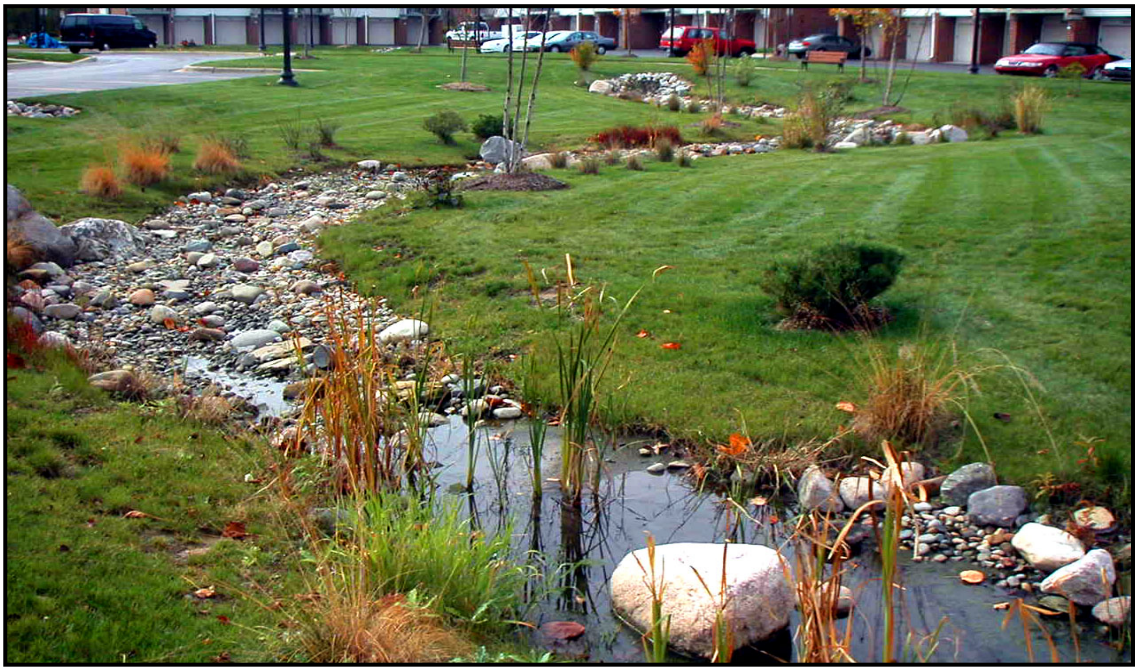
Best Management Practices for Storm Water: A Developers' Guide for Ann Arbor



Brentwood Square Condominiums Ann Arbor, Michigan

The Malletts Creek Coordinating Committee
and
The City of Ann Arbor
Planning and Development Unit and
Systems Planning Unit

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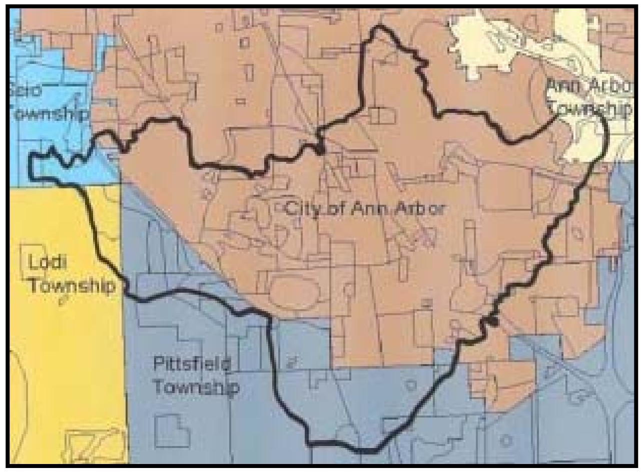
Introduction

A 1999 study of Malletts Creek, an 11-square mile urban watershed in southern Ann Arbor, demonstrated that the health and water quality of the creek is dependent on thousands of independent decisions made daily by private property owners.



Source: Malletts Creek Restoration Study

In response to the recommendations of the Malletts Creek Restoration Study, the City of Ann Arbor Planning Commission adopted a resolution on October 3, 2000 to strongly encourage any development proposals within the Malletts Creek watershed to incorporate "Best Management Practices" by

- o Minimizing impervious surfaces through efficient parking and drive design, shared parking, parking deferral and the use of multi-story building design wherever possible
- o Providing or retrofitting detention facilities to meet and, if possible, exceed the Rules of the Washtenaw County Drain Commissioner
- o Participating in creek-safe maintenance of the lawn and landscaping on the site, including use of low- or no-phosphorous fertilizers, and regular parking lot and catch basin cleaning

Storm Water Management Requirements for Private Development

On-site storm water management is required for all developments in the City of Ann Arbor with impervious surfaces greater than 5,000 square feet. Storm water management systems must be designed in accordance with the Rules of the Washtenaw County Drain Commissioner's Office. This guide provides suggestions for enhancing these basic requirements.

In general, non-structural approaches are more desirable than structural controls, primarily because of the costs necessary to properly maintain structural controls. In developing a storm water management plan for a development proposal, best management practices in the following areas should be explored:

Non-Structural (Source) Controls
1) Preservation of the natural environment
2) Minimization of impervious surfaces
3) Use of vegetated swales and natural storage

Structural (Site) Controls
1) Infiltration of runoff on-site (trenches, etc.)
2) Storm water retention ponds
3) Storm water detention structures
4) Conveyance off-site

Purpose of this Guide

Storm water management is more than a detention pond. Storm water management is any vegetative, structural or managerial practice used to treat, prevent, or reduce the volume of runoff water that impacts surface or ground water. Runoff water is rain water, snow melt or irrigation which does not infiltrate into the ground and runs over or off the land, picking up soil particles and other pollutants as it goes and carrying them to the storm drain system, the creek, and eventually to the Huron River.

This guide was created to familiarize developers with "best management practices" for development in the watershed. A best management practice (BMP) is the most effective, efficient and practical method that meets the desired objective. For storm water management, BMPs aim to:

- Reduce the volume of storm water runoff
- Improve the quality of storm water runoff
- Reduce the need for future capital improvements for maintenance and repair of storm water systems

This guide will identify a variety of storm water management BMPs, but is not intended to be all-inclusive. Rather, this guide identifies some of the most commonly used practices that meet the goals of the Malletts Creek study and are applicable to all of Ann Arbor's watersheds. Established BMPs not listed should be considered, and new practices should be evaluated as they become available.

Why Storm Water Management is Important

Storm water runoff in urban areas is intensified because the natural filtration system, the soil, is covered with impervious surfaces such as roads and buildings. In a natural environment, most rainwater infiltrates into the ground through wetlands and depressions. The rainwater is either stored as groundwater or slowly finds its way to a lake or stream. The majority of land area is vegetated, keeping most soil in place and filtering the runoff that does occur. Stream flows are more stable, causing less stream bank erosion and habitat destruction.

Once land is urbanized, very little water is able to infiltrate into the ground, and instead, is rapidly conveyed via storm drains or surface runoff to the nearest water resource. This results in significant changes in stream flow and wetland hydrology, which can cause stream bank erosion and loss of aquatic habitat. In addition to the problems caused by changes in hydrology, storm runoff in urban areas can collect a variety of pollutants and carry them to the nearest storm drain.

Successful restoration of the Malletts Creek Watershed depends on the ability to overcome two major challenges: 1) excessive flows (with high peak flows) and the resulting erosion and habitat degradation and 2) pollutants associated with storm water runoff. The first challenge is to slow down the rate of flow during wet weather events (i.e., storms). The second is to reduce the volume of water and the amount of pollutants carried by the storm water into the river system.

Phosphorous is a pollutant of concern in all of the creeks in Ann Arbor. Phosphorus occurs naturally in soil and is a valuable nutrient required for the growth of living things. Aquatic plants require nutrients to grow and reproduce. Phosphorous is usually the nutrient that is in short supply locally and, thus, limits the growth of aquatic plants in rivers and lakes. When excess nutrients applied to the land in the form of manure or commercial fertilizer find their way into the water, blooms or overabundant growth of algae and other aquatic plants can result. Algal blooms at the surface can interfere with photosynthesis of submerged plants by blocking sunlight, causing them to die. Dead plants are decomposed by bacteria, which take up the oxygen while little or no oxygen is produced by the dying plants, reducing oxygen available for fish and other aquatic organisms. The problem is compounded when organisms that flourish in oxygen-starved environments release hydrogen sulfide and methane. These substances are toxic to fish and other aquatic life.

Currently, the Michigan Department of Environmental Quality is enforcing a mandate to reduce the total maximum daily load (TMDL) of phosphorus by 50 percent for non-point sources and limit total suspended solids (TSS) to 80 parts per million in the Malletts Creek. If the City does not comply with these standards, it is subject to penalties from the State. Primary sources of phosphorus to the Huron River include fertilizers, treated wastewater, road run-off and eroded soil.

Non-Structural Controls: Preservation of the Natural Environment

Reduce Soil Compaction

When land is developed for urban and suburban purposes, soils become so compacted that even areas that aren't paved lose infiltration capacity and generate high volumes of run-off.

Source: North Carolina Forest Service

Soil compaction is the increase in the density of soil due to the particles closing together causing a reduction in the volume of air. Compacted soil stresses the root structure of newly planted vegetation by making it difficult for root penetration. When the earth is disturbed and deprived of its natural ability to absorb and infiltrate rainwater, storm water then needs to be collected, channeled, stored and filtered.

Since disturbance of any kind tends to destroy soil structure and lead to some degree of compaction, the most effective way to prevent erosion and preserve soil infiltration capacity on developed sites is to **preserve natural areas and limit soil disturbance to a minimum**. Site layout should maximize the size of undisturbed areas and provide fencing to keep construction activities out.

During construction, disturbed soil can often develop a 'crust'. Crusting is a kind of compaction that occurs in the top 1 millimeter of soil when rain separates the soil into very small aggregates and individual particles that cement into hard layers when rapid drying occurs. Once formed, a soil crust is impermeable and produces high runoff rates. Crusting is particularly a problem in clayey and silty urban soils. Vegetation helps prevent crusting, so it is important to **seed bare areas within 5 days of disturbance.** If disturbed area is not stabilized, inspection fees are assessed on a monthly basis.

Create or maintain a buffer in the riparian zone

Riparian zones lie between aquatic and upland ecosystems and play a critical role in the hydrology of watersheds. These strategic "buffers" can directly and significantly influence the physical conditions of the stream environment. Some of the most important functions include filtering and retaining sediment, immobilizing, storing, and transforming chemical inputs from uplands, maintaining stream bank stability, modifying stream environments, and providing water storage and recharge of subsurface aquifers. To protect these buffers, **do not mow grass up to the edge of the creek.** Mowing prevents grasses from filtering pollutants. Instead, leave a generous area (at least 25 feet) next to the creek uncut and vegetated by native plants.

Use Native Plantings

Native plants are those that have evolved to be specifically suited to the soil, climate, and precipitation of southeast Michigan. Once established, they need little maintenance, reducing the cost of fertilizers and pesticides. Their root systems help rainfall percolate into the soil, reducing erosion and runoff, and improve water quality. Each native plant species is a member of an ecological community that includes other plants, animals and microorganisms. The natural balance keeps each species in check, allowing it to thrive in conditions where it is suited, but preventing it from running amok. The best protection for surface and groundwater resources is to **leave the natural environment undisturbed**. A Native Landscaping fact sheet containing local examples of native landscaping in development projects is attached to this manual.

Limit Use of Fertilizers

Standard American lawns are, by conventional definition, mono-crops, consisting of cultivated grass plants. To keep them that way the lawns have to be treated with pesticides and herbicides. Around three million tons of fertilizers go into maintaining green lawns in the U.S., and about 60 percent end up in the storm water runoff.

In the Ann Arbor area, most soils already contain phosphorus. If a soil test shows that a fertilizer is needed to establish turf, the fertilizer should be applied in a manner to prevent fertilizer runoff. Consider compost as an alternative to fertilizers. Composting grass clippings into a lawn is beneficial. Phosphorus-free fertilizer is effective and readily available from major lawn care product manufacturers and distributors. Within Washtenaw County, local soy farmers have created a fertilizer product (Clean Green) that is also phosphorus-free. Crushed soybeans are used to create a 7-0-0 (nitrogen only) fertilizer.

Non-Structural Controls: Minimization of Impervious Surfaces

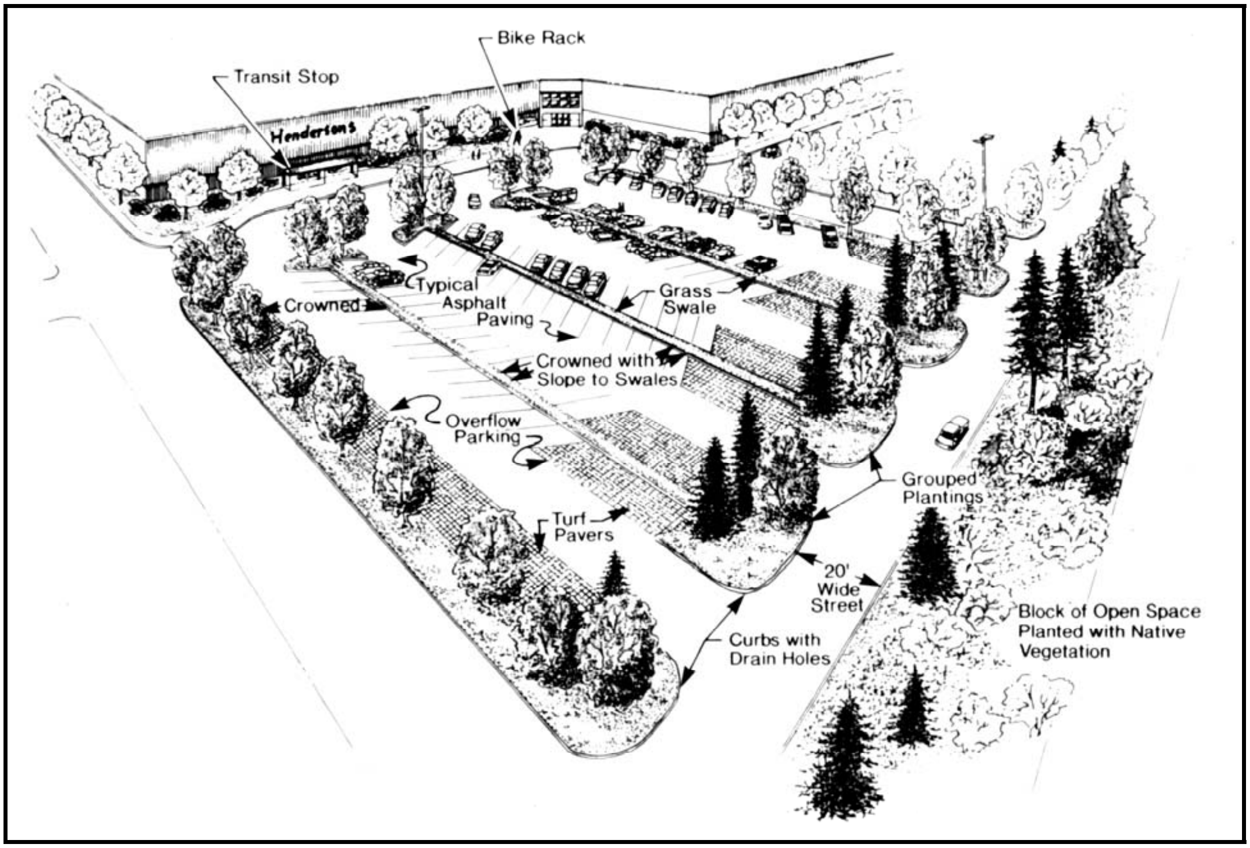
Minimize Parking Areas

Several techniques can be applied together to reduce the contribution of parking lots to the total impervious cover in a lot. These techniques include; reducing the number of parking lots created; minimizing the dimensions of parking lot spaces; designing open curbs; creating angled parking spaces; utilizing alternative pavers in overflow parking areas; using bio-retention areas to treat storm water; encouraging shared parking; and utilizing structured or underground parking.

Minimizing parking lot spaces can be accomplished by reducing both the length and width of the parking stall. Ann Arbor's Off-Street Parking ordinance allows for 35% of required spaces to be "small car" spaces with stall dimensions of 8 feet by 16 feet and backing aisles of 12-20 feet. Smaller vehicles comprise about 30% of all private vehicles. The ordinance also allows for up to 40% of required parking to be deferred, as long as the deferred parking is shown on an approved site plan.

To reduce parking runoff:

- Reduce stall dimensions
- Promote shared parking lots
- Increase the number of deferred parking spaces



Source: Robert W. Droll, ASLA, in Wells 1994

Use Porous or Pervious Pavement
Porous or permeable surfaces can replace asphalt and concrete for low-travel driveways, parking lots and walkways. Different types of alternative pavement include brick, grass pavers, turf blocks, natural stone, wood, pervious concrete, and porous asphalt.

In Michigan, climate and soil type must be considered when proposing porous or permeable surfaces. Accessibility, traffic volume, maintenance, and long-term performance also should be considered, along with costs and storm water quality controls, when choosing paving materials.

The attached Porous Pavement fact sheet, produced by the Washtenaw County Drain Commissioner, provides local examples of porous and pavement use and guidelines.

Incorporate Vegetation in Parking Areas
Vegetation in parking islands is an effective and attractive way to reduce runoff. Substitute deep-rooted perennials for traditional landscaping wherever suitable. Deep-rooted native plants, especially grasses, encourage filtration (see attached Native Landscaping fact sheet)

Bioretention islands (see Vegetated Swales and Natural Storage section, below) provide an option for incorporating storm water storage in parking lots. This technique is especially useful where land for traditional detention facilities is limited.

Use Green Roofs
In addition to retaining storm water, green roofs can simultaneously improve the energy performance of buildings, air quality and the urban ecology - without taking up additional land. A green roof is constructed of waterproofing, growing medium and plants. A common practice in Europe for centuries, green roofs became a popular storm water BMP in the United States only recently. Local examples include the Malletts Creek Library Branch at 3090 Eisenhower.

Green roofs can also be designed to be much lighter in weight with growing medium depths ranging from 3" to 7". Due to the shallow soils and the extreme environment on many roofs, plants are typically low growing ground cover that are sun and drought tolerant, such as some species of sedum. More elaborate green roofs requiring a minimum of one foot of growing medium depth to create a roof garden with large trees, shrubs and other manicured landscapes are also possible. These roof gardens are, however, designed to be accessible and are used as parks or building amenities.

Intensive

Extensive

Non-Structural Controls: Vegetated Swales and Natural Storage

Stabilize and Restore Stream Banks

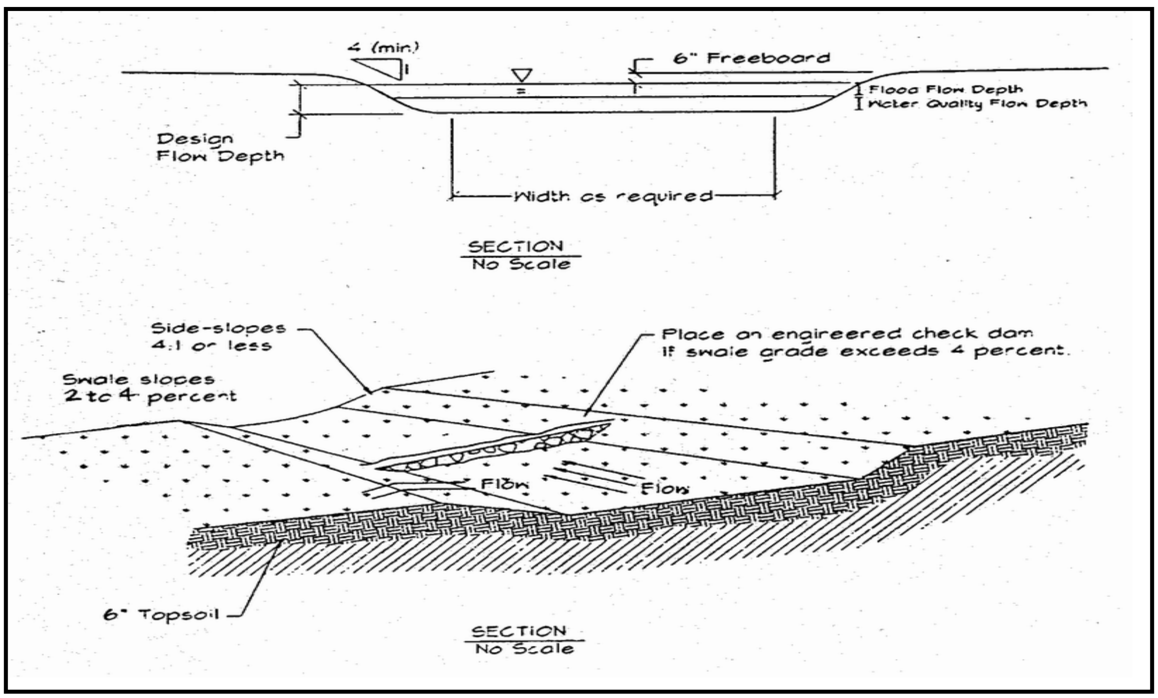
All stream banks erode to some degree. While bank erosion may occur naturally over time, it is a process that may be accelerated or decelerated by human activities. Changes are often caused by human activities such as urbanization, logging or overgrazing. These activities usually result in increased runoff and sediment yield compared with a basin in a natural condition.

Bank stabilization is a process of establishing and implementing resistive measures against erosion. Stabilization may be achieved by mechanical means, vegetative, or both.

Use Vegetated Swales

Vegetated swales use plants to help runoff water infiltrate into the ground. Swales are depressions formed by excavating, creating berms or small dams in a storm drainage channel to infiltrate water.

Bio-filtration involves using plants to impede flow and filter runoff water. Bio-filtration swales, or bioswales, are vegetated channels that filter sediments and pollutants. They are similar to standard storm drainage channels but are wider and shallower to maximize flow residence time and promote pollutant removal through the use of appropriate native plant species. Reconfigured roadside ditches have significant potential as bio-filtration swales.



Source: Center for Watershed Protection

Opportunities to incorporate bio-filtration into existing developments should be explored whenever possible, as it is relatively easy to retrofit a site with a bio-filtration swale. Equipping both sides of the swale with vegetative buffers or filter strips will also help reduce loading and decrease swale maintenance.

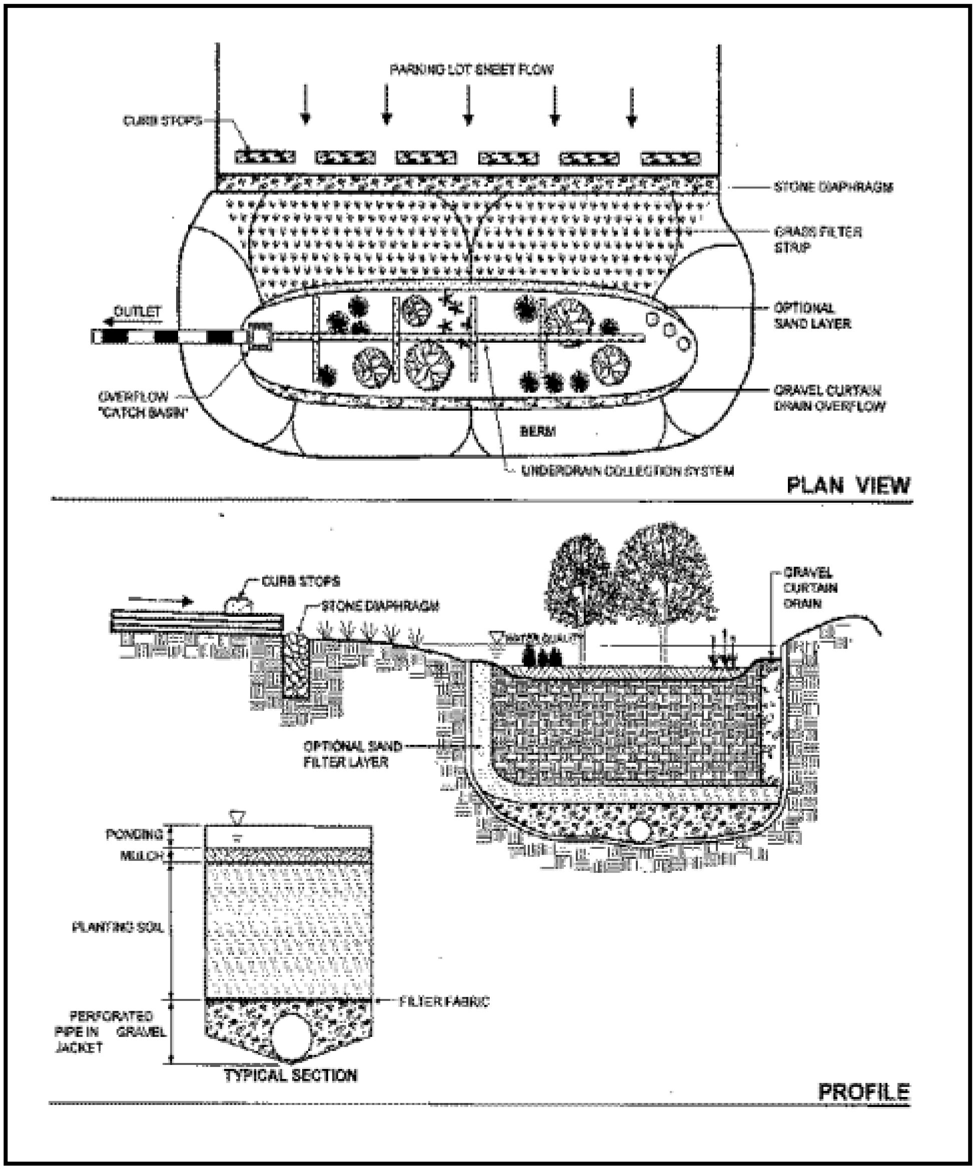
Bio-infiltration basins at the ground surface can also be used where sufficient open space is available. This practice takes advantage of existing natural surface depressions and swales on the site where a berm or a low dam could very simply create the needed area. Alternatively, the landscape can be designed to include a depressed area in which to place the basin. Level roadside ditches are suited to use for bio-infiltration swales if the proper soil conditions exists.

The attached Vegetated Swales fact sheet, produced by the Washtenaw County Drain Commissioner, provides local examples and construction considerations.

Incorporate Bio-retention

Bio-retention areas are landscaped areas that use growing medium to store, filter, and infiltrate run-off water. They are particularly useful in parking lot islands or within small pockets in residential land uses. Surface runoff is directed into shallow, landscaped depressions. These depressions are designed to incorporate many of the pollutant removal mechanisms that operate in forested ecosystems.

The attached Bioretention Islands fact sheet, produced by the Washtenaw County Drain Commissioner, provides local examples and construction considerations.



Source: The Stormwater Manager's Resource Center: Bioretention Fact Sheet

Provide Rain Gardens

Rain gardens are shallow depressions designed to collect rain on the site - typically from impervious surfaces such as roofs - and allow plants, bacteria, and soils to clean the water as it seeps into the ground.

Rain gardens capture and filter rainwater, mainly from roofs but also from driveways and lawns. These landscaped areas are planted with wild flowers and other native vegetation to replace areas of lawn.

Rain gardens are strategically created in low-lying areas, with specific layers of soil, sand, and organic mulch. These well-drained soils are 3-8" deep and filled with organic mulch and appropriate plant materials, preferably native species. These layers naturally filter the rain as it runs into the rain garden.

During the few days following a storm, the soil absorbs and stores the rainwater and nourishes the Garden's grasses, shrubs, and flowers.

Rain gardens don't involve a lot of detailed planning. They do not require much space, can be fitted into irregular shapes, and readily added to existing sites.

A local example of a constructed rain garden is the Buhr Park wet meadow.

Source: Buhr Park Children's Wet Meadow Project

Structural Controls: Infiltration of Runoff On-Site

Allow Infiltration

Allowing water to infiltrate into the ground, as would naturally occur on an undisturbed site, is highly desirable to control the quantity and quality of storm water runoff. Infiltration systems, a group of treatment systems in which the majority of the storm water is infiltrated into the ground rather than discharged to a surface water body or a storm sewer, include:

- Infiltration basin – a basin on the ground surface
- Infiltration vault – similar to a basin, but an open chamber located underground
- Infiltration trench – an underground chamber filled with rock, also called a rock well
- Dry well – essentially a vertical infiltration trench
- Porous pavement – both asphalt and concrete, to allow water to infiltrate directly into the ground through pores, or openings, in the pavement

Structural Controls: Retention Ponds and Detention Structures

Alternative Retention/Detention Approaches

Detention facilities should be designed to the Rules of the Washtenaw County Drain Commissioner. In addition to traditional surface pond and structure construction, underground engineered systems can be used where space is limited. The attached Engineered Systems fact sheet, developed by the Washtenaw County Drain Commissioner, provides local examples of these facilities.

Inline Pretreatment and Oil/Grit Separator

Proprietary storm water treatment devices provide for the removal of sediment, free floating oil, debris and other pollutants. These devices remove pollutants through a variety of treatments including the use of vortexes, filters, baffles and the reduction of flow velocity. To appropriately size and specify one of these devices, first determine the pollutants of concern, acceptable pollutant removal efficiency, design storm, design flow rate and maximum flow rate must all be determined. It is critical for maintenance of these devices to be completed on a regularly scheduled basis for storm water treatment to continue to meet design parameters.

Many of these devices are designed to treat low flow situations and bypass high flows. This must be taken into account when comparisons are made to typical first flush basin treatment. The basins will treat all runoff generated in the first flush storm event no matter the flow rate entering the basin. However, It is possible for much of a first flush event to bypass these devices if the intensity of the storm generates flows that exceed the design flow rate.

Roof Top Discharge

There are two alternatives for the discharge of water from the roof:

1. Surface Drainage: The roof drains directly to the ground surface. The surface outlet must be protected with some sort of stabilized outlet or energy dissipater. Adequate drainage away from the structure must be assured. It is desirable to discharge the water over the land surface as a sheet flow rather than a concentrated flow.

2. Subsurface Infiltration: Downspouts are directed to an infiltration BMP such as a dry well. The permeability of the soils must be adequate to use this technique.

Maintenance of Storm Water Management Systems

Storm Water Maintenance Plans
A storm water maintenance plan is required with all construction plans. The Rules of the Washtenaw County Drain Commissioner outline the information that should be included in a long-term storm water maintenance plan.

Catch Basin Sedimentation Basin/Detention Cleaning and Maintenance
The purpose of catch basin cleaning is the removal of sediment, leaves and debris from parking lot and driveway catch basins to maintain the flow of surface water into the storm sewer system. The optimum frequency for catch basin cleaning is typically eight months in urban areas. An exception to this is catch basins located on driveways that fill with sediment more often than once per year. These catch basins need periodic examination to determine the necessary cleaning frequency.

Technical Assistance

For assistance in incorporating the BMPs in this manual into site designs for projects within the City of Ann Arbor, contact the Systems Planning Unit at (734) 996-3004.

Information Sources

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13. Wisconsin Department of Natural Resources, *Rain Gardens Infiltrating Wisconsin,* accessed at http://dnr.wi.gov/org/water/wm/nps/rg/index.htm