

Water Quality Monitoring Results for CSO 143 on Pogues Run

INTRODUCTION

The City of Indianapolis commissioned a construction project at CSO 143 on Pogues Run to biologically treat runoff from the outfall during wet weather. Storm water which previously ran directly into Pogues Run during wet weather was channeled through a bioretention cell to capture and filter pollutants from the water. Construction on the project began in 2011 and was completed in September 2012. Water quality monitoring to assess the effectiveness of pollutant removal was begun in October 2012.

METHODS

Both chemical and biological monitoring techniques were used. For chemical monitoring, automatic samplers were set at sites upstream and downstream from the bioretention cell. Each sampler used a water detection trigger to start the sampling process. When a precipitation event exceeded 0.4 inches in a 24-hr period, sampling began. Each sampler took a “first flush” sample (runoff from the first hour of the rain event) and a composite sample (hourly aliquots for 6 hours). The samples were retrieved within 6 hours of the end of the composite sample completion and analyzed in the lab for the following parameters using APHA Standard Methods techniques. Water level and temperature associated with each sampling event was recorded with a pressure-sensitive data logger.

- Total phosphorus
- Nitrate + Nitrite
- TKN
- Ammonia
- TSS
- TDS
- Chloride
- T-BOD5
- Copper
- Lead
- Zinc
- Particle Size
- E.coli

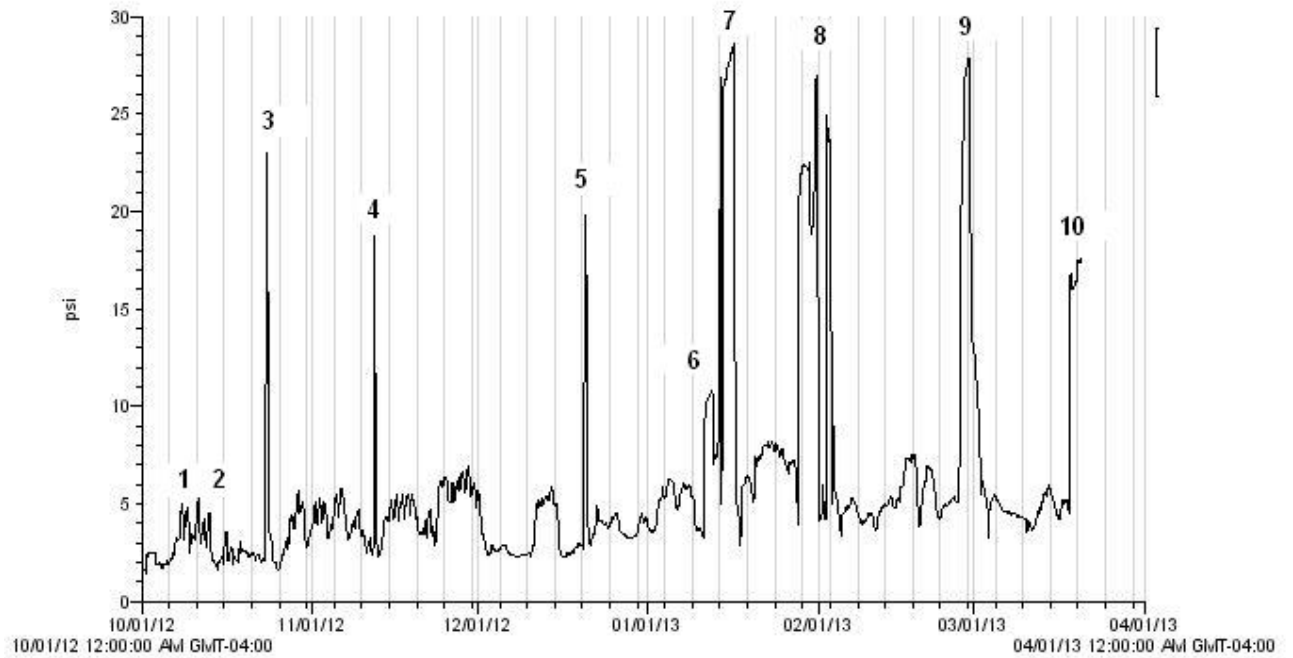
Chemical monitoring provided 520 individual measurements of water quality during ten runoff events between October 2012 and March 2013. Results are provided in the Appendix.

In addition, biological monitoring of the macroinvertebrate community was done upstream and downstream from the CSO 143 discharge to determine if the runoff from the bioretention cell contributed to measurable biological impairment of Pogues Run. The biological monitoring was done using IDEM methods (2010).

RESULTS

Ten storm events were recorded. A graph showing the storm hydrographs and associated sampling events is shown in Fig. 1.

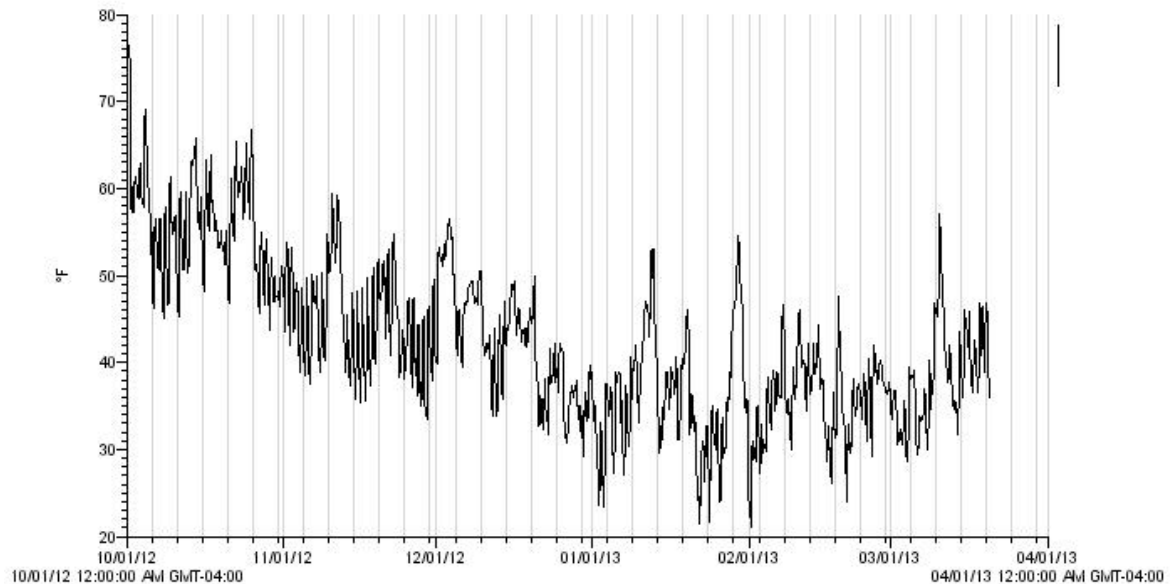
Fig. 1. Storm hydrograph



During the 6-month monitoring period, approximately 9.5 million gallons of storm water was discharged from CSO 143. Average flow was 50,000 gallons per day but during storm events, the average peak flow was usually over 100,000 gallons per hour.

Water temperature recorded by the data logger is shown in Fig. 2. Daily maximum and minimum temperatures are evident in the graph. However, storm events were not characterized by any significant temperature patterns.

Fig. 2. Water Temperature



Although this is considered a combined sewer overflow, many of the measured parameters indicate that raw sewage was not a major component of the untreated storm water. Total BOD and other “sewage indicators” such as E.coli, phosphorus and nitrogen were much lower than normally found in raw sewage. In fact, the average phosphorus, TKN, nitrate, and ammonia values were often lower than many relatively unpolluted surface streams.

The bioretention cell at CSO 143 on Pogues Run was most effective in reducing phosphorus and suspended solids. Reductions of 50 to 55% of these two parameters were observed between samples collected upstream and downstream of the outfall. Reductions of 40-50% were obtained for E.coli, chloride, and BOD. Lesser reductions occurred for TKN, zinc, copper, ammonia, and TDS. The bioretention cell had almost no effect on reducing nitrate, lead, or particle size.

Biological monitoring showed that Pogues Run has a biological integrity score that is somewhat lower than its habitat can support. This usually indicates that there are at least some water quality impairments present. For example, the most abundant form of life (the caddisfly Cheumatopsyche) is quite tolerant to sediment loading. According to IDEM’s biological assessment methodology, both sites are biologically impaired. However, the aquatic community downstream from the CSO is actually somewhat higher than upstream from the discharge. These results strongly indicate that CSO 143 has no adverse effect on the biotic health of Pogues Run.

COMPARISON TO PREVIOUS STUDIES

USGS collected macroinvertebrates in Pogues Run as part of its NAWQA program. The most recent sample for which data are available was from Vermont Street (downstream from CSO 143) in 2008. They found that the most abundant species present were *Baetis flavistriga* (a mayfly), *Stenelmis* sp. (a riffle beetle), *Ferrissia rivularis* (a snail), and the midges *Cricotopus*, *Paratanytarus*, and *Tanytarsus*.

The Marion County Health Department makes macroinvertebrate collections from Pogues Run as part of their water quality monitoring effort. One of their sites is at 21st Street, immediately downstream from CSO 143. Their most recent sample from that site was in 2008. At that time, the dominant animals were *Endochironomus* (a midge) and several species of damselflies. Only two EPT taxa (environmentally sensitive species) were present and the Hilsenoff Biotic Index for the site was 7.33, indicating poor water quality caused by organic (sewage-related) pollution.

Compared to samples from previous studies, the macroinvertebrate community of Pogues Run has shown recent significant improvement.

REFERENCES

- APHA, 1992. Standard methods for the examination of water and wastewater. 18th Edition. Washington, DC.
- IDEM, 2010. Standard operating procedure for collecting macroinvertebrate samples with a multi-habitat sampling method. Office of Water, S-001-OWQ-W-BS-10-S-RO, Indianapolis, IN.
- Stoddard, J.L. et al., 2008. A process for creating multimetric indices for large-scale aquatic surveys. J. N. Amer. Benthol. Soc. 27: 878-891.
- USGS, 2008. Unpublished macroinvertebrate data from USGS site 03352990. Available at the Indiana office website: www.in.water.usgs.gov.
- Marion County Health Department, 2012. Unpublished macroinvertebrate data. Available at the website: <http://www.mchd.com/wq/html/waterq.htm>,

Appendix

Water Quality Data

Benthos Data

Indy CSO-143 Sampling Results

Date: 5-Oct-12
 Precipitation: 1.25 inches
 Max. Flow 19 cfs

		Upstream First Flush	Upstream Composite	Downstream First Flush	Downstream Composite
BOD5	mg/l	17	10	9	10
Total P	mg/l	0.6	0.8	0.22	0.18
TKN	mg/l	0.4	0.3	0.3	0.3
NH3-N	mg/l	0.2	0.2	0.2	0.2
NO2+NO3	mg/l	2.4	2	2.4	1.7
TSS	mg/l	145	25	105	15
TDS	mg/l	583	333	500	417
Cl-	mg/l	48	12	36	12
Cu	mg/l	0.024	0.017	0.019	0.024
Pb	mg/l	0.01	0.01	0.01	0.01
Zn	mg/l	0.038	0.01	0.044	0.01
Part. Size	um	60	45	30	30
E. coli	cfu/100 ml	2620	5440	50	120

Indy CSO-143 Sampling
Results

Date: 18-Oct-12
 Precipitation: 0.7 inches
 Max. Flow 18 cfs

		Upstream First Flush	Upstream Composite	Downstream First Flush	Downstream Composite
BOD5	mg/l	58	38	28	22
Total P	mg/l	0.47	0.03	0.29	0.03
TKN	mg/l	1.1	0.5	0.5	0.5
NH3-N	mg/l	0.2	0.2	0.2	0.2
NO2+NO3	mg/l	0.3	0.33	0.22	0.2
TSS	mg/l	530	59	427	3
TDS	mg/l	444	260	312	264
Cl-	mg/l	36	24	24	24
Cu	mg/l	0.04	0.04	0.01	0.01
Pb	mg/l	0.01	0.01	0.01	0.01
Zn	mg/l	0.05	0.2	0.13	0.035
Part. Size	um	90	30	60	30
E. coli	cfu/100 ml	2120	280	660	260

Indy CSO-143 Sampling
Results

Date: 23-Oct-12
 Precipitation: 0.5 inches
 Max. Flow 150 cfs

		Upstream First Flush	Upstream Composite	Downstream First Flush	Downstream Composite
BOD5	mg/l	12	12	1	1
Total P	mg/l	0.43	0.44	0.22	0.12
TKN	mg/l	0.6	0.5	0.5	0.5
NH3-N	mg/l	0.4	0.3	0.3	0.3
NO2+NO3	mg/l	0.1	0.16	0.14	0.11
TSS	mg/l	76	4	122	4
TDS	mg/l	148	128	124	140
Cl-	mg/l	24	12	12	12
Cu	mg/l	0.015	0.01	0.008	0.01
Pb	mg/l	0.01	0.01	0.01	0.01
Zn	mg/l	0.01	0.01	0.01	0.01
Part. Size	um	60	30	60	30
E. coli	cfu/100 ml	300	940	750	1030

Indy CSO-143 Sampling Results

Date: 12-Nov-12
 Precipitation: 0.9 inches
 Max. Flow 30 cfs

		Upstream First Flush	Upstream Composite	Downstream First Flush	Downstream Composite
BOD5	mg/l	9	6	10	9
Total P	mg/l	1.8	0.18	0.04	0.14
TKN	mg/l	1.9	1.5	1.5	1.3
NH3-N	mg/l	0.5	0.4	0.2	0.2
NO2+NO3	mg/l	1.3	1.6	1.4	1.8
TSS	mg/l	58	10	91	8
TDS	mg/l	228	92	108	116
Cl-	mg/l	48	12	12	12
Cu	mg/l	0.022	0.022	0.015	0.019
Pb	mg/l	0.01	0.01	0.01	0.01
Zn	mg/l	0.03	0.06	0.01	0.01
Part. Size	um	120	30	90	30
E. coli	cfu/100 ml	400	1430	1320	2270

Indy CSO-143 Sampling Results

Date: 20-Dec-12
 Precipitation: 0.5 inches
 Max. Flow 15 cfs

		Upstream First Flush	Upstream Composite	Downstream First Flush	Downstream Composite
BOD5	mg/l	15	13	12	16
Total P	mg/l	0.18	0.16	0.11	0.08
TKN	mg/l	5	1.5	1.5	1.5
NH3-N	mg/l	0.4	0.2	0.2	0.2
NO2+NO3	mg/l	2.4	1.4	1.7	1.5
TSS	mg/l	462	26	145	18
TDS	mg/l	132	68	120	64
Cl-	mg/l	24	12	12	12
Cu	mg/l	0.006	0.008	0.008	0.008
Pb	mg/l	0.01	0.01	0.01	0.01
Zn	mg/l	0.01	0.01	0.01	0.01
Part. Size	um	120	30	120	30
E. coli	cfu/100 ml	2400	660	130	490

Indy CSO-143 Sampling Results

Date: 11-Jan-13
 Precipitation: 0.9 inches
 Max. Flow 51 cfs

		Upstream First Flush	Upstream Composite	Downstream First Flush	Downstream Composite
BOD5	mg/l	13	5	8	4
Total P	mg/l	0.09	0.18	0.11	0.14
TKN	mg/l	0.5	0.2	0.2	0.2
NH3-N	mg/l	0.5	0.2	0.2	0.2
NO2+NO3	mg/l	0.6	0.8	0.6	0.7
TSS	mg/l	550	13	201	14
TDS	mg/l	552	592	440	424
Cl-	mg/l	216	240	144	144
Cu	mg/l	0.031	0.018	0.02	0.019
Pb	mg/l	0.01	0.01	0.01	0.01
Zn	mg/l	0.04	0.04	0.035	0.03
Part. Size	um	120	30	60	30
E. coli	cfu/100 ml	590	520	150	710

Indy CSO-143 Sampling Results

Date: 13-Jan-13
 Precipitation: 2.4 inches
 Max. Flow 260 cfs

		Upstream First Flush	Upstream Composite	Downstream First Flush	Downstream Composite
BOD5	mg/l	9	2	6	2
Total P	mg/l	0.2	0.08	0.16	0.05
TKN	mg/l	0.3	0.3	0.3	0.4
NH3-N	mg/l	0.2	0.2	0.2	0.2
NO2+NO3	mg/l	0.8	0.4	0.6	0.3
TSS	mg/l	304	34	127	31
TDS	mg/l	336	156	392	224
Cl-	mg/l	108	36	132	60
Cu	mg/l	0.032	0.01	0.01	0.015
Pb	mg/l	0.01	0.01	0.01	0.01
Zn	mg/l	0.12	0.045	0.04	0.07
Part. Size	um	90	60	90	60
E. coli	cfu/100 ml	3560	1020	280	1810

Indy CSO-143 Sampling Results

Date: 30-Jan-13
 Precipitation: 0.8 inches
 Max. Flow 85 cfs

		Upstream First Flush	Upstream Composite	Downstream First Flush	Downstream Composite
BOD5	mg/l	15	6	10	1
Total P	mg/l	0.15	0.07	0.26	0.11
TKN	mg/l	0.4	0.4	0.4	0.2
NH3-N	mg/l	0.4	0.2	0.2	0.2
NO2+NO3	mg/l	2.4	2.1	6.5	1.6
TSS	mg/l	577	3	162	2
TDS	mg/l	950	97	200	241
Cl-	mg/l	480	72	120	96
Cu	mg/l	0.028	0.014	0.009	0.007
Pb	mg/l	0.01	0.01	0.01	0.01
Zn	mg/l	0.03	0.04	0.05	0.04
Part. Size	um	30	30	30	30
E. coli	cfu/100 ml	380	60	860	490

Indy CSO-143 Sampling Results

Date: 26-Feb-13
 Precipitation: 1.1 inches
 Max. Flow 70 cfs

		Upstream First Flush	Upstream Composite	Downstream First Flush	Downstream Composite
BOD5	mg/l	25	9	12	3
Total P	mg/l	0.13	0.18	0.12	0.16
TKN	mg/l	0.5	0.3	0.9	0.3
NH3-N	mg/l	0.4	0.3	0.3	0.3
NO2+NO3	mg/l	0.6	0.5	0.6	0.7
TSS	mg/l	787	170	505	19
TDS	mg/l	724	684	432	444
Cl-	mg/l	228	180	60	72
Cu	mg/l	0.021	0.015	0.01	0.019
Pb	mg/l	0.01	0.01	0.01	0.01
Zn	mg/l	0.07	0.07	0.03	0.03
Part. Size	um	60	45	30	30
E. coli	cfu/100 ml	170	310	160	520

Indy CSO-143 Sampling Results

Date: 18-Mar-13
 Precipitation: 0.4 inches
 Max. Flow 21 cfs

		Upstream First Flush	Upstream Composite	Downstream First Flush	Downstream Composite
BOD5	mg/l	8	4	6	2
Total P	mg/l	0.06	0.04	0.13	0.13
TKN	mg/l	2.2	0.4	0.4	0.5
NH3-N	mg/l	0.3	0.2	0.3	0.1
NO2+NO3	mg/l	0.3	0.9	0.5	0.4
TSS	mg/l	431	1	219	7
TDS	mg/l	424	536	560	440
Cl-	mg/l	84	168	156	72
Cu	mg/l	0.014	0.006	0.011	0.009
Pb	mg/l	0.01	0.01	0.01	0.01
Zn	mg/l	0.08	0.02	0.02	0.02
Part. Size	um	30	30	30	30
E. coli	cfu/100 ml	80	290	350	420

Macroinvertebrate Sampling Results
16-Jul-13

Upstream from CSO 143

Cheumatopsyche spp.	161
Hdryopsyche betteni	2
Chimarra obscura	
Tricorythodes spp.	
Caenis spp.	6
Baetis flavistriga	9
Ablabesmyia spp.	18
Polypedilum convictum	51
Tipula spp.	2
Simulium spp.	
Empididae	2
Ceratopogonidae	2
Calopteryx spp.	
Stenelmis spp.	2
Dugesia spp.	3
Physa spp.	
Helisoma spp.	1
Pisidium spp.	11
Corbicula fluminea	2
Total	272

Downstream from CSO 143

Cheumatopsyche spp.	121
Hdryopsyche betteni	6
Chimarra obscura	1
Tricorythodes spp.	11
Baetis flavistriga	3
Caenis spp.	
Ablabesmyia spp.	5
Polypedilum convictum	56
Polypedilum fallax	1
Cricotopus trifascia	1
Tipula spp.	2
Simulium spp.	32
Empididae	
Calopteryx spp.	2
Stenelmis spp.	

Dugesia spp.	6
Physa spp.	2
Helisoma spp.	
Pisidium spp.	8
Corbicula fluminea	
Total	257

Data Summary

	Upstream	Downstream
Number of taxa	14	15
Number of individuals	264	257
Number of EPT taxa	4	5
% of midges that are othoclads or tanytarsids	0	2
% non-insects	6	7
# of diptera taxa	6	7
% intolerant	0	0
% tolerant	0	1
% predators	8	5
% shredders and scrapers	3	2
% collector-filterers	81	85
% sprawlers	9	6

Metric Scores

	Upstream	Downstream
Number of taxa	1	1
Number of individuals	5	5
Number of EPT taxa	3	5
% of midges that are othoclads or tanytarsids	1	1
% non-insects	5	5
# of diptera taxa	1	3
% intolerant	1	1
% tolerant	5	5
% predators	1	1
% shredders and scrapers	1	1
% collector-filterers	1	1
% sprawlers	5	5
Total	30	34