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

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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
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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.
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 RingInfiltrometer 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
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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
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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.
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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