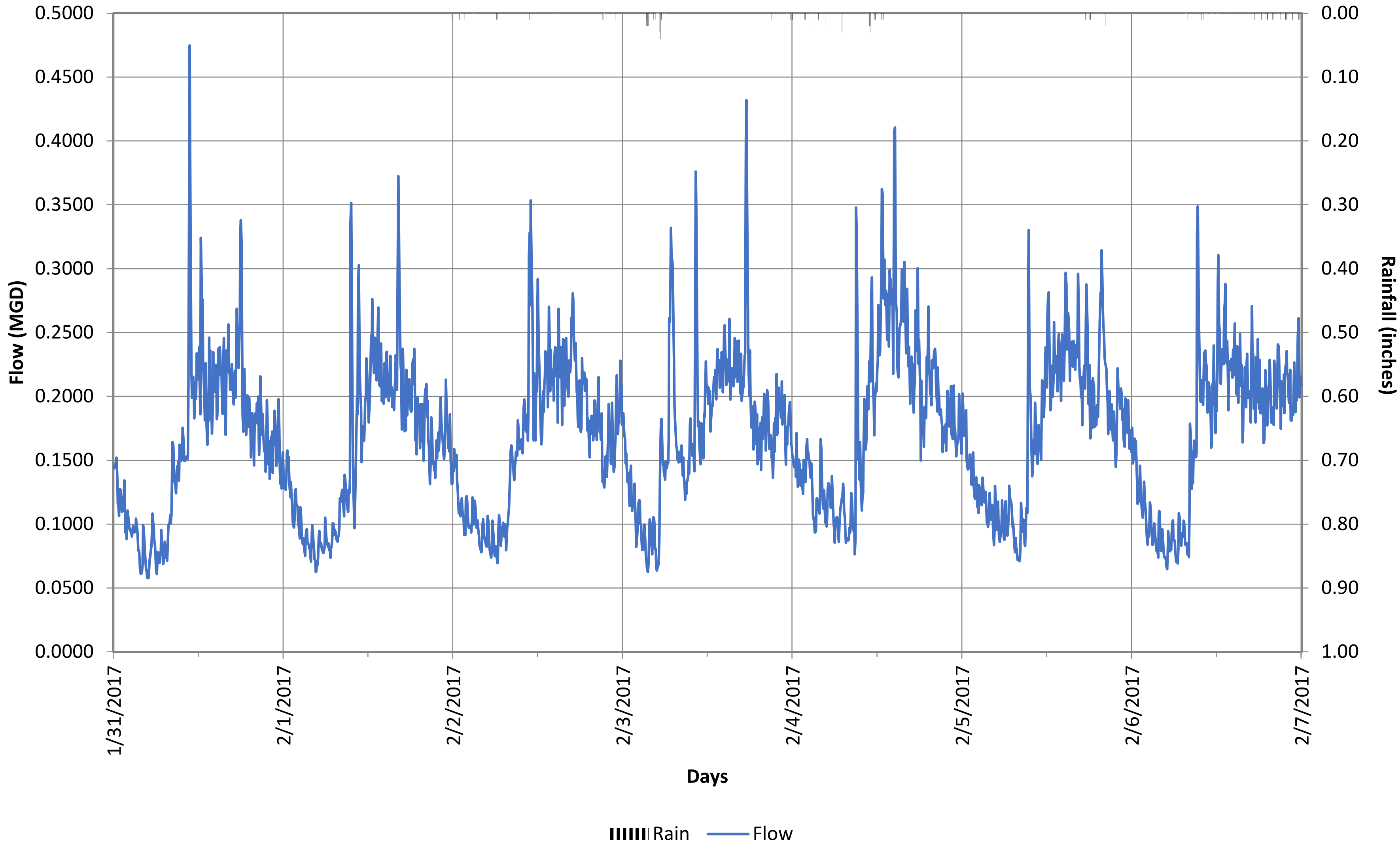
	1/17/2017(Tue)	1/18/2017(Wed)	1/19/2017(Thu)	1/20/2017(Fri)	1/21/2017(Sat)	1/22/2017(Sun)	1/23/2017(Mon)
Maximum	0.296	0.543	0.288	0.909	0.375	0.526	0.463
Average	0.098	0.176	0.162	0.205	0.184	0.197	0.185
Minimum	0.000	0.053	0.055	0.090	0.074	0.102	0.077
Rain (inches)	0.00	0.88	0.02	1.13	0.25	1.00	0.18

Colma Site 1 SSMH 10F25 Sanitary Flow Revised



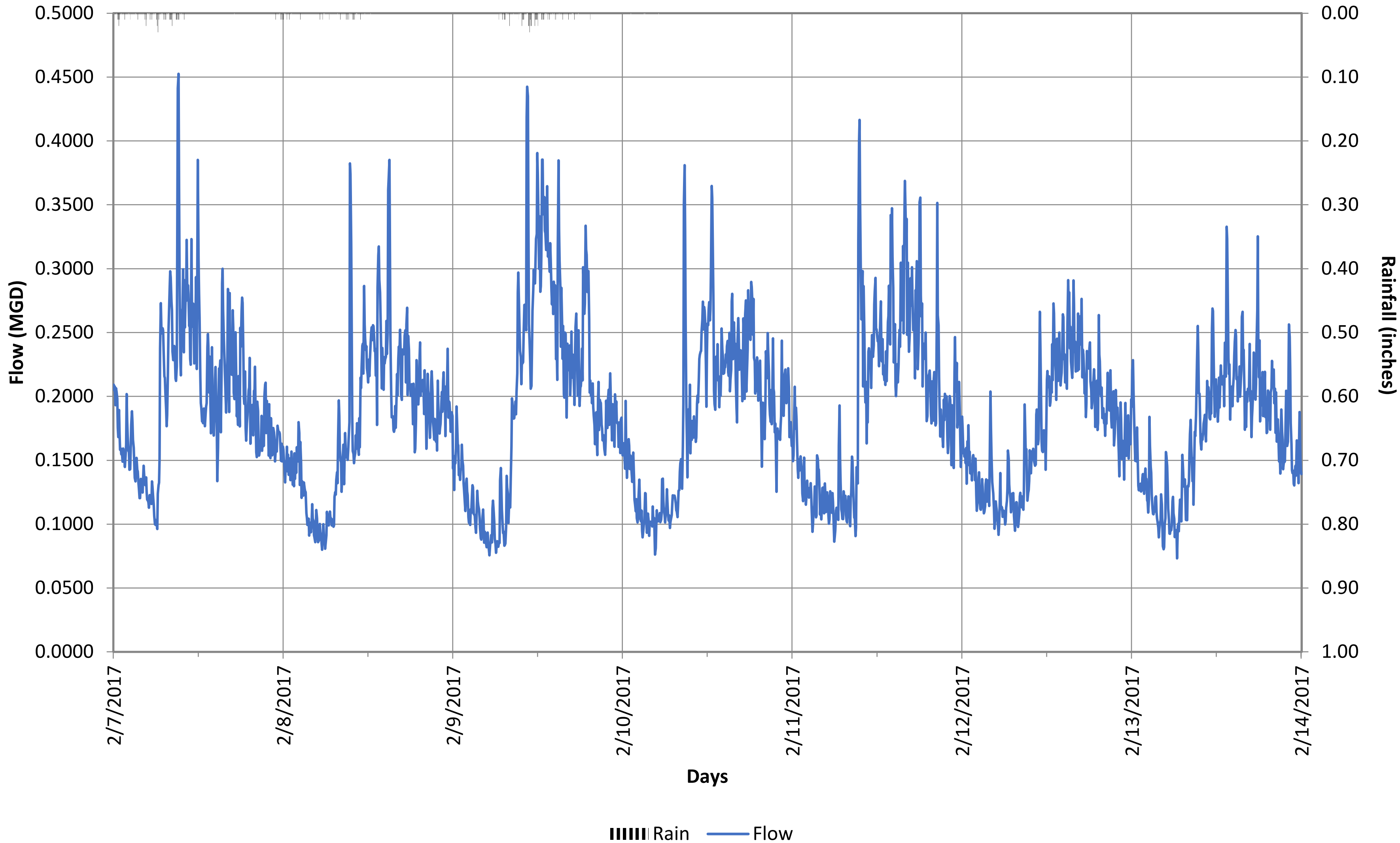
	1/24/2017(Tue)	1/25/2017(Wed)	1/26/2017(Thu)	1/27/2017(Fri)	1/28/2017(Sat)	1/29/2017(Sun)	1/30/2017(Mon)
Maximum	0.515	0.508	0.412	0.394	0.352	0.342	0.422
Average	0.174	0.164	0.164	0.166	0.172	0.160	0.161
Minimum	0.061	0.064	0.062	0.058	0.070	0.050	0.065
Rain (inches)	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Colma Site 1 SSMH 10F25 Sanitary Flow Revised



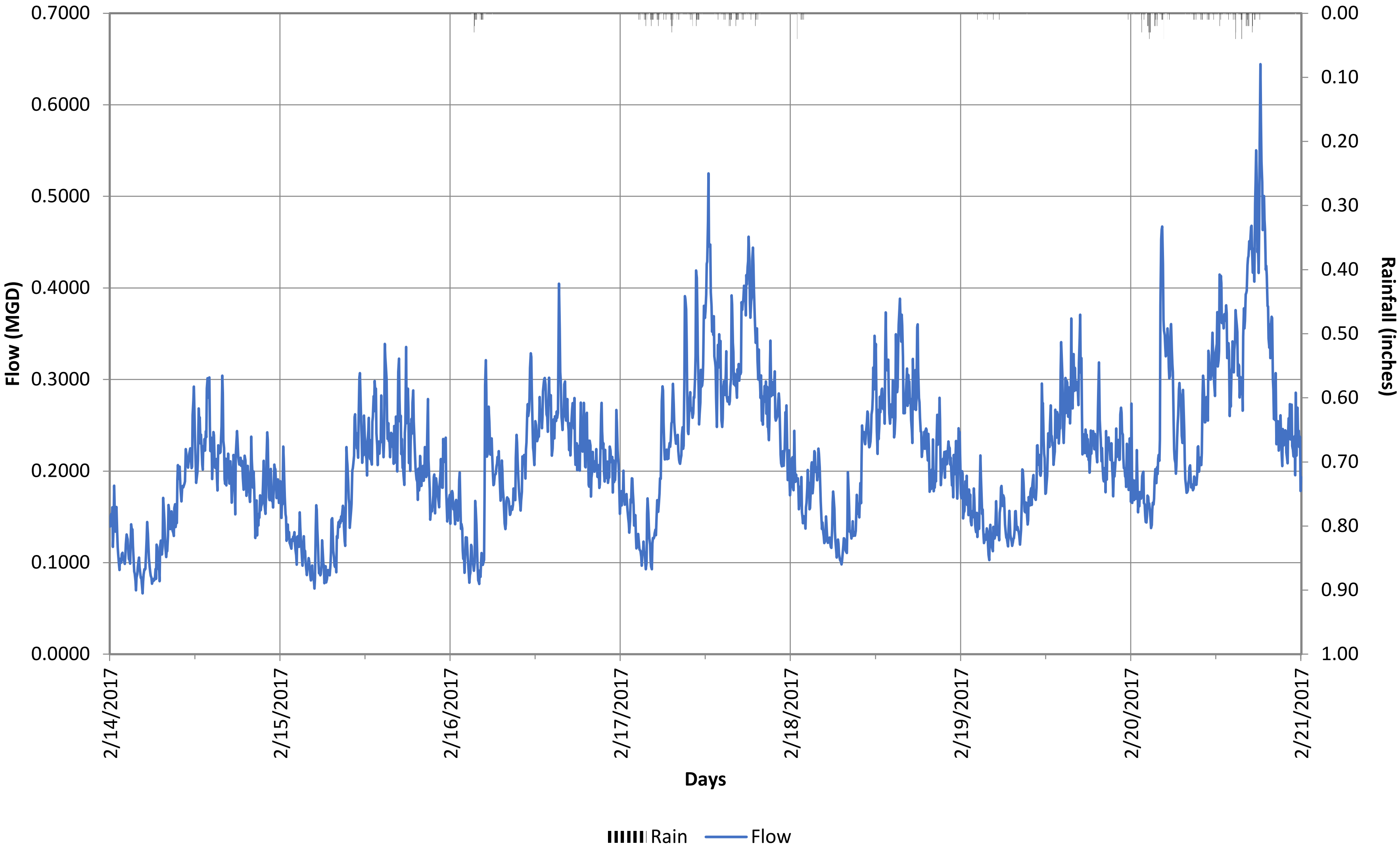
	1/31/2017(Tue)	2/1/2017(Wed)	2/2/2017(Thu)	2/3/2017(Fri)	2/4/2017(Sat)	2/5/2017(Sun)	2/6/2017(Mon)
Maximum	0.475	0.373	0.353	0.432	0.411	0.330	0.349
Average	0.161	0.159	0.165	0.175	0.183	0.174	0.172
Minimum	0.058	0.062	0.070	0.062	0.076	0.071	0.065
Rain (inches)	0.00	0.01	0.19	0.51	0.37	0.15	0.50

Colma Site 1 SSMH 10F25 Sanitary Flow Revised



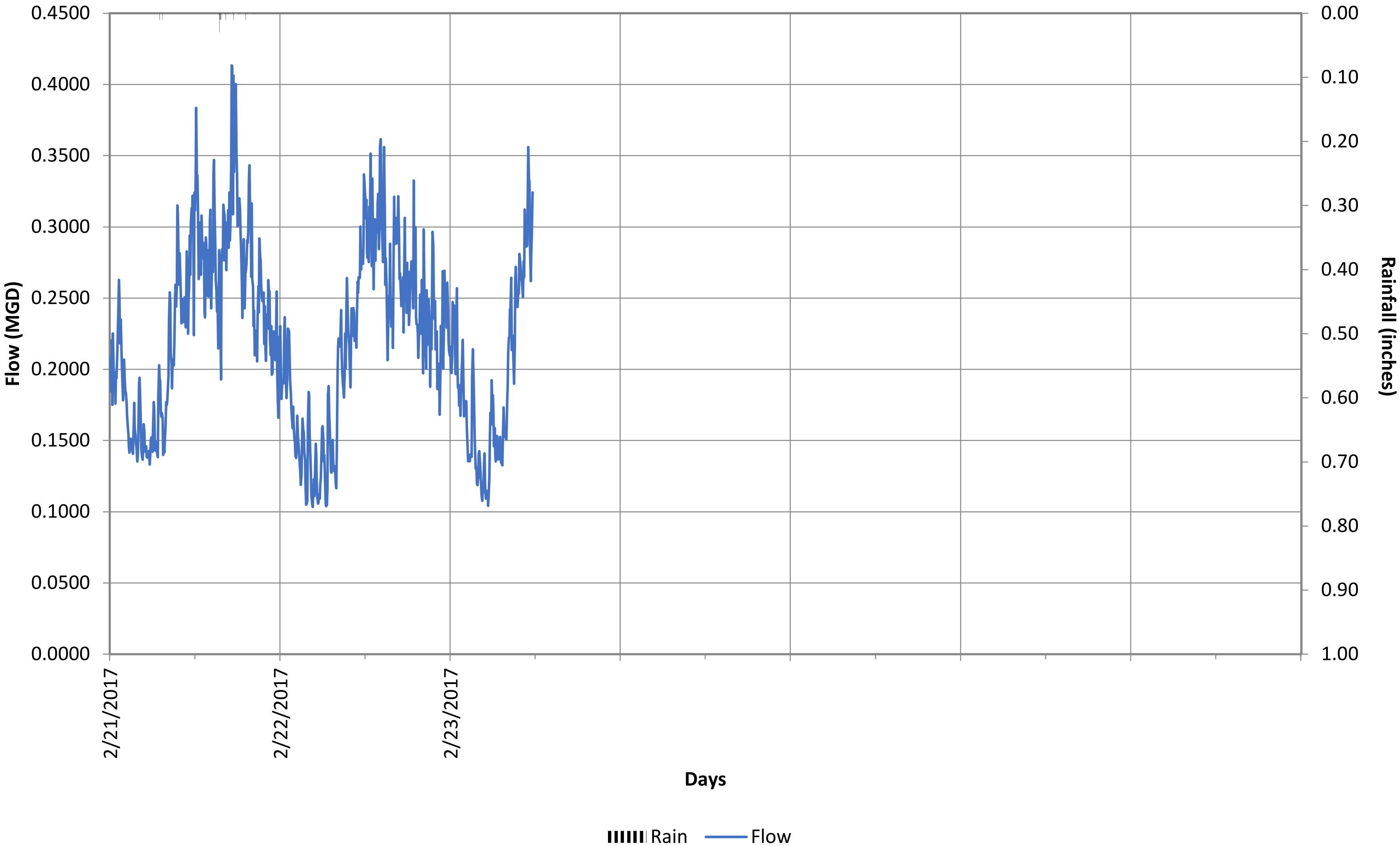
	2/7/2017(Tue)	2/8/2017(Wed)	2/9/2017(Thu)	2/10/2017(Fri)	2/11/2017(Sat)	2/12/2017(Sun)	2/13/2017(Mon)
Maximum	0.452	0.385	0.442	0.381	0.417	0.291	0.333
Average	0.199	0.180	0.198	0.184	0.194	0.173	0.172
Minimum	0.096	0.080	0.076	0.076	0.086	0.092	0.073
Rain (inches)	0.86	0.26	0.77	0.04	0.00	0.00	0.00

Colma Site 1 SSMH 10F25 Sanitary Flow Revised



	2/14/2017(Tue)	2/15/2017(Wed)	2/16/2017(Thu)	2/17/2017(Fri)	2/18/2017(Sat)	2/19/2017(Sun)	2/20/2017(Mon)
Maximum	0.304	0.339	0.405	0.525	0.388	0.371	0.644
Average	0.169	0.183	0.207	0.263	0.214	0.201	0.289
Minimum	0.066	0.072	0.077	0.093	0.098	0.103	0.138
Rain (inches)	0.00	0.00	0.39	1.23	0.14	0.08	1.61

Colma Site 1 SSMH 10F25 Sanitary Flow Revised

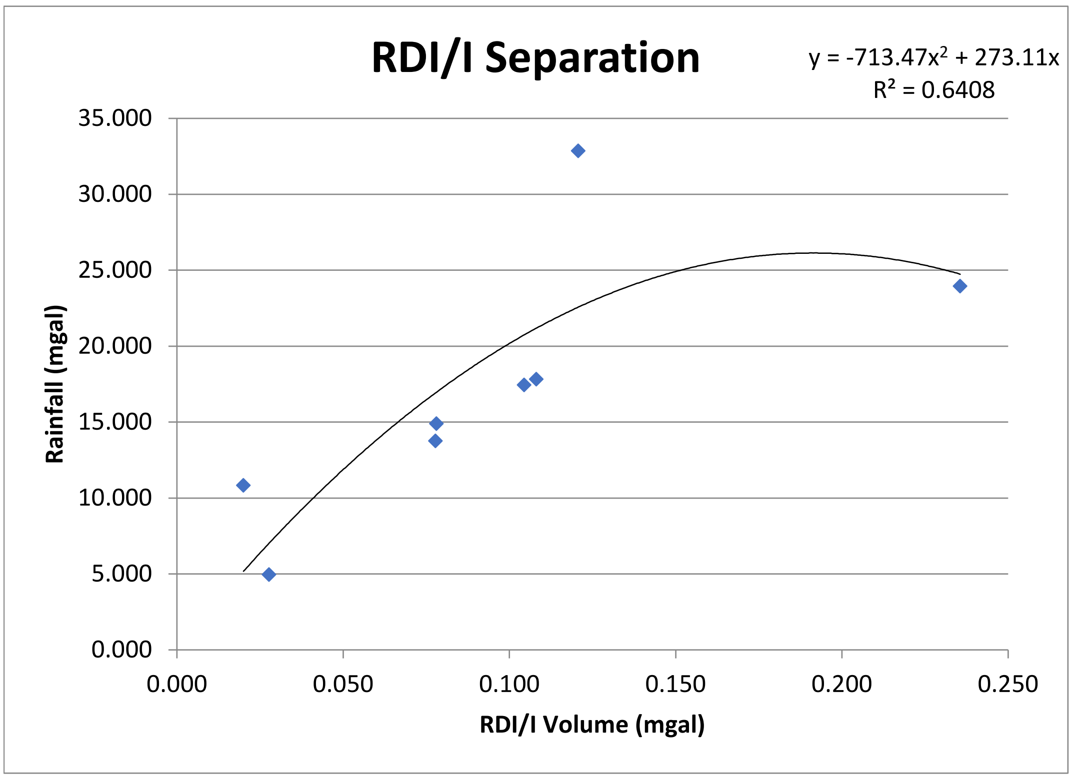


	2/21/2017(Tue)	2/22/2017(Wed)					
Maximum	0.413	0.362					
Average	0.235	0.220					
Minimum	0.133	0.103					
Rain (inches)	0.19	0.00					

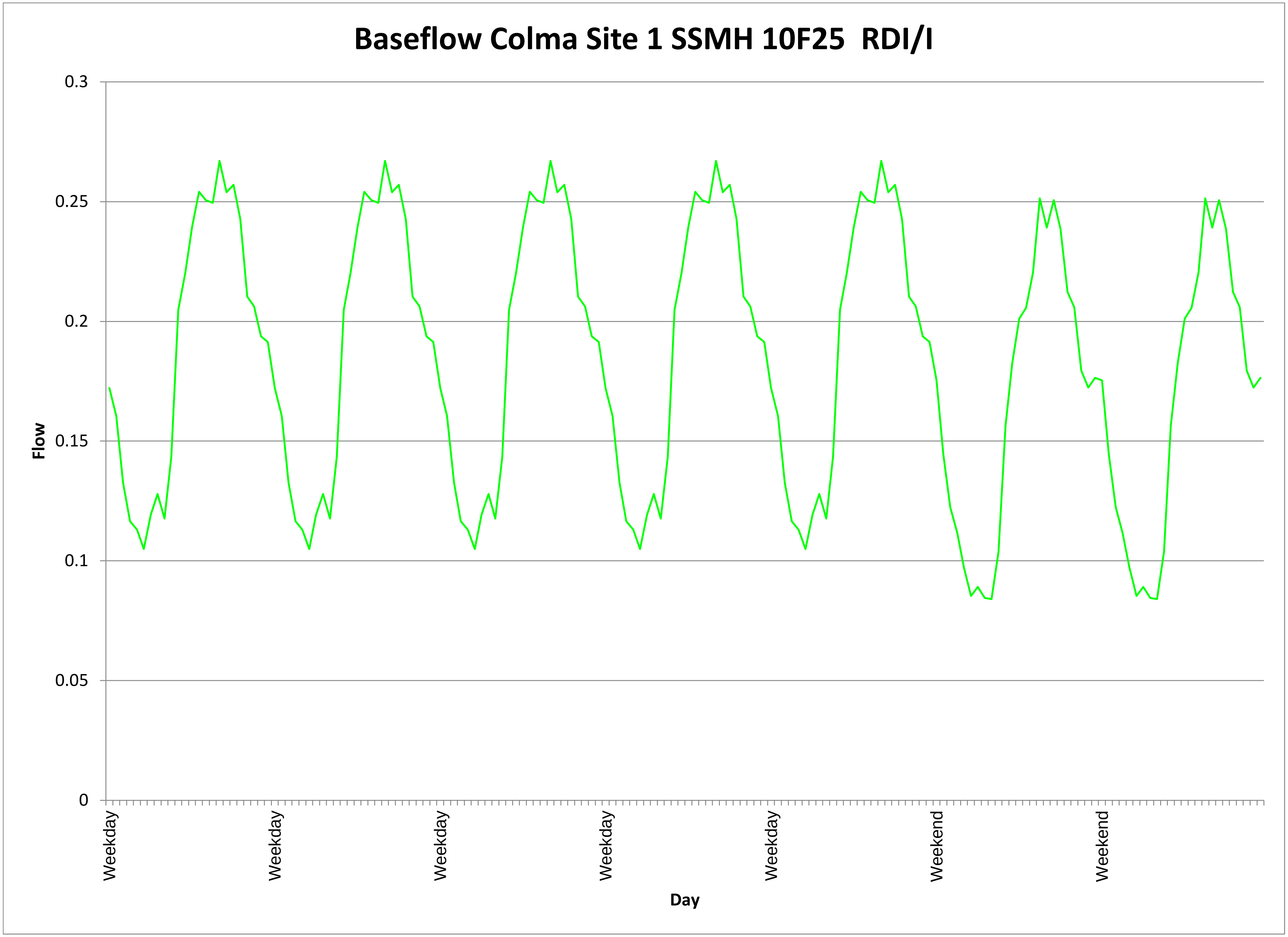
Colma Site 1 SSMH 10F25 RDI/I

RDI/I Analysis, Monitor Return Ratio Summary

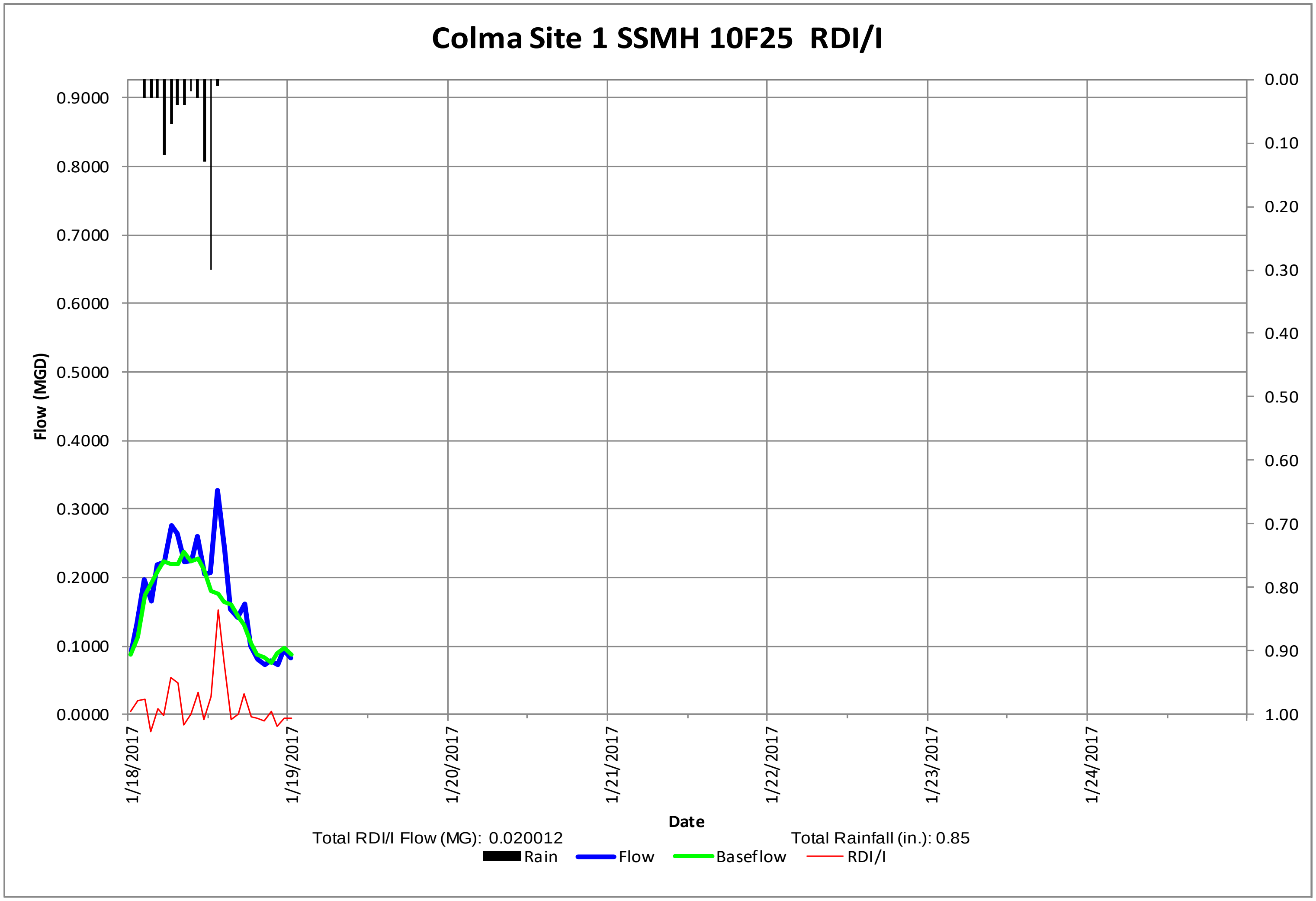
Storm Start (Date)	RDI/I Volume (mgal)	Monitor Area (acres)	Rainfall (mgal)	Return Ratio (%)
1/18/2017	0.020	469.2	10.829	0.18%
1/20/2017	0.078	469.2	14.906	0.52%
1/21/2017	0.108	469.2	17.836	0.61%
2/2/2017	0.078	469.2	13.759	0.57%
2/5/2017	0.121	469.2	32.869	0.37%
2/16/2017	0.028	469.2	4.969	0.56%
2/17/2017	0.104	469.2	17.454	0.60%
2/19/2017	0.236	469.2	23.951	0.98%
Average R%				0.55%
Average R% of top 3 R%				0.79%



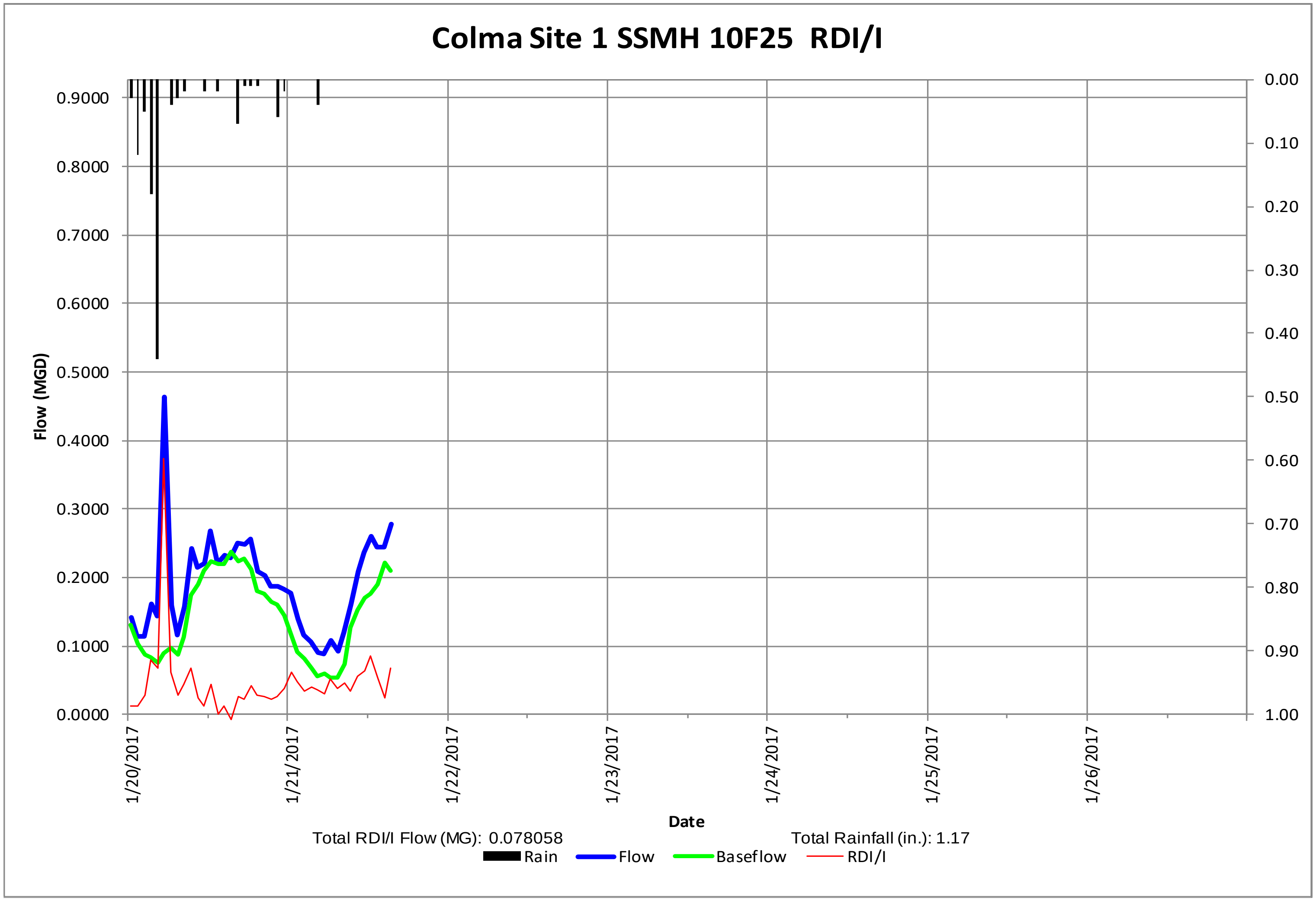
Baseflows	Weekend	Weekday
Max	0.251	0.267
Avg	0.166	0.190
Min	0.084	0.105



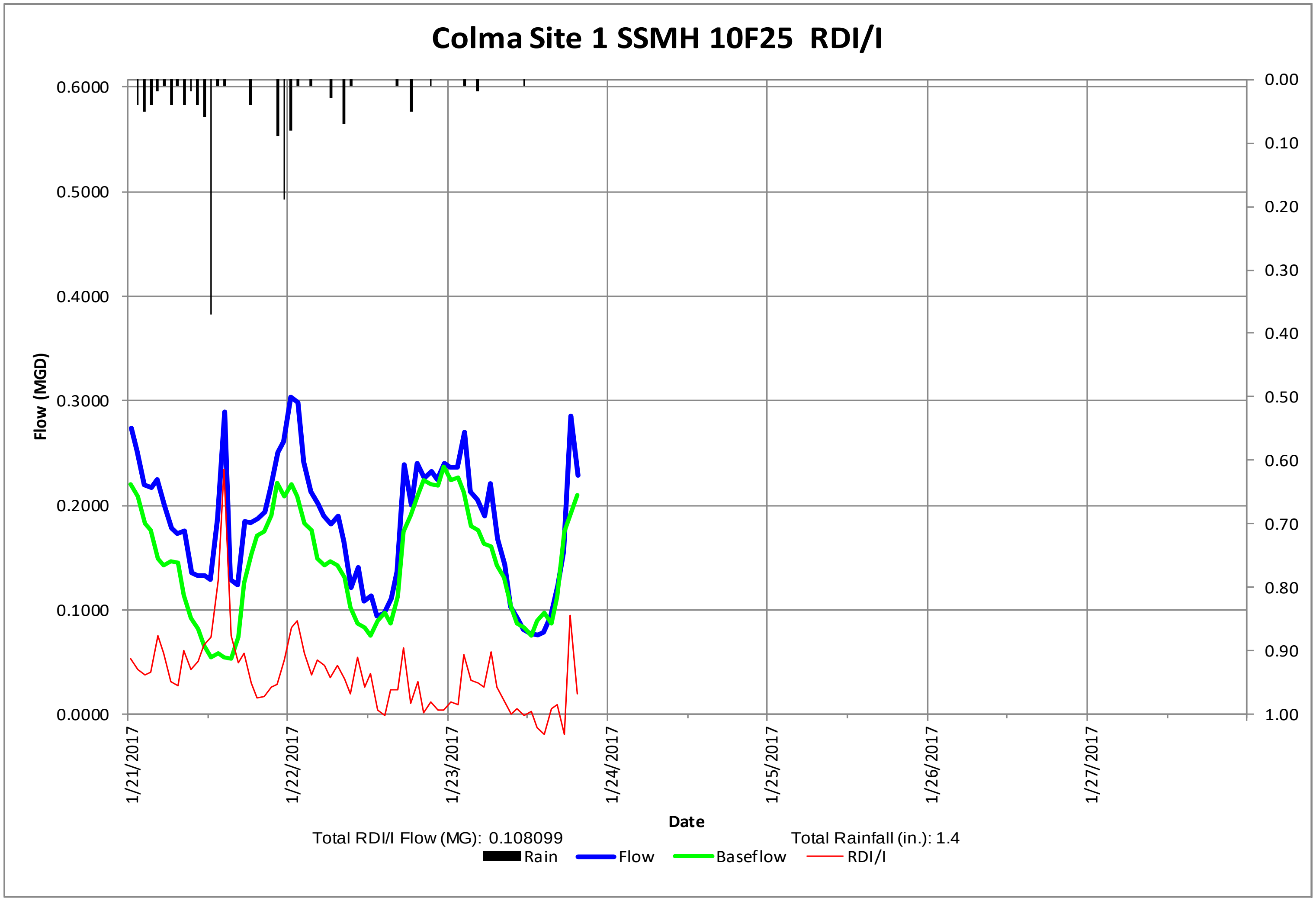
Baseflow Colma Site 1 SSMH 10F25 RDI/I
Flow
0.3
0.25
0.2
0.15
0.1
0.05
0
Weekday
Weekday
Weekday
Weekday
Weekday
Weekend
Weekend
Day



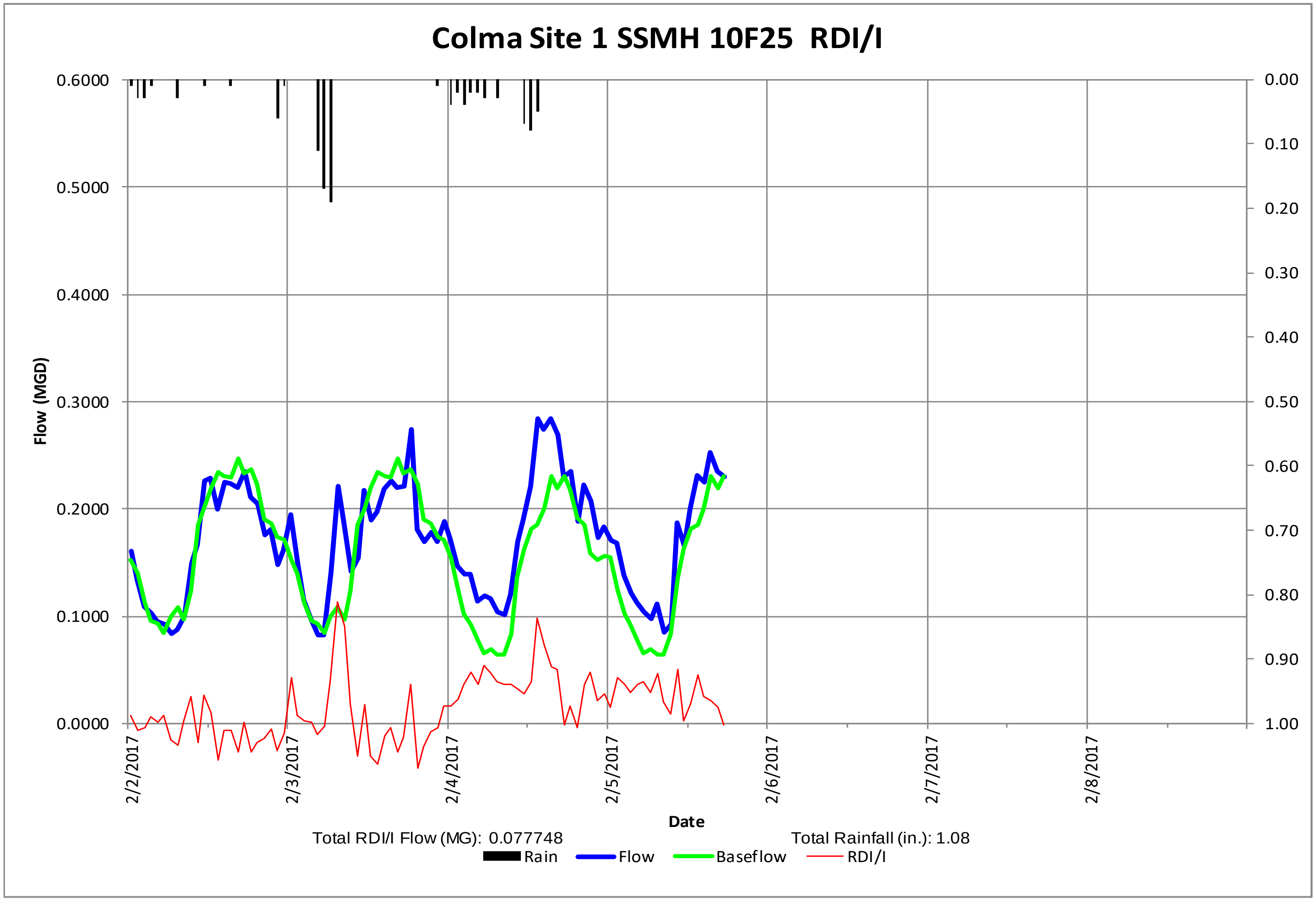
Storm of 1/18/2017



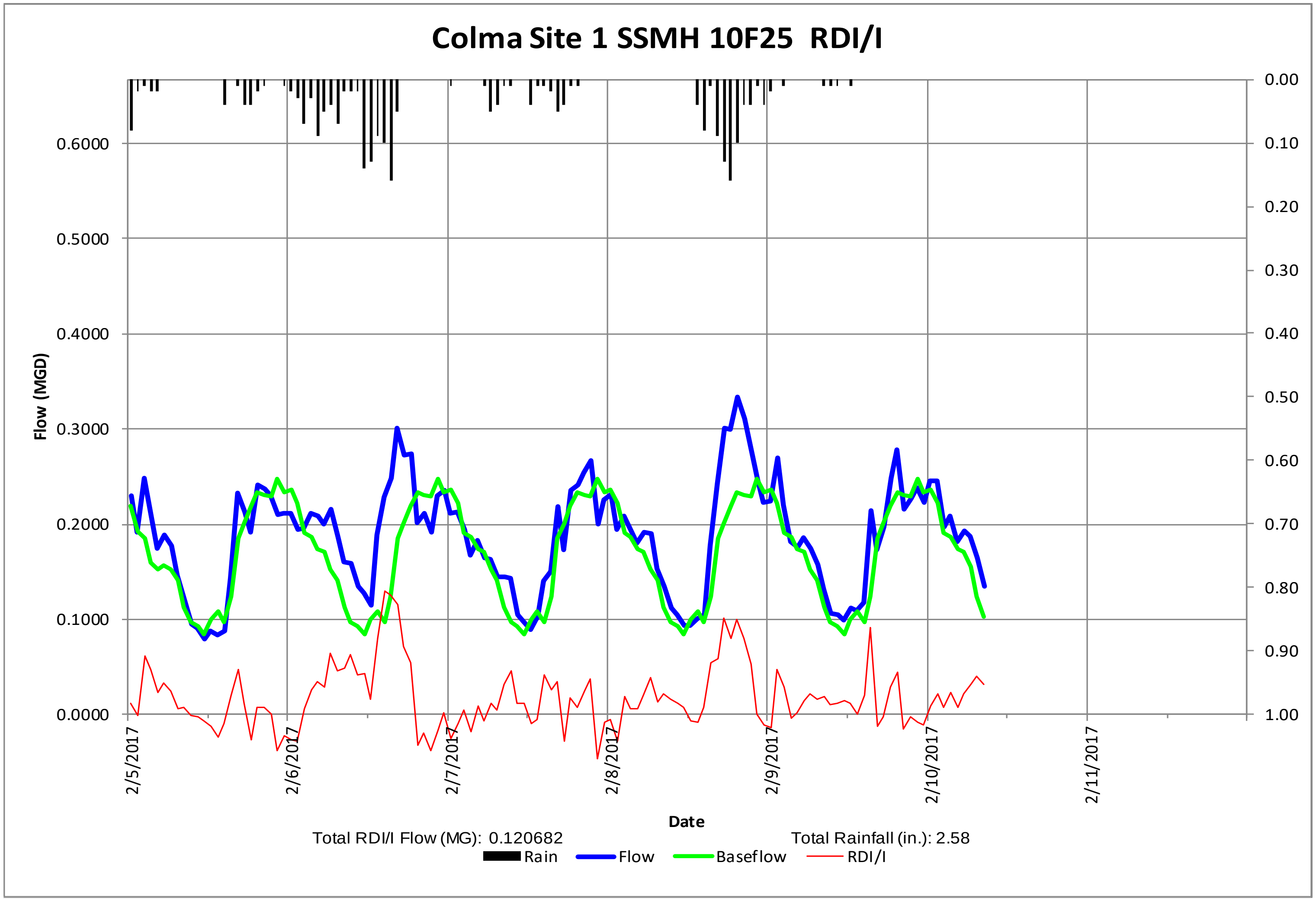
Storm of 1/20/2017



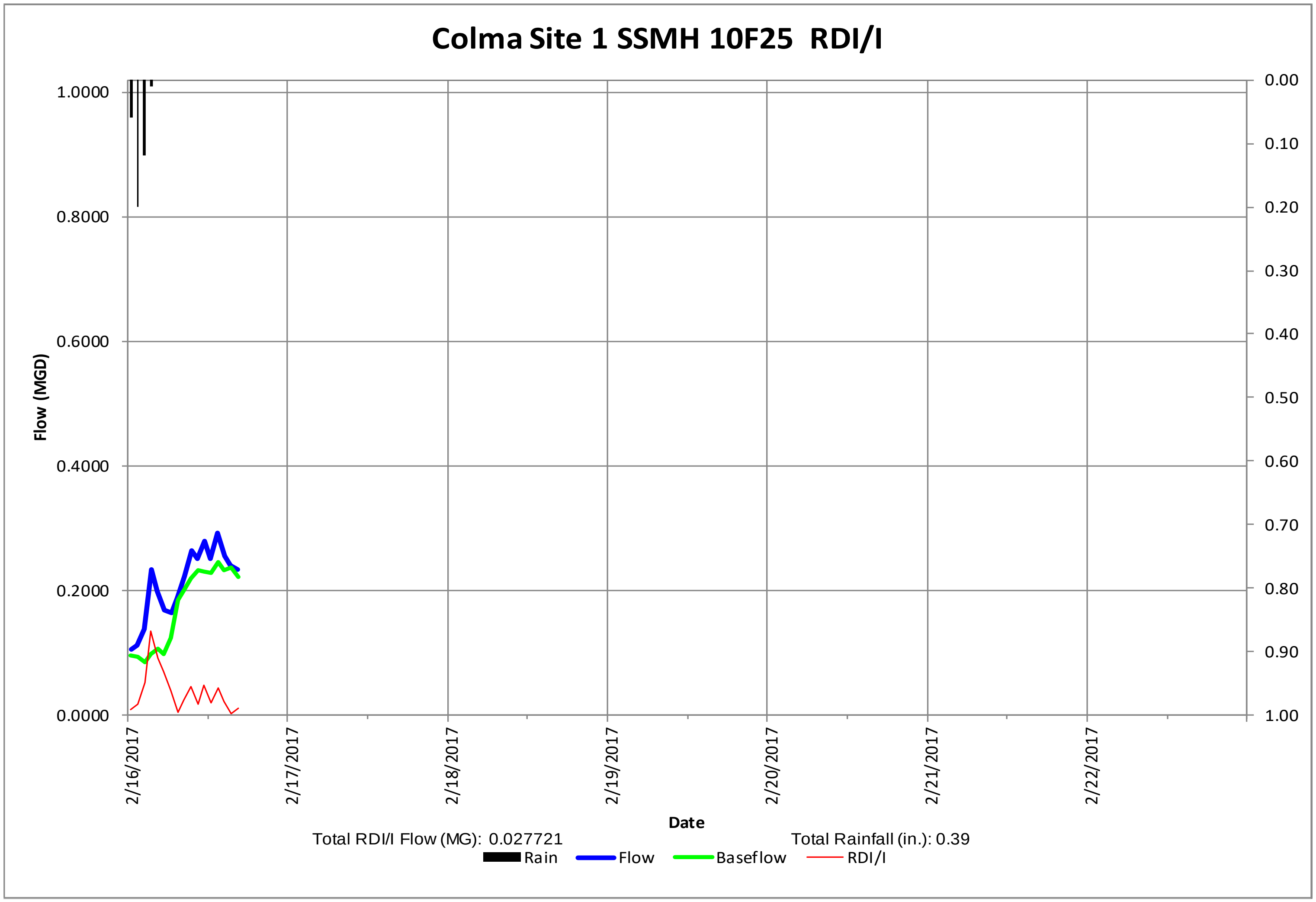
Storm of 1/21/2017



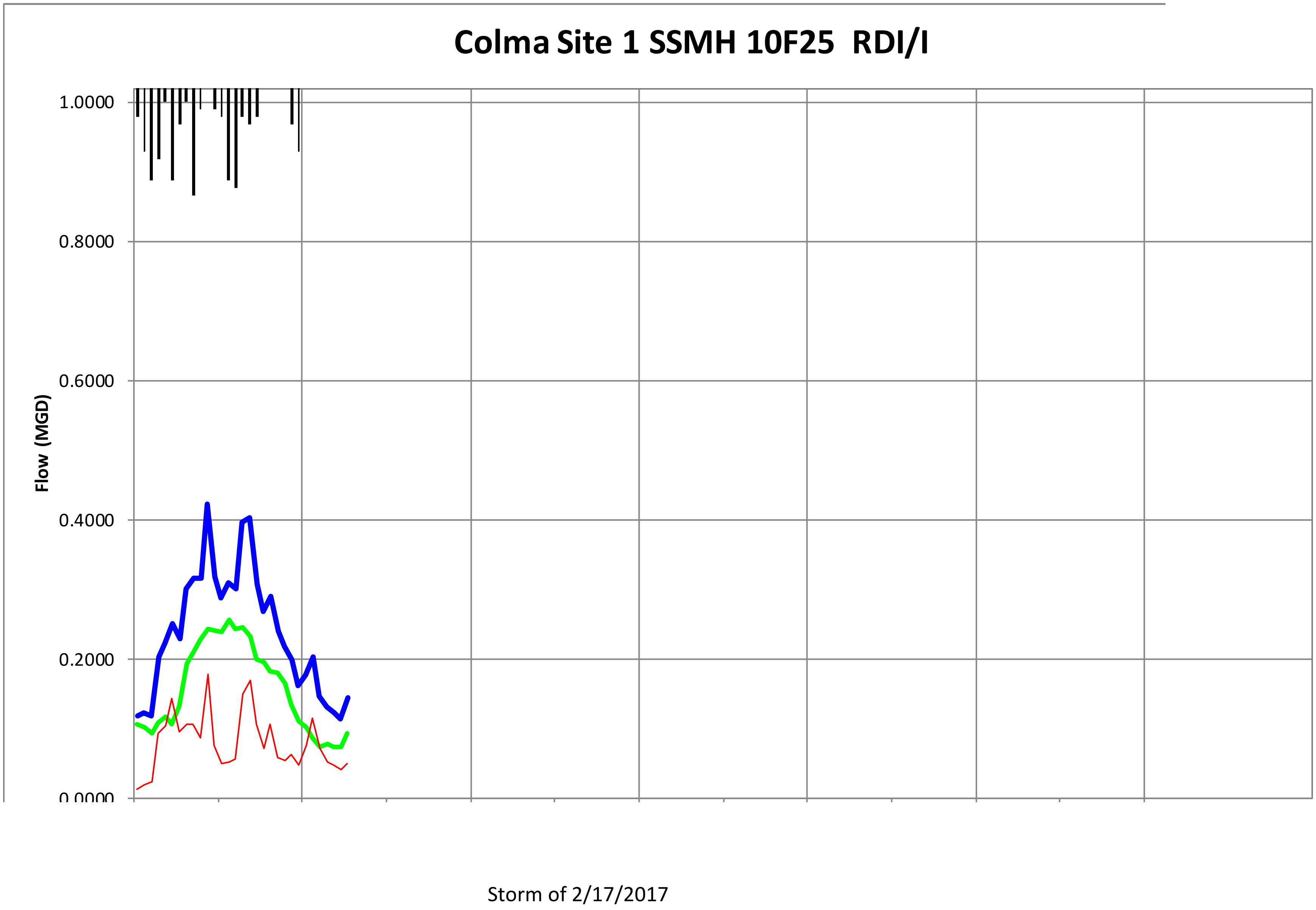
Storm of 2/2/2017

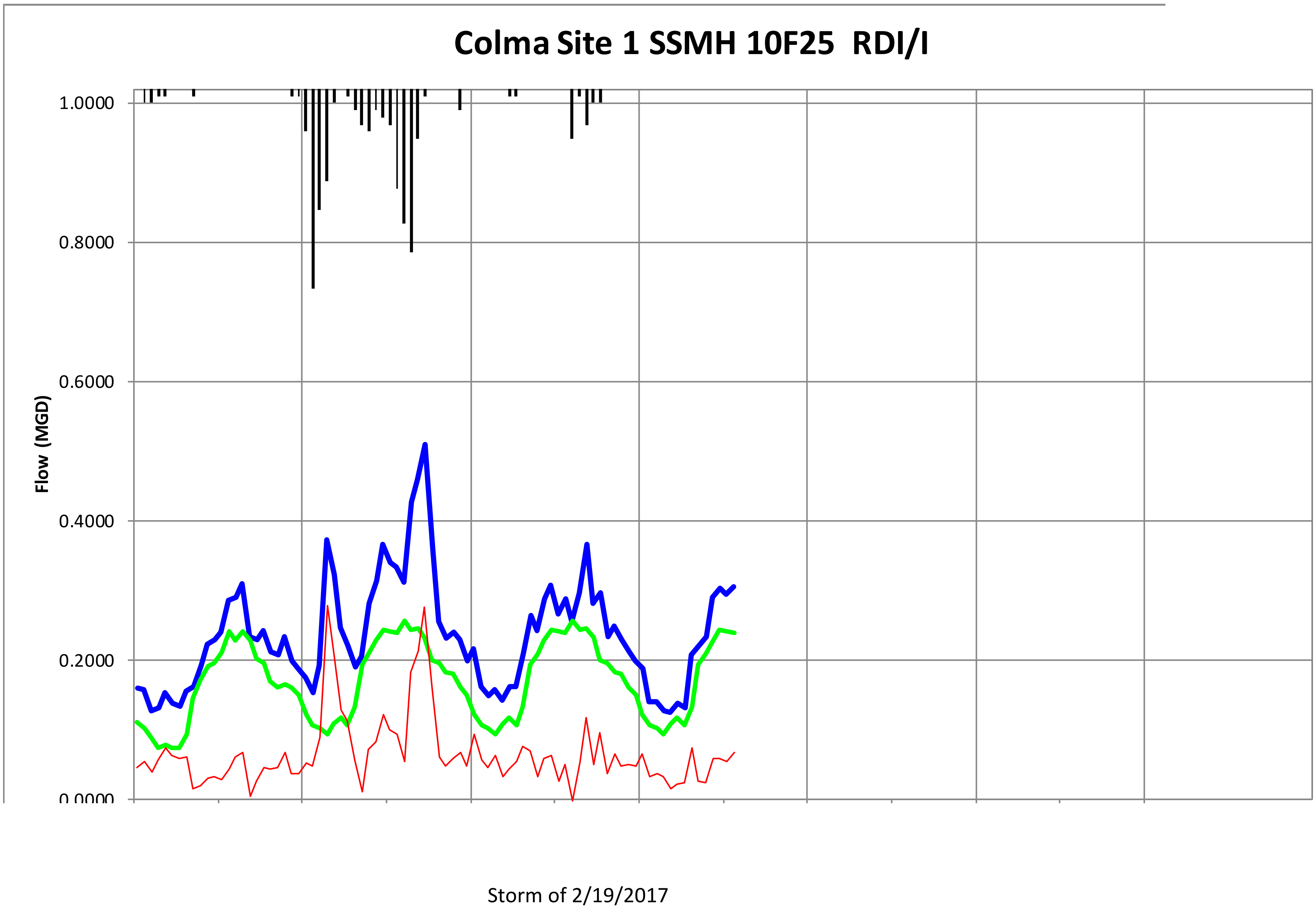


Storm of 2/5/2017



Storm of 2/16/2017


Colma Site 1 SSMH 10F25 RDI/I
1.0000
0.8000
0.6000
0.4000
0.2000
0.0000
Flow (MGD)
Storm of 2/17/2017


Colma Site 1 SSMH 10F25 RDI/I
1.0000
0.8000
0.6000
0.4000
0.2000
0.0000
Flow (MGD)
Storm of 2/19/2017

Site Information Report

Flow Monitor Site: 2

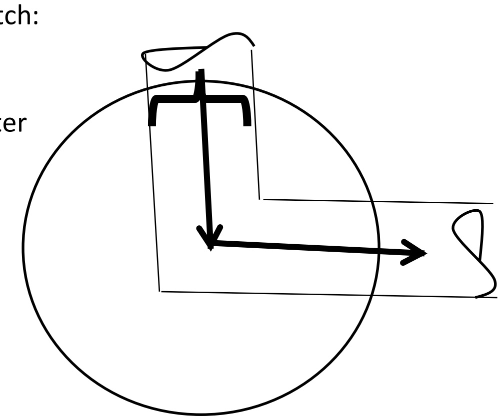
Manhole Number SSMH 9F61
Location: Junipero Serra Blvd. MH Depth ~4'
Diameter: 6"
Safety: Ok
Traffic: None
Gas: Ok
Rungs: No
Meter Type: Hach FL900
Depth: 0.75"
Velocity: Doppler 3 ft./sec
Meter Type FloDar

Ariel View:

City Sewer Map:

Flow Sketch:

Flow Meter



6-inch Pipe

Surface View:

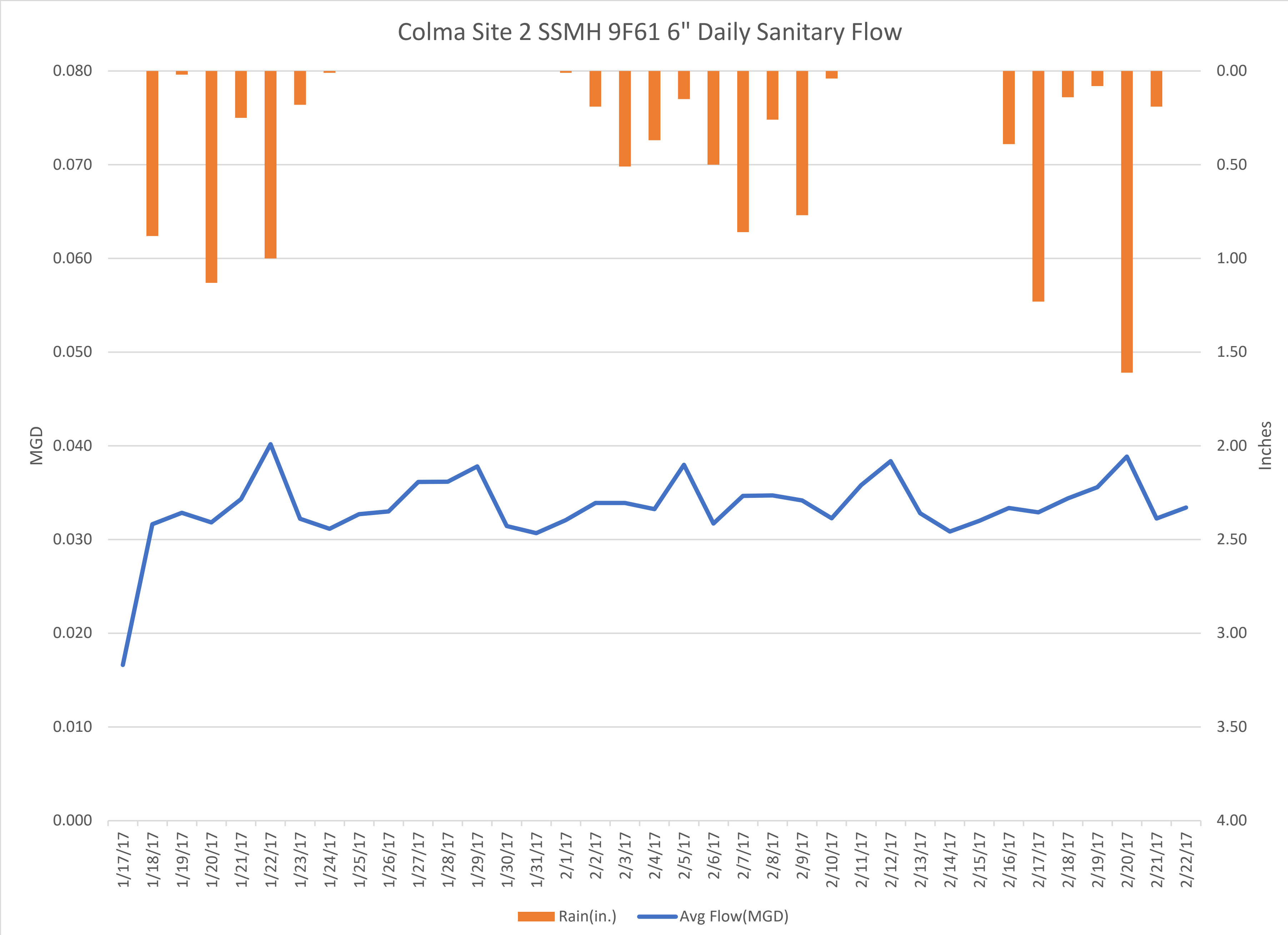
Invert View:

Outlet Pipe:	Inlet Pipe:
	

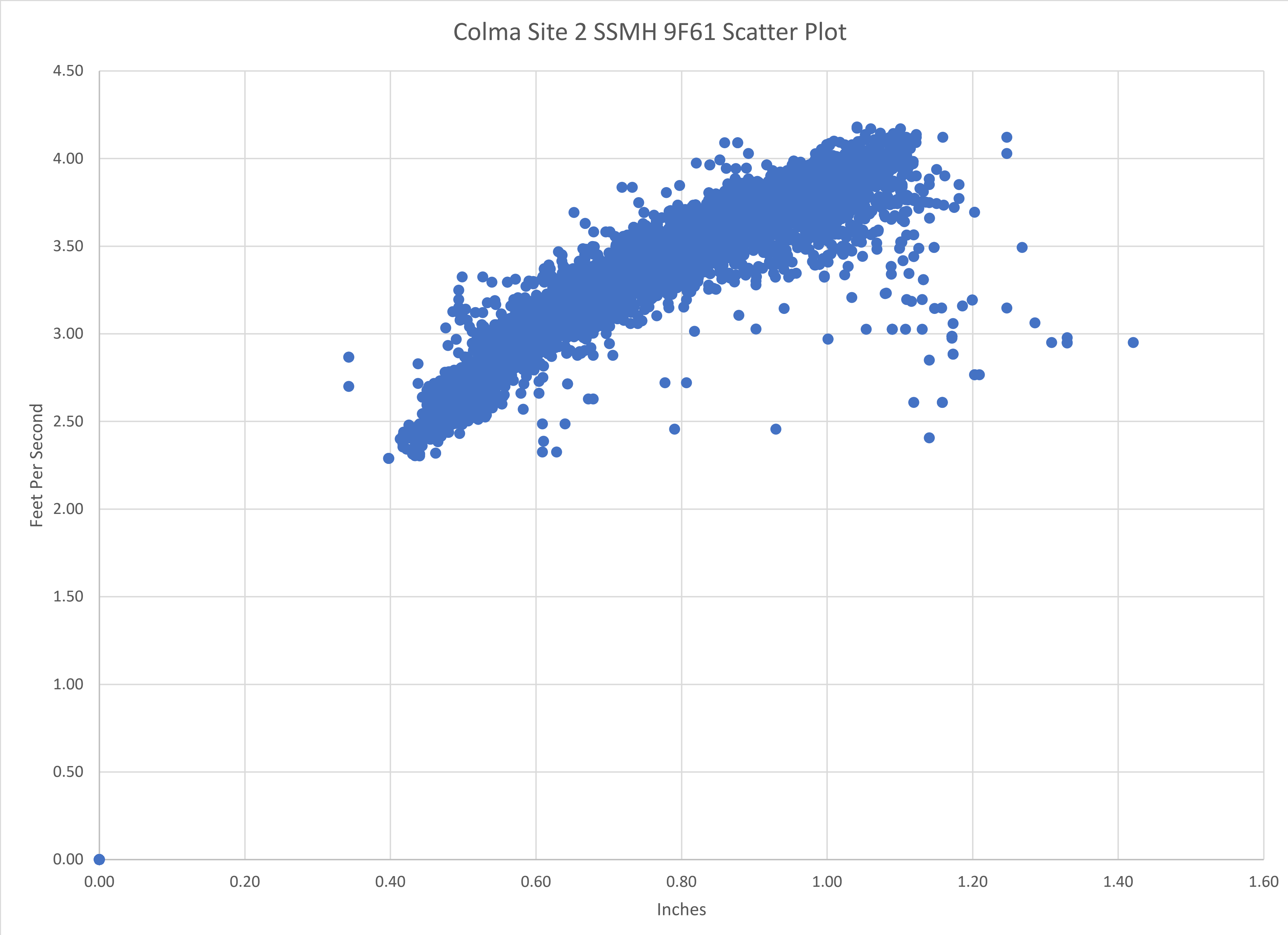
Colma Site 2 SSMH 9F61 6" Sanitary Flow

Daily Summary

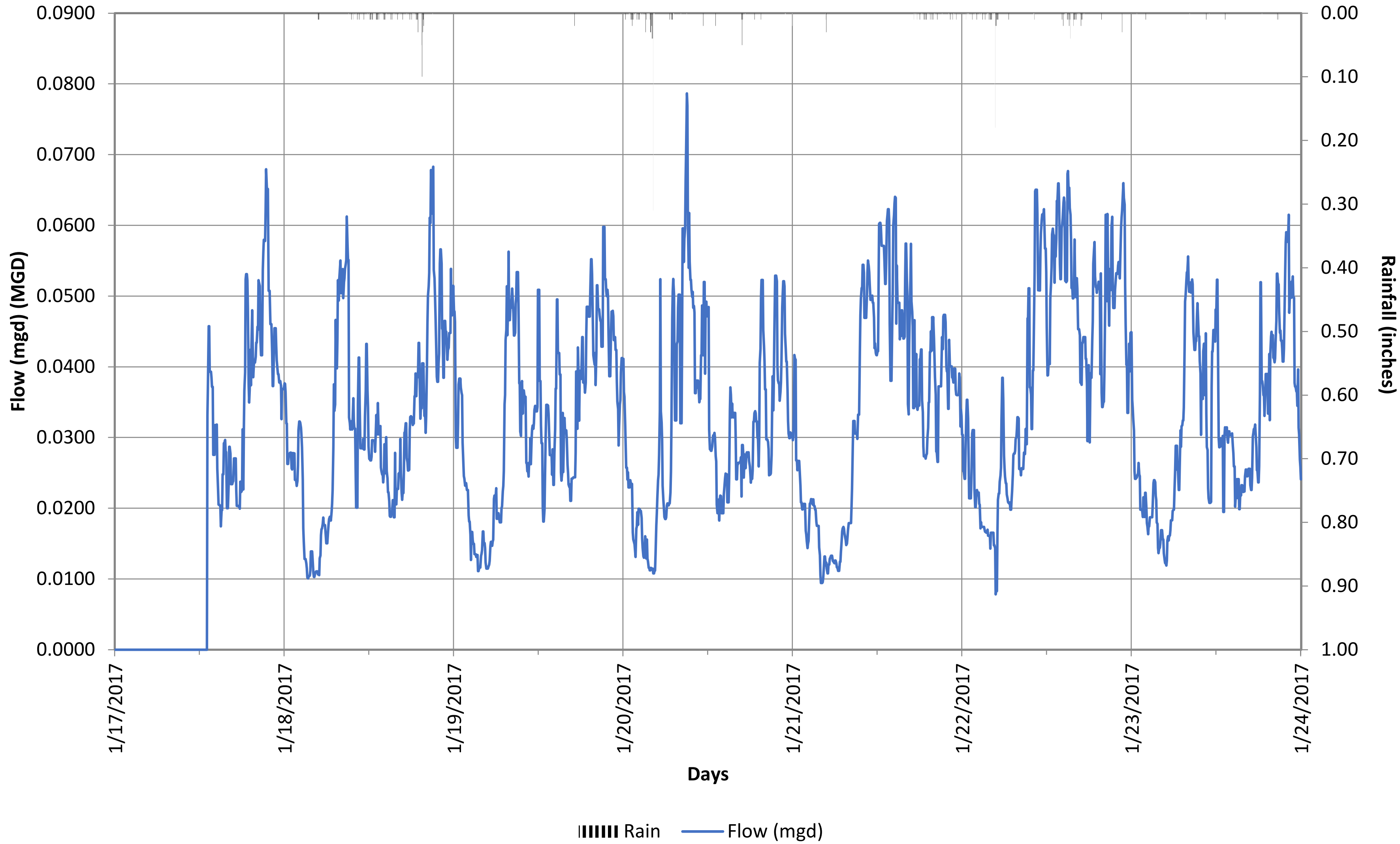
Day	Date	Avg Flow(MGD)	Min Flow(MGD)	Max Flow(MGD)	Max Depth(in.)	Rain(in.)
Tuesday	1/17/17	0.017	0.000	0.068	1.123	0.00
Wednesday	1/18/17	0.032	0.010	0.068	1.421	0.88
Thursday	1/19/17	0.033	0.011	0.060	1.051	0.02
Friday	1/20/17	0.032	0.011	0.079	1.247	1.13
Saturday	1/21/17	0.034	0.009	0.064	1.103	0.25
Sunday	1/22/17	0.040	0.008	0.068	1.172	1.00
Monday	1/23/17	0.032	0.012	0.061	1.199	0.18
Tuesday	1/24/17	0.031	0.008	0.057	1.043	0.01
Wednesday	1/25/17	0.033	0.012	0.062	1.147	0.00
Thursday	1/26/17	0.033	0.012	0.067	1.150	0.00
Friday	1/27/17	0.036	0.011	0.060	1.054	0.00
Saturday	1/28/17	0.036	0.012	0.066	1.109	0.00
Sunday	1/29/17	0.038	0.011	0.065	1.186	0.00
Monday	1/30/17	0.031	0.012	0.060	1.046	0.00
Tuesday	1/31/17	0.031	0.011	0.063	1.132	0.00
Wednesday	2/1/17	0.032	0.010	0.067	1.209	0.01
Thursday	2/2/17	0.034	0.012	0.065	1.141	0.19
Friday	2/3/17	0.034	0.009	0.064	1.106	0.51
Saturday	2/4/17	0.033	0.010	0.057	1.052	0.37
Sunday	2/5/17	0.038	0.012	0.067	1.114	0.15
Monday	2/6/17	0.032	0.008	0.059	1.065	0.50
Tuesday	2/7/17	0.035	0.014	0.063	1.119	0.86
Wednesday	2/8/17	0.035	0.010	0.064	1.111	0.26
Thursday	2/9/17	0.034	0.010	0.063	1.080	0.77
Friday	2/10/17	0.032	0.011	0.060	1.062	0.04
Saturday	2/11/17	0.036	0.010	0.067	1.119	0.00
Sunday	2/12/17	0.038	0.009	0.067	1.122	0.00
Monday	2/13/17	0.033	0.011	0.062	1.080	0.00
Tuesday	2/14/17	0.031	0.009	0.057	1.045	0.00
Wednesday	2/15/17	0.032	0.011	0.059	1.055	0.00
Thursday	2/16/17	0.033	0.009	0.057	1.040	0.39
Friday	2/17/17	0.033	0.011	0.058	1.071	1.23
Saturday	2/18/17	0.034	0.009	0.065	1.091	0.14
Sunday	2/19/17	0.036	0.009	0.067	1.103	0.08
Monday	2/20/17	0.039	0.015	0.068	1.181	1.61
Tuesday	2/21/17	0.032	0.011	0.059	1.047	0.19
Wednesday	2/22/17	0.033	0.012	0.057	1.031	0.00



Colma Site 2 SSMH 9F61 6" Daily Sanitary Flow
MGD
Inches
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
1/17/17
1/18/17
1/19/17
1/20/17
1/21/17
1/22/17
1/23/17
1/24/17
1/25/17
1/26/17
1/27/17
1/28/17
1/29/17
1/30/17
1/31/17
2/1/17
2/2/17
2/3/17
2/4/17
2/5/17
2/6/17
2/7/17
2/8/17
2/9/17
2/10/17
2/11/17
2/12/17
2/13/17
2/14/17
2/15/17
2/16/17
2/17/17
2/18/17
2/19/17
2/20/17
2/21/17
2/22/17
Rain(in.)
Avg Flow(MGD)

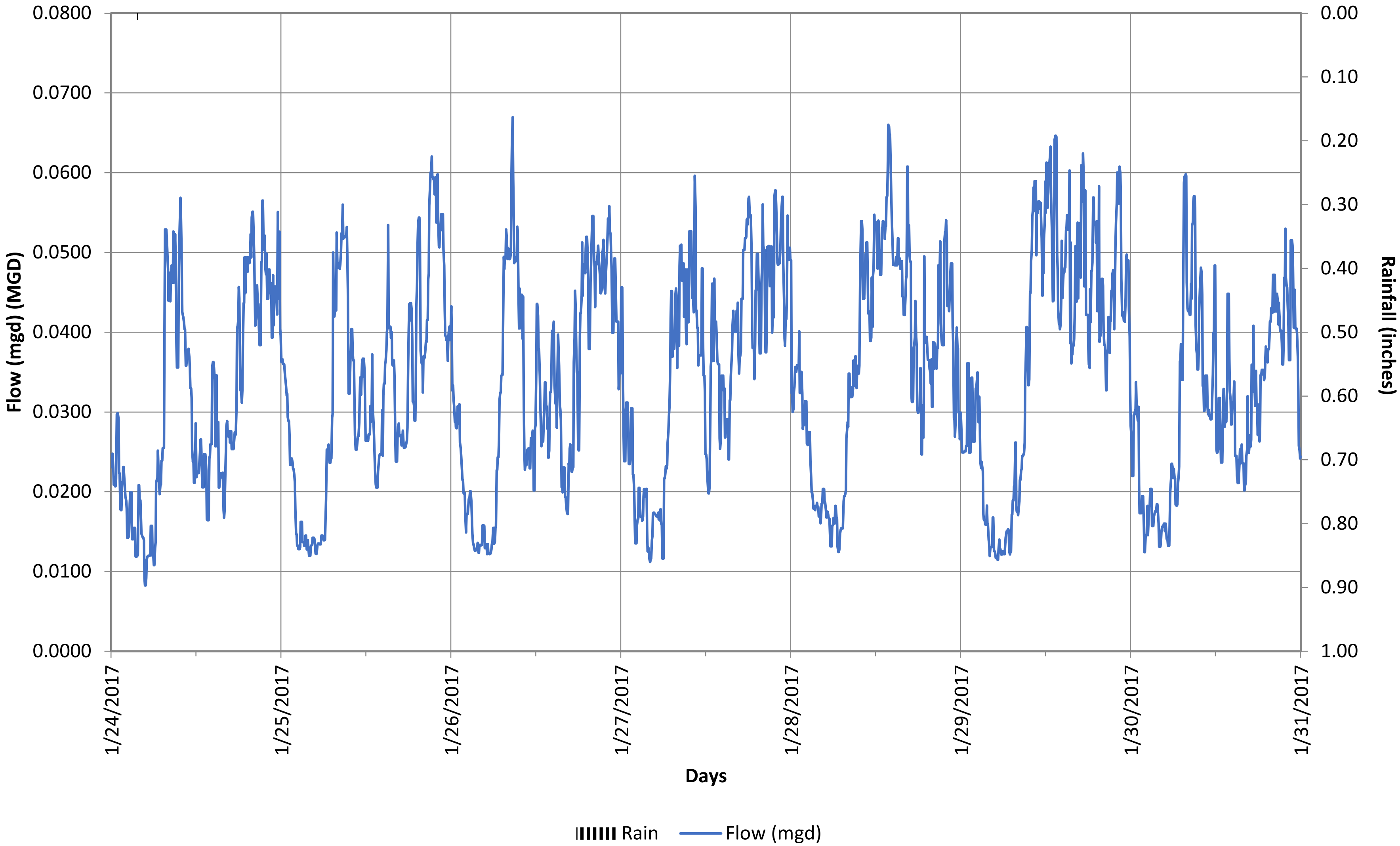

Colma Site 2 SSMH 9F61 Scatter Plot
Feet Per Second
Inches
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60

Colma Site 2 SSMH 9F61 6" Sanitary Flow



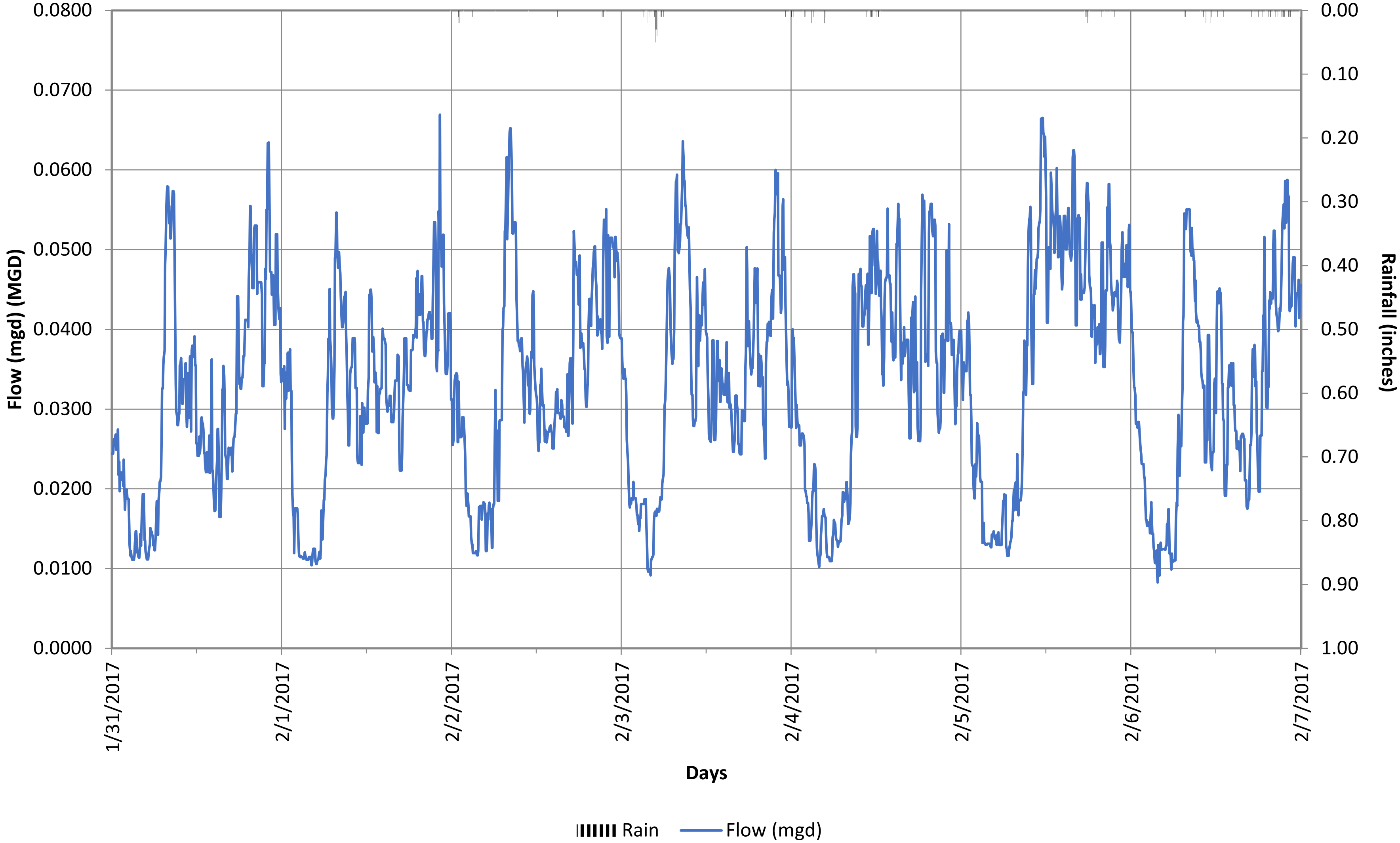
	1/17/2017(Tue)	1/18/2017(Wed)	1/19/2017(Thu)	1/20/2017(Fri)	1/21/2017(Sat)	1/22/2017(Sun)	1/23/2017(Mon)
Maximum	0.068	0.068	0.060	0.079	0.064	0.068	0.061
Average	0.017	0.032	0.033	0.032	0.034	0.040	0.032
Minimum	0.000	0.010	0.011	0.011	0.009	0.008	0.012
Rain (inches)	0.00	0.88	0.02	1.13	0.25	1.00	0.18

Colma Site 2 SSMH 9F61 6" Sanitary Flow



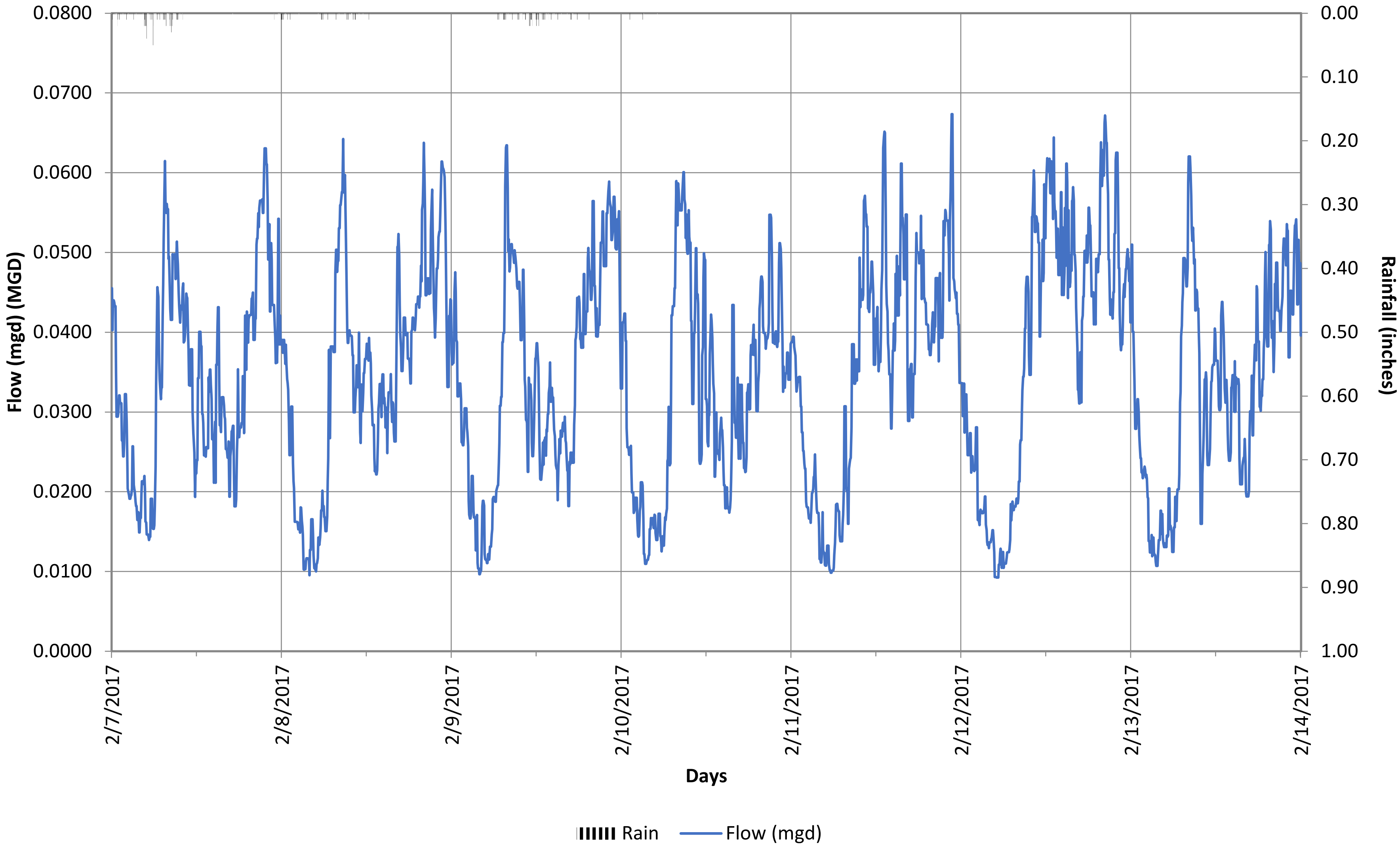
	1/24/2017(Tue)	1/25/2017(Wed)	1/26/2017(Thu)	1/27/2017(Fri)	1/28/2017(Sat)	1/29/2017(Sun)	1/30/2017(Mon)
Maximum	0.057	0.062	0.067	0.060	0.066	0.065	0.060
Average	0.031	0.033	0.033	0.036	0.036	0.038	0.031
Minimum	0.008	0.012	0.012	0.011	0.012	0.011	0.012
Rain (inches)	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Colma Site 2 SSMH 9F61 6" Sanitary Flow

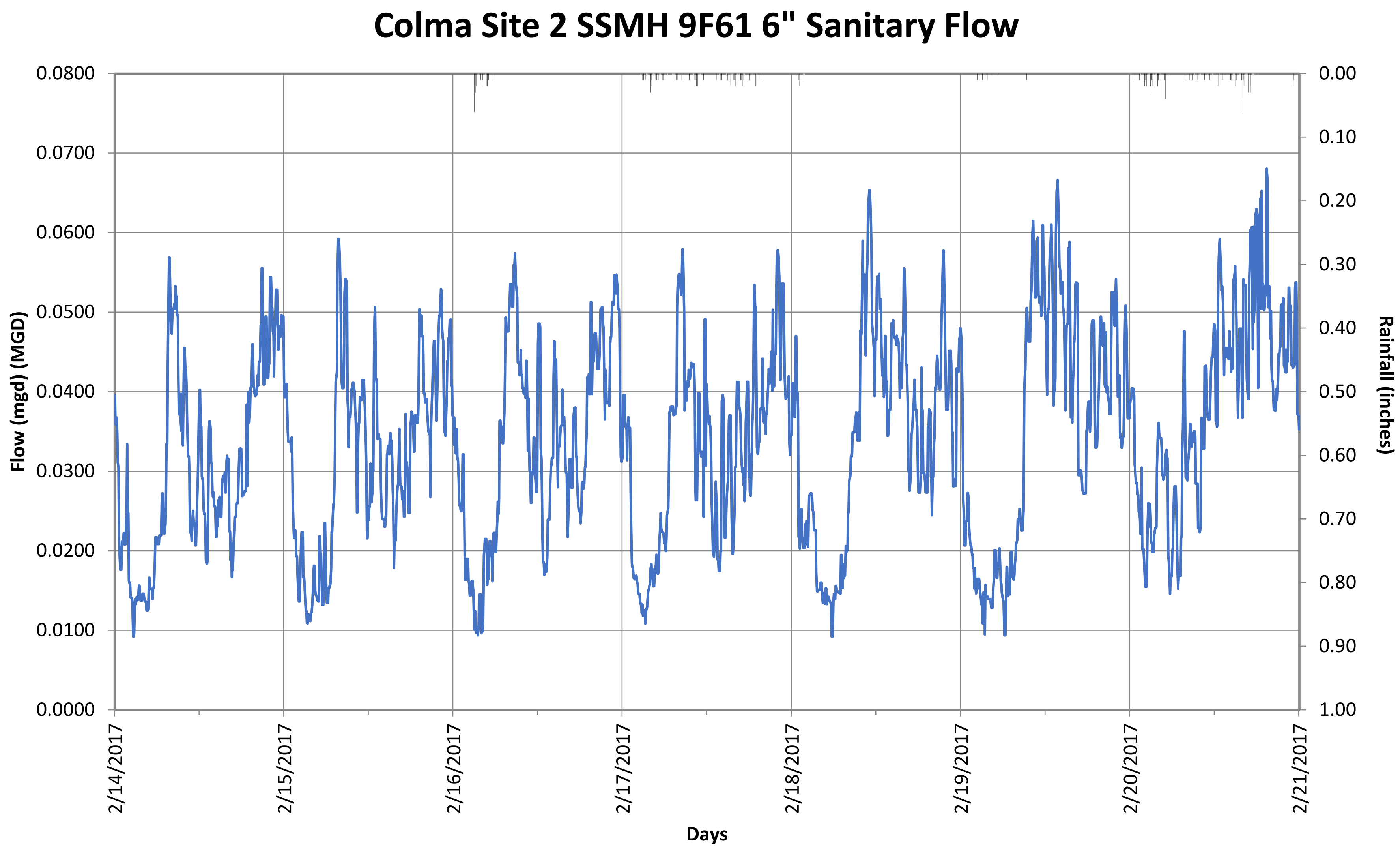


	1/31/2017(Tue)	2/1/2017(Wed)	2/2/2017(Thu)	2/3/2017(Fri)	2/4/2017(Sat)	2/5/2017(Sun)	2/6/2017(Mon)
Maximum	0.063	0.067	0.065	0.064	0.057	0.067	0.059
Average	0.031	0.032	0.034	0.034	0.033	0.038	0.032
Minimum	0.011	0.010	0.012	0.009	0.010	0.012	0.008
Rain (inches)	0.00	0.01	0.19	0.51	0.37	0.15	0.50

Colma Site 2 SSMH 9F61 6" Sanitary Flow

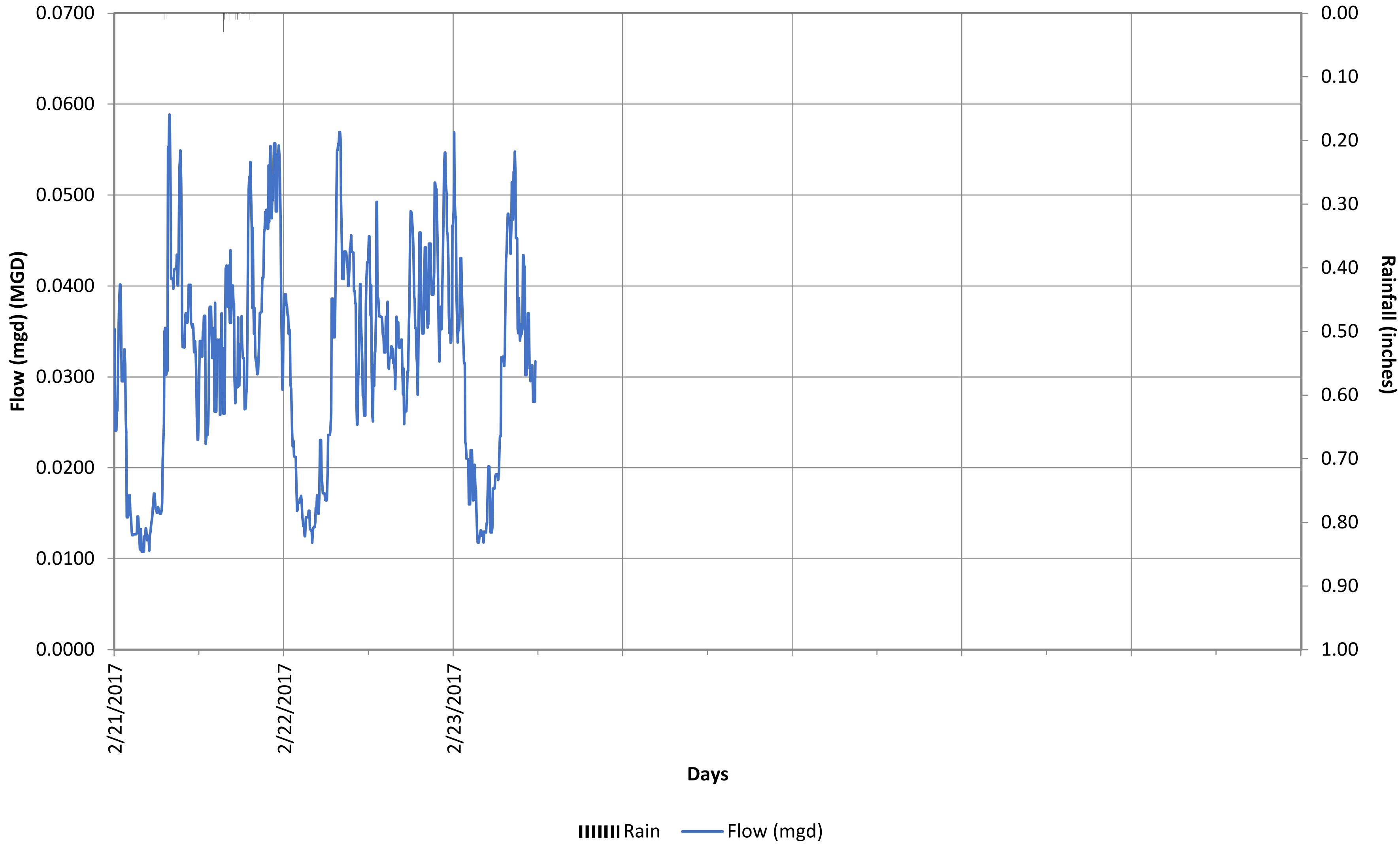


	2/7/2017(Tue)	2/8/2017(Wed)	2/9/2017(Thu)	2/10/2017(Fri)	2/11/2017(Sat)	2/12/2017(Sun)	2/13/2017(Mon)
Maximum	0.063	0.064	0.063	0.060	0.067	0.067	0.062
Average	0.035	0.035	0.034	0.032	0.036	0.038	0.033
Minimum	0.014	0.010	0.010	0.011	0.010	0.009	0.011
Rain (inches)	0.86	0.26	0.77	0.04	0.00	0.00	0.00



	2/14/2017(Tue)	2/15/2017(Wed)	2/16/2017(Thu)	2/17/2017(Fri)	2/18/2017(Sat)	2/19/2017(Sun)	2/20/2017(Mon)
Maximum	0.057	0.059	0.057	0.058	0.065	0.067	0.068
Average	0.031	0.032	0.033	0.033	0.034	0.036	0.039
Minimum	0.009	0.011	0.009	0.011	0.009	0.009	0.015
Rain (inches)	0.00	0.00	0.39	1.23	0.14	0.08	1.61

Colma Site 2 SSMH 9F61 6" Sanitary Flow

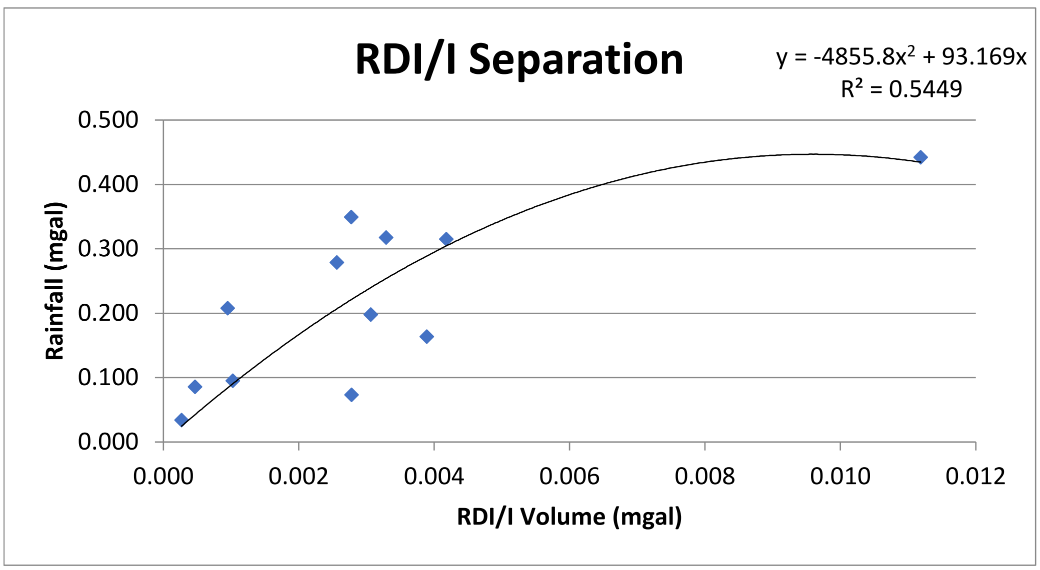


	2/21/2017(Tue)	2/22/2017(Wed)					
Maximum	0.059	0.057					
Average	0.032	0.033					
Minimum	0.011	0.012					
Rain (inches)	0.19	0.00					

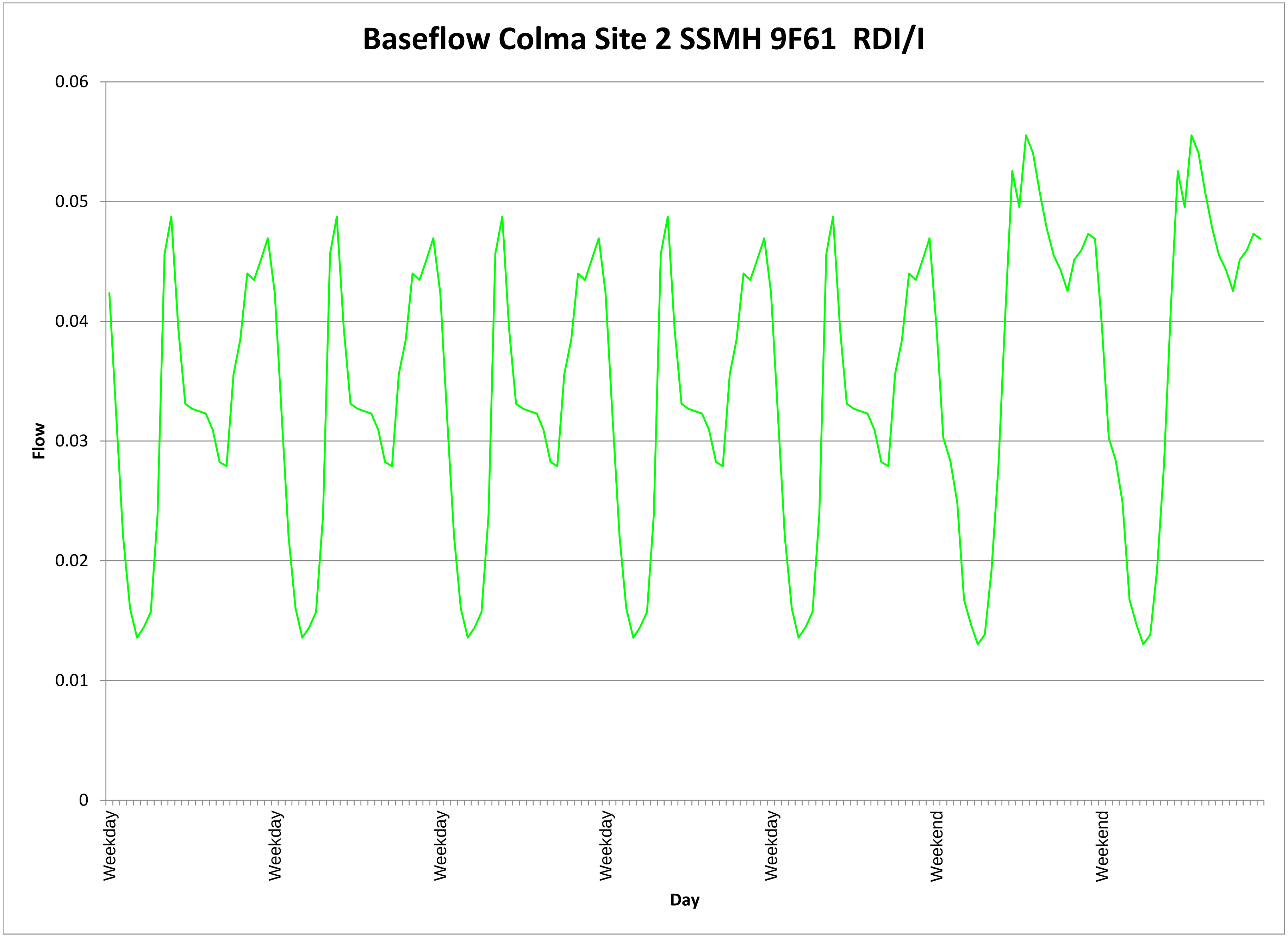
Colma Site 2 SSMH 9F61 RDI/I

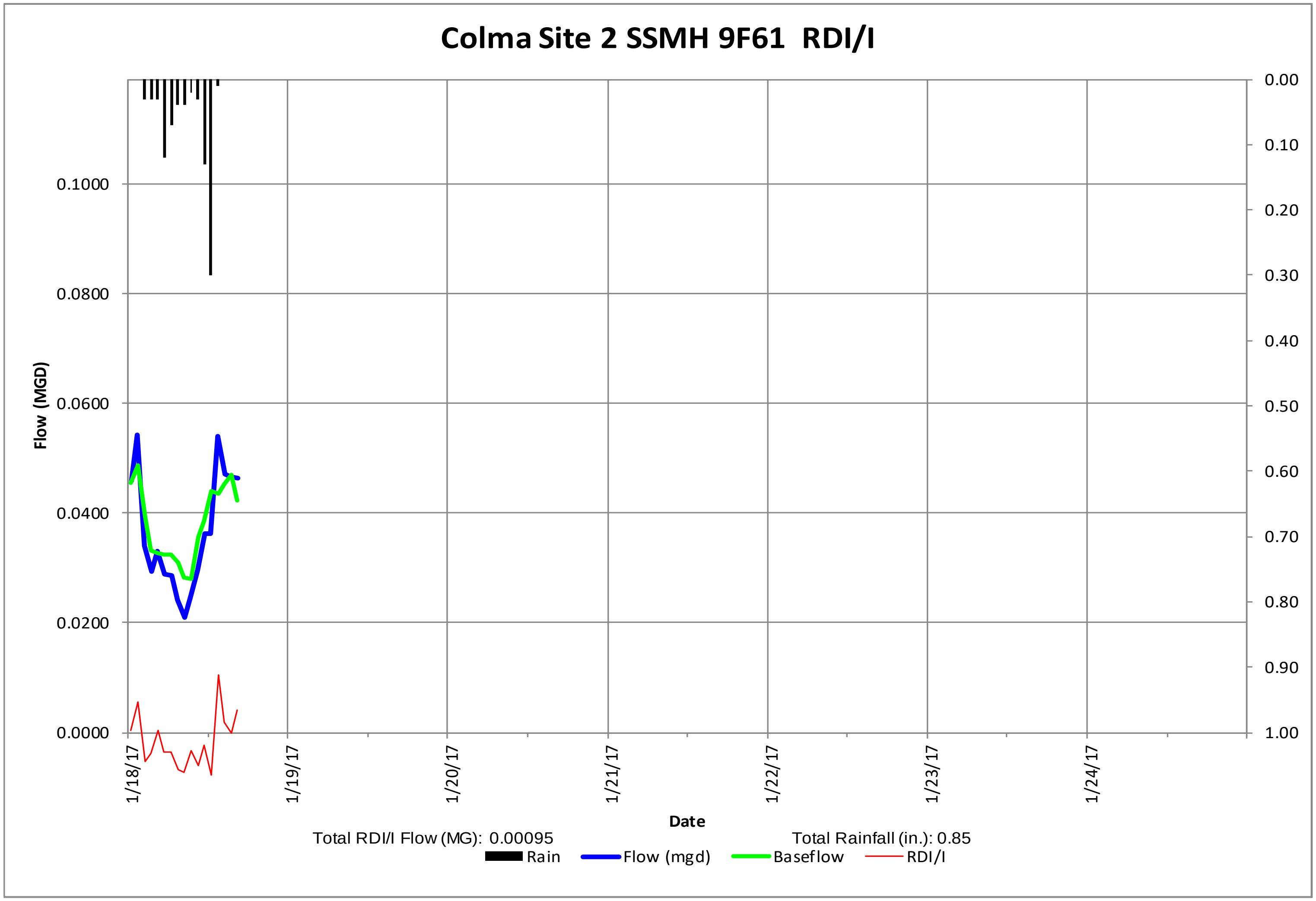
RDI/I Analysis, Monitor Return Ratio Summary

Storm Start (Date)	RDI/I Volume (mgal)	Monitor Area (acres)	Rainfall (mgal)	Return Ratio (%)
1/18/2017	0.001	9.0	0.208	0.46%
1/20/2017	0.003	9.0	0.279	0.92%
1/21/2017	0.004	9.0	0.315	1.33%
2/2/2017	0.004	9.0	0.164	2.38%
2/4/2017	0.000	9.0	0.086	0.55%
2/5/2017	0.000	9.0	0.034	0.79%
2/6/2017	0.003	9.0	0.318	1.03%
2/7/2017	0.003	9.0	0.073	3.79%
2/9/2017	0.003	9.0	0.198	1.55%
2/16/2017	0.001	9.0	0.095	1.07%
2/17/2017	0.003	9.0	0.349	0.79%
2/20/2017	0.011	9.0	0.442	2.53%
Average R%				1.43%
Average Top 3 Storms R%				2.90%

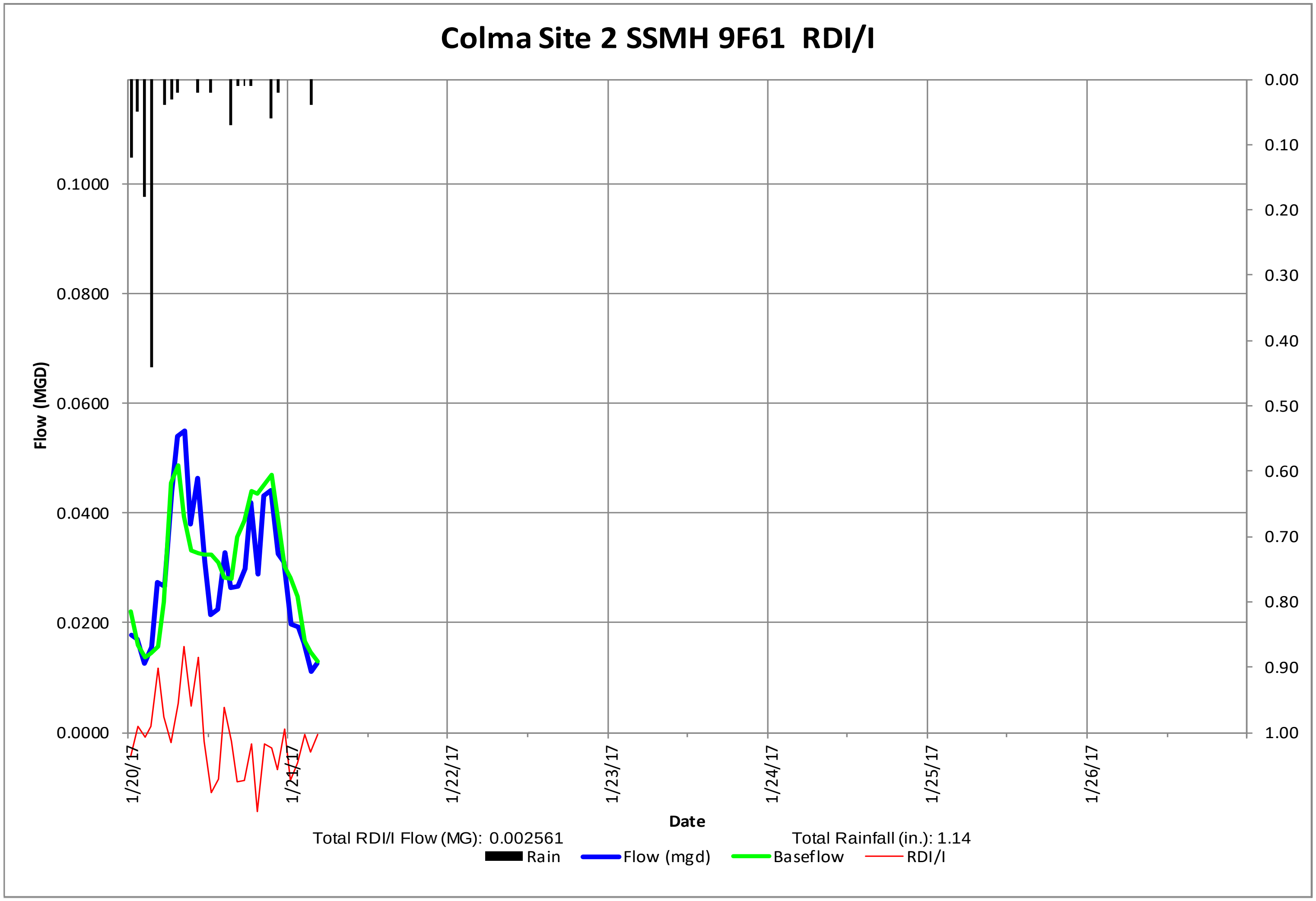


Baseflows	Weekend	Weekday
Max	0.056	0.049
Avg	0.037	0.033
Min	0.013	0.014

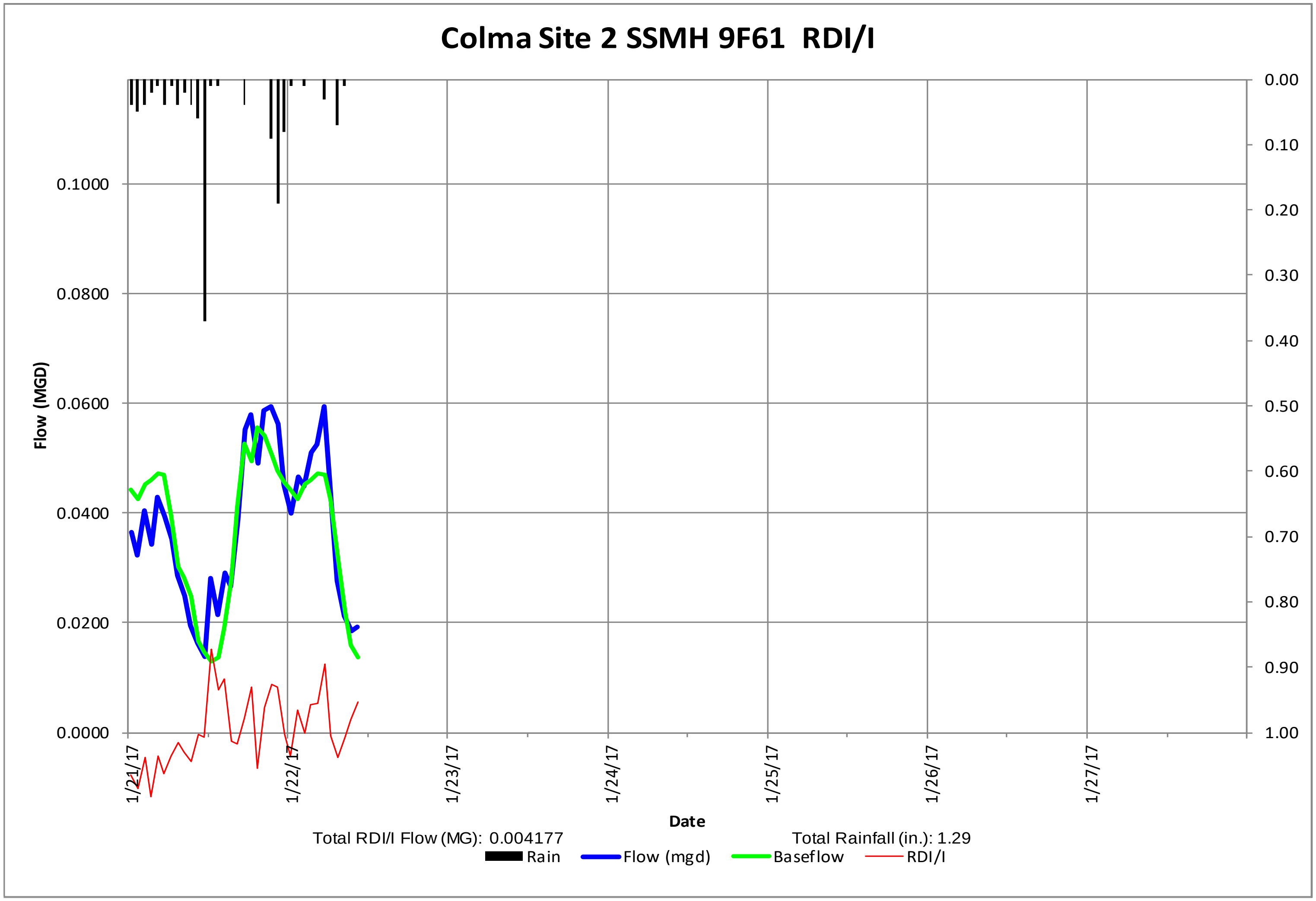

Baseflow Colma Site 2 SSMH 9F61 RDI/I
0.06
0.05
0.04
0.03
0.02
0.01
0
Flow
Weekday
Weekday
Weekday
Weekday
Weekday
Weekend
Weekend
Day



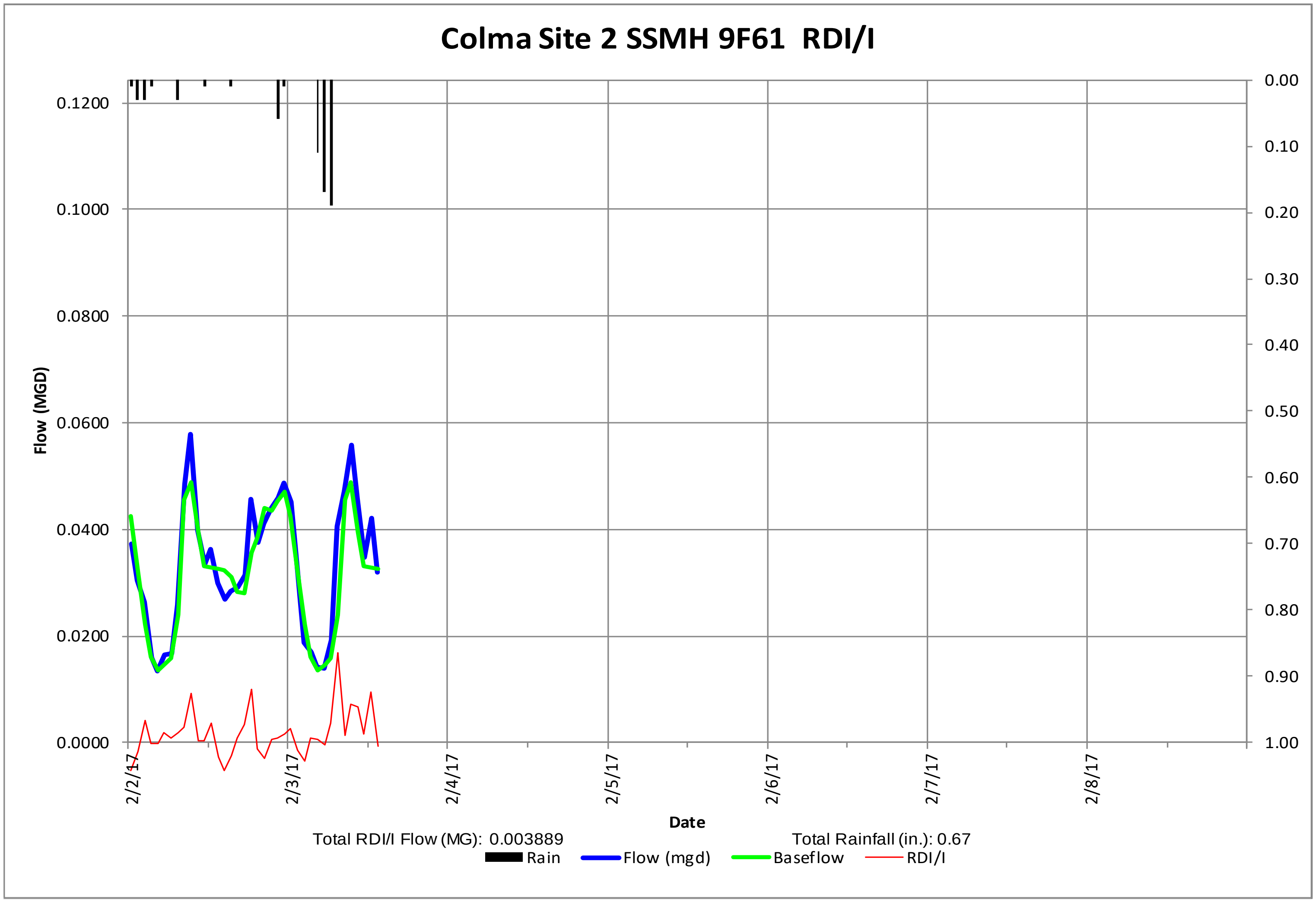
Storm of 1/18/2017



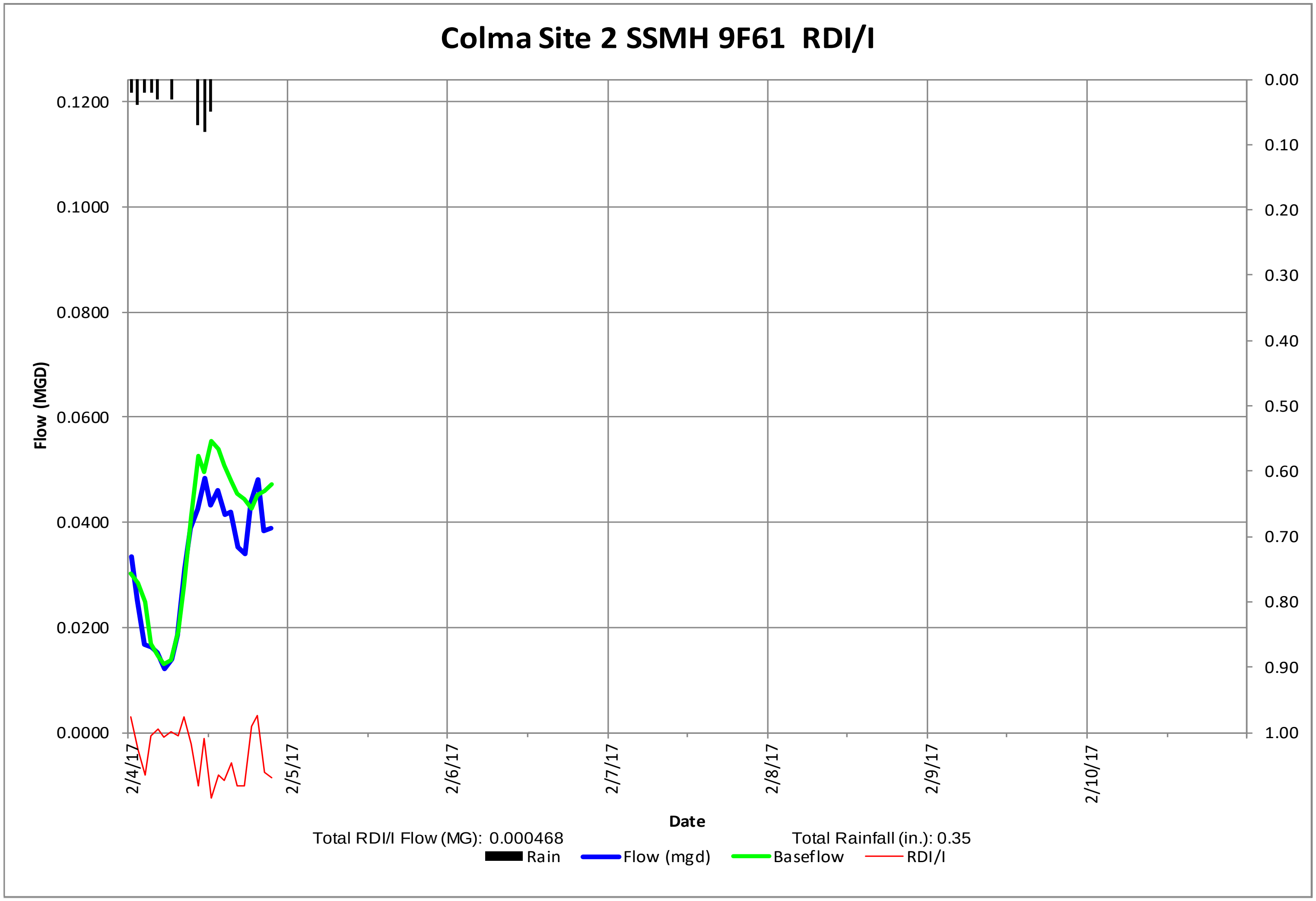
Storm of 1/20/2017



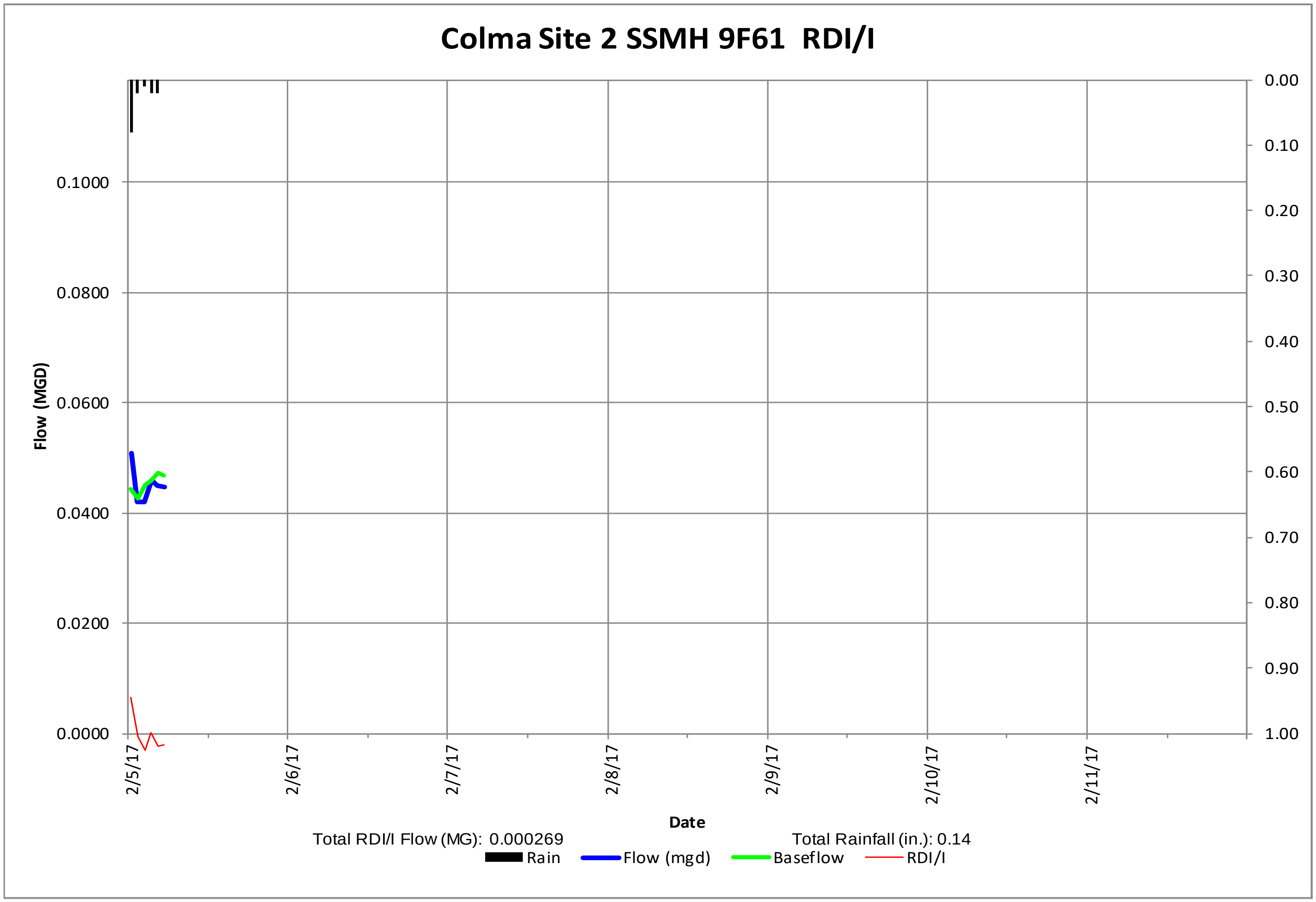
Storm of 1/21/2017



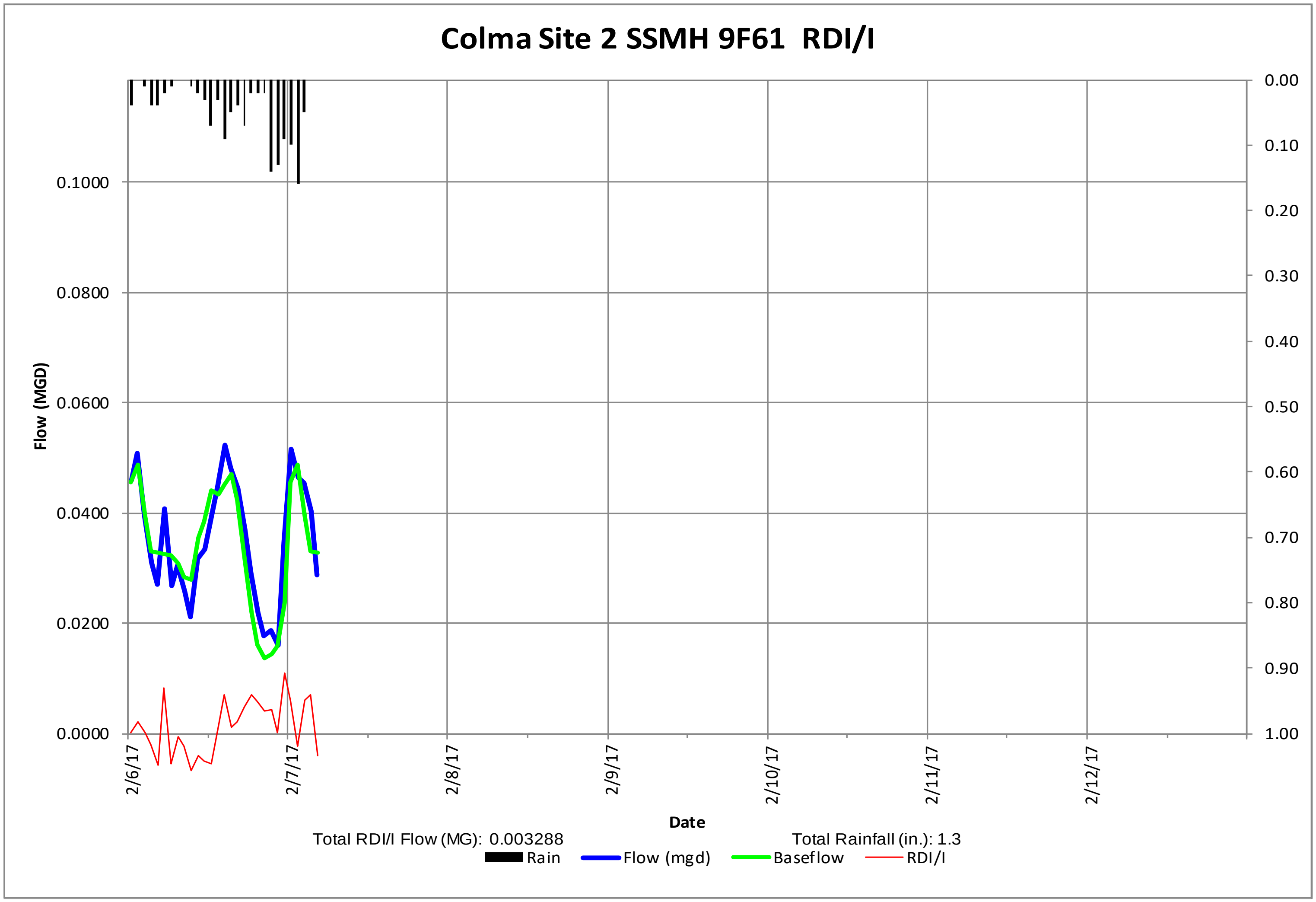
Storm of 2/2/2017



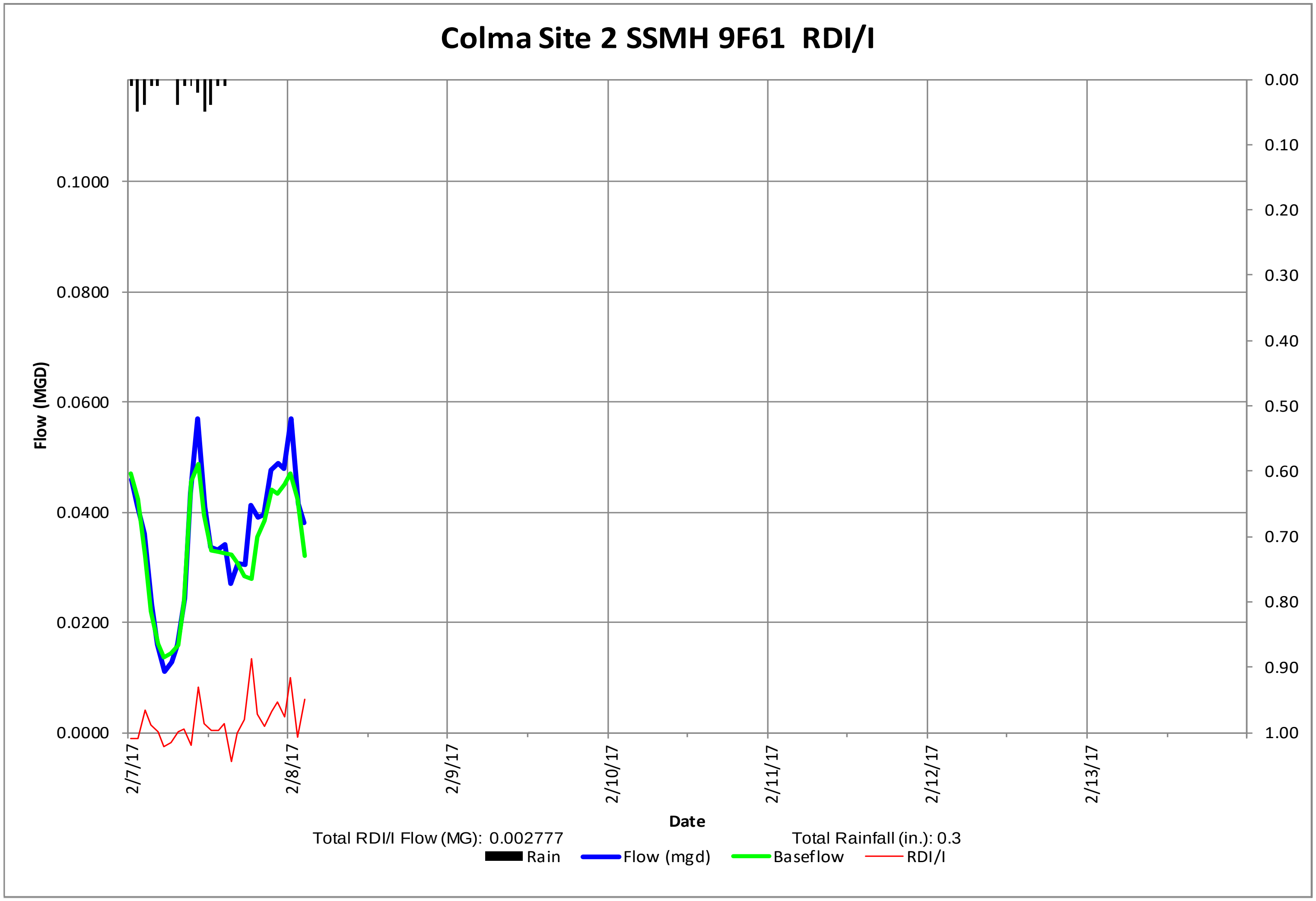
Storm of 2/4/2017



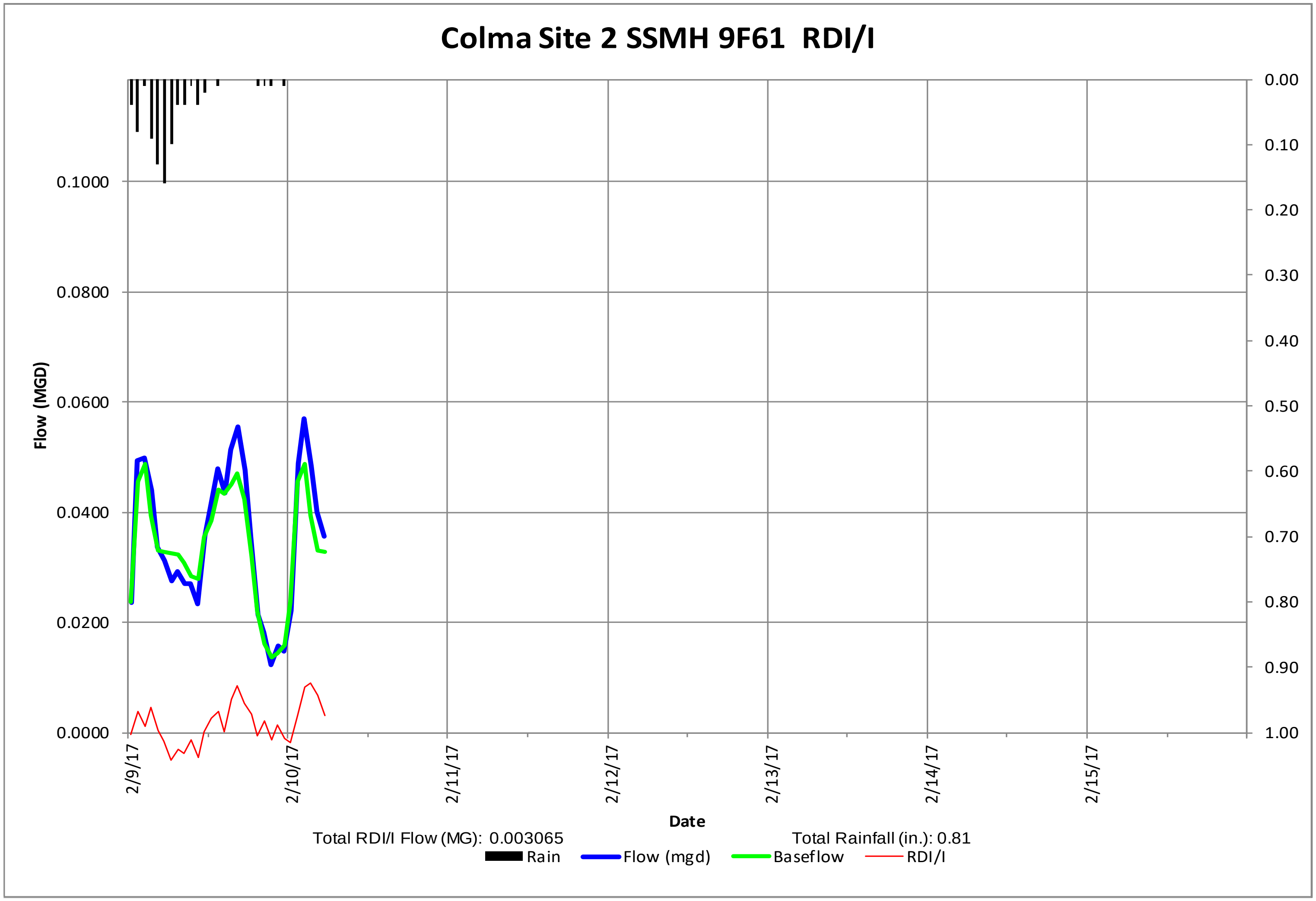
Storm of 2/5/2017



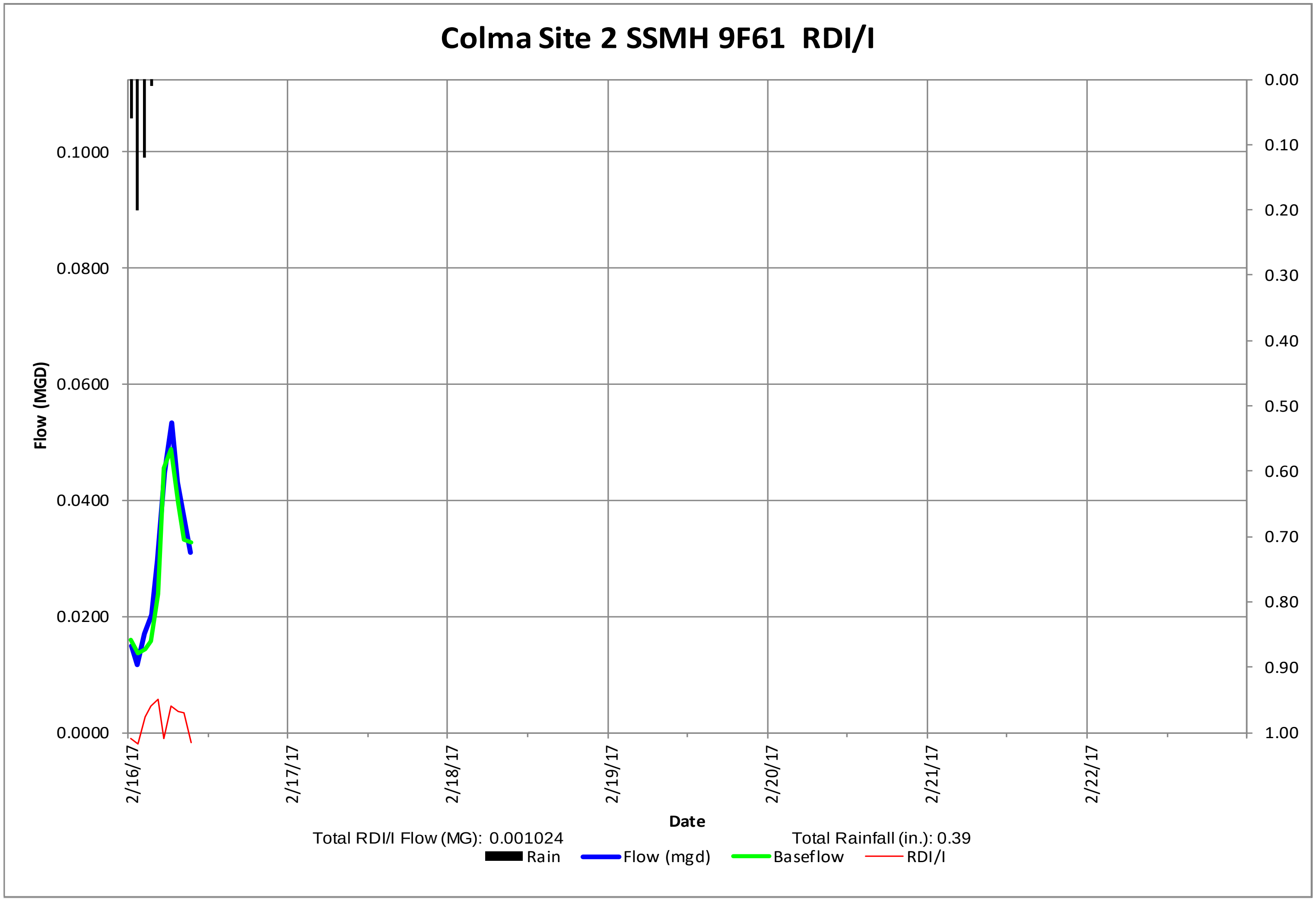
Storm of 2/6/2017



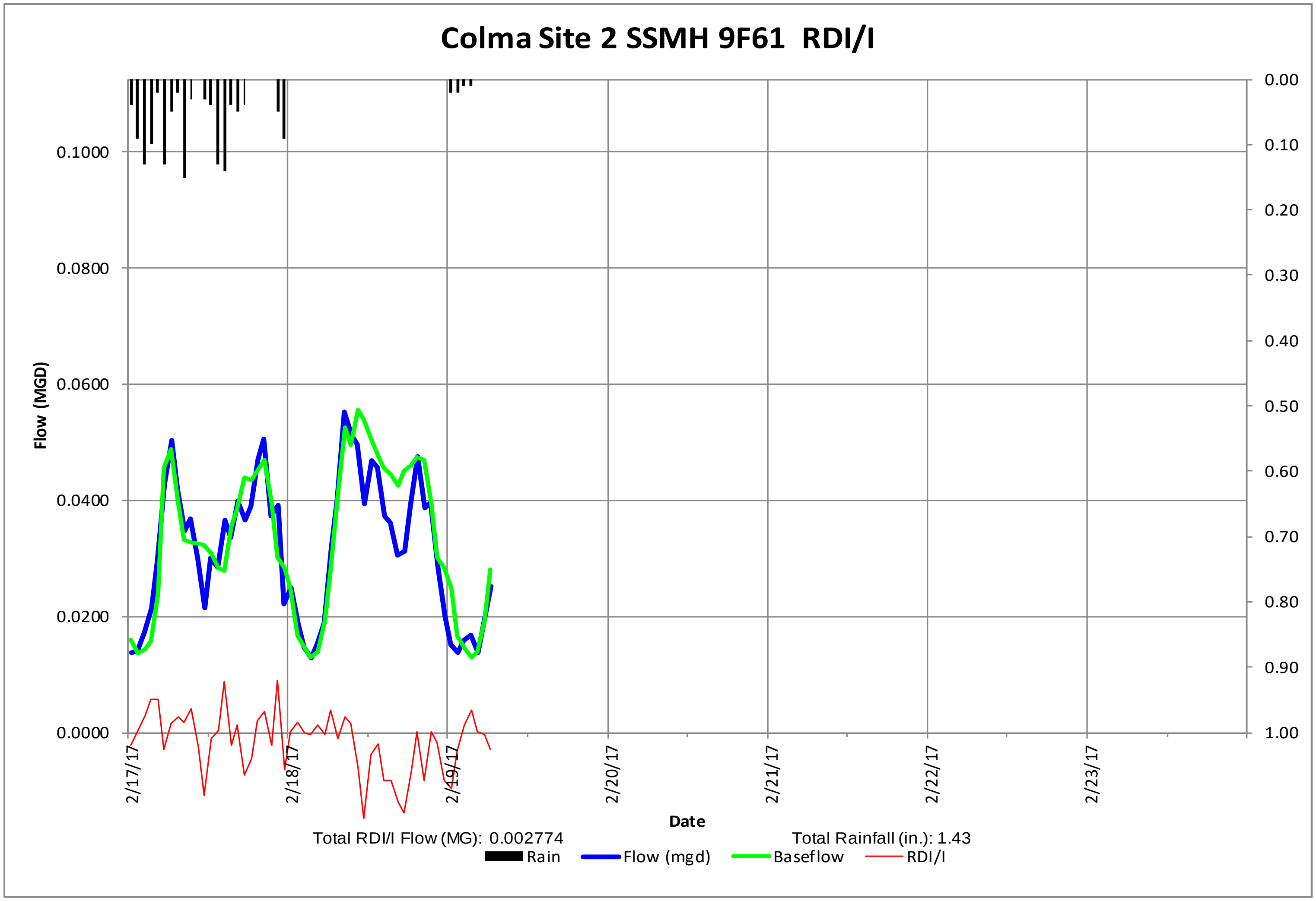
Storm of 2/7/2017



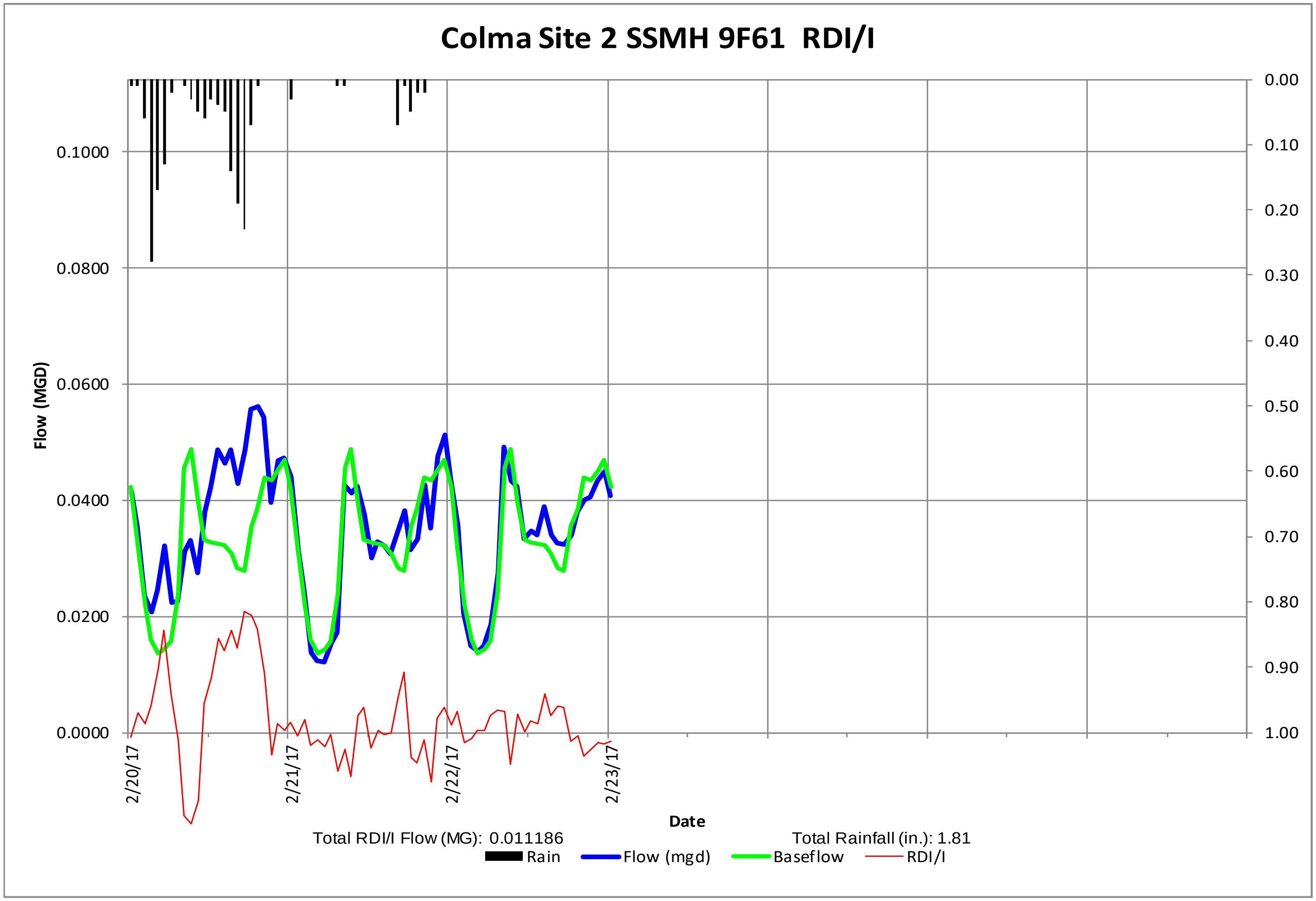
Storm of 2/9/2017



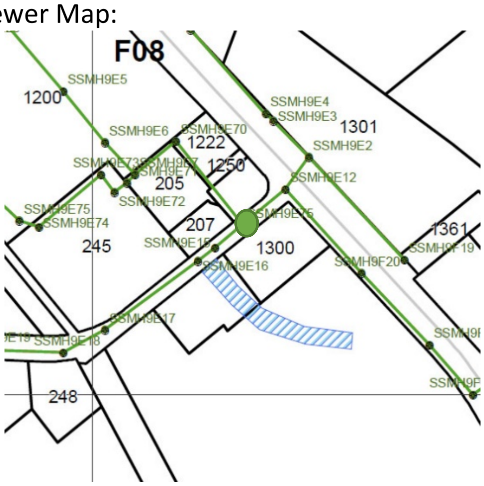
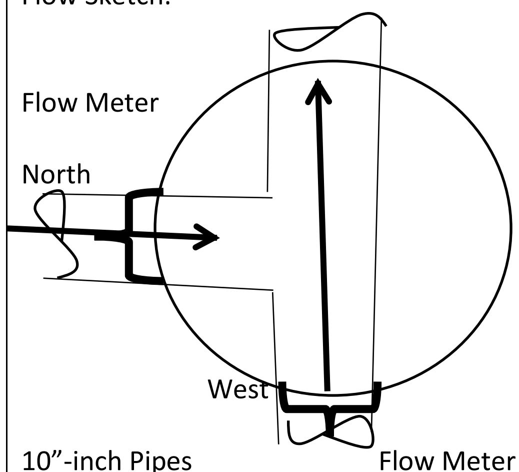
Storm of 2/16/2017



Storm of 2/17/2017



Storm of 2/20/2017

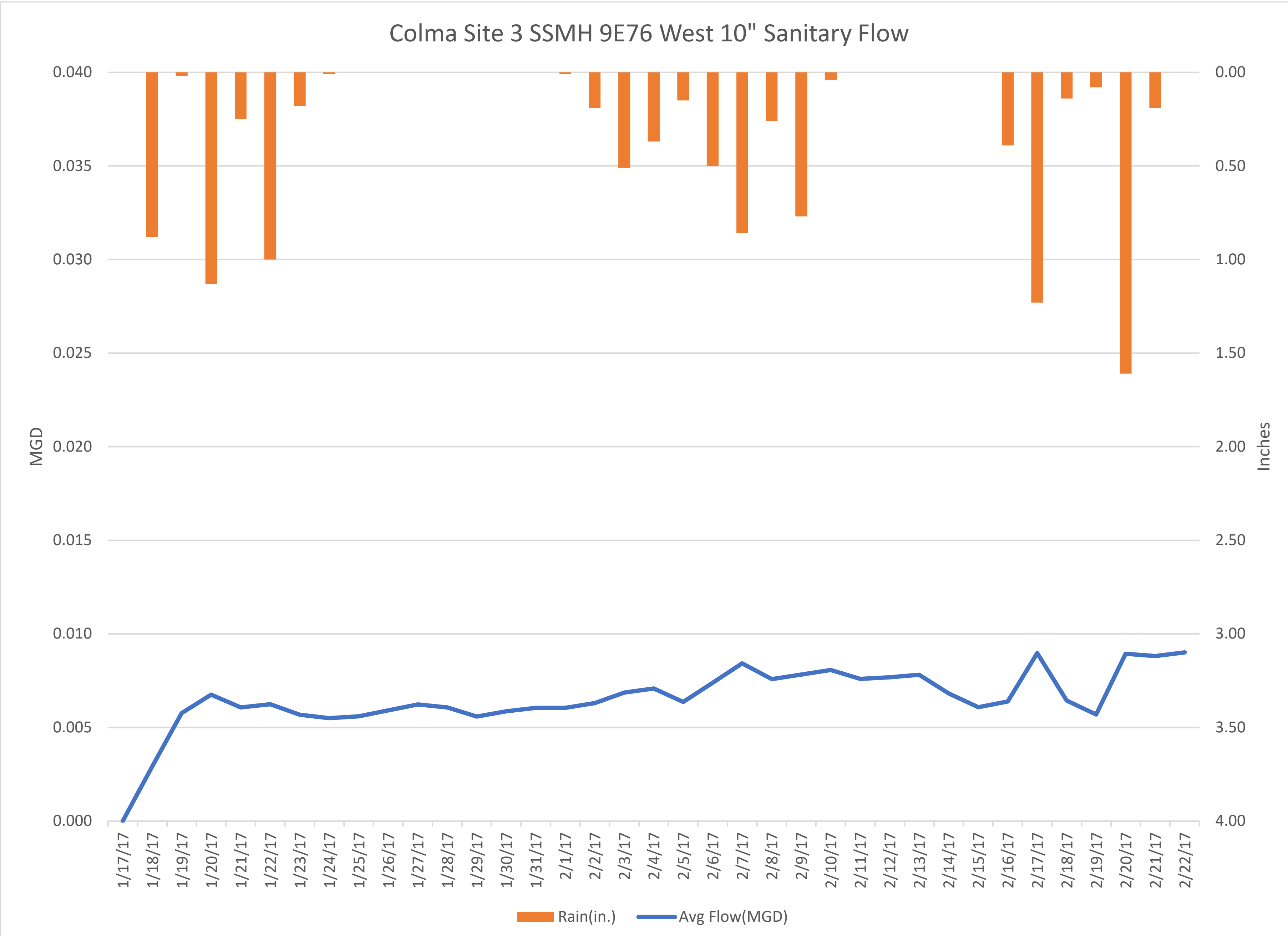
Site Information Report	Flow Monitor Site: 3
Manhole Number SSMH 9E76 Location205 Collins West of the El Camino MH Depth ~8’ Diameter: 10” and 10” Safety: OK Traffic: Light Gas: Ok Rungs no Meter Type: Hach FL900 2 Submerged AV Depth: Pressure 4” Velocity: Doppler 1.25 ft./sec	Ariel View: 
City Sewer Map: 	Flow Sketch: 
Surface View: 	Invert View: 

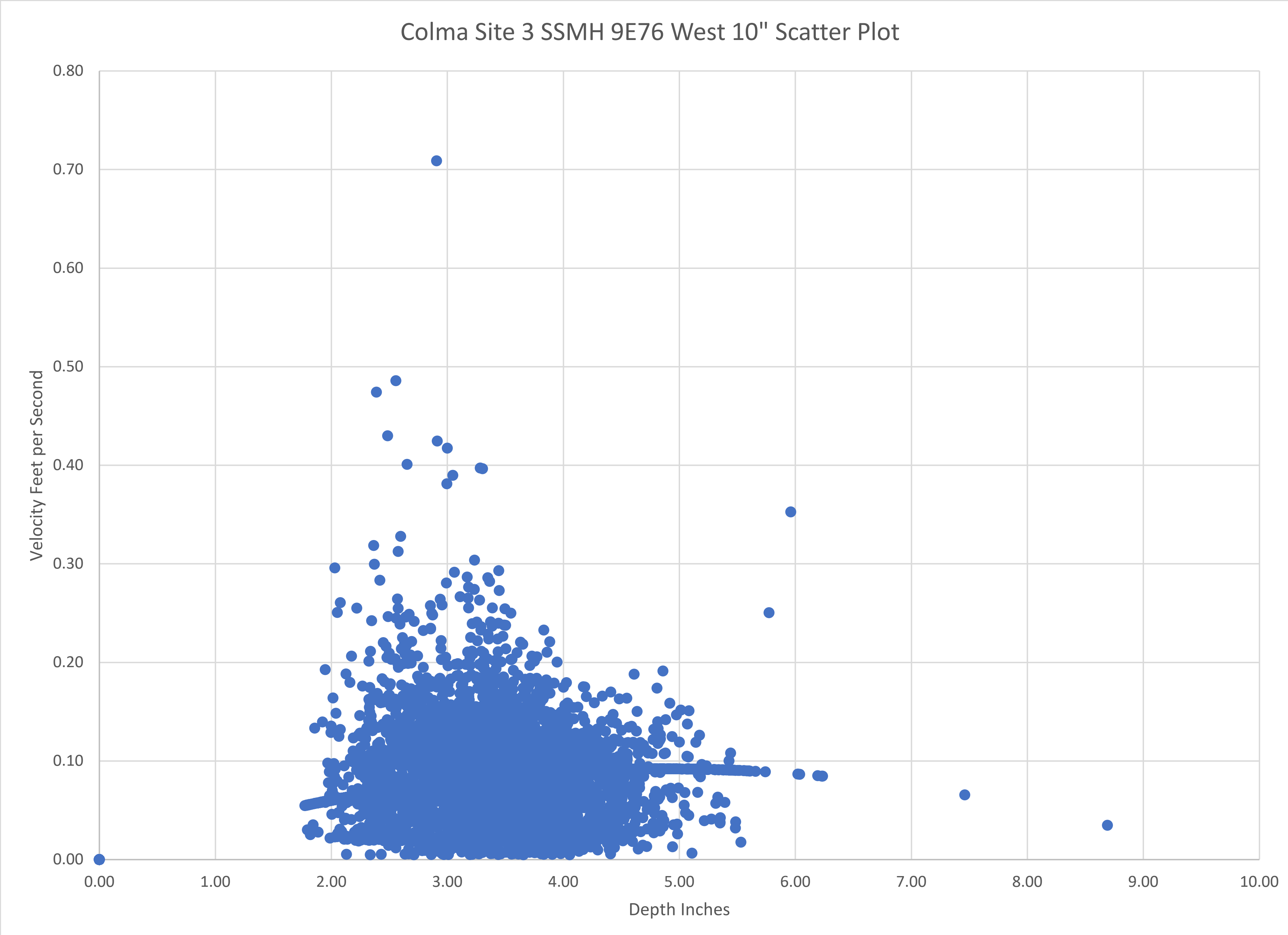
Outlet Pipe: P0	Inlet Pipe: P1
	
Inlet Pipe: P2 	

Colma Site 3 SSMH 9E76 West 10" Sanitary Flow

Daily Summary

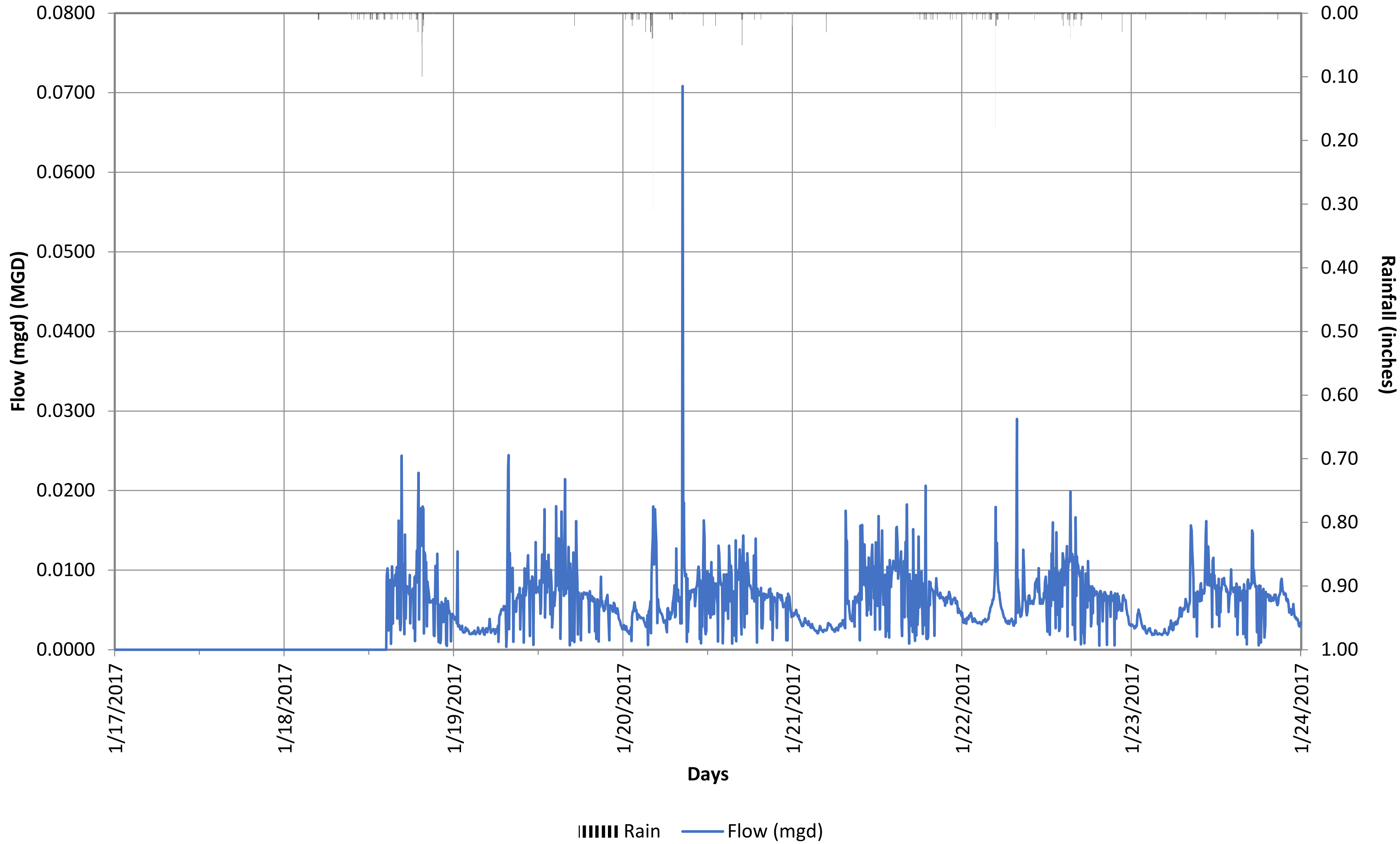
Day	Date	Avg Flow(MGD)	Min Flow(MGD)	Max Flow(MGD)	Max Depth(in.)	Rain(in.)
Tuesday	1/17/17	0.000	0.000	0.000	0.000	0.00
Wednesday	1/18/17	0.003	0.000	0.024	6.228	0.88
Thursday	1/19/17	0.006	0.000	0.024	4.974	0.02
Friday	1/20/17	0.007	0.001	0.071	8.691	1.13
Saturday	1/21/17	0.006	0.001	0.021	5.239	0.25
Sunday	1/22/17	0.006	0.000	0.029	6.192	1.00
Monday	1/23/17	0.006	0.001	0.016	5.297	0.18
Tuesday	1/24/17	0.006	0.001	0.018	5.559	0.01
Wednesday	1/25/17	0.006	0.000	0.020	5.483	0.00
Thursday	1/26/17	0.006	0.000	0.021	5.368	0.00
Friday	1/27/17	0.006	0.001	0.047	5.598	0.00
Saturday	1/28/17	0.006	0.001	0.019	4.867	0.00
Sunday	1/29/17	0.006	0.000	0.023	4.951	0.00
Monday	1/30/17	0.006	0.000	0.018	5.582	0.00
Tuesday	1/31/17	0.006	0.000	0.033	5.554	0.00
Wednesday	2/1/17	0.006	0.001	0.025	5.335	0.01
Thursday	2/2/17	0.006	0.001	0.019	5.335	0.19
Friday	2/3/17	0.007	0.001	0.048	5.772	0.51
Saturday	2/4/17	0.007	0.001	0.033	5.485	0.37
Sunday	2/5/17	0.006	0.001	0.029	4.801	0.15
Monday	2/6/17	0.007	0.001	0.022	5.081	0.50
Tuesday	2/7/17	0.008	0.000	0.024	5.656	0.86
Wednesday	2/8/17	0.008	0.001	0.024	5.441	0.26
Thursday	2/9/17	0.008	0.000	0.021	5.464	0.77
Friday	2/10/17	0.008	0.000	0.026	5.215	0.04
Saturday	2/11/17	0.008	0.001	0.018	4.931	0.00
Sunday	2/12/17	0.008	0.001	0.019	4.772	0.00
Monday	2/13/17	0.008	0.000	0.026	4.665	0.00
Tuesday	2/14/17	0.007	0.000	0.022	4.545	0.00
Wednesday	2/15/17	0.006	0.001	0.022	4.402	0.00
Thursday	2/16/17	0.006	0.000	0.022	4.220	0.39
Friday	2/17/17	0.009	0.001	0.021	5.247	1.23
Saturday	2/18/17	0.006	0.000	0.020	4.449	0.14
Sunday	2/19/17	0.006	0.001	0.016	4.505	0.08
Monday	2/20/17	0.009	0.001	0.026	5.741	1.61
Tuesday	2/21/17	0.009	0.000	0.024	5.000	0.19
Wednesday	2/22/17	0.009	0.001	0.022	5.065	0.00


Colma Site 3 SSMH 9E76 West 10" Sanitary Flow
MGD
Inches
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
1/17/17
1/18/17
1/19/17
1/20/17
1/21/17
1/22/17
1/23/17
1/24/17
1/25/17
1/26/17
1/27/17
1/28/17
1/29/17
1/30/17
1/31/17
2/1/17
2/2/17
2/3/17
2/4/17
2/5/17
2/6/17
2/7/17
2/8/17
2/9/17
2/10/17
2/11/17
2/12/17
2/13/17
2/14/17
2/15/17
2/16/17
2/17/17
2/18/17
2/19/17
2/20/17
2/21/17
2/22/17
Rain(in.)
Avg Flow(MGD)



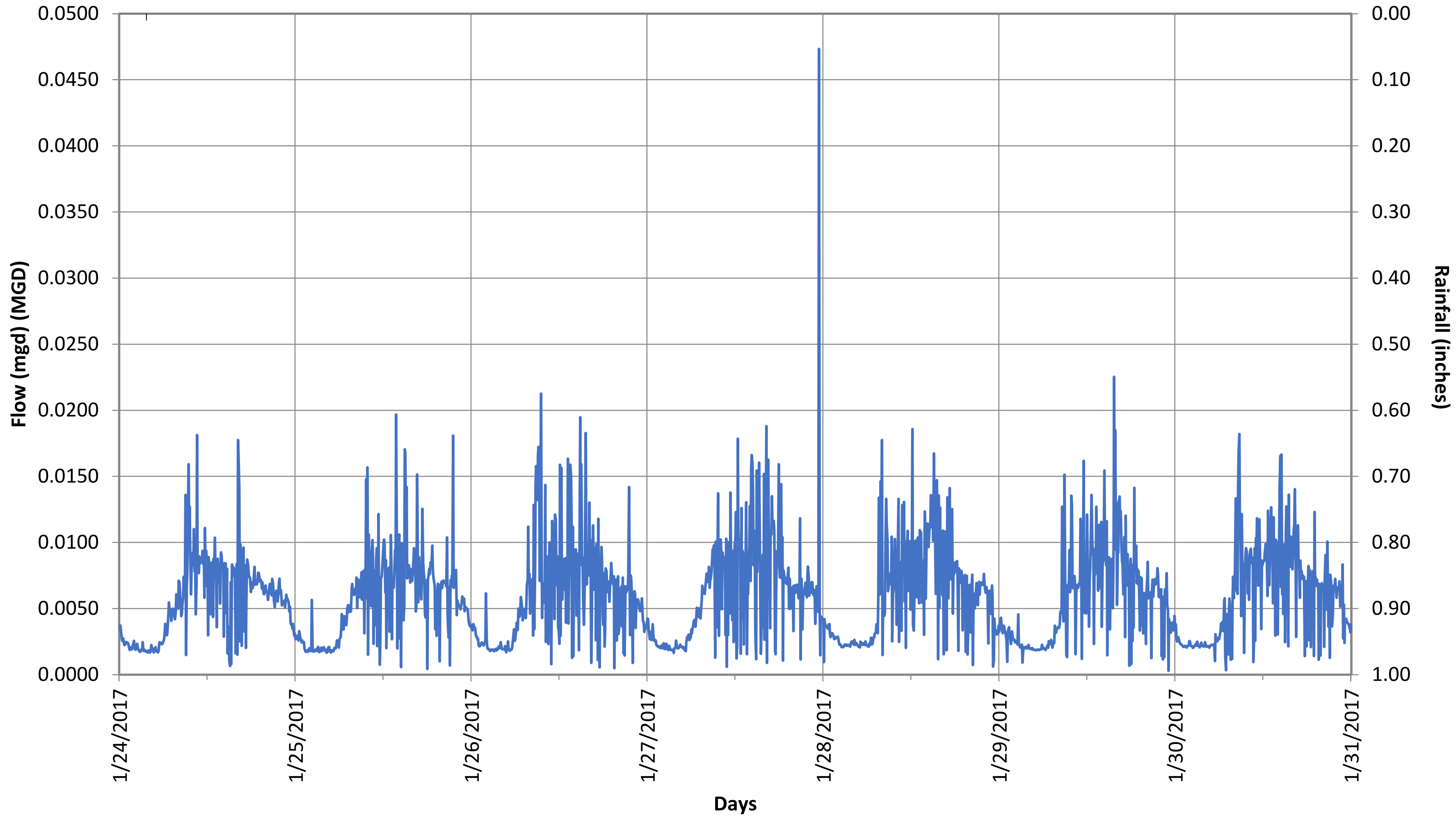
Colma Site 3 SSMH 9E76 West 10" Scatter Plot
Velocity Feet per Second
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Depth Inches

Colma Site 3 SSMH 9E76 West 10" Sanitary Flow



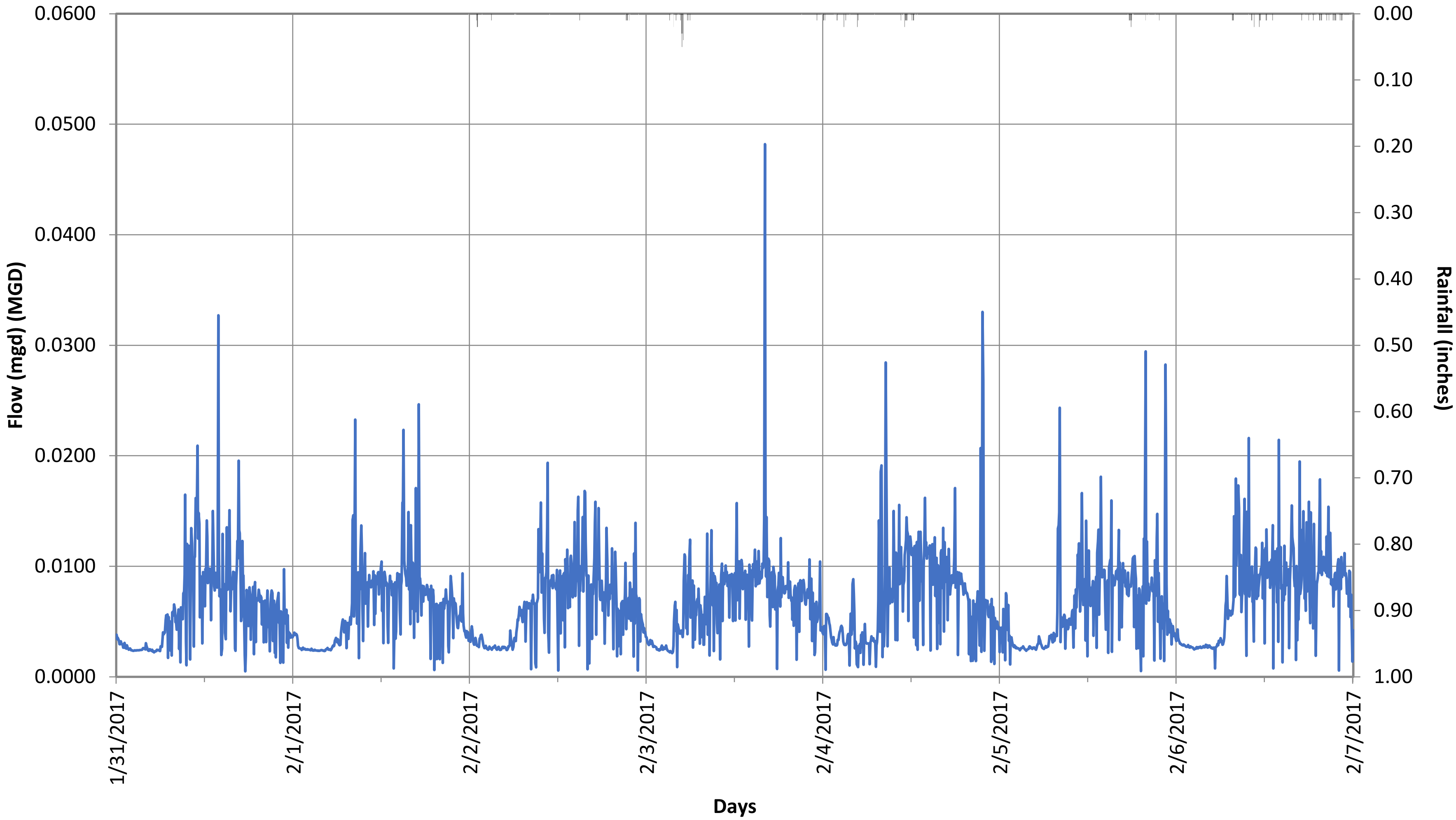
	1/17/2017(Tue)	1/18/2017(Wed)	1/19/2017(Thu)	1/20/2017(Fri)	1/21/2017(Sat)	1/22/2017(Sun)	1/23/2017(Mon)
Maximum	0.000	0.024	0.024	0.071	0.021	0.029	0.016
Average	0.000	0.003	0.006	0.007	0.006	0.006	0.006
Minimum	0.000	0.000	0.000	0.001	0.001	0.000	0.001
Rain (inches)	0.00	0.88	0.02	1.13	0.25	1.00	0.18

Colma Site 3 SSMH 9E76 West 10" Sanitary Flow



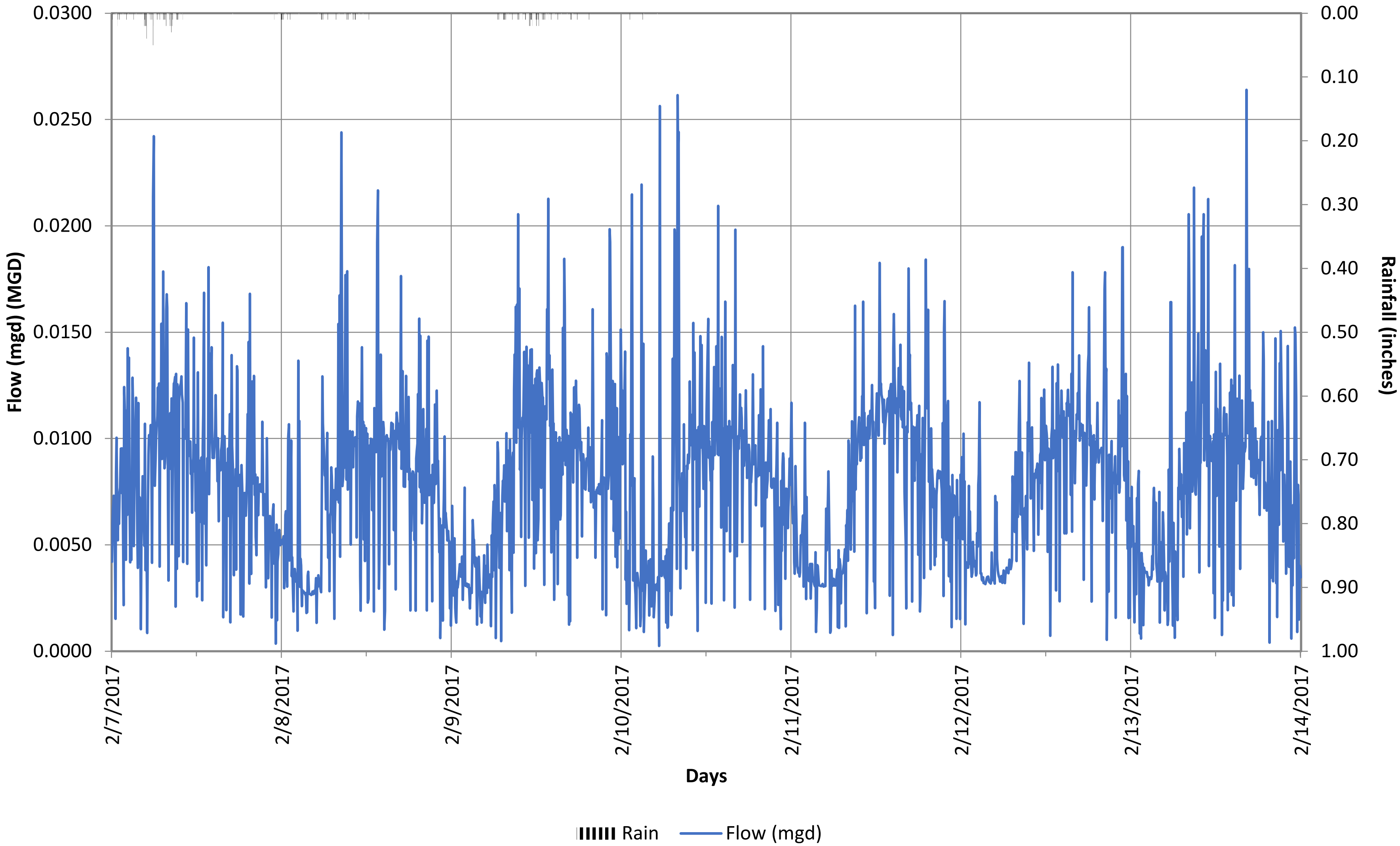
	1/24/2017(Tue)	1/25/2017(Wed)	1/26/2017(Thu)	1/27/2017(Fri)	1/28/2017(Sat)	1/29/2017(Sun)	1/30/2017(Mon)
Maximum	0.018	0.020	0.021	0.047	0.019	0.023	0.018
Average	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Minimum	0.001	0.000	0.000	0.001	0.001	0.000	0.000
Rain (inches)	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Colma Site 3 SSMH 9E76 West 10" Sanitary Flow



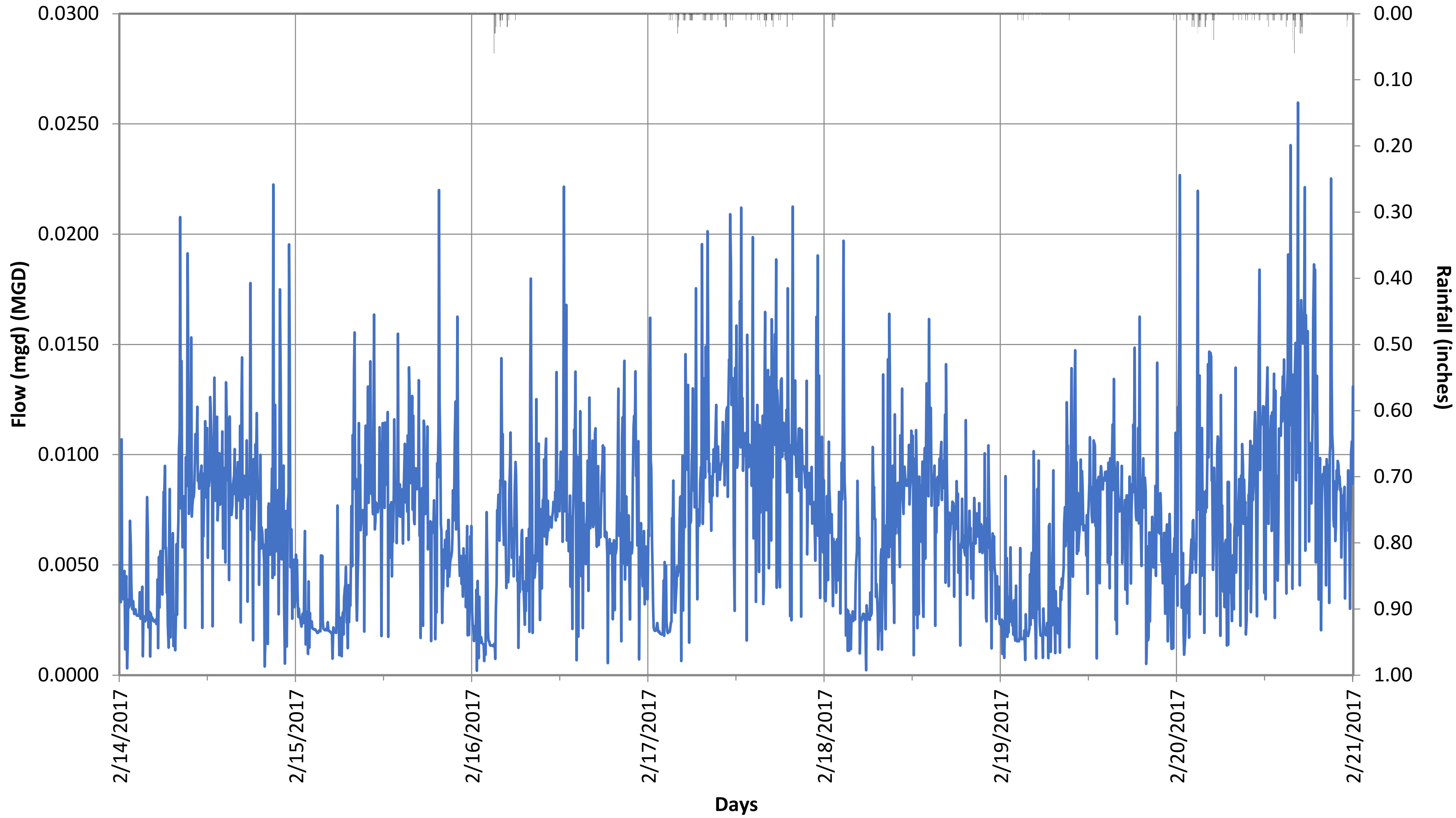
	1/31/2017(Tue)	2/1/2017(Wed)	2/2/2017(Thu)	2/3/2017(Fri)	2/4/2017(Sat)	2/5/2017(Sun)	2/6/2017(Mon)
Maximum	0.033	0.025	0.019	0.048	0.033	0.029	0.022
Average	0.006	0.006	0.006	0.007	0.007	0.006	0.007
Minimum	0.000	0.001	0.001	0.001	0.001	0.001	0.001
Rain (inches)	0.00	0.01	0.19	0.51	0.37	0.15	0.50

Colma Site 3 SSMH 9E76 West 10" Sanitary Flow



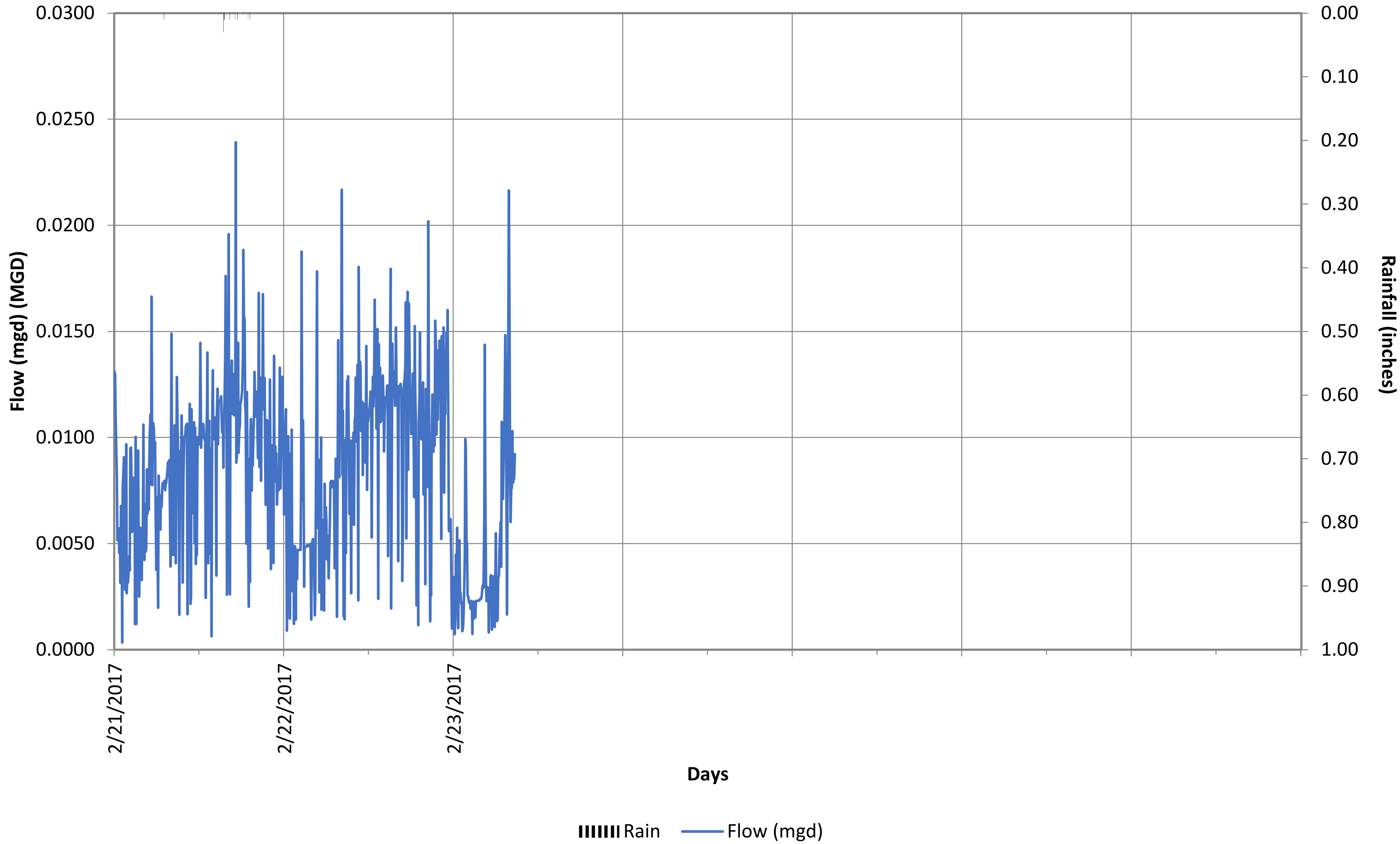
	2/7/2017(Tue)	2/8/2017(Wed)	2/9/2017(Thu)	2/10/2017(Fri)	2/11/2017(Sat)	2/12/2017(Sun)	2/13/2017(Mon)
Maximum	0.024	0.024	0.021	0.026	0.018	0.019	0.026
Average	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Minimum	0.000	0.001	0.000	0.000	0.001	0.001	0.000
Rain (inches)	0.86	0.26	0.77	0.04	0.00	0.00	0.00

Colma Site 3 SSMH 9E76 West 10" Sanitary Flow



	2/14/2017(Tue)	2/15/2017(Wed)	2/16/2017(Thu)	2/17/2017(Fri)	2/18/2017(Sat)	2/19/2017(Sun)	2/20/2017(Mon)
Maximum	0.022	0.022	0.022	0.021	0.020	0.016	0.026
Average	0.007	0.006	0.006	0.009	0.006	0.006	0.009
Minimum	0.000	0.001	0.000	0.001	0.000	0.001	0.001
Rain (inches)	0.00	0.00	0.39	1.23	0.14	0.08	1.61

Colma Site 3 SSMH 9E76 West 10" Sanitary Flow

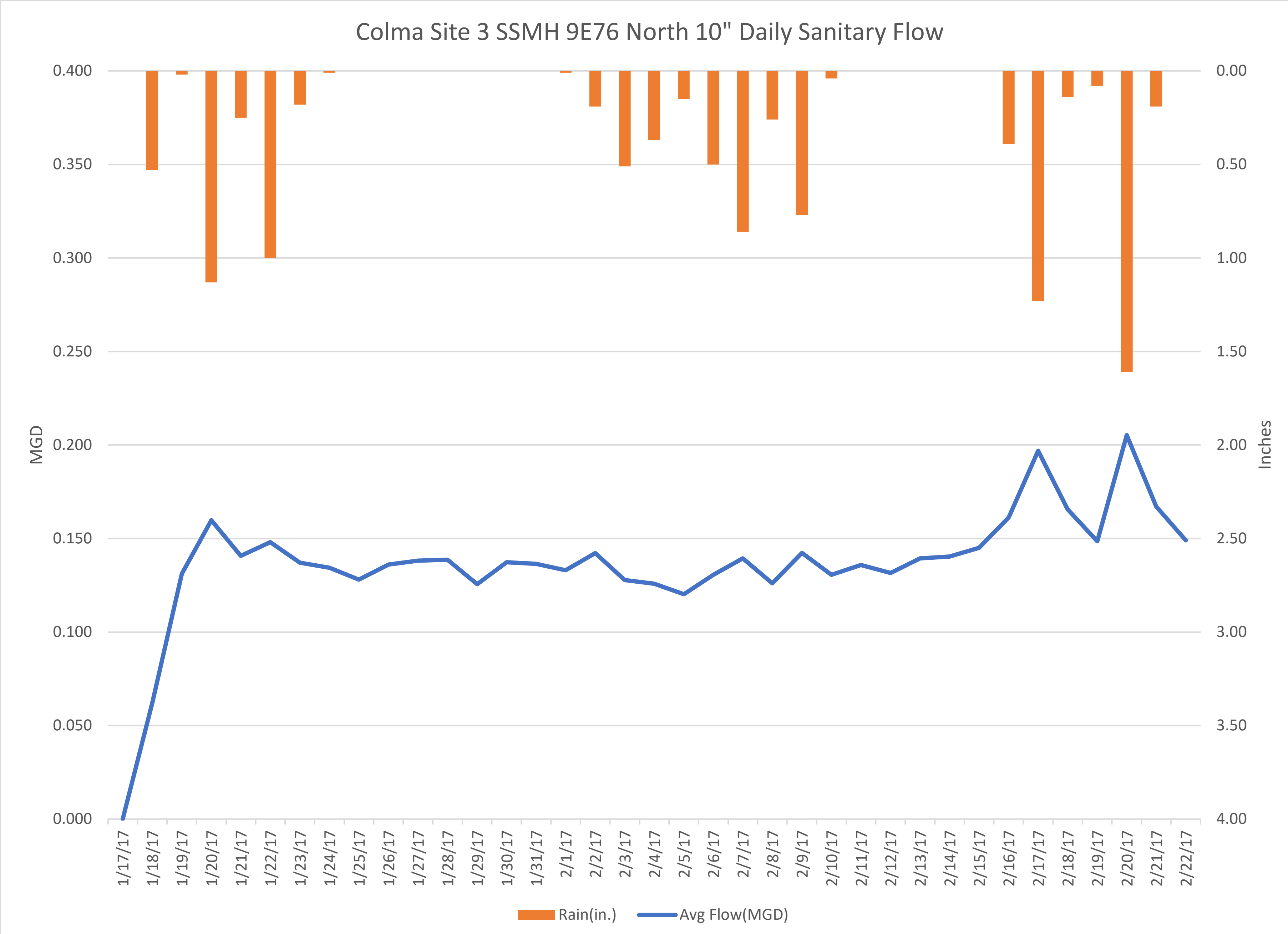


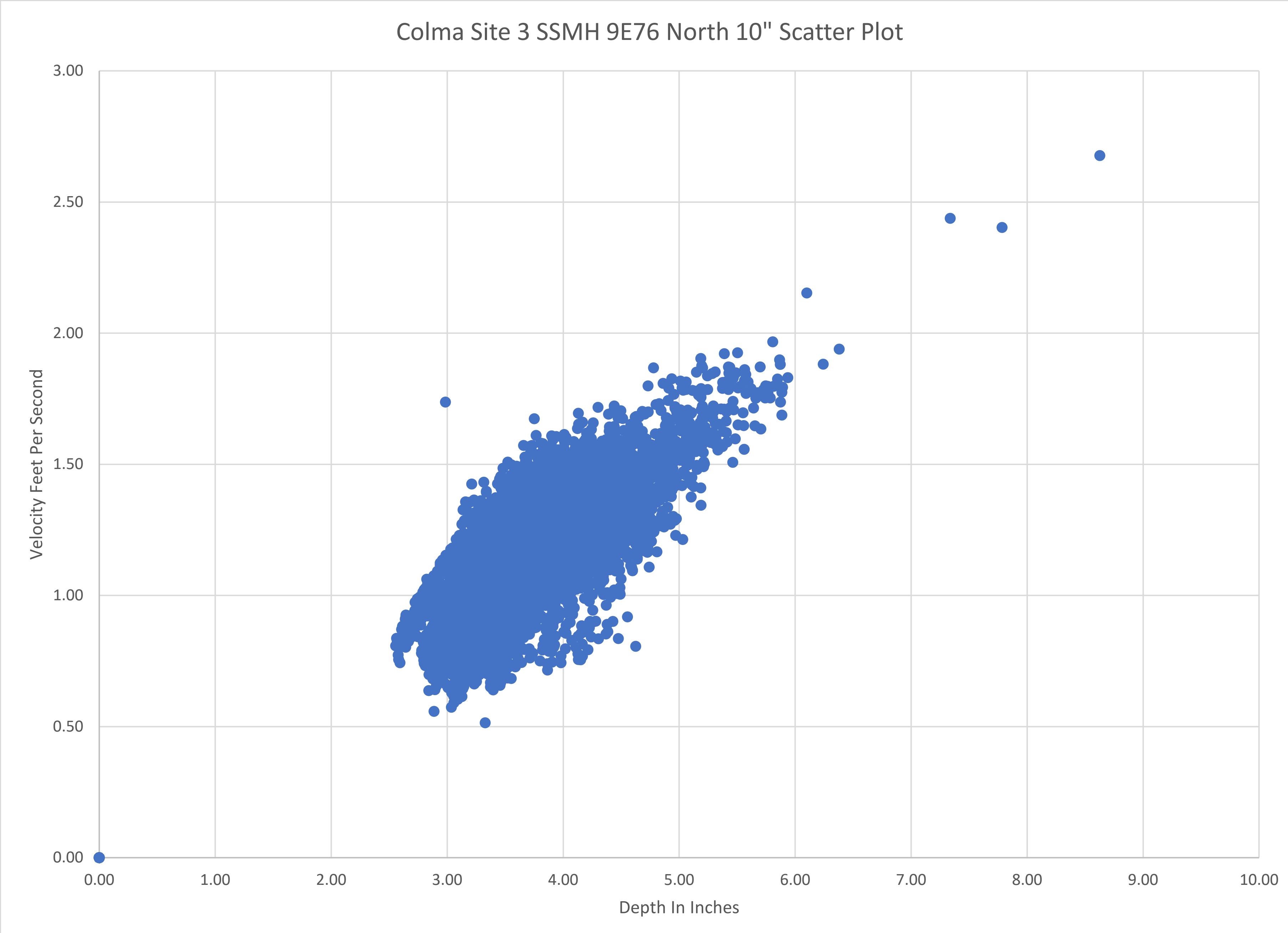
	2/21/2017(Tue)	2/22/2017(Wed)					
Maximum	0.024	0.022					
Average	0.009	0.009					
Minimum	0.000	0.001					
Rain (inches)	0.19	0.00					

Colma Site 3 SSMH 9E76 North 10" Sanitary Flow

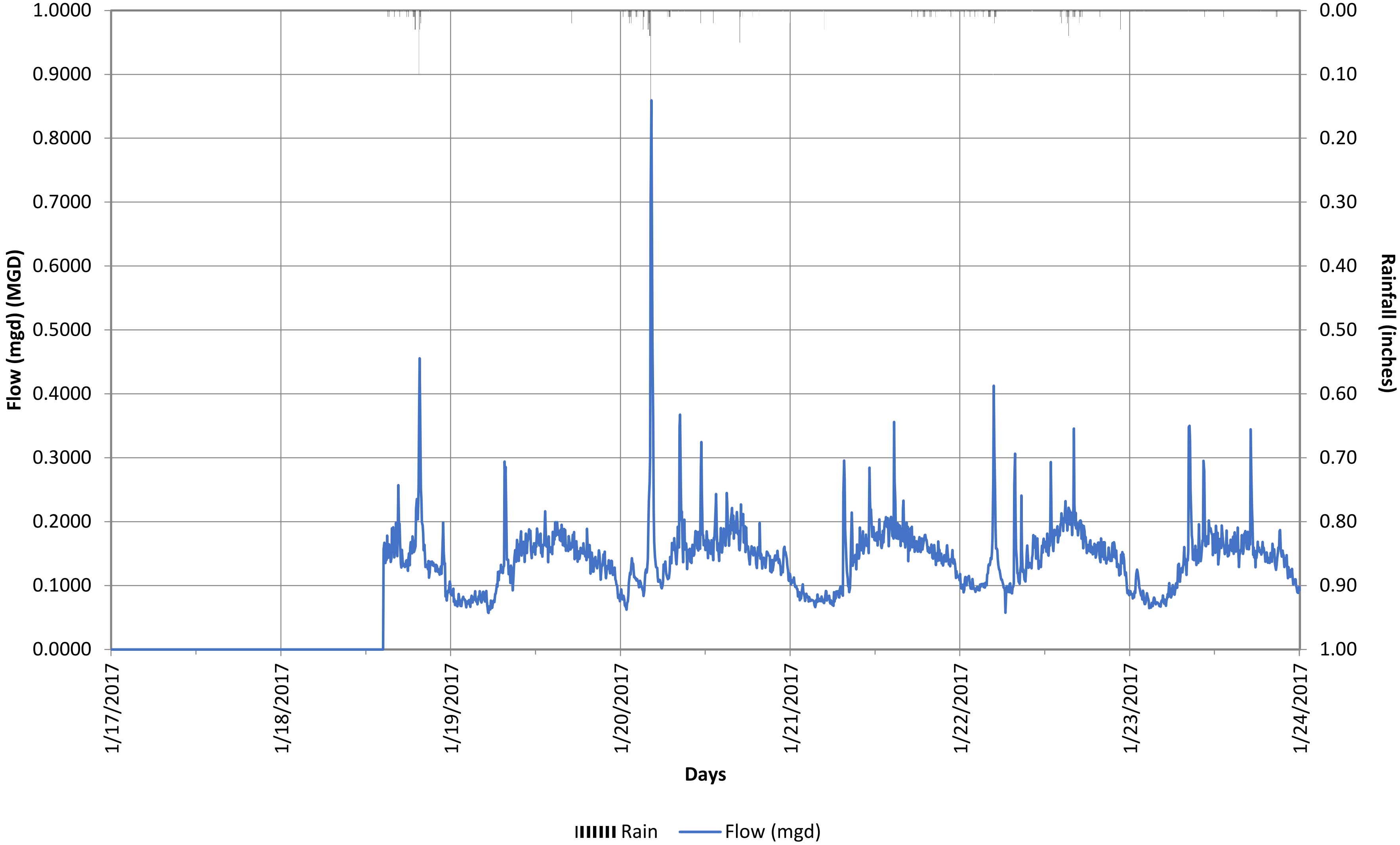
Daily Summary

Day	Date	Avg Flow(MGD)	Min Flow(MGD)	Max Flow(MGD)	Max Depth(in.)	Rain(in.)
Tuesday	1/17/17	0.000	0.000	0.000	0.000	0.00
Wednesday	1/18/17	0.062	0.000	0.456	6.381	0.53
Thursday	1/19/17	0.131	0.057	0.294	5.038	0.02
Friday	1/20/17	0.160	0.062	0.859	8.626	1.13
Saturday	1/21/17	0.141	0.066	0.356	5.466	0.25
Sunday	1/22/17	0.148	0.057	0.413	5.807	1.00
Monday	1/23/17	0.137	0.065	0.350	5.448	0.18
Tuesday	1/24/17	0.134	0.058	0.384	5.766	0.01
Wednesday	1/25/17	0.128	0.061	0.362	5.490	0.00
Thursday	1/26/17	0.136	0.051	0.378	5.503	0.00
Friday	1/27/17	0.138	0.056	0.403	5.872	0.00
Saturday	1/28/17	0.139	0.062	0.313	5.075	0.00
Sunday	1/29/17	0.126	0.058	0.320	5.060	0.00
Monday	1/30/17	0.137	0.062	0.368	5.728	0.00
Tuesday	1/31/17	0.137	0.046	0.386	5.873	0.00
Wednesday	2/1/17	0.133	0.058	0.371	5.563	0.01
Thursday	2/2/17	0.142	0.067	0.343	5.557	0.19
Friday	2/3/17	0.128	0.062	0.315	5.201	0.51
Saturday	2/4/17	0.126	0.056	0.295	4.963	0.37
Sunday	2/5/17	0.120	0.050	0.275	4.734	0.15
Monday	2/6/17	0.131	0.053	0.295	5.005	0.50
Tuesday	2/7/17	0.139	0.072	0.362	5.550	0.86
Wednesday	2/8/17	0.126	0.052	0.319	5.116	0.26
Thursday	2/9/17	0.142	0.060	0.368	5.574	0.77
Friday	2/10/17	0.131	0.064	0.317	5.196	0.04
Saturday	2/11/17	0.136	0.066	0.294	5.015	0.00
Sunday	2/12/17	0.132	0.068	0.284	5.135	0.00
Monday	2/13/17	0.139	0.064	0.265	4.837	0.00
Tuesday	2/14/17	0.140	0.067	0.294	5.125	0.00
Wednesday	2/15/17	0.145	0.064	0.288	5.124	0.00
Thursday	2/16/17	0.161	0.067	0.287	5.100	0.39
Friday	2/17/17	0.197	0.052	0.395	5.938	1.23
Saturday	2/18/17	0.166	0.088	0.295	5.333	0.14
Sunday	2/19/17	0.149	0.073	0.281	5.091	0.08
Monday	2/20/17	0.205	0.101	0.431	6.242	1.61
Tuesday	2/21/17	0.167	0.096	0.318	5.297	0.19
Wednesday	2/22/17	0.149	0.070	0.268	5.154	0.00


Colma Site 3 SSMH 9E76 North 10" Daily Sanitary Flow
MGD
Inches
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
1/17/17
1/18/17
1/19/17
1/20/17
1/21/17
1/22/17
1/23/17
1/24/17
1/25/17
1/26/17
1/27/17
1/28/17
1/29/17
1/30/17
1/31/17
2/1/17
2/2/17
2/3/17
2/4/17
2/5/17
2/6/17
2/7/17
2/8/17
2/9/17
2/10/17
2/11/17
2/12/17
2/13/17
2/14/17
2/15/17
2/16/17
2/17/17
2/18/17
2/19/17
2/20/17
2/21/17
2/22/17
Rain(in.)
Avg Flow(MGD)

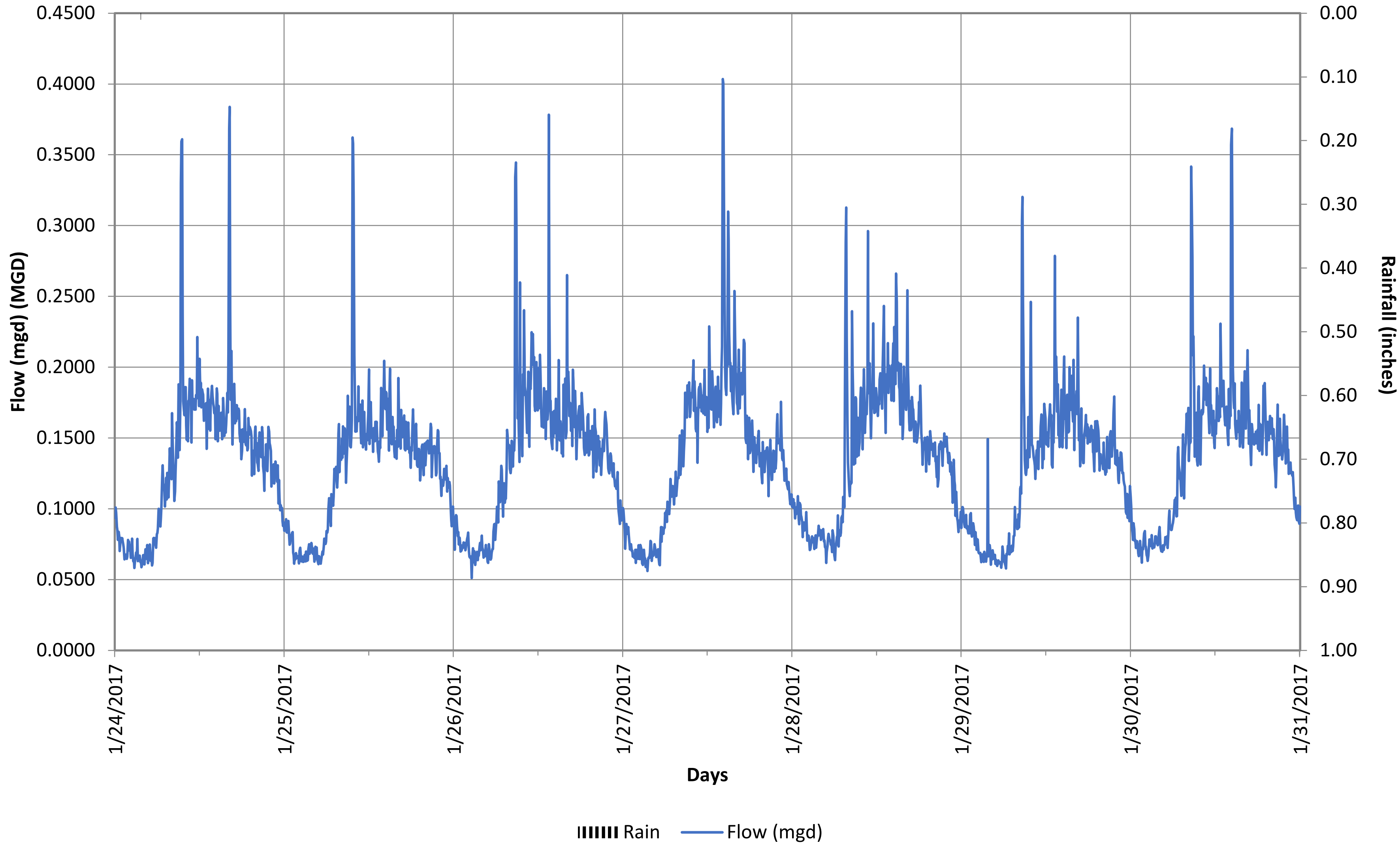

Colma Site 3 SSMH 9E76 North 10" Scatter Plot
Velocity Feet Per Second
Depth In Inches
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00

Colma Site 3 SSMH 9E76 North 10" Sanitary Flow



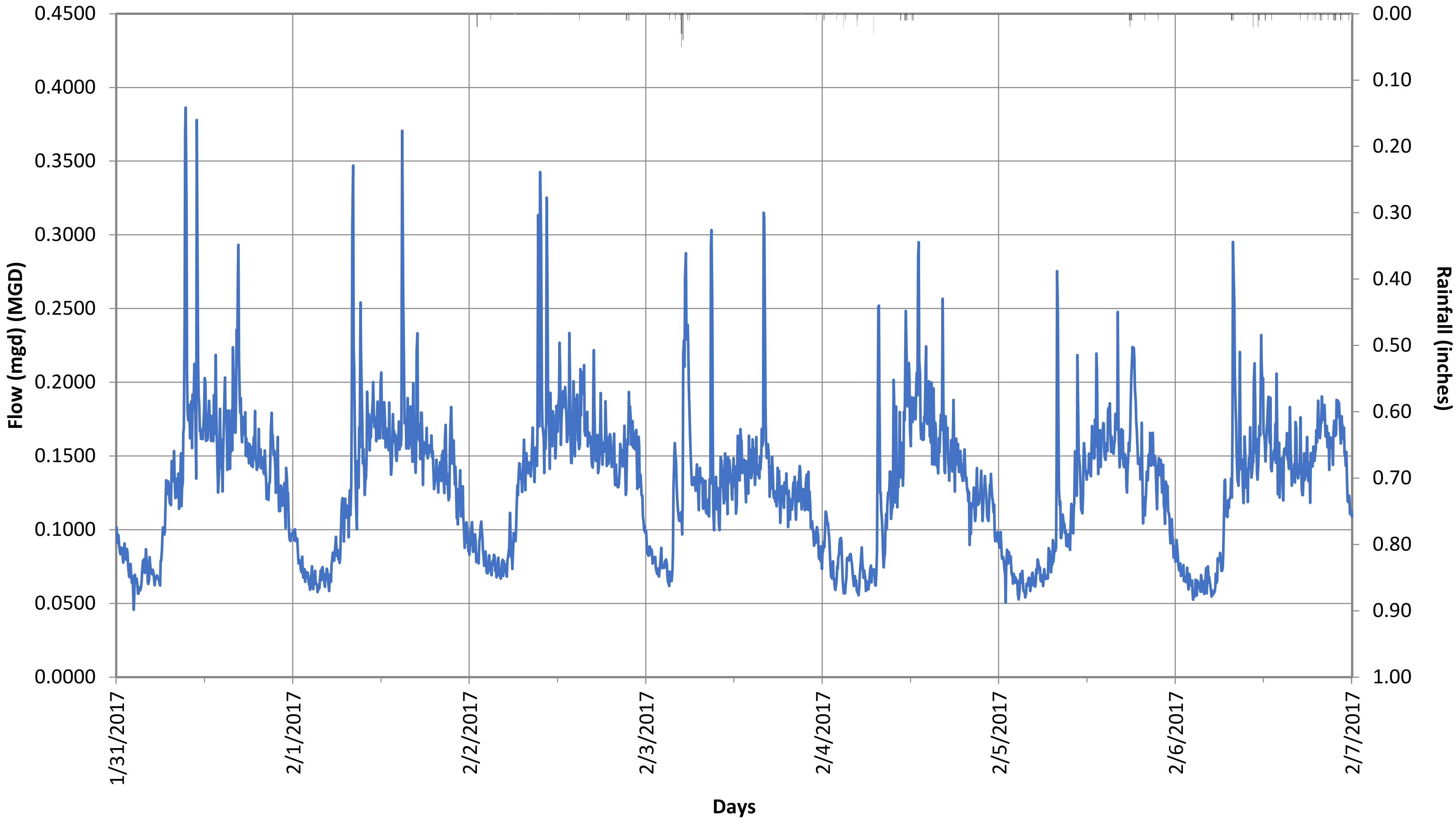
	1/17/2017(Tue)	1/18/2017(Wed)	1/19/2017(Thu)	1/20/2017(Fri)	1/21/2017(Sat)	1/22/2017(Sun)	1/23/2017(Mon)
Maximum	0.000	0.456	0.294	0.859	0.356	0.413	0.350
Average	0.000	0.062	0.131	0.160	0.141	0.148	0.137
Minimum	0.000	0.000	0.057	0.062	0.066	0.057	0.065
Rain (inches)	0.00	0.53	0.02	1.13	0.25	1.00	0.18

Colma Site 3 SSMH 9E76 North 10" Sanitary Flow



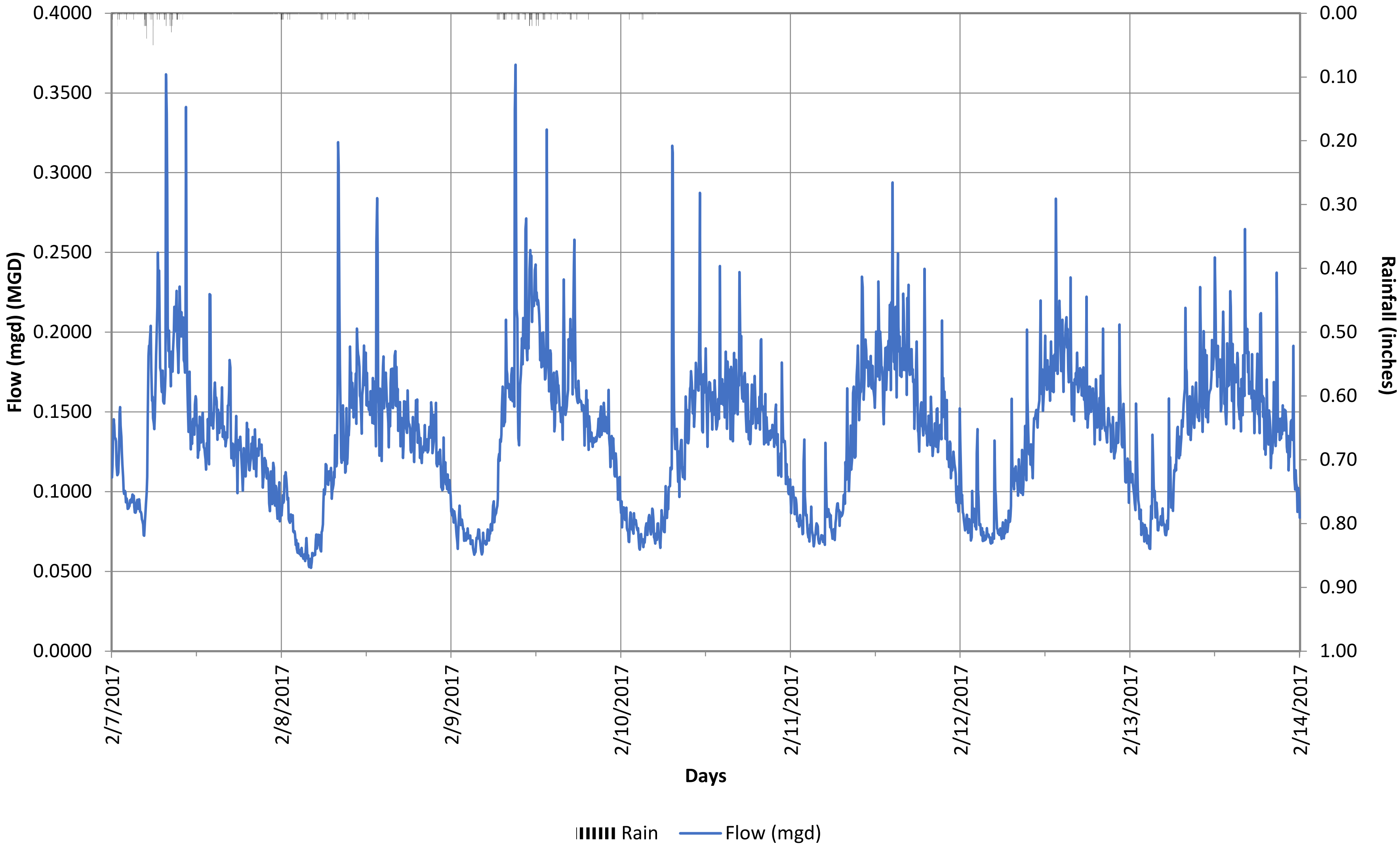
	1/24/2017(Tue)	1/25/2017(Wed)	1/26/2017(Thu)	1/27/2017(Fri)	1/28/2017(Sat)	1/29/2017(Sun)	1/30/2017(Mon)
Maximum	0.384	0.362	0.378	0.403	0.313	0.320	0.368
Average	0.134	0.128	0.136	0.138	0.139	0.126	0.137
Minimum	0.058	0.061	0.051	0.056	0.062	0.058	0.062
Rain (inches)	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Colma Site 3 SSMH 9E76 North 10" Sanitary Flow



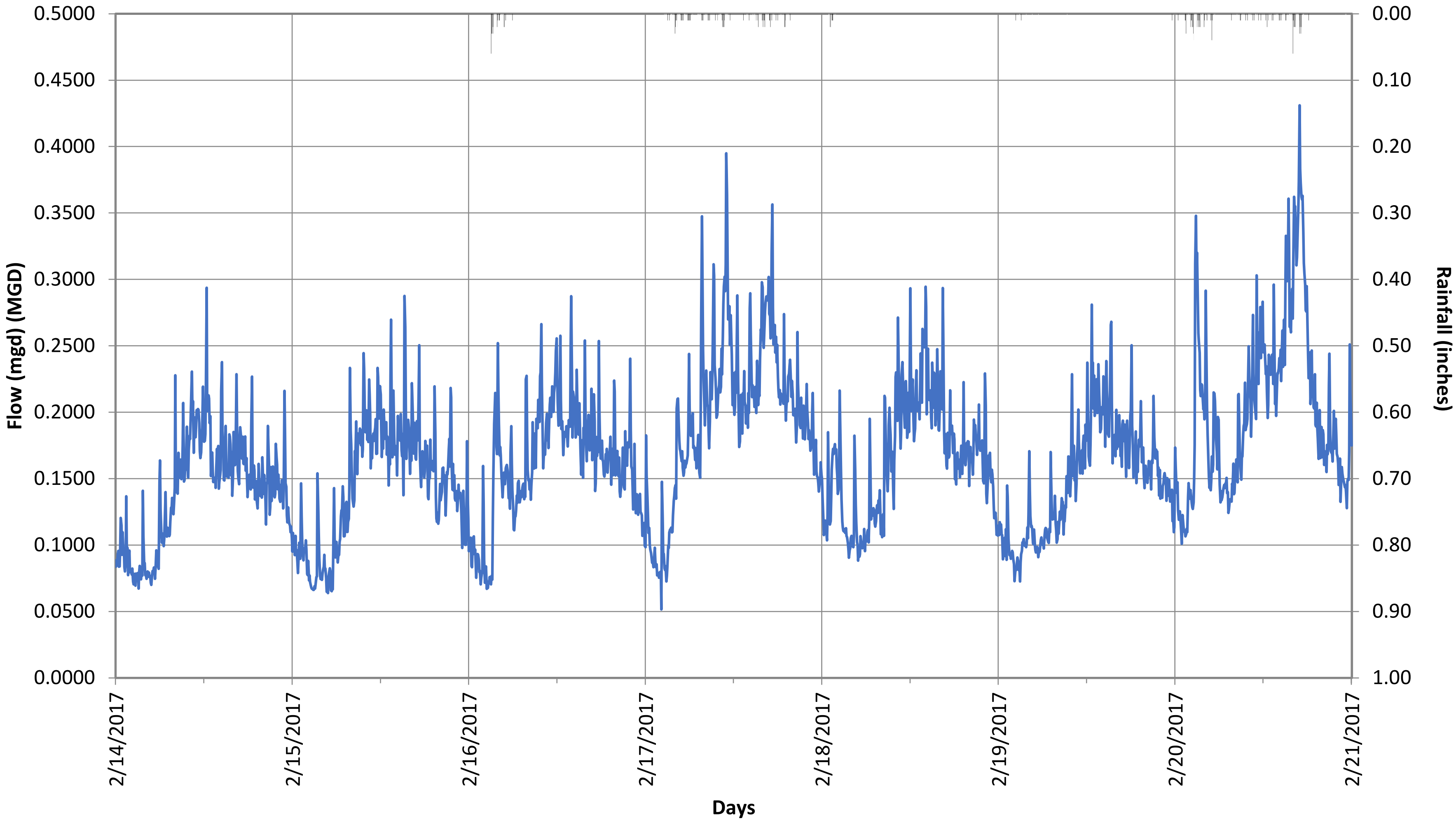
	1/31/2017(Tue)	2/1/2017(Wed)	2/2/2017(Thu)	2/3/2017(Fri)	2/4/2017(Sat)	2/5/2017(Sun)	2/6/2017(Mon)
Maximum	0.386	0.371	0.343	0.315	0.295	0.275	0.295
Average	0.137	0.133	0.142	0.128	0.126	0.120	0.131
Minimum	0.046	0.058	0.067	0.062	0.056	0.050	0.053
Rain (inches)	0.00	0.01	0.19	0.51	0.37	0.15	0.50

Colma Site 3 SSMH 9E76 North 10" Sanitary Flow



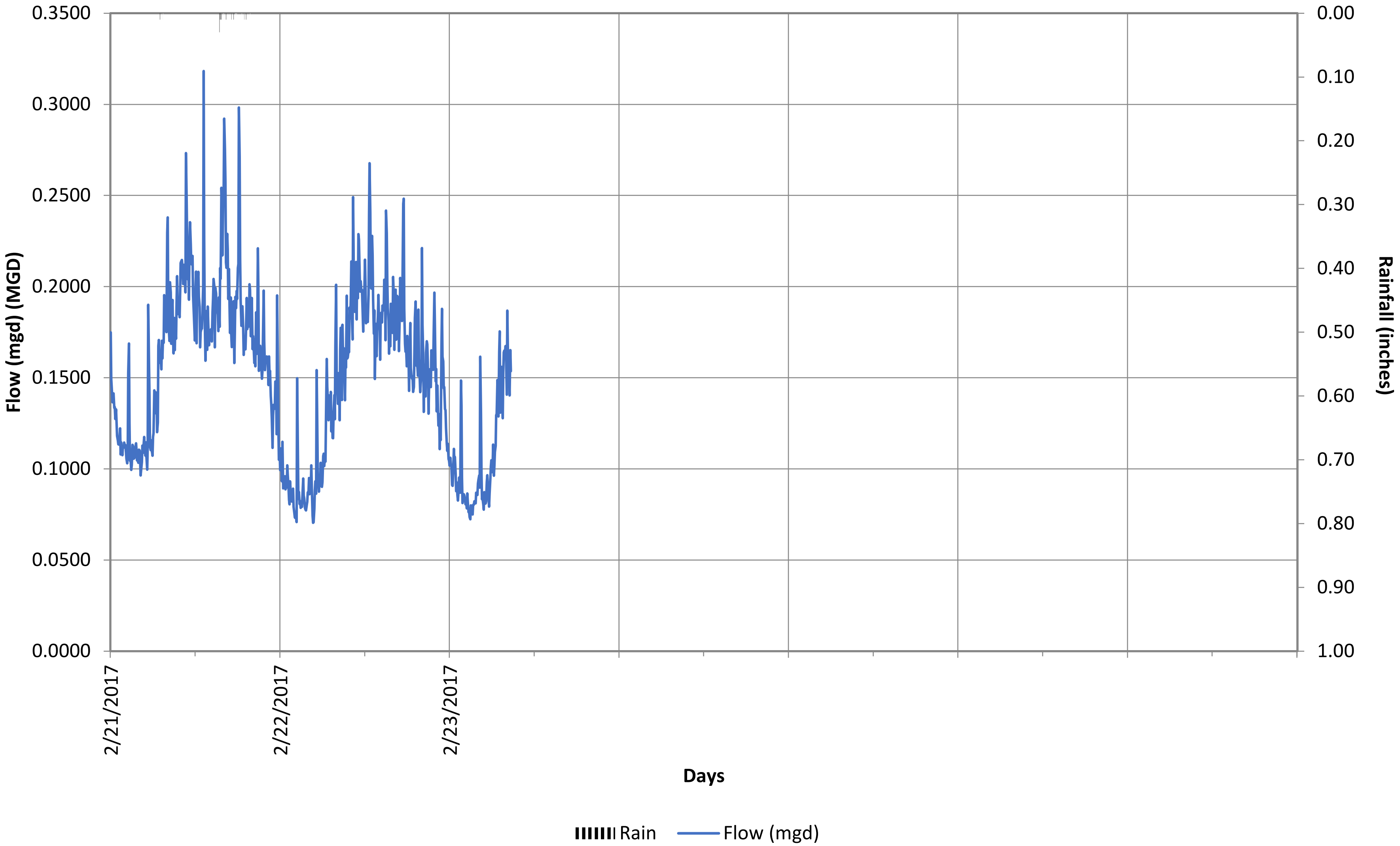
	2/7/2017(Tue)	2/8/2017(Wed)	2/9/2017(Thu)	2/10/2017(Fri)	2/11/2017(Sat)	2/12/2017(Sun)	2/13/2017(Mon)
Maximum	0.362	0.319	0.368	0.317	0.294	0.284	0.265
Average	0.139	0.126	0.142	0.131	0.136	0.132	0.139
Minimum	0.072	0.052	0.060	0.064	0.066	0.068	0.064
Rain (inches)	0.86	0.26	0.77	0.04	0.00	0.00	0.00

Colma Site 3 SSMH 9E76 North 10" Sanitary Flow



	2/14/2017(Tue)	2/15/2017(Wed)	2/16/2017(Thu)	2/17/2017(Fri)	2/18/2017(Sat)	2/19/2017(Sun)	2/20/2017(Mon)
Maximum	0.294	0.288	0.287	0.395	0.295	0.281	0.431
Average	0.140	0.145	0.161	0.197	0.166	0.149	0.205
Minimum	0.067	0.064	0.067	0.052	0.088	0.073	0.101
Rain (inches)	0.00	0.00	0.39	1.23	0.14	0.08	1.61

Colma Site 3 SSMH 9E76 North 10" Sanitary Flow

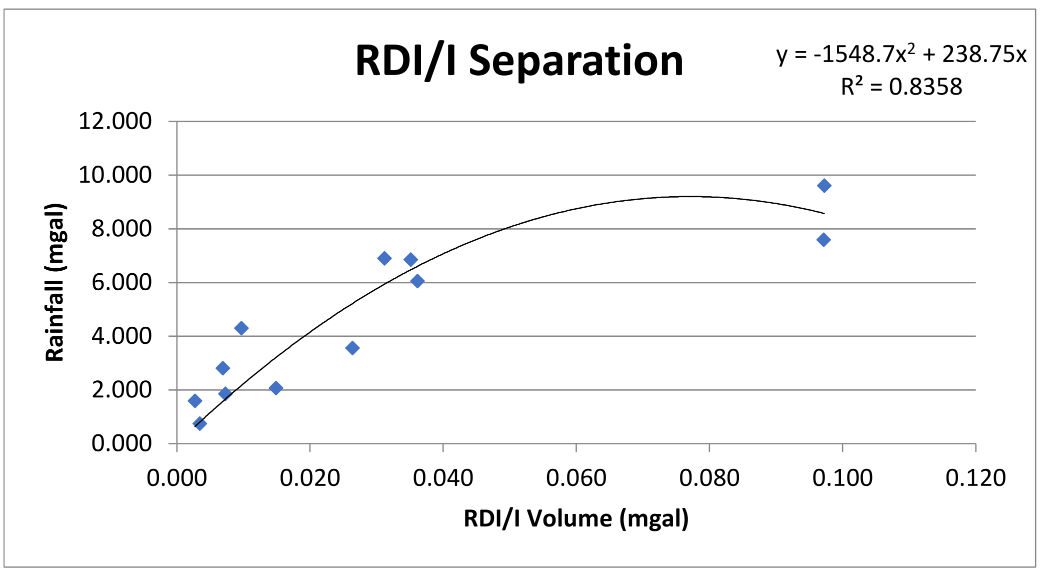


	2/21/2017(Tue)	2/22/2017(Wed)					
Maximum	0.318	0.268					
Average	0.167	0.149					
Minimum	0.096	0.070					
Rain (inches)	0.19	0.00					

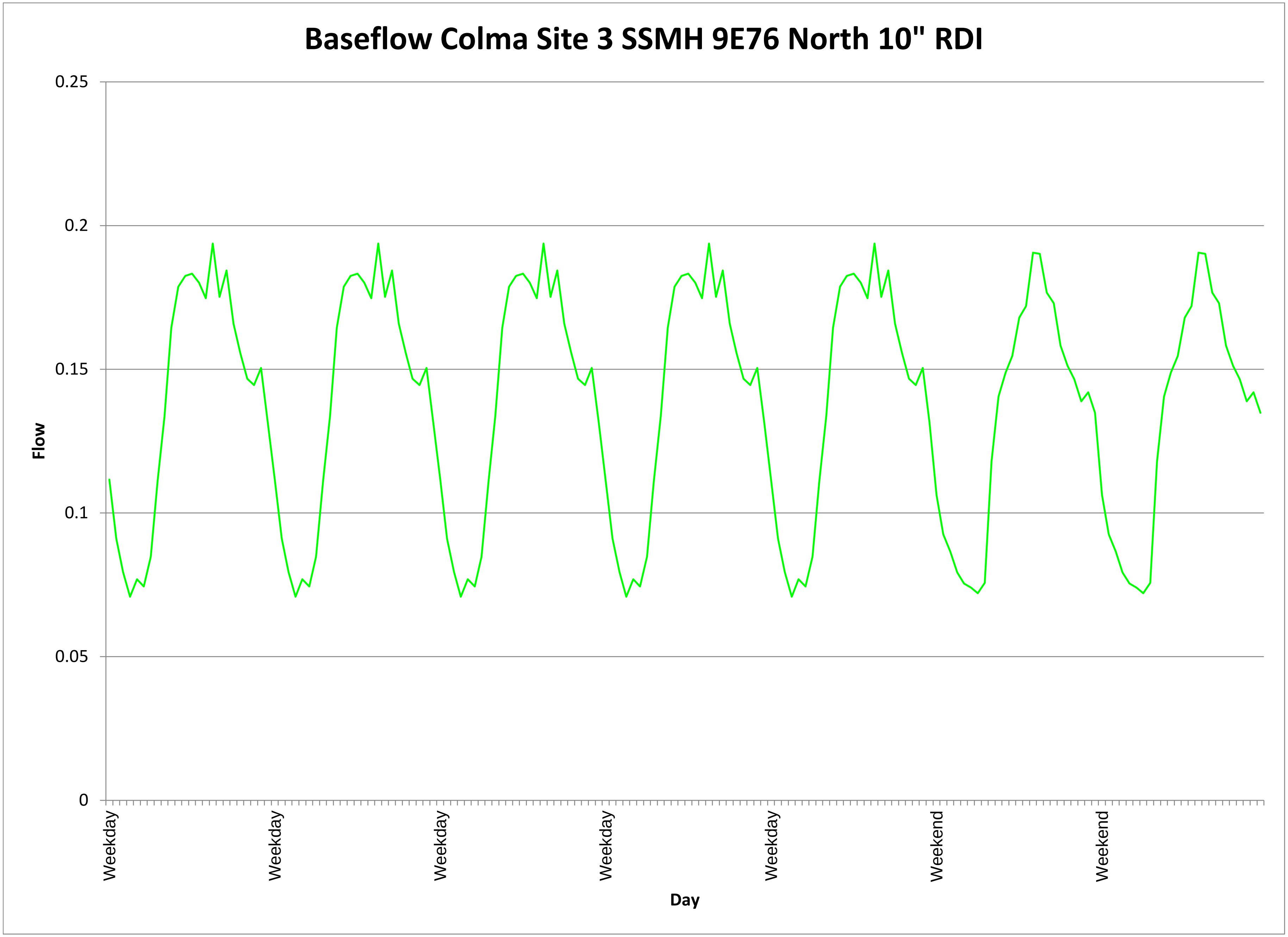
Colma Site 3 SSMH 9E76 North 10" RDI

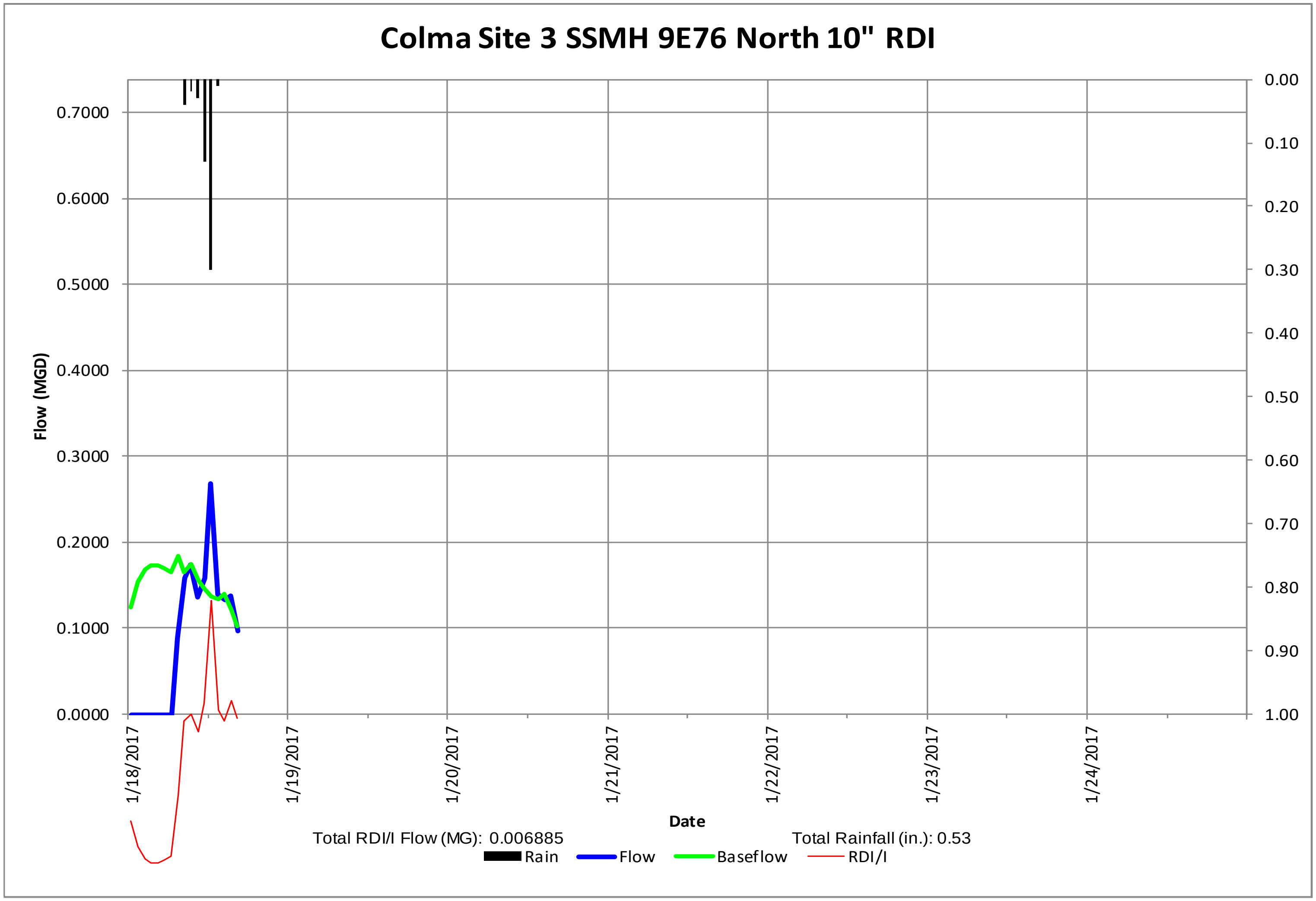
RDI/I Analysis, Monitor Return Ratio Summary

Storm Start (Date)	RDI/I Volume (mgal)	Monitor Area (acres)	Rainfall (mgal)	Return Ratio (%)
1/18/2017	0.007	195.5	2.813	0.24%
1/20/2017	0.036	195.5	6.051	0.60%
1/21/2017	0.035	195.5	6.848	0.51%
2/2/2017	0.026	195.5	3.557	0.74%
2/4/2017	0.007	195.5	1.858	0.39%
2/5/2017	0.003	195.5	0.743	0.46%
2/6/2017	0.031	195.5	6.901	0.45%
2/7/2017	0.003	195.5	1.592	0.17%
2/9/2017	0.010	195.5	4.300	0.23%
2/16/2017	0.015	195.5	2.070	0.72%
2/17/2017	0.097	195.5	7.591	1.28%
2/20/2017	0.097	195.5	9.608	1.01%
Average R%				0.57%
Average top 3 storms				1.01%

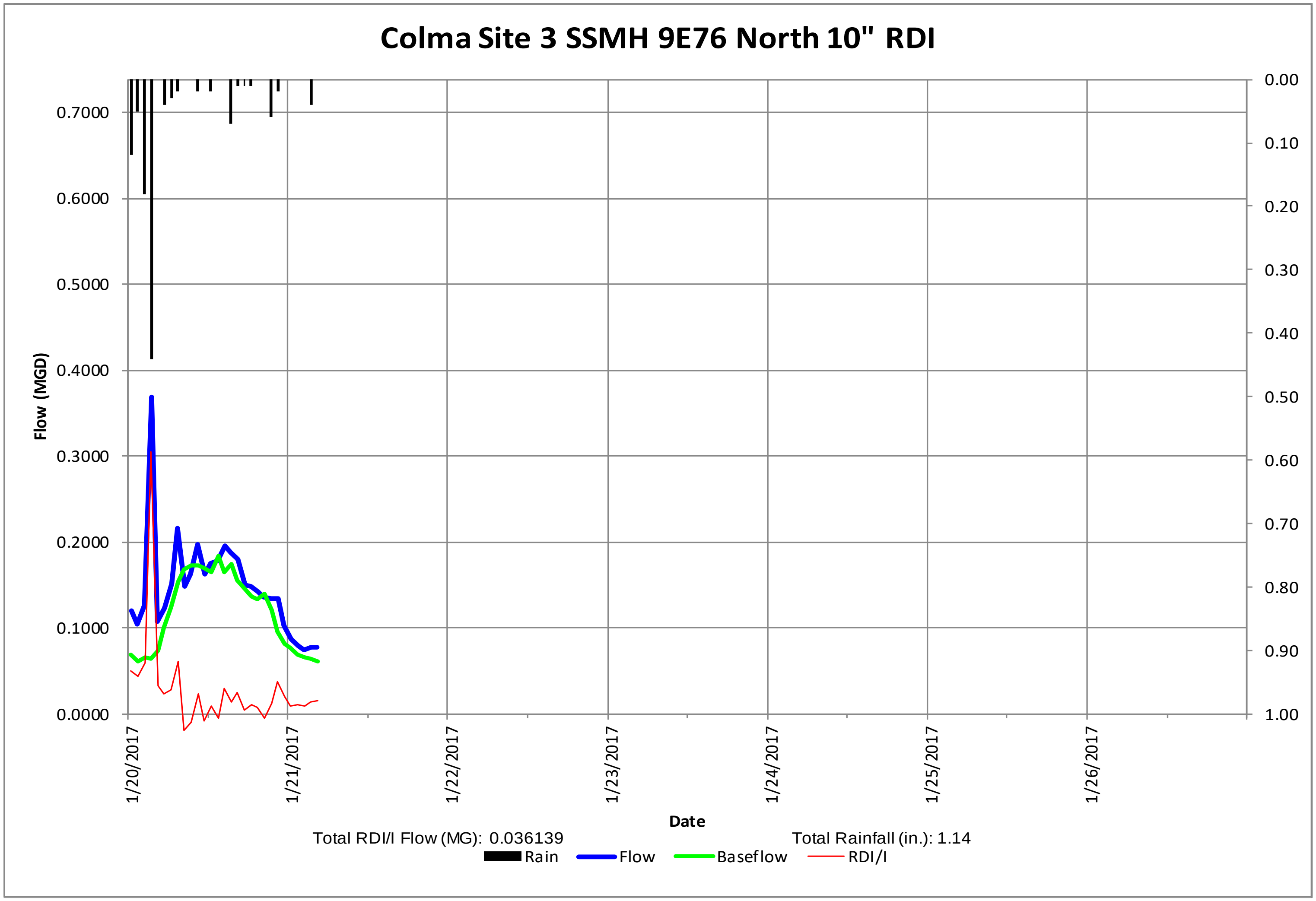


Baseflows	Weekend	Weekday
Max	0.191	0.194
Avg	0.132	0.139
Min	0.072	0.071

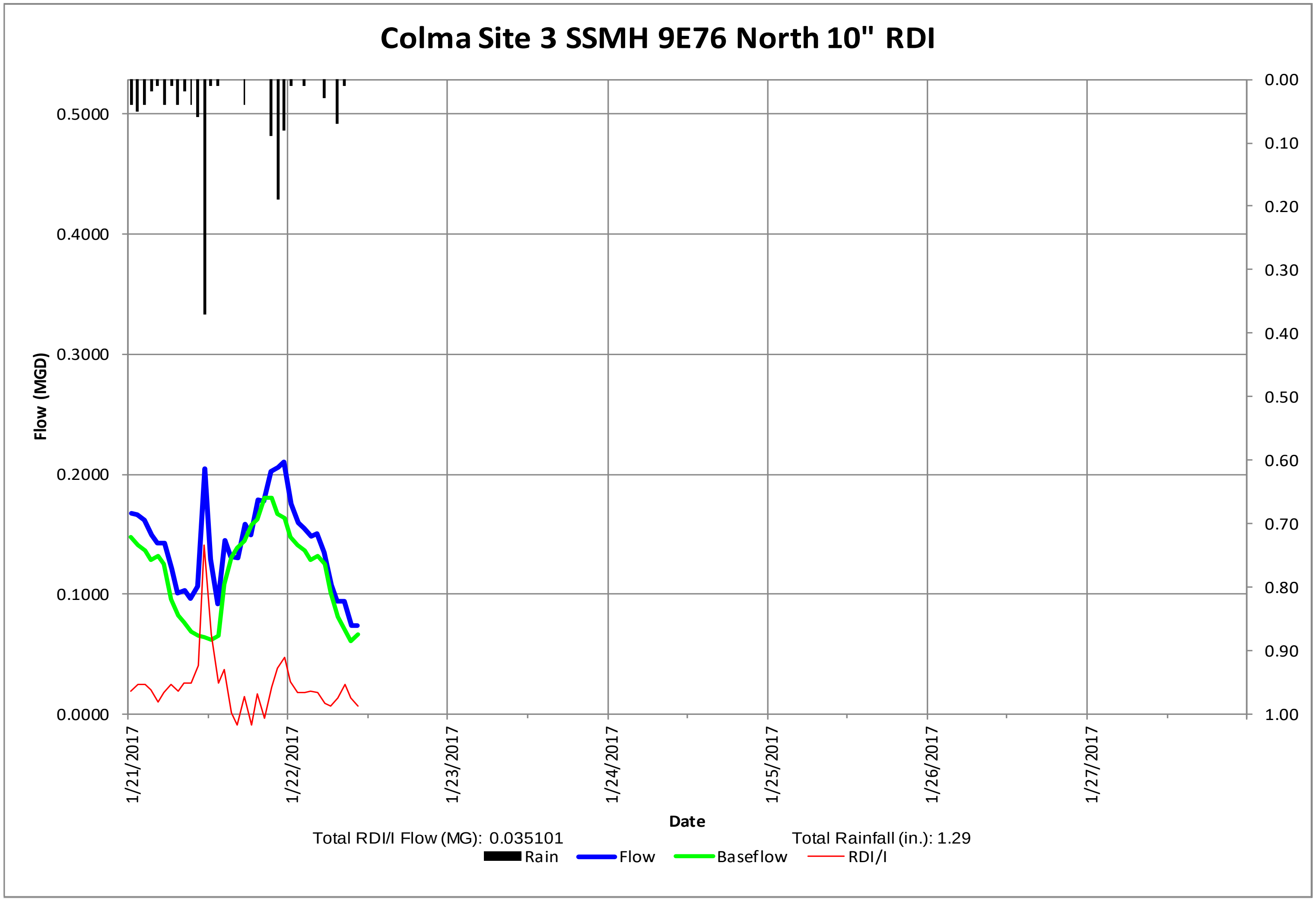

Baseflow Colma Site 3 SSMH 9E76 North 10" RDI
0.25
0.2
0.15
0.1
0.05
0
Flow
Weekday
Weekday
Weekday
Weekday
Weekday
Weekend
Weekend
Day



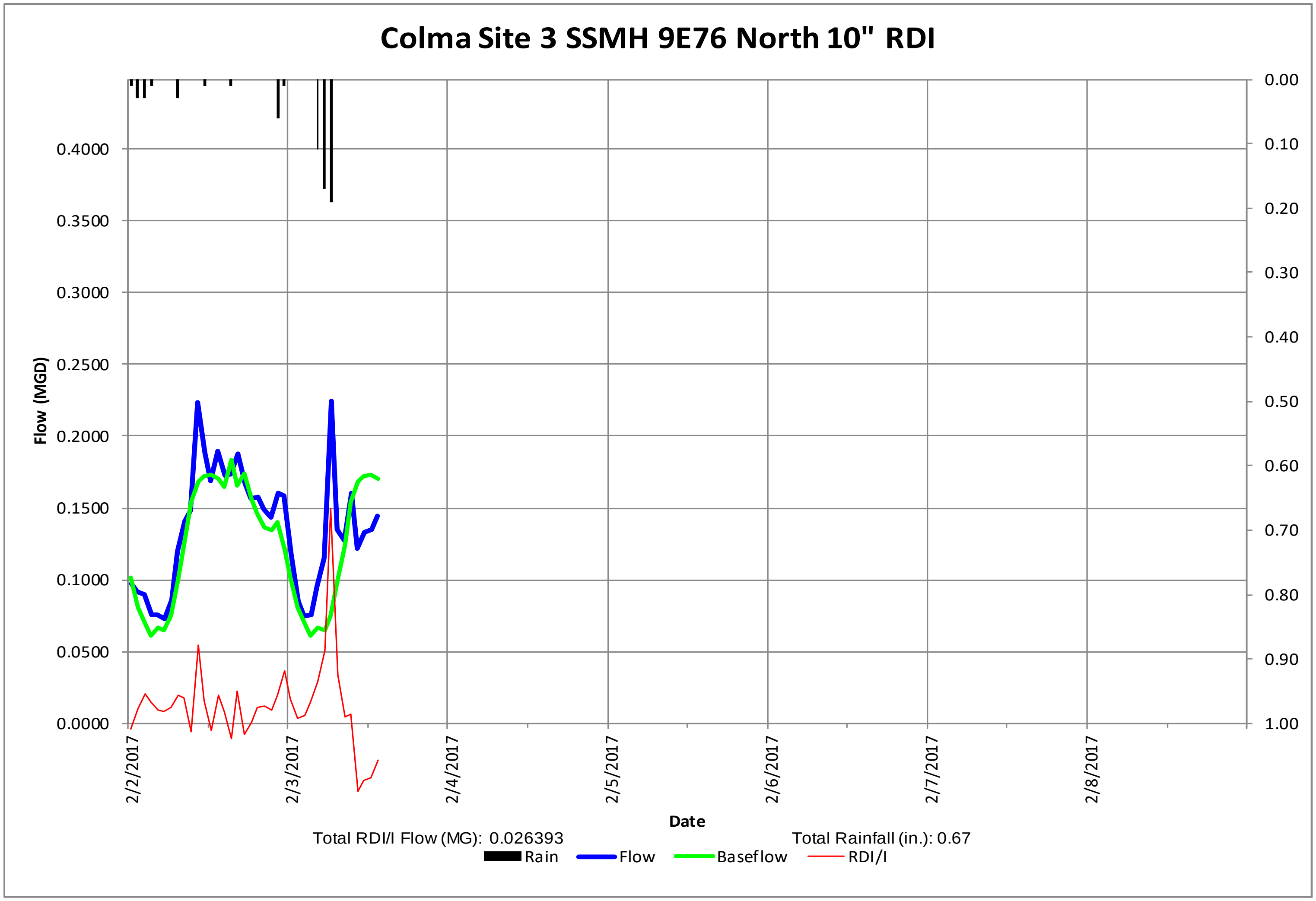
Storm of 1/18/2017



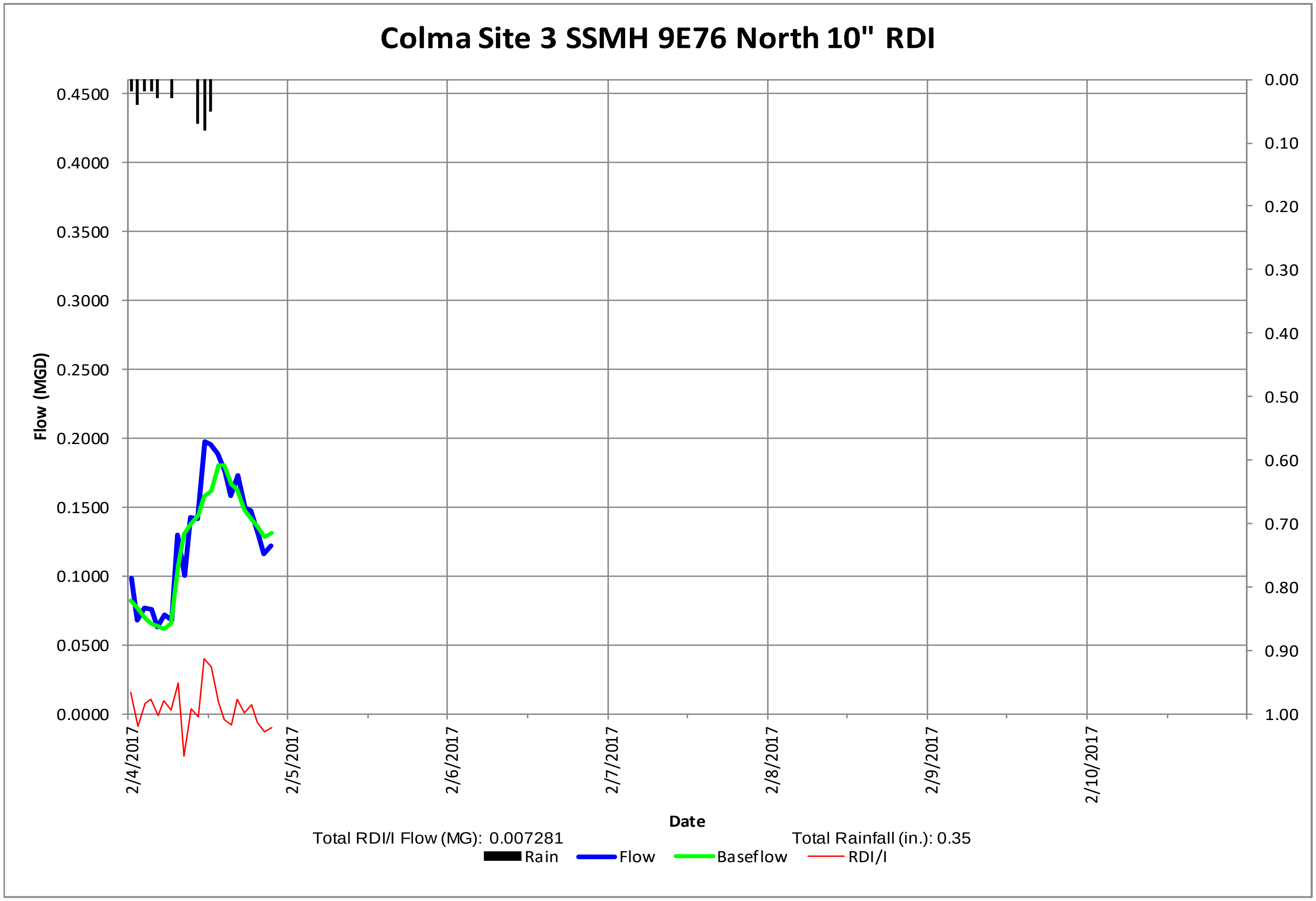
Storm of 1/20/2017



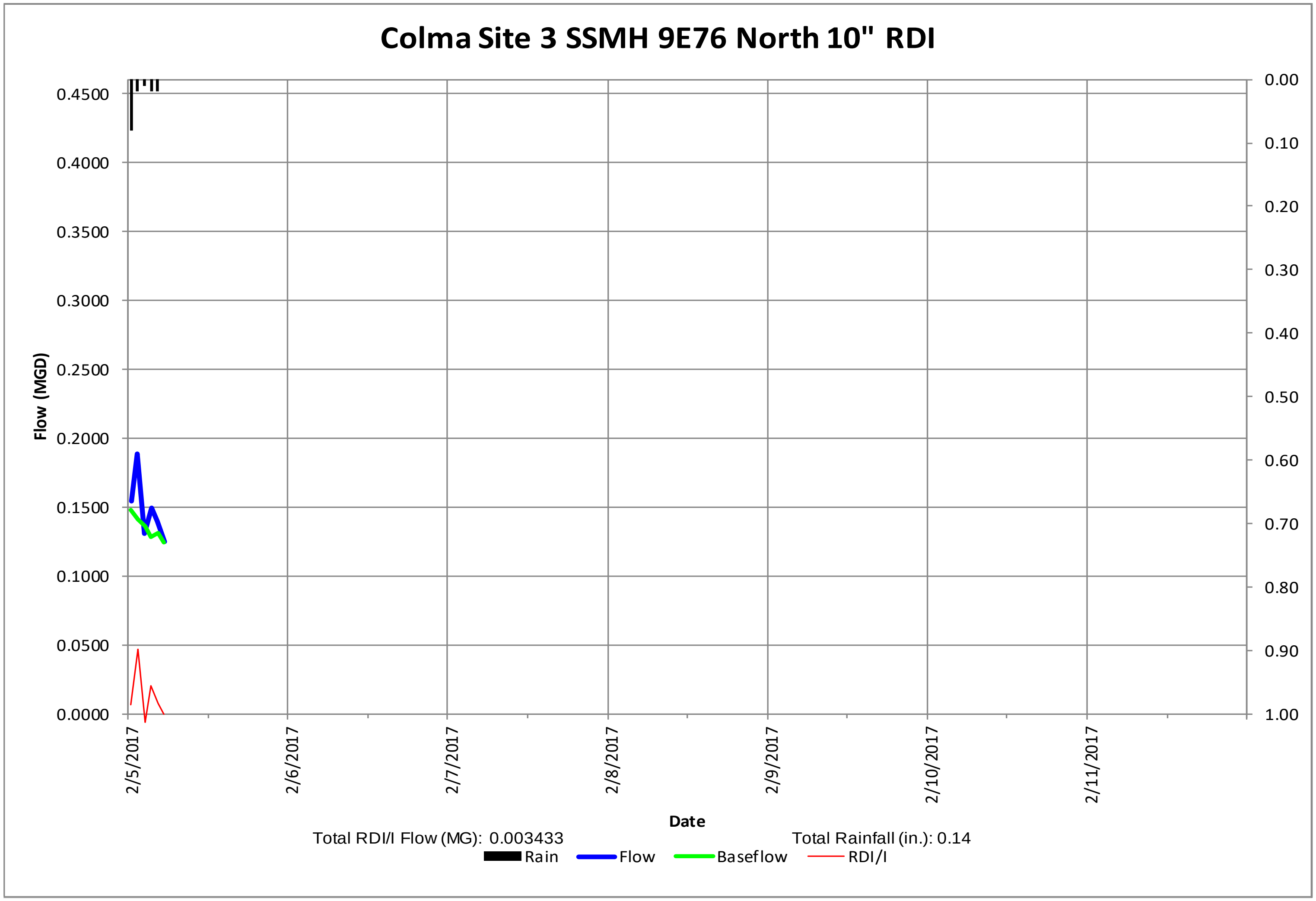
Storm of 1/21/2017



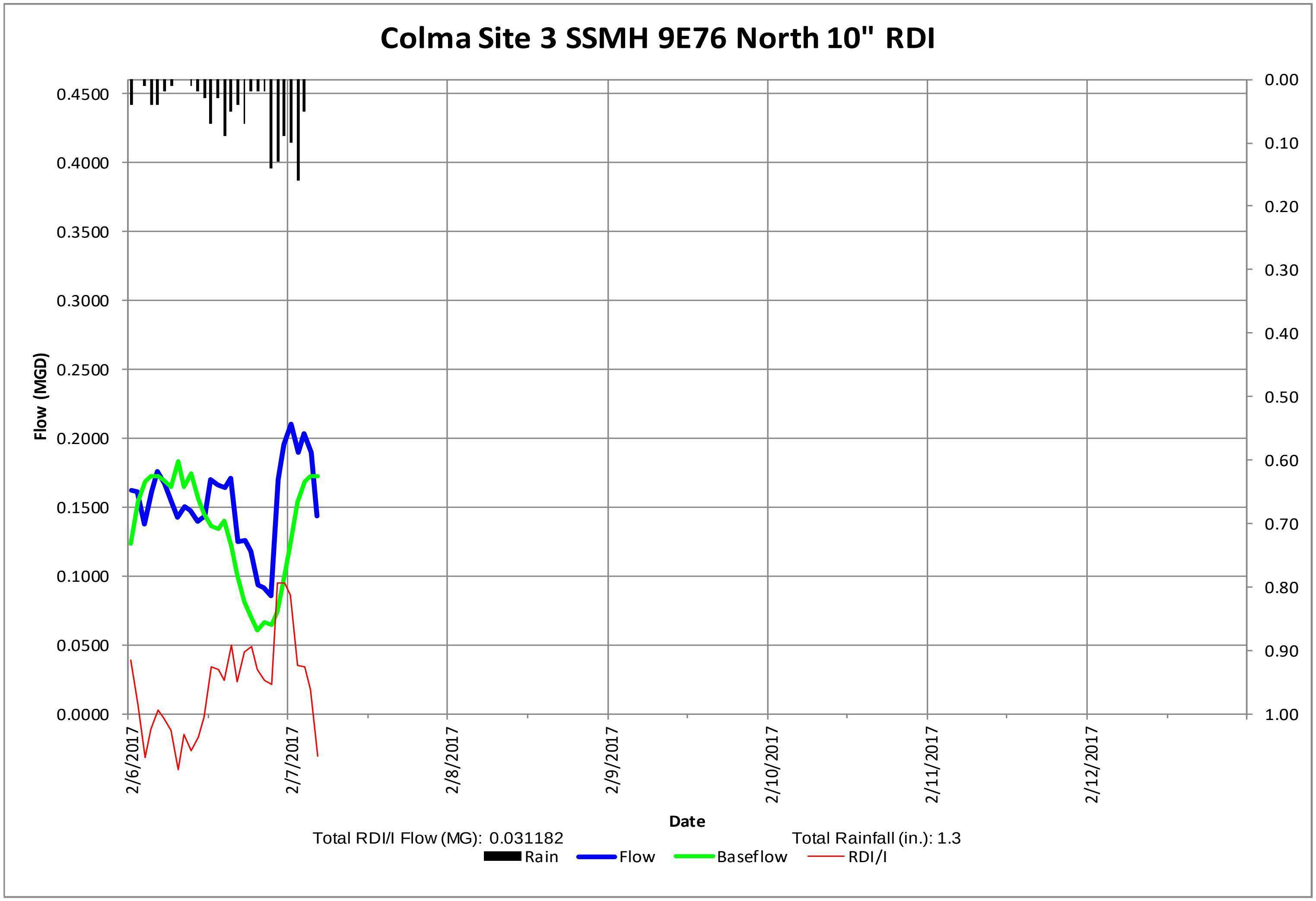
Storm of 2/2/2017



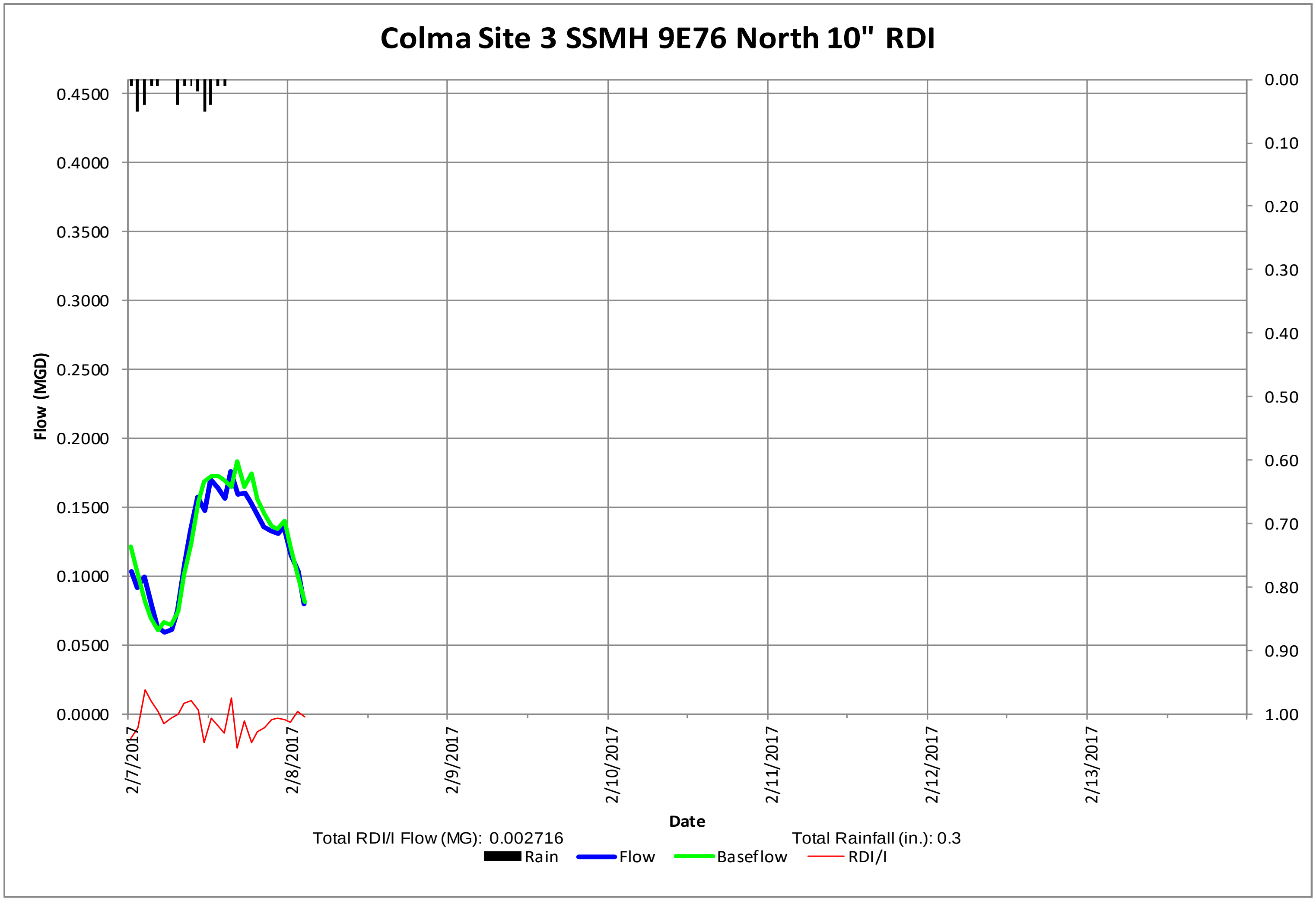
Storm of 2/4/2017



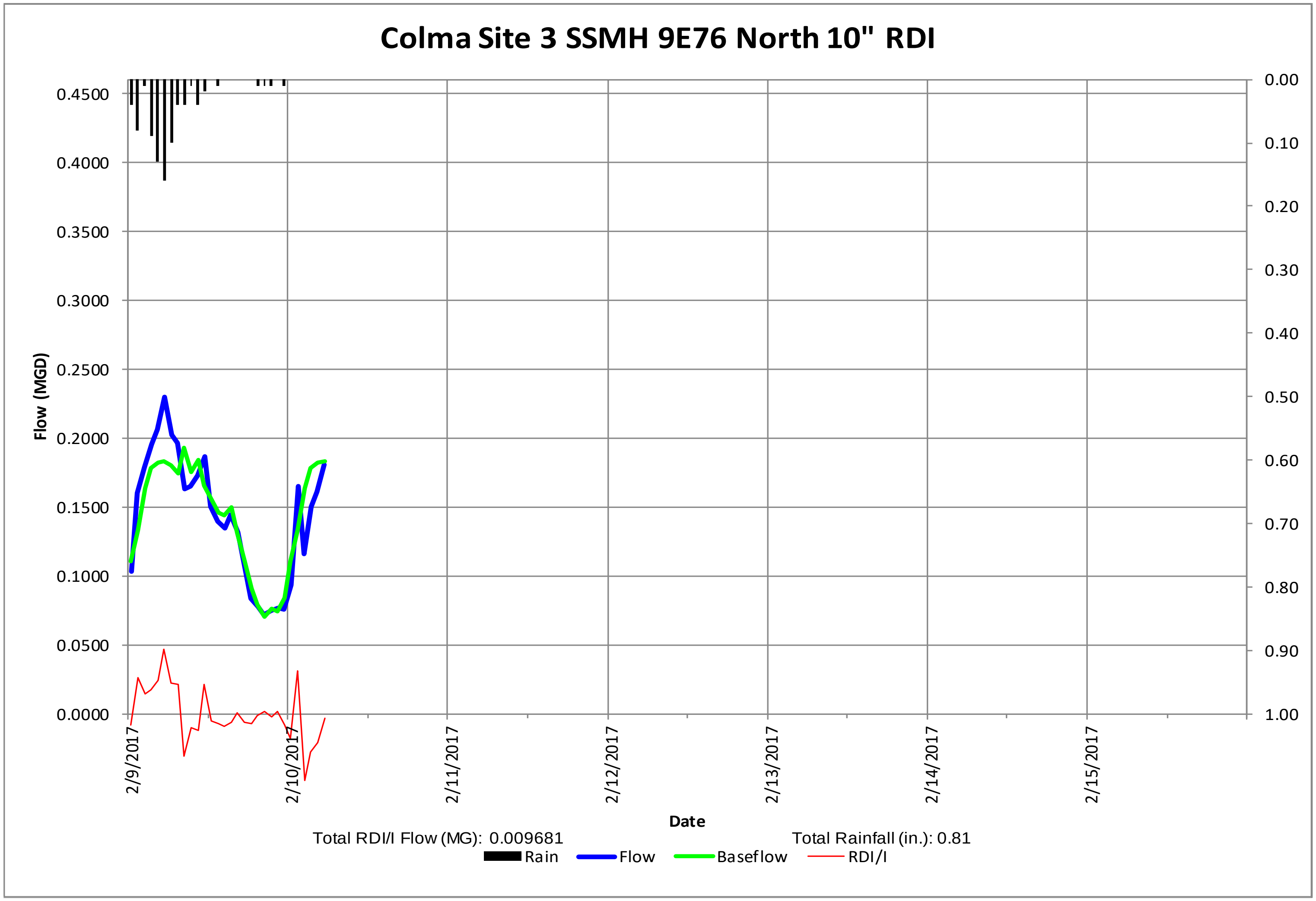
Storm of 2/5/2017



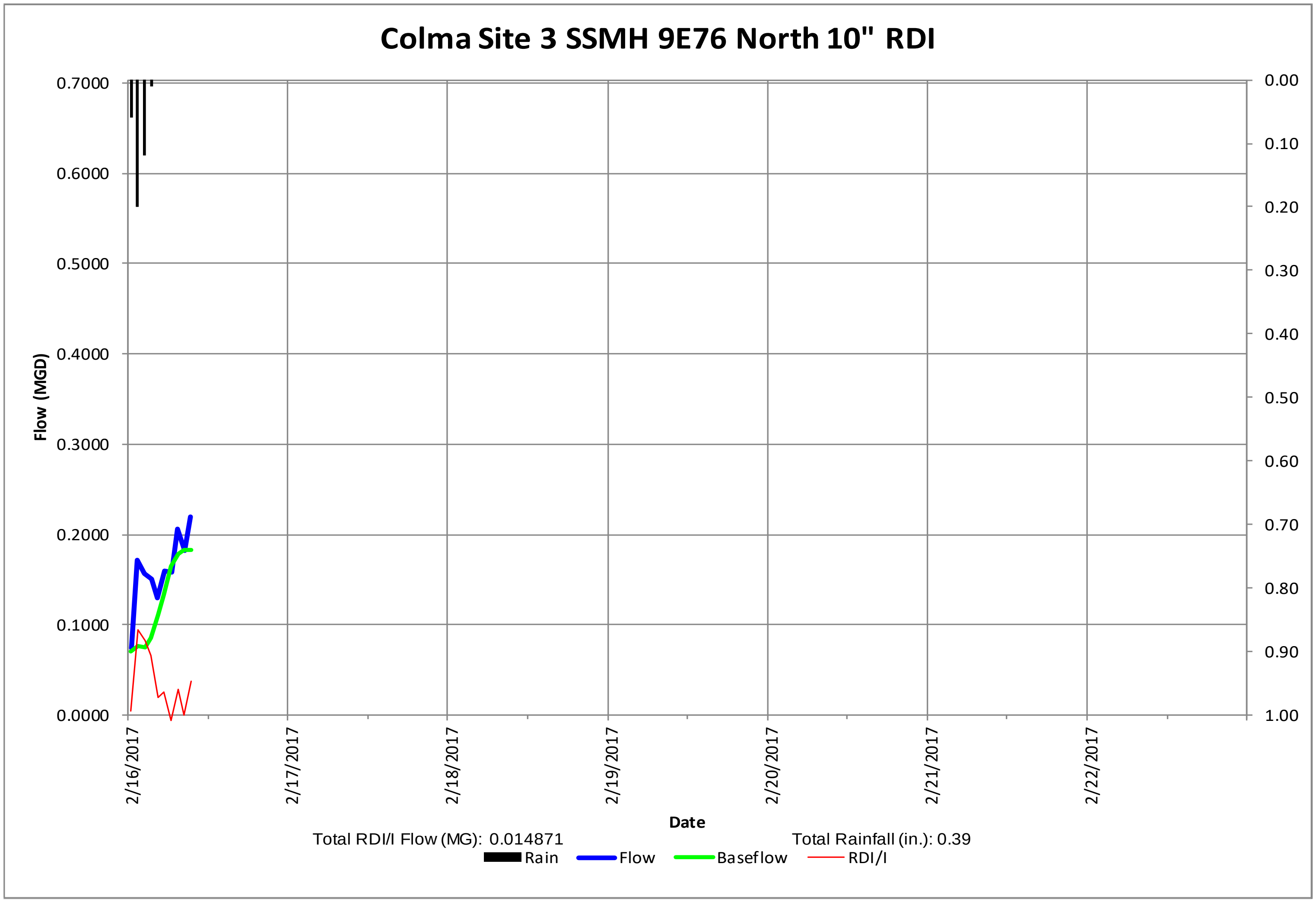
Storm of 2/6/2017



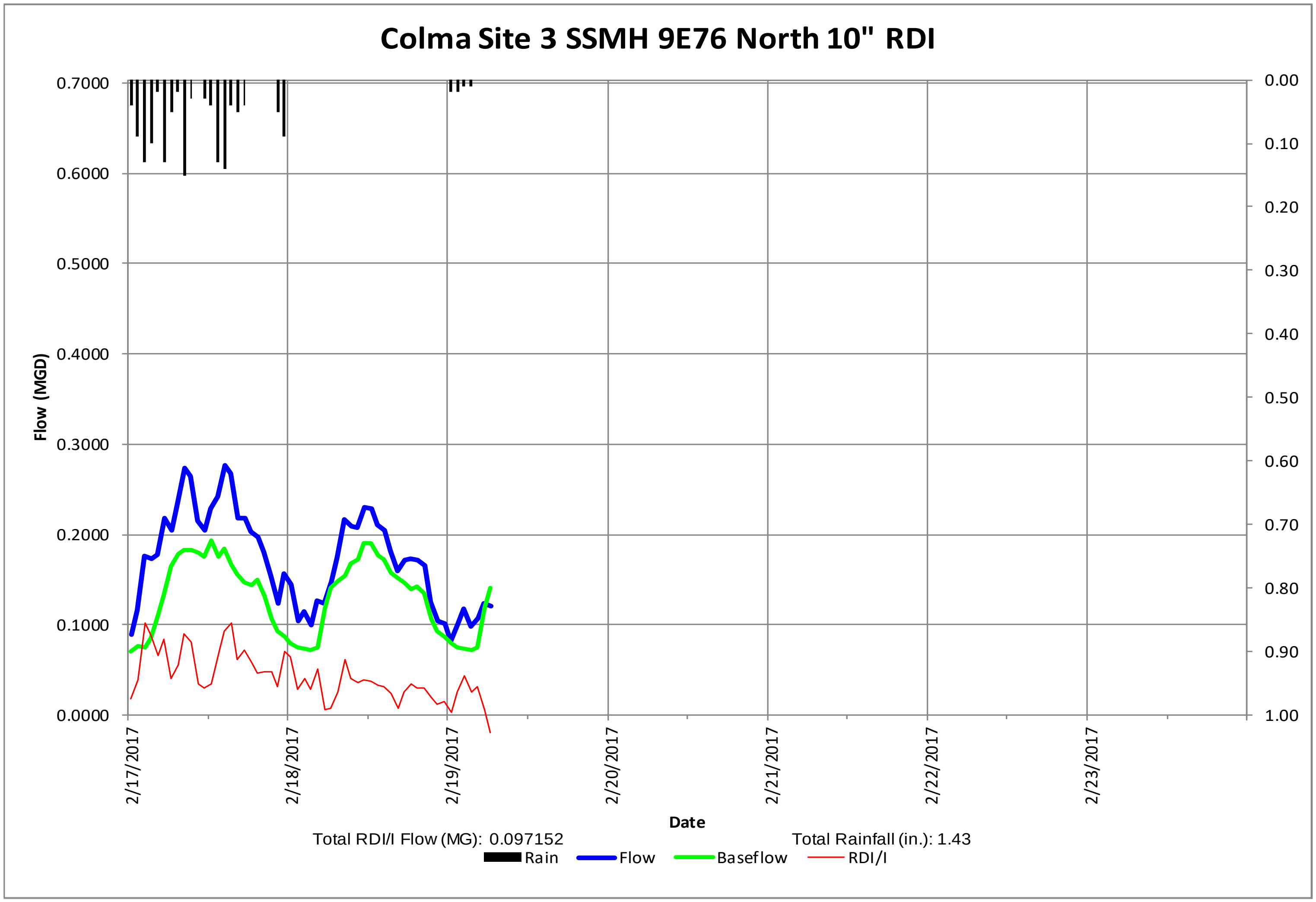
Storm of 2/7/2017



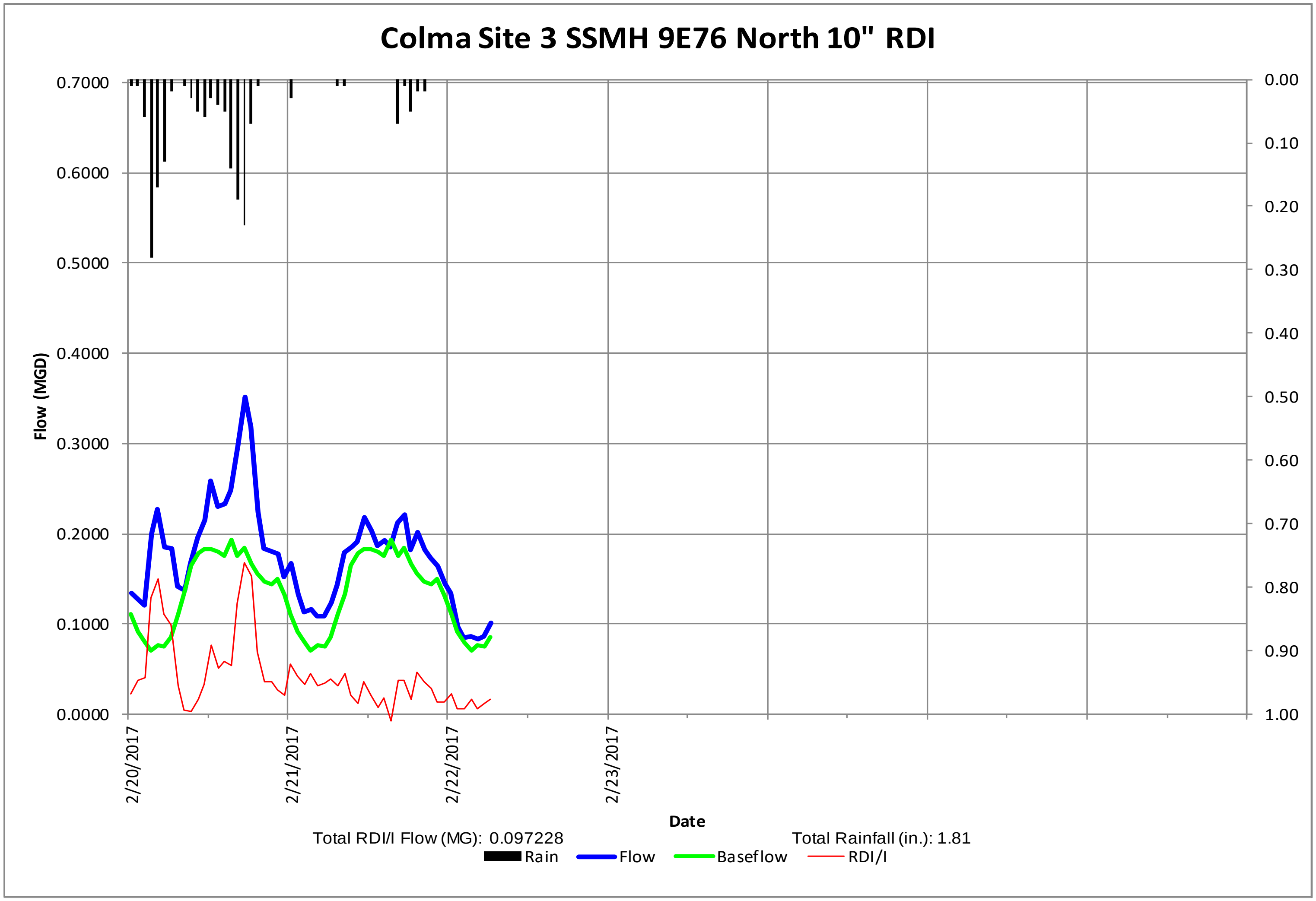
Storm of 2/9/2017



Storm of 2/16/2017



Storm of 2/17/2017

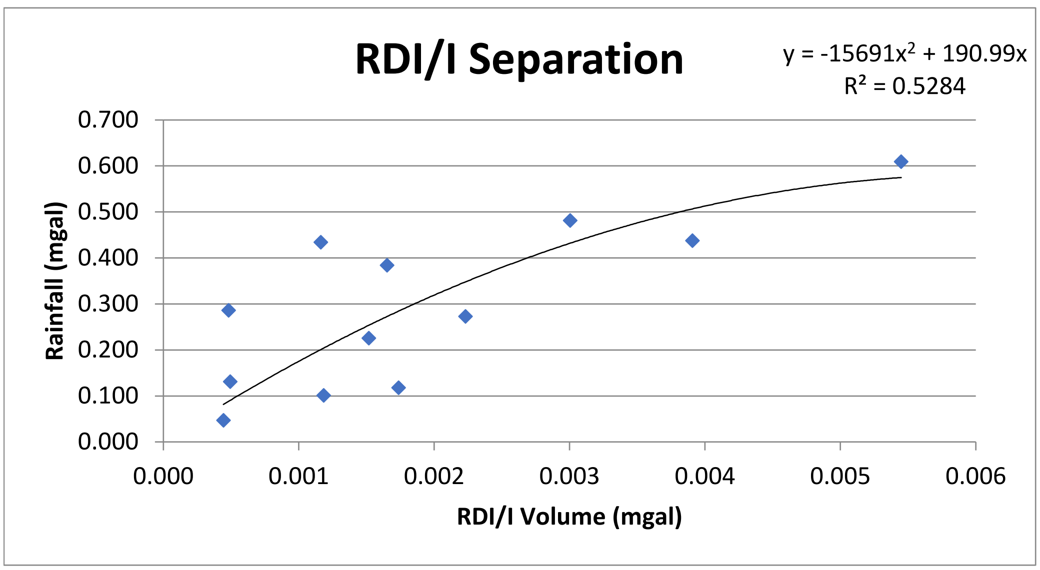


Storm of 2/20/2017

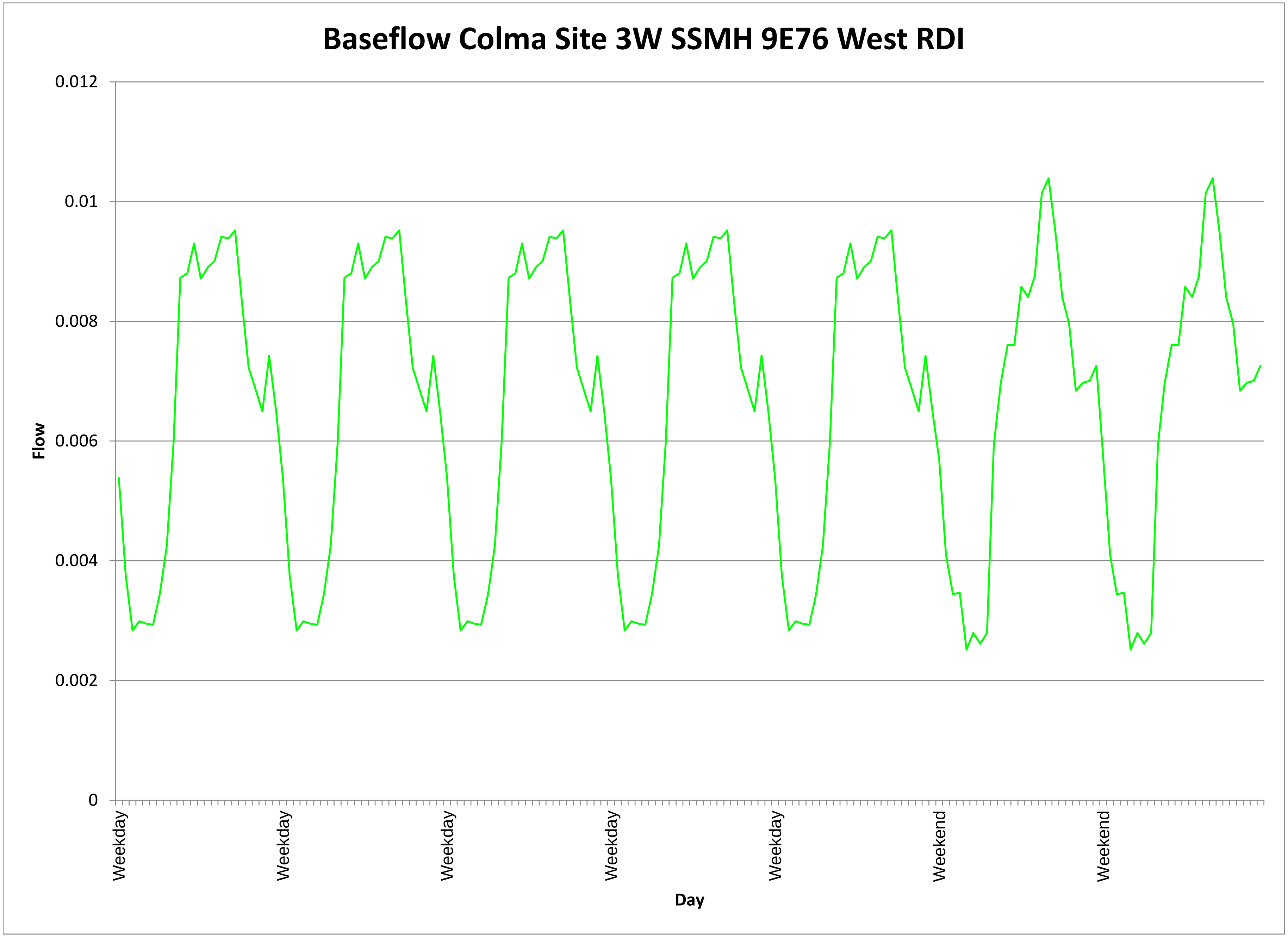
Colma Site 3W SSMH 9E76 West RDI

RDI/I Analysis, Monitor Return Ratio Summary

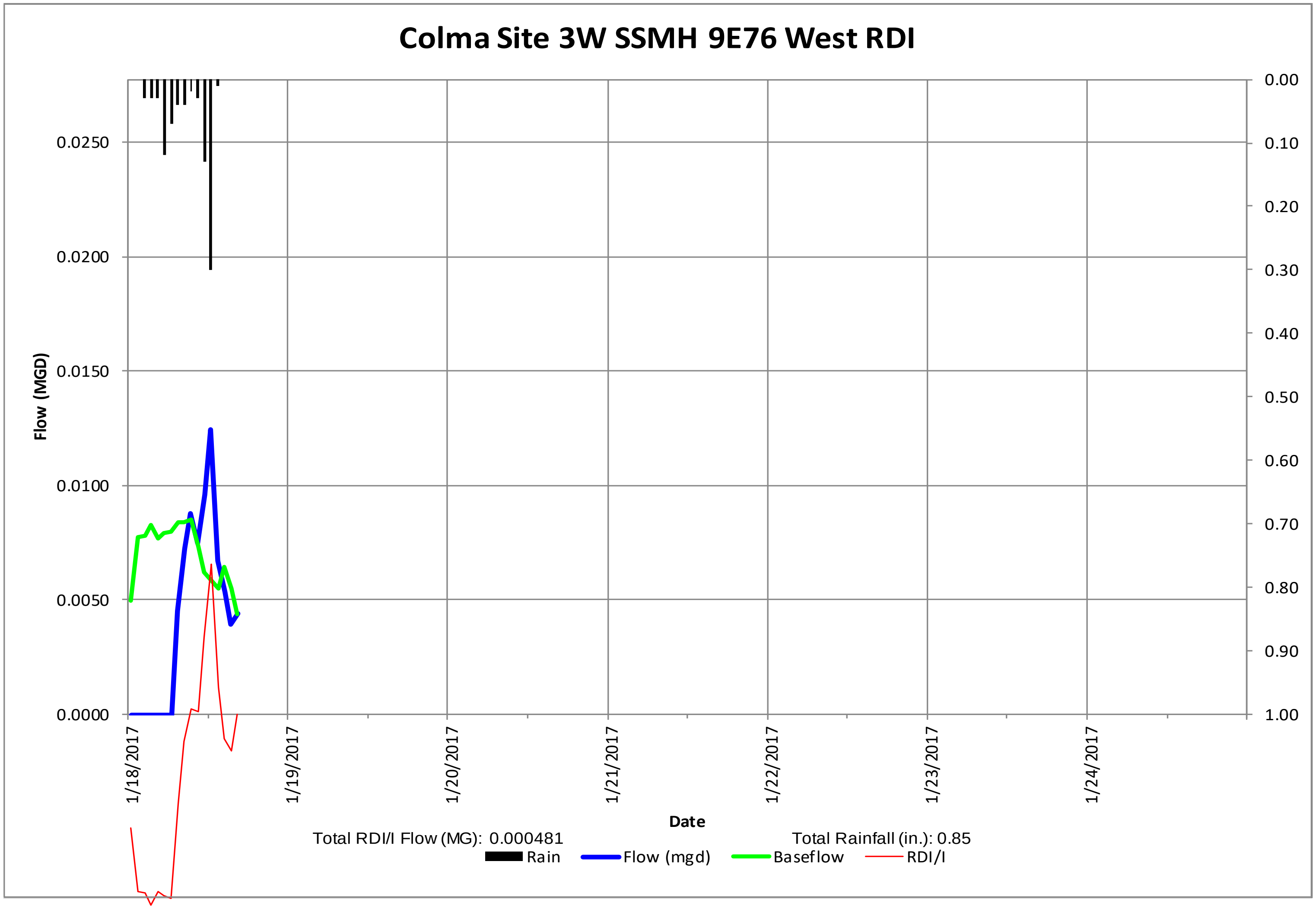
Storm Start (Date)	RDI/I Volume (mgal)	Monitor Area (acres)	Rainfall (mgal)	Return Ratio (%)
1/18/2017	0.000	12.4	0.286	0.17%
1/20/2017	0.002	12.4	0.384	0.43%
1/21/2017	0.001	12.4	0.434	0.27%
2/2/2017	0.002	12.4	0.226	0.67%
2/4/2017	0.002	12.4	0.118	1.47%
2/5/2017	0.000	12.4	0.047	0.94%
2/6/2017	0.004	12.4	0.438	0.89%
2/7/2017	0.001	12.4	0.101	1.17%
2/9/2017	0.002	12.4	0.273	0.82%
2/16/2017	0.000	12.4	0.131	0.38%
2/17/2017	0.003	12.4	0.481	0.62%
2/20/2017	0.005	12.4	0.609	0.89%
Average R%				0.73%
Average Top 3 Storms				1.18%



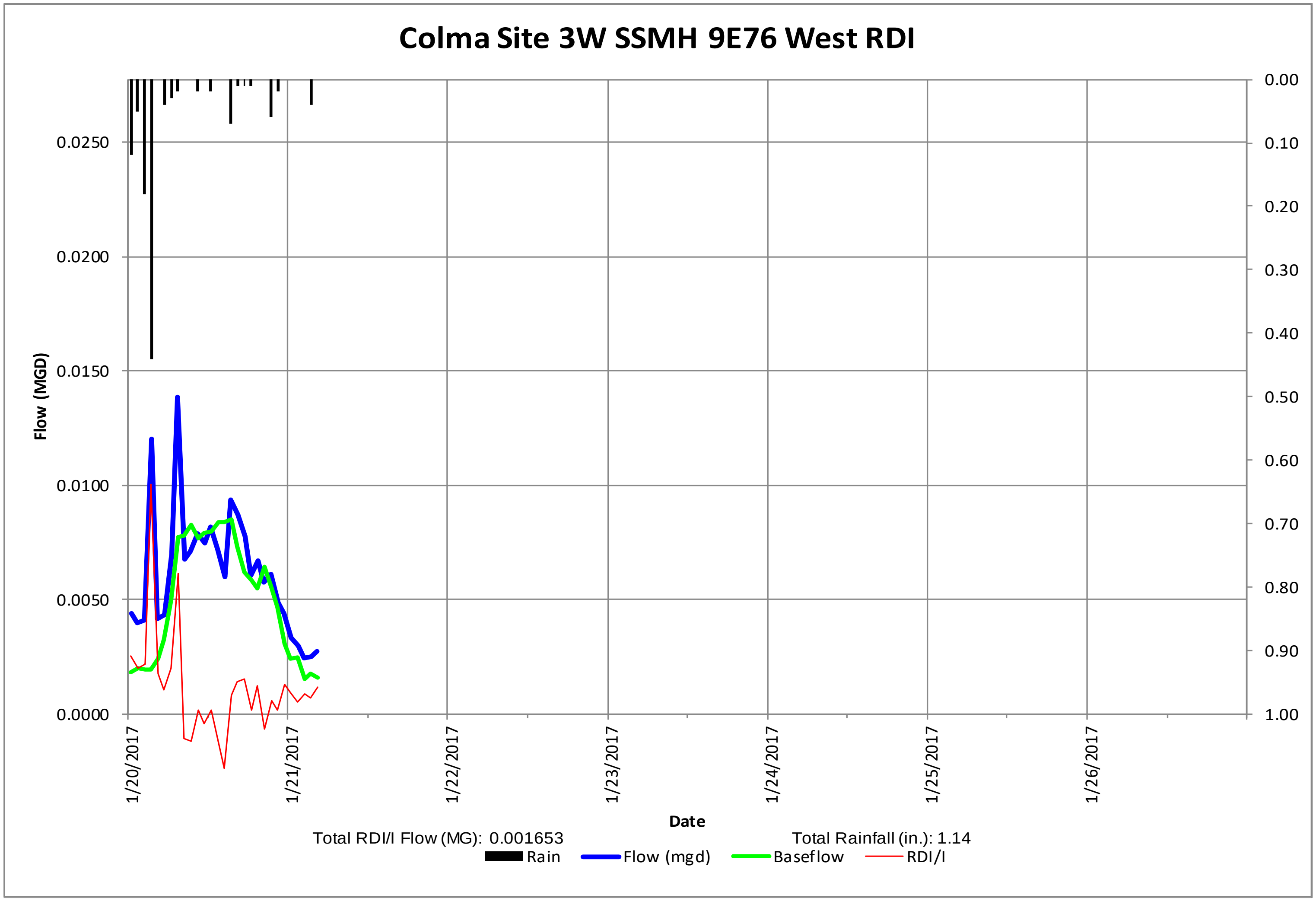
Baseflows	Weekend	Weekday
Max	0.010	0.010
Avg	0.006	0.007
Min	0.003	0.003



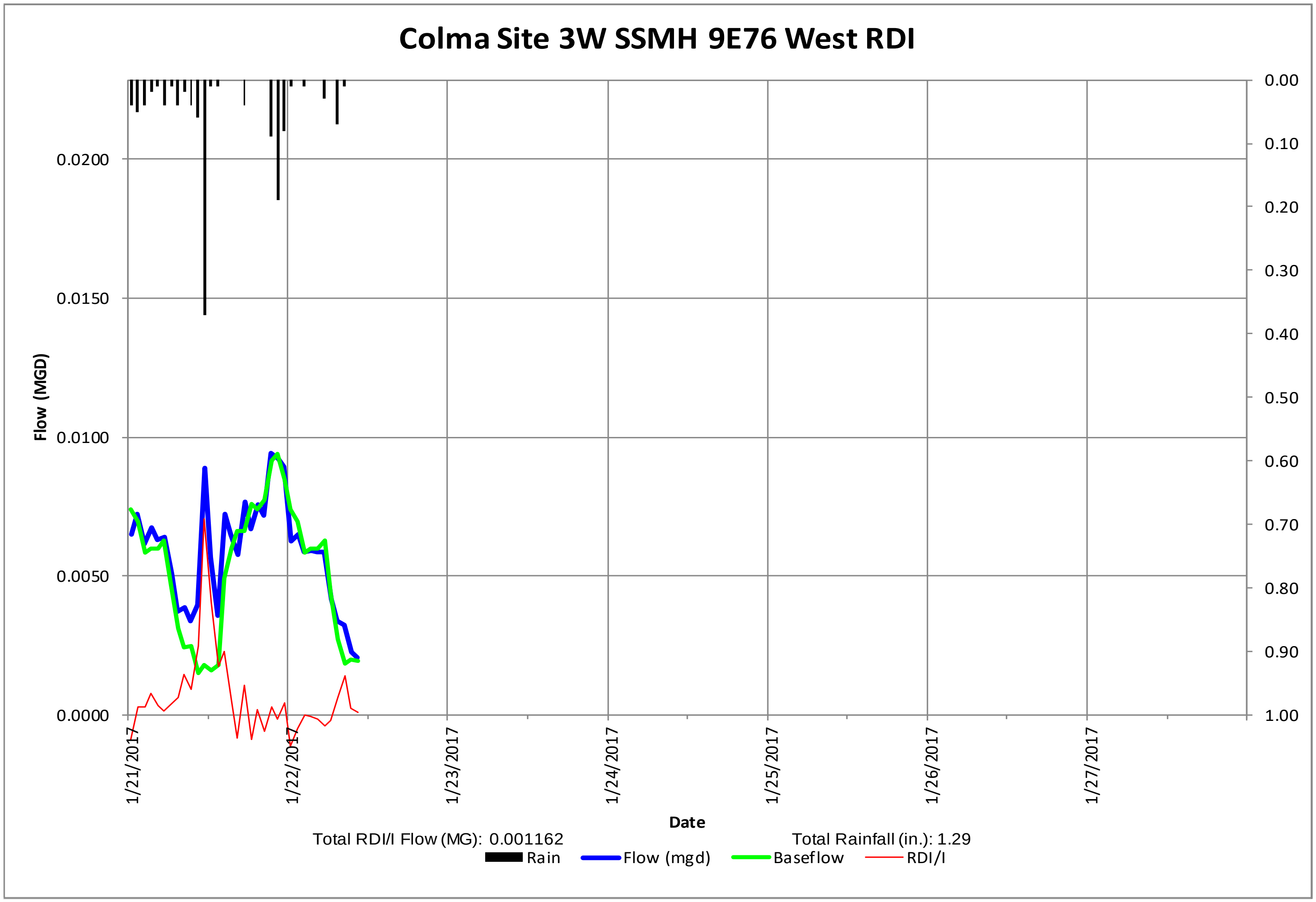
Baseflow Colma Site 3W SSMH 9E76 West RDI
0.012
0.01
0.008
0.006
0.004
0.002
0
Flow
Weekday
Weekday
Weekday
Weekday
Weekday
Weekend
Weekend
Day



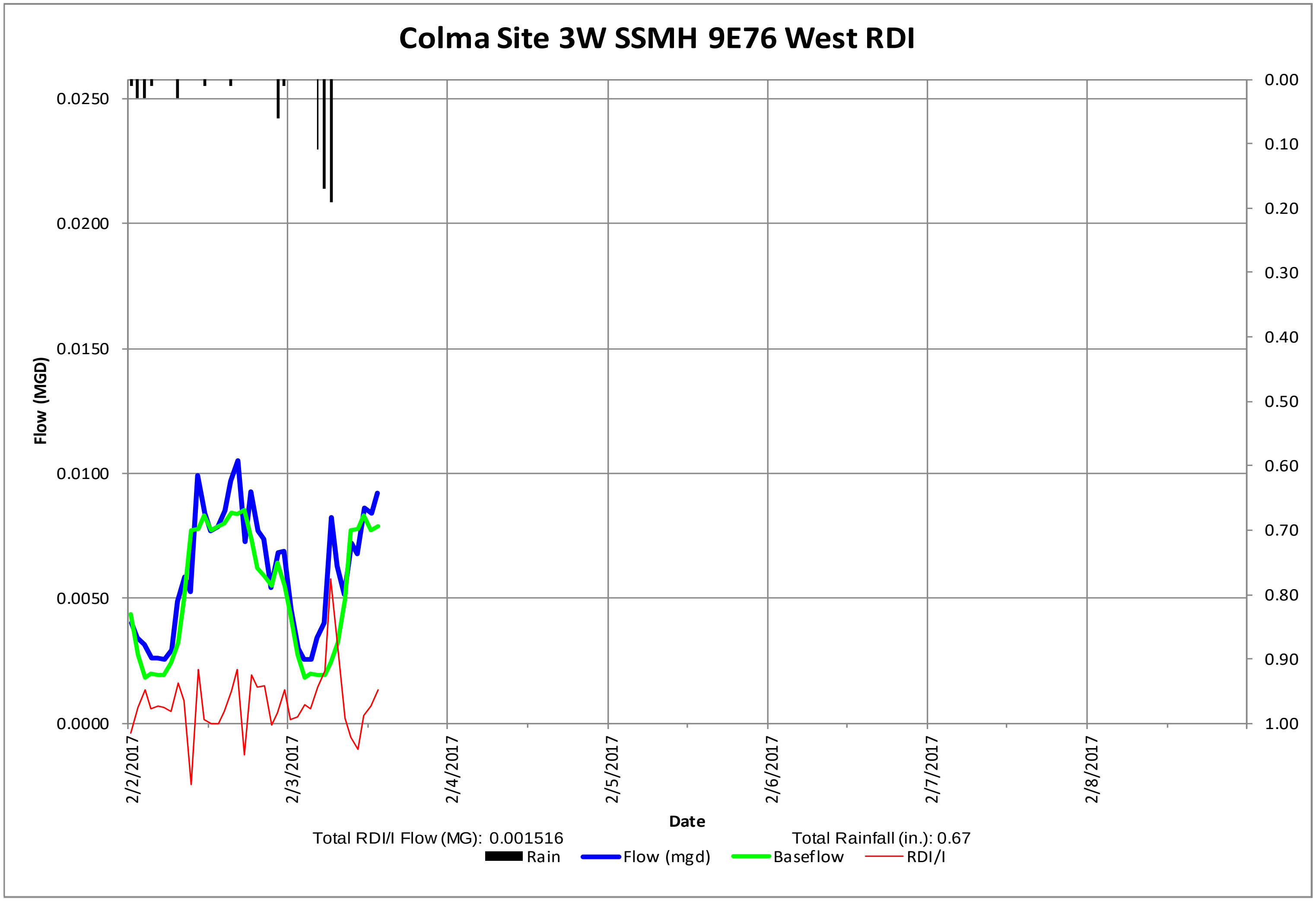
Storm of 1/18/2017



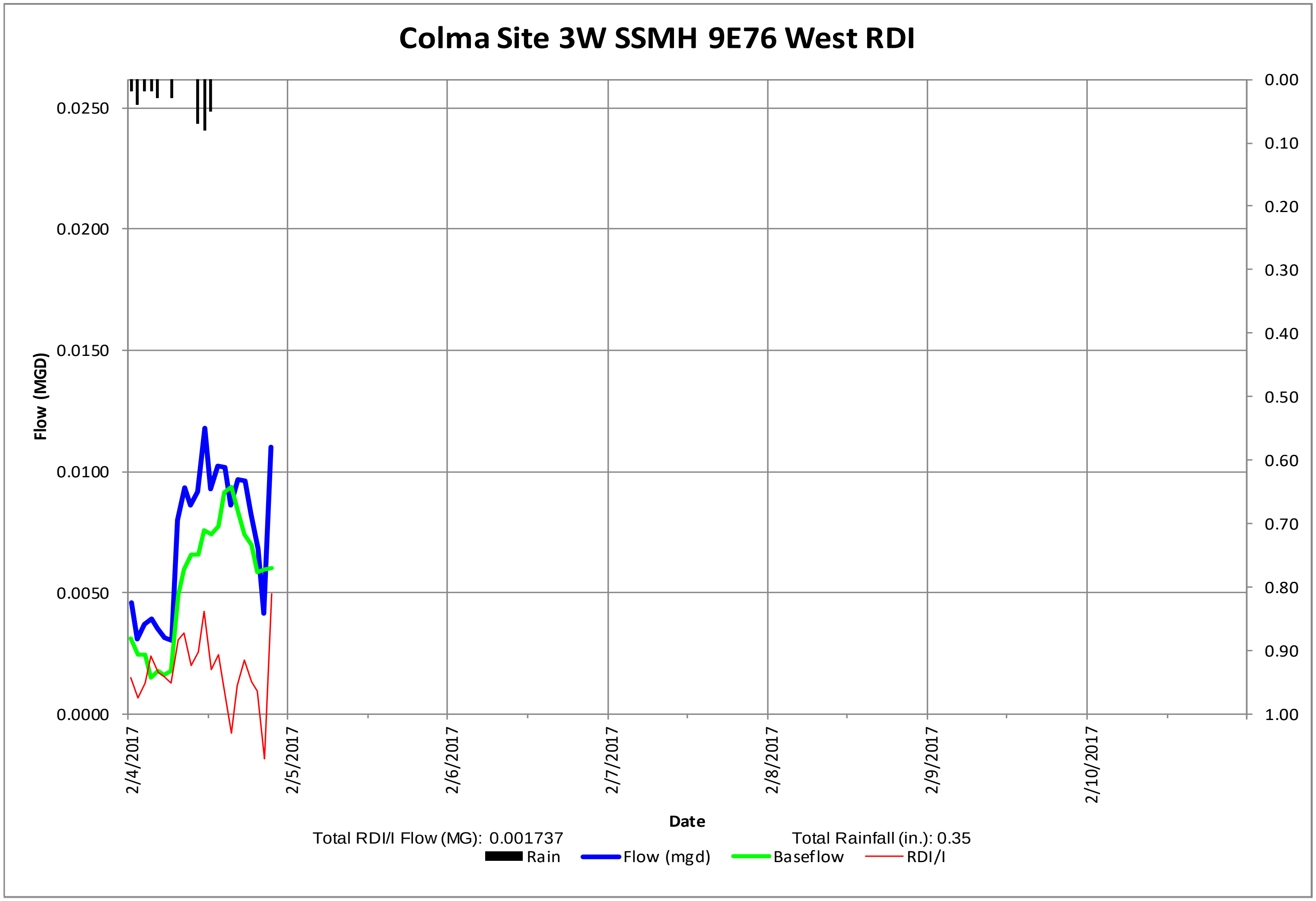
Storm of 1/20/2017



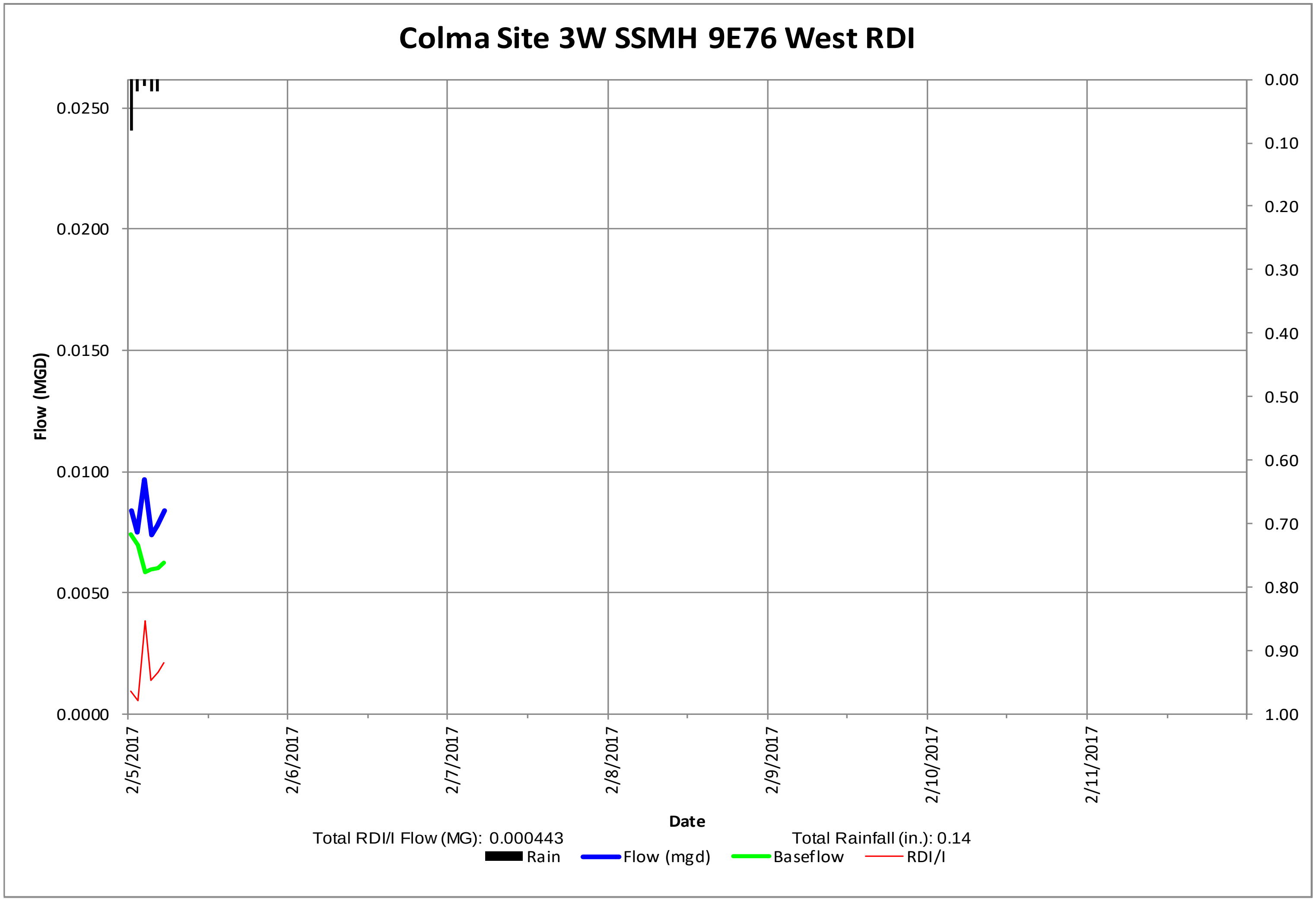
Storm of 1/21/2017



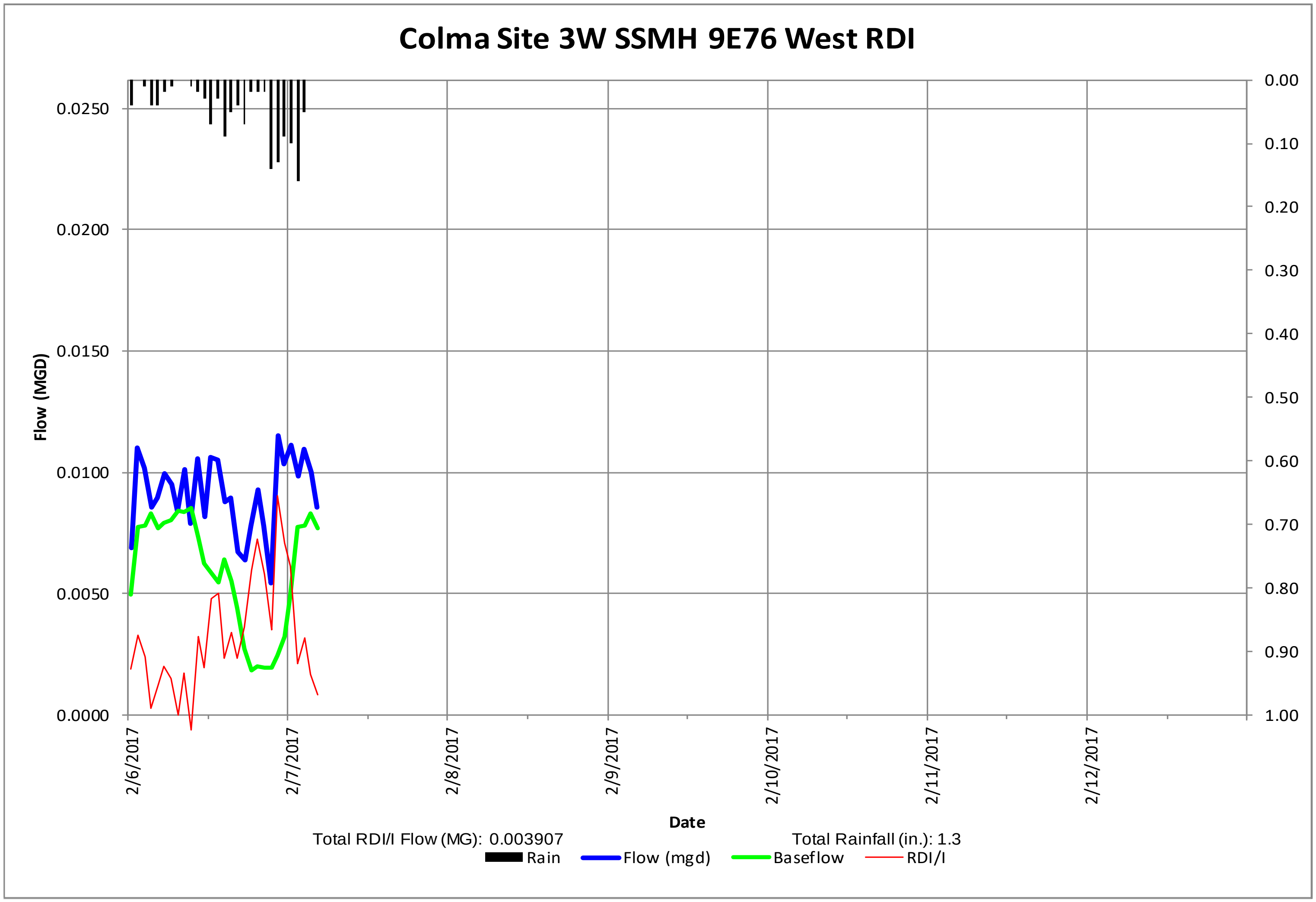
Storm of 2/2/2017



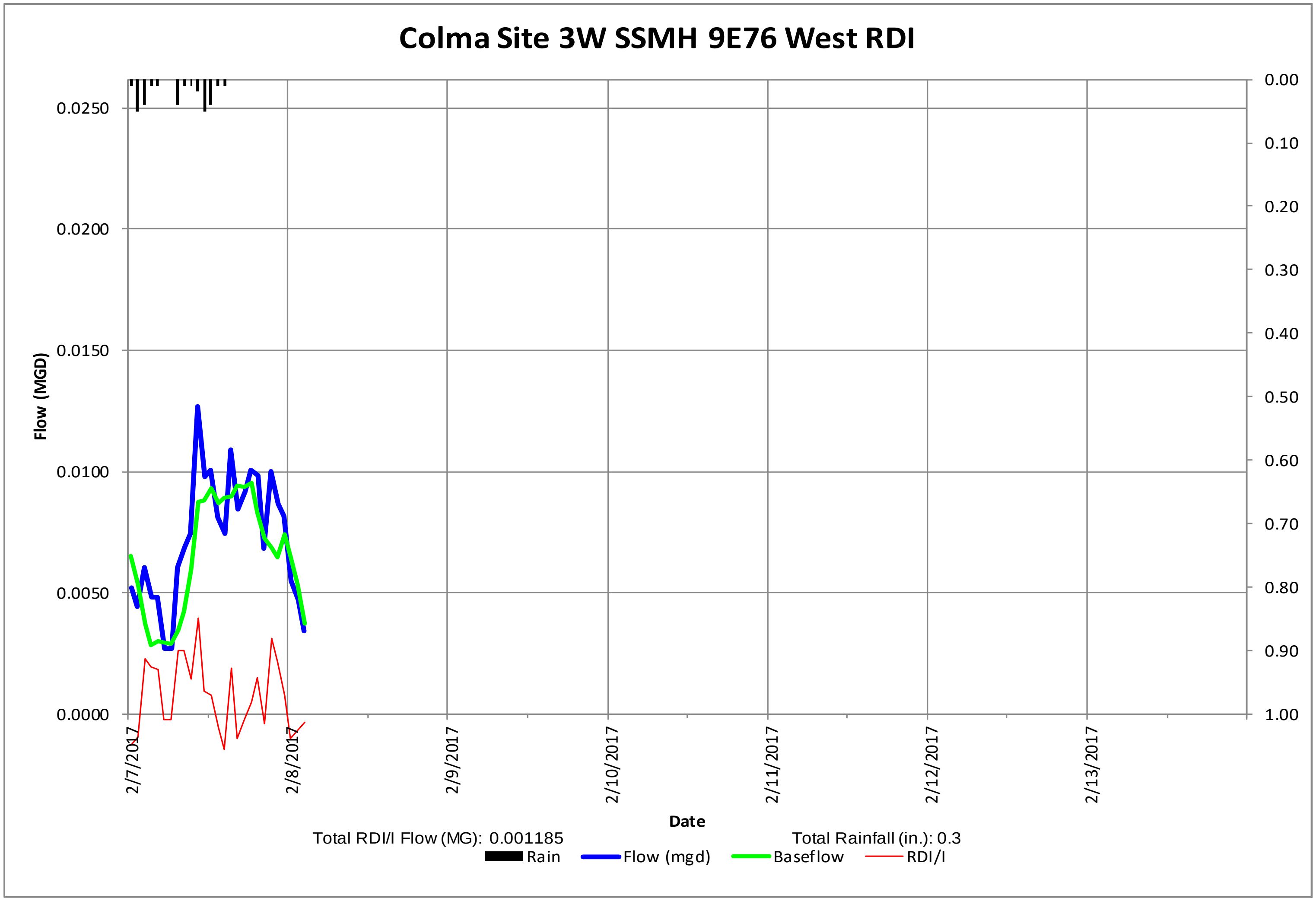
Storm of 2/4/2017



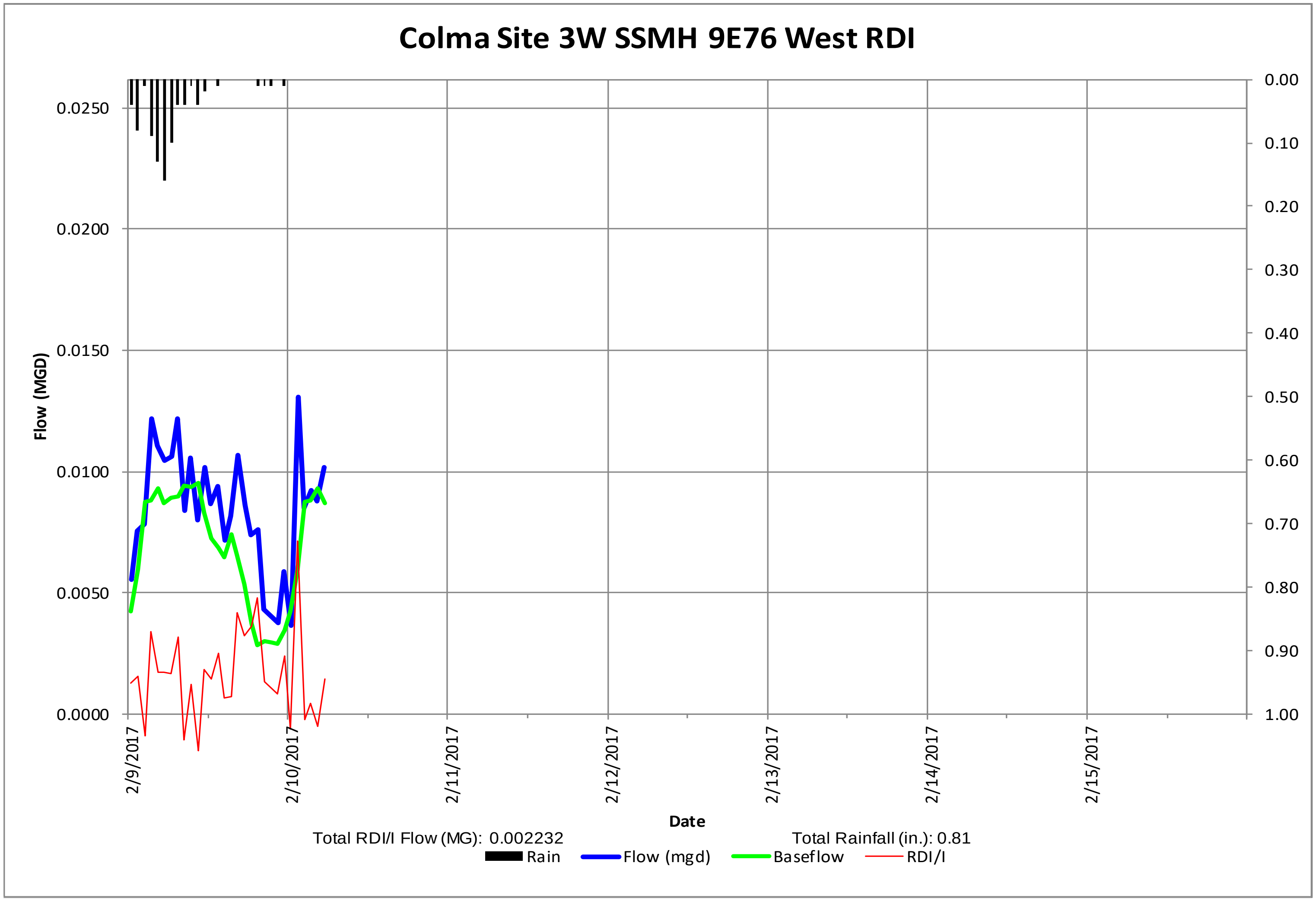
Storm of 2/5/2017



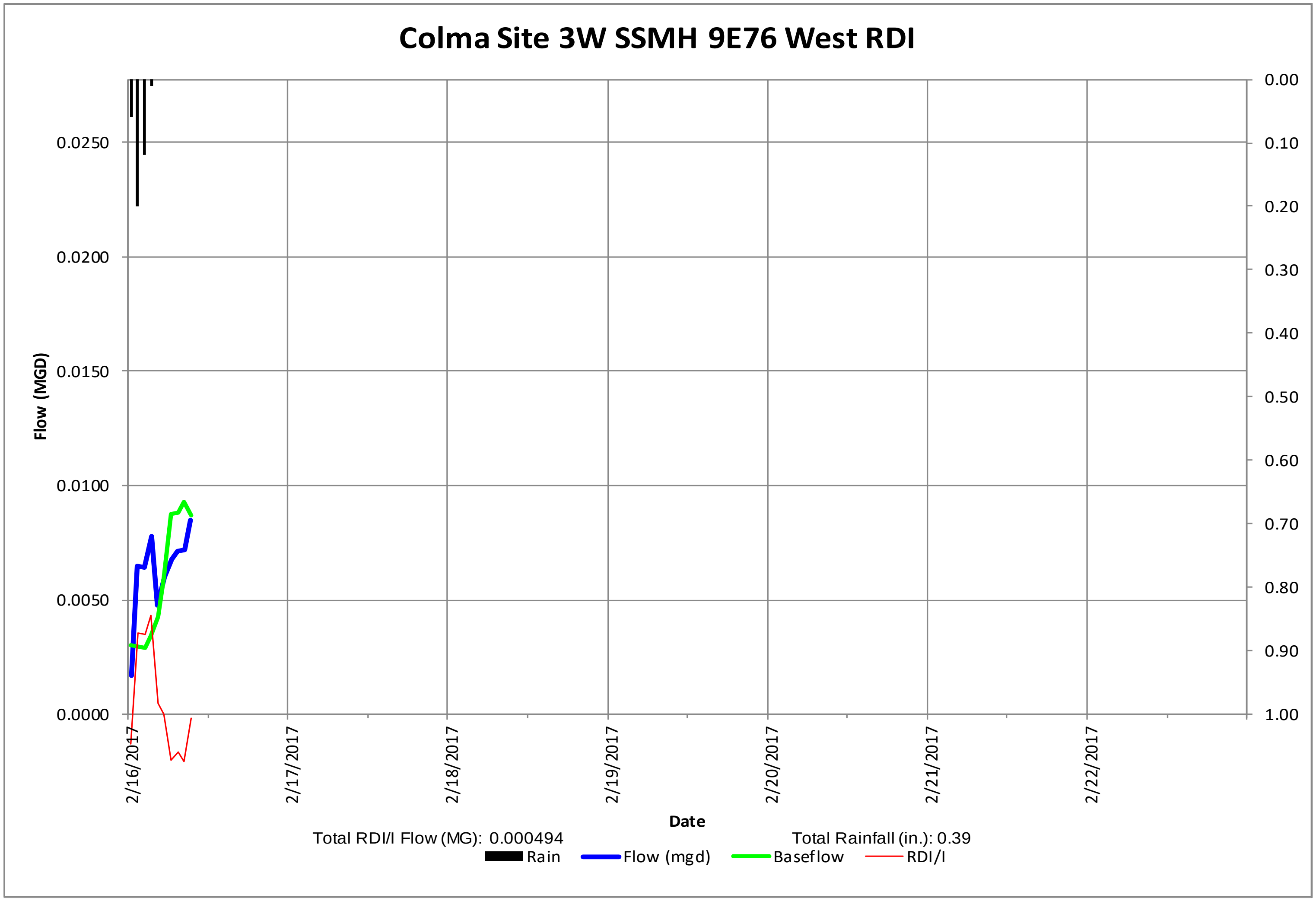
Storm of 2/6/2017



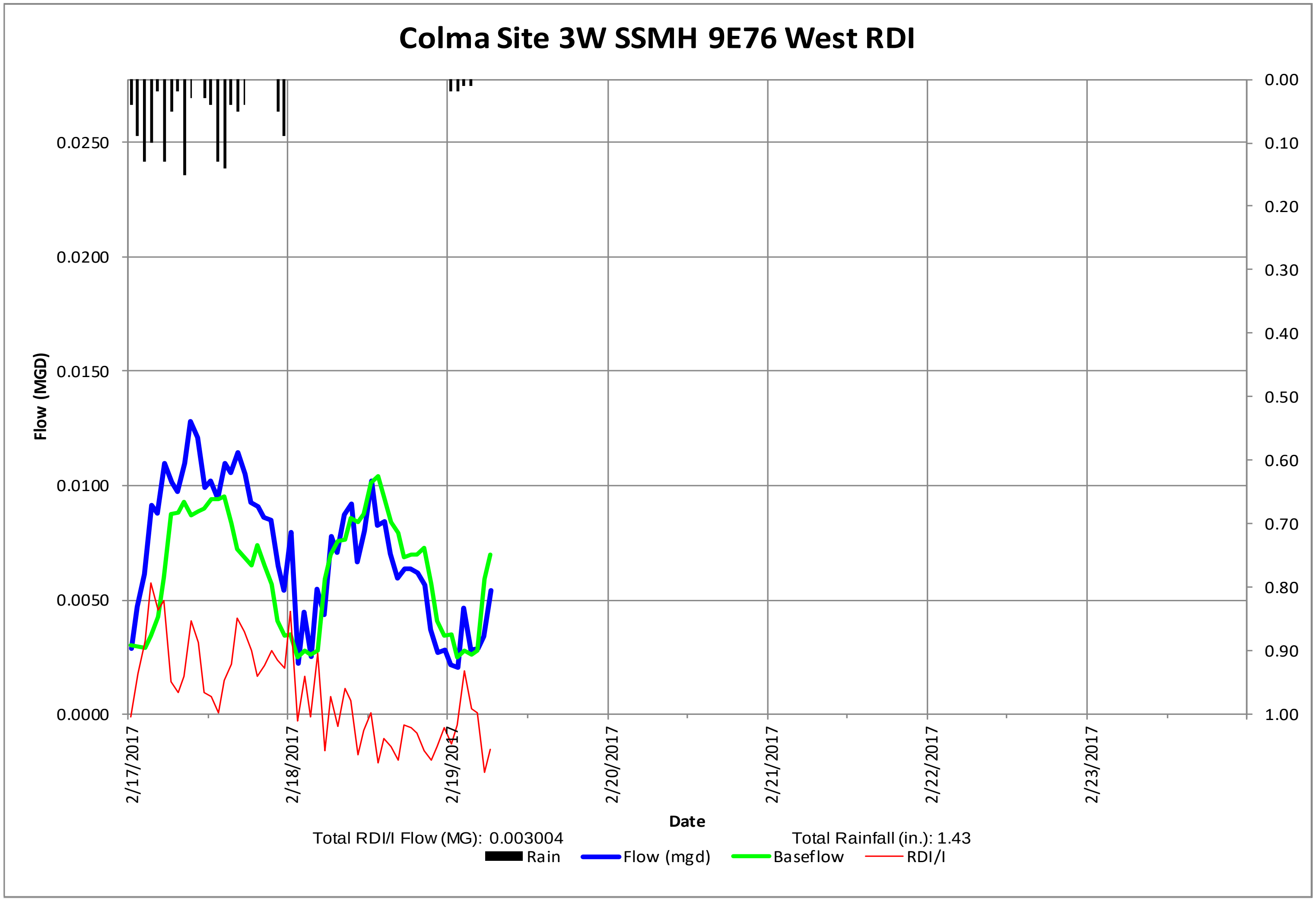
Storm of 2/7/2017



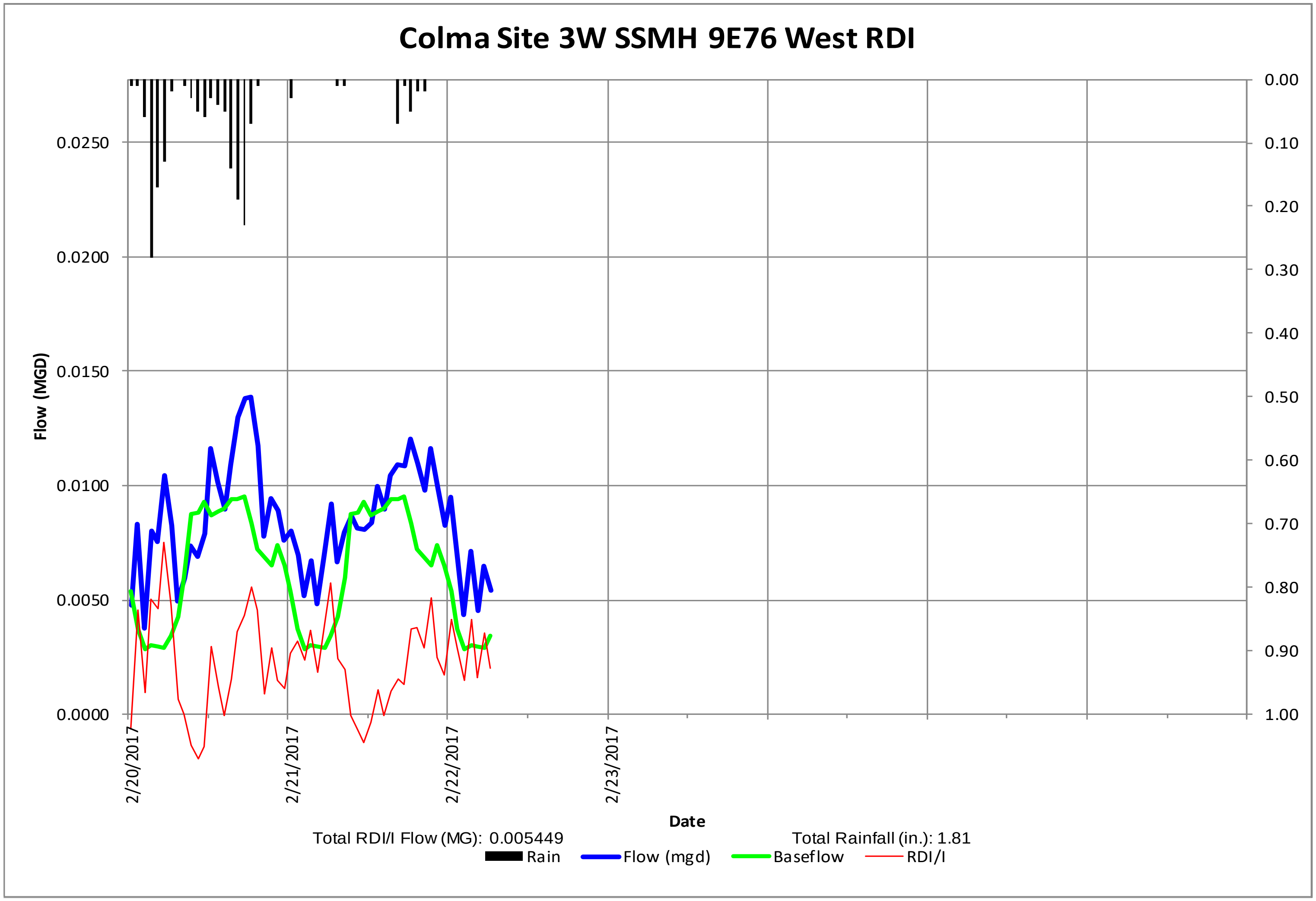
Storm of 2/9/2017



Storm of 2/16/2017



Storm of 2/17/2017



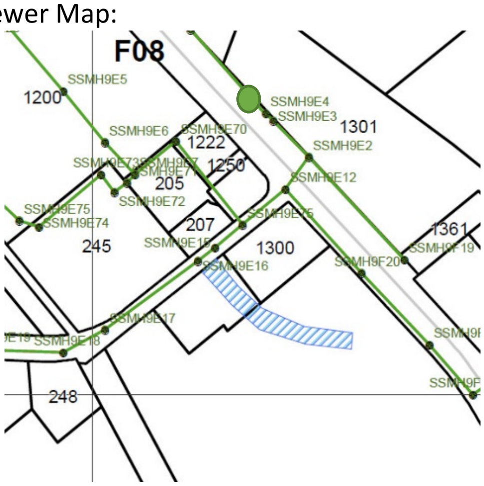
Storm of 2/20/2017

Site Information Report	Flow Monitor Site: 4

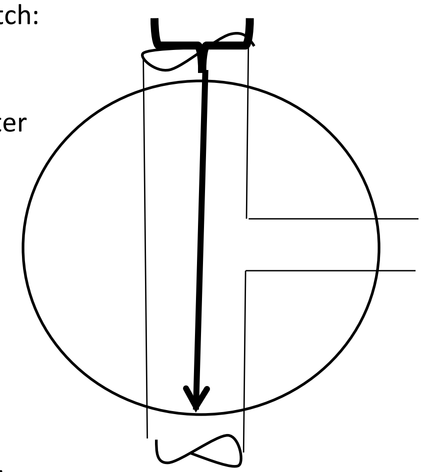
Manhole Number SSMH 9E4
Location: El Camino North of Collins MH Depth ~8’
Diameter: 8”
Safety: Ok
Traffic: Medium
Gas: Ok
Rungs: No
Meter Type: Hach FL900
Depth: Pressure 1”
Velocity: Doppler 2 ft./sec
Sensor type Flo Dar

Ariel View:

City Sewer Map:



Flow Sketch:



Surface View:

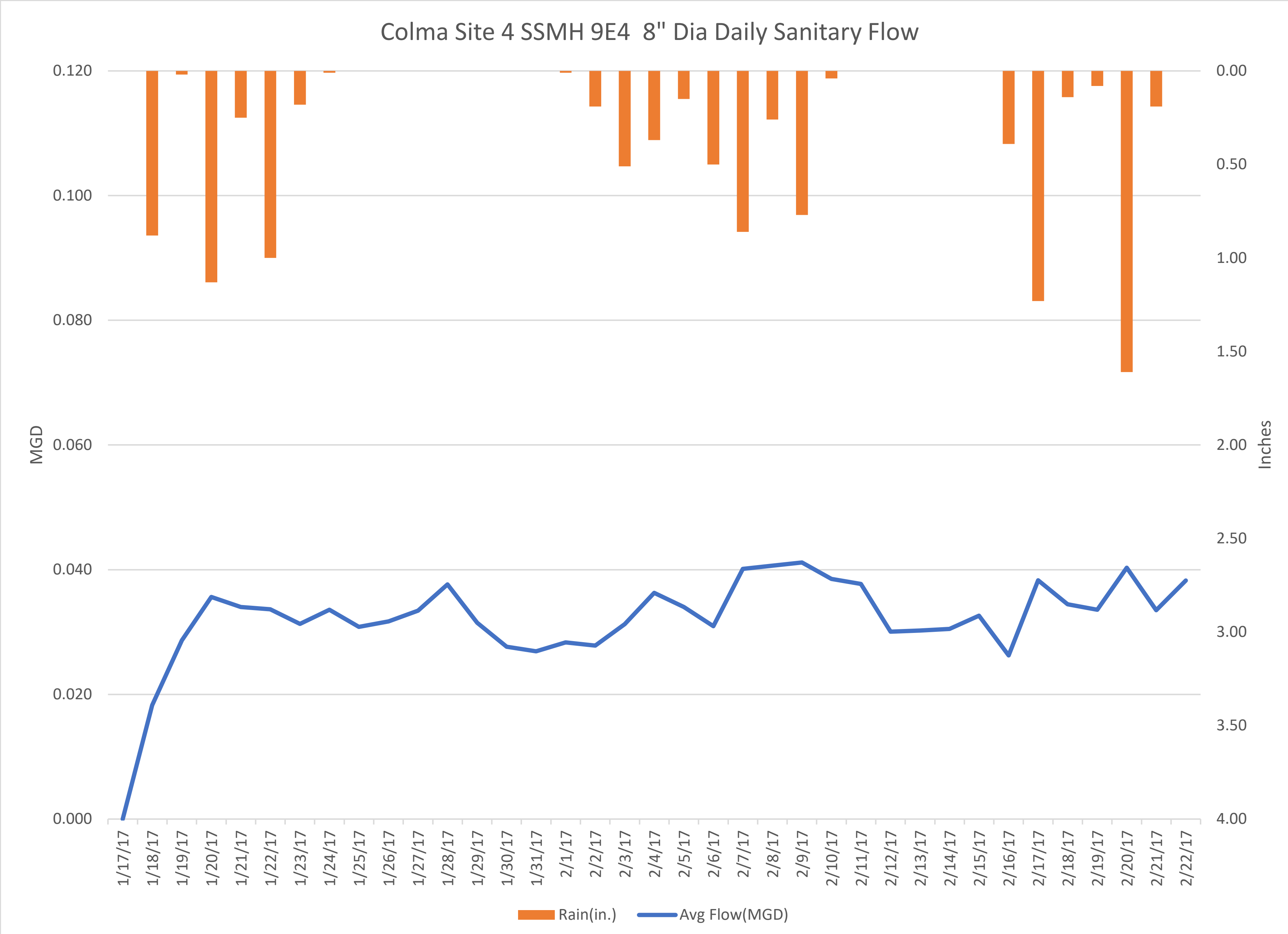
Invert View:

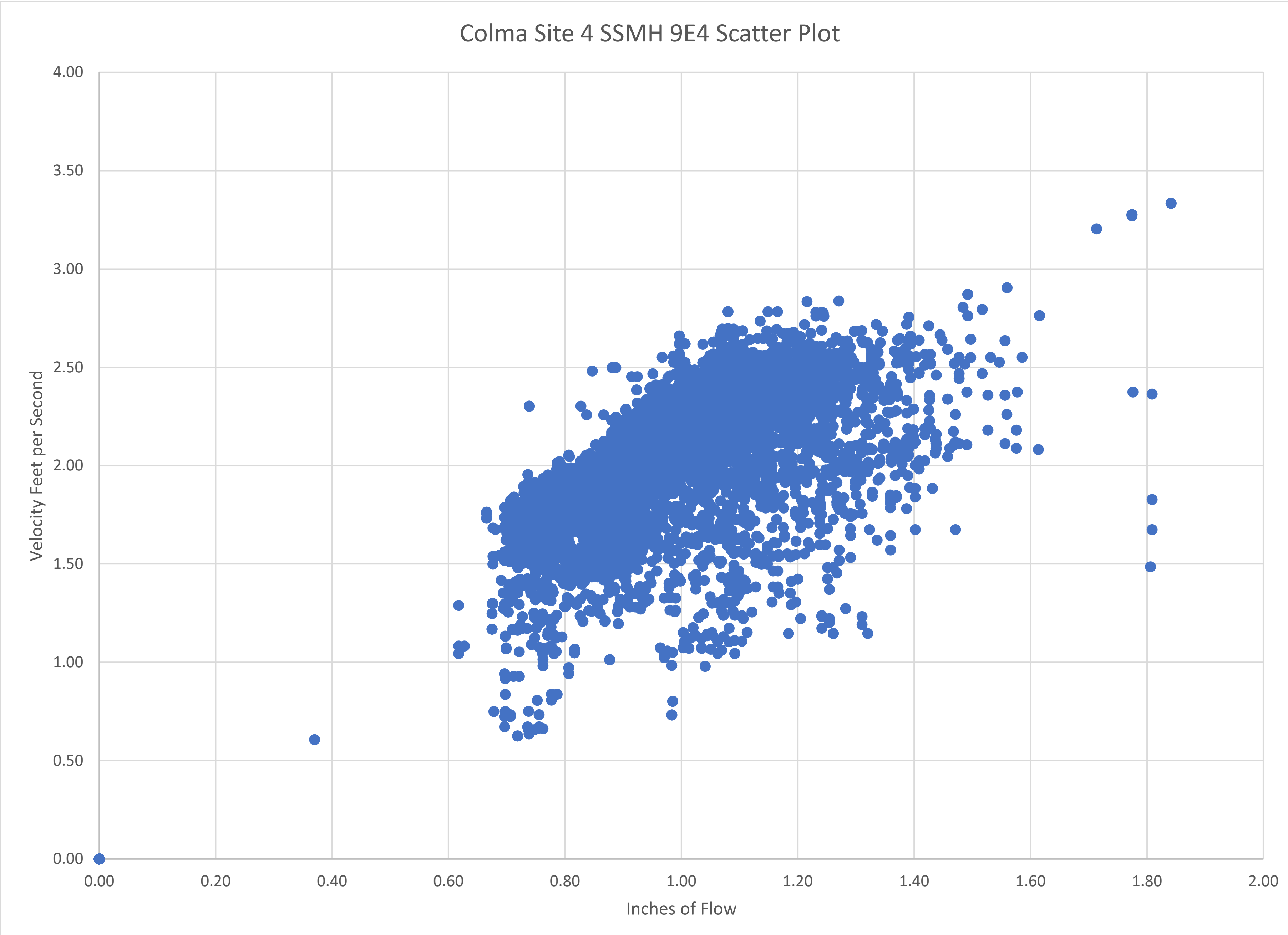
Outlet Pipe: P0 	Inlet Pipe: P1 
Inlet Pipe: P2 	

Colma Site 4 SSMH 9E4 8" Dia Sanitary Flow

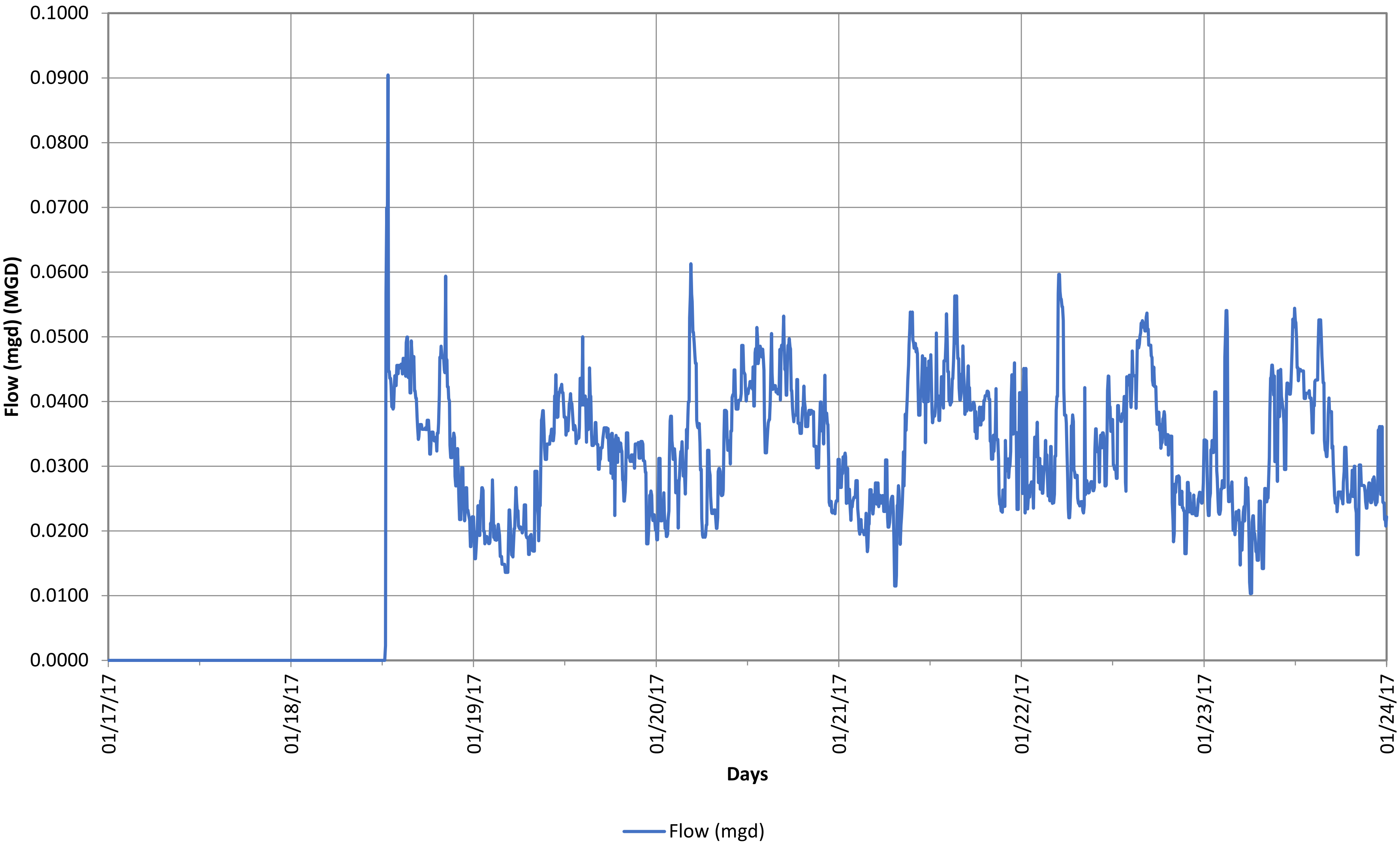
Daily Summary

Day	Date	Avg Flow(MGD)	Min Flow(MGD)	Max Flow(MGD)	Max Depth(in.)	Rain(in.)
Tuesday	1/17/17	0.000	0.000	0.000	0.000	0.00
Wednesday	1/18/17	0.018	0.000	0.090	1.809	0.88
Thursday	1/19/17	0.029	0.014	0.050	1.135	0.02
Friday	1/20/17	0.036	0.019	0.061	1.216	1.13
Saturday	1/21/17	0.034	0.012	0.056	1.193	0.25
Sunday	1/22/17	0.034	0.017	0.060	1.258	1.00
Monday	1/23/17	0.031	0.010	0.054	1.247	0.18
Tuesday	1/24/17	0.034	0.011	0.062	1.306	0.01
Wednesday	1/25/17	0.031	0.015	0.055	1.208	0.00
Thursday	1/26/17	0.032	0.012	0.056	1.228	0.00
Friday	1/27/17	0.033	0.012	0.058	1.229	0.00
Saturday	1/28/17	0.038	0.015	0.072	1.391	0.00
Sunday	1/29/17	0.031	0.014	0.058	1.286	0.00
Monday	1/30/17	0.028	0.007	0.048	1.195	0.00
Tuesday	1/31/17	0.027	0.012	0.042	1.031	0.00
Wednesday	2/1/17	0.028	0.008	0.043	1.054	0.01
Thursday	2/2/17	0.028	0.016	0.047	1.077	0.19
Friday	2/3/17	0.031	0.013	0.053	1.155	0.51
Saturday	2/4/17	0.036	0.017	0.056	1.204	0.37
Sunday	2/5/17	0.034	0.011	0.053	1.231	0.15
Monday	2/6/17	0.031	0.006	0.051	1.392	0.50
Tuesday	2/7/17	0.040	0.016	0.064	1.427	0.86
Wednesday	2/8/17	0.041	0.016	0.088	1.776	0.26
Thursday	2/9/17	0.041	0.012	0.081	1.586	0.77
Friday	2/10/17	0.039	0.016	0.081	1.532	0.04
Saturday	2/11/17	0.038	0.013	0.131	1.841	0.00
Sunday	2/12/17	0.030	0.016	0.049	1.171	0.00
Monday	2/13/17	0.030	0.007	0.062	1.425	0.00
Tuesday	2/14/17	0.031	0.012	0.048	1.133	0.00
Wednesday	2/15/17	0.033	0.015	0.053	1.161	0.00
Thursday	2/16/17	0.026	0.006	0.052	1.203	0.39
Friday	2/17/17	0.038	0.021	0.065	1.290	1.23
Saturday	2/18/17	0.034	0.019	0.058	1.267	0.14
Sunday	2/19/17	0.034	0.021	0.083	1.492	0.08
Monday	2/20/17	0.040	0.017	0.090	1.615	1.61
Tuesday	2/21/17	0.034	0.009	0.067	1.335	0.19
Wednesday	2/22/17	0.038	0.011	0.071	1.387	0.00


Colma Site 4 SSMH 9E4 8" Dia Daily Sanitary Flow
MGD
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Inches
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
1/17/17
1/18/17
1/19/17
1/20/17
1/21/17
1/22/17
1/23/17
1/24/17
1/25/17
1/26/17
1/27/17
1/28/17
1/29/17
1/30/17
1/31/17
2/1/17
2/2/17
2/3/17
2/4/17
2/5/17
2/6/17
2/7/17
2/8/17
2/9/17
2/10/17
2/11/17
2/12/17
2/13/17
2/14/17
2/15/17
2/16/17
2/17/17
2/18/17
2/19/17
2/20/17
2/21/17
2/22/17
Rain(in.)
Avg Flow(MGD)


Colma Site 4 SSMH 9E4 Scatter Plot
Velocity Feet per Second
Inches of Flow
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00

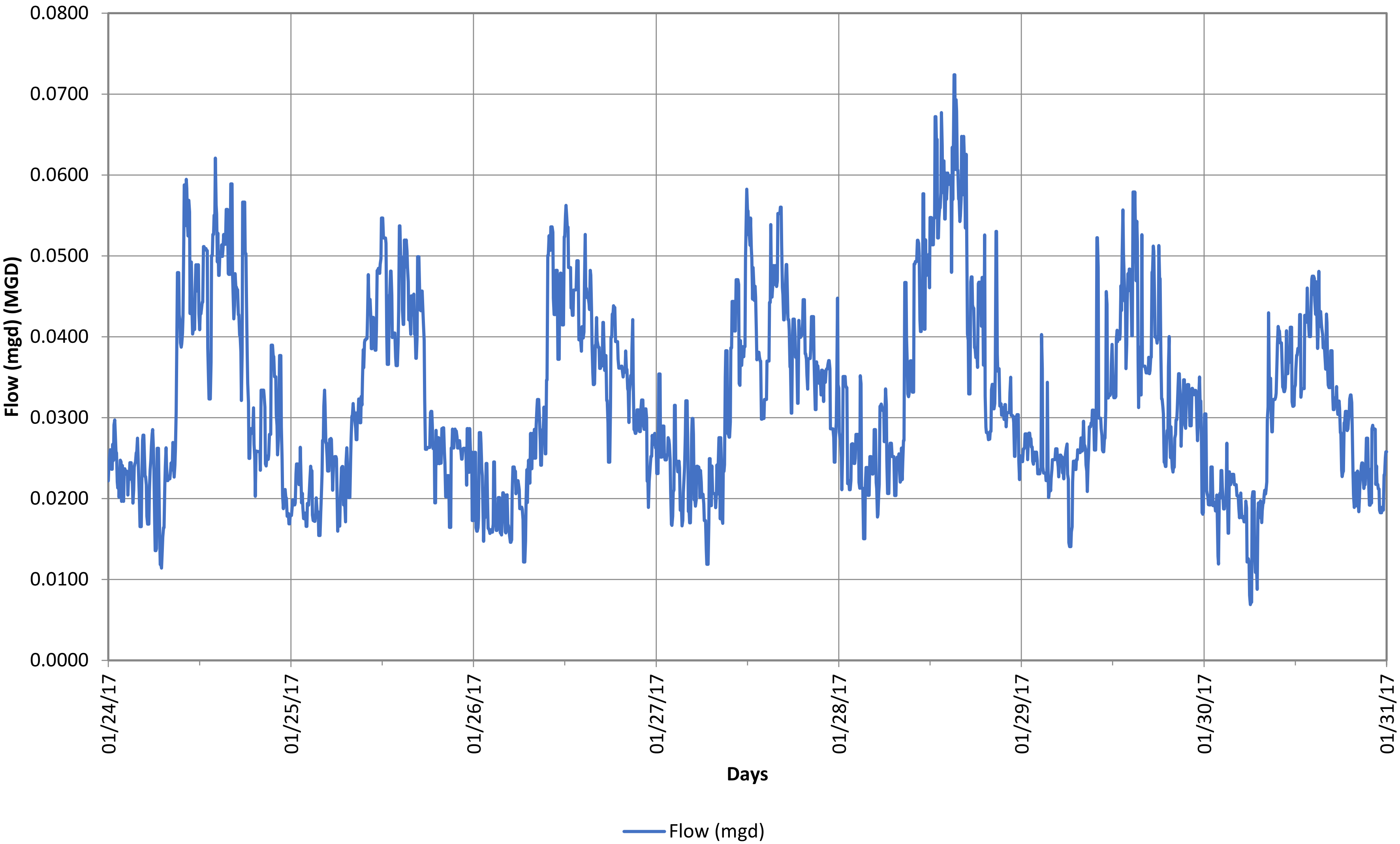
Colma Site 4 SSMH 9E4 8" Dia Sanitary Flow



	1/17/2017 11:55:00 PM(	'/2017 11:55:00 PM(	\/2017 11:55:00 PM(	)/2017 11:55:00 PM(	1/2017 11:55:00 PM(	/2017 11:55:00 PM(	'2017 11:55:00 PM(
Maximum	0.000	0.090	0.050	0.061	0.056	0.060	0.054
Average	0.000	0.018	0.029	0.036	0.034	0.034	0.031
Minimum	0.000	0.000	0.014	0.019	0.012	0.017	0.010
Rain (inches)	0.00	0.88	0.02	1.13	0.25	1.00	0.18

Mon)

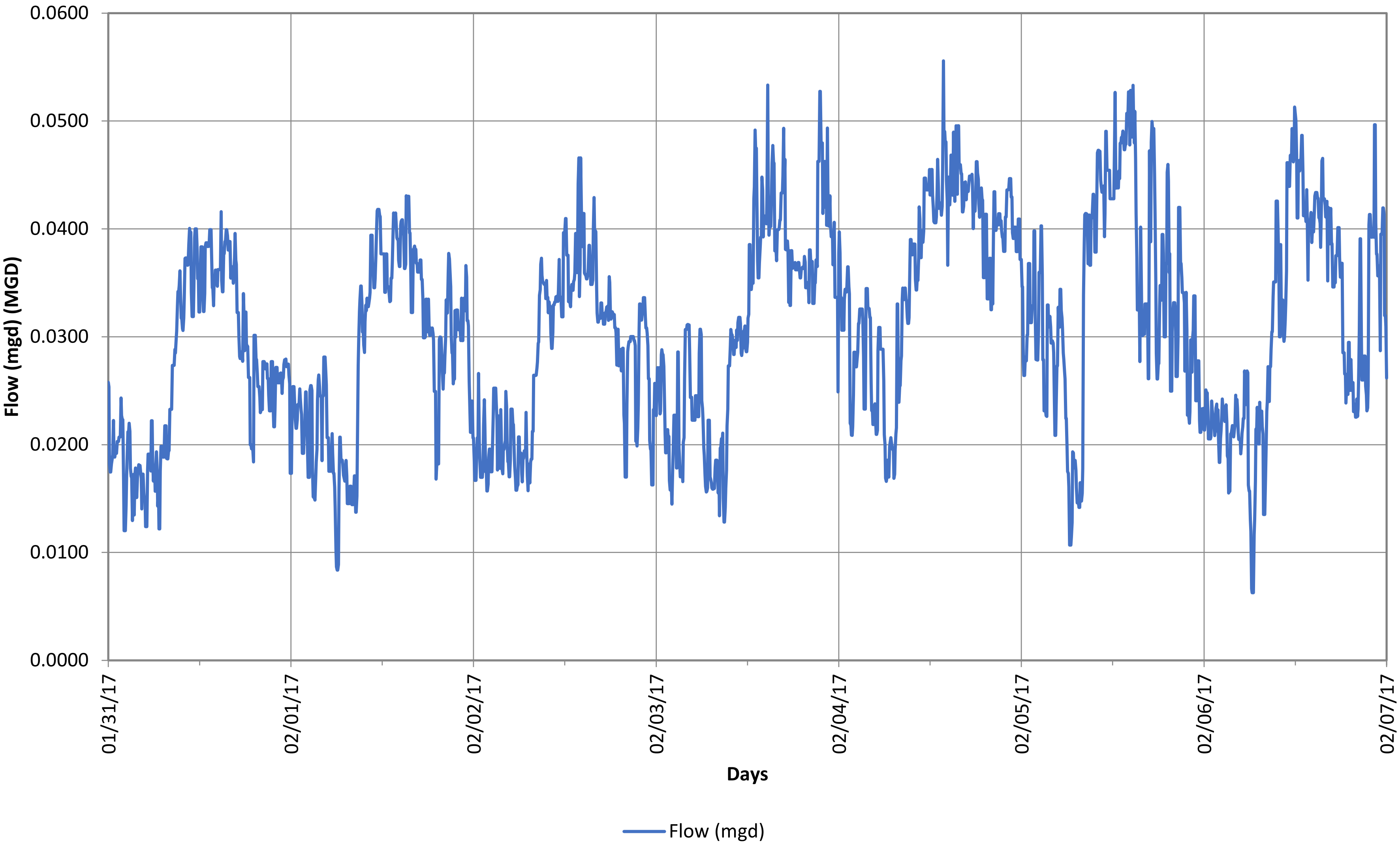
Colma Site 4 SSMH 9E4 8" Dia Sanitary Flow



	1/24/2017 11:55:00 PM('	/2017 11:55:00 PM(V	/2017 11:55:00 PM(T	/2017 11:55:00 PM(	3/2017 11:55:00 PM(	/2017 11:55:00 PM(	'2017 11:55:00 PM(M
Maximum	0.062	0.055	0.056	0.058	0.072	0.058	0.048
Average	0.034	0.031	0.032	0.033	0.038	0.031	0.028
Minimum	0.011	0.015	0.012	0.012	0.015	0.014	0.007
Rain (inches)	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Mon)

Colma Site 4 SSMH 9E4 8" Dia Sanitary Flow



	1/31/2017 11:55:00 PM(T	2017 11:55:00 PM(V	2017 11:55:00 PM(T	/2017 11:55:00 PM(F	/2017 11:55:00 PM(S	2017 11:55:00 PM(S	2017 11:55:00 PM(M
Maximum	0.042	0.043	0.047	0.053	0.056	0.053	0.051
Average	0.027	0.028	0.028	0.031	0.036	0.034	0.031
Minimum	0.012	0.008	0.016	0.013	0.017	0.011	0.006
Rain (inches)	0.00	0.01	0.19	0.51	0.37	0.15	0.50

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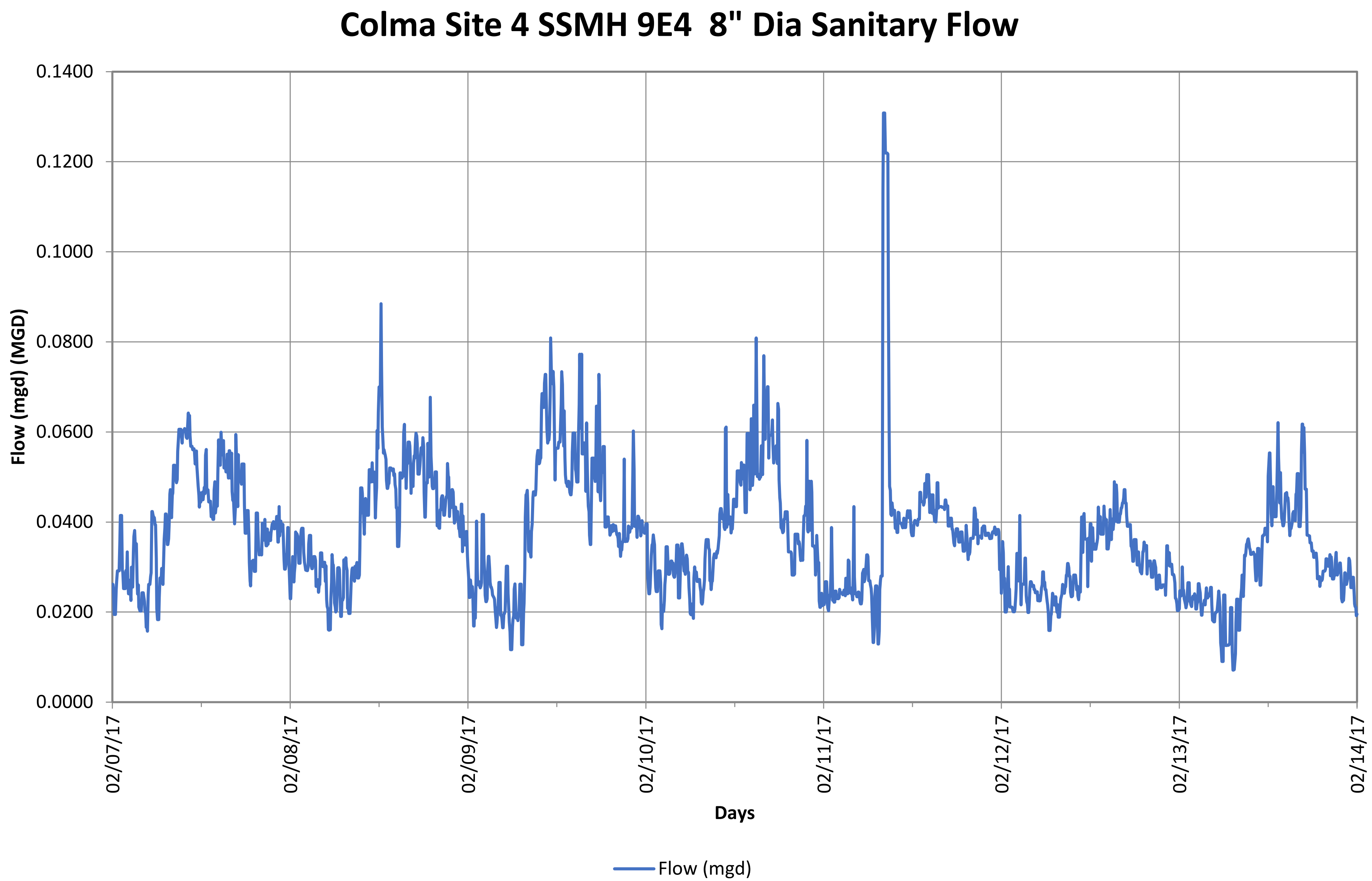
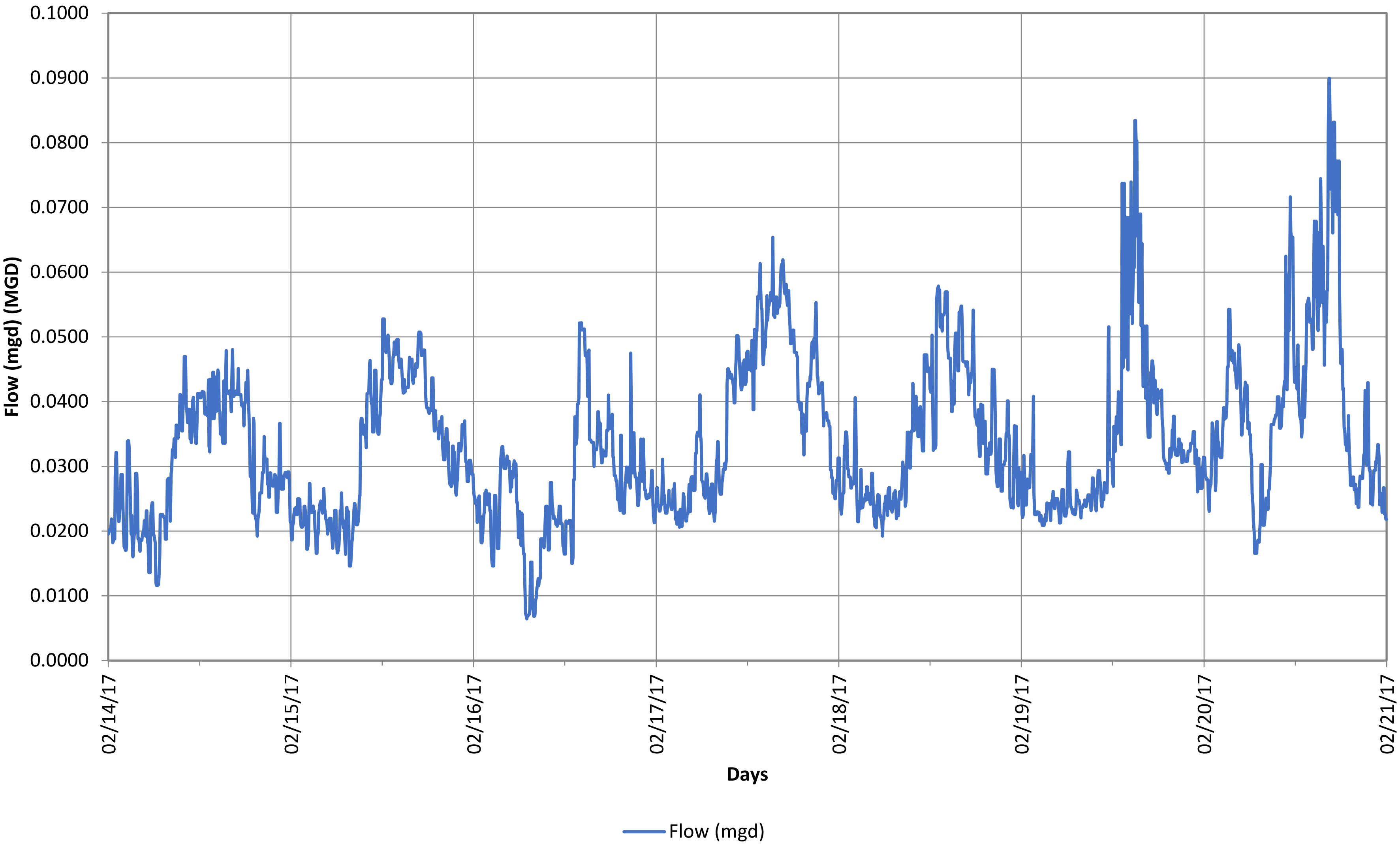


	2/7/2017 11:55:00 PM(T	2017 11:55:00 PM(W	2017 11:55:00 PM(T	/2017 11:55:00 PM(	1/2017 11:55:00 PM(	/2017 11:55:00 PM(	2017 11:55:00 PM(M
Maximum	0.064	0.088	0.081	0.081	0.131	0.049	0.062
Average	0.040	0.041	0.041	0.039	0.038	0.030	0.030
Minimum	0.016	0.016	0.012	0.016	0.013	0.016	0.007
Rain (inches)	0.86	0.26	0.77	0.04	0.00	0.00	0.00

Mon)

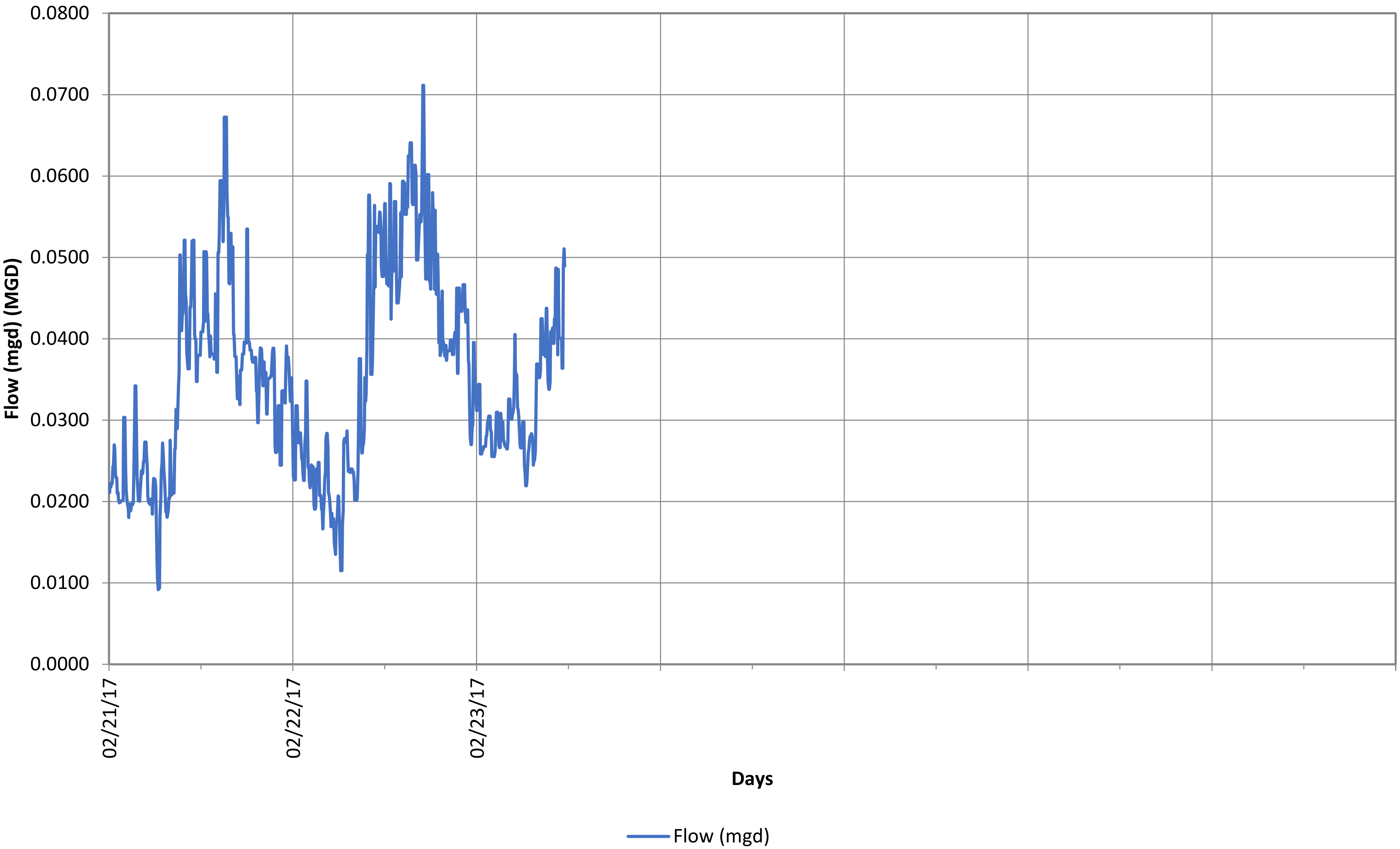
Colma Site 4 SSMH 9E4 8" Dia Sanitary Flow



	2/14/2017 11:55:00 PM(	/2017 11:55:00 PM(	/2017 11:55:00 PM(	/2017 11:55:00 PM(	3/2017 11:55:00 PM(	/2017 11:55:00 PM(	2017 11:55:00 PM(
Maximum	0.048	0.053	0.052	0.065	0.058	0.083	0.090
Average	0.031	0.033	0.026	0.038	0.034	0.034	0.040
Minimum	0.012	0.015	0.006	0.021	0.019	0.021	0.017
Rain (inches)	0.00	0.00	0.39	1.23	0.14	0.08	1.61

Mon)

Colma Site 4 SSMH 9E4 8" Dia Sanitary Flow

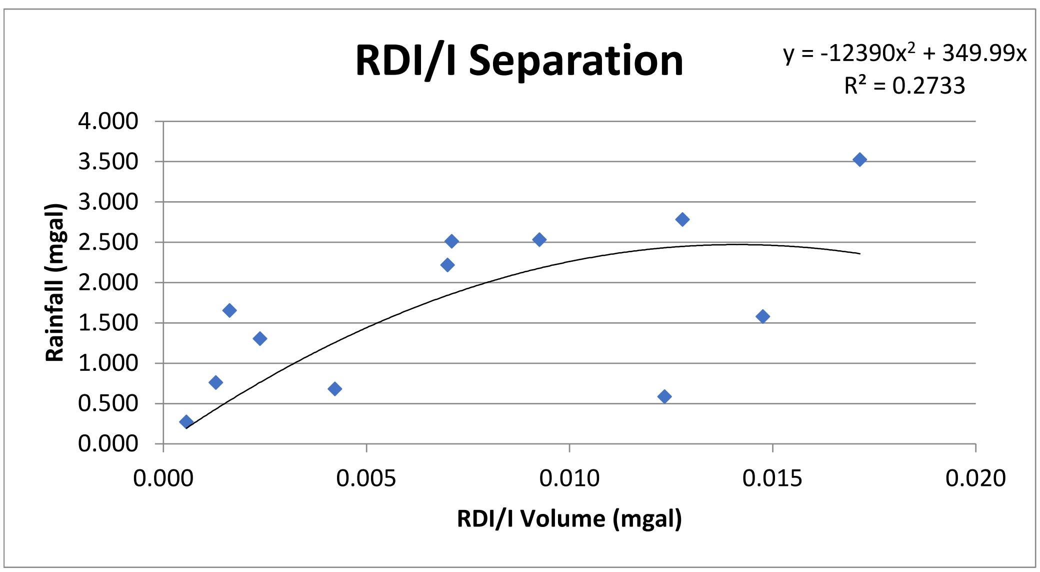


2/21/2017 11:55:00 PM(?/2017 11:55:00 PM(Wed)							
Maximum	0.067	0.071					
Average	0.034	0.038					
Minimum	0.009	0.011					
Rain (inches)	0.19	0.00					

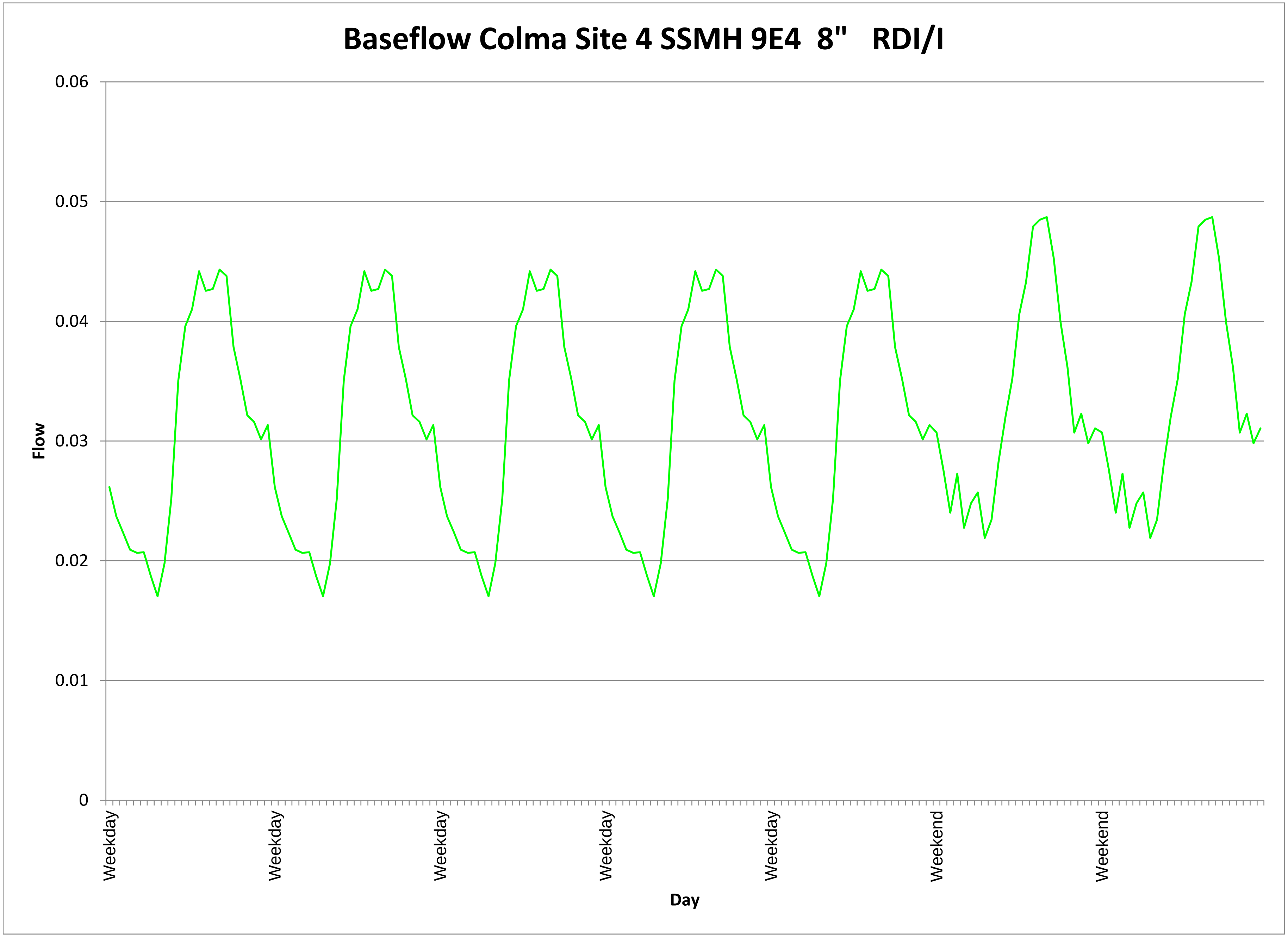
Colma Site 4 SSMH 9E4 8" RDI/I

RDI/I Analysis, Monitor Return Ratio Summary

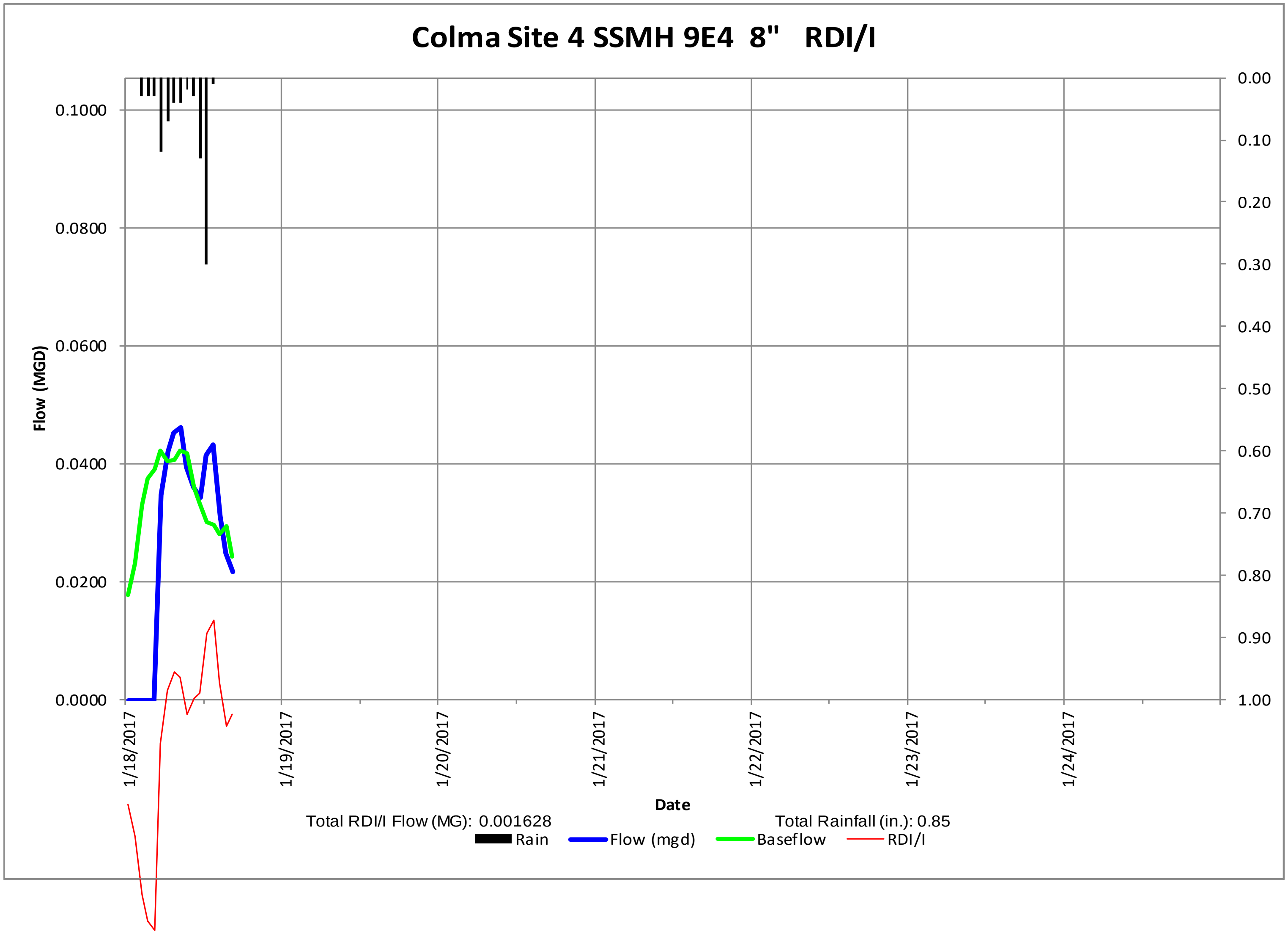
Storm Start (Date)	RDI/I Volume (mgal)	Monitor Area (acres)	Rainfall (mgal)	Return Ratio (%)
1/18/2017	0.002	71.7	1.655	0.10%
1/20/2017	0.007	71.7	2.219	0.32%
1/21/2017	0.007	71.7	2.511	0.28%
2/2/2017	0.002	71.7	1.304	0.18%
2/4/2017	0.004	71.7	0.681	0.62%
2/5/2017	0.001	71.7	0.273	0.21%
2/6/2017	0.009	71.7	2.531	0.37%
2/7/2017	0.012	71.7	0.584	2.11%
2/9/2017	0.015	71.7	1.577	0.94%
2/16/2017	0.001	71.7	0.759	0.17%
2/17/2017	0.013	71.7	2.784	0.46%
2/20/2017	0.017	71.7	3.524	0.49%
Average R%				0.52%
Average Top 3 Storms				1.22%



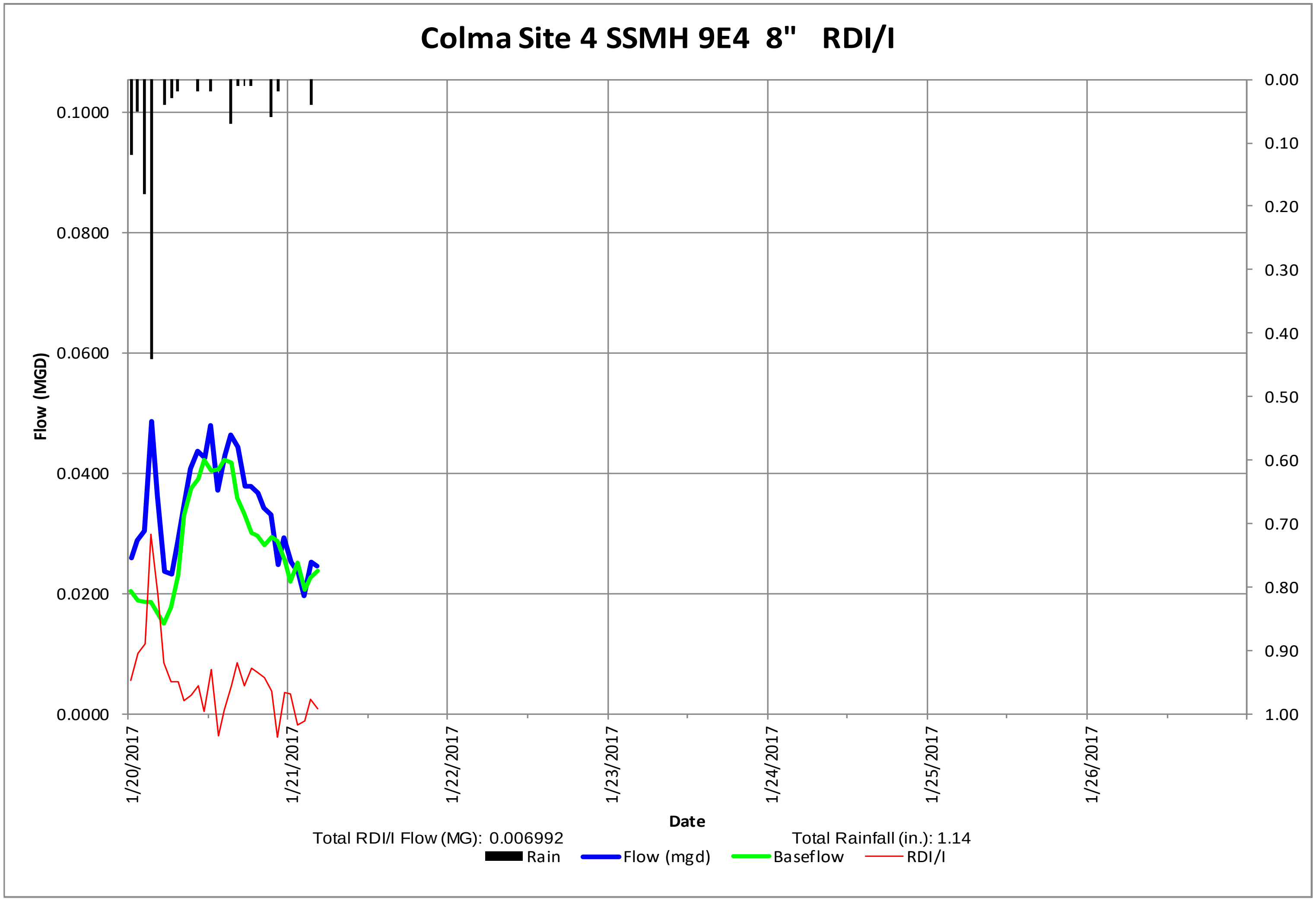
Baseflows	Weekend	Weekday
Max	0.049	0.044
Avg	0.033	0.031
Min	0.022	0.017



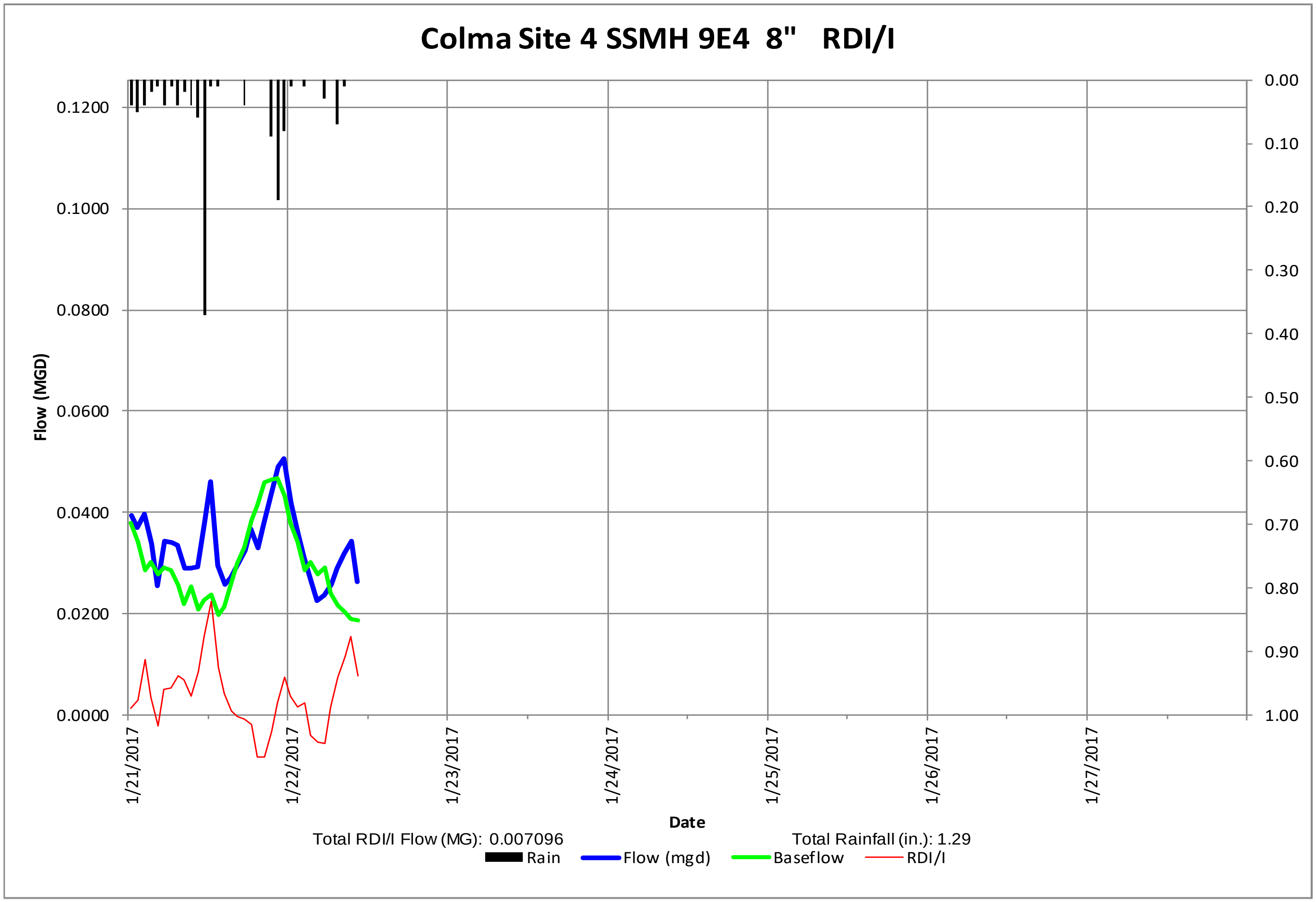
Baseflow Colma Site 4 SSMH 9E4 8" RDI/I
0.06
0.05
0.04
0.03
0.02
0.01
0
Flow
Weekday
Weekday
Weekday
Weekday
Weekday
Weekend
Weekend
Day



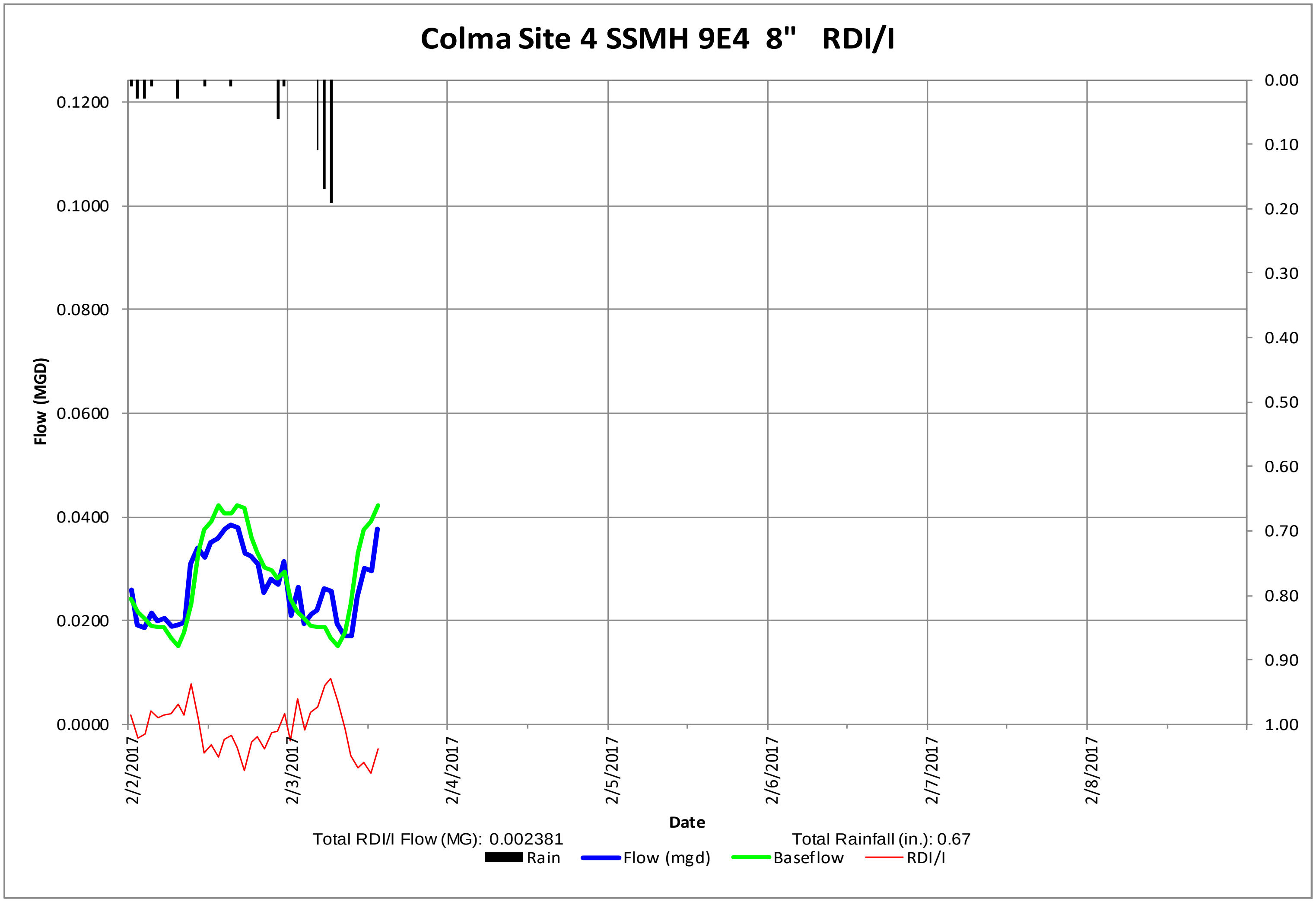
Storm of 1/18/2017



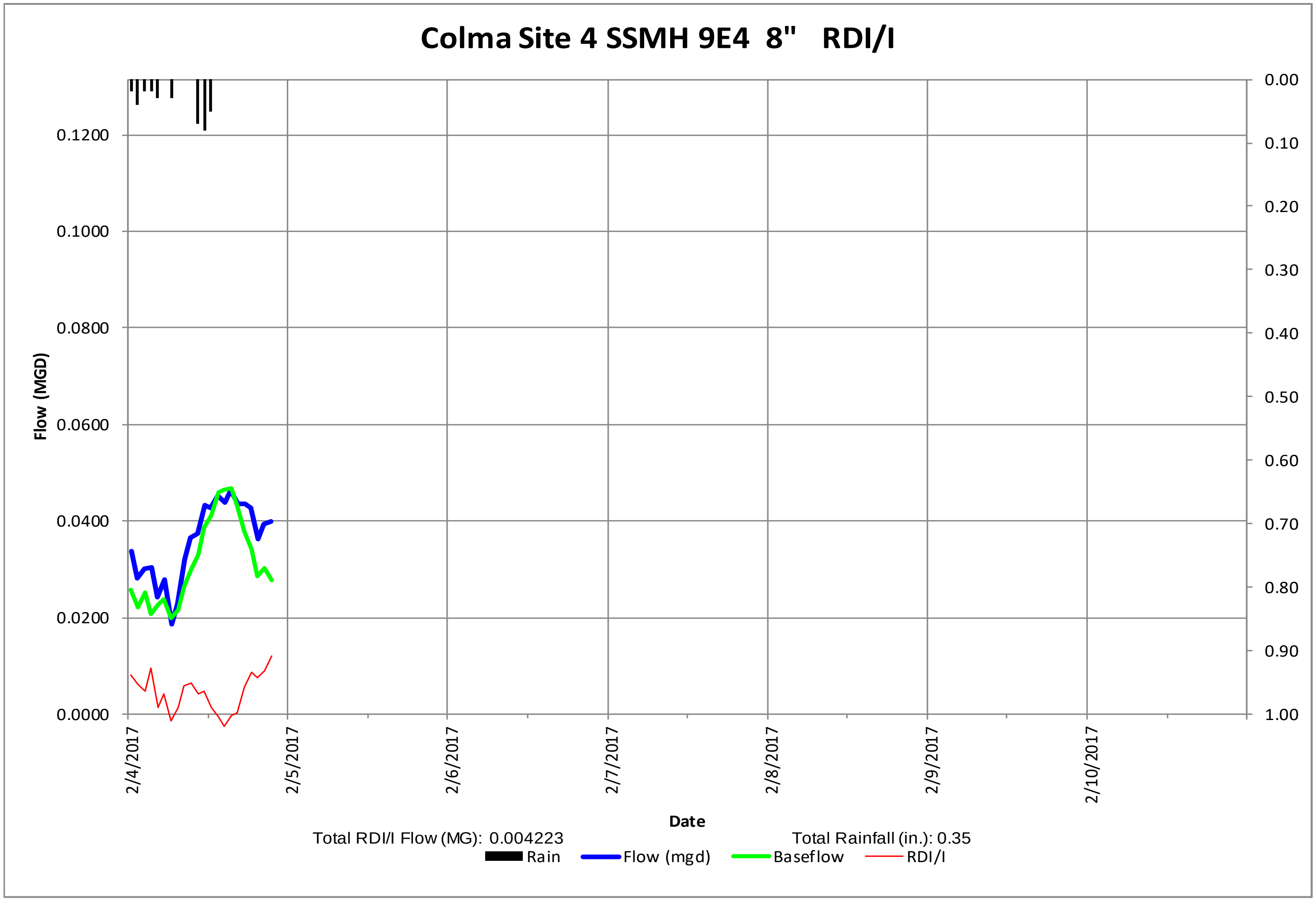
Storm of 1/20/2017



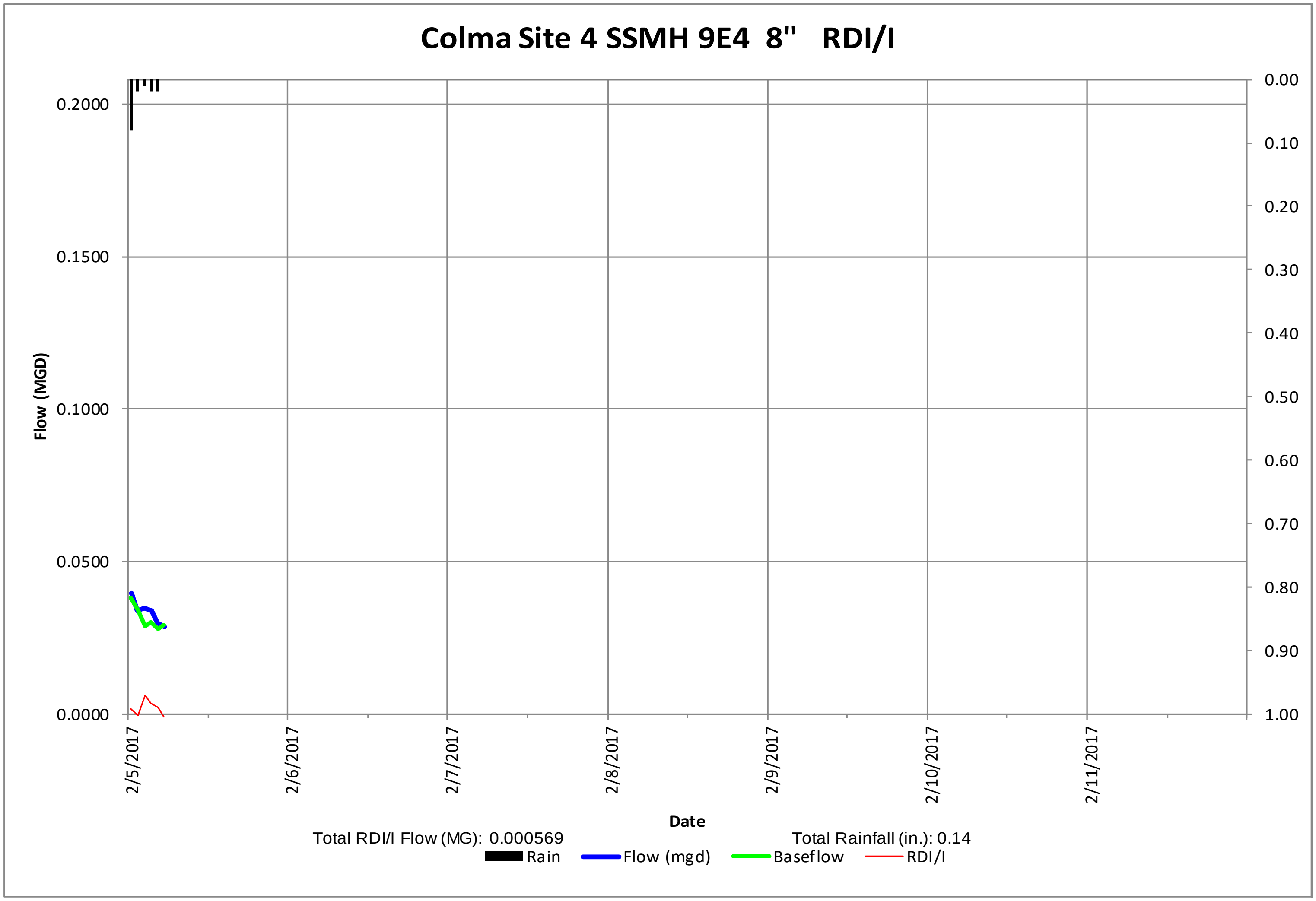
Storm of 1/21/2017



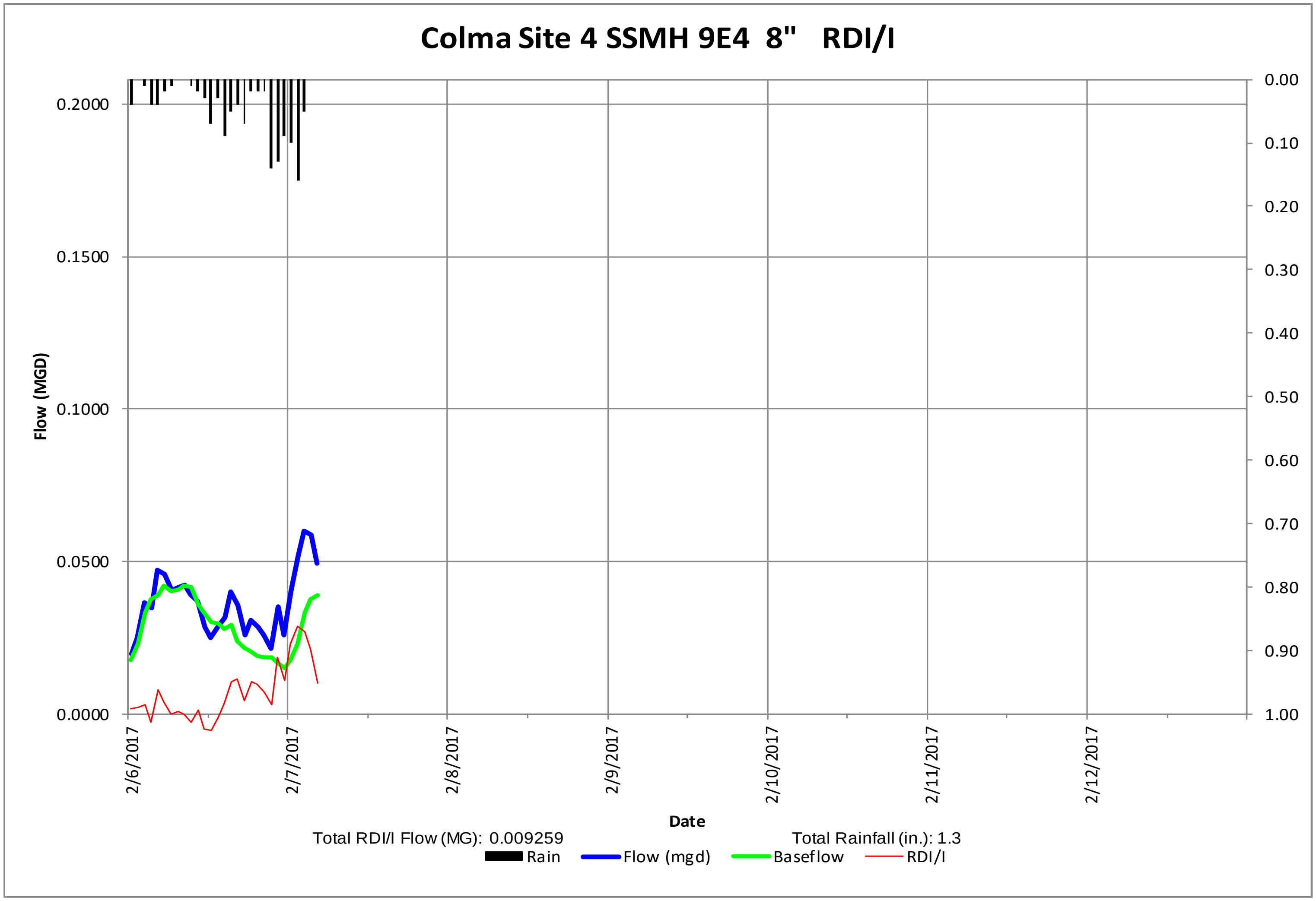
Storm of 2/2/2017



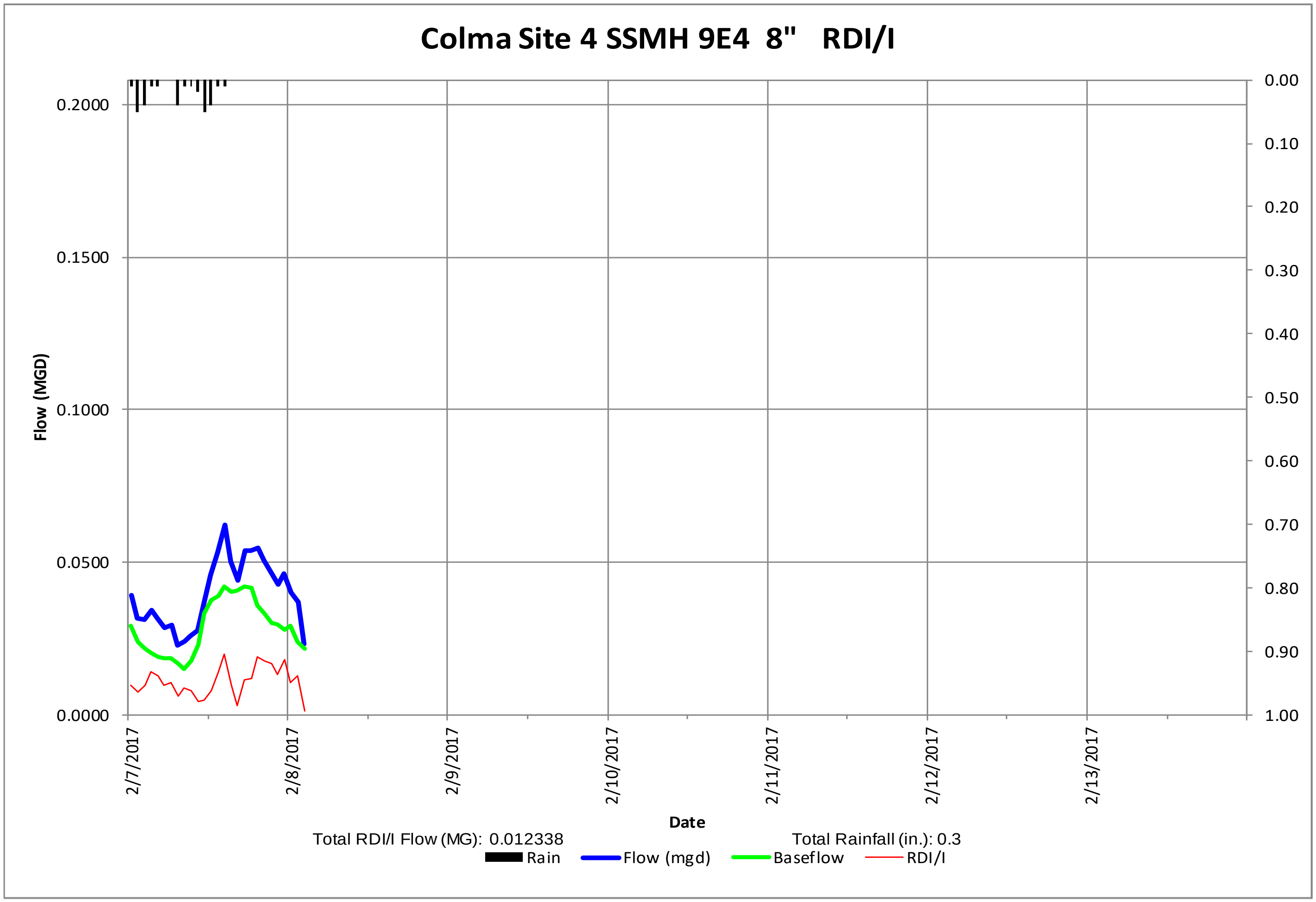
Storm of 2/4/2017



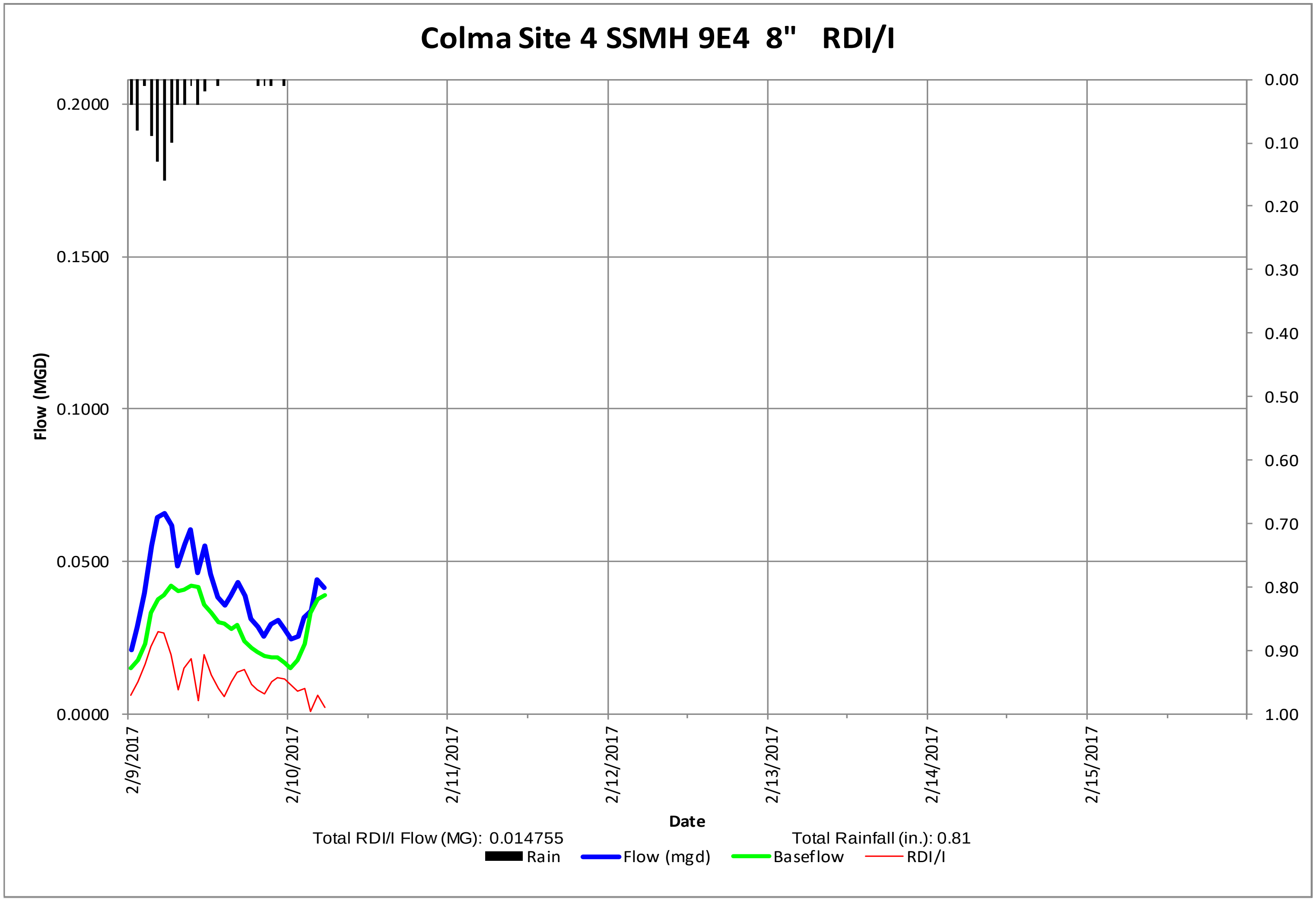
Storm of 2/5/2017



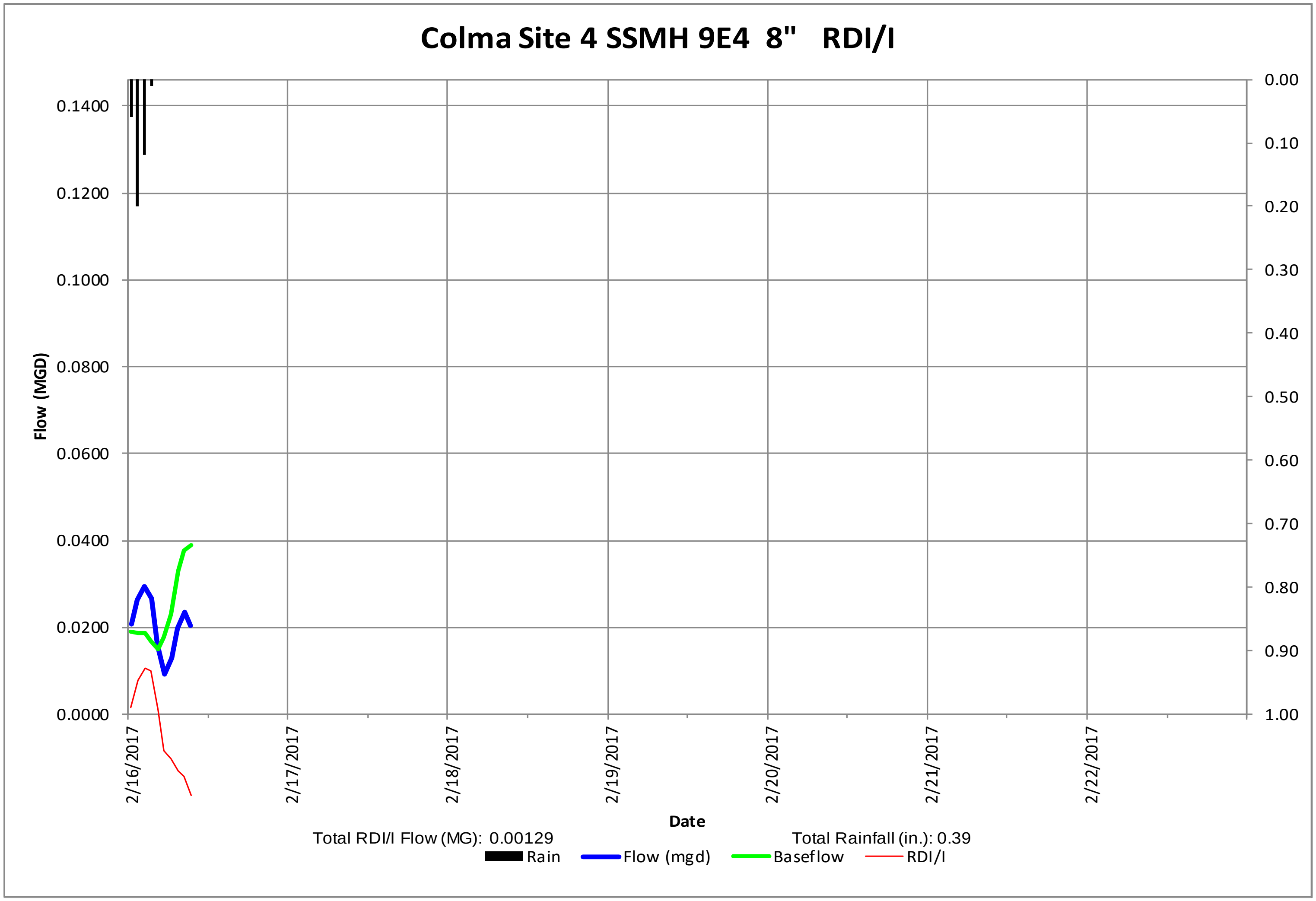
Storm of 2/6/2017



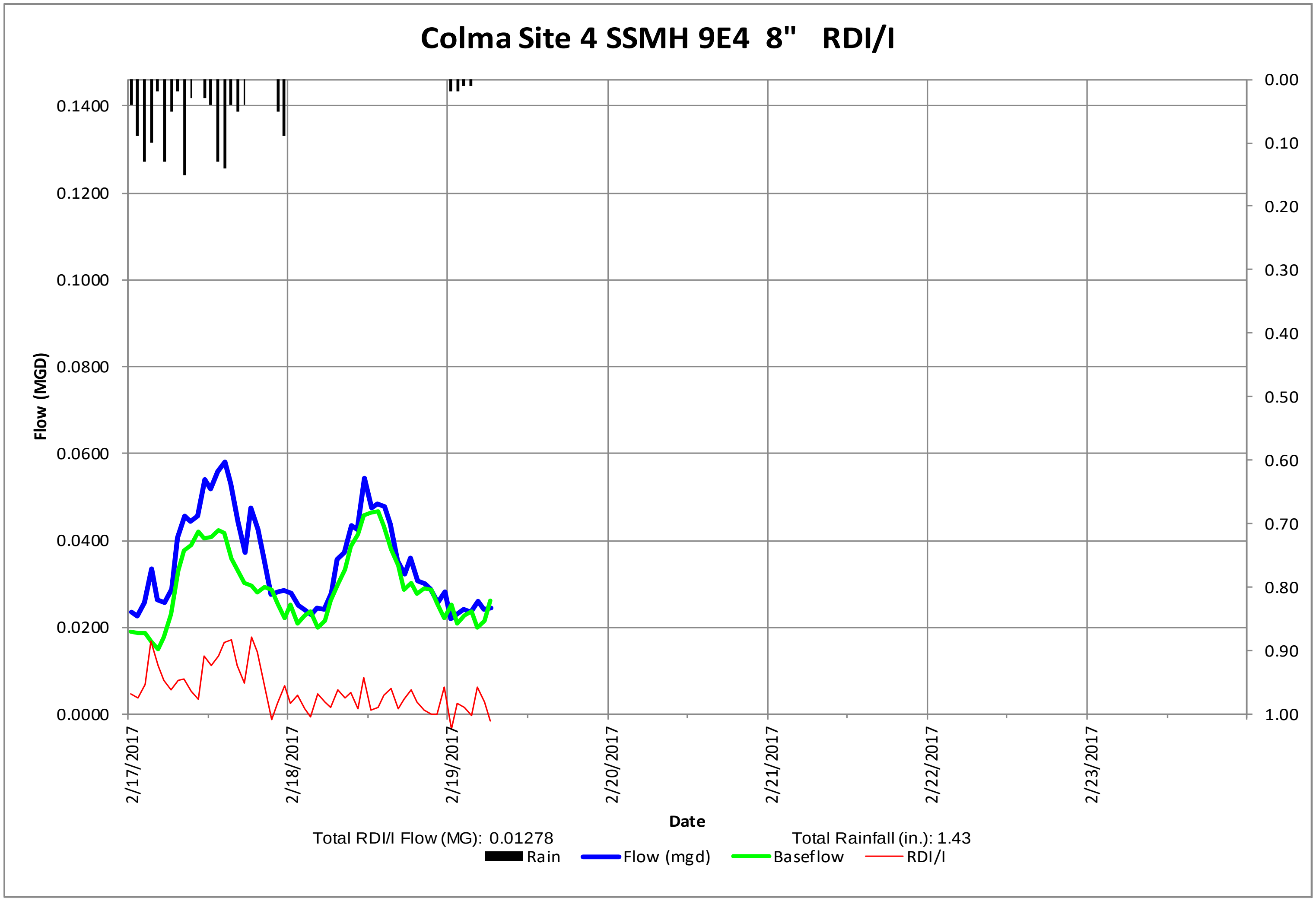
Storm of 2/7/2017



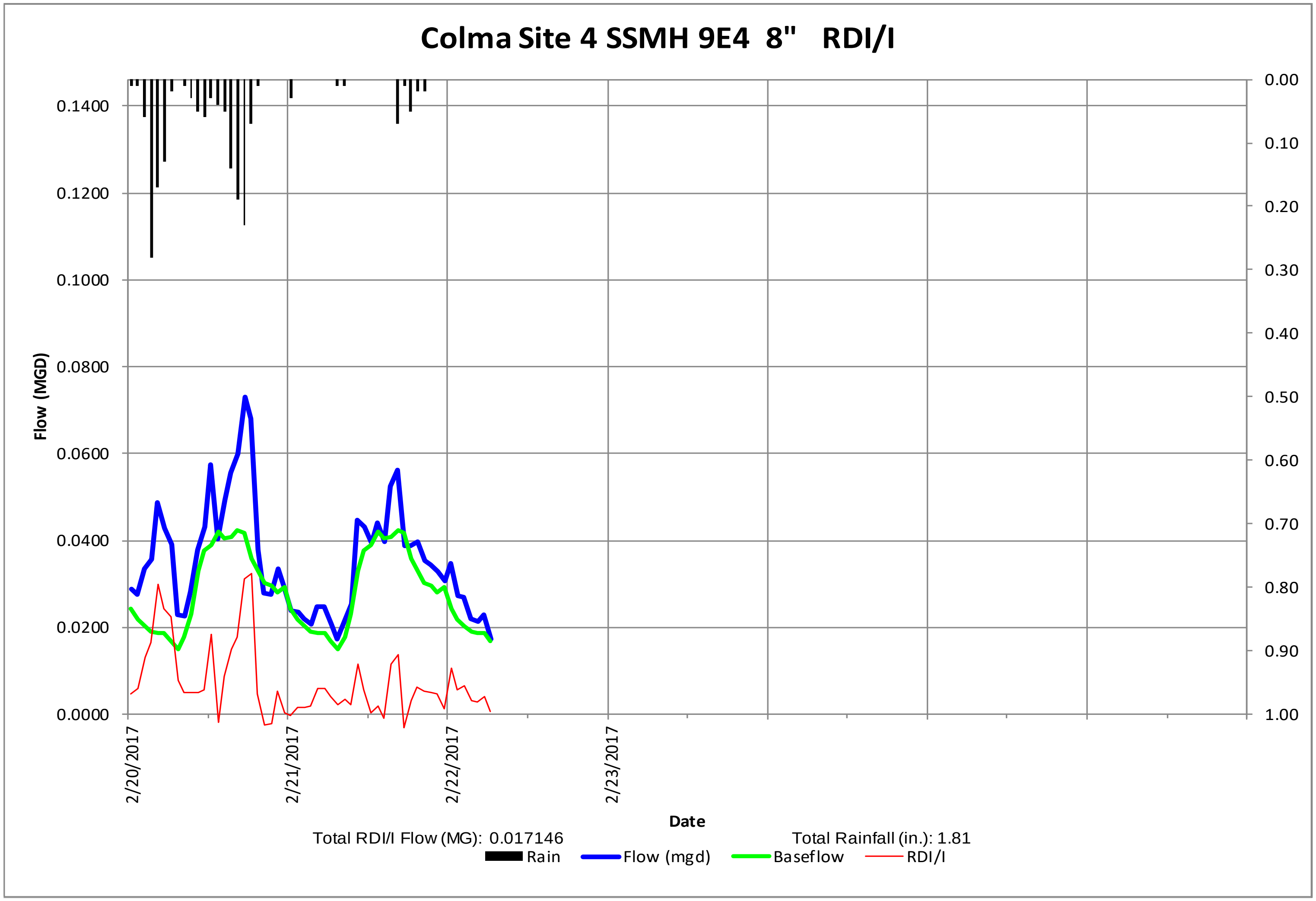
Storm of 2/9/2017



Storm of 2/16/2017



Storm of 2/17/2017



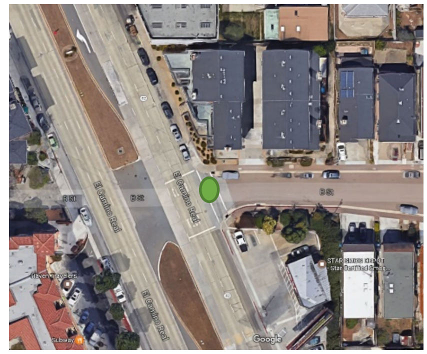
Storm of 2/20/2017

Site Information Report

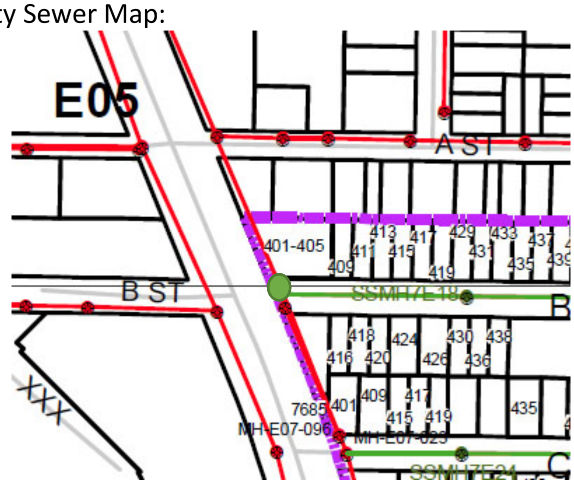
Flow Monitor Site: 5

Manhole Number SSMH B St.
Location: El Camino at B St.
MH Depth ~6.5’
Diameter: 10” to 12”
Safety: OK
Traffic: Medium
Gas: Ok
Rungs: No
Meter Type: Hach FL900
Depth: Pressure 4”
Velocity: Doppler 5 ft./sec
Sensor Type Submerged

Ariel View:

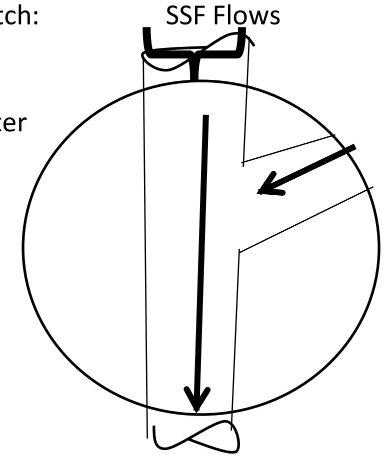


City Sewer Map:



Flow Sketch: SSF Flows

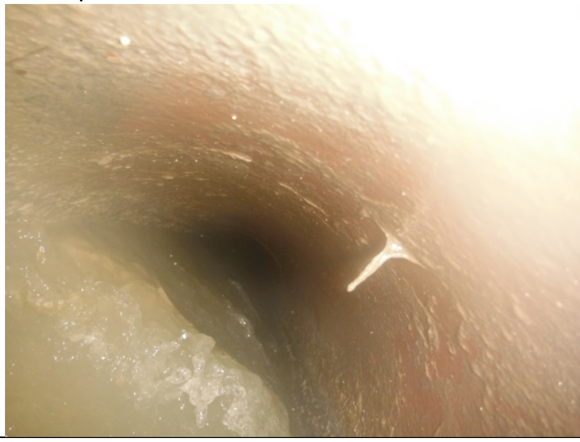
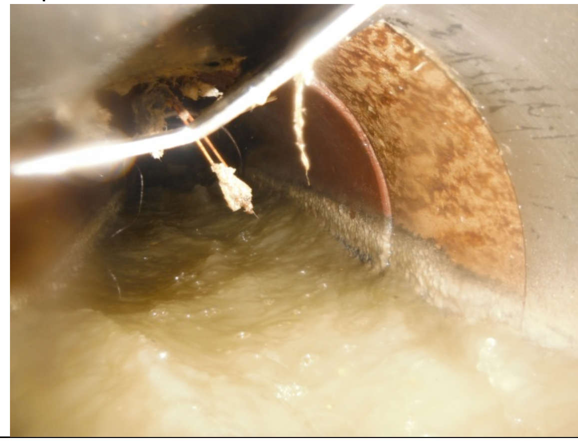
Flow Meter



10”-inch Pipes

Surface View:

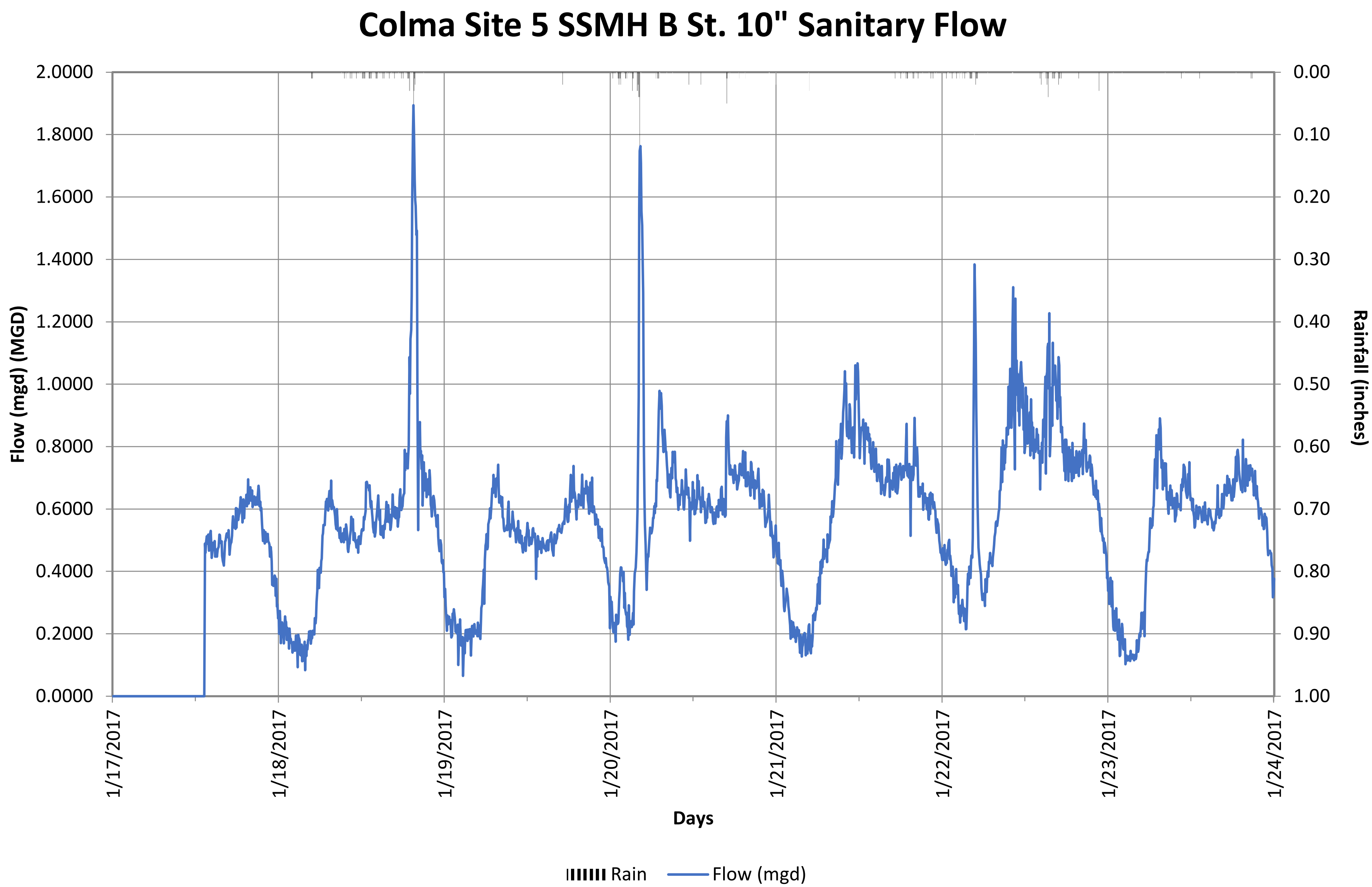
Invert View:

Outlet Pipe: 	Inlet Pipe: 
Inlet Pipe: P2 	Inlet Pipe: P3 

Colma Site 5 SSMH B St. 10" Sanitary Flow

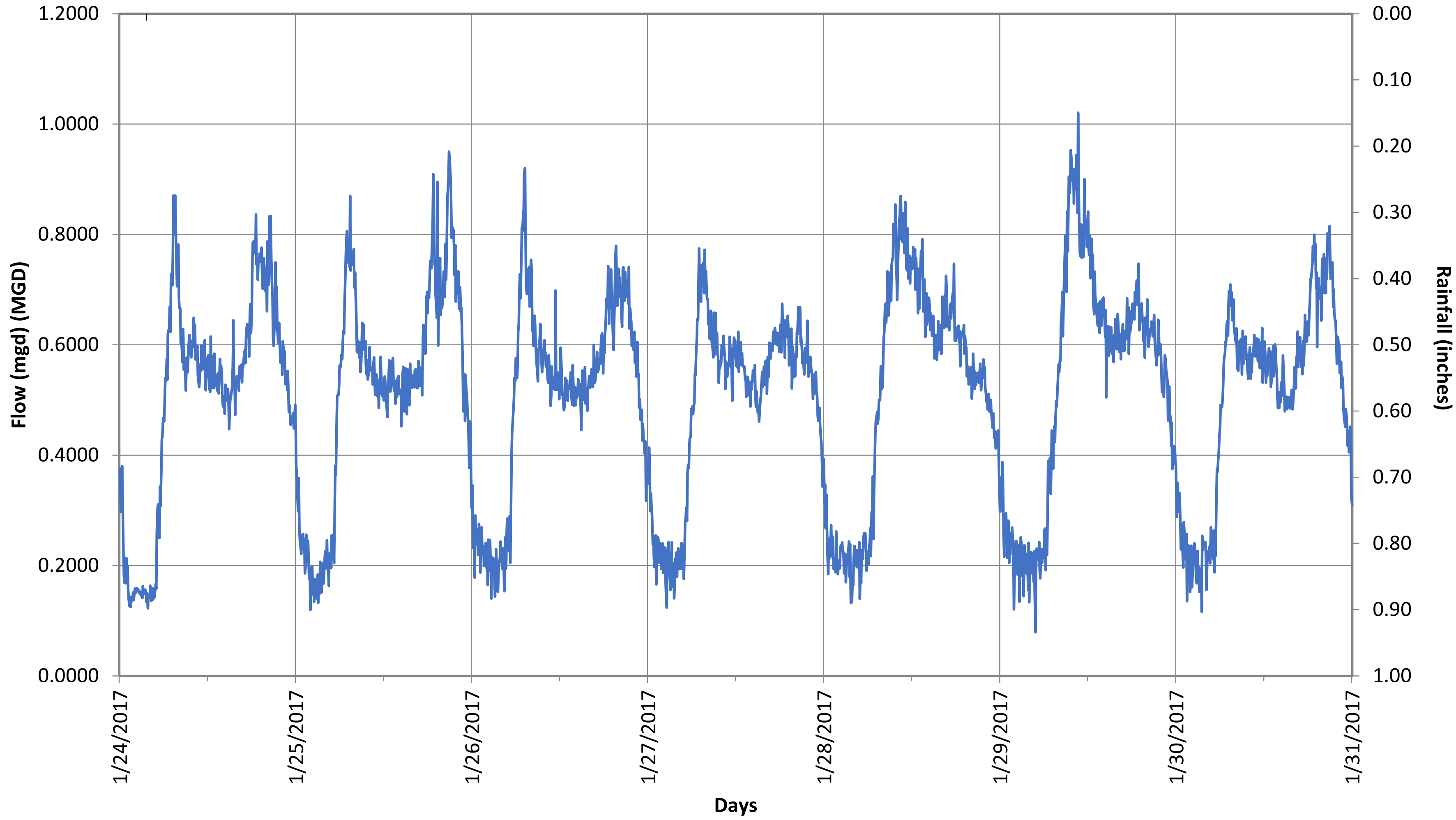
Daily Summary

Day	Date	Avg Flow(MGD)	Min Flow(MGD)	Max Flow(MGD)	Max Depth(in.)	Rain(in.)
Tuesday	1/17/17	0.233	0.000	0.695	4.222	0.00
Wednesday	1/18/17	0.531	0.083	1.894	77.665	0.88
Thursday	1/19/17	0.470	0.065	0.742	4.372	0.02
Friday	1/20/17	0.623	0.175	1.763	72.950	1.13
Saturday	1/21/17	0.589	0.127	1.067	5.831	0.25
Sunday	1/22/17	0.687	0.214	1.384	46.791	1.00
Monday	1/23/17	0.530	0.103	0.891	5.000	0.18
Tuesday	1/24/17	0.503	0.122	0.871	5.024	0.01
Wednesday	1/25/17	0.522	0.120	0.950	5.284	0.00
Thursday	1/26/17	0.506	0.140	0.920	5.191	0.00
Friday	1/27/17	0.496	0.124	0.774	4.497	0.00
Saturday	1/28/17	0.512	0.132	0.869	5.034	0.00
Sunday	1/29/17	0.528	0.079	1.021	5.552	0.00
Monday	1/30/17	0.505	0.116	0.815	4.695	0.00
Tuesday	1/31/17	0.509	0.093	0.836	4.799	0.00
Wednesday	2/1/17	0.510	0.121	0.937	5.307	0.01
Thursday	2/2/17	0.510	0.113	0.885	5.082	0.19
Friday	2/3/17	0.532	0.017	1.285	14.686	0.51
Saturday	2/4/17	0.566	0.102	1.230	6.645	0.37
Sunday	2/5/17	0.542	0.120	1.088	6.175	0.15
Monday	2/6/17	0.572	0.019	1.083	5.776	0.50
Tuesday	2/7/17	0.610	0.147	1.323	12.967	0.86
Wednesday	2/8/17	0.553	0.177	0.897	5.054	0.26
Thursday	2/9/17	0.584	0.138	0.969	12.053	0.77
Friday	2/10/17	0.522	0.134	0.943	5.278	0.04
Saturday	2/11/17	0.564	0.141	0.910	5.195	0.00
Sunday	2/12/17	0.587	0.147	1.079	5.952	0.00
Monday	2/13/17	0.521	0.145	0.835	4.878	0.00
Tuesday	2/14/17	0.519	0.128	0.889	5.127	0.00
Wednesday	2/15/17	0.521	0.154	0.998	5.643	0.00
Thursday	2/16/17	0.568	0.127	0.861	5.001	0.39
Friday	2/17/17	0.658	0.139	1.196	15.821	1.23
Saturday	2/18/17	0.672	0.128	1.078	5.913	0.14
Sunday	2/19/17	0.594	0.208	0.935	5.370	0.08
Monday	2/20/17	0.770	0.231	1.396	35.436	1.61
Tuesday	2/21/17	0.612	0.266	0.952	5.536	0.19
Wednesday	2/22/17	0.554	0.239	0.884	5.040	0.00



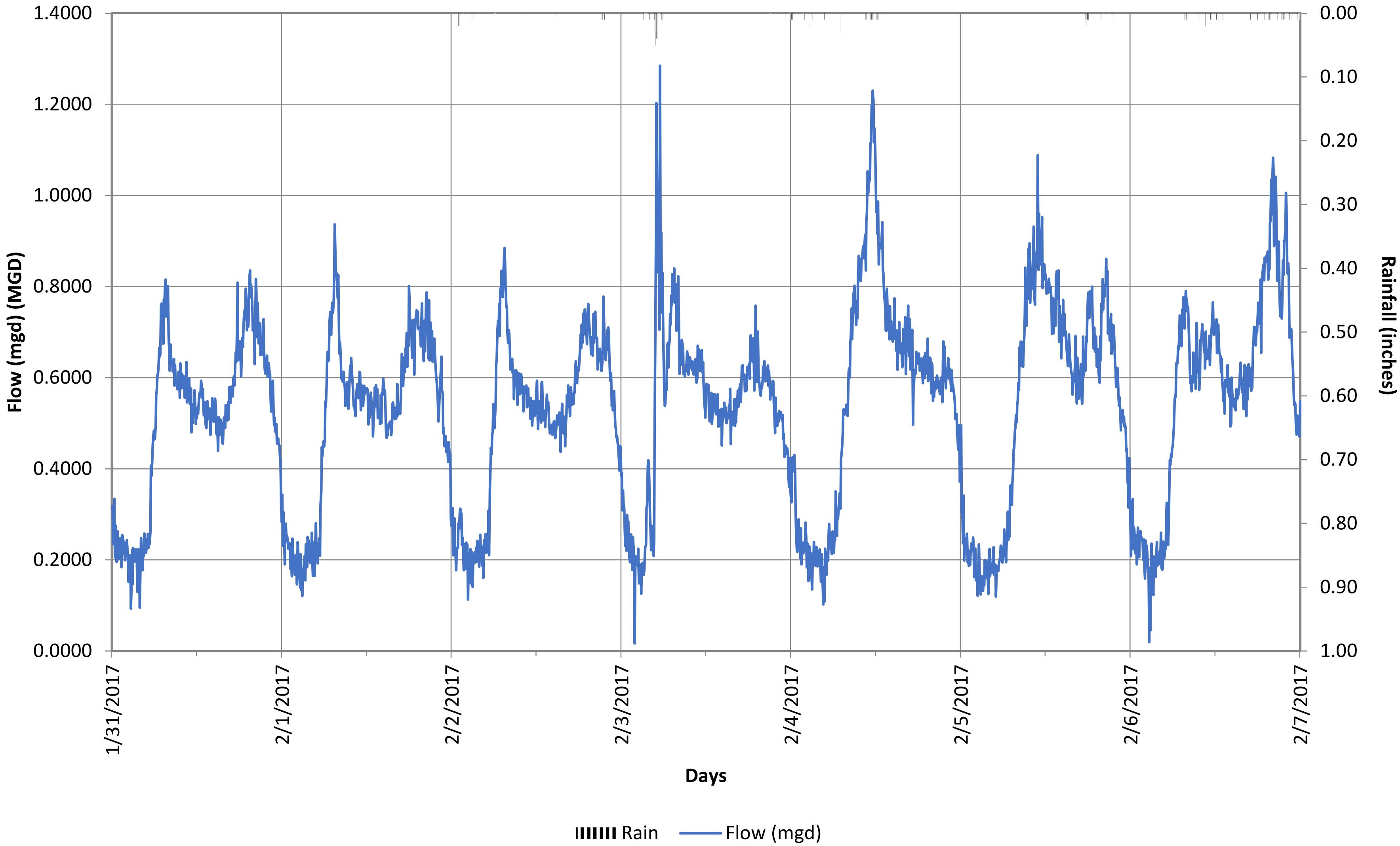
	1/17/2017(Tue)	1/18/2017(Wed)	1/19/2017(Thu)	1/20/2017(Fri)	1/21/2017(Sat)	1/22/2017(Sun)	1/23/2017(Mon)
Maximum	0.695	1.894	0.742	1.763	1.067	1.384	0.891
Average	0.233	0.531	0.470	0.623	0.589	0.687	0.530
Minimum	0.000	0.083	0.065	0.175	0.127	0.214	0.103
Rain (inches)	0.00	0.88	0.02	1.13	0.25	1.00	0.18

Colma Site 5 SSMH B St. 10" Sanitary Flow



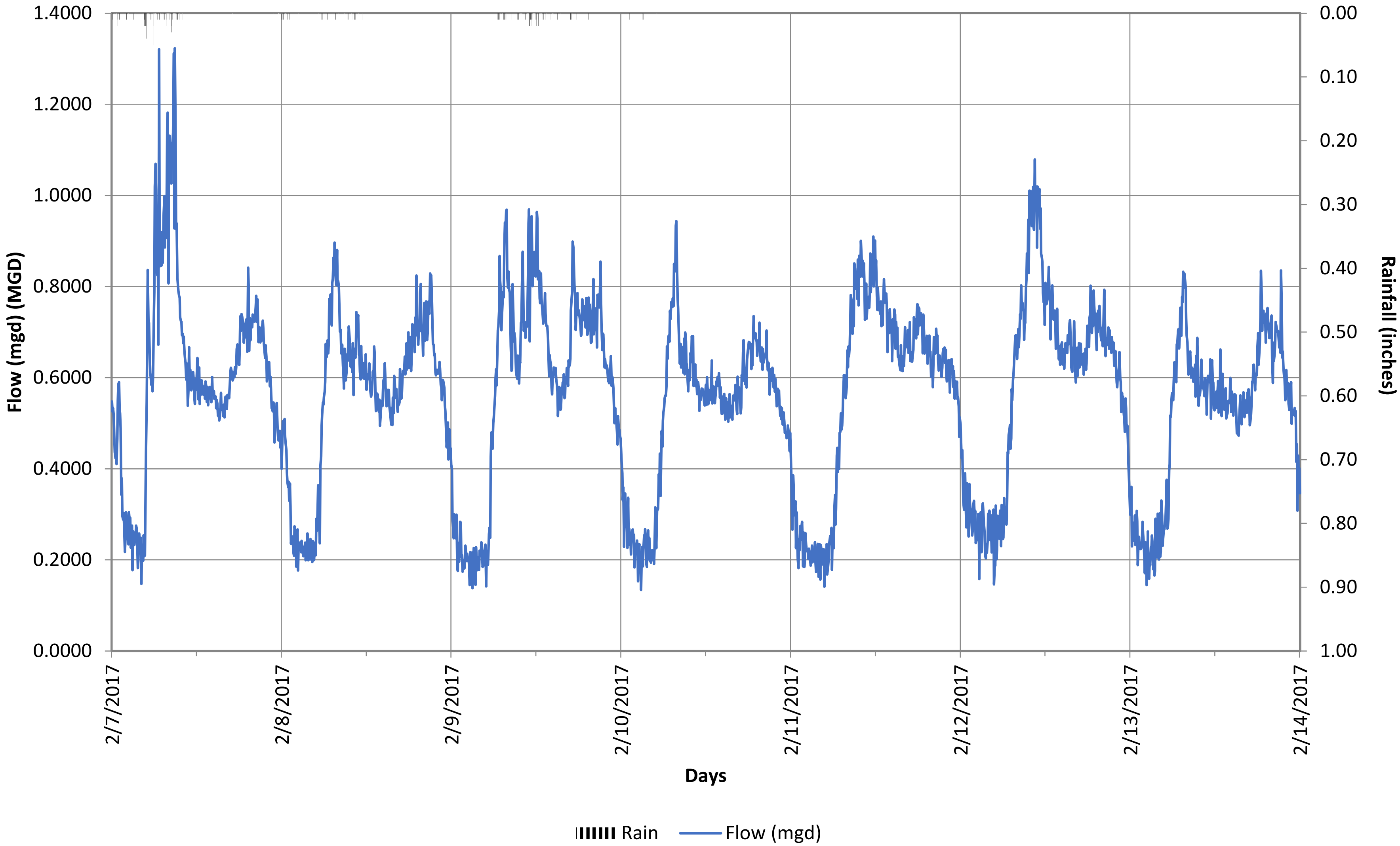
	1/24/2017(Tue)	1/25/2017(Wed)	1/26/2017(Thu)	1/27/2017(Fri)	1/28/2017(Sat)	1/29/2017(Sun)	1/30/2017(Mon)
Maximum	0.871	0.950	0.920	0.774	0.869	1.021	0.815
Average	0.503	0.522	0.506	0.496	0.512	0.528	0.505
Minimum	0.122	0.120	0.140	0.124	0.132	0.079	0.116
Rain (inches)	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Colma Site 5 SSMH B St. 10" Sanitary Flow



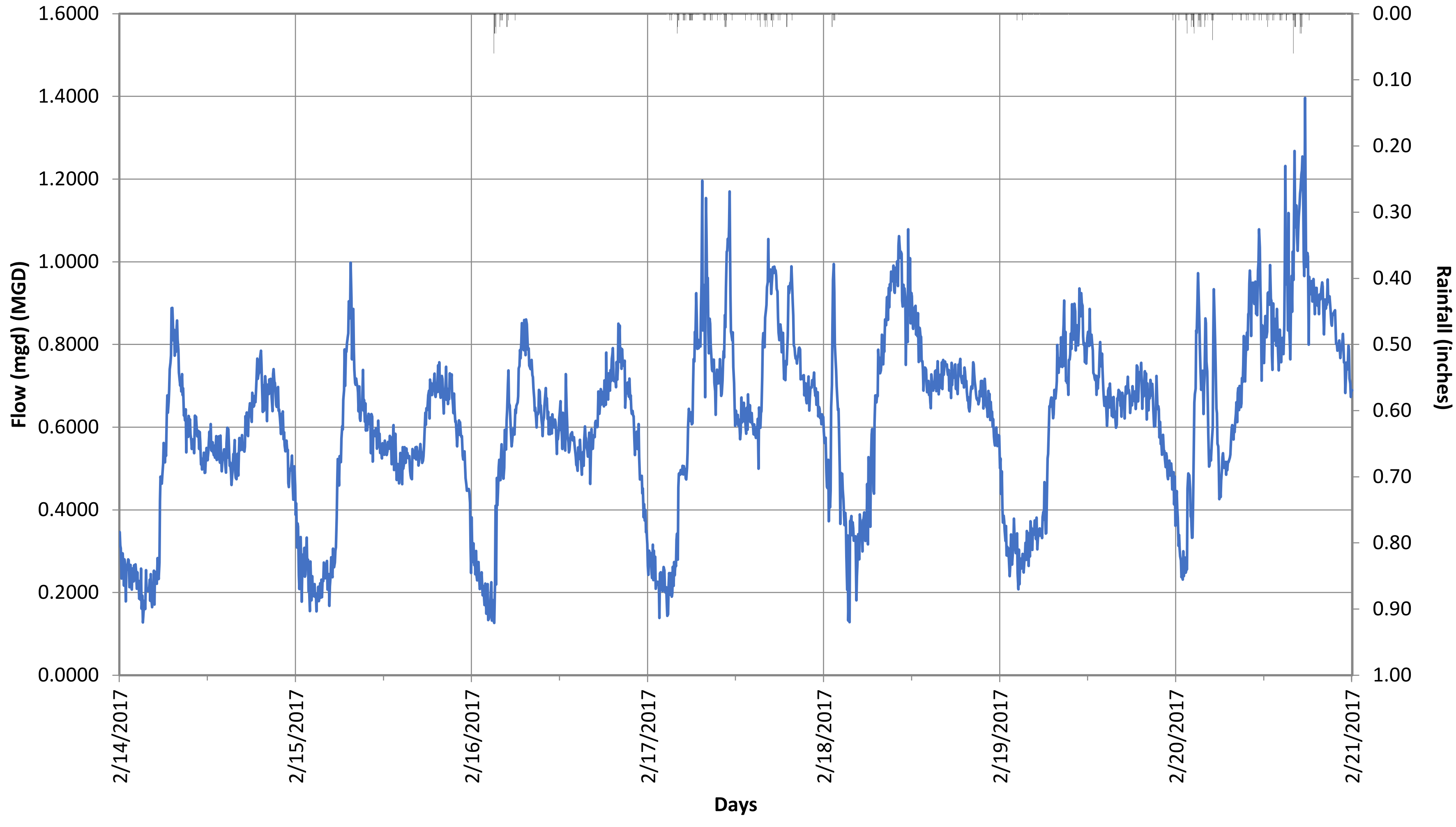
	1/31/2017(Tue)	2/1/2017(Wed)	2/2/2017(Thu)	2/3/2017(Fri)	2/4/2017(Sat)	2/5/2017(Sun)	2/6/2017(Mon)
Maximum	0.836	0.937	0.885	1.285	1.230	1.088	1.083
Average	0.509	0.510	0.510	0.532	0.566	0.542	0.572
Minimum	0.093	0.121	0.113	0.017	0.102	0.120	0.019
Rain (inches)	0.00	0.01	0.19	0.51	0.37	0.15	0.50

Colma Site 5 SSMH B St. 10" Sanitary Flow



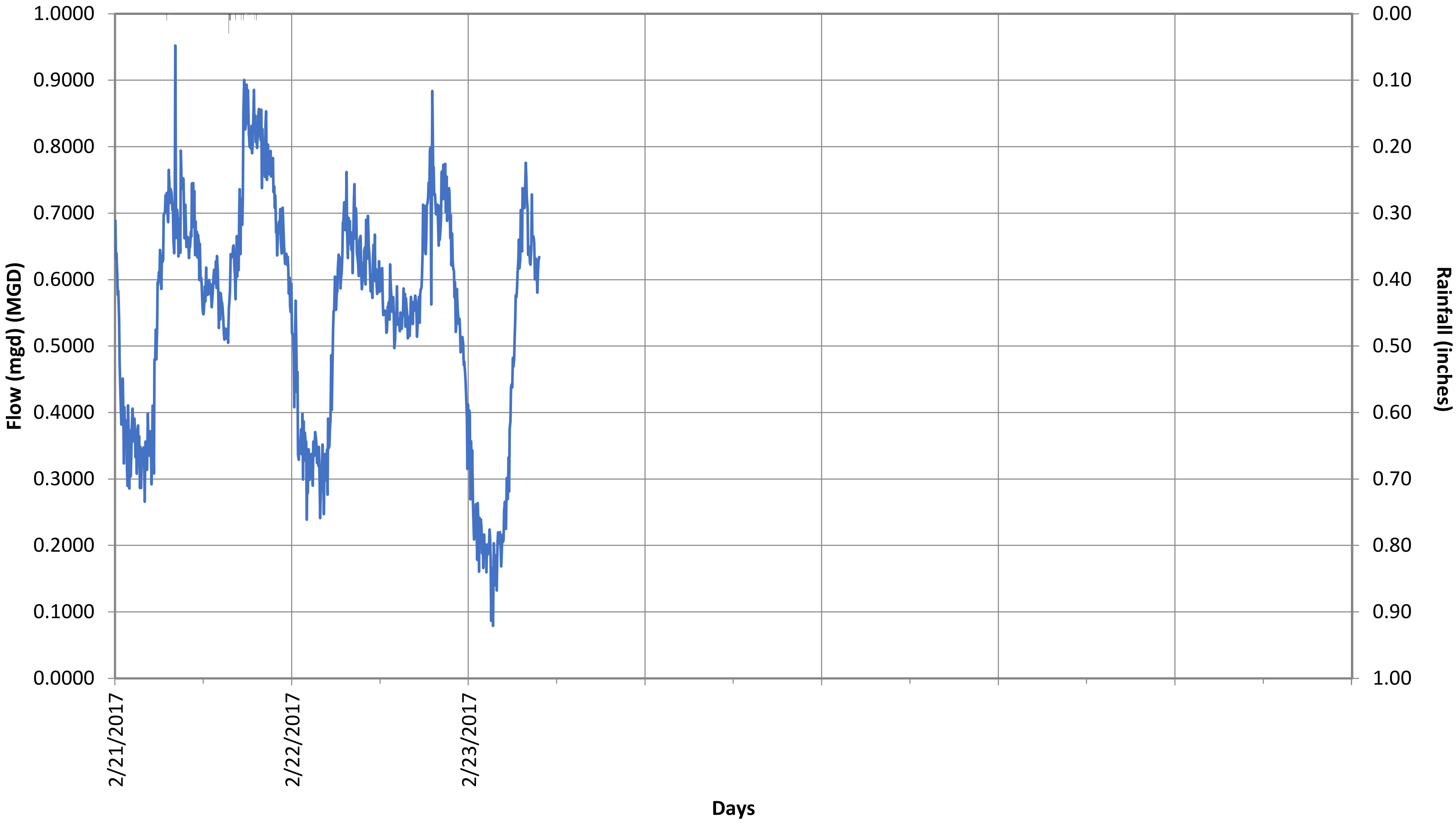
	2/7/2017(Tue)	2/8/2017(Wed)	2/9/2017(Thu)	2/10/2017(Fri)	2/11/2017(Sat)	2/12/2017(Sun)	2/13/2017(Mon)
Maximum	1.323	0.897	0.969	0.943	0.910	1.079	0.835
Average	0.610	0.553	0.584	0.522	0.564	0.587	0.521
Minimum	0.147	0.177	0.138	0.134	0.141	0.147	0.145
Rain (inches)	0.86	0.26	0.77	0.04	0.00	0.00	0.00

Colma Site 5 SSMH B St. 10" Sanitary Flow



	2/14/2017(Tue)	2/15/2017(Wed)	2/16/2017(Thu)	2/17/2017(Fri)	2/18/2017(Sat)	2/19/2017(Sun)	2/20/2017(Mon)
Maximum	0.889	0.998	0.861	1.196	1.078	0.935	1.396
Average	0.519	0.521	0.568	0.658	0.672	0.594	0.770
Minimum	0.128	0.154	0.127	0.139	0.128	0.208	0.231
Rain (inches)	0.00	0.00	0.39	1.23	0.14	0.08	1.61

Colma Site 5 SSMH B St. 10" Sanitary Flow

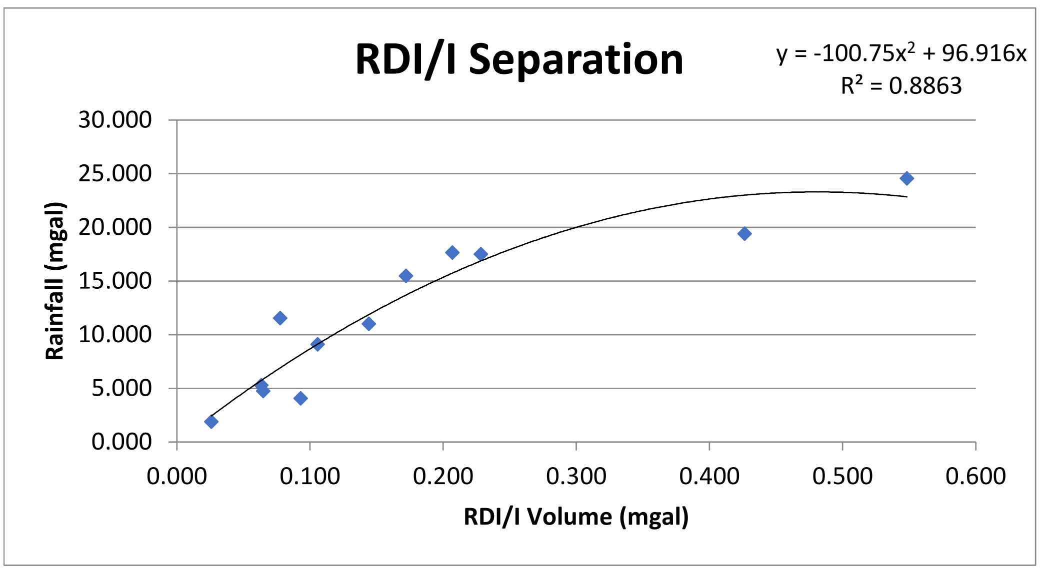


	2/21/2017(Tue)	2/22/2017(Wed)					
Maximum	0.952	0.884					
Average	0.612	0.554					
Minimum	0.266	0.239					
Rain (inches)	0.19	0.00					

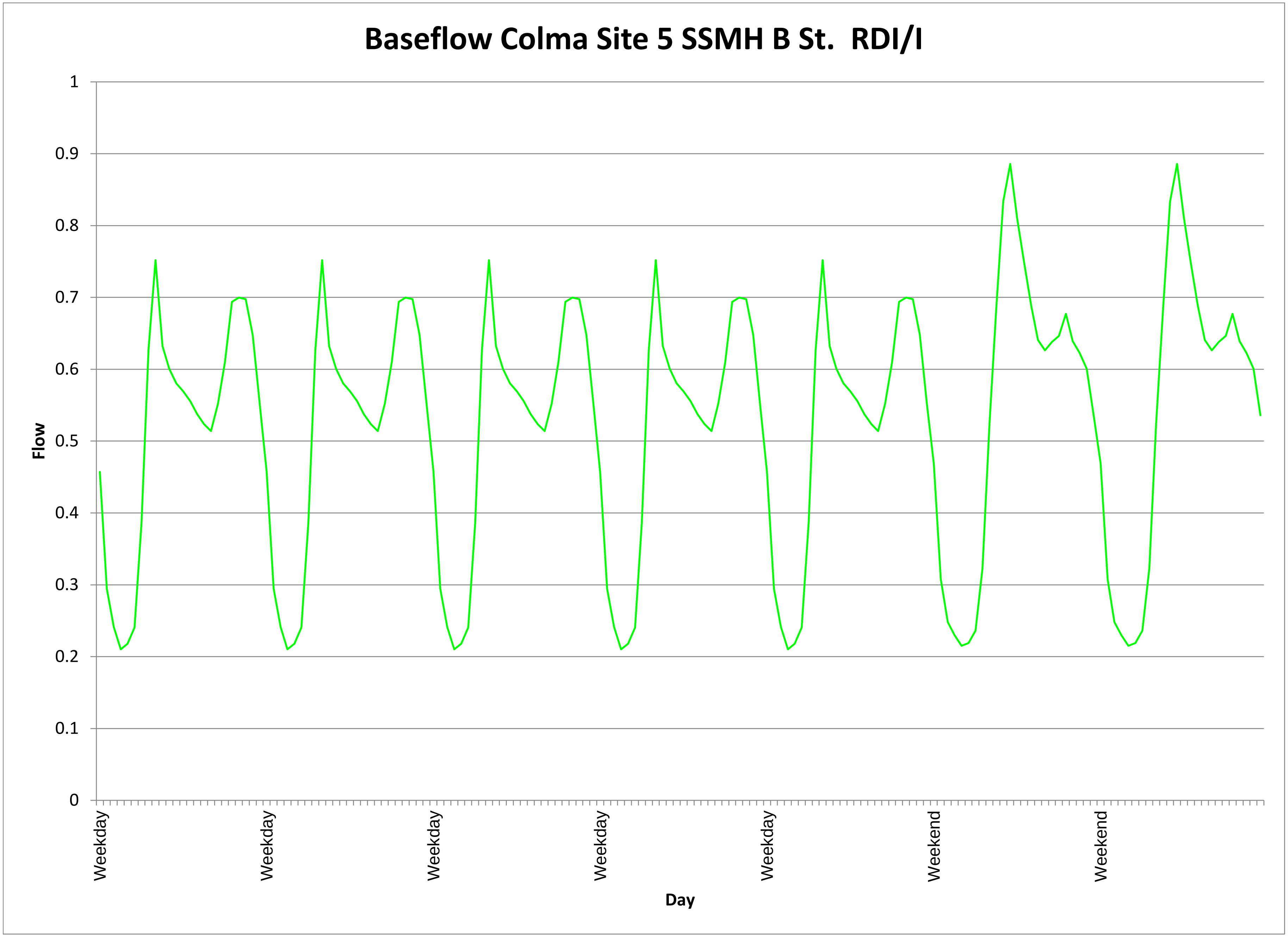
Colma Site 5 SSMH B St. RDI/I

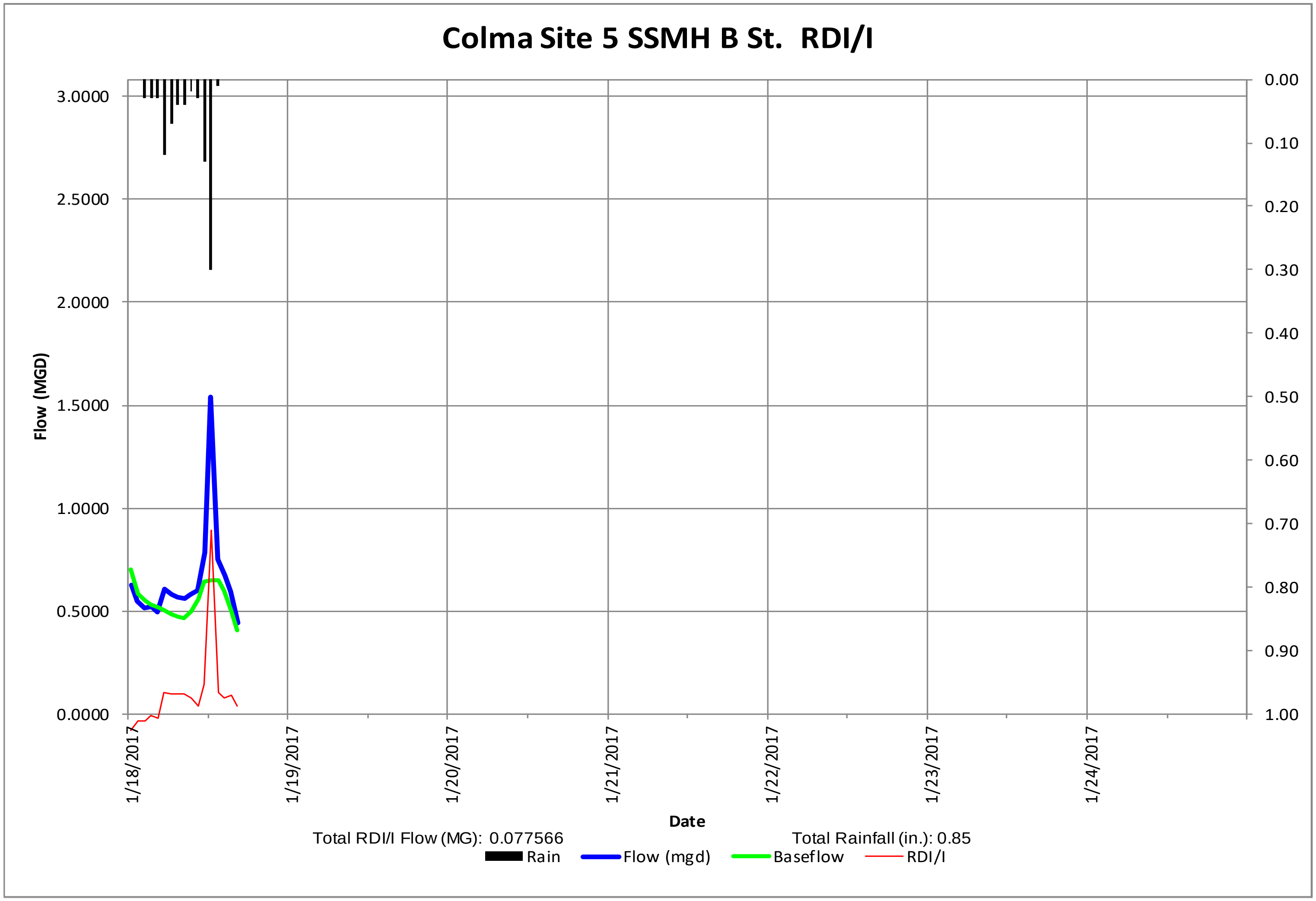
RDI/I Analysis, Monitor Return Ratio Summary

Storm Start (Date)	RDI/I Volume (mgal)	Monitor Area (acres)	Rainfall (mgal)	Return Ratio (%)
1/18/2017	0.078	500.0	11.540	0.67%
1/20/2017	0.172	500.0	15.477	1.11%
1/21/2017	0.228	500.0	17.513	1.30%
2/2/2017	0.106	500.0	9.096	1.16%
2/4/2017	0.065	500.0	4.752	1.36%
2/5/2017	0.026	500.0	1.901	1.36%
2/6/2017	0.207	500.0	17.649	1.17%
2/7/2017	0.093	500.0	4.073	2.28%
2/9/2017	0.144	500.0	10.997	1.31%
2/16/2017	0.063	500.0	5.295	1.20%
2/17/2017	0.426	500.0	19.414	2.20%
2/20/2017	0.548	500.0	24.573	2.23%
Average R%				1.45%
Average Top 3 Storms				2.24%

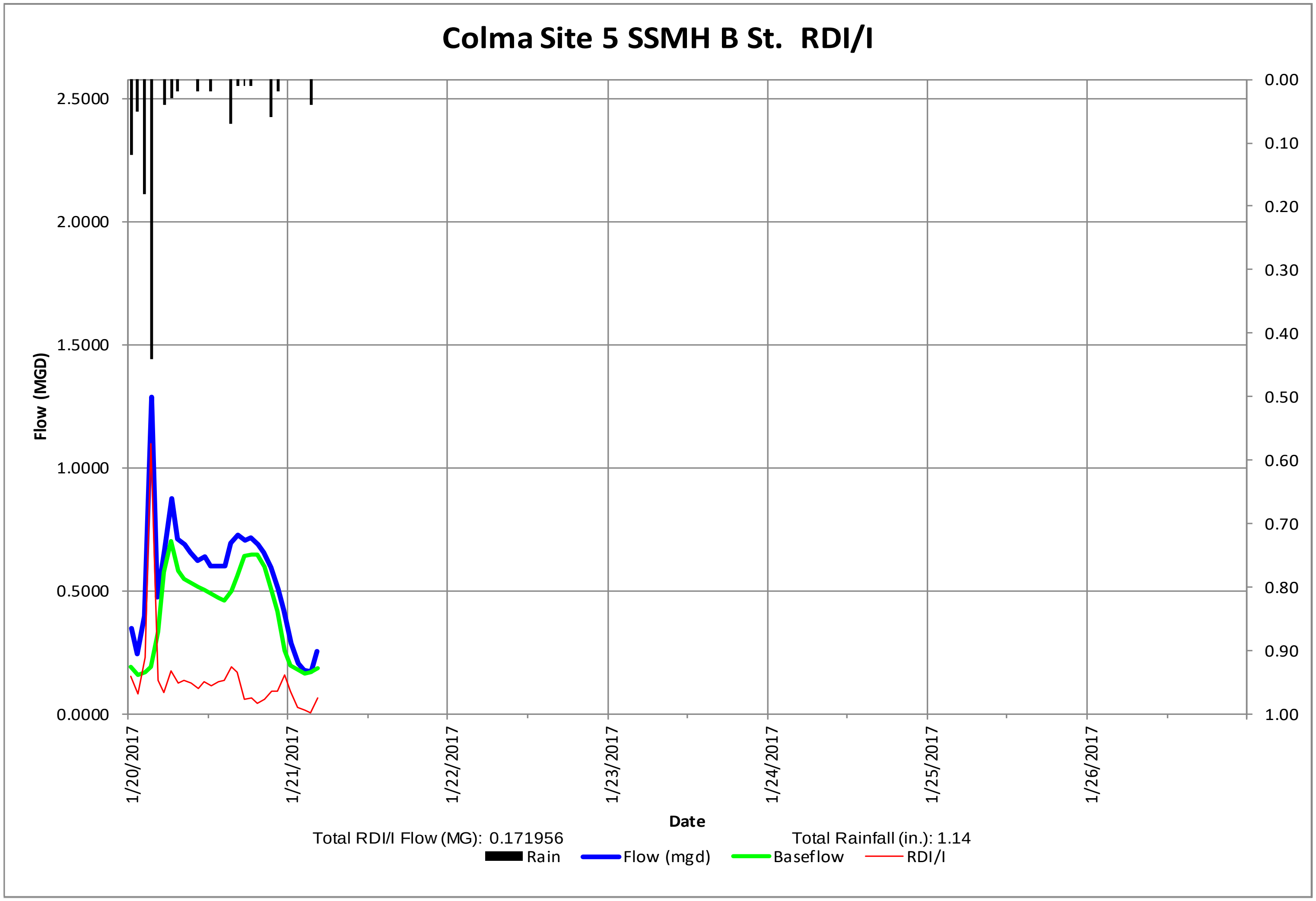


Baseflows	Weekend	Weekday
Max	0.886	0.752
Avg	0.544	0.516
Min	0.215	0.210

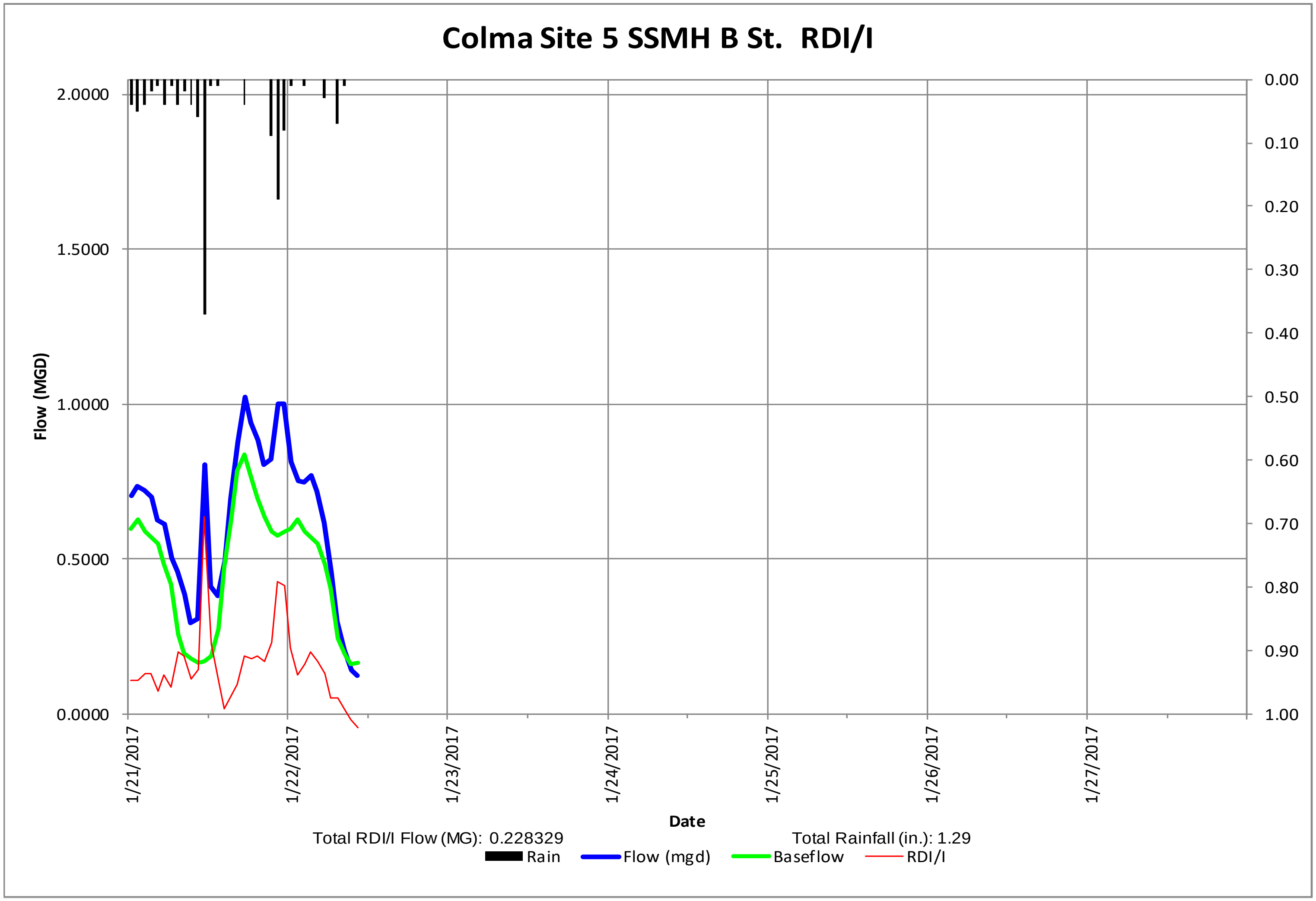

Baseflow Colma Site 5 SSMH B St. RDI/I
Flow
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Weekday
Weekday
Weekday
Weekday
Weekday
Weekend
Weekend
Day



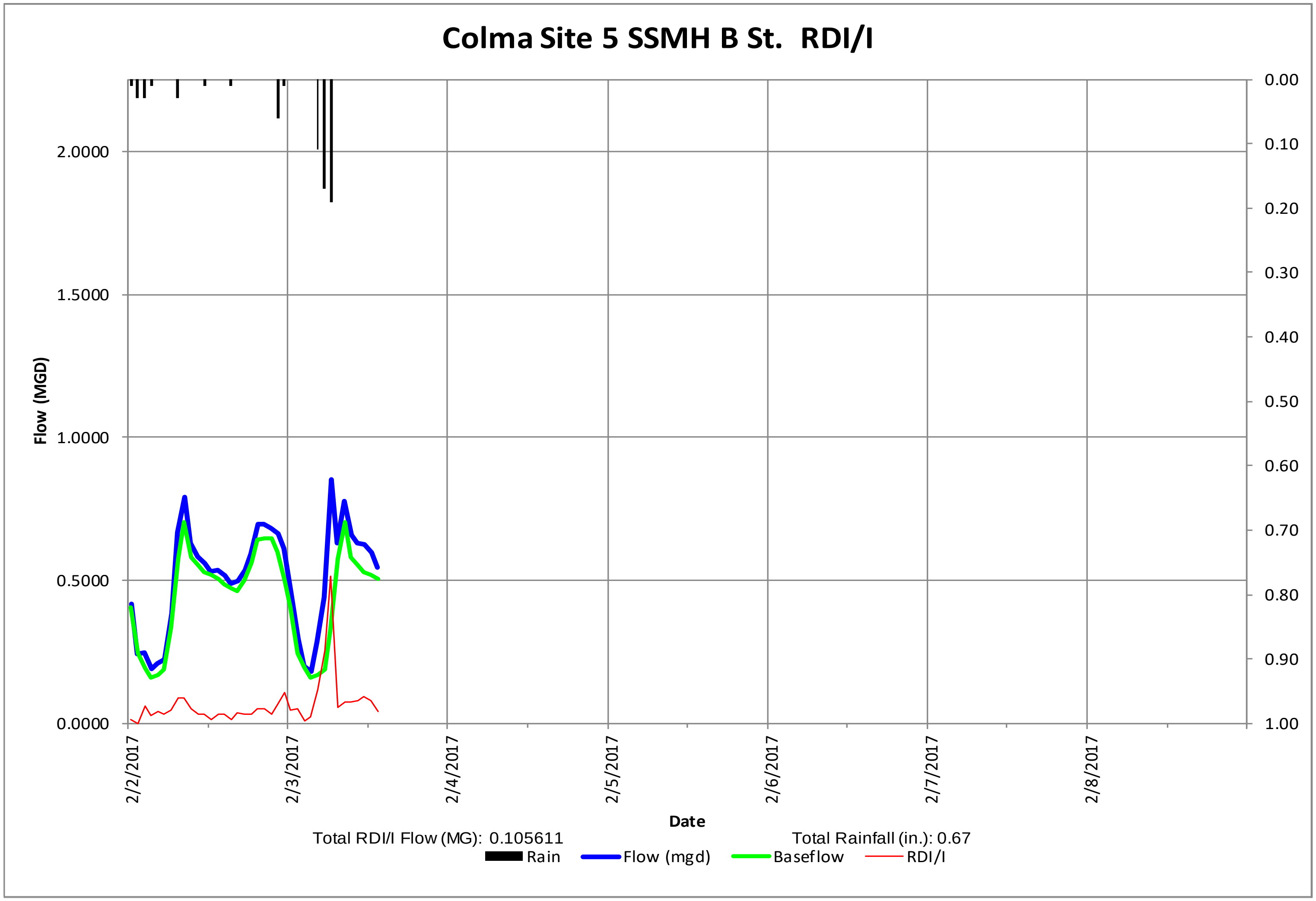
Storm of 1/18/2017



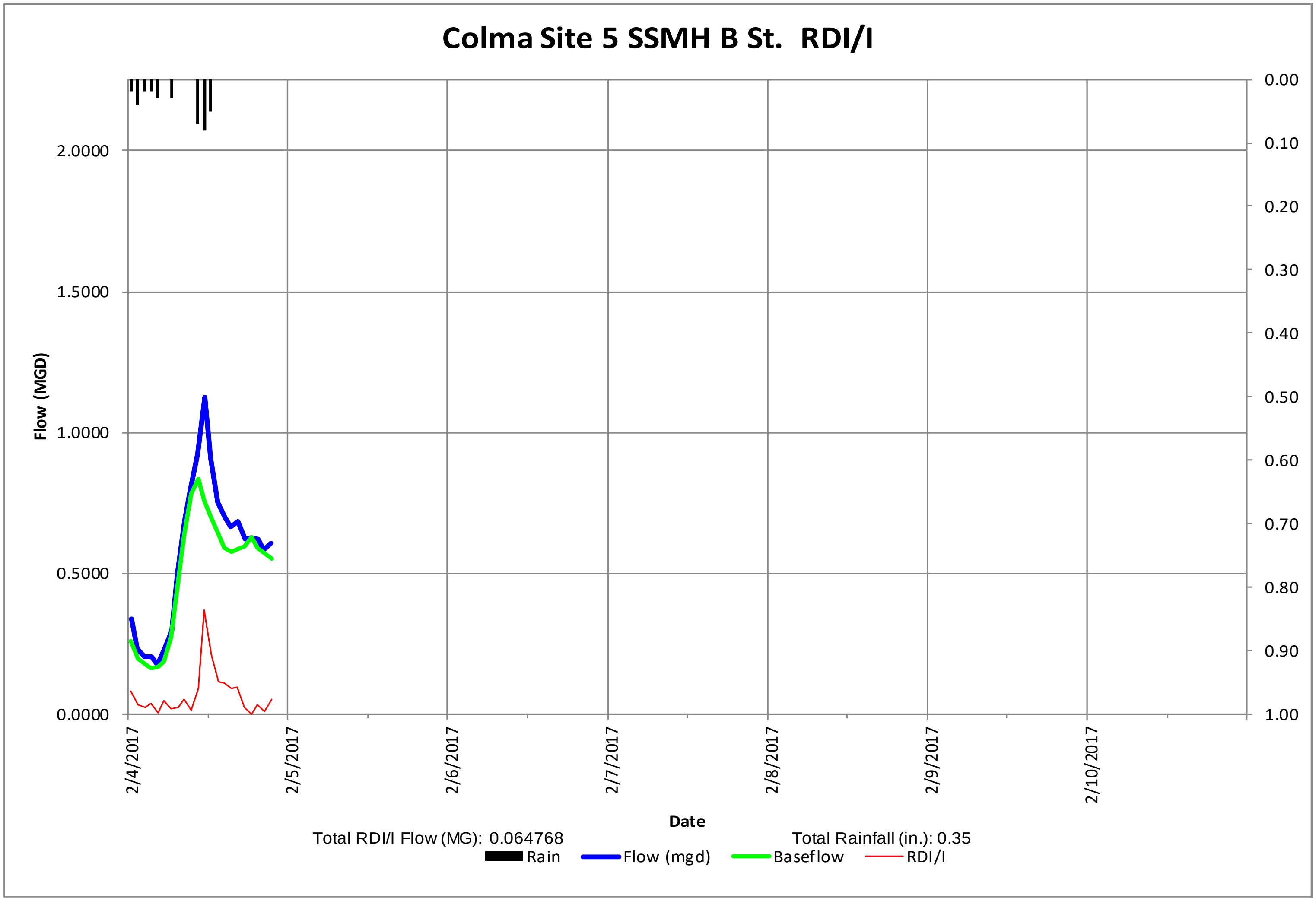
Storm of 1/20/2017



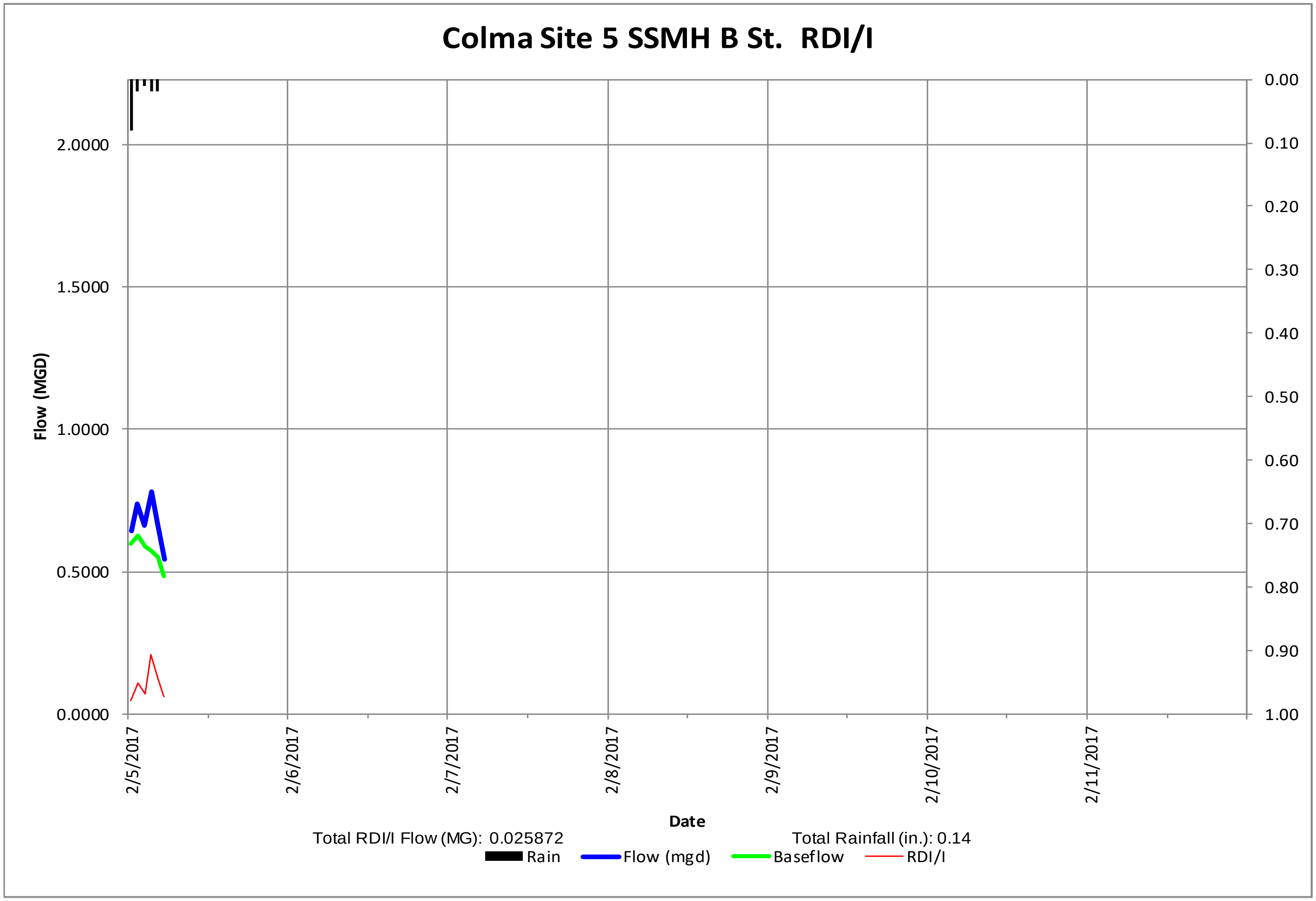
Storm of 1/21/2017



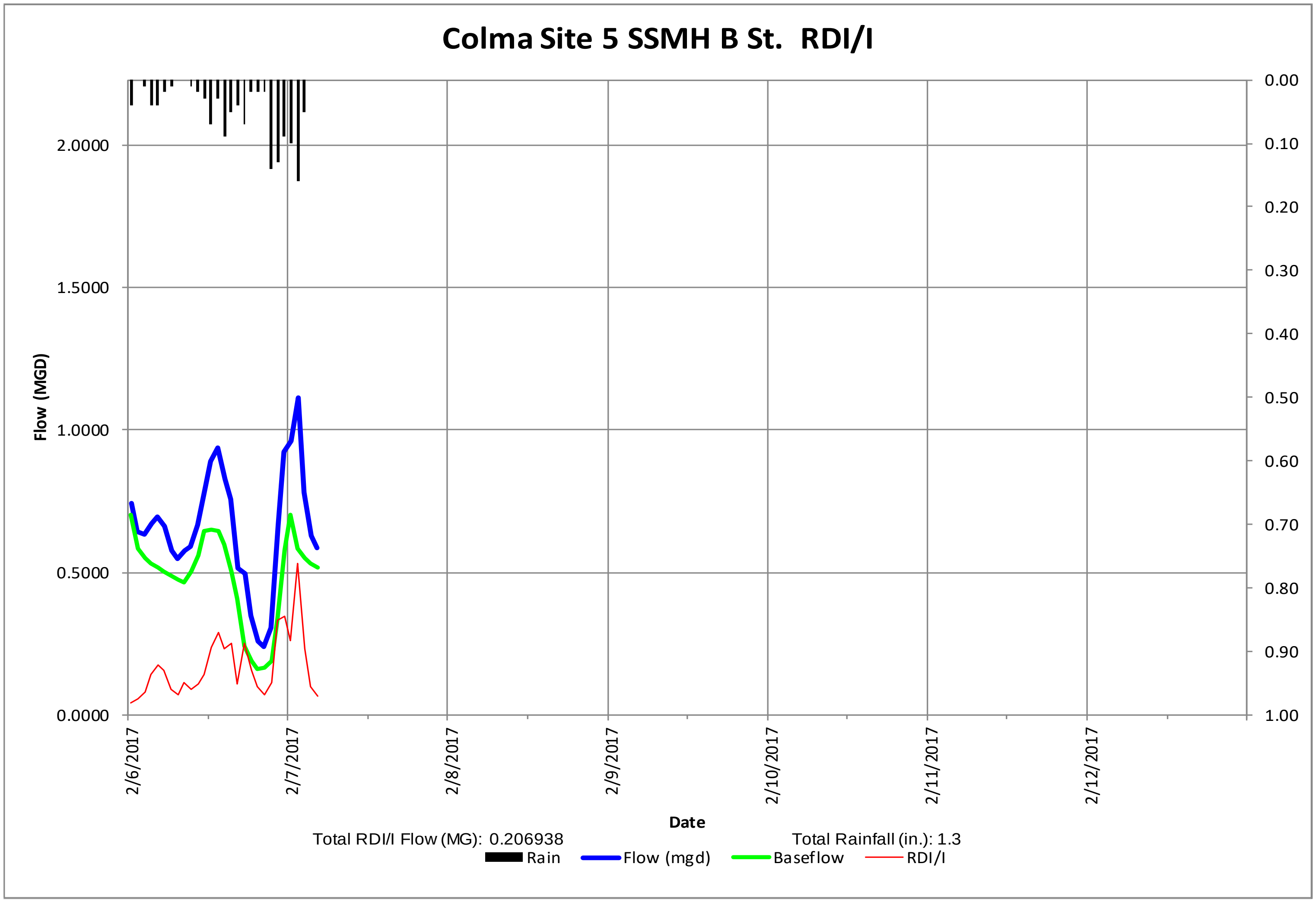
Storm of 2/2/2017



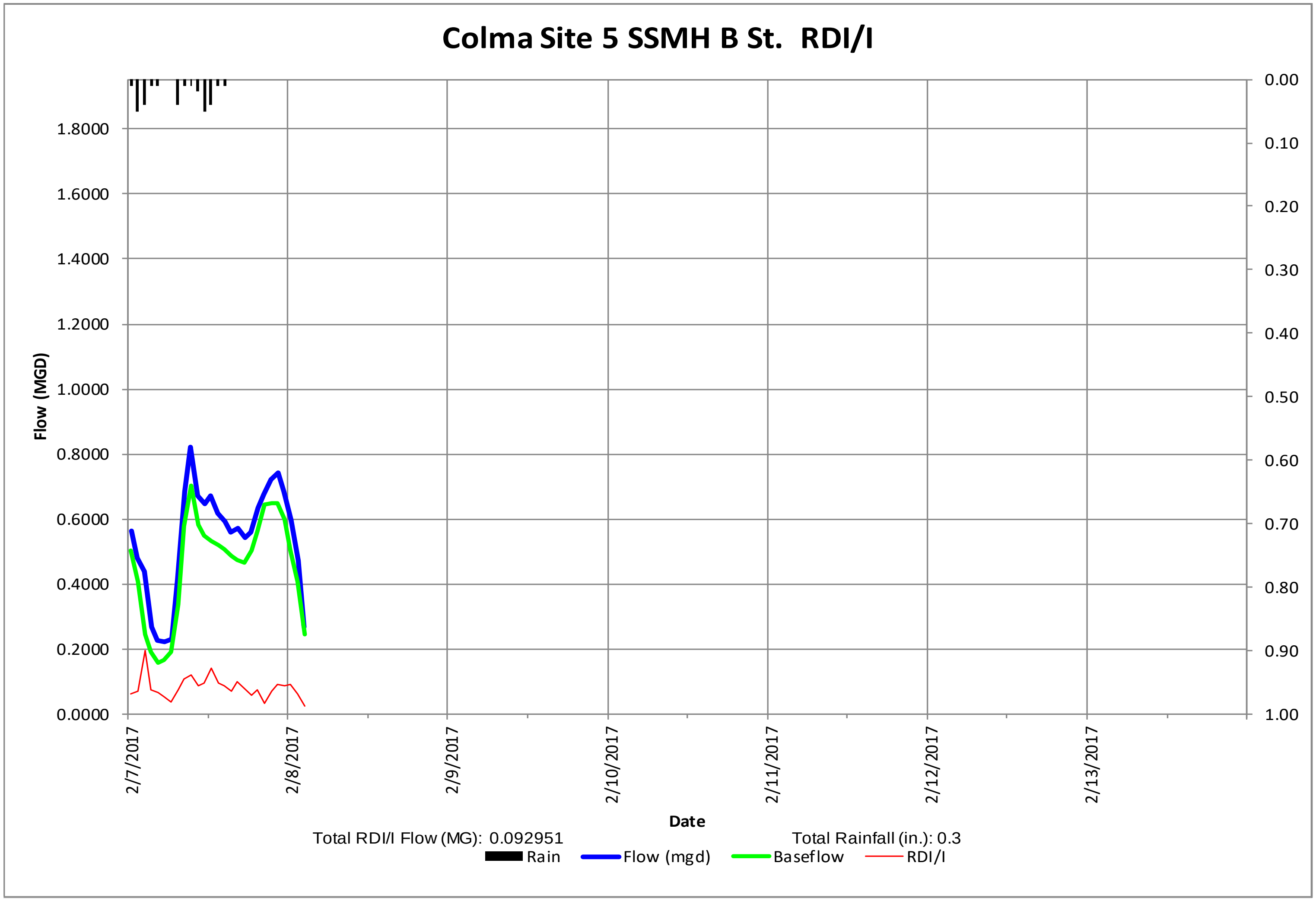
Storm of 2/4/2017



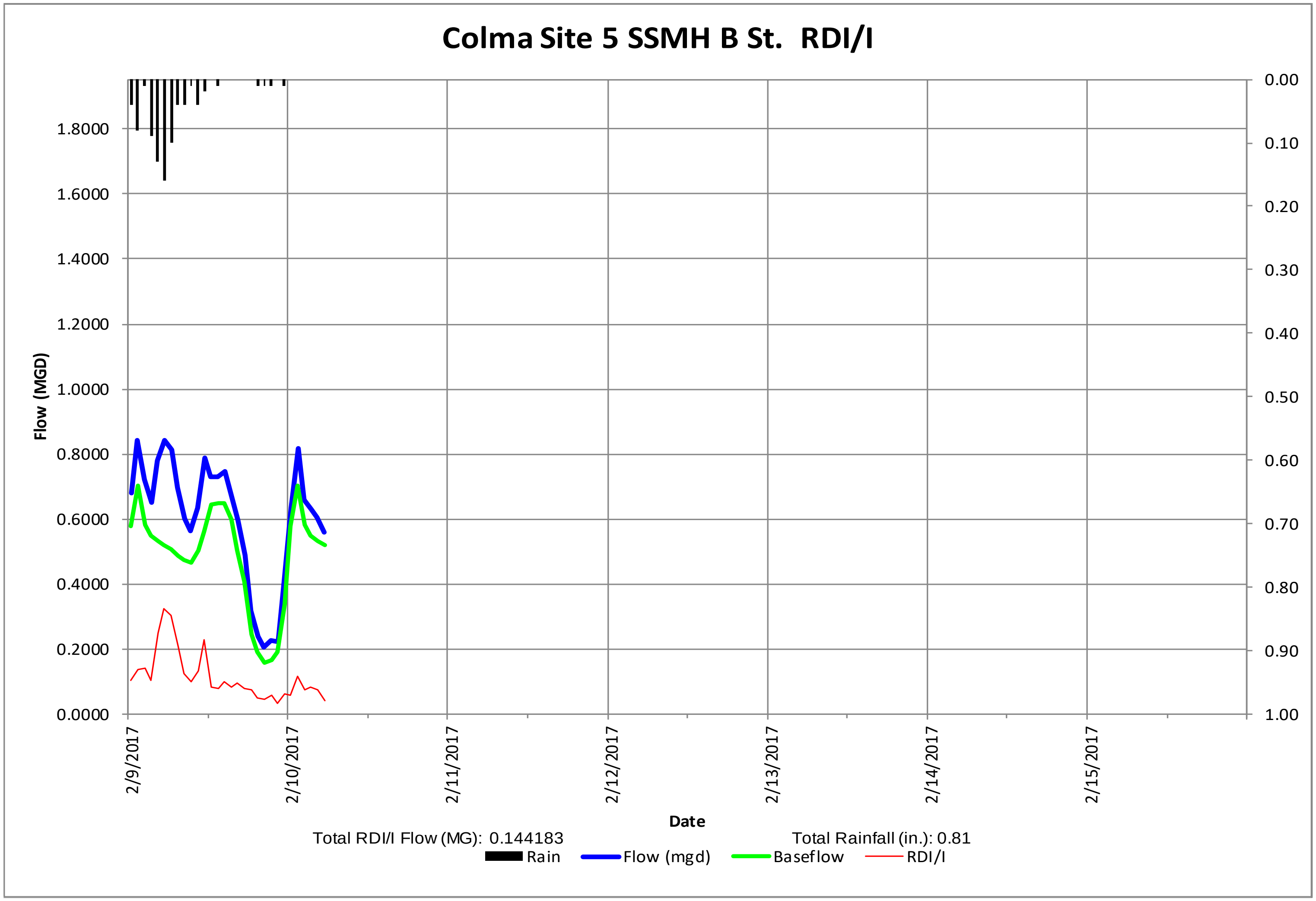
Storm of 2/5/2017



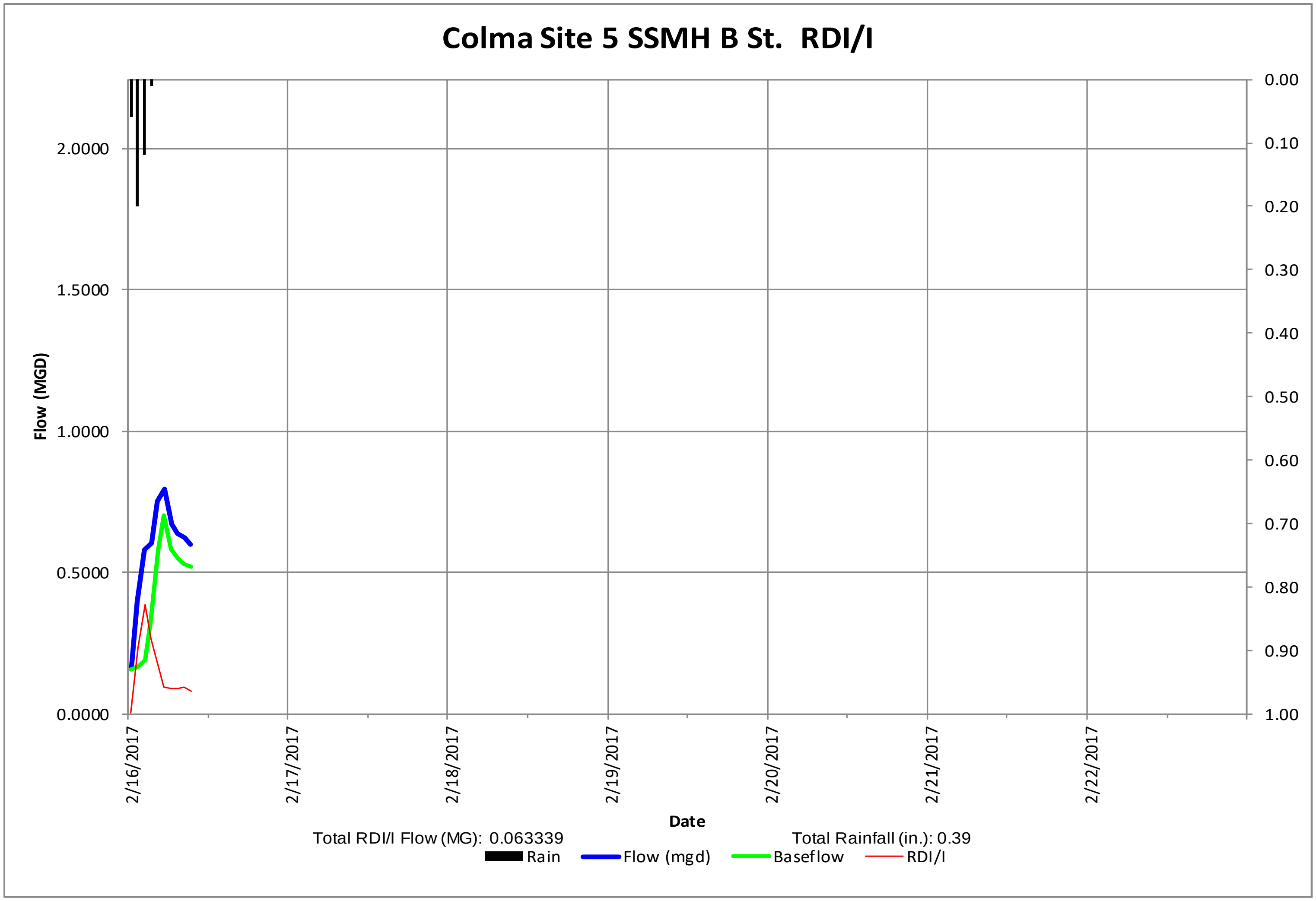
Storm of 2/6/2017



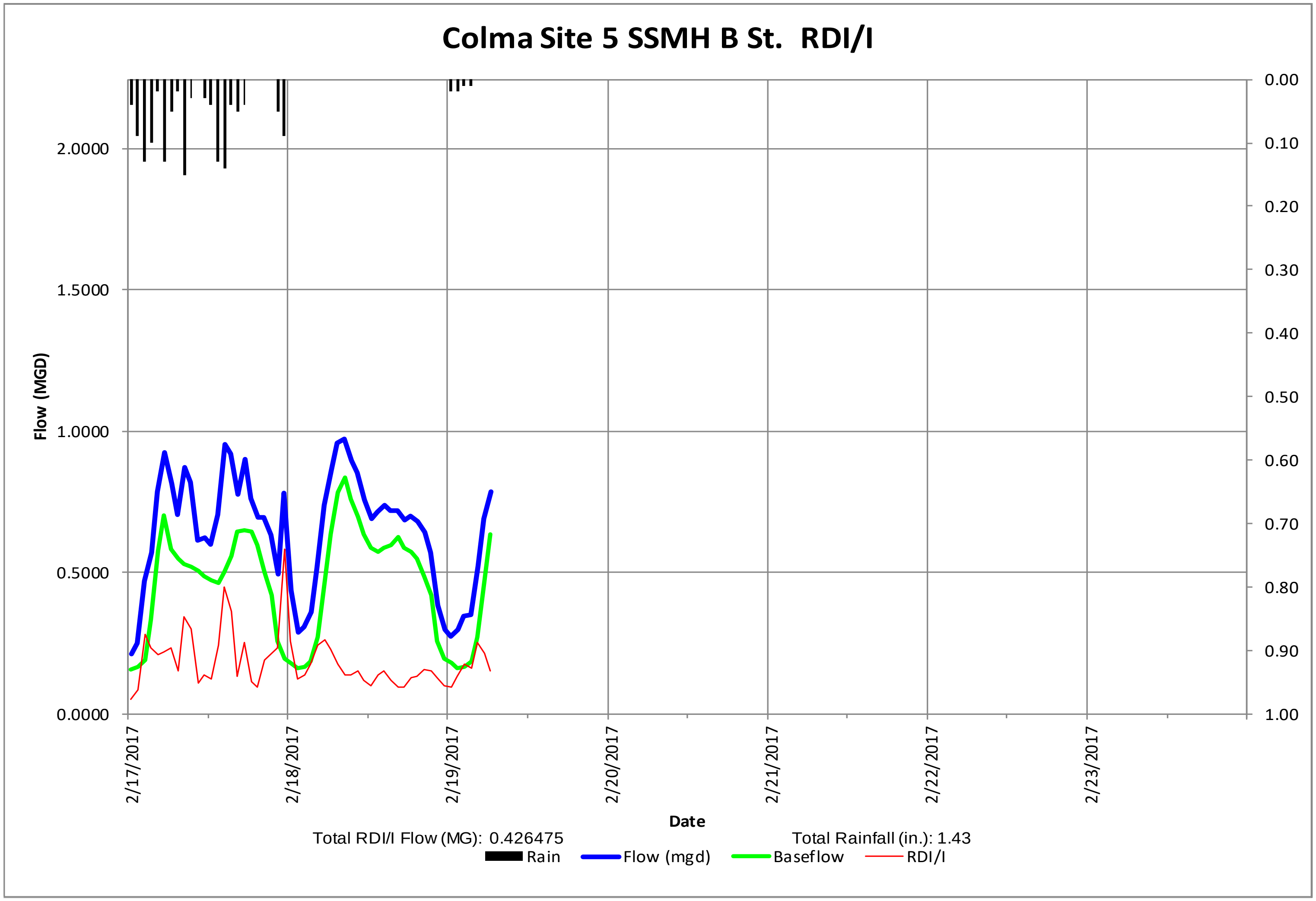
Storm of 2/7/2017



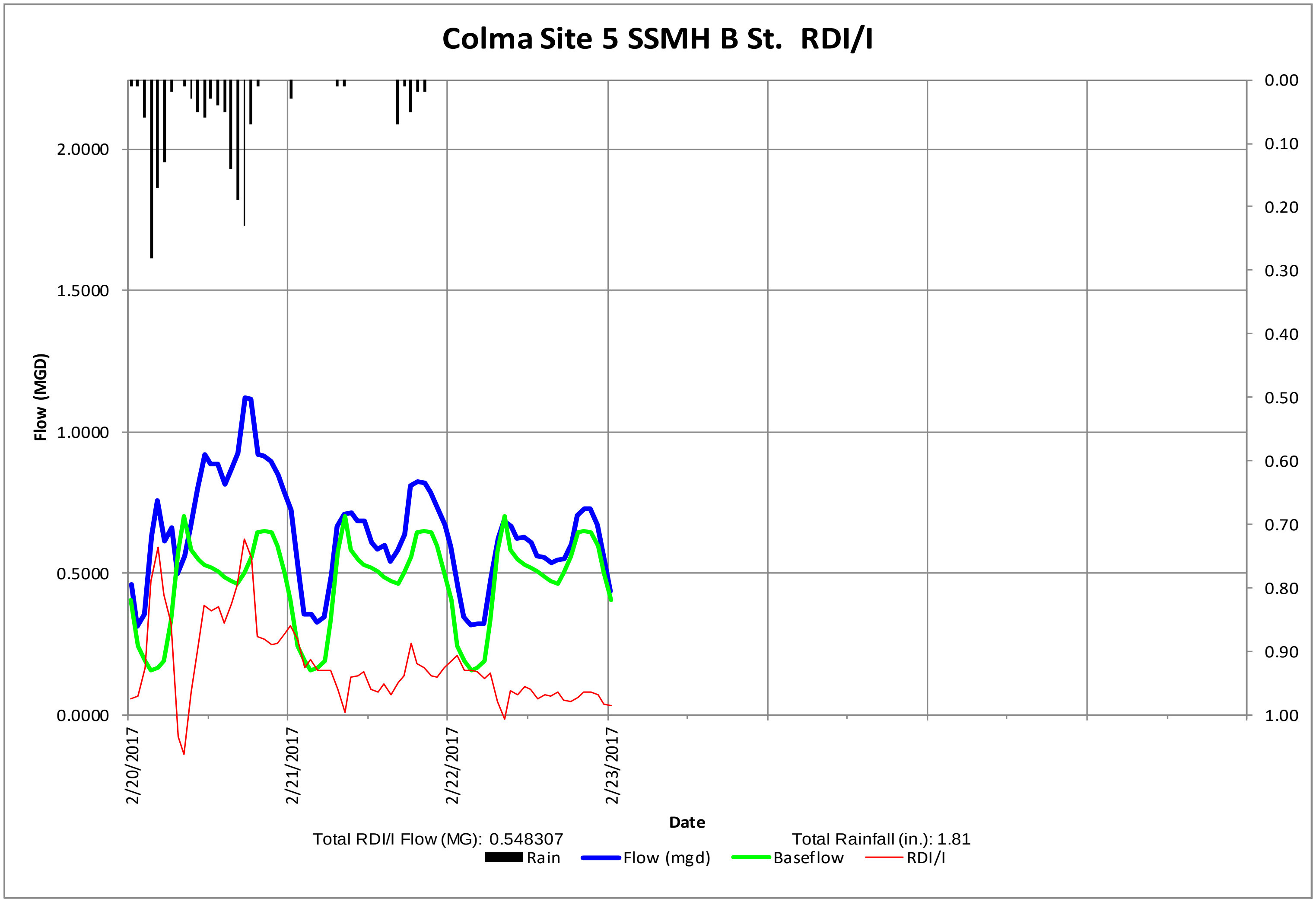
Storm of 2/9/2017



Storm of 2/16/2017



Storm of 2/17/2017



Storm of 2/20/2017

Site Information Report

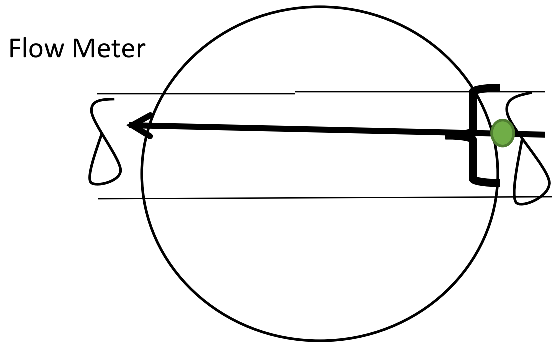
Flow Monitor Site: 6

Manhole Number SSMH E07-39
Location: El Camino at Albert M Teglia Blvd.
MH Depth ~12’
Diameter: 12”
Safety: OK
Traffic: Medium
Gas: Ok
Rungs: Yes
Meter Type: Hach FL900 Submerged
Depth: Pressure 7”
Velocity: Doppler 2.25 ft./sec

Ariel View:

City Sewer Map:

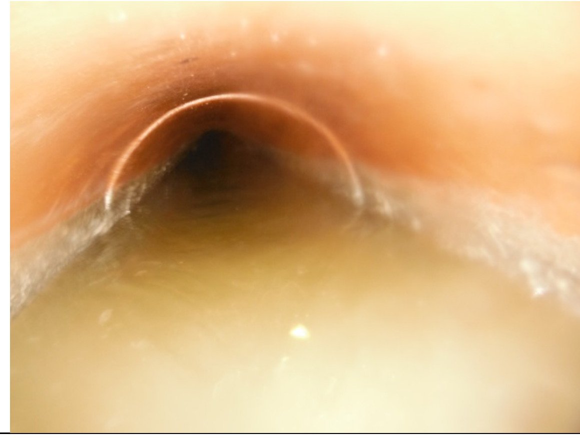
Flow Sketch:



12”-inch Pipes

Surface View:

Invert View:

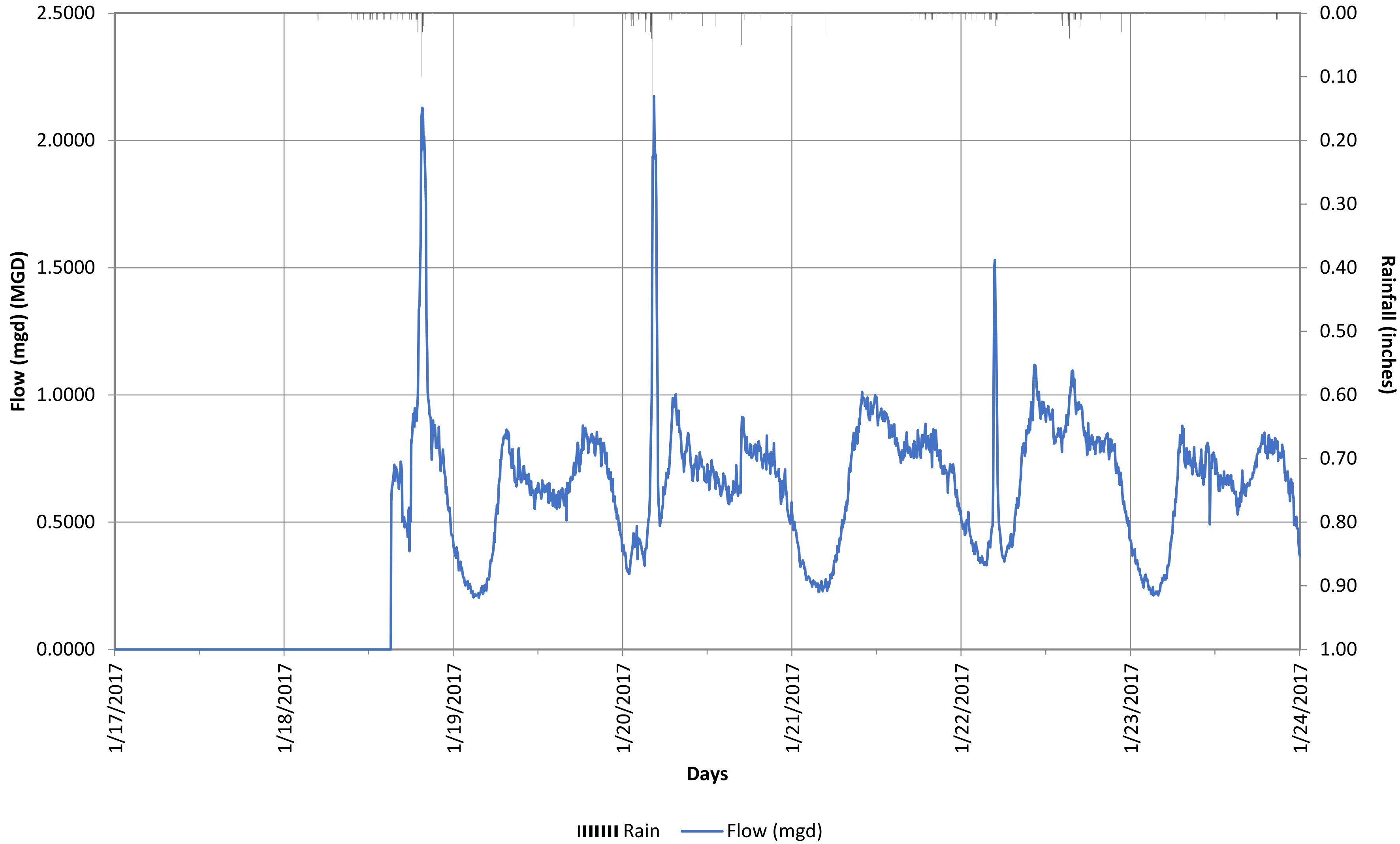
Outlet Pipe:	Inlet Pipe:
	

Colma Site 6 SSMH E07-39 12" Sanitary Flow

Daily Summary

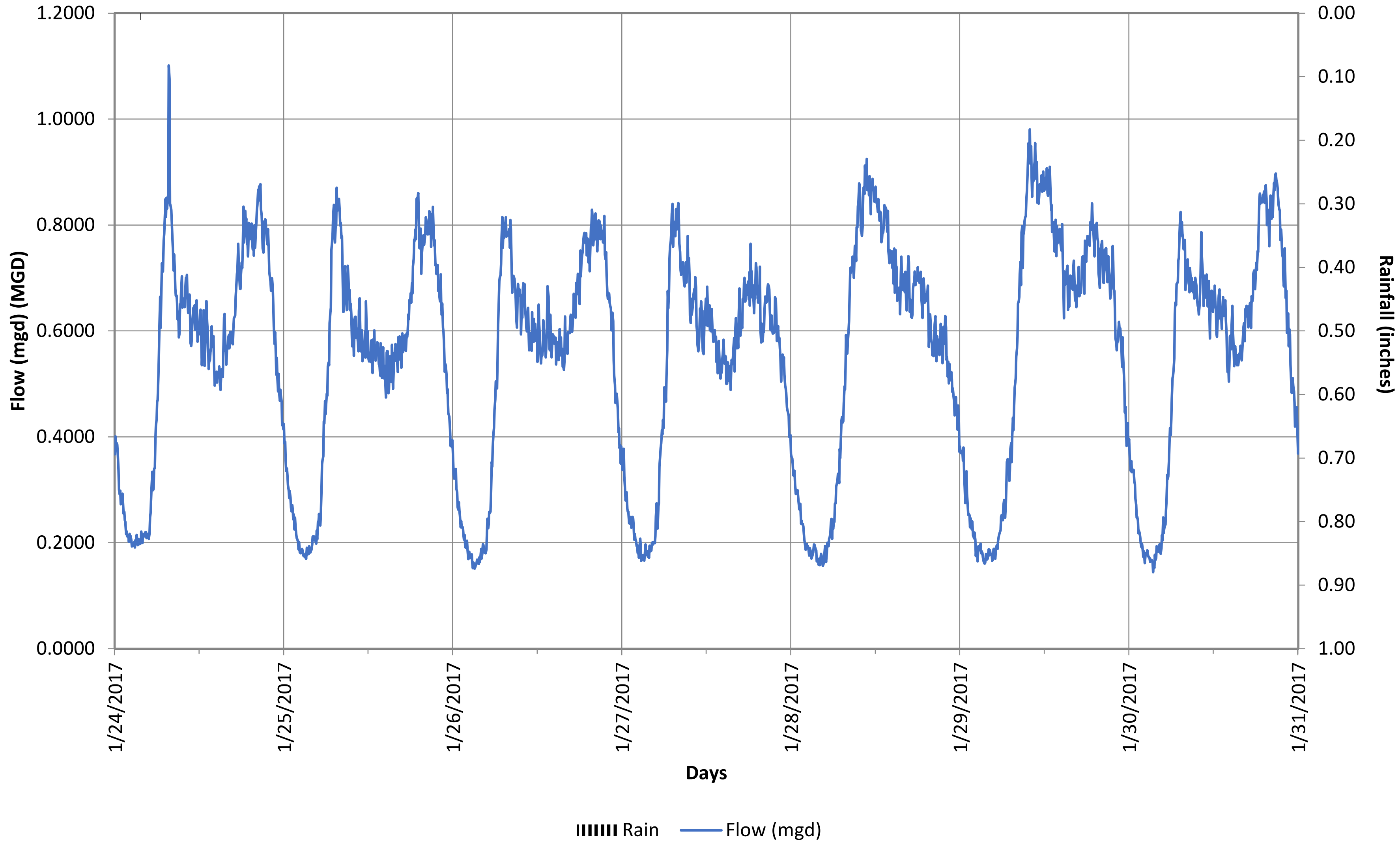
Day	Date	Avg Flow(MGD)	Min Flow(MGD)	Max Flow(MGD)	Max Depth(in.)	Rain(in.)
Tuesday	1/17/17	0.000	0.000	0.000	0.000	0.00
Wednesday	1/18/17	0.315	0.000	2.128	21.726	0.88
Thursday	1/19/17	0.585	0.203	0.880	8.118	0.02
Friday	1/20/17	0.700	0.297	2.174	20.203	1.13
Saturday	1/21/17	0.657	0.225	1.012	8.767	0.25
Sunday	1/22/17	0.720	0.331	1.530	11.947	1.00
Monday	1/23/17	0.598	0.212	0.878	8.395	0.18
Tuesday	1/24/17	0.561	0.191	1.101	9.765	0.01
Wednesday	1/25/17	0.539	0.170	0.870	7.966	0.00
Thursday	1/26/17	0.545	0.151	0.829	7.648	0.00
Friday	1/27/17	0.529	0.166	0.841	7.620	0.00
Saturday	1/28/17	0.547	0.156	0.925	8.093	0.00
Sunday	1/29/17	0.579	0.161	0.981	8.337	0.00
Monday	1/30/17	0.565	0.145	0.897	7.859	0.00
Tuesday	1/31/17	0.539	0.147	0.904	8.068	0.00
Wednesday	2/1/17	0.531	0.132	0.844	7.744	0.01
Thursday	2/2/17	0.571	0.167	0.884	7.976	0.19
Friday	2/3/17	0.634	0.179	1.235	10.524	0.51
Saturday	2/4/17	0.611	0.192	1.068	9.656	0.37
Sunday	2/5/17	0.592	0.163	0.944	8.677	0.15
Monday	2/6/17	0.602	0.177	1.017	9.110	0.50
Tuesday	2/7/17	0.658	0.232	1.120	10.057	0.86
Wednesday	2/8/17	0.607	0.218	0.893	8.393	0.26
Thursday	2/9/17	0.636	0.181	1.063	9.547	0.77
Friday	2/10/17	0.551	0.200	0.907	8.226	0.04
Saturday	2/11/17	0.593	0.172	0.955	8.662	0.00
Sunday	2/12/17	0.589	0.168	1.015	8.916	0.00
Monday	2/13/17	0.556	0.151	0.888	8.078	0.00
Tuesday	2/14/17	0.561	0.163	0.879	8.285	0.00
Wednesday	2/15/17	0.550	0.161	0.858	8.365	0.00
Thursday	2/16/17	0.584	0.155	0.905	8.172	0.39
Friday	2/17/17	0.703	0.183	1.195	10.162	1.23
Saturday	2/18/17	0.609	0.209	1.008	8.913	0.14
Sunday	2/19/17	0.542	0.202	0.873	8.403	0.08
Monday	2/20/17	0.758	0.272	1.419	11.849	1.61
Tuesday	2/21/17	0.614	0.230	0.892	8.133	0.19
Wednesday	2/22/17	0.584	0.198	0.878	7.986	0.00

Colma Site 6 SSMH E07-39 12" Sanitary Flow



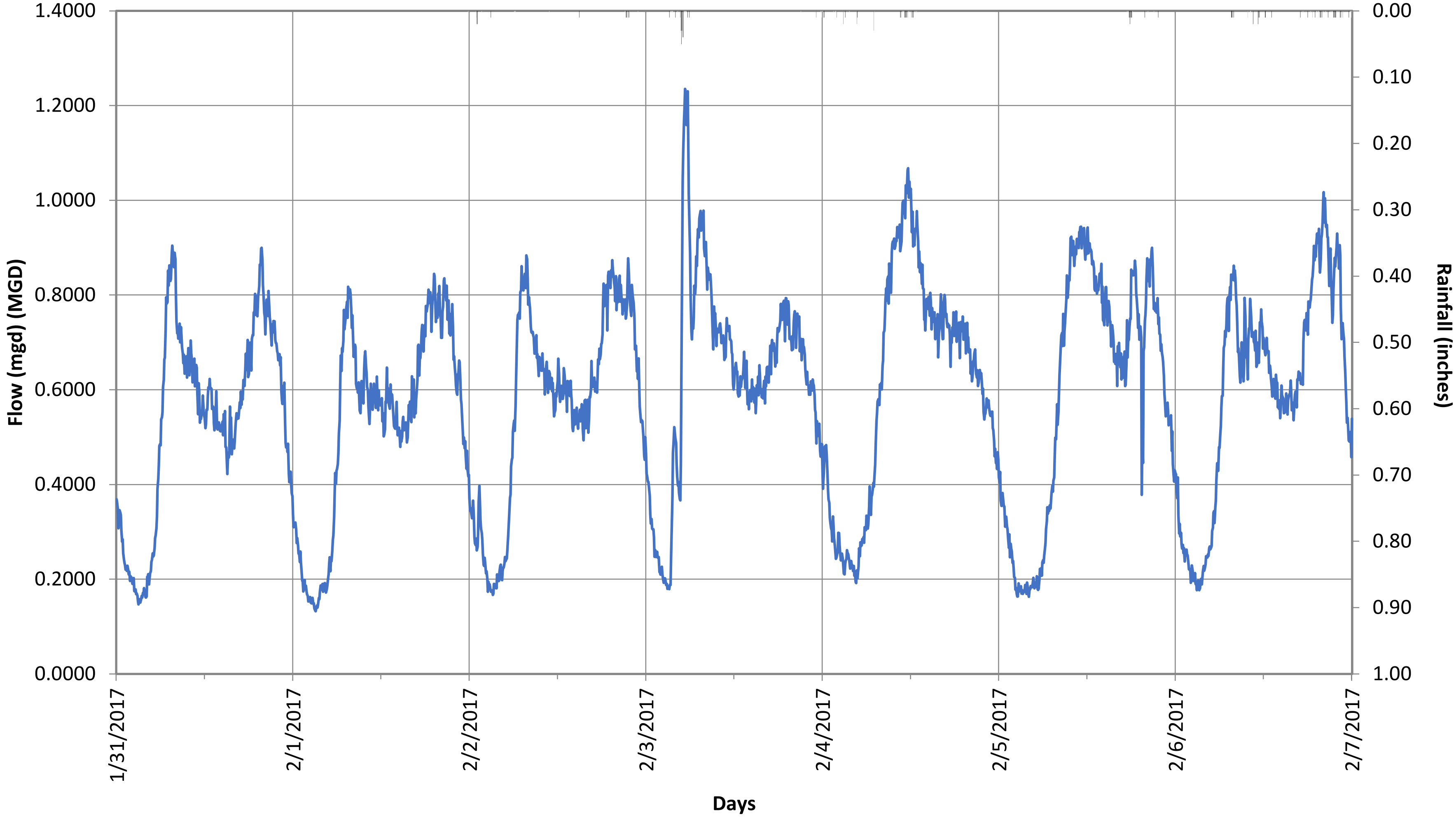
	1/17/2017(Tue)	1/18/2017(Wed)	1/19/2017(Thu)	1/20/2017(Fri)	1/21/2017(Sat)	1/22/2017(Sun)	1/23/2017(Mon)
Maximum	0.000	2.128	0.880	2.174	1.012	1.530	0.878
Average	0.000	0.315	0.585	0.700	0.657	0.720	0.598
Minimum	0.000	0.000	0.203	0.297	0.225	0.331	0.212
Rain (inches)	0.00	0.88	0.02	1.13	0.25	1.00	0.18

Colma Site 6 SSMH E07-39 12" Sanitary Flow



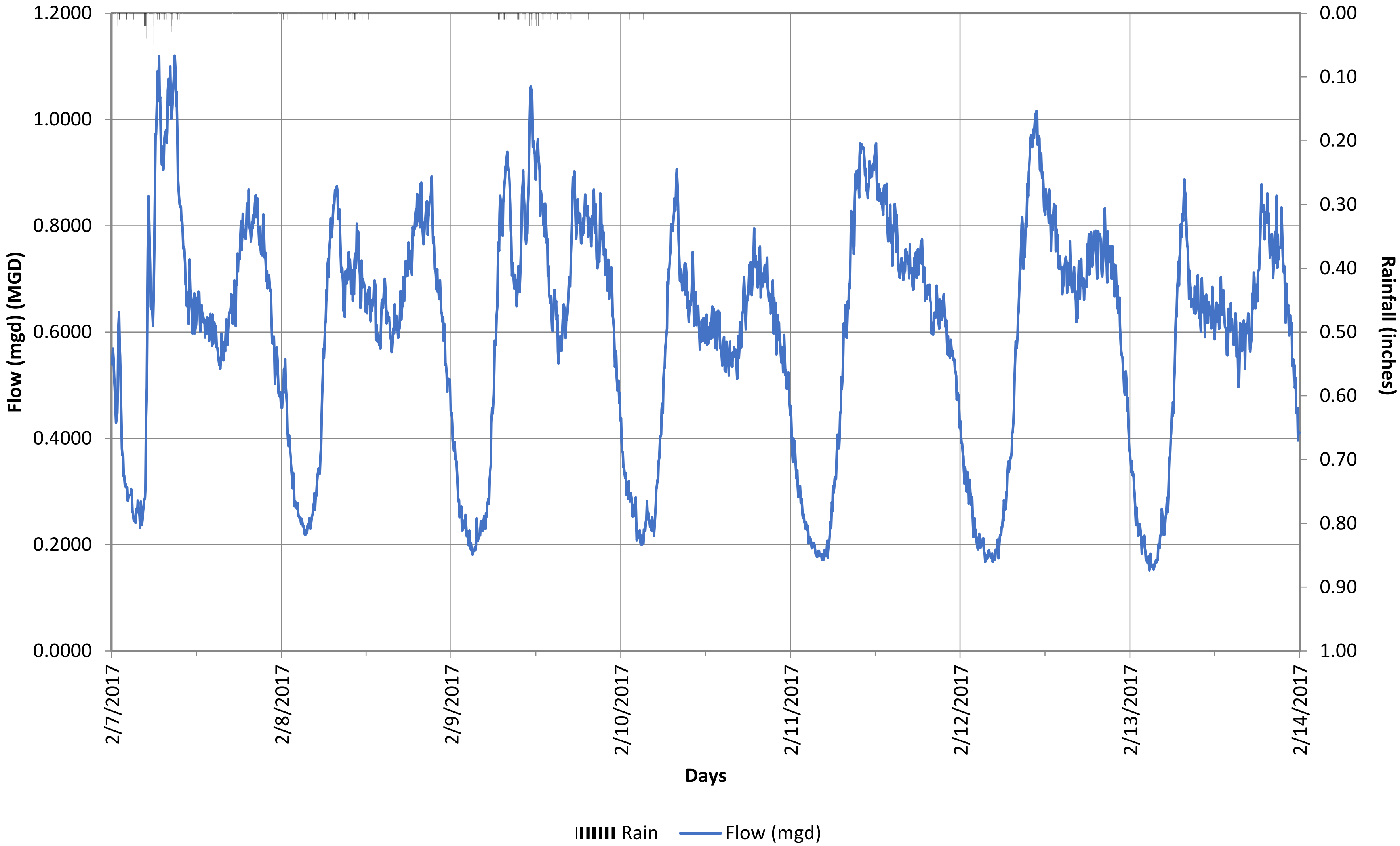
	1/24/2017(Tue)	1/25/2017(Wed)	1/26/2017(Thu)	1/27/2017(Fri)	1/28/2017(Sat)	1/29/2017(Sun)	1/30/2017(Mon)
Maximum	1.101	0.870	0.829	0.841	0.925	0.981	0.897
Average	0.561	0.539	0.545	0.529	0.547	0.579	0.565
Minimum	0.191	0.170	0.151	0.166	0.156	0.161	0.145
Rain (inches)	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Colma Site 6 SSMH E07-39 12" Sanitary Flow



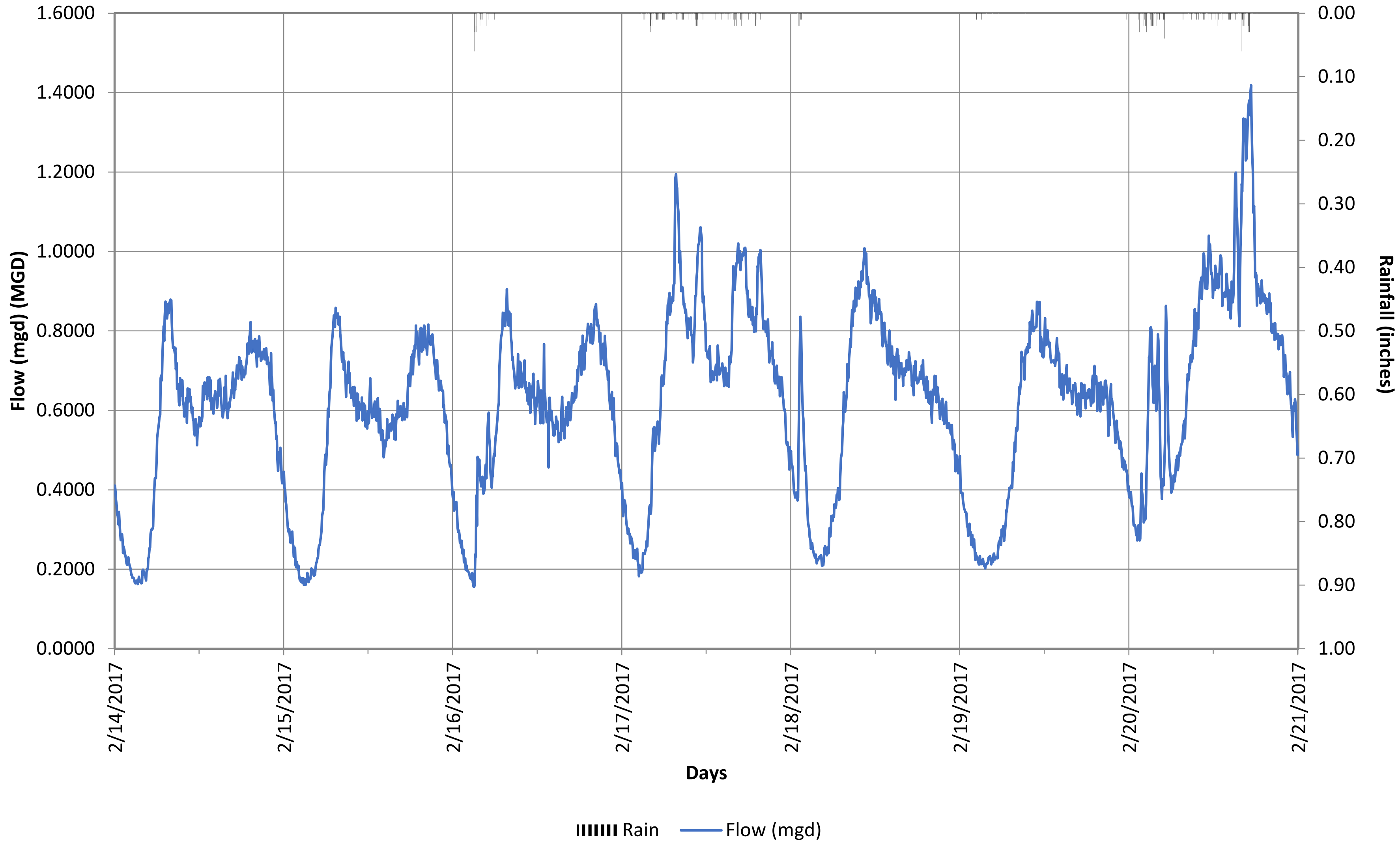
	1/31/2017(Tue)	2/1/2017(Wed)	2/2/2017(Thu)	2/3/2017(Fri)	2/4/2017(Sat)	2/5/2017(Sun)	2/6/2017(Mon)
Maximum	0.904	0.844	0.884	1.235	1.068	0.944	1.017
Average	0.539	0.531	0.571	0.634	0.611	0.592	0.602
Minimum	0.147	0.132	0.167	0.179	0.192	0.163	0.177
Rain (inches)	0.00	0.01	0.19	0.51	0.37	0.15	0.50

Colma Site 6 SSMH E07-39 12" Sanitary Flow



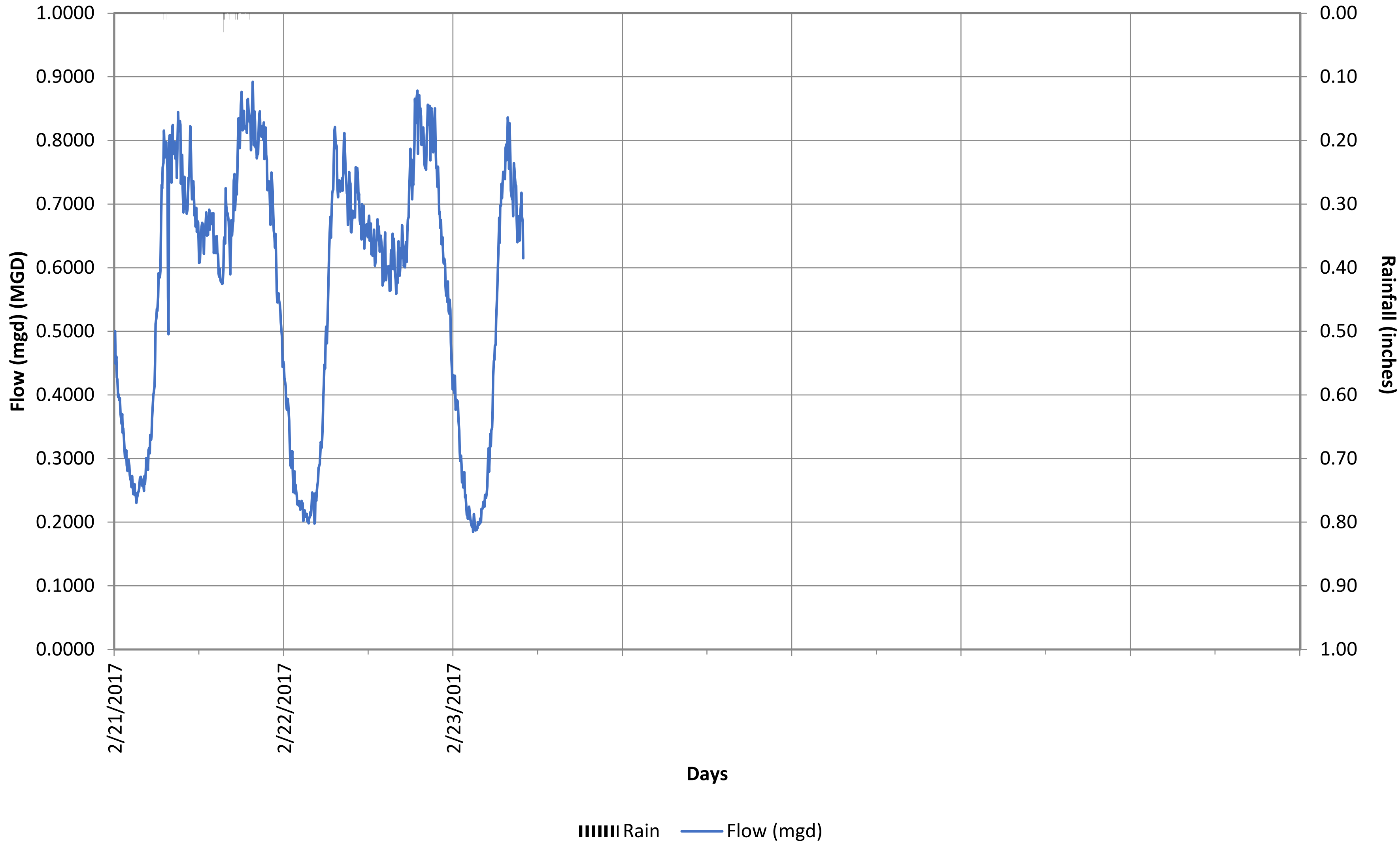
	2/7/2017(Tue)	2/8/2017(Wed)	2/9/2017(Thu)	2/10/2017(Fri)	2/11/2017(Sat)	2/12/2017(Sun)	2/13/2017(Mon)
Maximum	1.120	0.893	1.063	0.907	0.955	1.015	0.888
Average	0.658	0.607	0.636	0.551	0.593	0.589	0.556
Minimum	0.232	0.218	0.181	0.200	0.172	0.168	0.151
Rain (inches)	0.86	0.26	0.77	0.04	0.00	0.00	0.00

Colma Site 6 SSMH E07-39 12" Sanitary Flow



	2/14/2017(Tue)	2/15/2017(Wed)	2/16/2017(Thu)	2/17/2017(Fri)	2/18/2017(Sat)	2/19/2017(Sun)	2/20/2017(Mon)
Maximum	0.879	0.858	0.905	1.195	1.008	0.873	1.419
Average	0.561	0.550	0.584	0.703	0.609	0.542	0.758
Minimum	0.163	0.161	0.155	0.183	0.209	0.202	0.272
Rain (inches)	0.00	0.00	0.39	1.23	0.14	0.08	1.61

Colma Site 6 SSMH E07-39 12" Sanitary Flow

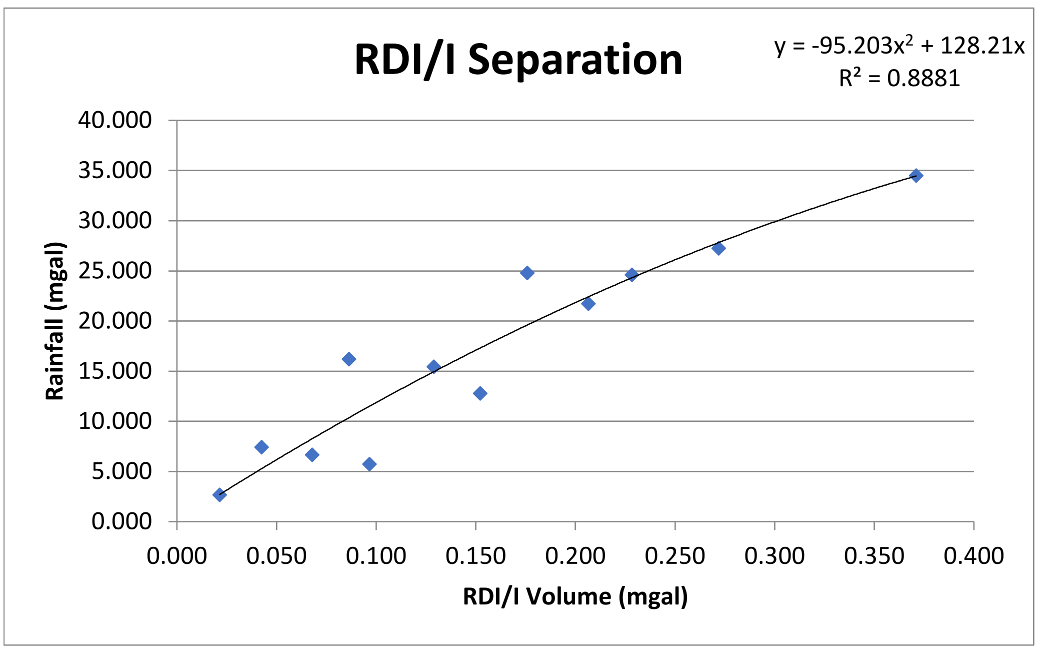


	2/21/2017(Tue)	2/22/2017(Wed)				
Maximum	0.892	0.878				
Average	0.614	0.584				
Minimum	0.230	0.198				
Rain (inches)	0.19	0.00				

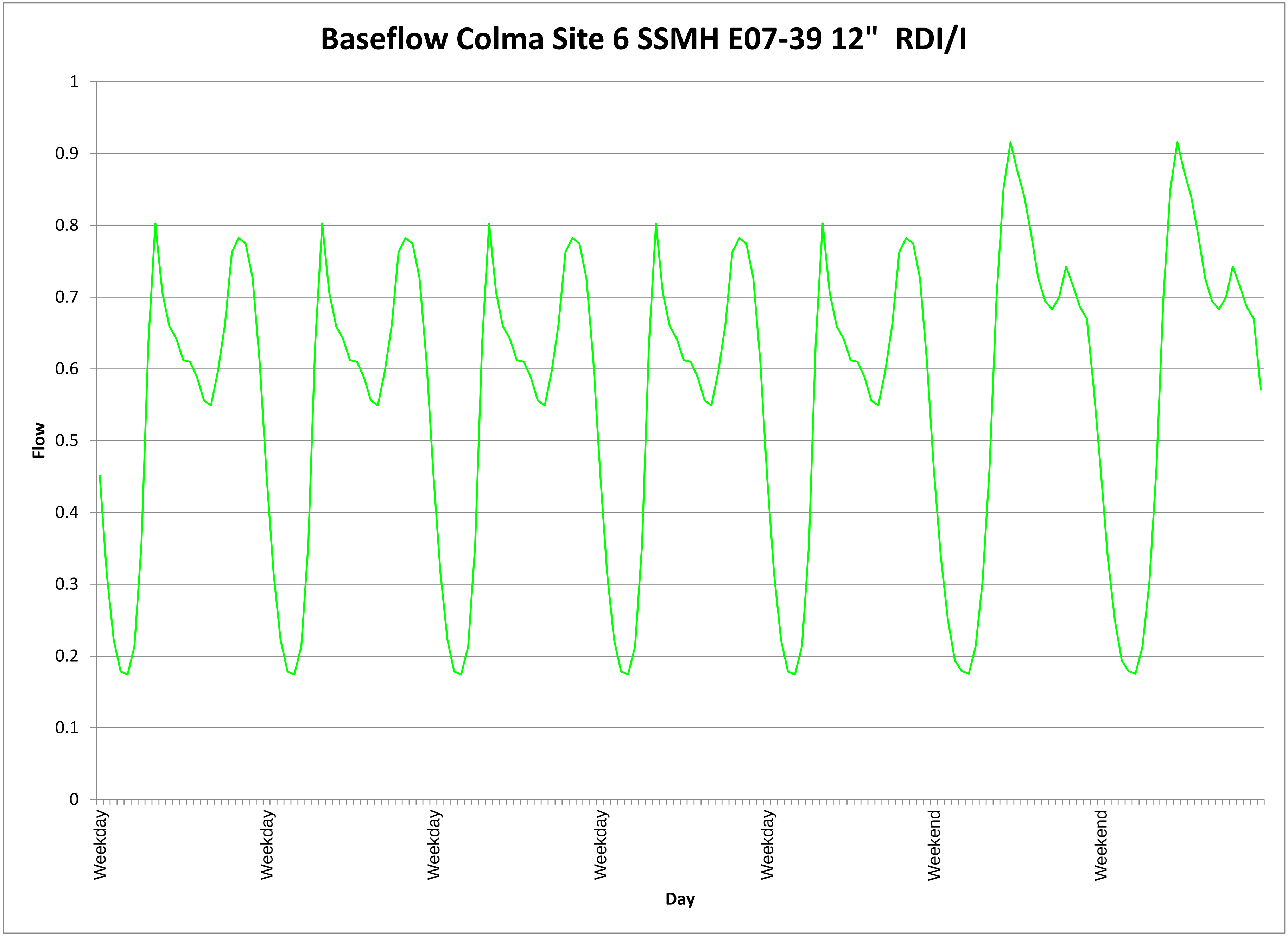
Colma Site 6 SSMH E07-39 12" RDI/I

RDI/I Analysis, Monitor Return Ratio Summary

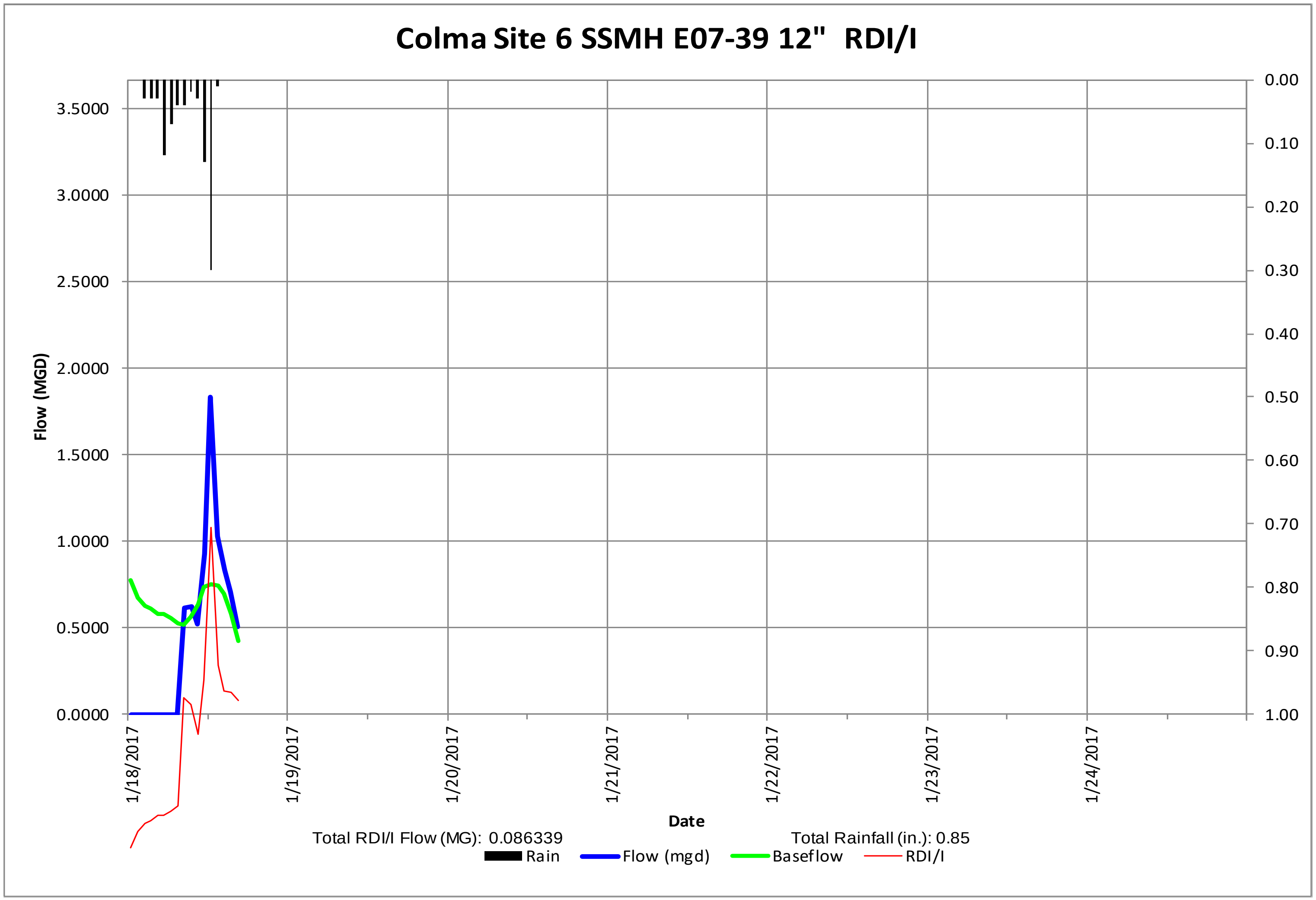
Storm Start (Date)	RDI/I Volume (mgal)	Monitor Area (acres)	Rainfall (mgal)	Return Ratio (%)
1/18/2017	0.086	702.2	16.206	0.53%
1/20/2017	0.207	702.2	21.736	0.95%
1/21/2017	0.228	702.2	24.596	0.93%
2/2/2017	0.152	702.2	12.774	1.19%
2/4/2017	0.068	702.2	6.673	1.02%
2/5/2017	0.021	702.2	2.669	0.80%
2/6/2017	0.176	702.2	24.786	0.71%
2/7/2017	0.097	702.2	5.720	1.69%
2/9/2017	0.129	702.2	15.444	0.84%
2/16/2017	0.043	702.2	7.436	0.57%
2/17/2017	0.272	702.2	27.265	1.00%
2/20/2017	0.371	702.2	34.510	1.08%
Average R%				0.94%
Average Top 3 Storms				1.32%



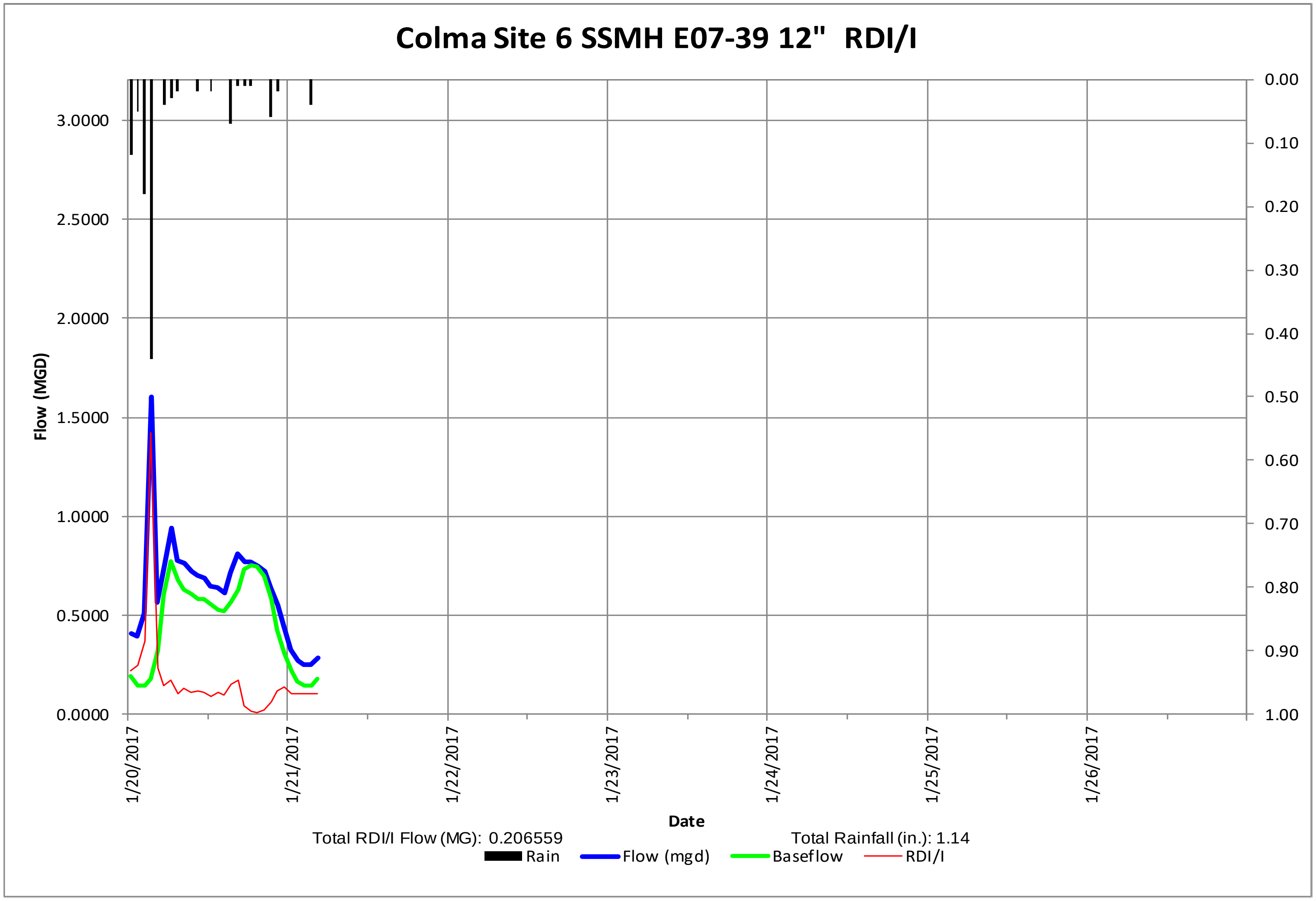
Baseflows	Weekend	Weekday
Max	0.916	0.802
Avg	0.572	0.549
Min	0.176	0.174



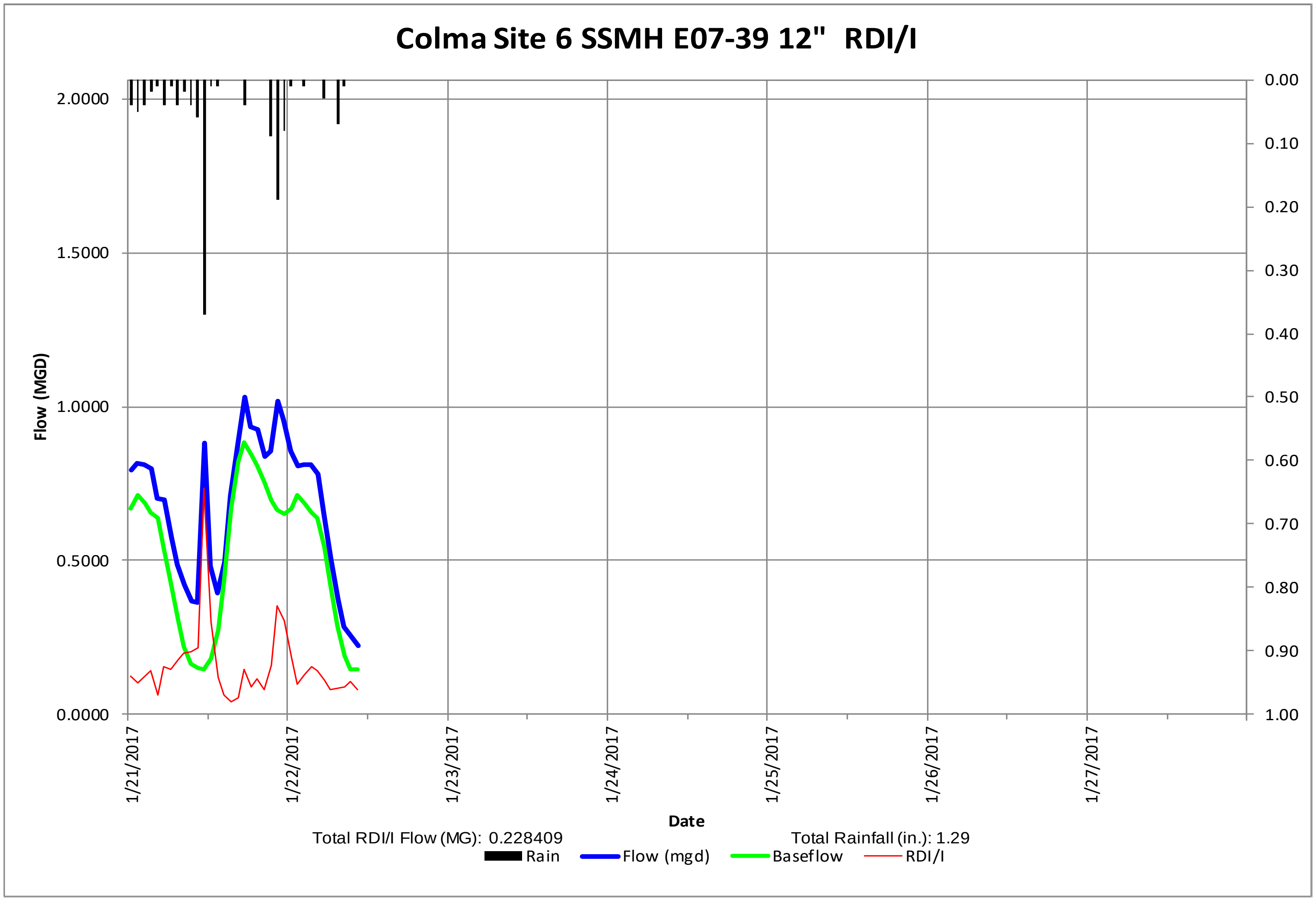
Baseflow Colma Site 6 SSMH E07-39 12" RDI/I
Flow
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Weekday
Weekday
Weekday
Weekday
Weekday
Weekend
Weekend
Day



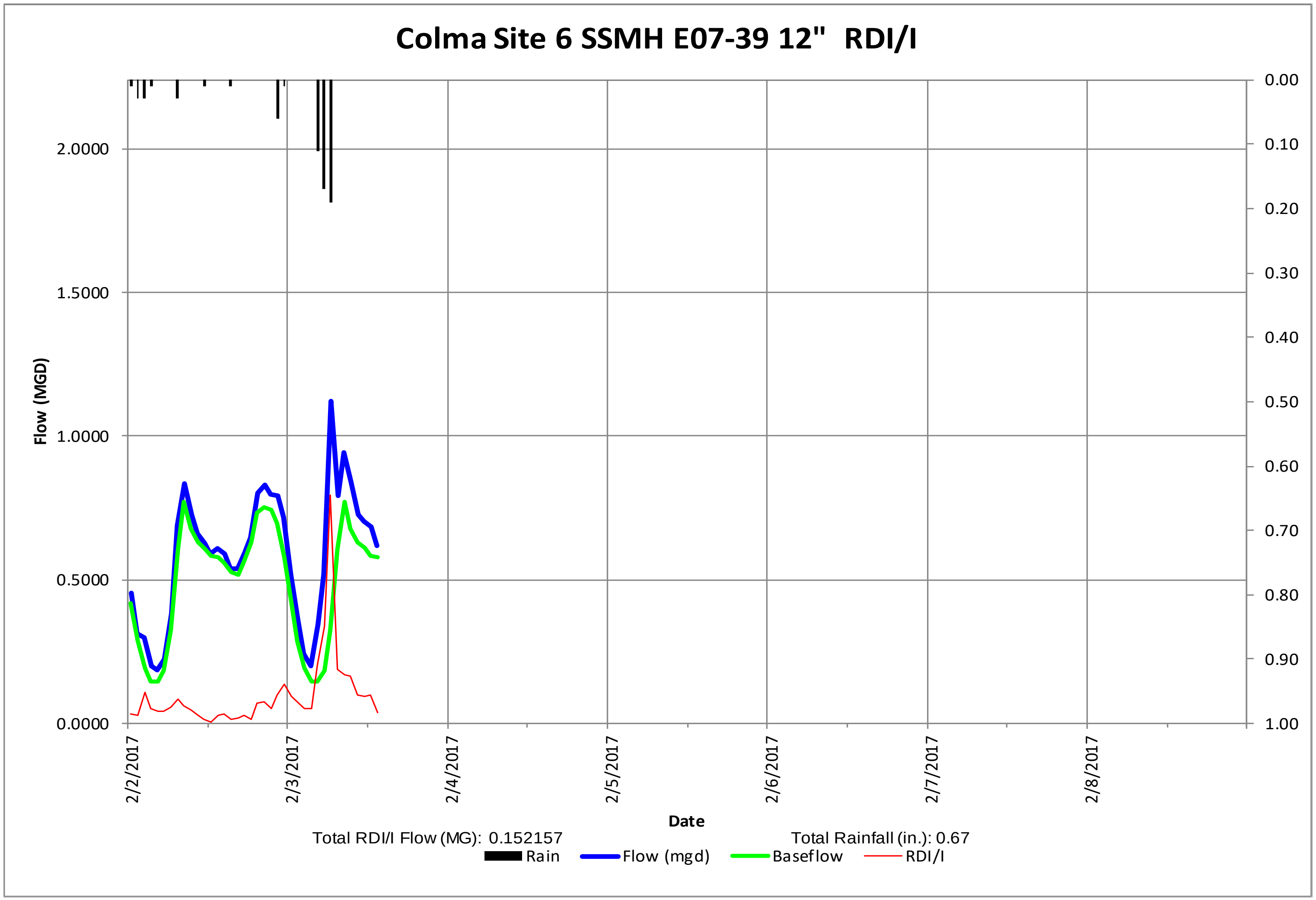
Storm of 1/18/2017



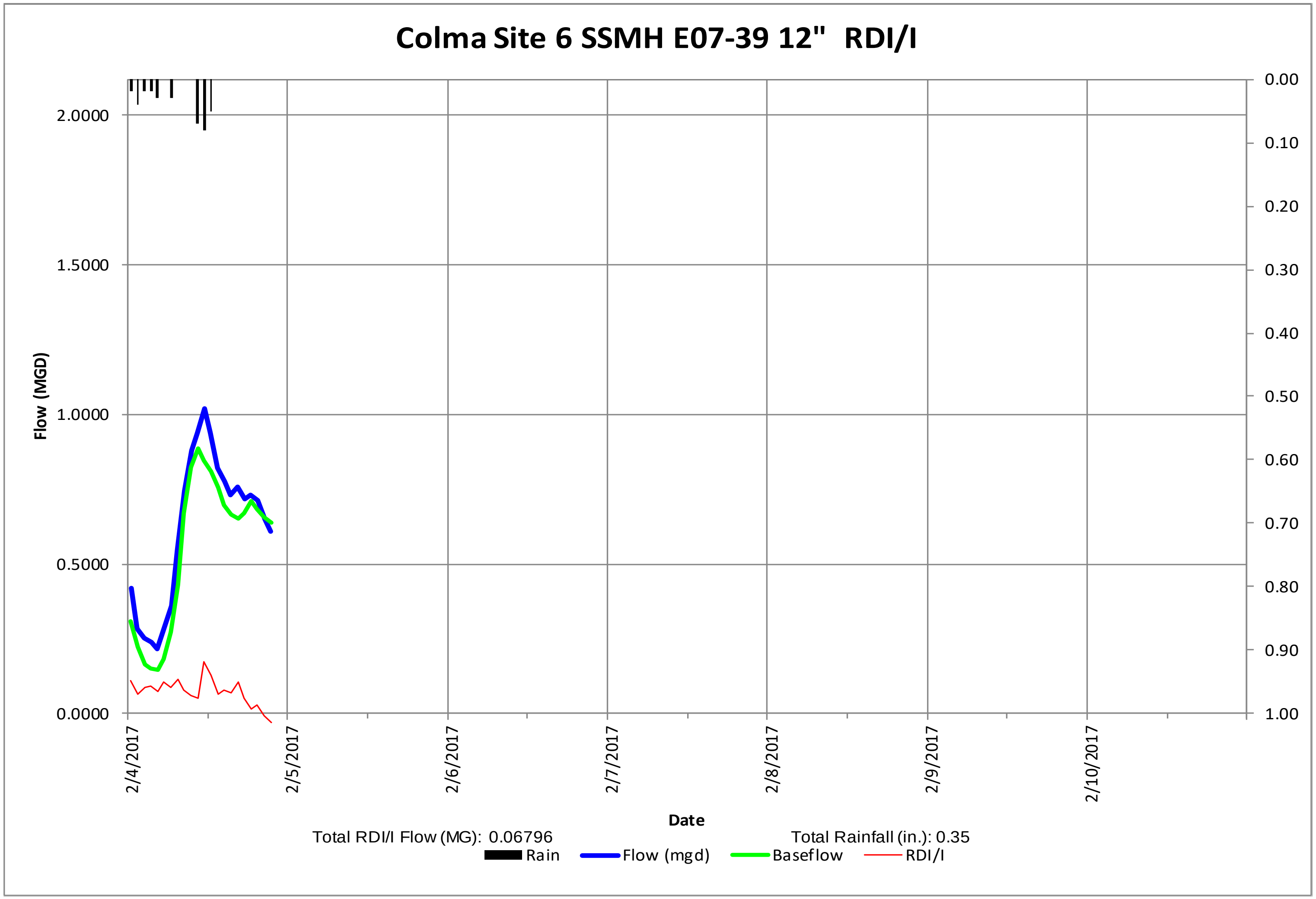
Storm of 1/20/2017



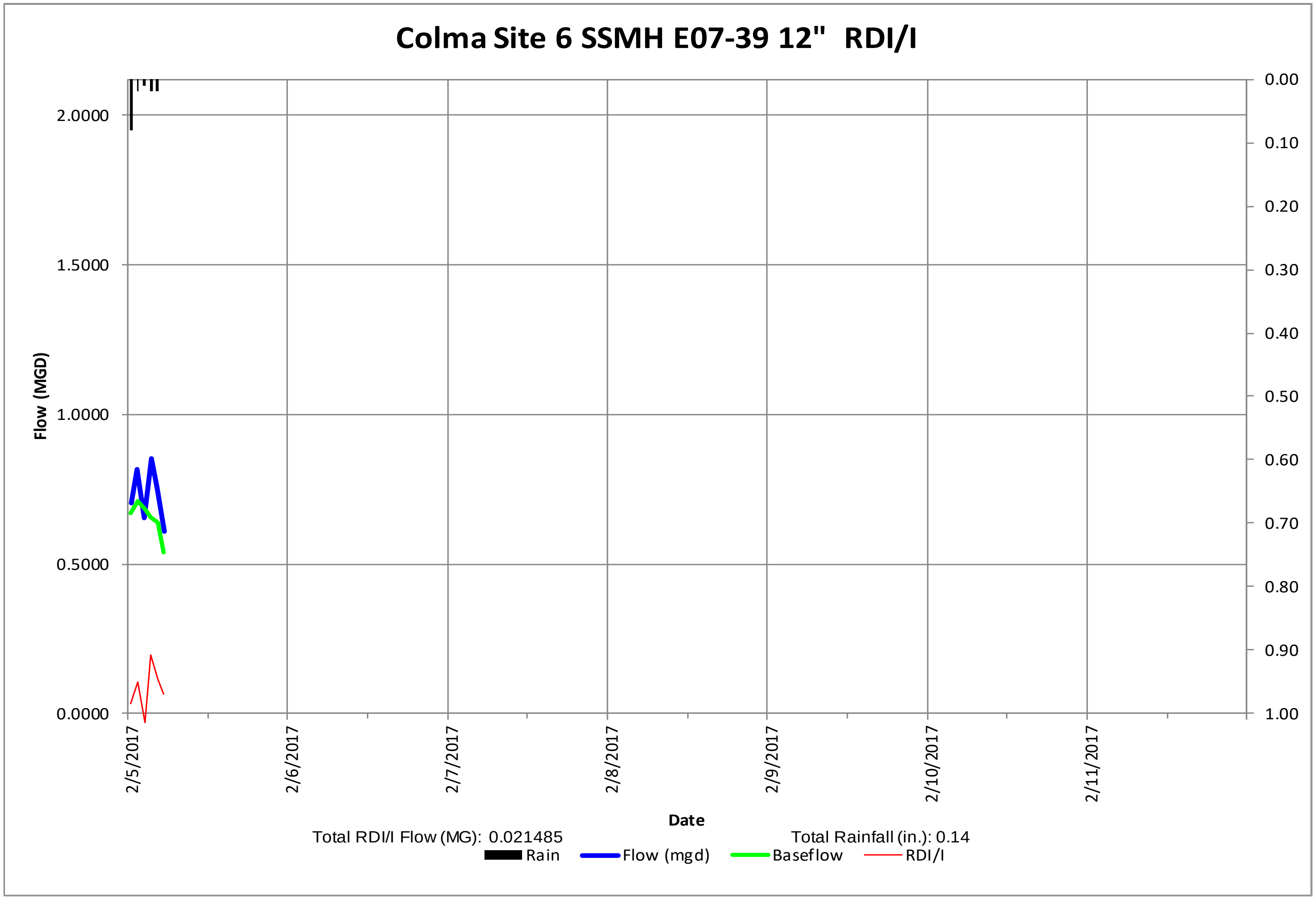
Storm of 1/21/2017



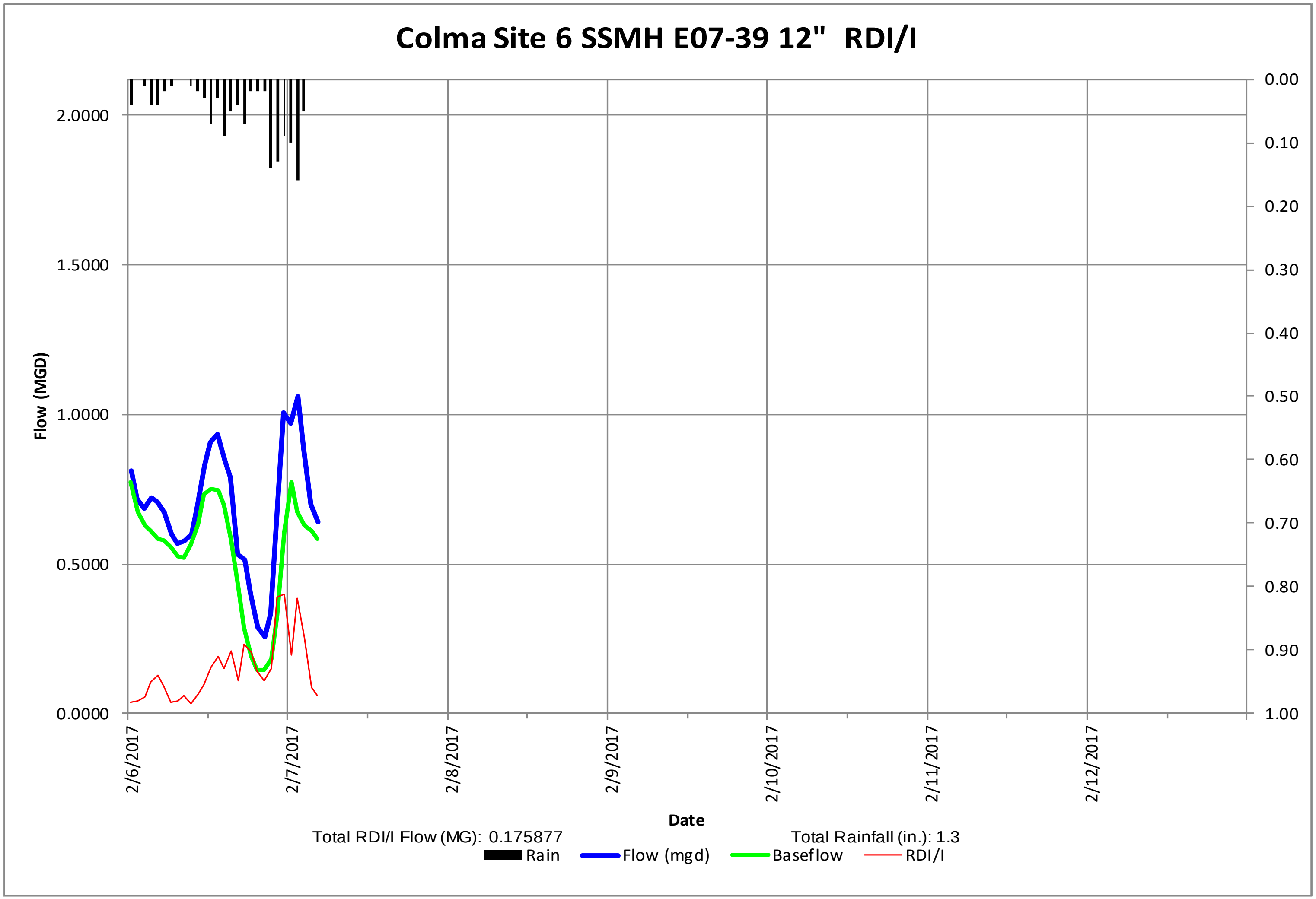
Storm of 2/2/2017



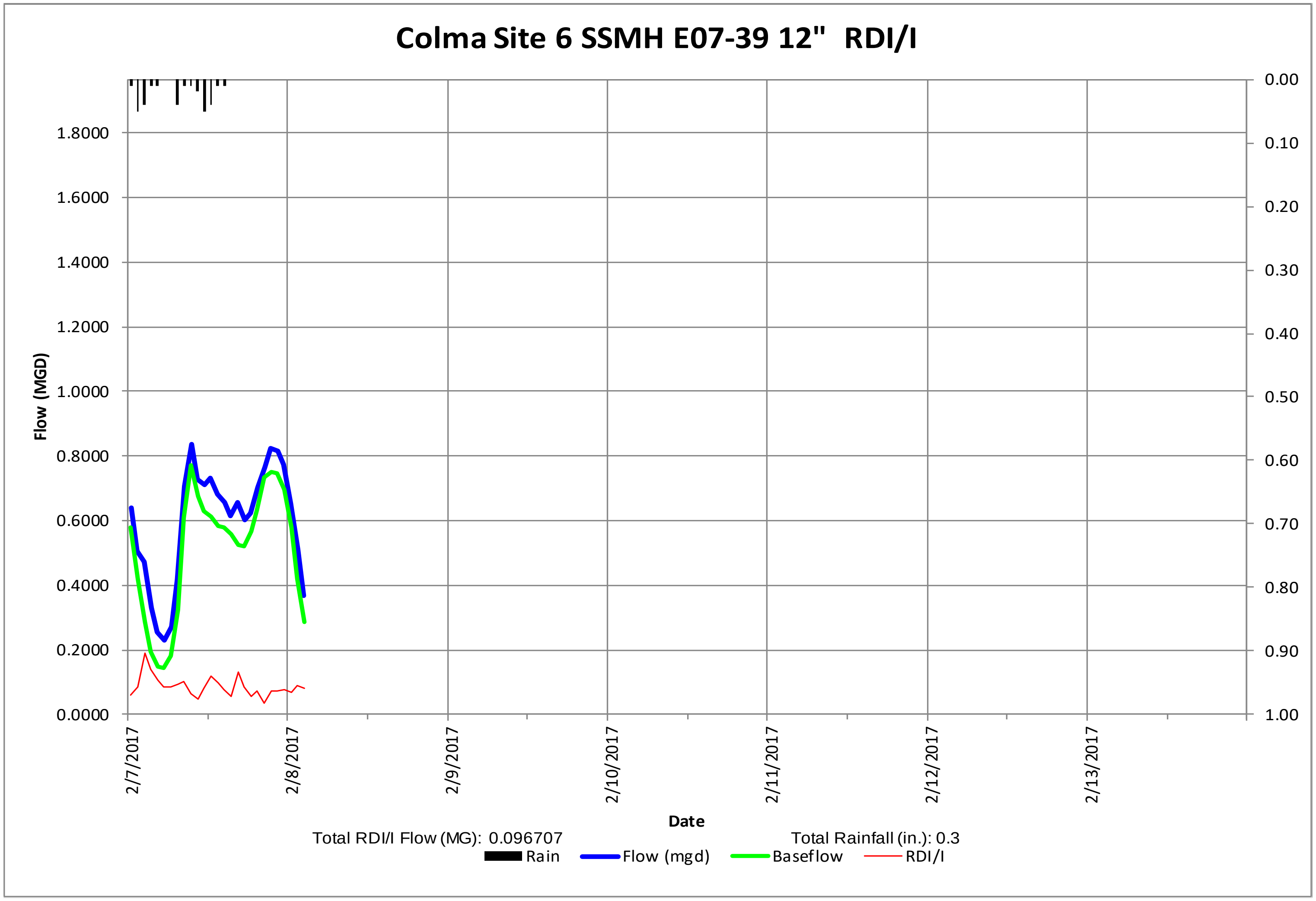
Storm of 2/4/2017



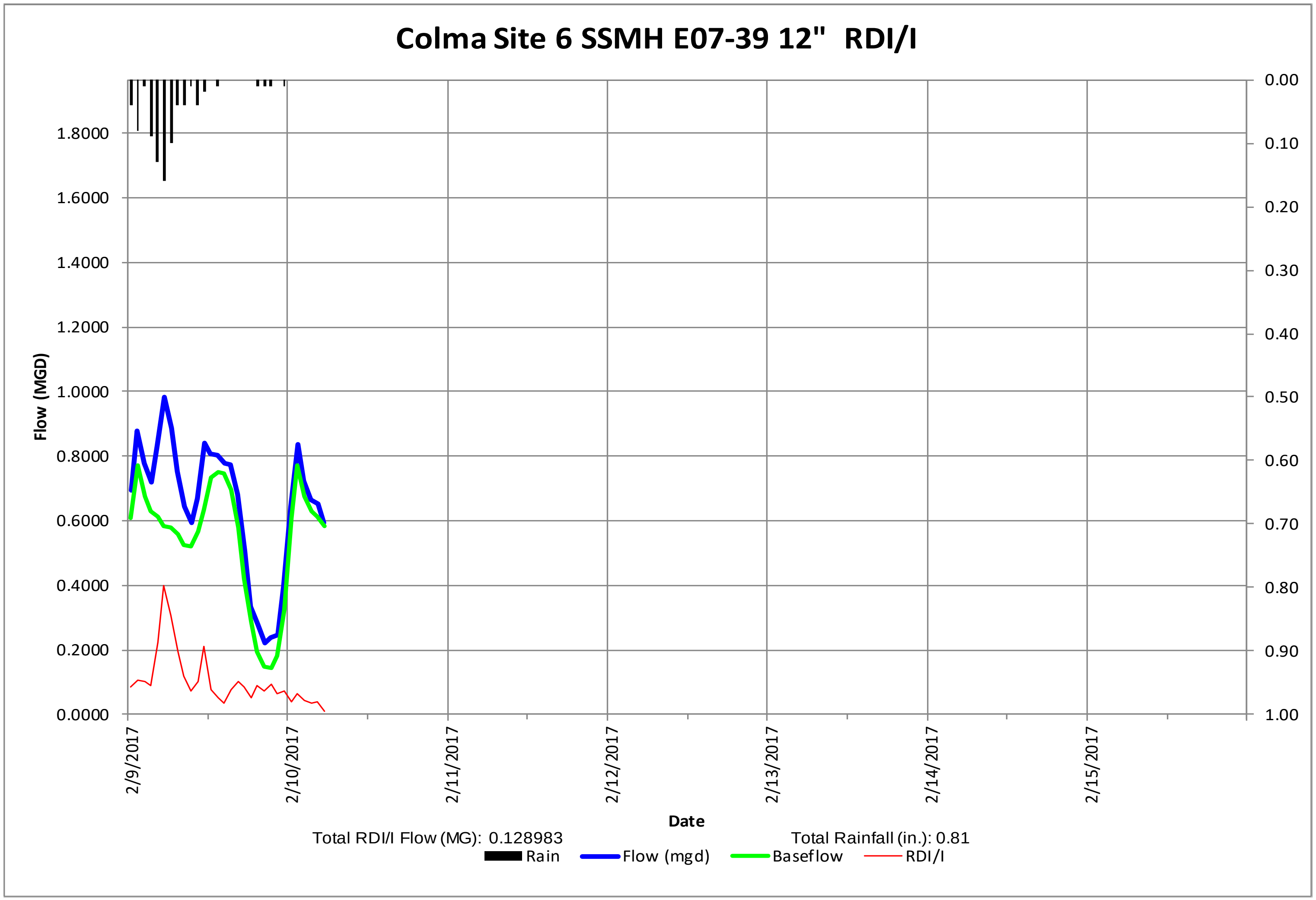
Storm of 2/5/2017



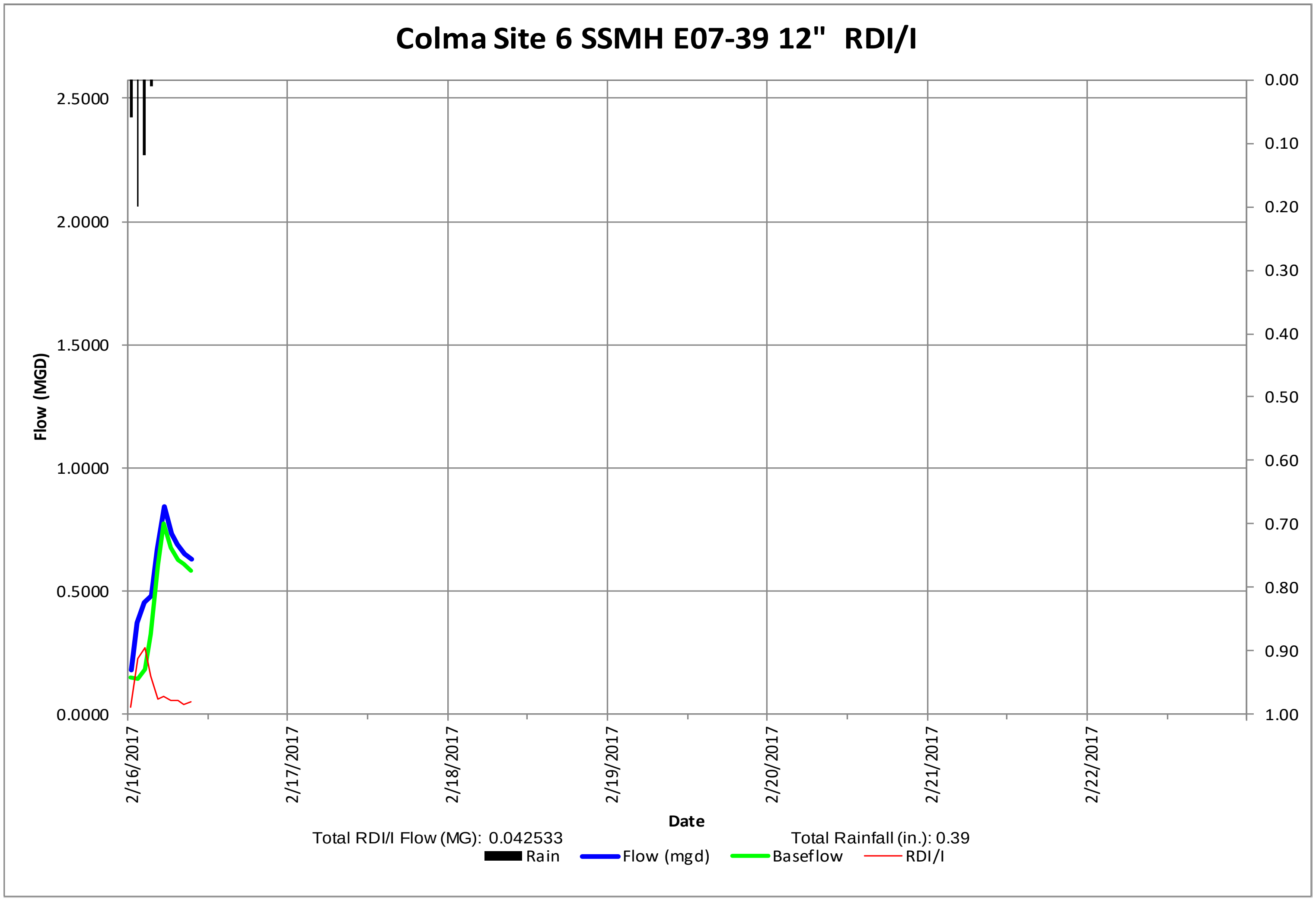
Storm of 2/6/2017



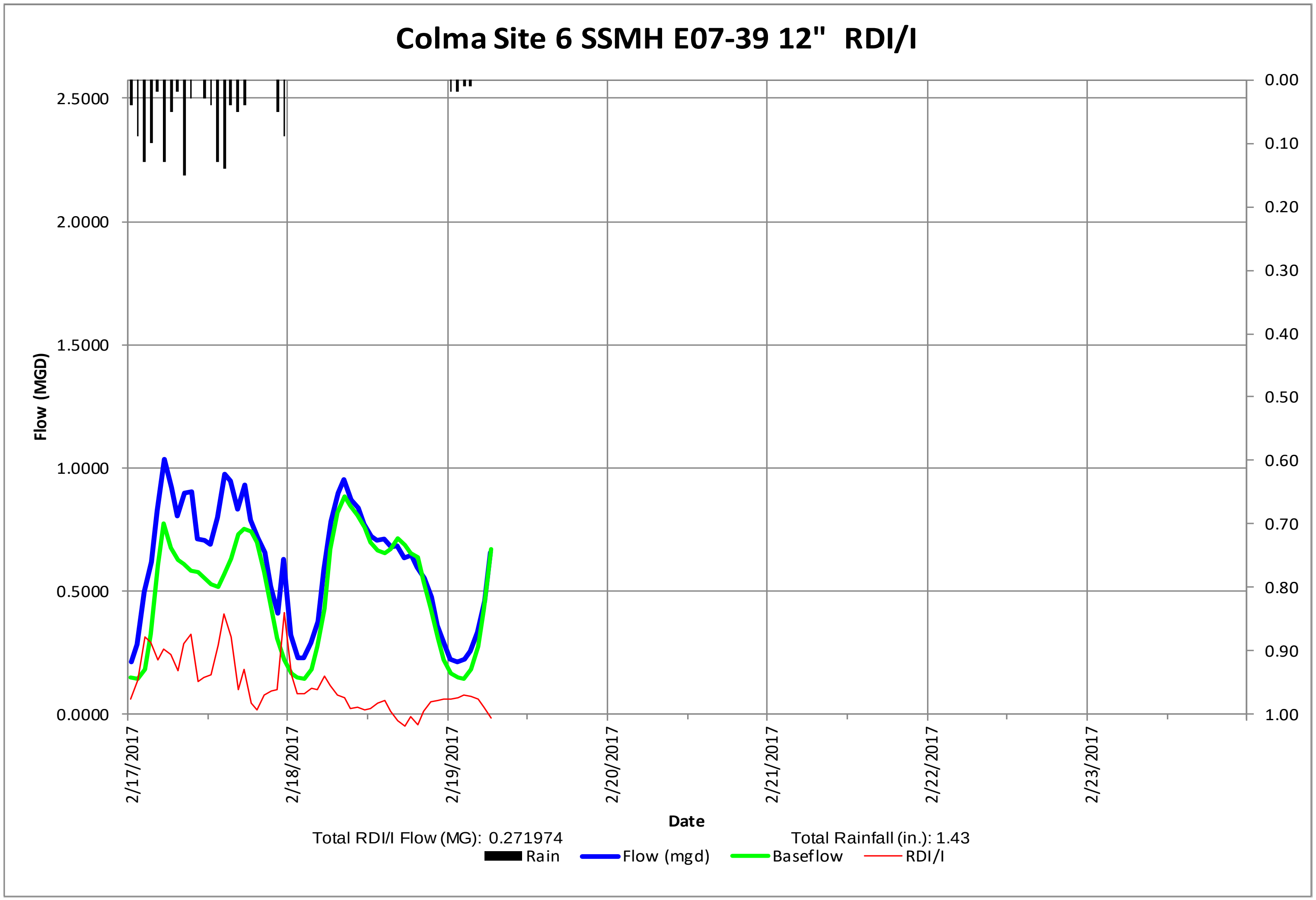
Storm of 2/7/2017



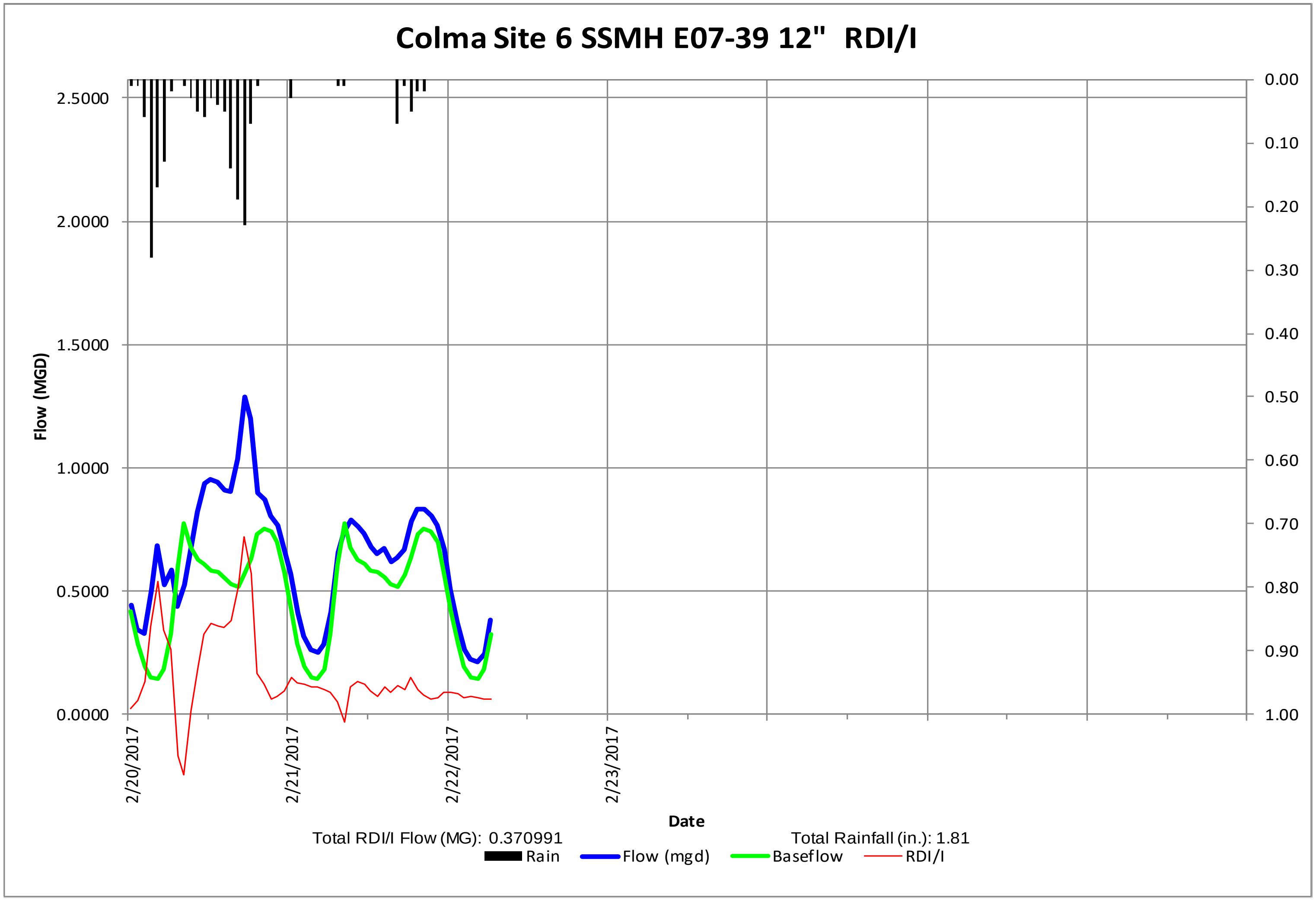
Storm of 2/9/2017



Storm of 2/16/2017



Storm of 2/17/2017



Storm of 2/20/2017

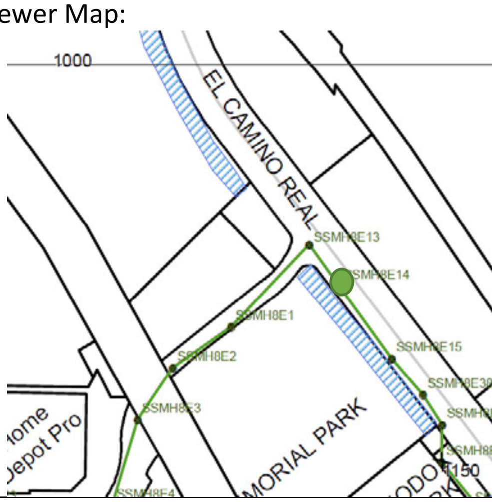
Site Information Report

Flow Monitor Site: 7

Manhole Number SSMH 8E14
Location: El Camino South of Colma Blvd on side rd.
MH Depth ~8'
Diameter: 8"
Safety: Ok
Traffic: Light
Gas: Ok
Rungs no
Meter Type: Hach FL900 Submerge
Depth: Pressure 1"
Velocity: Doppler 1.5 ft./sec

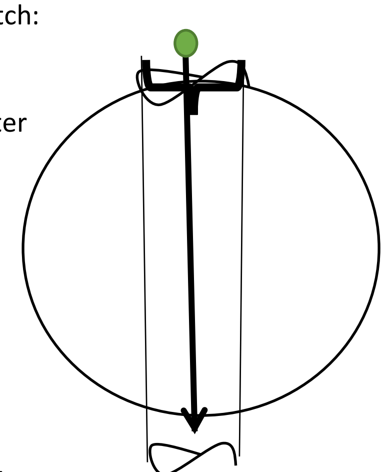
Ariel View:

City Sewer Map:



Flow Sketch:

Flow Meter



8"-inch Pipe

Surface View:

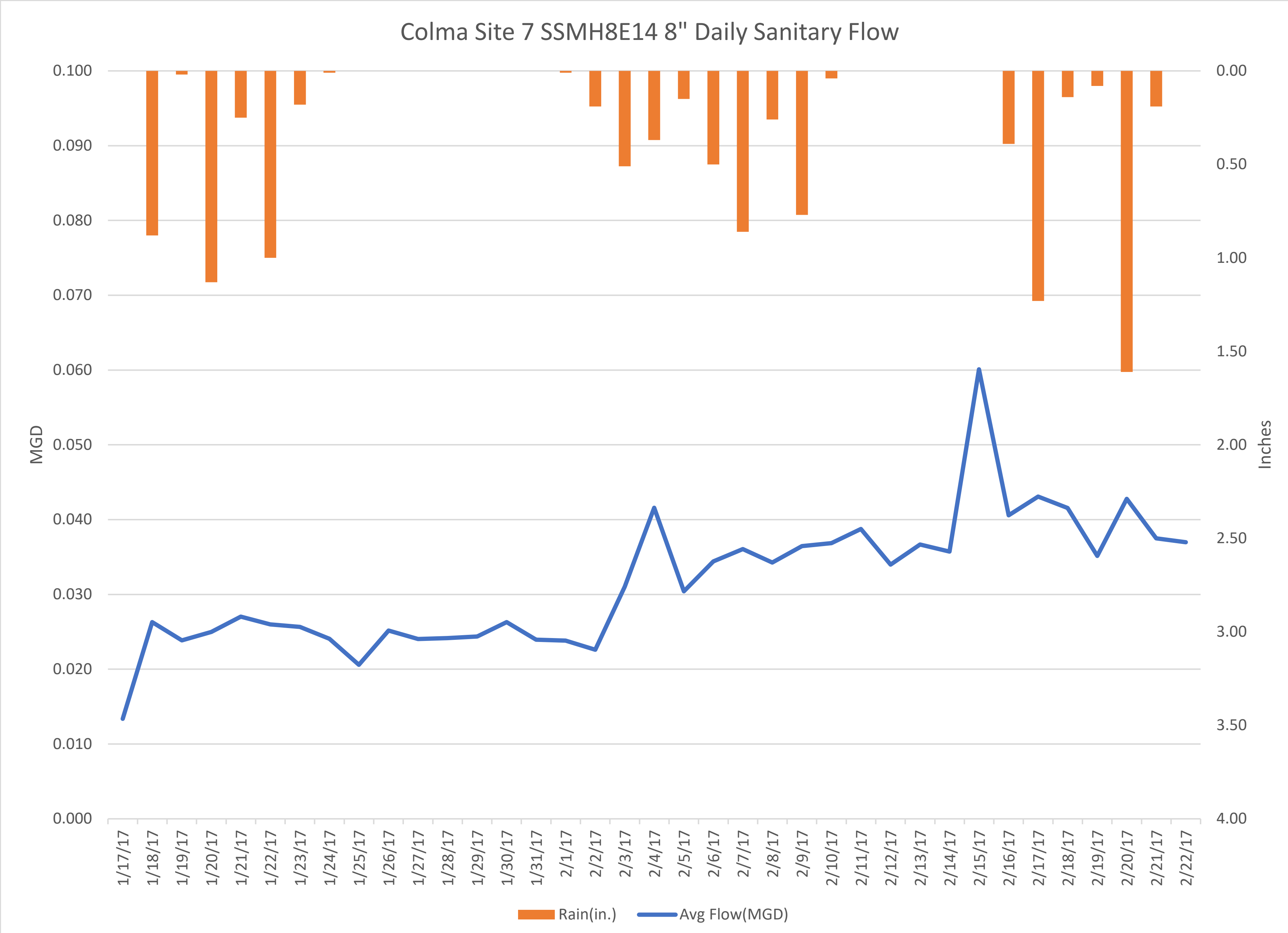
Invert View:

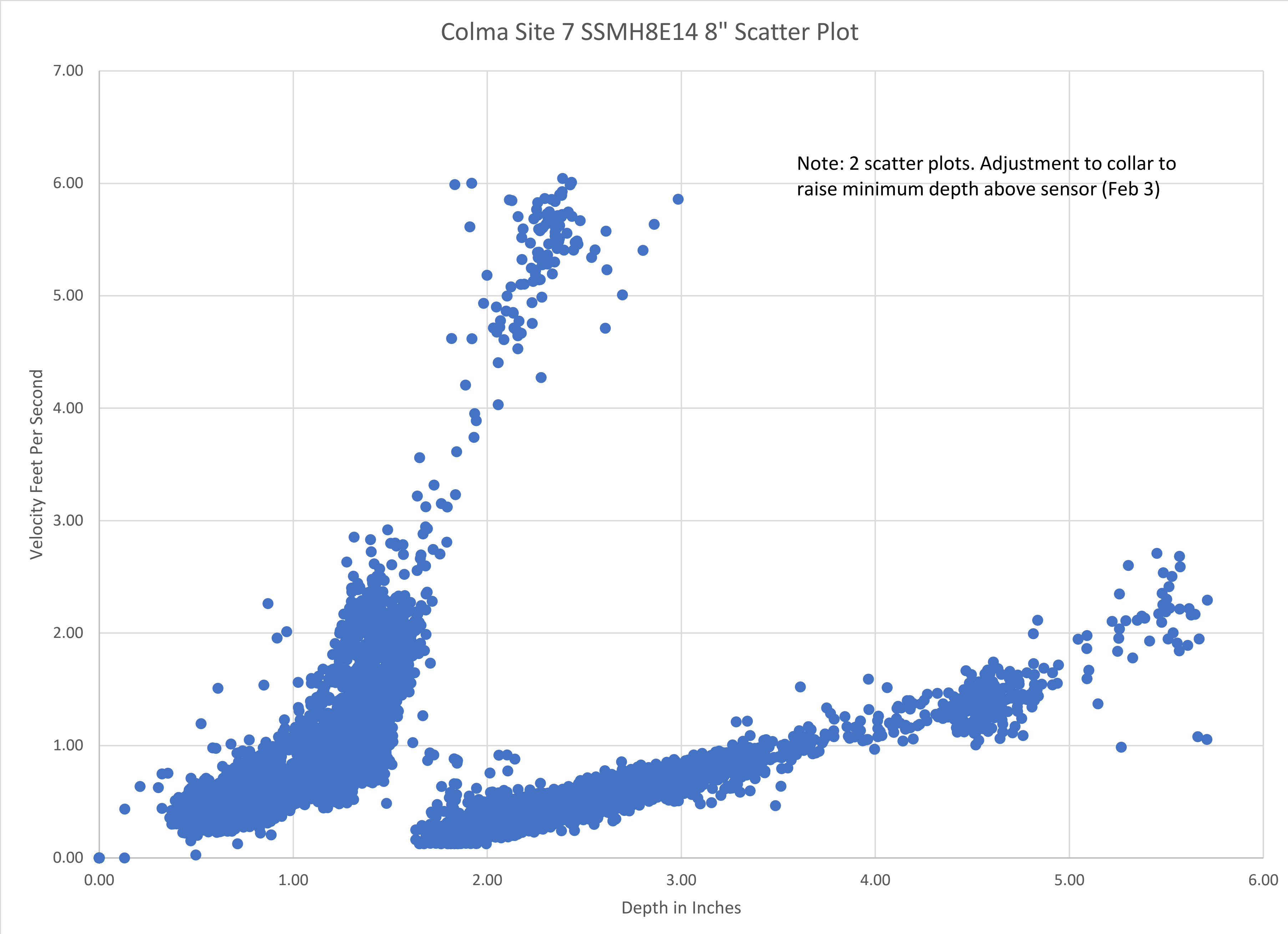
Outlet Pipe:	Inlet Pipe:
	

Colma Site 7 SSMH8E14 8" Sanitary Flow

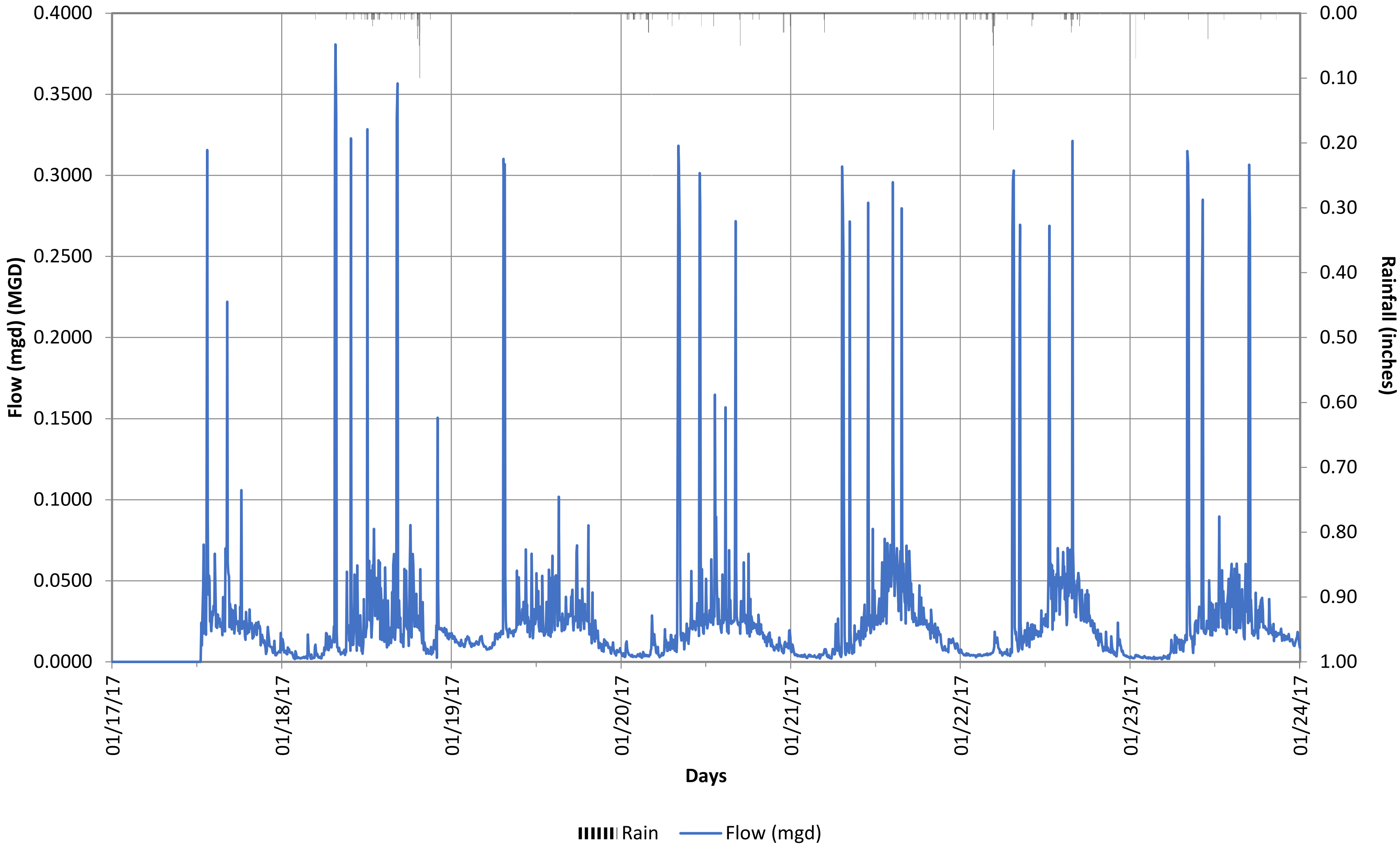
Daily Summary

Day	Date	Avg Flow(MGD)	Min Flow(MGD)	Max Flow(MGD)	Max Depth(in.)	Rain(in.)
Tuesday	1/17/17	0.013	0.000	0.316	2.444	0.00
Wednesday	1/18/17	0.026	0.002	0.381	3.614	0.88
Thursday	1/19/17	0.024	0.004	0.310	2.395	0.02
Friday	1/20/17	0.025	0.002	0.318	2.411	1.13
Saturday	1/21/17	0.027	0.002	0.305	2.349	0.25
Sunday	1/22/17	0.026	0.002	0.321	2.383	1.00
Monday	1/23/17	0.026	0.002	0.315	2.372	0.18
Tuesday	1/24/17	0.024	0.003	0.330	2.452	0.01
Wednesday	1/25/17	0.021	0.002	0.337	2.479	0.00
Thursday	1/26/17	0.025	0.002	0.346	2.427	0.00
Friday	1/27/17	0.024	0.001	0.332	2.437	0.00
Saturday	1/28/17	0.024	0.001	0.330	2.373	0.00
Sunday	1/29/17	0.024	0.001	0.312	2.320	0.00
Monday	1/30/17	0.026	0.002	0.449	2.984	0.00
Tuesday	1/31/17	0.024	0.001	0.342	2.388	0.00
Wednesday	2/1/17	0.024	0.001	0.309	2.372	0.01
Thursday	2/2/17	0.023	0.000	0.335	2.696	0.19
Friday	2/3/17	0.031	0.000	0.444	5.502	0.51
Saturday	2/4/17	0.042	0.005	0.450	5.568	0.37
Sunday	2/5/17	0.030	0.004	0.418	5.514	0.15
Monday	2/6/17	0.034	0.005	0.434	5.571	0.50
Tuesday	2/7/17	0.036	0.007	0.369	5.610	0.86
Wednesday	2/8/17	0.034	0.005	0.417	5.669	0.26
Thursday	2/9/17	0.036	0.005	0.395	5.712	0.77
Friday	2/10/17	0.037	0.005	0.371	5.647	0.04
Saturday	2/11/17	0.039	0.005	0.283	4.816	0.00
Sunday	2/12/17	0.034	0.005	0.243	4.868	0.00
Monday	2/13/17	0.037	0.004	0.215	4.713	0.00
Tuesday	2/14/17	0.036	0.005	0.218	4.659	0.00
Wednesday	2/15/17	0.060	0.005	0.284	5.709	0.00
Thursday	2/16/17	0.041	0.008	0.232	5.147	0.39
Friday	2/17/17	0.043	0.006	0.232	4.827	1.23
Saturday	2/18/17	0.042	0.005	0.251	4.943	0.14
Sunday	2/19/17	0.035	0.005	0.203	4.807	0.08
Monday	2/20/17	0.043	0.005	0.199	4.820	1.61
Tuesday	2/21/17	0.037	0.006	0.220	4.733	0.19
Wednesday	2/22/17	0.037	0.006	0.223	4.798	0.00


Colma Site 7 SSMH8E14 8" Daily Sanitary Flow
MGD
Inches
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
1/17/17
1/18/17
1/19/17
1/20/17
1/21/17
1/22/17
1/23/17
1/24/17
1/25/17
1/26/17
1/27/17
1/28/17
1/29/17
1/30/17
1/31/17
2/1/17
2/2/17
2/3/17
2/4/17
2/5/17
2/6/17
2/7/17
2/8/17
2/9/17
2/10/17
2/11/17
2/12/17
2/13/17
2/14/17
2/15/17
2/16/17
2/17/17
2/18/17
2/19/17
2/20/17
2/21/17
2/22/17
Rain(in.)
Avg Flow(MGD)

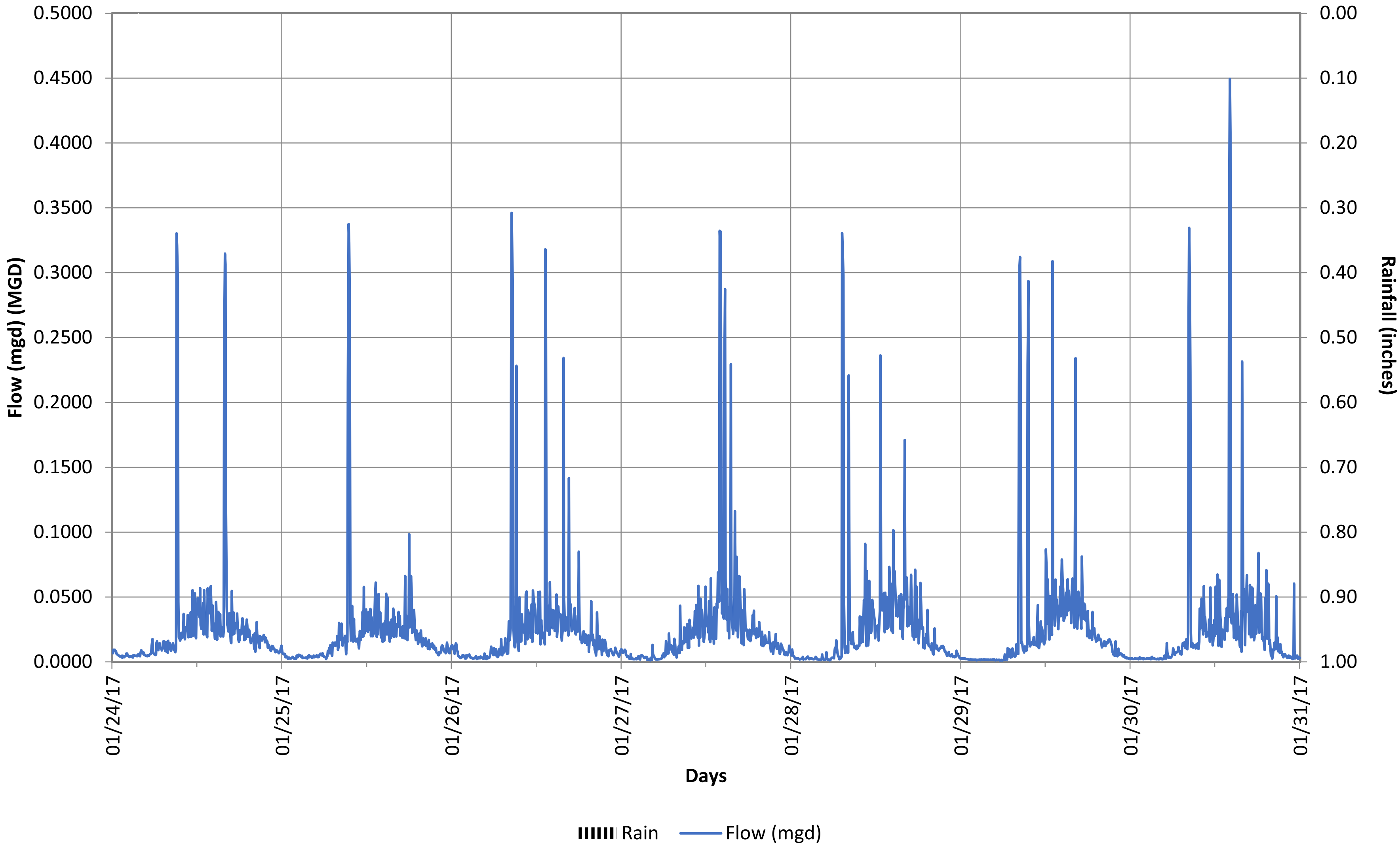

Colma Site 7 SSMH8E14 8" Scatter Plot
Note: 2 scatter plots. Adjustment to collar to raise minimum depth above sensor (Feb 3)
Velocity Feet Per Second
Depth in Inches
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00

Colma Site 7 SSMH8E14 8" Sanitary Flow



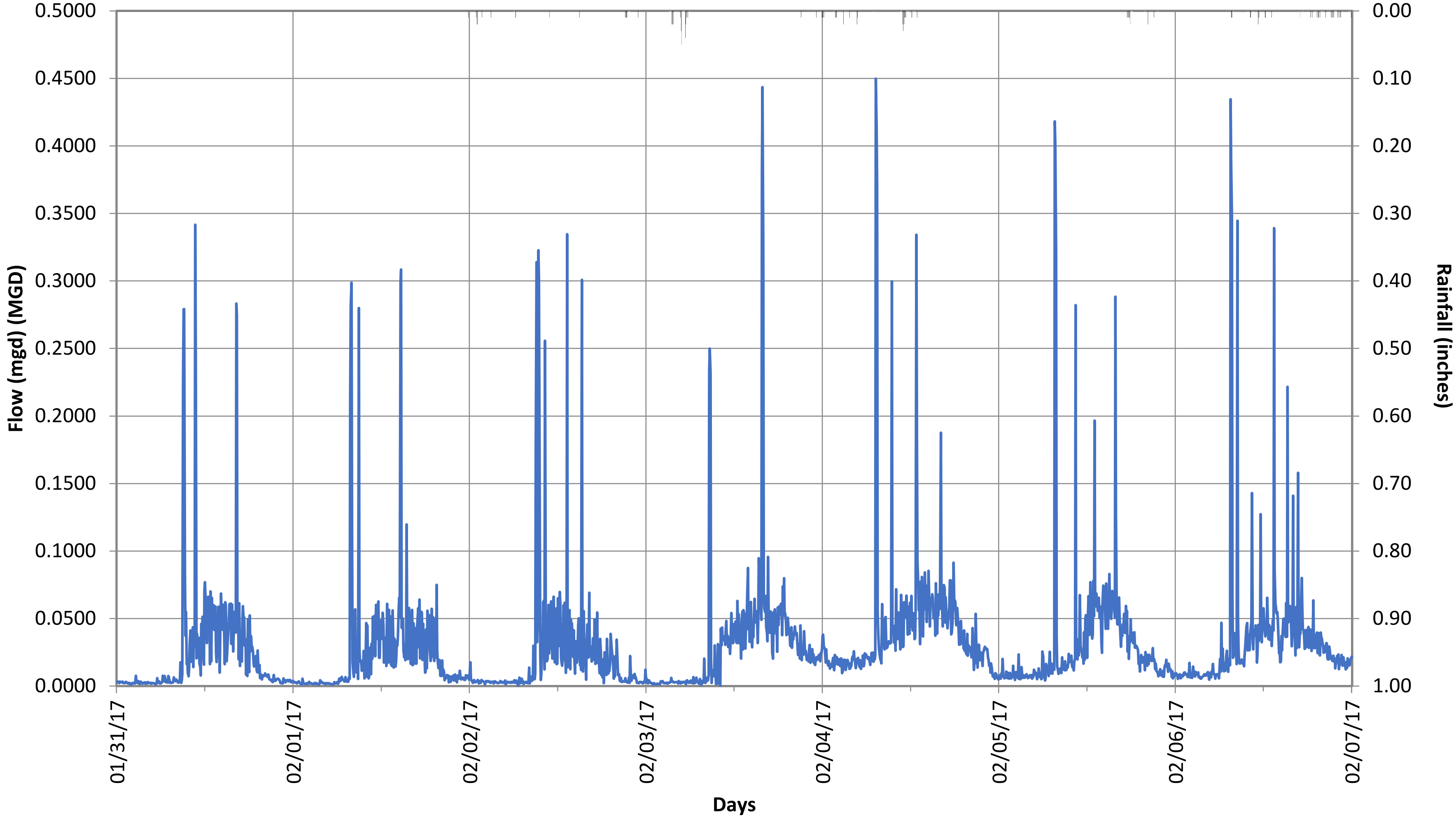
	1/17/2017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM	/2017 11:55:00 PM(	2017 11:55:00 PM	2017 11:55:00 PM(Mon)
Maximum	0.316	0.381	0.310	0.318	0.305	0.321	0.315
Average	0.013	0.026	0.024	0.025	0.027	0.026	0.026
Minimum	0.000	0.002	0.004	0.002	0.002	0.002	0.002
Rain (inches)	0.00	0.88	0.02	1.13	0.25	1.00	0.18

Colma Site 7 SSMH8E14 8" Sanitary Flow



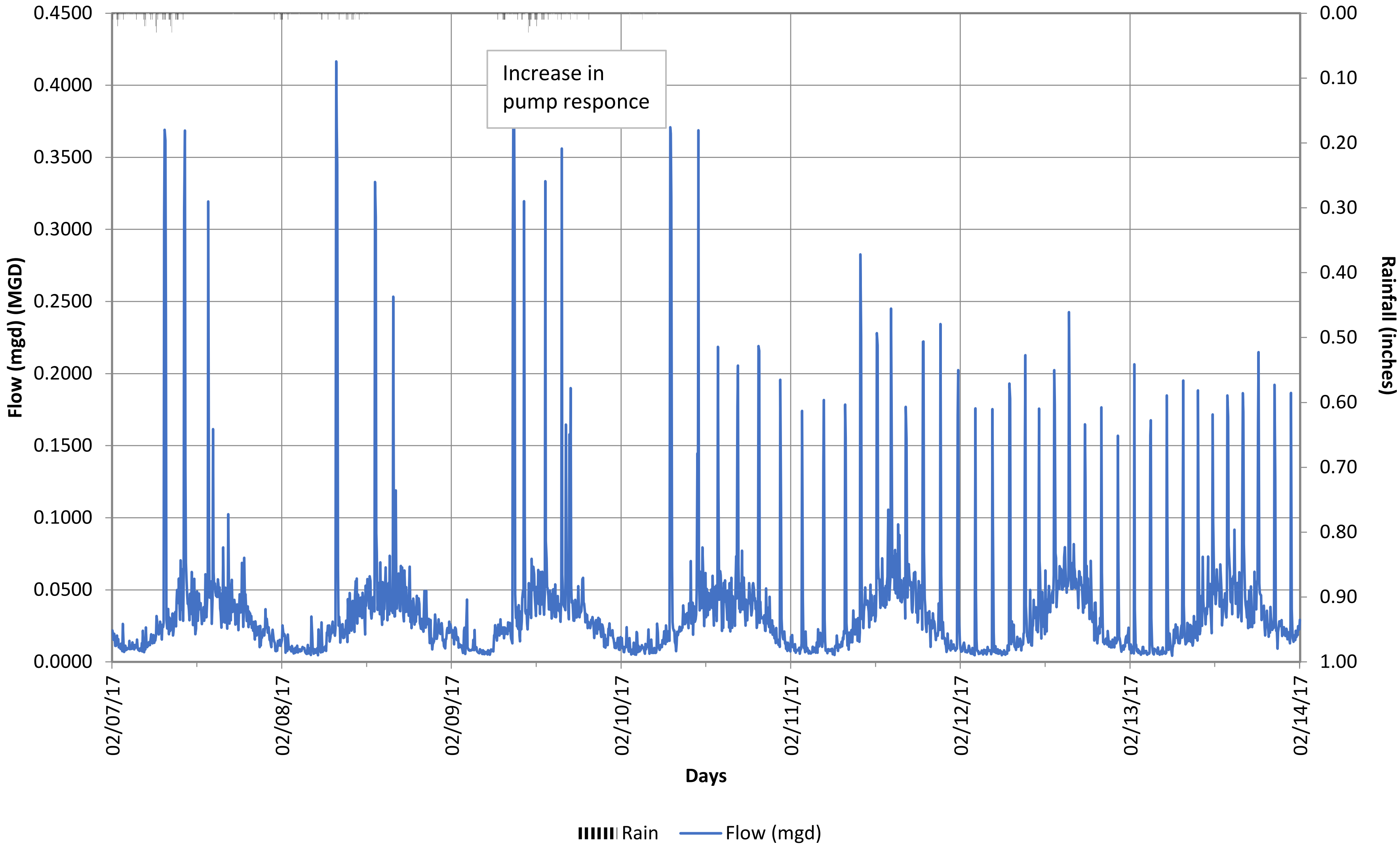
	1/24/2017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM	/2017 11:55:00 PM(	2017 11:55:00 PM	2017 11:55:00 PM(Mon)
Maximum	0.330	0.337	0.346	0.332	0.330	0.312	0.449
Average	0.024	0.021	0.025	0.024	0.024	0.024	0.026
Minimum	0.003	0.002	0.002	0.001	0.001	0.001	0.002
Rain (inches)	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Colma Site 7 SSMH8E14 8" Sanitary Flow



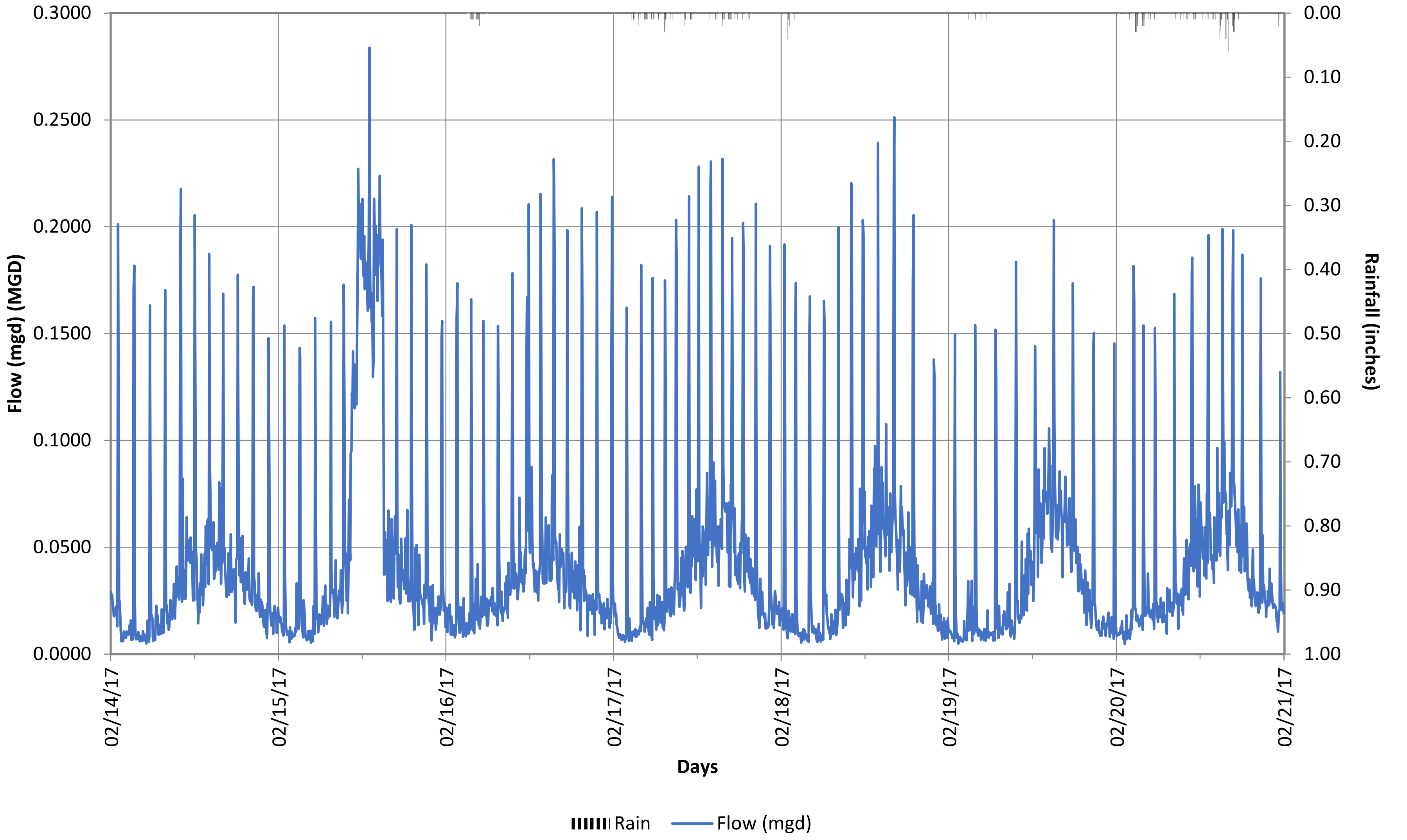
	1/31/2017 11:55:00 PM(	017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM(	017 11:55:00 PM(Mon)
Maximum	0.342	0.309	0.335	0.444	0.450	0.418	0.434
Average	0.024	0.024	0.023	0.031	0.042	0.030	0.034
Minimum	0.001	0.001	0.000	0.000	0.005	0.004	0.005
Rain (inches)	0.00	0.01	0.19	0.51	0.37	0.15	0.50

Colma Site 7 SSMH8E14 8" Sanitary Flow



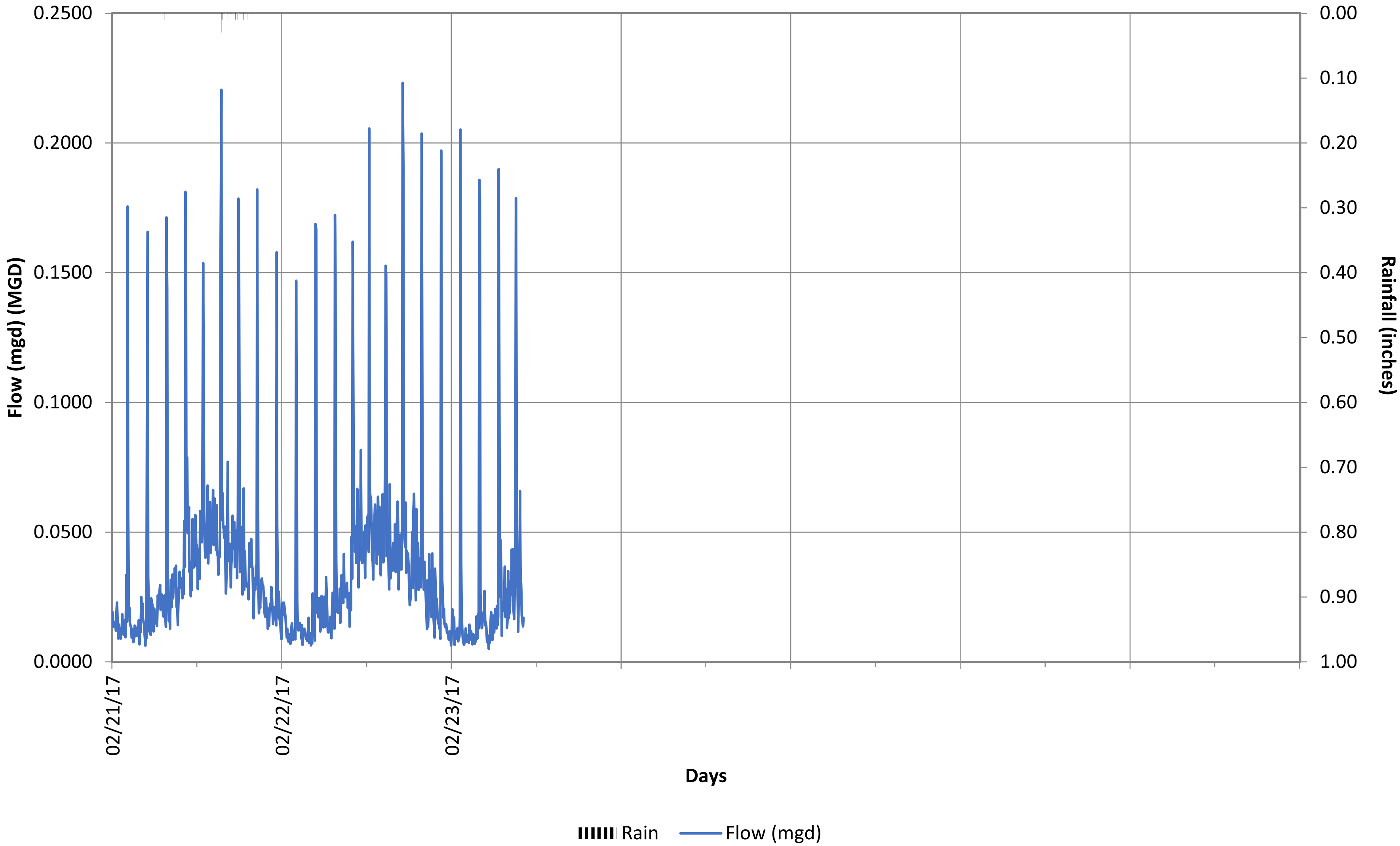
	2/7/2017 11:55:00 PM(	'017 11:55:00 PM(	'2017 11:55:00 PM(	'/2017 11:55:00 PM	/2017 11:55:00 PM(	2017 11:55:00 PM	2017 11:55:00 PM(Mon)
Maximum	0.369	0.417	0.395	0.371	0.283	0.243	0.215
Average	0.036	0.034	0.036	0.037	0.039	0.034	0.037
Minimum	0.007	0.005	0.005	0.005	0.005	0.005	0.004
Rain (inches)	0.86	0.26	0.77	0.04	0.00	0.00	0.00

Colma Site 7 SSMH8E14 8" Sanitary Flow



	2/14/2017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM(	/2017 11:55:00 PM	/2017 11:55:00 PM(	2017 11:55:00 PM	2017 11:55:00 PM(Mon)
Maximum	0.218	0.284	0.232	0.232	0.251	0.203	0.199
Average	0.036	0.060	0.041	0.043	0.042	0.035	0.043
Minimum	0.005	0.005	0.008	0.006	0.005	0.005	0.005
Rain (inches)	0.00	0.00	0.39	1.23	0.14	0.08	1.61

Colma Site 7 SSMH8E14 8" Sanitary Flow

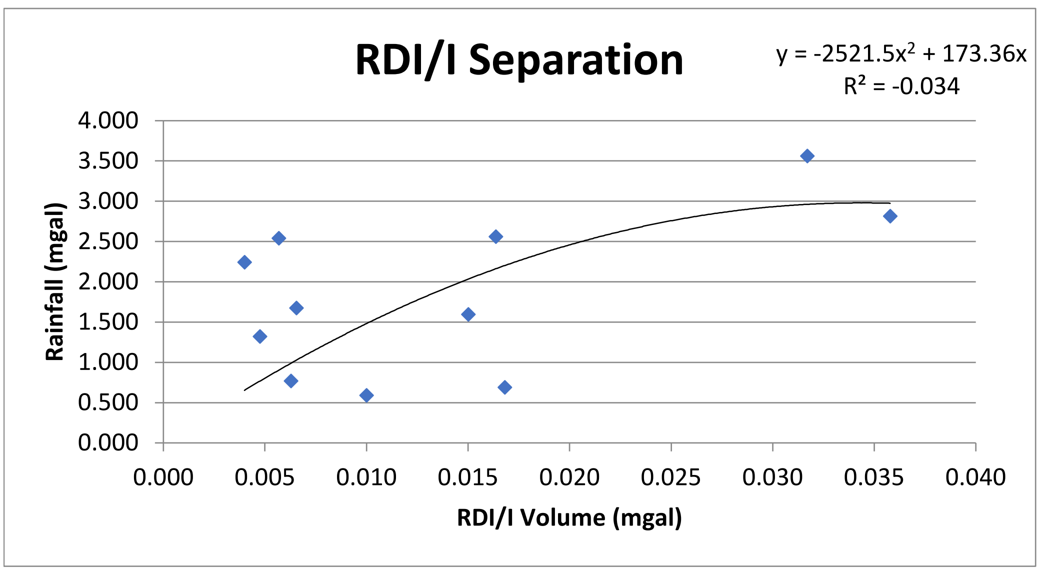


	2/21/2017 11:55:00 PM(	2017 11:55:00 PM(Wed)					
Maximum	0.220	0.223					
Average	0.037	0.037					
Minimum	0.006	0.006					
Rain (inches)	0.19	0.00					

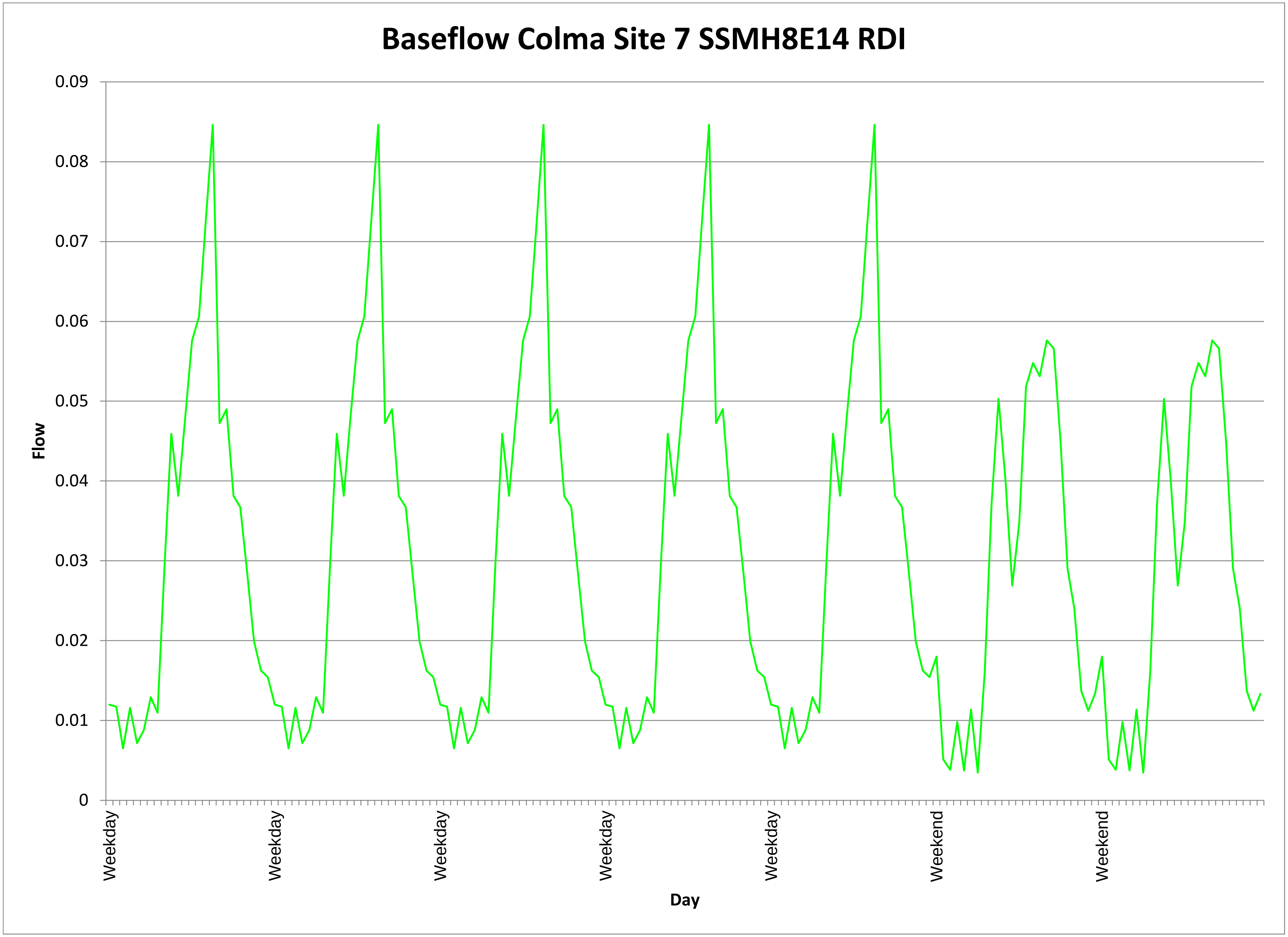
Colma Site 7 SSMH8E14 RDI

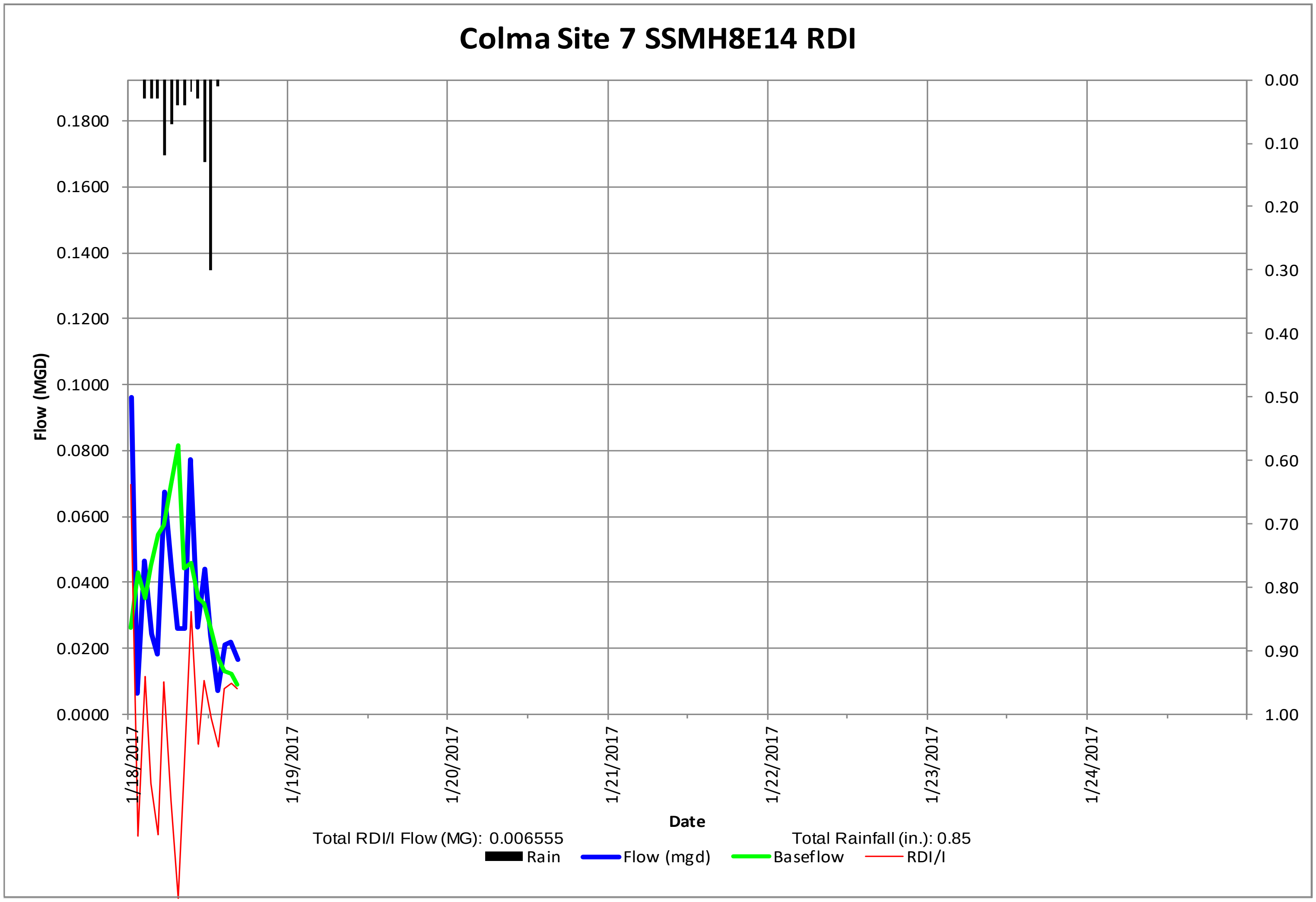
RDI/I Analysis, Monitor Return Ratio Summary

Storm Start (Date)	RDI/I Volume (mgal)	Monitor Area (acres)	Rainfall (mgal)	Return Ratio (%)
1/18/2017	0.007	72.5	1.673	0.39%
1/20/2017	0.004	72.5	2.244	0.18%
1/21/2017	0.006	72.5	2.539	0.22%
2/2/2017	0.005	72.5	1.319	0.36%
2/4/2017	0.017	72.5	0.689	2.44%
2/6/2017	0.016	72.5	2.559	0.64%
2/7/2017	0.010	72.5	0.591	1.69%
2/9/2017	0.015	72.5	1.595	0.94%
2/16/2017	0.006	72.5	0.768	0.82%
2/17/2017	0.036	72.5	2.815	1.27%
2/20/2017	0.032	72.5	3.563	0.89%
Average R%				0.90%
Average top 3 Storms				1.80%

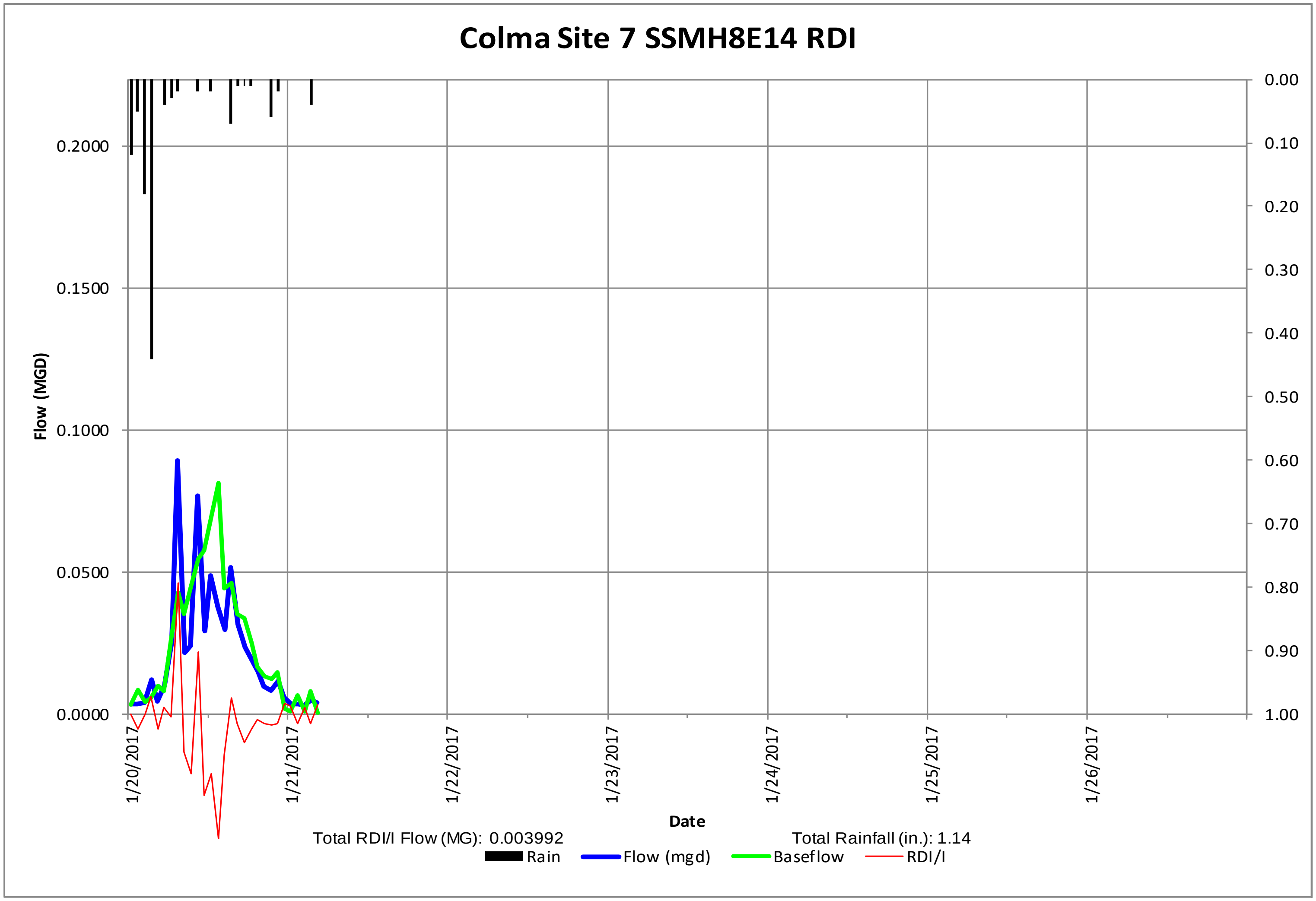


Baseflows	Weekend	Weekday
Max	0.058	0.085
Avg	0.028	0.032
Min	0.003	0.006

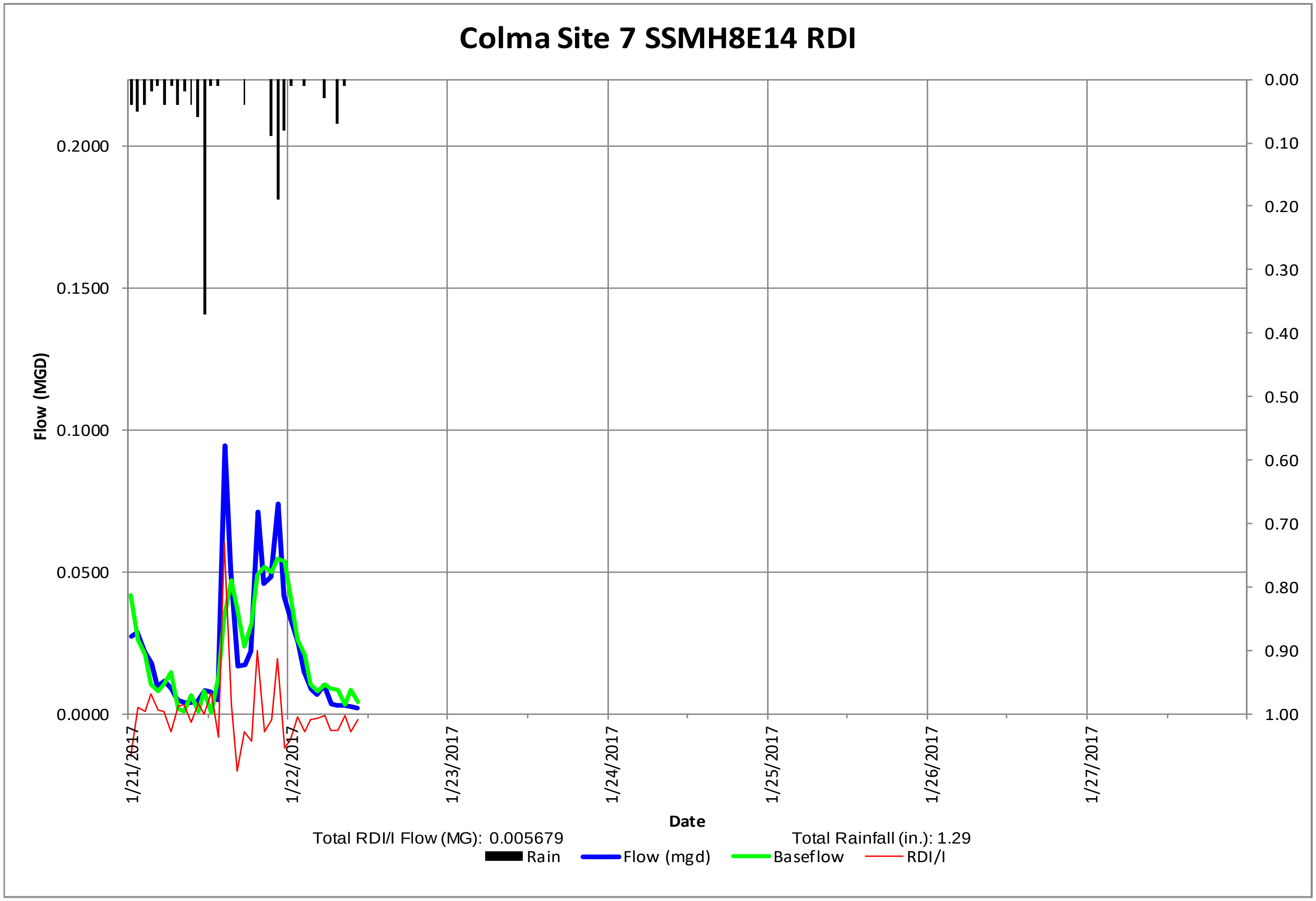

Baseflow Colma Site 7 SSMH8E14 RDI
Flow
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Weekday
Weekday
Weekday
Weekday
Weekday
Weekend
Weekend
Day



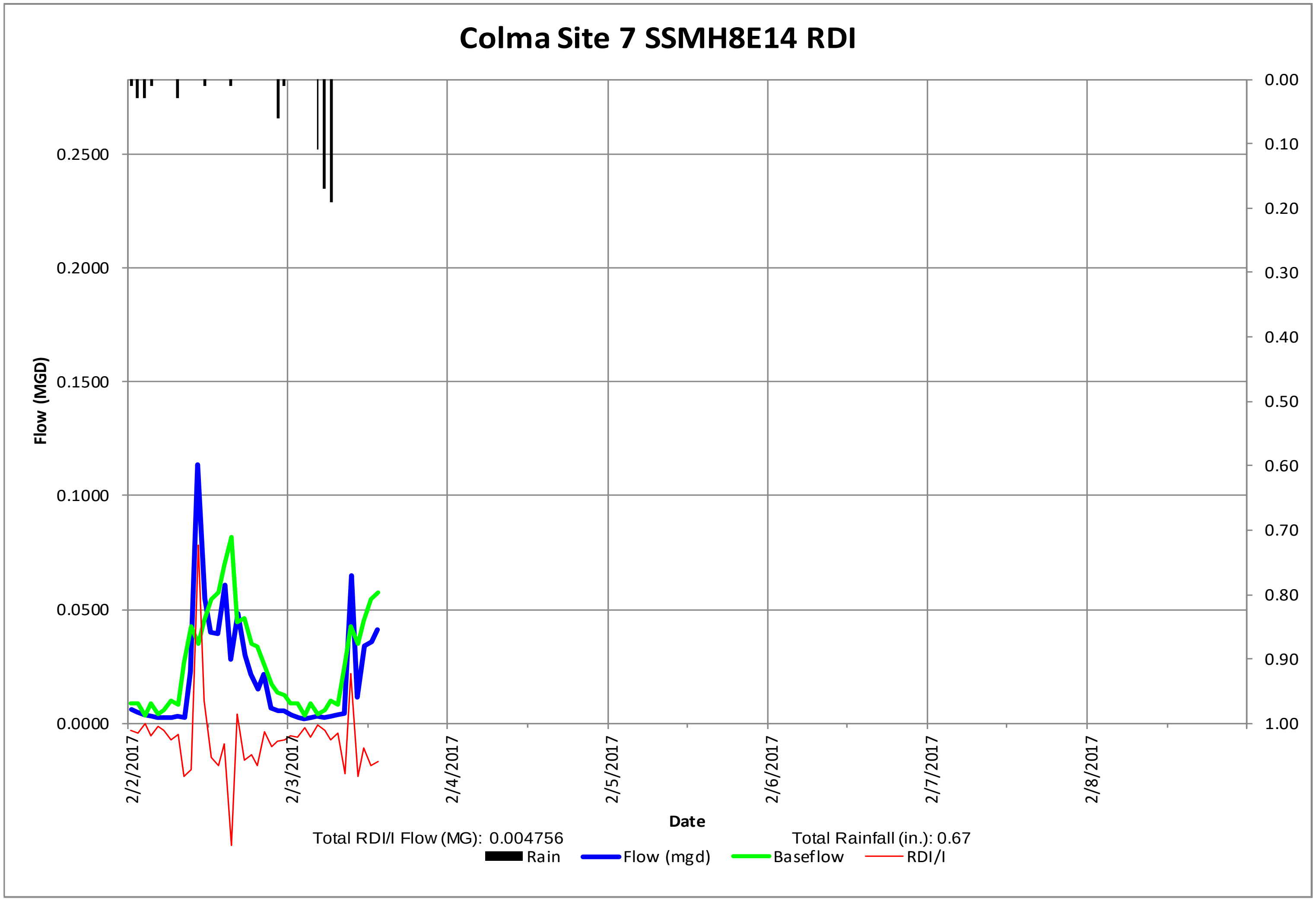
Storm of 1/18/2017



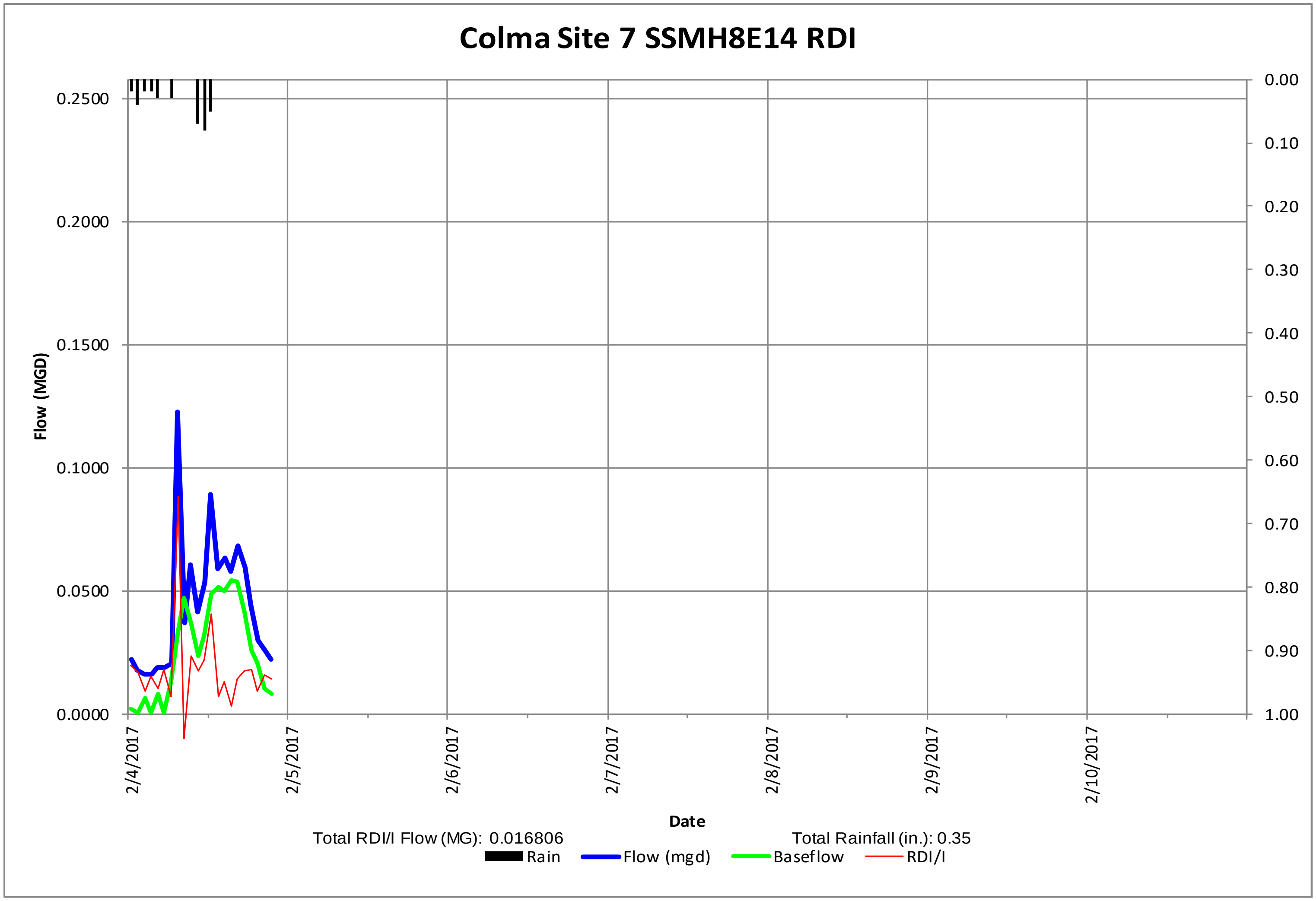
Storm of 1/20/2017



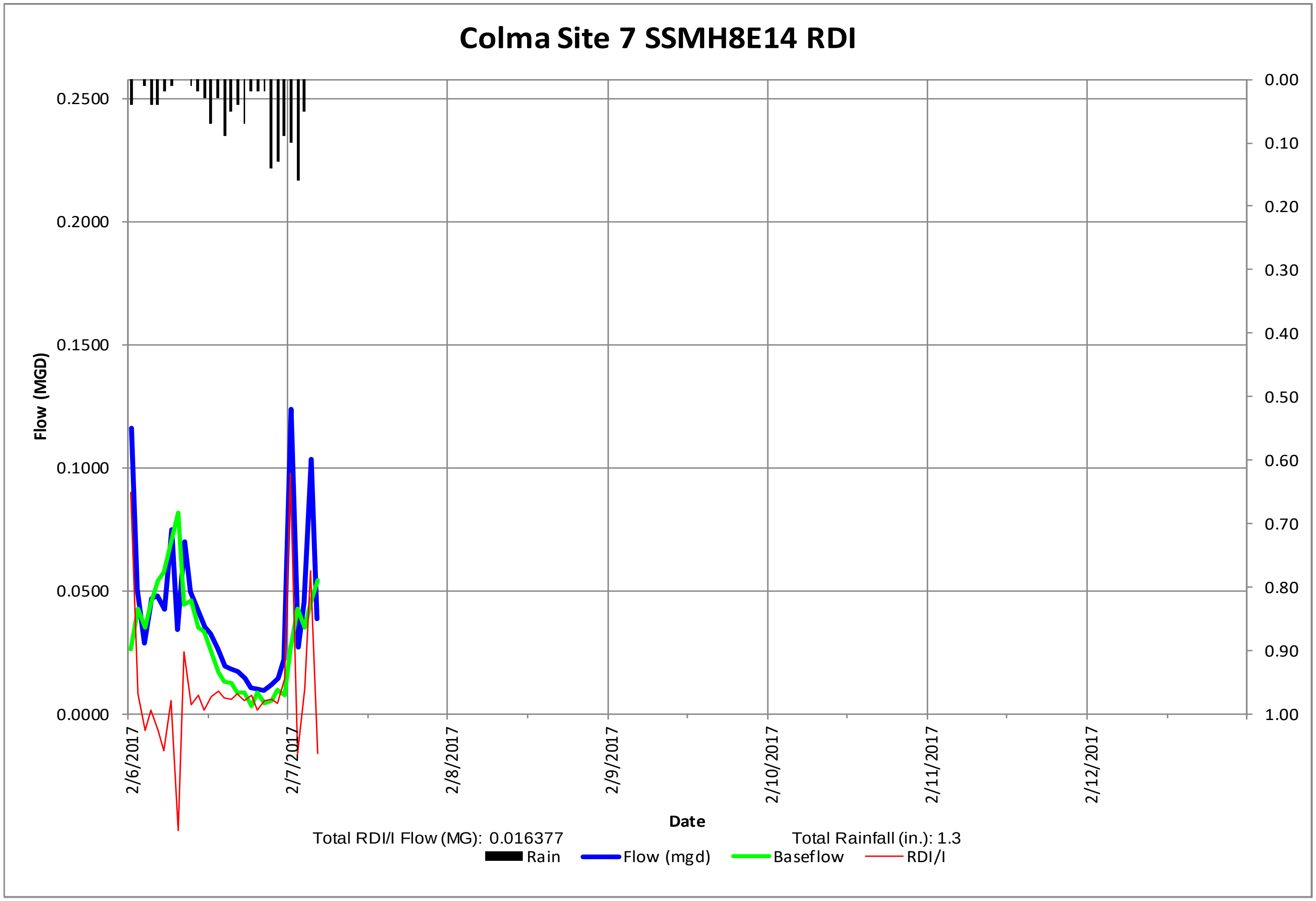
Storm of 1/21/2017



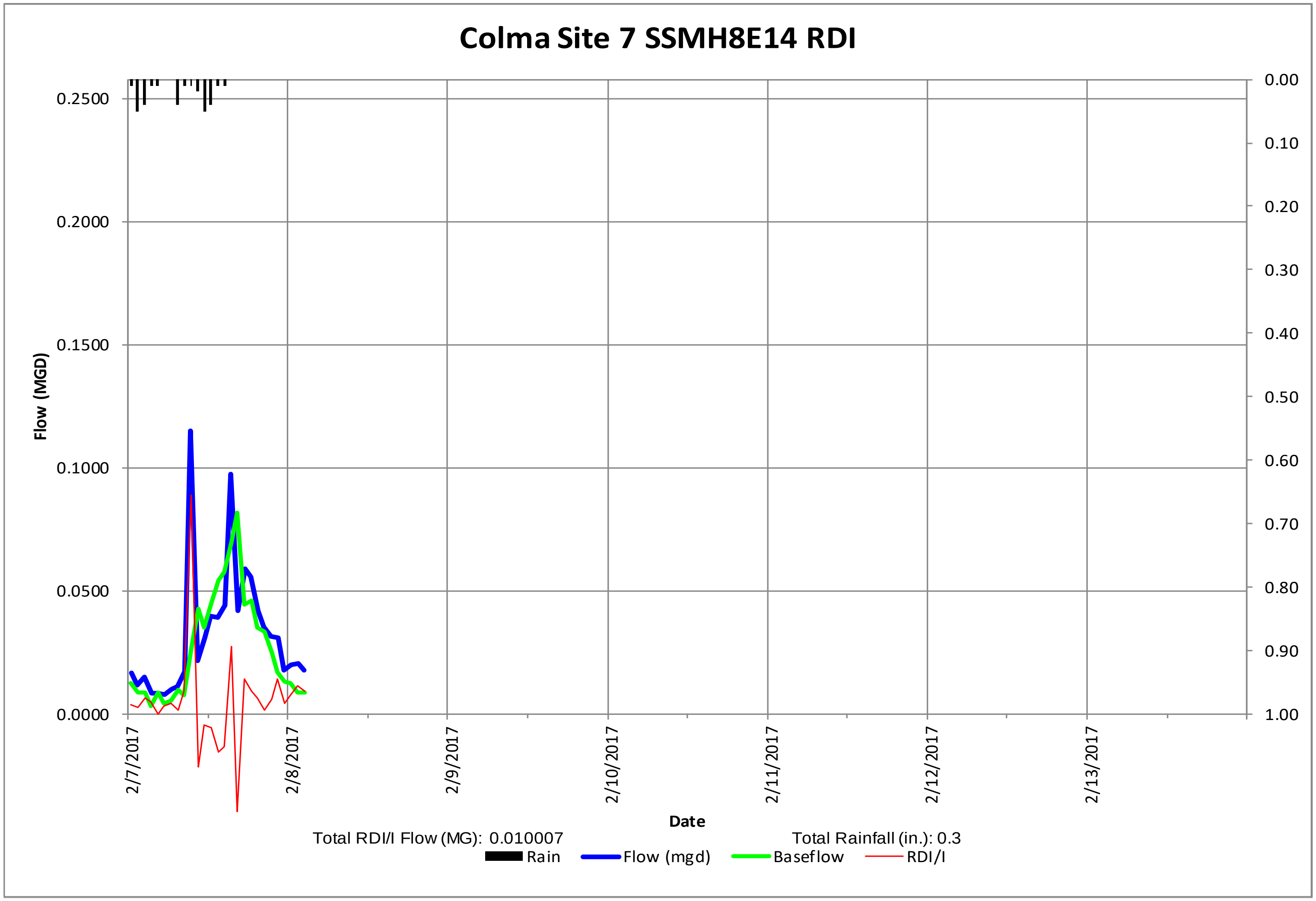
Storm of 2/2/2017



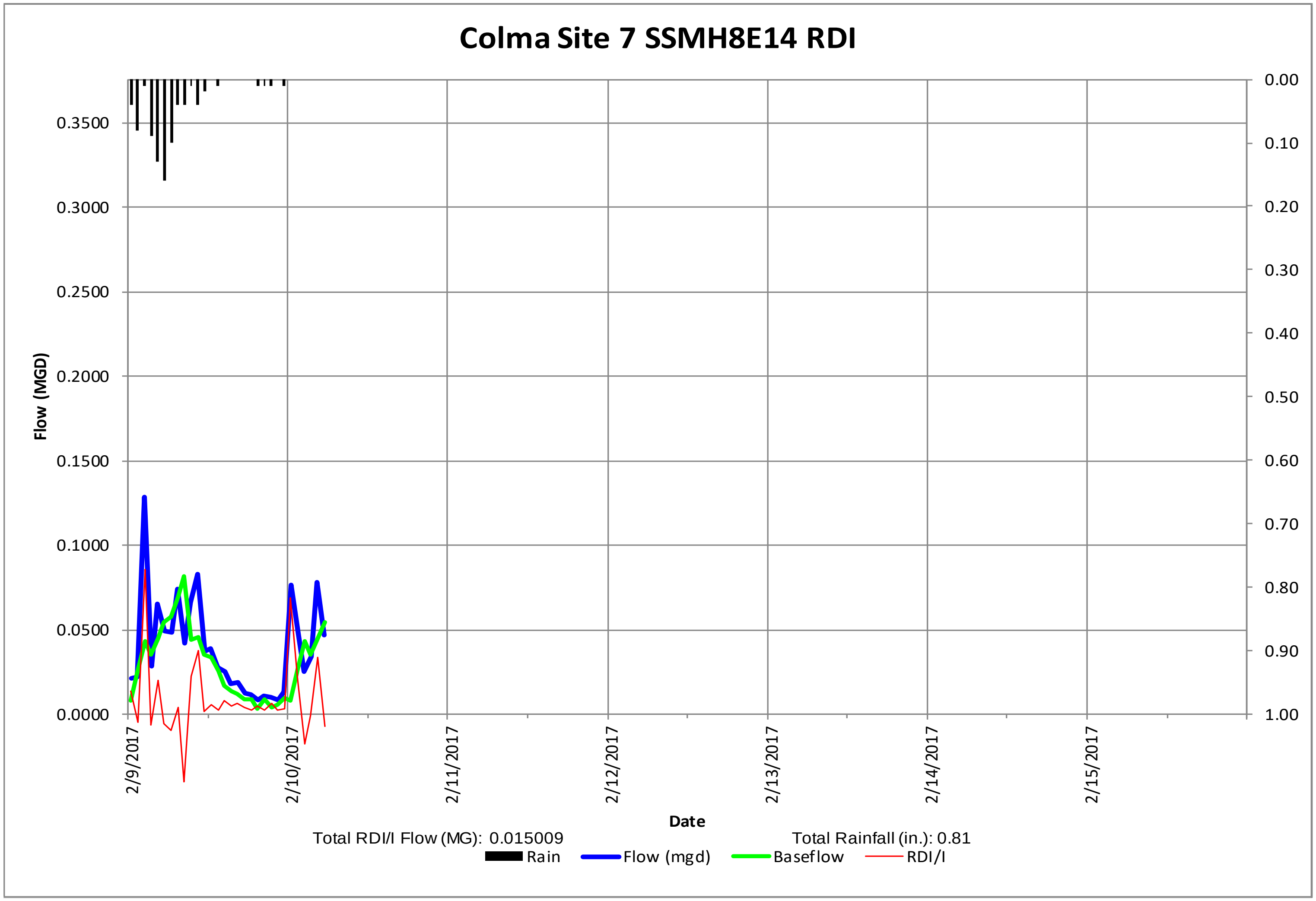
Storm of 2/4/2017



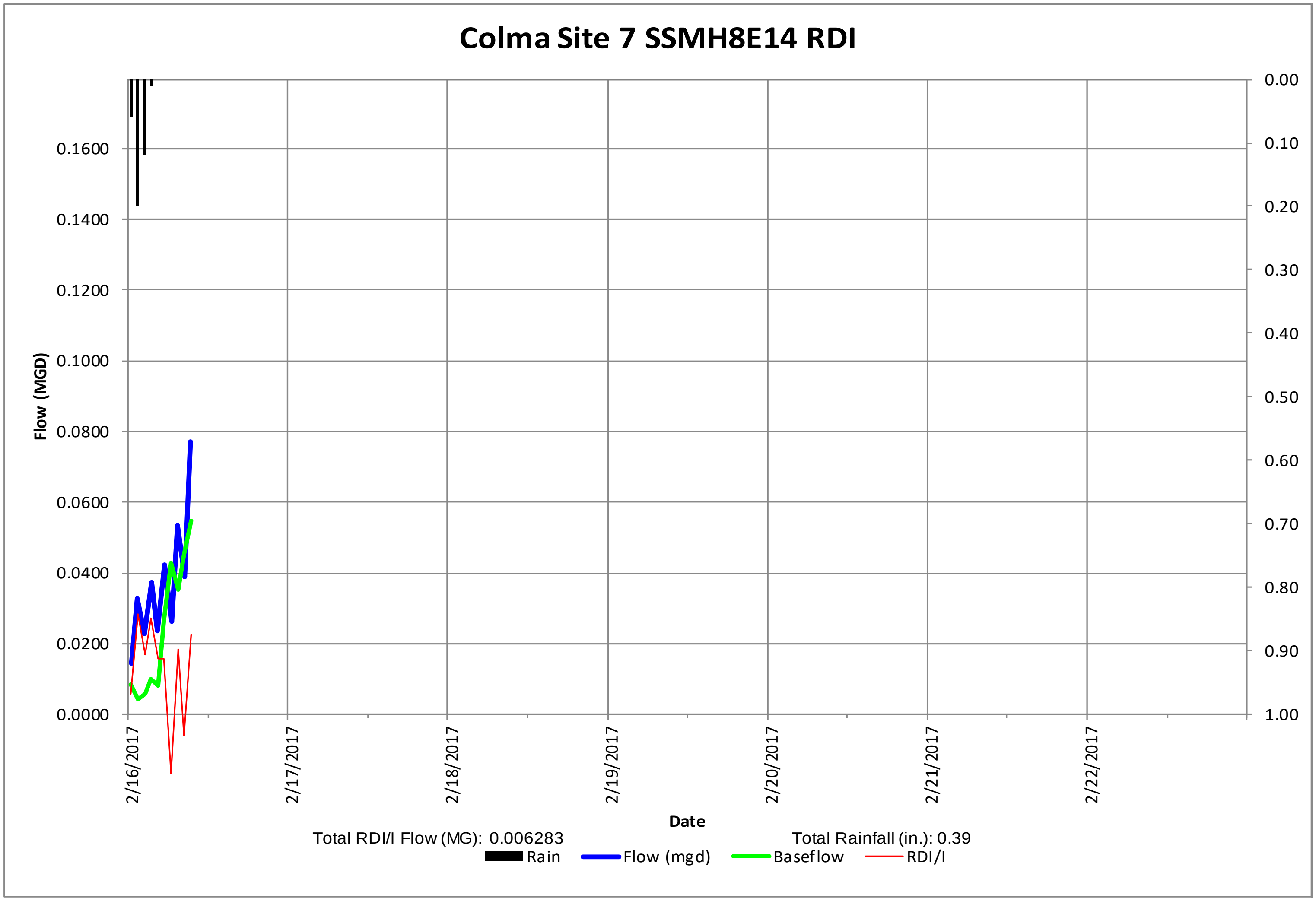
Storm of 2/6/2017



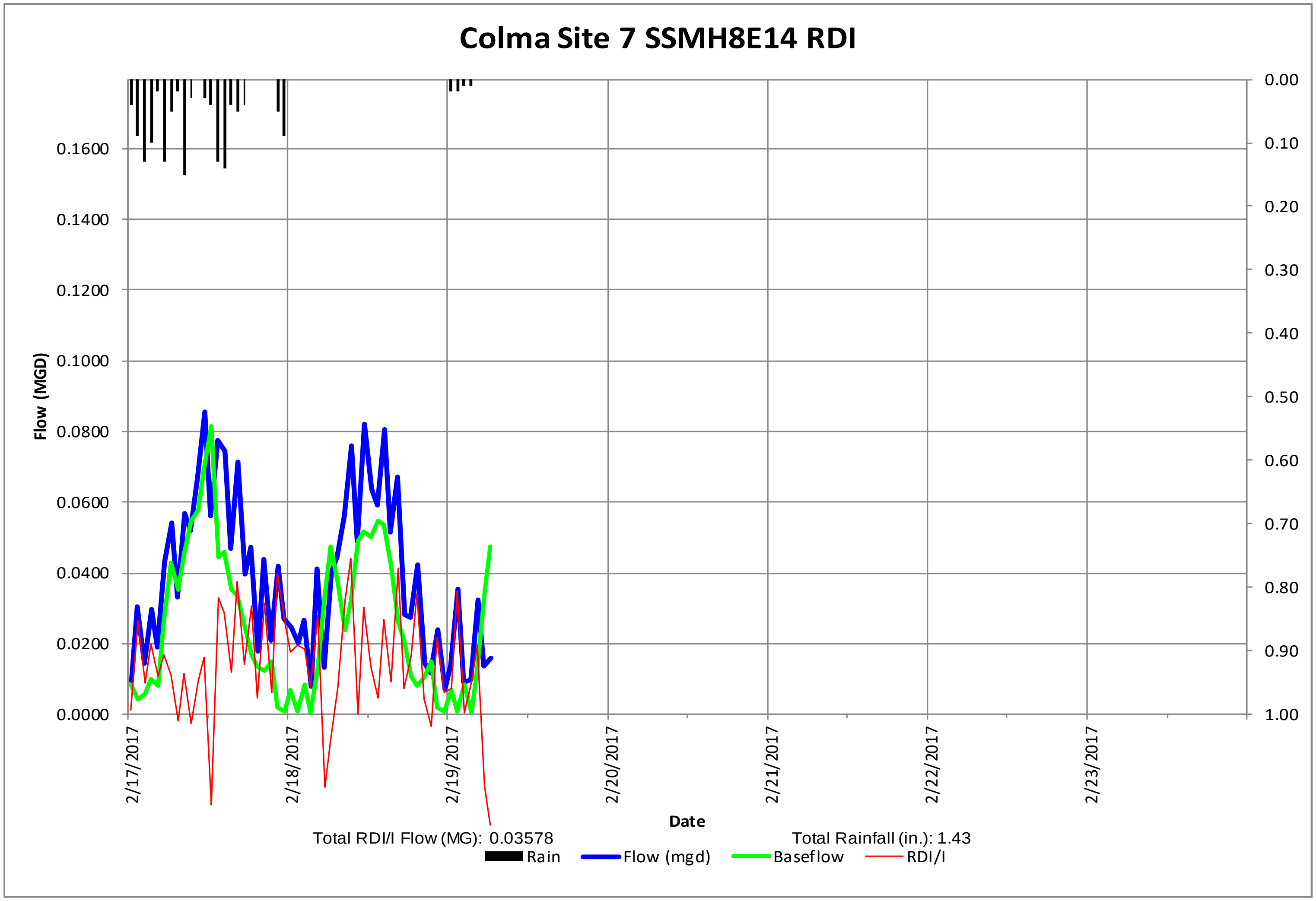
Storm of 2/7/2017



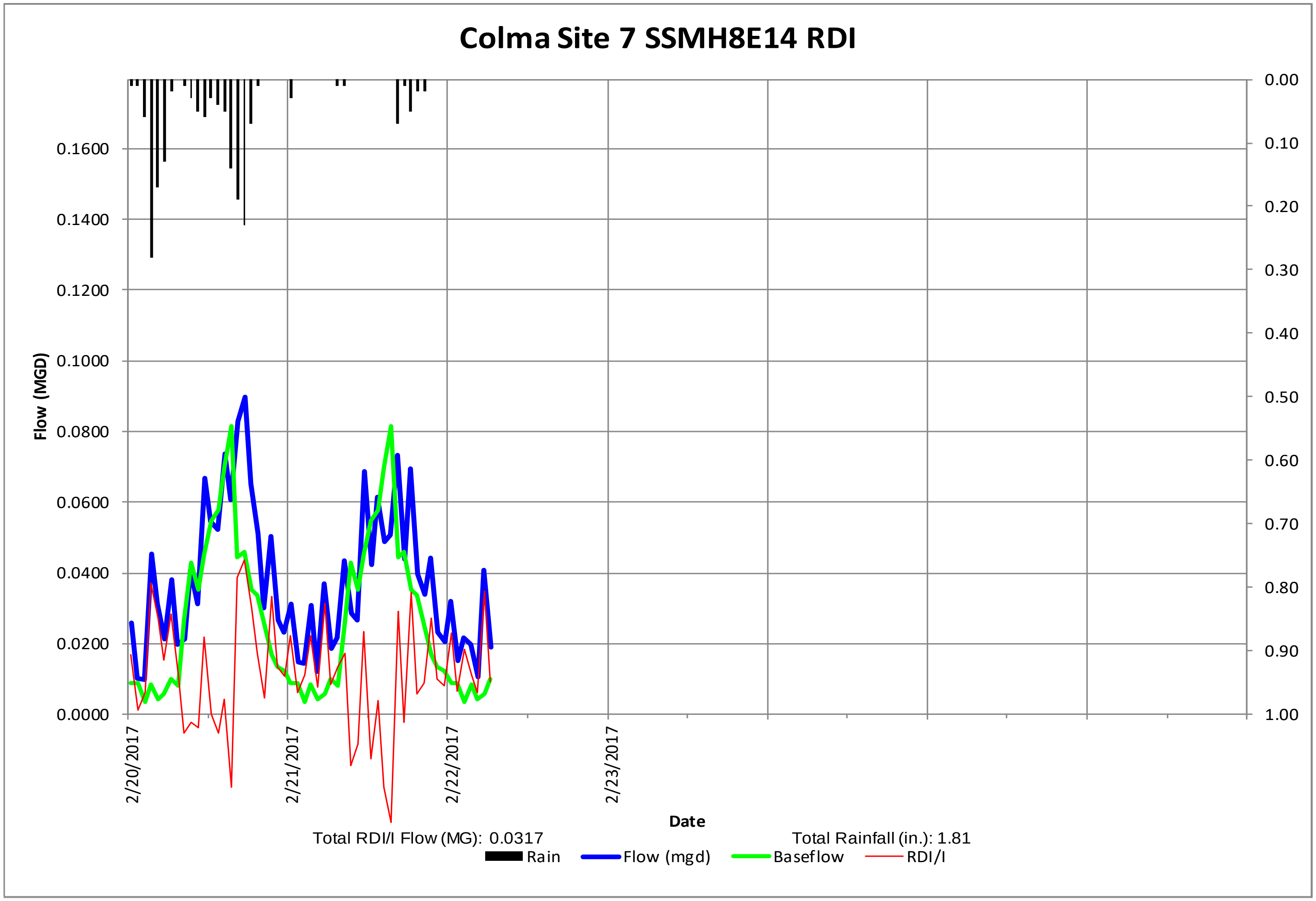
Storm of 2/9/2017



Storm of 2/16/2017



Storm of 2/17/2017

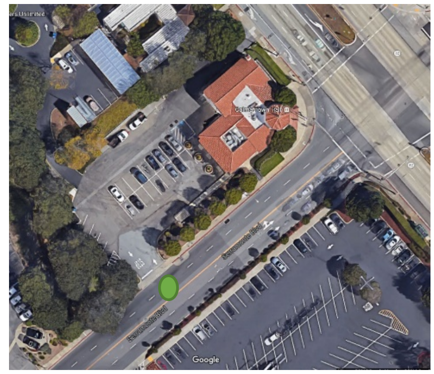


Storm of 2/20/2017

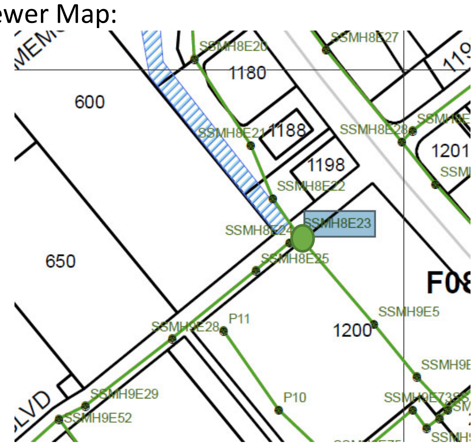
Site Information Report	Flow Monitor Site: 8

Manhole Number SSMH 8E23
Location: Serramonte Blvd west of El Camino
MH Depth ~9’
Diameter: 8”
Safety: Ok
Traffic: Medium
Gas: Ok
Rungs: No
Meter Type: Hach FL900 2 submerged
Depth: Pressure 3.75”
Velocity: Doppler 0.5 ft./sec

Ariel View:



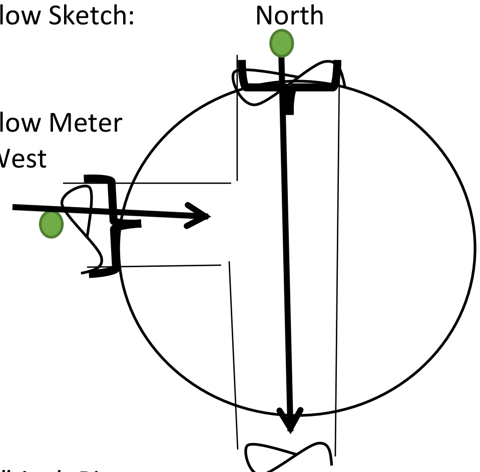
City Sewer Map:



Flow Sketch:

North

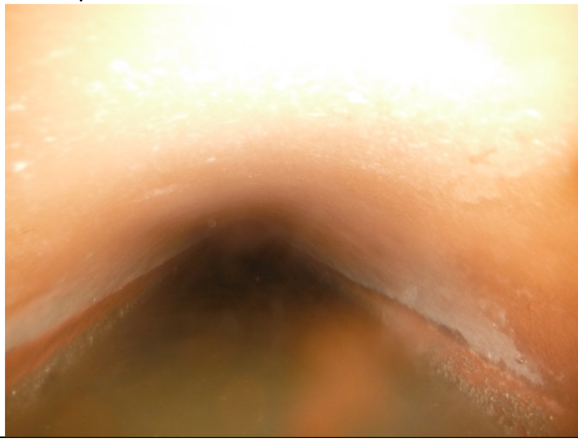
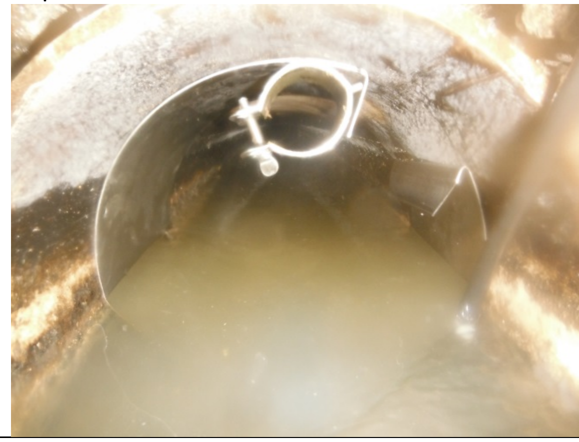
Flow Meter
West



8”-inch Pipes

Surface View:

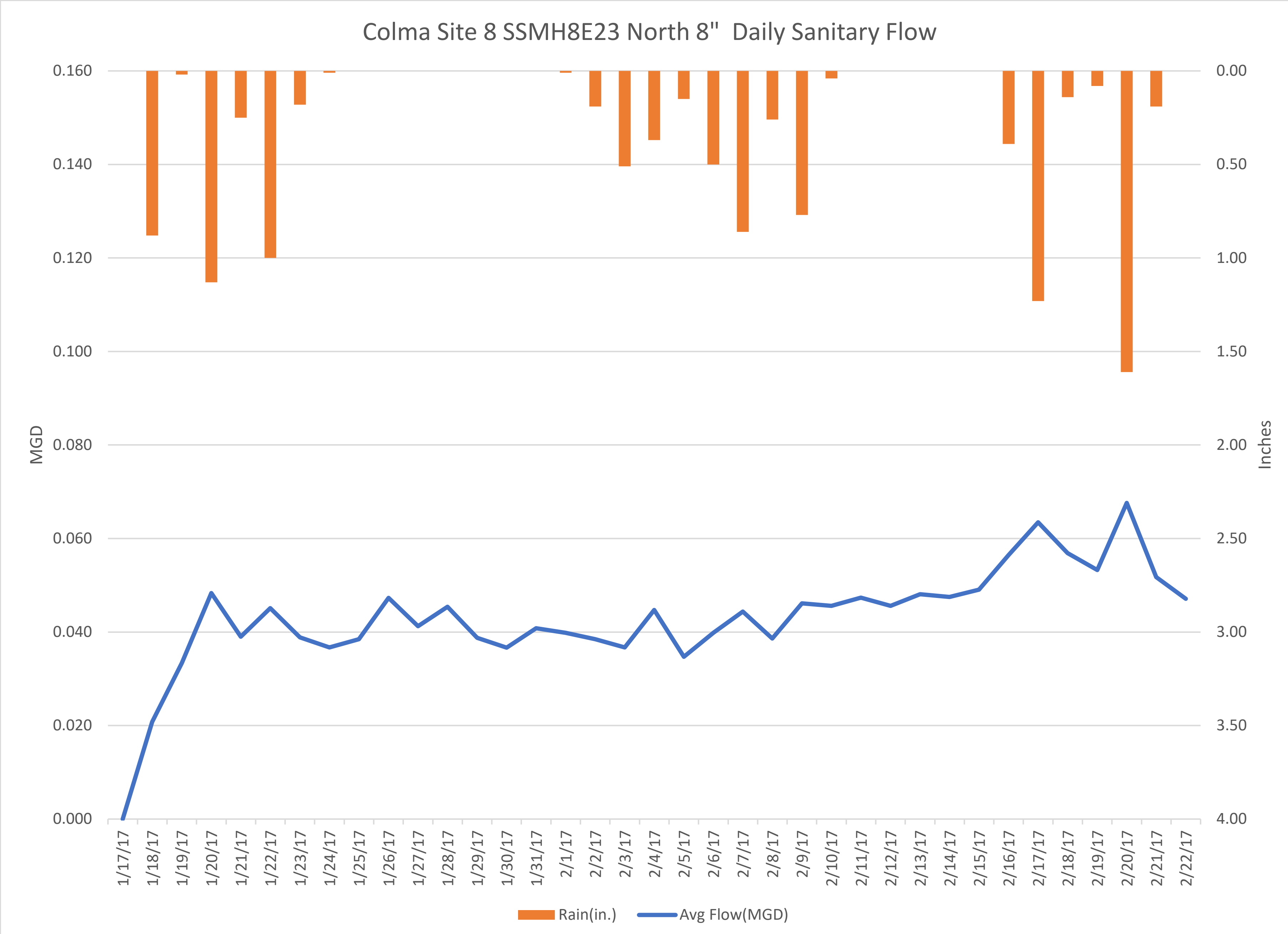
Invert View:

Outlet Pipe: P0 	Inlet Pipe: P1 
Inlet Pipe: P2 	

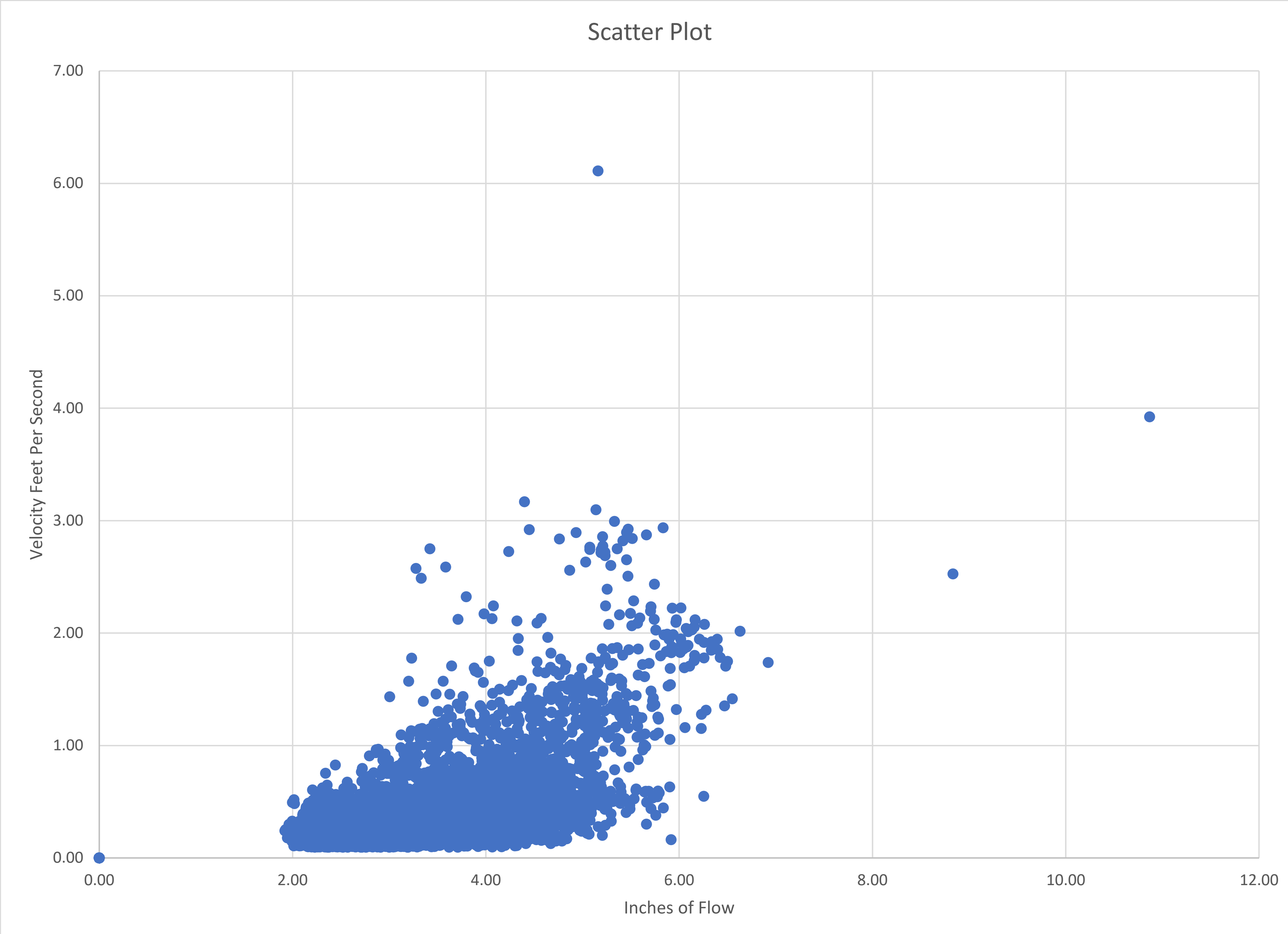
Colma Site 8 SSMH8E23 North 8" Sanitary Flow

Daily Summary

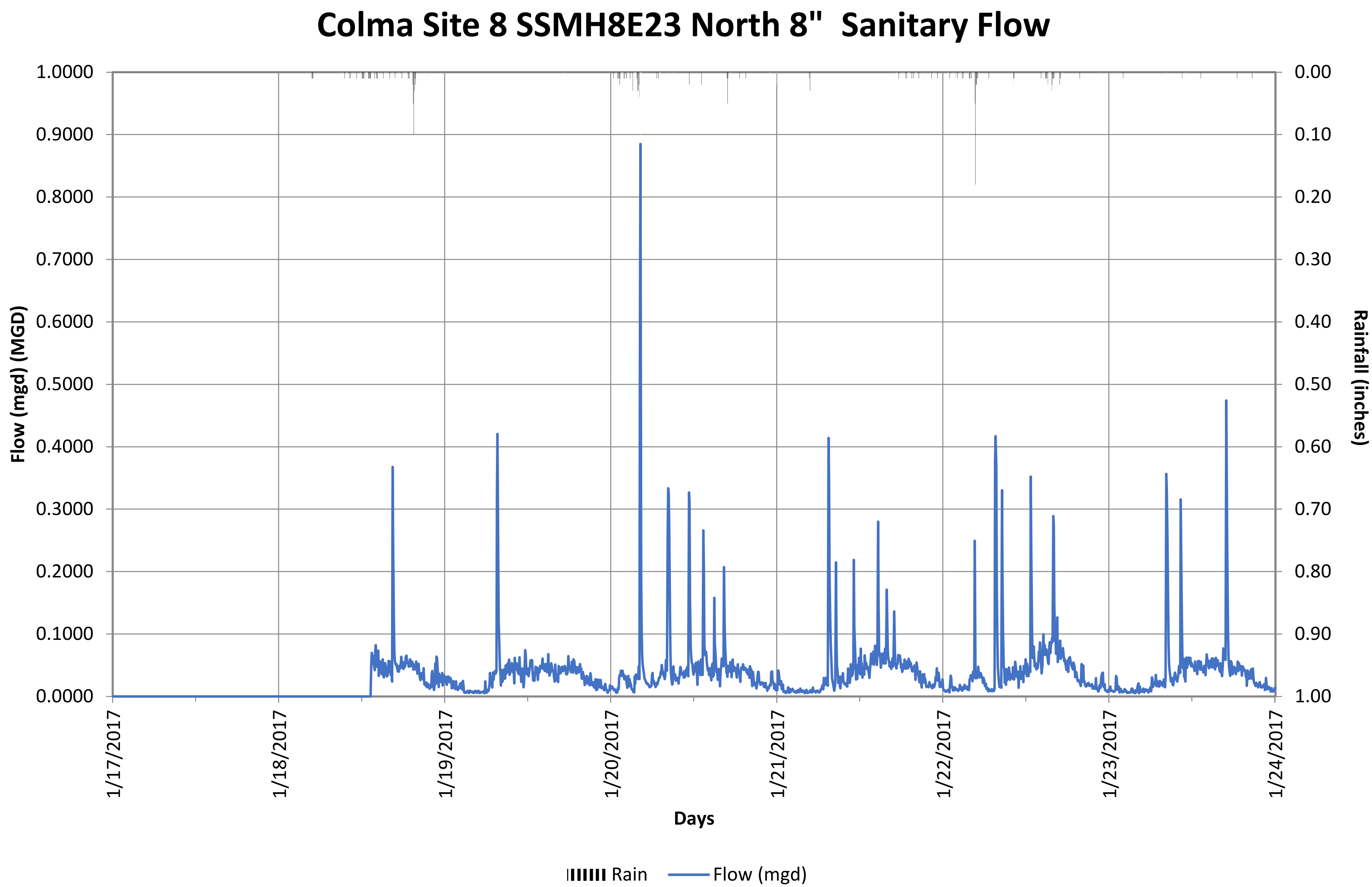
Day	Date	Avg Flow(MGD)	Min Flow(MGD)	Max Flow(MGD)	Max Depth(in.)	Rain(in.)
Tuesday	1/17/17	0.000	0.000	0.000	0.000	0.00
Wednesday	1/18/17	0.021	0.000	0.368	5.742	0.88
Thursday	1/19/17	0.033	0.005	0.421	5.270	0.02
Friday	1/20/17	0.048	0.006	0.885	10.868	1.13
Saturday	1/21/17	0.039	0.005	0.414	6.551	0.25
Sunday	1/22/17	0.045	0.006	0.417	6.277	1.00
Monday	1/23/17	0.039	0.005	0.474	5.938	0.18
Tuesday	1/24/17	0.037	0.005	0.394	6.262	0.01
Wednesday	1/25/17	0.038	0.005	0.412	6.631	0.00
Thursday	1/26/17	0.047	0.007	0.475	6.332	0.00
Friday	1/27/17	0.041	0.007	0.378	6.379	0.00
Saturday	1/28/17	0.045	0.006	0.459	5.620	0.00
Sunday	1/29/17	0.039	0.005	0.481	5.472	0.00
Monday	1/30/17	0.037	0.006	0.444	6.092	0.00
Tuesday	1/31/17	0.041	0.005	0.405	6.397	0.00
Wednesday	2/1/17	0.040	0.006	0.518	6.482	0.01
Thursday	2/2/17	0.038	0.007	0.432	6.080	0.19
Friday	2/3/17	0.037	0.005	0.383	6.921	0.51
Saturday	2/4/17	0.045	0.007	0.425	6.256	0.37
Sunday	2/5/17	0.035	0.005	0.425	5.479	0.15
Monday	2/6/17	0.040	0.005	0.471	5.530	0.50
Tuesday	2/7/17	0.044	0.006	0.385	6.257	0.86
Wednesday	2/8/17	0.039	0.005	0.490	6.010	0.26
Thursday	2/9/17	0.046	0.006	0.422	6.130	0.77
Friday	2/10/17	0.046	0.007	0.422	5.568	0.04
Saturday	2/11/17	0.047	0.007	0.940	5.595	0.00
Sunday	2/12/17	0.046	0.006	0.279	5.390	0.00
Monday	2/13/17	0.048	0.006	0.275	5.371	0.00
Tuesday	2/14/17	0.047	0.008	0.248	5.403	0.00
Wednesday	2/15/17	0.049	0.008	0.244	5.614	0.00
Thursday	2/16/17	0.056	0.008	0.243	5.649	0.39
Friday	2/17/17	0.063	0.009	0.241	6.061	1.23
Saturday	2/18/17	0.057	0.014	0.241	5.903	0.14
Sunday	2/19/17	0.053	0.008	0.259	5.780	0.08
Monday	2/20/17	0.068	0.013	0.264	6.469	1.61
Tuesday	2/21/17	0.052	0.014	0.243	5.576	0.19
Wednesday	2/22/17	0.047	0.007	0.228	5.455	0.00



Colma Site 8 SSMH8E23 North 8" Daily Sanitary Flow
MGD
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Inches
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
1/17/17
1/18/17
1/19/17
1/20/17
1/21/17
1/22/17
1/23/17
1/24/17
1/25/17
1/26/17
1/27/17
1/28/17
1/29/17
1/30/17
1/31/17
2/1/17
2/2/17
2/3/17
2/4/17
2/5/17
2/6/17
2/7/17
2/8/17
2/9/17
2/10/17
2/11/17
2/12/17
2/13/17
2/14/17
2/15/17
2/16/17
2/17/17
2/18/17
2/19/17
2/20/17
2/21/17
2/22/17
Rain(in.)
Avg Flow(MGD)

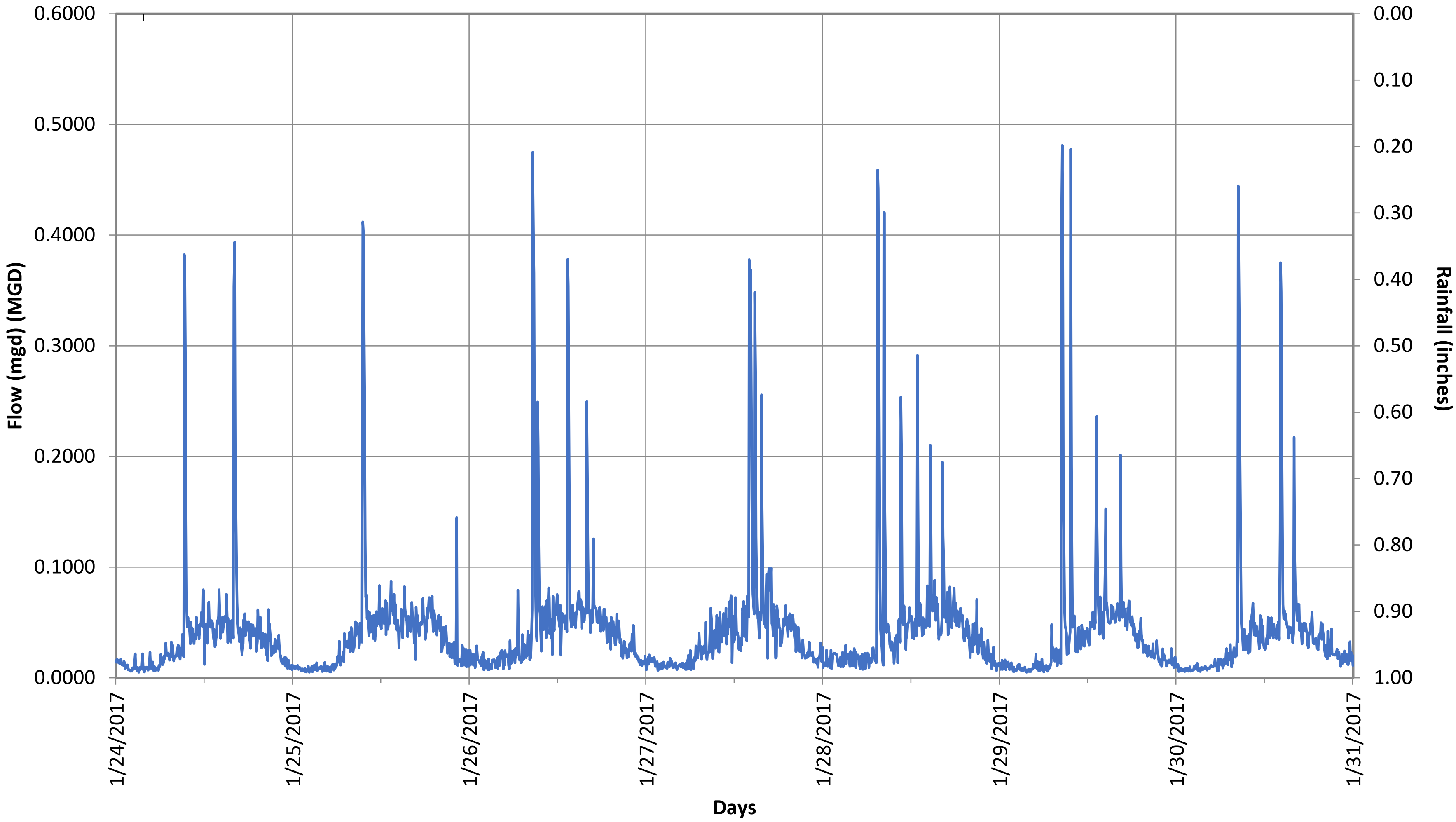


Scatter Plot
Velocity Feet Per Second
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
Inches of Flow



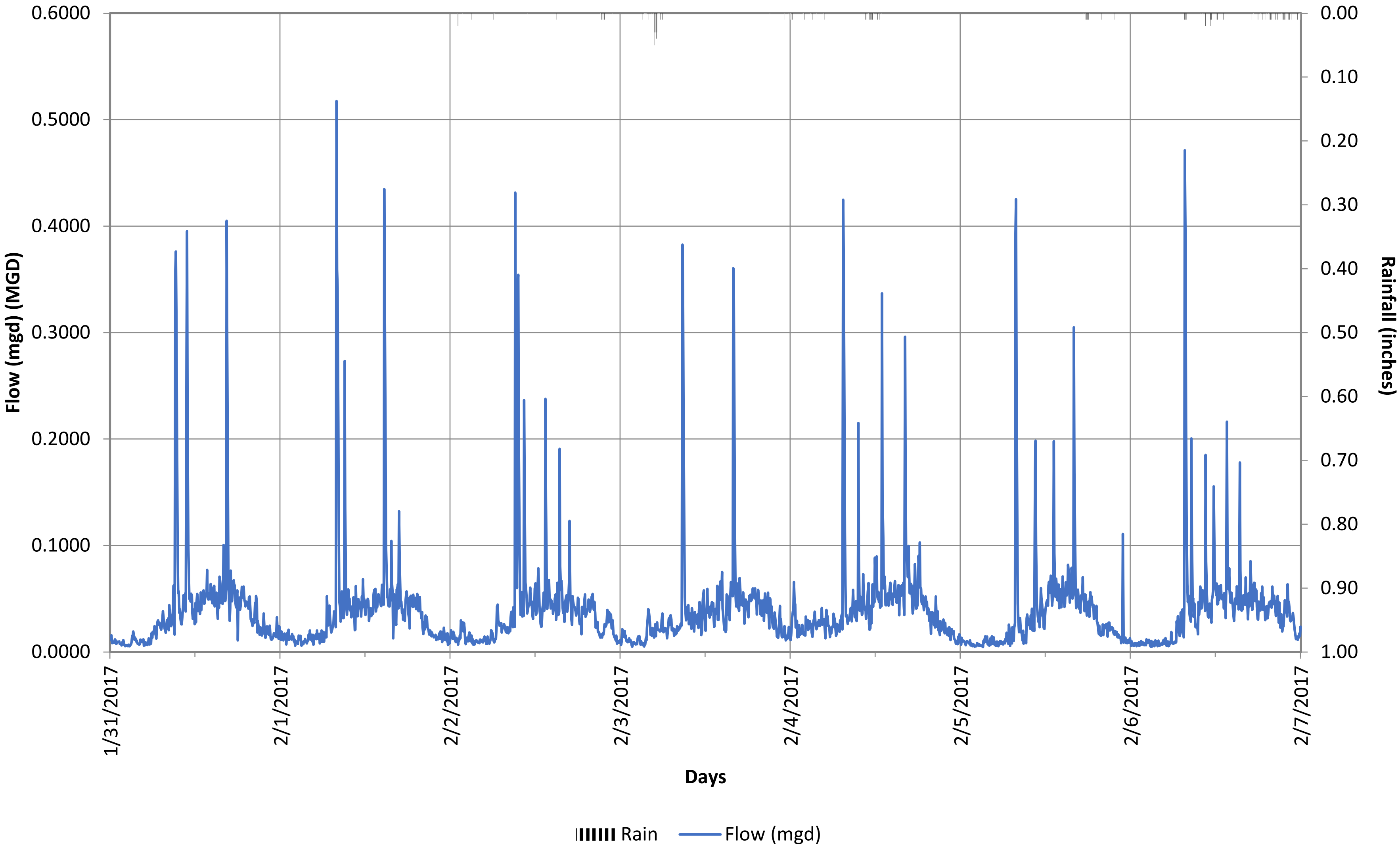
	1/17/2017(Tue)	1/18/2017(Wed)	1/19/2017(Thu)	1/20/2017(Fri)	1/21/2017(Sat)	1/22/2017(Sun)	1/23/2017(Mon)
Maximum	0.000	0.368	0.421	0.885	0.414	0.417	0.474
Average	0.000	0.021	0.033	0.048	0.039	0.045	0.039
Minimum	0.000	0.000	0.005	0.006	0.005	0.006	0.005
Rain (inches)	0.00	0.88	0.02	1.13	0.25	1.00	0.18

Colma Site 8 SSMH8E23 North 8" Sanitary Flow



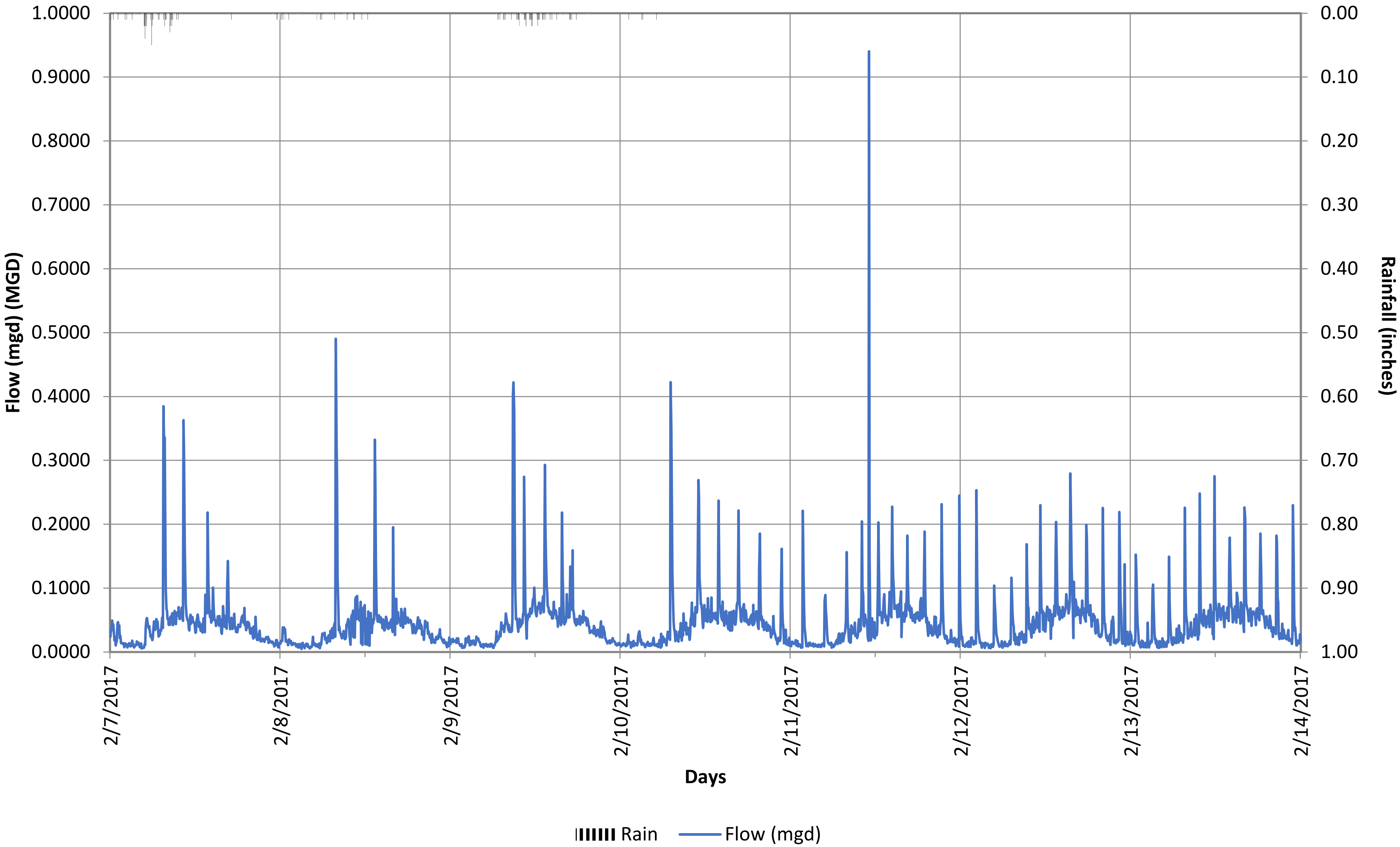
	1/24/2017(Tue)	1/25/2017(Wed)	1/26/2017(Thu)	1/27/2017(Fri)	1/28/2017(Sat)	1/29/2017(Sun)	1/30/2017(Mon)
Maximum	0.394	0.412	0.475	0.378	0.459	0.481	0.444
Average	0.037	0.038	0.047	0.041	0.045	0.039	0.037
Minimum	0.005	0.005	0.007	0.007	0.006	0.005	0.006
Rain (inches)	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Colma Site 8 SSMH8E23 North 8" Sanitary Flow



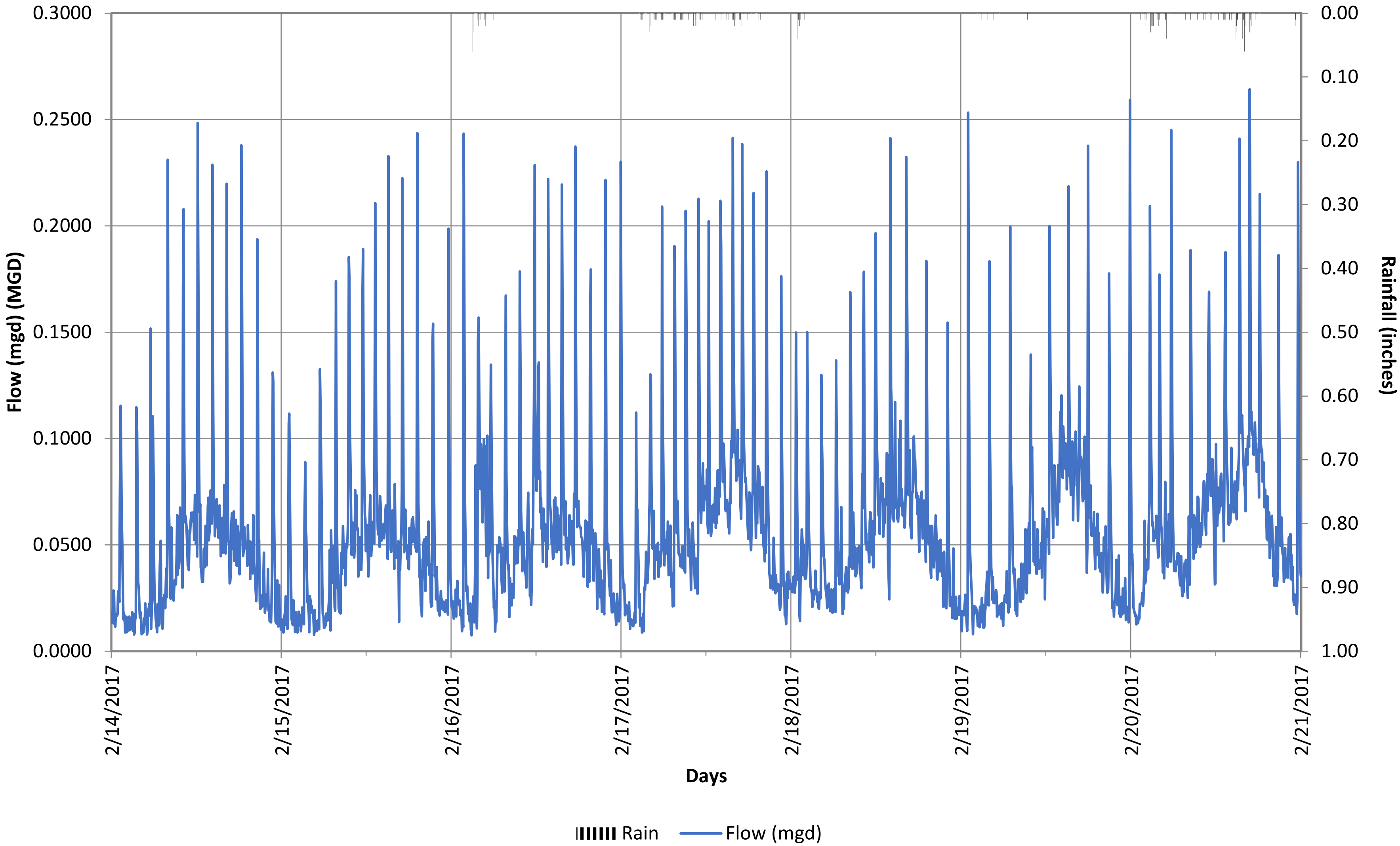
	1/31/2017(Tue)	2/1/2017(Wed)	2/2/2017(Thu)	2/3/2017(Fri)	2/4/2017(Sat)	2/5/2017(Sun)	2/6/2017(Mon)
Maximum	0.405	0.518	0.432	0.383	0.425	0.425	0.471
Average	0.041	0.040	0.038	0.037	0.045	0.035	0.040
Minimum	0.005	0.006	0.007	0.005	0.007	0.005	0.005
Rain (inches)	0.00	0.01	0.19	0.51	0.37	0.15	0.50

Colma Site 8 SSMH8E23 North 8" Sanitary Flow



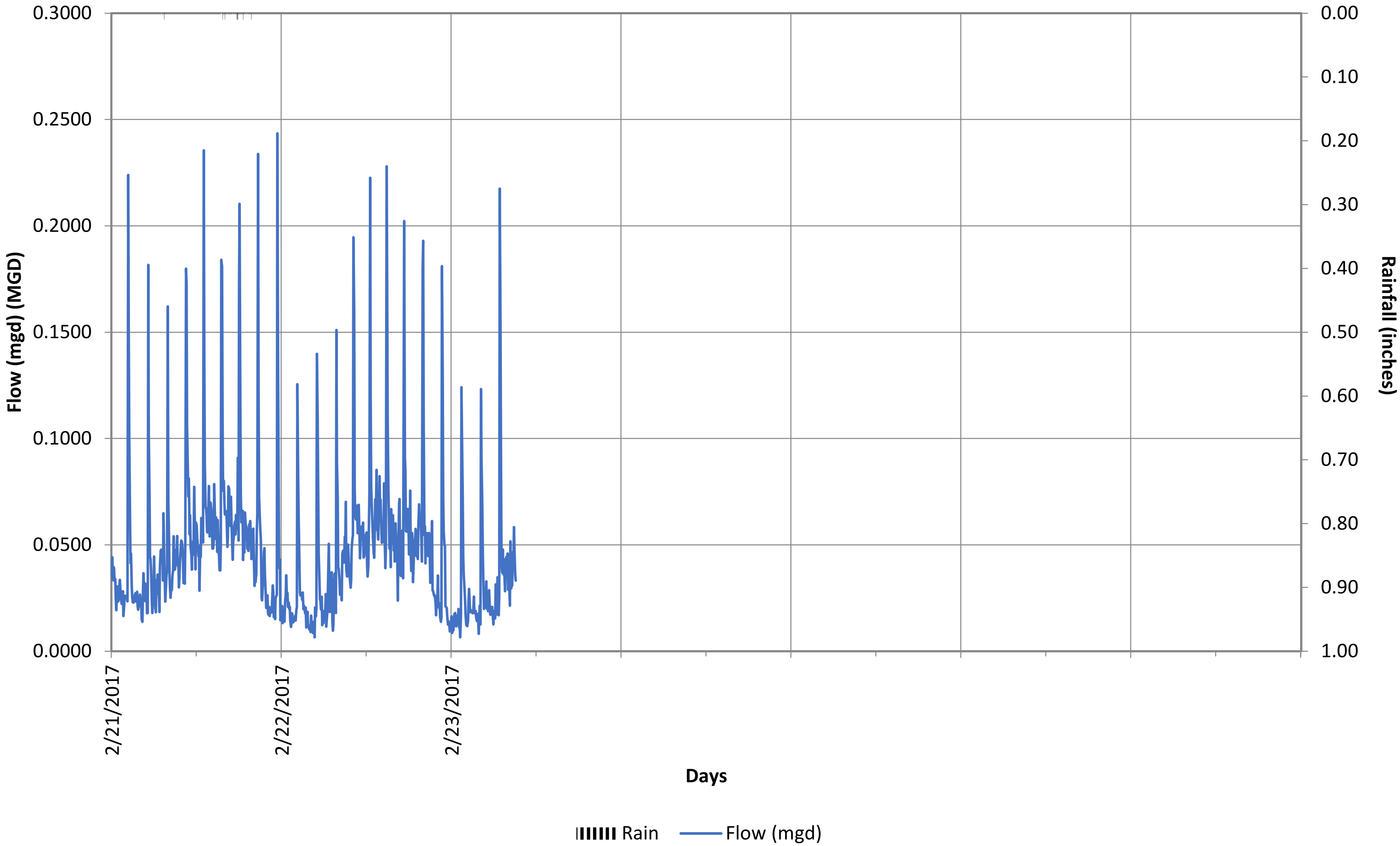
	2/7/2017(Tue)	2/8/2017(Wed)	2/9/2017(Thu)	2/10/2017(Fri)	2/11/2017(Sat)	2/12/2017(Sun)	2/13/2017(Mon)
Maximum	0.385	0.490	0.422	0.422	0.940	0.279	0.275
Average	0.044	0.039	0.046	0.046	0.047	0.046	0.048
Minimum	0.006	0.005	0.006	0.007	0.007	0.006	0.006
Rain (inches)	0.86	0.26	0.77	0.04	0.00	0.00	0.00

Colma Site 8 SSMH8E23 North 8" Sanitary Flow



	2/14/2017(Tue)	2/15/2017(Wed)	2/16/2017(Thu)	2/17/2017(Fri)	2/18/2017(Sat)	2/19/2017(Sun)	2/20/2017(Mon)
Maximum	0.248	0.244	0.243	0.241	0.241	0.259	0.264
Average	0.047	0.049	0.056	0.063	0.057	0.053	0.068
Minimum	0.008	0.008	0.008	0.009	0.014	0.008	0.013
Rain (inches)	0.00	0.00	0.39	1.23	0.14	0.08	1.61

Colma Site 8 SSMH8E23 North 8" Sanitary Flow

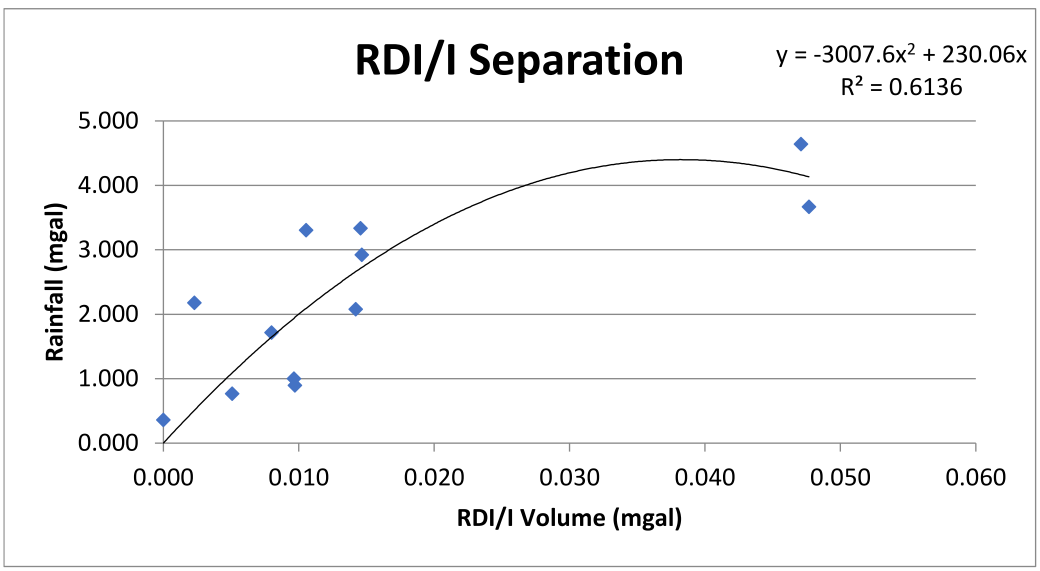


	2/21/2017(Tue)	2/22/2017(Wed)				
Maximum	0.243	0.228				
Average	0.052	0.047				
Minimum	0.014	0.007				
Rain (inches)	0.19	0.00				

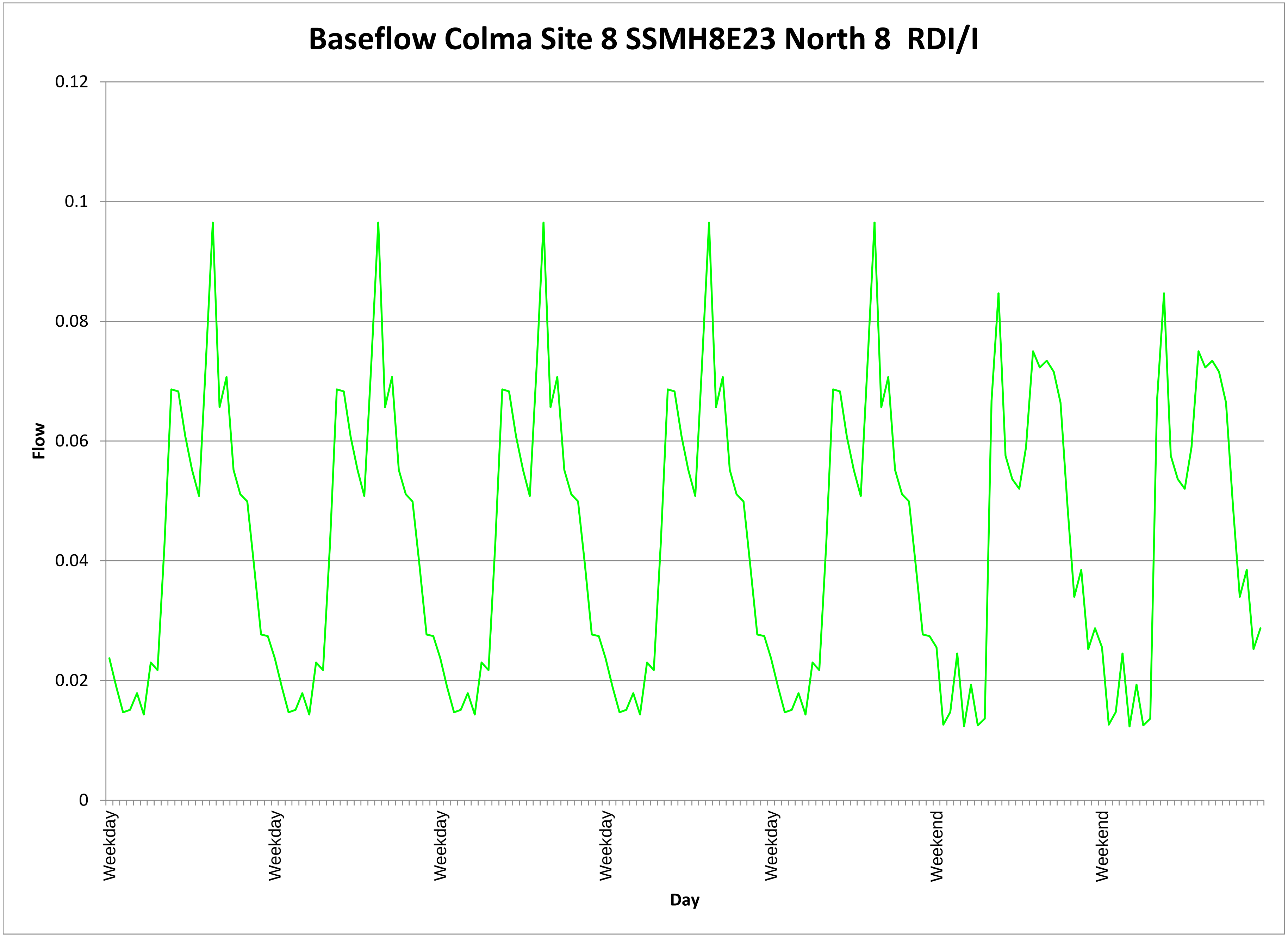
Colma Site 8 SSMH8E23 North 8 RDI/I

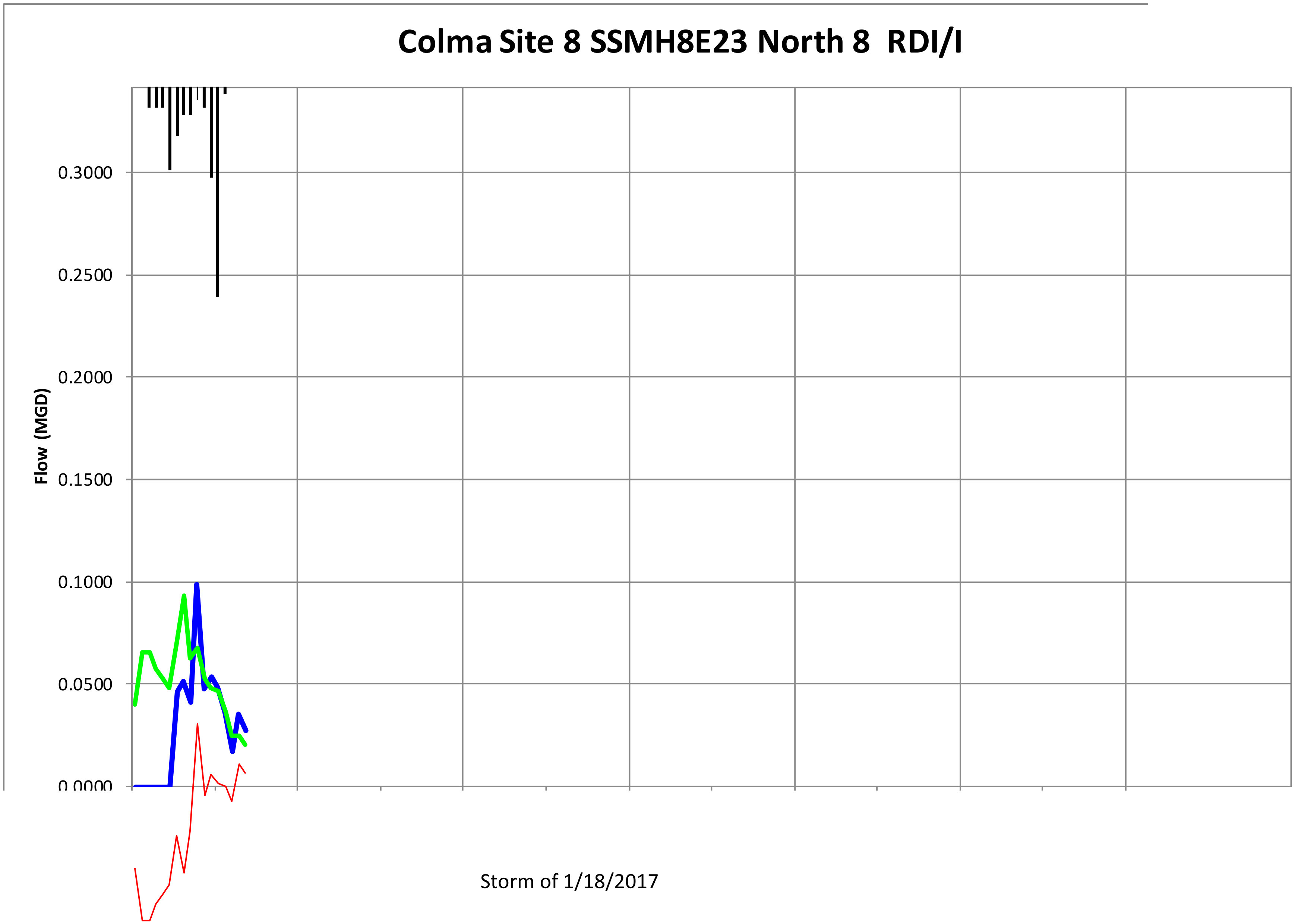
RDI/I Analysis, Monitor Return Ratio Summary

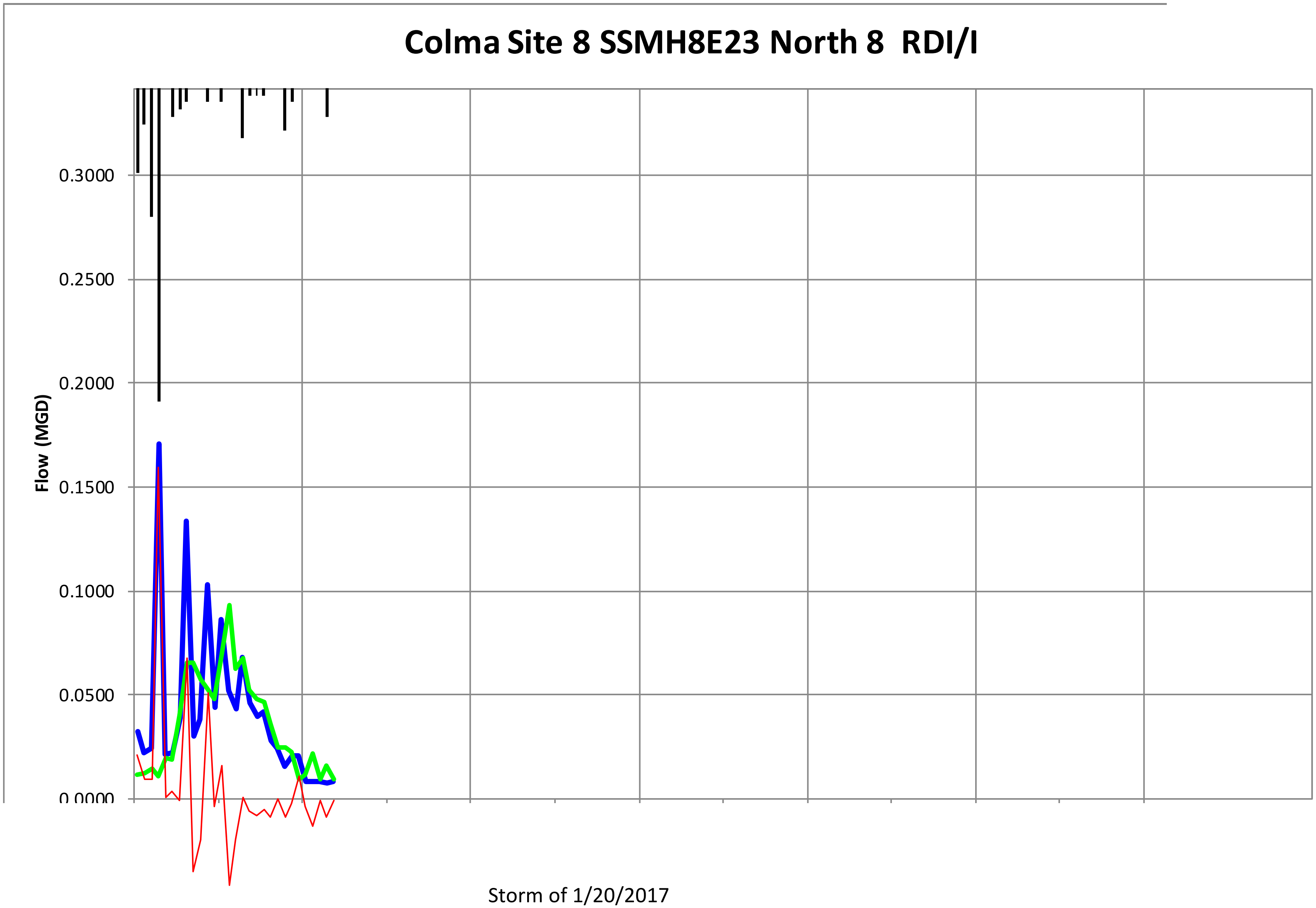
Storm Start (Date)	RDI/I Volume (mgal)	Monitor Area (acres)	Rainfall (mgal)	Return Ratio (%)
1/18/2017	0.002	94.4	2.179	0.11%
1/20/2017	0.015	94.4	2.922	0.50%
1/21/2017	0.011	94.4	3.307	0.32%
2/2/2017	0.008	94.4	1.717	0.47%
2/4/2017	0.010	94.4	0.897	1.08%
2/5/2017	0.000	94.4	0.359	0.00%
2/6/2017	0.015	94.4	3.332	0.44%
2/7/2017	0.005	94.4	0.769	0.66%
2/9/2017	0.014	94.4	2.076	0.68%
2/16/2017	0.010	94.4	1.000	0.96%
2/17/2017	0.048	94.4	3.665	1.30%
2/20/2017	0.047	94.4	4.639	1.01%
Average R%				0.63%
Average Top 3 Storms				1.13%

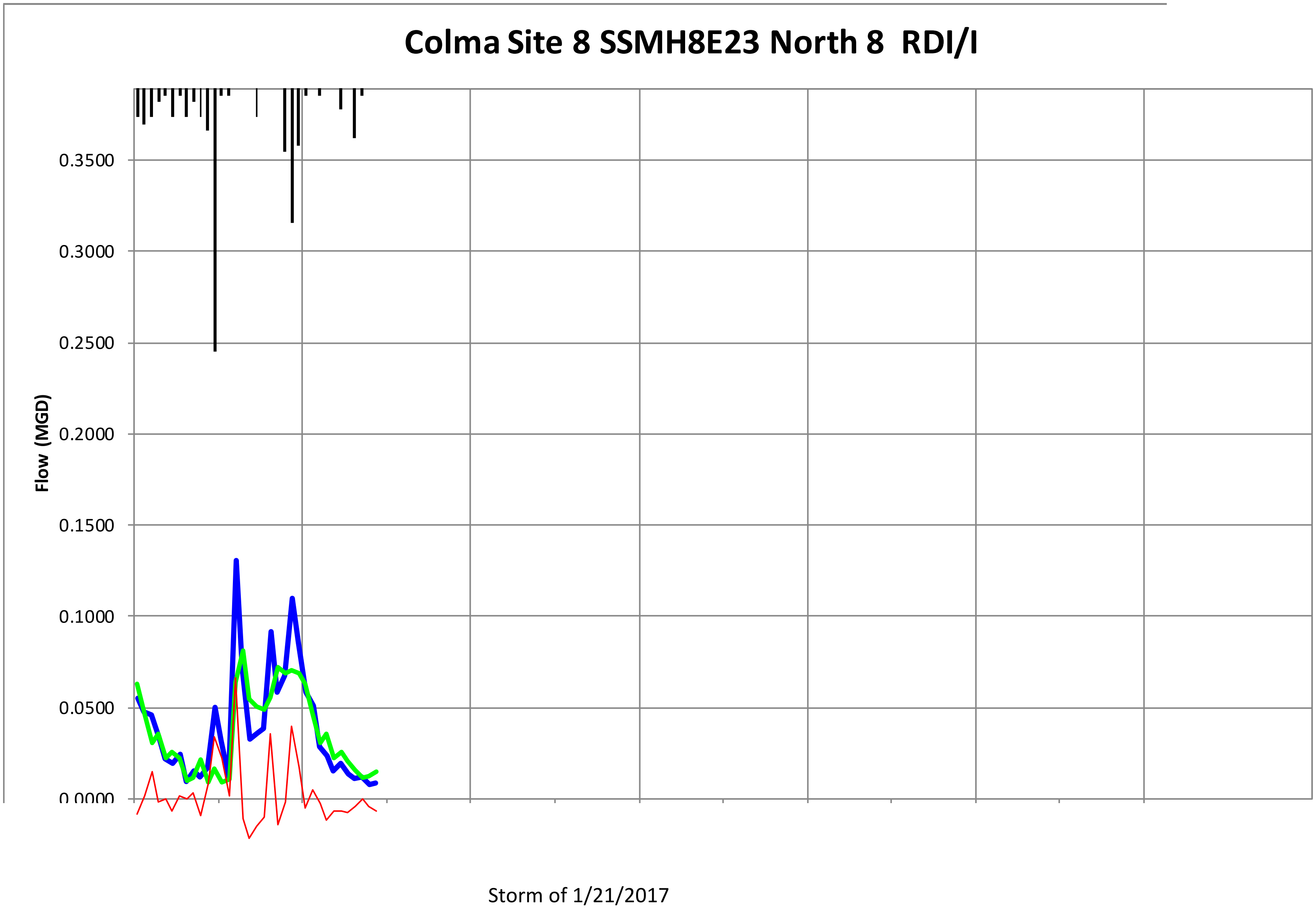


Baseflows	Weekend	Weekday
Max	0.085	0.097
Avg	0.043	0.044
Min	0.012	0.014

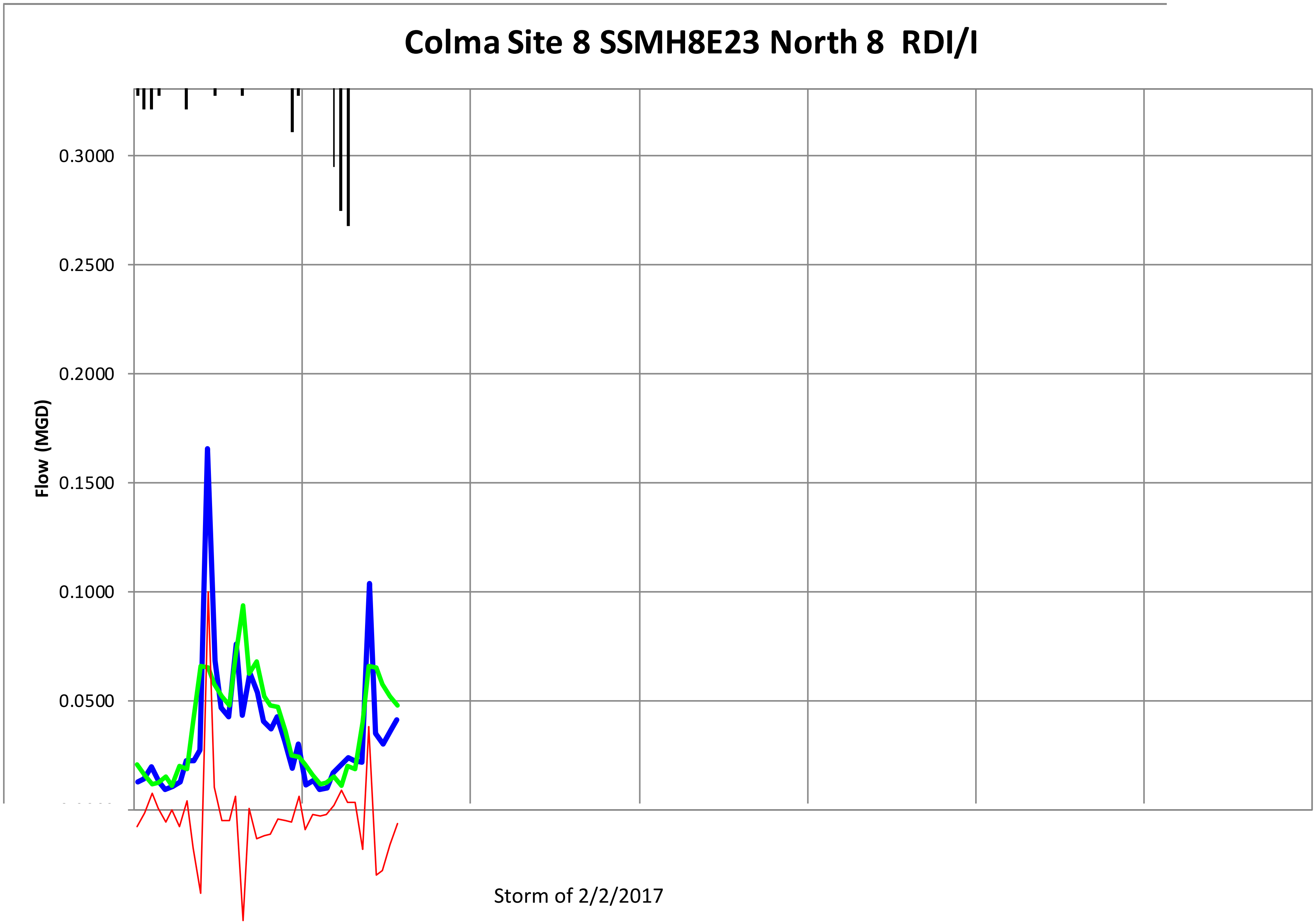

Baseflow Colma Site 8 SSMH8E23 North 8 RDI/I
Flow
0.12
0.1
0.08
0.06
0.04
0.02
0
Weekday
Weekday
Weekday
Weekday
Weekday
Weekend
Weekend
Day


Colma Site 8 SSMH8E23 North 8 RDI/I
Flow (MGD)
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 1/18/2017


Colma Site 8 SSMH8E23 North 8 RDI/I
Flow (MGD)
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 1/20/2017

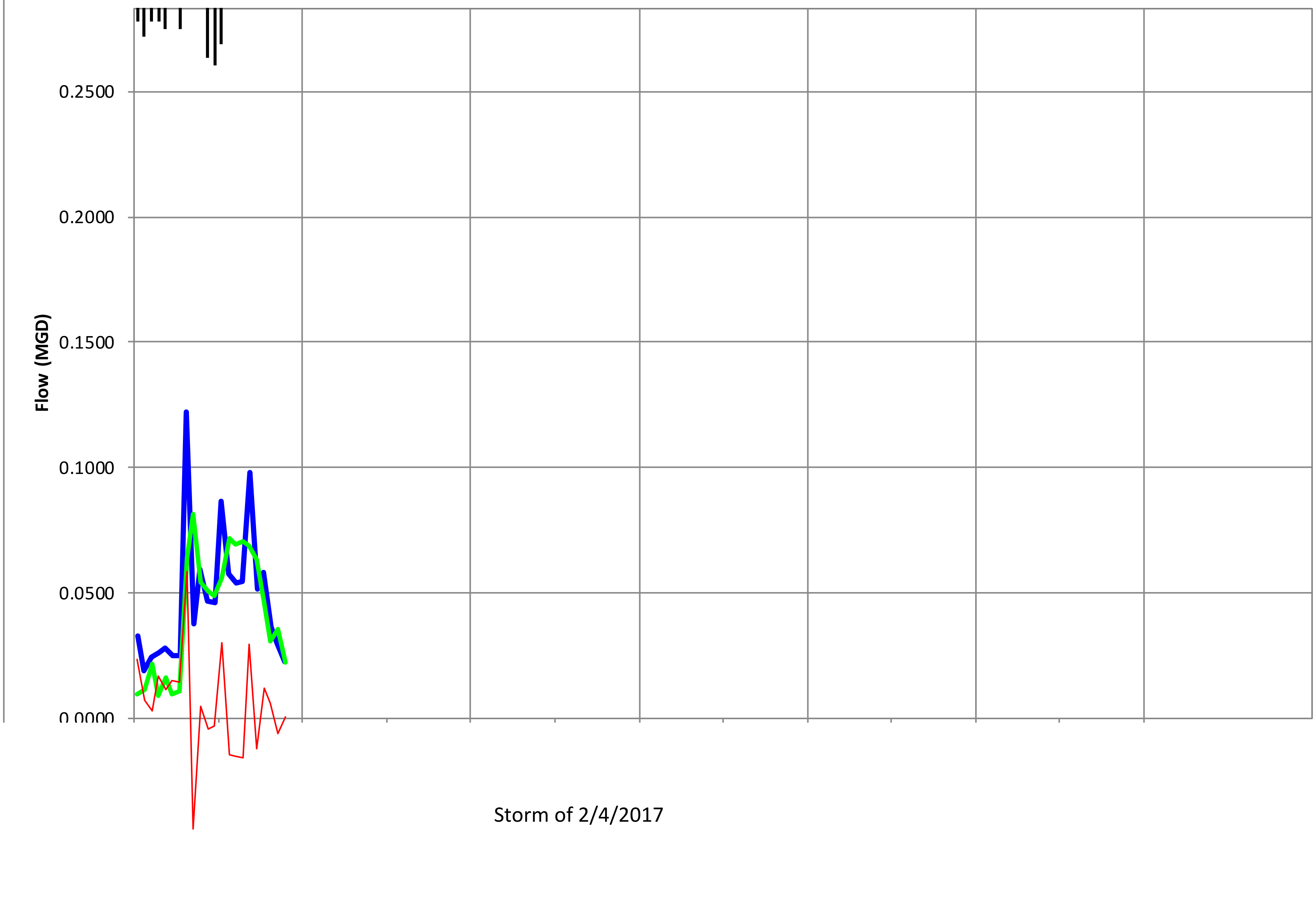


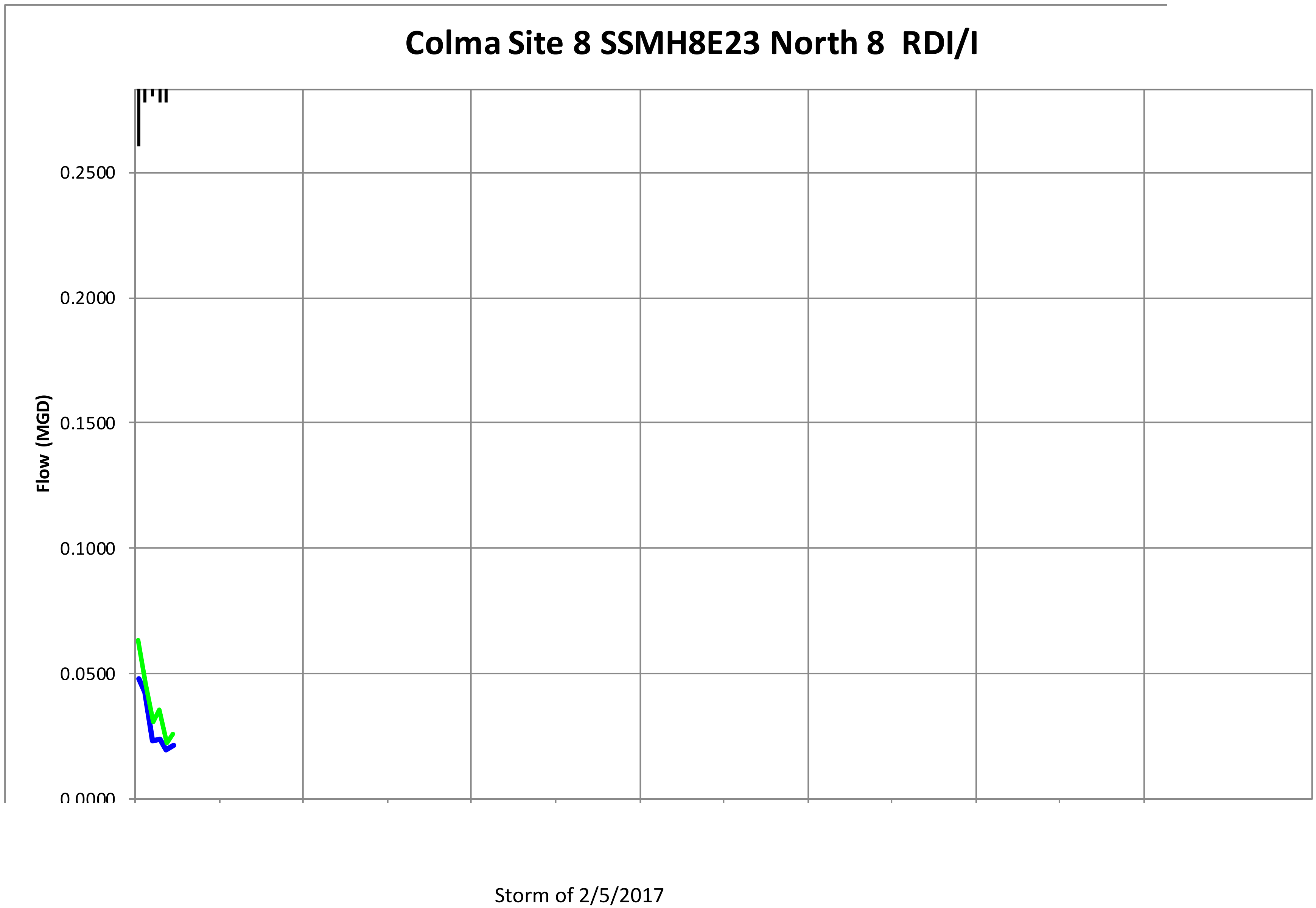
Colma Site 8 SSMH8E23 North 8 RDI/I
Flow (MGD)
0.3500
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 1/21/2017



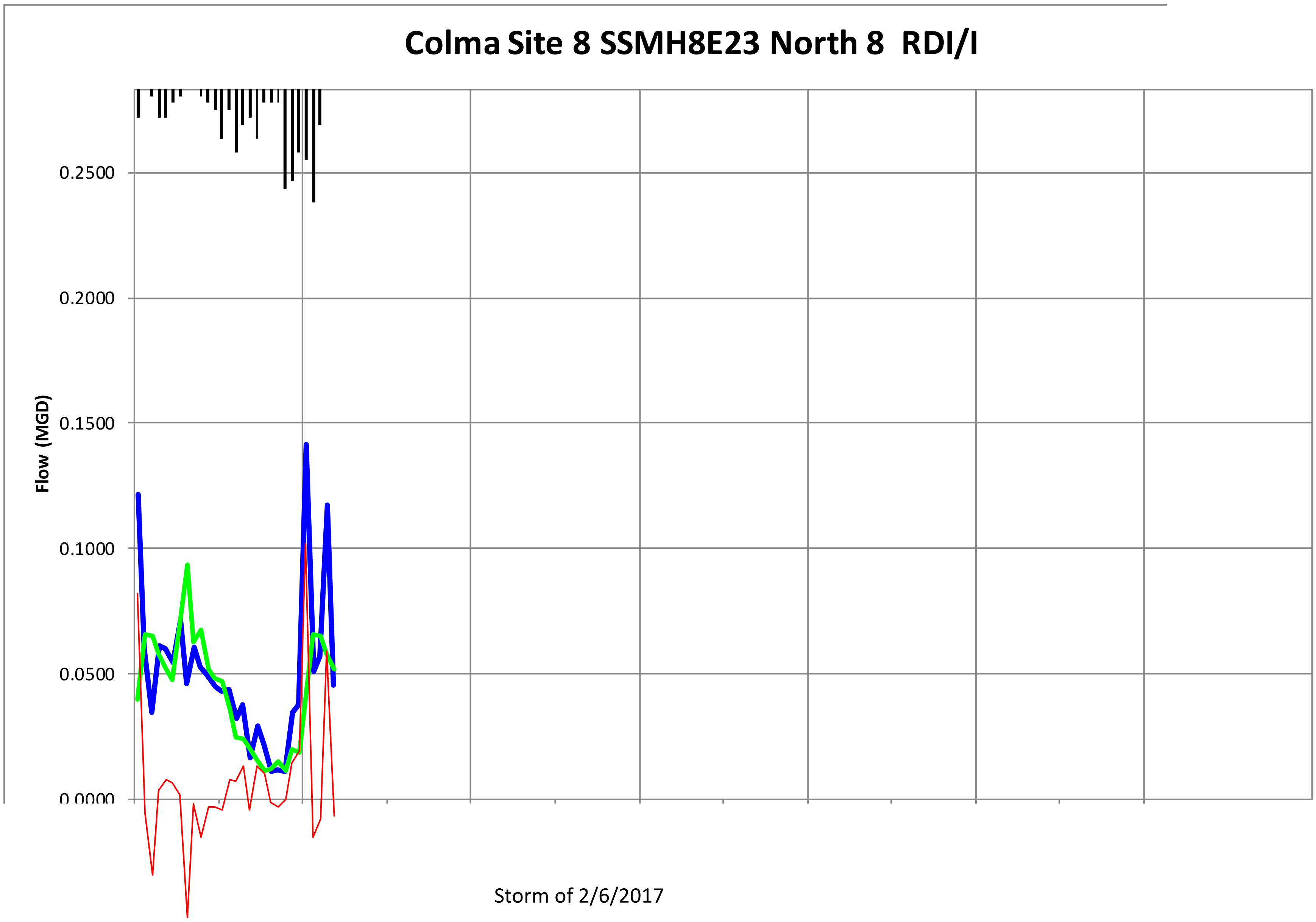
Colma Site 8 SSMH8E23 North 8 RDI/I
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
Flow (MGD)
Storm of 2/2/2017

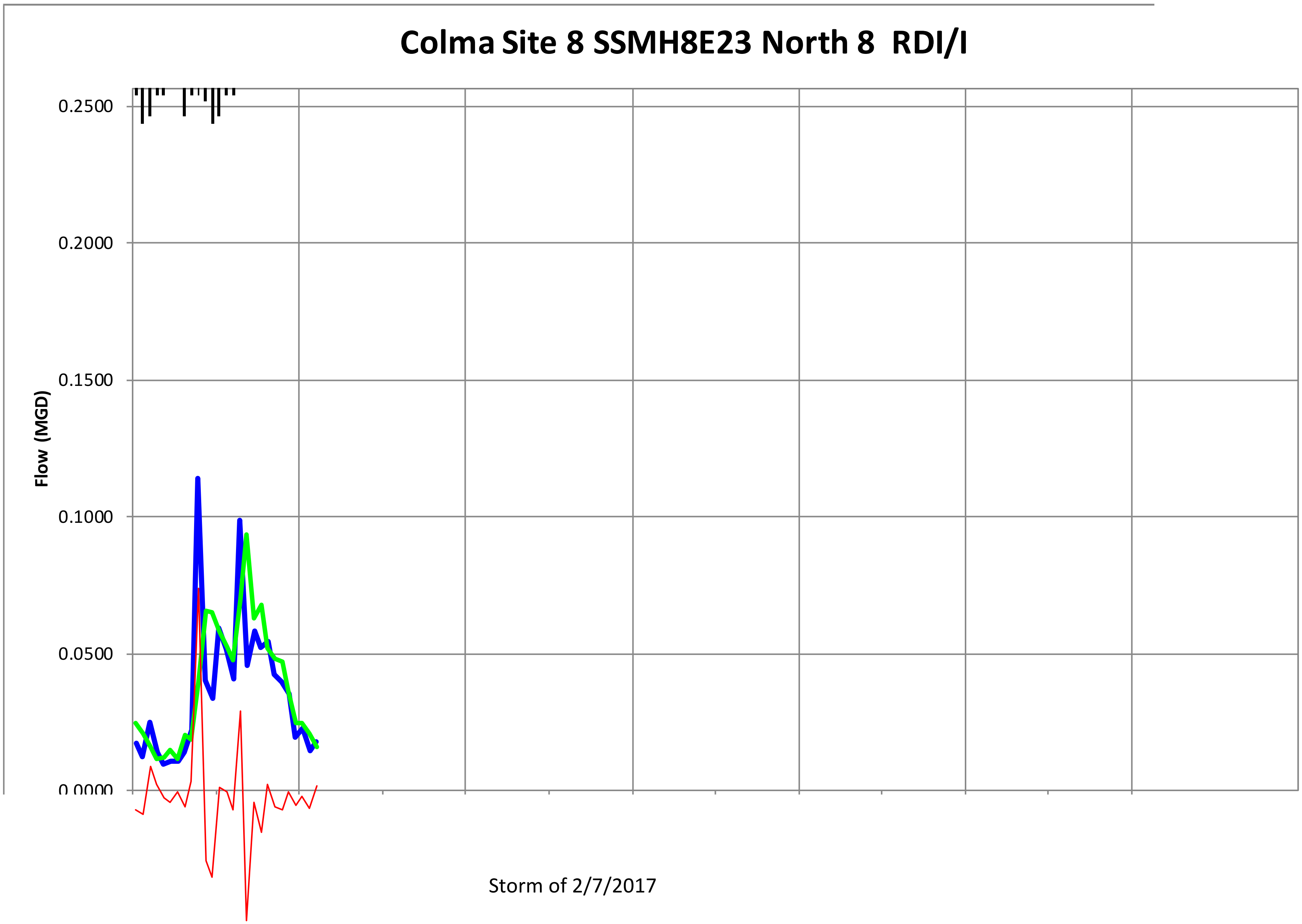
Colma Site 8 SSMH8E23 North 8 RDI/I



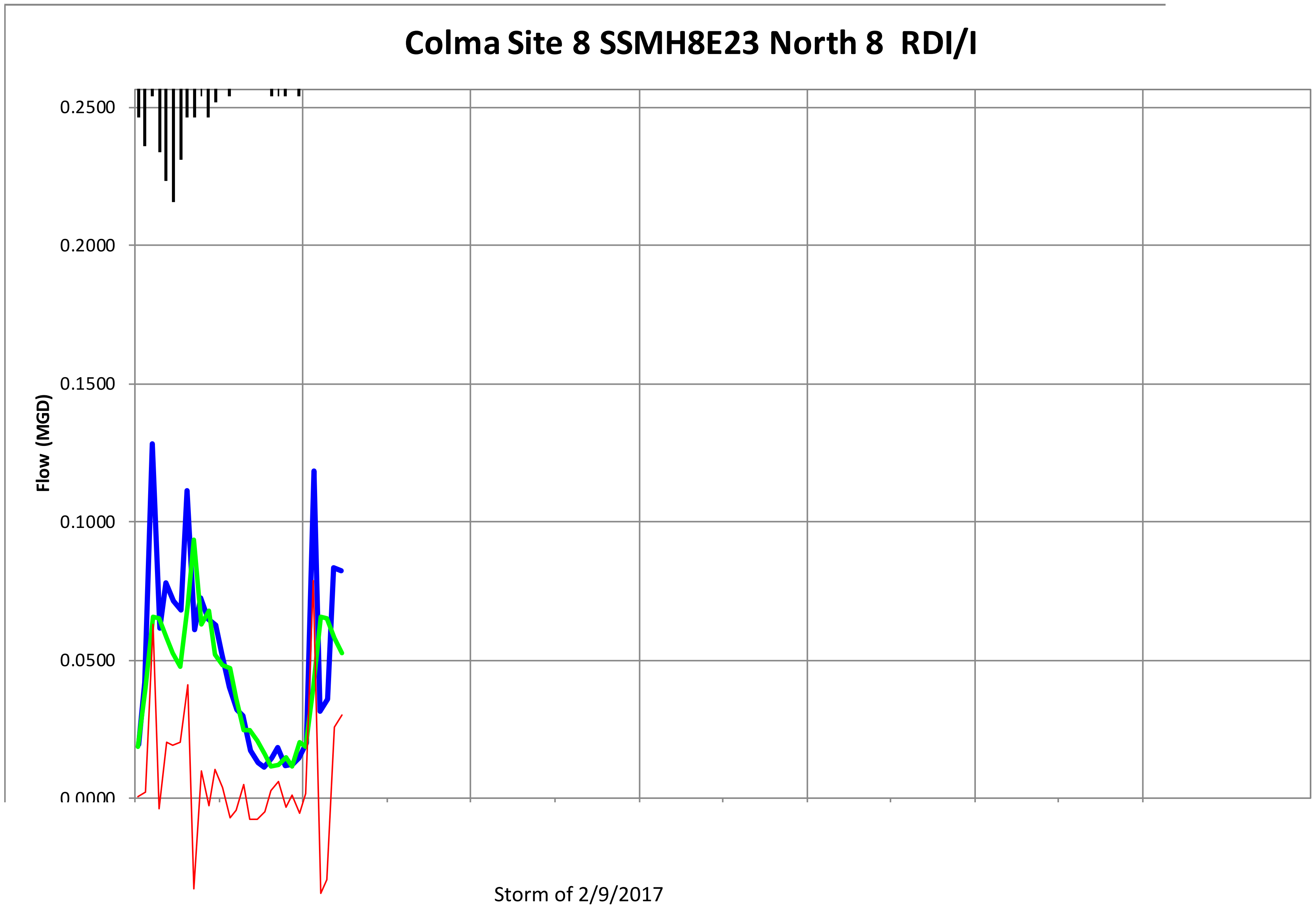


Colma Site 8 SSMH8E23 North 8 RDI/I
Flow (MGD)
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 2/5/2017

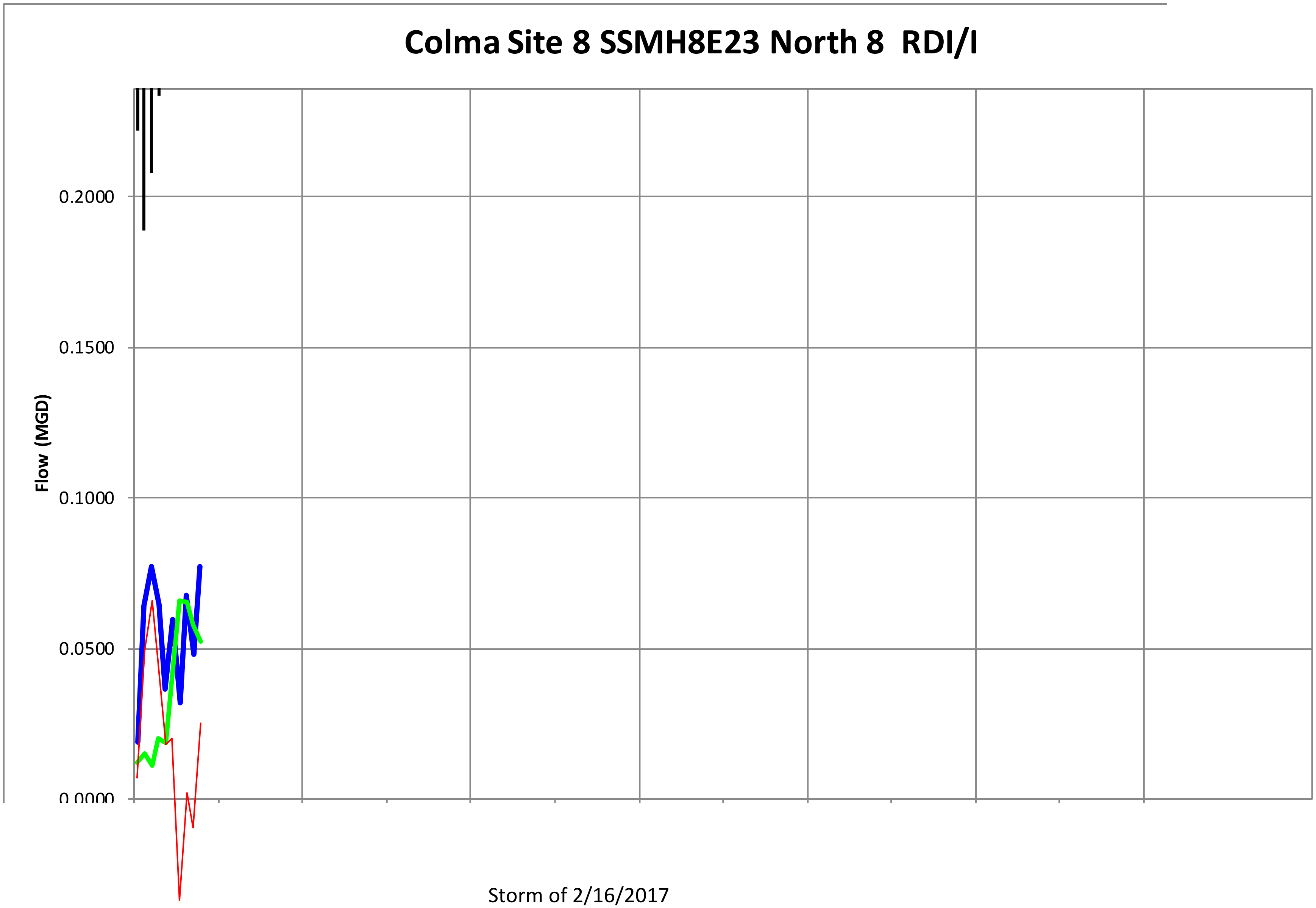

Colma Site 8 SSMH8E23 North 8 RDI/I
Flow (MGD)
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 2/6/2017



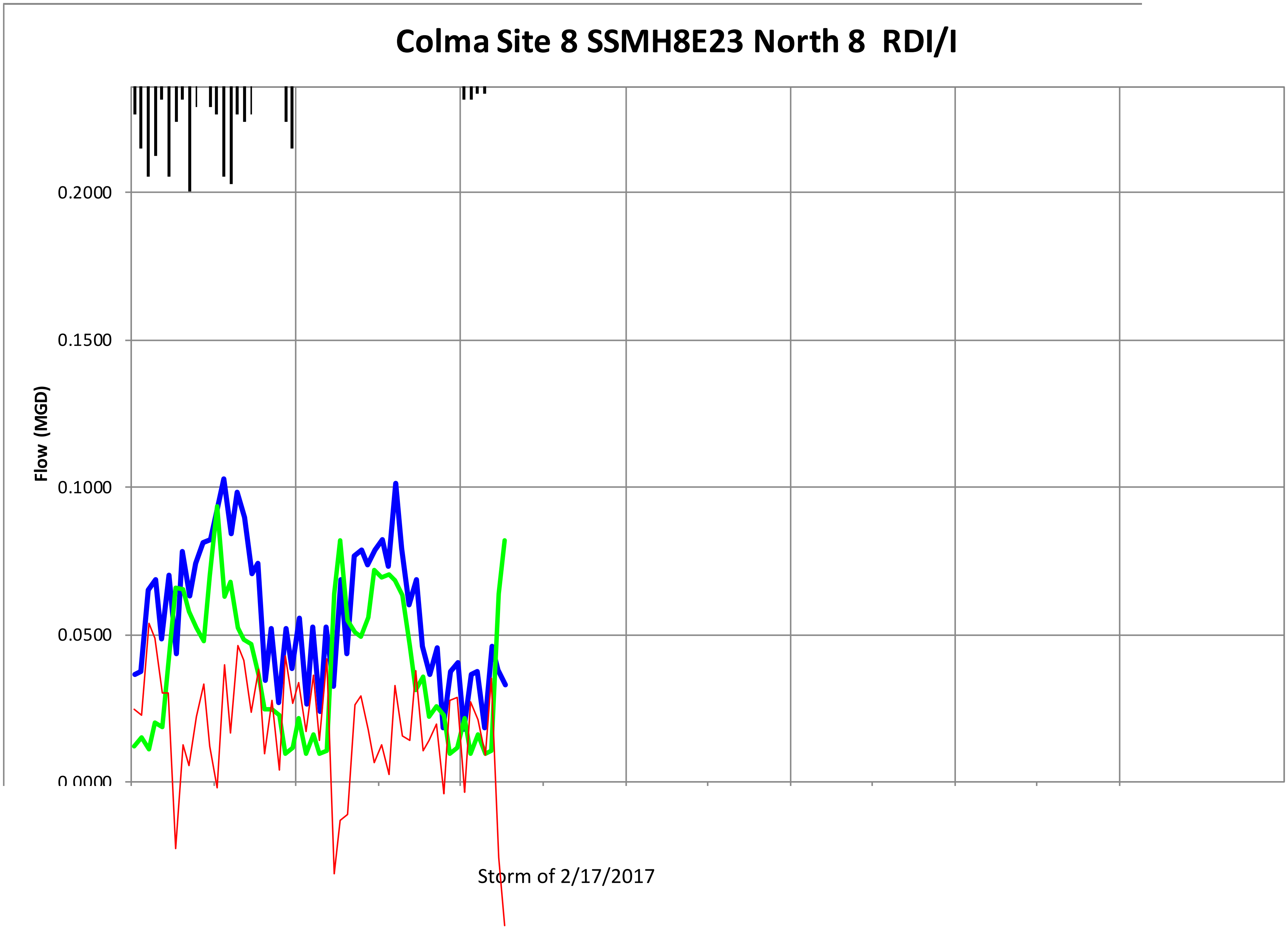
Colma Site 8 SSMH8E23 North 8 RDI/I
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Flow (MGD)
Storm of 2/7/2017



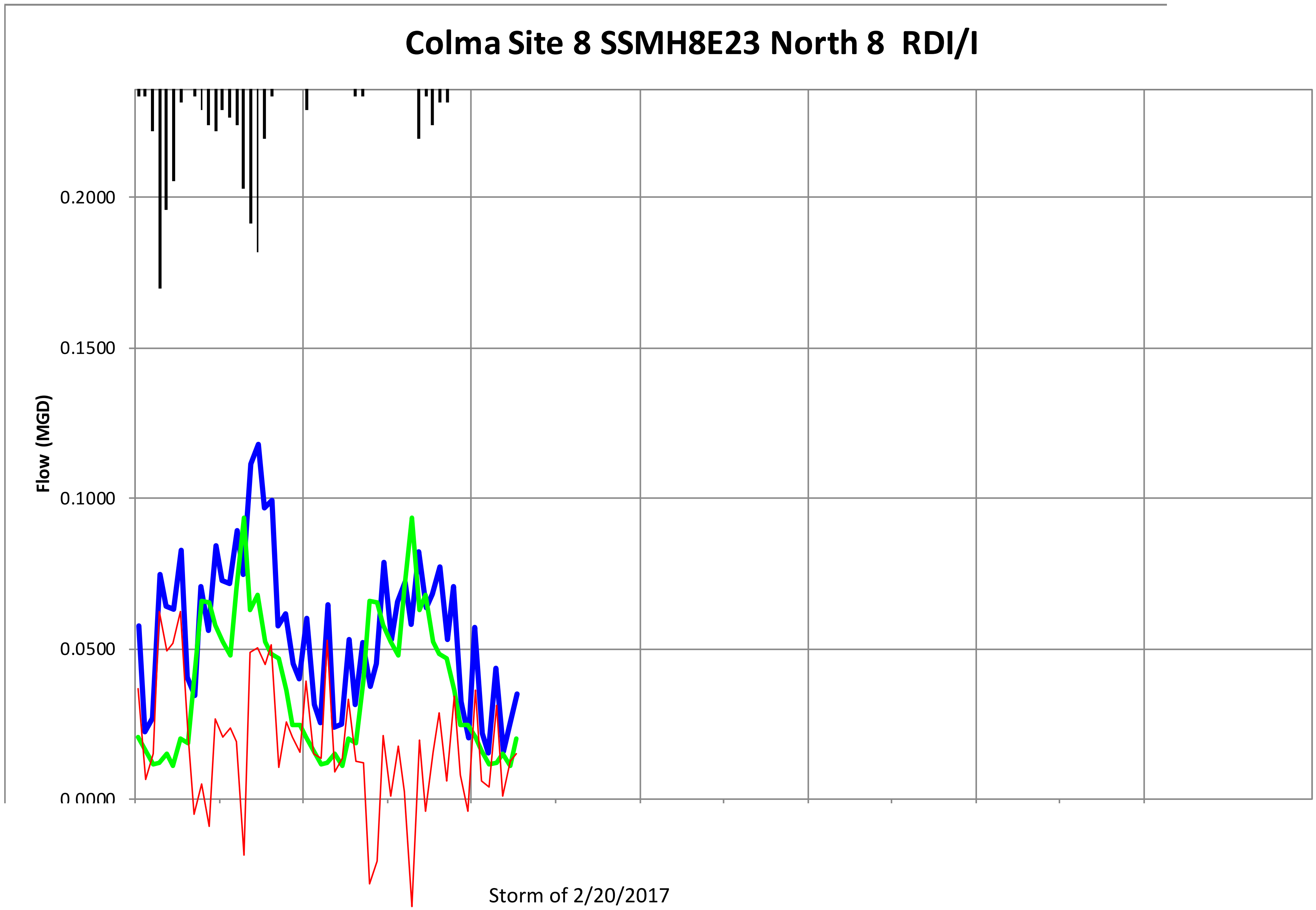
Colma Site 8 SSMH8E23 North 8 RDI/I
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Flow (MGD)
Storm of 2/9/2017



Colma Site 8 SSMH8E23 North 8 RDI/I
Flow (MGD)
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 2/16/2017



Colma Site 8 SSMH8E23 North 8 RDI/I
Flow (MGD)
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 2/17/2017

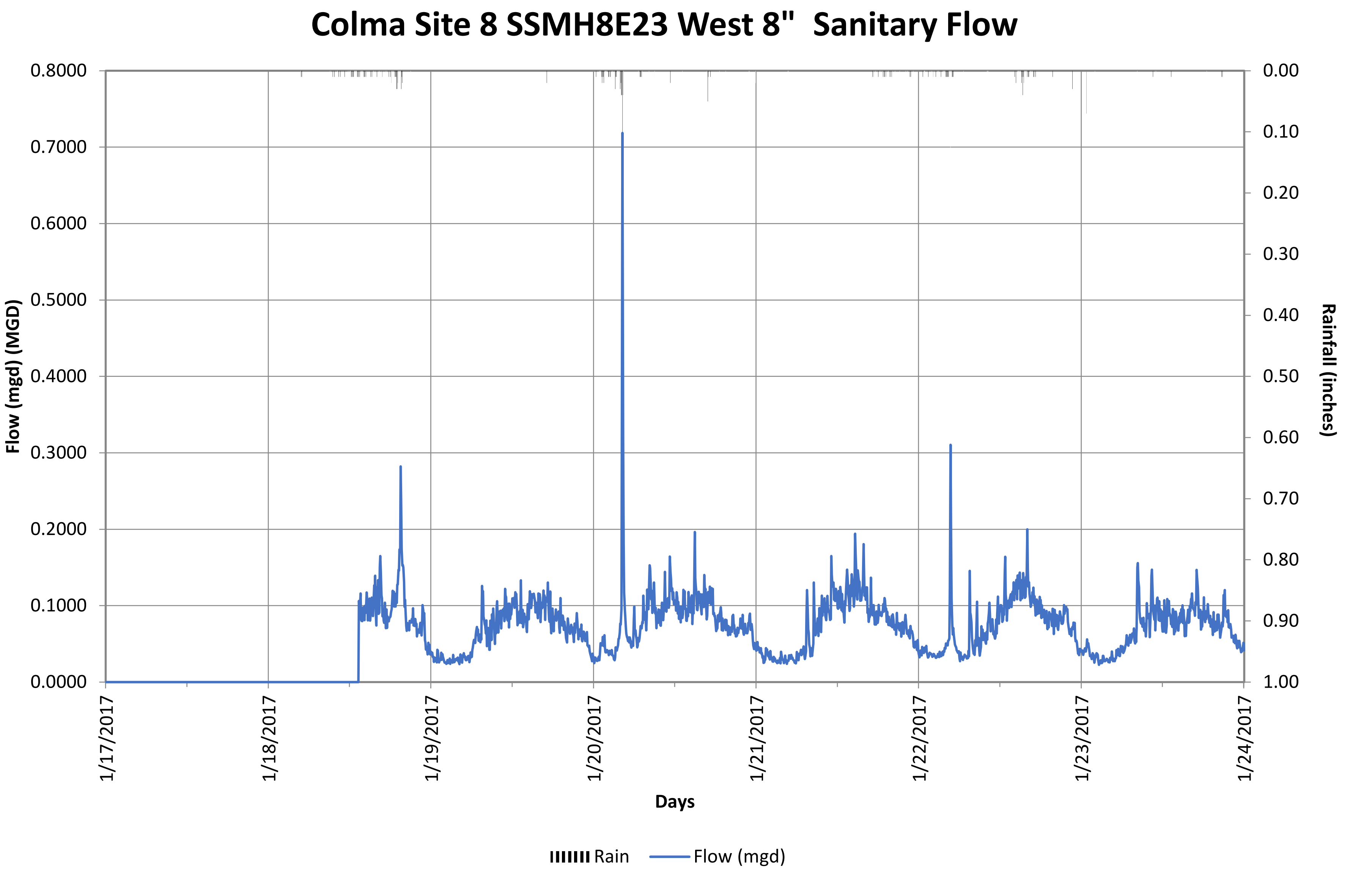


Colma Site 8 SSMH8E23 North 8 RDI/I
Flow (MGD)
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 2/20/2017

Colma Site 8 SSMH8E23 West 8" Sanitary Flow

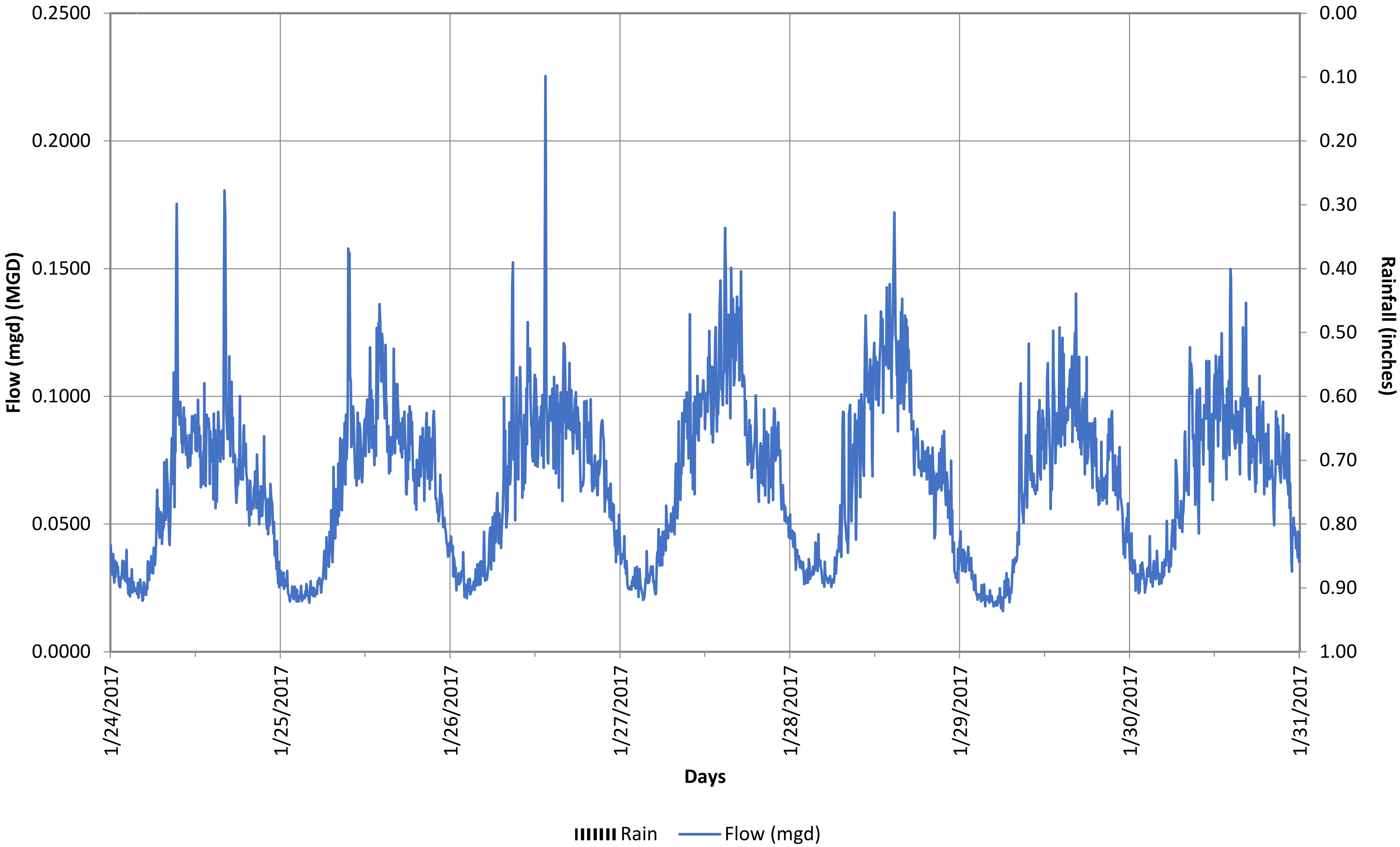
Daily Summary

Day	Date	Avg Flow(MGD)	Min Flow(MGD)	Max Flow(MGD)	Max Depth(in.)	Rain(in.)
Tuesday	1/17/17	0.000	0.000	0.000	0.000	0.00
Wednesday	1/18/17	0.042	0.000	0.282	4.655	0.88
Thursday	1/19/17	0.068	0.024	0.133	4.676	0.02
Friday	1/20/17	0.085	0.025	0.719	10.068	1.13
Saturday	1/21/17	0.073	0.024	0.194	5.843	0.25
Sunday	1/22/17	0.075	0.027	0.310	5.446	1.00
Monday	1/23/17	0.068	0.023	0.156	5.197	0.18
Tuesday	1/24/17	0.062	0.020	0.181	5.355	0.01
Wednesday	1/25/17	0.064	0.019	0.158	5.190	0.00
Thursday	1/26/17	0.068	0.021	0.225	5.139	0.00
Friday	1/27/17	0.073	0.020	0.166	5.162	0.00
Saturday	1/28/17	0.071	0.025	0.172	4.347	0.00
Sunday	1/29/17	0.061	0.016	0.140	4.451	0.00
Monday	1/30/17	0.068	0.023	0.150	5.193	0.00
Tuesday	1/31/17	0.066	0.019	0.166	5.160	0.00
Wednesday	2/1/17	0.067	0.018	0.180	5.467	0.01
Thursday	2/2/17	0.071	0.023	0.178	5.165	0.19
Friday	2/3/17	0.077	0.019	0.229	5.930	0.51
Saturday	2/4/17	0.077	0.021	0.209	5.438	0.37
Sunday	2/5/17	0.064	0.018	0.140	4.500	0.15
Monday	2/6/17	0.069	0.018	0.138	4.743	0.50
Tuesday	2/7/17	0.080	0.030	0.223	5.345	0.86
Wednesday	2/8/17	0.072	0.019	0.147	5.112	0.26
Thursday	2/9/17	0.077	0.018	0.186	5.293	0.77
Friday	2/10/17	0.069	0.018	0.144	4.802	0.04
Saturday	2/11/17	0.074	0.022	0.183	4.455	0.00
Sunday	2/12/17	0.068	0.022	0.180	4.247	0.00
Monday	2/13/17	0.069	0.025	0.152	4.101	0.00
Tuesday	2/14/17	0.069	0.023	0.149	4.180	0.00
Wednesday	2/15/17	0.071	0.021	0.160	4.497	0.00
Thursday	2/16/17	0.076	0.021	0.156	4.191	0.39
Friday	2/17/17	0.092	0.020	0.192	4.878	1.23
Saturday	2/18/17	0.081	0.024	0.193	4.679	0.14
Sunday	2/19/17	0.072	0.021	0.162	4.485	0.08
Monday	2/20/17	0.108	0.037	0.262	5.172	1.61
Tuesday	2/21/17	0.075	0.026	0.159	4.391	0.19
Wednesday	2/22/17	0.068	0.017	0.170	4.295	0.00



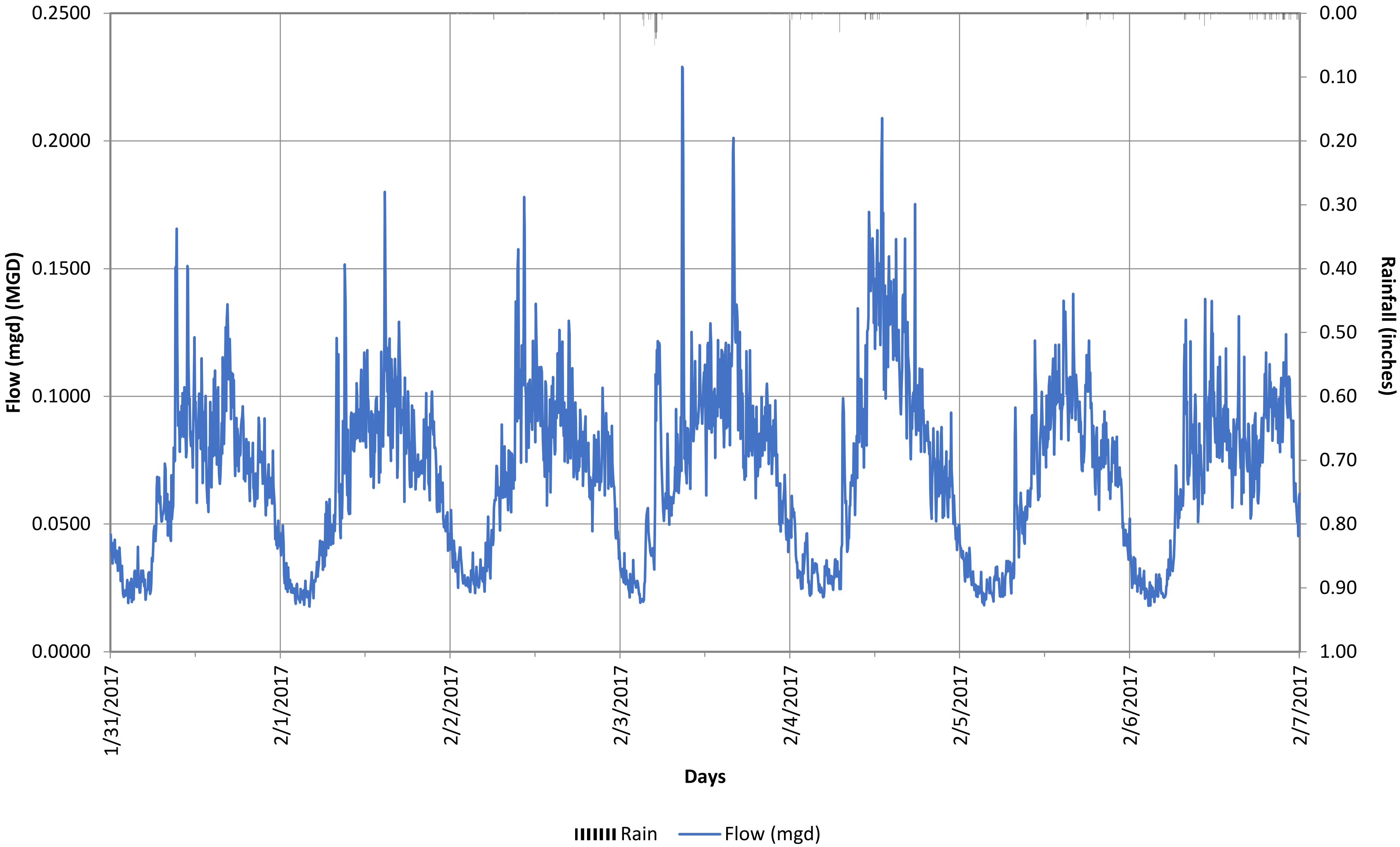
	1/17/2017 11:55:00 PM	(2017 11:55:00 PM	(2017 11:55:00 PM	(/2017 11:55:00 PM	/2017 11:55:00 PM	2017 11:55:00 PM	2017 11:55:00 PM(Mon)
Maximum	0.000	0.282	0.133	0.719	0.194	0.310	0.156
Average	0.000	0.042	0.068	0.085	0.073	0.075	0.068
Minimum	0.000	0.000	0.024	0.025	0.024	0.027	0.023
Rain (inches)	0.00	0.88	0.02	1.13	0.25	1.00	0.18

Colma Site 8 SSMH8E23 West 8" Sanitary Flow



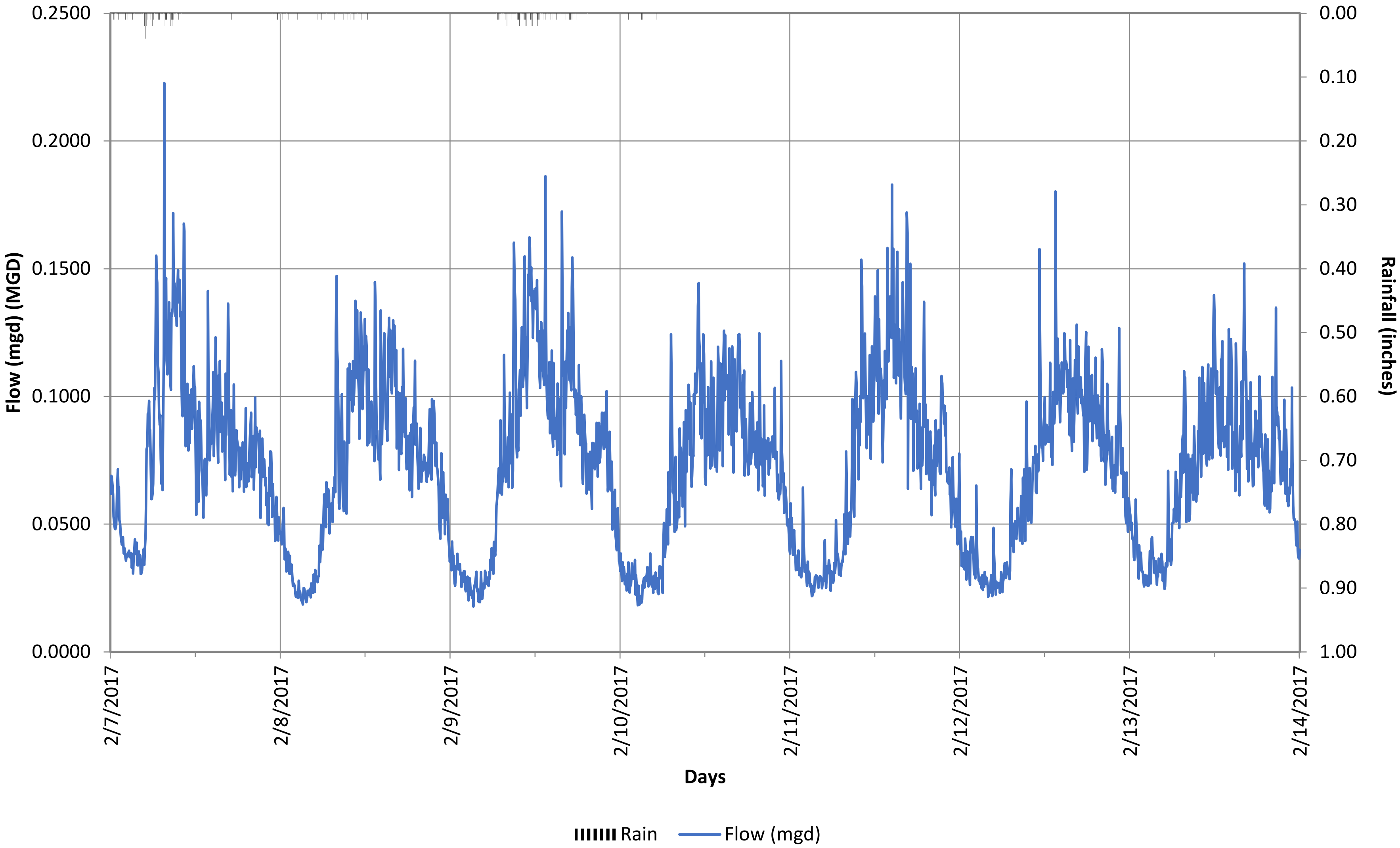
	1/24/2017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM(	/2017 11:55:00 PM	/2017 11:55:00 PM	2017 11:55:00 PM	2017 11:55:00 PM(Mon)
Maximum	0.181	0.158	0.225	0.166	0.172	0.140	0.150
Average	0.062	0.064	0.068	0.073	0.071	0.061	0.068
Minimum	0.020	0.019	0.021	0.020	0.025	0.016	0.023
Rain (inches)	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Colma Site 8 SSMH8E23 West 8" Sanitary Flow



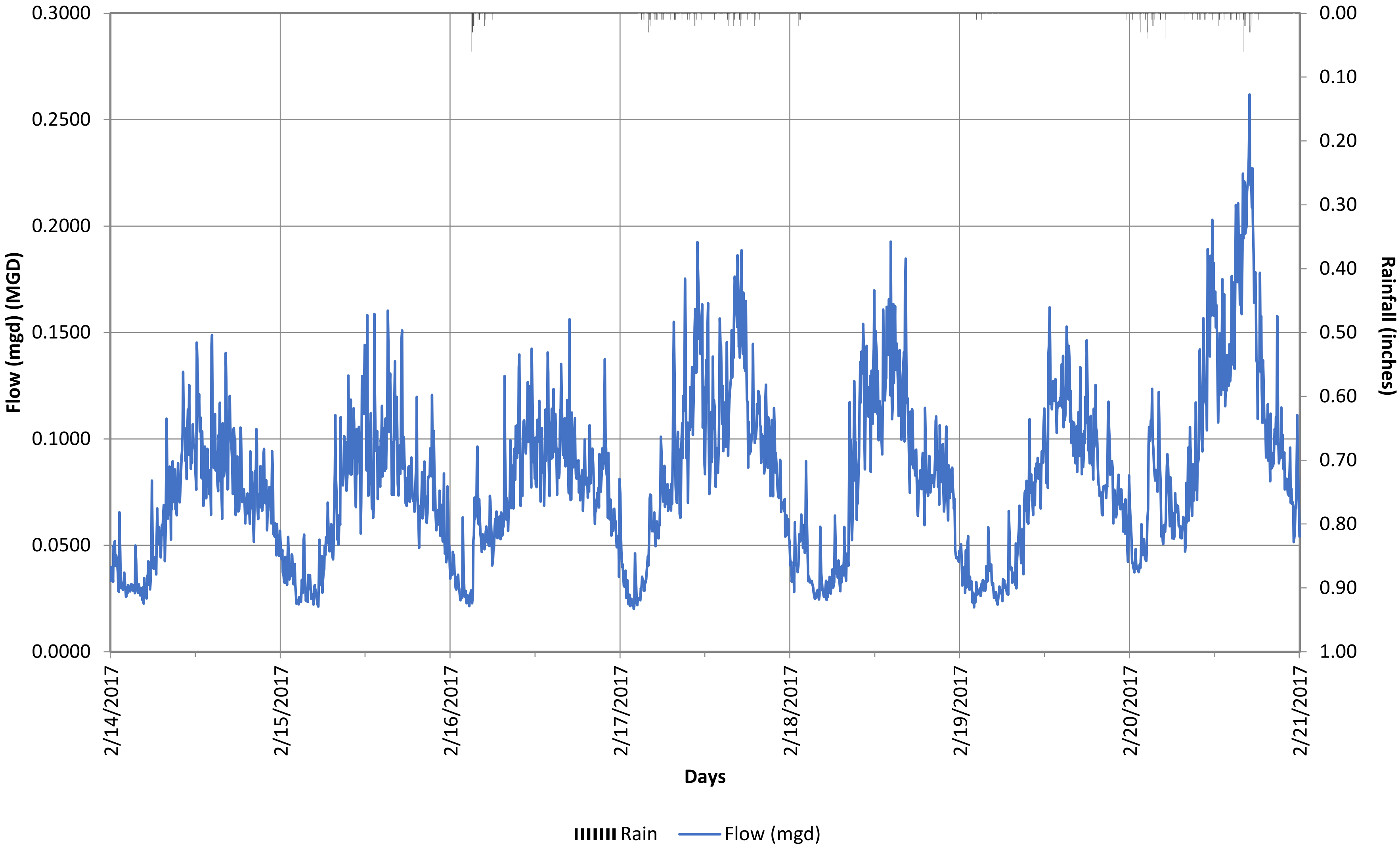
	1/31/2017 11:55:00 PM(	017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM(	017 11:55:00 PM(Mon)
Maximum	0.166	0.180	0.178	0.229	0.209	0.140	0.138
Average	0.066	0.067	0.071	0.077	0.077	0.064	0.069
Minimum	0.019	0.018	0.023	0.019	0.021	0.018	0.018
Rain (inches)	0.00	0.01	0.19	0.51	0.37	0.15	0.50

Colma Site 8 SSMH8E23 West 8" Sanitary Flow



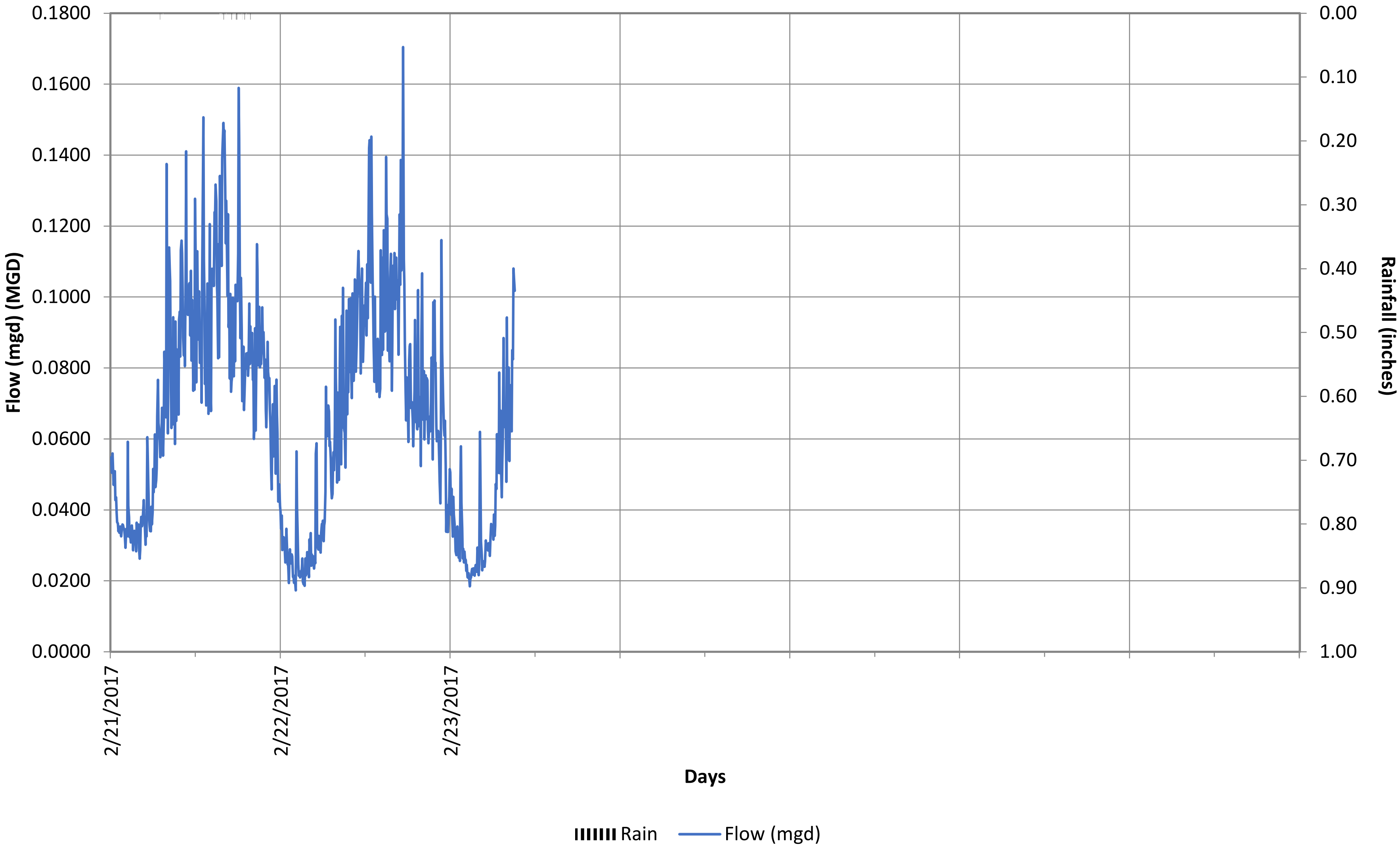
	2/7/2017 11:55:00 PM(	'017 11:55:00 PM(	'2017 11:55:00 PM(	'/2017 11:55:00 PM	/2017 11:55:00 PM	2017 11:55:00 PM	2017 11:55:00 PM(Mon)
Maximum	0.223	0.147	0.186	0.144	0.183	0.180	0.152
Average	0.080	0.072	0.077	0.069	0.074	0.068	0.069
Minimum	0.030	0.019	0.018	0.018	0.022	0.022	0.025
Rain (inches)	0.86	0.26	0.77	0.04	0.00	0.00	0.00

Colma Site 8 SSMH8E23 West 8" Sanitary Flow



	2/14/2017 11:55:00 PM(	2017 11:55:00 PM(	2017 11:55:00 PM(	/2017 11:55:00 PM/	2017 11:55:00 PM	2017 11:55:00 PM	2017 11:55:00 PM(Mon)
Maximum	0.149	0.160	0.156	0.192	0.193	0.162	0.262
Average	0.069	0.071	0.076	0.092	0.081	0.072	0.108
Minimum	0.023	0.021	0.021	0.020	0.024	0.021	0.037
Rain (inches)	0.00	0.00	0.39	1.23	0.14	0.08	1.61

Colma Site 8 SSMH8E23 West 8" Sanitary Flow

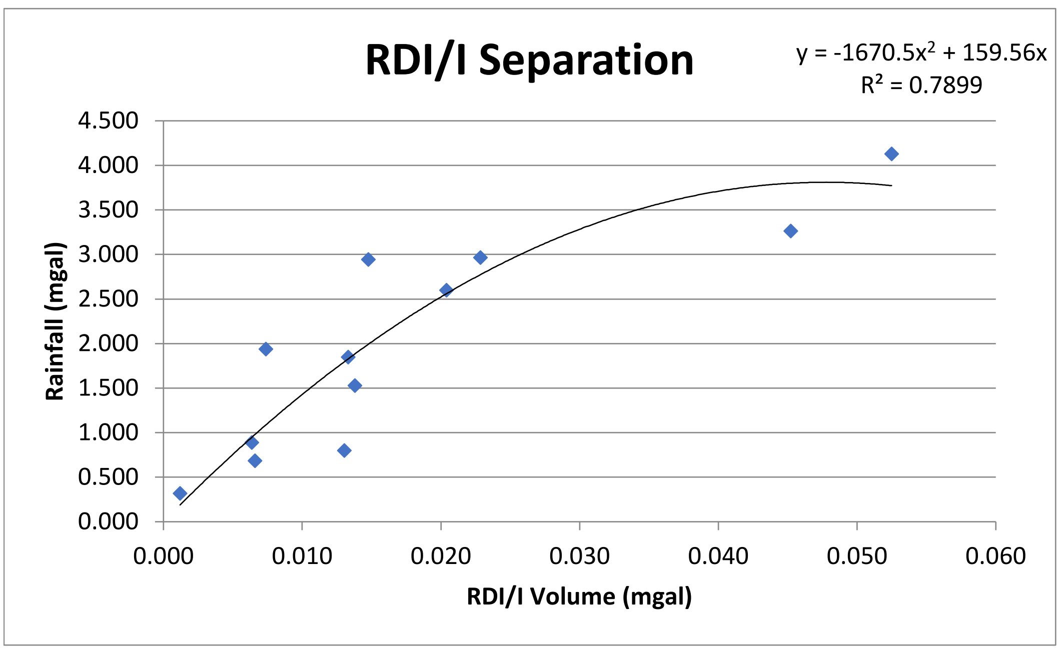


	2/21/2017 11:55:00 PM(	2017 11:55:00 PM(Wed)					
Maximum	0.159	0.170					
Average	0.075	0.068					
Minimum	0.026	0.017					
Rain (inches)	0.19	0.00					

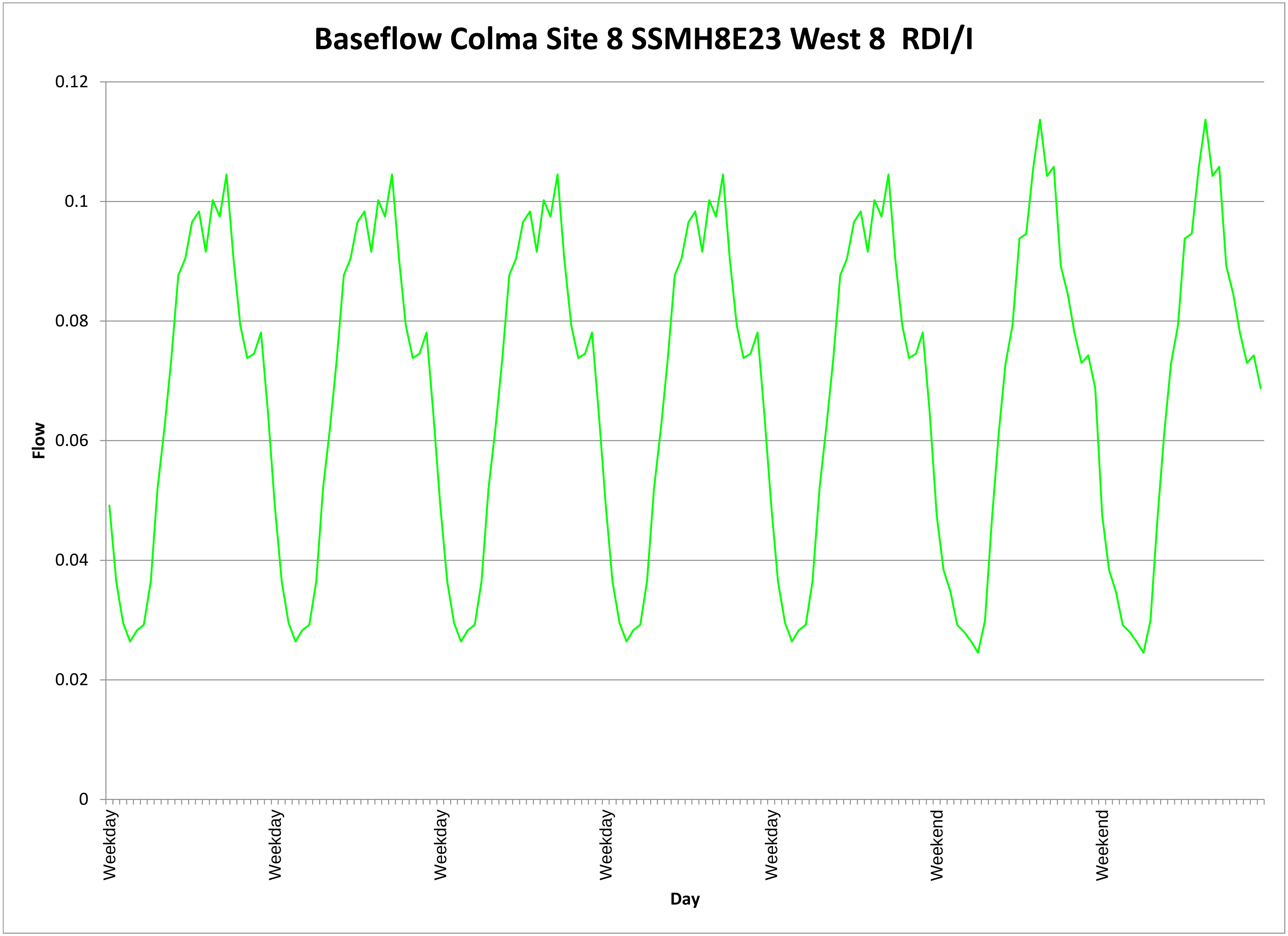
Colma Site 8 SSMH8E23 West 8 RDI/I

RDI/I Analysis, Monitor Return Ratio Summary

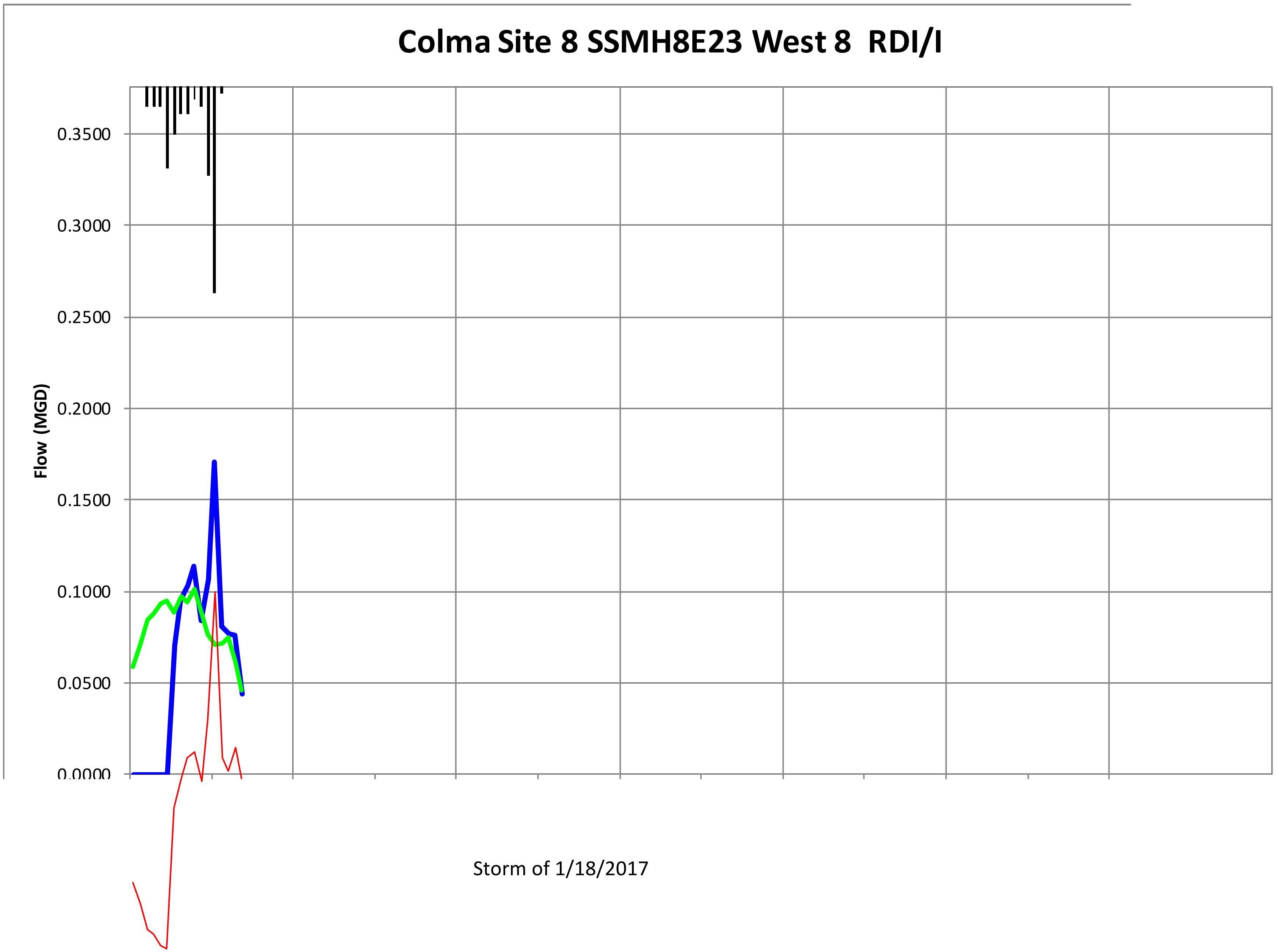
Storm Start (Date)	RDI/I Volume (mgal)	Monitor Area (acres)	Rainfall (mgal)	Return Ratio (%)
1/18/2017	0.007	84.0	1.939	0.38%
1/20/2017	0.020	84.0	2.600	0.78%
1/21/2017	0.015	84.0	2.942	0.50%
2/2/2017	0.014	84.0	1.528	0.90%
2/4/2017	0.013	84.0	0.798	1.63%
2/5/2017	0.001	84.0	0.319	0.37%
2/6/2017	0.023	84.0	2.965	0.77%
2/7/2017	0.007	84.0	0.684	0.96%
2/9/2017	0.013	84.0	1.847	0.72%
2/16/2017	0.006	84.0	0.890	0.72%
2/17/2017	0.045	84.0	3.262	1.39%
2/20/2017	0.052	84.0	4.128	1.27%
Average R%				0.87%
Average Top 3 Sorms				1.43%



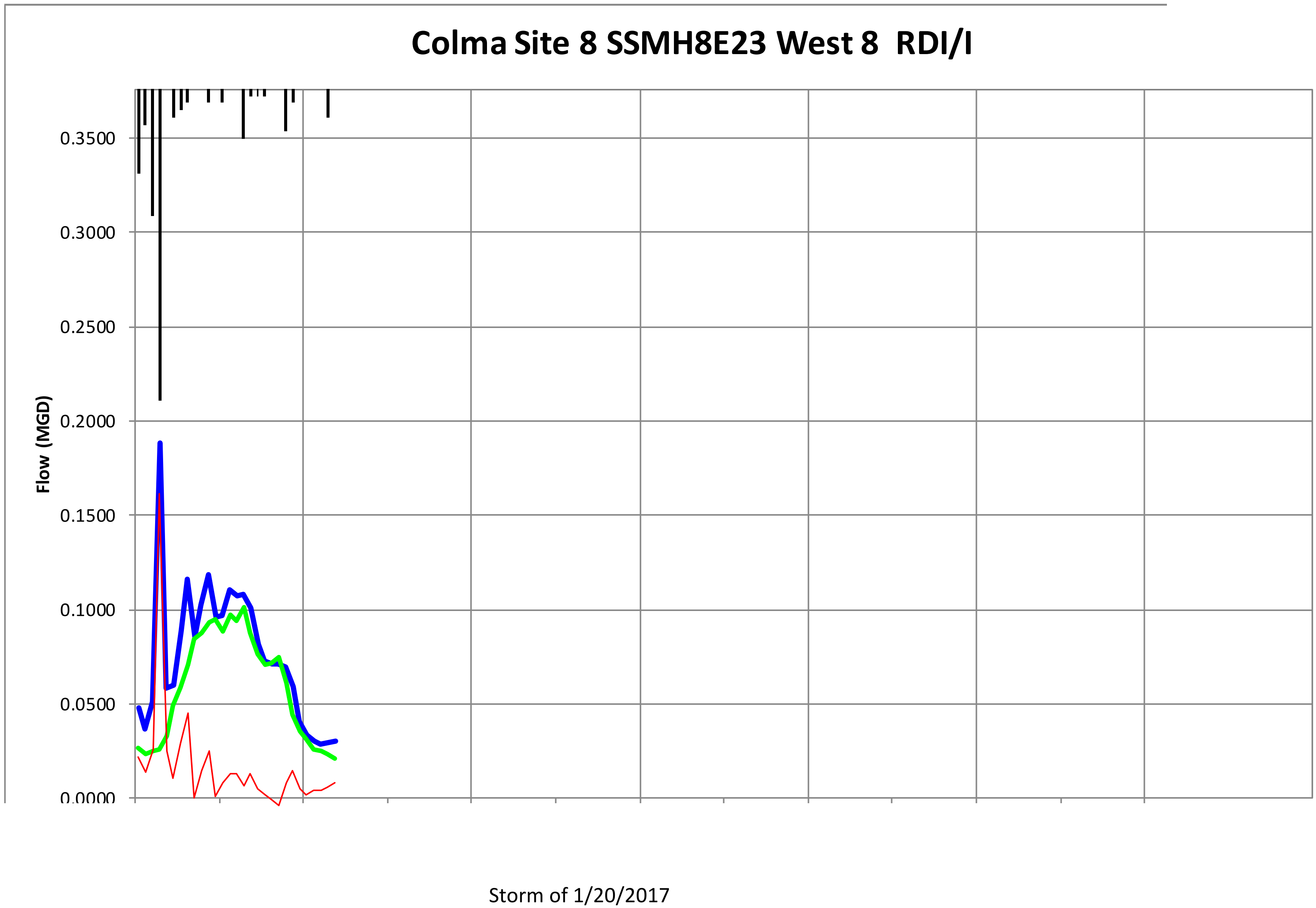
Baseflows	Weekend	Weekday
Max	0.114	0.105
Avg	0.067	0.069
Min	0.025	0.026

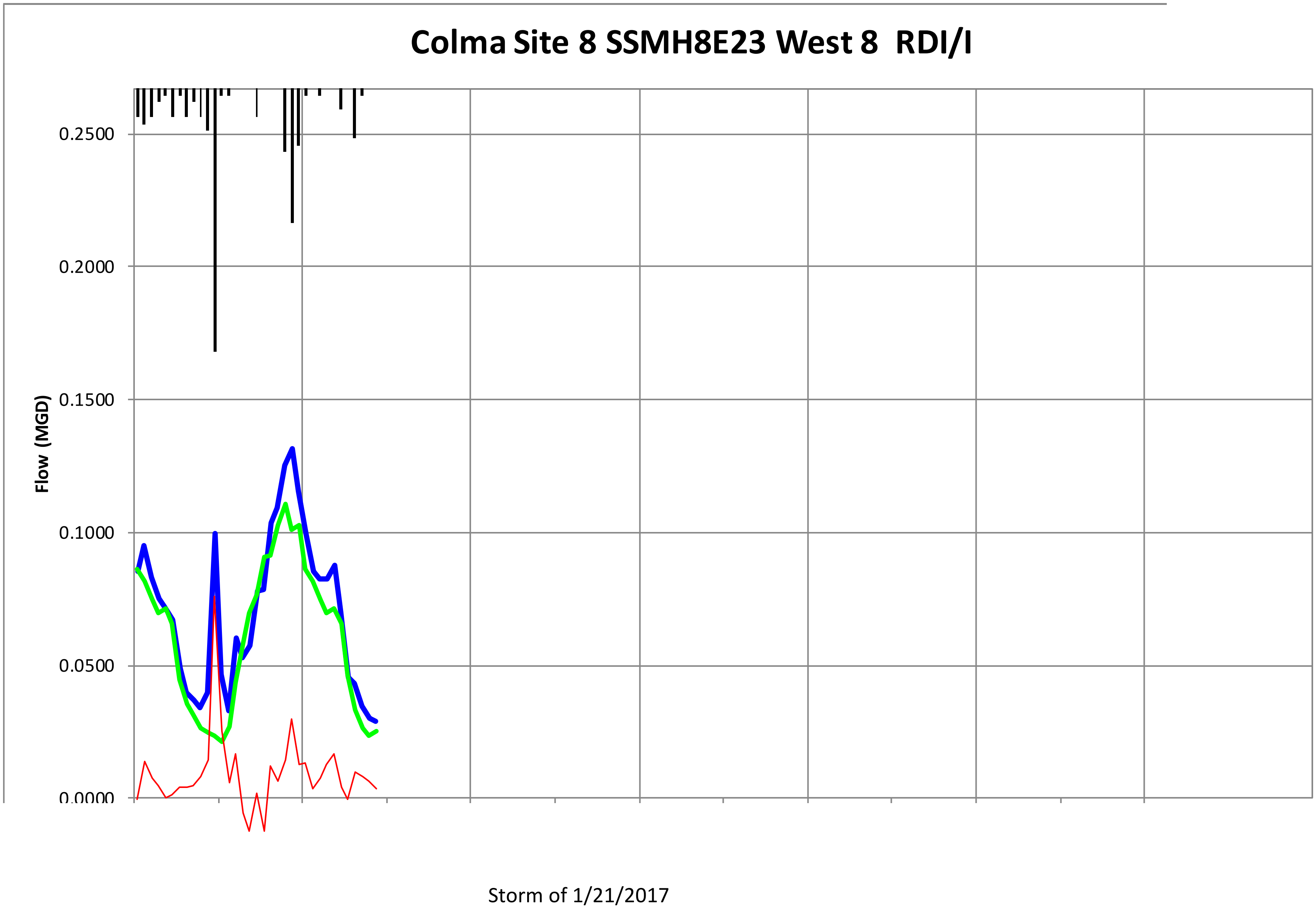


Baseflow Colma Site 8 SSMH8E23 West 8 RDI/I
0.12
0.1
0.08
0.06
0.04
0.02
0
Flow
Weekday
Weekday
Weekday
Weekday
Weekday
Weekend
Weekend
Day

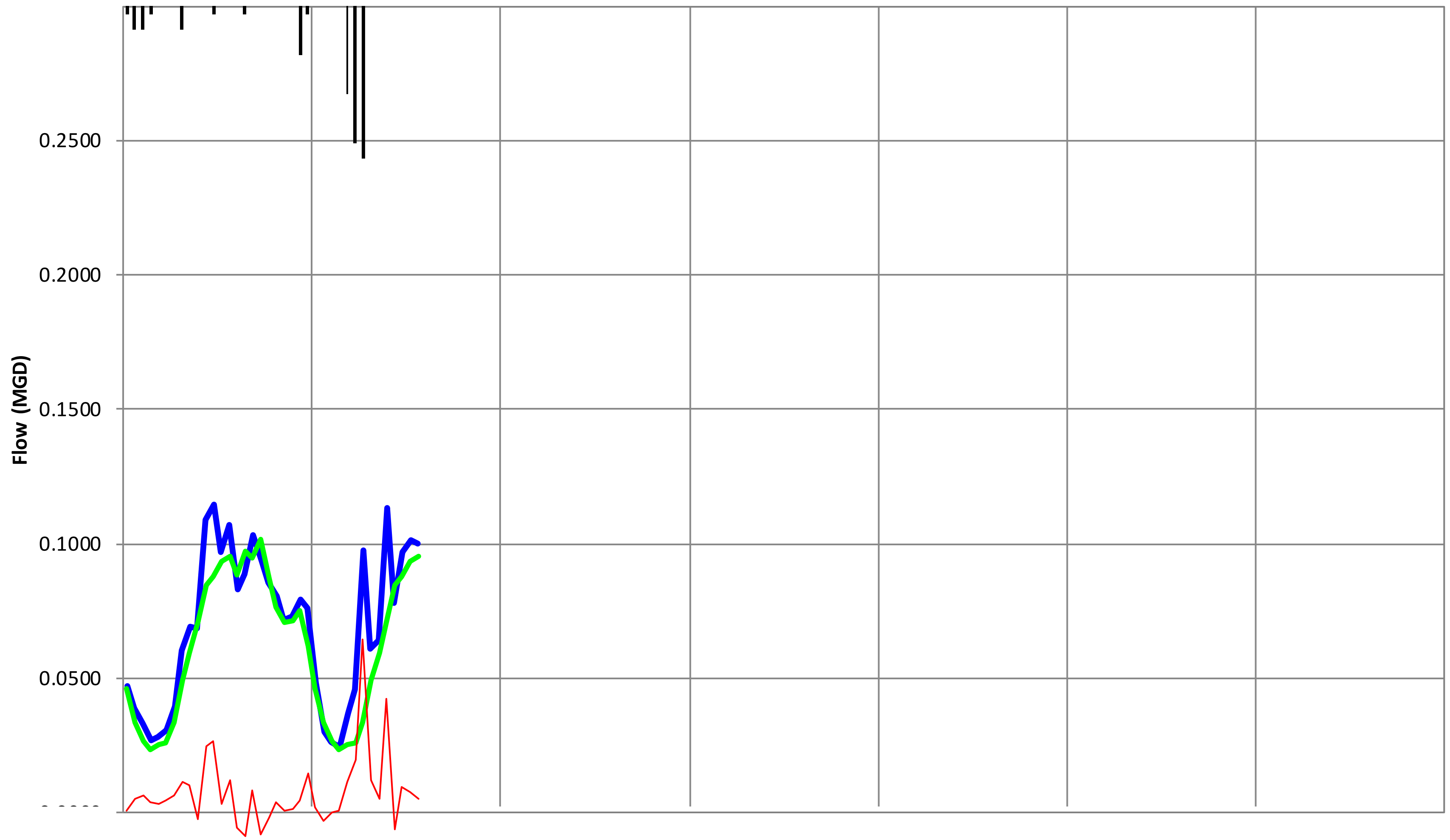


Colma Site 8 SSMH8E23 West 8 RDI/I
Flow (MGD)
0.3500
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 1/18/2017

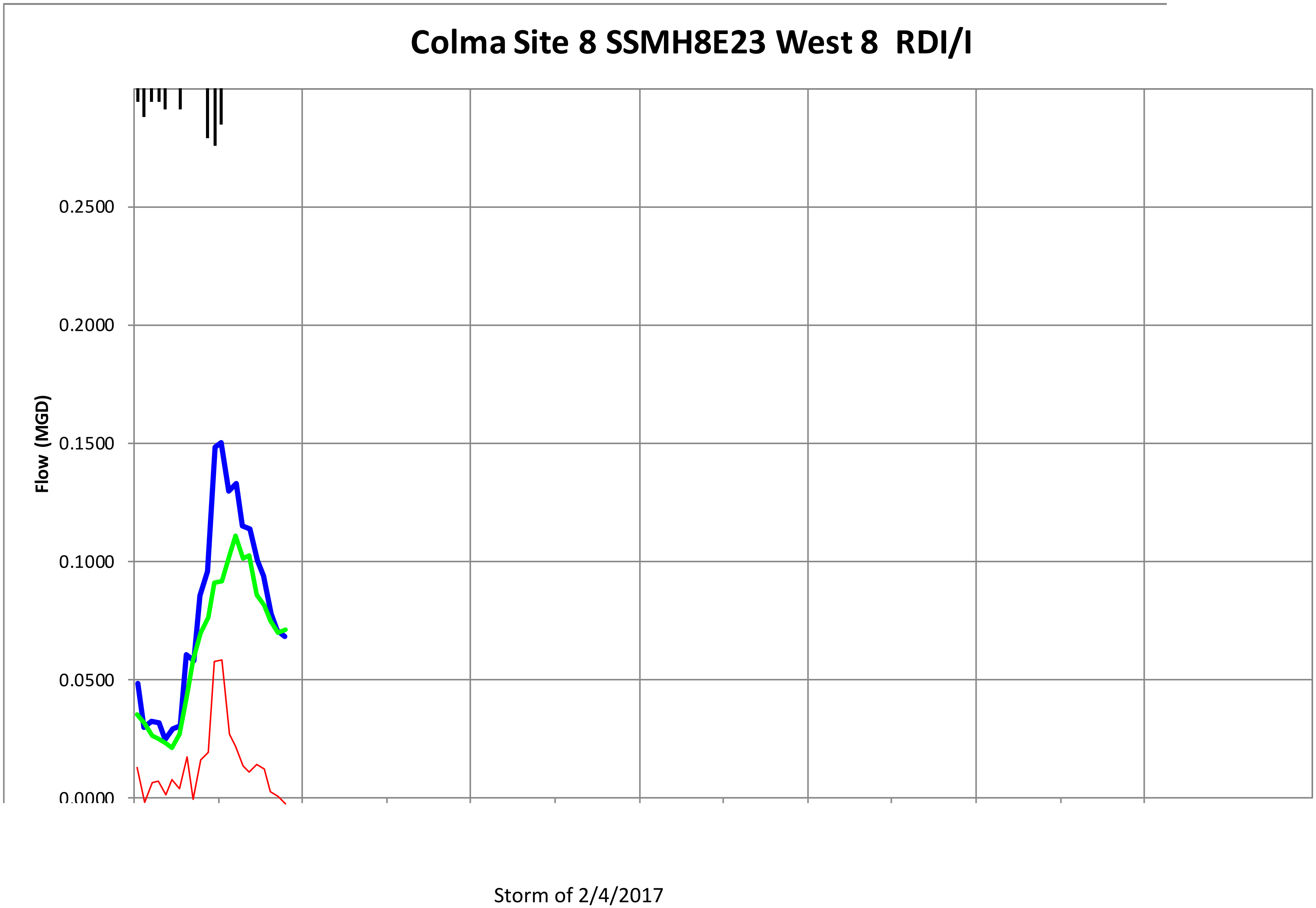

Colma Site 8 SSMH8E23 West 8 RDI/I
Flow (MGD)
0.3500
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 1/20/2017

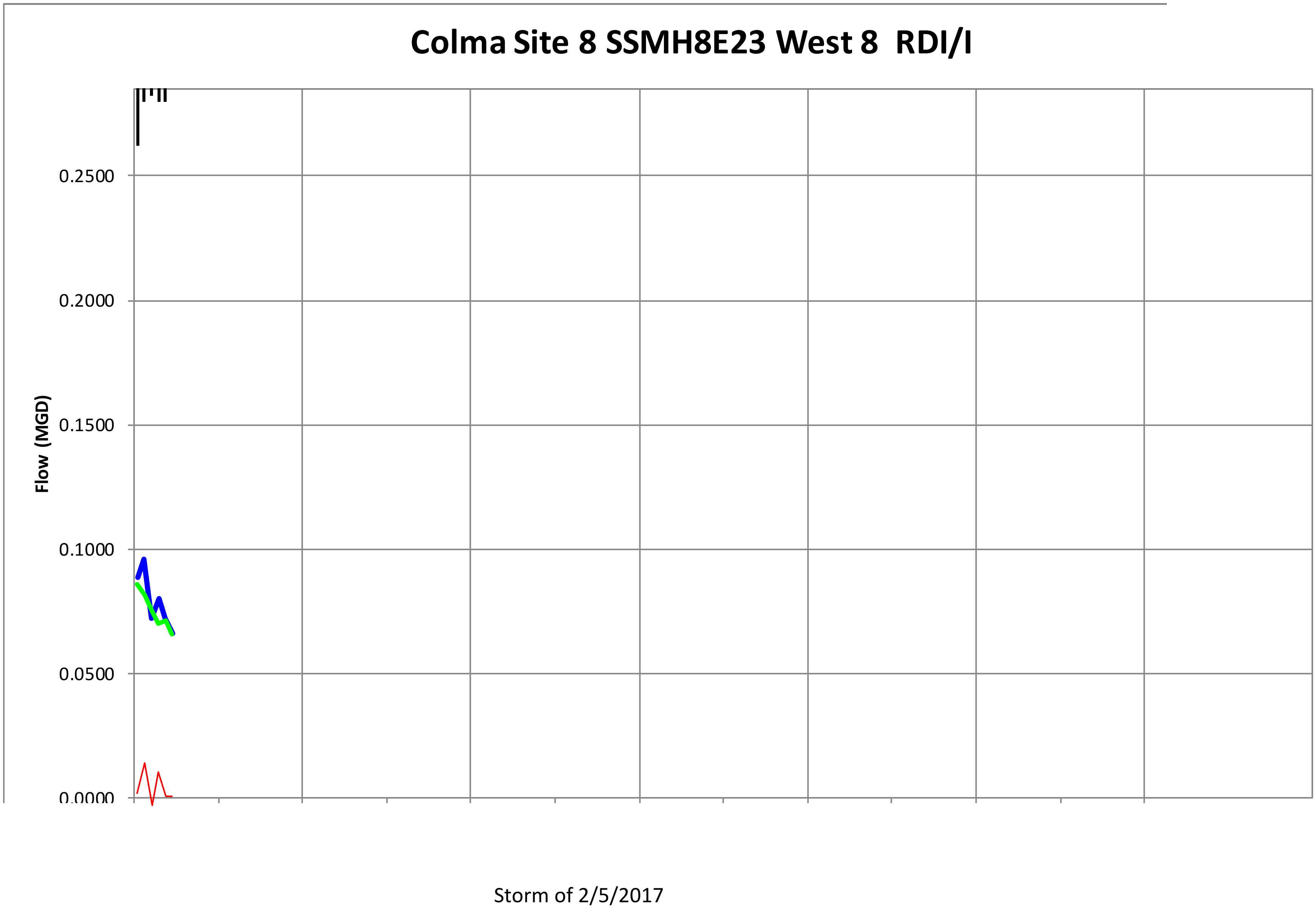

Colma Site 8 SSMH8E23 West 8 RDI/I
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Flow (MGD)
Storm of 1/21/2017

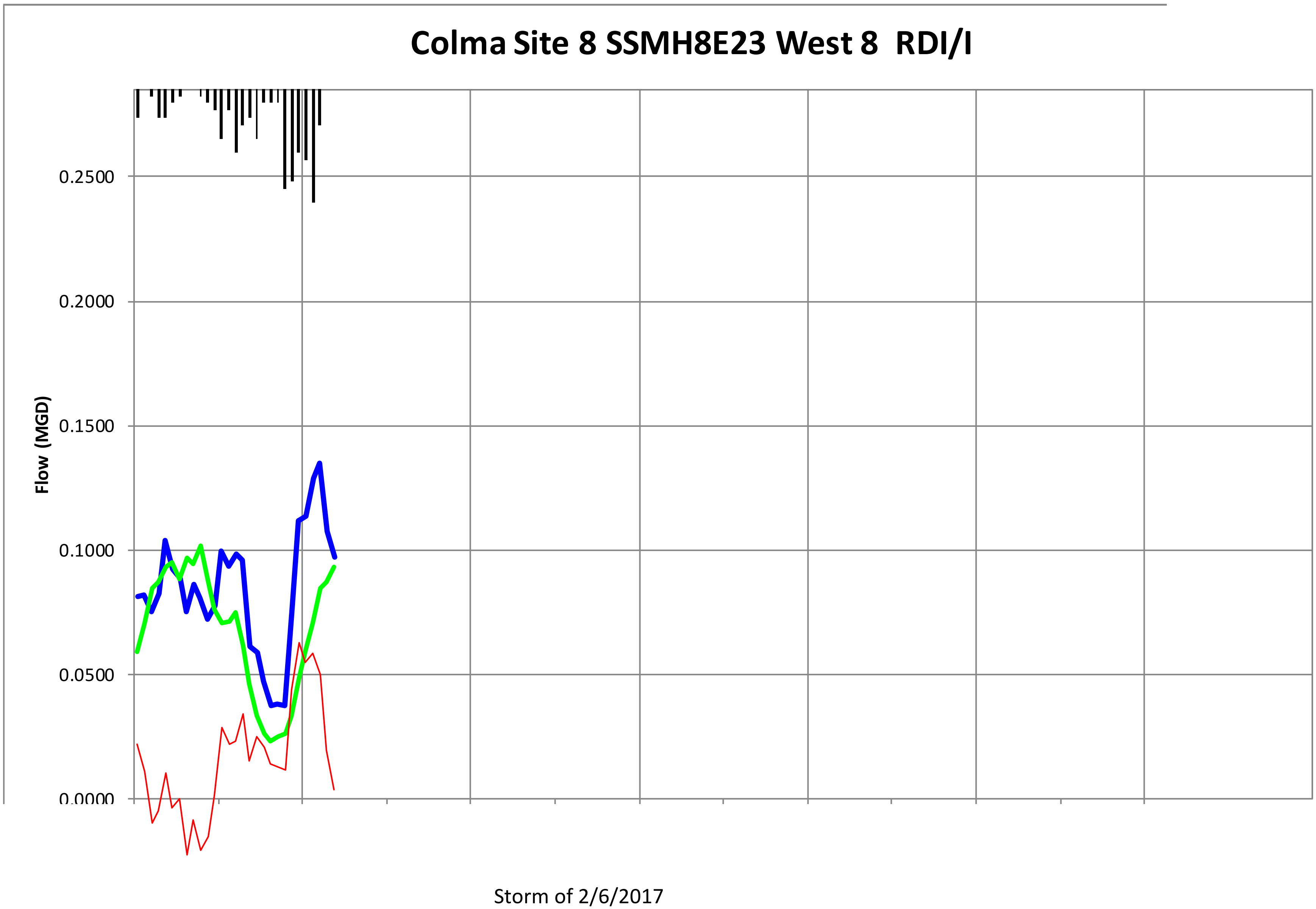
Colma Site 8 SSMH8E23 West 8 RDI/I



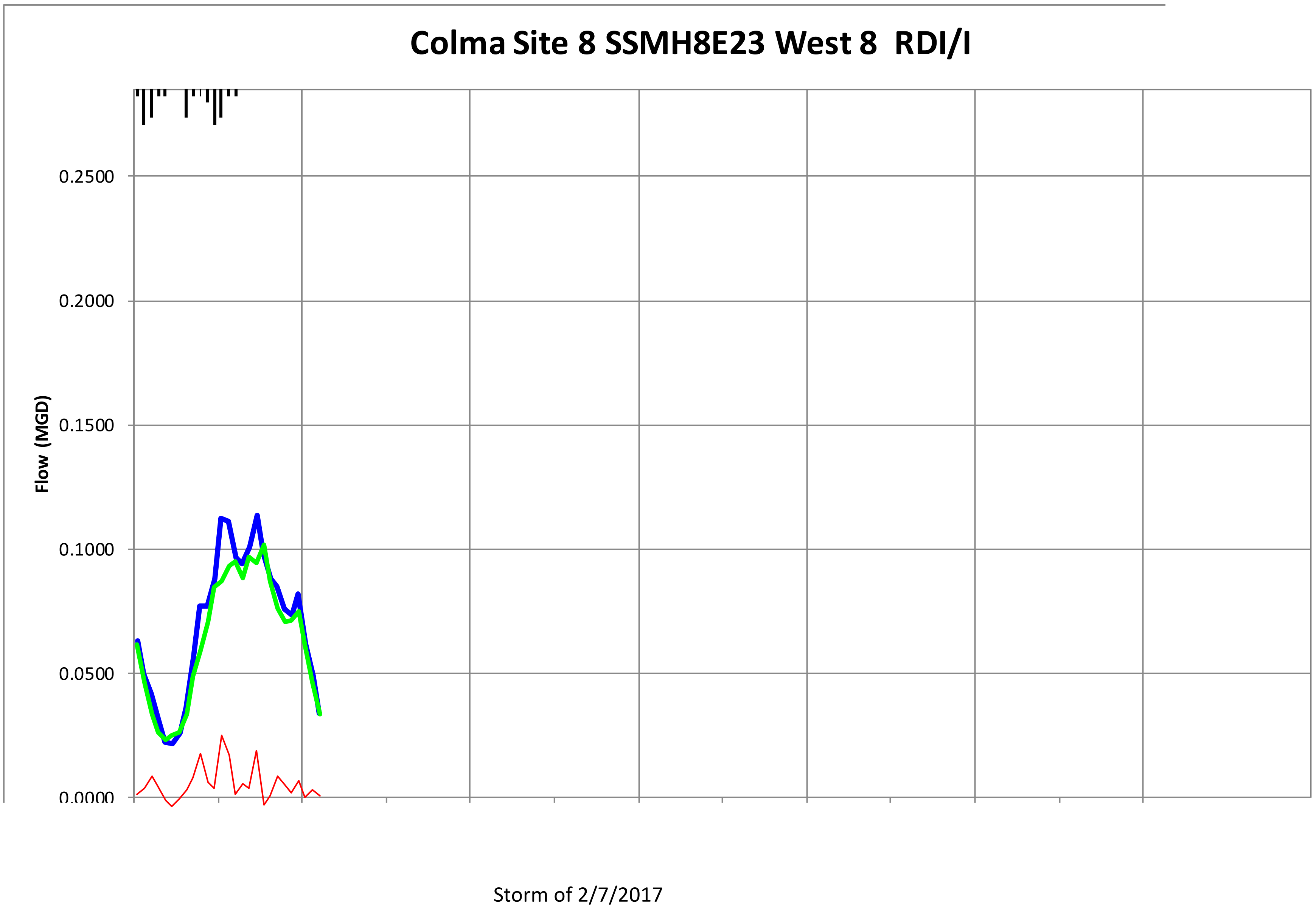
Storm of 2/2/2017


Colma Site 8 SSMH8E23 West 8 RDI/I
Flow (MGD)
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 2/4/2017

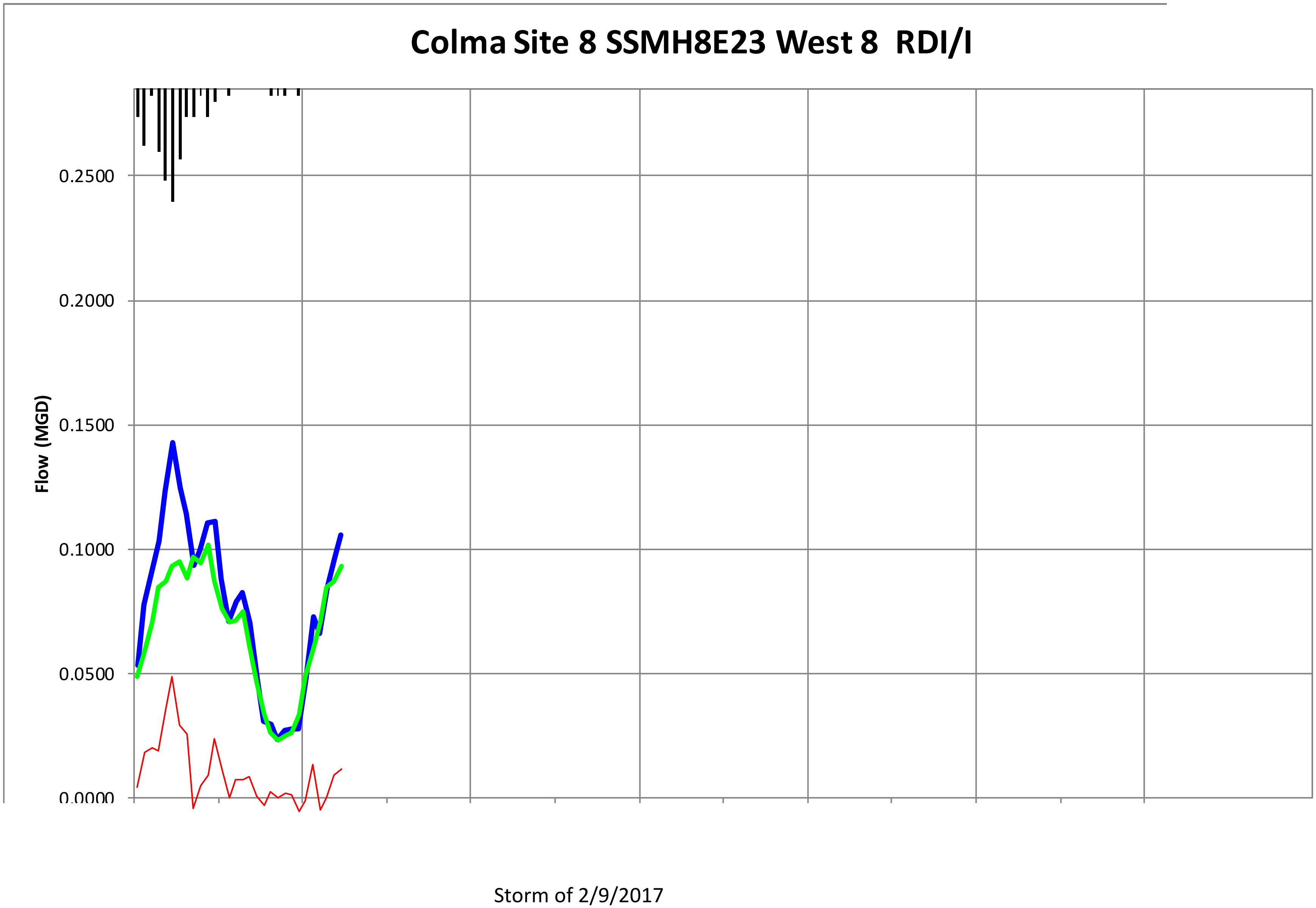

Colma Site 8 SSMH8E23 West 8 RDI/I
Flow (MGD)
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 2/5/2017



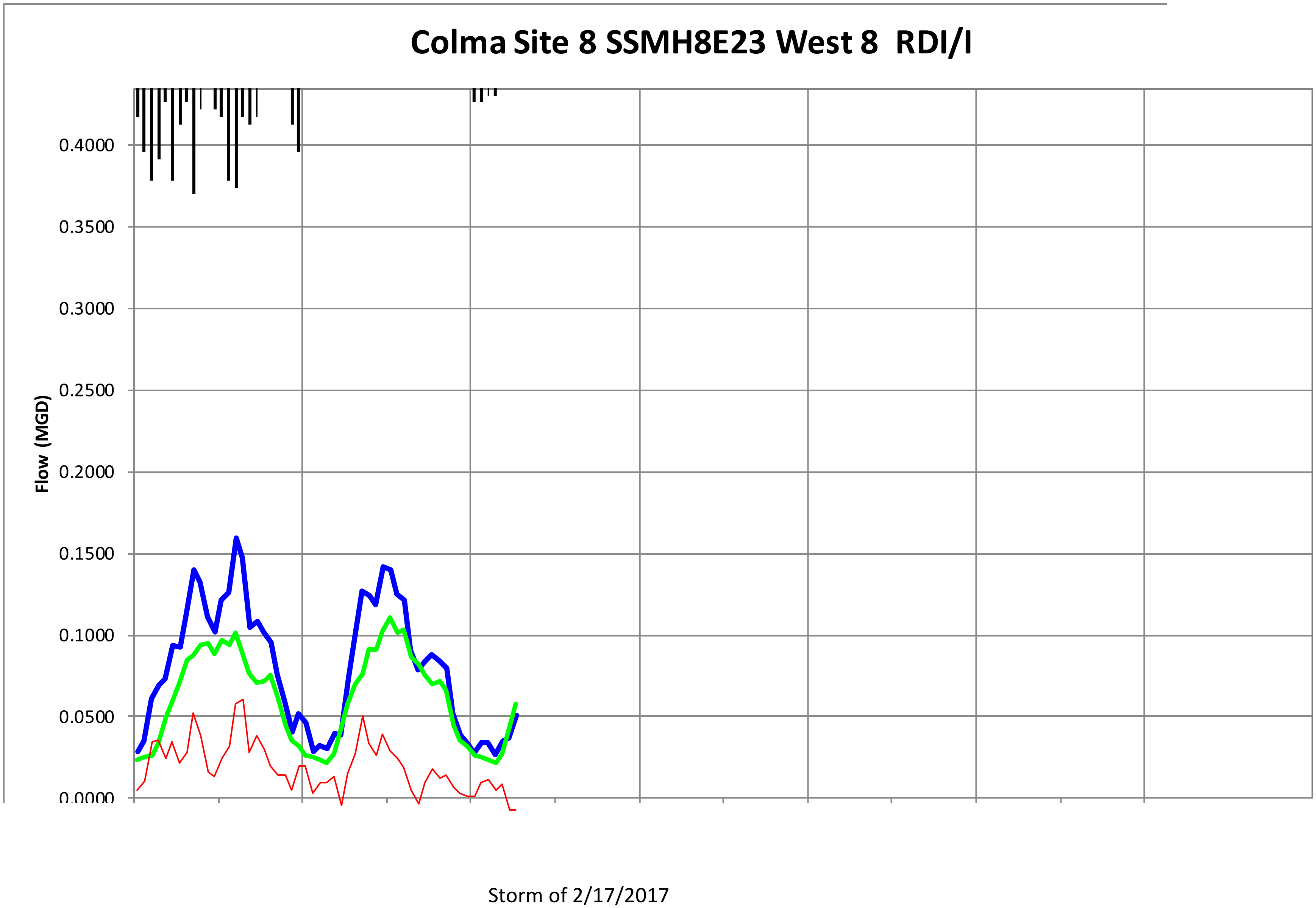
Colma Site 8 SSMH8E23 West 8 RDI/I
Flow (MGD)
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 2/6/2017

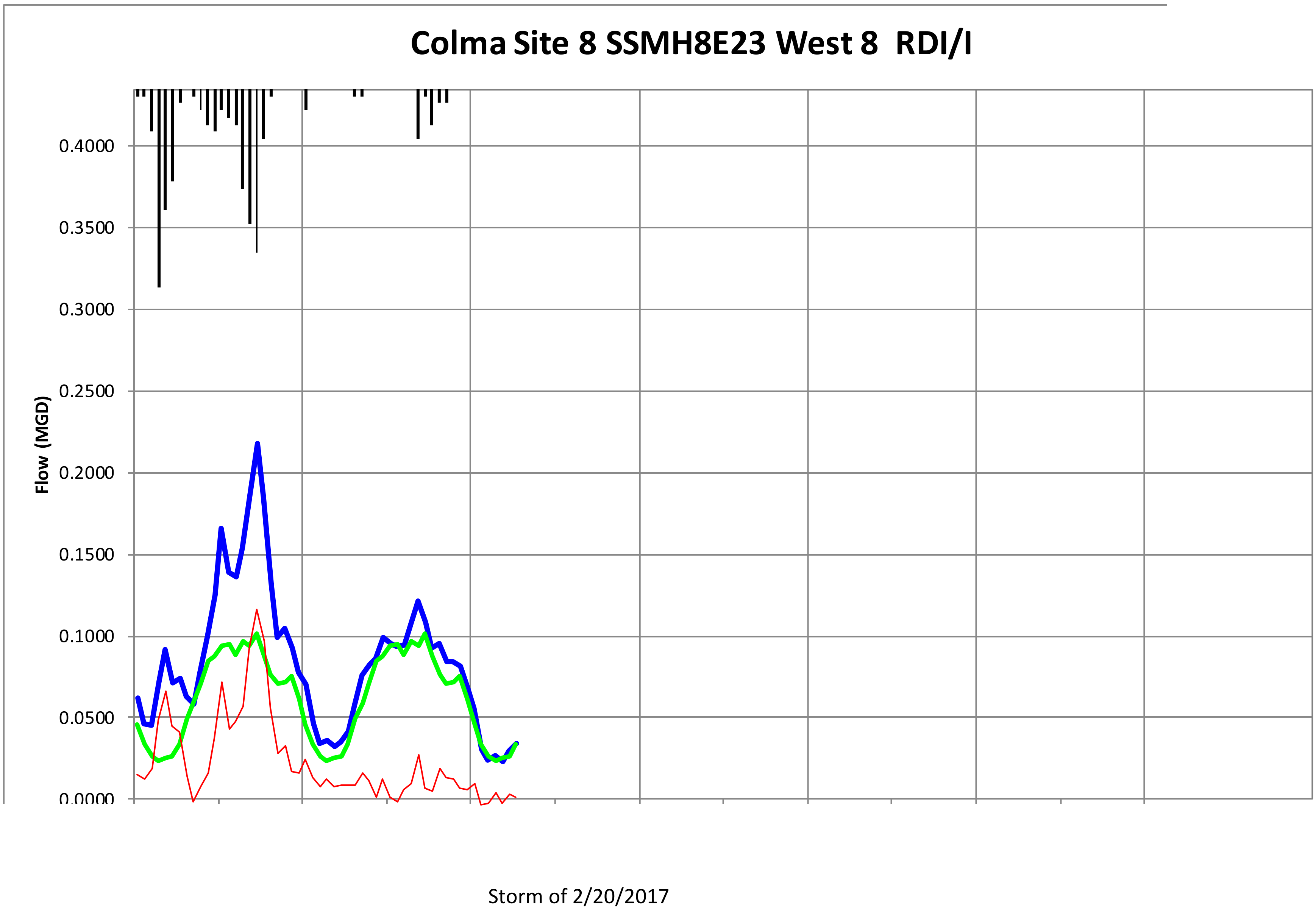


Colma Site 8 SSMH8E23 West 8 RDI/I
Flow (MGD)
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 2/7/2017


Colma Site 8 SSMH8E23 West 8 RDI/I
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Flow (MGD)
Storm of 2/9/2017

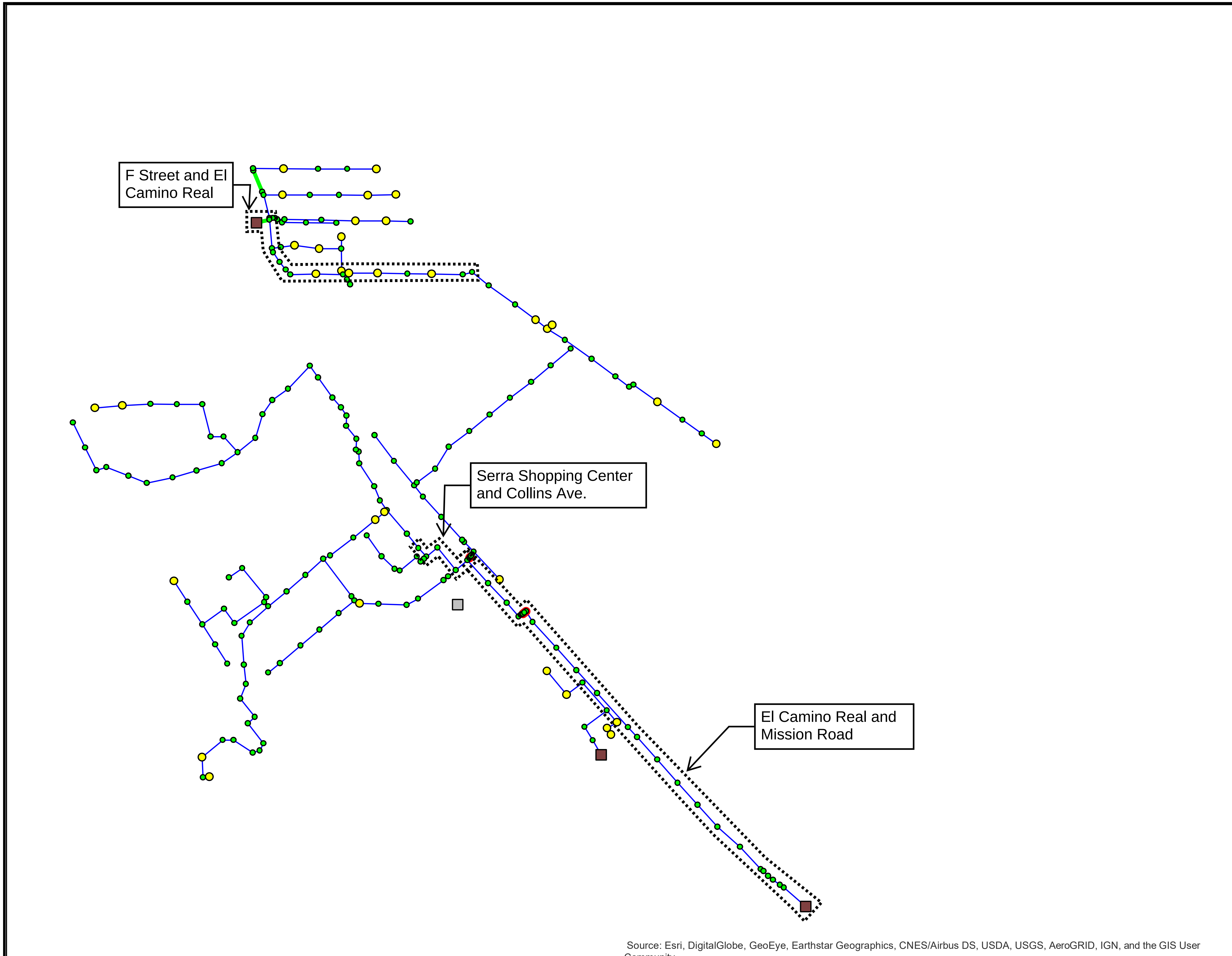
Colma Site 8 SSMH8E23 West 8 RDI/I


Colma Site 8 SSMH8E23 West 8 RDI/I
Flow (MGD)
0.4000
0.3500
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 2/17/2017



Colma Site 8 SSMH8E23 West 8 RDI/I
Flow (MGD)
0.4000
0.3500
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Storm of 2/20/2017

Appendix C.1 Existing Conditions Dry Weather Flow Results Figure



Legend

Manhole Unfilled Depth
- Potential SSO
- 0 - 3 Feet
- 3 - 5 Feet
- > 5 Feet

Outlet
- Active

Pipe Max "d/D" Ratio
- Less than 0.5
- 0.5~0.75
- 0.75~0.99
- Greater than 0.99

Basins
- DCMB
- SSFMB1A
- SSFMB1B
- SSFMB2
- SSFMB3
- SSFMB4A
- SSFMB4B
- SSFMB5
- SSFMB6
- SSFMB7
- Does not flow to Colma

N

800 400 0 800 Feet

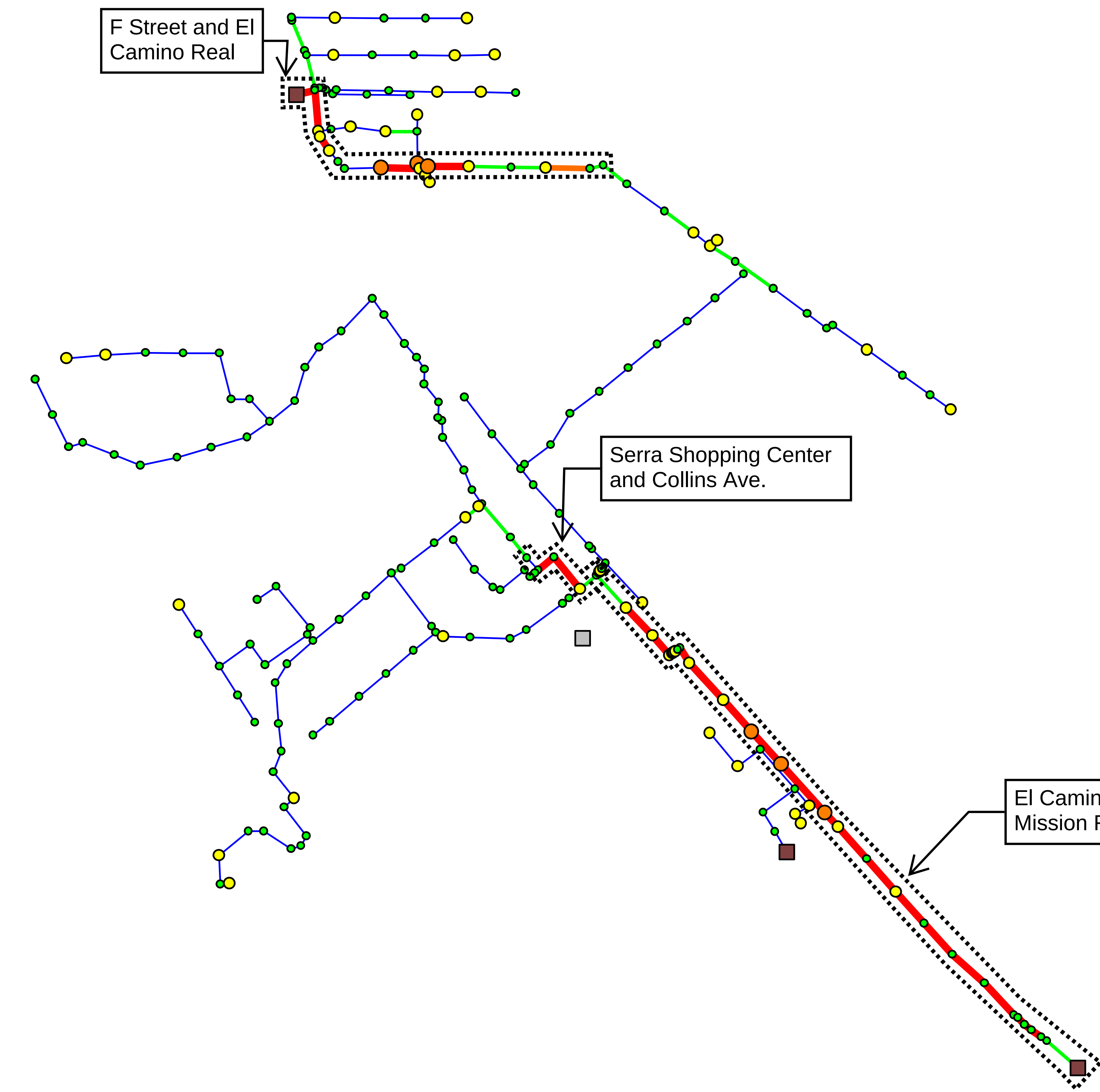
Appendix C.1

Existing Conditions Dry Weather Flow Results Figure*

*Refer to Appendix C.3, C.4, and C.5 for manhole IDs

WATERWORKS ENGINEERS

Appendix C.2 Existing Conditions Dry Weather Flow Results Figure



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

Manhole Unfilled Depth
- Potential SSO
- 0 - 3 Feet
- 3 - 5 Feet
- > 5 Feet

Outlet
- Active

Pipe Max "d/D" Ratio
- Less than 0.5
- 0.5~0.75
- 0.75~0.99
- Greater than 0.99

Basins
- DCMB
- SSFMB1A
- SSFMB1B
- SSFMB2
- SSFMB3
- SSFMB4A
- SSFMB4B
- SSFMB5
- SSFMB6
- SSFMB7
- Does not flow to Colma

N

800 400 0 800 Feet

Appendix C.2

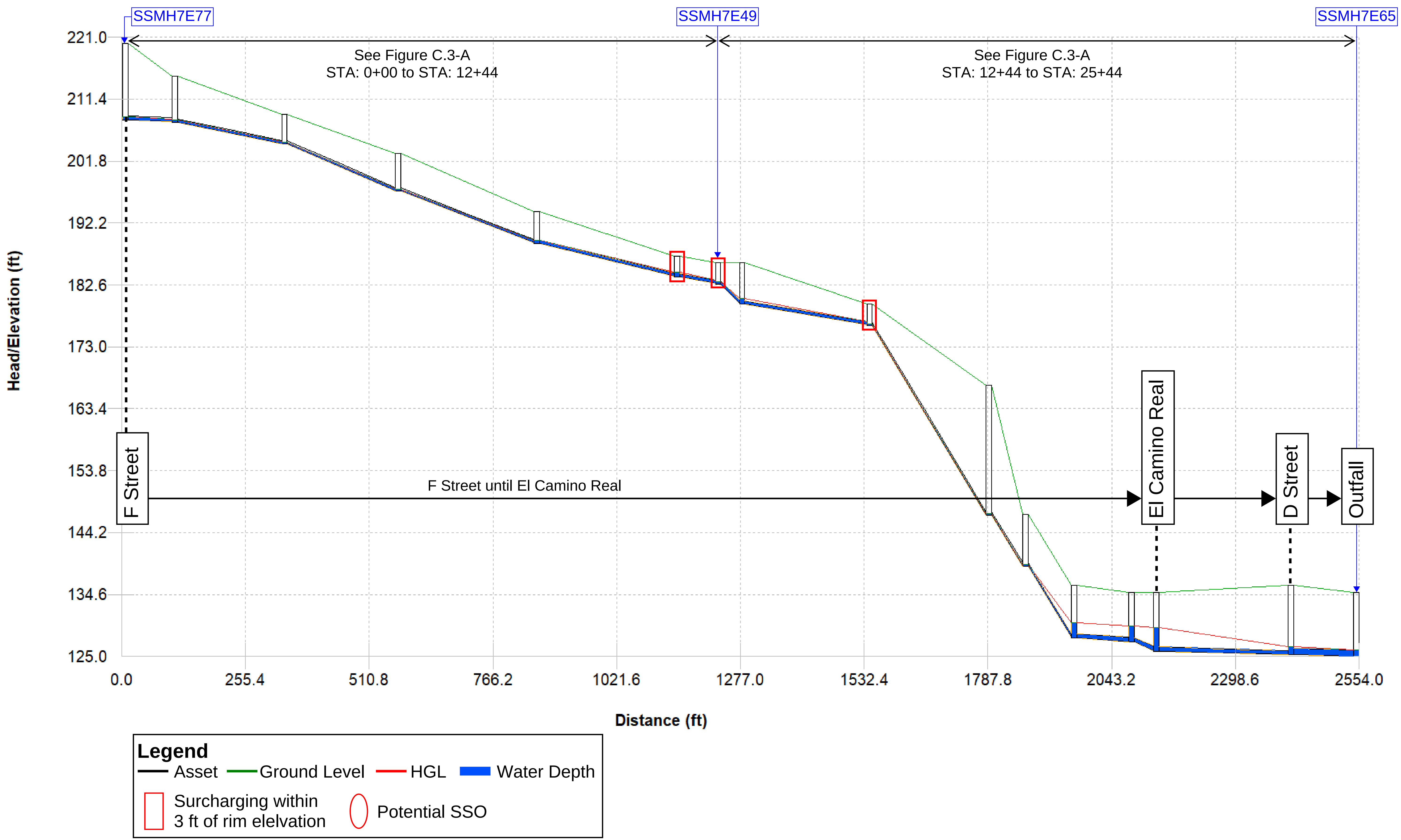
Existing Conditions Wet Weather Flow Results Figure*

*Refer to Appendix C.3, C.4, and C.5 for manhole IDs

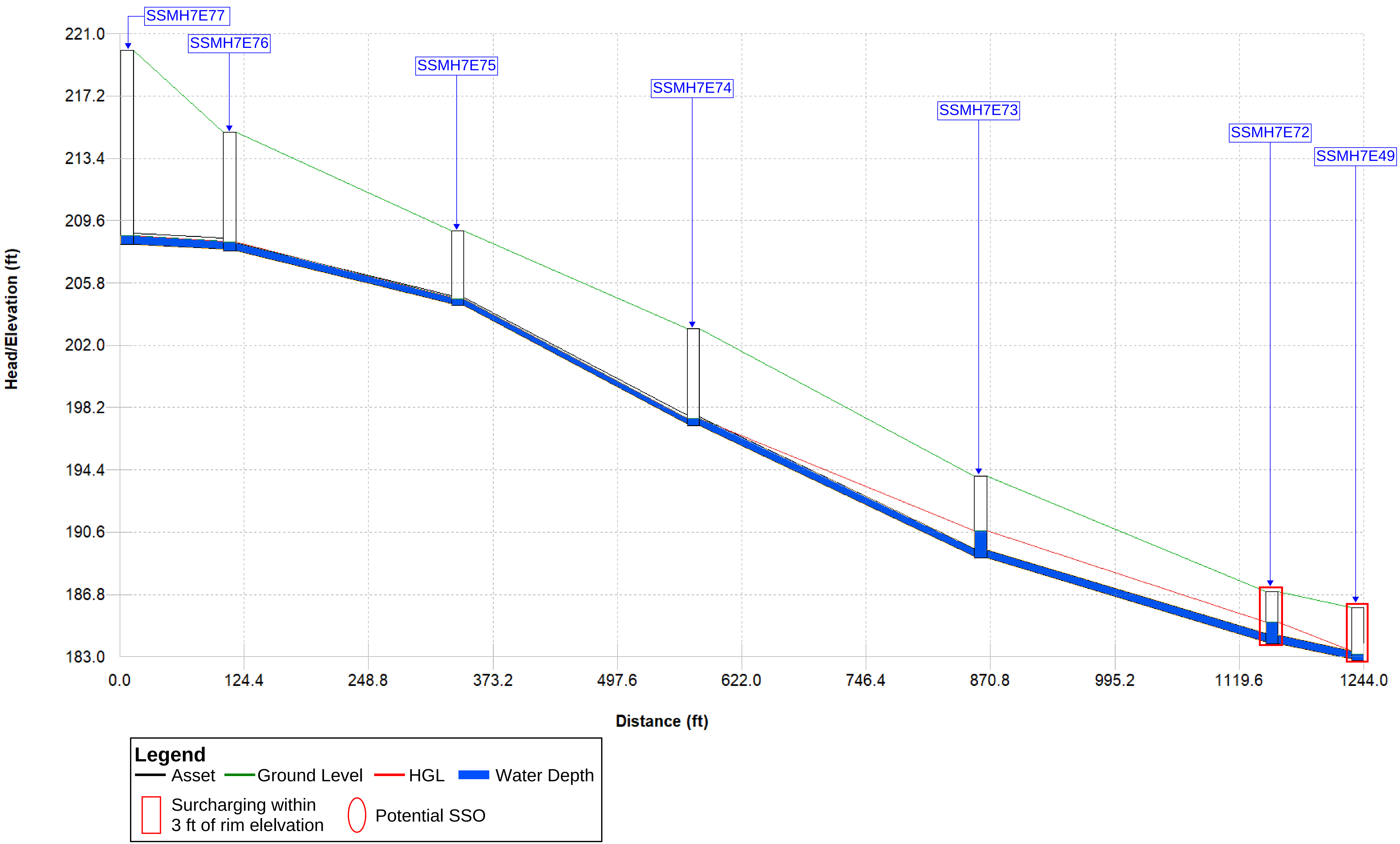
WATERWORKS ENGINEERS

Appendix C.3 HGL Profile of F Street and El Camino Real Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm

APPENDIX C.3
HGL Profile of F Street and El Camino Real Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm

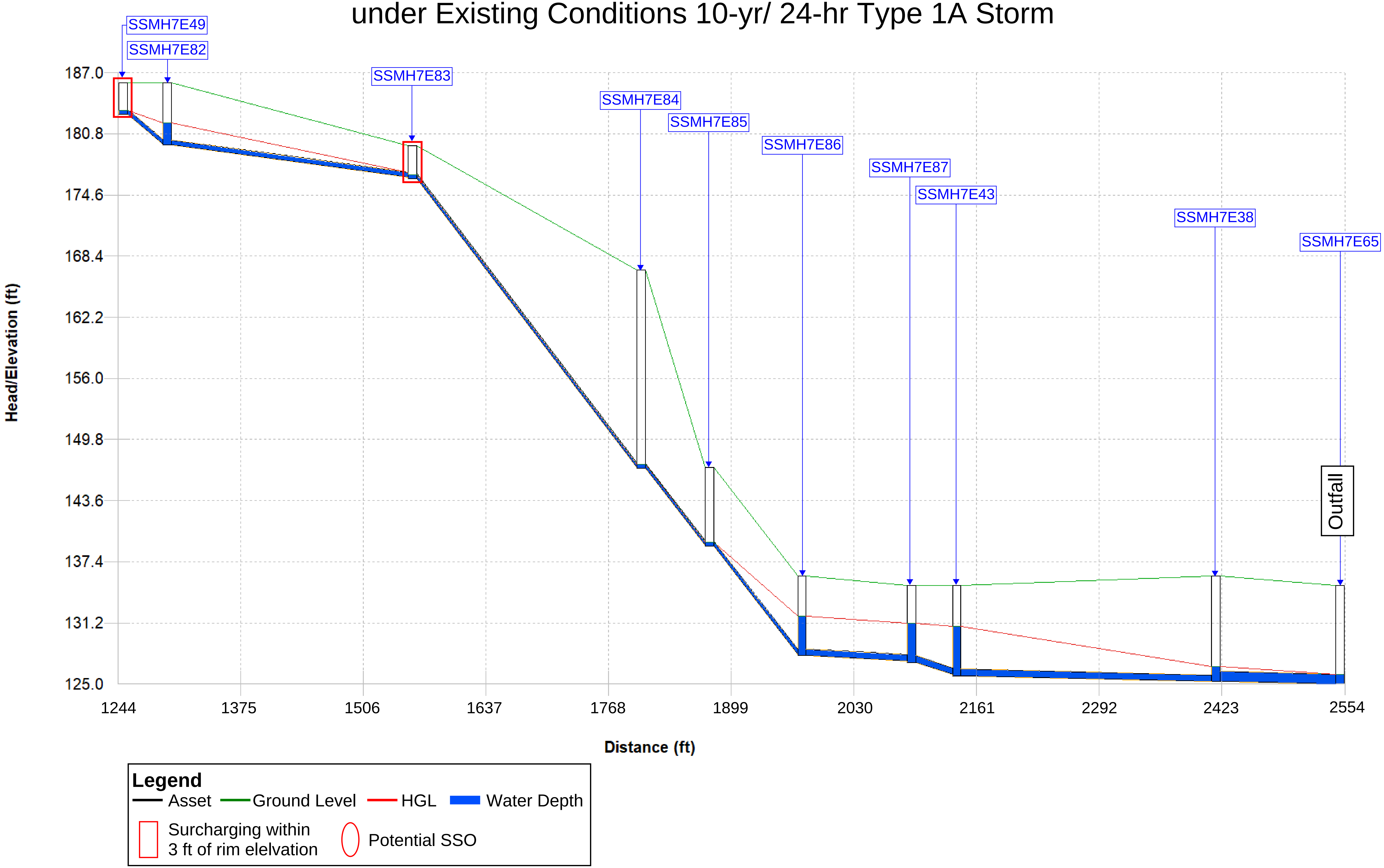


APPENDIX C.3-A
HGL Profile of F Street and El Camino Real Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm



APPENDIX C.3-B

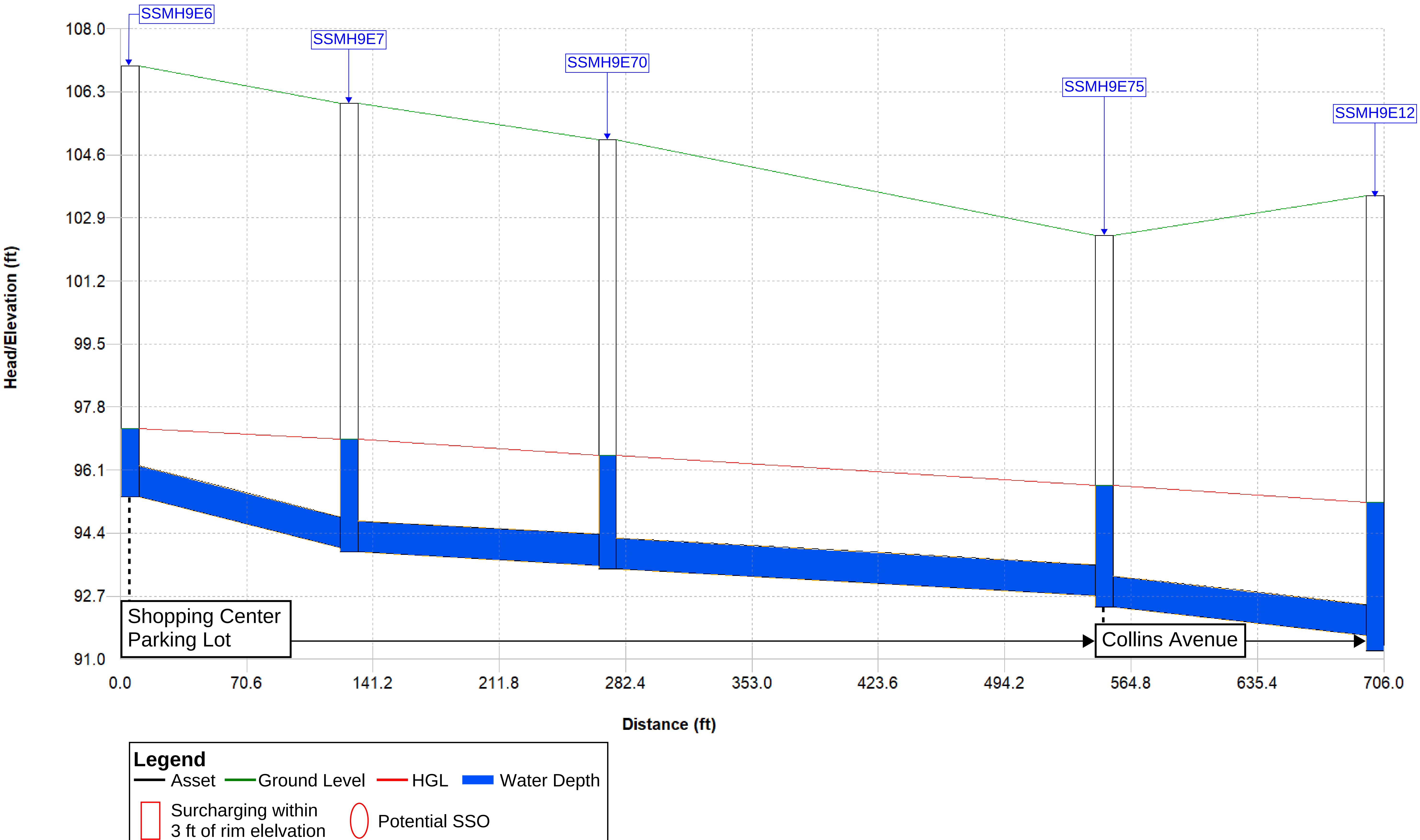
HGL Profile of F Street and El Camino Real Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm



Appendix C.4 HGL Profile of Serra Shopping Center and Collins Avenue Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm

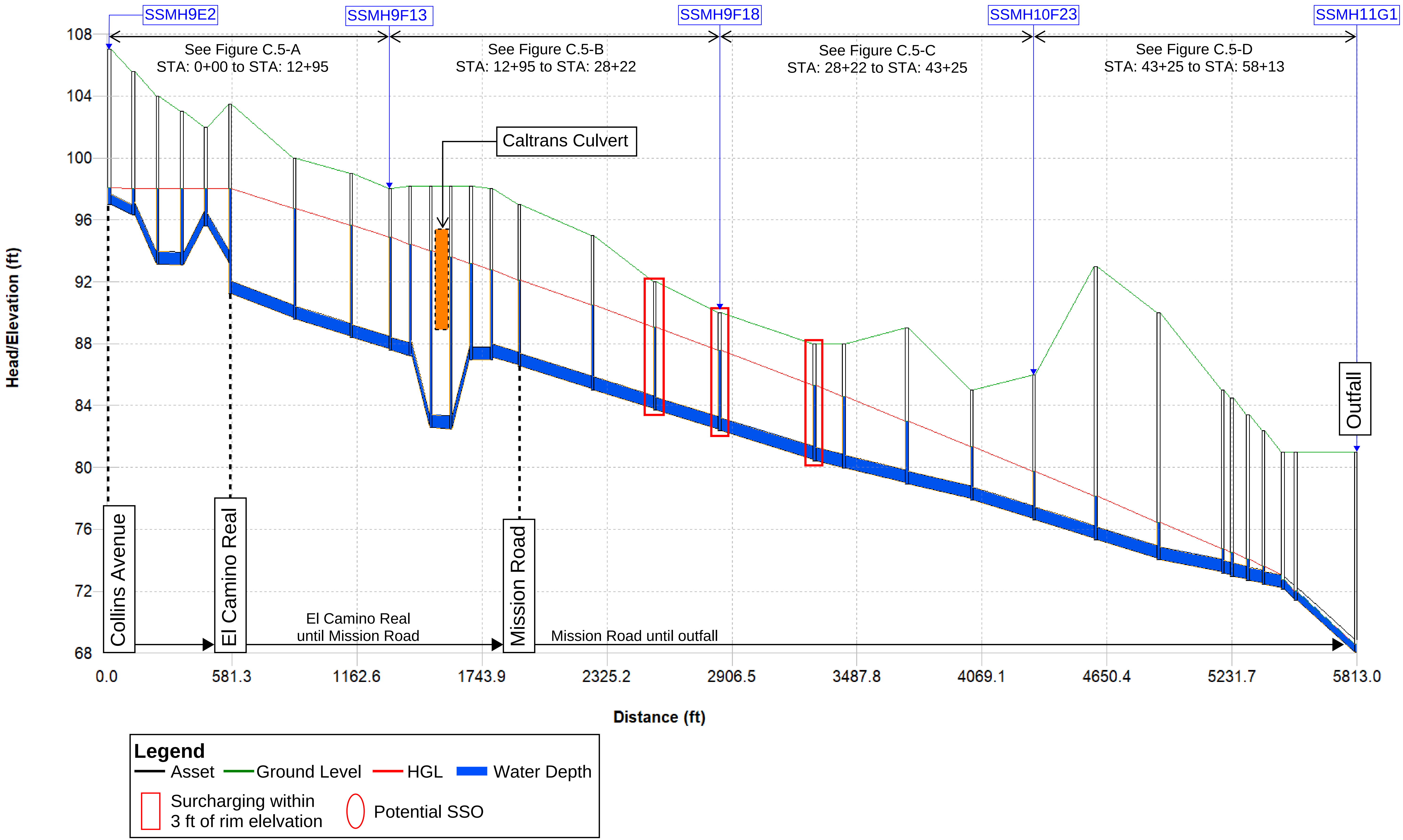
APPENDIX C.4

HGL Profile of Serra Shopping Center and Collins Avenue Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm

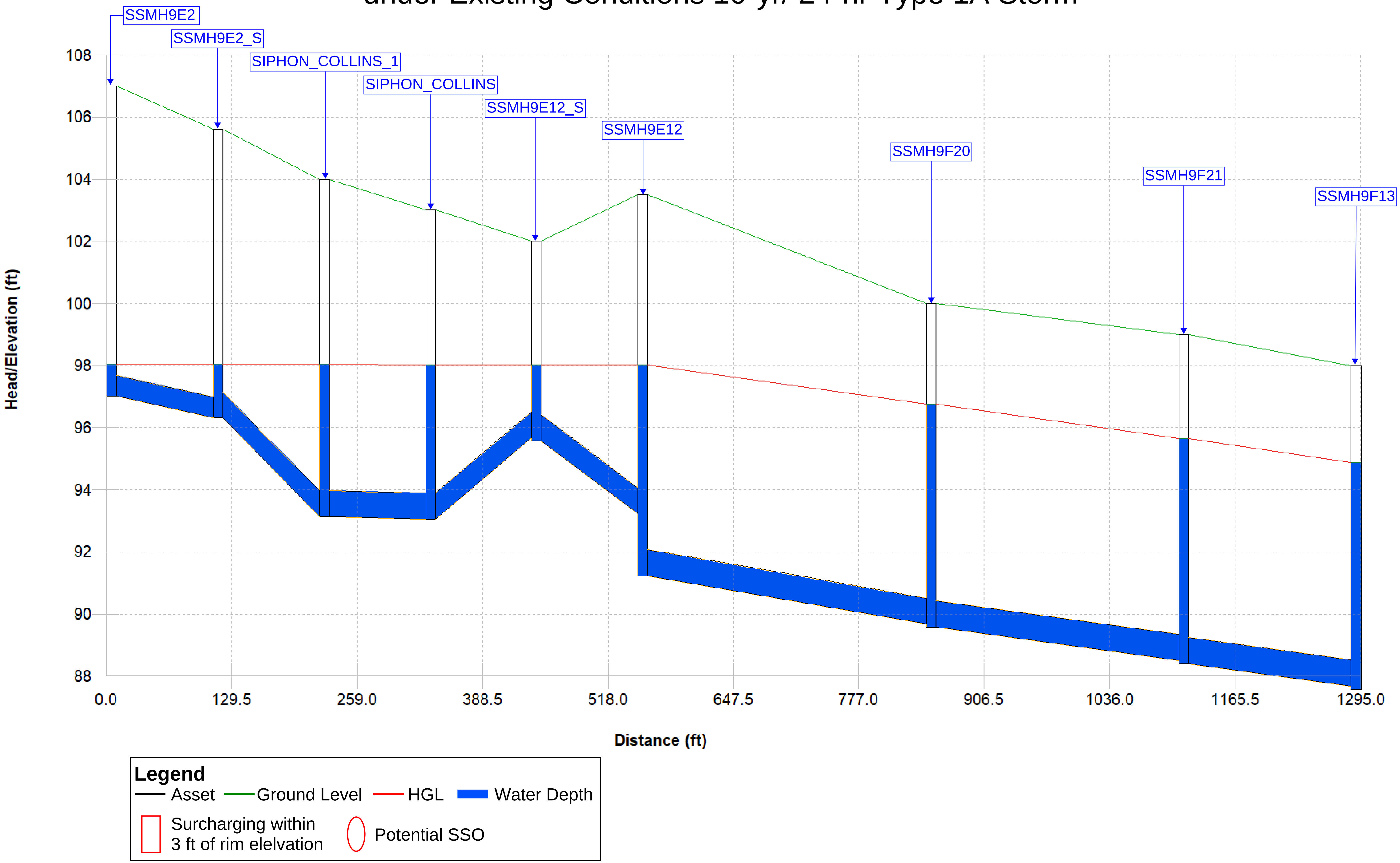


Appendix C.5 HGL Profile of El Camino Real and Mission Road Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm

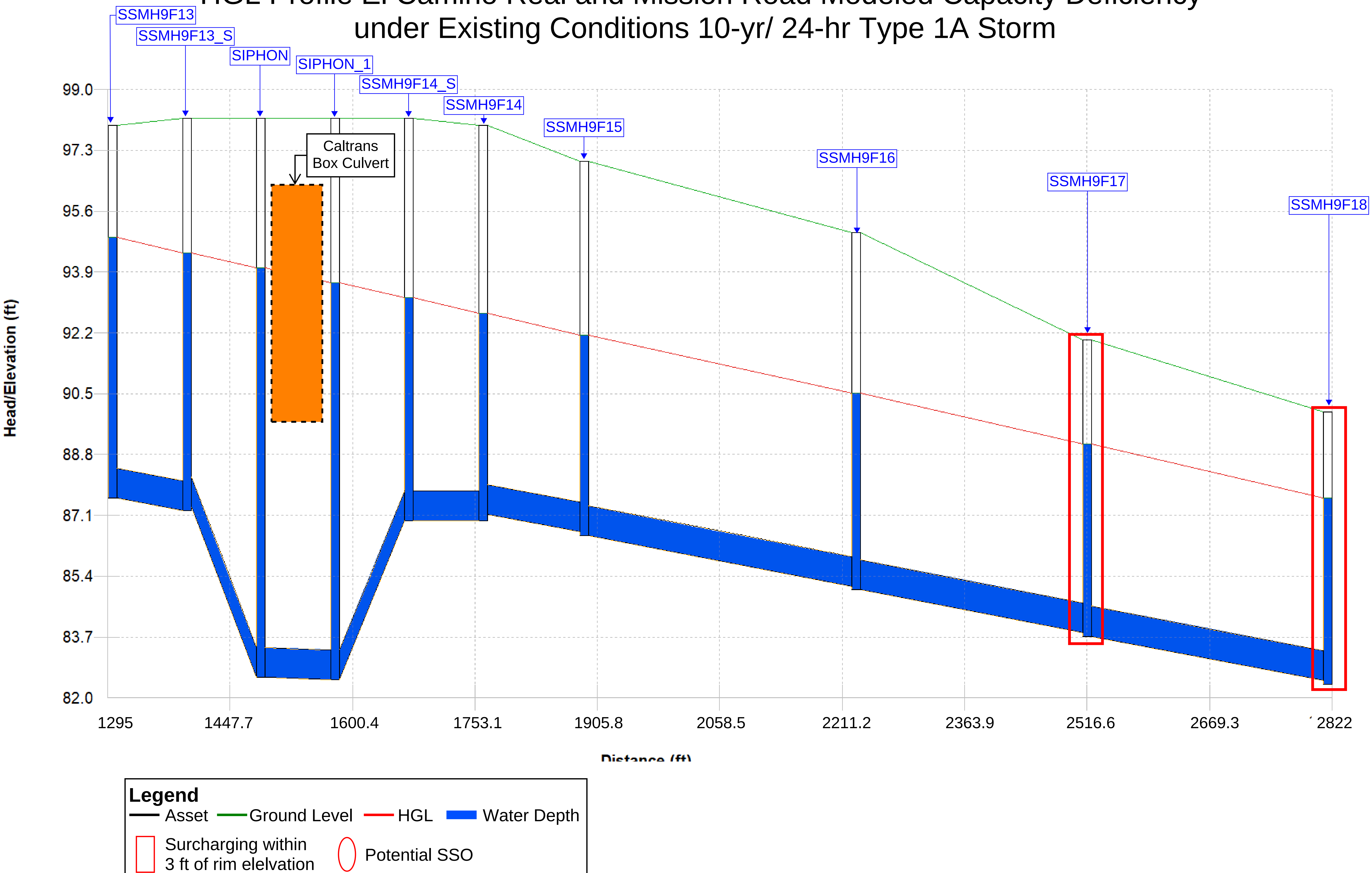
Appendix C.5
HGL Profile El Camino Real and Mission Road Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm



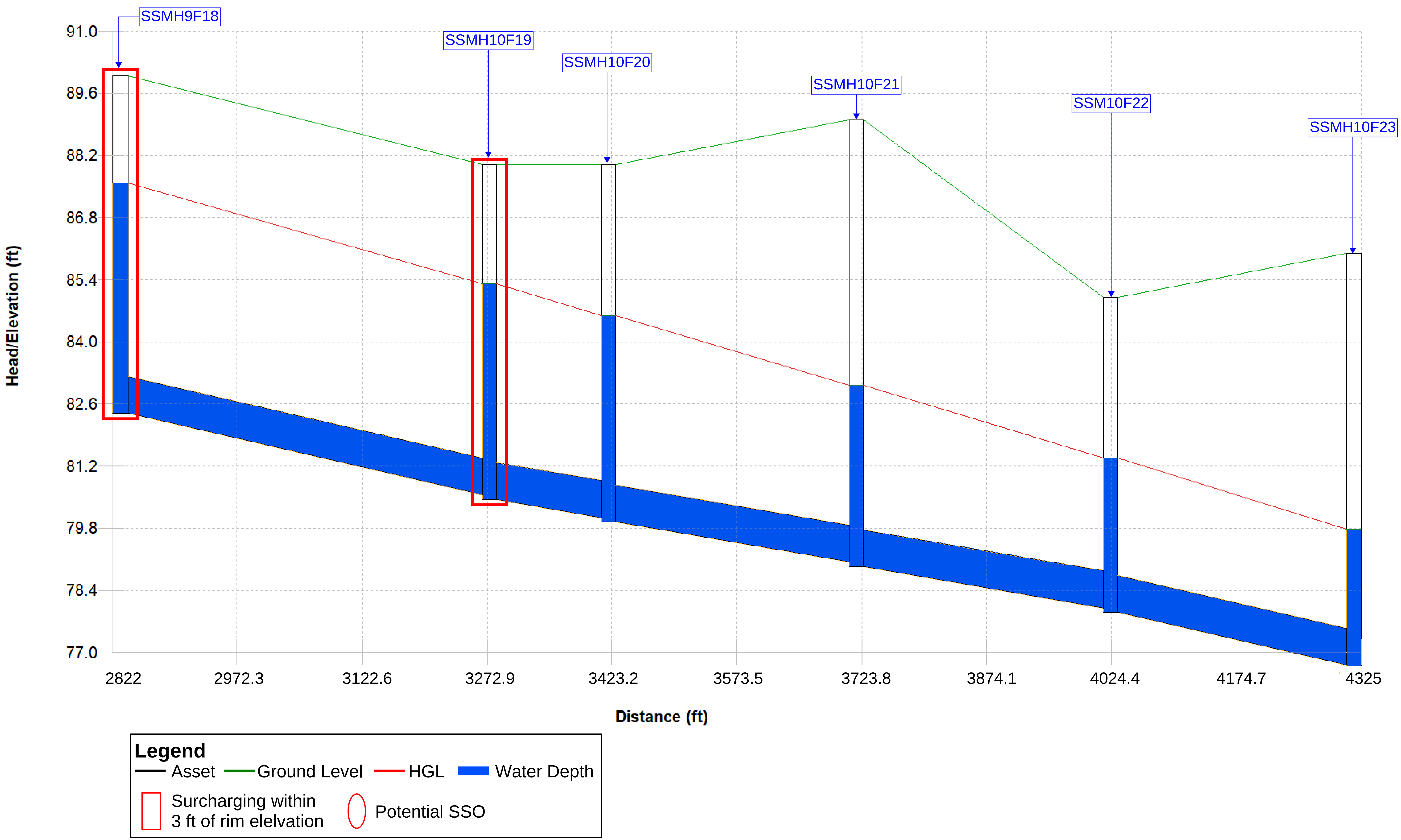
Appendix C.5-A
HGL Profile El Camino Real and Mission Road Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm



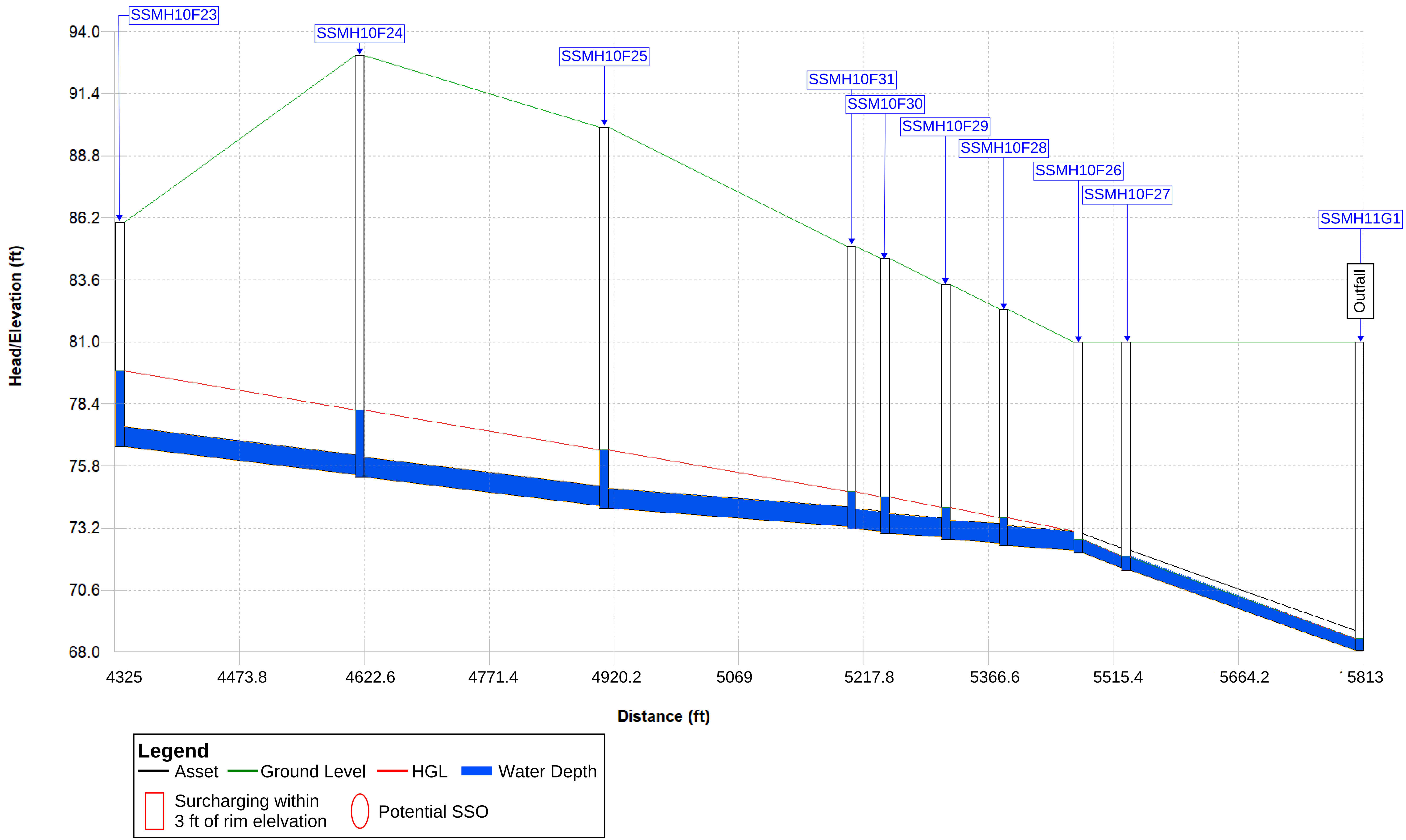
Appendix C.5-B
HGL Profile El Camino Real and Mission Road Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm



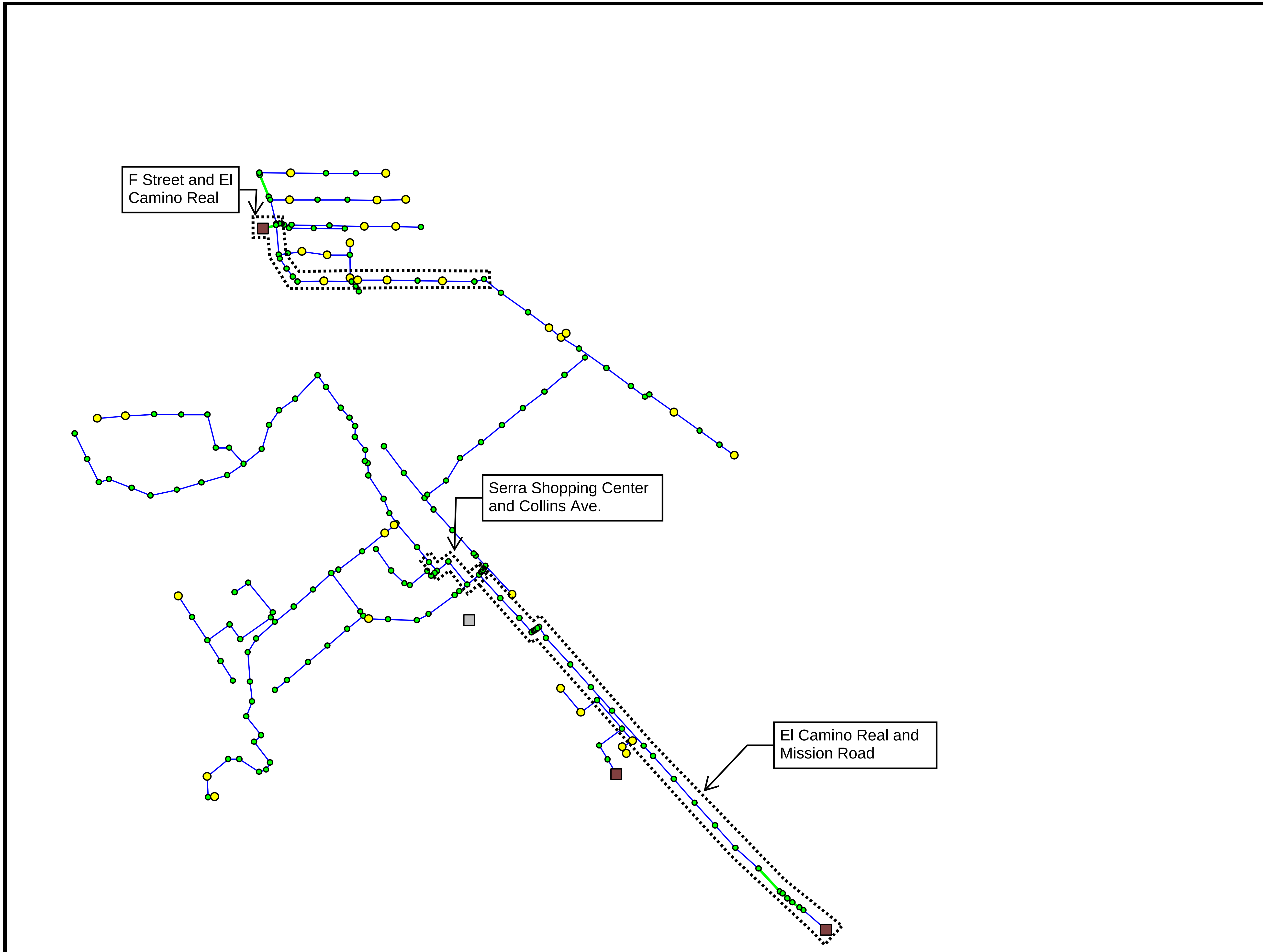
Appendix C.5-C
HGL Profile El Camino Real and Mission Road Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm



Appendix C.5-D
HGL Profile El Camino Real and Mission Road Modeled Capacity Deficiency under Existing Conditions 10-yr/ 24-hr Type 1A Storm



Appendix D.1 Ultimate Build-out Conditions Dry Weather Flow Results Figure



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

Manhole Unfilled Depth

- Potential SSO
- 0 - 3 Feet
- 3 - 5 Feet
- > 5 Feet

Outlet

- Active

Pipe Max "d/D" Ratio

- Less than 0.5
- 0.5~0.75
- 0.75~0.99
- Greater than 0.99

Basins

- DCMB
- SSFMB1A
- SSFMB1B
- SSFMB2
- SSFMB3
- SSFMB4A
- SSFMB4B
- SSFMB5
- SSFMB6
- SSFMB7
- Does not flow to Colma

N

800 400 0 800 Feet

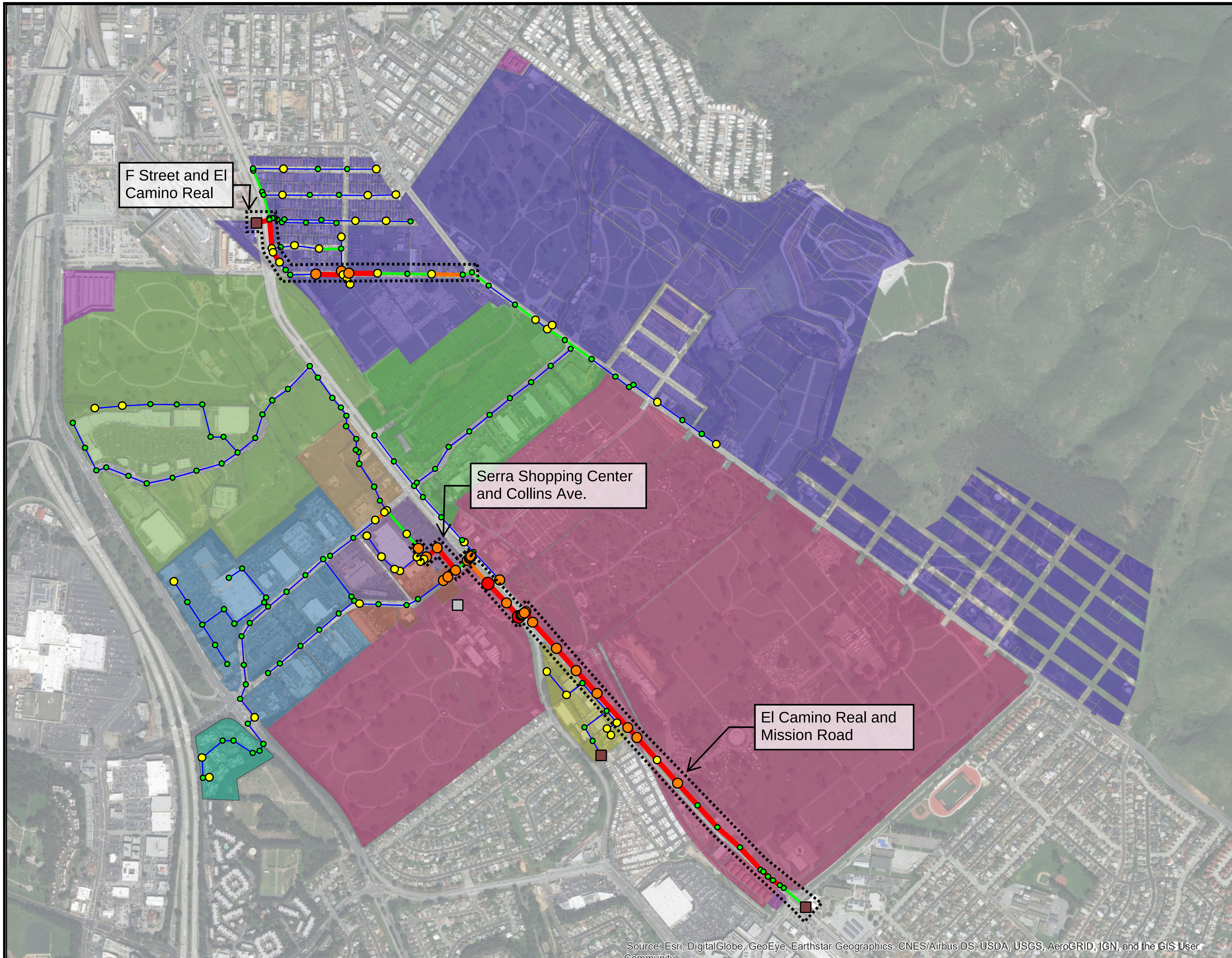
Appendix D.1

Ultimate Build-out Conditions Dry Weather Flow Results Figure*

*Refer to Appendix D.3, D.4, and D.5 for manhole IDs and more refined system layout.

WATERWORKS ENGINEERS

Appendix D.2 Ultimate Build-out Conditions Wet Weather Flow Results Figures



Legend

Manhole Unfilled Depth
- Potential SSO
- 0 - 3 Feet
- 3 - 5 Feet
- > 5 Feet

Outlet
- Active

Pipe Max "d/D" Ratio
- Less than 0.5
- 0.5~0.75
- 0.75~0.99
- Greater than 0.99

Basins
- DCMB
- SSFMB1A
- SSFMB1B
- SSFMB2
- SSFMB3
- SSFMB4A
- SSFMB4B
- SSFMB5
- SSFMB6
- SSFMB7
- Does not flow to Colma

N

800 400 0 800 Feet

Appendix D.2

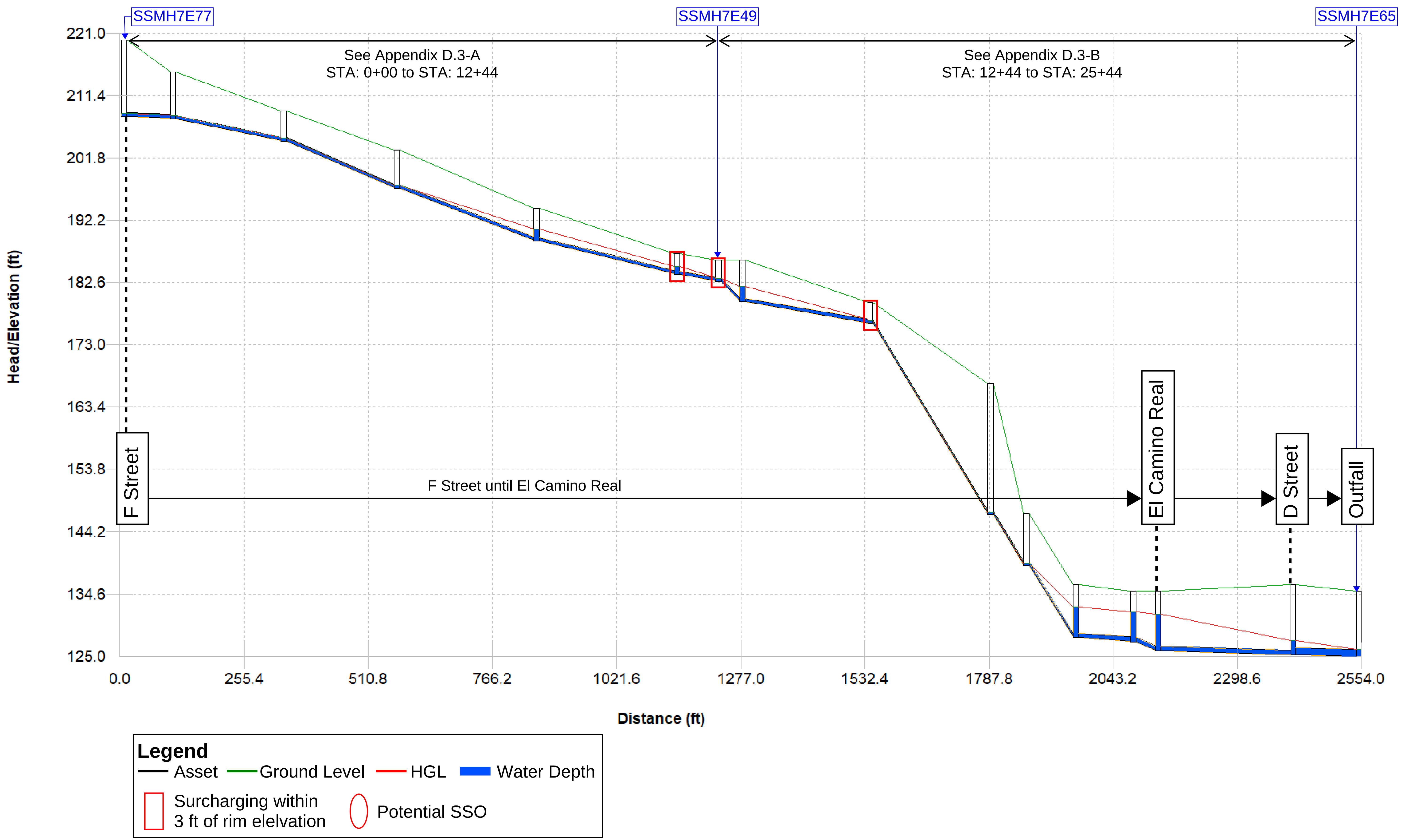
Ultimate Build-out Conditions Wet Weather Flow Results Figure*

*Refer to Appendix D.3, D.4, and D.5 for manhole IDs and more refined system layout.

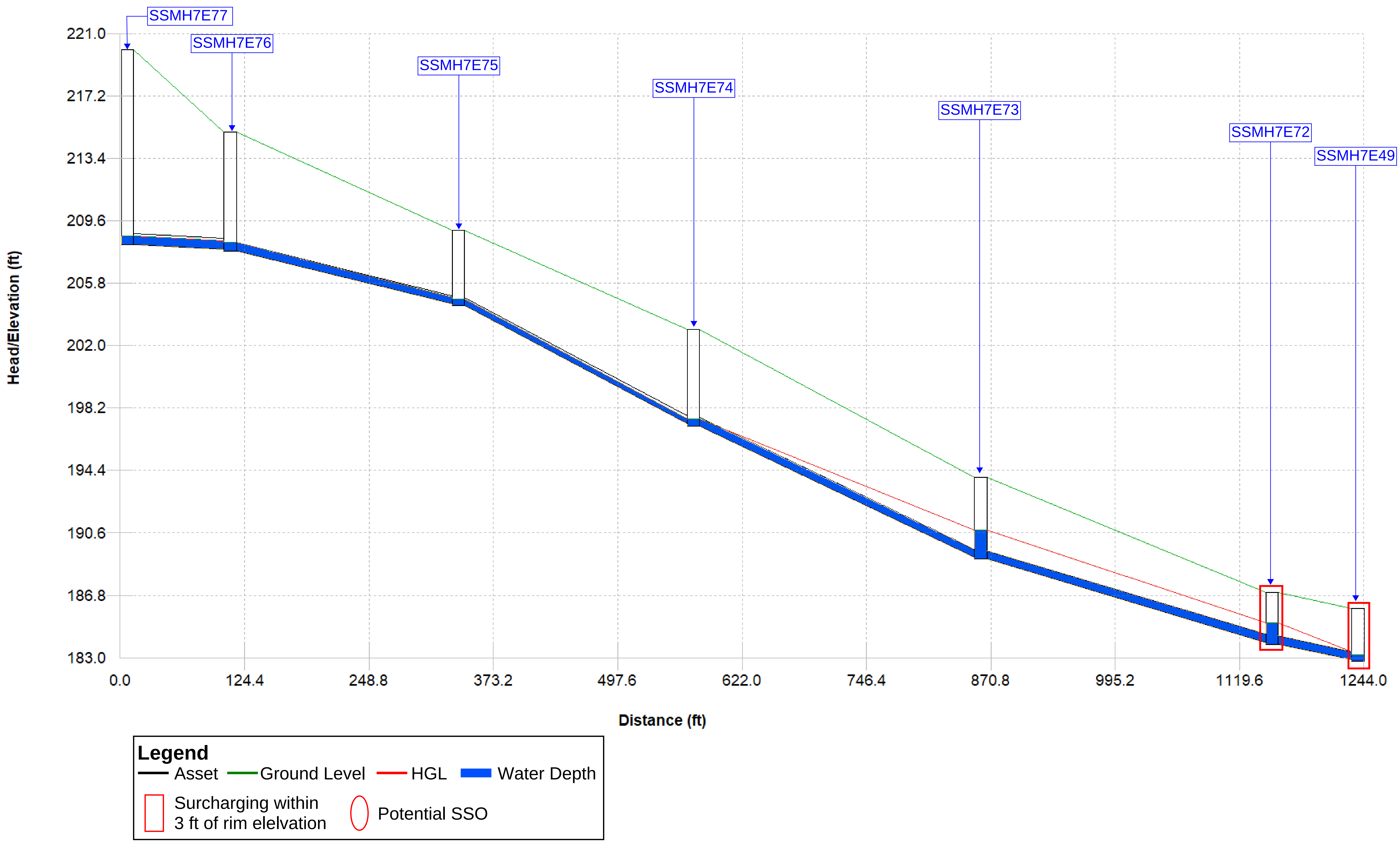
WATERWORKS ENGINEERS

Appendix D.3 HGL Profile of F Street and El Camino Real Modeled Capacity Deficiency under Ultimate Build-out Conditions 10-yr/ 24-hr Type 1A Storm

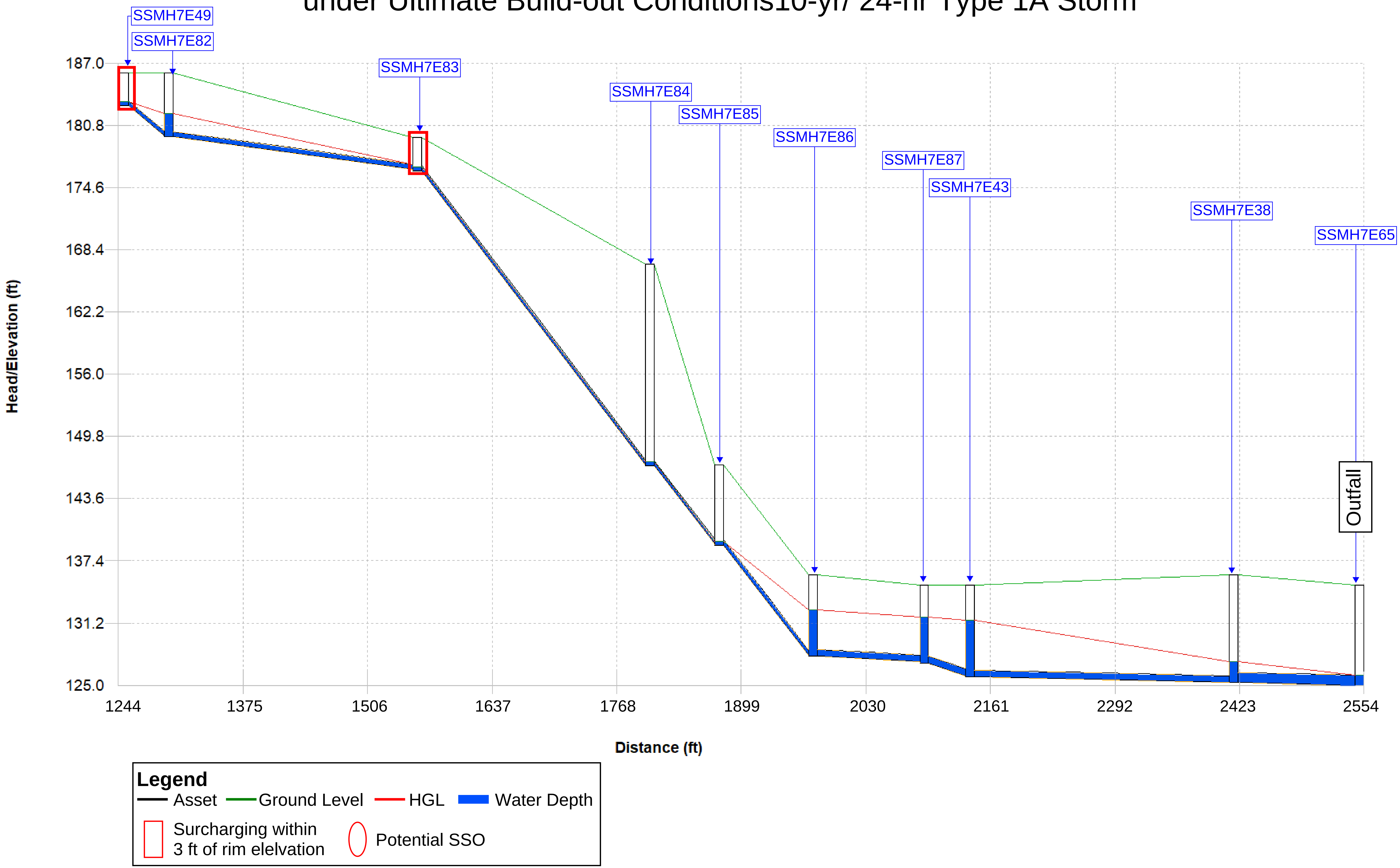
Appendix D.3
HGL Profile F Street and El Camino Real Modeled Capacity Deficiency under Ultimate Build-out Conditions10-yr/ 24-hr Type 1A Storm



Appendix D.3-A
HGL Profile F Street and El Camino Real Modeled Capacity Deficiency under Ultimate Build-out Conditions10-yr/ 24-hr Type 1A Storm

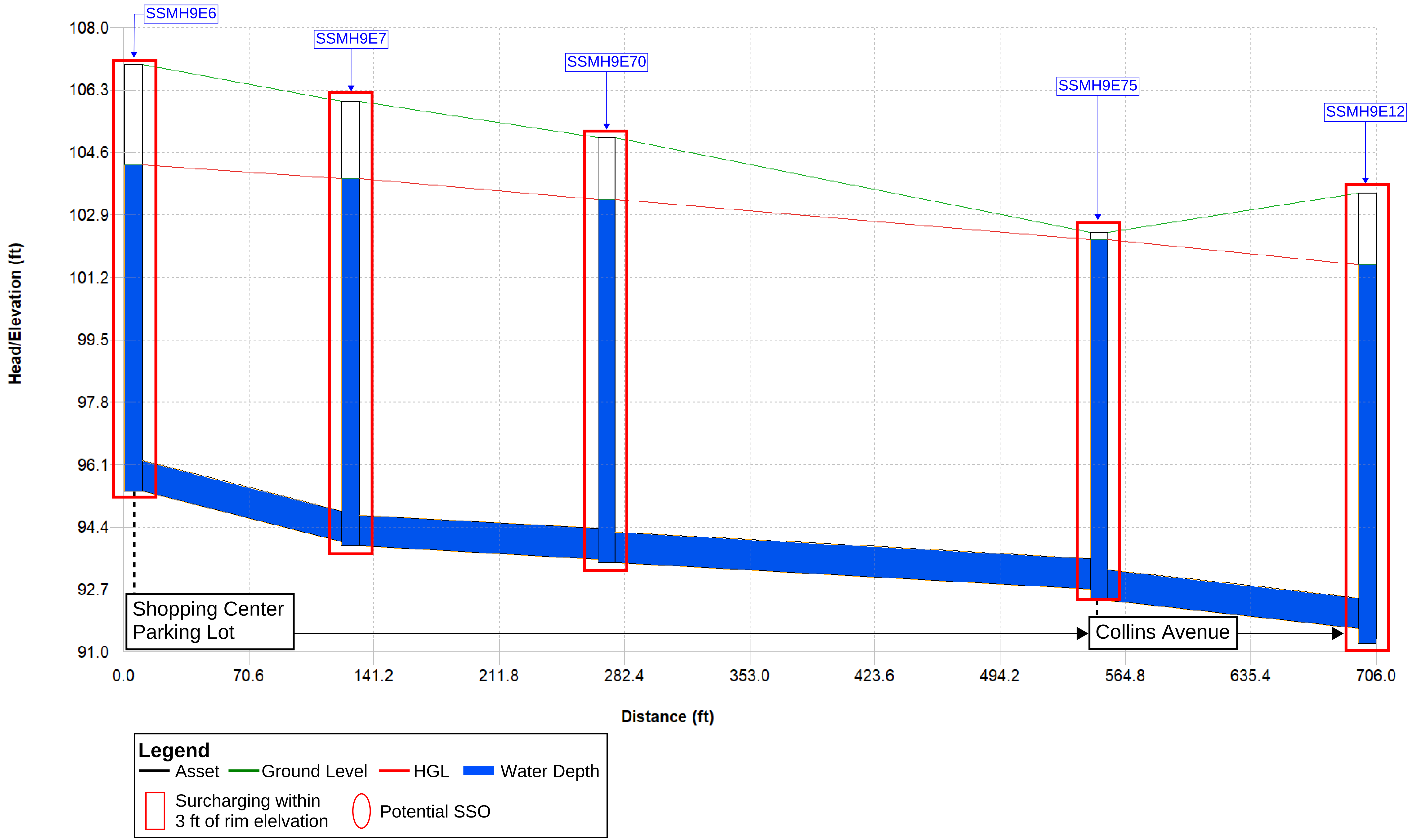


Appendix D.3-B
HGL Profile F Street and El Camino Real Modeled Capacity Deficiency under Ultimate Build-out Conditions10-yr/ 24-hr Type 1A Storm



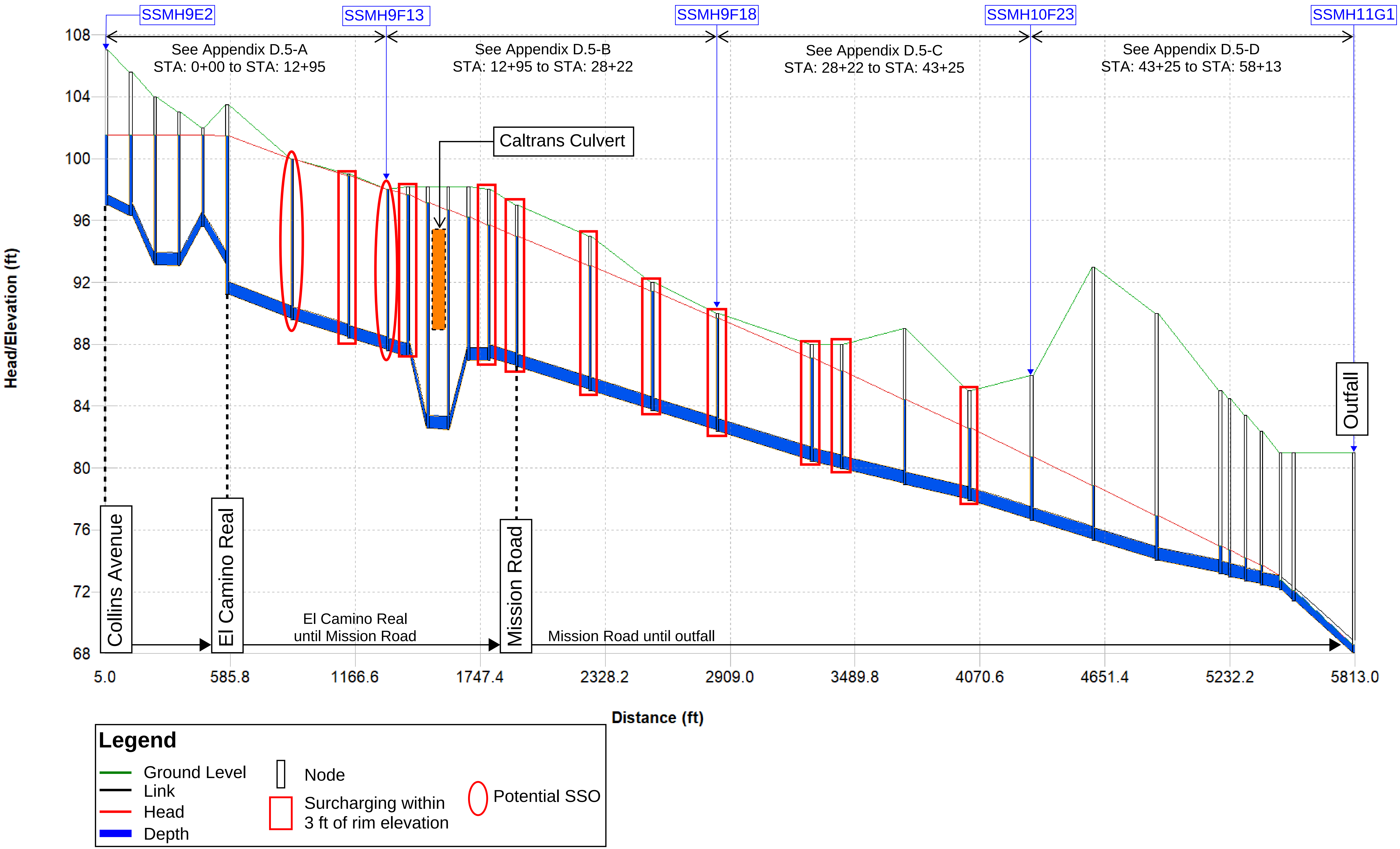
Appendix D.4 HGL Profile of Serra Shopping Center and Collins Avenue Modeled Capacity Deficiency under Ultimate Build-out Conditions 10-yr/ 24-hr Type 1A Storm

Appendix D.4
HGL Profile of Serra Shopping Center and Collins Avenue Modeled Capacity Deficiency under Ultimate Build-out Conditions 10yr 24hr Type 1A Storm

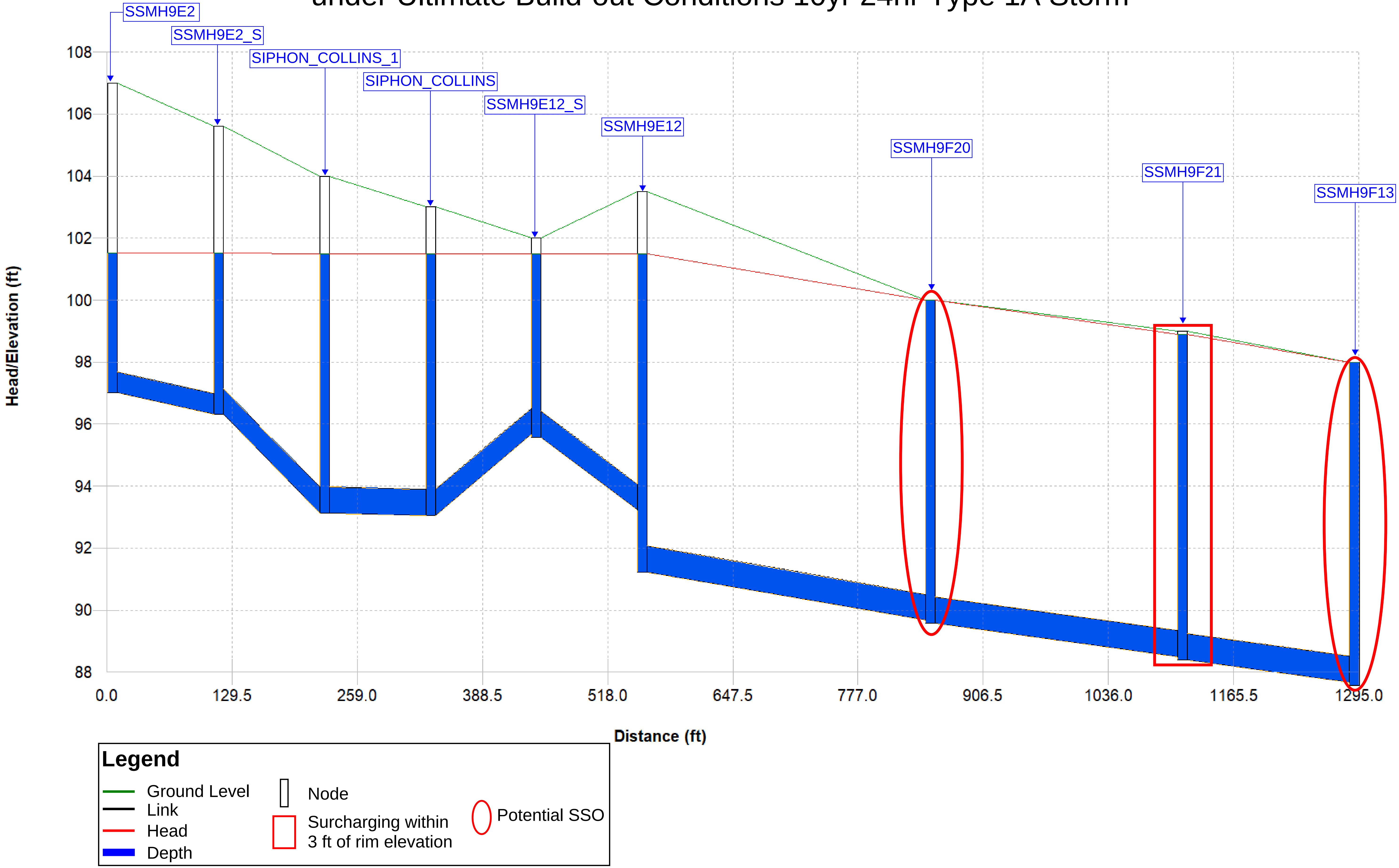


Appendix D.5 HGL Profile of El Camino Real and Mission Road Modeled Capacity Deficiency under Ultimate Build-out Conditions 10-yr/ 24-hr Type 1A Storm

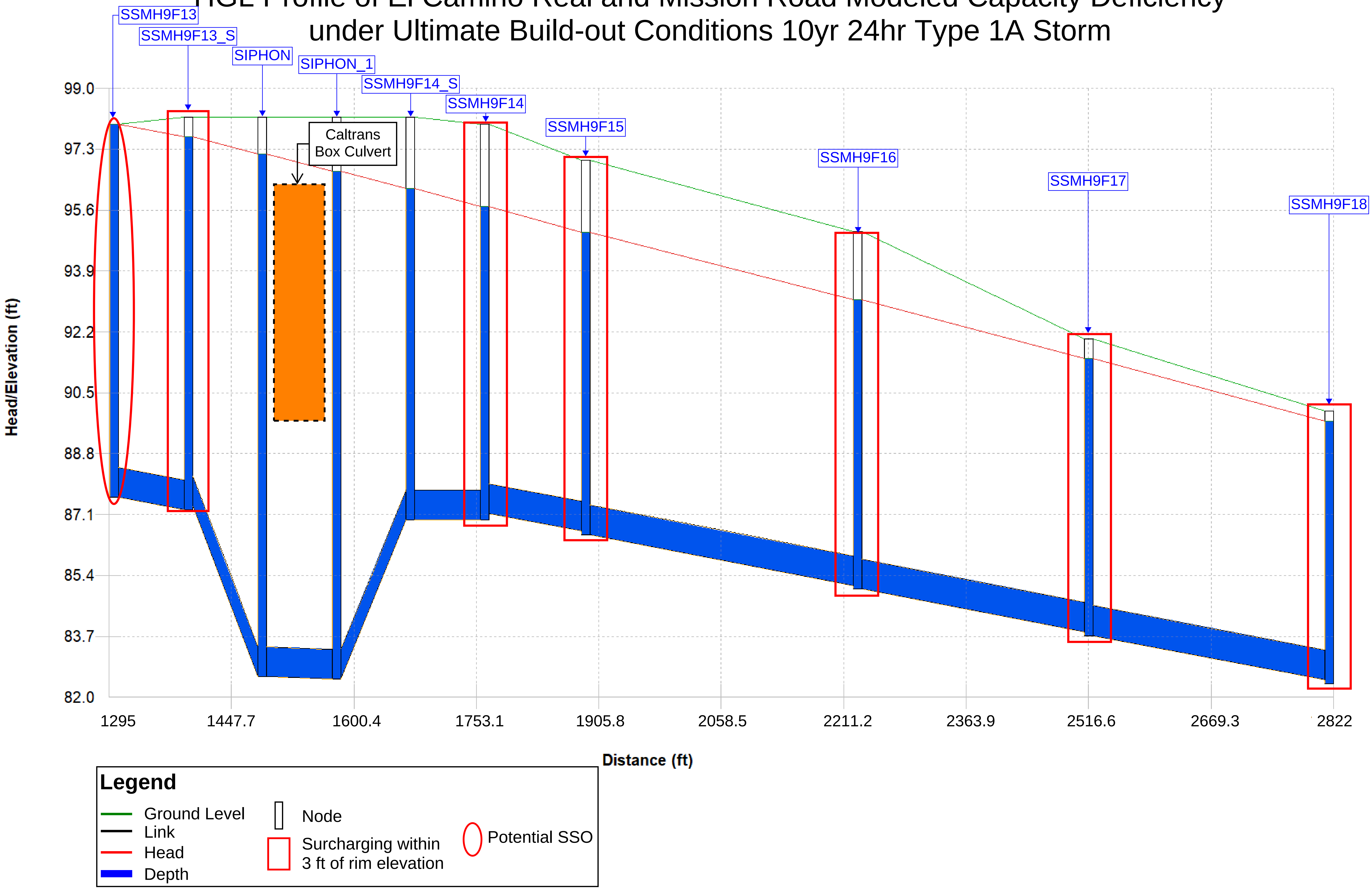
Appendix D.5
HGL Profile of El Camino Real and Mission Road Modeled Capacity Deficiency under Ultimate Build-out Conditions 10yr 24hr Type 1A Storm



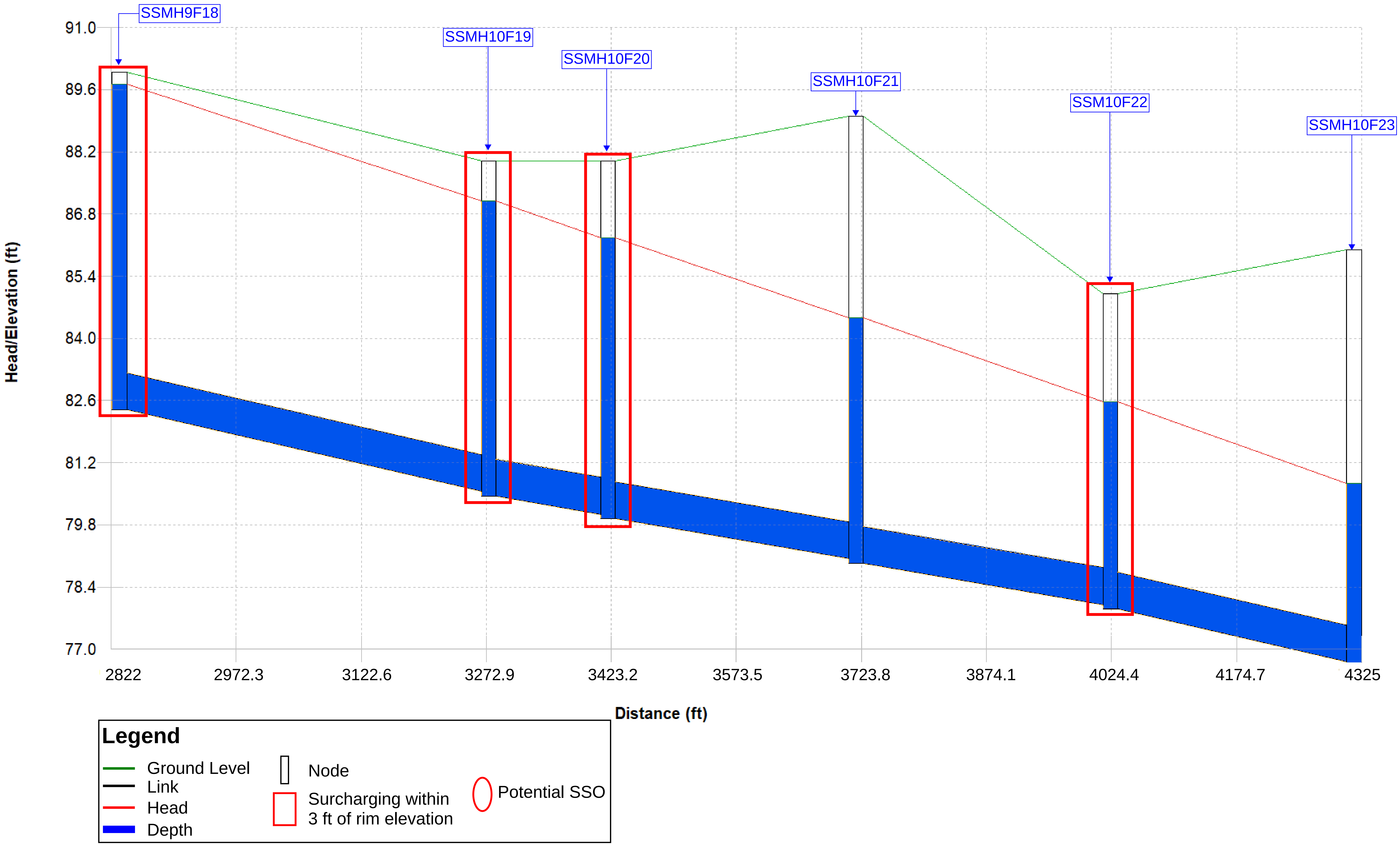
Appendix D.5-A
HGL Profile of El Camino Real and Mission Road Modeled Capacity Deficiency under Ultimate Build-out Conditions 10yr 24hr Type 1A Storm



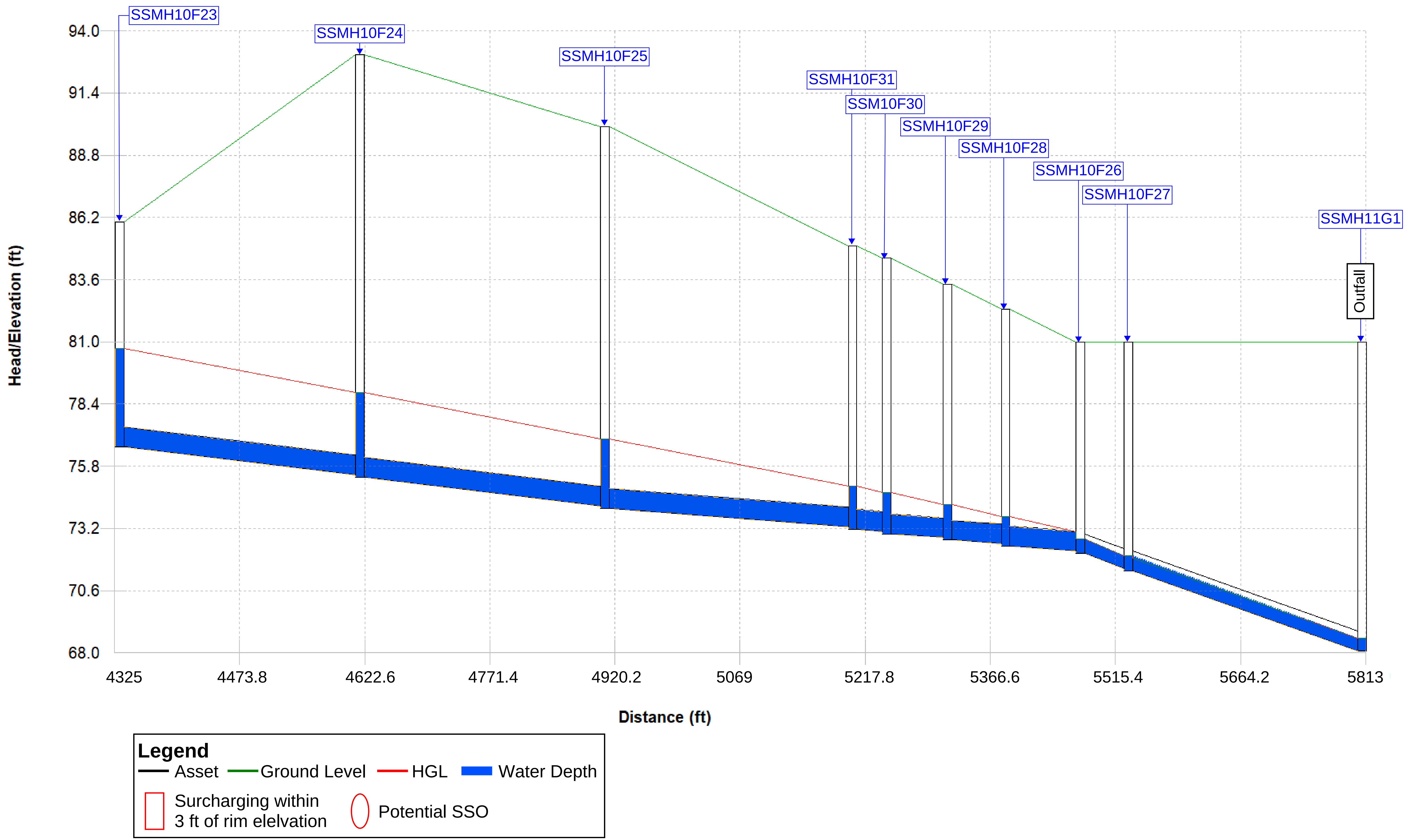
Appendix D.5-B
HGL Profile of El Camino Real and Mission Road Modeled Capacity Deficiency under Ultimate Build-out Conditions 10yr 24hr Type 1A Storm



Appendix D.5-C
HGL Profile of El Camino Real and Mission Road Modeled Capacity Deficiency under Ultimate Build-out Conditions10yr 24hr Type 1A Storm



Appendix D.5-D
HGL Profile of El Camino Real and Mission Road Modeled Capacity Deficiency under Ultimate Build-out Conditions10yr 24hr Type 1A Storm



Appendix E. City of South San Francisco Wastewater Collection System Capacity Analysis Package (Akel Engineering Group, Inc., January 2019)

LEGEND

- Existing Modeled Pipeline
- Existing Modeled Manhole
- 18" Existing Pipeline Diameter

PRELIMINARY

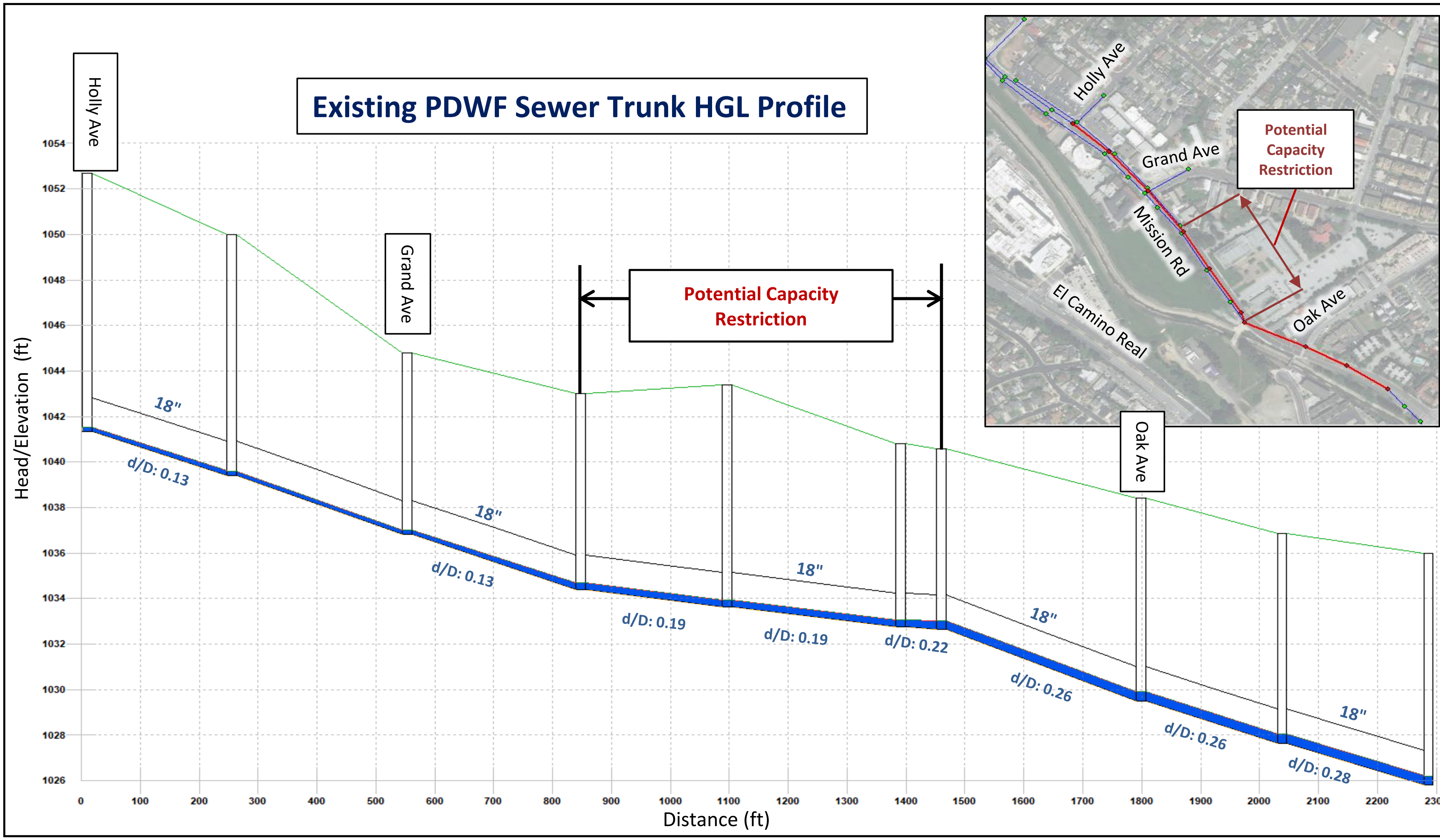
January 31, 2019

AKEL ENGINEERING GROUP, INC.

Figure 1

Mission Rd HGL Profile Study Area

City of South San Francisco



Notes:

PRELIMINARY

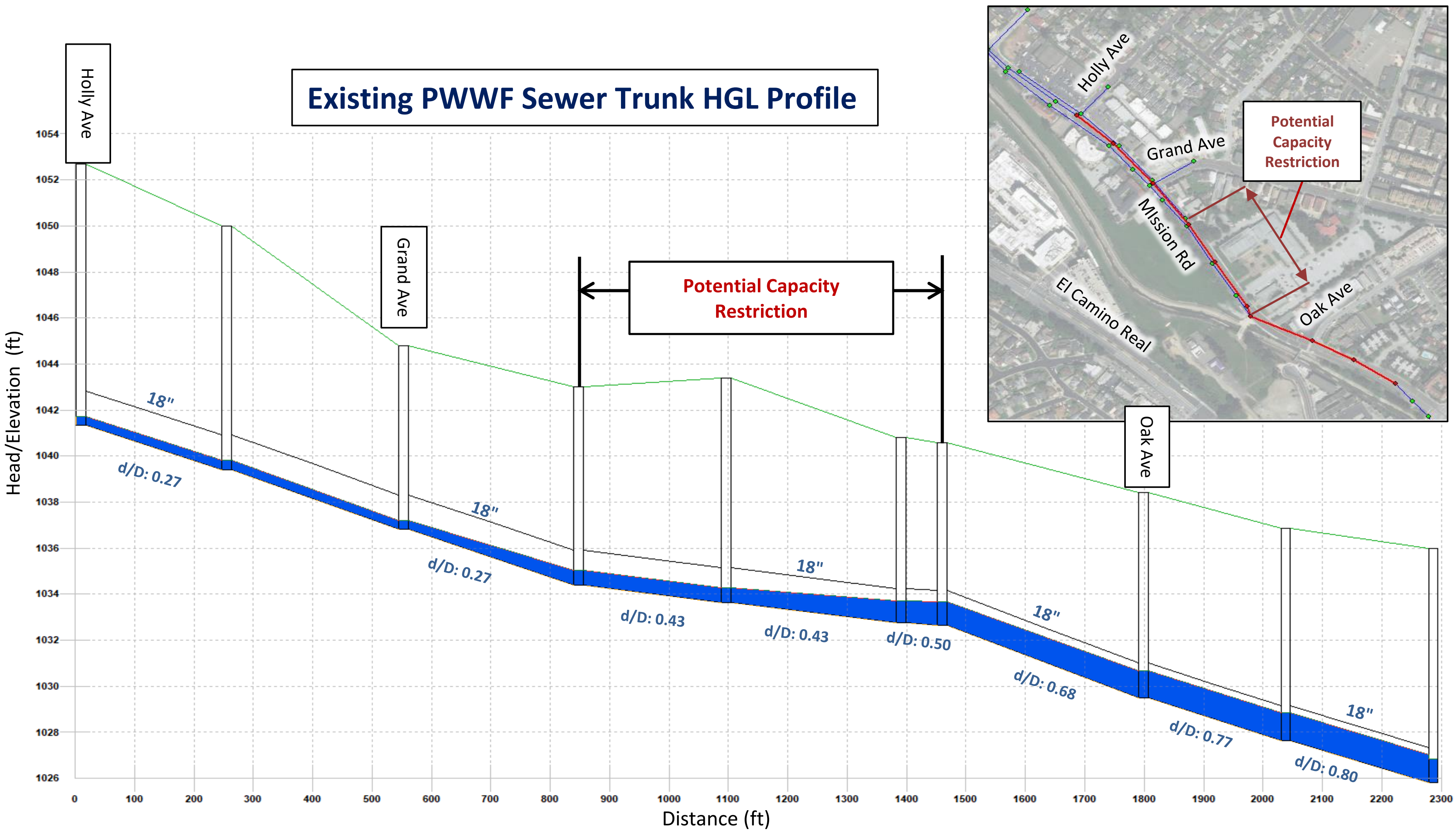
1. Flows are based on peak dry weather flows
2. Peak flow observed in sewer trunk: 725 gpm
3. Allocated flow based on Unit Flow Factor Analysis and Land Use for Basin B1 and B2
4. PDWF is equal to ADWF for Basin B1 and B2 and reflects historical flows at the WPCP and diurnal curve extracted from V&A Flow Monitoring Analysis.
5. 2018 SSMP Criteria: Sewer trunk d/D to be under 90% capacity
6.This analysis does not include flows downstream of Mission Road and Chestnut Avenue. This analysis was limited to the upstream portion of the sewer trunk where Colma flows enter the system. Additional analysis will be completed once the hydraulic model is calibrated.
7. Flows included in the hydraulic model reflect City of South San Francisco only, and do not include Colma or Daly City.

January 31, 2019

Figure 2

Mission Rd HGL Profile
Existing PDWF
City of South San Francisco

AKEL
ENGINEERING GROUP, INC.



Notes:

PRELIMINARY

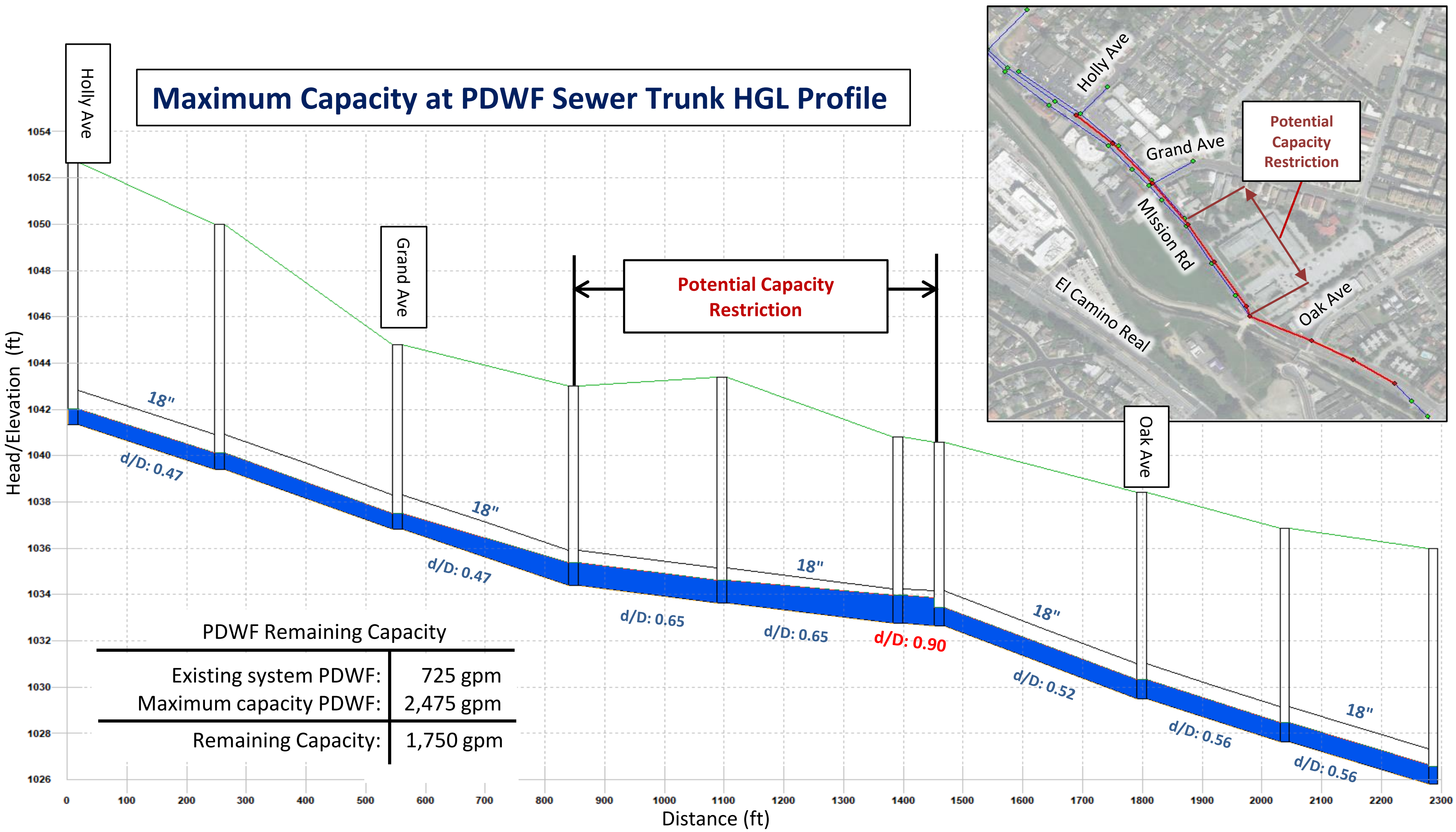
1. Flows are based on peak dry weather flows
2. Peak flow observed in sewer trunk: 3,925 gpm
3. Allocated flow based on Unit Flow Factor Analysis and Land Use for Basin B1 and B2
4. PDWF is equal to ADWF for Basin B1 and B2 and reflects historical flows at the WPCP and diurnal curve extracted from V&A Flow Monitoring Analysis.
5. 2018 SSMP Criteria: Sewer trunk d/D to be under 90% capacity
6. This analysis does not include flows downstream of Mission Road and Chestnut Avenue. This analysis was limited to the upstream portion of the sewer trunk where Colma flows enter the system. Additional analysis will be completed once the hydraulic model is calibrated.
7. Flows included in the hydraulic model reflect City of South San Francisco only, and do not include Colma or Daly City.
8. PWWF based on 10-year 24-hour storm event (3.85 in) obtained from NOAA Atlas 14.

January 31, 2019

Figure 3

Mission Rd HGL Profile
Existing PWWF
City of South San Francisco

AKEL
ENGINEERING GROUP, INC.



PDWF Remaining Capacity

Existing system PDWF:	725 gpm
Maximum capacity PDWF:	2,475 gpm
Remaining Capacity:	1,750 gpm

Notes:

PRELIMINARY

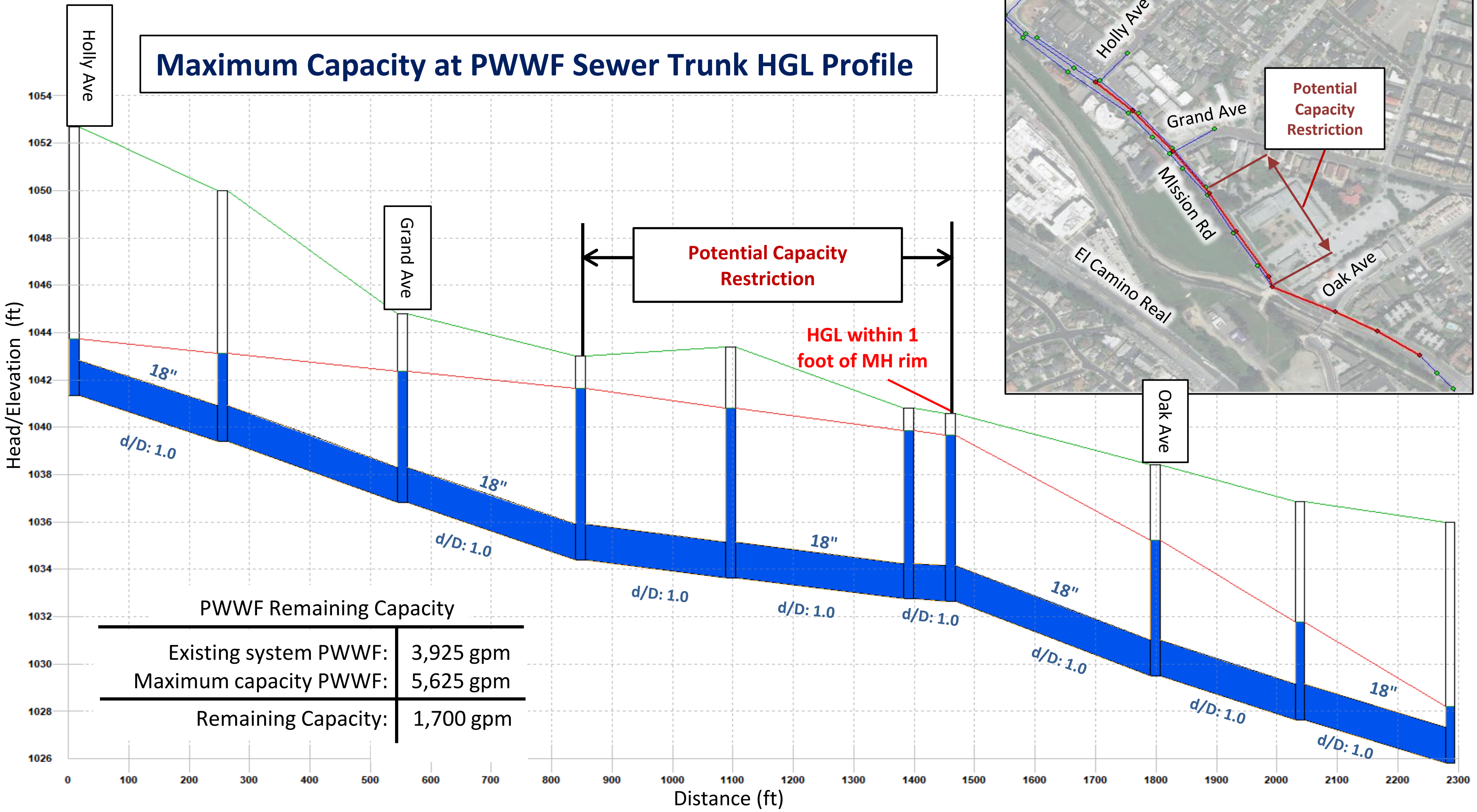
1. Flows and remaining capcity are based on peak dry weather flows
2. Allocated flow based on Unit Flow Factor Analysis and Land Use for Basin B1 and B2
3. PDWF is equal to ADWF for Basin B1 and B2 and reflects historical flows at the WPCP and diurnal curve extracted from V&A Flow Monitoring Analysis.
4. 2018 SSMP Criteria: Sewer trunk d/D to be under 90% capacity
5.This analysis does not include flows downstream of Mission Road and Chestnut Avenue. This analysis was limited to the upstream portion of the sewer trunk where Colma flows enter the system. Additional analysis will be completed once the hydraulic model is calibrated.
6. Flows included in the hydraulic model reflect City of South San Francisco only, and do not include Colma or Daly City.

January 31, 2019

AKEL
ENGINEERING GROUP, INC.

Figure 4
Mission Rd HGL Profile at Max Capacity (PDWF)
City of South San Francisco

Maximum Capacity at PWWF Sewer Trunk HGL Profile



PWWF Remaining Capacity

Existing system PWWF:	3,925 gpm
Maximum capacity PWWF:	5,625 gpm
Remaining Capacity:	1,700 gpm

Notes:

PRELIMINARY

1. Flows and remaining capcity are based on peak dry weather flows
2. Allocated flow based on Unit Flow Factor Analysis and Land Use for Basin B1 and B2
3. PDWF is equal to ADWF for Basin B1 and B2 and reflects historical flows at the WPCP and diurnal curve extracted from V&A Flow Monitoring Analysis.
4. 2018 SSMP Criteria: Sewer trunk d/D to be under 90% capacity
5.This analysis does not include flows downstream of Mission Road and Chestnut Avenue. This analysis was limited to the upstream portion of the sewer trunk where Colma flows enter the system. Additional analysis will be completed once the hydraulic model is calibrated.
6. Flows included in the hydraulic model reflect City of South San Francisco only, and do not include Colma or Daly City.
7. PWWF based on 10-year 24-hour storm event (3.85 in) obtained from NOAA Atlas 14.

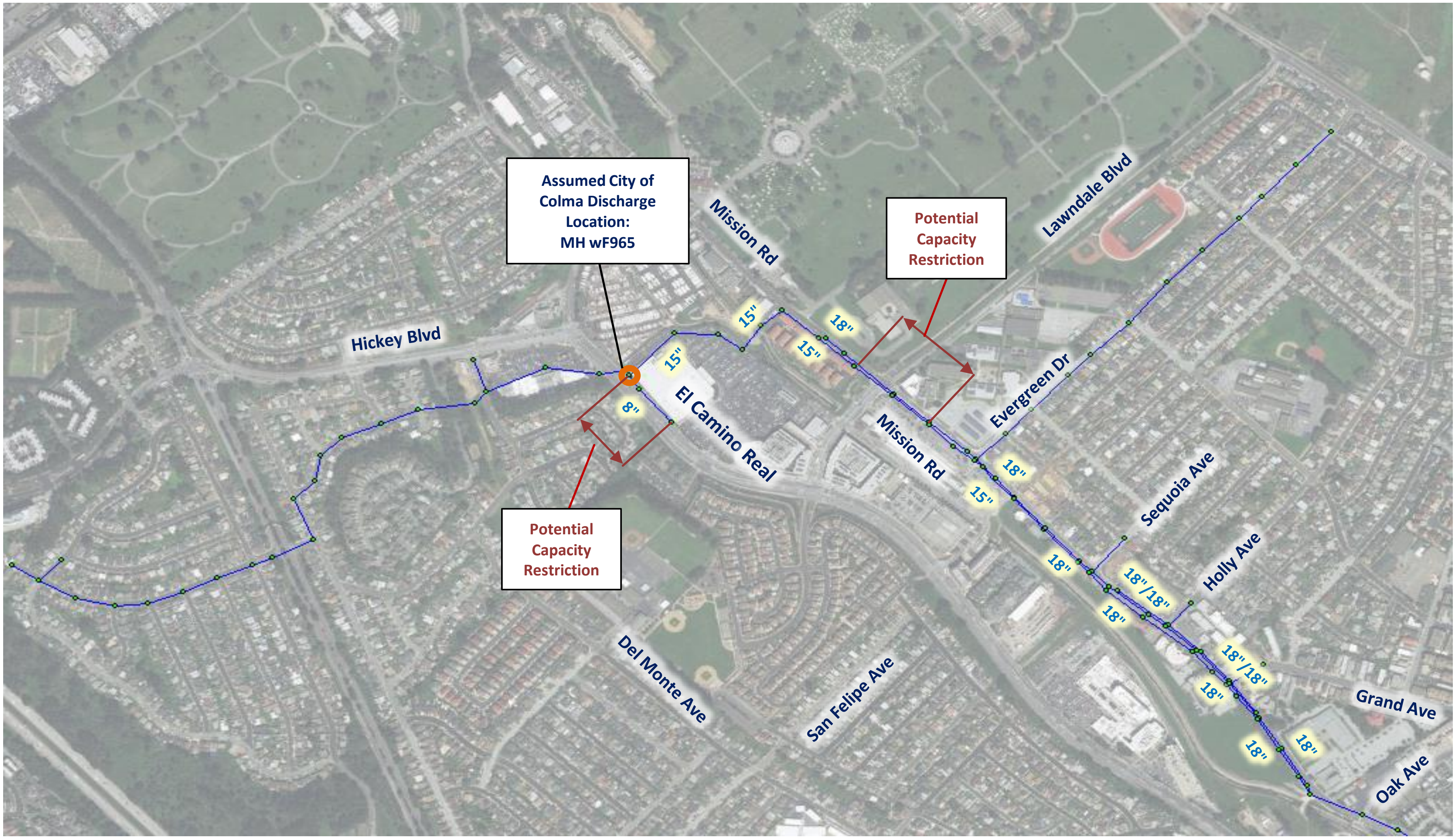
January 31, 2019

Figure 5

Mission Rd HGL Profile at Max Capacity (PWWF)

City of South San Francisco

AKEL ENGINEERING GROUP, INC.



LEGEND

- Existing Modeled Pipeline
- Existing Modeled Manhole
- 18" Existing Pipeline Diameter

PRELIMINARY

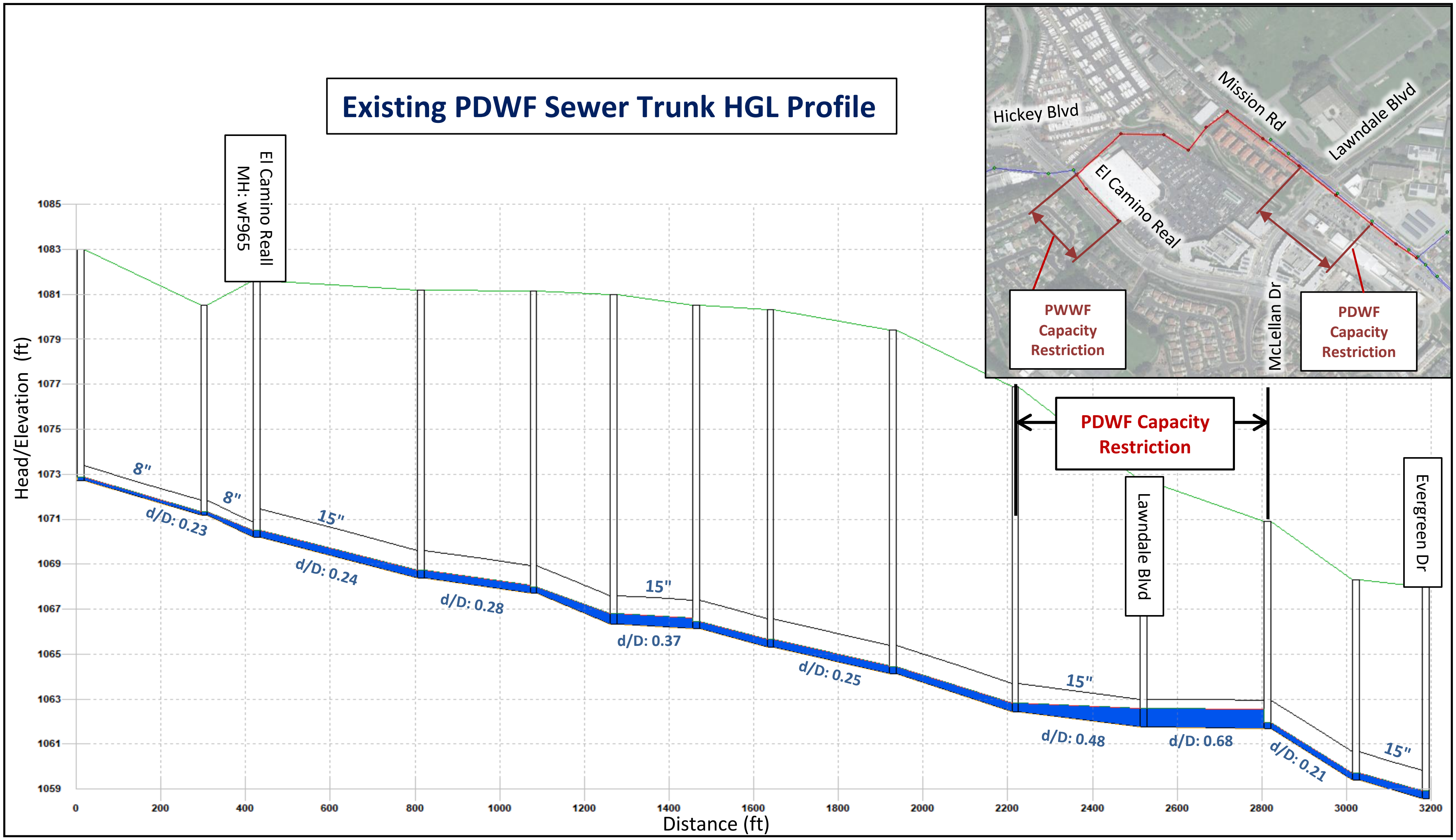
January 31, 2019

AKEL ENGINEERING GROUP, INC.

Figure 6

Hickey Blvd HGL Profile Study Area

City of South San Francisco



Notes:

PRELIMINARY

1. Flows are based on peak dry weather flows
2. Peak flow observed in sewer trunk: 300 gpm
3. Allocated flow based on Unit Flow Factor Analysis and Land Use for Basin B1 and B2
4. PDWF is equal to ADWF for Basin B1 and B2 and reflects historical flows at the WPCP and diurnal curve extracted from V&A Flow Monitoring Analysis.
5. 2018 SSMP Criteria: Sewer trunk d/D to be under 90% capacity
6. This analysis does not include flows downstream of Mission Road and Chestnut Avenue. This analysis was limited to the upstream portion of the sewer trunk where Colma flows enter the system. Additional analysis will be completed once the hydraulic model is calibrated.
7. Flows included in the hydraulic model reflect City of South San Francisco only, and do not include Colma or Daly City.

February 11, 2019

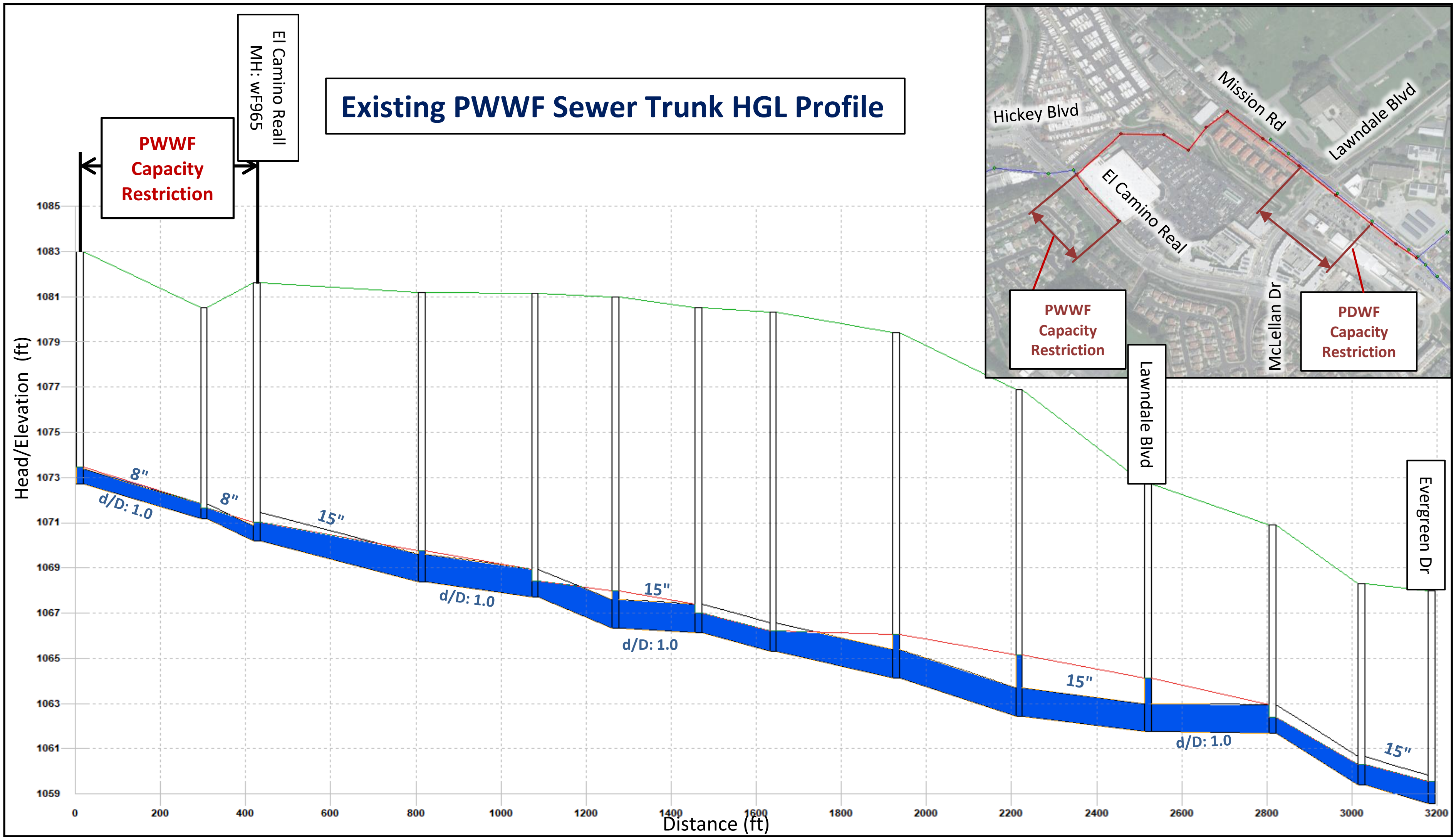
Figure 7

Hickey Blvd HGL Profile

Existing PDWF

City of South San Francisco

AKEL ENGINEERING GROUP, INC.



Notes:

PRELIMINARY

1. Flows are based on peak dry weather flows
2. Peak flow observed in sewer trunk: 1,900 gpm
3. Allocated flow based on Unit Flow Factor Analysis and Land Use for Basin B1 and B2
4. PDWF is equal to ADWF for Basin B1 and B2 and reflects historical flows at the WPCP and diurnal curve extracted from V&A Flow Monitoring Analysis.
5. 2018 SSMP Criteria: Sewer trunk d/D to be under 90% capacity
6.This analysis does not include flows downstream of Mission Road and Chestnut Avenue. This analysis was limited to the upstream portion of the sewer trunk where Colma flows enter the system. Additional analysis will be completed once the hydraulic model is calibrated.
7. Flows included in the hydraulic model reflect City of South San Francisco only, and do not include Colma or Daly City.
8. PWWF based on 10-year 24-hour storm event (3.85 in) obtained from NOAA Atlas 14.

February 11, 2019

Figure 8

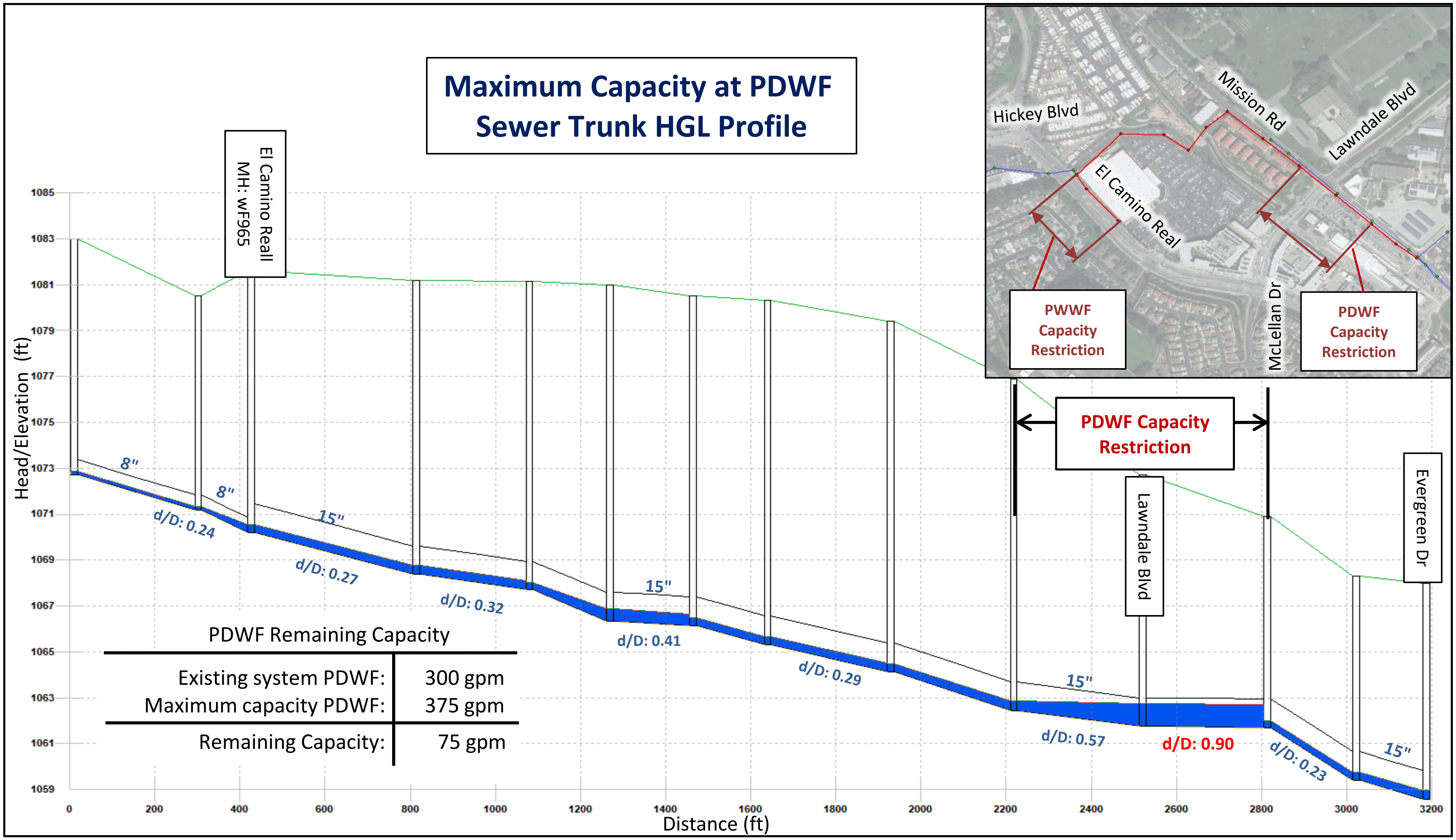
Hickey Blvd HGL Profile

Existing PWWF

City of South San Francisco

AKEL ENGINEERING GROUP, INC.

Maximum Capacity at PDWF Sewer Trunk HGL Profile



PDWF Remaining Capacity

Existing system PDWF:	300 gpm
Maximum capacity PDWF:	375 gpm
Remaining Capacity:	75 gpm

Notes:

PRELIMINARY

1. Flows and remaining capcity are based on peak dry weather flows
2. Allocated flow based on Unit Flow Factor Analysis and Land Use for Basin B1 and B2
3. PDWF is equal to ADWF for Basin B1 and B2 and reflects historical flows at the WPCP and diurnal curve extracted from V&A Flow Monitoring Analysis.
4. 2018 SSMP Criteria: Sewer trunk d/D to be under 90% capacity
5.This analysis does not include flows downstream of Mission Road and Chestnut Avenue. This analysis was limited to the upstream portion of the sewer trunk where Colma flows enter the system. Additional analysis will be completed once the hydraulic model is calibrated.
6. Flows included in the hydraulic model reflect City of South San Francisco only, and do not include Colma or Daly City.

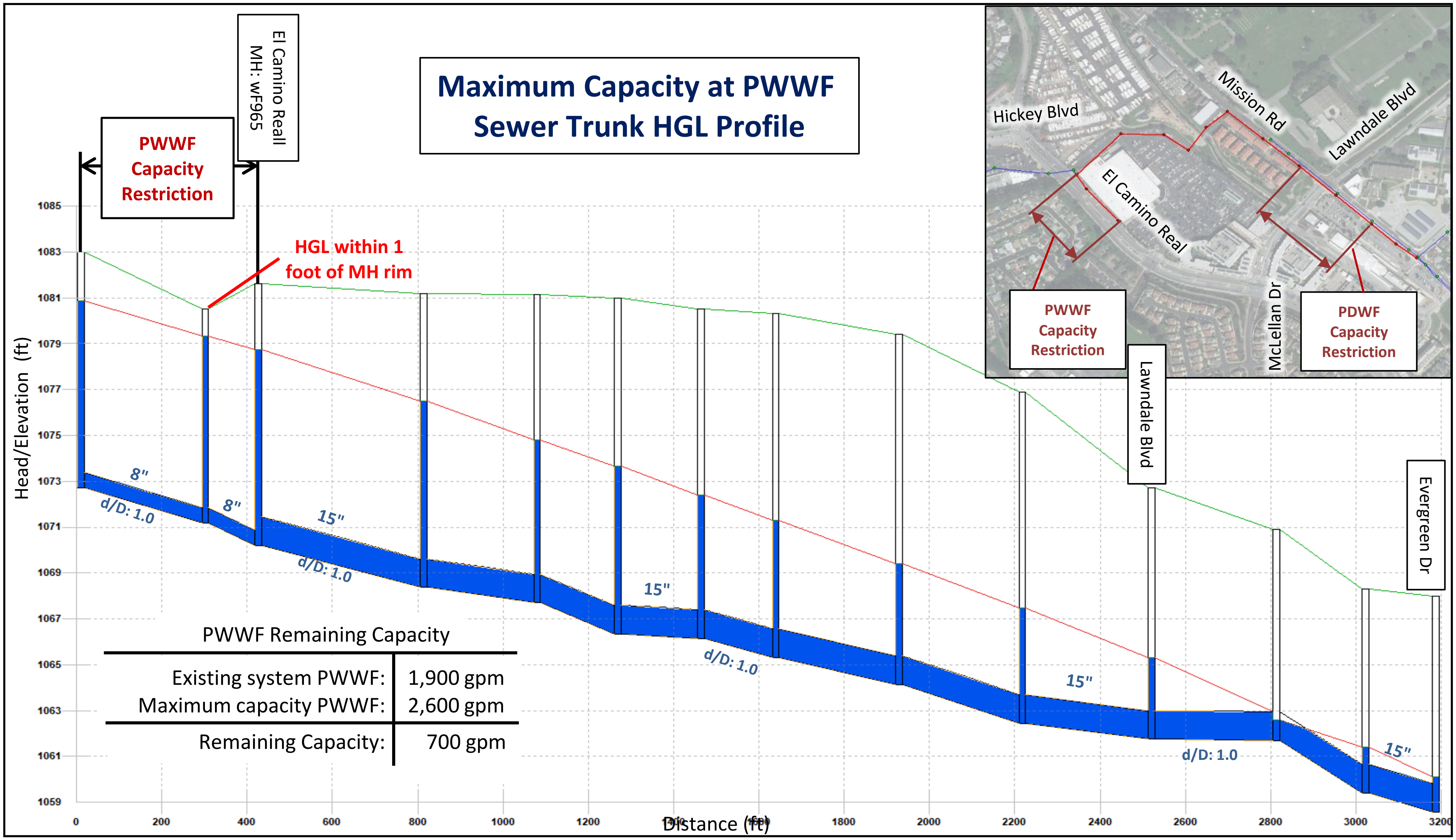
February 11, 2019

Figure 9

Hickey Blvd HGL Profile at Max Capacity (PDWF)

City of South San Francisco

AKEL ENGINEERING GROUP, INC.



PWWF Remaining Capacity

Existing system PWWF:	1,900 gpm
Maximum capacity PWWF:	2,600 gpm
Remaining Capacity:	700 gpm

Notes:

PRELIMINARY

1. Flows and remaining capcity are based on peak dry weather flows
2. Allocated flow based on Unit Flow Factor Analysis and Land Use for Basin B1 and B2
3. PDWF is equal to ADWF for Basin B1 and B2 and reflects historical flows at the WPCP and diurnal curve extracted from V&A Flow Monitoring Analysis.
4. 2018 SSMP Criteria: Sewer trunk d/D to be under 90% capacity
5.This analysis does not include flows downstream of Mission Road and Chestnut Avenue. This analysis was limited to the upstream portion of the sewer trunk where Colma flows enter the system. Additional analysis will be completed once the hydraulic model is calibrated.
6. Flows included in the hydraulic model reflect City of South San Francisco only, and do not include Colma or Daly City.
7. PWWF based on 10-year 24-hour storm event (3.85 in) obtained from NOAA Atlas 14.

February 11, 2019

Figure 10

Hickey Blvd HGL Profile at Max Capacity (PWWF)

City of South San Francisco

AKEL ENGINEERING GROUP, INC.