INFILTRATION TRENCH

(No. 1007)

Wisconsin Department of Natural Resources
Wisconsin Department of Safety and Professional Services
Conservation Practice Standard

I. Definition

An infiltration trench is a stormwater management practice that collects and stores runoff until it can infiltrate into the subsurface soil. Infiltration trenches typically are longer than they are wide, are less than 15 feet in width, and are intended to promote subsurface infiltration. Trenches are commonly filled with properly graded media that will promote infiltration and reduce pollutants discharged to surface waters, such as sediment, debris and nutrients. Infiltration trenches may be used as a detention feature in a stormwater management plan.

II. Purpose

This practice may be applied individually or as part of a structural stormwater management system to support one or more of the following purposes:

- Enhance stormwater infiltration to recharge groundwater.
- Reduce discharge of stormwater pollutants to surface and ground waters.
- Decrease runoff peak flow rates and volumes.
- Preserve stream base flow.
- Reduce runoff temperature.

III. Conditions Where Practice Applies

The infiltration trench stormwater management practice applies to drainage areas generally less than 5 acres in size where increased stormwater runoff volumes, peak flow discharges or thermal effects are a concern and where the area is suitable for infiltration (see ch. NR 151, Wis. Adm. Code section on post-construction performance standards for new development and re-development; WDNR Conservation Practice Standard 1002, Site Evaluation for Stormwater Infiltration; and s. SPS 382.365, Wis. Adm. Code). Infiltration trenches are best suited to provide onsite stormwater management opportunities for receiving runoff from *source areas* such as landscaped areas and rooftops. For runoff source areas with greater potential for pollutants, such as parking lots, streets and commercial sites, pretreatment for water quality shall be incorporated in the site design prior to the infiltration trench.

IV. Federal, State and Local Laws

Users of this standard shall be aware of potentially applicable federal, state and local laws, rules, regulations or permit requirements governing stormwater management practices. This standard does not contain the text of federal, state, or local laws.

V. General Criteria

A. Site Criteria – Screening criteria in the WDNR Conservation Practice Standard 1002, Site Evaluation for Stormwater Infiltration, shall be followed. In addition, the following site criteria shall be met.

1. The closest edge of the infiltration trench shall not be located less than 10 feet horizontally from a building foundation unless it can be demonstrated the trench will not be *hydraulically connected* to the foundation or pavements such that it causes negative impacts. These negative impacts may include: water in basements; short circuiting of the infiltration process; and foundation or pavement instability.
2. The discharge from the infiltration trench shall not cause side slope seepage that contributes to hill slope failure or increases erosion on down gradient slopes.
3. For ground surface, sloped areas within 20 feet upgradient to the infiltration trench shall be less than 20%, and greater than 1% for vegetated area to ensure positive flow toward the device. For sloped areas greater than 20%, a slope stability analysis shall be completed.
4. The infiltration trench shall be a minimum of 50 feet from any *POWTS* dispersal cell so as to not cause negative impacts such as cross contamination or hydraulic overloading, unless it can be demonstrated

that the trench is not hydraulically connected to the POWTS.

5. An infiltration trench shall meet the requirements in ch. NR 151, Wis. Adm. Code, post-construction performance standards with regard to groundwater limitations and source area restrictions.

B. Design

1. Pretreatment Practices – Pretreatment shall be provided prior to infiltration to remove the following percentage of total suspended solids, on an average annual basis, based on the following land uses.
    a. 60% for one- or two-family residential and associated roads.
    b. 80% for commercial, industrial, institutional, residential equal to or greater than 3 units and associated roads.
    c. Rooftop runoff discharging underground to the trench shall have an accessible means to remove debris larger than ½ inch in size.
2. Infiltration Rates – For proper selection of design infiltration rates, see WDNR Conservation Practice Standard 1002, Site Evaluation for Stormwater Infiltration.
3. Dimensions
    a. The storage volume of an infiltration trench is a function of depth, width, length, and *porosity* of the storage medium. The maximum width shall be no more than 15 feet, and the depth shall be less than the length or width, whichever is less. An infiltration trench that does not meet these dimension criteria may be considered a *Class V injection well*. The maximum drain down time of 72 hours, after the storm event, is a function of the depth and design infiltration rate.
    b. Effective Infiltration Area – Only the bottom area of the infiltration trench shall be used to determine the *effective infiltration area*.
    c. Slopes – The slope of the bottom of the infiltration trench shall be 0%.
4. Infiltration Trenches
    a. Installation – The longest dimension of an infiltration trench shall be oriented parallel to the surface contour. Infiltration trenches may be designed in series if the minimum horizontal separation is the greater of the trench depth or width, with a minimum of 4 feet.
    b. Distribution – A means, such as surface grading, piping or surface *level spreaders*, shall be provided to disperse stormwater along the length of the infiltration trench to promote even distribution. The slope of gravity flow distribution laterals shall be less than 0.4%. When distribution laterals are used, cleanouts shall be installed with a separation distance not to exceed 100 feet. Distribution laterals shall meet the specifications of Table 384.30-4 in ch. SPS 384, Wis. Adm. Code.
    c. Storage Cell – Stone aggregate or a *gravel-less system* used as a dispersal and storage medium in a stormwater infiltration trench, shall meet one of the following:
        i. For stone aggregate:
            a) Conform to ASTM C33 for coarse aggregate prior to washing.
            b) Be washed to remove fine material.
            c) Be no less than ½-inch and no more than 2½-inch in size.
            d) Have a hardness value of at least 3 on Moh's Scale of Hardness.
        ii. For a gravel-less system, it shall be an acceptable alternative approved by the Wis. Dept. of Safety and Professional Services.
        iii. For Open Graded Base, meet Section 310 of the Standard Specifications for Highway and Structure Construction, Wis. Dept. of Transportation.
    d. Overflow – An overflow method shall be designed to convey stormwater from the trench during peak flow conditions.

The overflow shall be designed to safely convey the 100-year, 24-hr. storm event for the tributary area the infiltration trench serves.

e. Observation Pipe – An observation pipe shall be installed in every infiltration trench to monitor the level of ponded water at the bottom of the trench. At least one observation pipe shall be installed for every 200 linear feet of trench, and near the center of the trench. Pipes shall be provided with a means of anchoring to keep the pipe vertical and at a steady elevation. Observation pipes extend from the bottom of the trench for stone aggregate systems, or from the inside of infiltration chambers to a point at or above finish grade. The lowest portion of the observation pipe for stone aggregate systems shall be slotted. The slots shall be ¼-inch to ½-inch in width, 6 inches minimum in length, and located on opposite sides of the pipe. Observation pipes for infiltration chamber systems shall be attached to the chambers in accordance with the chamber manufacturer's printed instructions and extend through the top of the infiltration chamber up to or above finish grade, and terminate with a removable watertight cap. All observation piping shall be a minimum nominal pipe size of 4 inches and shall conform to Table 384.30-1, s. 384.30, Wis. Adm. Code (see cross-section figure in App. B.)

Design Examples: Using Infiltration Trench Curves to Manually Calculate Size

The examples below describe the steps involved to manually calculate the size of an infiltration trench. The examples use the tools in App. B, including Chart 1—Target Stay-on Requirement, and the Infiltration Trench Design Curves graph (with description of assumptions).

Example 1

Size an infiltration trench for a 2-acre warehouse development. The pre-development CN for the site is 70. Site soils are sandy loam with an infiltration rate of 0.5 in/hr. The entire 2-acre development will drain to the proposed infiltration trench.

Step 1: Find the Target Stay-On Requirement (Chart 1)

For a commercial development and a CN of 70, the stay-on requirement is 16.5 in/yr.

Step 2: Use the infiltration trench design curves to determine the size of the trench as a percentage of the drainage area required to meet the stay-on requirement. The percentage of drainage area required for a 16.5 in/yr stay-on depth is approximately 3%.

For a 2-acre drainage area:

2 acres * 43,560 SF/acre * 0.03 = **2,614 SF** of trench.

Step 3: Given a max. drawdown time of 72 hours and an infiltration rate of 0.50 in./hr.

72 hrs. * 0.50 in./hr. = 36 inches = 3 feet deep

Example 2

Determine the volume of stormwater infiltrated by a 1,500 SF, 5-ft deep trench with a 1 acre drainage area. The soil type is loamy sand with an infiltration rate of 1.63 in/hr.

Step 1: Determine the % of drainage area:

1,500 SF/1 acre / (43,560 SF/acre) * 100 = 3.4%

Step 2: Use the infiltration trench design curves to determine the stay on depth and then multiply by the drainage area to determine the volume.

From the infiltration trench design curve, the stay-on depth for a % drainage area of 3.4% is 23.8 inches

23.8 in / 12 in/ft * 1 acre * 43,560 SF/acre = **86,393 CF**

C. Construction – A person trained and experienced in the construction, operation and maintenance of infiltration systems shall be responsible for construction. (See App. A, Field Inspection Checklist: Construction.) The following shall apply:

1. Construction shall be suspended if residual soil moisture contributes significantly to the potential for soil *smearing*, clumping or other forms of compaction.

2. An assessment of the active erosion in the drainage area to the infiltration trench shall be performed to determine when to bring the infiltration trench online. The trench shall be brought online when the area draining to the trench has been 90% stabilized. Stabilized means the upstream area is permanently vegetated or fully developed.

3. During construction, one of the following methods shall be used:

    a. Compaction Avoidance – Compaction of the area for the infiltration trench shall be avoided.

    b. Compaction Mitigation – If compaction or smearing occurs at the bottom of the active infiltration area, the effects of compaction shall be mitigated by incorporating two inches of coarse sand and refracturing to a depth of at least 12 inches. The active infiltration area shall be evaluated and documented for consistency with the original site investigation.

4. During construction, the elevation of the infiltration trench shall be surveyed for conformance to the grades, elevations, and specifications in the plan.

5. Excavate the infiltration trench to the design dimensions. Excavated materials shall be placed away from the trench sides to enhance trench wall stability. Care shall be taken to avoid sedimentation from entering the trench. Large tree roots must be trimmed flush with the trench sides in order to prevent fabric puncturing or tearing of the geotextile fabric during subsequent installation procedures. The side walls of the trench shall be roughened where sheared and sealed by heavy equipment.

6. Type DF geotextile fabric shall completely enclose the aggregate storage cell. Type DF geotextile fabric shall meet the requirements of Section 645, Wisconsin Standards and Specifications for Highway and Structures. The width of the geotextile fabric must include sufficient material to conform to trench perimeter irregularities and for a 6-inch minimum top overlap. Stones or other anchoring objects should be placed on the fabric at the edge of the trench to keep the fabric in place during windy periods. When overlaps are required between rolls, the uphill roll should lap a minimum of 24 inches over the downhill roll in order to provide a shingled effect. When gravel-less systems are used in a trench, the manufacturer's recommendations shall be followed with respect to use of geotextile filter fabric.

VI. Considerations

These are recommendations related to design that may enhance the use of, or avoid problems with, this conservation practice.

A. Pretreatment Options - For guidance, see Wisconsin Conservation Practice Standards for post-construction stormwater management. Also, see other treatment credits available through accepted modeling practices, such as SLAMM and P8.

B. Lawn Treatment – Application of lawn care nutrients and pesticides should be avoided on areas upstream of an infiltration trench.

C. Planting – To further enhance the removal of pollutants and help prevent compaction of the soil for an infiltration trench that receives runoff directly from the surface (e.g., sheet flow), consider vegetation. The use of prairie grass or other deep-rooted plants is encouraged. Dense vegetation will also reduce soil erosion. If the point of discharge to the infiltration trench is at the surface, and that surface is to be vegetated, then the topsoil used as a planting media should comply with the topsoil criteria in the WDNR Conservation Practice Standard 1004, Bioretention for Infiltration.

D. The DNR has created a technical note that may be used to size infiltration basins. The "Technical Note for Sizing Infiltration Basins and Bioretention Devices To Meet State Of Wisconsin Stormwater Infiltration Performance Standards" contains an approved method to determine the *target stay-on depth* and 12 design charts that can be used to size these basins for a variety of conditions. In addition, the technical note contains a reference to an infiltration model (RECARGA) that can also be used to determine effective infiltration area requirements for infiltration basins and bioretention devices. However, because the model has an evapotranspiration component in it, it should not be used to size an infiltration trench. The target stay-on-depth chart (see App. B, Chart 1) referred to in the Design Examples (see V.B) may be used to determine the appropriate quantity of stormwater that needs to be

infiltrated. Other models may be used if approved. The Technical Note can be accessed by visiting WDNR's website at: http://dnr.wi.gov and search for "stormwater."

E. Because infiltration trenches are conduits to groundwater, consider identifying the trench location with GPS coordinates and placing the coordinates in an emergency action plan for use in case of an unanticipated event such as a spill.

F. Create a separate financial account that is annually funded to provide for operation, maintenance and replacement.

VII. Plans, Specifications and Supporting Data

Plans, specifications and supporting data for the proper construction and installation of infiltration trenches shall be based on this technical standard and shall provide information to demonstrate the achievement of recharging local groundwater with clean stormwater. Plans, specifications and supporting data shall include:

A. A detailed site plan showing one-foot contour intervals defining the location, size and orientation of the infiltration trench and the total area draining to the infiltration trench. Site plans shall be at a scale sufficient for review and construction.

B. Construction drawings, specifications and details defining the infiltration trench's depth, width, length, elevations, construction materials, proposed construction schedule and sequence, and the required operation and maintenance plan.

C. Site data defining the specific infiltration rate of the soils at the location of the infiltration trench, in accord with WDNR Conservation Practice Standard 1002, Site Evaluation for Stormwater Infiltration.

D. Hydrologic and hydraulic data demonstrating the inflow to the infiltration trench, its infiltration capacity, and the capability of the installation to safely convey the 100-year, 24-hour rainfall peak discharge through the trench.

E. Narrative statements that define the party responsible for trench construction and maintenance.

VIII. Operation and Maintenance

Operation and Maintenance (O&M) plans for infiltration trenches shall at a minimum include the maintenance events and frequencies as outlined in the Inspection Checklists in App. A. Perform monthly physical inspections from April through October during the first year of operation. Also, O&M plans shall address the following:

A. Accumulated material or debris on the surface of the infiltration trench shall be removed immediately when discovered.

B. Snow shall not be placed in the effective infiltration area. It may be placed on the pretreatment area.

C. Any outlet structure, pipe or swale shall be cleaned of accumulated material or debris immediately when discovered, or at least twice each year.

D. Water depth in the observation pipe shall be measured and recorded twice per year at 72 to 80 hours after a rainfall event of 0.5 inches or more during a 24-hour period. Water depth in the observation pipe existing 72 hours after any storm event indicates additional monitoring may be needed to determine if maintenance or corrective action is necessary. The infiltration trench will be considered to be failing if observation of water depth shows that less than 90% of the trench's storage volume is available 72 hours after the last storm event.

IX. References

Dane County Erosion Control and Stormwater Management Manual, 2007.

California Stormwater BMP Handbook, 2003.

U.S. EPA, *Storm Water Technology Fact Sheet, Infiltration Trench*, 1999.

Minnesota Urban Small Sites BMP Manual, Infiltration Trenches.

Center for Watershed Protection, *Infiltration Trenches Fact Sheet*, 2001.

U.S. EPA, Stormwater Menu of BMPs, Infiltration Trench.

U.S. Department of Agriculture, Natural Resources Conservation Service, Illinois Urban Manual Practice Standard, Infiltration Trench, Code 847.

X. Definitions

Class V Injection Well (V.B.3.a) – Any bored, drilled, or driven shaft, or dug hole that is deeper than its widest surface dimension, or an improved sinkhole, or a subsurface fluid distribution system. Any infiltration device that has a subsurface pipe distribution system is considered to be a Class V

Injection Well and is subject to the requirements in NR 815, Wis. Adm. Code. *Note:* Private Onsite Wastewater Treatment Systems (POWTS) approved and regulated under ch. SPS 383, Wis. Adm. Code, are specifically exempt from the requirements of NR 815. Construction or use of a Class V Injection Well is subject to the reporting requirements in NR 815.08, Wis. Adm. Code.

Effective Infiltration Area (V.B.3.b) – The area of the bottom of a trench or infiltrative surface, not including the trench side walls.

Gravel-less system (V.C.6) – A manufactured product that has been approved by the Wis. Dept. of Safety and Professional Services as a storage and distribution material for an infiltration trench. An example of a gravel-less system is a leaching chamber or leaching system.

Hydraulically Connected (V.A.1) – Occurs when stormwater exits from an infiltration trench and flows to a point of concern such as a building foundation. Factors such as confining soil layers, flow gradients and distance affect whether the trench is hydraulically connected.

Level Spreader (V.B.4.b) – An outlet structure used to disperse or "spread" concentrated flow uniformly over a receiving area. A level spreader simulates sheet flow making treatment devices and infiltration devices more efficient and reduces the energy of the storm water, thereby reducing erosion and the movement of sediment.

POWTS (V.A.4) – A private on-site wastewater treatment system.

Porosity (V.B.3.a) – The ratio of the volume of the voids to the total volume of the trench.

Smearing (V.C.3.b) – Physical compaction of the soil that affects the soil structure and, subsequently, soil infiltration rates.

Source Area (III) – A component of developed land use, including rooftops, sidewalks, driveways, parking lots, storage areas, streets and lawn from which runoff pollutants and volumes are generated during periods of snow melt and rainfall runoff.

Target Stay-on Depth (VI.D): The amount of infiltration required on an average annual basis. It is the portion of the annual rainfall (inches) on the development site that must be infiltrated on an annual basis to meet the infiltration goal.

Appendix A

Infiltration Trench
Field Inspection Checklist: Construction

Project:		
Location:		
Site Status:		
Date:		
Time:		
Inspector:		
Construction Sequence	**Satisfactory/Unsatisfactory**	**Comments**
Pre–Construction		
Pre-construction meeting		
Flows diverted (if possible) during construction		
Soil permeability verified		
Groundwater/bedrock verified		
Facility location staked out and protected from compaction		
Project benchmark established		
Temporary erosion and sediment control established		
Filter Fabric Placement		
Fabric per specification		
Placed per plan location		
Excavation		
Size and location per plans		
Side slopes stable		
Trench area properly excavated without soil compaction or smearing. (If evidence of soil compaction or smearing, implement compaction mitigation measures)		
Elevation of infiltrative surface matches that of the design		
Soil texture/soil infiltration rate at the infiltrative surface matches that of the design		
Aggregate Material		
Size as specified		
Clean/washed material		
Placed properly		

Appendix A

Infiltration Trench
Field Inspection Checklist: Construction (cont'd.)

Construction Sequence	Satisfactory/Unsatisfactory	Comments
Observation Well		
Pipe size per plans		
Inlet installed per plans		
Pre-treatment devices installed per plans		
Vegetation		
Complies with planting specifications		
Topsoil complies with composition and placement in specifications		
Final Inspection		
Dimensions per plans		
Inlets - Outlets Operational		
Diversion of flows not intended to be infiltrated (if applicable)		
Pre-treatment facilities operational (if applicable)		
Contributing watershed stabilized before flow is routed to the facility		

Actions to be taken:

Comments:

Appendix A

Stormwater Infiltration Trench
Field Inspection Checklist: Post-Construction

Location:		
Site Status:		
Date:		
Time:		
Inspector:		
Responsible Party for Maintenance:		
Maintenance Item	**Satisfactory/Unsatisfactory**	**Comments**
Debris Cleanout (Monthly) (Additional inspections shall be made after every rainfall of 0.5 inches or more during a 24-hour period)		
Contributing drainage area clear of litter and vegetative debris		
Trench surface clean		
Inflow pipes clear		
Overflow spillway clear		
Inlet area clear		
Pretreatment Devices (Monthly During First Year, Then Annually) (Additional inspections shall be made after every rainfall of 0.5 inches or more during a 24-hour period)		
Device adequately functions (if applicable)		
Is maintenance required? (if applicable)		
Vegetation (if applicable) (Monthly During First Year, Then Monthly During Growing Season) (Additional inspections shall be made after every rainfall of 0.5 inches or more during a 24-hour period)		
Maintenance carried out in accordance with planting specifications (if applicable)		
Inlets (Monthly During First Year, Then Annually) (Additional inspections shall be made after every rainfall of 0.5 inches or more during a 24-hour period)		
Good condition		
No evidence of erosion		
Drawdown Time (Inspect two times per year, 72 to 80 hours after a rainfall of 0.5 inches or more in a 24-hour period)		
Depth of water in observation pipe less than 10% of trench volume. (Water depth measured from bottom of the trench) **See Section VIII of standard for additional requirements and definition of trench failure.**		

Appendix A

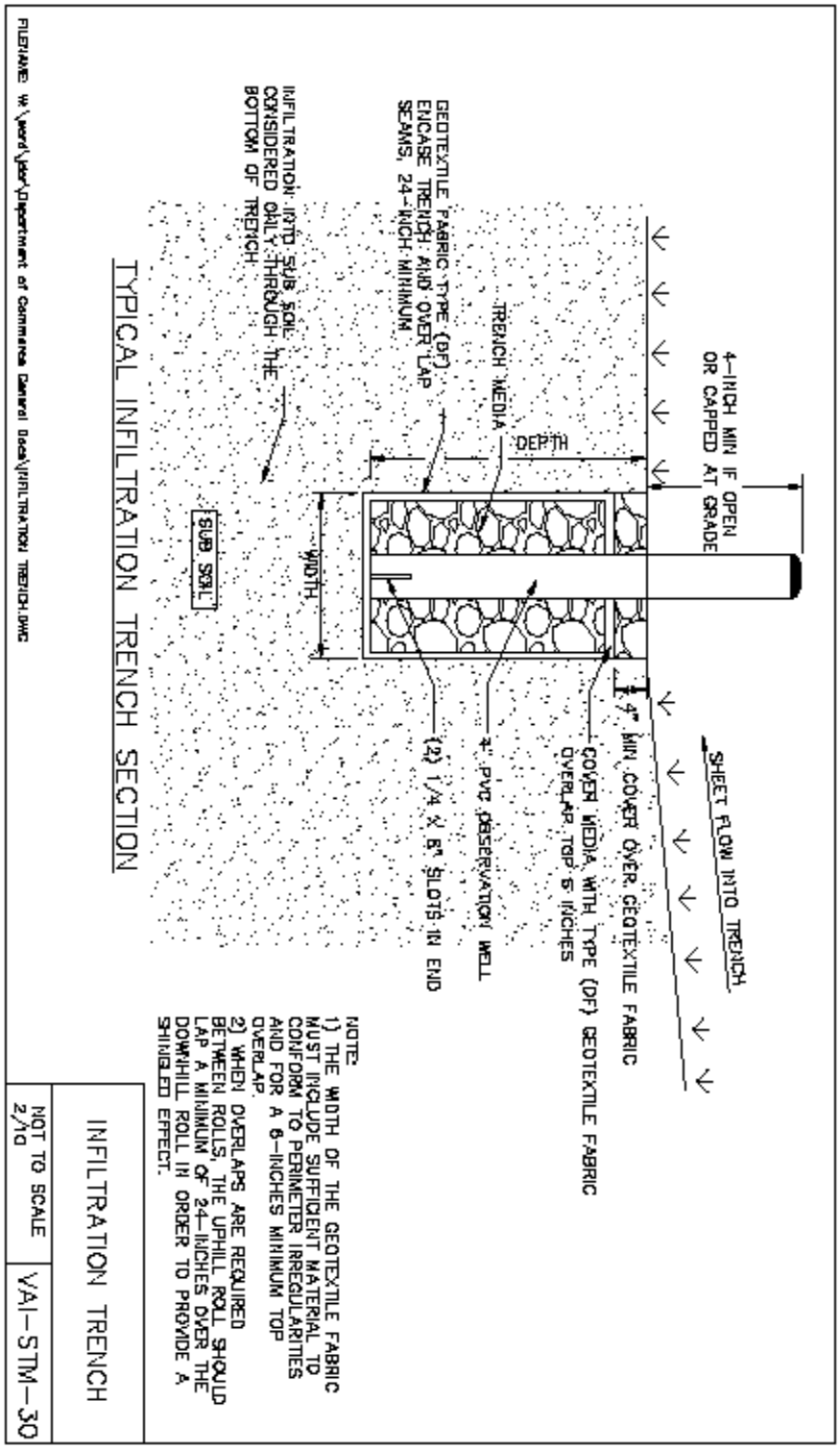
Stormwater Infiltration Trench
Field Inspection Checklist: Post-Construction (Cont'd.)

Maintenance Item	Satisfactory/Unsatisfactory	Comments
Outlet/Overflow Spillway (if applicable) (Monthly During First Year, Then Annually) (Additional inspections shall be made after every rainfall of 0.5 inches or more during a 24 hour period)		
Good condition, no need of repair		
No evidence of erosion		
No evidence of blockages		
Aggregate Repairs (Monthly During First Year, Then Annually) (Additional inspections shall be made after every rainfall of 0.5 inches or more during a 24-hour period)		
Surface of aggregate clean		
Top layer of stone does not need replacement		
Trench does not need rehabilitation		

Comments:

Actions To Be Taken:

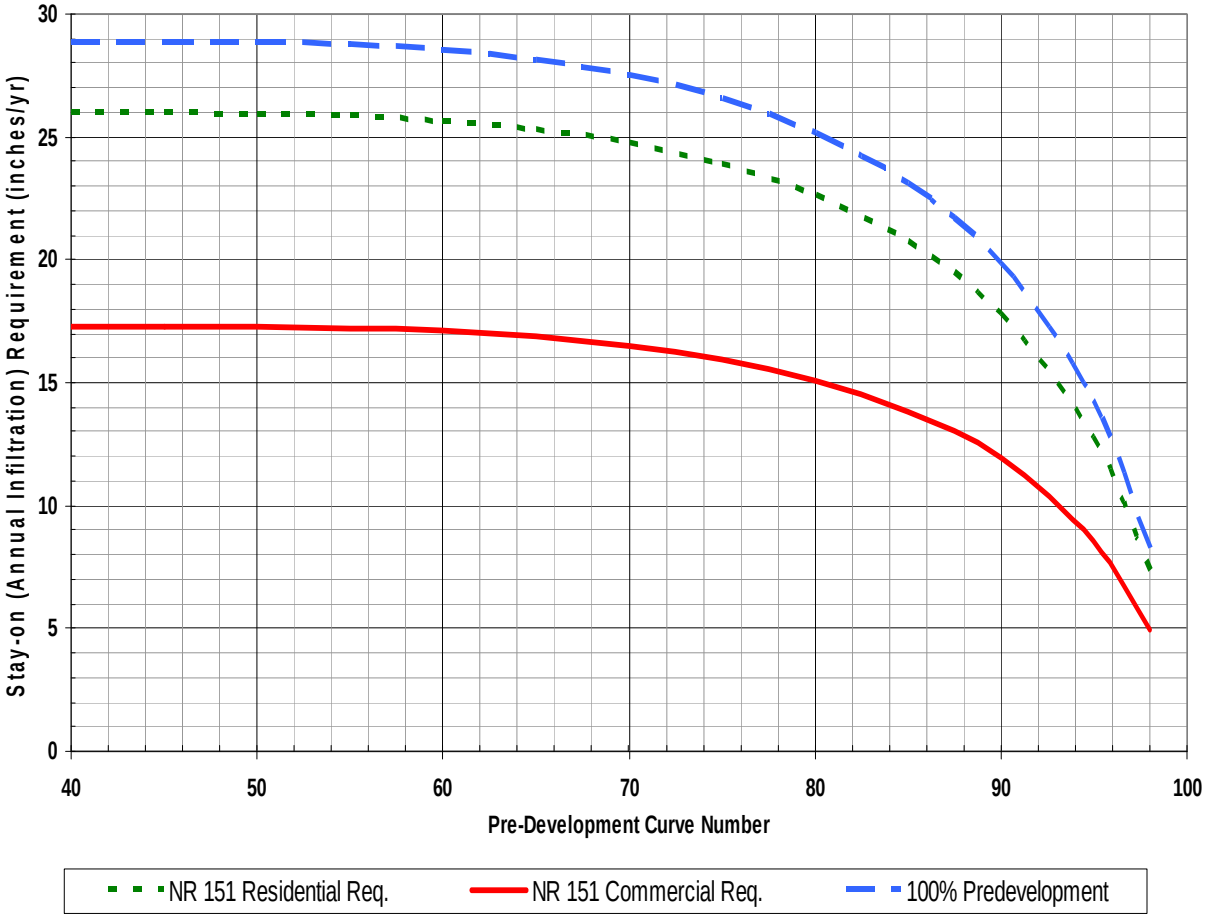
Appendix B


4" MIN. COVER OVER GEOTEXTILE FABRIC
COVER MEDIA WITH TYPE (DF) GEOTEXTILE FABRIC OVERLAP TOP 6 INCHES
4" PVC OBSERVATION WELL
(2) 1/4 X 6" SLOTS IN END
DEPTH
WIDTH
SUB SOIL
TYPICAL INFILTRATION TRENCH SECTION
NOTE:
1) THE WIDTH OF THE GEOTEXTILE FABRIC MUST INCLUDE SUFFICIENT MATERIAL TO CONFORM TO PERIMETER IRREGULARITIES AND FOR A 6-INCHES MINIMUM TOP OVERLAP.
2) WHEN OVERLAPS ARE REQUIRED BETWEEN ROLLS, THE UPHILL ROLL SHOULD LAP A MINIMUM OF 24-INCHES OVER THE DOWNHILL ROLL IN ORDER TO PROVIDE A SHINGLED EFFECT.
INFILTRATION TRENCH
NOT TO SCALE
2/10
VA1-STM-30

Appendix B

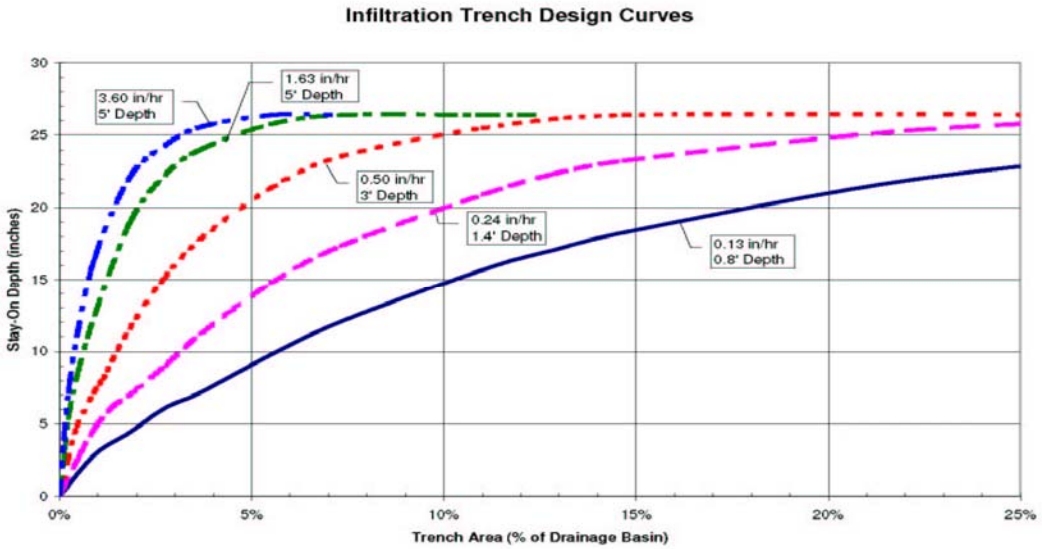
CHART 1 - TARGET STAY-ON (ANNUAL INFILTRATION) REQUIREMENT

Based on the annual 1981 Rainfall for Madison, WI



Note: 100% Predevelopment represents infiltration under predevelopment conditions

Appendix B



Note: The 5 ft. depth depicted in the Infiltration Trench Design Curves chart is not a limitation to the depth of an infiltration trench.

Summary of Assumptions and Variables Behind Infiltration Trench Design Curves

Purpose: Use WinSLAMM to develop a series of charts showing the volume of stormwater infiltrated for varying infiltrative surface area, contributing area, and soil types.

Assumptions:

1. Site is 100% impervious
2. Land use area is Residential
3. Source area is 100% Roofs (Pitched and directly connected)
4. Depth of trench = infiltration rate of soil (in/hr) * 72 hours (max draw down)
   Maximum trench depth = 5 feet for 1.63 in/hr and 3.6 in/hr infiltration rates
5. Total depth = Depth of trench + 1 foot
6. Typical width = 10 feet (used for cost estimating, not important)
7. Infil. rate fraction-bottom = 1.00
8. Infil. rate fraction-sides = 0.00 (All infiltration occurs from bottom)
9. Rock filled depth = Depth of trench
10. Rock fill void ratio = 0.33
11. No engineered soil or % reduction due to engineered soil
12. Inflow hydrograph peak to average flow ratio = 3.8
13. Number of devices in source area = 1
14. Outlet structure is a broad crested weir
    Weir crest length = 50 feet
    Weir crest width = 8 feet
    Height from datum to bottom of weir opening = trench depth
15. Use default weir coefficients

Variables:

1. Surface area of trench
2. Size of contributing source area
3. Volume of Stormwater Infiltrated
4. Soil type/infiltration rate

SLAMM Files:

Rain file: WisReg - Madison, WI 1981.RAN (Winter Range December 2 - March 12)
Pollutant Probability Distribution File - WI_GEO01.ppd
Runoff Coefficient File - WI_SL06 Dec06.rsv
Particulate Solids Concentration File - Wi_avg01.psc
Particulate Residue Delivery File - Wi_dlv01.prr
Street Delivery File:
- Residential/Other - WI_Res and Other Urban Dec06.std
- Institutional/Commercial/Industrial - WI_Com Inst Indust Dec06.std
- Freeway - Freeway Dec06.std

Drainage System: 100% curb and gutters, valleys, or sealed swales in good condition very steep