CITY UTILITIES
DESIGN STANDARDS MANUAL

Book 2
Stormwater (SW)
SW11 Stormwater Management

September 2017

SW11.01 Purpose

The purpose of this Chapter is to define the minimum requirements of stormwater management for new development and redevelopment projects. The stormwater management plan must address the quality and rate at which the stormwater leaves the site. The most successful stormwater management plan will retain all the runoff on site for the water quality storm event and have limited discharges during greater storm events. All development and redevelopment projects must comply with these standards.

The use of the generic term "basin" in this chapter will be synonymous with a stormwater detention or stormwater retention feature for the sole purpose of providing a storage volume associated with reducing the peak discharge. It can include traditional above ground detention basins and underground detention.

SW11.02 Stormwater Management Plans (SMP) for New Development

All new developments require a SMP. The SMP is a function of the existing site conditions, the amount of new impervious area constructed and the capacity of the existing stormwater infrastructure.

A major component of SMPs is detention and/or retention of stormwater. It impacts the stormwater quality and the discharge rates of a development site.

1. The stormwater volume retained on site during the water quality storm (1-inch rainfall) event is a leading variable in meeting the stormwater quality imperative. The City adopted a post-construction stormwater quality policy that requires a reduction of least 80% of the total suspended solids in the stormwater before it leaves the site. A zero discharge from a development for the 1-inch storm event satisfies the water quality imperative. Additional stormwater quality measure are required if a zero discharge is not feasible for the water quality rainfall event. A stormwater quality unit (SQU) is an acceptable alternative to utilizing detention/retention for stormwater quality.
2. SMPs utilize basins during larger rainfall events to reduce the peak release rate of stormwater discharges from a site. The allowable peak release rate for new developments is the product of the total shed area of the new development per the release rate shown in Figure SW11.1.

Figure SW11.1 – Peak Unit Discharge Rates for New Developments

Design Storm	Release Rates (cfs/acre)
100 year	0.18

For example, the 100-year release rate for a 10-acre site is 1.8 cfs. (10 acres x 0.18 cfs/acre = 1.8 cfs)

There are particular site situations when a peak release rate is not applicable. These site situations include, but are not limited to:

- The change in impervious area is less than 0.5 acres.
- The site drains to a regional detention basin that was adequately sized for the proposed development.

- The site is immediately adjacent to a river or major open channel.
- The site is with the 100-year floodplain.
- The site will discharge into the low end of an existing stormwater infrastructure system with that has sufficient capacity for a direct outfall from the new development.

A preliminary meeting should occur with Development Services for all projects that propose stormwater release rates higher than those stated in Figure SW11.1. Exhibit SW11-1 outlines the process utilized to determine if a site is exempt from the peak discharge rate requirement.

New developments that are less than 2-acres require release rates less than 0.36 cfs. An orifice small enough to control a flow rate this low can be a maintenance issue. Contact Development Services to establish possible alternatives. Potential options include water quality offsets, or a minimum 3-inch diameter orifice.

Storm-water quality measures will be required for sites that are less than 1-acre and need to receive a variance to release at a rate greater than those allowed by Figure SW11.1.

SW11.03 Stormwater Management Plans (SMP) for Redevelopments

An SMP is also required for projects that include land disturbing activities associated with site renovations to an existing development or a redevelopment project. The critical element for these projects is the change in impervious surfaces, any increase in impervious area will require additional stormwater control. This includes existing developments that may or may not have existing stormwater detention facilities.

1. Redevelopment projects with a net reduction in impervious area and an increase in green areas will require little or no special post-construction water quality features. The stormwater quality leaving the site will improve because of the reduction in run-off. A preliminary meeting should occur with Development Services for all projects that propose no net change in impervious areas to discuss post-construction stormwater requirements.
2. Redevelopment projects that increase the net impervious area will require post-construction stormwater quality. The extent of the stormwater quality will be a function of the increase in impervious area. For example, if a 50-acre development is adding 2-acres of impervious area, the run-off from the 2-acres will require post-construction stormwater quality. Exhibit SW11-2 shows an example of defining the areas that affect the required extents for post-construction water quality of a redevelopment project.
3. The SMP may require a basin to control the peak discharge of the new impervious area. The peak discharge leaving the site, shall not increase from site renovations or redevelopment project. The 100-year peak release rate for the runoff from the new impervious areas and the disturbed construction limits shall not exceed the peak unit discharge rates shown in Figure SW11.1. Exhibit SW11-2 shows an example of defining the areas that affect the required stormwater peak discharges for a site redevelopment project.

4. If the existing development has a stormwater detention facility and the improvements to the site will continue to drain to the detention facility, the detention facility shall be calibrated to meet the new conditions. This typically will include increasing the detention volume and may require modifications to the outfall control structure.

5. Release Rate Options

   When a new detention basin is required to control the increase in impervious area runoff, there are two options for addressing release rates from redevelopment projects into a new basin. Both options are dependent upon the downstream receiving channel having sufficient capacity to convey the new flows.

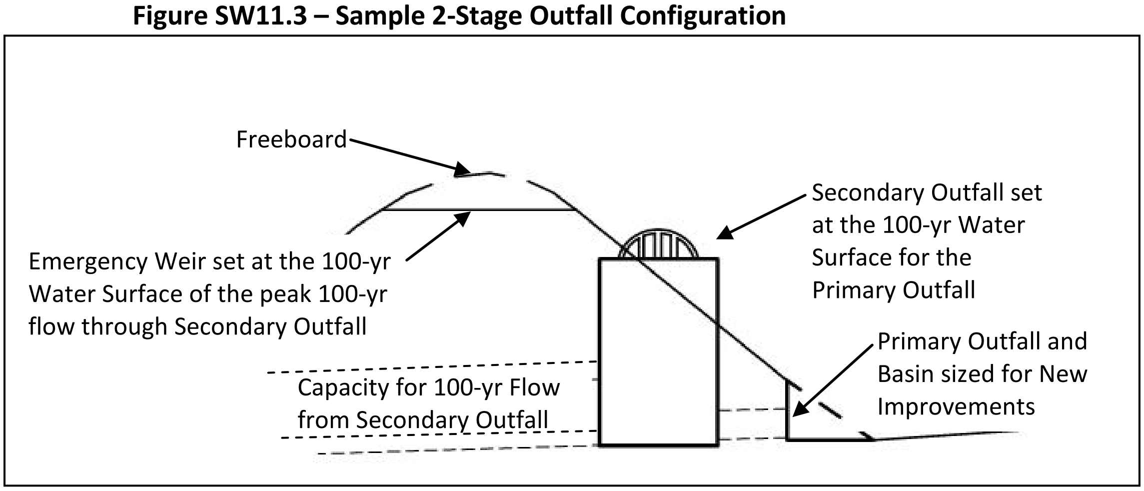
   Option 1 - The flows from the existing impervious surfaces can be passed through the new basin. This will require a 2-stage outfall. The release rate for the primary outfall will be the product of the area within the project's construction limits at the rate stated in Figure SW11.2. This will define the required release rate and the stormwater volume of the basin for the primary outfall.

   A second outfall will be set at the 100-year water elevation of the primary outfall. This second outfall must pass the peak 100-year flow from the existing site conditions that are outside of the proposed construction limits. The grade beam for the basin shall be at the peak 100-year water surface when the secondary outfall is passing the peak 100-year flow. Figure SW11-3 shows a sample of a 2-stage outfall configuration.

Figure SW11.2 – Detention Basin Method for Passing Existing Runoff

Primary Outfall	Sized to release at 0.18 cfs per acre for the shed area of the disturbed construction limits	Set at the pool elevation of the water quality retention or the basin floor
Secondary Outfall	Sized to release the peak 100-year flow of the undisturbed watershed	Set at the 100-year water surface of the Primary Outfall

Figure SW11.3 – Sample 2-Stage Outfall Configuration



Option 2 – The runoff from the existing impervious areas are routed around the new basin. The proposed project will follow the release rate as defined in Figure SW11.1 based on the new impervious areas and pervious areas draining to the new basin.

Development Services may dictate a reduced peak release rate for watersheds with known drainage issues. A reduced release rate will be required when the receiving channel or storm sewer is inadequate to accommodate the proposed discharge.

Development Services may require an overall watershed analysis, beyond the project's geographical limits, from the design consultant to determine the maximum allowable release rate for watersheds with known drainage issues.

Redevelopment projects with less than 2-acres of disturbed area require release rates less than 0.36 cfs. An orifice small enough to control a flow rate this low can be a maintenance issue. Contact Development Services to establish possible alternatives. Storm-water quality measures will be required for sites that are less than 1-acre and need to receive a variance to release at a rate greater than those allowed by Figure SW11.1.

SW11.04 Acceptable Stormwater Quality Calculation Methods

There are three acceptable methods for calculating the stormwater quality features. They are the:

- Reduced Runoff Method
- Volume Based Method
- Soil Conservation Service (SCS) Runoff Method

The type of stormwater quality feature will dictate which calculation method is required.

SW11.05 Reduced Runoff Method for Stormwater Quality Calculations

The Reduced Runoff Method (a.k.a. Quality Volumetric Control) is applicable when retaining the water quality storm event on-site. The objective is to prevent any of the runoff from the initial 1-inch rainfall from leaving the site. This method is the preferred option for providing water quality. The stormwater quality volume is discharged only by infiltration, evapotranspiration, and / or reuse of run-off. These calculations are required for low impact design (LID) water quality features that are "before the pipe" such as water quality swales, rain gardens and porous pavement.

Designers should utilize the LID storage volume within the site's stormwater quantity management calculations. This requires utilizing the retention within the LID features into the overall site hydrograph model with the appropriate rainfall for the 10-year and 100-year events. Refer to Exhibit SW11-3 which illustrates how some runoff volumes exit the system before leaving the site.

A "micro-model" of the overall development is used to document the stormwater retention for compliance with the stormwater quality imperative. All of the sub-basins of the site are modeled as interconnected basins. A site that has a zero discharge from the site per the micro-model for the 1-inch rainfall event is compliant with the stormwater quality imperative. The volume required in the detention basin(s) for larger rainfall events will be decreased by using this methodology.

The Reduced Runoff Method is described below.

1. Delineate the sub- or micro-watersheds. A micro-watershed is the area that contributes to an LID feature. The micro-watershed will have the impervious and the pervious areas delineated separately.
2. Determine the time of concentration for each LID feature using the TR-55 methodology per Exhibit SW5-1 "Time of Concentration Worksheet". The minimum time of concentration for any micro- watershed is 5 minutes.
3. Calculate the curve numbers (CN) for the impervious area and the pervious area of each basin per Exhibit SW5-3 "Runoff Curve Numbers for Urban Areas".
4. Determine the available storage volume and release paths for each LID feature. The LID features will be modeled as ponds with overflow weirs at an elevation above the water quality storage volume. The infiltration rate of LID features shall be included in the calculations as a constant outflow rate based on the soil permeability established by geotechnical report and the bottom surface area of the water quality feature. See Exhibit SW11-4 "Methodology for Modeling LID Features" for the method required to calculate the LID features.
5. Construct a micro-model using the above input parameters. See Exhibit SW11-5 for an example of a modeling diagram for the reduced run-off method.
6. Run a hydrograph calculation for each LID feature utilizing the TR-20 method of modeling the 1-inch storm with the appropriate Huff rainfall distribution at the 0.5-, 1-, 2-, 3-, 6-, 12-and 24-hour durations.
7. A zero discharge from the site during a 1-inch rainfall is considered a successful PC-SWPPP for stormwater quality.

The stormwater quality micro-models shall be incorporated into the site's overall stormwater quantity management calculations.

SW11.06 Volume Based Method Stormwater Quality Calculations

Volume based stormwater quality calculations can be utilized for sites to treat and release the water quality volume (WQv), sometimes referred to as the conventional stormwater quality volume. It is defined as the volume needed to capture 80% of the rainfall events at a site. It is utilized for sizing "end of pipe" performance based LID features such as bioretention basins and wet detention basins. The storage in forebays and other pre-treatment trains are included in the WQv.

The volume based stormwater quality calculation is:

$$WQ_v = \frac{(P)(R_v)(A)}{12}$$

Where:

WQ_v = Water quality volume in acre-feet

P = Water quality storm, 1-inch rainfall

R_v = Volumetric runoff coefficient, 0.05+0.009(I)

where I is the percent impervious cover

A = Drainage area in acres

The draw-down time for the WQv must be 12 to 48 hours to meet the required stormwater quality imperative.

SW11.07 SCS Method for Proprietary Stormwater Quality Units (SQUs)

The stormwater quality rate shall be determined using the Soil Conservation Service (SCS) runoff methodology for proprietary SQUs. Proprietary stormwater quality units (SQUs) shall be used when LID stormwater quality techniques are not a reasonable option.

The capacity of a proprietary SQU is sized based on the stormwater quality treatment rate. These treatment rates are the peak flow through the SQU that will remove 80% or more of the total suspended solids during the 0.3-inch rainfall event. The stormwater quality rate is determined using the SCS runoff methodology as outlined below.

1. Delineate the watershed basin(s) to be served by the proposed proprietary stormwater quality unit(s). Tabulate the total impervious and pervious areas. The sizing calculations assume the impervious area is connected directly to the stormwater quality unit and the time of concentration calculation must be adjusted for this assumption (i.e. no flow over grass) for the impervious basin. This is accomplished by creating two basins, one with an area equivalent to the total new impervious area and the other with an area equivalent to the total pervious area of the delineated watershed to be served by the SQU.
2. Determine the time-of-concentration for each basin using the TR-55 methodology, Exhibit SW5-1 "Time of Concentration Worksheet". The minimum time of concentration shall be 5 minutes.
3. Calculate the curve numbers (CN) for each basin, use a CN=98 for the impervious basin(s).
4. Use the hydrograph method to determine the peak discharge from the 0.3-inch storm using the appropriate Huff, 50% rainfall distribution. See Figure SW5.4 "Huff Rainfall Distribution"
5. A single hydrograph for each basin should be determined and all basin hydrographs combined to determine the peak flow for the water quality rate. Storm durations of 15, 30 and 45 minutes as well as 1, 2, 3, 6, 12 and

24 hours should be checked to determine the peak water quality rate of flow.

See Exhibit SW11-6 for an example of the rated based stormwater calculations.

The various proprietary SQUs have maximum treatment rates established by independent labs. The treatment rates of proprietary SQUs that are preapproved for use are found in Exhibit MA5-3.

All proprietary stormwater quality units shall be off-line and upstream of any stormwater detention facilities. Use of SQUs downstream of stormwater detention facilities is prohibited.

SW11.08 Stormwater Detention Calculations

There are two acceptable methods for calculating stormwater detention facilities: the Rational Method and the Hydrograph Method.

1. Rational Method

   The Rational Method or the Hydrograph Method can be used for projects of 20 acres or less.

   - The Rainfall Intensities shall be per Figure SW5.2 "Intensity-Duration-Frequency" or the current "Precipitation-Frequency Atlas of the United States" by NOAA. The NOAA publication will govern if there is a significant difference in the values.
   - The run-off coefficients shall be based on values per Exhibit SW5-2 "Coefficients for Use in Rational Formula".
   - The outfall rate shall be per Figure SW11.1 or per Figure SW11.2 as appropriate.

2. Hydrograph Method

   The Hydrograph Method can be used for projects smaller than 5 acres and shall be used for projects greater than 20 acres in area.

   - The Rainfall values shall be per Figure SW5.3 "Depth-Duration-Frequency" or the current "Precipitation-Frequency Atlas of the United States" by NOAA.
   - The runoff curve numbers shall be composites based on Exhibit SW5-3 and Exhibit SW5-4.
   - The appropriate Huff Distribution shall be utilized in the hydrograph method per Figure SW5.4 "Huff Rainfall Distribution".
   - The detention provided by LID features, if applicable, should be utilized in the overall detention calculations. See Exhibit SW11-5 "Reduced Runoff Method (Micro Model)" for additional information.

   Use of the NRCS Type II 24-Hour Rainfall Distribution will not be accepted.

   See Exhibit SW11-12 for a sample detention facility design Summary.

SW11.09 Acceptable Types of Stormwater Storage Facilities

The majority of SMPs will require stormwater storage to meet the peak discharge requirements. The following types of facilities are acceptable in Fort Wayne.

1. Detention Basins (Wet or Dry)
2. Retention Basins
3. Underground Detention
4. Parking Lot Detention
5. Porous Pavement Systems

Other types of stormwater storage facilities will require conceptual approval by Development Services prior to the calculation submittals.

Channel or stream inline stormwater storage is prohibited.

SW11.10 Design Standards for Detention and Retention Basins

Detention basins with a permanent pool are considered wet detention basins. Dry detention basins have no permanent pool. Special considerations can be incorporated into some designs to meet stormwater quality requirements.

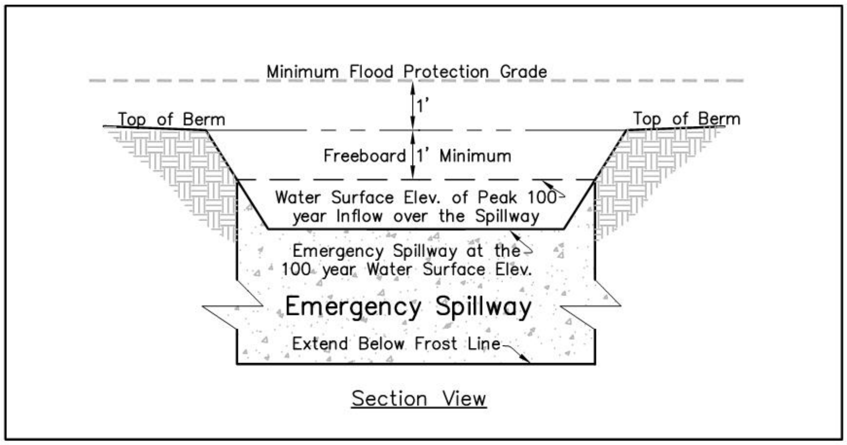
Retention basins have no obvious outfall. They drain by percolation into the soil and evapotranspiration processes. They share the same design standards and physical characteristics as the detention basins except for the lack of an outfall structure. Retention basins satisfy the stormwater quality requirements.

This manual will use the generic term “stormwater basin” to include detention and retention basins. Stormwater basins must comply with the following criteria:

1. Grading Requirements
   - The maximum side slope is 3:1.
   - The minimum top of berm width is 8-feet.
   - Berms constructed of fill material are to be keyed into virgin soil and compacted to a Standard Proctor Value of at least 95% dry density.
2. Use of Retaining Walls
   - The use of retaining walls in stormwater basins is generally discouraged. However, if walls are unavoidable, they shall receive railing or fencing to prevent falls when the vertical change is 30” or greater from the top of the wall to the ground (basin floor) below.
   - A professional engineer shall stamp the retaining wall plans. The structural design details and requirements for the retaining wall(s) shall be included in the construction drawings.
3. Emergency Spillway
   - Stormwater basins shall have an emergency spillway. The spillway shall be set at the basin’s peak 100-year water elevation. It shall be sized to pass the peak 100-year inflow.

- The spillway must direct the emergency overflows away from buildings and other structures.
- The emergency spillway must be resistant to vertical movement; concrete grade beams must extend below the frost line.

Figure SW11.4 – Emergency Spillway, Freeboard and Minimum Flood Protection Grade



4. Freeboard

Stormwater basins shall have a minimum of 1-foot of freeboard. Freeboard is the vertical difference between the basin's top of berm and the water surface of the peak 100-year inflow passing over the emergency spillway.

5. Minimum Flood Protection Grade

- All buildings adjacent to a stormwater basin shall have a Minimum Flood Protection Grade established. The elevation shall be 2-feet above the water surface elevation of the peak 100-year inflow passing over the emergency spillway (1-foot above the freeboard elevation). "Adjacent" to a stormwater basin shall be any building that is within 100-feet of the basin's peak water limits or on a parcel that is contiguous with the basin.
- The Minimum Flood Protection Grade applies to the lowest opening of a building that surface water could enter: a basement window, a walkout basement doorway or the structure's finished floor, whichever is lower.

6. Pipe Outfalls into the Basin

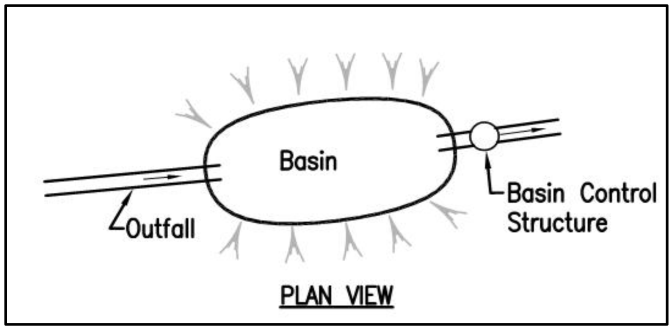
Pipes that outfall into stormwater basins shall have:

- Screen or bars to prevent entry by people or animals. Pipes that are smaller than 12-inches in diameter are exempt from having screens or bars.
- Energy dissipaters (e.g. riprap aprons or forebay).

- Anchoring to prevent vertical movement of pipe materials that are susceptible to floating. The anchor can be a concrete end section, ties to a concrete footer or other similar means.

The storm sewer outfall must be upstream of the stormwater basin's storage volume. Figure SW11.5 is the acceptable flow configuration. Basin outfall shall be above the normal water surface elevation.

Figure SW11.5 – Acceptable Flow Configuration between Outfall & Basin



7. Stormwater Basin Control Structures

Stormwater basin control structures limit the peak flows as established by Figures SW11.2 or SW11.3, as appropriate. The control structure can control the flows by utilizing orifices, weirs and/or culvert pipes. The minimum size of a pipe connected to the control structure is 12-inches regardless of the basin's release rate. The connected pipe must have capacity to handle the peak release rate of the basin by gravity flow.

Stormwater basin control structures must be designed to minimize the chances of clogging. Exhibit SW11-7 includes examples of control structures that are designed to minimize clogging.

Stormwater basin control structures must be vertically stable. Pipes and structures that are susceptible to floating must be anchored to prevent vertical movement. The anchor can be a concrete end section, ties to a concrete footer or other reasonable means.

8. Public Protection Guidelines

Stormwater basins can be a public hazard. The basins shall incorporate the following to reduce the risk of accidental entry by vehicles. Refer to Exhibit SW11-8.

a. Parking spaces that are perpendicular to and adjacent to stormwater basins shall have:

   - A 6-inch (or taller) non-mountable curb or
   - An earth berm that is at least 3-feet higher in elevation that the edge of the parking lot pavement.

b. Drives and streets that are parallel to stormwater basins shall have:

- A 6-inch (or taller) non-mountable curb or
- An earth berm that is at least 3-feet higher in elevation than the driving pavement.

c. Drives and streets that terminate perpendicular to stormwater basins shall have a visible barrier such as a dual arrow sign or substantial shrub hedge and either:

- A 6-inch (or taller) non-mountable curb or
- An earth berm that is at least 3-feet higher in elevation than the driving pavement.

9. Landscaping Guidelines

Landscaping around stormwater basins shall not be detrimental to the basin's structural integrity, overall performance or safety. In addition:

- No mulch shall be placed in or around basin.
- Landscaping shall allow for adequate vehicle access and general maintenance around the top of detention basin embankments. There shall be at least one access path to the bottom of dry detention basins that will accommodate lawn mowing equipment or small earth moving equipment.
- Surface vegetation shall provide erosion control and sediment entrapment.
- Side slopes, berms and basin surface shall be planted with species compatible with the expected hydrologic conditions.

10. Multi-use Configuration

Lands dedicated to detention/retention facilities should be laid out to promote multiple uses such as green spaces for recreational activities, wildlife habitat and/or buffer space between mixed uses.

The construction of some basins may require state approval. Any dam constructed for the purpose of storing water, with a surface area, volume, or dam height as specified in Indiana Code 14-27-7.5 and Title 312 IAC 10.5 Regulation of Dams as amended, shall require the approval of the plans by the Indiana Department of Natural Resources (IDNR). Those facilities subject to state statutes shall be designed and constructed in accordance with the criteria of the state, in addition to these criteria.

SW11.11 Stormwater Pretreatment

Stormwater entering basins and the majority of LID stormwater quality features requires pretreatment. The purpose of the pretreatment is to reduce the energy gradient and capture the larger loads of the pollutants in the stormwater. Pretreatment measures associated with stormwater basins include forebays and biofilters. SQU's can be used in lieu of a forebay and biofilter.

1. Forebays

The most common pretreatment practice for stormwater basins is a forebay. Forebays are not stand alone post-construction stormwater quality practices. Figure 11.06 depict a typical section view of a forebay.

a. Design Considerations

- The forebay must be sized to contain the volume equal to 0.1-inches of rain per impervious acre of contributing drainage shed area. For Example:

  There is 0.8 acres of impervious area in a 1.5 acres shed area. The forebay size would be 290 cu. ft.

$$0.8\text{ acres x }\frac{43560\text{ sq. ft.}}{1\text{ acre}}\text{x }\frac{0.1''}{12''} = 290\text{ cu. ft.}$$

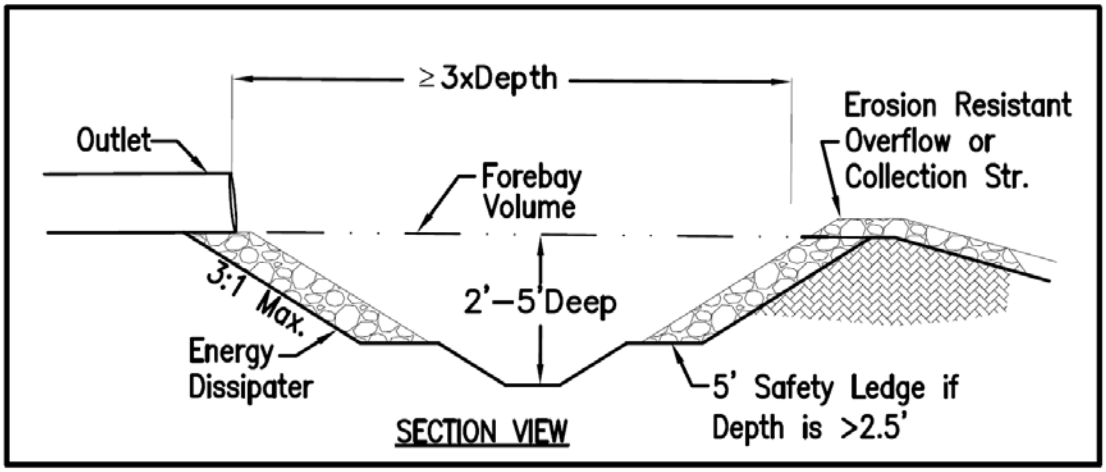
- The volume of the forebay is to be included in the total stormwater quantity management volume.
- The forebay must have direct maintenance access. The maintenance access shall have a maximum grade of 3:1.
- The side slopes of the forebay shall not exceed 3:1.
- The minimum depth of the wet forebay shall be 2.5-feet.
- The maximum depth of the wet forebay shall be 5-feet. A safety ledge is required when the forebay depth will be greater than 2.5-feet. Safety ledge requirements are included in Section SW11.12.
- The minimum flow length from the inlet pipe to the forebay overflow structure shall be 3 times the depth.
- The forebay overflow can be an earthen berm with scour protection, a concrete grade beam or a concrete structure such as a manhole with a grate.
- The wet perimeter of the forebay shall have native wetland grasses and other native wetland plants. A list of acceptable native plants is available at http://www.cityoffortwayne.org/utilities/images/stories/designman/PlantListFinal.pdf.
- If the forebay is used as a sediment control measure during construction, the forebay must be restored to the design capacity after the site has substantial vegetation established.

b. Operation and Maintenance Considerations

- It must include a schedule for inspection and maintenance of the forebays. Forebays shall be inspected at least twice a year.
- It must identify a process for measuring the sediment deposits within the forebay. This can be by requiring a fixed vertical sediment depth marker, specifying a depth from the pipe outfall or another logical method.
- It must state when the sediment deposits from the forebay needs to be removed. This should be given as a depth of sediment accumulation that is equal to the loss of 50% of the forebay's capacity or at least once every 5 years, whichever occurs first.

- It must address inspection and maintenance requirements for excessive weed and algae growths within the forebay(s).
- It must address mosquito control.

Figure SW11.6 – Forebay Example



2. Biofilters

Biofilters, like forebays, are pretreatment practices. They are not stand alone post-construction stormwater quality practices. The biofilters use dense vegetation to slow the velocity of the run-off so that large suspended solids can settle out of the flow. The vegetation also acts as a mechanical filter. Figure 11.8 depicts a typical section view of a biofilter.

a. Design Considerations

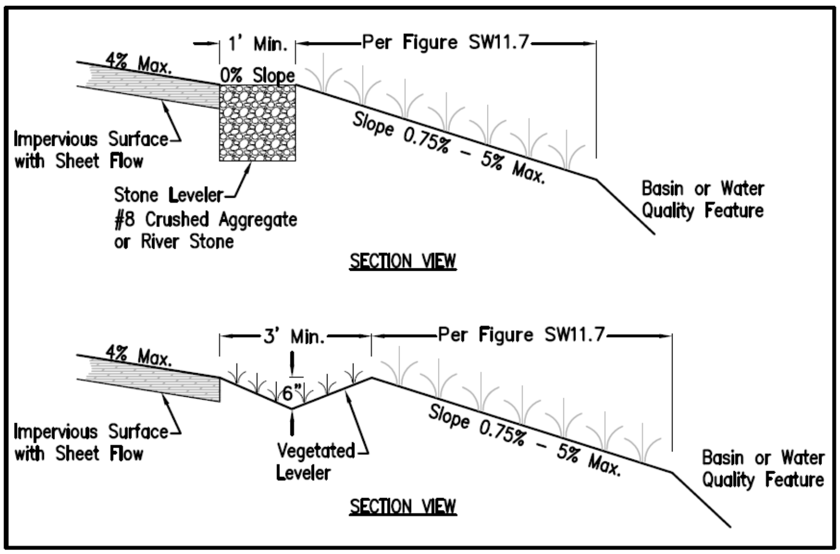
- The drainage area entering a biofilter shall be 5 acres or less.
- The biofilter shall be densely vegetated with grasses. It can include trees and other wood-stemmed vegetation but mulch is prohibited.
- The water entering and traveling through the biofilter shall be by sheet flow. (No concentrated flow outfalls.)
- A leveler is required between the impervious surface and the biofilter to insure the surface flows are entering the biofilter as a fully distributed sheet flow. The leveler can be:
    - a 12-inch width, or greater, band of crushed aggregate or river stone with no slope
    - a concrete grade beam or
    - a 3-foot wide vegetated buffer that has retentive grading of 6-inches, or more.
- The minimum slope for a biofilter is 0.75%.
- The maximum slope for a biofilter is 5%.
- The width of the biofilter shall be at least 20-feet. The width is measured perpendicular to the flow.
- The length of flow across the biofilter shall be per Figure SW11.7. The length is measured parallel to the flow.

Figure SW11.7 – Maximum Flow Parameters for Biofilters

Parameters	Impervious Areas				Pervious Areas			
Inflow Approach Length*	≤35’		35’-75’		≤75’		75’-100’	
Biofilter Strip Slope	≤ 2%	> 2%	≤ 2%	> 2%	≤ 2%	> 2%	≤ 2%	> 2%
Biofilter Strip Length	10’	15’	20’	25’	10’	12’	15’	18’

** Greater inflow approaches will be produce run-off flows that exceed the benefit capacity of the biofilter.*

Figure SW11.8 – Section View of Biofilters



b. Operation and Maintenance Considerations

- It must include a schedule for inspection and maintenance of the biofilter. Biofilters are to be inspected at least twice a year.
- The biofilter shall be inspected for “rill and gulley erosion” at least twice a year. These areas shall be repaired and reseeded as necessary.
- The drainage flows into the biofilter should be inspected for concentrated flow characteristics. These characteristics are to be addressed.
- The leveler shall be inspected for erosion or other grading changes that negates its function.

SW11.12 Design Standards Unique to Wet Basins

In addition to the requirements of Section SW11.10 “Design Standard for Detention and Retention Basins”, wet basins shall also conform to the following requirements:

- Wet Basins shall be at least 1 mile from an airport unless the Fort Wayne – Allen County Airport Authority has provided prior permission in writing.

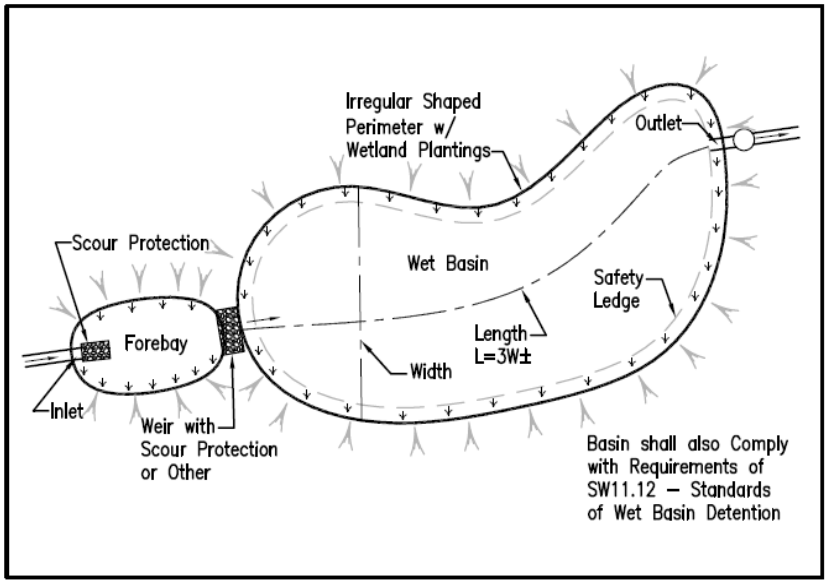
- A maintenance ledge of at least 6-feet in width is required around the wet basin. The maintenance ledge shall be 12-inches, measured vertically, above the normal pool elevation.
- A safety ledge of at least 6-feet in width is required. It shall be between 12-inches and 18-inches below the normal water surface.
- The average permanent pool depth of a wet basin shall be at least 4-feet.
- The basin shall have pockets that are at least 8-feet deep. The areas of the pockets are to be 25% or more of the basin's surface area.
- Bank armor to prevent wave action erosion is required 6-inches above and 6-inches below, measured vertically, the normal pool elevation. The armor can be stone, crushed aggregate or a proprietary product.
- Refer to Exhibit SW11-9 for an example of a typical plan view and cross section.

Wet detention basins can also be used for meeting the stormwater quality requirements. For a wet detention basin to meet the 80% TSS removal it shall comply with the following criteria. Figure 11.9 depicts a typical wet detention basin.

1. Design Considerations

- The basin shall have a length to width ratio of 3:1 or greater. The length is the travel distance between the inlet and outlet structures. The width of the basin is the empirical average.
- The length shall be maximized. Baffles or other controls shall be used when the placement of the inlet and outlet structures cannot be maximized.
- Irregular basin shapes are encouraged.
- The wet perimeter of the basin can have native wetland grasses and other native wetland plants in place of the bank armor required in Exhibit SW11-10. Refer to http://www.cityoffortwayne.org/utilities/images/stories/designman/PlantListFinal.pdf for a list of acceptable native wetland plants.
- All basins being used for water quality must include a forebay or SQU where the concentrated flow discharges into the basin(s).
- All pipes that discharge into the basin require energy dissipation treatments.
- The minimum drainage area for a wet detention basin to be utilized for water quality and stormwater management is 25 acres or if it has a drawdown time of at least 12 hours for the water quality storm event.
- If the basin and/or forebay are used as a sediment control measure during construction, the basin and/or forebay must be restored to the design capacity after the site has substantial vegetation established.

Figure SW11.9 – Typical Wet Detention Basin for Water Quality



2. Operation and Maintenance Manual Considerations

- It must include a schedule for inspection and maintenance of the basin and the basin's accessories such as forebays.
- It must address inspection and maintenance requirements for excessive weed and algae growths within the basins.
- It must be inspected for sediment accumulation at and above the safety ledge. A decrease in volume of 35% or more in comparison to the approved design drawings will require sediment removal.

SW11.13 Design Standards Unique to Dry Basins

In addition to the requirements of Section SW11.10 "Design Standard for Detention and Retention Basins", dry basins shall also conform to the following requirements:

- Dry basins shall completely drain within 48 hours of the rainfall event.
- Dry basins shall have a minimum longitudinal grade of 0.5% to the outlet structures.
- The dry basin shall have a minimum cross-slope of 1%.
- Refer to Exhibit SW11-10 for an example of a typical plan view and cross section.

Dry detention basins by themselves do not meet the stormwater quality requirements. A micropool component can be added to reach the stormwater quality requirements. This configuration is a micropool extended detention basin. For a micropool extended detention basin to meet the 80% TSS removal it shall comply with the following criteria. Figure SW11.10 depicts a typical micropool extended detention basin.

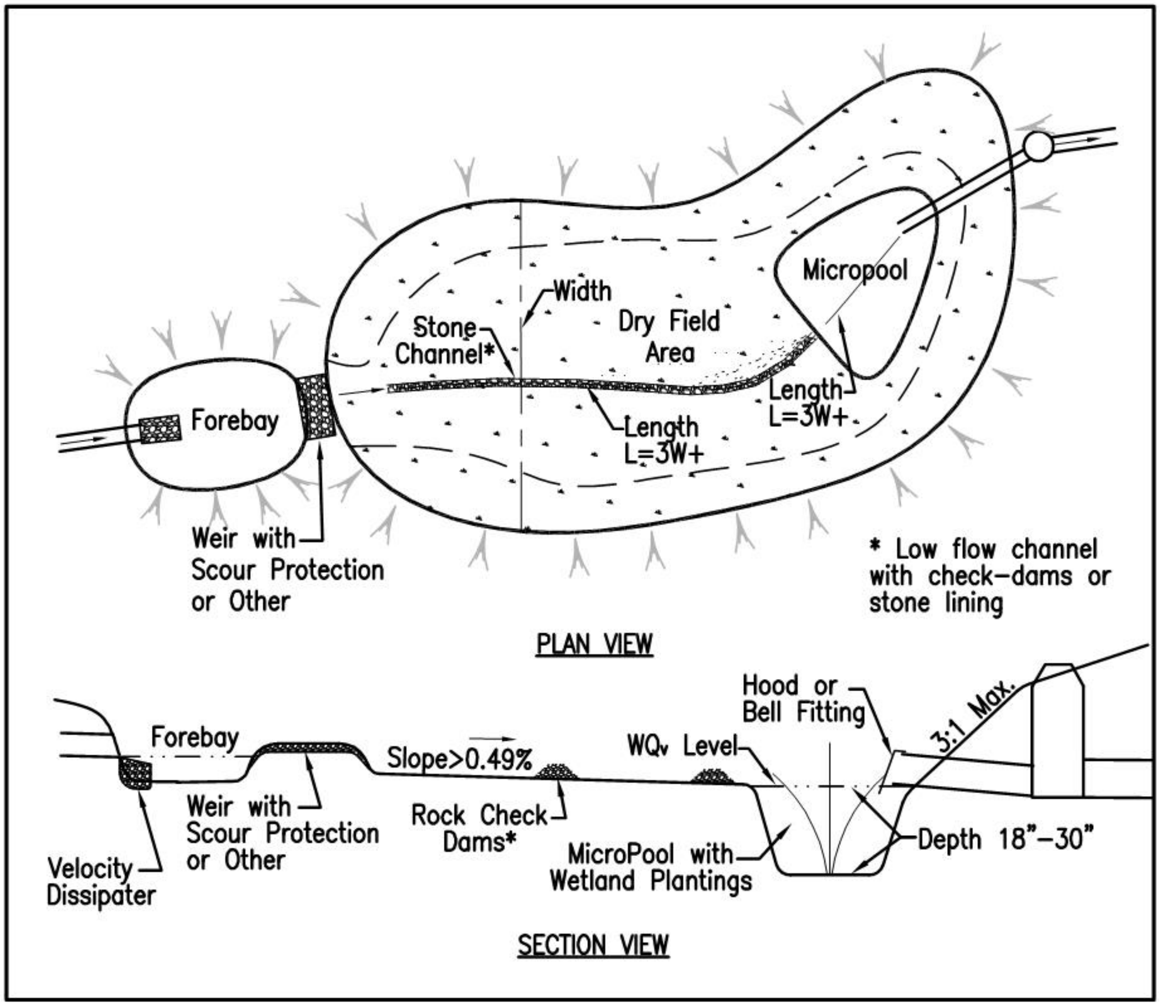
1. Design Considerations

   - The basin shall have a length to width ratio of 3:1 or greater. The length is the travel distance between the inlet and outlet structures. The width of the basin is the empirical average.
   - The length shall be maximized. Baffles or other controls shall be used when the placement of the inlet and outlet structures cannot be maximized.
   - Irregular basin shapes are encouraged.
   - A forebay is required at the concentrated flow discharges into the basin(s).
   - All pipes that discharge into the basin require energy dissipater treatments.
   - The minimum drainage area for a micropool extended detention basin is 10 acres or if it has a drawdown time of at least 12 hours for the water quality storm event.
   - If the basin and/or forebay are used as a sediment control measure during construction, the basin and/or forebay must be restored to the design capacity after the site has substantial vegetation established.
   - The micropool shall be 18-inches to 30-inches deep.
   - The micropool shall have a length to width ratio of 3:1 or greater.
   - The micropool shall be planted with wetland vegetation. Refer to http://www.cityoffortwayne.org/utilities/images/stories/designman/PlantListFinal.pdf for a list of acceptable native wetland plants.
   - The outfall control structure shall be protected with a hood or turned-down elbow to prevent debris from entering the structure.
   - A low-flow channel between the forebay and the micropool should be defined. The channel shall be lined with INDOT #2 stone or include permanent rock check dams to reduce flow velocities.

2. Operation and Maintenance Manual Considerations

   - It must include a schedule for inspection and maintenance of the basin and the basin's accessories such as forebays.
   - It must address inspection and maintenance requirements for the vegetation within the basin and the micropool.
   - It must be inspected for sediment and organic accumulation in the micropool. A decrease in volume of 50% or more in comparison to the design drawings will require removal of the accumulations.
   - The manual shall address the inspection of the wetland vegetation in the micropool and require removal of invasive species.
   - It must specify the inspection of the basin's banks for signs of erosion.
   - It must address inspection for and control of mosquito larva.

Figure SW11.10 – Typical Micropool Extended Detention Basin



SW11.14 Design Standards for Retention Basins

Retention basins have no obvious outfall. They drain by percolation into the soil and other evapotranspiration processes.

A site investigation is required to determine if the site is appropriate for a retention basin. A geotechnical engineer or a registered soil scientist shall conduct the investigation. The investigation must include at a minimum:

- Location of the groundwater table
- Location of bedrock
- Seasonal fluctuation of water table
- Soil permeability and porosity
- Soil profile
- Environmental conditions (e.g. contaminated soils)
- Proximity to structures (e.g. basements).

1. The following conditions preclude the use of a retention basin:
   - A seasonal high groundwater table that is less than 4-feet below the bottom of the basin.
   - Bedrock within 4-feet of the bottom of the basin.
   - Surface and underlying soil classified as NRCS Hydrologic Soil Group D.
   - Saturated infiltration rate not sufficient to drain the basin dry for the 100-year storm event within 72 hours.
   - Fill material is utilized to bring the bottom of the basin to design grade.
   - A negative recommendation by the registered soil scientist or geotechnical engineer.

The general requirements of a retention basin shall be the same as those required for a dry detention basin set forth in Section SW11.13.

Retention basins meet the stormwater quality requirements because they have a zero discharge, excluding infiltration. There are several stormwater quality features that utilize retention of the stormwater quality event on-site such as constructed wetlands, bioretention basins, and bioswales.

SW11.15 Design Standards for Constructed Wetlands

Constructed wetlands will remove 83% of the total suspended solids. The use of naturally existing wetlands as the water quality practice is prohibited.

The soils, vegetation selections and various pool depths are critical to designing a successful constructed wetland. The design must be by a professional wetland scientist, a licensed landscape architect, or a professional engineer with at least 3 years of experience with wetland design experience.

The constructed wetlands must meet or exceed the following requirements to be considered successful in accomplishing the stormwater quality imperative. Figure SW11.12 depicts a typical wetland configuration.

1. Design Considerations
   - A geotechnical report shall be prepared for the site. The report must be based on site-specific field data. The general information gathered from the soil surveys is insufficient for designing wetlands and bioretention basins.
   - Soil types conducive to wetland vegetation need to be present. These soil types can be imported to create an appropriate soil liner for the proposed wetlands. These soil types are identified in Exhibit SW11-11 Hydric Soils Suitable for Wetland Construction.
   - A water balance must be performed to demonstrate that a stormwater wetland could withstand a thirty-day drought at summer evaporation rates without completely drawing down the pool elevation. The inflow of water must be greater than that leaving the wetland by infiltration or exfiltration. The following water balance equation should be included in the wetland calculations:

$$S = Q_i + R + Inf - Q_o - ET$$

Where:

S = net change in storage
Q_i = stormwater runoff inflow
R = contribution from rainfall
Inf = net infiltration (infiltration – exfiltration)
Q_o = surface outflow
ET = evapotranspiration

- The wetlands must be designed for a detention time of approximately 48-hours for the water quality volume. Refer to Exhibit SW11-5 for an example of the "Reduced Runoff Method".
- The surface area of the wetland must be greater than 12% of the water shed surface area draining into it.
- The wetlands shall have a length to width ratio of 2:1. The length is the travel distance between the inlet and outlet structures.
- All concentrated discharges into the wetlands must be into a forebay.
- The design must maximize the use of pondscape grading to create vertical diversity. The proportion for the wetlands surface area for the different depths must comply with Figure SW11.11 "Required Vertical Depths for Constructed Wetlands".

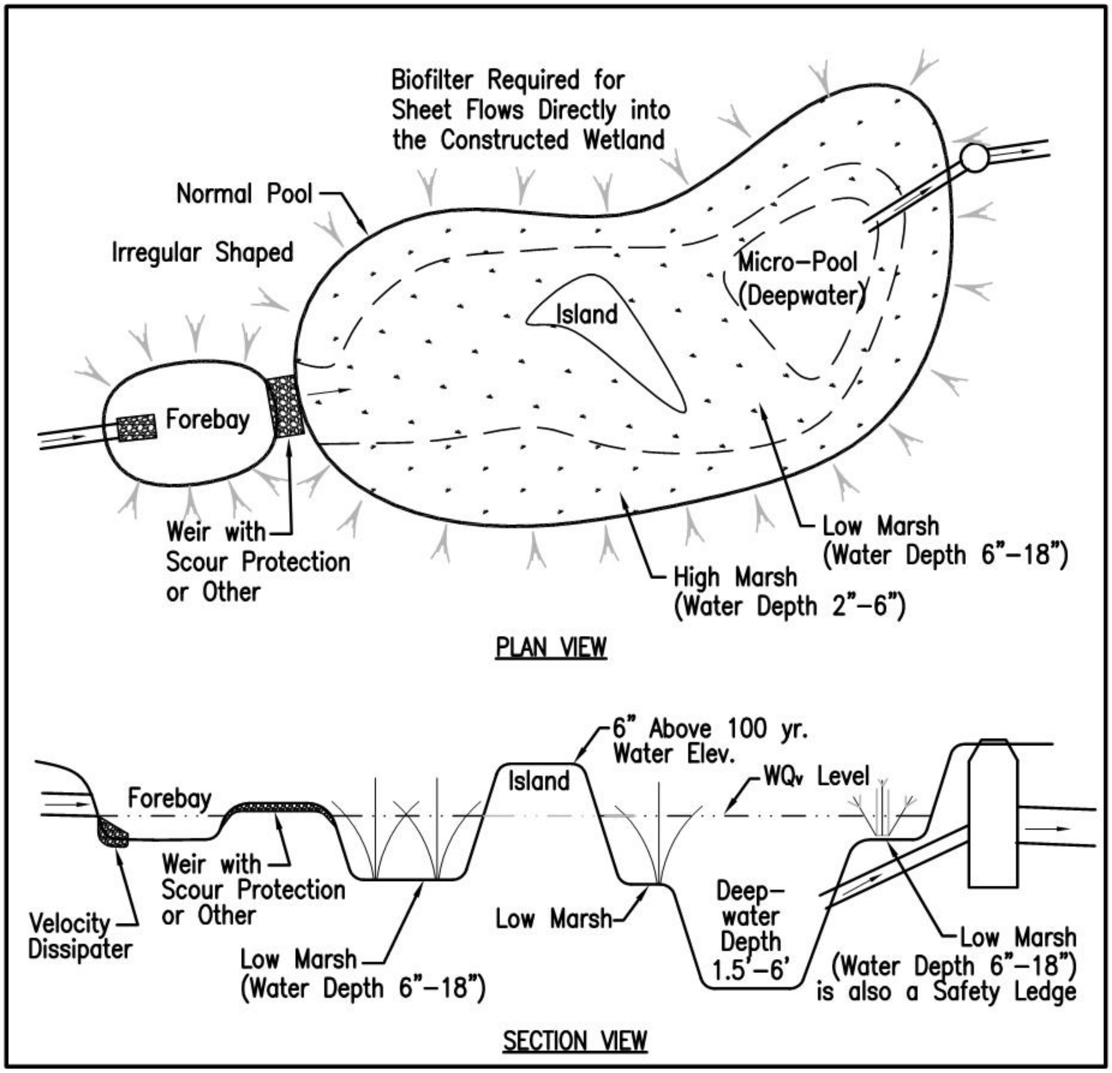
Figure SW11.11 – Required Vertical Depths for Constructed Wetlands

Strata	Depth from Pool Elevation	Surface Area
Deepwater	1.5' to 6' below	20%
Low Marsh	6" to 8" below	35%
High Marsh	0" to 6" below	40%
Semi-wet Zone	Areas of periodic flooding	5%

- A minimum of two types of aggressive emergent wetland species (primary species) that are native to Indiana shall be established in a quantity of 30%-50% coverage of the appropriate wetland surface area. The plantings shall be at the optimal pool depth required for the selected wetland species of emergent wetland plants. These plantings shall be near the pool's edge.
- An additional three wetland species of native vegetation (secondary species) shall also be planted within the wetland. The secondary species must be planted at a rate of 50 individual plants per acre of total wetland surface area. They are to be planted in clumps of approximately 5 individual plants. The plantings shall be at the optimal pool depth required for the selected wetland species.
- A minimum 25-foot buffer must be planted around the wetland with native riparian and upland vegetation.
- A micro-pool is required at the outfall of constructed wetlands. It can be a part of the deepwater strata.

- The outfall shall be a reversed pipe or protected by a hood.

Figure SW11.12 – Typical Constructed Wetland Configuration



2. Operation and Maintenance Considerations

   - A schedule shall be included for the inspection and maintenance of the wetlands and its accessories.
   - The wetland vegetation coverage shall be at least 50% of the surface area after the second growing season.
   - Monitor wetland vegetation and address “bare” spots as necessary on a semi-annual schedule after the third year.
   - Inspect for invasive vegetation and remove, as necessary, on an annual schedule.
   - Inspect inlet, outlet and embankments for damage on an annual schedule.
   - It must address inspection and maintenance requirements for excessive algae growths within the wetlands.

- The wetland must be maintained to prevent the loss of volume of ponded water available for emergent vegetation due to sedimentation and/or biomass.

SW11.16 Design Standards for Constructed Bioretention Basins

Constructed bioretention basins will remove approximately 90% of the total suspended solids. The volume of stormwater stored in a bioretention basin shall be included in the stormwater management detention calculations.

The bioretention must meet the following requirements to be considered successful in accomplishing the stormwater quality imperative. Figure 11.13 depicts a typical bioretention basin configuration.

1. Design Considerations

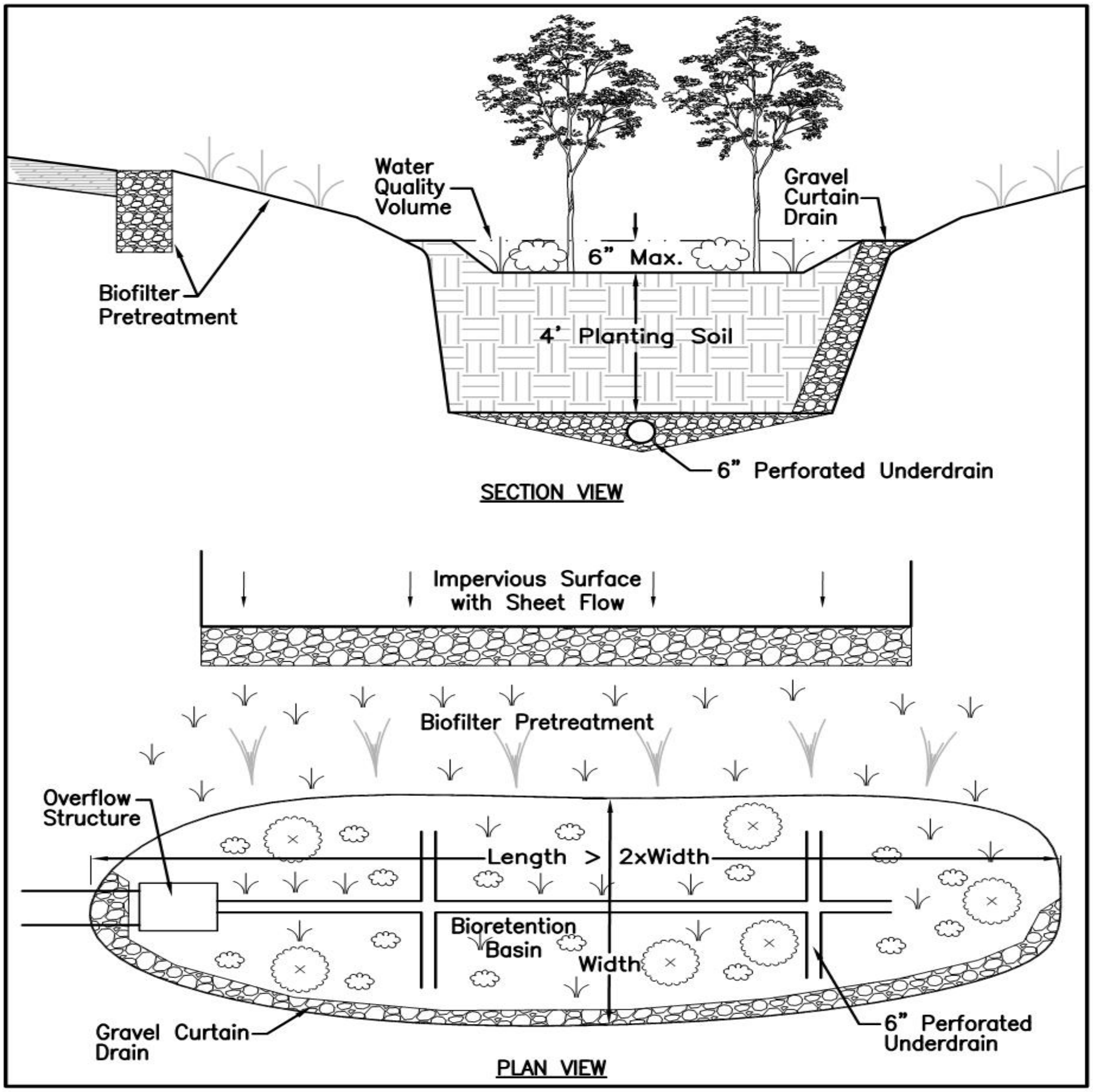
    - The watershed area contributing to a bioretention basin must be less than 5 acres. The optimal watershed areas for bioretention basins are between 0.5 to 2.0 acres.
    - The bioretention storage volume must equal or exceed the water quality volume. (See SW11.06 – "Volume Based Stormwater Quality Calculations")
    - The run-off must enter the bioretention basin as sheet flow.
    - A biofilter strip is required between the contributing drainage area and the bioretention basin. See Figure SW11.07 – Maximum Flow Parameters for Biofilters for the biofilter strip requirements.
    - The minimum size for a bioretention basin is 200 sq. ft.
    - The length to width ratio shall be at least 2:1. The length is the travel distance between the average inlet point and the outlet structure.
    - The bioretention basin must have a slope that is less than 5%.
    - The bioretention basin must have a planting soil bed with a depth of at least 4-feet.
    - The soil shall be sandy-loam, loamy sand or a loam textured with a clay content less than 25%.
    - The infiltration rate for the planting soil shall be at least 0.5-inches per hour.
    - The planting soil shall have a pH value between 5.5 and 6.5.
    - The planting soil shall have an organic content between 1.5% and 3.0%.
    - The maximum water quality pool depth in a bioretention basin is 6-inches.
    - The use of trees and shrubs are encouraged in the bioretention limits. The species shall be conducive to the fluctuating water levels.
    - The ground cover vegetation shall be conducive to the fluctuating water levels.
    - An underdrain system is required under the planting soil. The underdrain system shall include at least 8-inches of gravel and a 6-inch diameter perforated pipe. The pipe shall be a rigid wall PVC or HDPE.

- A non-woven geotextile (filter fabric) is required between the planting soil and the underdrain gravel.
- The seasonally high water table must be a minimum of 2-feet below the underdrain envelope.
- Continuous flows into the bioretention basin are prohibited.
- Geothermal discharges into bioretention basins are prohibited.
- An overflow structure and a non-erosive overflow channel are required for storm events that exceed the bioretention's volume capacity.
- If the bioretention basin is used as a sediment control measure during construction, it must be restored to the design capacity after the site has substantial vegetation established.

2. Operation and Maintenance Considerations

- A schedule shall be included for the inspection and maintenance of the bioretention and its accessories.
- The vegetation within the bioretention and biofilter pretreatment shall be inspected on a semiannual schedule. Address "bare" spots as necessary.
- Inspect for invasive vegetation and remove on a semiannual schedule.
- Inspect the overflow structure for debris and blockage on a semiannual schedule.
- Inspect for erosion and address as necessary.
- The bioretention basin and the pretreatment filter strip shall be policed for litter on a regular basis.
- Mulches used in and adjacent to a bioretention basin must consist of non-floating materials.
- The vegetation aggregate shall be inspected and maintained according to the approved plan.

Figure SW11.13 – Typical Bioretention Basin Configuration for Water Quality



SW11.17 Design Standards for Water Quality Swales

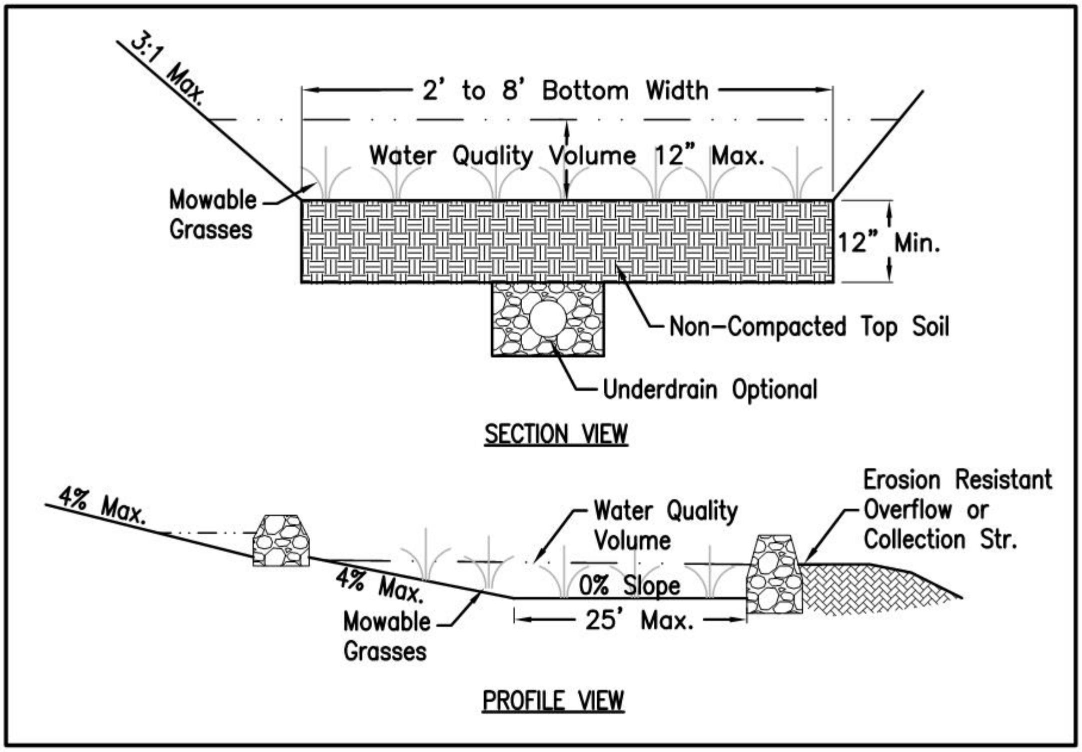
Water Quality Swales are channels that convey stormwater but also utilize low velocities and vegetation to treat stormwater during low flow events. The channels utilize retentive grading, terracing, check dams or other means to capture the stormwater. These are also referred to as bioswales or retentive grading practices. Water quality swales will remove approximately 81% of the total suspended solids.

Water quality swales can include an underdrain system. The water quality volume will pass through the top soil and out the underdrain. The majority of the time the channels are dry.

The water quality swale must meet the following requirements to be considered successful in accomplishing the stormwater quality imperative. Figure SW11.14 depicts a typical water quality swale configuration.

1. Design Considerations
    - The captured storage volume must equal or exceed the water quality volume. Refer to Exhibit SW11-5 for an example of the “Reduced Runoff Method”.
    - A maximum void ratio of 25% can be used for calculating the stormwater storage volume within the non-compacted top soil.
    - The maximum watershed draining to a water quality swale shall be less than 5 acres.
    - The drawdown time for the water quality volume shall be at least 30 minutes and shall not exceed 24 hours.
    - A perforated underdrain is required for soils with an infiltration rate less than 1-inch per hour.
    - The ponding depth of the water quality volume cannot exceed 12-inches. The peak 10-year flow depth cannot exceed 18-inches.
    - The swale is to have a flat bottom (not V-bottom). The bottom width shall be at least 2-feet wide and not exceed 8-feet.
    - The maximum longitudinal slope for the swale is 4%.
    - The swale can be terraced with a flat (zero) slope for a lineal distance of 25-feet or less.
    - The seasonally high water table must be at least 3-feet below the bottom of the swale.
    - Concentrated flows entering into the water quality swale shall be through a forebay.
    - The water quality swale shall have an overflow for storm events that exceed the water quality volume.
2. Operation and Maintenance Considerations
    - A schedule shall be included for the inspection and maintenance of the water quality swale and the pretreatment practices, if applicable.
    - The vegetation within the bioretention and biofilter pretreatment shall be inspected on a semiannual schedule. Address “bare” spots as necessary.
    - The water quality swale and any pretreatment practices shall be monitored for litter on a regular basis.
    - The vegetation of the swale’s bottom and side slopes shall be inspected and maintained as appropriate.
    - Debris and biomass build-up shall be raked, or otherwise removed, when the drawdown time is noticeably increased.
    - Fertilizers and other lawn maintenance chemicals to be used only if necessary to establish the initial vegetation.
    - The storage volume shall be re-established when 50% of the volume is lost.

Figure SW11.14 – Typical Water Quality Swale Configuration



SW11.18 Design Standards Stormwater Basins Adjoining Open Channels

The City may allow stormwater basins immediately adjoining the top of bank of a river, stream or regulated open drain to provide detention storage without constructing a restricted outfall. The non-restricted stormwater basin will be open to, and utilized by, the waters of the open channel during high water events. This option must be discussed and approved in concept by the City before the construction plans are submitted. Figure SW11.15 depicts an example of a non-restricted stormwater basin section. The applicant will also need to get consent from other governing entities with jurisdiction.

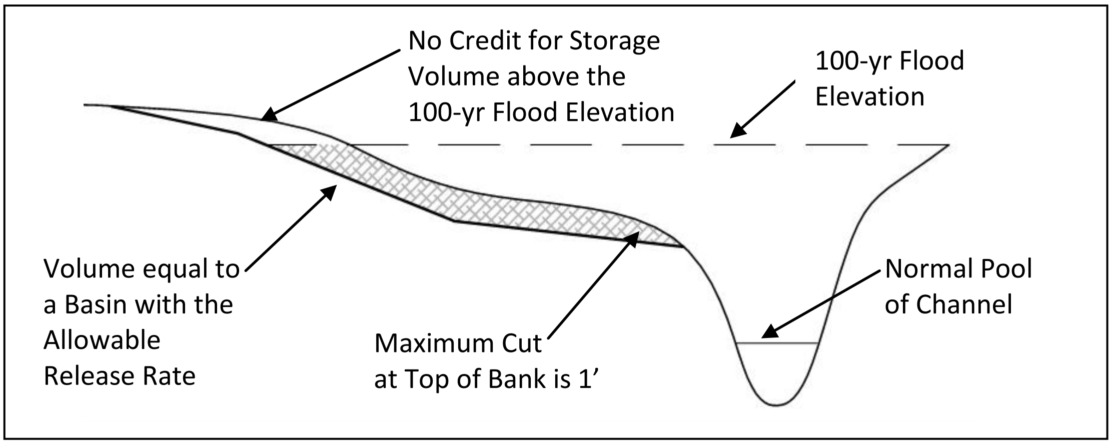
A non-restricted stormwater basin's storage volume shall be calculated based on the project's allowable release rate set in Figure SW11.1. The resulting storage volume must be provided. The project's stormwater run-off shall be treated for water quality prior to being released into the non-restricted stormwater basin.

Non-restricted stormwater basins shall:

- Be immediately adjacent to the open channel on the project site. It cannot cross an adjoining property to get to the open channel.
- Be adjacent to an open channel with a known 100-year water elevation. This can be per the current FEMA Map Studies or calculated by the consultant.
- Provide the required storage volume vertically between the adjoining channel's normal pool elevation and the 100-year water surface elevation.

- Be designed to the same grading requirements set forth in Section SW11.08.
- Use an overland flow path or an equalization culvert to allow the open channel's backwaters to enter and exit the basin. The equalization culvert needs to be designed to pass the 50-year event and be at least 18-inches in diameter. The construction of the overland flow path shall not lower the existing top of bank of the open channel by more than 1-foot. (See Figure SW11.15)
- Not compromise a protection levee.
- Not endanger adjacent parcels by increasing the chances of flooding.
- Not be a part of a water quality plan.

Figure SW11.15 – Non-Restricted Stormwater Basin Section



SW11.19 Design Standards for Parking Lot Detention

Parking lot detention allows stormwater to remain on a parking lot surface for an extended amount of time.

1. Depth Limitations
   - Parking lot detention shall not exceed a depth of 12-inches at an inlet or 6-inches at a distance of 10-feet from the inlet.
2. Parking Lot Detention is prohibited from:
   - Overflowing into a public right-of-way.
   - Preventing access between a building and a public right-of-way by submerging all driving lanes.
3. Outlet Configuration
   - Restrict the stormwater release rate per Section SW11.02 – "Stormwater Management Plans for New Developments" or Section SW11.03 – "Stormwater Managements Plan for Redevelopments", as appropriate. This can be by utilizing orifices, weirs, or culvert pipes.
   - Utilize a storm pipe, if applicable, that is a minimum of 12-inches in diameter.
   - Be designed to minimize the chances of clogging.

4. Surcharging

   Parking Lot Detention can be created by surcharging an inlet within the parking lot.

5. Parking Lot Maintenance

   Any repaving or other modification of the parking lot shall be evaluated for impact on stormwater storage volume and release rates. Development Services must review and approve any such modifications.

SW11.20 Design Standards for Underground Detention

Underground detention provides detention storage underground in vaults or pipes. The installation and design shall comply with the manufacturer's installation and design standards, as applicable. Non-vendor underground detention shall comply with the standards provided in this section.

For underground storage systems that utilize the bedding and backfill for storage, the storage of stormwater within the voids of the bedding and backfill shall be calculated as 40% of the stone volume. These systems will require an underdrain or an outfall configuration that will drain the bedding and backfill voids.

1. Materials

   - Underground detention shall be constructed using reinforced concrete pipe, high-density polyethylene (HDPE) pipe, concrete vaults or approved equivalents. See Chapter MA5 – Stormwater Materials and Testing Requirements.
   - Bedding and backfill requirements shall meet or exceed those provided by the manufacturer or the City's requirement for the material being utilized, whichever is more stringent.
   - The pipe and vault material shall be designed to withstand HS-20 loading at a minimum.

2. Configuration

   - Underground detention chambers shall not be within public right-of-ways or easements dedicated for use by public or private utilities.
   - Detention chambers cannot be under buildings or foundations.
   - Underground detention shall be downstream of the stormwater quality facilities.
   - Pipes and structures installed for the primary purpose of being a stormwater conveyance are not to be included in the detention volume calculations.

3. Basin Control Structure Configuration

   - The basin control structure shall be designed to release the design storm events according to the sections SW11.02 or SW11.03, as appropriate.
   - The minimum outlet pipe size shall be 12-inches in diameter.

4. Maintenance Access

- Maintenance access to inlet and outlet structures shall be by manholes.
- An inspection/maintenance port shall be provided at each end of every manifold.
- At least one inspection/maintenance port is required for each lateral.
- Inspection/maintenance ports shall be at least 4-inches in diameter.

SW11.21 Porous Pavement System Requirements

Porous pavement systems include permeable varieties of asphalt, concrete, and interlocking pavers. The detention volume is provided within the voids of the stone aggregate below the pavement system.

1. Components

   The components of a porous pavement system must consist of:

   - Permeable surface
   - Open-graded aggregate sub-base
   - Uncompacted, level sub-grade
   - Underdrain
   - Overflow System

2. Site Requirements

   The following are minimum site requirements for porous pavement systems:

   - The surface area of the porous pavement shall provide an infiltration rate equal to or greater than the 10-year storm event.
   - The depth from the "high" ground water table to the bottom of sub-grade must be greater than 4-feet.
   - Porous pavement shall be at least 100-feet from any ground water well.
   - Porous pavement shall be at least 10-feet from building foundations or as required by building code.

3. Storage Volume

   The storage of stormwater within the voids of the bedding and backfill is 40% of the stone volume.

4. Outlet

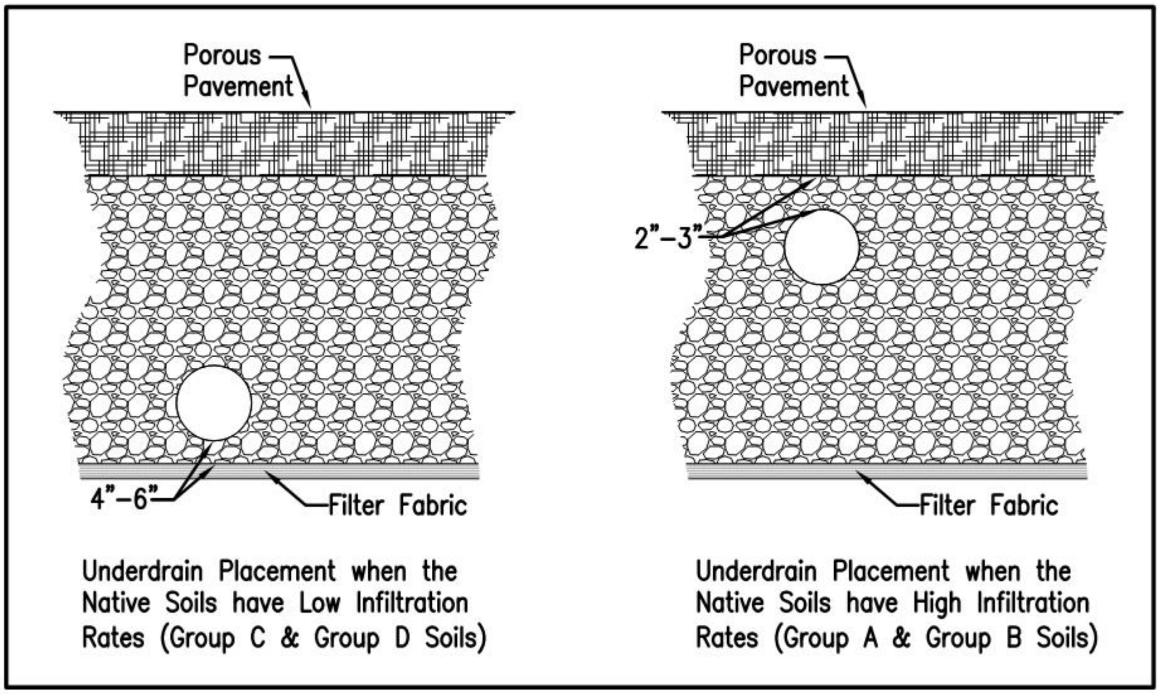
   Porous pavement systems shall have at least one underdrain that will drain the sub-base within 48 hours. Additional underdrains may be necessary based on layout and unique site conditions.

5. Maintenance

   Appropriate inspections and maintenance, including regular vacuum sweeping, shall be included in O&M agreement.

6. Properly designed porous pavement systems, including the use of pavers, meet the stormwater quality requirements. The porous pavement must meet the following requirements to be considered successful in accomplishing the stormwater quality imperative.
   - The surface area of the porous pavement shall be at least 50% of the total watershed area collecting on the porous pavement.
   - The captured storage volume in the voids of the sub-base materials must equal or exceed the water quality volume. See Section SW11.06 – Volume Based Stormwater Quality Calculations. The storage volume can be adjusted for infiltration rates.
   - Run-off entering the porous pavement shall be by sheet flow.
   - The surface slope of the porous pavement cannot exceed 5%.
   - The cross-section of the porous pavement shall be designed upon the anticipated load requirements.
   - A non-woven geotextile fabric (filter fabric) is required between the sub-grade and the gravel aggregate sub-base.
   - The subgrade shall be flat (zero slope).
   - A perforated underdrain pipe(s) is required. The pipe shall be a 4-inch or 6-inch diameter perforated schedule 40 PVC or an equivalent HDPE.
   - The underdrain pipe(s) shall have at least one clean-out.
   - The underdrain pipe(s) shall be near the top of the aggregate sub-base when the native soils have high infiltration rates (Hydrological Soil Types "A" or "B"). The underdrain pipe(s) shall be near the bottom of the aggregate sub-base when the native soils have low infiltration rates (Hydrological Soil Types "C" or "D"). See Figure SW11.16 Underdrain Placement for Porous Pavement.
   - The porous pavement system shall be modeled as a detention system to insure the underdrain system is adequate for a 10-year storm event or provide an overflow structure.
   - A concrete header, or similar device, is required to prevent water from migrating into the gravel aggregate sub-base of adjoining impervious surfaces.

Figure SW11.16 – Underdrain Placement for Porous Pavement



7. Operation and Maintenance Considerations

   Operations and Maintenance for porous pavements must include the following considerations:

   - Schedule for inspection and maintenance.
   - Monthly inspection for debris and sediment accumulations.
   - Clearing of leaves and lawn clippings.
   - Vacuumed at least once per year.
   - Sand and chemical deicers shall not be used on porous pavement or immediately adjoining surfaces.
   - Metal snowplows are prohibited.
   - Snow stockpiles are prohibited on porous pavement.
   - There shall be no surface treatments to the porous pavement (e.g. surface sealants, resurfacing…)

SW11.22 Design Standards for Rainwater Harvesting Methods

Rainwater harvesting is the collecting and retaining of rainwater that will be utilized for irrigation or other practical on-site uses. On a small scale, the rainwater is collected in rain barrels from roof downspouts. Large scale projects can utilize large tanks that collect rainwater from any impervious surface.

The retention of the run-off from the impervious surfaces during the water quality storm event will meet the stormwater quality imperative. The volume of the rainwater captured should be modeled in the site's overall hydrologic model.

The rainwater harvesting plan must comply with the following considerations.

1. Design Considerations
   - The rainwater harvesting vessel shall be, at a minimum, sized to retain the runoff volume from the 1-inch rainfall event. An overflow system shall be included for greater events.
   - A utilization plan shall be included that illustrates that the harvested rainwater can be used on site.
   - A structural engineer shall stamp any plans that elevate the retention vessel.
2. Operation and Maintenance Considerations
   - The O&M manual shall address the winterization of the harvesting system. The system shall be fully functional from March through November.
   - A schedule shall be provided for the inspection of the collection, retention and water utilization components.
   - The growth of algae and mosquito larva shall be addressed.

Rainwater harvesting is a developing concept in northeast Indiana. LEED projects might implement rainwater harvesting for grey water use and other uses not currently contemplated. Development Services will review these rainwater harvesting plans based on commonly accepted design principles.