Bioretention Cell in Blacksburg

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Biological Systems Engineering

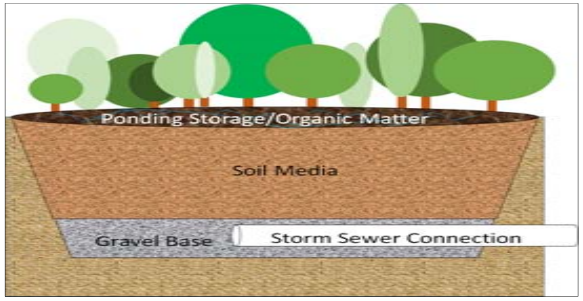
Virginia Tech
Invent the Future

Problem Statement

Stroubles Creek, which runs through Blacksburg, VA, is an impaired tributary of the New River. There is a benthic macro-invertebrate impairment as identified by the EPA TMDL program. The implementation plan for Stroubles Creek includes the 1.2 acre Architecture Annex parking lot. The task is to implement a Best Management Practice (BMP), specifically a bioretention cell, to fully attenuate a two-year, 24 hour duration storm and reduce the peak discharge volume.

What is Bioretention?

Bioretention practices use plants and soil to improve water quality and attenuate water flow. Bioretention cells collect water from small urban drainage areas and filter the water through the soil media. Impervious surfaces increase the rate of runoff to levels greater than the natural water body can handle, causing erosion of the stream bank. Bioretention cells combine attenuation with active pollutant removal, making it a good choice for this site . The filtering process lowers the peak discharge volume of the impervious area closer toward the site's natural condition. The plants and soil mix work together to remove pollutants from the water as it is being filtered through the system.



This is a picture of a typical bioretention cell. Water enters the cell via grading or a water conveyance structure. The water filters through the cell and re-enters the stream through an underdrain underneath the soil mix. Excess water is also able to infiltrate into the native soil, reducing the volume that enters the storm drain network. Some bioretention cells include an overflow structure to divert excess water from pooling.

Standards

Stormwater Runoff Control: NRCS 570
VA DCR Stormwater Design Specification NO. 9: Bioretention
VDOT BMP Design Manual of Practice: Chapter 11 Bioretention

Standards are important for design because they specify how a typical bioretention cell is design. of the bioretention cell to designs that are currently being implemented . Bioretention cells have multiple layers that include an organic layer, a soil layer, and a gravel layer. Depth of the soil layer can range from six inches to three feet. The surface area of the cell should be 5% of the drainage area of the site, allowing for higher volumes of water to be attenuated.

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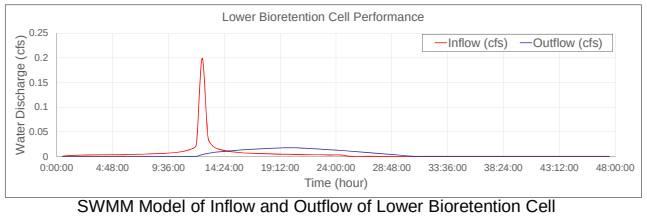
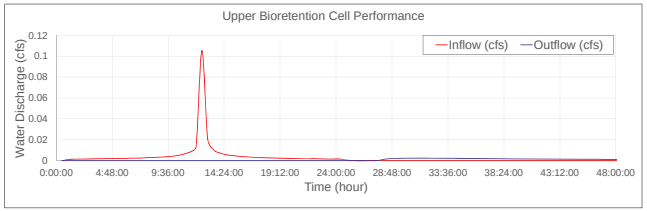
EPA's Storm Water Management Model (SWMM)

Area of the design site parking lot considered in the SWMM mode



SWMM Model of Inflow and Outflow of Lower Bioretention Cell



SWMM Model of Inflow and Outflow of Upper Bioretention Cell

The results of the SWMM model are very promising. With peak outflow rate being lowered and offset from the rainfall peak, it shows that the bioretention cells are able to handle the entirety of a two-year, 24 hour duration Type-II Design Storm. The cells reduce the peak discharge of the parking lot during rain events and move the discharge away from the main rainfall event. This has the greatest effect on reducing stream flow rate and in-stream erosion.

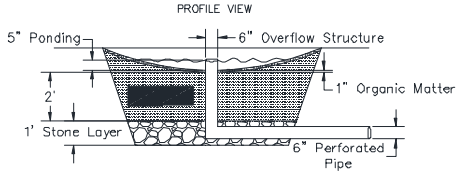
Cost Analysis

Material	Unit Cost	Number of units	Total Cost
Geotextile Fabric	$390 per roll (115x360 feet)	1	$390
Perforated Pipe	$10 per foot	200	$2,000
Soil Media	$25 per ton	256	$6,400
Trench Drain	$75 per foot	45	$3,375
Concrete Curb	$15 per foot	80	$1,200
Gravel Underlayer	$30 per cubic yard	182	$5,460
Sewer Connection	$500 per connection	2	$1,000
Plants	$50 per cluster	320	$16,000
Total			**$34,025**

Site Plan Proposal

Based on the grading of the parking lot, there is a ridge at the northern section of the lot, facilitating the need for two bioretention cells. The pink area represents the drainage toward the Virginia Tech Armory, while the blue area represents the drainage toward Architecture Annex. A trench drain will be installed to divert water from the parking lot into the lower bioretention area. Due to overall grading of the parking lot, the entire parking lot cannot be treated with a landscaped feature. Much of these areas drain directly to the storm drain network with little opportunity to divert to a BMP without grading the parking lot to specifically work in conjunction with the BMP.

AutoCAD Design Drawing



The cell is 120 feet long so the plan view will not fit on the poster.

Planting Schedule

Upper Site Qty	Lower Site Qty	Common	Botanical	Zone	Size	Photo
3	5	Soft Rush	Juncus effusus	Lower	12"-18"	
3	5	Iris Lousiana		Lower	12"-18"	
5	8	Black-eyed Susan	Rudbeckia fulgida "Goldstrum"	Mid	12"-18"	
5	8	Little Joe - Joe Pye Weed	Eupatorium purpureum 'Little Joe'	Mid	18"-24"	
5	8	Summersweet	Clethera alnlfolla	Upper	18"-24"	
5	8	Monkey Grass	liriope variegated	Upper	12"-18"	