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## Best Management Practice Fact Sheet 4:

# Soil Restoration

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This fact sheet is one of a 15-part series on urban *stormwater management* practices.

Please refer to definitions in the glossary at the end of this fact sheet.
Glossary terms are *italicized* on first mention in the text. For a comprehensive list, see Virginia Cooperative Extension (VCE) publication 426-119, "Urban Stormwater: Terms and Definitions."

## What Is Soil Restoration?

*Soil restoration* (SR) is the technique of enhancing compacted soils to improve their *porosity* and *nutrient* retention. It includes biological (worms) and mechanical *aeration*, mechanical loosening (*tilling*), planting dense vegetation, and applying *soil amendments*. Soil amendments involve the spreading and mixing of mature *compost* into disturbed and compacted urban soils (see Figure 1).

## Where Can SR Be Used?

Soil restoration is an environmental site design practice that treats *stormwater* from a broad area. It is suitable for areas that have been subjected to *compaction* or significant removal of *topsoil* and is most effective in drier soils with slope grades of less than 10 percent.

Figure 1. Typical compost-amended soil (VA-DCR 2011).

## How Does SR Work?

The intent of soil restoration is to improve *soil structure* by increasing porosity for root growth and microbial activity, and to provide a source of organic substrate to retain more water and nutrients for plant uptake. Compost, the most common soil amendment, contains a mixture of organic matter that enhances soil structure, *infiltration*, root growth, and water-holding capacity and reduces soil compaction.

Other methods of SR include aeration, mechanical loosening (tilling), and planting dense vegetation (see Figure 2). Mechanical processes work to physically *aerate* the soil and return it to its predevelopment porosity. However, repeated use of tilling can ultimately destroy soil structure.

Soil restoration provides runoff reduction in the form of increased porosity and water-holding capacity of the soil. It can also be effective in conjunction with *rooftop disconnection* (VCE publication 426-120), grass channels (VCE publication 426-122), and *sheet flow to open space* (VCE publication 426-121) to reduce runoff and improve infiltration performance. For more detailed instructions on how to apply compost to residential areas, see "Using Compost in Your Landscape," VCE publication 426-704. SR can easily be combined with *simple rooftop disconnection* to increase infiltration and reduce runoff from rooftops. The practice can also enhance *filter strips*, or *sheet flow to open space*.



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## Limitations

- SR should be avoided on slopes greater than 3 to 1 (3:1), because an increase in *soil moisture* may cause slope instability.
- SR is not recommended in soils that already have high infiltration rates.
- SR is not recommended for areas where the *water table* or bedrock is less than 1.5 feet from the surface.
- SR can Increase infiltration, which may result in *groundwater contamination* at *hot spots*, such as gas stations.

Figure 2. Applying soil amendments (VA-DCR 2011).

## Maintenance

### First-Year Maintenance
(one-time)

- Initial inspections: Inspect site after storms occur for first few months.
- Spot reseeding: Inspect area for bare or eroding spots to be reseeded and covered.
- Fertilization: Fertilize in order to provide the appropriate nutrient content to support the intended use. Should only be used as necessary after a soil analysis indicates a need.

### Nonroutine Maintenance
(as needed)

- Consider dethatching turf to *increase permeability*.
- Consider temporary irrigation during extreme droughts to save vegetation.

## Performance

Due to the increase in soil porosity, a runoff reduction can be expected of approximately 30 percent to 50 percent when used to augment other practices throughout a *watershed*, such as rooftop disconnection and grass channels. Lawn areas that undergo soil restoration and do not receive runoff from other areas can remove as much as 75 percent of runoff volume (VA-DCR 2011). Soil restoration is not expected to reduce total nitrogen or total phosphorous, although the reduction in storm water runoff can contribute to a reduction in nutrient loading.

## Expected Cost

Soil restoration is an inexpensive *stormwater treatment* practice when compared to other alternatives. The cost of compost (averages for the Chesapeake region) can range from $15 to $30 per cubic yard. In addition to these costs, other highly local installation costs, such as tilling, mechanical aeration, or soil loosening, should be included. At a coverage depth of 2 inches per acre (most common), the preliminary cost would be $7,000 per acre (Evanylo 2011).

Maintenance is performed as needed and generally only once; thus, it is a very small portion of cost analysis. In many cases, SR is used in conjunction with another purpose or land use, so the value of land is not included in this analysis.

## Additional Information

The Virginia departments of Conservation and Recreation (VA-DCR) and Environmental Quality (VA-DEQ) are the two state agencies that address nonpoint source pollution. The VA-DCR oversees agricultural conservation; VA-DEQ regulates stormwater through the Virginia Stormwater Management Program.

Additional information on best management practices can be found at the Virginia Stormwater BMP Clearinghouse website at http://vwrrc.vt.edu/swc. The BMP Clearinghouse is jointly administered by the VA-DEQ

and the Virginia Water Resources Research Center, which has an oversight committee called the Virginia Stormwater BMP Clearinghouse Committee. Committee members represent various stakeholder groups involved with stormwater management.

## Online Resources

Colorado State University Extension – www.cmg.colostate.edu/gardennotes/241.pdf

Idaho Department of Environmental Quality – www.deq.idaho.gov/media/622263-stormwater.pdf

Low Impact Development Center – www.lowimpactdevelopment.org/epa03/soilamend.htm

National Compost Prices – www.recycle.cc/compostprices.pdf

New Jersey Department of Environmental Protection – www.state.nj.us/dep/stormwater/bmp_manual2.htm

Oregon Department of Environmental Quality – www.deq.state.or.us/wq/stormwater/nwrinfo.htm

Virginia Stormwater BMP Clearinghouse – http://vwrrc.vt.edu/swc/

## Companion Virginia Cooperative Extension Publications

Daniels, W., G. Evanylo, L. Fox, K. Haering, S. Hodges, R. Maguire, D. Sample, et al. 2011. *Urban Nutrient Management Handbook*. Edited by M. Goatley. VCE Publication 430-350.

Gilland, T., L. Fox, M. Andruczyk, and L. Swanson. 2009. *Urban Water-Quality Management - What Is a Watershed?* VCE Publication 426-041.

Reif, D. 2009. *Using Compost in Your Landscape*. VCE Publication 426-704.

Sample, D., et al. 2011-2012. Best Management Practice Fact Sheet Series 1-15, VCE Publications 426-120 through 426-134.


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## References


Evanylo, G. 2011. Personal Communication.

Virginia Department of Conservation and Recreation (VA-DCR). 2011. *Virginia DCR Stormwater Design Specification No. 4: Soil Compost Amendment*, Version 1.7. http://vwrrc.vt.edu/swc/NonPBMPSpecsMarch11/VASWMBMPSpec4SOILAMENDMENT.html.


## Glossary of Terms

**Aerate** – The act of incorporating air into soil.

**Aeration** – The process by which air is mixed with soil.

**Best management practice (BMP)** – Any treatment practice for urban lands that reduces pollution from stormwater. A BMP can be either a physical structure or a management practice. Agricultural lands use a similar, but different, set of BMPs to mitigate agricultural runoff.

**Compaction** – The loss of soil porosity due to the weight of heavy machinery, continuous lightweight application, or lack of adequate moisture.

**Compost** – Vegetative or organic matter that has been allowed to fully decompose, leaving a rich, organic medium that can be mixed with soils.

**Environmental site design** – A practice intended to minimize the generation of runoff and facilitate infiltration.

**Filter strips** – Densely vegetated, uniformly graded areas that intercept runoff from impervious surfaces.

**Grass channels** – A stormwater treatment practice using open channels with grass sides that can carry runoff with modest velocities while treating stormwater for quality and reducing runoff quantities.

**Groundwater contamination** – The presence of unwanted chemical compounds in groundwater. In this case, it would normally refer to dissolved nitrogen compounds, such as nitrates. It could possibly include unwanted bacteria.

**Hot spots** – Areas that generate exceedingly high concentrations of pollutants due to land use or activities adjacent to the waterway.

**Impervious surfaces** – Hard surfaces that do not allow infiltration of rainfall into them; not pervious.

**Infiltration** – The process by which water (surface water, rainfall, or runoff) enters the soil.

**Nutrients** – Substances required for growth of all biological organisms. When considering water qualities, nutrients of greatest concern are nitrogen and phosphorus in stormwater, because they are often limiting in downstream waters. Excessive amounts of these substances are pollution and can cause algal blooms and dead zones to occur in downstream waters.

**Permeability** – *See permeable.*

**Permeable** – A surface that water can easily flow through (porous) and allows infiltration into it.

**Porosity** – The ratio of void space (air-filled, if completely dry) to total volume of a soil sample.

**Rooftop disconnection** – A best management practice that redirects runoff from streets, storm drains, and streams onto landscaped areas and away from *impervious surfaces.*

**Sheet flow to open space** – When sheet runoff flows from an impervious surface to open space, usually a filter strip.

**Simple rooftop disconnection** – A best management practice that directs residential rooftop runoff away from impervious surfaces.

**Soil amendment** – Any material mixed into the soil; usually compost to improve overall soil quality and structure.

**Soil analysis** – Soil testing procedure available through the Virginia Cooperative Extension that analyzes soils for nutrient, mineral, and organic matter content, among other options.

**Soil moisture** – Amount of water contained in a sample of soil; expressed as a fraction of the volume of soil.

**Soil restoration** – The technique of using compost to amend soils to improve their porosity and nutrient retention. The restored soils are less compacted and can replicate runoff from forested areas.

**Soil structure** – How individual soil particles bind together and the arrangement of soil pores between them.

**Stormwater** – Water that originates from impervious surfaces during rain events; often associated with urban areas. Also called runoff.

**Stormwater treatment practice** – A type of best management practice that is structural and reduces pollution in the water that runs through it.

**Tilling** – The process of mechanically or otherwise agitating compacted soil to produce looser, more aerated media.

**Topsoil** – The outermost layer of the soil, which has the highest content of organic matter and microorganisms.

**Watershed** – A unit of land that drains to a single "pour point." Boundaries are determined by water flowing from higher elevations to the pour point. The pour point is the point of exit from the watershed, or where the water would flow out of the watershed if it were turned on end.

**Water table** – The depth at which soils are fully saturated with water.