CITY OF OAK RIDGE
STORMWATER MANAGEMENT PROGRAM
MS4 STORMWATER DESIGN MANUAL

1. Run-off Reduction

The City's site design standards for all new and redevelopment sites that require a general NPDES Permit for Discharges of Stormwater Associated with Construction Activities (CGP) from the Tennessee Department of Environment and Conservation, also require in combination or alone, management measures that are designed, built and maintained to infiltrate, evapotranspire, harvest and/or use, at a minimum, the first inch of every rainfall event preceded by seventy-two (72) hours of no measurable precipitation. The design storm is a 1-year, 24-hour storm event. This first inch of rainfall (from new impervious surfaces) must be one-hundred percent (100%) managed with no discharge to surface waters.

The City recognizes re-development incentive standards, and for every standard met, there is an allowance credit of 10% reduction in the volume of rainfall to be managed. These credits are additive and have a maximum reduction of 50% for projects that meet all five criteria.

1) Redevelopment;
2) Brownfield redevelopment;
3) High density (>7 units per acre);
4) Vertical Density, (Floor to Area Ratio (FAR) of 2 or >18 units per acre)
5) Mixed use and Transit Oriented Development (within ½ mile of transit)

2. Pollutant Removal

For projects that include site-specific limitations for infiltration, evapotranspiration, or recapture/reuse (from new impervious surfaces) and therefore cannot meet 100% of the runoff reduction requirements, the remainder of the stipulated amount of rainfall must be treated prior to discharge with a technology documented to remove 80% total suspended solids (TSS). The treatment technology must be designed, installed and maintained to continue to meet this performance standard.

Site limitations of the run-off reduction requirement cannot be based solely on cost of installation, and instead must be based on factors such as:

1) Insufficient infiltration capacity of soils
2) A potential for introducing excessive pollutants into groundwater
3) Pre-existing soil contamination in areas subject to contact with infiltrated runoff
4) Presence of sinkholes or other karst features on the site or in close proximity
5) An extensive presence of shallow ground water table, shallow bedrock, or other restrictive layers
6) Presence of contractive or expansive soils in close proximity to structures

In order for the City to approve site-specific limitations, the site designer must submit a geotechnical or soils report, and a written description of why runoff reduction is limited. This must be approved by the Engineering Department.

2.1. Structural BMPs

Structural BMPs are designed for pollutant removal and are rated by their ability to remove Total Suspended Solids (TSS). The structural stormwater BMPs deemed acceptable for use to attain the 80% TSS removal standard are listed in Table 2.1. This value must be used to calculate the total weighted % TSS removal for the newly proposed impervious surfaces of the development site.

The structural BMPs listed in Table 2.1. fall into two categories (general application or limited application) based upon the BMP's ability to meet stormwater management goals and/or its maintenance requirements. Additional details can be found in the *Tennessee Permanent Stormwater Management and Design Guidance Manual* approved by TDEC. Specific design and maintenance considerations can be found using the *Knox County Tennessee Stormwater Management Manual, Volume 2, Chapter 4.3-4.4* (2008). New BMPs, or technologies that are not included in this table may be approved by the Engineering Department on a case-by-case basis for the treatment of stormwater quality.

Table 2.1. TSS Removal % for Structural BMPs
Knox County Tennessee Stormwater Management Manual (2008)

Structural BMP	TSS Removal %
General Application BMPs	
Wet Pond	80
Wet Extended Detention	80
Micropool Extended Detention Pond	80
Multiple Pond System	80
Dry Extended Detention Pond	60
Conventional Dry Detention Basins	10
Shallow Wetland	75
Extended Detention Shallow Wetland	75
Pond/Wetland System	75
Pocket Wetland	75
Bioretention Area	85
Sand Filters (Surface and Perimeter)	80
Infiltration Trench	90
WQ Dry Swales	90
Wet Swales	75
Filter Strip	50
Grass Channel[1]	30
Gravity (oil-grit) Separator	30
Modular Porous Paver Systems[2]	*
Porous Pavement/Concrete[2]	*
Limited Application BMPs	
Organic Filter	80
Underground Sand Filter	80
Submerged Gravel Wetland	75
Alum Treatment System	90
Proprietary Treatment Controls	10[3]
Underground Detention	10

1. Refers to open channel practice not designed for water quality
2. These practices are not treatment BMPs but are source control BMPs, so they are not assigned a pollutant removal.
3. Provisional % TSS Removal value pending third party information.

2.2. Propritary Devices or Manufactured BMPs

There are many commercially available BMPs that provide water quality treatment (e.g., Stormceptor, Vortechnics, etc.). Typically, such "proprietary" controls have high installation and maintenance costs and requirements. Therefore, they are best suited for non-residential developments or redevelopments that have limited space for water quality treatment, or have site-specific limitations present that would otherwise limit the use of standard BMPs. In order for the City to approve the priopritary device, an independent widely accepted third party stormwater treatment system evaluation must be conducted such as New Jersey Comprehensive Assessment Tool (NJCAT), or the Technology Assessment Protocol – Ecology (TAPE) Program. For a quick reference that includes some of the options available see Knox County's Approved Prioprietary BMP Device List (https://www.knoxcounty.org/stormwater/pdfs/KnoxCountyPropBMPDevices.pdf).

2.3. Structural BMP Calculations

2.3.1. Calculations for SCMs in a Series

SCMs that do not individually meet the city's pollutant reduction goal may be used with another SCM to meet the 80% TSS removal requirement. When runoff flows from a more efficient structure (one with a higher removal rate) to a less efficient structure (one with a lower removal rate), the cumulative pollutant removal of a structure does not increase. The reason is that a structure with a lower removal efficiency that follows a structure with a higher removal efficiency does not have an appreciable effect on cumulative pollutant reduction. The cumulative pollutant removal of SCMs in a series shall be calculated as follows.

Equation 1:

$$TSS = A + (1 - A) * B$$

Where:

TSS = Total Removal
A = TSS removal % from 1st structural control in series
B = TSS removal % from 2nd structural control in series

2.3.2. Calculations for SCMs in Parallel

The percent TSS removal (%TSS) that is achieved on a site can be calculated using Equation 2-3. Equation 2 is an area-weighted TSS reduction equation which accounts for the TSS reduction that is contributed from BMPs that area treating separate areas and not being used in series. Where BMPs are used in series, the total % TSS removal for the combination of two or more BMPs shall be used for TSS_n

Equation 2:

$$TSS_{site} = \frac{\sum_1^n (TSS_1 A_1 + TSS_2 A_2 + \ldots + TSS_n A_n)}{\sum_1^n (A_1 + A_2 + \ldots + A_n)}$$

Where:

TSS_n = TSS removal for each structural BMP located on site
A_n = the area draining to each BMP (acres)

Examples:

E-1. A site is planned to have a filter strip that is approved for a 50% TSS removal, followed by a dry extended detention basin designed, built, and maintained as required by TDEC recommendations. The calculation is as follows:

$$TSS = A + (1 - A) * B$$

$$TSS = 0.5 + (1 - 0.5) \times 0.6$$
$$TSS = 0.5 + (0.5) \times 0.6$$
$$TSS = 0.5 + 0.3$$
$$TSS = 0.8$$

Note: The second device will only remove 60% TSS from the 50% remaining after the first device has removed its 50% TSS.

E-2. A site is planned to have a Wet Pond that is approved to remove 80% TSS for 0.4 acres of a 1 acre proposed impervious area. The other 0.6 acres is expected to be treated by a combination of other methods. One suggestion follows:

Grass Channel in series with a Wetland:

$$TSS_{Total} = \frac{TSS_{Wet\ Pond} \times A_{Wet\ Pond} + TSS_{Grass\ Channel\ \&\ Wetland} \times A_{Grass\ Channel\ \&\ Wetland}}{A_{Wet\ Pond} + A_{Grass\ Channel\ \&\ Wetland}}$$

$$TSS_{Grass\ Channel\ \&\ Wetland} = 0.3 + (1 - 0.3) \times 0.75 = 0.825$$

$$TSS_{Total} = \frac{.80 \times 0.4 + 0.825 \times 0.6}{0.4 + 0.6}$$

$$TSS_{Total} = \frac{0.32 + 0.495}{1}$$

$TSS_{Total} = 0.815$ or 81.5% for the entire site, meeting the TSS removal minimum

References

Metro Water Services, Stormwater Division (2016). *Stormwater Management Manual, Volume 4 – Best Management Practices.* Metropolitan Nashville, Davidson County.

AMEC Earth & Environmental, Inc. (2008). *Stormwater Management Manual, Volume 2 – Technical Guidance.* Knox County, Tennessee.