BIORETENTION MEDIA SUPPLEMENTAL SPECIFICATION

Last updated May 4, 2021

DESIGNER NOTE: Green text corresponds to notes to the designer. Remove prior to use.

DESIGNER NOTE: Replace “Engineer/Landscape Architect” with the person in responsible charge for the project (e.g., Owner, Engineer, Landscape Architect).

PART 1: GENERAL

1.01 SUMMARY

A. This section includes:
   1. Bioretention Soil Mix
   2. Biosorption Activated Media
   3. Aggregate Storage
   4. Mulch [To be completed by the designer.]
   5. Streambed Gravel [To be completed by the designer.]

B. Related Sections:

DESIGNER NOTE: The designer should list any additional specification sections which relate to the bioretention work (i.e., cleanouts and underdrains, overflow structures, planting, temporary erosion control, utilities, irrigation, earthwork, other appurtenances, etc.).

1.02 STANDARDS AND CODES

A. Reference Standards: This section incorporates by reference the latest versions of the following documents. These references are a part of this section as specified and modified.

Reference	Title
FDOT	Standard Specifications
Pinellas County	Standard Technical Specifications for Utilities and Related Construction, June 2018
ASTM	Annual Book of ASTM Standards, American Society for Testing and

Materials, Philadelphia, PA, 1997 or latest edition.

1.03 DEFINITIONS

A. Bioretention Soil Mix (BSM): An engineered soil mixture that has been specially blended and tested for use in stormwater bioretention facilities with the intent to meet the following objectives:

1. Infiltrate stormwater runoff at a minimum rate of 5 inches per hour throughout the life of the facility;

2. By nature of its components, be capable of the removal of certain suspended and dissolved stormwater pollutants; and

3. Have sufficient moisture retention and other agronomic properties to support healthy vegetation.

B. Biosorption Activated Media (BAM): A bioretention media mixture containing added materials specifically designed to achieve the objectives listed above as well as enhance the removal of nitrogen and phosphorus nutrients from stormwater through physical, chemical, and biological processes.

1.04 REFERENCES

DESIGNER NOTE: Designer to provide references to all project-specific documents (e.g., geotechnical report, topographical survey, site assessment).

1.05 SUBMITTALS

A. Pre-Installation Submittals: The Contractor shall submit to the Engineer/Landscape Architect the following a minimum of 20 calendar days (or as directed by the Engineer/Landscape Architect) prior to the construction of bioretention facilities:

1. BSM Submittals

a) Two (2) one (1) gallon samples of the finished BSM mixture.

b) Source certificates for all BSM materials.

c) Sieve analysis of BSM per ASTM D422 performed within two (2) months of product delivery to site.

d) Certification from the soil supplier or an accredited testing agency that the BSM, including sand and compost components, conforms to industry or technical society reference standards specified in Sections 2.01.A, 2.01.B, and 2.01C.

e) Organic content test results of the BSM, performed in accordance with Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, “Loss-On-Ignition Organic Matter Method.”

f) Permeability test results for BSM per ASTM D2434

DESIGNER NOTE: A description of the equipment and methods used to mix the sand and compost to produce the BSM may be requested by the Engineer/Landscape Architect for documentation purposes.
DESIGNER NOTE: On larger projects, it may be appropriate to require that the above testing be performed on samples taken at the supplier’s yard from the stockpile to be used for the project; see designer note in Section 1.06.C.2.

2. Sand Submittals

a) Sieve analysis of sand per ASTM D 422, Standard Test Method for Particle Size Analysis of Soils performed within two (2) months of product delivery to site.
DESIGNER NOTE: Consider revising the acceptable age of sieve tests depending on the scale of the project. On a larger project, it may be appropriate to require testing on samples taken at the supplier’s yard from the stockpile to be used for the project.

3. Compost Submittals

a) Quality analysis results for compost performed in accordance with Seal of Testing Assurance (STA) standards, as specified in Section 2.01.C, and performed within two (2) months of product delivery to site.

b) Sieve analysis of compost per TMECC 02.02-B performed within two (2) months of product delivery to site.

4. BAM Submittals and Other Submittals

a) Material Safety Data Sheets (MSDS) provided by the BAM product supplier.

b) Cut sheets of any media or soil admix to enhance moisture retention properties if used in finished BSM mixtures.

c) Testing agency qualifications as specified in Section 1.06.B.

DESIGNER NOTE: The designer should include relevant submittal requirements for mulch and streambed gravel (e.g., sieve analysis), to ensure the quality of delivered products.

1.06 QUALITY CONTROL AND QUALITY ASSURANCE

A. General: Test and inspect bioretention materials and operations as Work progresses as described in this section. Failure to detect defective Work or materials at any time will not prevent rejection if a defect is discovered after installation, nor shall it constitute final acceptance.

B. Testing Agency Qualification:

1. General: Agencies that perform testing on bioretention materials, including permeability testing, shall be accredited by STA, ASTM, AASHTO, or other designated recognized standards organization. All certifications shall be current. A testing agency shall be capable of performing all tests to the designated and recognized standards specified and shall provide test results with an accompanying Manufacturer's Certificate of Compliance. The following information shall be provided for all testing laboratories used:

a) Name of lab(s) and contact person(s)

b) Address(es) and phone number(s)

c) Email address(es)

d) Qualifications of laboratory and personnel including the date of current certification by STA, ASTM, AASHTO, or approved equal.

2. Compost: Laboratory that performs testing shall be independent, enrolled in the US Composting Council's (USCC) Compost Analysis Proficiency (CAP) program, and perform testing in accordance with USCC Test Method for The Examination of Composting and Compost (TMECC). The sample collection protocol can be obtained from the U.S. Composting Council, 4250 Veterans Memorial

Highway, Suite 275, Holbrook, NY 11741, 631-737-4931, www.compostingcouncil.org.

C. Responsibilities of Contractor

1. Submittals: Some of the tests required for this specification are unique, and BSM shall be considered a long-lead-time item. Under no circumstance shall failure to comply with all specification requirements be an excuse for a delay or expedient substitution of unacceptable material(s). Pre-Placement Conference: A mandatory pre-placement conference will take place, including at a minimum the Engineer-of-Record/Landscape Architect, the Representative of the County, the Owner/Client Representative, Installer, and general Contractor, to review schedule, products, soil testing, permeability testing, and installation. The Contractor shall notify the Engineer-of-Record/Landscape Architect a minimum of 2 working days prior to conference.

   DESIGNER NOTE: Pre-placement conference is mandatory for all projects within the public right-of-way, or on other public property, and is strongly recommended for privately-owned parcel projects.

2. Testing: All testing specified herein is the responsibility of the Contractor and shall be conducted by an independent testing agency, retained by the Contractor. The Owner reserves the right to conduct additional testing on all materials submitted, delivered, or in-place to ensure compliance with Specifications.

   DESIGNER NOTE: Batch-specific test results and certifications shall be required for projects installing more than 500 cubic yards of BSM.

   DESIGNER NOTE: The Owner may, at any time, conduct additional testing on all materials submitted, delivered, or in-place, to ensure compliance with the Specifications. Testing may include permeability testing per ASTM D2434 (Modified), density testing per ASTM D6938, etc. If the Engineer/Landscape Architect suspects the facility does not conform to these specifications (e.g., as evidenced by lower than anticipated infiltration capacity).

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect the BSM and mulch from contamination and all sources of additional moisture at the supplier site, during transport, and at the project site, until incorporated into the Work.

B. The Contractor is required to coordinate delivery of BSM and aggregates with bioretention facility excavation and soil installation. A written schedule shall be submitted for review as part of the submittal package. BSM should not be stockpiled onsite for any length of time. In no case shall BSM be stockpiled onsite for more than 24 hours without prior written approval by the Engineer/Landscape Architect. If stockpiling onsite for any length of time, BSM stockpiles shall meet the following requirements:

1. Locate stockpiles away from drainage courses, inlets, sewer cleanout vents, and concentrated stormwater flows.

2. Place stockpiles on geotextile fabric.

3. Cover stockpiles with plastic or comparable material.

4. Perform maintenance of the stockpiles by physically inspecting and removing any observable foreign materials, debris, or weeds. Do not use herbicides for weed removal.

5. Contain stockpiles (and prevent contamination from adjacent stockpiles) with a temporary perimeter barrier (e.g., sandbags, wattles, silt fence).

PART 2: PRODUCTS

2.01 BIORETENTION SOIL MIX

A. General: BSM shall be a well-blended mixture of sand and compost, shall have sufficient moisture retention to support healthy plant growth, and shall meet the following criteria:

1. Mixture proportions: 30 to 40 percent compost by volume and 60 to 70 percent sand by volume
DESIGNER NOTE: Up to 15 percent of the sand fraction may be replaced with other media or soil admixtures (e.g., scoria, coconut coir, biochar) to enhance moisture retention capacity of soil, provided admixtures are low in fines (less than 5 percent passing the 200 sieve) and do not break down under normal handling and use. No topsoil, peat, silts, or clays are permitted to be used as admixtures. Admixtures shall be free of sediments and other

materials deleterious to plant growth. The use of other applicable admixtures comprised of perlite, expanded shale, gypsum, vermiculite, and pumice is discouraged as these materials are generated from non-renewable, mined resources with significant environmental impacts.

2. Organic matter content: Efforts should be made to attain organic matter content as close to 4 to 8 percent as possible, as determined by TMECC 05.07-A, Loss on Ignition Method, with the final mix to be determined by the engineer based on samples and test results submitted.

3. Extraneous materials: BSM shall be free of all roots, plants, weeds, sod, stones, clods, pockets of coarse sand, construction debris, or other extraneous materials harmful to plant growth.

4. Permeability/Saturated Hydraulic Conductivity: 10 inches per hour (minimum) tested in accordance with ASTM D2434.

   DESIGNER NOTE: 10-inch-per-hour minimum rate assumes a design rate of 5 inches per hour and a correction factor of 2 to account for the reduction in performance from initially measured rates.

5. Acceptance of BSM quality and performance may be based on samples taken from stockpiles at the supplier's yard, submitted test results, and/or onsite and laboratory testing of installed material at the discretion of the Engineer/Landscape Architect. The point of acceptance will be determined in the field by the Engineer/Landscape Architect.

   DESIGNER NOTE: Designer to consider non-compost-based BSM or low-phosphorus compost specification if the facility is serviced by an underdrain and if it is draining to a phosphorus-sensitive water body.

B. Sand: Sand in the BSM shall conform to the requirements for Sand, Type [specify type from table below] specified herein unless otherwise approved by the Engineer/Landscape Architect.

   DESIGNER NOTE: Designer to specify sand type based on project-specific requirements. If bioretention facilities will be subjected to heavy sediment loads (e.g., arterial runoff), consider specifying Sand, Type B (low fines sand) to reduce clogging risk (pending local availability). Additionally, projects anticipating heavy sediment loads should incorporate

pre-settling measures at the upstream end of the facility to allow for more efficient maintenance of facilities.

DESIGNER NOTE: Up to 15 percent of the sand fraction may be replaced with other media or soil admixtures (e.g., scoria, coconut coir, perlite, expanded shale, gypsum, vermiculite, pumice, biochar) to enhance moisture retention capacity of BAM, provided admixtures are low in fines (less than 2 percent passing the 200 sieve) and do not break down under normal handling and use. No topsoil, peat, silts, or clays are permitted to be used as admixtures. Admixtures shall be free of sediments and other materials deleterious to plant growth.

1. Sand shall be free of wood, waste, coating, or any other deleterious material.
2. Sand material shall meet the following specifications for gradation.

Sieve Size[1]	Percent Passing by Weight	
	Type A[2]	Type B (low fines)[3]
3/8 inch	100	100
No. 4	90 to 100	90 to 100
No. 8	70 to 100	70 to 100
No. 16	40 to 95	40 to 85
No. 30	15 to 70	15 to 60
No. 50	5 to 55	8 to 15
No. 100	0 to 15	0 to 4
No. 200	0 to 5	0 to 2

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.
[2] Sand conforming to ASTM C33 for Fine Aggregate satisfies the requirements of this specification for Sand, Type A.
[3] Type B (low fines) sand gradation pending local availability.

3. Coefficient of Uniformity: $C_u = D_{60}/D_{10}$: 4 or less for Sand, Type B
4. Effective Particle Size (D_{10}): 0.3 to 0.5 mm for Sand, Type B.
5. All aggregate passing the No. 200 sieve shall be non-plastic.
6. Acceptance of grading and quality of the sand may be based on samples taken from stockpiles at the supplier's yard or a submitted gradation report at the discretion of the Engineer/Landscape Architect. The point of acceptance will be determined in the field by the Engineer/Landscape Architect.

C. Compost: Compost in the BSM shall be well decomposed, stable, weed-free organic matter sourced from yard waste materials including yard debris, wood wastes, or other organic materials, not including food wastes, biosolids, or manure feedstock. Compost shall conform to Type "Y" Compost classifications as specified in Florida Rule 62-709.550, be certified through the USCC Seal of Testing Assurance (STA) Program, and meet the criteria specified herein.

1. Feedstock: Feedstock materials shall be specified and include one or more of the following: landscape/yard trimmings, grass clippings, and agricultural crop residues. Feedstock shall not include biosolids or manure.

2. Organic Matter Content: 35 to 75 percent by dry weight tested in accordance with TMECC 05.07-A (Loss on Ignition Organic Matter Method).

3. Carbon to Nitrogen Ratio: C:N between 15:1 and 25:1 when tested in accordance with TMECC 05.02-A.

4. Maturity/Stability: shall have a dark brown color and a soil-like odor. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or is hot (120°F) upon delivery or rewetting is not acceptable. Also, any one of the following is required to indicate stability:

    a) Specific Oxygen Uptake Rate (SOUR):1.5 milligrams O_2 per gram biodegradable volatile solids per hour (maximum) per TMECC 05.08-A.

    b) Carbon Dioxide Evolution Rate: 8 milligrams CO_2 per gram volatile solids per day per TMECC 05.08-B.

    c) Dewar Self Heating Test: 20°C temperature rise (maximum) per TMECC 05.08-D (Class IV or V).

    d) Solvita®: Index value greater than 6 per TMECC 05.08-E.

5. Toxicity: Seed Germination: greater than 80 percent of control AND Vigor: greater than 80 percent of control per TMECC 05.05-A.

6. Nutrient Content: provide analysis detailing nutrient content including N-P-K, Ca, Na, Mg, S, and B.

    a) Total Nitrogen: 0.9 percent (minimum).

    b) Boron: Total shall be < 80 ppm

7. Salinity/Electrical Conductivity: less than 6.0 deciSiemen per meter (dS/m or mmhos/cm) per TMECC 04.10-A (1:5 Slurry Method, Mass Basis).

8. pH: 6.5 to 8 per TMECC 04.11-A (1:5 Slurry pH).

9. Gradation: Compost for BSM shall meet the following size gradation per TMECC 02.02-B (test shall be run on dry compost sample):

Sieve Size	Percent Passing by Weight	
	Min	Max
1 inch	99	100
1/2 inch	90	100
1/4 inch	40	90
No. 200	1	10

10. Bulk density: 500 to 1,100 dry pounds per cubic yard.

11. Moisture content: 30 to 55 percent of dry solids.

12. Inert Content: compost shall be relatively free of inert ingredients, including glass, plastic, and paper, less than 1 percent by weight or volume per TMECC 03.08A.

13. Weed seed/pathogen destruction: provide proof of process to further reduce pathogens (PFRP). For example, turned windrows must reach a minimum of 55°C for 15 days with at least 5 turnings during that period.

14. Select Pathogens:

    a) Salmonella: less than 3 Most Probable Number per 4 grams of total solids, dry weight per TMECC 07.02.

    b) Coliform Bacteria: fecal coliform less than 1,000 Most Probable Number per gram of total solids, dry weight per TMECC 07.01.

15. Trace Contaminants Metals (lead, mercury, etc.): Product must meet US EPA, 40 CFR 503 regulations.

D. Soil Admixtures: [Specify admixtures, if used]

2.02 BIOSORPTION ACTIVATED MEDIA (BAM)

A. General: BAM can consist of a mixture of the following materials depending on the desired pollutant and sediment removal performance: expanded clay, expanded slate, sand, and a carbon source (e.g., crumbed tire, sawdust, or wood chips).

1. Mixture proportions: The proportions of sand, expanded clay, and carbon-source in a BAM can vary depending on application and site conditions. Commercially available BAM products adhere to the proportions listed below.

BAM No.	BAM Mixture	Percent Composition by Volume				
		Sand[1]	Expanded clay[2]	Tire Chip[3]	Expanded Slate[4]	Compost[5]
1	B&G® CTS	85	<1	15	-	-
2	B&G® ECT	-	75	25	-	-
3	Stalite MS16	-	-	-	80	20

[1] Sand: ASTM C-33 with no more than 3 percent passing #200 Sieve (approximate dry density = 2200 lbs/CY)
[2] Expanded clay: 5/8 and 3/8" blend (approximate density = 950 lbs/CY)
[3] Tire chips: 3/8" (approximate density = 730 lbs/CY)
[4] Expanded slate: 1 to 5 mm granules (approximate density is less than 1890 lbs/CY)
[5] Compost: particles are less than 3/8" in size (approximate density is 500 to 1,100 lbs/CY)

DESIGNER NOTE: The BAM composition shall be specified by the Engineer/Designer to achieve the desired performance for the bioretention or biofiltration system.

2. Permeability/Saturated Hydraulic Conductivity: 10 inches per hour (minimum) tested in accordance with ASTM D2434.

DESIGNER NOTE: 10-inch-per-hour minimum rate assumes a design rate of 5 inches per hour and a correction factor of 2 to account for the reduction in performance from initially measured rates.

3. Moisture Holding Capacity: the BAM mixture shall have a water holding capacity of at least 10 percent as measured by porosity, and total porosity of 35 percent

4. Acceptance of BAM quality and performance may be based on samples taken from stockpiles at the supplier's yard, submitted test results, and/or onsite and laboratory testing of installed material at the discretion of the Engineer/Landscape Architect. The point of acceptance will be determined in the field by the Engineer/Landscape Architect.

5. Extraneous materials: BAM shall be free of all roots, plants, weeds, sod, stones, clods, pockets of coarse sand, construction debris, or other extraneous materials harmful to plant growth.

6. Permeability/Saturated Hydraulic Conductivity: 10 inches per hour (minimum) tested in accordance with ASTM D2434

B. Bold and Gold®: Bold & Gold® (B&G) Filtration media is a patented product developed at the Stormwater Management Academy of the University of Central Florida. Environmental Conservation Solutions, LLC. (ECS) is the licensed manufacturer of the Bold & Gold® Filtration media.

DESIGNER NOTE: B&G CTS Filtration media is recommended for stormwater nutrient removal to be used in low loading or slow-flow filters, either in 12-, 24- or 30-inch depth filters; after a wet pond or within a dry basin, swale and strips. B&G ECT Filtration media is recommended for use as the first BMP such as an Up-flow filter baffle box and constructed wetland as defined by the user. It is not intended for storage to control volume attenuation but provides some storage capacity to the limits of the available porosity of 0.25 of the volume occupied by the filter media.

1. Storage and Handling: B&G Filtration media may be delivered pre-mixed and ready to install or the material components delivered separately and mixed on-site by a certified ECS representative. Pre-mixed material components shall be stored in a covered and well-drained area. Material shall not be stockpiled longer than 30 days before installation and must be covered at all times to prevent separation of the material due to adverse weather and environmental conditions such as, but not limited to, rainfall and wind.

2. Premixed Delivery: B&G Filtration media shall be mixed by Environmental Conservation Solutions, LLC. and delivered to the job site ready for installation. The delivered material is certified to meet the patent requirements and a certificate shall be issued as stated in Section 1.2 of this specification.

3. Onsite Mixing Delivery: The mixing shall be done either in a pugmill or other mechanical mixing system that has the capability of uniformly mixing the component material to the requirements of Section 1.3.1 of this specification. An Environmental Conservation Solutions, LLC. representative shall mix the material on a predesignated location. Care shall be taken to avoid contaminating the component material with the existing ground in the stockpile area. The mixed material may be stockpiled, and covered always, for up to 30 days before installation.

4. Installation: The surface on which the B&G Filtration media is placed shall be reasonably leveled within ±1-inch of the elevations shown in the plans. Unless a slope grade is specified in the plans, a

level surface is recommended for the subgrade soil to ensure even infiltration of filtered stormwater spread over the entire surface area.

a) The surface of the subgrade soil underneath the B&G Filtration media shall be compacted to meet the requirements as specified by the design engineer. All necessary construction practices shall be taken to minimize the compaction of the subgrade soil, above the specified subgrade density, to avoid the reduction of the infiltration rate at the soil-filter media interface. The contractor shall take all necessary measures needed to control the deposition of sediments on the surface of the subgrade soil prior to the placement of the B&G Filtration media.

b) The B&G Filtration media shall not be installed until all areas that drain to it have temporal/permanent erosion and sedimentation stabilization in place. No runoff shall be directed to the specified location of B&G filtration media until all drainage areas leading to the location are stabilized. If the installed B&G Filtration media becomes contaminated with sediment, prior to the placement of the cover material, the Engineer//Landscape Architect shall enforce the removal and replacement of contaminated media at the contractor’s expense.

c) A non-woven, geotextile fabric that meets the requirements specified in Section 985 of the FDOT Standard Specifications for Road and Bridge Construction (Engineer/Landscape Architect to specify) shall be installed in accordance with Section 514 of the FDOT Standard Specifications before the B&G Filtration media is placed within the bioretention area.

d) B&G Filtration media may be placed in one lift and compacted to the density specified in the plan by the design engineer. The maximum dry density of the B&G Filtration media is 100 pounds per cubic foot. The final in-place thickness of the B&G Filtration media shall not be less than the thickness shown in the plans for the specific project.

e) Compaction of the B&G Filtration media shall be achieved by using industry-standard compaction techniques. Water that

is free of contaminants (sediments and nutrients) may be sprinkled on to the B&G Filtration media to achieve the compaction requirements. If the compacted B&G Filtration media has an in-place density greater than 105 percent of the required density, the material will be reworked to meet density requirements. If rutting to the B&G Filtration media occurs due to vehicles or equipment during installation, the contractor shall repair it to the grades and elevations in the plans

C. Expanded ceramics: Expanded ceramic materials (e.g., clay, slate, shale) are produced by expanding and vitrifying selected material in a rotary kiln. The media must be produced to meet the requirements of ASTM C330, ASTM C331 and AASHTO M195. Expanded ceramic aggregates must have a minimum 24-hour water absorption of 10.5 percent mass. BAM comprised of expanded ceramic material may contain up to 20 percent expanded ceramic material by volume.

1. Stalite MS16: Stalite MS16 media shall be a homogeneous engineered media blend with approximate volumes of: (1) 75 to 85 percent medium to coarse washed expanded slate ASTM C330 sand; (2) 8 to 10 percent expanded slate fines passing a #200 screen; and (3) 5 to 10 percent organic matter by compressed volume (such as pine bark fines compressed volume)

DESIGNER NOTE: Percentages of sand and organics may vary to achieve the desired performance.

a) Organic Component

(1) Aged pine bark fines screened to minus ½”

(2) For Stalite Environmental quality control, compost shall not contain any manure products or municipal biosolids.

(3) Organic component nitrogen content shall be ≤ 2 percent N of dry weight.

(4) Organic component phosphorus content shall be ≤ 1 percent (P_2O_5) of dry weight.

(5) Organic component salt content shall be < 10 millimho/cm at 25 °C (EC_e <10) on a saturated paste extract.

(6) Organic component metals and contaminants must fall within US EPA Standard 40

b) Compaction: The media shall not be mechanically compacted after being placed by conveyance equipment. To avoid future settlement, where natural compaction has not yet occurred, it is recommended to either water in place or use foot pressure until firm to meet final elevation.

DESIGNER NOTE: When calculating the volume of Stalite necessary for the project, add approximately 22 percent to the calculated volume to allow for compaction necessary to meet infiltration rate and specified depth. One cubic yard of the Stalite Bioretention Media weighs approx. 0.78 tons dry loose

c) Delivery, Storage, and Handling: When stockpiling a finished bioretention media blend, place on a paved or protected base to prevent contamination. Do not deliver or place soil in frozen, wet, or muddy conditions.

2.03 AGGREGATE STORAGE

DESIGNER NOTE: Aggregate storage layer requirements are dependent on site-specific conditions (e.g., native soil infiltration rates, storage volume needs of the project, seasonal high groundwater table depth). The designer should update this specification based on the aggregate storage materials required for the project. DESIGNER NOTE: BSM depth may also be increased for additional storage capacity (in place of an aggregate storage layer), provided the facility is not serviced by an underdrain.

A. Aggregate Storage shall consist of hard, durable, and clean, sand, gravel, or mechanically crushed stone, substantially free from adherent coatings. Materials shall be washed thoroughly to remove fines, organic matter, extraneous debris, or objectionable materials. Recycled materials are not permitted. The material shall be obtained only from a source(s) approved by the Engineer/Landscape Architect. Written requests for source approval shall be submitted to the Engineer/Landscape Architect not less than ten (10) working days prior to the intended use of the Material. Should the proposed source be one that the Engineer/Landscape Architect has no history of Material performance with, the Engineer/Landscape Architect reserves the right to take preliminary

samples at the proposed source, and make preliminary tests, to first determine acceptability of the new source and then perform the applicable Material approval testing. Continued approval of a source is contingent upon the Materials from that source continuing to meet Contract requirements. Materials shall meet the Standard Specifications for grading and quality for use in the Work; however, allowable exceptions may be specified in the Contract.

B. Aggregate storage shall meet the following specifications for grading and quality.

1. Aggregate gradation testing in accordance with ASTM C136 at least once per 500 cubic yards.

Sieve[1]	Percent Passing by Weight		
	Choking Course ASTM No. 57	Reservoir Course ASTM No. 2 or 3	Permeable Aggregate (MS4 Areas Only)
1 inch	–	–	100
3/4 inch	–	100	90 to 100
1/2 inch	100	90 to 100	–
3/8 inch	100	40 to 70	40 to 100
No. 4	85 to 100	0 to 15	25 to 40
No. 8	10 to 40	0 to 5	18 to 33
No. 16	0 to 10	–	–
No. 30	–	–	5 to 15
No. 50	–	–	0 to 7
No. 200[2]	0 to 2	0 to 2	0 to 3

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.
[2] Gradation modified from ASTM for portion passing the No. 200 sieve.

2. Crushed Particles: 90 percent (minimum) fractured faces tested in accordance with ASTM D5821. Do not use rounded river gravel.

3. L.A. Abrasion (FM 1-T 096): 45 percent (maximum) tested in accordance with AASHTO T104

DESIGNER NOTE: If the designer chooses to specify materials that differ from those provided herein, the designer should check their filter criteria to evaluate the likelihood of finer-graded material migration into underlying coarser graded materials or reduction in permeability relative to the underlying material. Refer to the Pinellas County Standard Technical Specifications document for information on selecting appropriate alternate materials.

DESIGNER NOTE: The designer should verify that underdrain slot dimensions for the project are compatible with the aggregate gradation specified. Refer to the Pinellas County Standard Details for information on selecting appropriate underdrain materials.

2.04 MULCH

DESIGNER NOTE: This section intentionally left blank. Designer to specify mulch requirements for bioretention facilities. Mulch may be wood, compost, or rock mulch. Mulch shall be free of dyes, recycled dimensional or construction lumber, bark, and engineered wood products (e.g., fiberboard or particleboard). Materials selected shall be sufficiently permeable to allow water to pass through at a rate equal to or greater than the underlying BSM. Typical mulch recommended for this application includes tree trimming mulch per FDOT "Standard Specifications for Road and Bridge Construction" Section 570, or other comparable material (e.g., arbor mulch). When tree, shrub, and perennial planting is specified, add a 2 to 3-inch layer of triple shredded aged hardwood mulch to reduce substrate surface temperature, retain moisture, slow down infiltration, and capture heavy metals.

2.05 STREAMBED GRAVEL

DESIGNER NOTE: This section is intentionally left blank. Designer to specify gravel requirements, including gravel material (e.g., crushed concrete, lime rock, river stones, etc.) gradation, for bioretention facilities. Streambed Gravel shall be sized to provide energy dissipation and to minimize erosion at facility inlets and outlets. The following text is a sample/template specification for cobbles within a bioretention facility:

Streambed Gravel shall be clean, naturally occurring water rounded, or recycled gravel material. Streambed Gravel shall have a well-graded distribution of gravel size and conform to the following gradation [Designer to specify]: The grading of the gravels shall be determined by the Engineer/Landscape Architect by visual inspection of the load before it is dumped into place, or, if so, ordered by the Engineer/Landscape Architect, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load. Gravels must be washed before placement.

Streambed Gravel		
Material	Approximate Size[1]	Percent Passing by Weight

[1] Approximate size can be determined by taking the average dimension of the three axes of the rock, Length, Width, and Thickness, by use of the following calculation: (Length + Width + Thickness)/3 = Approximate Size Length is the longest axis, width is the second longest axis, and thickness is the shortest axis.

PART 3: EXECUTION

3.01 GENERAL

A. Prevent runoff from adjacent pervious and impervious surfaces from entering the bioretention facility (e.g., sandbag inlet curb cuts, stabilize adjacent areas, flow diversion) until authorization is given by the Engineer/Landscape Architect. Refer to the Pinellas County Stormwater Manual. Exclude equipment from bioretention facilities.

B. No equipment shall operate within the facility once bioretention facility excavation has begun, including during and after excavation, backfilling, mulching, or planting.

C. Prevent foreign materials and substances, such as silt laden runoff, construction debris, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid from entering or being stored in the facility at any point during construction.

3.02 GRADING

A. The Contractor shall not start bioretention facility grading until all areas draining to the facility are stabilized and authorization has been given by the Engineer/Landscape Architect.

B. Construct bioretention facility subgrade to +/- 1 inch of the grades and slopes specified on the Plans.

C. Excavation within 6 inches of final native soil grade shall not be permitted if facility soils have standing water or have been subjected to more than 1/2 inch of precipitation within the previous 48 hours.

3.03 SUBGRADE PREPARATION AND PROTECTION

A. Protect the bioretention excavation from over compaction and/or contamination.

1. Areas which have been over-compacted by equipment or vehicle traffic or by other means and which need to be ripped, over-excavated, receive additional scarification, or other restorative means shall be done at the Contractor's expense and at the direction of the Engineer/Landscape Architect.

2. Excavated areas contaminated by sediment laden runoff prior to placement of BSM or Aggregate Storage material shall be remediated at the Contractor's expense by removing and appropriately disposing the contaminated soil (top 3 inches minimum) and replacing with a suitable material, as determined by the Engineer/Landscape Architect.

B. Remove all trash, debris, construction waste, cement dust and/or slurry, or any other materials that may impede infiltration into prepared subgrade.

C. The subgrade shall be inspected and accepted by the Engineer/Landscape Architect prior to placement of any materials or final subgrade scarification.

D. Scarify the surface of the subgrade to a minimum depth of 3 inches immediately prior to placement of BSM or aggregate storage material. Acceptable methods of scarification include use of excavator bucket teeth or a rototiller to loosen the surface of the subgrade.

E. Place aggregate storage material, where shown on drawings with conveyor belt or with an excavator or loader from a height no higher than 6 feet unless otherwise approved by the Engineer/Landscape Architect. Placement of aggregate storage material shall be done in such a way that prevents compaction of underlayers.

F. Aggregate Storage areas contaminated by sediment-laden runoff prior to placement of BSM shall be remediated at the Contractor's expense by removing the contaminated aggregate storage material (top 3 inches minimum or as directed by the Engineer/Landscape Architect) and replacing with clean aggregate storage material per Section 2.03, to the lines and grades on the Plans.

G. Aggregate Storage material shall be inspected and accepted for placement and finish grade by the Engineer/Landscape Architect prior to the installation of BSM. Any material that does not conform to this

Specification shall be removed and replaced with acceptable material or remediated to the satisfaction of the Engineer/Landscape Architect, at the Contractor's expense.

3.04 BIORETENTION SOIL MIX PLACEMENT

A. The Contractor shall not place BSM until the Engineer/Landscape Architect has reviewed and confirmed the following:

1. BSM delivery ticket(s): Delivery tickets shall show that the full delivered amount of BSM matches the product type, volume and manufacturer named in the submittals. Each delivered batch of BSM shall be accompanied by a certification letter from the supplier verifying that the material meets specifications and is supplied from the approved BSM stockpile.

2. Visual match with submitted samples: Delivered product will be compared to the submitted 1-gallon sample by the Engineer/Landscape Architect, to verify that it matches the submitted sample. The Engineer/Landscape Architect may inspect any loads of BSM on delivery and stop placement if the soil does not appear to match the submittals and require sampling and testing of the delivered soil to determine if the soil meets the requirements of Section 2.01 before authorizing soil placement.

3. Inspection of the aggregate storage layer, underdrain, cleanout, and overflow structure installation, wherever included on the plans.

DESIGNER NOTE: On larger projects, it may be appropriate to require that the testing specified in Section 2.01 be performed on samples taken at the supplier's yard from the stockpile to be used for the project; see designer note in Section 1.06.C.2.

B. BSM placement, grading, and consolidation shall not occur when the BSM is excessively wet or has been subjected to more than 1/2 inch of precipitation within 48 hours prior to placement. Excessively wet is defined as being at or above 22 percent soil moisture by a General Tools & Instruments DSMM500 Precision Digital Soil Moisture Meter with Probe (or equivalent). A minimum of three readings with the soil moisture probe will be used to determine the average percent soil moisture reading per truckload. There should be no visible free water in the material.

C. The Contractor shall place BSM loosely, in 8-inch lifts, with a conveyor belt, a slinger truck, or with an excavator or loader from a height no higher than 6 feet, unless otherwise approved by the Engineer/Landscape Architect. Soil shall be placed upon a prepared subgrade in accordance

with these Specifications and in conformity with the lines, grades, depth, and typical cross-section shown in the Drawings or as established by the Engineer/Landscape Architect.

D. Excessively dry BSM may be lightly and uniformly moistened, as necessary, to facilitate placement and workability.

E. Compact BSM using water compaction to 83 percent (+/- 2 percent) of the maximum dry density per modified Proctor test (ASTM D1557), or as directed by the Geotechnical Engineer. Determination of in-place density shall be made using a nuclear gauge per ASTM D6938. Moisture content determination shall be conducted on a soil sample taken at the location of the nuclear gage reading per ASTM D2216. Water compaction shall be conducted by filling the cell with water, without creating any scour or erosion, to at least 1 inch of ponding. If water compaction is not an option, the final grade shall be measured at X inches above the grade specified on the plans to allow for settling after the first storm. Where X is calculated by the design depth of soil x 0.85 and rounded up to the nearest whole number.

DESIGNER NOTE: Designers are encouraged to report field density measurements, observed infiltration rates (if available), and anecdotal field observations (e.g., the soil appears well-draining, settlement observed minimal).

F. Grade BSM to a smooth, uniform surface plane with loose, uniformly fine texture. Rake, remove ridges and fill depressions to meet finish grades.

G. Final soil depth shall be measured and verified only after the soil has been compacted. If after consolidation, the soil is not within +/- 1 inch of the grades and slopes specified on the Plans, add material to bring it up to final grade and raked.

H. The BSM shall be inspected and accepted for placement and finish grade by the Engineer/Landscape Architect prior to the installation of planting and mulch. Any BSM that does not conform to this Specification shall be remediated to the satisfaction of the Engineer/Landscape Architect, or removed and replaced with acceptable BSM, at the Contractor’s expense.

3.05 PLANTING AND MULCHING

A. Bioretention facilities shall be planted and mulched as shown on the Plans.

B. Bioretention facilities shall not be planted or mulched when soils are excessively wet as defined in Section 3.04.

C. Bioretention facility areas contaminated by sediment C. laden runoff prior to planting or placement of mulch shall be remediated at the Contractor's expense by removing the contaminated BSM (top 3 inches minimum) and replacing it with BSM per Section 2.01, to the lines and grades on the Plans.

D. All mulch shall be inspected and accepted by the Engineer/Landscape Architect to ensure appropriate depth and material prior to facility commissioning (e.g., unblocking of inlets).

DESIGNER NOTE: Planting and mulching requirements shall be determined by the designer and included or referenced herein.

3.06 FLOOD TESTING

A. Inlets shall be constructed per the Plans and free from all obstructions prior to commencing flow testing.

B. Testing shall be conducted after the 90-day plant grow-in period. Protection and flow diversion measures installed to comply with Section 01 57 29 Temp Protection of GI Facilities shall be removed in their entirety prior to commencing flow testing.

C. Underdrains shall be plugged at the outlet structure to minimize water consumption during testing and unplugged after testing.

D. Prior to testing, broom sweep gutter and other impervious surfaces within the test area to remove sediments and other objectionable materials.

E. The Engineer/Landscape Architect shall be present during the demonstration. The Contractor shall notify the Engineer/Landscape Architect a minimum of 2 working days prior to testing.

F. The Contractor shall water test each facility to demonstrate that all inlet curb openings are capturing and diverting all water in the gutter to the facility, outlet structures are engaging at the elevation specified, and the designed ponding depth is achieved. Testing shall include the application of water from a hydrant or water truck at a minimum rate of 10 gallons per minute, into the gutter a minimum of 15 feet upstream of the inlet curb opening being tested. Each inlet shall be tested individually. If erosion occurs during testing, restore soils, plants, and other affected materials.

DESIGNER NOTE: The designer should update the test flow rate for inlets to reflect project-specific design, as needed.

G. Engineer/Landscape Architect will identify deficiencies and required corrections, including but not limited to relocating misplaced plants, adjusting streambed gravel, adjusting mulch, adjusting inlets, splash aprons, and forebays, removing and replacing inlets, and removing debris.

H. Once adjustments are made, the Contractor shall retest to confirm all tested water flows into the facility from the gutter and correct any remaining deficiencies identified by the Engineer/Landscape Architect.

I. Inlets, outlets, and other bioretention facility appurtenances shall not be accepted until testing and any required correction and retesting are complete and accepted by the Engineer/Landscape Architect.

END OF SECTION