BUREAU OF WATERSHED MANAGEMENT
PROGRAM GUIDANCE

WATERSHED MANAGEMENT TEAM
Storm Water Runoff Management Program

Wisconsin Department of Natural Resources
101 S. Webster Street, P.O. Box 7921
Madison, WI 53707-7921

Process to Evaluate Existing Vegetated Swales, Infiltration Basins and Dry Detention Basins for MS4 Permit Compliance

DRAFT 04-28-2025
EGAD Number: 3800-2025-21

This document is intended solely as guidance and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

APPROVED:

__________________________ ________________
Jason Knutson, Director Date
Bureau of Watershed Management

A. Statement of Problem Being Addressed

Municipal separate storm sewer system (MS4) permittees own or operate storm water control practices that treat urban storm water runoff. These practices are modeled to evaluate the level of pollution control provided toward compliance with s. NR 151.13, Wis. Adm. Code, developed urban area performance standards, and/or pollutant load reduction requirements established in total maximum daily load (TMDL) plans for impaired waterways.

Many MS4 permittees own or operate existing vegetated swales, infiltration basins and dry detention basins. Vegetated swales are associated with roadway drainage and can be highly effective pollutant removal systems. Dry detention basins, typically designed and constructed to provide flood control, can also remove pollutants under some conditions. Infiltration basins are similar to dry detention basins but allow a significant amount of the runoff to drain through the basin bottom rather than surface discharge. However, the conditions that determine the pollutant removal efficiency of these practices are highly variable. This variability can be challenging when determining the input parameters that are appropriate for pollutant load reduction modeling.

B. Objectives

This guidance identifies the approach that MS4s may use to evaluate and model vegetated swales, infiltration practices, and dry detention basins for pollutant removal credit.

C. Background

This guidance provides a basis for evaluating and modeling MS4 vegetated swales, infiltration practices, and dry detention basins for total suspend solids (TSS) and/or total phosphorus (TP) removal. To model these practices, various input parameters need to be determined, including physical characteristics (i.e., longitudinal slope and bottom width) and infiltration rate. This guidance identifies the process to determine the model input parameters.

D. Guidance Content

Section 1 – Vegetated Swales
Section 2 – Infiltration Basins
Section 3 – Dry Detention Basins
Section 4 – Field Test Procedure for Double-Ring Infiltrometer

Section 1 - Vegetated Swales

1. Determine and evaluate swale lengths and longitudinal slopes:

   a. Identify swale lengths and longitudinal slopes using available topographic information or road as-built drawings.
   b. Exclude driveways and culverts from the swale length.
   c. Include swales with slopes less than or equal to 4%.
   d. Include swales with slopes greater than 4% provided slope interruption devices are installed within the swale consistent with DNR Ditch Check Technical Standard 1062. Swales with slope interruption devices consistent with DNR Ditch Check Technical Standard 1062 may be modeled using a longitudinal slope of 1%, regardless of the actual longitudinal slope.
   e. Include swales with slopes less than 1% that do not have visual indicators for excessive ponding (e.g., standing water, wetland vegetation).

2. Evaluate the physical swale conditions:

   a. Identify swales with visual indicators of excessive ponding (e.g., standing water, wetland vegetation). This is most common when the longitudinal slope is less than 1%. Swales with visual evidence of excessive ponding should be modeled assuming no infiltration occurs in the swale.
   b. Identify swales with visual evidence of scour. Visual evidence of scour includes channel formation or bare soil in the bottom of the swale. These swales should be excluded from modeling.
   c. Identify swales with high flow velocity. Velocity calculations should be conducted for the representative swale geometry(s) and at locations where high velocity is suspected. If the peak flow velocity during the 2-year, 24-hour storm exceeds 1.5 feet per second or the maximum flow depth under that rainfall event exceeds 12 inches, exclude the swale from pollution control modeling.

3. Determine the swale geometry:

   a. Identify or measure a representative swale cross sectional geometry. If the swale geometry in the modeling area is variable, develop more than one representative swale geometry (e.g., separate swale geometry for arterial, collector and local roads).
   b. Use the swale dimensions from typical roadway sections if construction plans are available and reasonably consistent with existing conditions.
   c. When typical roadway sections plans are not available, measure swale bottom width and side slopes in the field. Measure the swale bottom width and side slopes at a minimum of three locations that are at least 10 feet apart and average the results of these measurements.

4. Determine and evaluate swale infiltrate rates based on soil texture or field infiltration rate testing.

    a. Swale soil texture can be identified in eligible swale areas using the Natural Resource Conservation Service (NRCS) Soil Survey or other soil data if available. The appropriate static infiltration rate should be selected from Table 2 of DNR Site Evaluation for Storm Water Infiltration Technical Standard 1002 (DNR Technical Standard 1002) based on soil texture.
    b. Swale infiltration rates can be measured in eligible swale areas in the field using a scientifically credible field test method:

        - Conduct at least 20 field infiltration tests at swales located in the MS4 permitted area. If MS4 specific conditions suggest that at lower number of tests is appropriate (e.g., uniform soil type, limited total swale length), contact DNR to discuss the potential for conducting a lower number of field infiltration tests.
        - Field infiltration tests can be conducted at locations where the swale geometry is measured and/or at other locations based on spatial variables including soil type, drainage area or land use type.
        - At each field infiltration test location, identify the lowest infiltration rate measured during the testing procedure based on a best fit curve or plot of all measurements. This rate is considered the static infiltration rate for that location.
        - To determine the static infiltration rate of existing swales using the double-ring infiltrometer method, modifications to procedures in American Society for Testing and Materials (ASTM) D3385 are allowed per Section 4 below.

    c. When the static infiltration rates have been determined by soil type or field infiltration testing, evaluate the values to determine how they will be used for modeling:

        - If the measured infiltration rate values show a similar infiltration rate range from one area to another, then the geometric mean of all values may be used for modeling.
        - If the measured infiltration rate values show a varying trend from one area to another, then it may be appropriate to establish multiple values for modeling based on spatial variables (e.g., soil type, drainage area, land use). In this situation, infiltration rate values should be assigned or grouped based on the appropriate spatial variable. For spatial variable groups, either the

lowest value within the group or the geometric mean of the group should be used for modeling.

- A geometric mean of the lowest measured rate from the individual locations is used to determine the static infiltration rate for modeling. Values used to calculate a geometric mean cannot be zero. Therefore, a value of 0.03 in/hr may be used in place of a zero value to calculate the geometric mean.

5. Calculate the pollutant removal effectiveness of swales using models such as WinSLAMM or P8. When modeling swales, considering the following:

   a. Subdivide drainage areas with a combination of swales and storm sewer by conveyance system type and model the subdivisions separately.
   b. Where a system of swales discharges to a single, larger swale, model the larger swale separately.
   c. Use the swale geometry that is appropriate for the modeling area.
   d. Where swale density varies within a modeled area, use an area weighted average that represents the modeled area. For example, if a 100-acre modeled area has 90 acres of residential land use with an average swale density of 359 ft/acre and 10 acres of strip commercial with an average swale density of 412 ft/acre, the area weighted average for the modeled area is 364 ft/acre.
   e. In WinSLAMM, use a swale retardance factor of C or D.
   f. Use a Manning's "n" value of 0.30 or less based on the type of vegetation, mowing height and depth of flow. Supporting documentation should be provided if Manning's "n" values greater than 0.30 are used.
   g. Prior to entering an infiltration rate in the model, reduce the static infiltration rate determined based on soil texture or field infiltration testing by 50% to obtain the dynamic infiltration rate that is used to model infiltration in swales. In WinSLAMM, the default "dynamic infiltration rate by soil type" values listed in the model, should not be used. Wisconsin default values are those derived from Table 2 in DNR Technical Standard 1002.

Section 2 - Infiltration Basins

1. Only use municipally owned or operated infiltration basins or private infiltration basins with municipal inspection and maintenance authority in modeling.

2. In WinSLAMM, use the biofiltration control device input with no rock filled depth, engineered media depth or underdrain.

3. Determine the native soil infiltration rate based on soil boring or pit data or infiltration rate testing within the basin footprint:

    a. Conduct soil texture evaluations or field infiltration testing in accordance with Table 1 of DNR Technical Standard 1002. When only on-site soil evaluation texture is used, select a static infiltration rate from Table 2 of DNR Technical Standard 1002 based on the least permeable soil layer located within 5 feet below the bottom of the basin.
    b. When a measured infiltration rate is determined, follow the example calculation under 'Infiltration Option 2' of DNR Technical Standard 1002, which reduces the measured infiltration rate by a correction factor in Table 3.

Section 3 - Dry Detention Basins

1. Only use municipally owned or operated dry ponds or private dry ponds with municipal inspection and maintenance authority in modeling.

2. Dry ponds with impervious low flow channel (e.g., concrete lined) are not eligible for modeling.

3. For modeling eligible dry basins, use one of the following options in a model that accounts for sediment resuspension (e.g., WinSLAMM):

    a. Model as a wet pond under the following conditions and model input parameters:

        - Appropriate energy dissipation is provided at inlet locations.
        - A stone weeper, gabion or similar structure is provided at the primary outlet.
        - The basin does not have a low flow pilot channel.
        - The basin vegetation is maintained in good condition.
        - The maximum water surface rise in the basin during 1-yr, 24-hr design storm event does not exceed 5 feet.
        - The basin drawdown time after a 1-yr, 24-hr design storm event is less than 24 hours.
        - For modeling, use the bottom area of the basin at stage 0.01 feet.

    b. Model as a grass swale without infiltration using the following model input parameters:

        - Use a bottom width of 10 to 20 feet.
        - Use side and longitudinal slopes based on basin contours.
        - Use a swale dynamic infiltration rate of zero.

    c. Model as a grass swale with infiltration using the following model input parameters:

        - Use a representative bottom width. If the bottom width is greater than 20 feet, use 20 feet.
        - Use side and longitudinal slopes based on basin contours.
        - Use a swale dynamic infiltration rate based on soil boring or pit data or infiltration rate testing within the basin footprint:

            - Conduct soil texture evaluations or field infiltration testing in accordance with Table 1 of DNR Technical Standard 1002.
            - When soil boring or pit data is used, select a static infiltration rate from Table 2 of DNR Technical Standard 1002 based on the least permeable soil layer located within 5 feet below the bottom of the basin.

- Prior to entered an infiltration rate in the model, reduce the static infiltration rate from Table 2 of DNR Technical Standard 1002 or field infiltration testing by 50% to account for dynamic infiltration.

d. Model as an infiltration basin using the following model input parameters:

- Use the biofiltration control device input with no rock filled depth, engineered media depth or underdrain.
- Use a native soil infiltration rate based on on-site soil evaluation data or on-site infiltration testing within the basin:

e. Determine the native soil infiltration rate based on soil boring or pit data or infiltration rate testing within the basin footprint:

- Conduct soil texture evaluations or field infiltration testing in accordance with the surface infiltration basin criteria found in Table 1 of DNR Technical Standard 1002. When only on-site soil evaluation texture is used, select a static infiltration rate from Table 2 of DNR Technical Standard 1002 based on the least permeable soil layer located within 5 feet below the bottom of the basin.
- When a measured infiltration rate is determined, follow the example calculation under ‘Infiltration Option 2’ of DNR Technical Standard 1002, which reduces the measured infiltration rate by a correction factor in Table 3.

Section 4 - Field Test Procedure for Double-Ring Infiltrometer

1. Select a relatively flat test area so that the double-ring infiltrometer will not be placed at an angle.
2. Cut the grass to a height of between two to four inches.
3. Gently drive the infiltrometer into the ground.
4. Inspect the soil seal around each ring to make sure that it is even and smooth.
5. Pour clean water into the inner chamber and allow it to overflow and fill up the outer ring. Maintain a level in the outer ring approximately equal to the level in the inner ring.
6. Add more water to both rings when the level in the inner ring has dropped a measurable amount. For most soil types this should be less than an inch.
7. Repeat this step until the rate the water level drops begins to decline.
8. When the rate of decline begins to slow, bring the water level up to the top and start timing the decrease in water level.
9. Record the start time.
10. Stop timing when the water level in the inner ring has gone down a measurable level (ASTM D3385 requires keeping the water level constant). Timing the rate of decline should probably be started almost immediately for more clayey soils, since it might be difficult to observe when the rate change has slowed.
11. Record the time, elapsed time, and change in water level.
12. Refill both rings and restart the timing.
13. Record the time, elapsed time, change in water level, and the elapsed time since the beginning of the first measurement.
14. Repeat the timing steps until the infiltration rate has become relatively constant or the test has been conducted for a minimum of two hours (ASTM D3385 requires 24 hours).
15. The measured rate of infiltration is considered a static infiltration rate. The dynamic infiltration rate is ½ the static rate. Be aware some models, such as WinSLAMM, call for the dynamic rate for swales.

CREATED:

_____________________________ _______________

Peter Wood, Stormwater Engineer Date
On behalf of the Storm Water Liaison Team

APPROVED:

__________________________ ______________

Shannon Haydin, Chief Date
Storm Water Runoff Management Section

Watershed Management Team approved on TBD, 2025.