



City of Wilmington Department of Public Works  
Louis L. Redding City/County Building  
800 French St. - 6th Floor  
Wilmington, DE 19801

### **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.

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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

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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