Low Impact Development Best Management Practices Implementation Plan

Submitted to

SW Illinois Resource Conservation & Development
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By

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DRAFT LOW IMPACT DEVELOPMENT
BEST MANAGEMENT PRACTICES CONSTRUCTION PLAN
Rock Hill Trails Subdivision, Wood River, Illinois

INTRODUCTION

This document provides information about Alternative Stormwater Best Management Practices (BMPs) that will be incorporated into the landscape features of the Rock Hill Trails Development at Wood River, Illinois. These BMPs meet the criteria for stormwater runoff and non-point source pollutant control as required by the Illinois Environmental Protection Agency (IEPA). The BMPs described in this document are just a few of many that will dominate the landscape features of Rock Hill Trails.

In 2000, the Wellspring Development Company began consideration of developing this property for residential and/or commercial uses. The company was formed by Chris, Anthony, and Barbara Schroeder to pursue sustainable development projects. Wanting to conserve natural resources on the property, the company made a significant investment in learning about the concept of low impact development. The learning process involved participation in numerous national and international workshops and conferences, a comprehensive design project with a team of students and researchers at the University of Illinois, engagement of internationally recognized experts on low impact developments, countless meetings with state and local stakeholders, as well as internal planning retreats.

This new development includes substantial open green space within which native landscaping, including restoration of native prairie, wetlands, and riparian areas will be completed. Minimal site grading is planned, and building lots will be platted in higher areas out of natural drainage features. Figure 1 depicts one of the original design strategies for the entire development (inclusive of Phases 1, 2, and 3).

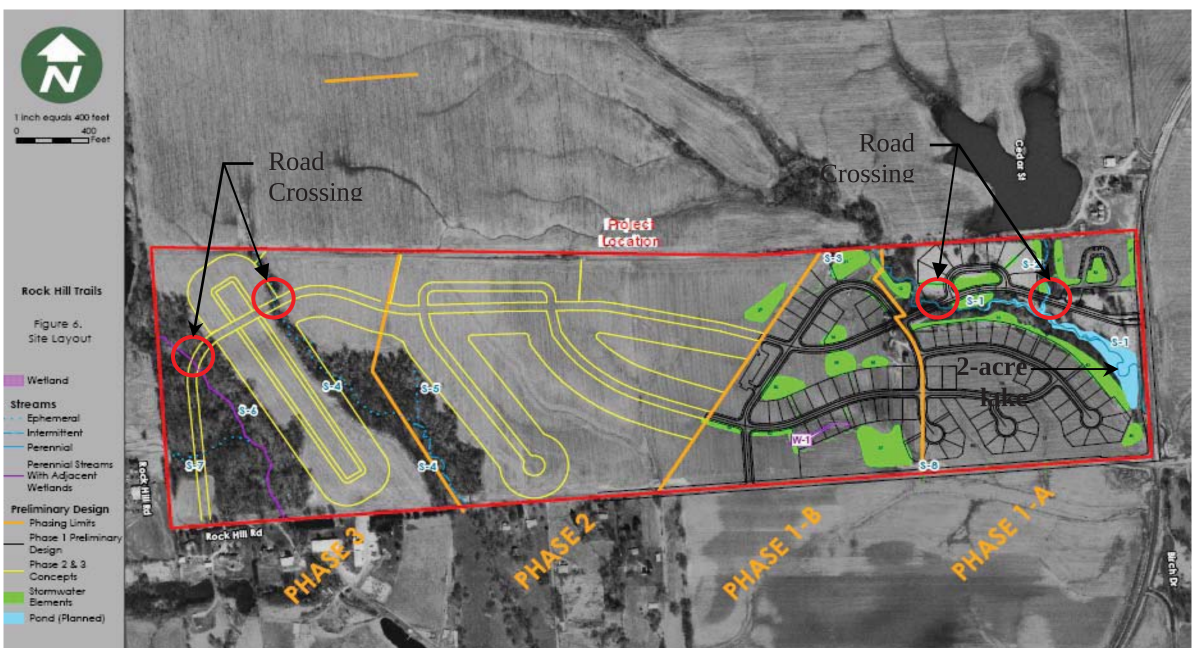

Figure 1: Property Map and Plan

The design of this development includes lots that remain on higher ground, retaining the natural drainage of the land. Constructed wetlands, open space, and riparian areas are restored and conserved as described above.

The development will manage non-permeable surface rainwater runoff in the following ways:

- From rooftops, the water will first be diverted into underground cisterns located on each home site. Once these cisterns are full the water will then be allowed to run onto the ground and into rain gardens located in the back yards of each home site. These rain gardens will be designed to filter the water and allow it to infiltrate into the soil.

- In circumstances of heavy rain when the cisterns and rain gardens reach their capacity, the water will flow into vegetated swales that will transport the water to planned drainage basins and wetlands. Vegetated swales will lie in the natural water flow patterns that existed on the site prior to development. Stormwater will be collected in smaller detention areas designed to hold the water for up to 48 hours if necessary, allowing it to gradually infiltrate into the soil and replenish the aquifer with clean naturally filtered water.

- Rainwater from streets and other non-permeable surfaces will enter bioswales located between the streets and homes, being directed across common areas where homes are not present. At a few locations where there is not enough space to have the runoff flow directly into a rain garden or vegetated swale, the water will be directed through curb and gutter to a location on site where it will be allowed to flow over a large open common prairie, or enter one of the planned water management areas that include constructed, restored wetlands or wet prairies.

The development includes construction of at least three wetlands and one pond for detaining stormwater flow, designed to reduce stormwater discharge to pre-development conditions. The wetlands and pond are designed to be both functional and to provide open space with trails for common use by residents as well as wildlife habitat.

The development will feature streets designed to minimize the amount of impermeable surface and keep traffic speeds at a safe, pedestrian-friendly pace, while accommodating the needs of emergency services and city maintenance. The majority of the rainwater runoff will be absorbed and filtered through bioswales and rain gardens that will line the streets.

Rock Hill Trails will promote natural landscape restoration and management through:

- Native landscaping to increase and highlight natural wildlife habitat and to reduce water consumption.

- Capture and treat excess water runoff on site by natural means:
    - Maximize rain gardens and bio-retention areas.
    - Use biowales lining streets to capture stormwater where it falls, facilitating infiltration and slow conveyance to wetland detention areas.
    - Re-create natural filtering systems through native plantings.
- Irrigate private lawns and gardens with roof water captured in cisterns.
- Implement a program for tree preservation and planting.

Riparian areas are an important feature of the Rock Hill Trails Development. Open streams, including both perennial and intermittent, will be restored and conserved in their natural state. The stream coursing through the northeast corner of the site will be restored to stabilize flow and bank conditions. A two-acre pond is planned for the lower reach of the stream, converting the stream to an aquatic feature that will enhance aquatic habitat as well as improve shoreline vegetation with native trees and grasses as opposed to existing overgrowth of invasive species. The stream on the west end of the development will also be restored, including bank stabilization and restoration, and cleaning the excessive, non-native vegetative growth. Impacts to these streams include culverts where roads will be constructed over the stream channels. Impacts to the streams will be less than 0.10 acres at each crossing.

Creation and/or restoration of wetlands are also an important component of the Rock Hill Trails community. Currently, wetland features on the site, including both streams and wetlands, occupy approximately 4.2 acres across the entire development site. Impacts to streams and wetlands are anticipated to total approximately 0.20 acres spread across several different locations. In addition to conserving existing stream and wetland features, this alternative will result in the construction of approximately 7.22 acres of wetland features in Phase 1 of the development alone, including inundated wetlands, wet meadows, and stormwater best management practices such as raingardens, bioretention cells, and vegetated filters and swales. Phase 2 and Phase 3 will most certainly increase the amount of constructed wetland features on the property.

This alternative provides several benefits, including development for residential and limited commercial use in combination with restoration of native landscapes, improvement of water quality, improved stormwater management, and restoration of the sites riparian and wetland features. The stormwater management plan for Rock Hill Trails is designed to reduce runoff discharge to below pre-development conditions, minimizing impacts to off-site water resources.

Ten different BMPs that will be featured for demonstration of the effectiveness of alternative stormwater management at Rock Hill Trails are described, including:

1. Rain Gardens
2. Filter Strips
3. Vegetated Swales
4. Wet Meadows
5. Bioretention Cells
6. Constructed Wetlands
7. Pervious Pavement
8. Recessed Street and Parking Lot Islands
9. Rain Barrels and Cisterns
10. Retention Pond

BMP SELECTION

Most of the BMPs will be used at multiple locations in the development, and in many cases in combination with other BMPs to provide a comprehensive system for controlling and cleansing runoff emanating from the neighborhood. The BMPs selected for the development are part of the stormwater management engineering design, and included the following criteria:

- Location in the neighborhood, including proximity to housing, parking lots, or open space.
- The amount of space available.
- The size of the stormwater runoff catchment.
- The effectiveness of each BMP to achieve water quality treatment goals.

The stormwater management design provided calculations of runoff volumes and where runoff can be captured and stored, maintaining runoff quantity and quality at or better than pre-development levels.

Our presentation of BMPs that will be used at Rock Hill Trails does not include the native landscape features that will be restored in general open areas of the development. Native plants and soils in themselves provide excellent stormwater runoff control. The combination of native landscapes with alternative stormwater BMPs will result in reductions in stormwater runoff volumes to near native conditions, and certainly less than currently exists at the site. Equally important, these features will provide enhanced wildlife habitat and community enhancement in Wood River.

To assure public awareness of the BMPs, signage describing each BMP, its function, and acknowledgement of funding from the Illinois Environmental Protection Agency will be featured at each BMP site.

BMP PERFORMANCE ASSESSMENT

The pollutant removal efficiencies for each BMP that will be demonstrated at Rock Hill Trails was calculated using the Illinois Environmental Protection Agency (IEPA) 2007 Load Reduction Estimator Model. Using this model, we assumed urban runoff conditions (as opposed to agricultural) for residential settings, and non-sewered stormwater runoff. Table 1 summarizes the results of the model, showing the estimated removal efficiencies for nitrogen (N), phosphorus (P), biological oxygen demand (BOD), and sediment.

Table 1: Summary of Pollutant Removal Efficiencies for Selected BMPs lbs/acre/yr

BMP	N Reduction			P Reduction			BOD Reduction			Sed Reduction		
	Pre	Post	Amt red	Pre	Post	Amt red	Pre	Post	Amt red	Pre	Post	Amt red
Rain Gardens (infiltration device)	3	U	U	0	0	0	11	2	9	159	9	145
Vegetated Filter	3	2	1	0	0	0	11	5	6	154	42	112

Table 1: Summary of Pollutant Removal Efficiencies for Selected BMPs
lbs/acre/yr

BMP	N Reduction			P Reduction			BOD Reduction			Sed Reduction		
Vegetated Swale (grass swale)	3	2	0	0	0	0	11	8	3	154	54	100
Wet Meadow (dry detention)	3	2	1	0	0	0	11	8	3	154	65	89
Bioretention cell (infiltration device)	3	U	U	0	0	0	11	2	9	154	9	145
Constructed Wetland	3	2	1	0	0	0	11	4	7	154	35	119
Pervious Pavement	3	0	3	0	0	0	11	U	U	154	15	139
Recessed Street Island	3	U	U	0	0	0	11	2	9	154	9	145
Rain Barrels/Cisterns*	1	1	0	0	0	0	3	U	U	39	15	23
Detention Pond	3	2	1	0	0	0	11	U	U	154	62	92

* Rain Barrels/Cisterns were modeled using the "wet pond" classification, and assumed collection of runoff from as much as 0.25 acres.

"Pre" means pre-treatment concentration of the stated compound.
"Post" means the post-treatment concentration of the stated compound.
"Amt red" is the amount of compound removed from the stormwater stream.

To supplement the results of the IEPA 2007 Load Reduction Estimator Model, we also conducted an assessment of pollutant removal efficiencies using the U.S. Environmental Protection Agency's (USEPA) Spreadsheet Tool for Estimating Pollutant Load (STEPL) model. The STEPL model employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs). The STEPL model was provided specific conditions for Madison County, Illinois, the location of Rock Hill Trails. Table 2 summarizes the results of the STEPL model.

Table 2: Summary of Pollutant Removal Efficiencies for Selected BMPs using the USEPA STEPL Model

BMP	%N Reduction	%P Reduction	%BOD Reduction	%Sed Reduction
Rain Gardens	35.0	26.7	37.9	66.7
Vegetated Filter	27.8	27.7	38.2	53.1
Vegetated Swale	32.6	69.1	0.0	3.7
Wet Meadow	9.7	29.9	7.1	81.8
Bioretention cell	21.3	43.0	0.0	2.4
Constructed Wetland	12.4	26.4	37.9	48.2

Table 2: Summary of Pollutant Removal Efficiencies for Selected BMPs using the USEPA STEPL Model				
BMP	%N Reduction	%P Reduction	%BOD Reduction	%Sed Reduction
Pervious Pavement	18.8	13.2	0.0	17.7
Recessed Street Island	50.0	50.0	70.0	90.0
Rain Barrels/Cisterns	18.0	18.0	18.0	18.0
Detention Pond	28.0	35.0	0.0	47.2

It must be noted that pollutant removal efficiencies using both load reduction estimating models are gross estimates, and both models present substantially different results. Actual removal efficiencies will vary based on site specific conditions and with time. In addition, more detailed environmental chemistry evaluation would suggest that the removal efficiencies for these pollutant parameters will likely be much greater than what is listed in the tables. Because many of these BMPs will be constructed in sequence within drainage pathways, and in combination with other native landscape features, the reduction of pollutants in stormwater discharging from Rock Hill Trails is expected to be significant.

BMP MAINTENANCE AND MONITORING

Maintenance and monitoring of all BMPs constructed at Rock Hill Trails is an important requirement of the stormwater management program. Maintenance is most important during the first two years after establishment of each BMP to assure that both the biological and the water quality functions are successful. After two years, periodic maintenance is appropriate, mostly for removal of trash, thinning some vegetative growth, and removal of invasive species. A Draft Establishment and Maintenance Manual for Rock Hill Trails is provided in Appendix B. This manual will be available for both the Home Owner's Association and individual homeowners for maintenance of BMPs established in the neighborhood, and of native vegetation that will be a primary feature throughout the development.

The life span of all of the BMPs demonstrated at Rock Hill Trails, with the exception of pervious pavement, cisterns, and rain barrels, is indefinite. Because the BMPs are natural systems utilizing native soil conditions and vegetation, they are expected to be self sustaining with time as long as site conditions remain as currently designed. Regular maintenance requirements will actually decrease with time, although it is expected that periodic removal of excess plant material – both living and dead – will be required to optimize BMP performance, condition, and aesthetics.

BMP DESCRIPTIONS AND ESTIMATED COSTS

All of the BMPs presented in this document are well suited and applicable for Rock Hill Trails. The information describes why the BMP was selected, where it will be located, and estimated incremental costs for construction of each BMP above standard landscape approaches. A map of where BMPs will be located is provided on the next page, followed by Table 3: Summary of Estimated BMP Costs that lists incremental cost increases for construction of the BMPs as features of Rock Hill Trails. Descriptions of each BMP type are provided on the pages following the BMP Map and Cost Summary Table.

DESIGN DETAILS

Design details are provided for the bioretention cell, street island, vegetated swale, constructed wetland, and rain garden in Appendix A.

These design elements demonstrate the sizing and geometry of the BMPs that will be featured at Rock Hill Trails. BMP designs for Pervious Pavement and the detention pond are not available at this time. Design details for rain barrels and cisterns will accompany designs for the first homes that will be built in the development. Designs for vegetated filter strips and wet meadows follow the establishment guidelines provided in the Draft Establishment and Maintenance Manual. All designs completed to date have been prepared by and stamped by Professional Engineers.


Rain Gardens
Recessed Islands
Constructed Wetland
Rain Garden
Retention Pond
Wet Meadow
Pervious Pavement
Vegetated Swale
Filter Strip
Sub-Watershed
Stormwater Management Area
0 100' 200' 400'
SCALE: 1"= 200'
NORTH
Revisions:
Stormwater Management Concept Plan
Drawn By: MBW
Checked:
Approved:
AES Project No.: 07-0422
File Name: 071907_prelim_plat.dwg
Date: 07-24-07
Rock Hill Trails
Alton, Illinois
Wellspring Development Company
Wood River, Illinois
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Table 3: Summary of Estimated BMP Costs						
BMP Number	Description	Est. Baseline	Design Cost (incl permits)	Implementation Cost	Total Est. Cost	Incremental Cost Increase
1	Rain Gardens (3)					
2	Vegetated Filter Strip					
3	Vegetated Swales					
4	Bioretention Cell					
5	Wet Meadows					
6	Constructed (Treatment) Wetland					
7	Pervious Pavement					
8	Recessed Parking & Street Islands (3)					
9	Rain Barrels & Cisterns					
10	Detention Pond – Partial Expenses					
	Total					

Assumptions:
1. Baseline consists of turfgrass vegetation only, started from seed (except pervious pavement, which assumes two-inch concrete driveways).
2. Design costs include obtaining Corps of Engineers and State of Illinois permits as necessary.

BMP CONSTRUCTION

During late fall 2007 through spring and summer of 2008, native vegetation will be seeded and/or planted in areas of the Rock Hill Trails development (Phase I) that will be common area. In addition, grading of the landscape, limited to streets and some home sites, will begin where wetlands and streams will not be impacted. Grading will generally follow the contour features developed for the site by the development engineers with SMS Engineers and Applied Ecological Services. With this grading, roadside swales will be roughly formed.

General BMP construction will be accomplished as described below:

Rain Gardens: Specific rain garden design, including rain garden dimensions, subsoil materials and planting plan specific for the rain garden site will be completed before any construction begins. Sizing of the rain garden has been established in the stormwater management plan to capture and treat the two-year rain event. Specific dimensions will be determined in the final plan. Construction will be completed with light earth moving equipment (e.g. Bobcat and/or small backhoe) to excavate the rain garden, fill materials will be placed, if necessary, and the garden planted with appropriate, desired vegetation. Vegetation will include a mix of wetland or facultative wetland vegetation in the base, with prairie forbs (flowers) and grasses along the berms. The rain garden will be positioned to capture directed surface flow of stormwater runoff from higher topographic elevations within the catchment area.

Filter Strips: A filter strip will be constructed near the bottom of a slope below multi-family housing planned for the northeast corner of Rock Hill Trails (Figure 1). The filter strip will be a planted garden of native vegetation with a small berm (size?) on the downhill side to detain stormwater runoff, allowing infiltration to occur. The filter strip will be sized to collect stormwater from the multi-family units and adjacent lawns. Construction will follow general landscaping procedures following grading specifications for development of contours. Vegetation will include native grasses and forbs. Mulch will cover bare ground areas to minimize possible erosion and to retain soil moisture during dry periods.

Vegetated Swales: vegetated swales will be constructed adjacent to lots in the north section of Phase Ia of Rock Hill Trails. The swales will convey stormwater runoff downhill to a bioretention cell nearby. Grading of the swales will follow the engineering design established for the development grading plan, and will occur when the residential lot is graded for home construction. During construction of the houses, the swale will include a berm to collect and detain stormwater runoff and collect sediments from being carried off of the lot. When construction is completed, the swales will be planted to native vegetation that includes prairie grasses and forbs.

Wet Meadows: A wet meadow will be constructed and planted in the open area behind lots 33 and 34 in the central portion of Phase 1a of Rock Hill Trails. The area will include a shallow berm to detain stormwater runoff, and an overflow weir that will allow excess water to drain to the south and a constructed wetland. Shaping of the wet meadow will occur with grading of the open area early during the site development process. When permitted by regulatory agencies, the berm will be constructed by moving/grading soil. Prairie vegetation (grasses and forbs) will be planted in mid- to late-spring.

Bioretention Cells: A bioretention cell will be constructed in the street island in front of lots 1 to 10 on the north side of Phase 1a of Rock Hill Trails. Sizing of the bioretention cell has been established in the stormwater management plan for Rock Hill Trails. Final shape and dimensions will be provided on final construction plans for the unit. Construction of the bioretention cell will not occur until street construction has been completed. Construction will require excavation to the designed depth and shape. Sub-drains will be placed, and backfill material placed to a depth that leaves a shallow depression that will capture runoff from a typical two-year storm event. Vegetation will include native species similar in composition to those used for the rain gardens.

Constructed Wetlands: A wetland will be constructed on the south side of Phase 1a of Rock Hill Trails to capture, detain, and treat stormwater before it leaves the site under Rock Hill Road. Construction will begin completed as specified in the engineering design and occur after the Corps of Engineers 404 permit has been approved. After the wetland has been excavated, graded, and berms built to specifications, an overflow weir will be constructed to control water depth. Following completion of the base grading, berm construction, and weir emplacement, the wetland will be planted to wetland vegetation and wet facultative prairie grasses in the late spring.

Pervious Pavement: Pervious pavement will be demonstrated on the driveways of two of the model homes on lots 1 through 10. Pervious pavement will be installed after construction of the model homes is complete. The pavement will consist of either porous asphalt or pervious paving blocks placed over a porous base of one-inch rock according to final design specifications. Water will drain below the driveway to the bioretention cell in the street island.

Recessed Street Islands: Recessed street islands will be constructed in the cul-de-sac circles on the south side of Phase 1a of Rock Hill Trails. The recessed street islands are similar to the bioretention cell in structure, the primary difference by location and size. The street island will be bordered by a ribbon curb that will allow surface runoff from the street to flow into the island and infiltrate into the soil. A sub-drain will facilitate drainage of excess water to one of the constructed wetlands nearby.

Rain Barrels and Cisterns: Rain barrels and cisterns will be constructed in the yards of two of the model homes on lots 1 through 10. Rain barrels will be placed at downspouts, and ciserns constructed below ground in locations specified in the final house design. Construction will occur with construction of the houses.

Retention Pond: A retention pond will be constructed by damming the stream on the east end of Rock Hill Trails. The dam will be constructed if permitted by the Corps, with engineering specifications for the damn meeting all Federal and State requirements. The detention pond is expected to occupy approximately two acres.

PERMIT REQUIREMENTS

Because of potential impacts and/or modifications to a tributary stream and wetlands at Rock Hill Trails, a U.S. Army Corps of Engineers Section 404 permit that is submitted as a joint application the State of Illinois is required before construction can begin. This joint application for a 404 permit was submitted to the Corps of Engineers and the Illinois EPA in September 2007. In addition, the Combined Review Consultation Process and Interagency Wetlands Policy review, and the threatened and endangered species surveys have been submitted to the Illinois Department of Natural Resources.

BMP DESCRIPTIONS

1. Rain Garden

Description	A rain garden consists of a relatively small depression planted with native wetland and prairie vegetation (rather than a turfgrass lawn) where sheet flow runoff collects and infiltrates. Rain gardens function similar to larger-scale bioretention areas. Typical sites for rain gardens include residential yards and community common areas.
Rock Hill Trails Location	Rain gardens will be built near the bottom of slopes in the multi-family housing area on the northeast portion of the development as shown on the BMP Map, and at the southeast corner of the development. These locations were selected to intercept stormwater runoff at the bottom of slopes, allowing maximum infiltration. Three rain gardens will cover approximately 7,000 sq. ft.

Estimated Cost	Est. Baseline	Design Cost	Implementation Cost	TotalEst. Cost	Incremental Cost Increase

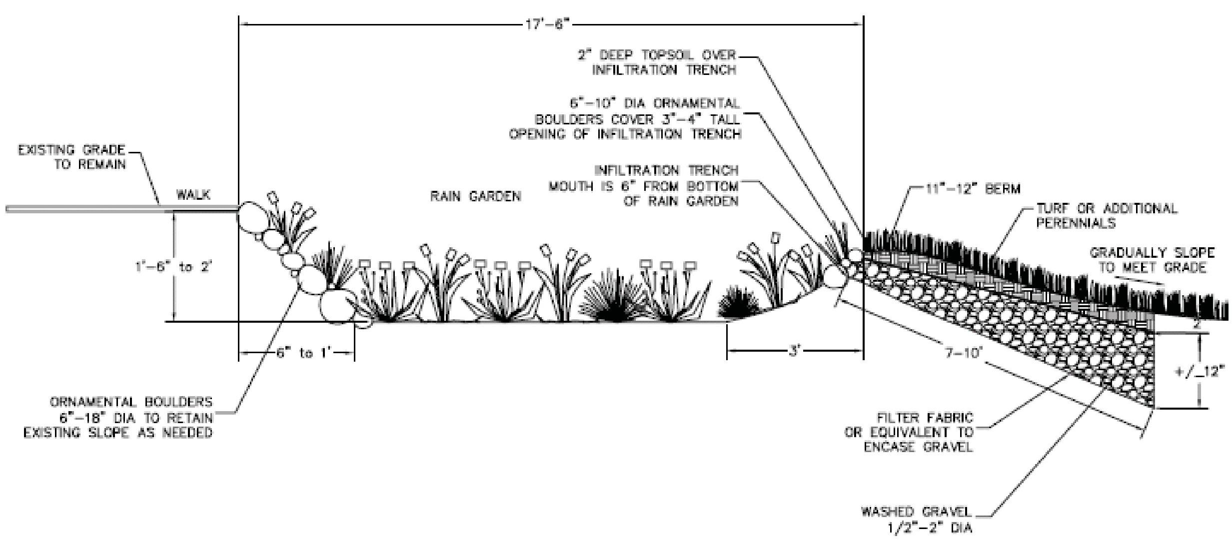
Effectiveness	Raingardens are effective in removing from 30 to 90 percent of nutrients (such and nitrogen and phosphorus) and up to 80 percent of sediments as well as rducing runoff volumes. Estimated removal efficiencies are (IEPA 2007 Load Reduction Estimate on top, USEPA STEPL on bottom):

	N Reduction			P Reduction			BOD Reduction			Sed Reduction		
	3	U	U	0	0	0	11	2	9	154	9	145
	35.0 %			26.7 %			37.9 %			66.7 %		

Advantages

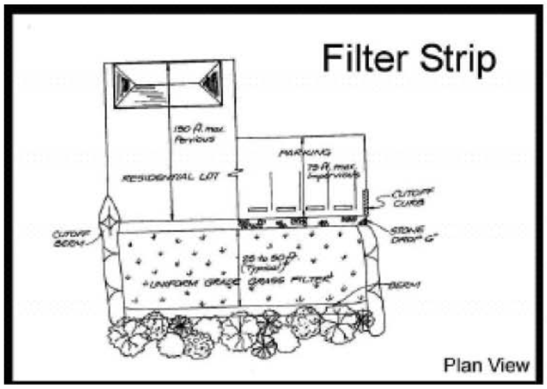
- Provides localized stormwater control by collecting and storing water, allowing water infiltration into the soil.
- Improves water quality by filtering pollutants from stormwater.
- Easy to plan and build.
- Aesthetically pleasing.
- Flexible to incorporate existing natural features.
- Preserves natural/native vegetation.

Implementation Considerations	• The ponding depth of a rain garden is typically 4 to 6 inches. • Limit ponding in the depressional area to 3 days or less to avoid nuisance insects. • Line the depressional area with a mulch and organic layer in which vegetation is planted. • The mulch holds moisture and aids removal of metals. • Underneath the mulch and organic layer is the planting soil. • Place rain gardens a minimum of 10 feet away from building foundations. • Placement of the rain garden and overflow path will not interfere with adjoining property drainage patterns. • Rain gardens should not be located in areas where ponded water may create problems for surrounding vegetation or land use.
Main Design Components	• Ponding depths restricted to 6 inches or less. • The planting soil should be a mixture of sand, loam, and clay to provide water and nutrients to the plants. • Native species that are tolerant of both wet and dry cycles will be used. • Modify soil with compost to increase permeability. • Provide a drain tile system if soil permeability is a problem. • Maintenance, including mowing and weeding, is typically required two times a year.



Example Cross Section of a Rain Garden with Infiltration Trench Connection

2. Filter Strip



Description

Filter Strips are densely-vegetated, often grassed practices that accept sheet flow runoff from adjacent surfaces. They slow runoff; filter out sediment and other pollutants; and enhance infiltration of surface water runoff. Use filter strips to treat shallow sheet flows and evenly distribute storm flows over very short contributing distance areas. Filter strips are well suited to areas adjacent to parking lots and other impervious surfaces where runoff can be conveyed and filtered before it is discharged into swales, stormwater systems, or surface water bodies. Filter strips are also appropriate for construction sites and developing land to filter sediment from overland sheet flow.

Well maintained filter strips can be very effective in reducing runoff volumes, particularly when the impervious drainage area is not overly large. Filter strips are most effective in reducing surface runoff volumes – by up to 40 percent – for small storm events (storms up to the magnitude that may occur, on average, once every year or every other year).

Rock Hill Trails Location

A vegetated filter strip will be located near the base of the slope west of the multi-family housing, as shown on the BMP Map. This site was selected to intercept stormwater runoff coming downhill from the housing units. The filter strip is estimated to occupy an area of about 3,800 sq. ft.

Estimated Cost

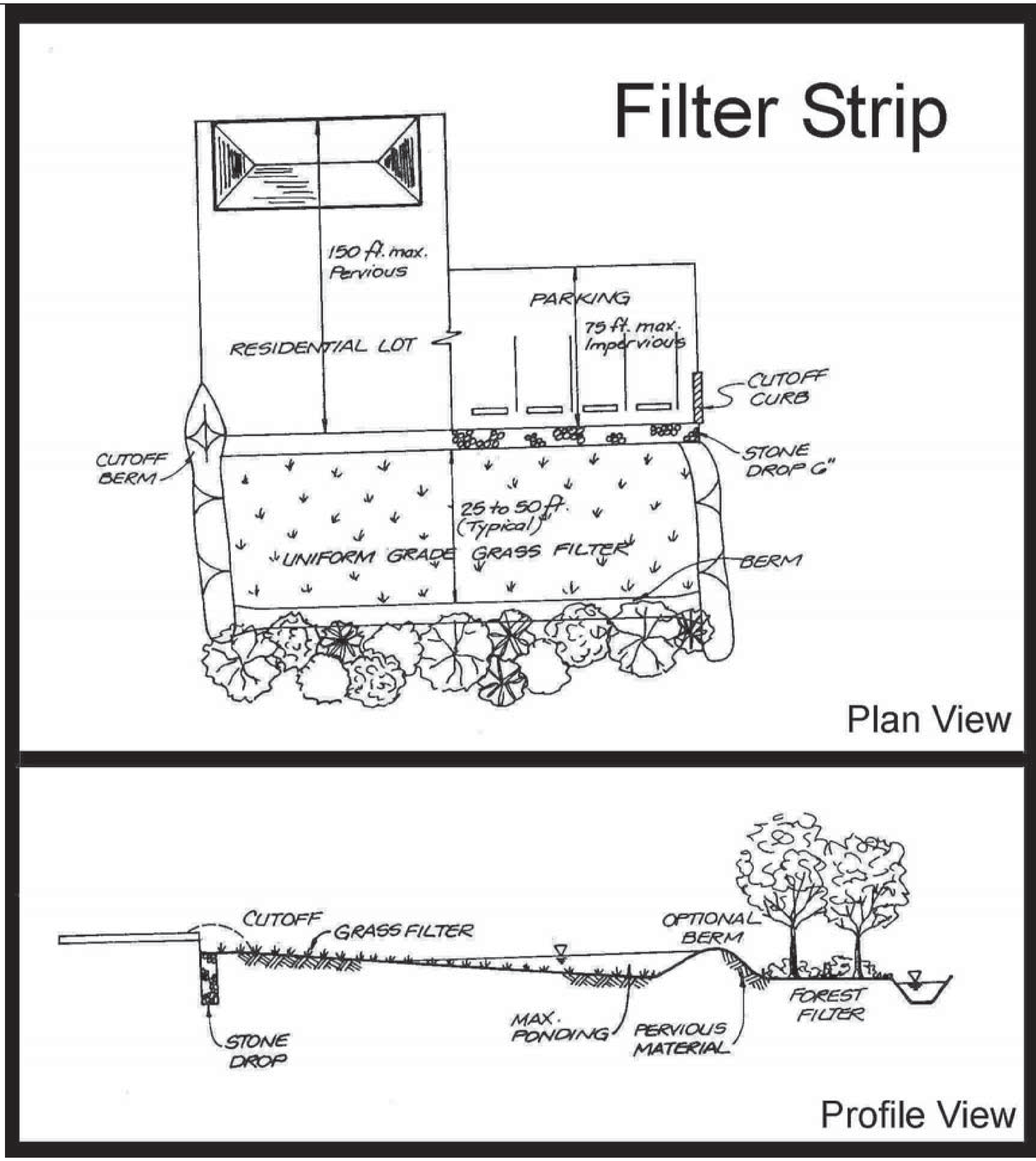
Est. Baseline	Design Cost	Implementation Cost	Total Est. Cost	Incremental Cost Increase

Effectiveness

Depending on the type of vegetation and the size of the filter strip, effectiveness of this BMP will vary. Filter strips with dense, high vegetation can remove up to 80 percent of suspended solids. Estimated removal efficiencies are:

N Reduction			P Reduction			BOD Reduction			Sed Reduction		
3	2	1	0	0	0	11	2	9	154	9	145
27.8			27.7			38.2			53.1		

Advantages	• Provides effective stormwater flood control by slowing down runoff and storing water, including water infiltration into the soil. • Improves water quality by filtering pollutants from stormwater. • Can be used as a system by itself, or in conjunction with other BMPs. • Easy to plan and build. • Reduces erosion. • May help maintain temperature of receiving waters. • Flexible to incorporate existing natural features and a variety of vegetation types. • Preserves natural/native vegetation and provides habitat for wildlife. • Protects adjacent properties.
Implementation Considerations	• The maximum drainage area into the filter strip will not be greater than 5 acres. • The filter strip width (dimension perpendicular to the flow path) should be as close to the width of the impervious area flowing into the filter strip as practical. • The filter strip length (dimension parallel to flow) depends on the filter strip width and drainage area. • The maximum slope of a filter strip will not exceed 6 percent, unless additional flow spreader devices are installed every 100 feet to maintain sheet flow.
Main Design Components	• Top and toe of slope should be as flat as possible to encourage sheet flow. • Concentrated flow should not be discharged into filter strips. If flow are concentrated, a level spreader should be included to spread the flow over the entire length of the filter strip. • Plants that are able to withstand flowing water and both wet and dry periods will be used for the filter strips. • Filter strips are typically designed to handle flows from 1- to 2-year storm events and are usually not able to reduce flows from larger storms.



Typical design elements for a filter strip.
Source: APWA 5600 BMP Guidance

3. Vegetated Swale

Description

Vegetated swales are basically a filter strip located along a gentle ditch known as a “swale”. Swales have gently sloping sides and are used to convey the overland flow of stormwater down a subtle gradient. Swales accomplish many of the same functions provided by filter strips (slowing and cleaning water, encouraging infiltration, etc.), while also providing directed conveyance. This conveyance function is particularly important when managing concentrated flows and during severe storm events when stormwater needs to be directed to a destination, such as a wetland.

Rock Hill Trails Location

Vegetated swales will be located between residences, in drainages at the base of slopes, and along roadways, as depicted on the BMP Map, where stormwater will be channeled to other BMPs. There will be four vegetated swales constructed, occupying an area of approximately 3,960 sq. ft.

Estimated Cost

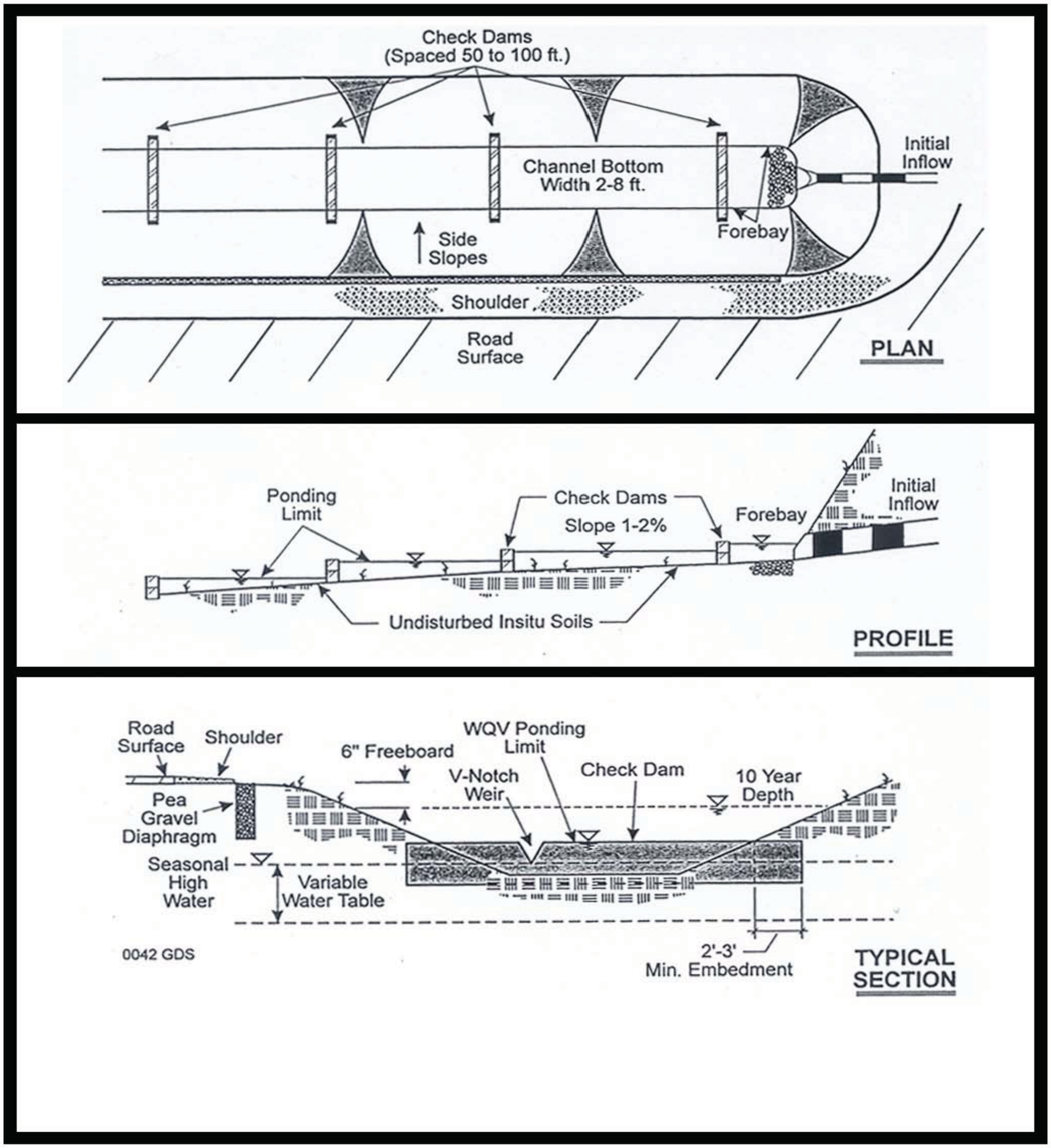
Est. Baseline	Design Cost	Implementation Cost	Total Est. Cost	Incremental Cost Increase

Effectiveness

Vegetated bioswales are effective in slowing stormwater and reducing significant amounts of runoff. Removal of sediments and pollutants is high, ranging from 20 to 40 percent, but removal rates have been reported to exceed 80 percent (USEPA, 1999). Estimated removal efficiencies are (IEPA 2007 Load Reduction Estimate on top, USEPA STEPL on bottom):

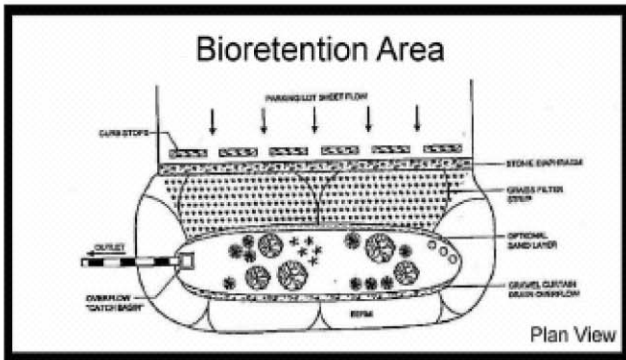
N Reduction			P Reduction			BOD Reduction			Sed Reduction		
3	3	0	0	0	0	11	8	3	154	54	100
32.6 %			69.1 %			0.0 %			3.7 %		

Advantages	• Provides effective stormwater flood control by slowing down runoff and storing water, including water infiltration into the soil. • Improves water quality by filtering pollutants from stormwater (oils, greases, metals, and sediments that can be picked up from paved surfaces). • Can be used as a system by itself or in conjunction with other Best Management Practices. • Reduces erosion. • Flexible to incorporate existing natural features. • Preserves natural/native vegetation and provides habitat for wildlife. • Although periodic cleaning may be required, swales should never need to be replaced, in contrast to conventional stormwater systems.
Implementation Considerations	• Public outreach and acceptance for existing developments or communities. • Extent of drainage area. • Demonstration of improved property values and cost of development with implementation of the Stormwater Treatment Train. • Planning and engineering of effective treatment train appropriate for each area. • Determine the necessary space and length to achieve stormwater management goals and water quality.
Main Design Components	• Individual swales will be designed to treat relatively small, flat drainage areas. • The bottom of the swale will be at least three feet above groundwater in order to prevent the swale bottom from remaining too wet. • The swale will typically have trapezoidal or parabolic cross section with relatively flat side slopes (less than 3:1). • The flat channel bottom will typically be between two and eight feet wide to ensure sufficient filtering surface for water quality treatment.



Typical design elements of a vegetated swale
Source: APWA 5600 BMP Guidance Manual

4. Bioretention Cell



Description	Bioretention areas are soil- and plant-based stormwater management practices that filter runoff from developed sites by mimicking natural vegetated systems; these naturally control hydrology through infiltration and evapotranspiration. A typical application for a bioretention area is to infiltrate and treat surface runoff from parking lots, in which the bioretention area may consist of a recessed, slotted-curb parking island. Bioretention areas are small vegetated depressions into which surface water is diverted. Stormwater flows into the bioretention area, ponds on the surface, and gradually infiltrates into the soil bed. Pollutants are removed by processes that include adsorption, filtration, volatilization, ion exchange, and decomposition. Treated water is allowed to infiltrate into the surrounding soil, or is collected by an underdrain system and discharged to the stormwater system or directly to receiving waters.
Rock Hill Trails Location	A bioretention cell will be located in the south portion of large road island area in front of lots 1 through 10 in the northeast portion of the developmen as shown on the BMP Map. The bioretention cell will occupy approximaty 1,500 sq ft of area, collecting runoff from the parking lot and meadow area.

Estimated Cost

Est. Baseline	Design Cost	Implementation Cost	Total Est. Cost	Incremental Cost Increase

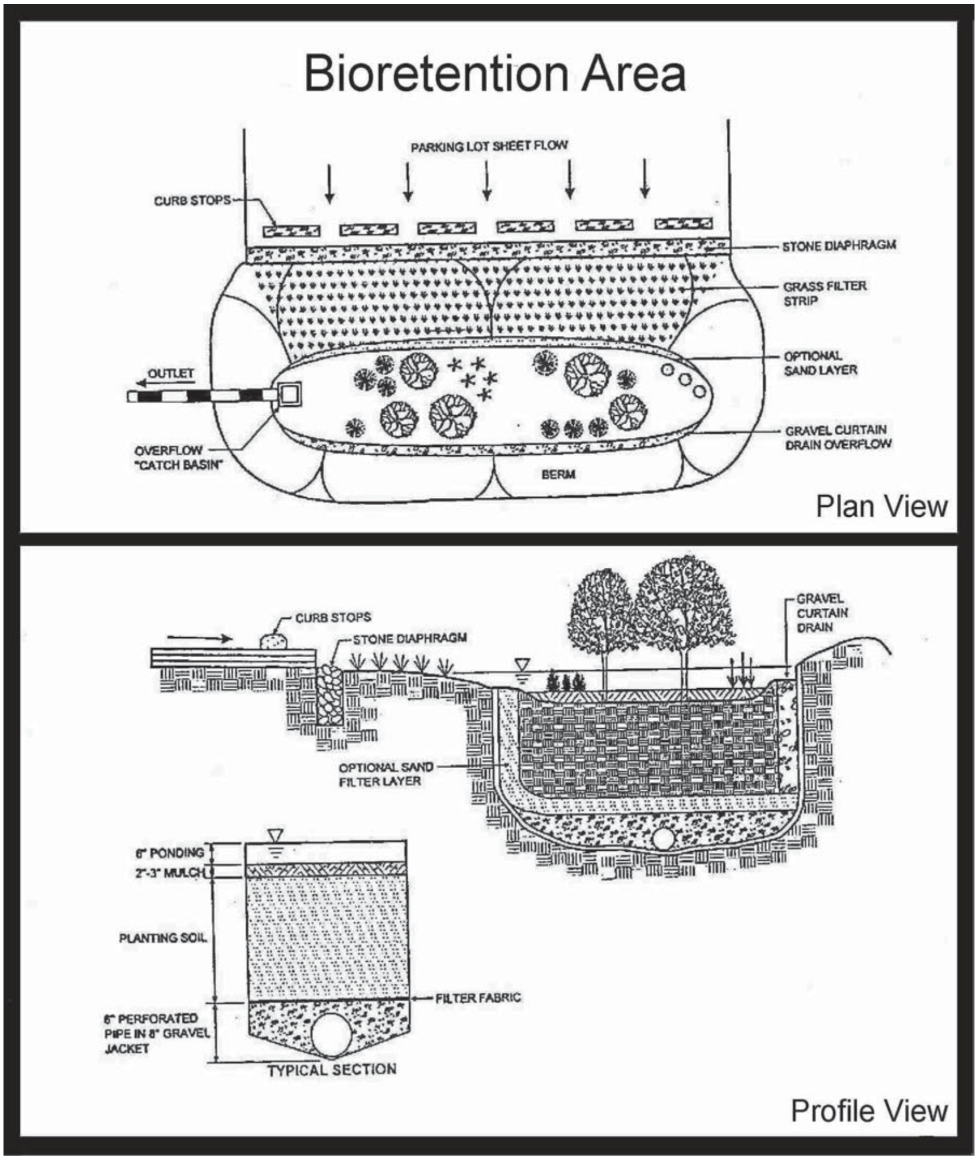
Effectiveness

Improves water quality. According to estimates, bioretention areas have the potential to remove 90 percent of suspended solids, 65 percent of phosphorous, 50 percent of nitrogen, and 80 percent of metals from stormwater. Estimated removal efficiencies are (IEPA 2007 Load Reduction Estimate on top, USEPA STEPL on bottom – see tables 1 and 2):

N Reduction			**P Reduction**			**BOD Reduction**			**Sed Reduction**		
3	U	U	0	0	0	11	2	9	154	9	145
21.3 %			43.0 %			0.0 %			2.4 %		

Wellspring Development Company

Advantages	• Provides effective stormwater flood control by slowing down runoff and increasing water infiltration into the soil. • Minimally consumes land. • Reduces site runoff. • Provides aesthetic enhancement. • Increases groundwater recharge. • Can be used as a stormwater retrofit.
Implementation Considerations	• Pine mulch and wood chips are not acceptable in the mulch layer because they are displaced during storm events. • The bioretention cell design includes clean-out pipes on the underdrain to facilitate cleaning. • A uniform mix of the planting soil will be installed during construction so that stormwater infiltrates evenly and does not create preferential pathways. • Vegetation for the bioretention area will consist of native plant species with hydric tolerances. Do not place woody vegetation near the stormwater inflow location. Plant trees primarily along the perimeter of the bioretention area. • Water will remain on site for less than 48 hours to prevent mosquito breeding.
Main Design Components	• Bioretention areas are best applied to areas with relatively shallow slopes (usually about 5 percent or less). • Bioretention areas can be applied in almost any soils as runoff percolates through a made soil bed and is returned to the stormwater system. It is also possible to design a bioretention system like an infiltration system. • Bioretention will be separated from the water table to ensure that the groundwater does not intersect with the bottom of the bioretention area. • A typical bioretention system involves the following components: • Pretreatment: Pretreatment to remove suspended sediments is a part of the bioretention cell. • Ponding area: A ponding area provides surface storage of stormwater before it filters through the soil bed. • Organic mulch layer: This layer protects the soil layer from erosion, retains moisture to sustain plants, and provides a medium for biological activity to decompose organic pollutants and adsorb inorganic pollutants. • Planting soil bed: Provides water and nutrients to support plant life in the bioretention system. Stormwater filters through the planting soil bed where pollutants are removed by sorption and biodegradation. • Under-drain: An under-drain is a perforated pipe in a gravel bed installed along the bottom of a sand bed to collect and filter stormwater directing it to an outflow or stormwater systems. • Provide redundant overflow structures to convey flow from large storms to the storm drain system. • Plants: Plants are an important component of a bioretention system. They remove water through transpiration, remove pollutants, enhance soil biological activity, and promote water infiltration. The plant species selected should replicate a native forest or grassland system, and be able to survive flooded conditions.



Typical Design Elements of a Bioretention Cell

Source: APWA 5600 BMP Guidance Manual.

5. Wet Meadows and Native Vegetation

Description

Wet meadows are areas typically above bottomlands and floodplains that are neither deepwater aquatic habitats nor special aquatic sites. They are occassionally inundated, but most often are wet or moist, with periodic dry periods. Prairie grasses and a few tree species typically dominate undisturbed and native landscaped wet meadow areas.

Undisturbed or native landscaped wet meadows and prairies serve many BMP functions. They help reduce erosion by protecting the underlying soil from splash erosion and slowing velocity of runoff. They reduce off-site runoff by providing infiltration, filter sediment and other pollutants from stormwater runoff. They also provide wildlife habitat and aesthetic values for the public.

Rock Hill Trails Location

Wet meadows and prairie vegetation will be used in most of the open areas of the development. Specific locations are in the circle in front of lots 1 through 10 (above the bioretention cell), and in the open area in the center of Phase 1 of the development, behind lots 33 and 34, as shown on the BMP Map. The wet meadow demonstration plots will cover approximately 6,800 square feet of area.

Estimated Cost

Est. Baseline	Design Cost	Implementation Cost	Total Est. Cost	Incremental Cost Increase

Effectiveness

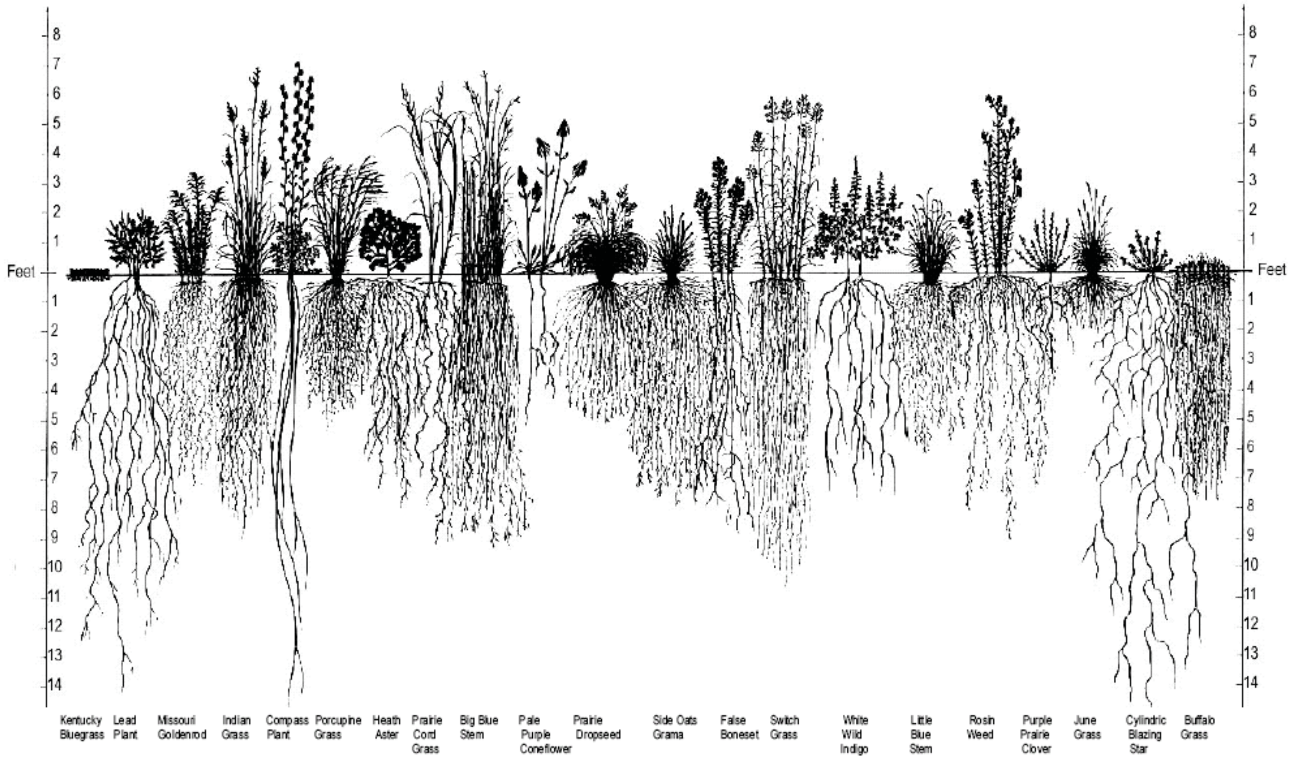
Wet meadows and native vegetation are essentially the core of using alternative strategies for reducing runoff volumes and pollutant transport. In wet meadows and prairies, native vegetation including grasses, forbs, and woody vegetation/trees, effectively slows runoff where if falls, maximizing infiltration and reducing the volume of pollutants.

Estimated pollutant removal efficiencies are:

N Reduction			P Reduction			BOD Reduction			Sed Reduction		
3	2	1	0	0	0	11	8	3	154	65	89
9.7 %			29.9 %			7.1 %			81.8 %		

Wellspring Development Company

Advantages	• Preserves predevelopment hydrology effectively. • Slows surface flows, promotes infiltration, and reduces erosion. • Traps sediment and sediment-bound pollutants. • Improves soil structure. • Transforms nutrients into usable forms and breaks down many pollutants. • Typically requires less maintenance than non-native landscaping. • Preserves wildlife habitat and provides aesthetic and recreational benefits. • Requires significantly less expense. May increase property values.
Implementation Considerations	• To establish native uplands, plant species suited to the location will be used. • Seedbed preparation is critical to the success of the plantings, *do not over compact the soil.* • Preserving existing upland native vegetation ultimately demands less maintenance than turf grass plantings or other landscaping, reducing operations and maintenance costs. • Minimal mowing and herbicide application is needed to maintain a healthy stand of native vegetation. • Some mechanical means may be necessary to control invasive species and preserve the health of the system. • Minimal fertilization is required. Establishing native uplands necessitates that seeded areas be kept moist during the first weeks of establishment; mulch also may be needed. Reseeding may be necessary if the first seeding does not produce a vigorous stand.
Main Design Components	Seed should be applied uniformly (cyclone, drill, or hydroseeder). If feasible, broadcast seed should be covered by light raking followed by a roller. Sod has the advantage of immediate erosion control, however native grass sod is rarely available. Native grasses can be installed as "plugs," (i.e. young, individual grass plants).



Comparative demonstration of above- and below-ground biomass of native plants, including turf (far left). *Source: Conservation Research Institute, 1995*

6. Constructed Wetland

Description

Stormwater wetlands are shallow marsh systems planted with emergent vegetation that are designed to treat stormwater runoff. While they are one of the best BMPs for pollutant removal, stormwater wetlands can also mitigate peak rates and even reduce runoff volume to a certain degree. They also can provide considerable aesthetic and wildlife benefits. Wetlands use a relatively large amount of space and require an adequate source of inflow to maintain the permanent water surface. Like detention basins and wet ponds, stormwater wetlands may be used in connection with other BMP components, such as forebays and micropools.

Rock Hill Trails Location

A constructed wetland (one of three) will be located primarily on the south, downslope side of the development near Rock Hill Road where topographic lows have been mapped, as shown on the BMP Map. The total area of the constructed wetland is estimated to be approximately 17,385 square feet.

Estimated Cost

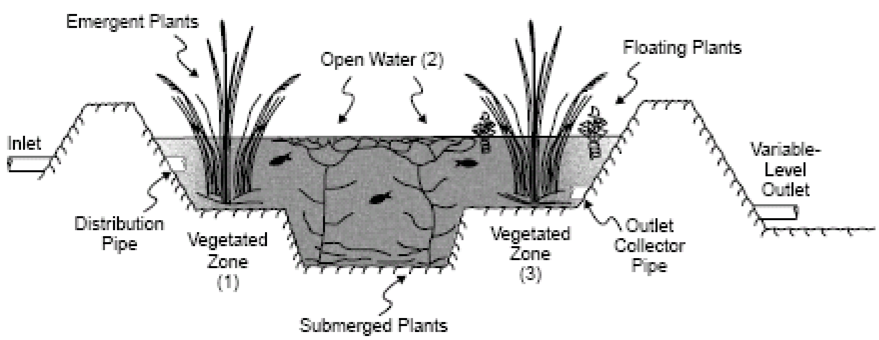
Est. Baseline	Design Cost	Implementation Cost	Total Est. Cost	Incremental Cost Increase

Effectiveness

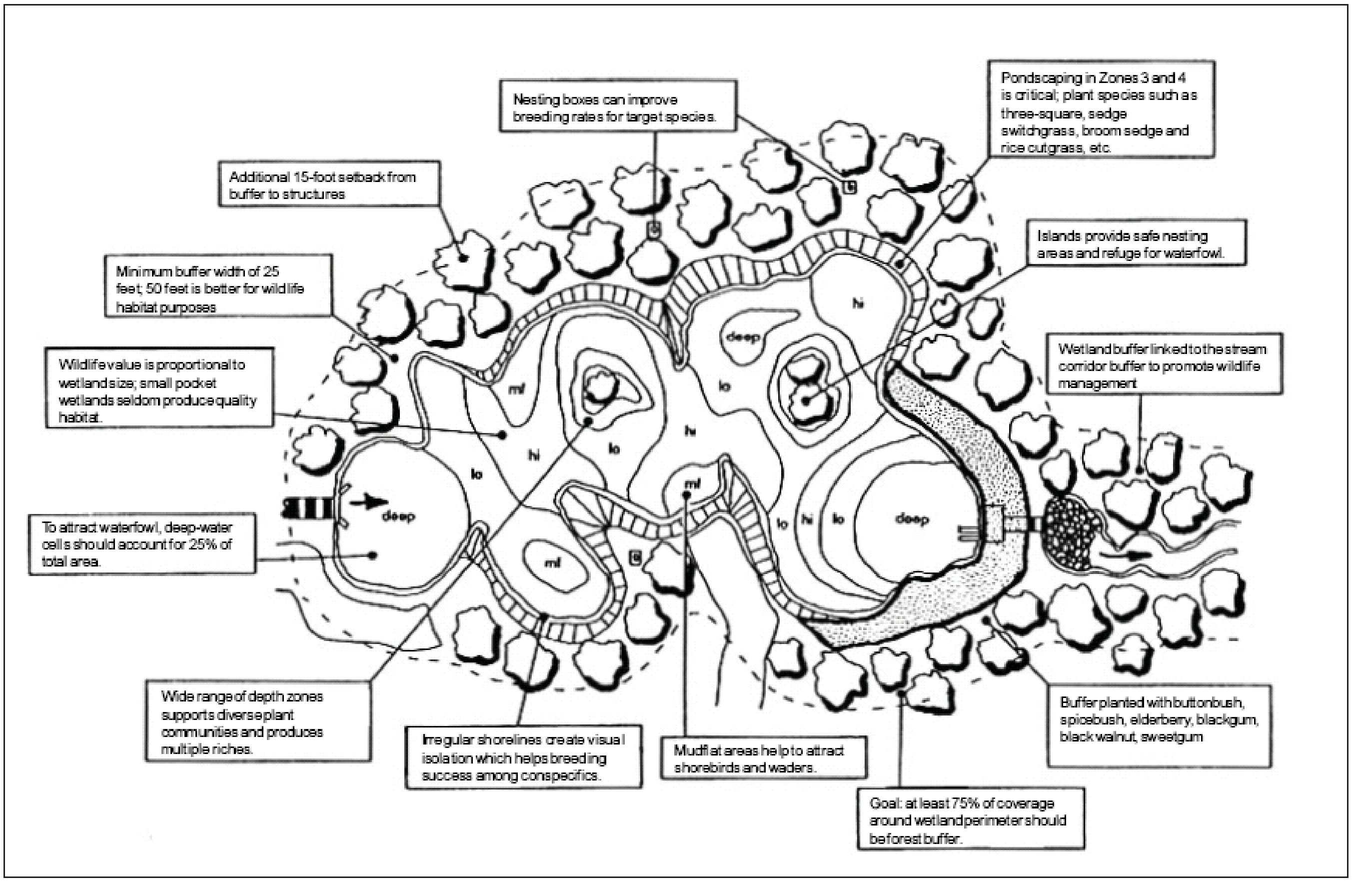
Properly designed wetlands can remove significant amounts of nitrogen and phosphorus, suspended solids, and other pollutants from urban environments. The relative amounts of pollutant and suspended solid removal is similar to other BMPs, however, with removal rates ranging from 40 to 80 percent. Wetlands are very effective for reducing runoff volume and velocity. The estimated efficiencies for Rock Hill Trails are:

N Reduction			**P Reduction**			**BOD Reduction**			**Sed Reduction**		
3	2	1	0	0	0	11	4	7	154	35	119
12.4 %			26.4 %			37.9 %			48.2 %		

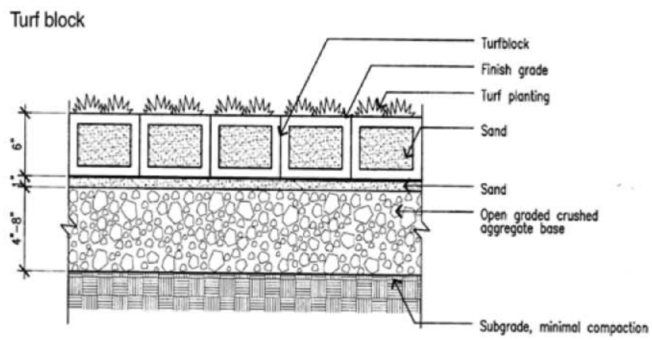
Advantages	• Improvements in downstream water quality. • Settlement of particulates. • Removal of pollutants. • Flood attenuation and reduction of peak discharge. • Relatively low maintenance costs.
Implementation Considerations	• Site must have adequate water flow and appropriate underlying soils. • Baseflow must be sufficient to maintain a shallow pool in the wetland. • Underlying soils should allow only allow small infiltration losses.
Main Design Components	• The wetland design should include a buffer to separate the wetland from surrounding land. • Above-ground berms or marsh wedges should be placed at approximately 50 foot intervals to increase the dry weather flow path within the wetland. • Before the outlet, a four- to six-foot micropool should be included in the design to prevent the outlet from clogging. The micropool should hold at least 10 percent of the total treatment volume. • Install a bottom drain pipe with inverted elbow to prevent sediment clogging in order to drain the wetland in case of emergencies or for routine maintenance. • As the wetland-to-watershed ratio increases, the average runoff residence time increases and the effectiveness of the wetland for pollutant removal also increases. • The stormwater wetland's effectiveness for removing pollutants depends on the residence time of water in the wetland. • Vegetation can be established by allowing volunteer vegetation to become established, or, from planting nursery stock.



"Typical" profile of a three-stage constructed wetland (source: U.S. EPA)


Nesting boxes can improve breeding rates for target species.
Pondscaping in Zones 3 and 4 is critical; plant species such as three-square, sedge switchgrass, broom sedge and rice cutgrass, etc.
Additional 15-foot setback from buffer to structures
Islands provide safe nesting areas and refuge for waterfowl.
Minimum buffer width of 25 feet; 50 feet is better for wildlife habitat purposes
Wetland buffer linked to the stream corridor buffer to promote wildlife management
Wildlife value is proportional to wetland size; small pocket wetlands seldom produce quality habitat.
deep
ml
lo
hi
To attract waterfowl, deep-water cells should account for 25% of total area.
Wide range of depth zones supports diverse plant communities and produces multiple riches.
Irregular shorelines create visual isolation which helps breeding success among conspecifics.
Mudflat areas help to attract shorebirds and waders.
Buffer planted with buttonbush, spicebush, elderberry, blackgum, black walnut, sweetgum
Goal: at least 75% of coverage around wetland perimeter should be forest buffer.

7. Pervious Pavement



Source: City of Eugene Stormwater Management Manual

Description

Pervious pavement allows precipitation to infiltrate by way of vertical pore spaces in the paving material. A wide variety of materials are used in the creation of pervious pavement, including brick, concrete, asphalt, plastic, rock, and gravel. A pervious pavement system may make use of porous concrete or asphalt, or it may make use of cobbles, bricks, or other evenly spaced paving units. Paving systems may even integrate vegetation within spaces in the paving units, augmenting the infiltration and filtration capacity.

Studies of existing pervious pavement indicate removal rates of over 80 percent for sediment and for a number of other pollutants. Infiltration of precipitation falls where it intercepts parking lots, roads, and sidewalks reducing the volume of runoff that must be handled by stormwater management systems. Pervious pavement is suitable at a variety of scales, including individual driveways, trails, overflow parking lots, and light traffic roadways.

Rock Hill Trails Location

Pervious pavement will be used for two of the homes on lots 1 through 10 on the north side of the development, as shown on the BMP Map. Assuming each driveway occupies approximately 800 square feet, the total area of pervious pavement is 1,600 square feet.

Estimated Cost

Est. Baseline	Design Cost	Implementation Cost	Total Est. Cost	Incremental Cost Increase

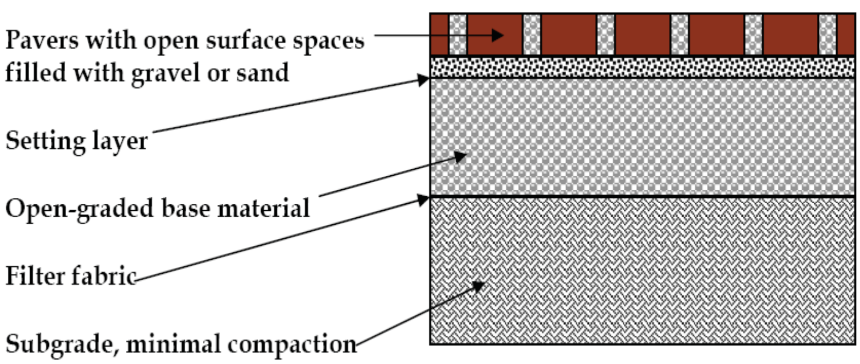
Effectiveness

Pervious or porous pavement, when properly maintained, has been shown to remove from 65 to 95 percent of pollutants and sediments (USEPA, 1999). Some monolithic porous pavement materials, however, have been show to clog within one- to two years. Clogging can be remediated to restore the function of the pavement material. Pollutant removal efficiencies for pervious pavement at Rock Hill trails are:

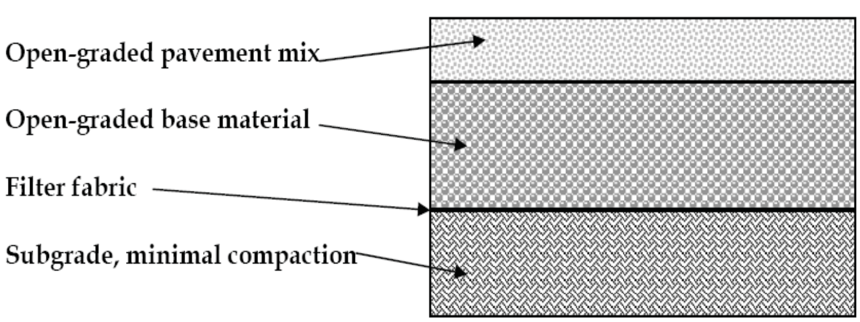
N Reduction			P Reduction			BOD Reduction			Sed Reduction		
3	0	3	0	0	0	11	U	U	154	15	139

	18.8 %	13.2 %	0.0 %	17.7 %
Advantages	• Reduces runoff volumes. • Reduces impervious surface area. • Depending on pavement system, may provide pollutant filtering.			
Implementation Considerations	• Given the potential for contamination by chemicals associated with automobile traffic, pervious pavement should not be employed near groundwater drinking supplies. • Snowplowing must be done carefully to avoid damaging the surface and paving units, and sanding and de-icing should be avoided as they will increase clogging. • Required maintenance, especially for porous concrete and asphalt paving includes vacuum sweeping to remove deposited sediment as well as washing with a high-pressure hose to remove clogs in the surface of the pavement.			
Main Design Components	• Pavement surface must allow water to infiltrate to a permeable infiltration medium below. • An underdrain system may be required where soils beneath paving system do not allow adequate infiltration (more than two inches per hour). • Slopes should be less than 5-10% to allow infiltration rather than runoff. • Integration with other BMPs improves the effectiveness of pervious pavement. For example, placing a vegetated filter strip around the pervious pavement will reduce sediment transport to the project area, reducing the amount of maintenance required.			

<u>Pervious Concrete Block or "Paver" Systems</u>



<u>Pervious (Open Graded) Concrete and Asphalt Mixes</u>



8. Street and Parking Islands

Description

Depressed or sunken street and parking islands consist of shallow swales underlain with subdrains that filter and infiltrate runoff from surrounding streets, parking lots, and sidewalks. They can be installed in a variety of sizes and styles, integrating a variety of plants, to suit any architectural style. Recessed street and parking islands work well in commercial, residential, or governmental parcel levels.

Rock Hill Trails Location

Recessed street islands will be a feature in each of the cul-de-sacs on the south side of the development, as shown in the BMP Map. The three islands are estimated to cover a total of approximately 5,400 square feet.

Estimated Cost

Est. Baseline	Design Cost	Implementation Cost	Total Est. Cost	Incremental Cost Increase

Effectiveness

Recessed street islands have excellent capability to reduce significant amounts of runoff, with limitations based on the receiving area of runoff flowing to the island, and the size of the island itself. For runoff that enters the parking island, removal of sediments and pollutants is high, often exceeding 80 percent. Estimated removal efficiencies are (IEPA 2007 Load Reduction Estimate on top, USEPA STEPL on bottom – see tables 1 and 2):

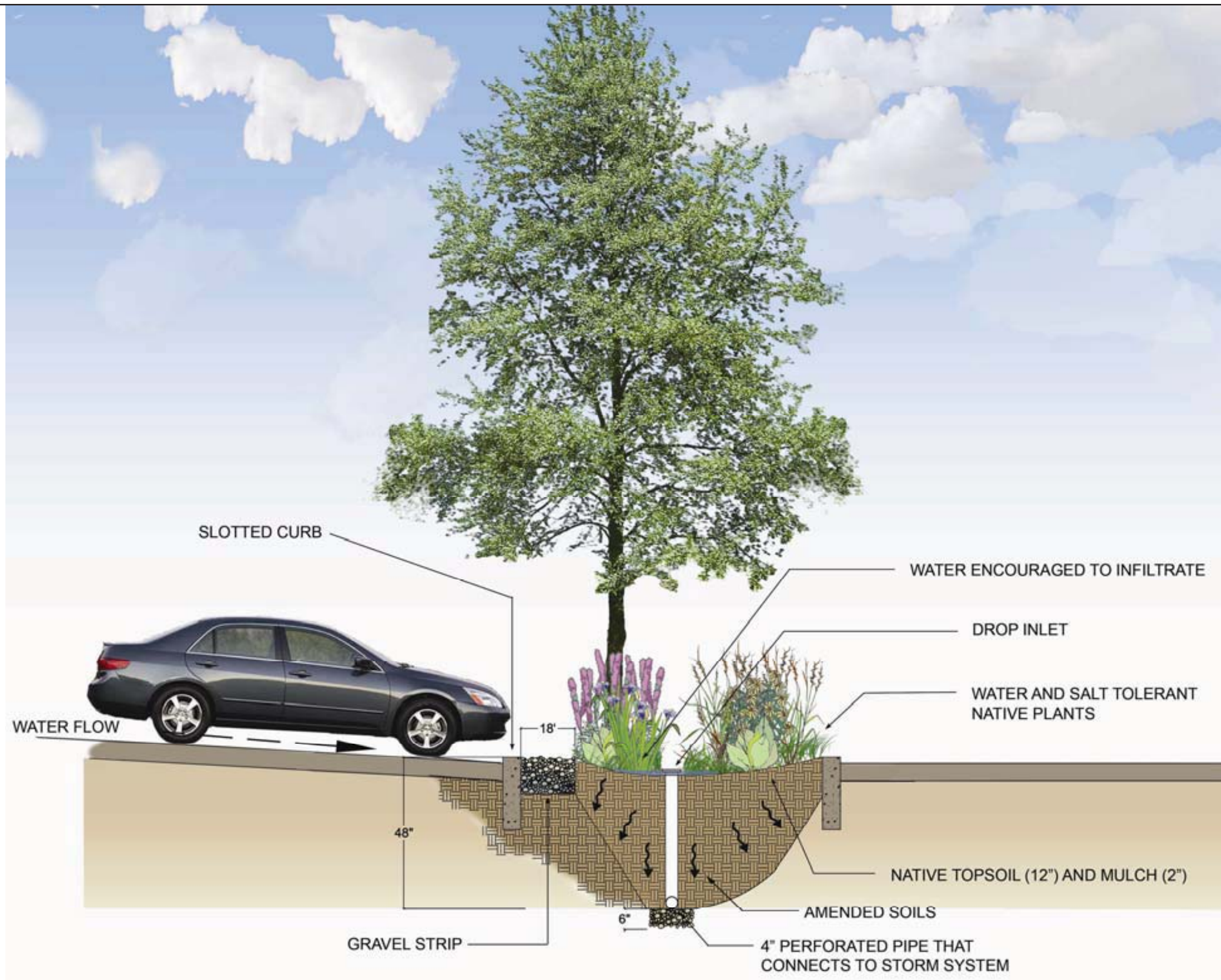
N Reduction			P Reduction			BOD Reduction			Sed Reduction		
3	U	U	0	0	0	11	2	9	154	9	145
50.0 %			50.0 %			70.0 %			90.0 %		

Advantages

- Provides filtration of pollutants, as well as infiltration of runoff.
- Reduces flow rates and volumes of stormwater runoff from streets and parking lots.

Implementation Considerations

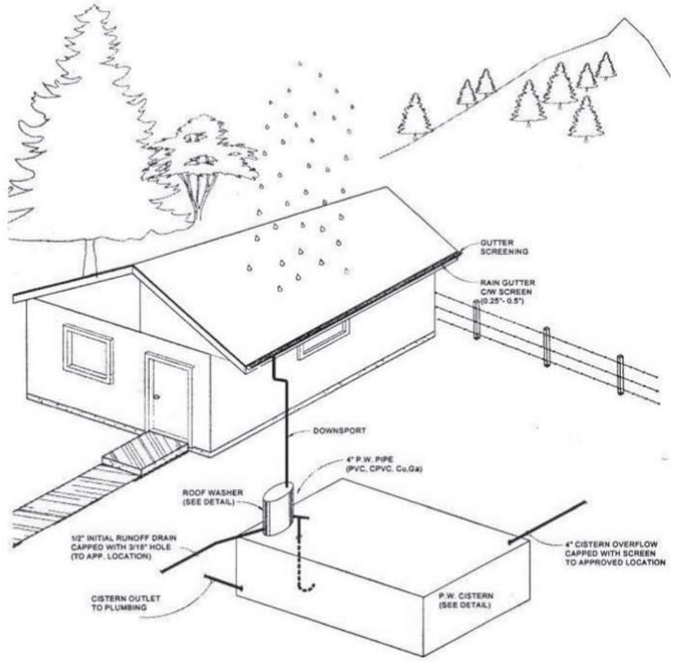
- Requires soils that allow at least two inches of infiltration per hour.
- The depth of the depressed parking island should allow up to six inches of standing water to accumulate for less than twelve hours.
- A minimum of three feet of permeable medium (washed gravel or other aggregate) will be plafced between the bottom of the growing medium (topsoil) and above impermeable layers or seasonally high water table.



Typical Parking Lot and Street Island Cross Section

9. Rain Barrels and Cisterns

Source: Stormwater Manager's Resource Center



Source: City of Portland Code Guide

Description

A rain barrel is any above-ground container modified to receive, store, and distribute rooftop runoff for non-potable uses. Rain cisterns are similar systems designed for below-ground use, but typically provide much greater storage and more complex construction techniques. Both practices supply water for gardens, lawns, and flowerbeds.

Rock Hill Trails Location

Rain barrels and/or cisterns will emplaced as a permanent feature of the 2 of the homes built on lots 1 through 10 on the north side of the development, with 2 rain barrels at one house, and a cistern system at another. House design will include collection stands for the barrels.

Estimated Cost

Est. Baseline	Design Cost	Implementation Cost	Total Est. Cost	Incremental Cost Increase

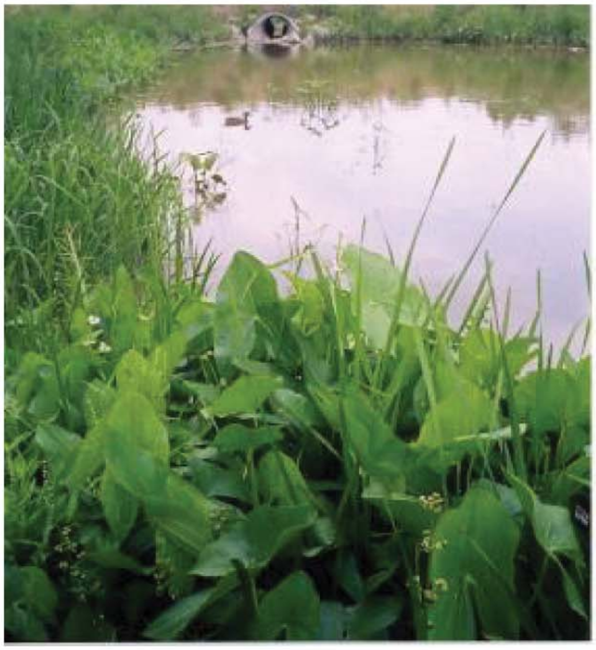
Effectiveness

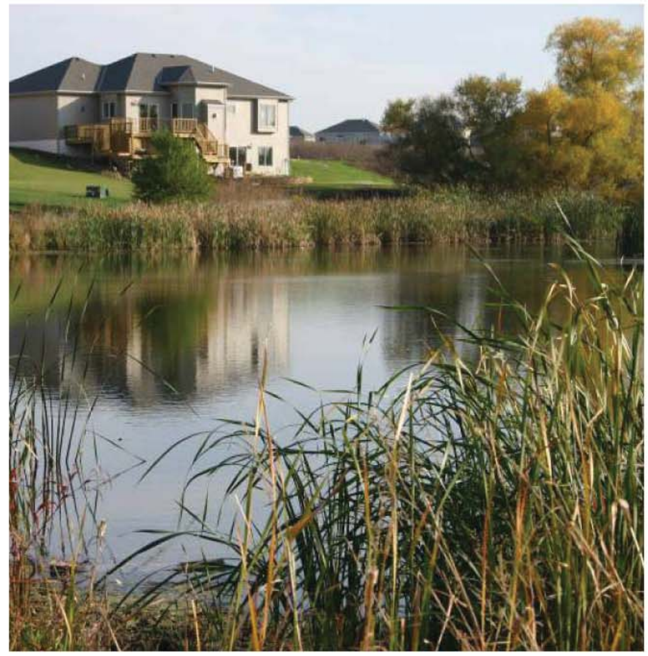
Rainbarrels and Cisterns are effective in storing limited volumes of water from rooftops. Larger cisterns can provide effective volume reduction of runoff during storms. For example, a 0.1" rainfall event falling on a 1000 sq ft roof produces about 60 gallons of runoff – more than enough to fill an average-sized 55-gallon rain barrel. Estimated removal efficiencies are (IEPA 2007 Load Reduction Estimate on top, USEPA STEPL on bottom – see tables 1 and 2):

N Reduction			P Reduction			BOD Reduction			Sed Reduction		
1	1	0	0	0	0	3	U	U	39	15	23
18.0 %			18.0 %			18.0 %			18.0 %		

Advantages	• Reduces flow volumes, thereby reducing demands on stormwater management systems. • Provides free supply of water for non-potable uses, easing demands on potable drinking water sources. • Provides homeowners and small businesses with water for irrigation.
Implementation Considerations	• Rain barrel should be sized to adequately capture runoff based on precipitation patterns in this area. • Occasional cleaning may be necessary to remove debris, such as leaves, coming off the rooftop. The barrel must also be sealed during warm months to avoid mosquito breeding, and should be drained prior to winter to prevent damage caused by freezing. • Water should be drained between rainfall events (for irrigation) to maximize effectiveness. • Rain barrels are most effective when they are designed to help meet demands for non-potable water, such as irrigation.
Main Design Components	• Complete rain barrels can be purchased from a number of retailers, or they can be constructed relatively easily and economically. • Instructions for creating your own rain barrel can be found at Maryland Environmental Design Program Website. (http://www.dnr.state.md.us/ed/rainbarrel.html) • The main components of a rain barrel include tubing to connect the barrel to a downspout, a cover to prevent mosquitoes from entering, a faucet to allow regulated use of the captured water, and an overflow pipe to divert excess water once the barrel is filled. • The basic components of a rain cistern are much the same as with rain barrels, but with a much larger storage tank that is buried underground. This means a pump must also be installed to bring water out of the cistern.
	

10. Wet Detention (Ponds and Lakes)





Description	Wet detention is typically a constructed pond or lake, or it may be a pond or lake incorporated into a stormwater treatment system. They are generally considered "end-of-the-pipe" BMPs. Lakes and ponds are standing bodies of water defined in terms of capacity, effective height, and effective storage. Lakes are larger than ponds, generally with total storage greater than 50 acre-feet, and the product of the effective height (in feet) and effective storage (in acre-feet) greater than 1,250. All developments involving lake and pond construction must conform to local, state, and federal regulations. Preserve undisturbed ponds and lakes during development according to federal and state laws and regulations. Preserving the natural drainage system, instead of replacing it with stormwater systems or concrete channels, reduces the potential for downstream degradation because of increased runoff. Ponds can be modified to increase their storage capacity and enhanced with vegetation to increase their water-quality treatment effectiveness.				
Rock Hill Trails Location	A detention pond is planned for the east portion of Rock Hill Trails, as shown on the BMP Map. The detention pond will cover an area of approximately two acres.				
Estimated Cost	Est. Baseline	Design Cost	Implementation Cost	Total Est. Cost	Incremental Cost Increase

<table>
<tr><td rowspan="4">Effectiveness</td><td colspan="12">Efficient pollutant removal. Studies indicate that wet detention ponds can remove up to 50 to 90 percent of suspended solids, 30 to 90 percent of total phosphorous, 40 to 80 percent of soluble nutrients, 40 to 80 percent of metals, and 20 to 40 percent of biochemical compounds.

The primary pollutant removal mechanism in wet detention is sedimentation, with a moderate to high potential for removing metals, nutrients, and organics. Since wet ponds have the capability of removing soluble pollutants, they are suitable for sites where nutrient or pollutant loads are expected to be high. Estimated removal efficiencies are (IEPA 2007 Load Reduction Estimate on top, USEPA STEPL on bottom – see tables 1 and 2):</td></tr>
<tr><td colspan="3">N Reduction</td><td colspan="3">P Reduction</td><td colspan="3">BOD Reduction</td><td colspan="3">Sed Reduction</td></tr>
<tr><td>3</td><td>2</td><td>1</td><td>0</td><td>0</td><td>0</td><td></td><td></td><td></td><td>154</td><td>35</td><td>119</td></tr>
<tr><td colspan="3">28.0 %</td><td colspan="3">35.0 %</td><td colspan="3">0.0 %</td><td colspan="3">47.2 %</td></tr>
<tr><td>Advantages</td><td colspan="12">• Improve runoff control, including reductions of overall runoff from adjacent sites with proper design.
• Create wildlife habitat.
• Encourage community recreation facilities.
• Aesthetically pleasing.
May increase property values. Requires significantly less expense for maintenance if natural vegetation is used along the banks.</td></tr>
<tr><td>Implementation Considerations</td><td colspan="12">• Vegetation on the dam will be monitored and invasive species removed.
• Cleaning and removal of debris from the pond will occur after major storm events.
• Sediment accumulating in the pond will be periodically removed.</td></tr>
<tr><td>Main Design Components</td><td colspan="12">• Sediment control: A sediment forebay will be constructed on the west end of the pond..
• An emergency spillway will be included in the basin design.
• The basin will include a low-flow drain to assist in maintenance of the detention area.
• Pond or lake depth: The pond will have an average pool depth of 3 to 6 feet.
• Slopes: Side slopes of a permanent pool will not be greater than 3:1. Flatter slopes minimize bank erosion.</td></tr>
</table>

APPENDIX A

TYPICAL DESIGN DETAILS FOR ROCK HILL TRAILS

Rain Gardens

Bioretention Cell

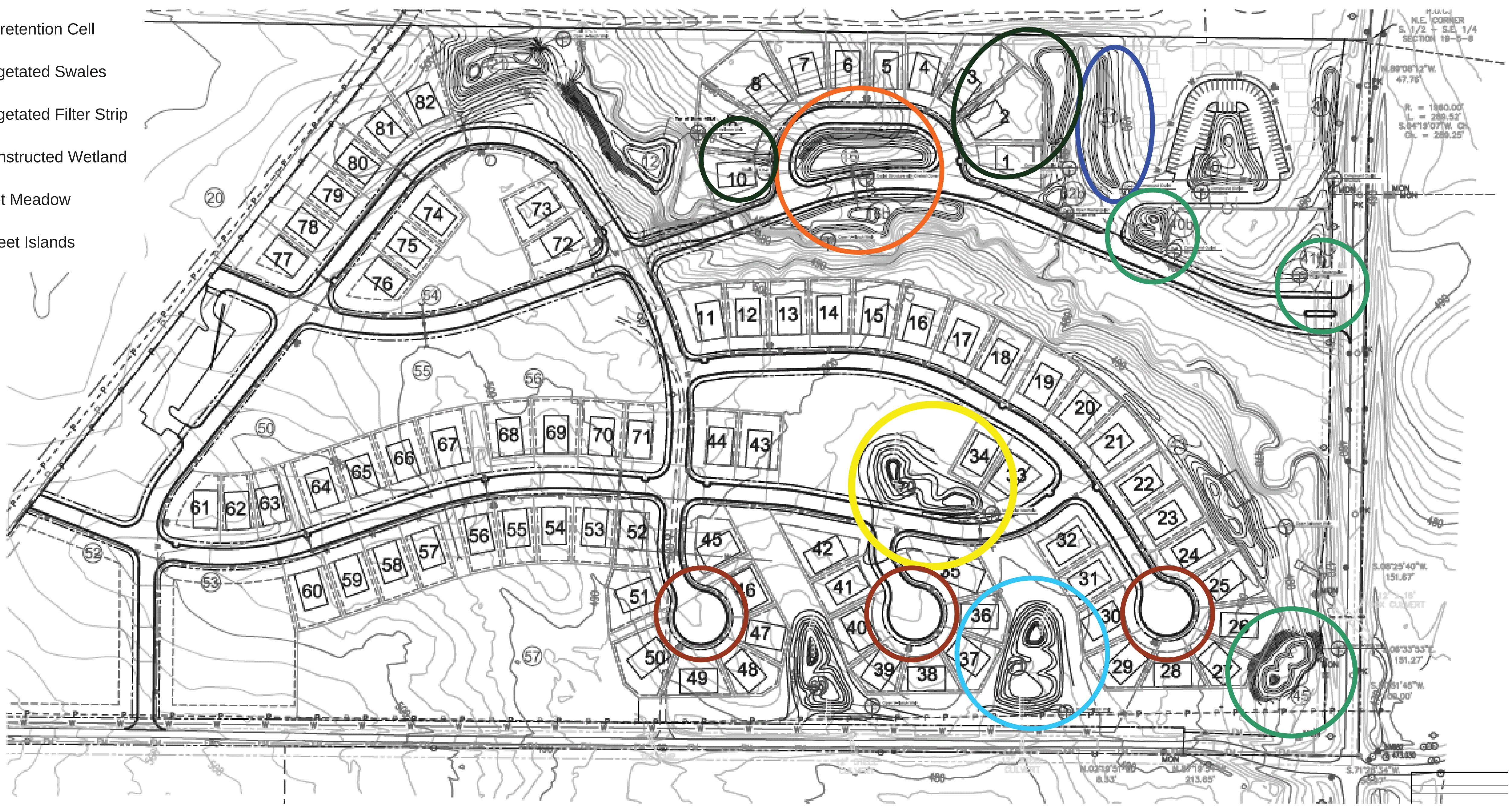
Vegetated Swales

Vegetated Filter Strip

Constructed Wetland

Wet Meadow

Street Islands



Sub-Watershed

Stormwater Management Area

0 50' 100' 200'

Scale 1" = 30'

N

Applied Ecological Services, Inc.
17921 Smith Road, P.O. Box 256
Brodhead, WI 53520
Phone: 608.897.8641 Fax: 608.897.8486
www.appliedeco.com
Email: info@appliedeco.com

Revisions

No: 1 Date: By:

Description:

Revisions

No: 2 Date: By:

Description:

Revisions

No: 3 Date: By:

Description:

Revisions

No: 4 Date: By:

Description:

Rock Hill Trails

Wellspring Development Company

Wood River, Illinois

Stormwater Management Plan

Stamped:

Dated:

AES Proj. No.: 07-0422

Checked:

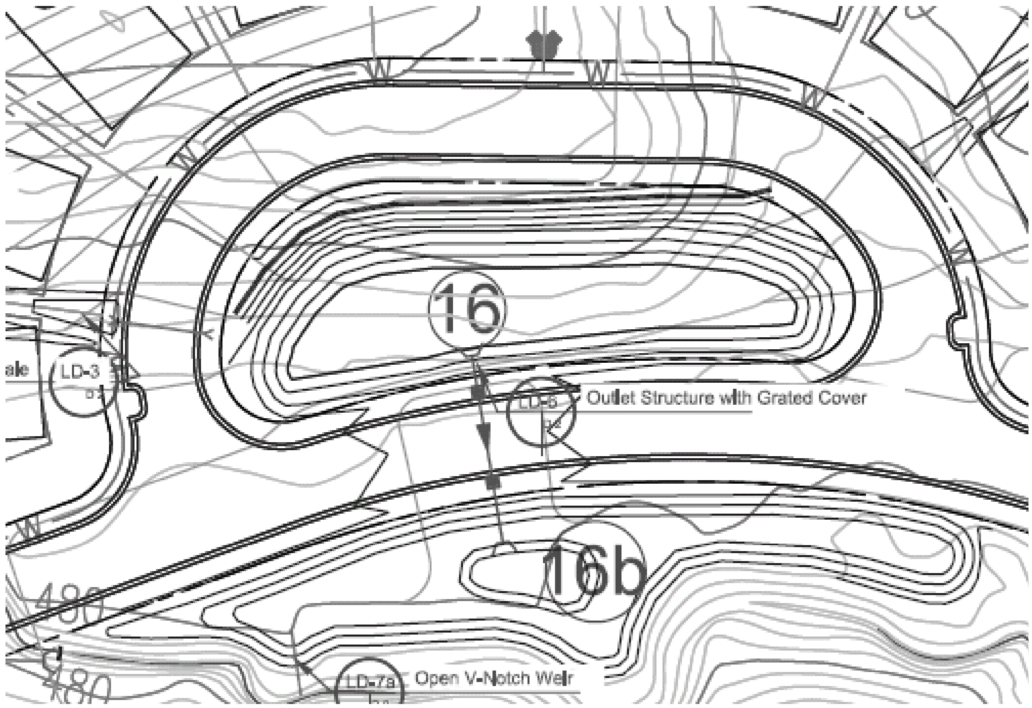
Approved:

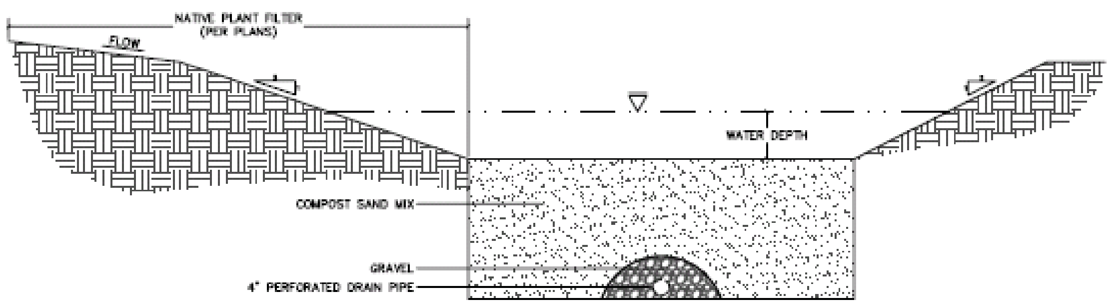
Drawn:

File: BMP_100807_2004.DWG

Date: Oct 10, 2007

Sheet Number



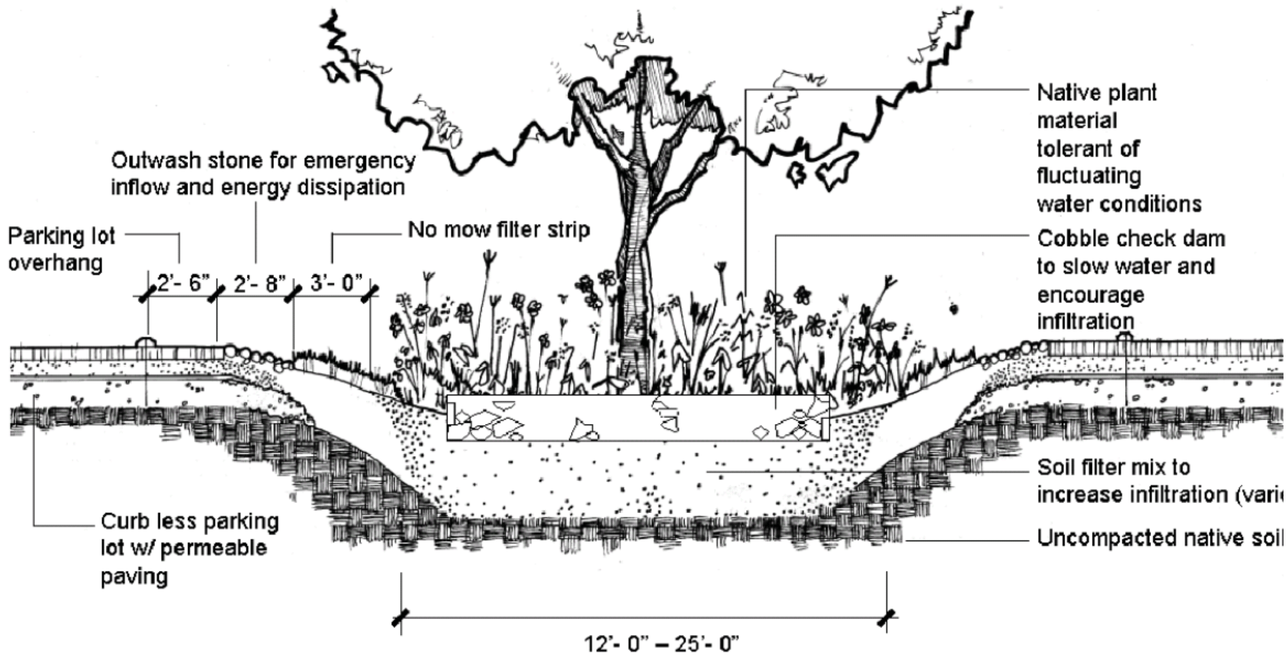


LD-3 TYPICAL BIORETENTION CELL

Not to Scale

Bioretention Cell Design Details

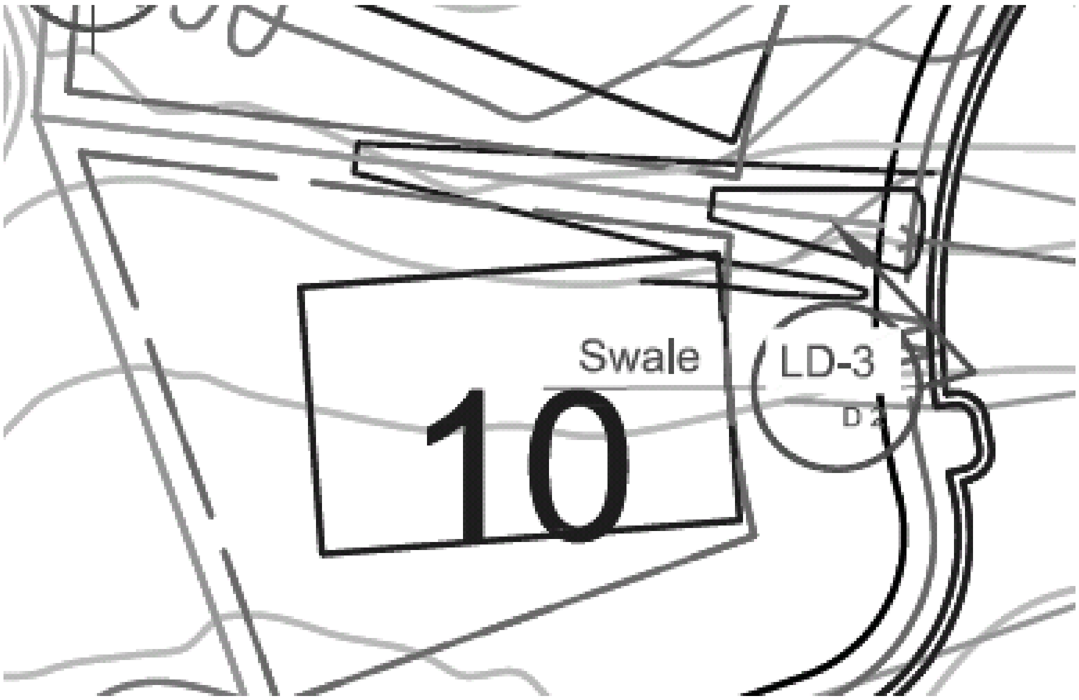
Refer to Drawing LD-6 for Outlet Structure Detail



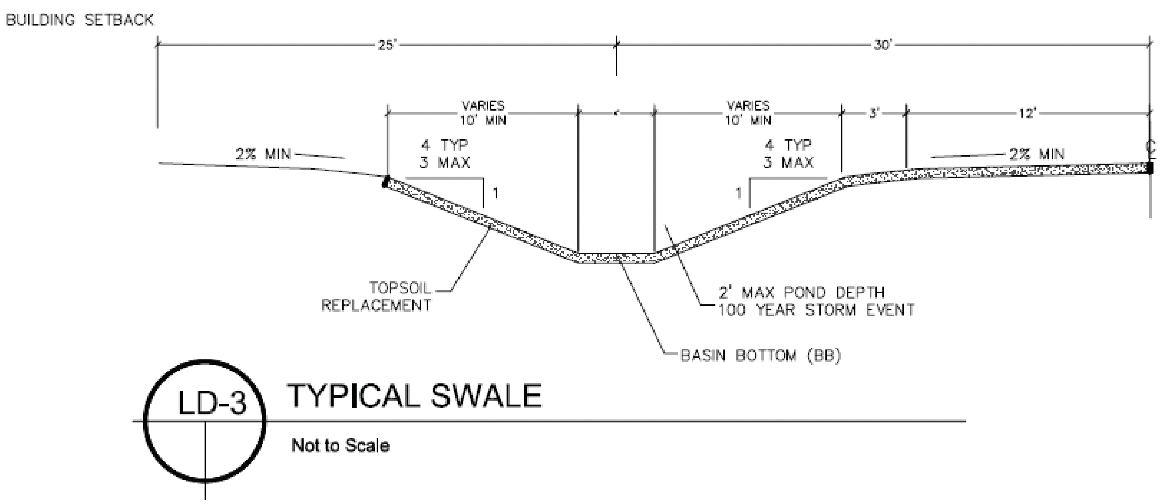
Ⓐ Infiltration Basin and Parking Lot

Street Island Detail

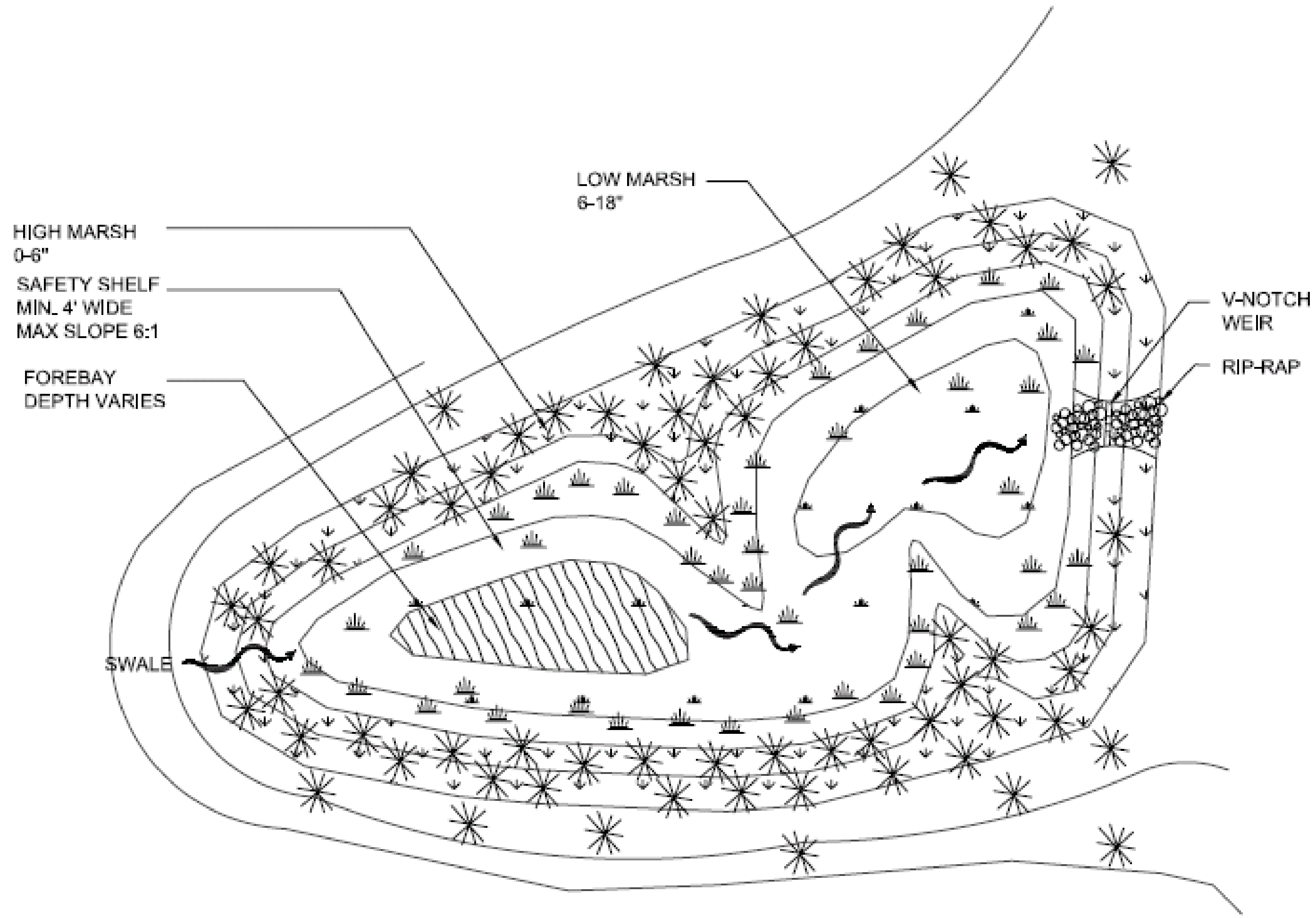
Note: Specific engineering drawing of the Rock Hill Trails Street Island BMPs have not been completed. This representation is a typical cross section of a street island that will be designed for Rock Hill Trails. Additional features to be added in the design will be slotted curbs and a sub-surface drain pipe with clean out.

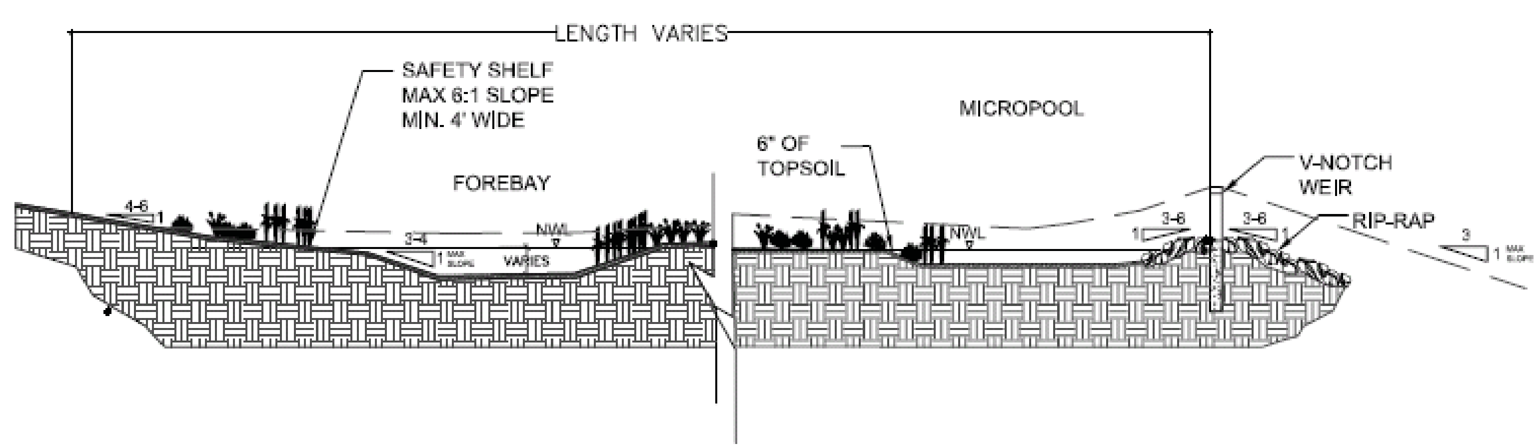


Rock Hill Trails Swale Design Contours



Vegetated Swale Design Details





SCALE: N.T.S.

NORTH

Revisions:

Stormwater Management
Typical Constructed Wetland

Drawn By: MBW
Checked:
Approved:
AES Project No.: 07-0422
File Name: 092607_2004.dwg
Date: 10-01-07

Rock Hill Trails

Wellspring Development Company
Wood River, Illinois

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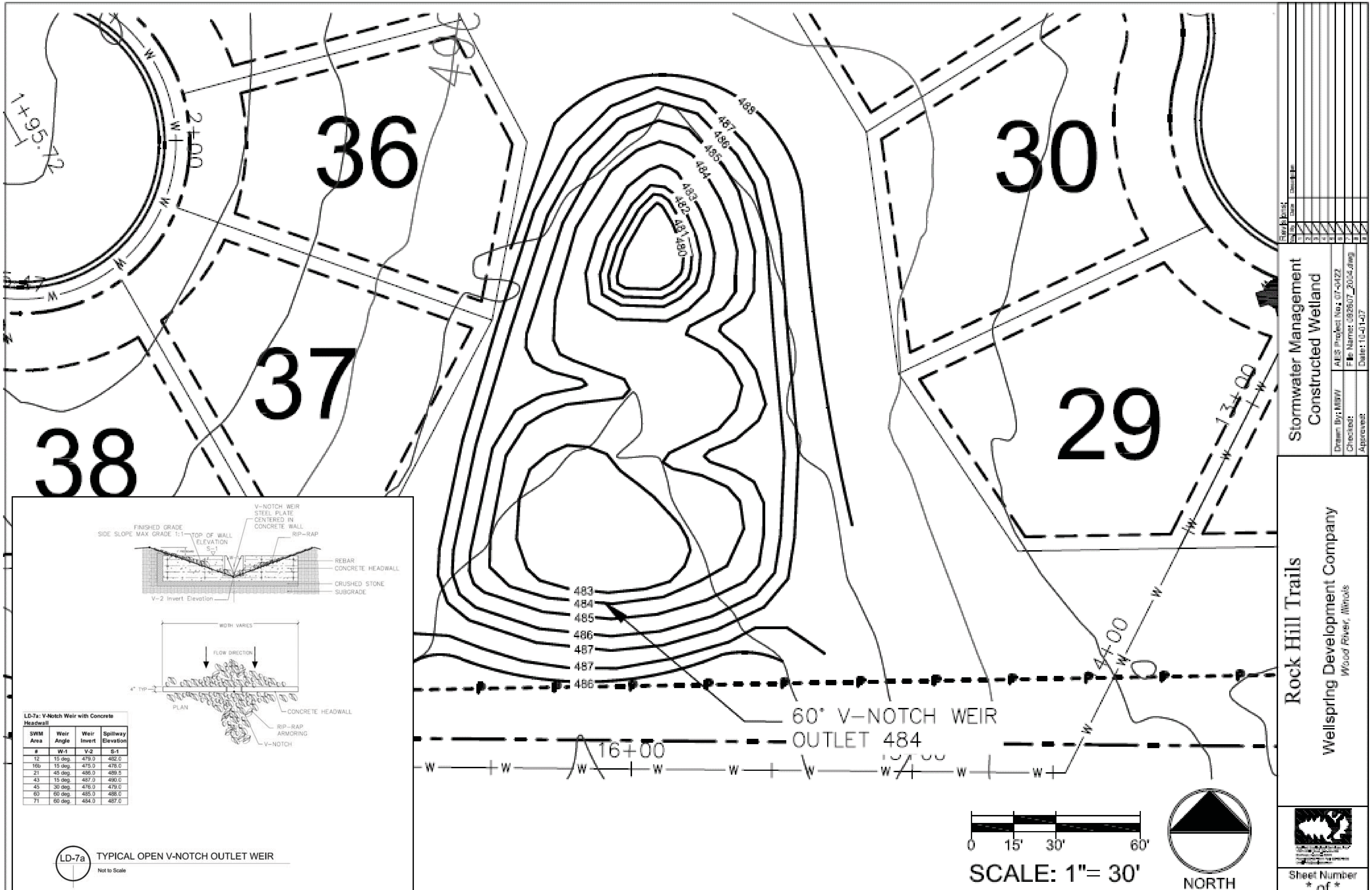
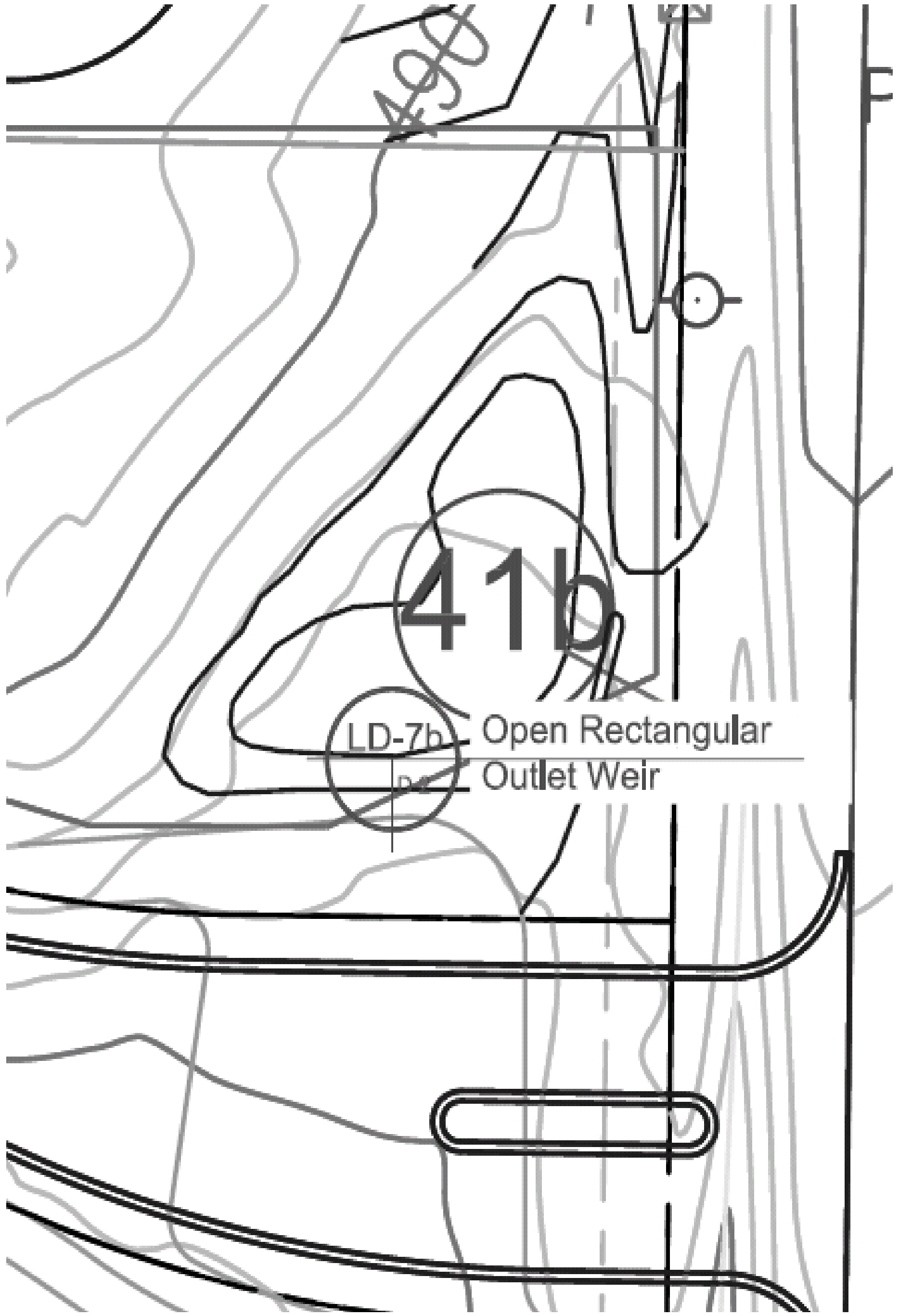
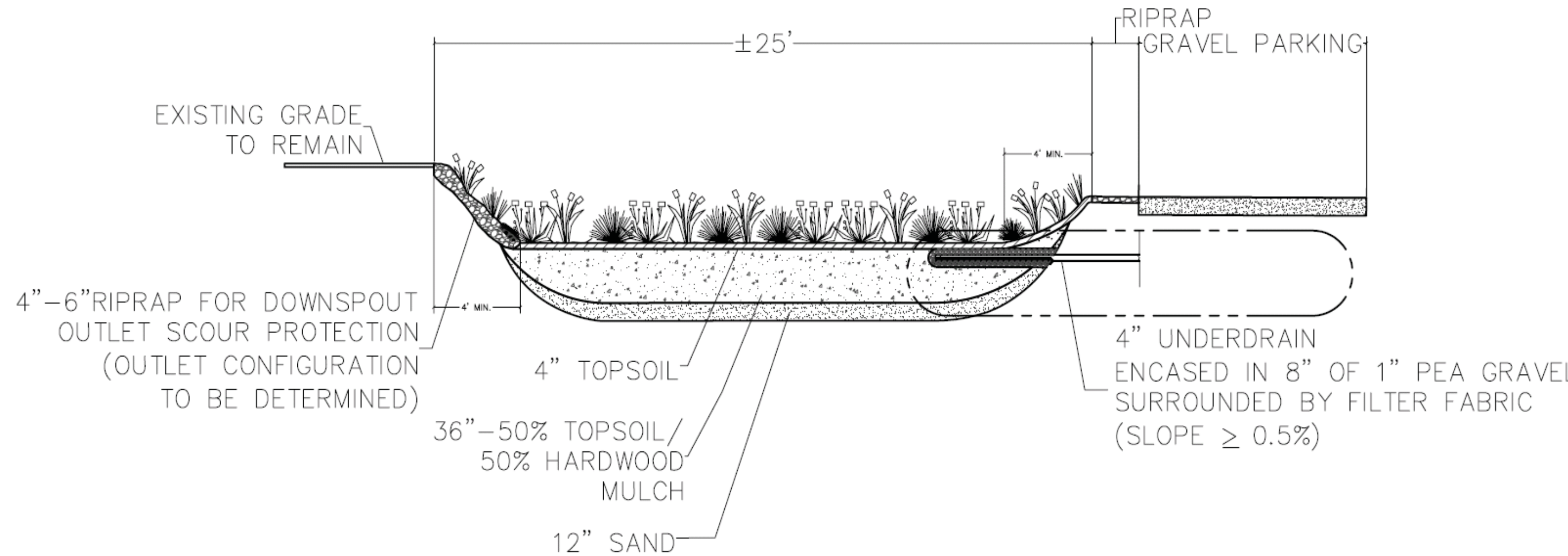
* of *



LD-7a: V-Notch Weir with Concrete Headwall

SWM Area	Weir Angle	Weir Invert	Spillway Elevation
#	W-1	V-2	S-1
12	15 deg.	479.0	482.0
16b	15 deg.	475.0	478.0
21	45 deg.	486.0	489.5
43	15 deg.	487.0	490.0
45	30 deg.	476.0	479.0
60	60 deg.	485.0	488.0
71	60 deg.	484.0	487.0





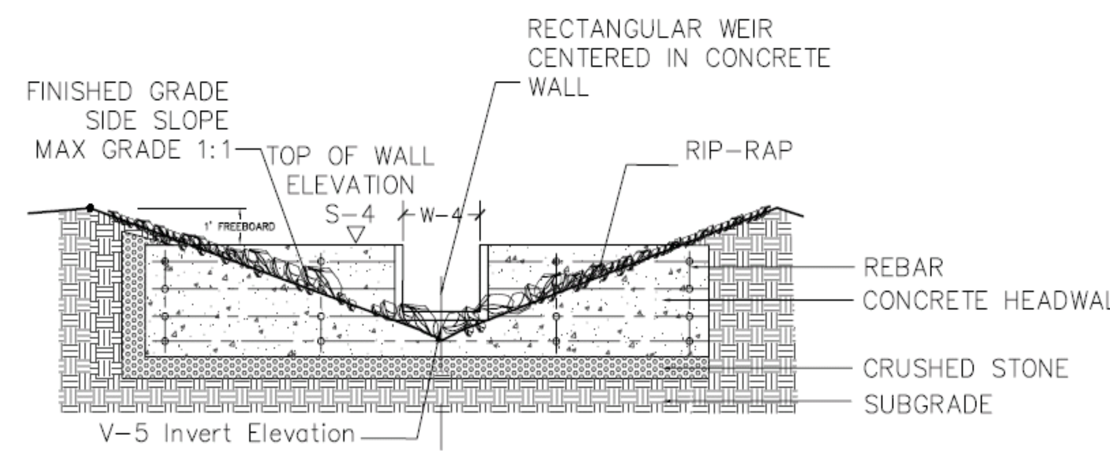
LD

RAIN GARDEN DETAIL

Not to Scale

LD-7b: Rectangular Weir with Concrete Headwall

SWM Area	Rectangle Length	Weir Invert	Spillway Elevation
#	W-4	V-5	S-4
32b	5'-0"	476.75	482.0
41b	5'-0"	485.75	478.0



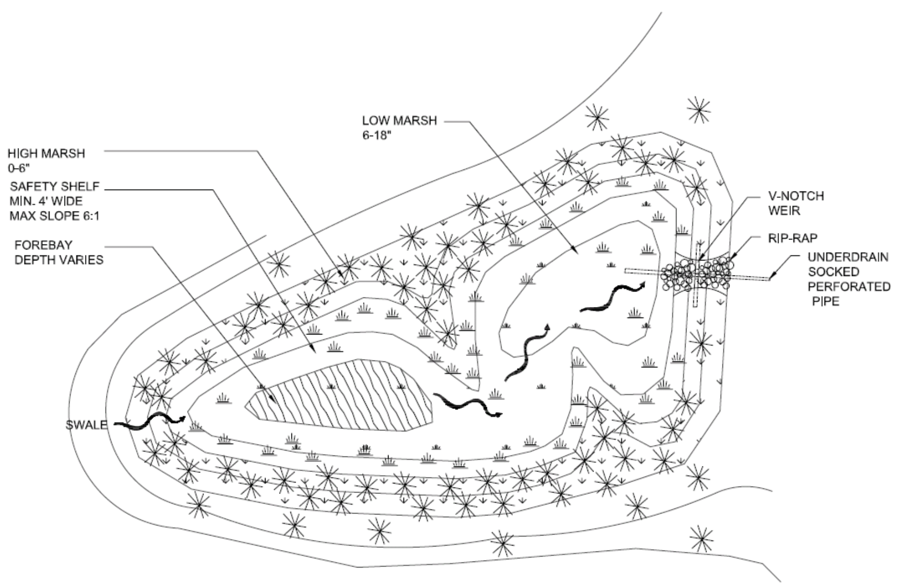
LD-7b

TYPICAL OPEN RECTANGULAR OUTLET WEIR

Not to Scale

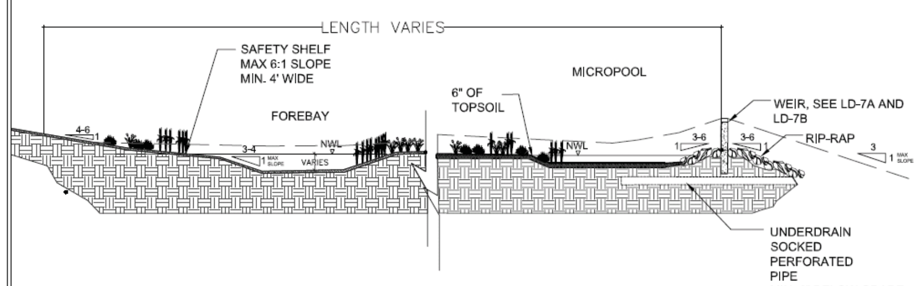
Typical Rain Garden Design Elements

Rock Hill Trails



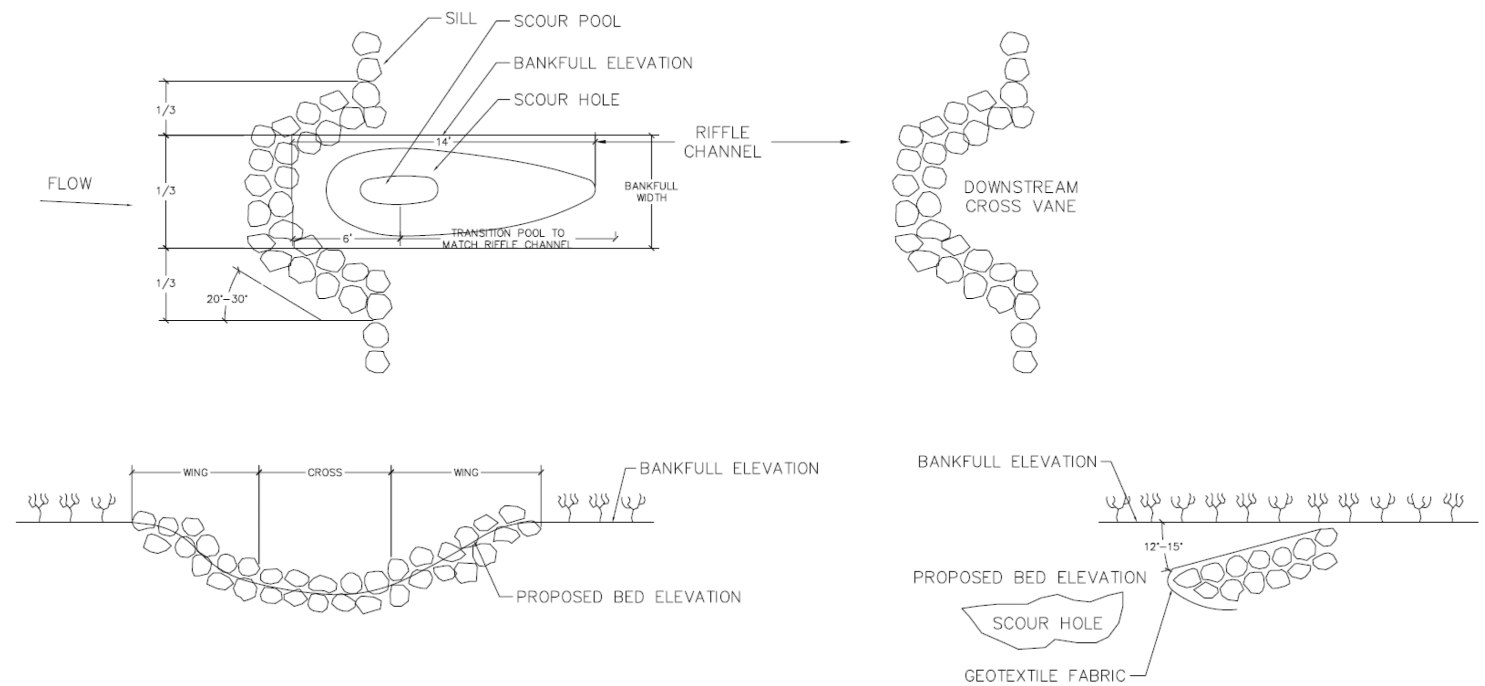
LD-1 TYPICAL CONSTRUCTED WETLAND

Not to Scale



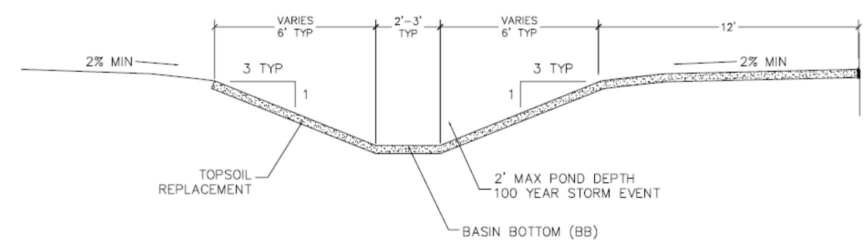
LD-1b TYPICAL CONSTRUCTED WETLAND SECTION

Not to Scale



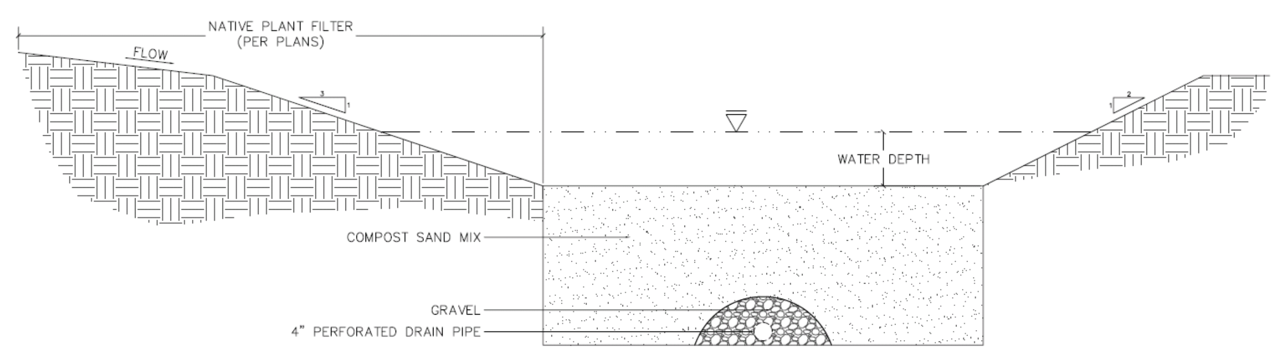
LD-2 TYPICAL CROSS VEIN

Not to Scale



LD-3 TYPICAL SWALE

Not to Scale



LD-4 TYPICAL BIORETENTION CELL

Not to Scale

Rock Hill Trails

Wellspring Development Company

Wood River, Illinois

DETAILS

REVISIONS

No: 1	Date:	By:
Description:		
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No: 3	Date:	By:
Description:		
No: 4	Date:	By:
Description:		

AES Proj. #:
Checked:
Approved:
Drawn by: CAQ
File: bmp_100907_2004.dwg
Date: 10-10-07
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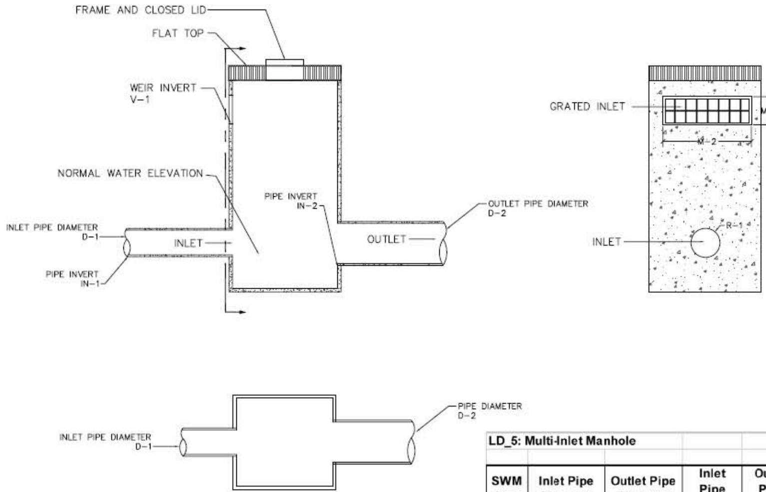
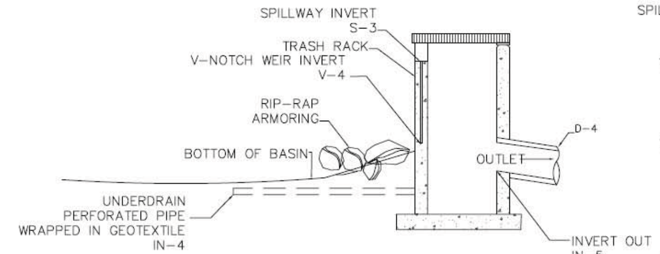
D-1

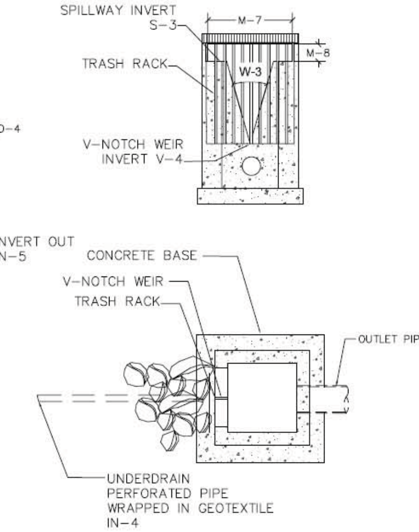


LD_5: Multi-Inlet Manhole							
SWM Area	Inlet Pipe Diameter	Outlet Pipe Diameter	Inlet Pipe Invert	Outlet Pipe Invert	Weir Invert	Grate Height	Grate Width
#	D-1	D-2	IN-1	IN-2	V-1	M-1	M-2
70	8"	18"	491	491	493.5	6"	3'-0"

LD-5 TYPICAL MULTI-INLET MANHOLE

Not to Scale

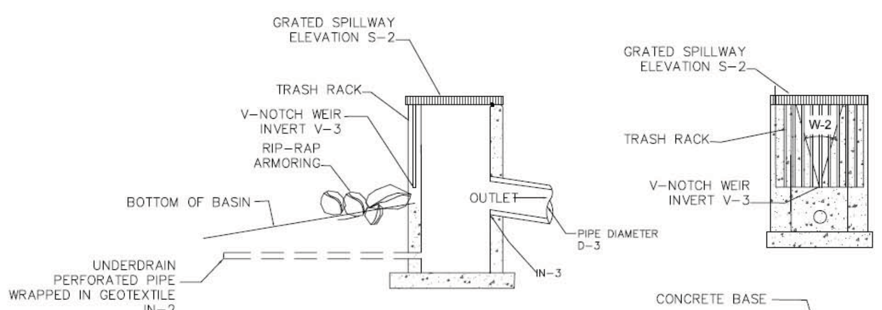


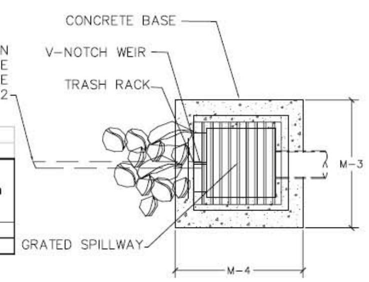


LD-8: Compound V-Notch Weir								
SWM Area	V-Notch Angle	V-Notch Weir Invert	Spillway Invert	Grate Width	Underdrain Invert	Outlet Pipe Invert	Outlet Pipe Diameter	Overland Flow Elevation
#	W-3	V-4	S-3	M-7	IN-4	IN-5	D-4	
32	15 deg.	481.5	482.5	2'-0"	479.0	479.0	min.12"	482.8
31	45 deg.	482.5	483.5	2'-0"	480.0	480.0	min. 12""	484.0
40	15 deg.	489.0	491.5	2'-0"	N.A.	488.0	min. 15"	492.0
40b	15 deg.	481.0	483.5	2'-0"	N.A.	481.0	min 15"	484.0
41	45 deg.	490.5	491.5	2'-0"	488.5	489.0	min. 15"	491.8

LD-8 TYPICAL COMPOUND OUTLET STRUCTURE

Not to Scale



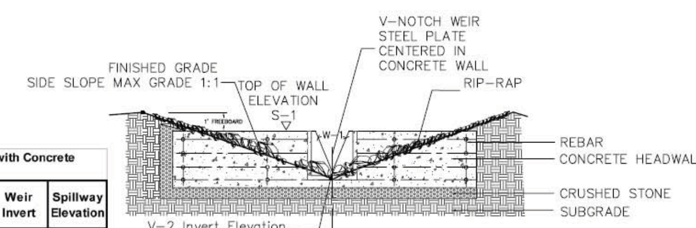


UNDERDRAIN
PERFORATED PIPE
WRAPPED IN GEOTEXTILE
IN-2

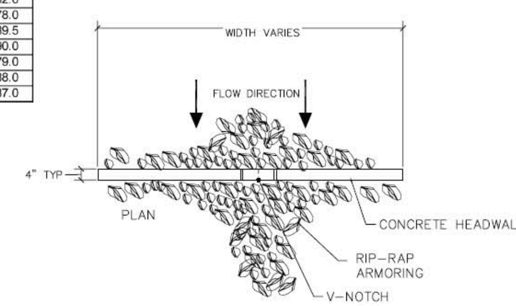
LD-6: Typical Outlet Structure with Grated Overflow Cover								
SWM Area	V-Notch Angle	V-Notch Weir Invert	Outlet Pipe Diameter	Underdrain Pipe Invert	Outlet Pipe Invert	Overflow Spillway Elevation	Legnth	Width
#	W-2	V-3	D-3	IN-2	IN-3	S-2	M-3	M-4
16	120 deg.	477.5	30'	475.5	476.5	479.0	4'-0"	3'-0"

LD-6 TYPICAL OUTLET STRUCTURE WITH GRATED COVER

Not to Scale



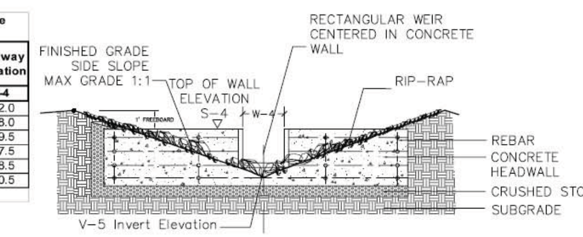
LD-9a: V-Notch Weir with Concrete Headwall			
SWM Area	Weir Angle	Weir Invert	Spillway Elevation
#	W-1	V-2	S-1
12	15 deg.	479.0	482.0
16b	15 deg.	475.0	478.0
21	45 deg.	486.0	489.5
43	15 deg.	487.0	490.0
45	30 deg.	476.0	479.0
60	60 deg.	485.0	488.0
71	60 deg.	484.0	487.0



LD-9a TYPICAL OPEN V-NOTCH OUTLET WEIR

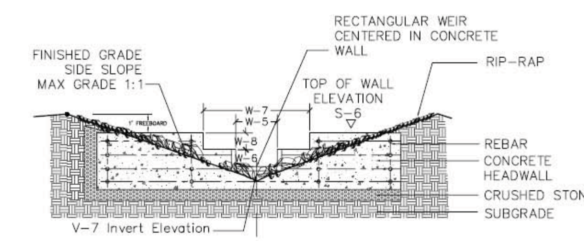
Not to Scale

LD-9b: Rectangular Weir with Concrete Headwall			
SWM Area	Rectangle Length	Weir Invert	Spillway Elevation
#	W-4	V-5	S-4
32b	60"	476.75	482.0
41b	60"	485.75	478.0
50	1"	497.00	499.5
51	36"	495.00	497.5
55	2"	496.00	498.5
56	6"	498.00	500.5



LD-9b TYPICAL OPEN RECTANGULAR OUTLET WEIR

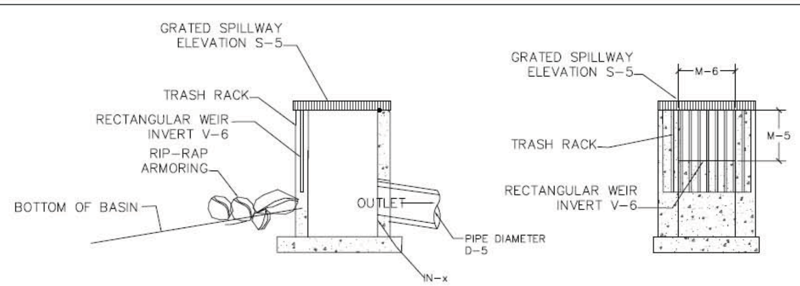
Not to Scale



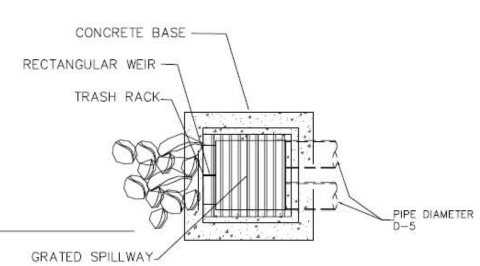
LD-9c: Double Rectangular Weir with Concrete Headwall						
SWM Area	Tier 1 Length	Tier 1 Height	Tier 2 Height	Tier 2 Height	Weir Invert	Spillway Elevation
#	W-5	W-6	W-7	W-8	V-7	S-6
53	4'-9"	18"	7'-6"	18"	496.00	499.0
57	36"	18"	6'-0"	36"	487.00	491.5

LD-9c TYPICAL DOUBLE RECTANGULAR OUTLET WEIR

Not to Scale

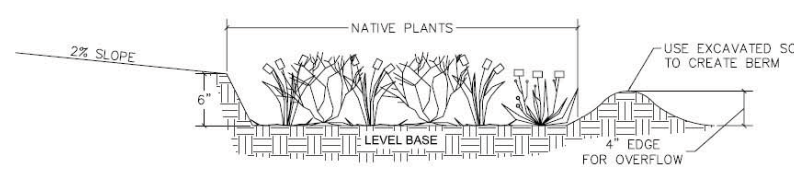


LD-7: Typical Multi-Outlet Structure with Grated Overflow Cover						
SWM Area	Weir Invert	Overflow Spillway Elevation	Outlet Pipe Diameter	Outlet Pipe Invert	Weir Height	Weir Width
#	V-6	S-5	D-5	IN-6	M-5	M-6
52	501.0	502.75	18"	XXX	18"	21"



LD-7 TYPICAL MULTI-OUTLET STRUCTURE
WITH GRATED COVER

Not to Scale



LD-10 TYPICAL RAIN GARDEN

Not to Scale

Rock Hill Trails

Wellspring Development Company
Wood River, Illinois

DETAILS

REVISIONS		
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Description:		
No: 4	Date:	By:
Description:		

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