| | |
|---|---|
| Red | New Language/Standards |
| Black | Existing Language/Standards (relocated from Section 50.80) |
| ~~Strikethrough~~ | Eliminate/Replace Existing Language/Standards (relocated from Sec 50.80) |
| GSM | Georgia Stormwater Manual |
| MSWDM | Maryland Storm Water Design Manual |

## 10.00 Definitions

Best Management Practices (BMPs) – Control measures taken to mitigate changes to both quantity and quality of urban runoff caused through changes to land use. BMPs can be classified as "structural" or "non-structural". Stormwater BMPs are designed to reduce or mitigate stormwater volume, peak flows, velocities and/or nonpoint source pollution through evapotranspiration, infiltration, detention, and filtration or biological and chemical actions.

County Engineer – The County Engineer of the St. Charles County Highway Department.

Department – For the purpose of this publication, the St. Charles County ~~Highway~~ Community Development Department.

Development – 1. The act of changing and the state of a tract of land after its function has been purposefully changed by man including, but not limited to, structures on the land and alterations to the land. 2. The limits and physical location of the land alterations.

Development, New – Land disturbing activities, structural development (construction, installation, or expansion of a building or other structure), and/or creation of impervious surfaces on a property that had no previous development.

Differential Runoff – For New Development, ~~T~~the difference in rate and volume of stormwater runoff from a ~~parcel or project~~ development between its ~~undeveloped~~ pre-development (natural) condition and its developed condition. For subsequent development of a previously developed site, the difference in rate and volume of stormwater runoff from a development between its developed condition in 2012 and its final developed condition.

Director – For the purpose of this publication, the ~~County Engineer~~ Director of the Division of Development Review.

Highway Department – For the purpose of this publication, the St. Charles County Highway Department.

Non-Structural Controls – Pollution prevention practices that focus on management by limiting or eliminating pollutants before they end up in stormwater. Non-structural controls may include but are not limited to; site and land use planning, natural resource conservation, vegetated filters, stream buffers, tree preservation, low impact development (LID), and open space preservation.

Pre-Development – The site in its natural, undisturbed conditions prior to any development including agricultural use. Where natural conditions cannot be determined, the pre-developed hydrologic condition and cover type shall be assumed to be "Meadow – continuous grass, protected from grazing and generally mowed for hay" with Curve Numbers of 30, 58, 71, 78 for hydrologic soil conditions A-D, respectively, and 5% impervious.

Redevelopment – Structural development (construction, installation, or expansion of a building or other structure), creation or addition of impervious surfaces, replacement of impervious surfaces not as part of routine maintenance, and land disturbing activities associated with structural or impervious development on a previously developed site. Redevelopment does not include such activities as exterior modeling.

Structural Controls – Pollution prevention practices that require the construction, or use of a device, to capture or prevent pollution in stormwater runoff. Structural controls may include but are not limited to extended detention basins, bio-retention, infiltration basins, stormwater wetlands, bio-swales, vegetative lined ditches, subsurface drains, permeable pavement, sand filter basins, stormwater planters, proprietary BMPs, storage tanks, and hydrodynamic separators.

## 70.00 Design Criteria & Guidelines for Post-Construction Stormwater Management

### 70.00.1 Purpose

Two (2) consequences of construction and development are increased runoff created by the changed properties of the ground surface and the rate of discharge of this increased runoff. These are both of great relevance to stormwater management. The natural condition of the land before development is in relative balance with the natural capacity of the receiving streams. Normally, the pre-development conditions provide greater permeability and longer times of concentration. By modification of the ground surface from irregular, pervious and vegetation-covered, the areas are changed to more impervious, more quickly drained and, in some cases, denuded of vegetation. It is the policy of the County to protect and promote the public health, safety and general welfare. The management of stormwater will reduce the erosion on land and in and along stream channels, will reduce the possibility of damage to public and private property, will assist in the attainment and maintenance of water quality standards, and will preserve the environmental quality of the watercourses in the County.

The basic goal of stormwater management is to align water quantity and water quality management techniques in such a way as to prevent further deterioration of our watersheds. Techniques for addressing these goals include maintaining natural, existing conditions, managing peak flows and volume, and reducing pollutants.

1. *Natural Resource Conservation, Runoff Reduction*. Better site plans and site design practices preserve existing vegetation and habitat, introduce native landscaping for water quality treatment, and protect streams from degradation by preventing stormwater impacts rather than mitigating them.

2. *Water Quality*. Development increases the concentration and number of different pollutants carried by runoff. As it runs over rooftops, lawns, parking lots, and industrial sites, stormwater picks up and transports a variety of pollutants to downstream

waterbodies. In order to preserve the quality of water in natural streams, it is important to provide mechanisms to remove contaminants on the site prior to water entering the natural watercourse. Water quality protection and treatment should be seamlessly integrated between preservation of natural site features that absorb rainfall to practices that use natural processes to treat pollutants as they infiltrate, convey, and detain runoff. A basic goal is to maintain or improve pre-development peak flows, runoff volumes, and water quality.

3. *Stream Impairment/Erosion*. Increased runoff volumes and peak flows increase the frequency and duration of smaller bankfull and near bankfull events which are the primary channel forming events. Changes in the rates and amounts of runoff generated from developed watersheds directly affect the morphology, or physical shape and character, of streams and rivers impacting stream widening, bank erosion, downcutting, loss of stream buffer and riparian canopy, and disconnection from the natural floodplain. Peak flows and velocities from channel forming storm events shall be managed and conveyed to streams without causing erosion, degradation, or pollution.

4. *Flooding*. The increased stormwater runoff rates and volumes resulting from the land development process also cause an increase in the frequency, duration and severity of overbank and extreme flooding events. In other words, as more development occurs without proper stormwater management, our natural and man-made infrastructure becomes more vulnerable to flooding. Peak flows shall be managed to maintain pre-development rates for overbank flooding events and be safely conveyed to streams during extreme flooding events.

5. *Reduced Costs of Construction & Maintenance*. State-of-the-art stormwater designs that mimic natural processes should be less expensive to build, more durable and less expensive to maintain, and better protect streams and other infrastructure.

6. *Recreation and Amenities*. Stormwater BMPs (such as stream buffers, native landscaping, preservation of tree canopy, ponds & wetlands) create open space, promote passive recreation, and should provide aesthetic, natural settings. Stormwater management should serve as an amenity to development.

7. *Economic Development, Property Value, Quality of Life*. Natural areas attract development. Natural areas, landscaping, and water quality BMPs should improve adjacent property values, recreational opportunities, and overall quality of life.

8. *Regulatory Compliance*. Stormwater management and the implementation of best practices help comply with water quality regulations of the National Pollutant Discharge Elimination System established under the Clean Water Act and the MS4 General State Operating Permit issued by the Missouri Department of Natural Resources.

## 70.10 Design Criteria

Post-construction stormwater management measures and facilities shall be required and designed according to the criteria defined in this section.

### 70.10.1 When Required

#### 70.10.1.1 Water Quality

1. The requirement to provide measures to protect stormwater quality shall be evaluated for all proposed developments submitted to the Department for review and approval and may be required, if deemed necessary. Stormwater management measures shall be provided and designated in accordance with the requirements of this section. See Table 70-1 for a summary of stormwater management requirements by development type.

2. Water quality treatment is required for all developments that disturb an area greater than or equal to one acre, including developments less than one acre that are part of a larger common plan or development, as follows:

    a. For all new developments, controls shall be designed and implemented to prevent or minimize water quality impacts to the maximum extent practicable. This includes assessment of site characteristics at the beginning of design with the goal of protecting sensitive areas, minimizing the creation of stormwater pollution, and utilizing Best Management Practices (BMPs) that effectively remove stormwater pollution. This can be achieved by reasonably mimicking pre-construction runoff conditions, such as reducing runoff volume through infiltration, evapotranspiration, and/or rainwater harvesting or reuse.

    b. For all infill and redevelopments, water quality strategies and technologies, including those that reduce runoff volume, shall be effectively used to the maximum extent practicable. Infill and redevelopments that cannot meet the full water quality requirement due to physical constraints shall be evaluated on a case-by-case basis.

3. Water quality treatment is not required in residential subdivision developments with five acre or larger lot sizes.

4. If there are known stormwater problems, impaired waterbodies, or other special conditions downstream from a development, water quality treatment shall be required regardless of land disturbance size.

#### 70.10.1.2 Channel & Flood Protection - Stormwater Detention

1. The requirement of stormwater detention shall be evaluated for all proposed developments ~~projects~~ submitted to the Department for review and approval and may be required, if deemed necessary. Detention facilities shall be provided and designated in accordance with the requirements of this section. See Table 70-1 for a summary of stormwater management requirements by development type.

2. New residential subdivision developments with five acre or larger lot sizes, new residential subdivision developments with three acre up to five acre lot sizes that have a differential runoff of less than five (5) cfs for the 15-year, 20-minute event, and all other new ~~D~~developments that have a differential runoff of less than two (2) cfs for the 15-year, 20-minute event ~~and developments with three acre or larger lot sizes~~ shall be exempt from detention requirements for channel and flood protection unless there are known storm water problems, impaired waterbodies, or special conditions downstream from ~~a~~ the proposed development ~~project~~.

3. Subsequent development of previously developed sites without prior stormwater detention shall be evaluated based on the development condition of the site in 2012. Channel and flood protection shall be required when subsequent development has a differential runoff since 2012 that equals two (2) cfs or greater for the 15-year, 20-minute event. ~~Projects~~ Redevelopments that cannot meet this requirement due to physical constraints ~~will~~ shall be evaluated on a case-by-case basis.

4. Redevelopments and subsequent development of previously developed sites with prior stormwater detention are exempt from providing additional channel and flood protection for the existing runoff. These projects shall provide channel and flood protection for any increase in runoff. When existing stormwater management facilities will be used to accommodate the increase in runoff from subsequent development or redevelopment, the facilities shall be retrofitted to meet the current post-construction stormwater management requirements for the additional runoff. ~~Projects~~ Redevelopments that cannot meet this requirement due to physical constraints ~~will~~ shall be evaluated on a case-by-case basis.

5. Detention for channel protection (CPv) shall not be required where the one-year post development peak discharge is less than or equal to 2.0 cfs for the entire development. Channel protection (CPv) shall not be required if the development discharges directly to permanent lakes or to enclosed pipe systems with adequate hydraulic capacity that discharge to permanent lakes or stormwater management facilities.

6. The flood protection (Qp) requirements may be waived by the Director where safe and effective conveyance is provided directly to a major river system, lake, or wetland that have capacity to handle flow increases at the 10-year level and where it would benefit to discharge the peak flows from the site prior to the peak flows in the receiving, natural system.

7. If there are known storm water problems, impaired waterbodies, or other special conditions downstream from a ~~project~~ development, detention for channel and flood protection ~~will~~ may be required at the discretion of the Director regardless of differential runoff or minimum lot size.

~~8. Detention requirements will be at the discretion of the County Engineer for projects that have a differential runoff of two (2) cfs to five (5) cfs for the 15-year, 20-minute event.~~

9. ~~When existing detention facilities are going to be used to accommodate additional runoff from building or parking lot expansions or subdivision additions, the facilities shall be retrofitted to meet the current detention requirements for the drainage area that is a tributary to the facility. Projects that cannot meet this requirement due to physical constraints will be evaluated on a case-by-case basis.~~

**Table 70-1 Stormwater Management Requirements By Development Type**

| Development Type | Required Stormwater Management | | |
|---|---|---|---|
| | **Water Quality (WQv)** | **Channel Protection (CPv)[4]** | **Flood Protection (Qp)[4]** |
| Infill/Redevelopment | LD ≥ 1 acre[1] | $Q_{15}$ differential ≥ 2 cfs since 2012 and $Q_1$ development > 2 cfs[1,2,3] | $Q_{15}$ differential ≥ 2 cfs since 2012[1,2,5] |
| New Private Commercial – Not in Subdivision | LD ≥ 1 acre | $Q_{15}$ differential ≥ 2 cfs and $Q_1$ development > 2 cfs[3] | $Q_{15}$ differential ≥ 2 cfs[5] |
| New Commercial or 0-3 Acre Lot Residential Subdivision | LD ≥ 1 acre | $Q_{15}$ differential ≥ 2 cfs and $Q_1$ development > 2 cfs[3] | $Q_{15}$ differential ≥ 2 cfs[5] |
| New 3-5 Acre Lot Residential Subdivision | LD ≥ 1 acre | $Q_{15}$ differential ≥ 5 cfs and $Q_1$ development > 2 cfs[3] | $Q_{15}$ differential ≥ 5 cfs[5] |
| New 5+ Acre Lot Residential Subdivision | Not Required | Not Required | Not Required |

[1] Infill development and redevelopments that cannot meet the full water quality, channel protection, or flood protection requirements due to physical site constraints shall be evaluated on a case-by-case basis.

[2] Previously developed sites with prior stormwater detention are exempt from providing additional channel and flood protection for the existing runoff. These projects shall provide channel and flood protection for any increase in runoff.

[3] Not required where the development discharges directly to permanent lakes or to enclosed pipe systems with adequate hydraulic capacity that discharge to permanent lakes or stormwater management facilities.

[4] If there are known storm water problems, impaired waterbodies, or other special conditions downstream from a project development, detention for channel and flood protection may be required at the discretion of the Director regardless of differential runoff or minimum lot size.

[5] Flood protection requirements may be waived by the Director where safe and effective conveyance is provided directly to a major river system, lake, or wetland that have capacity to handle flow increases at the 10-year level and where it would benefit to discharge the peak flows from the site prior to the peak flows in the receiving, natural system.

### 70.10.2 Design Standards and Sizing Criteria

#### 70.10.2.1 Stormwater Management Standards

1. *Natural Resource Conservation and Better Site Design Practices*. The identification, and subsequent preservation and/or restoration of existing natural resources, through the use of better site design practices, helps reduce the negative impacts of the land development process "by design." The goal is to reduce the amount of stormwater runoff and pollutants that are generated, provide for natural on-site control and treatment of runoff, and optimize the location of stormwater management facilities. Better site design concepts can be viewed as both water quantity and water quality management tools and can reduce the size and cost of required BMPs. The use of certain better site design practices that provide water quality benefits allows for a reduction (or "credit") of the water quality volume.

2. *Runoff Reduction*. Runoff reduction practices shall be sized and designed to retain rainfall on the site to the maximum extent practicable. Runoff reduction practices are stormwater BMPs used to disconnect impervious and disturbed pervious surfaces from the storm drain system, thereby reducing post-construction stormwater runoff rates, volumes, and pollutant loads. Runoff reduction practices inherently reduce total suspended solids (TSS) and other pollutants to provide water quality treatment (i.e. 100% pollutant removal for stormwater retention, infiltration, evaporation, transpiration, or rainwater harvesting and reuse). The water quality treatment volume in 70.10.2.3 shall be waived, if 0.9 inch of rainfall can be retained onsite using runoff reduction methods. If the entire 0.9-inch runoff reduction standard cannot be achieved, the remaining runoff from the 1.14-inch rainfall event must be treated by BMPs to remove at least 80% of the calculated average annual post-development TSS loading from the site per 70.10.2.3.

3. *Water Quality*. Stormwater management facilities shall be designed to retain or treat the runoff from 90% of the storms that occur in an average year and reduce average annual post-development total suspended solids loadings by 80%. This equates to treating storm events of 1.14 inches or less, as well as the first 1.14 inches of runoff for all larger storm events. This standard is quantified and expressed in terms of engineering design criteria through specification of the water quality volume (WQv). The $WQ_V$ must be treated to the 80% TSS removal performance goal.

4. *Stream Channel Protection*. Stream channel protection shall be provided by using 24-hour extended detention storage of the 1-year, 24-hour return frequency storm event, erosion prevention measures such as energy dissipation and velocity control, and preservation of the applicable stream buffer. The extended detention standard is intended to reduce the frequency, magnitude and duration of post-development bankfull flow conditions. The volume to be detained is also known as the channel protection volume (CPv). The use of nonstructural site design practices and runoff reduction BMPs that

reduce the total amount of runoff may also reduce CPv by a proportional amount. Where runoff reduction practices are used, an adjusted curve number (CN) is computed that is lower than the original CN based on an actual stormwater volume removed from the total runoff (see Section 70.30.1).

5. *Overbank and Extreme Flood Protection*. Overbank flood protection shall be provided by controlling the post-development peak discharge rate ($Q_p$) to the pre-development rate (natural or existing condition, as applicable) as required in 70.10.2.5. Extreme flood protection shall be provided by safely conveying the 100-year, 24-hour storm event. This is accomplished by sizing the onsite conveyance system to safely pass the extreme storm event. The use of nonstructural site design practices and runoff reduction BMPs that reduce the total amount of runoff will also reduce $Q_p$ by a proportional amount. Where runoff reduction practices are used, an adjusted curve number (CN) is computed that is lower than the original CN based on an actual stormwater volume removed from the total runoff (see Section 70.30.1).

### 70.10.2.2 Numerical Sizing Criteria

This section presents the sizing criteria for stormwater management facilities to meet pollutant removal goals, reduce channel erosion, prevent or reduce flooding, and pass extreme storm and flood events. A brief summary is listed below.

**Table 70-2 Summary Of Key Components & Stormwater Criteria**

| **Stormwater Volume**[2] | | **General Criteria & Calculation Method** |
|---|---|---|
| **Water Quality ($ft^3$)**[1] | **Runoff Reduction Volume** (RRv) | **RRv = [(P/12)(Rv)(A*43,560)]**<br>P = target runoff reduction rainfall = 0.9 in.<br>Rv = volumetric runoff coefficient<br>A = area in acres |
| | **Water Quality Volume** (WQv) | WQv shall be treated using one of the allowable BMPs where RRv is not fully retained<br>**WQv = [(P/12)(Rv)(A*43,560)]**<br>P = rainfall depth = 1.14 in.<br>Rv = volumetric runoff coefficient<br>A = area in acres |
| **Channel Protection Storage Volume** (CPv) | | CPv = 24 hour extended detention of post-developed one-year, 24-hour storm event |
| **Flood Protection Volume**[3] ($Qp_{10}$, $Qp_{100}$) | | The post-developed routed peak flow from the site shall not exceed the pre-development routed peak flow for the 10-year, 24-hour event or the allowable release rates for applicable watersheds. Calculated using NRCS unit hydrograph method routed through basin. The conveyance system shall be designed to safely control and convey the peak flows from the $Qp_{100}$ event. |

[1] Portions of the water quality volume (WQv) can be satisfied by providing for its treatment in combination with a channel protection volume (CPv) facility (See Sections 70.10.2.3 and 70.10.2.4).

[2] Subtractions for Non-structural Practices: When non-structural practices are employed in the site design, the WQv and to a lesser extent the CPv and Qp can be reduced in accordance with the conditions outlined in Section 70.30.1.

[3] In developments where channel protection is not required and flood protection is, the post-developed peak flow from the site may not exceed the pre-development peak flow for the 2-year, 24-hour event and the 10-year, 24-hour event.

### 70.10.2.3 Water Quality – Runoff Reduction Volume (RRv) & Water Quality Volume (WQv)

1. The Runoff Reduction approach to the Water Quality sizing criterion, denoted RRv, specifies the reduction or elimination of the total pollution load inherent in stormwater runoff by intercepting and reducing or eliminating the first 0.9 inch of rainfall, or to the maximum extent practicable. The RRv is directly related to the amount of impervious cover at a site. In numerical terms, it is equivalent to a rainfall depth of 0.9 inch multiplied by the volumetric runoff coefficient (Rv) and the site area. The following equations are used to determine RRv:

   RRv = [(P/12)(Rv)(A*43,560)]

   Where:

   RRv = target runoff reduction volume ($ft^3$)
   P = 0.9 inch of rainfall
   Rv = 0.05 + 0.009(I)
   I = percent impervious cover (in percent; eg. 100% = 100, 75% = 75 – see Table 50-1 for minimum impervious percentages)
   A = area in acres

2. WQv is the storage needed to capture and treat the runoff from 90% of the recorded daily rainfall events. In numerical terms, it is equivalent to 1.14 inches of rainfall multiplied by the volumetric runoff coefficient (Rv) and site area. The WQv is directly related to the amount of impervious cover created at a site. A minimum WQv of 0.2 inches per acre shall be met at all sites where WQv is required. The following equations are used to determine WQv:

   WQv = [(P/12)(Rv)(A*43,560)]

   Where:

   WQv = water quality volume ($ft^3$)
   P = 1.14 inches of rainfall

Rv = 0.05 + 0.009(I)
I = percent impervious cover (in percent; eg. 100% = 100, 75% = 75 – see Table 50-1 for minimum impervious percentages)
A = area in acres

3. As a basis for determining water quality treatment volume, the following assumptions shall be made:

   a. Percent Impervious Cover (I) must be based on Zoning District and shall use the minimum impervious percentages in Table 50-1. The Engineer shall provide adequate detailed computations for any proposed, expected or contingent increases in imperviousness and shall make adequate allowances for changes in zoning use. If consideration is to be given to any other value, the request must be made prior to the submittal of improvement plans, must be reasonable and fully supported, and must be approved in writing by the Director before its use is permitted.

   b. Measuring Impervious Cover: The measured area of a site plan that does not have vegetative or permeable cover shall be considered total impervious cover, including any rock surface supporting vehicular traffic.

   c. The WQv for offsite areas is not required if the offsite flows bypass the water quality facilities. If offsite runoff flows into the water quality facility, the WQv calculation must include the offsite area. Offsite areas are defined as those areas that are not a part of the proposed development but produce runoff that flows to the proposed development.

   d. Multiple Drainage Areas: When a project contains or is divided by multiple drainage areas, the entire WQv shall be addressed for each drainage area (i.e. the WQv in one drainage area cannot be increased to compensate for no or reduced WQv in another drainage area). The Director may waive this requirement where site constraints do not allow for the effective use of BMPs such as on remote lots. However, the sum of these waived areas may not exceed 5% of the total disturbed area (not including common ground or conservation easements) of the proposed development.

   e. BMP Treatment: The final RRv/WQv shall be treated by an acceptable BMP(s) per Section 70.30 or as approved by the Director.

   f. Subtractions for Non-structural Practices: When non-structural practices are employed in the site design, the WQv can be reduced in accordance with the conditions outlined in Section 70.30.1.

   g. Extended Detention (ED) for WQv: The water quality requirements can be met by providing a 24-hour draw down of a portion of the water quality volume (WQv) in conjunction with a stormwater pond or wetland system. Referred to as ED, this is different than providing the extended detention of the one-year storm for the channel

protection volume (CPv). If the same pond or wetland is used for the Cpv, the ED portion of the WQv may be included when routing the Cpv.

h. Water quality portions of a BMP may not serve as a sediment control device during the site construction phase after the BMP is under construction. In addition, the erosion and sediment control plan for the site must clearly indicate how sediment will be prevented from entering the BMP during construction.

4. All water quality facilities shall include a separate landscape plan prepared by an experienced professional with a degree or certification that qualifies them to develop the planting palettes and plans. Landscape plans prepared by a professional landscape architect are highly recommended.

### 70.10.2.4 Channel Protection Storage Volume (CPv)

1. To protect channels from erosion, a 24-hour extended detention of the 1-year, 24-hour storm event will be provided. The rationale for this criterion is that runoff will be stored and released in such a gradual manner that critical erosive velocities during bankfull and near bankfull events will seldom be exceeded in downstream channels. A detention basin or underground vault is normally needed to meet the CPv requirement (and subsequent flood protection criteria, $Qp_{10}$).

2. CPv shall not be required at sites where the one-year post development peak discharge is less than or equal to 2.0 cfs for the entire development per section 70.10.1.2, #5.

3. As a basis for determining CPv, the following assumptions shall be made:

   a. The model TR-55 (or approved equivalent) shall be used for determining peak discharge rates (see 70.10.2.5, #2 for additional TR-55 information).

   b. The rainfall depth for the one-year, 24 hour storm event shall be obtained from NOAA Atlas 14 (http://hdsc.nws. noaa.gov/hdsc/pfds/) for the specific development location. The rainfall distribution shall be Type II.

   c. The length of overland sheet flow used in time of concentration ($t_c$) calculations shall be limited to no more than 100 feet for post-project conditions.

   d. The 24-hour extended detention is defined as providing a 24-hour detention lag time (T) for the one-year storm. The lag time is defined as the interval between the center of mass of the inflow hydrograph and the center of mass of the outflow hydrograph. The lag time and CPv orifice diameter shall be determined by use of nationally recognized pond routing software capable of modelling industry standard methodologies and approved by the Director. The method for computing CPv as outlined in the Maryland Stormwater Design Manual, Appendix D.11 will not be accepted.

e. A CPv orifice diameter of less than 1½" shall not be allowed. CPv orifice diameters greater than 3" require an acceptable external hood that extends above/below it such as screens, baffles, or as approved by the Director. A CPv orifice diameter between 1½" and 3" shall require internal orifice protection as approved by the Director. An internal orifice protection may include an over-perforated vertical standpipe with ½ inch orifices or slots that are protected by wire cloth and a stone filtering jacket. A schematic design of an acceptable internal orifice protection is provided in Drawing Cxxx.xx [Detail No. 3, Appendix D-8 of Maryland SW Design Manual/GSM 3.4.3-3.4.5].

   The preferred method is a submerged reverse-slope pipe that extends downward from the riser to an inflow point one foot below the normal pool elevation.

   Alternative methods are to employ a broad-crested rectangular, V-notch, or proportional weir, protected by a half-round pipe or similar device that extends at least 12 inches below the normal pool (See Drawing Cxxx.xx [Detail #7, Appendix D-8 Maryland SW Design/GSM 3.4.3-3.4.5]).

   No steel, galvanized steel, or corrugated metal pipe shall be allowed. The use of horizontal perforated pipe protected by geotextile and gravel is not recommended and shall be allowed only by approval of the Director.

   Vertical pipes may be used as an alternative if a permanent pool is present.

f. Multiple Drainage Areas: When a development contains or is divided by multiple drainage areas, the entire CPv shall be addressed for each drainage area within that drainage area. The CPv in one facility cannot be increased to compensate for no or reduced CPv in another, except the Director may approve the CPv to be managed elsewhere in the following areas:

   i. Where the WQv is treated by widening the riparian buffer and a Sheet Flow to Buffer non-structural BMP credit for WQv is used as described in Section 70.30.1.2.
   ii. Where the site constraints do not allow for the effective use of BMPs, such as on remote lots, and the one-year post development peak discharge is less than or equal to 2.0 cfs for the individual drainage area.

g. Extended detention storage provided for the CPv does not fully meet the WQv requirement (that is CPv and WQv should be treated separately).

h. The storm water storage needed for CPv may be provided above the WQv storage in storm water ponds and wetlands; thereby meeting all storage criteria in a single facility with appropriate hydraulic control structures for each storage requirement.

i. The stormwater storage needed for WQv may be nested within the CPv storage in stormwater ponds, wetlands, and bioretention basins where applicable; thereby

meeting all storage criteria in a single facility with appropriate hydraulic control structures for each storage requirement.

j. Infiltration is not recommended for CPv control because of large storage requirements. However, if proven effective, appropriate, and desirable it may be approved by the Director.

### 70.10.2.5 Flood Protection – Stormwater Detention

1. When required to provide flood protection, developments ~~projects that have a differential runoff of greater than five (5) cfs for the 15-year, 20-minute event or projects where detention will be required by the County Engineer~~ shall have the following detention requirements:

   a. The post-developed peak flow from the ~~site~~ development may not exceed the ~~existing~~ pre-development peak flow for the ~~2-year, 24-hour event and the~~ 10-year, 24-hour event ~~for sites larger than ten (10) acres~~. ~~For sites less than 10 acres, the post-developed peak flow from the site may not exceed the existing peak flow for the 2-year, 20-minute event and the 15-year, 20-minute event~~. In developments where channel protection is not required and flood protection is, the post-developed peak flow from the site may not exceed the pre-development peak flow for the 2-year, 24-hour event and the 10-year, 24-hour event.

      The Department, at its discretion, can create stricter detention standards for watersheds that are known to have storm water management problems. The Engineer shall be made known of any stricter standards during the conceptual design or preliminary plat process.

   b. The ~~existing~~ pre-development and post-developed peak flows shall be determined using Technical Release 55 (TR-55) ~~for sites ten (10) acres or greater~~. All assumptions that are required for the TR-55 method shall be approved, in writing, by the Department prior to commencing clearing or grading activities or approval of an interim grading plan. ~~For sites less than 10 acres, flow rates shall be determined using the method set forth in section 50.30.1 "Flow Quantities."~~

   c. For developments less than five (5) acres, the Director may approve the following flood protection standards in place of the standards listed above. The post-developed peak flow from the site may not exceed the existing peak flow for the 15-year, 20-minute event. In developments where channel protection is not required and flood protection is, the post-developed peak flow from the site may not exceed the pre-development peak flow for the 2-year, 20-minute event and the 15-year, 20-minute event. Flow rates shall be determined using the method set forth in section 50.30.1 "Flow Quantities." The 20-minute inflow hydrographs shall be determined as directed in Figure 50-5.

2. The ~~2-year, 10-year, and 100-year,~~ 24-hour inflow hydrographs shall be determined by using Technical Release 55 (TR-55), "Urban Hydrology for Small Watersheds" from the

Natural Resources Conservation Service, formerly Soil Conservation Service (SCS). The inflow hydrograph shall be developed based on the actual flow and timing characteristics upstream of the detention facility. The rainfall distribution shall be Type II. Rainfall precipitation data shall be from NOAA Atlas 14 (http://hdsc.nws. noaa.gov/hdsc/pfds/) for the specific development location.

3. ~~The rates of runoff (pre-developedment and post developed) for sites developments less than ten acres shall be determined by the Rational Method for the 20-minute rainfall intensity. The 2-year, 15-year, and 100-year, 20-minute inflow hydrographs shall be determined as directed in Figure 50-5.~~

4. ~~For sites developments larger than ten acres, s~~ Stormwater shall be detained on-site or off-site, as approved by the Director, and released at a rate not to exceed the release rate from the ~~site~~ development under ~~existing (pre-developed)~~ pre-development conditions ~~for the 2-year and 10-year, 24-hour events~~. Note that stormwater pipes, downstream from the control structure, shall be sized to carry the runoff from the 15-year, 20-minute design storm for the total tributary upstream watershed. No reduction in outfall pipe size shall be permitted because of detention.

~~5. For sites developments less than 10 acres, stormwater shall be detained on-site or off-site, as approved, and released at a rate not to exceed the release rate from the site development under existing (pre-developed) pre-development conditions for the 2-year and 15-year, 20-minute events. Note that stormwater pipes, downstream from the control structure, shall be sized to carry the runoff from the 15-year, 20-minute design storm for the total tributary upstream watershed. No reduction in outfall pipe size shall be permitted because of detention.~~

5. The volume of detention may be provided through permanent detention facilities such as dry basins or ponds, permanent ponds or lakes, underground storage facilities or in parking lots. The Engineer shall make every effort to locate the detention facility at or near the lowest point of the ~~project~~ development such that all of the onsite runoff will be directed into the detention facility.

6. Flows from off-site upstream areas ~~should~~ shall be by-passed around the detention facility to ensure that the proposed detention facility will function as designed and will provide effective control of downstream flows with development in place. If off-site flows are approved by the Department to be directed into a detention facility, the Engineer ~~must~~ shall provide an analysis showing that the detention basin will adequately release storm water under both existing and future developed offsite conditions. Modifying the release rate to accommodate off-site flows may reduce or eliminate the effectiveness of the detention facility, because it will no longer control the increased volume of runoff during the critical time period of the watershed.

7. Detention basin volume ~~will~~ shall be based on routing the required post-developed ~~2-year, 10-year, and 100-year, 24-hour inflow hydrographs or the 2-year, 15-year, and 100-year, 20-minute~~ design storm inflow hydrographs through the detention facility while

satisfying the appropriate allowable release rate. The routing computations shall be based on an application of the continuity principle, (i.e., level pool routing).

8. Design of Underground Basins:

    a. Adequate access for basin maintenance and inspection shall be provided. A means of visual inspection from the ground surface of the low flow device, overflow weir and outlet structure ~~is necessary~~ shall be required. A manhole shall be provided at the upstream end of underground basins for access, inspection, to facilitate maintenance, and air release. Manhole ~~A~~access ~~also~~ shall be provided to allow for cleaning of the low-flow device and isolator row from the ground surface. This access shall be large enough to allow a vacuum truck access to the low-flow device and any isolator row.

    b. The basin ~~should~~ shall have sufficient volume and spillway capacity to pass/contain the 100-year, 24-hour event.

    c. Underground basins shall not be approved for use in residential subdivisions other than multi-family (condominium and apartment) developments where maintenance is provided by a management company.

9. The Engineer must submit the following for review of a detention facility:

    a. Elevation vs. Discharge tables or curves for all frequencies.

    b. Elevation vs. Storage tables or curves for all frequencies.

    c. Inflow calculations and data for all frequencies.

    d. Hydraulic gradeline computations for pipes entering and leaving the basin for all frequencies.

    e. If the embankment contains fill material a geotechnical report may be required.

    f. Site plan showing appropriate design information.

    g. Structural calculations for the outlet control structures (if required).

    h. Cross sections defining size, shape and depth of the detention basin shall be required. At a minimum, three sections, one at each end and one in the middle of the basin ~~will~~ shall be required. These sections ~~will~~ shall be used to compute the as-built volume of the basin and thus must be tied to a known physical structure or baseline.

10. All ends of pipes and open channels discharging concentrated flow into a dry basin ~~or pond~~ planted with turf grass shall have their outlets stabilized with riprap or other

approved erosion control and energy dissipation method and shall be connected with the low-flow pipe or control structure by means of a ~~paved~~ permeable swale that is lined with a permanent turf reinforcement blanket or an equivalent means of permanent erosion protection. The ~~paved~~ permeable swale shall ~~be non-reinforced concrete, six (6) inches thick, with a minimum two (2) percent slope to the center and~~ have a minimum ~~0.2~~ 1.0 percent and a maximum 2.0 percent longitudinal slope. Longitudinal slopes of up to 4% may be approved by the Director where site conditions justify a greater slope. ~~Paved~~ Permeable swales shall be a minimum of ~~six (6) inches deep and~~ four (4) feet wide or 1.3 times the diameter of the pipe entering the basin, whichever is greater~~, and be keyed to a structure or channel~~. At a minimum, the permeable swale shall be improved with amended soils per the standards of Section 70.30.1.5. Treatment and credit for WQv shall be allowed for permeable swale designs that incorporate amended soils and an underdrain system that is connected to the basin outlet control structure per standard drawing C604.98. The requirements for the modified soil depth may be waived or reduced by the Director for basins with adequately draining native soils (Hydrologic Soils Group A/B) provided that there is no further compaction or modification of the native soils during grading and construction of the basin. The bottom of the basin shall be sloped a minimum of two (2) percent towards the ~~concrete~~ permeable swale.

11. All ends of pipes and open channels discharging concentrated flow into a dry basin planted with native vegetation shall have their outlets stabilized with riprap or other approved erosion control and energy dissipation methods. The native vegetation shall be suitable to the hydrologic conditions of the basin and it must be regularly maintained by the owner.

12. Where retaining walls are proposed to support an embankment, design elements shall be used to protect the basin from failure and to protect against nuisance to downgradient properties due to seepage or hydrostatic pressure under its ponding conditions. Such design elements shall be supported by recommendations by a Geotechnical Engineer. Railroad tie walls cannot be used ~~where water will be in contact with the railroad tie wall~~.

13. The maximum side slopes for dry basins or ponds, and the fluctuating area of permanent ponds or lakes shall be 3:1 (three feet horizontal, one foot vertical) without fencing.

14. Dry basins ~~or ponds and the fluctuating areas of permanent ponds or lakes are to~~ shall be lined with placed revetment, seeded turf grass lined with temporary, commercial erosion control blanket or sod~~, or commercial erosion control blanket and kept~~ that is regularly mowed, or planted with native vegetation that is regularly maintained and is suitable for the hydrologic conditions in the basin.

15. Wet basins and the fluctuating areas of permanent basins, ponds, and lakes shall be lined with placed revetment, sod or seeded turf grass lined with permanent, commercial erosion control blanket that is regularly mowed, or native vegetation that is regularly maintained and suitable for aquatic conditions.

16. Control structures and overflow structures ~~are to~~ shall be reinforced concrete.

17. The outflow pipe shall be sized for the developed flow rate.

18. In basins with concrete walls or rock blanket covered slopes, ~~the bottoms should be paved or~~ provisions ~~should~~ shall be made for moving equipment to reach the bottom (ramps, etc.). Retaining walls and any required safety features ~~must~~ shall be designed and constructed as regulated by the St. Charles County Building ~~Department~~ Code Enforcement Division.

19. The design and construction of dams greater than eight (8) feet or as directed by the Department ~~must~~ shall be sealed and certified by a Professional Engineer registered in the State of Missouri with demonstrated expertise in geotechnical engineering.

### 70.10.2.6 Detention Basin Elevation

The low elevation of the detention basin shall be above the ~~15-year, 20-minute~~ 10 year, 24 hour hydraulic elevation of the receiving channel or the 15-year, 20-minute hydraulic elevation of the receiving pipe system. The Director may waive this requirement where site constraints do not allow for a design under free outfall conditions provided that an additional analysis is submitted showing that all detention requirements are achieved under the downstream tailwater conditions.

### 70.10.2.7 Maximum Depths

1. The maximum depth of water in a dry detention basin or pond shall not exceed six (6) feet. Projects that need a deeper basin to attain the required detention volume due to physical constraints may be evaluated on a case-by-case basis. ~~The design and construction of dams greater than eight (8) feet or as directed by the Department must be sealed and certified by a Professional Engineer registered in the State of Missouri with demonstrated expertise in geotechnical engineering.~~

2. Permanent detention ponds or lakes ~~are to~~ shall be designed to minimize fluctuating lake levels. Maximum fluctuation from the permanent pool elevation to the maximum ponding elevation shall be three (3) feet.

3. Parking lots used for automobiles shall have a maximum depth of eight (8) inches of water.

4. Parking lots used for trucks or truck trailers shall have a maximum depth of water of twelve (12) inches.

### 70.10.2.8 Limits of Maximum Ponding

1. The maximum ponding elevation shall be calculated based on a routing of the 100-year, 24-hour design storm ~~for sites greater than ten (10) acres and the 100-year, 20-minute design storm for sites less than 10 acres~~ assuming the low flow and any intermediate flow openings are fully blocked with water ponded to the overflow structure's sill, unless directed otherwise by the Director.

2. The limits of maximum ponding in dry basins or ponds and permanent lakes or ponds shall not be closer than thirty (30) feet horizontally to any building, and not less than two (2) feet vertically below the lowest sill elevation of any building.

3. The limits of maximum ponding in parking lots shall not be closer than ten (10) feet horizontally from any building and not less than one (1) foot vertically below the lowest sill elevation of any building.

4. A minimum of one (1) foot ~~two (2) feet~~ of freeboard shall be provided from the top of the basin berm or the crest of any emergency spillway to the maximum ponding elevation.

#### 70.10.2.9 Emergency Spillway [from UDO 410.410.B]

An emergency spillway~~, capable of passing a 100-year, 24-hour or 20-minute design storm, may also~~ shall be required ~~by the Director of the Division of Development Review to~~ wherever off site property, infrastructure, or structures exist in the downstream flow path of stormwater that would overflow the basin dam. When required, the emergency spillway shall be designed to pass the 100-year, 24-hour design storm and safely ~~route~~ convey any ~~basin~~ stormwater overflow away from developed areas to a point of stable, natural drainage. The overland flow route shall be depicted on the plan.

#### 70.10.2.10 Dam Permit Requirements

Dams with a height of thirty-five (35) feet or greater, as measured per Publication 2816 by the Missouri Department of Resources, ~~will~~ shall require approval from the Missouri Department of Natural Resources.

### 70.10.3 As-Built Certification for Storm Water Management Facilities

As-built surveys shall be required for all stormwater management facilities. The design engineer shall submit the Professional Engineer's or Professional Surveyor's certified as-built drawings and profiles for review and approval by the Department.

Grading and outfall structure opening tolerances should be kept at ± 0.1 foot. In the event that the tolerance requirements are not met, the design engineer shall prepare and submit a revised stormwater management facility design report to demonstrate that the system still meets the performance requirements of these criteria.

## 70.20 Facility Preservation and Maintenance Requirements

### 70.20.1 Common Ground Required (Subdivisions)

In subdivisions, the ~~detention basin~~ stormwater management facilities, access roads or paths, control structures and outfall pipes ~~are to~~ shall be located in common ground dedicated to the subdivision trustees. The minimum maintenance access shall be a fifteen (15) foot strip of common ground on which feasible vehicular access shall be constructed by the developer. Placement and preservation of facilities outside of common ground will be considered on case-

by-case basis and approved by the Director of Community Development. Justification must be provided for consideration. The preservation of non-structural BMPs in easements on private property in subdivisions with minimum three (3) acre lot sizes shall be approved.

### 70.20.2 Easements/Deed Restricted Areas Required (Non-subdivisions/Commercial Sites)

In non-residential (commercial/industrial) developments other than those in commercial subdivisions, stormwater management facilities, including control structures and outfall pipes, shall be located in easements or deed restricted areas that preserve the facility in perpetuity.

### 70.20.3 Maintenance ~~Agreement~~ Requirements

#### 70.20.3.1 Maintenance Responsibility

The ~~Department~~ County ~~will~~ shall not be responsible for maintenance of the ~~detention basins~~ stormwater management facilities. Stormwater management facilities shall be maintained by the subdivision homeowners or the property owner. Periodic maintenance shall be required of the facility owners per the approved maintenance plan and Section 420.020 of the Unified Development Ordinance. No modifications shall be made to the facilities without approval or a permit from the County.

#### 70.20.3.2 Maintenance Agreement - Subdivision Development

The ~~subdivision trust indentures shall provide for maintenance~~ responsibility and funding for ~~the basin(s)~~ stormwater management facilities maintenance shall be provided for in the subdivision trust indentures. A maintenance plan and schedule for all stormwater management facilities shall be established by the subdivision developer, approved by the Director, and made a part of the subdivision trust indentures.

#### 70.20.3.3 Maintenance Agreement - Non-Subdivision Development (Commercial & Industrial Developments)

~~Maintenance on privately owned sites shall be the responsibility of the owner.~~ Prior to the closure of a land disturbance permit for an approved commercial site plan, the property owner(s) of any stormwater management facility shall execute a Development Restrictions and Maintenance Agreement to ensure that the facilities are preserved, maintained, and kept in working order to the satisfaction of the County and per Section 420.020 of the Unified Development Ordinance. An exhibit of the restricted area(s) and a maintenance plan and schedule shall be developed by the property owner(s) or developer(s), approved by the Director, and made a part of the Development Restrictions and Maintenance Agreement. The Agreement shall be recorded and the cost of recording the document shall be paid by or recovered from the owner or developer of the development. A Development Restrictions and Maintenance Agreement form can be found in Appendix A of this manual.

## 70.30 Design Guidelines For Post-Construction Stormwater Management BMPs

This section furnishes design guidelines to provide the engineer a flexible tool to select and design appropriate structural and non-structural methods to mitigate stormwater runoff impacts caused by

urban development and land use in St. Charles County. Standard drawings for structural post-construction stormwater management measures are included in Appendix F.

This section is not intended to be the sole source regarding acceptable post-construction stormwater management methods:

1. Engineering professionals are encouraged to design innovative ways to address site specific conditions, including the use of available on-site, native, recyclable materials and manufactured technology.

2. Post-construction stormwater management design methods and BMPs from municipalities within St. Charles County and the St. Louis Metropolitan Sewer District that are in compliance with state and federal water quality standard requirements may be substituted.

3. Design methods and BMPs from regional planning, state, and federal agencies that have similar hydrology, soils, and geologic conditions with the development and that are in compliance with state and federal water quality standard requirements may be substituted, including the Georgia Stormwater Manual, the M.A.R.C. Manual, and the Maryland Stormwater Design Manual.

4. The substitution of design methods and BMPs shall not apply to the easement, ownership, and maintenance requirements of the County. It shall only apply to methodology and best management practices for post-construction stormwater quality to allow greater flexibility in compliant design.

5. Alternative post-construction stormwater management methods shall be reviewed with the Director and alternative design criteria shall be approved for use by the Director during the preliminary/conceptual design stage of the project. Alternative post-construction stormwater management methods shall only be considered when the methods proposed meet the design standards in Section 70.10.2 and support the purpose statements in Section 70.00.1.

### 70.30.1 Non-Structural BMPs/Credits

Development projects can be designed to reduce their impact on watersheds when careful efforts are made to conserve natural areas, reduce impervious cover and better integrate stormwater treatment. By implementing a combination of these non-structural approaches collectively known as stormwater better site design practices, it is possible to reduce the amount of runoff and pollutants that are generated from a development and provide for some non-structural on-site treatment and control of runoff.

Non-structural BMPs are increasingly recognized as a critical feature of stormwater BMP plans, particularly with respect to site design. In most cases, non-structural BMPs will be combined with structural BMPs to meet all stormwater volume requirements. The key benefit of non-structural BMPs is that they can reduce the generation of stormwater from the development, thereby reducing the size and cost of structural BMPs. In addition, they can provide partial removal of many nutrients and pollutants. The non-structural BMPs have been classified into nine broad categories. To promote greater use of non-structural BMPs, a series

of credits and incentives are provided for developments that use these progressive, conservation site planning techniques. The credits for RRv, WQv, CPv, Qp, and CN adjustment are summarized in Table 70-3.

Site designers are encouraged to utilize as many credits as they can on a site. Greater reductions in stormwater storage volumes can be achieved when many credits are combined (e.g., disconnecting rooftops and protecting natural conservation areas). However, credits cannot be claimed twice for an identical area of the site (e.g. claiming credit for stream buffers and disconnecting rooftops over the same site area).

**Table 70-3 Summary Of Stormwater Credits**

| Stormwater Credit | RRv | WQv | CPv or Qp |
|---|---|---|---|
| **Natural Area Conservation** | None | Reduce Site Area | Woods-good or Meadow CN for natural areas |
| **Sheet Flow to Buffer** | None | Subtract contributing site area to BMP | Woods-good CN for contributing areas |
| **Preservation of Existing Soil Conservation BMPs** | None | Reduce Site Area | Developed CN = Predevelopment CN for contributing areas |
| **Site Reforestation (Canopy)/Revegetation (Native Planting)** | Reduce Site Area by 50% of reforested area[1] | Reduce Site Area by 50% of reforested area[1] | Woods-fair or Meadow CN for restored areas[2] |
| **Soil Restoration (Amendments)** | Reduce Site Area by 50% of soil restoration area[1] | Reduce Site Area by 50% of soil restoration area[1] | Open space - good CN for restored areas |
| **Disconnection of Rooftop Runoff** | A/B or Amended Soils - RRv reduced 50%<br>C/D Soils – RRv reduced 25% | Reduced Rv | Longer $t_c$ (increased flow path)<br>CN Adjustment per 70.30.1.11 |
| **Disconnection of Non-Rooftop Impervious Area Runoff** | A/B or Amended Soils - RRv reduced 50%<br>C/D Soils – RRv reduced 25% | Reduced Rv | Longer $t_c$ (increased flow path)<br>CN Adjustment per 70.30.1.11 |
| **Open Channel Design** | A/B or Amended Soils - RRv reduced 25%<br>C/D Soils – RRv reduced 10% | May meet WQv | Longer $t_c$ (increased flow path) No CN Credit |
| **Environmentally Sensitive Development** | None | Meets WQv | No CN credit - $t_c$ may increase |

| | | | |
|---|---|---|---|
| **(LID)** | | | |

[1] Reduce Site Area by 100% of reforested area if combined with soil restoration practices/credits (Section 70.30.1.5).

[2] Woods-good or Meadow CN for restored areas if combined with soil restoration practices/credits (Section 70.30.1.5).

### 70.30.1.1 Natural Area Conservation

A stormwater credit can be taken when undisturbed natural areas are conserved on a site, thereby retaining their pre-development hydrologic and water quality characteristics. Under this credit, a designer can subtract conservation areas from total site area when computing water quality volume requirements.

An added benefit will be that the post-development peak discharges will be smaller, and hence water quantity control volumes (CPv, $Qp_{10}$ and $Qp_{100}$) will be reduced due to lower post-development curve numbers. The post development curve number (CN) used to compute the Cpv and Qp for all wooded natural areas protected by conservation easements can be assumed to be "Woods - good condition" when calculating the total site CN. The post development curve numbers (CN) used to compute the Cpv and Qp for all non-wooded natural areas protected by conservation easements can be assumed to be "Meadow – continuous grass, protected from grazing and generally mowed for hay" when calculating the total site CN.

The following criteria shall apply in order to receive the credit:

1. Conservation area cannot be disturbed during project construction and shall be protected by limits of disturbance clearly shown on all construction drawings. To help create contiguous, interconnected green infrastructure corridors on development sites, site planning and design teams should strive to connect reforested or revegetated areas with one another and with other primary and secondary conservation areas through the use of nature trails, bike trails and other "greenway" areas.

2. Proposed area shall be located within an acceptable conservation easement instrument that ensures perpetual protection per Section 70.20. The easement must clearly delineate the boundary limits and specify how the natural area vegetation shall be managed and boundaries will be marked. [Note: managed turf (e.g., playgrounds, regularly maintained open areas) is not an acceptable form of vegetation management]

3. Conservation areas have a minimum contiguous area requirement of 10,000 square feet.

**EXAMPLE:**

**Residential Subdivision**
**Area = 38 acres**
**Natural Conservation Area = 7 acres**

**Impervious Area = 13.8 acres**

**Rv = 0.05 + 0.009 (I) = 0.05 + 0.009 (36.3%) = 0.37**
**(Rv kept constant when calculating WQv)**

**Credit:**
**7.0 acres in natural conservation area**
**New drainage area = 38 – 7 = 31 acres**

**Before credit:**
**WQv = (1.14)(0.37)(38)/12 = 1.34 ac-ft**
**With credit:**
**WQv = (1.14)(0.37)(31)/12 = 1.09 ac-ft**

**(19% reduction in water quality volume)**

### 70.30.1.2 Sheet Flow to Buffer

This credit is given when stormwater runoff is effectively treated by a natural buffer to a stream. Effective treatment is achieved when pervious and impervious area runoff is discharged to a grass or forested stream buffer through overland flow. The use of a filter strip is also recommended to treat overland flow in the green space of a development site. The area draining by sheet flow to a stream buffer is subtracted from the total site area in the WQv calculation. A CN for "Woods - good condition" can be used for the contributing area if it drains to a forested buffer.

The following criteria shall apply in order to receive the credit:

1. The minimum buffer width shall be 50 feet as measured from the top of bank of the watercourse.

2. The maximum contributing length shall be 150 feet for pervious surfaces and 75 feet for impervious surfaces.

3. Runoff shall enter the buffer as sheet flow. Either the average contributing overland slope shall be 5.0% or less, or a level spreading device shall be used where sheet flow can no longer be maintained (see Details ESC-24 and ESC-25).

4. Not applicable if rooftop or non-rooftop disconnection is already provided (see Sections 70.30.1.6 and 70.30.1.7).

5. The buffer width shall be preserved and maintained per the requirements of Section 405, Article VI of the Unified Development Ordinance.

6. If any of the preserved buffer width must be re-established, the buffer plans must clearly specify how the natural area vegetation shall be established and managed and

how preservation boundaries will be marked [Note: managed turf (e.g. playgrounds, regularly maintained open areas ) is not an acceptable form of vegetation management].

Figure 70.1 illustrates how a stream buffer or filter strip can be used to treat stormwater from adjacent pervious and impervious areas.

**Figure 70.1 Example of Stream Buffer Credit Option**

**INSERT FIGURE**

### 70.30.1.3 Preservation of Existing Soil Conservation BMPs

Soil conservation practices such as Grassed Waterways, Vegetated Terraces, Irrigation Ponds, etc. are commonly incorporated into land that is under agricultural use. These practices slow or impound stormwater runoff, allowing any sediment to filter out and limiting erosion of natural drainageways and water bodies. These soil conservation features are typically eliminated when the property is developed for residential use.

The credit is intended for use on large lot residential subdivision developments and it eliminates the need for structural practices to treat the WQv. The adjustment allowed to the CN value will reduce and may eliminate the need for structural practices to treat the CPv and Qp. Credit is given when existing soil conservation features are preserved and incorporated into the post-construction stormwater management plans. The area draining to a preserved soil conservation practice is subtracted from the total site area in the WQv calculation. The CN value for the developed area draining to a preserved soil conservation practice can be assumed to be the same as the CN value for pre-development.

WQv, CPv, and Qp can be met without the use of structural practices in certain low-density residential developments when the following conditions are met:

1. Credit may be applied in large lot residential subdivisions. Credit may be applied in residential subdivisions with one acre to three acre lots by approval of the Director.

2. The upstream drainage area must be drained through one or more preserved soil conservation practices before being discharged into a natural drainageway in order to obtain credit.

3. The area being drained through a preserved soil conservation practice shall not be increased from the pre-development condition.

4. The existing soil conservation practices shall be preserved and maintained per the requirements in Sections 70.20.1 and 70.20.3.

5. A preserved soil conservation practice may be removed only by approval of the Director provided that it is replaced with an acceptable, alternative structural practice approved by the Department.

### 70.30.1.4 Site Reforestation (Canopy)/Revegetation (Native Planting)

Site reforestation/revegetation refers to the process of planting trees, shrubs and other native vegetation in disturbed pervious areas to restore them to their pre-development conditions. The process can be used to help establish mature native plant communities (e.g., forests) in pervious areas that have been disturbed by clearing, grading and other land disturbing activities.

The Center for Watershed Protection (Hirschman et al., 2008) documented the ability of the site reforestation/revegetation process to reduce annual stormwater runoff volumes and pollutant loads on development sites. Consequently, this low impact development practice can be used to help satisfy the reduce runoff volume and provide water quality improvements:

- Runoff Reduction - Site reforestation/revegetation is an effective low impact development (LID) practice that can reduce post-construction stormwater runoff and improve water quality. When used to improve site areas and create conservation amenities; runoff reduction, lower post-developed flow rates, and lower discharge velocities are all benefits of reforestation or revegetation. Subtract 50% of any reforested/revegetated areas from the total site area and re-calculate the runoff reduction volume (RRv) that applies to the development site.

- Water Quality Protection - Site reforestation and/or revegetation helps restore pre-development hydrology, which implicitly reduces post-construction stormwater runoff rates in addition to runoff volumes and pollutant loads. Subtract 50% of any reforested/revegetated areas from the total site area and re-calculate the water quality volume (WQv) that applies to the development site.

- Channel Protection and Overbank and Extreme Flood Protection - Assume that the post-development hydrologic conditions of any reforested/revegetated areas are equivalent to those of a similar cover type (e.g., meadow, brush, woods) in fair condition.

If site reforestation/revegetation can be combined with soil restoration (Section 70.30.1.5) on a development site, the following stormwater management benefits and incentives are available to help satisfy the requirements presented in this manual:

- Runoff Reduction - Subtract 100% of any restored and reforested/revegetated areas from the total site area and re-calculate the runoff reduction volume (RRv) that applies to the development site.

- Water Quality Protection - Subtract 100% of any restored and reforested/revegetated areas from the total site area and re-calculate the water quality volume (WQv) that applies to the development site.

- Channel Protection and Overbank and Extreme Flood Protection - Assume that the post-development hydrologic conditions of any restored and reforested/revegetated

areas are equivalent to those of a similar cover type (e.g., meadow, brush, woods) in good condition.

The following criteria shall apply in order to receive the credit:

1. Reforested/revegetated areas shall have a minimum contiguous area requirement of 10,000 square feet. To help create contiguous, interconnected green infrastructure corridors on development sites, site planning and design teams should strive to connect reforested or revegetated areas with one another and with other primary and secondary conservation areas through the use of nature trails, bike trails and other "greenway" areas.

2. Areas that have been reforested or revegetated shall be maintained in an undisturbed, natural state over time. A long-term vegetation management plan shall be developed and approved by the Department for all reforested/revegetated areas. The plan shall clearly specify how the area will be maintained in an undisturbed, natural state over time and include a method for watering during plant establishment period of one to two years. The reforested/revegetated areas shall be designated as conservation areas and protected in perpetuity per the requirements in Sections 70.20.1 and 70.20.3.

3. Maximum 25% slope in the disturbed pervious area to be reforested/revegetated.

4. Soils need to be capable of sustaining the vegetation proposed which may require significant amendments. A soil test shall be performed to determine what type of vegetation can be supported by the soils in the area to be reforested/revegetated and/or what soil amendments will be required.

5. A landscaping plan shall be prepared by a qualified licensed professional for all reforested/revegetated areas. The landscaping plan shall be reviewed and approved by the Department prior to construction. Managed turf cannot be used to landscape reforested/revegetated areas.

6. Methods used for site reforestation/revegetation shall achieve at least 75 percent vegetative cover one year after installation.

### 70.30.1.5 Soil Restoration (Amendments)

Soil restoration refers to the process of tilling and adding compost and other amendments to soils to restore them to their pre-development conditions, which improves their ability to reduce post-construction stormwater runoff rates, volumes and pollutant loads. The soil restoration process can be used to improve the hydrologic conditions of pervious areas that have been disturbed by clearing, grading and other land disturbing activities. It is ideal for use on lawns and other pervious areas that have been disturbed by clearing, grading and other land disturbing activities.

Soil restoration can also be used to increase the stormwater management benefits provided by other low impact development practices, such as site reforestation/revegetation (Section

70.30.1.4), vegetated filter strips (Section 70.40.X), grass channels (Section 70.40.X) and simple downspout disconnection (Section 70.30.1.6), on sites that have soils with low permeabilities (i.e., hydrologic soil group C or D soils). The soil restoration process can be used to help increase soil porosity and improve soil infiltration rates on these sites, which improves the ability of these and other low impact development practices to reduce post-construction stormwater runoff rates, volumes and pollutant loads.

- Runoff Reduction - Soil restoration is one of the most effective low impact development (LID) practices that can be combined with other BMPs to reduce post-construction stormwater runoff and improve runoff quality. Like other LID practices, soil restoration becomes more effective the higher the infiltration rate increases. When used to improve native soils when paired with another BMP, runoff reduction percentages can increase from 15 to 25 percent. Subtract 50% of any restored pervious areas from the total site area and re-calculate the runoff reduction volume (RRv) that applies to the development site.

- Water Quality Protection - Due to the soil amendments themselves, in addition to the runoff reduction benefits, soil restoration inherently improves water quality. Depending on the organic compounds and other amendments added, nutrient uptake and other pollutant removal processes can be achieved. Subtract 50% of any restored pervious areas from the total site area and recalculate the water quality volume (WQv) that applies to the development site.

- Channel Protection and Overbank and Extreme Flood Protection - Soil restoration helps restore pre-development hydrology, which implicitly reduces post-construction stormwater runoff rates in addition to runoff volumes and pollutant loads. Assume that the post-development hydrologic conditions of any restored pervious areas are equivalent to those of open space (e.g., lawns, parks, golf courses) in good condition.

The following criteria shall apply in order to receive the credit:

1. Credit shall be limited to pervious areas that have soils with low permeabilities (i.e. hydrologic soil group C or D soils) or that have been disturbed and compacted by land disturbing activities. Areas that have permeable soils (i.e. hydrologic soil group A or B soils) that have not been disturbed by land disturbing activities do not need to be restored and shall not be eligible for the credit.

2. Maximum 10% slope in the disturbed pervious area to be restored.

3. To properly restore disturbed pervious areas, soil amendments shall be added to existing soils to a minimum depth of 18 inches until an organic matter content of 8% to 12% is obtained. Depths greater than 18” shall be amended when shrubs or trees are being installed. Compost shall be incorporated into existing soils, using a rototiller or similar equipment, to a depth of 18 inches and at an application rate necessary to obtain a final average organic matter content of 8%-12%. Required application rates can be determined using a compost calculator, such as the one provided on the following

website: http://www.soilsforsalmon.org/how. A summary sheet and the Building Soil Manual are also available to use as resources. Other calculations are available online.

4. Only well-aged composts that have been composted for a period of at least one year shall be used to amend existing soils. Composts shall be stable and show no signs of further decomposition. Composts used to amend existing soils shall meet the following specifications (most compost suppliers will be able to provide this information):

    - Organic Content Matter: Composts shall contain 35%-65% organic matter.
    - Moisture Content: Composts shall have a moisture content of 40%-60%.
    - Bulk Density: Composts shall have an "asis" bulk density of 40-50 pounds per cubic foot (lb/cf). In composts that have a moisture content of 40%-60%, this equates to a bulk density range of 450-800 pounds per cubic yard (lb/cy), by dry weight.
    - Carbon to Nitrogen (C:N) Ratio: Composts shall have a C:N Ratio of less than 25:1.
    - pH: Composts shall have a pH of 6-8.
    - Cation Exchange Capacity (CEC): Composts shall have a CEC that exceeds 50 milliequivalents (meq) per 100 grams of dry weight.
    - Foreign Material Content: Composts shall contain less than 0.5% foreign materials (e.g., glass, plastic), by weight.
    - Pesticide Content: Composts shall be pesticide free.

5. To help prevent soil erosion, landscaping shall be installed immediately after the soil restoration process is complete. Simple erosion and sediment control measures, such as temporary seeding and erosion control mats, should be used on restored pervious areas that exceed 2,500 square feet in size. If the restored pervious areas will "receive" any stormwater runoff from other portions of the development site, measures should be taken (e.g., silt fence, temporary diversion berm) to prevent it from compromising the soil restoration effort.

6. To avoid damaging existing root systems, soil restoration shall not be performed in areas that fall within the drip line of existing trees.

7. Heavy vehicular and foot traffic shall be kept out of all restored pervious areas during and after construction. This can typically be accomplished by clearly delineating soil restoration areas on all development plans and, if necessary, protecting them with temporary construction fencing.

### 70.30.1.6 Disconnection of Rooftop Runoff

A credit is given when rooftop runoff is disconnected and then directed to a pervious area where it can either infiltrate into the soil or filter over it. If properly designed, downspout disconnects can provide measurable reductions in post-construction stormwater runoff rates, volumes and pollutant loads on development sites. The primary concerns associated with a downspout disconnect are the length of the flow path over the lawn, landscaping, or other pervious area below the disconnection point and the permeability of those soils. If a rooftop is adequately disconnected, the following credits can be obtained:

- Runoff Reduction - The runoff reduction volume (RRv) conveyed through a downspout disconnect located on hydrologic soil group (HSG) A/B or soils amended per Section 70.30.1.5 is reduced by 50%. Reduce the RRv conveyed through a downspout disconnect located on HSG C/D soils or any type soils that were graded and compacted during development by 25%.

- Water Quality Protection - If installed as per the design criteria and properly maintained, 80% total suspended solids removal will be applied to the water quality volume (WQv) flowing to the disconnected downspout. Therefore, the disconnected impervious area can be deducted from total impervious cover in the WQv calculation.

- Channel Protection and Overbank and Extreme Flood Protection – Proportionally adjust the post-development runoff CN to account for the runoff reduction provided by a downspout disconnect for the contributing drainage area per 70.30.1.11.

The following criteria shall apply in order to receive the credit:

1. This credit is only allowed for residential subdivision developments with minimum one-acre lot sizes and commercial/industrial developments.

2. Disconnections shall only be credited for lot sizes greater than 6000 sq. ft.

3. Disconnects shall be designed to convey stormwater runoff away from buildings to prevent damage to building foundations and to ensure no basement seepage.

4. The maximum contributing area of rooftop to a disconnected discharge shall be 2,500 square feet.

5. Rooftop runoff shall enter the disconnected area as sheet flow to ensure proper pollutant removal (this will require the use of splash pads/blocks or other approved level-spreading or energy dissipating device). The minimum length of the flow path in the pervious areas below the "disconnection" shall be equal to or greater than the length of the flow path in the contributing drainage area and a minimum of 15 ft.

6. The slope of the pervious area below the disconnection shall be a maximum of 6% and a minimum of 0.5% (1% to 5% is recommended).

7. The disconnection must drain continuously through a pervious area, vegetated channel, swale, or through a filter strip to the property line or BMP. Disconnected stormwater runoff shall not be allowed to "reconnect", or flow across impervious areas, before reaching a downstream BMP or being discharged off-site.

8. Downspouts must be at least 10 feet away from the nearest impervious surface or storm sewer pipe system to discourage "re-connections."

9. For those rooftops draining directly to a buffer, only the rooftop disconnection credit or the buffer credit can be used, not both.

### 70.30.1.7 Disconnection of Non-Rooftop Impervious Area Runoff

Credit is given for practices that disconnect surface impervious cover runoff by directing it to pervious areas where it is either infiltrated into the soil or filtered (by overland flow). This credit can be obtained by grading the site to promote overland vegetative filtering or providing bioretention areas. If an impervious area is adequately disconnected, the following credits can be obtained:

- Runoff Reduction - The runoff reduction volume (RRv) conveyed through an impervious area disconnect located on hydrologic soil group (HSG) A/B or soils amended per Section 70.30.1.5 is reduced by 50%. Reduce the RRv conveyed through an impervious area disconnect located on HSG C/D soils or any type soils that were graded and compacted during development by 25%.

- Water Quality Protection - If installed as per the design criteria and properly maintained, 80% total suspended solids removal will be applied to the water quality volume (WQv) flowing to the disconnected impervious area. Therefore, the disconnected impervious area can be deducted from total impervious cover in the WQv calculation.

- Channel Protection and Overbank and Extreme Flood Protection – Proportionally adjust the post-development runoff CN to account for the runoff reduction provided by an impervious area disconnect for the contributing drainage area per 70.30.1.11.

The following criteria shall apply in order to receive the credit:

1. This credit is only allowed on residential subdivision developments with minimum one-acre lot sizes and commercial/industrial developments.

2. The maximum contributing impervious flow path length shall be 75 feet.

3. The disconnection must drain continuously through a vegetated channel, swale, or filter strip to the property line or BMP.

4. The length of the "disconnection" must be equal to or greater than the contributing length.

5. The entire vegetative "disconnection" shall be on an average slope of 5% or less.

6. The surface imperviousness area to any one discharge location cannot exceed 1,000 sq. ft.

7. Disconnections are encouraged on relatively permeable soils (HSG's A and B).

8. For those areas draining directly to a buffer, only the non-rooftop disconnection credit or the buffer credit can be used, not both.

### 70.30.1.8 Open Channel Design

Credit may be given when open grass channels are used to reduce the volume of runoff and pollutants during smaller storms (e.g., < 1 inch). The schematic of the grass channel is provided in Figure 70.2. If designed according to the following criteria, the following credits can be obtained:

- Runoff Reduction – Like other LID practices, grass channels become more effective with higher infiltration rates of native soils. A grass channel can be designed to provide 25% of the runoff reduction volume for type A and B hydrologic soils or 10% of the runoff reduction volume for type C and D hydrologic soils.

- Water Quality Protection – the grass channel will meet the WQv.

- Channel Protection and Overbank and Extreme Flood Protection – CNs for channel protection (Cpv) and peak flow control (Qp) will not change.

The following criteria shall apply in order to receive the credit:

1. The maximum flow velocity for runoff from the water quality rainfall event (1.14") shall be less than or equal to 1.0 fps and the flow depth shall not exceed four (4) inches. [see Appendix D-10 MSWDM for methodology to compute flowrate]

2. The maximum flow velocity for runoff from the 15-year, 20-minute design event shall be non-erosive (2 fps or less).

3. The bottom width shall be 2 feet minimum and 8 feet maximum.

4. The side slopes shall be 3:1 or flatter.

5. The channel slope shall be less than or equal to 4.0% (1.0 - 2.0% recommended).

6. Not applicable if rooftop and/or non-roof-top disconnection is already provided (see 70.30.1.6 and 70.30.1.7).

7. In addition to the requirements above, Grass Channels shall meet the requirements of Engineered Channels in Section 50.30.5.

An example of a grass channel is provided in Figure 70.2.

**Figure 70.2 Example of Grass Channel**

[INSERT FIGURE]

### 70.30.1.9 Environmentally Sensitive Development (LID)

Credit is given when a group of environmental site design techniques are applied to low density and cluster residential development. The credit eliminates the need for structural practices to treat the WQv and is intended for use on large lots.

WQv can be met without the use of structural practices in certain low density residential developments when the following conditions are met:

1. Total subdivision impervious cover is less than 15%.

2. Minimum lot size must be at least one acre.

3. Rooftop runoff is disconnected in accordance with the criteria outlined under Section 70.30.1.6.

4. Grass channels are used to convey runoff versus curb and gutter.

5. Stormwater runoff is discharged into BMPs or preserved soil conservation features (see 70.30.1.3) before being discharged to natural drainageways.

WQv can be met without the use of structural practices in cluster residential developments when the following conditions are met:

1. Total site impervious cover is less than 15%.

2. The average lot density shall not be greater than one acre.

3. Rooftop runoff is disconnected in accordance with the criteria outlined under Section 70.30.1.6.

4. Grass channels are used to convey runoff versus curb and gutter.

5. A minimum of 25% of the subdivision is protected in natural conservation areas (by common ground, permanent easement, or other similar measure).

6. The design shall address stormwater (WQv, Cpv and/or Qp) for all roadway and connected impervious surfaces.

### 70.30.1.10 Impervious Cover Reduction

This is not a credit, per se, but it is a means of reducing the WQv, CPv, and Qp.

### 70.30.1.11 ADJUSTED CN PROCEDURE FOR PEAK FLOW REDUCTION

The following method utilizes the Natural Resource Conservation Service runoff equations originally provided in Urban Hydrology for Small Watersheds (USDA 1986) to compute a curve number adjustment that effectively reduces the peak flow of other storm events. A simplified approach has been provided that combines these runoff equations. The following modified equation is discussed in the 2010 Center for Watershed Protection journal article titled, *The Runoff Reduction Method*:

$$Q - R = (P - 0.2S)^2 / (P + 0.8S) \qquad \text{(Equation 70.1)}$$

*Where:*

Q = runoff depth (in),
P = rainfall depth (in),
Ia = Initial abstraction (in),
S = potential maximum retention after runoff begins (in),
CN = Runoff Curve Number, and
R = Retention storage provided by runoff reduction practices (in).

To calculate "R", the provided RRv of the practice(s) can be calculated by the following:

$$R = (VP)(RR\%) / Area$$

*Where:*

VP = Total Volume Provided by the BMP
RR% = runoff reduction credit provided by the BMP (See Table 70.X for RR%)

By solving the modified equation above for a new potential maximum retention value, S, the adjusted curve number can be back calculated as a representation of the runoff reduction achieved in any particular storm event.

**Runoff Reduction/Adjusted Curve Number Example**

Using the given data and information provided below, calculate the runoff reduction volume and the adjusted curve number for channel protection assuming a best management practice is used that provides a runoff reduction removal percentage (RR%) of 50%.

Given Information:

- Site Area: 3.0 ac (130,680 $ft^2$)
- Impervious Area: 1.9 ac; or I=1.9/3.0 = 63.3%
- Pre-developed CN: 70
- Post-developed CN: 88
- $P_{1YR}$: 3.4 inches
- S: 1.36 (1000/CN – 10)
- Post-$Q_{1YR}$: 2.18 inches (See Equation 70.1)

**Calculate water runoff reduction volume (RRv)**

Compute volumetric runoff coefficient, Rv

Rv = 0.05 + (0.009)(I)
= 0.05 + (0.009)(1.9/3 x 100%)
= 0.62

Compute runoff reduction volume, RRv

RRv = 0.9(Rv)(A)/12
= 0.9(0.62)(3)/12
= 0.140 acre-feet (6,077 cubic feet)

*Note: The Volume Provided (VP) of this practice must be a minimum of 12,154 $ft^3$.*

**Calculate the amount of Runoff Reduction (RRv provided) by the practice. This information will be needed in the adjusted curve number calculation (converted to the variable "R"):**

RRv (provided) = (RR%) (VP)
= (50%) (12,154 $ft^3$)
= 6,077 $ft^3$

**Adjusted Curve Number Procedure for Peak Flow Reduction of CPv**

Given Q = 2.18 in. and P = 3.4 in., Find "R" and "S" to back calculate an adjusted CN

$$Q - R = (P - 0.2S)^2 / (P + 0.8S) \qquad \text{(Equation 70.1)}$$

Retention storage (expressed in inches) for this basin is calculated by the following formula:

R = RRv (provided) / Basin Area
= (6,077 $ft^3$) / A = 6,077 $ft^3$ / 130,680 $ft^2$ (12 in / 1 ft)
= 0.56 inches

Solve for "S" to back calculate CN: S = 2.36
S = 1000/CN-10: therefore, Adjusted CN = 80.9

### 70.30.2 Acceptable Urban BMPs

Structural best management practices should be considered after all reasonable attempts have been made to minimize stormwater runoff and maximize its control and treatment through better site design methods and use of natural features and non-structural BMPs.

This section sets forth five acceptable groups of BMPs that can be used to meet the WQv. The design and selection of these BMPs shall generally conform to the criteria contained in Section 70.40 or as outlined in Section 70.30, #1-5. Acceptable uses of the BMPs are summarized in Table 70-X and Physical Feasibility Factors are summarized in Table 70-X. Details for each BMP design are provided in Section 99/70.40.

1. A combination of BMPs and/or credits is normally required at most developments to meet all three storm water sizing criteria.

2. New structural BMP designs are continually being developed, including many proprietary designs. To be considered an effective BMP for stand-alone treatment of WQv, current or new BMP design variants cannot be accepted for inclusion on the list until independent pollutant removal performance and monitoring data determine that the BMP can meet the following:

   a. Capturing and treating the required RRv or WQv,
   b. Reducing the average total load of suspended solids (TSS) by 80%, and,
   c. Having an acceptable level of maintenance and longevity rate in the field.

   The County allows proprietary BMPs from MSD Approved Products and Suppliers: Structural Proprietary BMPs. Other proprietary BMPs may be approved by the Director provided that the BMP meets the guidelines established in this section or it has been approved by other local MS4 municipalities or agencies that are in compliance with state and federal water quality standard requirements.

#### 70.30.2.1 Stormwater Ponds

Practices that have a combination of permanent pool, extended detention or shallow wetland equivalent to the entire WQv include:

| | |
|---|---|
| P-1 | Micropool Extended Detention (ED) Pond |
| P-2 | Wet Pond |
| P-3 | Wet Extended Detention Pond |
| P-4 | Multiple Pond System |
| P-5 | Pocket Ponds |

#### 70.30.2.2 Stormwater Wetlands

Practices that include significant shallow wetland areas to treat urban stormwater but often may also incorporate small, permanent pools and/or extended detention storage to achieve the full WQv include:

| | |
|---|---|
| W-1 | Shallow Wetland |
| W-2 | ED Shallow Wetland |
| W-3 | Pond/Wetland System |
| W-4 | Pocket Wetland |

Wetlands may be used for WQv and CPv but shall not be used for control of the flood protection volumes ($Qp_{10/100}$). Wetlands shall be designed by a professional with a degree or certification that qualifies them to design wetlands.

### 70.30.2.3 Infiltration Practices

Practices that capture and temporarily store the WQv before allowing it to infiltrate into the soil over a two-day period include:

| | |
|---|---|
| I-1 | Infiltration Trench |
| I-2 | Infiltration Basin |

Infiltration practices will be allowed on developments where it is proven that infiltration can be affectively achieved. Developments that are susceptible to prolonged flooding and sediment deposition or that are within high water tables shall not be approved for infiltration practices. Soil reports shall be required to determine the suitability of infiltration practices.

### 70.30.2.4 Filtering Practices

Practices that capture and temporarily store the WQv and pass it through a filter bed of sand, inorganic matter, soil, or other media. Filtered runoff may be collected and returned to the conveyance system. Practices include:

| | |
|---|---|
| F-1 | Surface Sand Filter |
| F-2 | Underground Sand Filter (restricted use – see below) |
| F-3 | Perimeter Sand Filter |
| F-4 | Organic Filter |
| F-5 | Pocket Sand Filter |
| F-6 | Bioretention (see below) |
| F-7 | Nested Basin (Combination Bioretention & Detention Basin) |

F-2 shall not be allowed on residential developments. F-6 may be used for infiltration where the underlying soils allow for infiltration and the BMP is designed with no underdrain. Soil reports shall be required to determine the suitability of infiltration practices. Developments that are susceptible to prolonged flooding and sediment deposition or that are within high water tables shall not be approved for filtering practices.

### 70.30.2.5 Open Channel Practices

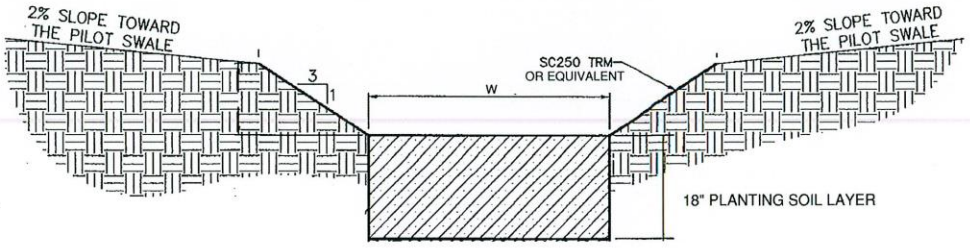
Vegetated open channels that are explicitly designed to capture and treat the full WQv within the dry or wet cells formed by check dams or other means. Practices include:

O-1 Dry Swale (restricted use – see below)
O-2 Wet Swale (restricted use – see below)
O-3 Vegetated Filter Strips

Open channel BMPs are different than engineered channels used for traditional stormwater conveyance. Open channel practices shall be designed with the proper plantings. Open channel practices are not allowed on single-family residential projects with the exception that dry swales are allowed on common ground. Open channel practices are allowed on multi-family residential projects only where maintenance is provided by a property management company.

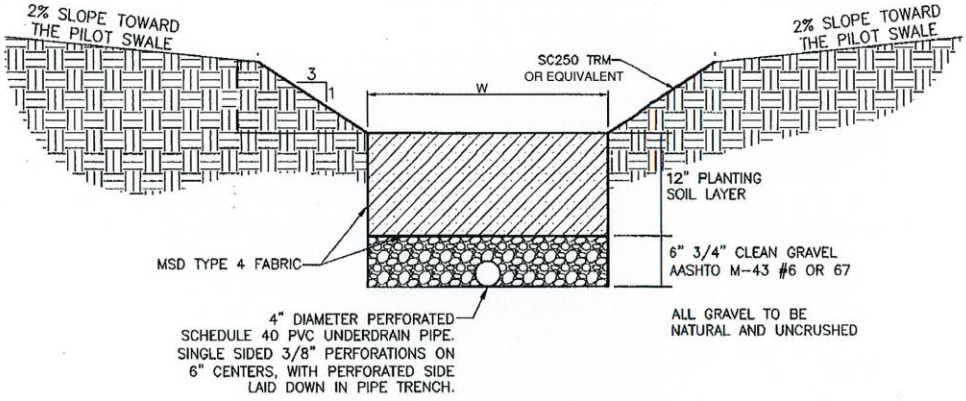
## 70.40 Urban BMP Design Guidelines [USE GSM & PFT STUDY FOR MSD]

**** BMP STANDARD DESIGNS TO BE REVIEWED BY TECHNICAL PEER/STAKEHOLDER GROUP ****




DETENTION BASIN
PERMEABLE SWALE

NOT TO SCALE




DETENTION BASIN
PERMEABLE SWALE WITH UNDERDRAIN

NOT TO SCALE

Planting Soil Specifications:
Sandy Loam or Loamy Sand should contain a minimum of 35 to 60 percent sand, by volume. The clay content for these soils should be less than 10 percent by volume. The soils shall be free of stones, stumps, roots, or other woody material over 1 inch in diameter. Placement of the planting soil should be in lifts of 12 to 18 inches and be placed loosely with no compaction.

**DRAFT DRAWING C604.98 - Detention Basin Permeable Swale**