Preliminary Summary of the May 1-2, 2017 PCCM Storm Event – Harbor Brook

Prepared for Onondaga County Department of Water Environment Protection

Prepared by Upstate Freshwater Institute

Section 1: Rainfall, Streamflow, and Monitoring

Post Construction Compliance Monitoring (PCCM) was conducted at four locations on Harbor Brook on May 1-2, 2017 in response to a rainfall event of 0.87 inches, as measured at the Metro rain gauge. The precipitation event occurred over a period of nearly eight hours, from 18:45 on May 1 to 02:20 on May 2, and consisted of two distinct periods of rainfall. Eighty-four percent (0.73 inches) of the total rainfall occurred during the first two hours of the storm (Figure 1a). There was a four hour break in precipitation, followed by an additional 0.14 inches of rainfall during the early morning hours of May 2 (Figure 1a). The maximum hourly rainfall intensity during this event was 0.53 inches per hour. Streamflow at the upstream Velasko Rd. USGS gauge increased rapidly from 12 cfs at 18:45 on May 1 to a peak of 68 cfs at 20:00 (Figure 1b). At the downstream gauge (Hiawatha Blvd.), flow increased from 14 cfs at 18:45 on May 1 to a peak of 70 cfs at 21:00 (Figure 1b). A rapid decrease in streamflow following the most intense rains was interrupted by the second lighter period of rainfall (Figure 1b). The stream returned to baseflow conditions two days following the rainfall event. Significant rainfall events occurred six days prior to (0.18 inches on April 25) and three days following (1.06 inches on May 5) this PCCM event.

Water samples were collected at four PCCM sampling locations (Velasko Rd., Fowler High School, Hiawatha Blvd., and the Culvert near Onondaga Lake) and analyzed at the Onondaga County laboratory for: (1) fecal coliform bacteria (FCOLI; cfu/100 mL), (2) total phosphorus (TP; µg/L), (3) turbidity (Tn; NTU), and (4) ammonia (t-NH_3; µg/L). In addition, observations of floatables were noted and *in-situ* measurements of temperature (T; °C), dissolved oxygen (DO; mg/L), pH, and specific conductance (SC; µS/cm) were made coincident with collection of water samples. Ten samples were collected at each location during this PCCM event (Figure 1b). In addition, pre-storm samples were collect at all for sites during mid-morning of May 1 (between 10:10-11:00). Sample collection began at 18:45 and continued every half-hour for the next six cycles. The final three sample cycles were collected hourly. Sampling covered the start of the storm, peak flows, and the first part of the falling limb of the hydrograph (Figure 1b). The second portion (more gradual decrease) of the falling limb of the hydrograph was not sampled, which necessitated ending our analysis of this event at 02:30, prior to the stream returning to baseflow (Figure 1b-f). Floatables were observed at the Hiawatha Blvd. and Culvert locations between cycles one and two of the event. These floatables were

described as street liter, containers, and packing material. Monitoring coverage for this event was excellent. Samples were collected during all four phases of the event hydrograph (baseflow, rising limb, peak flow, and start of the falling limb; Figure 1b-f).

Section 2: In-Stream Fecal Coliform Concentrations

Prior to the runoff event FCOLI concentrations were very low at all four sampling sites, ranging from 27 cfu/100 mL at Velasko Rd. to 73 cfu/100 mL at Hiawatha Blvd. These low concentrations may be due to the extended period of dry weather prior to this rainfall event. Fecal coliform concentrations increased dramatically at each of the four monitoring locations in response to the precipitation event (Figure 1 c-f). The highest FCOLI concentration measured during this event (620,000 cfu/100mL) came from the sample collected from Velasko Rd. at 19:25. This sample also had very high turbidity (Tn; Figure 1c), total phosphorus (TP) and ammonia (t-NH_3; Figure A1c). The second highest FCOLI concentration (150,000 cfu/100 mL) came from a sample collected at the Culvert site near Onondaga Lake at 20:45. The two remaining sites, Fowler High School and Hiawatha Blvd., had lower peak concentrations of 70,000 cfu/100 mL (20:45) and 86,000 cfu/100 mL (at 20:00), respectively. FCOLI concentrations decreased on the falling limb of the hydrograph, but remained elevated (>2,000 cfu/100ml) at all four sites through the duration of sampling (Figure 1 c-f). A dissolved oxygen (DO) sag was evident at all four monitoring sites during this event (Figure A3), suggesting the presence of sewage inputs.

Section 3: CSO Flow Volumes

Flow measurements were available from seven CSOs for this event (Figure 2 c-e, Table 1). Four of these CSOs (078, 003, 004, 004A) recorded no flow during this event. The largest estimated contribution from a CSO was 0.429 MG from CSO 014 (Figure 2c; Table 1). CSO 018 delivered a much smaller volume to the stream during the PCCM monitoring interval (0.047 MG). However, CSO 018 continued discharging for 26 hours beyond collection of the final PCCM sample and contributed a total volume of 0.48 MG to Harbor Brook. CSO 063A delivered 0.013 MG to the creek during this event (Figure 2e). Total measured CSO discharge during this event was 0.489 MG (Table 1). Model output from SWMM (2017 conditions) was used to estimate CSO discharge volumes in cases where flow measurements weren't available. According to SWMM estimates, an additional 0.33 MG was released from unmetered CSOs during this event. SWMM estimates were based on the 6/12/1991 event, which had a rainfall intensity of 0.55 inches/hour. Measured CSO volumes were low and SWMM estimates were zero for most CSOs (Table 1). Measured and estimated volumes for all CSOs can be found in Table 2. The best estimate of total CSO discharge volume to Harbor Brook during this event was 0.819 MG. This estimate was derived from a combination of measured CSO volumes and SWMM estimates (Table 2).

Section 4: In-Stream FCOLI Loading and CSO Contributions

Measured streamflow at Velasko Rd. (USGS No. 04220100) was used for estimating FCOLI loads at both Velasko Rd. and Fowler High School. Measured flow at Hiawatha Blvd. (USGS No. 04240105) as used for estimating loads at Hiawatha and the Culvert near Onondaga Lake. This approach was also adopted for the 2015 and 2016 PCCM analyses. This simplification likely represents a relatively small source of error in the loading estimates, particularly for the small Harbor Brook watershed. Fecal coliform samples were paired with flow (at the nearest 15-minute interval). Linear interpolation was used to develop 15-minute fecal coliform concentration estimates for periods between measurements. 15-minute loads were calculated as the product of these concentrations/estimates and 15-minute flows from the appropriate USGS gauges.

FCOLI loading estimates (as cfu) were estimated for CSO 018 from measured flow and measured FCOLI concentrations over the period of this event. For the remaining CSO's, FCOLI loading estimates were estimated as the product of CSO flow and a FCOLI concentration of 460,000 cfu/100 mL (Figure A4), which is the median value of 47 CSO facility influent samples collected during 2015-2017 from Clinton Storage Facility, Lower Harbor Brook Storage Facility, Maltbie FCF, and Midland RTF.

Fecal coliform loading was highest at Velasko Rd. (Figure 3), located upstream of CSOs and downstream of a formerly failing residential community septic system that was remediated by the Town of Onondaga in December 2016. A single very high FCOLI concentration (620,000 cfu/100mL) accounted for the high loading at this site. This result, which corresponds to high Tn, TP and t-NH_3, was verified by the Onondaga County laboratory.

FCOLI loading increased progressively moving downstream from Fowler High School to the Culvert near Onondaga Lake (Figure 3). An estimated 53% of the CSO load entered Harbor Brook between Velasko Rd. and Fowler High School (Figure 4). The reach from Fowler High School to Hiawatha Blvd. contributed 46% of the CSO load and the remaining 2% entered between Hiawatha Blvd. and the Culvert. Event mean concentrations (EMC) were calculated at the four monitoring locations as the total event load divided by the total event flow volume. Moving from upstream to downstream, EMCs were 56,442 cfu/100 mL, 15,357 cfu/100 mL, 21,486 cfu/100 mL, and 27,802 cfu/100 mL for Velasko Rd., Fowler High School, Hiawatha Blvd., and the Culvert, respectively (Figure 1c-f). With the exception of Velasko Rd., upstream CSO inputs were sufficient to explain FCOLI loads estimated at downstream locations (Figure 3). This analysis suggests an unaccounted for source of FCOLI between Hiawatha Blvd. and the Culvert (Figure 4). However, this may also be attributable to uncertainties in the loading estimates. Note that CSO 018 continued to discharge to Harbor Brook beyond the period of stream monitoring.

Section 5: Summary and Recommendations

Pre-storm FCOLI concentrations were low, suggesting an absence of significant dry weather sources of bacteria. Data collected during the event indicate a potentially unidentified short-lived source of FCOLI upstream of Velasko Rd. This analysis also suggests that CSO discharges contribute significantly to elevated fecal coliform levels in Harbor Brook. Given the uncertainties inherent in these analyses, we caution against over-interpreting the results of this single storm. Factors contributing to this uncertainty for the May 1-2 PCCM event include uncertainties in both measured and estimated CSO flow volumes and fecal coliform concentrations. Conclusions should be based on a "weight of the evidence" approach that considers the entire PCCM dataset. We offer the following recommendations:

1. CSO samples should continue to be analyzed for fecal coliform to better define representative concentrations for use in CSO loading calculations.
2. The use of auto-samplers is recommended in order to collect samples that represent rising limb and peak flow concentrations. The use of auto samplers may increase the likelihood of capturing pulses in fecal coliforms moving downstream. We understand there are concerns regarding sample handling and holding times for fecal coliform samples. Perhaps these concerns can be addressed to allow for the use of auto-samplers.
3. Monitoring of future storm events should attempt to cover the entire storm hydrograph, from baseflow to baseflow. Although monitoring coverage was generally excellent for this event, sampling did not extend through the return to baseflow conditions.
4. Post-construction storm event monitoring should follow the protocols (locations, frequency, duration) adopted during the pre-construction period in order to facilitate comparisons. Alternatively, the rating curves developed for pre-construction conditions might be adjusted to approximate the protocols used for the PCCM program.

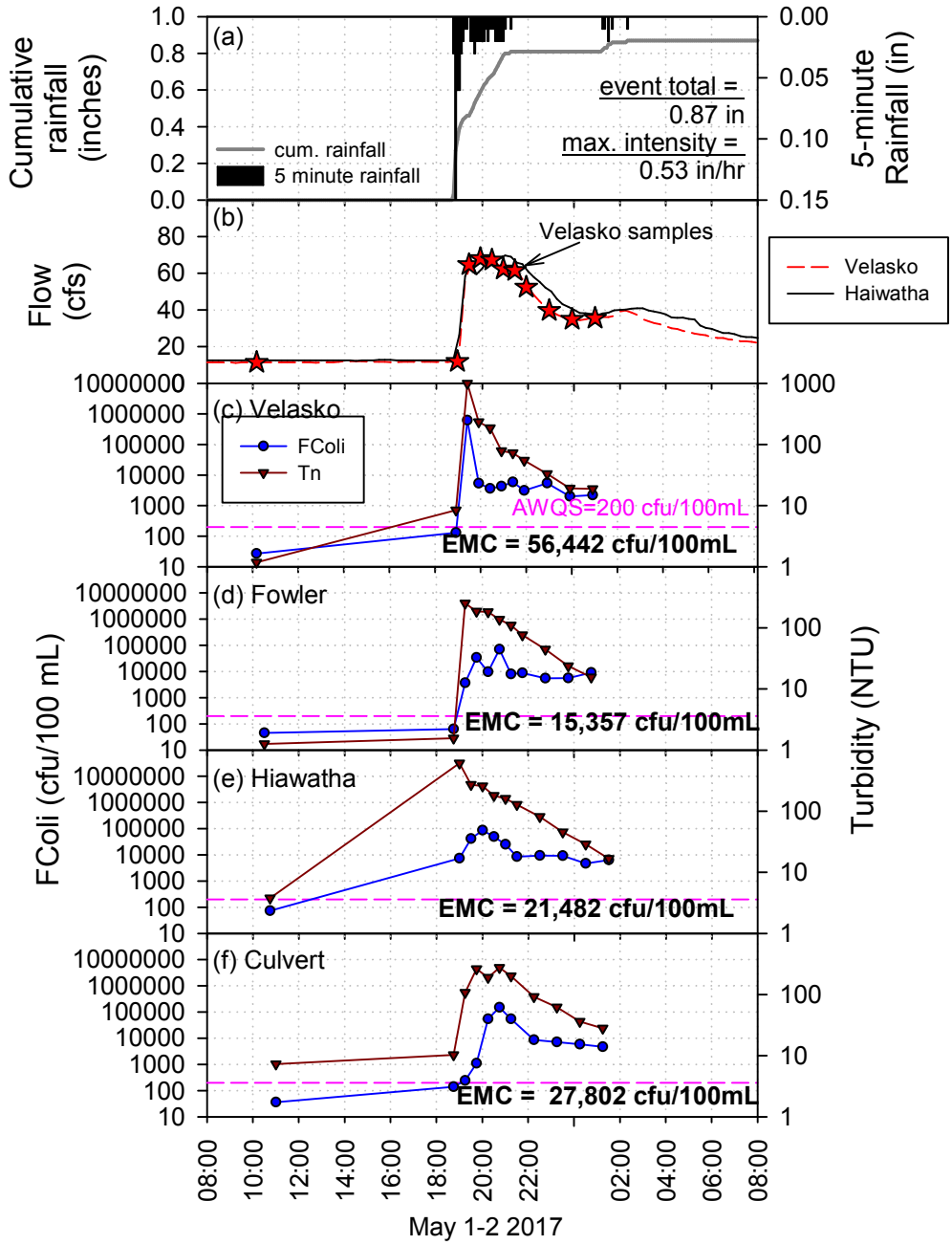


Figure 1. PCCM monitoring results for Harbor Brook on May 1-2, 2017: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd. and Hiawatha Blvd with times of Velasko samples indicated, (c) FCOLI and turbidity results from Velasko Rd., (d) FCOLI and turbidity results from Fowler High School, (e) FCOLI and turbidity results from Hiawatha Blvd., and (f) FCOLI and turbidity results from Culvert (near Onondaga Lake). Ambient Water Quality Standard (AWQS) for FCOLI (200 cfu/100mL) represented as dashed-pink line and EMC (Event Mean Concentration) for each site in bold.

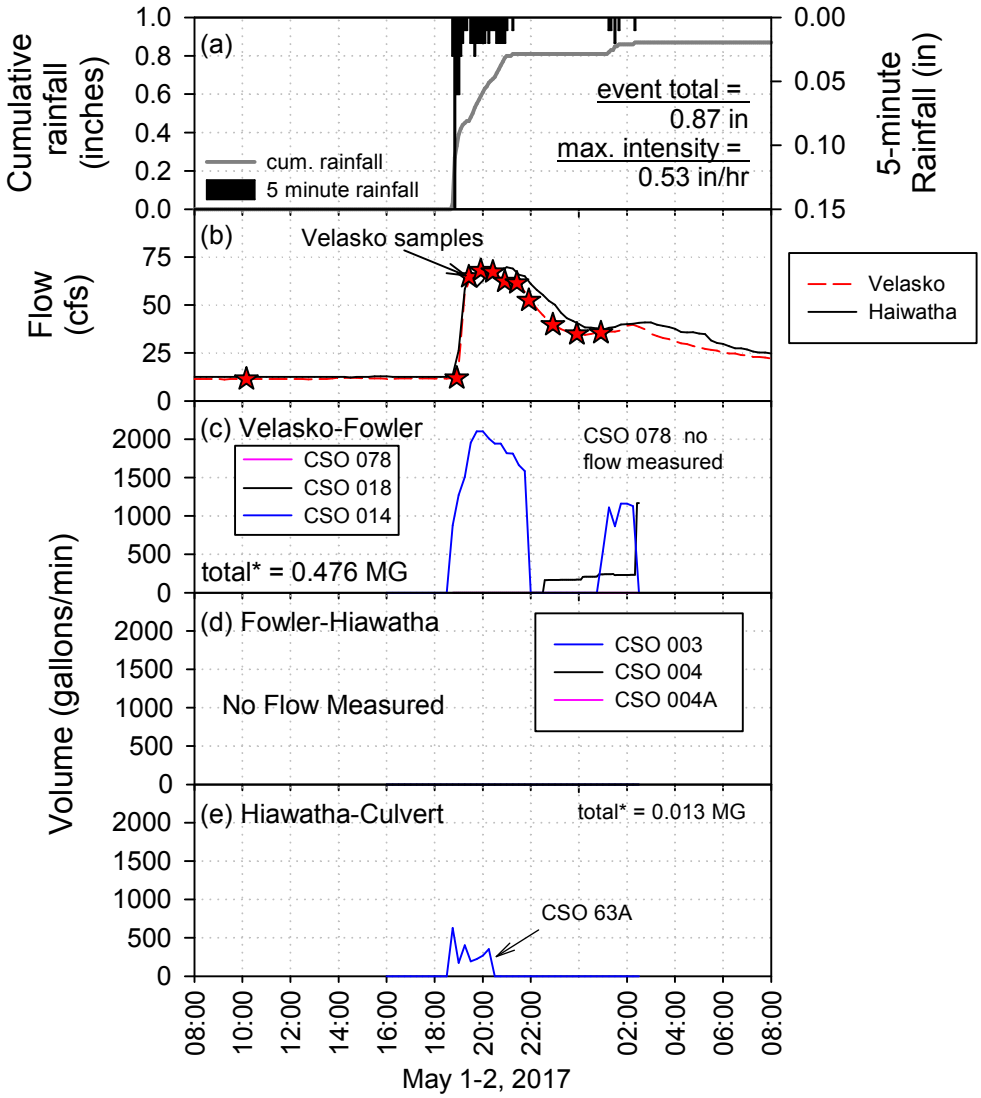


Figure 2. PCCM monitoring results for Harbor Brook on May 1-2, 2017: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd. and Hiawatha Blvd, (c) total measured CSO flow for the Velasko Rd. – Fowler High School reach, (d) total measured CSO flow for the Fowler High School – Hiawatha Blvd reach and (e) total measured CSO flow for the Hiawatha Blvd. - Culvert (near Onondaga Lake). reach. ***this is the total CSO flow as measured by *in-situ* flow monitoring devices only and is not equivalent to the total CSO flow estimate for the event (see Table 2 far right column).**

Table 1. A comparison of measured and predicted CSO flow volumes for the May 1-2, 2017 precipitation event, with peak intensity of 0.53 inches/hour and total precipitation of 0.87 inches.

Reach	CSO Number	CSO Description	Measured Flow (MG)*	SWMM Predicted Flow (MG)**
Velasko-Fowler	CSO 078	Bellevue Ave & Velasko Rd	0	0
	CSO 018	Constructed Wetland Outfall	0.047	0
	CSO 014	Delaware St.	0.429	0
		Reach Total	**0.476**	**0**
Fowler - Hiawatha.	CSO 004	State Fair Blvd	0	0
	CSO 004A	Lower Harbor Brook Storage Facility	0	--
	CSO 003	Hiawatha Blvd	0	0
		Reach Total	**0**	**0**
Hiawatha - Culvert.	CSO 063A	new location	0.013	0
		Reach Total	**0.013**	**0**

* only those CSOs with measured flow data are included in this table

** SWMM CSO Volume Discharge based on SWMM output results for a 0.55 inch per hour rainfall (6/12/1991 storm) from the 2017 trigger table. For more comprehensive event CSO volume estimates please see Table 2.

Table 2. Summary of CSO discharge volumes for the May 1-2, 2017 PCCM event at Harbor Brook. Discharge volumes calculated from flowmeter data and those based on SWMM output are provided (from event totals and intensity).

Harbor Brook CSO Volume Summary (May 1-2, 2017 - PCCM Event 1)

Onondaga County Department of Water Environment Protection

CSO Outfall	Outfall Description	Outfall Status	Rainfall Trigger Intensity (in/hr)	CSO Abatement Strategy	Flow Monitoring	Comments	Location	Measured CSO Volume Discharged, MG	Modeled CSO Volume Discharged, MG[4] (event total (0.87 in))	Modeled CSO Volume Discharged, MG[5] (event intensity (0.53 in/hr))	Best Estimate CSO Volume Discharged, MG
VELASKO RD.											
CSO 078	Bellevue Ave & Velasko Rd	Operational	0.9	Floatables Plan	water level sensor		Velasko-Fowler	0.000	0.040	0.000	0.000
CSO 018	Constructed Wetland Outfall	Operational	>0.9	GI - wetland treatment with floatables control	flow meter, sampler		Velasko-Fowler	0.047	0.000	0.000	0.047
CSO 017	Hoeffler St	Operational	0.9	Floatables Plan	water level sensor		Velasko-Fowler		0.030	0.000	0.000
CSO 015	Herriman St & Grand Ave	Operational	0.6	Floatables Plan	ultrasonic level sensor		Velasko-Fowler		0.160	0.000	0.000
CSO 014	Delaware St	Operational	0.6	Floatables Plan	flow meter	standing water prior to event	Velasko-Fowler	0.429	0.250	0.000	0.429
FOWLER											
CSO 011	Gifford St at Fowler-East side of HB	Operational	0.2	Floatables Plan	water level sensor		Fowler-Hiawatha		0.150	0.070	0.070
CSO 010	West Fayette St-East of HB	Operational	0.1	Floatables Plan	water level sensor		Fowler-Hiawatha		0.180	0.070	0.070
CSO 009	West Fayette St-West of HB	Operational	0.6	Floatables Plan	water level sensor		Fowler-Hiawatha		0.310	0.050	0.050
CSO 007	Richmond Ave & Liberty St	Operational	0.6	Floatables Plan	water level sensor		Fowler-Hiawatha		0.290	0.070	0.070
CSO 006	Park Ave-West of HB	Operational	0.3	Floatables Plan	water level sensor		Fowler-Hiawatha		0.130	0.020	0.020
CSO 006A	Park Ave-East of HB	Abated	0.6	Floatables Plan	water level sensor		Fowler-Hiawatha		0.070	0.000	0.000
CSO 005	West Genesee & Hackett St	Operational	0.3	Floatables Plan	water level sensor		Fowler-Hiawatha		0.130	0.050	0.050
CSO 004	State Fair Blvd	Abated	>0.9	Lower Harbor Brook SF, GI	flow meter		Fowler-Hiawatha	0.000	0.000	0.000	0.000
CSO 004A	Lower Harbor Brook Storage Facility	Abated		Lower Harbor Brook SF			Fowler-Hiawatha	0.000	--	--	0.000
CSO 003	Hiawatha Blvd	Abated	>0.9	Lower Harbor Brook SF, GI	flow meter		Fowler-Hiawatha	0.000	0.000	0.000	0.000
HIAWATHA BLVD.											
CSO 063A	new location	Abated	>0.9	Lower Harbor Brook SF	flow meter		Hiawatha-Culvert	0.013	0.000	0.000	0.013
CULVERT											
TOTAL								0.489	1.740	0.330	0.819

Footnotes:

[1] Actual completion date unknown at this time.

[2] Event Indicator: record date and duration of overflow.

[3] Water levels to be used to approximate flow rate.

[4] Modeled CSO Volume Discharge based on SWMM Model output results for a 0.96 inch rainfall (7/05/91 storm) from 2017 trigger table

[5] Modeled CSO Volume Discharge based on SWMM Model output results for a 0.55 inch/hr rainfall (6/12/91 storm) from 2017 trigger table

Reach	MG
Velasko-Fowler	0.476
Fowler-Hiawatha	0.330
Hiawatha-Culvert	0.013

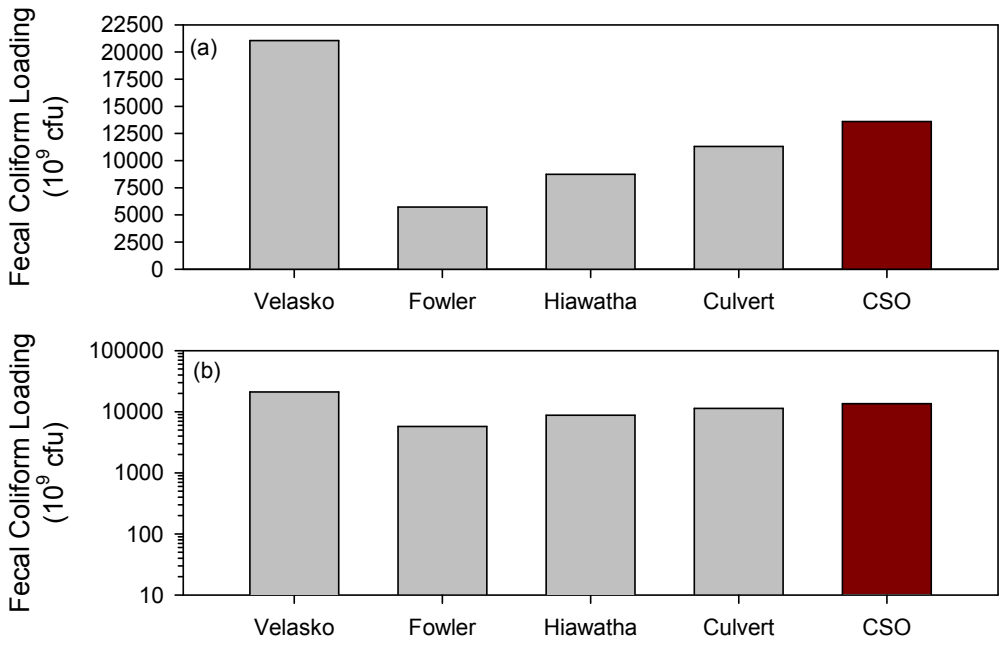


Figure 3. Estimated fecal coliform loads for the Harbor Brook PCCM storm event on May 1-2, 2017: (a) linear and (b) log-10 scales.

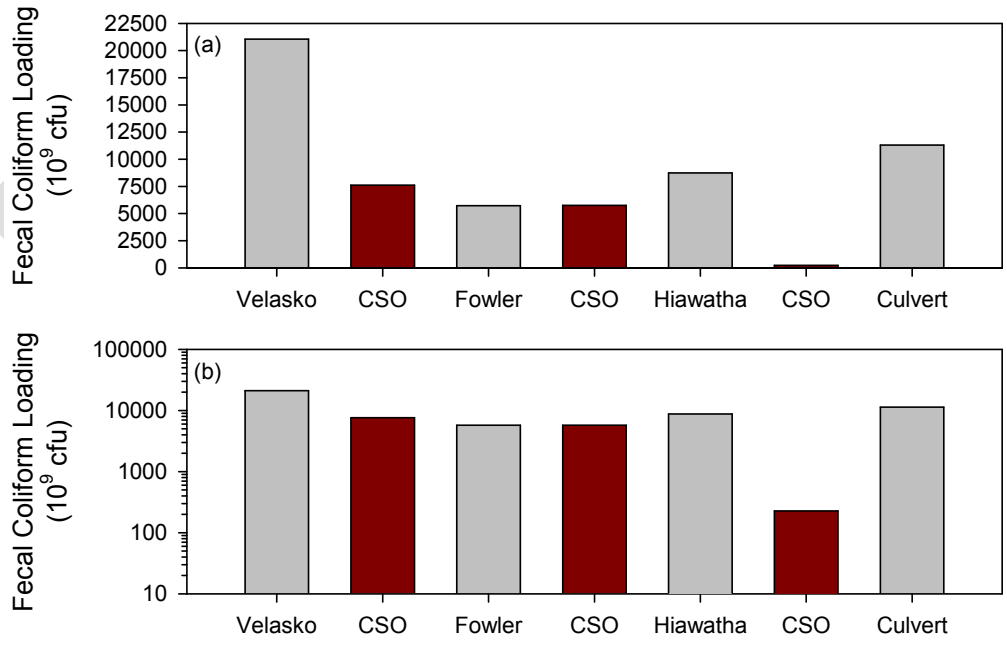


Figure 4. Estimated fecal coliform loads for the PCCM storm event on May 1-2, 2017 presented for the four sampling sites on Harbor Brook and for intervening CSO inputs: (a) linear and (b) log-10 scales.

Section 6: Ancillary Time Series Plots

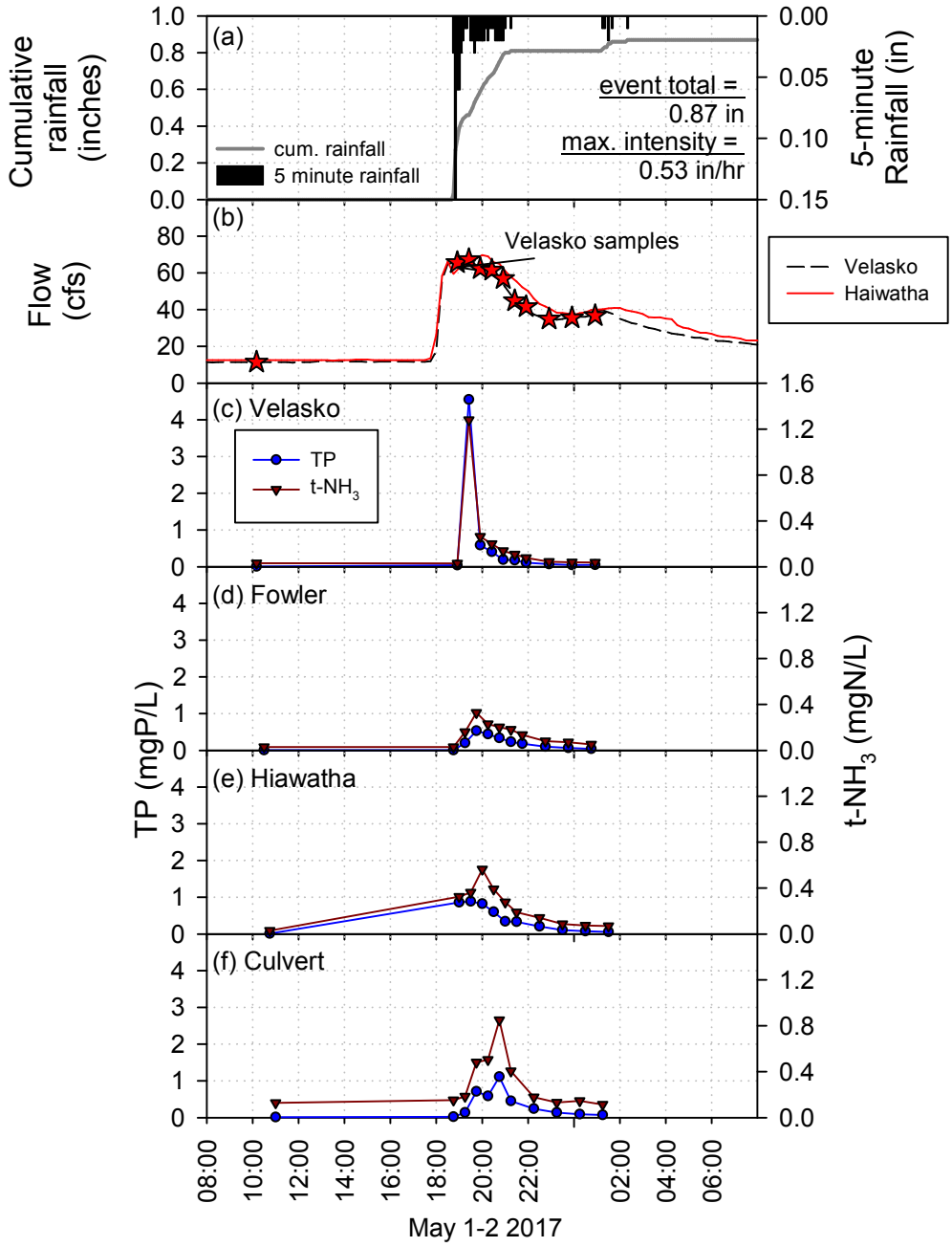


Figure A1. Precipitation event on May 1-2, 2017 and PCCM monitoring results from Harbor Brook for: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd and Hiawatha Blvd., with times of Velasko samples indicated, (c) total phosphorus (TP) and total ammonia (t-NH_3) results from Velasko Rd., (d) TP and t-NH_3 results from Fowler High School, (e) TP and t-NH_3 results from Hiawatha Blvd., and (f) TP and t-NH_3 results from Culvert. (near Onondaga Lake).

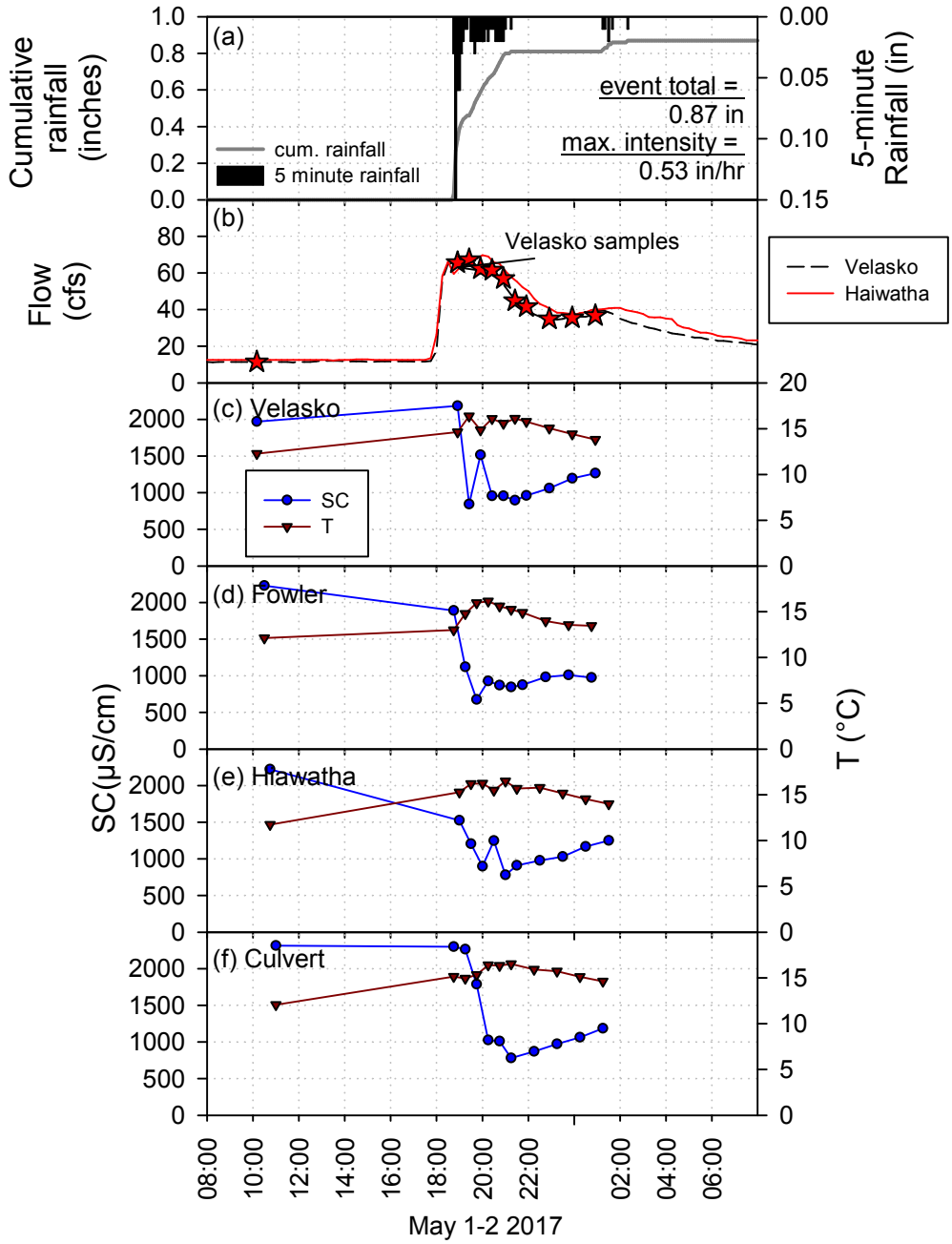


Figure A2. Precipitation event on May 1 - 2, 2017 and PCCM monitoring results from Harbor Brook for: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd. and Hiawatha Blvd., with times of Velasko Rd. samples indicated, (c) temperature (T) and specific conductance (SC) results from Velasko., (d) T and SC results from Fowler High School, (e) T and SC results from Hiawatha Blvd., and (f) T and SC results from Culvert (near Onondaga Lake).

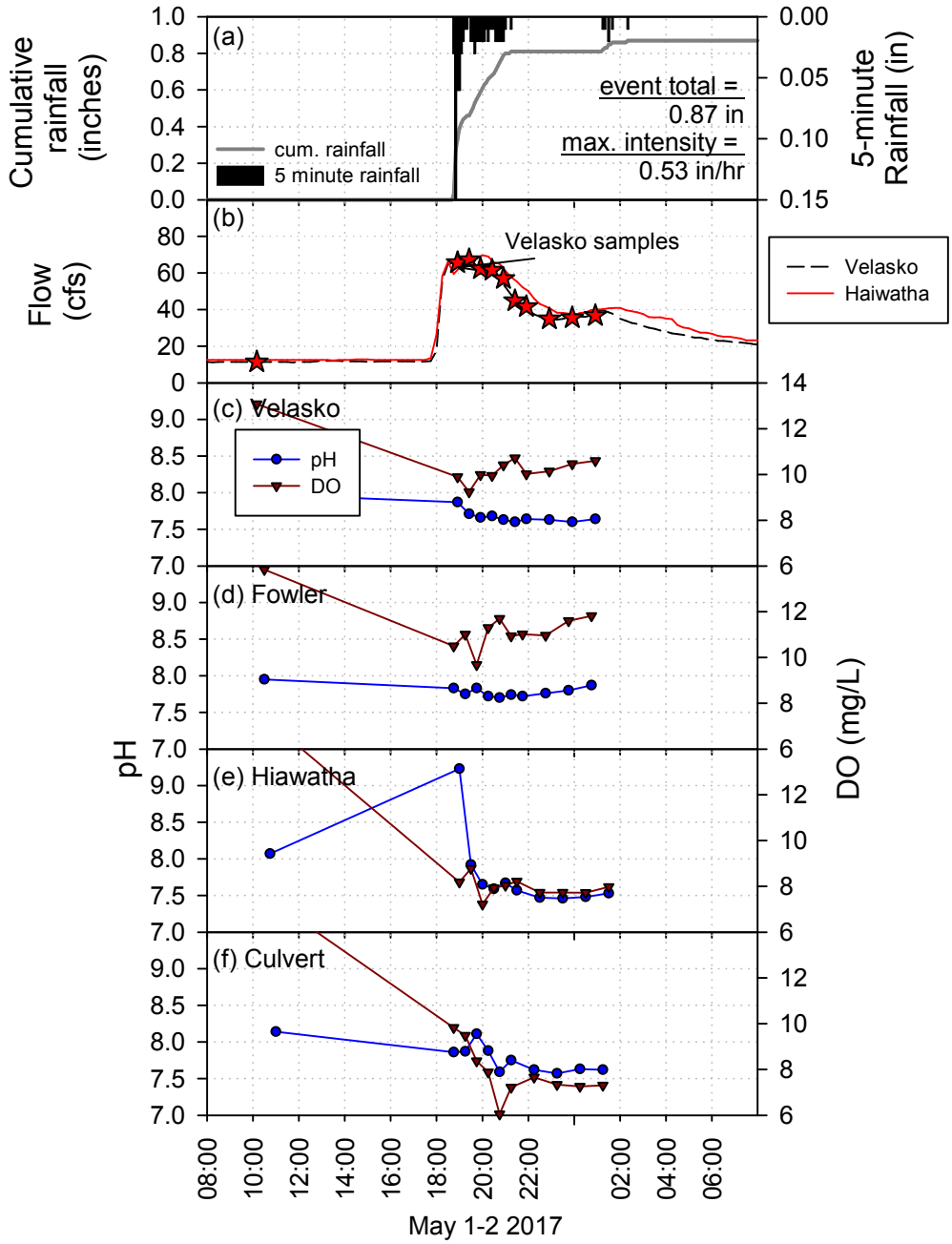
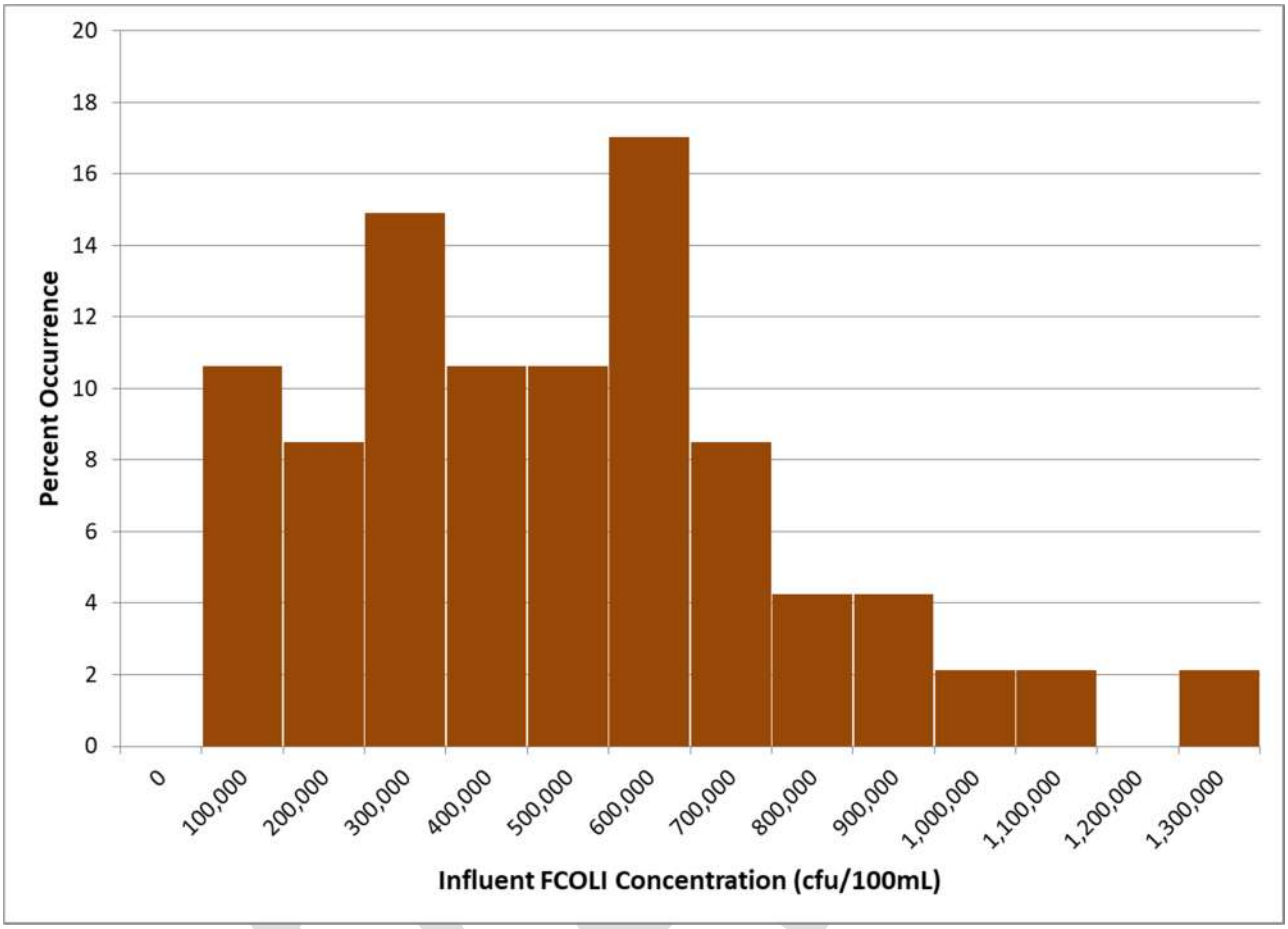


Figure A3. Precipitation event on May 1 - 2, 2017 and PCCM monitoring results from Harbor Brook for (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko and Hiawatha Blvd., with times of Velasko Rd. samples indicated, (c) pH and dissolved oxygen (DO) results from Velasko Rd., (d) pH and DO results from Fowler High School, (e) pH and DO results from Hiawatha Blvd., and (f) pH and DO results from Culvert (near Onondaga Lake).



2015-2017	
Mean	529,840
Standard Error	68,888
Median	**460,000**
Mode	600,000
Standard Deviation	472,271
Sample Variance	223,039,522,895
Kurtosis	10
Skewness	3
Range	2,676,000
Minimum	24,000
Maximum	2,700,000
Sum	24,902,500
Count	47

Figure A4. Frequency distribution and statistics for 47 FCOLI samples collected from CSO facility influent during 2015, 2016, and 2017.

Preliminary Summary of the July 8, 2017 PCCM Storm Event – Harbor Brook

Prepared for Onondaga County Department of Water Environment Protection

Prepared by Upstate Freshwater Institute

Section 1: Rainfall, Streamflow, and Monitoring

Post Construction Compliance Monitoring (PCCM) was conducted at four locations on Harbor Brook on July 8, 2017 in response to a rainfall event of 1.04 inches, as measured at the Metro rain gauge. Precipitation occurred over an interval of 7.5 hours and was made up of three periods of rainfall. The most intense rainfall was measured between 07:00 and 08:00, when 72% (0.75 inches) of the total precipitation occurred (Figure 1a). The maximum hourly rainfall intensity during this event was 0.75 inches per hour. Streamflow at the USGS gauges located at Velasko Rd. and Hiawatha Blvd. increased very little during the early morning part of the storm, but increased dramatically at both locations during the mid-morning portion of the storm (Figure 1b). Peak flow at Hiawatha Blvd. preceded the flow peak at Velasko Rd. by 45 minutes. Discharge at Velasko Rd. increased from 7.7 cfs at 04:00 to a peak of 82 cfs at 9:00 on July 8. At Hiawatha Blvd., flow increased from 8.3 cfs at 04:00 to a peak value of 91 cfs at 08:15. Complete return to base flow conditions occurred two days later. This event was preceded by a slightly larger storm that delivered 1.2 inches of rainfall on July 1.

Water samples were collected at four PCCM sampling locations (Velasko Rd., Fowler High School, Hiawatha Blvd., Culvert near Onondaga Lake) and analyzed at the Onondaga County laboratory for: (1) fecal coliform bacteria (FCOLI; cfu/100 mL), (2) total phosphorus (TP; µg/L), (3) turbidity (Tn; NTU), and (4) ammonia (t-NH_3; µg/L). In addition, observations of floatables were noted and *in-situ* measurements of temperature (T; °C), dissolved oxygen (DO; mg/L), pH, and specific conductance (SC; µS/cm) were made coincident with the laboratory samples. A sample was collected at each of the four PCCM monitoring locations two days prior to the event (on 7/6/2017 between 10:00 and 11:05). A total of eight samples were collected at each these same locations during the event (Figure 1b). Sample collection began at 9:10, about two hours after the rainfall event started. Samples were collected at half-hour intervals for the next five cycles and hourly for the final two cycles. Sampling was conducted exclusively on the falling limb of the hydrograph, with no coverage of the rising limb or peak of the event. Floatables were not observed at any of the four sampling sites.

Section 2: In-Stream Fecal Coliform Concentrations

The July 1 storm may have contributed to the elevated FCOLI concentrations measured two days prior to this PCCM on July 6 (480 cfu/100mL at Fowler, 1,100 cfu/100mL at Hiawatha, 730 cfu/100mL at Culvert). In contrast, a much lower pre-storm FCOLI concentration of 90 cfu/100mL was measured at Velasko Rd. Fecal coliform concentrations increased markedly at each of the four monitoring sites in response to this rainfall event (Figure 1 c-f). The peak FCOLI concentration was 61,000 cfu/100 mL at Velasko Rd., 130,000 cfu/100mL at Fowler High School, 93,000 cfu/100 mL at Hiawatha Blvd, and 94,000 cfu/100 mL at the Culvert near Onondaga Lake. Bacteria concentrations remained elevated at all four sites through the end of the sampling effort (Figure 1 c-f). Turbidity (Tn) levels decreased more rapidly than FCOLI concentrations on the falling limb of the hydrograph. Total phosphorus (TP) and total ammonia (t-NH_3) concentrations decreased progressively during the sampling period, with peaks occurring at all sites with the first sample on the falling limb of the storm (Figure A1 c-f). A dissolved oxygen (DO) sag was not observed for this event, perhaps because the sampling was conducted on the falling limb of the hydrograph when DO concentrations had leveled off (Figure A3 c-f).

Section 3: CSO Flow Volume

Flow measurements were available from seven CSOs for this event (Figure 2, Table 1). No flow was recorded at five of the gauged CSOs. The constructed wetlands (CSO 018) contributed 0.029 MG to Harbor Brook during periods of discharge both before and after the rainfall event (Figure 2c). CSO 018 continued to discharge for 10 hours after sampling ended and discharged a total volume of 0.25 MG to Harbor Brook. The measured discharge from CSO 063A was 0.097 MG. Total measured CSO discharge during this event was 0.126 MG. Model output from SWMM (2017 conditions model) was used to estimate CSO discharge volumes in cases where flow measurements weren't available (Table 2). According to SWMM estimates, an additional 1.45 MG was released from unmetered CSOs during this event. SWMM estimates were based on an event intensity of 0.87 inches/hour, which corresponds to the 7/5/1991 event (Table 2). Measured CSO volumes were low and SWMM estimates were zero for most CSOs. Measured and estimated discharge volumes for all CSOs to Harbor Brook can be found in Table 2. Measured CSO volumes and SWMM estimates compared poorly for four of the seven metered CSOs (Table 1). The best estimate of total CSO discharge volume to Harbor Brook during this event was 1.576 MG. This estimate was derived from a combination of measured CSO volumes and SWMM estimates (Table 2).

Section 4: In-Stream FCOLI Loading and CSO Contributions

Measured streamflow at Velasko Rd. (USGS No. 04240100) was used for estimating FCOLI loads at both Velasko Rd. and Fowler High School. Loading estimates at Hiawatha Blvd. and the Culvert near Onondaga Lake were based on flow measurements from the Hiawatha

Blvd. gauge (USGS No. 04240105). This approach was also adopted for the 2015 and 2016 PCCM analyses. This simplification likely represents a relatively small source of error in the loading estimates, particularly for the small Harbor Brook watershed. Fecal coliform samples were paired with flow (at the nearest 15-minute interval). Linear interpolation was used to develop 15-minute fecal coliform concentration estimates for periods between measurements. 15-minute loads were calculated as the product of these concentrations/estimates and 15-minute flows from the appropriate USGS gauges.

FCOLI loading estimates (as cfu) were estimated for CSO 018 from measured flow and measured FCOLI concentrations over the period of this event. For the remaining CSO's, FCOLI loading estimates were estimated as the product of CSO volume and a FCOLI concentration of 460,000 cfu/100 mL (Figure A4), which is the median value of 47 CSO influent samples collected during 2015-2017 from Clinton Storage Facility, Lower Harbor Brook Storage Facility, Maltbie FCF, and Midland RTF. Estimates of FCOLI concentrations for the rising limb and peak of the hydrograph came from interpolation between the dry weather measurements (two days prior) and the first event measurements (Figure 1c-f). This likely resulted in FCOLI loads being underestimated due to the lack of monitoring coverage during the rising limb and peak of the hydrograph.

FCOLI loading increased progressively moving downstream from Velasko Road to the Culvert near Onondaga Lake (Figure 3). An estimated 14% of the CSO load entered Harbor Brook between Velasko Rd. and Fowler High School (Figure 4). The reach from the Fowler High School to Hiawatha Blvd. contributed 80% of the CSO load and the remaining 6% entered between Hiawatha Blvd. and the Culvert. Event mean concentrations (EMC) were calculated at all four in-stream locations as the total event load divided by the total event flow volume. Moving from upstream to downstream, EMCs were 26,185 cfu/100 mL, 54,947 cfu/100 mL, 51,964 cfu/100 mL, and 62,949 cfu/100 mL for Velasko Rd., Fowler High School, Hiawatha Blvd., and the Culvert, respectively (Figure 1c-f). Upstream CSO inputs were sufficient to explain the majority of the estimated FCOLI loads at downstream locations (Figure 3).

Section 5: Summary and Recommendations

Samples were not collected during the rising limb and peak of the hydrograph, causing the estimated loads to be highly uncertain and likely underestimated. Pre-storm samples at the three downstream sites exceeded the AWQS for FCOLI, suggesting the potential for dry weather sources of bacteria to Harbor Brook. Data collected also suggest that CSO discharges contributed to elevated fecal coliform levels in Harbor Brook. Given the uncertainties inherent in these analyses, we caution against over-interpreting the results of this single storm. The largest contribution to uncertainty for this even is the poor sample coverage of the rising limb and peak of the hydrograph. Other factors contributing to this uncertainty for the July 8 PCCM event include: (1) uncertainties in measured and estimated CSO flow volumes, and (2) the fecal coliform concentration assumed for CSOs was a best estimate based on the median of 47

samples from CSO facilities during 2015-2017. Conclusions should be based on a "weight of the evidence" approach that considers the entire PCCM dataset. We offer the following recommendations:

1. CSO samples should continue to be analyzed for fecal coliform to better define representative concentrations for use in CSO loading calculations.
2. The use of auto-samplers is recommended in order to collect samples that represent rising limb and peak flow concentrations that were missed for this sampling event. We understand there are concerns regarding sample handling and holding times for fecal coliform samples. Perhaps these concerns can be addressed to allow for the use of auto-samplers.
3. Monitoring of future storm events should attempt to cover the entire storm hydrograph, from baseflow to baseflow.
4. Post-construction storm event monitoring should follow the protocols (locations, frequency, duration) adopted during the pre-construction period in order to facilitate comparisons. Alternatively, the rating curves developed for pre-construction conditions might be adjusted to approximate the protocols used for the PCCM program.

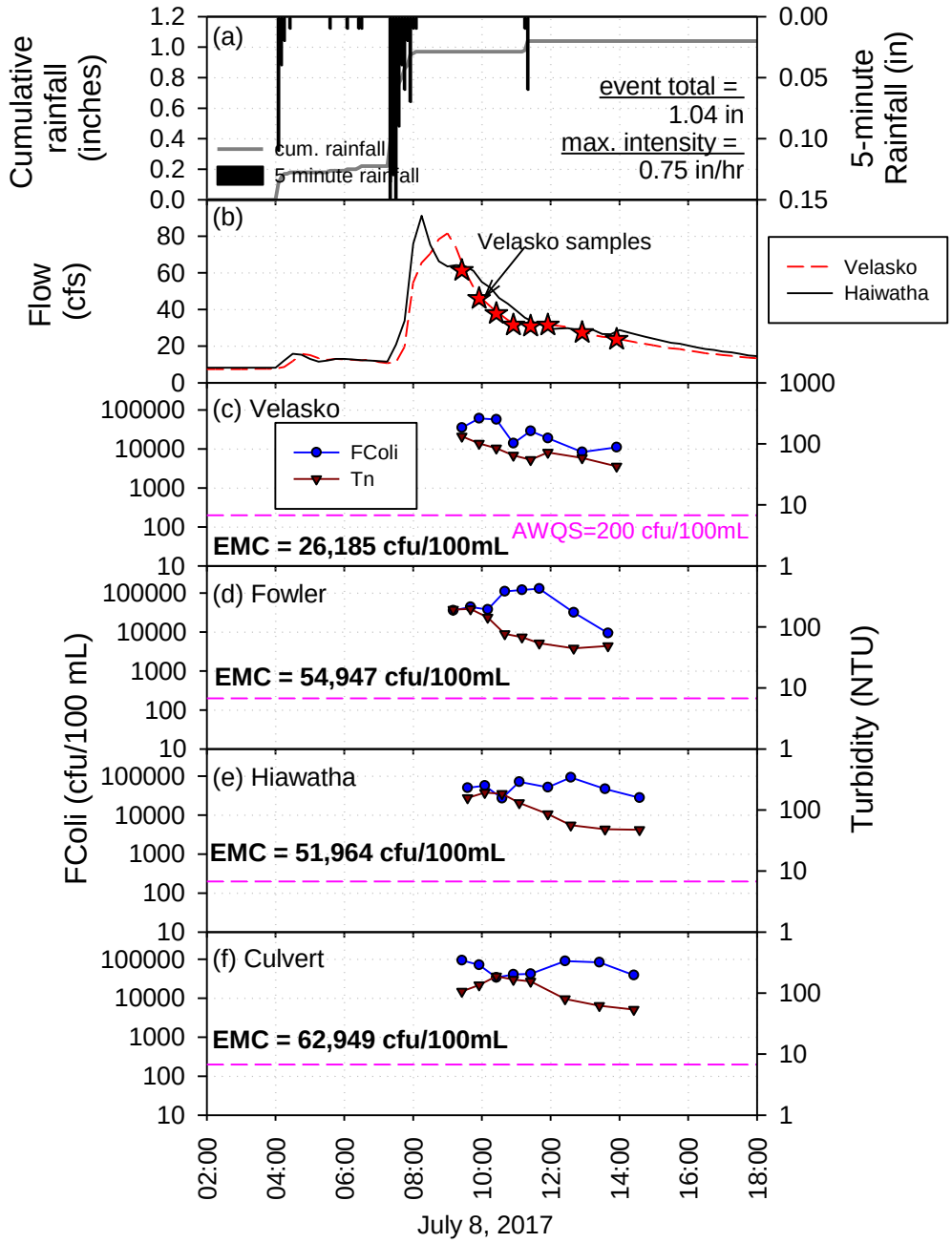


Figure 1. Precipitation event on July 8, 2017 and PCCM monitoring results from Harbor Brook for: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Velasko Rd and Hiawatha Blvd.., with times of Velasko samples indicated, (c) FCOLI and turbidity results from Velasko Rd.., (d) FCOLI and turbidity results from Fowler , (e) FCOLI and turbidity results from Hiawatha Blvd.., and (f) FCOLI and turbidity results from Culvert (near mouth). Ambient Water Quality Standard (AWQS) for FCOLI (200 cfu/100mL) represented as dashed-pink line and EMC (Event Mean Concentration) for each site in bold.

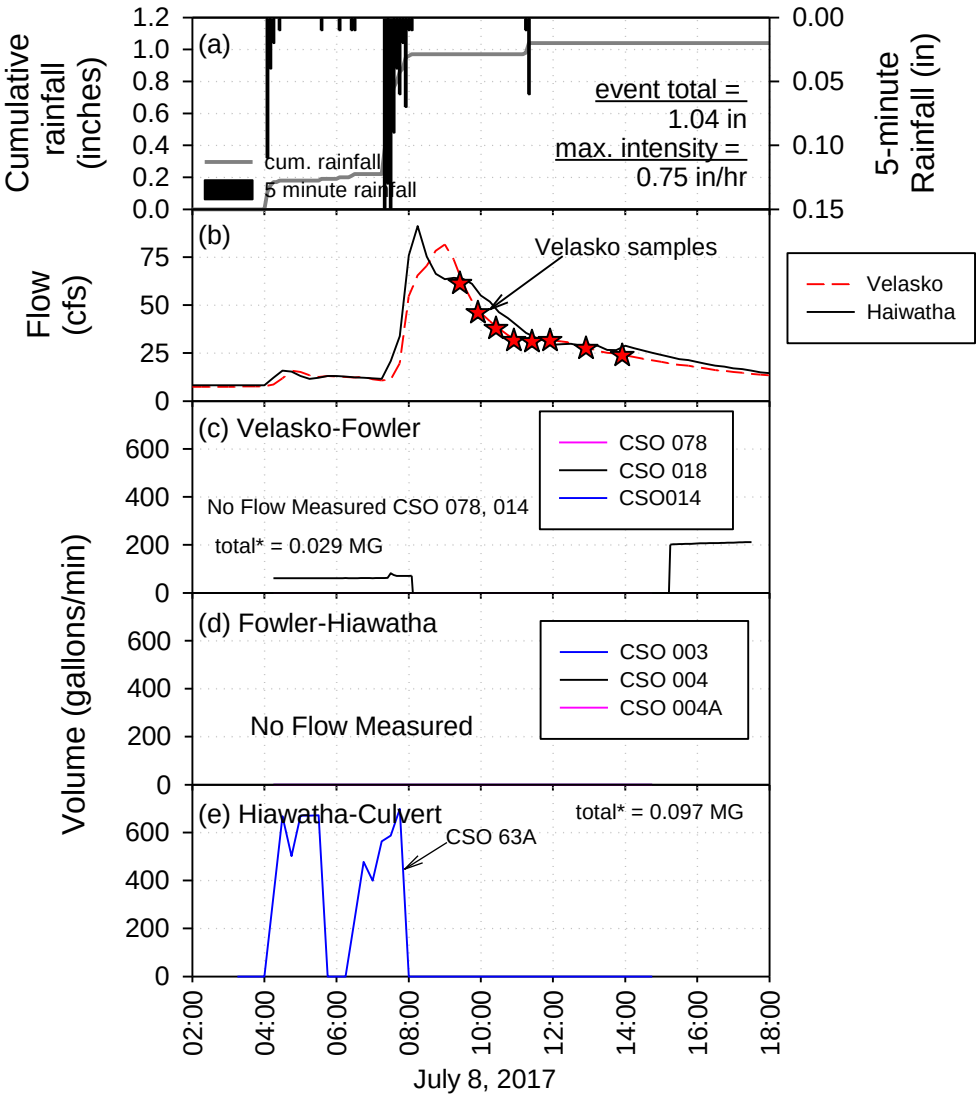


Figure 2. Precipitation event on July 8, 2017 and PCCM monitoring results from Harbor Brook for (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd.., (c) total measured CSO flow for the Velsko Rd. - Fowler reach, (d) total measured CSO flow for the Fowler – Hiawatha Blvd. reach, and (e) total measured CSO flow for the Hiawatha Blvd. Culvert (near mouth) reach. ***this is the total CSO flow as measured by *in-situ* flow monitoring devices only and is not equivalent to the total CSO flow estimate for the event (see Table 2 far right column).**

Table 1. A comparison of measured and predicted CSO flow volumes for the July 8, 2017 precipitation event, with peak intensity of 0.75 inches/hour and total precipitation of 1.04 inches.

Reach	CSO Number	CSO Descript.	Measured Flow (MG)*	SWMM Predicted Flow (MG)**
Velasko-Fowler	CSO 078	Belleview to Velasko Rd.	0	0.04
	CSO 018	Constructed Wetland Outfall	0.029	0
	CSO 014	Delaware St.	0	0.25
		Reach Total	**0.029**	**0.29**
Fowler - Hiawatha.	CSO 004	State Fair Blvd	0	0
	CSO 004A	Lower Harbor Brook Storage Facility	0	--
	CSO 003	Hiawatha Blvd	0	0
		Reach Total	**0**	**0**
Hiawatha - Culvert.	CSO 063A	new location	0.097	0
		Reach Total	0.097	**0**

* only those CSOs with measured flow data are included in this table

** SWMM CSO Volume Discharge based on SWMM output results for a 0.87 inch per hour rainfall (7/5/1991 storm) from the 2017 trigger tables. For more comprehensive event CSO volume estimates please see Table 2.

Table 2. Summary of CSO discharge volumes for the July 8, 2017 PCCM event at Onondaga Creek. Discharge volumes calculated from flowmeter data and those based on SWMM output are provided (from event totals and intensity).

Harbor Brook CSO Volume Summary (July 8, 2017 - PCCM Event 21)

Onondaga County Department of Water Environment Protection

CSO Outfall	Outfall Description	Outfall Status	Rainfall Trigger Intensity (in/hr)	CSO Abatement Strategy	Flow Monitoring	Comments	Location	Measured CSO Volume Discharged, MG	Modeled CSO Volume Discharged, MG[4] (event total (1.04in))	Modeled CSO Volume Discharged, MG[5] (event intensity (0.75 in/hr))	Best Estimate CSO Volume Discharged, MG
VELASKO RD.											
CSO 078	Bellevue Ave & Velasko Rd	Operational	0.9	Floatables Plan	water level sensor		Velasko-Fowler	0.000	0.040	0.040	0.000
CSO 018	Constructed Wetland Outfall	Operational	>0.9	GI - wetland treatment with floatables control	flow meter, sampler		Velasko-Fowler	0.029	0.000	0.000	0.029
CSO 017	Hoeffler St	Operational	0.9	Floatables Plan	water level sensor		Velasko-Fowler		0.030	0.030	0.030
CSO 015	Herriman St & Grand Ave	Operational	0.6	Floatables Plan	ultrasonic level sensor		Velasko-Fowler		0.160	0.160	0.160
CSO 014	Delaware St	Operational	0.6	Floatables Plan	flow meter	standing water prior to event	Velasko-Fowler	0.000	0.300	0.250	0.000
FOWLER											
CSO 011	Gifford St at Fowler-East side of HB	Operational	0.2	Floatables Plan	water level sensor		Fowler-Hiawatha		0.150	0.150	0.150
CSO 010	West Fayette St-East of HB	Operational	0.1	Floatables Plan	water level sensor		Fowler-Hiawatha		0.190	0.180	0.180
CSO 009	West Fayette St-West of HB	Operational	0.6	Floatables Plan	water level sensor		Fowler-Hiawatha		0.330	0.310	0.310
CSO 007	Richmond Ave & Liberty St	Operational	0.6	Floatables Plan	water level sensor		Fowler-Hiawatha		0.280	0.290	0.290
CSO 006	Park Ave-West of HB	Operational	0.3	Floatables Plan	water level sensor		Fowler-Hiawatha		0.140	0.130	0.130
CSO 006A	Park Ave-East of HB	Abated	0.6	Floatables Plan	water level sensor		Fowler-Hiawatha		0.060	0.070	0.070
CSO 005	West Genesee & Hackett St	Operational	0.3	Floatables Plan	water level sensor		Fowler-Hiawatha		0.120	0.130	0.130
CSO 004	State Fair Blvd	Abated	>0.9	Lower Harbor Brook SF, GI	flow meter		Fowler-Hiawatha	0.000	0.000	0.000	0.000
CSO 004A	Lower Harbor Brook Storage Facility	Abated		Lower Harbor Brook SF			Fowler-Hiawatha	0.000	--	--	0.000
CSO 003	Hiawatha Blvd	Abated	>0.9	Lower Harbor Brook SF, GI	flow meter		Fowler-Hiawatha	0.000	0.000	0.000	0.000
HIAWATHA BLVD.											
CSO 063A	new location	Abated	>0.9	Lower Harbor Brook SF	flow meter		Hiawatha-Culvert	0.097	0.000	0.000	0.097
CULVERT											
TOTAL								0.126	1.800	1.740	1.576

Footnotes:

[1] Actual completion date unknown at this time.

[2] Event Indicator: record date and duration of overflow.

[3] Water levels to be used to approximate flow rate.

[4] Modeled CSO Volume Discharge based on SWMM Model output results for a 1.06 inch rainfall (7/22/91 storm) from 2017 trigger table

[5] Modeled CSO Volume Discharge based on SWMM Model output results for a 0.87 inch/hr rainfall (7/5/91 storm) from 2017 trigger table

Reach	MG
Velasko-Fowler	0.219
Fowler-Hiawatha	1.260
Hiawatha-Culvert	0.097

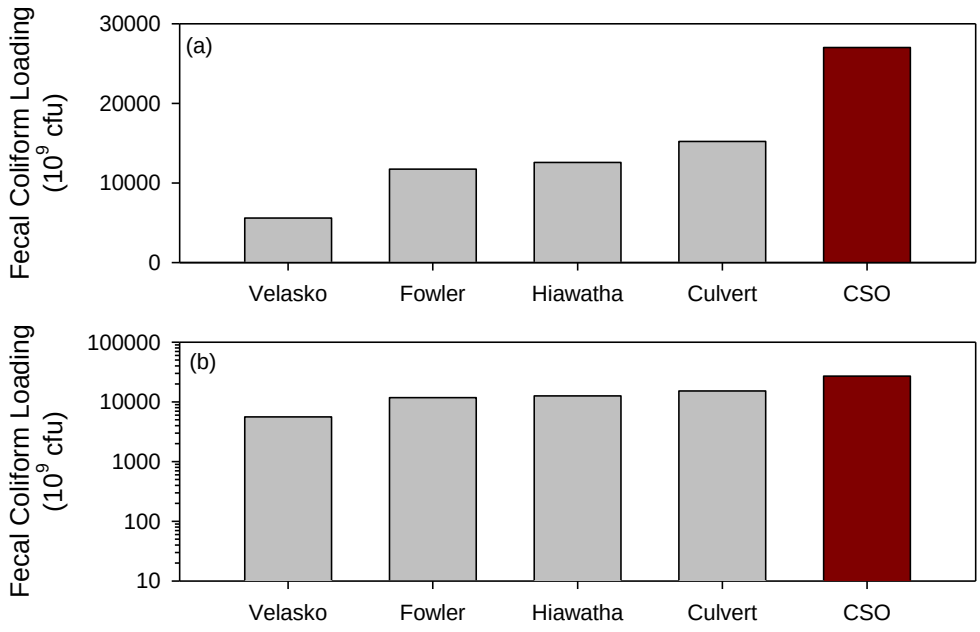


Figure 3. Estimated fecal coliform loads for the PCCM storm event on July 8, 2017: (a) linear and (b) log-10 scales.

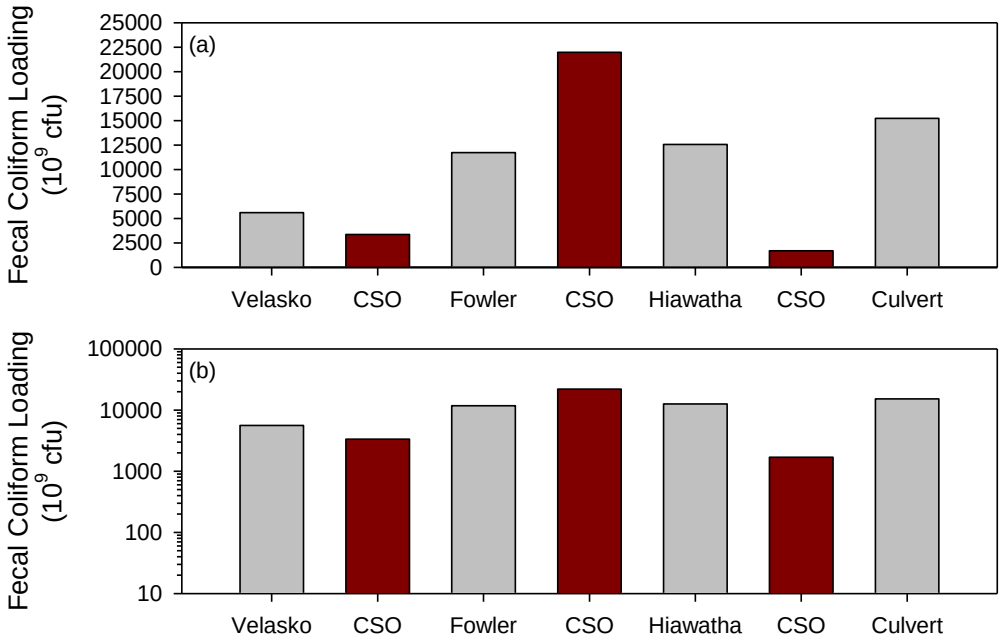


Figure 4. Estimated fecal coliform loads for the PCCM storm event on July 8, 2017 presented for the four sampling sites on Onondaga Creek and for intervening CSO inputs: (a) linear and (b) log-10 scales.

Section 6: Ancillary Time Series Plots

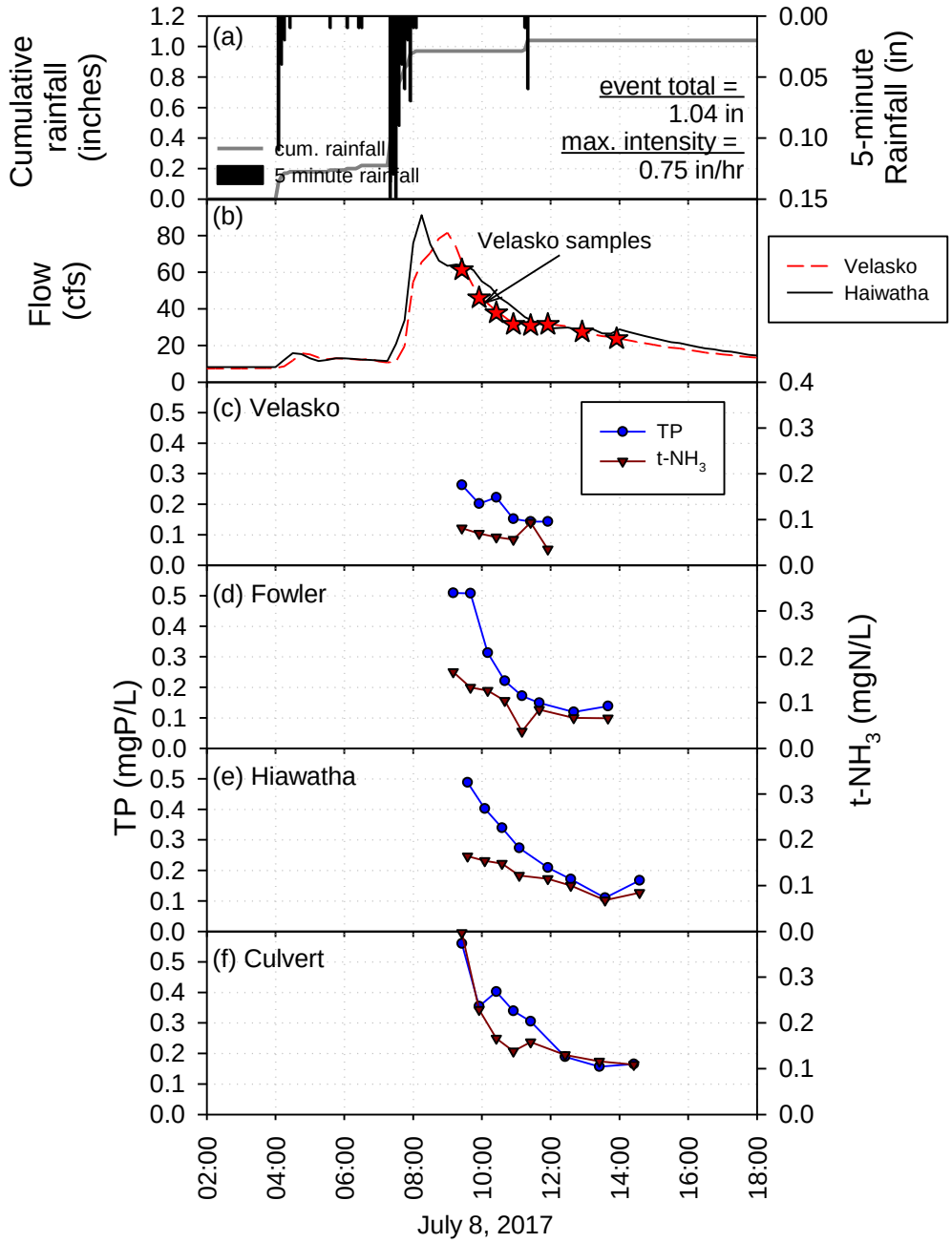


Figure A1. Precipitation event on July 8, 2017 and PCCM monitoring results from Harbor Brook for: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd and Hiawatha Blvd., with times of Velasko samples indicated, (c) total phosphorus (TP) and total ammonia (t-NH_3) results from Velasko Rd., (d) TP and t-NH_3 results from Fowler High School, (e) TP and t-NH_3 results from Hiawatha Blvd., and (f) TP and t-NH_3 results from Culvert. (near Onondaga Lake).

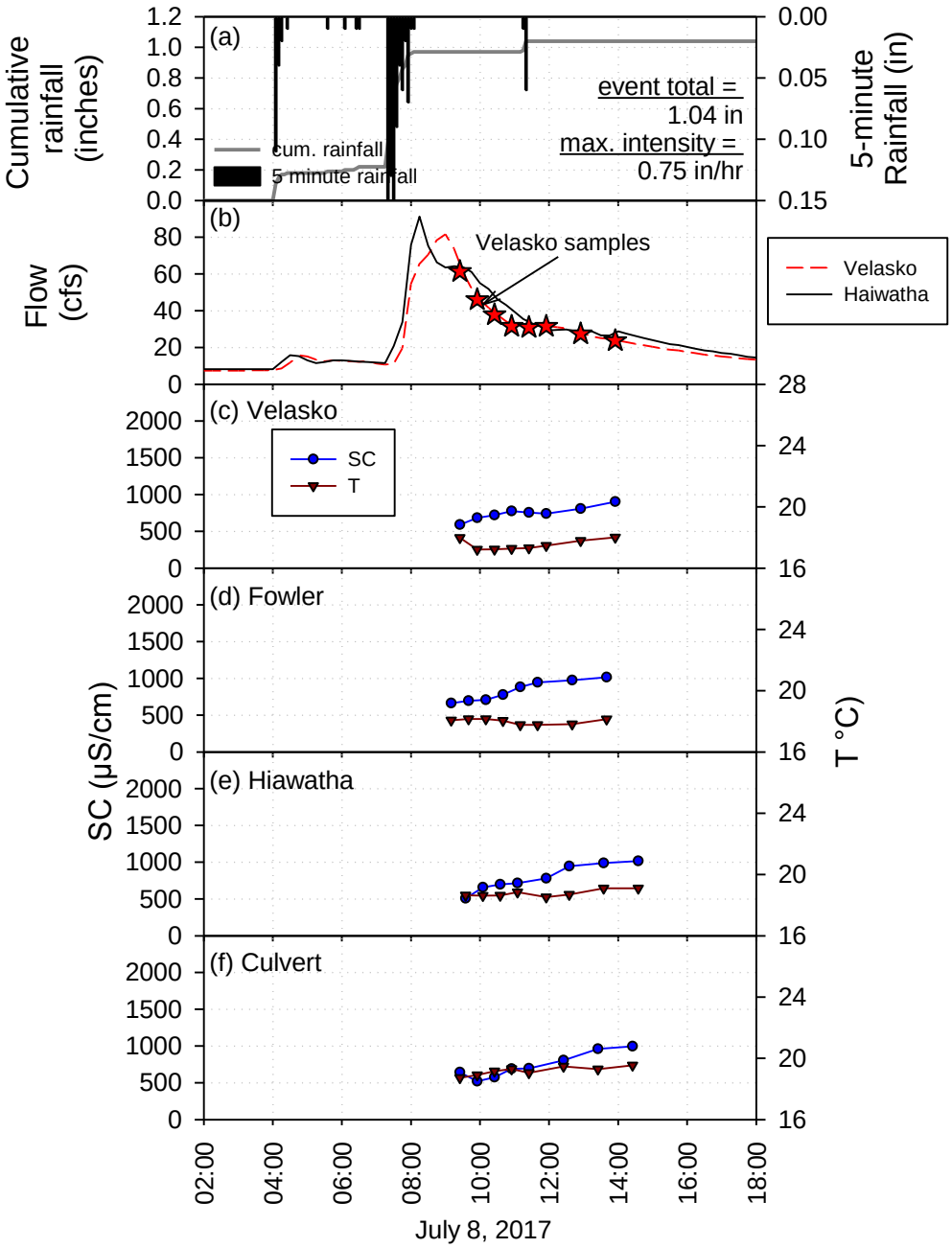


Figure A2. Precipitation event on July 8, 2017 and PCCM monitoring results from Harbor Brook for: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd. and Hiawatha Blvd., with times of Velasko Rd. samples indicated, (c) temperature (T) and specific conductance (SC) results from Velasko., (d) T and SC results from Fowler High School, (e) T and SC results from Hiawatha Blvd., and (f) T and SC results from Culvert (near Onondaga Lake).

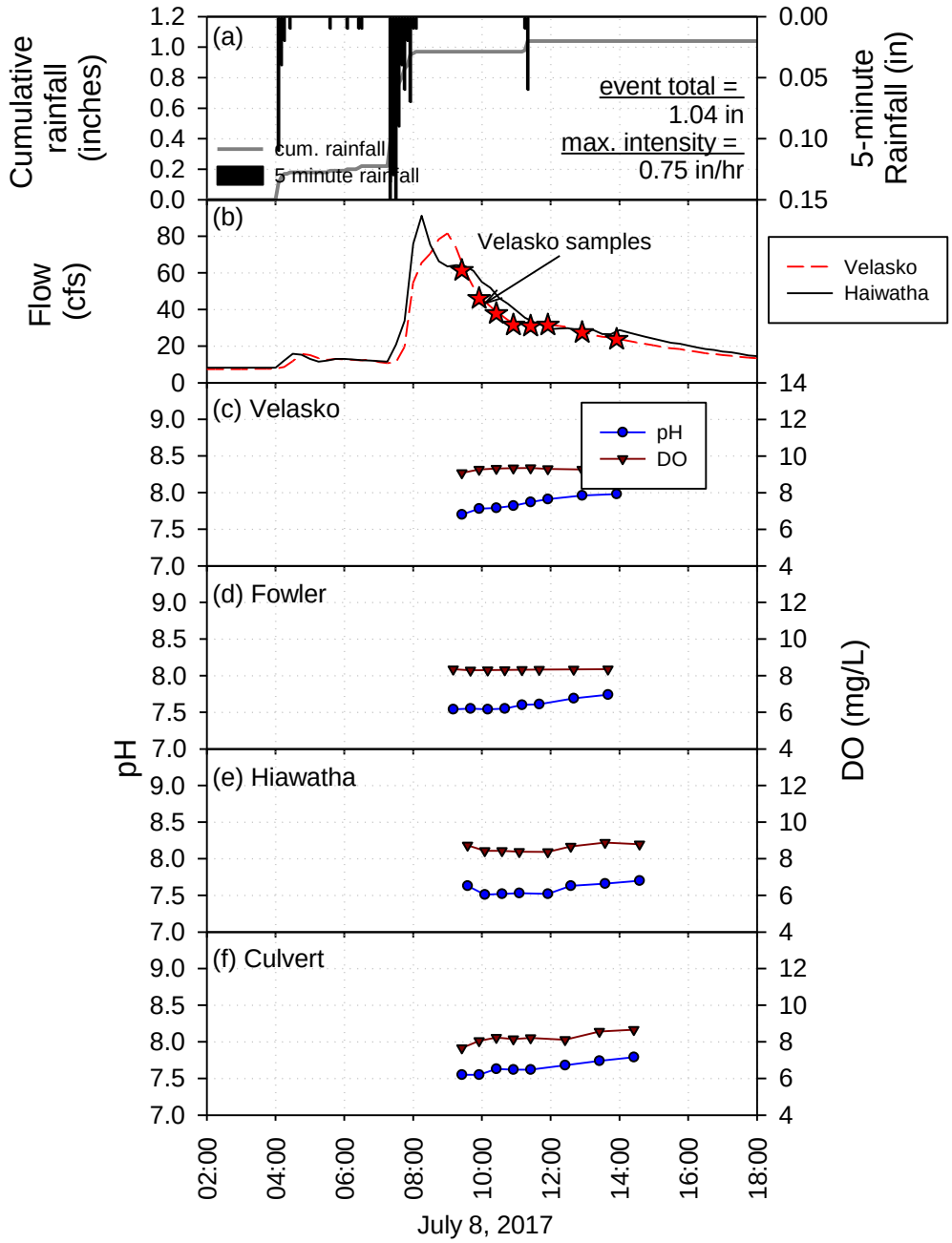
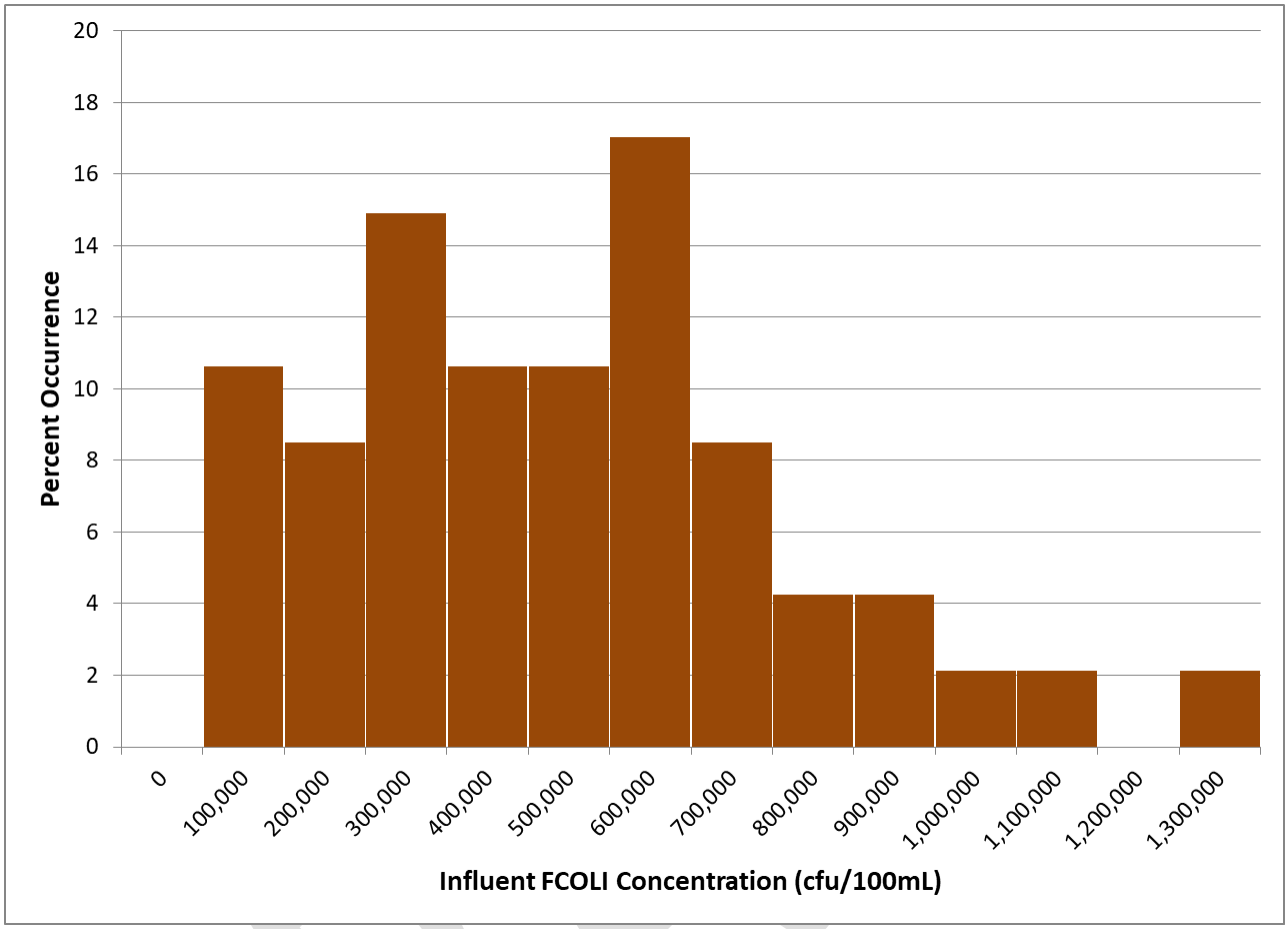


Figure A3. Precipitation event on July 8, 2017 and PCCM monitoring results from Harbor Brook for: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd. and Hiawatha Blvd.., with times of Velasko Rd. samples indicated, (c) pH and dissolved oxygen (DO) results from Velasko Rd.., (d) pH and DO results from Fowler., (e) pH and DO results from Hiawatha Blvd., and (f) pH and DO results from Culvert (near mouth).



2015-2017	
Mean	529,840
Standard Error	68,888
Median	**460,000**
Mode	600,000
Standard Deviation	472,271
Sample Variance	223,039,522,895
Kurtosis	10
Skewness	3
Range	2,676,000
Minimum	24,000
Maximum	2,700,000
Sum	24,902,500
Count	47

Figure A4. Frequency distribution and summary statistics for 47 FCOLI samples collected from CSO facility influent during 2015, 2016, and 2017.

Preliminary Summary of the August 22, 2017 PCCM Storm Event – Harbor Brook

Prepared for Onondaga County Department of Water Environment Protection

Prepared by Upstate Freshwater Institute

Section 1: Rainfall, Streamflow, and Monitoring

Post Construction Compliance Monitoring (PCCM) was conducted at four Harbor Brook locations on August 22, 2017 in response to a rainfall event of 0.62 inches, as measured at the Metro rain gauge. Precipitation occurred over an interval of seven hours (15:30–22:45) and was made up of three short bursts of rainfall followed by a longer period of very light rain. The most intense rainfall occurred during the first hour of the storm, when 65% of the total event rainfall occurred (Figure 1a). Stream flow increased at both the Velasko Rd. and Hiawatha Blvd. USGS gauges in response to the multiple brief bursts of rainfall (Figure 1b). Stream discharge at Velasko Rd. increased from 5 cfs at 14:30 to a peak of 30 cfs at 17:00 (Figure 1b). At Hiawatha Blvd., streamflow increased from 5 cfs at 14:30 to a peak flow of 30 cfs at 16:45 (Figure 1b). Flow at both gauges gradually decreased and approached pre-storm conditions of 6-7 cfs by 23:00 (Figure 1b). A storm event of similar magnitude occurred on August 18, 2017, four days prior to this PCCM event. The earlier rainfall event had no conspicuous effects on stream condition leading up to the event documented here.

Water samples were collected at four PCCM sampling locations (Velasko Rd., Fowler High School, Hiawatha Blvd., Culvert near Onondaga Lake) and analyzed at the Onondaga County laboratory for: (1) fecal coliform bacteria (FCOLI; cfu/100 mL), (2) total phosphorus (TP; µg/L), (3) turbidity (Tn; NTU), and (4) ammonia (t-NH_3; µg/L). In addition, observations of floatables were noted and *in-situ* measurements of temperature (T; °C), dissolved oxygen (DO; mg/L), pH, and specific conductance (SC; µS/cm) were made coincident with collection of water samples. A pre-storm (cycle 0) sample was collected at each of the four PCCM monitoring locations during mid-morning of August 17, 2017 and prior to the August 18, 2017 rainfall event. Subsequent analyses assume that fecal coliform concentrations from August 17 are representative of the conditions prior to the August 22 storm event. Nine samples were collected at each location during the event (Figure 1c). The first cycle of samples was collected between 15:20 and 15:45. All four sites were monitored for eight additional cycles, with the first five cycles collected every half hour and the remaining three cycles collected every hour. The rising and receding limbs of the hydrograph were both covered by the monitoring effort (Figure 1b). Floatables were not observed at any of the four sampling sites during this event.

Section 2: In-Stream Fecal Coliform Concentrations

Pre-storm (cycle 0 samples) FCOLI concentrations ranged from 210 cfu/100mL at Velasko Rd. to 1,400 at the Culvert. It is not known if the intervening rainfall event of August 17 affected these FCOLI results. Fecal coliform concentrations were higher for the cycle 1 samples at each of the four monitoring sites and remained elevated through the end of sampling. The peak FCOLI concentration was 14,000 cfu/100 mL at Velasko Rd., 50,000 cfu/100 mL at Fowler High School, 120,000 cfu/100 mL at Hiawatha Blvd., and 413,000 cfu/100 mL at the Culvert (Figure 1 c-f). Turbidity (Tn) levels tracked the FCOLI concentration trends during the start and peak of the storm but dropped off more quickly during the falling limb of the event, particularly at Velasko and Fowler (Figure 1c-f). Total Phosphorus (TP) and total ammonia (t-NH_3) concentrations generally tracked the FCOLI pattern, increasing early in the event and then decreasing slowly on the falling limb of the hydrograph (Figure A1 c-f). A further indicator of CSO influence is the presence of a dissolved oxygen (DO) sag at the three downstream sampling locations (Figure A3 c-f). At the Culvert, DO concentrations decreased from 11.4 mg/L to 6.2 mg/L during the monitoring period.

Section 3: CSO Flow Volume

Flow measurements were available from seven CSOs for this event (Figure 2 c-e, Table 1). No flow was recorded at six of the metered CSOs (078, 018, 014, 003, 004, 004A). The only CSO with measured flow was CSO 063A (Figure 2c; Table 1). Total measured CSO discharge during this event was 0.051 MG (Table 1). Model output from SWMM (2017 conditions model) was used to estimate CSO discharge volumes in cases where flow measurements weren't available. According to SWMM estimates, an additional 0.229 MG was released from unmetered CSOs during this event. SWMM estimates were based on an event intensity of 0.39 inches/hour, which corresponds to the 7/15/1991 event (Table 2). Measured CSO volumes were low and SWMM estimates were zero for most CSOs. Measured and estimated discharge volumes for all CSOs to Harbor Brook can be found in Table 2. The measured CSO volume and SWMM estimated flow compared reasonably well for CSO 063A (Table 1).The best estimate of total CSO discharge volume to Harbor Brook during this event was 0.331 MG. This estimate was derived from a combination of measured CSO volumes and SWMM estimates (Table 2).

Section 4: In-Stream FCOLI Loading and CSO Contributions

Measured streamflow at Velasko Rd. (USGS No. 04220100) was used for estimating loads at both Velasko Rd. and Fowler High School. Loading estimates at Hiawatha Blvd. and the Culvert were based on flow measurements from the Hiawatha Blvd. gauge (USGS No. 04240105). This approach was also adopted for the 2015 and 2016 PCCM analyses. This simplification likely represents a relatively small source of error in the loading estimates, particularly for the small Harbor Brook watershed. Fecal coliform samples were paired with flow (at the nearest 15-minute interval). Linear interpolation was used to develop 15-minute fecal

coliform concentration estimates for periods intervening measurements. 15-minute loads were calculated as the product of these concentrations/estimates and 15-minute flows from the appropriate USGS gauges.

FCOLI loading estimates (as cfu) for CSOs were estimated as the product of CSO volume and a FCOLI concentration of 460,000 cfu/100 mL, which is the median value of 47 influent samples collected during 2015-2017 from Clinton Storage Facility, Lower Harbor Brook Storage Facility, Maltbie FCF, and Midland RTF (Figure A4). Estimated FCOLI loading increased progressively moving downstream from Velasko Road to Hiawatha Blvd. and decreased at the Culvert (Figure 3). An estimated 85% of the CSO load entered Harbor Brook between Fowler High School and Hiawatha Blvd. and the remaining 15% entered between Hiawatha Blvd. and the Culvert. (Figure 4). Event mean concentrations (EMC) were calculated at all four in-stream locations as the total event load divided by the total event flow volume. Moving from upstream to downstream, EMCs were 13,761 cfu/100 mL, 32,155 cfu/100 mL, 69,358 cfu/100 mL, and 33,595 cfu/100 mL for Velasko Rd., Fowler High School, Hiawatha Blvd., and the Culvert, respectively (Figure 1c-f). Estimated CSO inputs were sufficient to explain the FCOLI levels in Harbor Brook (Figure 3). However, the increased FCOLI load at Fowler was not explained by CSO inputs.

Section 5: Summary and Recommendations

Pre-storm samples results exceeded of the AWQS for FCOLI at all four sites, suggesting bacteria contributions from dry weather sources along Harbor Brook. However, we cannot eliminate the possibility that a storm preceded this PCCM event contributed to the elevated FCOLI concentrations. Data collected also suggest that CSO discharges contributed significantly to elevated fecal coliform levels in Harbor Brook. Given the uncertainties inherent in these analyses, we caution against over-interpreting the results of this single storm. Factors contributing to this uncertainty for the August 22 PCCM event include: (1) uncertainties in measured and estimated CSO flow volumes, (2) the unquantified effects of a prior rainfall event, and (3) the fecal coliform concentration assumed for CSOs was a best estimate based on the median of 47 samples from CSO facilities during 2015-2017. Conclusions should be based on a "weight of the evidence" approach that considers the entire PCCM dataset. We offer the following recommendations:

1. CSO samples should continue to be analyzed for fecal coliform to better define representative concentrations for use in CSO loading calculations.
2. The use of auto-samplers is recommended in order to collect samples that represent rising limb and peak flow concentrations. We understand there are concerns regarding sample handling and holding times for fecal coliform samples. Perhaps these concerns can be addressed to allow for the use of auto-samplers.
3. Monitoring of future storm events should attempt to cover the entire storm hydrograph, from baseflow to baseflow.

4. Post-construction storm event monitoring should follow the protocols (locations, frequency, duration) adopted during the pre-construction period in order to facilitate comparisons. Alternatively, the rating curves developed for pre-construction conditions might be adjusted to approximate the protocols used for the PCCM program.

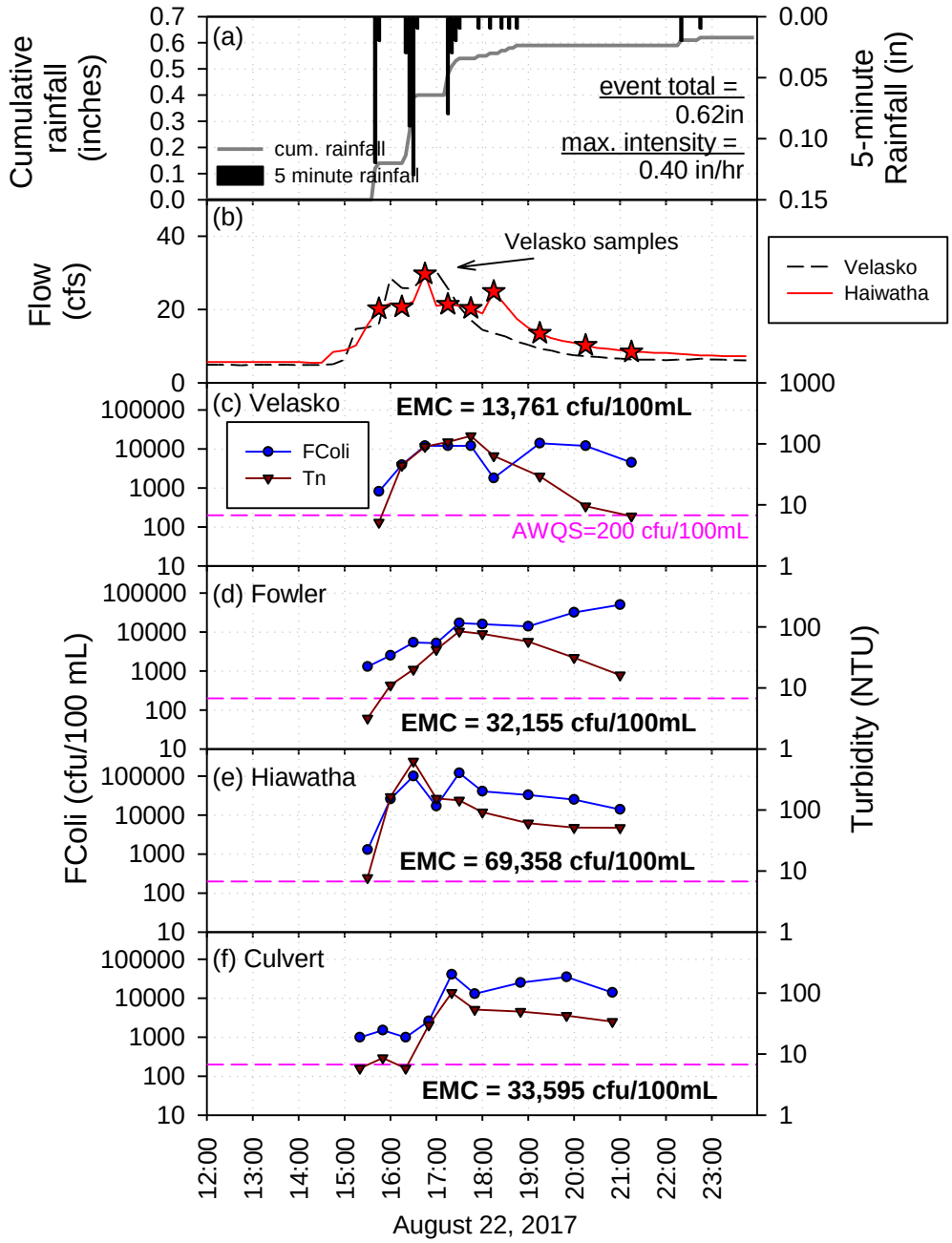


Figure 1. PCCM monitoring results for Harbor Brook on August 22, 2017: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd. and Hiawatha Blvd with times of Velasko samples indicated, (c) FCOLI and turbidity results from Velasko Rd., (d) FCOLI and turbidity results from Fowler High School, (e) FCOLI and turbidity results from Hiawatha Blvd., and (f) FCOLI and turbidity results from Culvert (near Onondaga Lake). Ambient Water Quality Standard (AWQS) for FCOLI (200 cfu/100mL) represented as dashed-pink line and EMC (Event Mean Concentration) for each site in bold.

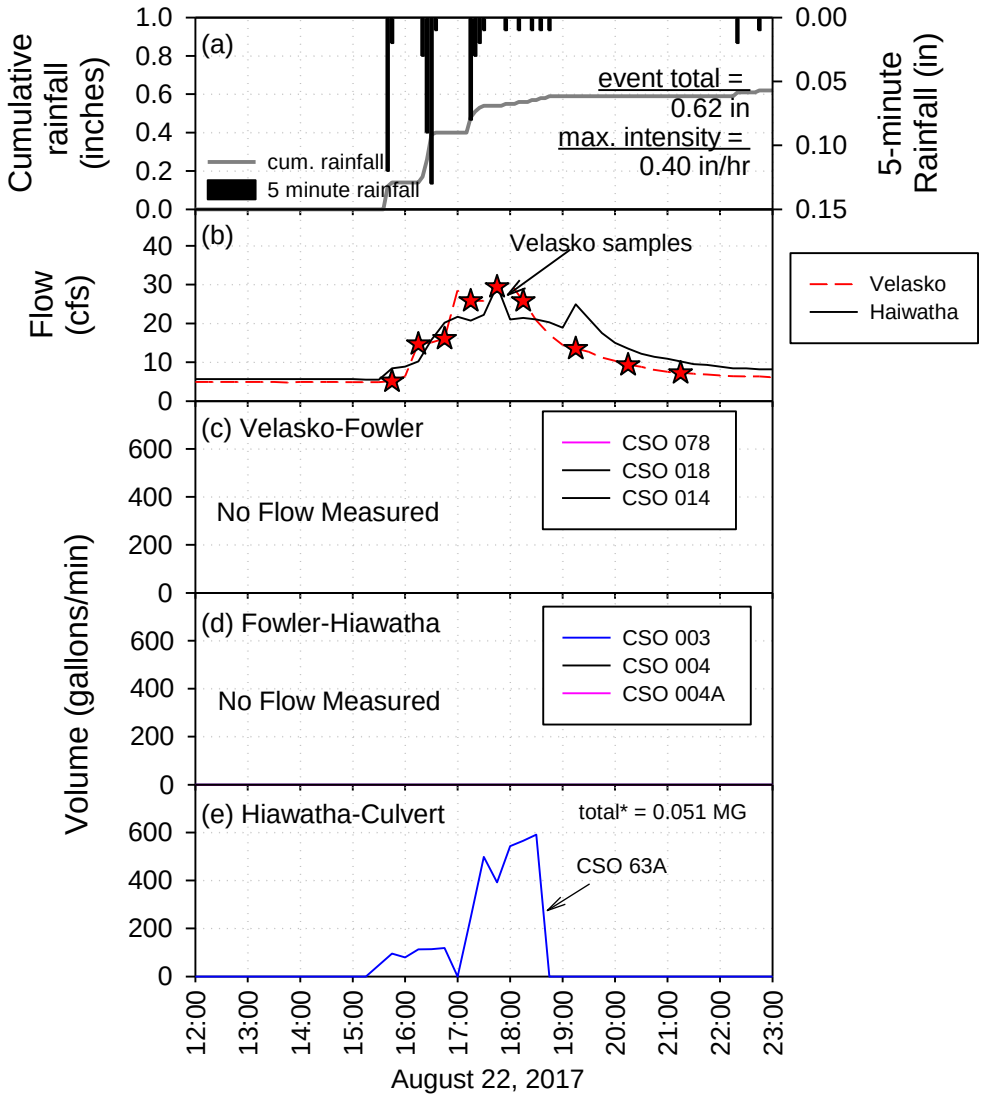


Figure 2. PCCM monitoring results for Harbor Brook on August 22, 2017: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd. and Hiawatha Blvd, (c) total measured CSO flow for the Velasko Rd. – Fowler High School reach, (d) total measured CSO flow for the Fowler High School – Hiawatha Blvd reach and (e) total measured CSO flow for the Hiawatha Blvd. - Culvert (near Onondaga Lake) reach. ***this is the total CSO flow as measured by *in-situ* flow monitoring devices only and is not equivalent to the total CSO flow estimate for the event (see Table 2 far right column).**

Table 1. A comparison of measured and predicted CSO flow volumes for the August 22, 2017 precipitation event, with peak hourly intensity of 0.40 inches/hour and total precipitation of 0.62 inches.

Reach	CSO Number	CSO Descript.	Measured Flow (MG)*	SWMM Predicted Flow (MG)**
Velasko-Fowler	CSO 078	Bellevue Ave & Velasko Rd.	0	0
	CSO 018	Constructed Wetland Outfall	0	0
	CSO 014	Delaware St.	0	0
		Reach Total	**0**	**0**
Fowler - Hiawatha.	CSO 004	State Fair Blvd	0	0
	CSO 004A	Lower Harbor Brook Storage Facility	0	--
	CSO 003	Hiawatha Blvd	0	0
		Reach Total	**0**	**0**
Hiawatha - Culvert.	CSO 063A	new location	0.051	0
		Reach Total	**0.051**	**0**

* only those CSOs with measured flow data are included in this table

** SWMM CSO Volume Discharge based on SWMM output results for a 0.39 inch per hour rainfall (5/17/1991 storm) from the 2017 trigger tables. For more comprehensive event CSO volume estimates please see Table 2.

Table 2. Summary of CSO discharge volumes for the August 22, 2017 PCCM event at Onondaga Creek. Discharge volumes calculated from flowmeter data and those based on SWMM output are provided.

Harbor Brook CSO Volume Summary Aug 22, 2017 - PCCM Event 3)

Onondaga County Department of Water Environment Protection

CSO Outfall	Outfall Description	Outfall Status	Rainfall Trigger Intensity (in/hr)	CSO Abatement Strategy	Flow Monitoring	Comments	Location	Measured CSO Volume Discharged, MG	Modeled CSO Volume Discharged, MG[4] (event total (0.62 in))	Modeled CSO Volume Discharged, MG[5] (event intensity (0.4 in/hr))	Best Estimate CSO Volume Discharged, MG
VELASKO RD.											
CSO 078	Bellevue Ave & Velasko Rd	Operational	0.9	Floatables Plan	water level sensor		Velasko-Fowler	0.000	0.000	0.000	0.000
CSO 018	Constructed Wetland Outfall	Operational	>0.9	GI - wetland treatment with floatables control	flow meter, sampler		Velasko-Fowler	0.000	0.000	0.000	0.000
CSO 017	Hoeffler St	Operational	0.9	Floatables Plan	water level sensor		Velasko-Fowler		0.000	0.000	0.000
CSO 015	Herriman St & Grand Ave	Operational	0.6	Floatables Plan	ultrasonic level sensor		Velasko-Fowler		0.000	0.000	0.000
CSO 014	Delaware St	Operational	0.6	Floatables Plan	flow meter	standing water prior to event	Velasko-Fowler	0.000	0.000	0.000	0.000
FOWLER											
CSO 011	Gifford St at Fowler-East side of HB	Operational	0.2	Floatables Plan	water level sensor		Fowler-Hiawatha		0.070	0.050	0.050
CSO 010	West Fayette St-East of HB	Operational	0.1	Floatables Plan	water level sensor		Fowler-Hiawatha		0.070	0.060	0.060
CSO 009	West Fayette St-West of HB	Operational	0.6	Floatables Plan	water level sensor		Fowler-Hiawatha		0.050	0.000	0.000
CSO 007	Richmond Ave & Liberty St	Operational	0.6	Floatables Plan	water level sensor		Fowler-Hiawatha		0.070	0.100	0.100
CSO 006	Park Ave-West of HB	Operational	0.3	Floatables Plan	water level sensor		Fowler-Hiawatha		0.020	0.000	0.000
CSO 006A	Park Ave-East of HB	Abated	0.6	Floatables Plan	water level sensor		Fowler-Hiawatha		0.000	0.000	0.000
CSO 005	West Genesee & Hackett St	Operational	0.3	Floatables Plan	water level sensor		Fowler-Hiawatha		0.050	0.070	0.070
CSO 004	State Fair Blvd	Abated	>0.9	Lower Harbor Brook SF, GI	flow meter		Fowler-Hiawatha	0.000	0.000	0.000	0.000
CSO 004A	Lower Harbor Brook Storage Facility	Abated		Lower Harbor Brook SF			Fowler-Hiawatha	0.000	--	--	0.000
CSO 003	Hiawatha Blvd	Abated	>0.9	Lower Harbor Brook SF, GI	flow meter		Fowler-Hiawatha	0.000	0.000	0.000	0.000
HIAWATHA BLVD.											
CSO 063A	new location	Abated	>0.9	Lower Harbor Brook SF	flow meter		Hiawatha-Culvert	0.051	0.000	0.000	0.051
CULVERT											
TOTAL								0.051	0.330	0.280	0.331

Footnotes:

[1] Actual completion date unknown at this time.

[2] Event Indicator: record date and duration of overflow.

[3] Water levels to be used to approximate flow rate.

[4] Modeled CSO Volume Discharge based on SWMM Model output results for a 0.57 inch rainfall (6/12/91 storm) from 2017 trigger table

[5] Modeled CSO Volume Discharge based on SWMM Model output results for a 0.39 inch/hr rainfall (5/17/91 storm) from 2017 trigger table

Reach	MG
Velasko-Fowler	0.000
Fowler-Hiawatha	0.280
Hiawatha-Culvert	0.051

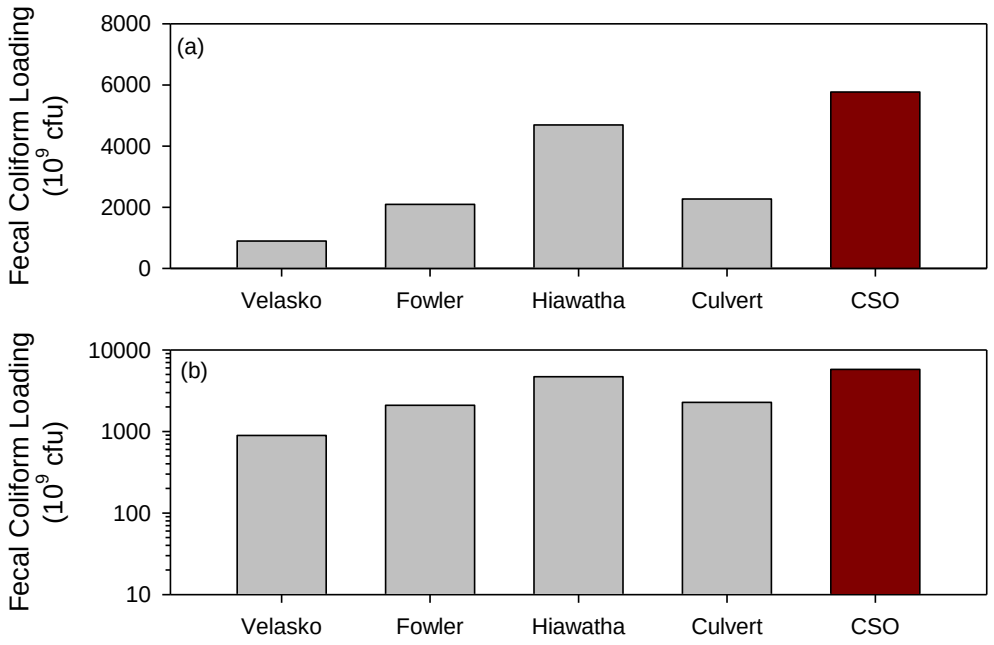


Figure 3. Estimated fecal coliform loads for the PCCM storm event on August 22, 2017: (a) linear and (b) log-10 scales.

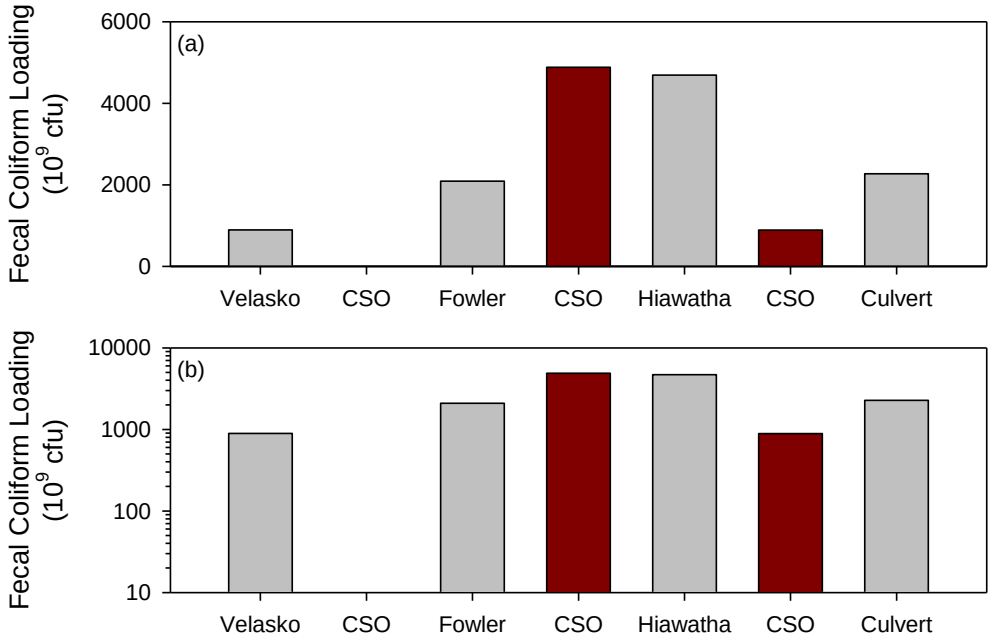


Figure 4. Estimated fecal coliform loads for the PCCM storm event on August 22, 2017: presented for the four sampling sites on Onondaga Creek and for intervening CSO inputs: (a) linear and (b) log-10 scales.

Section 6: Ancillary Time Series Plots

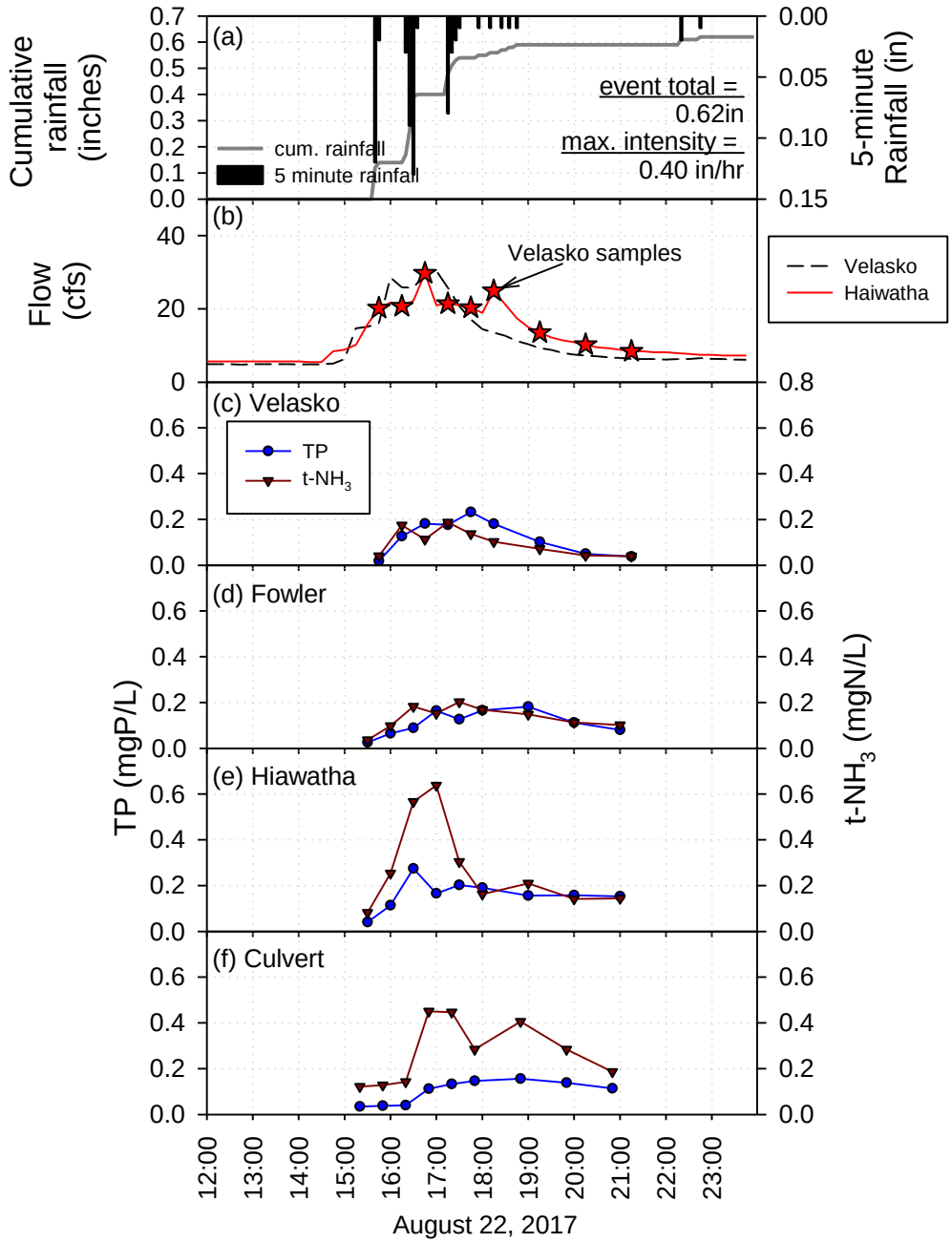


Figure A1. Precipitation event on August 22, 2017 and PCCM monitoring results from Harbor Brook for: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd and Hiawatha Blvd., with times of Velasko samples indicated, (c) total phosphorus (TP) and total ammonia (t-NH_3) results from Velasko Rd., (d) TP and t-NH_3 results from Fowler High School, (e) TP and t-NH_3 results from Hiawatha Blvd., and (f) TP and t-NH_3 results from Culvert. (near Onondaga Lake).

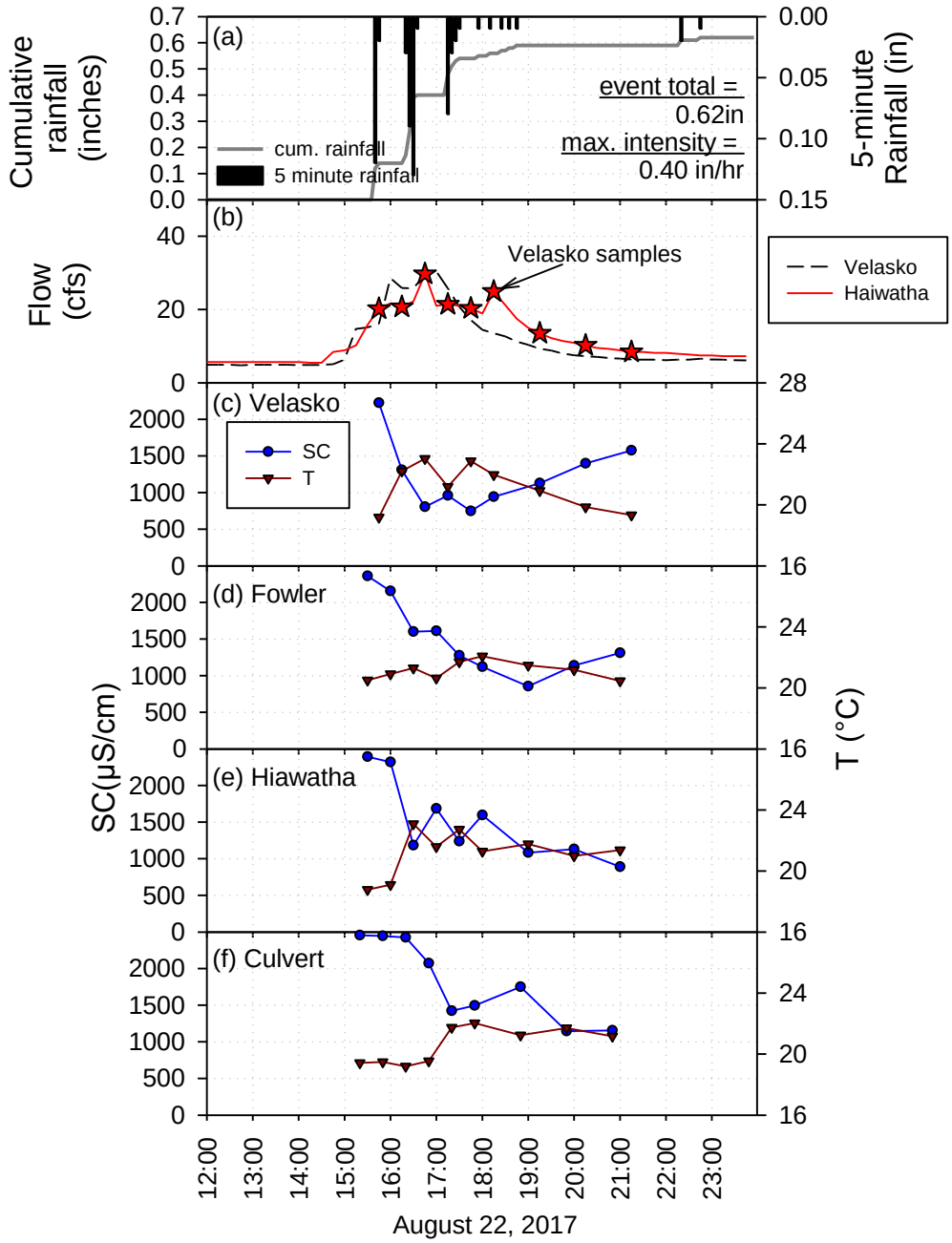


Figure A2. Precipitation event on August 22, 2017 and PCCM monitoring results from Harbor Brook for: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd. and Hiawatha Blvd., with times of Velasko Rd. samples indicated, (c) temperature (T) and specific conductance (SC) results from Velasko., (d) T and SC results from Fowler High School, (e) T and SC results from Hiawatha Blvd., and (f) T and SC results from Culvert (near Onondaga Lake).

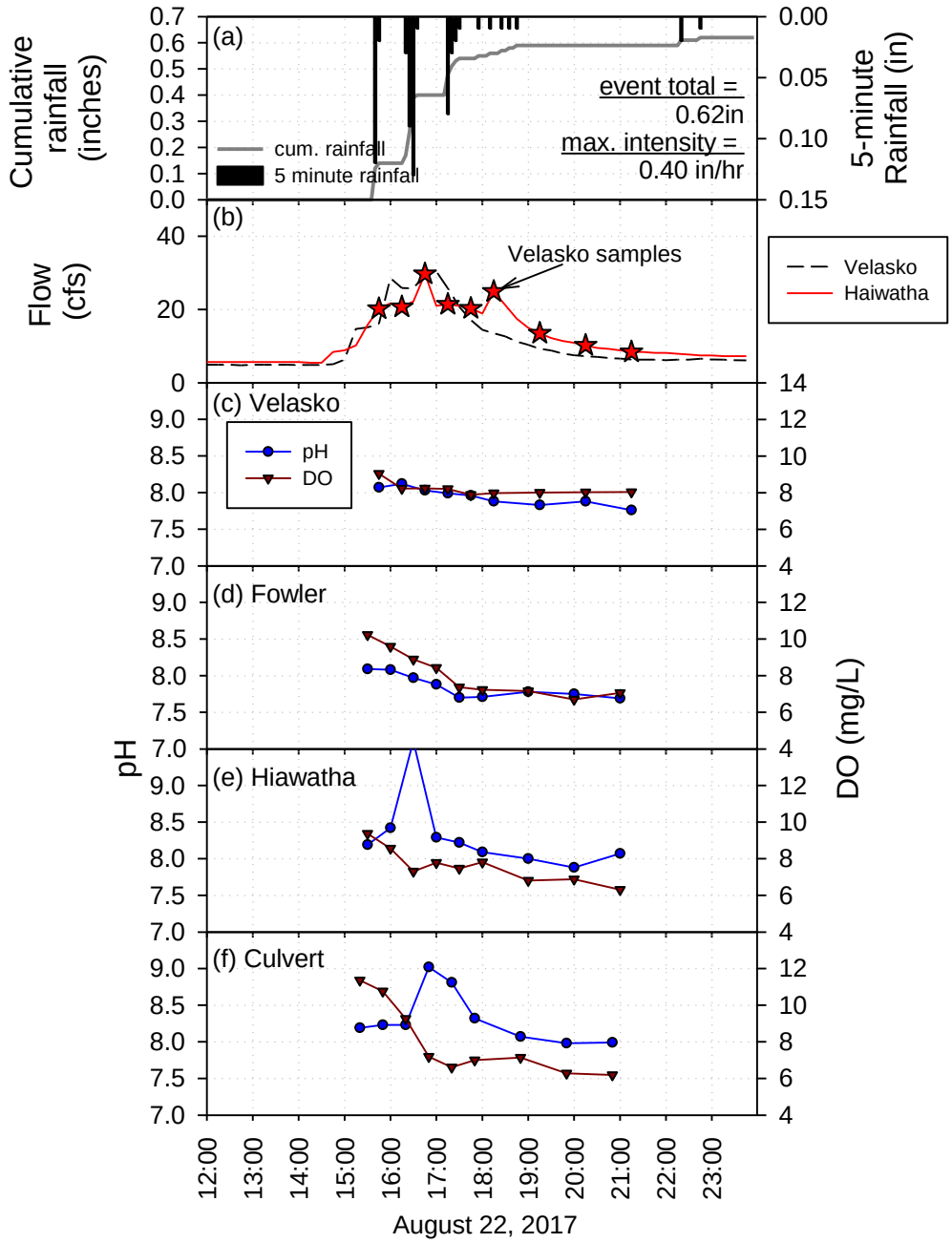
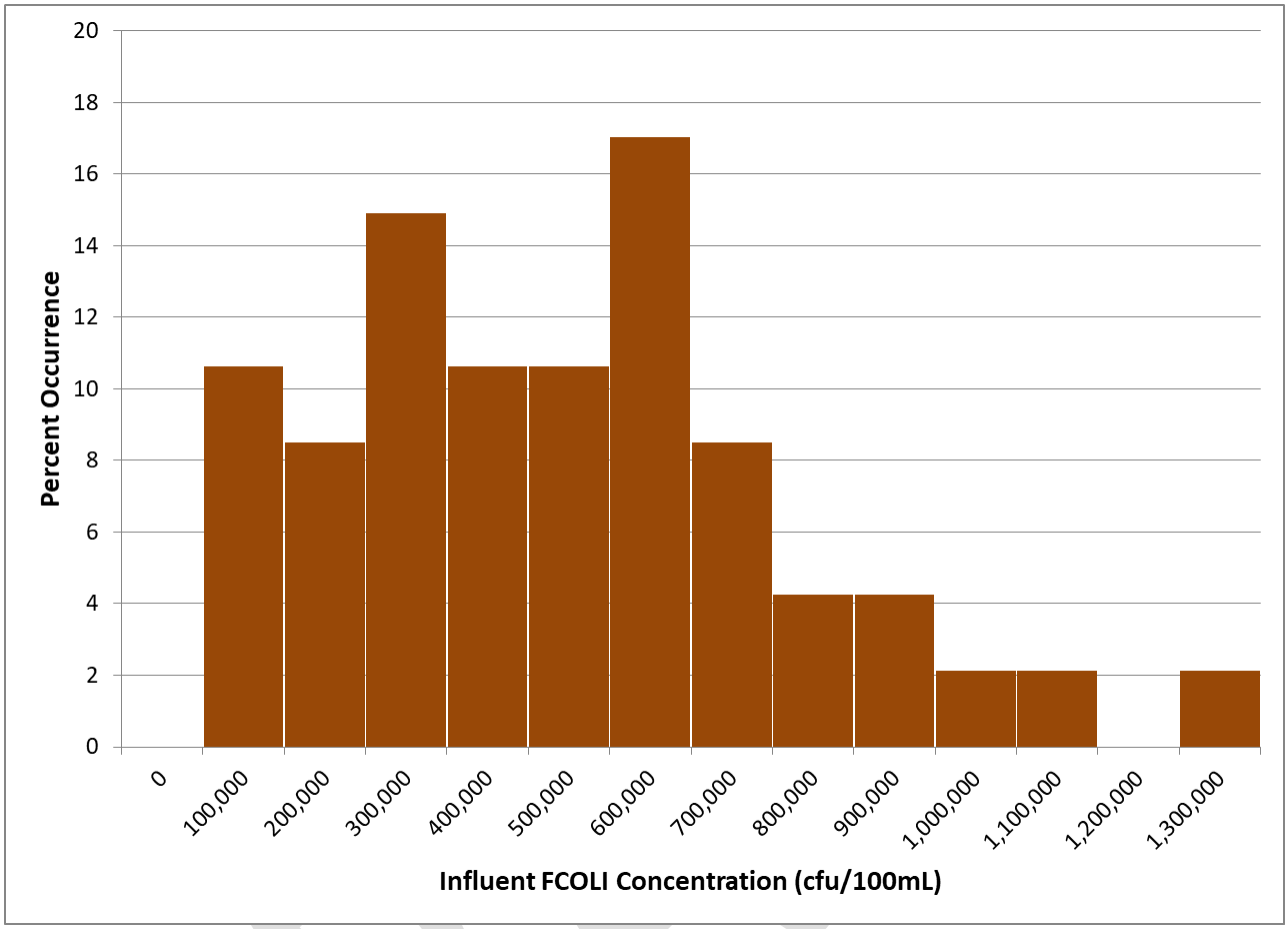


Figure A3. Precipitation event on August 22, 2017 and PCCM monitoring results from Harbor Brook for (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko and Hiawatha Blvd., with times of Velasko Rd. samples indicated, (c) pH and dissolved oxygen (DO) results from Velasko Rd., (d) pH and DO results from Fowler High School, (e) pH and DO results from Hiawatha Blvd., and (f) pH and DO results from Culvert (near Onondaga Lake)..



2015-2017	
Mean	529,840
Standard Error	68,888
Median	**460,000**
Mode	600,000
Standard Deviation	472,271
Sample Variance	223,039,522,895
Kurtosis	10
Skewness	3
Range	2,676,000
Minimum	24,000
Maximum	2,700,000
Sum	24,902,500
Count	47

Figure A4. Frequency distribution and summary statistics for 47 FCOLI samples collected from CSO facility influent during the 2015, 2016, and 2017.