Stormceptor® Monitoring Study

Como Park

St Paul, Minnesota

Prepared by:

Rinker Materials

February, 2002

Executive Summary

Monitoring was conducted on a Stormceptor model STC 1800 during eight storm events from August, 1998 to September, 1999. The results from this test indicated a high level of removal (76%) of total suspended solids during this period.

Significant levels of Kjeldahl nitrogren (65%) and total phosphorus (32%) removal were also recorded during the monitoring period.

All removal rates are based on mass reduction over eight storm events. The removal efficiency was based on load reduction since the event mean concentration of pollutants varied with each storm.

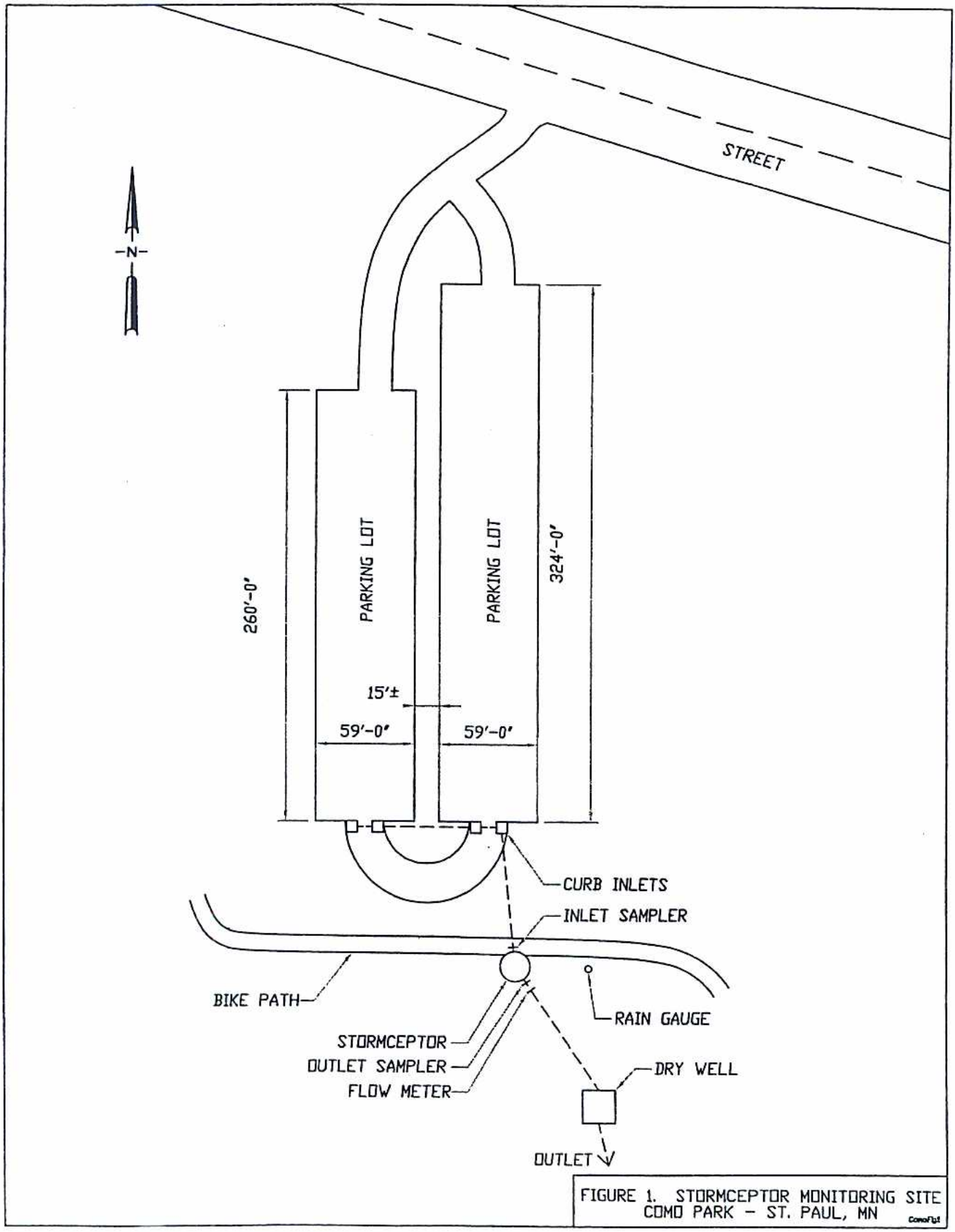


FIGURE 1. STORMCEPTOR MONITORING SITE
COMO PARK – ST. PAUL, MN

Results

Storm Events

Eight storms were monitored over the two-year period. Five storms were monitored in 1998 and three storms were monitored in 1999. The storm depths ranged from 0.13 inches to 2.02 inches with the mean rainfall depth of 0.58 inches. Storm event durations ranged from 1 hour and 20 minutes to 10 hours and 20 minutes. The average storm duration was 4 hours and 10 minutes.

Total Suspended Solids (TSS)

Levels of total suspended solids in stormwater can range from less than 10 mg/l to several thousand milligrams per liter depending on the site conditions and TSS generating activities. Typical levels for stabilized sites range from 50 mg/l to 150 mg/l (EPA, 1995). In this study, event mean concentration values for the influent TSS ranged from 13 mg/l to 318 mg/l with a flow-weighted average of 78 mg/l over the 8 events. Effluent values ranged from 3 mg/l to 59 mg/l with a flow-weighted average of 19 mg/l. The overall TSS load reduction for the monitoring period was 76%.

Total Petroleum Hydrocarbons (TPH)

No significant concentrations of petroleum hydrocarbons were observed. All effluent TPH levels were less than 2 mg/l. The highest level of TPH in the effluent stormwater was 3.7 mg/l, which is considerably less than the sewer use by-law requirement of 15 mg/l.

Total Phosphorus (TP)

Typical levels of total phosphorus in stormwater are 0.33 mg/l (EPA, 1995). Levels of total phosphorus in the influent stormwater monitored during this study ranged from 0.10 mg/l to 0.46 mg/l with a flow weighted average of 0.36 mg/l. Effluent values of TP from the Stormceptor ranged from 0.11 mg/l to 0.35 mg/l with a flow weighted average of 0.24 mg/l. The overall TP load reduction for the monitoring period was 32%.

Total Kjeldahl Nitrogen (TKN)

Typical levels of total kjeldahl nitrogen in stormwater are 1.5 mg/l (EPA, 1995). Influent levels of TKN at this site ranged from 0.65 mg/l to 2.80 mg/l with a flow weighted average of 1.82 mg/l. Effluent values ranged from 0.09 mg/l to 1.82 mg/l with a flow weighted average of 0.64 mg/l. The overall TKN load reduction for the monitoring period was 65%.

Metals

Total chromium (Cr), total copper (Cu), and total zinc (Zn) were measured in this study. Typical values for Cu and Zn in stormwater are 0.034 mg/l and 0.16 mg/l (EPA, 1995). Only two of the eight storms provided quantitative levels of total chromium for comparison. Accordingly the results are not considered significant. Three of the eight storms provided levels of total copper for comparison. All three storms provided copper

levels that were half of the average reported value listed above. The overall Copper load reduction for these three storms was 46% although the influent levels are noted as low. Four of the eight storms had Zinc levels that could be compared. All four influent values were four times less than the typical value for Zn listed above. In addition, the effluent concentration for the fourth storm seems questionable since it is four times higher than any of the influent concentrations. Accordingly, the results for Zinc are not considered significant. All levels of Cadmium and Lead were below 0.009 mg/l and 0.060 mg/l respectively.

Particle Size Distribution (PSD)

Two sludge samples were taken from the Stormceptor at the end of the monitoring period. Both samples indicated a large percentage of the sludge was fine in nature (65% to 75% silt and clay) with approximately 45% of the material by weight less than 25 μm in size.

Individual Storm Results

Detailed results for each storm event are given in Table 1. A result for any one individual event would not be statistically significant since the results vary from one storm to the next depending on antecedent conditions (traffic, atmospheric deposition, number of dry days) and storm characteristics (duration, intensity). Pollutant loading affects the performance during any one event. Typically the Stormceptor will perform better with higher influent concentrations since most applications are small stable sites that exhibit a first flush. There is less confidence in the results for storms with low pollutant concentrations due to sampling errors and the comparison of relatively clean water in with clean water out. Accordingly, the overall result which is flow weighted (load) over the entire monitoring period is a better reflection of Stormceptor performance than any one individual storm event.

Table 1. Storm Event Results								
Pollutant EMC (mg/l)	8/3/98	8/7/98	8/27/98	9/19/98	9/23/98	9/7/99	9/11/99	9/19/99
TSS in	64.00	318.00	196.00	26.00	33.00	22.70	48.00	13.30
TSS out	16.00	59.00	58.00	31.00	41.00	19.30	7.60	3.30
TPH in	1.4	3.7	0.6	0.2	0.2	0.5	0.2	0.4
TPH out	1.6	1.2	0.8	0.3	0.5	0.7	0.0	0.3
TP in	0.15	0.43	0.10	0.16	0.23	0.37	0.46	0.19
TP out	0.35	0.27	0.17	0.11	0.11	0.23	0.25	0.14
TKN in	2.27	2.33	1.55	2.80	0.54	1.20	1.60	0.65
TKN out	1.33	0.92	1.82	1.20	0.51	< 0.09	0.29	0.88
Cr in	< 0.007	0.340	0.011	0.007	< 0.007	NM	NM	NM
Cr out	< 0.007	0.280	0.008	< 0.007	0.009	NM	NM	NM
Cu in	0.013	0.017	0.015	< 0.033	< 0.033	NM	NM	NM
Cu out	0.004	0.013	0.010	< 0.033	< 0.033	NM	NM	NM
Zn in	< 0.006	0.042	0.044	0.033	< 0.033	NM	NM	NM
Zn out	0.009	0.019	0.029	0.180	< 0.033	NM	NM	NM
Flow Volume (cubic ft.)	2770*	2162	245	1938	769	384	10789	479
Rain (in)	0.83	0.46	0.16	0.55	0.19	0.13	2.02	0.27
Storm Duration (hr:min)	7:50	10:20	1:25	1:45	2:15	3:50	4:05	2:16

* Estimated from the rainfall depth over the contributing area
EMC = Event Mean Concentration
NM = Not Measured

Table 2. provides the overall removal rate for the parameters that were monitored based on the total load of each parameter removed by the Stormceptor.

Table 2. Overall Monitoring Period Results	
Parameter	% Removal
Total Suspended Solids (TSS)	76
Total Kjeldahl Nitrogen (TKN)	65
Total Phosphorus (TP)	32
Copper (Cu)	46
Chromium (Cr)	18
Zinc (Zn)	0*

* Excluding erroneous sample on 9/18/98

The rainfall hyetograph and flow hydrograph are shown on Figures 2 through 9. The sampling times are also given on these figures. Figure 10 plots the particle size distributions from the two sludge samples taken from the Stormceptor at the end of the study. Figures 11 through 13 provide a graphical representation of the influent and effluent concentrations of suspended solids (Figure 11), total phosphorus (Figure 12), and kjeldahl nitrogen (Figure 13) for each storm over the monitoring period.

Figure 2. Como Park - Aug 3, 1998 Storm Event

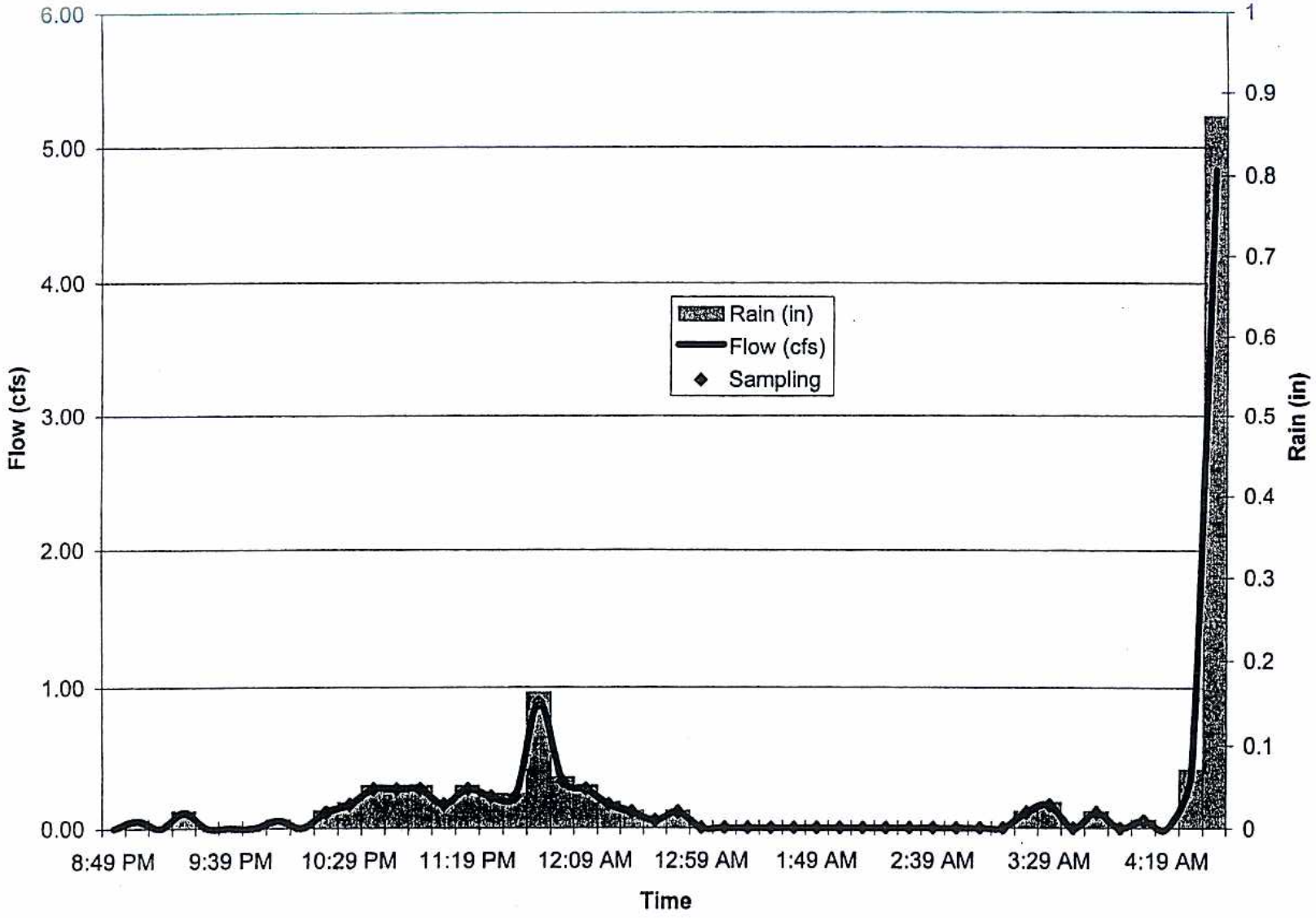


Figure 3. Como Park - Aug 7, 1998 Storm Event

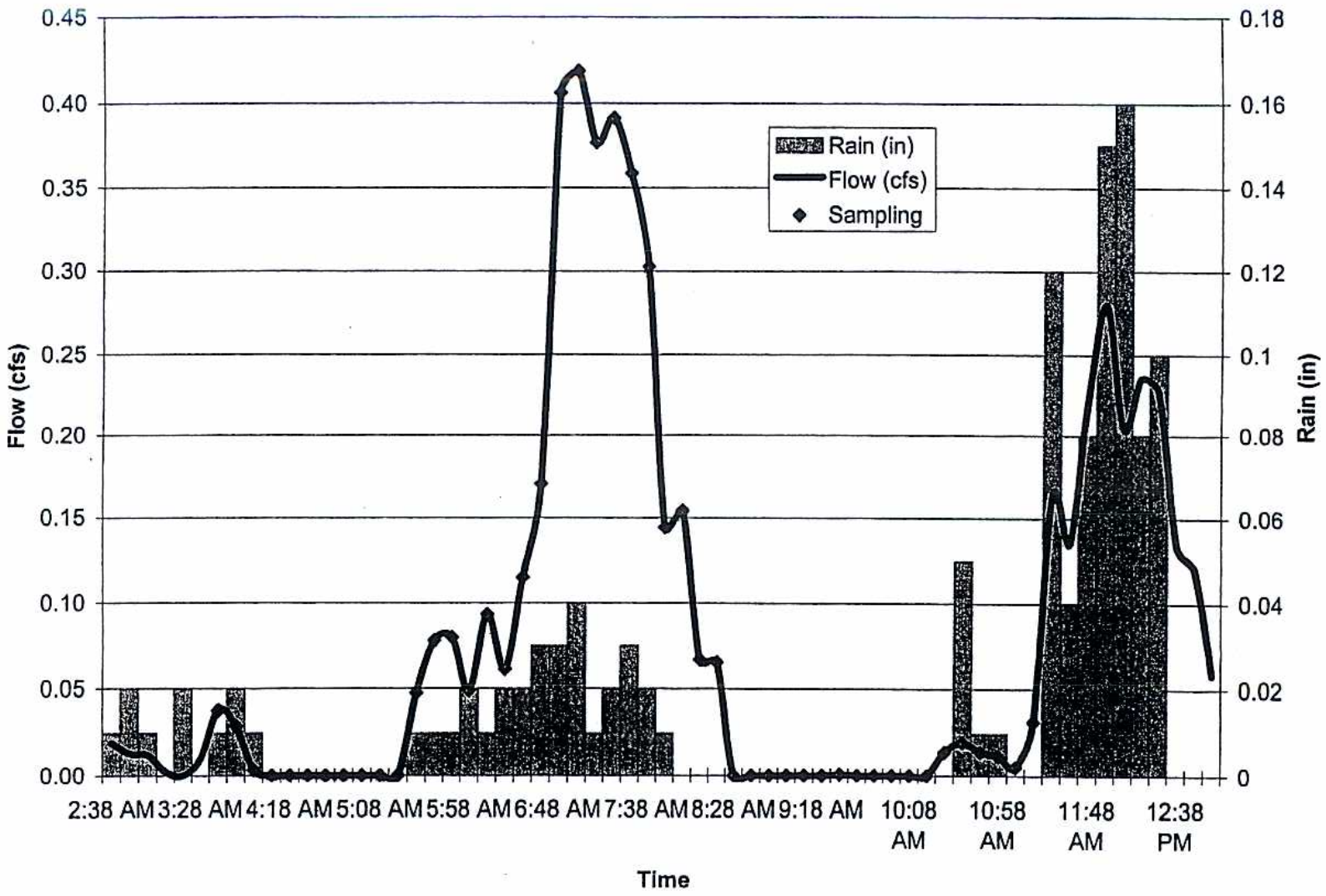


Figure 4. Como Park - Aug 27, 1998 Storm Event

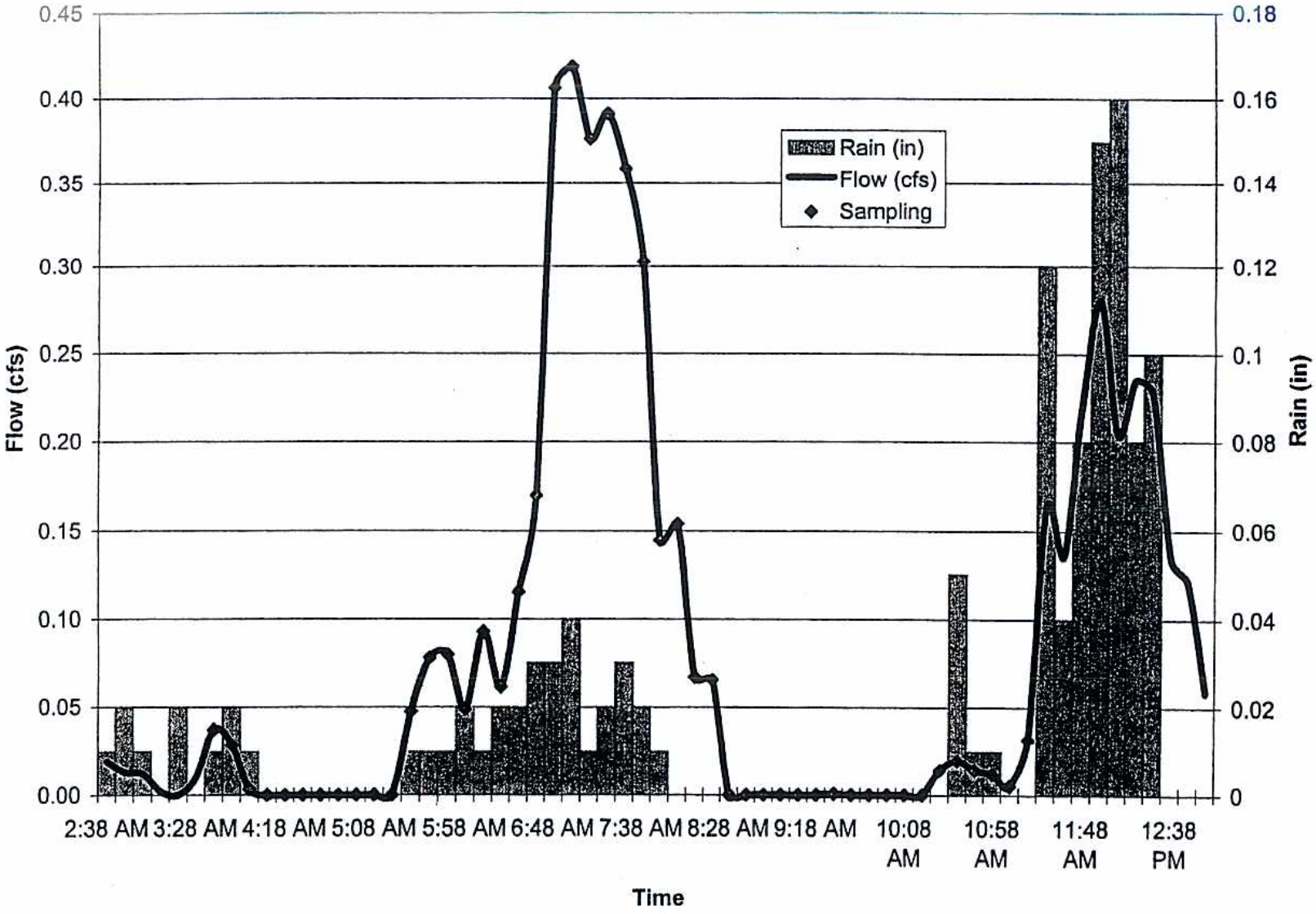


Figure 5. Como Park - Sept 19, 1998 Storm Event

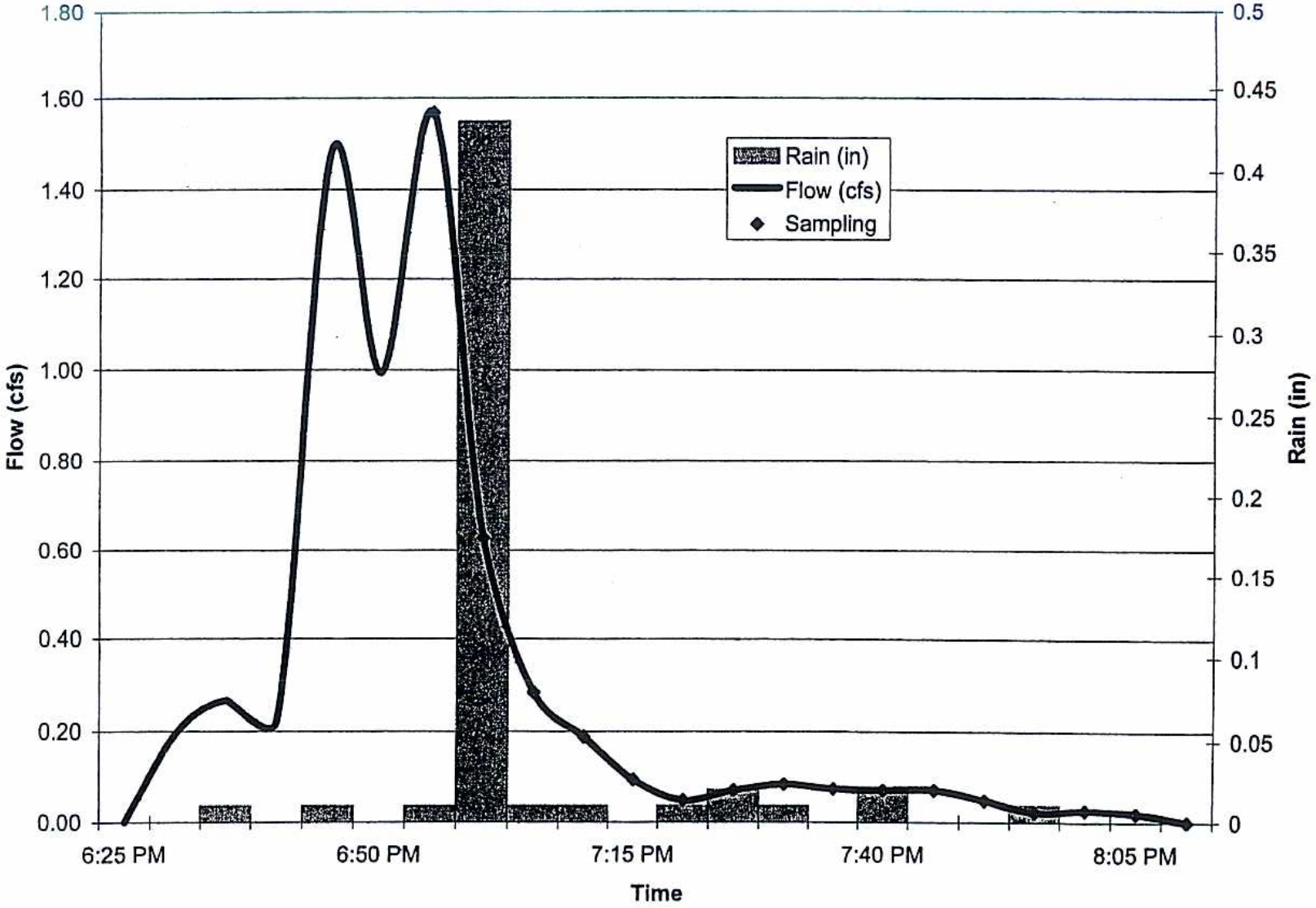


Figure 6. Como Park - Sept 23, 1998 Storm Event

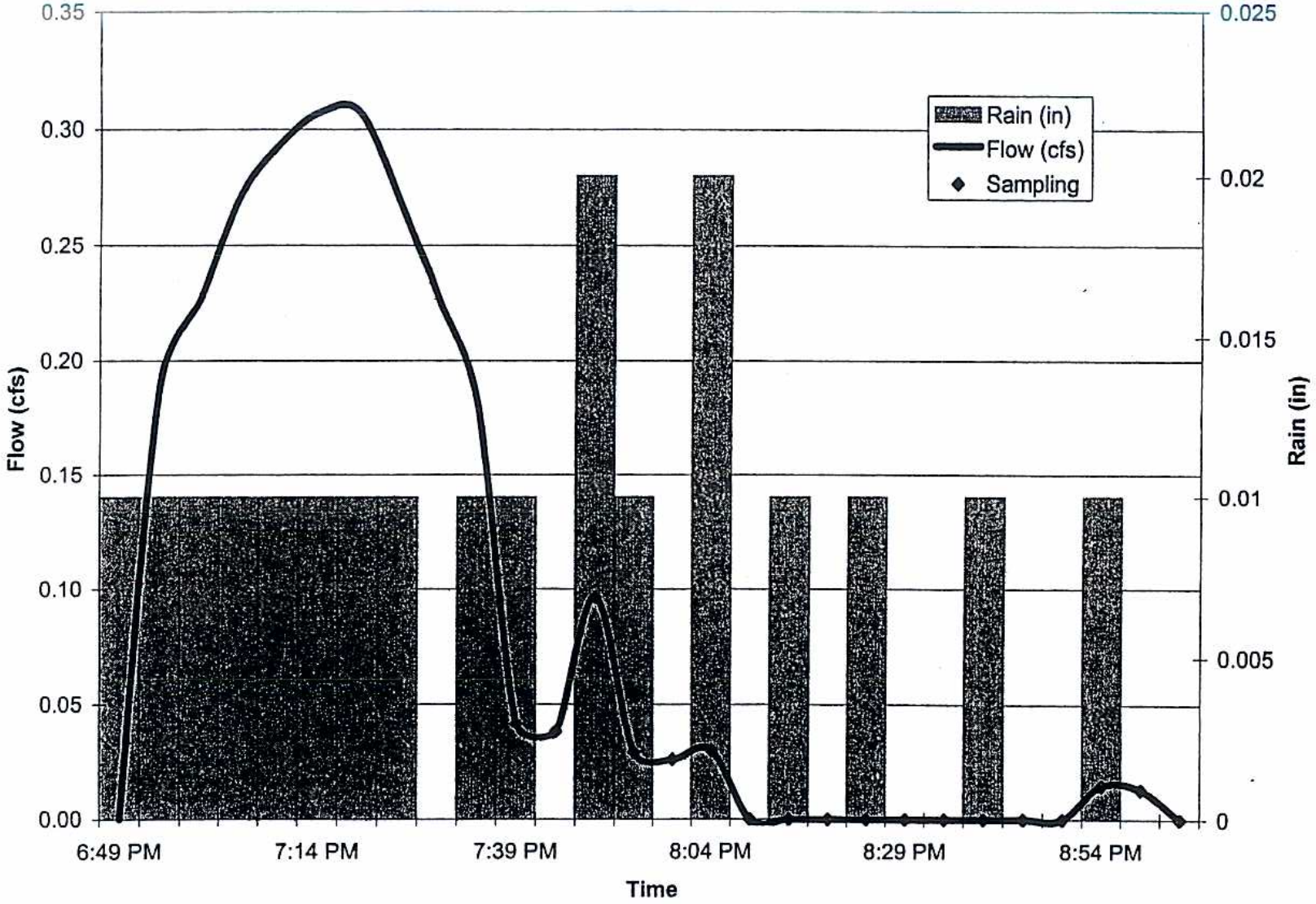


Figure 7. Como Park - Sept 7, 1999 Storm Event

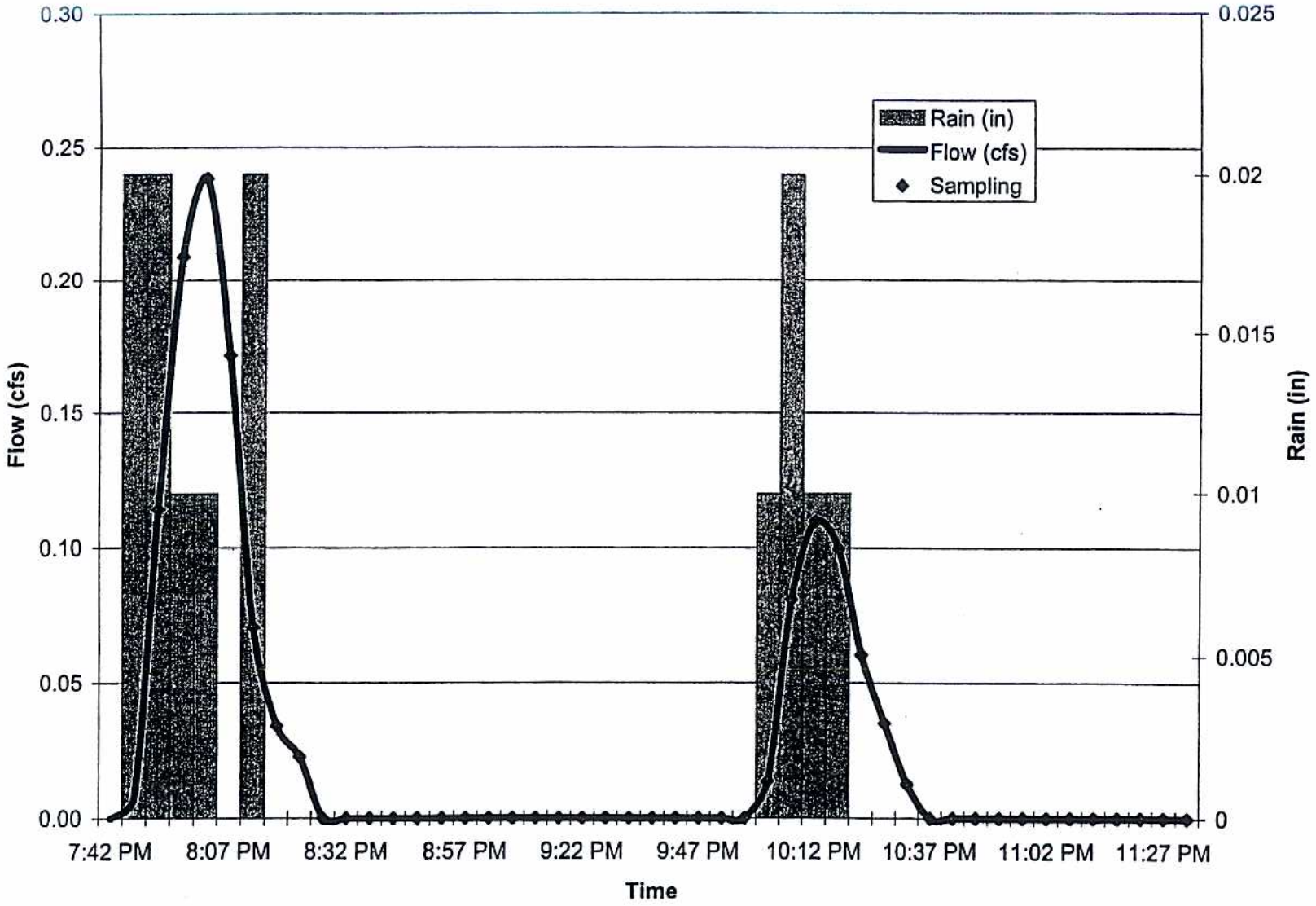


Figure 8. Como Park - Sept 11, 1999 Storm Event

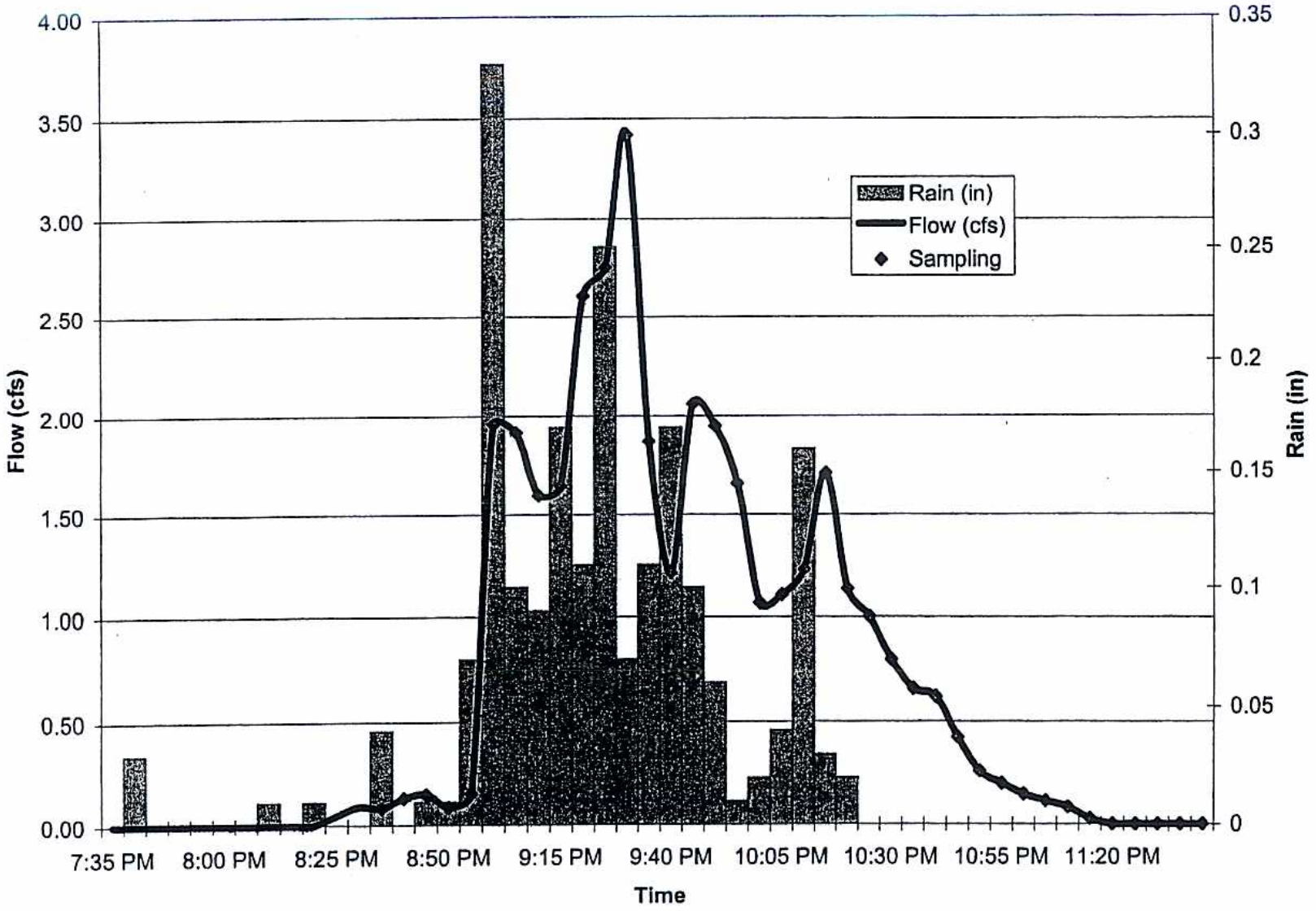


Figure 9. Como Park - Sept 19, 1999 Storm Event

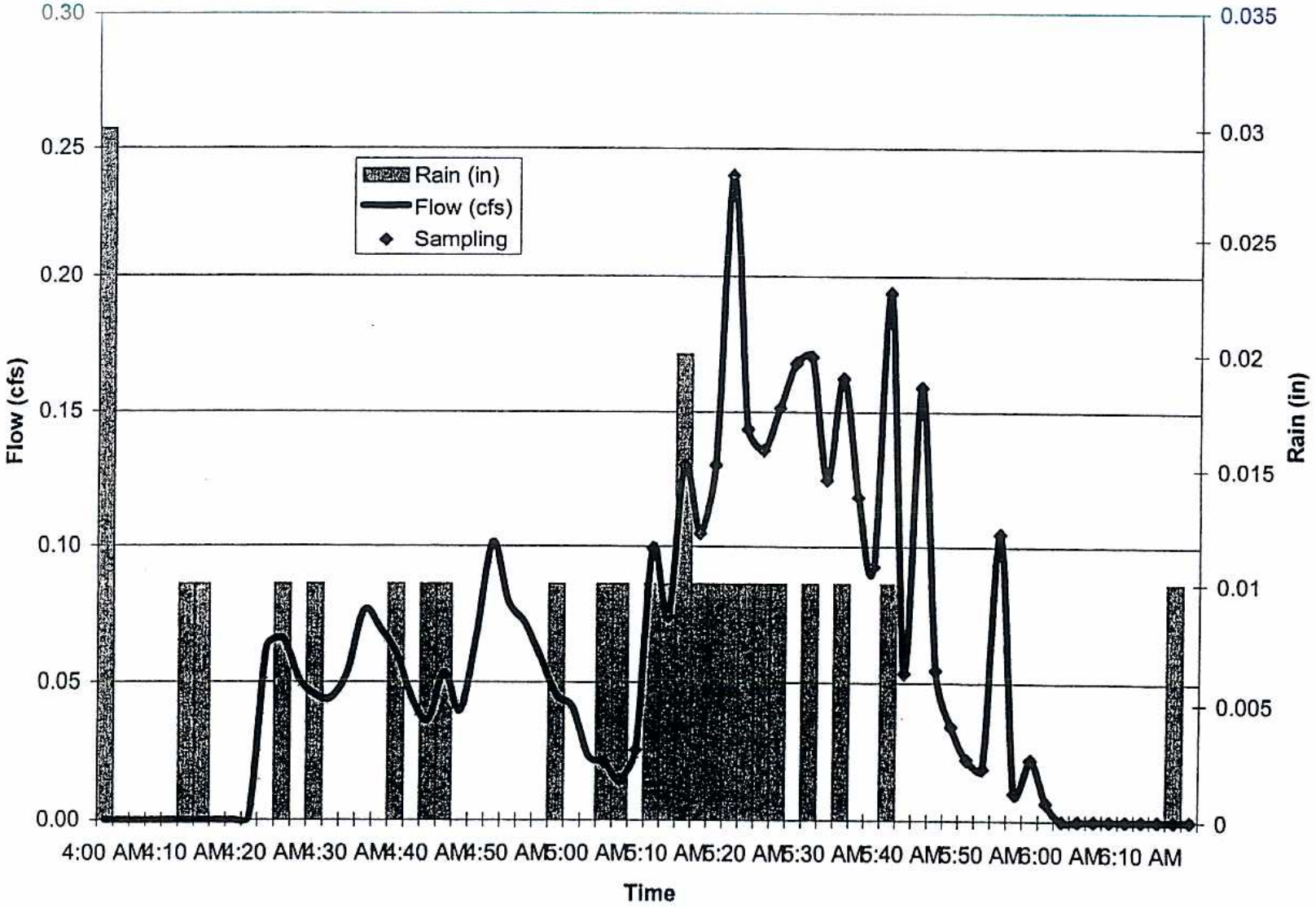


Figure 10. Como Park - Stormceptor Sludge Particle Size Distribution

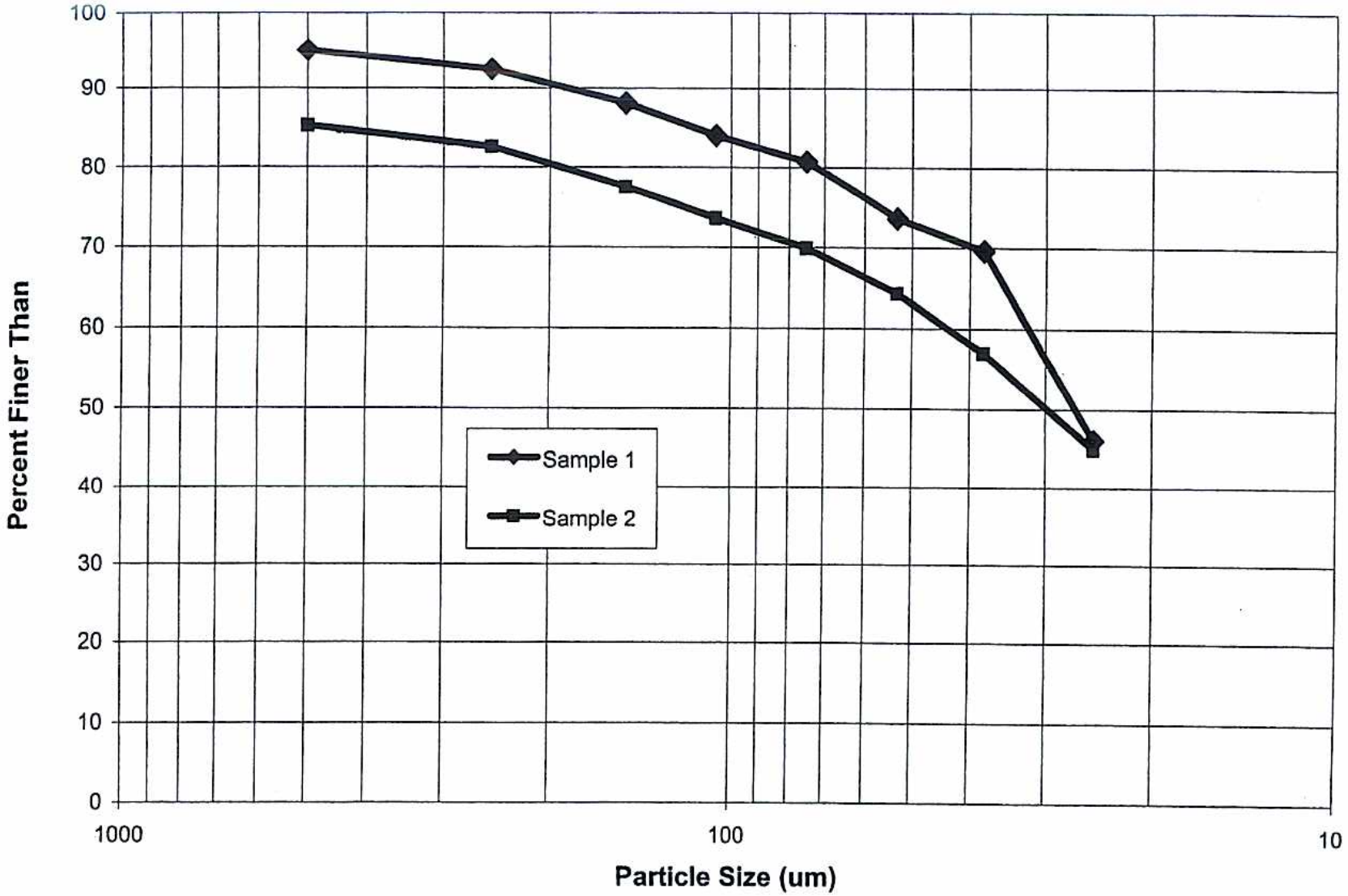


Figure 11. Como Park Total Suspended Solids Removal (Individual Storm Basis)

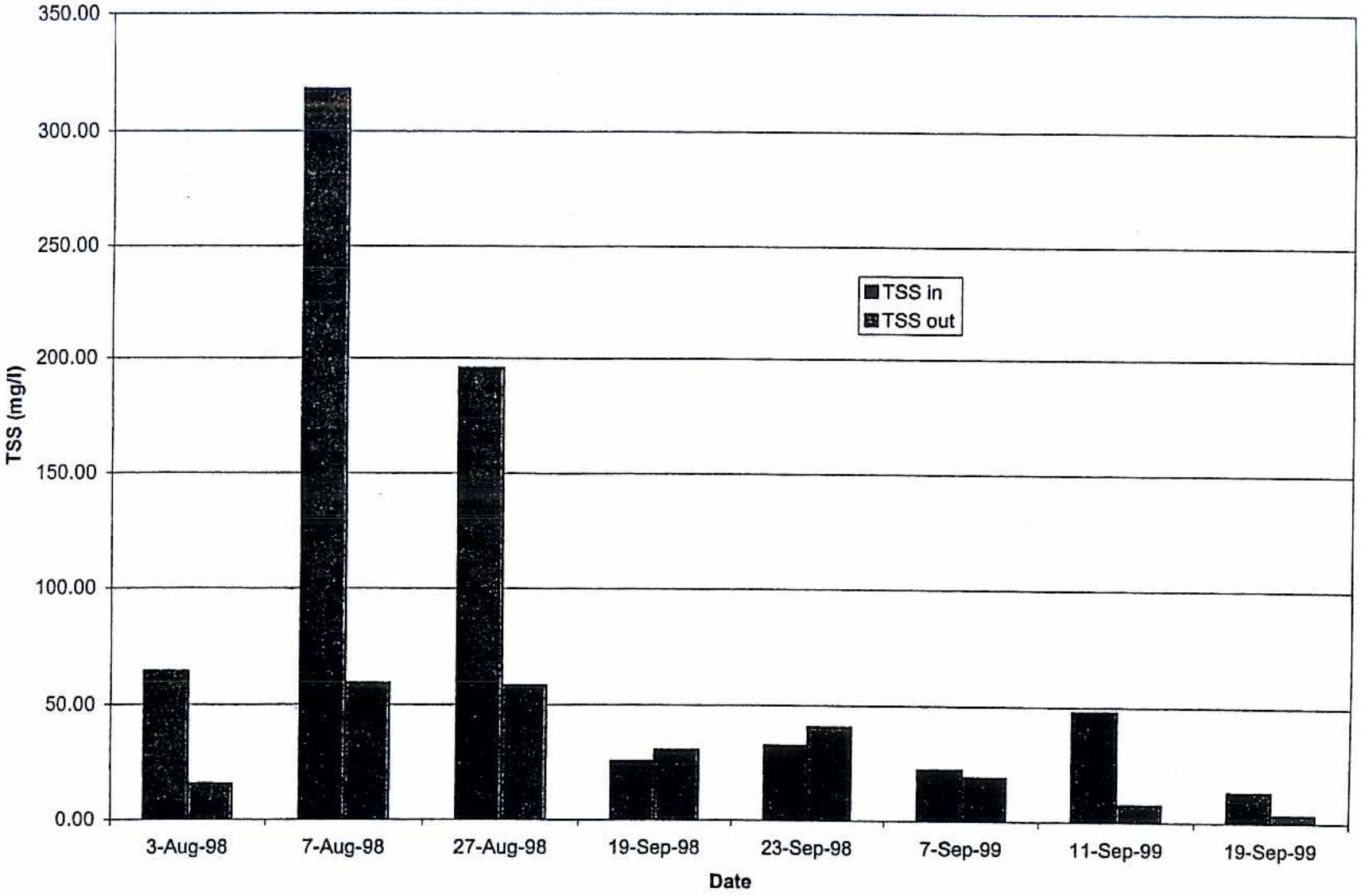


Figure 12. Como Park Total Phosphorus Removal (Individual Storm Basis)

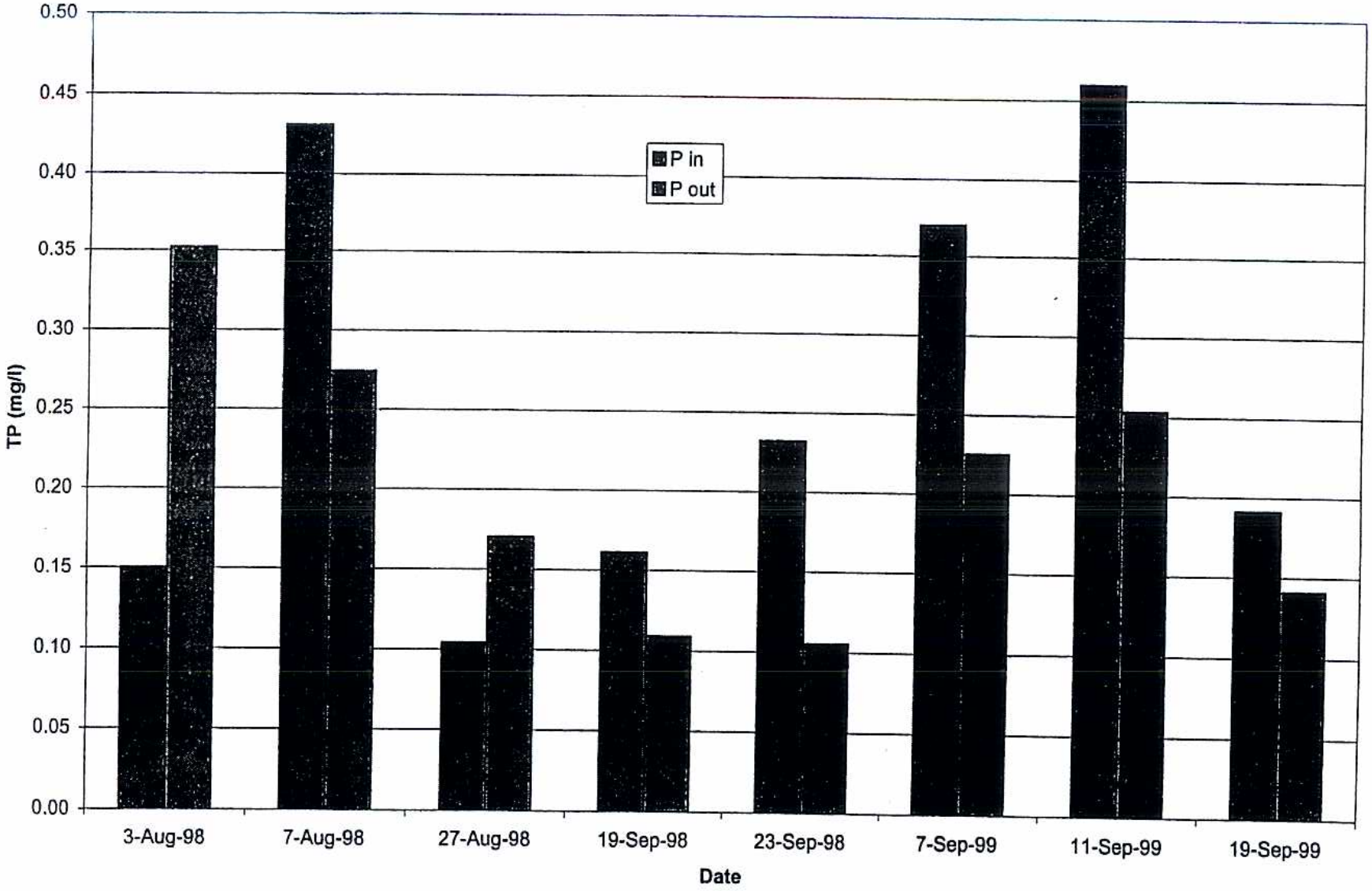
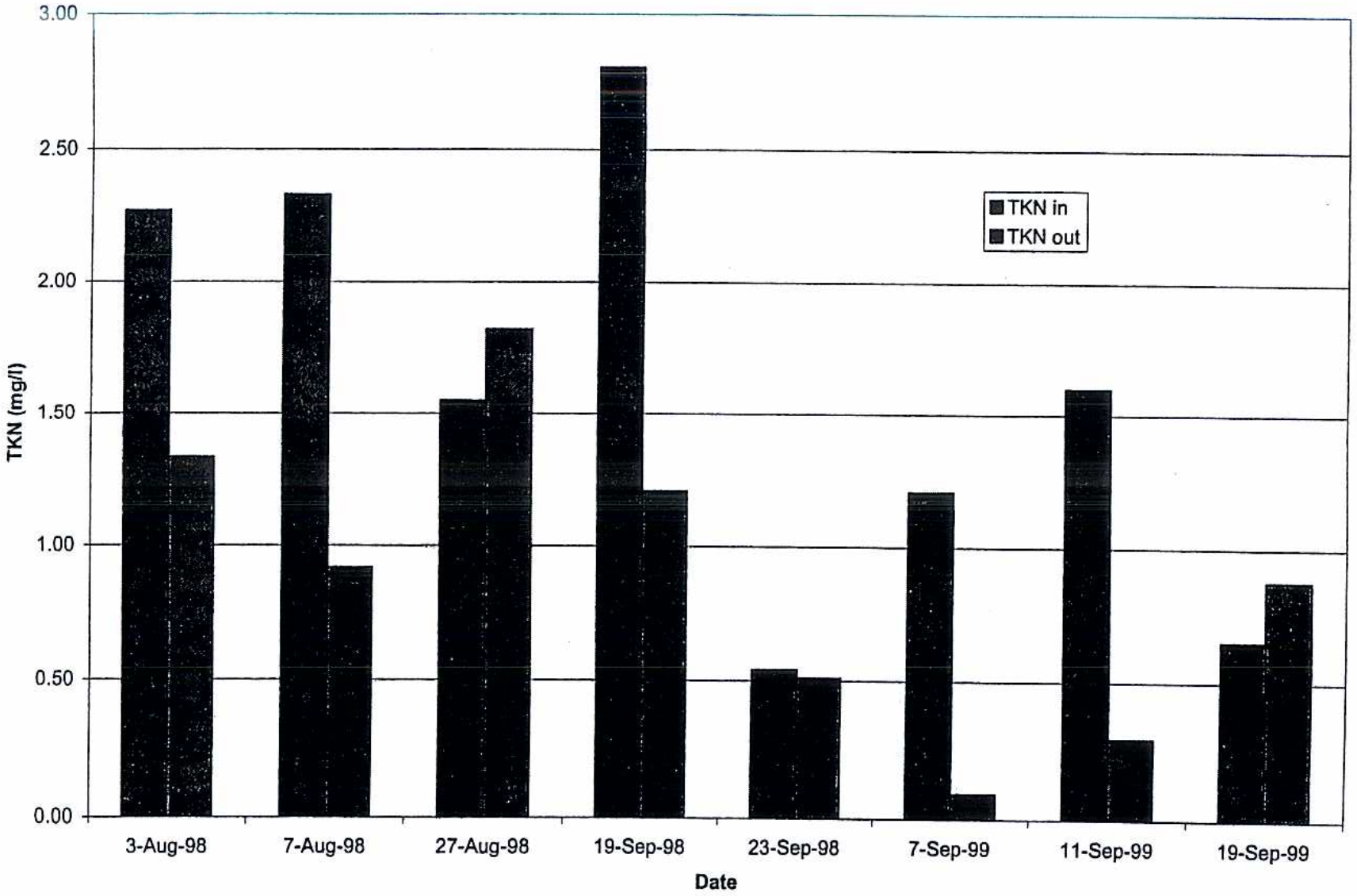


Figure 13. Como Park Total Kjeldahl Nitrogen Removal (Individual Storm Basis)



Discussion

The overall mass removal rate for TSS (76%) was consistent with the design target of 80% estimated using the Stormceptor sizing software. Nutrient removal rates (32% TP removal and 65% TKN removal) were consistent with other Stormceptor monitoring studies. The influent levels of petroleum hydrocarbons and metals recorded during the monitoring period were low. Low hydrocarbon and metals concentrations suggest limited traffic use during the monitoring period.

The particle size distribution of the sludge captured by the Stormceptor was predominantly fine with 65% to 75% of the sludge being comprised of particles less than or equal to 60 μm in size (silt and clay). This particle size distribution (predominantly fines) is consistent with results from other Stormceptor monitoring studies. The results from this study stress the importance of defining the particle size distribution with a significant proportion of fines as criteria for stormwater quality design.