DNREC Division of Watershed Stewardship
285 Beiser Boulevard, Suite 102
Dover, DE 19904
(302) 739-9921

# ***Soil Investigation Report Submittal Checklist***

**DATE RECEIVED:** _____**PROJECT NUMBER:** _____

**PROJECT NAME:** _____

The items contained on this checklist are necessary to properly evaluate and determine the completeness of any Soil Investigation Report submitted under subsection 12.1 of the Delaware Sediment and Stormwater Regulations. Complete all items. It is understood not all items will be applicable to all projects and as such marking an item "N/A" is acceptable.

I._____ **General Soil Investigation Reports.** The following information, as applicable, should be submitted for all projects.

1)_____ The signature, seal and date of a professional engineer or professional geologist experienced in soils licensed in the State of Delaware.

2)_____ General description of the project, project elements, and project background.

3)_____ Project site surface conditions and current use.

4)_____ Regional and site geology. An initial screening of readily available data to determine feasibility of infiltration practices, if applicable, including:

a) ____ Site topography

b) ____ Soil characteristics as defined in the USDA NRCS Web Soil Survey

c) ____ Depth to groundwater and seasonal high water table

d) ____ Historical groundwater level data from the nearest Delaware Geological Survey (DGS) monitoring well or wells

5)_____ Minimum number of borings or test pits conducted in accordance with the following:

a) ____ Surface area BMPs:

i)____ Two (2) borings or pits for the first 8,000 square feet

ii) ___ Three (3) borings or pits for up to 16,000 square feet

iii)____ Four (4) borings or pits for up to 25,000 square feet

iv) ___ One (1) additional boring or pit for each additional 25,000 square feet beyond the first 25,000 square feet

v)____ Boring or pit locations distributed within the facility and sufficient to determine soil variability

b) ____ Linear BMPS:

i)____ Two (2) borings or pits up to 500 linear feet, and

ii) ___ One (1) additional boring or pit per additional 500 linear feet of trench

iii)____ Boring or pit locations distributed and sufficient to determine soil variability

# ***Soil Investigation Report Submittal Checklist***

6)_____ Borings or test pits advanced to the depth of the limiting layer or a minimum of three (3) feet below bottom of the proposed facility, whichever is encountered first.

7)_____ Borehole or test pit logs including the following information:

a) ____ Project name

b) ____ Name of individual collecting the field data

c) ____ Date field data was collected

d) ____ Type of boring or test pit excavation method and equipment used

e) ____ Air temperature and precipitation, including significant precipitation prior to investigation

f) ____ Elevation of ground at boring location based on site benchmark

g) ____ Visual description of soil profile layers, and depths below grade encountered

h) ____ Sample numbers

i) ____ Depths to any indications of instability such as cave in, sloughing, flowing sands, or obstructions

j) ____ Blow counts if Standard Penetration Test (SPT) borings are performed

k) ____ Depth of seasonal high water table indicators such as mottling

l) ____ Depth of encountered free water during and after excavation

m) ____ Depth to bedrock if encountered

n) ____ General observations

o) ____ Testing standards

8)_____ Depth and type of field testing performed. A summary of the laboratory testing conducted, if applicable.

9)_____ Project soil and rock conditions including a description of the soil and rock units encountered, and how the units tie into the site geology.

10)____ Description of groundwater conditions, including the identification of any of the following:

a) ____ Confined aquifers

b) ____ Artesian pressures

c) ____ Perched water tables

d) ____ Potential seasonal variations, if known

e) ____ Any influences on the ground water levels observed

f) ____ Direction and gradient of groundwater, if known

11)____ Discussion of rock structure, if applicable, including but not limited to:

a) ____ The results of any field structure mapping using photographs as needed,

b) ____ Joint condition

c) ____ Rock strength

d) ____ Potential for seepage.

12)____ Summary of geological hazards identified and their impact on the project design, if any. Description of the location and extent of the geological hazard.

13)____ For analysis of unstable slopes including existing settlement areas, cuts, and fills, include background regarding the analysis approach, assessment of failure mechanisms, and determination of design parameters. Include a description of any back-analyses conducted, the results of those analyses, comparison of those results to any laboratory test data obtained, and the conclusions made regarding the parameters to be used for final design.

14)____ Geotechnical recommendations for structural earthwork including:

a) ____ Embankment design recommendations, as applicable, including but not limited to the following:

i)____ Slope required for stability

ii) ___ Need and extent of removal of any unsuitable materials beneath the proposed fills

iii)____ Any other measures that need to be taken to provide a stable embankment

iv) ___ Embankment settlement magnitude and rate

b) ____ Cut design recommendations, as applicable, including but not limited to the following:

i)____ Slope required for stability

ii) ___ Seepage and piping control

iii)____ Erosion control measures

iv) ___ Any special measures required to provide a stable slope

c) ____ Determination of adequacy of excavated material for use as structural fill or spoil

d) ____ Data for structural designs of BMP outlet works

15)____ Long-term or construction monitoring needs, if applicable.

a) ____ Recommendation for types of instrumentation needed to evaluate long-term performance or to control construction

b) ____ Specify the reading schedule required

c) ____ Specify how the data should be used to control construction or to evaluate long-term performance

d) ____ Specify the zone of influence for each instrument.

16)____ Address issues of construction staging, shoring needs and potential installation difficulties, temporary slopes, potential foundation installation problems, earthwork constructability issues, and dewatering, as applicable.

17)____ Appendices to support geotechnical recommendations.

# ***Soil Investigation Report Submittal Checklist***

II._____ **Infiltration Test Reports.** The following information, as applicable, should be submitted for all stormwater management BMPs that rely upon infiltration.

18)____ Description of approved infiltration testing method.

a) ____ Field Permeability Testing conducted in accordance with ASTM-D5126 "Comparison of Field Methods for Determining Hydraulic Conductivity in the Vadose Zone".

b) ____ Single Ring or Double Ring Infiltrometer test method

c) ____ Cased Borehole Permeameter test method

i)____ Department or Delegated Agency approval granted prior to conducting the test

ii) ___ Minimum four (4) inch diameter casing used

d) ____ Any deviation from infiltration testing procedures approved by the Department or Delegated Agency noted in the report.

19)____ Summary table of location of test, depth of test, elevation of test if available and field verified infiltration rate.

20)____ The minimum number of field measured infiltration tests are based on the proposed facility's dimensions as follows:

a) ____ For an infiltration trench with less than 10,000 square feet of impervious drainage area:

i)____ One (1) test up to 500 linear feet, and

ii) ___ One (1) additional test per 250 linear feet of trench, and

iii)____ Sufficient to determine variability.

b) ____ For an infiltration trench with greater than 10,000 square feet of impervious drainage area:

i)____ One (1) test up to 250 linear feet, and

ii) ___ One (1) additional test per 250 linear feet of trench, and

iii)____ Sufficient to determine variability.

c) ____ For an infiltration trench used with roadway perforated pipe layouts:

i)____ One (1) test up to 500 linear feet, and

ii) ___ One (1) additional test per 500 linear feet of trench, and

iii)____ Sufficient to determine variability.

d) ____ For an infiltrating bioretention system:

i)____ One (1) test for the first 8,000 square feet

ii) ___ Two (2) tests for up to 16,000 square feet

iii)____ Three (3) tests for up to 25,000 square feet

iv) ___ One (1) additional test for each additional 25,000 square feet beyond the first 25,000 square feet

v)____ Test locations distributed within the facility and sufficient to determine variability.

e) ____ For a surface infiltration basin:

i)____ One (1) test for the first 8,000 square feet

ii) ___ Two (2) tests for up to 16,000 square feet

iii)____ Three (3) tests for up to 25,000 square feet

iv) ___ One (1) additional test for each additional 25,000 square feet beyond the first 25,000 square feet.

v)____ Test locations distributed within the facility and sufficient to determine variability.

f) ____ For a subsurface infiltrating practice:

i)____ One (1) test per infiltration area

ii) ___ One (1) additional test for every 8,000 square feet of infiltration area

iii)____ Test locations distributed within the facility and Sufficient to determine variability

21)____ Infiltration test log, including:

a) ____ Name and license number of individual performing test. Individuals in responsible charge of infiltration testing possesses a Class D On-Site License issued by DNREC Division of Water Groundwater Discharges Section or be licensed in the State of Delaware as a Professional Engineer or Professional Geologist.

b) ____ Date test was performed

c) ____ Type of test method

d) ____ Air temperature and precipitation

e) ____ Depth of test below ground surface and elevation. Separation to a limiting layer such as bedrock or groundwater of at least two (2) feet maintained.

f) ____ Diameters of boring and casing

g) ____ Depth of casing penetration

h) ____ Time and depth from reference point for each time increment.

i)____ A saturation period of one hour or a drop of 12 inches or 30.5 centimeters achieved. Saturation period not used in determining field verified infiltration rate.

ii)____ After the saturation period, a minimum of two (2) test periods completed or until at least two (2) consecutive test periods are consistent and achieve a stabilized infiltration rate. Each test period has a maximum reading interval of 15 minutes and meets one (1) of the following criteria:

(1)____ A minimum of one hour as determined by the sum of the interval times

(2)____ A drop of at least 12 inches in 15 minutes or less for a minimum of 30 minutes as determined by the sum of the interval times

iii)____ Stabilized infiltration rate met as defined as one of the following:

(1)____ A difference of 0.25 inches or less of drop between the highest and lowest reading of four (4) consecutive readings for infiltration rates greater than two (2.0) inches per hour

(2)____ A difference of 0.125 inches or less of drop between the highest and lowest reading of four (4) consecutive readings for infiltration rates equal to or less than two (2.0) inches per hour.

iv)____ When using the constant head test method, water level inside the casing maintained at a constant level or refilled to the starting level after each reading throughout the test period at no more than 15 minute intervals.

v)____ When using the falling head test method each test period starts with the same initial head.

22)____ Infiltration rate graph for each test charting the field verified infiltration rate versus elapsed time of test. Append to each graph a table of the testing results. The field verified infiltration rate is the final steady state reading of the test performed.

23)____ Geotechnical recommendations for each stormwater management facility, including the following:

a) ____ Recommended design infiltration rate based on the following:

i)____ Apply a minimum factor of safety of 2.0 to field results from Single Ring or Double Ring Infiltrometer testing

ii)____ Apply a minimum factor of safety of 2.5 to field results from Cased Borehole Permeameter testing.

iii)____ Provide an elevation range over which the recommended design rates are applicable.

iv)____ The maximum design infiltration rate is less than or equal to 15 inches per hour.

b) ____ Impact of infiltration on adjacent facilities

c) ____ Effect of infiltration on slope stability

d) ____ If the facility is located on a slope, stability of slopes within the facility

e) ____ Foundation bearing resistance

f) ____ If steady state conditions for a given test are not achieved, provide an explanation as to why steady state could not be achieved and the professional's opinion regarding the use of the results for design purposes. If steady state is not achieved for a given test and a reasonable professional opinion is not provided, the Department or Delegated Agency may require additional testing.

# ***Soil Investigation Report Submittal Checklist***

III._____ **Geotechnical Reports for Embankments.** The following information, as applicable, should be submitted for all stormwater management BMPs containing an embankment.

24)____ The signature, seal and date of a professional engineer licensed in the State of Delaware.

25)____ Subsurface Exploration

a) ____ Explorations every 200 feet on center along the length of the embankment.

b) ____ Unless bedrock is encountered at a shallower depth, explorations at a depth twice the proposed height from bottom of pond to top of embankment.

c) ____ If bedrock is encountered, a minimum five (5) foot rock core performed. If organic, plastic, or soils with an actual or estimated N-value less than four (4) are encountered, extended exploration to a depth of four (4) times the proposed embankment height.

d) ____ If there is a potential for a significant groundwater gradient beneath an embankment or surface water levels are significantly higher on one side of the embankment than the other, the effect of reduced soil strength caused by water seepage has been evaluated.

e) ____ Seepage effects considered when an embankment is placed on or near the top of a slope that has known or potential seepage through it.

26)____ Summary of design analyses, which provide the project description and basis of the design recommendations.

27)____ Summary of stability analyses, which provide the results of the stability analyses performed for the given embankment dimensions.

28)____ Summary of settlement analyses, including design assumptions and settlement results for above-grade embankments.

29)____ Design recommendations for embankment construction identifying the following actions:

a) ____ Construction procedures for placement of material in embankment widening areas

b) ____ Embankment cut-off and core trench materials for above-grade embankments

c) ____ Special notes for excavation of unsuitable material, with specific backfill requirements

d) ____ Specific measures required prior to placing embankment material

e) ____ Installation of appropriate erosion control and vegetative cover