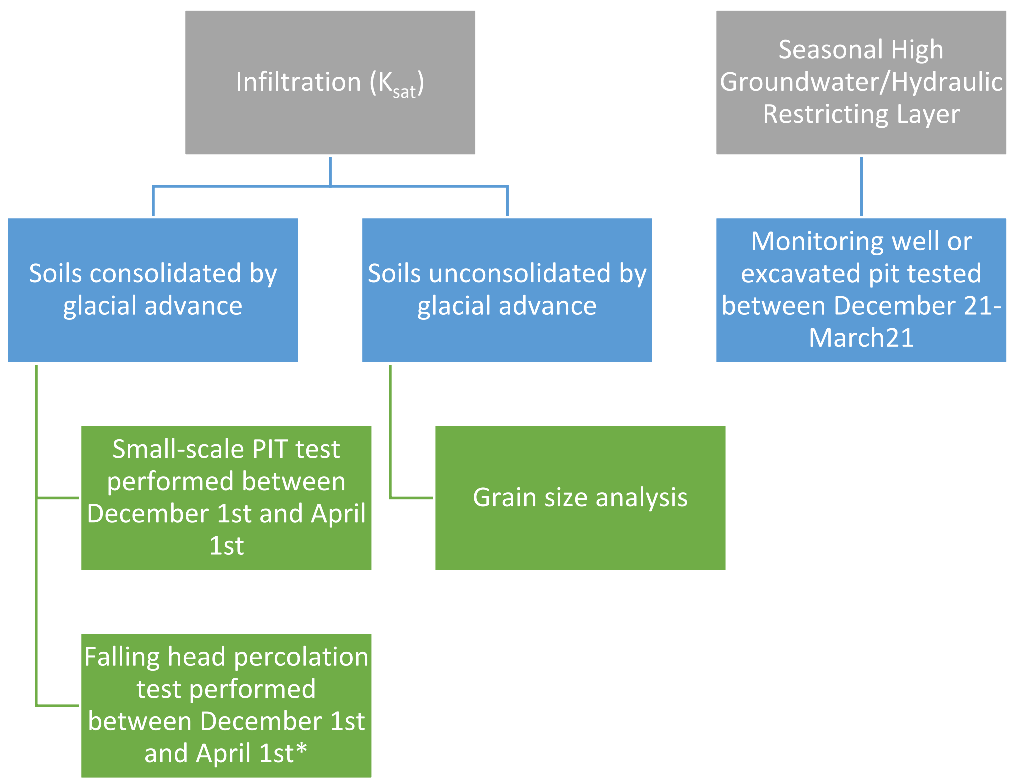
# Factsheet

# Geotechnical Testing Procedures

This factsheet is for Geotechnical professionals performing geologic testing in the City of Puyallup for projects who trigger stormwater minimum requirements #1-5. In addition to general soil characteristics, the State of Washington is concerned primarily with soil infiltration and groundwater or hydraulic restricting layers when designing LID facilities. Use the flow chart below to determine which test methods are acceptable for the subject site. Refer to the 2012 Stormwater Management Manual for Western Washington for further information.




***The Falling Head Percolation test is only permitted for use with single family infill lots. This test cannot be used to demonstrate infeasibility of infiltration practices.**

### *Groundwater/Hydraulic Restricting Layer*

Excavate monitoring well or pit 1 foot below estimated bottom of LID facility. If using one test location for multiple facilities, excavate to a depth 1 foot below the lowest expected bottom of the proposed LID facilities. For the purposes of LID design, the stormwater manual considers a hydraulic restrictive layer to be a soil layer with a Ksat less than 0.3in/hr.

### *Small-Scale PIT Test Method*

1. Excavate the test pit to the estimated surface elevation of the proposed infiltration facility. In the case of bioretention, excavate to the estimated elevation at which the imported soil mix will lie on top of the underlying native soil. For permeable pavements, excavate to the elevation at which the imported subgrade materials, or the pavement itself, will contact the underlying native soil. If the native soils (road subgrade) will have to meet a minimum subgrade compaction requirement, compact the native soil to that requirement prior to testing. Note that the permeable pavement design guidance recommends compaction not exceed 90% - 92%. Finally, lay back the slopes sufficiently to avoid caving and erosion during the test. Alternatively, consider shoring the sides of the test pit.
2. The horizontal surface area of the bottom of the test pit should be 12 to 32 square feet. It may be circular or rectangular, but accurately document the size and geometry of the test pit.
3. Install a vertical measuring rod adequate to measure the ponded water depth and that is marked in half-inch increments in the center of the pit bottom.
4. Use a rigid pipe with a splash plate on the bottom to convey water to the pit and reduce side-wall erosion or excessive disturbance of the pond bottom. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates. Use a 3-inch diameter pipe for pits on the smaller end of the recommended surface area, and a 4-inch pipe for pits on the larger end of the recommended surface area.
5. Pre-soak period: Add water to the pit so that there is standing water for at least 6 hours. Maintain the pre-soak water level at least 12 inches above the bottom of the pit.
6. At the end of the pre-soak period, add water to the pit at a rate that will maintain a 6-12 inch water level above the bottom of the pit over a full hour. The depth should not exceed the proposed maximum depth of water expected in the completed facility.
7. Every 15 minutes, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point (between 6 inches and 1 foot)

on the measuring rod. The specific depth should be the same as the maximum designed ponding depth (usually 6 – 12 inches).

8. After one hour, turn off the water and record the rate of infiltration (the drop rate of the standing water) in inches per hour from the measuring rod data, until the pit is empty.
9. A self-logging pressure sensor may also be used to determine water depth and drain-down.
10. At the conclusion of testing, over-excavate the pit to see if the test water is mounded on shallow restrictive layers or if it has continued to flow deep into the subsurface. The depth of excavation varies depending on soil type and depth to hydraulic restricting layer, and is determined by the engineer or certified soils professional. The soils professional should judge whether a mounding analysis is necessary.

**Data Analysis:**

Calculate and record the saturated hydraulic conductivity rate in inches per hour in 30 minutes or one-hour increments until one hour after the flow has stabilized.

*Note: Use statistical/trend analysis to obtain the hourly flow rate when the flow stabilizes. This would be the lowest hourly flow rate.*

**Correction Factors:**

Site Variability and number of test locations used ($CF_v$) = 0.33 to 1.0

Total Correction Factor = $CF_v$ X 0.50 X 0.90

$K_{sat}$ design* = $K_{sat}$ initial X Total Correction Factor

*When using $K_{sat}$ for bioretention design, apply factor of safety of 2.

## *Grain Size Analysis*

For bioretention facilities, analyze each defined layer below the top of the final bioretention area subgrade to a depth of at least 3 times the maximum ponding depth, but not less than 3 feet. For permeable pavement, analyze for each defined layer below the top of the final subgrade to a depth of at least 3 times the maximum ponding depth within the base course, but not less than 3 feet. If the licensed professional conducting the investigation determines that deeper layers will influence the rate of infiltration for the facility, soil layers at greater depths must be considered when assessing the site's hydraulic conductivity characteristics. Use the following equation to determine the $K_{sat}$ for each soil layer.

$$\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$$

Where, $D_{10}$, $D_{60}$ and $D_{90}$ are the grain sizes in mm for which 10 percent, 60 percent and 90 percent of the sample is more fine and $f_{fines}$ is the fraction of the soil (by weight) that passes the number-200 sieve ($K_{sat}$ is in cm/s).

If the soil layer being characterized has been exposed to heavy compaction (e.g., due to heavy equipment with narrow tracks, narrow tires, or large lugged, high pressure tires) the hydraulic conductivity for the layer could be approximately an order of magnitude less than what would be estimated based on grain size characteristics alone (Pitt, 2003). In such cases, compaction effects must be taken into account when estimating hydraulic conductivity.

For clean, uniformly graded sands and gravels, the reduction in $K_{sat}$ due to compaction will be much less than an order of magnitude. For well graded sands and gravels with moderate to high silt content, the reduction in $K_{sat}$ will be close to an order of magnitude. For soils that contain clay, the reduction in $K_{sat}$ could be greater than an order of magnitude.

Use the layer with the lowest $K_{sat}$ for designing bioretention facilities or permeable pavements.

**Correction Factors:**

Site Variability and number of test locations used ($CF_v$) = 0.33 to 1.0

Total Correction Factor = $CF_v$ X 0.40 X 0.90

$K_{sat}$ design* = $K_{sat}$ initial X Total Correction Factor

*When using $K_{sat}$ for bioretention design, apply factor of safety of 2.

## *Falling Head Percolation Test*

Refer to the Pierce County Stormwater and Site Development Manual (rev. December 2015) for procedures for the falling head percolation test.

# Worksheet A2

## Geotechnical Testing Results

Applicant must submit this worksheet completed by a professional soil scientist (or by other suitably trained persons working under the supervision of a professional engineer, geologist, or hydrogeologist) along with their stormwater site plan. The applicant must also submit supported documentation for the findings below including soil logs, test results, etc.

Geotechnical Engineer: ___________________________________

Firm: _________________________________________________

Email: ________________________________________________

Phone Number: __________________________________________

Professional's Seal

Description of Soils from Soils Log(s):

**Infiltration Testing:**

Type of test performed:

_____________________________________________

Date test was performed: ______________________

**Correction factors:**

Total Correction factor = ______ X ______ X 0.9

Total Correction factor = _______

Ksat measured = ________ in/hr

Ksat design* = ________ X ________in/hr

Ksat design = _________in/hr

*When using $K_{sat}$ for bioretention design, apply factor of safety of 2.

**Groundwater/Hydraulic Restrictive Layer Testing:**

Type of test performed:

_____________________________________________

Date test was performed: ______________________

Depth of test pit/monitoring well: ___________ ft

Observations (describe below):