TARP Field Monitoring Summary: Removal of Total Zinc, Copper and Lead

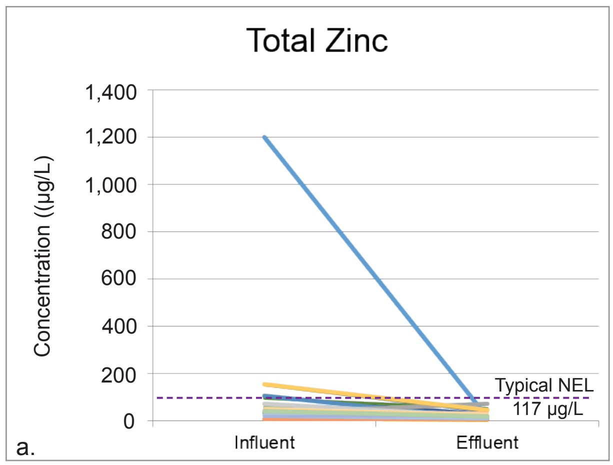
Introduction

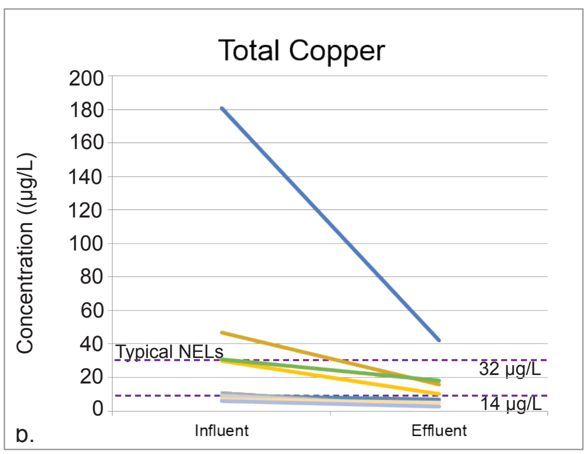
A 6-module Up-Flo® Filter using CPZ Mix filtration media was independently monitored by the University of Alabama at a 0.9 acre site in Tuscaloosa, AL for a 1-year period (Fig.1). The site had 0.55 acres of paved surfaces such as parking spaces and driveways. The filter was sized to treat 25 gpm per Filter Module, for a total water quality treatment flow rate of 150 gpm. Storms were monitored according to the Protocol for Total Suspended Solids Removal Based on Field Testing - Amendments to TARP Protocol (NJDEP, 2009). Although TSS was the primary pollutant of focus for the monitoring study, secondary constituents such as Total Zinc, Total Copper and Total Lead were also evaluated. In total, 30 storms were monitored from March 2012 through March 2013. The total precipitation depth for the 30 monitored storms was 30.16 inches, totalling 624,623 gallons of runoff.

Removal of Total Zinc, Copper and Lead

Metals concentrations in the influent and effluent samples were measured using the EPA 200.8 analysis method. The results of the monitoring program showed that the Up-Flo® Filter removed a large and statistically significant percentage of Total Zinc. The Up-Flo® Filter showed moderate to high levels of treatability for Total Copper and Total Lead, but had many samples with concentration measurements below the detection limit (BDL) so fewer paired values were available for rigorous statistical analysis. Total Copper influent concentrations were above the detection limit for 16 the 30 storms; 12 of the 30 storms had measureable influent concentrations for Total Lead. Paired concentration measurements are shown compared to common Numeric Effluent Limits (NELs) for Zinc, Copper and Lead in Fig.1(a) to (c).

Table 1 (next page) summarizes the measurements and calculations for the 30 sampled storms. The Up-Flo® Filter showed moderate to very high removal rates of Total Zinc, Total Copper and Total Lead. Influent concentrations for all three metals were variable, but effluent concentrations for each analyte were consistently below common NELs.





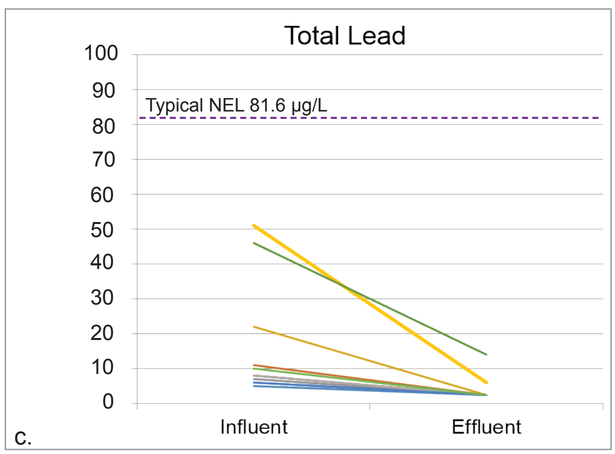


Fig.1 (a) All effluent samples had concentrations below 117 µg/L of Total Zinc, a common NEL for industrial facilities; (b) Of the 12 samples, 11 had Total Copper effluent concentrations below 32 µg/L and 8 had concentrations below 14 µg/L; (c) All Total Lead measurements were below the typical NEL of 81.6 µg/L.

Total Zinc

Event mean influent concentrations of total zinc ranged from 7 to 1,200 µg/L. The average event mean effluent concentration was 21 to 22 µg/L and the average removal efficiency was 42% to 46%, with the uncertainty introduced by several BDL effluent measurements.

Total Copper

Measureable event mean influent concentrations of total copper ranged from 6 µg/L to 181 µg/L. The average event mean effluent concentration was 5 to 10 µg/L and the average removal efficiency was 38% to 77% with the uncertainty caused by a number effluent concentrations below the detection limit.

Total Lead

Measureable event mean influent concentrations of total lead ranged from 5 to 51 µg/L. The average event mean effluent concentration was below the detection limit. The average removal efficiency ranged from 0 to 70% with uncertainty caused by a large number of effluent concentrations below the detection limit.

Table 1 Summary of 30 Monitored Storms.

Constituent	Storms with Influent >BDL	Measurement	Average	Median	Maximum	Minimum	Std. Dev.
Total Zinc (µg/L)	30	Influent EMC	50[1]	42	157	7	40
		Effluent EMC	21 to 22	18 to 20	72	BDL[2]	15 to 16
		Removal Efficiency	42% to 46%	50%	>90.5%	-112%	39.6%
Total Copper (µg/L)	16	Influent	23	9	181	6	42
		Effluent	5 to 10	BDL[2]	42	BDL[2]	10 to 11
		Removal Efficiency	39% to 84%	38%	77%	17 to 22%	17.3% to 27.5%
Total Lead (µg/L)	12	Influent	16	8	51	5	16
		Effluent	2 to 6	BDL[2]	14	BDL[2]	3 to 4
		Removal Efficiency	43% to 97%	38%	>88%	0 to 70%	9.1% to 26.4%

[1] *The highest influent concentration value of 1,200 ug/L was deemed a statistical outlier and was not used in the mean concentration calculation.*

[2] *The detection limit was 5 µg/L.*

Mass Loading Calculation

The performance of the Up-Flo® Filter can be expressed in terms of the mass of metals discharged over the course of the monitoring period (Table 2). The mass of metals discharged per acre was conservatively calculated by assuming the metals pollution was generated by the 0.55 acres of paved surfaces at the 0.9-acre Bama Belle site. The total metals load was then divided by 30.16 inches of rainfall (given that 1 inch of rainfall generates 1 inch of runoff) to determine the mass of metals discharged per paved acre per inch of runoff.

Table 2 Annual Metals Load Calculations for the Up-Flo® Filter Field Monitoring Study

Constituent	Flow-Weighted Avg. Influent EMC	Flow Weighted Avg. Effluent EMC	Percent of Annual Load Removed	Annual Load Influent	Annual Load Effluent
	(µg/L)	(µg/L)	(%)	(g/acre per inch of runoff)	(g/acre per inch of runoff)
Total Zinc	51	18	64%	7.3	2.6
Total Copper	17	6	63%	2.4	0.9
Total Lead	4.4	2.2	50%	0.6	0.3

References

TARP Amendments (2009). Protocol for Total Suspended Solids Removal Based on Field Testing, Amendments to TARP Protocol. Dated August 5, 2009, Revised December 15, 2009.

Cai, Y. (2013). Full-scale Up-Flo® Stormwater Filter Field Performance Verification Tests. University of Alabama.

Hydro International, 94 Hutchins Drive, Portland, ME 04102
Tel: 207.756.6200 Fax: 207.756.6212
Email: stormwaterinquiry@hydro-int.com Web: www.hydro-int.com