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Subject: Interim Report for Task 2: Bioretention soil preparation

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We prepared a bioretention soil mix (BSM) at the Washington State University (WSU) facility in Puyallup. The BSM materials (sand and compost) were tested separately for concentration of metals.

Deliverable 2.1 = 2 m^3 of well characterized bioretention soil media

The composition of the bioretention soil mix (BSM) was prepared to be the default bioretention soil mix: a 60% sand/40% compost (by volume) mix according to the current Stormwater Management Manual for Western Washington (SMMWW) specifications. Two cubic meters of compost and two cubic meters of sand were generously donated by Cedar Grove Composting, Inc. in August 2016. The product specification sheets provided by Cedar Grove documented that the material met specifications set forth in the Stormwater Management Manual for Western Washington (see Appendices 1 & 2).

Prior to mixing the sand and compost into the BSM, composite samples of compost and sand were collected separately by subsampling 10 locations at various depths throughout each two-yard pile. Subsamples were homogenized and three representative samples isolated for analysis. Sand and compost samples were submitted in triplicate to AmTest Laboratories (Kirkland, WA) for quantification of metals.

To achieve a well-mixed BSM, small batches of BSM were made and later used to fill the experimental drums. Each batch was made of an un-compacted volume of sand (15 L) and compost (10 L). Compost was sifted through a ½ inch screen (100% passing) to break up clods and achieve a relatively even compost density prior to volumetric proportioning. Sand and compost were proportioned by volume in 5-L increments and the wet weight for each increment was recorded. Each volume of sand or compost was randomly collected from the sand or compost pile. A composite sample was collected from each 25-L batch for moisture analysis. Samples for moisture content assessment were collected from the sand and compost fractions between every fifth batch. These measurements provided the data necessary to calculate the dry mass of sand and dry mass of compost in each 25-L batch. In total, 89 individual batches (25 L and 29.0 ± 1.2 kg (wet)) were prepared. This data was used later to proportion BSM in each of twelve field bioretention cells by total dry mass. Details of BSM composition are provided in Table 1.

Deliverable 2.2 = Report on chemistry of bioretention soil materials

Sand and compost samples were collected as previously described and were submitted in triplicate to AmTest Laboratories (Kirkland, WA) for quantification of metals by ICP-MS according to method SW-846 6020A. Compost was additionally sent to SoilTest Farm Consultants, Inc. (Moses Lake, WA) for analysis of total nitrogen (ASTM D5373), total carbon (ASTM D5373), nitrate (S-3.10 b), ammonia (S-3.50), total phosphorus (EPA 3050A/6010B), Olsen phosphorus (S-4.20 b), cation exchange capacity (S-10.10 b), and pH. Details of these analyses are provided in Table 2 and Table 3.

The compost contained higher dry-mass concentrations than the sand for all metals except Ni (Table 3). However, the composition of “60:40” BSM on a dry-mass basis is approximately 84% sand and 16% compost. Ultimately, the leachability of these two components of BSM will determine the contribution of each metal to effluents treated by the bioretention system.

Table 1: Composition characteristics of BSM batches proportioned by volume

	Gravimetric Moisture Content (%)	BSM Wet Mass (kg)	BSM Dry Mass (kg)	Sand Dry Mass (kg)	Compost Dry Mass (kg)
Total		2554.49	2132.31	1840.45	297.86
Mean	19.82	29.03	24.23	20.91	3.38
St. Dev.	3.01	1.23	0.93	1.02	0.19

Table 2: Chemical characteristics of compost and sand used in BSM

	Total N	Total C	NO3-N	NH4-N	Total P	OLSEN P	CEC	pH
	%	%	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	
D.L.	0.01%	0.02%	0.8	0.7	4.3	0.9	0.1	0.1
Mean	1.5	18	233	38	2559	135	40	7.4
St. Dev.	0.1	2	58	11	51	24	2	0.1
RSD (%)	6.9%	8.6%	25%	28%	2%	17%	6%	1%

D.L. = detection limit; RSD = relative standard deviation

Table 3: Metal concentrations of compost and sand used in BSM

	As	Cd	Cr	Cu	Ni	Pb	Zn
Compost	All values in mg/kg						
D.L.	0.052	0.043	0.086	0.086	0.086	0.086	0.172
Mean	**7.95**	**0.459**	**16.6**	**39.9**	**11.3**	**35.7**	**148**
St. Dev.	4.64	0.045	1.69	8.21	1.08	7.06	34.9
RSD (%)	58.3%	9.88%	10.1%	20.6%	9.52%	19.8%	23.6%
Sand	All values in mg/kg						
D.L.	0.025	0.021	0.043	0.043	0.043	0.043	0.085
Mean	**0.535**	**0.051**	**14.2**	**16.0**	**17.4**	**1.18**	**17.4**
St. Dev.	0.161	0.021	4.730	1.332	3.292	0.300	0.907
RSD (%)	30.0%	41.2%	33.2%	8.34%	18.9%	25.4%	5.20%

D.L. = detection limit; RSD = relative standard deviation

Appendix 1: Cedar Grove compost certificate of analysis

CEDAR GROVE

Cedar Grove Composting
Compost Quality Assurance Program 2016

Cedar Grove Fine Grade Compost

Cedar Grove Compost is made from 100% locally recycled landscape and food trimmings, and clean wood waste. Cedar Grove Compost facilities are in compliance with Washington Department of Ecology (WDOE) requirements for compost process and product quality (WAC 173-350-220). Cedar Grove also voluntarily meets the US Composting Council's Seal of Testing Assurance (STA) and Washington Department of Transportation (WDOT) standards. Results of tests for horticultural values and applicable WDOT standards are shown in Chart 1. WDOE compost quality requirements and Cedar Grove Compost results are in Chart 2.

Chart 1. Cedar Grove Fine Grade Compost Horticultural Values

		WDOT Standard	Cedar Grove (2/5/2016)
Organic Matter		>40%	59.3%
Carbon to Nitrogen Ratio		<25	19
Conductivity		≤4 mmhos/cm	3.4 mmhos/cm
Seedling Emergence		>80% of purified water	100%
Seedling Vigor		>80% of purified water	106% "Healthy"
pH		6.0-8.5	8.25
Compost Stability		<7 mg CO_2/gr. OM/day	3.5 mg CO_2/gr. OM/day "Stable"
Dry weight			19 lbs / cu. ft.
Major Nutrients	Total Nitrogen		1.9%
	Phosphorous (P_2O_5)		.74%
	Potassium (K_2O)		.79%
	Sulfate		16 mg/kg
	Calcium		2.0%
	Magnesium		0.31%

Chart 2. Compost Quality Requirements - Washington Administrative Code *173-350 Sect. 220*

	WAC 173-350-220 Standard	Cedar Grove Compost (2/5/2016)
Metals	*Parts per million (mg/kg), dry wt.*	
Arsenic	<=20	7.9
Cadmium	<=10	<1.0
Copper	<=750	61
Lead	<=150	29
Mercury	<=8	<1.0
Molybdenum	<=9	1.4
Nickel	<=210	15
Selenium	<=18	<1.0
Zinc	<=1400	160
pH	5-10 (range)	8.25
Salmonella (Pathogen indicator)	< 3 MPN / 4 grams of total solids	Pass
Sharps	0 percent	None Detected
Manufactured Inerts	< 0.5 percent	<0.1 percent

Chart 3. WDOT Particle Size Specifications by Compost Grade

Sieve size	WDOT "Fine" Compost	Cedar Grove (2/5/2016)
1"	95-100%	100%
5/8"	90-100%	100%
¼"	75-100%	75%

US Composting Council
Seal of Testing Assurance

All tests performed by Soil Control Lab, Watsonville, CA; using TMECC/STA specified methods.

Appendix 2: Cedar Grove sand certificate of analysis

associated earth sciences incorporated

GRAIN SIZE ANALYSIS - MECHANICAL ASTM D422

Project Name	Project Number	Date Sampled	Date Tested	Tested By
Cedar Grove	**KE140069A**	**5/12/2016**	**5/17/2016**	**MS**
Sample Source	Sample No.	Depth (ft)	Soil Description	
Cedar Grove	**75G255**		**SAND, trace silt, trace gravel (SP)**	
Total Sample Dry Wt. (g)	Moisture Content (%)	D_{10} (mm)	Reference Specification	
596.1	**4**	**0.214**		

Sieve No.	Diam. (mm)	Cum. Wt. Ret. (g)	% Ret. by Wt.	% Passing by Wt.	% Specs. Pass. by Wt.	
					Min	Max
3	76.1		0.0	100.0		
2.5	64		0.0	100.0		
2	50.8		0.0	100.0		
1.5	38.1		0.0	100.0		
1	25.4		0.0	100.0		
3/4	19		0.0	100.0		
3/8	9.51		0.0	100.0		
#4	4.76	2.3	0.4	99.6		
#8	2.38	82.8	13.9	86.1		
#10	2	112.1	18.8	81.2		
#20	0.85	273.4	45.9	54.1		
#40	0.42	428.2	71.8	28.2		
#60	0.25	524.0	87.9	12.1		
#100	0.149	565.7	94.9	5.1		
#200	0.074	584.6	98.1	1.9		

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