2E-7 Soils Testing Requirements for Infiltration Practices

(Note: The following procedures are adapted from the Wisconsin DNR Conservation Practice Standard 1002, and are recommended for use along with the design guidance provided in Section 2E-1 for confirming the suitability of site soils for infiltration practices.)

A. Definition

The requirements in this section define the site evaluation procedures to:

1. Perform an initial screening of a development site to determine its suitability for infiltration.
2. Evaluate each area within a development site that is selected for infiltration.
3. Prepare a site evaluation report.

B. Purpose

1. Establish methodologies to characterize the site.
2. Establish requirements for siting an infiltration device and the selection of design infiltration rates.
3. Define requirements for a site evaluation report that ensures appropriate areas are selected for infiltration and an appropriate design infiltration rate is used.

C. Conditions where practice applies

These requirements are intended for development sites being considered for stormwater infiltration devices. Additional site location requirements may be imposed by other stormwater infiltration device technical standards.

D. Criteria

The site evaluation consists of four steps for locating the optimal areas for infiltration and properly sizing infiltration practices. Steps 1 and 2 are completed as soon as possible in the approval process.

- Step 1: Initial screening
- Step 2: Field verification of information collected in Step 1
- Step 3: Evaluation of specific infiltration areas
- Step 4: Soil and site evaluation reporting

The steps should coincide, as much as possible, for when the information is needed to determine the following:

- Potential for infiltration on the site
- Optimal locations for infiltration devices
- Final design of the infiltration device(s)

1. **Step 1: Initial screening.** The initial screening identifies potential locations for infiltration devices. The purpose of the initial screening is to determine if installation is limited by any of the general restrictions for infiltration practices (Section 2E-1), and to determine where field work is needed for Step 2. Optimal locations for infiltration are verified in Step 2. Information collected in Step 1 will be used to explore the potential for multiple infiltration areas versus relying on a regional infiltration device. Smaller infiltration devices dispersed around a development are usually more sustainable than a single regional device that is more likely to have maintenance and groundwater mounding problems. The initial screening should determine the following:

    a. Site topography and slopes greater than 20%.

    b. Site soil infiltration capacity characteristics as defined in NRCS county soil surveys.

    c. Soil parent material.

    d. Regional or local depth to groundwater and bedrock. Use seasonally high groundwater information where available.

    e. Distance to sites identified as closed remediation sites within 500 feet from the perimeter of the development site.

    f. Presence of endangered species habitat.

    g. Presence of floodplains and flood fringes.

    h. Location of hydric soils based on the USDA county soil survey and wetlands within or adjacent of the project area.

    i. Sites where the installation of stormwater infiltration devices would not be recommended due to the potential for groundwater contamination as described below:
        1) An area within 250 feet of a private well.
        2) An area within 1000 feet of a municipal well.
        3) An area within 300 feet upslope or 100 feet downslope of karst features.
        4) A channel with a cross-sectional area equal to or greater than 3 ft^2 that flows to a karst feature.
        5) An area where the soil depth to groundwater or bedrock is less than 2 feet.
        6) Potential impact to adjacent property.
        7) A point system for initial evaluation of a site for infiltration practices is presented in Section 2E-1.

2. **Step 2: Field verification of the initial screening.**

    a. Field verification is required for areas of the development site considered suitable for infiltration. This includes verification of Steps 1a, 1b, 1c, 1d, 1i3, 1i4 and 1i5.

    b. Sites should be tested for depth to groundwater, depth to bedrock and percent fines information to verify any exemption and exclusion found in Steps 1l and 1m. The following is a description of the percent fines expected for each type of soil textural classification: Several textural classes are assumed to meet the percent fines limitations for both 3- and 5-foot soil layers. These classifications would include the sandy loams, loams, silt loams, and all the clay textural classifications. Coarse sand is the only soil texture that, by definition,

will not meet the limitations for a 3-foot soil layer consisting of 20% fines. Other sand textures and loamy sands may need the percent fines level verified with a laboratory analysis.

c. Borings and pits should be dug to verify soil infiltration capacity characteristics and to determine depth to groundwater and bedrock.

d. The following information should be recorded for Step 2:
   1) The date or dates the data was collected.
   2) A legible site plan/map that is presented on paper that is no less than 8 ½ x 11 inches in size and:
      - Is drawn to scale or fully-dimensional
      - Illustrates the entire development site
      - Shows all areas of planned filling and/or cutting
      - Includes a permanent vertical and horizontal reference point
      - Shows the percent and direction of land slope for the site or contour lines. Highlight areas with slopes over 20%.
      - Shows all floodplain information that is pertinent to the site
      - Shows the location of all pits/borings included in the report
      - Location of wetlands as field delineated and surveyed
      - Location of karst features, private wells within 100 feet of the development site, and public wells within 400 feet of the development site
   3) Soil profile descriptions are written in accordance with the descriptive procedures, terminology and interpretations found in the Field Book for Describing and Sampling Soils, USDA, NRCS, 1998. Frozen soil material must be thawed prior to conducting evaluations for soil color, texture, structure and consistency. In addition to the data determined in Step B, soil profiles must include the following information for each soil horizon or layer:
      - Thickness, in inches or decimal feet
      - Munsell soil color notation
      - Soil mottle or redox feature color, abundance, size, and contrast
      - USDA soil textural class with rock fragment modifiers
      - Soil structure, grade size, and shape
      - Soil consistence, root abundance, and size
      - Soil boundary
      - Occurrence of saturated soil, groundwater, bedrock, or disturbed soil

3. **Step 3: Evaluation of specific infiltration areas.** This step is to determine if locations identified for infiltration devices are suitable for infiltration, and to provide the required information to design the device. A minimum number of borings or pits should be constructed for each infiltration device (Table 1). The following information should be recorded for Step 3:

   a. All the information under Step 1.

   b. A legible site plan/map that is presented on paper no less than 8 1/2 x 11 inches in size and:
      - Is drawn to scale or fully dimensional
      - Illustrates the location of the infiltration devices
      - Shows the location of all pits and borings
      - Shows distance from device to wetlands

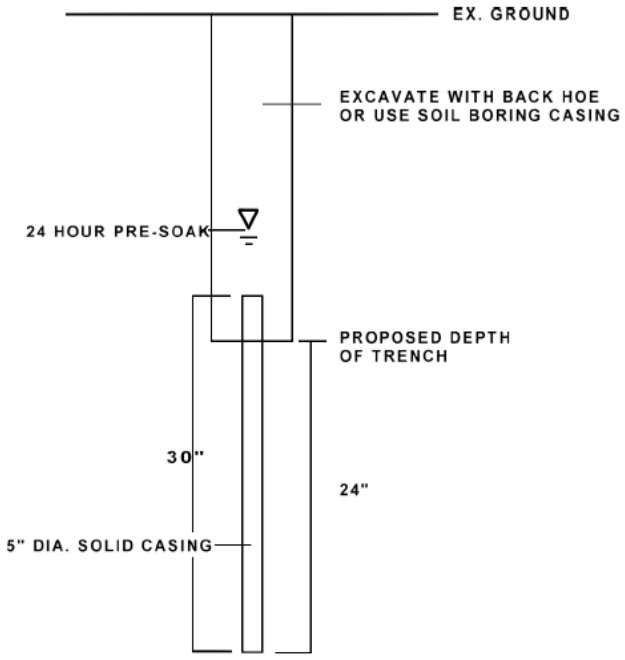
   c. An analysis of groundwater mounding potential is required as per Table 1. The altered groundwater level, based on mounding calculations, must be considered in determining the

vertical separation distance from the infiltration surface to the highest anticipated groundwater elevation. References include, but are not limited to Bouwer (1999), Guo (1998, 2001), Hantuch (1967).

d. One of the following methods should be used to determine the design infiltration rate:
   1) **Infiltration rate not measured.** Table 2 should be used if the infiltration rate is not measured. Select the design infiltration rate from Table 2 based on the least-permeable soil horizon 5 feet below the bottom elevation of the infiltration system.
   2) **Measured infiltration rate.** The tests should be conducted at the proposed bottom elevation of the infiltration device. Two procedures are recommended for the infiltration testing: Infiltration test column and double ring infiltrometer. The procedure of the infiltration test column is summarized below. If the infiltration rate is measured with a double-ring infiltrometer, the requirements of ASTM D3385 should be used for the field test.

e. **Procedure for infiltration test column.**
   1) Install casing (solid 5-inch diameter, 30-inch length) to 24 inches below proposed BMP bottom (see Figure 1).
   2) Remove any smeared soiled surfaces, and provide a natural soil interface into which water may percolate. Remove all loose material from the casing. Upon the tester's discretion, a 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scouring and sediment. Fill casing with clean water to a depth of 24 inches, and allow to pre-soak for 24 hours.
   3) After 24 hours, refill casing with another 24 inches of clean water, and monitor water level (measured drop from the top of the casing) for 1 hour. Repeat this procedure (filling the casing each time) three additional times, for a total of four observations or until there is no measurable change in the readings. Upon the tester's discretion, the final field rate may either be the average of the four observations, or the value of the last observation. The final rate should be reported in inches per hour.
   4) May be done through a boring or open excavation.
   5) The location of the test should correspond to the BMP location.
   6) Upon completion of the testing, the casings should be immediately pulled, and the test pit should be backfilled.

Figure 1: Infiltration testing requirements



The measured infiltration rate should be divided by a correction factor selected from Table 3. The correction factor adjusts the measured infiltration rates for the occurrence of less-permeable soil horizons below the surface and the potential variability in the subsurface soil horizons throughout the infiltration site.

A less-permeable soil horizon below the location of the measurement increases the level of uncertainty in the measured value. Also, the uncertainty in a measurement is increased by the variability in the subsurface soil horizons throughout the proposed infiltration site.

To select the correction factor from Table 3, the ratio of design infiltration rates must be determined for each place an infiltration measurement is taken. The design infiltration rates from Table 2 are used to calculate the ratio. To determine the ratio, the design infiltration rate for the surface textural classification is divided by the design infiltration rate for the least-permeable soil horizon. For example, a device with loamy sand at the surface and a least-permeable layer of loam will have a design infiltration rate ratio of about 6.8 and a correction factor of 4.5. The depth of the least-permeable soil horizon should be within 5 feet of the proposed bottom of the device or to the depth of a limiting layer.

Table 1: Evaluation requirements specific to proposed infiltration devices

BMP type	Design manual reference	Tests required [1]	Minimum number of borings/pits required	Minimum drill/test depth required below the infiltration surface (bottom of BMP)
Rain garden	2E-4	Pits or borings	NA [2]	5 feet or depth to limiting layer, whichever is less.
Infiltration trenches (<2000 ft^2 impervious drainage area)	2E-2	Pits or borings	1 test/100 linear feet of trench with a minimum of 2, and sufficient to determine variability	5 feet or depth to limiting layer, whichever is less
Infiltration trenches (>2000 ft^2 impervious drainage area)	2E-2	Pits or borings Mounding potential	1 pit required and an additional 1 pit or boring per 100 linear feet of trench, and sufficient to determine variability	Pits to 5 feet or depth to limiting layer Borings to 15 feet or depth to limiting layer
Bioretention systems	2E-4	Pits or borings	1 test per 50 linear feet of device with a minimum of 2, and sufficient to determine variability	5 feet or depth to limiting layer, whichever is less
Swales used for infiltration (dry or enhanced swale)	2I-3	Pits or borings	1 test per 1000 linear feet of swale with a minimum of 2, and sufficient to determine variability	5 feet or depth to limiting layer, whichever is less

[1] Continuous soil borings should be taken using a bucket auger, probe, split-spoon sampler, or Shelby tube. Samples shall have a minimum 2-inch diameter. Soil pits must be of adequate size, depth, and construction to allow a person to enter and exit the pit and complete a morphological soil profile description.

[2] Information from Step 2 is adequate to design rain gardens.

4. **Step 4: Soil and site evaluation report contents.** The site's legal description and all information required in Steps 2 and 3 should be included in the Soil and Site Evaluation Report. These reports are completed prior to the construction plan submittal.

Table 2: Design infiltration rates for soil textures receiving stormwater

Soil Texture[1]	Design infiltration rate without measurement[2] (inches/hr)
Coarse sand or coarser	3.60
Loamy coarse sand	3.60
Sand	3.60
Loamy sand	1.63
Sandy loam	0.5
Loam	0.24
Silt loam	0.13
Sandy clay loam	0.11
Clay loam	0.09
Silty clay loam	0.06[3]
Sandy clay	0.05
Silty clay	0.04
Clay	0.02

1 Use sandy loam design infiltration rates for fine sand, loamy fine sand, very fine sand, and loamy fine sand soil textures.
2 Infiltration rates represent the lowest value for each textural class presented in Table 2 of Rawls, 1998.
3 Infiltration rate is an average based on Rawls, 1982.

Table 3: Total correction factors divided into measured infiltration rates

Ratio of design infiltration rates[1]	Correction factor
1	2.5
1.1 to 4.0	3.5
4.1 to 8.0	4.5
8.1 to 16.0	6.5
16.1 or greater	8.5

1 Ratio is determined by dividing the design infiltration rate (Table 2) for the textural classification at the bottom of the infiltration BMP by the design infiltration rate (Table 2) for the textural classification of the least permeable soil horizon. The least permeable soil horizon used for the ratio should be within five feet of the bottom of the BMP facility or to the depth of the limiting layer.

E. Additional considerations

Additional recommendations relating to design that may enhance the use of, or avoid problems with infiltration practices, but are not required to ensure its function are as follows:

1. Groundwater monitoring wells can be used to determine the seasonal high groundwater level. Large sites considered for infiltration basins may need to be evaluated for the direction of groundwater flow.

2. Cation exchange capacity (CEC) of the soil can indicate the number of available adsorption sites. Sandy soils have limited adsorption capacity and a CEC ranging from 1-10 meq/100g. Clay and organic soils have a CEC greater than 20, and have a high adsorption rate.
3. Soil organic matter and pH can be used to determine adsorption of stormwater contaminants. A pH of 6.5 or greater is optimal. A soil organic content greater than 1 percent will enhance

adsorption. (See SUDAS Section 2E-5).

4. One or more areas within a development site may be selected for infiltration. A development site with many areas suitable for infiltration is a good candidate for a dispersed approach to infiltration. It may be beneficial to contrast regional devices with onsite devices that receive runoff from one lot or a single source area within a lot, such as rooftop or parking lot.

5. Stormwater infiltration devices may fail prematurely if there is:

   a. An inaccurate estimation of the design infiltration rate

   b. An inaccurate estimation of the seasonal high water table

   c. Excessive compacting or sediment loading during construction

   d. No pretreatment for post-development and lack of maintenance

   e. No construction erosion should enter the infiltration device. This includes erosion from site grading, as well as homebuilding and construction. If possible, rope off areas selected for infiltration during grading and construction. This will preserve the infiltration rate and extend the life of the device.

6. The development site should be checked to determine the potential for archeological sites. This search may be conducted by state staff for projects required or funded by the state.

7. Slopes 20% or greater are inappropriate for some infiltration devices.

8. Expect to complete the preliminary design work (Steps 1 through 3) before the approval process (platting). Once required information is compiled, the initial design work for an infiltration device can begin.

9. The approval process requirements for development sites vary across the state, and may also vary within the jurisdiction, depending on the type of project (residential/commercial) or number of lots being developed. The timing of Steps 1, 2, and 3 will need to be adjusted for the type of approval process. Step 1 should be completed before the preliminary plat, and Step 2 should be completed before the final plat is approved. For regional infiltration BMP facilities, and for BMPs constructed on public right-of-ways, public land or jointly-owned land, Step 3 should be completed before the final plat approval.