Deliverable 4.6: Progress Report 10

Overview of Work Period: 9/23/2023-12/20/2023

Water Year	Event	Water Quality		Toxicology		Stormwater	
		Basic	Full	Zfish	Coho	Collection Date (2023)	Treatment Dates
12	72	x	x	*		9/23-9/24	9/25-9/26
13	73	x				10/2-10/3	10/4-10/5
13	74	x				10/10-10/11	10/12-10/13
13	75	x				12/1-12/4	12/4-12/5
13	76	x				12/9-12/10	12/11-12/12
13	77	x				12/18-12/19	12/19-12/20

*Zebrafish molecular assays have not yet been completed for Event 72.

Report Summary

Work Progress Status

Project Tasks	% Completion
1. QAPP development	100
2. Prepare experimental columns	100
3. Condition experimental columns	100
4. Bioretention performance throughout accelerated aging	99
5. Outreach and communication	0

Discussions/decisions made since last report period
- None

Summary of Events

Full water chemistry

Summary of Full Water Chemistry

Event 72 (End of WY12)
- More dCu leached from 6" BSM than from 18" BSM
- All detected metals were at higher concentration in BSM treated with runoff than BSM treated with clean water
- NOx was leached into effluent from all depths, with no differences among BSM depth
- More oP was leached from the deeper BSM

Maintenance Activities and Dosing Notes
- Ponding during dosing was observed for various columns
- During Event 77, effluent valve was closed for replicate 1 of 18C, so column received runoff but most overflowed. Effluent was not included in the dosing statistics.

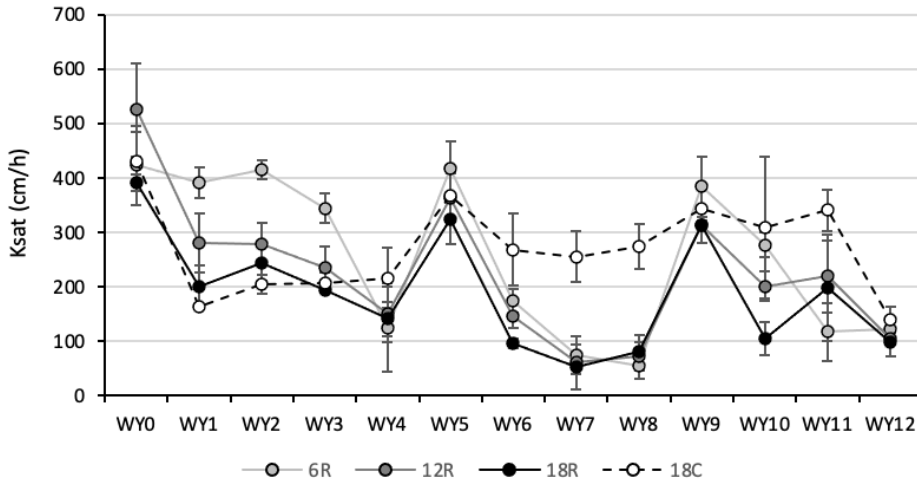- No maintenance activities were conducted during this performance period

Figure 1. Saturated hydraulic conductivity (mean ± SE) following each water year for the three depths of bioretention receiving runoff (6", 12", 18") and the clean water control (18").

Full Water Chemistry

Full water chemistry analysis was conducted for Events 77 (End of WY12). Samples for water chemistry were collected and analyzed as previously described (Deliverable 4.1: Progress Report 1). Statistical differences are shown when they exist between the depths of bioretention treating runoff (6R, 12R, 18R), and between the 18" BSM receiving runoff vs that receiving clean water.

Event 72 (End of WY12)

Metals

Table 1. Average concentrations of dissolved and total metals in ppb (standard error) for influent waters (clean water and influent stormwater runoff) and triplicate effluent waters from each of the runoff treatment (R) depths (6", 12", 18") plus the clean water control (C) for the event ending Water Year 12. One-half of the value of the detection limit was substituted for the value of non-detects in calculating means; used when the compound was detected in at least one replicate for the treatment. Values following '<' are below the detection limit. Depths sharing a letter did not release statistically different concentrations of metals into the effluent. Analytes for which metal concentrations were different when dosed with runoff or control water (18" depth only) are indicated by an asterisk.

Compound	MDL	Clean Water	Influent Runoff	6R	12R	18R	18C
Dissolved As	0.0373	<0.0373	0.736	0.649 (0.03)	0.656 (0.05)	0.605 (0.03)	0.07 (0.04)*
Dissolved Cd	0.03	0.04	<0.03	<0.03	<0.03	<0.03	<0.03
Dissolved Cu	0.173	0.185	15.6	12.3 (0.3) [a]	11.7 (0.8) [ab]	10 (0.2) [b]	1.84 (0.1) *
Dissolved Pb	0.05	<0.05	0.129	0.119 (0.005)	0.122 (0.006)	0.102 (0.008)	<0.05 *
Dissolved Ni	0.0792	0.194	1.26	0.976 (0.03)	1.16 (0.2)	1.26 (0.1)	0.544 (0.07) *
Dissolved Zn	2.92	<2.92	35.9	4.88 (0.2)	5.41 (0.3)	4.54 (0.2)	<2.92 *
As	0.0373	<0.0373	1.72	0.778 (0.006)	0.746 (0.006)	0.749 (0.02)	0.046 (0.006) *
Cd	0.03	<0.03	0.238	<0.03	<0.03	<0.03	<0.03
Cu	0.173	3.71	47.9	15.2 (0.3)	14.5 (1.2)	12.9 (0.3)	2.26 (1) *
Pb	0.05	<0.05	5.84	0.208 (0.006)	0.244 (0.04)	0.183 (0.02)	<0.05 *
Ni	0.0792	0.704	4.68	1.21 (0.06)	1.43 (0.3)	1.48 (0.2)	0.467 (0.1) *
Zn	2.92	<2.92	192	6.44 (0.4)	6.37 (0.6)	5.45 (0.2)	3.27 (0.2) *

Nutrient & Conventional Water Chemistry

Table 2. Average water chemistry values in mg/L (standard error) for influent waters (clean water and influent stormwater runoff) and triplicate effluent waters from each of the runoff treatment (R) depths (6", 12", 18") plus the clean water control (C) for the event ending Water Year 12. One-half of the value of the detection limit was substituted for the value of non-detects in calculating means; used when the compound was detected in at least one replicate for the treatment. Values following '<' are equal to the detection limit. n.m. = not measured for this event. Effluent from bioretention treated with runoff was compared among bioretention depths (6R, 12R, 18R). Analytes with significant differences among depths, values that share a superscript letter are not significantly different.

Compound	MDL	Clean Water	Influent Runoff	6R	12R	18R	18C
Dissolved Organic Carbon	0.5	0.6	7.27	7.44 (0.06)	7.68 (0.2)	8.12 (0.3)	2.03 (0.3) *
Total Suspended Solids	1	<1	61	3 (0)	3 (0.6)	2.33 (0.3)	0.667 (0.3) *
Turbidity		0.24	21.4	5.87 (1)	6.14 (0.5)	4.53 (0.2)	3.37 (0.07) *
Conductivity		831	79.4	81.5 (11)	82.4 (9)	114.8 (9)	855.3 (3.3) *
pH		7.734	7.293	7.202 (0.02)	7.219 (0.06)	7.064 (0.02)	7.473 (0.02) *
Alkalinity	1	30.1	20.5	16.67 (0.5) [ab]	17.3 (0.7) [a]	14.93 (0.5) [b]	29 (0.4) *
Dissolved Calcium	0.05	1.44	3.5	1.66 (0.7)	1.44 (0.5)	2.43 (0.6)	4.67 (0.6) *
Dissolved Magnesium	0.05	13.2	0.638	0.412 (0.01) [a]	0.195 (0.06) [b]	0.258 (0.06) [ab]	15.6 (0.05) *
Dissolved Sodium	0.5	115	5.16	6.16 (0.2) [a]	6.39 (0.2) [ab]	7.15 (0.3) [b]	1.15 (0.3) *
Nutrients							
Nitrate/Nitrite	0.05	0.112	0.216	1.54 (0.4)	1.1 (0.7)	3.78 (1.1)	2.34 (1.1)
Orthophosphate, as P	0.005	<0.005	0.058	0.053 (0.003) [a]	0.072 (0.002) [b]	0.078 (0.005) [b]	0.081 (0.005)

PAHs

Table 3. Average polycyclic aromatic hydrocarbon (PAH) concentrations in ppb (standard error) for influent waters (clean water and influent stormwater runoff) and triplicate effluent waters from each of the runoff treatment (R) depths (6", 12", 18") plus the clean water control (C) for the event ending Water Year 12. One-half of the value of the detection limit was substituted for the value of non-detects in calculating means; used when the compound was detected in at least one replicate for the treatment. Values following '<' are equal to the detection limit. There were no significant differences among the treatments.

PAHs	Clean Water	Influent Runoff	6R	12R	18R	18C
1-Methylnaphthalene	<0.008	<0.008	0.007 (0.003)	<0.008	<0.008	<0.008
2-Methylnaphthalene	<0.007	0.007	<0.007	<0.007	<0.007	<0.007
Naphthalene	<0.006	0.016	0.006 (0.0003)	0.007 (0.0003)	0.004 (0.001)	0.005 (0.001)
Acenaphthene	<0.004	<0.004	0.007 (0.005)	<0.004	0.003 (0.001)	0.004 (0.002)
Acenaphthylene	<0.005	0.005	<0.005	<0.005	<0.005	<0.005
Anthracene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Carbazole	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dibenzofuran	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Fluorene	<0.004	0.004	0.004 (0.002)	<0.004	<0.004	<0.004
Phenanthrene	<0.005	0.024	<0.005	<0.005	<0.005	<0.005
Benz[a]anthracene	<0.005	0.006	<0.005	<0.005	<0.005	<0.005
Chrysene	<0.008	0.03	<0.008	<0.008	<0.008	<0.008
Fluoranthene	<0.006	0.04	<0.006	<0.006	<0.006	<0.006
Pyrene	<0.008	0.058	<0.008	<0.008	<0.008	<0.008
Benzo(a)pyrene	<0.005	0.008	<0.005	<0.005	<0.005	<0.005
Benzo(b)fluoranthene	<0.005	0.019	<0.005	<0.005	<0.005	<0.005
Benzo(j)fluoranthene	<0.005	0.007	<0.005	<0.005	<0.005	<0.005
Benzo(k)fluoranthene	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Dibenzo(a,h)anthracene	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
Perylene	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Benzo(ghi)perylene	<0.009	0.036	<0.009	<0.009	<0.009	<0.009
Indeno(1,2,3-cd)pyrene	<0.008	0.01	<0.008	<0.008	<0.008	<0.008
Total PAHs	0	0.303	0.024 (0.010)	0.007 (0.000)	0.007 (0.002)	0.009 (0.001)