**AN ORDINANCE AMENDING CHAPTER 9.5 OF THE CODE OF THE CITY OF PEORIA REGARDING EROSION, SEDIMENT AND STORMWATER CONTROL**

WHEREAS, the City of Peoria is a home rule unit of government pursuant to Article VII, Section 6 of the Constitution of the State of Illinois 1970, and may exercise any power and perform any function pertaining to its government and affairs, including regulating erosion, sediment and stormwater control;

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF PEORIA, ILLINOIS, as follows:

**Section 1**: Chapter 9.5 of the Code of the City of Peoria is hereby amended by deleting the following stricken words and by adding the following underlined words:

### Sec. 9.5-27. Definitions

The following words, terms and phrases, when used in this article, shall have the meanings ascribed to them in this section, except where the context clearly indicates a different meaning:

*Adjacent lands* means surrounding land that may either impact a site, or be impacted by potential soil erosion, sediment, and/or stormwater run-off as a result of land disturbing activities conducted on a site, and at a minimum is an area within 50 feet of the site.

*Appeals board* means the erosion, sediment and stormwater control appeals board.

*Areas of concentrated flow* or *bodies of water* means any area where water may accumulate or flow, whether continual or as the result of a storm event, including but not limited to lakes, rivers, streams, creeks, ponds, ditches, swales, gullies, ravines, street gutters and other similar features.

*Building official* means the Inspections Manager for the City of Peoria.

*City* means the City of Peoria, Illinois.

*Commission* means the tri-county regional planning commission.

*Control measure* means any proposed temporary or permanent measures to be installed to control erosion, sediment and stormwater run-off from a project area.

*Department* means the City of Peoria Department of Public Works.

*Development* means the division of a parcel into two or more parcels; the construction, reconstruction, conversion, structural alteration, relocation, or enlargement of any structure; any mining, excavation, landfill, or land disturbance; and any use or extension of the use of land.

*Disturbed area* means any area of land on which the pre-development ground surface will be affected or altered by the development activities. This includes but is not limited to grading, clearing, stock piling, tracking and other similar activities.

*Erosion control administrator* means the person appointed by the Peoria City Manager to administer this chapter.

*Flood insurance rate maps (FIRM)* means maps prepared by the Federal Emergency Management Agency (FEMA) that depict the special flood hazard areas (SFHA) within a community. These maps include insurance rate zones and floodplains and may or may not depict floodways.

*Flow-Through Practices* means permanent volume control practices designed to treat stormwater runoff from impervious areas of a development after permanent stabilization is achieved.

*Five-year frequency storm event* means the storm event rainfall depth during a 24-hour period which is exceeded, on the average, once every five years.

*Institutional use* means a religious, or public use, such as a church, library, public or private school, hospital, or government owned or operated building, structure or land used for public purpose.

*Land disturbing activity* means any change in land, which may result in soil erosion from water or wind and the movement of sediments into state, county or city waters or lands, or a change in the amount and/or intensity of stormwater run-off, including but not limited to, the covering with an impervious surface, stockpiling, clearing, grading, excavating, rehabilitating, transporting, depositing or filling of land.

*Major Stormwater System* means that portion of a stormwater system needed to store and convey flows for the 100-year frequency storm event.

*Minor Stormwater System* means all infrastructure including curb, gutter, culverts, roadside ditches and swales, storm sewers, tiles, subsurface drainage systems, and other practices intended to convey or capture stormwater runoff from storm events less than a 100-year frequency storm event.

*Normal agricultural practices* means activities associated with the preparation and tiling [tilling] of land for the purposes of growing crops, or raising livestock, which may include, but are not limited to, the construction of conservation measures, plowing, disking, and cultivating.

*Perimeter control* means any control measure installed between the down slope side of the disturbed area and the property line and/or between the down slope side of the disturbed area and any area of concentrated flow.

*Pre-project condition* means a condition that impacts erosion, sediment, or stormwater runoff characteristics of a site prior to start of construction activity. The pre-project condition shall be based on the predominant land use for the past five years. For example, if a site has been cropland for four of the past five years, and in grass just prior to development, the land use would be cropland for the pre-project condition.

*Project* means any development involving modification to land which involves a land disturbing activity.

*Retention-Based Practices* means permanent volume control practices designed to capture, retain, infiltrate and treat stormwater runoff from impervious areas of a development after permanent stabilization is achieved.

*Runoff* means the water from melting snow and/or precipitation falling within a watershed drainage area that exceeds the infiltration capacity of the soil of that basin.

*Regional stormwater management* system means a system which is designed, constructed and maintained to provide stormwater control for multiple land owners.

*Road* means any right-of-way that has been improved for the purposes of providing a surface for vehicular traffic, including any federal, state, county, township, and municipal controlled facilities.

*Single-family dwelling* means a building designed for or occupied by one family.

*Site* means the lot or parcel on which the project is to be developed.

*Standards* means the Illinois Environmental Protection Agency's Illinois Urban Manual, A Technical Manual Designed for Urban Ecosystem Protection and Enhancement published in 1995 and Illinois Procedures and Standards for Urban Soil Erosion and Sedimentation Control published in 1988 by the Urban Committee of the Association of Illinois Soil and Water Conservation Districts, now in effect, or as hereafter amended which is incorporated by reference herein, the City of Peoria Standards for Stormwater Design Analyses, found at Attachment "A" of this chapter, and the erosion and sediment control criteria and specifications found in Attachment "B" of this chapter. Attachments "A" and "B" ~~shall be maintained in the office of the City Clerk of the City of Peoria, and shall be made available to the, public~~are found in Division 8. ATTACHMENTS, Section 9.5-301 of this Chapter. ~~[Said attachments are set out at the request of the city, following this chapter.]~~

*Standard plan* means a general erosion and sediment control permit for projects where the slope is less than ten percent and there are no areas of concentrated flow or bodies of water on or immediately adjacent to the site. Slope shall be determined by the maximum slope indicated on the site according to the USDA Soil Survey or topographic survey as prepared by an Illinois Registered Surveyor.

*Ten-year frequency storm event* means the storm event rainfall depth during a 24-hour period which is exceeded, on the average, once every 10 years.

*Twenty-five-year frequency storm event* means the storm event rainfall depth during a 24-hour period which is exceeded, on the average, once every 25 years.

*Two-family dwelling* means a building designed for or occupied by two families.

*Two-year frequency storm event* means the storm event rainfall depth during a 24-hour period which is exceeded, on the average, once every two years

*Utility service line* means the means by which utility service is provided to service users, such as electric, telephone and television cable; or gas, water and sewer pipes.

*Volume Control Practices* means permanent practices designed to capture, retain, and infiltrate stormwater runoff from impervious areas of a development after permanent stabilization is achieved.

*Volume Control Storage* means the first inch of runoff from the impervious area of development on the site.

*Working day* means days other than Saturday, Sunday, or any holiday when the Peoria City Hall is closed.

*100-year frequency storm event* means the storm event rainfall depth during a 24-hour period which is exceeded, on the average, once every 100 years.

### Sec. 9.5-29. Standards for design and maintenance of control measures for soil erosion, sediment and stormwater.

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(b) *Permanent stormwater control measures.*

(1) Volume Control: Volume control practices shall be designed to control the first inch of runoff from the impervious area of development on the site. Retention-based practices with quantifiable storage capacity shall be sized to retain and infiltrate the required volume. Practices include, but are not limited to: infiltration trenches, infiltration basins, porous pavement, bio retention systems, dry wells, open channel practices fitted with check dams, retention storage below the outlet of a detention facility and constructed wetlands that have quantifiable storage. When site limitations prohibit use of retention-based practices, flow-through practices may be considered. See Attachment "C" Technical Guidance for Volume Control found in Division 8. ATTACHMENTS, Section 9.5-301 of this Chapter.

(2) Detention: All stormwater controls shall be designed so that the peak discharge rate from the permitted area resulting from the two-year and 25-year frequency storm events for the post-project condition do not exceed the corresponding storm event peak discharges for the pre-project condition or a cropland equivalent, for straight row crops with crop residue greater than 20 percent and good hydrologic condition, whichever is less. Evaluation of submitted plans shall be based on the stormwater design analyses standards in Attachment "A."

(c) *Regional stormwater control systems.* To allow for the beneficial development and maintenance of regional stormwater management systems, where they are available and they are appropriate, an applicant may submit a design dependent on such a system. The applicant shall submit documentation of the approval for the use of the regional storm water management facility from the governmental agency having jurisdiction over it. The applicant shall submit evidence showing that there will be no adverse flooding impact to any receiving stream between the point of discharge and the regional stormwater facility. If the applicant is approved to use the regional stormwater management system, the applicant may request exemption from the requirements in this section for permanent on site stormwater controls from the erosion control administrator. Such exemption shall not apply to any temporary stormwater control measures required by this chapter.

(d) *Runoff control measures.* All development shall safely convey the 100-year storm event through the site without increasing flood elevations or decreasing flood conveyance capacity upstream or downstream of the area under the ownership or control of the Applicant, and causing localized flooding to existing or future buildings within the area under the Applicant's control.

(1) Design runoff rates for major stormwater systems shall be calculated by using event hydrograph methods. Event hydrograph methods must be HEC-1 (SCS runoff method), HEC-HMS, or TR-20. Event hydrograph methods shall incorporate the assumptions presented in Attachment "A" Standards for Stormwater Design Analyses.

(2) Minor stormwater systems shall be sized to convey runoff from the tributary area under fully developed conditions consistent with a 10-year storm event or the existing storm sewer system.

(3) Major stormwater systems and minor stormwater systems shall be located within easements or public right-of-way.

(4) Upstream tributary flows must be considered for all developments and safely routed through or around the site.

(5) Maximum flow depths on roads for all development shall not exceed twelve (12) inches during the 100-year storm event.

(6) Maximum ponding depths on new parking lots shall not exceed twelve (12) inches during the 100-year storm event.

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**Sec. 9.5-31. Retrofitting presently developed sites.**

In instances where the project involves a presently developed site, the applicant may request an exemption from fully complying with the stormwater control requirements. The erosion control administrator shall determine the type and extent of compliance required based on existing and proposed site conditions, and the impact of stormwater runoff on the surrounding area. This exemption will only be granted in cases where the proposed condition of the site will not be significantly different from the existing condition as determined by the erosion control administrator. The purpose of this section is to allow for alterations to presently developed sites without a major redesign of the existing (or non-existing) stormwater system, while assuring that all projects will be moving closer to compliance with the stormwater control requirements of this chapter. At a minimum, volume control practices shall be installed. Design shall be in accordance with Sec. 9.5-29, paragraph (b)4, for the impervious portion of the disturbed area of the site. An applicant may reduce the volume control storage by twenty-five percent (25%) for every five percent (5%) of reduced impervious area, on redevelopment sites where volume control practices are not feasible due to site constraints.

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**Sec. 9.5-77. Application.**

The applicant shall file the application with the department on forms provided by the department. The applicant shall supply the number of copies of application documents as provided in the application. Each application shall be accompanied by the following information:

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(4) *Stormwater management plans and controls.*

a. Volume Control: For volume control practices, the following information shall be provided by the applicant:

1. A map delineating all proposed impervious areas and sizes for entire project area. Show drainage divides and subwatersheds, if applicable.

2. Required storage calculations

3. Locations, dimensions and construction details for all proposed volume control practices

4. Proposed volume calculations

5. Volume control practice outlet or overflow calculations, if applicable.

b. Detention: Design calculations and information related to the permanent stormwater management system for any project with a net increase of impervious area greater than one-half of an acre. For the purposes of this section the net increase is the cumulative change since the implementation of this chapter, April 1, 1997. For example, in year one, a commercial site increases the parking lot by 20,000 square feet. In year two, the same commercial site adds a building with an area of 20,000 square feet. In year 1, no permanent stormwater control measures (or calculations) are required by this chapter. In year 2, stormwater calculations shall be submitted and shall be based on the total increase of 40,000 square feet of impervious area. The following information shall also be provided by the applicant:

~~a~~1. A map showing the drainage area divides, including off-site drainage areas that drain into the site; and

~~b~~2. Location and identification of soil types for entire watershed; and

~~c~~3. Location and identification of vegetative cover for entire watershed; and

~~d~~4. Run-off-curve number calculations for both pre- and post-project conditions for all subwatersheds; and

~~e~~5. Time of concentration calculations for both pre- and post-project conditions for all subwatersheds, and include a map showing hydraulic flow lengths used; and

~~f~~6. Peak flow-rate calculations for two-year and 25-year storms for both pre- and post-project conditions; and

~~g~~7. Design calculations for detention basin outlets for both two-year and 25-year storms, include stage-storage table and discharge rating curve data or outflow calculations (refer to optional form in Attachment "A"); and

~~h~~8. Location, dimensions, and construction details of proposed detention basins and outlets; and

~~i~~9. Detention volume calculations; and

~~j~~10. Summary of peak flow-rates for pre-, post-, and proposed conditions with detention showing that the requirements of this chapter are met (refer to Attachment "A").

~~k~~11. If the disturbed area is two acres or more, provide a design certification by a registered Illinois professional engineer stating that federal, state and city requirements for stormwater and erosion control are met.

c. Runoff Control: Provide design calculations for the major conveyance system through the site, including all drainage ways and ditches, and each location of potential restriction or localized ponding, including, but not limited to the upstream end of culverts or storm sewers, area inlet drains, and roadway sags:

1. The 100-year peak rate of runoff for all sub-areas
2. The maximum depth of conveyance flow and/or ponding and corresponding elevations for each sub-area.
3. Locations, dimensions and construction details for all proposed storm water conveyance practices

(5) Schedule or sequence of development or installation of the elements of the site management control measures proposed above.

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DIVISION 8. ~~EFFECTIVE DATE~~ATTACHMENTS

**Sec. 9.5-301. ~~Effective date~~Attachments.**

This section contains the Attachments incorporated by reference herein this chapter ~~shall be in full force and effect from and after April 1, 1997, after its passage, approval, and publication in pamphlet form according to law~~.

**Section 2**: There shall be added to the Code of the City of Peoria, Illinois, Chapter 9.5, Section 9.5-301 in its entirety following Attachment "B" to read as follows:

# ATTACHMENT "C"

CITY OF PEORIA

# TECHNICAL GUIDANCE FOR MEETING VOLUME CONTROL REQUIREMENTS

## Volume Control Practices Overview

Volume control practices utilize designated infiltration areas or structures to capture a portion of stormwater runoff (i.e., the volume control storage) and retain it onsite such that the runoff is able to 1) percolate through (or into) the underlying soils, 2) evaporate, 3) dissipate through evapotranspiration by plants, or 4) drain back slowly into the minor system via underdrains. The process of percolating runoff through the soil is an effective mechanism for both site runoff volume reduction and pollutant removal. Pollutants such as fine sediment, nutrients, bacteria, and organic materials can be filtered, absorbed by soil particles, or utilized by plants, thus providing a water quality benefit.

Since volume control practices reduce the quantity of stormwater runoff discharged from the site, "credit" for these practices provided in Section 9.5-29(b)1 may be applied to the site detention requirements in Section 9.5-29(b)2, when applicable. In other words, the total required site detention volume may be reduced by the volume stored within volume control practices. Additionally, site detention facilities may be modified by storing the volume control storage below the outlet restrictor. Credits and approaches for volume control storage are discussed in detail later in this section.

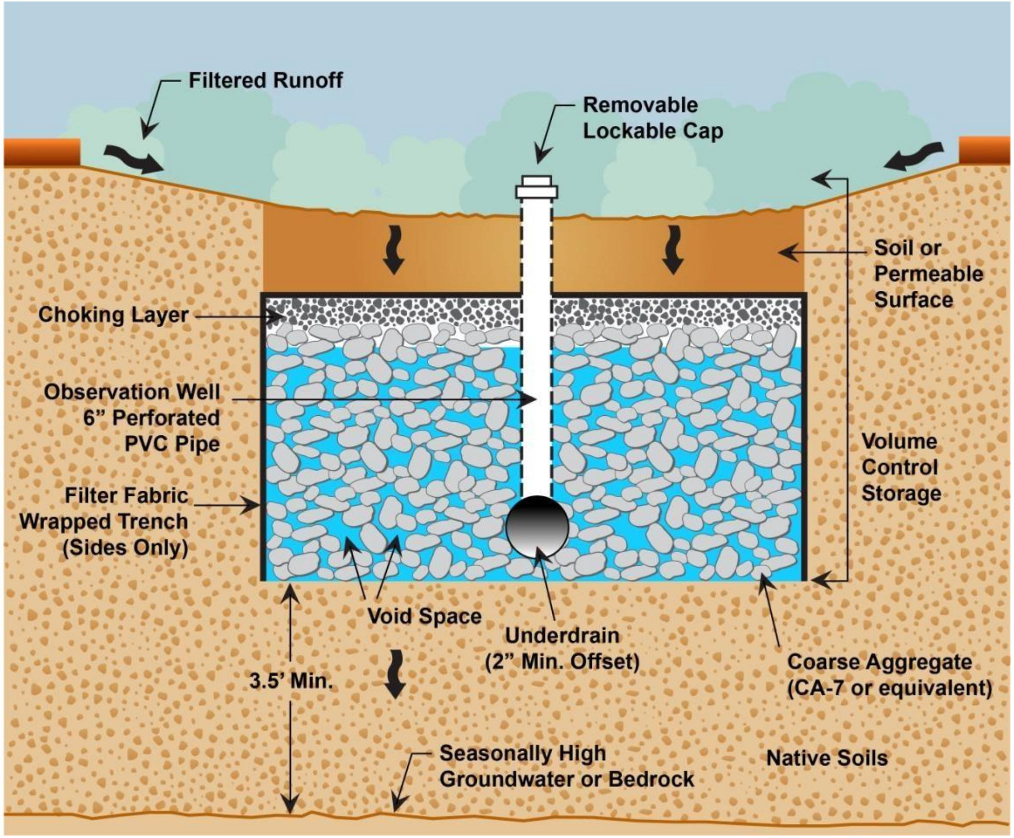


**Figure 5.10. Example of Volume Control Practice**

## Flow-Through Practices

Flow-through practices are designed to provide water quality treatment by filtering out pollutants from the runoff before it is discharged from the site. Many flow-through practices provide some infiltration, however the volume reduction is not quantifiable. Many flowthrough practices are conveyance systems that provide stormwater treatment along the flow path. For most practices, this is in the form of a series of vegetated swales, filter strips, or mechanical structures such as oil and grit separators. These practices should be sized to allow sufficient contact time with the treatment practice, such as shallow water depths and low velocities, in order for adequate pollutant removal to occur. Flow-through practices utilize deep-rooted plants that can trap suspended sediment and incorporate nutrients into their biomass as water flows through the practice.

**Figure 5.11. Flow-Through Practice**

For the purposes of the City of Peoria's Erosion, Sediment and Stormwater Control Ordnance, flow-through practices also serve as pretreatment practices to protect the functionality of volume control practices. Flow-through practices are not required for stormwater runoff that has originated from roofs.

## Site Feasibility Assessment

A site feasibility assessment that examines site limitations is necessary to determine the appropriate approach for volume control practice design. Volume control practices should be located on soils that are significantly permeable to ensure that the captured volume of runoff can infiltrate and dewater the structure at a minimum rate of 0.5 inches per hour. Other considerations, such as the groundwater table and discharge of volume control practice overflows, should be examined and used in the design. Installing retention based volume control practices within a floodway is prohibited due to the risk of washout from deep and swift flood waters in these flood prone areas.

*Soil Suitability*

Retention-based practices require soils with appropriate infiltration capacity. The infiltration rate is strongly influenced by the proportion of sand, silt, and clay (texture). Predominately clay soils have infiltration rates that are too low (in inches per hour) to accommodate the volume of volume control practices and predominately sandy soils can infiltrate runoff too rapidly and adversely impact groundwater. In addition to infiltration capacity, the soils must be free of contaminants, which can also adversely impact groundwater. Therefore, sites with contaminated soils are not suitable for volume control practices.

Onsite soils must be tested in order to determine if they are appropriate for volume control practices. Testing must include a determination of the soil type(s) and the infiltration capacity, including the capacity of the soils at the base of the structure.

Soil borings or pits should be taken in the location of the proposed volume control practice to verify soil particle size distribution (textural class) and to determine the depth to groundwater and bedrock. The number of soil borings should be selected as needed to determine soil conditions. The minimum depth of the soil borings or pits must be five feet below the bottom elevation of the proposed volume control practice. This serves the purpose of determining the location of the seasonally-high groundwater table. Infiltration tests should be conducted at the proposed bottom elevation of the volume control practice. The infiltration rate must be measured with a double-ring infiltrometer and meet the requirements of ASTM D3385. For sites where the double-ring infiltrometer test is impractical, the single-ring infiltrometer test may be used, provided that the testing follows the procedure contained on Page 28 of the *City of Chicago Stormwater Ordinance Manual* (March 2014).

Soils must have sufficient infiltration capacity to accept the volume control storage. The infiltration range of onsite soils for volume control practices should be between 0.5 and 2.41 inches per hour. These restrictions limit the use of volume control practices to soils with textures of sandy loam, loam, silt loam, silt, most sandy clay loams, and only some clay loams and silty clay loams.

In the event that a natural depression is proposed to be used as a volume control practice, the applicant must demonstrate the following information:

1. Infiltration capacity of the soils under existing conditions (inches/hour);
2. Existing drawdown time for the high water level (HWL) and a natural overflow elevation; and
3. Operation of the natural depression under post-development conditions mimics the hydrology of the system under pre-development conditions.

Poor infiltration rates (< 0.5 inches/hour) are common in Peoria County and do not prevent the use of retention-based practices. If onsite soils do not provide a suitable infiltration rate, the design of the volume control practice should incorporate the use of an underdrain system. As described in the next section, only certain site constraints (contaminated soils or high groundwater levels) are acceptable reasons for not providing retention-based practices.

| Retention-Based Practices in Sandy Soils |
| --- |
| Soils with large percentages of sand generally infiltrate water more quickly than finer textured soils, and therefore, are effective with retention-based practices, provided that precautions are taken to protect the groundwater. The level of treatment in sandy soils, however, is quite variable. Sands can be ideal for filtration of particulate material, whereas soluble pollutants generally move through the soil quite rapidly and unattenuated. Soil cleansing via filtration, adsorption, and microbial uptake can be very effective removal processes for some of the more difficult-to-treat runoff pollutants. However, soils that infiltrate too rapidly may not provide enough time for sufficient treatment, creating the potential for groundwater contamination. |

*Contaminated Sites*

There are sites, such as those previously used as gas stations or sites with known contaminants (based on a Phase I Environmental Site Assessment), where it would be impractical to use retention-based practices. For these sites, the volume control requirements can be met by providing flow-through practices or a reduction in impervious area.

*Groundwater Analysis*

An investigation into the location of the seasonally-high groundwater table must be carried out in order to avoid groundwater contamination. In combined sewer areas, the seasonally-high groundwater table must be at a minimum of 3.5 feet below the bottom of the proposed volume control practice to allow for treatment of collected runoff prior to it entering the groundwater system (2 feet in separate sewer areas). If soil borings or pits do not show the seasonally-high groundwater table to be within 3.5 (or 2) feet of the bottom of the proposed volume control practice, then further investigation is not required.

For instances where the seasonally-high groundwater table is within 3.5 (or 2) feet of the bottom of the proposed volume control practice, then the proposed volume control practice must be relocated or redesigned such that a minimum of 3.5 (or 2) feet is maintained.

## Volume Control Practices for Site Development

Section 9.5-29(b)1 requires that volume control practices must be sized to retain and/or infiltrate the volume control storage. The volume control storage is equal to one (1) inch of runoff from the impervious surfaces of the development. The volume control practices can include:

- Infiltration Trenches*
- Infiltration Basins*
- Porous Pavement (storage in the voids below the pavement)
- Bio-Retention Systems*
- Dry Wells
- Open Channel Practices Fitted With Check Dams*
- Storage Below the Outlet of a Site Detention facility*
- Constructed Wetlands that have Forebays, Deepwater Zones, and Micropools

As discussed above, pretreatment measures to protect the functionality of volume control practices are required where necessary. The volume control practices marked with an asterisk (*) will usually require pretreatment. A summary of the pretreatment measures that may be used for various volume control practices is included in Table 5-11.

Depending on the volume control practice, the storage volume may consist of surface storage, storage in the voids of growing media, and/or storage in the void space of aggregate. The aggregate layer may be incorporated into a number of practices ranging from infiltration trenches to porous pavements. Many volume control practices are in the form of reservoirs filled with coarse aggregate with no outlet beneath a vegetated depressional area (such as with bio-retention systems). When coarse aggregate is used, the capacity of the reservoir is determined by the void space of the coarse aggregate used in the system. If the infiltration rate of the underlying soil is less than 0.5 inches/hour, an underdrain must be used to drain the accumulated volume of runoff.

There can be a great deal of flexibility in the types of practices selected as well as the location and configuration of these practices onsite. For example, the dimensions (length, width, and depth) of these practices can be manipulated such that they can take on irregular shapes, thereby allowing for easier integration into the site design, such as along property lines, in parking lot islands, or unusable portions of the site. Additionally, underground storage can be provided using the stone voids under permeable pavement, and other systems can be designed to function below impervious areas.

## Volume Control Practice Sizing and Drainage Criteria

### Calculate Required Volume Control Storage

Determine the portion of the volume control storage that will need to be treated with volume control practices. The volume control storage is equal to one inch of runoff from the impervious surfaces of the development. This volume is best represented in cubic feet.

$$V_C = Std_C \times \text{Unit Conversion} \times A_{IMPV}$$

| | | | |
|---|---|---|---|
| Where: | $V_C$ | = | **Volume control storage** (cubic feet) |
| | $Std_C$ | = | Control Standard = 1.0 in. |
| | Unit Conversion | = | 1 ft/12 in. |
| | $A_{IMPV}$ | = | Proposed **Impervious area** ($ft^2$) |

The dimensions of the volume control practices will be a combination of the depth and surface area available to retain the volume control storage. In order to minimize the footprint of the practice, the allowable depth is often the limiting factor. The maximum allowable depth is determined by the depth necessary to maintain a 3.5 foot separation from the seasonally high groundwater level, bedrock, or other limiting layer (3.5 feet in combined sewer areas, 2 feet in separate sewer areas). The surface area of the volume control practice is determined using the design volume and final depth values.

All volume control practices must have quantifiable storage space to retain the calculated volume control storage. Depending on the volume control practice, the storage volume may consist of surface storage, storage in the voids of growing media, and/or storage in the void space of aggregate.

The capacity of an aggregate-filled reservoir to retain the volume control storage should be based on the volume of void space (% porosity) of the coarse aggregate used in the system, where the volume of voids is equal to the volume control storage. If test data is not available, use 36% porosity for the coarse aggregate. The size of an aggregate-filled reservoir can be computed by converting the volume control storage to reservoir volume:

$$V_{RES\ REQ'D} = V_C \times \frac{100}{\%\ \text{Void Space}}$$

| | | | |
|---|---|---|---|
| Where: | $V_{RES\ REQ'D}$ | = | Required Reservoir Volume (cubic feet) = volume of voids + volume of aggregate (This is the volume necessary to contain the coarse aggregate and the **volume control storage**.) |
| | $V_C$ | = | **Volume control storage** (cubic feet) |

Perforated underdrain is required for each volume control retention-based practice due to the region's typical clayey soils where infiltration rates are assumed to be low. In most cases, a required underdrain should be no larger than 4-inches in diameter to encourage retention, have an observation well installed at the terminal end, be spaced no more than 30 feet on center across a retention field area, and laid with the perforations on the bottom of the pipe. Void volume credit available below the invert of the perforated underdrain must be limited to no more than 12-inches and will be credited at 100% toward volume control requirements. Void volumes below the underdrain invert must extend across the entire volume control storage system, and not limited to only an underdrain trenched area. Void volume above the invert of the underdrain up to the ground surface will be deducted by a factor of 50% to account for losses out of the underdrain. When calculating the storage volume in aggregate a void volume of 0.36 is used. A void ratio of 0.25 is used for growing media.

Volume provided above the ground surface will be limited in depth to 12-inches of wetland ponding and credited at 100%. For calculating surface volume control storage, the average end area method between the ground elevation and the elevation of the overflow grate/outlet pipe/check dam is recommended. Wet ponding depths above one foot of depth are not considered volume control and are considered impervious areas.

For more information, see the volume control practice details located in MWRD Technical Guidance Manual (TGM), Appendix C. The complete Manual is available at:

http://www.mwrd.org/irj/go/km/docs/documents/MWRD/internet/protecting_the_environment/Stormwater_Management/htm/WMO/Technical_Guidance_Manual.htm

If high infiltrating soils are suspected, provide a detailed soils report documenting the additional in situ percolation tests to confirm actual infiltration rates and to allow for design of a volume control facility without underdrains and take credit for additional infiltrative release.

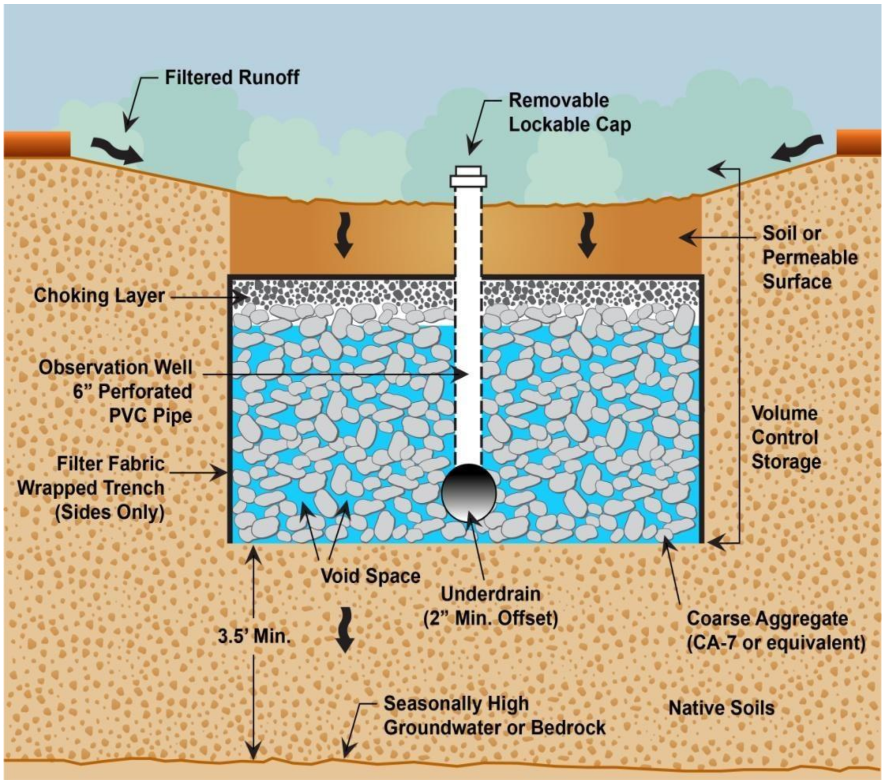


**Figure 5.12. Volume Control Practice – Surface Storage, Media Storage and Aggregate Storage**

## Volume Control Practice Site Location

Determine how volume control practices will fit into the development site design (on available pervious area of the development), and select the appropriate volume control practice. Information collected during the site feasibility assessment should identify the potential for multiple volume control practices versus relying on a single volume control practice. Again, volume control practices should be located on soils that are significantly permeable to ensure the captured volume control storage can infiltrate and dewater the structure at a minimum rate of 0.5 inches per hour.

The following should be considered when determining the location of volume control practices:

1. Conveyance path of the runoff to the practice;

2. Overland flow path from the practice to the main drainage system;

3. Practices should be a minimum of 10 feet from a building foundation (unless waterproofed), 20 feet from a sanitary sewer, and 100 feet from potable water wells and septic tanks;

4. Practices should not be installed on slopes greater than 15;

5. Practices should not be installed above soils that are considered fill; and

6. A minimum setback of 20 feet from a road's gravel shoulder is required to ensure that the practices do not cause frost heaving.

## Volume Control Storage Design

The volume control practice should be filled with coarse aggregate that meets IDOT Section CA-7 quality and gradation. Other types of coarse aggregate will be permitted, provided that it is crushed angular stone that is clean and washed free of fines. A void ratio of 0.36 is used when calculating the storage volume in aggregate. For growing media, a void ratio of 0.25 applies. A layer of choking stone or filter fabric must separate the growing media from thecoarse aggregate, and/or sand layers. No filter fabric shall be placed along the bottom of the trench between the volume control media and the native subsoil. Filter fabric must wrap along the trenching sides to prevent soils migration from clogging the system. The filter fabric should meet the requirements of the *Illinois Urban Manual Material Specifications 592* for geotextile fabric.

The storage reservoir should have direct access for maintenance activities. An observation well (e.g., a perforated PVC pipe that leads to the bottom of the structure) is needed to enable inspectors to visually monitor the drawdown rate of the water. For more information, see the observation well detail located in the MWRD Technical Guidance Manual (TGM), Appendix C. One well per 40,000 $ft^2$ of practice surface area is required. Where infiltration rates of the soil are less than 0.5 inches per hour, volume control practices must incorporate an underdrain pipe that will allow the structure to be dewatered within 72 hours or less, if the structure becomes clogged. An underdrain can be a perforated pipe system in a gravel bed, installed at the base of the structure (minimum of 2" and maximum of 12" from the bottom) to collect and remove filtered runoff. The period of inundation is defined as the time from the high water level in the practice to one to two inches above the bottom of the facility (see Figure 5.12). This criterion was established to provide:

1. Wet-dry cycling between rainfall events;
2. Unsuitable mosquito breeding habitat;
3. Suitable habitat for vegetation;
4. Aerobic conditions; and
5. Storage for back-to-back precipitation events.

Additional details and specifications for the design of volume control practices are provided in this article and in the MWRD Technical Guidance Manual (TGM), Appendix C:

- Underdrain
- Coarse aggregate
- Filter fabric
- Monitoring well
- Turf fields

*Overflow Path from Volume Control Practice*

In addition to a conveyance design that routes flows to a volume control practice, an equally important consideration is a conveyance design that routes flows from the practice back to the main drainage system. The overflow path is a necessary component designed to prevent structural damage to the volume control practice from localized flooding in the event that the practice does not dewater fast enough to prevent an overflow. Overflows can occur as a result of clogging or during long-duration, high-intensity storm events that raise the groundwater level to an elevation that impedes infiltration. Therefore, overflow designs should route excess flows through a stabilized discharge point that allows these flows to be directed back to the main drainage system in a controlled manner that will not cause scour.

*Protection of Volume Control Facilities During Construction*

Volume control practices are susceptible to failure during construction and therefore it is important that staging, construction practices, and erosion and sediment control practices all be considered during their installation. To protect the long-term functionality of volume control practices, the following measures should be addressed in the construction sequencing, general notes, and/or soil erosion and sediment control plan for a development:

- Volume control practices should be installed toward the end of the construction period.
- The contributing drainage area must be stabilized prior to the installation of the volume control practice.
- Soil compaction shall be minimized as much as possible during site grading. Appropriate measures (such as fencing) should be used to prevent heavy construction equipment traffic from accessing the area.
- Volume control facilities must be protected with a double-row of silt fence (or equivalent measure) during construction. The two layers of silt fence should be placed at least 5 feet apart and must follow the *Illinois Urban Manual* standards.
- In general, volume control facilities should not be used as temporary sediment traps during construction. For sites where this is not practicable, special construction notes and/or details are required to protect the functionality of the facility.

*Protection of Volume Control Practice Infiltration Capacity: Pretreatment*

Pretreatment is critical for runoff entering volume control practices in order to prevent clogging within the volume control practice. This reduces maintenance and also provides an added level of protection against groundwater contamination. Pretreatment of runoff entering a volume control practice is strongly recommended to protect the functionality of the structure. Where practicable, flow-through practices such as vegetated swales or filter strips should be used to meet the pretreatment requirement. Additionally, upland drainage should be properly stabilized both during and after construction to reduce erosion, thus minimizing the sediment loads being delivered to the structure. The use of trash racks or downspout screens will also satisfy the pretreatment requirements in some cases, as these measures prevent debris from clogging the volume control practice. Table 5-11 provides a summary of pretreatment measures that may be used for various volume control practices.

## Flow-through Practices for Site Development

Section 9.5-29(b)1 requires flow-through practices for treatment of any portion of the volume control storage that has not been treated using volume control practices. Flow-through practices must be sized to filter or detain the volume control storage as it passes through the structure. Maximizing the contact time between the vegetation and the runoff is critical to the effectiveness of flow-through practices to provide adequate treatment. Vegetation selection varies depending on climate, soil type, topography, land use, available light (shade tolerance), aesthetics, and planned use of the area.

Flow-through practices include, but are not limited to:

- Vegetated Filter Strips;
- Bio Swales;
- Constructed Wetlands;
- Catch Basin Inserts; and
- Oil and Grit Separators.

Again, any of these practices are also a suitable form of pretreatment for volume control practices and site detention facilities (detention ponds). However, these practices are not appropriate for all sites due to several limitations, particularly in redevelopment areas.

Providing vegetated flow-through practices may be difficult in many redevelopment areas due to the lack of ideal soils capable of supporting hearty vegetative growth. Many soils have undergone significant compaction and nutrient loss, which can limit root development and proper drainage. Flow-through practices can also have the potential to interfere with existing infrastructure and practice design should be considered accordingly.

*Flow-through Practice Sizing and Criteria*

## Calculate Volume Control Storage for Flow-Through Treatment

Determine the portion of the volume control storage that will need to be treated with flowthrough practices. The volume control storage is equal to one inch of runoff from the impervious surfaces created by the development. If a portion of the volume control storage is to be treated by volume control practices, subtract that portion from the volume control storage to determine the volume to be treated by flow-through practices.

- First, Calculate Volume to be Treated Using a Volume Control Practice:

$$V_{C\ RET} = V_C \times \%_{RET}$$

| | | | |
|---|---|---|---|
| Where: | $V_{C\ RET}$ | = | Portion of volume control storage in Volume Control Practice ($ft^3$) |
| | $V_C$ | = | Volume control storage (ft ) |
| | $\%_{RET}$ | = | Portion of volume control storage in Volume Control Practice (%) |

- Then, Calculate Volume to be Treated Using a Flow-Through Practice

$$V_{C\ FLW} = V_C - V_{C\ RET}$$

| | | | |
|---|---|---|---|
| Where: | $V_{C\ FLW}$ | = | Portion of volume control storage in Flow-Through Practice ($ft^3$) |
| | $V_C$ | = | Volume control storage (ft ) |
| | $V_{C\ RET}$ | = | Portion of volume control storage in Volume Control Practice ($ft^3$) |

## Volume Control Examples

This section provides examples of the five most common volume control practices that have been utilized in Illinois. There are additional acceptable volume control practices that have not been addressed in this Technical Guidance document, which will be considered by the City with adequate documentation.

## Porous (Permeable) Pavement

The concept of porous pavement is to allow rainwater to infiltrate into and through the surfaces of parking lots, streets, and other traditional impervious surfaces. When designing a porous surface, the designer must carefully evaluate where the infiltrated rainwater is draining and how the stormwater is being conveyed.

The main benefits of porous pavements are increased stormwater infiltration, decreased surface runoff, improved water quality, and reduction in runoff velocity. Porous pavements are particularly important in filtering the first flush pollutants commonly observed at the beginning of a storm event. First flush pollutants are present on the land surface before the storm event and typically include car oil, gasoline, trash, road salt and suspended solids.

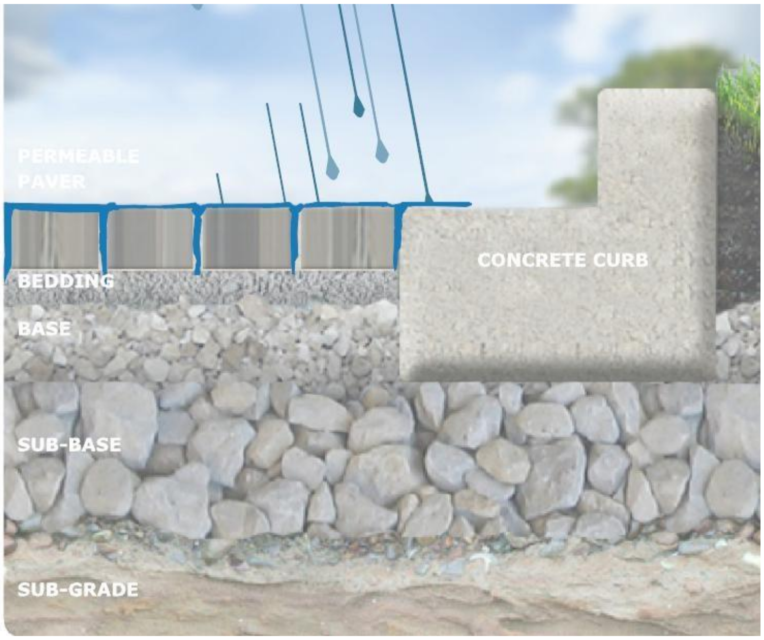

**Figure 5.13. Example of a Permeable Paver Parking Lot Cross-Section (APT, 2011)**

*Design Considerations:*

- There are several pavement options: pervious concrete, permeable pavers, and porous asphalt (not preferred).
- Must be sized and designed based on drainage area, structural requirements, soils, and the volume control storage.
- Underdrains may be used to provide drainage unless infiltration rate is greater than 0.5 inches/hour.
- Maintenance is necessary to ensure long-term functionality. Maintenance procedures include: sweeping organic materials off of gravel-filled pavers, and conventional streetsweeping with vacuums, brushes, and water to clear out voids (aggregate fill may be needed following each cleaning to refill the voids). Schedule R and Exhibit R must be submitted for the volume control facility, as well as a detail drawing of proposed signage, as required.
- This practice should be used with caution in areas underlain with highly permeable soils (i.e., surface sand or gravel) where infiltrated pollutants could reach groundwater without opportunity for attenuation.
- The effects of subgrade compaction, freeze-thaw cycles, de-icing, and snow removal must be considered in determining the applicability of this practice.
- The bottom should be at least 3.5 feet above the seasonal high water table (in combined sewer areas, 2 feet in separate sewer areas) and as level as possible in order to uniformly distribute infiltration to the surrounding soil.

For additional design considerations for porous pavement, the Illinois Urban Manual practice standard is available on-line at: http://aiswcd.org/IUM/standards/urbst890.html.

## Dry Wells

A dry well consists of an excavated area which is backfilled with aggregate to temporarily store and infiltrate stormwater runoff from rooftops. Their typical application is for single family residences. The purpose of the dry well is to reduce runoff volume and peak discharges from a development. They also have the ability to filter soluble contaminants out of the stormwater runoff.

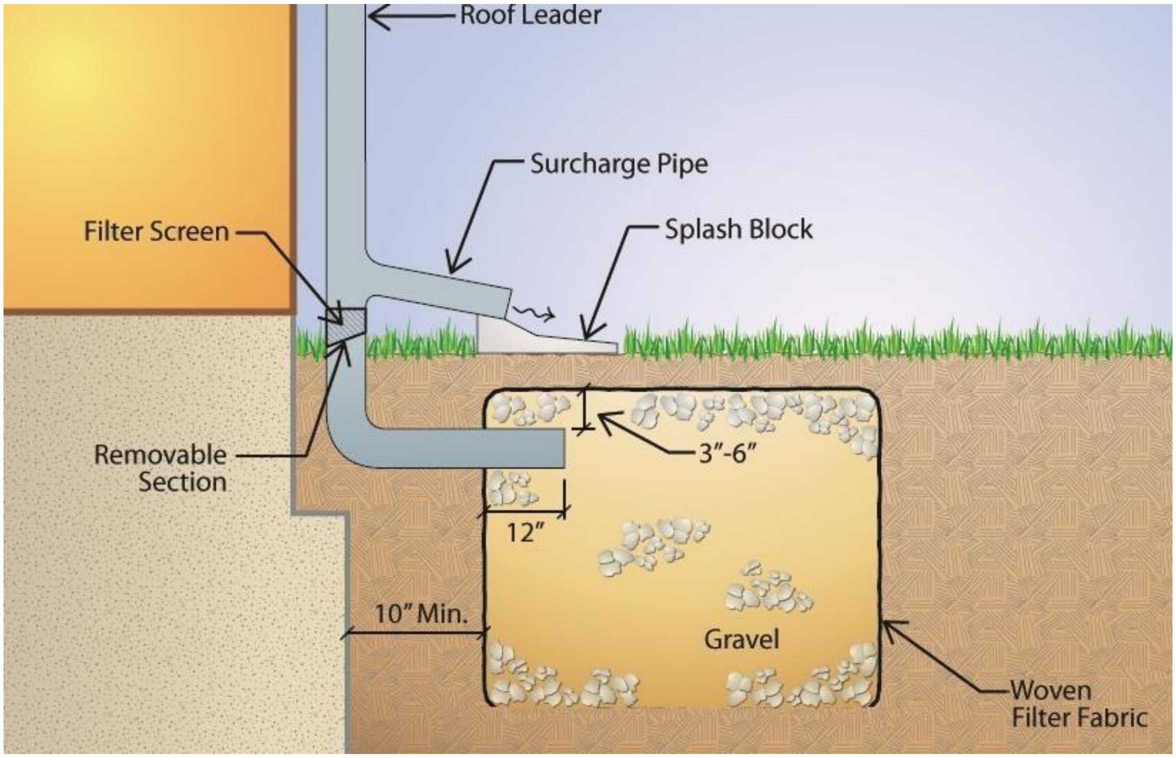


**Figure 5.14. Typical Cross-section for Dry Well**

### *Design Considerations:*

- Must be sized and designed based on the drainage area, soils, and volume control storage.
- Dry wells can be constructed in two different forms: either a structural chamber that is assembled or inserted into an excavated pit, or an excavated pit filled with aggregate.
- It is important that the location of the dry well is adequately placed so that it does not cause basement seepage, flooding, or ponding at the ground surface.
- Dry wells should drain accumulated volume within 72 hours.
- They must be sized with consideration of both drainage area (1 acre maximum) and soil type (sandy soils will drain much more quickly than clay dominated soils).

- The bottom of the well should be at least 3.5 feet above the seasonal high water table (in combined sewer areas, 2 feet in separate sewer areas) and as level as possible in order to uniformly distribute infiltration to the surrounding soil.
- Dry wells should be protected from construction site runoff to prevent clogging.
- Dry well use is restricted by concerns of site feasibility, soil types, clogging, seasonally high groundwater, and bedrock.

For additional design considerations for dry wells, the Illinois Urban Manual practice standard is available on-line at: http://aiswcd.org/IUM/standards/urbst847.html.

## Bio-retention System

Bio-retention systems consist of landscaped areas that are designed to intercept, infiltrate, and store stormwater runoff from the site. A permeable soil layer allows stormwater runoff to infiltrate to a layer of coarse aggregate, where stormwater can be stored in the void space of the stone. Bio-retention systems provide surface storage (between the ground elevation and the elevation of the overflow grate), storage in the void space of the growing media, and storage in the void space of aggregate.

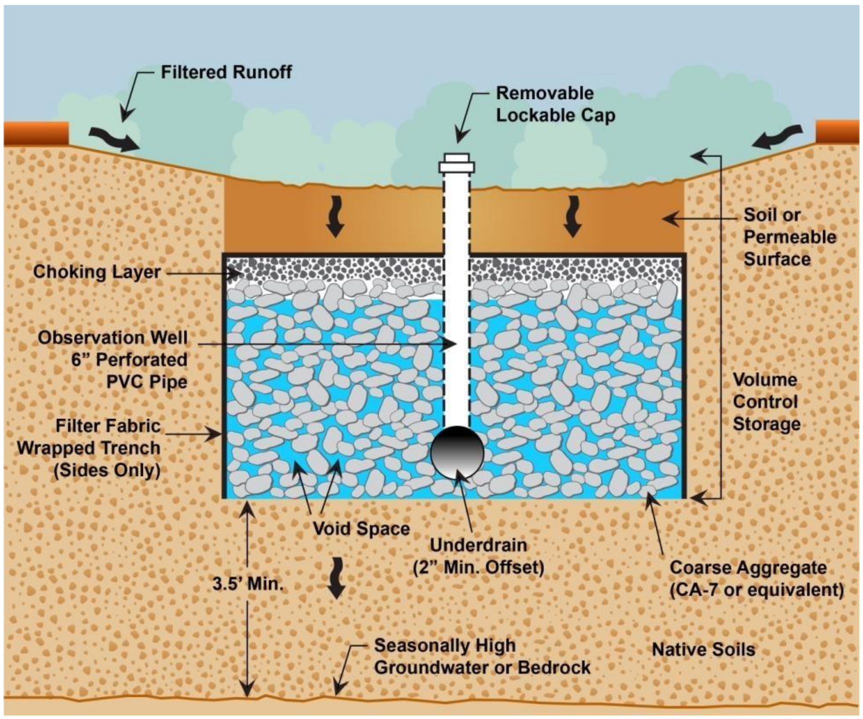


**Figure 5.15. Typical Cross-section for Bio-retention System**

*Design Considerations:*

- Bio-retention Systems are commonly located in parking lot islands or as small pockets within residential land uses.
- Runoff can be drained to Bio-retention Systems using curb cuts or wheel stops.

- They must be sized and designed based on drainage area, soils, and the volume control storage.
- Generally, a one- to three-foot gravel layer wrapped in a woven geotextile provides temporary stormwater storage. However, this may vary depending on the amount of storage needed to meet the volume control requirement.
- Mix should be 50% sand, 30% organic (e.g. aged composted leaf mulch), 20% high quality topsoil (minimal clay content). Several District mixes, which vary by the underlying soil type, are also acceptable and consist of the following:

### Mix-1, for Area Where Native Soil is Clay

50% sand, 50 % **District** composted biosolids or any other compost

(Incorporate in top 4-inches)

### Mix-2, for Areas Where Native Soil is Sandy

40% top soil, 60% **District** composted biosolids or any other compost (Incorporate in top 4-inches)

### Mix-3, for Areas Where Native Soil is Loamy

25 % Sand, 75 % **District** composted biosolids or any other compost (Incorporate in top 4-inches)

- The mulch layer should consist of shredded hardwood mulch (commercial), District's unscreened composted biosolids, or another non-floating mulch.
- During smaller storm events, runoff filters through the mulch and prepared soil mix is collected in a perforated underdrain and returned to the storm drain system. Runoff from larger storms is generally diverted past the bio-retention system to the storm sewer system.
- Additional design details are available on-line at: http://www.stormwatercenter.net/.

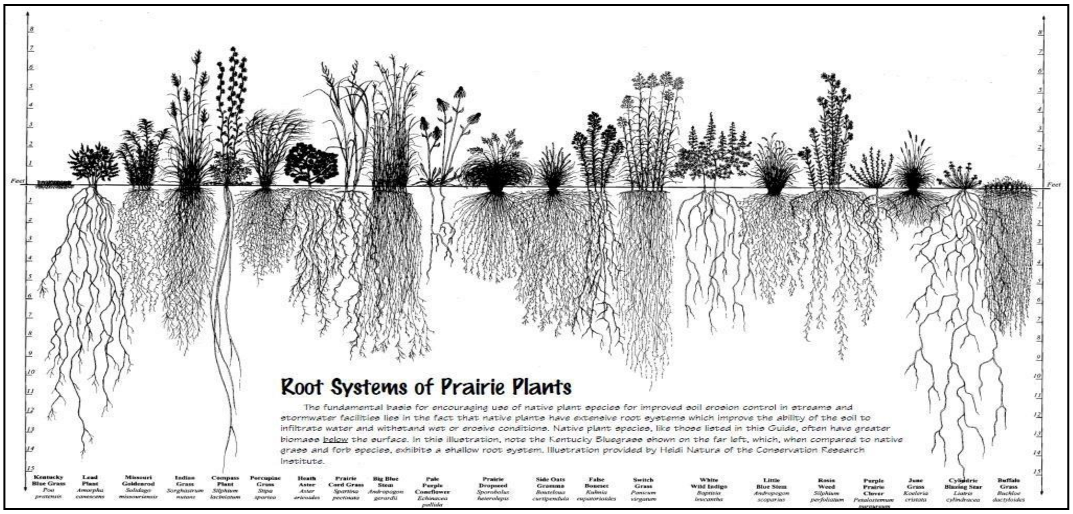


**Figure 5.16. Root Systems of Grass and Prairie Plants (Source: Heidi Natura, CRI, 1995).**

## Water Reuse Systems

Water reuse systems consist of structures that are designed to intercept and temporarily store stormwater runoff. These systems are beneficial because they capture stormwater runoff and allow it to be used for irrigation, which promotes infiltration of that stored water following a storm event. If a storage system does not contain a water reuse application, it does not qualify as a volume control practice since there is no infiltration.

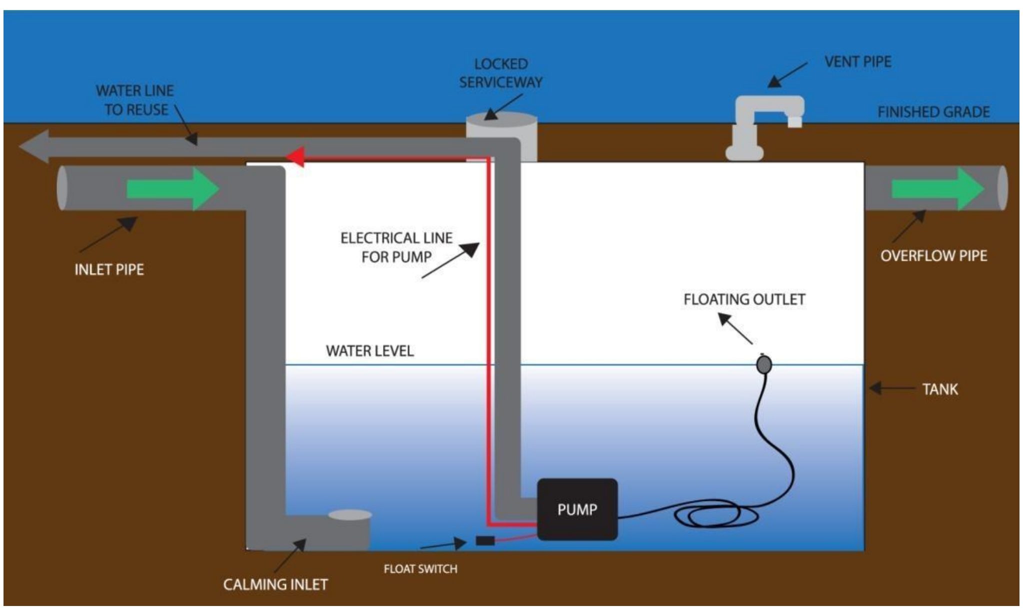


**Figure 5.17. Typical Water Reuse System (Stormwatersmart.org, 2015)**

Water reuse systems can either be above-ground or underground, and may be gravity-drained or pump-evacuated. A typical underground water reuse system is shown as Figure 5.17. There are several common variations of these systems available that include:

- Rain barrels
- Rain cisterns (above-ground and underground)
- Underground storage (tanks, vaults, or other manufactured products)

*Design Considerations:*

- Water reuse systems are commonly used to intercept and store stormwater runoff from rooftops, but can be designed with other areas such as parking lots.
- Placement of water reuse system in the up-gradient portions of a site may eliminate or reduce the need for pumping.
- An overflow pipe must be provided to bypass large storm events through the system.
- To ensure that the storage is available for the next storm event, the system should be designed so that it completely drains within 72 hours. If a low-flow pump is used to dewater the facility, an operation plan should be provided that follows this dewatering schedule.
- Overflow conditions should be considered when prescribing an offset from building foundations. The minimum setback for water reuse systems should be 10 feet from the nearest building foundation (unless waterproofed).
- Pretreatment measures for water reuse systems consist of screens and/or trash racks to filter debris from incoming stormwater runoff.

## Green Roofs

A green roof is a conventional rooftop that includes a covering of vegetation which allows it to act like a pervious surface instead of an impervious one. There are two types of green roofs: intensive and extensive. Extensive green roofs involve a shallow growing medium layer (typically four inches or less) and therefore support plants with shallow root systems, such as herbs, grasses, moss, and sedum. Intensive green roofs include a deeper growing medium layer (typically between 4 and 12 inches) that can support plant species with deeper root zones, including trees and shrubs. Intensive green roof systems are generally limited to flat roofs and require significantly more maintenance than extensive green roof systems.

The overall thickness of a green roof may range anywhere from two inches to 12 inches, and consists of multiple layers that include: planting layer (native vegetation), growing medium layer, geotextile fabric, drainage layer, insulation, membrane protection and root barrier, and structural supports. An example cross-section of a green roof is provided as Figure 5.18 below.

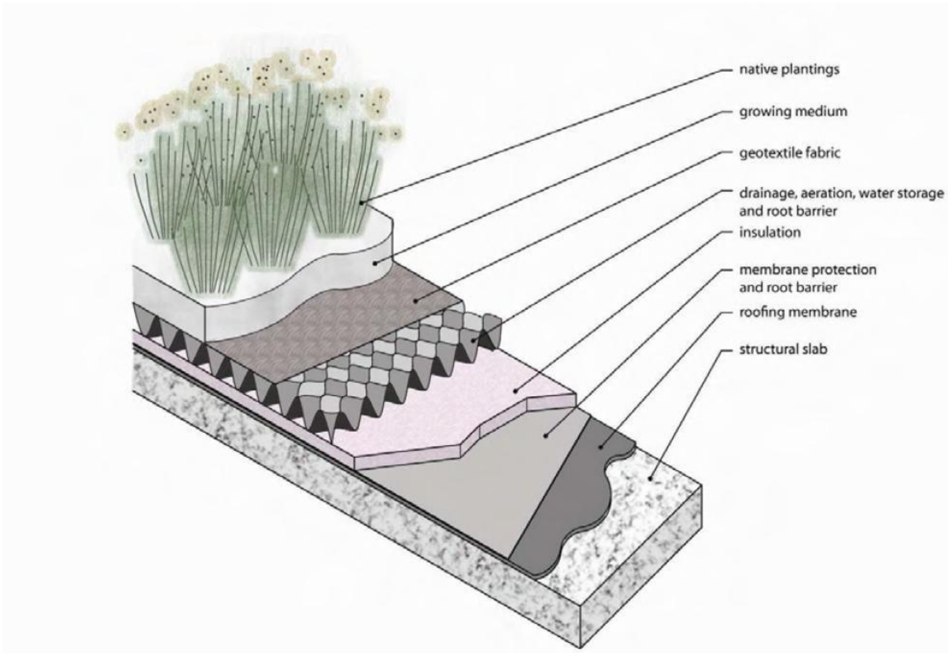


**Figure 5.18. Typical Green Roof Cross-section (Source: City of Chicago, 2014).**

Green roofs provide runoff storage volume in the void space of both the growing medium layer and the drainage layer. Therefore, the runoff volume reduction potential of a green roof is a function of the thickness of its growing medium and drainage layers. Table 5-9 provides a summary of the curve number and available volume control storage for a variety of media thicknesses. For calculating volume control storage, a void ratio of 0.25 should be used for the growth medium layer and also the drainage layer (typically pea gravel).

***Table 5-9. Summary of Curve Numbers and Volume Control Storage for Green Roofs***

| Media Depth* (inches) | Void Ratio | Reduced CN | Reduced Runoff Coefficient, C | Volume Control Storage ($ft^3/ft^2$ of Green Roof) |
|---|---|---|---|---|
| 0 | --- | 98 | 0.90 | --- |
| 2 | 0.25 | 94 | 0.83 | 0.042 |
| 4 | 0.25 | 90 | 0.74 | 0.083 |
| 6 | 0.25 | 85 | 0.66 | 0.125 |
| 9 | 0.25 | 79 | 0.54 | 0.188 |
| 12 | 0.25 | 72 | 0.40 | 0.25 |
| >12 | 0.25 | 63 | 0.10 | >0.25 |

*Media Depth includes growing medium layer and drainage layer

*Design Considerations:*

- Roofs with slopes greater than $45^o$ are typically not suitable for a green roof system.
- Careful attention and additional maintenance are necessary during the first two growing seasons to ensure establishment and proper function as a volume control system.
- Access should be considered for ease of inspection and maintenance.
- The load-bearing capacities of green roofs must be verified by a licensed structural engineer and architect (design plans must be sealed by either). Roof structure must be able to support snow loads in addition to green roof loading.
- A minimum setback of two feet is required from the roof perimeter and all roof penetrations (e.g. water connections, building parts for the usage of roof area, etc.)
- Growth media should consist of 80% lightweight inorganic materials and 20% organic matter.
- Native plants should be selected according to ASTM E2400-06, *Guide for Selection, Installation and Maintenance of Plant for Green (Vegetated) Roof Systems*.
- If vegetation consists of drought-resistant plants, irrigation is usually only necessary during the plant establishment period. Otherwise, an irrigation system is a typical component of a green roof system (water reuse system may be used for irrigation).
- Pretreatment measures are not required for green roof systems.

## Filter Strip

Filter strips are vegetated sections of land that treat sheet flow from adjacent impervious areas. Filter strips are beneficial because they remove pollutants from stormwater before they reach the receiving storm sewer system. Filter strips may provide some reduction in stormwater runoff volume, but their primary function is to filter out contaminants in stormwater runoff. Since they do not provide any quantifiable storage, the use of filter strips is appropriate as a flow-through practice only.


**Figure 5.19. Illustration of a Filter Strip**

*Design Considerations:*

- Filter strips are suitable for draining areas that are five acres or less.
- The minimum length of the filter strip may be determined by the type of vegetative cover, permeability of the soil present, and slope of the filter strip. In general, filter strips should be no less than 30 feet in length and should not exceed 100 to 150 feet in length, as sheet flow will concentrate and cause erosion.
- Longitudinal slopes for filter strips should be between 2 and 5%, but can be up to 10%. The slope should be uniform throughout the strip to maintain sheet flow.
- Since concentrated flows entering a filter strip can cause erosion, a level spreader may be required at the top of the slope.

For additional design considerations, the Illinois Urban Manual practice standard is available on-line at: http://aiswcd.org/IUM/standards/urbst835.html.

## Vegetated Swale

Vegetated swales are shallow earthen channels that are designed to slow stormwater runoff and promote infiltration. Similar to filter strips, vegetated swales intercept stormwater runoff from nearby impervious areas. Their primary function is to filter pollutants and sediment from stormwater runoff. Since they do not provide any quantifiable storage, the use of vegetated swales is appropriate as a flow-through practice only.

Vegetated swales may be combined with non-infiltration related storage volume to provide the required volume control storage. For example, an underground concrete vault (concrete bottom) may be used to provide the one inch of volume over the proposed impervious area. The vault may be pump-evacuated to a flow-through practice (such as a vegetated swale) to treat the volume. For configurations such as these, the storage volume component of volume control is provided in the vault, while the infiltration and pollutant removal component is provided in the flow-through practice. These facilities must be operated and maintained in a manner that maximizes the availability of the provided storage volume.

**Figure 5.20. Typical Cross-section for Vegetated Swale**

*Design Considerations:*

- Vegetated swales can be applied in most development situations with few restrictions. They are well-suited to treat highway or residential road stormwater runoff due to their linear nature.
- They must be sized and designed based on drainage area, soils, and the volume control storage.
- To maximize the wetted perimeter, side slopes of 4:1 or flatter are recommended. Side slopes should not exceed a 3:1 ratio.
- Longitudinal channel slopes should range from as close to zero as drainage permits to 4%. Slopes greater than 4% can be used if check dams are used to reduce flow velocity.
- Additional design details are available on-line at: http://www.stormwatercenter.net/.

## Example 5.5 – Calculation of Required Volume Control

A five acre commercial area is proposed in a combined sewer area with the land use described below. The required volume control is to be provided by a permeable parking lot. The average surface elevation is at 636.0 feet and the groundwater elevation has been determined to be at 631.0 feet.

- Area of building = 2.3 acres
- Area of permeable parking lot = 1.5 acres
- Area of dry-bottom detention pond = 0.3 acres
- Landscaping = 0.9 acres
- Volume of voids in the stone below the permeable pavement is 36%
- Depth of permeable paver and settling base = 9 inches
- Infiltration rate of underlying soil = 0.3 inches/hour

The required volume control storage, $V_c$, is calculated as follows:

$$V_c = 2.3 \text{ acres} \times \frac{43{,}560 \text{ ft}^2}{\text{acre}} \times 1'' \textbf{ runoff} \times \frac{\text{ft}}{12''} = 8{,}349 \text{ ft}^3$$

Note that the permeable pavement is not included in the impervious area calculation.

The first step is to calculate the volume that is provided in the 2-inch (minimum) offset between the bottom of the facility and the invert of the underdrain, over the 1.5-acre parking lot. The void space storage in this location is credited at 100%, and is calculated by the following:

$$2 \text{ inches} \times \frac{1 \text{ ft}}{12 \text{ inches}} \times 1.5 \text{ acre} \times \frac{43{,}560 \text{ ft}^2}{1 \text{ acre}} \times 0.36 = 3{,}920 \text{ ft}^3$$

Therefore, a storage volume of 4,429 $ft^3$ must be provided above the underdrain invert (8,349 $ft^3$ – 3,920 $ft^3$). Since the storage volume in this location is only credited at 50%, the required volume and depth of stone above the underdrain invert can be calculated by:

$$\frac{4{,}429 \text{ ft}^3}{0.36 \times 0.50} = 24{,}606 \text{ ft}^3 \times \frac{1}{1.5 \text{ acre}} \times \frac{1 \text{ acre}}{43{,}560 \text{ ft}^2} = 0.38 \text{ ft}$$

Since the required depth of stone is now known, the design can be checked against the site constraints and Ordinance requirements:

Depth to the bottom of stone:

636.0 ft – (9 in/12) – 0.38 ft – (2 in/12) = 634.70 ft

Depth from the bottom to groundwater:

634.70 ft – 631.0 ft = 3.70 ft → OK > 3.5 ft

See Figure 5.21 below for the configuration of the proposed permeable pavement parking lot, as determined in Example 5.5.

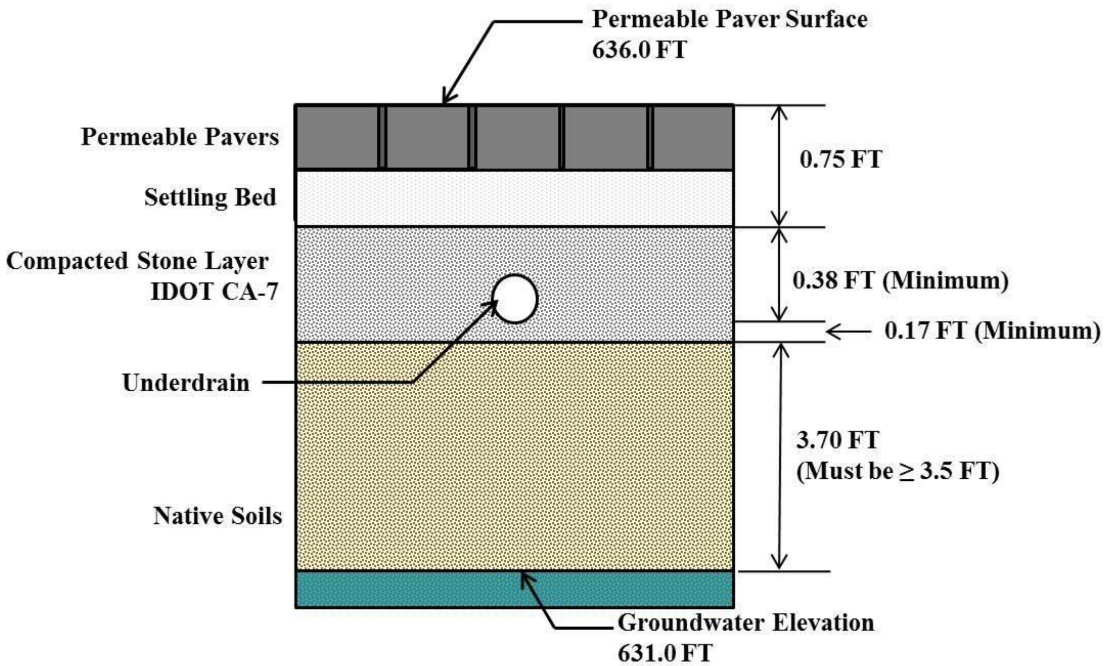


**Figure 5.21. Configuration of Volume Control Storage for Example 5.5**

While this design provides the required volume control storage and satisfies the offset requirements for groundwater, there are several alternative designs that could also work. Since the void storage below the underdrain invert is credited at 100%, the offset from the bottom could be increased (instead of the minimum 2 inches) to provide more volume control storage. This would reduce the depth of stone needed above the underdrain invert. Alternatively, the depth of stone could also be reduced by expanding the area of the permeable pavement parking lot.

<u>Other Design Requirements</u>:

- Because the infiltration rate of the existing soils is less than 0.5 inches/hour, an underdrain must be provided for the storage. The underdrain must be offset a minimum height of 2 inches (0.17 feet), with a maximum allowable offset of 12 inches (1 foot) from the bottom.
- Because this example is located in a combined sewer area, the bottom of the volume control storage must be at least 3.5 feet above the seasonal groundwater elevation. In separate sewer areas, the requirement is 2 feet.
- The permeable pavement storage will need two monitoring wells (1 per 40,000 $ft^2$).
- In this example, the aggregate was assumed to be IDOT CA-7. Other aggregate sizes may be used for volume control practices, provided that it is crushed, angular stone that is cleaned and washed free of fines. Since the available void space will vary with aggregate size, extra care must be taken in the volume control storage calculations.

- The permeable pavement should be designed to slope towards a drainage structure such as an inlet so overflows can be captured. This structure can also be the structure that the underdrain connects to. Since the only impervious area not draining to the volume control practice is the roof area, no flow-through practice is required.

*Table 5-10. Summary of Storage Calculations for Volume Control Practices*

| Volume Control Practice | Void Space of Aggregate[1] | Surface Storage[2] | Growing Media[3] |
|---|---|---|---|
| **Bioretention Facility** | X | X | X |
| **Bioswale[4]** | X | X | X |
| **Constructed Wetlands** | X | X | X |
| **Drywell** | X | | |
| **Green Roof** | X | | X |
| **Infiltration Trench** | X | | |
| **Permeable Pavement** | X | | |
| **Storage Below Detention Basin Outlet** | | X | |
| **Vegetated Filter Strip (Flow-Through)** | | | |
| **Water Reuse System** | | X | |

1 A void ratio of 0.36 shall be used to calculate volume in CA-1 or CA-7 gradations, 0.25 for pea gravel or CA-16 (volume above underdrain credited at 50%)
2 Storage calculated using average-end method between surface elevation and elevation of overflow grate/check dam/outlet pipe
3 Porosity of 0.25 shall be used to calculate volume in growing media (volume above underdrain credited at 50%)
4 Surface storage only if check dams are installed

*Table 5-11. Summary of Pretreatment Measures for Volume Control Practices*

| Volume Control Practice | Pretreatment Measures |
|---|---|
| **Bioretention Facility** | • Level spreader must be installed where runoff enters the facility as shallow concentrated flow to distribute the runoff as sheet flow over the entire facility.<br>• Vegetated filter strip, grass-lined channel, or sump must be installed upstream of the facility to filter out settleable particle and floatable materials.<br>• Where inflow velocities are greater than 3 ft/s, a vegetated filter strip or rock outlet protection must be installed to prevent erosion and distribute flows across the facility.<br>• Vegetated portions of the contributing drainage area must be stabilized. |
| **Bioswale** | • Level spreader must be installed where runoff enters the facility as shallow concentrated flow to distribute the runoff as sheet flow over the entire facility.<br>• Vegetated portions of the contributing drainage area must be stabilized. |
| **Constructed Wetlands** | • Where inflow velocities are greater than 3 ft/s, rock outlet protection should be provided to prevent erosion and distribute the flows into the facility.<br>• Vegetated portions of the contributing drainage area must be stabilized.<br>• Sediment forebay shall be installed upstream of the facility. |
| **Drywell** | • Filter screens must be installed on all roof drains directed toward the facility.<br>• For facilities that include inflow pipes, sump and/or trash rack shall be installed at manhole immediately upstream of facility. |
| **Green Roof** | • No pretreatment measures required. |
| **Infiltration Trench** | • Level spreader must be installed where runoff enters the facility as shallow concentrated flow to distribute the runoff as sheet flow over the entire facility.<br>• Vegetated filter strip, grass-lined channel, or sump must be installed upstream of the trench to filter out settleable particle and floatable materials.<br>• Where inflow velocities are greater than 3 ft/s, a vegetated filter strip or rock outlet protection should be provided to prevent erosion and distribute flows across the facility.<br>• Vegetated portions of the contributing drainage area must be stabilized. |
| **Permeable Pavement** | • Vegetated filter strip, grass-lined channel, or sump must be installed upstream of the facility to filter out settleable particle and floatable materials.<br>• Vegetated portions of the contributing drainage area must be stabilized. |
| **Storage Below Detention Basin Outlet** | • Where inflow velocities are greater than 3 ft/s, rock outlet protection should be provided to prevent erosion and distribute the flows into the facility.<br>• Vegetated portions of the contributing drainage area must be stabilized.<br>• Sediment forebay shall be installed upstream of the facility. |
| **Vegetated Filter Strip (Flow-Through)** | • Level spreader must be installed where runoff enters the facility as shallow concentrated flow to distribute the runoff as sheet flow over the entire facility.<br>• Vegetated portions of the contributing drainage area must be stabilized. |
| **Water Reuse System** | • Filter screens must be installed on all roof drains directed toward the facility.<br>• For facilities that include inflow pipes, sump and/or trash rack shall be installed at manhole immediately upstream of facility. |

*Impervious Area Reduction for Redevelopment Sites*

For redevelopment sites, where volume control practices are not feasible due to site limitations (contaminated soils, high groundwater table, close proximity to wells, etc.) a reduction in existing impervious area may be permitted. This strategy relies on several techniques to reduce the total area of rooftops, parking lots, streets, sidewalks and other types of impervious cover created at a development site. The basic approach is to reduce each type of impervious cover by downsizing the required minimum geometry specified in current local codes, keeping in mind that there are minimum requirements that must be met for fire, snowplow, and school bus operation. In many communities, local codes may need to be changed to allow the use of this group of better site design techniques.

Section 9.5-31 states that for redevelopments, a proportionate reduction in existing impervious area is required for retention of any portion of the volume control storage that cannot be addressed using volume control practices. To utilize this provision, the applicant must:

1. Demonstrate that site limitations prevent the use of volume control practices to retain the volume control storage in full; and

2. Provide the volume control storage onsite to the maximum extent practicable.

For developments that satisfy the above requirements, for every 5% of impervious area that is reduced onsite, the volume control storage may be reduced by 25%. To satisfy the full volume control storage requirements, the site's impervious area would have to be reduced 20% from existing conditions.

*Demonstration of Redevelopment Site Limitations*

If the redevelopment site can retain a portion of the volume control storage, then volume control practices must be provided. For any portion of the volume control storage that cannot be retained on site, then soil data, groundwater data, and other site design limitations, such as zoning requirements, must be included in the Watershed Management Permit submittal. The information provided must demonstrate why a portion of the volume control storage cannot be retained and infiltrated or treated with a flow-through practice.

*Volume Control Storage Credit for Volume Control Practices*

The required detention facility volume can be reduced by the volume control storage provided onsite. To ensure that the detention facility and outlet control structures are appropriately sized for the 100-year, 24-hour runoff volume, the volume control storage credit is provided as a reduction in the overall curve number (CN) of the developed site.

The following steps outline the CN reduction methodology.

For a given watershed (site) with area, $A_W$, stormwater storage is required using the NRCS procedure and is also required to provide a volume of infiltration storage equal to or greater than 1 inch over the impervious area, $A_I$, of the development. This procedure was developed to reflect the volumetric reduction in the runoff hydrograph for the site area ($A_W$).

The NRCS runoff equation is:

$$R_W = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

Where,

$R_W$ = runoff depth (in) from Area, $A_W$

P = rainfall depth used to calculate runoff (in),

S = potential maximum retention after runoff begins (in), and is calculated by:

$$S = \frac{1000}{CN_W} - 10$$

Where,

$CN_W$ = runoff curve number for the watershed

The volume of runoff (acre-feet), $V_W$, from watershed $A_W$ can then be calculated by:

$$V_W = \frac{A_W}{12} \times R_W$$

The total volume of runoff from the site can be reduced by the volume control required and the extra green infrastructure volume that may be provided:

$$V_{ADJ} = V_W - V_R - V_{GI}$$

Where,

$V_{ADJ}$ = adjusted runoff volume from site (acre-feet)
$V_R$ = volume of volume control storage (one-inch over impervious area of development)
$V_{GI}$ = volume of green infrastructure provided in addition to the required one- inch

This reduced volume of runoff can be reflected in an overall reduction to the CN used in detention basin sizing by using:

$$\frac{V_{ADJ}}{A_W} = R_{ADJ} = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

Since $R_{ADJ}$ is known, and P = 7.58 inches for the 100-year, 24-hour storm event, we can solve for S, which then translates to the adjusted CN. The adjusted curve number ($CN_{ADJ}$) is then used to calculate the required detention volume for the site.

## Example 5.6 – Calculation of Volume Control Storage Credit (CN Reduction)

For a 10-acre proposed residential area with a developed CN of 78, and 3 acres of impervious area, find the revised CN resulting from the one-inch volume control provisions of the Ordinance.

The future 100-year runoff volume for the proposed development without volume control can be calculated using the NRCS runoff equation.

$$R_W = \frac{(7.58\text{ in}-0.2S)^2}{(7.58+0.8S)}$$

$$S = \frac{1000}{78} - 10 = 2.82\text{ in}$$

$$R_W = \frac{(7.58\text{ in} - (0.2)(2.82\text{ in}))^2}{7.58\text{ in} + 0.8(2.82\text{ in})}$$

$$Rw = 5.00\text{ inches}$$

The total volume is therefore:

$$V_W = \frac{R_W}{12} \times A_W = \frac{5}{12} \times 10\text{ acres} = 4.17\text{ acre-feet}$$

The volume associated with the total impervious area that must be stored is:

$$V_R = 3 \text{ acres} \times \frac{1 \text{ in}}{12} = 0.25 \text{ acre feet}$$

For this example, $V_{GI}$ =0, so the adjusted runoff volume is:

$$V_{ADJ} = 4.17 \text{ acre-feet} - 0.25 \text{ acre feet} = 3.92 \text{ acre-feet}$$

And therefore:

$$12 \times \frac{V_{ADJ}}{A_W} = \frac{(P - 0.2S)^2}{(P + 0.8S)} = 4.70 \text{ in}$$

Since P = 7.58 inches:

$$4.70 \text{ inches} = \frac{(7.58 \text{ in} - 0.2S)^2}{(7.58 \text{ in} + 0.8S)}$$

Solving this equation iteratively:

S = 3.28, and the adjusted CN, $CN_{ADJ}$ = 75.32

The curve number in this example is reduced from 78 to 75.32. This procedure reflects the stormwater volume reduction and allows for hydrologic routing through proposed stormwater management facilities. To simplify this procedure, an Excel spreadsheet has been provided which reflects the analysis described above. The applicant would only have to provide areas, developed CN and the depth of storage being provided and the reduced CN would be solved for the user. The spreadsheet version of Example 5.6 is shown below.

| RUNOFF CURVE NUMBER ADJUSTMENT CALCULATOR | | | | |
|---|---|---|---|---|
| **Site Information:** | | | | |
| Total Site Area, $A_w$ (ac) = | 10 | | Total Impervious Area, $A_I$ (ac) = | 3 |
| Runoff, R (in) = | 5.00 | | | |
| P = rainfall depth (in) = | 7.58 | | | |
| CN = | 78 | | | |
| S = | 2.82 | | | |
| Runoff Volume Over Watershed, $V_w$ (ac-ft) = | 4.17 | | | |
| **Volume of GI Provided:** | | | | |
| Volume Control Storage, $V_R$ = | 0.25 | ac-ft | 1" of volume over impervious area | |
| Additional Volume, $V_{GI}$ = | 0.00 | ac-ft | Additional volume over the required 1" | |
| Adjusted Volume Over Watershed, $V_{ADJ} = V_W - V_R - V_{GI}$ | | | | |
| $V_{ADJ}$ (ac-ft) = | 3.92 | | | |
| Adjusted Runoff Over Watershed, $R_{ADJ} = \frac{V_{ADJ}}{A_W}$ | | | | |
| $R_{ADJ}$ (in) = | 4.70 | | | |
| $S_{ADJ}$ = | 3.28 | | | |
| Adjusted CN for detention calcs, $CN_{ADJ}$ = | 75.32 | | | |
| *Blue values are entered by user | | | | |

Volume control facilities that make use of void volume above the invert of an underdrain (and which is reduced by 50%), may take full credit for this void volume toward required detention (at 100%), provided the void volume is tributary to the restrictor.

**Section 3**: This Ordinance shall be in full force and effect immediately upon and after its passage, approval, and publication in pamphlet form according to law.

PASSED BY THE CITY COUNCIL OF THE CITY OF PEORIA, ILLINOIS, this ____ day of __________________, 2016.

APPROVED:

_________________________________

Mayor

ATTEST:

City Clerk

EXAMINED AND APPROVED:

Corporation Counsel