APPENDIX G. BIORETENTION SOIL MEDIA EXAMPLE SPECIFICATIONS

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G.1 Bioretention Soil Media (BSM) Example Specifications

Any bioretention facilities being installed in the County of San Diego should meet the following bioretention soil media (BSM) criteria.

G.1.1 General Requirements

BSM should achieve a long-term, in-place infiltration rate of 5 inches per hour, according to the County of San Diego 2012 Standard Urban Stormwater Mitigation Plan (SUSMP) requirements.

BSM should also support plant growth while providing pollutant treatment. In order to achieve these two goals, the BSM should be a mixture of sand, fines, and compost. The following composition includes the measurements for determining the BSM by volume and weight:

BSM Composition	Sand	Sandy Loam			Compost
		Sand	Silt	Clay	
Volume	65%	20%			15%
Weight	75–80%		10% max.	3% max.	9% max.[1]

[1]9% compost by weight results in approximately 5% organic matter by weight.

G.1.2 Submittals

Product Data: Submit manufacturer's product data and installation instructions. Include required substrate preparation, list of materials, application rate/testing, and permeability rates.

Verifications: Manufacturer shall submit a letter of verification that the products meet or exceed all physical property, endurance, performance and packaging requirements.

Tests should be conducted no more than 120 days prior to the delivery date of the BSM to the project site. Batch-specific test results and certification will be required for projects installing more than 100 cubic yards of BSM.

The applicant should submit the following to the municipality for approval if requested:

A. A sample of mixed BSM.

B. Grain size analysis results of the sand component performed in accordance with American Society for Testing and Materials (ASTM) D422, *Standard Test Method for Particle Size Analysis of Soils*.

C. Grain size analysis results of sandy loam soil component performed in accordance with ASTM D422., *Standard Test Method for Particle Size Analysis of Soils*.

D. Grain size analysis results of compost component performed in accordance with ASTM D422, *Standard Test Method for Particle Size Analysis of Soils*.

E. Organic matter content test results of compost. Organic matter content tests should be performed in accordance with ASTM F 1647, *Standard Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes* or *Testing Methods for the Examination of Compost and Composting* (TMECC) 05.07A, *Loss-On-Ignition Organic Matter Method*.

F. A description of the equipment and methods used to mix the sand, sandy loam, and compost to produce BSM.

G. Constant head permeability results of the mixed BSM. Constant head permeability testing in accordance with ASTM D2434, *Standard Test Method for Permeability of Granular Soils (Constant Head)* should be conducted on a minimum of two samples with a 6-inch mold and vacuum saturation.

H. Provide the following information about the testing laboratory(ies) including:

1) Name of laboratory(ies)

2) Contact person(s)

3) Address(es)

4) Phone contact(s)

5) Email address(es)

6) Qualifications of laboratory(ies), including use of ASTM and U.S. Department of Agriculture (USDA) method of standards

G.1.3 Sand Specifications for BSM

G.1.3.1 Sand Quality

Sand should be thoroughly washed prior to delivery and free of wood, waste, and coatings such as clay, stone dust, carbonate, or any other deleterious material. All aggregate passing the No. 200 sieve size should be non-plastic.

G.1.3.2 Sand Texture

Sand for BSM should be analyzed by a qualified lab using #200, #100, #40, #30, #16, #8, #4, and 3/8-inch sieves (ASTM D422 or as approved by municipality) and meet the following gradation:

Sieve Size	Percent Passing (by weight)	
	Min.	Max.
3/8 inch	100	100
No. 4	90	100
No. 8	70	100
No. 16	40	95
No. 30	15	70
No. 40	5	55
No. 100	0	15
No. 200	0	5

Note: all sands complying with ASTM C33, *Standard Specification for Concrete Aggregates* for fine aggregate comply with the above gradation requirements.

G.1.4 Sandy Loam Soil Specifications for BSM

G.1.4.1 Sandy Loam Soil Quality

Sandy loam soil for the BSM shall be free of wood, waste, coating such as stone dust, carbonate, etc., or any other deleterious material. All aggregate passing the No. 200 sieve size shall be non-plastic.

G.1.4.2 Sandy Loam Soil Texture

Sandy loam soil should comply with the following specifications by weight based on ASTM D422 (or as approved by municipality):

A. 50–74 percent sand

B. 0–48 percent silt

C. 2–15 percent clay

Note: these ranges were selected from the USDA soil textural classification for a sandy loam, such that clay content does not exceed 15 percent of sandy loam.

G.1.5 Compost Soil Specifications for BSM

G.1.5.1 Compost Texture

A qualified lab should analyze compost using No. 200 and 1/2-inch sieves (ASTM D422 or as approved by municipality), and meet the following gradation:

Sieve Size	Percent Passing (by weight)	
	Min.	Max.
1/2 inch	97	100
No. 200	0	5

G.1.5.2 Compost Quality Testing

Compost should be a well-decomposed, stable, weed-free organic matter source derived from waste materials including yard debris, wood wastes or other organic materials, **not including manure or biosolids**. Compost shall have a dark brown color and a soil-like odor. Compost that is exhibiting a sour or putrid smell, contains recognizable grass or leaves, or is hot (120 degrees Fahrenheit) upon delivery or rewetting is not acceptable.

Compost shall be produced at a facility inspected and regulated by the Local Enforcement Agency for CalRecycle. The past three inspection reports shall be submitted verifying testing compliance with CalRecycle Title 14, *Process to Further Reduce Pathogens* (PFRP), and EPA 40 CFS 503.

Compost should comply with the following requirements:

Parameter	Method	Requirement	Units
Bulk Density	-	400–600	dry lbs/cubic yd
Moisture Content	Gravimetric	30%–60%	dry solids
Organic Matter	ASTM F 1647 Standard Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes or Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method."	35%–75%	dry weight
pH	Saturation Paste	6.0–8.0	
Carbon:Nitrogen Ratio	-	15:1–25:1	
Maturity/Stability	Solvita®	> 5	Index value

Parameter	Method	Requirement	Units
Metals			
Arsenic	-	< 20	mg/kg dry weight
Cadmium		< 10	
Chromium		< 600	
Copper		< 750	
Lead		< 150	
Mercury		< 8	
Nickel		< 210	
Selenium		< 18	
Zinc		< 1400	
Pathogens			
Salmonella	-	< 3	MPN per 4 g
Fecal Coliform		< 1000	MPN per 1 g
Inert Material/Physical Contaminants			
Plastic, Metal, and Glass	-	< 1%	by weight
Sharps (% > 4mm)		0%	by weight

G.1.5.3 Alternative Organic Amendments

Alternative organic amendments (in lieu of previously defined compost) will be reviewed on a case-by-case basis. Organic amendments should make up no more than 5 percent of the BSM bulk volume, unless organic alternatives comply with the specifications of section G.1.5.2.

G.1.6 BSM Specifications

BSM shall be free of roots, clods stones larger than 1-inch in the greatest dimension, pockets of coarse sand, noxious weeds, sticks, lumber, brush, and other litter. It shall not be infested with nematodes or undesirable disease-causing organisms such as insects and plant pathogens. BSM shall be friable and have sufficient structure in order to give good aeration to the soil. The following specifications should govern the bulk BSM.

G.1.6.1 BSM Texture

Gradation Limit: The definition of the soil should be the following USDA classification scheme by weight:

A. Sand: 85–90 percent

B. Silt: 10 percent maximum

C. Clay: 5 percent maximum

Compost should compose no more than 9 percent of the bulk BSM weight and should primarily fall into the sand component above (per section G.1.5.1 compost gradation limits).

G.1.6.2 BSM Quality Testing

In addition to the compost quality testing requirements outlined in section G.1.5.2, the final BSM should meet the following standards. Testing results from the following specifications shall be submitted for approval prior to BSM acceptance.

Parameter	Method	Requirement	Units
Organic Matter	Loss on Ignition	2%–5%	dry weight
pH	Saturation Paste	6.0–8.0	-
Carbon:Nitrogen Ratio	-	10:1–20:1	-
Cation Exchange Capacity (CEC)	-	≥ 5	meq/100 g of dry soil
Salinity (Electrical Conductivity)	Saturation Extract	0.5–3	dS/m
Boron	Saturation Extract	< 2.5	ppm
Chloride	Saturation Extract	< 150	ppm
Sodium Adsorption Rate (SAR)	-	< 3	-
Extractable Nutrients			
Phosphorus	Ammonium Bicarbonate/DPTA extraction method	< 15	mg/kg dry weight
Potassium		100–200	
Iron		24–35	
Manganese		0.6–6.0	
Zinc		1.0–8.0	
Copper		0.3–5.0	
Magnesium		50–150	
Sodium		0–100	
Sulfur		25–500	
Molybdenum		0.1–2.0	
Aluminum		< 3.0	

G.2 Alternative BSM Specifications

BSMs not meeting the above criteria may be evaluated on a case-by-case basis.

G.2.1 General Requirements

Alternative BSM should meet the following specifications:

A. Should be sufficiently permeable to infiltrate runoff at a minimum rate of 5 inches per hour during the life of the facility

B. Should provide sufficient retention of moisture and nutrients to support adequate vegetation while providing pollutant removal

C. Should meet the requirements of the compost chemical analysis outlined in section G.1.5.2 and the BSM quality testing in section G.1.6.2

The following guidance is offered to assist municipalities with verifying that alternative soil mixes meet the specifications.

G.2.2 Submittals

The applicant should submit the following to the municipality for approval:

A. A sample of alternative BSM.

B. Certification from the soil supplier that the BSM meets the requirements of these guidelines.

C. Constant head permeability results of the alternative BSM. Constant head permeability testing in accordance with ASTM D2434, *Standard Test Method for Permeability of Granular Soils (Constant Head)* should be conducted on a minimum of two samples with a 6-inch mold and vacuum saturation.

D. Organic matter content test results of BSM. Organic content test should be performed in accordance with ASTM F1647, *Standard Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes or Testing Methods for the Examination of Compost and Composting* (TMECC) 05.07A, *Loss-On-Ignition Organic Matter Method*.

E. Grain size analysis results of alternative BSM performed in accordance with ASTM D422, *Standard Test Method for Particle Size Analysis of Soils*.

F. A description of the equipment and methods used to mix the sand and compost to produce alternative bioretention soil.

G. Provide the following information about the testing laboratory(ies):

1) Name of laboratory(ies)

2) Contact person(s)

3) Address(es)

4) Phone contact(s)

5) Email address(es)

6) Qualifications of laboratory(ies), including use of ASTM and USDA method of standards

G.2.3 Alternative BSM Texture

Alternative BSM should be analyzed by an accredited lab using No. 200 and 1/2-inch sieves (ASTM D422 or as approved by municipality) and should meet the following gradation:

Sieve Size	Percent Passing (by weight)	
	Min.	Max.
1/2 inch	97	100
No. 200	2	5

G.3 Installation of BSM

The following section provides considerations for proper BSM installation.

G.3.1 Considerations Prior to BSM Installation

The following questions and guidelines should be discussed with the contractor prior to installing the BSM at the project site to prevent any confusion and errors.

A. Ensure that the contractor is familiar with constructing bioretention systems.

B. Plan how inspections will be handled as part of the construction process.

C. Verify BSM meets specification prior to delivery and placement in the facility.

D. Prevent over-compaction of native soils in areas of the basin where infiltration will occur. Delineate the facility area, and keep construction traffic off. Protect soils with fencing, plywood, etc.

E. Provide erosion control in the contributing drainage areas of the facility. Stabilize upslope areas.

F. Drainage should be directed away from bioretention facilities until upslope areas are stabilized. The concentration of fines could prevent post-construction infiltration and cause design failure.

G. If drainage is to be allowed through the facility during construction, leave or backfill at least 6 inches above the final grade. Temporarily cover the underdrain with plastic or fabric. Line or mulch the facility.

H. Bioretention facilities should remain outside the limit of disturbance to prevent soil compaction by heavy equipment. Protect bioretention areas with silt fence or construction fencing.

I. Verify installation of underdrain is correct prior to placing soil.

G.3.2 BSM Mixing and Placement

These guidelines should be followed to ensure proper BSM mixing and placement:

A. Erosion and sediment control practices during construction should be employed to protect the long-term functionality of the bioretention. The following practices shall be followed for this reason:

   1) Provide erosion control in the contributing drainage areas to the facility and stabilize upslope areas.

   2) Facilities should not be used as sediment control facilities, unless installation of all bioretention-related materials are withheld towards the end of construction, allowing the temporary use of the location as a sediment control facility, and appropriate excavation of sediment is provided prior to installation of bioretention materials.

B. Do not excavate, place soils, or amend soils during wet or saturated conditions.

C. Operate equipment adjacent to the facility. Equipment operation within the facility should be avoided to prevent soil compaction. If machinery must operate in the facility, use lightweight, low ground-contact pressure equipment.

D. If constructing an infiltrating facility, the subgrade should be ripped or scarified to a minimum depth of 9 inches on 3-foot centers to promote greater infiltration.

E. Consider the time of year and site working area when determining whether to mix BSM on-site or to import pre-mixed soil. It is recommended that the BSM should be mixed prior to being delivered to the site, and mixing is not allowed on-site during rainy season. If BSM mixing occurs on-site during the dry season, use an adjacent impervious area or mix BSM on plastic sheeting. (Mixing should not occur within the bioretention basin.)

F. Place soil in 6- to 12-inch lifts with machinery adjacent to the facility (to ensure equipment is not driven across soil). If working within the facility, to avoid over-compacting, place first lifts at far end from entrance and place backwards towards entrance.

G. Allow BSM lifts to settle naturally, lightly water to provide settlement and natural compaction between lifts. After lightly watering, allow soil to dry between lifts. Soil cannot be worked when saturated, so this method should be used with caution to ensure dry conditions. After all lifts are placed, wait a few days to check for settlement, and add additional media as needed. No mechanical compaction is allowed.

H. The long-term hydraulic conductivity rate should not be less than 5 inches per hour when tested with a double ring infiltrometer (in accordance with ASTM D3385, *Standard Test Method for Infiltration Rate of Soils in Field Using Double Ring Infiltrometer*), a single ring infiltrometer, a Modified Philip-Dunne Infiltrometer, or other approved methods.

I. Vehicular traffic and construction equipment shall not drive on, move onto, or disturb the BSM once placed and water-compacted.

J. Rake bioretention soil as needed to level out. Verify BSM elevations before applying mulch or installing plants.

Other Considerations:

- Protect adjacent infiltration systems including swales, soils, and porous pavement from sediment.
- Protect adjacent trees.

G.3.3 Mulch for Bioretention Facilities

According to the County of San Diego Water Conservation in Landscaping Ordinance (2010), a 2-inch layer of aged mulch shall be installed on the surface of the bioretention soil for planting of container stock and if no hydroseeding is to be installed.

Aged mulch reduces the ability of weeds to establish, keeps soil moist, and replenishes soil nutrients. Aged mulch can be obtained through soil suppliers or directly from commercial recycling yards. Apply 2 inches of well-aged shredded hardwood mulch once a year, preferably in June, after any weeding.

Compared to green wood chip or bark mulch, aged mulch has less of a tendency to float into overflow inlets during intense storms. Bark or wood chip mulch may be used on the side slopes of basins above the maximum water line. The project landscape architect may also specify another type of **non-floating** mulch, subject to approval by the local jurisdiction. Composted mulch should be avoided due to its potential to contribute pathogens and nutrients to the bioretention facility.

If hydroseeding is to be installed on the surface of the bioretention soil, no stabilized matrix shall be used in the hydroseed components or mix.