EXECUTIVE SUMMARY

This report summarizes the feasibility study conducted throughout 2012 to determine the feasibility of vegetated swales in the City of O’Fallon, Illinois. The feasibility included design and construction of retrofitting existing hard armored roadside ditches with vegetative swales, future recommended areas for vegetative swales and other site specific green infrastructure, and the use of storm water best management practices in new development.

Utilizing Geographic Information Systems (GIS) technology and two pilot project locations, this report outlines the best locations for roadside vegetated swale implementation, design and construction guidelines and operation and maintenance guidelines. This study includes potential future implementation, analysis of any potential ordinance revisions and the development of hypothetical future branding and marketing strategies for engaging with City residents.

While the focus of this document is retrofitting existing concrete swales, the planning process has also identified the benefits of vegetative swales and other green infrastructure strategies for areas of future development. The benefit of removing hard armored concrete swales and replacing with vegetative swales is the increased stormwater infiltration (less stormwater runoff) and increased removal of pollutants and sediments from stormwater runoff. The drawback of retrofitting is the cost associated with removing existing hard armoring. However, in areas of future development, installing vegetative swales and other green infrastructure can be more readily accommodated.

The primary recommendations as a result of this study include:

1. In areas of new development, the City should encourage the use of vegetative swales and other storm water best management practices. The City should encourage pilot projects that would showcase storm water best management practices and green infrastructure.

2. For both existing and new developments, the City should encourage stormwater best practices and ensure that City ordinances allow for the utilization of best practices such as rain barrels/cisterns, rain gardens, and residential downspout disconnections.

3. In existing areas with hard armor ditches or curb/stormwater piping, the City should seek opportunities to implement vegetated swales in priority areas. To avoid costs of removing existing facilities, the City should consider opportunities when existing infrastructure is being replaced or repaired.

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The City of O’Fallon and its 1.5-mile extraterritorial jurisdiction overlap two 10-digit hydrologic unit code (HUC-10) watersheds—Richland Creek and Silver Creek. Both are listed on the Illinois EPA’s Section 303(d) of the Federal Clean Water Act list of impaired waters, in addition to two smaller order streams in O’Fallon, Ogles Creek and Loop Creek. The cause of impairment listed in the Illinois EPA’s 2010 Integrated Report for these four streams varies, but they all have the following causes in common: streambank erosion, municipal point source discharge, and urban runoff/storm sewers (non-point source).

To reach a significant reduction of pollutants in the receiving streams, multiple storm water best management practices (BMPs) such as vegetative swales, rain gardens, porous pavement, bioswales, etc. need to be installed throughout the City’s storm system to collectively reduce storm water runoff and increase infiltration and ground water recharge. For the purposes of this feasibility study, the potential impact of one type of BMP was analyzed: the roadside vegetated swale. A vegetative swale is a linear, shallow, planted channel that guides water away from its entry point on the property (roadway runoff, downspouts, etc.). Swales are planted/seeded with plant species that thrive in this environment, and are also seasonally tolerant. The plants’ deep root structure aids in reducing the flow rate of stormwater runoff and enhances the absorption rate of stormwater before it even reaches its destination. Erosion can be a problem in drainageways where velocities are high, such as roadside ditches. Deep-rooted native species, as opposed to turf grasses, can help to bind and stabilize the soil.

Many of the roadside stormwater ditches throughout the City of O’Fallon have been “hard-armored” to help alleviate the stormwater issues outlined above: erosion, flooding, stagnant water, etc. Removing the concrete swales and replacing them with vegetated swales will slow the flow of stormwater, increase the infiltration rate (thus reducing flooding risk), filter pollutants carried by the runoff, and improve regional water quality downstream. While no water quality measurements were included in this particular study, these benefits are well-documented and can be an assumed benefit of proper installation and maintenance.

**BENEFITS OF VEGETATED SWALES**

- Cost effectively retrofit BMP to help manage storm water
- Reduce runoff volume, velocity, and temperature
- Reduce downstream erosion potential through sediment deposition
• Reduce peak flow storm water volume spikes downstream
• Filter pollutants such as nutrients, metals, pesticides, and petroleum hydrocarbons, reducing loading to receiving waters
• Remove pathogens and pesticides from storm water runoff
• Enhances aesthetic appeal of streets, neighborhoods, and commercial sites
• Vegetative makeup can be altered and modified as desired, post implementation
• Growing media and filter media are organic, all natural, biodegradable, and sustainable

GREEN INFRASTRUCTURE NETWORK
For purposes of discussing vegetated swales as part of O’Fallon’s green infrastructure, it is important to place them in context with similar practices regionally and nationally. Green infrastructure BMPs are recognized as an approach to site design that minimizes impacts on the environment from stormwater.

From a municipal public works perspective, the incorporation of multiple, connected vegetated swales in the overall storm water management system will maximize their benefits along with exponentially increasing the quality of the water delivered to the receiving streams. The goal of this feasibility study was to determine the optimum locations for roadside vegetated swale installation - where would the City see the most “bang for their buck”? In addition to this detailed analysis, two pilot locations were studied for a six-month period to establish baseline flow data in existing “hard-armed” roadside swales. Should the City decide to undertake implementation, design and construction guidelines have been provided, along with an operation and maintenance manual. The City’s planning and zoning documents have been analyzed for potential changes needed to allow successful implementation of roadside vegetated swales. And finally, a community education program has been developed, along with a new branding strategy for the City, which will educate area residents about the benefits of implementation.

To achieve the recommendations of this report, the following initial implementation steps are recommended:

1. Identification and implementation of a Vegetative Swale Pilot Project. Candidates for a pilot project would include:
   (a) Vegetative swale as part of a new private site development.
   (b) Vegetative swale as part of a new City owned project.
   (c) Retrofit of an existing hard armored ditch (funded through a grant).
   (d) Vegetative swale retrofit as part of another infrastructure project.

2. Update Ordinances to ensure storm water best management practices are allowed.

3. Utilize “Green Up” Branding & Marketing Materials to Publicize Pilot Project

Once a local success story exists, the likelihood of support from elected officials and residents alike will make city-wide implementation a more realistic possibility.
Vegetated Swale

Description
Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems.

California Experience
Caltrans constructed and monitored six vegetated swales in southern California. These swales were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

Advantages
- If properly designed, vegetated, and operated, swales can serve as an aesthetic, potentially inexpensive urban development or roadway drainage conveyance measure with significant collateral water quality benefits.

Design Considerations
- Tributary Area
- Area Required
- Slope
- Water Availability

Targeted Constituents
- Sediment ▲
- Nutrients ●
- Trash ●
- Metals ▲
- Bacteria ●
- Oil and Grease ▲
- Organics ▲

Legend (Removal Effectiveness)
- Low
- High
- Medium
Table 2  Swale Cost Estimate (SEWRPC, 1991)

<table>
<thead>
<tr>
<th>Component</th>
<th>Unit</th>
<th>Extent</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Mobilization / Demobilization-Light</td>
<td>Swale</td>
<td>1</td>
<td>$1.07</td>
<td>$274</td>
</tr>
<tr>
<td>Site Preparation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clearing</td>
<td>Acre</td>
<td>0.5</td>
<td>$2,000</td>
<td>$3,800</td>
</tr>
<tr>
<td>Chipping</td>
<td>Acre</td>
<td>0.25</td>
<td>$3,800</td>
<td>$5,200</td>
</tr>
<tr>
<td>General</td>
<td>Yd²</td>
<td>372</td>
<td>$2,10</td>
<td>$3,70</td>
</tr>
<tr>
<td>Level and Tilt</td>
<td>Yd²</td>
<td>1,210</td>
<td>$0.20</td>
<td>$0.35</td>
</tr>
<tr>
<td>Site Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salvage Topsoil</td>
<td>Yd²</td>
<td>1,210</td>
<td>$0.40</td>
<td>$1.00</td>
</tr>
<tr>
<td>Seed, and Mulch</td>
<td>Yd²</td>
<td>1,210</td>
<td>$1.20</td>
<td>$2.40</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contingencies</td>
<td>Swale</td>
<td>1</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source (SEWRPC, 1991)

Note: Mobilization/demobilization refers to the organization and planning involved in establishing a vegetative swale.

¹ Swale has a bottom width of 1.0 foot, a top width of 10 feet with 1:3 side slopes, and a 1,000-foot length.

² Area cleared = (top width + 10 feet) x swale length.

³ Area grubbed = (top width x swale length).

⁴ Volume excavated = (0.57 x top width x swale depth) x swale length (parabolic cross-section).

⁵ Area tilled = (top width + Biswale depth²) x swale length (parabolic cross-section).

⁶ Area seeded = area cleared x 0.5.

⁷ Area sodded = area cleared x 0.5.
Case Study #1 cont.

## Vegetated Swale

### Table 3 Estimated Maintenance Costs (SEWRPC, 1991)

<table>
<thead>
<tr>
<th>Component</th>
<th>Unit Cost</th>
<th>Swale Size (Depth and Top Width)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width</td>
<td>3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width</td>
</tr>
<tr>
<td>Lawn Mowing</td>
<td>$0.86 / 1,000 ft² / mowing</td>
<td>$0.14 / linear foot</td>
<td>$0.21 / linear foot</td>
</tr>
<tr>
<td>General Lawn Care</td>
<td>$0.00 / 1,000 ft² / year</td>
<td>$0.18 / linear foot</td>
<td>$0.28 / linear foot</td>
</tr>
<tr>
<td>Swale Debris and Litter Removal</td>
<td>$0.10 / linear foot / year</td>
<td>$0.10 / linear foot</td>
<td>$0.10 / linear foot</td>
</tr>
<tr>
<td>Grass Reseeding with Mulch and Fertilizer</td>
<td>$0.00 / yd³</td>
<td>$0.01 / linear foot</td>
<td>$0.01 / linear foot</td>
</tr>
<tr>
<td>Program Administration and Swale Inspection</td>
<td>$0.15 / linear foot, plus $25 / inspection</td>
<td>$0.15 / linear foot</td>
<td>$0.15 / linear foot</td>
</tr>
<tr>
<td>Total</td>
<td>--</td>
<td>$0.58 / linear foot</td>
<td>$0.75 / linear foot</td>
</tr>
</tbody>
</table>
1. ISSUES AND CONCERNS:
Roadside drainage ditches were observed throughout the Mulhockaway Creek Watershed. Ditches and swales convey runoff to the Creek and various tributaries throughout the watershed. Many are sparsely vegetated, actively eroding and contributing to runoff quality or quantity issues in the watershed. According to the stormwater inventory conducted by Hunterdon County Soil Conservation District, 25% of ditches and swales in approximately 4.3 miles of the watershed were failing or in poor condition, with exposed bare soil, sedimentation at the swale bottoms, and eroded side slopes. The impervious surfaces created by roadway pavement drastically increase runoff volumes and peak flow rates from the natural conditions in the watershed. Increased runoff volumes and peak flow rates cause many environmental concerns, including decreased recharge, decreased baseflow to local streams, increased erosion, elevated pollutant loads, and ultimately degraded water quality in lakes and streams. While the stormwater ditches are preferred to piped conveyance, there is potential to improve stormwater management by stabilizing and retrofitting the ditches into water quality swales.

2. EXISTING CONDITION BASED ON FIELD EVALUATION:
Currently, multiple stormwater ditches are located throughout the Mulhockaway Creek Watershed that can be characterized as being in poor condition and in need of stabilization and possible retrofit improvements. The most significant problems are observed in ditches with steep side slopes, narrow bottom widths, visibly eroded soils, and little or no permanent vegetation. In general, they accumulate and discharge sediment laden runoff from the roadways during significant rainfall events.

3. PROPOSED SOLUTIONS:
Where possible, the swales should be reconstructed to meet the design requirements set forth in the NJ Soil Erosion and Sediment Control Standards. In general ditches and swales should have wider bottom widths and maximum side slopes of 3:1. These dimensions can sustain a healthy grassy cover. In addition to stabilizing eroding soils and reconstructing the ditches, opportunities exist to retrofit many of these areas into water quality swales. The design of the swales will depend on site-specific parameters, such as the right of way width, depth to groundwater, nearby vegetation, and topography. In general, the water quality retrofits should include infiltration and bioretention media, native plantings and vegetation, and periodic gabion check dams to detain flows.
4. ANTICIPATED BENEFITS:
Water quality swales use natural processes, such as infiltration, evapotranspiration, and phytoremediation to manage stormwater from nearby roads. While the NJDEP BMP Design Manual does not explicitly give pollutant loading values for transportation areas, we can assume similar loading rates to commercial areas. According to the Manual, commercial areas generate 200 lbs/acre/year of total suspended solids (TSS) and 2.1 lbs/acre/year of Total Phosphorus (TP). The proposed water quality swales will greatly reduce the pollutant loading through detention and filtration processes. By regarding the swales with wider bottom widths and gentler side slopes, less erosion will occur within the swales and lower sediment loads to nearby streams. The proposed check dams also slow runoff velocities, detain water behind the dams, and trap sediment.

5. MAJOR IMPLEMENTATION ISSUES:
Any retrofits or design modifications will require that municipalities and the county road department work with project partners to allow for swale construction along the existing roadways. Specifically, local municipalities and the county will need to endorse these efforts and allow construction and provide routine maintenance of the stormwater BMPs. One of the most important components of implementing stormwater retrofits is to ensure that routine maintenance is provided and the systems function as they are designed.

<table>
<thead>
<tr>
<th>TASK</th>
<th>DESCRIPTION</th>
<th>ESTIMATED COSTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conduct pre-application meeting with Hunterdon SCD. Prepare final design plans and permits.</td>
<td>$5,000.00</td>
</tr>
<tr>
<td>2</td>
<td>Prepare Stormwater BMP Maintenance Plan per NJDEP requirements.</td>
<td>$2,000.00</td>
</tr>
<tr>
<td>3</td>
<td>Prepare construction documents and solicit quotes from contractors.</td>
<td>$2,500.00</td>
</tr>
<tr>
<td>4</td>
<td>Install stormwater BMP retrofits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MOBILIZATION/EROSION CONTROL</td>
<td>QUANTITY</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>LF</td>
</tr>
<tr>
<td></td>
<td>CURB AND PIPE REPAIR</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>SWALE CONSTRUCTION</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>CLOSEOUT/CONTINGENCY (20%)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>TOTAL CONSTRUCTION COST</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL COST:</td>
<td>$31,700.00</td>
</tr>
<tr>
<td></td>
<td>ANNUAL O&amp;M COST:</td>
<td>$500.00</td>
</tr>
</tbody>
</table>

Note: Construction and O&M costs are per 100 linear feet of swale/ditch.
CASE STUDY #2 cont.

Stormwater BMP Retrofit Summary Sheet - *Roadside Drainage Retrofits*
Mulhockaway Creek Stormwater Management
and Associated Watershed Restoration Plan

SDO-13&15 Ditch with steep side slope

SDO-186 Ditch with sediment deposition in channel

Open area near SDO-186 Ditch discharge
An important part of the success of any new campaign is branding and marketing. To facilitate the introduction of roadside vegetated swales to the community of O’Fallon, we have developed a branding and marketing strategy that could be implemented along with the new construction, whether it be the City or a developer.

As opposed to branding and marketing just the concept of roadside vegetated swales, we have developed a brand for the City as a whole. “Green Up O’Fallon” is a larger concept that can include various stormwater best management practices, tree plantings, new parks, etc. Any new sustainability initiative undertaken by any department within the City could include this logo, tying together a larger community mission to be an environmentally-conscious community.

Beginning with a re-branding of the City’s Public Works website, Green Up O’Fallon can become the “umbrella” campaign for comprehensive stormwater management. As demonstrated on the cover of this report, roadside vegetated swales become just a tool in the larger initiative. Not only does this take the focus off this individual BMP, but it educates citizens about the larger issue/concept of green infrastructure and sustainable stormwater management.

Through use of the various branding avenues highlighted in the following pages, the City can garner community support and buy-in as well as communicate its commitment to comprehensive sustainable stormwater management in a uniform way.

There are two basic categories of branding and marketing strategies under the Green Up O’Fallon Campaign - internal and external.

**INTERNAL**
These digital and printed materials have been developed for use by the City and its various departments. Beginning with the City’s website, there are various “banners” and “ads” that can be utilized to create a uniform campaign approach.

*Webpage Banner 1*
Green Up

Stormwater can be BEAUTIFUL too!
Join us in the beautification and clean water initiatives for our City!
Follow us on Twitter and Facebook or call us for more information: 618.624.4500

www.ofallon.org/greenup

Q: What will be BLUE, GREEN & AMAZING?
A: Look on...

Q: What will be BLUE, GREEN & YOURS?
A: Look on...

Three different types of webpage “ads” - these would be utilized as either “side banners” (3) or as stand-alone ads (1 & 2) on internal city webpages or external webpages the city is partnering with, i.e. participating developer’s websites, landscaping companies, etc.
Stormwater can be BEAUTIFUL too!

Join us in the beautification and clean water initiatives for our City!
Sign up for information on best practices for trees, vegetative swales, rain gardens and native plantings. You will receive tips on selection, installation, incentives, care and maintenance.

Help ensure the quality of your community is enhanced for today and for future generations. Careful beautification now, can mean less costs for hard infrastructure in the future!

Follow us on Twitter and Facebook or call us for more information: 618.624.4500

Utility Insert
Stormwater can be BEAUTIFUL too!

Join us in the beautification & clean water initiatives for our City!

Sign up for information on best practices for planting trees, installing vegetative swales, how to manage rain gardens and select native plantings. Green Up O’Fallon will improve the look of the city and improve the quality of life, air and water.

Subscribe to our newsletter and you will get tips on selection, installation, incentives, care and maintenance. Help ensure the quality of the community is enhanced for today and for future generations.

Careful beautification now, can mean less costs for infrastructure in the future!

Follow us on Twitter and Facebook or call us for more information: 618.624.4500
“Green Infrastructure” is an interconnected network of open spaces and natural landscapes. It can be made up of many different connected components, on developed and undeveloped land: parks, greenways, forests, wetlands, farms and ranches, waterways, conservation lands, and wilderness. It has also come to mean built mimicry of these systems - connected ultimately to each other and back into the symbiotic landscapes.

The term “Infrastructure” is used because this network, like familiar systems of built infrastructure (highways, electrical power, sewers, etc.) serves vital social, economic, and ecological functions: Green Infrastructure combats air pollution and climate change, because plant life removes carbon dioxide and other pollutants from the atmosphere. Green Infrastructure makes communities more attractive for residents, and fosters a stronger connection to nature. It reveals quality spaces and places. It is additive in its benefits. Green Infrastructure maintains natural hydrological cycles.

By conserving wetlands and waterways, and by introducing more natural, planted landscape into developed areas, Green Infrastructure protects the natural water cycle. In this way, Green Infrastructure can serve as a cost effective and ecologically sound stormwater management strategy. It is even more so by combining it with Low Impact Development best management practices (LID BMPs). Green Infrastructure can absorb, filter, process, and direct stormwater. As rain falls, plant roots absorb rainwater. Some water filters back through the soil, to natural aquifers. Some landscapes and wetlands can filter rainwater, eventually releasing it into lakes, ponds, and waterways. Traditional stormwater systems collect stormwater and release it to nearby waterways, bypassing aquifers, altering the natural water cycle, and potentially causing floods or overflows.

Q: What is the difference between bioswales & rain gardens?

A: Bioswales vs Raingardens

Description: Bioswales are similar to rain gardens, but while rain gardens are level, bioswales slope. They tend to resemble drainage ditches and are often constructed near large pavement areas or roadsides where greater volumes of water may flow after a rain. The roots of plants within bioswales help in erosion control and water absorption. Because of the slope, water is generally not held as long as in a rain garden. Often a rain garden may be constructed at the end of a bioswale. Bioswales may have steep sides, requiring additional commercial products to aid in soil retention. They may be dry for long periods of time, once rainfall or snow melt has dissipated.

Description: A Rain Garden is a planted depression that is designed to take all, or as much as possible, of the excess rainwater run-off from a house/building and its associated landscape, where native plants soak up some of the water allowing the rest to percolate slowly (within one to five days) into the ground. Benefits: Keeps rainwater and melted snow on site, so as not to overload storm sewers and cause flooding. Allows streams and creeks to be fed by cool groundwater at a constant rate. Provides a way to use and optimize rainfall, reducing or avoiding the need for irrigation. Because water is held for a short amount of time, mosquito breeding does not take place. Filters some pollutants caused by runoff from paved areas, roads and roofs. Encourages wildlife and biodiversity. Recharges groundwater, reducing the need for costly stormwater treatment structures.
Ask Mr. Smarty Plants
via the Lady Bird Johnson Wildflower Center

QUESTION:
I have a 300ft by 15 ft bioswale in Illinois. What plants would be best used? Is there a percentage of each plant to take into consideration?

ANSWER:
What a great project! A bioswale or rain garden is the ideal marriage of function and form. It will slow down storm water runoff to allow infiltration of water into the soil. This prevents erosion, facilitates the removal of pollutants by soil biota and reduces irrigation requirements to adjacent garden areas. On top of these not insignificant benefits, the choice of appropriate native plants will also provide wildlife habitat.

Your area is long and narrow so you will likely be planting a garden that will simulate a stream and bank. The light conditions will impact whether you are creating a “woodland” or “sunny meadow” stream and control your plant choices. You have an area that is large enough to incorporate trees and shrubs as well as perennials and grasses. Plant percentages are entirely up to you; you will design this garden the same way you design any other “mixed border” in your garden.

Although your swale will look like a stream and will some times have an (over)abundance of water in it, your plants will also need to be adapted to dry conditions as well. Fortunately, many plants that can survive in saturated conditions are also able to handle dry and even compacted soil. If it is possible to amend the soil before you begin to remediate compaction, you will have more success as the water will infiltrate the soil quicker. You need to evaluate your conditions before you select plants to determine how long you actually have standing water. If the water stands for an extended period, you will want to choose only plants that can tolerate those conditions.

Ultimately, your plant selection will be limited by what is available in your area but our Native Plant Database will be a great starting point. By doing a Combination Search choosing Illinois and Wet Conditions along with your light requirements and water depth, you will have a much smaller list of plants that can survive in saturated conditions. This will result in a much smaller list of plants that are readily available. There is also a list of recommended suppliers linked to that page. Sample pages are presented as such and should not be used as the only resource.

Low Impact Development & Redevelopment in Southwestern Illinois is a (Green) Upward Trend!

SUSTAINABLE + ATTAINABLE

Green Infrastructure and Low Impact Development best management practices (LID BMPs) as a network of natural landscapes are often less expensive to establish and maintain than traditional stormwater strategies of complex system of drains, pipes, and storm sewers. Furthermore, Green Infrastructure can filter and process certain pollutants and undesirable runoff, while traditional stormwater systems may release them into our waterways (See reverse side).

LID BMPs support the larger green infrastructure and framework from their particular site, thus becoming symbiotic piece of the larger framework. These initiatives are mutually beneficial to the site as well as the greater whole. Examples of these will be explored in the pages of the booklet. Sample pages are below.

A builder or property owner can be provided with a concept plan by a landscape professional, or by following guidelines through research online. The conceptual plan looks to create opportunities and establish a compelling vision to foster confidence and provide broad direction for mutually supportive and integrated projects in order to create a distinctive, viable green infrastructure framework throughout the community.

Grasses & Perennials
- Calamagrostis canadensis (bluejoint)
- Carex stipata (owlfound sedge)
- Spartina pectinata (prairie cordgrass)
- Asclepias incarnata (swamp milkweed)
- Allium fimbriatum (common ladyfern)
- Chelon glabra (white turtlehead)
- Gentiana andrewsii (closed bottle gentian)
- Iris virginica (Virginia iris)
- Iris virginica (Virginia iris)

Shrubs & Small Trees
- Cephalanthus occidentalis (common buttonbush)
- Physocarpus opulifolius (common ninebark)
- Viburnum opulus var. americanum
- (American cranberrybush)
- Alnus incana (gray alder)
- Amelanchier arborea var. arborea
- (common serviceberry)
- (American cranberrybush)
The following materials are ideas for ways to get O’Fallon residents involved with this initiative. A grassroots, bottom-up support network should be encouraged, as this will create “champions” for this initiative within the community, alleviating some pressure from city staff to carry the torch for building support.

These products can be made available to any interested citizens, e.g. for free at both “front desks” in City Hall, or they can be distributed as incentives to active citizens - those that distribute door hangers, volunteer to help maintain swales, and/or members of a “friends” group created in support of the initiative.

Below are a sample bumper sticker (1), a “button” sticker or magnet or actual button (2), and a window cling (3). These are just three possible types of materials for external use.
PLANT LIST
Another component of the marketing campaign we encourage the City include is the plant list. One of the first complaints about green infrastructure is the “weed” comparison. Educating citizens up front about which types of plants are on the “approved” list, including their expected growth height, flowering season and photos of the plans in bloom can help alleviate these concerns, increase the excitement and support from interested citizens, and focus the community’s attention on one of the best parts of green infrastructure - the pretty flowers!

Here is the recommended plant list (also included in the Appendix):

Low Profile Prairie Seed Mix (Mesic Soils)

Mix Description: Pizzo's Low Profile Prairie Seed Mix is designed for sunny areas that remain mesic-dry for most of the growing season. This mix is composed of a diverse collection of shorter-profile prairie grass and wildflower species, and is ideal for areas where taller vegetation is not appropriate. Over 82% of the seeds in this mix typically grow to an average height of 3’ or less and over 48% of the mix is composed of wildflowers that will provide an array of blooms from April through October. When installed and maintained correctly this mix will typically begin flowering in its second growing season, starting with the yellow blooms of annual Partridge Pea and biennial Black-Eyed Susan, with additional more colorful permanent species appearing in years 3-5. This mix can be supplemented with the recommended plug list provided below to add diversity, color, and resilience to the long-term health of your prairie.

Clockwise: Nodding Onion (blooms May-June-July), Butterfly Weed (blooms June-July-August), and Flowering Spurge (blooms June-July-August)

photos: Missouri Botanical Garden
To proceed further with implementation of roadside vegetated swales, O’Fallon’s Subdivision and Development Control Ordinance (Ord. No. 3319) and accompanying Development Manual, both adopted Feb. 22, 2005, will need to be modified as they pertain to municipal and private ditches, incorporating the components of the vegetated swale design manual into city code.

EXISTING SITUATION

The City of O’Fallon and its 1.5-mile extraterritorial jurisdiction overlap two 10-digit hydrologic unit code (HUC-10) watersheds—Richland Creek and Silver Creek. The O’Fallon stormwater management system is a public and private network of curbs and gutters, piping, drainage ditches, and detention/retention basins.

Based on the guidelines within the Design & Construction and Operations & Maintenance Manuals, investigation was conducted into necessary City ordinance changes that would facilitate construction of the vegetated swales. The objective was to remove regulatory barriers that may impede private property owners and land developers from voluntarily implementing green infrastructure practices, as well as to encourage the City to implement such practices along public road right-of-ways.

Some of the methods that can be used to mitigate stormwater impact may be in conflict with other regulatory development requirements (e.g., reducing cul-de-sac radii, reducing parking spaces, using narrower streets and sidewalks, alternative pervious materials, etc.). Municipal officials are encouraged to identify impediments to these practices, determine what flexibility is available, and modify their rules as appropriate. Area local governments are increasingly supportive of green infrastructure and have an incentive to be supportive as an NPDES permittee or co-permittee. Municipalities should continue to work toward greener stormwater management solutions by removing policy barriers and allowing exemptions to conflicting requirements where it makes sense.

In the case of St. Louis City & County’s Metropolitan Sewer Department (MSD), the property owner must maintain any stormwater treatment devices, and they are periodically inspected by MSD to ensure proper maintenance is occurring. A maintenance plan is recorded with the property and is transferable with property ownership. Therefore, whatever BMP’s are selected, they need to be maintainable by the end user of the property. It is important to recognize that all designed systems will require maintenance, and as a rule, the more “engineered” the solution, the more frequent and expensive the maintenance that will be required.

There are economic trade-offs: while establishing buffer areas and managing stormwater may reduce the amount of land available for development, maintenance costs on future property owners are reduced. However, due to varying land values, some commercial users may have the financial resources and elect to maintain more expensive engineered structural practices. The best green infrastructure solution is the one that balances future maintenance costs, given the resources of the user, with the cost of development. (See page 14 for a table of the various benefits of green infrastructure)
<table>
<thead>
<tr>
<th>Benefit</th>
<th>Practice</th>
<th>Green Roofs</th>
<th>Tree Planting</th>
<th>Bioretention &amp; Infiltration</th>
<th>Permeable Pavement</th>
<th>Water Harvesting</th>
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<tbody>
<tr>
<td>Improves Habitat</td>
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<td>Improves Livability</td>
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<td>Improves Community</td>
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<td>Improves Aesthetics</td>
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<td>Reduces Urban</td>
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<tr>
<td>Reduces Heat Island</td>
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<tr>
<td>Reduces Pollutant</td>
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<tr>
<td>Reduces CO₂</td>
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<tr>
<td>Improves Air Quality</td>
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<tr>
<td>Reduces Saline Use</td>
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<tr>
<td>Increases Groundwater Recharge</td>
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<td>Increases Water Supply</td>
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<tr>
<td>Reduces Stormwater Runoff</td>
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</tbody>
</table>
The opportunity for the use of green infrastructure in the City of O’Fallon is quite broad. The catalog of stormwater management BMP’s has grown extensively just over the past 10 years. One reference regularly cited for “green” stormwater practices is the Maryland Stormwater Design Manual, Volumes I & II (Effective October 2000, Revised May 2009). They categorize BMP’s as either non-structural or structural as described below.

**POST-CONSTRUCTION NON-STRUCTURAL BMPS**

Non-structural BMP’s are development strategies that minimize the impact of land development on natural resources. Many of the non-structural techniques can be used to treat, as well as reduce, site runoff. These methods include:

- Natural area conservation
- Disconnection of rooftop runoff
- Disconnection of non-rooftop runoff
- Sheet flow to buffers
- Open (grass) channel use (for roadways)

In most cases, non-structural practices must be combined with structural practices to meet stormwater requirements. Nationally and at the St. Louis MSD, non-structural practices are increasingly recognized as a critical and economical feature of stormwater management.

**POST-CONSTRUCTION STRUCTURAL BMPS**

In all new development and redevelopment, MSD regulations “require” the use of BMP’s to treat stormwater quality and volume of runoff from rainfall and they specify certain structural BMP’s for this use. The structural BMP’s allowed for stormwater quality control are divided into six general categories. Post-construction structural BMP’s include:

1) Stormwater Ponds
   - Micropool Extended-Detention (ED) Ponds
   - Wet Ponds
   - Wet ED Ponds
   - Multiple Pond System
   - “Pocket Ponds”

2) Stormwater Wetlands
   - Shallow Wetland
   - ED Shallow Wetland
   - Pond/Wetland System
   - “Pocket Wetland”

3) Stormwater Infiltration
   - Infiltration Trench
   - Infiltration Basin

4) Stormwater Filtering Systems
   - Surface Sand Filters
   - Underground Sand Filters
   - Perimeter Sand Filters
   - Organic Filters
   - Pocket Sand Filters
   - Bioretention
   - Proprietary Cartridge Devices

5) Open Channel Systems
   - Dry Swale
   - Wet Swale

6) Hydrodynamic Separator Devices
   - See MSD Approved Devices

**O’FALLON’S NPDES PERMIT**

The basic regulatory components of municipal stormwater management were achieved with the adoption of the City’s Subdivision and Development Control Ordinance and accompanying Development Manual on February 22, 2005. However, these documents did not address the specifics
of NPDES Post-Construction Runoff Controls, such as the specific use of BMP’s, final inspection checklists, and long-term operations and maintenance agreements with private landowners.

Further reference to and policy support for BMP’s relative to the applicability of vegetated swales in O’Fallon can be found in the City’s NPDES Phase II Permit (ILR400412) of October 25, 2004 and 2009 Update. The NPDES (National Pollutant Discharge Elimination System) Permit is the EPA’s method of regulating and approving O’Fallon’s Municipal Separate Storm Sewer System, or MS4. Within the permit, O’Fallon’s proposed BMP’s related to Category E—Post-Construction Runoff Control include BMP’s E.2, E.3, and E.6 as described here:

BMP E.2, Regulatory Control Program
“The City currently has buffer yard (setbacks from creeks) and landscape requirements intended to minimize run-off and water quality impacts. The City will investigate implementing a post-construction stormwater control-related ordinance or amending existing ordinances to require additional protection of sensitive areas, encourage the minimization of impervious surfaces, promote minimal disturbance of the ecology, and use of structural and non-structural BMP’s in design. The City will also conduct a workshop for developers to introduce the new ordinance requirements and encourage the use of the promoted storm water controls.” The goal was for the ordinance and developer workshop to be enacted and implemented prior to March 2006.

BMP E.3, Long-Term Operation and Maintenance Procedures
“The City currently has ordinances addressing the ownership and the maintenance of stormwater systems not turned over to the City. The City will review the existing stormwater management ordinance to ensure its inclusion of long-term operation and maintenance responsibility agreements between the City and post-development landowners or regional authorities and the inclusion of filtration and storage practices.” The goal was for the ordinance revisions to be enacted by March 2005.

BMP E.6, Post-Construction Inspections
“Develop and implement a requirement for final inspections of developments to include check of swales, detention basins, etc., before sign-off by inspector. Continue to inspect for and enforce the revised post-construction stormwater runoff control related ordinances. Begin inspecting previously completed projects to check on long term operation and maintenance.” The goal was to implement the inspections prior to March 2006 and for inspections and enforcement to be on-going.

O’FALLON’S STORMWATER RESPONSIBILITIES
While the 2005 NPDES Permit defines O’Fallon’s intended stormwater management practices, it does not assign responsibility for implementation. In 2006-2007, the City of O’Fallon commissioned a Stormwater Management Program Rate Study. Part of that study included an analysis of the stormwater-related responsibilities of city departments. The Public Works and Planning & Zoning Departments are responsible for many direct stormwater and stormwater-related activities, including:

- Land disturbance/building permit application review
- Review of rezoning requests and variance requests
- Engineering design of medium sized road and drainage projects
- Creating and implementing drainage regulations
- Feasibility and drainage studies
• Capital Improvement Project (CIP) planning and development
• Street construction and maintenance planning
• Drainage system planning
• ROW and easement acquisition
• Erosion and sedimentation control

The Public Works Department is responsible for implementing the stormwater program, and shares
with Planning & Zoning in the administration of the City's Erosion and Sedimentation Control
Program under the Subdivision and Development Control Ordinance. Public Works is also responsible
for the planning and direction for streets, sewer lines, construction and maintenance, drainage
systems, right-of-way and easement acquisition.

The Operations and Engineering Groups comprise the Department of Public
Works. The Operations Group has two divisions that work part-time on
stormwater related responsibilities that include:
• Minor construction of drainage system headwalls and storm drains
• Clearing of rights-of-ways and drainage obstructions
• Public complaint response and coordination

O’FALLON’S STORMWATER-RELATED ORDINANCES
As mentioned earlier, the City’s primary regulatory document for stormwater management
practices is the Subdivision and Development Control Ordinance (Ord. No. 3319) and accompanying
Development Manual, both adopted February 22, 2005. The Subdivision Ordinance is the primary
policy document, setting forth “minimum requirements” for the standards and improvements for
any subdivision of land in the City or within its 1.5-mile extraterritorial jurisdiction. The Development
Manual is the design and construction document for the subdivision of land and provides minimum
standards for design and improvements.

Subdivision and Development Control Ordinance
Since the Subdivision and Development Control Ordinance is policy related, it does not contain
direct references to the specific manner in which storm water should be managed. References
are more generalized, prescribing that storm water utility service is to be provided and that it should
be functionally adequate (Section 1, p. 2). Within the Definitions (Section 2), several references to
stormwater management are provided, including Best Management Practices (BMP’s), Erosion
and Sediment Control, Storm Sewer System, and Watercourse/Drainageway. Section 3 defines the
Preliminary Plat Requirements and requires that preliminary plats provide the general location
and size of drainage ways or facilities (#10), and that all proposed drainage easements be noted
(#20). Section 3 also discusses performance guarantees and final improvement requirements for all
improvements, including stormwater facilities, intended to be dedicated to the City for maintenance
and operation.

Development Manual
The City of O’Fallon Development Manual provides for Minimum Standards of Design (Section 2),
Minimum Standards of Improvements (Section 3), Soil Excavation and Erosion Control (Section 4),
and Street Tree Planting Requirements (Section 5).
• Section 2.1 (p. 2) states that IDOT standards and policies shall be followed for all street design and
construction, except as modified by this Ordinance.
• Section 2.2 discusses the minimum widths for easements for storm sewers and drainage swales (#1); and states that adequate easements for storm water drainage shall be established along natural drainage channels and other locations as necessary, the location and width of easements to be determined by the City Engineer (#2).
• Section 3.3 requires that all new streets be designed and constructed according to IDOT standards (#18) and that curbing be combination concrete curb and gutters (#20-21).

The primary stormwater management practices in the City of O’Fallon potentially requiring modifications for BMP practices are outlined in Sections 3.10 through 3.13 (p. 15-28). These cover Drainage, Storm Sewers, and Other Drainage Appurtenances; Hydraulics; Stormwater Detention Regulations; and Drainage Planning Submittal Requirements. Section 3.10 provides for the use of water quality BMP’s in the detention or retention of stormwater. It further states that it is the developer’s responsibility for constructing adequate facilities for the management of stormwater on the site and the acceptable discharge of water from the site.

EPA and others recommend a review of local ordinances against a checklist (or scorecard) to evaluate existing development codes, regulations, and ordinances to identify potential regulatory and planning process impediments that affect the use of or successful implementation of best management practices (BMP’s) that infiltrate stormwater in new development, and that mandate unnecessary impervious area. The Water Quality Scorecard is detailed on pages 20 & 21, but an initial review provided the following sections of interest:

Sections of the existing ordinance requiring evaluation and potential modification include:
• Design Storm (3.10, 1) requires that water quality BMP’s (which will be required in the future to comply with the City’s NPDES Stormwater Phase II permit requirements) must be designed with the capacity to convey peak rates of runoff from the 2 Year Design Storm. All drainage facilities from inlet structure (catch basin grates) to outlet structure within road easements must meet the 10 Year Design Storm (with a reference for allowable on-road pavement encroachment per the IDOT Drainage Manual). Swales and ditches must meet the 25 Year Design Storm; and detention/retention basins the 100 Year Design Storm.
• Storm Water Discharge (3.10, 2) requires that permanent easements at least 20 feet wide must be provided where storm drainage facilities are installed in land other than the street right-of-way.
• Hydraulics (3.11) provides the requirements for hydraulic calculations for pipes, culverts, and open channels. 3.11, 3.C provides specific guidance for the evaluation and design of open channels.
• Detention Regulations (3.12) provides the design parameters for stormwater detention/retention basins. This section may need modification to include parameters for vegetated swales. Regulations cover the depth of basins (4’ maximum without a 6’ perimeter bench), size of outlet pipes (12” minimum), and required inlet trash guards; as well as the slope of the sides (4:1, horizontal:vertical maximum), the grade of the bottom (2% minimum), and a requirement for a concrete channel in the basin.
• Drainage Report Requirements (3.13) would benefit from the inclusion of “vegetated swales” as acceptable drainage facilities in meeting the requirements of a proposed subdivision’s Drainage Plan.
• Typical Cross Sections (see Appendix) includes various examples/models for the design of
storm inlets and street cross sections. This would be an appropriate location for a typical cross section of a vegetated swale, as well as any other stormwater BMP’s the City wishes to encourage.

There does not appear to be any clear statement as to the City’s policy and procedures for accepting stormwater facilities or for the maintenance of such facilities if they are not dedicated to the City. As an example, the Metropolitan St. Louis Sewer District (MSD) provides the following requirements for stormwater facilities in Chapter 4 of their Design Requirements for Storm Drainage Facilities:

“Easement Required: In subdivisions, the detention basin, BMP’s, access roads or paths, control structures, and outfall pipes are to be located in easements dedicated to the subdivision trustees. Lack of appropriate easement(s) will not relieve trustees of responsibility for required maintenance of the Stormwater Management System BMP’s.”

“Maintenance Agreement: Prior to plan approval, the property owner(s) of the Detention Basin site(s) shall execute a District (MSD) Maintenance Agreement for the urban BMP’s and the detention basin or pond to insure the urban BMP’s and the detention area will be kept in working order, to the satisfaction of the District. The District will not be responsible for maintenance of detention basins or BMP’s. Annual trustee or non-residential Property Owner’s certification and reporting of performance of required maintenance, operation, and repairs shall commence upon MSD Construction Approval of detention facilities; final closeout of the subdivision or project SWPPP; or as otherwise specified. The annual report will be required for those projects where the recorded Maintenance Agreement requires the reporting directly or by reference included in the Agreement. The annual report shall be submitted to the Engineering Department, Design Division, Development Review (return receipt requested).”

See an example of MSD’s maintenance agreement document on page 23.

To supplement and clarify maintenance responsibilities, MSD has adopted a Statement of Policy covering the maintenance of stormwater sewer systems and facilities within their jurisdiction. Generally:

- MSD maintains unimproved and improved channels, storm sewers they own, and weeds and fences on property they own.
- Local or state roadway jurisdiction is responsible for road culverts and bridges, inlets, ditches, gutters, and grates.
- Private property owners are responsible for driveway culverts, yard swales, retention and detention basins, and weeds on easements.
RECOMMENDATIONS FOR STORMWATER MANAGEMENT PRACTICES & MODEL ORDINANCES

The following recommendations and accompanying model documents will assist the City in identifying and prioritizing improvements to stormwater management design and control regulations, including procedures and documents for long-term operation and maintenance and final inspection of stormwater management facilities.

EPA Water Quality Scorecard

Many communities face the challenge of balancing flood and water quality protection with the desire to accommodate new growth and development. These cities have found that a review of local ordinances beyond just stormwater regulations is necessary to remove barriers and ensure coordination across all development codes for better stormwater management and watershed protection. Local policies, such as landscaping and parking requirements or street design criteria, should complement strong stormwater standards and make it easier for developers to meet multiple requirements simultaneously.

EPA's Water Quality Scorecard was developed to help local governments identify opportunities to remove barriers, and revise and create codes, ordinances, and incentives for better water quality protection. It guides municipal staff through a review of relevant local codes and ordinances, across multiple municipal departments and at the three scales within the jurisdiction of a local government (municipality, neighborhood, and site), to ensure that these codes work together to protect water
quality goals. The two main goals of this tool are to:
• help communities protect water quality by identifying ways to reduce the amount of stormwater flows in a community
• educate stakeholders on the wide range of policies and regulations that have water quality implications

Completing the Water Quality Scorecard requires the review of many different municipal documents, plans, codes, and guidance manuals. The following are the most common documents and code sections needed to complete the Scorecard:

<table>
<thead>
<tr>
<th>Zoning Ordinance</th>
<th>Setbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subdivision Code</td>
<td>Height Limitations</td>
</tr>
<tr>
<td>Street Standards/Design Guidelines</td>
<td>Open Space or Natural Resource Plan</td>
</tr>
<tr>
<td>Parking Requirements</td>
<td>Comprehensive Plan</td>
</tr>
</tbody>
</table>

The Scorecard has five sections:
Section 1: Protect Natural Resources (Including Trees) and Open Space
Section 2: Promote Efficient, Compact Development Patterns and Infill
Section 3: Design Complete, Smart Streets that Reduce Overall Imperviousness
Section 4: Encourage Efficient Provision of Parking
Section 5: Adopt Green Infrastructure Stormwater Management Provisions

For each of these five sections, the Scorecard provides tools and policies across four categories:

<table>
<thead>
<tr>
<th>Adopt plans/Educate</th>
<th>Adopt incentives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove barriers</td>
<td>Enact regulations</td>
</tr>
</tbody>
</table>


**MODEL STORMWATER ORDINANCES**

**EPA Model Stormwater Ordinance**
The U.S. EPA provides a model Post-Construction Stormwater Runoff Control Ordinance as a tool for communities who are responsible for meeting the stormwater management requirements of the National Pollutant Discharge Elimination System (NPDES) regulations. The EPA recommends using this document in conjunction with other sources, such as the City of O’Fallon’s ordinance and existing ordinances created by other stormwater management programs in the area, such as St. Clair County. (See the Appendix for the USEPA Model Post-Construction Stormwater Runoff Control Ordinance, September 2012, http://water.epa.gov/polwaste/nps/mol6.cfm)

**St. Clair County Stormwater Control Ordinance**
As part of its compliance with NPDES regulations, St. Clair County adopted a Stormwater Control Ordinance effective January 4, 2010. Section 33-1-10 requires that new development and redevelopment must comply with the NPDES regulations by adhering to the Code, ILR10 permits, the General NPDES for St. Clair County, and the NOI (Illinois EPA Notice of Intent for New or Renewal of General Permit for Discharges from Small Municipal Separate Storm Sewer Systems) submitted for each individual community.
The following sections provide particular language related to vegetated swales, long-term maintenance responsibility, and inspections:

- **33-4-36 Vegetated Filter Strips and Swales:** To effectively filter stormwater pollutants and promote infiltration of runoff, sites should be designed to maximize the use of vegetated filter strips and swales. Whenever practicable, runoff from impervious surfaces should be directed onto filter strips and swales comprised of native grasses and forbs before being routed to a storm sewer or detention basin.

- **33-5-1 Long-Term Maintenance Responsibility:** (A) Developers shall provide for maintenance of engineered stormwater controls including stormwater retention or detention basins and other erosion control and stormwater management structures by setting up a homeowner’s association with appropriate covenants and deed restrictions or by providing a binding contract for the purpose of maintenance. (B) At such time as the County has authority to provide funding for long-term maintenance through tax revenues or some other source it may waive (or reinstate) the requirement in subsection A. (C) The County may as alternative to subsection B create an alternative perpetual-type fund for purposes of long-term maintenance of structural measures whereby an up-front payment would be made by the permit applicant to the County to be used to cover future expenses for long-term maintenance costs of structures developed for stormwater management and erosion and sediment control.

DOCUMENT TYPE: AGREEMENT

DATE OF DOCUMENT:  8/15/08

GRANTOR:  McDONALD'S REAL ESTATE COMPANY
          10801 MASTIN BLVD. SUITE 400 OVERLAND PARK, KS 66210

GRANTEE:  METROPOLITAN ST LOUIS SEWER DISTRICT
          2350 MARKET STREET, ST. LOUIS, MO 63103

PROPERTY ADDRESS:  10431 PAGE AVENUE

COUNTY LOCATOR #:  15M320926

CITY OF ST. LOUIS PARCEL #:  N/A

CITY/MUNICIPALITY:  OVERLAND, MISSOURI

LEGAL DESCRIPTION:  PART OF LOT 6 OF MASON RIDGE SUBDIVISION IN U.S.
                    SURVEY 3040, T. 46 N. R. 6 E. CITY OF OVERLAND, ST.
                    LOUIS, COUNTY, MISSOURI
MAINTENANCE AGREEMENT

KNOW ALL MEN BY THESE PRESENTS, that, McDonald’s Real Estate Company, a Delaware corporation, its successors and assigns ("McDonald’s"), for and in consideration of the approval of sewer plans and of the issuance of a sewer permit by The Metropolitan St. Louis Sewer District for storm water management facilities according to plans to be approved by said District for a development known as 10431 Page Avenue, City of Overland in St. Louis County, Missouri, and other good and valuable considerations, do hereby agree and promise, as follows:

1. To build and construct stormwater management facilities, including Best Management Practices (BMP), basins, drainage facilities, appurtenances and sewer lines, in accordance with the design, plans and report, submitted to and approved by The Metropolitan St. Louis Sewer District, Project No. MSD P# 7880-01. The stormwater management facilities are to be perpetually located within the dimensioned and reserved area, as shown hachured on the exhibit “A” as attached hereto and made a part hereof.

2. To maintain and operate the stormwater management facilities in conformity with the approved Stormwater Management Facilities Report.

3. To maintain all pipes and drains in good working order and maintain all walls, dikes, vegetation, filter media, and any other requisite appurtenances and improvements for the retention and management of stormwater in good repair.

4. That in the event McDonald’s or its successor in title to said property shall fail to maintain the stormwater management facilities, BMP, basins, drainage facilities, appurtenances and sewer lines in accordance with this agreement, The Metropolitan St. Louis Sewer District shall be permitted to enter onto the property and make the repairs and corrections and perform such maintenance as it deems necessary and bill the owners of said property for the services performed. It is further agreed that in the event said bill or charge for the services performed shall not be paid within a period of thirty (30) days said sum shall become a lien on the real property and shall accrue interest at a rate of eight percent (8%) until paid in full.

5. This agreement is irrevocable and shall continue forever.
IN WITNESS WHEREFORE, the said McDonald’s Real Estate Company has caused these presents to be signed by its Vice President & Assistant Secretary and its corporate seal to be affixed this 15th day of August, 2008.

McDonald’s Real Estate Company
A Delaware corporation

By: Catherine A. Griffin
Vice President and Assistant Secretary

STATE OF ILLINOIS )
COUNTY OF DUPAGE ) ss

I, Sandra Bieschke, a Notary Public in and for the county and state aforesaid, DO HEREBY CERTIFY that Catherine A. Griffin, Vice President and Assistant Secretary of McDonald’s Real Estate Company, a Delaware corporation, who is personally known to me to be the same persons whose name is subscribed to the foregoing instrument as such Vice President and Assistant Secretary, appeared before me this day in person and acknowledged that she signed, sealed and delivered the said instrument as her free and voluntary act as such Vice President and Secretary and as her free and voluntary act of said corporation for the uses and purposes therein set forth.

Given under my hand and notarial seal, this 15th day of August, 2008.

Notary Public
My commission expires: June 28, 2007

OFFICIAL SEAL
SANDRA BIESCHKE
NOTARY PUBLIC - STATE OF ILLINOIS
MY COMMISSION EXPIRES: 06/28/07
IN WITNESS WHEREOF, the parties hereto have duly executed these presents to be signed by the Director of Engineering for The Metropolitan St. Louis Sewer District.

THE METROPOLITAN ST. LOUIS SEWER DISTRICT

By

Brian Hoelscher
Director of Engineering

STATE OF MISSOURI )
COUNTY OF ST. LOUIS )

On this 30th day of Sept., 2008, before me personally appeared Brian Hoelscher to me personally known, who being by me duly sworn, did say that he is the Director of Engineering, of THE METROPOLITAN ST. LOUIS SEWER DISTRICT and that said instrument was signed and sealed in behalf of said THE METROPOLITAN ST. LOUIS SEWER DISTRICT by authority of its Board of Trustees and said Brian Hoelscher acknowledged said instrument to be the free act and deed of said THE METROPOLITAN ST. LOUIS SEWER DISTRICT.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my notarial seal this 30th day of Sept., 2008.

My Commission expires 9-24-09

Notary Public

TERRI C. STEWART
Notary Public - Notary Seal
State of Missouri
St. Louis County
My Commission Expires Sept. 26, 2009
Commission # 05774247

MSD 5.18 (CORPORATE with exhibit A)
Document #: 505254-v2
EXHIBIT "A"

A TRACT OF LAND BEING PART OF LOT 6 OF MASON RIDGE SUBDIVISION IN U.S. SURVEY 3040, T. 46 N., R. 6 E. CITY OF OVERLAND, ST. LOUIS COUNTY, MISSOURI
# Water Quality Swale Operation, Maintenance, and Management Inspection Checklist for BMP Owners

**Site Name:** _________________________________  **Owner changed since last inspection?**  
Y   N

**Owner name, address and phone number:**

---

**Location:** 

---

**Date:** 

---

**Time:** 

---

**Inspector Name:** 

---

## Maintenance Item | Satisfactory/ Unsatisfactory | Comments
---|---|---
### Debris Cleanout  (Inspect monthly)
1. Contributing drainage areas free from debris

### Vegetation  (Inspect monthly)
1. Mowing done when needed
2. No evidence of erosion
3. Ponding areas dry after 36 hours

### Check Dams or Energy Dissipators  (Inspect annually)
1. No evidence of flow going around structure
2. No evidence of erosion at the downstream toe
3. Soil permeability

### Sediment Forebay
1. Sediment cleanout needed (clean out when 50% full)

**Additional Comments and Actions to be Taken**

---

**Timeframe:**
CONCLUSION

The City of O’Fallon has expressed their desire for accommodating stormwater quality best management practices (BMP’s) through their NPDES Phase II Permit, Subdivision Ordinance and Development Manual, and through this EPA Region 5 FY10 Water Quality Cooperative Agreement (WQCA) study. Key concerns in accommodating BMP’s are to ensure that municipal regulations do not prohibit their use, avoid creating maintenance issues that may create future problems, affix responsibility for maintenance of BMP facilities with private land-owners where appropriate, and, ideally, create a long-term, broad-based funding mechanism for the City’s stormwater management.

The background analysis conducted for this report defined the practice of green infrastructure BMP’s in a regional/national context. It investigated O’Fallon’s NPDES Permit Applications, municipal stormwater responsibilities, and stormwater-related ordinances. With the focus on vegetated swales as a primarily water quality BMP, the primary objectives were to remove regulatory barriers that may impede private property owners and land developers from voluntarily implementing green infrastructure practices, as well as to allow and encourage the City to implement such practices along public road right-of-ways.

We noted that the existing City Subdivision Ordinance and Development Manual did not suggest or prescribe the specific use or design of stormwater management BMP’s, whether on private property or public right-of-way, or provide for a perpetual maintenance agreement between private owners of BMP’s and the City of O’Fallon for the proper construction, operation, and maintenance of such facilities. At a minimum, the existing Development Manual would benefit from modifications within Sections 3.10 through 3.13 related to BMP use, performance, design, and maintenance requirements.

To serve as guidance for the City’s accommodation of BMP’s as an alternative approach to stormwater management we identified and have provided the accompanying Appendix documents. These documents include a Water Quality Scorecard from the USEPA to allow the City to undertake a comprehensive assessment of local policies, documents, and regulations that may be prohibiting certain preferred actions. They include Model Ordinances from the USEPA and St. Clair County for stormwater management that specifically address the requirements of the National Pollutant Discharge Elimination System (NPDES) regulations. And they include Design Manuals from the Metropolitan St. Louis Sewer District and the City of Indianapolis for the design, construction, and maintenance of stormwater BMP’s.

The provided documents also contain an example maintenance agreement and an on-going maintenance inspection checklist; as well as several examples for the dedication of easements, imposition of annual inspection fees, and the use of property liens in cases where the City is required to repair or maintain private facilities.

We hope that this review of the use of vegetative swales, whether on private property or along roadways in public right-of-way; review of City of O’Fallon objectives and provisions for stormwater BMP’s (including vegetative swales); identification of areas within the existing City subdivision ordinance and development manual requiring modifications to encourage and accommodate vegetative swales and other forms of BMP’s; and inclusion of model documents; will provide the City with the necessary tools to implement appropriate BMP’s while at the same time protecting the City from future financial and functional concerns.
PRIORITY AREAS ANALYSIS

METHODOLOGY

To determine priority areas for roadside vegetated swale implementation in O’Fallon, Illinois, two key tools were utilized: Long Term Hydrological Impact Analysis (L-THIA) and Arc Geographic Information Systems (ArcGIS). L-THIA modeled future stormwater rates in O’Fallon, IL in two scenarios: (a) no implementation of roadside vegetated swales and (b) with roadside vegetated swale implementation. ArcGIS was used to generate the data necessary to run the L-THIA analysis and to then select areas within the city where roadside vegetated swales would reduce future stormwater flows. Based on these outcomes, priority areas for implementation were determined.

L-THIA Analysis

The Long Term Hydrological Impact Analysis (L-THIA) tool, developed by the Engineering Department at Purdue University, is an on-line program used to estimates changes in recharge, runoff, and non-point source pollution resulting from past or purposed development. It does this by combining soil and long term climate data from the study areas.

For O’Fallon, the L-THIA Low Impact Development (LID) spreadsheet was used to analyze the impact of implementing roadside vegetative swales on the volume of stormwater runoff. This model enabled predictions in two scenarios: (a) if development continues as is (without roadside vegetated swales) and (b) if roadside vegetated swales are implemented.

By breaking the entire City of O’Fallon planning area into smaller watersheds it was easier to determine where implementing roadside vegetative swales would have the biggest impact on the reduction of stormwater volume. ArcGIS was used to obtain the specific acre data inputs required to run the L-THIA modeling tool. Inputs were recorded in an Excel document (figure 1).

![Figure 1. Example inputs recorded in Excel](image-url)
**Process**

1. Current Land Use (CLU), provided in the form of parcel data from the City of O’Fallon, was clipped to the Future Planning Area (FPA).
2. Proposed Land Use (PLU), provided in the form of O’Fallon’s Comprehensive Plan Data, was clipped to the FPA.
3. CLU and PLU were clipped to each of the HUC (Hydrologic Unit Code) 12 watersheds boundaries that intersect the FPA. This allows the model to be run for each watershed individually. In O’Fallon’s FPA there are five HUC 12 watersheds, meaning there were 5 smaller CLU layers and 5 smaller PLU layers.
4. A new Data Field was added to each new layer and Calculate Geometry was used to insure accurate acre measurements. This is column was used when making calculations.
5. Then data from each watershed was derived one at a time, first CLU then PLU, to acquire the acreage and land use data needed by the L-THIA LID tool to run.
   a. To begin, watershed CLU total acres by land use class were calculated. This was done by using Select by Attribute to select by Land Use Class based on the following GIS python of Land Use codes provided by the City:
      i. Commercial
      ii. Industrial
      iii. High Density Residential
      iv. Low Density Residential
      v. Agriculture
      vi. Forest
   b. CLU total acres for each Land Use Class were recorded and the process was repeated to find total acres for PLU Land Use Classes using the following GIS python of Land Use codes provided by the City:
      i. Commercial:
      ii. Residential
      iii. Agriculture
      iv. Industrial
   c. PLU Land Use class total were recorded and the process (5.a. – 5.b) was repeated for each watershed.
6. Since the L-THIA model requires separate inputs for each soil type (A, B, C, or D), data from each watershed was further divided by soil type. The O’Fallon FPA consisted of mostly B Soils, there were no A soils and some C and D Soil areas. So, Land Use data for C and D soils was found using GIS and then subtracted from each Land Use Class total to find the amount of acres for each class in B soils. This was done first for CLU and then for PLU.
   a. First, Select by Location was used to isolate the CLU parcels that intersect the C type soils layer.
   b. Once the C soil type parcels were isolated, the same python used to select Land Use Classes from the total watershed, were used to find the acres for each class; commercial, industrial, various residential, and agriculture.
   c. The same process was then used to isolate and categorize the D soil area.
   d. The acres of each Land Use Class for C and D soils where added together and subtracted from the total acres of the corresponding for that Land Use Class to find the B soil type Land Use Classes.
   e. This same process (6.a. – 6.d.) was repeated for Proposed Land Use, using the python codes established when finding Total PLU. Note: The Proposed Land Use data did not contain
parcel size information, as the layer consisted of generalized zone polygons. Therefore, the size of residential lots for PLU was estimated based on the Residential Lot percentage of total residential CLU for each soil type.

f. This process (6.a. – 6.e.) was repeated for all watersheds.

7. Next, each set of data, one watershed at a time, was plugged into the L-THIA LID spreadsheet.

a. When entering the Post-Developed Area with LID, 100% percent was chosen to show the maximum potential of swales reducing stormwater runoff volume (figure 2).

b. Since this analysis was specifically looking at the impact of vegetative swales, the Lot-Level screening was selected. This allowed the model to only evaluate the effects of roadside vegetative swales on stormwater runoff, by selecting the “swales/disconnection” option in the Streets/Road section of each Land Use tab on the Lot Level LID page (figure 3).

c. The Runoff Results generated for each watershed was then saved for comparison with the data from

Figure 2. Example L-THIA LID worksheet
the watersheds (figure 4).

d. This process (7.a. - 7.c.) was repeated for all watersheds.

ArcGIS Analysis
Following L-THIA analysis, the results were carefully examined. All cases, throughout the five watersheds, where L-THIA results indicated a positive impact of low-impact development (LID) on future land use were cataloged. This established which types of land use/parcels, within each watershed, would provide the greatest benefit to overall stormwater management. These areas then became candidates for priority roadside vegetated swale implementation.
Next, within ArcGIS, parcels were selected that matched the L-THIA analysis result parameters.

<table>
<thead>
<tr>
<th>Watershed Location</th>
<th>Future Land Use</th>
<th>Parcel Size</th>
<th>Soil Type</th>
<th># Identified</th>
</tr>
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<tbody>
<tr>
<td>Scott Lake watershed</td>
<td>High density residential</td>
<td>1/8 acre</td>
<td>B soils</td>
<td>34</td>
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<tr>
<td><strong>Scott Lake TOTAL</strong></td>
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<td></td>
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<td><strong>34</strong></td>
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<tr>
<td>Ogles watershed</td>
<td>High density residential</td>
<td>1/8 acre</td>
<td>B soils</td>
<td>145</td>
</tr>
<tr>
<td>Ogles watershed</td>
<td>High density residential</td>
<td>1/8 acre</td>
<td>D soils</td>
<td>0</td>
</tr>
<tr>
<td><strong>Ogles TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>145</strong></td>
</tr>
<tr>
<td>Mill Creek watershed</td>
<td>Industrial</td>
<td>n/a</td>
<td>B soils</td>
<td>0</td>
</tr>
<tr>
<td>Mill Creek watershed</td>
<td>High density residential</td>
<td>1/8 acre</td>
<td>B soils</td>
<td>27</td>
</tr>
<tr>
<td>Mill Creek watershed</td>
<td>High density residential</td>
<td>1/8 acre</td>
<td>C soils</td>
<td>0</td>
</tr>
<tr>
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<td>¼ acre</td>
<td>B soils</td>
<td>17</td>
</tr>
<tr>
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<td>½ acre</td>
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</tr>
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<td>B soils</td>
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</tr>
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<td>High density residential</td>
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<td>B soils</td>
<td>198</td>
</tr>
<tr>
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<td>103</td>
</tr>
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<td>B soils</td>
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</tr>
<tr>
<td>Loop Creek watershed</td>
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<td>B soils</td>
<td>10</td>
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<td><strong>Loop Creek TOTAL</strong></td>
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<td></td>
<td></td>
<td><strong>339</strong></td>
</tr>
<tr>
<td>Wolf Branch watershed</td>
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<td>B soils</td>
<td>1093</td>
</tr>
<tr>
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<td>High density residential</td>
<td>1/8 acre</td>
<td>C soils</td>
<td>106</td>
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<td>High density residential</td>
<td>¼ acre</td>
<td>B soils</td>
<td>1211</td>
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<td>Wolf Branch watershed</td>
<td>Low density residential</td>
<td>½ acre</td>
<td>B soils</td>
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<td>B soils</td>
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<td>C soils</td>
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<td><strong>TOTAL (ALL WATERSHEDS)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>3451</strong></td>
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</table>

Based on the analysis described above, priority should be given to implementing roadside vegetated swales adjacent to residential parcels in Wolf Branch, Loop Creek and Mill Creek watersheds.
This manual provides general guidance for the design and construction of retrofitting existing hard armored roadside ditches with vegetated swales in the City of O’Fallon, Illinois.

The procedures used in this manual involve standardization of some design criteria in order to simplify design and construction. The use of these procedures is not mandatory, but a guideline. The design, installation, and maintenance of Best Management Practices (BMPs) is an evolving science and is dependent on many highly variable individual site conditions.

Two pilot project locations have been identified in the City for potential vegetated swale retrofit installations. These projects are used in this manual to provide more detailed examples of using the vegetated swale as a storm water BMP.

The focus of this document is retrofitting existing swales, not new development. The design approach for utilizing a vegetated swale as part of the site or watershed storm water management treatment train is considerably different than the design of a retrofit to improve a current conveyance system.

Removing hard armored swales and replacing with excavated permeable soils, filter fabrics, select plant materials, check dams, or riffle pools may provide significant additional BMP benefits. The cost benefit of construction and maintenance of these swales will determine the level of complexity of the designs and the benefits recognized.

CHALLENGES TO VEGETATED SWALE SUCCESS
- If not installed correctly, not maintained, or used for an unintended purpose, performance will be diminished.
- If vegetation does not establish or cover density is low, performance will be diminished.
- Not all roadside ditch locations in the City are practical for vegetated swale retrofits.
- Swales may need to be reseeded if significant storm flow occurs prior to vegetation establishment or if vegetation fails.
- High pollutant concentrations, high sedimentation loads, and overly compacted soils may reduce the performance of the BMP.
- Maximum drainage area for vegetated swale benefit is approximately five acres.
- Swale slopes should be between 1/2% and 4%.
- Flow velocities in the swale should not exceed four feet per second (fps).
- If not designed or maintained properly, they can become mosquito breeding areas or may omit odors from standing water.

DESIGN CONSIDERATIONS
Location/Applicability – Vegetated swales are typically located along property boundaries with a natural grade, although they can be used effectively wherever the site provides adequate space.

Slopes
Areas with steep slopes may limit the use of swales. Channel slopes of 1/2% to 2% and no greater than 4% are recommended. If steeper slopes are necessary, 6 to 12 inch check dams can be used to limit runoff energy. The temporary pools created by check dams must drain down within a maximum of 48
hours. Check dams can be created with natural wood, concrete, or stone. Energy dissipaters must be installed below drop structures, and drop structures must be no closer than 50 foot spacing.

![Diagram of check dam and swale](image)

Flow Volume/Velocity
Vegetated swales are most effective when the flow depth is shallow and the velocities are low. At the system entrance, it is important to maintain sheet flow or create equalized flow conditions, reduce runoff velocities, and stabilize soil and vegetation complexes. Options include level spreaders, gravel infiltration trenches, pretreatment forebays, turf reinforcement mats, and flexible channel liners.

A velocity of 1 fps is the maximum design storm flow velocity recommended when vegetated swales are being designed as a BMP. Higher velocities are acceptable, especially in retrofit situations where modifications to incoming flow quantities and swale slopes are not possible. A result of higher velocities is potential for resuspension of settled particulates. All channel velocities should be checked for compatibility with chosen vegetation, slopes, and soils.

Flow Duration/Conveyance
To be effective in removing storm water pollutants, swales must not be subjected to low flows of long duration and not be kept wet for long, as constant wetness will keep the soil saturated and may kill vegetation reducing pollutant removal. The maximum ponding time is 48 hours; 24 hours is more desirable.

Vegetated swales are typically designed for a six month, 24 hour storm event, but also must convey the 10 year, 24 hour storm event with minimum 6 inches of freeboard and must be designed for nonerosive velocities up to the 2 year storm event. Runoff must enter the swale through a pretreatment forebay.

Soils
Soils should be suitable or be amended to establish a vigorous stand of vegetation. If dense vegetation cannot be maintained in the swale, its effectiveness will be severely reduced. Sites on A or B hydrologic group soils will be more effective for infiltration, although swales on other soil types will still provide some treatment through sedimentation.

In new installations where the basin is being designed by water quality calculations based on permeability, compaction, acidity, and other particular soil characteristics, soil samples should be taken and analyzed for the individual site. For the general design applied to multiple locations throughout the City on a retrofit basis, the Custom Soil Resource Report from the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) can be used for general soil characteristics.
**Swale Geometry**
The swale should have a *bottom channel width of two to eight feet*. The minimum width of the flat bottom of the trapezoidal channel should be at least three times the channel depth (6 to 15 feet). Non-trapezoidal channels should have similar depth to width relationships. Wider sections may be installed only as part of basin designs and only if designed with berms, walls, or a multi level cross section that prevent the channel from meandering and eroding. Cross sections of the swale are to be parabolic or trapezoidal with moderate slopes no greater than 3:1. *More gentle slopes of 4:1 are recommended*. A V shaped swale is not recommended. Minimum width should be determined using Manning's equation with an n of 0.2 to 0.25.

Regardless of the recommended detention time, the swale should be a *minimum of 100 feet in length*.

**Flow Depth**
Flow depths in the swales should be minimized to increase the amount of vegetative filtering and settling. A suggested maximum ponding design flow depth is *one foot*. However, for retrofit situations, this is often controlled by existing swale size, geometry, and tributary runoff volumes.

The depth of the water at the downstream end of the swale *must not exceed 18 inches*, and the average ponding depth should be 12 inches. The depth of the ponding should never exceed the height of the plants and grasses. Submerging the vegetation could cause it to bend over in the flow. This would lead to reduced roughness of the swale, higher flow velocities, and reduced contact filtering opportunities.

The optimal length of a swale is between 100 and 200 feet, although actual design lengths will vary depending on area conditions. A method to calculating length is based on the design velocity (design flow rate divided by the cross sectional area). Length equals the product of the design velocity and the desired residence time.

If the swale requires an underdrain system, it must discharge to the storm drainage structure or a stable outfall. If an underdrain system is not required, the swale needs to have outlet protection at the overflow to prevent scour and erosion.

**Vegetation**
Vegetation selection is a key item for success of any system, and the following variables should be considered: soil type, soil porosity, water holding capacity, drainage of site, rainfall amounts, slope of site, hardiness zone, maintenance considerations, and irrigation availability if necessary.

Use of native plants is strongly advised, as they are better adapted to local climate, soil conditions, and hydrology. *Invasive plant species should not be permitted*. Swale vegetation must also be salt tolerant if winter road maintenance activities are expected to
contribute salt/chlorides. Trees may be used along the side slopes and will help with aesthetically integrating the overall site design without unnecessary loss of space. It is important to consider the amount of sunlight needed for the plants in the swale and ensure the trees are not blocking any needed light.

Local landscape architects, USDA NRCS personnel, or cooperative extension specialists should be consulted and used as a resource for local/regional seed and plant selection. Page 12 provides the recommended approved list of plants to be used in roadside vegetated swales in the City, per the recommended ordinance language. It is also available in the Appendix.

**Erosion Protection**

Prior to establishment of vegetation, which can take *three to five years*, a swale is particularly vulnerable to scour and erosion and, therefore, its seed bed must be protected with temporary seeding (annuals) and temporary erosion control such as straw matting, compost blankets, or fiberglass roving. Determine the maximum allowable velocities and determine the appropriate erosion control, typically rip rap at point discharges (incoming pipes) and turf reinforcement mat in disturbed channel, to hold seed and soil until vegetation is established.

**Equipment Access and Crossings**

If the swale or waterway must be crossed or maintained with large equipment, the width should be increased to a flatter cross section incorporated into the design. Large mowing equipment may require significant changes in geometry. This problem deserves careful consideration for each location to modify the channel while maintaining capacity and freeboard requirements. Easements of sufficient width to allow access by equipment and personnel to maintain the swales must be provided.

**Underdrain**

In new BMP installations, the use of an underdrain is normally recommended or even required. For filtration basins, bioretention swales, rain gardens, or other selected BMPs, the underdrain serves to keep the BMP acting as an underground filter. In the retrofit applications that this manual is addressing, there may not be an opportunity to daylight an underdrain. In cases where an underdrain is not constructible, the BMP will still add beneficial filtering. Saturation may diminish these benefits, but as a retrofit to an existing concrete swale, it is still a very beneficial installation.

**DESIGN PROCEDURES**

This section covers specific design guidelines for two pilot flow-monitor locations (Silver Creek and Richland Creek Pilot Locations). *Please note that the two pilot flow-monitor locations are not part of a planned or scheduled capital improvement project. Instead the two locations are being used as ‘example locations’ to discuss the application of a vegetative swale at an actual location.*
Silver Creek Watershed Pilot Location
The project is located along Kyle Road between Illini Drive and Tazewell Drive. The property is located on the Edward A. Fulton Junior High School campus. This location along public roadway (Kyle Road) with the access availability, concrete bottom, side slopes, and potential for public involvement made this a chosen location for a pilot location. (Please see the plan layout of the Silver Creek Watershed Pilot Location on Exhibits 1 and 2 that follow.)

The basin is approximately 1.7 acres in area, with a swale length of 380 feet between inlet and outlet pipes with flow traveling from west to east. The basin receives flow from a 48 inch diameter pipe at the west end, a 24 inch pipe from the north (Kyle Road), and a 36 inch pipe from the south (Junior High School). The basin releases all flow through a 24 inch diameter pipe on the east end of the basin. Although this is a dry bottom detention basin, the sizes of the incoming pipes in relation to the outgoing pipe size indicates frequent detention functioning.

Slopes: This site has a channel slope of 1/2%. This slope is great for the slowing of the flow velocities. Care must be taken to fine grade the site appropriately to eliminate potential ponding in the channel. The side slopes are currently turf grass and sloped between 3:1 and 6:1.
Flow Volume/Velocity: This site experiences very low dry weather flows based on visual inspection and the flow data gathered by monitors. During wet weather events, the flow volumes and velocities are significant. The design of this BMP includes velocity reduction at the incoming pipe flow lines with rip rap blankets. This slowing of the flow, in addition to a flow spreader and a mid swale check dam, and the overall low slope profile of the swale will result in a low velocity flow that can be infiltrated.

Flow Duration/Conveyance: The Hydraflow calculations for this location are provided in the Appendix.

Soils: A custom Soil Resource Report is included in the Appendix.

<table>
<thead>
<tr>
<th>Elevation (ft)</th>
<th>Contour Area (ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>546</td>
<td>430</td>
</tr>
<tr>
<td>547</td>
<td>4,535</td>
</tr>
<tr>
<td>548</td>
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<td>32,148</td>
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<tr>
<td>552</td>
<td>38,174</td>
</tr>
</tbody>
</table>

Hydraulic Assessment: The property has approximately 60,500 cubic feet of storage. A 19 foot out-pipe with a 24 inch orifice located at 546.00 feet and placed at a slope of 0.53% drains the detention basin. The contour areas at each elevation can be found in the table at right.

During the 2 year, 24 hour rain event, a total precipitation of 3.10 inches is applied to the 15.19 acre watershed. The peak discharge from the basin for this rain event is 5.29 cubic feet per second (cfs), the hydraulic volume is 32,305 cubic feet, and the maximum elevation is 547.60 feet. The maximum elevation allows 4.40 feet of freeboard, which is well within the required 6 inches.

During the 10 year, 24 hour rain event, a total precipitation of 4.64 inches is applied to the 15.19 acre watershed. The peak discharge from the basin is 12.12 cfs, the hydraulic volume is 80,998 cubic feet, and the maximum elevation is 548.75 feet. This allows 3.25 feet of freeboard, which is also well within the 6 inch tolerance for the event.
In summary, the Silver Creek Watershed Pilot Location project meets the hydraulic requirement of 6 inches of freeboard during the 2 year, 24 hour and 10 year, 24 hour rain events.

These characteristics and evaluations have led to the following design parameters:

The swale should be underlain by a depth of at least 30 inches of permeable soil layer above a 12-24 inch aggregate layer to provide significant volume reduction and reduce the storm water conveyance rate. The permeable soil media should have a minimum infiltration rate of 0.5 inch per hour and contain a high level of organic material to enhance pollutant removal. A nonwoven geotextile should completely wrap the aggregate trench. Excavation and replacement of existing soils with other soils (such as loamy or sandy soils) may be required. The bottom of the excavated trench should not be loaded in a way that causes soil compaction and scarified prior to placement of gravel and permeable soil.

The swale should have a 10 foot wide, flat bottom, trapezoidal channel with 3:1 side slopes where necessary to catch the side slopes (i.e., the south side of the channel). On the north side of the channel where the basin has an existing wide, flat bottom, the side slope of the channel shall be straight graded to the existing toe of slope of the basin. This will result in a very wide area of potential infiltration in the bottom and planting area. This will maintain the overall volume of the basin, which is required in order to ensure that this project does not negatively impact the detention basin functionality.

See page 12 for recommended planting information.

Three forms of erosion control are recommended for this project site. At the point discharge locations of the incoming storm water pipes, a rip rap blanket should be installed to slow the flow. Rip rap, in combination with a flow spreader, are the measures recommended to provide slower, wider, and more laminar flow in the channel during the lower flow rainfall events.

Additionally, all disturbed areas that will be seeded (or planted, City preference) should be covered with a turf reinforcement mat. This mat may be permanent or temporary, provided the mat does not begin degrading until the vegetation is substantially established. For this project, a mat such as the North American Green SC150 or equivalent should be used to ensure erosion is controlled while vegetation is being established.

Access to this project location should not be an obstacle. The site is accessible from Kyle Road with easier and more convenient access available from the Edward A. Fulton Junior High School campus. As this site is on private property, easements for any work and any access must be obtained from the owner.

Due to the original design and construction of this detention basin, it is not possible to install an underdrain without significant renovations to the current basin and affecting the storm water management system.

Richland Creek Watershed Pilot Location
The project is located between residences and businesses on the western side of Shamrock Drive, between Country Pine Drive and Pierce Boulevard. The property is located on commercial private property owned by NG Investments, LLC. The topography and geometry of this location, as well as
the potential access from Pierce Boulevard, made this site an attractive pilot location. (Please see the plan layout of the Richland Creek Watershed Pilot Location project on Exhibits 3, 4, and 5 that follow.)

The basin is approximately 0.4 acre in area, with a swale length of 250 feet between inlet pipe and the end of our project, flowing from north to south. The basin receives flow from an 18 inch diameter pipe at the north end and multiple downspout drains and an existing drainage swale from the north. The basin releases all flow through a 60 inch by 40 inch pipe on the southern end of the basin. Although this is a dry bottom detention basin, the size of the basin and the flow meter data indicate frequent rises in flow.

This basin is compromised of three components as far as out-design approach is concerned – an open, non-armored channel to the north, a straight concrete bottom swale in the middle, and a concrete bottom swale with two 90 degree curved sections at the downstream end. For this project we are addressing the middle section, the straight concrete bottom section.

Slopes: This site has a channel slope of 1/2%. This slope is well-suited for slowing flow velocities. The side slopes are currently turf grass and sloped between 3:1 and 6:1. Care must be taken to fine grade the site appropriately to eliminate potential ponding in the channel.

Flow Volume/Velocity: This site experiences very low dry weather flows based on visual inspection and the flow data gathered by monitors. In wet weather events, the flow volumes and velocities are significant. The design of this BMP includes velocity reduction at the incoming pipe flow line and incoming swale flow line with rip rap blankets. This slowing of the flow, in addition to a flow spreader and a mid swale check dam and the overall low slope profile of the swale, will result in a low velocity flow that can be infiltrated.

Flow Duration/Conveyance: The Hydraflow calculations for this location are provided in the Appendix.

Soils: A custom soil resource report is included in the Appendix.

Hydraulic Assessment: The property contains a series of detention basins. The first detention basin is along Aladar Drive and services approximately 79 acres from two contributing watersheds. The basin is 3 feet deep and has a total volume of 15,612 cubic feet. A 30 foot out-pipe with a 40 inch by 60 inch orifice located at 540.00 feet and placed at an approximate slope of 2.6% drains the detention basin. In order to enable Hydraflow to run the 100 year, 24 hour rain

<table>
<thead>
<tr>
<th>Richland Creek Watershed Detention Pond (Aladar Dr.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation (ft)</td>
<td>Contour Area (ft2)</td>
</tr>
<tr>
<td>540</td>
<td>54</td>
</tr>
<tr>
<td>541</td>
<td>8,656</td>
</tr>
<tr>
<td>542</td>
<td>14,248</td>
</tr>
<tr>
<td>543</td>
<td>16,587</td>
</tr>
<tr>
<td>544 (assumed weir)</td>
<td>18,000</td>
</tr>
</tbody>
</table>
event, an additional contour with an overflow weir was assumed to allow the excess flow to proceed to the next detention basin. The parameters of the detention basin located along Aladar Drive can be found in the table at right.

The above detention basin enters the basin along Pierce Boulevard, along with three other watersheds that contribute an additional 23 acres. The second basin is 5 feet deep and has a total volume of 17,180 cubic feet. An out-pipe with a 40 inch by 60 inch orifice located at 535.00 feet and placed at an approximate slope of 2% drains the detention basin. The pipe is approximately 100 feet long. As with the first detention basin, an additional contour with an overflow weir was assumed to allow the excess flow to exit the system during rain events that could not be contained by the basin. The parameters of the detention basin located along Pierce Boulevard can be found in the table at right.

During the 2 year, 24 hour rain event, the peak discharge from the basin along Aladar Drive is 24.72 cfs, the hydraulic volume is 117,483 cubic feet, and the maximum elevation is 541.28 feet. The maximum elevation allows 1.72 feet of freeboard, which is within the required 6 inches. During this event, the detention basin along Pierce Drive experiences a peak discharge of 26.01 cfs, the hydraulic volume is 133,743 cubic feet, and the maximum elevation is 536.33 feet. This allows 3.67 feet of freeboard, which is within the 6 inch requirement.

During the 10 year, 24 hour rain event, the peak discharge from the basin along Aladar Drive is 105.93 cfs, the hydraulic volume is 336,983 cubic feet, and the maximum elevation is 542.55 feet. The maximum elevation allows 0.45 foot of freeboard, which is outside of the tolerance of 6 inches of freeboard. During this event, the detention basin along Pierce Drive experiences a peak discharge of 107.89 cfs, the hydraulic volume is 383,623 cubic feet, and the maximum elevation is 538.48 feet. This allows 1.52 feet of freeboard, which is within the 6 inch requirement.

In summary, the upper detention basin in the Richland Creek Watershed Pilot Location project does not meet the requirement of 6 inches of freeboard during the 10 year event; however, the lower basin does meet the requirement. It is advised that low impact development projects be added to the watershed areas tributary to the upper basin to control the runoff in addition to improvements to the lower detention basin.

These characteristics and evaluations have led to the following design parameters:

- The swale should be underlain by a depth of at least 30 inches of permeable soil layer above a 12-24 inch aggregate layer to provide significant volume reduction and reduce the storm water conveyance rate. The permeable soil media should have a minimum infiltration rate of 0.5 inch per hour and contain a high level of organic material to enhance pollutant removal. A nonwoven geotextile should completely wrap the aggregate trench. Excavation and replacement of existing soils with other soils (such as loamy or sandy soils) may be required. The bottom of the excavated trench shall not be loaded in a way that causes soil compaction and scarification prior to placement of gravel and permeable soil.
The swale should have a 10 foot wide, flat bottom, trapezoidal channel with 3:1 side slopes. This configuration will maintain the overall volume of the basin, which is required in order to ensure that this project does not negatively impact the detention basin functionality. See page 12 for recommended planting information.

Three forms of erosion control are recommended for this project site. At the point discharge locations of the incoming storm water pipes, a rip rap blanket should be installed to slow the flow. Rip rap, in combination with a flow spreader, are the measures recommended to provide slower, wider, and more laminar flow in the channel during the lower flow rainfall events.

Additionally, all disturbed areas that will be seeded (or planted, City preference) should be covered with a turf reinforcement mat. This mat may be permanent or temporary, provided the mat does not begin degrading until the vegetation is substantially established. For this project, a mat such as the North American Green SC150 or equivalent should be used to ensure erosion is controlled while vegetation is being established.

Access to this project may be obtained off of Pierce Boulevard or, if absolutely necessary, from Country Pine Drive. Easements of sufficient width to allow access of equipment and the personnel to maintain the swales must be obtained from the owner, NG Investments, LLC.

Due to the original design and construction of this detention basin, it is not possible to install an underdrain without significant renovations to the current basin and affecting the storm water management system.

**SUMMARY OF HYDRAFLOW DATA AND HYDRAULICS**

For low flow rain events the removal of the concrete ditch and replacement with a vegetated swale will provide benefits. Water quality will be improved by the removal of suspended solids, nutrients, and pollutants in the storm runoff. Infiltration will obviously be improved, and the slowing of water will provide more time for evapotranspiration, both reducing the quantity of runoff being carried downstream.

In higher flow storm events, the benefits do not increase in proportion to the amount of runoff through the system. Once the vegetated system is inundated, no more benefit will be gained from
infiltration, evapotranspiration, or velocity reduction.

To garner maximum benefit from a vegetated swale, the quantity of runoff tributary to the swale should be small enough that the swale can sufficiently treat that water. When implementing green infrastructure improvements to a watershed, a “treatment train” approach with multiple installations working together is much more efficient that trying to treat large drainage areas at a single point.

However, we can make two assumptions regarding the replacement of concrete swales or pipes with vegetated swales. Any replacement of concrete with vegetation will slow flow and increase infiltration. Additionally, the further upstream these improvements are made, the greater the benefit because the runoff to filter ratio is reduced.

**CONSTRUCTION**

Remove Existing Hard Armor: All concrete and grouted rip rap should be removed in accordance with the design drawings. Removed material shall be disposed off site at a location approved by the City.

Rough Grade the Vegetated Swale: Only the lightest, least disruptive equipment may be used to avoid excessive compaction and/or land disturbance. *Excavating equipment should operate from the side of the swale and never the bottom.* If excavation leads to substantial compaction of the subgrade (where an infiltration trench is not proposed), the first several feet should be removed and replaced with a blend of topsoil and sand to promote infiltration and biological growth. At the very least, topsoil should be thoroughly deep plowed into the subgrade in order to penetrate the compacted zone and promote aeration and the formation of macrospores. Following this, the area should be disked prior to final grading of topsoil. Dependent on soil conditions of the particular project site, removal of subgrade and replacement with a better filtering soil may be required.

Construct: The underdrain (if applicable), forebay, and check dams should be constructed as required by the design drawings.

Fine Grade the Vegetated Swale: Accurate grading is crucial for swales. Even the smallest non conformities may compromise flow conditions.

Seed and Vegetate According to Final Planting List: Plant the swale at a time of the year when successful establishment without irrigation is most likely. Temporary irrigation may be needed in periods of little rain or drought. Vegetation should be established as soon as possible to prevent erosion and scour.

Stabilize Freshly Seeded Swales: Stabilize swales with appropriate temporary or permanent soil stabilization methods such as erosion control matting or blankets. Erosion control for seeded swales should be required for at least the first 75 days following the first storm event of the season. If runoff velocities are high, consider sodding the swale or diverting runoff until vegetation is fully established.

Once the swale is sufficiently stabilized, remove temporary erosion and sediment controls. It is very important that the swale be stabilized before receiving upland storm water flow. Follow maintenance guidelines.
This manual provides general guidance for the maintenance and operation of hard armored roadside ditches retrofitted with vegetated swales in the City of O’Fallon, Illinois.

The use of these procedures is not mandatory, but a guideline. The maintenance of Best Management Practices (BMPs) is an evolving science and is dependent on many highly variable individual site conditions.

A vegetated swale will only perform as designed and last only as long as it is properly maintained. Although maintenance of a vegetated swale is relatively low, it is also the most important factor in keeping the swale operational. The useful life of a vegetated swale is directly proportional to its maintenance frequency.

Inspections of swales must be done at various times due to different conditions at the swale. Inspecting the swales each month, before the rainy seasons, and after a major rain event (over 1 inch of rainfall in a 24 hour period) will ensure the integrity and efficiency of the swale. The Appendix has a checklist for the swale inspections to be conducted by City personnel.

**Properly Maintained Biofiltration Swale**

- Good grass height
- No trash or debris present
- No alterations to original design
- No obstructions to water flow

**Poorly Maintained Biofiltration Swale**

- In this photo, the wetland plants are cut too short. Mow no shorter than 8” in height.

**Debris Removal**

Remove any trash or other debris (limbs, fallen leaves, grass clippings, dead vegetation, etc.) in and around the swale. Remove any debris or sedimentation around inlets and outlets that block the even distribution of flow into or out of the swale. Remove any yard waste dumped into the swale.

**Vegetation**

Determine if any vegetation is damaged, dead, or needs to be replenished. Replenish plants as described in the construction phase of the project. Mow grass on sides of swale and trim plants to prevent them from getting excessively tall. Remove any invasive species of plants and all weeds from the swale. Use fertilizers and pesticides only when absolutely needed. Watering of plants during
drought conditions is permitted. When inspecting the swale, note any plants or trees that are not part of the original plan and have them removed.

**Mowing**
Grass and flowering plants should not be trimmed short, as this will reduce the filtering effect of the swale and possibly kill the plants. If a native species of grass seed mix or if individual plantings or plugs are used in the swale, mowing guidelines specific to the maintenance of those plants should be used. Generally, a native grass mix will require only one mowing or controlled burn each year at the end of the growing season. Substantial cut vegetation should be removed to prevent the decaying organic matter from adding pollutants to the discharge from the swale. Mowing of vegetation to a minimum height of 4 inches and a maximum height of 10 inches will deter weeds and allow sunlight to kill captured pathogens.

**Filtration Capacity**
Remove any evidence of oils and grease from the swale, determine their source, and prevent the source from flowing into the swale if possible. Determine if the swale holds water longer than the 48 hour holding limit. If so, the underdrain (if installed), outfall, or check dams may need to be unclogged. In severe situations, the swale may need to be tilled due to compaction and then revegetated.

**Check Dams and Energy Dissipaters**
Determine if there has been any erosion, and replenish mulch and topsoils if needed. Side slopes should be maintained and stabilized to reduce chances of erosion and help to convey the sediments and flow to the swale. Also, correct any erosion issues with added energy dissipaters, regrade the swale, or use other methods to eliminate erosion or scouring issues.

**Sediment Deposition**
Remove any excessive sedimentation buildup in the forebay, inlets, outfall, and swale if needed. If sedimentation is more than 20% of the swale’s design depth, remove the sedimentation from the swale to increase the swale efficiency.

**Outlet/Overflow Spillway**
Determine if the outfall is in good condition and working properly. Correct any erosion or scouring issues, and remove any debris or sedimentation that is blocking the normal flow from the swale.

**Fertilization**
Routine fertilization and/or use of pesticides is strongly discouraged to prevent pollution of the receiving waters. Properly selected, installed and maintained native vegetation should not need fertilizing.

**Damage Control**
Another aspect of a good maintenance plan is repairing damaged areas within a channel. If a channel develops ruts or holes, it should be replaced using a suitable soil that is properly tamped and seeded.
Our Mission is to provide leadership and solutions to sustain and enrich the diverse environmental resources of Southwestern Illinois

Our Vision is communities with healthy and sustainable air, land and water resources for current and future generations

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