



## **1.6 Post Construction BMP Design Procedures**

### **1.6.1 BMP Treatment Approaches and Selection Requirements**

The City of Bowling Green's approach to stormwater management addresses two concerns: stormwater quantity and stormwater quality resulting from runoff. The guidelines for these measures help define the level of treatment required of the best management practices to pollutant levels in runoff are lowered to a point such that the level of recreation and wildlife habitat are as unimpeded as they were prior to development. These guidelines fall into two categories: performance-based and prescriptive.

Performance-based guidelines are set goals such as removing 80% of suspended solids. The prescriptive guidelines define requirements of pretreatment or the distance or size a BMP must be to provide treatment to polluted runoff. These guidelines are provided within each BMP in Section 4 of this Manual.

### **1.6.2 Stormwater Quantitative Design Criteria**

Stormwater management practices are designed so that the peak flow discharge rates of a post-developed area match the pre-developed flow rates.

### **1.6.3 First Flush**

The EPA describes *first flush* as the pollutants that are washed off of an exposed area during a wet weather event and its subsequent runoff process. Typically, the initial concentration of the runoff will be more polluted than the stormwater that runs off later.

By controlling or capturing first flush pollutants with BMPs, the opportunities and chances of improving stormwater quality is increased, thereby allowing subsequent runoff to be diverted to the stormwater system without collecting the residue of the first flush.

The 85<sup>th</sup> percentile storm event has a precipitation depth of the Bowling Green region is 1.1 inches. This value should be used in subsequent equations in designing stormwater facilities and practices.

### **1.6.4 Stormwater Quality Design Criteria**

The City of Bowling Green's stormwater quality design measures are based on portions of the *Unified Stormwater Sizing Criteria* developed by the Maryland Department of the Environment. The goals of following procedures are to meet pollutant removal standards; maintain groundwater recharge wherever possible; reduce channel erosion; prevent overbank flooding and pass extreme floods.

### **1.6.5 Water Quality Volume**

The Water Quality Volume (WQv) is storage required to capture and treat stormwater runoff from 85% of the average annual rainfall, the first flush. The following equation shows that this value is equal to the product of precipitation, volumetric runoff coefficient and site area, divided by twelve.



Equation 2.1 states:

$$WQ_v = [(P)(R_v)(A)]/12$$

Where,

*P* is the average rainfall in inches, (in the case of Bowling Green, is 1.1 inches);

*R<sub>v</sub>* is the volumetric runoff coefficient, which is:

$$R_v = 0.05 + 0.009(I), \text{ where } I \text{ is the percent impervious cover;}$$

and *A* is the area in acres

### 1.6.6 Recharge Volume

Recharge volume

Equation 2.2 states:

$$Re_v = [(S)(R_v)(A)]/12$$

Where,

*S* is the Soils Specific Recharge Factor, which is found in the following table;

Hydrologic Soil Group	Soil Specific Recharge Factor ( <i>S</i> )
A	0.38
B	0.26
C	0.13
D	0.07

*R<sub>v</sub>* is the volumetric runoff coefficient, which is:

$$R_v = 0.05 + 0.009(I), \text{ where } I \text{ is the percent impervious cover; and}$$

*A* is the area in acres.

A simplified variation of Equation 2.2 uses the value *A<sub>i</sub>*, the measured impervious cover, to directly calculate *Re<sub>v</sub>*. It reads:

$$Re_v = (S)(A_i)$$

Since Bowling Green’s topography includes karst features, check with the City’s Stormwater Group to determine if a Recharge Volume is required for a project area.

### 1.6.7 Channel Protection Storage Volume

The channel protection storage volume is the quantity of water that shall be detained to protect the City of Bowling Green’s drainage channels and from erosion. The rationale for providing this protection is that runoff will be stored and released in a more gradual manner with lower



velocities during bankfull and near-bankfull events. The method of determining the  $C_{pv}$  is based on the Design Procedures for Stormwater Management Extended Detention Structures (MDE, 1987) and utilizes the NRCS, TR-55 Graphical Peak Discharge Method (USDA, 1986).

The steps are as follows:

- Compute the time of concentration ( $t_c$ ) and the one-year post development runoff depth ( $Q_a$ ) in inches
- Compute the initial abstraction ( $I_a$ ) [ $I_a = 100/CN - 2$ ] and the ratio  $I_a/P$  where  $P$  is the one-year rainfall depth
- With  $T_c$  and  $I_a/P$ , find the unit peak factor ( $q_v$ ) from a SCS Graph of 24-hour Type II Storm Distribution. Then compute the one year post-development peak discharge  $q_t - q_uAQ_a$  where  $A$  is the drainage area in square miles.
  - If  $q_i$  is  $\leq 2.0$  cfs, the  $CP_v$  is not required, Provide for water quality ( $WQ_v$ ) and groundwater recharge ( $Re_v$ ) as necessary.
- With  $q_u$ , find the ratio of outflow to inflow ( $q_o/q_i$ ) for  $T=24$  hours from the Unit Discharge Graphic
- Compute the peak outflow discharge  $q_v = q_o/q_i \times q_i$
- With  $q_o/q_i$ , compute the ratio of storage to runoff volume ( $V_s/V_r$ ).  

$$V_s/V_r = 0.683 - 1.43 (q_o/q_i) + 1.64 (q_o/q_i)^2 - 0.804 (q_o/q_i)^3$$
- Compute the extended detention storage volume  $V_s = (s/V_r) \times V_r$  (note:  $V_r = Q_a$ ); Convert  $V_s$  to acre-feet by  $V_s/12 \times A$ , where  $V_s$  is in inches and  $A$  is in acres
- Compute the required orifice area ( $A_o$ ) for extended detention design:

$$A_o = \frac{q_o}{C\sqrt{2gho}} = \frac{q_o}{4.81\sqrt{4.81ho}}$$

Where  $h_o$  is the maximum storage depth associated with  $V_s$ .

- Determine the required maximum orifice diameter ( $d_o$ )  $d_o = \sqrt{4A_o/\pi}$

A  $d_o$  less than 3.0” is subject to approval by the City of Bowling Green and is not recommended unless an internal control for orifice protection is used.

### 1.6.8 Waterway Buffers

Areas of new development and redevelopment shall include a 25- to 50-foot undisturbed no-build buffer zone will be left from top of bank on both sides for the entire length of blue-line streams that are identified in the most recent USGS Quadrangle maps within the City of



Bowling Green. Buffers are vegetated areas, including trees and shrubs which exist or are established to protect a stream system, lake, or reservoir area. These buffers also apply to other sensitive areas such as springs, wetlands and sinkholes as follows:

1. A waterway buffer shall be applied to all waterways serving 25.0 or more acres of tributary area. No new construction of any building or structure shall be permitted in the buffer.
2. The waterway buffer shall be defined as area contained within a boundary established 25-feet beyond the floodplain boundary as defined by FEMA or the City of Bowling Green, which ever is larger.
3. For areas without a defined floodplain the waterway buffer shall be defined on a case-by-case basis by the City of Bowling Green Section 21 of its stormwater ordinance.
4. The waterway buffer and floodplain may be used for application of water quality devices. This may only be permitted provided EPSC, stormwater quality, and cut-fill policies are adequately addressed.
5. Detention/retention volumes in the floodplain buffer shall count as fill if applied in a manner where off site floodplain storage volume is lost.

### **1.7 Residential and Home Owner Pollution Control**

Citizens of Bowling Green, also hold a stake in the maintenance and improvement of water quality in the community. If residents and property owners would take measures to minimize their impact in their surrounding environment, pollution can be greatly reduced.

Residential and Homeowner BMPs (RHPs) describe methods that individuals can use and employ throughout their community to make ditches, streams and receiving waters safe. The pollutants that they discharge (most of the time unknowingly) can be reduced simply through education. Information on “do’s and don’ts” on chemical treatments (fertilizers, herbicides, insecticides, etc.) and disposal of other hazardous wastes (use of detergents into streams, or dumping petroleum based products into stormwater appurtenances such as catch basins) are just two examples on how to improve the water quality in a community. The City of Bowling Green should raise awareness of these BMPs to homeowners and residents via billings or community outreach programs and schools.

### **1.8 How to Use this Manual**

On the opposite page, please find a sample BMP Fact Sheet. This sample helps illustrate and explain the components that make up a fact sheet. Please note that some of the metrics used for the EPP and SMP section were not applicable to other sections and as such are not included.