Bioretention Soils (and the BMP Toolkit)

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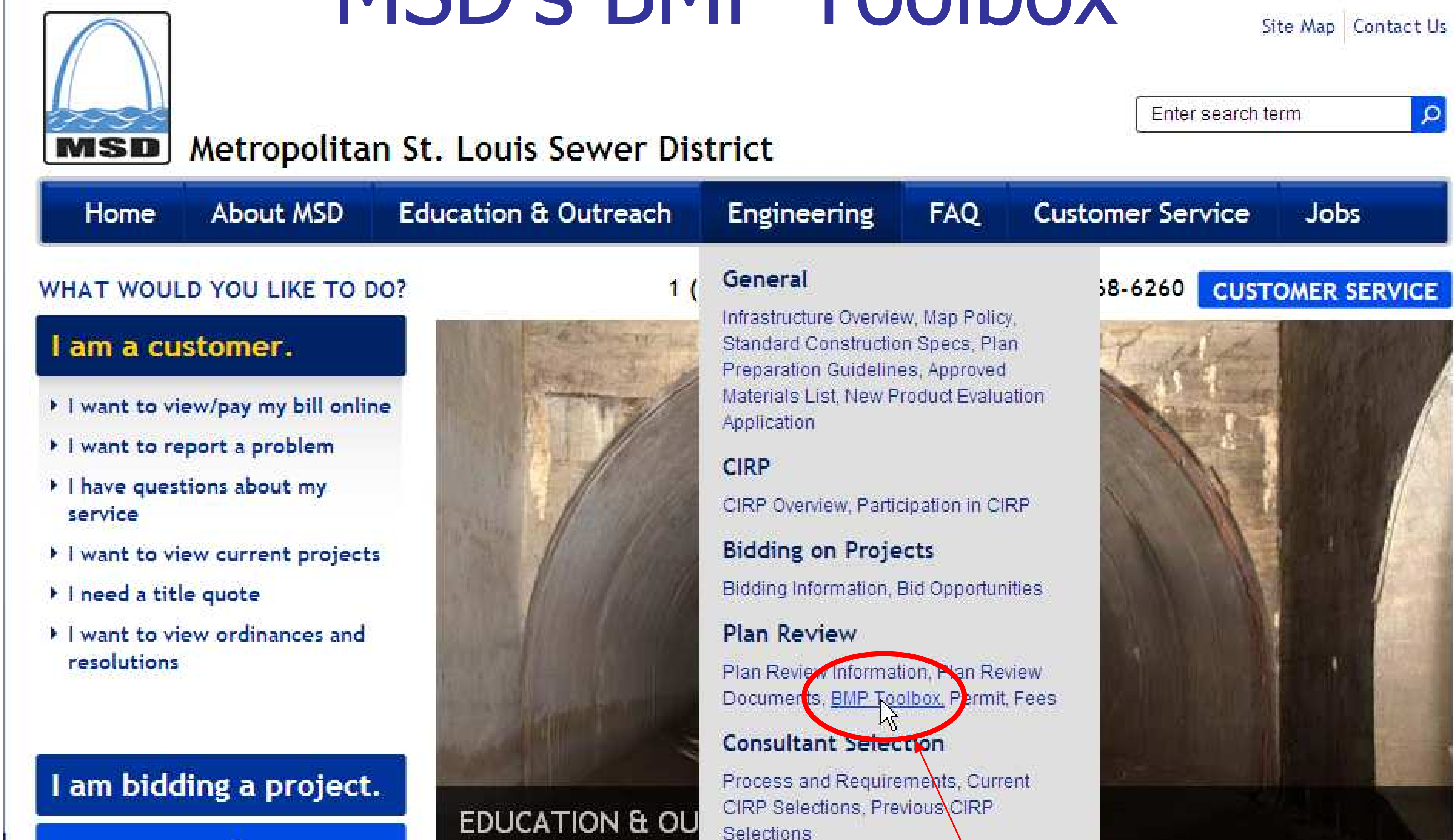
Metropolitan St. Louis Sewer District

MSD's BMP Toolbox



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BMP Toolbox

Stormwater Best Management Practices (BMP) Toolbox

These resources will help you successfully navigate the technical and procedural path to post-construction stormwater BMPs design, installation and maintenance.

The information below will take you to a more complete understanding of stormwater management from MSD's perspective. Please note that this website is continually updated. Not all links are currently available. Your patience is appreciated.

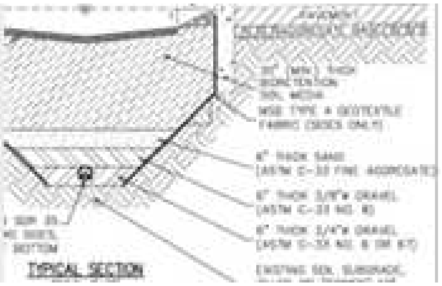
Our Goal - Good water quality is important. MSD's goal is to lead efforts that balance water quality protection and Clean Water Act compliance with economic growth through land development. Additional information on MSD's efforts are available in the Phase II Stormwater Management Plan.

The Development Review Process - Site design plays a key role in implementing effective stormwater management. The oversight and approval of the site stormwater quality plan has two significant components: land use and engineering design. In St. Louis, MSD and municipalities work together to protect the region's water quality by using post-construction BMPs.

- Stormwater Quality
- Channel Protection (Extended) Detention
- Flood Detention

BMP Design - Selecting the best post-construction stormwater BMP for your site requires understanding the performance criteria and BMP technology. MSD is developing tools to help and will publish them here as they become available.

- Technology Matrix ← Link Here
- Calculation and Report Preparation Tools
- Maintenance Agreement



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Technology Matrix

In 2006, MSD established performance requirements for post-construction BMP requirements in its Rules and Regulations and adopted Chapters 3 and 5 of the 2000 Maryland Stormwater Design Manual (Maryland Manual). The Maryland Manual provides the methodology for designing many kinds of post-construction stormwater BMPs, including stormwater ponds, infiltration BMPs, filtering systems, open channel systems, stormwater wetlands, and stormwater credits (e.g., natural area conservation and impervious area disconnection). MSD anticipated that it would be necessary to adapt its rules and the Maryland Manual to local conditions and requirements. A primary goal of the BMP toolkit is to share these adaptions. Click on the technology names below to find design, construction, and maintenance information on the technologies most commonly used in MSD.

BMP Technology	Performance/Function			
	Volume Reduction	Water Quality Treatment	Channel Protection Storage	Peak Flood Detention Storage
Bioretention	Yes	Yes	Yes	Qp_v Reduction Only*
Porous Pavement	Yes	Yes	Yes	Qp_v Reduction Only*
Rainwater Harvesting	Yes	WQ_v Reduction Only	CP_v Reduction Only*	Qp_v Reduction Only*
Green Roof	Yes	WQ_v Reduction Only	CP_v Reduction Only*	Qp_v Reduction Only*
Sheet Flow to Buffer (Credit)	Yes	Yes	CP_v Reduction Only*	Qp_v Reduction Only*
Sand/Perlite Filters	No	Yes	No	No
Stormwater Ponds and Wetlands	No	Yes	Yes	Yes
Proprietary BMPs	No	Technology Dependent	Technology Dependent	Technology Dependent
Open Channel Use (Credit)	No	Yes	No	No
Dry Detention Basin	No	No	Yes	Yes

*By curve number modification. See calculation tools.

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Bioretention

Bioretention is a depressed landscape feature which stores, filters, and infiltrates stormwater runoff. Bioretention is an attractive Best Management Practice (BMP) on many developments because it can be tucked into greenspace such as curb and cul-de-sac islands, streetscape, and planter boxes.

Basic components important to most St. Louis area bioretention "cells" are vegetation; organic soil that will drain well and provide growing media for plants; a graded filter of sands and gravels below the soil; a perforated underdrain pipe beneath the graded filter to ensure the bioretention will drain; and an overflow structure to pass storms larger than the bioretention design storm.

- Performance Criteria
- Bioretention Design Details
- Construction
- Maintenance

Links Here

Related Links

BMP Technology Matrix

Bioretention Soils Performance Criteria

Performance Criteria

Storage Volume

A significant factor affecting bioretention performance is storage volume. Bioretention cells within MSD's jurisdiction are typically sized based on the "stormwater quality volume," and sometimes the "channel protection volume."

The water quality volume is defined as $WQ_v = P * R_v * A$, where

$P = 0.095$ feet (1.14 inches)
$R_v = 0.05 + 0.1 * I$, where I is the percent impervious area (whole number)

A is the drainage area (square-feet)
(A minimum storage volume of 0.2 inches per acre shall be met at all sites where WQ_v is required.)

When sized for the stormwater quality volume, bioretention should provide a minimum storage of 75 percent of the WQ_v. Storage is considered as the volume provided within and above the bioretention soil. (A porosity of 30 – 35 percent voids is typically used for bioretention soil.) The ponding depth (i.e., storage above the soil) should be 3 – 18 inches when bioretention is sized for the stormwater quality volume.

When bioretention is sized to store the **channel protection volume** or **flood detention volume**, stormwater may pond up to 36 inches deep. The entire channel protection volume should be stored in the basin, and should drain through the filter bed (i.e., no orifice is needed). In some situations (typically 1-2 acre drainage areas with small amount of impervious area), flood detention can also be nested in the bioretention storage volume. Orifices, weirs, and other outlet devices are typically needed to release flood events from bioretention.

Bioretention Soils Performance Criteria

Filter Bed (Soil Bed) Area

The aerial footprint of the bioretention soil affects the time needed to fully drain the bioretention basin.

$A_f = WQ_v * d_f / [k * (h_f + d_f) * t_f]$, where

A_f = Minimum surface area of filter bed (ft^2)

WQ_v = Stormwater quality volume (ft^3)

d_f = filter bed thickness (feet)

k = saturated hydraulic conductivity (feet/day)
h_f = maximum ponding depth ÷ 2 (feet)

t_f = maximum drain time (days)

Bioretention should fully drain the water quality storage volume within 2 days.

If the bioretention soil meets the material specification provided in the BMP Landscape Guide, then MSD recognizes k = 2 feet/day.

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Related Links

BMP Technology Matrix

Bioretention Soils Design Details

Design Details

Typical Section

MSD has developed details illustrating typical sections for bioretention.

Parking Lot Detail

Residential Street Detail

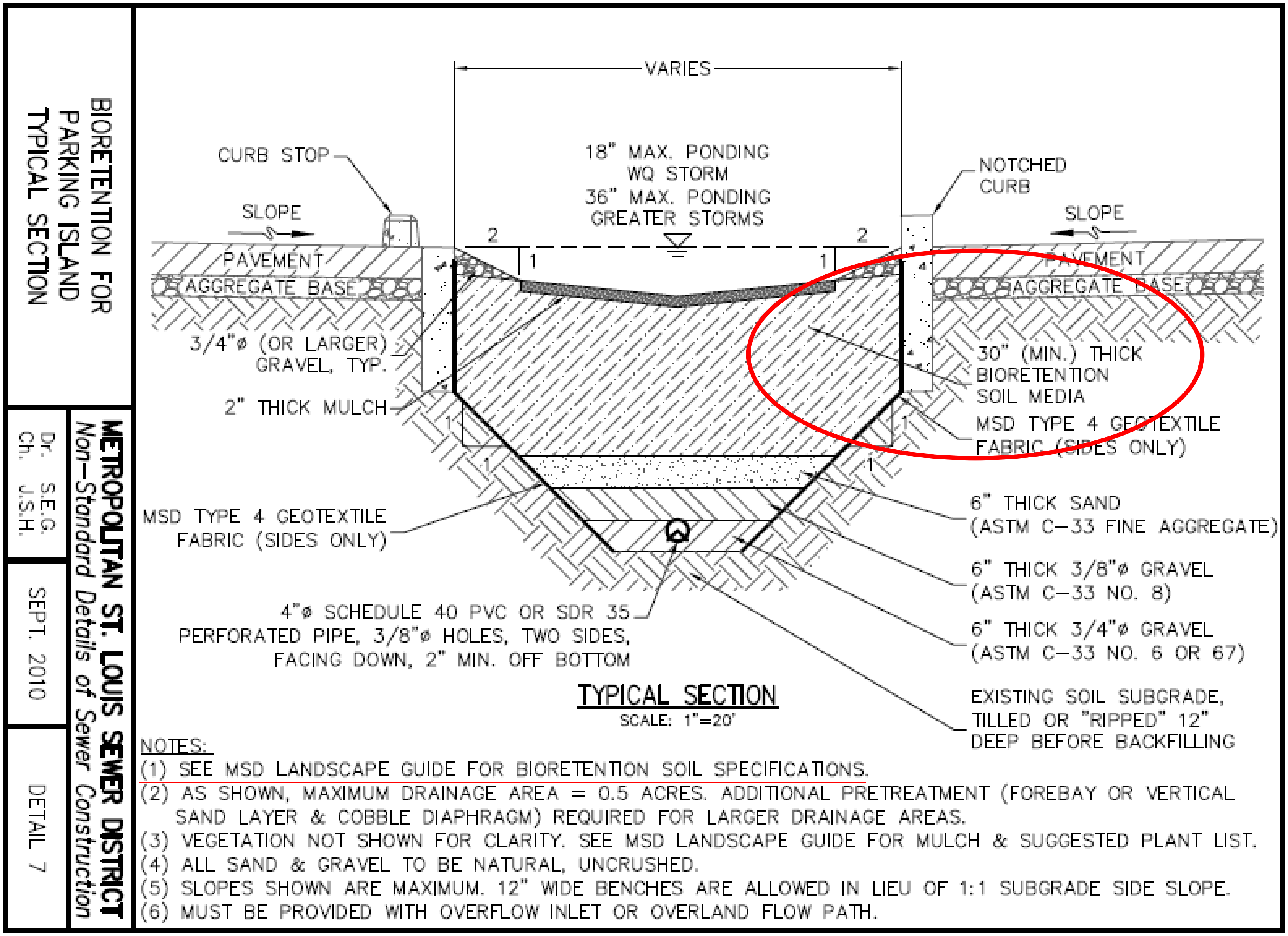
Retrofit Detail

Vegetation

The Landscape Guide for BMPs provides information on vegetating bioretention.

The primary value that vegetation provides is a deep root structure that maintains drainage through the soil media. Vegetation should promote social acceptance: bioretention is a landscape feature, as well as a stormwater BMP.

Parking Lot Detail



MSD Landscape Guide

The planting soil should be a sandy loam or loamy sand (should contain a minimum of 35 to 60 percent sand, by volume). The clay content for these soils should be less than 10 percent by volume. A saturated hydraulic conductivity of at least 1.0 feet per day (0.5 inches per hour) is required. (Without post-construction verification, a conservative default value of 0.5 feet per day is acceptable. The design rate may be increased to 2 feet/day if field observation, post-construction infiltration testing, or other equivalent testing (as determined by the District) is provided to confirm the design rate is achieved.) The soil should be free of stones, stumps, roots, or other woody material over 1 inch in diameter. For best results, brush or seeds from noxious weeds, such as Johnson grass, mugwort, nutsedge and Canadian thistle should not be present in the soils. Placement of the planting soil should be in lifts of 12 to 18 inches, loosely compacted (rubber wheeled heavy equipment and mechanical tamping devices are not recommended for compaction). The specific characteristics are presented in the following table.

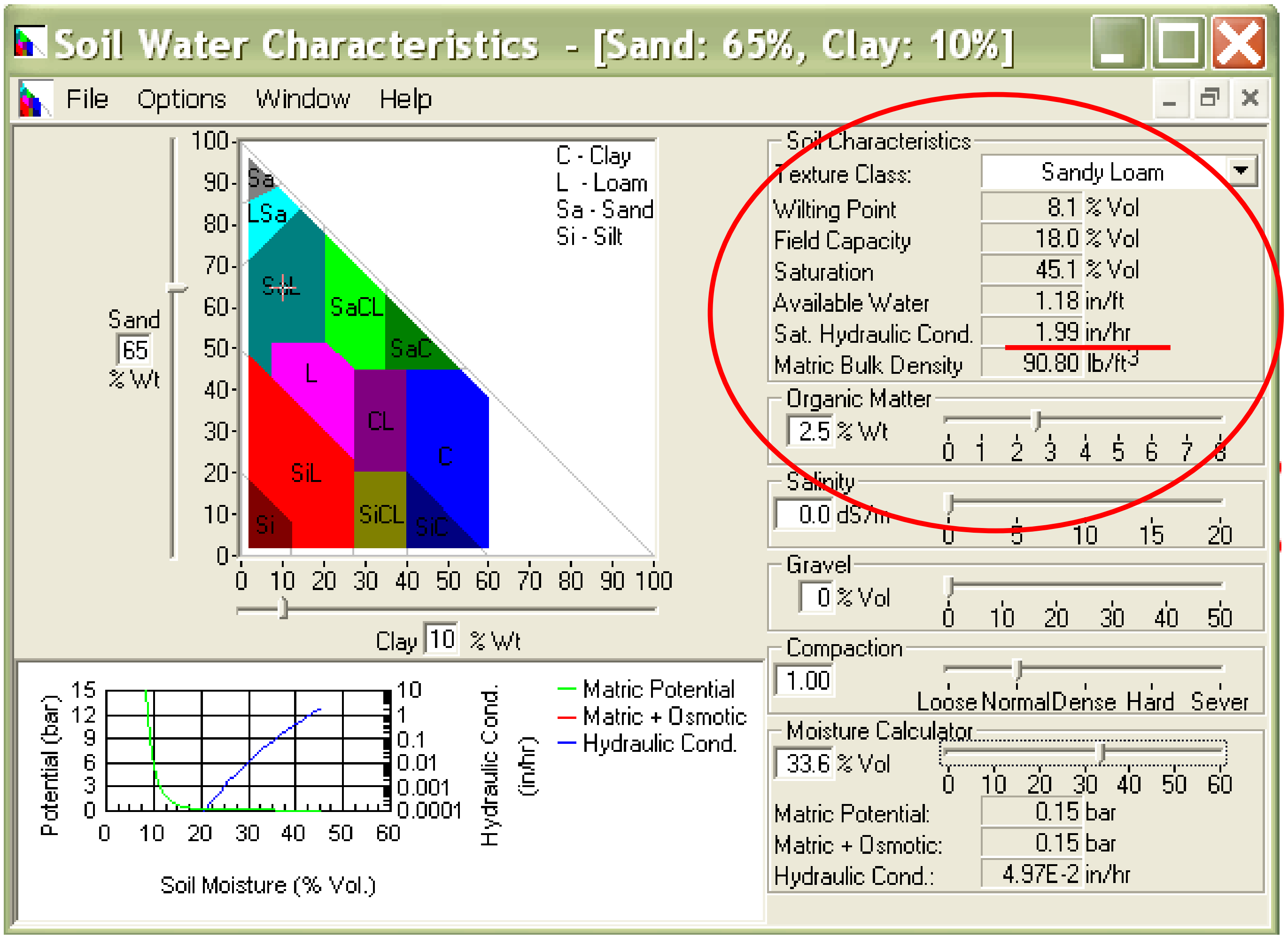
Not Inert Soil!

Table 1: Planting Soil Characteristics. Source: Maryland Stormwater Manual

Parameter	Value
pH range	5.2 to 8.00
Organic matter	1.5 to 5.0%
Magnesium	35 lbs. per acre, minimum
Phosphorus (P_2O_5)	75 lbs. per acre, minimum
Potassium (K_2O)	85 lbs. per acre, minimum
Soluble salts	≤ 500 ppm

Site Specific Mix Design Model: SPAW (Soil Water Characteristics)

ftp://hydrolab.arsusda.gov/pub/incoming/SPAWDownload.html



Bioretention Soil Research

- Bioretention Effectiveness
  - Volume reduction
  - Phosphorous (and other contaminant leaching)
  - Aesthetic value
- Composition
  - "East Coast" soil mix
    - 90% sand, <10% silt and clay, 3-5% organic matter
  - MLG Soil mix
    - 60% sand, <10% clay, 1.5-5% organic matter

Sustainable Soil Media

What if…

- An alternative to sand was available?
- Using this alternative would enhance phosphorous removal?
- A waste product could be recycled?
- AND the alternative was <u>free</u>?