Methods for Determining Infiltration Rates Checklist

This checklist reflects most, but not necessarily all of the items that will be reviewed by the Development Review. It is intended to be used as an aid by us to provide a consistent review of development work in Thurston County. All items may not be applicable in the review of each project and all items of concern to this office may not be covered on this checklist.

Y	N	
		APPLICATIONS
		Method 1 – Field Testing
		U.S. EPA Falling Head Percolation Test Procedure applies to all infiltration facilities, but may not be used to demonstrate infeasibility of bioretention, permeable pavement, or rain gardens in meeting Minimum Requirement #5.
		Large-Scale Pilot Infiltration Test (PIT) applies to infiltration facilities with drainage areas greater than 1 acre, and may be used to demonstrate infeasibility of bioretention, permeable pavement, or rain gardens in meeting Minimum Requirement #5.
		Small-Scale Pilot Infiltration Test (PIT) applies to infiltration facilities with drainage areas less than 1 acre, and may be used to demonstrate infeasibility of bioretention, permeable pavement, or rain gardens in meeting Minimum Requirement #5.
		Method 2 – Soil Property Relationship (USDA Soil Textural Classification)
		Soil Property Relationships (USDA Soil Textural Classification) applies to projects sites that trigger Core Requirements #1 through #5 (not #1 through #10) AND are underlain by hydrologic soil group A soils (as defined by the NRCS Web Soil Survey and field verified by a qualified professional). USDA Soil Textural Classification may not be used to demonstrate infeasibility of bioretention, permeable pavement, or rain gardens in meeting Core Requirement #5.
		Method 3 – Soil Grain Size Analysis
		Soil Grain Size Analysis applies to project sites that are underlain by type A soils and may not be used to demonstrate infeasibility of bioretention, permeable pavement, or rain gardens in meeting Core Requirement #5.
		PROCEDURES
		Method 1
		Measure the infiltration rate of the underlying soil using: • U.S. EPA falling head percolation test procedure as modified for Thurston County, or • Double ring infiltrometer test (ASTM D3385, not presented in the DDECM Appendix III-A), or • Ecology large and small scale Pilot Infiltration Test (PIT) described below and presented in the 2019 Ecology *Stormwater Management Manual for Western Washington*.

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		Perform number of tests in accordance with specific BMP requirements.
		Soaking Period – Fill the test hole or apparatus with water and maintain at depths above the test elevation for the saturation periods specific for the appropriate test.
		Determine the Infiltration Rates – Following the saturation period, determine the infiltration rate in accordance with the specified test procedures.
		Design Infiltration Rate – Apply an appropriate safety factor.
		Safety Factor
		For bioretention, permeable pavement, and rain gardens, refer to ***Field and Design Procedures for Bioretention, Permeable Pavement, Rain Gardens, and Downspout Infiltration Systems Checklist***.
		For all other infiltration facilities, the safety factor is calculated using the following equation: $I_{design} = I_{measured} \times F_{testing} \times F_{geometry} \times F_{plugging}$ $F_{testing}$ • For the full scale PIT method, $F_{testing} = 0.75$; • For the small-scale PIT method, $F_{testing} = 0.50$ • For smaller-scale infiltration tests such as the double-ring infiltrometer test, $F_{testing} = 0.40$ • For grain size analysis, $F_{testing} = 0.40$. $F_{geometry} = 4\ D/W + 0.05$ • D = depth from the bottom of the proposed facility to the maximum wet season water table or nearest impervious layer, whichever is less. • W = width of facility $F_{plugging}$ • 0.7 for loams and sandy loams • 0.8 for fine sands and loamy sands • 0.9 for medium sands • 1.0 for coarse sands or cobbles.
		The design infiltration rate may not exceed 30 inches/hour.
		Falling Head Percolation Test Procedure (as Modified for Thurston County)
		Space tests uniformly throughout the area. For larger facilities or if soil conditions are highly variable, more tests may be required.
		Preparation of Test Hole
		The diameter of each test hole is 8 inches.
		The depth of each test is to the proposed depths of the absorption systems or to the most limiting soil horizon.
		To expose a natural soil surface, scratch the bottom of the hole with a sharp pointed instrument and remove the loose material from the test hole.
		Set a PVC pipe (6 inch-inner-diameter, 4 foot long) into the hole and press into the soil 6 inches.

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		Place 2 inches of 0.5- to 0.75-inch rock in the pipe to protect the bottom from scouring when water is added.
		Soaking Period
		In sandy soils with little or no clay, soaking is not necessary (proceed to Measurement of the Percolation Rate).
		Carefully fill the pipe with at least 12 inches of clear water. Maintain the depth of water for at least 4 hours (and preferably overnight if clay soils are present).
		If, after filling the pipe twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately (proceed to Measurement of the Percolation Rate).
		Measurement of the Percolation Rate
		Except for sandy soils, make percolation rate measurements 15 hours but no more than 30 hours after the soaking period began.
		Adjust the water level to 6 inches above the gravel (or 8 inches above the bottom of the hole). At no time during the test is the water level allowed to rise more than 6 inches above the gravel.
		Immediately after adjustment, measure the water level from a fixed reference point to the nearest 1/16th-inch at 30 minute intervals. Continue the test until two successive water level drops do not vary by more than 1/16-inch within a 90 minute period. At least three measurements are to be made.
		After each measurement, readjust the water level to the 6 inch level.
		Use the last water level drop to calculate the percolation rate.
		In sandy soils or soils in which the first 6 inches of water added after the soaking period seeps away in less than 30 minutes, make water level measurements at 10 minute intervals for a 1 hour period. Use the last water level drop to calculate the percolation rate.
		Percolation Rate Calculation
		Calculate the percolation rate for each test site by dividing the time interval used between measurements by the magnitude of the last water level drop. This calculation results in a percolation rate in minutes/inch. To determine the percolation rate for the area, average the rates obtained from each hole. (If tests in the area vary by more than 20 minutes/inch, variations in soil type are indicated. Under these circumstances, percolation rates should not be averaged.)
		To compute the design infiltration rate (I_{design}), adjust the final percolation rates by the appropriate safety factors outlined above.
		Large-Scale Pilot Infiltration Test (PIT)
		Preparation of Test Hole
		Testing should occur between December 1 and April 1.
		The horizontal and vertical locations of the PIT shall be surveyed by a licensed land surveyor and accurately shown on the design drawings.
		Excavate the test pit to the depth of the bottom of the proposed infiltration facility.
		Lay back the slopes sufficiently to avoid caving and erosion during the test, or consider shoring the sides of the test pit.

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		The horizontal surface area of the bottom of the test pit should be approximately 100 square feet.
		Accurately document the size and geometry of the test pit.
		Install a vertical measuring rod (minimum 5 feet long) marked in 0.5-inch increments in the center of the pit bottom.
		Use a rigid 6-inch diameter pipe with a splash plate on the bottom to convey water to the pit.
		Soaking Period
		Pre-soak: Add water to the pit at a rate that will maintain a water level between 6 and 12 inches above the bottom of the pit. *Note: For infiltration facilities serving large drainage areas, designs with multiple feet of standing water can have infiltration tests with greater than 1 foot of standing water. The depth must not exceed the proposed maximum depth of water expected in the completed facility.*
		Pre-soak: Every 15 to 30 minutes, record the cumulative volume and instantaneous flow rate (in gallons per minute) necessary to maintain the water level at the same point on the measuring rod.
		Stabilization: Add water to the pit until 1 hour after the flow rate into the pit has stabilized while maintaining the same pond water level (usually 6 hours). The total of the pre-soak time plus 1 hour after the flow rate has stabilized should be no less than 6 hours.
		Measurement of the Infiltration Rate
		After the flow rate has stabilized for at least 1 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.
		Calculate the Design Infiltration Rate
		Calculate and record the infiltration rate in inches per hour in 30 minute or 1 hour increments until 1 hour after the flow has stabilized. Use statistical/trend analysis to obtain the hourly flow rate when the flow stabilizes.
		To compute the design infiltration rate (I_{design}), adjust the final measured infiltration rates by the appropriate safety factors outlined above.
		Small-Scale Pilot Infiltration Test
		Preparation of Test Hole
		Excavate the test pit to the estimated surface elevation of the proposed infiltration facility.
		Lay back the slopes sufficiently to avoid caving and erosion during the test, or consider shoring the sides of the test pit.
		The horizontal surface area of the bottom of the test pit should be 12 to 32 square feet.
		Accurately document the size and geometry of the test pit.
		Install a vertical measuring rod that is marked in 0.5-inch increments in the center of the pit bottom.
		Use a rigid pipe with a splash plate on the bottom to convey water to the pit. 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.

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		Soaking Period
		Pre-soak: Add water to the pit so that there is standing water for at least 6 hours. Maintain the water level at least 12 inches above the bottom of the pit.
		Pre-soak: 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.
		Stabilization: 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 – 12 inches) on the measuring rod. The specific depth should be the same as the maximum designed ponding depth (usually 6 – 12 inches).
		Measurement of the Infiltration Rate
		After the flow rate has stabilized for 1 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. A self-logging pressure sensor may also be used to determine water depth and drain-down.
		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 soils professional should judge whether a mounding analysis is necessary.
		Calculate the Design Infiltration Rate
		Calculate and record the infiltration rate in inches per hour in 30 minutes or 1 hour increments until 1 hour after the flow has stabilized. Use statistical/trend analysis to obtain the hourly flow rate when the flow stabilizes.
		To compute the design infiltration rate (I_{design}), adjust the final measured infiltration rates by the appropriate safety factors outlined above.
		Method 2 – USDA Soil Textural Classification
		Conduct the grain size distribution test in accordance with the USDA test procedure (Soil Survey Manual, USDA, October 1993, page 136)
		Soil passing the US #10 sieve may be used to determine percentages of sand, silt, and clay for use in Figure A.1 (see end of this checklist).
		Correction factors are only reduced with prior approval from the County (to a minimum of 2.0) if there is little soil variability, there will be a high degree of long-term facility maintenance, and there is adequate pretreatment to reduce total suspended solids in influent stormwater.
		Use the gradation from soil samples and the textural analysis to determine the short-term (field) infiltration rates, required correction factors, and design (long-term) infiltration rates (see Table A.1 below).
		Method 3 – Soil Grain Analysis
		For infiltration basins and trenches, perform the grain size analysis for each defined layer below the infiltration facility to a depth below the facility bottom of 2.5 times the maximum depth of water in the pond, but not less than 6 feet.

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		For large infiltration facilities serving drainage areas of 10 acres or more, soil grain size analyses is performed on layers up to 50 feet deep (or no more than 10 feet below the water table).
		For bioretention areas, each defined layer is analyzed 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 (1 meter).
		For permeable pavement, each defined layer is analyzed below the top of the final subgrade to a depth of at least 3 times the maximum ponding depth within the base (reservoir) course, but not less than 3 feet (1 meter).
		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 may be considered when assessing the site's hydraulic conductivity characteristics.
		Use the following relationship to determine the initial hydraulic conductivity: $$\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{\text{fines}}$$ 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 US #200 sieve (K_{sat} is in cm/s).
		Compaction effects must be taken into account when estimating hydraulic conductivity where applicable.

Table A.1. Recommended Infiltration Rates Based on USDA Soil Textural Classification.

	Short-Term Infiltration Rate (in./hr)[1]	Correction Factor CF	Estimated Design (Long-term) Infiltration Rate (in./hr)
Clean sandy gravels and gravelly sands (i.e., 90% of the total soil sample is retained in the US #10 sieve)	20	2	10
Sand	8	4	2
Loamy Sand	2	4	0.5
Sandy Loam	1	4	0.25
Loam	0.5	4	0.13

Source: Stormwater Management Manual for Western Washington (Ecology 2005).

1 From WEF/ASCE (1998).

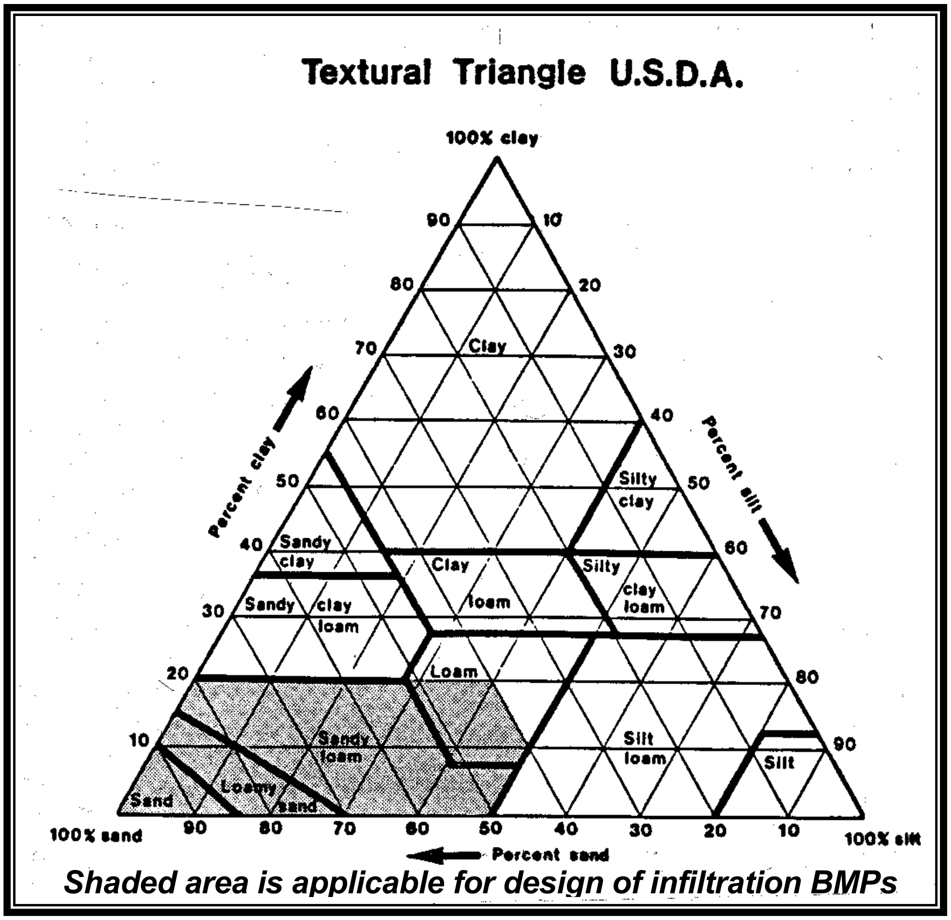

Figure 1.A. USDA Textural Triangle