4. Inspection and maintenance templates for each type of BMP or approved equivalent. For manufactured BMPs, the template must have maintenance items filled out in the template prior to submission to the City.
5. Annual BMP report template or approved equivalent. The form must be used by the BMP owner for the annual inspection of the BMP(s).

Templates and examples of these components can be found in Appendix H. All components must be included in the O&M Plan that is recorded with the Shelby County Clerk's Office.

The City's NPDES Phase II permit (KYG20) requires the City to ensure that permanent water quality BMPs are maintained perpetually.

2.6 Stormwater Quality Treatment

All types of development must provide treatment of the water quality volume.

2.6.1 Structural Stormwater Quality Treatment Design

Stormwater quality treatment for Shelbyville is defined as a goal of 80% total suspended solids (TSS) removal of the average annual post-development load. All stormwater BMPs shall be designed in a manner to minimize the need for maintenance and reduce the chances of failure, while maintaining the required function. The City's stormwater quality program requires new development and redevelopment to treat the runoff from up to the 80th percentile rain event in Shelbyville to a load reduction goal of 80% of the average annual post-development total suspended solids (TSS) based upon data in the Nationwide Urban Runoff Program. Treatment may be achieved using a single treatment method, such as a wet pond, or by using a treatment train. A treatment train achieves 80% removal of TSS using a combination of pretreatment and/or treatment methods.

It is presumed that a stormwater management system complies with this performance standard if:

- It is sized to capture and treat the prescribed water quality treatment volume, which is defined as the runoff volume resulting from the first 0.6 inches of rainfall from a site (see Equation 1).
- Appropriate structural stormwater controls are selected, designed, constructed, and maintained according to the specific criteria in this Manual to provide an 80% TSS removal of the average annual post-development load.
- Runoff from hotspot land uses and activities is adequately treated and addressed through the use of appropriate pre-treatment stormwater controls and pollution prevention practices.

Permanent BMPs should be proposed by the developer early in the planning stage of a project. For most projects, there will be no single BMP which addresses all the long-term stormwater quality problems. Instead, a multi-level strategy will be worked out which incorporates source controls, a series of on-site treatment controls, and community-wide treatment controls.

The Water Quality Volume (WQv) equation, which forms the foundation of the City's stormwater quality management program, establishes the volume that must be treated. The WQv is storage required to capture and treat stormwater runoff from 80% of the average annual rainfall, which is considered the "first flush". The 80th percentile storm event in Shelbyville is 0.6 inches. All storms greater than 0.6 inches must be routed non-erosively through the water quality treatment device or routed around it. The following equation shows that this value is equal to the product of precipitation, volumetric runoff coefficient and site area, divided by twelve.

Equation 1 Water Quality Volume Calculation

$$WQv = \left[P\,Rv\right)\left(A\right)\right]/12$$

Where,

P is the average rainfall in inches, (in the case of Shelbyville, is 0.6 inches);
Rv is the volumetric runoff coefficient, which is:
Rv = 0.05 + 0.009(*I*), where I is the percent impervious cover; and
A = the area in square feet

In the equation above, I is based upon the percent impervious cover proposed for the area to be disturbed, and A is the total area to be disturbed.

2.6.2 Choosing the Right Permanent Treatment Practice (PTP)

Table 2.6-1 is an “at-a-glance” table of all of the Permanent Treatment Practices found in Section 3. Use Table 2.6-1 for initial screening of potential measures based upon site constraints such as drainage area, landuse, pollutant removal needed, long term maintenance requirements, and surface area available. Once potential measures have been identified for a site, the design sheets in Section 3 outline detailed design criteria.

The designer may also refer to and use the Louisville and Jefferson County Metropolitan Sewer District (MSD) Green Infrastructure Design Manual –“Green Management Practices and Design Strategies to Manage Stormwater in our Community” for a detailed design criteria.

Table 2.6-1 At-A-Glance Permanent Treatment Practices Decision Matrix

Structural BMP Category	BMP Type	Stormwater Treatment		Water Quality Performance		Drainage Area (ac)	Implementation Considerations			
		Water Quality	Water Quantity	TSS/Sediment Removal Rate	Hotspot Application		Residential	Commercial / Industrial	Unit Cost	Maintenance Burden
Fitration Systems	Surface Sand Filter	✓		80	✓	≤10		✓	Moderate	Moderate to High
	Underground Sand Filter	✓			✓	≤5		✓		
	Perimeter Sand Filter	✓			✓	≤2		✓		
	Organic Sand Filter	✓				≤5		✓		
	Pocket Sand Filter	✓			✓	≤5		✓		
	Bioretention	✓				≤5	✓	✓		Low
Open Channel System	Dry Swale	✓		90		≤5	✓	✓	Moderate	Low
	Wet Swale	✓		75		≤5		✓		
Stormwater Ponds	Micropool Extended Detention Pond	✓	✓	80		≥10	✓	✓	Low	Low
	Wet Pond	✓	✓			≥25	✓	✓		
	Wet Extended Detention Pond	✓	✓			≥25	✓	✓		
	Multiple Pond System	✓	✓			≥25	✓	✓		
	Pocket Pond	✓	✓			≥25	✓	✓		
Stormwater Wetlands	Shallow Wetland	✓		75		≥25	✓	✓	Moderate	Moderate to High
	Extended Detention Shallow Wetland	✓				≥25	✓	✓		
	Pond/Wetland System	✓				≥25	✓	✓		
	Pocket Wetland	✓				5-10	✓	✓		
Infiltration Systems[1]	Infitration Trench	✓		90		≤5	✓	✓	Moderate to High	Moderate
	Infiltration Basin	✓						✓		
Water Quality Units	Hydrodynamic Separators	✓		TBD[2]	✓	Minimal		✓	Moderate	Moderate to High
	Filtration	✓			✓			✓		
	Continuous Deflection	✓			✓			✓		
Grease Management					✓			✓	Low	High
Extended Detention/Retention Dry Basins	Detention Basin with Gravity Outfall	✓	✓	60		≤75	✓	✓	Low	Low
	Retention Basin with Drywell Outfall	✓	✓				✓	✓		
Oil & Grease/Water Separator				40	✓			✓	Low	Moderate

Notes: 2) To be determined based upon City-approved testing

2.6.3 Weighted total suspended solids reduction

The City's stormwater quality management program is designed to give the developer flexibility in meeting the 80% TSS reduction goal on each site. The BMPs identified in Section 3 of this manual as Permanent Treatment Practices (PTPs) give the developer options to meet the water quality requirements in numerous ways. Calculations to verify the TSS reduction for each site are provided below.

The percent TSS removal (%TSS) that is achieved on a site can be calculated using the equation below. This equation is an area-weighted TSS reduction equation which accounts for the TSS reduction that is contributed from each stormwater treatment BMP that is utilized on the site.

Equation 2 Weighted TSS Reduction

$$\%TSS = \frac{\sum_n^1 (TSS_1 A_1 + TSS_2 A_2 + ... + TSS_n A_n)}{\sum_n^1 (A_1 + A_2 + ... + A_n)}$$

where:

TSS_n = TSS removal percentage for each structural BMP located on-site (%);
A_n = the area draining to each BMP (acres).

An example calculation of weighted TSS reduction on a project is provided below.

Example 1: Weighted TSS reduction example: Wetland and Dry Detention

A 20 acre site is divided into 2 subwatersheds: Subwatershed 1 has 12 acres and contains a constructed wetland for stormwater quality treatment. Subwatershed 2 has 8 acres and contains a dry detention facility. What is the %TSS reduction?

TSS reductions from Table 2.6-1:
Wetland = 75%
Dry detention = 60%

<u>Step 1:</u> Calculate % TSS removal for the site:
$\%TSS = ((TSS_{dry} \text{ x } 8 \text{ acres}) + (\%TSS_{wetland} \text{ x } 12 \text{ acres})) \div 20 \text{ acres}$
%TSS = ((60% x 8 acres) + (75% x 12 acres)) ÷ 20 acres = 69%

Therefore, the % TSS removal for the site is 69%. Additional BMPs must be constructed at the site to bring the TSS removal to 80%.

When two or more BMPs are used in series (stormwater discharges from one BMP into another), a different calculation is necessary. This scenario is called a **treatment train**. Stormwater discharging from the upper most BMP will be considerably "cleaner" than the influent, meaning TSS particle sizes will be much smaller. Pollutant removal rates for BMPs used in a treatment train are not additive. For pollutants in particulate form, such as TSS, the actual removal rate (expressed in terms of percentage of pollution removed) varies directly with the pollution concentration and sediment size distribution of runoff entering a facility. For example, a stormwater treatment pond will have a much higher pollutant removal percentage for very turbid runoff than for relatively clear water. When two stormwater ponds are placed in series, the downstream pond will treat an incoming TSS load that is very different from the upstream pond. The upstream pond easily captures the larger solids, and discharges an outflow that has a lower concentration of TSS, but with a relatively higher proportion of fine particle sizes. Therefore, further TSS reduction will be difficult for the second and subsequent BMPs. Hence, the TSS removal capability of the downstream pond is considerably less than the upstream pond. Recent studies suggest that the downstream pond in a series can provide as little as half the removal efficiency of the upstream pond.

Note that manufactured treatment devices such as oil water separators and hydrodynamic units must be a first treatment BMP when used in a treatment train design. These units are most effective at capturing gross solids.

To calculate the total % TSS removal for a treatment train comprised of two or more structural BMPs, the following equation should be used.

Equation 3 Treatment Train Calculation

$$TSS_{train} = A + B - \frac{(A \times B)}{100}$$

where:

TSS_{train} = total TSS removal for treatment train (%);
A = % TSS removal of the first (upstream) BMP, from Table 2.6-1 (%)
B = % TSS removal of the second (downstream) BMP, from Table 2.6-1 (%).

For development sites where the treatment train provides the only stormwater treatment on the site, TSS_{train} must be greater than or equal to 80%. For development sites that have other structural BMPs for stormwater treatment that are not included in the treatment train, TSS_{train} must be included in Equation 2 in the calculation of the overall % TSS removal for the site. An example application of the latter situation is presented below.

Example 2: Treatment Train Example: Wetland, Dry Pond, Bioretention

A 20 acre site is divided into 2 subwatersheds: Subwatershed 1 has 12 acres and contains a constructed wetland for stormwater quality treatment. Subwatershed 2 has 8 acres and contains a bioretention area that discharges into a dry detention facility. What is the %TSS reduction?

TSS reductions per Table 2.6-1:
Control A (wetland) = 75%
Control B (bioretention) = 80%
Control C (dry detention) = 60%
Controls B and C are part of a treatment train.

Step 1: Calculate TSS_{train}:

TSS_{train} = B + C – (B x C)/100 = 80 + 60 - (80 X 60)/100 = 92% removal

Step 2: Calculate % TSS removal for the site:

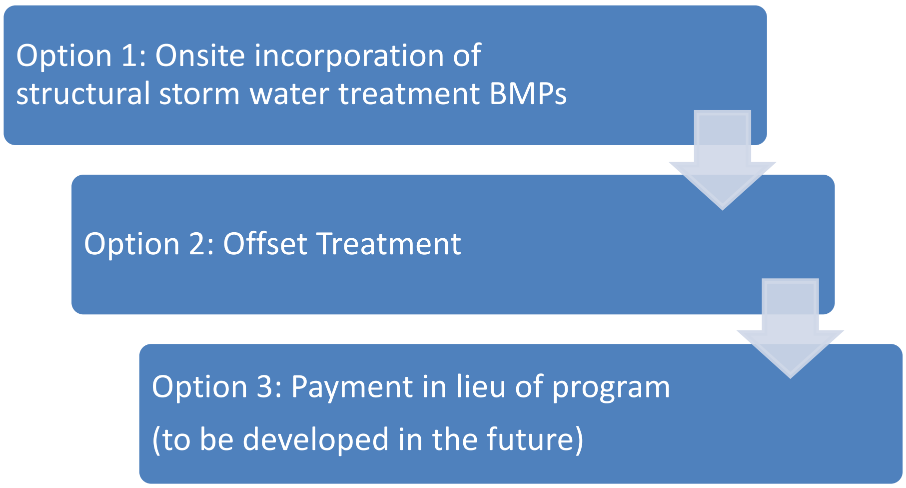
%TSS = ((TSS_{train} x 8 acres) + (%$TSS_{wetland}$ x 12 acres)) ÷ 20 acres
%TSS = ((92% x 8 acres) + (75% x 12 acres)) ÷ 20 acres = 82%

Therefore, the % TSS removal for the site is 82%. No other BMPs need to be constructed at the site.

2.6.4 Redevelopment stormwater quality treatment strategies.

Redevelopment projects in highly urbanized, built-out environments are desirable and encouraged forms of development, in that redevelopment projects typically do not need new infrastructure such as roadways to be constructed, reduce urban sprawl, and keep the overall imperviousness of a watershed the same. For the purposes of the Stormwater Quality Treatment Program, "redevelopment" is defined as any new construction on a site that has a pre-existing use on it. The preferred stormwater quality treatment strategies are outlined in Figure 2.6-1 below, in a prioritized order.

Figure 2.6-1 Stormwater Quality Treatment Strategy Steps



These strategies are described below.

Option 1: Onsite incorporation of structural stormwater treatment BMPs.

Structural stormwater quality treatment BMPs (PTPs) include bioretention, wet ponds, dry/wet swales and other practices as outlined in Section 3. These types of practices typically require some amount of surface land area for treatment, unless the system is a manufactured underground system. The WQv calculation in section 2.6.1 shall apply. Where a site has significant constraints such as limited surface area, setbacks, etc., option 2 or 3 (when developed) may be chosen for treating water quality.

Option 2: Offset treatment.

In the 2010 KYG20 Phase 2 MS4 Permit, KDOW included an allowance for developers to provide offset treatment where onsite treatment isn't feasible. The language from the permit is as follows:

> *The off-site mitigation option entails infiltration/evapotranspiration/reuse measures that may be implemented at another location in the same sewershed/watershed as the original project, approved by the permittee(s). The permittee shall identify priority areas within the sewershed or watershed in which mitigation projects can be completed.*

The City of Shelbyville acknowledges the benefits of and need for pollutant trading credits, mitigation and/or offsets. Pollutant trading or offset isn't a new concept, as it has been applied to point source dischargers, specifically wastewater treatment facilities, for many years. Typically, trading or offsets occur within watersheds where a TMDL has been approved. However, the same approach for pollutant trading applied to TMDL watersheds can be applied to non-TMDL watersheds. The following section outlines the City's policy on pollutant offsets for new development or redevelopment. This policy is consistent with EPA's policy on water quality trading.

Redevelopment typically occurs in highly urbanized areas, where surface area for treatment of the WQ_v is typically minimal or non-existent. In such areas where the developer can demonstrate the site limitations cause the first option to be impractical or infeasible, the City Engineer has the ability to approve on a case-by-case basis pollutant treatment offsets. Pollutant treatment offset is defined as providing water quality (WQ_v) treatment adjacent to the existing redevelopment site such that, from a water quality perspective, there is no net gain of new impervious surfaces or TSS discharges. Note that the preference for water quality treatment is onsite treatment. The following factors will be considered when reviewing applications including pollutant treatment offsets:

1. The engineer and/or developer must provide an alternatives analysis that demonstrates the site constraints that make the onsite treatment of water quality impractical or infeasible. While the economic feasibility of onsite treatment versus offsite treatment can be considered, it cannot be the only constraint identified for treatment onsite.
2. The preferred pollutant treatment offset is to provide treatment of an equivalent amount of impervious surface on land contiguous to and within the same subwatershed of the redevelopment project.
3. Pollutant treatment offsets must occur within the same subwatershed as the location of the redevelopment site.
4. The pollutant treatment offset BMP must be located within a drainage easement, with access from a public right-of-way. An Operation and Maintenance Plan (O&M Plan) must be submitted to and approved by the City. In addition, the O&M Plan must be recorded with the deed for the offset treatment BMP. The City will not assume ownership of the offset BMP.
5. For pollutant treatment offsets providing treatment of impervious surfaces located contiguous to the development site and within the same subwatershed, the offset WQ_v treatment shall be 1:1.
6. Pollutant offset treatment is NOT allowable for new subdivisions of land, residential or non-residential.
7. Pollutant offset treatment it NOT allowable when areas on the development site are available, either above ground or below ground, to provide full treatment of the required WQ_v.

2.6.5 Hot Spot Landuse Treatment Requirements

In addition to the treatment standards noted above, the City requires post construction stormwater management BMPs for "hot spot" locations. "Hot spot" landuses include the following:

Table 2- 1 Hot Spot Landuse Treatment Recommendations

Landuse
Automotive fueling
Automotive repair facilities
Vehicle washing/stream cleaning facilities
Auto recycling facilities
Restaurants with outside grease collection and disposal areas
Outdoor material storage areas
Loading and transfer areas
Landfills
Industrial sites
Other landuses as determined to have a high potential of pollutant discharge into the MS4 as determined by the City Engineer

Hot spot BMPs shall be designed to remove targeted pollutants based on land use and typical pollutant for the land use. This hot spot landuse treatment requirement is in addition to the 80% TSS reduction goal established for all new development. For example, automotive fueling facilities are likely to have higher than normal loads of petroleum products, and the appropriate hot spot treatment device would likely be an oil/water separator in additional to other PTPs installed to meet the 80% TSS treatment goal. Most hot spot landuse treatment BMPs are pre-treatment devices, designed to remove gross solids, floatables and oils and grease. A 50% TSS reduction can be assigned to pre-treatment devices and included in the site's overall treatment train.

2.7 Approval and Design of Proprietary Stormwater Treatment Devices

The standard PTPs included in Chapter 3 of this manual are non-proprietary BMPs and can be designed to meet the water quality treatment design. The City of Shelbyville allows the use of other types of PTPs, though the approval and review process is more rigorous. Many proprietary treatment devices are designed based upon a peak flow rate as opposed to a volume of treatment. Non-proprietary treatment devices, such as detention ponds, bioretention, and wetlands, are designed based upon a treatment volume (for stormwater quality treatment) and peak flow (for flow attention). Therefore, a slightly different design approach is necessary for proprietary treatment devices. In addition, pollutant reduction rates are significantly impacted by the design flow rate.

2.7.1 Approval of Manufactured Treatment Devices

All treatment devices designed for stormwater quality or quantity treatment in the City of Shelbyville must be approved by the City Engineer prior to installing them. Many manufactured stormwater treatment devices are available to treat stormwater runoff. However, some of these BMPs do not have established pollutant removal data based on standardized testing methods. The City of Shelbyville considers proprietary BMPs as Limited Application BMPs because of a lack of historic pollutant removal data or because of high maintenance requirements.

Proprietary devices must be approved before they can be considered for use in the City of Shelbyville. Manufacturers' claims for BMP performance must be verified through data that is obtained in independent third party testing.

The City of Shelbyville recognizes two levels of treatments:

1. Pretreatment. Pretreatment devices do not meet the full 80% TSS reduction goal; however, they can be used in a treatment train approach with other BMPs to fully meet the treatment goal. In addition, pretreatment BMPs are required for hot spot landuse applications, as described in Section 2.6.5.
2. Full Treatment. Manufactured treatment devices that show through testing that they meet the full 80% TSS reduction goal are considered full treatment devices. If the manufactured treatment device is a flow-based device, the peak flow rate for the TSS reduction must be provided and cannot be exceeded in the design.

2.7.2 Design of Manufactured Treatment Devices

As noted above, most manufactured treatment devices are flow based devices. Applying the WQv equation (see Equation 1) is therefore not possible. The City developed the following design tools for use in sizing manufactured treatment devices. This design methodology is considered to provide an equivalent treatment as the treatment provided with the WQv methodology.

Most proprietary BMPs are flow based BMPs and rated for TSS removal based upon a specified flow rate. The WQv equation, which forms the foundation of Shelbyville's stormwater quality program, establishes a volume that must be treated. In an effort to simulate the WQv approach for proprietary BMPs, the following peak flow design equation must be used to develop the stormwater quality treatment required.