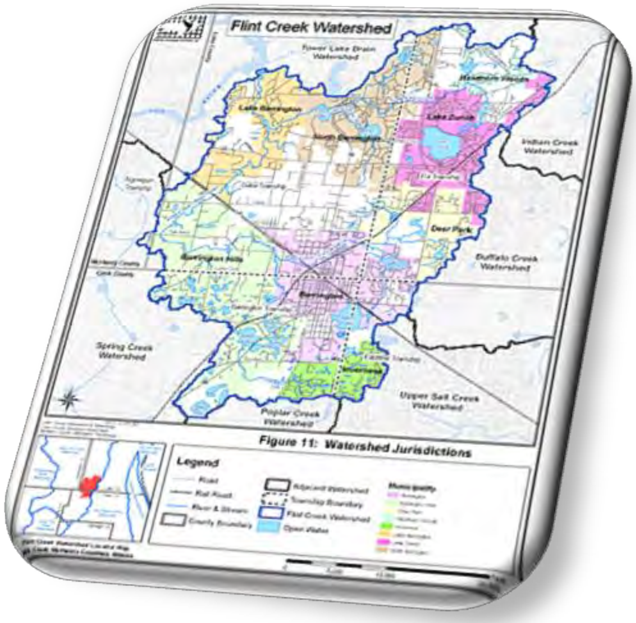

Village of North Barrington, Illinois
Watershed BMP Handbook

First Edition
February 2010

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Prepared By:
Baxter & Woodman, Inc.
8678 Ridgefield Road
Crystal Lake, IL 60012

The development of this Watershed BMP Handbook was facilitated by the Barrington Area Conservation Trust. It was funded as a cooperative effort between the Village of North Barrington, the Barrington Area Conservation Trust and the Barrington Area Council of Governments.

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Village of North Barrington

BAXTER & WOODMAN

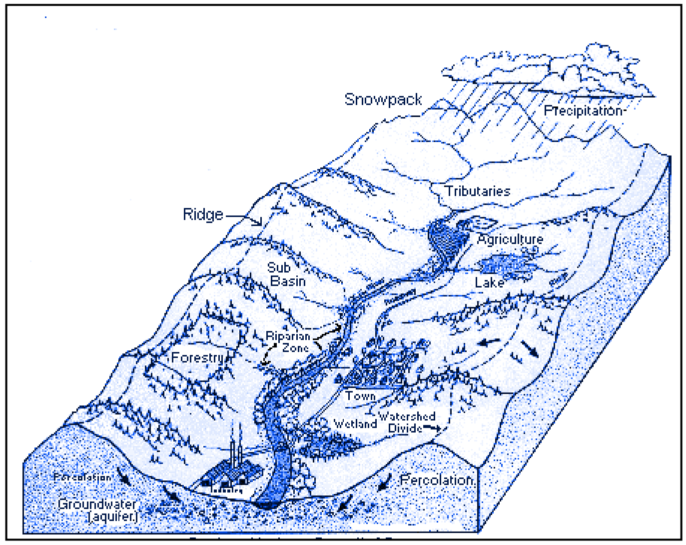
BARRINGTON AREA CONSERVATION TRUST
Space to Breathe | Space to Ride | Space to Play

BACOG
Barrington Area Council of Governments

Foreword

Preface

A watershed is all of the land that drains into a single body of water, such as a lake, stream or wetland. Because water always flows downhill, watershed boundaries are always located on top of ridges or hills. Rain that falls on one side of a watershed boundary will flow into one body of water, while rain that falls on the other side of a watershed boundary will flow into another. While watershed boundaries can be more difficult to identify in flat terrain, they still exist, often as subtle ridges that traverse the terrain.



Watershed
(Source: Lane Council of Governments)

The Village of North Barrington lies within the Flint Creek Watershed. Before development, the Flint Creek Watershed was dominated by prairies, savannas, forests, marshes, wet meadows and other mature native plant communities. Much of the precipitation that fell during rain and snow events was absorbed by these native plant communities, where it was subjected to the runoff-reducing hydrologic processes of interception, evaporation, transpiration and infiltration. The small amount of precipitation that did leave the landscape as stormwater runoff was filtered by extensive wetlands that once existed along streams and other low-lying areas. The water that eventually made it to the streams, which, at the time, were little more than small, vegetated swales, exhibited excellent water quality.

Today, the Flint Creek Watershed exhibits many of the same symptoms of urbanization that have been observed in other watersheds in northeastern Illinois and across the U.S. Many of its mature native plant communities have been replaced with turf grass and impervious cover, which has changed the hydrology of the watershed and has increased the amount of stormwater runoff leaving the landscape. As a result, many of its streams suffer from streambank erosion, sediment deposition, degraded in-stream habitat and poor water quality. All of these symptoms can be traced back to the changes in watershed hydrology caused by the land development process.

This Watershed Best Management Practice (BMP) Handbook provides information about the various BMPs that can be used to protect and restore the Flint Creek Watershed and counteract many of the negative impacts of the land development process.

Acknowledgements

The development of this Watershed BMP Handbook was facilitated by the Barrington Area Conservation Trust. It was funded by a grant from the Lake County Stormwater Management Commission as a cooperative effort between the Village of North Barrington, the Barrington Area Conservation Trust and the Barrington Area Council of Governments.

Individuals contributing to the development of this Handbook included:

- Michael Novotney (Baxter & Woodman, Inc.), Project Manager and Lead Author

The following individuals deserve special recognition, as they provided thoughtful comments and insights that helped improve the organization and utility of this Handbook:

- Kathy Nelander (Village of North Barrington)
- Nancy Schumm-Burgess (Barrington Area Conservation Trust)
- Patsy Mortimer (Flint Creek Watershed Partnership)

The Flint Creek Watershed Partnership and the Barrington Area Conservation Trust also deserve special recognition, as they provided the photographs and images adorning the cover of this Handbook. The photographs depict watershed BMPs in and around the Village of North Barrington.

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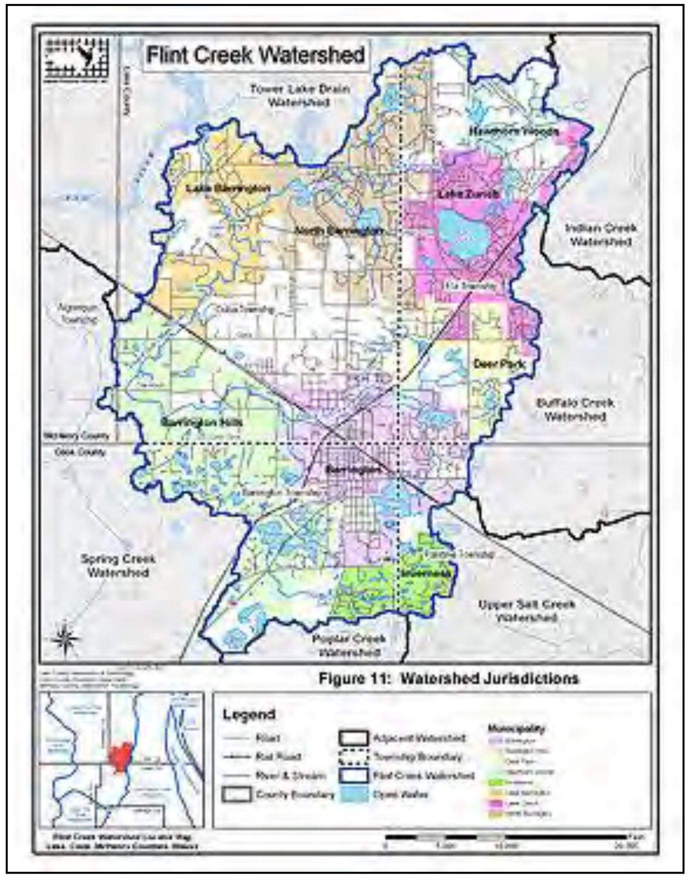
Introduction

The Flint Creek Watershed drains approximately 36.5 square miles of land in southwest Lake County, northwest Cook County and southeast McHenry County, Illinois. A total of eight municipalities, including the Villages of Inverness, Barrington, Barrington Hills, Lake Barrington, North Barrington, Hawthorn Woods, Lake Zurich and Deer Park, and five townships, including Ela, Cuba, Algonquin, Barrington and Palatine Townships, are located partially or entirely within the watershed. Existing land use is mostly low-density residential with several higher density residential and commercial areas.



Flint Creek Watershed
(Source: Flint Creek Watershed Partnership)

Before development, the Flint Creek Watershed was dominated by prairies, savannas, forests, marshes, wet meadows and other mature native plant communities. Much of the precipitation that fell during rain and snow events was absorbed by these native plant communities, where it was subjected to the runoff-reducing hydrologic processes of interception, evaporation, transpiration and infiltration. The small amount of precipitation that did leave the landscape as stormwater runoff was filtered by extensive wetlands that once existed along streams and other low-lying areas. The water that eventually made it to the streams, which, at the time, were little more than small, vegetated swales, exhibited excellent water quality.

Today, the Flint Creek Watershed exhibits many of the same symptoms of urbanization that have been observed in other watersheds in northeastern Illinois and across the U.S. Many of its mature native plant communities have been replaced with turf grass and impervious cover, which has changed the hydrology of the watershed and has increased the amount of stormwater runoff leaving the landscape. As a result, many of its streams suffer from streambank erosion, sediment deposition, degraded in-stream habitat and poor water quality. All of these symptoms can be traced back to the changes in watershed hydrology caused by the land development process.

In December 2007, the Flint Creek Watershed Partnership received a grant from the Illinois Environmental Protection Agency to develop a plan to restore the Flint Creek Watershed. The plan documents existing problems and restoration opportunities and identifies the actions that can be taken to improve water quality, protect and enhance natural resources and open space and reduce flooding within the watershed. For more information about the Flint Creek Watershed Plan and the Flint Creek Watershed Partnership, please visit http://www.flintcreekwatershed.org.

To help educate stakeholders and engage them in the implementation of the Flint Creek Watershed Plan, the Village of North Barrington, the Barrington Area Council of Governments and the Barrington Area Conservation Trust have partnered to develop this Watershed Best Management Practice (BMP) Handbook. In time, this Handbook will be used to educate various stakeholder groups (e.g., residents, business owners, developers, municipalities) about the various BMPs that can be used to protect and restore the Flint Creek Watershed. Once the stakeholder groups have been better educated on the practice of watershed protection and restoration, they are more likely to begin implementing BMPs that address the goals and objectives of the Flint Creek Watershed Plan:

- Protect water resources and enhance water quality
- Protect natural areas and open space
- Reduce flooding
- Improve habitat
- Increase coordination among stakeholders
- Enhance stewardship and education

This Handbook contains short, two- to four-page profile sheets that provide basic information about each of the BMPs that can be used to protect and restore the Flint Creek Watershed. They can be used individually to educate stakeholders on specific BMPs or groups of BMPs or collectively to educate stakeholders on the concept of comprehensive watershed management. The profile sheets have been written so that stakeholders with only a basic understanding of the practice of watershed protection can understand the information and concepts presented within.

It is important to note that the profile sheets provided in this Handbook should only be used for educational and preliminary project planning purposes. They should not, on their own, be used for design, construction or inspection and maintenance purposes.

User's Guide

Whether you are a homeowner, business owner, developer or a municipal official or employee, you can help protect and restore the Flint Creek Watershed. This Watershed BMP Handbook contains a series of short, two- to four-page profile sheets that provide basic information about the various best management practices (BMPs) that can be used to protect and restore the watershed. The table below identifies each of the profile sheets and the stakeholder groups that will get the most use out of them.

Profile Sheet	Home Owners	Business Owners	Developers	Municipal Officials and Employees
Pollution Prevention Practices				
Turf Management	X	X		X
Landscape Management	X	X		X
Building Maintenance	X	X		X
Driveway Maintenance	X			X
Parking Lot Maintenance		X		X
Vehicle Maintenance	X	X		X
Waste Management	X	X		X
Stormwater Management Practices				
Erosion and Sediment Control	X	X	X	X
Soil Amendments	X	X	X	X
Native Landscaping	X	X	X	X
Green Roofs	X	X	X	X
Permeable Pavement	X	X	X	X
Downspout Disconnection	X		X	X
Filter Strips	X		X	X
Rain Barrels	X		X	X
Rain Gardens	X		X	X
Grass Channels			X	X
Dry Swales			X	X
Wet Swales			X	X
Dry-Bottom Detention Basins			X	X
Wet-Bottom Detention Basins			X	X
Detention Basin Retrofits				X
Stormwater Wetlands			X	X
Bioretention Areas		X	X	X
Filtration Practices		X	X	X
Infiltration Practices		X	X	X
Stream Corridor Management Practices				
Stream Cleanups	X			X
Stream Buffers	X	X	X	X
Hard Bank Stabilization	X	X	X	X
Soft Bank Stabilization	X	X	X	X
In-Stream Habitat Improvements				X
Fish Passage Improvements				X
Natural Resource Management Practices				
Natural Area Management	X	X		X

To help stakeholders identify the BMPs that are most applicable to their own lives, each profile sheet has a color-coded header that matches the color-coding in the previous table. To find the BMPs that they will find most applicable to their own situations, stakeholders need only identify the color associated with their stakeholder group and then find the profile sheets that have a header with that color.

The BMPs that each stakeholder group can use to help protect and restore the Flint Creek Watershed are briefly described below.

- Homeowners: Homeowners can help protect and restore the Flint Creek Watershed by using improved turf and landscape management practices to reduce the amount of pollution carried into local lakes, streams and wetlands. They can also improve their own building, driveway and vehicle maintenance and waste management practices to prevent pollutants from being picked up and carried away in stormwater runoff. Homeowners can also act as watchdogs to ensure that erosion and sediment control practices are used on active construction sites to prevent sediment from being carried into local lakes, streams and wetlands. They can also use small-scale stormwater management practices, such as soil amendments, native landscaping, downspout disconnection, filter strips, rain gardens and rain barrels, to reduce stormwater runoff rates, volumes and pollutant loads at or near the source (i.e., rooftops, driveways, lawns). Lastly, homeowners can use stream corridor management practices, such as stream cleanups, stream buffers and hard and soft bank stabilization, and natural area management practices to restore the stream corridor and maintain and improve the appearance and functionality of floodplains, natural areas and open space in the Flint Creek Watershed.

- Business Owners: Like homeowners, business owners can help protect and restore the Flint Creek Watershed by using improved turf and landscape management practices to reduce the amount of pollution carried into local lakes, streams and wetlands. They can also improve their building, parking lot and vehicle maintenance and waste management practices to prevent pollutants from being picked up and carried away in stormwater runoff. Business owners can also work to ensure that erosion and sediment control practices are being used to prevent sediment from being carried into local lakes, streams and wetlands. They can also use small-scale stormwater management practices, such as soil amendments, native landscaping, green roofs, permeable pavers, pervious concrete, bioretention areas, filtration practices and infiltration practices, to reduce stormwater runoff rates, volumes and pollutant loads at or near the source (i.e., rooftops, parking lots, landscaping beds). Lastly, business owners can use stream corridor management practices, such as stream buffers and hard and soft bank stabilization, and natural area management practices to restore the stream corridor and maintain and improve the appearance and functionality of floodplains, natural areas and open space in the Flint Creek Watershed.

- Developers: Developers can help reduce the negative impacts of the land development process by using site planning and design techniques that preserve floodplains, natural areas and open space and minimize the creation of new impervious cover. They can also help protect and restore the Flint Creek Watershed by using proper erosion and sediment control practices to prevent sediment from being carried into local lakes, streams and wetlands. They can also use a wide variety of stormwater management practices, including wet- and dry-bottom detention basins, stormwater wetlands and bioretention areas, to reduce stormwater runoff rates, volumes and pollutant loads at or near the source. Lastly, developers can use stream corridor management practices, such as stream buffers and hard and soft bank stabilization, to restore the stream corridor and maintain and improve the appearance and functionality of floodplains in the Flint Creek Watershed.

- Municipal Officials and Employees: Municipal officials and employees can encourage other stakeholders to protect and restore the Flint Creek Watershed by demonstrating the use of pollution prevention, stream corridor management and natural area management practices at their own properties and facilities. They can also educate home and business owners on the use of small-scale stormwater management practices, such as soil amendments, native landscaping, green roofs, permeable pavers, rain gardens and rain barrels, to reduce stormwater runoff rates, volumes and pollutant loads at or near the source. They can also develop and enforce regulations that require developers to use proper erosion and sediment control and stormwater management practices, including wet- and dry-bottom detention basins, stormwater wetlands and bioretention areas, on new development and redevelopment sites. Lastly, they can implement stormwater retrofit projects, including detention basin retrofits, and stream restoration projects, such as in-stream habitat and fish passage improvements, on publicly-owned land.

Pollution Prevention Practices

Turf Management

Turf management involves mowing, fertilizer and pesticide application and supplemental irrigation. While these practices can help create healthy and attractive lawns, research has demonstrated that poor turf management practices, particularly fertilizer and pesticide application practices, produce polluted, nutrient-rich runoff that increases algae growth and reduces dissolved oxygen content in nearby lakes, streams and wetlands (Barth, 1995a; Barth, 1995b). In fact, scientists have found that nutrient (i.e., nitrogen, phosphorus) concentrations in runoff from lawns can be two to ten times higher than those in runoff from other parts of the landscape, such as rooftops, streets and parking lots (Bannerman et al., 1993; Steuer et al., 1997; Waschbusch et al., 2000; Garn, 2002). This polluted runoff has contributed to the elevated levels of nutrients and poor water quality found in the lakes, streams and wetlands of the Flint Creek Watershed.

Lawn Care Equipment
(Source: http://www.donnybrookhome.com)

Fertilizer and Broadcast Spreader
(Source: http://floridalawn.com)

Typical Applications:
In a typical watershed, residential lawns account for about two thirds of all turf cover; the other one third is found in parks, school sites, rights-of-way, golf courses and other commercial, institutional and municipal lawns. Improved turf management practices can be applied at all of these locations to help reduce the amount of pollution carried into the lakes, streams and wetlands of the Flint Creek Watershed.

Advantages/Benefits:
- Reduces fertilizer and pesticide use as well as the amount of money spent on purchasing and applying these chemicals
- Reduces the amount of fossil fuels used to power lawn mowers, leaf blowers and other lawn care equipment

Disadvantages/Limitations:
- Improving turf management practices can be difficult because of a cultural desire for lush, green lawns
- Can be challenging to educate of all of the individuals, including individual homeowners, that perform lawn care services within a watershed

Implementation Costs:
- Low; increased costs associated with more labor intensive practices are typically offset by savings resulting from reduced fertilizer and pesticide use

Operation & Maintenance:
- No requirements beyond those associated with traditional lawn care practices

Pollutant Removal:

Provides water quality benefits by reducing the amount of pollution carried into local lakes, streams and wetlands

Description:
Runoff from lawns has contributed to the elevated levels of nutrients and poor water quality found in the lakes, streams and wetlands of the Flint Creek Watershed. In fact, with the exception of Lake Zurich, all of the lakes in the Flint Creek Watershed have elevated levels of nutrients, including phosphorus. Improved turf management practices can help reduce the amount of pollution that is carried into these local lakes, streams and wetlands.

The table below summarizes a variety of pollution prevention practices that can be used to improve turf management practices within the Flint Creek Watershed. Of course, the best pollution prevention practice would be to replace all turf grass with native trees, shrubs, grasses and ground covers that don't require fertilizer, pesticides or supplemental irrigation. However, given our cultural desire for lush, green lawns, it will be difficult, if not impossible, to convince individual homeowners to replace their turf grass lawns with native landscaping. The next best solution, then, is to convince them to use mowing, irrigation and fertilizer and pesticide application practices that are based on the actual needs of their lawns.

Pollution Prevention Practices for Turf Management (Schueler et al., 2005)
• Consider replacing some or all of the turf with native landscaping (BMP Profile Sheet SWM-3), such as trees, shrubs, grasses and ground covers • Sweep grass clippings away from paved surfaces and storm drain inlets and back on to the lawn immediately after mowing • Use mulching-type mowers to return grass clippings to the lawn while mowing is occurring • Collect and compost grass clippings and other yard waste to reapply to the lawn as fertilizer • Use a low or no fertilizer approach to turf management • Support the Village of North Barrington's resolution to promote the use of phosphorus-free fertilizers by using phosphorus-free fertilizers for turf management • Perform a soil test to determine the actual needs of the lawn being cared for and to properly set fertilizer application rates • Place absorbent mats or other absorbent materials under work areas when mixing or loading fertilizers and pesticides into application devices • Carefully calibrate fertilizer spreaders to avoid excessive application • Work fertilizers into the soil, rather than just applying to the surface • Do not apply fertilizer just prior to predicted rainfall events • Avoid applying fertilizers and pesticides within five feet of paved areas, 25 feet of storm drain inlets and 50 feet of lakes, streams and wetlands • Minimize non-target application of fertilizers and establish no-application zones around paved areas, storm drain inlets and lakes and streams • Use reputable lawn care and landscaping services that use proper fertilizer application rates and natural pest management techniques • Reduce supplemental irrigation needs and maintain a healthier lawn by mowing a maximum of one third of the grass blade height • Place absorbent mats or other absorbent materials under work areas when storing or servicing lawn care equipment

The best way to ensure the implementation of these pollution prevention practices is to make an effort to educate all of the individuals that perform lawn care services within the watershed, including individual homeowners and small lawn care companies. Communities that have been able to improve local turf management practices have used a combination of printed educational materials, homeowner training workshops and professional training and certification programs for lawn care company employees.

Resources:

Flint Creek Watershed Partnership. http://www.flintcreekwatershed.org.

Lake County, Illinois. Department of Health. Lakes Management Unit. Phosphorus Free Fertilizer Available in Lake County. http://www.lakecountyil.gov/Health/want/Documents/Fertilizer[1].pdf.

University of Wisconsin Cooperative Extension. Yard Care and the Environment Fact Sheet Series. http://clean-water.uwex.edu/pubs/home.htm#yard.

Cornell University Cooperative Extension. The Homeowner's Lawn Care and Water Quality Almanac. http://www.hort.cornell.edu/gardening/lawn/almanac/almanac.pdf.

North Carolina Department of Agriculture and Consumer Services. Agronomic Services Division. Frequently Asked Questions about Soil Testing and Fertilizer. http://www.ncagr.gov/agronomi/stfaqs.htm.

Landscape Management

Landscaping is a common feature found on many residential, commercial, institutional and municipal development sites, and typically consists of beds of trees, shrubs, ground covers and/or flowering plants. Once installed, landscaping beds are managed on a regular basis through mulching, weeding and pruning, removing leaves and trash, inspecting and repairing irrigation systems and applying fertilizers and pesticides. Although a well designed and maintained landscaping bed can help absorb rainfall and runoff, poorly maintained landscaped areas can produce polluted, nutrient-rich runoff that negatively impacts nearby lakes, streams and wetlands. Improved landscape management practices can help reduce the negative impact that these landscaped areas have on the lakes, streams and wetlands of the Flint Creek Watershed.

Weeding a Landscaping Bed
(Source: http://www.deepwild.org)

Mulched Landscaping Bed
(Source: http://www.colostate.edu)

Typical Applications:
Landscaping can be found on many residential, commercial, institutional and municipal development sites within the Flint Creek Watershed and the Village of North Barrington. Improved landscape management practices can be applied at all of these locations to help reduce the amount of pollution carried into local lakes, streams and wetlands.

Advantages/Benefits:
- Reduces fertilizer and pesticide use as well as the amount of money spent on purchasing and applying these chemicals
- Reduces the amount of fossil fuels used to power weed wackers, leaf blowers and other landscaping equipment

Disadvantages/Limitations:
- Can be challenging to educate of all of the individuals, including landscaping companies and individual homeowners, that perform landscape management services within a watershed

Implementation Costs:
- Low; increased costs associated with more labor intensive practices are typically offset by savings resulting from reduced fertilizer and pesticide use

Operation & Maintenance:
- No requirements beyond those associated with traditional landscape management practices

Pollutant Removal:

Provides water quality benefits by reducing the amount of pollution carried into local lakes, streams and wetlands

Description:
The table below summarizes a variety of pollution prevention practices that can be used to improve landscape management practices within the Flint Creek Watershed. Of course, the best pollution prevention practice would be to replace all ornamental and non-native plants with native trees, shrubs, grasses and ground covers that don't require fertilizer, pesticides or supplemental irrigation. However, given the cost and availability of native landscape stock, it will be difficult to convince home and business owners to completely replace their existing landscaping beds with native plants. The next best solution, then, is to convince them to use irrigation and fertilizer and pesticide application practices that are based on the actual needs of their landscaping beds.

Pollution Prevention Practices for Landscape Management (Schueler et al., 2005)
• Collect and compost landscape waste to reapply to landscaping beds as fertilizer • Collect landscape waste and dispose of at a local yard waste recycling/composting facility • Avoid using leaf blowers to blow landscape waste toward paved surfaces, storm drain inlets and ditches • Cover exposed landscaping beds with mulch to minimize soil erosion and increase water retention • Use manual and/or mechanical methods, instead of herbicides, to remove weeds and other unwanted vegetation • Support the Village of North Barrington's resolution to promote the use of phosphorus-free fertilizers by using phosphorus-free fertilizers for landscape management • Perform a soil test to determine the actual needs of the landscaping bed being cared for and to properly set fertilizer application rates • Use reputable landscaping services that use native plants, proper fertilizer application rates and natural pest management techniques • Avoid applying fertilizers and pesticides within five feet of paved areas, 25 feet of storm drain inlets and 50 feet of lakes, streams and wetlands • Place absorbent mats or other absorbent materials under work areas when mixing or loading fertilizers and pesticides into application devices • If installing a new landscaping bed, consider designing as a rain garden (BMP Profile Sheet SWM-9) or bioretention area (BMP Profile Sheet SWM-17) • Use a low or no pesticide approach to landscape management • Develop and implement an integrated pest management plan that uses chemical pesticides only as a last resort • Apply pesticides only when rain is not expected and when wind speeds are low • Use the minimum amount of pesticide needed for the job and employ application techniques that prevent non-target application • Install automatic shut-off devices on irrigation systems to prevent irrigation from occurring during or immediately after rainfall events • Avoid irrigating during the middle of the day, when temperatures and evaporation rates are at their highest, by irrigating only after sunset and before sunrise • Place absorbent mats or other absorbent materials under work areas when storing or servicing landscaping equipment

As with turf management (BMP Profile Sheet PP-1), the best way to ensure the implementation of these pollution prevention practices is to make an effort to educate all of the individuals that perform landscape management services within the watershed, including individual homeowners. Communities that have been able to improve local landscape management practices have used a combination of printed educational materials, homeowner training workshops and professional training and certification programs for landscape company employees.

Resources:

Flint Creek Watershed Partnership. http://www.flintcreekwatershed.org.

Cornell University Cooperative Extension. The Homeowner's Lawn Care and Water Quality Almanac. http://www.hort.cornell.edu/gardening/lawn/almanac/almanac.pdf.

Green Communities Canada. Pesticide Free Naturally Campaign Website. http://www.gca.ca/indexcms/index.php?pfn.

California Urban Water Conservation Council. Water Saver's Home Website. http://www.h2ouse.org/index.cfm.

Irrigation Association. Turf and Landscape Irrigation Best Management Practices Website. http://www.irrigation.org/gov/default.aspx?r=1&pg=bmps.htm.

Building Maintenance

Many of the practices (i.e., washing, power washing, sanding, sandblasting, painting, roof maintenance) that are used to maintain the rooftops and exterior walls of single family homes and other buildings can have a negative impact on water quality. Some of the building maintenance practices (i.e., power washing) produce polluted wash water that enters receiving streams or storm sewer systems during dry weather, while others (i.e., sanding, painting) produce pollutants that can be picked up and carried into nearby lakes, streams and wetlands during storm events. Improved building maintenance practices can help reduce the negative impact that these routine maintenance practices have on the health of the lakes, streams and wetlands of the Flint Creek Watershed.

Power Washing a Single Family Home
(Source: http://www.housewashing.us)

Sandblasting a Single Family Home
(Source: http://www.exteriorworldinc.com)

Typical Applications:
Routine maintenance occurs at all buildings, including single family homes, but is most frequently performed at commercial, institutional and municipal sites with a steady flow of visitors. Although improved building maintenance practices would have the biggest impact at these high visibility sites, where maintenance most frequently occurs, they can be applied wherever building maintenance practices are used to help reduce the amount of pollution carried into local lakes, streams and wetlands.

Advantages/Benefits:

- Helps protect water quality in local lakes, streams, wetlands and other receiving waterbodies

Disadvantages/Limitations:

- Can be challenging to educate all of the individuals, including property management companies, contractors and individual homeowners, that perform building maintenance within a watershed

Implementation Costs:

- Low; some increased costs associated with necessary equipment (e.g., storm drain inserts, tarps) and paints, sealants, detergents and other materials that have less of an impact on the environment

Operation & Maintenance:

- No requirements beyond those associated with traditional building maintenance practices

Pollutant Removal:

Provides water quality benefits by reducing the amount of pollution carried into local lakes, streams and wetlands

Description:
The table below summarizes a variety of pollution prevention practices that can be used to improve building maintenance practices within the Flint Creek Watershed. Although most of these practices are simple good housekeeping practices, the challenge involved with implementing them is ensuring that all of the individuals that perform building maintenance within the watershed, including property management companies, contractors and individual homeowners, receive training and education on them. Communities that have successfully educated others about these practices have used a combination of printed educational materials and training workshops.

Pollution Prevention Practices for Building Maintenance (Schueler et al., 2005)
• Enclose exterior scraping, stripping and sanding operations whenever practical • Place tarps or filter fabric beneath outdoor work areas to help collect fine particles and splatters • Sweep paved surfaces immediately after scraping, stripping, sanding or sandblasting operations are completed; sweep materials away from storm drain inlets and avoid using blowers or hoses • Prevent wash water from being discharged directly to the storm drain system • Block adjacent storm drain inlets when stripping or cleaning buildings using power washing equipment • Direct wash water toward grassy areas or areas where it can be collected for disposal in the sanitary sewer; filtering wash water at the storm drain inlet is acceptable if no detergents are used • Never clean paint brushes, sprayers or containers in a location where wash water can reach a storm drain inlet or lake, stream or wetland • When cleaning up after using water-based paints, first paint out the brushes as much as possible and then rinse in a sink • When cleaning up after using oil-based paints, first paint out the brushes as much as possible and then use thinners and solvents to clean them; treat thinners, solvents and leftover paint as household hazardous wastes and dispose of them accordingly • Empty paint cans and spent brushes and rags should be properly disposed of in the trash • Purchase paints, sealants and finishes that have less of an impact on the environment

Resources:
California Stormwater Quality Association. Municipal Stormwater Best Management Practice Handbook. Fact Sheet SC-41: Building and Grounds Maintenance. http://www.cabmphandbooks.org/Documents/Municipal/SC-41.pdf

Alameda County, California. Clean Water Program. Best Management Practice Fact Sheet: Building Maintenance and Remodeling. http://www.cleanwaterprogram.org/bddmaint_fact_sht.pdf.

Washtenaw County, Michigan. Community Partners for Clean Streams Program. Fact Sheet 4: Maintaining Buildings and Pavement. http://www.ewashtenaw.org/government/drain_commissioner/dc_webWaterQuality/dc_cpcs/factsheets/dc_drnbmp4.pdf.

City of Fort Worth, Texas. Department of Environmental Management. Fact Sheet: Power Washers. http://www.fortworthgov.org/dem/info/default.aspx?id=8260&ekmensel=1792_submenu_4890_link_3.

Driveway Maintenance

Driveways are associated with single family most homes located within the Flint Creek Watershed. Research has shown that the practices used to maintain these driveways (e.g., sweeping, washing, power washing, degreasing, sealing, resurfacing, deicing) can be a source of a number of pollutants including sediment, nutrients, metals, chlorides and hydrocarbons (CWP, 2003). Some of the practices (i.e., power washing, degreasing) produce polluted wash water that enters receiving streams or storm sewer systems during dry weather, while others (i.e., resurfacing, deicing) produce pollutants that can be picked up and carried into nearby lakes, streams and wetlands during snowmelt or storm events. Improved driveway maintenance practices can help reduce the impact that these routine maintenance practices have on the lakes, streams and wetlands of the Flint Creek Watershed.

Driveway Sealing
(Source: http://www.greasebusters.net)

Excess Road Salt on a Driveway
(Source: http://natsci.edgewood.edu)

Typical Applications:
Home and business owners conduct year round maintenance activities on their driveways. Whether these activities are performed during the summer months (e.g., removing sediment and grass clippings, resealing, resurfacing) or the winter months (e.g., deicing), improved driveway maintenance practices can be used to help reduce the impact that they have on local lakes, streams, wetlands and other receiving waterbodies.

Advantages/Benefits:
- Helps protect water quality in local lakes, streams, wetlands and other receiving waterbodies
- Reduces road salt use as well as the amount of money spent on purchasing and applying it

Disadvantages/Limitations:
- Can be challenging to educate of all of the individuals, including property management companies, contractors and individual homeowners, that perform driveway maintenance within a watershed

Implementation Costs:
- Low; some increased costs associated with more labor intensive practices and sealants, detergents and other materials that have less of an impact on the environment

Operation & Maintenance:
- No requirements beyond those associated with traditional driveway maintenance practices

Pollutant Removal:

Provides water quality benefits by reducing the amount of pollution carried into local lakes, streams and wetlands

Description:
The table below summarizes a variety of pollution prevention practices that can be used to improve driveway maintenance practices within the Flint Creek Watershed. Although most of these practices are simple good housekeeping practices, the challenge involved with implementing them is ensuring that all of the individuals that perform driveway maintenance within the watershed, including property management companies, contractors and individual homeowners, receive training and education on them.

Pollution Prevention Practices for Driveway Maintenance
• Sweep grass clippings off of driveways and away from storm drain inlets and back on to the lawn immediately after mowing • To minimize non-target application, avoid applying fertilizers and pesticides within five feet of paved areas, including driveways • Use dry methods such as absorbents, brooms and wire brushes to clean driveway surfaces whenever practical; sweep materials away from storm drain inlets and avoid using blowers or hoses • Wash or pressure wash driveways only when necessary; avoid using acids, soaps, solvents and other cleaning agents whenever practical • Prevent wash water from being discharged directly to the storm drain system • Block adjacent storm drain inlets when using power washing equipment • Direct wash water toward grassy areas or areas where it can be collected for disposal in the sanitary sewer; filtering wash water at the storm drain inlet is acceptable if no detergents are used • Block adjacent storm drain inlets when sealing or resurfacing driveways; apply sealants only when rain is not expected • Avoid washing vehicles and conducting automobile maintenance on driveway surfaces whenever practical • Minimize the use of road salt by applying salt to driveways prior to winter storm events; use shovels, snowblowers or plows instead of salt to remove large amounts of snow and ice

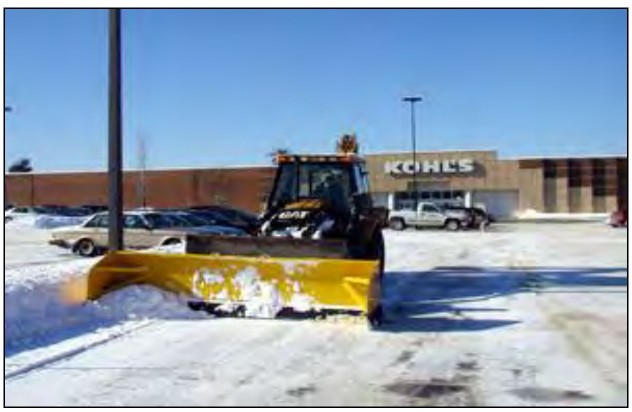
Resources:
California Stormwater Quality Association. Municipal Stormwater Best Management Practice Handbook. Fact Sheet SC-43: Parking/Storage Area Maintenance.
http://www.cabmphandbooks.org/Documents/Municipal/SC-43.pdf

Washtenaw County, Michigan. Community Partners for Clean Streams Program. Fact Sheet 4: Maintaining Buildings and Pavement.
http://www.ewashtenaw.org/government/drain_commissioner/dc_webWaterQuality/dc_cpcs/factsheets/dc_drnbmp4.pdf.

City of Fort Worth, Texas. Department of Environmental Management. Fact Sheet: Power Washers.
http://www.fortworthgov.org/dem/info/default.aspx?id=8260&ekmensel=1792_submenu_4890_link_3.

Parking Lot Maintenance

Parking lots are typically associated with commercial, industrial, institutional and municipal development sites. Every parking lot requires regular maintenance, including sweeping, power washing, degreasing, patching, sealing, striping, resurfacing and deicing. Research has shown that these activities can be a source of a number of pollutants including sediment, nutrients, metals, chlorides and hydrocarbons (CWP, 2003). Some of these practices (i.e., power washing, degreasing) produce polluted wash water that enters receiving streams or storm sewer systems during dry weather, while others (i.e., resurfacing, deicing) produce pollutants that can be picked up and carried into nearby lakes, streams and wetlands during snowmelt or storm events. Improved parking lot maintenance practices can help reduce the impact that these routine maintenance activities have on the lakes, streams and wetlands of the Flint Creek Watershed.



Parking Lot Deicing
(Source: http://www.waverlylandscape.com)

Parking Lot Sealing
(http://water.usgs.gov)

Typical Applications:
Routine maintenance occurs on most parking lots, but is most frequently performed at commercial, institutional and municipal sites that have high visibility and a steady flow of visitors. Although improved parking lot maintenance practices would have the biggest impact at these high visibility sites, where maintenance occurs most frequently, they can be applied wherever parking lot maintenance practices are used to help reduce the amount of pollution carried into local receiving waters.

Advantages/Benefits:

- Helps protect water quality in local lakes, streams, wetlands and other receiving waterbodies
- Reduces road salt use as well as the amount of money spent on purchasing and applying it

Disadvantages/Limitations:

- Can be challenging to educate of all of the individuals, including property management companies, contractors and individual business owners, that perform parking lot maintenance within a watershed

Implementation Costs:

- Low; some increased costs associated with more labor intensive practices and sealants, detergents and other materials that have a lower environmental impact

Operation & Maintenance:

- No requirements beyond those associated with traditional parking lot maintenance practices

Pollutant Removal:

Provides water quality benefits by reducing the amount of pollution carried into local lakes, streams and wetlands

Description:
The table below summarizes a variety of pollution prevention practices that can be used to improve parking lot maintenance practices within the Flint Creek Watershed. Although most of these practices are simple good housekeeping practices, the challenge involved with implementing them is ensuring that all of the individuals that perform parking lot maintenance within the watershed, including property management companies, contractors and individual business owners, receive training and education on them.

Pollution Prevention Practices for Parking Lot Maintenance (Schueler et al., 2005)
• Use dry methods such as absorbents, brooms and wire brushes to clean parking lots surfaces whenever practical; sweep materials away from storm drain inlets and avoid using blowers or hoses • Wash or pressure wash parking lots only when necessary; avoid using acids, soaps, solvents and other cleaning agents whenever practical • Use street sweepers to sweep parking lots on a regular basis, particularly right after snowmelt in the spring and leaf off in the fall • Inspect and cleanout parking lot catch basins and storm drain inlets on a regular basis to remove sediment, trash and debris • Prevent wash water from being discharged directly to the storm drain system • Block adjacent storm drain inlets when using power washing equipment • Direct wash water toward grassy areas or areas where it can be collected for disposal in the sanitary sewer; filtering wash water at the storm drain inlet is acceptable if no detergents are used • Block adjacent storm drain inlets when sealing or resurfacing parking lots; apply sealants only when rain is not expected • Conduct parking lot repair and resurfacing work only when rain is not expected • Post signs to discourage people from washing vehicles and conducting automobile maintenance on parking lot surfaces • Minimize the use of road salt by applying salt to parking lots prior to winter storm events; use snowblowers or plows to remove large amounts of snow and ice

Resources:
California Stormwater Quality Association. Municipal Stormwater Best Management Practice Handbook. Fact Sheet SC-41: Building and Grounds Maintenance. http://www.cabmphandbooks.org/Documents/Municipal/SC-41.pdf

California Stormwater Quality Association. Municipal Stormwater Best Management Practice Handbook. Fact Sheet SC-43: Parking/Storage Area Maintenance. http://www.cabmphandbooks.org/Documents/Municipal/SC-43.pdf

Washtenaw County, Michigan. Community Partners for Clean Streams Program. Fact Sheet 4: Maintaining Buildings and Pavement. http://www.ewashtenaw.org/government/drain_commissioner/dc_webWaterQuality/dc_cpcs/factsheets/dc_drnbmp4.pdf.

City of Fort Worth, Texas. Department of Environmental Management. Fact Sheet: Power Washers. http://www.fortworthgov.org/dem/info/default.aspx?id=8260&ekmensel=1792_submenu_4890_link_3.

Vehicle Maintenance

Routine vehicle maintenance and repair activities, including changing oil, exchanging fluids, washing and refueling, can have a negative impact on water quality. Research has shown that these activities can be a source of a number of pollutants including sediment, nutrients, detergents, metals, hydrocarbons and other toxic compounds. All of these pollutants can have negative impacts on nearby lakes, streams and wetlands, regardless of whether they are picked up and carried by wash water or stormwater runoff. Improved vehicle maintenance practices can help reduce the negative impacts associated with these routine vehicle maintenance activities.

Vehicle Washing
(Source: http://www.epa.gov/owow/nps/toolbox)

Vehicle Oil Change
(Source: Center for Watershed Protection)

Typical Applications:
Pollution prevention practices can be applied anywhere vehicle maintenance activities occur. Examples include private residences, car dealerships, service stations, automotive repair shops and fleet maintenance operations at commercial, industrial and municipal sites (e.g., school bus depots, public works facilities). Although improved vehicle maintenance practices can be difficult to implement across an entire watershed, they can help reduce the amount of pollution carried into local lakes, streams, wetlands and other receiving waterbodies.

Advantages/Benefits:
- Helps protect water quality in local lakes, streams and wetlands
- Reduces the frequency and magnitude of illicit discharges and illegal dumping

Disadvantages/Limitations:
- Can be challenging to educate of all of the individuals, including municipal and private-sector employees and individual vehicle and business owners, that perform vehicle maintenance within a watershed

Implementation Costs:
- Low; some increased costs associated with necessary equipment (e.g., tarps, drip pans, wash basins) and detergents, automotive fluids and other materials that have a lower environmental impact

Operation & Maintenance:
- No requirements beyond those associated with traditional vehicle maintenance practices

Pollutant Removal:

Provides water quality benefits by reducing the amount of pollution carried into local lakes, streams and wetlands

Description:
The table below summarizes a variety of pollution prevention practices that can be used to improve vehicle maintenance practices within the Flint Creek Watershed. Although most of these practices are simple good housekeeping practices, the challenge involved with implementing them is ensuring that all of the individuals that perform vehicle maintenance within the watershed, including municipal and private-sector employees and individual vehicle and business owners, receive training and education on them. Communities that have successfully educated others about better vehicle maintenance practices have used a combination of printed educational materials, training workshops, on-site inspections and automotive fluid recycling programs.

Pollution Prevention Practices for Vehicle Maintenance (Schueler et al., 2005)
• Collect used antifreeze, oil, oil filters, cleaning solutions, solvents, batteries and hydraulic and transmission fluids and recycle or dispose of appropriately • Contact Cuba Township (847) 381-1924 for more information about the proper disposal of used automotive fluids and other household hazardous wastes, including latex- and oil-based paints, cleaning products and used electronics • Conduct all vehicle maintenance and repair activities indoors or under cover • Use a tarp, ground cloth or drip pans beneath vehicles that are being repaired or maintained outdoors to capture all spills and drips • Store used batteries in a covered area with secondary containment until they can be properly disposed of • Wash automotive parts in a self-contained sink rather than outdoors or in a sink connected directly to the sanitary sewer system; collect and properly dispose of cleaning solutions and solvents • Ensure that floor drains in areas where vehicle repair and maintenance activities occur are not connected directly to the storm drain system; ideally, floor drains would be connected to an oil/grit separator and then to a holding tank or the sanitary sewer system • Use dry methods such as absorbents, brooms and wire brushes to clean areas where vehicle repair and maintenance activities have occurred; do not wash directly into the storm drain system • Wash vehicles at commercial car wash facilities that recycle or treat and convey wash water to the sanitary sewer system • Use biodegradable, phosphate-free detergents when washing vehicles • When washing vehicles, use hose nozzles that turn off automatically when left unattended • Prevent wash water from being discharged directly to the storm drain system • Block adjacent storm drain inlets when washing vehicles • Direct wash water toward grassy areas or areas where it can be collected for disposal in the sanitary sewer system; filtering wash water at the storm drain inlet is acceptable if biodegradable, phosphate-free detergents are used • Maintain a spill prevention and response plan at all service stations and other vehicle fueling facilities

Resources:

U.S. Environmental Protection Agency. Region 9. Auto Repair and Fleet Maintenance Pollution Prevention Website. http://www.epa.gov/region09/waste/p2/autofleet/.

State of Washington. Department of Ecology. Water Quality Program. Vehicle and Equipment Wash Water Discharges Best Management Practices Manual. http://www.ecy.wa.gov/pubs/95056.pdf.

Los Angeles, California. Department of Public Works. Stormwater Best Management Practice Fact Sheet: Automotive Maintenance and Care. http://www.lacitysan.org/watershed_protection/pdfs/autobmp.pdf.

Los Angeles, California. Department of Public Works. Stormwater Best Management Practice Fact Sheet: Gasoline Stations. http://www.lacitysan.org/watershed_protection/pdfs/gasstation.pdf.

Waste Management

Dumpsters, trash cans and trash bags are used to provide temporary storage of solid waste at many homes and businesses in the Flint Creek Watershed. If not properly used, these temporary waste storage practices can become a significant source of pollution. If dumpsters, trash cans or trash bags are left out in the open or left uncovered, rainfall can mix with waste, and create a potent brew affectionately known as "dumpster juice." When spilled, as it almost always is, dumpster juice can carry a variety of pollutants, including trash, fats, oils and greases, metals, nutrients and pathogens into nearby lakes, streams and wetlands. Poor waste management practices can also create odor, aesthetic and rodent issues. Improved waste management practices can help reduce the negative impacts that waste management practices have on the lakes, streams and wetlands of the Flint Creek Watershed.

Waste Management at a Single Family Home
(Source: http://www.co.dekalb.ga.us/sanitation)

Poor Waste Management
(Source: Center for Watershed Protection)

Typical Applications:
Pollution prevention practices can be applied anywhere that waste management activities occur, including private residences and commercial, industrial, institutional and municipal development sites. These practices include improved waste storage and disposal practices, as well as more frequent sweeping and pick up practices. Although improved waste management practices can be difficult to implement across an entire watershed, they can help reduce the amount of pollution carried into local lakes, streams, wetlands and other receiving waterbodies.

Advantages/Benefits:
- Helps protect water quality in local lakes, streams and wetlands
- Improves watershed aesthetics

Disadvantages/Limitations:
- Can be challenging to educate of all of the individuals, including municipal and private-sector employees and individual home and business owners, that perform waste management practices within a watershed

Implementation Costs:
- Low; some increased costs associated with necessary equipment (e.g., new dumpsters, new trash cans, covers, lids) and materials

Operation & Maintenance:
- No requirements beyond those associated with traditional waste management practices

Pollutant Removal:

Provides water quality benefits by reducing the amount of pollution carried into local lakes, streams and wetlands

Description:
The table below summarizes a variety of pollution prevention practices that can be used to improve waste management practices within the Flint Creek Watershed. Although most of these practices are simple good housekeeping practices, the challenge involved with implementing them is ensuring that all of the individuals that perform waste management practices within the watershed, including municipal and private-sector employees and individual home and business owners, receive training and education on them. Communities that have successfully educated others about better waste management practices have used a combination of printed educational materials, training workshops, on-site inspections and household hazardous waste collection programs.

Pollution Prevention Practices for Waste Management (Schueler et al., 2005)
• Always store trash bags in a dumpster, trash can or other storage container; never leave them out in the open or left uncovered as this will attract rodents and other animals that will tear them open and spread trash and debris • Locate dumpsters, trash cans and other storage containers on flat surfaces that do not drain directly to the storm drain system • Use covers and lids on dumpsters, trash cans and other storage containers to prevent rainfall from mixing with waste • Close covers and lids on dumpsters, trash cans and other storage containers after opening them • Use clear, visible signs on dumpsters, trash cans and other storage containers to indicate what types of waste are acceptable • Never throw used automotive fluids and household hazardous wastes into dumpsters, trash cans or other storage containers; temporarily store and properly dispose of these materials • Contact Cuba Township (847) 381-1924 for more information about the proper disposal of used automotive fluids and other household hazardous wastes, including latex- and oil-based paints, cleaning products and used electronics • Empty dumpsters, trash cans and other storage containers on a frequent basis to prevent overfilling and storage outside the bin • Repair or replace leaking or damaged dumpsters, trash cans and other storage containers as soon as possible • Avoid using bleach and other harsh chemicals when washing dumpsters, trash cans and other storage containers • Direct wash water toward grassy areas or areas where it can be collected for disposal in the sanitary sewer • Sweep and pick up loose trash and debris on a regular basis • Use stream clean ups (BMP Profile Sheet SC-1) to remove accumulated trash and debris from streams and stream corridors on a regular basis

Resources:
City of Portland, Oregon. Bureau of Environmental Services. Stormwater Management Manual. Source Control Fact Sheet: Solid Waste Storage Areas, Containers and Trash Compactors. http://www.portlandonline.com/bes/index.cfm?c=47954&a=202885.

Orange County, California. Watersheds Program. Help Prevent Ocean Pollution Fact Sheet: Proper Disposal of Household Hazardous Waste. http://www.ocwatersheds.com/documents/HHW_English_Press_12_2006.pdf.

Harvard University. Stormwater Best Management Practices Fact Sheet: Solid Waste Container. http://www.uos.harvard.edu/ehs/environmental/stormwater_containers.shtml

California Stormwater Quality Association. Municipal Stormwater Best Management Practice Handbook. Fact Sheet SC-34: Waste Handling and Disposal. http://www.cabmphandbooks.org/Documents/Municipal/SC-34.pdf.

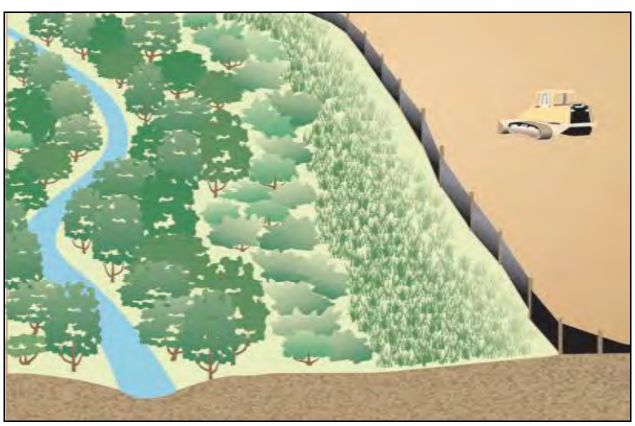
Stormwater Management Practices

Construction Stormwater Management Practices

Erosion and Sediment Control

Construction sites have long been recognized as a source of stormwater pollution, especially sediment. To reduce the amount of sediment generated on construction sites, the Lake County Watershed Development Ordinance requires the use of erosion and sediment control practices on construction sites that are equal to or greater than 5,000 square feet in size. While erosion and sediment control is the greatest concern on active construction sites, many of the other activities that occur on construction sites (i.e., demolition, paving, pavement grinding, vehicle maintenance, vehicle refueling) can also have a negative impact on water quality. Implementing erosion and sediment control practices, as well as other pollution prevention measures, can help reduce the impact that construction sites have on the lakes, streams and wetlands of the Flint Creek Watershed.

Active Construction Site
(Source: Center for Watershed Protection)



Silt Fence Used on a Construction Site
(Source: U.S. Environmental Protection Agency)

Typical Applications:
Erosion and sediment control practices are used throughout the Flint Creek Watershed. According to the Lake County Watershed Development Ordinance, they must be used on construction sites that are equal to or greater than 5,000 square feet in size. When properly designed, installed and maintained, they help reduce the amount of sediment and other pollutants carried into local lakes, streams, wetlands and other receiving waters.

Advantages/Benefits:
- Helps preserve prairies, savannas, forests and other terrestrial resources on development sites
- Helps protect water quality in local lakes, streams, wetlands and other receiving waterbodies

Disadvantages/Limitations:
- Can be challenging to educate developers, design professionals and contractors about the proper design, installation and maintenance of erosion and sediment control practices

Implementation Costs:
- Moderate; some increased costs associated with necessary equipment (e.g., storm drain inserts) and materials (e.g., silt fence, mulch)

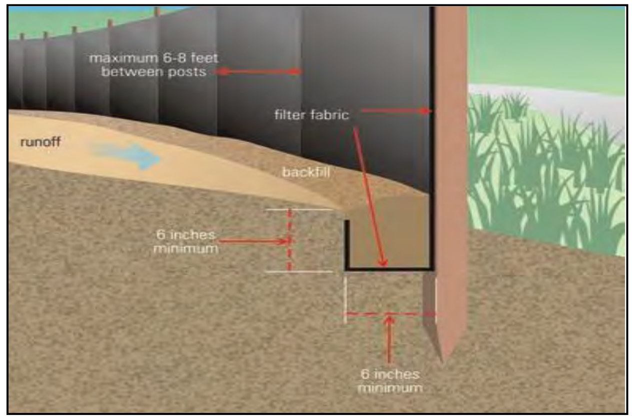
Operation & Maintenance:
- Inspect erosion and sediment controls before and immediately after rainfall events; repair or replace as necessary
- Remove accumulated sediment from sediment control practices as needed to maintain performance

Pollutant Removal:

Provides water quality benefits by reducing the amount of pollution carried into lakes, streams and wetlands

Description:

In order to be able to control erosion at a construction site, it is important to understand how erosion occurs. Erosion begins when raindrops hit the soil surface and begin to break down the structure of the soil. Individual soil particles are dislodged and carried into nearby lakes, stream and wetlands by stormwater runoff.



Properly Installed Silt Fence
(Source: U.S. Environmental Protection Agency)

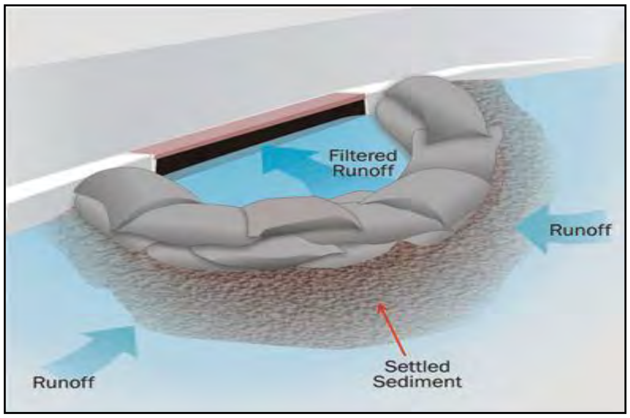
The best way to control erosion is to stop it from occurring in the first place, through the use of erosion control practices, which prevent individual soil particles from being carried away in stormwater runoff. However, it is difficult to completely prevent erosion from occurring on a construction site. Therefore, erosion control practices are best used in conjunction with sediment control practices, which slow stormwater runoff and encourage sediment and other stormwater pollutants to settle out.

Implementing erosion and sediment control practices, as well as other pollution prevention measures, can help reduce the negative impacts that construction sites have on the health of the lakes, streams and wetlands of the Flint Creek Watershed. The table below summarizes a variety of erosion and sediment control practices that can be used on construction sites located within the Flint Creek Watershed.

Erosion and Sediment Control Practices for Construction Sites
• Prior to construction, develop a Stormwater Pollution Prevention Plan (SWPPP) that outlines all of the erosion and sediment control practices that will be used to reduce the negative impacts that the construction site will have on the health of nearby lakes, streams and wetlands; the Lake County Watershed Development Ordinance requires that a SWPPP be created for all sites equal to or greater than 5,000 square feet in size • Schedule and sequence construction activities to reduce the potential for erosion on construction sites; the use of other, more costly erosion and sediment control practices may be reduced with proper scheduling • Preserve existing vegetation, including trees, shrubs, grasses and ground covers, to help prevent soil erosion • Use hydraulic seeding and mulching techniques to quickly establish vegetation in areas that have been disturbed by clearing and grading activities; hydroseeding typically involves applying a mixture of wood fiber, plant seed, fertilizer and soil binders to exposed soils using special equipment • Use soil binding agents or mulches to reduce erosion in areas have been disturbed by clearing and grading activities and that will be disturbed again in the very near future; if exposed soils will not be disturbed within the next 14 days, hydraulic seeding and mulching or other more permanent stabilization techniques should be used • Use erosion control fabrics to stabilize areas with steep slopes and other areas where vegetation will be difficult to establish using conventional seeding and mulching techniques • Use earthen berms and swales to divert stormwater runoff away from areas with steep slopes and into sediment control practices (e.g., sediment basins) • Use check dams, rip rap aprons and other velocity dissipation measures in swales to slow stormwater runoff and reduce the potential for erosion • Use silt fence and fiber rolls to establish a perimeter around the construction site and prevent sediment from entering adjacent properties and natural areas

Erosion and Sediment Control Practices for Construction Sites (Continued)
• Prevent sediment from entering existing catch basins and storm drain inlets using filter fabric, fiber rolls, sand bags, storm drain inserts or other applicable measures • Establish stabilized construction entrances to prevent vehicles entering or leaving the site from tracking sediment onto nearby streets and roadways • Train design professionals and contractors on the proper design, installation and maintenance of erosion and sediment control practices

To help ensure that erosion and sediment control practices are properly installed and maintained on development sites, the Lake County Designated Erosion Control Inspector (DECI) program requires regular inspections of active construction sites. Designated inspectors must attend an approved one-day training workshop, pass an exam and submit a statement of qualifications. Once certified, designated inspectors may oversee the installation and maintenance of erosion and sediment control practices on development sites. The Lake County DECI program applies to development sites larger than 10 acres in size and sites larger than 1 acre in size that have floodplains or wetlands on or adjacent to the site.



Protected Storm Drain Inlet
(Source: U.S. Environmental Protection Agency)

Resources:
U.S. Environmental Protection Agency. Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites. http://www.epa.gov/npdes/pubs/sw_swppp_guide.pdf.

California Stormwater Quality Association. Construction Stormwater Best Management Practice Handbook. http://www.cabmphandbooks.org/construction.asp.

Minnesota Pollution Control Agency. Minnesota Stormwater Construction Inspection Guide. http://www.pca.state.mn.us/publications/wq-strm2-10.pdf.

Ohio Environmental Protection Agency. Construction Site Inspection Checklist. http://www.epa.state.oh.us/dsw/storm/CGP_Ins1.pdf.

Upper Chattahoochee Riverkeeper. Get the Dirt Out Program Website. http://www.getthedirtout.org.

Post-Construction Stormwater Management Practices

Soil Amendments

Many people think of their lawns as "sponges" – areas that create little, if any, stormwater runoff. In reality, most lawns are able to absorb and retain only a small amount of rainfall. In fact, many lawns function more like impervious surfaces than other, more natural pervious areas, like forests and meadows (Pitt et al., 2002; Schueler, 2000). This is primarily a result of the very high level of soil compaction that occurs during the land development process. Fortunately, soil amendments can be used to help restore these underlying soils to their pre-development conditions. The process involves tilling and adding compost and other amendments to soils to restore their ability to absorb and retain rainfall.

Soil Amendment Process
(Source: http://www.towncountryltd.com)

Organic Compost Used to Amend Soils
(Source: http://www.organicgardeninfo.com)

Typical Applications:
Soil amendments can be used on a wide variety of development sites, including sites with residential, commercial, institutional and municipal land uses. They are ideal for use in pervious areas that have been disturbed by clearing, grading and other land disturbing activities. When compared with other stormwater management practices, soil amendments have a moderate construction cost and a relatively low maintenance burden.

Advantages/Benefits:
- Help restore pre-development hydrology on development sites
- Help reduce stormwater runoff rates, volumes and pollutant loads
- Promote plant growth and improve the health of native trees, shrubs, grasses and other herbaceous plants

Disadvantages/Limitations:
- Impractical in wet areas, areas with very steep terrain and areas with poorly drained soils
- Landscaping should be installed immediately after the amendment process is complete to prevent excessive soil erosion
- Amended soils should be protected from future soil compaction

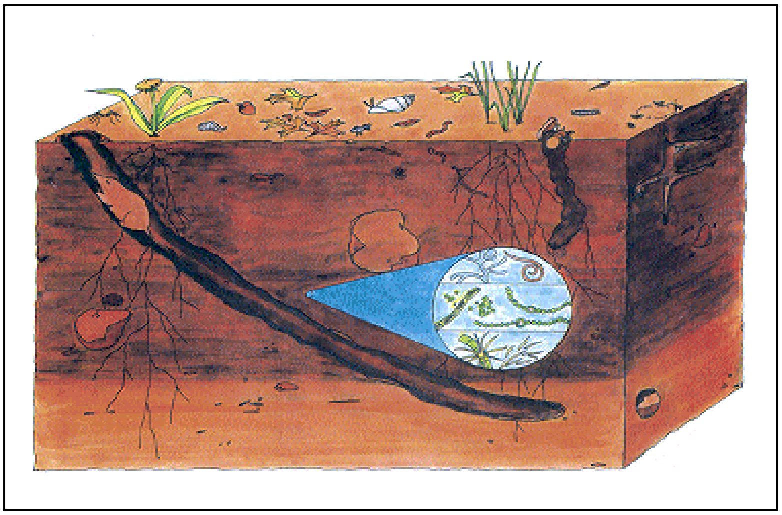
Construction Costs:
$0.50 - $1.50 per square foot
($6.00 - $18.00 per cubic foot of stormwater runoff treated)

Operation & Maintenance:
- Protect amended soils from future soil compaction
- Inspect amended areas for erosion and dead or dying vegetation; plant replacement vegetation as needed

Pollutant Removal:

Provides water quality benefits by reducing stormwater runoff rates, volumes and pollutant loads

Description:



Healthy Soil Matrix
(Source: http://www.ic.ucsc.edu)

Many lawns function more like impervious surfaces than other more natural pervious surfaces, like forests and meadows (Pitt et al., 2002; Schueler, 2000). This is primarily a result of the very high level of soil compaction that occurs during the land development process. Fortunately, soil amendments can be used to help restore these underlying soils to their pre-development conditions and increase their ability to absorb and retain rainfall. The process involves tilling and adding compost and other amendments to soils to create healthier, uncompacted soil matrices that have enough organic matter to support a diverse community of native trees, shrubs, grasses and other herbaceous plants.

Soil amendments can be used on a wide variety of development sites, including sites with residential, commercial, institutional and municipal land uses. They are ideal for use in pervious areas that have been disturbed by clearing, grading and other land disturbing activities. They can also be used to enhance the ability of stormwater management practices to reduce stormwater runoff rates, volumes and pollutant loads. This is particularly true for practices located on sites that have soils with low permeabilities (e.g., hydrologic soil group C or D soils).

Resources:

Washington Organic Recycling Council. Soils for Salmon Program Website. http://www.soilsforsalmon.org/index.htm.

Washington Organic Recycling Council. Building Soil Program Website. http://www.buildingsoil.org.

State of Washington. Department of Ecology. Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth. http://www.soilsforsalmon.org/pdf/Soil_BMP_Manual.pdf

State of Washington. Department of Ecology. Compost Amendment Rate Calculator. http://www.soilsforsalmon.org/excel/Compost_Calculator.xls.

U.S. Composting Council. U.S. Composting Council Website. http://www.compostingcouncil.org.

Native Landscaping

Landscaping is a common feature found on many residential, commercial, institutional and municipal development sites, and is typically contained in beds of trees, shrubs, ground covers and/or flowering plants. In many cases, these landscaping beds contain ornamental and non-native plants that can invade adjacent natural areas and require supplemental irrigation and regular maintenance, fertilizer and pesticide application. Non-native plants in these landscaping beds can be replaced with native trees, shrubs, grasses and ground covers that don't require as much maintenance and that provide valuable habitat for other native plant and animal species. Native landscaping can also be used to replace turf grasses with the native plant communities (e.g., forests, prairies, savannas) that once covered most of the Flint Creek Watershed.

Native Landscaping
(Source: http://www.co.ozaukee.wi.us)

Native Landscaping
(Source: http://www.co.ozaukee.wi.us)

Typical Applications:
Landscaping beds can be found on many residential, commercial, institutional and municipal sites within the Flint Creek Watershed. Native landscaping can be used in all of these locations to replace ornamental and non-native plant species. It can also be used to replace turf grasses with native plant communities (e.g., forests, prairies) that help reduce stormwater runoff rates, volumes and pollutant loads.

Advantages/Benefits:
- Helps restore pre-development hydrology on development sites
- Provides valuable habitat for other native plant and animal species

Disadvantages/Limitations:
- Cost of native landscape stock may be high and availability may be limited
- Deer and other animals like to eat many native plant species
- Areas landscaped with native trees, shrubs, grasses and ground covers should be managed in a natural state (BMP Profile Sheet NR-1) and protected from future disturbance

Construction Costs:
$0.50 - $2.50 per square foot
($6.00 - $30.00 per cubic foot of stormwater runoff treated)

Operation & Maintenance:
- Inspect landscaped area for erosion and dead or dying vegetation; plant replacement vegetation as needed
- Prune and care for native trees, shrubs, grasses and ground covers as needed

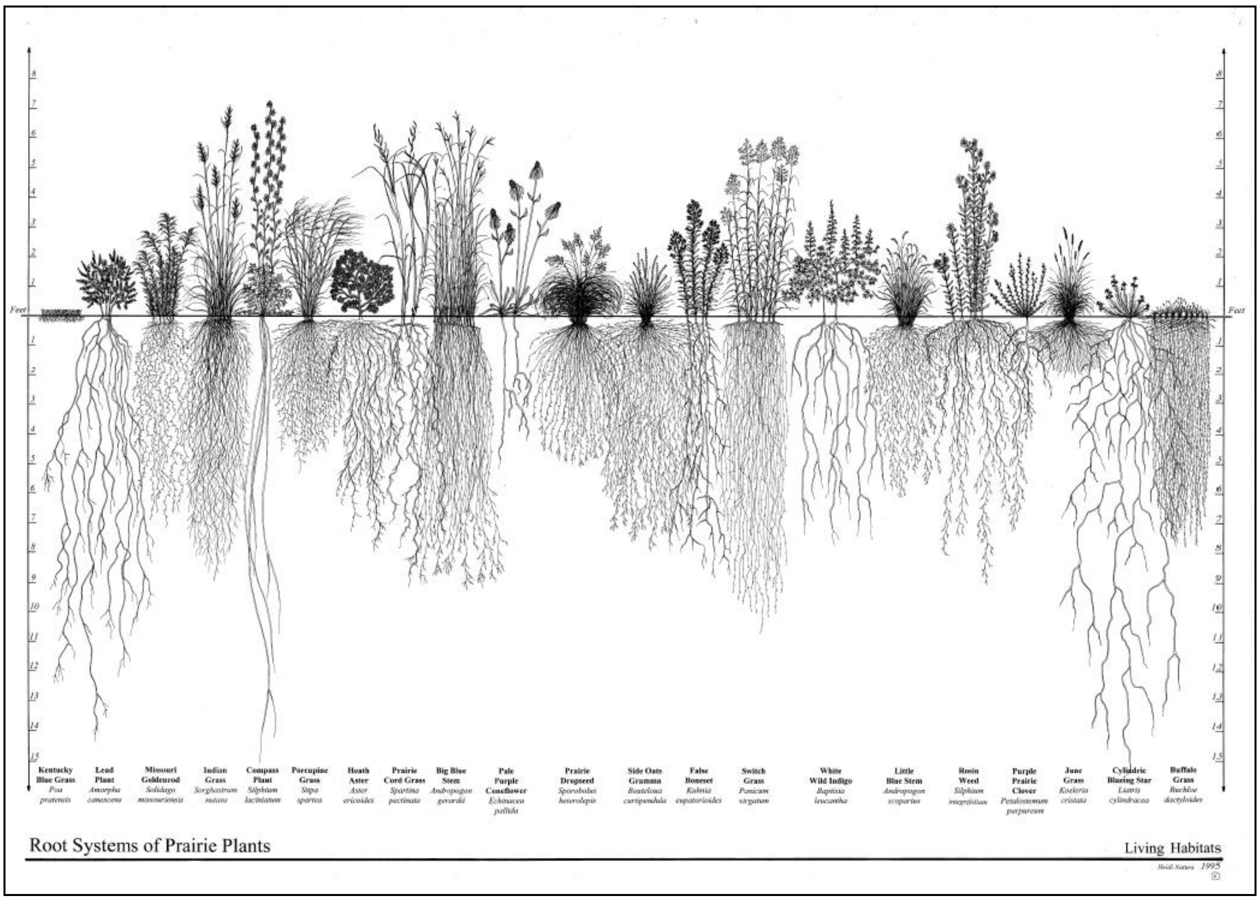
Pollutant Removal:

Provides water quality benefits by reducing stormwater runoff rates, volumes and pollutant loads

Description:

Native landscaping can be used to replace turf grasses with the native plant communities (e.g., forests, prairies, savannas) that once covered most of the Flint Creek Watershed. Native plants require less maintenance, provide valuable habitat for native plant and animal species and can be used on a wide variety of development sites, including sites with residential, commercial, institutional and municipal land uses. They are ideal for use in landscaping beds as a replacement for ornamental and non-native plant species.

Native plants have deep root systems that improve the ability of the soil to retain and infiltrate stormwater runoff, which helps reduce stormwater runoff rates, volumes and pollutant loads. Native landscaping also helps improve air quality on both a local and global scale. At the local scale, air pollution is reduced by reducing the need for turf and landscape management (e.g., mowing, edging, leaf blowing), which is fueled by the combustion of fossil fuels. On a more global scale, native landscaping helps reduce greenhouse gas emissions and helps capture carbon dioxide, which helps address climate change.



Root Systems of Prairie Plants
(Source: Heidi Natura, Living Habitats)

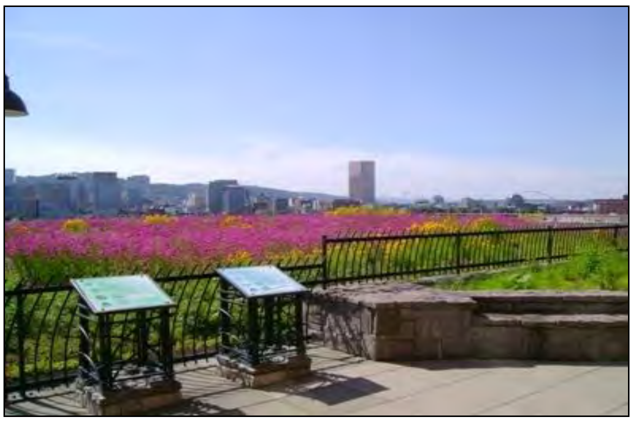
Resources:

Flint Creek Watershed Partnership. http://www.flintcreekwatershed.org.

Citizens for Conservation. Conservation@Home Program Website. http://www.citizensforconservation.org/ConsAtHome.asp.

Green Roofs

Green roofs represent an alternative to traditional composite shingle and tar paper roofs. They replace these traditional roofing materials with waterproofing and drainage materials and a thin, lightweight layer of engineered growing media designed to support plant growth. Stormwater runoff is captured and temporarily stored in the engineered growing media, where it is subjected to the hydrologic processes of evaporation and transpiration before being conveyed back into the storm drain system. This allows green roofs to provide significant reductions in stormwater runoff rates, volumes and pollutant loads.



Green Roof
(Source: http://www.portlandonline.com/bes)

Green Roof
Chicago, IL City Hall
(Source: http://www.greenroofs.org)

Typical Applications:
Green roofs are suitable for use on a wide range of buildings, including commercial, municipal and institutional buildings, as well as single family homes. Although they can be expensive to install, green roofs are an important component of "green buildings," including those that are certified by the Leadership in Energy and Environmental Design (LEED) Green Building Rating System.

Advantages/Benefits:
- Reduce annual stormwater runoff volumes; at least a 50% reduction in the amount of stormwater runoff generated on the rooftop can be expected
- Decrease energy use associated with building heating and cooling
- Help reduce air pollution and the urban heat island effect

Disadvantages/Limitations:
- More intensive green roofs must be cared for and maintained just like conventional landscaping areas
- Requires installation of waterproofing and drainage materials
- Installation on an existing building may require structural retrofit to increase load bearing capacity of roof

Construction Costs:
$12.00 - $35.00 per square foot
($140.00 - $420.00 per cubic foot of stormwater runoff treated)

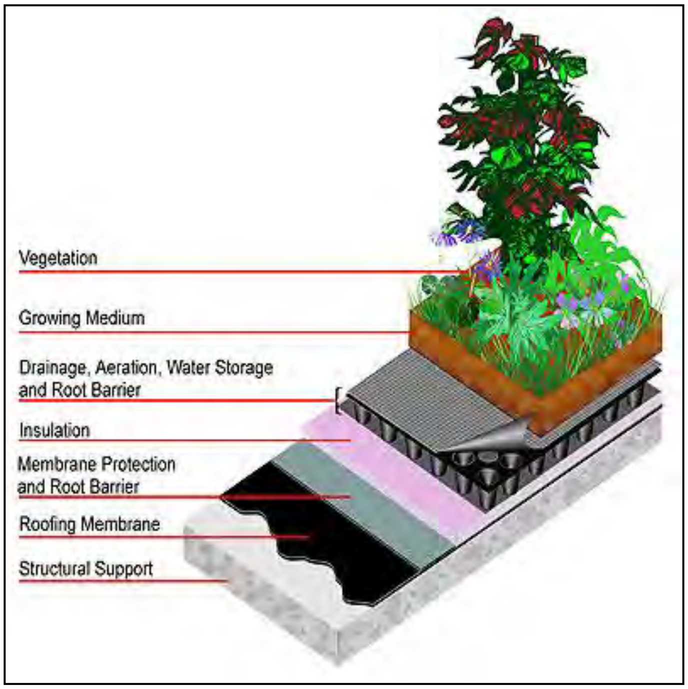
Operation & Maintenance:
- Care for and maintain plants; water vegetation during dry periods
- Inspect waterproofing and drainage materials on a regular basis

Pollutant Removal:

Total Suspended Solids	80%
Total Phosphorus	50%
Total Nitrogen	50%
Metals	N/A
Pathogens	N/A

(Source: CWP, 2009)

Description:
There are two different types of green roofs: intensive green roofs and extensive green roofs. Intensive green roofs, which are also known as rooftop gardens, have a thick layer of engineered growing media (e.g., 12 to 24 inches) that supports a diverse plant community that may even include trees. Extensive green roofs typically have a much thinner layer of engineered growing media (e.g., 2 to 6 inches) that supports a plant community that is comprised primarily of drought tolerant vegetation (e.g., sedums, succulent plants).



Typical Green Roof System
(Source: http://www.e-roofing.com)

Extensive green roofs, which can cost up to twice as much as traditional impervious roof surfaces, are much lighter and less expensive than intensive green roofs. They contain multiple layers of roofing materials and are designed to support plant growth while preventing stormwater runoff from ponding on the roof surface. Extensive green roofs are designed to drain stormwater runoff vertically through the engineered growing media and then horizontally through a drainage layer towards an outlet. They are designed to require minimal long-term maintenance and, if the right plants are selected to populate the green roof, should not need supplemental irrigation or fertilization after the initial vegetation establishment period.

Resources:
Green Roofs for Healthy Cities. Green Roofs for Healthy Cities Website. http://www.greenroofs.org.

International Green Roof Association. International Green Roof Association Website. http://www.igra-world.com.

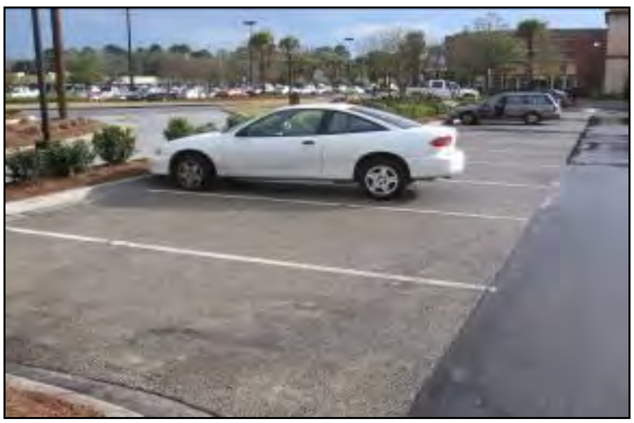
City of Portland, Oregon. Bureau of Environmental Services. Stormwater Management Manual. Facility Design Fact Sheet: Ecoroof. http://www.portlandonline.com/bes/index.cfm?c=47954&a=202883.

ASTM International. Standard Practice for Determination of Dead Loads and Live Loads Associated with Green Roof Systems. http://www.astm.org/Standards/E2397.htm.

ASTM International. Standard Guide for Selection, Installation and Maintenance of Plants for Green Roof Systems. http://www.astm.org/Standards/E2400.htm.

Permeable Pavement

Permeable pavement represents an alternative to traditional impervious paving surfaces, such as asphalt and concrete. It allows rainfall to pass through the surface course (i.e., pavement surface) and into an underlying stone reservoir, where it is temporarily stored and allowed to infiltrate into the surrounding soils or conveyed into a receiving stream or storm sewer system through an underdrain. By temporarily storing stormwater runoff and allowing it to infiltrate into the surrounding soils, permeable pavement systems help reduce flooding and other downstream impacts of the land development process.



Pervious Concrete
(Source: Center for Watershed Protection)

Permeable Interlocking Concrete Pavers
(Source: Center for Watershed Protection)

Typical Applications:
Permeable pavement can be used to construct sidewalks, parking lots, overflow parking areas, driveways and parking lanes on public streets and roadways. It is suitable for use in areas with residential, commercial and industrial land uses and is especially well suited for use in areas with low traffic densities and in overflow parking applications.

Advantages/Benefits:
- Provides significant water quality benefits as well as significant reductions in stormwater runoff rates and volumes
- Reduces the amount of stormwater infrastructure needed on the development site (e.g., storm drains, detention basins)

Disadvantages/Limitations:
- Relatively high construction costs, which are typically offset by savings on other stormwater infrastructure
- Should only be installed by qualified, experienced personnel
- Potential for failure if not properly installed or adequately maintained

Construction Costs:
$5.00 - $12.00 per square foot
($60.00 - $140.00 per cubic foot of stormwater runoff treated)

Operation & Maintenance:
- Inspect pavement surface on a monthly basis to ensure that it is clear of sediment and debris
- Vacuum sweep pavement surface up to four times a year to keep it free of sediment
- Inspect pavement surface annually for deterioration or spalling and repair any damage

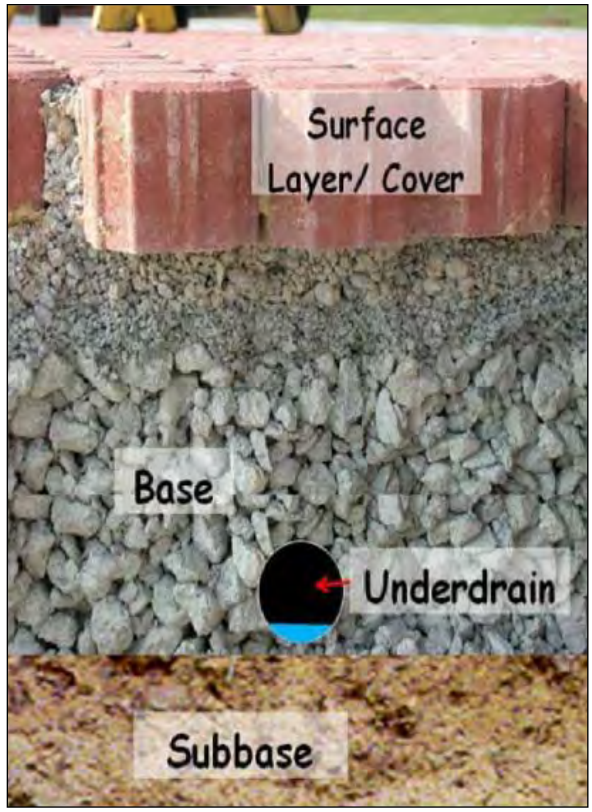
Pollutant Removal:

Total Suspended Solids	80%
Total Phosphorus	50%
Total Nitrogen	50%
Metals	60%
Pathogens	N/A

(Source: CWP, 2009)

Description:

Permeable pavement represents an alternative to traditional impervious paving surfaces, such as asphalt and concrete. It allows rainfall to pass through the surface course (i.e., pavement surface) and into an underlying stone reservoir, where it is temporarily stored and allowed to infiltrate into the surrounding soils or conveyed into a receiving stream or storm sewer system through an underdrain.



Typical Permeable Pavement System
(Source: Hunt and Collins, 2008)

There are a variety of permeable pavement surfaces available in the commercial marketplace, including pervious concrete, porous asphalt, permeable interlocking concrete pavers, concrete grid pavers and plastic grid pavers. Each of these permeable pavement surfaces is briefly described below:

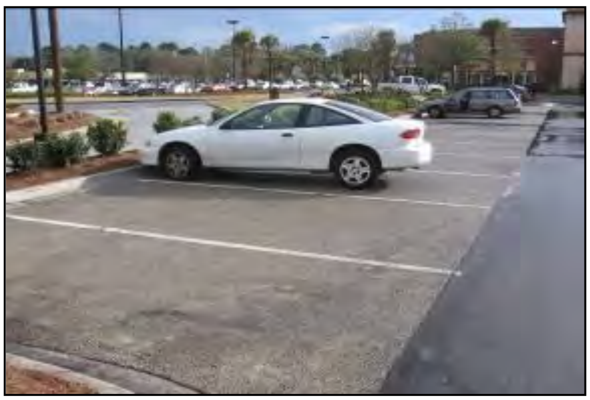
- Pervious Concrete: Pervious concrete is similar to traditional concrete in structure and form, but consists of a special open-graded surface course, typically 4 to 8 inches thick, that is bound together with portland cement. This open-graded surface course has a void ratio of 15% to 25% (conventional concrete pavement has a void ratio of between 3% and 5%), which gives it a high permeability that is often many times more than that of the underlying native soils, and allows rainwater and stormwater runoff to rapidly pass through it and into the underlying stone reservoir. Although this particular type of permeable pavement surface may not require an underlying base to support traffic loads, including a stone reservoir in the design can increase the ability of the system to help reduce flooding and other downstream impacts of the land development process.

- Porous Asphalt: Porous asphalt is similar to pervious concrete, and consists of a special open-graded surface course that is bound together by asphalt cement. The open-graded surface course in a typical porous asphalt installation is 3 to 7 inches thick and has a void ratio of between 15% and 20%. Porous asphalt is thought to have a limited ability to maintain its structure and permeability during hot summer months. If it is used in the Flint Creek Watershed, it should be carefully inspected and maintained over time.

- Permeable Interlocking Concrete Pavers: Permeable interlocking concrete pavers (PICP) are solid structural units (e.g., blocks, bricks) that are installed in a way that provides regularly spaced openings through which rainfall and runoff can rapidly pass through the pavement surface and into the underlying stone reservoir. The regularly spaced openings, which generally make up between 8% and 20% of the total pavement surface, are typically filled with pea gravel. Typical PICP systems consist of the pavers, a 1.5 to 3 inch thick fine gravel bedding layer and an underlying stone reservoir.

- Concrete Grid Pavers: Concrete grid pavers (CGP) are precast concrete units that allow rainfall and stormwater runoff to pass through large openings that are filled with gravel, sand or topsoil and turf. CGP are typically 3.5 inches thick and have between a void ratio of between 20% and 50%, which means that the material used to fill the spaces between the grids has a large influence on the overall permeability (i.e., void space) of a CGP system. A typical CGP installation consists of the pavers, a 1 to 1.5 inch sand or pea gravel bedding layer and an underlying stone reservoir.

- Plastic Grid Pavers: Plastic grid pavers (PGP) are similar to CGP. They consist of flexible, interlocking plastic units that allow rainfall and stormwater runoff to pass through large openings that are filled with gravel, sand or topsoil and turf. Since the empty plastic grids have a void ratio of between 90% and 98%, the material used to fill the spaces between the grids has a large influence on the overall permeability (i.e., void space) a PGP system.



Pervious Concrete
(Source: Center for Watershed Protection)

Concrete Grid Pavers
(Source: Atlanta, GA Regional Commission)

Plastic Grid Pavers
(Source: Atlanta, GA Regional Commission)

Permeable Interlocking Concrete Pavers
(Source: Center for Watershed Protection)

Although permeable pavement systems have seen some use in the Chicago metropolitan area, there is still relatively limited experience with the design and installation of this stormwater management practice on a regional scale. On a national scale, permeable pavement installations, particularly pervious concrete and porous asphalt systems, have historically had high failure rates due to poor design, poor installation, underlying soils with low infiltration rates and poor maintenance practices. Consequently, if permeable pavement is used in the Flint Creek Watershed, it should be carefully inspected and maintained over time.

Resources:

North Carolina State University Cooperative Extension. Urban Waterways Bulletin AG-588-14: Permeable Pavement: Research Update and Design Implications. http://www.bae.ncsu.edu/stormwater/PublicationFiles/PermPave2008.pdf.

Center for Watershed Protection. Coastal Stormwater Supplement to the Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 7.8.4: Permeable Pavements. http://www.gaepd.org/Documents/CoastalStormwaterSupplement.html.

U.S. Department of Agriculture. Natural Resources Conservation Service. Illinois Urban Manual. Practice Standards Fact Sheet: Permeable Pavement. http://www.il.nrcs.usda.gov/technical/engineer/urban/standards/urstnd_alpha.html.

Downspout Disconnection

As the name implies, a downspout disconnection "disconnects" individual downspouts from the stream or storm drain system by spreading rooftop runoff across lawns, landscaping beds or other stormwater management practices (e.g., filter strips, rain barrels, rain gardens), where it is slowed, filtered and allowed to infiltrate into the underlying soils. Downspout disconnections can significantly reduce stormwater runoff rates, volumes and pollutant loads and, consequently, can help reduce flooding and other negative downstream impacts of the land development process.

Downspout Disconnection to Landscaping Bed
(Source: http://www.lowimpactdevelopment.org)

Downspout Disconnection to Lawn
(Source: http://www.myhamilton.ca)

Typical Applications:
Downspout disconnections can be used to manage rooftop runoff in urban and suburban watersheds, such as the Flint Creek Watershed. Disconnections can be used on residential, commercial, institutional and municipal sites in areas that have a high percentage of downspouts that are directly or indirectly connected to a storm drain system or stream. They can also be used in areas where sump pumps discharge directly to a stream or storm drain system. Downspout disconnections are easy to understand, easy to implement, and are amongst the most cost-effective of all stormwater management practices.

Advantages/Benefits:
- Provides reductions in stormwater runoff rates, volumes and pollutant loads
- Provides groundwater recharge, particularly during small storm events
- Relatively low construction cost and long-term maintenance burden

Disadvantages/Limitations:
- Discharge points should be located at least 6 feet from buildings with basements and at least 2 feet from buildings without basements
- Neighborhoods with small lots (i.e., less than 5,000 square feet) and compact soils are typically poor candidates for downspout disconnection

Construction Costs:
$25.00 - $50.00 per disconnection
($1.00 - $3.50 per cubic foot of stormwater runoff treated)

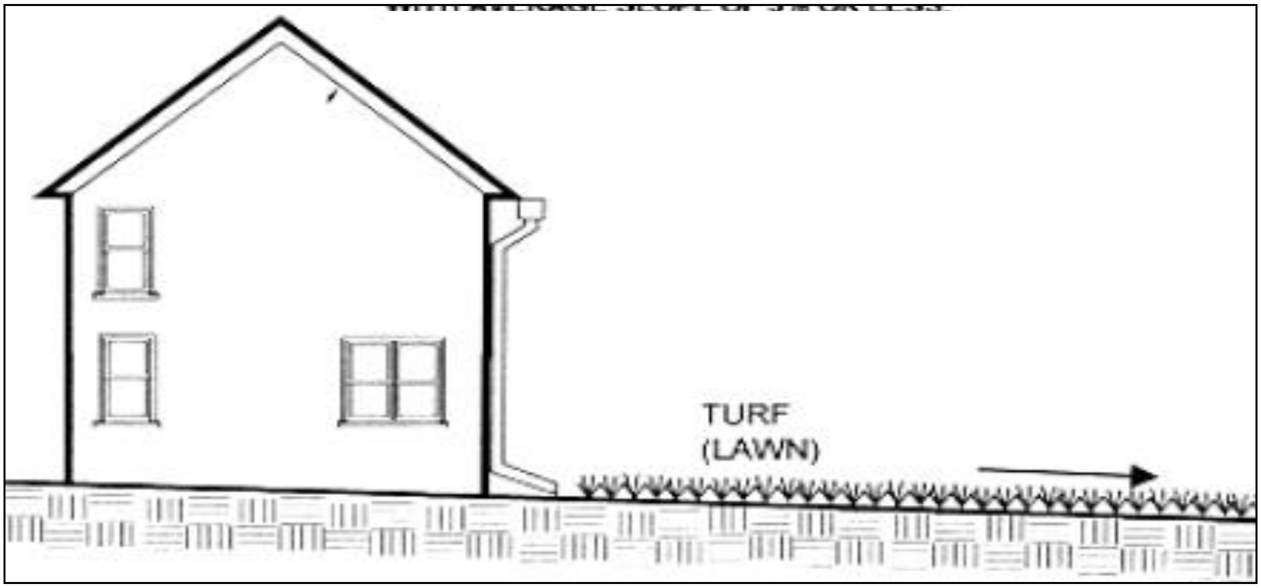
Operation & Maintenance:
- Inspect to ensure disconnection is not damaging adjacent buildings or property
- Reconnect problematic disconnections to the storm drain system as soon as possible

Pollutant Removal[1]:

Total Suspended Solids	80%
Total Phosphorus	25%
Total Nitrogen	25%
Metals	40%
Pathogens	N/A

[1] Provided by disconnection to filter strip
(Source: CWP, 2009)

Description:
As the name implies, a downspout disconnection "disconnects" individual downspouts from the stream or storm drain system by spreading rooftop runoff across lawns, landscaping beds or other stormwater management practices (e.g., filter strips, rain barrels, rain gardens), where it is slowed, filtered and allowed to infiltrate into the underlying soils. Downspout disconnections can be used to disconnect downspouts that are directly or indirectly connected to a storm drain system or stream. They can also be used to disconnect sump pump discharges from a stream or storm drain system.



Downspout Disconnection to Lawn
(Source: Maryland Department of the Environment)

Downspout disconnections should be designed to discharge to a lawn, landscaping area or other stormwater management practice (e.g., rain garden, filter strip, rain barrel) that slopes away from the building. Discharge points should be located at least 6 feet away from buildings with basements and at least 2 feet away from buildings without basements. Downspout disconnections should be designed to prevent any damage to adjacent buildings or property and should not create unsafe conditions on any street, alleyway, sidewalk or other public right-of-way.

Because a single downspout disconnection is capable of managing stormwater runoff from only a few hundred or few thousand square feet of drainage area, hundreds or thousands of disconnections are needed to make a measurable difference at the watershed scale. In order for downspout disconnections to substantially reduce stormwater runoff rates, volumes and pollutant loads in the Flint Creek Watershed, a variety of techniques (i.e., printed educational materials, homeowner training workshops, technical assistance programs, financial incentive programs) should be used to encourage property owners to disconnect their downspouts and sump pump discharges.

Downspout Disconnection
(Source: http://www.sustainablestormwater.com)

Resources:
Flint Creek Watershed Partnership. http://www.flintcreekwatershed.org.

City of Portland, Oregon. Downspout Disconnection Program Website.
http://www.portlandonline.com/BES/index.cfm?c=43081.

City of Milwaukee, Wisconsin. Downspout Disconnection Program Website.
http://v3.mmsd.com/DownspoutDisconnect.aspx.

City of Boston, Massachusetts. Downspout Disconnection Program Website.
http://www.bwsc.org/SERVICES/Programs/downspout/downspout.asp.

Center for Watershed Protection. Urban Stormwater Retrofit Practices Manual.
http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm.

Filter Strips

Filter strips are uniformly graded, densely vegetated areas of land designed to slow and filter stormwater runoff. They are typically installed in areas such as lawns, parks and open space that have been disturbed by clearing, grading and other land disturbing activities. Although they are typically planted with turf grass, they provide additional benefits if they can be planted with native trees, shrubs, grasses and herbaceous plants. By slowing stormwater runoff and allowing it to infiltrate into the underlying soils, filter strips help reduce flooding and other negative downstream impacts of the land development process.

Wildflower Prairie Filter Strip
(Source: U.S. Army Corps of Engineers)

Grass Filter Strip
(Source: Atlanta, GA Regional Commission)

Typical Applications:
Filter strips can be used to manage stormwater runoff at or near the source, reducing stormwater runoff rates, volumes and pollutant loads and providing “pretreatment” for downstream stormwater management practices. Although it can be difficult to apply them on small sites (i.e., sites less than ¼-acre in size), due to space requirements, filter strips can be applied on a variety of development sites, including residential, commercial, institutional and municipal sites.

Advantages/Benefits:
- Provide significant reductions in stormwater runoff rates, volumes and pollutant loads
- Provide groundwater recharge, particularly during small storm events
- Relatively low construction cost and long-term maintenance burden

Disadvantages/Limitations:
- Can be difficult to maintain sheet flow within a filter strip, which is needed to prevent soil erosion and ensure practice performance
- Filter strips require a relatively large amount of surface area

Construction Costs:
$0.50 - $2.50 per square foot
($4.00 - $10.00 per cubic foot of stormwater runoff treated)

Operation & Maintenance:
- Maintain (i.e., mow, prune, trim, weed) vegetation on a regular basis to maintain appearance and function
- Inspect for erosion on a semi-annual basis and plant replacement vegetation in any eroded areas
- Remove sediment and debris as needed to maintain appearance and function

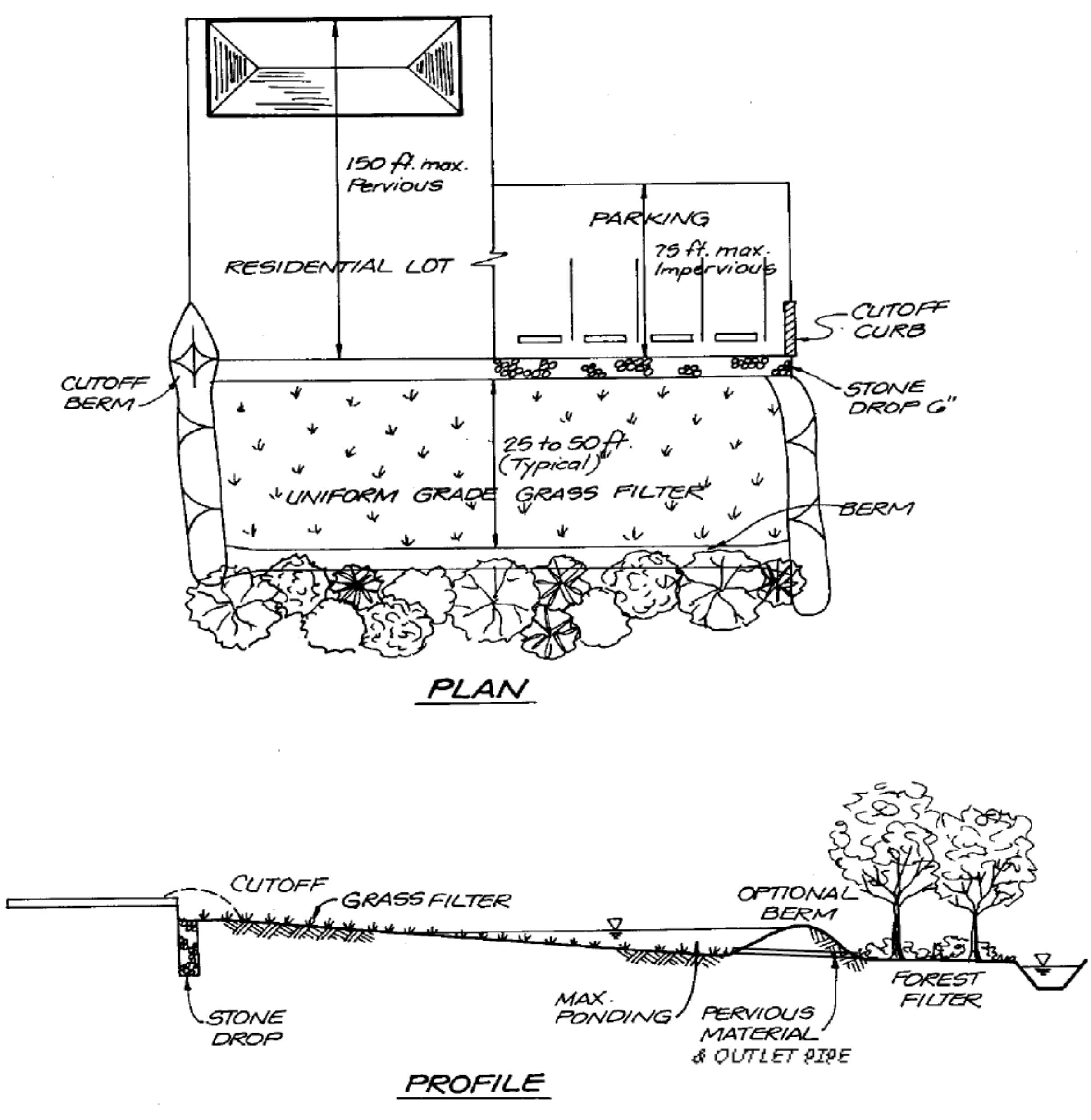
Pollutant Removal:

Total Suspended Solids	80%
Total Phosphorus	25%
Total Nitrogen	25%
Metals	40%
Pathogens	N/A

(Source: CWP, 2009)

Description:

Filter strips can be attractively integrated into development sites as landscaping features and are well suited to manage stormwater runoff from local streets and roadways, highways, downspouts, sump pump discharges, small parking lots and disturbed pervious surfaces (e.g., lawns, parks, community open spaces). They are particularly well suited for use in the "outer zone" of stream buffers (BMP Profile Sheet SC-2), in the landscaped areas commonly found between adjoining properties (e.g., setbacks) and around the perimeter of parking lots. They can also be used in "stormwater management trains" to "pretreat" stormwater runoff before it enters other stormwater management practices, such as bioretention areas (BMP Profile Sheet SWM-17), infiltration practices (BMP Profile Sheet SWM-19) and dry-bottom detention basins (BMP Profile Sheet SWM-13).



Filter Strip
(Source: Atlanta, GA Regional Commission)

Filter Strip Adjacent to Stream in Agricultural Area
(Source: http://plantandsoil.unl.edu)

Filter strips rely on vegetation to slow runoff velocities and filter sediments and other pollutants from stormwater runoff. Although they are typically planted with turf grass, they provide additional benefits if they can be planted with native trees, shrubs, grasses and herbaceous plants. See BMP Profile Sheet SWM-3 for more information on the use of native landscaping within the Flint Creek Watershed.

If concentrated stormwater runoff is allowed to flow through a filter strip, it can cause soil erosion and can significantly reduce the stormwater management benefits that a filter strip provides. Consequently, stormwater runoff needs to be intercepted and distributed evenly, as overland sheet flow, across a vegetated filter strip. This can be accomplished by limiting the length of the flow path within the contributing drainage area and by using a level spreader at the upstream end of the filter strip.

Resources:

Center for Watershed Protection. Design of Stormwater Filtering Systems.
http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm.

U.S. Department of Agriculture. Natural Resources Conservation Service. Illinois Urban Manual. Practice Standards Fact Sheet: Filter Strip.
http://www.il.nrcs.usda.gov/technical/engineer/urban/standards/urstnd_alpha.html.

Minnesota Pollution Control Agency. Minnesota Stormwater Manual. Stormwater Credits and Development Sites Fact Sheet: Surface Impervious Cover Disconnection Credit.
http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html.

Center for Watershed Protection. Coastal Stormwater Supplement to the Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 7.8.6: Vegetated Filter Strips.
http://www.gaepd.org/Documents/CoastalStormwaterSupplement.html.

Atlanta, Georgia Regional Commission. Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 3.3.1: Filter Strip. http://www.georgiastormwater.com.

Rain Barrels

Rainwater harvesting is the ancient stormwater management practice of intercepting, diverting and storing rainfall for later use. In a small-scale rainwater harvesting system, rain barrels are used to capture and store rooftop runoff for later use. Once it is captured in a rain barrel, rainwater may be used for non-potable uses, such as vehicle washing and landscape irrigation. Since the rooftop runoff captured in a rain barrel would otherwise flow directly into a receiving stream or storm sewer system, rain barrels help reduce stormwater runoff rates, volumes and pollutant loads. Rain barrels also help reduce demand on potable water supplies, which helps protect groundwater aquifers from drawdown and depletion.

Rain Barrel
(Source: http://www.lakecountyil.gov/stormwater)

Typical Applications:
Rain barrels can be used to manage rooftop runoff in urban and suburban watersheds, such as the Flint Creek Watershed. They can be used on new and existing residential, commercial, institutional and municipal development sites, but are particularly well suited for use on single family home sites. Rain barrels are easy to understand, relatively inexpensive to install and help improve overall watershed awareness.

Advantages/Benefits:
- Reduce potable water use and water utility bills; as much as 40% of domestic potable water use can be attributed to landscape irrigation, which can be accomplished using harvested rainwater
- Reduce demand on public water supplies, which helps protect groundwater aquifers from drawdown and depletion
- Reduce stormwater runoff rates, volumes and pollutant loads

Disadvantages/Limitations:
- Not intended for large-scale applications (i.e., drainage areas larger than 1 acre in size); larger and more complex rainwater harvesting systems are required at these sites
- Effective only when harvested rainwater is used on a regular basis

Construction Costs:
$50.00 - $300.00 per rain barrel
($9.00- $45.00 per cubic foot of stormwater runoff treated)

Operation & Maintenance:
- Use harvested rainwater on a regular basis to maintain system capacity
- Inspect and clean gutters and downspouts on a regular basis to prevent leaves and other organic material from entering rain barrels

Pollutant Removal:

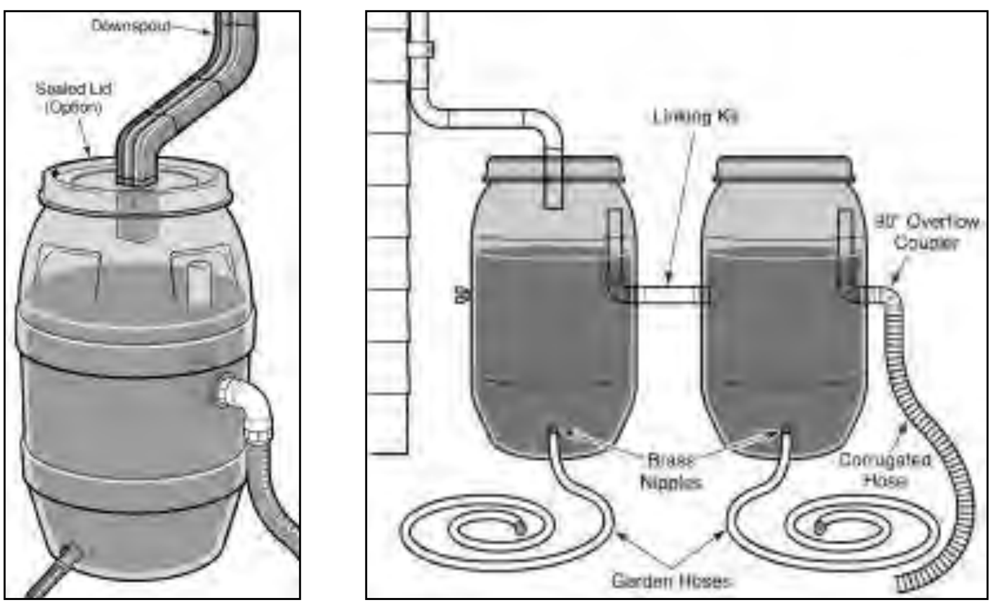
Pollutant removal varies according to the storage capacity of the rainwater harvesting system

Description:

Rain barrels can be used to manage rooftop runoff in urban and suburban watersheds, such as the Flint Creek Watershed. They can be used in conjunction with downspout disconnections (BMP Profile Sheet SWM-6) on new and existing residential, commercial, institutional and municipal development sites, but are particularly well suited for use on sites with single family homes in areas that have a high percentage of their downspouts directly or indirectly connected to a stream or storm drain system.

Rain Barrel
(Source: http://www.composters.com)

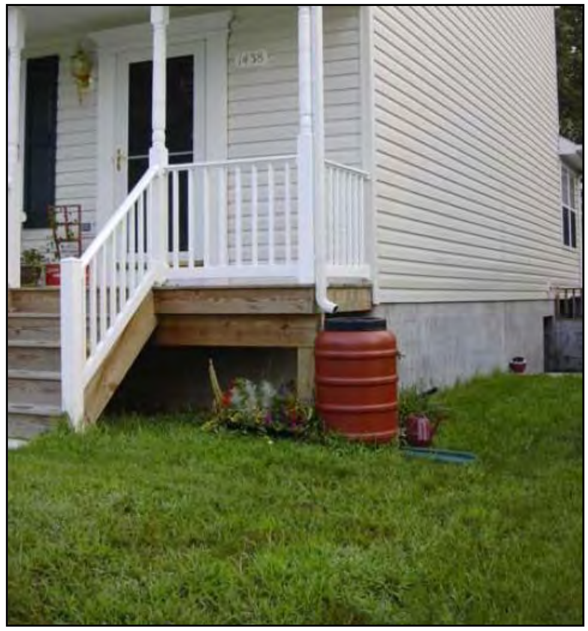
During a rainfall event, stormwater runoff is collected from rooftops using gutters and downspouts. Instead of discharging directly into a stream or storm sewer system, as downspouts typically do, the downspouts are "disconnected" and diverted into a rain barrel or series of rain barrels. Stormwater runoff is stored in the rain barrel until the home or business owner uses the water for irrigation or other non-potable uses. Fittings are provided at the bottom of each rain barrel so that a conventional garden hose may be connected directly to the barrel. Linking kits allow multiple rain barrels to be connected in series so that the overall storage capacity of the rainwater harvesting system may be increased. Each rain barrel is provided with an overflow device, which allows the stormwater runoff from very large rainfall events to pass through the system.



Small-Scale Rainwater Harvesting System
(Source: http://www.composters.com)

Several issues surrounding water quality, temperature and algae and mosquito control should be taken into account during the planning and design of a small-scale rainwater harvesting system. Because rainwater picks up very little contamination from individual rooftops, water quality is typically not a concern for small-scale rainwater harvesting systems. However, since rooftop runoff does contain small amounts of metals, such as zinc, copper and lead, and other stormwater pollutants, it must be treated before it can be used indoors. The presence of these pollutants, however, does not prevent harvested rainwater from being used for non-potable outdoor uses, such as vehicle washing and landscape irrigation.

Rain barrels do not function properly when temperatures reach the freezing point during the winter months. They must be drained and disconnected during the winter to ensure that ice does not damage the rain barrel or cause water to back up into downspouts or building foundations. Efforts should also be made to reduce the amount of leaves and other organic materials from entering rain barrels to prevent algae from growing inside. It is also important to screen inlets and empty rain barrels on a regular basis to prevent them from becoming mosquito breeding sites.


Downspout Disconnection and Rain Barrel
(Source: Center for Watershed Protection)

Because a single rain barrel is capable of managing stormwater runoff from only a few hundred or few thousand square feet of drainage area, hundreds or thousands of rain barrels are needed to make a measurable difference at the watershed scale. In order for rain barrels to substantially reduce stormwater runoff rates, volumes and pollutant loads in the Flint Creek Watershed, a variety of techniques (i.e., printed educational materials, homeowner training workshops, technical assistance programs, financial incentive programs) should be used to encourage property owners to install them.

Resources:

Center for Watershed Protection. How to Build and Install a Rain Barrel Fact Sheet. http://www.cwp.org/Resource_Library/Center_Docs/Residential/rainbarrelgarden.pdf.

City of Bremerton, Washington. Make Your Own Rain Barrel Fact Sheet. http://www.cityofbremerton.com/content/sw_makeyourownrainbarrel.html.

State of Maryland. Department of Natural Resources. Maryland Environmental Design Program. Build a Simple Rain Barrel Fact Sheet. http://www.dnr.state.md.us/ed/rainbarrel.html

Illinois Rain Garden Initiative. Rain Barrels Website. http://www.standingupforillinois.org/cleanwater/rb_info.php.

GreenCulture, Inc. Rain Barrels Website. http://www.composters.com/docs/rainbarrels.html.

Rain Gardens

A rain garden is a small, landscaped depressional area that is designed to replace turf grass with wildflowers and native grasses. Rain gardens soak up rainwater and capture stormwater runoff from nearby roofs, driveways, parking lots and streets. Permeable soils and deep-rooted native plants help retain stormwater runoff and allow it percolate into the ground. The soils within a rain garden act as a natural filter, removing harmful chemicals and pollutants from stormwater runoff before it reaches groundwater aquifers, streams and storm sewer systems, which helps protect the overall health of local lakes, streams and wetlands.

Residential Rain Garden
(Source: Low Impact Development Center)

Rain Garden at Barrington Area Library
(Source: Flint Creek Watershed Partnership)

Typical Applications:
Rain gardens can be used to manage stormwater runoff at or near the source, reducing stormwater runoff rates, volumes and pollutant loads and providing "pretreatment" for downstream stormwater management practices. They can be applied on a variety of development sites, including residential, commercial, institutional and municipal development sites, but can only be used to manage runoff from small drainage areas of up to about one acre in size. They are particularly well suited for use on single family home sites.

Advantages/Benefits:
- Provide shallow groundwater recharge and reductions in stormwater runoff rates, volumes and pollutant loads
- Can be integrated into development plans as attractive landscaping features
- Can be used on existing development sites as stormwater retrofits

Disadvantages/Limitations:
- Can only be used to manage runoff from small drainage areas of up to about one acre in size
- Long-term maintenance is the responsibility of the property owner
- Not recommended for use in areas with high sediment loads or highly contaminated runoff

Construction Costs:
$3.00 - $6.00 per square foot
($3.00 - $6.00 per cubic foot of stormwater runoff treated)

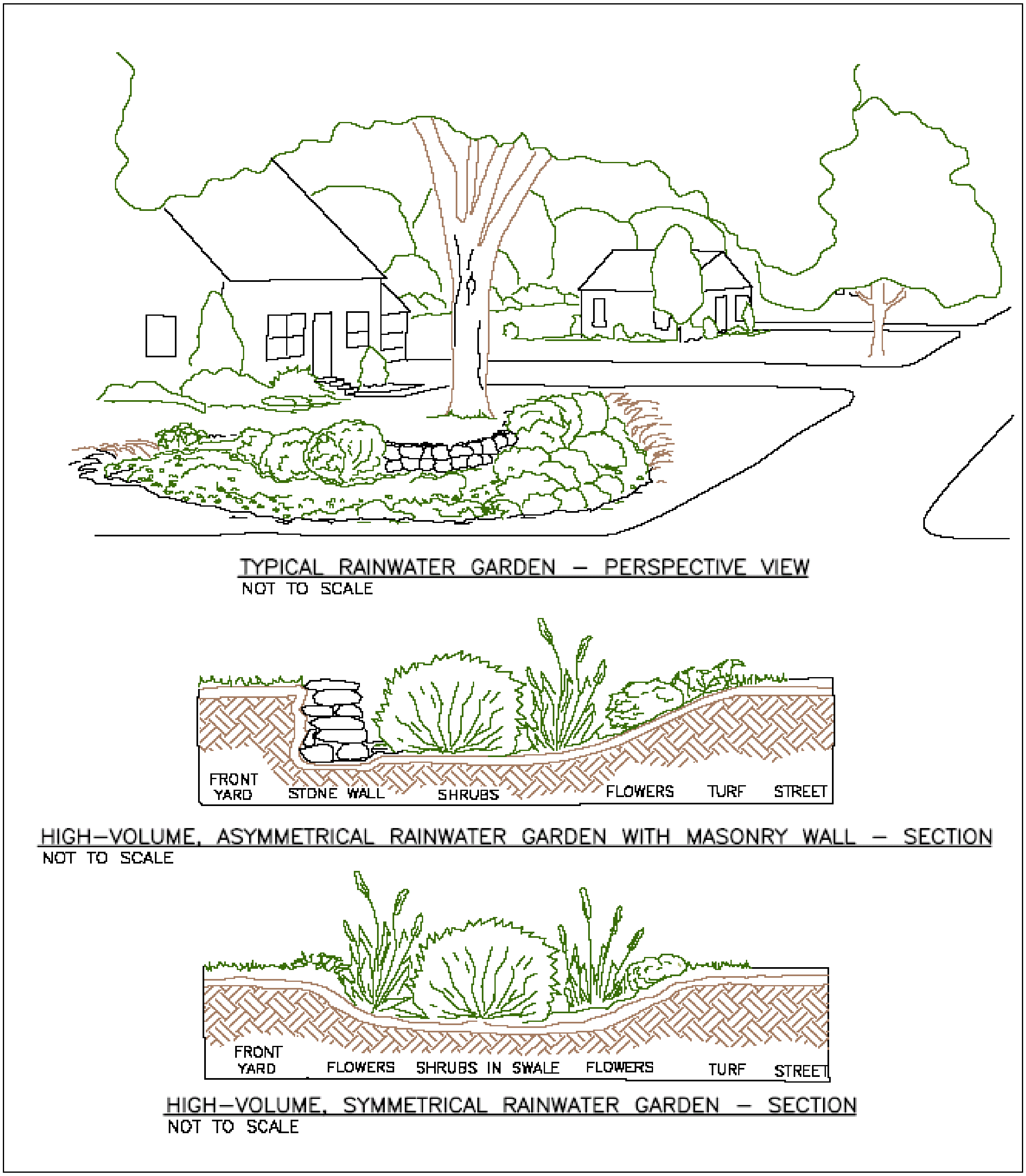
Operation & Maintenance:
- Maintain (i.e., mow, prune, trim, weed) vegetation on a regular basis to maintain appearance and function
- Remove sediment and debris as needed

Pollutant Removal:

Total Suspended Solids	80%
Total Phosphorus	40%
Total Nitrogen	40%
Metals	80%
Pathogens	N/A

(Source: CWP, 2007; CWP, 2009)

Description:
Rain gardens are small, landscaped depressional areas that are filled with amended soils or an engineered soil mix and planted with native trees, shrubs and other herbaceous vegetation. They are essentially small bioretention areas that are designed to capture and temporarily store stormwater runoff from rooftops and lawns so that it may be subjected to the hydrologic processes of evaporation, transpiration and



Rain Gardens
(Source: City of Valparaiso, Indiana)

infiltration. This helps reduce stormwater runoff rates, volumes and pollutant loads and, consequently, helps reduce flooding and other negative impacts of the land development process.

Residential Rain Garden
(Source: http://www.ci.eagan.mn.us)

Rain gardens can be used to manage rooftop runoff in urban and suburban watersheds, such as the Flint Creek Watershed. They can be used in conjunction with downspout disconnections (BMP Profile Sheet SWM-6) on new and existing residential, commercial, institutional and municipal development sites, but are particularly well suited for use on sites with single family homes in areas that have a high percentage of their downspouts directly or indirectly connected to a stream or storm drain system. They provide many benefits, including increased watershed awareness, improved aesthetics and valuable habitat for birds and butterflies.

Residential Rain Garden
(Source: Center for Watershed Protection)

A rain garden should be designed to have a maximum ponding depth of 6 to 12 inches and surface area that is about 25% of the size of its drainage area. This will help ensure that the rain garden will drain within 24 hours of the end of a rainfall event and reduce its potential to create nuisance ponding conditions and mosquito problems. Since mosquitoes need five to seven days to breed (USWG, 2003), water standing in a rain garden for 24 hours will not provide the conditions necessary to create a mosquito breeding ground. Rain gardens should also be designed with slopes that are as close to flat as possible to help ensure that stormwater runoff is evenly distributed over the planting bed.

Plant selection is an important part of planning and installing a successful rain garden. Plants selected for use in rain gardens should include drought-tolerant plants that do not require much supplemental irrigation but that can also withstand wet soils for periods of up to about 24 hours. Plant selection should also consider how much sun the rain garden will receive throughout the day. Additional guidance on planning and designing a rain garden is provided in a number of existing resources, a handful of which are listed below.

Resources:

Flint Creek Watershed Partnership. http://www.flintcreekwatershed.org.

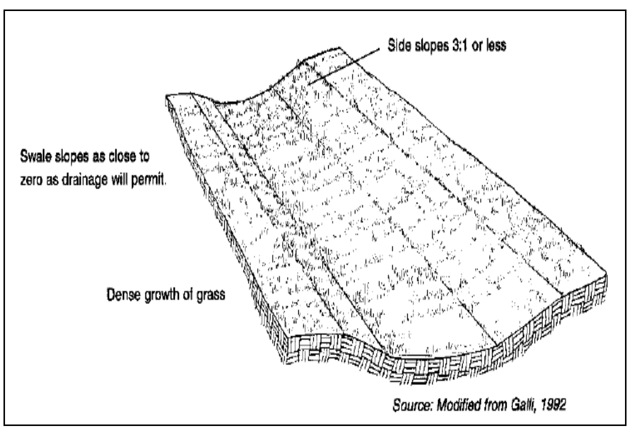
University of Wisconsin Cooperative Extension. Home and Garden Clean Water Practices Fact Sheet: Rain Gardens: A Household Way to Improve Water Quality in Your Community. http://clean-water.uwex.edu/pubs/pdf/home.gardens.pdf.

University of Wisconsin Cooperative Extension. Home and Garden Clean Water Practices Fact Sheet: Rain Gardens: A How-To Manual for Homeowners. http://clean-water.uwex.edu/pubs/pdf/home.rgmanual.pdf.

Grass Channels

Grass channels are densely vegetated stormwater conveyance features that are designed to slow and filter stromwater runoff while it is conveyed to a receiving stream, storm sewer system or stormwater management practice. They differ from the old, sparsely vegetated roadside ditches of the past, which often suffered from erosion and standing water and occasionally worked to undermine the roadsides themselves. If they are properly designed and maintained (e.g., sufficient channel widths, relatively flat slopes, dense vegetative cover), grass channels can help reduce stormwater runoff rates, volumes and pollutant loads and minimize the negative impacts of the land development process.

Grass Channel
(Source: Atlanta, GA Regional Commission)



Grass Channel
(Source: Atlanta, GA Regional Commission)

Typical Applications:
Grass channels can be used to convey stormwater runoff away from the source and into a receiving stream, storm sewer system or stormwater management practice. They can be used on a variety of development sites, including residential, commercial, institutional and municipal sites, but are particularly well suited for use within transportation corridors and along property lines.

Advantages/Benefits:
- Provide reductions in stormwater runoff rates, volumes and pollutant loads while providing stable stormwater conveyance
- Provide shallow groundwater recharge in areas with permeable underlying soils
- Less expensive than comparable curb, gutter and storm drain systems

Disadvantages/Limitations:
- Impractical in wet areas, areas with very flat or very steep terrain and areas with poorly drained soils
- Should be designed with a slope of between 0.5% and 3%, although a slope of between 1% and 2% is recommended
- Potential to create nuisance ponding conditions and mosquito problems if not properly designed and maintained

Construction Costs:
$8.00 - $12.00 per linear foot
($4.50 - $9.00 per cubic foot of stormwater runoff treated)

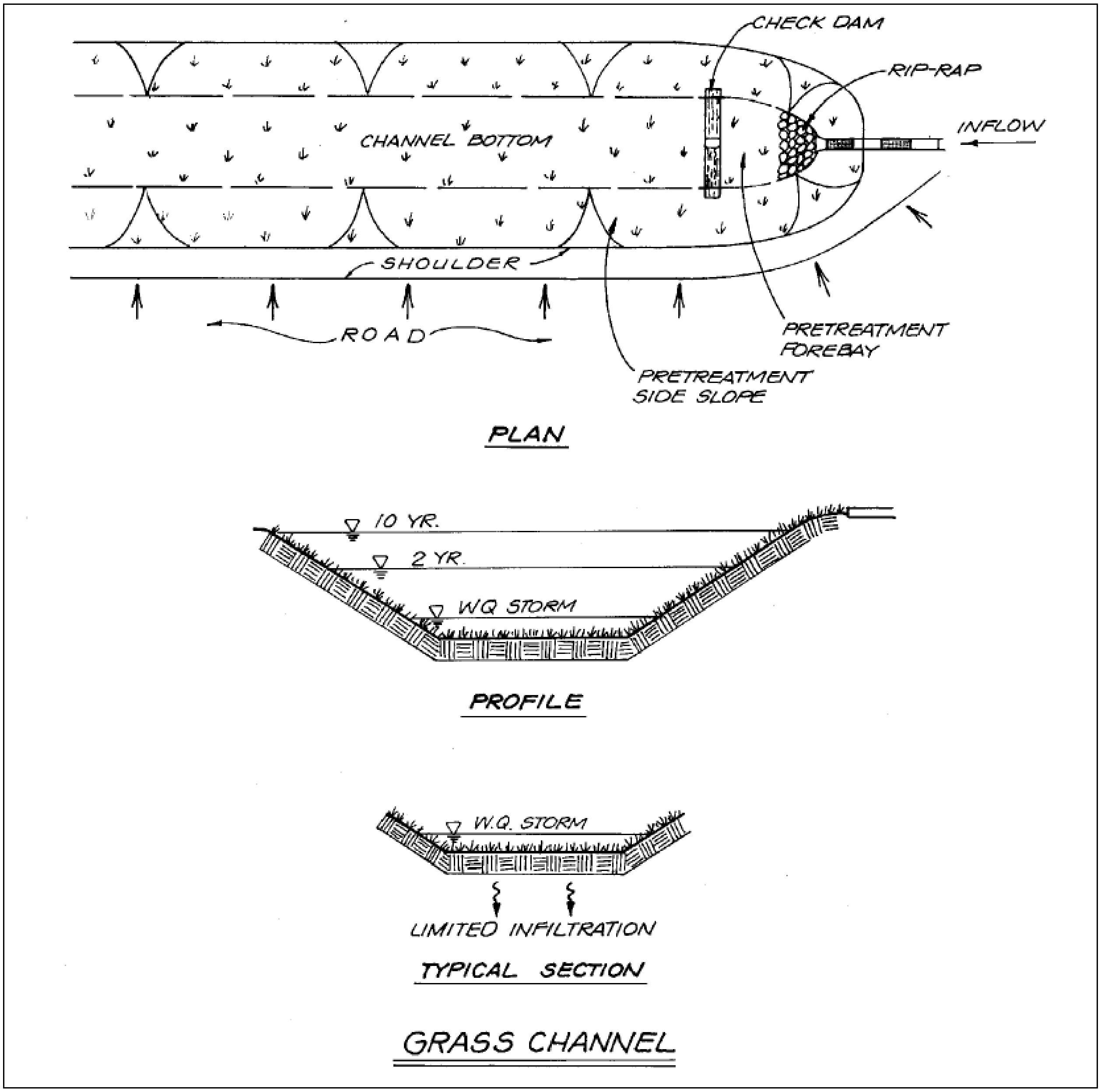
Operation & Maintenance:
- Remove accumulated sediment and debris as needed to maintain appearance
- Inspect regularly for erosion and the formation of rills and gullies; plant replacement vegetation as needed

Pollutant Removal:

Total Suspended Solids	60%
Total Phosphorus	25%
Total Nitrogen	30%
Metals	30%
Pathogens	N/A

(Source: CWP, 2009)

Description:
Conventional storm drain systems are designed to quickly and efficiently convey stormwater runoff away from buildings, roadways and other impervious surfaces and into nearby lakes, streams and wetlands. When these conventional systems are used, opportunities to reduce stormwater runoff rates, volumes and pollutant loads and minimize the negative impacts of the land development process are lost. To take better advantage of these opportunities, grass channels can be used in place of conventional curb, gutter and storm drain systems to convey stormwater runoff.



Grass Channel
(Source: Atlanta, GA Regional Commission)

Grass channels are densely vegetated stormwater conveyance features that are designed to slow and filter stromwater runoff while it is conveyed to a receiving stream, storm sewer system or stormwater management practice. They can be integrated into development sites as landscaping features and are well suited to "receive" stormwater runoff from local streets and roadways, highways, small parking lots and disturbed pervious surfaces (e.g., lawns, parks, community open spaces). They are particularly well suited for use in transportation corridors and along property lines.

Grass channels are typically less expensive to install than conventional curb, gutter and storm drain systems and can be used to "pretreat" stormwater runoff before it enters other stormwater management practices, such as bioretention areas (BMP Profile Sheet SWM-17) and infiltration practices (BMP Profile Sheet SWM-19).

Grass Channel
(Source: Center for Watershed Protection)

Resources:

Center for Watershed Protection. Design of Stormwater Filtering Systems.
http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm.

U.S. Department of Agriculture. Natural Resources Conservation Service. Illinois Urban Manual. Practice Standards Fact Sheet: Grass Lined Channel.
http://www.il.nrcs.usda.gov/technical/engineer/urban/standards/urstnd_alpha.html.

California Stormwater Quality Association. New Development and Redevelopment Stormwater Best Management Practice Handbook. Fact Sheet TC-30: Vegetated Swale.
http://www.cabmphandbooks.com/Development.asp.

Center for Watershed Protection. Coastal Stormwater Supplement to the Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 7.8.7: Grass Channels.
http://www.gaepd.org/Documents/CoastalStormwaterSupplement.html.

U.S. Environmental Protection Agency. Stormwater Technology Fact Sheet: Vegetated Swales.
http://www.epa.gov/OWM/mtb/vegswale.pdf.

Dry Swales

Swales are vegetated open channels that are designed to manage stormwater runoff within cells formed by check dams or other control structures (e.g., culverts). They are designed with relatively mild slopes to force stormwater runoff to flow through them slowly and at relatively shallow depths, which encourages sediment and other stormwater pollutants to settle out. Swales differ from grass channels (BMP Profile Sheet SWM-10), in that they incorporate features that enhance their ability to reduce stormwater runoff rates, volumes and pollutant loads on development sites.

Dry swales are swales built upon a bed of engineered soil and planted with native trees, shrubs and other herbaceous vegetation. They are essentially linear bioretention areas (BMP Profile Sheet SWM-17), in that they are designed to capture and temporarily store stormwater runoff, where it is subjected to the hydrologic processes of evaporation and transpiration before being conveyed back into the storm drain system through an underdrain or allowed to infiltrate into the surrounding soils. This allows them to provide significant reductions in stormwater runoff rates, volumes and pollutant loads.

Dry Swale in Roadway Median
(Source: Atlanta, GA Regional Commission)

Typical Applications:
Dry swales can be used to convey stormwater runoff away from nearly any small drainage area, including local streets and roadways, highways, driveways, small parking areas and disturbed pervious areas (e.g., lawns, parks, community open spaces). They can be used on a variety of development sites, including residential, commercial, institutional and municipal sites, but are particularly well suited for use within transportation corridors and along property lines.

Advantages/Benefits:
- Provide reductions in stormwater runoff rates, volumes and pollutant loads while providing stable stormwater conveyance
- Less expensive than comparable curb, gutter and storm drain systems
- Can be integrated into development plans as attractive landscaping features

Disadvantages/Limitations:
- Higher maintenance requirements than comparable curb and gutter systems
- Should be designed with a slope of between 0.5% and 4%, although a slope of between 1% and 2% is recommended
- Potential to create nuisance ponding conditions and mosquito problems if not properly designed and maintained

Construction Costs:
$12.00 - $24.00 per linear foot
($6.00 - $12.00 per cubic foot of stormwater runoff treated)

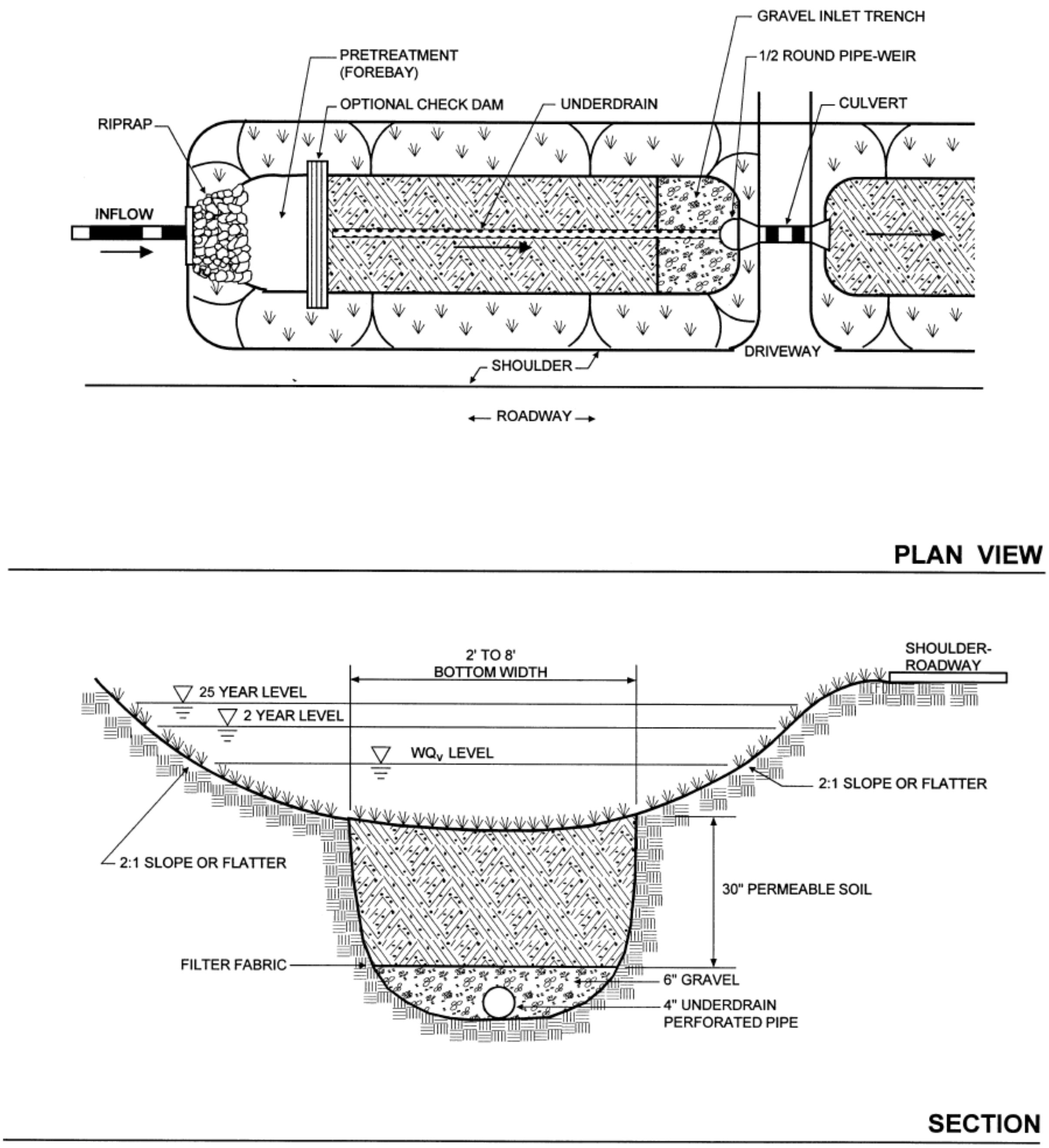
Operation & Maintenance:
- Inspect monthly to ensure proper dewatering after storm events
- Remove accumulated sediment and debris as needed to maintain appearance and function
- Inspect regularly for erosion; plant replacement vegetation as needed

Pollutant Removal:

Total Suspended Solids	80%
Total Phosphorus	50%
Total Nitrogen	50%
Metals	N/A
Pathogens	N/A

(Source: CWP, 2007; CWP, 2009)

Description:
Dry swales are swales built upon a layer of engineered soil and planted with native trees, shrubs and other herbaceous vegetation. They are essentially linear bioretention areas (BMP Profile Sheet SWM-17), in that they are designed to capture and temporarily store stormwater runoff in the engineered soil, where it is subjected to the hydrologic processes of evaporation and transpiration before being conveyed back into the storm drain system through an underdrain or allowed to infiltrate into the surrounding soils.



Dry Swale
(Source: Atlanta, GA Regional Commission)

Dry swales can be used to convey stormwater runoff away from nearly any small drainage area, including local streets and roadways, highways, driveways, small parking areas and disturbed pervious areas (e.g., lawns, parks, community open spaces). They can be used on a variety of development sites, including residential, commercial, institutional and municipal sites, but are particularly well suited for use within transportation corridors and along property lines.

Dry Swale
(Source: http://www.lakecountyil.gov)

Dry swales should not be confused with filter strips or grass channels. Filter strips are designed to accommodate overland flow rather than channelized flow, while grass channels are not capable of providing the reductions in stormwater runoff rates, volumes and pollutant loads that dry swales are capable of providing. However, both of these practices may be used in a "stormwater management train" upstream of a dry swale to "pretreat" stormwater runoff before it reaches the swale.

Resources:

Center for Watershed Protection. Design of Stormwater Filtering Systems. http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm.

Center for Watershed Protection. Coastal Stormwater Supplement to the Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 7.8.15: Dry Swales. http://www.gaepd.org/Documents/CoastalStormwaterSupplement.html.

Atlanta, Georgia Regional Commission. Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 3.2.6: Enhanced Swales. http://www.georgiastormwater.com.

Wet Swales

Swales are vegetated open channels that are designed to manage stormwater runoff within cells formed by check dams or other control structures (e.g., culverts). They are designed with relatively mild slopes to force stormwater runoff to flow through them slowly and at relatively shallow depths, which encourages sediment and other stormwater pollutants to settle out. Swales differ from grass channels (BMP Profile Sheet SWM-10), in that they incorporate features that enhance their ability to reduce stormwater runoff rates, volumes and pollutant loads on development sites.

Wet swales are swales designed to retain water and maintain the hydrologic conditions necessary to support the growth of wetland vegetation. A high water table and/or poorly drained soils are typically necessary to maintain a permanent water surface within a wet swale, which essentially acts as a linear stormwater wetland (BMP Profile Sheet SWM-16), where stormwater runoff is stored and treated over an extended period of time.

Wet Swale
(Source: Atlanta, GA Regional Commission)

Typical Applications:
Where site characteristics allow, wet swales can be used to convey stormwater runoff away from small impervious and pervious drainage areas and into receiving streams, storm sewer systems or stormwater management practices. They can be used on a variety of development sites, including residential, commercial, institutional and municipal sites, but are particularly well suited for use within transportation corridors and along property lines.

Advantages/Benefits:
- Provide significant water quality benefits while providing stable stormwater conveyance
- Less expensive than comparable curb, gutter and storm drain systems
- Can be integrated into development plans as attractive landscaping features

Disadvantages/Limitations:
- Higher maintenance requirements than comparable curb and gutter systems
- Should be designed with a slope of between 0.5% and 4%, although a slope of between 1% and 2% is recommended
- Potential to create nuisance ponding conditions and mosquito problems if not properly designed and maintained

Construction Costs:
$10.00 - $20.00 per linear foot
($5.00 - $10.00 per cubic foot of stormwater runoff treated)

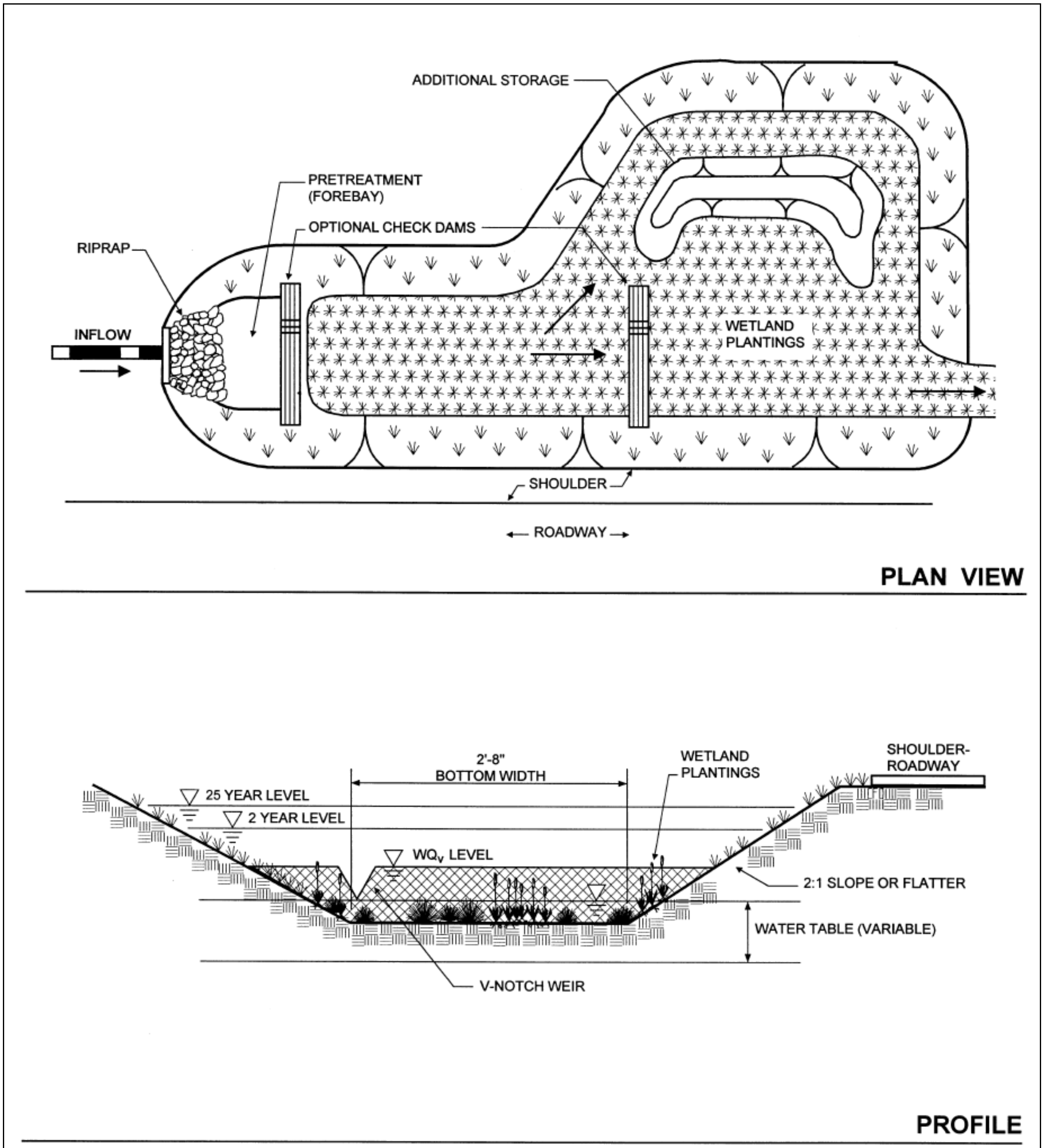
Operation & Maintenance:
- Ensure contributing drainage area is not eroding; plant vegetation as needed
- Remove accumulated sediment and debris as needed to maintain appearance and function
- Inspect regularly for erosion; plant replacement vegetation as needed

Pollutant Removal:

Total Suspended Solids	80%
Total Phosphorus	50%
Total Nitrogen	50%
Metals	N/A
Pathogens	N/A

(Source: CWP, 2007; CWP, 2009)

Description:
Wet swales are swales designed to retain water and maintain the hydrologic conditions necessary to support the growth of wetland vegetation. A high water table and/or poorly drained soils are typically necessary to maintain a permanent water surface within a wet swale, which essentially acts as a linear stormwater wetland (BMP Profile Sheet SWM-16), where stormwater runoff is stored and treated over an extended period of time.



Wet Swale
(Source: Atlanta, GA Regional Commission)

Where site characteristics allow, wet swales can be used to convey stormwater runoff away from small impervious and pervious drainage areas and into receiving streams, storm sewer systems or stormwater management practices. They can be used on a variety of development sites, including residential, commercial, institutional and municipal sites, but are particularly well suited for use within transportation corridors and along property lines.

Wet Swale
(Source: http://sudsnet.abertay.ac.uk/images)

Wet swales should not be confused with filter strips or grass channels. Filter strips are designed to accommodate overland flow rather than channelized flow, while grass channels are not capable of providing the reductions in stormwater runoff rates, volumes and pollutant loads that wet swales are capable of providing. However, both of these practices may be used in a "stormwater management train" upstream of a wet swale to "pretreat" stormwater runoff before it reaches the swale.

Resources:

Center for Watershed Protection. Coastal Stormwater Supplement to the Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 8.6.6: Swales. http://www.gaepd.org/Documents/CoastalStormwaterSupplement.html.

Atlanta, Georgia Regional Commission. Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 3.2.6: Enhanced Swales. http://www.georgiastormwater.com.

Center for Watershed Protection. Design of Stormwater Filtering Systems. http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm.

Dry-Bottom Detention Basins

Dry-bottom detention basins are large depressional areas designed to capture and temporarily store stormwater runoff before gradually releasing it into a receiving stream or storm sewer system over an extended period of time. By reducing the rate at which stormwater is released from a development site, dry-bottom detention basins help reduce flooding and other negative impacts of the land development process.

Dry-Bottom Detention Basin
(Source: California Stormwater Quality Association)

Dry-Bottom Detention Basin in North Barrington
(Source: Flint Creek Watershed Partnership)

Typical Applications:
Dry-bottom detention basins are widely used within the Flint Creek Watershed. In fact, there are at least three dry-bottom detention basins in the Village of North Barrington alone. They are used to reduce downstream flooding by controlling the rate at which stormwater is released from a development site. They are suitable for use in areas with residential, commercial or industrial land uses and can be used to manage stormwater runoff from areas up to 75 acres in size.

Advantages/Benefits:
- Dry-bottom detention basins can be designed to provide passive recreational opportunities between storm events, as they can be used as parks, playing fields and/or open space
- Can be, and typically are, used to meet the release rate requirements of the Lake County Watershed Development Ordinance

Disadvantages/Limitations:
- Dry-bottom detention basins provide limited water quality benefits
- Potential to create nuisance ponding conditions and mosquito problems if not properly designed and maintained
- Basin outlet structures can be clogged by the sediment transported within stormwater runoff

Construction Costs:
$0.75 - $2.50 per cubic foot of storage
($0.75 - $2.50 per cubic foot of stormwater runoff treated)

Operation & Maintenance:
- Remove accumulated sediment and debris from basin on a regular basis to maintain appearance and function
- Inspect regularly for erosion; plant replacement vegetation as needed
- Mow to manage and control vegetation in and around basin

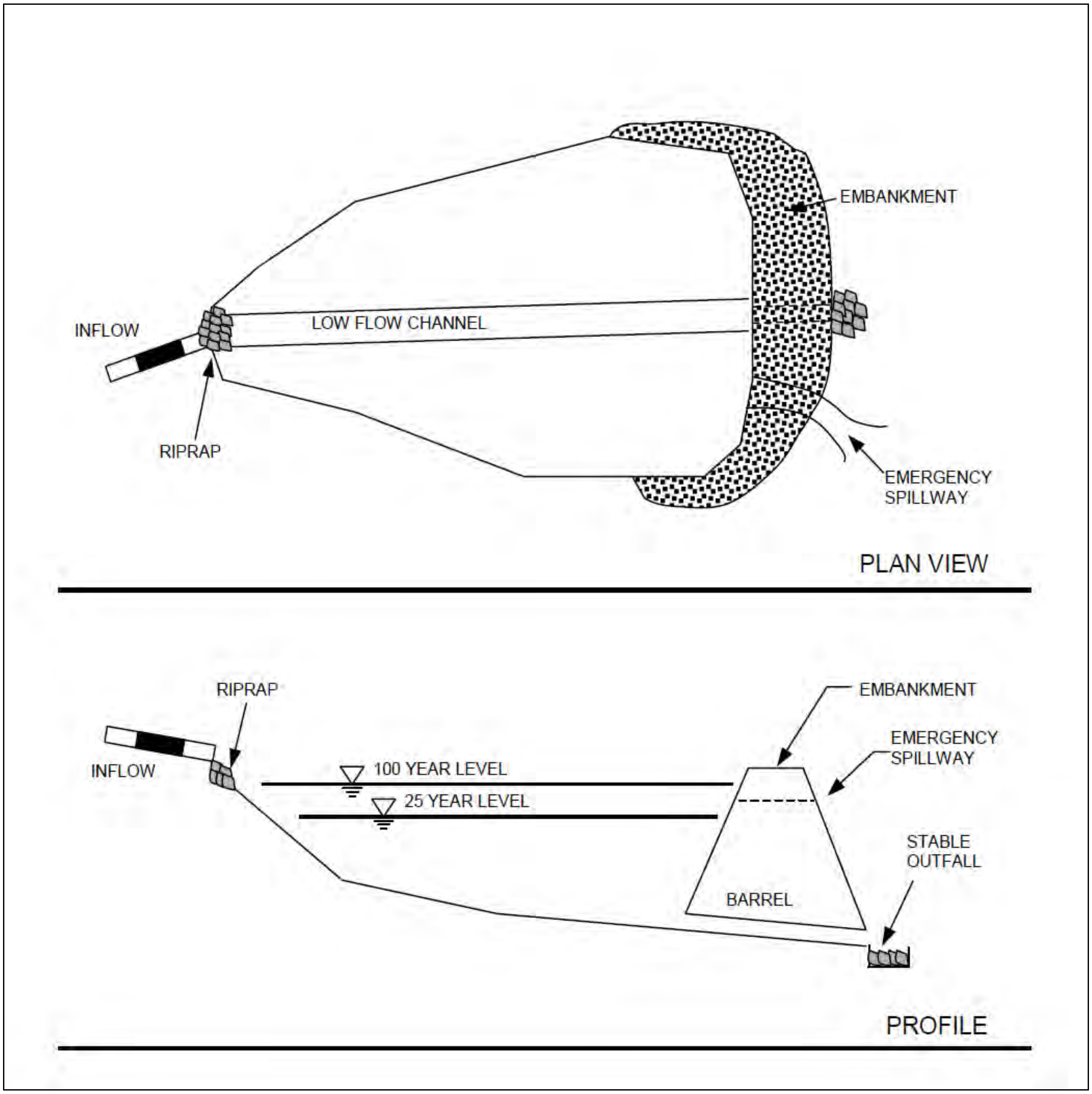
Pollutant Removal:

Total Suspended Solids	40%
Total Phosphorus	20%
Total Nitrogen	10%
Metals	30%
Pathogens	N/A

(Source: CWP, 2007; CWP, 2009)

Description:
Dry-bottom detention basins are depressional areas designed to capture and temporarily store stormwater runoff before gradually releasing it into a receiving stream or storm sewer system over an extended period of time. By reducing the rate at which stormwater is released from a development site, dry-bottom detention basins help reduce the negative impacts of the land development process.

To reduce the risk of creating nuisance ponding conditions, and the associated odor and mosquito problems, dry-bottom detention basins are typically designed to drain within 48 hours of the end of a rainfall event. Dry-bottom detention basins can be created either through excavation or through the construction of embankments in an existing depressional area.



Dry-Bottom Detention Basin
(Source: Atlanta, GA Regional Commission)

Although dry-bottom detention basins are designed primarily to reduce downstream flooding, existing basins can be improved in order to provide them with additional pollutant removal capabilities. See the Detention Basin Retrofits profile sheet (BMP Profile Sheet SWM-15) for additional information.

Dry-Bottom Detention Basin in North Barrington
(Source: Flint Creek Watershed Partnership)

Since they typically provide only limited water quality benefits, dry-bottom detention basins work best when they are used in combination with other stormwater management practices. They may be used in "stormwater management trains," where they are placed downstream of other stormwater management practices that provide more significant water quality benefits. An example of a "stormwater management train" is a filtration practice (BMP Profile Sheet SWM-18) that is installed to "pretreat" stormwater runoff before it enters a dry-bottom detention basin. In this "management train," both water quality and quantity benefits are realized.

Resources:

California Stormwater Quality Association. New Development and Redevelopment Stormwater Best Management Practice Handbook. Fact Sheet TC-22: Extended Detention Basin. http://www.cabmphandbooks.com/Development.asp.

Atlanta, Georgia Regional Commission. Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 3.4.1: Dry Detention/Dry Extended Detention Basins. http://www.georgiastormwater.com.

Illinois Environmental Protection Agency. Lake Notes: Stormwater Detention Ponds. http://www.epa.state.il.us/water/conservation/lake-notes/stormwater-detention-ponds.pdf.

Wet-Bottom Detention Basins

Wet-bottom detention basins, also known as stormwater ponds, are depressional areas designed to capture and temporarily store stormwater runoff before gradually releasing it into a receiving stream or storm drain over an extended period of time. Like dry-bottom detention basins, they help reduce flooding by reducing the rate at which stormwater is released from a development site. However, they also have a permanent pool of water, which allows them to provide significant water quality benefits.

Wet-Bottom Detention Basin in North Barrington
(Source: Flint Creek Watershed Partnership)

Wet-Bottom Detention Basin in North Barrington
(Source: Flint Creek Watershed Partnership)

Typical Applications:
Wet-bottom detention basins are widely used within the Flint Creek Watershed. In fact, there are at least ten wet-bottom detention basins within the Village of North Barrington alone. They are suitable for use in areas with residential, commercial or industrial land uses and can be used to manage stormwater runoff from areas that are larger than about 25 acres in size. They are capable of providing both stormwater quantity and stormwater quality benefits.

Advantages/Benefits:
- Can be used to provide water quality benefits and meet the release rate requirements of the Lake County Watershed Development Ordinance
- If properly designed, provide ancillary benefits, such as wetland and deep water habitat
- Can provide passive recreational opportunities for nearby residents, including walking and fishing

Disadvantages/Limitations:
- Standing water in and around wet-bottom detention basins can create nuisance ponding conditions and may lead to odor and mosquito problems
- Ponds designed without safety and aquatic benches can become safety hazards

Construction Costs:
$1.00 - $3.50 per cubic foot of storage
($1.00 - $3.50 per cubic foot of stormwater runoff treated)

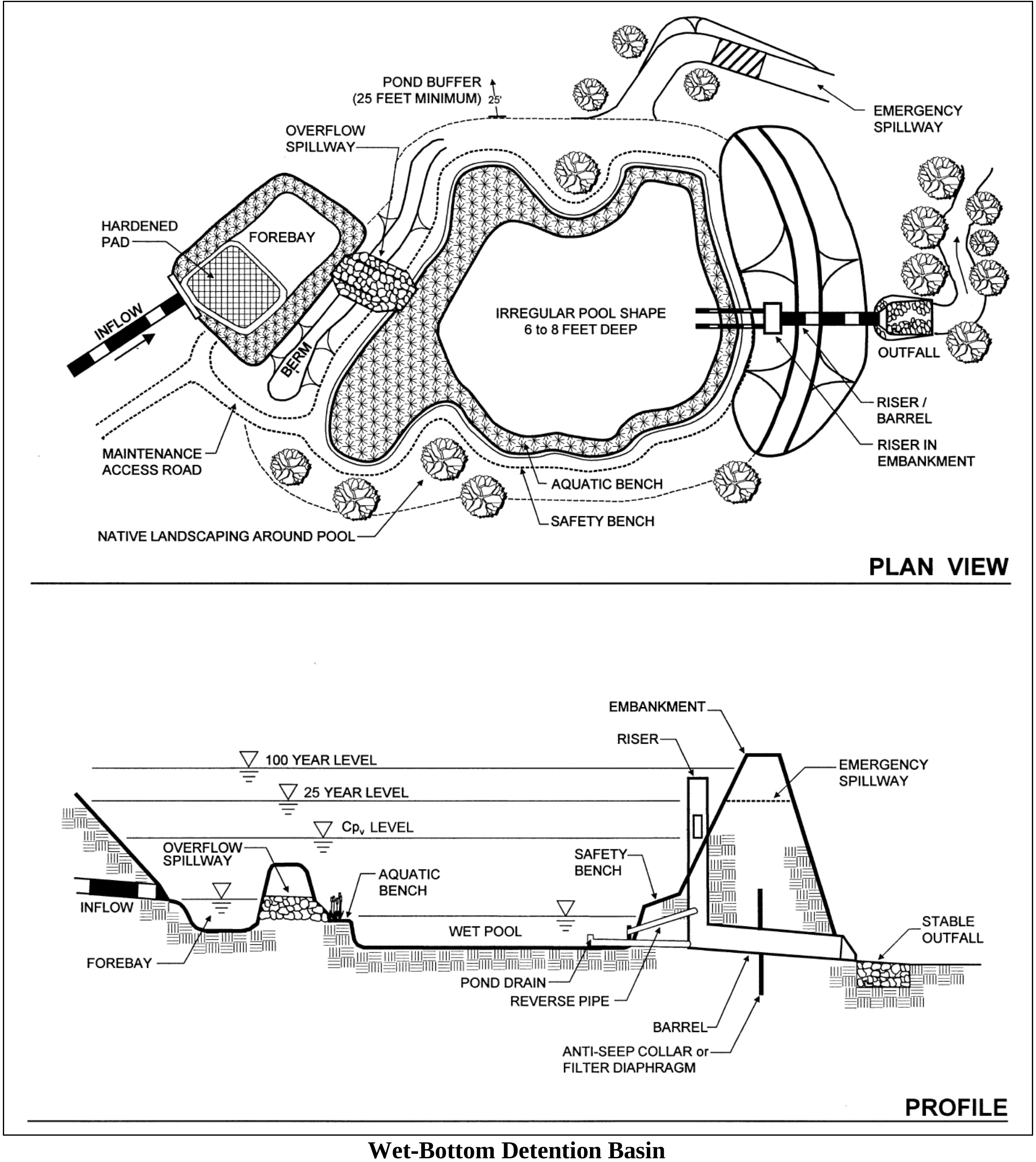
Operation & Maintenance:
- Remove debris from basin to minimize clogging and improve aesthetics
- Monitor sediment accumulation and remove periodically
- Repair and replant vegetation in eroded areas

Pollutant Removal:

Total Suspended Solids	80%
Total Phosphorus	50%
Total Nitrogen	30%
Metals	50%
Pathogens	70%

Source: CWP 2007; CWP, 2009

Description:
Wet-bottom detention basins, also known as stormwater ponds, are depressional areas designed to capture and temporarily store stormwater runoff before gradually releasing it into a receiving stream or storm sewer system over an extended period of time. Like dry-bottom detention basins, they help reduce flooding by reducing the rate at which stormwater is released from a development site. However, wet-bottom detention basins also have a permanent pool of water, which allows them to provide significant water quality benefits.



Wet-Bottom Detention Basin
(Source: Atlanta, GA Regional Commission)

Wet Pond
(Source: Merrill et al., 2005)

Wet Extended Detention Pond
(Source: Atlanta, GA Regional Commission)

Micropool Extended Detention Pond
(Source: Atlanta Regional Commission)

Wet Pond
(Source: Center for Watershed Protection)

There are four types of wet-bottom detention basins, including wet ponds, wet extended detention ponds, micropool extended detention ponds and multiple pond systems. Each of these is briefly described below:

- Wet Ponds: Wet ponds are detention basins that are designed with a permanent pool of water that provides enough storage for the entire water quality treatment volume. Stormwater runoff is conveyed into the pool, where it is detained and treated over an extended period of time, primarily through gravitational settling and biological uptake, until it is displaced by stormwater runoff from the next storm event. Additional temporary storage (i.e., live storage) can be provided above the permanent pool for stormwater quantity control.

- Wet Extended Detention (ED) Ponds: Wet extended detention ponds are wet ponds that are designed with a permanent pool of water that provides enough storage for approximately 50% of the target water quality treatment volume. The remainder of the target water quality treatment volume is managed in an extended detention zone that is provided immediately above the permanent pool. During wet weather, stormwater runoff is detained in the extended detention zone where it is gradually released over a 24-hour period.

- Micropool Extended Detention (ED) Ponds: Micropool extended detention ponds are a variation of the standard wet extended detention pond that have only a small permanent pool (i.e., micropool). The "micropool" provides enough storage for approximately 10% of the target water quality treatment volume. The remainder of the target water quality treatment volume is managed in an extended detention zone that is provided immediately above the "micropool" where it is gradually released over an extended 24-hour period.

Wet-Bottom Detention Basin in North Barrington
(Source: Flint Creek Watershed Partnership)

- Multiple Pond Systems: Multiple pond systems consist of a series of two or more wet ponds, wet extended detention ponds or micropool extended detention ponds. The additional cells provided in a multiple pond system increase the storage capacity provided on a development or redevelopment site.

A wet-bottom detention basin can be attractively integrated into a development site as a landscaping feature and, if properly designed, sited and landscaped, can provide valuable wildlife habitat. Well-designed wet-bottom detention basins are typically not subject to odor and mosquito problems, as they provide habitat for natural mosquito predators, such as dragonflies.

Resources:

Minnesota Pollution Control Agency. Minnesota Stormwater Manual. Best Management Practices Details Fact Sheet 2.9: Stormwater Ponds. http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html.

Center for Watershed Protection. Coastal Stormwater Supplement to the Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 8.6.1: Stormwater Ponds. http://www.gaepd.org/Documents/CoastalStormwaterSupplement.html.

California Stormwater Quality Association. New Development and Redevelopment Stormwater Best Management Practice Handbook. Fact Sheet TC-20: Wet Ponds. http://www.cabmphandbooks.com/Development.asp.

Illinois Environmental Protection Agency. Lake Notes: Stormwater Detention Ponds. http://www.epa.state.il.us/water/conservation/lake-notes/stormwater-detention-ponds.pdf.

U.S. Environmental Protection Agency. Stormwater Technology Fact Sheet: Wet Detention Ponds. http://www.epa.gov/owm/mtb/wetdtnpn.pdf.

Detention Basin Retrofits

Detention basin retrofits are used to modify existing detention basins, especially dry-bottom detention basins, to increase the water quality or flood control benefits they provide. Common detention basin retrofits include converting a dry-bottom detention basin to a wet-bottom detention basin and adding appropriate native landscaping in and around existing dry- and wet-bottom basins.

Lake Emily Retrofit, During Construction
Oak Forest, IL
(Source: Baxter & Woodman, Inc.)

Lake Emily Retrofit, After Construction
Oak Forest, IL
(Source: Baxter & Woodman, Inc.)

Typical Applications:
Detention basin retrofits are suitable for use in many existing dry- or wet-bottom detention basins. They are ideal for improving dry-bottom basins and providing them with increased pollutant removal capabilities. They can also be used for improving the appearance and functionality of wet-bottom detention basins.

Advantages/Benefits:
- Retrofits can provide dry-bottom detention basins with increased pollutant removal capabilities
- Retrofitting an existing wet-bottom basin can provide additional wildlife habitat and passive recreational opportunities (e.g. walking, fishing) for residents
- Addition of aquatic vegetation and native plant buffers can remove pollutants and turn an unsightly pond into a neighborhood amenity

Disadvantages/Limitations:
- Site constraints and permitting issues related to wetlands and floodplains may make present design and construction challenges
- Alteration of detention basins may require an update of the hydrologic and hydraulic models associated with them

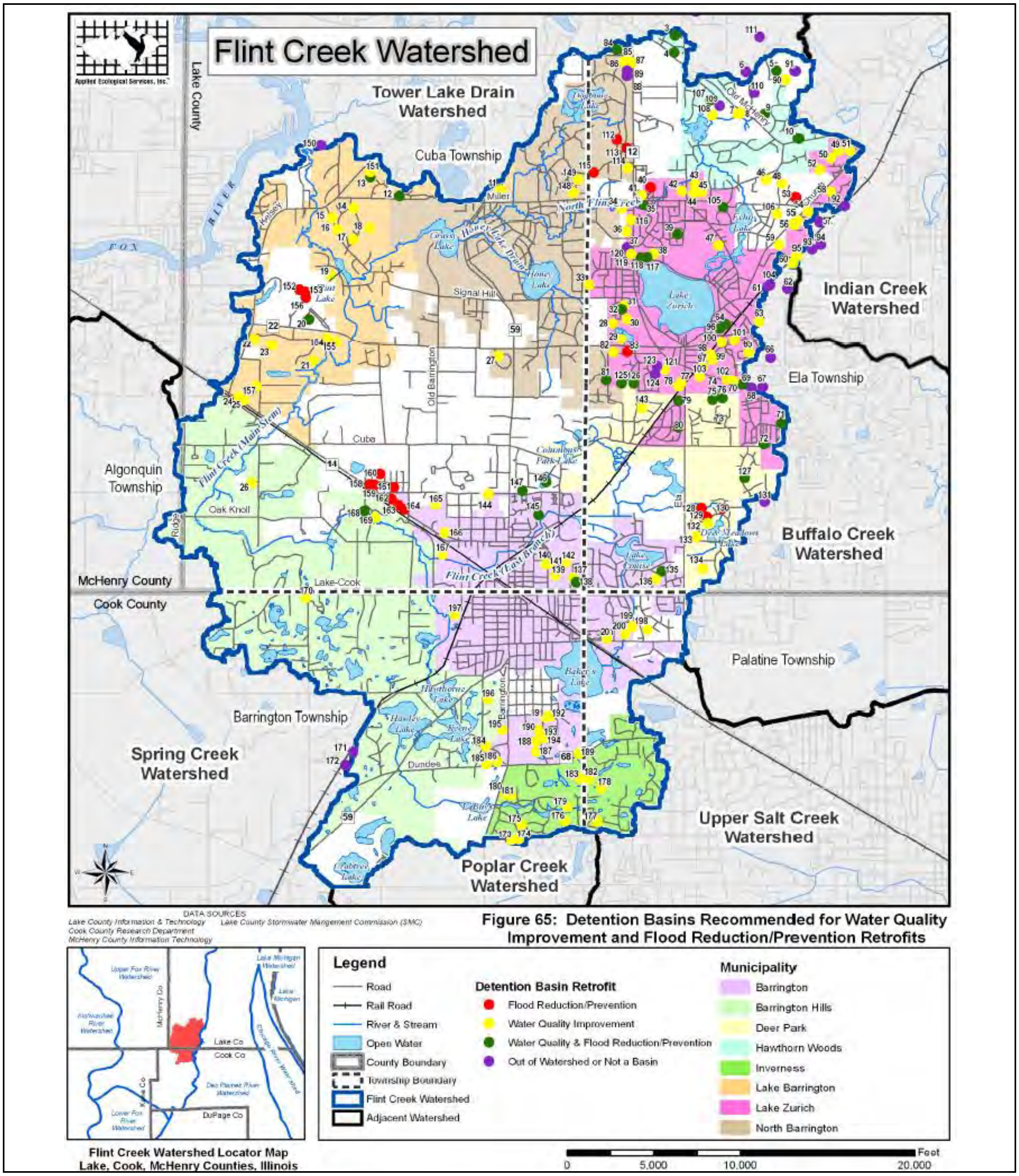
Construction Costs:
Vary according to the modifications made to the existing wet- or dry-bottom detention basin; range from low to high

Operation & Maintenance:
- Monitor any modifications made to detention basins to ensure that they are having the desired effect
- Repair and replant any damaged vegetation within and around detention basin retrofits

Pollutant Removal:

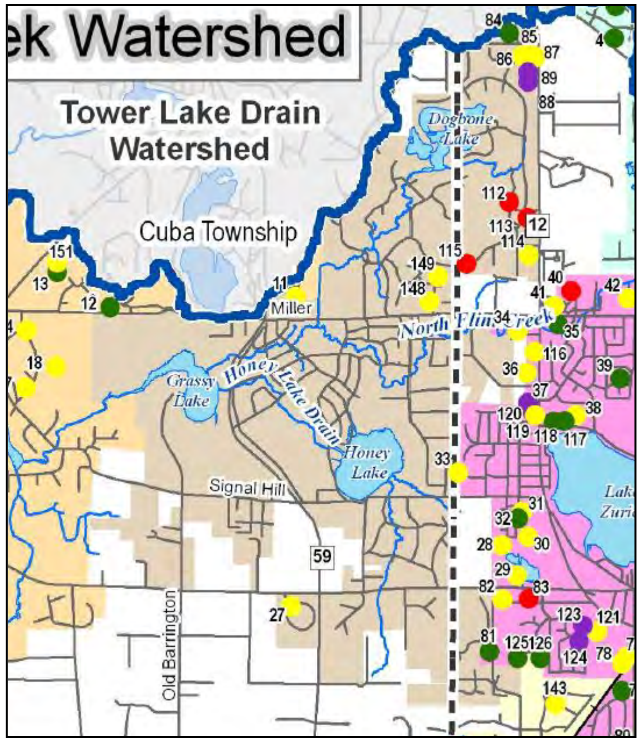
Pollutant removal varies according to the modifications made to the existing wet- or dry-bottom detention basin

Description:
Detention basin retrofits are used to modify existing detention basins, especially dry-bottom detention basins, to increase the water quality or flood control benefits they provide. Common detention basin retrofits include converting a dry-bottom detention basin to a wet-bottom detention basin and adding appropriate native landscaping in and around existing dry- and wet-bottom basins.



Flint Creek Watershed Detention Basin Inventory
(Source: Flint Creek Watershed Partnership)

During the summer of 2006, the Lake County Stormwater Management Commission inventoried all of the detention basins found within the Flint Creek Watershed. The inventory found 16 wet- or dry-bottom detention basins and stormwater wetlands (BMP Profile Sheet SWM-16) in the Village of North Barrington that could be retrofit to improve their appearance and function. Of these 16 potential retrofit projects, six were considered to be high or medium priority retrofit projects. These include the retrofit projects at detention basins 11, 84, 87, 112, 113 and 115.



Potential Detention Basin Retrofits
North Barrington, IL
(Source: Flint Creek Watershed Partnership)

There are several different detention basin modifications that can be used to complete a detention basin retrofit:

- Dry-Bottom Detention Basin Conversion: Many dry bottom ponds that provide water quantity, but not water quality benefits have been constructed over the last few decades. Many of these ponds can be modified to provide them with increased pollutant removal capabilities.

  One potential modification is to turn the bottom of a dry-bottom detention basin into a large bioretention area using soil amendments (BMP Profile Sheet SWM-2) and native landscaping (BMP Profile Sheet SWM-3). Another potential modification is to decrease the size of the basin's outlet to increase the amount of time that stormwater runoff stays within the basin. Yet another potential modification is to alter the basin's outlet so that it retains a permanent pool of water and is converted into a wet pond or wet extended detention pond. One other potential modification is to excavate the bottom of the pond to provide space for a permanent pool of water to create a wet pond or wet extended detention pond.

Lake Emily Retrofit, After Construction
(Source: Baxter & Woodman, Inc.)

  Regardless of the retrofit techniques used, dry-bottom detention basin retrofits can be used to turn marginal dry-bottom basins into effective stormwater management practices, complete with forebays, vegetative benches and deep-water zones for stormwater storage.

- Fringe Marsh Creation: Aquatic vegetation can be planted along the perimeter of wet-bottom detention basins and other open water systems, such as stormwater wetlands, to enhance sediment removal and provide some biological pollutant uptake of other stormwater pollutants.

The key to successful stormwater retrofit design is balancing the desire to maximize pollutant removal and flood control with the need to avoid impacts to existing infrastructure and adjacent property. Stormwater retrofitters must try to avoid relocations of existing utilities, minimize wetland, prairie and forest impacts, maintain existing floodplain elevations, comply with dam safety requirements, avoid creating nuisance conditions and provide adequate access to the site for construction and maintenance purposes. All detention basin retrofit design efforts should include geotechnical investigations, detailed topographic mapping, adequate hydrologic and hydraulic modeling, preparation of site grading plans, preparation of erosion and sediment control plans and construction scheduling and phasing.

Resources:

Flint Creek Watershed Partnership. Flint Creek Watershed Based Plan.
http://www.flintcreekwatershed.org/watershed_plan.html.

Center for Watershed Protection. Urban Stormwater Retrofit Practices Manual.
http://www.cwp.org/Resource_Library/Controlling_Runoff_and_Discharges/sm.htm.

Center for Watershed Protection. Stormwater Retrofits: Tools for Watershed Enhancement.
http://www.cwp.org/Resource_Library/Center_Docs/PWP/ELC_PWP143.pdf.

Stormwater Wetlands

Stormwater wetlands are constructed wetlands built specifically for stormwater management purposes. They are depressional areas that are designed to capture and store stormwater runoff before gradually releasing it into a receiving stream or storm sewer over an extended period of time. They typically consist of a combination of open water, shallow marsh and saturated areas located just above the permanent water surface. Like detention basins, they help reduce flooding by reducing the rate at which stormwater is released from a development site. Their permanent pool of water allows them to provide significant water quality benefits.

Stormwater Wetland in North Barrington
(Source: Flint Creek Watershed Partnership)

Stormwater Wetland
(Source: Merrill et al., 2005)

Typical Applications:
Stormwater wetlands are suitable for use in the Flint Creek Watershed, particularly on new development sites and at the regionally significant storage locations and potential wetland restoration sites identified in the Flint Creek Watershed Plan. They can be used on sites with agricultural, residential, commercial, industrial, institutional and municipal land uses and can be used to manage stormwater runoff from areas more than 25 acres in size.

Advantages/Benefits:
- Can be used to provide water quality benefits and meet the release rate requirements of the Lake County Watershed Development Ordinance
- If properly designed, stormwater wetlands provide ancillary benefits, such as wildlife and aquatic habitat
- Can provide passive recreational opportunities for nearby residents, such as walking and fishing

Disadvantages/Limitations:
- Standing water in and around wetlands can create nuisance ponding and may lead to odor and mosquito problems
- Enough water must be provided (e.g. large drainage area, groundwater) to maintain a permanent pool of water

Construction Costs:
$1.50 - $3.50 per cubic foot of storage
($1.50 - $3.50 per cubic foot of stormwater runoff treated)

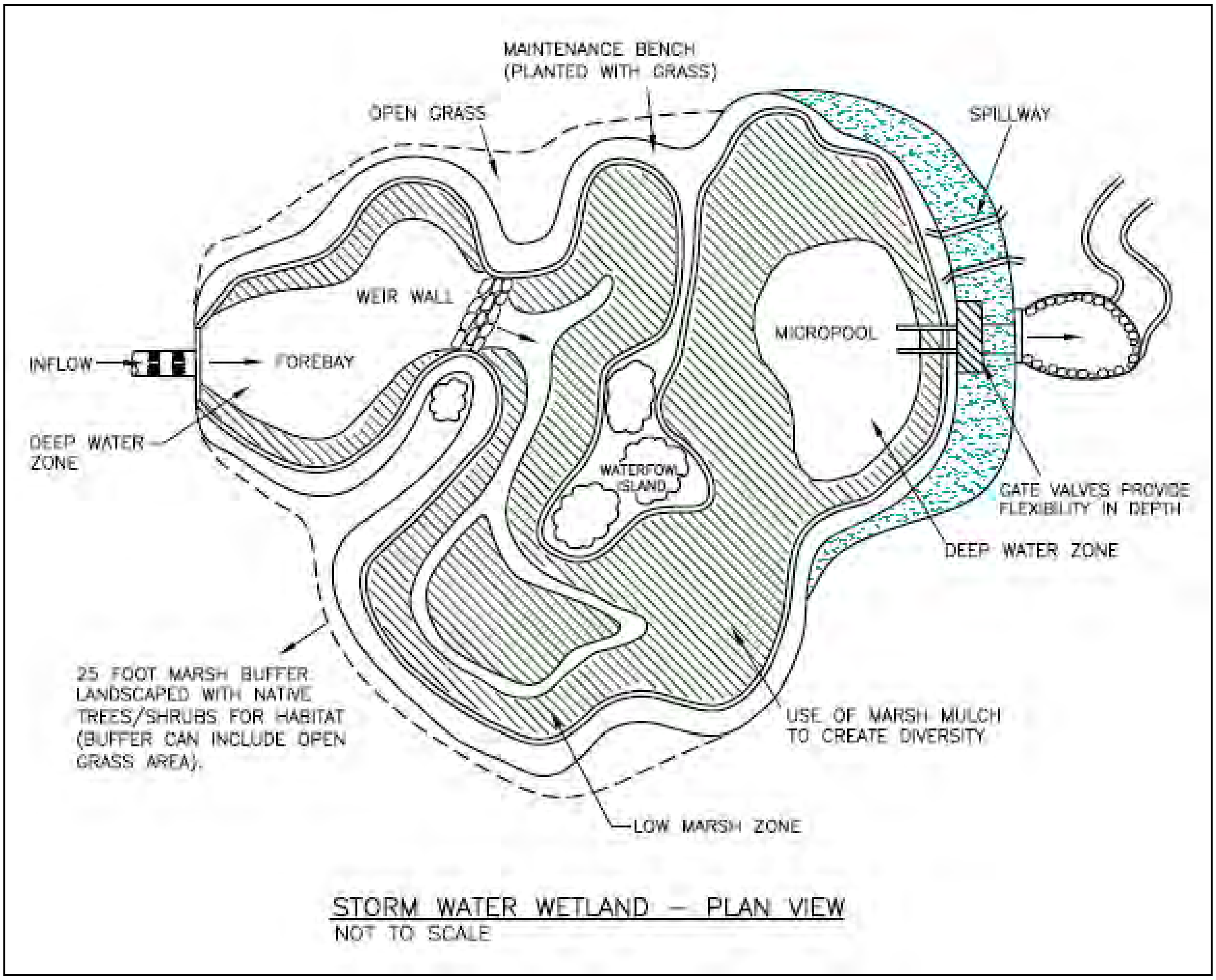
Operation & Maintenance:
- Repair and replant vegetation in eroded areas to maintain at least 50% coverage over the surface of the wetland
- Monitor sediment accumulation and remove periodically

Pollutant Removal:

Total Suspended Solids	80%
Total Phosphorus	50%
Total Nitrogen	30%
Metals	50%
Pathogens	70%

Source: CWP 2007; CWP, 2009

Description:
Stormwater wetlands are constructed wetlands built specifically for stormwater management purposes. They are depressional areas that are designed to capture and temporarily store stormwater runoff before gradually releasing it into a receiving stream or storm sewer system over an extended period of time. They typically consist of a combination of open water, shallow marsh and saturated areas located just above the permanent water surface. Like detention basins, they help reduce flooding by reducing the rate at which stormwater is released from a development site. Their permanent pool of water also allows them to provide significant water quality benefits.



Stormwater Wetland
(Source: City of Valparaiso, IN)

There are four types of stormwater wetlands, including shallow wetlands, shallow extended detention wetlands, pond/wetland systems and pocket wetlands. Each of these is briefly described below:

- Shallow Wetlands: In a shallow wetland, most of the storage volume that is provided within the wetland is provided in some relatively shallow high marsh and low marsh areas. The only deep water areas found within a shallow wetland are the forebay, which is located at the entrance to the wetland, and the "micropool," which is located at the outlet. One disadvantage to the shallow wetland design is that, since most of the storage volume is provided in the relatively shallow high marsh and low marsh areas, a significant amount of surface area is required.

Shallow Wetland
(Source: Atlanta, GA Regional Commission)

Shallow Extended Detention Wetland
(Source: Atlanta, GA Regional Commission)

Shallow Wetland
(Source: Atlanta, GA Regional Commission)

Pocket Wetland
(Source: Atlanta, GA Regional Commission)

- Shallow Extended Detention Wetlands: A shallow extended detention wetland is essentially a shallow wetland, except that approximately 50% of the target water quality treatment volume is managed in an extended detention zone that is provided immediately above the permanent water surface. During wet weather, stormwater runoff is detained in the extended detention zone and gradually released over a 24-hour period. Although this design requires less surface area than the shallow wetland, it can be difficult to establish vegetation within the extended detention zone due to frequently fluctuating water surface elevations.

- Pond/Wetland Systems: A pond/wetland system has two separate cells, one of which is a wet pond and the other of which is a shallow wetland. The wet pond cell is used to trap sediment and reduce stormwater runoff velocities upstream of the wetland cell. Less surface area is typically required for pond/wetland systems than for shallow wetlands or shallow extended detention wetlands.

- Pocket Wetlands: Pocket wetlands can be used to intercept and manage stormwater runoff from relatively small drainage areas of up to about 10 acres in size. In order to ensure that they have a permanent water surface throughout the year, they are typically designed to interact with the groundwater table.

Stormwater wetlands are among the most effective stormwater management practices that can be used in the Flint Creek Watershed. They reduce downstream flooding and provide significant water quality benefits. They can be created either through excavation or through the construction of embankments in an existing depressional area. A stormwater wetland can be attractively integrated into a development site as a landscaping feature and, if properly designed, sited and landscaped, can provide valuable wildlife habitat. Although the standing water in and around stormwater wetlands can create nuisance ponding conditions and lead to odor and mosquito problems, a well-designed wetland typically has minimal ponding and odor issues and provides habitat for natural mosquito predators, such as dragonflies.

Stormwater wetlands differ from natural wetland systems in that they are engineered facilities designed specifically for the purpose of managing stormwater runoff. They typically have less biodiversity than natural wetlands in terms of both plant and animal life but, like natural wetlands, require continuous base flow or a high water table to maintain a permanent water surface and support the growth of aquatic vegetation. Stormwater wetlands should not be constructed within natural wetlands, which are protected by applicable local, state and federal laws.

Resources:

U.S. Department of Agriculture. Natural Resources Conservation Service. Illinois Urban Manual. Practice Standards Fact Sheet: Urban Stormwater Wetlands.
http://www.il.nrcs.usda.gov/technical/engineer/urban/standards/urstnd_alpha.html.

Minnesota Pollution Control Agency. Minnesota Stormwater Manual. Best Management Practices Details Fact Sheet 2.10: Stormwater Wetlands.
http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html.

Center for Watershed Protection. Coastal Stormwater Supplement to the Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 8.6.2: Stormwater Wetlands.
http://www.gaepd.org/Documents/CoastalStormwaterSupplement.html.

Center for Watershed Protection. Wetlands and Watersheds Article Series. Article 5: The Next Generation of Stormwater Wetlands.
http://www.cwp.org/Resource_Library/Special_Resource_Management/wetlands.htm.

Bioretention Areas

Bioretention areas are landscaped depressional areas that are built upon a bed of engineered soil and planted with native trees, shrubs and other herbaceous vegetation. They are designed to capture and temporarily store stormwater runoff so that it may be subjected to the hydrologic processes of evaporation, transpiration and infiltration. This helps reduce stormwater runoff rates, volumes and pollutant loads and, consequently, helps reduce flooding and other negative impacts of the land development process.

Bioretention Area
(Source: U.S. Environmental Protection Agency)

Bioretention Area
(Source: Center for Watershed Protection)

Typical Applications:
Bioretention areas can be used to manage stormwater runoff at or near the source or downstream of other stormwater management and conveyance practices (e.g., swales, storm drain systems). They can be applied on a variety of development sites, including residential, commercial, institutional and municipal development sites, but are particularly well suited for use within transportation corridors, in parking lots and in existing depressional areas.

Advantages/Benefits:
- Provide shallow groundwater recharge and reductions in stormwater runoff rates, volumes and pollutant loads
- Can be integrated into development plans as attractive landscaping features
- Can be used on both new and existing development sites

Disadvantages/Limitations:
- Long-term maintenance is the responsibility of the property owner
- Can only be used to manage runoff from relatively small drainage areas of less than about five acres in size
- Not recommended for use in areas with high sediment loads or highly contaminated runoff

Construction Costs:
$8,000 - $16,000 per bioretention area
($6.00 - $14.00 per cubic foot of stormwater runoff treated)

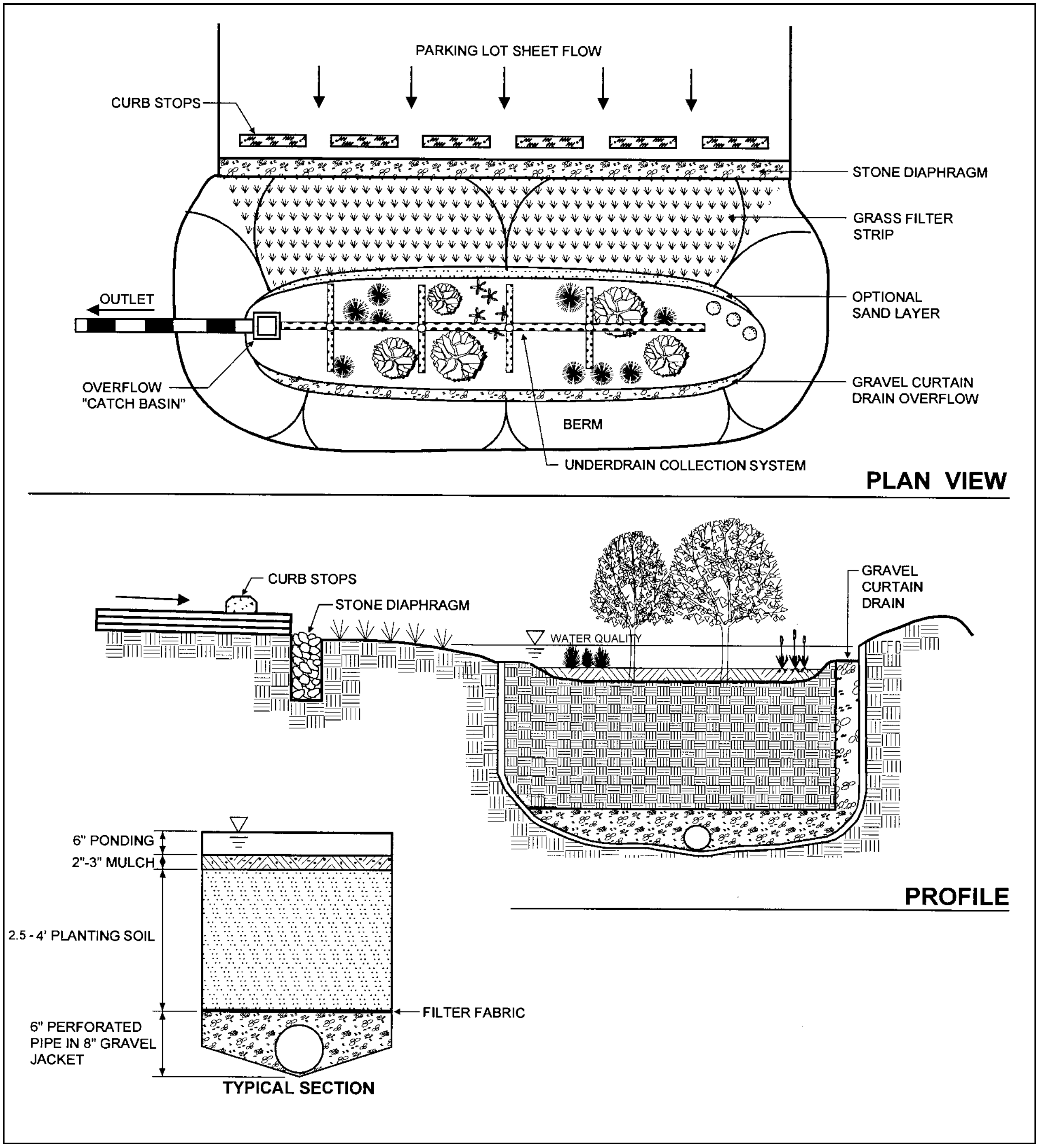
Operation & Maintenance:
- Inspect bioretention areas on a regular basis
- Maintain (i.e., mow, prune, trim, weed) vegetation on a regular basis to maintain appearance and function
- Remove accumulated sediment and debris

Pollutant Removal:

Total Suspended Solids	80%
Total Phosphorus	80%
Total Nitrogen	80%
Metals	80%
Pathogens	N/A

(Source: CWP, 2007; CWP, 2009)

Description:
Bioretention areas are landscaped depressional areas that are built upon a bed of engineered soil and planted with native trees, shrubs and other herbaceous vegetation. They are designed to capture and temporarily store stormwater runoff so that it may be subjected to the hydrologic processes of evaporation, transpiration and infiltration. This helps reduce stormwater runoff rates, volumes and pollutant loads and, consequently, helps reduce flooding and other negative impacts of the land development process.



Bioretention Area
(Source: Center for Watershed Protection)

Bioretention areas are one of the most effective stormwater management practices that can be used in the Flint Creek Watershed. In addition to reducing stormwater runoff rates, volumes and pollutant loads, they also provide a number of other benefits, including improved aesthetics, wildlife habitat, urban heat island mitigation and improved air quality. They are particularly well suited for within transportation corridors and in parking lots as "landscaping islands." They can also be used to retrofit existing depressional areas to allow them to provide stormwater management benefits.

Bioretention Area
(Source: Center for Watershed Protection)

Bioretention areas differ from rain gardens (BMP Profile Sheet SWM-9), in that they are designed to receive stormwater runoff from larger drainage areas, are constructed using an engineered soil mix, and are typically equipped with an underdrain.

Resources:

North Carolina State University Cooperative Extension. Urban Waterways Bulletin AG-588-5: Bioretention Performance. http://www.bae.ncsu.edu/stormwater/PublicationFiles/Bioretention2006.pdf.

Lake County, Ohio. Stormwater Management Department. Bioretention Guidance. http://www2.lakecountyohio.org/smd/Forms.htm.

Minnesota Pollution Control Agency. Minnesota Stormwater Manual. Best Management Practices Details Fact Sheet 2.6: Bioretention Areas. http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html.

Center for Watershed Protection. Coastal Stormwater Supplement to the Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 8.6.3: Bioretention Areas. http://www.gaepd.org/Documents/CoastalStormwaterSupplement.html.

Filtration Practices

Filtration practices are multi-chamber structures designed to treat stormwater runoff using the physical processes of screening and filtration. After passing through a sediment forebay, stormwater passes through a filter bed (i.e., sand) before being released into a receiving stream or storm sewer system through an underdrain. Because they have very few site constraints beyond depth (i.e., vertical distance between inlet and outlet), filtration practices can be used on development sites where stormwater management practices that require large amounts of land, such as wet-bottom detention basins (BMP Profile Sheet SWM-14) and stormwater wetlands (BMP Profile Sheet SWM-16), can not.

Sand Filter
(Source: Atlanta, GA Regional Commission)

Sand Filter
(Source: Atlanta, GA Regional Commission)

Typical Applications:
Filtration practices can be used to manage stormwater runoff on a wide variety of development sites. They are particularly well suited for managing stormwater runoff from small, highly impervious areas (e.g., parking lots) on development sites where space for other stormwater management practices is limited. Filtration practices should primarily be considered for use on development sites where fine sediment (e.g., clay, silt) loads will be relatively low, as high sediment loads cause them to clog and fail.

Advantages/Benefits:
- Ideal for intercepting and treating stormwater runoff from small, highly impervious areas (e.g., parking lots, loading/unloading areas)
- Ideal for use on development sites with space constraints and on existing development sites in retrofit applications

Disadvantages/Limitations:
- Should not be used on development sites where sediment loads will be high, as sediment will clog the filter bed
- Relatively high construction and maintenance costs

Construction Costs:
$12,000 - $40,000 per filtration practice
($6.00 - $22.00 per cubic foot of stormwater runoff treated)

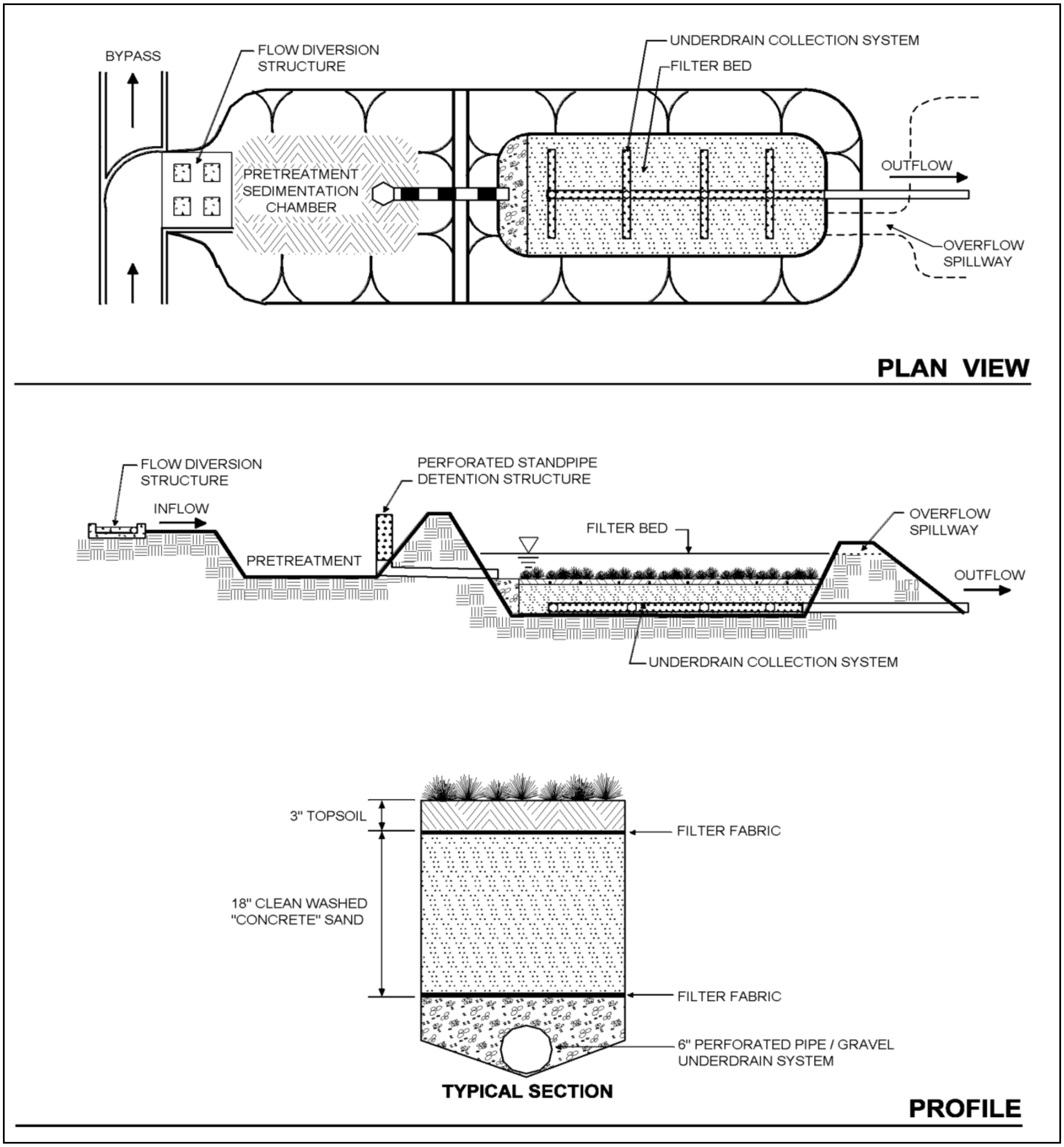
Operation & Maintenance:
- Inspect to ensure that contributing drainage area and filtration practice are clear of sediment, trash and debris
- Check to ensure that the filtration practice is properly dewatering after storm events

Pollutant Removal:

Total Suspended Solids	80%
Total Phosphorus	60%
Total Nitrogen	40%
Metals	50%
Pathogens	40%

(Source: CWP, 2007; CWP, 2009)

Description:
Filtration practices are multi-chamber structures designed to treat stormwater runoff using the physical processes of screening and filtration. Most filtration practices are two-chamber structures. The first chamber is a sediment forebay or sedimentation chamber, which works to remove trash, debris and larger sediment particles. The second chamber is a filtration chamber, which removes additional stormwater pollutants by conveying stormwater runoff through a filter bed. After passing through the filter bed (i.e., sand), stormwater runoff is typically released into a receiving stream or storm sewer system through an underdrain.



Surface Sand Filter
(Source: Center for Watershed Protection)

Surface Sand Filter
(Source: Center for Watershed Protection)

Perimeter Sand Filter
(Source: Center for Watershed Protection)

There are several types of filtration practices that can be used to manage stormwater runoff on development sites, the most common of which are surface sand filters and perimeter sand filters. Each of these is briefly described below:

- Surface Sand Filters: Surface sand filters are exposed, at-grade stormwater management practices that consist of a pretreatment forebay and filter bed chamber. Surface sand filters can treat stormwater runoff from contributing drainage areas as large as 10 acres in size and are typically designed as off-line stormwater management practices. Surface sand filters can be designed as excavations with earthen side slopes or as structural concrete or block structures.

- Perimeter Sand Filters: Perimeter sand filters are enclosed stormwater management practices that are typically located just below grade in a trench along the perimeter of a parking lot, driveway or other impervious surface. Perimeter sand filters consist of a pretreatement forebay and a filter bed chamber. Stormwater runoff is conveyed into a perimeter sand filter through grate inlets located directly above the system.

Other design variants, such as the underground sand filter and the organic filter, are intended primarily for use on ultra-urban development sites where space is limited or for use at stormwater hotspots where enhanced removal of particular stormwater pollutants (e.g., heavy metals) is desired.

Resources:

Center for Watershed Protection. Design of Stormwater Filtering Systems.
http://www.cwp.org/Resource_Library/Center_Docs/SW/design_swfiltering.pdf

Minnesota Pollution Control Agency. Minnesota Stormwater Manual. Best Management Practices Details Fact Sheet 2.7: Filtration Practices. http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html.

Center for Watershed Protection. Coastal Stormwater Supplement to the Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 8.6.4: Filtration Practices.
http://www.gaepd.org/Documents/CoastalStormwaterSupplement.html.

Infiltration Practices

Infiltration practices are shallow excavations, typically located in depressional areas, that are filled with stone or an engineered soil mix and designed to capture and temporarily store stormwater runoff until it infiltrates into the underlying and surrounding soils. This helps reduce stormwater runoff rates, volumes and pollutant loads and, consequently, helps reduce flooding and other negative impacts of the land development process. It also helps maintain shallow groundwater recharge, particularly during small storm events.

Infiltration Trench
(Source: Center for Watershed Protection)

Infiltration Basin
(Source: Dakota County, MN SWCD)

Typical Applications:
Infiltration practices can be used to manage stormwater runoff on a wide variety of development sites, as long as the soils are permeable enough and the water table is low enough to permit the infiltration of stormwater runoff. They should only be used on development sites where fine sediment (e.g., clay, silt) loads will be relatively low, as high sediment loads will cause them to clog and fail. In addition, infiltration practices should be carefully sited to avoid the potential contamination of shallow groundwater aquifers.

Advantages/Benefits:
- Provide shallow groundwater recharge and help maintain base flow in streams, wetlands and other surface waterbodies
- Provide reductions in stormwater runoff rates, volumes and pollutant loads, which reduces the size of downstream storm drains and detention basins

Disadvantages/Limitations:
- Should not be used on development sites where sediment loads will be high, as sediment will clog infiltration practices
- Pretreatment must be provided upstream of infiltration practices
- Can only be used to manage runoff from relatively small drainage areas of less than five acres in size

Construction Costs:
$8,000 - $24,000 per infiltration practice
($6.00 - $18.00 per cubic foot of stormwater runoff treated)

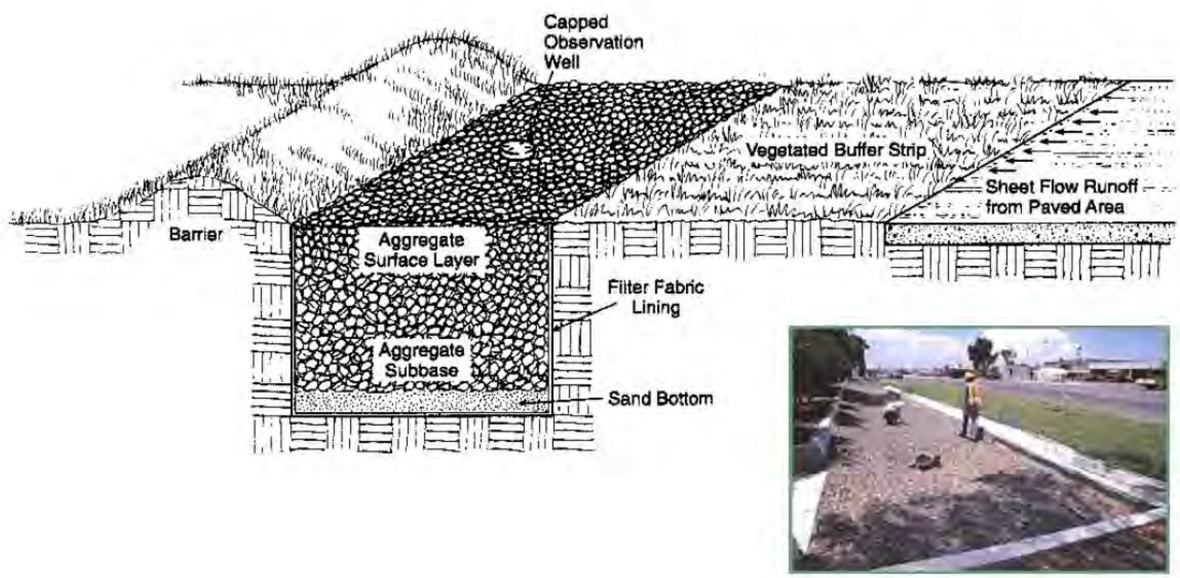
Operation & Maintenance:
- Inspect to ensure that contributing drainage area and infiltration practice are clear of sediment, trash and debris
- Check to ensure that the infiltration practice is properly dewatering after storm events

Pollutant Removal:

Total Suspended Solids	80%
Total Phosphorus	60%
Total Nitrogen	60%
Metals	60%
Pathogens	N/A

(Source: CWP, 2007; CWP, 2009)

Description:
Infiltration practices are shallow excavations, typically located in depressional areas, that are filled with stone or an engineered soil mix and designed to capture and temporarily store stormwater runoff until it infiltrates into the underlying and surrounding soils. This helps reduce stormwater runoff rates, volumes and pollutant loads and, consequently, helps reduce flooding and other negative impacts of the land development process. It also helps maintain shallow groundwater recharge, particularly during small storm events.



Infiltration Trench
(Source: Center for Watershed Protection)

Although infiltration practices can provide significant reductions in stormwater runoff rates, volumes and pollutant loads, they have historically experienced high rates of failure due to clogging caused by poor design, poor construction and neglected maintenance. If infiltration practices are to be used within the Flint Creek Watershed, great care should be taken to ensure that they are properly designed, carefully installed and adequately maintained. They should only be applied on development sites that have permeable soils (e.g., hydrologic soil group A and B soils) and that have a water table and confining layers (e.g., bedrock, clay lenses) that are located at least 2 feet below the bottom of the proposed practice. Additionally, infiltration practices should always be designed with adequate pretreatment (e.g., filter strip, sediment forebay) to prevent sediment from reaching them and causing them to clog and fail.

There are several types of infiltration practices that can be used to manage stormwater runoff on development sites, the most common of which are infiltration trenches and infiltration basins. Each of these is briefly described below:

- Infiltration Trenches: Infiltration trenches are excavated trenches filled with stone. Stormwater runoff is captured and temporarily stored in the stone reservoir, where it is allowed to infiltrate into the surrounding and underlying native soils. Infiltration trenches can be used to manage stormwater runof from contributing drainage areas of up to about 2 acres in size and should only be used on development sites where sediment loads can be kept relatively low.

- Infiltration Basins: Infiltration basins are shallow, landscaped excavations filled with an engineered soil mix. They are designed to capture and temporarily store stormwater runoff in the engineered soil mix, where it is subjected to the hydrologic processes of evaporation and transpiration before being allowed to infiltrate into the surrounding soils. They are essentially non-underdrained bioretention areas (BMP Profile Sheet SWM-17), and should only be used on development sites where sediment loads can be kept relatively low.

Infiltration Trench
(Source: Center for Watershed Protection)

Infiltration Basin (During Installation)
(Source: Center for Watershed Protection)

Resources:

U.S. Department of Agriculture. Natural Resources Conservation Service. Illinois Urban Manual. Practice Standards Fact Sheet: Infiltration Trench. http://www.il.nrcs.usda.gov/technical/engineer/urban/standards/urstnd_alpha.html.

Minnesota Pollution Control Agency. Minnesota Stormwater Manual. Best Management Practices Details Fact Sheet 2.8: Infiltration Practices. http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html.

Center for Watershed Protection. Coastal Stormwater Supplement to the Georgia Stormwater Management Manual. Stormwater Best Management Practice Fact Sheet 8.6.5: Infiltration Practices. http://www.gaepd.org/Documents/CoastalStormwaterSupplement.html.

California Stormwater Quality Association. New Development and Redevelopment Stormwater Best Management Practice Handbook. Fact Sheet TC-10: Infiltration Trench. http://www.cabmphandbooks.com/Development.asp.

California Stormwater Quality Association. New Development and Redevelopment Stormwater Best Management Practice Handbook. Fact Sheet TC-11: Infiltration Basin. http://www.cabmphandbooks.com/Development.asp.

Stream Corridor Management Practices

Stream Cleanups

Stream cleanups are used to enhance the appearance of stream corridors by removing unsightly trash and debris. In some cases, stream cleanups can even provide significant water quality benefits, particularly if drums, tires, appliances and other potentially hazardous materials are removed from the stream corridor. Typically, stream cleanups are completed by volunteers that are led by a local watershed group and/or local government staff. Although most stream cleanups can be completed without the aid of mechanical equipment, in some cases, equipment is needed to help remove large quantities of rubble, appliances and other large items that have been dumped into the stream corridor.

Stream Cleanup
(Source: http://www.watershedactivities.com)

Trash Collected During a Stream Cleanup
(Source: http://www.watershedactivities.com)

Typical Applications:
Stream cleanups can be conducted anywhere within the stream corridor, but are most effective where significant amounts of trash and debris have accumulated. Several factors should be considered when scouting potential stream cleanup sites, including access to the stream corridor (e.g., bridge, road crossing, easement), safety (e.g., steep slopes, thorny vegetation, poor water quality), access to a trash stockpile (e.g., parking lot, roadside area) and any required permits or approvals.

Advantages/Benefits:
- Improve the appearance of the stream corridor by removing unsightly trash and debris
- Can provide water quality benefits, particularly if hazardous materials are removed from the stream corridor
- Engage local residents and other watershed stakeholders in the larger watershed restoration effort

Disadvantages/Limitations:
- Access to the stream corridor may be limited and working in the stream corridor may present safety concerns
- Can be difficult to round up a diverse group of volunteers to participate in the stream cleanup
- Site may require continued attention unless an effort is made to identify the source of the trash and debris

Implementation Costs:
- Low; some costs associated with required equipment, supplies, safety equipment and waste hauling and disposal

Operation & Maintenance:
- None

Pollutant Removal:

Provides water quality benefits by reducing the amount of trash and debris carried into local lakes, streams and wetlands

Description:
Stream cleanups are used to enhance the appearance of stream corridors by removing unsightly trash and debris. Implementing a successful stream cleanup requires the completion of three tasks: planning and organizing the cleanup, conducting the cleanup and performing follow-up activities. Each of these tasks is briefly described below:

- Planning and Organizing a Cleanup: Planning and organizing is the most time-consuming part of a successful stream cleanup. Several details need to be considered to ensure a successful event including: selecting an appropriate site; choosing an appropriate cleanup date; choosing a rain date; assessing safety concerns; selecting appropriate safety equipment; recruiting volunteers and organizing cleanup teams; acquiring necessary permits and approvals (e.g., landowner permission); arranging for trash hauling and disposal; buying supplies; and publicizing the event.

- Conducting the Cleanup: Cleanups are typically accomplished in a single day. All trash and debris collected during the cleanup should be organized into piles of recyclable (e.g., plastic, glass, aluminum) and non-recyclable waste. Municipal recycling and solid waste agencies should be able to help with hauling and disposal of the waste. It is important to use before and after photographs to document how much was accomplished during the cleanup. Also, it is helpful to track the amount and types of trash collected during the cleanup.

- Performing Follow-Up Activities: Be sure to thank all of the volunteers and individuals who participated in the cleanup or who contributed in some way to the effort (e.g., donated equipment, donated supplies). Also, be sure to provide a summary of the amount and types of trash removed from the stream to the press and other local agencies. After the cleanup, an effort should be made to identify the source of the trash and debris to help prevent the need for frequent future cleanup efforts.

Resources:
Flint Creek Watershed Partnership. http://www.flintcreekwatershed.org.

Interstate Commission on the Potomac River Basin. Watershed Activities to Encourage Restoration Website. Project Fact Sheet: Organizing a Stream Cleanup. http://www.watershedactivities.com/projects/spring/scleanup.html.

State of Virginia. Department of Education. Improving Streams Through Waterway Cleanups Website. http://www.doe.virginia.gov/VDOE/LFB/pag/projects/cleanups/index.html.

State of Georgia. Department of Natural Resources. Watershed Protection Branch. Adopt-a-Stream Program. How To Organize a Waterway Cleanup Resource Guide. http://aesl.ces.uga.edu/aascd/RiversAlive/OrganizerGuide2008.pdf.

University of Wisconsin Cooperative Extension. Water Action Volunteers Program Website. Stream and River Clean Up Guide. http://watermonitoring.uwex.edu/pdf/level1/river/cleanupall.pdf.

Stream Buffers

Stream buffers are natural areas that can be found immediately adjacent to lakes, streams, wetlands and other receiving waterbodies. Although they function primarily to preserve the integrity of streams, wetlands and other aquatic resources and protect them from the negative impacts of the land development process, stream buffers also provide a number of other important ecological services and functions, including pollutant removal, erosion control and temporary storage of flood flows. While some neighborhoods built within the last few decades still have decent stream buffers, many do not. In these neighborhoods, turf grass should be replaced with native landscaping (BMP Profile Sheet SWM-3), such as trees, shrubs, grasses and ground covers, to better protect the lakes, streams and wetlands of the Flint Creek Watershed.

Stream and Adjacent Stream Buffer
(Source: Barrington Area Conservation Trust)

No Stream Buffer Adjacent to Stream
(Source: Barrington Area Conservation Trust)

Typical Applications:
Stream buffers can be protected or created in urban, suburban and rural watersheds, but provide the greatest water quality benefits in areas where stormwater runoff has to first pass through the buffer before it reaches the adjacent lake, stream or wetland (i.e., storm drain systems do not bypass the stream buffer). The creation of new stream buffers is particularly beneficial in areas that have been significantly altered by clearing, grading and other land disturbing activities or that consist exclusively of managed turf.

Advantages/Benefits:
- Improve the appearance and function of the stream corridor by replacing turf grass with native plants and trees
- Reduce streambank erosion and provide water quality benefits, particularly if a storm drain system does not bypass the stream buffer

Disadvantages/Limitations:
- Can be difficult to educate all of the landowners along the stream corridor about the benefits of protecting or creating a stream buffer
- Working in the stream corridor can be challenging and may present safety concerns

Implementation Costs:
Moderate; some costs associated with establishing and maintaining a stream buffer as a natural area (BMP Profile Sheet NR-1)

Operation & Maintenance:
- Inspect stream buffer for erosion and dead or dying vegetation; plant replacement vegetation as needed
- Prune and care for native trees, shrubs, grasses and ground covers as needed

Pollutant Removal:

Provides water quality benefits by reducing stormwater runoff rates, volumes and pollutant loads

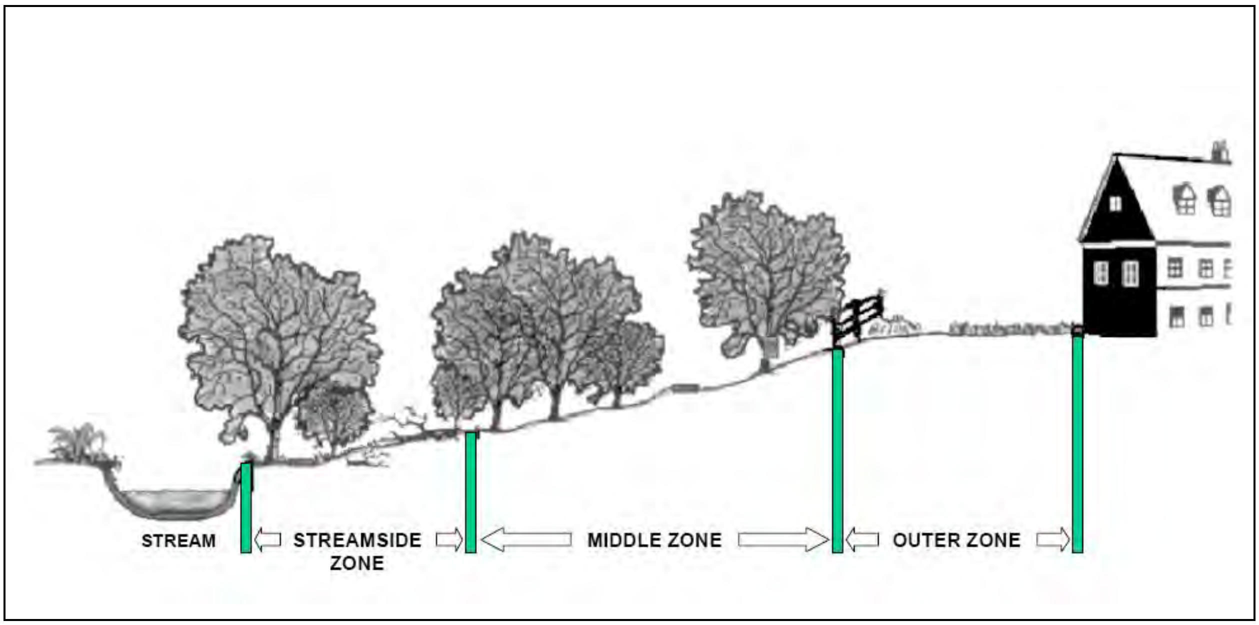
Description:

Stream buffers are natural areas that can be found immediately adjacent to lakes, streams, wetlands and other receiving waterbodies. In a natural state, stream buffers create an ecotone between the aquatic and terrestrial environments and provide important habitat for both aquatic and terrestrial organisms.

Stream Buffer Creation
(Source: http://www.omafra.gov.on.ca)

While some neighborhoods built in the last few decades still have decent stream buffers, many do not. In these neighborhoods, turf grass should be replaced with native landscaping (BMP Profile Sheet SWM-3), such as trees, shrubs, grasses and ground covers, to better protect local lakes, streams and wetlands.

Although a 75- to 100-foot wide stream buffer is preferred (CWP, 1998, Rowe et al., 2007, Franzen et al., 2006), a minimum 25-foot wide undisturbed buffer should be established around all of North Barrington's streams, lakes, wetland and other aquatic resources. Stream buffers can be of fixed or variable width, but should be continuous and should not be interrupted by impervious surfaces or bypassed with storm drain systems that discharge stormwater runoff directly into streams, wetlands or other aquatic resources. Where buffers have been significantly altered by clearing, grading and other land disturbing activities, or where they consist exclusively of managed turf, soil amendments (BMP Profile Sheet SWM-2) and native landscaping (BMP Profile Sheet SWM-3) should be used to restore them.



Multi-Zone Stream Buffer System
(Source: Center for Watershed Protection, 1998)

Even if site characteristics or constraints only permit the use of a 25-foot wide undisturbed stream buffer, additional "disturbed buffer zones" can be added to extend the total width of the buffer to 100 feet or more. These "disturbed buffer zones" can be occupied by filter strips (BMP Profile Sheet SWM-7) and other stormwater best management practices, such as rain gardens (BMP Profile Sheet SWM-9). Although they do not provide the same benefits as undisturbed stream buffers, these "disturbed buffer zones" provide individual home and business owners with additional flexibility in balancing their needs with the need to protect local lakes, streams and wetlands.

Resources:

Lake County, Illinois. Stormwater Management Commission. Riparian Area Management: A Citizen's Guide. http://lakecountyil.gov/Stormwater/Publications/BMPs/Riparian%20Area%20Management%20Guide.pdf

State of Maryland. Department of Natural Resources. Forest Service. Riparian Forest Buffer Design and Maintenance Manual. http://dnrweb.dnr.state.md.us/download//forests/rfb_design&maintenance.pdf.

U.S. Department of Agriculture. Natural Resources Conservation Service. Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers. http://www.na.fs.fed.us/pubs/misc/riparian_handbook/chesapeake_bay_riparian_handbook.pdf.

Tennessee Valley Authority. Riparian Restoration Website. http://www.tva.gov/river/landandshore/stabilization/index.htm.

Center for Watershed Protection. The Architecture of Urban Stream Buffers. http://www.cwp.org/Resource_Library/Center_Docs/PWP/ELC_PWP39.pdf.

Hard Bank Stabilization

Hard bank stabilization involves the use of structural materials to protect streambanks from further erosion and to prevent further property damage. It typically involves the use of non-deformable rocks, timbers, concrete and other manufactured materials to form revetments that are intended to remain in place for long periods of time. Hard bank stabilization is typically used in areas where eroding streambanks threaten property or infrastructure, where stream flows are highly erosive or where space is limited. Hard bank stabilization techniques can be implemented on their own, or implemented in conjunction with in-stream habitat and fish passage improvements (BMP Profile Sheets SC-5, SC-6).

Rip Rap Revetment Along a Streambank
(Source: http://www.knoxcounty.org/)

Boulder Revetment Along a Streambank
(Source: http://www.kingcounty.gov)

Typical Applications:
Hard bank stabilization techniques, including boulders, rip rap, a-jacks and live crib walls, can be used to stabilize streambanks in urban, suburban and rural watersheds. These hard bank stabilization techniques should be used in areas where continued erosion threatens property and infrastructure or where stream banks cannot be stabilized through the use of soft bank stabilization techniques (BMP Profile Sheet SC-4) alone.

Advantages/Benefits:
- Reduce streambank erosion and protect property and infrastructure from further damage
- Can be implemented with in-stream habitat and fish passage improvement projects to reduce implementation costs and create comprehensive stream restoration projects

Disadvantages/Limitations:
- Can be difficult to implement due to access restrictions, permitting requirements and other challenges associated with working in the stream corridor
- Without an effort to control stormwater runoff rates, volumes and pollutant loads, bank stabilization efforts may provide only temporary benefits

Construction Costs:
Vary according to the specific hard bank stabilization practices used to stabilize stream banks, but are typically high

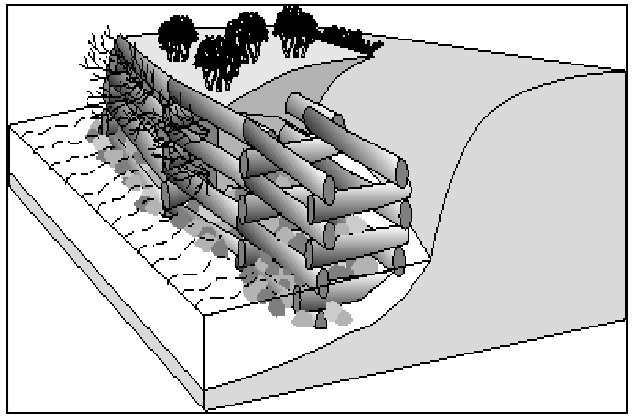
Operation & Maintenance:
- Inspect after bankfull and flood events to maintain appearance and function
- Monitor improvements to ensure that they are having the desired effect

Pollutant Removal:

Although the water quality benefits of stream restoration projects are difficult to measure, some pollutant removal should be expected

Description:

Hard bank stabilization techniques, including boulders, rip rap, a-jacks and live crib walls, can be used to stabilize streambanks in urban, suburban and rural watersheds. They are typically used when the cause of the streambank erosion is toe erosion, bank scouring or channel widening. However, hard bank stabilization techniques should not be used on streambanks that are eroding due to stream downcutting. In these situations, hard bank stabilization techniques can be undermined as the stream continues to downcut, unless the underlying grade control problem is addressed through the use of step pools, cross vanes or other grade control techniques.



Live Crib Wall
(Source: http://www.nrcs.usda.gov)

Hard bank stabilization techniques prevent the lateral migration of stream channels and, consequently, should generally be confined to the outer edges of meander bends, streambanks and terraces. Overreliance on hard bank stabilization techniques may simply transfer stream energy to upstream and downstream areas, causing erosion and channel adjustment in areas that would otherwise be stable. Whenever practical, soft bank stabilization techniques (BMP Profile Sheet SC-4) should be used in combination with hard bank stabilization techniques to prevent this situation from occurring.

A-Jacks Along the Toe of a Streambank
(Source: http://www.lakecountyil.gov)

Hard bank stabilization projects and other projects within the stream corridor (e.g., soft bank stabilization, in-stream habitat improvements, fish passage improvements) typically require permits or sign-offs to be obtained from the U.S. Army Corps of Engineers, Illinois Environmental Protection Agency, Illinois Department of Natural Resources and other state and local agencies. Consequently, these types of projects should be planned, designed and installed only by qualified professionals. Contact the Village of North Barrington for more information about the use of hard bank stabilization techniques.

Resources:

Lake County, Illinois. Stormwater Management Commission. Riparian Area Management: A Citizen's Guide. http://lakecountyil.gov/Stormwater/Publications/BMPs/Riparian%20Area%20Management%20Guide.pdf

U.S. Department of Agriculture. Natural Resources Conservation Service. Engineering Field Handbook. Chapter 16: Streambank and Shoreline Protection. http://policy.nrcs.usda.gov/viewerFS.aspx?hid=21429.

Federal Interagency Stream Restoration Working Group. Stream Corridor Restoration: Principles, Processes and Practices. http://www.nrcs.usda.gov/technical/stream_restoration.

Ontario Streams. Ontario Stream Rehabilitation Manual. http://www.ontariostreams.on.ca/rehabilitation%20_manual.html.

Soft Bank Stabilization

Most soft bank stabilization projects are actually combinations of individual soft bank stabilization techniques, such as bank shaping, toe protection and erosion control fabrics, that are used together to create a stable, but relatively flexible, stream bank. In most cases, native trees and shrubs are used as part of a soft bank stabilization project. These woody plants develop extensive root systems that stabilize stream banks and provide vegetative cover along the stream corridor. Soft bank stabilization techniques can be implemented on their own, or implemented in conjunction with in-stream habitat and fish passage improvements (BMP Profile Sheets SC-5, SC-6).

Coir Fiber Logs Along a Streambank
(Source: http://www.landandwater.com)

Erosion Control Fabric Along a Streambank
(Source: Center for Watershed Protection)

Typical Applications:

Soft bank stabilization techniques can be used to stabilize stream banks in urban, suburban and rural

watersheds, but may need to be used in combination with hard bank stabilization techniques (BMP Profile Sheet SC-3), particularly where eroding streambanks threaten property or infrastructure, where stream flows are highly erosive or where space is limited.

Advantages/Benefits:

- Reduce streambank erosion and protect property and infrastructure from further damage
- Can be applied with minimal disturbance to the stream corridor
- Can be implemented with in-stream habitat and fish passage improvement projects to create comprehensive stream restoration projects

Disadvantages/Limitations:

- Can be difficult to implement due to access restrictions, permitting requirements and other challenges associated with working in the stream corridor
- Without an effort to control stormwater runoff rates, volumes and pollutant loads, bank stabilization efforts may provide only temporary benefits

Construction Costs:
Vary according to the specific soft bank stabilization practices used to stabilize stream banks, but are typically high

Operation & Maintenance:

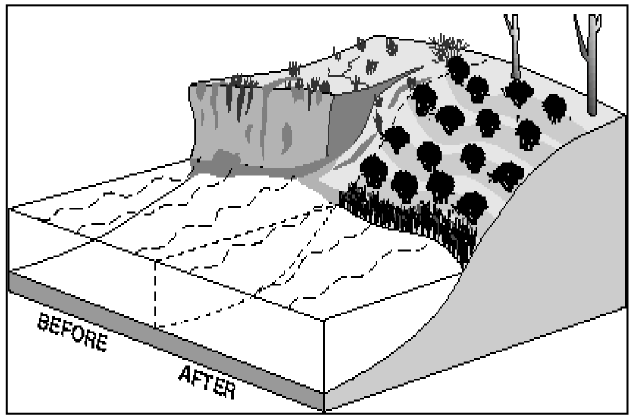
- Inspect after bankfull and flood events to maintain appearance and function
- Monitor improvements to ensure that they are having the desired effect

Pollutant Removal:

Although the water quality benefits

of stream restoration projects are difficult to measure, some pollutant removal should be expected

Description:
Soft bank stabilization techniques, including bank shaping, rootwads, coir fiber logs, erosion control fabrics, soil lifts, live stakes, brush mattresses and vegetation establishment, can be used to stabilize stream banks in urban, suburban and rural watersheds. They are most appropriate for smaller, low gradient streams that are not rapidly incising or widening. Most soft bank stabilization techniques appear natural and unobtrusive and gradually decompose over the course of several years, leaving the roots of established native vegetation to stabilize the stream bank.



Bank Shaping to Stabilize a Stream Bank
(Source: http://www.nrcs.usda.gov)

Most soft bank stabilization projects are actually combinations of individual bank stabilization techniques, such as bank shaping, toe protection and erosion control fabrics, that are used together to create a stable, but relatively flexible, stream bank. In most cases, native trees and shrubs are used as part of a soft bank stabilization project. These woody plants develop extensive root systems that stabilize stream banks and provide valuable vegetative cover along the stream corridor.

Rootwads to Stabilize a Stream Bank
(Source: http://www.tuswvt.org)

In areas where eroding streambanks threaten property or infrastructure, where stream flows are highly erosive or where space is limited, soft bank stabilization techniques may need to be combined with hard bank stabilization techniques (BMP Profile Sheet SC-3) to prevent the lateral migration of the stream and further infrastructure and property damage.

Soft bank stabilization projects and other projects within the stream corridor (e.g., hard bank stabilization, in-stream habitat improvements, fish passage improvements) typically require permits or sign-offs to be obtained from the U.S. Army Corps of Engineers, Illinois Environmental Protection Agency, Illinois Department of Natural Resources and other state and local agencies. Consequently, these types of projects should be planned, designed and installed only by qualified professionals. Contact the Village of North Barrington for more information about the use of soft bank stabilization techniques.

Resources:
Lake County, Illinois. Stormwater Management Commission. Riparian Area Management: A Citizen's Guide. http://lakecountyil.gov/Stormwater/Publications/BMPs/Riparian%20Area%20Management%20Guide.pdf

U.S. Department of Agriculture. Natural Resources Conservation Service. Illinois Urban Manual. Practice Standards Fact Sheet: Vegetative Streambank Stabilization. http://www.il.nrcs.usda.gov/technical/engineer/urban/standards/urstnd_alpha.html.

Federal Interagency Stream Restoration Working Group. Stream Corridor Restoration: Principles, Processes and Practices. http://www.nrcs.usda.gov/technical/stream_restoration.

In-Stream Habitat Improvements

In-stream habitat improvements are improvements made within a stream or stream corridor to create or improve habitat for fish, birds, aquatic insects and other aquatic organisms. Common habitat enhancement techniques include adding lunkers, large woody debris, boulder clusters and creating baseflow channels to create pools, riffles, resting areas, undercut banks, overhead cover and other features that enhance the quality of the riparian environment. In-stream habitat improvements can be implemented on their own or in conjunction with stream bank stabilization projects (BMP Profile Sheets SC-3, SC-4).

Buffalo Creek Stream Restoration
(Source: Baxter & Woodman, Inc.)

Indian Creek Stream Restoration
(Source: Baxter & Woodman, Inc.)

Typical Applications:
In-stream habitat improvements can be implemented in urban, suburban and rural watersheds. The actual improvements that used to improve a particular stream or stream reach should consider existing conditions, the species for which habitat will be created, stream width, stream depth and stream flow rates, volumes and velocities.

Advantages/Benefits:
- Improves the biodiversity and appearance of the stream and the stream corridor
- Can be implemented as a part of a larger watershed restoration program to meet specific regulations or requirements (e.g., TMDL regulations)
- Can be implemented with hard or soft stream bank stabilization projects to reduce overall implementation costs and create comprehensive stream restoration projects

Disadvantages/Limitations:
- Can be difficult to implement due to access restrictions, permitting requirements and other challenges
- Without an effort to control stormwater runoff rates, volumes and pollutant loads, stream restoration efforts may provide only temporary benefits

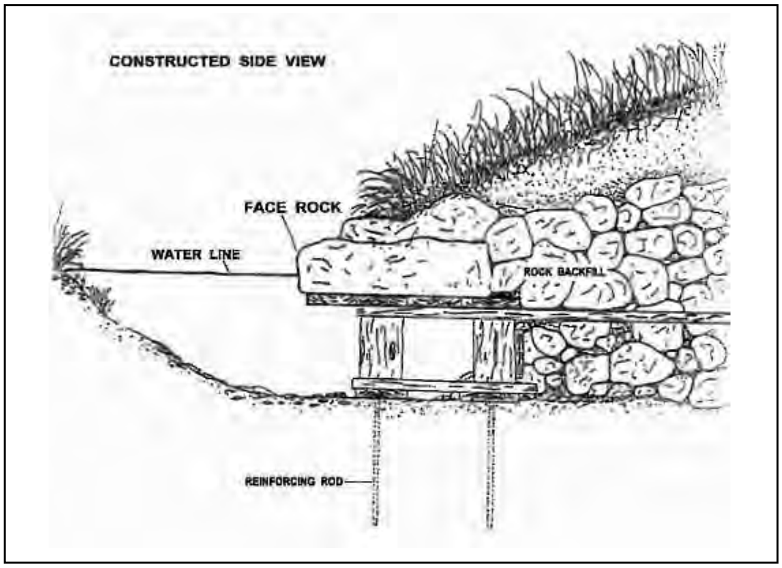
Construction Costs:
Vary according to the specific improvements made to the stream or stream corridor, but are typically high

Operation & Maintenance:
- Inspect after bankfull and flood events to maintain appearance and function
- Monitor any improvements to ensure that they are having the desired effect

Pollutant Removal:

Although the water quality benefits of stream restoration projects are difficult to measure, some pollutant removal should be expected

Description:



Lunker
(Source: http://www.co.vernon.wi.gov)

In-stream habitat improvements are improvements made within a stream or stream corridor to create or improve habitat for fish, birds, aquatic insects and other aquatic organisms. Common habitat enhancement techniques include adding lunkers, large woody debris, boulder clusters and creating baseflow channels to create pools, riffles, resting areas, undercut banks, overhead cover and other features that enhance the quality of the riparian environment. In-stream habitat improvements can be implemented on their own or in conjunction with hard or soft stream bank stabilization projects (BMP Profile Sheets SC-3, SC-4). While other practices, such as wing deflectors, rock vanes and step pools, can also be used to improve in-stream habitat, they are primarily used to address other stream repair objectives (e.g., flow deflection, grade control) and are not as effective in improving in-stream habitat as lunkers, large woody debris, boulder clusters and baseflow channels.

In-stream habitat improvements and other projects within the stream corridor (e.g., hard bank stabilization, soft bank stabilization, fish passage improvements) typically require permits or sign-offs to be obtained from the U.S. Army Corps of Engineers, Illinois Environmental Protection Agency, Illinois Department of Natural Resources and other state and local agencies. Consequently, these types of projects should be designed and installed only by qualified professionals. Contact the Village of North Barrington for more information about the use of in-stream habitat improvements.

Resources:

Federal Interagency Stream Restoration Working Group. Stream Corridor Restoration: Principles, Processes and Practices. http://www.nrcs.usda.gov/technical/stream_restoration.

State of Ohio. Department of Natural Resources. Division of Water. Stream Management Guides. http://www.dnr.state.oh.us/tabid/4178/Default.aspx.

Ontario Streams. Ontario Stream Rehabilitation Manual. http://www.ontariostreams.on.ca/rehabilitation%20_manual.html.

State of Washington. Department of Fish and Wildlife. Integrated Streambank Protection Guidelines. http://wdfw.wa.gov/hab/ahg/ispgdoc.htm.

State of Virginia. Department of Conservation and Recreation. Virginia Stream Restoration and Stabilization Best Management Practices Guide. http://www.dcr.virginia.gov/soil_and_water/documents/streamguide.pdf.

Fish Passage Improvements

Fish passage improvements are improvements made within a stream or stream corridor to allow fish to move upstream and downstream with greater ease. Common fish passage improvements include modifying and replacing existing culverts, removing existing infrastructure and installing "fish ladders" to remove barriers to fish passage (e.g., stream crossings, culverts) in areas where fish survey data suggests that fish passage improvements would be beneficial to aquatic life. Fish passage improvements can be implemented on their own or in conjunction with stream bank stabilization projects (BMP Profile Sheets SC-3, SC-4).

Culvert Blocking Fish Passage
(Source: http://www.fs.fed.us)

Bridge Installed to Improve Fish Passage
(Source: http://www.al.nrcs.usda.gov)

Typical Applications:
Fish passage improvements can be implemented in urban, suburban and rural streams. Before designing and implementing fish passage improvements, it is important to understand the infrastructure that is acting as a barrier to fish passage and how it affects the stream itself. The actual fish passage improvements used on a particular stream should consider existing conditions, the species for which improvements will be made, stream width, stream depth and stream flow rates, volumes and velocities.

Advantages/Benefits:
- Allows the upstream and downstream migration of fish and other aquatic life
- Can be implemented as a part of a larger watershed restoration program to meet specific regulations or requirements
- Can be implemented with hard or soft stream bank stabilization projects to reduce implementation costs

Disadvantages/Limitations:
- Can be difficult to implement due to access restrictions, permitting requirements and other challenges
- Without an effort to control stormwater runoff rates, volumes and pollutant loads, fish passage improvements may provide only temporary benefits

Construction Costs:
Varies according to the specific improvements made to the stream corridor, but are typically high

Operation & Maintenance:
- Inspect after bankfull and flood events to maintain appearance and function; remove sediment and debris as needed
- Monitor any improvements to ensure that they are having the desired effect

Pollutant Removal:

Fish passage improvement projects are not intended to provide any water quality benefits, but do provide benefits to aquatic life

Description:

Fish passage improvements are improvements made within a stream or stream corridor to allow fish to move upstream and downstream with greater ease. Common enhancement techniques include modifying and replacing existing culverts, removing existing infrastructure and installing "fish ladders" to remove barriers to fish passage (e.g., stream crossings, culverts, dams) in areas where fish survey data suggests that fish passage improvements would be beneficial to aquatic life. Fish passage improvements can be implemented on their own or implemented in conjunction with stream bank stabilization projects (BMP Profile Sheets SC-3, SC-4).

Existing Infrastructure Blocking Fish Passage
(Source: Baxter & Woodman, Inc.)

Of all of the potential fish passage improvement techniques, infrastructure removal and culvert replacement are preferred because culvert modifications and "fish ladders" provide only temporary benefits, do not pass all fish species and require frequent maintenance. Culvert replacement is a particularly attractive option in many urban and suburban watersheds because many aging and undersized culverts need to be replaced anyway to prevent flood damage and protect other infrastructure (e.g., roadways, utility crossings). As aging culverts are replaced, serious consideration should be given to improving fish passage if fish survey data suggests that fish passage improvements would be beneficial to aquatic life.

Fish passage improvements and other projects within the stream corridor (e.g., hard bank stabilization, soft bank stabilization, in-stream improvements) typically require permits or sign-offs to be obtained from the U.S. Army Corps of Engineers, Illinois Environmental Protection Agency, Illinois Department of Natural Resources and other state and local agencies. Consequently, these types of projects should be designed and installed only by qualified professionals. Contact the Village of North Barrington for more information about the use of in-stream habitat improvements.

Resources:

Federal Interagency Stream Restoration Working Group. Stream Corridor Restoration: Principles, Processes and Practices. http://www.nrcs.usda.gov/technical/stream_restoration.

U.S. Fish and Wildlife Service. National Fish Passage Program Website. http://www.fws.gov/fisheries/fwco/fishpassage.

State of Washington. Department of Fish and Wildlife. Design of Culverts for Fish Passage Manual. http://wdfw.wa.gov/hab/engineer/cm.

Ontario Streams. Ontario Stream Rehabilitation Manual. http://www.ontariostreams.on.ca/rehabilitation%20_manual.html.

State of Washington. Department of Fish and Wildlife. Integrated Streambank Protection Guidelines. http://wdfw.wa.gov/hab/ahg/ispgdoc.htm.

Natural Resource Management Practices

Natural Area Management

Natural areas found within the Flint Creek Watershed include prairies, savannas, forests, wet meadows and other mature native plant communities. Although these natural areas provide food and habitat for birds, fish, insects and other wildlife, they also provide a number of other important ecological services and functions, including stormwater runoff reduction, pollutant removal, erosion control and temporary storage of flood flows. While they require less maintenance than turf grass and landscaping beds, natural areas do require some periodic maintenance to remove invasive and non-native species, such as buckthorn, purple loosestrife and garlic mustard, and maintain their overall function and appearance.

Forest
(Source: http://cfhe.cfans.umn.edu)

Wetland in North Barrington
(Source: Barrington Area Conservation Trust)

Typical Applications:
Natural area management practices can be used in any of the natural areas found within the Flint Creek Watershed, including prairies, savannas, and forests. Various measures can be used to control and remove invasive and non-native species that are transported into these natural areas via wind, stormwater runoff and other means. The first step in managing these natural areas is to design a management plan based on the characteristics and conditions of the area being cared for.

Advantages/Benefits:
- Improves the appearance and function of natural areas by removing invasive and non-native species
- Helps ensure that food and habitat are available for birds, fish, insects and other wildlife
- Functional natural areas capture carbon dioxide and help address climate change

Disadvantages/Limitations:
- Some expertise is necessary to identify invasive and non-native species and develop a proper natural area management plan
- Access to some natural areas may be limited and working in some natural areas (e.g., stream corridors) may present safety concerns

Implementation Costs:
Low; some increased costs associated with more labor intensive natural area management practices

Operation & Maintenance:
- Identify and remove invasive and non-native species, such as buckthorn, purple loosestrife and garlic mustard
- Prune and care for native trees, shrubs, grasses and ground covers as needed

Pollutant Removal:

Provides water quality benefits by reducing stormwater runoff rates, volumes and pollutant loads

Description:
Natural areas found within the Flint Creek Watershed include prairies, savannas, forests, wet meadows and other mature native plant communities. They can be found in developed and undeveloped areas along streams as buffers or floodplains, along railroad tracks and in existing depressional areas. Although these natural areas provide food and habitat for birds, fish, insects and other wildlife, they also provide a number of other important ecological services and functions, including stormwater runoff reduction, pollutant removal, erosion control and temporary storage of flood flows.

Invasive plants represent a serious threat to the biological diversity of the natural areas found within the Flint Creek Watershed. The following is a summary of the invasive plant species commonly encountered within the Flint Creek Watershed and the rest of northeastern Illinois:

Garlic Mustard
(Source: http://dnr.state.il.us)

Common Buckthorn
(Source: http://dnr.state.il.us)

Reed Canary Grass
(Source: http://dnr.wi.gov)

Purple Loosetrife
(Source: http://dnr.state.il.us)

White Sweet Clover
(Source: http://dnr.wi.gov)

Yellow Sweet Clover
(Source: http://dnr.wi.gov)

Multiflora Rose
(Source: http://dnr.state.il.us)

Canada Thistle
(Source: http://dnr.wi.gov)

Crown Vetch
(Source: http://dnr.wi.gov)

Common Teasel
(Source: http://dnr.wi.gov)

Common Reed
(Source: http://dnr.wi.gov)

Amur Honeysuckle
(Source: http://dnr.state.il.us)

There are a variety of natural area management practices that can be used to control these and other invasive and non-native species. These include mowing, prescribed burning, hand weeding and herbicide application. Each of these management practices is briefly described below:

- Mowing: Mowing is often used while native landscaping (BMP Profile Sheet SWM-3) is being established or as a substitute for prescribed burns when burning cannot be successfully accomplished. Natural areas are mowed to 6 to 8 inches in height during the late spring or late fall. During the late spring, non-native or invasive species tend to grow taller and mature earlier than native species. Mowing prevents these non-native species from producing flowers and seeds but allows native species to continue to grow and thrive. Mowing in the late fall removes dead plant material to clear ground space for native plant growth in the following spring.

- Prescribed Burning: Prescribed burning is used to control invasive and non-native species, encourage native species to produce flowers and seeds and retard the growth of trees, shrubs and other woody vegetation. Natural areas are burned during the early spring or late fall. Burning in the early spring tends to promote the growth of native grasses, while burning in the late fall tends to promote the growth of flowering plants. Native plants have deep root systems, which allow them to survive below ground and continue to grow after a prescribed burn occurs. In fact, many native plant species rely on fire to promote seed germination. Most invasive and non-native species have shallow root systems and cannot survive a prescribed burn. Prescribed burns should only be conducted by trained professionals who have secured all of the necessary permits and approvals.

- Hand Weeding: Hand weeding involves the removal of invasive and non-native species from a natural area by hand or with a weed puller. Hand weeding should be performed before or during flowering, but before the appearance of seeds. It can be a very successful way to control invasive species, particularly sweet clover and garlic mustard. All invasive and non-native species that are removed by hand should be transported away from the natural area as soon as possible.

- Herbicide Application: Herbicides are used to target specific invasive and non-native species. The best time to apply herbicide usually depends on the invasive or non-native plant that is being targeted. Spring and summer applications are usually completed before flowering and seed production. Fall applications are usually completed before winter dormancy. When herbicides are applied prior to winter dormancy, the targeted plants absorb the herbicides into their root systems, which prevents them from growing the following year.

While all of these measures can be used to control and remove invasive and non-native species, the first step in managing a natural area is to design a management plan based on the characteristics and conditions of the area being cared for. Once the target invasive and non-native species have been identified, proper natural area management practices can then be used to control them.

Resources:

Citizens for Conservation. Conservation@Home Program Website.
http://www.citizensforconservation.org/ConsAtHome.asp.

Lake County, Illinois. Stormwater Management Commission. Riparian Area Management: A Citizen's Guide.
http://lakecountyil.gov/Stormwater/Publications/BMPs/Riparian%20Area%20Management%20Guide.pdf

DuPage County, Illinois. Division of Environmental Concerns. Maintenance and Management of Naturalized Areas: A Homeowner's Guide.
http://www.dupageco.org/emplibrary/Homeowners%20Guide%20to%20Natural%20Areas2%5B1%5D.pdf.

Ohio State University Cooperative Extension. Fact Sheet W-10-2001: Backyard Enhancement for Wildlife. http://ohioline.osu.edu/w-fact/pdf/0010.pdf.

State of Wisconsin. Department of Natural Resources. Invasive Species Website.
http://dnr.wi.gov/invasives/plants.asp.

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For More Information

If you would like additional information about the Flint Creek Watershed, or would like more information about the various BMPs that can be used to protect and restore it, please contact the Village of North Barrington or any of the following agencies:

Village of North Barrington
(847) 381-6000
http://www.northbarrington.org

Flint Creek Watershed Partnership
(847) 382-7283
http://www.flintcreekwatershed.org

Citizens for Conservation
(847) 382-7283
http://www.citizensforconservation.org

Barrington Area Conservation Trust
(847) 381-4291
http://www.bactrust.org

Lake County Stormwater Management Commission
(847) 918-5260
http://www.lakecountyil.gov/stormwater/default.htm

Lake County Soil and Water Conservation District
(847) 223-1056
http://www.lakeswcd.org/

Lake County Department of Health, Lakes Management Unit
(847) 377-8030
http://www.lakecountyil.gov/Health/want/LMUServices.htm

Fox River Ecosystem Partnership
(630) 482-9157
http://foxriverecosystem.org/

Illinois Environmental Protection Agency, Bureau of Water, Water Pollution Control Permit Section, Stormwater Program
(217) 782-0610
http://www.epa.state.il.us/water/permits/storm-water/index.html

Illinois Environmental Protection Agency, Bureau of Water, Watershed Management Section
(217) 782-3362
http://www.epa.state.il.us/water/watershed/index.html