STORMWATER

Best Management Practices for East Baton Rouge Parish - Master Development Program

City of Baton Rouge - Parish of East Baton Rouge Planning Commission
Louisiana Department of Environmental Quality
U.S. Environmental Protection Agency

STORMWATER
Best Management Practices
East Baton Rouge Parish - Master Development Program

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in collaboration with **BROWN+DANOS** land**design**, inc.

MISSION STATEMENT

"It is an undisputable fact that most, if not all, land development and public improvement projects have an impact on the natural conditions of adjacent areas. Unfortunately, this impact is negative due to the intrusion of civilization upon any environment. The purpose of the (committee) is to minimize or eliminate these adverse impacts through the promulgation of guidelines, policies and procedures designed to protect the environmental quality of surrounding areas and water bodies, through education of the public; and through utilization of existing environmental systems integrated with urban planning."

City-Parish Wetlands Steering Committee, 2006.

INTRODUCTION

This document summarizes the work that was completed by the Louisiana Department of Environmental Quality (LDEQ), the City-Parish Planning Commission (CPPC), and Louisiana State University's School of the Coast and Environment, in association with the grant entitled, "Mitigating Nonpoint Source Pollution in Urban Watersheds with Spatial Modeling, Best Management Practices for Wetlands and Community Outreach."

The sources of water pollution are characterized as either nonpoint or point source pollution. Point source pollution can be traced to a specific spot as the source, such as pollution from industrial waste or sewage treatment plants. Nonpoint Source (NPS) Pollution originates from many diffused sources that deposit pollutants on the ground. Pollution occurs when rain, snowmelt or irrigation drains over (runoff) and through (filtration) the ground. As the runoff moves, it picks up and carries away natural and manmade pollutants, ultimately depositing them into lakes, rivers, wetlands, coastal waters, and even aquifers (underground sources of drinking water). This Master Development Program Manual will guide the implementation of measures necessary to protect the watersheds within and around the City of Baton Rouge-Parish of East Baton Rouge from the adverse impacts of nonpoint source pollution.

Stormwater management (SWM) is a diverse issue that concerns practically everyone, including engineers, landscape architects, architects, planners, developers, environmentalists, public officials, civic groups, realtors, homeowners, and renters. They can all use this information as practical guidance in site planning and design, control of pollutant sources, and stormwater treatment. The result will mitigate urban runoff pollution and improve stormwater management for new development projects or redevelopments of underutilized land.

The ways in which land is developed and used is the most obvious and influential contributor to urban runoff. There is a direct correlation between human activities and regional patterns of wet and dry pollutants entering the urban landscape. Undeveloped land in its natural state is very effective in minimizing stormwater runoff and water pollution through several processes.

The quantity of runoff is minimized compared to developed land because

A watershed is the specific land area that drains water into a river system or other body of water.

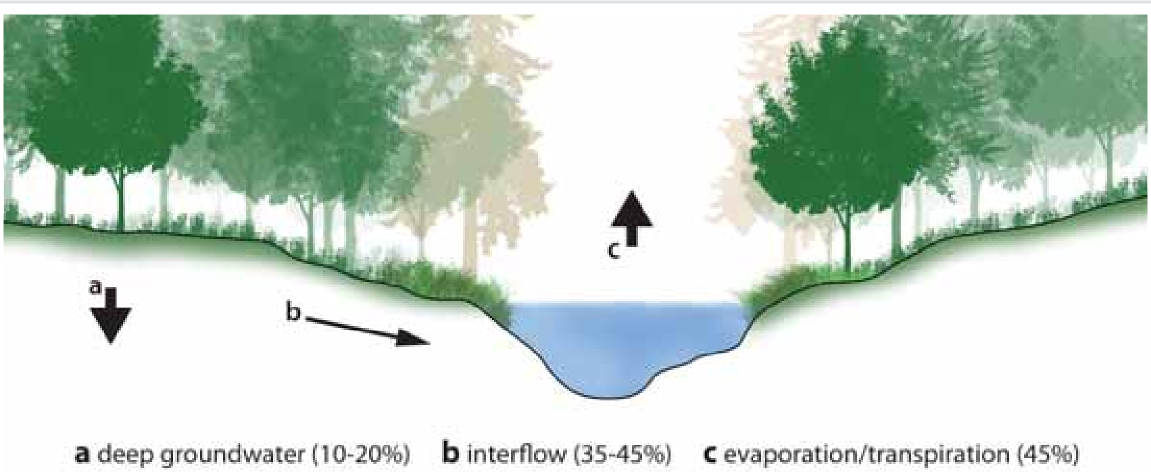


Figure 1: Hydrologic Cycle, Natural Environment

Our water bodies must be fishable and swimmable.

trees, shrubs, grasses and other plants utilize the water, taking it in through leaves and roots. Plant leaves dissipate the energy of raindrops, which reduces impact on the ground and, in turn, reduces erosion. Rainwater and runoff are also slowed by plants, providing more time for evapotranspiration and infiltration processes to occur. Finally, water that does become runoff is filtered and treated by plants, resulting in cleaner water entering lakes and streams.

Typical urban development practices in Louisiana often begin with completely clearing the land, leaving it unprotected. Construction activities, particularly earthmoving and grading work, increase soil erosion, runoff, and water pollution. Projects are typically designed and built with significantly increased impervious surfaces, such as roofs, roads, and parking areas. The result creates higher peak flows which in turn increases pollutant runoff and pollution deposition into lakes and streams. This typical urbanized condition also contributes to backwater flooding in Louisiana. Backwater flooding is upstream flooding caused by downstream conditions such as channel restrictions or high flow in a downstream confluence of waterways. The water has no place toward which to drain, so it backs up and floods the areas upstream.

Water Bodies and Hydrology

The LDEQ and the U.S. Environmental Protection Agency (EPA) have assessed water quality for ten hydrologic sub-basins in East Baton Rouge Parish (EBRP). Louisiana State University's (LSU) School of the Coast and Environment Research Team divided the LDEQ sub-basins into smaller sub-watersheds. Best Management Practices (BMPs) can be applied to individual developments within these watersheds. The scale of the new sub-watershed is a compromise between development and the water quality assessment made by regulatory authorities (G. Paul Kemp, 2005 Annual Report).

Using existing Light Detection And Ranging (LIDAR) Data, EBRP was divided into five geologically defined terraces that change in elevation from south to north beginning with the Manchac Alluvium, continuing through Terraces 1, 2 and 3, and finally to the Mississippi River Drainage terrace. Elevation thresholds were derived for each area to separate source (runoff producer) from sink (runoff receiver) zones. The sink zones have historically experienced occasional backwater flooding (Kemp et al. 2005), and make up approximately 18 percent of the Parish (Figure 2).

East Baton Rouge Parish is bordered on three sides by natural waterways. The Mississippi River is the western boundary and receives a limited amount of drainage from the northeastern part of the parish and downtown Baton Rouge. Bayou Manchac, formerly a tributary of the Mississippi River, is the southern boundary and drains much of the southern part of the parish. The Amite River flows north to south along the eastern boundary and receives all the water from Bayou Manchac and the Amite River watershed. The northern boundary is drawn along a latitudinal line (roughly 30.7° north latitude) and is not defined by a drainage feature. Within the parish the average rainfall is 77.64 inches per year, which also significantly contributes to the Baton Rouge waterways.

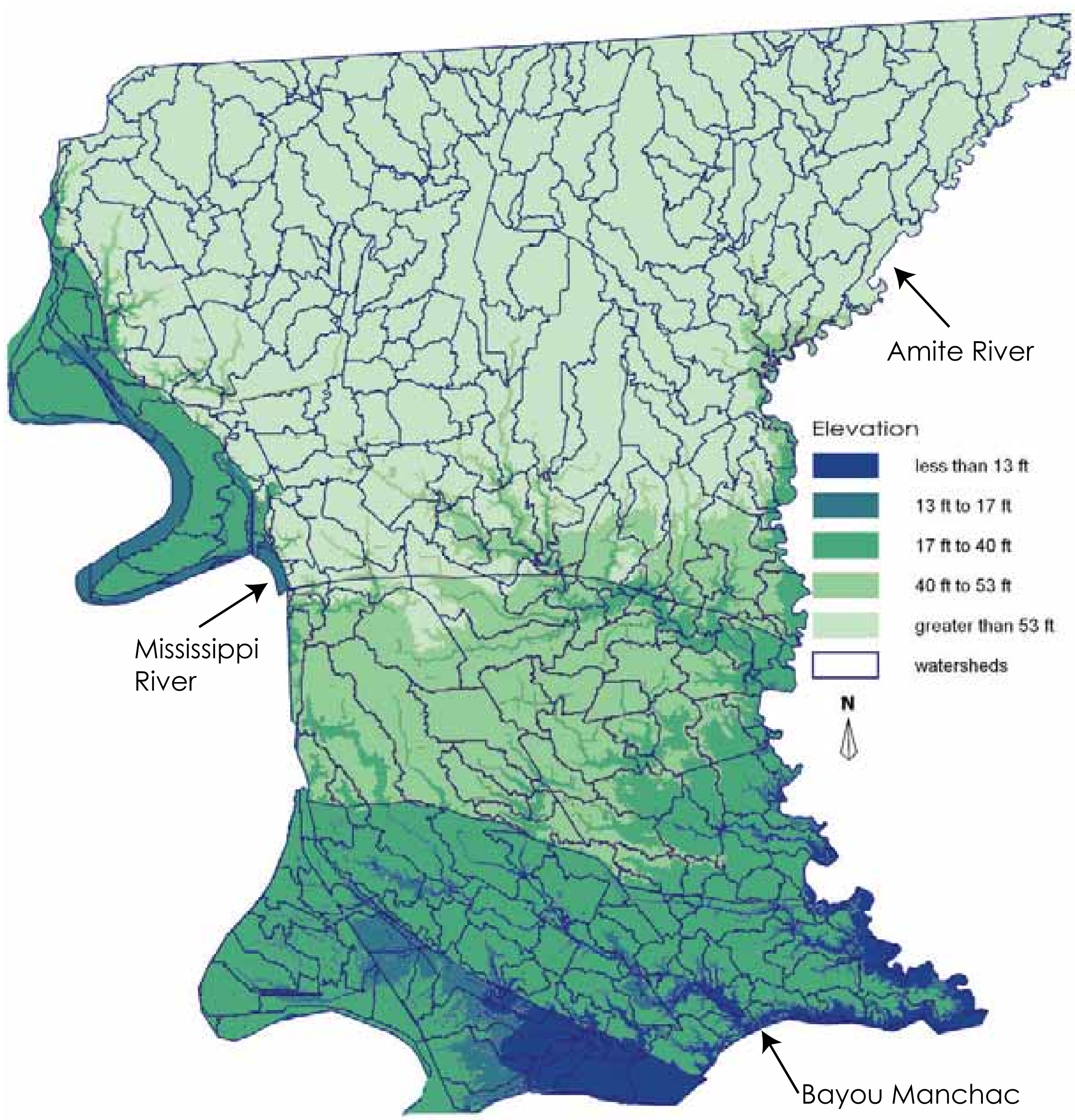


Figure 2: Watersheds and Elevation in East Baton Rouge Parish

Terrace	Elevation Threshold (ft., NAVD88)
Manchac Alluvium	13
Terrace 1	17
Terrace 2	40
Terrace 3	53
Mississippi River Drainage	35

Table 1: East Baton Rouge Parish Terrace Elevation Thresholds

According to the 1996 National Water Quality Inventory, stormwater runoff is a leading source of water pollution.

The sources of water pollution are characterized as either nonpoint or point source pollution.

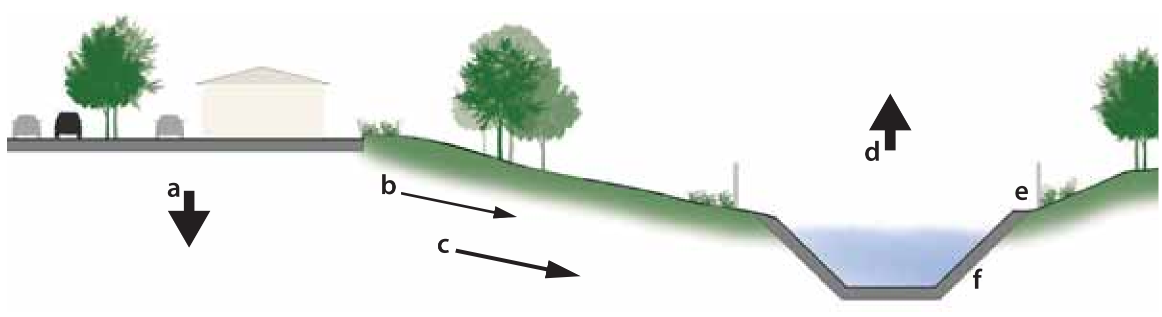
Water-based activities are a central component of our culture and daily social lives.

Water Pollution Problems

According to the 1996 National Water Quality Inventory, stormwater runoff is a leading source of water pollution. A Total Maximum Daily Load (TMDL) establishes the maximum amount of a pollutant (sum of allowable pollutant loads from point and nonpoint sources) that can be released into a water body without causing the water body to become impaired and/or violate state water quality standards (Source LDEQ). Early efforts in improving water quality focused on regulating discharges from traditional "point source" facilities; such as municipal sewage plants and industrial facilities. In many cases it was found that only addressing "point sources" did not adequately reduce pollutants. Additional measures under Section 303(d) of the 1972 Clean Water Act require states to develop a list of water body segments that are impaired or limited in quality. These water bodies do not meet water quality standards even after point source pollution prevention measures have been implemented. Federal law requires that state and local jurisdictions establish priority rankings for water quality limited segments on the lists and develop Total Maximum Daily Loads (TMDLs). TMDLs for each segment, as their name implies, set the standard for discharges of each pollutant into each segment, with the purpose of improving water quality.

Pollutants generated by human activities, deposited over exterior surfaces, such as rooftops, parking lots, streets, patios, lawns and any other open land, are exposed to rain. The pollutants are washed and carried out by rainwater runoff into streams, ponds, lakes, and ground water. Typical pollutants include excess fertilizer, herbicide, and insecticide from agricultural lands and residential areas; oil, grease, and toxic chemicals from urban land uses and energy production; sediment from improperly managed construction sites, crop, forest lands, and eroding stream banks; salt from irrigation practices; acid drainage from inactive mines; and bacteria and nutrients from livestock, pet wastes, and faulty septic systems.

Activities which generate pollutants include landscape irrigation runoff, street washing, car washing, cleaning of outdoor facilities, groundwater seepage, illegal connections, hydrant flushing, construction runoff, and other commercial and residential activities. A common characteristic of urban runoff is the transport of pollutants into the stormwater collection system through the gutter of an adjacent road. Any



a deep groundwater (5%) **b** runoff (55-75%) **c** interflow (10%)
d evaporation/transpiration (15-25%) **e** fencing **f** concrete lined drainage canal

Figure 3: Hydrologic Cycle, Typical Manmade Environment

pollutants that are associated with roads and streets will also be washed away and will contribute to the myriad pollutant loads generated by the particular land use activity. All surfaces will, therefore, have a direct impact on runoff water quality with greater impacts occurring from runoff generated by water flowing over impervious surfaces.

Improving Water Quality

Why is it important to protect our waters? Nonpoint source pollutants are transported by runoff over impervious ground surfaces or through the layers of soil into surface water bodies and subsurface aquifers, contaminating the quality of drinking water and creating a threat to public health. For waterbodies that are not a source of drinking water, water quality is critical both to protecting humans during recreation activities and fish and wildlife that depend upon it for sustenance. Simply stated, our water bodies must be fishable and swimmable.

Furthermore, East Baton Rouge Parish in its entirety drains into Bayou Manchac and the Amite River, and ultimately into Lake Pontchartrain. This makes nonpoint source pollution an issue in East Baton Rouge Parish because it affects much of the southeastern section of the state. Although this manual focuses on single developments, a regional perspective is also needed. Stormwater management can be and must be implemented at the regional scale by discouraging urban sprawl, encouraging infill development, and preserving natural features. Developers are more focused on their individual development projects, but their development practices can be greatly enhanced through regional and statewide measures. This manual focuses on SWM for land development.

The Stormwater Treatment Train

When properly planned and designed, stormwater is filtered and cleaned through a series of BMPs before reaching a surface water body. This is called the stormwater treatment train. The longer the distance and time stormwater must travel before beginning treatment, the more pollutants it collects and carries. Therefore, the first and most effective place to implement BMPs is at the source, that is, where the rain falls.

The **first stage** of the treatment train is at the site development scale. Stormwater runoff should be reduced at the site and runoff that does occur should be treated onsite through a series of stormwater BMPs. This will require the water to remain onsite for a longer time for treatment to occur before leaving, while being certain that flooding does not occur. The treated stormwater would leave the site by entering either the city's storm drainage system through a subsurface pipe or open waterway. As the water flows through the pipe or waterway, stormwater from other sites flows with it, some of which might not have been adequately treated.

The **second stage** of treatment should occur offsite, but within the same subwatershed to further clean the water before it enters the larger watershed along with other waters. Treatment can be accomplished by implementing BMPs along the waterway and at the lowest area of the subwatershed at the outfall. Manufactured BMPs are available for in-pipe treatment as well.

The **third stage** of treatment should occur within the larger watershed before the water enters the basin. In the case of East Baton Rouge Parish, the basin is Lake Pontchartrain. Considering the parish is part of such a large water basin, a site's sub-watershed is nested within other larger watersheds, sub-basins, and basins. As in the second stage, treatment can be accomplished along the waterways and at the outfall of each sub-watershed as it empties into the larger watershed.

The **final stage** of treatment within the basin should be at the outfall into Lake Pontchartrain. Wetlands can be found all around the lake in areas that have been developed right up to the lake edge. In these areas, the natural wetlands serve an important function in filtering and cleaning water that flows into the lake. Where wetlands do not exist, other stormwater BMPs should be implemented, completing the stormwater treatment train within the Lake Pontchartrain Basin.

Using BMPs to Improve Water Quality

The use of BMPs for Stormwater Management (SWM) offers an alternative to the typical practices of conveyance by minimizing impervious surfaces and mitigating changes to the natural hydrologic system. This is termed "Integrated Stormwater Management," an approach which regards stormwater as a resource rather

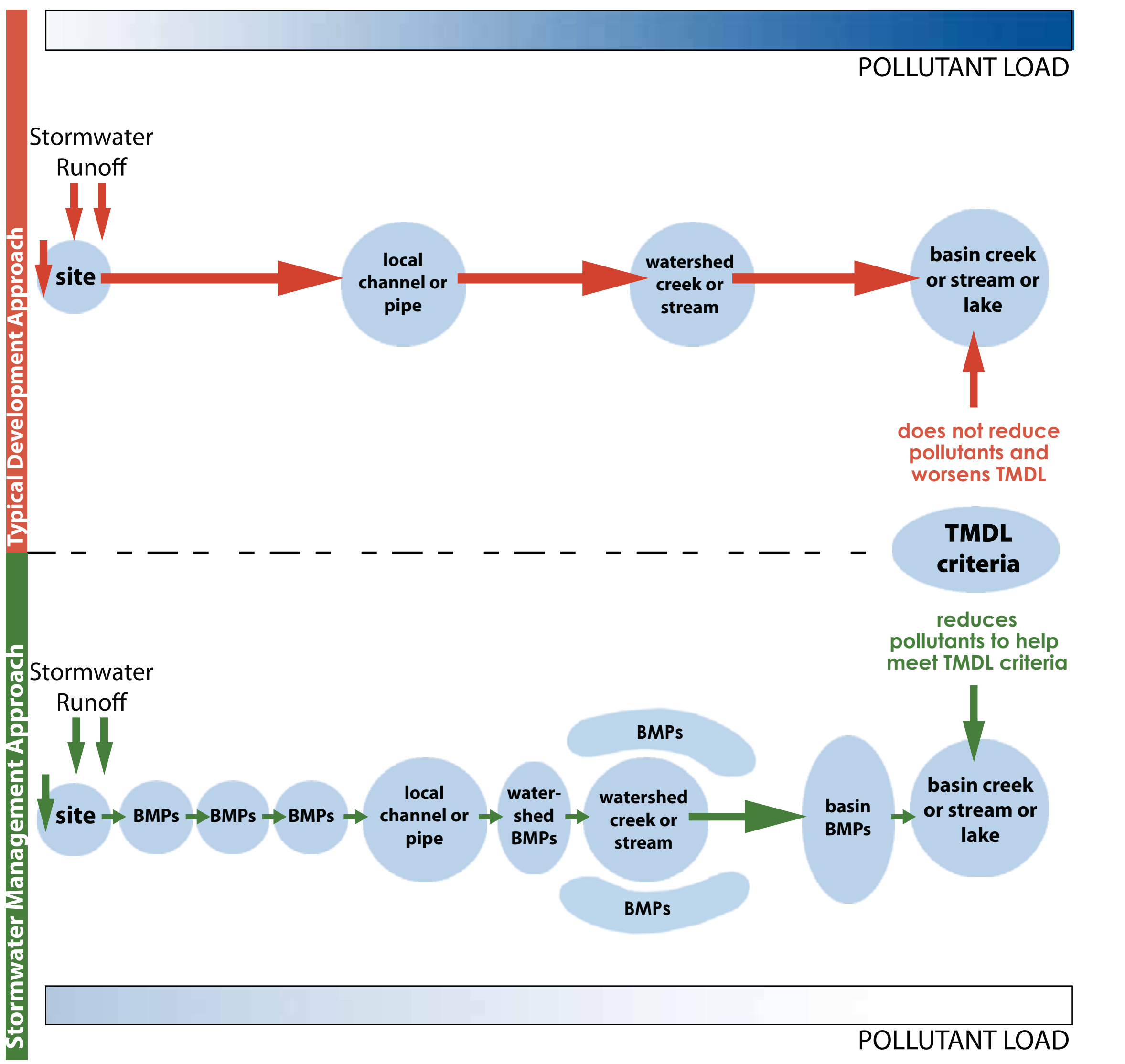
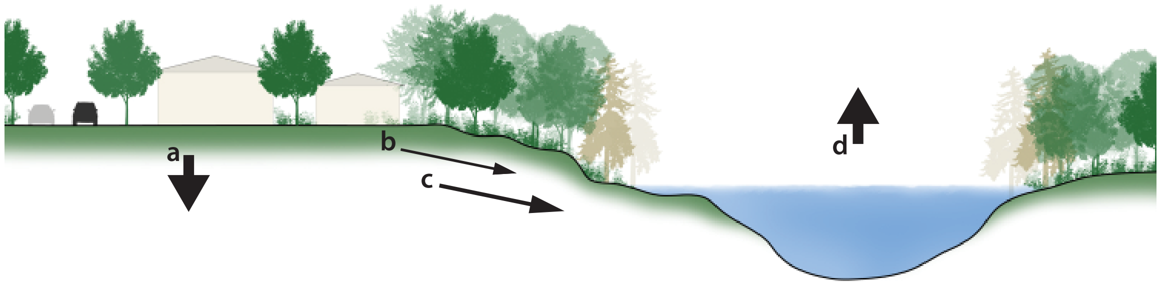


Figure 4: Development Stormwater Treatment Train



a deep groundwater (15%) **b** runoff (10%) **c** interflow (45%) **d** evaporation/transpiration (30%)

Figure 5: Hydrologic Cycle, Green Environment

than as waste which must be disposed. Integrated SWM recognizes all aspects of hydrology and water resources: environmental, social, and cultural. Water bodies are found throughout Louisiana and most residents live near a water resource. As a result, water-based activities are a central component of our culture and social activities. By utilizing a site's natural hydrology, the size of artificial drainage facilities can be minimized. Conserving and utilizing natural hydrology means the natural integrity of the site is disturbed less and the environmental, social, and cultural resources of the site remain intact. Integrated SWM utilizes natural drainage corridors and areas in multiple ways, serving drainage, water quality, and aesthetic, wildlife, and recreation functions. Multi-functioning streams, lakes, and wetlands mimic how water resources have historically performed in Louisiana.

The goals of integrated SWM are

- To reduce runoff and peak flows by reducing impervious surfaces
- To protect the quality of water bodies and groundwater by effectively using BMPs to filter and remove pollutants from runoff.
- To protect and enhance natural hydrologic systems.
- To use stormwater as visual and recreational amenities in the landscape.
- Add value and enhance sense of place while minimizing development costs.

Figure 6: Most Louisiana residents live near a water resource

STORMWATER MANAGEMENT PLANNING PROCESS

To efficiently and effectively manage and treat stormwater onsite, it must start at the beginning, at the site planning stage. This chapter will address SWM in two major steps in the site planning process: Existing Conditions Analysis and Schematic Site Planning. Stormwater management in site design is addressed in Chapter 4.

Step 1: Identify and Analyze Site Conditions

In East Baton Rouge Parish, the typical development approach is to first completely clear the site of vegetation and grade it to fill in low areas and create an even surface of soil. This usually results in the loss of rich topsoil that could be stockpiled for use later in planted areas. The practice also causes the uncovered soil to erode during rainfall, often flowing into and polluting creeks, rivers, and subsurface drainage systems.

For subdivision developments, as many residential lots as possible are planned along roadways that access the entire property. Massive retention/detention basins are used to retain the stormwater runoff from the increased area of impervious surfaces. This typical approach creates a small percentage of lots with "lake views" which are actually views of retention basins that are not designed as lakes. The overriding flaw in the typical approach is that the resulting development has little relationship to the original site and, as a result, has little character or identity. This represents a missed opportunity to create a distinctive and more easily marketable development that utilizes its cultural and natural resources. As an example, the natural site hydrology and existing vegetation should be used as the basis for the development's drainage scheme, which will also serve to maintain water quality.

Figure 7: Typical Development, no erosion control measures employed

Context

Understanding the surrounding setting of the development site is important in planning the SWM and in knowing how the hydrology, terrain, and vegetation link with other areas. For instance, how close is the development site to the subwatershed outfall or to a creek, stream, or lake? Does the elevated part of the site offer special views of nearby landmark buildings or historic areas? Is a small waterway part of a larger network of vegetated waterways that provide wildlife habitat? The answers to these types of questions should inform the site planning, and ultimately the design, of the development.

In analyzing the topography of the site and surrounding land, it is critical to identify the location of the site within its subwatershed. A map of East Baton Rouge watersheds is available online at http://www.brgov.com/dept/planning/wetlands.htm. All of the watersheds in EBR Parish are sensitive because all of the water drains directly into either the Amite River or Bayou Manchac and then the Amite River. Both waterbodies are identified by the EPA as impaired and not in compliance with the Clean Water Act. EBR Parish must meet its responsibility in substantially reducing water pollution so that these waterbodies become compliant, otherwise fines and development restrictions will likely be imposed.

Upstream watersheds contribute pollution that affects downstream waterbodies and are considered source areas for water contaminants. Downstream watersheds not only contribute to water pollution, but bear the burden of upstream pollution and are considered sink areas that receive the polluted waters. It is even more critical to treat stormwater in sink areas because they represent the last opportunity before the water enters Bayou Manchac and the Amite River. In addition to locating the watershed within which the site lies,
the surface waterways and underground drainage system, as well as floodplains, must be identified and researched. The East Baton Rouge Parish Department of Public Works (DPW) can provide information on floodplains, the low flow and flood stage of surface waterways, and the capacity of culverts and underground pipes.

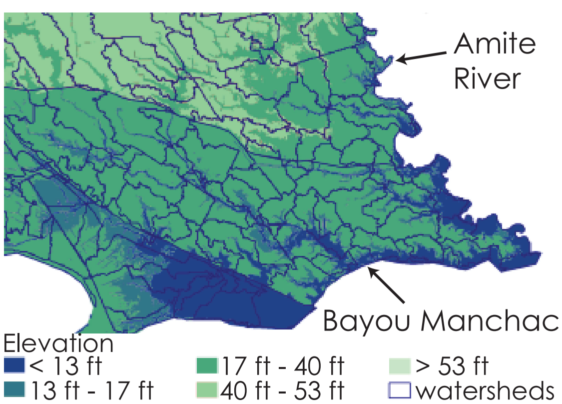


Figure 8: Closeup of the Southeast East Portion of Baton Rouge Parish

The Louisiana Department of Environmental Quality (LDEQ) is in the process of testing water samples from EBR Parish waterbodies and will provide on their website information about pollutant levels, total maximum daily loads (TMDLs) allowed, and any water quality restrictions for developing within each waterbody's watershed. All of this information will determine not only the criteria for designing a development's drainage system for water conveyance and flood prevention purposes, but also criteria for improving water quality.

The Development Site

Understanding the development site's hydrology is important in planning post-development drainage and stormwater management. Identify the high points and ridges as well as the low points and swales or channels. In which directions does the water flow in all areas of the site? Define the watershed boundaries on the site. It is likely that some small watersheds will not be wholly contained within the site and will be shared with adjacent properties. The above described analysis of the site's context will be helpful here. A simple diagram of existing watersheds and surface hydrology on the site should be prepared. (see figure 9) In addition to analyzing the surface drainage patterns, the pre-development runoff rate and volume for a minimum ten-year design storm should be calculated.

The site's topography and slope should be analyzed, along with soils, to be aware of potential for soil erosion during both the development's construction phase and post-occupancy when stormwater BMPs are functioning. Steeper slopes, particularly in highly erodable soils, should be identified for protection and stabilization. Floodplains and areas susceptible to flooding should be

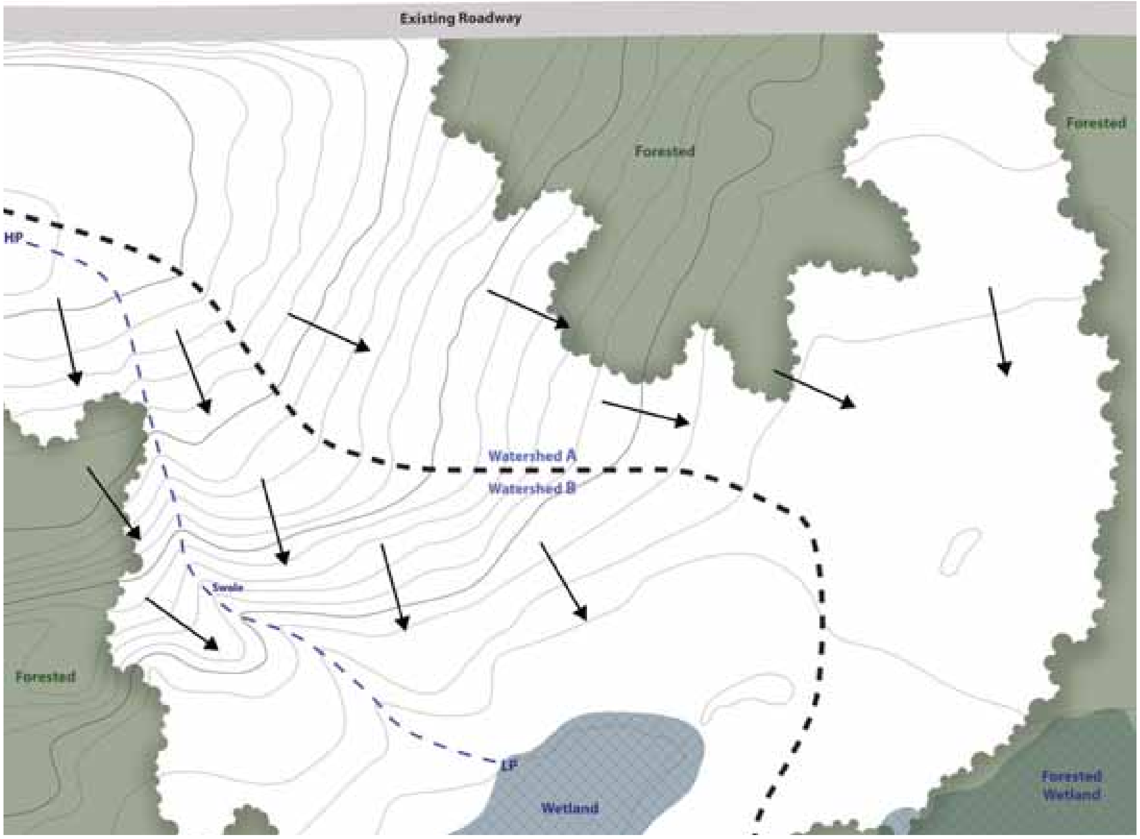


Figure 9: Step 1, Existing Watersheds and Surface Hydrology Map

mapped and development minimized in those areas where possible. Higher areas on the site are the prime development zones. Concentrating development in higher zones and leaving the lowest lying areas as conservation and for stormwater management saves construction costs and long term maintenance post-construction.

Soil borings from the areas suitable for development should be tested, not just for structural purposes, but for infiltration rates and planting media quality. Much of EBR Parish has silty clay soils characterized by very low infiltration rates. In other words, such soils hold the water for long periods of time before reaching groundwater. Some parts of the parish have more permeable soils. The types of soils and their depths is important in selecting and design BMPs as described in Chapter 4.

Vegetation and land cover, such as grasses, concrete, asphalt, forests, wetlands, ponds, and creeks cover the land within the site.

Bare soil will erode during rainstorms, while vegetation holds soil together and prevents or minimizes erosion. Mature stands of trees can be maintained and protected rather than cleared, creating an amenity and possible stormwater BMP as well as reducing runoff from the development. Major stands of vegetation onsite might be part of an even larger stand when examined in the site context. This could mean the vegetation provides habitat for wildlife and fish, if a waterbody exists within. Once again, such a resource on site should be conserved and used as an amenity with trails and passive recreation, as well as for stormwater management. Less environmentally valuable portions of the site can be more densely developed to provide for full development rights.

"Did you know that because of impervious surfaces such as pavement and rooftops, a typical city block generates 9 times more runoff than a woodland area of the same size?"

EPA website

Development	Development statistics	Notes regarding the developments preservation of natural areas
Garnet Oaks Bethel Township, Pennsylvania	80 homes 58 acres	51% of the land preserved as open space, including woodlands, tree specimens, and structures from the property's original estate Housing price premiums are based in part on the lots' proximity to open space
Newpoint Beaufort, South Carolina	124 homes 54 acres	The site layout preserved small wetlands and saved many large existing trees, some in the greenway between the street and sidewalk The riverside green and a community dock provide river access for the neighborhood
Prairie Crossing Grayslake, Illinios	337 homes 667 acres	350 acres devoted to prairies, pastures, farms, fields, gardens, marshes, & lakes Community-supported organic garden The community is the western anchor of the Liberty Prairie Reserve, a 2,500-acre preserve of forest, marshes, prairies, and farmland
The Fields of St Croix Lake Elmo, Minnesota	90 homes 226 acres	60 percent of the community's land preserved as permanent open space Home sites are clustered near a wooded ridgeoverlooking the site's ponds and open space An historic Civil War-era barn was preserved and used as a community center Thirty acres of prairie restoration featuring native plants indigenous to the area Existing wooded slopes, which are home to many specimen oak trees and provide excellent wildlife habitat, preserved The open space is permanently guaranteed by a conservation easement granted to the Minnesota Land Trust

Table 2: Examples of community design which took site hydrology, topography, and soils into consideration while planning the development and maintained natural site features as amenities

The following table lists just a few of the many subdivision and new community projects across the nation that have employed this approach. It is worth noting that homes in these developments typically sell quicker and at higher prices than those developed on sites that have been completely cleared of its natural resources.

Step 2: Prepare a Preliminary Stormwater Management Plan

A Stormwater Management Plan (SMP) is composed of two parts, the Water Quality Impact Study (WQIS) and the Drainage Impact Study (DIS). The DIS is described in the East Baton Rouge Parish Unified Development Code (UDC) and the WQIS is detailed below.

To guide more sustainable site planning, a schematic site WQIS should be prepared once the developable areas are identified. The preliminary WQIS will take into account the rate and volume of post-construction runoff, the likely pollutants in the stormwater, treatment objectives, and the site's stormwater treatment train.

Runoff Rate and Volume (post-construction)

In planning the development, it is imperative that all increased runoff post-development remain on site until the city's stormwater system has capacity to receive it. More importantly, all runoff from the site after development must be treated using stormwater BMPs, so the amount of water to be treated must be

Water Quality Impact Study Outline

A. Existing Conditions
- Site location
- Watershed and subwatersheds (on and off site)
  - route of drainageways to the Amite River or Bayou Manchac
  - Total Maximum Daily Loads (TMDLs) for applicable affected waterbodies www.deq.louisiana.gov/portal/tabid/130/Default.aspx
- Soils and Topography
  - site contours at maximum two-foot contour interval
  - general land slopes
  - soil types and characteristics
- Land cover – be specific, show on a current aerial photo and in a table with land cover area (acres or SF) and percent of total site
  - forest
  - paving (list by type)
  - meadow
  - crops
  - buildings
  - waterbodies
  - wetlands
  - etc.

B. Proposed Conditions
- Watershed and subwatersheds (on and off site)
  - route of drainageways to outfall that connects to Bayou Manchac or the Amite River
  - indicate proposed modifications to the existing drainage pattern (map and design cross-sections)
- Land cover – be specific, show on a current aerial photo / site plan and in a table with land cover area (acres or SF) and percent of total site
  - forest
  - paving (list by type)
  - meadow
  - rooftops
  - waterbodies
  - wetlands
  - etc.
- Land cover comparison table
  - existing versus proposed
- Site uses and activities – be specific, show on current site plan, indicate area (acres of SF)
  - parking
  - retail commercial building
  - outdoor market
  - auto repair
  - building maintenance area
  - trash collection
  - restaurant grease disposal
  - kitchen area
  - salvage yard
  - restaurant dining area
  - plant nursery growing area
  - dry cleaning
  - chrome plating
  - car washing
  - fueling station
  - lumber storage
  - recreation areas
  - dog park
  - roadways
  - dwelling units
  - etc.
- Empirically expected pollutants from land cover, uses, and activities

C. Proposed Water Quality Treatment
- Stormwater Treatment Train
  - subwatersheds
  - drainageways
  - BMPs
- Water flows per subwatershed (cfs)
- BMPs
  - sizes
  - water capacity
  - function
  - empirically expected pollutant reduction (percentage)
- Operation and maintenance
  - control and containment per special activity
  - housekeeping

D. Conclusion
- Table of empirically expected percent removal of each pollutant per BMP for expected impact to affected waters

The economic benefit of using a natural drainage system was demonstrated in The Woodlands community north of Houston, Texas: the construction estimates for the "storm sewers required for the conventional system were $18,679,300, while the natural drainage systems costs were $4,200,400…a savings of $14,478,900."

The Woodlands, WRT, 1973

calculated. The rate of stormwater runoff, such as in cubic feet per second (cfs) is a factor of the ten-year design storm rainfall and the land cover over which it flows. The volume of runoff is a factor not only of the design storm, but also of the land cover, particularly impervious and pervious surfaces.

Likely Pollutants and Treatment Objectives

Most commercial and housing development projects will generate water pollutants from vehicles, golf course and lawn maintenance, and erosion. The primary pollutants from these sources are oil, grease, freon, other chemicals from vehicles, heavy metals, nutrients, pesticides, herbicides, and sediment.

Determining the treatment objectives and designing the site treatment train are informed by both the source of each type of pollutant and the surface stormwater drainage patterns planned for the development.

Sediment is caused by soil erosion, for which the first defense is to prevent the erosion from occurring at all. Erodable soils and slopes should be stabilized and runoff should be diverted so it does not flow over these slopes. The velocity of runoff can be reduced to minimize erosion. The area to which the sediment flows should be designed with a treatment area up stream of it to initially capture the sediment.

To minimize nutrients, pesticides, and herbicides from entering the stormwater, the best and first line of defense is to reduce the use of these chemicals in golf courses and lawn areas. See Chapter 4: Site Management and Maintance for specific suggestions. Runoff from these areas should be treated in any case. This will require use of vegetated BMPs that will not only biologically uptake the nutrients and use them, but also uptake and break down many pesticides and herbicides into their non-hazardous components.

Oil, grease, chemicals, and heavy metals from vehicles are washed off of parking lots and roadways during the first few minutes of a rainstorm. These areas should be designed to drain into vegetated BMPs for filtering and biological uptake before flowing into the storm drainage system.

Stormwater that runs off of rooftops typically contains heavy metals, organic materials, and coatings and other components of the roofing materials. Rain gutter downspouts can carry rooftop runoff to stormwater BMPs.

Schematic Site Water Quality Impact Study

Knowing the source and type of pollutants, and determining the treatment objectives, a site treatment train of BMPs can be developed. It involves simply following the stormwater where it falls and flows on the site, and creating areas for BMPs to treat the water from erosion areas, turf areas, vehicle areas, rooftops, and activity areas that generate pollutants.

The example schematic Water Quality Treatment Plan (see figure 10) shows the general areas where each type and intensity of development will be constructed, the direction of surface drainage, and the treatment train of stormwater BMPs. When compared to the diagram of the pre-construction site drainage, it shows how the site's existing hydrology is used as the basis for planning the development drainage.

Expected Pollutants by Activity / Use						
Roadways and Parking Lots	oil	grease	freon	heavy metals	other chemicals	
Lawn, Plantings, and Golf Course Maintenance	oil	grease	pesticides	herbicides	nutrients	other chemicals
Roofs and Gutters	organic materials	roofing materials	coatings	heavy metals		
Automotive Repair Shops	oil	grease	freon	heavy metals	other chemicals	
Food Preparation	organic materials	grease	other chemicals			
Commercial Buildings	oil	heavy metals	other chemicals			
Residential Buildings	organic materials	pesticides	herbicides	other chemicals		
Light Industrial	oil	grease	coatings	heavy metals	other chemicals	

Table 3: Likely Pollutants from Commercial and Housing Development Projects

Step 3: Prepare a Final Stormwater Management Plan

Now that the concepts for the site development and stormwater treatment train have been developed, the designer can work out the site plan details while designing specific BMP components.

The most effective means of minimizing stormwater pollution and runoff is to minimize impervious surfaces. If natural features of the site are conserved as amenities in perpetuity, then the same development intensity can be achieved by concentrating development in the areas most suitable for structures and roadways. Denser and more clustered development means shorter road lengths. Roadway widths can also be minimized while following the EBR Unified Development Code (UDC). Reducing the lengths of driveways, narrowing driveways, and providing for shared parking in commercial areas minimizes impervious surfaces.

The results of this approach to site planning not only helps prevent water pollution by reducing runoff, but also reduces infrastructure costs. If the same number of homes are served by less street paving (shorter and narrower streets), the construction costs are reduced. The cost of constructing drainage, sewerage, and other infrastructure will also be much lower.

Water Quality Impact Study

The site development plan, including stormwater management, were designed and detailed based on the planned treatement train diagrammed in the Water Quality Treatment Plan (see figure 11) Note that in many areas of the project, stormwater BMPs are integrated into the site design, rather than placed off to the side, separate from the development. For instance, the boulevard entrances are planned with biofiltration medians, which are bioswales into which the road slopes and drains. Instead of continuous curbing around the median, curb gaps at frequent intervals are employed to allow water to runoff the roadway, enter the biofiltration median, and flow down the median instead of down a gutter. The water is treated in the bioswale as it moves. See Chapter 5: Stormwater BMPs for more information on bioswales.

Summary of the Stormwater Management Planning Process

Step 1: Identify and Analyze Site Conditions

- Context
- The development site
- Existing Watershed and Surface Hydrology Map

Step 2: Preliminary Stormwater Management Plan (SMP)

- Prepare a Drainage Impact Study (DIS)
- Prepare a Preliminary Water Quality Impact Study (WQIS)
    - Runoff rate and volume (post-construction)
    - Stormwater treatment train
    - Likely pollutants and treatment objectives
    - Schematic Water Quality Treatment Plan

Step 3: Final Stormwater Management Plan

- Prepare a Final Water Quality Impact Study
- Final Water Quality Treatment Plan

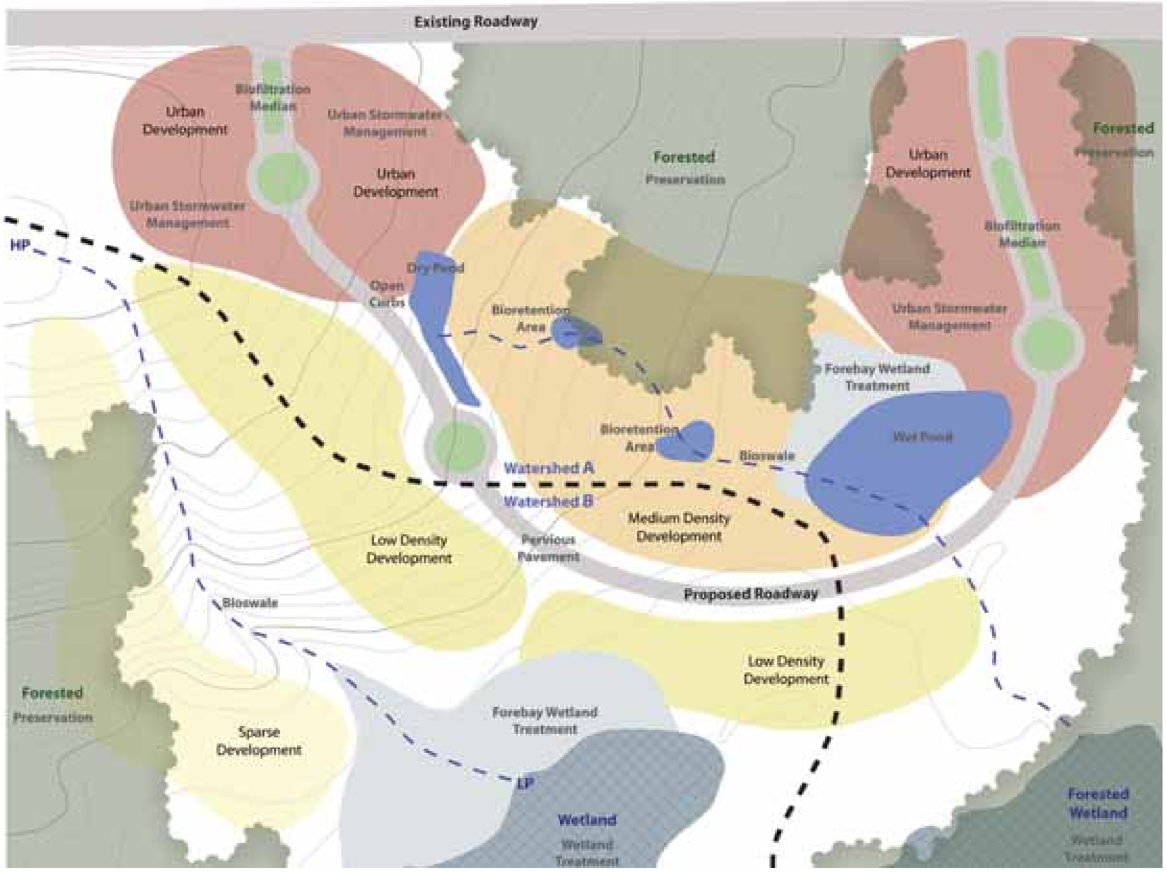


Figure 10: Step 2, Schematic Water Quality Treatment Plan

Figure 11: Step 3, Final Water Quality Treatment Plan

Integrating BMPs into the Planning Process

On the following pages show examples of how to integrate BMPs into the site plan during the stormwater management planning process.

Figure 12: Typical roadway development

Figure 13: Roadway with a biofiltration median

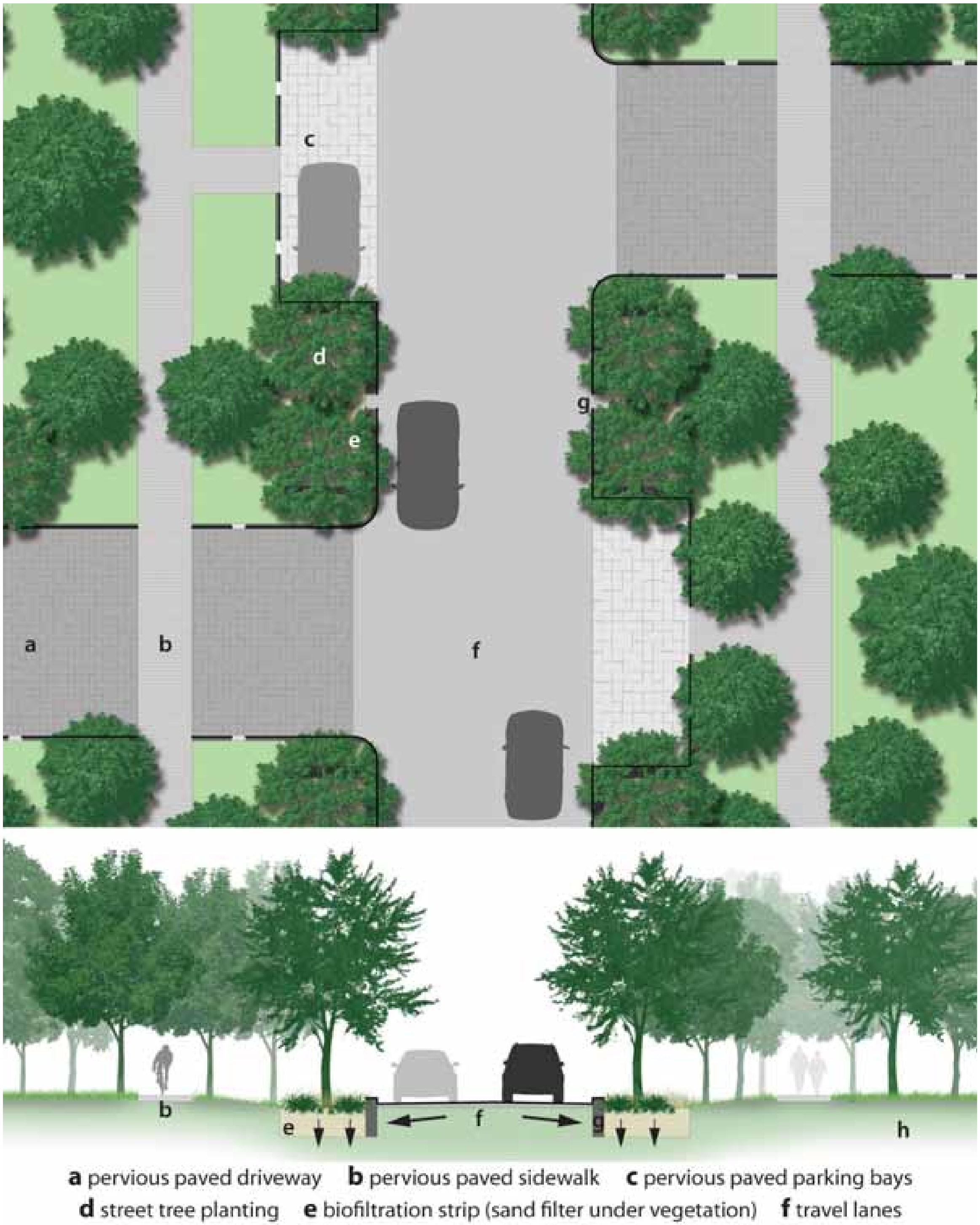
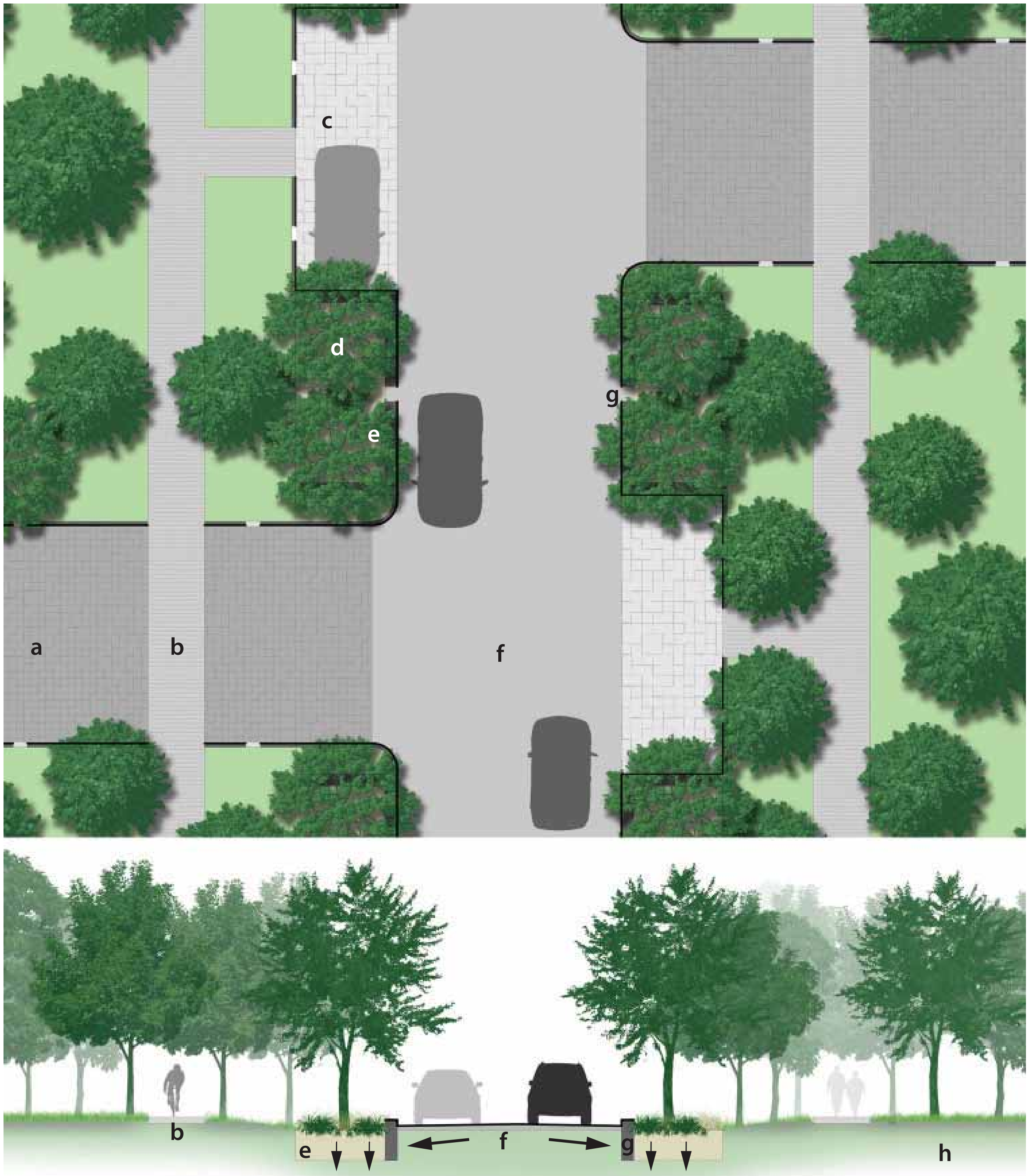


Figure 14: Above, plan of a typical biofiltration median Below, section of a typical biofiltration median

Water Quality Boulevard

Biofiltration medians on a roadway can act as filtration devices. Instead of closed curbs all around the median to retain the soil, the median is built at a lower elevation and curb gaps allow the stormwater from the street to flow into the median. There, plants use and clean the water before it drains into the stormwater system. Runoff is also reduced as water infiltrates into the soil in the median.

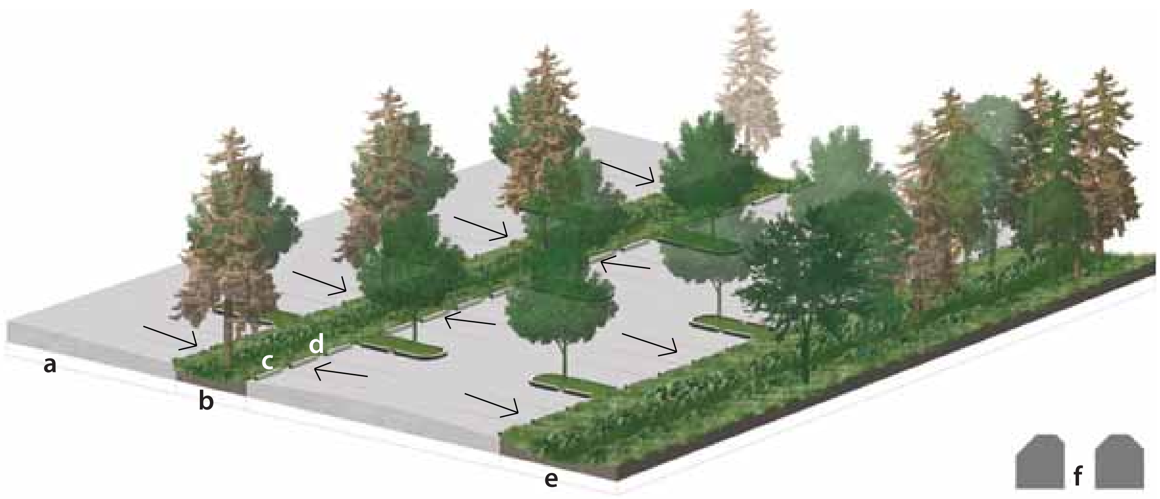


a pervious paved driveway **b** pervious paved sidewalk **c** pervious paved parking bays
d street tree planting **e** biofiltration strip (sand filter under vegetation) **f** travel lanes
g gapped curbs **h** non-compacted subgrade

Figure 15: Above, plan of a typical roadway biofiltration strip Below, section of a typical roadway biofiltration strip

Water Quality Road

Local roads with or without on-street parking can help filter pollutants. Water that would normally runoff into sewer systems can be directed into pervious parking along the street, and then drain into planted areas along the right-of-way. Local roads without on-street parking can drain through curb gaps into planted areas. This strategy could also be considered an infiltration strategy as stormwater drains into planted areas and pervious pavement into the soil below.



a pervious pavement **b** biofiltration median **c** wheel stop **d** curb cuts **e** bioswale
f wheel stop/curb finishing options

Figure 16: Diagram of a typical environmentally sensitive parking lot and drainage

Figure 17: Environmentally sensitive parking lot

Environmentally Sensitive Parking Lot

Environmentally sensitive parking lots reduce the amount of non-pervious surface a typical parking lot presents. These parking lots include pervious paving, bioswales in the medians, and could include stormwater storage under the surface. Environmentally sensitive parking lots are also considered an infiltration strategy.

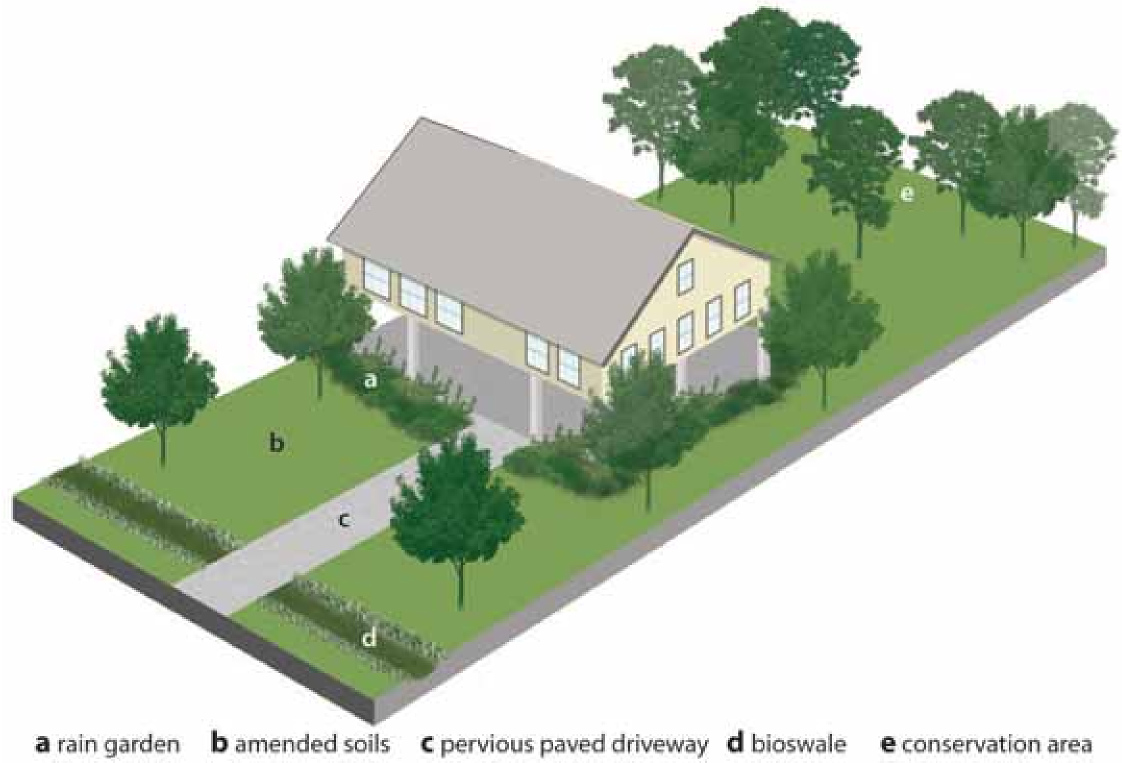
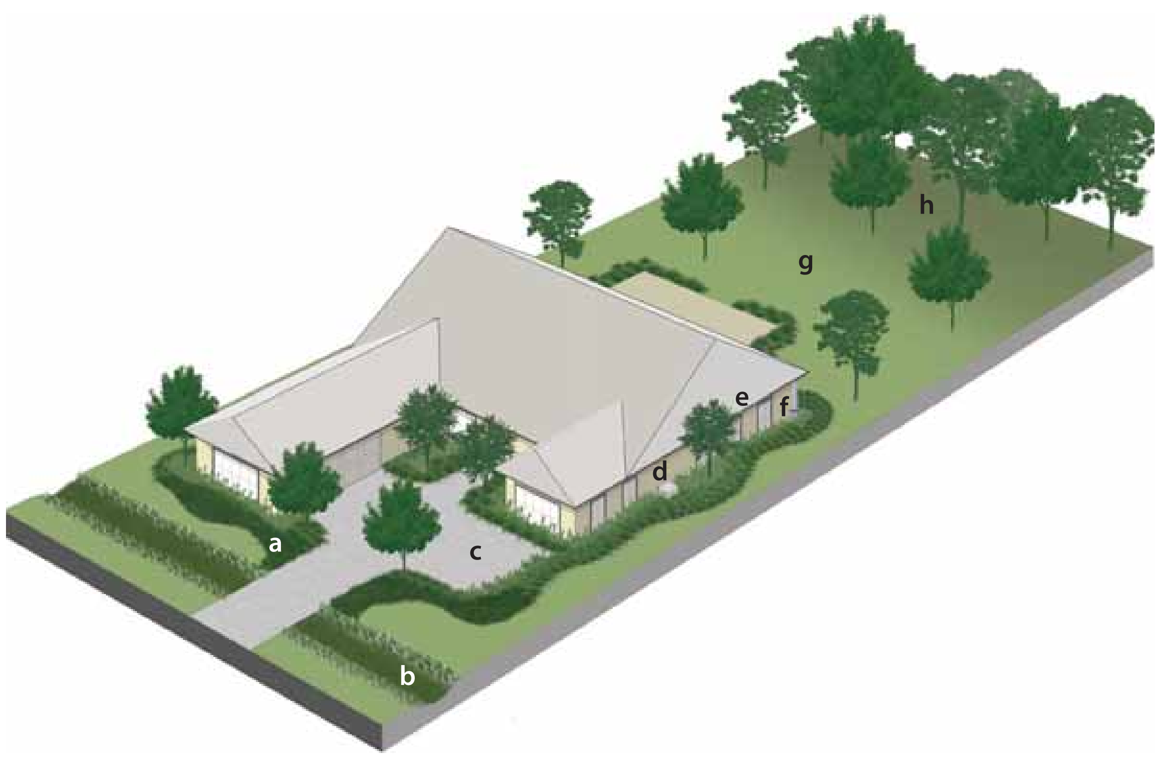


Figure 18: Diagram of a typical environmentally sensitive residential lot with a raised house



a rain garden **b** bioswale **c** pervious paved driveway **d** air conditioning unit
e rain gutters **f** rain barrel **g** amended soils **h** conservation area

Figure 19: Diagram of a typical environmentally sensitive residential lot with a slab house

Water Quality Residential Lot

Environmentally sensitive residential lots, also considered infiltration and retention/detention strategies, concentrate on keeping stormwater on the property for longer periods. They include bioswales, rain gardens to filter the water, cisterns to store water for irrigation and outdoor uses, and pervious pavement.

Water Quality Commercial Property

For commercial developments, the same principles apply. The office building project in the following diagram was engineered with the typical approach. (see figure 20) As a result, the development would have to incorporate a five-acre detention/ retention pond to handle the runoff from the rooftop and pavement. The pond was planned in a tight space directly across from the entrance to the development. This is clearly not an ideal situation, with five acres of land dedicated to a rectangular pond with steep slopes and a chain link fence surrounding it.

As is often typical, the developer did not want to start the site planning process over because so much architectural and engineering work had already been completed. The next two diagrams illustrate two ways in which a site plan that did not consider stormwater management from the beginning could be modified to reduce stormwater runoff, improve water quality and, as a result, reduce the size of the required detention and retention pond.

The first solution merely modifies grading of the parking lots. (see figure 21) Instead of sloping toward the center of the drive aisles, the paving is sloped away from the center and toward the landscaped islands. The landscaped

Figure 20: Typical development - lots, parking, curbs gutters

Figure 21: Stormwater BMP option - curb cuts, graded so water drains to islands

Figure 22: Stormwater BMP integrated - pervious paving, bioswales, curb cuts, graded so water drains to islands

areas would be redesigned to be at a lower elevation and with curb gaps so water flows from the impervious parking surface into raingardens and bioswales. Raingardens were also designed in open areas around the perimeter of parking lots. Using stormwater runoff modeling, the first solution showed the pond could be reduced in size by over 20%.

The second solution for this commercial development utilized the grading and drainage approach of the first, and added two additional features which dramatically reduced the required size of the pond and further improved the quality of water entering our water bodies. (see figure 22) Pervious concrete was designed for all the parking spaces. Although it has been proven to be durable and strong enough to be used for all the parking lot roadways as well, the developer's engineer preferred that it not be used in travel lanes. In addition to the pervious concrete which allows water to drain off the parking surface at a rate more rapid than any storm (up to 50 inches per hour), a manufactured subsurface retention storage system was used. The soil excavated for the four-feet of subsurface storage system was used as fill under the building. The subsurface system was connected at the top to a pipe leading into the city's stormwater system, serving as the outlet and as an overflow outlet. This design reduced the pond to less than one acre in size, reduced from original size (using the typical approach) by 80%. Perhaps the pond could have been eliminated altogether if the site plan had been designed from the start with stormwater management in mind.

Benefits to Development

In considering the approach to site development planning discussed in this chapter, it is important to remember the benefits:

- Conservation of green space and compactness of development provides flexibility in the site design.
- More open space that serves stormwater management also provides additional amenities.
- Conservation of the site's natural and cultural features provides the opportunity to create a unique development with a strong sense of place.
- These developments are in higher demand and can demand higher sales prices due to their unique character.
- Less infrastructure is required to be constructed.
- Construction costs are reduced.
- Infrastructure maintenance costs are reduced.

CONSTRUCTION PHASE

Stormwater Pollution Prevention Plan

A Stormwater Pollution Prevention Plan (SWPPP) is a site-specific document that is required by the Environmental Protection Agency for construction sites that must comply with stormwater discharge requirements. This plan is more than just a sediment and erosion control plan, but it describes all the activities needed to prevent stormwater contamination and comply with the requirements of the Clean Water Act during construction. For more information please visit:

http://www.epa.gov/Region8/water/stormwater/downloads.html

http://www.deq.louisiana.gov/portal/tabid/80/Default.aspx
http://brgov.com/dept/dpw/environmental.htm

An SWPPP document will identify potential sources of stormwater pollution on the construction site and describe both BMPs and procedures that will be implemented to reduce pollutants and stormwater discharge at the site. Construction site BMPs can be structural or non-structural.

In Louisiana, if you are building new construction, whether it is a subdivision, commercial, or private property, if you will disturb one acre or more of development, you must have a SWPPP to receive a permit. The Louisiana Department of Environmental Quality (LDEQ) has issued EBR Parish, Louisiana State University, and Southern University an overall stormwater discharge permit, known as a National Pollutant Discharge and Elimination System (NPDES) permit. This requires

The contractor is responsible for preparing the SWPPP and its associated Notice of Intent (NOI).

Figure 22: Lack of erosion prevention measures has allowed sediment to flow directly into the drain

Figure 23: Drain inlet protection employed to prevent sediment from entering the storm drain system

the parish to prevent polluted discharge of stormwater into any waterbodies within or adjacent to the parish. During the construction phase of a development project, the SWPPP is the means by which the parish ensures you do not violate the terms of their LDEQ permit. It is the responsibility of the contractor to prepare the SWPPP, implement it onsite, and inspect and maintain the BMPs during the entire construction period.

Figure 25: Sediment control BMP - silt fencing

The contractor is legally obligated to implement the SWPPP, and to **inspect** and **maintain** the BMPs during the **entire** construction period.

Site Clearing BMP's

During site preparation and clearing, the contractor should plan early. Minimizing the area that is disturbed is crucial to preventing stormwater pollution. There is no need to disturb site areas in which construction will not take place. The construction area limits must be identified on the SWPPP. Soil disturbance and unprotected exposure should be minimized and and revegetated and mulched as soon as possible. Protective zones should be established around valued natural resources, such as mature trees, wetlands, major tree stands, and wildlife habitat. No construction activities should be allowed outside the construction area limits, including the storage of materials and equipment and the parking of construction and workers vehicles.

Erosion Control BMPs

Erosion control is intended to prevent soil particles from detaching and being transported in runoff. The first and best means of accomplishing this is to minimize disturbed areas and to preserve existing vegetation and surface drainage patterns. In areas that must be disturbed, temporary or permanent measures can prevent soil erosion. Erosion control BMPs include establishing vegetation in disturbed areas as soon as possible, mulching, covering stockpiles, stabilizing the construction site entrances, and diverting runoff from disturbed areas.

Figure 24: Construction activities in violation of the Water Quality Act

Figure 26: Construction with erosion prevention measures

Figure 27: Erosion control BMPs must be maintained throughout construction to ensure that they are functioning properly

Vegetation plays a big role in erosion control. For the most success, establish vegetation as soon as possible after a disturbance. Test the soil and use an appropriate seed mix for the particular time of year.

Sediment Control BMPs

Sediment control is the second line of defense because soil erosion has already occurred and the sediment must be stopped from leaving the site. These can be very effective, but require more effort than preventing erosion in the first place. Sediment control BMPs involve removing as much as possible of the suspended soil particles from runoff. This requires proper installation and maintenance which is crucial throughout the construction phase. Sediment control BMPs include silt fences, check dams, drain inlet protection, and sediment retention basins.

Figure 28: Sediment from unstabilized bank has washed out onto the sidewalk

Figure 30: Protection against sediment runoff can be increased by layering sediment control measures such as a sediment retention basin and silt fencing

BMPs to Control Water Runoff

Drainage-ways should be stabilized through all construction phases to minimize increased erosion from channels as needed or called for in the SWPPP. Additional temporary swales and detention basins must be constructed to control runoff and resulting erosion. It may be possible after construction to convert these into permanent open channel systems by following the development site plan in creating temporary drainage ways.

Figure 29: Bank is being stabilized with erosion control matting

Good Housekeeping Measures

The construction site SWPPP must be implemented prior to breaking ground at a construction site in order to protect the existing site. The construction site should be kept free from debris as much as possible. Spills from paint, oil, and chemicals used during construction can contaminate the soil and surrounding water bodies, so they should be disposed of offsite at the appropriate facilities in the parish.

SITE MANAGEMENT AND MAINTENENCE

The staff who will maintain and repair the development, once construction is completed and the the property is in use, are key players in stormwater management. They must ensure the stormwater treatment train continues to function in improving water quality, and must practice good housekeeping on the property to prevent the introduction of new pollution sources.

The most important step is to prepare and implement a maintenance program. As part of the design of BMPs, the landscape architect should prepare a maintenance manual to assist staff in properly caring for the individual BMPs and the entire stormwater treatment train. The maintenance manual should include specific information on when and how to maintain and replace vegetation, clean pervious paving, and prevent stormwater pollution when repairing and maintaining other parts of the development.

Maintaining the Stormwater Treatment Train

General recommendations for maintenance of each type of BMP are itemized in Table 4.

Good Housekeeping Measures

Practicing good housekeeping in maintaining and operating the development will minimize future problems and costs. Those addressed below serve the primary goal of reducing pollution and waste in the environment, particularly water pollution. Practicing these measures will also help developments comply with EPA water quality regulations.

Cleaning
- Practice regular street sweeping to prevent litter build up.
- Clean structures and surfaces to remove oil and grease.

Repairs and Storage
- Do not store motor parts or equipment containing grease, oil, or gasoline in

BMP	Maintenance Actions	Schedule
Dry/Wet Pond	Check for erosion of banks & repair	Twice annually
	Ensure conveyance is operational	Twice annually
	Check for sediment accumulation in pond & forebay	Annually
	Clear inlet & outlet of debris	Annually
	Manage pesticides & fertilizer	Standard
	Remove litter & debris	Standard
	Remove sediment from forebay	Every 5-7 years
	Remove sediment from pond when 25% filled	Every 20 years
Pervious Paving	Use a street sweeper to vacuum	Twice annually
Vegetated BMP's	Remove invasive species	Annually (End of Autumn)
	Check for plant pests and diseases	Twice annually
	Ensure conveyance & overflow outlets are clear and operational	Twice annually

Table 4: General recommendations for maintenance of Stormwater BMPs

uncovered areas susceptible to runoff.
- Do not store uncovered or unsealed trash or chemical containers in uncovered areas susceptible to runoff.
- Repair machines and vehicles in covered areas or on a pad of absorbent material to contain leaks, spills, and discharges.

Water and Waste
- Do not allow irrigation water to run off of the property.
- Do not allow fluids from washing or cleaning activities to run off of the property.
- Dispose of waste and pollutants properly.
- Recycle materials to minimize waste.

Plants
- Use alternatives to herbicides, such as
    - keeping planted areas mulched (do not use cypress mulch, which is made from logging cypress in Louisiana's coastal wetlands)
    - mowing grass to maintain higher grass, which is more competitive
    - leaving grass clippings which provide nutrients
    - water deeply and infrequently
    - planting native grasses or wildflowers in large areas
- Use alternatives to fertilizers, such as
    - compost
    - leave twigs and leaves on the ground under trees (not on lawns)
- Use alternatives to pesticides, such as
    - diversify plant species
    - handpick pests off of plants early
    - set traps, such as: netting, can traps, and sticky boards
    - use beneficial insects, such as butterflies and bees
    - use fish to control mosquitoes
- Use low-toxicity pesticides
- Replace dying, diseased, or damaged plants immediately

The most important things to remember in site management and maintenance are that every action has the potential to prevent or reduce water pollution, and that a regular maintenance regime conducted by trained staff is a worthwhile investment.

STORMWATER BMPs

Best Management Practices (BMPs) are a broad range of methods and procedures. These practices include pre-construction and post-construction implementation, urban to rural settings, and landscape or hardscape composition. In this chapter, various BMPs will be described and shown in the following categories: Detention and Retention Systems, Infiltration Systems, and Filtration Systems.

<u>Detention and retention systems</u> function as stormwater BMPs by providing places that collect stormwater and then slowly release it over a period of time.

Detention systems are designed to hold water only during storm events, allowing the water to percolate into the ground or flow out of the basin over a range of time. Some systems are designed to store water for a specified number of hours, while others a specified number of days. Either option can be accomplished with an at surface (open) or below surface (closed) system.

Retention systems are permanent bodies of water that are designed to accommodate a specified volume of stormwater in excess of their normal levels. These systems then allow the additional water to slowly percolate into the ground or flow out of the basin, which returns to its normal water level.

<u>Infiltration systems</u> create a highly porous surface layer that prevents runoff by allowing water to quickly flow below the surface and filters it before the water percolates into the groundwater supply. The efficacy of infiltration systems is completely dependent upon the permeability of the soil.

<u>Filtration systems</u> collect and filter stormwater with the use of plants, sand, and/or gravel. They are often used in combination with other types of stormwater BMPs.

For more information please visit:
www.epa.gov/waterscience/guide/stormwater/
www.epa.gov/waterscience/guide/stormwater/files/usw_a.pdf

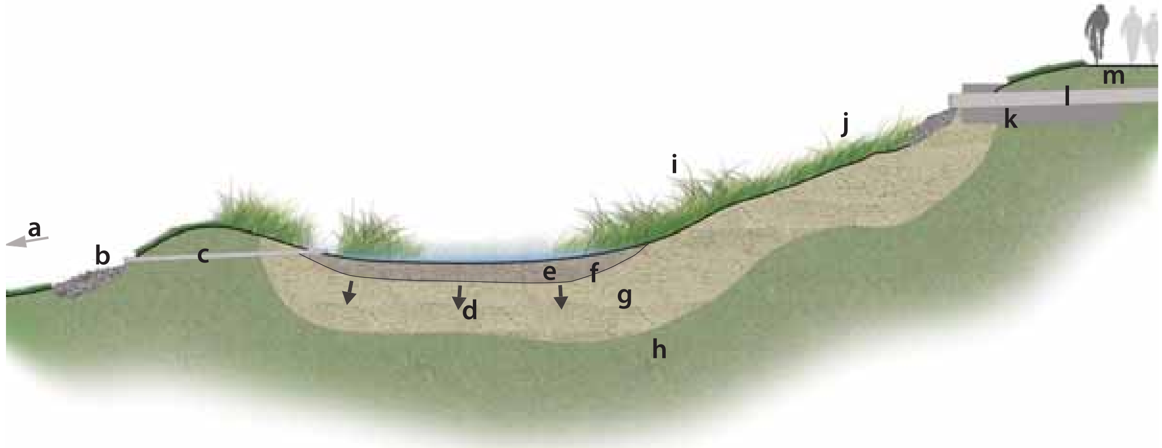
Stormwater BMP	Percent Pollutant Removal (Median)						
	Total Suspended Solids	Total Phosphorus	Soluble Phosphorus	Total Nitrogen	Nitrate & Nitrite Nitrogen	Copper	Zinc
Detention and Retention Systems							
Dry Ponds	47	19	-6.0	25	4	26	26
Wet Ponds	80	51	66	33	43	57	66
Infiltration Systems							
Infiltration BMPs	95	70	85	51	82	n/a	99
Filtration Systems							
Filtration BMPs	86	59	3	38	-14	49	88
Bioswales	81	34	38	8	31	51	71
Water Quality Wetland	76	49	35	30	67	40	44

Source, National Pollutant Removal Performance Database for STPs: 2nd Edition, www.cwp.org

Table 5: Efficacy of Stormwater BMPs

Detention and Retention Systems

- Dry Pond
- Wet Pond
- Pond Edge with Bulkhead
- Pervious Paving with Manufactured Subsurface Storage



a connection to stormwater management system **b** gravel bed **c** outflow pipe **d** slow infiltration **e** soil media **f** geotextile fabric **g** sand **h** non-compacted soil **i** wetland plants & natural grasses **j** forebay **k** rock headwall **l** inflow spray pipe **m** path

Figure 31: Schematic Section of a Dry Pond

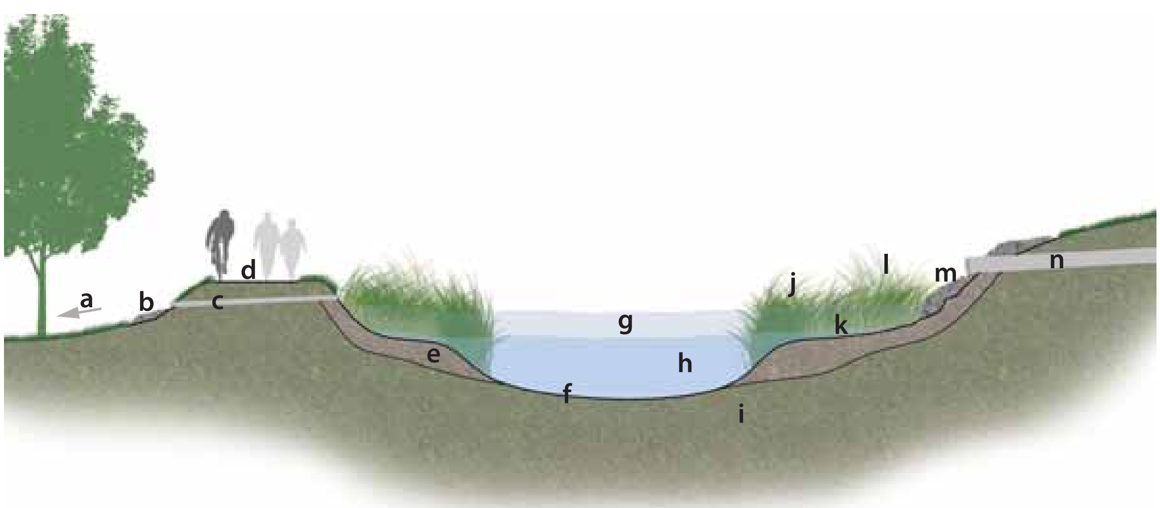
DETENTION AND RETENTION SYSTEMS

Dry Pond

Dry ponds, also known as detention ponds, are designed to hold water for a minimum time and then completely drain. This allows pollutants to be filtered by the vegetation along the edges and bottom on the pond. Stormwater can then infiltrate into the soil or flow out of the basin slowly into a surface water body on closed drainage system.

Wet Pond

Wet ponds, also known as stormwater ponds or retention / detention ponds, are permanent bodies of water. Above the permanent water line is an area in which water levels are allowed to fluctuate as stormwater is detained. This area of water level fluctuation is known as freeboard. The edges of wet ponds, including the freeboard area, are vegetated with plants that filter the water before it enters the pond. Wet ponds also treat water through particle settlement.

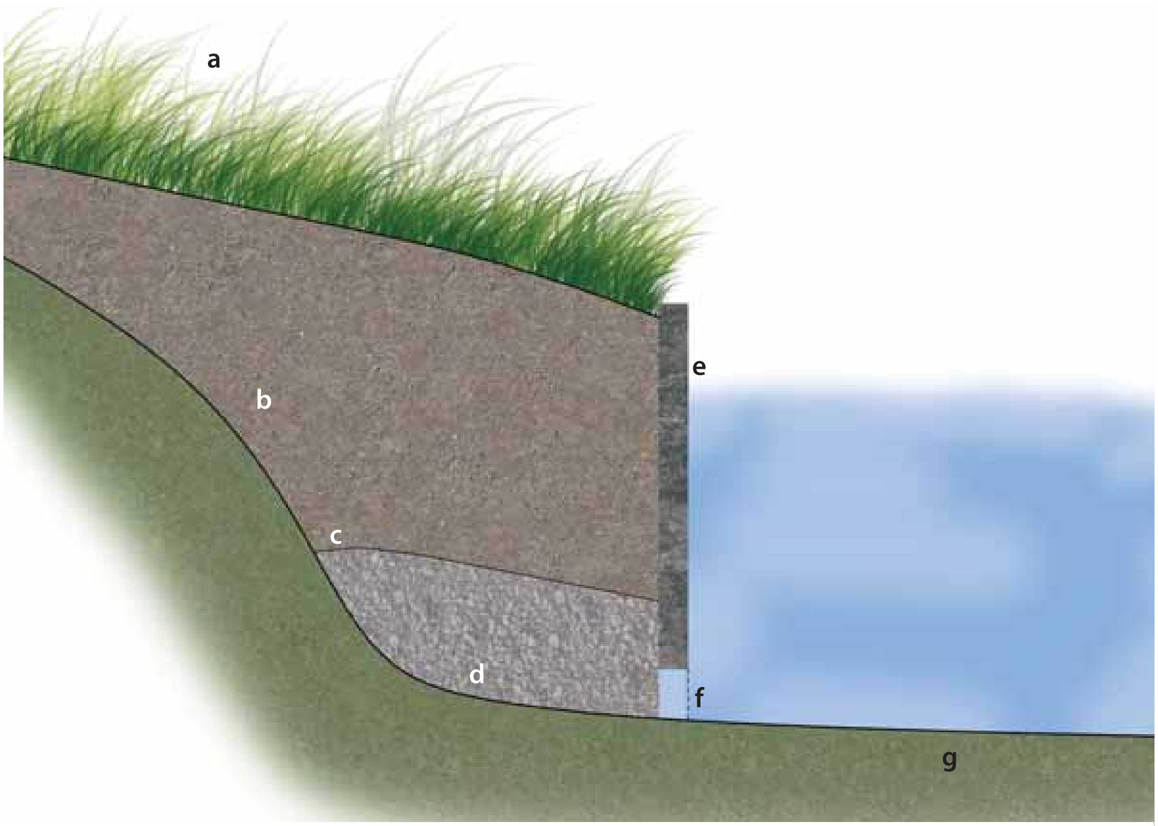


a connection to stormwater management system **b** gravel bed **c** emergency spillway **d** path **e** amended soil **f** pond liner **g** freeboard **h** permanent wet pond **i** non-compacted soil **j** wetland plants & natural grasses **k** aquatic bench **l** forebay **m** rocks to reduce velocity & energy of flow **n** inflow pipe

Figure 32: Schematic Section of a Wet Pond

Pond Edge with Bulkhead

Ponds in restricted spaces can still filter runoff from the surrounding areas. When bulkheads are used, the pond can receive water that flows through vegetation over the bulkhead. Water can also enter the pond through the amended soil and gravel, then through a permeable barrier below the bulkhead. This device is also serves to filter stormwater.

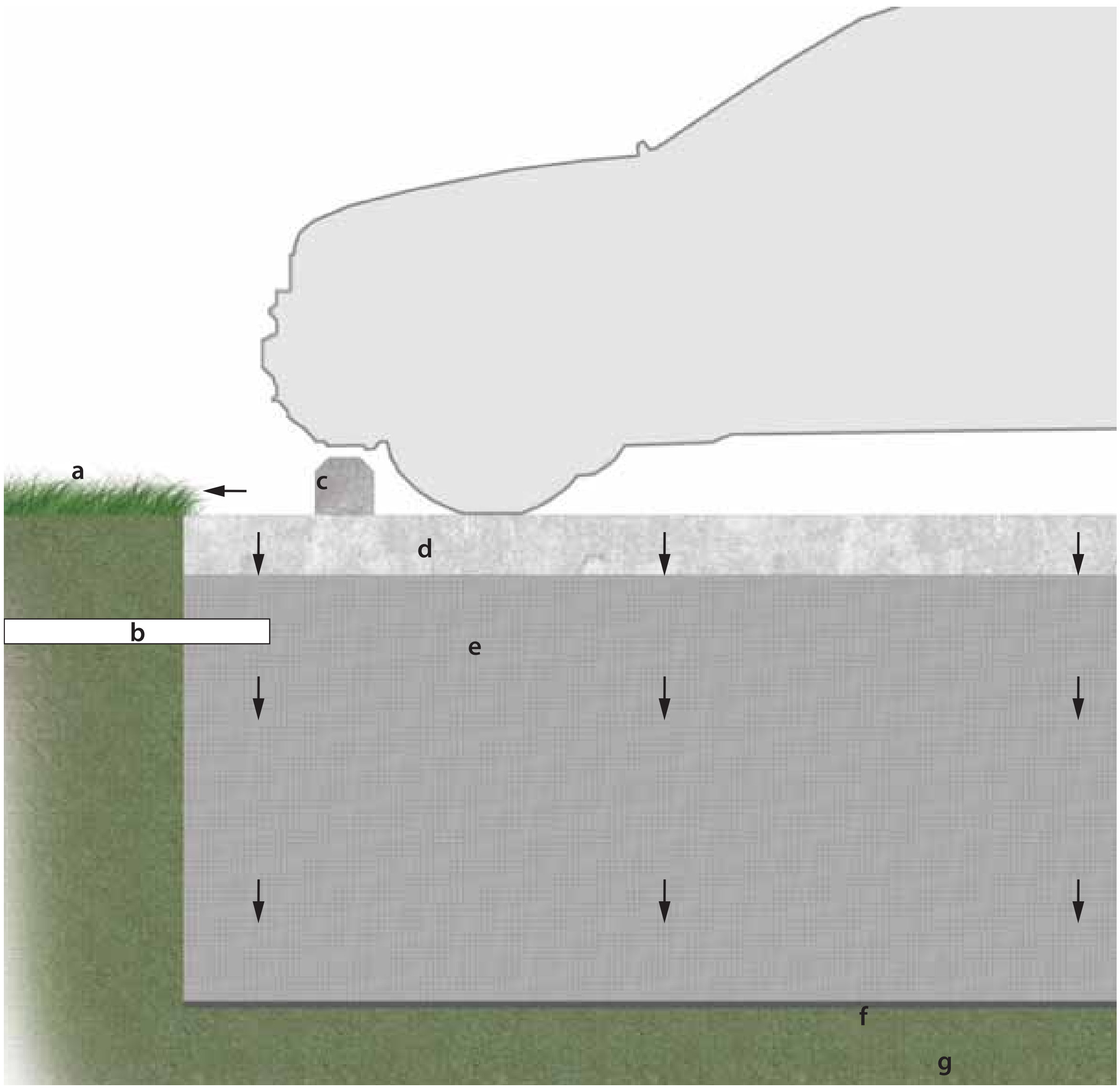


a vegetated filter **b** amended soil **c** geotextile fabric **d** gravel **e** barrier/bulkhead **f** permeable barrier **g** undisturbed subgrade

Figure 33: Schematic Section of Bulkhead

Pervious Paving with Manufactured Subsurface Storage

Subsurface stormwater storage features hold stormwater below pervious pavement until it infiltrates or drains into the groundwater or enters the closed drainage system. It is considered a detention area and can also act as filtration devices if filtration layers are included above the storage area.



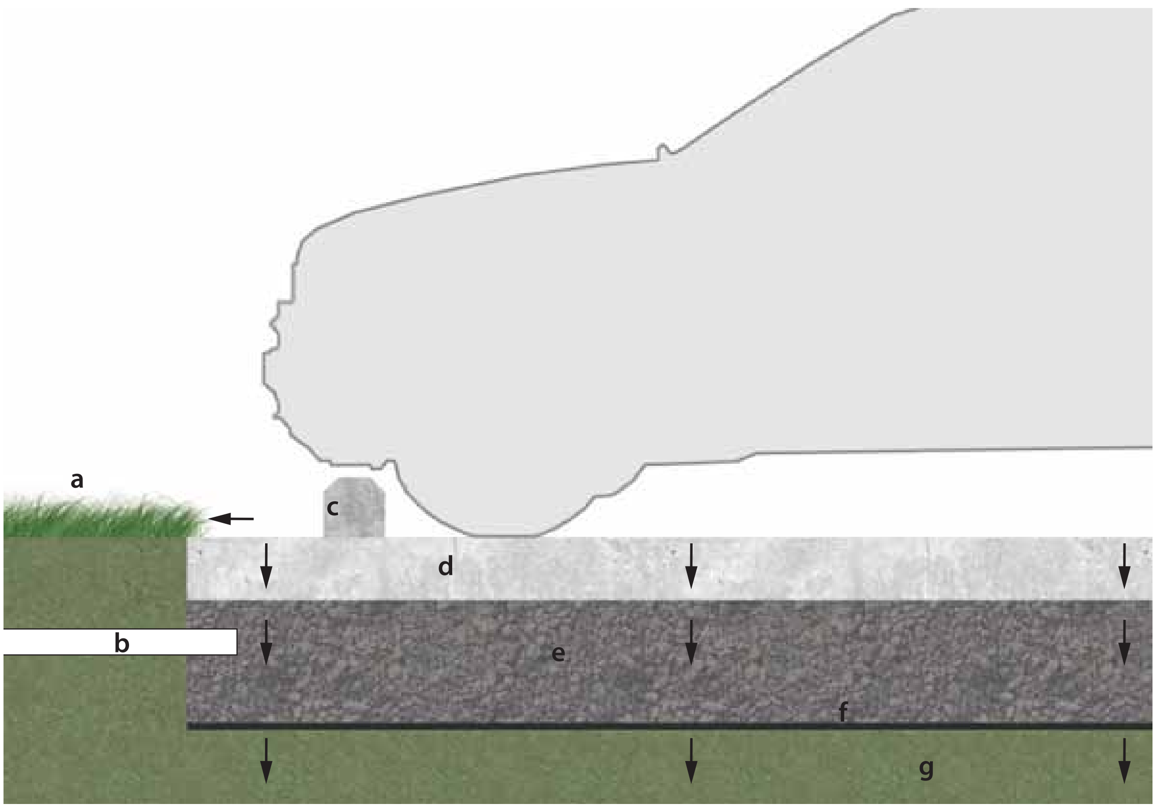
a median/grass area **b** overflow safety pipe to stormwater system
c concrete wheel stop or curb with curb gaps **d** pervious concrete or asphalt
e manufactured subsurface storage device **f** pervious landscape fabric **g** non-compacted subgrade

Figure 34: Schematic Section of Subsurface Stormwater Storage Feature

INFILTRATION SYSTEMS

Pervious Paving

A shallow base under pervious pavement allows for filtration of stormwater into the soil below. This shallow aggregate should be used where the soil has a high infiltration rate. If the aggregate under the pervious pavement holds too much water, a drain pipe will allow the excess water to drain into the closed drainage system. Curb gaps or wheel stops also allow water to flow into the median grass area to infiltrate there.



a median/grass area **b** overflow safety pipe to stormwater system
c concrete wheel stop or curb with curb gaps **d** pervious concrete or asphalt
e aggregate with 40% void space **f** pervious landscape fabric **g** non-compacted subgrade

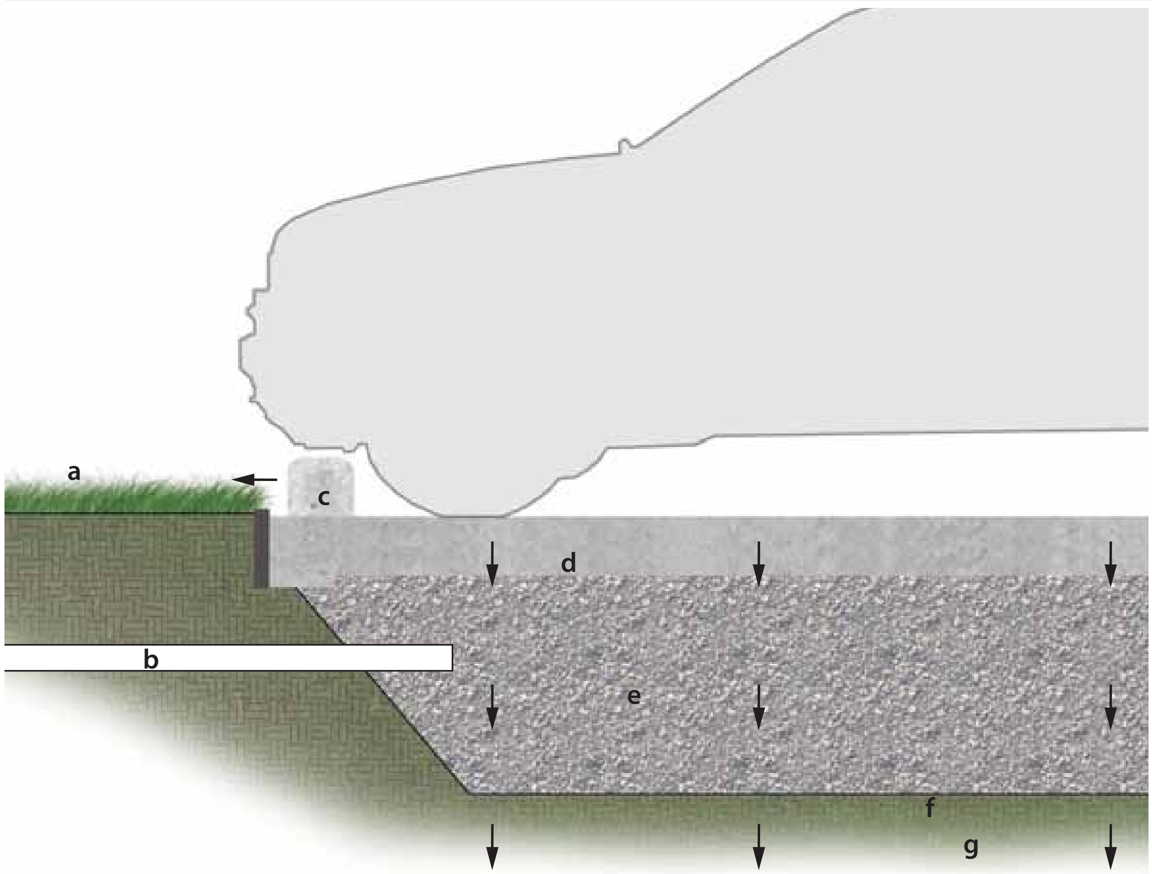
Figure 35: Schematic Section of Pervious Paving

Infiltration Systems

- Pervious Paving
- Pervious Paving with Aggregate Subsurface Storage
- Infiltration Device
- Cistern

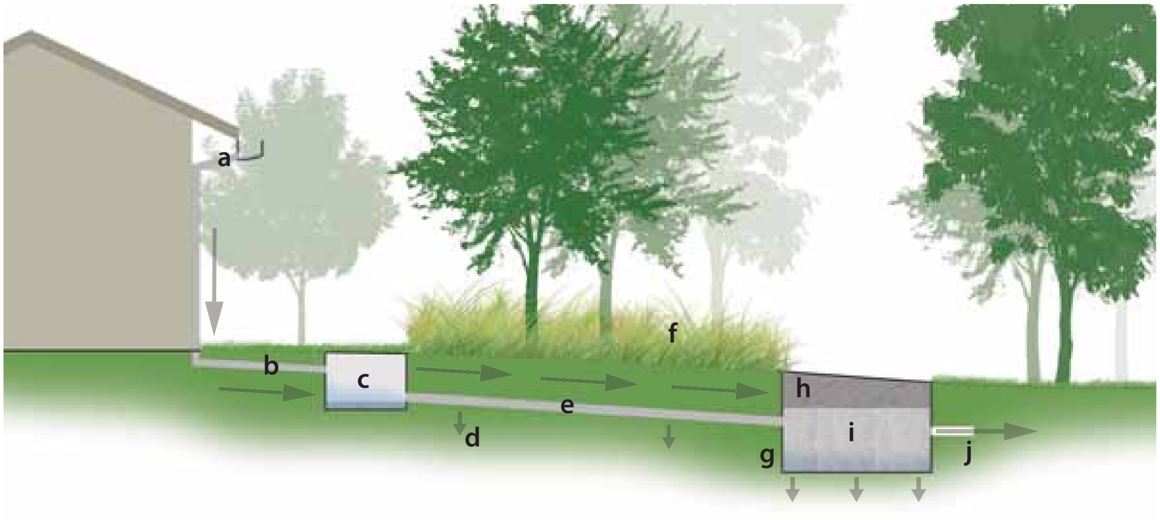
Pervious Paving with Aggregate Subsurface Storage

Pervious pavement allows infiltration into the pavement and soil below whereas non-porous pavement causes water to immediately runoff into the drainage system. This allows water to be detained in the aggregate sub-base until it enters back into the groundwater and recharges aquifers or enters the closed drainage system. The technique is also considered a filtration device.



a median/grass area **b** overflow safety pipe to stormwater system
c concrete wheel stop or curb with curb gaps **d** pervious concrete or asphalt
e aggregate with 40% void space **f** pervious landscape fabric **g** non-compacted subgrade

Figure 36: Schematic Section of Pervious Paving with Aggregate Subsurface Storage



a rain gutter system **b** perforated pipe **c** sediment basin **d** stormwater infiltrates subsoil **e** sand trench **f** vegetative filter area **g** infiltration device **h** gravel layer **i** sand layer **j** overflow to storm drainage system

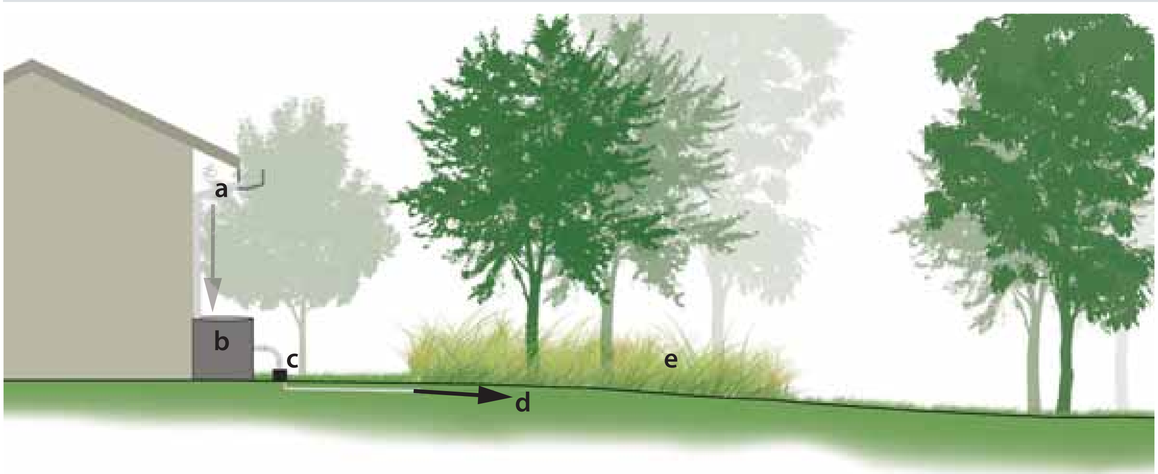
Figure 37: Schematic Section of an Infiltration Device

Infiltration Device

Large rooftop areas generate large amounts of stormwater runoff. When it is impractical or undesirable to either collect the rooftop runoff in a cistern or direct it to a raingarden or bioswale, another means should be used to treat the water. This infiltration device uses perforated pipe, sand, and gravel to filter the water before it infiltrates into the ground. Manufactured infiltration systems, sometimes called stormwater leaching devices, are also available.

Cistern

A cistern, which captures rooftop runoff, serves several stormwater functions. It retains the runoff until it can be used. Also, sediments in the water settle to the bottom of the cistern. Finally, if the cistern water is connected to a pump and is used for site irrigation, it recycles the rainwater and allows it to eventually infiltrate into the ground.



a rain gutter system **b** cistern **c** irrigation pump/main line **d** flows outward to the rest of the irrigation system **e** lawn/vegetation

Figure 38: Schematic Section of a Cistern

Filtration Systems
- Bioswale
- Stormwater Planter with Permeable Base
- Stormwater Planter with Impermeable Base
- Sand Filter Basin
- Catch Basin Insert
- Water Quality Wetlands
- Rain Garden
- Green Roofs

FILTRATION SYSTEMS

Bioswale

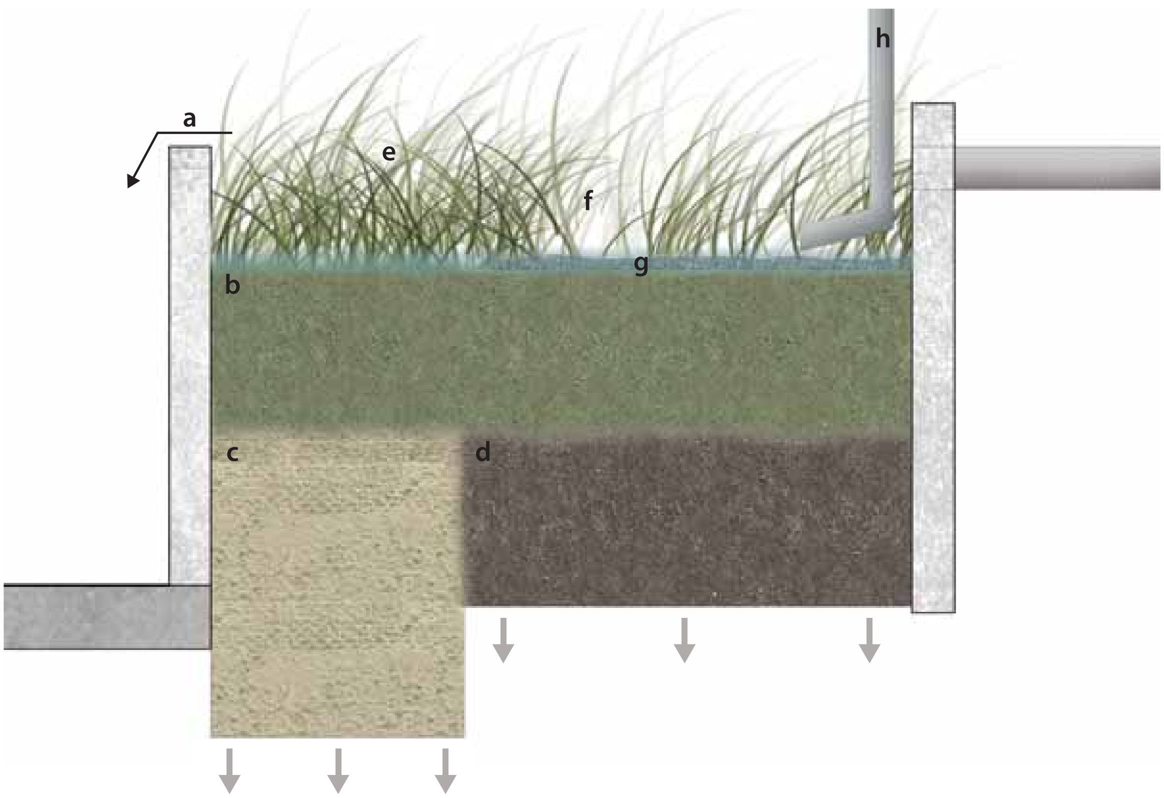
Bioswales act as filtration devices in place of typical swales. Water is filtered by plants, sand, and gravel before entering into another BMP system or into the closed drainage system and carried offsite.

a native grasses **b** wetland plants **c** vegetated filtration swale **d** amended soil
e path **f** pea gravel pocket surrounding entire drain pipe **g** perforated pipe (optional)
h filter fabric around gravel pocket **i** non-compacted subgrade

Figure 39: Schematic Section of a Bioswale

Stormwater Planter 1
Permeable

Stormwater Planters are designed to take roof water, filter it, and use it as irrigation for plants on the site. Excess water is filtered then allowed to infiltrate into the soil to help recharge the groundwater. This technique could also be considered an infiltration or detention device because it holds the stormwater and allows it to slowly infiltrate into the soil or enter the closed drainage system.

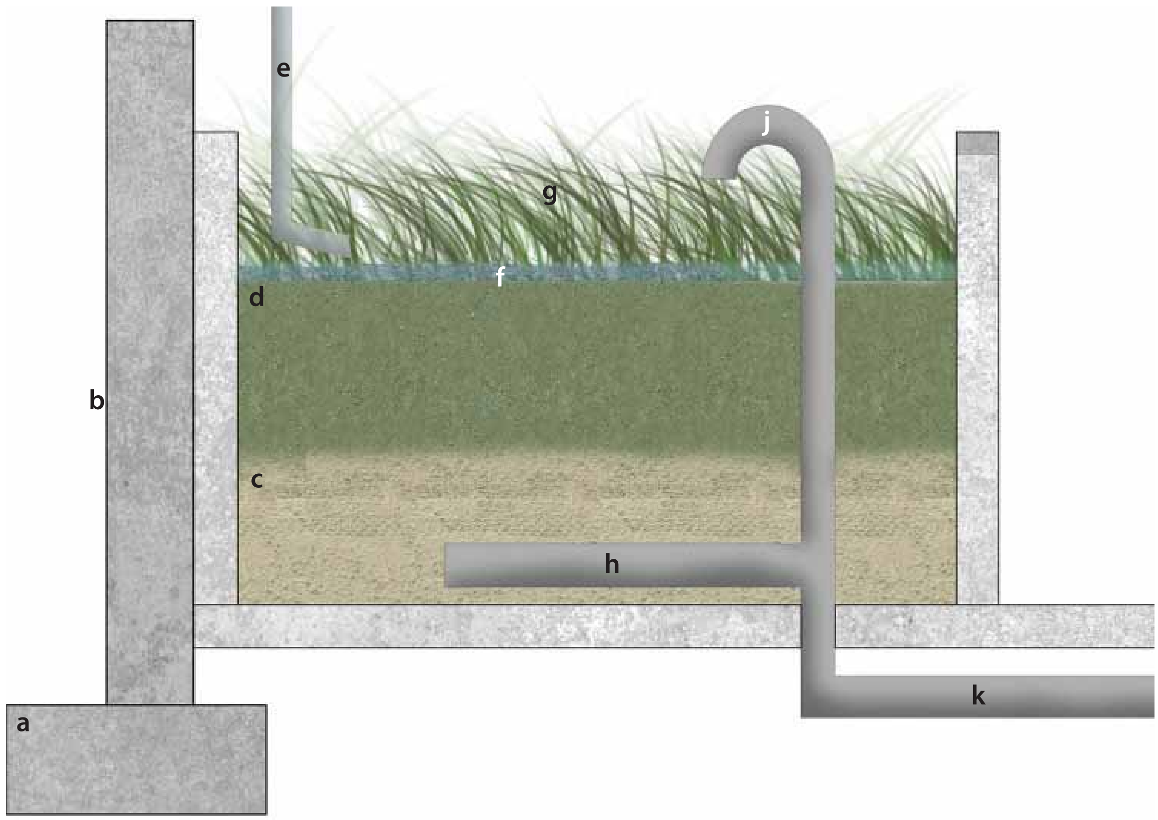


a overflow option **b** 18 inch sandy loam topsoil
c gravel/recycled glass with minimum width of 12 inch **d** topsoil/subsoil **e** water tolerant plantings
f reservoir depth should be 4-12 inches **g** gravel as splash block and mulch to protect soil
h drainage downspout

Figure 40: Schematic Section of a Permeable Stormwater Planter

Stormwater Planter 2
impermeable

Stormwater Planters are designed to take roof water, filter it, and use it as irrigation for plants on the site. If conditions do not allow permeable surfaces below the planter for infiltration, a drainage pipe can be added at the bottom to collect and convey filtered water for reuse, to a raingarden or bioswale or to a closed drainage system.

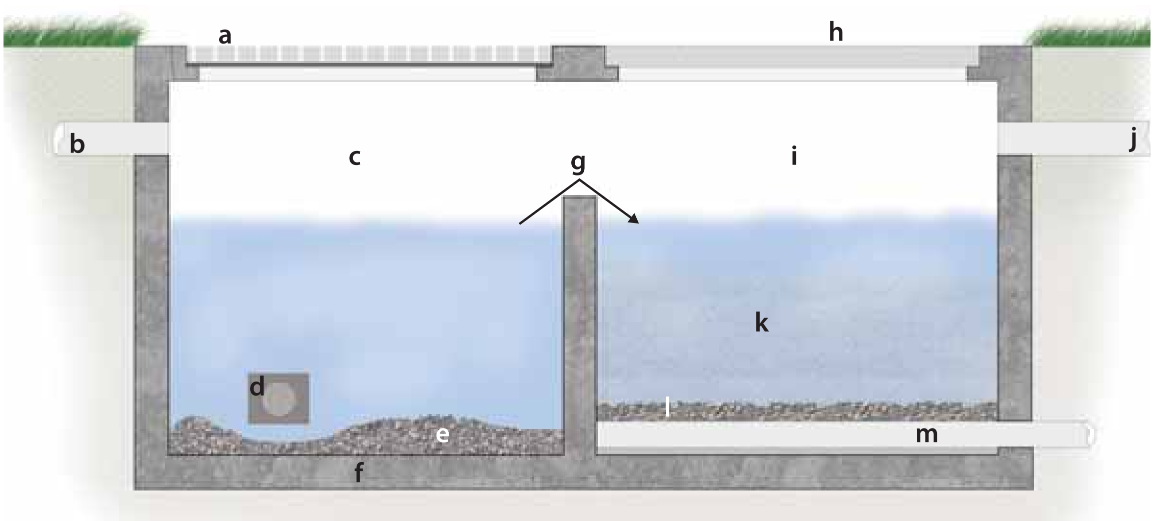


a foundation drains as required **b** waterproof building as needed
c 12 inch gravel/sand **d** 18 inch sandy loam topsoil **e** downspout
f stone or mulch to protect soil **g** reservoir 4-12 inches in depth **h** perforated pipe
j reverse bend trap **k** pipe to main storm system

Figure 41: Schematic Section of a Impermeable Stormwater Planter

Sand Filter Basin

Sand Filter Basins are designed as a two chambered device with the first chamber designed for the settlement of large particles and the second chamber designed for filtering smaller particles and other pollutants. The filtered water then flows out of the discharge pipe into a pond or other waterbody.

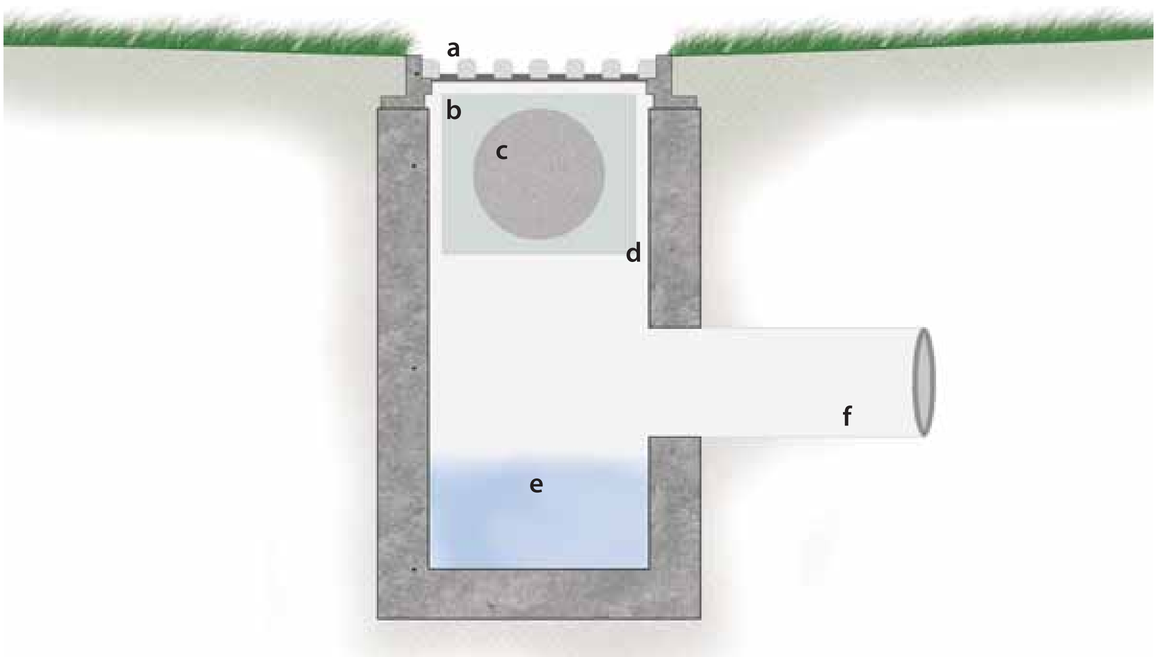


a grated lid **b** inflow pipe **c** sedimentation chamber **d** low flow outlet pipe with filter screen **e** accumulated heavy sediments/debris **f** reinforced concrete slab **g** overflow barrier **h** access cover **i** sand filter chamber **j** overflow discharge pipe **k** sand filter media **l** clean gravel layer **m** perforated pipe

Figure 42: Schematic Section of a Sand Filter Basin

Catch Basin Insert

Catch Basin Inserts are manufactured devices used to capture settlement and debris from stormwater before flowing through the system. These are usually used as pretreatment for other practices by catching large sediment particles. The filtered water then flows out of the discharge pipe into a pond or other waterbody.



a catch basin grate **b** insert **c** oil absorbant material **d** media housing **e** treated stormwater **f** outlet pipe

Figure 43: Schematic Section of a Catch Basin Insert

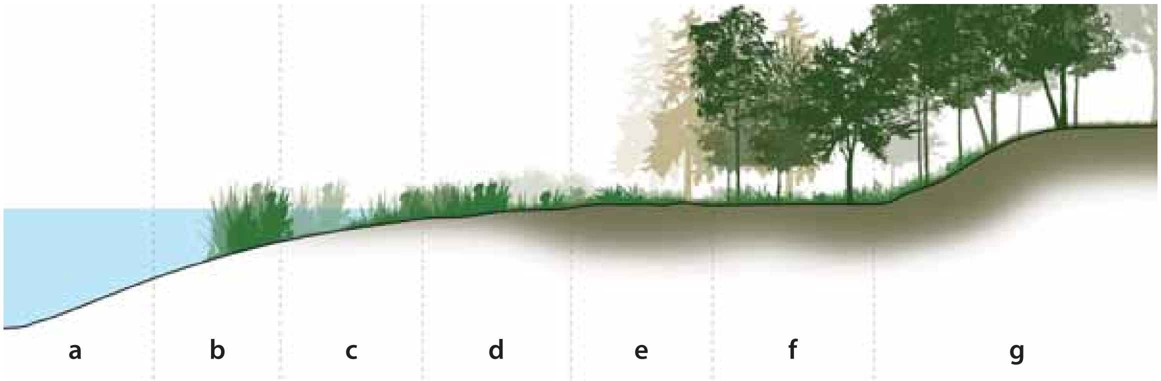


Figure 44: Schematic Section of a Water Quality Wetland

Water Quality Wetlands

Constructed wetlands provide for a progressive cleaning of stormwater before it drains into surface water. As it flows from forested areas to marshes, the stormwater is filtered and cleaned by plant material along the way. Smaller wetland forebays can also be designed to filter water runoff.

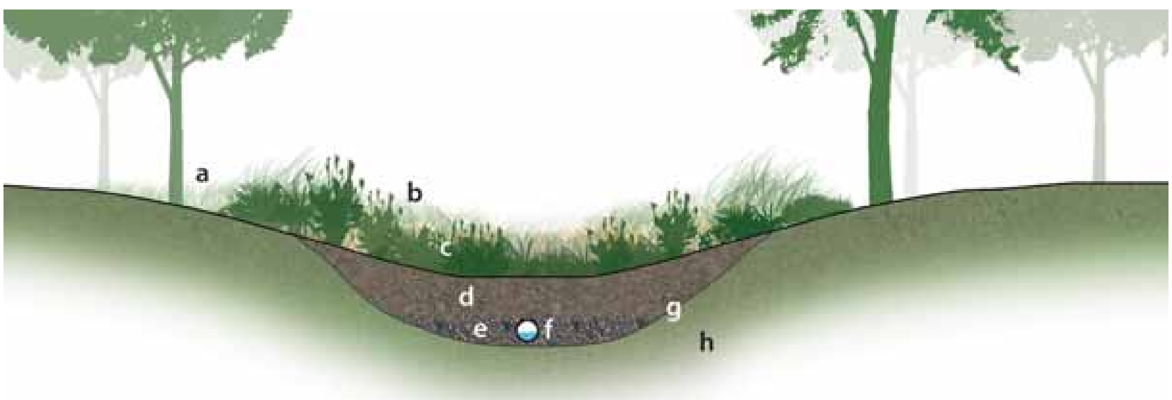


Figure 45: Schematic Section of a Rain Garden

Rain Garden

Rain Gardens are depressed landscaped areas that detain and treat stormwater runoff. Water is directed into the gardens by pipes, swales or curb openings. While the water is detained, sediments settle to the bottom, water is used by the plants, and plants uptake pollutants and either hold them in their tissues or break them down into non-toxic elements. Rain Gardens can vary in size and design based on the area that drains into it and the type of soil in which it is implemented. As an option, perforated pipes can be installed below the rain garden soil and connected to the closed drainage system. They can be cared for as either gardens or can be blended into the landscape making them look "natural." Many native Louisiana plants grow and thrive in rain gardens.

Green Roof

Green roofs are designed to intercept rainwater that falls on a roof, allowing plants to filter and uptake the water.

Green roofs provide a number of benefits:

- reduced stormwater runoff
- higher quality of runoff water
- less extreme roof temperatures
- reduced BTU consumption in the building
- extended life of the roof

The thickness of the green roof structure can vary by design, but need not be substantial in thickness or weight. On top of the existing roof, a waterproof membrane adds additional protection upon which a drainage mat lays, providing space for water that is not used by the plants to drain. The filter fabric prevents the growth media from clogging the drainage area. The growth media is designed to be light in weight, to retain water for use by plants, and to provide plant nutrients. Locally available rice hulls are light and retain water, so are an excellent component of the growth media. The vegetation planted on the green roof can vary significantly, from native grasses to species tolerant of drought and wind, fluctuating temperature, and full sun conditions. A licensed landscape architect should design the planting and the growth media for the green roof.

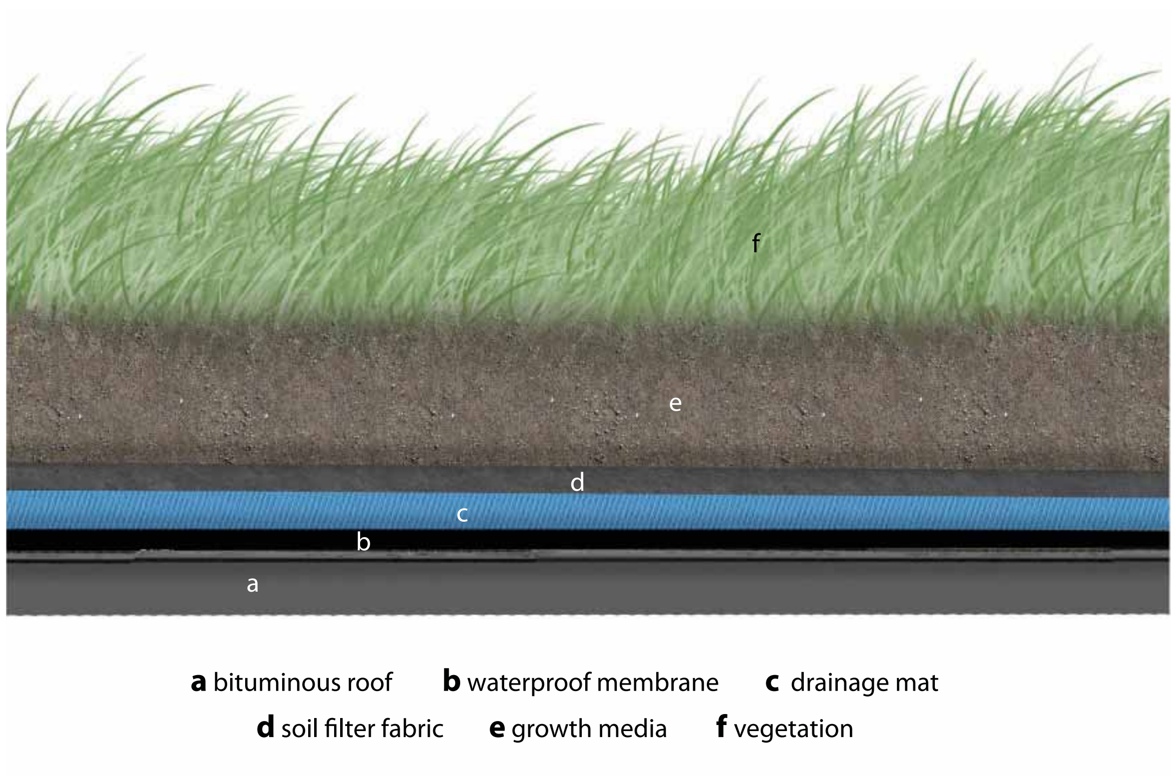


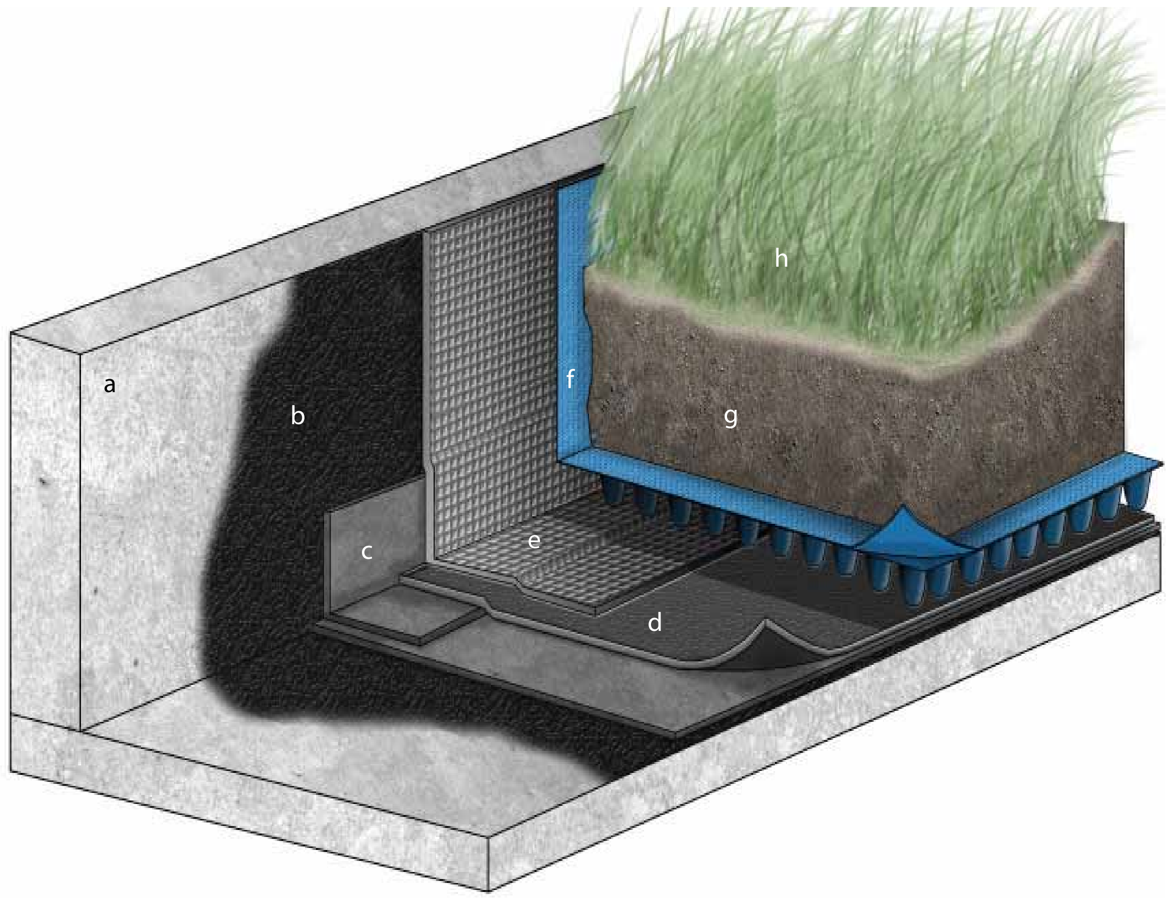
Figure 46: Schematic Section of a Green Roof

Slanted roofs can be retrofitted as green roofs using technology similar to flat roofs, but the drainage system has to accomodate more rapid rate of runoff and the roof edges must be retrofitted to contain the green roof system.

a shingle roof **b** waterproof membrane **c** drainage mat **d** soil filter fabric **e** growth media **f** vegetation

Figure 47: Schematic Section of a Slanted Green Roof

Green roofs can be installed or retrofitted on many roof types including: concrete, shingle, bituminous, slate, and asphalt.



a concrete roof **b** primed substrate **c** water proof membrane **d** root protection barrier
e protection board **f** filter fabric **g** growth media **h** vegetation

Figure 48: Schematic Section of a Concrete Green Roof

RESOURCES FOR STORMWATER BMPs

Websites

The following represent a small sampling of useful stormwater-related information.

American Institute of Hydrology
www.aihydro.org

American Society of Landscape Architects
www.asla.org

Baton Rouge Department of Public Works
http://brgov.com/dept/dpw

Center for Watershed Protection
www.cwp.org

Environmental Protection Agency
www.epa.gov

Environmental and Water Resources Institute of ASCE
www.ewrinstitute.org

International Stormwater Best Management Practices Database
www.bmpdatabase.org

Louisiana Department of Environmental Quality
www.deq.louisiana.gov

Louisiana State University Ag Center
www.lsuagcenter.com/en/environment/water_issues/quality/

Natural Resources Defense Council
www.nrdc.org

River Network
www.rivernetwork.org

Smart Growth Online
www.smartgrowth.org

Stormwater Authority
www.stormwaterauthority.org

City Parish Contacts

City Parish Planning Commission
planning@brgov.com

Department of Public Works
dpw@brgov.com

Reference Books

These books and articles offer perspectives and valuable resources for the implementation of Best Management Practices and Smart Growth.

Construction

Environmental Stewardship Practices, 2004. Procedures, and Policies for Highway Construction and Maintenance. Veneer Consulting and Parsons Brinckerhoff. Ernst, Caryn and Hart, Kelley.

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Abatement Reducing the degree or intensity of, or eliminating, pollution.

Acute Toxicity The ability of a substance to cause severe biological harm or death soon after a single exposure or dose. Also, any poisonous effect resulting from a single short-term exposure to a toxic substance.

Agricultural Pollution Farming wastes, including runoff and leaching of pesticides and fertilizers; erosion and dust from plowing; improper disposal of animal manure and carcasses, crop residues, and debris.

Aquifer An underground geological formation, or group of formations, containing water. Are sources of groundwater for wells and springs.

Assimilation The ability of a body of water to purify itself of pollutants.

Basin Any area draining to a point of interest.

Best Management Practice (BMP) Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Bioswale A long, gently sloped, vegetated ditch designed to filter pollutants from stormwater. native grasses are the most common vegetation, but wetland vegetation can be used if the soil is saturated.

Buffer strip A relatively undisturbed section of forest adjacent to an area requiring special attention or protection such as a stream, lake, or road.

Channel A natural stream which conveys surface runoff water within well-defined banks.

Culvert A metal, concrete, or plastic pipe through which water is carried.

Detention The temporary storage of stormwater runoff in a BMP with the goals of controlling peak discharge rates and providing gravity settling of pollutants.

Discharge Flow of surface water in a stream or canal or the outflow of groundwater from a flowing artesian well, ditch, or spring. Can also apply to discharge of liquid effluent from a facility or to chemical emissions into the air through designated venting mechanisms.

Drainage Impact Study (DIS) A component of the Stormwater Management Plan required by the stormwater management planning process.

Drainage structure A human-made structure that facilitates the movement of water off an area.

Dredging Removal of mud from the bottom of waterbodies. This can disturb the ecosystem and cause silting that kills aquatic life. Dredging of contaminated muds can expose biota to heavy metals and other toxics.

Dry Pond A facility that provides stormwater quantity control by containing excess runoff in a detention basin, then releasing the runoff at allowable levels.

Ecosystem The interacting system of a biological community and its non-living environmental surroundings.

Edge An area where two or more vegetation types converge.

Erosion The wearing away of land surface by wind or water, intensified by land-clearing practices related to farming, residential or industrial development, road building, or logging.

Eutrophication The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. During the later stages of eutrophication the waterbody is choked by abundant plant life caused by higher levels of nutritive compounds such as nitrogen and phosphorus. Human activities can accelerate the process.

Evapotranspiration The process of transferring moisture from the earth to the atmosphere by evaporation of water and transpiration from plants.

Filter strip A vegetated area of land that filters runoff and separates a water body from activities that generate runoff; or a vegetated area that collects, filters, and conveys water much like a bioswale.

Filtration A water treatment process for removing solid (particulate) matter and other pollutants from water by means of porous media such as sand, a man-made filter, or vegetation.

GIS (Geographic Information Systems) A set of powerful tools that visualize and manage large data sets with complex spatial and physical interactions. GIS helps identify potential problems and solutions, and facilitates alternatives and analysis using maps and other graphics depicting the outcome of each modeled alternative.

Gray Water Domestic wastewater composed of wash water from kitchen and laundry sinks, tubs, and washers. Does not include toilet water (black water).

Groundwater The fresh water found beneath the Earth's surface, usually in aquifers, which supplies wells and springs. Because groundwater is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants or leaking underground storage tanks.

Groundwater Discharge Groundwater entering near coastal waters which has been contaminated by landfill leachate, deep well injection of hazardous wastes, septic tanks, etc.

Habitat The place where a population (e.g., human, animal, plant, microorganism) lives and its surroundings, both living and non-living.

Hazardous Waste By-products of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity), or appears on special EPA lists.

Heavy Metals Metallic elements with high atomic weights; (e.g. mercury, chromium, cadmium, arsenic, and lead); can damage living things at low concentrations and tend to accumulate in the food chain.

Hydromodification The alteration of the natural flow of water through a landscape, and often takes the form of channel modification or channelization.

Hydrology The science dealing with the properties, distribution, and circulation of water.

Infiltration The penetration of water through the ground surface into sub-surface soil. The technique of applying large volumes of waste water to land to penetrate the surface and percolate through the underlying soil.

Integrated Stormwater Management An approach which regards stormwater as a resource rather than as waste which must be disposed of.

Invasive Species Introduced species or non-indigenous species that are rapidly expanding outside of their native range.

Load Allocation (LA) The portion of a receiving water's total maximum daily load that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources.

Maximum Daily Load The maximum pollutant load that a body of water can safely accommodate and meet water quality standards.

Mitigation Measures taken to reduce adverse impacts on the environment.

Native Species Originating naturally, growing or produced in a particular country or region, as animals or plants.

Natural Channel A watercourse created by the erosive forces of water moving over land. Drainage ditches are not considered natural channels.

Natural Drain A naturally occurring conveyance for he flow of water.

Natural Regeneration The planned regeneration of a forest that either uses existing trees as a source of seed or encourages sprouting from stumps or roots.

Nonpoint Source Pollution (NPS) Pollution which is induced by runoff; is not traceable to any discrete or identifiable facility; and is controllable through the utilization of best management practices.

Nonpoint Sources Diffuse pollution sources (i.e., without a single point of origin or not introduced into a receiving stream from a specific outlet). The pollutants are generally carried off the land by stormwater. Common nonpoint sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets.

Nutrient Any substance assimilated by living things that promotes growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.

Nutrient Pollution Contamination of water resources by excessive inputs of nutrients. In surface waters, excess algal production is the major concern.

Operation and Maintenance BMPs
Activities conducted after construction to ensure that facilities constructed to treat runoff water will be properly operated and maintained to be effective and efficient in stormwater management.

pH An expression of the intensity of the basic or acid condition of a liquid; may range from 0 to 14, where 0 is the most acid and 7 is neutral. Natural waters usually have a pH between 6.5 and 8.5.

Phosphorus An essential chemical food element that can contribute to the eutrophication of lakes and other waterbodies. Increased phosphorus levels result from discharge of phosphorus-containing materials into surface waters.

Phytoremediation Low-cost remediation option for sites with widely dispersed contamination at low concentrations.

Point Source A stationary location or fixed facility from which pollutants are discharged; any single identifiable source of pollution; e.g., a pipe, ditch, ship, ore pit, factory smokestack.

Potable Water Water that is safe for drinking and cooking.

Rain Garden A low-lying garden that intercepts stormwater runoff, filters it, and allows for percolation of water back into the groundwater supply

Receiving Waters A river, lake, ocean, stream, or other watercourse into which wastewater or treated effluent is discharged.

Recharge Zone A land area in which water reaches the zone of saturation from surface infiltration, e.g., where rainwater soaks through the earth to reach an aquifer.

Remediation Cleanup or other methods used to remove or contain a toxic spill or hazardous materials.

Retention The process of collecting and holding surface and stormwater runoff with no surface outflow. The amount of precipitation on a drainage area that does not escape as runoff.

Retrofit Addition of a pollution control device on an existing facility without making major changes to the generating plant.

Runoff That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into receiving waters.

Sediments Soil, sand, and minerals washed from land into water, usually after rain. They pile up in reservoirs, rivers and harbors, destroying fish and wildlife habitat, and clouding the water so sunlight cannot reach aquatic plants. Careless farming, mining, and construction activities will expose sediment materials, allowing them to wash off the land after rainfall.

Stormwater Precipitation that accumulates in natural and/or constructed storage and storm water systems during and immediately following a storm event.

Surface Water All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.).

Suspended Solids Small particles of solid pollutants that float on the surface of, or are suspended in water.

SWM Storm Water Management

SWPPP Storm Water Pollution Prevention Plan (required by Louisiana Department of Environmental Quality)

TMDL (Total Maximum Daily Load) The allowable loadings or other quantifiable parameters for a waterbody to meet the U.S. EPA's TMDL Program, authorized under Section 303(d) of the Clean Water Act (CWA), water quality standards. The CWA addresses waters in the nation that do not meet the national goal of "fishable, swimmable," despite implementation of nationally required levels of control pollution technology that requires each state to identify and develop TMDLs.

Total Suspended Solids (TSS) A measure of the suspended solids in wastewater, effluent, or waterbodies, determined by tests for "total suspended non-filterable solids."

Uptake The absorption by plant tissues of a substance, such as a nutrient, and its permanent or temporary retention.

Urban Runoff Stormwater from city streets and adjacent domestic or commercial properties that carries pollutants of various kinds into the drainage systems and receiving waters.

Wastewater The spent or used water from a home, community, farm, or industry that contains dissolved or suspended matter.

Water Quality Impact Study (WQIS) A component of the Stormwater Management Plan required by the stormwater management planning process.

Water Quality Standards (WQS) State-adopted and EPA-approved ambient standards for waterbodies. The standards prescribe the use of the waterbody and establish the water quality criteria that must be met to protect designated uses.

Watershed Approach A coordinated framework for environmental management that focuses public and private efforts on the highest priority problems within hydrologically defined geographic areas (watersheds) taking into consideration both surface and groundwater flow.

Watershed The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point. At the larger scale, East Baton Rouge Parish is in the Lake Ponchartrain Basin (watershed) and one-third of the U.S. drains into the Atchafalaya Basin (watershed).

Wetlands An area saturated by surface or groundwater with vegetation adapted for life under those soil conditions, as swamps, bogs, fens, marshes, and estuaries.

Wet Pond A facility that treats stormwater for water quality by utilizing a permanent pool of water to remove conventional pollutants from runoff through sedimentation, biological uptake and plant filtration.