VIRGINIA DCR STORMWATER DESIGN SPECIFICATION No. 4

SOIL COMPOST AMENDMENT

VERSION 1.7
March 8, 2010

SECTION 1: DESCRIPTION

Soil restoration is an Environmental Site Design (ESD) practice applied after construction, to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce the generation of runoff from compacted urban lawns and may also be used to enhance the runoff reduction performance of downspout disconnections, grass channels, and filter strips (**Table 4.1**).

SECTION 2: PERFORMANCE

Table 4.1: Stormwater Functions of Soil Compost Amendments [1]

Stormwater Function	HSG Soils A and B		HSG Soils C and D	
	No CA [2]	With CA	No CA	With CA
Annual Runoff Reduction (RR) Rate				
Simple Rooftop Disconnection	**50**	**NA [3]**	**25**	**50**
Filter Strip	**50**	**NA [3]**	**NA [4]**	**50**
Grass Channel	**20**	**NA [3]**	**10**	**30**
Total Phosphorus (TP) Removal [4]	**0**		**0**	
Total Nitrogen (TN) Removal	**0**		**0**	
Channel Protection & Flood Mitigation	**Partial.** Designers can use the RRM spreadsheet to adjust the curve number for each design storm for the contributing drainage area, based on annual runoff volume reduction achieved.			

[1] CWP and CSN (2008), CWP (2007)
[2] CA = Compost Amended Soils, see Stormwater Design Specification No. 4.
[3] Compost amendments are generally not applicable for A and B soils, although it may be advisable to incorporate them on mass-graded B soils to maintain runoff reduction rates.
[4] Filter strips in HSG C and D should use composted amended soils to enhance runoff reduction capabilities. See Stormwater Design Specification No. 2: Sheetflow to Vegetated Filter Strip or Conserved Open Space.

SECTION 3: DESIGN TABLE

Not applicable.

SECTION 4: TYPICAL DETAILS

Not applicable.

SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

Compost amended soils are suitable for any pervious area where soils have been or will be compacted by the grading and construction process. They are particularly well suited when existing soils have low infiltration rates (HSG C and D) and when the pervious area will be used to filter runoff (downspout disconnections and grass channels). The area or strip of amended soils should be hydraulically connected to the stormwater conveyance system. Soil restoration is recommended for sites that will experience mass grading of more than a foot of cut and fill across the site.

Compost amendments are not recommended where:

- Existing soils have high infiltration rates (e.g., HSG A and B), although compost amendments may be needed at mass-graded B soils in order to maintain runoff reduction rates.

- The water table or bedrock is located within 1.5 feet of the soil surface.
- Slopes exceed 10%.
- Existing soils are saturated or seasonally wet.
- They would harm roots of existing trees (keep amendments outside the tree drip line).
- The downhill slope runs toward an existing or proposed building foundation.
- The contributing impervious surface area exceeds the surface area of the amended soils.

Compost amendments can be applied to the entire pervious area of a development or be applied only to select areas of the site to enhance the performance of runoff reduction practices. Some common design applications include:

- Reduce runoff from compacted lawns.
- Enhance rooftop disconnections on poor soils.
- Increase runoff reduction within a grass channel.
- Increase runoff reduction within a vegetated filter strip.
- Increase the runoff reduction function of a tree cluster or reforested area of the site.

SECTION 6: DESIGN CRITERIA

6.1. Performance When Used in Conjunction With Other Practices

As referenced in several of the other specifications, soil compost amendments can be used to enhance the runoff reduction capabilities of allied practices. The specifications for each of these practices contain design criteria for how compost amendments can be incorporated into those designs:

- Rooftop (impervious) Disconnection – see Stormwater Design Specification No. 1, Section 3.2.
- Vegetated Filter Strips – see Stormwater Design Specification No. 2, Section 6.1.
- Grass Channels – see Stormwater Design Specification No. 3, Section 6.5.
- Site Reforestation – see Appendix A of this design specification.

6.2. Soil Testing

Soil tests are required during two stages of the compost amendment process. The first testing is done to ascertain pre-construction soil properties at proposed amendment areas. The initial testing is used to determine soil properties to a depth 1 foot below the proposed amendment area, with respect to bulk density, pH, salts, and soil nutrients. These tests should be conducted every 5000 square feet, and are used to characterize potential drainage problems and determine what, if any, further soil amendments are needed.

The second soil test is taken at least one week after the compost has been incorporated into the soils. This soil analysis should be conducted by a reputable laboratory to determine whether any further nutritional requirements, pH adjustment, and organic matter adjustments are necessary for plant growth. This soil analysis should be done in conjunction with the final construction inspection to ensure tilling or subsoiling has achieved design depths.

6.3. Runoff Volume Reduction

The runoff volume reduction achieved by soil restoration depends on the site application and the pre-construction hydrologic soil group. When compost amendments are used simply to reduce runoff volume from compacted lawns, the lower runoff coefficients shown in **Table 4.2** can be used to lower the total treatment volume for the site as a whole. If the soil restoration area accepts runoff from adjacent impervious areas, the higher runoff reduction rates outlined in **Table 4.1** above may be used for the indicated practices.

Table 4.2. Runoff Coefficients for Use for Different Pervious Areas

Hydrologic Soil Group	Undisturbed Soils [1]	Disturbed Soils [2]	Restored and Reforested [3]
A	0.02	0.15	0.02
B	0.03	0.20	0.03
C	0.04	0.22	0.04
D	0.05	0.25	0.05

Notes:
[1] Portions of a new development site, outside the limits of disturbance, which are not graded and do not receive construction traffic.
[2] Previously developed sites, and any site area inside the limits of disturbance as shown on the E&S Control plan.
[3] Areas with restored soils that are also reforested to achieve a minimum 75% forest canopy

6.4. Determining Depth of Compost Incorporation

The depth of compost amendment is based on the relationship of the surface area of the soil amendment to the contributing area of impervious cover that it receives. **Table 4.3** presents some general guidance derived from soil modeling by Holman-Dodds (2004) that evaluates the required depth to which compost must be incorporated. Some adjustments to the recommended incorporation depth were made to reflect alternative recommendations of Roa Espinosa (2006), Balousek (2003), Chollak and Rosenfeld (1998) and others.

Table 4.3. Short-Cut Method to Determine Compost and Incorporation Depths

	Contributing Impervious Cover to Soil Amendment Area Ratio [1]			
	IC/SA = 0 [2]	IC/SA = 0.5	IC/SA = 0.75	IC/SA = 1.0 [3]
Compost (in) [4]	2 to 4 [5]	3 to 6 [5]	4 to 8 [5]	6 to 10 [5]
Incorporation Depth (in)	6 to 10 [5]	8 to 12 [5]	15 to 18 [5]	18 to 24 [5]
Incorporation Method	Rototiller	Tiller	Subsoiler	Subsoiler

Notes:
[1] IC = contrib. impervious cover (sq. ft.) and SA = surface area of compost amendment (sq. ft.)
[2] For amendment of compacted lawns that do not receive off-site runoff
[3] In general, IC/SA ratios greater than 1 should be avoided
[4] Average depth of compost added
[5] Lower end for B soils, higher end for C/D soils

Once the area and depth of the compost amendments are known, the designer can estimate the total amount of compost needed, using an estimator developed by TCC, (1997):

$$C = A * D * 0.0031$$

Where: C = compost needed (cu. yds.)
A = area of soil amended (sq. ft.)
D = depth of compost added (in.)

6.5. Compost Specifications

The basic material specifications for compost amendments are outlined below:

- Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of local providers.

- The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions that promote anaerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have a moisture content that has no visible free water or dust produced when handling the material. It shall meet the following criteria, as reported by the U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor:

  a. 100% of the material must pass through a half inch screen
  b. The pH of the material shall be between 6 and 8
  c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight
  d. The organic matter content shall be between 35% and 65%
  e. Soluble salt content shall be less than 6.0 mmhos/cm
  f. Maturity should be greater than 80%
  g. Stability shall be 7 or less
  h. Carbon/nitrogen ratio shall be less than 25:1
  i. Trace metal test result = “pass”
  j. The compost must have a dry bulk density ranging from 40 to 50 lbs./cu. ft^3.

SECTION 7: REGIONAL & SPECIAL CASE DESIGN ADAPTATIONS

7.1. Karst Terrain

No special adaptations are needed in karst terrain, but the designer should take soil tests to ensure that soil pH is adjusted to conform to pre-existing soil conditions found in limestone dominated areas.

7.2. Coastal Plain

Designers should evaluate drainage and water table elevations to ensure the entire depth of soil amendment will not become saturated (i.e., a minimum separation depth of 2 feet from groundwater). Compost amendments are most cost effective when used to boost the runoff reduction capability of grass vegetated filter strips, grass channels and rooftop disconnections.

7.3. Steep Terrain

Compost amendments are ineffective when longitudinal slopes exceed 5%, so some terracing may be needed on steeper slopes.

7.4. Cold Climate and Winter Performance

Soil restoration is not recommended for areas that will be used for snow storage.

7.5. Linear Highway Sites

Soil amendments can improve the runoff reduction of drainage swales in open section rights-of-way and highway medians.

SECTION 8: CONSTRUCTION

8.1. Construction Sequence

The construction sequence for compost amendments differs depending whether the practice will be applied to a large area or a narrow filter strip, such as in a rooftop disconnection or grass channel. For larger areas, a typical construction sequence is as follows:

Step 1. Prior to building, the proposed area should be deep tilled to a depth of 2 to 3 feet using a tractor and sub-soiler with two deep shanks (curved metal bars) to create rips perpendicular to the direction of flow. (This step is usually omitted when compost is used for narrower filter strips.)

Step 2. A second deep tilling to a depth of 12 to 18 inches is needed after final building lots have been graded.

Step 3. It is important to have dry conditions at the site prior to incorporating compost.

Step 4. An acceptable compost mix is then incorporated into the soil using a roto-tiller or similar equipment at the volumetric rate of 1 part compost to 2 parts soils.

Step 5. The site should be leveled and seeds or sod used to establish a vigorous grass cover. Lime or irrigation may initially be needed to help the grass grow quickly.

Step 6. Areas of compost amendments exceeding 2500 square feet should employ simple erosion control measures, such as silt fence, to reduce the potential for erosion and trap sediment.

8.2. Construction Inspection

Construction inspection involves digging a test pit to verify the depth of mulch, amended soil and scarification. A rod penetrometer should be used to establish the depth of uncompacted soil at one location per 10,000 square feet.

SECTION 9: MAINTENANCE

9.1. Maintenance Agreements

When soil compost amendments are applied on private residential lots, homeowners will need to be educated on their routine maintenance needs, understand the long-term maintenance plan, and be subject to a deed restriction or other mechanism enforceable by the qualifying local program to ensure that infiltrating areas are not converted or disturbed. The mechanism should, ideally, grant authority for local agencies to access the property for inspection or corrective action. In addition, the GPS coordinates for all amended areas should be provided upon facility acceptance to ensure long term tracking.

A simple maintenance agreement should be provided if soil restoration is associated with more than 10,000 square feet of reforestation. A conservation easement or deed restriction, which also identifies a responsible party, may be required to make sure the newly developing forest cannot be cleared or developed management is accomplished (i.e., thinning, invasive plant removal, etc.). Soil compost amendments within a filter strip or grass channel should be located in a public right-of-way, or within a dedicated stormwater or drainage easement.

9.2. First Year Maintenance Operations

In order to ensure the success of soil compost amendments, the following tasks must be undertaken in the first year following soil restoration:

Initial inspections. For the first six months following the incorporation of soil amendments, the site should be inspected at least once after each storm event that exceeds 1/2-inch of rainfall.

Spot Reseeding. Inspectors should look for bare or eroding areas in the contributing drainage area or around the soil restoration area and make sure they are immediately stabilized with grass cover.

Fertilization. Depending on the amended soils test, a one-time, spot fertilization may be needed in the fall after the first growing season to increase plant vigor.

Watering. Water once every three days for the first month, and then weekly during the first year (April-October), depending on rainfall.

9.3. Ongoing Maintenance

There are no major on-going maintenance needs associated with soil compost amendments, although the owners may want to de-thatch the turf every few years to increase permeability. The owner should also be aware that there are maintenance tasks needed for filter strips, grass channels, and reforestation areas. An example maintenance inspection checklist for an area of Soil Compost Amendments can be accessed in Appendix C of Chapter 9 of the *Virginia Stormwater Management Handbook* (2010).

SECTION 10. COMMUNITY & ENVIRONMENTAL CONCERNS

Not applicable.

SECTION 11: REFERENCES

Balusek. 2003. *Quantifying decreases in stormwater runoff from deep-tilling, chisel-planting and compost amendments*. Dane County Land Conservation Department. Madison, Wisconsin.

Chollak, T. and P. Rosenfeld. 1998. *Guidelines for Landscaping with Compost-Amended Soils*. City of Redmond Public Works. Redmond, WA. Available online at: http://www.ci.redmond.wa.us/insidecityhall/publicworks/environment/pdfs/compostamendedsoils.pdf

City of Portland. 2008. "Soil Specification for Vegetated Stormwater Facilities." *Portland Stormwater Management Manual*. Portland, Oregon.

Composting Council (TCC). 1997. *Development of a Landscape Architect Specification for Compost Utilization*. Alexandria, VA. http://www.cwc.org/organics/org972rpt.pdf

Holman-Dodds, L. 2004. *Chapter 6. Assessing Infiltration-Based Stormwater Practices*. PhD Dissertation. Department of Hydroscience and Engineering. University of Iowa. Iowa City, IA.

Lenhart, J. 2007. "Compost as a Soil Amendment for Water Quality Treatment Facilities." *Proceedings: 2007 LID Conference*. Wilmington, NC.

Low Impact Development Center. *Guideline for Soil Amendments*. Available online at: http://www.lowimpactdevelopment.org/epa03/soilamend.htm

Roa-Espinosa. 2006. *An Introduction to Soil Compaction and the Subsoiling Practice. Technical Note.* Dane County Land Conservation Department. Madison,Wisconsin.

Soils for Salmon. 2003. *Soil Restoration and Compost Amendments*. Available online at: http://www.soilsforsalmon.org/pdf/SoilsforSalmonLIDrev9-16-04.pdf

APPENDIX 4-A

INITIAL MINIMUM DESIGN CRITERIA FOR REFORESTATION, DISCONNECTION, FILTER STRIPS AND GRASS CHANNELS

SECTION 4-A.1: SITE REFORESTATION

Several design criteria apply when compost amendments are used to enhance the performance of reforested areas. Site reforestation involves planting trees on existing turf or barren ground at a development site with the explicit goal of establishing a mature forest canopy that will intercept rainfall, increase evapotranspiration rates, and enhance soil infiltration rates. Reforestation areas at larger development sites (and individual trees at smaller development sites) are eligible under the following qualifying conditions.

- The minimum contiguous area of reforestation must be greater than 5,000 square feet.
- A long term vegetation management plan must be prepared and filed with the local review authority in order to maintain the reforestation area in a natural forest condition.
- The reforestation area must be protected by a perpetual stormwater easement or deed restriction which stipulates that no future development or disturbance may occur within the area.
- Reforestation methods must achieve 75% forest canopy within ten years.
- The planting plan must be approved by the appropriate local forestry or conservation authority, including any special site preparation needs.
- The construction contract should contain a care and replacement warranty extending at least 3 growing seasons, to ensure adequate growth and survival of the plant community.
- The reforestation area shall be shown on all construction drawings and E&S Control plans during construction.

SECTION 4-A.2: SIMPLE DOWNSPOUT DISCONNECTION

See VA DCR Stormwater Design Specification No. 1.

SECTION 4-A.3: FILTER STRIP

See VA DCR Stormwater Design Specification No. 2.

SECTION 4-A.4: GRASS CHANNEL

See VA DCR Stormwater Design Specification No. 3.