Deliverable 4.3: Progress Report 3

Overview of Work Period: 6/15/20 – 12/10/20

		Water Quality		Toxicology		Stormwater	
Water Year	Event	Basic	Full	Zfish	Coho	Collection Date	Treatment Dates
4	21	x				6/15/20	6/15/20-6/16/20
	22	x				6/22/20	6/22/20-6/23/20
	23	x				8/21/20	8/21/20-8/22/20
	24	x	x	*	x	9/15/20	9/16/20-9/17/20
5	25	x				9/24/20	9/24/20-9/25/20
	26	x				10/12/20	10/12/20-10/13/20
	27	x				11/10/20	11/11/20-11/12/20
	28	x				11/16/20	11/17/20-11/18/20
	29	x				11/20/20	11/20/20-11/21/20
	30	x	x	*		12/8/20	12/9/20-12/10/20

*Zebrafish molecular assays have not yet been completed for Events 24 and 30.

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	50
5. Outreach and communication	0

Discussions/decisions made since last report period

- The collection downspouts at the SR 16 sampling site became clogged in late November 2020, precluding collection of sufficient volumes of stormwater for dosing events. For Event 30, two auxiliary collection tanks were used to collect stormwater runoff from two alternate downspouts along the 1-5/SR 16 interchange: SR 16 East and the Sprague/SR 16 East on-ramp. These auxiliary tanks will continue to be used for stormwater collection until the clogs in the original downspouts are cleared.

Summary of Events (WY4, WY5)

Highlights of Full Water Chemistry

Event 24 (WY4)

- Higher influent concentrations of metals and DOC for Event 24 may be attributable to wildfire smoke in WA State in September 2020.
- Total arsenic and total zinc concentrations were significantly higher in effluent from the shallower than the deeper BSM treatments.

- As with WY3, a net export of nitrates continued to be observed for all treatment depths.
- Removal of DOC occurred for the two shallower BSM treatments, but there was some net export for the deepest BSM treatment.

Event 30 (WY5)

- Of the measured metals, only total and dissolved copper and zinc were detected in effluent waters. Copper and zinc mean concentrations in effluent generally decreased with increasing BSM depth.

Summary of Toxicology: Event 24 (WY4)

- Untreated highway runoff was acutely lethal to juvenile coho salmon (90% mortality).
- As with WY0, treatment of runoff with bioretention completely prevented juvenile coho mortality for all BSM depths.

Summary of Saturated Hydraulic Conductivity

- Average K_{sat} values for stormwater-dosed bioretention columns were lower after WY4 than for any previous K_{sat} measurement, but elevated again after WY5

Full Water Chemistry (WY4, WY5)

Samples for water chemistry were collected and analyzed as previously (Deliverable 4.1: Progress Report 1).

Event 24 (End of WY4)

Metals

Table 1. Mean (standard error) of metals in influent waters (clean water and stormwater runoff) and triplicate effluent waters from each of the three BSM depths treating runoff (6", 12", 18") plus the standard BSM depth (18") treating clean water (18C) for Event 24. One-half of the value of the detection limit (DL) was substituted for the value of non-detects in calculating means unless all replicates were below the detection limit (BDL).

Metal	DL	Influent Water (ug/L)		Effluent water (ug/L)			
		Clean	Runoff	6R	12R	18R	18C
Arsenic	0.05	BDL	3	1.97 (0.03)[a]	1.73 (0.03)[ab]	1.6 (0)[b]	0.87 (0.03)
Cadmium	0.05	BDL	BDL	BDL	BDL	BDL	BDL
Copper	0.2	BDL	86.4	24.5 (0.9)	20 (2)	16.8 (0.1)	6.5 (0.6)
Lead	0.079	BDL	2.3	BDL	BDL	BDL	BDL
Nickel	0.2	BDL	8.4	2.67 (0.07)	3.1 (0.9)	2.23 (0.03)	0.8 (0.06)
Zinc	0.19	2.5	105	18.47 (0.09)[a]	17.8 (0.1)[ab]	17.13 (0.07)[b]	1.8 (0.06)

Dissolved Arsenic	0.05	BDL	2.7	1.9 (0.06)	1.7 (0.06)	1.6 (0.06)	0.83 (0.03)
Dissolved Cadmium	0.05	BDL	BDL	BDL	BDL	BDL	BDL
Dissolved Copper	0.05	BDL	69.9	22.4 (0.8)	20 (2)	16.3 (0.2)	5.7 (0.3)
Dissolved Lead	0.079	BDL	BDL	BDL	BDL	BDL	BDL
Dissolved Nickel	0.2	BDL	6.9	2.6 (0.06)	2.7 (0.6)	2.2 (0.1)	0.77 (0.09)
Dissolved Zinc	0.19	2.4	73.4	18.4 (0.3)	17.1 (0.7)	10 (1)	1.3 (0.2)

BDL = Below Detection Limit (DL)
Note: Treatments with different superscript group labels (a, b, c) are significantly different at alpha = 0.05 (Kruskal-Wallis with post-hoc Dunn Test).

Nutrient & Conventional Water Chemistry

Table 2. Mean (standard error) of nutrients and conventional parameters in influent waters (clean water and stormwater runoff) and triplicate effluent waters from each of the three BSM depths treating runoff (6", 12", 18") plus the standard BSM depth (18") treating clean water (18C) for Event 24. One-half of the value of the detection limit (DL) was substituted for the value of non-detects in calculating means unless all replicates were below the detection limit (BDL).

Compound	DL	Influent waters (ug/L)		Effluent waters (ug/L)			
		Clean	**Runoff**	**6R**	**12R**	**18R**	**18C**
Alkalinity	0.3	33.3	96.5	87 (1)	80.2 (0.6)	78 (1)	33.1 (0.9)
Dissolved Calcium	3.4	8680	52800	55533 (30)^{a}	50700 (1000)^{ab}	49200 (600)^{b}	BDL
Dissolved Magnesium	1.9	20100	2440	2763 (100)	3090 (200)	3667 (200)	20100 (300)
Dissolved Organic Carbon	0.01	4.3	90	73.5 (0.5)	76 (7)	95 (4)	25 (1)
Dissolved Sodium	27	BDL	35700	31600 (300)	30067 (600)	31833 (300)	270000 (20000)
Fecal Coliform by MF	NA	NA	69000	49600 (10000)	27200 (6000)	33667 (3000)	NA
Nitrate/Nitrite	0.003	0.18	7.22	7.9 (0.1)	7.8 (0.04)	8.04 (0.02)	0.82 (0.08)
Orthophosphate, as P	0.01	BDL	BDL	0.073 (0.003)^{a}	0.107 (0.003)^{ab}	0.123 (0.003)^{b}	0.22 (0.01)
Total Suspended Solids	0.5	BDL	28.8	2.6 (0.7)	1.4 (0.2)	1.8 (0.2)	1.67 (0.07)
Conductivity	NA	1477	406	391 (2)^{a}	380 (0)^{ab}	368 (2)^{b}	1479 (5)
pH	NA	7.49	7.53	7.29 (0.03)^{a}	7.19 (0.01)^{ab}	7.13 (0.02)^{b}	7.3 (0.01)
Temperature	NA	-	55.7	57.6 (0.4)^{a}	55.3 (0.1)^{ab}	55.07 (0.07)^{b}	54.9 (0.2)
Turbidity	NA	0.06	34.4	1.9 (0.4)	1.7 (0.5)	1.8 (0.4)	4.9 (0.4)

PAHs

A complete table of PAH congeners can be found in Appendix A.

Table 3. Mean (standard error) of TPAHs in influent waters (runoff or clean water) and triplicate effluent waters from each of the three BSM depths treating runoff (6", 12", 18") plus the standard BSM depth (18") treating clean water (18C), and removal efficiencies for the three treatment depths treating runoff for Event 24. PAH congeners below the method detection limit (MDL) were assigned a value of zero.

Treatment	TPAH (µg/L)	Removal Efficiency (%)
R	0.527	n.a.
6R	0.014 (0.005)	97 (1)
12R	0.027 (0.003)	94.9 (0.6)
18R	0.020 (0.005)	96 (1)
C	0.022	n.a.
18C	0.013 (0.005)	n.a.

Event 30 (End of WY5)

Metals

Table 4. Mean (standard error) of metals in influent waters (clean water and stormwater runoff) and triplicate effluent waters from each of the three BSM depths treating runoff (6", 12", 18") plus the standard BSM depth (18") treating clean water (18C) for Event 30. One-half of the value of the detection limit (DL) was substituted for the value of non-detects in calculating means unless all replicates were below the detection limit (BDL).

Metal	DL	Influent Water (ug/L)		Effluent water (ug/L)			
		Clean	Runoff	6R	12R	18R	18C
Arsenic	0.05	BDL	1.2	BDL	BDL	BDL	BDL
Cadmium	0.05	BDL	BDL	BDL	BDL	BDL	BDL
Copper	0.2	BDL	30.5	8.4 (0.8)	6.9 (0.6)	6.9 (0.4)	4.4 (0.7)
Lead	0.079	BDL	BDL	BDL	BDL	BDL	BDL
Nickel	0.2	BDL	1.8	BDL	BDL	BDL	BDL
Zinc	0.19	3	135	22.3 (0.3)	20 (1)	16.3 (0.9)	0.8 (0.2)
Dissolved Arsenic	0.05	BDL	0.4	BDL	BDL	BDL	BDL
Dissolved Cadmium	0.05	BDL	BDL	BDL	BDL	BDL	BDL
Dissolved Copper	0.05	BDL	6.8	5.2 (0.1)	4.4 (0.3)	4.5 (0.2)	2 (0.4)
Dissolved Lead	0.079	BDL	BDL	BDL	BDL	BDL	BDL
Dissolved Nickel	0.2	BDL	BDL	BDL	BDL	BDL	BDL

Dissolved Zinc	0.19	2.4	23.3	10.2 (0.3)	9 (0.3)	10 (1)	0.5 (0.06)

BDL = Below Detection Limit (DL)

Nutrient and Conventional Water Chemistry

Table 5. Mean (standard error) of nutrients and conventional parameters in influent waters (clean water and stormwater runoff) and triplicate effluent waters from each of the three BSM depths treating runoff (6", 12", 18") plus the standard BSM depth (18") treating clean water (18C).

Measurement	Detection Limit	Influent Water		Effluent Water			
		Clean	**Runoff**	**6R**	**12R**	**18R**	**18C**
Nitrates (mg/L)*	0.003	BDL	0.25	0.437 (0.009)[a]	0.55 (0.01)[ab]	0.62 (0.01)[b]	0.32 (0.01)
Orthophosphate (mg/L)	0.01	0.01	0.01	0.063 (0.003)[a]	0.09 (0)[ab]	0.11 (0.006)[b]	0.167 (0.009)
DOC (mg/L)*	0.08	BDL	4.2	3.23 (0.03)	3.13 (0.09)	5 (2)	1.47 (0.03)
Temperature (°F)	NA	NA	33.8	38 (0.7)[a]	34.2 (0.4)[b]	34.9 (0.2)[ab]	34.8 (0.2)
pH	NA	7.584	7.545	7.41 (0.02)[a]	7.316 (0.006)[ab]	7.27 (0.01)[b]	7.248 (0.005)
Conductivity ($\mu S/cm$)	NA	1492	146.6	144.2 (0.3)[a]	142 (0.2)[ab]	139.1 (0.7)[b]	1484 (3)
Turbidity (NTU)	NA	0.08	71	14.4 (0.3)	10 (1)	9.2 (0.7)	1.6 (0.2)
Alkalinity (as $CaCO_3$)	0.3	42	48.7	43.6 (0.3)	43.7 (0.8)	42 (1)	37 (1)
TSS (mg/L)	0.5	BDL	37	0.8 (0.1)	BDL	0.7 (0.1)	BDL
Fecal Coliform (CFU/100 mL)	NA	BDL	BDL	337 (100)	180 (60)	237 (100)	BDL
Dissolved Calcium (µg/L)	3.4	7780	14300	15800 (100)	15667 (200)	15933 (70)	9577 (30)
Dissolved Magnesium (µg/L)	1.9	23900	609	973 (10)	1077 (30)	1093 (10)	23533 (30)
Dissolved Sodium (µg/L)	27	313000	19300	14800 (100)[a]	13800 (60)[ab]	12733 (90)[b]	306333 (1000)

BDL = Below Detection Limit (DL)
Note: Treatments with different superscript group labels (a, b, c) are significantly different at □ = 0.05 (Kruskal-Wallis with post-hoc Dunn Test).
*Analyzed by Spectra Laboratories-Kitsap.

PAHs

A complete table of PAH congeners can be found in Appendix A.

Table 6. Mean (standard error) of TPAHs in influent waters (clean water and stormwater runoff) and triplicate effluent waters from each of the three BSM depths treating runoff (6", 12", 18") plus the standard BSM depth (18") treating clean water (18C), and removal efficiencies for the three depths treating runoff. PAH congeners below the method detection limit (MDL) were assigned a value of zero.

Treatment	TPAH (µg/L)	Removal Efficiency (%)
R	0.571	n.a.
6R	0.07 (0.01)	88 (2)
12R	0.075 (0.002)	86.8 (0.3)
18R	0.070 (0.001)	87.7 (0.2)
C	0.053	n.a.
18C	0.04 (0.01)	n.a.

Basic Water Chemistry: Events 21-23; 25-29

Basic chemistry events were used to age the experimental columns. Influent water (stormwater runoff and clean lab water) and effluent waters (filtered through experimental columns) were not sub-sampled for chemistry or toxicology during these events. Temperature, pH, conductivity, and turbidity of influent and effluents waters were recorded (Table X). Differences among the five treatment depths for concentrations of each conventional parameter in effluent were assessed by a Kruskal-Wallis test, followed by a post-hoc Dunn's test.

Table 7. Mean (standard error) of conventional parameters in influent waters (clean water and stormwater runoff) and triplicate effluent waters from each of the three BSM depths treating runoff (6", 12", 18") plus the standard BSM depth (18") treating clean water (18C).

Measurement	Influent Water		Effluent Water			
	Lab	**SW**	**6"**	**12"**	**18"**	**18" CWC**
			Event 21			
Conductivity (µS/cm)	1560	70.8	80 (2)	77.9 (0.7)	76.4 (0.4)	1568 (4)
pH	7.732	7.703	7.58 (0.03)	7.5 (0.03)	7.45 (0.04)	7.58 (0.01)
Temperature (°F)	NA	NA	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Turbidity (NTU)	0.05	38	1.62 (0.09)[ab]	1.31 (0.04)[a]	2 (0.1)[b]	2.5 (0.3)
			Event 22			
Conductivity (µS/cm)	1558	170.9	172.8 (0.8)	170 (2)	168.1 (0.8)	1579 (6)
pH	7.862	7.512	7.42 (0.02)[a]	7.35 (0.02)[b]	7.374 (0.005)[ab]	7.55 (0.06)
Temperature (°F)	NA	63.8	51.9 (0.1)	51.3 (0.1)	52.2 (0.3)	52.7 (0.2)
Turbidity (NTU)	0.1	39.4	1.8 (0.1)	1.4 (0.1)	1.6 (0.3)	6.5 (0.9)
			Event 23			
Conductivity (µS/cm)	1479	182.3	188.3 (0.9)	196 (3)	201 (2)	1527 (2)
pH	7.822	7.359	7.2 (0.02)	7.18 (0.008)	7.1 (0.02)	7.41 (0.02)
Temperature (°F)	NA	64.4	56.7 (0.4)	54.1 (0.3)	54.7 (0.6)	55.2 (0.3)
Turbidity (NTU)	0.14	112	4 (0.8)	5 (1)	4.1 (0.6)	8.3 (0.5)
			Event 25			

Conductivity ($\mu S/cm$)	1467	52.3	107 (3)[a]	130 (2)[ab]	150 (1)[b]	1464 (4)
pH	7.58	7.462	7.59 (0.07)	7.49 (0.02)	7.4 (0.02)	7.33 (0.02)
Temperature (°F)	NA	45.8	43.7 (0.6)	41.2 (0.6)	42 (0.8)	41.1 (0)
Turbidity (NTU)	0.07	34.4	4.5 (0.8)	6 (0.4)	5.8 (0.3)	6 (2)
Event 26						
Conductivity ($\mu S/cm$)	1513	99.7	96 (2)	99 (2)	99 (1)	1538 (1)
pH	7.247	7.52	7.38 (0.05)	7.27 (0.02)	7.22 (0.05)	7.167 (0.009)
Temperature (°F)	NA	55.9	52.4 (0.8)	49 (0.2)	48.9 (0.1)	49.97 (0.09)
Turbidity (NTU)	0.04	35.4	2.1 (0.5)	3 (0.3)	3.1 (0.2)	5.8 (0.2)
Event 27						
Conductivity ($\mu S/cm$)	1492	200	197 (1)	199.5 (0.8)	202 (2)	1531.7 (0.3)
pH	7.27	7.703	7.43 (0.02)	7.36 (0.04)	7.28 (0.02)	7.151 (0.004)
Temperature (°F)	NA	52.1	55.5 (0.7)[a]	52.4 (0.3)[b]	53.1 (0.3)[ab]	52.6 (0.2)
Turbidity (NTU)	0.06	35.5	2.4 (0.2)	2.1 (0.2)	2.4 (0.4)	5.66 (0.03)
Event 28						
Conductivity ($\mu S/cm$)	1499	65.8	67 (4)	68 (2)	70 (2)	1506 (1)
pH	7.297	7.529	7.44 (0.04)[a]	7.29 (0.03)[ab]	7.21 (0.04)[b]	7.03 (0.02)
Temperature (°F)	NA	44.9	48 (0.6)[a]	43.9 (0.4)[b]	44.6 (0.3)[ab]	43.5 (0.5)
Turbidity (NTU)	0.03	20.5	2.7 (0.3)	2.7 (0.3)	3.4 (0.6)	3.1 (0.1)
Event 29						
Conductivity ($\mu S/cm$)	1512	120.6	108 (2)	103 (1)	102 (3)	1494.3 (0.3)
pH	7.569	7.585	7.43 (0.04)	7.28 (0.03)	7.25 (0.03)	7.184 (0.004)
Temperature (°F)	NA	NA	35.57 (0.09)	34.2 (0.3)	35.3 (0.4)	35.8 (0.6)
Turbidity (NTU)	0.04	28.5	2.2 (0.3)	1.2 (0.1)	1.7 (0.1)	2.42 (0.07)

Note: Treatments with different superscript group labels (a, b, c) show significance at α = 0.05 (Kruskal-Wallis with post-hoc Dunn Test).
NTU = Nephelometric Turbidity Unit

Toxicology – Event 24 (End of WY4)

Toxicity Testing – Salmon

Toxicity testing using juvenile coho salmon was conducted as previously described (Deliverable 4.1: Progress Report 1), but with 35 L per replicate instead of 30 L to account for larger juvenile coho ($\bar{x}$ (SD): length = 115 (13) mm) at the time of the exposure. The temperature in recirculating water baths was decreased from 12 to 11 °C.

Untreated highway runoff was acutely lethal to juvenile coho salmon. At the end of the exposure (24 h), 90% mortality was observed. Treatment of runoff through any of the BSM treatments completely prevented mortality.

Saturated Hydraulic Conductivity

Saturated hydraulic conductivity (K_{sat}) of each bioretention treatment was measured following Events 24 (WY4) and 30 (WY5) using the falling head method (Klute and Dirksen 1986).

Table 8. Average (standard error) of saturated hydraulic conductivity (K_{sat}) measurements for each treatment depth prior to stormwater dosing in July 2019 (WY0), at the end of the first water year in February 2020 (WY1), at the end of the second water year (WY2) in March 2020, at the end of the third water year (WY3) in June 2020, at the end of the fourth water year (WY4) in September 2020, and at the end of the fifth water year (WY5) in January 2021.

	Ksat (cm/hr)					
Treatment	**WY0**	**WY1**	**WY2**	**WY3**	**WY4**	**WY5**
6R	423 (70)	391 (30)	415 (20)	345 (30)	125 (80)	416 (50)
12R	525 (90)	280 (50)*	279 (40)*	235 (40)*	149 (50)*	362 (5)*
18R	391 (20)	200 (40)	243 (30)	194 (5)	141 (30)	324 (50)
18C	431 (50)	164 (2)*	204 (20)*	208 (20)*	216 (60)*	368 (40)
Average	442 (31)	259 (31)	285 (27)	245 (21)	158 (27)	368 (20)

*Average of two replicates because of leaking from one replicate.

Appendix A.

Table A1.1. Mean (standard error) of PAHs in influent waters (clean water and stormwater runoff) and triplicate effluent waters from each of the three BSM depths treating runoff (6”, 12”, 18”) plus the standard BSM depth (18”) treating clean water (18C) during Event 24. One-half of the value of the detection limit (DL) was substituted for the value of non-detects in calculating means unless all replicates were below the detection limit (BDL).

Compound	DL (µg/ L)	Influent Waters (µg/ L)		Bioretention-Treated Effluent Water (µg/ L)			
		Clean	Runoff	6R	12R	18R	18C
Total PAHs		0.0392	0.534	0.033 (0.007)	0.045 (0.002)	0.037 (0.005)	0.032 (0.002)
Benzo(ghi)perylene	0.002	BDL	0.027	BDL	BDL	BDL	BDL
Indeno(1, 2, 3- cd)pyrene	0.001	BDL	0.008	BDL	BDL	BDL	BDL
Benzo(a)pyrene	0.003	BDL	0.008	BDL	BDL	BDL	BDL
Benzo(b)fluoranthene	5e-04	BDL	BDL	BDL	BDL	BDL	BDL
Benzo(j)fluoranthene	0.002	BDL	0.003	BDL	BDL	BDL	BDL
Benzo(k)fluoranthene	0.004	BDL	0.005	BDL	BDL	BDL	BDL
Dibenzo(a,h)anthracene	0.001	BDL	BDL	BDL	BDL	BDL	BDL
Perylene	0.007	BDL	BDL	BDL	BDL	BDL	BDL
Benz[a]anthracene	8e-04	BDL	BDL	BDL	BDL	BDL	BDL
Chrysene	0.001	BDL	0.018	BDL	BDL	BDL	BDL
Fluoranthene	0.002	BDL	0.047	BDL	BDL	BDL	BDL
Pyrene	0.001	BDL	0.053	BDL	BDL	BDL	0.001 (5e-04)
Acenaphthene	0.003	BDL	0.007	0.004 (0.001)	0.005 (0.002)	0.005 (3e-04)	BDL
Acenaphthylene	0.002	BDL	BDL	BDL	BDL	BDL	BDL
Anthracene	0.001	BDL	0.006	BDL	BDL	BDL	BDL
Carbazole	0.001	0.003	BDL	BDL	BDL	BDL	BDL
Dibenzofuran	0.002	0.002	BDL	BDL	BDL	BDL	BDL
Fluorene	0.002	BDL	0.03	0.008 (0.007)	0.02 (3e-04)	0.01 (0.005)	BDL
Phenanthrene	0.001	0.003	0.034	0.001 (5e-04)	0.002 (5e-04)	0.003 (0)	0.002 (5e-04)

1-Methylnaphthalene	0.001	0.002	0.114	BDL	BDL	BDL	0.002 (0)
2-Chloronaphthalene	NA	0	0	0 (0)	0 (0)	0 (0)	0 (0)
2-Methylnaphthalene	0.001	0.003	0.038	0.001 (8e-04)	BDL	BDL	0.002 (3e-04)
Naphthalene	0.001	0.009	0.109	0.002 (3e-04)	0.002 (0)	0.002 (0)	0.007 (0.002)
Sum Low Molecular Weight (LMW)*		0.0289 (0.0006)	0.5 (0.01)	0.02 (0.007)	0.03 (0.0001)	0.03 (0.005)	0.021 (0.002)
Sum High Molecular Weight (HMW)**		0.0103 (0.0004)	0.07 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)

Table A1.2. Mean (standard error) of PAHs in influent waters (clean water and stormwater runoff) and triplicate effluent waters from each of the three BSM depths treating runoff (6", 12", 18") plus the standard BSM depth (18") treating clean water (18C) during Event 30. One-half of the value of the detection limit (DL) was substituted for the value of non-detects in calculating means unless all replicates were below the detection limit (BDL).

Compound	DL (µg/ L)	Influent Waters (µg/ L)		Bioretention-Treated Effluent Water (µg/ L)			
		Lab	SW	6"	12"	18"	18" CWC
Total PAHs		0.069	0.057	0.082 (0.008)	0.087 (0.001)	0.083 (0.001)	0.057 (0.008)
Benzo(ghi)perylene	0.001	BDL	0.052	0.0033 (3e-04)	0.002 (0)	0.002 (0)	BDL
Indeno(1, 2, 3- cd)pyrene	0.001	BDL	0.019	0.0013 (3e-04)	BDL	BDL	BDL
Benzo(a)pyrene	0.002	BDL	0.018	BDL	BDL	BDL	BDL
Benzo(b)fluoranthene	5e-04	BDL	BDL	BDL	8e-04 (2e-04)	5e-04 (2e-04)	BDL
Benzo(j)fluoranthene	0.002	BDL	0.007	BDL	BDL	BDL	BDL
Benzo(k)fluoranthene	0.003	BDL	0.009	BDL	BDL	BDL	BDL
Dibenzo(a,h)anthracene	0.001	BDL	0.002	BDL	BDL	BDL	BDL
Perylene	0.006	BDL	0.008	BDL	BDL	BDL	BDL
Benz[a]anthracene	8e-04	BDL	BDL	BDL	BDL	BDL	BDL
Chrysene	9e-04	BDL	BDL	BDL	BDL	BDL	BDL
Fluoranthene	0.002	BDL	0.085	0.0067 (3e-04)	0.0043 (9e-04)	0.0037 (3e-04)	BDL
Pyrene	0.001	BDL	0.117	0.0073 (3e-04)	0.0047 (7e-04)	0.004 (0)	BDL
Acenaphthene	0.003	BDL	BDL	BDL	BDL	BDL	BDL

Acenaphthylene	0.002	BDL	0.004	BDL	BDL	BDL	BDL
Anthracene	0.001	BDL	0.009	0.0012 (4e-04)	BDL	BDL	BDL
Carbazole	0.001	BDL	BDL	BDL	BDL	BDL	BDL
Dibenzofuran	0.002	BDL	0.008	BDL	0.002 (0)	0.002 (0)	BDL
Fluorene	0.002	BDL	0.01	0.0023 (3e-04)	0.002 (0)	BDL	BDL
Phenanthrene	0.001	0.002	0.058	0.0037 (3e-04)	0.0033 (3e-04)	0.003 (0)	0.0015 (5e-04)
1-Methylnaphthalene	9e-04	BDL	BDL	BDL	BDL	BDL	BDL
2-Chloronaphthalene	0.001	BDL	BDL	BDL	BDL	BDL	BDL
2-Methylnaphthalene	0.001	0.02	0.031	0.0147 (0.006)	0.0217 (3e-04)	0.021 (6e-04)	0.0153 (0.007)
Naphthalene	0.001	0.018	0.035	0.0123 (0.003)	0.0163 (3e-04)	0.016 (6e-04)	0.0137 (0.003)
Sum Low Molecular Weight (LMW)*		0.06 (0.03)	0.4 (0.2)	0.068 (0.008)	0.077 (0.001)	0.073 (0.001)	0.049 (0.008)
Sum High Molecular Weight (HMW)**		0.008 (0.004)	0.14 (0.07)	0.0137 (0.0005)	0.0103 (0.0003)	0.0100 (0.0003)	0.008 (0.00)